SECTION 26 20 00 - ELECTRICAL LOW VOLTAGE DISTRIBUTION WORK

1.01 [A7]SUMMARY:[A7]

A. [A7]**Basic Function**:[A7] The electrical low voltage distribution, defined for the purposes of this section as 600 volts or less, conveys electrical power to all electrical lighting and power loads and outlets, as well as fixed, low voltage electrical equipment, to meet their operational electric power requirements.

B. [A7]**Scope**:[A7] This section contains the performance and prescriptive specifications for the design and installations for low voltage lighting and power requirements in buildings and other locations in each [A17]locks complex. [A17] Buildings electrical and lighting systems, exterior outlets and lighting, and locks equipment electric motors shall be fed from motor control centers as described in Section 26 24 19 (*Motor Control Centers*) and Drawings No. 5802-400 and 5803-400.

[A16]1.02 REFERENCES: [A16]

A. **American National Standards Institute (ANSI) Standards**:

C80.1-2005	Electrical Rigid Steel Conduit (ERSC)
C84.1-2006	Electric Power Systems and Equipment Voltage Ratings (60 Hz)
Y32.9-1972 (1989)	Graphic Symbols for Electrical Wiring and Layout Diagrams Used in Architecture and Building Construction

B. **American Society for Testing and Materials (ASTM) Specifications**:

B 2-2005	Medium-Hard-Drawn Copper Wire
B 8-2004	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

C. **Federal Specifications**:

W-C-375D	Circuit Breakers, Molded Case, Branch Circuit & Service
W-C-586D (1)	Conduit Outlet Boxes, Bodies, and Entrance Caps, Electrical: Cast Metal
W-C-596G	Connector, Electrical, Power General Supp. 1
W-F-408E	Fitting for Conduit, Metal Rigid, (Thick-Wall and Thin-Wall (EMT) Type)
W-F-1814C	Fuses, Cartridge, High-Interrupting Capacity
W-J-800F	Junction Box: Extension, Junction Box: Cover, Junction Box; (Steel Cadmium or Zinc-coated)
W-P-115C	Panel, Power Distribution
W-S-610E	Splice, Connectors

W-S-896F	Switches, Toggle (Toggle and Lock) Flush Mounted (General Specification)

D. **Institute of Electrical and Electronics Engineers (IEEE) Standard**:

383-2003	Qualifying Class 1E Electrical Cables and Field Splices for Nuclear Power Generating Stations

E. **National Fire Protection Association (NFPA) Publication**:

NFPA 70-2008	National Electrical Code

F. **National Electrical Manufacturers Association (NEMA) Standards**:

FG-1-1994	Nonmetallic Cable Tray System
ICS 1-2005	General Standards for Industrial Control and Systems
ICS 2-2006	Industrial Control Devices, Controllers and Assemblies
ICS 6-2006	Enclosures for Industrial Control and Systems
KS 1-2006	Enclosed and Miscellaneous Distribution Equipment Switches
PB 1.1-2002	Panelboards Rated 600 Volts or Less
VE-1-2002	Metal Cable Tray System
VE-2-2006	Cable Tray Installation Guidelines
WC 5-1996	Thermoplastic-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
WC 7-1998	Cross-linked-thermosetting-polyethylene insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

G. **Underwriters´ Laboratories Inc. (UL) Standards**:

6-2004	Electrical Rigid Metal Conduit
20-2004	General-Use Snap Switches
67-2006	Panelboards
83-2006	Thermoplastic-Insulated Wires and Cables
198B-1995	Class H Fuses
198E-1994	Class R Fuses
360-2003	Liquid-Tight Flexible Steel Conduit
489-2006	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
510-2005	Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
651-2007	Schedule 40 and 80 Rigid PVC Conduit and Fittings
869A-2006	Reference Standard for Service Equipment
891-2005	Dead Front Switchboard

943-2006	Ground Fault Circuit Interrupters
1277-2005	Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
1660-2004	Liquid-tight Flexible Non-metallic Conduit
1682-2002	Plugs, Receptacles and Cable Connectors of the Pin and Sleeve Type

1.03 [A7]**REQUIREMENTS**:[A7]

A. [A7]**Safety Requirements**:[A7]

1. **General**: Equipment, boxes, cable trays, wiring and conduit shall be installed to secure the required results in accordance with NFPA 70.

2. **Certification**: Electrical materials shall be new and listed by the Underwriters´ Laboratories, Inc. (UL), wherever standards have been established by that agency. Instead of the UL listing, consideration will be given to certified test reports of an adequately equipped, recognized, independent testing laboratory competent to perform such testing, indicating conformance to the requirements of the applicable UL standards.

3 **Conformance to Codes**: Electrical design and installation, and spaces about electrical equipment shall conform to NFPA 70.

4. [A7]**Physical Protection**:[A7] The electrical installations shall provide a high degree of safety for occupants and visitors. Equipment and wiring shall be located and installed to reduce the possibility of physical damage. Equipment, cable trays, and conduit shall be adequately supported as per NFPA 70, to prevent deformation and physical damage.

5. [A7]**Protection**:[A7] Equipment and wiring shall be adequately protected from short circuit, overcurrent, overloads, ground faults and other electrical faults as applicable. Motors operating critical equipment, such as valves and gates shall be provided with phase failure and reverse phase protection. Panelboard feeder circuits shall be protected against voltage surges in accordance with Section 26 43 13 (*Transient Voltage Surge Suppressors*). Short circuit withstand ratings shall be as calculated under Section 26 05 73 (*Short Circuit and Load Flow Coordination Study*). Protective devices shall be coordinated to isolate the faulted equipment or wiring, without affecting the powering and operation of redundant circuits or equipment and of the rest of the electrical installation.

6. **Grounding**: Shall be in accordance with Section 26 05 26 (*Grounding and Bonding for Electrical Systems*).

B. [A7]**Accessibility Requirements**:[A7]

1. **Accessibility**: Equipment, wiring devices, conduits, and boxes shall be readily accessible and functional, avoiding interference with architectural and structural features, and with fire alarm, air-conditioning and ventilation systems, and other mechanical or electrical equipment.

2. [A7]**Physical Location Coordination**:[A7] Electrical outlets for appliances and other fixed electrical utilization equipment shall be coordinated with the location of such equipment.

C. [A7]**Expandability Requirements**:[A7]

1. **Spare Capacity**: Service entrance equipment, panelboards, and feeders shall have an amperes rating suitable for all connected loads and in addition at least a 50% spare capacity for growth.

2. **Stub Ups**: Where a flush-mounted panelboard is installed inside a room provided with a suspended ceiling, at least two empty, stub-up, 2" diameter conduits shall run from the panelboard to 30mm above the ceiling. Stub-up conduits shall be terminated with female adapters and shall be separated from each other by at least 0.30 m.

D. [A7]**Environment and Weather Resistance Requirements**:[A7]

1. Equipment metal enclosures installed outdoors shall be of corrosion resistant materials and shall be NEMA 4X weatherproof enclosures.

2. Boxes located outdoors or exposed to the weather shall be cast metal having threaded hubs and shall conform to Federal Specification W-C-586.

3. Interior electrical cables and wiring insulation shall be heat and humidity resistant.

4. Exterior electrical cables shall be flame retardant, heat and moisture resistant. Tray cables shall be termite resistant, oil resistant, and shall have a sunlight resistant jacket in accordance with UL 1277.

5. [A7]**Expansion Joints**:[A7] Where thermal expansion and contraction is anticipated, conduit runs shall be provided with expansion or articulated joints.

E. **Aesthetic Requirements**:

1. **Layout**: Conduit shall be concealed in walls, floors, and ceilings. Exposed conduit shall run parallel with or at right angles to building walls.

2. **Exposed Raceway and Conduit**: Exposed raceway or conduit shall be coated in accordance with Section 09 96 00 (*Corrosion Control Coatings*). Color shall match the color of adjacent finishes.

F. [A7]**Corrosion Protection Requirements**:[A7]

1. [A7]**Conductors**:[A7] Wiring conductors and bars shall be copper. Do not use aluminum wiring and bars.

2. **Conduits**: Use rigid galvanized steel conduit in above ground locations, and non-metallic pvc conduit in underground locations. Do not use intermediate conduit or electrical metallic tubing.

3. **Dissimilar Metals**: The contact between dissimilar metals shall be avoided where possible.

4. **Exterior Locations**: Metal conduits, boxes and electrical equipment unless corrosion-resistant shall be protected against corrosion with a corrosion control coating in accordance with Section 09 96 00 (*Corrosion Control Coatings*).

G. [A7]**Fire Protection Requirements**:[A7]

1. **Firestops**: Each conduit crossing an interior block wall or floor shall be provided with a firestop, to prevent smoke or fire from spreading to an adjacent

area or to another floor. Firestops shall be as indicated in Section 07 84 00 (*Fire Stopping for Communications Inside Plant*).

2. **Tray cables**: Shall pass IEEE 383 flammability and smoke resistance requirements.

3. [A7]**Neutral**:[A7] Neutral bars in dry type transformers, required under Section 26 22 09 (*Dry Type Transformers*), panelboards, and other electrical equipment shall be sized to carry the calculated neutral load, but shall not be smaller than 100%. Do not use reduced neutrals.

4. [A7]**Grounded Conductor**:[A7] Grounded conductor shall be the same size as the other current/-carrying conductors in the same circuit. Do not use common grounded conductor for different circuits supplying non-linear loads. Do not use reduced neutral conductor sizes.

H. [A7]**Maintenance Requirements**:[A7]

1. [A7]**Identification**:[A7] Electrical equipment and cables shall be identified in accordance with Section 26 05 53 (*Identification for Electrical Systems*), Cables passing through a pull box shall be clearly tagged to indicate their electrical system characteristics, circuit number, and panelboard designation.

1.04 [A7]DESIGN CRITERIA/SYSTEM DESCRIPTION AND PERFORMANCE:[A7]

A. [A7]**General**:[A7]

1. **Standard Products**: Materials and equipment submitted for approval shall be standard cataloged products of concerns regularly engaged in the commercial production of these products and shall be the latest standard design that conforms to the specifications. Products shall comply with ANSI C84.1.

2. **Nameplates**: Major components of equipment shall have manufacturer's name, address catalog number, model, style or type identified on a plate securely and conspicuously attached to each item of equipment.

3. **Identification**: Shall be in accordance with Section 26 05 53 (*Identification for Electrical Systems*).

B. [A7]**Electrical Power Requirements**:[A7]

1. **Power Supply**: Electrical power shall be provided to all lighting loads specified in Section 26 50 00 (*Lighting Systems*), power loads of fixed appliances and other electrical utilization equipment, and wiring devices, connected or furnished under this Section, loads described in Section 01 81 29 (*Electrical and Lighting Systems*), and in Section 01 81 36 13 (*O&M Buildings and Facilities – Space Programming*) inside or adjacent to the buildings and other locations at the Locks Complex.

2. **Maintenance Outlets**: Electrical power shall be provided at all exterior locations where repair and maintenance work is likely to be required, including station posts along [A17]Chamber[A17] walls, at the top of valve pits and at the top of lock gate recesses. At these locations, provide ground fault circuit interrupter receptacles for small power tools and three-phase outlets for welding machines.

3. **Shore Power**: Electrical power shall be provided for four (4) tugboats at lake entrance approach walls and for two (2) tugboats at sea entrance approach walls. Provide shore power receptacles matching the floating equipment plug-in devices.

4. **Dedicated Circuits**: Loads of different nature shall be fed from different dedicated electrical circuits, to provide flexibility for maintenance and repair, without affecting other loads. Motorized loads shall be fed from dedicated circuits. Circuits for electronic ballasted lighting fixtures, computer, CCTV, metal detectors, vehicular control systems, fire alarm control panel, and other non-linear loads shall be fed from dedicated circuits.

C. **Conduit**:

1. [A7]**Interior and Exposed Conduit**:[A7] In all interior electrical work and in exterior, exposed electrical work, conduit shall be galvanized rigid steel conduit conforming to ANSI C80.1 and UL 6. Conduit fittings shall be threaded and shall conform to Federal Specification W-F-408. Conduit shall be sized in accordance with NFPA 70, considering the number of conductors, temperature rating of wiring terminals, and exterior ambient temperature.

2. [A7]**Underground Raceway**:[A7] Shall conform to Section 26 05 43 (*Underground Ducts and Raceways for Electrical Systems*).

3. [A7]**Concrete Encased Conduit**:[A7] Shall conform to UL 651 and to Section 26 05 43 (*Underground Ducts and Raceways for Electrical Systems*).

4. **Flexible Raceway**: Flexible Metal Conduit shall be galvanized steel and liquid-tight, conforming to UL 360. Flexible Nonmetallic conduit shall be liquid-tight, conforming to UL 1660.

D. **Boxes**:

1. **Outlet, Extension, and Junction Boxes**: Each outlet shall be provided with a box to suit the conditions encountered. Concealed boxes shall be provided with the proper type extension or plaster rings where required and shall be set flush with the finished surface. Each box shall have sufficient volume to accommodate the number of conductors entering the box in accordance with NFPA 70. A means shall be provided in each metal box for the connection of an equipment grounding conductor.

2. **Pull Boxes**: Conduit runs shall not contain more than three 90-degree between pull points. Pull boxes and junction boxes shall be installed as necessary to comply with these requirements and where the length of the conduit run requires pull boxes for installation or to avoid damage to the wires and cables. Pull boxes shall be constructed without knockouts and sized in accordance with NFPA 70.

3. **Boxes**: Boxes shall have screw fastened covers. Box, covers and fittings shall conform to Federal Specifications W-F-408 and W-J-800.

E. **Wireways**: Each wireway shall have sufficient volume to accommodate the number and sizes of conductors and cables entering the wireway in accordance with NFPA 70. Wireways shall be NEMA 1 for interior locations and NEMA 3R for exterior locations. Wireways shall have screw fastened covers.

F. **Cable Trays**:

1. [A7]**General**:[A7] Cable trays shall conform to NFPA 70 and shall have dimensions, strength, and rigidity to support the cables plus a future cable load of 50%. Cable trays shall be exposed and accessible for cable maintenance and repair. All cable tray segments shall be supported to prevent tray deformation and stresses on cables, at intervals in accordance with the tray installation instructions. Cables shall be fastened securely to transverse members of the cable tray. Cable tray installations shall conform to the manufacturer requirements and ANSI/NEMA VE-2.

2. **Metal cable trays**: [A7]Shall conform to ANSI/NEMA VE-1.[A7] Cable tray sections shall be bonded in accordance to NFPA-70 and Section 26 05 26 (*Grounding and Bonding for Electrical Systems*). Ferrous metal cable trays shall be protected from corrosion with a protective coating in accordance with Section 09 96 00 (*Corrosion Control Coatings*).

3. [A7]**Nonmetallic Cable Trays**: Shall be made of flame-retardant material and shall conform to NEMA FG-1.[A7] Where used, adhesives shall be those recommended by the cable tray manufacturer. Hardware shall be stainless steel.

G. [A7]**Hangers and Supports**:[A7] Hangers and supports shall be spaced to prevent deformation or sagging of items supported. Hangers and supports shall be capable of supporting the installed loads plus an additional future load of 50%. Hangers shall be of corrosion resistant materials, securely fastened to walls, columns or other structural components. Fasteners shall be toggle bolts on hollow masonry block, expansion bolts on concrete or brick. Threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in place of expansion bolts, machine screws or wood screws. Do not use wooden plugs inserted in concrete or masonry.

H. **Wiring**:

1. **Conductors**: Shall conform to UL 83 and NEMA WC 5. Solid conductors shall be medium hard drawn copper conforming to ASTM B 2. Stranded conductors shall be soft drawn, Class B stranded, uncoated copper per ASTM B 8. Conductor electrical insulation shall be thermoplastic, Type THHN/THWN, 600-volt rated. Conductors shall be sized to carry the served load in compliance with NFPA 70, and to compensate for voltage drop, but in no case shall be smaller than #12 AWG. Conductors #12 AWG or smaller shall be solid, and #10 AWG and larger shall be stranded. [A5]Refer to Section 40 95 73 (Control Cables), Subparagraph 1.03 C for control cable requirements.[A5]

2. **Exterior Cables**: Low voltage distribution power cables installed underground inside ducts shall be flame retardant, heat and moisture resistant, cross-linked polyethylene insulated, 600-Volt rated, type RHH/RHW, USE for exterior cables inside concrete-encased ducts. Exterior cables shall conform to NEMA WC 7.

3. **Tray Cables**: In addition to other requirements, low voltage distribution power cables and control cables installed on cable trays shall be type TC, 600-volt rated, UL listed for cable tray installations in accordance with NFPA 70 and UL 1277. Tray cables shall have an overall, UL listed, sunlight resistant jacket in accordance with UL 1277. Tray cables shall be termite resistant, oil resistant, and shall pass IEEE 383.

4. **Control Cable**: Shall be as indicated in Section 40 95 73 (*Control Wiring and Cable*) and installed in rigid galvanized steel conduit in order to shield the system from induced voltages.

5. **Solderless Pressure Connectors**: Shall conform to Federal Specification W-S-610.

6. **Insulating Tape**: Exposed conductors and splices shall be covered with an insulating material equivalent to the insulation of the current-carrying conductors, to prevent contact with non-current carrying metal surfaces. Insulating material shall be insulating electrical tape, flame resistant vinyl, suitable for 600 volts and 80 °C, conforming to UL 510.

I. [A7]**Wiring Devices**:[A7]

1. **General Purpose Receptacles (convenience Outlets)**: Shall be furnished as required by NFPA 70 in Rooms and Buildings, required in Section 01 81 00 (*O & M Buildings and Facilities – Program*) and Section 01 81 36.13 (*O&M Buildings and Facilities – Space Programming*). Convenience outlets shall be duplex receptacles, rated 125 volts, grounding type, conforming to Federal Specification W-C-596.

2. **Wall Switches**: Independently of any other energy saving device or time control device, building lighting supplied under Section 26 50 00 (*Lighting Systems*) shall be controlled by separate wall switches at each space. Where a room or other space has separate entrances/exits, lighting control shall be provided at each entrance/exit. Each small fixed electrical utilization equipment such as ventilating fans supplied under Section 01 86 13 (*Plant – Mechanical Systems and Equipment*) shall be controlled by a wall switch. Wall switches shall be rated 120/277 volts, for use on alternating current only, shall conform to Federal Specification W-S-896 and UL 20, and shall be suitable for the control of incandescent lamp loads and inductive loads up to their full rated capacity.

3. **Ground Fault Circuit Interrupter (GFCI) Receptacles**: GFCI receptacles shall be provided at buildings, in accordance with NFPA 70. In addition, all 120-volt receptacles installed in exterior locations metallic locations such as inside locks gates, and humid or potentially humid locations such as [A17]Crossunder[A17] tunnels and cable galleries shall be GFCI type. There shall be at least one GFCI receptacle inside every Electrical Room [ELR], Gate Machinery Room [MRG], Valve Machinery Room [MRV] and the shop area in the Maintenance Building [MB] GFCI receptacles shall be duplex, 125-volt rated, grounding type and shall comply with UL 943.

4. **Dimmer Switches**: Lighting circuits, where required by Section 26 50 00 (*Lighting Systems*) shall be controlled by dimming switches. Dimming switches shall provide full range, continuously variable control of light intensity via a linear slider and shall have a separate on/off switch to turn the light on to the level set by the slider, or off. Dimmers shall be rated 120-volts, minimum 1000 watts, and shall be UL Listed for use with incandescent lamps and/or fluorescent lamps.

5. **Device Plates**: Each wiring device shall have a cover with color matching that of the device. Wiring devices and other power outlets installed in exterior locations shall have weatherproof covers.

6. **Maintenance and Shore Power Wiring Devices**:

   a. **Small Power Tool Outlets**: Shall be duplex, of the ground-fault circuit interrupting type, 20 Amp, 125 volt, single-phase, 3 wire, 60 Hertz, heavy duty, with NEMA configuration 5-20R grounding pole, in corrosion resistant aluminum body and hinged, weatherproof cover. Outlets shall conform to UL 943.

   b. **Welding Machines Outlets**: Shall be 200 Amp, 480 volt, three-phase, 4 wire, 60 Hertz, heavy duty, with grounding pole, in weatherproof, UV stabilized, nonmetallic body and hinged, weatherproof cover. Outlets shall conform to UL 1682.

   c. **Tugboat Shore Power Outlets**: Shall be 200 Amp, 240 volt, three-phase, 4 wire, 60 Hertz, heavy duty, with grounding pole, in corrosion resistant aluminum body and hinged, weatherproof cover. Outlets shall conform to UL 1682.

J. **Service Entrance and Distribution Equipment**: Service entrance equipment shall conform to UL 869A and shall consist of a main disconnect, switchboard and/or distribution panelboard, with ampere rating for the calculated loads and 50% spare capacity, and with a short circuit rating exceeding the calculated short circuit level for each location.

K. **Safety Switches**: Shall be fusible, horsepower rated, equipped with an external handle for manual operation. Safety switches installed indoors shall be in NEMA 1 general purpose enclosures. Safety switches installed outdoors shall be in NEMA 3R weatherproof enclosures. Voltage rating, ampacity, number of poles, and fuses shall be adequate for the connected load, in accordance with NFPA 70. Switches shall have positive, quick-make/quick-break mechanism, defeatable door interlock, provisions for padlocking in the "OFF" position, and shall conform to NEMA Standard KS 1 for Type HD [A17] (heavy duty) [A17] switches. Safety Switches, when used as Service Entrance Equipment shall have 50% spare capacity and shall be UL labeled for use as Service Entrance Equipment.

L. **Dry Type Transformers**: Shall be in accordance with Section 26 22 09 (*Dry Type Transformers*).

M. **Fuses**: Shall have a voltage rating of not less than the circuit voltage. The ampere rating shall be as allowed by NFPA 70.

   1. **Motor Branch-circuit Protection**: Fuses shall be nonrenewable, dual element, time delay type and shall be Class RK5, conforming to UL 198E.

   2. **Standard Class-H**: Shall have an interrupting capacity not less than 10,000 amperes RMS symmetrical and shall conform to UL 198B and to Federal Specification W-F-1814.

N. **Circuit Breakers**: Shall conform to UL 489 and Federal Specification W-C-375. Circuit breakers voltage rating, amperage, and short circuit capacity shall be as calculated for each feeder and branch circuit. In general, circuit breakers with short circuit interrupting capacity of 10,000 amps RMS shall be plug-in type and non-interchangeable trip type. Circuit breakers with higher ratings shall be bolt-on type. Unless installed inside panelboards, circuit breakers shall be of the molded case, totally enclosed type in NEMA 1 enclosure at interior locations or NEMA 3R enclosures at exterior locations.

Enclosed circuit breakers, when used as [A17]service entrance equipment shall have 50% spare capacity and shall be UL labeled for use as service entrance equipment.[A17]

O. **Switchboards**: Switchboards shall be dead front and shall conform to UL 891. Switchboards shall be surface mounted and shall have a rated capacity for the connected load plus 50% spare rated capacity. Switchboards used as [A17]service entrance equipment shall be installed at a location protected from the weather and shall be UL labeled for use as service entrance equipment.[A17]

P. **Panelboards**: Panelboards shall be rated for the intended voltage and shall be installed only in interior locations and shall conform to NEMA PB-1.1 and UL 67. Bus bars and ground bar shall be copper including full-size neutral. In addition to the required protective devices for distribution circuits, each panelboard shall have 30% space capacity for additional circuit breakers. Panelboard enclosures shall be NEMA Type 1.

1. **Types**: Distribution panelboards shall be surface mounted and shall have a rated capacity for the connected load plus 50% spare rated capacity. Distribution panelboards used as [A17]service entrance equipment shall be installed at a location protected from the weather and shall be UL labeled for use as service entrance equipment.[A17]

2. **Lighting and Power Panelboards**: Shall be flush mounted and shall have a rated capacity for the connected load plus 30% spare rated capacity. Lighting and [A17]power panelboards[A17] shall be rated for the intended voltage and shall conform to NEMA Standard PB 1.1 and Federal Specification W-P-115.

3. [A7]**Cover and Doors**:[A7] Panelboard enclosures shall include a hinged door covering all switching device handles. Doors shall have a cylinder lock and catch. Panelboards locks shall be keyed alike with two keys per lock. Trims for surface mounting panels shall have the same width and height as the box and trims for flush mounting panels shall overlap the box by at least 7 cm all around.

Q. [A7]**Electric Motor Disconnecting and Starting Equipment**:[A7]

1. [A7]**Electric Motors fed from Motor Control Center**:[A7] In general, electric motors shall be fed from a motor control center as required in Section 26 24 19 (*Motor Control Centers*).

2. [A7]**Electric Motors Fed from a Panelboard**:[A7] Electric motors of equipment and fixtures related to buildings may be fed from a panelboard branch circuit; shall have a means of disconnect, starting equipment, and short-circuit, overcurrent, and overload protection in accordance with NFPA 70. Motor [A17]starters[A17] shall be sized and rated for the satisfactory operation of the corresponding electric motor. The motor controller and controls shall comply with NEMA ICS 1 and ICS 2. Enclosures for controls shall conform to NEMA ICS 6.

R. [A7]**Explosion-proof Electrical Installations**: Shall be required in confined or enclosed spaces and at locations below ground level where hazardous vapors and gases may accumulate, as a result of nearby or interior industrial cleaning and painting operations, hazardous cargo spills or leakage from transiting vessels, or ozone produced by local arcing or environmental conditions.[A7] Typical locations where explosion-proof electrical installations are required are: [A17]Crossunder[A17] tunnels and shafts, and the passageway inside lock gates. Explosion-proof electrical installations, in addition to other requirements, shall comply with NFPA 70, particularly Articles 500 and 501 for Class I hazardous locations. All electrical equipment, including panelboards, circuit breakers,

wiring seals, conduit, boxes, lighting, wiring devices, tray cables, motors and controls, control, flood or fire alarm, and instrumentation and related wiring, shall be UL listed for use in such locations. Unless otherwise allowed by Code and practical considerations, all metal used inside such locations shall be non-spark, including cable tray, ladders and security cage. Ferrous metal surfaces shall be thoroughly painted to minimize the possibility of spark generation.

1.05 [A7]**SUBMITTALS**:[A7] Shall be in accordance with Section 01 33 00 (*Submittal Procedures*).

A. **Before Installation**:

1. **Equipment Certifications**: Certifications or technical data sheets of the proposed electrical system components showing compliance with the codes and standards shall be submitted.

2. **Calculations**:

   a. **General**: The Contractor shall furnish all relevant electrical calculations.

   b. **Wiring and Cable Size Calculations**: Calculations of conductor or cable length, size, ampacity, and voltage drop shall be submitted for each feeder and branch circuit

   c. [A7]**Equipment Capacity**:[A7] Calculations of connected load and spare capacity shall be submitted for each protective device, main disconnect, panelboard, and switchboard, including short circuit withstand ratings as determined under Section 26 05 73 (*Short Circuit and Load Flow Coordination Study*).

   d. **Coordination Data**: The Contractor shall submit coordination data for all protective devices.

3. **Certification of Listings and Approvals**: The Contractor shall provide certified copies of equipment current applicable approvals issued by UL, and/or other national recognized testing laboratory. Such certifications shall not be older than two years.

4. **Descriptive Data**: The Contractor shall submit descriptive data for review of the following proposed items:

   a. Wiring, cable, conduit, and boxes

   b. Hangers and supports

   c. Wiring devices

   d. Cable trays

   e. Service Entrance Equipment

   f. Panelboards

   g. Circuit breakers

   h. Electric motor disconnecting and starting equipment

5. **Electrical Design Drawings**: Complete sets of electrical design drawings and specifications shall be submitted in accordance with Section 01 33 00 (*Submittal Procedures*), for review before proceeding with installation work. Drawings

submitted shall include plan layout, location of each equipment and component, one-line diagram, details, panel diagrams, and schematic diagrams. Graphic symbols used shall conform to ANSI Y32.9. Electrical equipment on drawings shall be identified using the numbering system supplied under Section 26 05 53 (*Identification for Electrical Systems*).

B. [A7]**Taking-Over Submittals**:[A7] After field tests and commissioning have been completed satisfactorily, the Contractor shall furnish and deliver to the Employer's Representative the following, in accordance with Section 01 33 00 (*Submittal Procedures*) and Section 01 77 00 (*Taking-Over Procedures*):

1. Copies of Field Test Reports.
2. One set of reproducible tracings showing "as-built" conditions, including all modifications.
3. Sets of printout copies of the "as-built" drawings.
4. "As-Built" drawings in electronic format.

1.06 QUALITY ASSURANCE: Shall comply with Section 01 44 00 (*Quality Requirements*).

A. **Testing and Commissioning**: The Contractor shall conduct testing and commissioning work. Testing shall be in accordance with Section 26 90 00 (*Testing of Electrical Systems*). [A17]Commissioning shall be in accordance with Section 01 91 00 (*Tests on Completion and Tests After Completion*). [A17]

B. **Test Instruments and Personnel**: The Contractor shall furnish all instruments and personnel required for the tests.

END OF SECTION