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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
- B. Theatrical lighting control system
 1. Feed-through relay panels, as indicated on drawings
 2. Ethernet control distribution system with Ethernet taps, network switches, and patch bays, and with interface to architectural control processor
 3. DMX-512 control distribution system and Ethernet-to-DMX gateways
 4. Rack and panel enclosures for equipment
 5. Stage lighting control console and accessories
- C. Architectural lighting control system
 1. Lighting control network processor with interfaces to building automation system, fire alarm system, and related input/output interfaces
 2. Pushbutton and touch-screen architectural lighting control stations
 3. Occupancy / vacancy sensors and daylight sensors
 4. UL924 DMX Bypass controllers
- D. It shall be the responsibility of the Lighting Control System Manufacturer to furnish equipment complete in all respects and to provide any additional equipment required to fulfill the intent of these drawings and specifications regardless of whether or not such items are herein specified or indicated.

1.3 MANUFACTURING STANDARDS

- A. All work shall be manufactured in accordance with the Division 26 specifications, the latest editions of applicable publications, and standards of the following organizations:
 1. National Electric Code (NEC) and all prevailing local and state regulations including:
 - a. ANSI/NFPA 70: National Electrical Code
 2. Entertainment Services and Technology Association (ESTA) including:
 - a. ANSI/ESTA E1.3-2001(R2016): Lighting Control Systems – 0-10V Analog Control Specification
 - b. ANSI/ESTA E1.11-2008 (R2018): USITT DMX512-A
 - c. ANSI/ESTA E1.17-2015: Architecture for Control Networks (ACN)
 - d. ANSI/ESTA I E1.20-2010: Remote Device Management over USITT DMX512
 - e. ANSI/ESTA E1.27-1-2006 (R2016): Portable Control Cables for DMX512
 - f. ANSI/ESTA E1.27-2-2009 (R2014): Permanently Installed Control Cables for DMX512

- g. ANSI/ESTA E1.31-2018: ACN transport of DMX-512
- 3. Occupational Safety & Health Act (OSHA)

1.4 SUBMITTALS

- A. Lighting Control System Manufacturer shall prepare and submit complete shop drawings according to the requirements set forth in the Contract Documents.
- B. Product Data Sheets
 - 1. For Manufacturer standard panels, enclosures, modules, devices, and other equipment, with options and other variables clearly noted on data sheets.
- C. Shop Drawings
 - 1. Shop drawings shall be reviewed by the Architect before fabrication shall begin.
 - a. Such review does not relieve the Lighting Control System Manufacturer of the responsibility of providing equipment in accordance with this Specification.
 - 2. Shop drawings shall show optical or transformer isolation of all control data lines between dimmer racks, panels, and architectural lighting processor.
 - 3. Shop drawings shall show materials, finishes, metal gauges, overall and detail dimensions, sizes, electrical and mechanical connections, fasteners, welds, provisions for the work of others, and similar information.
 - 4. Shop drawings shall indicate complete details of equipment, including manufacturer's catalog numbers for components, and shall include complete wiring diagrams. Confirm weight for each device to show conformance with drawings.
 - 5. Any deviation from this Specification shall be "starred" and noted in letters a minimum 1/4" high.
 - a. In order for a deviation to be considered, it shall upgrade the quality of the equipment or respond to a field condition.
 - 6. The reviewed shop drawings shall be updated to show any changes made during manufacturing and assembly and shall be sent to the Architect before the equipment is delivered.
- D. Lighting Control System Manufacturer shall provide installation instructions for all equipment. These instructions shall include connection diagrams, termination designations, etc.
- E. Coordination Drawings:
 - 1. Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - a. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - b. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
 - c. Coordinate zoning and fixture addressing with Electrical Contractor. Provide fixture address list for all architectural lighting fixtures controlled by system. Electrical Contractor to provide control riser for architectural lighting layout for review and coordination based on wire runs.
- F. After the installation is complete, the Lighting Control System Manufacturer shall provide the Owner with Operations and Maintenance Manuals not more than fourteen (14) days after the checkout is completed.
 - 1. One (1) O&M manual shall be a printed "hard" copy and O&M manual shall also be provided in electronic format on two (2) flash drives.

2. Each O&M manual shall include, but not be limited to, the following:
 - a. Copies of all "record" shop drawings.
 - b. Detailed panel schedules and architectural fixture addresses / patch information.
 - c. Catalog cuts of all equipment provided.
 - d. Recommendations for periodic maintenance.
 - e. Catalog numbers and manufacturer's names and addresses for perishable items such as pilot lamps and fuses.
 - f. Diagnostic procedures.
 - g. Internet address for online access to manuals, product literature and troubleshooting guides.
 - h. Emergency and normal repair telephone contact sheet for 7-day, 24-hour service.
3. Lighting Control System Manufacturer shall provide the Owner with three (3) instruction manuals for each control console type.
 - a. Instruction manual shall be supplied to the Owner's Representative on the day of the Lighting Control System checkout.
 - b. Instruction manuals may be requested by the Owner's Representative at a date prior to the system checkout.

1.5 SYSTEM INTEGRATORS

- A. System Integrator shall be responsible for scope outlined in this Specification and for the following related Specification sections:
 1. 116113 – Theatrical Lighting Fixtures and Accessories
 2. 116116 – Theatrical Wiring Devices
- B. System Integrator must have minimum five (5) years' experience with supply, installation, commissioning, and integration of theatrical and architectural lighting control systems. System Integrator must have at least ten (10) recent projects of similar scope and characteristics to those specified herein.
- C. System integrator shall be responsible for furnishing factory authorized personnel for system startup, programming, commissioning, and Owner training.
 1. System Integrators for the Work of this Section include:
 - a. HolzmueLLer Corporation – San Francisco, CA – 415-826-8383
 - b. **LVH Entertainment Systems, Los Angeles, CA - 805-278-4584**
 - c. Musson Theatrical Inc. – Santa Clara, CA – 408-986-0210
 - d. Sacramento Theatrical Lighting – Sacramento, CA – 916-447-3258

1.6 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 1. Ambient temperature: 0 degrees to 40 degrees C (32 degrees to 104 degrees F).
 2. Relative humidity: Maximum 90 percent, non-condensing.
 3. Lighting Control System must be protected from dust during installation.

1.7 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.

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1. Match components and interconnections for optimum performance of lighting control functions.
 2. Coordinate lighting controls with BAS if applicable. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
 3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.
- B. Coordinate lighting control loads specified in this Section with components providing overcurrent protection as specified in Division 26 Section "Panelboards."

1.8 LABELING

- A. Ethernet Taps and DMX devices shall have Control Device Number (i.e. 'ET-5') clearly indicated with minimum 1/4" tall white on black characters on the faceplate. Label shall be centered above control port(s).
1. All faceplate labels shall be as shown on the QT-series Drawings and verified in Shop Drawings.
- B. Furnish and install removable adhesive labels for each Theatrical Control Device back box and rear of faceplate, indicating the Control Device Number (i.e. 'ET-5') and serial code to facilitate programming and commissioning.

1.9 DELIVERY

- A. The Lighting Control System Manufacturer shall coordinate delivery of all equipment with the Construction Manager and/or Electrical Contractor.
- B. If required by the Construction Manager or Electrical Contractor, equipment shall be delivered in a minimum of three (3) separate shipments that shall include:
1. Shipment #1: All items in which conduit is terminated which includes dimmer racks, panels, control station back boxes, etc.
 2. Shipment #2: All items in which wiring is terminated including control station faceplates, etc.
 3. Shipment #3: All items that are not required until system activation by the Lighting Control System Manufacturer's field service representative. This shall include dimmer modules, electronics modules, control consoles, gateways, monitors, cables, etc.
- C. Lighting Control System Manufacturer shall deliver all material to the job site suitably crated, packed, and protected, and bearing the manufacturer's identification label and the nomenclature of the product(s) found in each carton or crate.
- D. If, through no fault of the Owner, the timely completion of the work of this Section is imperiled, the Lighting Control System Manufacturer shall prevent or minimize any delay by shipping the required product to the job site by air freight, at no additional cost to the Owner.
- E. Bid price shall include full freight and insurance charges for all items to the job site.

1.10 QUALITY ASSURANCE

- A. Manufacturer: Minimum 10 years' experience in manufacture of architectural and theatrical lighting controls.
- B. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
- C. Source Limitations: Obtain lighting control and power distribution components through one source from a single manufacturer wherever possible. All components shall be furnished by the Integrator regardless of source.
- 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 47 CFR, Subparts A and B, for Class A digital devices.
- F. Comply with NFPA 70.

1.11 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years. Support shall include 24-hour telephone support with guaranteed callback time of less than one hour.
- B. Upgrade Service: Update software and firmware to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading of software shall include operating systems where applicable. Upgrade shall include new or revised licenses for use of the software.
 - 1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

1.12 WARRANTY

- A. Lighting Control System Manufacturer agrees to make all repairs, including replacement of components and parts, made necessary due to defects in design, workmanship, and materials without additional cost to the Owner for a period of two (2) years from the date of acceptance of the completed system.
- B. In the event of a system failure during the warranty period, manufacturer agrees to send to the job the necessary field service technician(s) within twenty-four (24) hours of notification.
 - 1. Technician(s) shall remain on the job until all necessary repairs have been made and the system is operational to the satisfaction of the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design

1. Subject to compliance with these specifications, the design basis networked lighting control system is Paradigm Control as manufactured by Electronic Theatre Controls of Middleton, Wisconsin. Contact:
 - a. Randy Pybas, Western Sales Manager – ETC
 - 1) 323-461-0216
 - 2) Randy.pybas@etconnect.com
2. Basis of design for other system components includes:
 - a. Network Switches
 - 1) GigaCore 14R as manufactured by Luminex Network Intelligence of Hechtel-Eksel, Belgium.
 - b. Rack UPS units
 - 1) 5P1500R series from Eaton Corporation of Cleveland, OH

B. Equal Manufacturers

1. Subject to Division 01 Specifications, other manufacturers may submit for consideration as equal to the design basis manufacturer products. Submittals for consideration must show conformance to project Specifications and system design requirements.
2. Final determination of suitability shall be at the discretion of the Specifier.
3. Manufacturers pre-approved to bid subject to the above requirements and to this Specification include the following:
 - a. Philips Strand Lighting of Dallas, TX.
 - 1) Contact: Leonard Miller, North American Sales Manager
 - 2) 214 647 7985 – leonard.miller@philips.com
 - b. American Power Conversion, Inc. – Kingston, RI (Rack UPS)

2.2 LIGHTING CONTROL RELAY PANELS (LRP-##)

A. General:

1. Each relay panel shall consist of up to (48) network-controlled relays. System shall be UL listed and labeled.
2. Relays shall be configured for single or dual pole load control as scheduled.
3. Relays shall be remotely operated by network communication link.
4. Relay panel shall have the capability to act as a standalone lighting control system with the following capabilities:
 - a. Internal Astronomical Time Clock for programmed events.
 - b. Accepts input from external button stations for recall of presets.
 - c. Signal arbitration to prioritize inputs by source (sACN, DMX, Preset Stations, Time Clock, etc).
 - d. Configurable loss-of-signal behavior including 'hold last look' and 'activate preset'.
5. Relay panel shall be equipped with UL924 rated input for triggering emergency 'panic' preset.
6. USB port for upload of configuration files and firmware updates.

B. Physical:

1. Cabinets and Enclosures: NEMA 1 enclosure sized to accept required relays. Surface mounted cover as required with captive screws in a hinged, lockable configuration.
2. Interior: Interiors shall be provided with installed and tested relays and interface modules.

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3. Panel side-mount enclosure shall provide low voltage control interface between network and relays, compliant with partitioning requirements for separation of line and low voltage.
4. Provide physical separators between relays fed by 120V and 277V circuits, as well as between relays fed by Normal and Emergency circuits, as noted on each panel's associated Relay Panel Schedule on QT-series Drawings.

C. Electrical:

1. Relays:
 - a. Mechanically held latching relays, 20A or 30A tungsten and NEMA electronic ballast rated, as scheduled.
 - b. Rated for 50,000 ON/OFF cycles at full load.
 - c. Support #10 - #14 AWG solid or stranded wire.
 - d. 120V and 277V rated.
 - e. FCC approved for commercial use.

D. Control Electronics:

1. Control electronics shall be integral to the panel side enclosure, providing network and user interface for individual control of relays in panelboard.
2. Configuration of network addressing shall be by means of digital graphical display interface or by network port. Status LEDs shall indicate presence of Power and DMX signal.
3. Control and communication signals shall be accommodated by means of system network and DMX512 interfaces.
 - a. The system network interface shall serve as primary integrating means between the rack electronics and the lighting control network, and shall also support remote configuration, file storage, playback, and monitoring capabilities from other devices on the network.
 - b. There shall be at least one (1) optically isolated DMX512 input and one (1) optically isolated DMX512 output per panel.
4. Furnish ride-through power supply to permit electronics to remain energized during short duration loss of power, such as during transfer to backup generator.
5. Furnish 0-10v control interface card in each panel.

E. Basis of Design

1. Basis of Design for Lighting Control Relay Panels shall be:
 - a. Echo Feedthrough, as manufactured by Electronic Theatre Controls

2.4 LIGHTING CONTROL NETWORK AND INTERFACE

A. General

1. Furnish and install a complete lighting control network system, capable of supporting the specified dimming racks, lighting control panelboards and relay panels, stage lighting control console, architectural control stations, time and calendar schedules, and related network devices indicated on the drawings and in this Specification.
2. The network shall use category 5e Ethernet distribution to communicate between control consoles, dimmer racks, nodes, and computers.
3. Manufacturer specified wiring and topology shall be used to communicate with control stations, sensor devices and relay panels.

B. Network Components

1. Control processors

- a. Furnish architectural processor as required to interface dimmer rack, lighting control relay panels, control stations, sensors, system I/O contacts, and any appurtenant devices or equipment required for system to function fully as intended. Processor shall provide necessary programming interface for setup and configuration of system and system components.
- b. Furnish a second backup processor, which shall be configured as a redundant standby to the primary processor.
2. Ethernet switches and patch bays
 - a. Switches shall have integral Power over Ethernet (PoE) following IEEE 802.3 standard.
 - b. Furnish 10/100 Ethernet switches with port quantity as required for system, plus 25% spare for future expansion at each rack location.
 - c. Patch bays in port quantities as required for devices in system, plus 25% spare for future expansion at each rack location.
3. DMX signal splitters
 - a. ANSI/USITT E1.1-2008 compliant DMX512 opto-isolating splitters, in quantity and configuration of inputs and outputs as required for system.
 - b. All DMX signal cables terminating at the splitter location shall be outfitted with 5-pin XLR connectors or RJ45 connectors as necessary to permit user patching where required. This includes signals to DMX node receptacles, dimmers, and relay panels.
4. Equipment racks
 - a. Wall or floor mounted 19" equipment racks with mounting rails, hinged locking door, and sized to accommodate all required processing equipment including that indicated above. Furnish in quantities shown on drawings plus any additional required for complete system.
 - b. Each rack shall have minimum of one four-space contiguous blank section with cover plate for future equipment addition.
 - c. Each rack shall be furnished with a three-space pull out drawer for storage of manuals, patch cabling, and user notes.
 - d. Racks shall be Middle Atlantic EWR series or equal.
 - e. Coordinate electrical power connections for rack contents.
5. Ethernet cabling
 - a. Ethernet cabling used in theatrical lighting control network shall have the following properties:
 - 1) Comply with NEMA WC-63.1 Category 5e, UL verified.
 - 2) Comply with TIA 568.C.2.
 - 3) Outer jacket shall be PURPLE in color.
 - b. Furnish and install RJ45 category 5 patch cables as necessary to fully patch between all network switch ports and patch bay ports in each rack location, plus 20% spares.
 - c. Furnish additional RJ45 category 5 patch cables to allow connection of distributed Ethernet taps to portable Ethernet-to-DMX gateways in the performance spaces. Refer to Theatrical Lighting Fixtures and Accessories Schedule on sheet QT5.06 for lengths and quantities to be furnished.
6. DMX network cabling
 - a. Furnish and install 5-pin XLR M/F DMX jumper patch cables as necessary to fully patch between all DMX-512 splitter ports and DMX patch points, racks, or other DMX devices at equipment racks.
 - b. Furnish additional 5-pin XLR M/F DMX jumper cables to allow connection of DMX node devices to portable dimmer bars, luminaires, and other devices in the performance spaces. Refer to Theatrical Lighting Fixtures and Accessories Schedule on sheet QT-502 for lengths and quantities to be furnished.
7. Ethernet taps

- a. Mounting type as shown on drawings
 - b. Each tap with two (2) RJ45 Ethernet connectors, discretely fed from patch panel, unless noted otherwise.
8. Ethernet-to-DMX gateways/nodes
- a. Mounting as shown on drawings, furnish with necessary hardware.
 - b. Each gateway/node with one, two, or four each 5-pin XLR connectors configurable for DMX512 input or output, or for ESTA/ANSI E1.20 two-way communication. Each connector may be addressed to discrete universes. Gateway/node universes shall be programmed to not overlap architectural lighting and wiring device universes.
 - c. Surface mount gateways/nodes shall have Ethernet wire feed from patch panel to device.
 - d. Portable gateways/nodes shall have one (1) RJ45 Ethernet connection to permit patching into any Ethernet tap shown on drawings. Each shall be outfitted with 10'-0" black category cable, black Light Source MAB mega clamp or equal aluminum pipe clamp and black safety cable.
 - e. Refer to drawings and schedules for quantity of each gateway/node type to be furnished.
9. Emergency signal overrides
- a. Furnish UL924 listed emergency signal override devices that shall drive selected DMX addresses to full output when triggered by loss of normal power or by contact closure from fire alarm control panel. Override device shall be an ETC model DEBC or equal. Quantity as necessary to serve each DMX universe and fixture group that is served from Emergency lighting branch.
 - b. Refer E-series drawings for emergency lighting requirements for architectural fixtures.
10. Input/Output devices for communication with other systems
- a. Furnish RS-232 communication interface for connection with audio-visual network.
 - b. Furnish dry contact closures configurable as input or output signals, to connect with fire alarm system, effects controls, shading systems, and future interfaces. Confirm all system contacts in shop drawings.
 - c. Furnish BACnet-over-IP interface device to permit future communication between Building Automation System and Lighting Control System.

2.5 STAGE LIGHTING CONTROL CONSOLES

- A. Black Box Theater lighting control console (LCC-1):
1. Consoles shall be the following:
 - a. Electronic Theatre Controls – Ion 20 Xe series.
 2. Consoles shall have the following minimum capabilities:
 - a. 2,048 outputs
 - b. Configurable encoders for intelligent lighting attributes
 - c. DVI monitor output
 - d. USB ports for data storage and accessory connections
 - e. Remote focus connection
 - f. Ethernet port for network connection
 - g. DMX-512 ports for at least (2) universes
 - h. Offline programming software for Macintosh or Windows.
 3. The following accessories shall be furnished with the control console:
 - a. (2) 21" multi-touch monitors with power supply and control cables.
 - b. USB keyboard and mouse.
 - c. (2) commercial grade USB flash drives for backup storage, minimum 1Gb each.
 - d. (1) 25' RJ45 Ethernet control cable for connection of console to network taps.

THEATRICAL LIGHTING CONTROL SYSTEM

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- e. (1) 50' RJ45 Ethernet control cable for connection of console to network taps.
- f. (2) 25' DMX control cables, 5-pin male XLR to 5-pin female XLR, for backup DMX connection to network DMX ports.
- g. Dust covers for console and monitors.
- h. (1) Fortress 0520-0750-RUB or equal uninterruptible power supply.
4. Furnish all power and interface devices, cabling, and accessories necessary for a fully functioning system.
5. Rolling Cart
 - a. Provide wheeled console cart with brakes, of sufficient size to hold all components related to this console.
 - b. Cart shall be of metal construction, painted black.

2.6 ARCHITECTURAL LIGHTING CONTROL STATIONS

- A. Stations shall serve as user interface to recall and manipulate common room lighting presets via the lighting control network.
- B. Pushbutton stations shall have quantity of buttons / faders as scheduled.
- C. LCD Touch-screen stations
 1. Stations shall be minimum 16-bit color with resolution of minimum 600x360.
 2. Stations shall have auto-fade with adjustable time out and shall adjust brightness proportionally to room ambient light levels.
 3. Station programming shall support up to (10) discrete screen shots configurable for preset recall, virtual faders, clock and time scheduling functions, dynamic color wheel for LED fixture color selection, and group selection and assignment.
 4. Station shall be configured with code lockout on home page.
- D. Stations shall operate on low voltage network bus as specified by Manufacturer, and shall be programmable via this network. Separate control device programming in Black Box Theater / Commons/Presentation Arena from control device programming in Broadcasting/TV Studio.

2.7 NETWORK OCCUPANCY / PHOTOCCELL SENSORS

- A. Sensors
 1. Sensor shall be low-voltage type with 24vdc normally closed contacts to permit series installation of sensors on a contact loop home-run to lighting control network panel. Refer Electrical for device locations and quantities.
 2. Sensors shall be powered by a power supply transformer approved by Manufacturer, with class 2 output not to exceed 24vdc and 1A current. Supply shall be located in accessible area near sensors, and fed from unswitched power source.
 3. Sensors shall be PIR passive infrared type, with rectangular corridor coverage pattern and sensitivity to half-step walking motion at minimum 25 foot distance from sensor. Sensor shall detect 6-inch movement of any portion of a body presenting a target of at least 48 square inches to the sensor at this distance.
 4. Sensors shall be mounted on junction box at elevation shown on drawings. Orient sensor head to provide maximum coverage of corridor.
 5. Coordinate sensor placement to avoid false detection from supply air diffusers in vicinity.
 6. Mask sensors as necessary to avoid nuisance detection from adjacent areas when doors are left open.
 7. Provide timed override for sensors at LCD Touch-screen architectural master stations so sensors do not activate lighting functions during performances. Override shall time out

after number of hours to be determined by Owner during programming in the event user does not restore override after performance ends.

PART 3 - EXECUTION

3.1 EXECUTION

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts existing conditions.
- E. Install in accordance with manufacturer's instructions and approved shop drawings.
- F. All wiring shall be installed in conduit.
- G. All branch load circuits shall be live tested before connecting the loads to the lighting control panels.

3.2 SUPPORT SERVICES

- A. System Startup
 - 1. Upon completion of installation, Contractor shall notify the Lighting Control System manufacturer that the system is ready for formal checkout and programming. No power shall be applied to the Lighting Control System unless specifically authorized by written instructions from the manufacturer.
 - 2. Manufacturer shall provide Factory-Authorized Technician to confirm proper installation and operation of all system components.
- B. Testing
 - 1. System shall undergo complete functional testing by a Factory-Authorized Technician. All loads shall be tested live for continuity and freedom from defects and all control wiring shall be tested for continuity and connections prior to energizing the system components.
 - 2. Contractor shall be responsible for correction of any improper wiring or component installation as identified by the Factory-Authorized Technician during testing. Contractor shall be responsible for any return visits by Factory-Authorized Technician resulting from lack of system readiness for checkout or from any incomplete or incorrect wiring or installation.
- C. Initial Programming
 - 1. Programming of initial button assignments, touch screen page layouts, normal and emergency presets, control priorities, sensor settings, time clock events, etc, shall be performed by a Factory-Authorized Technician. Consultant shall provide instructions for initial programming at request of Factory-Authorized Technician; however, all final decisions regarding programming shall be at the direction of the Owner.

2. Programming and addressing of architectural lighting fixtures by Electrical Contractor. Information on the addressing of architectural lighting fixtures shall be provided to Factory-Authorized Technician as coordination drawing at time of shop drawings.

3.3 OWNER TRAINING

A. General

1. Manufacturer's authorized technician shall perform Owner Training.
2. Class size is limited to twelve (12) participants and shall include at minimum:
 - a. Owner shall provide a list of participants by title. For example, 'Technical Director, Master Carpenter, Master Electrician, etc.' To facilitate scheduling, include only mandatory participants on this list. Attendees not on the list will still be permitted to attend.
3. The Lighting System Integrator shall schedule instruction with the Owner's designated representatives. Agenda shall be sent in advance. All O&M materials, as designated in this Specification, shall be available at the time of training.
4. Instruction shall not necessarily follow immediately after the system check-out and activation.
5. Instruction shall be independent of the system check-out and activation. Length of engineering check-out and activation shall not affect the length of instruction time.
6. At Owner's discretion, instruction may occur in multiple time blocks.
7. Written documentation of Owner training shall be provided to the Owner upon completion.
 - a. Form to include:
 - 1) The date, time, and location of training.
 - 2) Name, title, company and signature of trainer.
 - 3) Name, title, and signature of all participants.
 - 4) Topics covered at training.
 - b. If training is non-continuous, provide one form for each training segment.
8. Training may be video and audio recorded by the Owner at the Owner's expense.

B. Up to twenty-four (24) hours of Owner training to include the following:

1. Minimum of three (3) separate training sessions with Owner, as follows:
 - a. First session shall occur at conclusion of startup and system commissioning and shall include eight (8) hours training time with Owner representatives. This session shall include the following general subjects, but shall be tailored to Owner's preference at time of training:
 - 1) General system overview.
 - 2) Routine care and maintenance.
 - 3) Operation of dimmer racks and relay panels.
 - 4) House Light Station operation and configuration, including review of initial programming provided by Consultant.
 - 5) Lighting Control Console introduction and basic programming
 - 6) Review of warranty and software updates
2. Second session shall occur no less than two weeks following substantial completion, but within one month of initial training. This session shall include up to an additional eight (8) hours training time with Owner representatives. This session shall include the following general subjects, but shall be tailored to Owner's preference at time of training:
 - a. In-depth Lighting Control Console operation and programming.
 - b. House Light Station preset review and adjustment to reflect actual operational needs.
 - c. Other review as requested by Owner.

3. Third session of additional eight (8) hours training time shall occur no less than one month after substantial completion, but within three months of initial training. Format and timeline shall be similar to the second session.

END OF SECTION 11 61 19

SECTION 23 09 00 – BUILDING MANAGEMENT AND CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Building Management and Control Systems (BMCS) specified herein shall include materials, operator workstation, building controllers, sensors, control valves, wiring, installation, start-up, testing, documentation and training for a complete operable system as required for this project.
- B. Controls Engineering shall be provided by the local controls manufacture representative.
- C. Work specified under this section shall be performed by, or under the direct supervision of the local controls manufacture representative, or by a contractor that is certified by the controls manufacture to perform all work within Section 23 09 00 Instrumentation and Control for HVAC and those sections of 23 09 00 that have been specified herein.
- D. Alternate techniques, modifications or changes to any aspect of these specifications may be submitted as a voluntary alternate no later than (15) days prior to the bid date and with sufficient information for a complete evaluation. This information shall include product data sheets, a UL508A Standard for Industrial Control Panels statement of compliance for any locally manufactured control panels, a detailed sequence of operation and engineered shop drawing. Shop drawings shall include the following as a minimum. Point to point wiring diagrams for each piece of equipment to be controlled, a network riser diagram that will depict quantity and location of all operator workstation, controllers, routers and repeaters required for this project.

1.2 RELATED SECTIONS

- A. Division 1: General Requirements
- B. Division 23: Heating, Ventilating, and Air Conditioning (HVAC)
- C. Division 26: Electrical

1.3 SUBMITTALS

- A. Submit engineered shop drawings, sequences of operation, third party equipment and controls integration points and product data sheets covering all items of equipment for the proposed system prior to installation for approval. Any deviation from the contract documents shall be noted and the drawings signed and dated by the Contractor. Additionally, submit a UL508A Standard for Industrial Control Panels statement of compliance for any locally manufactured control panels.
- B. After completion of the installation and commissioning, a full set of as-built documentation shall be turned over to the Owner. The as-built shall include operation and maintenance manuals, sequence of operation, shop drawings and digital copies of the following.
 - 1. Complete BMCS System databases backup
 - 2. Source files for all custom written controller applications
 - 3. Source files for graphics if required for this project

1.4 WARRANTY

- A. Components, system software, and parts shall be guaranteed against defects in materials, fabrication, and execution for (1) year from date of system acceptance. Provide labor and materials to repair, reprogram, or replace components at no charge to the Owner during the warranty period.
- B. Provide a list of applicable warranties for components, this list shall include warranty information, names, addresses, telephone numbers, and procedures for filing a claim and obtaining warranty services.
- C. Respond to the Owner's request for warranty service within (24) hours during normal business hours. Submit records of the nature of the call, the work performed, and the parts replaced or service rendered.
- D. Contractor shall request VPN access from owner and provide remote maintenance, software updates and repair service for the duration of the warranty period.

1.5 TRAINING

- A. Provide a competent instructor who is factory trained and has comprehensive knowledge of system components and operations to provide full instructions to designated personnel in the system operation, maintenance, and programming. Training shall be specifically oriented to installed equipment and systems.
- B. Provide (8) hours of onsite owner familiarization and training for the installed system. Training shall include system overview, time schedules, emergency operation, and programming and report generation.
- C. Owner employees attending this training session shall be provided with the following documentation:
 - 1. System layout point to point connection diagram.
 - 2. System components cut sheets.
 - 3. Operations and maintenance data.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Do not store or install electronic hardware on the project until non-condensing environmental conditions have been established.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. BMCS Equipment: Carrier OPEN BACnet Controls. No substitutions will be accepted.
- B. Controls installation will be by Carrier Controls Expert Dealer.
- C. The local manufacture representative will operate a free 40 hour a week, toll free customer support hotline for additional user support services that are required.

2.2 SYSTEM LISTING COMPLIANCE

- A. Locally manufactured control panels shall meet all requirements as outlined by UL 508A standard and shall be both approved and listed by Underwriters Laboratories, Inc.

2.3 COMMUNICATION

- A. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- C. Use owner provided Ethernet backbone for network segments.

2.4 OPERATOR INTERFACE

- A. Description. The control system shall be as shown and consist of a high-speed, peer-to-peer network of BMCS controllers and a stand-alone web server operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators with sufficient access level shall have an ability to make changes to all system and equipment graphics in the web server in addition to having full BMCS system access to make configuration changes to the control system. Any tools required for making graphic changes shall be provided with web server.
- B. Operator Interface. (1) Existing Carrier I-Vu Pro Web server interface as shown on the system drawings.
 - 1. With the use of an owner provided remote SMTP email server the operators interface web server shall notify personnel of an alarm and record information about an alarm in the BMCS system.
 - 2. Any required installation or commissioning software shall be provided to the owner.
- C. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
 - 1. Log In and Log Out
 - 2. Point-and-click Navigation
 - 3. View and Adjust Equipment Properties
 - 4. View and Adjust Operating Schedules
 - 5. View and Respond to Alarms
 - 6. View and Configure Trends
 - 7. Manage Control System Hardware
 - 8. Manage Operator Access
- D. System Graphics. Operator interface shall be graphical and shall include at least one graphic per piece of equipment and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

- E. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs.
- F. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Furnish the following standard system reports:
 - 1. Alarm Reports
 - 2. Schedule Reports
 - 3. Security Reports
 - 4. Commissioning Reports
 - 5. Equipment Reports
- G. Energy Conservation
 - 1. Outside Air Lockout. Lock out heating or cooling modes based on configurable outside air temperature limits.
 - 2. Demand Limiting
 - a. System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer.
 - b. The system shall include all required hardware and software necessary to receive an Automated Demand Response (ADR) signal from the utilities Demand Response Automation Server (DRAS).
 - c. When power consumption exceeds adjustable levels, or the system receives an ADR signal from the utility, the system shall automatically adjust set points, and take other programmatic actions to reduce demand.
 - 3. Optimal Start. The system shall bring the conditioned space to within occupied set points prior to the occupied time period to ensure occupant comfort.

2.5 CONTROLLERS

- A. General. The control system shall be available as a complete package with the required input sensors and devices readily available. Provide BACnet Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), and Sensors (SEN) as required.
- B. Stand-Alone Operation. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure.
- C. Serviceability. Controllers shall have diagnostic LEDs for power, communication, and processor.
- D. Rooftop Unit Controller (RTC). Defined as Application Specific Controllers (ASC), shall be factory installed by the HVAC manufacturer and shall control all associated HVAC rooftop equipment functions in a single zone application or as part of a zoning system application.
 - 1. Capacity control shall be based by the RTC internal time clock and setpoints (cooling and heating) coupled with a communicating room sensor. The controls shall provide separate occupied and unoccupied cooling and heating setpoints.

2. RTC shall utilize up to 2 speed of fan control, up to 3 stages of cooling, and up to 4 stages of heating.
3. RTC shall provide economizer control that has been certified for Fault Detection and Diagnostics (FDD) by California Energy Commission (CEC). The FDD system shall detect the following faults:
 - a. Air temperature sensor failure/fault
 - b. Not economizing when it should
 - c. Economizing when it should not
 - d. Damper not modulating
 - e. Excess outdoor air
- E. General Purpose Controller. Defined as Advanced Application Controller (AAC) shall be a solid state micro-controller with pre-tested and factory configured software designed for controlling building equipment using BMCS algorithms and facility management routines. The controller shall be capable of operating in either a stand-alone mode or as part of a network.

2.6 FIELD INSTALLED SENSORS

- A. Space Temperature Sensors shall communicate to the controller over a 4-wire communication network and have setpoint adjustment, after hours override, LCD display and a communication service port.
- B. Status indication for fans or pumps shall be provided by a split core design current sensing sensor. The sensor shall be installed at the motor starter or motor to provide load indication. The unit shall consist of a current transformer, a solid state current sensing circuit (with adjustable set point) and a solid state switch. A light emitting diode (LED) shall indicate the on off status of the unit.

2.7 CONTROL PANELS

- A. Provide single-door, UL 508A Listed; Type 4, wall-mount enclosures for each system under automatic control. Mount relays, switches, and controllers in cabinet and indicators, pilot lights, push buttons and switches flush on enclosure exterior face as required.
- B. Fabricate panels from 16 gauge steel with ANSI 61 gray finish and shall include (1) black padlock handle that will accommodate a padlock with up to a 5/16-in. locking bar for secure access to the enclosure contents. All additional latches shall be black non-locking handle type.
- C. Provide engraved name plates that identify each control panel and for each component mounted to the exterior of the enclosure.
- D. Provide a complete wiring diagram, bill of material for all components and markings with the following information:
 1. Manufacturer's name or trademark
 2. Supply voltage, number of phases, frequency, and full-load current for each incoming supply circuit
 3. Enclosure type number

2.8 SEQUENCE OF OPERATION

- A. See Appendix A

PART 3 - EXECUTION

3.1 ELECTRICAL WIRING

- A. This contractor is responsible for all low voltage electrical installation and wiring for a fully operational BMCS System as shown on the drawings and shall perform electrical installation in accordance with local and national electrical codes and in accordance with Division 26.
- B. Install all HVAC control wiring, 24vdc or less, in electrical metallic tubing (EMT) when wire is concealed in walls and in exposed areas. Rigid metal conduit (RMC) will be used when conduit will be installed on roofs. Plenum wire may be used in ceilings where anchored support is provided every 10 feet.
- C. Electrical Contractor is responsible for providing power from local electrical panels to the BMCS System control panels.
- D. When transitioning between buildings above or below ground level, provide a pull box with necessary surge suppression hardware to transition exterior rated wiring to interior applications.

3.2 ACCEPTANCE PROCEDURE

- A. Upon completion of the installation, the contractor shall start-up the system and perform all necessary calibration and testing to ensure the proper operation of the BMCS System.
- B. After all calibration and testing have been completed, the contractor shall schedule a hardware demonstration and system acceptance test to be performed in the presence of the owner.

END OF SECTION 23 09 00

1.0 APPENDIX A

1.1 SEQUENCE OF OPERATION FOR EMUHSD SOUTH EL MONTE HS

1.1.1 GAS/ELECTRIC ROOFTOP UNIT CONTROLLER (AC-M1 THRU M4, AC-K1 AND AC-K2)

Indoor Fan

During Occupied periods, the fan shall operate continuously. During Unoccupied periods, the fan shall operate when the space temperature exceeds the unoccupied heating or cooling setpoints. The fan operates at a variable speed to meet the load conditions and SAT safety requirements to provide maximum energy savings by minimizing fan horsepower consumption. Fan speed is NOT controlled by static pressure.

Heating Mode

When space temperature is below the occupied heating setpoint, unit shall operate in the heating mode. Unit shall stage available heat stages to satisfy demand in the occupied space.

Cooling Mode

When space temperature is above occupied cooling setpoint, unit shall operate in the cooling mode. Unit shall enable available cooling stages to satisfy demand in the occupied space.

Economizer

Economizer shall close when fan is off or during a loss of power. During occupied hours when fan is energized, the economizer shall open to adjustable minimum position. When outside air temperature is below 71° and occupied space requires cooling, economizer shall open. If economizer air is not sufficient to meet the demand in the occupied space, unit shall enable available mechanical cooling stages to satisfy demand in the occupied space.

CO2 Control

Unit shall monitor space CO2 when the supply fan is energized. When CO2 is above setpoint of 1000 PPM, economizer shall modulate open toward an adjustable maximum CO2 position. As the CO2 level in the space increases above the setpoint, the minimum positions of the dampers will be increased proportionally, until the maximum ventilation setting is reached. As the space CO2 level decreases because of the increase in fresh air, the outdoor-damper will follow the higher demand condition from the DCV mode or from the free-cooling mode.

Power Exhaust

The exhaust fan shall modulate to maintain the room pressure setpoint (as determined by air balancer). Not controlled through EMS.

1.1.2 EXHAUST FAN CONTROLLER (CP-1 THRU CP-3)

Exhaust Fans

EF-D1 thru EF-D5, D7, D8, EF-M1, M1, M2, and EF-L1 shall run based on an occupied time schedule (configurable)

Exhaust fan status will be monitored through a current sensing switch. If the current switch does not detect fan status after a start command has been sent to the associated exhaust fan, an alarm will be generated to the i-Vu web server.

1.1.3 PLANT CONTROLLER (CP-4 THRU CP-5)

Single Stage Boiler Loop Water Temperature Control

The controller will measure the loop water supply temperature and stage the boiler, its circulation pump and heating stage on in sequence to maintain setpoints. The boiler system will run subject to its own internal safeties and controls. To prevent short cycling, there will be a user definable (adj.) delay between stages, and each stage will have a user definable (adj.) minimum runtime.

Cooling Tower - Run Conditions

The cooling tower condenser water control will stage its components (spray pump, fan, etc.) in sequence to maintain condenser water supply temperature setpoint. The following setpoints are recommended values. All setpoints will be field adjusted during the commissioning period to meet the requirements of actual field conditions. When the cooling tower is running the boiler shall be locked out.

Cooling Tower Fan - Loop Water Supply Temperature Control

The controller will measure the loop water supply temperature and stage the fans on in sequence to maintain setpoints. The following setpoints are recommended values. All setpoints will be field adjusted during the commissioning period to meet the requirements of actual field conditions. On rising loop water supply temperature, the fan speeds will stage on at the setpoints given below. When the condenser water supply temperature drops back below the setpoints by the differentials listed below, the fan speeds will stage off.

To prevent short cycling and back-emf in the fan motors, there will be a minimum user adjustable delay between each stage.

Condenser Water Pump Lead/Standby Operation

The condenser water pumps will run anytime the boiler is called to run.

The lead pump will start prior to the boiler being enabled and will stop only after the boiler is disabled. The pumps will therefore have:

- A user adjustable delay on start.
- AND a user adjustable delay on stop.

The delay times will be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.

The condenser water pumps will operate in a lead/standby fashion.

- The lead pump will run first.
- On failure of the lead pump, the standby pump will run and the lead pump will turn off.

The designated lead pump will rotate upon one of the following conditions (user selectable):

- manually through a software switch
- if pump runtime (adj.) is exceeded
- daily
- weekly
- monthly

Condenser Water Return Temperature Monitoring

The condenser water return temperature will be monitored.

Condenser Water Supply Temperature Reset

The Condenser Water Supply Temperature (CWST) reset will be based on linearly outside wet bulb temperature (calculated from OAT and OARH) and heating/cooling demands.

Condenser Water Supply Flow Monitoring

The condenser water flow will be monitored.

Pumps Flow Monitoring

The pumps water flow will be monitored.

Chemical Return Monitoring

The chemicals in the return will be monitored.

Alarms

See the alarms below:

- High Condenser Water Return Temp: If the condenser water return temperature is greater than 100°F (adj.).
- Low Condenser Water Return Temp: If the condenser water return temperature is less than 75°F (adj.).
- Pump Failure: Commanded on, but the status is off.
- Pump Running in Hand: Commanded off, but the status is on.
- CT Fan Failure: Commanded on, but the status is off.
- CT Fan Running in Hand: Commanded off, but the status is on.
- Boiler Alarm

Trends

The following points shall be trended at 15 minute (adj) intervals:

- CWR Temperature
- CWS Temperature
- Outside Air Temperature
- Outside Air Relative Humidity
- Pump Enable
- Boiler Enable
- Cooling Tower Fan Low Enable
- Cooling Tower Fan High Enable
- CW Flow

SECTION 32 31 19 – ORNAMENTAL METAL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Custom fabricated Ornamental Metal Fencing
 - 2. Rough and finish hardware, fasteners, and related accessories
- B. Related Requirements:
 - 1. Section 32 13 13, Sitework Concrete.

1.3 REFERENCE STANDARDS

- A. Conform to current adopted reference standards by date of issue of the current code cycle and the date of the Contract Documents.
- B. ASTM International
 - 1. ASTM A36 - Carbon Structural Steel
 - 2. ASTM A123 - Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
 - 3. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
 - 4. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 5. ASTM A513 - Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
 - 6. ASTM A641 - Standard Specifications for Zinc-Coated (Galvanized) Carbon Steel Wire
 - 7. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 8. ASTM A568/A568M - General Requirements for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.
 - 9. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - 10. ASTM B117 - Test Method of Salt Spray (Fog) Testing
 - 11. ASTM B221-Standard Specification for Aluminum and Aluminum – Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
 - 12. ASTM C1107 - Packaged Dry, Hydraulic - Cement Grout (Non-Shrink)
 - 13. ASTM D2247 - Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
 - 14. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
 - 15. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test

- C. American Welding Society (AWS)
 - 1. AWS D1.1 - Structural Welding Code, Steel
 - 2. AWS A5.1 - Carbon Steel Electrodes for Shielded Metal Arc Welding
 - 3. AWS 5.5 - Low Alloy Steel Covered Arc Welding Electrodes.
- D. American Institute of Steel Construction (AISC)
 - 1. AISC Specifications - Manual of Steel Construction
- E. CBC - 2019 California Building Code
 - 1. Chapter 10, Means of Egress
 - 2. Chapter 11B, Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing.
 - 3. Chapter 19A, Concrete
- F. National Ornamental and Miscellaneous Metals Association (NOMMA)
 - 1. NOMMA Guidelines - Guideline 1 Joint Finishes

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: qualify procedures and personnel according to AWS D1.1.
- B. Mock-ups:
 - 1. One (1) complete fencing panel from post to post, and
 - 2. One (1) complete accessible pedestrian gate assembly
 - 3. Approved mock-ups, in undisturbed condition at time of Certified Completion, may remain as part of the finished work.

1.5 ACTION SUBMITTALS

- A. Product Data for each fencing system component and accessory item.
- B. Shop Drawings, showing materials, construction and fabrication details, layout and erection diagrams as required, finish of materials and methods of anchorage to adjacent construction. Indicate welding by AWS code symbols.
- C. Samples
 - 1. Color Selection Samples for each specified pre-finished item
 - 2. Record Samples of selected finishes
 - 3. Material Samples. If requested, submit samples of materials. Samples of finials, caps, and accessories shall be whole pieces.
- D. Welding Certifications

1.6 DELIVERY, STORAGE AND HANDLING

- A. Stack, store, and handle fencing sections and components to prevent damage during transit and storage at the site. Follow manufacturer's instructions.

1.7 PROJECT CONDITIONS

- A. Verify Existing Conditions. Verify conditions, affecting work of this Section, by taking accurate measurements at site of dimensions, elevations, and grades. Fabricate work to fit measured dimensions.

1.8 WARRANTY

- A. Manufacturer and installer shall jointly warrant that the installed fencing and gates are and will remain free from defects in material and workmanship including cracking, peeling, blistering and corroding of finish for a period of at least 5 years from the date of Substantial Completion. Upon written notice from Owner, they shall promptly, without cost, and with the least practicable inconvenience to Owner correct such defects.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Gates that are part of the accessible route shall meet all the requirements of an accessible door in compliance with CBC Section 11B-404.
- B. The levers of lever actuated latches or locks for accessible gates shall be curved with a return to within 1/2" of the gate surfaces to prevent catching on the clothing or persons.
- C. Swing doors and gate surfaces within 10" of the finish floor or ground shall have a smooth surface on the push side extending the full width of the door or gate. Parts creating horizontal or vertical joints in these surfaces shall be within 1/16" of the same plane as the other and be free of sharp or abrasive edges. Cavities created by added kick plate shall be capped. CBC Section 11B-404.2.10.

2.2 MATERIALS

- A. Steel Material: ASTM A924, A123 and ASTM A653, hot-dipped galvanized, G-90 for sheet steel, cold-rolled, butt welded, square or rectangular, minimum 50,000 psi.
 - 1. Custom Fence: as indicated on drawings and the following:
 - a. Fence Pickets: 1" square x 15 Ga. HSS Tubing at 6" o.c., welded each end; four sides.
 - b. Rails: 3/16" x 2" square HSS.
 - c. Posts: 1/4" x 4" square HSS.
 - d. Gate frame: HSS 3" x 2" x 1/8".
 - e. Swing Gate posts: 2-1/2 inches square x 12-gauge steel for up to 6' gate opening.
 - f. Gate frame and pickets: same material as fence materials.
 - 2. Miscellaneous Materials:
 - a. Welding Rods and Bare Electrodes: Select according to AWS Specifications for metal alloy welded.
- B. Screws: stainless steel, self-drilling hex-head screws. Type 304 or 316 stainless-steel fasteners.

- C. Threaded Bolts and Nuts: Standard, commercial quality, hot dip, galvanized, steel conforming to ASTM A307.
- D. Accessories: Internal retaining rod, panel brackets, post and picket cap, rubber grommets picket to rail.
- E. Touch Up Material for Galvanized Coatings: Anodic zinc-rich coating or hot applied repair compound.
- F. Concrete for Footings: Specified in Section 32 13 13, Sitework Concrete.
- G. Non-Shrink Grout: ASTM C1107, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 5,000 pounds per square inch in 24 hours and 8,000 pounds per square inch in 7 days; of consistency suitable for application and 30-minute working time.

2.3 FABRICATION

- A. Provide new stock of standard sizes specified or detailed. Fabricate materials in shop to produce high- grade metal work. Form and fabricate to meet required conditions.
- B. Pickets, rails and posts shall be pre-cut to specified lengths. Rails pre-punched to accept rails.
- C. Include bolts, screws and other fastenings necessary to secure work.
- D. Conform applicable work to latest edition of AISC Specifications and AWS D1.1.
- E. Accurately make and tightly fit joints and intersections in true planes with adequate fastenings.
- F. Coordinate Work with work of other sections. Provide punching and drillings indicated or required for attachment of Work to other Sections.
- G. Welding: weld joints, unless otherwise indicated or specified, using shielded electric arc method. Use coated welding rods, not fluxed or type recommended by manufacturer for use with parent metal.
- H. Grinding: Grind welds to smooth flush joints.
- I. EXIT Gates: Fabricate posts and lintels to height indicated on drawing but no less than 6'-8", and ready to receive closer and gate hardware.
- J. General:
 - 1. Fences and Gates shall be all-welded construction.
 - 2. Fabricate in shop in largest possible sections; minimize field welding.
 - 3. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.
 - 4. Provide custom fabricated fences and gates as indicated on Drawings.

2.4 FINISHES

- A. Galvanized finish for steel products, ASTM A123 and sheet steel ASTM A653.
 - 1. Clean surfaces of rust, scale, grease and foreign matter prior to finishing. Prepare in accordance with SSPC SP-2.
 - 2. Galvanize steel items to zinc coating thickness in accordance with ASTM A123, minimum Coating Grade 80 (1.9 oz/sq. ft.) and ASTM A653 for sheet steel G60 (0.60 oz/ft square). Surfaces shall be free of icicles, spangles and puddling. Provide venting holes at all enclosed sections, "V" notch, and drilled holes are acceptable. Locate to prevent rainwater from entering enclosed sections at exterior galvanized items. Galvanize after fabrication.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify existing conditions are ready the work of this Section. Do not begin erection of fencing until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Post spacing: Line posts shall be spaced in line maximum of 96 inches on center.
- B. Post Footings: Set posts in concrete footings 12 inches in diameter and 36 inches deep. Tops of footings: Crowned to shed water. Concrete mix: Minimum 3000 pounds per square inch.
- C. Post Tops: Line posts shall be fitted with pressed steel caps. Gate post top: Welded flush and ground smooth.
- D. Install in largest practicable sections and field weld all connections.
 - 1. Finish exposed welds to comply with NOMMA Guideline 1, Finish # 2 - completely sanded joint, some undercutting and pinholes okay.
 - 2. Clean welds, mechanical connections, and abraded areas and repair galvanizing to comply with ASTM A780.
- E. Repair of Galvanized Surfaces: Ready mixed, zinc-rich galvanizing compound, ASTM A780 - A2. Repair Using Paints Containing Zinc Dust, minimum thickness 5 mils.

END OF SECTION 32 31 13