SECTION 16010 – BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes general requirements for electrical installation and is applicable to all Division 16 Sections.

1.2 SERVICE CHANGE OVER

A. Service change over to be coordinated with serving utility to minimize power outage.

B. Required power outages to be scheduled with Owner, 72 hours in advance, on weekend (Saturday and Sunday) days only.

1.3 SCOPE OF WORK

A. Provide all labor, equipment, materials, and services required for a complete installation, testing, and startup of all systems denoted on the plans and specifications.

B. Bring questionable or obscure items, apparent conflicts between plans, specifications, governing codes or utilities regulations to the attention of the Project Manager in writing using the standard Request for Information (RFI) Format.

C. Existing project conditions can be determined prior to bid of the project by site inspection and review of available as-built drawings.

D. Coordinate all work with Project Manager.

1.4 ELECTRICAL DRAWINGS AND SYMBOLS

A. Electrical drawings are diagrammatic and are not intended to show all features of work. However, the Contractor shall provide products necessary for a complete and operable system in accordance with NFPA 70 (National Electrical Code) and NFPA 72.

B. Install electrical items that are not dimensioned in a manner to provide symmetrical appearance. Do not scale drawings for exact equipment location. Adjust work to conform to actual conditions for a complete installation.

C. The drawings and specifications are complementary. Refer to specifications for description outlining products to be provided.

D. Drawing symbols used for basic materials, equipment, etc., are denoted by industry standard symbols. Special items are denoted by symbol legend or called out on the drawings or specification.

1.5 DEFINITIONS

A. “ASD” – Anchorage School District.

B. “BASIS OF DESIGN” - Particular specialized products around which a system was designed. In such cases, the products specified may be critical with regard to physical sizes and

performance characteristics. Where variations or substitutions to products are made, the Contractor is solely responsible for resolving all impacts of such a deviation. Approval of a substitution and/or variation request does not relieve the Contractor of responsibility for complying with the design intent.

C. "CALL OUT" - Products specifically denoted by manufacturer's model and part number, or referenced standards listed on the drawings without further specification. In these cases the Contractor shall provide the products and/or perform in accordance with the references listed.

D. "EQUAL" - A product, system or installation which:
1. Meets or exceeds all ratings, performance characteristics, standard features and denoted options of specified item.
2. Includes primary characteristics identified in the drawings and specifications.
3. Complies with requirements similar to the "Basis of Design."
4. Is produced by a manufacturer specifically listed as an acceptable manufacturer on the drawings, or in the specifications.
5. Is acceptable and approved to the Architect/Engineer specifically addressed in writing and must be acceptable to ASD.

E. "EXPOSED" - Exposed to view after construction is completed.

F. "FURNISH" - Purchase materials as shown and specified. Deliver to project site at location shown to be installed by supporting crafts.

G. "INSTALL" - Set in place and connect equipment furnished by others for a complete and ready to use installation.

H. "PRODUCT" - Term which includes materials, equipment, fixtures, devices for any tangible item used on the project.

I. "PROJECT MANAGER" – Individual employed and designated by the Anchorage School District.

J. "PROVIDE" - Furnish all products, equipment, subcontracts, labor, testing, etc., required and install for a complete ready to use installation.

K. "SHOP DRAWING" - Detailed, dimensioned working construction drawing drawn to a particular scale adequately showing installation intent, details and coordination of interrelated trades.

L. "SUBSTITUTION" - A product, system or installation which is not listed as an acceptable manufacturer, but the Contractor warrants meets or exceeds specified equipment denoted in the contract documents. Approval through submittal process is required to establish product or system is "equal".

M. "WIRING" - Electrical conductors, raceway, devices, connections and associated accessories, or any combination of labor and material thereof in order to provide a complete and operable system.

N. "WEATHERPROOF" - Electrical equipment noted as weatherproof or "WP" shall be provided with raintight enclosures or device plates as applicable and approved for wet location by listing or label.

1.6 COORDINATION

A. Exposed Raceways and Cables where specifically allowed shall be routed in such a manner agreeable to the Project Manager. Coordinate all such work prior to installation.

B. Coordinate the work specified in this Division under the provisions of Division 1.

C. Obtain written permission from Project Manager prior to cutting, drilling or weakening structural components.

1.7 PAINTING AND REPAIR

A. All building materials, equipment and existing furniture damaged during the installation of the work must be repaired or replaced with materials in like kind and quality of the original by skilled labor experienced in that particular building trade.

B. Items scratched or marred in shipment or installation shall be refinished with touchup paint selected to match installed equipment finish.

C. Contractor to replace all ceiling tiles that are damaged during removal and replacement.

1.8 CODES AND STANDARDS

A. Codes: Perform all work in accordance with all latest legally enacted editions of National, State and Local codes including:
1. NFPA 70 - National Electrical Code (NEC).
2. NFPA 72 - Fire Alarm Design and Installation Requirements.
3. International Building Code (IBC).
4. International Fire Code (IFC).
5. Americans with Disabilities Act Accessibility Guidelines (ADAAG).

B. Standards: Provide all equipment, materials and installation in conformance with the following latest current publications and standards as applicable:
1. Underwriter's Laboratory (UL).
2. American National Standards Institute - ANSI.
3. American Society of Testing and Materials - ASTM.
4. Institute of Electrical and Electronics Engineers - IEEE.
5. National Electrical Manufacturers' Association - NEMA.
6. National Fire Protection Association - NFPA.

1.9 SPECIAL SYSTEMS

A. Special system additions or modifications to special systems such as fire alarm, security, telecommunication etc shall be done using new components and parts that are manufactured by the original manufacturer of the equipment of the existing equipment.

B. The design and supply of all equipment for the system changes and equipment provided shall be provided by the factory authorized representative.

C. Shop drawings and catalog cuts shall be provided to show all aspects of the design and equipment to be supplied.

D. Test and check out of each system shall be performed by the factory authorized representative with a written test report to be submitted.

1.10 SUBMITTALS

A. Provide submittals for products or systems specified by call out, equipment list items shown on the drawings and products, equipment or systems described in Division 16 Specifications. Submittals shall comply with all requirements of Division 1. In addition, submittal shall comply with the following:

1. Each submittal copy shall be bound in an individual three-hole, 8-1/2"x11 hard back loose-leaf binder.
   a. Mark outer cover front and spine with job name.
   b. List the submittal contents in an index by specification section numbers and titles under first tab of binder.
   c. Provide subsequent tabs in binders for each specification section numbers on which material is being submitted. Provide additional tabs at the end for equipment called out on drawings, according to equipment name, type or equipment number.
   d. Material and tabs in the binder shall be arranged in ascending numerical order by specification number.
2. Submittal shall provide the following for each item submitted on at a minimum:
   a. Manufacturer's name, address, nearest supplier address and phone number.
   b. Equipment designation and/or model number.
   c. Submit catalog cuts, printed product data, pamphlets and specification sheets.
   d. Rough-in data and dimensional aspects.
   e. Operational features, included options and characteristics.
   f. Wiring diagrams.
   g. Shop drawings.
   h. Documentation denoting equipment is listed by a third party testing organization acceptable to the authority having jurisdiction.
   i. All proposed substitutions and deviations from the products or systems specified shall be denoted as such at the beginning of each section. Each deviation shall be specifically itemized for comparison to specified equipment. Submittal approval does not include any deviations not specifically itemized. Substitution submittal approval does not relieve the Contractor of responsibility for complying with design intent. Unapproved products or installation deviations shall be corrected as described by the Project Manager.
   j. Delete all extraneous material data from submittal which does not apply to equipment specified and/or highlight the specific items which are being submitted on.
3. Submittal review is for general design criteria and does not relieve the Contractor from any of the contract requirements.

1.11 QUALITY ASSURANCE

A. Workmanship is considered important and is subject to approval. Employ workmen skilled in the trade and familiar with particular techniques applicable to various sections of work.

B. Provide all Materials to conform with applicable industry standards and Underwriters Laboratories standards. Whenever possible, similar items shall be supplied by the same manufacturer throughout the project.

1.12 EQUIPMENT SCHEDULES

A. Fixture and equipment schedules on the drawings denoting capacities, ratings, sizes, etc., shown are the minimum acceptable and may not necessarily correspond with catalog ratings or equipment specified.

1.13 WARRANTY

A. As required in the general conditions of the contract.

B. All workmanship, labor and materials shall be warranted for a minimum period of one (1) year form the date of final acceptance.

C. Warranty work shall be promptly performed at Contractor's sole expense.

D. Correction of Work: Within one year after the Substantial Completion of the work, any work found to not be in conformance with the Contract Documents will be corrected the Contractor promptly after written notice from the owner outlining the deficiency. This requirement shall survive the acceptance of the work under this Contract and termination of the contract.

1.14 ELECTRICAL DRAWINGS

A. Electrical Drawings are diagrammatic and complementary to all other Drawings; not intended to show all features of work. Coordinate with work of other trades to avoid conflicts. Drawings and specifications are complementary, each to the other; what is shown in one is as binding as if called for in both.

B. Install equipment to provide symmetrical appearance where not dimensioned on drawings. Do not scale drawings for equipment location. Review Contract Documents and adjust work to conform to conditions shown. Data presented on drawings are as accurate as planning can determine. Dimensional accuracy not guaranteed and field verification of dimensions, locations, and levels to suit field conditions is directed. Provide a complete and satisfactory working installation.

1.15 RECORD DRAWINGS

A. Reference requirements stated in Division 1.

B. In addition to other requirements, mark up a clean set of drawings as the work progresses, to show the location and routing of all work.

1.16 CONSTRUCTION, OBSERVATION, INSPECTIONS, AND TESTS

A. Request construction observation at least 48 hours prior to the covering of any buried or conceal work; pulling of wires and cable; installation of light fixtures, or placing of covers over outlets, or panelboards.

B. Notify state and local inspectors of work progress in accordance with applicable requirements. Submit copies of all inspection reports to Architect/Engineer.

C. Contractor Inspections: At or near the completion and prior to final acceptance testing the Contractor shall prepare a deficiency list (punch list) of all items that are not in accordance

with contract requirements, state or federal regulations, or are not complete. Submit A copy of the deficiency list to the Architect/Engineer prior to the Architect/Engineer conducting a final inspection.

1.17 POWER REQUIREMENTS AND CIRCUIT BREAKERS

A. Provide power from the nearest available branch circuit panelboard with adequate capacity as required for all new equipment added as a part of the contract.

B. Coordinate and provide the compatible circuit breaker, amperage, size, ratings, lugs and AIC rating for all circuit breakers added in existing panelboards.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and Equipment shall be acceptable to the authority having jurisdiction as suitable for the use intended. All electrical equipment shall bear the seal of a nationally recognized testing laboratory for the purpose for which it is installed.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. All electrical work must be installed in strict accordance with the latest adopted National Electrical Code and local amendments.

END OF SECTION 16010

SECTION 16060 – GROUNDING AND BONDING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Wire and connection materials..

1.2 REFERENCES

A. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. NFPA 70 (National Fire Protection Association) - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Provide new grounding electrode systems at each new service and at each generator denoted as a separately derived system.

B. Provide all bonding per NEC requirements.

PART 2 PRODUCTS

2.1 GROUND AND BONDING CONDUCTOR

A. Material: Bare or insulated stranded copper. Use only insulated copper conductor for telecommunication grounding conductors.

B. Equipment Grounding Conductor: Copper conductor bare or insulated.

C. Terminations: Irreversible crimp or exothermically welded.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove paint and surface contaminants at connection points.

3.2 EXISTING WORK

A. Modify existing grounding system to maintain continuity to accommodate renovations.

3.3 GENERAL INSTALLATION

A. Install grounding and bonding conductors concealed from view except in mechanical and electrical rooms.

B. Provide raceway for each grounding or bonding conductor. Bond the raceway and conductor together at each ferrous conduit termination with grounding bushings.

C. Clean each mechanical connection and coat with antioxidant prior to connection.

D. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Provide bond to every electrical box and enclosure.

E. Provide bonding for each metallic raceway and wireway system to provide continuous electrical continuity. Provide bond to every box and enclosure.

F. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

G. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, threaded screw in light switch and outlet boxes or metal enclosures of service equipment.

H. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.

I. Permanently attach equipment and grounding conductors prior to energizing equipment.

END OF SECTION 16060

SECTION 16070 – ELECTRICAL HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Equipment bases and supports.
5. Seismic Restraints.

1.2 REFERENCES

A. NFPA 70 (National Fire Protection Association) - National Electrical Code.

B. 2006 IBC (International Building Code).

1.3 RELATED SECTIONS

A. Section 00230 Hazardous Materials Survey Report.

B. Section 01561 Airborne Contaminant Control.

1.4 SUBMITTALS

A. Division 1 and Section 16010 - Electrical General Provisions.

B. Submit manufacturers Product Data:
1. Hangers and Supports.
2. Conduit Straps.
3. Anchors.
4. Seismic Shop Drawings.

C. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

B. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

C. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

D. Conduit clamps - general purpose: One hole galvanized stamped steel or malleable iron for surface mounted conduits.

2.2 FORMED STEEL CHANNEL AND ACCESSORIES

A. Product Description: U-channel strut Exterior and Wet Areas – Hot dipped galvanized 12 gage thick steel. Dry Indoor Areas – Zinc or Cadmium Plated 12 gage thick steel.

B. Accessories: Modular to match channel finish and configuration by the same manufacturer.

2.3 SPRING STEEL CLIPS

A. Product Description: "Caddy" spring steel electrical support systems for each type required (Provide only where concealed in walls or above ceilings).

2.4 MANUFACTURED SEISMIC RESTRAINT SYSTEMS

A. Product Description: Provide pre-approved manufactured seismic restraint systems for all seismic support. Systems to be Superstrut seismic restraint system pre-approval No. R-0003, Kinline pre- approval No. R-0071, or B-Line pre-approval No. R-0114.

2.5 SEISMIC SUPPORT WIRE AND CABLE

A. Product Description: #12 gage ceiling support wire where concealed. Aircraft stainless steel cable where exposed.

PART 3 EXECUTION

3.1 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
1. Concrete Structural Elements: Provide expansion anchors and powder actuated anchors.
2. Steel Structural Elements: Provide beam clamps. Provide spring steel clips where concealed.
3. Concrete Surfaces: Provide expansion anchors.
4. Plaster and Gypsum Board Partitions: Provide sheet metal backing installed behind wallboard.
5. Hollow Masonry: Provide toggle bolts.
6. Solid Masonry Walls: Provide expansion anchors.
7. Sheet Metal: Provide sheet metal screws.
8. Wood Elements: Provide wood screws.

B. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity.
2. Install spring lock washers under nuts. Double nut all trapeze hanger supports.
3. Install surface mounted cabinets and panelboards with minimum of four anchors.
4. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
5. Provide conduit back spacers in all wet or wash down areas.

C. Support vertical conduit at every floor.

D. Install raceway supports in accordance with NEC and do not exceed 10 feet.

E. Do not support raceways or boxes from ceiling suspension wires or suspended ceiling systems. Provide support from building structure independently to allow ceiling removal and replacement without removal of electrical system. Exception: Outlet boxes for ceiling mounted smoke detectors may be mounted in the ceiling system.

F. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

G. Install multiple conduit runs on common hangers.

H. Do not drill or cut structural members except where specifically approved.

I. Do not screw to the roof pan decking without prior ASD Project Manager written approval.

END OF SECTION 16070

SECTION 16075 – ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.

1.2 SUBMITTALS

A. Division 1 and Section 16010 – Electrical General Provisions.

B. Product Data:
1. Submit manufacturer's catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved white letters on red background. Attach to equipment using threaded screws or pop-rivets.

B. Letter Size:
1. 1/4 inch high letters for identifying individual panel or equipment.
2. 1/8 inch high letters for remaining lines with 1/8 inch spacing between lines.

C. Minimum nameplate size: 1/8 inch thick with a consistent length and height for each type of nameplate wherever installed on the project.

2.2 WIRE MARKERS

A. Power and Lighting Description: Cloth tape type wire markers for all neutrals and Phase conductors.

B. Low Voltage System Description: Machine printed label with unique wire number that is shown on the fire alarm shop drawing.

2.3 LABELS

A. Product Description: Thermal Transfer, 180 DPI self adhesive tape printer. Clear tape with black letters, approximately 3/16” high characters.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:

1. General Requirements.

a. Degrease and clean surfaces to receive nameplates and labels.
b. Install nameplate and label parallel to equipment lines.
c. Secure nameplate to equipment front using screws or rivets.
d. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

2. Enclosed Circuit Breakers, disconnects, motor starters and similar control equipment: Provide engraved nameplate. Nameplate shall include equipment description, characteristics, load supplied and supply circuit and origin. For example:

ENCLOSED CIRCUIT BREAKER – 150 AMP 120/208V 3f , 4W FEEDS PANEL A IN ROOM A200 FED FROM TRANSFORMER TA IN ROOM F120

3. Wiring devices such as switches and receptacles: Provide adhesive label. Label shall include supply circuit and origin and load controlled. For example:

PANEL A - 42

4. Wires and cables: Provide wire marker at each junction and within 6” of termination at wiring devices and panelboards. For power circuits indicate branch circuit or feeder number. For neutral conductors indicate branch circuit supplied. For control circuits indicate wire number indicated on schematic and interconnection diagrams or shop drawings. For example:

A - 42

5. Conduit Marker Spacing: Provide wire marker 20 feet on center in accessible locations. Markers not required in concealed locations. For power circuits indicate branch circuits contained in conduit. For other systems indicate system wiring contained. For example:

120V POWER, CIRCUITS A-1,3,5

OR

GENERATOR REMOTE ANNUNCIATOR

C. Wire Marker Installation:
   1. Power Circuits: Provide panelboard and circuit number at each pull box, junction box, and termination.

END OF SECTION 16075

SECTION 16095 – MINOR ELECTRICAL DEMOLITION AND EXISTING SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Removal of existing electrical equipment, wiring, and conduit in areas to be remodeled; removal of designated construction; dismantling, cutting and alterations for completion of the Work.
2. Disposal of materials.
3. Storage of removed materials.
4. Identification of utilities.
5. Salvaged items.
6. Protection of items to remain as indicated on Drawings.
7. Relocate existing equipment to accommodate construction.

1.2 COORDINATION

A. Conduct demolition to minimize interference with adjacent building areas.

B. Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.

C. Shut-down Periods:
1. Arrange timing of shut-down periods of in service panels with Project Manager. Do not shut down any utility without prior written approval.
2. Keep shut-down period to minimum.
3. Maintain life-safety systems in full operation in occupied facilities.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.

3.2 PREPARATION

A. Erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor’s employees, and existing improvements to remain.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Project Manager before disturbing existing installation.

B. Remove exposed abandoned raceways. Cut conduit flush with walls ceilings, floors, and patch surfaces to match adjacent finishes.

C. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.

D. Remove, relocate, and extend existing installations to accommodate new construction.

E. Repair adjacent construction and finishes damaged during demolition and extension work. T-bar ceiling tiles damaged under normal construction conditions or having voids where junction boxes were removed will be replaced by the contractor.

F. Protect and retain power to existing active equipment remaining.

G. Cap abandoned empty conduit at both ends.

H. Provide stainless steel cover plate for each device box located in non-accessible walls or ceilings which are abandoned in place.

I. Remove abandoned wiring back to source.

3.4 SALVAGE EQUIPMENT

A. EXISTING CIRCUIT BREAKERS
1. All removed circuit breakers shall remain the property of the owner.

3.5 EXISTING PANELBOARDS

A. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers.

B. Tag unused circuits as spare.

C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.

D. Remove existing wire no longer in use from panel to equipment.

E. Provide new updated directories where power circuits were modified.

F. Demolished circuit breakers to salvaged and remain property of the owner.

3.6 CLEANING AND REPAIR

A. Repair and clean adjacent construction and finishes damaged during demolition and construction.

END OF SECTION 16095

SECTION 16123 – BUILDING WIRE AND CABLE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes building wire and cable and wiring connectors and connections.

1.2 REFERENCES

A. National Electrical Code (NEC).

B. NECA (National Electrical Contractors Association) - Standard of Installation.

C. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems..

1.3 SYSTEM DESCRIPTION

A. Wiring Methods - Provide the following wiring methods for all branch circuits, feeders and fire alarm circuits:
   1. Heated indoor locations: XHHW-2 or THHN insulation in raceway.
   2. Exterior, wet or other cold locations: XHHW-2 insulation in raceway.

B. Conductors and cables for special systems not covered by this section are denoted in the associated specification section, drawing reference or as recommended by the system manufacturer whichever is greater.

PART 2 PRODUCTS

2.1 THHN/THWN BUILDING WIRE

A. Product Description: General purpose single stranded conductor.

B. Conductor: Class B or C stranded, annealed copper per UL 83 or 1063.

C. Insulation: Polyvinyl chloride (PVC) sheathed with nylon jacket meeting requirements of UL 83. Sizes 1/0 AWG and larger marked “For CT Use” and be sunlight resistant.

D. Temperature: THHN 90 degrees C Dry and THWN 75 degrees C Wet.

E. Voltage: 600 Volts.

2.2 XHHW-2 BUILDING WIRE

A. Product Description: General purpose single stranded conductor.

B. Conductor: Class B stranded, annealed copper per UL 44.

C. Insulation: Crosslinked polyethylene (XLP) per UL 44.

D. Temperature: 90 degrees C.

E. Voltage: 600 Volts.

2.3 WIRING CONNECTORS

A. 8 AWG and smaller
1. Dry interior areas: Spring wire connectors, pre-insulated “twist-on” rated 105 degrees C per UL 468C. Crimp insulated fork or ring terminals for conductors terminating under screw type terminals, Thomas & Betts Sta-Kon or equal.
2. Motor connections: Spring wire connectors, pre-insulated “twist-on” rated 105 degrees C per UL 468C. Provide a minimum of 8 wraps of Scotch 33+ electrical tape around conductors and connector to eliminate connector back off.
3. Wet or exterior: Spring wire connectors, pre-insulated “twist-on”, resin filled rated for direct burial per UL 486D.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Remove exposed abandoned wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.

B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.

C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.

D. Extend existing circuits using materials and methods compatible with existing electrical installations, or as specified.

E. Clean and repair existing wire and cable remaining or is wire and cable to be reinstalled.

3.2 INSTALLATION

A. Voltage Drop: Size all branch circuit conductors to provide voltage drop of 3% or less based on the actual field routing and the load served or as denoted on the panel schedule whichever is greater. As a minimum homeruns over 75 ft to #10 AWG.

B. Use conductor not smaller than #12 AWG for power and lighting circuits.

C. Use conductors not smaller than #16 AWG for control circuits.

D. Provide continuous raceway system for all conductors and cables unless specifically noted otherwise on the drawings or specifications.

E. Route wire and cable to meet Project conditions.

F. Route conductors from each system in independent raceway system and not intermix in the same raceway, enclosure, junction box, wireway, or gutter as another system unless otherwise shown on the plans. Examples of circuits to not be intermixed are 480Y/277

with 208Y/120 Volt circuits, emergency power, line voltage circuits with low voltage wiring, power limited, telecommunication, direct current, etc.

G. Do not install XHHW-2 conductors when ambient temperatures are below -5 degrees C and THHN/THWN conductors when ambient temperatures are above 0 degrees C.

H. Provide stranded wire for all fire alarm devices, security devices, connections to motors, transformers and equipment that vibrates or requires flexibility.

I. Do not terminate more than one conductor per individual branch circuit breakers.

J. Install wire and cable in accordance with NECA "Standard of Installation."

K. Neatly train and lace wiring inside boxes, equipment, and panelboards supported with cable ties.

L. Provide cable supports as recommended by the NEC or cable manufacturer in vertical conduits.

M. Color code wire and cable and identify each conductor with its circuit number or other designation indicated under provisions of Section 16075.

N. Special Techniques - Wiring Connections:
1. Perform wiring connections and splices only in accessible outlet or junction boxes.
2. Do not splice feeder conductors unless otherwise noted on the drawings.
3. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
4. Clean conductor surfaces before installing lugs and connectors.
5. Strip conductor insulation to the exposed length as recommended by the manufacturer for the connector used.
6. Tape un-insulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
7. Install insulated spring wire connectors with plastic caps or compression when not available for copper conductor splices and taps, 8 AWG and smaller.
8. Where stranded conductors are terminated on screw type terminals install crimp on fork terminals. Do not place bare stranded conductors directly under screws.

3.3 WIRE COLOR

A. General
1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
   a. Black and red for single phase circuits at 120/240 volts.
   b. Black, red, and blue for circuits at 120/208 volts single or three phase.
   c. Brown, orange and yellow for circuits at 277/480 volts single or three phase.
2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
   a. Black and red for single phase circuits at 120/240 volts.
   b. Black, red, and blue for circuits at 120/208 volts single or three phase.
   c. Brown, orange and yellow for circuits at 277/480 volts single or three phase.

B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

C. Ground Conductors:
   1. For 8 AWG and smaller: Green.
   2. For 6 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.4 FIELD QUALITY CONTROL AND TESTING

A. Division 1 – Contract Closeout.

B. Do not test cables while connected to TVSS devices.

C. Perform an insulation resistance test on all new feeder conductors prior to termination, employing the Time-Resistance (Absorption) testing method. Test each conductor at the manufacturer's recommended voltage level for new cable installation, for a time period of not less that 10 minutes. Record insulation values at 1-minute intervals. Tabulate results and confirm that measured values fall within the cable manufacturer's acceptable values. Cables that do not fall within the cable manufacturer's acceptable values shall be replaced.

D. Perform an insulation resistance test on all new branch circuit conductors, employing the spot-reading testing method. Test each conductor at the manufacturer's recommended voltage level for new cable installation, for a time period of not less that 60 seconds. Record insulation values. Tabulate results and confirm that measured values fall within the cable manufacturer's acceptable values. Conductors which do not fall within the cable manufacturer's acceptable values shall be replaced.

E. Notify Owner 72 hours before performing insulation tests. Provide Owner with proposed schedule so that a technical representative may observe the testing procedure.

F. Submit technical information for each test instrument to include manufacturer, model number, serial number, ratings, accuracy, and National Institute of Standards and Technology (NIST) Traceable calibration certification.

G. Submit test report, include all testing equipment used, for review and include in O & M manuals.

END OF SECTION 16123

SECTION 16130 – RACEWAYS AND BOXES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
1. Metal conduit.
2. Flexible metal conduit.
3. Liquidtight metal conduit.
4. Electrical metallic tubing.
5. Surface mounted raceway (SMR).
6. Fittings and conduit bodies.
7. Pull and junction boxes.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
3. ANSI C80.5 - Rigid Aluminum Conduit.

B. American Society for Testing and Materials (ASTM):
1. ASTM A 123 – Specification for Zinc Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip.

C. National Electrical Manufacturers Association (NEMA):
1. NEMA FB 1 (National Electrical Manufacturers Association) - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
2. NEMA OS 1 (National Electrical Manufacturers Association) - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
3. NEMA OS 2 (National Electrical Manufacturers Association) - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
4. NEMA RN 1 (National Electrical Manufacturers Association) - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
5. NEMA TC 2 (National Electrical Manufacturers Association) - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
6. NEMA TC 3 (National Electrical Manufacturers Association) - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
7. NEMA 250 (National Electrical Manufacturers Association) - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code.

E. International Building Code (IBC):
1. IBC Seismic Category C requirements.

1.3 SYSTEM DESCRIPTION

A. Provide raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with

regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Raceway Minimum Size:
1. Below Grade: Provide 1 inch minimum.
2. Above Grade or Slab on Grade: Provide ¾ inch minimum. Raceway may be reduced to ½ inch for final connection of raceway up to 6 feet for connection to fixture or device where maximum conduit entry size is ½ inch.

C. Outdoor Above Grade, Damp or Wet Locations:
1. Raceway: Provide rigid steel.
2. Boxes and Enclosures: Provide weatherproof malleable iron for branch circuit junction and outlet boxes.
3. Fittings: Provide galvanized malleable iron with gaskets. Provide Myers threaded hubs for all conduit entries into top and side of sheet metal enclosures. Provide gland raintight fittings for electrical metallic tubing.

D. Concealed Dry Locations:
1. Raceway: Provide electrical metallic tubing. Flexible metal conduit where fished in walls or ceiling spaces that are not accessible otherwise.
2. Boxes and Enclosures: Provide sheet-metal boxes.
3. Fittings: Provide cast and steel.

E. Exposed Dry Locations:
1. Raceway: Mechanical and electrical spaces: Provide electrical metallic tubing. Exposed in non-mechanical spaces: Provide surface mounted raceway (SMR).
2. Boxes and Enclosures: Provide red factory manufactured boxes by same supplier as the fire alarm devices.
3. Fittings: Provide cast alloy.

F. Hazardous Locations (Classified Wiring):
1. Raceway: Provide rigid steel conduit.
2. Boxes and Enclosures: Provide galvanized malleable iron rated Class 1 Division 1, NEMA FB1.
3. Class 1 Division 1 conduit seals to be provided at NEC classified boundary locations.

G. Equipment Connections: Connections to components in T-bar ceilings, vibrating equipment or equipment that requires removal for maintenance or replacement: Flexible metal conduit in dry locations and liquidtight flexible metal conduit in damp or wet locations. Maximum length 6 feet in length.

1.4 DESIGN REQUIREMENTS

A. Conduit Minimum Raceway Size: Size all raceways not shown on the drawings to not exceed the percentage fill specified in the NEC Table 1, Chapter 9 using the conduit dimensions of the NEC Table 4, Chapter 9 and conductor properties of the NEC Table 5, Chapter 9. Where specific cable is not listed use major diameter provided by the manufacturer.

B. Box Minimum Size: Provide all boxes sized and configured per NEC Article 370.

C. IBC Seismic Design: Provide support to per Seismic Category C requirements.

1.5 SUBMITTALS

A. Division 1 and Section 16010 - Electrical General Provisions.

B. Product Data: Submit data for products to be provided.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.7 COORDINATION

A. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

B. Coordinate layout and installation of raceways and boxes to provide adequate headroom, working clearance and access.

PART 2 PRODUCTS

2.1 METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1, UL 6.

B. Rigid Aluminum Conduit: ANSI C80.5.

C. Fittings and Conduit Bodies: NEMA FB 1, UL 514B; Galvanized malleable iron with threaded hubs for all conduit entries. Provide threaded connections and couplings only. Set Screw and running thread fittings are not permitted. Provide copper free aluminum fittings and conduit bodies with Aluminum Conduit.

D. Provide bushings at all conduit terminations.

2.2 FLEXIBLE METAL CONDUIT

A. Product Description: UL 1, galvanized or zinc coated flexible steel construction.

B. Fittings: NEMA FB 1. Galvanized malleable iron or steel with insulated throats.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Product Description: UL 360, Interlocked steel construction with PVC jacket.

B. Fittings: NEMA FB 1. Galvanized malleable iron or steel liquidtight.

2.4 ELECTRICAL METALLIC TUBING (EMT)

A. Product Description: ANSI C80.3, UL 797; galvanized steel tubing.

B. Fittings and Conduit Bodies: NEMA FB 1; galvanized steel or malleable iron, compression or set screw type. Die cast or pressure cast fittings and locknuts are not permitted.

2.5 SURFACE MOUNTED RACEWAY

A. Product Description: One piece 1.0 mm low profile steel surface raceway. Ivory finish. Wiremold V700 or approved equal.

B. Fiitings: All bushings, mounting straps, connection covers, elbows, connectors, and boxes to be Wiremold V700 Series or approved equal. Appliance boxes for pull stations, indicating appliances, and door holder boxes to be factory boxes specified

2.6 DEVICE AND APPLIANCE BOXES

A. Concealed: Sheet Metal Outlet Boxes: NEMA OS 1, UL514A galvanized steel with plaster ring where applicable.
   1. Minumum size 4 inches wide x 4 inches wide x 2-1/8 inch deep.

B. Surface Box: Red fire alarm factory manufactured fire alarm appliance box for surface mounting of fire alarm devices. 4” square K.O. boxes, Wiremold, cast aluminum or field painted junction boxes not provided from the fire alarm equipment supplier are not acceptable.
   1. Interior Locations: Sheet steel factory red sized for installed device.
   2. Exterior Locations: Weatherproof Cast box sized for Installed device.

C. Door Holder: Provide stainless steel cast steel back box from the door holder manufacturer for surface applications.

2.7 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
   1. Material: Galvanized cast iron.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

C. Class 1 Division 1: Boxes to be rated Class 1 Division 1.

D. Fiberglass Concrete composite Type 1A Handholes: Die-molded, glass-fiber concrete composite hand holes:

   1. Cover: Glass-fiber concrete composite, weatherproof cover with nonskid finish.
   2. Cover Legend: "FIRE ALARM".

2.8 EXPANSION FITTINGS:

A. Galvanized malleable iron, galvanized with grounding bond jumper.

2.9 RACEWAY SEALING FITTINGS:

A. Galvanized malleable iron, galvanized filled with sealing compound.
1. Class 1 Division 1 and Division 2 boundary lines and isolation of arcing devices use Class 1 Division 1 sealing compound.

2.10 BUSHINGS:

A. Non-grounding: Threaded impact resistant plastic.

2.11 LOCKNUTS:

A. Threaded Electro Zinc Plated Steel designed to cut through protective coatings for ground continuity.

2.12 WIREWAY:

A. Product Description: General purpose type wireway. Size per NEC minimum fill capacity required.

B. Knockouts: Field install, no factory knockouts acceptable.

C. Cover: Screw cover.

D. Fittings and Accessories: Include factory couplings, offsets, elbows, adapters and support straps required for a complete system. Provide internal ground bonding jumper bonded to each section.

2.13 FIRE STOP:

A. Fire and/or Smoke rated Surfaces:

1. 3M #CP 25N/S or #CP25S/L caulk, 3M #FS 195 wrap/strip with restricting collar, 3M CS 195 composite sheet, Pipe Shields Inc. series F fire barrier kits, Proset systems fire rated floor and wall penetrations, Insta-Foam Products Insta-Fire seal Firestop Foam, Dow Corning Fire Stop System, or an approved equal.
2. All products must be UL listed or tested by an independent testing laboratory. Use a product that has a rating not less than the rating of the wall or floor being penetrated.

B. Non-Rated Surfaces:

1. At interior wall or floor openings use Tremco Dymonic, Sika Corp. Sikaflex la, Sonneborn Sonolastic NPI, or Mameco Vilken 116 urethane caulk or approved equal to effect the seal.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Remove exposed abandoned boxes, raceway. Cut raceway flush with walls and floors, and patch surfaces.

B. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.

C. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.

D. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.

E. Clean and repair existing raceway and boxes to remain or to be reinstalled.

F. Upgrade all raceways and junction boxes that are reused to conform to current code requirements.

3.2 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 16060.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 16070.

C. Identify raceway and boxes with origin and destination in accordance with Section 16075.

3.3 RACEWAY INSTALLATION

A. Provide raceways concealed in construction unless specifically noted otherwise. Do not route conduits on roofs, outside of exterior walls, or surface on interior finished walls unless specifically noted to do so on the plans.

B. Raceway routing and boxes are shown in approximate locations unless dimensioned. Where raceway routing is not denoted field route to provide complete wiring system.

C. The drawings do not necessarily show every pull or junction box required. Provide boxes as shown or as necessary to facilitate bend limitations and conductor pulling.

D. Do not route raceways on floor. Arrange raceway and boxes to maintain a minimum of 6 feet 6 inches of headroom. Install raceways level and square to a tolerance of 1/8” per 10 feet. Route raceways parallel and perpendicular to walls and ceilings for all exposed and concealed areas.

E. Provide bushing at each raceway termination not installed within an enclosure threaded to the raceway end or connector.

F. Provide independent raceway system for the entire fire alarm installation.

G. Provide permanent accessibility to all junction boxes, pull boxes and conduit access fittings.

H. Arrange raceway supports to prevent misalignment during wiring installation.

I. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 16070; provide space on each for 25 percent additional raceways.

J. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

K. Do not attach raceway to ceiling support wires or other piping systems.

L. Construct wireway supports from steel channel specified in Section 16070.

M. Maintain clearance between raceway and piping for maintenance purposes.

N. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

O. Cut conduit square using saw or pipe cutter; de-burr all conduit ends to smooth finish prior to installation.

P. Bring conduit to shoulder of fittings; fasten securely. Where locknuts are used install with one inside box and one outside with dished part against box.

Q. Coat non-ferrous conduit threads prior to joining with conductive metallic grease antioxident.

R. Install conduit threaded raintight hubs to fasten conduit to sheet metal boxes for all exterior or interior damp or wet locations. Sealing locknuts are not acceptable.

S. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams and corners.

T. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

U. Install fittings and flexible metal conduit to accommodate 3 axis movement where raceway crosses seismic joints.

V. Install fittings to accommodate expansion and contraction where raceway crosses control and expansion joints.

W. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

X. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

Y. Close ends and unused openings in wireway and surface raceway.

Z. Do not intermix conductors from separate panelboards or any other system in the same raceway system or junction boxes unless specifically denoted otherwise.

AA. Provide box barrier for separation of boxes which contain multiple devices and wiring over 150 Volts to ground and more than 300 Volts between conductors into compartments and where normal and emergency power in the same junction box.

BB. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating, seal opening around conduit with UL listed firestop sealant or intumescent firestop, preserving the fire time rating of the construction.

CC. Use non-hardening duct seal to satisfy requirement of Article 300-7, NEC for different temperature portions of raceways, including those passing from interior to exterior portions of structure.

DD. Provide blank covers or plates for all boxes that do not contain devices.

EE. Provide weatherhead on all raceway stub ups which are outdoors and do not terminate in to equipment.

FF. Paint all exposed conduits and junction boxes to match existing décor.

GG. Do not screw to the roof pan decking without prior ASD Project Manager written approval.

3.4 BOX INSTALLATION

A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.

B. Adjust box location up to 6 feet prior to rough-in to accommodate intended purpose.

C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

D. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel.

E. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation.

F. Install with minimum 24 inches separation in fire rated walls. Limit penetrations in fire rated walls to 16 square inches each and a maximum total combined penetration area of 100 square inches in any given 100 square feet of wall. Where penetrations are in excess of these requirements provided UL listed fire stop wrap acceptable to Authority having Jurisdiction.

G. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

H. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

I. Install adjustable steel channel fasteners for box support in existing walls.

J. Do not fasten boxes to ceiling support wires or other piping systems.

K. Support boxes independently of conduit.

L. Do not screw to the roof pan decking without prior Project Manager written approval.

3.5 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material and clean exposed surfaces and restore finish.

END OF SECTION 16130

SECTION 16999 – ELECTRICAL CLOSEOUT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
1. Project close out requirements.
2. Project close out documentation.

1.2 CLOSEOUT SUBMITTALS

A. Provide project closeout requirements and documentation of the following items:
1. Project Clean Up.
2. Demonstration of Electrical System.
3. Record Drawings.
4. Site Building Documentation.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PROJECT CLEAN UP

A. Clean-Up - Leave project completely free of debris resulting from electrical work, and leave all electrical items clean.

B. Repair – Paint to match existing any surfaces damaged during construction. Repair or replace any items damaged during construction.

3.2 DEMONSTRATION OF ELECTRICAL SYSTEM

A. Electrical Inspection - Provide Owner with Certificate of Occupancy signed by the Inspector having jurisdiction.

B. During final inspection, conduct an operating test for approval by Architect/Engineer. Demonstrate installation of the contract documents. Should any portion of the installation fail to meet requirements of Contract Documents, repair or replace items failing to meet requirements until items can be demonstrated to comply. Have instruments available for measuring voltage and current values, and for demonstration of continuity, grounds or open circuit conditions. Have personnel available to take measurements and make tests.

C. Furnish assistant to Architect/Engineer for inspection at any time, as requested, to remove covers, operate machinery, perform continuity tests, and as necessary to demonstrate quality and adequacy.

3.3 OPERATION AND MAINTENANCE MANUALS

A. Submittals shall comply with provisions of Division 1 and this section. Submit (3) copies of the manual no later than five (5) working days prior to final inspection.

B. Manuals shall be assembled in three-ring binders. Binders shall be 3" thick or less, and more than one binder shall be used for each set of data if required to prevent overfilling. All information shall be arranged in the same order as the specifications, by equipment list item and by specific drawing call out as applicable, each section to identify equipment and specification number with a heavy paper divider with a protruding tab and label. The first section shall be the index. Shop drawings which are larger than 8-1/2" x 11" shall be individually folded so they are 8-1/2" x 11" or less and inserted behind the appropriate tabs.

C. General - Provide the following items as applicable for each product or system:
1. Provide manufacturer's catalog cuts, brochures and descriptive literature. Highlight all applicable data or mark out information not applicable.
2. Narrative/diagrams required describing procedures for start-up, operation, emergency operation and shut down of each system. If a particular sequence is required for operation, provide step by step instructions in chronological order.
3. Outline seasonal adjustments required.
4. Provide manufacturer's recommended preventative maintenance for each product, including time intervals for each task.
5. Provide instructions for all adjustments and minor repairs. Provide troubleshooting information for lighting equipment, motor starters, panelboards, and special systems.
6. Provide all information with regard to warranty and special requirements. Include copy of warranty, name, address and phone number of personnel to contact for warranty service.
7. Provide complete information on all replacement parts. Identify each part by manufacturer and part number (graphically when available).
8. Provide hard copy of each panelboard circuit directory and in excel format.

3.4 RECORD DRAWINGS

A. Contractor shall maintain one set of the contract electrical drawings and specifications and telecommunication system shop drawings of the most current issue on the job site and progressively record thereon any change in installation from that indicated on the drawings. Final approval will be withheld until drawings marked in a satisfactory manner are delivered to the project manager prior to substantial completion.
1. Mark record drawings with red pencil actual installation that varies from the work originally shown.
2. Include addendum and revisions items made during construction.
3. Erase, white out or "X-out" to clearly convey as actual " as constructed" condition.
4. Provide revised electrical plans with the "as constructed" conditions in electronic format. ASD will provide an Electronic copy of the plans in Autocad format for contractor use.
5. Provide one complete as-built set in paper format and electronic format on Cdrom.

3.5 SITE BUILDING DOCUMENTATION

A. Panelboard Circuit Directory.
1. Provide panel circuit directory installed in each panelboard in accordance with Section 16075.

END OF SECTION 16999

C21 ADVANCED TECHNOLOGY DIMMER RACK SPECIFICATION.

GENERAL.

A.) Overview.

1.) The dimmer racks shall be fully digital, designed specifically for entertainment and architectural lighting, and shall consist of 24 or 48 dimmer module spaces. Dimmer rack systems shall be ETL and cETL marked devices.

2.) Rack setup and preset data shall, as standard, be fully user programmable on a per rack or system wide basis. The dimmer rack shall report rack status to a remote personal computer or control console and, as an option, report dimmer status information.

B.) Mechanical.

1.) The dimmer rack shall be a freestanding, dead front switchboard, substantially framed and enclosed with16-gauge formed steel panels. All rack components shall be properly treated, primed and finished in fine texture, scratch resistant, coating.

2.) The 48 module dimmer rack shall not exceed 80" H x 24.5" W x 23.6" D. Racks shall be designed to allow for adjacent mounting and for bolting to the floor. The 24 module dimmer rack shall not exceed 57"H x 24.5"W x 23.6"D. Rack doors shall not increase the total rack depth by more than 1.0", and will not increase the rack footprint.

3.) The dimmer rack shall be designed to allow for easy insertion and removal of all modules without the use of tools. Optional dimmer row tie down bars shall be available to mechanically block each row of six dimmer modules into the rack and require the use of a tool. Dimmer supports shall be provided for precise alignment of dimmer modules into power and signal connector blocks.

4.) Rack spaces shall be mechanically keyed such that modules of greater current capacity cannot be accepted for that space. Racks that allow modules of higher wattage to plug into the same space shall not be acceptable.

5.) Multiple low-noise fans shall be provided to allow redundancy in case of fan failure. The fans shall maintain the temperature of all components at proper operating levels with dimmers at any load, providing the ambient temperature of the dimmer room does not exceed 95 degrees Fahrenheit (35 degrees Celsius). Air shall flow over the surfaces of the heat generating components using a combination of convection and fan assisted airflow. Each rack shall be outfitted with a lockable door that does not impede airflow in any manner.

6.) Fans shall be gradually controlled between off and full speed in order to minimize fan noise under all operating conditions. In the event of a rack over temperature condition, a warning shall be displayed on the rack LCD display and remote personal computer (via web browser) and control console (via web browser). If the temperature rises 5 degrees C over the warning threshold, the dimmer rack shall shut down automatically. The system shall also provide low temperature shutdown below 33 degrees Fahrenheit (1 degrees Celsius) to prevent condensation damage to system electronics.

7.) Load terminations shall be clearly marked with the dimmer rack circuit number. Signal terminations shall be by plug-in screw terminals or insulation displacement to facilitate contracting and servicing and shall be clearly labeled. Rear access shall not be required for rack installation and termination.

8.) Module numbering shall be clearly marked via a numbering strip on the front of the dimmer module tray. Standard number strips shall be available in two channel module configurations. Custom lamacoid number strips may be used on custom installations.

C.) Electrical.

1.) Dimmer racks shall operate at 90 to 264VAC 3-phase, 4 wire + ground or 90 to 264VAC, 1 phase, 2 wire + ground, 47 - 63 Hz at a maximum of 800A per phase. 2400A per phase bussing across adjacent multiple racks shall be possible.

2.) Load circuit wiring terminals for line, neutral, and ground terminals shall accept up to a #6 AWG wire. An optional terminal adapter accepting up to #2 AWG wire shall be available. The fault current protection of the rack shall be 50,000 AIC. Provisions shall be made for optional amp trap devices to provide 100,000 AIC fault current protection if required.

3.) Dimmer racks shall be available with side or bottom power feeds to meet a wide range of installation requirements.

D.) Rack Electronics, Physical.

1.) The main dimmer control electronics shall be housed in a Rack Processor Module (RPM). The dimmer control electronics shall be completely digital without employing any digital to analog demultiplexing schemes or analog ramping circuits.

2.) All rack setup and preset data shall be stored in a non-volatile manner and may be transferred to a replacement Rack Processor Module without losing data.

3.) Each Rack Processor Module shall have a back-lit LCD display with a six key (minimum) keypad for rack setup, preset control, testing, rack status, error and diagnostics. Bi-Color LED's shall indicate "Network Connection", "DMX512 Port A", "DMX512 Port B", "Processor OK", "Module Event", "Panic", "Over temperature" "Phase A", "Phase B", "Phase C", "Active Processor".

4.) An optional backup Rack Processor Module shall provide full redundant tracking processor functions. The Backup RPM shall track all setup, preset and other commands at all times without any operator action. The Backup RPM shall take over all communications and dimming control upon automatic activation.

5.) All rack setup and preset data shall be electronically transferable between the main Rack Processor Module and the backup RPM in case of the replacement of either of the modules. Rack set up data shall be stored in non-volatile memory.

6.) The Rack Processor Module shall provide signal connections in conjunction with optional power supply units. The RPM shall provide the only point for contractor connection of signal cables and PANIC activation. The contractor connections shall be made with two-part plug in screw terminals (dedicated connector per input) or crimped RJ45 connectors for ease of installation. The RPM shall feature an integrated Ethernet switch to permit the cross connection of up to 4 dimmer racks in a single dimmer room. RPM to RPM Ethernet connections shall be made with pre-made RJ45 patch cables.

7.) All DMX512 & RS485 communication ports and remote contact input connections shall be optically isolated from all processor electronics by a minimum of 2,500V RMS isolation.

8.) The Rack Processor Module shall have the provision to select any of a maximum of 96 dimmer outputs to be activated by the PANIC function. The PANIC function shall be activated or de-activated by one or more local or remote contact closures.

E.) Rack Electronics, Control and Communications.

1.) The control electronics shall provide the following control and communication inputs as standard:

a.) An Ethernet control input. This input can support a connection to a Strand ShowNet system. Each Ethernet control input can generate Reporting messages for the dimmer rack. This input shall also allow for local connection to a personal computer, providing setup, playback, dimming reporting features, and the ability to load rack-operating software.

b.) Two optically isolated DMX512 control inputs. The first input shall accept DMX512 only. The second DMX512 input may be configured to accept DMX512, or Strand Lighting's Vision.net architectural protocol.

c.) Optically isolated contact inputs, for external switching interfaces (24V 100ma). These closures are dedicated for:

1.) PANIC ON Momentary Turns Panic On.

2.) PANIC OFF Momentary Turns Panic Off.

3.) FIRE ALARM Maintained Turns Panic On, no Override.

F.) Rack Electronics, Features.

1.) The rack electronics shall provide two levels of operator interface:

a.) A local standard interface that includes 6 menu keys and a bitmapped backlit LCD display (minimum 16 character x 2 line) to access standard system menus.

b) A networked customizable Web based interface that includes status displays, configuration and maintenance utilities, integrated on-line help system, and alert emails. Support for wireless PDA's shall allow query and control functions.

2.) The dimmer control electronics shall have 16 bit (minimum) fade processing and a dimmer update rate better than 16 ms (60 Hz) or 20 ms (50 Hz). Dimmers set to the same level shall output within +/-.5V of each other, regardless of phase or input voltage, providing the desired level is less than the phase input voltage less the dimmer insertion voltage.

3.) The dimmer output levels shall be regulated for incoming line voltage variations. The regulation shall adjust for both RMS voltage and frequency changes of the incoming AC wave form. Regulation shall maintain the desired output voltage +/- .5V volt for the entire operation range (90 - 264 VAC). The regulation shall compensate for variations of the AC waveform on a dimmer-by-dimmer basis. There shall be no interaction between dimmers in the system or any other equipment. The output shall be regulated to the user programmable maximum voltage level on a dimmer-by dimmer basis. The processor response time to incoming line changes shall take no more than 16 ms (60 Hz) or 20 ms (50 Hz). Dimming systems that do not respond to line voltage and frequency variations shall not be acceptable.

4.) The control electronics shall allow the maximum output levels of individual dimmers to be adjusted, e.g. to compensate for load circuit voltage loss. The selected dimmer curve shall regulate so that the curve is proportional to the programmed maximum voltage.

5.) The RPM shall also have the capability to support dimmers of different types and sizes that may be mixed throughout the rack. Individual dimmers may be dimmed or switched (non-dim). The individual phase control or switching of positive and negative line voltage half cycles shall not be acceptable, as the net resultant DC line current may damage or degrade line supply transformers.

6.) As a standard, dimmer rack status reporting shall report the following conditions/data:

a.) Rack input line voltage per phase.

b.) DMX512 Port A input fail.

c.) DMX512 Port B input fail.

d.) Phase failure (A, B and C).

e.) Rack temperature.

f.) Rack overtemp warning (100 degrees Fahrenheit.) (37 degrees Celsius).

g.) Rack overtemp shutdown (105 degrees Fahrenheit.) (40 degrees Celsius).

h.) Rack under temp shutdown (32 degrees Fahrenheit) (0 degrees Celsius).

7.) IGBT dimmer modules shall be fully status reporting as a standard. Optional Dimmer Reporting Cards (DRC) can be factory installed into a standard SCR dimmer modules. All status reporting dimmers and shall report the following conditions/data:

a.) Dimmer type in slot. (Dimmer dipswitch set at factory).

b.) Load (Wattage) per dimmer.

c.) Deviation from recorded dimmer load.

d.) No dimmer load.

e.) Excess DC on dimmer.

f.) Overload on dimmer.

g.) Power device failure (short circuit or open circuit).

h.) Circuit breaker open.

i.) Dimmer fault.

j.) Change in dimmer type fitted.

k.) RMS Phase current per rack phase.

l.) Dimmer module temperature (w/module shutdown on and over temperature condition.

m.) Forced on at dimmer module.

n.) Dimmer panic.

8.) The control electronics shall provide the following setup functions that shall be user programmable on a per rack or system wide basis:

a.) DMX512 Port A patch.

b.) DMX512 Port B patch.

c.) Architectural controls for Vision.net control systems.

d.) Set rack and circuit ID's (CID).

e.) Dimmer reporting enable/disable. (By dimmer module).

f.) Set dimmer level (%).

g.) Set dimmer maximum voltage (12V - 260V in 1V steps).

h.) Set SCR dimmer maximum voltage (24V - 260V in 1V steps).

i.) Set dimmer minimum level (0 to 99%).

j.) Set dimmer curve.

k.) Set dimmer response time.

l.) Set control input priority logic.

m.) Set status reporting parameters.

n.) Program user curves.

9.) The DMX512 Port A and B patching shall support a rack start address and individual dimmer patch. The architectural patch shall define the rack circuit/room/room channel relationship for Vision.net control systems.

10.) The control electronics shall provide a facility to disable the output of any individual dimmer by setting the level to 0. It shall also be possible to enable and disable dimmer status reporting on a per dimmer basis.

11.) The control electronics shall contain Vision.net user programmable presets, a permanent blackout preset (preset 0) and a user-definable power up preset. It shall be possible to record individual preset crossfade times, including preset 0. The presets shall be user programmable as a snapshot of the current dimmer outputs resulting from all dimmer control sources according to selected control logic, on a per rack or system wide basis. Each preset may have an individual crossfade time between 0 seconds and 60 minutes.

12.) The control electronics shall support a user assignable "control lost" Vision.net preset. Each rack shall, in the event of loss of control signal according to the selected port logic, maintain the last levels for a user programmable period ranging from 0 seconds to 60 minutes. After this time period it shall automatically fade to the "control lost" preset. Alternatively it shall be possible to program the rack to indefinitely hold the last dimmer levels. It shall be possible to continue control without an active control signal using any of the architectural presets. Time resolution to be a minimum of one second.

13.) The processor shall provide an architectural Vision.net control system preset capability of 125 channels for each of 255 separate rooms with programmable fade times. Time resolution to be a minimum of one second.

14.) The system shall provide the ability to set one or a group of dimmers to any level.

15.) The control electronics shall provide the ability to set a library or user programmable 100-point curve (processor to apply a linear interpolation between the user points) to any individual dimmer. Library curves shall be:

a.) Square curve.

b.) S-curve.

c.) Linear power output curve.

16.) User selectable curves shall be:

a.) Non-dim (switched) with a programmable trigger level 0 - 99%.

b.) Electronic ballast fluorescent curve with a kick-start voltage and user programmable top set and bottom cut-off point.

c.) Magnetic ballast fluorescent curve with user programmable top set and bottom cut-off point.

d.) Five user defined programmable curves, programmed with up to 100 steps. The processor is to apply a linear interpolation between the user points.

17.) Each dimmer shall have one of three user programmable response (rack will fade to the new target level in the defined response time) in order to optimize lamp filament life and speed of operation:

a.) Fast (30 ms).

b.) Normal (100 ms).

c) Slow (300 ms).

18.) The system processor shall provide a number of user programmable control logic schemes, regulating the logical relationship between dimmer control sources It shall be possible to set the way in which various control inputs interact with each other to create priorities between all control inputs.

19.) It shall be possible to load new rack operating software via the Ethernet connection to the dimmer rack. There shall be no requirement to turn power to the rack off during the loading of rack

software, and in addition the Panic facility and Redundant Tracking Backup (RTB) processors shall be fully operational during software loading to the active processor. It shall be possible to load new rack operating software into the processor, regardless of the state of the program storage.

G.) Dimmer Modules.

1.) The dimmer modules shall be designed using advanced, state-of-the-art components specifically for entertainment lighting. IGBT dimmer modules for 120 volt applications shall be available in dual 20 amp and single 50 amp configurations. SCR Dimmer modules for 120 volt applications shall be available in single 20 amp 3 wire fluorescent, dual 15 amp, dual 20 amp, single 50 amp and single 100 amp configurations. Modules of similar types shall be interchangeable allowing systems with both SCR and IGBT dimmers to be configured freely. Systems that do not permit the mixing of SCR and IGBT dimmers shall not be accepted.

2.) The dimmer modules shall be designed using advanced, state-of-the-art components. The dimmer module shall be capable of "hot patching" cold, incandescent loads up to its full rated capacity without malfunction with the control signal at full ON.

3.) All single and dual dimmer modules shall be available with optional dimmer status reporting.

4.) The dimmer modules shall be fully plug-in and factory wired. Dimmer modules shall be of rugged and heavy-duty construction enclosed by a formed aluminum chassis. Power and signal pins shall be recessed in a self-aligning housing to avoid handling, storage, and insertion damage. A contoured handle shall be provided for ease of insertion and withdrawal. All chassis parts, except heat sinks, shall be properly treated, primed and finished in fine texture, scratch resistant, coating. Each module shall be labeled with the Philips Strand Lighting logo and rating. Modules constructed of molded plastic for structural support shall not be acceptable. Dimmer modules shall be ETL and cETL listed and CE marked devices.

5.) Dimmer modules shall be keyed so that dimmer modules of greater capacity shall not be interchangeable.

6.) Non-Dim modules shall be available to provide dedicated non-dim circuits not employing SSR devices. Dual modules shall be available providing non-dim/non-dim configurations. Each non-dim shall be provided with a primary circuit breaker of the appropriate rating. Non-dims shall be designed so they can be used for inductive loads.

7.) IGBT dual dimmer modules shall be available with current ratings of 20 amps. IGBT single dimmer modules shall be available with current ratings of 50 amps. Each module shall offer full dimmer status reporting to match all other modules in the C21 Advanced Technology product family. IGBT Dimmer modules shall be fully interchangeable with standard SCR dimmer modules of the same current rating and may be used in systems with standard SCR dimmers. They shall conform to the following specification:

a.) The insertion loss (voltage drop across the complete dimmer at full load current while producing a full output sine wave) shall be less than three volts RMS. Insertion loss at reduced dimmer loading shall not vary significantly from that produced with a full rated load. IGBT Dimmers with insertion loss greater than three volts RMS at full rated load shall not be acceptable.

b.) IGBT dimmers shall regulate dimmer output to within +/- 0.5 volts RMS of the assigned setting. Regulating response shall occur in the same power line cycle as the disturbance when the dimmer is in Reverse Phase Control (RPC) mode.

c.) IGBT dimmers shall not use zero cross detection to synchronize to the power line. Dimmer output voltage shall be unaffected by severely distorted or noisy power line waveforms.

d.) IGBT dimmers shall automatically switch from Reverse Phase Control (RPC) mode to Forward Phase Control (FPC) mode when inductive loads are detected. In RPC mode the dimmer is on from the beginning of the half-cycle until the desired output voltage is reached. In FPC mode, the dimmer turns on within the half-cycle and stays on until the end of the half-cycle. Use of RPC mode, when load type and other conditions permit, reduces the level of lamp filament noise. IGBT dimmers may also be user set to FPC or RPC modes for LED luminaires.

e.) LOW HARM mode shall reduce harmonic currents present on the feed neutral conductor by automatically switching the dimmers in the system to an optimum configuration of FPC and RPC operation. The reduction in neutral current shall be a minimum of 33% with a maximum of 100%, depending upon load sizes and their associated levels.

f.) Each IGBT dimmer will detect operating conditions and take active measures to protect itself (and the load). Protective measures shall include, but are not limited to the following:

1.) At power-up, each dimmer will detect excessive line voltages. When over-voltage is detected, the dimmer will not turn on its load. Dimmers shall withstand line voltages up to 230 VAC for an indefinite period and up to 280 VAC for fifteen minutes with no damage.

2.) Each dimmer shall detect excessive heat sink operating temperatures and automatically reduce its own "fall time", which minimizes the production of heat.

3.) Each dimmer shall detect load current in excess of its own rating. An overload will cause a dimmer to shut down.

8.) Each dimmer module shall contain circuit breakers, associated solid state switching modules, filters, power and control components.

9.) Standard dimmer electronics shall be completely solid state. They shall utilize two silicon controlled rectifiers in a back-to-back electrical configuration. The full load of the circuit is to be carried and controlled by the silicon controlled rectifiers.

10.) Each 120 volt dimmer shall be protected by a single pole fully magnetic circuit breaker of the appropriate current rating and 10,000 AIC surge rating mounted on the face plate of the dimmer module so that the trip current is not affected by ambient or rack temperature. The circuit breaker shall be rated for tungsten loads having an inrush rating of no less than 20 times normal current and shall disconnect the power to the dimmer module before damage can be done to the dimmer power components. The circuit breakers shall be rated for 100 percent switching duty applications and shall be UL, and cUL marked devices.

H.) Dimmer Module Power Devices.

1.) SSR power devices shall be encapsulated, epoxy filled high impact plastic cases with optically isolated firing circuits, control circuitry, and two silicon controlled rectifiers (SCR's). There shall be a minimum of 2,500 (4,000 in 50Hz systems) volts RMS of isolation between the AC line and the

control lines of the SCR. The SCR shall be in an industry standard format that is easily field replaceable without removing any other electrical or electronic devices.

I.) SCR Power Device Filtering.

1.) Each SCR power device dimmer module shall have an integral inductive filter to reduce the rate of current rise time resulting from the SSR switching on. The filter shall limit objectionable harmonics, reduce lamp filament sing and limit the radio frequency interference on line and load conductors.

2.) Basic Rise dimmers shall have a rise time of not less than 350 microseconds measured at 90 degrees conduction angle from 10% to 90% of output wave form with dimmer operating at maximum load. Voltage rate of rise (slew rate) must not exceed 420 millivolts per microsecond in any point of the wave under full load conditions.

3.) Medium rise time dimmers shall have a rise time of not less than 500 (250 at 50Hz) microseconds measured at 90 degrees conduction angle from 10% to 90% of output wave form with dimmer operating at maximum load. Voltage rate of rise (slew rate) must not exceed 300 millivolts per microsecond in any point of the wave under full load conditions.

4.) Hi-Rise dimmers shall have a rise time of not less than 800 (400 at 50Hz) microseconds measured at 90 degrees conduction angle from 10% to 90% of output wave form with dimmer operating at maximum load. Voltage rate of rise (slew rate) must not exceed 210 millivolts per microsecond in any point of the wave under full load conditions.

5.) IGBT dimmers shall have a rise time of not less than 1000 microseconds measured at 90 degrees conduction angle from 10% to 90% of output wave form with dimmer operating at maximum load. Voltage rate of rise (slew rate) must not exceed 210 millivolts per microsecond in any point of the wave under full load conditions.

J.) Approved Manufacturer and Products.

1.) Dimmer racks, modules and control electronics shall be Strand Lighting C21 Advanced Technology dimmer racks.

VISION.NET 4 CONTROL SYSTEM SPECFICATIONS.

SYSTEM OVERVIEW.

A.) System shall be a fully integrated digital lighting control system, utilizing digital communications between stations, and the control devices (dimmers, relays, and DMX-512 controlled equipment) in the system as required.

GENERAL.

A.) Capacities.

1.) The lighting system shall be fully scalable to meet the needs of complexes of any size. Each complex can consist of up to 1000 areas.

2.) Each area shall support up to 255 rooms with a maximum of 127 control channels per room, which can be connected to an unlimited number of dimmers, relays, or DMX512 controlled equipment. The control connection between stations and to C21, A21 and R21 dimming systems shall be via standard Cat 5e cable or Belden 9773 cable using the Vision.net control protocol. For DMX512 applications an optional Vision.net to DMX512 module shall be available.

3.) Star wiring shall be supported using any number of available 4 port Vision.net data hubs.

4.) Large-scale systems consisting of multiple Vision.net networks may be linked using a Strand Lighting ShowNet Ethernet network.

5.) No central processor shall be required. Systems requiring a separate processor shall not be acceptable.

6.) Connections to BMS systems shall be supported through the use of

a. Simple contact closures from the BMS system to a standard Vision.net AV interface card. Any number of cards may be used with 8 contact closure inputs per card. Each closure may be defined as a system room preset command, toggle command or Smart button command.
b. RS 232 serial interface modules shall also be available permitting simple ASCII text commands and acknowledgements between the BMS system and the Vision.net lighting control system. Commands may access any room or preset or through the use of Smart button commands multiple rooms and presets system wide.

B.) Interconnection.

1.) Each station shall be connected as an RS485 serial "daisy chain" using Belden 1583A Cat 5e cable or Belden 9773 cable.

2.) It shall be possible to change standard control stations at any location on the data network without requiring additional wiring or alterations to the wiring specification. Touchscreen stations shall require a separate power feed to operate the station electronics.

C.) Vision.net 4 Configuration Interface.

1.) The system shall support a digital communications link for station configuration and set up.

2.) An RS232 programming station shall be used for connecting a Windows PC operating Vision.net 4 Designer software to the Vision.net data network.

3.) A Windows PC can communicate either via an RS232 port or via the available network interface card.

VISION.NET 4 DESIGNER CONFIGURATION SOFTWARE.

A.) General.

1.) Vision.net 4 Designer software shall be a graphical set up and configuration programmed designed to operate under Windows XP (or later) operating systems.

2.) An astronomical clock shall be available on any system touchscreen capable of being programmed to any geographical location in the world. The clock shall be able to execute any number of daily, weekly or date specific events at fixed times, or offset relative to sunset and sunrise.

3.) Each system area shall support 127 control channels per room with up to 255 rooms per system. Any number of dimmers may be assigned to a room.

4.) Each room shall be capable of having any combination or quantity of control stations.

5.) It shall be possible to change stations at any location by replacing it with a different station type, and modifying the systems configuration file accordingly.

6.) Each room shall have 32 presets available, regardless of the number of rooms or number of channels within each room. Presets shall be selected from control stations, or shall be "played back" automatically by time clock events. Each preset shall have its own programmable fade, delay and hold time and may be linked for sequential playback in a single sequence, or using system macros if a continuous loop is required.

7.) Programmable delay, fade and hold times shall be available in the following increments; instant, 1 sec., 2 sec., 3 sec., 5 sec., 7 sec., 10 sec., 15 sec., 30 sec., 1 min., 5 min., 15 min., 60 min.

8.) It shall be possible to allocate a name or label to every room, panel, station, preset and group in the system.

9.) It shall be possible during system configuration to create macros using a "Smart" button. Smart buttons shall carry out a sequence of standard system commands. It shall be possible to program Smart buttons from any control station pushbutton, remote input or, automatically using the astronomical time clock. It shall be possible to assign any of the system commands to any station pushbutton, external device input, time clock event, or Macro step.

10.) In cases where an area is to be divisible for separate or combined control, it shall be possible to combine the constituent rooms either manually or with automatic partition switches. Rooms are combined using a "Room Link" touchscreen button. Rooms that are not linked shall maintain their own presets, levels and channels. "Room Link" coordinates the selection of presets within the combined rooms from any control station within those rooms.

11.). The following commands shall be programmable to any system button:

a.) Preset.

b.) Preset/Off.

c.) Toggle.

d.) Smart.

e.) Raise.

f.) Lower.

g.) State / Mode.

h.) Room Link.

i.) Console button.

j.) Share Button.

k.) CK Show.

l.) Set Clock.

m.) Suspend Clock.

n.) Toggle Master.

o.) Screen Saver.

12.) The system shall include an output simulation mode allowing the system designer to test all configurations prior to system installation.

13.) Touchscreen configuration shall be supported with simple drag and drop tab, button, slider, sliders, and text entities.

14.) Tabbed touchscreen pages may be created for:

a.) Buttons and Sliders.

b.) PaletteOS Monitor.

c.) Web Browser.

d.) Real Time Clock.

15.) Touchscreens may optionally be connected to a Strand Lighting ShowNet Ethernet network to connect to PaletteOS series control consoles or Network control devices. In this mode of operation, it shall be possible to view console pages that display information on Cues, Submasters, Macros, Lamp Check and Channels.

Vision.Net CONTROL STATIONS.

A.) Mechanical.

1.) The control station faceplates shall be free of visible fasteners and shall be of a pleasing aesthetic appearance.

2.) Control stations shall be supplied standard with a white finish, optional custom colors shall be available on request.

3.) On control stations with sliders, the sliders shall have 1.75" (45mm) travel with matching slider knobs.

4.) Control station push buttons shall have matching button caps with long life programmable LED backlighting. The backlight intensity shall be fully adjustable to allow for ambient lighting conditions. Backlighting shall be user definable with a choice of Blue, Amber or White. Different backlighting colors may be programmed to indicate the state of each button.

5.) Key caps shall be available with optional custom engraving.

6.) Each station shall inputs for up to 8 photo cells or occupancy sensors or any combination of these devices. The function of the sensors shall be programmable using the system design software and may be updated at any time.

B.) Operation.

1.) All control stations shall have a unique address between 1 and 255 configured at the initial system start up.

2.) A Vision.net control station may consist of sliders and button keypads with a maximum of 5 gangs per station.

C.) Installation.

1.) 2 gang and larger control stations require flush mounted masonry ("ears-in") back boxes, with a minimum depth of 3.5" (90mm). Back boxes must be grounded / earthed in accordance with local wiring practices to provide a discharge path to ground for static electricity.

2.) Control stations shall be supplied complete with a sub-plate, which is screwed to the flush mounting back box with the screws provided. The sub-plate allows the control station to be hinged into position and secured with hexagonal setscrews on the bottom edge of the trim ring.

3.) Touchscreen stations shall be available with surface and flush mount enclosures designed to simplify station mounting.

4.) Vision.net data line terminations shall be via a screw-terminal plug and socket to facilitate removing a control station while maintaining the continuity of the data network.

Vision.Net SLIDER WITH PUSHBUTTON STATIONS.

A.) Specific Features.

1.) Each station shall have a MANUAL (Take Control) button, which shall give control to the manually operated channel sliders.

3.) Stations shall be available with 3, 6, or 9 sliders plus a proportional master. It shall be possible to allocate several channels within a room to a single slider. Expansion stations shall be available to accommodate rooms requiring more sliders.

4.) Channels not allocated to a slider shall either go out or remain at the previously selected preset level when MANUAL is selected according to the configuration software.

5.) Sliders may also be configured in submaster mode allowing them to operate as group masters.

6.) All buttons may be programmed to overwrite their default settings. Each button may be assigned any of the following functions:

a.) Preset.

b.) Preset/Off.

c.) Toggle.

d.) Smart.

e.) Raise.

f.) Lower.

g.) State / Mode.

h.) Room Link.

i.) Console button.

j.) Share Button.

k.) CK Show.

l.) Set Clock.

m.) Suspend Clock.

n.) Toggle Master.

o.) Screen Saver.

7.) Smart button commands including room combine, cross room commands and commands to Strand Lighting PaletteOS controller consoles.

8.) If enabled pressing and holding any preset button shall enable recording, which will allow the current slider settings to be recorded into one of the presets available from the local pushbuttons. Fade times for these presets will remain unchanged by this record action.

9.) Within each room, MANUAL buttons can be configured to operate on a "last action takes precedence basis" where recalling a preset or pressing another MANUAL or TAKE CONTROL button will cancel the current selection. During the configuration procedure it shall be possible to

select "Override" mode for each room. In this mode an active MANUAL button can be canceled by toggle action. It shall be possible to define whether channels fade to the OFF preset or return to the previously selected preset when TAKE CONTROL is canceled.

VISION.NET PUSHBUTTON STATIONS.

A.) Specific Features.

1.) All button stations shall be fully configurable.

2.) Each button may be assigned any of the following functions:

a.) Preset.

b.) Preset/Off.

c.) Toggle.

d.) Smart.

e.) Raise.

f.) Lower.

g.) State / Mode.

h.) Room Link.

i.) Console button.

j.) Share Button.

k.) CK Show.

l.) Set Clock.

m.) Suspend Clock.

n.) Toggle Master.

o.) Screen Saver.

3.) Smart button commands including room combine, cross room commands and commands to Strand Lighting PaletteOS controller consoles.

4.) Each station shall store all active control information at all times. No central processor shall be required.

RS232 SERIAL INTERFACE PORT.

A.) Specific Features.

1.) The RS232 Serial Interface port allows a programming PC to connect to the Vision.net system for system configuration and operation.

DATA CABLE SPECIFICATION.

A.) Specific Features.

1.) Vision.net stations Belden 1583A Cat 5 cable.

2.) DMX512 Belden 9829.

3.) Vision.net stations shall be backwards compatible with Belden 9773, 3 twisted pairs, each pair individually shielded.

DOCUMENTATION.

A.) Specific Features.

1.) An Operations Manual and Installation Instructions are supplied with each system. Project installation & connection drawings shall be supplied as specified.

ENVIRONMENTAL SPECIFICATION.

A.) Specific Features.

1.) For all control stations and associated equipment, the following recommendations shall apply:

a.) Ambient temperature extremes: 32° - 104° F (0° - 40° C).

b.) Recommended ambient temperature: 64° - 77° F (18° - 25° C).

c.) Relative humidity: 10% - 90% non-condensing.

d.) General conditions: Office level cleanliness - Interior use only.