City of Long Beach Harbor Department

Engineering Design Division

ELECTRICAL DESIGN CRITERIA

December 2017

Port of
LONG BEACH
The Green Port

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1.0 INTRODUCTION

Port of Long Beach contracted with P2S Engineering to develop and compile electrical design standards for both the Wharf & Backland areas. The objective of developing these standards is to establish a set of standards and rules that will be adopted by design professionals in preparing electrical designs and Contract documents for Port of Long Beach projects.

These Design Standards are the minimum Port of Long Beach requirements to be adopted for wharf and backland development projects. Standards may be modified and updated by Port of Long Beach to respond to changing designs, market conditions, construction, operational conditions and requirements. **Prior to relying on or implementing these Design Standards, the Engineer is to verify with Port of Long Beach that the Design Standard is current and contains the latest modifications.**

These Design Standards shall ensure that the implemented design and installation of the various electrical systems have an appropriate quality standard and incorporate a unified set of codes and standards where applicable and help standardization of these systems at the Port.

The Design Standards reflect the requirements of Port of Long Beach and consequently bring about standardization of electrical systems at the wharf and backland areas at Port of Long Beach.

The Engineer(s) are responsible for compliance with governing laws, codes and regulations of the relevant jurisdiction for the development project. Any potential conflicts with the Design Standards shall be referred to Port of Long Beach Chief Harbor Engineer for resolution.

The content of these design standards are organized into two main sections and include the following:

- **Wharf Design Section** includes design criteria for providing crane power and lighting at the Wharf.
- **Shore to Ship Power Section** provides design criteria for Cold Ironing Facilities and their installation and testing requirements.
- **Backland Design Section** includes design criteria for providing building electrical design, design for gates, street lighting, reefers and specifications for the materials to be used in the projects.
- **Specifications Section** covers specifications for all materials to be used in the projects and their installation requirements.

Appendices at the end of the sections provide standard port details for both wharf and backland designs and an electrical review check list.

These Design Standards address the specific development of electrical systems as part of the design and construction of a Project at the wharf and backland areas at Port of Long Beach. Application of these Standards to a substantially different project or location will require approval by Port of Long Beach Chief Harbor Engineer.

The Design Standards may not provide complete design solutions for the specific development of electrical systems as part of the design and construction of a POLB Project and or projects and situations at POLB. The POLB will provide additional interpretations and information to assist in integrating the design standards into the project design.

2.0 GENERAL ELECTRICAL DESIGN CRITERIA

The following electrical design criteria are to be applied to the development of electrical systems as part of the design and construction of POLB projects. These design criteria are intended to be followed as "Design Standards" for consultants and designers to implement in the preparation and use of Contract Documents for various projects, In addition to the requirements of the City of Long Beach Building and Safety and all the applicable codes, these Port of Long Beach standards shall be adhered to.

These guidelines are intended to provide designers with standards that are acceptable to the Port of Long Beach, and have proved to be satisfactory to Regulatory Agencies, End Users, Contractors and Contract Administrators. These Guidelines are not intended to be complete electrical requirements for a typical Wharf design, Shore to Ship power, or backland. Consultant and Engineer are responsible to prepare such requirements as part of their effort in producing Contract Drawings and Specifications.

If at any time there is a need to deviate from these guidelines, it will be necessary to obtain the Chief Harbor Engineer's explicit approval. It will be the responsibility of the Designer to verify that implementation of these design standards meet all applicable rules and codes and are satisfactory to the End User.

The consultant and designer are responsible for verifying the accuracy of the Port of Long Beach Design Standards, Specifications and notes, before copying the same into a project document. If corrections are necessary, consultant should notify and obtain approval of the Chief Harbor Engineer before proceeding further with the design.

2.1 Codes and Standards

All design work shall be conducted in compliance with all applicable Federal, State and local laws, codes and regulations.

The design of all electrical systems must be in accordance with these POLB design criteria, along with current applicable codes, standards, and regulations. It is the Designer's responsibility to determine the applicable and appropriate codes and standards that apply to each of the projects.

Electrical systems and equipment shall comply with the latest edition of the following codes and standards:

- California Electrical Code (CEC)
- American National Standards Institute (ANSI)
- City of Long Beach Municipal Code
- City of Long Beach Standard Plans
- City of Los Angeles Department of Public Works, Bureau of Engineering Manual*

- National Electrical Manufacturer's Association (NEMA)
- National Fire Protection Association (NFPA)
- Underwriters Laboratories, Inc (U.L.)
- Port of Long Beach Standard Drawings
- Illuminating Engineering Society (IES)
- California Energy Code
- Port of Long Beach CAD Standards

* The Port of Long Beach (POLB) owns and develops property located within the city limits of the City of Los Angeles.

Electrical design calculations and drawings must be signed by a registered Electrical Engineer licensed in the State of California. The calculations and design shall be complete and clearly presented, indicating that the design standards have been met.

2.1.1 Electrical Plans and General Notes

Make certain that the title of each drawing listed on the Title Sheet drawing index is identical to the title shown on the individual drawing itself. Avoid repetition. For instance; in the case of a conduit feeder shown on more than one drawing or detail in a Contract set, the information for the size and type of feeder conduit and associated conductors should be shown on a Feeder Schedule sheet. The drawings and details should then make reference to the schedule using feeder callout symbols or reference notes. When an "existing" design is shown on the plans, it is required to have a reference drawing number listed on the plans from which the "existing" information was gathered. This reference drawing number should also be listed on the Title Sheet.

2.1.2 General Notes

Where applicable, the following notes must be included on Electrical Plans under "General Notes"

- "When references are made to specific code sections, standards, guidelines and other similar references, they are intended to add emphasis to the requirements of that particular reference, and is not intended in any way to relieve the contractor of the remaining applicable references."

- "Contractor shall be responsible to perform testing of the ground-fault protection system after installed on site, in accordance with the National Electrical Code, Section 230.95(C)". A written record of this test shall be made and shall be available to the Engineer.

- Conduit that is to be abandoned and not required to remain as spare, shall have wires removed. The conduit ends shall be removed to a depth of at least 12” below the finished surface. Both ends of abandoned conduits shall be crimped, if conduit is metallic, otherwise cap ends with concrete. If abandoned conduit is terminated at a pull box/junction box, that end of the conduit needs to be capped with concrete and marked with a tag identifying as abandoned conduit.

- Conduit that is to be abandoned and required to remain as spare, shall have wires removed. The conduit ends shall be removed to a depth of at least 12” below the finished surface. Install a pull rope in the spare conduit. Both ends of spare conduits shall be capped. Both ends of the spare conduit must be identified with a marker located flush with finished surface. If spare conduit is terminated at a pull box/junction box, that end of the conduit needs to be marked with a tag identifying as spare conduit with a note describing where the opposite end of that spare conduit terminates. Such spare conduit termination should be similar to Port of Long Beach Engineering Division standard plan #E-70, titled “Conduit Stub Detail – Section”.

- All electrical equipment and materials shall be U.L. listed and labeled.

- All electrical drawings must be signed and stamped by a licensed Electrical Engineer in the State of California.*

**(FPN: City of Long Beach, plan check officer, will not accept nor approve electrical drawings without such signature by a licensed Electrical Engineer in the State of California).*

2.1.3 <u>General Requirements</u>

- When “existing” design is shown on plans, it is required to have reference drawing number listed on the plans where “existing” was copied from. This reference drawing number should be listed on the title sheet also.

- Whenever specifying instruments or special equipment, add provision for appropriate training by the manufacturer, for the use and maintenance of the item specified. Specifically for; Switchgear, lighting controls, sewer pump controls, high voltage splices and terminations.

- Make sure the title of sheet listed on the title sheet is **IDENTICAL** to what it is on the individual sheet itself.

- Identify each electrical drawing with an appropriate title. Titles on each drawing shall be unique. Similarly, details must have a unique title each. Such as; for two drawings avoid using titles as "Electrical Plan" for both, but rather "Electrical Plan – North Half" and "Electrical Plan – South Half". For details, avoid using "Detail" as title, but rather "Pull Box – Plan" and "Pull Box – Elevation" for instance.

- On large feeders, use Square D PowerLogic with circuit breakers. This will allow monitoring the feeders, breaker status, loads etc. from a remote office as well as locally.

- PowerLogic monitoring should be made available at the Port terminal where the switchgear is installed, and at the computer terminal of the electrical engineer at the Port, U.O.N.

- Provide a communication conduit to all switchgear areas within a project site, with conduit only provision tied to the Terminal's Administration building, or a control building within the project site, to facilitate wiring of the controls to the PowerLogic system.

- For outdoor lighting of terminals, use Square D Powerlink system, instead of contactors and photocells.

- With Powerlink system, there is no need to provide photocell.

- In addition to electrical code required nameplates, require contractor to provide Port of Long Beach identifying nameplate. The identifying nameplate information, printed on an appropriate surface, shall be installed inside the panelboard (or switchboard, or switchgear as the case may be) with the following information:

    - "Port of Long Beach
    - Panel xxxxx (Name of panelboard)
    - HD-Sxxxx (Specification Number)
    - HD 10-xxxx (Drawing Number)
    - Contact xxxxx (Name of person most familiar at POLB, and Telephone number)
    - Contact Manufacturer (Name of person most familiar by Manufacturer, and Telephone number)
    - Date (contractor's Notice To Proceed date).

- All electrical plans must include a One Line Diagram. No Exceptions.

- When specifying a new product make sure it meets the approval of the Chief Harbor Engineer, Port tenant/operator, and Building and Safety requirements.

- Avoid repetition. For instance; if conduit is shown on more than one drawing and detail in a contract set, the call out for the size of the conduit should be on one of the drawings or details, and the remaining drawings and details should make reference to that specific drawing for the size of the conduit.

- Manufacturer's name and part numbers should be on the contract drawings, and not in the specifications. Specifications should describe the features of the product specified on the plans.

- When designing specialty systems or equipment, such as Fire Warning System, cranes, hoists, or dimming system, avoid leaving it to the contractor to "design as needed". Rather, specify the model number and manufacturer's name of the hoist, for instance, and provide the branch circuit conductor and overcurrent protection necessary. If contractor substitutes, require the contractor to submit the whole system as shop drawing. This approach will minimize misunderstandings during construction.

- For outdoor enclosed disconnect switches, specify enclosure to be NEMA 3R.

- For NEMA 3R finish, specify as follows:

  > "The finish for outdoor, weatherproof, NEMA 3R enclosures, shall have all covers and doors thoroughly cleaned using a phosphate wash. Apply a zinc rich corrosion resistant primer and then a polyester powder coat suitable for a marine environment. Exterior surfaces shall be given a final finish coat of ANSI 61 light grey air-dried acrylic enamel, covered with a clear polyurethane top coat."

- Require the contractor to attach a permanent waterproof tag to all conductors in outdoor pull boxes and manholes. Instruct to have tags marked appropriately such as "480 V. Lighting control, Ckt. HS-2" for a circuit HS-2 that controls the lighting fixtures.

- As of 2010, for City of Long Beach Plan check, the 2008 California Electrical code applies.

- After contract drawings, as well as the electrical drawings, are considered 99% complete, make a study to determine plans have no interferences with conduit runs, gas lines, water lines, manholes, pull box locations, fire hydrants, lighting poles and similar structures.

- To be considered equal, write a similar note in specifications or drawings, such as:

"Manufacturer to be considered as equal must first submit all that is specified in contract documents for a similar work they have performed within the recent past five years. This submittal shall be complete and delivered to the Engineer in one package. This submittal will be first evaluated to determine if all that is listed in contract documents is included in the submittal package, any missing item will be adequate reason to not approve the submittal. If determined that the package is complete, it will next be reviewed to determine if the information contained can meet the requirements of the project specifications and industry standards. After successfully passing these two reviews, only then can the manufacturer be considered equal by the Engineer. The Engineer will make this final determination. Only after this approval is granted by the Engineer, will the contractor proceed with submitting shop drawings, by the manufacturer determined equal, in accordance with the plans and specifications."

2.1.4 Specifications

Use the specifications already adopted as the electrical standard specifications, as filed with POLB Engineering Division, Administrative Control Section. If changes are necessary to these specifications, notify Administrative Control Section to revise and adopt changes before proceeding to include in the final design specifications. If electrical standard specification is not available on a particular item from POLB, notify Administrative Control Section of proposed specification to review and adopt before proceeding to include in the final design specifications.

2.1.5 Removals

When giving instructions for removals, make sure its clear what is to be removed. Instruction such as "Remove pole" is not the same as "Remove pole, light fixture, footing, conduit, wires and all attachments to the pole" which is still not the same as "Remove pole, light fixture, footing, conduit, wires and all attachments to the pole and dispose of, off the project site".

If an electrical item is to be removed, verify and confirm whether the item will be removed and disposed of by the contractor, or if it is to be salvaged.

a) If it is to be disposed of, provide clear instructions on the contract drawings, that contractor shall be responsible for it.
b) If it is to be salvaged, provide clear instructions on the contract drawings, where exactly will the item be delivered to, and the contact person, by name and telephone number, who has agreed to accept it.

2.1.6 Quality Work by Contractor

To assure a qualified contractor for the construction of the project, add the following notes to the drawings, for major projects, such as a large terminal:

A. Contractor shall provide at the job site, a full time electrical engineer with minimum 5 years of electrical construction experience. The electrical engineer shall layout on plans the installation of electrical equipment, conduit trenching, terminations, wiring, and work pertaining to electrical construction, which shall be used by the electricians for field installations.
B. Contractor shall provide the personnel committed in its prequalification information. If these personnel are no longer available to the Contractor, the Contractor shall submit the name, experience, and resumé of a person meeting the same qualification requirements to the Engineer. If the Engineer deems the substitute qualified, that person may be used on the project. If the proposed replacement person is rejected by the Engineer, the process shall be continued until an acceptable replacement is found."

2.1.7 Utility Service Coordination

For projects which require electrical service from Southern California Edison (SCE), make contact with the SCE service planner early during the preparation of the plans with schematics, detailed plans, meetings and any other required communications to assure service is available at the necessary location within the requested time frame. Once an understanding is reached, a formal request for service letter should be sent to SCE (particularly for medium voltage services) stating the type, size, schedule and any other pertinent information specific to the project.

Complete the design for electrical service equipment in accordance with SCE requirements, including the requirements in their publication "Electrical Service Requirements." Keep utilities informed of project changes that may affect their work as the project develops.

If the project involves interruption of electrical power and communications to existing facilities which are required to remain in service, provide procedural information in the design to accommodate the facility requirements by providing temporary power and communications during construction and permanent service to the facilities upon completion of construction.

When a new metered service is part of the work, an address for SCE billing purposes should be shown on the plans, preferably on the single line diagram with the service meter.

For new electrical services and for buildings, POLB Design Group can issue a street address, and should be shown on drawings, where the new electrical service meter is shown.

For existing electrical services, the address assigned to it, must be shown on the drawing, where the electrical meter is shown.

If there is a cost charge for service connection by the utility company, and contractor must pay during construction, make sure to provide the note below and add to the applicable drawing:

"Contractor shall arrange to obtain the electrical service connection from SCE. Contractor shall be responsible for paying SCE charges for this service connection. Bids shall include a sum of $xxxx for each of these services by the contractor. If this SCE charge is less than $xxxx, contractor shall reimburse the balance to the Port. If it is more than $xxxx, then the Port will reimburse this extra to the contractor. This addition or reduction of change is strictly the difference between the SCE billing and the $xxxx included in this note. There will be no other considerations for profit, supervision, overhead, management or ANY OTHER similar items."

Note: For $xxxx above, inquire what the approximate cost is from SCE, and use that figure + 15%.

Make sure a letter from SCE is received and filed, stating that SCE will serve the new service. This letter should be from an SCE representative, before the project is advertised.

Make sure a letter from SCE is received and filed, stating what the SCE available interrupting current (AIC) is at the service point, before the project is advertised.

SCE prepares drawing showing how they will serve the customer's new service and where the service point will be. Include this drawing as part of the contract set, because the contractor will need to work off of this drawing and be in compliance with SCE requirements. POLB contract drawings must be checked by the engineer to make sure there is no discrepancy between POLB contract drawings with the SCE drawing.

Indicate on drawings and show detail that the maximum meter socket height measured from the center of the socket to the standing and working surface is six foot, three inches (6'3"). <u>SCE requires a name of contact person for correspondence.</u> That person's name, address and telephone number should be listed on the drawing, where electrical service meter is shown.

SCE does not want RED color cement around their ductbanks, just the natural gray color is sufficient.

Long Beach B&S, requires separate drawings for separately addressed sewer lift pumps. Provide a separate drawing, where applicable.

Provide the following note to drawings, where project requires new electrical service from the Utility company:

"Contractor shall be responsible to coordinate the electrical service connection by a) Notifying the POLB project manager, two months in advance of connection date required, to formally request the utility company to provide this service connection, b) To make sure the POLB project manager follows POLB procedures in notifying POLB Accounting, if POLB is responsible for billing. Otherwise notify the responsible party to request billing from the utility company."

2.1.8 Utility Service Coordination – Underground Installations

Note that SCE requires 2-1/2" service conduit size minimum. Always verify with SCE if electrical service design meets their approval.

SCE requires to show on service pole, the service riser conduit and the weather proof entrance cap. Reproduce this detail in contract drawings, and make reference to SCE standards.

SCE requires a note on the plans to state; "The Contractor shall install a service feed conduit from the existing SCE Transformer to the SCE service pole near the transformer per SCE requirements. The contractor performing this work shall be an SCE approved contractor."

SCE requires risers to their poles to be PVC schedule 80.

SCE requires that manhole covers be provided with provisions for lifting the lids. Reproduce drawing, that SCE has provided the POLB, onto the contract drawings. Reproduce only the manhole cover, not the lifting device onto POLB contract documents. Verify both with SCE and manufacturer that what's on the drawing is still valid, available, acceptable and applicable to the project in consideration. (Electronic copy of drawing is filed under "SCE Manhole Cover")

2.1.9 Electrical Drawings Organization

The drawings should be organized such that they begin with an overview and proceed with increasing detail. For most projects, this order should be:

- General Notes, abbreviations and symbol list

- Site electrical plan or key plan
- Single line diagram
- Conduit, feeder and pullbox schedules
- Power plans.
- Lighting plans.
- Communication plans.
- Fixture schedules, panel schedules and details
- Control and instrumentation details and schematics
- Plans and details for fire alarm, security, intercom and other data systems

2.1.10 Materials and Equipment

Equipment installed in outdoor locations should be suitable for a marine environment. Finish on all outdoor equipment should meet the requirements of ASTM B 117. Finish color shall be ANSI No. 61 light gray. Hinge pins and normally unpainted hardware shall be stainless steel.

Equipment mounting should be designed to resist forces encountered in Seismic Zone 4.

Distribution equipment should be sized to handle the connected loads combined with 25% spare capacity minimum.

Panels and switchboards should be designed" with minimum 20% additional space for breakers and additional 10% spare circuit breakers should be included in all panels and switchboards.

2.1.11 Products

When specifying a product which may be new or unusual to the Industry or product substituting what is specifically called for in this Guideline, make certain it meets the approval of the "Chief Harbor Engineer, Port Tenant/Operator, and Building and Safety requirements.

Manufacturer' s name and part numbers should be included on the Contract drawings, and not in the specifications. Specifications should describe the features of the product identified on the plans.

Include requirements for all equipment warranties to provide names and phone numbers of Installing Contractor and Manufacturer, warranty period, related manuals, drawings and specifications.

2.1.12 Calculations

Perform calculations as required to determine equipment ratings, conductor sizes, quantities and types of luminaires to satisfy user and plan check requirements.

Short circuit calculations and over-current protection coordination curves shall be included whenever the project includes new distribution equipment. Voltage drop calculations should be performed on all circuits to verify that the worst case voltage drop for any combined feeder and branch circuit is less than 5%, per the N.E.C. A statement confirming this voltage drop compliance should be included on the plans, or alternatively, voltage drop results can be shown individually on the single line diagram.

Require a review of the short circuit and coordination study with the POLB's engineer, when this study is completed and after the report is submitted to the POLB for evaluation. This review period should be one day, eight hours long, and contractor must have the engineer, who prepared the report, available during this review period. (For smaller projects, require a 4 hour long session for such review).

Make sure available short circuit current is indicated on the plans at the service point and at all panelboards and switchboards.

Make sure the characteristics of the first upstream protective device is also indicated on the single line diagram. If this device is a fuse, provide the manufacturer model number and ampacity. If a relay is applied, then provide the manufacturer model number and CT setting.

Indicate on single line diagram, what time margin SCE requires between the SCE protective device and the POLB main overcurrent at the maximum fault level.

Cable pulling calculations should be performed on long conduit runs or runs with complex multiple bends. Pullboxes shall be located to accommodate the distribution design and to prevent pulling stresses from damaging the cable being installed.

Lighting calculations should be performed to insure that lighting levels meet the minimum requirements for various tasks and areas as determined by the I.E.S. standard and POLB requirements. Site lighting design for terminals should include a computer generated point by point plan of lighting levels in footcandles.

Energy conservation calculations should be performed for interior lighting according to the California Energy Commission's energy efficiency standards for non-residential buildings. Forms, worksheets, instructions and samples are detailed in the California Energy Commission's Manual for compliance with the energy efficiency standards.

California Electrical Code requires flash protection. Include in specifications the requirement to provide arc flash calculations in accordance with IEEE Std. 1584, stamped and signed by a licensed electrical engineer in the State of California. Include in specifications that contractor shall provide labels for arc flash and shock hazard, attached to equipment, in accordance with the Code.

The note on POLB drawings should read as follows:

“CEC requires flash protection. Contractor shall provide arc flash calculations in accordance with IEEE Std. 1584, stamped and signed by a licensed electrical engineer in the State of California. Contractor shall be responsible to provide labels for arc flash and shock hazard, attached to each electrical equipment, in accordance with the Code."

Reproduce POLB standard detail on drawings titled “Arc Flash Calculation Results” and POLB standard detail titled “Arc Flash Label” as shown on detail sheet E-87. included in Appendix.

2.1.13 Alarms

Some installations are required to have an alarm installed, such as fire protection system and sewer lift stations. When such alarms are designed, consultant shall coordinate with POLB and any other interested parties, to transmit the alarm signal to the proper area, and to design an appropriate sign to be posted at the alarm equipment that reads “(insert telephone number) CALL FOR ALARM”.

2.1.14 Control Wiring

Whenever control wiring is included in the contract drawings, such as controls for sewer pumps, and lighting controls, include a narrative describing the steps of operations, and the function of the components.

Include in the specifications, that contractor will provide similar narratives as above, with the submittal of such shop drawings.

2.1.15 Grounding

Copper-clad steel grounding electrodes, each with ¾” diameter and 10 ft length, shall be used for grounding where needed. Where a ground rod is needed, a ground well set flush with the finished surface shall be provided as required by the City of Long Beach Building and Safety Department. Otherwise, the ground rod and the attached grounding conductor may be buried under the finished surface or terminated above the finished surface in accordance with the National Electrical Code. Where multiple ground rods are to be installed, rods shall be placed at least 15 ft from any adjacent rods.

The ground resistance shall be measured by employing the "fall-of-potential" method using the Biddle "Megger Earth Tester" with two electrodes. This method shall be required in the specifications. The specifications shall also require that any grounding system test reports include the soil temperature at the time the test was conducted. The specifications shall require the Contractor to provide a copy of the test reports certified by the testing technician and the Engineer's representative authorized to witness the test.

Following notes shall be added on drawings covering WATER SYSTEM:

> "Water system installed must be approved for electrical grounding and bonding purpose. Proper pipe couplings must be installed and approved for electrical grounding system."

On ELECTRICAL drawings make reference to this requirement and refer contractor to see this note on WATER SYSTEM drawings.

2.1.16 Nameplates and Warning Signs

Ensure all nameplates and warning signs are specified on the drawings and required to be installed by the contractor.

2.1.17 Information Technology Equipment Room

NEC no longer recognizes "Computer Room", so identify room as "Information Technology Equipment Room".

2.1.18 Warranties

Warranties shall be provided for all products and systems. The name and phone number of the Contractor/manufacturer, years of warranty, related drawing and manual/specification shall be included in the warranties.

2.1.19 Operations and Maintenance Manual

The Operations and Maintenance Manual shall have a cover page that includes as a minimum: Title, specification number of the Port of Long Beach project, the Port of Long Beach base drawing number of the contract set, date the manual was prepared, person to contact regarding the manual and his/her telephone number.

2.1.20 Fire Department Requirements

When a terminal is developed, Fire Dept. requires an address posted by the main gate of the terminal. Provide an appropriate sign to the satisfaction of the Fire Department, and coordinate with the Fire Department to assure their approval after the sign is installed.

2.1.21 Switchgear

Show switchgear schedule, as well as panelboard schedules, on the plans. The schedule should also indicate clearly the overcurrent devices specified, its manufacturer, the type, and the electrical ratings should be spelled out for each overcurrent device.

Provide 25% space in switchboards and panelboards, for adding future circuit breakers.

Do not specify “series” rated circuit breakers. If an application of “series” rated breakers is necessary, obtain the Chief Harbor Engineers approval to do so.

Provide means inside switchboard to hold spare fuses under lock, with instructions on what type of fuses to purchase and name and address of vendor to purchase from. This requirement is for large fuses, that are not commonly stored in warehouses, or fuses that are critical to a terminal, or load it serves.

Ask for certified test summaries for switches, such as a 600Amps, 5KV or 15KV switches that Square D has. Certified Test Summary must list the tests done, and the test file numbers, and must be signed and dated with staff engineer and manager.

Require contractor to furnish engineering report signed by a registered electrical engineer, that switchgear equipment is installed and tested as recommended by manufacturer.

Include wording in specifications to have contractor provide nameplates, on the EXTERIOR doors of switchgear, to identify the name of the switchgear section, or feeder number etc., or work out a detail for each section, indicating the size of the nameplate, the wording on the nameplate, and the method of attachment to the board.

Require contractor to record ground fault protection tests, and results to be furnished to engineer in a report form signed by a registered electrical engineer.

Specify if conduit routing into the switchgear is from the top or from the bottom.

Require hinged doors for switchboards and panelboards.

Require contractor to provide appropriate conspicuous signs required by Code around high voltage switchgears, such as:

> “WARNING – SWITCH MAY BE ENERGIZED BY BACKFEED”
>
> “WARNING – FUSES MAY BE ENERGIZED FROM MORE THAN ONE SOURCE”

“WARNING – DO NOT OPEN UNDER LOAD”

- In addition to this minimal warning sign, require the contractor to add the POLB drawing number on the sign, to facilitate electricians in locating the source or cause for the warning.

Have concrete pad designed thoroughly for switchgear.

Provide the seismic calculations required.

Make sure code required clearances are considered into the design, around all switchgears and panelboards.

Verify with manufacturers of the switchgears specified on the plans, as to which side(s) of the switchgear, access is required per code.

Make sure rebars are shown on the plans clearly, as to the size and quantity.

Show coordinates, or referenced dimensions, for all corners of the pads, with elevations.

2.1.22 Transformers

Specify dry type transformers with high efficiencies. Efficiency of 97% or more. In the specifications, list the load and no-load losses of the transformers. Specify that total-owned-cost of transformer will be evaluated for a period of 20 years, with electricity cost at 15 cents a KWH.

Where transformers are required to meet the NEMA TP 1 standards for Energy Efficient Transformers, include the following wording in the specifications:

> “Ventilated dry type distribution transformers rated 15KVA and larger shall have energy efficiencies that meet or exceed the latest requirements of the California Code of Regulations Title 20 and Title 24, NEMA TP 1, and applicable local codes and ordinances. Transformers shall be Energy Star labeled. Transformer manufactured date must appear on label.”

Select transformer during preparation of plans, and identify the manufacturer’s name and transformer part number, and list so on the drawing.

In specifications, require a test report on transformers with shop drawing submittals, on similar transformers as required in design, certified by a company official.

Require contractor to provide nameplate with the following information:

1) Power ratings in KVA or MVA including nominal and force cooled ratings if applicable.
2) Impedance expressed in percent.
3) X/r ratio.
4) Primary Voltage rating.
5) Secondary voltage rating.
6) Neutral grounding configuration – solidly grounded, impedance grounded, or high resistance grounded. When the neutral is impedance or resistance grounded, indicate the impedance or resistance values.
7) Is the transformer supplied with automatic primary tap Changers? If so, what is the response time?
8) Is the transformer supplied with fixed primary taps? If so, what are the tap ratings?

2.1.23 MOTEMS

When projects involve MOTEMS requirements, provide POLB with a copy of the final approved document as submitted to the California State Lands Commission, Marine Facilities Division for their Electrical Engineering Review.

3.1 Power

Electrical power to the Wharf area shall be designed using the Site Terminal medium voltage loop distribution system (typically distributed throughout the yard at 12,000 volts or higher) and converted to utilization voltages for the wharf cranes, lighting and equipment via intermediate substations.

Wharfs with existing 4.16kV distribution system shall be addressed with the POLB before starting design of the project. A detailed discussion with POLB shall be undertaken to determine voltage and layout of trench.

3.1.1 Crane Power Supply

Electrical power supply to the cranes shall be provided from crane substations supplying 12,000V power via a bus collector or trailing cable system installed below grade in a trench along the entire length of the wharf. The trench shall be located adjacent to and on the waterside of the waterside crane rail. No crane bus transitions shall be allowed in the middle of berths.

A detailed discussion with POLB shall be undertaken to determine voltage and layout of trench. Terminals with existing 4.16kV distribution system shall be addressed with the POLB before starting design on the project.

An analysis shall be provided for the crane bus bar and feeder calculations, voltage drop, and short circuit withstand rating. Isolation bars, expansion joints, and feeder connection points shall be staggered on all three phases, as opposed to side by side and in line.

A weld shall be placed around the entire bracket when it is welded to the anchor plate

3.1.2 Crane System

The Contractor shall complete installation; include bus bar alignments and elevations, include torque connections and bolts based on Conductix Insul-8 provided data, secure all caps and covers, and clean the bar system including the power trench. Inspection should be coordinated with the Port.

Detail of the wharf trench and crane rail are shown in Figure 1, through Figure 4.

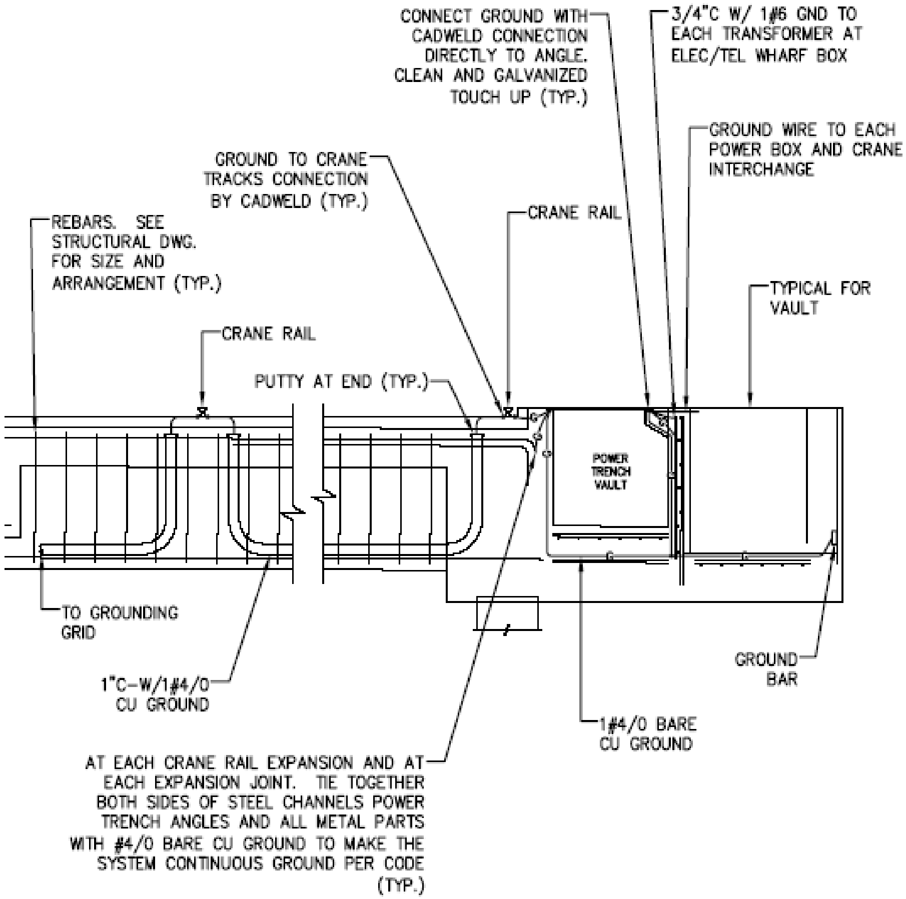

Figure 1: Wharf Trench and Crane Rail Cross Section

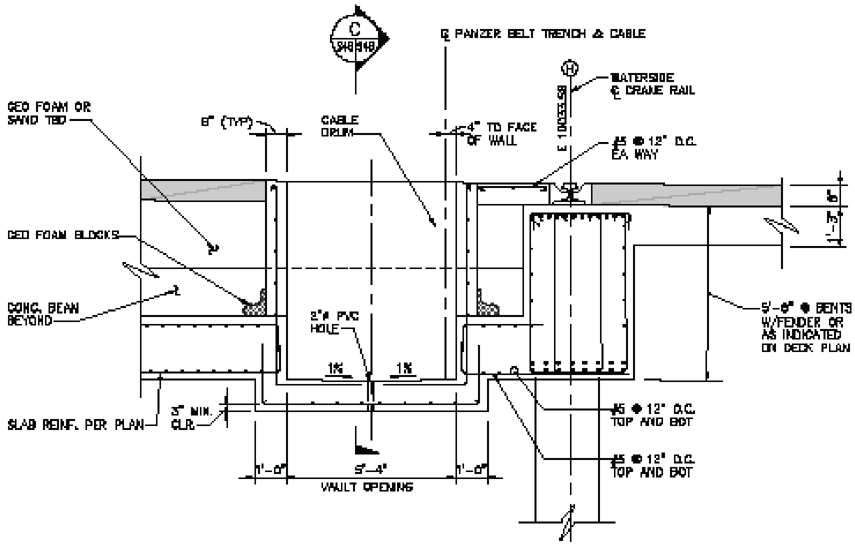

Figure 2: Crane Power/ Cable Vault Cross Section

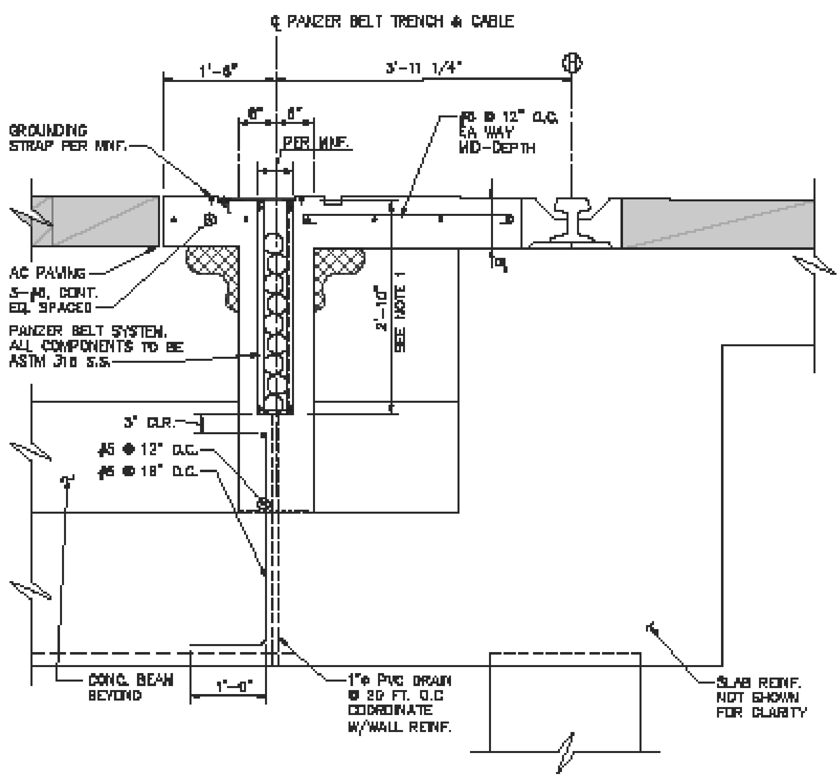

Figure 3: PanzerBelt Trench and Cable Detail

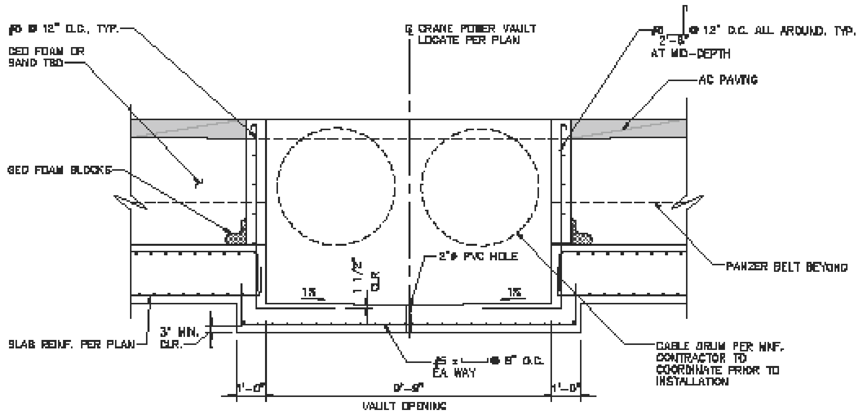

Figure 4: Cable Drum Vault Detail - Section

3.1.3 <u>Crane System Details</u>

High potential dielectric tests of the new bus system shall be performed. Results of these tests are to be provided to the Port. Tests shall be conducted by a qualified high voltage testing Contractor using a 20kVDC (15kVAC) high potential test instrument for a 5kVAC conductor bus and a 38kVDC (27kVAC) high potential test instrument for a 15kVAC conductor bus. Test results shall be followed with a certified test report that includes the make and model of the test instrument, the date of the last calibration of the test instrument, a statement on the weather conditions including temperature, the signature and electrical license number of the high voltage test technician, and the date of the test.

Table 1 Maximum Acceptable Leakage

Conductor Length (ft)	Maximum Acceptable Leakage (total based on system length) (mA)	Test Unit Size Required (for AC test unit, increase size by 40% for DC units) (VA)	
		5kVAC Conductor Bus	15kVAC Conductor Bus
100	7.5	110	200
200	15.0	220	410
300	22.5	330	620
400	30.0	440	830
500	37.5	550	1040
600	45.0	660	1250
700	52.5	770	1460
800	60.0	880	1670
900	67.5	990	1880
1000	75.0	1100	2090
1500	112.5	1210	3130
2000	150.0	1320	4170
2500	187.5	1430	5210

Prior to testing, people in the vicinity of the high voltage test shall be instructed to clear the area. The system shall be free of trash and debris. Each phase of the conductor system shall be tested to ground and to each of the other phase conductors. The test leads shall be connected according to the High-Pot test unit instructions. The voltage shall be gradually increased to the required level and held for one minute. If the system leakage is within the levels outlined in the above table then the field test is a PASS. After the test has been passed, power shall be energized to the bus.

3.1.4 Crane Bus bar System

FPN: Where used, the design of the bus bar system shall follow the standard design and specifications that were developed for Pier S Wharf design, Spec. No. HD-S2l60. Include crane bus bar analysis and feeder calculations.

3.1.5 Bus Bar Construction Notes:

Bus bar construction notes are to be included in bus bar design Schedule of activities to energize new crane bus bar system:

- Contractor to complete installation; include bus bar alignments including elevation, torque connections and bolts based on Insul -8 provided data, secure all caps & covers, and clean bar system including the power trench.

Work above will be inspected by POLB Inspector.

3.1.6 Crane Transition Section:

Crane transition section allows cranes to transfer from a bus fed from one feeder to another bus fed from another feeder. Feeders may be from one source.

System is designed so that when utility power to the transition section switchboard is interrupted, (such as power interruption from SCE or feeder damage to switchboard), the controls for the transition system automatically revert to manual mode, regardless whether the controls were on automatic mode or not. Activation to automatic mode, is done with a manual switch re-setting to automatic mode.

Make sure Synch Check Relay is set correctly.

(FPN: Pier G (HD-S2170) Basler relay was installed and set at 1degree phase setting. Basler was recording many failures due to this close setting. This setting was increased to 5 degree, which was adequate. Analysis is required as to what the appropriate setting ought to be.)

(FPN: POLB and terminal operator must be made aware that once crane transition system is installed, operator of the system, need to be familiar of the requirements and limitations of the system and be able to make adjustments necessary for uninterrupted operation of cranes moving through the transition section. Such familiarity requires:

Knowledge of Basler relays (or equivalent unit by others) as to how they are set and what the settings mean. Interpretations of events caused by the relay.

Knowledge of crane operations at the terminal and hours of operation of the terminal will facilitate interpretation of Basler relay events)

3.1.7 Crane Substations

Crane substations shall be designed with redundant equipment in order to provide a highly reliable power supply to the cranes. Redundant components of a crane substation (or each substation where separate redundant substation are designed) should be sized to carry the load of all the available and anticipated future cranes.

3.1.8 Wharf Distribution and Communications

Electrical distribution to wharf outlets, lighting, support buildings, etc. shall be provided via an underground conduit duct bank and manhole system fed from intermediate substations. The substations shall be located in the vicinity of the equipment or buildings to be supplied, and the power transformed to the required service voltage. On large feeders, use Square D circuit breakers with PowerLogic feature to allow local and remote monitoring of feeders, circuit breaker status, loads, etc.

Outdoor enclosed distribution equipment, switchboards, panelboards, disconnect switches, etc. shall be rated NEMA 3R.

Communication conduits shall be provided in an underground conduit duct bank, manhole system and shall be designed to follow the routing of electrical duct banks to reduce the amount of trenching wherever practical. Conduits shall be equipped with pull strings for the installation of communication cables. Communication conduits shall be designed to provide a raceway system for Telephone, Data, Intercom, Fire Alarm, Security, Fiber Optics, and miscellaneous terminal equipment as required to individual buildings, light poles, camera poles, etc. throughout the Wharf area. All conduits shall have adequate space, bending radius, and pull string to allow for the installation of required cable without damage from pulling tension or equipment.

3.1.9 Underground Electrical Work

For underground conduits, Schedule 40 PVC conduits shall be used in wharfs. Type EB conduits shall not be used. The top of the underground conduit bank shall be a minimum of 3’0” below the finished surface. Pull ropes shall be provided in all empty conduits, including stubbed conduits or dead end conduits. For communication conduits between manholes, and structures, a minimum of 4” conduits should be provided. For a typical conduit at expansion joints, see Figure1 below.

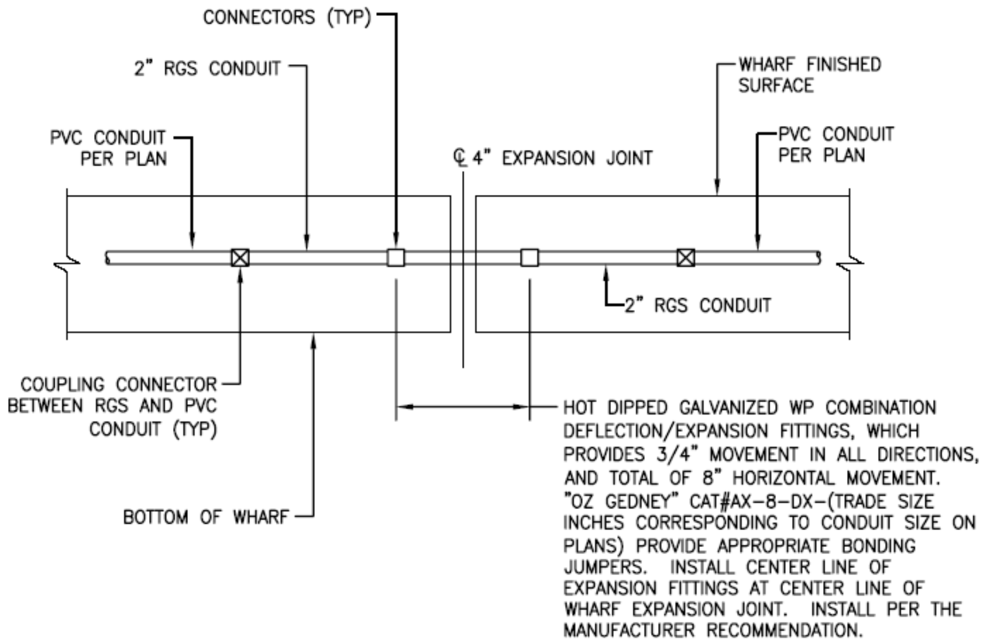

Figure 1: Conduit at Expansion Joints

Conduit stubs shall be capped with plastic caps, not with metal caps. For conduit stub detail, see Figure 2. The brass cap shall be engraved, indicating E or T, conduit quantity, and size. All actual stub-out locations shall be shown on record drawings. One 90 degree elbow conduit and engraved brass cap shall be provided per duct bank. All conduits shall have adequate space, bending radius and pull rope to allow for the installation of required cable without damage from pulling tension or equipment.

Each duct bank shall have no more than six conduits. Separate multiple duct banks, with compacted sandy soil.

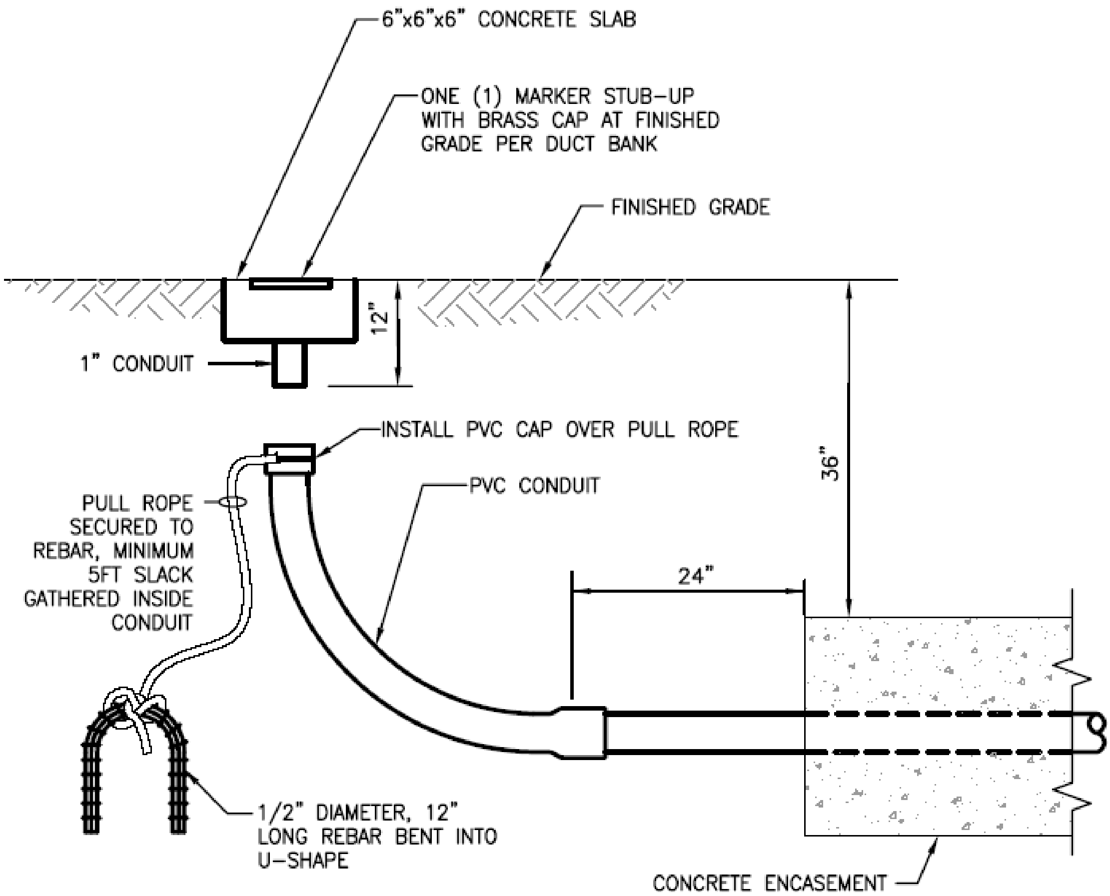

Figure 2: Conduit Stub

The following note shall be added to the drawings for underground duct banks to specify the slurry encasement:

> “Construct underground duct lines of individual conduits encased in red concrete slurry. The cement slurry shall consist of three sacks of Portland cement per cubic yard of sand with 10 pounds of red oxide or one gallon of red color. The slurry mix shall be allowed to solidify sufficiently to support a man’s weight before beginning the backfill. Compaction of the backfill shall not begin until at least 36 hours after placement of the slurry. No deformed or broken pieces of conduit shall be used. The slurry encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 3-inches of slurry covering the ducts. Separate conduits using plastic spacers. Provide red color admixture in concrete to indicate the duct bank as electrical, except Southern California Edison duct banks. Southern California Edison design mix is required in all Southern California Edison duct banks.”

Duct banks shall be separated and the space between them shall be filled with slurry. From a point no more than 60 ft away from a manhole, conduits in a duct bank may begin deflecting to terminate into the manhole. Ampacities of conductors used for electrical ducts shall be calculated per the latest Californial Electrical Code adopted by the City of Long Beach. A typical duct bank section is shown on Figure 3.

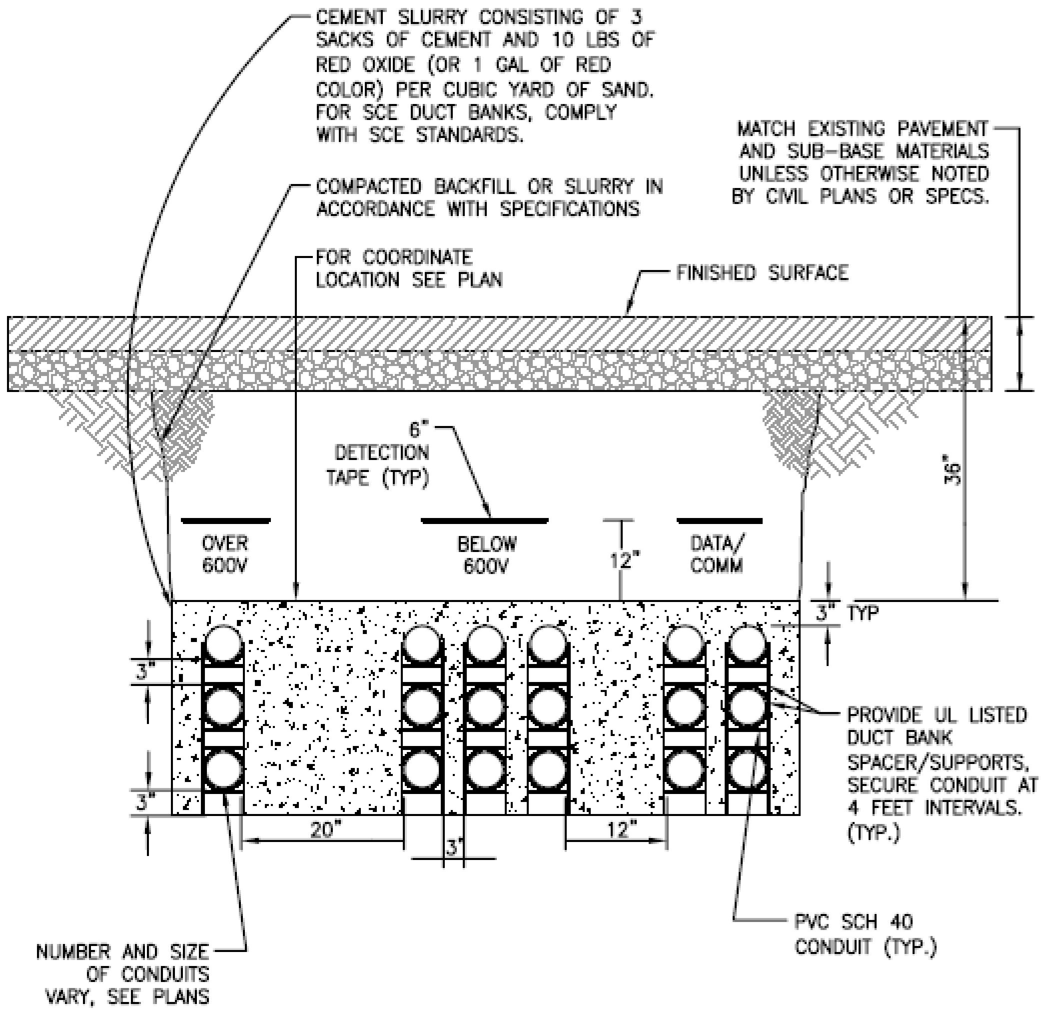

Figure 2: Duct Bank Section

The Contractor shall be required to attach a permanent waterproof tag to all conductors in outdoor pull boxes and manholes. Tags shall be marked appropriately.

If pull boxes are rectangular, a detail of the orientation of the box with respect to the conduits entering the box shall be clearly shown. The respective conduits shall allow proper bending radius for the conductors to be pulled through.

Sump drains in pull boxes shall be opened, and clear notes shall be provided on the drawing for the Contractor.

A narrative describing the steps of operation and the function of the components of the control wiring shall be included whenever control wiring is included in the contract drawings.

3.1.10 Manholes and Pull boxes for Power and Communication Conduits

Manholes and pull boxes for distribution shall be provided at intervals not exceeding 500 feet apart and located at all locations requiring connection to the Site distribution system. Manholes and pull boxes shall be designed and sized in accordance with the National Electrical Code and shall have a minimum loading capacity of 125 kips.

For rectangular shaped boxes, clearly show a detail indicating the orientation of the box with respect to the conduits entering the box

Insure that all conduits entering manholes or pull boxes are positioned to allow proper bending radius for the conductors to be pulled through.

Provide requirements in the contract documents for the Contractor to attach a permanent waterproof tag to all conductors in outdoor pull boxes and manholes. The tags shall be appropriately marked to identify each circuit. Example: "480V Lighting Control - Circuit HS-2" for a circuit controlling lighting fixtures.

3.1.11 Cables

3.1.12 Low Voltage Cables

During design stage of low voltage cables, ask the manufacturer of the cables to give you a set of their calculations and criteria for pulling the cables through the conduits. In the contract documents, require the contractor provide this criteria and calculations as part of their submittal. Particular attention to sidewall pressure of conductors while pulling through conduit bends and recommended limits for the cables are not exceeded should be addressed.

Megger tests for low voltage cables shall be required in the specifications.

3.1.13 High Voltage Cables

During design stage of high voltage cables, ask the manufacturer of the cables to give you a set of their calculations and criteria for pulling the cables through the conduits. In the contract, require the contractor provide this criteria and calculations as part of their submittal. Particular attention to sidewall pressure of conductors while pulling through conduit bends and recommended limits for the cables are not exceeded should be addressed.

During design stage have the manufacturer of specified cable provide a written statement that cable has a 40 year warranty.

Make it a contract requirement to have high voltage cables installed in the presence of the manufacturer's representative.

Make sure specifications and drawings clearly describe the cable splices and terminations required for the project, such as the kits to be used and at what locations.

3.1.14 Grounding

Refer to general section 2.1.15 for grounding requirements and details.

3.2 Highmast Lighting

The design of high mast lighting system shall include pole, luminaires with lamps and ballasts and all associated pole hardware, anchor bolts and luminaire mounting accessories. High Mast Lighting system shall be constructed and tested as an integral system, and shall be supplied and warranted by a single manufacturer. The light poles shall be provided as a complete assembly including anchor bolts, bolt covers, pole cap, handhole with cover plate, gasket and screws, and luminaire rings. Also, the Contractor shall be required to provide photometric calculations, operating voltage, lamps and ballast data, structural calculations of the pole foundation and light level calculations showing minimum, average and maximum footcandle levels with minimum and average to maximum uniformity ratios. The contract shall clearly define all the light level parameters.

Light poles and fixtures installed in existing terminals shall match existing.

3.2.1 Light Poles and Fixtures

Galvanized steel 120 ft. high mast light poles with (12) light fixtures per pole each equipped with 1000W high pressure sodium vapor lamps should be used to illuminate the wharf. If poles other than 120' in height are being considered for a particular application, provide comparison with computerized calculation results to the Chief Harbor Engineer and obtain approval, before proceeding with design details. The poles and foundations shall be designed to specific soils, seismic and wind load conditions for the area in which they are to be installed. Poles shall be located so as not to interfere with the travel of cranes and the operations of the wharf.

The light fixtures on high mast poles should be as specified in the lighting specifications. Care in design shall be taken to minimize glare and light spill along the pierhead of the Wharf and on the water so as not to obstruct the visibility of the ship's pilot or any other waterside operations.

Luminaries shall be designed in precise alignment with axes, level, plumb, and with symmetrical spacing, using supports in accordance with manufacturer's recommendations.

Luminaries shall be cleaned prior to lamp installation. Install lamps and energize lighting system to check for proper operation. Perform corrections to lighting system.

The anchoring and foundation requirements shall be specified on the contract drawings. The contract documents shall specify that the Contractor shall consult with pole supplier for proper installation requirements. All anchor bolts, nuts, washers and covers shall be clearly indicated on the drawings as required by pole manufacturer. The vertical centerline of the pole shall be within 0.200 percent of plumb in an undeflected condition. Poles shall be checked by the Engineer for plumbness prior to final installation.

The contract shall specify Luminaires to be aimed and adjusted to provide illumination levels and distribution as indicated on the drawings. Relamping of luminaires that have failed lamps at date of substantial completion shall also be specified.

3.2.2 Light Levels

The minimal light level specified below, for the wharf area, are from the light poles set in the backland, closest to the pierhead line. Wharf lighting should not depend solely on the light poles within the terminal. Wharf lighting should not depend solely on the light poles within the terminal. Lighting levels necessary for an active Wharf will be furnished from luminaries mounted on the crane. The lighting system should be designed to achieve the following minimum illumination levels in the wharf area.

- A minimum illumination level of 1 footcandle along the pierhead
- 5.0 footcandles average, 1 footcandle minimum on the wharf
- 10 footcandles maximum
- A lighting uniformity ratio of 10:1 maximum to minimum shall be maintained throughout.

3.2.3 Lighting Controls

A narrative describing the steps of operation and the function of the lighting control system and its components shall be included as part of the contract drawings.

Control of the lighting system should be designed using Square D - Powerlink System.

Powerlink lighting panelboards should be equipped with individual circuit breakers, which provide control with automatic and manual options. Automatic option will allow setting of time and duration for daily operation including features characteristic to photocell control. A reduced "security level" lighting option shall also be provided to reduce the lighting to keeping only two light fixtures on.

Provide printed information on an appropriate surface on the interior of the Powerlink panelboard door. Information shall read:

Port of Long Beach
Panel xxxxx - (panel designation)
HD-Sxxxxx - (Specification Number)
Contact xxxx - (Name and telephone number of POLB Representative)

Contact xxxx - (Name and telephone number of Mfgr. Representative)

3.2.4 Lowering Device on Poles

For POLB projects DO NOT specify lowering devices for poles. If necessary to use lowering devices, please contact the POLB electrical engineer first to confirm the need, so that a recommendation may be prepared to obtain the Chief Harbor Engineer's approval.

3.2.5 Lighting Calculations

Light level calculations should be made based on horizontal footcandles, and a light loss factor of 90% should be applied.

Use Light Loss Factor (LLF) of 0.90 to calculate horizontal Footcandle (FC) levels.
Before advertising a project, a lighting calculation with the final layout of the light poles must be obtained from the manufacturer of the light fixture, that's specified for the project. This calculation should show horizontal FC levels. Photometric curves for the light fixture, showing the isocandela curves, and used in the calculation, must be included. The calculation result, and the photometric curves, must be included in the project folder.

Require contractor to make arrangement, at the completion of light pole installation, to measure the actual FC levels, with the Engineer. If necessary, contractor shall readjust light fixtures as directed by Engineer.

For Long Beach Planning and Building (Plan check) all that is required is a copy of the site plan showing the pole locations and the footing details with the structural or civil engineer's signature. Contractor is not required to submit pole or foundation plans and drawings for plan check.

3.2.6 Grounding

Each luminaire housing shall be connected to equipment grounding conductor by means of a crimped spade-type terminal connector secured to housing with a self-tapping screw or housing grounding lug. Bond luminaries, metal accessories, and metal poles to branch circuit equipment grounding conductor.

Please refer to general section 2.1.15 for additional grounding requirements.

3.2.7 **Operations and Maintenance Manual:**

Make it a specification requirement that Operations and Maintenance Manual be provided for the complete high mast lighting system. The manual shall have a cover title that includes for a minimum: Title, specification number of the POLB project, and POLB base drawing number of the contract set, date manual was prepared, person to contact regarding the manual and telephone number.

4.1 Shore to Ship Facilities - Overview

See Shore to Ship Facilities Requirements Section 4.2 for guidelines and additional details.

This document describes the installation of a new electrical system that will provide shore to ship power to vessels docked at the Port of Long Beach. It covers the general overall layout of the system as well as particular requirements of the shore to ship facilities. The Shore Power Outlet (SPO) will be the point of connection between the shore power system and the ship. Refer to the POLB specifications for specific requirements of the individual pieces of equipment and general wiring.

Note: The terms socket and receptacle are interchangeable in this specification.

4.1.1 Shore to Ship Power

4.1.2.1 The electrical power supply for the Shore to Ship power system shall be provided from a 7.5 MVA 12kV -6.6kV, NEMA 3R Non Walk In, Resistance grounded Unit Substation. If a 7.5MVA transformer is deemed inappropriate for the application, any deviation must be approved by the Engineer. The Unit Substation will consist of a 12kV Main Breaker, 7.5MVA dry type Cast Coil Transformer, and a 6.6kV breaker feeding multiple disconnect switches. Each Disconnect switch will have an associated grounding switch, and feed a single SPO with two 5/8kV feeder cables of equal length. The shore power feeder shall have a medium voltage circuit breaker with overcurrent protective relays for each ungrounded conductor installed in the switchgear. Protective relays shall be set to the maximum rating of the SPO and shore power feeder. The available fault from shore power shall be below the withstand rating of the ship service distribution.

4.1.2.2 The 6.6kV circuit breaker shall be control wired through a Programmable Logic Controller (PLC) and the SPO as prescribed in the attached control diagram.(Standards Plan E-87). A Human Machine Interface (HMI) will be installed in the unit substation. The HMI shall indicate the status of the PLC and display the sequence of operation to operate the SPO.(See section 4.1.5) A mechanical interlock system will ensure that one and only one SPO is energized at a time.(See section 4.1.5 for sequence of operation and Key interlock s

4.1.2.3 The shore power feeder disconnect switch shall have a lockable grounding switch which can only be unlocked by a unique interlock key. The disconnect switch and its associated grounding switch shall be provided with windows to allow viewing the blades to verify if in “open” or “closed” position. The disconnect switch and its associated grounding switch shall be designed so that they cannot be closed simultaneously. The shore power feeder grounding switch will discharge the induced voltage in the feeder and ships cable before the ships cables are disconnected from the SPO. The grounding switch shall have a mechanical interlocking scheme between the shore power disconnect switch and SPO to prevent the mating or un-mating of a plug and receptacle while the shore power feeder is energized. A multifunction meter shall be present to read shore power voltage, current, power (kVA, kW, & kVAR), harmonics, 15-minute demand and energy consumption.

4.1.2.4 A mechanical or electrical interlocking system shall be implemented between the shore power circuit breaker and ship generator circuit breakers unless load transfer paralleling capability is provided. A ground check relay shall be provided to automatically open the shore power circuit breaker once the plug is released from the SPO or once the ship circuit breaker provided for the shore power feeder is opened.

4.1.2.5 A Shore to Ship connection box mounted in exposed locations shall be rated for NEMA 4X enclosures, 14-gauge, and 304 stainless steel. It shall be properly sized to accommodate conductor bending radius and have provisions for bottom and end entrances. The Shore to Ship Connection Box assembly shall be rated for the maximum available fault and shall be designed to prevent moisture or water entrance.

4.1.2.6 Shore to Ship power outlets shall have current and voltage ratings. Kirk Key interlocks shall be provided in accordance with the approved procedure. A ground switch shall be provided to discharge the induced voltage of the shore power feeder before being disconnected from the SPOs. The minimum clearance for live parts shall be per the latest National Electrical Code. Cable lugs shall be properly sized and shaped to facilitate satisfactory connections, and the phase sequence shall be marked and arranged per National Electrical Code.

4.1.3 Design Assumptions

The following are design assumptions for the Shore to Ship Power for a ship at berth, which shall be the basis for the design of the substation, feeders and shore power receptacles and ship plugs.

The Port of Long Beach will design and provide installation in conformance with this section:

4.1.3.1 The incoming service voltage to the shore power substation will be 12,000 volts to be supplied by the local utility company or a feeder from an electrical substation.

4.1.3.2 Each berth shall have access to SPOs at a number of locations along the wharf, spaced approximately 220 Feet (67 Meters) apart, each of which will be designed to supply 7,500 KVA of electric power at 6.6kV. The number of locations is dependent on tenant's operation and must be negotiated and approved by POLB (Berth is defined as the space one ship occupies along the wharf). In the future a fewer number of power outlets may be installed due to improved standard system design.

4.1.3.3 At each berth, the substation will have capacity for a maximum of one shore power outlet operating at any one time, at full load. A physical interlocking device, such as akey interlock, will be designed into the SPOs and the associated disconnect switches at the substation to prevent personnel from connecting to the outlets unless the 6.6kV circuit breaker is openand the circuit is not energized.

4.1.3.4 The substation switchgear will be designed to power only one of the shore power outlets at a time, per berth. The switchgear will be designed for all outlet locations as agreed upon by tenant and POLB. One circuit breaker for all outlet feeders will be provided in the switchgear design. Each of the paralleled conductors used for feeders, shall have an electrical current sensor to monitor the conductor ampacity. This current sensor will cause the circuit breaker to trip in the event maximum ampacity is exceeded in either parallel conductor. This will be implemented to limit current capacity to prevent burnout of the conductors.

The SPO will consist of two 350 Amp receptacles rated for 6,600 volts, housed in a single weatherproof enclosure. The receptacles will utilize a push-pull coupling device which will be factory built into the receptacle units. One receptacle shall be identified with a red color and another receptacle with a blue color. Each receptacle shall have a separate keyway to assure plugs cannot be switched from one receptacle to another. These receptacles shall be Cavotec Co. part numbers PC5-VX04-K1850R for the red, and PC5-VX04-K1850B for the blue. These receptacles will be housed inside a “Power Unit” manufactured by Cavotec Co. catalog number PC5-AX04-K1855. (Receptacles are also referred to as sockets). Furthermore, each receptacle shall have a separate Kirk® Key to keep the receptacle cover in place when de-energized. After the plugs from the ship are engaged to the receptacles on shore, both Kirk® Keys from the receptacles will be required at the feeder disconnect switch to allow the circuit breaker to activate and energize the feeder, (See Specification 16142 – “SHORE POWER OUTLET & ENCLOSURES” for additional requirements)

Each of the receptacles specified in item 3 will have three special pins reserved for continuity check control wires, in addition to the three power pins. These control wires will be energized from the switchgear where the circuit breaker for the feeder of the outlet is located, utilizing a continuity check relay. The intent of the ground check relay and the wiring is to trip the circuit breaker when personnel disengage the plug from the receptacle while the plug and receptacles are energized. Since the continuity check pins will disengage first, before the power pins do, the continuity check circuit will therefore be interrupted and thus send a signal to the ground check relay to trip the respective circuit breaker. Continuity check wiring aboard the ship must conform to the shore-side wiring to assure proper operation of the continuity check system when plugs from the ship are engaged with the receptacles on shore. See Standard Plan E87 for typical wiring diagram.

The Double loop design shown in Electrical Standard Plan E-87 shall be used for all future installations. This double loop design is in conformance with IEC/ISO/IEEE 80005-1 Utility Connections in Port—Part 1: High Voltage Shore Connection (HVSC) Systems — General Requirements

Positive direction of phase rotation shall be A-B-C counterclockwise rotation, as shown in POLB Electrical Standard Plan E-88

1 The shore power substation will be located near the wharf, but not on the wharf, to avoid interference with terminal operations.

2 The frequency shall be 60Hz nominal rating.

3 For rated load conditions, the voltage at the point of shore supply connection shall not exceed a voltage drop of 3.5% of nominal voltage.

4 The following notes are listed here to clarify additional requirements to complete the shore to ship power system design. The design and equipment needed for these additional requirements shall be the responsibility of the ship owner/operator and shall be located on the ship.

5 The shore power design will not include synchronizing switchgear, therefore when a ship connects to the shore power system, there will be a break in its on-board power during the switchover. If the ship has synchronizers and is capable of putting them to use and meets the requirements of California Public Utilities Code (PUC) Rule 21,, the ship may do so.

6 Cable handling system known as cable manager shall accommodate tide changes and vessel movement will be achieved with equipment on the ship and the design and procurement of this equipment shall be the responsibility of the ship owner/operator. The landside shore power receptacles will be fixed and unmovable inside their respective vault enclosures. Therefore the cable manager system, such as a Cavotec Co. manufactured unit, shall be located on the ship.

7 The plugs on the ship's cable manager system shall match the receptacles that the Port of Long Beach will provide in the wharf outlet. The shipside plugs shall be Cavotec Co. part number PC5-SX04-K1850FOR for a red colored plug and PC5-SX04-K1850FOB for a blue colored plug. These plugs have provisions to accommodate fiber optic cable as part of the cable manager system located on the ship. If the use of fiber optic cable is not desired, the same plug may be used for power cables only, or same plug with no fiber optic provisions may be substituted. Both of the specified plugs must be connected to shore-side receptacles to successfully transmit shore power to the ship. The cables from the shipside plugs to the ship's electrical switchgear must be of equal length and terminated at a single overcurrent device or single bus.

8 The Port of Long Beach will not provide fiber optic cable, or electrical control wires of any type within the wharf outlets except for those controls that are explicitly identified and specified in this section. Should the ship or terminal operator choose to install fiber optic cable or electric control wires, the wharf structure will contain a spare two inch conduit for this purpose.

4.1.4 Shore to Ship Power System Details

An instruction plate or a sheet indicating connection procedures shall be provided. Warning signs shall be provided that read "Do not engage or disengage plug and receptacle while energized." A nameplate indicating supply voltage, maximum current per outlet, and matching plug shall be provided. The shore-to-ship connection box assembly shall be constructed as shown in Electrical Standard Plan E-88

A minimum of two 4” and two 2” PVC 40 conduits terminating at Shore to Ship vault enclosure shall be provided. Watertight PVC fittings shall be provided, and all conduits shall be sealed with approved foam. Provide approved drop-in anchor, threaded hook. Exposed non-current carrying metal parts of equipment, conductor supports or racks, conduits and other metal appurtenances, including any metal cover and its supporting ring, shall be bonded together and connected to a common ground and to the incoming ground conductors per the National Electrical Code.Verify ship’s short circuit withstand rating to make sure it’s adequate to what’s available at shore power.

The 6.6kV bus and grounding disconnect switch shall have Live Line Indicators (LLIs) with both a red light, indicating it is energized when illuminated and a green light, indicating that the it is deenergized when illuminated. These lights shall have a testing capability to test if the LLI is working properly. These lights should have a testing capability to test if the lamps are good or bad. Also, provide a nameplate to be posted permanently next to these lamps describing it’s function, such as for red light it should say “Red light when lit, earthing switch is closed. DO NOT TURN ON CIRCUIT BREAKER”. Also ensure that a window is provided to allow viewing the blades of the earthing switch if in open or closed positions.

4.1.5 <u>Grounding</u>

Please refer to contract specifications and general section 4-2 for additional considerations for grounding details and requirements.

Advise the ship-owner that the nominal voltage is 6,600 volt at the SPO..

Ensure that tenant is advised and drawings indicate that the ship’s 6,600 volt cable plug will have an earth pin to insert into the SPO receptacle

Ensure tenant understands continuity check conductors will be furnished to the ship, through the receptacles at the SPO and the shore side controls needs to be looped inside the ship at a minimum to complete the shore side circuit and to permit the shore side breaker to operate.

The other receptacle will provide continuity check conductors specifically for ship side controls and must be energized by a 48Vdc power supply located on the ship. A break in either continuity check conductors will keep the shore side breaker from closing or open the breaker if it is closed..

(FPN: Some tenants or ship-owners are using a jumper wire and installed internally across the ship’s 6,600 volt cable plug’s two control pins. This jumper is required to close the plug/receptacle continuity check circuit.)

The following settings have been agreed upon during discussions from SCE. The shore power 6,600 volt circuit breaker’s protective relay settings. Values outside these settings will trip the circuit breaker and there is no automatic re-closure.

Under Power 32U will be sets to 300 seconds at 150kW.

Reverse Power 32R will be set to 2 seconds at 500kW, and 600 seconds for under 500kW.

THESE VALUES WILL CHANGE FROM TERMINAL TO TERMINAL AND THE DESIGNER MUST ANALYZE AND DETERMINE APPROPRIATE SETTINGS SUCH AS:

- Under-voltage (27-1) - 88% of nominal voltage, 120 cycle delay (27-2) - 50% of nominal voltage, 10 cycle delay.

(FPN: For Pier G (POLB HD-S2170) ANSI 27 relay on shore-side was set to prevent shore breaker from closing, if the ship accidentally back-feeds into the shore-side breaker.)

- Over-voltage (59-1) - 110% of nominal voltage, 30 cycle delay (59-2) - 138% of nominal voltage, 6 cycle delay
- Under-frequency (81-1) - 59.3 Hz, 10 cycle delay
- Over-frequency (81-2) - 60.5 Hz, 10 cycle delay

Ensure a third party is involved to analyze the wiring before going out to bid so that the wiring is complete and all requirements are shown in the contract document. The third party is to review and assure that at the end of construction coordination study results are complied with and tested for.

(FPN: POLB, terminal operator and ship-owner must be made aware that once shore to ship power system is installed, PIC or operator of the shore to ship power system, need to know the requirements and limitations of the system and be able to make adjustments necessary for uninterrupted operation of Shore to Ship power. Such knowledge requires:

- Knowledge of Sepam series relays by Square D (or equivalent unit by others)as to how they are set and what the settings mean)

Make sure to provide a breather located on the SPO enclosure to prevent condensation.

Provide a note on the drawings that states: “Use of any type of “extension cord” between the cable manager (located on the ship) and the Shore Power Outlet (SPO) is forbidden”.

Make it a contract requirement to measure system charging current after electrical equipment is installed and right before the neutral grounding resistor is connected. To do this measurement, use method proposed by Peter Sutherland in a paper titled “Conversion of Ungrounded Systems to High-Resistance Grounding System”, Page 4, Paragraph B(1)(4) titled “A new method for charging current measurement”.

4.1.6 (Approved procedure) Typical system sequence of operation for Shore Power Outet (SPO#1) at pier x - berth x-xxx

See attached Electrical Standard Plans E-88, E-87 (Typical for all SPOs, Unless Otherwise Noted (UON) sequence of operation to be mounted on plate in SPO vault enclosure and shown on drawing containing the control wiring diagram

General notes:

Only qualified personnel shall operate high voltage equipment with proper Personal Protective Equipment (PPE) and training.

Substation xxx serves pier x berth x-xxxx, shore power outlets SPO#1, SPO#2 and SPO#3.(More than three SPOs may be supplied from one switchgear to feed one berth. Adjust as needed.)

Each substation switchgear will consist of a 12kV feed to a 12kV-6.6kV 3 Phase, 4 Wire dry type transformer with resistance grounding. The 6.6kV Main Breaker will be connected to three disconnect switches. Each disconnects switch will supply power to an individual SPO, SPO#1, SPO#2 or SPO#3. Only one SPO can be powered at a time .

A PLC will check the status of all disconnect switches and will energize a permissive to close signal to the HMI if and only if only one disconnect is closed, it detects no power on the SPO, and all other conditions have been met.

4.1.7 Grid Based Shore Power System Test Procedure for Load Bank Testing

Some grid-based shore power projects may be unable to demonstrate completion and operability by the project completion deadline, because a ship capable of plugging into the shore power equipment is not available in time. As an alternative, these projects may be considered complete and operational if successful load bank system test is completed.

Load bank testing is the industry standard for verifying that shore power systems are operational and in proper working order. A successful shore power load bank test (hereafter "load bank test") will simulate a ship connection to the shore power equipment and satisfies the system test requirement.

A successful load bank test shall, at a minimum, meet the following requirements for each berth:

- Connect at least one SPO, comprised of two receptacles, to the load bank.
- Using the SPO and the load bank, draw a minimum of 1 Mega Watt ("MW") of electrical power from the shore power substation for at least 5 minutes. The total testing time under load shall be 15 minutes or longer.
- The installed system must perform, without fault, over the duration of the test.

If a third party must witness the test to successfully complete the system test procedure, the contractor shall be responsible to perform the following actions for each berth:

- Notify the third party at least 7 calendar days in advance of the load bank test with the date, time and location. Allow the third party representative the opportunity to witness the test.
- Complete a successful load bank test on the date, time and location specified.

- Submit a completed Statement of Compliance to the third party representative within 10 calendar days of the load bank test.
- Submit test data and any other information requested by the third party representative within 60 calendar days of the load bank test.
- Any additional test-related information requested by the third party representative after the load bank test shall be submitted to the third party representative within 60 calendar days of the request.

4.2 Shore to Ship Facilities - Requirements

This section is intended to provide a guideline for Electrical facilities required in a typical Shore to Ship Power System.

TABLE OF CONTENTS

1. FOREWORD

This document has been prepared to assist Port of Long Beach program managers and engineers in the development of shore-to-ship power facilities.

This document is intended to provide the Port's staff and it's customers with knowledge of the details of shore-to-ship electrical installations. This document also provides guidelines for the Port of Long Beach staff and customers of the port to aid them in dealing with technical issues in a manner that reduces risk and improves understanding of the technical issues.

Furthermore, the purpose of this document is to identify critical areas and issues and to provide an insight into the solution of technical issues.

2. SUMMARY

2.1 ENGINEERING INFORMATION

2.1.1 General

California State Air Quality Management District has determined that the use of electric power from the shore to power ships in port will provide significant improvement in air quality and can reduce costs while ships are in port. The Port of Long Beach is pursuing a plan to provide shore-to-ship electric power in keeping with the letter and the spirit of State of California requirements.

Facilities are being developed to meet the requirements of terminal operators in support of commerce through the Port of Long Beach. During the development of port facilities it is important that terminal operators, ship owners and the Port of Long Beach clearly identify requirements and technical issues necessary to assure project success. The purpose of this document is to help meet that need.

The tables in Annex A summarize the deliverable requirements and are intended to be used as check-off lists. The check-off lists are for project managers, designers, inspectors, ship owners, and facility tenants. These are presented for convenience; it is incumbent upon the various participants to comply with the contracts. The contracts contain the requirements while the tables are provided as guidance.

2.1.2 Project Plan

Annex B contains a notional project plan in a manner that links the four engineering phases with the review schedules described in this report.

2.1.3 Electrical System Concept of Operations

Annex C provides a notional outline for the electrical system concept of operations (ES CONOPS) in its earliest state of development.

3. INTRODUCTION

3.1 PORT OF LONG BEACH RESPONSIBILITIES

The Port of Long Beach (POLB) is responsible for administration of the port and development of facilities required to support operations by the various terminal operators and tenants. Shore-to-ship electric capabilities are developed for each category of ship as required by tenants and ship owners.

POLB is responsible for:

- Design and construction of shore-to-ship power systems.
- Providing one set of operational and maintenance manuals to tenants.

3.2 RESPONSIBILITIES OF OTHERS

3.2.1 Tenants Responsibilities

Tenants are responsible for:

- Validating and updating the Electrical System Concept of Operations (ES CONOPS) which describes the intended use of the system.
- Assuring that personnel are properly trained in use of the system.
- Providing personnel with proper personnel protective equipment (PPE).
- Safe connection of the shore power system to the ship.
- Safe operation of the equipment.
- Safe disconnection of the equipment (and stowage of the shore-to-ship flexible power cable if stowed ashore).
- Periodic maintenance of the system.
- Custody of system Kirk keys.

Tenants shall also be responsible for coordination with ship owners for:

- Ensuring their ships are properly configured for use of the shore-to-ship power system.
- Only properly trained and qualified ship personnel are used for connecting, operating, and disconnecting the system onboard the ship.
- Ship personnel are retrained annually on safe operation of the system.

3.3 DESIGN TARGETS AND SPECIFIC SHIPS

Since there may be many different ships that will use a facility, it is necessary to develop design targets. There are three "ships" that should be considered when developing requirements for a facility. These are a notional ship, a design ship, and the specific ship that will call upon the port.

The notional ship and the design ship are design targets and represent characterizations of specific ships that will use the facility.

3.3.1 Notional Ship

The notional ship is a rough approximation of the ships that will eventually use the port. Only the principal characteristics are known and they may be approximated. For example, a notional container ship would require 7.5 MVA at 6.6 kV.

3.3.2 Design Ship

The design ship is used for detailed design of the facility. Parameters include maximum draft, length, and number of containers as well as electrical details which impact on the facility design. Where characteristics are necessary for design of the facility are not fully known they should be highlighted and clearly identified as risk areas which must be resolved before the facility can be completed. All characteristics and features of a ship that will use the facility must be identified. The design ship is used to define the requirements for all interfaces. Similarly, settings of relays must be identified if a shore connection will employ a data interface for control.

3.3.3 Specific Ship

The term specific ship refers to an actual ship that will use the facility. Specific ship information must be used when qualifying a ship to use the facility. Information about the specific ship should be compared to the design ship as part of the compatibility analysis.

3.4 COMPLIANCE WITH INDUSTRY STANDARDS

Compliance with the requirements of the proposed IEC/ISO standard for high voltage shore connection (HVSC) systems is expected and any deviations from the recommendations must be documented. This report was prepared using the requirements of IEEE P1713/IEC P60092-510[1] as they existed in December 2009.

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[1] IEEE P1713 Recommended Practice for Electrical Shore-to-Ship Connections / IEC P60092-510 Electrical Installations in Ships Part 510: Special Features – High Voltage Shore Connecton Systems

4. 15% PROJECT REVIEW

4.1 OVERVIEW

The information about the project is sketchy at best and may be subject to significant changes. The POLB and tenant will frequently differ in their views on system capabilities and costs. It is the purpose of this review to reconcile these differences and arrive at a concept that is acceptable to all.

4.2 REQUIREMENTS

The baseline established by the 15% Project Review documents all of the design work done up to that point in the design process. The following requirements shall be included in the drawings and reviewed at the 15% Project Review.

4.2.1 Electric System Concept of Operations

An ES CONOPS is a statement of the required behaviors of electrical system based on the expected use of the system. The ES CONOPS should articulate shore-to-ship power system attributes which should be optimized for each of the expected scenarios. Scenarios should include cable management and handling, connection and energizing, normal shore power operation, de-energizing and disconnection, and emergency operation. Typical attributes should include quality of service, energy efficiency, safety, emissions, and business needs. The ES CONOPS should address the human systems interface. An important aspect is the interaction between humans and the electric power system equipment, especially where safety matters are involved.

The ES CONOPS should reflect either the notional ship or the design ship, depending on the state of the design.

The ES CONOPS is prepared by the POLB, describes the typical operations the electric system will see and provides a fundamental view of how the system is intended to be used. It should be started early and revised as the design progresses. The tenant will provide assistance to the POLB in preparing revisions to the ES CONOPS. It is the tenant’s responsibility to coordinate with the ship owner.

4.2.2 Service Category

The notional ship’s service category shall be provided per Table 1 – Systems Characteristics.

Table 1 —System characteristics[2]

Service Category	Service Voltage (kV AC)	Nominal Volt-Amps (MVA)	Number of Receptacles	Typical Marine Application
1	6.6	7.5	2	Container Ships, Bulk Carriers
2	6.6	10.0	3	Liquid Tanker Ships
3	11.0	20.0	4	Cruise Ships

4.2.3 Notional Ship Information

Notional ship information should include ship type, length, beam and draft. The information should also include the number of ships expected to be served as well as their marine categories[3], services types as listed in Table 1, and expected frequency of their visits.

4.2.3.1 Electric Power Transfer

Provide a brief description of operation for the electric power transfer at each phase of the transition from ship power to shore power. These phases will include but are not limited to paralleling, load shedding, and connecting and disconnecting from shore power. The description shall include electric power transfer operation when restarting and transferring from shore power to ship's power when preparing to disembark.

4.2.3.2 TEU Capacity

The TEU capacity of the notional ship shall be provided.

4.2.3.3 Grounding

The shoreside transformer's neutral grounding resistor (NGR) shall be low resistance grounded. The NGR's rating shall be between 25A and 50A.

4.2.3.4 Power

The following information need only be determined as a rough order of magnitude value during the early phases of design.

- Provide a single line diagram of the notional ship.

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[2] Table 1 is part of IEEE P1713 Recommended Practice for Shore-to-ship Connections, D0.2.
[3] Per IEEE P45.4 Recommended Practice for Electrical Installations on Shipboard – Marine Sectors and Mission Systems

- Provide the approximate maximum real power and total power consumption of the notional ship while at berth. This may be provided by service category per Table 1 — System characteristics.
- High Voltage (HV) shore connections shall be provided with a nominal voltage of 6.6 and/or 11 kV galvanically isolated from the shore distribution system.

4.2.4 Concept Site Plan

A concept site plan should be prepared to show the approximate locations of all major items in the terminal. The concept site plan should include terminal property lines, shore-to-ship electrical power system including berths served and location of system transformer.

4.2.5 Cable Management and Handling

The cable management and handling concept shall be provided according to the following:

- Determine if the medium voltage shore-to-ship cable manager shall be carried on the ship, provided at berth, or other.
- Notional information on the medium voltage shore-to-ship cable and connector shall be provided.

5. 50% PROJECT REVIEW

5.1 OVERVIEW

The 50% Project Review sets the requirements for the system. Potential alternatives for certain details, evaluation of details, and recommended options should be presented and the details of the berths should be made available and coordinated in design. Locations of equipment should be confirmed. Schematics and single line drawings should be prepared and reviewed for cost and constructability. Preliminary drawings for critical items should be available. Any remaining options which require evaluation should be identified.

The design ship shall be the basis of the 50% Project Review. While not representing a specific ship, the design ship shall include details of all interfaces and shall represent the expected specific ships as accurately as practical a range of expected values may be shown. Where characteristics are necessary for design of the facility are not fully known they should be highlighted and clearly identified as risk areas which must be resolved before the facility can be completed.

5.2 REQUIREMENTS

The baseline established by the 50% Project Review documents all of the design work done up to that point in the design process. The following information shall be provided on the drawings.

5.2.1 ES CONOPS

The ES CONOPS should be updated prior to the 50% Project Review to reflect the design ship. The revised information shall be provided and the updated ES CONOPS shall be reviewed.

5.2.2 Point of Common Coupling

The point of common coupling is the interface connector either at the shore-to-ship connection enclosure connector or the connector at the end of the flexible power cable in the case where the flexible power cable is part of the shore to ship electrical power system[4].

Provide the nominal ratings of the shore ship-to-shore connection.

5.2.3 Design Ship Information

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[4] As per IEEE P1713 Recommended Practice for Shore-to-ship Connections, Clause 5.2

The following design ship information shall be included on the drawings and reviewed during the 50% Project Review.

5.2.3.1Equipment and Circuit Breakers

Provide the ship electrical system and equipment short circuit breaking and interrupting ratings, identify the maximum short circuit withstand rating of the equipment on the design ship connected to shore power.

5.2.3.2Single Line Diagram

Provide a single line diagram of the design ship that will connect to shore power at the subject terminal.

5.2.3.3Ship Voltage and Frequency Tolerances

The design ship shall operate normally when power at the point of common coupling is within the voltage and frequency tolerances specified in 5.2.7 System Voltage and Frequency Tolerances.

5.2.3.4Ship's Relay Settings

Design ship relays are listed below.

Note: Relay settings in shore power systems shall be coordinated both with ship's settings and upstream, feeder settings. If ship's settings are not available, then shore power system relay settings shall be set to the maximum settings to allow coordination with upstream feeder protection while fully protecting the shore power system.

- Shore Device 51C – A shoreside breaker shall be tripped if a phase current exceeds the set point for longer than a set period of time during the generator start. The phase current set point and time period must be provided.
- Shore Device 51P – Once started and at the normal operating rate, a shoreside breaker shall automatically trip when one of the phase currents is greater than the set point for a longer period of time than is allowed. The phase current set point and time period must be provided.
- Shore Device 19F – If a large motor is locked on start for longer period of time than the time allowed, the shoreside breaker shall trip. The phase current set point and time period must be provided. Note that large motors may take a very long time to start (longer than the permissive rotor blocking time) because of their inertia or a reduced voltage supply. To protect such a motor the timer initiates a trip if a start has not been detected or if the motor speed is zero.
- Shore Device 59P – The phase to phase overvoltage (59P) setting for the voltage and the time delay permitted acceptable to the ship shall be provided.
- Shore Device 59N – The neutral voltage displacement (59N) setting for the voltage

and the time delay permitted shall be provided. Note: the residual voltage is the phasor sum of line to neutral voltages, or Vr = Van+ Vbn+ Vcn.

- Shore Device 32P – The reverse directional active power (ANSI 32P), in KW, that is foreseeable at the point of common coupling on the wharf shall be provided. Also provide the minimum time delay acceptable before initiating trip due to this reverse active power.
- Shore Device 32Q – The reverse directional reactive power (ANSI 32Q), in KVAR, that is foreseeable at the point of common coupling on the wharf shall be provided. Also provide the minimum time delay acceptable before initiating trip due to this reverse reactive power
- Shore Device 67 – The reverse directional phase overcurrent (ANSI 67), that is foreseeable at the point of common coupling on the wharf shall be provided. Also provide the minimum time delay acceptable before initiating trip due to this directional phase overcurrent.
- Shore Device 81U – The underfrequency (ANSI 81U) that is tolerable at the point of common coupling on the wharf shall be provided. Also provide the minimum time delay acceptable before initiating trip due to this underfrequency.
- Shore Device 81O – The overfrequency (ANSI 81O), that is tolerable at the point of common coupling on the wharf shall be provided. Also provide the minimum time delay acceptable before initiating trip due to this overfrequency.

5.2.3.5 Design Ship Electrical Interface

The following design ship information shall be provided.

- The number of generators that will operate at berth shall be provided as well as an indication of how many of the generators are for backup, stand-by, or spare.
- The quantity and type of each of the ship's generators shall be provided.
- Provide a description of the operation of the ship's shore connection circuit breaker and paralleling controls including the synchronizer and synchro-check relay settings.
- Grounding philosophy.
- Nominal ratings of the ship connection.

5.2.3.6 Interfaced Equipment

Provide the following information.

- Maximum short circuit withstand rating of the equipment on the "design ship" connected to shore power.
- If shore feeders are terminated at transformer on a ship, confirm that the primary of the transformer is delta connected and secondary is Y connected otherwise analysis of shire and ship electrical system shall be performed to assure proper operation.
- If secondary of transformer is connected in Y, confirm that secondary of transformer grounding protection is independent of the shore side grounding protection system and backup on shore side is not necessary.

5.2.4 Interface Requirements

Interface requirements should be well-documented on the drawings and should conform to industry standards. Both hardware and software interfaces shall be documented. It is recommended that copies of the relevant standards be obtained and placed with the drawings. Interfaces shall be fully and completely specified. Alternatives shall be identified and ranked in order of preference.

Interfaces include:

- Power and cable connections
- Grounding and bonding
- Data and similar connections
- Protection and coordination
- Communications connections e.g. phone and internet
- Entertainment connections
- Mechanical connections such as interface to the cable handling system

Note: Data communications and entertainment connections are not currently implemented at the Port of Long Beach.

5.2.5 Shore Supply Information

The following information shall be provided for the 50% Project Review.

- Nominal ratings of the shore supply.
- Shore electrical service or service transformer winding configuration, number of phases, neutral impedance, system grounding and surge protection shall be provided.
- Shore-to-ship feeder circuit earth continuity check devices shall be provided.
- Information on the medium voltage shore-to-ship cable and connector shall be provided.
- Procedures and requirements for connecting and energizing the shore-to-ship feeder

5.2.6 Connector Information

The plugs on the ship's cable management system shall match the receptacles that the Port of Long Beach will provide in the wharf outlet. The shipside plugs shall be Cavotec Co. part number PC5-SX04-K1850FOR for red colored plug and PC5-SX04-K1850FOB for blue colored plug. These plugs have provisions to accommodate fiber optic cable as part of the cable management system located on the ship. If the use of fiber optic cable is not desired, the same plug may be used for power cables only, or same plug with no fiber optic provisions may be substituted. Both of the specified plugs must be connected to shore-side receptacles to successfully transmit shore power to the ship. Furthermore, the cables from the shipside plugs to the ship's electrical switchgear must be of equal length and terminated at a single overcurrent device or single bus.

The following connector information shall be shown on the drawings.

- Quantity, type and rating for each receptacle in each connection enclosure.
- Information on the shore-to-ship ground continuity check circuit interface requirements. Any tests performed to verify these requirements and their results shall also be shown.
- The shore-to-ship feeder circuit protective device ANSI types and settings.
- The nominal voltage and appropriate connector for the HV shore connections shall be shown.
- The phase sequence (L1-L2-L3 or A-B-C or R-S-T) at the connection point shall be clockwise (looking at the socket face).

5.2.7 System Voltage and Frequency Tolerances

The system shall operate within the voltage and frequency tolerances as provide by the local utility company, Southern California Edison Company. Verify that the system has been designed to meet the following requirements.

- For no-load conditions, the voltage at the point of common coupling shall not exceed a voltage increase of 3.5 % of nominal voltage.
- For rated load conditions, the voltage at the point of common coupling shall not exceed a voltage drop of -3.5 % of nominal voltage.

5.2.8 System Voltage and Frequency Transients

Verify that the system has been designed to meet the following requirements.

- The response of the voltage at the point of common coupling when subjected to an appropriate range of step changes in load shall be defined and documented for each HV shore supply installation.
- The maximum step change in load expected when connected to a HV shore supply shall be defined and documented for the design ship. The part of the ship subjected to the largest voltage dip or peak in the event of the maximum step load being connected or disconnected shall be identified.
- A comparison of the items above shall be done to ensure that the voltage transient limits of voltage + 20 % / −15 % will not be exceeded.

5.2.9 Protection

Verify that the system has been designed to meet the following requirements.

- The calculated values shall be used to select suitably rated shore connection equipment and to allow the selection and setting of protective devices to ensure that successful discriminatory fault clearance is achieved for the largest on-board load while connected.
- The shore-side supply system shall consider protection against fast transients (e.g., spikes caused by lightning strikes or atmospheric overvoltages) to protect connection and ship equipment from resultant damage.

5.3 REVISED INFORMATION

Any changes from the baseline set at the 15% Project Review to the following information shall be documented on the drawings and reviewed at the 50% Project Review.

5.3.1 Design Ship Information

5.3.1.1 Power

The following information shall be confirmed.

- Maximum real power and total power consumption of the design ship while at berth.
- Verify that the appropriate HV shore connection nominal voltage (6.6 or 11kV) is selected.
- The HV connections shall be galvanically isolated from the shore distribution system.

5.3.1.2 Cable Management and Handling

The following information shall be confirmed.

- Cable management system shall be located on the ship.
- Connection for the medium voltage shore-to-ship cable.
- Details on the MV shore-to-ship cable and connector.
- Explicit description of how the power conductors supplied from ship will be terminated on shore.
- For the cable used on the ship to connect to shore power, provide cable length, cable capacitance, inductance, resistance and coupling capacitance. This information shall used to calculate the value of the NGR.

6. 100% PROJECT REVIEW

6.1 OVERVIEW

6.1.1 General Approach

The 100% Project Review completes the design review of the system. All design details should be shown on the drawings. Locations of equipments and details of berths should be reviewed. Schematics and single line drawings should be reviewed for cost and constructability. Any areas of risk or other concern should be identified and agreement confirmed on the proposed design.

The design ship shall be the basis of the 100% Project Review. The design ship shall include details of all interfaces and shall represent the expected specific ships as accurately as practical. Where appropriate, a range of expected values may be shown. All characteristics necessary for the design of the facility shall be identified.

The 100% Project Review will normally cover:

- The final ES CONOPS
- Detailed design and specifications of the system to be installed
- Test requirements and procedures for individual equipment
- Test requirements and procedures for the installed system
- Operation and maintenance manuals requirements
- Final drawing package
- Lock-out tag-out requirements and procedures for the installed system
- Commissioning plan and procedures
- Maintenance requirements and plan including schedule
- Test and acceptance procedures
- System proofing plan and procedures
- Other similar items

6.1.2 100% Project Review Report

A report shall be prepared to document the results of the 100% Project Review. The report shall include all areas of risk and concern, and shall clearly identify those items which may require design change or assumption of risk. Any items not meeting program requirements shall be identified.

6.2 REQUIREMENTS

Ensure there are no open items from the 50% Project Review.

6.2.1 ES CONOPS

The final ES CONOPS shall be reviewed to ensure all parties are in agreement.

6.2.2 Ship's Maneuvering, Mooring, and Personnel Safety

The ship's maneuvering, mooring, and personnel safety information listed below shall be reviewed. Review the location of all equipment including transformer, switchgear, and each shore-to-ship connection enclosure.

- Ensure cargo handling and mooring equipment and the areas that must be clear for their operation are not restricted in their use.
- Traffic management considerations shall be reviewed to ensure the use of the HVSC system does not:
    - interfere with other ship operations.
    - hinder or prevent necessary traffic flow on the pier.
    - hinder or constrain fire lane access where required.
- Ensure adequate personnel safety measures, including physical barriers to prevent unauthorized personnel access to HVSC equipment or the cable management equipment.

6.2.3 Shoreside Power Requirements

The following information shall be reviewed.

- The HV shore power supply system voltage quality specification.
- The sequence for synchronizing from shore-to-ship power. Specifically review current, voltage and time characteristics during a typical synchronizing sequence. The review shall include nominal, maximum and minimum values.
- The shore electrical service or service transformer winding configuration, number of phases, neutral impedance, system grounding and surge protection.
- Requirements for documentation concerning principles of operation, technical specifications, mounting instructions, required start up or commissioning procedures, fault-finding procedures, maintenance and repair, as well as lists of necessary test facilities and replaceable parts for each HVSC system and control apparatus.
- The system study calculations used to select suitably rated shore connection equipment and the selection and setting of protective devices to ensure that successful discriminatory fault clearance is achieved for the largest on-board load while connected.

6.3 REVISED DATA

6.3.1 Design Ship Information

The following design ship data shall be reviewed and confirmed:

- Ship’s relay settings
- System voltage and frequency tolerances
- Cable management and handling information if installed on shipboard

6.3.2 Shoreside Information

The following information shall be reviewed and confirmed:

- Shore supply information
- Connector information
- Cable management and handling information if installed on shore

6.4 TESTING AND ACCEPTANCE

The requirements for testing and acceptance of the system shall be reviewed.

6.4.1 Testing

A test plan shall be provided. The test plan shall address both individual equipment and the total system requirements. The test plan shall include a list of equipment to be tested and shall note any equipment which is to be excluded from the test plan and the reasons for the exclusion. At a minimum, the test plan shall test the system enough to assure that it meets the specifications and ensures safe operation under the normally operating conditions. The test plan shall cover all configurations and scenarios envisioned by the ES CONOPS.

6.4.2 Commissioning

Requirements for commissioning shall be reviewed. The commissioning schedule shall be included in the test plan.

The commissioning plan shall be reviewed to ensure that the system performs according to the design intent and the owner’s operational needs, and that specified system documentation and training are provided to the facility staff.

Commissioning is accomplished by or for the Port of Long Beach and shall be observed by the terminal or facility operator. Commissioning should use the drawings updated to as-built status.

Commissioning activities shall include:

- Complete switchgear function tests.
- Setting shore transformer taps for proper voltage at the point of common coupling.
- Measurement of the shore-to-ship power system charging current.
- Phase-sequence verification at each shore side power receptacle.

- Confirmation of proper operation of receptacle interlock, ground-check, and monitoring circuits.
- System operational tests.
- System integration tests.

6.4.3 Acceptance

The acceptance test plan shall be reviewed. At a minimum, the test plan shall test the system enough to assure that it meets the specifications including safe operation under normal operating conditions. The test plan shall cover all configurations envisioned by the ES CONOPS.

Requirements for system acceptance shall be reviewed insure they adequately address the following:

- Visual inspection.
- HV test.
- Insulation resistance measurement.
- Measurement of the earthing resistance.
- Function test of the protection devices.
- Function test of the interlocking system.
- Function test of the control equipment.
- Earth-fault monitoring test.
- Phase sequence test.
- Function test of the cable management system (if part of the shore facility).
- Integration test to demonstrate that the shore and shipside installations work properly together.

7. FINAL PROJECT REVIEW

7.1 OVERVIEW

7.1.1 General Approach

The Final Project Review marks the end of the program. This should be considered the "sell" point. At the conclusion of the final review, acceptance decisions are made and the project is brought to conclusion. From this point on, the system is considered to be in an operational state and normal life-cycle activities are begun.

The design ship shall be the basis of the Final Project Review and future analysis of specific ships.

The Final Project Review will normally cover:

- Drawing changes (As-built drawings)
- Commissioning documentation
- Acceptance test results, see 8. TESTING AND ACCEPTANCE on page 21
- Any deviations or waivers
- Certification letters

7.1.2 Final Project Review Report

A report shall be prepared to document the results of the Final Project Review. The report shall include all areas of risk and concern, and shall clearly identify those items which may require design change or assumption of risk. Any items not meeting program requirements shall be identified and clearly highlighted.

7.2 AS-BUILT DRAWINGS

As-built drawings shall be reviewed closely. Where the design requires deviation from design requirements, as-built drawings shall be provided and design drawings shall be revised to show the actual construction. This includes physical, functional, electrical, and interface schematic modifications.

7.3 COMMISSIONING DOCUMENTATION

Commissioning documentation shall be reviewed to ensure the following.

- The system is installed as designed and is capable of supporting the intended operations.

- The operator is ready and able to operate the system in a safe and useable fashion.
- Specific ships are expected to be safely connected after evaluation and qualification.
- The system performs according to the design intent.

7.3.1 Shore Facility Documentation

Verify the following information has been provided.

- Test reports showing that the quality of power specifications and the quality of service parameters for the HVSC system have been met.
- Start-up and commissioning procedures.
- Operation and maintenance manuals.
- List of replaceable parts.
- System technical specifications.
- Procedures for accomplishing and recording annual maintenance, test, repair, and modifications.
- Record of annual maintenance, test results, repair, and equipment modifications.
- Certification artifacts of the first call of all ships certified to use the port, including the first call commissioning procedures.
- Documentation that the tests have been carried out to demonstrate that the electrical system, control, monitoring and alarm systems have been correctly installed and are in good working order before being put into service shall be provided.
- Configuration management procedures identifying a single configuration manager and the roles and responsibilities of all parties involved.
- Test reports of HV test and insulation measurement.
- Documentation showing training and qualifications of operators.
- The name and contact information of the Persons in Responsible Charge for the POLB, the tenant, and any specific ships currently qualified.

7.3.1.1 Shore-to-ship Connection

- Procedures for connection of the shore-to-ship flexible feeder cable to the connection enclosure receptacles shall be provided.
- Procedures and requirements for energizing and paralleling of the shore-to-ship feeder shall be provided.
- Exception: No ship-to-shore control interface or protocols are provided.

7.3.1.2 Persons in Charge

The terminal operator identifies Persons in Charge for operation, maintenance, and configuration management among the parties responsible for shore and ship HVSC systems.

- During operation of HVSC systems, Persons in Charge shall be identified at the shore facility and on board the ship for the purposes of communication.

- These parties shall be provided with sufficient information, instructions, tools and other resources to allow activities to be conducted in a sufficiently safe and effective manner.
- Procedures should employ an approved "Lock-out, Tag-out" system that is jointly controlled by the ship and shore Persons in Responsible Charge.

7.3.2 Commissioning Report

A commissioning report documenting the results of commissioning activities shall be prepared.

7.4 ACCEPTANCE TEST RESULTS

The results of the following tests below shall be reviewed.

- Visual inspection.
- HV test.
- Insulation resistance measurement.
- Measurement of the earthing resistance.
- Function test of the protection devices.
- Function test of the interlocking system.
- Function test of the control equipment.
- Earth-fault monitoring test.
- Phase sequence test.
- Function test of the cable management system (if part of the shore facility).
- Integration test to demonstrate that the shore and shipside installations work properly together.
- Commissioning report.

7.5 DEVIATIONS AND WAIVERS

Any deviations and waivers shall be reviewed and a final determination made. All deviations and waivers shall be documented in the final project review report.

7.6 DELIVERY

At the completion of the final project review, the Port turns over the installation to the terminal operator.

8. TESTING AND ACCEPTANCE

8.1 OVERVIEW

Testing is performed to assure performance and reduce risk. Both component testing and system testing shall be conducted. Tests may be performed as visual inspections, observations, measurements, and calculations. The method of performing the test and the test results shall be clearly documented as well as a clear statement of purpose. Tests shall be realistic and simulations avoided as much as is practicable.

8.2 TEST SPECIFICS

8.2.1 Test Plan

A test plan shall be prepared. IEEE Std. 829™ provides a good test plan format. The test plan shall identify equipment to be tested, testing schedule, and procedures to be performed.

The individual components listed below shall be tested during individual components testing.

- Cables and connectors.
- Switchgear.
- Circuit breakers.
- Load interrupter switches.
- Protective relays.
- Switchgear controls.
- Control power.
- Instrument transformers.
- Grounding devices and interlocks.
- Ground-check circuits.
- Power transformers.
- Neutral-grounding devices.
- Neutral-ground over-current relay.
- Shoreside power plug and receptacle assembly including quick-connect connector.
- Interlocking system control and monitoring cable and connectors.
- Grounding system components.
- Earth resistance measurements.

8.2.2 Test Procedures

Test procedures provide the detailed measurements and expected results of a specific test. A test procedure is required for each test to be performed. Test procedures should include test equipment required, points of measurement, and operational settings. Blanks to record printed tester name, signature, test date, and measured data shall be provided. Test procedures shall also contain areas to record anomalies or unusual conditions.

8.2.3 Test Report

A test report documenting the results of the tests shall be prepared and made available for the Final Project Review. Any failures, the nature of failure, how the failure was fixed, and retesting results of the failure should be explicitly noted in the report. The report shall include test inputs, expected results, criterion for evaluating results, test procedure and all assumptions and constraints.

8.2.4 Cables and Connectors

Cables and connectors shall be visually inspected after installation. Connector part numbers and serial numbers should be recorded. Cables should be subjected high-potential tests and results recorded.

8.2.5 Switchgear, Controls, and Related Equipment

Switchgear, circuit breakers, load interrupter switches, protective relays, switchgear controls, control power, instrument transformers, grounding devices and interlocks, and ground-check circuits should be visually inspected after installation and testing according to the manufacturer's recommendations.

8.2.6 Shore-to-ship Connection Enclosure

The shore-to-ship connection enclosure shall be visually inspected and photographed. Phase rotation at the connector shall be verified. Preventer pad eyes shall be tested to 125% of their rated load[5].

8.3 ACCEPTANCE

At a minimum, the acceptance test plan should test the system enough to assure that it meets the specifications including safe operation under the normally operating conditions. The test plan should cover all configurations envisioned by the ES CONOPS.

The acceptance test plan shall include requirements for the following:

- Visual inspection.
- HV test[6].

[5] OSHA 1917.50(c)(5)

- Insulation resistance measurement.
- Measurement of the earthing resistance.
- Function test of the protection devices.
- Function test of the interlocking system.
- Function test of the control equipment.
- Earth-fault monitoring test.
- Phase sequence test.
- Function test of the cable management system (if part of the shore facility).
- Integration test to demonstrate that the shore and shipside installations work properly together.

8.3.1 Deviations and Waivers

Deviations are defined as changes made before or during construction and authorized prior to testing and acceptance. Waivers permit acceptance without accomplishment of a test requirement.

Authorized deviations must be fully documented in the as-built drawings. Waivers must be documented as part of the acceptance test report and the final project review.

8.4 DELIVERY TO TERMINAL OPERATOR

The Port turns over the installation to the terminal operator.

8.4.1 System Documentation

The Port provides a copy of the system documentation to the terminal operator reflecting the current configuration of the system.

8.4.2 Terminal Operator's Requirements

The terminal operator assures that the system is ready for use by "visiting ships" which have been prepared for connection to and use of the system. If there are multiple systems then a separate confirmation shall be provided for each system.

8.4.2.1 Shore Facility Operation

The terminal operator confirms that it's prepared with the requirements for safe operation of the system.

- Provide verification of the compatibility of safety circuits of specific ships authorized to use the facility.
- Provide verification of the compatibility of the shore connection to energize the on board transformer used on specific ships.

[6] The HV test may be conducted at the reduced voltage as per IEC 60502-2.

8.4.2.2Tests after Extended Time between Port Calls

The following verification must be carried out or provided. If the time between port calls[7] does not exceed 12 months and if no modifications have been carried out either on the shore side or ship side, or both, as outlined on page 24 . If this time is exceeded the tests according to "first visit" tests shall be carried out.

- Visual inspection.
- Confirmation that no earth fault is present.
- Statement of voltage and frequency.
- Review of the procedure for authorized switching and connection.
- The HV test and insulation resistance measurement shall be carried out only if one of the installations, shore side or ship side, was out of service or not in use for more than 30 months[8].
- Record of annual maintenance, repair, equipment modifications and the test results shall be available for the shore and ship side HVSC system.
- Documentation of periodic testing and maintenance of the ship-to-shore electrical system including all equipment, protective relays, ground continuity check circuit, control equipment, and flexible cable and connector shall be provided. Provide the results of the latest test.

[7] The time between port calls means same ship at the same Port

[8] The HV test may be conducted at the reduced voltage per IEC 60502-2.

9. SPECIFIC SHIP REQUIREMENTS

9.1 OVERVIEW

The term "specific ship" refers to an actual ship that will use the facility. Specific ship information must be used when qualifying a ship to use the facility. The specific ship and the facility must be analyzed together as a system in order to ensure compatibility.

After the analysis, a first visit is accomplished under close supervision to observe that in fact the system works as expected. Successful completion of the analysis and the first visit will result in certification that the ship and the shore facility are compatible and may be routinely connected on subsequent visits.

9.1.1 General Approach

The general approach to analyze a specific ship addresses the following areas:

- System Study – compares the specific ship with the design capability of the facility.
- First Visit – the first visit of a specific ship includes testing and verification of the expected performance. The "first visit" includes extra attention to detail that is not normally required during subsequent visits.
- Reproofing – can be considered an abbreviated system study and "first visit". The abbreviated system study shall validate the configuration and focus on any areas that have been changed. Reproofing details may vary based on the level of change to the ship's electric system.

9.2 SYSTEM STUDY

The system study shall determine if the "specific ship" may be safely connected to the system. The system study must specifically recommend proceeding with the first visit or the visit cannot occur.

The system study must be documented as a report. Compliance with the requirements of the proposed IEC/ISO standard for HVSC systems is expected and any deviations from the recommendations must be documented. Other areas which must be addressed are:

- Document the grounding philosophy and any changes from previous baselines.
- Document the galvanic protection equipment and any changes from previous baselines.
- Provide the galvanic protection system settings.
- Provide the electrical load during shore connection in KVA and KW.
- Short-circuit current calculations in accordance with IEC 61363-1 shall be performed that take into account the prospective contribution of the shore supply and the ship's

configuration. The following ratings shall be defined and used in these calculations:

    - for shore supply installations, maximum and minimum[9] prospective fault currents for the specific ship
    - for specific ships, maximum and minimum prospective fault currents for visited shore supply installations
- The calculations may take into account any arrangements that:
    - prevent parallel connection of HV shore supplies with ship sources of electrical power except those specifically identified to be connected during transfers from ship's power to shore power
    - restrict the number of ship generators operating during parallel connection to transfer load
    - Restrict load to be connected.
- Provide the minimum and maximum prospective short-circuit currents to set relay limits and verify neutral grounding resistor will be in the range of 25 to 50 amps.
- Provide the ship-to-shore feeder circuit earth continuity check devices.
- The connectors should be inspected for damages and documented via photographs. The phase sequence should be verified as clockwise looking at the socket face.

9.2.1 Ship's Relay Settings

The Ship's Relay Settings should be readdressed and confirmed. Any changes to the ship's relay settings shall be documented.

9.2.2 Compatibility Assessment

Compatibility assessment shall be carried out to verify the possibility of connecting the ship-to-shore supply HV and must be performed prior to the first arrival at a terminal.

The compatability assessment shall validate the following:

- Minimum and maximum prospective short-circuit current.
- Nominal ratings of the shore supply, ship-to-shore connection and ship connection.
- Any de-rating for cable coiling or other factors.
- Acceptable voltage variations at ship switchboards between no-load and nominal rating.
- Steady state and transient ship load demands when connected to a HV shore supply, HV shore supply response to step changes in load.
- Verification of ship equipment impulse withstand capability.
- Compatibility of shore and ship side control voltages.
- Ship-to-shore control interface and protocol.
- Compatibility of communication link.
- Grid configuration compatibility assessment (neutral point connection).
- Sufficient cable length.

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[9] The minimum currents are used to ensure the neutral grounding resistor is properly sized to trip when a fault occurs; the maximum are set by the hardware limits of container ship configuration by IEC.

- Compatibility of safety circuits.

Assessment shall be made of the total harmonic distortion (THD) level after a HV shore supply connection has been made. Where applicable, electrical equipment installed in areas where flammable gas or vapor and/or combustible dust may be encountered shall be in accordance with IEC 60079 and/or IEC 61241 series.

9.2.3 Voltage Tolerances

The voltage tolerances shall be reviewed and confirmed. Any changes to the tolerances shall be documented. The voltage tolerances should be provided in accordance with the IEC/ISO Compatibility Check.

9.2.4 Ship Documentation

The following documentation for the ship shall be provided.

- Provide the name and contact information for Person in Charge of ship, in charge of shore-to-ship power transfer operation.
- Provide documentation of periodic maintenance and testing program for the ship's electrical system equipment, protective devices, paralleling controls, ground continuity check devices, control equipment, communications equipment, and flexible cable, connector, and cable management system if installed on the ship.
- A complete system description, including circuit diagrams, specifying set points and operation instructions, for the ship HVSC systems shall be provided.

9.2.5 Procedures for Shore-to-ship Connections

Ensure that the procedures below are current and readily available for shore-to-ship connections.

- Procedures for connection of the ship-to-shore flexible power cable & flexible feeder cable to the connection enclosure receptacles.
- Procedures to verify proper operation ship-to-shore feeder circuit earth continuity check devices.
- Procedures and requirements for energizing and paralleling of the shore-to-ship feeder.
- Operational procedures to be used while connected to shore power.
- Procedure for use in emergency situations.
- Procedures and requirements for de-energizing and shifting to ship's power.
- Requirements for the first call of a ship including the first call commissioning procedures.

9.2.6 Inrush Current Information

The following information about the ship's inrush current is required for the ship's relay settings shall be provided.

- Magnitude of maximum inrush current and number of starts per day.
- Inrush current limitations for both magnitude and number of starts per day.

9.2.7 Ship's Motor Information

The following information should be provided for a ship.

- Provide information on large motors, or similar equipment, including size, starter and control associated with each.
- For larger motors on the ship, that may affect the operation of shoreside breaker; provide the breaker settings necessary for protection. Specifically these are Excessive Starting Time and Locked Rotor.
- Confirm that no "Number of Starts before Blocking" protection is required on shoreside, for motor operation on ship.

9.2.8 Ground Fault & System Protection

The following information should be provided for a ship.

- Will the equipment grounding conductor supplied from shore be terminated on the ship? If so, describe how.
- Confirm that no specific ground fault protection scheme is required on shore for the ship. If a scheme is required, then define the scheme. Definite Time (DT) or an Inverse Definite Minimum Time (IDMT) schemes require delay tripping curves. Provide trip settings accordingly.
- For ships with low voltage main distribution the connection between LV-side of the transformer and main switchboard shall be evaluated and, if necessary, overload protection shall be provided.
- Confirm that there will be no other devices (other than the E-stop controls) connected to the continuity check wiring system, installed on the ship.[10]
- Provide details of the ship's incoming panel including disconnect with earthing switch, protective devices, protective device settings, controls, alarms and shut down devices.

9.2.9 Ship's Electric Plant

The following information about the ship's electric plan shall be provided.

- The maximum power (or peak demand) that the ship requires from shore, both in KVA

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[10] If such devices must be installed, coordination is necessary with shore portion of the wiring system.

and in KW.

- The ship electrical system nominal operating voltage, frequency, phase sequence and the operating tolerances.
- A single line diagram of each ship that will cold iron at the subject terminal.
- The nominal ratings of the shore supply and ship-to-shore connection and ship connection.
- The ship electrical system configuration, interface transformer winding configuration, neutral impedance, and grounding system requirements.
- The maximum short circuit withstand rating of the equipment on the ship connected to shore power.
- The minimum and maximum prospective short-circuit current.
- A description of the operation of the ship's shore connection circuit breaker and paralleling controls including the synchronizer and synchro-check relay settings.
- A description of how the power conductors supplied from shore will be terminated on the ship.
- The location on board the ship for the flexible power cable management system, if installed.
- Ship's hull impedance, between the shore power conductor terminations on the ship and the sea water below the ship hull shall be provided. Also provide the impedance of the equipment grounding conductor at the hull enclosure.

9.2.10 Ship Documentation

The following information shall be provided by the ship:

- Name of ship.
- The size of the ship in TEU capacity.
- Other information including plans, drawings, details, documentation as requested by the Port Authority and its representative.
- A record of annual maintenance, repair, equipment modifications and the test results shall be available for the shore and ship side HVSC system.
- For the HVSC system and each control apparatus, the manufacturer shall deliver documentation concerning principles of operation, technical specifications, mounting instructions, required start up or commissioning procedures, fault-finding procedures, maintenance and repair, as well as lists of necessary test facilities and replaceable parts.
- Provide documentation of the results of the testing carried out after completion of the installation of the ship side shore-to-ship power system.

9.3 FIRST VISIT

On the first visit of a ship to the Port of Long Beach, extra precautions shall be taken to ensure safe and acceptable operation of the system. These precautions shall include inspection and testing to ascertain the system and the ship are correctly connected for safe operation.

Prior to the first visit, the following shall be accomplished:

- The system study shall be completed and the report shall contain a recommendation for conducting the first visit.
- Persons in responsible charge for the port, the terminal, and the ship shall be identified.
- Certification letters for the port facility shall be obtained and reviewed for compliance with requirements.
- Any deviations, waivers, and non-conformances for the ship and port facility shall be reviewed.
- The first visit shall be approved or denied.

9.3.1 First Visit Test Plan

The first visit test plan shall be prepared and made available to all interested parties no later than 60 days prior to the test. This plan shall delineate requirements and test procedures for initial tests of the ship's installation and integration testing to verify that the connected system performs as desired with the specific ship. Personnel and special equipment such as communications and test equipment shall be identified. The test plan shall identify the sequence of tests to be performed.

A test plan review meeting shall be scheduled no later than 30 days prior to the test.

The first visit test plan shall include:

- Initial tests of ship side installation
  - Verification of operator training.
  - Maintenance records demonstrating that the system has been properly maintained.
  - Visual inspection.
  - High Voltage test.
  - Insulation resistance measurement.
  - Earthing resistance measurement.
  - Communications testing to all involved stations.
  - Functional testing and correct settings of protection devices.
  - Functional test of interlocking devices and system.
  - Functional test of the control system.
  - Earth-fault monitoring test.
  - Phase sequence test.
  - Functional test of cable management system.
- Integration test to demonstrate that the shipside installations such as power management system, integrated alarm, monitoring and control system work properly together before power is applied.

9.3.2 First Visit Testing

The HVSC system, including control equipment, shall be tested according to the first visit test plan. First Visit tests shall verify that the ship side installation complies with the proposed IEC/ISO standard for HVSC systems.

The tests shall be conducted as witnessed tests with the appropriate authorities having jurisdiction. Tests shall be carried out to demonstrate that the electrical system, control, monitoring and alarm systems have been correctly installed and are in good working order. Tests shall be realistic and simulations avoided as far as is practicable. Upon completion of the initial tests of ship side installation, the integration test is required to demonstrate that the shore and shipside installations work properly together.

During First Visit testing, all stations shall be manned and separate voice communications systems shall be established. If at any time unsatisfactory or unsafe conditions arise, first visit testing shall be stopped and the persons in charge shall meet to determine further testing. All persons in charge shall be in agreement to continue testing. One person in charge dissenting, either shipside or shoreside, shall be sufficient for the test to be halted.

9.3.2.1Initial Tests

The initial system tests shall be performed in accordance with the test plan stated in the Test Specifics section of this document. Initial testing includes both individual component testing and total system testing.

9.3.2.2Integration Test

The following is an outline for the integration test. The test items shall be executed in the order in which they are shown.

- Set relays.
- Do connection according to the procedures for ship-to-shore connections.
- Energize.
- Check inrush current.
- Operate any large motors and check the currents.
- Emergency stop.
- De-energize and disconnect the cables.

9.3.3 Procedures for Shore-to-ship Connections

Ensure that the procedures below are current and readily available for shore-to-ship connections.

9.4 REPROOFING

Reproofing is necessary when the ship's system has either been out of use for a period of 12 months or more or has had major maintenance repair or upgrade.

Reproofing of ships shall be accomplished annually and after every shipyard period e.g. dry-docking to ensure the ship remains in a safe and useable configuration for connection to shore power. Ships which have undergone a major shipyard overhaul or upgrade to its electrical system may require first visit procedures to be re-accomplished.

Prior to the reproofing, the following shall be achieved:

- Persons in Charge for the terminal operator and the ship shall be identified.
- Prior certification letters shall be obtained and reviewed for compliance with requirements.
- Deviations, waivers or other non-conformances shall be reviewed.
- The reproofing shall be approved or denied.

9.4.1 Reproofing Study

A reproofing study similar to the first visit study shall be conducted. The study shall:

- Identify configuration changes.
- Verify operator training.
- Review maintenance records.
- Verify continued compatibility.

The reproofing study shall be documented in a report and shall include a recommendation for reproofing visit testing.

The System Study shall be reviewed and areas where changes have occurred in the ship shall be evaluated for compatibility impact. As before, the reproofing System Study shall be documented in a report and shall contain a recommendation for First Visit Testing.

9.4.2 Reproofing Visit

The procedures for First Visit Testing shall be performed again as a Reproofing Visit. As with the original First Visit Testing, the tests shall be conducted as witnessed tests together with the appropriate authorities. A reproofing test plan shall be prepared and tests shall be documented in a reproofing test report.

ANNEX A – CHECKLISTS

A.1 15% PROJECT REVIEW

A.1.1 ES CONOPS

Service Category		
✔	**Requirement**	**Remarks**
	The notional ship's service category shall be provided per Table 1 – System characteristics.	

A.1.2 Notional Ship Information

Electric Power Transfer		
✔	**Requirement**	**Remarks**
	Provide a brief description of operation for the generation plant at each phase of the transition from ship power to shore power. These phases will include but are not limited to paralleling, load shedding, and connecting and disconnecting from shore power. The description shall include generation plant operation when restarting and transferring from shore power to ship's power when preparing to disembark.	

TEU Capacity		
✔	**Requirement**	**Remarks**
	The TEU capacity of the notional ship shall be provided.	

Grounding		
✔	**Requirement**	**Remarks**
	The shoreside transformer's neutral grounding resistor (NGR) shall be low resistance grounded. The NGR's rating shall be between 25A and 50A.	

Power		
✔	**Requirement**	**Remarks**
	Provide a single line diagram of the notional ship.	
	Provide the approximate maximum real power and total power consumption of the notional ship while at berth. This may be provided by service category per Table 1 — System characteristics.	
	High Voltage (HV) shore connections shall be provided with a nominal voltage of 6.6 and/or 11 kV galvanically isolated from the shore distribution system.	

A.1.3 Concept Site Plan

✔	Requirement	Remarks
	A concept site plan shall be prepared to show the approximate locations of all major items in the terminal. The concept site plan should include terminal property lines, shore-to-ship electrical power system including berths served and location of system transformer.	

A.1.4 Cabling Management and Handling

✔	Requirement	Remarks
	Determine if the medium voltage shore-to-ship cable shall be carried on the ship, provided at berth, or other.	
	Notional information on the medium voltage shore-to-ship cable and connector shall be provided.	

A.2 50% PROJECT REVIEW

A.2.1 ES CONOPS

ES CONOPS		
✔	**Requirement**	**Remarks**
	The ES CONOPS should be updated to reflect the design ship prior to the 50% Project Review. This refined information shall be provided.	

Point of Common Coupling		
✔	**Requirement**	**Remarks**
	Provide the nominal ratings of the shore ship-to-shore connection.	

A.2.2 Design Ship Information

Equipment and Circuit Breakers		
✔	**Requirement**	**Remarks**
	Provide the ship electrical system and equipment short circuit breaking and interrupting ratings, identify the maximum short circuit withstand rating of the equipment on the design ship connected to shore power.	

Single Line Diagram		
✔	**Requirement**	**Remarks**
	Provide a single line interface diagram of each ship that will cold iron at the subject terminal.	

Design Ship Electrical Interface		
✔	**Requirement**	**Remarks**
	The number of generators that will operate at berth shall be provided as well as an indication of how many of the generators are for backup, stand-by, or spare.	
	The quantity and type of each of the ship's generators shall be provided.	
	Provide a description of the operation of the ship's shore connection circuit breaker and paralleling controls including the synchronizer and synchro-check relay settings.	
	Grounding philosophy.	
	Nominal ratings of the ship connection.	

Interfaced Equipment		
✔	**Requirement**	**Remarks**
	Maximum short circuit withstand rating of the equipment on the design ship connected to shore power.	
	If shore feeders are terminated at transformer on a ship, confirm that the primary of the transformer is delta connected and secondary is Y connected.	
	If secondary of transformer is connected in Y, confirm that secondary of transformer grounding protection is independent of the shore side grounding protection system and backup on shore side is not necessary.	

A.2.3 Interfaced Requirements

✔	Requirement	Remarks
	Interface requirements should be well-documented on the drawings and should conform to industry standards. Interfaces include:	
	– Power and cable connections	
	– Grounding and bonding	
	– Data and similar connections	
	– Protection and coordination	
	– Communications connections e.g. phone and internet	
	– Entertainment connections	
	– Mechanical connections such as interface to the cable handling system	

A.2.4 Shore Supply Information

✔	Requirement	Remarks
	Nominal ratings of the shore supply.	
	Shore electrical service or service transformer winding configuration, number of phases, neutral impedance, system grounding and surge protection shall be provided.	
	Shore-to-ship feeder circuit earth continuity check devices shall be provided.	
	Information on the medium voltage shore-to-ship cable and connector shall be provided.	
	Procedures and requirements for connecting and energizing the shore-to-ship feeder	

A.2.5 Connector Information

✔	Requirement	Remarks
	The shipside plugs shall be Cavotec Co. part number PC5-SX04-K1850FOR for red colored plug and PC5-SX04-K1850FOB for blue colored plug. These plugs have provisions to accommodate fiber optic cable as part of the cable manager system located on the ship.	
	Quantity, type and rating for each receptacle in each connection enclosure.	
	Information on the shore-to-ship ground continuity check circuit interface requirements. Any tests performed to verify these requirements and their results shall also be included.	
	The shore-to-ship feeder circuit protective device ANSI types and settings.	

	The nominal voltage and appropriate connector for the HV shore connections shall be shown.	
	The phase sequence (L1-L2-L3 or A-B-C or R-S-T) at the connection point shall be clockwise (looking at the socket face).	

A.2.6 System Voltage and Frequency Tolerances

✔	Requirement	Remarks
	For no-load conditions, the voltage at the point of the shore-supply connection shall not exceed a voltage increase of 3.5 % of nominal voltage.	
	For rated load conditions, the voltage at the point of the shore supply connection shall not exceed a voltage drop of -3.5 % of nominal voltage.	

A.2.7 System Voltage and Frequency Transients

✔	Requirement	Remarks
	The response of the voltage and frequency at the point of common coupling when subjected to an appropriate range of step changes in load shall be defined and documented for each HV shore supply installation.	
	The maximum step change in load expected when connected to a HV shore supply shall be defined and documented for the design ship. The part of the ship subjected to the largest voltage dip or peak in the event of the maximum step load being connected or disconnected shall be identified.	
	A comparison of the items above shall be done to ensure that the voltage transient limits of voltage + 20 % / -15 % will not be exceeded.	

A.2.8 Protection

✔	Requirement	Remarks
	The calculated values shall be used to select suitably rated shore connection equipment and to allow the selection and setting of protective devices to ensure that successful discriminatory fault clearance is achieved for the largest on-board load while connected.	
	The shore-side supply system shall consider protection against fast transients (e.g., spikes caused by lightning strikes or atmospheric overvoltages) to protect connection and ship equipment from resultant damage.	

A.3 REVISED INFORMATION

A.3.1 Design Ship Information

Power		
✔	**Requirement**	**Remarks**
	Maximum real power and total power consumption of the design ship while at berth.	
	Verify that the appropriate HV shore connection nominal voltage (6.6 or 11kV) is selected.	
	The HV connections shall be galvanically isolated from the shore distribution system.	

Cable Management and Handling		
✔	**Requirement**	**Remarks**
	Cable management system shall be located on the ship.	
	Connection for the medium voltage shore-to-ship cable.	
	Details on the medium voltage shore-to-ship cable and connector.	
	Explicit description of how the power conductors supplied from ship will be terminated on shore.	
	For the cable used on the ship to connect to shore power, provide cable length, cable capacitance, inductance, resistance and coupling capacitance.	

A.4 100% PROJECT REVIEW

A.4.1 ES CONOPS

✔	Requirement	Remarks
	The final ES CONOPS shall be reviewed to ensure all parties are in agreement.	

A.4.2 Ship's Maneuvering, Mooring, and Personnel Safety

✔	Requirement	Remarks
	Ensure cargo handling and mooring equipment and the areas that must be clear for their operation are not restricted in their use.	
	Traffic management considerations shall be reviewed to ensure the use of the HVSC system does not:	
	– interfere with other ship operations.	
	– hinder or prevent necessary traffic flow on the pier.	
	– hinder or constrain fire lane access where required.	
	Ensure adequate personnel safety measures, including physical barriers to prevent unauthorized personnel access to HVSC equipment or the cable management equipment.	

A.4.3 Shoreside Power Requirements

✔	Requirement	Remarks
	The HV shore power supply system voltage quality specification.	
	The sequence for synchronizing from shore-to-ship power. Specifically review current, voltage and time characteristics during a typical synchronizing sequence. The review shall include nominal, maximum and minimum values.	
	The shore electrical service or service transformer winding configuration, number of phases, neutral impedance, system grounding and surge protection.	
	Requirements for documentation concerning principles of operation, technical specifications, mounting instructions, required start up or commissioning procedures, fault-finding procedures, maintenance and repair, as well as lists of necessary test facilities and replaceable parts for each HVSC system and control apparatus.	
	The system study calculations used to select suitably rated shore connection equipment and the selection and setting of protective devices to ensure that successful discriminatory fault clearance is achieved for the largest on-board load while	

	connected.	
	The HV shore power supply system voltage quality specification.	

A.5 REVISED INFORMATION

A.5.1 Design Ship Information

Ship's Relay Settings		
✔	**Requirement**	**Remarks**
	All ship's relay settings shall be reviewed and confirmed.	

System Voltage and Frequency Tolerances		
✔	**Requirement**	**Remarks**
	The voltage and frequency tolerance requirements shall be reviewed and confirmed.	

Cable Management and Handling Information		
✔	**Requirement**	**Remarks**
	The cabling information shall be reviewed and confirmed if installed on shipboard.	

A.5.2 Shoreside Information

Shore Supply Information		
✔	**Requirement**	**Remarks**
	The shore supply information shall be reviewed and confirmed.	

Connector Information		
✔	**Requirement**	**Remarks**
	The connector information shall be reviewed and confirmed.	

Cable Management and Handling Information		
✔	**Requirement**	**Remarks**
	The cabling information shall be reviewed and confirmed if installed on shore.	

A.6 TESTING AND ACCEPTANCE

A.6.1 Testing

✔	**Requirement**	**Remarks**
	A test plan shall be prepared. The test plan requirements shall address both individual equipment and the total system. The	

	requirements should include a list of equipment to be tested and should note equipment which is to be excluded from the test plan and the reasons for the exclusion.	

A.6.2 Commissioning

✔	Requirement	Remarks
	Create a commissioning plan that includes:	
	– Complete switchgear function tests	
	– Set shore transformer taps for proper voltage	
	– Measure shore-to-ship power system charging current	
	– Phase-sequence at each shore side power receptacle	
	– Confirm proper operation of receptacle interlock, ground-check, and monitoring circuits	
	– System operational tests	
	– System integration tests	
	Review the plan ensure that the system performs according to the design intent and the owner's operational needs, and that specified system documentation and training are provided to the facility staff.	

A.6.3 Acceptance

✔	Requirement	Remarks
	Create an acceptance plan that adequatedly addresses:	
	– Visual inspection.	
	– HV test.	
	– Insulation resistance measurement.	
	– Measurement of the earthing resistance.	
	– Function test of the protection devices.	
	– Function test of the interlocking system.	
	– Function test of the control equipment.	
	– Earth-fault monitoring test.	
	– Phase sequence test.	
	– Function test of the cable management system (if part of the shore facility).	
	– Integration test to demonstrate that the shore and shipside installations work properly together.	
	Review the test plan to assure that it meets the specifications including safe operation under normal operating conditions.	

A.7 FINAL PROJECT REVIEW

A.7.1 Commissioning Documentation

✔	Requirement	Remarks
	The system is installed as designed and is capable of supporting the intended operations.	
	The operator is ready and able to operate the system in a safe and useable fashion.	
	Specific ships are expected to be safely connected after evaluation and qualification.	
	The system performs according to the design intent.	

A.7.2 Shore Facility Documentation

✔	Requirement	Remarks
	Test reports showing that the quality of power specifications and the quality of service parameters for the HV shore power supply have been met.	
	Start-up and commissioning procedures.	
	Operation and maintenance manuals.	
	List of replaceable parts.	
	System technical specifications.	
	Procedures for accomplishing and recording annual maintenance, test, repair, and modifications.	
	Record of annual maintenance, test results, repair, and equipment modifications.	
	Certification artifacts of the first call of all ships certified to use the port, including the first call commissioning procedures.	
	Documentation that the tests have been carried out to demonstrate that the electrical system, control, monitoring and alarm systems have been correctly installed and are in good working order before being put into service shall be provided.	
	Configuration management procedures identifying a single configuration manager and the roles and responsibilities of all parties involved.	
	Test reports of HV test and insulation measurement.	
	Documentation showing training and qualifications of operators.	
	The name and contact information of the Persons in Responsible Charge for the POLB, the tenant, and any specific ships currently qualified.	

A.7.3 Shore-to-ship Connection

✔	Requirement	Remarks
	Provide the shore-to-ship feeder circuit earth continuity check devices.	
	Procedures for connection of the shore-to-ship flexible feeder cable to the connection enclosure receptacles shall be provided.	
	Procedures and requirements for energizing and paralleling of the shore-to-ship feeder shall be provided.	
	Exception: No ship-to-shore control interface or protocols are provided.	

A.7.4 Persons in Charge

✔	Requirement	Remarks
	During operation of HVSC systems, Persons in Charge shall be identified at the shore facility and on board the ship for the purposes of communication.	
	These parties shall be provided with sufficient information, instructions, tools and other resources to allow activities to be conducted in a sufficiently safe and effective manner.	
	Procedures should employ an approved “Lock-out, Tag-out” system that is jointly controlled by the ship and shore Persons in Charge.	

A.7.5 Commissioning Report

✔	Requirement	Remarks
	A commissioning report documenting the results of commissioning activities shall be prepared.	

A.8 TESTING AND ACCEPTANCE

A.8.1 Test Specifics

The individual components listed below shall be tested during the Individual Components Testing.

Test Plan		
✔	**Requirement**	**Remarks**
	Cables and connectors.	
	Switchgear.	
	Circuit breakers.	
	Load interrupter switches.	
	Protective relays.	
	Switchgear controls.	
	Control power.	
	Instrument transformers.	
	Grounding devices and interlocks.	
	Ground-check circuits.	
	Power transformers.	
	Neutral-grounding devices.	
	Neutral-ground over-current relay.	
	Shoreside power plug and receptacle assembly including quick-connect connector.	
	Interlocking system control and monitoring cable and connectors.	
	Grounding system components.	
	Earth resistance measurements.	

Test Procedures		
✔	**Requirement**	**Remarks**
	Test procedures provide the detailed measurements and expected results of a specific test. A test procedure is required for each test to be performed. Test procedures should include test equipment required, points of measurement, and operational settings. Blanks to record printed tester name, signature, test date, and measured data shall be provided. Test procedures shall also contain areas to record anomalies or unusual conditions.	

Test Report

✔	Requirement	Remarks
	A test report documenting the results of the tests shall be prepared and made available for the Final Project Review. Any failures, the nature of failure, how the failure was fixed, and retesting results of the failure should be explicitly noted in the report. The report shall include test inputs, expected results, criterion for evaluating results, test procedure and all assumptions and constraints.	

Cables and Connectors		
✔	**Requirement**	**Remarks**
	Cables and connectors shall be visually inspected after installation. Connector part numbers and serial numbers should be recorded. Cables should be subjected high-potential tests and results recorded.	

Switchgear, Controls, and Related Equipment		
✔	**Requirement**	**Remarks**
	Switchgear, circuit breakers, load interrupter switches, protective relays, switchgear controls, control power, instrument transformers, grounding devices and interlocks, and ground-check circuits should be visually inspected after installation and testing according to the manufacturer's recommendations.	

Shore-to-ship Connection Enclosure		
✔	**Requirement**	**Remarks**
	The shore-to-ship connection enclosure shall be visually inspected and photographed. Phase rotation at the connector shall be verified. Preventer pad eyes shall be tested to 125% of their rated load.	

A.8.2 Acceptance

The acceptance test plan shall include requirements for the following:

Test Plan		
✔	**Requirement**	**Remarks**
	Visual inspection.	
	HV test.	
	Insulation resistance measurement.	
	Measurement of the earthing resistance.	
	Function test of the protection devices.	
	Function test of the interlocking system.	
	Function test of the control equipment.	
	Earth-fault monitoring test.	
	Phase sequence test.	
	Function test of the cable management system (if part of the shore facility).	
	Integration test to demonstrate that the shore and shipside installations work properly together.	

A.8.3 Delivery to Terminal Operator

Tests after Extended Time between Port Calls		
✔	**Requirement**	**Remarks**
	Visual inspection.	
	Confirmation that no earth fault is present.	
	Statement of voltage and frequency.	
	Review of the procedure for authorized switching and connection.	
	The HV test and insulation resistance measurement shall be carried out only if one of the installations, shore side or ship side, was out of service or not in use for more than 30 months.	
	Record of annual maintenance, repair, equipment modifications and the test results shall be available for the shore and ship side HVSC system.	
	Documentation of periodic testing and maintenance of the ship-to-shore electrical system including all equipment, protective relays, ground continuity check circuit, control equipment, and flexible cable and connector shall be provided. Provide the results of the latest test.	

A.9 SPECIFIC SHIP REQUIREMENTS

A.9.1 System Study

The system study must be documented as a report. Compliance with the requirements of the proposed IEC/ISO standard for HVSC systems is expected and any deviations from the recommendations must be documented. Other areas which must be addressed are:

✔	Requirement	Remarks
	Document the grounding philosophy and any changes from previous baselines.	
	Document the galvanic protection equipment and any changes from previous baselines.	
	Provide the galvanic protection system settings.	
	Provide the electrical load during shore connection in KVA and KW.	
	Short-circuit current calculations in accordance with IEC 61363-1 shall be carried out that take into account the prospective contribution of the shore supply and the ship's configuration. The following ratings shall be defined and used in these calculations:	
	– for shore supply installations, a maximum and minimum prospective fault currents for the design ship	
	– for ships, a maximum and minimum prospective fault currents for visited shore supply installations	
	The calculations may take into account any arrangements that:	
	– prevent parallel connection of HV shore supplies with ship sources of electrical power except those specifically identified to be connected during transfers from ship's power to shore power	
	– restrict the number of ship generators operating during parallel connection to transfer load	
	– restrict load to be connected.	
	Provide the minimum and maximum prospective short-circuit currents to set relay limits and verify neutral grounding resistor will be in the range of 25 to 50 amps.	
	Provide the ship-to-shore feeder circuit earth continuity check devices.	
	The connectors should be inspected for damages and documented via photographs. The phase sequence should be verified as clockwise looking at the socket face. (deal with this later)	

Ship's Relay Settings		
✔	**Requirement**	**Remarks**
	The Ship's Relay Settings should be readdressed and confirmed. Any changes to the ship's relay settings shall be documented.	

Compatibility Assessment		
✔	**Requirement**	**Remarks**
	The compatability assessment shall validate the following:	
	– Minimum and maximum prospective short-circuit current.	
	– Nominal ratings of the shore supply, ship-to-shore connection and ship connection.	
	– Any de-rating for cable coiling or other factors.	
	– Acceptable voltage variations at ship switchboards between no-load and nominal rating.	
	– Steady state and transient ship load demands when connected to a HV shore supply, HV shore supply response to step changes in load.	
	– Verification of ship equipment impulse withstand capability.	
	– Compatibility of shore and ship side control voltages	
	– Ship-to-shore control interface and protocol	
	– Grid configuration compatibility assessment (neutral point connection)	
	– Sufficient cable length	
	– Compatibility of safety circuits	
	– Assessment shall be made of the total harmonic distortion (THD) level after a HV shore supply connection has been made.	

Voltage Tolerances		
✔	**Requirement**	**Remarks**
	The Voltage Tolerances shall be reviewed and confirmed. Any changes to the tolerances shall be documented.	

Ship Documentation		
✔	**Requirement**	**Remarks**
	Provide the name and contact information for Person in Charge of ship, in charge of shore-to-ship power transfer operation.	
	Provide documentation of periodic maintenance and testing program for the ship's electrical system equipment, protective devices, paralleling controls, ground continuity check devices, control equipment, communications equipment, and flexible cable, connector, and cable management system if installed on the ship.	
	A complete system description, including circuit diagrams, specifying set points and operation instructions, for the ship HVSC systems shall be provided.	

Procedures for Shore-to-ship Connections		
✔	**Requirement**	**Remarks**
	Procedures for connection of the ship-to-shore flexible power cable & flexible feeder cable to the connection enclosure receptacles.	
	Procedures to verify proper operation ship-to-shore feeder circuit earth continuity check devices.	
	Procedures and requirements for energizing and paralleling of the shore-to-ship feeder.	
	Operational procedures to be used while connected to shore power.	
	Procedure for use in emergency situations.	
	Procedures and requirements for de-energizing and shifting to ship's power.	
	Requirements for the first call of a ship including the first call commissioning procedures.	

Inrush Current Information		
✔	**Requirement**	**Remarks**
	Magnitude of maximum inrush current and number of starts per day.	
	Inrush current limitations for both magnitude and number of starts per day.	

Ship's Motor Information		
✔	**Requirement**	**Remarks**
	Provide information on large motors, or similar equipment, including size, starter and control associated with each.	
	For larger motors on the ship, that may affect the operation of shoreside breaker; provide the breaker settings necessary for protection. Specifically these are Excessive Starting Time and Locked Rotor.	
	Confirm that no "Number of Starts before Blocking" protection is required on shoreside, for motor operation on ship.	

Ground Fault & System Protection

✔	**Requirement**	**Remarks**
	Is the equipment grounding conductor supplied from shore terminated on the ship? If so, describe how.	
	Confirm that no specific ground fault protection scheme is required on shore for the ship. If a scheme is required, then define the scheme. Definite Time (DT) or an Inverse Definite Minimum Time (IDMT) schemes require delay tripping curves. Provide trip settings accordingly.	
	For ships with low voltage main distribution the connection between LV-side of the transformer and main switchboard shall be evaluated and, if necessary, overload protection shall be provided.	
	Confirm that there will be no other devices (other than the E-stop controls) connected to the continuity check wiring system, installed on the ship.	
	Provide details of the ship's incoming panel including disconnect with earthing switch, protective devices, protective device settings, controls, alarms and shut down devices.	

Ship’s Electric Plant		
✔	**Requirement**	**Remarks**
	Provide the maximum power (or peak demand) that the ship requires from shore, both in KVA and in KW.	
	Provide the ship electrical system nominal operating voltage, frequency, phase sequence and the operating tolerances.	
	Provide a single line diagram of each ship that will cold iron at the subject terminal.	
	Provide the nominal ratings of the shore supply and ship-to-shore connection and ship connection.	
	Provide the ship electrical system configuration, interface transformer winding configuration, neutral impedance, and grounding system requirements.	
	Provide the maximum short circuit withstand rating of the equipment on the ship connected to shore power.	
	Provide the minimum and maximum prospective short-circuit current.	
	Provide a description of the operation of the ship’s shore connection circuit breaker and paralleling controls including the synchronizer and synchro-check relay settings.	
	Describe how the power conductors supplied from shore will be terminated on the ship.	
	Provide the location on board the ship for the flexible power cable management system, if installed.	
	Ship’s hull impedance, between the shore power conductor terminations on the ship and the sea water below the ship hull shall be provided. Also provide the impedance of the equipment grounding conductor at the hull enclosure.	

Ship Documentation		
✔	**Requirement**	**Remarks**
	Name of ship.	
	The size of the ship in TEU capacity.	
	Other information including plans, drawings, details, documentation as requested by the Port Authority and its representative.	
	A record of annual maintenance, repair, equipment modifications and the test results shall be available for the shore and ship side HVSC system.	
	For the HVSC system and each control apparatus, the manufacturer shall deliver documentation concerning principles of operation, technical specifications, mounting instructions, required start up or commissioning procedures, fault-finding procedures, maintenance and repair, as well as lists of necessary test facilities and replaceable parts.	

A.9.2 First Visit

✔	**Requirement**	**Remarks**
	The system study shall be completed and the report shall contain a recommendation for conducting the first visit.	
	Persons in charge for the port, the terminal, and the ship shall be identified.	
	The first visit shall be approved or denied.	

First Visit Test Plan		
✔	**Requirement**	**Remarks**
	Initial tests of ship side installation	
	– Verification of operator training.	
	– Maintenance records demonstrating that the system has been properly maintained.	
	– Visual inspection.	
	– High Voltage test.	
	– Insulation resistance measurement.	
	– Earthing resistance measurement.	
	– Communications testing to all involved stations.	
	– Functional testing and correct settings of protection devices.	
	– Functional test of interlocking devices and system.	
	– Functional test of the control system.	
	– Earth-fault monitoring test.	
	– Phase sequence test.	
	– Functional test of cable management system.	
	Integration test to demonstrate that the shipside installations such as power management system, integrated alarm, monitoring and control system work properly together before power is applied.	

Integration Test		
✔	**Requirement**	**Remarks**
	Set relays.	
	Do connection according to the procedures for ship-to-shore connections.	
	Energize.	
	Check inrush current.	
	Operate any large motors and check the currents.	
	Emergency stop.	
	De-energize and disconnect the cables.	

ANNEX B – MICROSOFT® PROJECT GANTT CHART

Insert Gantt Chart here

ANNEX C – ELECTRICAL SYSTEM CONCEPT OF OPERATIONS

C.1 OUTLINE FOR ES CONOPS

C.1.1 Overview

An electrical system concept of operations (ES-CONOPS) is a statement of the required behaviors of an electrical system based on its intended use.

The ES-CONOPS should include scenarios that the system is expected to encounter normal operation, as well as scenarios unique to special operations such as start-up, shut-down and casualty control.

The ES-CONOPS should articulate power system attributes which should be optimized for each of the expected scenarios. Typical attributes should include quality of service, energy efficiency, safety, emissions, and safety of life to meet the system's functions and business needs. It should also include margin policy and provisions for future changes, and should foster a design which meets or exceeds the requirements and expectations for the system. The ES-CONOPS should address the human systems interface and the interaction between humans and the electric power system equipment.

C.1.2 Principle Electrical Parameters

- Volts
- Amps
- KW
- KVAR
- Load Profile
- Grounding

C.1.3 Saftey Considerations

- Hazardous Conditions

C.1.4 Conditions Not Covered

C.2 SCENARIOS

C.2.1 Operational Scenarios

- Connection
- Normal Start-Up
- Normal Operation

- Normal Shut-Down
- Disconnection

C.2.2 Special Scenarios

- Emergency Start-up
- Emergency Shut-Down
- Overload

C.2.3 Human Systems Interface

- Systems Components
- Connection Box
- Cable and Cable Handling
- Kirk Locks

C.2.4 Program & Business Needs

5.1 BUILDINGS

5.1.1 ELECTRICAL SYSTEM DESIGN GOAL

A. Engineer is required to provide a complete operational system that meets all the requirements of the RFP. The electrical systems shall be designed with emphasis and focus on energy efficient systems to achieve sustainable "Green Building" and maximize LEED points. Engineer is responsible for system selection, design, engineering, calculations, coordination with other trades, installation, testing, and commissioning. Engineer is responsible for selecting appropriate locations for all new electrical spaces and equipment. Engineer is responsible for focusing on maximizing energy efficient systems to achieve sustainable "Green Building" and maximize LEED points.

5.1.2 ELECTRICAL SYSTEMS - GENERAL

A. The design of the electrical system for the proposed buildings will encompass service to the proposed building, interior and exterior lighting, power distribution systems and a fire alarm system. All these systems will be designed to provide the user with maximum flexibility and all equipments that form part of these systems will be selected for durability and maintenance ease that are consistent with the current campus standards.

The following applicable codes and standards will be referenced for the electrical design for the proposed building.

Applicable Codes:

- California Building Standards Administrative Code (Title 24, Part 1), 2007
- California Building Code (Title 24, Part 2), 2007
- California Electrical Code (Title 24, Part 3), 2007
- California Energy Code (Title 24, Part 6), 2008
- California Fire Code (Title 24, Part 9), 2007
- California Referenced Standards Code (Title 24, Part 12), 2007

Reference Standards and Guidelines:

NFPA 72: National Fire Alarm Code
1999 Edition of the Illuminating Engineering Society of North America Handbook

Design Criteria

Following design voltages and load calculation criteria shall be followed for the building.

Design Voltages

1. Primary:
   - 12kV, 3 phase, 3 wire

2. Secondary voltage, Emergency/standby:
   - 480Y/277V, 3 phase, 4 wire
   - 208Y/120V, 3 phase, 4 wire

3. Secondary voltage, Normal:
   - 480Y/277V, 3 phase, 4 wire
   - 208Y/120V, 3 phase, 4 wire

4. Distribution Voltages
   - 480V, 3 phase, 3 wire for all motor loads ½horsepower and larger
   - 277V for lighting
   - 120V for receptacles
   - 120/208V, single and three phase for lab equipment.

5.1.3 COORDINATION AND SUBMITTALS

A. Engineer is responsible for coordination of routing and equipment layouts for all trades.

   1. All construction drawings, specifications, calculations, product submittals, and other documents pertaining to the electrical design of this project must be prepared by and bear the stamp and signature of a California licensed electrical engineer with a minimum of 8 years experience. The electrical engineer must have experience in projects of the size, type, and complexity of this project.

5.1.4 ELECTRICAL DESIGN BASIS

A. The design of the building Electrical system shall be based on the following:

   1. PRIMARY SERVICE

SCE is the primary power provider in the area and will be providing power to the proposed facilities. Power to the proposed facilities shall be accomplished as follows:

The proposed buildings will be served from a SCE service available at 12kV in the vicinity of the proposed buildings.

Main 12kV substations rated at 12kV-480V/277V, 3phase, 4wire will be provided in the main electrical room of the proposed buildings.

Engineer shall select an interior location for the main substation/ switchboard. The service for the proposed building shall be sized based on the criteria provided in this narrative. A digital watt-hour/demand meter shall be provided with LON capability in addition to the utility meter. CT's and PT's shall be sized to allow IDR level metering.

In addition to the space provided for a telephone backboard and electrical room in a building, make sure there is adequate space for computer equipment or LAN equipment. Preferably make rooms separate from each other. Each floor of the building should have its own telephone and electrical room, preferably located near the center of the building of each floor.

2. BUILDING POWER AND DISTRIBUTION

Design-Builder is required to furnish and install Switchboards, Panels, Motor Control Centers, Relays, and all electrical apparatus and equipment necessary for a complete and functional power distribution system.

3. BUILDING POWER AND DISTRIBUTION SYSTEM

A 277/480-volts, 3-phase, 4-wire and 120/208-volts, 3-phase, 4-wire system is to be provided as follows:

a. Large motors (1/2 HP & larger)	480-volts, 3 phase.
b. Small motors (1/3 HP & smaller)	120-volts and 208-volts
c. Lighting, fluorescent	277-volts
d. Lighting, incandescent	120-volts
e. Receptacles, general purpose	120-volts
f. Receptacles, special Purpose	208-volts, 1 phase
g. VAV boxes	120-volts
h. Misc. power	120-volts and 208-volts

The basis for calculating the Volt-Ampere to be provided per Square Foot floor area would be as follows:

Office:	Lighting	-	1.5
	Receptacle	-	2.0
Conference rooms:	Lighting	-	1.5
	Receptacle	-	3.0
Lounges, Restrooms:	Lighting	-	0.6
	Receptacle	-	1.5
Storage Rooms:	Lighting	-	0.6
	Receptacle	-	1.5
Shops and Support Rooms:	Lighting	-	1.5
	Power	-	20
Information Technology Rooms:	Lighting	-	1.2
	Equipment/Receptacles		6.0
	Power	-Actual motor Hp	
Corridor:	Lighting	-	1.0
	Receptacle	-	0.5
Mechanical Areas:	Lighting	-	1.5
	Power	-Actual Motor HP	

Engineer is responsible for coordination of power requirements of all equipment supplied by supplied by others.

4. ELECTRICAL REQUIREMENTS FOR TELECOMMUNICATION ROOMS

a. One dedicated 100A electrical panel connected to standby power with built in Transient Voltage Surge Suppression (TVSS), located in BDF is required.
b. One dedicated 60A electrical panel connected to standby power with built in TVSS, located in each IDF is required.
c. One rack mounted dedicated 30 amp quad outlet per equipment rack.
d. Wall mounted 120V outlets no less than 6 feet on center or one per wall minimum.
e. Location of other non-dedicated electrical equipment within telecommunication rooms is not allowed per industry standard.

5. ELECTRICAL SYSTEM SPARE CAPACITY

a. A spare capacity of 25% shall be designed for the main electrical system.

b. Electrical Distribution

All conduits consisting of 480/277V, 3-phase, 4-wire conductors will originate from the 480/277V Switchboards to different lighting panels throughout the buildings. Likewise, conduits consisting of 208/120V, 3-phase, 4-wire conductors will originate from the 208/120V Distribution Boards housed in the main electrical room and floor electrical rooms shall serve the power panels in electrical rooms and labs on each floor. 480-120/208V, 3phase, 4wire distribution transformers sized to meet the load requirements shall be provided in the electrical room on each floor. Dedicated panel boards shall be provided in all labs to serve lab receptacles and related equipment. Panel boards shall be surface mounted in the electrical rooms and recess mounted in other locations. All panel boards shall be 42 circuits 3-phase. 25% spare circuit breakers shall be included in each panel.

Equipment not related to the support of the electrical rooms (e.g., piping, ductwork, etc.) cannot be installed in, pass through, or enter electrical rooms per California Electrical Code (CEC) 110.26, f.

5.1.5 <u>WIRING METHOD</u>

A. Perpendicular and Plumb

Run all cables and/or conduits parallel and perpendicular to the structure. Cables and/or conduits run diagonally to the structure are unacceptable.

B. Conduit

Minimum conduit size of 3/4 inch when installed above ground, serving receptacles and other power related is required. Minimum size for lighting circuit conduit is ½". Increase conduit size as required per code. Support all conduits per current CEC. Allowed length of flex conduit shall be limited to 4 feet or less. Surface mounted conduit is acceptable only in locations where exposed structure is the finished surface; in such cases, locate conduit for minimum visual impact.

1. Above ground: rigid conduit, IMC or EMT are acceptable. Rigid conduit is required in outdoor locations and where conduit is exposed to physical damage.

2. Underground: Schedule 40 PVC with concrete encasement (red dye on top surface of the duct bank) is required. Use PVC-wrapped or PVC-coated steel elbows for plastic conduit runs and elbows penetrating floor slabs. Minimum underground conduit size shall be 1”.

3. MC cable, rigid non metallic conduits, electrical non-metallic tubing, and screw type fittings are unacceptable.

C. POWER AND LIGHTING SYSTEMS 600V OR LESS

1. Conductors:

- #12 and #10: AWG solid copper
- #8 AWG and larger: stranded copper

2. Minimum conductor size for runs over 100 feet for 120/208V system shall be #10 AWG or larger as per CEC Voltage Drop calculations.

3. Provide no more than (3) duplex receptacles on one 20A/1P branch circuit. Determine the exact number of duplex outlets on each circuit based on load proposed to be connected to each outlet.

4. Multi-wire (shared neutral and ground) receptacle circuits are not acceptable**.** A dedicated neutral and ground is required for each receptacle circuit.

5. Provide power outlets as required to support Audio-Visual (A-V) equipment.

6. Provide power outlet, one duplex per each communications outlet location including those equipped with cable and jacks, or conduits and boxes placed for future.

7. One floor mounted power outlet per conference room is to be provided. The outlet shall be centrally located under the conference room table.

8. Provide wall mounted 120V convenience outlets no more than 6 feet on center or one per wall minimum.

9. Provide above the counter 120V convenience outlets no more than 3 feet on center or one per counter space minimum unless otherwise specified.

10. Provide 120V power to irrigation controller.

11. Provide 120V Power to “Blue Light Phone” (emergency telephone station) locations.

12. Provide 120V and 208V outlets as detailed in the data sheet for each shop. All necessary power to shop equipment shall also be provided based on the power requirements of the equipment. Surface metallic raceways with outlets spaced at 24” on center shall also be provided in the labs as provided in the matrix. Surface raceways in labs shall be metallic type with multi compartments. A dedicated compartment will be provided for power receptacles connected to normal power, another compartment will be provided for receptacles connected to the stand-by power system and a separate compartment shall be provided for low voltage wiring. Each bench table in all shops shall be provided with a pair of duplex outlets on a dedicated circuit. Floor outlets shall be provided under each table in the computer labs.

13. Provide power wiring to all motors, fans, pumps and all equipment provided under mechanical, plumbing and architectural sections shall be provided as part of the electrical construction. All wiring below 120V will be considered as part of other trades such as mechanical systems. All low voltage devices, where required, shall be provided with raceway only. 20 ampere branch circuits shall be provided for convenience outlets.

14. Transformers in office areas should be "K" rated, somewhere between 13 to 20, to handle harmonic currents. After installation is complete and system is put to use, require contractor to analyze the system and determine the transformer "K" rating is in accordance with specifications.

15. When designing heat pumps to be installed in buildings, show the heat pump and where the disconnecting switch is located, making sure minimum required clearance for the switch is maintained.

D. GROUNDING

1. A new grounding system per CEC shall be established in the building and the main switchboards will be connected to this grounding system. A central grounding system will be provided from the building service substation to panels, metallic conduit and raceways. A separate ground conductor will be provided for all circuits. All metallic piping attached to the building is also required to be bonded. Provide a #6 grounding wire from telephone backboard to building grounding network.

E. LIGHTING

1. Light fixtures and systems will be selected for efficiency, durability, maintenance ease, and to accentuate the area architecture. Indoor lighting will be tailored to building's needs and theme.

2. The illumination levels will conform to the latest edition of Illuminating Engineering Society (IES) guidelines, and shall be as follows:

AREA	AVERAGE FOOT CANDLES
Administration/Offices	35-50 FC on desk
Shops	50 FC minimum on working space
Shop Support Spaces	50 FC minimum on desk
Utility & Storage Rooms	30 FC at floor
Telecom Room	50 FC at floor
Corridor	15 FC at floor
Information Technology rooms	40 FC on desk
Restrooms	20 FC
Conference rooms	50 FC
Lobby/Lounge	30 FC

3. Foot-candle levels shall comply with campus energy standards and shall be designed based on user requirements.

4. Offices shall be illuminated with suspended, linear, fluorescent fixtures equipped with T5 lamps and low harmonic electronic ballast. In areas with ceilings indirect/direct fixtures are required. Task lighting should be considered to reduce the amount of over head lighting to maximize energy savings.

5. Down lights equipped with compact fluorescent lamps and electronic ballast shall illuminate the corridors and restrooms.

6. Conference rooms shall be illuminated with a combination of indirect/direct suspended light fixtures equipped with T5 lamps and compact fluorescent down lights. Additional track light fixtures with halogen lamps and dimmer controls are required for conference rooms.

7. All fixture ballasts shall be CBM certified, UL approved and certified per CEC 2-5314(B).

8. Fluorescent, high-pressure sodium or metal-halide fixtures shall be installed on the outside building perimeter as needed. All exterior lighting, including building perimeter lighting shall conform to the campus exterior lighting policy and guidelines. The perimeter of the buildings shall be highlighted by wall mounted light fixtures and down lights located to enhance architectural features. These fixtures shall also provide coverage for pedestrians in proximity of the buildings.

9. Bi-level Switching shall be provided in areas exceeding 0.8w/sqft and are over 100sqft. Automatic dimming controls shall be provided in all day-lit areas to harvest the daylight savings. Single level switches shall be provided in service areas and utility rooms. Automatic shut off for all building areas shall be accomplished through low voltage lighting control panel and override switches in compliance with current California Energy Code. Likewise corridor lighting shall be controlled with lighting control panel and override switches in compliance with CEC code. Occupancy sensors equipped with bi-level switches consistent with POLB standards shall be provided in all offices. Restrooms shall be provided with single level switch and ceiling mounted occupancy sensors.

10. Architectural dimming systems will be provided in conference rooms.

11. Lighting power densities and controls shall comply with Utility Company's Energy Savings program and shall beat current Title 24 requirements by a minimum of 20%.

12. Outdoor lighting will be controlled by a photocell/timeclock that interfaces with the lighting control panel.

13. LED Exit signs will be provided at all exits and along the path of egress. Emergency lighting (light fixtures on emergency power) will be provided in labs, pathways, corridors and public access areas and illumination will conform to the current CBC requirement of a minimum one-foot candle level at floor level during loss of normal power. Emergency lighting will be served from an emergency panel located on each floor that in turn is served from the main emergency distribution board.

F. STANDBY POWER GENERATOR SYSTEM

a. A standby diesel generator unit with sub base fuel tank is to be provided to serve life safety loads such as emergency lighting and supply fans/exhaust fans serving the computer/secured areas.

b. The emergency generator will be sized to provide 25% spare capacity. Two automatic transfer switches; one for life safety loads and one for standby loads shall be provided.

c. The Generator shall be located outside the Building and its noise shall be kept to 70db at 23'.

d. Capacity of fuel to maintain continuous full duty for 24 hours is required.

e. A remote alarm annunciator tied into the Port of Long Beach EMS is to be provided.

f. Transfer switches used in three-phase four-wire emergency or standby generator systems, shall be three-pole automatic switch **with overlapping neutral transfer contact**. Three-pole automatic switch is not acceptable, neither is the four-pole automatic switch.

G. FIRE ALARM SYSTEM

A complete make Analog/Addressable manual Fire Alarm System is required. The Long Beach Fire Department and the State Fire Marshal is the primary jurisdictional authority for this project.

Fire Alarm System shall be installed in dedicated and marked conduits (red stripes at each end is required). All fire alarm boxes are required to have red covers. New initiating and indicating devices shall be placed throughout the floors to meet current code requirements.

1. One remote LCD alphanumeric annunciator at the main building entrance with an eighty character digital readout indicating which device is in alarm or trouble mode is required. Coordinate exact location with the State Fire Marshal.

2. Locate the Fire Alarm Control Panel (FACP) with an eighty character digital readout indicating which device is in alarm or trouble mode inside the main electrical room.

3. Fire alarm connections to all fire suppression systems, hoods, and door hold-opens are required.

4. Fiber-optic cable connection from the FACP to the campus main command center located in Public Safety building via the main communications room is required.

H. ASSISTIVE LISTENING SYSTEM

Assistive Listening System in accordance with current codes shall be provided. Phonic Ear equipment is preferred.

I. RENEWABLE POWER SYSTEM

A portion of the building energy usage shall be offset by the provision of renewable energy source. The renewable power system shall be sized to offset a minimum of 10% of the total projected energy costs of the building.

J. SECURITY SYSTEM

The building shall be equipped with a security system comprising of card readers, motion sensors and cameras at public areas. The security panel shall be located in the data closet and shall report to a central security system at the Port.

K. COMMISSIONING

All electrical systems of the building shall be commissioned. The systems commissioned shall include lighting control panel, switchgear, occupancy and daylit sensors, calibration of meters, fire alarm control system and security system.

5.2 Parking Lots Lighting

5.2.1 Light Fixtures and Poles

Parking Lots shall be illuminated with cut off light fixtures and shall limit the Lighting for parking lots should be achieved using poles no higher than 40 ft. The light poles should be square and painted. Unless otherwise approved by the POLB, parking lot light poles should be installed on concrete footings which extend above finished grade a minimum of 30", for protection against vehicles.

Steel (For backland lighting within terminals)

Review the steel pole specifications with the pole manufacturer, and structural engineer of the project, and confirm the specifications are accurate and complete. Consultant shall obtain Long Beach City plan check approval for steel pole, and for it's foundation.

5.2.2 Wooden

Show details on drawings, of how wooden poles are to be installed, to the satisfaction of City of Long Beach, Plan Check requirements. Some of the required information is; Depth of pole setting, compaction requirements, pole calculations for adequacy of intended use.

5.2.3 Light Levels

The light source for parking lots should be high pressure sodium Spacing and pole height should be designed to achieve a 2 footcandle average light level, a .5 footcandle minimum, and a maximum to minimum uniformity ratio of 8: 1.

The reference standard used for determining footcandle (FC) level shall be Illumination Engineering Society (IES) standard recommendations. IES recommends an average maintained horizontal level of 1 FC. with minimum maintained horizontal level of 0.2 FC and uniformity ratio of maximum to minimum of 20:1. This is the guide recommended for use, with the entrance and exit areas of the parking lot having good lighting, that is the maximum lighting levels must be assured at these points, which is usually accomplished by placing a light pole or two near these entrances or on either side of the entrances to the parking lot. In calculating these values, use Light Loss Factor (LLF) of 0.9. These are minimum recommendations, so depending on the final layout of the parking lot and where lighting poles may be conveniently located, these values may be difficult to accomplish exactly, so if there is a need to deviate from these values, the deviation shall be to obtain higher values, such as 1.5 FC average maintained horizontal instead of 1 FC.

5.2.4 Lighting Controls

Parking lot lighting shall be controlled through photocells mounted on top of light poles or located on meter pedestal.

5.2.5 Grounding

Each luminaire housing shall be connected to equipment grounding conductor by means of a crimped spade-type terminal connector secured to housing with a self-tapping screw or housing grounding lug. Bond luminaries, metal accessories, and metal poles to branch circuit equipment grounding conductor.

5.2.6 Communication and Security

Parking lot lighting shall be provided with provision of security cameras on top of the pole. A 2” dedicated conduit shall be provided to each pole for provision of security and communication wiring.

5.2.7 Communication/Power conduits

Terminate two spare conduits for communications, and two spare conduits for power, at each light pole. Size all conduits at 2”. These conduits terminating at the poles, need not be routed further than the closest pull boxes located in the backland area.

5.3 Gates and Guard House

Each gate shall be provided with power and communication connections to remotely monitor the gate activities. In addition, cameras shall be provided at each of the gates. These cameras shall be IP based cameras and shall be connected via data cables to the nearest telecom distribution system.

Terminate two spare conduits for communications, and two spare conduits for power, at each gate. Size all conduits at 2". These conduits terminating at the gates, need not be routed further than the closest pull boxes located in the backland area.

5.3.1 Guard House

Make sure guard houses or prefabricated buildings have state approval seals on the building, otherwise Building & Safety will not approve it.

5.4 Street Lighting

Street lighting design should conform to the requirements of the illuminating Engineering Society ''RP-8 Roadway Lighting" publication. For highway lighting within the Port area where Caltrans requirements are to be followed, lighting design shall conform to the latest edition of Caltrans Standard Plans and Standard Specifications. Light poles for roadways should be as shown in the standard plans with a fixture mounting height of 35 ft.

Street lighting fixtures should be high pressure sodium "cobra head" type unless specific job requirements call for a special fixture type. Light fixtures should be cutoff type with clear flat lens.

Street lighting pullboxes should be precast concrete, #5 or #6 pullboxes, per the Standard Plans. Street lighting pullbox covers should be marked "POLB Street Lighting".

Metered service pedestals for street lighting circuits should be free standing pedestal type, designed for multiple circuits.

Meter pedestal enclosures should be stainless steel, corrosion resistant with hinged, lockable covers. Indicate on the plans required circuit breakers, contactors, photocells and any options required. Design a concrete pad for each pedestal according to its size.

Where street lighting is designed to be on extension of an existing system, light fixtures and poles should be designed to match the appearance of the existing system.

5.4.1 Light Levels

Illumination levels should conform to the requirements of the illuminating Engineering Society ''RP-8 Roadway Lighting" publication. For highway lighting within the Port area where Caltrans requirements are to be followed, lighting design shall conform to the latest edition of Caltrans Standard Plans and Standard Specifications.

5.4.2 Lighting Controls

Street lighting shall be controlled through photocells mounted on top of light poles or located on meter pedestal.

5.4.3 Grounding

Each luminaire housing shall be connected to equipment grounding conductor by means of a crimped spade-type terminal connector secured to housing with a self-tapping screw or housing grounding lug. Bond luminaries, metal accessories, and metal poles to branch circuit equipment grounding conductor.

5.4.4 Communication/Power conduits

Terminate two spare conduits for communications, and two spare conduits for power, at each light pole. Size all conduits at 2”. These conduits terminating at the poles, need not be routed further than the closest pull boxes located in the backland area.

5.5 Reefer Outlets

Reefer outlets should be 480V three-phase, 32 amp, pin-in-sleeve receptacles as shown on the Standard Plans. Use reefer boxes w/4 outlets per box.

The receptacles should be installed as part of a listed multi-gang/stacked assembly and shall be 5 gang high.

At-grade outlet assemblies (such as for wheeled reefer containers) reefer outlet assemblies should be bunker mounted. See Standard Plans for design of concrete bunker.

For design purposes, reefer outlets should be considered to draw 18 amps (15kVA) each. No more than 8 receptacles should be supplied by any single feeder, and all feeders should be designed for 100% reefer loading, with a 3-pole overcurrent device rated 225A.

For multiple feeders coming from a switchboard, a demand factor of 65% should be taken at the supplying switchboard to size the switchboard.

SECTION 02582

POLES
(Parking Lots & Street Lights)

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following poles for support of luminaires:

1. Steel poles.

B. Related Sections include the following:

1. Division 16 Section "Exterior Lighting" for lighting fixtures, lamps, ballasts, and accessories.

1.02 DEFINITIONS

A. Luminaire: Complete lighting fixture, including ballast housing if provided.

B. Pole: Luminaire support structure, including foundation, standard, pole top and high pole, and tower used to illuminate large area.

C. Standard: Same definition as "Pole" above.

1.03 PERFORMANCE REQUIREMENTS

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-3.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-3.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-3.

D. Wind Load: Pressure of wind on standard and luminaire, calculated and applied as stated in AASHTO LTS-3.

1. Wind speed for calculating wind load for poles 50 feet in height or less is 110 mph

1.04 SUBMITTALS

A. Product Data: For each type of pole indicated, arranged in order of lighting unit designation. Include data on accessories, finishes, and the following:

1. Materials and dimensions of poles.
2. Means of attaching luminaires and indication that attachment is suitable for it.
3. Bases.

B. Shop Drawings: Include anchor-bolt templates keyed to specific poles and certified by manufacturer.

1. Design calculations, certified by a qualified professional engineer, indicating strength of concrete base foundation.

C. Product Certificates: Signed by manufacturer of poles, certifying that products are designed for load requirements in AASHTO LTS-3 and that load imposed by luminaire has been included in design.

1. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

B. Retain factory-applied pole wrappings on metal poles until just before pole installation.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace lighting poles and standards that fail in finish, materials, and workmanship within specified warranty period.

1. Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.
2. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.
3. Warranty Period: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Valmont Industries, Inc or equal.

2.02 POLES, GENERAL

A. Description: Comply with AASHTO LTS-3 in structural design of poles.

B. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Performance Requirements" Article, with a gust factor of 1.3.

1. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

C. Luminaire Attachment: Structural supports to comply with luminaire mounting requirements.

D. Finish: Match finish of pole and support structure on arm, bracket, and tenon mount materials.

E. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Mountings: Correctly position luminaire attachment to provide indicated light distribution.
3. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.
4. Anchor-Bolt Template: Plywood or steel.
5. Concrete Bases: Cast-in-place concrete.

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and having strength, mounting bolt, and top-plate dimensions required to support pole, luminaire, and accessories.

G. Breakaway Supports: Frangible breakaway supports for indicated poles, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-3.

2.03 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in length with access handhole in pole wall.

1. Shape: Round, straight "NPS" is an industry standard designation for "nominal pipe size" in inches. "DN" is the equivalent metric designation for "dimension nominal."

B. Steel Mast Arms: NPS 2 black steel pipe, continuously welded to pole attachment plate.

C. Metal Pole Brackets: Cantilever brackets without underbrace, with straight tubular end section to accommodate luminaire. Match pole finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch flush and gasketed handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip. Connection of green grounding conductors located opposite of handhole..

G. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 16 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

H. Cable Support Grip: Wire-mesh type (Kellum grip or similar) with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

I. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

J. Brackets for Luminaires: Detachable, with pole and adapter fittings. Adapter fitting welded to pole and bracket, then bolted together with galvanized steel bolts.

K. Tapered oval cross section, with straight tubular end section to accommodate luminaire.

L. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

M. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

N. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Interior Surfaces: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
   3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

      a. Color: As indicated by manufacturer's designations.

2.04 ACCESSORIES

A. Cast base cover, of same material and color as pole.

B. Transformer Base: Same material and color as pole. Coordinate base dimensions to accept ballast and other specified accessories.

PART 3 - EXECUTION

3.01 ERECTION, GENERAL

A. Set reinforcement for anchor bolts, nuts, and washers according to anchor-bolt templates furnished by pole manufacturer.

   1. Concrete Finish: Trowel and rub smooth.

B. Embedded Poles: Set poles to depth indicated below finished grade, but not less than one-sixth of pole length.

1. Dig holes large enough to permit use of tampers in the full depth of hole.
2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

C. Install poles as follows:

1. Use web fabric slings (not chain or cable) to raise and set poles.
2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
3. Secure poles level, plumb, and square.
4. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
5. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

3.02 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 16 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.03 GROUNDING

A. Ground metal poles/support structures according to Division 16 Section "Grounding and Bonding."

1. Install grounding electrode for each pole.
2. Nonmetallic Poles: Ground metallic components of pole accessories and foundations.
3. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

C. Ground poles and support structures according to Division 16 Section "Grounding and Bonding."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.

END OF SECTION

SECTION 16010

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

Electrical General Requirements specifically applicable to Division 16 Sections, in addition to Division 1 – General Requirements. Work includes but is not necessarily limited to the following:

A. Definitions, guarantees, submittals, clean-up, "As-Builts" and all other applicable requirements of and Division 1 apply to the work of this section.

B. Examine all other sections for work related to those sections, which are required to be included as, work under this section.

C. Coordinate all work in this Division with related trades.

D. The work includes but is not limited to the following:

1. Provide underground duct banks, manholes, including excavation, shoring, backfill and surface repair.
2. Provide conductors in new ducts / manholes.
3. Provide conduits for telephone and communication.
4. Provide transformers and low voltage switchgear.
5. All construction power and lighting and all power for testing of equipment and systems through final acceptance tests.
6. All equipment and facilities required to provide temporary and permanent services.
7. All electrical work for the building power, lighting, signal, control, life safety and mechanical systems at all building sites, except as specified herein to be furnished or installed as part of other sections of the specifications.
8. Incidental items not indicated on the drawings nor mentioned in the Specifications that belong to the work described, or are required to provide complete and operable systems, as though called out here in every detail.
9. The power distribution system through new and existing ductbanks that includes the 15kV cables, splices, terminations and connections, all the concrete encased conduit, the direct buried conduits, the conduit terminations, medium voltage switchgear, equipment pads, metering equipment, substations, transformers, wiring, and necessary connections.
10. Miscellaneous conduit, ductbanks, manholes, handholes, wiring, cable, junction boxes, pull boxes, and other electrical equipment needed to provide for the complete and operational systems shown on the drawings and specified herein.

E. Work related to the mechanical trade as listed below shall be included in this Division of the work. Refer to control drawings and mechanical drawings for exact requirements of work in this scope. Furnish and install the following:

F. The drawings and specifications are complementary, and what is called for in either is binding as if called for in both.

1.02 WORK NOT INCLUDED

A. Telephone and fiber optic systems wires, telephone cables, and telephone equipment will be provided and installed by others.

1.03 RELATED WORK

A. The Contractor shall coordinate this section with all other sections of the specifications.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Perform all work and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:

a. Local Laws and Ordinances

b. State and Federal Laws

c. National Electrical Code (NEC)

d. Life Safety Code (NFPA-101)

e. State Fire Marshal

f. Underwriters' Laboratory (UL)

g. National Electric Safety Code (NESC)

h. American National Standards Institute (ANSI)

i. National Electrical Manufacturers' Association (NEMA)

j. Institute of Electrical and Electronics Engineer (IEEE)

k. Insulated Cable Engineers Association (ICEA)

l. The Occupational Safety and Health Act (OSHA)

m. Federal, State and Local Building Codes

n. Southern California Edison (SCE)

2. Nothing in these Drawings and Specifications shall be construed to permit work not conforming with governing codes or regulations.

B. Responsibility: The Contractor shall be responsible for:

1. Complete systems in accordance with the intent of these Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions that affect the work covered under this Division.

3. Referring to all of the Drawings, Specifications, and approved shop drawings for other trades for details of facility, equipment, and construction that affect the work covered under this Section.

4. Furnishing and installing all incidental items not specifically shown or specified that are required by good practice to provide the complete systems specified.

C. Inspection: All materials, equipment, and workmanship subject to inspection at any time by the Engineer or his representatives. Correct any work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Engineer at no additional cost to the City.

1.05 PROJECT CONDITIONS

A. Existing Conditions: Verify all conditions by visiting the site and include in the bid all factors which may affect the execution of this work. Include all related costs in the initial bid proposal.

B. Protection During Construction

1. Throughout this Contract, provide protection for materials and equipment against loss or damage. Protect everything from the effects of weather. Prior to installation, store items in indoor, dry locations. Store in indoor, heated, dry locations items subject to corrosion under damp conditions, and items containing insulation, such as transformers, conductors, motors, and controls.

2. Following installation, protect materials and equipment from corrosion, physical damage and the effects of moisture on insulation. Cap conduit runs during construction with manufactured seals. Keep openings in boxes or equipment closed during construction.

3. All debris shall be removed from premises during work, as directed, and at completion of job.

4. The contractor shall furnish and place on his portion of work proper guards for prevention of accidents. Provide and maintain construction required for the safety of life or property, including the maintenance of sufficient light during night hours.

C. Temporary Utilities

1. The Contractor shall be responsible for providing and paying for the electrical power required for construction.

2. Temporary or interim use of any and all portions of the electrical system shall be under the supervision of the Contractor.

3. Provide temporary facilities in accordance with Section 01500 Temporary Facilities and Controls.

1.06 CONTRACT DOCUMENTS

A. Intent of Drawings

1. Drawings are partly diagrammatic. They are intended to show circuiting and switching details which shall be exactly as shown. Exact conduit locations are not shown unless so indicated or specifically dimensioned. Installation of conduit stub-ups shall be in accordance with field conditions and actual manufacturer’s shop drawings. The Contractor shall be responsible for verifying all dimensions before proceeding with the work.

2. The electrical drawings do not indicate all fittings, hardware, or appurtenances required for a complete operating installation.

3. Wiring diagrams are not intended to indicate the exact course of raceways or exact location of outlets. Raceway and outlet locations are approximately correct and are subject to revision as may be necessary or desirable at the time of installation. Precise location in every case shall be subject to the Engineer's approval.

4. One-line and riser diagrams are schematic and do not show physical arrangement of equipment.

B. Departures From Contract Documents

1. Submit to the Engineer in writing details of any necessary, proposed departures from these Contract Documents, and the reasons therefor. Submit such requests

as soon as practicable. Make no such departures without written approval of the Engineer.

1.07 AS CONSTRUCTED DRAWINGS:

A. Provide as-built drawings directed in the Special Provisions.

1.08 DEFINITIONS

A. When "provide" is used, it shall be interpreted as "furnishing and installing complete in operating condition.”

B. When "drawings" is used, it shall be interpreted as "all contract drawings for all disciplines.”

1.09 PERMITS & FEES

A. The Contractor shall obtain and pay for all licenses, permits and inspections required by laws, ordinances and rules governing work specified herein. The Contractor shall arrange for inspection of work by the inspectors and shall give the inspectors all necessary assistance in their work of inspection.

B. The Contractor shall consult with, coordinate with, and follow the requirements of Southern California Edison Company (SCE).

1.10 INSTRUCTIONS AND MANUALS

A. A preliminary copy, 100% complete, shall be submitted for checking and review. Three bound, corrected copies shall be delivered to the Engineer 14 days prior to scheduled instruction periods.

B. The O&M manuals shall contain shop drawings, wiring diagrams, operating and maintenance instructions, replacement parts lists, and equipment nameplate data for all equipment and systems installed under the project.

C. Each type of device provided shall be identified in the O & M Manual using the same identification as shown on the drawings and specifications. The information included must be the exact equipment installed, not the complete "line" of the manufacturer. Where sheets show the equipment installed and other equipment, the installed equipment shall be neatly and clearly identified on such sheets. Parts lists shall give full ordering information assigned by the original parts manufacturer. Relabeled and/or renumbered parts information as reassigned by equipment supplier are not acceptable. The following information shall be provided for each device.

1. Manufacturer's name, address, and phone number.

2. Local supplier's name, address, and phone number.

3. Complete parts lists, including quantities and manufacturer's part numbers.

4. Installation instructions.

5. Recommended maintenance items including maintenance procedure and recommended interval of maintenance listed in hours of operation, calendar units, or other similar time unit.

D. The O & M Manual shall be assembled in three ring binders, or equal. The information contained in the manuals shall be grouped in an orderly arrangement by specification index. The manuals shall have a typewritten index and divider sheets between categories with identifying tabs. The covers shall be imprinted with the name of the City of Long Beach Harbor Department, Architect, Electrical Engineer, Contractor, and year of completion. The back edge shall be imprinted with the name of the job, City, and year of completion. As a minimum, the following sections shall be tabbed.

1. Medium Voltage Metal Clad Switchgear

2. Medium Voltage Load Interrupter Switchgear

3. Power Transformers

4. Crane Collector System

5. Cable and Wire

6. Manholes, Junction and Pullboxes

7. Splices

8. Enclosed Transformer Neutral Grounding Resistor

9. Medium Voltage Busway

E. Wiring diagrams for each system shall be complete for the specific system installed under the contract. "Typical" line diagrams will not be acceptable unless properly marked to indicate the exact field installation.

1.11 INSTRUCTION PERIODS:

A. Upon completion of the work and after all tests and final inspection of the work by the Authority(s) having jurisdiction, the Contractor shall demonstrate and instruct the City’s designated operating and maintenance personnel in the operation and maintenance of the various electrical systems. The Contractor shall arrange scheduled instruction periods with the City. Contractor shall schedule training minimum of 2 weeks in advance. The Contractor's representatives shall be superintendents or foremen knowledgeable in each system and suppliers representatives when so specified.

B. Scheduled instruction periods shall be:

1. Medium Voltage Switchgear — 1 day

2. Crane Collector System — 1/2 day

C. Costs for time and materials involved by the Contractor shall be included in the bid.

1.12 COMPLETION OF WORK

A. Arrange for and obtain all required inspections and certificates pertaining to the Division 16 work and deliver the certificates to the Engineer in triplicate.

B. Prior to or at the time of final inspection, the Contractor shall, as outlined in detail in the specifications, complete the delivery of all the following items:

ITEM		REFERENCE SPEC. SECTION
1.	Certificate of Final Inspection, In triplicate from A. Electrical Inspector	16050 Para 1.09
2.	Marked set & reproducible mylar set of "As-Built" Electrical Drawings	16050 Para 1.07
3.	Equipment Shop Drawings and Final Approved List of Materials Installed	16050 Para 1.13
4.	Warranty, wiring diagrams, operation installations and brochures (5 copies)	16050 Para 1.13

1.13 SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals,” product information for the following items:

- Raceways
- Fittings
- Raceway supports
- Wire & Cable
- Junction and Pull Boxes
- Medium Voltage Switchgear
- Power Transformers
- Crane Collector System
- Device Boxes
- Neutral Grounding Resistor

- Manholes
- Cable Splice Materials
- Medium Voltage Busway

B. Submit to the Engineer no later than thirty (30) calendar days after the award of contract, and at least twenty (20) calendar days before the material is required for fabrication or installation, a minimum five (5) copies, each bound under a separate cover (with index), detailed product data to include:

1. Manufacturer's Product Data, including catalog sheets, brochures, diagrams, performance charts, schedules, and other descriptive literature.

    a. Clearly mark each copy to identify pertinent product or models.

    b. Show dimensions, weights, and clearances required.

    c. Show performance data, including electrical ratings and noise levels.

    d. Show wiring diagrams and controls

2. Manufacturer's schematic drawings and wiring diagrams:

    a. Modify to delete information which is not applicable.

    b. Supplement standard information to provide information specifically applicable to this project and the equipment specified.

3. Shop Drawings:

    a. Present data in a clear and thorough manner.

    b. Identify details by reference to contract sheet and detail numbers and by location in the structure.

    c. Submit one reproducible transparency plus three prints.

4. Samples, if required:

    a. Provide samples of sufficient size and quantity to clearly illustrate the functional characteristics of the product or material. After review, samples may be used in the construction of the project if approved.

    b. Submit the number and type specified in each Specification Section.

C. Submittals shall include:

1. Detailed reference (written or highlighted) noting compliance with the appropriate specification section and applicable item numbers within that section.

2. Project title, date and revision date, names of supplier and manufacture

3. Applicable standards

4. Other descriptive data, as required by individual specification sections or the Engineer.

D. Submittals shall be complete, submitted at one time with each item indexed with dividers, and shall be indexed according to the individual specification sections.

E. Resubmission requirements:

1. Revise initial drawings as required and resubmit as specified for initial submittal.

2. Indicate on the drawings any changes which have been made other than those requested by the City.

3. The City may return without review any submittal not meeting the requirements listed above.

F. Within ten (10) working days after the date of letter rejecting any items of equipment, or materials as not in accordance with these specifications, Contractor shall submit a new list of items he proposes to furnish and install in place of those items rejected. If the Contractor fails to submit this new list within the above specified time, or if any items on this second list are rejected as not being in accordance with these specifications, the Engineer may select the items which the Contractor shall furnish and install without change in contract price or time of completion.

PART 2 - PRODUCTS

2.01 COMPETITIVE PRODUCTS

A. Any reference in the Specifications to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may at his option propose substitutions for such material in accordance with the substitution procedure outlined in this section.

2.02 MATERIALS

A. Provide all first-quality, new materials and equipment, free from any defects, in first-class condition, and suitable for the space provided. Provide materials and equipment approved by UL or other nationally recognized testing agency, wherever standards have been established by that agency.

B. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

C. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these specifications.

D. Provide materials and equipment with manufacturers' standard finish system, except where otherwise specified. Provide manufacturers' standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with ANSI Number 61, light gray color.

E. Environmental and Seismic Conditions: Material and Equipment shall be designed to insure satisfactory operation and operational life in the environmental and seismic conditions which will prevail where they are being installed.

2.03 SUBSTITUTIONS AND PRODUCT OPTIONS

A. Submit a written request for proposed substitutions in accordance with the requirements of the Special Provisions (S.P.3) and Section 01300. Include in request:

1. Complete data substantiating compliance of proposed substitution with Contract Documents.

    a. Product identification, including manufacturer's name and address.

    b. Manufacturer's literature, including complete catalogue data, physical and technical data, wiring diagrams, schematics, performance and test data, reference standards, and any other descriptive data as required by the Engineer to determine equality.

    c. Name and address of similar projects on which product was used, and date of installation.

    d. Revised drawings showing the proposed changes.

    e. Electrical calculations that demonstrate that the original design requirements are met by the proposed substitution.

2. Itemized comparison of proposed substitution with product or method specified.

3. Data relating to changes in construction schedule.

B. Substitutions Will Not Be Considered If:

1. They are indicated or implied on Shop Drawings or product data submittals without request submitted in accordance with this Article.

2. Acceptance will require substantial revision of Contract Documents.

2.04 COMPLETE SYSTEM

A. All the systems mentioned shall be complete and operational in every detail except where specifically noted otherwise. Nothing in these specifications shall be construed as releasing the Contractor from furnishing such additional materials and performing all labor required to provide complete and operable systems.

2.05 NAMEPLATES

A. Provide nameplates constructed of plastic (black on white) laminated material engraved through black surface material to white sublayers.

1. Medium Voltage Switchgear – Refer to Sections 16350 and 16361.

2. Power Transformers – Refer to Section 16320.

3. Medium Voltage Grounding Resistor – Refer to Section 16451.

PART 3 - EXECUTION

3.01 GENERAL

A. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance.

B. Check the approximate locations of all electrical equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, utilities, and components of other systems and equipment having fixed locations. In the event of conflicts, consult the Engineer. The Engineer's decision shall govern. Make necessary changes at no cost to City.

C. Follow manufacturers' installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturers' instructions, codes and regulations, and these Contract Documents, follow Engineer's direction at no additional cost to City. Keep copy of manufacturers' installation instructions on the jobsite available for review at all times.

3.02 COORDINATION

A. The Division 16 work shall be coordinated with that of the other divisions and trades and all drawings, shall be examined for construction details and necessary coordination.

3.03 FIELD QUALITY CONTROL

A. Field Tests:

1. Carry out tests specified in this Section and as specified under individual sections of this division.

2. Operations: After the electrical system installation is completed and at such time as the Engineer may direct, conduct an operating test for approval. Demonstrate that the equipment operates in accordance with the requirements of these Specifications. Furnish all instruments and personnel required for the tests.

3. Grounds: Test all wiring connections for continuity and grounds before any loads are connected.

4. Perform all tests in the presence of the Engineer or his authorized representative.

3.04 CLEANING AND PAINTING

A. All equipment, whether exposed to the weather or stored indoors, shall be covered to protect it from water, dust, and dirt.

B. After installing, all metal finishes shall be cleaned and polished, cleaned of all dirt, rust, cement, plaster, grease, and paint.

C. All equipment with a primer coat of paint shall be given two (2) or more coats of a finish enamel and scratched surfaces be refinished to look like new. Markings, identification, and nameplates shall be replaced.

3.05 EQUIPMENT IDENTIFICATION

A. Provide identifying engraved nameplates on all equipment, including pull boxes, to clearly indicate the use, area served, circuit identification, voltage, and other data, as noted on the drawings.

3.06 DEVIATION FROM SHOP DRAWINGS

A. Deviation from the Shop Drawings in construction or installation of equipment shall not be made unless Shop Drawings showing proposed deviations are submitted to and approved by the Engineer.

3.07 EXCAVATIONS

In addition to the requirements of Section 02221, the Contractor shall ensure that:

A. All excavations are to be so conducted that no walls or footings shall be disturbed or damaged in any way.

B. Remove all surplus earth not needed for backfilling and dispose of same as directed by the Engineer.

3.08 WIRING METHODS

A. All electrical wiring shall be installed in raceways with manholes, handholes, junction boxes and fittings as noted and/or required.

3.09 HANGERS AND SUPPORTS

A. Provide all hangers, brackets, channels and supplementary steel required to support equipment.

B. Hangers provided under other Divisions shall not be used for support of Division 16 equipment unless permitted by Engineer.

3.10 CUTTING AND PATCHING

A. Obtain permission from the Engineer prior to cutting. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. Cut concrete with diamond core drills except where space limitations prevent the use of such drills.

B. All construction materials damaged or cut into during the installation of this work must be repaired or replaced with materials of like kind and quality as original materials by skilled labor experienced in that particular building trade.

PART 4 - MEASUREMENT AND PAYMENT

4.01 The Electrical General work will be measured and paid for with Bid Item No. 3: “Site Electrical”.

END OF SECTION

SECTION 16030

ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

Acceptance testing requirements for electrical power systems.

1.02 WORK INCLUDED

A. Provide acceptance testing for all equipment and cabling provided under this project, including medium voltage equipment, cabling, and splices.

1.03 RESPONSIBILITY

A. The Contractor is responsible for acceptance testing of all equipment and cabling provided.

1. The Contractor shall have all testing, unless otherwise noted, completed by an independent testing agency which shall be a NETA certified and NETA member testing company. The Contractors insurance coverage shall cover the testing agency as specified in the Special Provisions

2. Changes in the project that add equipment or cabling shall include applicable testing, and equipment or cabling shall be tested.

1.04 APPLICABLE PUBLICATIONS

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. American National Standards Institute, Inc. (ANSI) Publication:

1. C2-97 National Electrical Safety Code

2. C37.16-88 Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements and Application Recommendations

B. International Electrical Testing Association Inc. (NETA) Publication:

1. NETA/ATS-1999 Acceptance Testing Specifications for Electrical Power

Distribution Equipment and Systems

C. Institute of Electrical and Electronic Engineers (IEEE) Publications:

1. 141 Recommended Practice for Electric Power Distribution for Industrial Plants

2. 242 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

3. 399 Recommended Practice for Industrial and Commercial Power System Analysis

4. 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems

D. National Fire Protection Association (NFPA) Publication:

1. 70-99 National Electrical Code (NEC)

1.05 SUBMITTALS

A. Submit a schedule of testing for all equipment approximately 30 days prior to commencing the first test or group of tests. Update the testing schedule and submit revised schedules of testing to reflect all changes to the testing schedule.

B. Submit copies of the test results on all equipment and cabling.

C. Submit six (6) copies under provisions of Sections 01300 and 16010.

D. Qualifications: Provide for:

1. Independent testing organization.

2. Designated project safety representative.

3. Certified Engineering Technician(s) to be assigned to the project.

4. Power system analysis firm

E. Acceptance Test Procedures: Provide for:

1. Transformers (all types)

2. Low voltage switchgear

3. Distribution switchboards

4. Ground fault protective systems

5. Low voltage circuit breakers (> 100A)

6. Grounding systems

7. Cable and Wires

8. Medium Voltage Load Interrupter Switchgear

9. Medium voltage Metal Clad Switchgear

10. Meters and associated instrument transformers

11. Medium voltage circuit breakers

12. Low voltage power circuit breakers

13. Low voltage circuit breakers (> 100A)

F. Certified Test Reports: The final report shall be signed and shall include the following information: Summary of the project, description of the equipment tested, visual inspection report, description of the tests, test results, conclusions and recommendations, appendix including appropriate test forms, and identification of the test equipment used. Provide bound copies for:

1. Transformers (all types)

2. Low voltage switchgear

3. Distribution switchboards

4. Ground fault protective systems

5. Low voltage circuit breakers (> 100A)

6. Grounding systems

7. Cable and Wires

8. Medium Voltage Load Interrupter Switchgear

9. Medium voltage Metal Clad Switchgear

10. Meters and associated instrument transformers

11. Medium voltage circuit breakers

12. Low voltage power circuit breakers

13. Low voltage circuit breakers (> 100A)

1.06 QUALIFICATIONS

A. The contractor shall engage the services of a qualified independent testing organization to provide final inspection, testing, calibration, and adjusting on the electrical distribution system as defined in this Section. The independent testing organization shall have been engaged in full practice for a minimum of five years. The organization shall be corporately independent of the supplier, producer, manufacturer or installer of the equipment.

B. The independent testing organization shall have a calibration program with accuracy traceable every six months, and in an unbroken chain, to the National Institute of Standards and Technology (N.I.S.T.).

C. The independent testing organization shall have a designated safety representative on the project. The safety standards shall include OSHA and NFPA 70E.

D. Testing, inspection and calibration shall be performed by an Engineering Technician, certified by a national organization, with a minimum 5 years experience inspecting, testing and calibrating electrical distribution equipment, systems and devices. Information on the qualifications of the Certified Engineering Technician shall be submitted to the Engineer for approval prior to the start of work.

E. The qualifications of the independent testing organization shall be submitted to the Engineer for approval minimum 30 days prior to the start of testing.

PART 2 - PRODUCTS

2.01 ACCEPTANCE TESTING

A. The contractor and testing agency shall use installation tools and test equipment which are designed for the specific task and use per the manufacturer's instructions.

1. All test equipment shall have current calibration certification by a third party calibration laboratory, and shall have a signed and dated calibration sticker affixed to the device. Defective test equipment and installation tools shall not be

used.

2. Installation tools, such as torque wrenches, shall be calibration certified.

B. Provide a standard calibration sticker on each protective device, circuit breaker or instrumentation device tested or calibrated. The sticker shall include the tester's initials, date, and function performed. A cable schedule shall be maintained for all cable tested, including testers name, date and test results.

C. Generally, the National Electrical Testing Association (NETA) testing specifications shall be used as the basis for performing and evaluating acceptance testing.

1. The NETA testing specifications and acceptance criteria shall be modified or appended as listed.

D. All tests and inspections shall be documented, including:

1. Testers name.

2. Date.

3. Items tested.

4. Test results.

5. Acceptance criteria.

6. Corrective work.

7. Witnesses.

8. Test Instrument Calibration Date.

E. Submit a preliminary copy of the test results to the Engineer no longer than one week after tests are completed, along with a letter stating that the installed systems meet the requirements of the plans and specifications.

1. Include all test and inspection reports in the Operations and Maintenance Manual.

PART 3 - EXECUTION

3.01 <u>GENERAL</u>

A. Plan all testing and device adjustments with sufficient time available to complete all work well in advance of the service date for the equipment.

1. Phase work and complete the testing and adjustments as equipment is installed. Seal or lock all equipment to prevent tampering or altering of setpoints following adjustment.

2. Submit a comprehensive schedule for all testing a minimum of four weeks prior to starting the work.

3. If 25kV power for the lighting transformers is not available from the Pier T Main Terminal Substation, Contractor shall provide a temporary source of power, sufficient to support testing the lighting systems, at no additional cost.

B. Submit completed test results and setpoint list for review approximately 30 days prior to project completion. Update and correct the reports as required after review by the Engineer and include final copies in the O & M manuals.

C. All inspections shall be performed in accordance with applicable codes and standards including NEC, ANSI, IEEE, NEMA and OSHA.

D. The independent testing organization shall provide all materials, equipment, labor and technical supervision to perform the inspections and tests.

3.02 INSPECTION

A. A visual inspection of the installed equipment shall be performed by the independent testing organization to verify that the distribution equipment installed and to be tested is the equipment denoted on the approved shop drawings. The inspection shall check the equipment designations, device characteristics, special installation requirements, applicable codes and standards.

B. After completion of the visual inspection, a report shall be developed stating any discrepancies that may have been found. The Contractor shall then be responsible to correct all discrepancies, shall re-inspect and another report shall be developed. This process shall be repeated until all discrepancies are resolved.

3.03 TESTING, CALIBRATION AND ADJUSTMENT

A. The independent testing organization shall perform tests on each item of distribution equipment identified in accordance with the latest edition of the International Electrical Testing Association's (NETA) Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.

B. Field acceptance testing shall be accomplished on each item of electrical distribution equipment installed or connected as part of this contract. This shall include:

1. Transformers (all types)

2. Low voltage switchgear

3. Distribution switchboards

4. Ground fault protective systems

5. Low voltage circuit breakers (> 100A)

6. Grounding systems

7. Cable and Wires

8. Medium Voltage Load Interrupter Switchgear

9. Medium voltage Metal Clad Switchgear

10. Meters and associated instrument transformers

11. Medium voltage circuit breakers

12. Low voltage power circuit breakers

13. Low voltage circuit breakers (> 100A)

C. Systems shall be energized or otherwise placed in service only after completion of all required tests and an evaluation of the test results have been completed.

D. Listed below are the type of equipment, and the test to be performed on each. Tests must meet the criteria recommended by NETA.

E. Perform visual and mechanical inspection for all medium voltage cable installed under this project. This requires the testing agency be present during cable installation to perform and document the visual and mechanical inspections.

1. Visually inspect cable jacket and insulation condition during installation as cable is pulled from reels.

2. Where cables are terminated through window type CTs inspect for proper CT polarity and to verify neutrals and ground are properly terminated. Improper CT polarity shall be corrected prior to connecting cables.

3. Verify cable is supplied and connected in accordance with the one-line diagrams, and marked for phasing and connected to maintain consistent phase sequence and rotation throughout the project.

4. Verify correct installation of fireproofing tape in common cable areas.

F. Perform electrical testing and document for all medium voltage cable installed under this project.

1. Perform a shield continuity test on each cable by ohmmeter method.

2. Perform an insulation resistance test utilizing a megohmmeter with a voltage output of at least 2500 volts. Individually test each conductor with all other conductors and shields grounded. Test duration shall be one minute or as recommended by the meter manufacturer.

3. Perform a DC high potential test and document for all cables.

a. Testing shall be performed in accordance with ANSI/IEEE Std. 400.

b. Current sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.

c. Record wet and dry bulb temperatures or relative humidity and temperature.

d. Test each section of cable individually.

e. Individually test each conductor with all others conductors grounded and all shields grounded.

f. Terminations shall be properly corona suppressed by guard ring, field reduction sphere, or other suitable means.

g. Verify that the maximum test voltage does not exceed the limits for terminations or splices.

h. Apply a DC high potential test in at least five equal increments until the maximum test voltage is reached. No increment shall exceed the voltage rating of the cable. Record the DC leakage current at each step after a constant stabilization time consistent with system charging current.

i. Raise the conductor to the specified maximum test voltage and hold for fifteen minutes. Record readings of leakage current at 30 seconds, at one minute and at one-minute intervals thereafter.

j. Reduce the conductor test potential to zero and measure residual voltage at discrete intervals.

k. Apply grounds to drain all insulation stored charge.

l. Test DC voltage (kilovolts) shall be as specified by the cable manufacturer.

G. Perform electrical testing and document for all 600V cable installed under this project.

1. Test all conductors #8 AWG and larger to verify that no short or accidental grounds exist.

2. Test shall be made using an instrument which applies a voltage of approximately 500 volts and provides a direct reading of resistance in ohms.

3. Resistance readings of "infinite" value not accepted.

4. Insulation resistance, corrected to 60ºF, shall not be less than the following values:

250-750	50 megohms
4-4/0 AWG	50 megohms
8-6 AWG	100 megohms

Record resistance readings, temperature and weather conditions on the test form.

5. Perform continuity test on each cable by ohmmeter method.

H. Instrumentation Cable Shield Grounding

After instrumentation cable installation and conductor termination, perform tests witnessed by the Engineer to ensure that instrumentation cable shields are isolated from ground, except at the one designated grounding point. Remove all improper grounds.

I. Protective Devices

1. Perform visual and mechanical inspection per NETA and per manufacturer's recommendations.

2. Perform electrical tests per NETA and per manufacturer's recommendations.

3. Adjust protective devices to the values provided by the Engineer.

4. Adjustments/inspections shall be performed by a technician with particular qualifications for the work.

J. Power System Analysis

1. Perform a load flow and short circuit analysis, based on the selected major components (i.e., transformers, switchgear, cabling). On the basis of this analysis, provide recommended types/settings for all protective devices, in order to obtain a coordinated power distribution system.

3.04 TEST REPORTS

A. Test reports shall be submitted for each type of equipment detailed above. Should any equipment show test results outside of normal NETA test tolerances, the Engineer shall be notified immediately.

3.05 SYSTEM FUNCTION TESTS

A. Each system provided under this Contract and covered by this Section shall be function tested to ensure total system operation. This functional testing shall be witnessed by the Owner's representative.

B. Upon satisfactory completion of equipment acceptance tests, the system functional tests shall be performed. It is the intent of system functional tests to prove the proper interaction of all sensing, processing, and action devices to affect the designed end product or result.

C. All interlocks, safety devices, fail-safe functions, and design functions shall be tested.

3.06 CORRECTION OF DEFICIENCIES

Any deficiencies found shall be rectified, and work affected by such deficiencies shall be completely re-tested at the Contractor's expense. Final acceptance of the electrical power system is contingent upon satisfactory completion of the acceptance and system function tests.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16050

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Conduit

B. Fittings and Conduit Bodies

C. Boxes

D. Wiring Devices

E. Cabinets and Enclosures

1.02 APPLICABLE PUBLICATIONS:

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. American National Standards Institute, Inc. (ANSI) Publications:

1. C80.1 Rigid Steel Conduit, Zinc Coated

2. C80.3-83 Electrical Metallic Tubing, Zinc Coated

3. FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies

4. OS 1 Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports

5. OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

B. National Electrical Manufacturers Association (NEMA) Publications:

1. AB 1 Molded Case Circuit Breakers

2. ICS 2 Industrial Control Devices, Controllers, and Assemblies

3. ICS6 Enclosures for Industrial Controls and Systems

4. KS 1 Enclosed Switches

5. TC 2 Electrical Plastic Tubing and Conduit

6. WD 1 General Purpose Wiring Devices

7. WD 6 Wiring Device Configurations

C. National Fire Protection Association (NFPA) Publication:

1. 70-96 National Electrical Code (NEC)

D. State of California Administrative Codes:

1. Title 24, Part 3, CCR, 1998 California Electrical Code

E. Underwriters Laboratories, Inc. (U.L.) Publications:

1. 1-85 Standard for Flexible Metal Conduit

2. 6-81 (R86) Rigid Metallic Conduit

3. 50-80 Cabinet and Boxes

4. 83-1983 Thermoplastic Insulated Wires

5. 198E-82 (R87) Class R Fuses

6. 360-80 (R86) Liquid-tight Flexible Steel Conduit

7. 486A-1980 (R86) Wire Connectors and Soldering Lugs, for use with Copper Conductors

8. 498-86 (R87) Attachment Plugs and Receptacles

9. 508-84 (R85) Industrial Control Equipment

10. 510-77 (R82) Insulating Tape

11. 514A-1983 (R85) Metallic Outlet Boxes

12. 514B-1982 (R85) Fittings for Conduit and Outlet Box

13. 651-81 Schedule for 40 & 80 Rigid PVC Conduit

14. 797-77 Electrical Metallic Tubing

15. 869-84 Standard for Service Equipment

16. 1242-83 Standard for Intermediate Metal Conduit

1.03 SUBMITTALS

A. Submit under provisions of Sections 01300 and 16010.

B. Product Data: Provide for:

1. Conduit, Connectors, Conduit Support, Expansion Fittings, and Conduit Roof Tacks (all types)

2. Conductors (all types)

3. Cabinets, Enclosures, Junction/Outlet Boxes, Pullboxes and Wireways

4. Safety Switches

5. Wiring Devices (receptacles and switches)

6. Device Plates

C. Test Reports: Provide for:

1. Insulation resistance tests of low voltage conductors.

2. Operational tests.

3. Written Copies of field Test Results.

1.04 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01720.

B. Accurately record routing of conduits larger than 1-1/2 inches.

C. Accurately record actual locations and mounting heights of outlet, pull and junction boxes.

D. Accurately record actual location of each receptacle.

1.05 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70 and with all state adopted amendments, except where requirements herein are more stringent.

B. Products provided shall be listed and classified by Underwriters Laboratories, Inc. or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.06 QUALITY ASSURANCE:

In each standard referenced to herein, consider the advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or other words of similar meaning, to mean the City.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle Products to site under provisions of Section 16010.

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

1.08 PROJECT CONDITIONS

A. The drawings are diagrammatic and shall not be scaled for exact locations. Field conditions and non-interference with other utilities and trades, shall determine exact locations.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT:

Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated. Except where specifically indicated otherwise, provide only new materials having all legally required approvals and/or labels. Items of a similar nature shall be of the same type and manufacturer.

2.02 CONDUIT

A. Rigid Steel Conduit (Zinc-coated): ANSI C80.1, UL 6, hot-dip galvanized, threaded type.

B. Electrical Metallic Tubing: UL 797, ANSI C80.3.

C. Rigid Plastic Conduit: NEMA TC-2, UL 651, PVC Schedule 40, Carlon or approved equal.

D. Liquidtight Flexible Non-Metallic Conduit: UL 1660, Non-metallic, liquid-tight conduit with a polyvinyl chloride reinforced core. Conduit must conform to NEC 351B. Electri-Flex Liquatite® Type LNM-P, Kellems Polytuff I or approved equal.

E. Liquidtight Flexible Metallic Conduit: UL 360, Interlocked steel construction with a polyurethane jacket, Electri-Flex Liquatite® type CEA or approved equal.

F. Conduit Support: ASTM A570 GR33, A653 GR33; Raw Steel. ASTM A575, A576, A635 or A36; Steel Fittings. ASTM B633 Type III SC1, Electro-Galvanized. Unistrut or approved equal.

2.03 FITTINGS

A. Fittings for Rigid Metallic Conduit and Intermediate Metallic Conduit: UL 514B, threaded-type.

B. Fittings for EMT: Compression type. Split or set-screw couplings unacceptable.

C. Fittings for Liquidtight Flexible Metallic Conduit: ANSI FB 1.

D. Fittings for Liquidtight Flexible Non-Metallic Conduit: ANSI FB 1.

E. Expansion/Deflection Fittings: Provide fitting capable of a straight line expansion movement of 2" in either direction and a movement of 3/4" from the normal in all other directions, OZ Gedney Type AXDX or approved equal. Provide complete with grounding and bonding jumpers.

2.04 RACEWAY SUPPORTS

A. Conduit Clamps: One hole, cadmium plated or galvanized heavy gauge steel, or galvanized malleable iron.

B. Channels, Fittings, Hangers, Clamps and Accessories: Hot dipped galvanized, or electrogalvanized and zinc chromate coated steel. Channels shall be 14 gauge minimum, 13/16 inch or 1-5/8 inch deep by 1-5/8 inch wide minimum by the following manufacturer:

1. Midland Ross "Kindorf"

2. Midland Ross "Superstrut A-1200"

3. Unistrut

C. Single Runs: Galvanized conduit straps or ring bolt type hangers. Above suspended ceilings use spring clips. Do not use plumbers perforated straps.

2.05 ANCHOR METHODS

A. Provide anchors with sufficient strength to support four times the load.

B. Metal Surfaces: Machine screws, bolts, or welded studs.

C. Concrete Surfaces: Expansion anchors. Powder driven studs shall not be used.

2.06 OUTLET BOXES

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

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.

2. Concrete Ceiling Boxes: Concrete type.

B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast feralloy. Provide gasketed cover and threaded hubs by box manufacturer.

2.07 RECEPTACLES: UL 498 and NEMA WD 1

A. Receptacles shall be Leviton Decora Black NEMA 5-20R unless otherwise indicated on the drawings.

B. Weatherproof Receptacles: For flush mounted weatherproof convenience outlets, provide duplex receptacles as listed above with gasketed stainless steel cover plate and gasketed cap over each receptacle opening, Sierra WP series. Where surface mounted, use cast box with gasketed cast aluminum plate having duplex lift covers, Hubbell No. 5206. Receptacles shall be UL listed for use in "wet locations."

C. All receptacles located in restrooms, mechanical rooms, electrical rooms, and on exterior of building shall be protected by a GFCI type receptacle. In addition to this requirement, provide GFCI type receptacles where indicated on the drawings or required by code.

2.08 SWITCHES: NEMA WD 1

A. General purpose wall switches shall be Leviton Decora Black Rocker Switches, 20A, 277V AC, general use snap switch with ivory handle. Provide single pole, 2-pole, 3-way, 4-way, momentary contact, weatherproof, lock or other type switches indicated.

B. AC Manual Motor Starting Switches: UL 508. Acceptable manufacturers: Hubbell, Pass & Seymour, Sierra.

2.09 DEVICE PLATES

A. Provide UL listed, one-piece device plates for all wiring devices, for telephone and computer outlets and for outlet boxes used as junction or pull boxes. Plates shall be stainless steel, with satin finish, having round or smooth edges. Plates installed in wet locations shall be gasketed and UL listed for "wet locations."

B. In addition to the requirements specified in Section 16195, provide nameplates with 3/16" high block letters, black enamel filled, machine engraving for new device plates under any of the following conditions listed below. Use designations indicated or select words to best describe purpose of each device.

1. Plates containing more than two switch devices.

2. Selector switches.

3. Manual motor starting switches.

4. Special outlets where indicated.

2.10 CABINETS: UL 50.

A. Cabinets for same type of use shall be the product of a single manufacturer.

B. Construct of cold-rolled drawn quality steel, with metal gages and construction methods conforming to National Electrical Code requirements, and Underwriters Laboratories' standards. Provide 12 gauge G-90 grade galvanized steel minimum, unless otherwise noted.

C. Finish doors, trims, and back boxes for surface-mounted cabinets in finished areas by applying a rust-resistant treatment, prime coat, and a final coat of manufacturers standard enamel or lacquer finish. Galvanize all other sheet metal components of cabinets including back boxes for flush cabinets, excepting non-ferrous metal parts, or steel parts provided with cadmium plating or equivalent protective plating.

D. Equip doors with concealed or semi-concealed hinges and with flush or semi-flush spring catch type flush cylinder locks. Key cabinet doors of similar use alike, and provide two keys with each lock.

E. Equip cabinets for use with telephone, alarm or signal systems with a 0.5" thick plywood backboard. Equip cabinets with terminal strips. Equip cabinets with nameplates.

F. Surface cabinets shall be furnished without knockouts. Punch or drill required openings during installation. Equip flush back boxes with manufacturer's standard pattern of knockouts.

G. Equip cabinet doors exceeding 40" in height with vertical bolt three point locking mechanisms.

H. Acceptable manufacturers: Products of the following manufacturers are acceptable.

1. Cabinets for general use: Hoffman Engineering Co., Square D, or Columbia Manufacturing Co.

2. Cabinets for systems and/or products, use cabinets furnished by manufacturer with system or product. Where system or product cabinets do not comply with these Specifications, submit cabinet shop drawings, indicating deviations, and obtain approval for their use.

2.11 JUNCTION BOXES AND PULL BOXES: UL 50.

A. Provide pull and junction boxes of Code gauge steel sized as indicated or required. Provide 16 gauge steel minimum, unless otherwise noted. Indoor enclosures shall conform to NEMA ICS 6 for the Type 12, unless otherwise noted.

B. Size junction and pull boxes to not less than minimum Code requirements. Increase size above Code requirements where necessary to provide space for pulling, racking or splicing enclosed conductors, or where specified or indicated dimensions exceed Code requirements.

C. Fabricate sheet metal junction and pull boxes of galvanized, Code gauge, sheet steel. Include angle iron framing where required for rigidity. Boxes shall not deflect or deform visibly when covers are removed after conduit and conductors are installed, and any deflection occurring shall not prevent the easy installation and removal of cover attachment screws.

D. Do not use single covers for junction and pull boxes having cover length or width dimension exceeding three feet unless so specified, indicated, or approved. Sectionalize covers that exceed three feet in either dimension into two or more sections.

E. Equip metal junction and pull boxes exposed to weather (and not installed in or below grade) with raintight or weatherproof removable covers. Enclosures shall conform to NEMA ICS 6 for the Type 4X, unless otherwise noted. Rain tight or weather proof boxes shall be used. Threaded, watertight hubs for top or side entry and may use knockout for bottom entry only. For exterior pull boxes, use a minimum of 14 gage galvanized G-90 grade shut steel.

F. Use concrete junction and pull boxes for exterior underground conduit unless otherwise specified or indicated. Use steel plate or cast iron covers and rims in no traffic areas, and cast iron covers and rims designed for AASHTO Class H20 wheel loading wherever vehicular traffic will occur.

G. For interior junction and pull boxes located in concrete floors, and 24" square or smaller, use cast iron boxes with integral cast tapped conduit hubs, and having recessed cover flush in the box trim placing all elements of the face of the box flush in the plane of the surrounding floor. Equip boxes with watertight covers where so indicated.

H. For interior pull boxes located in concrete floors and larger than 24" square, use precast concrete boxes or form these boxes at the job site. Equip with angle iron cover rim, and with reinforced steel cover plate set flush with the finish floor plans. Specific plan details shall supersede these general requirements.

I. Equip grade level exterior pull boxes with a sump, and with knockouts for conduit on sides and ends. Coordinate requirements for conduit openings with underground conduit requirements. Identify the covers of exterior grade level junction and pull boxes with the work "ELECTRIC" cast into or otherwise permanently inscribed in the metal of the cover. Equip exterior grade level pull boxes with pull irons where so indicated.

J. Equip surface sheet metal junction and pull boxes with covers aligning with the sides of the boxes and equip flush boxes with covers extending 3/4" all around the perimeter of the back box. Provide sufficient cover attachment screws to ensure that box covers will contact the surface of the box for the entire perimeter of the enclosure. Use galvanized or cadmium-plated screws, or brass screws to attach covers to boxes.

K. Use brass screws to attach junction and pull box covers to interior floor boxes or to boxes located where moisture may be present.

L. Acceptable manufacturers:

1. Sheet steel junction and pull boxes: Columbia Electric Co., .Hoffman Engineering Co., Pico Metal Products Co.

2. Cast iron junction and pull boxes: O.Z. Electric Manufacturing Co., Alhambra Foundry Co., Ltd., Crouse Hinds Co.

3. Concrete junction and pull boxes: Brooks Products Inc., Quickset Co. or approved equal.

2.12 WIRE CONNECTORS AND TERMINALS

For use with copper conductors. UL 486A.

2.13 INSULATING TAPES

UL 510.

2.14 NAMEPLATES

Provide as specified in Section 16195, "Electrical Identification."

PART 3 - EXECUTION

3.01 INSTALLATION

Electrical installation shall conform to requirements of NFPA 70, state and local codes, and to requirements specified herein.

3.02 LOCATIONS

A. The drawings indicate diagrammatically the desired locations and arrangements of the components of the electrical work. Follow the drawings as closely as possible, but use judgment and coordinate with other trades to secure the best possible installation in the available space and under the developed conditions.

B. Before installing any equipment, conduit, or locating any outlet, examine the complete set of documents, including shop drawings and specifications, and verify all dimensions and space requirements. Make such minor adjustments as may be necessary to fit the building structure and accommodate the work of other trades. Install all electrical work to preserve legal headroom, access, work space, clearances and to keep openings and passage ways clear. Arrange for additional space if required for the servicing, maintenance, and replacement of the electrical equipment.

C. Control devices shall not be mounted more than 6'-6" above the floor.

D. Prior to installation, the Engineer reserves the right to relocate any outlet or device within six feet of the location indicated on the plans and at no additional cost to the City.

E. No additional compensation will be allowed for omissions, inadequate space, misunderstandings or rejected work caused by neglect of these requirements.

3.03 CONDUIT

A. Rigid steel conduit shall be used for circuits greater than 600 volts installed above grade and may be used in all locations unless otherwise indicated.

1. Rigid steel conduit shall not be installed below grade in direct contact with

earth, it shall be encased in 3" concrete envelope or painted with two coats of black asphalt paint.

2. Provide "DANGER - HIGH VOLTAGE" labels on exposed conduits containing circuits greater than 600 volts. Refer to Section 16195.

3. Rigid steel conduit shall be installed for circuits 600 volts or less installed outdoor above grade.

B. Electrical metallic tubing (EMT) may be installed in indoor dry locations only, it shall not be installed lower than six feet above the finished floor. Restrictions applicable to EMT:

1. Do not use in feeder circuits.

2. Do not install below grade.

3. Do not encase in concrete.

4. Do not use in areas subject to severe physical damage (including, but not limited to, mechanical equipment rooms and electrical equipment rooms).

5. Do not use in hazardous areas.

6. Do not use outdoors.

C. PVC Schedule 40 conduit may be used underground within the building perimeter (below 600V):

1. The top of the duct shall not be less than 24 inches below finished grade.

2. Risers shall be galvanized rigid steel.

Refer to Section 16110, "RACEWAYS," for site underground duct requirements.

D. Use liquidtight flexible conduit in short lengths for final connections to lighting fixtures in accessible ceilings, motors, transformers and other vibration type equipment, or with the approval of the Engineer, where absolutely necessary due to structural conditions. Provide green ground conductor in all flexible conduit.

E. Install conduit in accordance with NECA "Standard of Installation." The electrical drawings are diagrammatic and do not show all offsets, bends, fittings, junction boxes, pull boxes and expansion fittings required to meet field conditions. Determine actual material and hardware requirements and verify all dimensions by field inspection.

F. Arrange supports to prevent misalignment during wiring installation.

G. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

H. Group related conduits; support using conduit rack. Construct rack using steel channel provide space on each for 25 percent additional conduits.

I. Arrange conduit to maintain headroom and present neat appearance.

J. Route exposed conduit parallel and perpendicular to walls.

K. Maintain adequate clearance between conduit and piping.

L. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.

M. Cut conduit square using saw or pipecutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Provide pull fittings in all overhead conduit runs exceeding 200 feet of straight conduit, or having more than the equivalent of three 90 degree bends. Each 90 degree bend shall be considered the equivalent of 50 feet of straight run. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2 inch size.

P. Where conduit passes from one type of construction to another, or where there is a possibility of dissimilar movements, an expansion/deflection device or a suitable loop of sealtight flexible conduit shall be installed. Looped sealtight flexible conduit shall consist of 18" minimum length of looped conduit with a junction box at one or both ends, wherever conduit crosses building seismic joints.

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

R. Provide 1/8" diameter polyethelene pull line in each new empty conduit except sleeves and nipples. Provide identification tags at each end.

S. Conduit which penetrates fire walls, fire partitions, or floors shall be metallic on both sides of fire walls, fire partitions, or floors for minimum distance of 6 inches. Restore fire rating integrity at conduit penetration. All holes created to extend electrical systems through fire rated floors and walls shall be sealed by the electrical contractor with an intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250°F. It shall be UL Classified and have I.C.B.O., B.O.C.A.I. and S.B.C.C.I. (NRB 243) approved ratings to three hours per ASTM E-814 (UL 1479).

Acceptable Manufacturers: 3M, Hilti, Hevi-Duty/Nelson

T. Where conductors of No. 4 AWG or larger are to be installed in a conduit, or where any conductors are to be deflected more than 30 degrees when leaving a conduit, terminate the conduit with an insulating bushing.

U. Ground and bond conduit under provisions of Section 16170.

3.04 SUPPORTING DEVICES

A. Provide supports at intervals to meet the requirements of the National Electrical Code and the manufacturer's loading requirements.

3.05 FITTINGS

A. Use threaded fittings for rigid metal conduit and compression fittings for tubing.

B. Use cement-on fittings for plastic conduit.

C. Fittings for flexible conduit shall be of the threadless hinged clamp type. Do not use fittings threaded internally into the flexible conduit ends.

D. Use fittings made of the same material as the raceway except:

1. Malleable iron and steel are interchangable.

2. Die cast fittings may be used for flexible steel conduit and for factory manufactured offsets.

3. Use aluminum fittings only with aluminum conduit.

4. Use plastic insulated bushings for conduit sizes larger than 1".

5. Use insulated throat connectors for electrical metallic tubing.

3.06 CABINETS

A. Set cabinets at heights indicated or specified. In the absence of such information, set cabinets at not to exceed 6'6" from finish floor to top of cabinet.

B. Align tops of cabinets in sight of each other at a uniform height.

C. Install cabinets and other enclosure products in plumb with the building construction. Install flush enclosures so that the trim will rest against the surrounding surface material around the entire perimeter of the enclosure.

D. Where cabinets are located in poured-in-place concrete wall construction, brace internally with temporary wood or other bracing to prevent deformation of the back or sides of the enclosure.

E. Do not locate cabinets (or other electrical enclosures) where room doors will touch enclosure face when room door is opened 180°. Locate cabinets (and other enclosures) so that enclosure door can be opened through a minimum 180° arc, except that the arc may be reduced to 130° for enclosures mounted to wireways. Do not install surface mounted cabinets in finished areas, unless so indicated. Where conflicting data is indicated, verify mounting requirements prior to ordering cabinets.

3.07 WIRING DEVICES

A. Use products of a single manufacturer for each type of wiring device. Different manufacturers may be used for different type devices, if the requirements of the specification are fulfilled.

B. Use the products of a single manufacturer for all device plates. Obtain prior approval for any variations from this requirement except that plate variations are allowed for the following devices:

1. Where the selected plate manufacturer does not manufacture a suitable finish plate.

2. For heavy-duty receptacles rated at more than 30 amperes.

3. Where the raceway system enclosure employs a non-standard finish plate.

4. Where non-standard plates are specified or indicated.

C. Where pilot lights are indicated, use incandescent lamp and jewel type lens mounted in the same outlet as the switch, with common finish plate. Pilot lights shall be "on" when controlled load is "on".

D. Substitute key operations for toggle where locking switches are indicated. Provide not less than two keys for each such switch, except not more than ten keys of the same pattern for the total project. Use only keys that are compatible with key system established for site.

E. Position receptacles so that the ground contact in grounding type receptacles is on top of parallel prongs.

F. Install adjacent devices of the same type and with the same mounting height in a common outlet box.

G. Prior to installation of switch outlets, examine architectural plans and verify locations. Place switches in the wall at the latch side of the door.

H. Connect three phase receptacles to establish clockwise phase rotation, viewing face of receptacle. Terminate phase conductor at same terminals on all such receptacles.

I. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with specialty building equipment requiring very exact electrical rough-in.

3.08 BOXES, OUTLETS AND SUPPORTS

Provide boxes in wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when installed exposed up to 7 feet above interior floors, when installed under raised floor or when installed in hazardous areas. Boxes in other areas shall be sheet steel. Each box shall have volume required by NFPA 70 for number of conductors enclosed in the box. Provide gaskets for cast-metal boxes installed in wet locations.

3.09 JUNCTION AND PULL BOXES

A. Provide all pullboxes, junction boxes and terminal boxes to permit pulling and installation of terminal blocks when required, according to these specifications, whether specifically shown on the drawings or not.

B. Wherever possible use outlet boxes for junction and pull boxes.

C. Locate interior junction and pull boxes in machine rooms, equipment rooms, storage rooms, electrical rooms and similar utility spaces unless otherwise indicated or approved. Where junction or pull boxes must be used in finished areas, use flush boxes only equipped with prime finished sheet metal plates. Fasten plates to boxes with countersunk flat head screws. Provide plates with 3/4" trim all around.

D. Do not use sectionalized boxes except where indicated. Do not mix feeder and branch circuit conductors in a common pull or junction box.

E. Where more than one circuit passes through a common junction or pull box, tag conductors to indicate circuit number and panel designation.

F. Size junction or pullboxes to meet the requirements of the National Electrical Code (NEC), except where indicated to be larger.

G. Outdoor, exposed to weather: Use NEMA 4X boxes.

3.10 OPENINGS, CHASES AND SLEEVES

A. Provide openings, chases, cutting, patching, sleeves and other products, necessary to permit the electrical raceways and cables to pass through the structure.

B. Establish locations for openings, chases and sleeves sufficiently in advance of construction to avoid cutting and patching. Perform any required cutting and patching for electrical work and obtain approval for cutting from Engineer prior to work being done.

C. Repair damages to finished work and surfaces caused by cutting, to the satisfaction of Engineer.

D. Install sleeves wherever raceways of any type pass through walls or floors above grade, except that sleeves are not required for drywall construction or laid up masonry construction used for interior partitions and not fire rated.

E. Use pipe or sheet steel sleeves for interior dry locations.

F. Install sleeves with both ends flush with wall surfaces and with upper ends 3" above floor surfaces. Install bottom end of floor sleeves flush with slabs if not concealed by ceiling system. Use steel pipe sleeves through floors.

G. Furnish galvanized steel 24 gauge roof jacks and pitch dams for roof penetrations. For installation of roof jacks and pitch dams (pockets), refer to Architectural drawings. Size roof jacks to extend 6" out on roof and 8" up conduit above roof. Solder or braze a flashing collar to conduits passing through roof jacks. Size pitch dams to extend 6" above roof and 6" beyond roof opening.

H. Core drill existing concrete walls or slabs to pass new runs of conduit or tubing. Seal core drilled openings as described for sleeves.

I. For exterior walls below grade conduit entries, use manufacturer fabricated wall entrance seals.

3.11 MOUNTING HEIGHTS

Mount disconnecting switches so height of operating handle at its highest position is maximum 6'-6" above floor or platform. When installing switch next to existing switch, match mounting height of existing switch.

3.12 FIELD TESTS

Refer to Section 16030, "ELECTRICAL," for additional requirements. As an exception to requirements that may be stated elsewhere in the contract, the Engineer shall be given minimum 5 working days notice prior to each test. The Contractor shall provide all test equipment and personnel and submit written copies of all test results.

A. Operational Tests: Demonstrate the operation of each switch, relay and other item of electrical control with the system fully energized and operating. Each shall be demonstrated three times. Any faulty or defective Contractor furnished materials and workmanship found during the tests shall be replaced or corrected by the Contractor at no additional cost to the City.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16104

MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide precast concrete manholes and handholes for power and telephone cabling and equipment. The design for precast concrete manholes shall be accomplished by the Contractor to accommodate the load criteria shown on the drawings.

B. Precast concrete manholes and handholes are to be provided for installation and pulling cables, changes in direction of ductbanks and cabling, and terminating and splicing cabling. Precast concrete manholes are, in general, over 48 inch x 48 inch x 48 inch with manhole lid rings and risers and cast iron manhole lids. Precast concrete manholes are intended for personnel entry during installation and maintenance of cabling and wiring systems.

C. Precast concrete handholes include miscellaneous handholes, junction boxes, pullboxes, and termination points for power, communication, and signal wiring. Their interior dimensions are up to a nominal 48 inch x 48 inch x 48 inch, with fixed covers, but without manhole rings or steel handhole lids. Provide where shown on the drawings.

1.02 QUALITY ASSURANCE

A. Precast concrete manholes shall be fabricated by a supplier regularly engaged in design, fabrication, and installation of concrete products for electrical power wiring.

1.03 SUBMITTALS

A. Submit shop drawings and calculations, sealed by a currently licensed Structural Engineer in the State of California, for all precast concrete manholes.

1. Submit fully dimensioned shop drawings for all precast concrete items showing weights, steel reinforcing, openings, blockouts, and accessory items such as pulling irons, ladders, manhole risers, covers, hatches, and sumps.

2. Submit structural calculations for all precast concrete items as follows:

a. Submit structural calculations for all loads including traffic, soil pressure, and live loads.

b. Submit buoyancy calculations based on water table at five (5) feet below grade. All products shall have a buoyancy safety factor of 1.5 minimum.

c. The calculations shall include a statement by the structural engineer that products are suitable for use in seismic zone 4 as defined by the Uniform Building Code.

3. Shop drawings or calculations shall include fabricators cautions, warnings, or restrictions on product use or installation.

PART 2 - PRODUCTS

2.01 PRECAST CONCRETE MANHOLES

A. Provide precast concrete manholes for power cabling, sized and located where indicated on the drawings. Manholes shall be integrally formed walls and floor with cover, base unit with risers and cover, or panel construction with base, walls and cover(s), depending on size.

B. Manholes shall be designed and constructed to accommodate the load criteria shown on the drawings.

C. Each manhole shall have ladders with extendable ladder safety posts, as manufactured by Bilco Ladderup, O'Keefe, Milcor or approved equal, and three (3) cast-in-place steel channels on each side wall for cable racking and support.

D. Manholes shall be steel reinforced precast concrete with integrally formed base and walls.

1. Provide with pulling irons, 1 in each corner.

2. Provide with 30" diameter cast iron or ductile iron manhole ring and 30" diameter cast iron cover, rated for load criteria shown on drawings. Covers shall be bolted down with stainless steel bolts, nuts and washers.

E. Manholes shall be manufactured by Utility Vault, Brooks Jensen or approved equal.

F. Manholes shall have a sump and drain in the floor fitted with a removable grate that is flush with the floor of the manhole so as to result in a uniform smooth walking surface.

G. Where the drawings call for a manhole to include a check valve, install a Zurn 4 inch backwater valve, model Z-1099, or approved equal.

H. For additional requirements, see Section 16402 - Underground Electrical Work.

2.02 PRECAST CONCRETE HANDHOLES

A. Provide Precast concrete handholes sized and located where indicated on the drawings.

B. Handholes shall be designed and constructed to accommodate the load criteria shown on the drawings.

C. Provide integrally formed floors and walls. Provide watertight easl suing keyed cover and neoprene or butyl sealing strip with mastic backing.

D. Provide cutouts or blockouts for ductbank and conduit entry, or at Contractor's option, field cut openings for ductbanks and conduits.

E. Handholes shall be manufactured by Utility Vault, Brooks, or approved equal.

PART 3 - EXECUTION

3.01 SECURING SITE WORK

A. The Contractor alone is solely responsible for securing all electrical site work with adequate barriers, warning indicators, and shoring.

3.02 EXCAVATIONS

A. Excavations shall be as required for installation intended or as shown on the drawings.

B. The Excavation bottom shall be free of debris and graded smooth.

3.03 BACKFILL AND COMPACTION

A. Backfill around vaults to be free of debris larger than 2 inches in all directions to 1 foot from vault.

B. Bedding for manholes shall be 12 inches of ¾" A Crushed Rock as specified in SSPWC Section 200-1, Table 200-1.2 (A).

C. All other backfill and compaction shall be in conformance with Section 02221, TRENCH EXCAVATION AND BACKFILL.

3.04 MANHOLES

A. Seal all joints of all conduits or ductbanks that enter or leave manholes to ensure water tightness.

B. All cables routed through manholes shall be securely fastened to the walls, so as to support the weight of the cables and to provide separation between circuits. Where circuits of different voltage ratings occupy the same manhole, comply with code requirements for permanently and effectively separating the conductors of the various systems.

C. All lift points and all joints between precast elements shall be thoroughly wetted and then completely filled with mortar, smoothed, and sealed both inside and out, to ensure water tightness.

D. In precast sections where steel loops have been provided in lieu of lift holes, remove loops flush with the inside wall surface. No short cutoff protrusions will be permitted. If concrete spalling occurs as a result of the loop removal, restore the spalled area with mortar to a uniformly smooth surface.

E. Requirements of Section 16402.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all material and equipment necessary to provide complete raceway systems for power systems.

B. Provide concrete encased conduits for underground ductbank raceway systems for power systems.

1.02 QUALITY ASSURANCE

A. All raceway of each type shall be the end product of one manufacturer. Similar raceway types, such as IMC, PVC, and GRS, need not be the product of the same manufacturer.

B. All fittings and accessories for each type of raceway shall be the end product of one manufacturer.

C. All raceways, fittings, and accessories, to the extent that UL standards have been established as of the bid date, shall be UL listed and UL labeled.

D. All raceway shall be delivered, stored, and protected to prevent damage due to construction activity, damage from weather, and to prevent the entrance of foreign materials prior to installation.

1.03 SUBMITTALS

A. Submit product data for all raceways, fittings, and accessories, consisting of manufacturers published specification sheets and catalog data.

B. Submit concrete mix design as specified in Section 03300 for ductbanks.

1. Product data shall be marked to indicate the specific items to be furnished. Where multiple products or multiple raceway types or sizes are shown on the same specification sheet or catalog page, clearly mark all items to be provided, or submit separate pages for each item.

PART 2 - PRODUCTS

2.01 GALVANIZED RIGID STEEL CONDUIT (GRS)

A. Provide galvanized rigid steel conduit for all direct buried, non concrete encased, medium and high voltage cabling and wiring, and for all direct buried, non concrete encased, secondary voltage wiring.

B. Provide galvanized rigid steel conduit for all exterior above grade medium and high voltage cabling and wiring, and for all exterior above grade secondary voltage wiring.

C. Provide Allied, Republic Steel, or Triangle hot galvanized rigid conduit with threads hot galvanized after cutting, minimum size 3/4 inch.

D. Provide O.Z. Gedney, Steel City, or Appleton rigid conduit fittings, couplings and accessories. Fittings and accessories shall be threaded and plated.

a. Provide zinc plated steel insulating bushings with tin plated copper grounding saddle and stainless steel clamping tension body, for conduit terminations within enclosures. O.Z. Gedney type SBLG.

b. Provide 3/4 inch - 2 inches zinc plated steel, 2-1/2 inches - 6 inches zinc plated malleable iron locknuts for securing conduit terminations at enclosures with threaded hubs, and for use outside enclosures without threaded hubs, O.Z. Gedney type 1 standard, or O.Z. Gedney type SLG sealing type where exposed to the weather.

c. Provide galvanized steel conduit couplings for connecting conduits. Conduit manufacturer’s factory fabricated coupling systems, such as Allied Conduit Threaded Kwik-Couple, are acceptable.

2.02 INTERMEDIATE METAL CONDUIT (IMC)

A. Provide galvanized intermediate metal conduit, in lieu of galvanized rigid steel at contractors option, for all direct buried, non concrete encased, secondary voltage wiring.

B. Provide galvanized intermediate metal conduit, in lieu of galvanized rigid steel, for all exterior above grade secondary voltage wiring.

C. Provide Allied, Republic steel, or Triangle hot galvanized intermediate metal conduit with threads hot galvanized after cutting, minimum size 3/4 inch.

D. Fittings and accessories for IMC conduit shall be the same as for GRS.

2.03 RIGID NON-METALLIC CONDUIT (PVC)

A. Provide Carlon or Cantex heavy wall Schedule 40 rigid polyvinyl chloride (PVC) conduit suitable for direct burial, installed in concrete encasement, for all below grade ductbanks for medium voltage cabling and wiring, and for secondary voltage cabling and wiring.

B. Provide exterior above grade Schedule 40 and Schedule 80 PVC conduit for secondary voltage cabling and wiring, as specifically indicated on the drawings.

C. Provide Schedule 40 PVC conduit for all below grade and exterior above grade individual ground conductors run without phase conductors, where ground conductors are required or shown to be in raceway.

D. Schedule 40 PVC conduit shall be heavy wall, suitable for direct burial whether direct buried or concrete encased, sunlight resistant, suitable for 90^0 conductors, with manufactured standard radius elbows, except raceways for medium voltage cables shall use 36 inches radius 45^0 and 90^0 bends.

E. PVC conduit shall be plain end or bell end, at contractors option. Couplings and connectors shall be PVC, solvent cement applied, threaded for connection to non metallic conduits or enclosures, and with solvents provided by, or specifically recommended by, the conduit manufacturer. All conduit terminations in hand holes, manholes or cable vaults shall be with manufactured bell end with flared edges to facilitate cable pulling, and conduits not used in this project capped with poly plugs with pulling eye.

2.04 DUCT SPACERS

All rigid non-metallic conduit in runs of two or more shall be spaced and held uniformly in position using Carlon Snap-Loc duct spacers or approved equal. Duct spacers shall have an open web design to allow ductbank encasement concrete to flow freely through the spacer to completely encase the conduits.

PART 3 - EXECUTION

3.01 GENERAL

A. Install raceways and their accessories according to applicable codes.

B. Cut raceway ends square, ream, and extend maximum distance into all couplings and connectors. Tighten all fittings securely.

C. Provide and install manufactured end caps on all raceway ends during construction, to prevent the entrance of water or dirt. Tape, as a cover, is not permitted.

D. All raceways after final assembly in place, shall be thoroughly cleaned and a mandrel correctly sized for each size of conduit shall be pulled through all raceways prior to installing wires or pull cords. Mandreling shall be done in the presence of the Engineer.

E. All elbows shall be factory elbows.

F. Size all raceways per code unless specifically noted to be larger on the drawings.

3.02 EXISTING UTILITIES

A. Existing utilities shown on the contract drawings have been plotted from available records. No guarantee is made as to the accuracy of the locations indicated, and is shown for whatever benefit the contractor may derive therefrom.

B. The Contractor shall locate all utility lines prior to commencing work.

C. Protect utilities from damage and promptly have repaired all active utilities damaged by construction. This repair shall be made solely at the expense of the Contractor.

D. Adjust the depth of electrical utilities to avoid existing utilities with no change to contract price.

3.03 TRENCHING

A. Trenching shall be to depths as required by code, the particular installation, or as shown on the drawings, whichever is deeper. Trenching shall be in accordance with Section 02221, TRENCH EXCAVATION, AND BACKFILL.

B. Trench bottom shall be free of debris and graded smooth.

C. Separation between new electrical utilities and other utilities shall be 6 inches minimum both vertical and horizontal and water lines shall be 3 foot minimum (horizontal), except where shown otherwise on the drawings.

D. Dewatering shall be in conformance with Section 02221, TRENCH EXCAVATION, AND BACKFILL.

3.04 GALVANIZED RIGID STEEL CONDUIT (GRS) AND INTEMEDIATE METAL CONDUIT (IMC)

A. All connections shall be watertight.

3.05 RACEWAYS UNDERGROUND DIRECT BURIED

A. Galvanized rigid steel conduit and galvanized intermediate metal conduit - painted with two coats Ameron Amercoat 385 epoxy; apply to dry conduit before entrenchment - or galvanized rigid steel conduit with 15 mil. polyvinyl chloride (PVC) jacket (repair abrasions with PVC base paint or PVC).

B. Rigid non-metallic PVC raceways shall be used for underground ductbank runs. Field bends, when necessary, shall be formed only with factory recommended heater with radius not less than that noted in the NEC.

C. Ground wires shall be provided as shown on the Drawings.

3.06 PULL CORDS

A. Nylon type pull cords, 3/8” minimum shall be included in all installed empty raceway.

B. All raceways shall be sloped to drain to nearest manhole.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16117

600V AND BELOW - VOLTAGE CONDUCTORS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work includes providing copper wire, cable, associated connectors, and termination hardware used on systems operating at 600 volts or less.

1.02 RELATED WORK

A. NOT APPLICABLE

1.03 REFERENCE STANDARDS

A. NOT APPLICABLE

1.04 QUALITY ASSURANCE

A. Furnish all copper wire bearing UL labels.

1.05 SUBMITTALS

A. Submit copper wire product data for approval.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. Soft drawn, annealed copper, Class “B” stranding.

2.02 POWER WIRE AND CABLE

A. Acceptable Manufacturers: Single source manufacture is required for power wire and cable specified in this Section.

1. Houston Wire and Cable
2. Okonite
3. Pirelli

B. General: Conform to UL 83 and NEMA WC 5.

C. Single Conductor: Type THWN-THHN (75ºC wet/90ºC dry) or XHHW (75ºC wet/90ºC dry) cable rated 600 volts.

D. TW Cable (60ºC wet or dry): Single conductor rated 600 volts.

E. Bare Cable: Single conductor, stranded.

2.03 CONNECTORS AND TERMINALS

A. Insulated Crimp Type Connectors and Terminals: Nylon insulated, Burndy "INSULINK" and "INSULUG", or Thomas & Betts "Sta-Kon".

B. Split Bolts: High-conductivity copper alloy, Burndy "SERVIT" or Thomas & Betts "Split-Bolt".

C. Two Bolt Connectors: High-conductivity copper alloy, Burndy "OKLIP Type KVS" or Blackburn "2BU".

D. Compression Terminals: Copper long barrel, Burndy "HYLUG" or Thomas & Betts "Color-Keyed", or aluminum alloy Buchanan "Cytolok CL500" series.

E. Bolted Terminals: Cast copper alloy, Burndy "QIKLUG" or Thomas & Betts "Locktite".

2.04 TERMINATORS

A. Cable Types "AC" and "MC": Crouse-Hinds "ALS" or Thomas & Betts "2300".

2.05 MISCELLANEOUS COMPONENTS

A. Tape

1. Vinyl Plastic: 3M "Scotch 33+ " or "Scotch 88".
2. Friction: Black friction tape.
3. Electrical Insulation Putty: 3M "Scotchfil.

B. Splice Kits: 3M "Scotchlast 82 Series".

C. Pulling Lubricants: Ideal "Yellow 77" or Polywater "Type J".

D. Wire Markers:

1. Individual Wires: Write-on type with self-laminating vinyl overwrap, 3M "ScotchCode", Ideal "Write-On", or Thomas & Betts "WSL".

E. Wire and Cable Ties: Thomas & Betts "Ty-Raps".

PART 3 - EXECUTION

3.01 INSTALLATION

A. Wire and Cable

1. General:

a. Limit pulling tension to maximum values recommended by manufacturer.
b. Do not pull through boxes, fittings, or enclosures where change of raceway alignment or direction occurs.
c. Do not cut strands from conductors to fit lugs or terminals.

B. Compression Connectors and Terminals: Install on wire and cable with approved tool and die to recommended compression pressure.

C. Bolted Connectors and Terminals

1. Torque to manufacturer’s recommended foot-pounds for size and class of connector.
2. Where manufacturer’s published torquing requirements are not indicated, tighten connectors and terminals to comply with UL 486A torque values.
3. Use plated bolts and lock washers on terminal connections.

D. Wiring in Enclosures

1. Form and tie conductors inside panels, cabinets, enclosures in a neat and orderly manner.
2. Use Thomas & Betts wire and cable ties of appropriate size and type.
3. Limit spacing between ties to not more than 6 inches.

E. Taping:

1. Above Ground and Dry Locations: Fill voids and irregularities with half-lapped layers of VC (2 minimum) or electrical insulation putty. Insulate with 3 half-lapped layers of vinyl plastic and 1 half-lapped layer of friction tape.
2. Below Ground and Wet Locations: In lieu of taping protect connection with resin splicing kit.

3.02 APPLICATION

A. Wire and Cable

1. THWN-THHN or XHHW for power wiring through No. 2 AWG, and control wiring in conduit. XHHW for sizes above No. 2 AWG in underground conduit.
2. XHHW for wiring in underground conduit.
3. TW for equipment grounding conductor.
4. Bare copper for ground electrode.
5. No. 12 AWG minimum for power circuits and No. 4 AWG minimum for control circuits unless noted otherwise on Drawings.

B. Connectors and Terminals

1. Transformer Terminations: Split bolt connectors for pigtail connections. Compression terminals for all other connections.

C. Color Coding

1. Power Wiring: Provide color coding for single and multi-conductor power circuits as follows:

Voltage	ØA	ØB	ØC	Neutral
240 volts and below	Black	Red	Blue	White
250-600 volts	Brown	Orange	Yellow	Natural Gray

2. For specified insulations and jackets not manufactured with integral colors, use conductors with black insulation or jacket and color coding tape.
3. Color code conductors entering boxes, troughs, cabinets, and other enclosures.
4. Color code conductors in wireways, trenches, and other locations where conductors are continuously accessible at intervals not exceeding 5 feet.

D. Insulated Equipment Ground: Green.

E. Identification

1. Cables: Attach nylon tie on marker on both ends of cable denoting both cable type and number as noted on Drawings. Where a number of 1/C wires are identified as a single cable, group conductors using "Ty-Raps" and attach markers.
2. Conductor Identification: Attach conductor markers on both ends of wire and inside all manholes and pullboxes and label.

END OF SECTION

SECTION 16118

5 kV MEDIUM VOLTAGE CONDUCTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Medium voltage power cable

B. Grounding conductor

C. Separable connectors and splices

D. Terminators

E. Fireproofing

F. Medium voltage cable tags.

1.02 RELATED SECTIONS

A. Section 16030 - Electrical Acceptance Testing

B. Section 16170 - Grounding and Bonding

C. Section 16402 - Underground Electrical Work

1.03 APPLICABLE CODES AND STANDARDS:

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest publication in effect at the time the contract is awarded shall be used.

A. Association of Edison Illuminating Companies (AEIC) Publication:
   1. AEIC CS-8 Extruded Dielectric Shielded Power Cable Rated 5 kV through 46 kV.

B. American Society for Testing and Materials (ASTM)
   1. ASTM B-8 Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors, Class A, B, C or D.
   2. ASTM B-496 Standard Specification for Compact Round Stranded.

C. American National Standards Institute (ANSI) / Insulated Cable Engineers Association (ICEA) Publication:

   1. ANSI/ICEA S-93-639/NEMA WC74- Shielded Power Cable rated 5kV through 46kV for Use in the Transmission and Distribution of Electric Energy.
   2. ANSI/ICEA S-97-682 Utility Shielded Power Cable rated 5kVthrough 46 kV.

D. Institute of Electrical and Electronics Engineers (IEEE) Publications:
   1. IEEE 48-90 Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations 2.5 kV through 765 kV.
   2. IEEE 386-95 Standard for Separable Insulated Connectors System for Power Distribution Systems above 600 V.
   3. IEEE 400.2 – Very Low Frequency Testing (VLF).
   4. IEEE 404-2012 Extruded and Laminated Dielectric shielded Cable Joints for Use with Extruded Dielectric Cable Rated 5000-138000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500-500000V.

E. State of California Administrative Code (CAC):
   1. Title 24, Part 3, CCR, 2013 California Electrical Code.

F. National Fire Protection Association (NFPA) Publication:
   1. 70-2011 National Electrical Code (NEC)

G. State of California Public Utilities Commission (PUC) Publication:
   1. G.O. 128 Rules for Construction of Underground Electric Supply and Communication Systems.

H. Underwriters Laboratories (UL) Publication:
   1. UL 1072 Medium Voltage Power Cables.
   2. UL Listed as type MV 105, sunlight resistant.

1.04 SUBMITTALS

A. Submit under provisions of Section 01300 and 16010.

B. Product Data: Provide for:
   1. Medium Voltage Cables (include proposed warranty with Product Data submittal)
   2. Separable Connectors
   3. Inline Splice Kits
   4. Terminations
   5. Cable Lubricant – Specified in section 2.09.
   6. Fireproofing Tape
   7. Medium voltage cable tags

C. Field samples: Samples will not be returned to the Contractor. Provide for:
   1. Medium voltage cable: Provide samples of 500-kcmil products, two each at 8 inches long.
   2. Separable Connector: Provide sample of one unit installed on 1/C of same cable provided under this project.
   3. Inline Splice: Provide sample of one unit installed on 1/C of same cable provided under this project.
   4. Termination: Provide sample of one unit installed on 1/C of same cable provided under this project.

D. Manufacturer's Instructions:
   1. Installation instructions for cable.

2. Installation instructions for each type of splicing kit.
3. Installation instructions for each type of termination kit.
4. Installation instructions for fireproofing tape.

E. Factory Test Reports:
1. Medium Voltage Cable: Submit certified report of factory tests performed in accordance with section 3.07.
2. Inline Splice Kits: The splice manufacturer shall provide test reports certifying that the cable splices have been tested and qualified to the IEEE-404 and ANSI-C119.2 standards on the same type of cable as specified for this contract.
3. Terminations: Manufacturer shall provide test reports certifying compliance with IEEE 48 Class 1 on the same type of cable as specified for this contract.

F. Certification of Cable Spicer/Terminator:
1. Submit medium voltage cable Splicer/Terminator certification of competency and experience 30 days before splices or terminations are made in medium voltage cables. Spicer/Terminator experience during the immediate past 3 years shall include performance in splicing and terminating cables of the type and classification being provided under this Contract.
2. In lieu of a certification of competency, the Contractor shall demonstrate the qualification of a proposed cable splicer/terminator through formal training and relevant experience in splicing and termination cables of the type and class under this Contract. A notarized listing of all relevant projects completed by the proposed splicer/terminator during the past three years and all completed formal training must be submitted to demonstrate qualification.
3. Each cable splicer shall be required to make an approved dummy splice in the presence of the Engineer's representative in accordance with the manufacturer's instructions. The contractor shall furnish all tools, materials and supplies necessary for the dummy splices.

G. Cable Field Test Reports:
1. Submit field test reports on all new cables installed under this project within 30 days of testing.
2. Contractor shall maintain operation and maintenance manual on heavy-duty, 3-ring binder at the field office with all these cable test reports sorted by feeder number. These reports shall be available for review by the Engineer at all times. The lack of a testing report shall be cause for rejection of that portion of Work. All relevant test reports shall be incorporated into O&M Manual.
3. Perform VLF with Tan Delta per IEEE 400.2 and provide report.
4. Refer to IEEE Guide 400-2001 IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems. See IEEE Guide 400.2-2004 IEEE Guide for Field Testing of Shielded Power Cable Systems using Very Low Frequency (VLF).

5. Perform high voltage potential tests (or VLF) on cables after installation. Test each individual conductor of each length of cable in the system, after installation. Furnish necessary test equipment, experienced testing personnel, and necessary temporary power. Record current and voltage readings at the end of each step and prepare a written copy of the test data for submission.

H. Cable Warranty: Submit manufacturer's cable warranty per 01700.

I. Cable Pull Tension:

1. Cable pulling calculations shall be done during the design stage of a raceway-feeder or cable installation, to find values for expected tension when pulling cable, and to find the pulling force caused by sidewall pressure

   on the cable pulled around bends. The contractor shall not exceed the pulling tensions specified by the manufacturer. The Contractor shall submit cable pulling calculations for approval prior to installation.

2. The maximum stresses must not be exceeded when pulling a cable:

   a. The maximum tension shall not exceed 0.008 times CM area when pulled with a pulling eye attached to the copper.

   T_m = 0.008 x n x CM

   T_m = maximum tension lb.

   where

   n = number of conductors in cable

   (n=2 for parallel pulls)

   (n=3 for factory triplexed cables)

   CM = circular mil area of each conductor.

   The maximum tension shall not exceed the above calculated value or 10,000 lbs whichever is less.

   b. The maximum tension at a bend shall not exceed 1,000 pounds times the radius of curvature of the duct expressed in feet or the value calculated from item ‘a’ whichever is less.

3. The pulling tension in a given horizontal duct section shall be calculated from the following:

   a. For a straight section the pulling tension is equal to the length of the duct run multiplied by the weight per foot of the cable and the coefficient of friction which, will vary depending on lubrication used (lubricant specified in 2.09)

$$T = L \times w \times f \times c$$

where:

T = total pulling tension

L = length of duct run in ft.

W = weight of cable in lbs. per ft.

f = coefficient of friction

c = weight correction factor

For ducts having curved sections, the following formula applies:

$$T_{out} = T_{in}\, e^{cfa}$$

where:

T_{out} = tension out of bend

T_{in} = tension into bend

f = coefficient of friction

e = naperian logarithm base 2.718

a = angle of bend in radians

c = weight correction factor

To aid in solving the above formula, values of e^{fa} for specific angles of bend and coefficients of friction are listed in the Table below for Okonite cable.

Angle of bend degrees/ radians	Values of e^{fa} coefficients of friction f =		
	0.75	0.50	0.35
15/ 0.2618	1.22	1.14	1.10
30/ 0.5236	1.48	1.30	1.20
45/ 0.7854	1.80	1.48	1.32
60/ 1.0472	2.19	1.68	1.44
90/ 1.5708	3.25	2.20	1.73

For two or more cables for friction (f) use 0.35 for lubricated duct and 0.50 for dry duct. These factors include weight correction factor for maximum fill.

J. Provide detailed shop drawings for splices and connectors.

1.05 CONDUCTOR COLOR CODING

A. Phase A, B, and C implies the direction of positive phase rotation.

B. Use the following tape colors at termination ends unless directed otherwise by the Engineer.

System (6.6kV)	Conductor	Color
6,600 Volts	Phase A	Yellow
3-Phase, 3-Wire	Phase B	Red
	Phase C	Blue

Wrap at least six full overlapping turns of tape around the conductor covering an area 1-1/2 to 2 inches wide at a visible location.

PART 2 - PRODUCTS

2.01 MEDIUM VOLTAGE POWER CABLE

A. This specification covers single conductor, Ethylene Propylene Rubber (EPR) insulated shielded power cables medium voltage applications rated 5/8kV application. The cables shall be capable of operating continuously in both wet and dry locations in conduit and underground duct systems at conductor temperature of 105° C for normal operations, 140° C under emergency overload conditions and 250° C under short circuit conditions. Conductor shall be rated to operate at 140° C temperature for 1500 hours. Furnished cable shall be UL listed as type MV-105 in accordance with UL 1072, Article 328 Medium Voltage Cable and 501.10 (B), Class 1 Division 2 locations.

B. Conductors shall be, annealed uncoated copper compact stranded per ASTM B-496 and B8 for sizes up to and including 1000 kcmil and per Part 2 of ICEA S-93-639/NEMA WC74. Larger sizes shall be class B compressed concentric per ASTM B-8 for copper.

C. Strand screen shall be extruded layer semi-conducting EPR thermosetting compound applied over the conductor, with a volume resistivity not in excess of 100 ohm-meters at 105° C. The compound shall have a minimum elongation after an air oven test at 136° C for 168 hours of 100% and a brittleness temperature not warmer than -40° C. The material shall be compatible with the conductor metal, shall be uniformly and firmly bonded to the overlying insulation and be free stripping from the conductor. A semiconducting tape shall be applied between the conductor and the extruded conductor screen.

D. Insulation shall be high quality, heat, moisture, ozone and corona resistant, high dielectric strength Ethylene Propylene Rubber compound. The insulation shall contrast in color from the strand screen and insulation shield per AEIC CS-8. Insulation level shall be 133% 5kV and 100% for 8kV with 115 mils thickness.

The minimum thickness of the insulation at any point shall not be less than 90% of the specified nominal thickness. The ethylene content of the elastomer used in the insulation compound shall not exceed 72% by weight nor shall the insulation compound contain any polyethylene. The insulation shall be compounded by the cable manufacturer in its own facility using a closed system to insure maximum cleanliness.

E. Insulation screen shall be extruded EPR semi-conducting compound applied directly over the insulation. With a volume resistivity not in excess of 100 ohm-meters at 110° C when tested per ICEA S-93-639.The material shall be compatible with the insulation and overlying metallic shield. The insulation shield shall free stripping from the insulation and have a peel strength from the insulation between 4 to 24 pounds/0.5 inch when tested per ICEA S-93-639. The insulation shield shall leave no conductive residue on the surface of the insulation after stripping. Shield resistivity to remain constant and stable for aging up to 140° C.

F. The strand screen, insulation and insulation screen shall be applied in a single pass employing a triple tandem extrusion process to provide a virtual corona free cable core. The EPR insulation shall not be exposed to the atmosphere during manufacture.

G. Cable shall have a metal tape or metal tape with wire shield. Metallic shield shall be a single 0.005" thickness of copper tape, helically applied over the insulation screen material with a 12.5% nominal overlap. The tape shall be free from burrs and where jointed shall be electrically continuous. Application of the tape shield shall not deform the insulation.

H. Jacket shall be extruded polyvinyl chloride (PVC) material meeting physical and dimensional requirements of ICEA S-93-639/NEMA WC74, Section 7.

I. Identifying information shall be printed on the jacket in a contrasting color. Information shall consist of manufacturer's name, location code of plant, conductor size, insulation type, insulation thickness, voltage rating, marking to indicate sunlight resistant and UL designation. Mark “For CT Use” where applicable.

J. Size of cable shall be as indicated on the drawings.

K. The manufacturer shall have five years U.S. experience manufacturing medium voltage power cable. The cable shall be manufactured and tested in accordance with AEIC CS-8 and ICEA S-93-639/NEMA WC74 and UL 1072.

L. Cable Warranty: Manufacturer shall warrant that the cable is free from defects in materials and workmanship for a life of forty (40) years from the date of installation when installed, terminated and operated within acceptable industry practices. In the event the cable is found to be defective, the manufacturer shall replace the length of cable free of charge and shall extend the same guarantee on the replacement cable.

M. Cables shall be manufactured within 12 months of delivery. Manufacturer shall provide certification of manufacturing date for each cable. Copies of certificates shall be included in O&M manuals.

N. Identification:

1. The following identifying legend shall be printed on the jacket repeated at no more than two (2) foot intervals with unmarked surfaces not exceeding six inches.

   MANUFACTURE NAME, PLANT NUMBER, CU or COMPACT CU, CONDUCTOR SIZE, JACKET TYPE (PVC), VOLTAGE, % INSUL LEVEL (133), INSULATION THICKNESS

O. Approved Manufacturers: The Okonite Company. Alternate manufacturer shall duly comply with all the requirements of the specifications. Copies of all listed factory reports in Section 3.08, need to be submitted for prior approval of "the Engineer'.

2.02 MANUFACTURER MV CABLE TAGS

A. Identification tags shall be engraved laminated plastic connected to the cable by means of self-locking cable ties. Tags provided by the installation contractor shall contain the following information:

1. Feeder Number (i.e. F1A-T13)
2. Cable starts point.
3. Cable destination.
4. Cable quantity, size, insulation and voltage.
5. Date installed.

B. Cable tags shall be aluminum indented via computer printing process.

2.03 EQUIPMENT GROUNDING CONDUCTORS

A. 600 volt insulated stranded copper conductors sized at 4/0 AWG if not otherwise indicated on the drawings.

2.04 SEPARABLE CONNECTORS

A. Premolded EPDM type connection system conforming to ANSI/IEEE 386 dimensional requirements. The system shall be made up of specific kits designed for splicing, tapping (adding-on), dead-ending, equipment connecting. The system shall be capable of making dead-end, 2-way, and multiple tap splices and shall be suitable for continuous immersion under water. All rubber parts shall be molded of peroxide cured EPDM, fully shielded, non-load break, dead front, submersible separable connector assemblies. Provide all necessary elbows, extensions, insulating receptacles, connectors, insulating and/or deadend plugs, connecting plugs and ground shield adapters required to form the complete assembly and all the connecting components shall be insulated with molded epoxy. Each connector shall be factory pre-tested before packaging. Connectors shall meet the following minimum ratings:

5/8 kV cable

1.	Class rating	15 kV
2.	BIL Impulse withstand1.2 x 50 microseconds	95 kV
3.	Withstand Voltage	34 kV, 60-Hz, 1 minute; 53 kV, DC, 15 minutes
4.	Corona Extinction Level @ 3pC Sensitivity	11 kV
5.	Separable Components	
	a. Current Rating	200 amperes continuous;
	Symmetrical Momentary Current	10,000 amperes symmetrical, 10 cycles
	b. Current Rating	600 amperes continuous;
	Symmetrical Momentary Current	25,000 amperes symmetrical, 10 cycles

B. Use separate parts of copper or copper alloy in contact with copper or copper alloy parts in the construction and installation of the connector.

C. Cable ground connections shall be sealed with an elbow sealing adapter, Raychem ESA-1.

D. Acceptable Manufacturers: Elastimold, 3M or Raychem Dead break Separable Connectors.

2.05 IN-LINE SPLICES

A. In-line splices shall meet the requirements of IEEE-404-2012, and ANSI C119.2. The splice manufacturer shall provide test reports certifying that the cable splices have been tested and qualified to the IEEE-404 and ANSI-C119.2 standards on EPR insulated power cables. Splices shall contain shrinkable components to reinstate the primary cable insulation, and semicon. A solderless mechanical grounding clamp and braid shall be applied to provide metallic shield continuity. The entire splice entire splice kit and connector shall be shall be the product of one manufacturer, rejacketed with adhesive coated heat shrinkable tubing and shall be suitable for continuous operation under water. Hand taped splices are not acceptable.

B. 5/8 kV Cable Acceptable Manufacturers: 3M 5500 series or Raychem HVS-820S series.

2.06 TERMINATIONS

A. Shrink type termination kits rated 15 kV, 150 kV BIL with current rating same as cable supplied in a factory engineered kit. Manufacturer shall provide test reports certifying compliance with IEEE 48 Class 1 on the same type of cable as specified for this contract. Factory engineered kits shall be the product of one manufacturer. All kits shall contain instructions for the proper preparation, installation and handling for the specific type of cable to be used. Hand taped terminations will not be allowed.

B. Splice manufacturer shall have completed IEEE-404 testing to the 105/140 degrees C level at an independent testing agency within the United States. The conductor shall be terminated with a compression-type tinned copper, seamless barrel terminal lug. The cable termination must be capable of normal and continuous operation at the voltage and current rating of the cable that it is used.

C. The termination shall provide a stress relief material at the semicon cutback and a stress relief, high dielectric constant layer.

D. A mechanical non-solder ground clamp assembly shall be included as part of the kit. The grounding braid shall be factory solder blocked to prevent moisture from wicking into the termination.

E. A sealing mastic shall be used at both the ground strap and terminal lug ends to provide a fully sealed termination. The outer insulation shall be a non-tracking polymeric material.

F. Bolted terminations to bushing or insulted bus connections shall be reinsulated with equivalent voltage heat shrink bus insulation.

G. All cable shield grounding connections shall be suitable for a wet environment and compatible with shield material and copper ground conductors.

H. Acceptable Manufacturers: Raychem HVT-Z-80 series for 5kV; 3M 7600 series.

I. Live front connections to equipment shall be termination kits, rated for 5 kV systems, designed for use with the type of 5 kV cable provided heat shrink type IEEE-48 Class 1A rated 5kV systems, Tyco-Raychem HVT-Z series. Stress cone kits shall include compression applied connector rod, non tracking rubber modules with cap and molded stress relief, and ground (drain) shield adapters.

J. Connections to deadfront equipment shall be 600 amp non loadbreak connectors where terminating cable No. 3/0 and larger and 200 amp loadbreak connectors where terminating cable No. 2/0 and smaller and elbow is surface operable with a hot stick, and shall be manufactured by Thomas and Betts Elastimold. Connectors shall conform to ANSI/IEEE standards.

K. Connection to live front insulated bus shall be re-insulated with a suitable voltage class heat shrinkable bus insulation tubing or tape. Tyco-Raychem BPTM or approved equal.

2.07 PLASTIC CABLE TIES

A. Cable ties shall be nylon or equivalent, locking type. Panduit EH cross-section, PLT locking type, 250 pound loop tensile strength.

2.08 ELECTRICAL TAPES

A. Electrical tapes shall be as follows:
   1. Insulating tape shall be 3M Scotch Super 33+ vinyl electrical type or equal.
   2. Fire proofing tape shall be 3 inch wide, Scotch 3M No. 77 Fire and Electric Arc Proofing tape or equal.
   3. Glass cloth electrical tape shall be Scotch 3M No. 69 or equal.

2.09 CABLE LUBRICANT:

A. Cable lubricants for assisting in the pulling of all jacketed cables. The lubricant shall be U.L. listed and shall not be deleterious to the cable sheath, jacket or outer coverings. Cable lubricant shall be water based, Polywater Type J or equal.

2.10 CONDUCTOR ARC AND FIREPROOFING MATERIALS

A. Scotch Brand 77 or Plymouth Ply arc 30 arc and fireproofing tape

B. Scotch Brand 69 or Plymouth Ply glass cloth electrical tapes, or equal.

C. Glass cloth electrical tape shall be Scotch 3M No. 69 or equal.

PART 3 - EXECUTION

3.01 QUALITY ASSURANCE

A. Manufacturer's quality system shall be based on ISO 90001, 2 & 3, QA standards 10CFR50 Appendix B, ANSI N45.2, AAR M 1003, ASQC-1 and Mil I 45208.

B. Medium voltage cable shall be delivered and stored on Site in factory assembled packaging or on factory reels. Cable shall be furnished in one continuous length per reel. All cable ends for medium voltage cable shall be provided with water tight seal with heat shrinkable sealant coated end caps. End seals shall be Tyco-Raychem ESC series or approved equal. Hand taped caps are not acceptable.

C. Medium voltage cable shall be shipped on reels with both ends of the cable pigtailed out and accessible for high-potential testing while on the reel.

D. All medium voltage cable shall be brought to Project Site in original containers bearing the Underwriters Label or on original factory reels. A waterproof tag shall be fixed to each reel with, Buyer's order number, reel number assigned by buyer, name of manufacturer, voltage class, type of insulation, conductor size, and number of conductors on reel and length of cable reel.

E. The following engineering data shall be supplied for each cable; Diameter of conductor, thickness of conductor shield, thickness of insulation, overall diameter of cable, thickness of jacket, maximum allowable pulling tension, both for pulling eye and cable grip, maximum allowable sidewall pressure and minimum allowable bending radii for cable.

F. Manufacturer of medium voltage cables shall implement inspection and testing programs to ensure compliance with appropriate instructions, procedures, and/or drawings. Inspections shall be performed by trained and qualified personnel.

G. Applicable test methods and procedures shall be documented for determination of physical and electrical properties involving product qualification testing, production, in-process and final acceptance testing to ensure compliance with applicable customer requirements. Testing shall be performed by trained and qualified personnel.

H. A product traveler document shall be prepared for each item to be manufactures. This document defines the manufacturing process involved, the proper sequence of all manufacturing test and inspection operations required to assure the product complies with applicable specifications.

I. All cables shall have a factory installed label that indicates manufacturing within 12 months.

J. All factory test reports shall be submitted to “The Engineer” of POLB for prior approval before the shipment to the site.

K. Manufacturer to be ISO 9001 compliant and provide necessary certification.

3.02 INSTALLATION

A. Underground cable installation shall conform to NFPA 70, (NEC), Cal. P.U.C. G.O.128, and all other state and local codes.

B. Install and terminate primary cables in accordance with the manufacturer’s approved recommendations and tools suggestions. The conductors shall be free of kinks and twists and all bends shall be formed with a smooth radius not smaller than 12 times the diameter of the cable, not smaller than the minimum radius recommended by the manufacturer whichever is greater. All 600 Amp and 200 Amp terminations shall be mounted to avoid stress on the terminations.

C. The two-hole cable connectors shall be crimped with only the manufacturer’s approved tool recommendations.

D. A copper ground conductor insulated for 600V shall be installed with all cable circuits. Conductor size shall be as shown on the drawings. The ground conductor shall be bonded to all metal parts inside manhole including ground rod.

E. The conductor shield shall be grounded at each termination of the cable run and on both side of all splices using a stranded #6 bare copper wire to the nearest ground system.

3.03 CABLE PULLING

A. Prepare the ducts for pulling in conductors in accordance with the requirement of Section 16402. Cable shall be inspected for damage during installation and shall be pulled in the raceways as indicated on the Drawings.

B. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Cables shall not be pulled into conduits until the conduit runs have been cleaned and are free from obstructions and sharp corners. A mandrel, followed by a clean, dry, tight-fitting rag shall be drawn through the conduit immediately before installing the cable. The cable shall be installed so that there will not be cuts or abrasions in the insulation or protective covering or kinks in the cables. Gradual and uniform pulling stresses shall be applied to the wires and cables. Where pulling compound is used, use only compound compatible with the cable outer jacket and with the raceway involved.

C. Cable pulling equipment shall be equipped with an accurate gauge to allow continuous monitoring of pulling tension. Pulling tension shall not exceed manufacturers maximum recommended values for pulling tensions and sidewall pressures. Record these values and submit log to the Engineer and include in O&M manual.

D. Cable shall be pulled using a tugger or winch, similar to Greenlee power puller, Ideal pulling kit, or vehicle mounted electric winch. Vehicles shall not be utilized for pulling cable.

E. A ball bearing type swivel shall be placed between the pulling rope and pulling grip.

F. The cable shall be fed through a cable feeder or over sheaves in such a way that it does not contact the edge of the manhole or duct. Bending radius shall not be less than 12 times the conductor or cable diameter. The cable shall be fed straight into the duct in the pay-off manhole and straight out of the duct at the pulling manhole.

G. Cable shall be adequately lubricated at pay-off end with cable manufacturer approved cable pulling compound.

H. The pay-off reel shall be tended throughout the pulling process, but shall permit back tension to limit the amount of cable that backs out of the test hole.

I. The rate of pull shall be constant and shall not exceed 50 feet per minute.

J. Pull boxes, manholes and cable vaults shall fill with water due to tide and groundwater fluctuations. Prior and during cable pulling, Contractor shall pump pull boxes, manholes and cable vaults and keep them dry until the Project is completed to allow subsequent inspections.

K. Cable installation shall occur in some manholes, pull boxes or cable vaults with other energized wire and cable. Contractor to perform work in a safe manner and conform to local safety regulations.

L. Seal all duct runs in manholes going inside building with a water tight seal.

M. At the completion of the pull, immediately remove the pulling eye and re-seal with heat shrink end cap.

3.04 GENERAL

A. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

B. Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 18 inches on centers.

C. Cables shall be racked in the pull boxes, manholes, and cable vaults with consideration given to cable movement during load cycling. The cables shall be racked or supported in such a manner that adequate room is allowed for splicing and they shall be fanned out from the duct mouth so as not to cross other ducts or cables. Cable shall be racked so that personnel can enter and leave the manhole easily without stepping on or hitting cables.

D. Splices will not be permitted except where noted without prior written approval of the Engineer.

E. Make all joints and terminations with high voltage termination kits specified herein and in accordance with termination manufacturer's instructions. Once started, install splices or terminations as a continuous operation.

F. Provide terminals or connectors acceptable for the type of conductor material used.

G. Give 5 working days notice to the Engineer prior to installing first joint or termination.

3.05 FIELD INSTALLED MV CABLE TAGS

A. Contractor to provide and install cable tags. All new cables installed shall be identified at each end and at all accessible points in between (such as manholes, pull boxes, switchgear, etc.). Identify existing cables that are being re-routed or changed with new tags. Modification of existing tags shall not be acceptable.

3.06 CONDUCTOR ARC AND FIREPROOFING TAPES

A. Use arc and fireproofing tapes on all 5/8 kV single conductors throughout their entire exposed length in all manholes and vaults.

B. Wrap together as a single cable all conductors entering from each conduit.

C. Wrap conductors individually within 36" of a separable connector to allow for disconnection.

D. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape. Make each band of at least two wraps of tape directly over each other.

3.07 FIELD TESTS

A. Perform high potential test, Insulation resistance test, VLF test and Shield continuity test on cables after installation in the presence of the Engineer. Test each individual conductor of each length of cable in the system, after installation, with splices and terminations in place but disconnected from equipment.

B. Furnish necessary test equipment experienced testing personnel, and necessary electric power.

C. In the event that any Contractor furnished cable fails to meet any of the tests, the entire faulty cable shall be removed and new cable shall be installed and tested at no additional costs to the Engineer. Replace cables not passing test. Replaced cables must pass above tests.

3.08 FACTORY TESTS

A. Prior to delivery of all cables to the Site, Contractor shall ensure the following factory tests are done per applicable ICEA and/or AEIC and/or UL Specifications. Third party testing at field is not required.

A certified test report shall be sent to the engineer prior to shipment from manufacturer stating that the cable has been tested during manufacture and meets or exceeds contract requirement. Report shall contain the following:

1. AC voltage the cable was tested at for 5 minutes.
2. Insulation resistance test results.
3. Results of the DC resistance test of the conductors.
4. Results of Continuity tests for cable and shield.
5. Confirm that the cable passed Corona test per AEIC.
6. Test report shall be signed by the testing Engineer. (See sample of certified test report, certificate of compliance, at end of section)

3.09 TRAINING

A. The Contractor shall employ qualified personnel. Manufacturer shall provide one (1) day of training for Contractor's employees prior to installation. Training shall be performed in contractors on site trailer.

B. Training syllabus shall be:

1. Method of Installation, including pull plan showing location of reels, tuggers, personnel, equipment type, bend radii, pulling lube and pulling tension calculation.
2. Recommended Field Tests
3. Maintenance Procedures

CERTIFIED TEST REPORT
CERTIFICATE OF COMPLIANCE

MANUFACTURER		Report No.
		Date
		Reg. No.
Customer:		Page 1 of
Customer Order Number:	Item:	Code No N/A
Manufacturing Order No.		Product Code

Specification: Applicable ICEA and/or AEIC and/or UL specifications.
Description: Description of Cable

CERTIFICATE OF COMPLIANCE: Issued in conjunction with and subject to Manufacturer Warranty and Limitation Liability.

Manufacturer hereby certifies to the customer named above that the above described materials were duly tested during manufacture and the materials meet or exceed the applicable requirements.

Quantity Ordered xxxx ft	Quantity Accepted for Shipment xxxxx ft	Number of Reels x

QC Length Number Footage

Certified Test Report

The insulated conductor(s) withstood the following tests: 18kV AC for 5 minutes.

The insulated cable conductor(s) has an INSULATED RESISTANCE of not less than that corresponding to a constant of 50,000 at 15.6°C.

The DC RESISTANCE of the conductor(s) at 25°C does not exceed ICEA values of 0.xxx Ohms per 1,000 ft.

Conductor Continuity: Passed Shield Continuity: Passed

Corona Level (cables over 3kV ONLY): Passed AEIC

This report covers materials shipped from the FACILITY WHERE THE CABLE WAS MANUFACTURED.

We hereby certify this to be true and accurate copy of the results of tests conducted in accordance with orders and specifications listed.

____
Signature

Name, Engineer of Test

PART 4 - MEASUREMENT AND PAYMENT

A. No separate measurement and payment will be made for any items in this Section. They will be considered incidental to and included in the prices for other items provided in the Schedule of Bid Items.

END OF SECTION

SECTION 16119

15kV MEDIUM VOLTAGE CONDUCTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Medium voltage power cable

B. Grounding conductor

C. Separable connectors and splices

D. Terminators

E. Fireproofing

F. Medium voltage cable tags.

1.02 RELATED SECTIONS

A. Section 16030 - Electrical Acceptance Testing

B. Section 16170 - Grounding and Bonding

C. Section 16402 - Underground Electrical Work

1.03 APPLICABLE CODES AND STANDARDS:

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest publication in effect at the time the contract is awarded shall be used.

A. Association of Edison Illuminating Companies (AEIC) Publication:
   1. AEIC CS-8 Extruded Dielectric Shielded Power Cable Rated 5 kV through 46 kV.

B. American Society for Testing and Materials (ASTM)
   1. ASTM B-8 Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors, Class A, B, C or D.
   2. ASTM B-496 Standard Specification for Compact Round Stranded.

C. American National Standards Institute (ANSI) / Insulated Cable Engineers Association (ICEA) Publication:
   1. ANSI/ICEA S-93-639/NEMA WC74- Shielded Power Cable rated 5kV through 46kV for Use in the Transmission and Distribution of Electric Energy.
   2. ANSI/ICEA S-97-682 Utility Shielded Power Cable rated 5kVthrough 46 kV.

D. Institute of Electrical and Electronics Engineers (IEEE) Publications:
1. IEEE 48-90 Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations 2.5 kV through 765 kV.
2. IEEE 386-95 Standard for Separable Insulated Connectors System for Power Distribution Systems above 600 V.
3. IEEE 400.2 – Very Low Frequency Testing (VLF).
4. IEEE 404-2012 Extruded and Laminated Dielectric shielded Cable Joints for Use with Extruded Dielectric Cable Rated 5000-138000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500-500000V.

E. State of California Administrative Code (CAC):
1. Title 24, Part 3, CCR, 2013 California Electrical Code.

F. National Fire Protection Association (NFPA) Publication:
1. 70-2011 National Electrical Code (NEC)

G. State of California Public Utilities Commission (PUC) Publication:
1. G.O. 128 Rules for Construction of Underground Electric Supply and Communication Systems.

H. Underwriters Laboratories (UL) Publication:
1. UL 1072 Medium Voltage Power Cables.
2. UL Listed as type MV 105, sunlight resistant.

1.04 SUBMITTALS

A. Submit under provisions of Section 01300 and 16010.

B. Product Data: Provide for:
1. Medium Voltage Cables (include proposed warranty with Product Data submittal)
2. Separable Connectors
3. Inline Splice Kits
4. Terminations
5. Cable Lubricant – Specified in section 2.09.
6. Fireproofing Tape
7. Medium voltage cable tags

C. Field samples: Samples will not be returned to the Contractor. Provide for:
1. Medium voltage cable: Provide samples of 500-kcmil products, two each at 8 inches long.
2. Separable Connector: Provide sample of one unit installed on 1/C of same cable provided under this project.
3. Inline Splice: Provide sample of one unit installed on 1/C of same cable provided under this project.
4. Termination: Provide sample of one unit installed on 1/C of same cable provided under this project.

D. Manufacturer's Instructions:

1. Installation instructions for cable.
2. Installation instructions for each type of splicing kit.
3. Installation instructions for each type of termination kit.
4. Installation instructions for fireproofing tape.

E. Factory Test Reports:
1. Medium Voltage Cable: Submit certified report of factory tests performed in accordance with section 3.07.
2. Inline Splice Kits: The splice manufacturer shall provide test reports certifying that the cable splices have been tested and qualified to the IEEE-404 and ANSI-C119.2 standards on the same type of cable as specified for this contract.
3. Terminations: Manufacturer shall provide test reports certifying compliance with IEEE 48 Class 1 on the same type of cable as specified for this contract.

F. Certification of Cable Spicer/Terminator:
1. Submit medium voltage cable Splicer/Terminator certification of competency and experience 30 days before splices or terminations are made in medium voltage cables. Spicer/Terminator experience during the immediate past 3 years shall include performance in splicing and terminating cables of the type and classification being provided under this Contract.
2. In lieu of a certification of competency, the Contractor shall demonstrate the qualification of a proposed cable splicer/terminator through formal training and relevant experience in splicing and termination cables of the type and class under this Contract. A notarized listing of all relevant projects completed by the proposed splicer/terminator during the past three years and all completed formal training must be submitted to demonstrate qualification.
3. Each cable splicer shall be required to make an approved dummy splice in the presence of the Engineer’s representative in accordance with the manufacturer's instructions. The contractor shall furnish all tools, materials and supplies necessary for the dummy splices.

G. Cable Field Test Reports:
1. Submit field test reports on all new cables installed under this project within 30 days of testing.
2. Contractor shall maintain operation and maintenance manual on heavy-duty, 3-ring binder at the field office with all these cable test reports sorted by feeder number. These reports shall be available for review by the Engineer at all times. The lack of a testing report shall be cause for rejection of that portion of Work. All relevant test reports shall be incorporated into O&M Manual.
3. Perform VLF with Tan Delta per IEEE 400.2 and provide report.

4. Refer to IEEE Guide 400-2001 IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems. See IEEE

Guide 400.2-2004 IEEE Guide for Field Testing of Shielded Power Cable Systems using Very Low Frequency (VLF).

5. Perform high voltage potential tests (or VLF) on cables after installation. Test each individual conductor of each length of cable in the system, after installation. Furnish necessary test equipment, experienced testing personnel, and necessary power. Record current and voltage readings at the end of each step and prepare a written copy of the test data for submission.

H. Cable Warranty: Submit manufacturer's cable warranty per 01700.

I. Cable Pull Tension:

1. Cable pulling calculations shall be done during the design stage of a raceway-feeder or cable installation, to find values for expected tension when pulling cable, and to find the pulling force caused by sidewall pressure

   on the cable pulled around bends. The contractor shall not exceed the pulling tensions specified by the manufacturer. The Contractor shall submit cable pulling calculations for approval prior to installation.

2. The maximum stresses must not be exceeded when pulling a cable:

   a. The maximum tension shall not exceed 0.008 times CM area when pulled with a pulling eye attached to the copper.

      T_m = 0.008 x n x CM

      T_m = maximum tension lb.

      Where = number of conductors in cable

      (n=2 for parallel pulls)

      (n=3 for factory triplexed cables)

      CM = circular mil area of each conductor.

      The maximum tension shall not exceed the above calculated value or 10,000 lbs whichever is less.

   b. The maximum tension at a bend shall not exceed 1,000 pounds times the radius of curvature of the duct expressed in feet or the value calculated from item ‘a’ whichever is less.

3. The pulling tension in a given horizontal duct section shall be calculated from the following:

   a. For a straight section the pulling tension is equal to the length of the duct run multiplied by the weight per foot of the cable and the coefficient of friction which, will vary depending on lubrication used (lubricant specified in 2.09)

$$T = L \times w \times f \times c$$

where:

T = total pulling tension

L = length of duct run in ft.

W = weight of cable in lbs. per ft.

f = coefficient of friction

c = weight correction factor

For ducts having curved sections, the following formula applies:

$$T_{out} = T_{in}\, e^{cfa}$$

where:

T_{out} = tension out of bend

T_{in} = tension into bend

f = coefficient of friction

e = naperian logarithm base 2.718

a = angle of bend in radians

c = weight correction factor

To aid in solving the above formula, values of e^{fa} for specific angles of bend and coefficients of friction are listed in the Table below for Okonite cable.

Angle of bend degrees/ radians	Values of e^{fa} coefficients of friction f =		
	0.75	0.50	0.35
15/ 0.2618	1.22	1.14	1.10
30/ 0.5236	1.48	1.30	1.20
45/ 0.7854	1.80	1.48	1.32
60/ 1.0472	2.19	1.68	1.44
90/ 1.5708	3.25	2.20	1.73

For two or more cables for friction (f) use 0.35 for lubricated duct and 0.50 for dry duct. These factors include weight correction factor for maximum fill.

J. Provide detailed shop drawings for splices and connectors.

1.05 CONDUCTOR COLOR CODING

A. Phase A, B, and C implies the direction of positive phase rotation.

B. Use the following tape colors at termination ends unless directed otherwise by the Engineer.

System (15kV)	Conductor	Color
12,470 Volts	Phase A	Yellow
3-Phase, 3-Wire	Phase B	Red
	Phase C	Blue

Wrap at least six full overlapping turns of tape around the conductor covering an area 1-1/2 to 2 inches wide at a visible location.

PART 2 - PRODUCTS

2.01 MEDIUM VOLTAGE POWER CABLE

A. This specification covers single conductor, Ethylene Propylene Rubber (EPR) insulated shielded power cables medium voltage applications rated 15kV application. The cables shall be capable of operating continuously in both wet and dry locations in conduit and underground duct systems at conductor temperature of 105° C for normal operations, 140° C under emergency overload conditions and 250° C under short circuit conditions. Conductor shall be rated to operate at 140° C temperature for 1500 hours. Furnished cable shall be UL listed as type MV-105 in accordance with UL 1072, Article 328 Medium Voltage Cable and 501.10 (B), Class 1 Division 2 locations.

B. Conductors shall be, annealed uncoated copper compact stranded per ASTM B-496 and B8 for sizes up to and including 1000 kcmil and per Part 2of ICEA S-93-639/NEMA WC74. Larger sizes shall be class B compressed concentric per ASTM B-8 for copper.

C. Strand screen shall be extruded layer semi-conducting EPR thermosetting compound applied over the conductor, with a volume resistivity not in excess of 100 ohm-meters at 105° C. The compound shall have a minimum elongation after an air oven test at 136° C for 168 hours of 100% and a brittleness temperature not warmer than -40° C. The material shall be compatible with the conductor metal, shall be uniformly and firmly bonded to the overlying insulation and be free stripping from the conductor. A semiconducting tape shall be applied between the conductor and the extruded conductor screen.

D. Insulation shall be high quality, heat, moisture, ozone and corona resistant, high dielectric strength Ethylene Propylene Rubber compound. The insulation shall contrast in color from the strand screen and insulation shield per AEIC CS-8. Insulation level shall be 133% with 210 mils minimum thickness for 15kV. The minimum thickness of the insulation at any point shall not be less than 90% of the specified nominal thickness. The ethylene content of the elastomer used in the insulation compound shall not exceed 72% by weight nor shall the insulation compound contain any polyethylene. The insulation shall be compounded by the cable manufacturer in its own facility using a closed system to insure maximum cleanliness.

E. Insulation screen shall be extruded EPR semi-conducting compound applied directly over the insulation. With a volume resistivity not in excess of 100 ohm-meters at 110° C when tested per ICEA S-93-639.The material shall be compatible with the insulation and overlying metallic shield. The insulation shield shall free stripping from the insulation and have a peel strength from the insulation between 4 to 24 pounds/0.5 inch when tested per ICEA S-93-639. The insulation shield shall leave no conductive residue on the surface of the insulation after stripping. Shield resistivity to remain constant and stable for aging up to 140° C.

F. The strand screen, insulation and insulation screen shall be applied in a single pass employing a triple tandem extrusion process to provide a virtual corona free cable core. The EPR insulation shall not be exposed to the atmosphere during manufacture.

G. Cable shall have a metal tape or metal tape with wire shield. Metallic shield shall be a single 0.005" thickness of copper tape, helically applied over the insulation screen material with a 12.5% nominal overlap. The tape shall be free from burrs and where jointed shall be electrically continuous. Application of the tape shield shall not deform the insulation.

H. Jacket shall be extruded polyvinyl chloride (PVC) material meeting physical and dimensional requirements of ICEA S-93-639/NEMA WC74, Section 7.

I. Identifying information shall be printed on the jacket in a contrasting color. Information shall consist of manufacturer's name, location code of plant, conductor size, insulation type, insulation thickness, voltage rating, marking to indicate sunlight resistant and UL designation. Mark “For CT Use” where applicable.

J. Size of cable shall be as indicated on the drawings.

K. The manufacturer shall have five years U.S. experience manufacturing medium voltage power cable. The cable shall be manufactured and tested in accordance with AEIC CS-8 and ICEA S-93-639/NEMA WC74 and UL 1072.

L. Cable Warranty: Manufacturer shall warrant that the cable is free from defects in materials and workmanship for a life of forty (40) years from the date of installation when installed, terminated and operated within acceptable industry practices. In the event the cable is found to be defective, the manufacturer shall replace the length of cable free of charge and shall extend the same guarantee on the replacement cable.

M. Cables shall be manufactured within 12 months of delivery. Manufacturer shall provide certification of manufacturing date for each cable. Copies of certificates shall be included in O&M manuals.

N. Identification:

1. The following identifying legend shall be printed on the jacket repeated at no more than two (2) foot intervals with unmarked surfaces not exceeding six inches.

   MANUFACTURE NAME, PLANT NUMBER, CU or COMPACT CU, CONDUCTOR SIZE, JACKET TYPE (PVC), VOLTAGE, % INSUL LEVEL (133), INSULATION THICKNESS

O. Approved Manufacturers: The Okonite Company. Alternate manufacturer shall duly comply with all the requirements of the specifications. Copies of all listed factory reports in Section 3.08, need to be submitted for prior approval of "the Engineer'.

2.02 MANUFACTURER MV CABLE TAGS

A. Identification tags shall be engraved laminated plastic connected to the cable by means of self-locking cable ties. Tags provided by installation contractor shall contain the following information:
   1. Feeder Number (i.e. F1A-T13)
   2. Cable starts point.
   3. Cable destination.
   4. Cable quantity, size, insulation and voltage.
   5. Date installed.

B. Cable tags shall be aluminum indented via computer printing process.

2.03 EQUIPMENT GROUNDING CONDUCTORS

A. 600 volt insulated stranded copper conductors sized at 4/0 AWG if not otherwise indicated on the drawings.

2.04 SEPARABLE CONNECTORS

A. Premolded EPDM type connection system conforming to ANSI/IEEE 386 dimensional requirements. The system shall be made up of specific kits designed for splicing, tapping (adding-on), dead-ending, equipment connecting. The system shall be capable of making dead-end, 2-way, and multiple tap splices and shall be suitable for continuous immersion under water. All rubber parts shall be molded of peroxide cured EPDM, fully shielded, non-load break, dead front, submersible separable connector assemblies. Provide all necessary elbows, extensions, insulating receptacles, connectors, insulating and/or deadend plugs, connecting plugs and ground shield adapters required to form the complete assembly and all the connecting components shall be insulated with molded epoxy. Each connector shall be factory pre-tested before packaging. Connectors shall meet the following minimum ratings:

   15kV cable

1.	Class rating	25 kV
2.	BIL Impulse withstand1.2 x 50 microseconds	125 kV
3.	Withstand Voltage	40 kV, 60-Hz, 1 minute; 78 kV, DC, 15 minutes
4.	Corona Extinction Level @ 3pC Sensitivity	19 kV
5.	Separable Components	
	a. Current Rating	200 amperes continuous;
	Symmetrical Momentary Current	10,000 amperes symmetrical, 10 cycles
	b. Current Rating	600 amperes continuous;
	Symmetrical Momentary Current	25,000 amperes symmetrical, 10 cycles

B. Use separate parts of copper or copper alloy in contact with copper or copper alloy parts in the construction and installation of the connector.

C. Cable ground connections shall be sealed with an elbow sealing adapter, Raychem ESA-1.

D. Acceptable Manufacturers: Elastimold, 3M or Raychem Dead break Separable Connectors.

2.05 IN-LINE SPLICES

A. In-line splices shall meet the requirements of IEEE-404-2012, and ANSI C119.2. The splice manufacturer shall provide test reports certifying that the cable splices have been tested and qualified to the IEEE-404 and ANSI-C119.2 standards on EPR insulated power cables. Splices shall contain shrinkable components to reinstate the primary cable insulation, and semicon. A solderless mechanical grounding clamp and braid shall be applied to provide metallic shield continuity. The entire splice entire splice kit and connector shall be shall be the product of one manufacturer, rejacketed with adhesive coated heat shrinkable tubing and shall be suitable for continuous operation under water. Hand taped splices are not acceptable.

B. 15kV Cable Acceptable Manufacturers: 3M Quick Splice III-551X series or Raychem HVS-C-1520S series.

2.06 TERMINATIONS

A. Shrink type termination kits rated 15 kV, 150 kV BIL with current rating same as cable supplied in a factory engineered kit. Manufacturer shall provide test reports certifying compliance with IEEE 48 Class 1 on the same type of cable as specified for this contract. Factory engineered kits shall be the product of one manufacturer. All kits shall contain instructions for the proper preparation, installation and handling for the specific type of cable to be used. Hand taped terminations will not be allowed.

B. Splice manufacturer shall have completed IEEE-404 testing to the 105/140 degrees C level at an independent testing agency within the United States. The conductor shall be terminated with a compression-type tinned copper, seamless barrel terminal lug. The cable termination must be capable of normal and continuous operation at the voltage and current rating of the cable that it is used.

C. The termination shall provide a stress relief material at the semicon cutback and a stress relief, high dielectric constant layer.

D. A mechanical non-solder ground clamp assembly shall be included as part of the kit. The grounding braid shall be factory solder blocked to prevent moisture from wicking into the termination.

E. A sealing mastic shall be used at both the ground strap and terminal lug ends to provide a fully sealed termination. The outer insulation shall be a non-tracking polymeric material.

F. Bolted terminations to bushing or insulted bus connections shall be reinsulated with equivalent voltage heat shrink bus insulation.

G. All cable shield grounding connections shall be suitable for a wet environment and compatible with shield material and copper ground conductors.

H. Acceptable Manufacturers: Raychem HVT-Z-150 series for 15kV; 3M 7600 series.

I. Live front connections to equipment shall be termination kits, rated for 15 kV systems, designed for use with the type of 15 kV cable provided heat shrink type IEEE-48 Class 1A rated 15kV systems, Tyco-Raychem HVT-Z series. Stress cone kits shall include compression applied connector rod, non tracking rubber modules with cap and molded stress relief, and ground (drain) shield adapters.

J. Connections to deadfront equipment shall be 600 amp non loadbreak connectors where terminating cable No. 3/0 and larger and 200 amp loadbreak connectors where terminating cable No. 2/0 and smaller and elbow is surface operable with a hot stick, and shall be manufactured by Thomas and Betts Elastimold. Connectors shall conform to ANSI/IEEE standards.

K. Connection to live front insulated bus shall be re-insulated with a suitable voltage class heat shrinkable bus insulation tubing or tape. Tyco-Raychem BPTM or approved equal.

2.07 PLASTIC CABLE TIES

A. Cable ties shall be nylon or equivalent, locking type. Panduit EH cross-section, PLT locking type, 250 pound loop tensile strength.

2.08 ELECTRICAL TAPES

A. Electrical tapes shall be as follows:
   1. Insulating tape shall be 3M Scotch Super 33+ vinyl electrical type or equal.
   2. Fire proofing tape shall be 3 inch wide, Scotch 3M No. 77 Fire and Electric Arc Proofing tape or equal.
   3. Glass cloth electrical tape shall be Scotch 3M No. 69 or equal.

2.09 CABLE LUBRICANT:

A. Cable lubricants for assisting in the pulling of all jacketed cables. The lubricant shall be U.L. listed and shall not be deleterious to the cable sheath, jacket or outer coverings. Cable lubricant shall be water based, Polywater Type J or equal.

2.10 CONDUCTOR ARC AND FIREPROOFING MATERIALS

A. Scotch Brand 77 or Plymouth Ply arc 30 arc and fireproofing tape

B. Scotch Brand 69 or Plymouth Ply glass cloth electrical tapes, or equal.

C. Glass cloth electrical tape shall be Scotch 3M No. 69 or equal.

PART 3 - EXECUTION

3.01 QUALITY ASSURANCE

A. Manufacturer’s quality system shall be based on ISO 90001, 2 & 3, QA standards 10CFR50 Appendix B, ANSI N45.2, AAR M 1003, ASQC-1 and Mil I 45208.

B. Medium voltage cable shall be delivered and stored on Site in factory assembled packaging or on factory reels. Cable shall be furnished in one continuous length per reel. All cable ends for medium voltage cable shall be provided with water tight seal with heat shrinkable sealant coated end caps. End seals shall be Tyco-Raychem ESC series or approved equal. Hand taped caps are not acceptable.

C. Medium voltage cable shall be shipped on reels with both ends of the cable pigtailed out and accessible for high-potential testing while on the reel.

D. All medium voltage cable shall be brought to Project Site in original containers bearing the Underwriters Label or on original factory reels. A waterproof tag shall be fixed to each reel with, Buyer’s order number, reel number assigned by buyer, name of manufacturer, voltage class, type of insulation, conductor size, and number of conductors on reel and length of cable reel.

E. The following engineering data shall be supplied for each cable; Diameter of conductor, thickness of conductor shield, thickness of insulation, overall diameter of cable, thickness of jacket, maximum allowable pulling tension, both for pulling eye and cable grip, maximum allowable sidewall pressure and minimum allowable bending radii for cable.

F. Manufacturer of medium voltage cables shall implement inspection and testing programs to ensure compliance with appropriate instructions, procedures, and/or drawings. Inspections shall be performed by trained and qualified personnel.

G. Applicable test methods and procedures shall be documented for determination of physical and electrical properties involving product qualification testing, production, in-process and final acceptance testing to ensure compliance with applicable customer requirements. Testing shall be performed by trained and qualified personnel.

H. A product traveler document shall be prepared for each item to be manufactures. This document defines the manufacturing process involved, the proper sequence of all manufacturing test and inspection operations required to assure the product complies with applicable specifications.

I. All cables shall have a factory installed label that indicates manufacturing within 12 months.

J. All factory test reports shall be submitted to "The Engineer" of POLB for prior approval before the shipment to the site.

K. Manufacturer to be ISO 9001 compliant and provide necessary certification.

3.02 INSTALLATION

A. Underground cable installation shall conform to NFPA 70, (NEC), Cal. P.U.C. G.O.128, and all other state and local codes.

B. Install and terminate primary cables in accordance with the manufacturer's approved recommendations and tools suggestions. The conductors shall be free of kinks and twists and all bends shall be formed with a smooth radius not

smaller than 12 times the diameter of the cable, not smaller than the minimum radius recommended by the manufacturer whichever is greater. All 600 Amp and 200 Amp terminations shall be mounted to avoid stress on the terminations.

C. The two-hole cable connectors shall be crimped with only the manufacturer's approved tool recommendations.

D. A copper ground conductor insulated for 600V shall be installed with all cable circuits. Conductor size shall be as shown on the drawings. The ground conductor shall be bonded to all metal parts inside manhole including ground rod.

E. The conductor shield shall be grounded at each termination of the cable run and on both side of all splices using a stranded #6 bare copper wire to the nearest ground system.

3.03 CABLE PULLING

A. Prepare the ducts for pulling in conductors in accordance with the requirement of Section 16402. Cable shall be inspected for damage during installation and shall be pulled in the raceways as indicated on the Drawings.

B. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Cables shall not be pulled into conduits until the conduit runs have been cleaned and are free from obstructions and sharp corners. A mandrel, followed by a clean, dry, tight-fitting rag shall be drawn through the conduit immediately before installing the cable. The cable shall be installed so that there will not be cuts or abrasions in the insulation or protective covering or kinks in the cables. Gradual and uniform pulling stresses shall be applied to the wires and cables. Where pulling compound is used, use only compound compatible with the cable outer jacket and with the raceway involved.

C. Cable pulling equipment shall be equipped with an accurate gauge to allow continuous monitoring of pulling tension. Pulling tension shall not exceed manufacturers maximum recommended values for pulling tensions and sidewall pressures. Record these values and submit log to the Engineer and include in O&M manual.

D. Cable shall be pulled using a tugger or winch, similar to Greenlee power puller, Ideal pulling kit, or vehicle mounted electric winch. Vehicles shall not be utilized for pulling cable.

E. A ball bearing type swivel shall be placed between the pulling rope and pulling grip.

F. The cable shall be fed through a cable feeder or over sheaves in such a way that it does not contact the edge of the manhole or duct. Bending radius shall not be less than 12 times the conductor or cable diameter. The cable shall be fed straight into the duct in the pay-off manhole and straight out of the duct at the pulling manhole.

G. Cable shall be adequately lubricated at pay-off end with cable manufacturer approved cable pulling compound.

H. The pay-off reel shall be tended throughout the pulling process, but shall permit back tension to limit the amount of cable that backs out of the test hole.

I. The rate of pull shall be constant and shall not exceed 50 feet per minute.

J. Pull boxes, manholes and cable vaults shall fill with water due to tide and groundwater fluctuations. Prior and during cable pulling, Contractor shall pump pull boxes, manholes and cable vaults and keep them dry until the Project is completed to allow subsequent inspections.

K. Cable installation shall occur in some manholes, pull boxes or cable vaults with other energized wire and cable. Contractor to perform work in a safe manner and conform to local safety regulations.

L. Seal all duct runs in manholes going inside building with a water tight seal.

M. At the completion of the pull, immediately remove the pulling eye and re-seal with heat shrink end cap.

3.04 GENERAL

A. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

B. Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 18 inches on centers.

C. Cables shall be racked in the pull boxes, manholes, and cable vaults with consideration given to cable movement during load cycling. The cables shall be racked or supported in such a manner that adequate room is allowed for splicing and they shall be fanned out from the duct mouth so as not to cross other ducts or cables. Cable shall be racked so that personnel can enter and leave the manhole easily without stepping on or hitting cables.

D. Splices will not be permitted except where noted without prior written approval of the Engineer.

E. Make all joints and terminations with high voltage termination kits specified herein and in accordance with termination manufacturer's instructions. Once started, install splices or terminations as a continuous operation.

F. Provide terminals or connectors acceptable for the type of conductor material used.

G. Give 5 working days notice to the Engineer prior to installing first joint or termination.

3.05 FIELD INSTALLED MV CABLE TAGS:

A. Contractor to provide and install cable tags. All new cables installed shall be identified at each end and at all accessible points in between (such as manholes, pull boxes, switchgear, etc.). Identify existing cables that are being re-routed or changed with new tags. Modification of existing tags shall not be acceptable.

3.06 CONDUCTOR ARC AND FIREPROOFING TAPES

A. Use arc and fireproofing tapes on all 15 kV single conductors throughout their entire exposed length in all manholes and vaults.

B. Wrap together as a single cable all conductors entering from each conduit.

C. Wrap conductors individually within 36" of a separable connector to allow for disconnection.

D. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape. Make each band of at least two wraps of tape directly over each other.

3.07 FIELD TESTS

A. Perform high potential test, Insulation resistance test, VLF test and Shield continuity test on cables after installation in the presence of the Engineer. Test each individual conductor of each length of cable in the system, after installation, with splices and terminations in place but disconnected from equipment.

B. Furnish necessary test equipment experienced testing personnel, and necessary electric power.

C. In the event that any Contractor furnished cable fails to meet any of the tests, the entire faulty cable shall be removed and new cable shall be installed and tested at no additional costs to the Engineer. Replace cables not passing test. Replaced cables must pass above tests.

3.08 FACTORY TESTS

A. Prior to delivery of all cables to the Site, Contractor shall ensure the following factory tests are done per applicable ICEA and/or AEIC and/or UL Specifications. Third party testing at field is not required.

A certified test report shall be sent to the engineer prior to shipment from manufacturer stating that the cable has been tested during manufacture and meets or exceeds contract requirement. Report shall contain the following:

1. AC voltage the cable was tested at for 5 minutes.
2. Insulation resistance test results.
3. Results of the DC resistance test of the conductors.
4. Results of Continuity tests for cable and shield.
5. Confirm that the cable passed Corona test per AEIC.
6. Test report shall be signed by the testing Engineer. (See sample of certified test report, certificate of compliance, at end of section)

3.09 TRAINING

A. The Contractor shall employ qualified personnel. Manufacturer shall provide one (1) day of training for Contractor’s employees prior to installation. Training shall be performed in contractors on site trailer.

B. Training syllabus shall be:

1. Method of Installation, including pull plan showing location of reels, tuggers, personnel, equipment type, bend radii, pulling lube and pulling tension calculation.
2. Recommended Field Tests
3. Maintenance Procedures

CERTIFIED TEST REPORT
CERTIFICATE OF COMPLIANCE

MANUFACTURER		Report No. Date Reg. No.
Customer:		Page 1 of
Customer Order Number:	Item:	Code No N/A
Manufacturing Order No.		Product Code

Specification: Applicable ICEA and/or AEIC and/or UL specifications.
Description: Description of Cable

CERTIFICATE OF COMPLIANCE: Issued in conjunction with and subject to Manufacturer Warranty and Limitation Liability.

Manufacturer hereby certifies to the customer named above that the above described materials were duly tested during manufacture and the materials meet or exceed the applicable requirements.

Quantity Ordered xxxx ft	Quantity Accepted for Shipment xxxxx ft	Number of Reels x

QC Length Number Footage

Certified Test Report

The insulated conductor(s) withstood the following tests: 44kV AC for 5 minutes.

The insulated cable conductor(s) has an INSULATED RESISTANCE of not less than that corresponding to a constant of 50,000 at 15.6°C.

The DC RESISTANCE of the conductor(s) at 25°C does not exceed ICEA values of 0.xxx Ohms per 1,000 ft.

Conductor Continuity: Passed Shield Continuity: Passed

Corona Level (cables over 3kV ONLY): Passed AEIC

This report covers materials shipped from the FACILITY WHERE THE CABLE WAS MANUFACTURED.

We hereby certify this to be true and accurate copy of the results of tests conducted in accordance with orders and specifications listed.

____
Signature

Name, Engineer of Test

PART 4 - MEASUREMENT AND PAYMENT

A. No separate measurement and payment will be made for any items in this Section. They will be considered incidental to and included in the prices for other items provided in the Schedule of Bid Items.

END OF SECTION

SECTION 16120

25kV MEDIUM-VOLTAGE CONDUCTORS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide medium voltage wires, cables, terminations, terminal blocks, splices, and accessories. The design and specifications for high and medium voltage cable are based on BICC, Unishield cable. The design and specifications for secondary voltage cable are based on BICC building wire. The design and specifications for high and medium voltage splices and terminations are based on Elastimold. The design and specifications for secondary voltage terminations and splices are based upon Scotch, Raychem, Ideal, and Burndy.

1.02 QUALITY ASSURANCE

A. Wire and cable shall be delivered and stored on site in factory assembled packaging or on factory reels. All cable ends for medium voltage cable shall be sealed with heat shrinkable tubing.

B. Medium voltage cable shall be shipped on reels with both ends of the cable pigtailed out and accessible for high-potential testing while on the reel. Medium voltage cable reels shall be completely wood lagged for shipping to provide mechanical protection for the cable while in transit.

C. All wire and cable shall be brought to project in original containers bearing the Underwriters Label or on original factory reels.

1.03 SUBMITTALS

A. Submit product data for all medium voltage cable, secondary voltage cable, terminations, splices and accessories consisting of manufacturer's published specification sheets and catalog data. Submit medium voltage certifications.

1. Product data shall be marked to indicate the specific items to be furnished. Where multiple products or multiple cable types or sizes are shown on the same specification sheet or catalog page clearly mark all items to be provided, or submit separate pages for each item.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. BICC

B. OKONITE

C. Or Equal

2.02 WIRE AND CABLE, MEDIUM VOLTAGE, 25 KV

A. Medium voltage 25 kV cables shall be copper conductor Ethylene Propylene Rubber insulated, shielded, with combination composite insulation shield and jacket, capable of operating continuously in both wet and dry locations at a conductor temperature of 90 degrees C for normal operation, 130 degrees C under emergency operating conditions and 250 degrees C under short circuit conditions.

1. Single conductor, size as noted on the drawings, compact class B stranded, annealed copper per Part 2 of ICEA S-68-516.

2. Extruded black strand shield, conducting stress control layer over conductor.

3. Heat, moisture, ozone and corona resistant ethylene propylene rubber insulation compound contrasting in color from the black strand shield and composite insulation shield and jacket per AEIC CS6. Insulation level shall be 133% as follows:

Voltage Class	Insulation Thickness
25 kV	345 mils

The minimum thickness of the insulation at any point shall not be less than 90 percent of the specified nominal thickness.

4. Composite insulation shield and jacket with solid copper drain wires laid parallel to the axis of the conductor, imbedded in flame resistant, semi-conducting chlorinated polyethylene jacket material meeting the requirements of ICEA S-68-516, Part 4.1.1.1.

Voltage Class	Size	Drain Wire
25 kV	350 KCM	#17

25 kV	500 KCM	#17
25 kV	750 KCM	#16

5. The overall jacket shall be printed with the following information:

    a. Manufacturer's Name
    b. Location
    c. Cable Size
    d. Insulation Type and Thickness
    e. Voltage Rating
    f. UL Designation

6. Manufacturer shall furnish a certificate of compliance to demonstrate cable furnished is in complete compliance with ICEA S-68-516, Part 3. Test reports including X-Y plot of corona test shall be supplied with cable delivery. Include copies of these reports and certificate in the O & M Manual.

7. Furnished cable shall be UL listed as Type MV-105 and "For CT Use" where applicable.

8. Cable and materials shall meet the most recent editions of the following standards:

    a. ICEA S-68-516
    b. AEIC CS6
    c. UL 1072

9. Cable shall be manufactured within twelve (12) months of delivery. Manufacturer shall provide certification as to manufacture date. Include a copy in the O & M Manual.

10. The cable shall be BICC Unishield, Okonite Okogard/Okoseal or approved equal, EPR 25 kV, 133% insulation level for 25 kV applications.

2.07 <u>TERMINATIONS (25 KV)</u>

A. Live front connections to equipment shall be stress cones using premolded, outdoor type, modular terminator type, rated for 25 kV systems, designed for use with the type of 25 kV cable provided, manufactured by Elastimold Division of AMERACE Corporation or approved equal. Stress cone kits shall include compression applied connector rod, non tracking rubber modules with cap and molded stress relief, and ground (drain) shield adapters.

B. Connections to deadfront equipment shall be 600 amp non loadbreak connectors where terminating cable #3/0 and larger and 200 amp loadbreak connectors where terminating cable #2/0 and smaller as manufactured by Elastimold Division of AMERACE Corporation or approved equal. Connectors shall conform to ANSI/IEEE standards.

2.08 GROUND WIRE

A. Ground wire shall be 600 volt insulated copper where installed with ungrounded conductors, bare copper where direct buried or exposed in handholes, manholes, or cable vaults, soft drawn, sized as noted on the drawings and as required by the NEC.

2.09 CABLE RACKS

A. Cable racks and supports to be installed inside manholes shall be adjustable type, one piece molded glass reinforced nylon, of sizes as noted on the drawings. Cable racks and supports shall be as manufactured by Underground Devices, Inc.

2.10 PLASTIC CABLE TIES

A. Cable ties shall be nylon or equivalent, locking type. Panduit EH cross-section, PLT locking type, 250 pound loop tensile strength.

2.11 ELECTRICAL TAPES

A. Electrical tapes shall be as follows:

Insulating tape shall be 3M Scotch Super 33+ vinyl electrical type or equal.

Fire proofing tape shall be Scotch 3M No. 77 Fire and Electric Arc Proofing tape or equal.

Glass cloth electrical tape shall be Scotch 3M No. 69 or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Wire and cable shall be installed in conduits and ductbanks as shown on the contract drawings. The installation shall include preparing of conduits, pulling, laying and securing of wires and cables and making conductor splices, terminal connections to equipment and devices, and performing cable tests.

B. Wires and cables shall not be pulled into conduits until the conduit runs have been cleaned and are free from obstructions and sharp corners. A mandrel, followed by a clean, dry, tight-fitting rag shall be drawn through the conduit immediately before installing the wire or cable. The wires and cables shall be installed so that there will not be cuts or abrasions in the insulation or protective covering or kinks in the wires and cables. Gradual and uniform pulling stresses shall be applied to wires and cables. Where a lubricant is needed as an aid to the pulling of wires and cables, use only compounds acceptable to, or approved by, the cable manufacturer. Cable guides shall be installed as required in order to prevent the cable from being damaged by sharp surfaces. For long pulls of wire or cable in which the pulling force would exceed that recommended by the cable manufacturer, an expendable pulling messenger shall be used and the cables taped to the messenger at intervals to avoid excessive stresses in the conductors and the messenger left in the conduit. Wire and cable damaged during installation shall be removed and replaced with equivalent wire or cable at no expense to the City.

C. Cables shall be racked in the handholes, manholes, and cable vaults with consideration given to cable movement during load cycling. The cables shall be racked or supported in such a manner that adequate room is allowed for splicing and they shall be fanned out from the duct mouth so as not to cross other ducts or cables. Cable shall be racked so that personnel can enter and leave the manhole easily without stepping on or hitting cables. In handholes and manholes where no splices are made, provide cable slack for future connections by looping the cable the longest route around the perimeter of the handhole or manhole before exiting.

D. All medium voltage 25,000 Volt cables in handholes and manholes, shall be individually wrapped using the fire proofing tape spirally wound tightly around the conductor. Use half lapped wrapping. The fire proofing tape shall be applied with the coated side toward the conductor and shall extend one inch into the duct. To prevent the fire proofing tape from unraveling, each individual set of three conductors shall be bundled and randomly wrapped for the entire length of the fire proofing with pressure sensitive glass cloth tape.

3.02 <u>CABLE PULLING</u>

A. Wire and cable shall be inspected for damage during installation and shall be pulled in the raceways indicated on the drawings.

B. Wire and cable pulling equipment shall be equipped with an accurate gauge to allow continuous monitoring of pulling tension. Pulling tension shall not be sufficient to exceed the manufacturers maximum recommended values for pulling tensions and sidewall pressures. Record these values and submit log to the Engineer.

C. Wire and cable shall be pulled using a tugger or winch, similar to Greenlee power puller, Ideal pulling kit, or vehicle mounted electric winch. Vehicles shall not be utilized for pulling cable.

D. Cable installation shall be done in fenced, secured areas, each end of installation, or from within secured areas.

E. A swivel shall be placed between the pulling rope and pulling grip.

F. The wire and cable shall be fed through a cable feeder or over sheaves in such a way that it does not contact the edge of the manhole or duct. Bending radius shall not be less than 12 times the conductor or cable diameter. The cable shall be fed straight into the duct in the pay-off manhole and straight out of the duct at the pulling manhole.

G. Wire and cable shall be adequately lubricated at pay-off end with approved cable pulling compound.

H. The pay-off reel shall be tended throughout the pulling process.

I. The rate of pull shall be constant and shall not exceed 50 feet per minute.

J. Handholes, manholes, cable vaults and duct banks shall be free from water prior to cable pulling and shall be kept dry until the project is completed to allow subsequent inspections.

3.04 <u>POWER CABLE TERMINATIONS 25 KV</u>

A. Power cable shall be terminated by means of the specified compression lug or at appropriate terminals in the equipment. Manual or hydraulic tools shall be utilized as specified for the size of wire by the lug manufacturer. The correct size jaws shall be used for the indenting tool so that a full stroke is required for proper indentation. For installing the lug, the insulation shall be stripped from the conductor only the distance required for inserting the conductor to the full depth of the lug. Cable insulation on power conductors shall be properly penciled and tapered where the conductors enter terminating devices.

3.06 POWER CABLE SPLICES 25 KV

A. 25 kV splices and taps shall be installed in accordance with manufacturer's instructions.

1. Splice locations are scheduled on the drawings and are to facilitate Contractor's installation of the cable. Splice locations, with approval, may be changed or deleted by the Contractor as long as the cable manufacturer's maximum pulling tensions are not exceeded.

2. Additional splices, at the Contractor's option, are permitted at no additional cost to the Owner, if required by the Contractor due to the Contractor's installation procedure or schedule.

3.07 CABLE SHIELDS 25 KV

A. Cable shields shall be connected to the appropriate ground bus in the handholes, manholes, and cable vaults and at equipment. All ends of cables shall have shields connected to ground. Cable ends shall have an appropriate shield adapter to collect and terminate the drain wires at terminations and splices.

3.08 POWER CABLE 25 KV SUPPORTS

A. Provide conductor support device assemblies as shown on the Contract Drawings.

B. Cable entering equipment shall be securely clamped or secured inside the equipment. Cable supports shall be installed in the equipment for supporting the incoming cable from the point of entrance to the point of termination.

C. Attach cables and splices to support assemblies by using nylon cable ties, Panduit EH, PLT locking type, 250 pound loop tensile strength rating.

3.09 CABLE IDENTIFICATION

A. Power cables shall be identified at each manhole entry/exit point and in cable vault below Substations with an engraved cable identification tag showing the Cable destination, voltage, year of installation, circuit designation and phase identification for each cable. Use plastic tie wraps to attach identification tags.

3.10 TESTS

A. Perform all tests in accordance with the requirements of Section 16106. Test cable prior to energizing cable or putting cable into service. In addition, test all wiring connections for continuity and ground before loads are reconnected. If tests indicate faulty or defective insulation, the defective cables shall be repaired or replaced and the tests conducted again.

3.12 POWER CABLE 25 KV PHASE MARKING/PHASE ROTATION

A. The phase conductors for the 25 kV distribution system shall be identified at all handholes, manholes, cable vaults and equipment, switches, and transformers, using the indicated cable identification tags.

B. The cable shall be terminated at switchgear and equipment with phase sequence A-B-C left to right when viewed from the front of the equipment.

1. Phase sequence and rotation for the 25 kV distribution shall be established at the Main Terminal Substation Main Switchgear and shall be maintained throughout the project.

    a. The same phase identification, sequence and rotation, shall be maintained throughout the project to assure that the same phase sequence and rotation is maintained when loads are transferred from one switchgear line up, feeder, or from one Southern California Edison feeder to another, and to allow for future paralleling of feeders.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16121

MEDIUM-VOLTAGE BUSWAY

PART 1 - GENERAL

1.01 WORK INCLUDED

A. 5kV, metal enclosed busway for crane substations.

B. Provide a complete prefabricated, low-impedance busway distribution system as shown on the drawings with all necessary termination components, fittings, support devices and accessories.

C. The medium-voltage busway shall be UL listed and labeled.

1.02 RELATED WORK

A. Section 16106 – Acceptance Testing

B. Section 16443 – Crane Substation Assemblies

1.03 QUALITY ASSURANCE

A. Like items of equipment provided hereunder shall be the end product of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer’s services.

1.04 SUBMITTALS

A. Provide following submittals prior to construction.

1. Manufacturer’s product data on busway supports, and other components.

2. Manufacturer’s shop drawings indicating dimensioned busway layout with all components identified by catalog numbers. Indicate conformance with utility requirements where applicable.

3. The drawings shall be certified for installation in Seismic Zone 4.

4. Three copies of certified factory test reports.

1.05 REFERENCES

A. The busway shall be designed, manufactured and tested in accordance with NEMA, UL 857, IEEE and ANSI standards.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square – D or approved equal

2.02 SERVICE CONDITIONS

A. Suitable for outdoor service with following conditions:

1. Maximum elevation above sea level: 50 feet
2. Maximum ambient air temperature: 44 degree C
3. Minimum ambient air temperature: 0 degree C
4. Seismic Zone: 4
5. Maximum Wind: 80 mph
6. Relative humidity: 95%

2.03 RATINGS

A. Voltage: 4160V, three-phase, three-wire with ground bus.

B. Current Rating: as shown on the drawings.

C. Short Circuit Withstand Rating:

i. Momentary 132 kA Peak.

ii. Short Time 49 kA symmetrical, 3 second.

D. Basic Impulse Level (BIL): 60 kV

2.04 HOUSING

A. Busway shall be totally enclosed over the entire length.

B. Housing shall be of fabricated, galvanized sheet steel to provide protection against corrosion from water and other contaminates.

C. The outdoor busway shall be UL listed for outdoor use. All weatherizing of busway, busway joints and joint covers shall be done at factory prior to shipment. No field caulking or sealing shall be required by the Contractor.

D. All hardware shall be plated to prevent corrosion.

E. Welds shall be closely spaced along both sides of the full length of the busway to insure that the conductor insulation is held in continuous contact with the housing.

F. Steel drivers between housing sides shall brace housing and bus bars.

G. Busway shall be finished in ANSI 61 Gray Enamel.

2.05 JOINTS

A. The busway joints shall be of the one-bolt type. The busway joint design shall permit safe, practical testing of joints for tightness without de-energizing the run. This operation must be possible without exposing maintenance personnel to any electrical hazard and without downtime of the busway or the equipment it feeds.

B. Access shall be required to only one side of the busway for tightening joint bolts.

C. It shall be possible to remove any one length in a run without disturbing adjacent lengths.

D. Joints shall utilize Belleville washers to maintain positive pressure.

E. All joints shall be furnished with torque indicating means to ensure proper installation.

F. Provide flexible joints, where shown on the drawings, to prevent vibration from one equipment to be transmitted to the other connected equipment through busway.

2.06 BUSBARS

A. Busbars shall be copper and shall be silver or tin plated at all joints and contact surfaces, insulated over entire length. Insulation material applied by an automated fluidized bed process.

B. The maximum hot-spot temperature rise at any point in the busway at continuous rated load shall not exceed 65 degrees C above a maximum ambient temperature of 40 degrees C in any mounting position.

C. Provide busway with internal ground bus conforming with the larger of UL 891 or 30% of busway rating for minimum size except larger as required by Code for grounding neutral conductor.

D. Provide an external 2-hole ground pad at each end for ground connection or connect the ground bus in the enclosure to the ground bus in the terminal equipment, as applicable.

2.07 BUSWAY SUPPORT

A. Outdoor busways shall be designed to be supported from below by structural steel. The support system shall be designed and provided by the Contractor, to meet the requirements of Seismic Zone 4.

2.08 WEATHERPROOF BUSWAY

A. The outdoor type busway shall be enclosed in a weatherproof housing. The manufacturer shall warrant the entire busway installation for a period of 3 years from the shipping date.

2.09 FACTORY TESTS

A. Perform all standard factory tests as required by ANSI, and NEMA Standards.

PART 3 - EXECUTION

3.01 RESPONSIBILITY FOR ROUTING AND MEASUREMENT

A. Responsibility for routing and measurement is entirely the Contractor’s.

B. Coordinate busway routing to clear work of other trades.

C. Make final field measurements prior to release of busway for fabrication to assure measurements and coordination.

3.02 BUSWAY

A. Install parallel to floors. Horizontal and vertical offsets shall be made with manufactured fittings.

B. Prior to on site assembly busway shall be stored indoors in a dust and moisture free environment.

C. Provide necessary support system for specified service condition, whether specifically shown on drawings or not.

3.03 FIELD TESTS

A. Perform visual, mechanical inspection and electrical tests per Section 16106 "Acceptance Testing."

3.04 TRAINING

A. Provide the services of a factory trained Field Engineer for training at the jobsite on adjusting, servicing and maintaining the equipment and components. The Field Engineer shall be on site for one-half working day for all busways system.

3.05 MANUFACTURER'S STARTUP SERVICES

A. Provide the services of a qualified factory-trained Field Engineer for a period of one-half working day for each busway system. The Field Engineer shall certify that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

PART 4 - MEASUREMENT AND PAYMENT

No separate measurement and payment will be made for medium voltage busway as described within this section. The cost of this work shall be considered incidental to and included in the lump sum cost of "Crane Substations 1 & 2".

END OF SECTION

SECTION 16122

CRANE COLLECTOR SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Furnish and install a complete, functional, and operational crane bus collector (conductor bar) system, including all hangars, hanger clamps, insulators, bus covers, connectors, expansion joints, and other accessories, in accordance with the drawings and these specifications.

1.02 RELATED WORK

A. Section 16120 – Wires and Cables

B. Section 16450 – Grounding

1.03 QUALITY ASSURANCE

A. The crane collector bar system shall conform to the current standards of the Institute of Electrical and Electronic Engineers (IEEE), National Electrical Code (NEC), and the Underwriter's Laboratories (UL) or another nationally recognized testing laboratory, where applicable.

1.04 SUBMITTALS

A. The Contractor shall submit shop and installation drawings, prepared by the Bus Bar System manufacturer, to the Engineer for approval, before fabrication. The drawings shall show the location of the brackets, expansion joints, anchor points, power feed connection points, and any other relevant details.

B. Shop drawings shall include the manufacturer's calculated DC resistance of the bus bars and the calculated AC impedance for the three-phase AC system.

C. The Bus Bar System manufacturer shall submit, via the Contractor, a certificate of testing that is acceptable to the inspection authority. The certificate shall state that the proposed Bus Bar System:

1. Has been tested by a nationally recognized testing laboratory, and

2. Is acceptable for the application that is described in the drawings and in these specifications.

PART 2 - PRODUCTS

2.01 SYSTEM

A. The crane collector system shall constitute one continuous, three-phase, AC conductor system. It shall be rated at 4160 volts and 1500 amps (continuous).

B. The Contractor shall provide all bus bars, connectors, insulators, and other components necessary to install the length of crane collector system that is shown on the drawings.

C. The Contractor shall procure the additional components for the length shown on the drawings as "Future Crane Collector." These components shall be packaged so as to be protected from damage and placed in a 8' x 8' x 40' on-site storage container provided by the City.

D. The crane collector system shall be of the design and manufacture of the Insul-8 Corporation's Hevi-Bar System, or the Engineer's approved equal.

2.02 CONDUCTORS

A. The conductors shall be 2-piece composite sections of 6101-T6 aluminum alloy conductor body and type 304 stainless steel finish contact surface assembled in the manufacturer's plant. The assembled conductors shall be supplied in 30-foot lengths.

B. The stainless steel contact cap shall be mechanically attached to the aluminum body by swaging and knurling. The mating surfaces between the aluminum body and the stainless steel contact cap shall be coated with suitable aluminum anti-corrosion compound that shall withstand the conductor operating temperature.

C. The conductor current carrying body shall be an aluminum alloy 6101-T6 with a minimum volume conductivity of 55 percent IACS at 20 degree C (68 degree F) per ASTM B 317-95.

D. The assembled conductors shall be rated for 1500 amperes continuous, with no more than 60 degree C rise over a 40 degree C ambient temperature.

E. The stainless steel current pickup surface of the conductor shall have a minimum thickness of 0.06 inches (ga. 16), inverted "V" and suitable for the engagement of current collectors.

F. The conductor shall have the capacity of sustaining a 300 percent overload for an intermittent period, based on one (1) minute duration.

G. The conductor shall have a DC resistance of not more than 0.00000667 ohms/ft at 20 degree C or not more than 0.0000071 ohms/ft at 40 degree C.

H. The conductor three-phase impedance shall have not more than 0.000030 ohms/ft at 6 inches center-to-center distance between conductors, 40 degree C ambient temperature, 60 Hz, and at 0.9 power factor.

I. The conductors shall be designed to be joined end-to-end by incorporating aluminum splice plates and utilizing stainless steel hardware.

J. The conductor rails shall be field-joined with through-bolts to the splice plates sandwiching the web of the conductor and thereby providing a positive and rigid splice joint, using double Belleville washers at each bolt.

K. The temperature rise of the splice assembly shall not be more than 2 degree C above the conductor bar temperature at its operating capacity.

2.03 <u>CONDUCTOR COVERS</u>

A. The conductors shall be enclosed on three sides with extruded suitable insulating cover installed on the conductor at the factory. One side of the conductor cover shall have an opening so that the conductor stainless steel Vee contact cap shall be accessible to high voltage current collector shoes.

B. The minimum thickness of the cover shall be calculated based on the dielectric strength of insulating cover material to withstand 95 kV BIL.

C. The opening width of conductor cover shall be more than 5/16-inch wide and at least 1-9/16-inch from the live surface of the conductor.

D. Splices and conductor ends shall have covers formed from the same material as the conductor cover.

2.04 <u>INSULATORS</u>

A. Conductors shall be supported by 7.5 kV porcelain insulators compounded from non-track materials and suitable to outdoor marine locations.

2.05 <u>HANGER AND HANGER CLAMPS</u>

A. Hanger and hanger clamps shall be the bus system manufacturer’s standard product designed to support the bus system. Hangers shall be of the type noted on the Drawings.

B. Hanger clamps from the insulators to the conductors shall be of pressed stainless steel of suitable gage to maintain its formed profile and as approved by the Engineer.

C. Hangers shall be designed to securely hold the conductor bus and allow it to float when the bus expands and contracts longitudinally due to load current and change of ambient temperature.

2.06 EXPANSION SECTIONS AND ANCHORS

A. The expansion section is designed to accommodate the thermal expansion and contraction of conductor bus due to the change of ambient temperature, heat rise of the conductor created by the electrical load and wharf structural movement.

B. The Contractor shall provide expansion sections as shown in the drawing and where the system design may require.

C. The expansion sections shall be mounted centrally between insulated hanger clamps, in staggered installation, shall be of low-profile type, and with extremely high flexible jumper wire rated not less than 8 kV.

D. The expansion sections shall be provided to cater to the structural joints, as shown on the Drawings and for expansion within the bus system itself.

E. The Contractor shall provide anchor points to delineate the conductor bus lengths suitable for the expansion section stroke capacity and recommended by the bus manufacturer.

2.07 POWER FEED CONNECTORS

A. The power feed connectors shall establish a solid electrical connection, with minimum resistance, between the conductor bar and the feed cables. The connectors shall be capable of receiving and attaching a set of three 750 kcmil cables per phase.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The installation of the system shall be under the supervision of the conductor bar manufacturer’s representative.

B. The Contractor shall install the insulated hanger brackets by welding to the trench frame angles as shown on the Drawings.

C. The conductor busbars shall be installed longitudinally straight with maximum deviation of plus or minus 1/8-inch with no offset change in alignment exceeding 1/8-inch in 10 feet.

D. During the field joining of the conductor busbars, the splice plate surfaces interfacing with the conductor ends shall be cleaned thoroughly with steel brushes. Special No-Oxide grease shall then be immediately applied and abraded, to preclude oxidation of the mating surfaces, thereby minimizing if not eliminating the surface contact resistance.

E. In each construction phase, the Contractor shall arrange the work to make the tie-in with only one-day shutdown of the "hot" bus system. The Engineer shall approve the date of the shutdown and tie-in.

F. Prior to tie-in, the Contractor shall validate the newly installed bus system by impedance measurement and isolation dielectric characteristic measurements performed in accordance with the procedures approved by the Engineer.

G. Prior to tie-in to the existing bus, the Contractor shall verify the phases of each bus to insure that they match.

3.02 STORAGE

A. The Port will provide an 8' wide by 8' high by 40' long shipping container on-site for storage of the 1300 LF of Crane Collector System, mounting brackets and other hardware to be installed at a later date. The Contractor shall be responsible for placing this material in the container including any blocking required to protect all parts for future use.

B. This material shall not be delivered to the site until two weeks prior to completion of the project. The Contractor will be responsible for storing and protecting these materials until acceptance by the City.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. "Furnish and Install Crane Collector System" will be measured as a unit at the Contract lump sum price stated in the Schedule of Prices.

B. "Furnish Crane Collector System" will be measured as a unit at the Contract lump sum price stated in the Schedule of Prices.

4.02 PAYMENT

A. Payment for "Furnish & Install Crane Collector System" will be made at the Contract lump sum price as stated in the Schedule of Prices and will be full compensation for furnishing all labor, equipment, materials and incidentals required to supply, install and test 3700 LF of Crane Collector System as specified.

B. Payment for "Furnish Crane Collector System" will be made at the Contract lump sum price as stated in the Schedule of Prices and will be full compensation for furnishing all labor, equipment, materials and incidentals required to supply, deliver and place into storage 1300 LF of Crane Collector System including all mounting brackets and other hardware necessary for a complete system as specified.

END OF SECTION

SECTION 16123

CRANE CONDUCTOR BUS

PART 1 - GENERAL

1.01 SCOPE

A. Crane conductor bus consists of furnishing transportation, labor, materials, and equipment to furnish and install the crane conductor bus system.

B. Provide services of manufacturer’s representative to direct the installation.

1.02 SUBMITTALS

A. Submit for the Engineer’s approval before fabrication, shop and installation drawings prepared by bus manufacturer.

B. Shop drawings shall include manufacturer-calculated DC impedance for each bus and the calculated AC impedance for the 3-phase system.

C. Should deviation from the shop drawing and installation drawings occur during the fabrication and installation, modify drawings to as-built condition and resubmit for Engineer’s review within 5 days.

1.03 PRODUCTS

A. System

1. The crane conductor bus system shall be Insul-8, Hevi-Bar type or equal, and shall be of the manufacturer’s standard design.

2. The systems shall constitute one continuous 3-phase AC, 1500A conductor bus, for the length shown on Drawings, and mechanically shielded by insulated covers for safety.

3. The system shall be furnished complete with power feed sections, expansion sections, removable sections, splice covers, insulating conductor covers, hanger clamps and insulators, and hanger brackets.

B. Conductors

1. Conductors shall be 2-piece composite sections of 6101-T6 aluminum alloy and Type 304 stainless steel assembled in the manufacturer's plant.

2. Connect aluminum and stainless steel by swaging and knurling.

3. Conductivity shall be at least 52 percent of the IACS standard conductor.

4. Conductors shall be rated for the amperage listed at a 30 degree rise over a 40 degree C ambient temperature.

5. The stainless steel current pickup surface of the conductor shall have a minimum thickness of 1/16-inch in an inverted "V".

6. Conductor shall have thermal capacity capable of sustaining a 300 percent overload for an intermittent period, based on a 2 minute interval.

7. Conductors shall have a DC resistance of not more than 0.000010 ohms per foot, measured at 40 degrees C.

8. Bolt splices using double Bellville washers at each bolt.

C. Conductor Covers

1. Enclose conductors in an extruded PVC cover, Goodrich Chemical Compound No. 8700-A, factory-installed on the conductor.

2. Minimum thickness of the cover shall be 3/32-inch.

3. Slot width in the cover for the bus conductor rail contact shall not be more than 5/16-inch wide and shall be at least 1-1/2 inch from the live surface of the conductor.

4. Splices and bar ends shall have covers formed from the same PVC material as the conductor cover. Covers shall be 27 inches long.

D. Insulators

1. Conductor shall be supported by 7.5 kV porcelain insulator compounded from non-track materials and approved for outdoor marine locations.

E. Hanger and Hanger Clamps

1. Hanger and hanger clamps shall be bus system manufacturer's standard product designed to support the bus system. Hangers shall be of the type noted on the Drawings.

2. Hangers from insulators to conductors shall be of pressed stainless steel, coated with fused epoxy compound approved by the Engineer.

3. Hangers shall be designed to permit conductors to float.

F. Expansion Sections and Anchors

1. Provide provision for expansion as shown and where design may require. Mount expansion section with expansion fitting centrally located between hanger clamps for a staggered installation, and shall be low-profile type, with high flex wire rated at 8 kV.

2. Expansion provided shall be adequate for the structural joints, as shown on Drawings, and for expansion within the bus system itself.

3. Provide anchors as shown and as recommended by manufacturer.

G. Removable Sections

1. Removable sections shall be provided as shown on the Drawings and where required.

1.04 <u>INSTALLATION</u>

A. Furnish and install system including incidentals and fastening devices necessary for a complete and operational system.

B. Install hanger angles by welding to trench frame angles as shown on the Drawing.

C. Install bars straight with maximum deviation in alignment of plus or minus 1/8-inch with no offset change in alignment exceeding 1/8-inch in 10 feet.

D. Join conductors end to end by bolted connection with each bolt torqued to 12 foot-pounds unless otherwise directed by the manufacturer. In each phase of construction the system shall constitute, upon completion, one continuous 3-conductor system.

E. Install the system under supervision of conductor bar manufacturer's representative.

F. Tighten anchor point hardware to provide fixity as directed by the manufacturer. Adjust hanger clamps to tight sliding fit to allow for expansion.

G. Install expansion sections and anchors as directed by the crane bus manufacturer.

1.05 FIELD TESTING

A. The insulation of each conductor bar shall be measured to ground and to the other two phases using a 2,500 volt megger. The results shall be recorded on test forms which shall include signature of tester, date, weather conditions, temperature and relative humidity. The completed test forms shall be submitted to the Engineer.

B. The Contractor shall provide power for testing.

END OF SECTION

SECTION 16131

JUNCTION AND PULLBOXES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all pullboxes, junction boxes, and terminal boxes to permit pulling and installation of terminal blocks when required, according to these specifications, whether specifically shown on the drawings or not.

1.02 RELATED WORK

A. Section 16190 - Supporting Devices

B. Section 16110 - Raceways

1.03 SUBMITTALS

A. Submit product data for each item specified in accordance with Section 16050.

1.04 QUALITY ASSURANCE

A. Junction boxes and pullboxes shall be listed by Underwriters Laboratories (UL) for the purpose intended.

B. Codes and Standards: Comply with the provisions of (NEMA) National Electrical Manufacturers Association.

PART 2 - PRODUCTS

2.01 JUNCTION BOXES AND PULLBOXES:

A. NEMA 4X Boxes: Fiberglass, Gasketed, Corrosion resistant.

PART 3 EXECUTION

3.01 INSTALLATION

A. Size junction or pullboxes to meet the requirements of the National Electrical Code (NEC), except where indicated to be larger.

B. Outdoor, exposed to weather: Use NEMA 3R finish boxes, see Section 16470.

PART 4 – MEASUREMENT AND PAYMENT

Measurement and payment for each junction box installed will be included with the Bid Item under which the component(s) served by that junction box were installed.

END OF SECTION

SECTION 16170

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Grounding electrodes and conductors.

B. Ground wells.

C. Equipment grounding conductors.

D. Bonding.

1.02 APPLICABLE PUBLICATIONS

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. American National Standards Institute (ANSI) Publication:

1. C2-97 National Electrical Safety Code

B. Institute of Electrical and Electronic Engineers (IEEE) Publication:

1. 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems

C. National Fire Protection Association (NFPA) Publication:

1. 70-96 National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (U.L.) Publication:

1. 467-84 (R86) Grounding and Bonding

1.03 GROUNDING ELECTRODE SYSTEM

A. Rod electrodes.

B. Building Steel.

1.04 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: Less than or equal to 2 ohms unless otherwise indicated. If this resistance is not obtained then additional ground rods and retest until the resistance is below 2 ohms, at no additional cost to the city.

1.05 SUBMITTALS

A. Submit under provisions of Sections 01300 and 16010.

B. Product Data: Provide data for the following:

1. Grounding electrodes

2. Precast ground wells

3. Conductors

4. Connections (all types)

C. Test Reports: Indicate overall resistance to ground and resistance of each exposed electrode.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01720.

B. Accurately record actual locations of grounding electrodes.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

1.08 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to Owners as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated. Except where specifically indicated otherwise, provide only new materials having all legally required approvals and/or labels. Materials shall conform to the requirements of UL 467 where applicable.

2.02 ROD ELECTRODE

A. Material: Copper clad.

B. Diameter: 3/4 inch, unless otherwise indicated.

C. Length: 10 feet, unless otherwise indicated.

2.03 CONDUCTOR

A. Ground and bonding conductors shall be soft-drawn stranded copper conductors, unless otherwise indicated, installed with sufficient slack to avoid breaking due to settlement and movement of conductors or attached points.

B. System grounding conductors shall be minimum of 4/0 AWG copper, unless otherwise indicated, and shall be continuous with no joints or splices.

2.04 PRE-CAST GROUND WELL

A. Provide as indicated on the drawings.

B. Provide with cover labeled "GROUNDING ELECTRODE."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

Provide complete grounding system including ground cables and wires, ground rods and all connections for equipment grounding. Provide grounding and bonding in accordance with the requirements of NFPA 70, IEEE 142, state and local codes, and to requirements specified herein. Codes shall be complied with as a minimum requirement with specifications prevailing when they are more stringent.

A. Grounding Electrode System:

1. Install rod electrodes at locations indicated. Install additional rod electrodes as

required to achieve specified resistance to ground.

2. Where indicated, the point of connection of the ground conductor to the grounding electrode shall be mechanically protected in a concrete box with a removal cast iron cover plate marked: "Grounding Electrode" and shall be visible for inspection. Provide crushed rock in the bottom of the box - 18" in depth.

3. Grounding connections which are buried or otherwise normally inaccessible, and excepting specifically those connections for which periodic testing is required, shall be made by exothermic type process weld (Cadweld, Thermoweld or equal). Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which have "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable.

4. Transformers, emergency systems, and other isolated system neutrals shall be grounded from the neutral bushing or connector to a continuous metallic cold water main or to building steel where available and solidly grounded to ground electrode.

B. Bonding

1. Metallic conduits, wireways, metal enclosures of busways, cable boxes, electrical equipment housings, cable racks in manholes and all non-current carrying metallic parts shall be grounded. The metallic conduit system shall be used for equipment and enclosure grounding but not as a system ground conductor. Include a code sized green insulated copper grounding conductor in nonmetallic conduits and terminate each end on suitable lug, bus, or bushing.

2. All conduit stub-ups shall be grounded and where multiple stub-ups are made within an equipment enclosure, such as a switchboard, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.

3. Bond together each metallic raceway, pipe, duct and other metal object entering the new buildings. Use 2 AWG bare copper conductor.

C. Equipment Ground

1. In addition to the equipment ground conductors shown on the drawings, all feeder runs and branch circuit wiring in nonmetallic conduit shall carry a green TW insulated code sized ground conductor per circuit properly connected for electrical ground continuity.

2. Flexible conduit shall not be used as a ground path. Include code sized green conductor in all flex conduit.

3. Provide bonding devices, fittings or jumpers at expansion fitting, isolation sections or wherever continuity of ground is broken.

3.03 FIELD TESTS

Refer to Section 16030, "Acceptance Testing" for additional requirements. As an exception to requirements that may be stated elsewhere in the contract, the Engineer shall be given 5 working days notice prior to each test. The Contractor shall provide all test equipment and personnel and submit written copies of all test results.

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Measure resistance to ground of the grounding system before connecting equipment per the requirements of Section 16030.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16180

EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Electrical connections to equipment specified under other sections.

B. Examine Contract Drawings and other Divisions of these Specifications to ascertain the extent of powered equipment covered by the Drawings and Specifications and the methods by which each item of equipment will be furnished, delivered to the site, and installed and the amount of electrical work required for each item of powered equipment.

1.02 APPLICABLE PUBLICATIONS:

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. National Electrical Manufacturers Association (NEMA) Publications:

1. WD 1-83 General Purpose Wiring Devices

2. WD 6 Wiring Device Configurations

B. National Fire Protection Association (NFPA) Publication:

1. 70-96 National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit under provisions of Sections 01300 and 16010.

B. Submit layout shop drawings only for areas with deviations from design drawings.

C. Powered equipment suppliers shall furnish, in addition to the manufacturer's data specified in other Sections, the following:

1. Wiring diagrams.

2. Operating Sequences.

3. Installation layouts.

4. Electrical load, voltage and phase data.

5. UL Listing.

1.04 GENERAL REQUIREMENTS

A. Flexible conduit may be used for lab, shop and similar fixed connections to equipment from adjacent outlets.

B. Provide the products, and execute the work for this Section in accordance with the product and execution requirements, where applicable, as set forth in the other Sections of Division 16, to provide a complete electrical system.

1.05 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Products provided shall be listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.06 COORDINATION

A. Coordinate work under provisions of Section 01040.

B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

C. Determine connection locations and requirements.

D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

E. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.07 ELECTRICAL WORK FOR POWERED EQUIPMENT

A. Disconnect switches in general shall be furnished and installed as electrical work where indicated or required, except where integrally mounted on "package units" provided by other trades.

B. Provide all starters, combination and magnetic, in motor control centers and individually located, except "chiller" starters and starters in "package units". Starters for three phase equipment shall be combination type. Magnetic starters shall be used for all single phase equipment requiring remote control.

C. Provide manual starters for 120 volt single phase motors except starters supplied with package units.

D. Provide all power wiring to all powered equipment installed on this project and included in any section of the Contract Specifications, except as specified in Division 15. Power wiring shall be defined as conductors, conduit, enclosures and connections and related electrical work to supply powered equipment and including electrical power to supply point for powered equipment control systems.

E. Do not order motor controllers or motor control centers until requirements for auxiliary contacts and final motor sizes are verified.

1.08 <u>SUBSTITUTIONS</u>:

When powered equipment other than that originally specified or indicated is approved for use at the Contractor's request, then the Contractor shall be responsible for any costs incurred by other trades, including revisions to the electrical work such as electrical power supply, wiring, disconnects, circuit breakers, etc.

PART 2 - PRODUCTS

2.01 <u>CORDS AND CAPS</u>

A. Attachment Plug Construction: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

C. Cord Construction: ANSI/NFPA 70, Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.01 <u>EXAMINATION</u>

A. Coordinate electrical connections to equipment with other trades under provisions of Section 16010.

B. Verify conditions under provisions of Section 01040.

C. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using liquidtight flexible conduit with watertight connectors.

C. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Install disconnect switches, controllers, control stations, and control devices as indicated.

G. Modify equipment control wiring with terminal block jumpers as indicated.

H. Provide interconnecting conduit and wiring between devices and equipment where indicated.

3.03 EQUIPMENT SCHEDULES:

Refer to Architectural, Mechanical and Plumbing drawings for equipment schedules. Provide all power wiring to all powered equipment installed on the construction project and included in any section of the Specifications.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Conduit Supports

1.02 RELATED WORK

A. Section 16104 – Manholes

B. Section 16110 – Raceways

C. Section 16120 – Wires and Cables

1.03 QUALITY ASSURANCE

A. Framing channel system shall be UL approved for installation of conductors.

B. Codes and Standards: Comply with the provisions of the following codes, standards, and specifications for manufacture and testing, except where more stringent requirements are shown or specified:

1. NEMA (National Electrical Manufacturers Association)

2. ANSI (American National Standards Institute)

3. UL (Underwriters Laboratory)

C. Provide supports bearing a UL Label.

1.04 SUBMITTALS

Submit product data for each item specified in accordance with Section 16050.

PART 2 - PRODUCTS

2.01 RACEWAY SUPPORTS

A. Conduit Clamps: One hole, cadmium plated or galvanized heavy gauge steel, or galvanized malleable iron.

B. Channels, Fittings, Hangers, Clamps and Accessories: Hot dipped galvanized, or electrogalvanized and zinc chromate coated steel. Channels shall be 14 gauge minimum, 13/16 inch or 1-5/8 inch deep by 1-5/8 inch wide minimum by the following manufacturer:

1. Midland Ross "Kindorf"

2. Midland Ross "Superstrut A-1200"

3. Unistrut

C. Single Runs: Galvanized conduit straps or ring bolt type hangers. Above suspended ceilings use spring clips. Do not use plumbers perforated straps.

2.02 ANCHOR METHODS

A. Provide anchors with sufficient strength to support four times the load.

B. Metal Surfaces: Machine screws, bolts, or welded studs.

C. Concrete Surfaces: Expansion anchors. Powder driven studs shall not be used.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Layout to provide a headroom, neat mechanical appearance, and to support equipment loads.

B. Provide supports at intervals to meet the requirements of the National Electrical Code and the manufacturer' s loading recommendations.

PART 4 - MEASUREMENT AND PAYMENT

Measurement and payment for each supporting device installed will be included with the Bid Item under which the component(s) supported by that device were installed.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Nameplates and labels.

B. Wire and cable markers.

C. Medium voltage cable tags.

D. Underground warning tape.

E. Conduit markers.

F. Warning Signs.

1.02 APPLICABLE PUBLICATIONS

The following publications form a part of this specification. The publications are referred to in the text by the basic designation only.

A. American National Standards Institute, Inc. (ANSI) Publications:

1. C2-96 National Electrical Safety Code

2. Z35.1-72 Accident Prevention Signs

B. State of California Administrative Code:

1. Title 8, Industrial Relations

2. Title 24, Part 3, CCR, 1998 California Electrical Code

C. National Fire Protection Association (NFPA) Publication:

1. 70-99 National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit under provisions of Sections 01300 and 16010.

B. Product Data: Provide data for:

1. Nameplates
2. Wire/Cable markers
3. Medium voltage cable tags
4. Underground warning tape
5. Conduit markers

C. Field Samples: Provide for:

1. Nameplates: (1) sample
2. Wire/Cable markers: (1) sample
3. Medium voltage cable tags: (1) sample
4. Underground warning tape: (1) sample, 24" long
5. Conduit markers: (1) sample

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

PART 2 - PRODUCTS

2.01 NAMEPLATES

A. Nameplate designations shall clearly state:

1. Manufacturer's nameplate including equipment design rating of current, voltage, KVA, HP, bus bracing rating, or as applicable.
2. Equipment nameplate designating system usage and purpose, system nominal voltage, equipment rating for KVA, amperes, HP and RPM as applicable. Panel designation and circuit number. I.D. of equipment (per mechanical drawings designation) they feed.
3. Contactors: Voltage, continuous current, horsepower or interrupting current, and whether "mechanically-held" or "electrically-held". Panel designation and circuit number. I.D. of load or equipment (per mechanical drawings designation) they feed.

4. Motors: Rated voltage, full load amperes, frequency, phases, speed, horsepower, code letter rating, time rating, type of winding, class and temperature. I.D. of motors per mechanical drawings designation.

5. Controllers: Voltage, current, horsepower, and trip setting of motor running overcurrent protection. Panel designation and circuit number. I.D. of load or equipment (per mechanical drawings designation) they feed.

6. Distributionboards / Panelboards: Distributionboards / Panel I.D. per electrical drawings, I.D. of feeder distributionboard & circuit number and all branch circuit load description.

7. Receptacles and lighting switches (wiring devices): Panel designation and circuit number.

B. Nameplates shall be melamine plastic, 0.125-inch thick, black with white center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering into the black core. Minimum size of nameplates shall be 1.0 inch by 2.5 inches except that wiring device nameplates shall be 0.5 inch by 1.5 inch. Lettering shall be normal block style unless otherwise noted.

C. Letter Size:

1. Use 0.25 inch letters for identifying individual equipment and loads.

2. Use 0.50 inch for identifying grouped equipment and loads.

2.02 WIRE MARKERS

A. Description: Heat shrinkable, flame-retarded, crosslinked polyolefin wire marker. Wire tags shall have a dielectric strength of 500 V/mil minimum and a temperature range from -30°C to 105°C. Thermoplastic or wraparound tags are not acceptable. All tags shall be printed using a 9 or 24 pin dot matrix printer. Raychem ShrinkMark™, Brady Permasleeve or approved equal.

B. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

2. Control Circuits: Control wire number indicated on schematic or interconnection diagrams on shop drawings.

2.03 UNDERGROUND WARNING TAPE

The tape shall be 6" wide x 0.004" polyethelene plastic with a metallic core detection tape. The tape shall be of a bright color contrast with soil, with identifying printing on one side. The imprint shall read "Caution (type of utility) Line Buried Below". The identifying lettering shall be repeated continuously the full length of the tape. Refer to Section 02795, DETECTION TAPE.

2.04 CONDUIT MARKERS

A. ANSI Z35.1 G.2.

B. Pressure-sensitive, adhesive-backed vinyl markers with fade-proof ultraviolet inhibitors, black characters on orange background. 2.25" x 9" marker with 1.5" high letters. Marker shall read "4160 VOLTS" depending on circuit phase-to-phase voltage. Carlton Industries type EM-1, Seton Code Electrical Markers style AA, Brady B-500 series or approved equal.

C. Provide 12”x12”x6” thick concrete marker with “Conduits Buried Below” engraved on the visible surface. Top of marker shall be at finished grade. Marker shall be placed directly above the stub end of all stubbed out buried conduits. If conduits are grouped less than 1’ from center to center, a single marker may be used.

2.05 MV CABLE TAGS

A. Identification tags shall be engraved laminated plastic connected to the cable by means of self-locking cable ties. Tags shall contain the following information:

1. Feeder Number (i.e. F1A-T13)

2. Cable start point.

3. Cable destination.

4. Cable quantity, size, insulation and voltage.

5. Date installed (if new).

B. Cable tags shall be melamine plastic, 0.125-inch thick x 2.5" x 5.0", black with white center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering into the black core. Lettering shall be 0.25" high normal block style unless otherwise noted.

2.06 WARNING SIGNS

ANSI Z35.1.

A. Warning signs shall be minimum 18 gauge steel white porcelain enamel finish with red lettering. Lettering to read "DANGER - HIGH VOLTAGE" with "DANGER" in 1-1/2" letters and "HIGH VOLTAGE" in 1" letters. New warning signs shall be provided on door/gate or immediately above door of all electrical equipment rooms, vaults, closets or outdoor substations containing equipment energized above 150 volts to ground, except where such spaces are accessible from public areas.

B. Warning designations in 1" red letters shall be painted by stencil or pre-printed adhesive on each new pull box or cabinet stating "DANGER" and giving voltage of enclosed conductors such as "DANGER - 12,000 VOLTS", for all systems over 150 volts to ground.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

B. Coordinate installation of nameplates, markers and warning signs with the sequence of painting. Refer to Section 09900, "PAINTING."

3.02 NAMEPLATES

A. Provide laminated plastic nameplates for all electrical equipment and devices including, but not limited to, the following:

1. Enclosures for switchgear, medium voltage controllers, transformers, low voltage switchgear, distribution board, motor control centers, variable frequency drives, panels, panelboards, busway, pull boxes, junction boxes, cabinets and motors.

2. Enclosures for all separately enclosed devices including but not limited to disconnect switches, circuit breakers, contactors, time switches, control stations and relays.

3. All receptacles and lighting switches.

4. Special systems such as but not limited to telephone, warning and signal systems. Identification shall be at each equipment rack, terminal cabinet, control panel, annunciator, and pull box.

5. Devices mounted within and part of an equipment including circuit breakers, switches, control devices, control transformers, relays, indication devices and instruments.

B. Mounting: Provide number, location, and letter designation of nameplates as indicated. Install nameplate parallel to equipment lines. Fasten nameplates to enclosures with a minimum of two sheet-metal screws or two rivets. Fasten nameplates to device plates with suitable adhesive. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

3.03 WIRE MARKERS

Provide markers for each conductor at panelboard gutters, pull boxes, junction boxes, outlet boxes, and each load connection.

3.04 UNDERGROUND WARNING TAPE

Identifying tapes shall be buried in all utility line trenches. Each trench shall have one tape above the centerline of each duct. In non-paved areas, the tape shall be located approximately 8" below the final finish grade. In areas where paving is to be installed, the tape shall be placed in the trench 2 feet above utility or 6 inches below finish subgrade, which ever provides most separation between tape and utility.

3.05 CONDUIT MARKERS

Provide markers on all exposed conduit for circuits greater than 600 volts. Provide markers at lengths not greater than 20 feet on center.

3.06 MV CABLE TAGS

All new cables installed shall be identified at each end and at all accessible points in between (such as manholes, pull boxes, switchgear, etc.). Identify existing cables that are being re-routed or changed with new tags. Modification of existing tags shall not be acceptable.

3.07 WARNING SIGN MOUNTING

Signs shall be permanently mounted with cadmium plated steel screws or nickel-plated brass bolts.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16201

COORDINATION STUDY

PART 1 - GENERAL

1.01 SUMMARY

A. The electrical equipment manufacturer shall provide electrical power system studies for this project. The type and content of each study is specified in the following articles.

1.02 SUBMITTALS

A. Completed electrical power system studies shall be bound and submitted to POLB Project Manager.

PART 2 - PRODUCT (NOT USED)

PART 3 - EXECUTION

3.01 ELECTRICAL POWER SYSTEM STUDIES

A. Protective Device Time-Current Coordination Analysis

1. The time-current coordination analysis shall be performed with the aid of SKM computer software, and will include the determination of settings, ratings, or types for the overcurrent protective devices supplied.
2. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.
3. A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
4. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
5. The study shall include a separate, tabular computer print out containing the suggested
6. device settings of all adjustable over current protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.

7. A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
8. A discussion section which evaluates the degree of system protection and service continuity with over current devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

B. Significant deficiencies in protection and/or coordination shall be called to the attention of the POLB Project Manager and recommendations made for improvements as soon as they are identified.

END OF SECTION

SECTION 16320

POWER TRANSFORMERS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide crane substation transformers as specified herein and shown on the drawings.

1.02 RELATED WORK

A. Section 16106 – Acceptance Testing

B. Section 16443 – Crane Substation Assemblies

1.03 QUALITY ASSURANCE

A. Like items of equipment provided hereunder shall be the end product of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

1.04 SUBMITTALS

A. Submit product data for approval for transformer assemblies consisting of manufacturer's literature, catalog data, and installation and maintenance instructions. Product data shall include all mechanical features such as dimensions and appearances; and all electrical ratings associated with the assembly or component.

B. Followings shall be submitted as a minimum:

1. Descriptive information and drawings for equipment, material, devices furnished, and nameplate. Use device and equipment tag numbers that appear on Drawings.

2. Certified outline drawings showing general arrangement size, dimensions, capacity, and special features required, physical dimensions, and center of gravity (shipping and installed), both horizontal and vertical. Also show location of accessories, and indicate phase-to-phase and phase-to-ground dimensions.

3. Elementary (schematic) diagrams.

4. Interconnection and connection diagrams of terminal boards, panels, and control circuits.

5. Calculated values of impedance (reactance and resistance), no-load loss, load loss and efficiency.

6. Schematic (elementary) control diagrams, using NEMA device designations and symbols for electric circuit diagrams. Make content of schematic (elementary) connection or interconnection diagrams in accordance with latest edition of NEMA ICS 1-88.

   a. Manufacturer’s standardized elementary diagrams are not acceptable unless applicable portions of the diagram have been clearly identified and nonapplicable portions deleted or crossed out. Individual cut-sheets shall bear manufacturer’s name, trade name, or logo for identification purposes and items furnished shall be indicated or highlighted or unused items crossed out.

   b. Modify manufacturer’s standard drawings and schematic diagrams to include appropriate device, equipment, and circuit tag numbers.

7. Current transformer ratio correction factor and secondary excitation curves, polarity, nameplate, and connection diagrams.

8. Bill of Material, keyed to plan and section drawings.

9. Complete components parts list, including original manufacturer’s catalog numbers and prices.

C. Quality Control Submittals:

1. Manufacturer’s test reports.

2. Complete set of factory tests shipped with each piece of equipment.

3. Product data for impact recording system.

4. Operation and maintenance manuals.

5. Manufacturer’s Certificate of Proper Installation.

1.05 <u>REFERENCES</u>

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):

   a. B16.5, Slip-On Welding Flanges.

   b. C57.12.00-87, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

c. C57.12.90-87, Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers.

d. C57.12.10-88, Transformers.

e. C57.12.11-80, Guide for Installation of Oil-Immersed Transformers.

f. C57.92-81, Guide for Loading Mineral-Oil-Immersed Power Transformers.

g. C80.1, Standard Specifications for Rigid Steel Conduit.

h. 24-84, Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings. (IEEE C76.2)

i. 359-A-85, Standard Colors for Color Identification and Coding.

2. National Electrical Manufacturer's Association (NEMA):

a. TR-1, Transformers, Regulators, and Reactors.

b. TR-98, Loading Oil-Immersed Power Transformers with Average 65 degrees C Average Winding Rise.

c. ICS 1-88, General Standards for Industrial Control and Systems.

d. 250-91, Enclosures for Electrical Equipment (1,000 Volts Maximum).

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square – D or approved equal

2.02 SERVICE CONDITIONS

A. Suitable for outdoor service with following conditions:

1. Maximum elevation above sea level: 50 feet

2. Maximum ambient air temperature: 44 degree C

3. Minimum ambient air temperature: 0 degree C

4. Daily maximum average air temperature: 30 degree C

5. Seismic Zone: 4

6. Relative humidity: 95%

7. Maximum wind: 80 mph

2.03 TRANSFORMERS

A. The transformers shall be step-down type, 24.9 kV (high side) to 4160 v (low side), delta grounded wye, 12 MVA, OA/FA, three-phase, oil-immersed power transformer with no-load tap changer.

B. The transformer shall have following ratings:

1. Intended Use: To provide power to cranes.

2. Number of Phases: Three-phase.

3. Frequency: 60 Hz

4. Insulating Fluid: Mineral Oil.

5. Rating: 12 MVA / 13.44 MVA / 17.9 MVA OA/FA.

C. The transformer shall carry its continuous rating with average winding temperature rise by resistance, that shall not exceed 55 degree C, based on average ambient of 30 degree C over 24 hour with a maximum of 40 degree C. The insulation system shall allow an additional 12 percent KVA output at 65 degree C average winding temperature rise by resistance, on a continuous basis, without any decrease in normal transformer life.

D. High Voltage Windings:

1. Rated Voltage: 24.9 kV

2. Basic Insulation Level: 150 kV.

3. Delta Connected.

4. Full capacity rated taps with a manual tap changer for de-energized operation.

E. Low Voltage Windings

1. Rated Voltage: 4160 V

2. Basic Insulation Level: 75 kV

3. Wye connected, low resistance grounded.

F. Phase Relationship: High voltage shall lead low voltage by 30 degrees.

G. Impedance: At 65 degree C at rated voltage and self-cooled MVA rating: 7 percent.

H. Audible noise level when energized at maximum rating: 69 decibels (A) or less.

2.04 BUSHINGS

A. Design

1. HV Terminal: 25 kV Class.

2. LV Terminal: 5 kV Class.

3. Neutral Terminal: 5 kV Class with minimum Low Frequency Insulation Level of 19 kV RMS.

B. General

1. Bring winding leads out through bushings.

2. Bushings of Like Voltage: Interchangeable.

3. Design bushings so there will be no undue stresses on any parts due to temperature changes.

4. Adequate means to accommodate conductor expansion.

5. Standard spade type terminals on bushings.

6. Meet requirements of ANSI C57.12.00-87.

7. Color: ANSI 359-A-85, No. 70, light gray.

8. Furnish air terminal chamber for LV and neutral terminals. Terminals shall be suitable for bus duct connections.

9. Furnish air terminal chamber for HV terminals. Terminals shall be suitable for cable connection.

C. Locations

1. High Voltage Bushings: On transformer sidewall, Segment 4, in accordance with ANSI C57.12.10-88.

2. Low Voltage Bushings: On transformer sidewall, Segment 2, in accordance with ANSI C57.12.10-88.

3. Low Voltage Neutral Bushings: On transformer sidewall, Segment 2 along with LV Bushings.

D. Current Ratings.

1. Base on continuous line current at maximum specified MVA rating.

2. Sufficient excess capacity to permit transformer loading with “moderate sacrifice of life expectancy” as tabulated in NEMA TR-98 and ANSI C57.92.

2.05 COOLING

A. Oil-immersed, self-cooled/forced air-cooled (OA/FA).

B. Loading: Design to permit transformer loading with “moderate sacrifice of life expectancy” as tabulated in ANSI C57.92-81.

C. Fans, Radiators, and Controls:

1. Transformer Forced Cooling: Provide for automatically controlled and actuated by transformer winding temperature.

2. Energize cooling system from an independent electrical circuit.

3. Fans: Rated 240-volt, 60-Hz, single-phase.

4. Removable Radiators: Provide with the following:

a. Lifting eye on each radiator.

b. Isolating shutoff valves at top and bottom of each radiator to permit removal of radiator without interfering with operation of transformer.

c. Oiltight blank flanges properly gasketed, for shipment of tank without radiators attached and to make flanges available when a radiator needs to be removed in service.

d. Drain plug and vent plug in each radiator header.

e. No gasketed joints are allowed between valves and tank, so when valves are closed all gasketed joints are accessible for maintenance without requiring transformer tank be drained.

5. Control:

a. Weatherproof and suitable for outdoor operation at substation site.

b. Equip individual fan motors with weatherproof plugs and receptacles for ease in removal.

c. Enclose controls, fuses, and breakers for cooling equipment in one cabinet.

d. Selector Switch: Three-position switch with ON/OFF/AUTO positions for manual and automatic control of each stage of cooling.

e. Furnish fan motors with overload protection.

f. Furnish air circuit breakers with manual reset for each group of fans.

6. Fans shall have OSHA approved safety guards.

7. Magnetic Contactor:

a. Furnish for each group of fans.

b. Bring contactor coil leads to terminal blocks in control cabinet.

c. Each contactor shall have two auxiliary contacts that are independently reversible.

2.06 TRANSFORMER OIL

A. Pure mineral oil prepared and refined by fractional distillation of petroleum, especially for use in transformers, free from moisture, acid, alkali, polychlorinated biphenyls (PCB's), and injurious sulphur compounds.

B. Oil shall not form a deposit under normal operating temperatures.

C. Minimum Dielectric Strength: 30,000 volts between 1-inch discs spaced 1/10 inch apart.

2.07 WIRING AND TERMINAL CABINET FOR ACCESSORIES

A. Run wiring for relays, current transformers, temperature detectors, and other control and indication devices in rigid conduit to terminal blocks in a centrally located terminal cabinet mounted on transformer.

B. Cabinet:

1. NEMA 250, Type 3R (raintight), located on Segment 3 sidewall of transformer at a convenient height.

2. Include provision for locking and an ample-sized bottom plate for conduit entrance, which will be field drilled.

3. Label wires, terminal blocks, and devices and identify in accordance with schematic and wiring diagrams.

C. Terminal Blocks:

1. Screw type, and except for electrical conducting parts, fabricated from a thermosetting phenolic material that is unaffected by contact with transformer insulating oil.

2. Types of blocks that depend upon spring return of deformed metal to secure terminal leads are not acceptable.

3. Provide with bases and barriers molded integrally with brass inserts.

4. Rated for not less than 600 volts and accommodate up to No. 6 AWG wire.

5. Furnish marking strips for terminal designations.

6. Each block shall have one spare blank marking strip.

7. Furnish 20 percent spare terminals.

8. Equip terminals for current transformers with devices for short circuiting secondary leads.

D. Wiring:

1. Control, Signal, and Auxiliary Circuits: Insulated wire, oil- and water-resistant, and suitable for operation at an ambient temperature of 90 degrees C.

2. Current Transformer Secondary Circuit: Minimum No. 10 AWG stranded copper.

3. Other Circuits: Minimum No. 12 AWG stranded copper.

4. Where construction requires bending of wires while in service, provide multistrand hinge wire.

2.08 <u>NO-LOAD TAP CHANGING MECHANISM</u>

A. Furnish an operating handle for hand operation at or near foundation level, capable of being padlocked in any position and include an outside position indicator.

2.09 <u>GROUND CONNECTIONS</u>

A. Furnish two NEMA two-hole ground pads welded on base or on tank wall near base on opposite sides of transformer. Locate pads so as not to interfere with jacking facilities.

B. Weld NEMA two-hole ground pads to top of tank near each lightning arrester and furnish with copper clamp type terminal to fasten lightning arresters ground leads.

2.10 TANK CONSTRUCTION

A. Design: Construct to withstand operating pressures and stresses and to withstand full vacuum.

B. Welded Main Cover:

1. Construct so welded cover can be removed and rewelded without damage to coils.

2. Furnish minimum one manhole with sloped cover, 15-inch minimum diameter, for access to lower ends of bushings, terminals, and upper portion of core and coil assembly.

3. Bolt on manhole covers, no welding.

C. Furnish gasketed surfaces with gasketed recess and gasket compression limit stops.

D. Furnish guides for guiding of core assembly and coils when untanking transformer for inspection.

E. Clearly show center of gravity marks and permanently mark on transformer for both shipping assembly and fully assembled transformer.

2.11 WINDINGS

A. Windings and Leads: Copper.

B. Aluminum: Not acceptable for winding material or current-carrying parts.

C. Transformer shall be capable of withstanding, without injury for a time of 2 seconds, thermal and mechanical stresses caused by a short-circuit on the terminals of any winding or combination of windings with rated voltage maintained on unshorted windings.

2.12 ACCESSORIES

A. Nameplate: Metal, mounted on transformer, including:

1. Diagram of connections, including polarities.

2. Voltage of taps and corresponding ampere rating.

3. Impedances and corresponding mVA capacity ratings.

4. Weights: Core and coils, tank and fittings, oil, and total weight.

5. Quantity of oil (U.S. gallons).

6. Permissible vacuum.

7. CT connections, ratings, and polarity.

8. KVA rating at 55 degrees C and 65 degrees C average winding rise.

9. Serial number.

10. Other information as prescribed in ANSI C57.92.

B. General:

1. Furnish standard accessories located in accordance with ANSI C57.92.

2. Group dial type gauges, valves, and tap-charger handle together on low voltage side of transformer for easy accessibility and maintenance so that untanking is not required for removal of gauges. None of these items shall protrude beyond the floor space determined by the radiating surfaces.

3. Tilt gauge faces above 96 inches from foundation down at an angle of 30 degrees from the vertical.

4. Each gauge, dial, etc., shall have a legible, weatherproof nameplate.

5. Locate wells for thermometer bulbs and liquid-level gauge floats outside main tank so removal is not required for untanking.

6. Service Life of Accessories: Comparable with transformer.

7. Shock mount, or construct sufficiently rugged, gauges, meters, relays, recorders, thermal breakers, other instruments, and cabinets constituting or associated with control of fans, inert gas equipment and all other temperature and pressure alarm systems to protect them from damage or wear which could be caused by normal transformer shock and vibration.

8. Contacts for ac Operation: Rated 250V ac.

9. Contacts for dc Operation: Rated 250V dc.

10. Wire for Alarm and Auxiliary Circuits: Stranded, minimum No. 12 AWG copper, oil-and water-resistant, and suitable for operation at an ambient temperature of 90 degrees C.

11. Valves shall hold hot oil without leaking and shall withstand, when submerged, an air test of 125 psig.

C. Magnetic Liquid-Level Gauge:

1. As specified in 5.1.2 of ANSI C57.12.10-1988, except with two stages of contacts.

2. Use first stage to initiate low oil alarm and use second stage for low oil level tripping.

3. Set second stage at least 1-1/2 inches below alarm stage but at a level as not to cause damage to transformer.

4. Trip circuitry shall include an adjustable time-delay relay set to delay tripping from 18 to 180 seconds after second stage contacts close.

5. Alarm and Trip Circuitry Operation: 125 VDC.

D. Indicating Thermometer:

1. Liquid temperature, dial type, with alarm contacts, mounted at approximately eye level to be easily read and reset from the ground.

2. Thermometer shall permit true temperature indication after alarm point is passed.

3. Furnish thermal well to allow thermometer bulb to be removed without lowering oil in tank.

4. Furnish an indicating hand and a maximum indicating hand.

E. High Temperature Alarm Contacts:

1. 125V dc for high temperature alarm and future tripping.

2. Adjustable type with factory temperature settings as follows:

Contact	Function
1	Activate alarm relay at 90 degrees C
2	Activate tripping relay at 110 degrees C

F. Pressure-Vacuum Gauge:

1. Furnish to indicate gas pressure and vacuum in transformer tank, with an accuracy within 5 percent at full scale.

2. Furnish alarm contacts to signal overpressure or underpressure conditions within the tank.

G. Winding Temperature Indicator:

1. Furnish service or device with dial type indicator and manual reset maximum indicator for local indication of hottest spot winding temperature.

2. Locate instrument at eye level adjacent to dial type oil thermometer.

3. Furnish 125V dc contacts for automatic control of each stage of forced cooling equipment and two contacts for high temperature alarm and tripping.

4. Adjustable type contacts with factory temperature settings as follows:

Contact	Function
1	Start the first stage of cooling at 80 degrees C
2	Activate alarm relay at 120 degrees C
3	Activate tripping relay at 135 degrees C

5. Operate winding temperature equipment with a current transformer in all three phases of the low voltage winding.

H. Pressure-Vacuum Bleeder Device: Furnish if sealed-tanked construction is proposed.

I. Oil Drain, Lower Filter Press Connection, and Sampling Valves: Furnish at bottom of tank. Furnish oil sampling valve for main tank, conservator, and LTC compartment.

J. Flange for Vacuum Equipment:

1. 4-inch pipe size, 150-pound rating, in accordance with American National Standard Requirements for Steel Pipe Flanges, Flanged Valves and Fittings, including ratings for Class 150 (ANSI B16.5-81).

2. Suitable for connecting a 4-inch Airco Temescal Vacuum Valve, Series 2520.

3. Separate flange from oil-fill valve as far as practical.

4. Locate on cover for connection of vacuum processing equipment.

K. Upper Filter Press: Furnish valve and connection located on cover diametrically opposite 4-inch flange for connection of vacuum processing equipment.

L. Utility Valve: Furnish ½inch bronze or brass globe valve, installed in a horizontal position at highest point of transformer for venting when filling and testing.

M. Lifting Lugs:

1. Adequate strength and size, so arranged on transformer tank to provide a suitable lift of transformer unit.

2. Also provide lifting eyes for lifting cover and for lifting core and coil assembly.

N. Moving and Handling Facilities:

1. Suitable jacking facilities on transformer tank.

2. Pulling eyes and smooth base for skidding and rolling transformer in any direction.

O. Control Cabinet Heaters:

1. Mount two or more 120-volt, single-phase heaters in each control housing and terminal cabinet to prevent collection of moisture.

2. Wire one heater for continuous operation.

3. Thermostat-control remaining heater(s).

4. Make connections to heaters from below heaters to minimize deterioration of insulation of supply wires.

5. Locate heaters in lower portion of control housing and arrange so they can be energized from a completely independent circuit.

P. Gas Sampling Valve: Not applicable.

Q. Pressure Relief Devices:

1. Two, recloseable, self-setting, mechanical type to automatically relieve internal pressure greater than 7 psi or 100 percent of maximum operating pressure, whichever is greater.

2. A device with nominal rated relief pressure greater than that specified above may be used, in which case tank pressure test shall be run at the higher nominal rating.

3. Construct device to minimize oil discharge when it operates.

4. Mount directly on top of transformer tank.

5. Furnish alarm contacts for pressure relief devices, with ability to reset alarm while transformer is energized.

R. Sudden Pressure Relay and Reset Switch:

1. Furnish to protect transformer against damage due to internal faults.

2. Relay shall operate on rate of pressure change, but be insensitive to pressure pulses caused by electrical disturbances such as magnetizing in-rush currents or mechanical shocks such as a change in transformer temperature, while protecting against small arcs which would not cause a pressure relief device to operate.

3. Operation: 125V dc.

4. Furnish with two contacts, one for alarm and one for tripping.

2.13 FACTORY FINISHING

A. Thoroughly clean exterior surface free from scale, rust, oil, and grease prior to painting.

B. Painting: At least three coats as follows:

1. Initial coating of rust-inhibiting primer, an intermediate coat, and a finish coat of alkyd enamel.

2. Finish Coat: ANSI 359-A-85, No. 70, light gray.

2.14 FACTORY TESTS

A. Factory Inspections: Inspect transformers for required construction, electrical connection, and intended function.

B. Notify Engineer at least 2 weeks prior to any testing to allow Engineer to observe tests.

C. Completely assemble and adjust transformer at the factory and perform manufacturer's standard shop tests, ANSI, and other tests as specified.

D. Perform standard routine tests that include no-load and copper losses in accordance with ANSI C57.12.90-87.

E. Prior to shipment, pressure test liquid-filled assembled transformer for minimum 8 hours at maximum operating pressure to determine presence of leaks.

F. In addition to standard routine tests, perform the following tests:

1. Excitation losses at 100, 105, and 110 percent of rated voltage on rated tap.

2. Excitation current at 100, 105, and 110 percent of rated voltage on rated tap.

3. Insulation power factor test.

G. Short-circuit Strength: Demonstrate transformer has sufficient mechanical strength to withstand, without failure, through-fault currents by one of the following methods:

1. Certified Test Data:

a. Showing transformer with a core and coil identical in design and construction and identical or similar with respect to kVA capacity, kV ratings, BIL, impedance, and voltage taps have been tested without failure for short-circuit strength.

b. Provide description of test code under which transformer was tested for short-circuit strength.

2. History of successful experience with transformers of identical or similar ratings, design, and construction as follows:

a. List transformers in service with core and coils that are essentially identical in design, construction, and manufacture to transformer covered by this Specification and provide information on date of installation, location, and failures, if any.

b. Where such transformers have not been built or cumulative service record is less than 20 transformer years, list transformers in service which represent closest approximation to transformer covered by this Specification.

c. Information provided shall be representative of total experience of manufacturer with design of transformer it proposes to furnish and include dates of installation or shipping, ratings of transformers, and failures and causes of failure if any have been experienced.

2.15 PACKAGING, SHIPMENT AND STORAGE

A. Packing and Shipping: Ship as follows:

1. Ship f.o.b. site with oil in transformers.

2. Ship transducer unmounted.

3. Ship transformer so transformer and accessories will arrive at individual destinations simultaneously.

4. Install impact recorder(s) on transformer at the factory to record impacts in directions that occur during shipping and placing on the foundation.

B. Storage and Protection:

1. Packing methods and material shall be such that it will provide weatherproof protection in outdoor storage areas.

2. Method of shipment preparation shall be such as to protect adequately the transformer, relays, bushings, and other auxiliary devices and accessories against corrosion, dampness, and breakage.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install, wire, test, and verify ready for operation.

B. Install plumb, level and securely anchored in place.

C. Install in accordance with ANSI C57.12.11-80.

3.02 FIELD TESTS

A. Perform visual, mechanical inspection and electrical tests per Section 16106, “Acceptance Testing.”

3.03 TRAINING

A. Provide the services of a factory trained Field Engineer for training at the job site. Training shall include instruction on adjusting, servicing and maintaining the equipment and components. The Field Engineer shall also provide recommendations for spare parts to be kept by the Owner. The Field Engineer shall be on site for one working day.

3.04 MANUFACTURER’S START-UP SERVICES

A. Provide the services of a qualified factory-trained Field Engineer for a period of one working day for each transformer. The Field Engineer shall certify that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations.

3.05 STORAGE OF TRANSFORMERS 3 & 4

A. Construct a temporary oil containment berm within the fenced area of the Main Terminal Switchgear as shown on the drawings. Anchor transformers to wood blocking and provide temporary power as shown on the drawings.

B. Provide minimum 80 mil HDPE Lining, GSE Hyperflex or approved equal, with sandbag berm as shown on the drawings. All lining welds shall be in accordance with the manufacturer's recommendations and accomplished by factory certified installers.

C. Install auger type 6' long trailer tie-down anchors, as shown on the drawings. Use 3/8" diameter wire cable from the 4 transformer lifting eyes to the anchors to secure the equipment and prevent movement during an earthquake.

D. The Contractor shall be responsible for maintaining and protecting the two stored transformers to include removal of any rainwater collected within the temporary containment berm until final acceptance of the project by the City.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

No separate measurement and payment will be made for Power Transformers as described within this section. The cost of Power Transformers shall be considered incidental to the lump sum cost of the various bid where the transformers will be required.

4.02 PAYMENT

A. Payment for Power Transformers 1 & 2 will be considered included in the Contract lump sum price for "Crane Substations 1 & 2" and will be full compensation for furnishing all labor, equipment, materials, incidentals and testing required to install Power Transformers 1 & 2 as specified.

B. Payment for "Furnish Crane Transformers 3 & 4" will be made at the Contract lump sum price as stated in the Schedule of Prices and will be full compensation for furnishing all labor, equipment, materials and incidentals required to supply, deliver and place into storage Crane Transformers 3 & 4 including construction of temporary oil containment, tie downs and temporary power as specified.

END OF SECTION

SECTION 16321

UNIT SUBSTATION TRANSFORMERS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Dry Type substation transformer.

B. Medium voltage load interrupter switch.

C. Air Terminal Chamber.

1.02 RELATED SECTIONS

A. Section 16010 – Electrical General Requirements.

B. Section 16121 – Medium Voltage Cable.

C. Section 16170 – Grounding and Bonding

1.03 REFERENCES

A. The substation transformers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA and ANSI.

1.04 SUBMITTALS

Submit under the provisions of Sections 01300 and 16010.

A. Product Data: Provide for

1. Outdoor dry type unit substation transformer: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA and impedance ratings and characteristics, tap configurations, insulation system type, rated winding temperatre rise and nameplate legends.
2. Medium voltage load interrupter switch: Porivde outline dimensions, connection and support points, specified ratings and materials.
3. Air terminal chamber.
4. Substation concrete pad: Submit drawings indicating outline dimensions.

B. Test reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load and sound level.

C. Certificates: Provide manufacturer’s statement certifying that the product supplied meets or exceeds contract requirements.

D. Manufacturer Test Reports: Indicate results of factory production tests. Provide prior to shipment.

E. Anchor Calculations: The mounting and attachment of the equipment to floor hsll be designed for Seismic Zone 4. Anchor calculations signed and stamped by a registered Structural engineer shall be submitted with the shop drawings for review.

F. Field Acceptance testing Organization Qualifications: Provide for:
   1. Independent testing organization.
   2. Designated project safety representative.
   3. .

   4. Top view.

   5. Single line.

   6. Schematic diagram.

   7. Nameplate schedule.

   8. Component list.

   9. Conduit entry/exit locations.

   10. Assembly ratings including:

       a. Short-circuit rating

       b. Voltage

       c. Continuous current

       d. Basic impulse level for equipment over 600 volts

   11. Major component ratings including:

       a. Voltage

       b. Continuous current

       c. Interrupting ratings

   12. Cable terminal sizes.

G. Shop Drawings:

Shop Drawings shall be submitted for switchgear assemblies to include all mechanical features, such as dimensions, weights, enclosure construction, and assembly details. Shop drawings shall include all electrical ratings associated with the assembly. Product data shall be submitted with the shop drawings for any component or assembly which the switchgear manufacturer requests substitution for a previously approved assembly or component.

1. Shop drawings shall include overall outline dimensions for all equipment and assemblies and shall include manufacturer's recommended installation clearances for operation and maintenance. Contractor and manufacturer's representative shall field verify space available with equipment sizes proposed including code required working clearances and identified access restrictions, and manufacturer's recommended clearances, prior to submittal of shop drawings.

2. Provide point-to-point interconnect wiring diagrams for all internal wiring between components.

3. Provide point-to-point wiring diagrams for all wiring requiring or allowing external connection.

4. Provide dimensioned shipping splits, weights, handling provisions.

5. Complete bill of materials.

6. Certification for use in seismic Zone 4. In addition, include equipment weights, center of gravity locations, and manufacturer's requirements and/or restrictions for anchoring and/or support in seismic Zone 4 areas.

H. Operation and Maintenance Data

1. Include maintenance instructions for cleaning methods, cleaning materials recommended, instructions for circuit breaker removal, replacement, testing and adjusting, and lubrication.

2. Complete one-line, three-line drawings, equipment elevations, and interconnection drawings.

3. Include material and equipment summary sheets and recommended spare parts list.

4. Include descriptive bulletins and instructions for all relays, instruments, current and voltage transformers, control devices, capacitors, diodes, and resistors. Include excitation curves and ratio connection factor curves for instrument transformers.

5. Include certified factory test reports specified herein.

6. Manufacturer's original time-current coordination curves.

E. Quality Control Submittals

1. Manufacturer's test report.

2. Complete set of factory tests shipped with each piece of equipment.

3. Manufacturer's Certificate of Proper Installation.

F. Calculations: Submit calculations and details for the anchoring of all the switchgear equipment provided under this Section of the specifications.

1. Calculations and details shall be done by the equipment manufacturer or designated agent, to meet the requirements of Seismic Zone 4.

2. Calculations and details shall be stamped and signed by a Registered Professional Structural Engineer currently licensed in the State of California.

3. The Contractor shall coordinate the anchoring details supplied by the equipment manufacturer with the construction details of the equipment pads shown on the drawings.

4. Include calculations and details in the O & M manual.

1.05 <u>REFERENCES</u>

A. The medium-voltage metal-clad switchgear shall be designed, manufactured, and tested in accordance with the latest applicable NEMA, ANSI and IEEE standards.

PART 2 – PRODUCTS

2.01 <u>ACCEPTABLE MANUFACTURERS</u>

A. Square – D or approved equal

2.02 <u>SERVICE CONDITIONS</u>

A. Suitable for outdoor service with following conditions:

1. Maximum elevation above sea level: 50 feet

2. Maximum ambient air temperature: 44 degree C

3. Minimum ambient air temperature: 0 degree C

4. Seismic Zone: 4

5. Maximum wind: 80 mph

6. Relative humidity: 95%

2.03 METAL-CLAD SWITCHGEAR

A. Circuit Breaker Switchgear:

1. IEEE 37.20; metal-clad switchgear assembly, including drawout vacuum-type circuit breakers in freestanding cubicles, securely bolted together to form an integrated structure.

2. Each section shall be isolated from adjoining sections by metal barriers.

3. Individual front doors shall be provided over each breaker compartment.

4. Two bolted rear covers shall be provided for each vertical section of the switchgear. The covers shall expose only the secondary of the corresponding breaker when removed.

5. Where fitted circuit breaker spaces are indicated on the Drawings, provide empty cubicles that are fitted with all hardware necessary to accommodate installation of future circuit breakers in field without any modifications. Fitted spaces shall also be provided with doors and all instruments as shown on the Drawings.

6. Bus supports, standoff insulators, and sleeves shall be of porcelain or epoxy.

B. Breaker/Bus Module:

1. Bus shall have flame-retardant insulation.

2. Openings between housings shall be covered or sealed to provide a noncombustible fire separation.

3. Bus joints shall be provided in each unit.

4. A stationary guiderail shall function with the circuit breaker to provide operating, test, and disconnected positions.

5. An automatic shutter assembly shall cover the stationary contacts when the breaker is disconnected (including test position) or removed.

6. A ground contact shall ground the breaker in and between all positions.

C. System Voltage:

1. Crane Substation: 4.16 kV, three-phase, 60 Hz.

D. Voltage and Insulation Levels: to IEEE C37.20.

E. Main Bus Ampacity: as indicated on the Drawings. Bus shall be full capacity over the length of the lineup; tapered bus not approved. Bus shall be silver-plated copper. Buswork shall be arranged Phase A, B, C, left to right, top to bottom, front to back, as viewed from the front. All joints shall have a minimum of four bolts with Belleville washers on each side.

F. Bus Insulation and Bracing: Bus shall be fully insulated with flame-retardant, nonhygroscopic, track-resistant insulating material. Field taping of joints shall be unacceptable. Bussing shall be braced for 350 MVA short circuit.

G. Momentary Current Rating: to IEEE C37.20, equal to momentary rating of circuit breakers.

H. Provide a ¼inch by 2-inch silver-plated copper ground bus over the entire length of the switchgear bolted to each housing and breaker ground contact.

I. Front switchgear doors shall open without disturbing relays and meters. Provide “lock open” stops to limit door swing to 110 degrees of arc. Doors shall be gasketed (dusttight).

2.04 CIRCUIT BREAKERS

A. Circuit Breaker: IEEE C37.04; horizontal drawout type, mounted two high.

B. Circuit Breaker Operator: Spring-charged stored energy with electric operator.

C. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing, and to discharge stored energy mechanisms upon insertion or removal from the housing.

D. Related Maximum Voltage

1. Crane Substation: 4.76 kV

E. Rated Voltage Range Factor

1. Crane Substation: 1.19

F. Nominal Voltage:

1. Crane Substation: 4.16 kV, three-phase, three wires plus ground, 60 Hz for use on a low resistance grounded system.

G. Voltage and Insulation Levels: to IEEE C37.20

H. Rated Frequency: 60 Hz

I. Rated Dielectric Strength:

1. Crane Substation: 19 kV RMS, low frequency; 60 kV crest, impulse.

J. Rated Permissible Tripping Delay: 2 seconds.

K. Rated Interrupting Time: five cycles.

L. Short-Circuit Rating:

1. Crane Substation: 41 KA RMS at rated maximum voltage.

M. Closing and Latching:

1. Crane Substation: 132 KA Crest.

N. Operating Endurance Capability: IEEE C37.06

O. Control Voltages:

1. Breaker Spring Charge: 125V dc

2. Breaker close and trip: 125V dc

P. Provide wear indicator on vacuum bottle contacts.

Q. Provide breaker auxiliary contacts, two A and B per breaker. Contacts shall be rated 120V AC or 125V dc, 10A.

2.05 PROTECTIVE RELAYS AND INSTRUMENTS

A. Protective Relays: Provide relaying instruments as indicated on Drawings for each circuit breaker. Relays shall be as specified on the Drawings or equivalent unit manufactured by Basler, General Electric, Cutler-Hammer, or Siemens. All relays shall have semiflush-mounted cases, drawout arrangement. All relays (except time delay and auxiliary) shall have integral test switches. Relays shall be factory calibrated and blocked before shipment. Provide two sets of test plugs.

B. Overcurrent Relays: Provide multifunction, microprocessor based relays with program selectable ANSI curves. The relay shall have separate trip output contacts for overcurrent element and instantaneous element. Relay shall allow disabling the instantaneous element through key pad entry.

C. Transformer Differential Relays: Provide microprocessor based, fully numerical design, high speed, 3-phase protection relay. The relay shall be programmable with variable percent differential instantaneous overcurrent and thermal overload protection elements. The relay shall provide selection of 2^{nd} and 5^{th} harmonic restraint. The relay shall allow all current transformers to be connected in wye, with internal zero sequence current elimination. The relay shall have nonvolatile memory to retain the settings. The relay shall be Siemen's Type FUT513 or equal.

D. CT: IEEE C37.20; 5-ampere secondary, with single secondary winding and secondary shorting device, primary/secondary ratios as shown on Drawings, burden consistent with connected metering and relay devices. Metering accuracy shall be 0.3, and relaying accuracy shall be C200 minimum.

E. PT: IEEE C57.13; 120-volt secondary, drawout- or trunion-mounted disconnecting type with integral fuse mountings, primary/secondary ratio as shown on Drawings, burden consistent with connected metering and relay devices. Accuracy shall be 0.3. Interlock with access door to disconnect; ground and isolate from primary voltage when door is open. Interlock control power transformers with breaker to prevent access when breaker is closed.

F. Control Power Transformers: IEEE C57; 120/240V single-phase, three-wire secondary, drawout-mounted disconnecting type with primary and secondary fuses. Provide a 100A (minimum), 120/240V, single-phase, three-wire panelboard for control power. Interlock transformer with access door to disconnect, ground, and isolate from primary voltage when door is open.

G. Microprocessor Based Multifunction Power Meter:

1. Where indicated on the Drawings, provide a microprocessor based multifunction power meter. Meter shall have true RMS capabilities for accurate measurement of nonlinear single- and 3-phase loads.

2. Accuracy:

   a. Current and Voltage: 0.2 percent.

   b. Power and Energy: 0.4 percent.

3. Real-Time Readings: The meter shall be capable of measuring the following real-time parameters:

   a. Current: per phase, neutral, ground, three-phase.

   b. Voltage: L-L, L-n; input voltage 208Y/120, 480, or 480Y/277V.

   c. Real Power: per phase, three-phase.

   d. Reactive Power: per phase, three-phase.

   e. Apparent Power: per phase, three-phase.

   f. Power Factor: per phase, three-phase.

g. Frequency.

h. Temperature: internal ambient (via communications only).

i. Total Harmonic Distortion (THD): current and voltage.

j. K Factor: per phase.

4. Demand Readings:

   a. Demand Current: per phase present, peak.

   b. Average Power Factor: three-phase total.

   c. Demand Real Power: three-phase total.

   d. Demand Reactive Power: three-phase total (via communications only).

   e. Demand Apparent Power: three-phase total.

   f. Coincident readings.

   g. Predicted Demands: via communications only.

5. Energy Readings:

   a. Accumulated Energy: real, reactive, apparent (apparent value via communications only).

   b. Bidirectional Readings: via communications only.

6. Power Analysis Values: via communications only.

   a. Crest Factor: per phase.

   b. K Factor Demand: per phase.

   c. Displacement Power Factor: per phase, three-phase.

   d. Fundamental Voltages: per phase.

   e. Fundamental Currents: per phase.

   f. Fundamental Real Power: per phase.

   g. Harmonic power.

   h. Unbalance: current and voltage.

i. Phase rotation.

7. Alarm Relay Functions:

   a. Meter shall be capable of having any measured value as defined herein assigned as an under- or oversetpoint alarm. Time-delay feature (in seconds) shall be separately programmable for each alarm.

   b. Any alarm condition can initiate one or more relay functions. Three each, Form C, 10A mechanical relay, and one solid-state output shall be available.

8. Onboard Alarm/Event Recording:

   a. For any alarm, the circuit monitor shall be capable of logging the event type, date, and time and the most extreme reading during the pickup delay.

   b. When the alarm condition drops out, the drop time and date and the most extreme reading since pickup can be logged. The size of the event log shall be user configurable up to the limits of the onboard memory.

9. Data Logging:

   a. Provide nonvolatile memory for storing meter readings at regular intervals. Up to 14 independent user-defined data logs shall be possible.

   b. Log Interval: 1 minute to 24 hours.

   c. Each log shall be capable of up to 51,200 values.

10. Communications: Provide optically isolated RS-485 communication port. Protocol shall be of the open-architecture variety using standard ANSI character and control set.

11. Waveform Capture:

   a. Waveform capture shall be initiated on demand by the user or by any assigned setpoint.

   b. Waveform capture shall capture all three voltage (line-to-line) and four current waveforms. Each waveform shall be simultaneously sampled 64 times per cycle; resolution shall be 12 bits.

12. Event Capture:

a. Provide event capture feature capable of recording short duration events (less than 12 cycles).

b. Cycles of data shall be captured for each waveform. User shall be capable of determining the number of cycles prior to and after the event captured.

13. Harmonics: Unit shall be capable of calculating the THD for any waveform on board the meter. Meter shall be capable of true RMS operation up through the thirty-first harmonic.

14. Meter shall Cutler-Hammer IQ Analyzer.

F. Ammeters: ANSI C39.1; indicating ammeter with 4.5-inch square recessed case and 250 degree scale, white dial with black figures and pointer, 5 amperes, 60-Hz movement, 1 percent accuracy. Scale as indicated on the Drawings.

G. Voltmeters: ANSI C39.1; indicating voltmeter with 4.5-inch square recessed case and 250 degree scale, white dial with black figures and pointer, 120-volt, 60-Hz movement, 1 percent accuracy. Scale as indicated on the Drawings.

H. Control Switches: rotary, multistage, snap-action type with 600V ac-dc silver-plated contacts, engraved escutcheon plate, pistol grip handle.

1. Breaker Control: two positions (open-close) with green (open) and red (closed) target; GE Type SB-1.

2. Lockout Relay Control: two positions (normal-reset); GE Type HSA11.

3. Ammeter Switch: four positions (off-A-B-C); GE Type SB-1.

4. Voltmeter Switch: four positions (off-AB-BC-CA); GE Type SB-1.

I. Indicating Lights: push-to-test LED type, Allen-Bradley 800T-PL series; no exceptions. Red, breaker closed; green, breaker open.

2.06 ACCESSORIES

A. Incoming and Outgoing Cable Terminations: two-hole, long-barrel, compression type. Provide adequate room for pre-manufactured indoor-type stress cones as manufactured by RayChem. Stress cones furnished and installed by others; cable lug sizes as per the Drawings. All cables shall enter/exit at the bottom of the switchgear.

B. Incoming Bus Duct Terminations: provide suitable flange and terminals for outdoor type bus duct termination, where shown on the Drawings.

C. Wiring and Terminal Blocks:

1. All control, metering, and instrumentation wiring shall be terminated on 600V, 30A, heavy-duty terminal blocks. CT terminal blocks shall be separately mounted with all CT secondaries terminated on four-point shorting-type terminal blocks. Terminal blocks will be provided on each side of shipping splits and be clearly labeled. Provide 25 percent spare terminals.

2. Test switches shall be provided per the Drawings and mounted on hinged instrument panels and fully wired.

3. Test switches shall be made of molded polycarbonate with screw-type terminals for ring-tongue connectors at rear. Provide shorting switches on all current circuits. Switches shall have four potential and six current poles. Switches shall be Westinghouse, Type FT-1, Style 129A514G01, or equivalent General Electric or Superior model.

4. All control wiring shall be 14 AWG minimum, 600V, 90 degree C, Type SIS. All control conductors shall be terminated in crimp-on lugs. All current leads shall be T&B Sta-Kon spade type, except current leads, which shall be Sta-Kon ring type.

5. Conductor and Terminal Block Identification: All conductors shall have machine-lettered, PVC sleeve-type wire markers. All terminal blocks shall be identified with phenolic nameplates as described herein. Individual terminals shall be clearly and neatly labeled with indelible, black marking pen.

6. Both sides of all trip and close coils shall be wired to terminal blocks.

D. Battery System 125V dc:

1. General: Provide battery, battery racks, and battery charger, all installed in a freestanding panel to be installed as shown on the Drawings.

2. Battery, Battery Racks, and Connectors:

   a. Battery: Battery cells shall be of lead-calcium type in sealed plastic containers. The containers shall be impact resistant. Each cell shall be equipped with an explosionproof vent. The battery shall have a minimum ampere-hour rating of 200 at an 8-hour rate and a 1-minute rating of 290 amps to final voltage of 1.75 volts per cell, all based on an initial specific gravity of 1.21 at 25 degrees C with electrolyte at normal level and a minimum ambient temperature of 13 degrees C.

   b. Racks: Racks shall have maximum of three tiers and shall be coated with electrolyte-resistant paint.

   c. Connectors: Intercell and interior connectors for racks shall be end to end and/or back to back. Maximum connection voltage drop shall be 30 mV between adjacent units.

3. Battery Charger: Charger unit shall be solid-state and shall provide direct-current battery charging. The unit shall have a thermal magnetic input circuit breaker. The circuit breaker shall be sized to supply a full-rated load and recharge the battery at the same time. The charger shall have built-in provisions for protecting itself from damage due to overload, including a short circuit on the output terminals. This function shall be accomplished by current-limit circuitry, which shall limit the output current of the charger to an adjustable range (50 to 200 percent). The input power to the charger will be 120 Vac, single phase.

4. The battery system shall be operated ungrounded. Two lights shall be provided for ground indication, which shall be connected in series between the negative and positive terminals, with the midpoint junction connected to ground by the normally open contact of a push button.

E. Nameplates: white phenolic engraved to a black core. Nameplate size, character height, and inscription shall be per the Drawings. Provide nameplates for each breaker, relay, instrument, control device, transformer, and incoming line compartment. Minimum character height shall be 5/32 inch. All nameplates shall be attached with steel screws. Provide master nameplate on tie-breaker cubicle indicating equipment name (1-inch letters), voltage and service (1/2-inch letters), and source of power (1/2-inch letters).

F. Mimic Bus: Provide a laminated plastic mimic bus over the face of the switchgear. Mimic bus shall depict incoming line, breaker, voltage transformer, and control power transformer. Mimic bus shall be medium blue in color and fastened with countersunk screws, locknuts, and washers.

G. Key Interlocks: As indicated on the Drawings.

H. Circuit Breaker Lifting Device: Carriage and track on top of switchgear lineup with lifting device to serve drawout circuit breakers in switchgear.

I. Provide 120-Vac space heaters in each cubicle to prevent condensation. Heaters shall be controlled by a common thermostat mounted on the interior wall opposite the front of the switchgear. Feed heaters from emergency power panel.

2.07 <u>OUTDOOR SWITCHGEAR ENCLOSURE</u>

A Provide switchgear in a walk-in, weatherproof structure.

B. Structure shall be rated NEMA 3R.

C. Provide 120-Vac space heaters in each cubicle with individual thermostat control. Power for space heaters shall be provided from internal control power systems.

D. Assembly shall be suitable for site erection on a concrete pad.

E. The enclosure shall be extended on the breaker drawout side to form an operating and/or maintenance aisle large enough to permit interchange of circuit breakers.

F. Provide interior lights, light switches and duplex ground fault receptacles in the aisle.

G. Provide ventilation fans, adequately sized for site conditions.

2.08 FACTORY TESTS

A. General

1. Actual operation performed whenever possible. Otherwise, inspection of continuity checks made.

2. Component devices operated in circuits as shown on diagrams.

3. Control and primary circuits given dielectric tests as described therein.

B. Detailed Tests:

1. Control Circuits and Devices:

a. Control bus energized at 80 percent rated dc or 85 percent rated ac control voltage.

b. Control devices operated as shown on diagrams.

c. Verification of all remote circuits which were not included in operational test.

2. Instruments, Meters, Protective Relays, and Associated Equipment:

a. Functionally tested by energizing current and potential circuits to rated values.

b. Instruments operated and expected readings verified.

c. Meters checked for proper calibration; current and voltage circuits for phasing.

d. Protective relays operated for functional check in accordance with rating and application. Instantaneous trips manually operated to verify correct functioning of operation indicator and associated circuits.

e. Relays set on maximum and checked for operation and friction.

3. Dielectric Tests:

a. Control circuits and associated wiring received insulation test of 1,500V, 60 cycles, for 1 minute, except where equipment manufacturer specifications do not permit.

b. Primary circuits (except PTs) tested phase to phase and phase to ground with 60-cycle voltage applied for 1 minute.

PART 3 – EXECUTION

3.01 PREPARATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as shown on shop drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts conditions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.03 FIELD TESTS

A. Perform visual, mechanical inspection and electrical tests per Section 16106, "Acceptance Testing."

3.04 TRAINING

A. Provide the services of a factory trained Field Engineer for training at the job site on adjusting, servicing and maintaining the equipment and components. The Field Engineer shall be on site for one working day.

3.05 MANUFACTURER'S STARTUP SERVICES

A. Provide the services of a qualified factory-trained Field Engineer for a period of two working days for each switchgear lineup. The Field Engineer shall certify that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

PART 4 - MEASUREMENT AND PAYMENT

Measurement and payment for switchgear associated with the Crane Substations will be included with Bid Item No. 4, "Crane Substations 1 and 2." All other switchgear will be measured and paid for with Bid Item No. 3, "Site Electrical."

END OF SECTION

SECTION 16342

REEFER OUTLET ASSEMBLY

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work of this Section consists, in general, of furnishing and installing reefer outlet assemblies as indicated on the drawings, as specified and as directed by the Engineer.

1.02 REFERENCE STANDARDS

A. Both the assembly and the individual outlets shall be UL Listed.

B. NEC – National Electric Code

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: ESL Power Systems or equal.

2.02 EQUIPMENT

A. Reefer Outlet Assemblies (ROA's)

1. Contractor shall provide 4-Gang Bunker Mount ROA's. Quantities and dimensions as shown on the Drawings.
2. All ROA Enclosures shall be NEMA 4X, constructed of continuous seam-welded, 14 gauge 304 Stainless Steel. Access doors shall be hinged and gasketed full length and secured with stainless steel captive clamps. Enclosures shall be powder coated Gray after fabrication.
3. All Modular Interlocked Reefer Outlets within the enclosure shall be factory-prewired to a single UL Recognized 3 pole power distribution block (PDB) and ground connection.
4. Conduit hubs shall be UL Listed (NEMA 4) gasketed sealing Hubs, as manufactured by MYERS or equal, for each conduit entry on the ROA's. The hub size shall be as specified on the Drawings.
5. Each ROA must include a provision for moisture control within the installed enclosure. As a minimum, moisture control system shall consist of (1) one 1.25-lb bag of desiccant per 5 cubic feet of enclosure.

6. Contractor shall furnish and install UL approved *Polycel® Expanding Foam* or approved equal for sealing all conduit entries in each ROA Enclosure. The sealing product must be able to permanently seal around all wires and the conduit (common 'Duct Seal' is not acceptable for this application).
7. All installation hardware shall be stainless steel or as shown on the Drawings.

B. Modular Interlocked Reefer Outlets (Modules)

1. Interlocked modules shall be 480VAC 32 AMP Cat. No. R32-480-30-65SD-SP as manufactured by ESL Power Systems, Inc. or approved equivalent.
2. Modular Interlocked Reefer Outlets (Modules) shall be UL Listed 480VAC as shown on the drawings. Each 480VAC module shall include a UL 489 Listed circuit breaker with 30 ampere trip rating and 65K ampere interrupting capacity at 480VAC. The Module frames shall be constructed of stainless steel and shall include a spring loaded, self-aligning, snap cover and a ½" minimum diameter stainless steel on/off control rod.
3. The Module interlocking mechanism shall prevent the Outlet from being energized unless a mating plug is fully inserted and the on/off control rod engaged. The mechanism will allow manual de-energizing but will also automatically de-energize the Outlet if the plug is withdrawn. The mechanism must be fully operational if the plug nose key is damaged or missing. The mechanism must not operate if the ground pin is missing from the mating plug.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Prior to installation of ROA's, Contractor shall examine the areas and conditions under which the ROA's are to be installed and notify the Engineer in writing if any unsatisfactory conditions exist.

B. ROA's shall be installed as shown on the Drawings and per the manufacturer's written instructions. In addition, the installation shall meet the requirements of local codes, the NEC and National Electrical Contractors Association's "Standard of Installation".

C. All installation hardware shall be stainless steel or as shown on the Drawings.

D. Conduit Hubs shall be used at all conduit entries into the ROA's. Hubs shall be properly installed and tightened to maintain NEMA 4X integrity of the ROA enclosure.

E. All ROA field writing connections shall be per the specifications shown on the ROA's Power Distribution Block, Ground Lug and Monitoring Cable Terminal Blocks. This includes size, number and material of conductors in addition to torque specifications. A corrosion inhibitor shall be used on PDB and ground field wiring terminations in the ROA's.

F. After all wiring terminations are complete, the conduit shall be sealed to prevent moisture intrusion. The sealing shall be done at the entry into the enclosure so the seal can be verified and inspected by opening the hinged access door(s).

G. The moisture-absorbing system provided by the ROA manufacturer must be installed immediately before closing the enclosure for the last time (after all wiring, sealing, and inspections have been completed). The enclosure interior must be free of all dirt and moisture and the access door secured tightly.

END OF SECTION

SECTION 16350

MEDIUM-VOLTAGE METAL-CLAD SWITCHGEAR

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Metal-clad circuit breaker switchgear for crane substations.

B. The equipment shall be completely factory built, assembled, wired, and tested. All the equipment and components shall be of new construction. Used or rebuilt equipment is not acceptable.

C. The switchgear equipment covered by these specifications shall be designed, tested, and assembled in accordance with the latest applicable standards of ANSI, IEEE, and NEMA.

D. The metal-clad switchgear and vacuum circuit breakers shall be UL listed and labeled.

1.02 RELATED WORK

A. Section 16106 – Acceptance Testing

B. Section 16443 – Crane Substation Assemblies

1.03 QUALITY ASSURANCE

A. Like items of equipment provided hereunder shall be the end product of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer’s service.

1.04 SUBMITTALS

A. Product Data:

Submit product data for approval for switchgear assemblies consisting of manufacturer’s literature, manufacturer’s catalog data, and manufacturer’s installation and maintenance instructions. Product data shall include all mechanical features such as dimensions and appearance and all electrical ratings associated with the assembly or component. At Contractors option, submit product data and resubmit if required, prior to submittal of shop drawings.

B. The following information shall be submitted to the Engineer:

1. Master drawing index.

2. Front view elevation.

3. Floor plan.

4. Top view.

5. Single line.

6. Schematic diagram.

7. Nameplate schedule.

8. Component list.

9. Conduit entry/exit locations.

10. Assembly ratings including:

    a. Short-circuit rating

    b. Voltage

    c. Continuous current

    d. Basic impulse level for equipment over 600 volts

11. Major component ratings including:

    a. Voltage

    b. Continuous current

    c. Interrupting ratings

12. Cable terminal sizes.

C. Shop Drawings:

Shop Drawings shall be submitted for switchgear assemblies to include all mechanical features, such as dimensions, weights, enclosure construction, and assembly details. Shop drawings shall include all electrical ratings associated with the assembly. Product data shall be submitted with the shop drawings for any component or assembly which the switchgear manufacturer requests substitution for a previously approved assembly or component.

1. Shop drawings shall include overall outline dimensions for all equipment and assemblies and shall include manufacturer’s recommended installation clearances for operation and maintenance. Contractor and manufacturer’s representative shall field verify space available with equipment sizes proposed

including code required working clearances and identified access restrictions, and manufacturer's recommended clearances, prior to submittal of shop drawings.

2. Provide point-to-point interconnect wiring diagrams for all internal wiring between components.

3. Provide point-to-point wiring diagrams for all wiring requiring or allowing external connection.

4. Provide dimensioned shipping splits, weights, handling provisions.

5. Complete bill of materials.

6. Certification for use in seismic Zone 4. In addition, include equipment weights, center of gravity locations, and manufacturer's requirements and/or restrictions for anchoring and/or support in seismic Zone 4 areas.

D. Operation and Maintenance Data

1. Include maintenance instructions for cleaning methods, cleaning materials recommended, instructions for circuit breaker removal, replacement, testing and adjusting, and lubrication.

2. Complete one-line, three-line drawings, equipment elevations, and interconnection drawings.

3. Include material and equipment summary sheets and recommended spare parts list.

4. Include descriptive bulletins and instructions for all relays, instruments, current and voltage transformers, control devices, capacitors, diodes, and resistors. Include excitation curves and ratio connection factor curves for instrument transformers.

5. Include certified factory test reports specified herein.

6. Manufacturer's original time-current coordination curves.

E. Quality Control Submittals

1. Manufacturer's test report.

2. Complete set of factory tests shipped with each piece of equipment.

3. Manufacturer's Certificate of Proper Installation.

F. Calculations: Submit calculations and details for the anchoring of all the switchgear equipment provided under this Section of the specifications.

1. Calculations and details shall be done by the equipment manufacturer or designated agent, to meet the requirements of Seismic Zone 4.

2. Calculations and details shall be stamped and signed by a Registered Professional Structural Engineer currently licensed in the State of California.

3. The Contractor shall coordinate the anchoring details supplied by the equipment manufacturer with the construction details of the equipment pads shown on the drawings.

4. Include calculations and details in the O & M manual.

1.05 REFERENCES

A. The medium-voltage metal-clad switchgear shall be designed, manufactured, and tested in accordance with the latest applicable NEMA, ANSI and IEEE standards.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square – D or approved equal

2.02 SERVICE CONDITIONS

A. Suitable for outdoor service with following conditions:

1. Maximum elevation above sea level: 50 feet

2. Maximum ambient air temperature: 44 degree C

3. Minimum ambient air temperature: 0 degree C

4. Seismic Zone: 4

5. Maximum wind: 80 mph

6. Relative humidity: 95%

2.03 METAL-CLAD SWITCHGEAR

A. Circuit Breaker Switchgear:

1. IEEE 37.20; metal-clad switchgear assembly, including drawout vacuum-type circuit breakers in freestanding cubicles, securely bolted together to form an integrated structure.

2. Each section shall be isolated from adjoining sections by metal barriers.

3. Individual front doors shall be provided over each breaker compartment.

4. Two bolted rear covers shall be provided for each vertical section of the switchgear. The covers shall expose only the secondary of the corresponding breaker when removed.

5. Where fitted circuit breaker spaces are indicated on the Drawings, provide empty cubicles that are fitted with all hardware necessary to accommodate installation of future circuit breakers in field without any modifications. Fitted spaces shall also be provided with doors and all instruments as shown on the Drawings.

6. Bus supports, standoff insulators, and sleeves shall be of porcelain or epoxy.

B. Breaker/Bus Module:

1. Bus shall have flame-retardant insulation.

2. Openings between housings shall be covered or sealed to provide a noncombustible fire separation.

3. Bus joints shall be provided in each unit.

4. A stationary guiderail shall function with the circuit breaker to provide operating, test, and disconnected positions.

5. An automatic shutter assembly shall cover the stationary contacts when the breaker is disconnected (including test position) or removed.

6. A ground contact shall ground the breaker in and between all positions.

C. System Voltage:

1. Crane Substation: 4.16 kV, three-phase, 60 Hz.

D. Voltage and Insulation Levels: to IEEE C37.20.

E. Main Bus Ampacity: as indicated on the Drawings. Bus shall be full capacity over the length of the lineup; tapered bus not approved. Bus shall be silver-plated copper. Buswork shall be arranged Phase A, B, C, left to right, top to bottom, front to back, as viewed from the front. All joints shall have a minimum of four bolts with Belleville washers on each side.

F. Bus Insulation and Bracing: Bus shall be fully insulated with flame-retardant, nonhygroscopic, track-resistant insulating material. Field taping of joints shall be unacceptable. Bussing shall be braced for 350 MVA short circuit.

G. Momentary Current Rating: to IEEE C37.20, equal to momentary rating of circuit breakers.

H. Provide a ¼inch by 2-inch silver-plated copper ground bus over the entire length of the switchgear bolted to each housing and breaker ground contact.

I. Front switchgear doors shall open without disturbing relays and meters. Provide “lock open” stops to limit door swing to 110 degrees of arc. Doors shall be gasketed (dusttight).

2.04 CIRCUIT BREAKERS

A. Circuit Breaker: IEEE C37.04; horizontal drawout type, mounted two high.

B. Circuit Breaker Operator: Spring-charged stored energy with electric operator.

C. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing, and to discharge stored energy mechanisms upon insertion or removal from the housing.

D. Related Maximum Voltage

1. Crane Substation: 4.76 kV

E. Rated Voltage Range Factor

1. Crane Substation: 1.19

F. Nominal Voltage:

1. Crane Substation: 4.16 kV, three-phase, three wires plus ground, 60 Hz for use on a low resistance grounded system.

G. Voltage and Insulation Levels: to IEEE C37.20

H. Rated Frequency: 60 Hz

I. Rated Dielectric Strength:

1. Crane Substation: 19 kV RMS, low frequency; 60 kV crest, impulse.

J. Rated Permissible Tripping Delay: 2 seconds.

K. Rated Interrupting Time: five cycles.

L. Short-Circuit Rating:

1. Crane Substation: 41 KA RMS at rated maximum voltage.

M. Closing and Latching:

1. Crane Substation: 132 KA Crest.

N. Operating Endurance Capability: IEEE C37.06

O. Control Voltages:

1. Breaker Spring Charge: 125V dc

2. Breaker close and trip: 125V dc

P. Provide wear indicator on vacuum bottle contacts.

Q. Provide breaker auxiliary contacts, two A and B per breaker. Contacts shall be rated 120V AC or 125V dc, 10A.

2.05 PROTECTIVE RELAYS AND INSTRUMENTS

A. Protective Relays: Provide relaying instruments as indicated on Drawings for each circuit breaker. Relays shall be as specified on the Drawings or equivalent unit manufactured by Basler, General Electric, Cutler-Hammer, or Siemens. All relays shall have semiflush-mounted cases, drawout arrangement. All relays (except time delay and auxiliary) shall have integral test switches. Relays shall be factory calibrated and blocked before shipment. Provide two sets of test plugs.

B. Overcurrent Relays: Provide multifunction, microprocessor based relays with program selectable ANSI curves. The relay shall have separate trip output contacts for overcurrent element and instantaneous element. Relay shall allow disabling the instantaneous element through key pad entry.

C. Transformer Differential Relays: Provide microprocessor based, fully numerical design, high speed, 3-phase protection relay. The relay shall be programmable with variable percent differential instantaneous overcurrent and thermal overload protection elements. The relay shall provide selection of 2nd and 5th harmonic restraint. The relay shall allow all current transformers to be connected in wye, with internal zero sequence current elimination. The relay shall have nonvolatile memory to retain the settings. The relay shall be Siemen’s Type FUT513 or equal.

D. CT: IEEE C37.20; 5-ampere secondary, with single secondary winding and secondary shorting device, primary/secondary ratios as shown on Drawings, burden consistent with connected metering and relay devices. Metering accuracy shall be 0.3, and relaying accuracy shall be C200 minimum.

E. PT: IEEE C57.13; 120-volt secondary, drawout- or trunion-mounted disconnecting type with integral fuse mountings, primary/secondary ratio as shown on Drawings, burden consistent with connected metering and relay devices. Accuracy shall be 0.3. Interlock with access door to disconnect; ground and isolate from primary voltage when door is open. Interlock control power transformers with breaker to prevent access when breaker is closed.

F. Control Power Transformers: IEEE C57; 120/240V single-phase, three-wire secondary, drawout-mounted disconnecting type with primary and secondary fuses. Provide a 100A (minimum), 120/240V, single-phase, three-wire panelboard for control power. Interlock transformer with access door to disconnect, ground, and isolate from primary voltage when door is open.

G. Microprocessor Based Multifunction Power Meter:

1. Where indicated on the Drawings, provide a microprocessor based multifunction power meter. Meter shall have true RMS capabilities for accurate measurement of nonlinear single- and 3-phase loads.

2. Accuracy:

    a. Current and Voltage: 0.2 percent.

    b. Power and Energy: 0.4 percent.

3. Real-Time Readings: The meter shall be capable of measuring the following real-time parameters:

    a. Current: per phase, neutral, ground, three-phase.

    b. Voltage: L-L, L-n; input voltage 208Y/120, 480, or 480Y/277V.

    c. Real Power: per phase, three-phase.

    d. Reactive Power: per phase, three-phase.

    e. Apparent Power: per phase, three-phase.

    f. Power Factor: per phase, three-phase.

    g. Frequency.

    h. Temperature: internal ambient (via communications only).

    i. Total Harmonic Distortion (THD): current and voltage.

j. K Factor: per phase.

4. Demand Readings:

a. Demand Current: per phase present, peak.

b. Average Power Factor: three-phase total.

c. Demand Real Power: three-phase total.

d. Demand Reactive Power: three-phase total (via communications only).

e. Demand Apparent Power: three-phase total.

f. Coincident readings.

g. Predicted Demands: via communications only.

5. Energy Readings:

a. Accumulated Energy: real, reactive, apparent (apparent value via communications only).

b. Bidirectional Readings: via communications only.

6. Power Analysis Values: via communications only.

a. Crest Factor: per phase.

b. K Factor Demand: per phase.

c. Displacement Power Factor: per phase, three-phase.

d. Fundamental Voltages: per phase.

e. Fundamental Currents: per phase.

f. Fundamental Real Power: per phase.

g. Harmonic power.

h. Unbalance: current and voltage.

i. Phase rotation.

7. Alarm Relay Functions:

a. Meter shall be capable of having any measured value as defined herein assigned as an under- or oversetpoint alarm. Time-delay feature (in seconds) shall be separately programmable for each alarm.

b. Any alarm condition can initiate one or more relay functions. Three each, Form C, 10A mechanical relay, and one solid-state output shall be available.

8. Onboard Alarm/Event Recording:

a. For any alarm, the circuit monitor shall be capable of logging the event type, date, and time and the most extreme reading during the pickup delay.

b. When the alarm condition drops out, the drop time and date and the most extreme reading since pickup can be logged. The size of the event log shall be user configurable up to the limits of the onboard memory.

9. Data Logging:

a. Provide nonvolatile memory for storing meter readings at regular intervals. Up to 14 independent user-defined data logs shall be possible.

b. Log Interval: 1 minute to 24 hours.

c. Each log shall be capable of up to 51,200 values.

10. Communications: Provide optically isolated RS-485 communication port. Protocol shall be of the open-architecture variety using standard ANSI character and control set.

11. Waveform Capture:

    a. Waveform capture shall be initiated on demand by the user or by any assigned setpoint.

    b. Waveform capture shall capture all three voltage (line-to-line) and four current waveforms. Each waveform shall be simultaneously sampled 64 times per cycle; resolution shall be 12 bits.

12. Event Capture:

    a. Provide event capture feature capable of recording short duration events (less than 12 cycles).

    b. Cycles of data shall be captured for each waveform. User shall be capable of determining the number of cycles prior to and after the event captured.

13. Harmonics: Unit shall be capable of calculating the THD for any waveform on board the meter. Meter shall be capable of true RMS operation up through the thirty-first harmonic.

14. Meter shall Cutler-Hammer IQ Analyzer.

F. Ammeters: ANSI C39.1; indicating ammeter with 4.5-inch square recessed case and 250 degree scale, white dial with black figures and pointer, 5 amperes, 60-Hz movement, 1 percent accuracy. Scale as indicated on the Drawings.

G. Voltmeters: ANSI C39.1; indicating voltmeter with 4.5-inch square recessed case and 250 degree scale, white dial with black figures and pointer, 120-volt, 60-Hz movement, 1 percent accuracy. Scale as indicated on the Drawings.

H. Control Switches: rotary, multistage, snap-action type with 600V ac-dc silver-plated contacts, engraved escutcheon plate, pistol grip handle.

1. Breaker Control: two positions (open-close) with green (open) and red (closed) target; GE Type SB-1.

2. Lockout Relay Control: two positions (normal-reset); GE Type HSA11.

3. Ammeter Switch: four positions (off-A-B-C); GE Type SB-1.

4. Voltmeter Switch: four positions (off-AB-BC-CA); GE Type SB-1.

I. Indicating Lights: push-to-test LED type, Allen-Bradley 800T-PL series; no exceptions. Red, breaker closed; green, breaker open.

2.06 ACCESSORIES

A. Incoming and Outgoing Cable Terminations: two-hole, long-barrel, compression type. Provide adequate room for pre-manufactured indoor-type stress cones as manufactured by RayChem. Stress cones furnished and installed by others; cable lug sizes as per the Drawings. All cables shall enter/exit at the bottom of the switchgear.

B. Incoming Bus Duct Terminations: provide suitable flange and terminals for outdoor type bus duct termination, where shown on the Drawings.

C. Wiring and Terminal Blocks:

1. All control, metering, and instrumentation wiring shall be terminated on 600V, 30A, heavy-duty terminal blocks. CT terminal blocks shall be separately mounted with all CT secondaries terminated on four-point shorting-type terminal blocks. Terminal blocks will be provided on each side of shipping splits and be clearly labeled. Provide 25 percent spare terminals.

2. Test switches shall be provided per the Drawings and mounted on hinged instrument panels and fully wired.

3. Test switches shall be made of molded polycarbonate with screw-type terminals for ring-tongue connectors at rear. Provide shorting switches on all current circuits. Switches shall have four potential and six current poles. Switches shall be Westinghouse, Type FT-1, Style 129A514G01, or equivalent General Electric or Superior model.

4. All control wiring shall be 14 AWG minimum, 600V, 90 degree C, Type SIS. All control conductors shall be terminated in crimp-on lugs. All current leads shall be T&B Sta-Kon spade type, except current leads, which shall be Sta-Kon ring type.

5. Conductor and Terminal Block Identification: All conductors shall have machine-lettered, PVC sleeve-type wire markers. All terminal blocks shall be identified with phenolic nameplates as described herein. Individual terminals shall be clearly and neatly labeled with indelible, black marking pen.

6. Both sides of all trip and close coils shall be wired to terminal blocks.

D. Battery System 125V dc:

1. General: Provide battery, battery racks, and battery charger, all installed in a freestanding panel to be installed as shown on the Drawings.

2. Battery, Battery Racks, and Connectors:

a. Battery: Battery cells shall be of lead-calcium type in sealed plastic containers. The containers shall be impact resistant. Each cell shall be equipped with an explosionproof vent. The battery shall have a minimum ampere-hour rating of 200 at an 8-hour rate and a 1-minute rating of 290 amps to final voltage of 1.75 volts per cell, all based on an initial specific gravity of 1.21 at 25 degrees C with electrolyte at normal level and a minimum ambient temperature of 13 degrees C.

b. Racks: Racks shall have maximum of three tiers and shall be coated with electrolyte-resistant paint.

c. Connectors: Intercell and interior connectors for racks shall be end to end and/or back to back. Maximum connection voltage drop shall be 30 mV between adjacent units.

3. Battery Charger: Charger unit shall be solid-state and shall provide direct-current battery charging. The unit shall have a thermal magnetic input circuit breaker. The circuit breaker shall be sized to supply a full-rated load and recharge the battery at the same time. The charger shall have built-in provisions for protecting itself from damage due to overload, including a short circuit on the output terminals. This function shall be accomplished by current-limit circuitry, which shall limit the output current of the charger to an adjustable range (50 to 200 percent). The input power to the charger will be 120 Vac, single phase.

4. The battery system shall be operated ungrounded. Two lights shall be provided for ground indication, which shall be connected in series between the negative and positive terminals, with the midpoint junction connected to ground by the normally open contact of a push button.

E. Nameplates: white phenolic engraved to a black core. Nameplate size, character height, and inscription shall be per the Drawings. Provide nameplates for each breaker, relay, instrument, control device, transformer, and incoming line compartment. Minimum character height shall be 5/32 inch. All nameplates shall be attached with steel screws. Provide master nameplate on tie-breaker cubicle indicating equipment name (1-inch letters), voltage and service (1/2-inch letters), and source of power (1/2-inch letters).

F. Mimic Bus: Provide a laminated plastic mimic bus over the face of the switchgear. Mimic bus shall depict incoming line, breaker, voltage transformer, and control power transformer. Mimic bus shall be medium blue in color and fastened with countersunk screws, locknuts, and washers.

G. Key Interlocks: As indicated on the Drawings.

H. Circuit Breaker Lifting Device: Carriage and track on top of switchgear lineup with lifting device to serve drawout circuit breakers in switchgear.

I. Provide 120-Vac space heaters in each cubicle to prevent condensation. Heaters shall be controlled by a common thermostat mounted on the interior wall opposite the front of the switchgear. Feed heaters from emergency power panel.

2.07 OUTDOOR SWITCHGEAR ENCLOSURE

A Provide switchgear in a walk-in, weatherproof structure.

B. Structure shall be rated NEMA 3R.

C. Provide 120-Vac space heaters in each cubicle with individual thermostat control. Power for space heaters shall be provided from internal control power systems.

D. Assembly shall be suitable for site erection on a concrete pad.

E. The enclosure shall be extended on the breaker drawout side to form an operating and/or maintenance aisle large enough to permit interchange of circuit breakers.

F. Provide interior lights, light switches and duplex ground fault receptacles in the aisle.

G. Provide ventilation fans, adequately sized for site conditions.

2.08 FACTORY TESTS

A. General

1. Actual operation performed whenever possible. Otherwise, inspection of continuity checks made.

2. Component devices operated in circuits as shown on diagrams.

3. Control and primary circuits given dielectric tests as described therein.

B. Detailed Tests:

1. Control Circuits and Devices:

a. Control bus energized at 80 percent rated dc or 85 percent rated ac control voltage.

b. Control devices operated as shown on diagrams.

c. Verification of all remote circuits which were not included in operational test.

2. Instruments, Meters, Protective Relays, and Associated Equipment:

a. Functionally tested by energizing current and potential circuits to rated values.

b. Instruments operated and expected readings verified.

c. Meters checked for proper calibration; current and voltage circuits for phasing.

d. Protective relays operated for functional check in accordance with rating and application. Instantaneous trips manually operated to verify correct functioning of operation indicator and associated circuits.

e. Relays set on maximum and checked for operation and friction.

3. Dielectric Tests:

a. Control circuits and associated wiring received insulation test of 1,500V, 60 cycles, for 1 minute, except where equipment manufacturer specifications do not permit.

b. Primary circuits (except PTs) tested phase to phase and phase to ground with 60-cycle voltage applied for 1 minute.

PART 3 – EXECUTION

3.01 PREPARATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as shown on shop drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts conditions.

3.02 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

3.03 FIELD TESTS

A. Perform visual, mechanical inspection and electrical tests per Section 16106, “Acceptance Testing.”

3.04 TRAINING

A. Provide the services of a factory trained Field Engineer for training at the job site on adjusting, servicing and maintaining the equipment and components. The Field Engineer shall be on site for one working day.

3.05 MANUFACTURER’S STARTUP SERVICES

A. Provide the services of a qualified factory-trained Field Engineer for a period of two working days for each switchgear lineup. The Field Engineer shall certify that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations.

PART 4 - MEASUREMENT AND PAYMENT

Measurement and payment for switchgear associated with the Crane Substations will be included with Bid Item No. 4, “Crane Substations 1 and 2.” All other switchgear will be measured and paid for with Bid Item No. 3, "Site Electrical.”

END OF SECTION

SECTION 16361

MEDIUM-VOLTAGE LOAD-INTERRUPTER SWITCHGEAR

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Medium-Voltage metal enclosed load-interrupter switchgear for crane substations.

B. The metal enclosed load-interrupter switchgear shall be UL listed and labeled.

1.02 RELATED WORK

A. Section 16106 – Acceptance Testing

B. Section 16443 – Crane Substation Assemblies

1.03 QUALITY ASSURANCE

A. Like items of equipment provided hereunder shall be the end product of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service.

1.04 SUBMITTALS

A. Product Data:

Submit product data for approval for switchgear assemblies consisting of manufacturer's literature, manufacturer's catalog data, and manufacturer's installation and maintenance instructions. Product data shall include all mechanical features such as dimensions and appearance and all electrical ratings associated with the assembly or component. At Contractors option, submit product data and resubmit if required, prior to submittal of shop drawings.

B. The following information shall be submitted to the Engineer:

1. Master drawing index.

2. Front view elevation.

3. Floor plan.

4. Top view.

5. Single line.

6. Schematic diagram.

7. Nameplate schedule.

8. Component list.

9. Conduit entry/exit locations.

10. Assembly ratings including:

    a. Short-circuit rating

    b. Voltage

    c. Continuous current

    d. Basic impulse level for equipment over 600 volts

11. Major component ratings including:

    a. Voltage

    b. Continuous current

    c. Interrupting ratings

12. Cable terminal sizes.

C. Shop Drawings:

Shop Drawings shall be submitted for switchgear assemblies to include all mechanical features, such as dimensions, weights, enclosure construction, and assembly details. Shop drawings shall include all electrical ratings associated with the assembly. Product data shall be submitted with the shop drawings for any component or assembly which the switchgear manufacturer requests substitution for a previously approved assembly or component.

1. Shop drawings shall include overall outline dimensions for all equipment and assemblies and shall include manufacturer's recommended installation clearances for operation and maintenance. Contractor and manufacturer's representative shall field verify space available with equipment sizes proposed including code required working clearances and identified access restrictions, and manufacturer's recommended clearances, prior to submittal of shop drawings.

2. Provide point-to-point interconnect wiring diagrams for all internal wiring between components.

3. Provide point-to-point wiring diagrams for all wiring requiring or allowing external connection.

4. Provide dimensioned shipping splits, weights, handling provisions.

5. Complete bill of materials.

6. Certification for use in seismic Zone 4. In addition, include equipment weights, center of gravity locations, and manufacturer’s requirements and/or restrictions for anchoring and/or support in seismic Zone 4 areas.

D. Operation and Maintenance Data

1. Include maintenance instructions for cleaning methods, cleaning materials recommended, instructions for circuit breaker removal, replacement, testing and adjusting, and lubrication.

2. Complete one-line, three-line drawings, equipment elevations, and interconnection drawings.

3. Include material and equipment summary sheets and recommended spare parts list.

4. Include descriptive bulletins and instructions for all relays, instruments, current and voltage transformers, control devices, capacitors, diodes, and resistors. Include excitation curves and ratio connection factor curves for instrument transformers.

5. Include certified factory test reports specified herein.

6. Manufacturer’s original time-current coordination curves.

E. Quality Control Submittals

1. Manufacturer’s test report.

2. Complete set of factory tests shipped with each piece of equipment.

3. Manufacturer’s Certificate of Proper Installation.

F. Calculations: Submit calculations and details for the anchoring of all the switchgear equipment provided under this Section of the specifications.

1. Calculations and details shall be done by the equipment manufacturer or designated agent, to meet the requirements of Seismic Zone 4.

2. Calculations and details shall be stamped and signed by a Registered Professional Structural Engineer currently licensed in the State of California.

3. The Contractor shall coordinate the anchoring details supplied by the equipment manufacturer with the construction details of the equipment pads shown on the drawings.

4. Include calculations and details in the O & M manual.

1.05 REFERENCES

A. The medium-voltage metal-enclosed switchgear shall be designed, manufactured, and tested in accordance with the latest applicable NEMA, ANSI and IEEE standards.

1.06 SPARE PARTS

A. Provide two insulated handle tools designed for pulling fuses.

B. Provide two sets of spare fuses of each size and rating.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square D or approved equal

2.02 SERVICE CONDITIONS

A. Suitable for outdoor service with following conditions:

1. Maximum elevation above sea level: 50 feet

2. Maximum ambient air temperature: 44 degree C

3. Minimum ambient air temperature: 0 degree C

4. Seismic Zone: 4

5. Maximum wind: 80 mph

6. Relative humidity: 95%

2.03 LOAD-INTERRUPTER SWITCHGEAR

A. Load-interrupter switchgear ratings:

1. Nominal System Voltage: 24.9 kV, three-phase, three-wire.

2. System Grounding: Solid.

3. Maximum Design Voltage: 27 kV.

4. Base Impulse Level (BIL): 125 kV.

5. Bus Continuous Current: 600A.

6. Momentary Current: 40 KA.

7. Two-Second Current: 25 KA.

B. Each switch shall have the following minimum ratings:

1. Maximum Design Voltage: 27 kV.

2. Basic Impulse Level (BIL): 125 kV.

3. Continuous and Load-Interrupting Current: 600 amperes.

4. Momentary Current (Switch Closed, 10 cycle): 40 KA asymmetrical.

5. Fault Close Current: 40 KA asymmetrical.

6. Two-Second Current: 25 KA.

2.04 CONSTRUCTION

A. Switchgear assembly, including individual air interrupter switches in freestanding cubicles, securely bolted together to form an integrated structure.

B. The switchgear assembly shall be integrally designed and produced by the manufacturer of the interrupter switches, enclosure, and operators to ensure a completely coordinated design.

C. The metal enclosed load interrupter switchgear shall consist of dead-front, completely metal-enclosed vertical sections containing load interrupter switches and fuses (where shown) of the number, rating, and type noted on the Drawings or specified herein.

D. The following features shall be supplied on every vertical section containing a three-pole, two-position open-closed switch:

1. Barriers: glass polyester between fuse and switch compartments, between individual poles (both switch and fuses), and between outer phases and the enclosure.

2. Each switch shall be actuated by means of a quick-make, quick-break, manually operated, stored energy mechanism. Provide motor operator where shown on the Drawing. Operating voltage shall be 120V, 60 Hz available from a fused control transformer.

3. Mechanical Linkages Between the Interrupter Switchblades and Operating Mechanism: insulating material meeting or exceeding the BIL of the bus insulation system.

4. Speed of opening or closing of contacts shall be independent of the operator.

5. The operating mechanism shall provide sufficient force to overcome the forces associated with closing the switch into a fault.

6. The interrupter switch shall have separate main, make, and break contacts to provide maximum endurance for fault close and load interrupting duty.

7. Arcing contacts shall be spring loaded on make and break and shall be last in and last out. Arc interruption shall take place in arc chutes.

8. High-impact viewing window shall be provided to enable visual inspection of all three-switch poles from outside the enclosure.

9. Opening the fuse access door shall not be required to observe the blown fuse indicator or switch position.

E. Fuse Holder: All fuses shall be positively clamped in position with provision for easy removal and replacement from the front without the use of special tools.

F. Through-bushing for fault isolation shall be provided between source-and-load bays and source-and-tie bays and not between load bay and load bay.

2.05 SAFETY INTERLOCKING

A. Hinged door shall be interlocked with the switch shaft so the switch must be open before the door can be opened, and the door must be closed before the switch can be closed.

2.06 INSULATION

A. All insulation supporting current-carrying parts shall be porcelain or epoxy.

2.07 MAIN BUS AND CONNECTIONS

A Buses shall be made of high-conductivity silver-plated copper.

B. All hardware shall have high tensile strength and anticorrosive plating.

C. A ground bus sized to carry rated 2-second current of the assembly shall be furnished to extend the entire length of the switchgear; ground bus conductor shall be copper.

D. Provide compression-type ground lugs for each compartment.

E. Provisions shall be made for convenient extension of main and ground bus in the future.

2.08 WIRING AND TERMINATIONS

A. One terminal pad per phase shall be provided for attaching cable terminal lugs for a maximum of two conductors per phase of the sizes indicated on the Drawings. Sufficient space shall be supplied for electrical stress relief termination devices.

B. Small wiring, fuse blocks, and terminal blocks within the vertical section shall be furnished as indicated on the Drawings. Each control wire shall be labeled with wire markers. Terminal blocks shall be provided for customer connections to other apparatus.

2.09 SURGE ARRESTERS

A. Provide 24 kV line to ground, suitable for operation on a 24.9 kV line-to-line, three-phase, three-wire system, distribution class lightning arresters mounted in main switch compartment.

B. Arresters shall be a totally solid-state type using metal oxide ceramic elements. Cap-type arresters are not approved. Arresters shall be Cutler-Hammer/Westinghouse, Type SMX, or approved equal.

2.10 INSTRUMENTATION AND METERING

A. Microprocessor Based Multifunction Power Meter:

1. Where indicated on the Drawings, provide a microprocessor based multifunction power meter. Meter shall have true RMS capabilities for accurate measurement of nonlinear single- and 3-phase loads.

2. Accuracy:

    a. Current and Voltage: 0.2 percent.

    b. Power and Energy: 0.4 percent.

3. Real-Time Readings: The meter shall be capable of measuring the following real-time parameters:

    a. Current: per phase, neutral, ground, three-phase.

    b. Voltage: L-L, L-n; input voltage 208Y/120, 480, or 480Y/277V.

    c. Real Power: per phase, three-phase.

d. Reactive Power: per phase, three-phase.

e. Apparent Power: per phase, three-phase.

f. Power Factor: per phase, three-phase.

g. Frequency.

h. Temperature: internal ambient (via communications only).

i. Total Harmonic Distortion (THD): current and voltage.

j. K Factor: per phase.

4. Demand Readings:

a. Demand Current: per phase present, peak.

b. Average Power Factor: three-phase total.

c. Demand Real Power: three-phase total.

d. Demand Reactive Power: three-phase total (via communications only).

e. Demand Apparent Power: three-phase total.

f. Coincident readings.

g. Predicted Demands: via communications only.

5. Energy Readings:

   a. Accumulated Energy: real, reactive apparent (apparent value via communications only).

   b. Bi-directional Readings: via communications only.

6. Power Analysis Values: via communications only.

   a. Crest Factor: per phase.

   b. K Factor Demand: per phase.

   c. Displacement Power Factor: per phase, three-phase.

   d. Fundamental Voltages: per phase.

   e. Fundamental Currents: per phase.

   f. Fundamental Real Power: per phase.

   g. Harmonic power.

   h. Unbalance: current and voltage.

   i. Phase rotation.

7. Alarm Relay Functions:

   a. Meter shall be capable of having any measured value as defined herein assigned as an under- or oversetpoint alarm. Time-delay feature (in seconds) shall be separately programmable for each alarm.

   b. Any alarm condition can initiate one or more relay functions. Three each, Form C, 10A mechanical relay, and one solid-state output shall be available.

8. Onboard Alarm/Event Recording:

   a. For any alarm, the circuit monitor shall be capable of logging the event type, date, and time and the most extreme reading during the pickup delay.

   b. When the alarm condition drops out, the drop time and date and the most extreme reading since pickup can be logged. The size of the event log shall be user configurable up to the limits of the onboard memory.

9. Data Logging:

   a. Provide nonvolatile memory for storing meter readings at regular intervals. Up to 14 independent user-defined data logs shall be possible.

   b. Log Interval: 1 minute to 24 hours.

   c. Each log shall be capable of up to 51,200 values.

10. Communications: Provide optically isolated RS-485 communication port. Protocol shall be of the open-architecture variety using standard ANSI character and control set.

11. Waveform Capture:

   a. Waveform capture shall be initiated on demand by the user or by any assigned setpoint.

   b. Waveform capture shall capture all three voltage (line-to-line) and four current waveforms. Each waveform shall be simultaneously sampled 64 times per cycle; resolution shall be 12 bits.

12. Event Capture:

   a. Provide event capture feature capable of recording short duration events (less than 12 cycles).

   b. Cycles of data shall be captured for each waveform. User shall be capable of determining the number of cycles prior to and after the event captured.

13. Harmonics: Unit shall be capable of calculating the THD for any waveform on board the meter. Meter shall be capable of true RMS operation up through the thirty-first harmonic.

14. Meter shall be Cutler-Hammer IQ-Analyzer.

B. Potential Transformers

1. Molded type with 0.3 accuracy classification at burden imposed by meters and instruments (including future) as shown with primary fuses on each ungrounded conductor connected to switchgear bus.

C. Current Transformers

1. Molded type, bar or donut type, with 0.3 accuracy at burden imposed by meters and instruments (including future) shown; furnish shorting-type terminal boards for all current transformer leads.

D. Test Switch

1. Provide test switch constructed of molded polycarbonate with screw-type terminals for ring-tongue connectors at rear, suitable for panel mounting on switchboard. Switch shall automatically short circuit current transformer circuits when the knife switches are opened prepatory to inserting the test plug. Switch shall have four potential and six current poles and shall be Westinghouse Type FG-1, Style 129A514G01, or equivalent model manufactured by Superior.

2.11 ACCESSORIES

A. Space Heaters: for 120 AC internal source, sized by switchgear manufacturer. One heater for each cubicle; one thermostat shall control all heaters.

B. Provide permanently mounted operating handle, lockable in both positions. Interlock fuse compartment door to prevent opening with switch in closed position.

C. Auxiliary Contacts: Furnish with each switch four 5-amp 120 VAC auxiliary contacts (two each NO and NC). Extend leads to terminal strip in the instrument or fuse compartment.

D. Signage: Provide “danger-high voltage, keep out” signs on all doors and covers providing access to live parts. Provide laminated nameplates (white, engraved to black core) as per the schedule in the Drawings.

E. Internal Light: Each unit shall have a switched 120 VAC light within the cubicle for viewing status of the switch contacts; 120V power shall be provided from an internal source. The light switch shall be accessible through the outer door.

2.12 FABRICATION

A. Construction: universal frame type; formed, welded, and bolted members. Top and rear covers shall be removable.

B. All covers and doors shall be fabricated from not less than 11-gauge steel. Maximum dimensions shall be as shown on the Drawings.

C. Each switch cubicle shall have a single or double door over the switch/fuse assembly. Provide high-impact windows for viewing contact position and blown fuse indicators.

D. Provide spare fuse compartment on interior side of each switch door.

E. Outdoor units shall be door-to-door, nonwalk-in, construction with sloped, dripproof roof. All openings shall be screened to prevent the entrance of small animals and barriered to prevent entrance of snow, sand, etc.

2.13 FACTORY FINISHING

A. Clean surfaces before applying paint.

B. Apply corrosion-resisting primer to all surfaces.

C. Apply finish coat of baked enamel paint to (2) (4) mils thick.

D. Finish Color: ANSI 61 Light Gray.

2.14 FACTORY TESTS

A. The metal-enclosed gear shall be fully assembled and tested at factory prior to shipment. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

B. Provide three certified copies of test report on fault close, momentary, and BIL based on ANSI and NEMA standards for essentially duplicate units.

2.15 NAMEPLATES

A. Nameplates: white phenolic engraved to a black core. Nameplate size, character height, and inscription shall be per the Drawings. Provide nameplates for each breaker, relay, instrument, control device, transformer, and incoming line compartment. Minimum character height shall be 5/32 inch. All nameplates shall be attached with steel screws. Provide master nameplate on tie-breaker cubicle indicating equipment name (1-inch letters), voltage and service (1/2-inch letters), and source of power (1/2-inch letters).

PART 3 – EXECUTION

3.01 PREPARATION

A. Install in accordance with manufacturer’s instructions.

B. Secure switchgear rigidly to floors or mounting pads with anchor bolts, Phillips Drill Company concrete anchors, or other approved means.

C. Retighten to NEMA standards all current-carrying bolted connections and all support framing and panels.

D. After the equipment is installed, touch up any scratches, etc., incurred during shipment or installation.

3.02 FIELD TESTS

A. Perform visual, mechanical inspection and electrical tests per Section 16106 "Acceptance Testing."

3.03 TRAINING

A. Provide the services of a factory trained Field Engineer for training at the job site on adjusting, servicing and maintaining the equipment and components. The Field Engineer shall be on site for one working day

3.04 MANUFACTURER'S STARTUP SERVICES

A. Provide the services of a qualified factory-trained Field Engineer for a period of one working day for each switchgear lineup. The Field Engineer shall certify that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

PART 4 - MEASUREMENT AND PAYMENT

No separate measurement and payment will be made for medium-voltage load-interrupter switchgear as described within this section. The cost of this work shall be considered incidental to the lump sum cost of "Crane Substations 1 & 2" where this equipment will be required.

END OF SECTION

SECTION 16364

REEFER UNIT SUBSTATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work of this Section consists, in general, of furnishing a refrigerated container (reefer) substation consisting of a 15kV class, fused Air Interrupter Switch, 2500kVA Oil-Filled Transformer and 600V Low Voltage Switchgear as indicated on the drawings, as specified and as directed by the Engineer.

1.02 REFERENCES

A. References include, but are not limited to the following:

1. ANSI C57.12.
2. IEEE C57.12.
3. ANSI/IEEE C37.20.
4. ANSI/IEEE C37.30.
5. NEMA SG-6.
6. Underwriters Laboratories.
7. OSHA 1910.7.
8. NFPA 70 – National Electric Code.

1.03 SUBMITTALS

A. Submit the following information for the approval by the Engineer, prior to fabrication:

1. Manufacturers' Data: Submit copies of manufacturers' catalog data clearly showing component manufacturers' name and catalog number(s), nameplate data and description of the following items:

    a. Transformer primary fuses including minimum melt and total clearing time-overcurrent curves.
    b. Oil-Filled transformer.
    c. Low voltage switchboard.
    d. Circuit breakers, including time-overcurrent curves.
    e. Ground fault sensors and relays, including time-overcurrent curves.
    f. Current transformers.

g. Potential transformers.
h. 480 – 120/240 volt transformer.
i. Voltmeter.
j. Ammeter.
k. Meter switches.
l. Space heaters and thermostat.

2. Design Tests: Submit copies of design tests done by the load interrupter switch manufacturer, in accordance with ANSI C37.34 and the transformer manufacturer, in accordance with ANSI C57.12.90, on equipment of the same ratings as that being furnished.
3. Shop Drawings: Submit shop drawings of the following:

a. One-line or three-line diagram.
b. Equipment weight, dimensional data and line-up drawings, including front, top and side views of transformer, switchboard heaters and landing lugs.
c. Schematic and wiring diagrams for the ground fault relays.
d. C.T. mounting.
e. Instrument arrangements.
f. Transformer plan and elevations locating all components.
g. Recommended method of anchoring to concrete slab.
h. Anchor seismic stress calculations.

1.04 <u>ACCEPTABLE MANUFACTURERS</u>

A. Square D or approved equal

PART 2 – PRODUCTS

2.01 <u>GENERAL</u>

A. All components of the unit substation shall be manufactured for a seismic zone 4 and shall be corrosion resistant NEMA 3R.

2.02 <u>TRANSFORMER</u>

A. Ratings and Electrical Characteristics:

1. Voltages, capacity, and winding configuration for each transformer are shown on Drawings.
2. Standard BIL (Base Impulse Level).

3. Full capacity primary taps, 2-2 ½% above and 2-2 ½% below rated voltage. External manual tap changer for de-energized operation, equipped for padlocking.
4. Standard impedance.
5. Continuous rated 2500kVA at 55°C average winding temperature rise, 112% rated kVA at 65°C average temperature rise.
6. Copper Windings.

B. Enclosure

1. Sealed tank with welded cover.
2. Bolted cover handhole in tank cover.
3. Manufacturer's standard finish.

C. Accessories

1. Top filter press connection.
2. 1 inch globe type drain and filter press valve with sampling device.
3. Diagrammatic nameplate.
4. Liquid level gage with alarm contacts.
5. Top oil thermometer.
6. Pressure-vacuum gage.
7. Copper faced ground pad with NEMA drilling.
8. Lifting lugs and provisions for jacking.
9. Cover mounted bushings.
10. Provisions for future automatic temperature controlled cooling fans.

A. Coolant: Oil, in accordance with NEC article 450 in units installed outdoors.

B. Equip with suitable flanges and transition sections for coordinated field connection to primary and secondary apparatus at opposite ends of transformer tank.

C. Warning Signs:

1. OSHA Subpart J – General Environmental Controls, Section 1910.145.
2. Signs provided with equipment are acceptable provided all necessary signs are issued with equipment.
3. Provide identical signs for each application.
4. High voltage warning signs to read "DANGER – HIGH VOLTAGE – KEEP OUT".

D. Audio noise level of the units shall conform to NEMA standards for industrial transformers.

2.03 SECONDARY LOW VOLTAGE SWITCHBOARD

A. Housing: Welded steel framework rigidly braced and covered with sheet steel in accordance with ANSI/IEEE C37.20.1, constructed in such a manner as to permit rolling in place using conduit or pipe.

1. Compartments: Separate compartmentation with insulating or grounded metal barriers to segregate circuit breakers and auxiliary compartments, main bus, incoming line buswork, and rear cable compartment of each vertical frame or section.
2. Doors: Formed steel, mounted on concealed hinges, with latches.
3. Ventilation: Openings for natural ventilation designed to prevent entry of rodents and to guard against accidental contact with energized parts.
4. Finish: Manufacturer’s standard.

B. Buses: High conductivity electrical grade copper bars with silver-plated connection contact surfaces. Use Belleville type washers on bolted connections.

1. Uninsulated ground buss entire length of switchgear assembly.
2. 100% rated isolated neutral bus.
3. Insulate or provide barriers for load side runbacks to feeder cable connection terminals where they pass through main bus compartment.

C. Power Circuit Breakers:

1. Rated 600 volts, 60 Hz. And of frame size as designated on Drawings.
2. Electrically operated (pump free) main breaker served from a power source inside switchgear assembly.
3. Solid state trip devices with current sensors as required for long-time, short-time, instantaneous, and ground sensing functions as designated on Drawings.
4. Minimum short circuit interrupting capacity of 65,000 RMS symmetrical amperes.

D. Metering: Panel mounted, digital metering unit with metering functions as designated on Drawings.

E. Cable Entrance/Exit: Bottom

F. Instrument Transformers: Provide with accuracy classes suitable for applications and burdens imposed and with thermal and mechanical characteristics adequate to withstand stresses caused by maximum possible short circuit conditions.

G. Operating Handle Height: Position power circuit breaker units so that center of operating handle grip does not exceed 6'-6" above finished floor or working platform.

H. Accessories:

1. Hoist: Manually operated hoisting device, mounted on top of switchgear assembly, capable of raising and lowering circuit breakers between their operating position and floor.
2. Test Set: Portable test set, operating on 115 volts AC, capable of verifying circuit breaker operation within band-width of trip device characteristic curves at desired settings.

I. Equip switchgear for direct connection to transformer secondary with full-height full depth, flanged transition section coordinated with transformer flanges.

2.04 PRIMARY INTERRUPTER SWITCH

A. Electrical Ratings (Without Fuses):

Max. KV.	Continuous AMP	Interrupting AMP	Momentary AMP	Fault Closing AMP	KV BIL
15.0	600	600	40,000	40,000	95

B. Mechanism:

1. Switch operating mechanism providing simultaneous, quick-make and quick-break operation of 3 poles by a manual crank or lever located outside enclosure and with blade movement inherently independent of the speed at which manual lever is moved.
2. Separate arcing contacts, arc-chutes, and phase segregation barriers.

C. Doors: Equip with glass or polycarbonate viewing ports located to facilitate visual verification of switchblade position.

D. Insulation: Insulate switch bases, fuse mountings and buswork by means of air and glazed porcelain, glass polyester, or cast epoxy.

E. Lightning Arresters: Intermediate class; quantity and location as indicated on Drawings.

F. Fuses: Current limiting power fuses with minimum interrupting rating of 40,000 RMS symmetrical amperes mounted below interrupter switch. Mechanically interlock fuse door with switch operator to prevent access to energized fuses.

G. Cable Entrance: Bottom primary circuit entrance. Primary circuit consists of 1 run of 3 single conductor cables in conduit.

H. Termination: Provide compression-type connectors.

I. Outdoor Switches:

1. Weatherproof steel enclosure with sloped roof and openings screened to prevent entrance of small animals and airborne particles such as sand or snow.
2. Thermostatically controlled space heaters served by a transformer mounted in the switch enclosure.

J. Equip switch for direct connection to transformer primary with full-height, full depth, flanged transition section coordinated with transformer flanges.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install anchor bolts and hardware required to level, align, secure, and connect substation components in accordance with manufacturer’s instructions. Make electrical connections for supply and load circuits and leave items in operating condition.

3.02 TESTING

A. Refer to Section 16950.

3.01 IDENTIFICATION

A. Refer to Section 16195.

END OF SECTION

SECTION 16402

UNDERGROUND ELECTRICAL WORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. PVC conduit

B. Plastic Utilities Duct

C. Precast Manholes

D. Moisture Sealing Material

1.02 APPLICABLE PUBLICATIONS

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. American National Standards Institute, Inc. (ANSI) Publication:

1. C2-97 National Electrical Safety Code

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

1. A48 Gray Iron Castings

2. A123 Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips

3. A153 Zinc Coating (Hot Dip) on Iron and Steel Hardware

4. A569 -Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality

5. C478-95 Specification for Precast Reinforced Concrete Manhole Sections

C. National Electrical Manufacturer's Association (NEMA) Publications:

1. TC2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

2. TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing

3. TC 6 PVC and ABS Plastic Utilities Duct for Underground Installation

4. TC 8 Extra-Strength PVC Plastic Utilities Duct for Underground Installation

5. TC 9 Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation

6. TC 10 PVC and ABS Plastic Communications Duct and Fittings for Underground Installation

7. RN 1 PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metallic Conduit Tubing

D. National Fire Protection Association (NFPA) Publication:

1. 70-99 National Electrical Code (NEC)

E. State of California Administrative Code:

1. Title 24, Part 3, CCR, 2001 California Electrical Code

F. State of California Public Utilities Commission (Cal. P.U.C.) Publication:

1. G.O.128 Rules for Construction of Underground Electrical Supply and Communications Systems

G. Underwriter's Laboratories Inc. (U.L.) Publications:

1. 6-97 (R86) Rigid Metallic Conduit

2. 514B-89 Fittings for Conduit and Outlet Boxes

3. 651-95 Schedule 40 and 80 Rigid PVC Conduit

1.03 SUBMITTALS: The following information shall be submitted for approval:

A. Product Data: Provide for:

1. Conduit/Duct (all types)

2. Precast Manholes

3. Sealing Material for Precast Manholes

4. Manhole Frames and Covers

B. Shop drawings: Provide for:

1. Precast Manholes: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.

2. Submit structural calculations for all precast concrete items as follows:

a. Submit structural calculations for all loads including traffic, soil pressure and live loads.

b. Submit buoyancy calculations based on water table at five (5) feet below grade. All products shall have a buoyancy safety factor of 1.5 minimum.

c. The calculations shall include a statement by the structural engineer that products are suitable for use in seismic zone 4 as defined by the Uniform Building Code

C. Certificates:

1. Material and Equipment: Provide manufacturer's statement certifying that the product supplied meets or exceeds contract requirements.

a. Precast manhole and accessories.

1.04 QUALITY ASSURANCE

In each standard referenced to herein, consider the advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or other words of similar meaning, to mean Engineer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle Products to site under provisions of Sections 01600 and 16010. Inspect for damage.

B. Store and protect in accordance with manufacturer’s instructions.

1.06 PROJECT CONDITIONS

A. The drawings are diagrammatic and shall not be scaled for exact locations. The location of existing underground utilities are based on record drawings and casual field observations. The Contractor shall use reasonable care in excavating for the installation of new underground ducts and shall be responsible for damage to existing underground utilities. Field conditions and non-interference with other utilities and trades, shall determine exact locations of new underground electrical ducts.

B. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

1.07 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700.

B. Accurately record actual locations of exact routing of ductbank indicating plan location and depths every 50 linear feet. Measure conduit locations from permanently fixed readily discernible landmarks such as building corners, columns, manhole centerline, etc.

C. Accurately record actual locations of each manhole.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

All materials and equipment shall be new and of high quality to give long life and reliable operation. All equipment shall be modern in design and shall not have been in prior service except as required by factory tests. Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated.

2.02 CONDUIT

A. Rigid Metal Conduit: UL 6, hot-dip galvanized, threaded type.

B PVC Coated Rigid Steel Conduit: NEMA RN 1.

C. Rigid Plastic Conduit: NEMA TC2; Schedule 40 PVC.

2.03 PLASTIC DUCT

A. Concrete Encased Plastic Utilities Duct: U.L. 651: Schedule 40 Rigid PVC Conduit.

B. Concrete Encased Plastic Telecommunication Duct: U.L. 651: Schedule 40 Rigid PVC Conduit.

2.04 FITTINGS AND OUTLET BOXES

A. Metal Fittings and Outlet Boxes: UL 514A and 514B. Fittings and boxes for use with steel conduit, rigid or flexible shall be cast-metal with gasketed closures.

B. PVC Fittings and Conduit Bodies: NEMA TC3.

C. Plastic Utility Duct Fittings: NEMA TC6, TC 9, TC10. & ASTM F512.

2.05 PULL WIRE

Pull wire shall be nylon having a minimum tensile strength of 200 lbs in each empty duct. Minimum 48 inches of slack shall be left at each end of pull wires. Plug spares for future use.

2.06 CABLE SUPPORTS

Provide a means of supporting all cables running through electrical manholes. This shall be in the form of vertical channels cinch anchored to the manhole wall. A cantilevered support fastened to the channels shall be used to support the cable and splices. Cable racks, including rack arms and insulators, shall be adequate to accommodate the cable. A porcelain clamp shall be used to insulate and protect cables from supports. All cables smaller than 0.75" diameter shall be provided with some supplementary means of support such as cable tray or conduit. All exposed metal parts and fasteners shall be fabricated of stainless steel or double hot-dip galvanized steel.

2.07 PRECAST CONCRETE MANHOLES

A. Precast concrete manholes, risers and tops shall conform to ASTM C 478, except that the spacing of manhole steps or ladder rungs shall not exceed 16 inches. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete manholes. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete constructed in modular sections with tongue-and-groove joints. Walls and bottom shall be of monolithic concrete construction. Covers shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair their strength or appearance. Exposed metal shall have a smooth finish and sharp lines. Provide all necessary lugs, rabbets, and brackets.

B. Reinforcing: Shall be designed and constructed to accommodate the loading criteria shown in plans for the various areas of the Terminal.

C. Duct Entry Provisions: Windows with plastic duct terminators and diaphragms. Duct entrances and windows shall be located near the corners of structures to facilitate cable racking.

D. Cable Pulling Irons: Use galvanized rod and hardware. A pulling-in iron shall be installed in the wall opposite each duct line entrance. Set pulling-in irons and other built-in items in place before depositing concrete. Provide watertight seal.

E. Cable Rack Inserts: Minimum load rating of 800 pounds.

F. Ladder: Steel, with top hook to engage manhole step in riser casting. Provide one ladder for each manhole.

G. Sump Covers: ASTM A48; Class 30B gray cast iron.

H. Riser Casting: 6 inch, with manhole step cast into frame.

I. Frames and Covers: ASTM A48; Class 30B gray cast iron, 30 inch size, machine finished with flat bearing surfaces. The word "ELECTRIC" shall be cast in the top face of all power manhole covers. In addition, manhole identification (i.e. "EMH 1-1") shall be welded on cover.

J. Requirements of Section 16104.

2.08 MOISTURE SEALING MATERIAL

A. Provide a two-part urethane foam sealant which when mixed will expand approximately 15 times in volume to form a dense, strong tough foam unit with density of 3 to 4 pounds per cubic foot. Sealant shall reach 60% full strength in 8 to 10 minutes after application.

2.09 GROUNDING

A. Shall conform to UL 467 and requirements of Section 16170.

PART 3 - EXECUTION

3.01 INSTALLATION

Underground cable installation shall conform to NFPA 70, Cal. P.U.C. G.O.128, and all other state and local codes.

3.02 CONCRETE

Concrete for electrical requirements shall be at least 3000 psi concrete with one-inch aggregate and in accordance with Section 03300, unless otherwise noted.

3.03 UNDERGROUND DUCT WITH CONCRETE ENCASEMENT

Construct underground duct lines of individual conduits encased in concrete. Concrete encased conduit shall be of polyvinyl chloride, Schedule 40 for power and telecommunication. Do not mix the kind of conduit used in any one duct bank. Ducts shall not be smaller than 5 inches in diameter, unless otherwise indicated. The concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches, except separate power conduits from telephone conduits by a minimum concrete thickness of 12 inches. Risers shall be pvc coated rigid steel.

A. Duct Line: Duct lines shall have a continuous slope downward toward manholes and away from buildings with a pitch of not less than 4 inches in 100 feet. Except at conduit risers, changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 48 inches for ducts of 3 inches in diameter and larger.

1. Join nonmetallic duct using adhesive as recommended by manufacturer. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

2. Use suitable separators or chairs of high impact polystyrene installed not greater than 4 feet on center.

3. The joints of the conduits shall be staggered by rows and layers so as to provide a duct line having the maximum strength.

4. During construction, partially completed duct lines shall be protected from the entrance of debris such as mud, sand and dirt by means of

suitable conduit plugs.

B. Conduit Termination to Manholes: Conduits shall terminate in end-bells at right angles with the wall, where duct lines enter manholes. As each section of a duct line is completed from manhole to manhole, a testing mandrel not less than 12 inches long with a diameter 1/4 inch less than the size of the conduit shall be drawn through each conduit, after which a brush having the diameter of the duct, and having stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand, of gravel; conduit plugs shall then be immediately installed.

C. Concrete Envelope: Securely anchor duct to prevent movement during concrete placement. The top of the concrete envelope shall not be less than 24 inches below grade, except that under roads and pavement it shall not be less than 36 inches below grade, unless otherwise indicated on drawings. Concrete for encasement of conduit shall be cement slurry consisting of 3 sacks of cements and 10 pounds of red oxide per yard of sand and in accordance with Section 03300. Excavated material shall be removed from the site on the same day as excavation. Backfill shall be a two sack slurry.

D. Underground Warning Tape: Identifying tapes shall be buried in all utility line trenches. Place one tape above the centerline of each duct bank. Refer to Section 16195.

3.04 PRECAST MANHOLES

Provide precast manholes complete with all accessories, sumps, drain facilities, and strengths as required. Identify each casting by having the manufacturers name and address cast into an interior face or permanently attached thereto. The complete assembly, including neck, collar, frame, and cover shall accommodate the load criteria shown on the drawings. Submit manufacturer's certificate of compliance with requirements.

A. Install and seal precast sections in accordance with manufacturer's instructions. Install manholes plumb. Use precast neck and shaft sections to bring manhole cover to finished elevation.

B. Attach cable racks to inserts after manhole installation is complete.

C. Install drains in manholes and connect to 4 inch pipe terminating in crushed gravel bed.

D. Ground Rods: In each electric manhole, at a convenient point close to the wall, a 3/4-inch by 10-foot T-304 stainless steel clad ground rod shall be driven into the earth so that the approximately 4 inches of the ground rod will extend above the manhole floor.

E. Manhole Grounding: Ground rods installed in electrical manholes shall be properly connected to the cable shielding, metallic sheath, and armor at each cable joint or splice by means of No. 6 AWG or equivalent braided tinned copper wire. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Ground wires shall be neatly and firmly attached to manhole and the amount of exposed bare wire shall be held to a minimum.

F. Core drill or saw cut conduit entrances into existing manholes. Provide a bell end into the manhole panel. Completely seal around the conduit penetrations.

G. Install additional cable racks in existing manholes as required for the cables being installed. Set racks and inserts on not greater than 36 inch centers.

H. Requirements of Section 16104.

3.05 PREPARATION FOR PULLING IN CONDUCTORS

A. Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

B. Immediately after installation, plug or cap all raceway ends with water-tight and dust-tight seals until the time for pulling in conductors.

C. For all new concrete-encased raceways, after the concrete envelope has set, pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway. Then pull a bristle brush through each raceway to remove debris.

D. Rod, clean and provide pull rope in all existing ducts to be used for conductor paths under this Contract. For existing underground raceways, pull a mandrel of a diameter approximately 1/2 inch less than the raceway inside diameter, through each raceway. Then pull a bristle brush through each raceway to remove debris.

3.06 EMPTY RACEWAYS

A. Certain raceways will have no conductors pulled in as part of the Contract. Identify with tags at each end and at any intermediate pull point the origin and destination of each such empty raceway. Where a raceway has been identified with a name (number) in the Feeder Schedule, use that name on the tag in lieu of origin and destination. Provide a removable permanent cap over each end of each empty raceway. Provide a 3/8" nylon pull cord in each empty raceway.

3.07 GROUNDING

Grounding shall be in accordance with ANSI C2. All ground wire shall be copper. Refer to Section 16170 "Grounding and Bonding".

END OF SECTION

SECTION 16426

DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.01 SCOPE

Work includes but is not necessarily limited to the following:

A. Definitions, guarantees, submittals, clean-up, as-builts and all other applicable requirements of Division 0 and Division 1 apply to the work of this section.

B. Examine all other sections for work related to those sections which are required to be included as work under this section.

C. Coordinate all work in the section with related trades.

D. Verify all dimensions in the field.

1.02 APPLICABLE PUBLICATIONS

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. American National Standards Institute, Inc. (ANSI) Publications:

1. C12.1 Code for Electricity Metering

2. C39.1 Electrical Analog Indicating Instruments

3. C57.13 Instrument Transformers.

B. National Electrical Manufacturer's Association (NEMA) Publications:

1. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches.

2. NEMA KS 1 Enclosed Switches.

3. NEMA PB 2 Deadfront Distribution switchboard.

4. NEMA PB 2.1 Proper Handling, Installation, Operation and Maintenance of Deadfront switchboard Rated 600 Volts or Less.

C. National Fire Protection Association (NFPA) Publication:

1. 70-99 National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit under provisions of Section 01300 and 16010.

B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral and ground; and switchboard instrument details.

C. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.

D. Test Reports: Indicate results of factory production tests.

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

1.04 OPERATION AND MAINTENANCE MANUAL

A. Submit under provisions of Section 01300 and 16010.

B. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.05 INSTRUCTION TO CITY PERSONNEL

Instruction shall be provided for items specified in this Section. See Section 16010, “ELECTRICAL GENERAL REQUIREMENTS”.

1.06 QUALIFICATIONS

A. To be considered for approval, a manufacturer shall have specialized in the manufacturing and assembly of switchboard for at least twenty (20) years.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Products provided shall be listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 16010.

B. Deliver individually wrapped for protection and mounted on shipping skids.

C. Accept switchboard on site. Inspect for damage.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA PB 2 service conditions during and after installation of switchboard.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

1.11 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Section 01430.

B. Provide two of each key.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Square D or approved equal

2.02 SWITCHBOARD

A. Description: NEMA PB 2 with electrical ratings and configurations as indicated. Distribution switchboards shall be NEMA Class I for bus ratings through 2000 amps and NEMA Class II above 2000 amps. The distribution branch protective devices shall be group mounted with gutter clearances in accordance with UL and with hinged full height wiring gutter doors for clear access to wiring terminals. Vertical sections shall have full height bus and spaces for future and shall be such that devices can be installed readily without drilling or field modifications.

B. Main Section Devices: Individually mounted and compartmented, two-step stored energy, electronic trip power circuit breakers with ammeter/trip indicator LSIG full-function trip unit.

C. Distribution Section Devices

1. Rated 400A or above: Electronic trip molded case full function 80% rated circuit breakers. Full function trip system shall include ammeter/trip indicator and LSIG full-function trip unit

2. Rated below 400A: Thermal magnetic molded case circuit breakers, group mounted.

D. Bus Material: Copper with tin plating, standard size.

E. Bus Connections: Bolted, accessible from rear for maintenance.

F. A-B-C type bus arrangements - left-to-right, top-to-bottom and front-to-rear shall be used throughout to assure convenient and safe testing and maintenance. Fully insulate load side bus bars in rear accessible compartments. Do not reduce spacing of insulated bus.

G. Ground Bus: Extend length of switchboard and shall be sized per UL Standard 891.

H. Molded Case Circuit Breakers: NEMA AB 1, integral thermal and instantaneous magnetic trip in each pole. Circuit breakers up to 250 amperes at 600 VAC shall be UL listed with HACR ratings. The operating mechanism shall be entirely trip-free, so that the contacts cannot be held closed against an abnormal overcurrent or short circuit condition. The operating handle shall open and close all poles of the breaker simultaneously and the breaker mechanism must have a common internal trip bar to trip all poles simultaneously. The breaker shall have a UL label showing UL tested interrupting rating equal to or exceeding the fault current available. Breakers shall include terminal lugs with UL label for CU/AL.

1. Solid-State Molded Case Circuit Breakers: Provide with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip where indicated; instantaneous trip; and adjustable long and short time trip.

I. Line and Load Terminations: Accessible from the front of the switchboard, suitable for the conductor materials and sizes indicated.

J. Provide SQD Powerlogic CM4000 metering and monitoring as indicated.

K. All devices shown on the drawings or described herein, and necessary small wiring, fuse blocks and terminal blocks within the switchboard shall be factory installed. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips.

L. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

M. Enclosure: NEMA Type 3R for outdoor.

1. Align sections at front and rear.

2. Switchboard Height: 91-1/2 inches, excluding floor sills and lifting members.

3. Finish: Coat surfaces with minimum one coat of zinc rich corrosion-resisting primer and apply a polyester power coat suitable for marine environment. Exterior surfaces shall be given a final finish of gray (ANSI 49) air-dried acrylic enamel with clear polyurethane top coat.

2.03 ELECTRONIC CIRCUIT MONITOR

A. Provide electronic metering device where indicated on the drawings.

2.04 METERING TRANSFORMERS

A. Current Transformers: ANSI C57.13; 5 ampere secondary, wound type, with single secondary winding and secondary shorting device, primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13; 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify conditions under provisions of Section 16030.

B. Verify that surface is suitable for switchboard installation.

3.02 PREPARATION

A. Provide concrete housekeeping pad under the provisions of Division 3.

3.03 INSTALLATION

A. Install switchboards at location shown on Drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Provide cable ties for cables from point of entrance to respective device terminals.

D. Bolt each switchboard securely to the concrete slab sufficient for seismic zone 4

E. Conduits entering bottom of switchboard shall be terminated with a metal grounding bushing with neoprene throat insert. Each bushing shall be connected to the switchboard ground bus with #4 insulated ground conductor.

F. Contractor is responsible for ensuring that termination of conduits entering the top of switchboard constitutes a tight and continuous metal-to-metal contact penetrating the finish paint on enclosure.

3.04 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

C. Adjust circuit breaker trip and time delay settings to values established by manufacturer's coordination study.

3.05 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

3.06 FIELD TESTS

Refer to Section 16030, "ELECTERICAL ACCEPTANCE TESTING," for additional requirements. As an exception to requirements that may be stated elsewhere in the contract, the Engineer shall be given minimum 5 working days written notice prior to each test. The Contractor shall provide all test equipment and personnel and submit written copies of all test results.

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each, at test voltage of 1000 volts; minimum acceptable value for insulation resistance is 2 megohms.

C. Check tightness of accessible bolted bus joints using calibrated torque wrench.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16443

CRANE SUBSTATION ASSEMBLIES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Crane Substation Assemblies No. 1 and 2 includes following work:

1. Medium-voltage (24.9 kV) load-interrupter switchgear.
2. Power transformer.
3. Medium-voltage (4160v) metal-clad switchgear.
4. Medium-voltage (4160v) busway.
5. Medium-voltage (2400v) low resistance, transformer neutral grounding resister.
6. Interconnect power wiring; all control and instrumentation devices and interconnect control wiring.

1.02 RELATED WORK

A. Section 02444 – Chain Link Fence and Gates

B. Section 03100 – Concrete Formwork

C. Section 03200 – Concrete Reinforcement

D. Section 03300 – Cast-in-Place Concrete

E. Section 16106 – Acceptance Testing

F. Section 16110 – Raceways

G. Section 16120 – Wires and Cables

H. Section 16121 – Medium-Voltage Busway

I. Section 16320 – Power Transformers

J. Section 16350 – Medium-Voltage Metal-Clad Switchgear

K. Section 16361 – Medium-Voltage Load-Interrupter Switchgear

L. Section 16451 – Medium-Voltage Low Resistance Grounding

1.03 QUALITY ASSURANCE

A. Like items of equipment provided hereunder shall be the end product of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer'’ services.

1.04 SUBMITTALS

A. Submittals as required under individual equipment specification sections.

B. Control and alarm schematic and wiring diagram indicating all interconnection wiring between individual equipment.

C. Handling and installation instructions.

D. Anchoring instruction per UBC California State Seismic Zone 4 requirements. The anchoring instruction shall be certified for construction.

E. Operation and Maintenance Manuals with equipment shipment.

1.05 REFERENCES

A. The equipment shall be designed, manufactured, and tested in accordance with the latest applicable NEMA, ANSI and IEEE Standards.

PART 2 - PRODUCTS

2.01 MEDIUM-VOLTAGE (24.9 KV) LOAD-INTERRUPTER SWITCHGEAR

A. Provide medium-voltage load-interrupter switchgear in accordance with Section 16361.

B. Connect the load side of the load-interrupter switch to the power transformer high-voltage side through power cables as shown on the drawings.

2.02 POWER TRANSFORMER

A. Provide power transformer in accordance with Section 16320.

B. Connect primary side with power cables in an enclosed air terminal chamber.

C. Connect secondary side with busway system in an enclosed air terminal chamber.

2.03 MEDIUM-VOLTAGE (4160 V) METAL-CLAD SWITCHGEAR

A. Provide medium-voltage metal-clad switchgear in accordance with Section 16350.

2.04 MEDIUM-VOLTAGE (4160 V) BUSWAY

A. Provide medium-voltage busway in accordance with Section 16121.

2.05 FACTORY TESTS

A. Perform factory tests as required under individual equipment specification sections.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install each item of equipment as recommended by the respective manufacturer.

B. Equipment installation shall comply with the requirements of NFPA 70, ANSI C2 and State of California PUC GO 128.

C. Each piece of equipment shall be securely bolted to the concrete pads to resist the forces encountered in Seismic Zone 4.

3.02 EXAMINATION

A. Equipment shall be carefully inspected for damage prior to installation. Carefully inspect bus joints, door hinges, door handles, meters, protective relays and other major components. Torque all bus connections to the values recommended by the equipment manufacturer. All equipment shall be re-inspected and re-torqued prior to energizing equipment.

B. Verify that field measurements are as shown on the drawings.

3.03 CONNECTIONS AND TERMINATIONS

A. Conductors terminations and connections shall be made and supported in such manner as not to cause damage to the equipment connection points.

B. Secure all wiring within the equipment using nylon cable ties.

C. Refer to Section 16450 Grounding for grounding requirements.

3.04 ADJUSTMENTS

A. Refer to the manufacturer's instruction books to make adjustments to the circuit breakers, door hinges, handles and other miscellaneous hardware.

B. Set relay and circuit breakers to the settings recommended by the coordination protection anaylsis.

3.05 CLEANING

A. Clean interiors to remove construction debris, dirt and shipping materials. This clean up shall be completed prior to field testing.

B. Repaint any scratched or marred exterior surfaces to match original paint.

3.06 FIELD TESTS

A. Perform visual, mechanical inspection and electrical tests per Section 16106 " Acceptance Testing."

3.07 TRAINING

A. Provide the services of factory-trained Field Engineer(s) as indicated under individual equipment specification sections.

PART 4 – MEASUREMENT AND PAYMENT

No separate measurement and payment will be made for Crane Substation Assemblies as described within this section. The cost of this work shall be considered incidental to the lump sum cost of "Crane Substations 1 & 2" where crane substation assemblies will be required.

END OF SECTION

SECTION 16444

REEFER SUBSTATION ASSEMBLIES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide Reefer Substation Assemblies consisting of pad mount oil filled transformers low voltage distribution sections and automatic capacitor banks, double ended Reefer Substations, 24.9 kV 3 phase primary and 277/480 volt 3 phase 4 wire secondary.

B. All equipment shall be rated and certified by the manufacturer for use in Seismic Zone 4 as defined in the Uniform Building Code.

1.02 QUALITY ASSURANCE

A. Switchboard assemblies shall be individually mounted main circuit breakers in drawout construction with group mounted feeder circuit breakers in NEMA 3R rated construction with galvanized corrosion resistant coating, suitable for installation in a wet outdoor marine environment.

B. Miscellaneous minor components in the switchgear and transformers and switchboards such as meter switches, meters, lugs, etc. need not be the end product of the same manufacturer, however they shall be the switchgear manufacturer's and transformer and switchboard manufacturer's normal OEM supplier and shall be standard products of the OEM supplier. Where the same component is used multiple places in either final assembly, the component shall be supplied by the same OEM supplier in each type of construction and shall be identical and interchangeable.

C. Comply with the provisions of the following codes, standards and specifications for manufacture, testing, and installation.

1. NEMA

2. ANSI

3. NEC

D. Provide switchgear, transformer and switchboard assemblies, to the extent that U.L. standards have been established as of the date of bid, with U.L. listed and U.L. labeled medium voltage and low voltage equipment.

E. Fabrication of materials or equipment shall be from approved shop drawings.

F. Manufacturers whose equipment dimensions exceed those indicated shall notify the Engineer in writing 10 days prior to bid date. Manufacturers may not bid the project unless they properly notify the Engineer and qualify their bid as "Not Conforming To Contract Documents". Contractor shall base bid only on equipment which fully complies with contract documents. Cost of modifications or equipment relocations, if permitted, or other additional work required to fit larger size equipment than shown on drawings shall be born totally by the Contractor.

1.03 SUBMITTALS

A. Submit product data for approval for switchgear, transformer and switchboard assemblies consisting of manufacturer's literature, manufacturer's catalog data, and manufacturer's installation and maintenance instructions. Product data shall include all mechanical features such as dimensions and appearance, and all electrical ratings associated with the assembly or component. At Contractor's option, submit product data, and resubmit if required, prior to submittal of shop drawings.

1. Submit product data for final, assembled, capacitor banks, transformers and switchboards.

2. Submit product data for transformers and switchboards and circuit breakers including all instrumentation and relaying equipment.

3. Submit product data for OEM supplied components in transformers and switchboards.

4. Submit product data for medium voltage fuses.

B. Shop Drawings shall be submitted for capacitor banks, transformers and switchboards to include all mechanical features, such as dimensions, weights, enclosure construction, assembly details. Shop drawings shall include all electrical ratings associated with the individual components as well as the complete assembly. Product data shall be submitted with the shop drawings for any component or assembly which the switchgear manufacturer or transformer and switchboard manufacturer requests substitution for a previously approved assembly or component.

1. Shop drawings shall include overall outline dimensions for all equipment and assemblies and shall include manufacturer's recommended installation clearances for operation and maintenance. Contractor and manufacturer's representatives shall field verify space available with equipment sizes proposed including code required working clearances and identified access restrictions, and manufacturer's recommended clearances, prior to submittal of shop drawings.

2. Provide point to point interconnect wiring diagrams for all internal wiring between components.

3. Provide point to point wiring diagrams for all wiring requiring or allowing external connections.

4. Provide dimensioned shipping splits, weights, handling provisions.

5. Provide preliminary short circuit and coordination study report to the extent of indicating worst case short circuit current calculations and required minimum electrical ratings.

6. Complete bill of materials for transformers, switchboards and capacitor banks.

7. Certification for use in seismic zone 4. In addition, include equipment weights, center of gravity locations, and manufacturer' s requirements and / or restrictions for anchoring and / or support in seismic zone 4 areas.

C. A complete short circuit and coordination study shall be prepared and submitted:

1. The short circuit and coordination study shall be prepared for the specific electrical overcurrent devices and feeder lengths to be installed under this project from the Main Terminal Substation medium voltage switchgear assemblies to each branch circuit breaker panelboard. For purposes of the study, each individual Reefer Outlet assembly supplied from any of the Reefer Substation Assemblies shall be considered a "branch circuit panelboard" and included in the short circuit and coordination study.

2. Submit preliminary study report with the switchgear, transformer and switchboard shop drawings.

3. Submit final study as soon as possible after proposed final field conditions have been determined.

4. The Contractor is responsible for providing all pertinent information for performing the short circuit and coordination study.

D. Include product data, shop drawings and the short circuit and coordination study in the 0 & M manuals.

1. Update all product data to include as installed and as assembled conditions. Include the Reefer Substation Assemblies information in the 0 & M manuals as a separately bound volume.

2. Update shop drawings to include as assembled, as wired and as installed conditions. Provide hard copy and read only electronic copies of all shop

drawings for switchgear transformers and switchboards in AutoCAD version 2000.DWG format.

3. Update the short circuit and coordination study to include as installed conditions. Include the short circuit and coordination study in the 0 & M manuals as a separately bound volume.

PART 2 – PRODUCTS

2.01 TRANSFORMERS

A. Transformers shall have 24.9kV 3 phase delta primary and 277/480 volt 3 phase 4 wire wye secondary.

1. All Reefer Substation assemblies are double ended units with main tie circuit breakers and are to be operated with the tie circuit breaker normally open. However, transformers in each substation are to be suitable for parallel operation, tie and mains closed, and all bussing and electrical connections are to be provided for proper phase match each end including phase sequence and rotation.

2. For the double ended substation assemblies the left end shall be normal, left to right, primary to secondary, and the right end shall be reversed, right to left, primary to secondary.

2.02 LOW VOLTAGE SWITCHBOARDS

A. Refer to Drawings for layout and location of equipment and components, current ratings of devices, current ratings of bus bars and components, voltage ratings of devices, components and assemblies; and other required details. The switchboards shall be rated 277/480 volt, 3 phase, 4 wire, wye and configured double ended with tie circuit breaker. The short circuit rating for all Reefer Substation switchboards shall be 65k AIC symmetrical minimum.

B. Switchboards shall be fully self supporting structures with 90 inch tall vertical sections, excluding lifting eyes and pull boxes, bolted together to form the required arrangement. Frames shall be die formed steel with reinforced corner gussets and shall be rigidly bolted to support cover plates, bus bars and installed devices during shipment and installation.

1. Switchboards shall be outdoor NEMA 3R, gasketed non walk in construction with side barriers between vertical sections.

2. All switchboard sections shall be capable of being rolled, moved or lifted into position and shall be rear and front aligned.

3. Switchboard sections shall have open bottoms to install conduit. Locations for conduit entries shall be indicated on the shop drawings.

4. Doors shall have concealed hinges, and fronts shall have locking handles with padlock provisions.

5. Switchboards shall have transition sections between main circuit breakers and transformers.

6. Switchboard current ratings, including all devices, shall be based on 25 degree C ambient temperature in accord with UL 891.

7. All switchboard distribution sections shall be provided with factory installed cable supports.

8. All switchboard sections shall have hinged wiring gutter covers.

C. Bus bars shall be continuously silver plated copper, rated for a current density of 1000 amperes per square inch and shall have sufficient cross sectional area to meet UL 891 temperature rise requirements. Phase and neutral bus ampacity shall be as shown on drawings, neutral bus shall be rated at same ampacity as phase bus.

1. Bus bars shall be mounted on high impact non tracking insulated supports.

2. Bus bars shall be braced for 65k AIC for all Reefer Substations.

3. Provide full length ground bus sized at 50% of the phase bus ampacity or sized to meet UL 891, whichever is larger. Ground bus shall extend full length of switchboard.

4. Provide NEC complying phase bus arrangement, A-B-C bus arrangement, left to right, top to bottom, front to rear, throughout. Provide necessary phase bus transitions, if required, to maintain proper phase sequence and phase rotation. Double ended substations shall be provided suitable for parallel transformer operation. Where phase bus arrangement does not comply with A B C left to right, top to bottom, front to real- phase sequence, bus bars shall be labeled to identify correct phases.

5. All feeder device line and load connection straps and / or lugs, shall be rated to carry the current rating of device frame, not the installed trip rating.

6. The main incoming bus bars from the transformer shall have an ampacity rated equal or higher than the main circuit breaker trip rating.

7. Horizontal bus bars shall have full rated ampacity throughout, tapered bus is not acceptable. Horizontal bus shall be mounted at top, center, or bottom of the

sections at manufacturer's option. Main horizontal bus shall be fully insulated throughout with 600 volt rated, minimum, insulation. Bus joints shall have removable insulation for testing and maintenance.

8. Each distribution section shall have full height vertical bus bar, rated at the same ampacity as the main horizontal bus for the full height of the section. Vertical bus bars shall have a single bar for the full height without any joints or splices except where connected to the main horizontal bus.

D. Device lugs and neutral lugs shall be plated copper suitable for terminating copper wire. Lug ampacities shall be based on 75° C conductor temperature ratings.

1. Lugs on feeder devices shall be provided with lug covers.

2. Provide mechanical type lugs to accommodate conductor sizing indicated. Where oversize conductors are shown, provide optional lugs to accommodate the conductors.

E. Main circuit breakers, Tie circuit breakers, and Feeder circuit breakers rated larger than 1200 amperes shall be individually mounted, draw out General Electric Company Power Break insulated case circuit breakers with MicroVersaTrip PM, solid state trip unit with power management.

1. Circuit breakers shall be 100% continuous current rated when switchboard mounted in drawout structures.

2. Circuit breakers shall include a stored energy mechanism with a spring charging handle, trip and close push buttons, mechanical indicators for open, closed, tripped and spring charged conditions.

3. Circuit breakers shall have a true RMS digital electronic trip, with interchangeable trips plugs, power management, and the following adjustments and characteristics.

a. Adjustable long time pickup and adjustable time delay.

b. Adjustable short time pickup and adjustable delay with I2T ON/OFF selection.

c. Adjustable instantaneous pickup.

d. Adjustable ground fault pickup, adjustable delay and selectable I2T slope and trip indicator.

e. Overload, Short Circuit, and Short Time local trip indicators with overload pickup warning.

f. Power Leader communications system link with user selectable address assignment for Coronet communication.

g. 3 phase Voltmeter configurable for wye or delta systems. Configure for wye.

h. 3 phase Ammeter.

i. KW meter.

j. KVA meter.

k. KWH meter.

4. Each Main circuit breaker compartment shall include a Power Supply Plate module and Voltage Conditioner Plate Module for 24 Volt DC power for the PM trip units and voltage sensing. Tie circuit breaker trip units on double ended unit substations shall have a user selectable 24 Volt DC source from either end.

   a. Provide all necessary interconnect cables, wiring harnesses and internal switchboard wiring.

5. Drawout circuit breakers shall be installed in suitable substructures including shutters, two secondary disconnects, racking padlock, and racking tool.

6. Provide Kirk Key interlocks on Main and Tie circuit breakers in double ended switchboard construction to prevent simultaneous closing of both main circuit breakers and the tie circuit breaker. Key interlock shall not allow closing the circuit breaker unless the key is inserted and the lock rotated, and the key shall be captive with the circuit breaker closed.

F. Feeder circuit breakers rated 1200 amperes and smaller shall be group mounted stationary General Electric Company Spectra RMS molded case circuit breakers with MicroVersaTrip Plus, solid state trip unit.

1. Circuit breakers shall be 100% continuous current rated when group mounted in switchboard construction.

2. Circuit breakers shall have a true RMS. digital electronic trip, with interchangeable trips plugs and the following adjustments and characteristics.

   a. Adjustable long time pickup and adjustable time delay.

   b. Adjustable short time pickup and adjustable delay with I2T ON/OFF selection.

c. Adjustable instantaneous pickup.

d. Adjustable ground fault pickup, adjustable delay and selectable I2T slope and trip indicator for all feeder circuit breakers in all Reefer Substations.

e. Overload, Short Circuit, and Short Time local trip indicators with overload pickup warning.

f. 3 phase Ammeter.

G. Provide multifunction electronic metering at each main circuit breaker in each Reefer Substation Assembly. Meter shall be General Electric Company Multilin Power Quality Meter mounted in the main circuit breaker compartment. Meter shall be panel mount with display with RS485 Modbus communications.

1. Meter shall be designated as PQM on drawings.

2. Meter shall measure and display the following.

a. Amps.

b. Volts.

c. Watts

d. Watthours.

e. Vars

f. Varhours

g. Volt Amps

h. Volt Amp hours

i. Power Factor.

j. Frequency.

k. Demand Amps, Watts and Volt Amps.

3. Provide with optional Power Analysis, Event Recorder and Waveform capture.

4. Provide Current transformers in the main circuit breaker compartment for 5 amp input to the PQM.

5. Provide 24 Volt DC input power from the main circuit breaker MVT PM power source.

6. Provide 480:120V Voltage transformers for voltage input, fused with 200k AIC current limiting fuses.

7. Personal Computer and software for remote monitoring of the PQM are not included in this project.

8. Display shall be illuminated 40 character. Readings shall utilize industry standard abbreviations for units and parameters.

9. Provide with security code programming for protection of demand reset functions and other settings.

10. Provide all communication cards and ports for communication.

H. Switchboards shall include all protective devices and equipment as indicated on drawings with all necessary interconnections, instrumentation, measurement, and control wiring.

1. Provide fuse blocks and terminal blocks for protection and termination of all internal switchboard wiring and for termination of all external wiring into or out of the switchboards.

2. All current inputs for instrumentation, measurement or control shall be from window type CT's, bolted into and part of the bussing. Provide with shorting terminal blocks and shorting jumpers.

3. All voltage inputs for instrumentation, measurement or control shall be from 1:1 voltage transformers with 200k AIC current limiting fused primary and secondary wiring.

I. On double ended Substation Assemblies with ground fault on Main circuit breakers and Tie circuit breakers include wiring, interlocking and sensors as required for accurate and reliable ground fault protection. Double ended Reefer Substation Assemblies are intended for operation with the tie circuit breaker open and open circuit switching from double ended to single ended operation. However, ground fault protection shall permit parallel operation with ground fault protection in effect without false tripping. Under parallel operation a bus ground fault would be expected to open one main and the tie circuit breaker, leaving a single main closed.

J. Reefer Substation Assembly switchboards shall be installed in factory assembled outdoor NEMA 3R, gasketed non walk in structures, fully weatherproof, with lifting plates at the base, doors with rubber gaskets and pad locking provisions. Heaters with thermostat control shall be provided for each vertical section. Enclosures shall be provided with reach in space as required. Bolted rear doors shall have gaskets and hinges and roof shall be sloped to the rear.

K. Provide accessory panelboards mounted within the switchboard construction where shown. Panelboard shall be General Electric type AQ with THQB branch breakers. Provide 5 kVA dry type transformer in section, fed by a circuit breaker on the switchboard bus.

L. Provide 24" high space as shown for future addition of a reefer monitoring panel. Space shall include removable backpan with handles, and hinged full width door.

M. Switchboards shall be finished in baked enamel paint with a clear polyurethane top coat, color ANSI 61 gray.

2.03 LOW VOLTAGE AUTOMATIC CAPACITOR BANKS

A. All capacitor banks shall be 480V, 3Ph, 905kVAr, automatically switched.

B. Refer to drawings for layout and location of equipment and components.

C. The short circuit current rating for all Switched Capacitor banks shall be 65k AIC symmetrical minimum.

D. Automatic capacitor banks shall be fully self supporting structures with 90-inch tall vertical sections, excluding lifting eyes and pull boxes, bolted together to form the required arrangement.

E. Automatic capacitor banks shall have open bottoms to install conduit. Locations for conduit entries shall be indicated on the shop drawings.

F. Automatic capacitor banks shall have a minimum of 6 equal step increments in reactive power.

G. Automatic capacitor banks shall be furnished in a gasketed NEMA 3R enclosure finished with a baked enamel paint and a clear polyurethane top coat. Color ANSI 61 gray.

H. Automatic capacitor banks shall be furnished with a solid copper buss.

I. Automatic capacitor banks shall be furnished without circuit breaker.

J. Automatic capacitor banks shall be furnished with lockable doors.

K. All necessary control components shall be installed per the manufacturer's recommendations.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify that Substation Assemblies are ready to install.

B. Verify field measurements are as shown on Drawings.

C. Verify that required utilities, conduits, cables and anchoring devices are available, in proper location and ready for use.

D. Beginning of installation means installer accepts conditions.

3.02 LOCATION

A. Substation lineups shall have adequate clearance for required rear and front access.

3.03 INSTALLATION

A. Contractor shall furnish and completely install all switchgear as shown on drawings and per manufacturer's instruction books.

3.04 FIELD QUALITY CONTROL

A. Refer to manufacturer's instruction books for details.

3.05 ADJUSTING

A. Refer to manufacturer's instruction book to make adjustments to circuit breakers, doors, handles, and miscellaneous hardware as required.

B. Set trip units as per Engineer's recommendations and coordination study.

3.06 CLEANING

A. Clean interiors to remove construction debris, dirt, and shipping materials. This shall be completed prior to field testing.

B. Repaint scratched or marred exterior surfaces to match original finish.

3.07 TRAINING

A. Provide services of factory trained Field Engineer for training at City's job site. Training shall include instructions on adjusting, servicing, and maintaining switchboards and other components. Field Engineer shall be at the site for 1 day. The

Field Engineer shall provide written certification that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. Include in the 0 & M manual.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED - See Section 01025, "MEASUREMENT AND PAYMENT", paragraph 1.03.B.

END OF SECTION

SECTION 16451

MEDIUM-VOLTAGE LOW RESISTANCE TRANSFORMER NEUTRAL GROUNDING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Enclosed, outdoor type, transformer neutral grounding resistor for crane substations.

B. The equipment shall be completely factory built, assembled, wired and tested. All components shall be of new construction. Used or rebuilt equipment is not acceptable.

C. The grounding resistor unit shall be UL listed and labeled.

1.02 RELATED WORK

A. Section 16106 – Acceptance Testing

B. Section 16443 – Crane Substation Assemblies

1.03 QUALITY ASSURANCE

A. Like items of equipment provided hereunder shall be the end product of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service.

1.04 SUBMITTALS

A. Provide following submittals prior to construction:

1. Shop drawing indicating outline dimensions, floor plan and connection details.

2. Bill of material for all equipment with part numbers.

3. Operation and maintenance manual with equipment shipment package.

4. Certified factory test report.

1.05 REFERENCES

A. The medium-voltage resistance system shall be designed, manufactured, and tested in accordance with the latest applicable NEMA, ANSI, IEEE and UL Standards.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. Square – D or approved equal.

2.02 SERVICE CONDITIONS

A. Suitable for outdoor service with following conditions:

1. Maximum elevation above sea level: 50 feet
2. Maximum ambient air temperature: 44 degree C
3. Minimum ambient air temperature: 0 degree C
4. Seismic Zone: 4
5. Maximum Wind: 80 mph
6. Relative humidity: 95%

2.03 GROUNDING RESISTOR

A. The grounding resistor shall have following ratings:

1. Current rating: 400A
2. Line ground voltage rating: 2400V
3. Time rating: 10 sceconds
4. Temperature rise: 760 degree C rise

B. Register unit shall be constructed of stainless steel with welded connections between units. The register strap shall be wound around a refractory core reinforced by longitudinal steel supports. Each register element shall be individually supported at each end by ceramic insulators and shall be designed to permit thermal expansion.

C. The register units shall be housed in an aluminum enclosure suitable for outdoor installation. The frame assembly shall be constructed of corrosion resistant hot dipped galvanized angle. All members shall be of sufficient strength to withstand severe mechanical stress.

D. The register unit with enclosure shall be suitable for mounting on top the transformer.

E. Provide current transformers as shown on the drawings. Provide suitable mounting arrangements. Terminate current transformer secondary wires on terminal blocks.

F. Provide entrance bushing and terminal pads suitable for termination of 5 kV insulated cable.

G. Provide base insulators with minimum rating of 5 kV, conforming to ANSI Standards.

H. Provide a grounding pad for register ground connection.

2.04 FACTORY TESTS

A. Perform all standard factory tests as required by ANSI and NEMA.

2.05 NAMEPLATES

A. Nameplates: white phenolic engraved to a black core. Nameplate size, character height, and inscription shall be per the Drawings. Provide nameplates for each breaker, relay, instrument, control device, transformer, and incoming line compartment. Minimum character height shall be 5/32 inch. All nameplates shall be attached with steel screws. Provide master nameplate on tie-breaker cubicle indicating equipment name (1-inch letters), voltage and service (1/2-inch letters), and source of power (1/2-inch letters).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install the grounding register unit on top of the power transformer in accordance with the recommendations of register manufacturer and power transformer manufacturer.

B. Brace the register unit for Seismic Zone 4 conditions.

C. Terminate the power transformer cable utilizing termination kits suitable for outdoor use.

3.02 FIELD TESTS

A. Perform visual, mechanical inspection and electrical tests per Section 16106, “Acceptance Testing.”

3.03 TRAINING

A. Provide the services of a factory trained Field Engineer for training at the job site on adjusting, servicing and maintaining the equipment and components. The Field Engineer shall be on site for one working day.

3.04 MANUFACTURER'S START-UP SERVICES

A. Provide the services of a qualified factory-trained Field Engineer for a period of two working days for each switchgear lineup. The Field Engineer shall certify that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED

END OF SECTION

SECTION 16460

PAD MOUNT OIL FILLED TRANSFORMERS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide pad mount oil filled transformers for Building Substations and Lighting Transformers complete with enclosures, connections and grounding, and primary and secondary features and accessories.

B. The pad mounting transformer design and specification is based upon ABB MTR Padmount distribution transformers.

1.02 QUALITY ASSURANCE

A. All equipment and materials for the pad mount oil filled transformers shall be the end product of a single manufacturer. The pad mount oil filled transformer manufacturer shall be the same as for the pad mount oil filled transformers for the building substations.

B. Miscellaneous minor components in the transformer assemblies such as fuses, lugs, separable connectors, etc. need not be the end product of the same manufacturer, however they shall be the transformer manufacturer's normal OEM supplier and shall be standard products of the OEM supplier. Where the same component is used multiple places in the same or different transformers provided this project, the component shall be supplied by the same OEM supplier in each unit or multiple units and shall be identical and interchangeable.

C. Comply with the provisions of the following codes, standards and specifications for manufacture, testing, and installation.

1. NEMA

2. ANSI

3. NEC

D. Provide pad mount transformer assemblies, to the extent that UL standards have been established as of the date of bid, UL listed and UL labeled.

E. Fabrication of materials or equipment shall be from approved shop drawings.

F. Manufacturers whose equipment dimensions exceed those indicated shall notify the

Engineer in writing 10 days prior to bid date. Manufacturers may not bid the project unless they properly notify the Engineer and qualify their bid as "Not Conforming To Contract Documents". Contractor shall base bid only on equipment which fully complies with contract documents. Cost of modifications or equipment relocations, if permitted, or other additional work required to fit larger size equipment than shown on drawings shall be born totally by the Contractor.

1.03 SUBMITTALS

A. Submit product data for approval for transformer assemblies consisting of manufacturer’s literature, manufacturer’s catalog data, and manufacturer’s installation and maintenance instructions. Product data shall include all mechanical features such as dimensions and appearance, and all electrical ratings associated with the complete transformer and all accessories. At contractors option submit product data, and resubmit if required, prior to submittal of shop drawings.

1. Submit product data for final, assembled, transformer.

2. Submit product data for components including protective fusing, secondary circuit breakers, connection system, gauges and instruments, switches, and additional specified accessory items.

3. Submit product data for OEM supplied components.

B. Shop Drawings shall be submitted for transformers to include all mechanical features, such as dimensions, weights, enclosure construction, assembly details. Shop drawings shall include all electrical ratings associated with the transformer. Product data shall be submitted with the shop drawings for any component or subassembly which the manufacturer requests substitution for a previously approved assembly or component.

1. Shop drawings shall include overall outline dimensions and shall include manufacturer’s recommended installation clearances for operation and maintenance.

2. Provide shipping weights and handling provisions.

3. Provide preliminary short circuit and coordination study report to the extent of indicating worst case short circuit current calculations and required minimum electrical ratings. See Section 16030.

4. Complete bill of materials.

C. A complete short circuit and coordination study shall be prepared and submitted in accordance with Section 16030.

1. The short circuit and coordination study shall be prepared for the specific

electrical overcurrent devices and feeder lengths to be installed under this project from the Main Terminal Substation medium voltage switchgear assemblies to each branch circuit breaker panelboard. For purposes of the study the secondary terminals of the pad mount oil filled transformers shall be considered a "panelboard" and shall be included in the study.

D. Include product data, shop drawings and the short circuit and coordination study in the O & M manuals.

1. Update all product data to include as installed and as assembled conditions.

2. Update shop drawings to include as assembled, as wired and as installed conditions.

3. Update the short circuit and coordination study to include as installed conditions.

PART 2 - PRODUCTS

2.01 PAD MOUNT OIL FILLED TRANSFORMERS

A. Acceptable Manufacturers

1. Square D or approved equal.

B. Pad mount transformers shall be complete with a weatherproof metal transformer tank cabinet with oil immersed transformer, primary voltage compartment, and secondary voltage compartment, suitable for outdoor mounting on a concrete pad.

C. Transformer sizes shall be as indicated on the drawings. Provide 125 kV BIL rated units for 12.47 kV and 25kV primary voltage. Transformers shall be constructed in compliance with applicable IEEE, NEMA, and ANSI standards for oil immersed distribution transformers.

D. Transformers shall be 25 kV 3 phase delta primary 60 Hertz, with two 2-1/2% below normal and two 2-1/2% above normal taps with no load tap changing mechanism. Maximum temperature rise at continuous full load shall be 65^{o} C. Transformer impedances shall be manufacturers standard for sizes shown. Secondary voltage shall be 277/480 volt 3 phase 4 wire wye.

E. Provide dead front, loop feed primary compartment with (6) - 600 amp deadbreak bushings for use with 25 kV rated 600 amp non loadbreak elbow terminations. Bushings to be externally clamped. Primary compartment shall also include three non loadbreak dry well current limiting fuseholders equipped with internal fuse links. Provide safety baffle and switch interlock to prevent removing fuses with the transformer energized. Furnish one set of three spare fuse links for each unit provided, turn over spare fuse links to City and include receipt in O & M manual. Provide oil immersed “T” blade sectionalizing switch operable from hot stick for isolating de-energizing the transformer while maintaining the loop feed.

F. Secondary compartment shall contain 4 or 6 hole copper spade type bushings, depending on KVA rating. Provide secondary compartment with dial type thermometer, oil level gauge, oil drain valve, pressure -vacuum gauge, and manufacturers nameplate listing technical data for the unit, and secondary voltage circuit breaker type disconnects for feeder overcurrent protection sizes as indicated on the drawings. Low voltage bushings shall have adequate internal bracing to support the secondary cable and circuit breaker without undue strain on the bushings. The neutral bushing shall have a copper ground strap to the transformer tank and neutral lug shall be solidly grounded to below grade ground rods at each transformer location. Provide secondary voltage circuit breakers, amp rating, and 18,000 AMPS RMS symmetrical interrupting capacity. Secondary circuit breakers shall be factory installed and shall be thermal magnetic, molded case with solid state trip elements with fully adjustable settings.

G. Transformer tank shall be provided with self resetting pressure relief valve to automatically release excessive pressure buildup without damage to the tank. Provide a manual vent to allow releasing any pressure or vacuum in the tank before the tank is opened.

H. Provide tank with fill plug, drain valve, and sampling devices for periodic inspection and sampling of the transformer oil.

I. Provide visible, removable tank ground strap in the secondary compartment.

J. Provide two interlocked flat hinged doors, one over the primary compartment, one over the secondary compartment. Doors shall be interlocked such that access to the primary compartment requires the secondary compartment to be open. Provide steel barrier between the primary and secondary compartments. The primary compartment shall be secured with a pentahead bolt, accessible only with the secondary compartment open. The secondary compartment shall be secured with a three point latch, pentahead bolt, and shall have provisions for pad locking.

K. Provide four lifting lugs in addition to provisions for rolling or jacking units into position.

L. All insulating materials and components shall be thermally upgraded materials compatible at 65^{o} C temperature rise. Transformer windings shall be copper.

M. Transformers shall be finished olive green, Munsell No. 7GY3.29/1.5, or manufacturers similar, standard, green finish color.

PART 3 - EXECUTION

3.01 GENERAL

A. Install securely outside of buildings on a level concrete pad designed to accept the transformer.

B. Repaint all scratched and marred surfaces to original condition using color and type of paint recommended by the manufacturer.

C. Connect and ground in accordance with manufacturer's recommendations and code requirements.

D. Test per NETA requirements. See Section 16030.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16461

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

Dry type two winding transformers, including all labor, materials, appliances, tools, equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein.

1.02 APPLICABLE PUBLICATIONS

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. American National Standards Institute, Inc. (ANSI) Publications:

1. C57.12.01-79 General Requirements for Dry-Type Distribution and Power Transformers
2. C57.12.91-79 Test Code for Dry-Type Distribution and Power Transformers
3. C57.94-82 Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers

B. National Electrical Contractors Association (NECA) Publication:

1. Standard of Installation.

C. National Electrical Manufacturer's Association (NEMA) Publications:

1. ST 20-72 (R78) Dry Type Transformers for General Applications.
2. TR 1-80 (R83) Transformers, Regulators and Reactors

D. National Fire Protection Association (NFPA) Publication:

1. 70-99 National Electrical Code (NEC)

1.03 SUBMITTALS

Submit under provisions of Sections 01300 and 16010.

A. Manufacturer' s Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, rated winding temperature rise, nameplate legends and anchor calculations.

B. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

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

1.04 QUALIFICATIONS

A. Manufacturer: Square-D or approved equal.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

B. Maintain one copy of each document on site.

1.06 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL as suitable for purpose specified and shown.

1.07 DELIVERY, STORAGE, AND HANDLING

A Store, protect, and handle products to site under provisions of Section 16010.

B. Deliver transformers individually wrapped for protection and mounted on shipping skids.

C. Accept transformers on site. Inspect for damage.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer' s written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

All materials and equipment shall be new and of high quality to give long life and reliable operation. All equipment shall be modern in design and shall not have been in prior service except as required by factory tests.

2.02 TWO-WINDING TRANSFORMERS

A. Manufacturers:

1. Square D or approved equal company.

B. Description: NEMA ST 20, ANSI C57.12.01, 60 Hertz, factory-assembled, distribution, air cooled, dry type transformers, with copper windings and ratings as indicated.

C. Transformer shall have 220°C insulation with a winding temperature rise not exceeding 80°C under full load in a maximum ambient of 40°C.

D. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point.

E. Winding Taps: NEMA ST 20. Equip with NEMA standard taps. If taps are not standard, equip transformer with two 2-1/2% FCAN and two 2-1/2% FCBN.

F. Sound Levels: NEMA TR 1. Maximum sound levels shall be an average of 3 dB lower than NEMA TR 1 standard sound levels for the transformer size indicated.

G. Basic Impulse Level: 10 kV. [ti,' t r',

H. Minimum impedances, unless otherwise indicated, shall be as follows:

1. 75 kVA and smaller: 3.0%

2. Larger than 75 kVA: 4.5%

I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap. Where neutral connection is indicated, attach to bolt and lug inside enclosure and extend bolt through enclosure to permit external ground connection.

J. Mounting: Suitable for wall, trapeze or floor mounting as indicated.

K. Copper Coil Conductors: Continuous windings with terminations brazed or welded. Brace and locate windings, terminals, and connections for maximum short circuit stresses to prevent accidental grounding of windings and connections.

L Enclosure: NEMA ST 20; Type 1 unless otherwise noted. Provide lifting eyes or brackets. Construct enclosures of heavy gage sheet steel, primed inside and out with a zinc chromate or iron oxide rust-inhibiting primer. Finish with manufacturer's standard color enamel. Overall dimensions shall not exceed the limits indicated or the space available.

M. Isolate core and coil from enclosure using vibration-dampeners.

N. Efficiency: Transformer shall have an efficiency rating of 97% or more.

O. Nameplates:

1. Conspicuously display on each transformer enclosure a metal nameplate with stamped or engraved markings showing: connection, including taps; kVA; phases; frequency; primary and secondary voltages; percent R, X and Z; temperature rise; insulation class; BIL rating; no-load and full-load losses; and sound level rating.

2. Provide laminated plastic nameplate as specified in Section 16195, identifying transformer designation in 1/2" high letters.

2.03 SOURCE QUALITY CONTROL

A. Provide testing of transformers under provisions of Section 01400.

B. Provide production testing of each unit in accordance with NEMA ST 20 and ANSI C57.12.91. The following tests shall be performed at the factory:

1. Applied voltage test (to each winding and from each winding to ground).

2. Induced voltage test - 2 times normal voltage.

3. Ratio, polarity and sound level.

PART 3 - EXECUTION

3.01 INSTALLATION

Transformer installation shall conform to NFPA 70, ANSI C57.94, and all other state and local codes, and to requirements specified herein.

A. Contractor shall make all field verifications necessary to ensure proper installation of all equipment as supplied.

B. Contractor is responsible for coordinating timely equipment delivery.

C. Install Products in accordance with manufacturer's instructions.

D. Set transformer plumb and level.

E. Make conduit connections to side panel of enclosure. Provide seismic restraints.

3.02 GROUNDING

Grounding shall be in accordance with ANSI C2. All ground wire shall be copper. Refer to Section 16170 "GROUNDING AND BONDING".

3.03 NAMEPLATES

Provide as specified in Section 16195, "RT.FCTRICAL IDENTIFICATION."

3.04 FIELD TESTS

Refer to Section 16030, "EIF.CTRICAL ACCEPTANCE TESTING,". for additional requirements. As an exception to requirements that may be stated elsewhere in the Contract, the Engineer shall be given a minimum of five (5) working days notice prior to each test. All testing shall comply with ANSI C57.12.91.

A Field inspection and testing will be performed under provisions of Section 16030.

B. Check for damage and tight connections prior to energizing transformer.

C. Measure the secondary voltage of the new transformer and reset the primary taps if necessary.

D. Test information shall be supplied to the Engineer within 10 days after completion of testing.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED - See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.3.B.

END OF SECTION

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Panelboards.

1.02 APPLICABLE PUBLICATIONS

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. National Electrical Contractors Association (NECA) Publication:

1. Standard of Installation.

B. National Electrical Manufacturer's Association (NEMA) Publications:

1. NEMA AB 1 Molded Case Circuit Breakers.

2. NEMA ICS 2 Industrial Control Devices, Controllers, and Assemblies.

3. NEMA PB 1 Panelboards.

4. NEMA PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

C. National Fire Protection Association (NFPA) Publication:

1. 70-99 National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (U.L.) Publications:

1. 50-80 Cabinet and Boxes

2. 67-79 Standard for Panelboards

3. 869-84 Standard for Service Equipment

1.02 SUBMITTALS

A. Submit under provisions of Section 01300 and 16010.

B. Product Data: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.

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

D. Maintenance Materials as specified.

1.04 QUALIFICATIONS

A. Manufacturer: Square-D or Approved equal.

1.06 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Section 01430.

B. Provide two of each panelboard key per panelboard.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated. Except where specifically indicated otherwise, provide only new materials having all legally required approvals and/or labels. Items of a similar nature shall be of the same type and manufacturer.

2.02 ACCEPTABLE MANUFACTURERS

A. Square D or approved equal

.

2.03 PANELBOARDS

A. Panelboards: UL 50, UL 67, NEMA PB1, circuit breaker type, size and number of breakers as indicated.

B. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard. Where isolated ground bus is required, a ground bus shall be mounted on insulators isolated from the enclosure.

C. Minimum integrated short circuit rating: 10,000 amperes rms symmetrical for 240 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated on the drawings.

D. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type, ambient compensated, thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers. Where main breaker is shown as non-automatic, it shall be equipped with high magnetic trip with same interrupting capacity as all branch circuit breakers.

E. Enclosure: NEMA PB 1, Type 1 for indoor installation and NEMA Type 3R for outdoor installation. NEMA 3R enclosures shall have all covers and doors thoroughly cleaned using phosphate wash and apply a zinc rich corrosion resistant primer and then a polyester powder coat suitable for marine environment. Exterior surfaces shall be given final finish coats of ANSI 61 light grey air-dried acrylic enamel, covered with a clear polyurethane top coat.

F. Cabinet box: 6 inches deep; width: 20 inches.

G. Cabinet Front: Flush or surface cabinet front as indicated with concealed trim clamps, concealed hinge, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

PART 3 - EXECUTION

3.01 INSTALLATION

Electrical installation shall conform to requirements of NFPA 70, state and local codes, and to requirements specified herein.

A. Install panelboards in accordance with NEMA PB 1.1 and NECA Standard of Installation.

B. Align and level panelboards and securely fasten to the building. Do not use connecting conduits to support the panelboards. Install trim plumb and square.

C. Height: 6 ft to top of panelboard; install panelboards taller than 6 ft with bottom no more than 4 inches above floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard affected by work under this contract. Revise directory to reflect circuiting changes on existing panelboards.

F. Provide engraved plastic nameplates under the provisions of Section 16195.

G. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Minimum spare conduits: 5 empty 1-inch. Identify each as SPARE.

3.02 FIELD TESTS

A. Field inspection and testing will be performed under provisions of Section 16030.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, Paragraph 1.03.B.

END OF SECTION

SECTION 16490

DISCONNECTS AND FUSED SWITCHES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all disconnects, fused and unfused, required by code for equipment furnished under this and other Divisions of these Specifications whether specifically shown on the drawings or not.

1.02 QUALITY ASSURANCE

A. All switches provided shall be the end product of one manufacturer.

B. Codes and Standards: Comply with the provisions of the following codes, standards and specifications for manufacture and testing, except where more stringent requirements are shown or specified.

1. NEMA (National Electrical Manufacturers Association).

2. UL (Underwriters Laboratories).

C. Provide switches bearing a UL Label.

1.03 SUBMITTALS

A. Submit data for all items in accordance with Sections 01300 and 16010.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. General Electric (Type TH)

B. Square-D (Heavy Duty)

C. Cutler-Hammer

2.02 DISCONNECTS

A. Switches shall be heavy duty type, shall be quick-make, quick-break and shall be horsepower rated. Switch shall have blades to open each ungrounded conductor and shall be single throw unless noted. All switches shall have switch blades which are fully visible in the Off position when the door is open. Switches shall permit easy access to line-side lugs. Lugs shall be UL listed for aluminum and/or copper cables and front removable. All current carrying parts shall be plated. Short circuit ratings shall be minimum 10,000 AIC symmetrical unless noted otherwise.

B. Switches shall have an operating handle and mechanism which shall be an integral part of the box, not the cover. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door in the ON position or closing of the switch mechanism with the door open. The handle position shall indicate if the switch is ON or OFF. The door interlock shall include a defeating scheme, and shall be padlockable in the "off" position.

C. The enclosure shall be suitable for the environment in which mounted. All exterior enclosures shall have (as a minimum) a rain tight (NEMA 4X) rating. Covers on NEMA 1 enclosures shall be attached with pin type hinges. Rainproof covers shall be securable in the open position. NEMA 4X switches thru 200 amperes shall be provided with closing caps and have provisions for interchangeable bolt-on hubs and these hubs shall be provided as indicated on plans.

2.03 FUSED SWITCHES (OR FUSED DISCONNECTS)

A. Fused switches shall be as specified above with the addition of fuse spaces and clips to accept only fuses as noted in Section 16491.

2.04 NAMEPLATES

A. Provide nameplates on all enclosures and include the following information: Load served, voltage, phase, panel and circuit number. Construct and attach in accordance with Section 16195.

PART 3 - EXECUTION

3.01 MOUNTING

A. Secure solidly to wall or approved mounting frame. Disconnects supported only by raceway are not acceptable.

B. Mount plumb at a maximum of six feet to the top from the finished floor.

3.02 SPLICES

A. Wiring space within the enclosure shall not be used as a junction box.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16491

FUSES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all fuses. Provide three (3) spare of each size and type required. Fuses shall be U.L. listed, Class RK1 time delay rejection type for under 600 amp and Class L for 600 amp and over with characteristics noted below.

1.02 SUBMITTALS

A. Submit data on all items in accordance with Sections 01300 and 16010.

PART 2 - PRODUCTS

2.01 RATED 600 AMPERES AND OVER

A. All fuses rated over 600 amperes or over shall be UL Class L labeled for 200,000 amperes and as current limiting, such as Gould/Shawmut Amp-Trap A4BY or approved equal.

2.02 RATED UP TO 600 AMPERES

A. All fuses rated up to 600 amperes shall be UL Class RK1 with time delay and suitable for up to 200,000 amperes, current limiting such as Gould/Shawmut Amp-Trap II, A2D or A6D or approved equal.

2.03 SPARE FUSES

A. Spare fuses shall be provided with a minimum of three of each ampere rating.

2.04 ACCEPTABLE MANUFACTURERS

A. Gould Shawmut

B. Bussman

C. Federal Pacific

D. General Electric

E. LittelFuse

PART 3 - EXECUTION

3.01 FUSES

A. Install in all fusible devices provided under this contract.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16510

LIGHTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide all lighting fixtures as shown, scheduled on the drawings, and for certain fixtures specified in detail herein. Provide complete with all lamps, completely wired, controlled, and securely attached to supports. Support shall comply with local Codes and ordinances for securing against seismic forces.

B. Where both catalog number and narrative and/or pictorial description are indicated, the requirements of the description shall take precedence and prevail.

C. General Contractor shall provide electrical subcontractor with entire lighting specification (including fixture catalog cuts and sketches); electrical subcontractor shall provide each specified manufacturer with complete information about the fixtures they will supply.

D. Type of fixtures shall be as indicated alphanumerically and as specified.

E. Fixture details shown may be modified by the manufacturer provided all of the following conditions have been met:

1. Fixture performance is equal or improved;

2. Structural, mechanical, electrical, safety and maintenance characteristics are equal or improved;

3. Cost to the City is unchanged or reduced;

4. Modifications have been reviewed and approved by the Engineer in writing.

F. Reflector cones, baffles, louvers, aperture plates, and decorative elements of fixtures shall be packed by the manufacturer separate from the housing (body, stem, etc.) of the fixture.

G. Blemished, damaged or unsatisfactory fixtures shall be replaced in a satisfactory manner.

1.02 RELATED SECTIONS

Examine other Sections of Division 16 and ascertain their effect upon, and relationship to the work of this Section. Provide the products, and execute the work in this Section in accordance with the product and execution requirements, where applicable, as set forth in the other Sections of Division 16, to provide an interrelated electrical system.

1.03 APPLICABLE PUBLICATIONS

The following publications form a part of this specification. The publications are referred to in the text by the basic designation only.

A. American National Standards Institute, Inc. (ANSI) Publications:

1. C78.379 Electric Lamps - Incandescent and High- Intensity Discharge Reflector Lamps - Classification of Beam Patterns.

2. C82.01 Specification for Fluorescent Lamp Ballasts.

3. C82.04 High-Intensity Discharge Lamp Ballast (Multiple Supply Types).

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

1. B136-84 Measurements of Stain Resistance

C. National Electrical Manufacturers Association (NEMA) Publications:

1. WD 6 Wiring Device Configurations.

D. National Fire Protection Association (NFPA) Publication:

1. 70-96 National Electrical Code (NEC)

2. 101 Life Safety Code.

1.04 SUBMITTALS

A. Submit under provisions of Section 01300 and 16010.

B. Shop Drawings:

1. Fixtures: Indicate name of project; building name; fixture type; complete details and/or data of fixtures, including manufacturer's name, catalog numbers for lampholders, ballasts, lightshields, switches; metal gauges; type of wiring; color and texture of finishes; and list of materials. If scallop shields, wallwash

reflectors or baffles are required, shop drawings shall indicate their relative position to the wall or adjacent vertical surface.

C. Product Data: Provide dimensions, ratings, and performance data for lighting fixtures electronic ballast. Submit samples of finishes and photometric data from an independent testing laboratory to completely describe fixture performance.

D. Manufacturer's Installation Instructions: Indicate handling and installation methods.

E. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

F. 2-year Warranty for ballasts for fluorescent and high density discharge fixtures.

1.05 OPERATION AND MAINTENANCE MANUAL

A. Submit operation and maintenance manual for fixtures and ballast under provisions of Section 01300 and 16010.

B. Maintenance Data: Include replacement parts list.

1.06 INSTRUCTION TO CITY PERSONNEL

A. Provide minimum one half day to instruct City personnel in proper operation and maintenance of system. Train City personnel in procedures to follow in identifying sources of operational failures or malfunctions.

1.07 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01720.

B. Accurately record actual locations of each luminaire.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.09 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70 and NFPA 101.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

C. Fixtures installed outdoors in areas exposed directly to weather shall be UL listed for wet locations.

D. Fixtures installed in outdoor protected areas (such as building soffits) and indoors in areas subject to water or extreme humidity shall be UL listed for damp locations.

E. All fixtures shall meet all required local codes and regulations.

1.10 GENERAL LIGHTING REQUIREMENTS

A. Verify ceiling materials employed and coordinate fixtures to mount to the ceiling system used.

B. Provide support materials of all types necessary to secure lighting fixtures to the building structure.

1.11 FIXTURE EVALUATION

A. Fixtures offered as equal to the fixtures listed herein shall be equal in the following characteristics:

1. General appearance and physical dimension.
2. Finish of materials.
3. Gage and type of metal used.
4. Equivalent optical system and lighting efficiency as determined by certified photometric test report.
5. Equivalent lamp (and ballast) types.
6. General construction, including door hanging, method of suspension, wire quantities permitted in attached junction boxes and other pertinent construction features.
7. Type, quality, and thickness of plastic and glass material used for lenses, diffusers or trim.

1.12 VOLTAGE AND CEILING SYSTEMS COORDINATION

A. Fixtures as scheduled on the drawings and specified herein include catalog numbers indicating the basic design intent. The fixtures installed shall be suitable for the circuit electrical characteristics indicated for their supply, and compatible with the specified ceiling systems where installed, or with alternate ceiling systems which may be substituted for the specified ceiling systems.

B. Do not order any lighting fixtures, after approval of shop drawings, without first certifying that the fixtures have correct electrical characteristics and are of proper dimension and have mounting methods and trims conforming to the ceiling systems into or onto which the lighting fixtures will be installed.

C. Approval of shop drawings is for general design concept, quality of materials, finish, optical characteristics, general construction and lighting efficiency, and shall not relieve the Contractor from the necessity of coordinating with indicated electrical characteristics and with ceiling systems being installed prior to ordering fixtures.

1.13 FIXTURE SUPPORT AND INSTALLATION

A. Surface fixtures:

1. Do not mount fluorescent fixtures directly on combustible material such as fiber acoustical tile unless specifically approved for such use. Provide material required for complying with this code requirement. Install in perfect vertical and horizontal alignment.

2. Support surface mounted fixtures over 4" in width and over 50" in length with a minimum of six fastenings per fixture, two located near each fixture end and two near each fixture center.

3. Locate fastenings for all surface mounted fixtures to provide maximum fixture support and optimum fixture alignment.

4. Fastenings for surface mounted fixtures that are installed on concrete slab or concrete joist construction shall consist of 1/4" minimum size machine screws fastened to concrete inserts that are installed in the slab or joist areas before the concrete is poured.

B. Pendant fixtures:

1. Supports for suspended fluorescent fixtures shall consist of code approved single stem hangers. Chain hangers shall not be approved unless specifically identified on the drawings.

2. Stems for pendant fixtures shall have a swivel hanger and canopy at the ceiling. The method for connecting stems to fluorescent fixtures shall be of a type to allow a 45° fixture swing. Spacing between stems shall be the manufacturer's standard or shall be based on code requirements, whichever is the most stringent.

3. Individually mounted, suspended fluorescent fixtures over 50" in length shall have a minimum of three supports per fixture. Supports shall be located near each fixture end and in the fixture center.

4. Suspended fluorescent fixtures that are mounted in continuous rows shall have a minimum of one support per each 50" of fixture. Supports shall be located near each fixture end.

5. Code approved wiring channel that is used to support suspended fixtures shall have hanger supports as per manufacturer's and/or code requirements, whichever is the more stringent. Maximum distance between hanger supports shall be 100".

6. Fastenings for suspended fixture supports that are attached to suspended ceilings shall consist of a minimum of two 3/8" machine screws fastened to metal straps or channels that are supported by the suspended ceiling supporting channels.

7. Fastenings for suspended fixture supports that are attached to concrete slab or concrete joist construction shall consist of a minimum of two 3/8" machine screws fastened to concrete inserts for each individual fixture support.

8. Provide canopies on stems fitting snugly to and covering outlet boxes and support devices.

C. Recessed fixtures:

1. Equip recessed fixtures with attached junction boxes unless noted otherwise in the fixture list.

2. Provide plaster frames, and other mounting material compatible with the ceiling and wall systems employed.

3. Support recessed fixtures separately from ceiling system where ceiling members are not structurally capable of supporting lighting fixtures, or where required by Code. Interconnect fixture bodies and ceiling system members to prevent independent movement where required by Code.

D. Supplemental support:

1. Include any supplemental support and framing material and fastenings necessary to support lighting fixtures in the locations indicated. Attach this material onto the building structural members. All such materials and installations shall comply with code requirements.

2. Include any foundations required for the support of base mounted lighting

fixtures. If the pedestals, poles, or standards supporting such fixtures exceed 10 feet in height, and no foundation details are included on the Contract Documents, provide details of proposed foundations for review by the Structural Engineer. If required by code, proposed foundation designs must be signed by a registered Structural Engineer.

1.14 BIDDING PROCEDURE FOR SUBSTITUTIONS

Bidders' attention is called to the following procedure to be followed in submitting their bids for the Lighting section of the Electrical Work:

A. Bidders wishing to obtain approval on brands other than those specified by name and catalog number on the drawings, shall submit their requests not later than fourteen (14) days before the bid opening. Approval will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved as equal to those specified as far as the requirements of the project are concerned. If the bidders do not elect to obtain prior approval during the time so specified, the Engineer has no obligation to review or consider any such article after the contract award.

B. If the bidder wishes to substitute fixtures from alternate manufacturers, refer to Paragraph 2.02 of this section of the specifications. Note that the dimensions of visible parts of many fixtures, (for example, the aperture diameters of incandescent fixtures) are binding to the bidder and cannot be changed without prior approval by the Engineer.

C. Request for approval shall be accompanied with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the Owner, the Architect and the Engineer of record.

1.15 DELIVERY, STORAGE, AND HANDLING

A. Store, protect, and handle products to site under provisions of Section 16010.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions.

1.16 WARRANTY

A. Ballasts for fluorescent and high intensity discharge fixtures shall be covered by a two-year warranty against defects in workmanship or material. Warranty shall include in-warranty service program providing for payment of authorized labor charges incurred in replacement of inoperative, in-warranty ballasts.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated. Except where specifically indicated otherwise, provide only new materials having all legally required approvals and/or labels.

2.02 GENERAL MATERIAL REQUIREMENTS

A. Ferrous mounting hardware and accessories shall be finished using either a galvanic or phosphate primer/baked paint process to prevent corrosion and discoloration of plaster.

B. For weatherproof installation and painted finishes of fixtures and accessories shall be weatherproof enamel using proper primers or galvanized and bonderized epoxy, so that the entire assembly is completely corrosion resistant for the service intended.

1. Hangers shall be conduit with chemically resistant, weatherproof, baked enamel finish.

2. Where aluminum parts come in contact with bronze parts, apply to both surfaces a coating material to prevent corrosion.

C. Fasteners shall be manufactured of non-magnetic stainless steel or anodized aluminum, except in indoor applications where galvanized steel shall be acceptable.

D. Fixtures shall be free of light leaks and shall be designed to provide sufficient ventilation of lamps and ballasts including vent holes where required. Outdoor fixtures shall have wire mesh corrosion resistant screens in the vent holes.

E. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any deformation after assembly. All sheet metal shall be free of light leaks. All edges shall be finished so there are no sharp edges exposed. All mitres shall be in accurate alignment with abutting intersecting members. Piecing of plates in individual runs in single planes and the use of spliced pieces or filler material to cover defective workmanship shall not be allowed. Sheet metal work shall be properly fabricated so that planes will not deform, i.e. become concave or convex, due to normal expected ambient and operating conditions.

F. Lampholders shall hold lamps securely against normal vibrations and maintenance handling. Provide solid nickel or nickel-and-silver-plated contacts in lampholders for following types of lamps:

1. Metal halide lamps.

2. Lamps in outdoor fixtures.

3. Tungsten-halogen lamps.

G. Wiring channels and lampholder mountings shall be rigid and accurately made.

H. Fluorescent Fixtures:

1. Hot Cathode:

a. Housing:

1) No. 20 minimum gauge steel, bonderized or equal rust protected, or No. 16 gauge aluminum rigid construction suitable for continuous row mounting where indicated.

2) Finish: Baked enamel paint finish unless otherwise specified, color as specified or as selected. For exterior finish, refer to "EXTERIOR FIXTURE FINISHES" below.

b. Reflector: Minimum 85% reflectance.

c. Light shields:

1) Louvers: Continuously bound in channel formed frame, finish and color as specified or as selected. When more than one louver panel occurs in a fixture, submit as a part of the shop drawings the dimensioned layout of individual louver panels and supporting "tee" members.

2) Louvers shall be of 100% virgin acrylic (except as shown) and shall have matte finish on exterior (facing away from lamps) surface (except as shown).

3) Lenses shall fully eliminate lamp images when viewed from all directions within the 45° to 90° angle from vertical when the ratio of lamp spacing to the distance from lamp underside to top of

lens does not exceed 1.50. Within the viewing angle from 0° to 45° the ratio of maximum brightness (under a lamp) to minimum brightness (between lamps) shall not exceed 3 to 1

4) No cross bars shall be permitted over lightshields.

d. For rapid start lamps on single ballast, provide one (1) grounding lampholder per lamp. Lampholders operating with open circuit voltage in excess of 300 volts shall be safety type and shall open supply circuit when lamp is removed from lampholder.

1) Mount lamps used in rapid start circuits 40 watts and below: within 1/2" of grounded metal as long as the lamp.

e. Fluorescent fixtures shall conform to NEMA Standards, including references to fixture dimensions and temperature ratings.

f. Ballasts shall be high power factor (greater than 90%), approved by UL and certified by ETL. Ballasts shall be certified for voltage and number of lamps specified and equipped with internal thermal overload protectors unless otherwise specified.

1) Ballasts for indoor applications shall be marked "Class P" to show compliance with 1987 NEC Section 410-73(e).

2) Provide two-lamp ballasts where possible including continuous rows of one-lamp fixtures, and one lamp ballasts where the fixture layout does not permit the use of two lamp ballast or as noted on drawing.

3) All ballasts shall operate on voltage as specified and confirmed on the electrical drawings. Ballasts shall operate lamps properly through the following supply voltage ranges.

a) 277 volt ballasts: 254-289 volts
b) 120 volt ballasts: 110-125 volts

4) Frequency shall be 60 hertz except as noted.

5) Ballast minimum sound ratings:

a) 265ma: Class :A"

6) All 4' long fluorescent ballasts for interior use shall be energy saving, electronic type, dedicated T8 or equal.

7) All fixtures installed in exterior or unheated interior spaces shall be supplied with ballasts which start lamps down to 0°F.

g. Lighting fixtures recessed in a hung ceiling where the space above the hung ceiling is used as a plenum chamber for either supply or return air for the air conditioning system shall be designed, manufactured and wired to conform to NEC Article 300-22.

I. High Intensity Discharge Fixtures:

1. Housing, where applicable:

a. Steel, bonderized or equal rust protected or aluminum, rigid construction. Minimum gauge thickness shall be as follows:

1) Interior locations: No. 20 gauge steel, No. 16 gauge aluminum.

2) Exterior locations: No. 18 gauge steel, No. 14 gauge aluminum.

b. Finish: Baked enamel finish

1) Concealed surfaces: matted black.

2) Visible surfaces: color and texture as specified below for each fixture type or as selected by the Engineer.

3) Exterior fixture finish: Refer to paragraph N., "Exterior Fixture Finishes" below.

c. Lampholder housing: cast aluminum with integral heat radiating fins to assure cool lamp base operation.

d. Fixture housing design shall provide for top and bottom relamping, unless otherwise specified.

2. Reflectors: High purity (not less than 99.0%) aluminum. Specular finish shall be achieved by mechanical-and electro-polishing. Reflector shall be anodized to prevent surface corrosion or deterioration. Minimum reflectance shall be 83%.

3. Provide safety devices for removable fixture elements (cones,reflectors, lenses, and fixture doors,etc.). Safety devices shall support removable elements when not in normal position, and be detachable if necessary. These devices shall not interfere with fixture performance, maintenance, or the seating of any fixture element, and shall not be visible during normal fixture operation.

4. Ballasts: High power factor, UL approved constant wattage auto-transformer type for voltage and lamp specified, 60 hertz.

5. Lighting fixtures recessed in a hung ceiling where the space above the hung ceiling is used as a plenum chamber for either supply or return air for the air conditioning system shall be designed, manufactured and wired to conform to NEC Article 300-22.

J. Wiring:

1. Voltage Rating

   a. For voltages up to 120 volts fixture wiring shall be rated for 300 volts minimum.

   b. For voltages above 120 volts fixture wiring shall be rated for 600 volts minimum.

2. Temperature Rating - Internal to Fixture

   All wiring shall be code-approved for fixture wiring and shall comply with the following temperature ratings unless fixture design or local codes require higher temperature wire.

   a. Fluorescent

      1) 90°C minimum rating between lampholder(s) and internal ballast.

      2) 90°C minimum rating between ballast and separate junction box or connection with integral wireway.

   b. High Intensity Discharge

      1) 150°C minimum rating between lampholder(s) and separate junction box or connections with ballast components.

      2) 150°C minimum rated between core and coil ballast components and separate junction box.

      3) 90°C minimum rating between encased and potted ballast components and separate junction box.

3. Temperature Rating - External to Fixture

a. All flexible cord wiring between fixture components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105°C.

b. Cord type shall be suitable for application and shall be fitted with proper strain reliefs and watertight entries where required by application.

4. Splices

a. Splices internal to fixture shall be made within separate splice compartments and shall utilize nylon insulated crimped connections or insulated quick disconnects.

b. Splices to branch circuit wiring in separate junction boxes shall utilize flame retardent thermoplastic caps with fully seated helical metal spring and threaded entry.

5. No internal wiring shall be visible at normal viewing angles, i.e., above 45° from vertical. Use additional wire clamps if necessary. Anticipate increased visibility if fixtures are mounted on or recessed within a sloping surface.

6. Any fixture fed from more than one panel, i.e., for normal and night or emergency operation, shall have separate neutrals to each panel.

7. Furnish code-approved wiring in ceiling cavities forming air plenums.

K. Lamps:

1. Hot cathode fluorescent lamps: warm white except as shown. Refer to fixture schedules on drawings. All lamps, except as specified, shall be of the same manufacturer (General Electric, GTE Sylvania, North American Philips, or Osram).

2. High intensity discharge lamps: Refer to fixture schedules on drawings. All lamps, unless specified otherwise, shall be of the same manufacturer (General Electric, GTE Sylvania, North American Philips, or Osram).

L. Where acrylic plastic is specified, use 100% raw virgin acrylic plastic meeting the ASTM Specification for methacrylate molding compound equal to Rohm and Haas "Plexiglass". The raw material used must be of the quality to exceed IES-SPI-NEMA Specifications with a minimum requirement of 2000 hours of exposure in a Fade-O-Meter and not exceed (3) units of yellowing. E.T.L. report to be supplied confirming above requirements.

M. Exterior Fixture Finishes:

1. Unless otherwise specified, all painted surfaces shall have an outdoor life expectancy of not less than twenty (20) years. Surfaces shall be prepared, primed, and material applied in accordance with the manufacturers requirements.

2. Color: Colors shall be as specified on drawings or selected by the Engineer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrate and supporting grids for luminaires.

B. Examine each luminaire to determine suitability for lamps specified.

3.02 INSTALLATION:

Electrical installation shall conform to requirements of NFPA 70, state and local codes, and to requirements specified herein.

A. Provide a lighting fixture for each lighting outlet as indicated.

B. Provide complete fixtures, including glassware, diffusers, lenses, fitters, canopies, sockets, reflectors, ballasts, wiring, hangers and any accessories necessary to complete each fixture installation.

C. Provide spacers where required for surface-mounted fixtures mounted to low density cellulose or similar ceiling materials.

D. Aim floodlights and other adjustable fixtures to the satisfaction of the Engineer.

E. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Fixture catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a fixture may be installed.

F. Provide adequate and sturdy support for each lighting fixture. Verify weight and mounting method of all fixtures and furnish and install suitable supports. Fixture mounting assemblies shall comply with all local seismic codes and regulations.

G. Install rows of fixtures accurately on straight lines unless otherwise indicated on drawings. Coordinate with mechanical work.

H. Install fixtures with vent holes free of air blocking obstacles.

I. Top Relamping Fixtures: Top relamping fixtures shall have the necessary top-relamping screws loosened and moderately tightened, prior to installation, to assure ease of operation when relamping is required.

J. Fluorescent Fixtures: Replace noisy ballasts as directed, at no cost to the City.

K. High Intensity Discharge Fixtures:

1. Replace noisy ballasts as directed, at no cost to the City.

2. Ballasts for indoor application shall be encased in a housing which provides necessary wiring compartments and provisions for required electrical connectors or devices.

3. Ballast components shall be surrounded with a thermosetting fill to assure adequate heat dissipation and quiet operation.

4. Ballasts shall be provided with necessary mounting hardware and vibration dampers.

5. Ballasts for outdoor use shall be encased in weathertight enclosures with proper outdoor type wiring devices. Ballasts shall be suitable for starting lamps between -29°C and 41°C.

L. Mask the trims and bottoms of all lighting fixtures if necessary to protect the fixture during construction.

M. All lighting fixtures recessed in a ceiling which have a fire resistive rating of one hour or more shall be enclosed in a box which has a fire rating equal to that of the ceiling. The space from the fixture to the enclosure shall be a minimum of one inch.

N. At the completion of construction clean the bottoms, the trim, the reflecting surfaces, lenses, baffles, louvers and reflector cones of all lighting fixtures so as to render them free of any material, substance or film foreign to the fixture.

O. Ascertain and ensure that all lamps installed are exactly as specified for each fixture type.

P. Provide labor and materials for final targeting of all adjustable fixtures under the Engineer's supervision. Targeting shall take place immediately before building is turned over to the City, after regular working hours where required.

Q. Replace all burned-out or inoperative lamps and inoperative ballasts in all high intensity discharge and fluorescent fixtures before the project is accepted by the University so that all lighting fixtures will be in first-class operating condition.

3.03 FIXTURE LOCATIONS

A. Locations of fixtures are shown diagrammatically. Verify exact location and spacing with Reflected Ceiling Plans and other reference data before ordering of fixtures and during installation.

1. Notify the Engineer about field conditions at variance with Contract Documents before commencing installation.

2. Coordinate space conditions with other trades before ordering of fixtures.

3. Coordinate length of continuous-run fluorescent fixtures with adjacent walls, partitions, coffers and other architectural elements as required.

B. Prior to installing fixture outlets, examine the plans of other trades in order to conform to all of the following conditions:

1. Locate fixtures to conform with reflected ceiling plans included in the Contract Drawings.

2. Fixtures shall not conflict with the installation of doors or cabinets.

3. Locate fixtures symmetrical with tile and wall material patterns and room dimensions.

4. Fixture outlets shall be accessible and fixtures shall hang clear of ducts and piping. Verify exposed duct and piping locations prior to rough-in of electrical outlets. Adjust outlet locations to coordinate with ducts and piping.

5. Follow indicated mounting heights. Obtain missing heights, if any, from the Engineer.

3.04 EXPANSION SHIELD ANCHORS

A. Expansion shields may be used for supporting lighting fixtures instead of concrete inserts under the following conditions:

1. Fastenings and expansion shield anchors shall be one trade size larger than Specification requirements for fastenings used with concrete inserts.

2. Holes for expansion shield anchors, cinch anchors, etc., shall be self-drilled or drilled with carbide tipped, rotary type concrete drills. Do not drill holes with pneumatic or impact tools. Do not install fasteners in concrete by powder actuated methods.

3. Drill holes for expansion shields carefully in a workmanlike manner. Drill to the full depth of the expansion shield anchor and in a manner that will develop the full strength of the fastening.

3.05 INTERFACE WITH OTHER PRODUCTS

A. Interface with air handling accessories furnished and installed under Section 15800.

3.06 CLEANING

A. Clean Work under provisions of Section 01710.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosure.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.07 FIELD TEST

A. Provide systems demonstration under provisions of Section 16030.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation. Provide minimum of 48 hours demonstration of luminaire operation.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16531

HIGH MAST LIGHTING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide high mast lighting system consisting of 120’ sectional steel poles, winches, luminaires and lighting controls.

B. Assemble steel sectional poles, lowering devices, and luminaire rings. Install and wire all luminaires and controls.

C. Test High Mast Lighting system including lowering devices, luminaires, and controls.

D. The Contractor shall furnish the poles, luminaire rings, disconnect switches, contactors and fixtures and deliver and store this equipment as directed by the Engineer. For these poles, the Contractor shall also furnish and install the drilled pier footings, handholes and grounding system.

1.02 RELATED WORK

A. Section 16105 Electrical Sitework.

B. Section 16120 Wires And Cables.

C. Section 16450 Grounding.

1.03 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Steel High Mast Lighting poles shall conform to AASHTO standards.

C. Wood poles shall conform to AASHTO standards.

D. Provide, to the extent that U.L. standards have been established as of the bid date, with U.L. listed and U.L. labeled poles, luminaires, controls, and accessories including the lowering devices, fuses, enclosed circuit breakers, and wiring devices.

1.04 DELIVERY, STORAGE, HANDLING AND ASSEMBLY

A. Poles, luminaires, and accessories shall be delivered and stored at the site. Provide secured outdoor storage for all luminaires and accessories. Provide traffic protection for poles. Inspect all delivered materials for damage.

B. Assemble the steel sectional poles including lowering system, winch assembly, luminaires and cables. Contractor and the lowering device manufacturer's representative shall conduct a half day training session for all contractor personnel involved in pole and lowering device assembly. Contractor shall record and submit a list of all personnel attending the training session and only persons attending the training session shall participate in assembly of the poles and lowering device system. Manufacturer's video recording of pole and lowering device assembly procedures shall be included as a training aid.

C. Protect assembled poles, luminaires and accessories from damage during storage or installation.

1.05 COORDINATION

A. Furnish bolt templates, anchor bolts, and pole mounting accessories to pole foundation installer in sufficient time to not delay installation of the pole foundations. Anchor bolts and templates shall be shipped ahead of the poles, if required, to allow pole foundation work to proceed.

1.06 EXTRA MATERIALS

A. Furnish under provisions of Section 01700.

B. Provide 2 complete spare luminaire assemblies for each luminaire type S1 and S2.

C. Provide 12 spare 1000 watt HPS lamps in compact and standard sizes.

PART 2 PRODUCTS

2.01 120' HIGH MAST LIGHTING SYSTEM

A. Provide poles and anchor bolts and pole hardware as manufactured by Ameron Pole Products Division.

B. Provide lowering device, winch, control and power cables, lowering cables and hardware as manufactured by Holophane Lighting.

C. Provide luminaires and electrical and mounting accessories as manufactured by Holophane Lighting.

D. Provide 120 foot sectional steel lighting poles.

1. The assembled lengths of the steel poles shall be 120’ as scheduled on the drawings. Provide shaft, handholes, access holes, support plate, anchor plate, bolt covers, anchor bolts and nuts. Poles shall be fabricated from high strength low alloy steel conforming to applicable ASTM Standards and have a minimum yield strength of 55 KSI. Poles shall conform to AASHTO90w/ 1.3 requirements for installation in areas subject to 90-mph winds with gust factor of 1.3. Pole shafts shall be hot dipped galvanized per ASTM A 123, after fabrication, round or 16 sided tapered steel using a maximum of three sections with no more than two telescoping sections. Round or 16 sided pole exterior shall be at manufacturer’s option, however all steel poles shall be the same. The pole sections shall telescope into each other and have a minimum overlap of 1-1/2 times the top outside diameter of the bottom section. Top pole sections which telescope onto a section below shall contain a drilled hole of approximately 1/2” diameter to confirm compliance with the overlap requirement. The hole shall be located above the bottom edge of the top section, 1-1/2 times the diameter of the top of the lower pole section. Poles shall maintain a uniform taper from top to bottom. The contractor and Engineer shall have the option to inspect the pole sections and galvanizing process at the manufacturing site prior to shipment.

2. All welding shall be done by the shielded metal arc, gas shielded fluxcore, gas metal arc, or submerged arc process. Welding shall be performed by certified welders and the quality shall conform to the current AWS D1.1 Section 8. There shall be only one longitudinal weld in the tapered sections of the shaft, two longitudinal when the poles are constructed by the “break” process, which shall be made by automatics seam welding. The longitudinal weld seams shall have not less than 60 percent penetration, except in the areas where the shaft section telescopes over another. In overlapping areas the weld penetration shall be 100 percent. No transverse butt welds shall be used in fabricating the shafts.

3. The base plate shall be integrally welded to the pole shaft using a full penetration butt weld with backup bar. The base plate shall be ASTM A 36 steel with 36KSI minimum yield strength.

4. Anchor bolts shall be fabricated of ASTM A 615 Grade 75 with 75KSI minimum yield strength. Provide quantity and size as recommended by the manufacturer of the pole for AASHTO 90w/1.3 conditions. Each anchor bolt shall be supplied with one

leveling nut and two hold down nuts, the second as a locknut. The threaded ends of the bolts shall be galvanized in accordance with ASTM a 153. Maximum load case, due to wind, shall be resisted by no less than 2 anchor bolts in tension. The anchor bolts shall be hooked or headed. Anchor bolts shall be fabricated in accord with the light pole manufacturer’s requirements.

5. The handhole for installation of the winch assembly and lowering device plate shall be 10.5 inches x 30 inches externally reinforced by a .25 inch reinforcement sleeve and shall allow adequate clearance for installing, maintaining, and servicing the lowering device, winch, and circuit breaker. There shall be no internal reinforcement which could trap acid in the galvanizing process. The handhole shall begin 15 inches up from the base of the pole. Opposite the handhole shall be an approximately 14 inch (minimum) x 22 inch x 5/16 inch support plate for mounting of the winch. A 1/2 inch UNC-2A nut shall be welded inside the pole adjacent to the handhole for grounding. The handhole cover shall be at least 11 gauge steel and shall be hinged. The cover hinging shall be industrial grade, of suitable strength and durability for the cover provided. A closed cell neoprene gasket meeting MIL -r-6130B, Type II, grade A or B, Soft shall be provided on the cover for weatherproofing.

6. A 3 inch x 7 inch handhole for wiring access shall be provided opposite the handhole for the winch and lowering device. Provide with gasketed, bolted, 11 gauge galvanized cover to match pole finish.

7. A minimum of (3) 2-1/2 inch conduit access holes shall be provided in the bottom section of the pole. The holes shall be located 90^0 from the handhole for the winch and lowering device access, exact height above the bottom of the pole to be determined by the contractor. The access holes are to accommodate line side and load side wiring from the pole interior to the fusible disconnect switch. Contractor to determine exact access hole location based on equipment to be installed. Contractor to provide 2” conduit between pole and disconnect. No equipment shall be located higher than six feet above the bottom of the pole and proper clearance shall be maintained in front of the handholes and disconnect switch.

8. The base plate, exposed portion of the anchor bolts, nuts, washers, and the lower 12 inches of the interior of the pole and the lower 8 inches of the exterior surface of the pole shall be

etched with Galvaprep 45 and then coated with Tarmastec 100, manufactured by Porter Paint Company. Provide 14 mils minimum dry film thickness.

9. The poles, complete with lowering device and luminaires in place, shall be capable of withstanding a sustained wind velocity of 90 mph with gusts up to 130 percent of sustained velocity. Calculations shall be provided that are prepared, signed, and stamped by a Structural Engineer currently licensed in the state of California.

10. The contractor, as part of the submittals, shall provide certificates of compliance that prove all products meet or exceed the specified ASTM and AASHTO requirements.

11. Each pole shall be identified. The contractor shall label all poles according to their number, as indicated on the drawings. Labeling shall consist of spray on stenciled letters and numbers, 4” high, installed at an elevation of 15’ above the bottom of the pole. Three labels shall be prayed on each pole at an equal distance from one another. The label paint color shall be dark blue. Submit color sample for color selection.

12. Supports shall be provided on the poles for the fusible disconnect switches. The supports shall be 2” x 2” angle iron brackets extending the horizontal width of the enclosure. Contractor shall determine exact mounting height and length of the brackets to accommodate the equipment to be provided. Contractor shall bolt 2” x 2” angle iron to the disconnect enclosure and drill and bolt the enclosure angle iron to the angle iron bracket on the pole.

E. Provide luminaire ring, internal winch, luminaire mounting brackets and hardware, controls, and all wiring for each pole.

1. The lighting luminaires, controls and poles shall be tested as an integrated system after assembly and installation.

F. Provide High Mast Lighting System area light luminaires, Holophane HMSD series open bottom cut off version with photometric distributions as indicated on the drawings.

1. The area luminaires shall consist of a cast aluminum housing, a built in ballast and open ventilated borosilicate glass optical assembly.

2. The luminaire housing shall be die cast, copper free aluminum and provide a weather tight environment for all components and shall have passed the U.L. 1572 rain test and be U.L. listed to operate in a 40^0 C ambient.

    a. The cast aluminum bracket arm clamp shall attach to a 2” nominal schedule 40 pipe with (2) grade 5 zinc plated steel bolts allowing $\pm$ 3^0 adjustment for leveling the luminaire.

    b. The nickel plated, lamp grip, porcelain enclosed, pulse rated lamp socket shall prevent undue lamp vibrations.

    a. The luminaire shall have a weather shield between the reflector and housing.

3. The ballast shall be copper wound, 480 volt single phase input voltage, 1000 watt, and shall operate the lamps at full rated output with starting current less than operating current.

    a. The ballast lamp combination shall operate at a power factor of 90% or higher.

    b. All ballast components shall be mounted to a single die cast aluminum plate which shall be completely removable as a unitized assembly for maintenance without removing the luminaire from the bracket arm.

    c. All ballast components shall be factory tested and prewired to the quick disconnect.

    d. A terminal block shall be provided to simplify wiring and provide positive connections

4. The optical assembly shall be of the open ventilated design consisting of a spun borosilicate prismatic glass reflector.

    a. The glass reflector shall have a smooth, non porous inner surface encased within a spun on, sealed aluminum cover which is factory assembled to the die cast aluminum housing.

b. The lamp shall operate in the vertical, base up lamp position.

G. Provide High Mast Lighting System flood light luminaires, Holophane Prismbeam II series, enclosed, with integral ballast assembly with photometric distributions as indicated on the drawings.

1. The flood light luminaires shall consist of a die cast aluminum housing, spun aluminum reflector, integral ballast housing and prismatic for asymmetric distributions or clear for symmetrical distributions, borosilicate glass lens.

2. The luminaire housing shall be die cast, the reflector shall be spun, both of copper free aluminum and provide a weather tight environment for all components and shall have passed the U.L. 1572 rain test and be U.L. listed to operate in a 40^0 C ambient.

a. Provide with adapter brackets for mounting the luminaire yoke to the luminaire ring arms, nominal 2" schedule 40 pipe, and to allow vertical and horizontal aiming. Provide with horizontal protractor vertical yoke mounting plate.

b. The unit shall have a breather to eliminate a vacuum in the optical chamber.

c. The lens frame shall be hinged to the reflector.

b. The luminaire shall have a 90^0 C conductor rated water tight cord connector for connecting the luminaire ring wiring.

3. The ballast shall be copper wound, 480 volt single phase input voltage, 1000 watt, and shall operate the lamp at full rated output with starting current less than operating current.

a. The ballast lamp combination shall operate at a power factor of 90% or higher.

b. All ballast components shall be mounted in an integral ballast compartment.

c. All ballast components shall be factory tested prior to shipment.

d. The ballast and lamp shall have in line fuse protection using weatherproof fuse holders and slow blow fuses. Fuses shall be factory installed and sized as recommended by the ballast manufacturer.

4. The optical assembly shall be of the enclosed with breather design consisting of a spun aluminum reflector with borosilicate prismatic glass or borosilicate clear glass lens.

H. The 120’ High Mast Lighting System pole and luminaires are to be provided with lighting contactors for control of the luminaires

1. Lighting contactors shall be Asco and shall be supplied as part of the poles and installed in NEMA 4 enclosures mounted on the poles as shown.

a. Contactors shall be electrically operated mechanically held Asco 917, 480 volt 2 pole, 20 amp, 30 Amp general purpose, contract rating with 277 bolt coils and option number 47 for operation from a two wire pilot device

b. Tap the lighting circuit for control power for the contactors and auxiliary relay for two wire pilot device operation, tap one phase and neutral. Provide 10 Amp maximum 100K AIC inline fuse for control circuit.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine excavation and concrete foundation for lighting poles.

B. Examine each luminaire to determine suitability for lamps specified.

3.02 INSTALLATION

A. Install in accordance with manufacturers' instructions.

B. Install lighting poles at locations indicated.

C. Install poles plumb,

D. Install lamps in each luminaire. Provide shims, double nuts to adjust plumb. Grout around each base.

E. Bond luminaires, metal accessories, and metal poles to branch circuit equipment grounding conductor. Provide supplementary grounding electrode at each pole.

F. Connect up lighting system and test controls.

3.03 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

B. Measure illumination levels to verify conformance with performance requirements.

C. Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

3.04 ADJUSTING

A. Aim and adjust luminaires to provide illumination levels and distribution indicated on drawings as directed.

B. Relamp luminaires which have failed lamps at date of substantial completion.

3.05 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosure.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

PART 4 – MEASUREMENT AND PAYMENT

NOT USED

SECTION 16600

CRANE CABLE PROTECTION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. CRANE CABLE PROTECTION SYSTEM consists of furnishing transportation, labor, materials, and equipment for the installation of the crane cable protection system.

1.2 RELATED WORK

A. CONCRETE WHARF CONSTRUCTION	Section XXXXX
B. METALS FABRICATION	Section XXXXX
C. CORROSION CONTROL	Section XXXXX

1.3 REFERENCES

A. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A-1	Specification for Carbon Steel Tee Rails
ASTM A-36	Specification for Structural Steel
ASTM A-123	Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
ASTM A-128	Specification for Steel Castings, Austenitic Manganese
ASTM A-193	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service (Rev. A)
ASTM A-194	Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A-307	Specification for Carbon Steel Bolts and Studs (Rev. A), 60,000 psi Tensile
ASTM A-325	Specification for High Strength Bolts for Structural Steel Joints

ASTM A-370	Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A-759	Carbon Steel Crane Rail
ASTM A-781	Specification for Castings, Steel and Alloy, Common Requirements, for General Industrial Use

B. AMERICAN WELDING SOCIETY (AWS)

1.4 SUBMITTALS

A. Submit details, installation procedures and supporting information for the crane cable protection system.

B. SHOP DRAWINGS: Submit for all field-assembled metalwork and the following installations:

1. Crane Cable Protection System: Consolidate all preinstallation and installation information into a single submittal for this item.

    a. All Ferrous Items: Mill test certificates for each heat number.

    b. Welding procedures and welder qualification records.

    c. Credentials of certified welding inspector.

    d. Credentials of nondestructive testing agency and personnel.

    e. Nondestructive testing procedure specifications.

    f. Submit plan of work and areas of responsibility for staff or single contractor that shows how the crane power cable protection system will be procured and installed.

    g. Submit a detailed installation plan, approved by the manufacturer complete with narrative text, drawings, photographs, and any other graphic information to thoroughly describe the following:

        1. Fabrication details of the belt system, including all necessary temporary and permanent installation guides, aids, and components.

        2. Details for joining all components of adjoining sections of the Belt system.

        3. Details for joining the Belt system to the cable horn vaults.

4. Details for attaching the belt system to adjacent structural element of the wharf.

5. Details for supporting the belt system prior to placement of concrete fill. Show all ancillary components and describe how they will be installed.

6. Details for supporting the belt system during placement and curing of concrete fill. Show all ancillary components, including components for securing the Panzerbelt system in the concrete fill, and describe how they will be installed.

7. Details for attaching the "belt" and splicing the "belt".

h. Statement from the manufacturer the belt system is installed in accordance with their requirements based on the personal observations of the manufacturer's representative directly employed by and representing the manufacturer.

C. QUALITY CONTROL SUBMITTALS

1. Crane Cable Protection System: Provide specific installation sequences and detailed drawings showing how the belt system will be held in place before, during and after placement of concrete around the belt until the concrete sets up.

D. SPECIAL WARRANTY

1. Provide 5-year manufacturer's written warranty against defects in materials and workmanship for the belt crane power cable protection system. Warranty shall commence upon substantial completion of the project or when the facility is first placed in service, whichever occurs first.

1.5 <u>QUALITY ASSURANCE</u>

A. PREINSTALLATION CONFERENCE FOR SPECIALTY PRODUCTS

1. Conduct training by representative of manufacturer, directly employed by manufacturer and personally familiar with the systems prior to beginning installation for the crane power cable protection system

1.6 <u>DELIVERY, STORAGE, AND HANDLING</u>

A. PREPARATION FOR SHIPMENT

1. Insofar as practical, factory assemble items specified herein.

2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled, in a manner that will protect materials from damage, and facilitate identification and field assembly.

PART 2 - PRODUCTS

2.1 MATERIALS

A. CRANE POWER CABLE PROTECTION SYSTEM

1. Crane power cable protection system shall be specifically designed to hold and protect 5000 volt crane power cables in areas subject to heavy wheel loads.

2. Power cable protection system shall be designed for heavy wheel loads shown on the drawings.

3. Crane power cable protection system shall consist of a fabricated stainless steel metal channel profile section, steel reinforced rubber cover (belt), and predrilled fixing strip for securing belt to steel channel profile with stainless steel rivets and all necessary appurtenances and modifications necessary to provide coverage over the complete length of wharf as shown on the Drawings. The stainless steel channel for storing the cables shall be specially designed and fabricated to hold a maximum of 8 cables plus clearances, as reviewed by the Engineer.

4. Crane power cable protection system shall be "PANZERBELT" as manufactured by Specimas and distributed by Gantrex, or equal.

2.2 EPOXY ANCHORS (IF USED)

A. CRANE POWER CABLE PROTECTION SYSTEM

1. Coordinate installation of crane power cable protection system with installation of tension relief/flop over drum in locations shown on the drawings.

3.0 INSTALLATION

A. GENERAL

1. Install in accordance with shop drawings, the Drawings, and these Specifications.

2. Install fabricated metalwork plumb or level as applicable.

3. Completed installations shall be rigid, substantial, and neat in appearance.

4. Install commercially manufactured products in accordance with manufacturer' s recommendations as approved.

B. CRANE POWER CABLE PROTECTION SYSTEM

1. Provide support install steel channel profile, place concrete around channel profile, and allow concrete to achieve at least 50% of specified 28 day design strength before fixing belt to steel channel profile in accordance with manufacturer’s instructions.

2. Provide temporary bracing and support for steel channel profile that will maintain a uniform top of channel elevation while keeping the entire length of both vertical sides of the profile plumb during placement and curing of concrete.

3. Perform trial installation of length of system not to exceed 20 feet to demonstrate that proposed installation procedures produce satisfactory installation prior to proceeding with placement along full length of wharf.

4.0 MANUFACTURERS' SERVICES

A. CRANE POWER CABLE PROTECTION SYSTEM: Provide on site technical supervision of the crane power cable protection system and all appurtenances associated with the crane power cable protection system as herein specified.

END OF SECTION

SECTION 16732

LIFE SAFETY SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide fully electronic, electrically supervised, complete addressable fire alarm systems for the buildings indicated. The work will include, but not be limited to, the following:
   1. Fire Alarm Control Panel (FACP)
   2. Alarm Initiating Devices
      a. Manual Stations
      b. Temperature Detectors (Rate-of-Rise)
      c. Area Photoelectric Smoke Detectors
   3. Alarm Indicating Devices
   4. All wiring (conduit, outlets, wire, etc.) required providing power to and interconnecting all components in Items 1 through 3.
   5. All wiring (conduits, wire, etc.) required to provide power to and interconnect, devices supplied under other divisions, including:
      a. Sprinkler Water Flow Switches
      b. Sprinkler Valve Supervisory Switches
      c. Electro-thermal links
      d. Duct Detectors
   6. Submittals required by the Engineer and local authorities and the obtaining of all approvals there from.
   7. Shop Drawings and As-Built Drawings.
   8. Service manuals and training.
   9. A one (1) year warranty of all components and systems operation.

B. Related work in other Sections:
   1. Electro-thermal links: Division 8
   2. Water Flow Switches: Division 15
   3. Sprinkler Valve Supervisory Switches: Division 15
   4. Duct Detectors: Division 15

1.2 APPLICABLE PUBLICATIONS

The following publications form a part of this specification. The publications are referred to in the text by the basic designation only.

A. National Fire Protection Association (NFPA) Publications:
   1. NFPA 72A Installation, Maintenance, and Use of Local Protective

Signaling System for Guard's Tour, Fire Alarm, and Supervisory Service.

2. NFPA 72B Installation, Maintenance, and Use of Auxiliary Protective Signaling System for Fire Alarm Service.
3. NFPA 72C Installation, Maintenance, and Use of Remote Station Protective Signaling System.
4. NFPA 72E Automatic Fire Detectors.
5. NFPA 72G Notification Appliances for Protective Signaling Systems.
6. NFPA 72H Guide for Test Procedures for Protective Signaling Systems.

B. State of California Administrative Codes:
1. Title 19, State Fire Marshal Regulations
2. Title 24, Part 3, CCR, 1994 California Electrical Code
3. Title 24, Part 9, CCR, 1994 California Fire Code

C. Underwriters' Laboratories (UL) Publication:
1. 864 Control Units for Fire Protective Signaling Systems

1.3 REGULATORY REQUIREMENTS

A. All fabrication and installation practices shall be in accordance with the following codes and regulations:
1. National Electrical Code (NEC)
2. National Fire Protection Association (NFPA)
3. Uniform Building Code (UBC) 1988 Edition and Title 24
4. Underwriter's Laboratories, Inc. (UL)
5. California Fire Code
6. California Electrical Code

B. All articles and services covered by the specification shall meet or exceed the safety standards established under the California Occupational Safety and Health Act (CAL-OSHA), latest edition.

C. Equipment supplied under this contract shall be approved for use within the State of California and shall comply with all codes and ordinances of applicable Federal, State, and local authorities. Any inspections, tests, corrections or other required activities to insure the complete compliance of the offered equipment shall be the responsibility of and at the expense of the fire alarm contractor.

1.4 SUBMITTALS

A. In addition to the requirements of Section 01300 and 16010, the submittal material shall include:
1. Six copies of descriptive data for all products and materials called for

herein.

2. All and any information and data (such as drawings showing device locations and types, zone schedules, riser diagrams, wiring diagrams, approvals, test data, battery calculations, etc.) required by local authorities.
3. Complete shop drawings of all custom-fabricated or assembled products, including wiring diagrams.
4. Drawings identifying all terminals and illustrating all device-wiring connections.
5. Data: submit catalog cuts for all equipment including special fabrication designs and State Fire Marshal listing numbers.
6. 1-year warranty.
7. Service Manuals and Maintenance Instructions.
8. System Test Reports.

1.5 CODES & APPROVALS

A. Obtain all necessary approvals from the State Fire Marshal, for all materials to be supplied, methods of installation and system operations, as required herein and by the authority having jurisdiction.

B. All electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

1.6 TESTING AND REPORTS

Upon completion of the system's installation, an approved representative of the system manufacturer shall be employed to conduct a thorough test of the system and submit a written report of the findings to the Engineer. The test shall include at the least, verifying the following:

A. The functional operation of each resettable initiating device (manual stations, detectors, etc.) and circuit.

B. The functional operation of each and every alarm device and circuit.

C. The functional operation of each monitored device circuit.

D. The functional operation of each control circuit.

E. The supervision function of each Initiating, Indicating, Monitoring, Control and Supply Circuit.

F. Terminal system automatic signaling.

1.7 WARRANTY

A All components, parts and assemblies supplied by the manufacturer shall be guaranteed against defects in materials and workmanship for a period of 12 months following acceptance. Warranty service shall be provided by a trained specialist of the equipment manufacturer who shall be based in a fully staffed, fully stocked (replacement parts and test equipment) branch office, located within 50 miles of the site.

B. The equipment manufacturer shall provide as part of this contract a minimum of two (2) service calls for inspections and tests in the first year in compliance with NFPA-72H guidelines.

1.8 SYSTEM OPERATION

A. Automatic Functions:
1. Upon actuation of any manual station, heat or smoke detector or sprinkler system waterflow switch, the following shall automatically occur:
   a. The alarm condition shall be annunciated visually in the FACP. The FACP and Remote Annunciator audible signals shall sound.
   b. The alarm shall activate all alarm indicating devices. The alarm signals shall sound continuously until manually silenced by authorized personnel or until five (5) minutes have elapsed, when they shall automatically be silenced. It shall be possible to acknowledge the alarm at the FACP and silence the local audible without silencing the alarm indicating devices.
2. Upon activation of a sprinkler valve supervisory switch, the sequence in A.1.a. shall be initiated. Supervisory alarms shall be differentiated from a trouble condition on the circuit.
3. All smoke detector circuits shall be provided with alarm verification with field-adjustable time from 0 to 60 seconds.
4. All smoke detector circuits shall perform per NFPA Series 72.

B. Manual Functions
1. At any time, even without an alarm condition on an initiating circuit, the operator shall have the following manual capabilities at the FACP by means of switches located behind a key switch or code:
   a. Initiate the general alarm signal.
   b. Silence the local audible signal.
   c. Silence the alarm signals.
   d. Reset the FACP after all initiating devices have been restored to normal.
   e. Disconnect any individual initiating or indicating circuit from the

alarm sequence in A.1. above.

f. Perform a complete operational test of the system microprocessor with a visual indication of satisfactory communications with each board.

C. System Supervision:

1. Upon application of primary power, or reapplication following power failure, the FACP shall automatically energize all circuitry and shall automatically be in a normal supervisory condition.
2. The following shall be electrically supervised:
   a. All initiating and indicating device circuits.
   b. Any relay intended to be replaceable shall be supervised against removal.
3. Upon power failure, the system shall sound an audible trouble signal. Standby power will be automatically provided by the system's batteries. The system's batteries and power supply shall be sized to provide (60) hours of supervisory operation with the capability of sounding the general alarm for at least five (5) minutes at any time during the 60-hour period following the loss of AC power. Following restoration to normal AC power, the trouble indicators shall be automatically reset.
4. An open circuit in an initiating loop shall cause the common "Trouble" LEDs at the operator's panel in FACP. The trouble audibles at the FACP and the Remote Annunciator will sound.
5. Other circuit faults in the system shall be indicated at the operator's LCD panel and sound the audible trouble signal at the FACP.
6. Operation of a momentary "Silence" switch shall silence the audible trouble signal but the visual "Trouble" LED's shall remain on until the malfunction has been corrected and the system reset. To prevent the system from being inadvertently left in an abnormal condition, the "Silence" function shall be such that a new trouble condition will reinitiate the sequence described in Paragraphs 3, 4 or 5.

1.9 <u>CONTRACTOR LICENSES AND QUALIFICATIONS</u>

A. Installer shall be licensed by the State Contractor's License Board with a Class C-10 license, in conformance with the provisions of the state of California Business and Professions Code. In addition, the Contractor shall certify in writing that persons installing the Work of this Section and their supervisor(s) shall be personally experienced in fire alarm systems, shall have been engaged in the installation of fire alarm systems for a minimum of 10 years and shall be a certified factory-trained installer by the manufacturer.

1.10 <u>EXTRA MATERIALS</u>

A. Provide two keys of each type.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment and materials used shall be standard components, regularly manufactured and of only one manufacturer for all buildings.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. All equipment shall be listed and labeled by Underwriters Laboratories and California State Fire Marshal.

2.2 ACCEPTABLE MANUFACTURERS

A. This specification is based upon equipment manufactured by Digital Monitoring Products, Inc to establish the standard for design and quality.

2.3 FIRE ALARM CONTROL PANEL (FACP): DMP XR2400F

A. Provide and install FACP where indicated on the drawings. The Fire Alarm Control Panel (FACP) shall be the DMP XR2400F Addressable Fire Alarm Control Panel. The FACP shall be capable of operating and supervising notification appliance devices as well as addressable initiating detection devices and an integrated supervised dual line digital communicator.

The FACP shall be completely programmable locally from the on-board annunciator or any of the remote annunciators, and/or remotely using upload/download software that communicates using SDLC 300 baud, Multiplex DNET data network, or IP Addressed data network. On-site programming from a personal computer shall also be permitted.

A battery test shall be automatically performed to test the integrity of the standby battery. The test shall disconnect the standby battery from the charging circuit and place a load on the battery. This test shall be performed no more than every 180 seconds.

The FACP shall be equipped with an anti-reversing circuit breaker to prevent damage due to accidental reversal of battery leads.

B. On-Board Annunciator

1. The FACP shall have an on-board annunciator to indicate fire and supervisory alarm, zone trouble, and status conditions on a 32-character

LCD alphanumeric display. The annunciator shall include LEDs for AC and Battery supervision, Trouble conditions, and Alarm indication.

2. The FACP shall be fully functional from the on-board annunciator and include buttons for Silence, Reset, System Test, and Fire Drill. Operation of the on-board annunciator shall be limited to authorized users by the use of a code or key.

C. Remote Annuciators

1. The system shall support a maximum of seven supervised remote annunciators with the same capabilities, functions and display layout to match the on-board annunciator identically. Operation of the remote annunciators shall be limited to authorized users by the use of a code or key.
2. Communication between the FACP and all remote annunciators shall be multiplexed over a multi-conductor cable as recommended by the manufacturer.
3. If at any time a remote annunciator does not detect polling from the FACP, the remote annunciator shall indicate “SYSTEM TROUBLE” on its alphanumeric LCD display within 200 seconds. If at any time the remote annunciator detects polling, but not for its particular address, the alphanumeric display shall indicate “NON-POLLED ADDR” to signify an addressing conflict.
4. The remote annunciators shall be capable of operating at a maximum wiring distance of 15,000 feet from the FACP on unshielded, non-twisted cable.

D. User Authorization

1. The system shall be capable of operation by 200 unique passcodes, with each passcode having its own custom authority level. This allows for the limitation of certain functions to authorized users. The operation of all annunciators shall be limited to authorized users by this code or by a key.

E. Test Modes

1. Each annunciator shall include self-test diagnostics enabling the installer to test all annunciator functions, including LCD display test, key test, zone test, and LED test.
2. The system shall include a provision that permits system testing from the on-board annunciator or any remote annunciator. The test shall include standby battery, NAC circuit, and communication to a central station or a remote station. The system shall also include a provision for an automatic daily test of the communication link from the FACP installation site to a central station or a remote station.
3. The system shall include a provision for displaying the condition of the internal system power and wiring. Internal monitors shall include the

NAC circuits, AC power, battery voltage level, phone line trouble 1, phone line trouble 2, and transmit trouble.

4. The system shall be capable of initiating a Walk Test that allows a single technician to test all connected devices. In Walk Test mode, each alarm input shall operate the associated NAC circuit for two (2) seconds. The Walk Test shall be capable of operating from the on-board annunciator or any remote annunciator.
5. The system shall be capable of initiating a Fire Drill that allows manual testing of the NAC circuits. The Fire Drill shall be capable of operating from the on-board annunciator or any remote annunciator.

F. Communication

1. The system shall be capable of signaling two remote monitoring station receivers utilizing four telephone numbers of 32 digits each using two (2) separate switched telephone network lines.
2. Signaling to central station or remote station receivers shall occur as follows: If two unsuccessful attempts are made on the first line to the first number, the system shall make two attempts on the second line to the first number. If these attempts are unsuccessful, the system shall make two further attempts on the first line to the second number, and then two attempts on the second line to the second number. It shall then make two more attempts on the first line to the first number, for a total of ten (10) attempts. After the tenth unsuccessful attempt, dialing shall stop and all alphanumeric annunciators shall display "TRANSMIT FAIL". Should another event occur that requires a report to be transmitted, the dialing process shall be repeated.
3. The communicator shall be capable of reporting all zones of alarm, supervisory and trouble conditions, as well as system status information, with individual and distinct messages to a central station or a remote station.
4. The system shall have a programmable option to report alarm, supervisory and trouble conditions, as well as system status information, to an alphanumeric pager.
5. The system shall be capable of communicating at 300 baud using the IBM Synchronous Data Link Control (SDLC) format.
6. The system shall be capable of communicating via multiplex communication with digital dialer backup, existing data networks, satellite communication, fiber optics networks, local area networks (LAN), wide area networks (WAN), cellular communication, and retail data networks.

G. Initiating Zone Configuration

1. The system shall be capable of monitoring a maximum of 238 individual initiating zones. 230 of these zones shall be capable of Class B operation for support of compatible two wire smoke detectors.

2. The system shall have a minimum of two (2) Class B initiating zones available from the control panel for support of compatible two wire smoke detectors.
3. The system shall have a minimum of four (4) zones available from the control panel, which allow for the connection of Model 869 Style D Initiating Modules, providing Class A Style D four wire-initiating zones for the monitoring of waterflow devices. These zones shall be capable of monitoring for open circuits, short circuits, and ground fault conditions.
4. A minimum of four (4) Class B addressable reporting initiating zones shall be available for each address on the digital annunciator bus.
5. The system shall have the capacity of 100 Class B addressable reporting initiating zones on each of two (2) digital Signaling Line Circuits (SLC). All Class B zones shall be two wires, 18 AWG minimum, supervised by an end-of-line (EOL) device and shall be able to detect open, short, and ground fault conditions in excess of 200ms duration.
6. The Digital SLC loop shall be capable of operating at a maximum wiring distance of 15,000 feet from the FACP on unshielded, non-twisted cable.

H. Output Configuration
1. The system shall have the capacity of a maximum of 200 auxiliary relays (Form C rated for 1 Amp at 30 VDC) and 238 switched ground (open collector) outputs (50 mA maximum).
2. All relay and switched ground outputs shall be capable of being independently programmed to turn on and off for selected events and at selected times.
3. The system shall be capable of supporting 238 open collector annunciator outputs that follow that state of each zone for use with a graphic annunciator. Each annunciator output shall switch 50 mA of current.

I. NAC Circuit Configuration
1. Notification Appliance Circuit (NAC) supervision shall be provided by
2. two (2) Class B Style W NAC outputs that monitor for short circuits, open circuits, and ground faults. The NAC circuits shall include a dry output relay for external NAC trouble condition and a manual bell silence switch.
3. The system shall be capable of additional Class B NAC circuits utilizing the Model 867 Notification Modules. Each module shall be controlled and supervised via the SLC loop and monitor for short circuits, open circuits, and ground faults. The NAC circuits shall include a dry output relay for external NAC trouble conditions.
4. The system shall be capable of providing Class A NAC circuits utilizing the Model 865 Notification Modules. Each module shall monitor for short circuits, open circuits, and ground faults. The NAC circuits shall include a dry output relay for external NAC trouble conditions and a

manual bell silence switch.

J. Power Supply
1. Power Supplies for the FACP shall operate from 120 VAC supplied at the respective protected areas. Power supplies shall be all Solid State.
2. The FACP shall have a 24 VDC 4 Amp power limited supply for Notification Appliance Circuits (NAC) with up to 6 Amps peak power available for inrush current demands.
3. Standby batteries shall be supplied to power the system in the event of a utility power failure. Controls shall be designed to maintain full battery charge when alternating current power is available. The system shall be automatically transferred to battery power upon loss of alternating current (AC) power and return to alternating current (AC) power upon restoration.
4. The system shall be capable of connecting multiple Model 504-24LX Addressable Power Boosters that are controlled and supervised by the digital SLC loop. Each Power Booster shall have a 24 VDC 4 Amp power limited supply with up to 6 Amps peak power available for inrush current demands. Each Power Booster shall also have two (2) independent Class B Style W Notification Appliance Circuits (NAC) that are controlled and supervised by the digital SLC loop.
5. The FACP shall be capable of operating for twenty-four (24) hours on battery standby with five (5) minutes of alarm signaling at the end of this twenty-four (24) hour period (as required by NFPA 72 Central Station Signaling requirements).

K. Serial Interface
1. The FACP shall be capable of a serial interface to output information to a standard serial printer or to a communication port on a standard computer. The system shall include a provision to allow the selection of which reports are to be output through programming of the FACP.

2.4 FIRE ALARM DEVICES

Provide devices as hereinafter specified and as shown on the drawings.

A. Fire Alarm System Devices: As shown on the drawings.

B. Sprinkler Valve Supervisory Switches:
1. Supplied and installed as part of the Mechanical Division of work.
2. All electrical connections and wiring to the switch shall be provided as part of the work of this Division.

2.5 FIRE ALARM WIRE AND CABLE

A. Fire Alarm Power Branch Circuits: Wire as specified in Section 16050.

B. Initiating and Signal Circuits: Power limited fire-protective signaling cable, copper conductor, 300 volts insulation rated, Class A wiring as indicated on the drawings

PART 3 - EXECUTION

3.1 INSTALLATION

Electrical installation shall conform to requirements of NFPA 70, NFPA 72, state and local codes, other applicable authorities having jurisdiction and to requirements specified herein.

A. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC - Article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC - Article 760 A and B. Upon completion, the contractor shall so certify in writing to the Engineer and general contractor.

B. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.

C. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.

3.2 WIRING AND CONDUIT

A. System shall be installed with all conduits, conductors, outlet boxes, fittings, connectors and accessories necessary to ensure a complete, operable system in compliance with all applicable codes and regulations.

B. Conduits shall be installed in accordance with Section 16050.

C. Wire and Cable: All wiring shall be installed in metal conduit or within equipment. Conductors shall be installed in accord with Section 16. Conductors within equipment enclosures shall be carefully cabled and laced. Individual conductors shall be tagged with E-Z code markers indicating circuit number and type. Markers shall be used on all conductors at each outlet or pull box at each equipment enclosure. Provide fire alarm circuit conductors with color-coded insulation, or use color-coded tape at each conductor termination and in each junction box as follows:

1. Power Branch Circuit Conductors: Black, red, white.
2. Initiating Device Circuit: Black, red.
3. Signal Device Circuit: Blue (positive), white (negative).

D. Outlet pull and junction boxes shall be painted red and labeled "Fire Alarm" on the exterior and shall be installed in accordance with Section 16050.

E. T-tapped connections shall not be allowed on any supervised circuits. Connections shall be made directly to and from device terminal screws. Screw terminals shall have rising plates to terminate more than one wire or each wire shall be terminated to individual screws or each wire shall terminate in a ring lug.

3.3 POSTED OPERATING INSTRUCTIONS

User operating instructions shall be provided prominently displayed on a separate sheet located next to the control unit in accordance with UL Standard 864.

3.4 TRAINING

Two half-day training sessions shall be presented by a fully qualified, trained representative of the equipment manufacturer who is thoroughly knowledgeable of the specific installation. One shall be given to the personnel responsible for operating the system and one to the representatives of the local Fire Department. Training shall be in accordance with Section 01730.

3.5 COORDINATION OF MAINTENANCE AND MONITORING

It shall be the responsibility of the Representative of Equipment Manufacturer to arrange for meetings between Owner representatives and the representatives of qualified companies who specialize in the maintenance, testing and central station monitoring of fire alarm systems.

3.6 FIELD TESTS

A. The Inspector shall be given minimum five (5) working days notice prior to testing.

B. Before the installation shall be considered complete and acceptable by the awarding authority, a test on the system shall be performed as follows:
   1. The contractor, in the presence of a representative of the manufacturer, the Engineer, and the fire department shall operate every building fire alarm device to ensure proper operation and correct annunciation at the control panel.
   2. One-half of all tests shall be performed on battery standby power.

3. The communication loops and the signaling circuits shall be opened in at least two (2) locations per zone to check for the presence of correct supervisory circuitry.
4. When the testing has been completed to the satisfaction of both the contractor and the representatives of the manufacturer and the Engineer, a notarized letter co-signed by each attesting to the satisfactory completion of said testing shall be forwarded to the City and the fire department.
5. The contractor shall leave the fire alarm system in proper working order, and, without additional expense to the City, shall replace any defective materials or equipment provided by him under this contract within one year from the date of final acceptance by the awarding authority.
6. Prior to final test, the fire department must be notified in accordance with local requirements.

END OF SECTION

SECTION 16902

ELECTRIC CONTROLS AND RELAYS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Contactors and Relays

B. Time Clocks and Photoelectric Controllers

1.02 APPLICABLE PUBLICATIONS

The following publications form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. National Electrical Manufacturer's Association (NEMA) Publications:

1. NEMA ICS 1 General Standards for Industrial Control Systems.

2. NEMA ICS 2 Standards for Industrial Control Devices, Controllers and Assemblies.

3. NEMA ICS 6 Enclosures for Industrial Controls and Systems.

4 NEMA ST 1 Standard for Specialty Transformers (Except General Purpose Type).

B. National Fire Protection Association (NFPA) Publication:

1. 70-96 National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 01300 and 16010.

B. Submit shop drawings indicating field panel layouts, wiring connections and diagrams, dimensions, support points.

C. Submit product data under provisions of Section 01300 and 16010.

D. Submit product data for each component specified.

E. Submit manufacturer's installation instructions under provisions of Section 01300 and 16010.

1.04 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Section 01720.

B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 16010.

B. Include instructions for adjusting and resetting time delay relays, timers, and counters.

C. Include recommended preventive maintenance procedures and materials.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated. Except where specifically indicated otherwise, provide only new materials having all legally required approvals and/or labels. Items of a similar nature shall be of the same type and manufacturer.

A. Unless indicated otherwise, contactors and relays for remote control of lighting circuits, etc. shall be mechanically held and mounted on shock mounts in bottom of panelboards, in enclosures adjacent to panelboards or in relay cabinets as indicated on the drawings.

2.02 CONTACTORS

A. For control of branch circuits supplying lighting, provide multi-pole mechanically held relays, 25 ampere continuous rating, ASCO No. 1255-166.

B. For control of feeders or panelboard bus, provide multi-pole, mechanically held contactors, continuous rating as indicated, ASCO Bulletin 920RC series.

C. For motor control provide Square D, Class 8501, Type "S" relays for voltages 300 volts or lower, and Square D, Class 8501, Type "D" relays for voltages over 300 volts. Select number of poles, contact close/open configuration timing accessories and other variables to comply with control function indicated.

D. Verify coil voltages for relays and contactors in order to comply with control voltage indicated.

E. Provide NEMA 1 enclosures for indoor mounted relays where not indicated to be installed in a panelboard, motor control center or similar product. Provide NEMA 4X enclosures for exterior mounted relays.

F. Install contactors on sound-absorbing mounts.

2.03 TIME CLOCKS AND PHOTOELECTRIC CONTROLLERS

A. Provide time switches having product construction requirements as specified and/or indicated. Where not otherwise indicated, the following requirements apply:

1. Enclosure: NEMA 1 surface type in equipment storage, janitor spaces and in manufacturing areas.

2. Dials: Plain for switches controlling interior loads and astronomic type where used for control of exterior lighting. 24 hour dials.

3. Omitters: Provide with all 24 hour dial time switches.

4. Contacts: 25 ampere minimum rating. Number of poles as required to provide indicated switching.

5. Spring Driven Reserve: Provide reserve sufficient to operate time switch contacts at least 10 hours after power failure.

6. Motor: Voltage compatible with power source indicated.

B. Provide time switches of the following manufacturers or an approved equal. Select motor voltage and contacts to comply with indicated requirements:

1. 24 hour plain dial: Sangamo Series LHZ, Tork Series 7000, Paragon Series 4000 S.

2. 24 hour astronomic dial: Sangamo Series LHZ, Tork Series 7000Z, Paragon Series 4000 SZ.

C. Time switches for other purposes shall be as specified on drawings for number of poles and type of dial. Approved manufacturers are Tork, Sangamo or Paragon.

D. Photoelectric controllers shall be provided as indicated on the drawings:

1. For lighting which is energized at dusk and de-energized at dawn, the photo-electric controller shall control either a single branch lighting circuit or a magnetically held lighting contactor as required.

2. For lighting which is energized at dusk and de-energized before dawn, a photoelectric controller shall be installed on the line side of the time clock contacts.

3. One photoelectric controller per building may be used to control all lighting contactors which are energized at dusk.

E. Extend conduit and wire as required to photoelectric controllers on the roof. Install photoelectric controllers in such a manner as not to be affected by artificial illumination (such as building lights or automobile headlights).

F. Photoelectric controllers controlling contactors shall be sized for connected loads, but shall be rated for minimum 15 amperes. Approved manufacturers are Tork, Sangamo or Paragon.

PART 3 - EXECUTION

3.01 INSTALLATION

Electrical installation shall conform to requirements of NFPA 70, state and local codes, and to requirements specified herein. Install devices and equipment in accordance with manufacturer's instructions.

3.02 CONTACTORS AND RELAYS

A. Install contactors and relays as shown on the drawings and connect coils and contacts to perform the functions indicated.

B. Verify coil voltage and contact load prior to installing contactors or relays.

C. Install individual relays and time delay relays in enclosures.

3.03 TIME CLOCKS AND PHOTOELECTRIC CONTROLLERS

A. Install time clocks and photoelectric controllers where indicated on the drawings.

B. Initially set clocks as directed by the Engineer.

3.04 FIELD TESTS

As an exception to requirements that may be stated elsewhere in the contract, the Inspector shall be given 5 working days notice prior to each test. The Contractor shall provide all test equipment and personnel and submit written copies of all test results.

A. Operational Tests: Demonstrate the operation of each switch, relay and other item of electrical control with the system fully energized and operating. Each shall be demonstrated three times.

B. Test results shall be submitted to the Commissioning Agent.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

SECTION 16999

ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The purpose of this section is to specify the Division 16 responsibilities and participation in the commissioning process.

B. Under the direction and supervision of the commissioning agent as outlined in Division 17000 of these specifications, the contractor and his subcontractors shall participate in the commissioning of the Division 16 equipment and systems. The commissioning process requires the participation of the contractor and his subcontractors and does not diminish the role and obligations to complete all portions of work in a satisfactory and fully operational manner, prior to commissioning.

C. Work of Division 16 includes:

1. Testing and start-up of the equipment.

2. Testing, adjusting, and balancing of systems.

3. Providing qualified personnel for participation in commissioning tests, including seasonal testing required after the initial commissioning.

4. Providing equipment, materials, and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.

5. Providing operation and maintenance information and as-built drawings to the Commissioning Agent for verification, organization, and distribution.

6. Participate in the training of the facilities operation staff.

7. Attending all scheduled commissioning meetings.

8. Notification to Commissioning Agent when systems are ready for commissioning.

9. Compliance with construction completion schedule and commissioning

schedule.

1.02 EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

A. Thermal Storage Tank: TES-1

B. Chillers: CH-1, CH-2, CH-3

C. Cooling Towers: CT-1, CT-2, CT-3, CT-4

D. Chilled Water Pumps: CHWP-1, CHWP-2, CHWP-3, CHWP-20, CHWP-21

E. Condenser Water Pumps: CWP-1, CWP-2, CWP-3, CWP-4

F. Piping Distribution System

G. Chilled Water System

H. Cooling coils being provided water from the new system at the following buildings:

1. Main Entry Gate and Customs Inspection Facilities
2. Secondary Gate Facilities
3. Administration Building
4. Maintenance and Repair Building
5. Crane Maintenance building
6. Roadability and Reefer Wash Facilities
7. Marine Operations Building
8. Rail Operations Building
9. Marine Restrooms and Gear Locker

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. Provide test equipment as necessary for start-up of the mechanical equipment.

Refer to Division 17 for specific test equipment expected to be provided by Division 16.

2.02 TEST EQUIPMENT - PROPRIETARY

A. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist the Commissioning Agency in the commissioning process. Proprietary test equipment shall become the property of the City upon completion of commissioning.

PART 3 - EXECUTION

3.01 WORK PRIOR TO COMMISSIONING

A. Complete all phases of work so the system can be started, tested, balanced, and otherwise commissioned. Division 16 has primary start-up responsibilities with obligations to complete systems, including all sub-systems so they are functional. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc. per the contract documents and related directives, clarifications, change orders, etc.

B. A commissioning plan will be developed by the Commissioning Agency. Upon request of the Commissioning Agency, Division 16 Contractor shall provide assistance and consultation. The commissioning plan will be developed prior to completion of the installation. Division 16 is obligated to assist the Commissioning Agency in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation. If system modifications/clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the City. If Contractor initiated system changes have been made that alter the commissioning process, the Commissioning Agency will notify the City.

C. Specific pre-commissioning responsibilities of Division 16 are as follows:

1. Factory start-up and acceptance testing services for the following items of equipment:

a. Protective relays and associated instrument transformers
c. Meters and associated instrument transformers
d. Power transformers
e. Variable frequency drives
f. Low voltage switchgear

g. Distribution boards
h. Motor control centers
i. Ground fault protective systems
j. Low voltage circuit breakers (> 100A)
k. Equipment grounding

2. Normal start-up services required to bring each system into a fully operational state. This includes motor rotational check, cleaning, filling, purging, control sequences of operation, leak testing, full load, and part load performance, etc. The Commissioning Agency will not begin the commissioning process until each system is complete, including normal contractor start-up. Notify the Commissioning Agent one week prior to initial start-up of equipment.

3. Commissioning is intended to begin upon completion of a system. The contractor shall complete the prefunctional check list prior to informing the Commissioning Agent that the system is ready for commissioning.

4. The contractor shall submit a "Verification of Completion" form to the Engineer when the system or piece of equipment is ready for commissioning. If prior to the testing or during the testing it appears that a deficiency exists that will impede the proper testing of the equipment or system, the Commissioning Agent will provide a Notice of Deficiency form to the City for forwarding to the Contractor or Design Team. Once the Deficiency form is completed and returned to the Commissioning Agent, the equipment or system will be tested. IF THE RETESTING OF THE SYSTEM IS REQUIRED A THIRD TIME DUE TO A CONTRACTOR'S PROBLEM, THE COST OF THE COMMISSIONING AGENT AND CITY OPERATION STAFF DURING THIS THIRD OR SUBSEQUENT TESTING SHALL BE REIMBURSED BY THE CONTRACTOR TO THE OWNER.

5. The contractor shall comply with the Completion of Construction schedule and commissioning schedule.

3.02 PARTICIPATION IN COMMISSIONING

A. Provide skilled technicians to start-up and debug all systems within Division 16. These same technicians shall be made available to assist the Commissioning Agency in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc. will be requested by the Commissioning Agency and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustment, and/or problem resolutions.

B. System problems and discrepancies may require additional technician time, Commissioning Agency time, redesign and/or reconstruction of systems, and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

C. The Commissioning Agency reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or subsystem. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the Commissioning Agency to get the job done. A liaison or intermediary between the Commissioning Agency and qualified factory representatives does not constitute the availability of a qualified technician for purposes of this work.

3.03 WORK TO RESOLVE DEFICIENCIES

A. In some systems, misadjustments, misapplied equipment and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work will be completed under the direction of the Engineer, with input from the Contractor, design team, equipment supplier, and Commissioning Agency. Whereas all members will have input and the opportunity to discuss, debate and work out problems, the Engineer will have final jurisdiction on the necessary work to be done to achieve performance.

B. Corrective work be completed in a timely fashion to permit the timely completion of the commissioning process. Experimentation to render system performance will be permitted. If the Commissioning Agency deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Agency will notify the Engineer, indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities. If the deadline(s) pass without resolution of the problem, the Engineer reserve the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

3.04 ADDITIONAL COMMISSIONING

A. Additional commissioning activities may be required after system adjustments, replacements, etc. are completed. The Contractor, suppliers, and Commissioning Agency shall include a reasonable reserve to complete this work as part of their standard contractual obligations.

3.05 SEASONAL COMMISSIONING AND OCCUPANCY VARIATIONS

A. Seasonal commissioning pertains to testing under full load conditions during peak heating and peak cooling seasons, as well as part load conditions in the spring and fall. Initial commissioning will be done as soon as contract work is completed regardless of season. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.

B. All equipment and systems will be tested and commissioned in a peak season to observe full load performance. Heating equipment will be tested during winter design extremes. Cooling equipment will be tested during summer design extremes, with a fully occupied building. Each Contractor and supplier will be responsible to participate in the initial and the alternate peak season test of the systems required to demonstrate performance.

C. Subsequent commissioning may be required under conditions of minimum and/or maximum occupancy or use. All equipment and systems effected by occupancy variations will be tested and commissioned at the minimum and peak loads to observe system performance. Each Contractor and supplier will be responsible to participate in the occupancy sensitive testing of systems to provide verification of adequate performance.

3.06 RECOMMISSIONING

A. After the initial and peak seasoning commissioning is completed, there may be additional work required to serve new or revised loads. This work is not part of the contract.

3.07 TRAINING

A. In addition to the requirements of Division 1, arrange for and participate in the training of City's engineering and maintenance staff on each system and related components. Training will be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids.

B. Training will be supervised and coordinated by the Commissioning Agent. The training will be conducted jointly by the Commissioning Agent, the design engineers, the equipment vendors, and the Contractor. The Contractor will be responsible for highlighting system peculiarities specific to this project.

3.08 SYSTEMS DOCUMENTATION

A. In addition to the requirements of Division 1, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations. Division 16 as-built drawings shall include architectural floor plans, and the individual electrical systems in relation to actual building layout.

B. Maintain as-built red-lines on the job site as required in Division 1. Red-line drawings at completion of construction, based on memory of key personnel, is not satisfactory. Continuous and regular red-lining of drawings is considered essential and mandatory.

C. In addition to the requirements of Division 1 for operation and maintenance data, provide five (5) copies of equipment technical literature, operation and maintenance literature, and shop drawings to the Commissioning Agent as soon as they are available. This requirement is in addition to the Contractor submitting the final operating and maintenance technical literature at project closeout.

PART 4 - MEASUREMENT AND PAYMENT

NOT USED – See Section 01025, MEASUREMENT AND PAYMENT, paragraph 1.03.B.

END OF SECTION

A	AMPERE
ABS	ACRYLONITRILE BUTADIENE STYRENE
AC	ALTERNATING CURRENT
AFF	ABOVE FINISHED FLOOR
AIC	AMPERE INTERRUPTING CAPACITY
AUX	AUXILIARY
AWG	AMERICAN WIRE GAUGE
BLDG	BUILDING
BKBD	BACKBOARD
BRKR	BREAKER
C	CONDUIT
C/B, CB	CIRCUIT BREAKER
CKT	CIRCUIT
CO	CONDUIT ONLY
CONC	CONCRETE
CONN	CONNECT, CONNECTION, CONNECTED
CT	CURRENT TRANSFORMER
CU	COPPER
DC	DIRECT CURRENT
DISC	DISCONNECT
DWG	DRAWING
EA	EACH
EB	ENCASED BURIAL
ENCL	ENCLOSURE
EQUIP	EQUIPMENT
ESD	EMERGENCY SHUTDOWN
EXT	EXTERIOR
F	FUSE, FAULT
FLUO	FLUORESCENT
FT	FEET
GFI, GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GND OR G	GROUND
HID	HIGH INTENSITY DISCHARGE
HMWPE	HIGH MOLECULAR WEIGHT POLYETHYLENE
HOA	HAND-OFF-AUTOMATIC
HPS	HIGH PRESSURE SODIUM
HT	HEIGHT
HV	HIGH VOLTAGE
JB	JUNCTION BOX
K	THOUSAND
Kcmil	THOUSAND CIRCULAR MILS
KVA	KILO VOLT-AMPERE
KW	KILOWATT
CL	CONTINUOUS LOAD
LCP	LOCAL CONTROL PANEL
LTG	LIGHTING
LV	LOW VOLTAGE
MAX	MAXIMUM
MCM	THOUSAND CIRCULAR MILS
MH	METAL HALIDE, MANHOLE
MIN	MINIMUM
MTD	MOUNTED
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NF	NON FUSED
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NO.	NUMBER
NTS	NOT TO SCALE
OD	OUTSIDE DIAMETER
OL, O/L	OVERLOAD
PB	PULL BOX
PF	POWER FACTOR
PH, Ø	PHASE
PC	PHOTO CELL
P.C.C.	PORTLAND CONCRETE CEMENT
PNL	PANEL
POLB	PORT OF LONG BEACH
PT	POTENTIAL TRANSFORMER
PVC	POLYVINYL CHLORIDE CONDUIT
PWR	POWER
RPM	REVOLUTIONS PER MINUTE
RM	ROOM
SHT	SHEET
SPDT	SINGLE-POLE, DOUBLE-THROW
SPEC	SPECIFICATION
SPO	SHORE POWER OUTLET
SPST	SINGLE-POLE, SINGLE-THROW
SW	SWITCH
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYM	SYMETRICAL
TB	TERMINAL BLOCK, OR TERMINAL BOX
TEL	TELEPHONE
TERM	TERMINAL
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
UL	UNDERWRITERS LABORATORIES INC.
UG	UNDERGROUND
UGPS	UNDERGROUND PULL SECTION
V	VOLTAGE
VA	VOLT-AMPERES
VD	VOLTAGE DROP
W	WATT, WIRE
WH	WATTHOUR
WP	WEATHERPROOF
XFMR	TRANSFORMER
Z	IMPEDANCE
2P	TWO-POLE
3P	THREE-POLE
3W	THREE-WIRE
4W	FOUR-WIRE

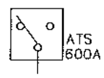
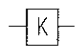
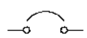
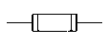
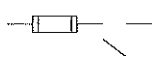
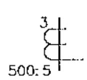
Port of LONG BEACH The Green Port

ELECTRICAL ABBREVIATIONS

STANDARD PLAN

E-1

APPROVED BY: P. R. CHAVDARIAN SR ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

	METER
	AMMETER
	VOLTMETER
	AUTOMATIC TRANSFER SWITCH, RATING AS INDICATED
	KEY INTERLOCK
	GROUND
	GROUND WELL WITH 3/4" x 10' GROUND ROD
	CIRCUIT BREAKER
	SHUNT TRIP
	FUSE
	FUSED DISCONNECT
	MOTOR, HORSEPOWER RATING AS INDICATED
	TRANSFORMER
	CURRENT TRANSFORMER, RATIO AND NUMBER OF CT'S AS INDICATED
	GROUND FAULT INTERRUPTER

Port of LONG BEACH
The Green Port

ELECTRICAL SYMBOLS

STANDARD PLAN

E-2

APPROVED BY: P. R. Chavdarian
P. R. CHAVDARIAN SR ELECTRICAL ENGINEER

P.E. NO.: E-8410

DATE: 01-31-16

	BELOW GRADE CONCRETE ENCASED DUCTBANK
	BELOW GRADE CONDUIT
	CONDUIT RUN CONCEALED IN ABOVE GRADE STRUCTURE
	CONDUIT RUN EXPOSED
EX	EXISTING CONDUIT
#10	CROSS LINES INDICATE NUMBER OF CONDUCTORS IN CONDUIT, SIZE AS INDICATED (#12 MIN). LONG LINE INDICATES NEUTRAL, SHORT LINE INDICATES PHASE CONDUCTOR, DIAGONAL LINE INDICATES CODE-SIZED GROUND.
A-1,3	BRANCH CIRCUIT HOME RUN TO PANELBOARD; LETTER AND NUMBER NOTATION IDENTIFIES PANEL AND CIRCUIT NUMBER(S)
	CONDUIT STUBBED AND CAPPED
	CONDUIT TURNED UP (OR TOWARDS)
OR	CONDUIT TURNED DOWN (OR AWAY)
	FLEXIBLE CONDUIT
MH2 O	UNDERGROUND POWER MANHOLE, SEE SCHEDULE FOR DESIGNATION
P4	UNDERGROUND POWER PULLBOX, SEE SCHEDULE FOR DESIGNATION
C4	UNDERGROUND COMMUNICATIONS PULLBOX, SEE SCHEDULE FOR DESIGNATION
P123	NEW FEEDER CALLOUT
P123	EXISTING FEEDER CALLOUT
	FLUSH MOUNTED PANELBOARD, REFER TO SINGLE LINE FOR VOLTAGE AND PHASING
	SURFACE MOUNTED PANELBOARD, REFER TO SINGLE LINE FOR VOLTAGE AND PHASING
	SWITCHBOARD OR DISTRIBUTION PANELBOARD
F	SAFETY SWITCH - 3 PHASES UON, F - FUSED
T	TRANSFORMER, SIZE, VOLTAGE AND PHASING PER SINGLE LINE

Port of LONG BEACH The Green Port

ELECTRICAL SYMBOLS

STANDARD PLAN

E-3

APPROVED BY: P. R. CHAVDARIAN SR ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

2	MOTOR STARTER, SIZE AS INDICATED
	COMBINATION MOTOR STARTER, SIZE AS INDICATED
	DISCONNECT SWITCH, SIZE AS INDICATED
F	FUSED DISCONNECT SWITCH, SIZE AS INDICATED
J	JUNCTION BOX - RECESSED OR SURFACE CEILING MOUNTED
J	JUNCTION BOX - FLUSH FLOOR MOUNTED
J	JUNCTION BOX - WALL MOUNTED
	SINGLE RECEPTACLE, WALL MOUNTED, NEMA 5-20R, GROUNDING TYPE, +15" UON
	DUPLEX RECEPTACLE, WALL MOUNTED, NEMA 5-15R, GROUNDING TYPE; SUBSCRIPT LETTERS INDICATE: GFI=GROUND FAULT INTERRUPTER IG=ISOLATED GROUND, +15" UON
	DUPLEX RECEPTACLE, WALL MOUNTED, NEMA 5-20R, WITH ISOLATED GROUND, +15" UON
	QUAD-RECEPTACLE (DOUBLE DUPLEX), WALL MOUNTED, NEMA 5-15R, GROUNDING TYPE, +15" UON
	DUPLEX RECEPTACLE, IN FLUSH FLOOR BOX
	QUAD-RECEPTACLE (DOUBLE DUPLEX), IN FLUSH FLOOR BOX
	CLOCK HANGER RECEPTACLE, +84" AFF
	SPECIAL RECEPTACLE AS NOTED ON PLANS
	DATA OUTLET, WALL MOUNTED, +15"(UON) WITH 3/4"C.O. STUBBED UP INTO ACCESSIBLE CEILING SPACE
	TELEPHONE OUTLET, WALL MOUNTED, +15" (UON) WITH 3/4"C.O. STUBBED INTO ACCESSIBLE CEILING SPACE. ADJACENT "P" INDICATES PAY PHONE @ +48" WHERE ABOVE COUNTER & +54" ON WALL.
	DATA OUTLET IN FLUSH FLOOR BOX
	TELEPHONE OUTLET IN FLUSH FLOOR BOX

A — LIGHTING FIXTURE IDENTIFICATION SYMBOL

EXIT LIGHT, CEILING MOUNTED, ARROW INDICATES DIRECTION OF EGRESS

EXIT LIGHT, WALL MOUNTED, ARROW INDICATES DIRECTION OF EGRESS

PC — PHOTOELECTRIC SWITCH

DUAL HEAD EMERGENCY LIGHT FIXTURE

FLUORESCENT FIXTURE WITH EMERGENCY BALLAST/BATTERY BACK-UP.
ADJACENT "NL" INDICATES NIGHT LIGHT

a b — FLUORESCENT FIXTURE WITH DUAL LEVEL SWITCHING SWITCH Sa CONTROLS OUTBOARD LAMPS AND SWITCH Sb CONTROLS INBOARD LAMP(S)

RECESSED DOWNLIGHT

SURFACE MOUNTED FIXTURE

RECESSED STEPLIGHT

2'X4' RECESSED MTD FLUORESCENT FIXTURE

1'X4' SURFACE MTD FLUOR FIXTURE

4' INDUSTRIAL FLUOR. FIXTURE WITH WIRE GUARD

SURFACE MOUNTED FIXTURE, HID

POLE MOUNTED CUTOFF TYPE III LUMINAIRE

POLE MOUNTED TWIN CUTOFF LUMINAIRES

Port of LONG BEACH
The Green Port

ELECTRICAL SYMBOLS

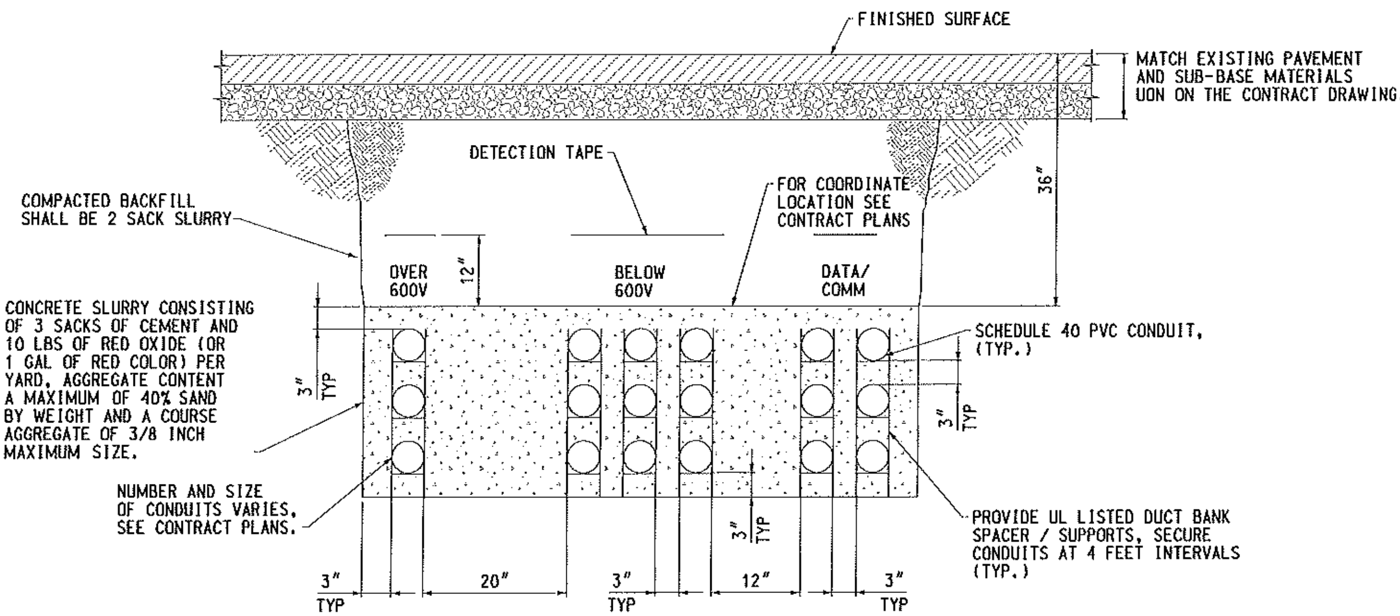
STANDARD PLAN

E-5

APPROVED BY: P. R. CHAVDARIAN SR ELECTRICAL ENGINEER   P.E. NO.: E-8410   DATE: 01-31-16

S	SINGLE POLE SWITCH, + 46" UON
S_3	THREE-WAY SWITCH, + 46" UON
S_4	FOUR-WAY SWITCH, + 46" UON
S_{ab}	SWITCH THAT CONTROLS FIXTURES MARKED WITH SUBSCRIPT INDICATED
S_k	KEY OPERATED SWITCH, + 46" UON
S_P	SWITCH WITH PILOT LAMP, + 46" UON
S_{BP}	BY-PASS SWITCH, + 46" UON
S_D	DIMMER SWITCH, + 46" UON
TS	TIME SWITCH
S_M	1Ø MOTOR RATED SWITCH WITH THERMAL OVERLOADS
S_{WP}	WEATHERPROOF SWITCH
S	OCCUPANCY SENSOR/SWITCH, WALL MOUNTED, + 46" UON
S	OCCUPANCY SENSOR, ONE-WAY, CEILING MOUNTED
S	OCCUPANCY SENSOR, TWO-WAY, CEILING MOUNTED.
T	THERMOSTAT OUTLET, VERIFY MOUNTING HEIGHT WITH MECHANICAL
FACP	FIRE ALARM CONTROL PANEL
	TELEPHONE/COMMUNICATION BACKBOARD, 4' x 8' x 3/4" THICK PLYWOOD

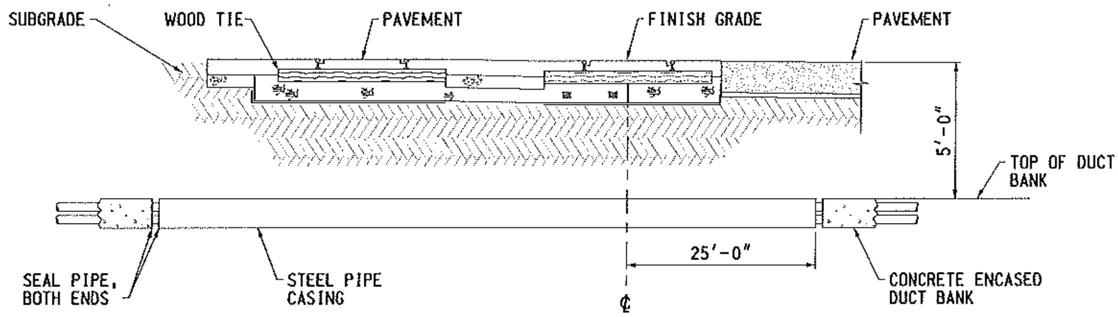
APPROVED BY: P. R. CHAVDARIAN SR ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16



NOTES:

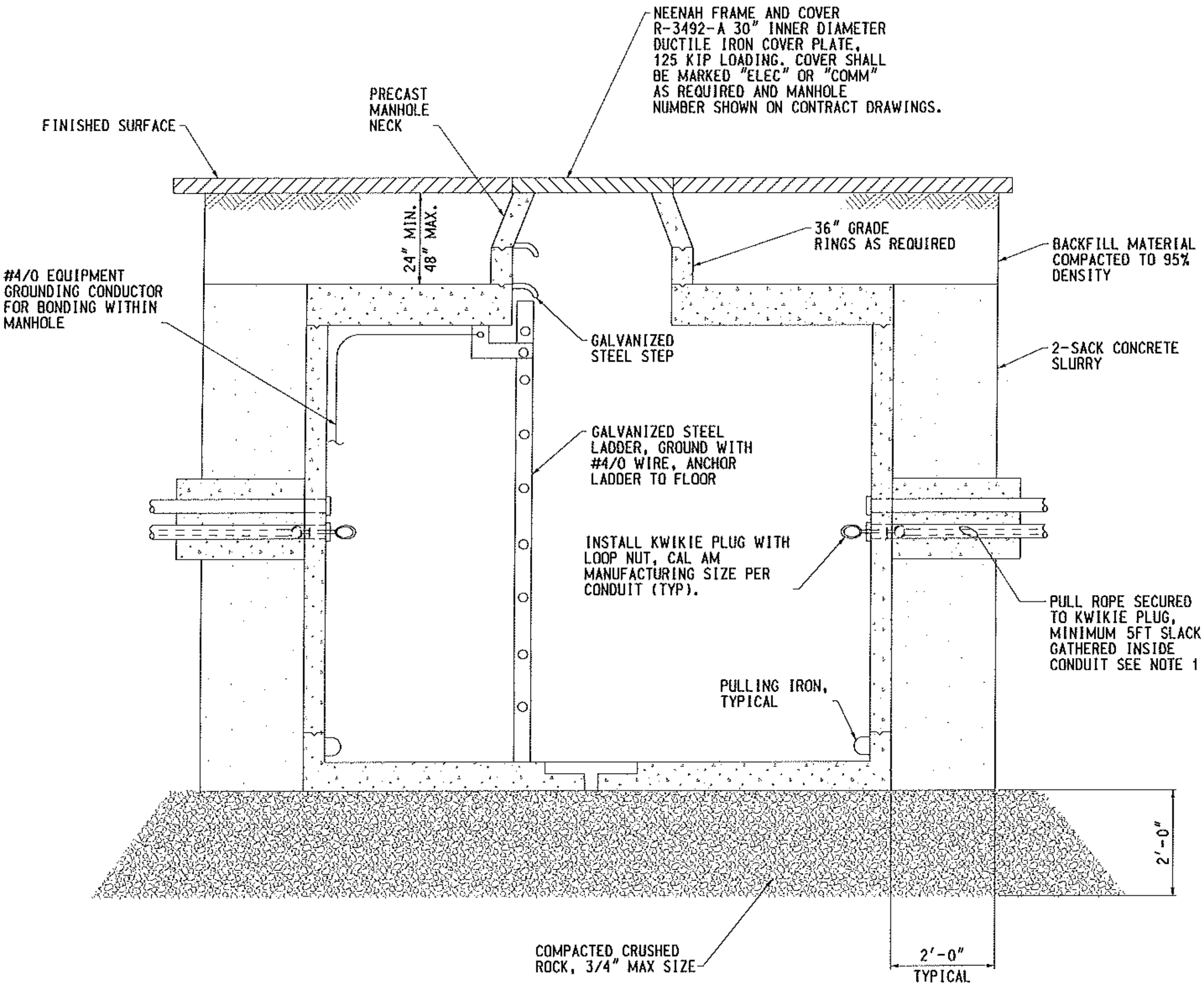
1. ARRANGE CONDUITS AND DUCT BANK DEPTH FOR SHORT LENGTHS AS REQUIRED TO AVOID UNDERGROUND OBSTRUCTIONS.
2. SLOPE DUCT BANKS DOWN TOWARDS MANHOLES AND PULL BOXES.
3. IF REPLACING EXISTING EB CONDUIT, USE SCHEDULE 40 PVC FOR NEW INSTALLATION.

Port of LONG BEACH The Green Port	DUCT BANK SECTION DETAIL IN OUTDOOR TRENCHES	STANDARD PLAN E-9
APPROVED BY: P. R. CHAVDARIAN SR ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1



SEE RAILROAD STANDARD CASING REQUIREMENTS (NON-FLAMMABLE) FOR ADDITIONAL INFORMATION

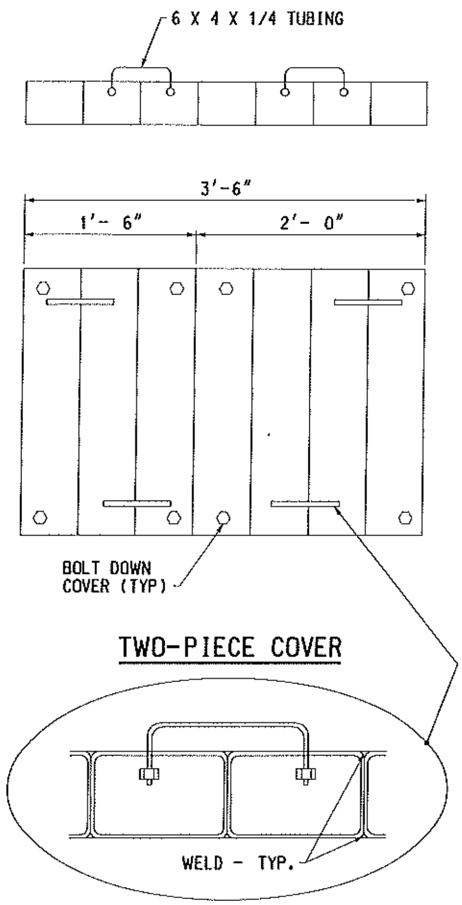
Port of LONG BEACH The Green Port	DUCT BANK BELOW RAILROAD TRACK CROSS SECTION	STANDARD PLAN E-10
APPROVED BY: P. R. CHAVDARIAN SR ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1

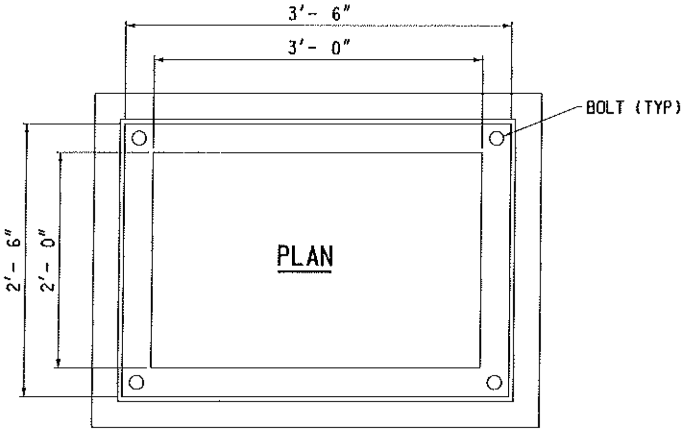


NOTE:

1. INSTALL KWICKIE PLUG AND PULL ROPE IN ALL SPARE CONDUITS. ATTACH BAKELITE TAG TO EACH PLUG WITH LOCATION OF OTHER END OF CONDUIT USING 3/16" MIN. LETTERING.

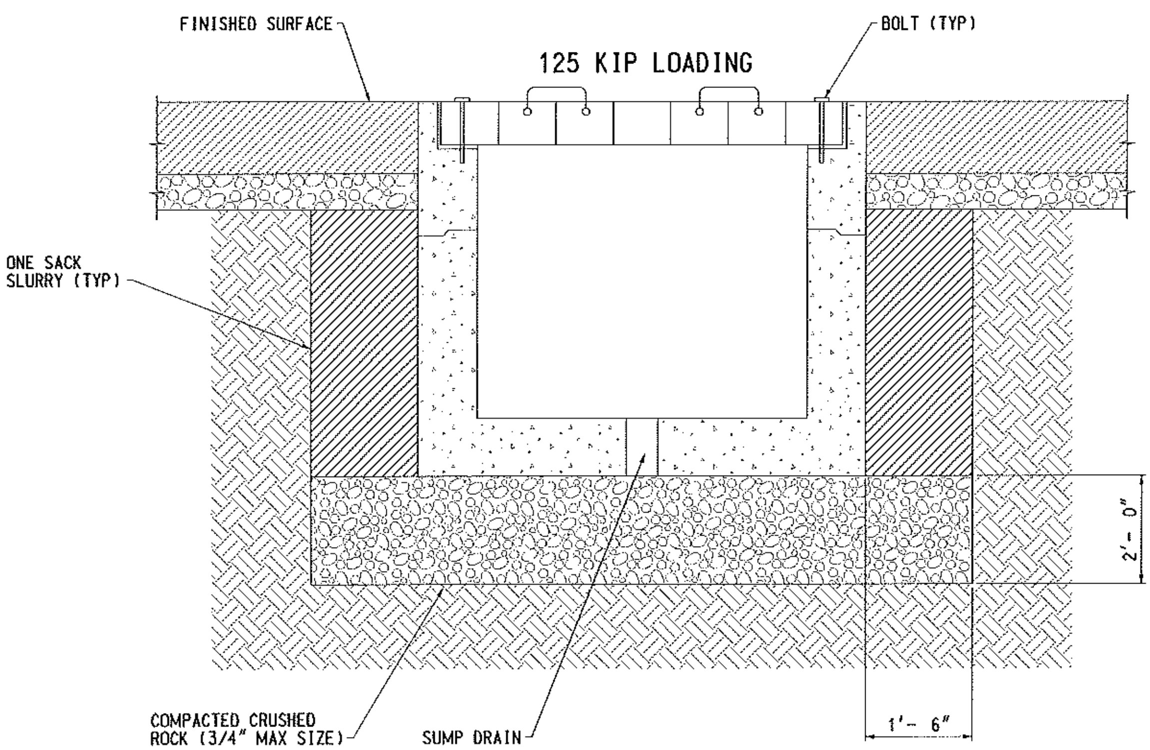
Port of LONG BEACH The Green Port	ELECTRIC MANHOLE DETAIL	STANDARD PLAN E-11
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1





NOTES:

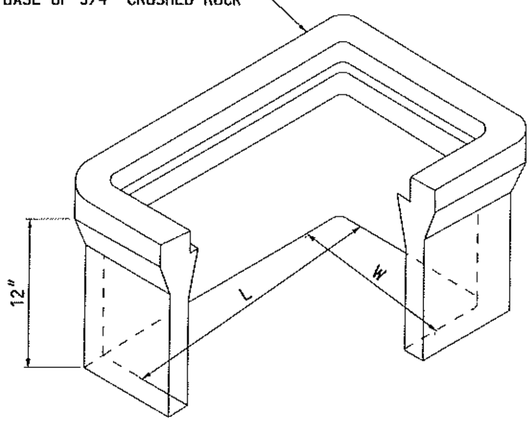
1. DIMENSIONS SHOWN ARE FOR A 24" X 36" PULL BOX AND REPRESENT THE TYPE OF CONSTRUCTION REQUIRED FOR ALL PULL BOXES & COVERS.
2. ONE SACK SAND SLURRY SHALL BE PLACED AROUND ALL PRECAST CONCRETE BOXES (ELECTRICAL, COMMUNICATION, ETC.) AS SHOWN. THIS STANDARD SHALL APPLY TO ALL BOXES 2' X 3' MEASURED HORIZONTALLY OR LARGER.
3. COVER SHALL BE MARKED 'ELEC' OR 'COMM', AS APPROPRIATE, AND PULL BOX NUMBER AS SHOWN ON CONTRACT DRAWING.



SECTION

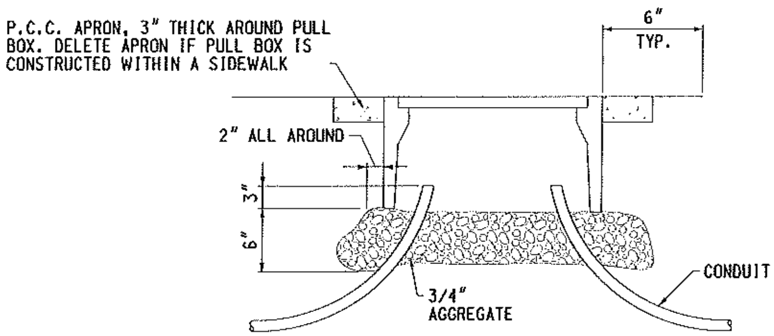
Port of LONG BEACH The Green Port	2' X 3' PRECAST PULL BOX DETAIL	STANDARD PLAN E-16 1 OF 1

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

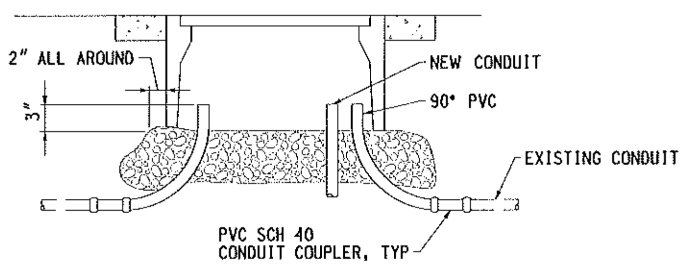


PULL BOXES MANUFACTURED BY JENSEN PRECAST			
NON-TRAFFIC RATED			
SIZE	BOX PART NO.	COVER PART NO.	MAX. # CONDUITS
10"x17"	HN1017-B	HN1017-L09	3
13"x24"	HN1324-B	HN1324-L09	4
17"x30"	HN1730-B	HN1730-L09	6
TRAFFIC RATED SHALL BE INSTALLED PER CALTRANS ES-8			
10"x17"	HT1017-B	HT1017-L03	3
13"x24"	HT1324-B	HT1324-L03	4
17"x30"	HT1730-B	HT1730-L03	6

PULL BOX DETAILS



TYPICAL PULL BOX INSTALLATION



TYPICAL CONDUIT INTERCEPT

NOTES:

1. SIZE OF COUPLER AND NEW CONDUIT SHALL BE SAME SIZE AS EXISTING CONDUIT.
2. PULL BOX SHALL BE PRE-CAST CONCRETE NON-BOLTDOWN TYPE UON.
3. IF AREA IS SUBJECT TO CONTAINER TRAFFIC, USE 2'x3' MINIMUM SIZE PULL BOX WITH 125 KIP COVER (E-16).
4. SEE CALTRANS ES-8B FOR INSTALLATION OF TRAFFIC RATED PULL BOXES.

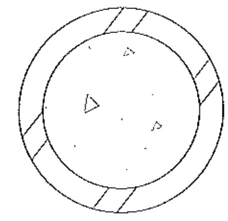
Port of LONG BEACH
The Green Port

SMALL PRECAST CONCRETE PULL BOX

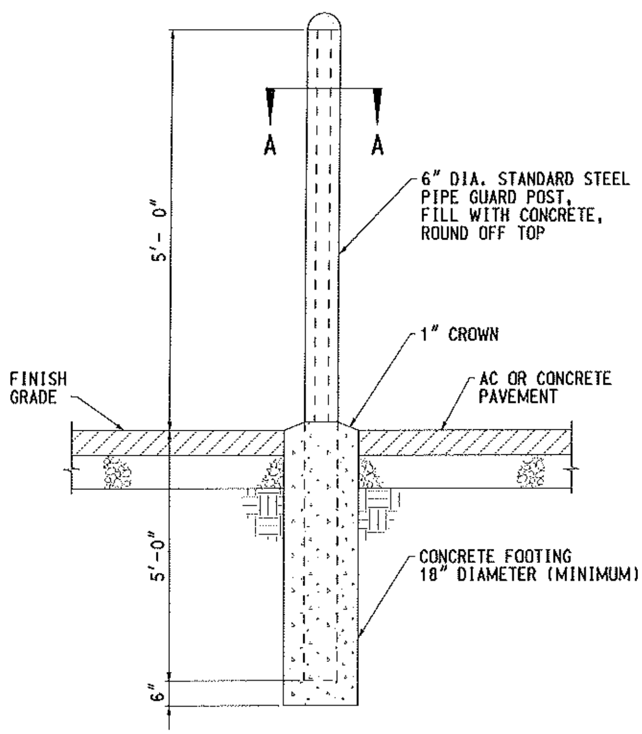
STANDARD PLAN
E-17

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

1 OF 1



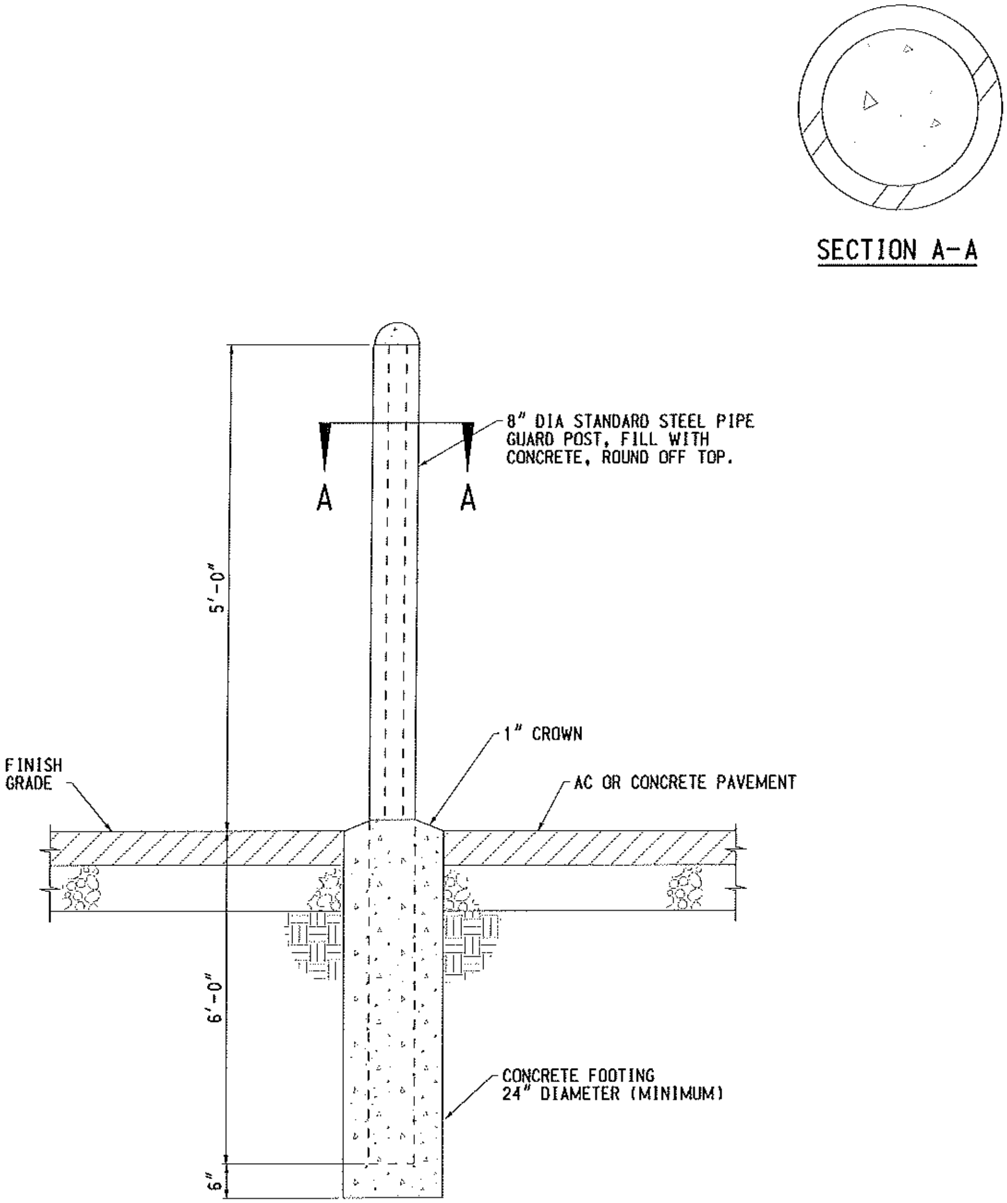
SECTION A-A



NOTES:

1. STEEL PIPE = ASTM A53
2. CONCRETE f'c = 4000 PSI (MINIMUM) W/C=0.40 MAX.
3. MAXIMUM LOAD PER ASCE 7-10, SECTION 4.5.3 (6K @ 2.25')
4. COHESIONLESS SOIL, FIXED HEAD CONDITION, UNIFORM SOIL PROFILE
5. WATER TABLE DEPTH 7'-0" BELOW FG, WATER DENSITY=62.4 PCF
6. 1'-0" DEPTH FROM FG IGNORED FOR PASSIVE PRESSURE.
7. SOIL DENSITY=110 PCF MIN., SOIL FRICTION ANGLE=30° MIN.

Port of LONG BEACH The Green Port	6" DIAMETER GUARD POST DETAIL	STANDARD PLAN E-20
APPROVED BY: R. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16		1 OF 1



NOTES:

1. STEEL PIPE = ASTM A53
2. CONCRETE f'c = 4000 PSI (MINIMUM) W/C=0.40 MAX.
3. MAXIMUM LOAD 12 KIPS HORIZONTAL @ 2'-6" ABOVE FG.
4. COHESIONLESS SOIL, FIXED HEAD CONDITION, UNIFORM SOIL PROFILE
5. WATER TABLE DEPTH 7'-0" BELOW FG, WATER DENSITY=62.4 PCF
6. 1'-0" DEPTH FROM FG IGNORED FOR PASSIVE PRESSURE.
7. SOIL DENSITY=110 PCF MIN., SOIL FRICTION ANGLE =30° MIN.

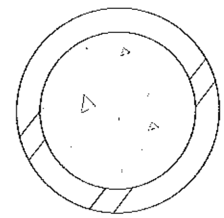
Port of LONG BEACH
The Green Port

8" DIAMETER GUARD POST DETAIL

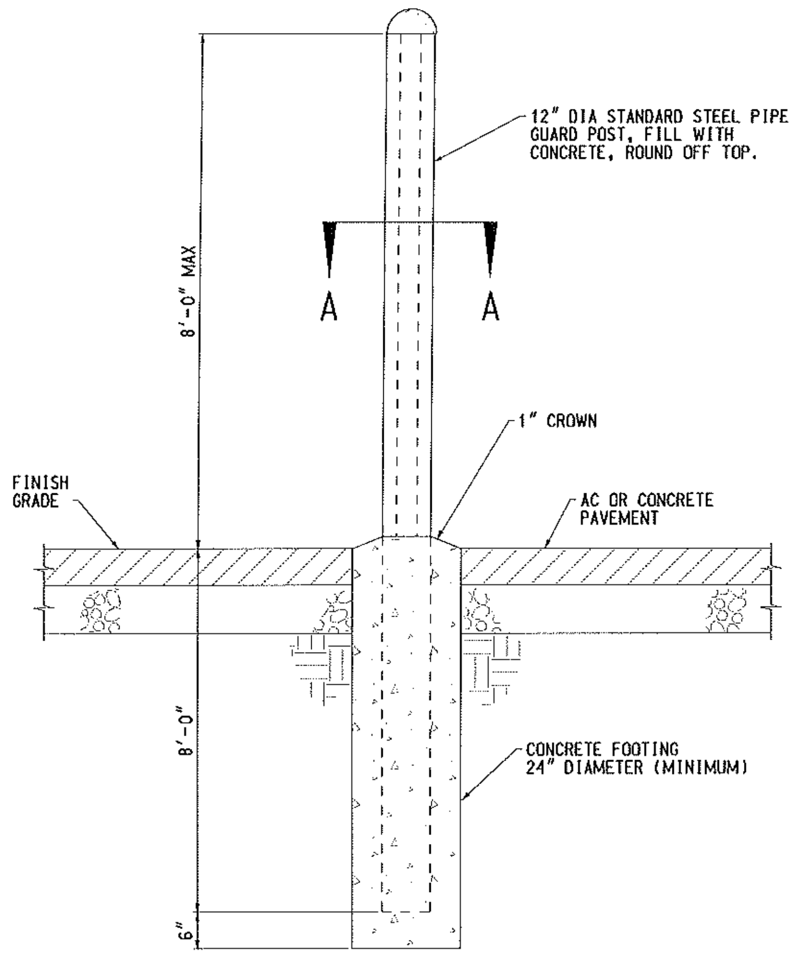
STANDARD PLAN

E-21

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16



SECTION A-A



NOTES:

1. STEEL PIPE = ASTM A53
2. CONCRETE f'c = 4000 PSI (MINIMUM) W/C=0.40 MAX.
3. MAXIMUM LOAD 24 KIPS HORIZONTAL @ 3'-0" ABOVE FG.
4. COHESIONLESS SOIL, FIXED HEAD CONDITION, UNIFORM SOIL PROFILE
5. WATER TABLE DEPTH 7'-0" BELOW FG, WATER DENSITY=62.4 PCF
6. 1'-0" DEPTH FROM FG IGNORED FOR PASSIVE PRESSURE.
7. SOIL DENSITY=110 PCF MIN, SOIL FRICTION ANGLE=30° MIN

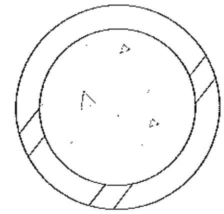
Port of LONG BEACH
The Green Port

12" DIAMETER GUARD POST DETAIL

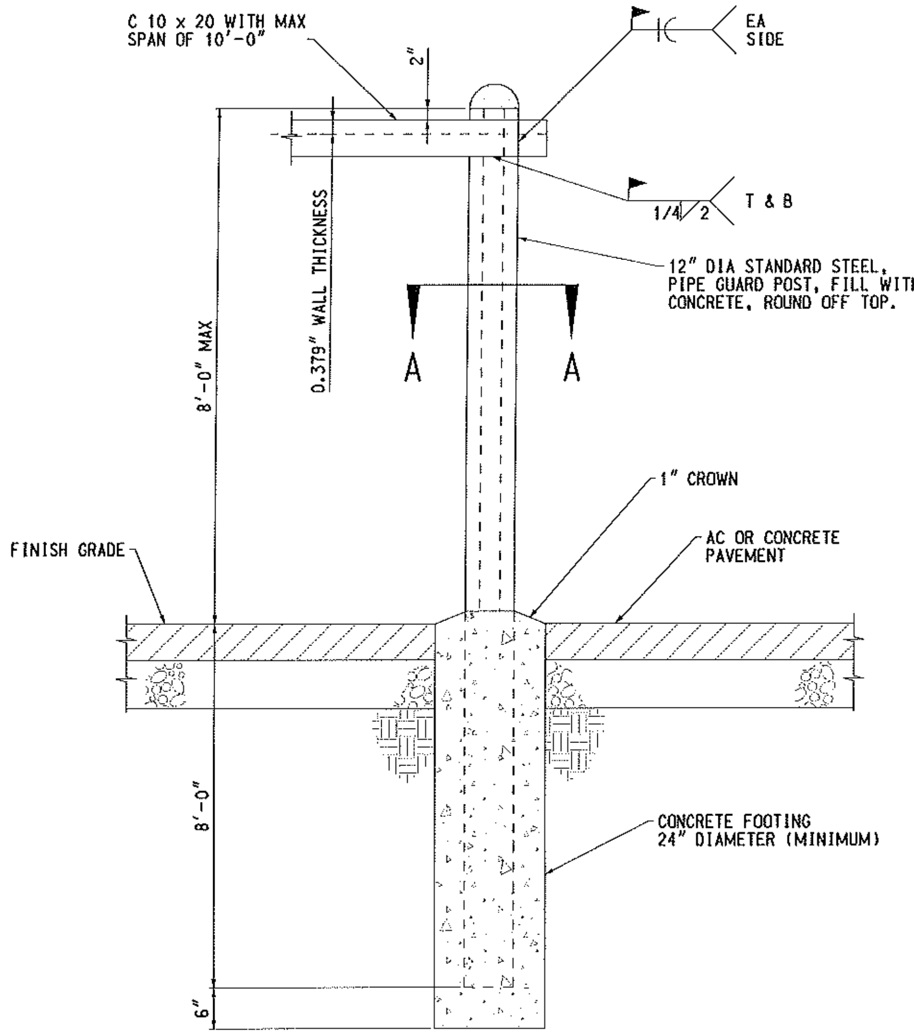
STANDARD PLAN

E-22

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16



SECTION A-A



12" DIAMETER GUARD POST DETAIL

NOTES:

1. STEEL PIPE = ASTM A53
2. CONCRETE f'c = 4000 PSI (MINIMUM) W/C=0.40 MAX.
3. MAXIMUM LOAD 24 KIPS HORIZONTAL @ 3'-0" ABOVE FG.
4. COHESIONLESS SOIL, FIXED HEAD CONDITION, UNIFORM SOIL PROFILE
5. WATER TABLE DEPTH 7'-0" BELOW FG, WATER DENSITY=62.4 PCF
6. 1'-0" DEPTH FROM FG IGNORED FOR PASSIVE PRESSURE.
7. SOIL DENSITY=110 PCF MIN, SOIL FRICTION ANGLE =30° MIN
8. STEEL CHANNEL = ASTM A36

Port of LONG BEACH The Green Port

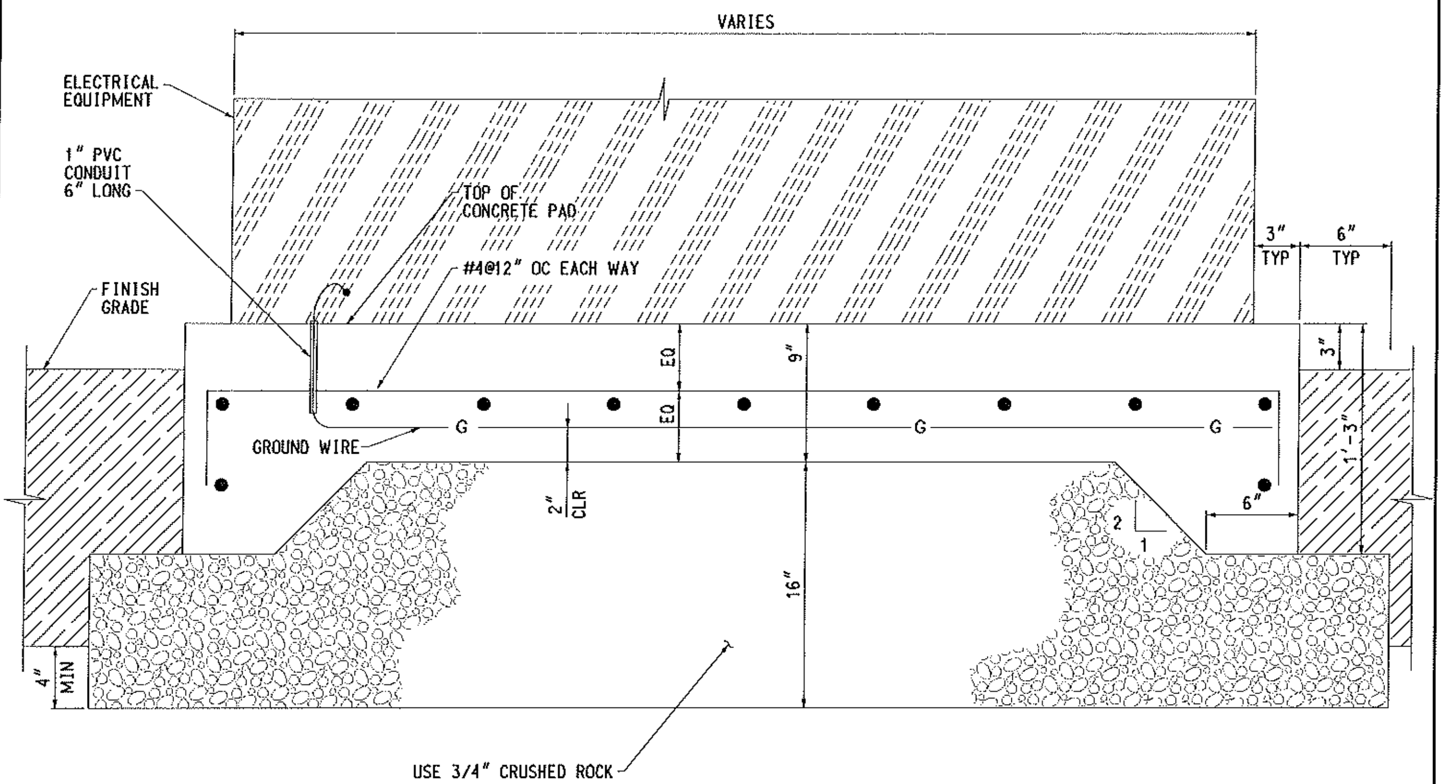
GUARD POSTS AND CAGE AT LIGHT POLE

STANDARD PLAN

E-23

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

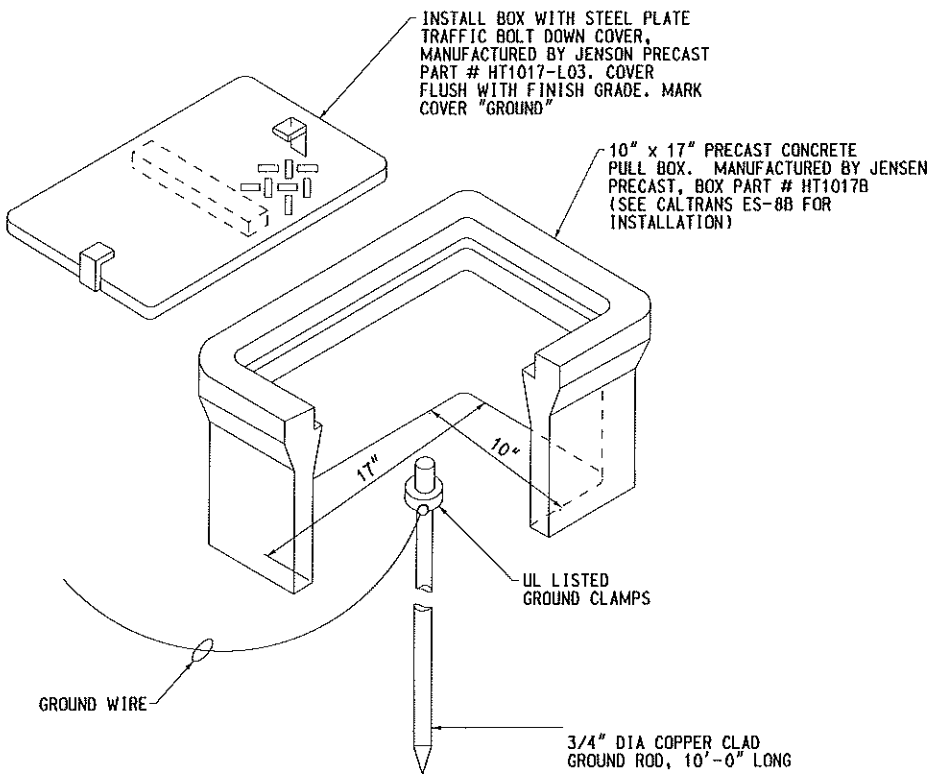
1 OF 1



NOTES:

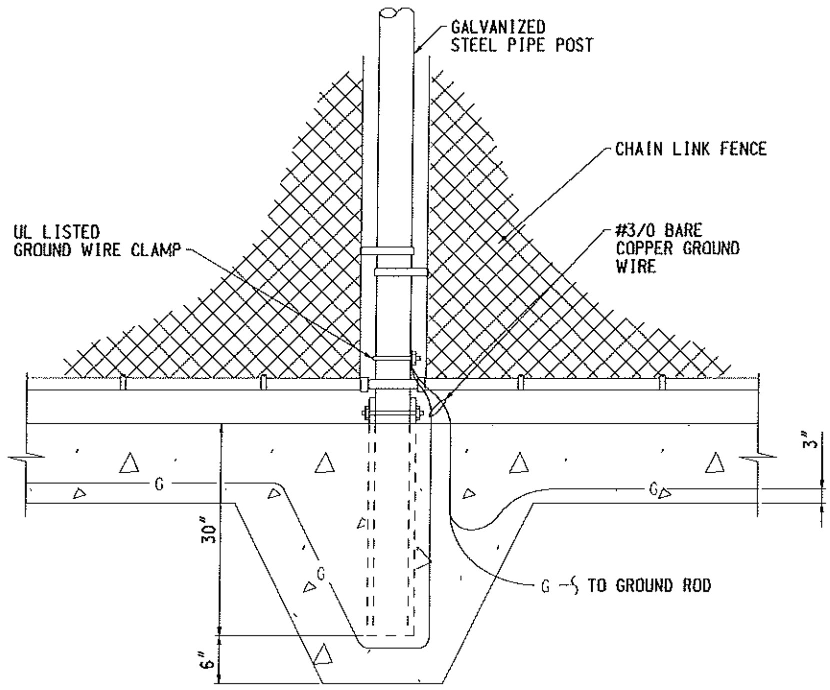
1. PROVIDE AND INSTALL 1-#3/0 MIN. BARE COPPER UFER GROUND WIRE 2" ABOVE BOTTOM OF PAD. BOND TO ELECTRICAL EQUIPMENT.
2. CONCRETE SHALL BE CLASS 560-C-3250 WITH A MAXIMUM SLUMP OF 5", UON ON THE CONTACT PLANS.
3. WELDED WIRE FABRIC SHALL BE DEFORMED WIRE ASTM A496 OR 494, GRADE 60.
4. REINFORCING STEEL SHALL BE DEFORMED REBARS ASTM A615 OR ASTM A706, GRADE 60. PLACING OF REINFORCEMENT AND SPLICING LENGTH SHALL CONFORM TO ACI CODE, LATEST EDITION.
5. ANCHORAGE REQUIREMENTS TO BE VERIFIED BY STRUCTURAL ENGINEER.

Port of LONG BEACH *The Green Port*	CONCRETE PAD DETAIL	STANDARD PLAN E-24
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1

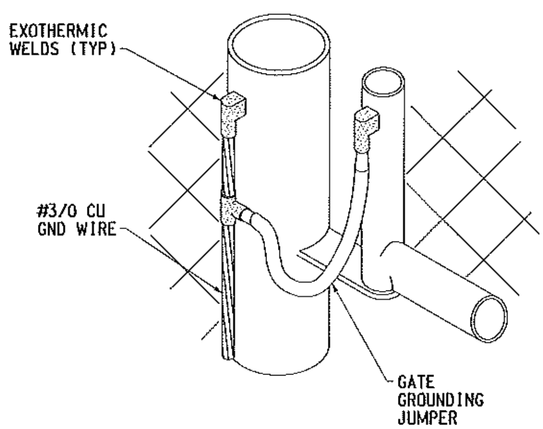


GROUND ROD & WELL DETAIL

Port of LONG BEACH The Green Port	GROUND ROD AND WELL DETAIL	STANDARD PLAN E-25
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1



FENCE SUPPORT & GROUNDING DETAIL

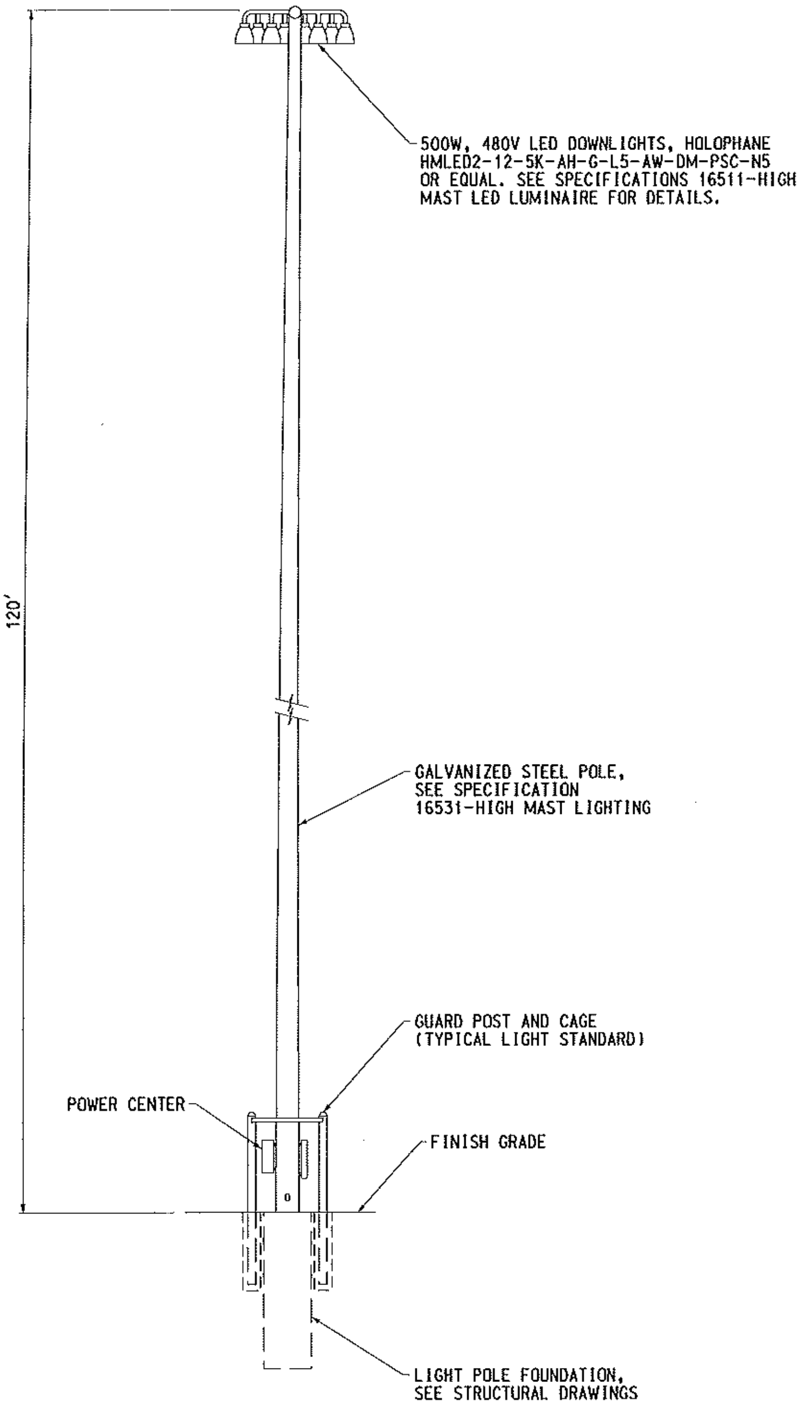


NOTE:

1. REAPPLY PVC COATING OVER WELDING.

FENCE GATE GROUNDING

Port of LONG BEACH The Green Port	FENCE GROUNDING DETAIL	STANDARD PLAN E-26
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16		1 OF 1



LIGHT POLE ELEVATION

NOT TO SCALE

Port of LONG BEACH
The Green Port

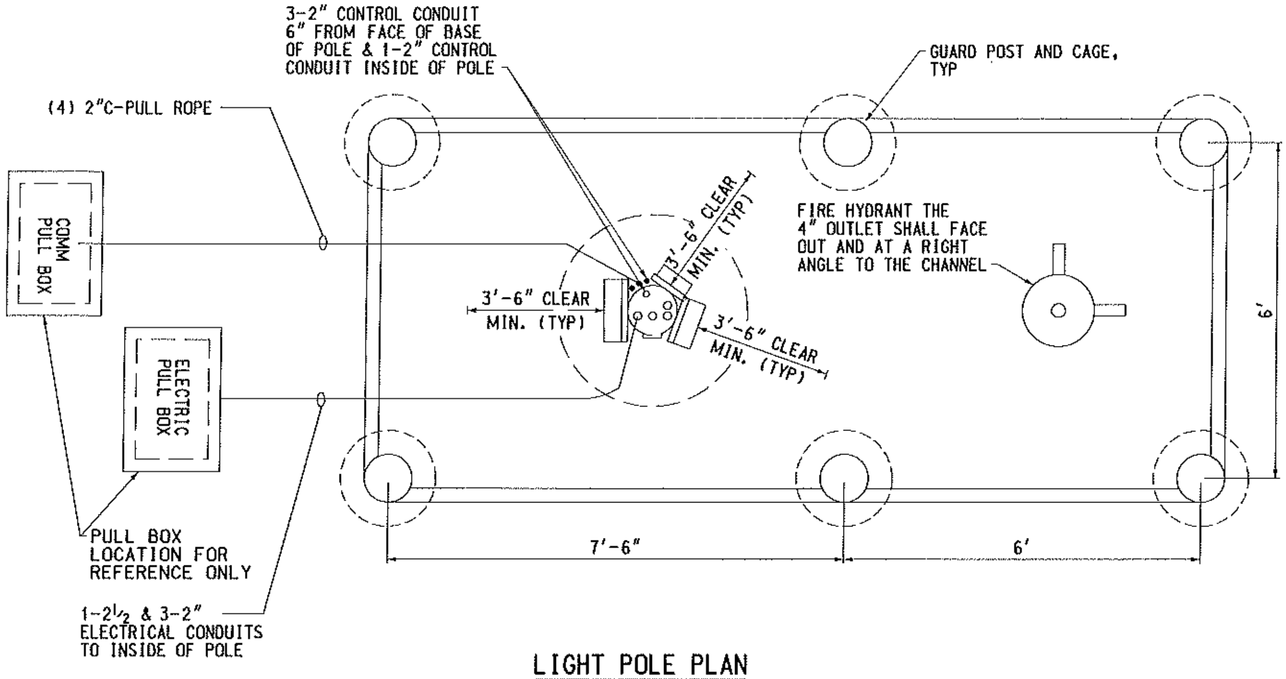
120' LIGHT POLE DETAIL

STANDARD PLAN

E-30

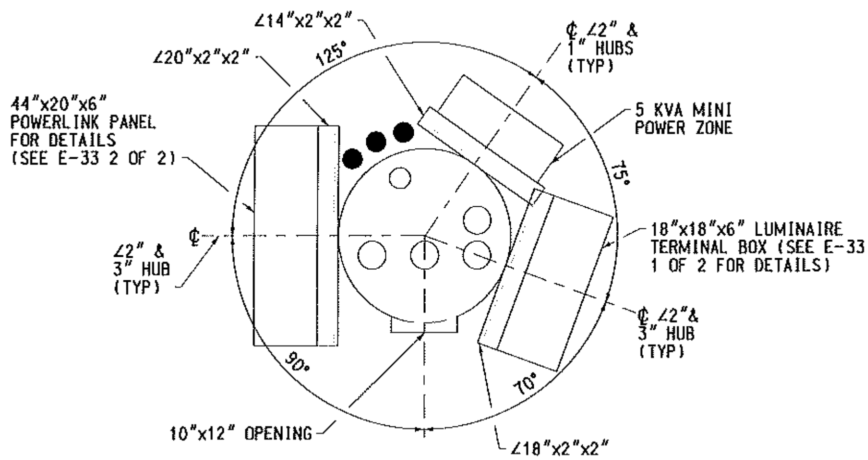
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

1 OF 1



LIGHT POLE PLAN

NOT TO SCALE



PLAN VIEW

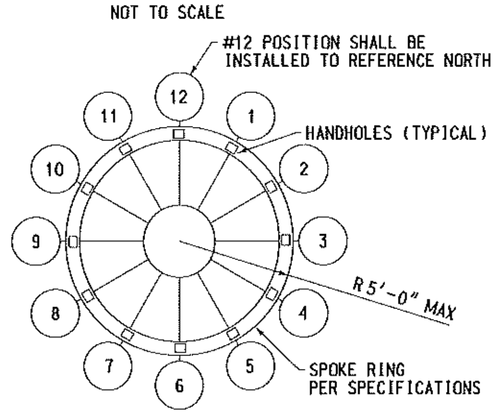
NOT TO SCALE

NOTE:

1. SEE E-31 (2 OF 2) FOR ELEVATION

NOTE:

1. LUMINARIES #10 AND #4 ON SECURITY LIGHTING CIRCUIT



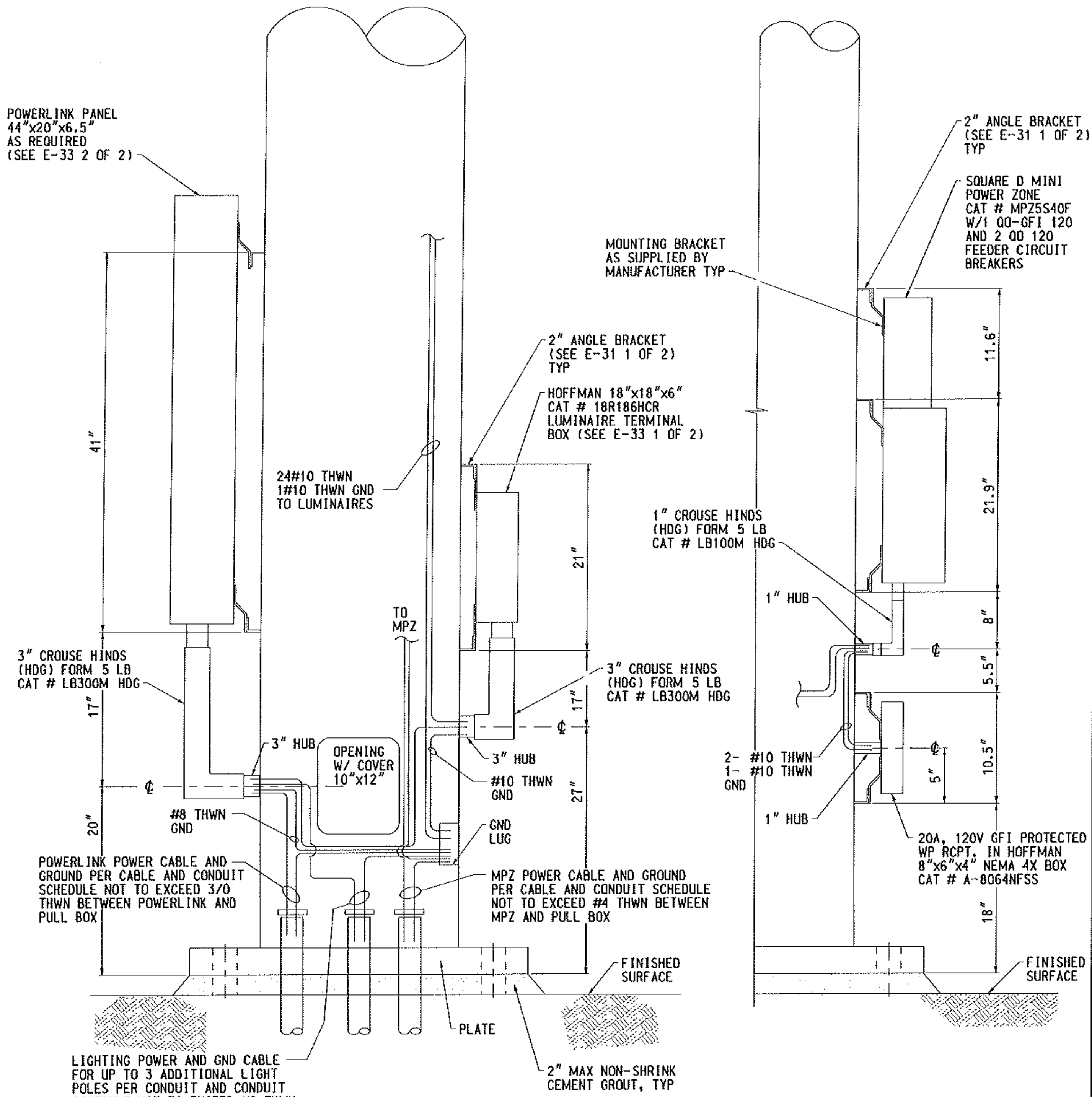
DOWNLIGHT FIXTURE CONFIGURATION

NOT TO SCALE

NOTE:

1. CONTRACTOR SHALL INSTALL "HOLOPHANE" LUMINAIRE (SEE STANDARD PLAN E-30)
2. SEE STANDARD PLAN E-32 FOR LIGHT POLE WITHOUT POWERLINK PANEL

Port of LONG BEACH The Green Port	120' LIGHT POLE PLAN W/ POWERLINK PANEL - WIRING	STANDARD PLAN E-31
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16		1 OF 2



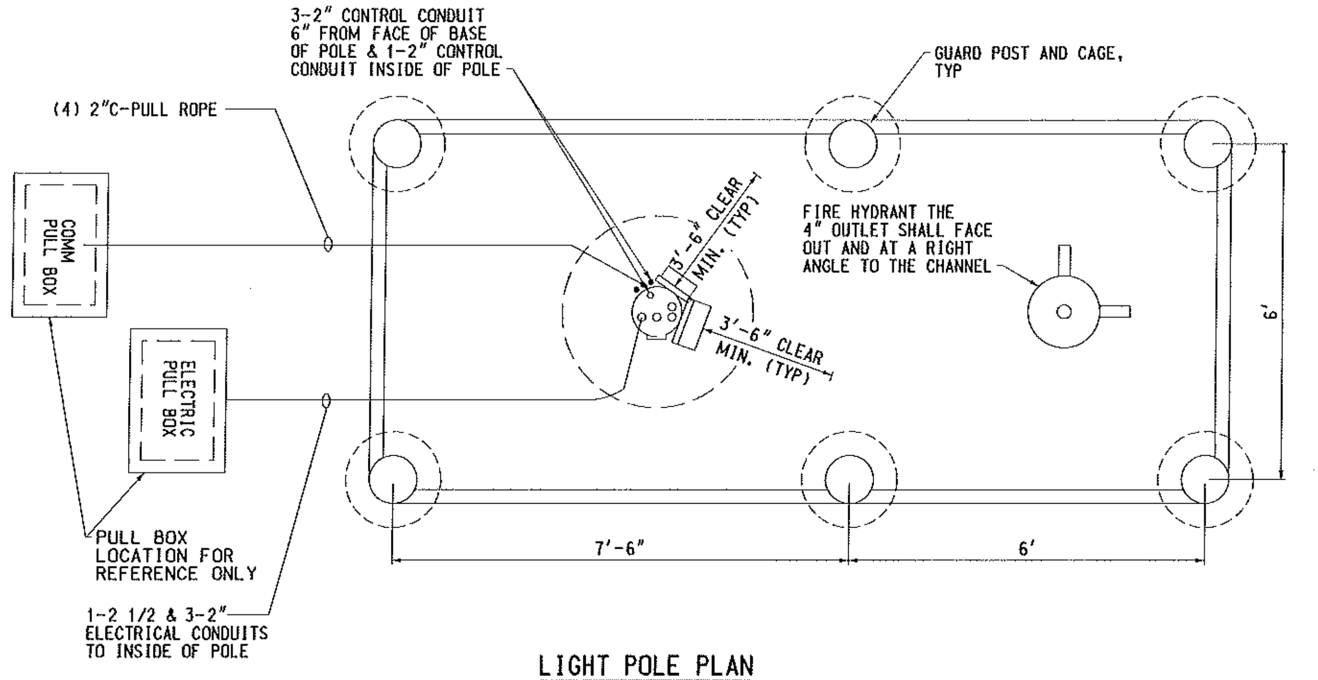
PANELBOARD ELEVATION AT POLE

NOT TO SCALE

NOTE:

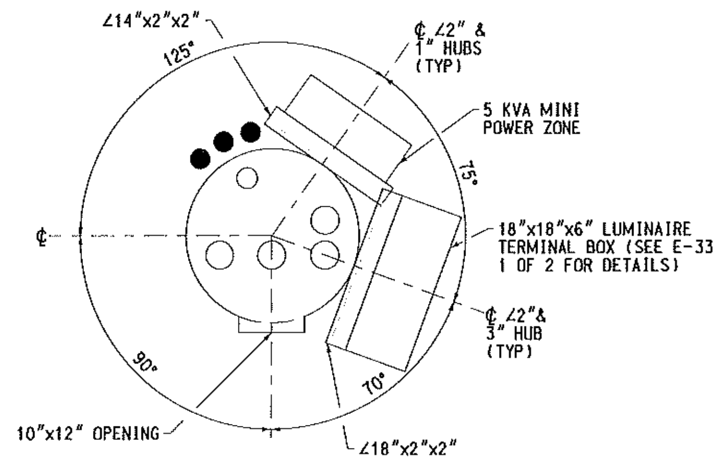
1. SUPPORTS SHALL BE 2" x 2" ANGLE IRON BRACKETS EXTENDING THE HORIZONTAL LENGTH OF ENCLOSURE, LOCATED AS SHOWN. SEE PLAN DETAIL E-31 (1 OF 2). THE ANGLE IRON BRACKETS SHALL BE DRILLED AND THE ENCLOSURES SHALL BE BOLTED TO THEM. THE ANGLE IRON BRACKETS SHALL BE WELDED TO THE POLES PRIOR TO GALVANIZING. IT IS THE RESPONSIBILITY OF THE CONTRACTOR THAT THE ANGLE IRON SUPPORTS ARE NOT BENT OR DAMAGED PRIOR TO ERECTION OF POLES AT THE SITE.
2. SEE E-32 FOR LIGHT POLE WITHOUT POWERLINK PANEL.
3. VERIFY MOUNTING DIMENSIONS WITH BOX MANUFACTURER.
4. SEE LIGHT POLE MANUFACTURER FOR BASE PLATE INFO.

Port of LONG BEACH The Green Port	120' LIGHT POLE ELEVATION W/ POWERLINK PANEL - WIRING	STANDARD PLAN E-31
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	2 OF 2



LIGHT POLE PLAN

NOT TO SCALE

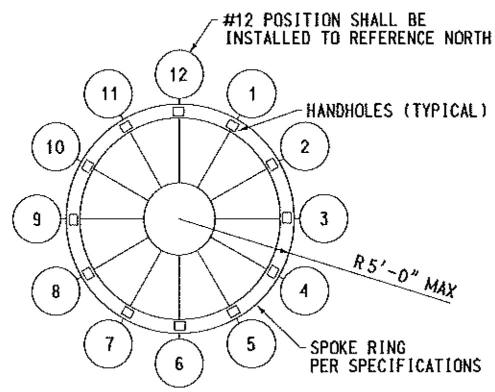


PLAN VIEW

NOT TO SCALE

NOTE:

1. SEE E-32 (2 OF 2) FOR ELEVATION



NOTE:

1. LUMINARIES #10 AND #4 ON SECURITY LIGHTING CIRCUIT

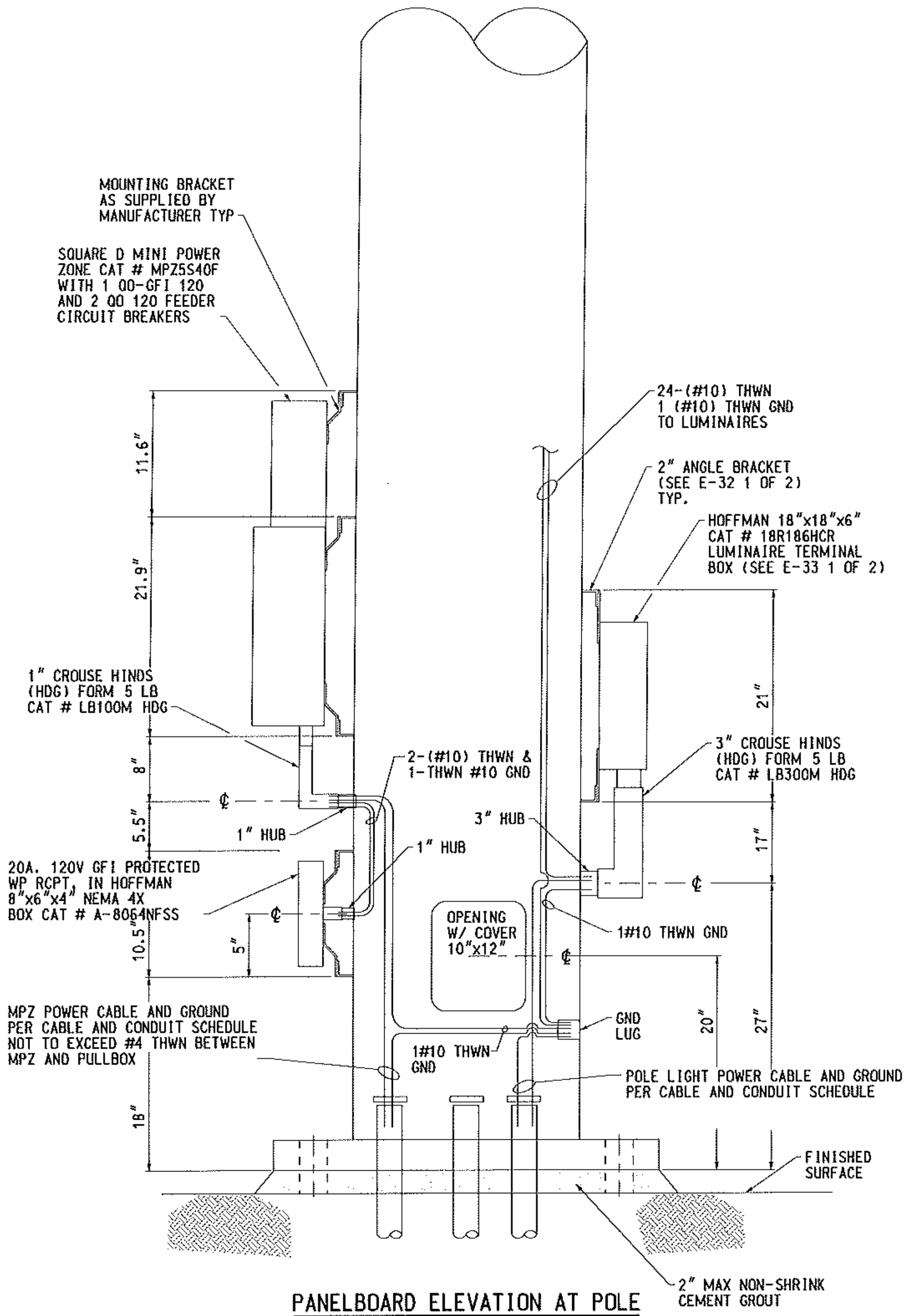
DOWNLIGHT FIXTURE CONFIGURATION

NOT TO SCALE

NOTE:

1. CONTRACTOR SHALL INSTALL "HOLOPHANE" LUMINAIRE (SEE STANDARD PLAN E-30)
2. SEE E-31 STANDARD PLAN FOR LIGHT POLE WITH POWERLINK PANEL

Port of LONG BEACH The Green Port	120' LIGHT POLE PLAN W/O POWERLINK PANEL - WIRING	STANDARD PLAN E-32
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16		1 OF 2



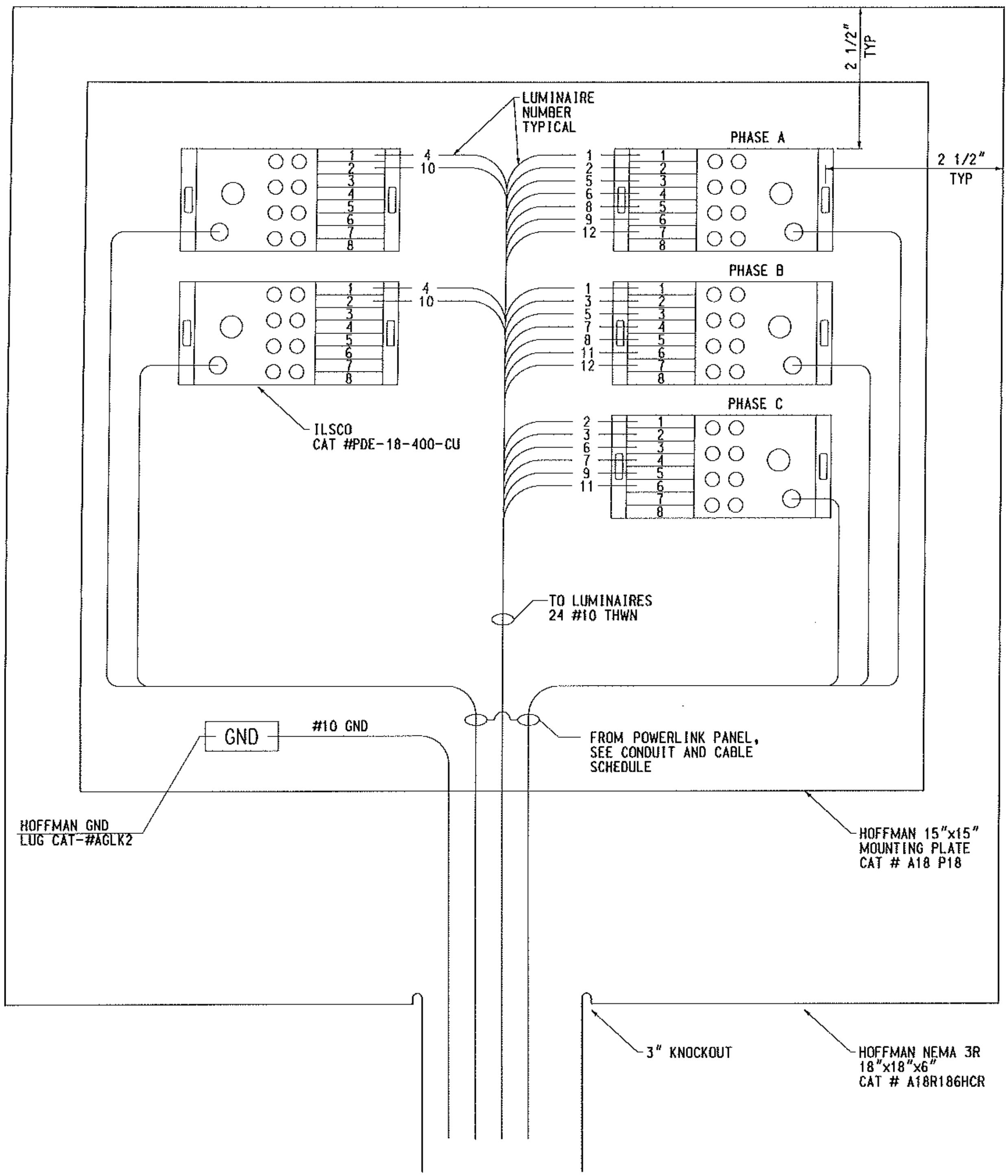
PANELBOARD ELEVATION AT POLE

NOT TO SCALE

NOTE:

1. SUPPORTS SHALL BE 2" x 2" ANGLE IRON BRACKETS EXTENDING THE HORIZONTAL LENGTH OF ENCLOSURE, LOCATED AS SHOWN. SEE PLAN DETAIL E-32 (1 OF 2). THE ANGLE IRON BRACKETS SHALL BE DRILLED AND THE ENCLOSURES SHALL BE BOLTED TO THEM. THE ANGLE IRON BRACKETS SHALL BE WELDED TO THE POLES PRIOR TO GALVANIZING. IT IS THE RESPONSIBILITY OF THE CONTRACTOR THAT THE ANGLE IRON SUPPORTS ARE NOT BENT OR DAMAGED PRIOR TO ERECTION OF POLES AT THE SITE.
2. SEE E-31 FOR LIGHT POLE WITH POWERLINK PANEL.
3. VERIFY MOUNTING DIMENSIONS WITH BOX MANUFACTURER.
4. SEE LIGHT POLE MANUFACTURER FOR BASE PLATE INFO.

Port of LONG BEACH The Green Port	120' LIGHT POLE ELEVATION W/O POWERLINK PANEL - WIRING	STANDARD PLAN E-32
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	2 OF 2



NOTE:

1. PROVIDE ENGRAVED PHENOLIC NAMEPLATE ON FRONT OF EACH TERMINAL WIRING/BOX WITH 3" HIGH (MIN.) LETTERING STATING POLE NUMBER AS IDENTIFIED ON PLANS SUCH AS "P01".
2. PROVIDE ENGRAVED PHENOLIC NAMEPLATE ON FRONT OF EACH TERMINAL WIRING/BOX WITH 1" HIGH (MIN.) LETTERING STATING POWER CIRCUITS TO EACH POLE, AS IDENTIFIED ON PLANS SUCH AS "LPSA1-1 REGULAR LPSA1-1 SECURITY".
3. ALL CONDUCTORS SHALL BE MARKED WITH LUMINAIRE NO., AND CIRCUIT NO. USING BRADY HEATSHRINK CABLE SLEAVES, MARKED WITH CABLE I.D. PRINTER.

Port of LONG BEACH The Green Port	LUMIAIRE TERMINAL BOX - WIRING	STANDARD PLAN E-33

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

POWERLINK CONTROLLER BUS

LOADS	WATTS			CKT		CKT	WATTS			LOADS
POWERLINK G3 1000 CONTROLLER	6			1	X	2	6			G3 POWER SUPPLY NF277PSG3
		6		3	X	4		6		
			6	5	X	6			6	
POLE #1 LUMINAIRES	3600			7	X	8	3600			POLE #2 LUMINAIRES
		3600		9	X	10		3600		
			3600	11	X	12			3600	
POLE #3 LUMINAIRES	3600			13	X	14	3600			POLE #4 LUMINAIRES
		3600		15	X	16		3600		
			3600	17	X	18			3600	
POLE #1 SECURITY	1080			19	X	20	1080			POLE #4 SECURITY
		1080		21	X	22		1080		
POLE #2 SECURITY			1080	23	X	24			180	SPARE POWERLINK BREAKER
	1080			25	X	26				
POLE #3 SECURITY		1080		27	X	28				SPARE POWERLINK BREAKER
			1080	29	X	30				

POWERLINK CONTROLLER BUS

POWERLINK G3 CONTROLLER, IN NF 100A PANEL BOARD, 3 POLE MAIN BRREAKER. NEMA 3R ENCLOSURE, 480V 3 PHASE, 3 WIRE.

5-20A, 3 POLE POWERLINK CIRCUIT BREAKERS CAT # ECB34020G3

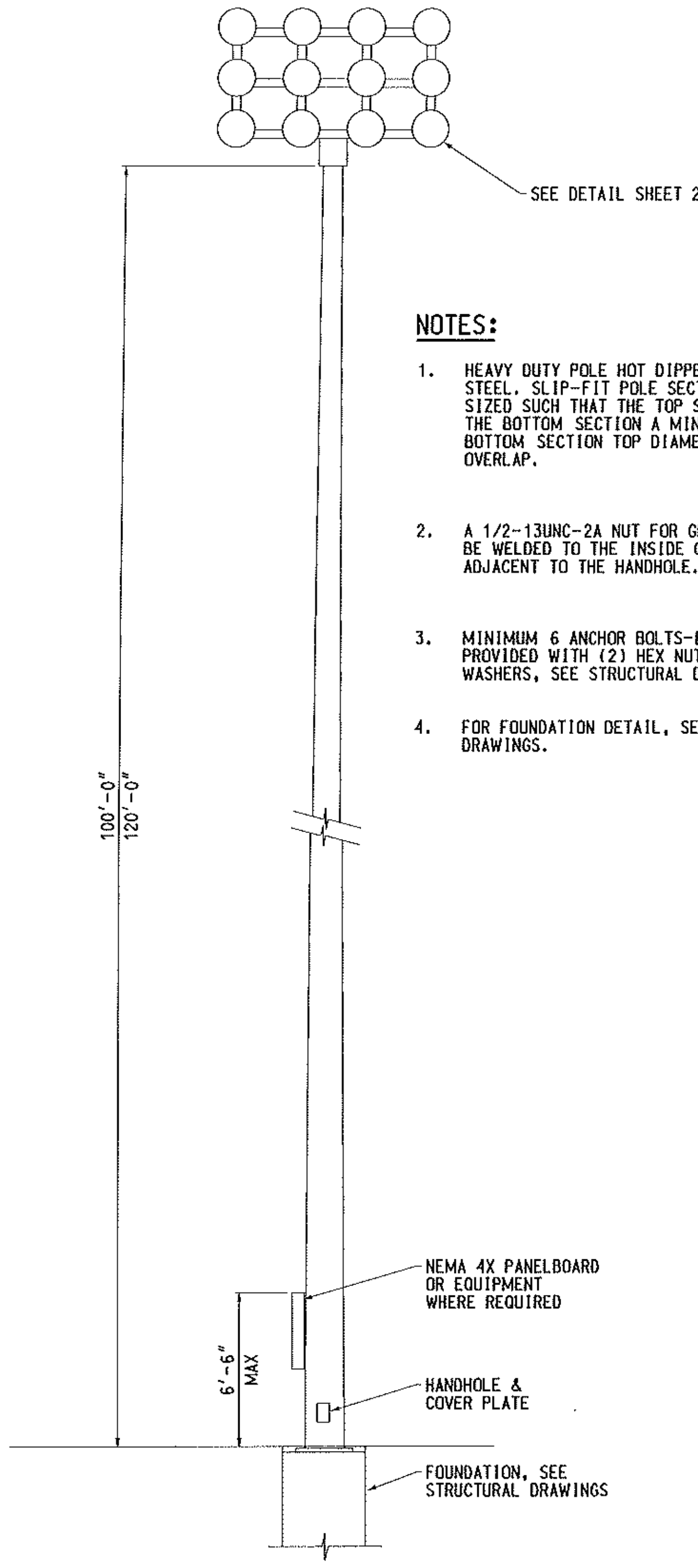
4-20A, 2 POLE POWERLINK CIRCUIT BREAKERS, CAT # ECB24020G3

Port of LONG BEACH The Green Port

POWERLINK G3 CONTROLLER

STANDARD PLAN E-33

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16



ELEVATION

NOTES:

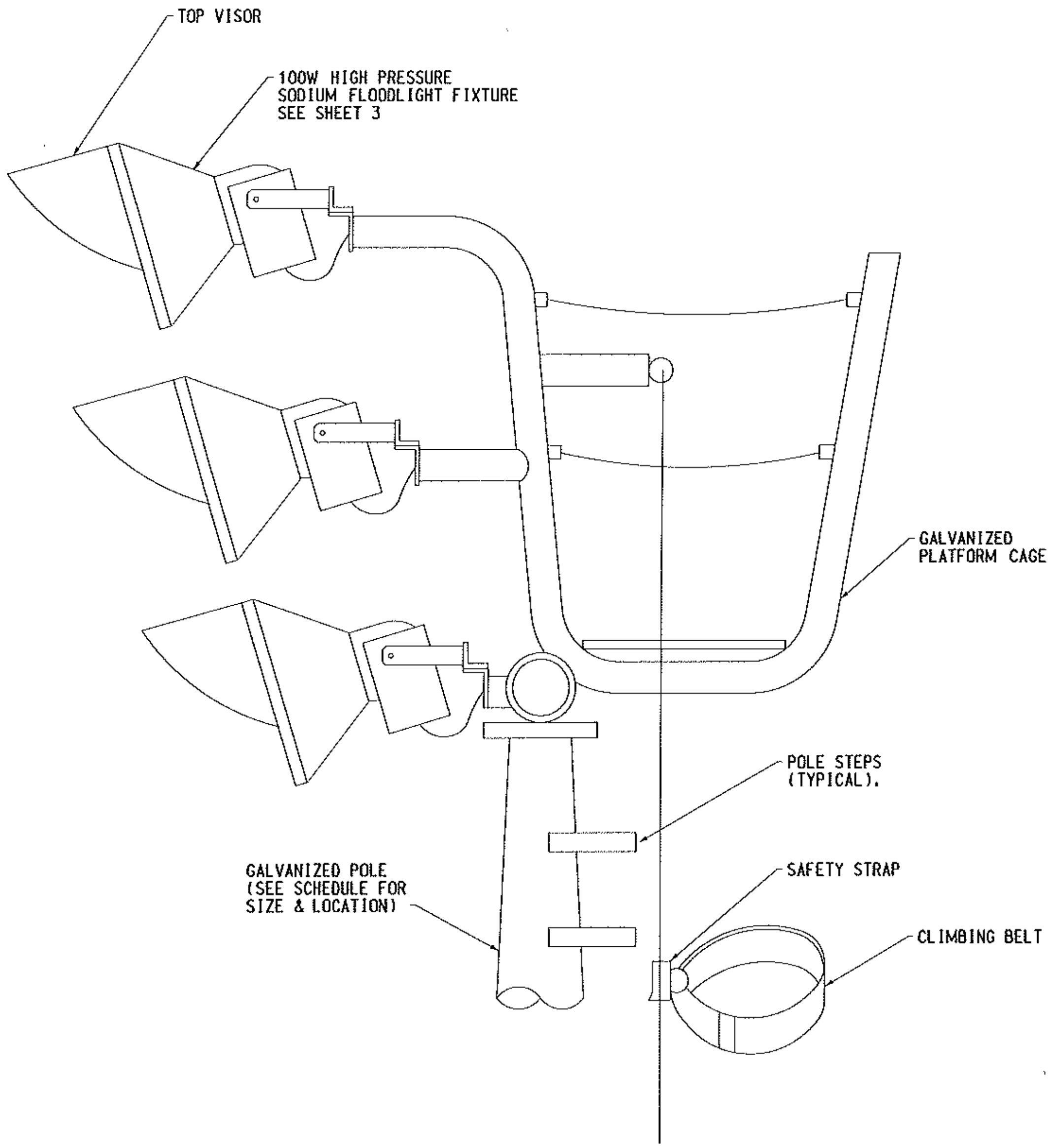
1. HEAVY DUTY POLE HOT DIPPED GALVANIZED STEEL. SLIP-FIT POLE SECTION SHALL BE SIZED SUCH THAT THE TOP SECTION SLIP-FITS THE BOTTOM SECTION A MINIMUM 15 TIMES THE BOTTOM SECTION TOP DIAMETER AT POINT OF OVERLAP.

2. A 1/2-13UNC-2A NUT FOR GROUNDING SHALL BE WELDED TO THE INSIDE OF THE POLE ADJACENT TO THE HANDHOLE.

3. MINIMUM 6 ANCHOR BOLTS-EACH BOLT PROVIDED WITH (2) HEX NUTS AND (2) FLAT WASHERS, SEE STRUCTURAL DRAWINGS.

4. FOR FOUNDATION DETAIL, SEE STRUCTURAL DRAWINGS.

Port of LONG BEACH The Green Port	AREA FLOODLIGHT POLE	STANDARD PLAN E-34
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 3

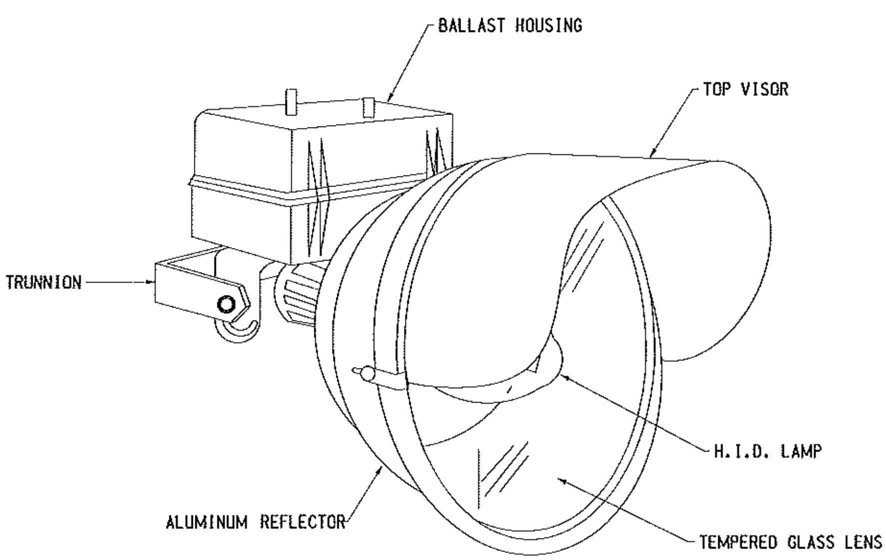


TOP DETAIL

Port of LONG BEACH The Green Port	AREA FLOODLIGHT POLE	STANDARD PLAN E-34
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	2 OF 3

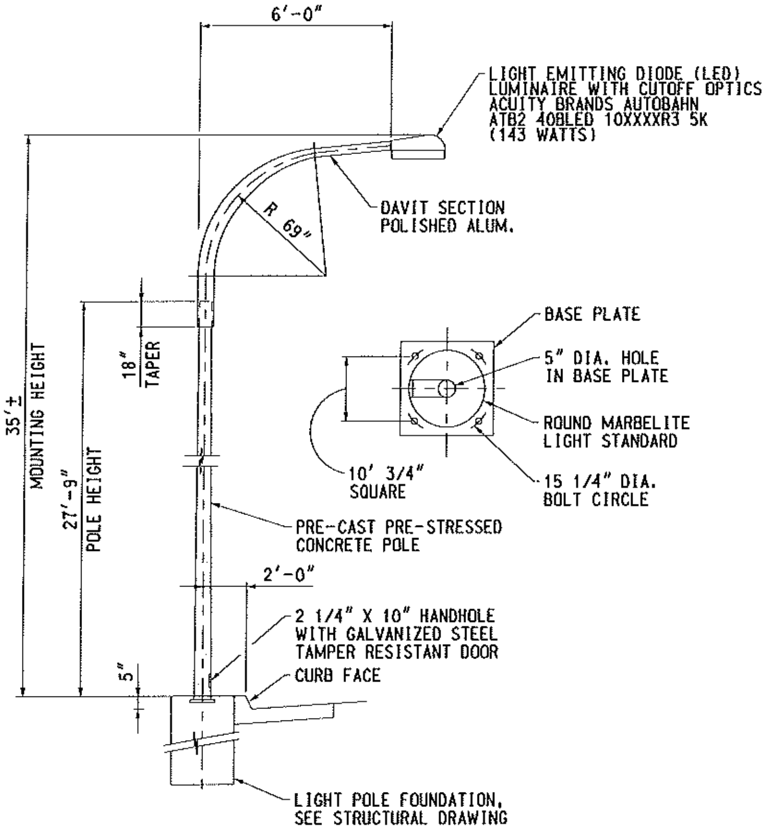
LUMINAIRE REQUIREMENTS:

1. CAST ALUMINUM COPPER-FREE BALLAST HOUSING.
2. ALUMINUM OUTER SHROUD.
3. SPUN ANODIZED ALUMINUM REFLECTOR.
4. TEMPERED, HEAT RESISTANT CLEAR GLASS LENS.
5. HINGED STAINLESS STEEL DOOR WITH GASKET AND LATCHES.
6. 1,000 WATT HIGH PRESSURE SODIUM.
7. INTEGRAL BALLAST, TYPE AND VOLTAGE AS SPECIFIED.
8. LAMP STABILIZER.
9. MINIMUM 36" 3/C #14 "SO" CORD.
10. ALL HARDWARE, STAINLESS STEEL OR NONCORROSIVE.
11. GALVANIZED STEEL TRUNNION.
12. PORCELAIN SOCKET.
13. AIMING DEVICE.
14. UL "WET LOCATION LABEL".



FIXTURE DETAIL

Port of LONG BEACH The Green Port	AREA FLOODLIGHT POLE	STANDARD PLAN E-34
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16		3 OF 3



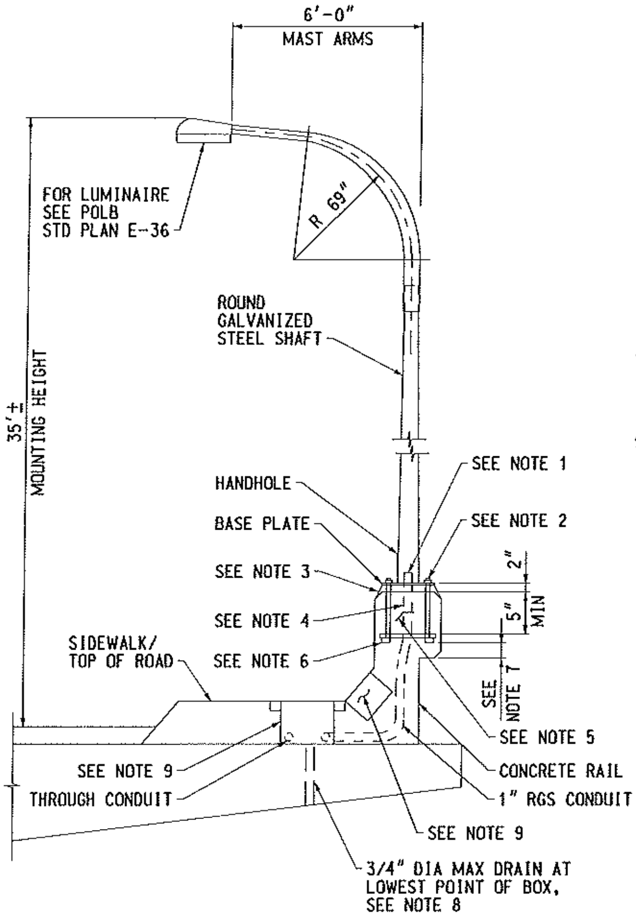
NOTES:

1. POLE SHAFT SHALL BE CONSTRUCTED TO WITHSTAND LOADING AS SPECIFIED IN THE LATEST EDITION OF A.A.S.H.T.O. STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES, AND TRAFFIC SIGNS. LOADING RESULTING FROM LUMINAIRE ARM, AND LUMINAIRE SHALL BE TAKEN INTO ACCOUNT.
2. VERIFY ALL BOLT CIRCLE & SPACING DIMENSIONS WITH MANUFACTURER.

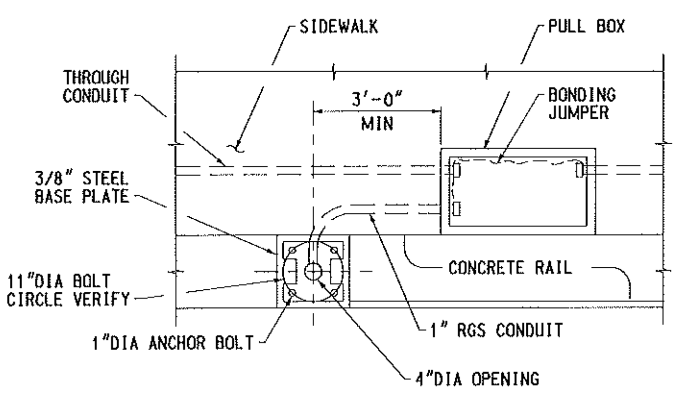
Port of LONG BEACH The Green Port	STREET LIGHT POLE DETAIL	STANDARD PLAN E-36
APPROVED BY: R. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1

NOTES:

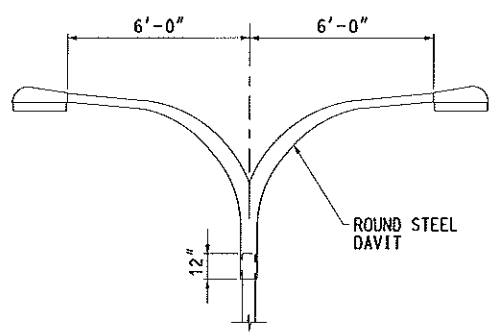
1. TOP OF CONDUIT SHALL BE 2" BELOW BOTTOM OF HANDHOLE DOOR.
2. ANCHOR BOLT LENGTH SHALL BE SUCH THAT THREAD EXTENDS 1/2" MAXIMUM ABOVE NUT ON LEVEL BASE PLATE AFTER GROUTING.
3. AFTER PLUMBING LIGHT STANDARD, GROUT ALL AROUND BOLTS. FINISH WITH A 45 DEGREE SLOPE.
4. 1" STEEL CONDUIT WITH BUSHING.
5. BONDING STRAP.
6. LIGHTPOLE ANCHOR BOLTS SHALL BE HELD IN POSITION FOR PLACING CONCRETE BY MEANS OF ANCHOR PLATES AND SUITABLE TEMPLATES. DEVIATION FROM THE TRUE POSITION, VERTICAL AND HEIGHT, SHALL NOT EXCEED 1/16".
7. MINIMUM 1" SPACE BETWEEN BOLT HEAD AND BOTTOM SURFACE OF CONCRETE RAILING.
8. PLACE DRAIN IN CENTER IF BOX IS HORIZONTAL, OR AT LOW END IF BOX IS INCLINED. WHEN BOX IS MOUNTED IN SLOPING PARAPET DRILL 1/2" ELONGATED DRAIN HOLE INSIDE AT CENTER OR NEAR END AS REQUIRED FOR DRAINAGE.
9. PROVIDE STEEL PULL BOX (9"W X 20"L X 8.5"D) AND COVER.
   - A) AXIS OF PULL BOX SHALL BE PARALLEL TO TOP OF SIDEWALK.
   - B) TOP OF PULL BOX SHALL BE FLUSH WITH THE TOP OF SIDEWALK. MODIFY BASE OF PULL BOX AS REQUIRED.
   - C) BOXES INSIDE OF VERTICAL BARRIER OR RAILING SHALL BE CLOSED DURING POURING OF P.C.C. WITH 1/4" PLYWOOD OF SUFFICIENT SIZE TO PROVIDE 1:1 CHAMFER ON 3 SIDES OF COVER. UPPER EDGE OF PLYWOOD SHALL FIT AGAINST LOWER EDGE OF RAINTIGHT HOOD.



ELEVATION

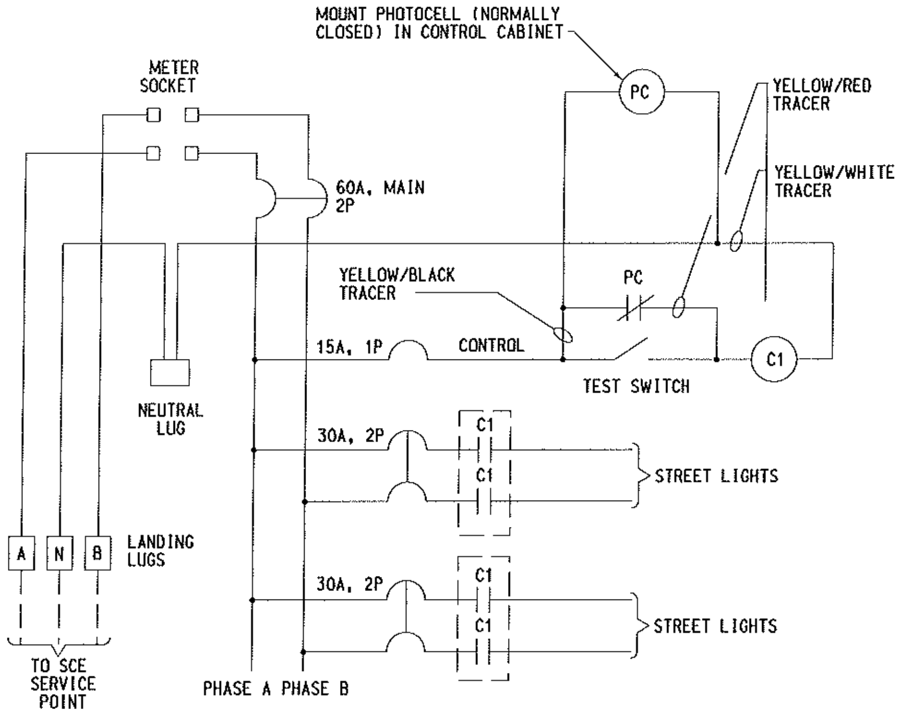


PLAN

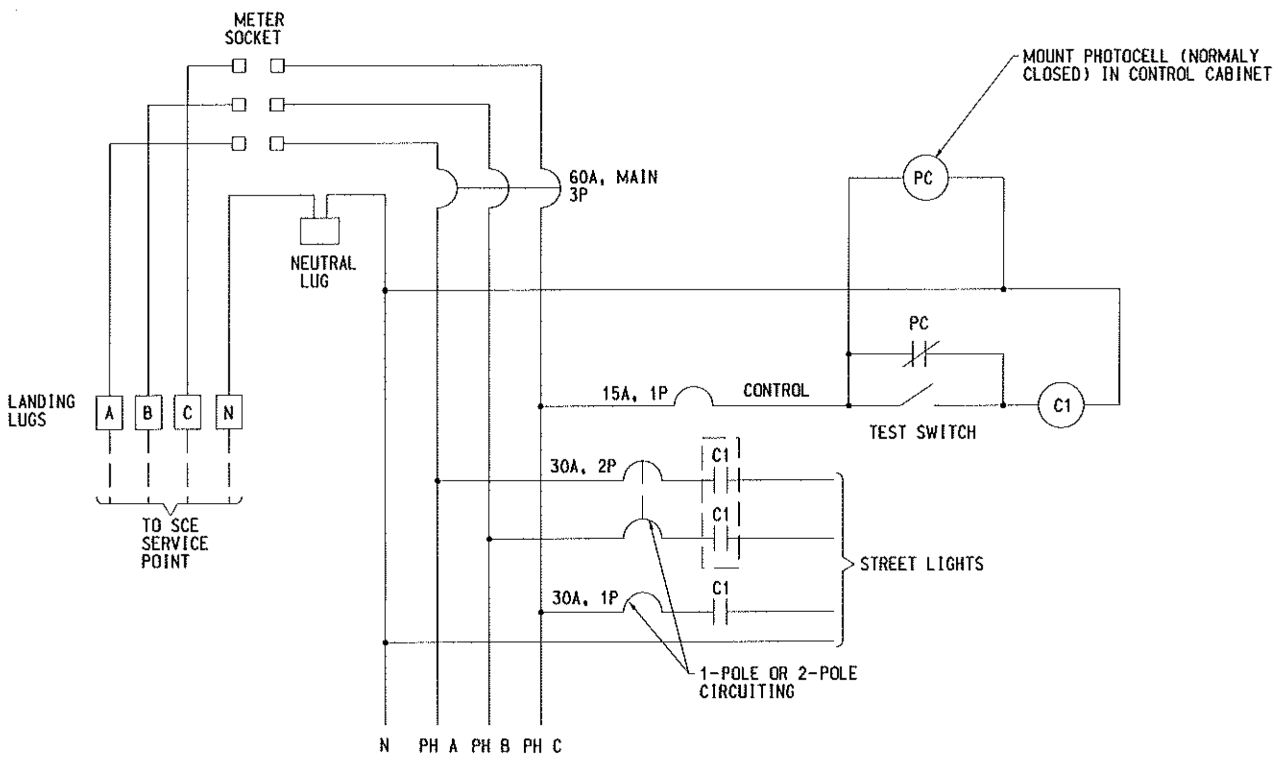


TWIN MAST ARM ELEVATION

Port of LONG BEACH The Green Port	BRIDGE LIGHT POLE DETAIL	STANDARD PLAN E-37
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1

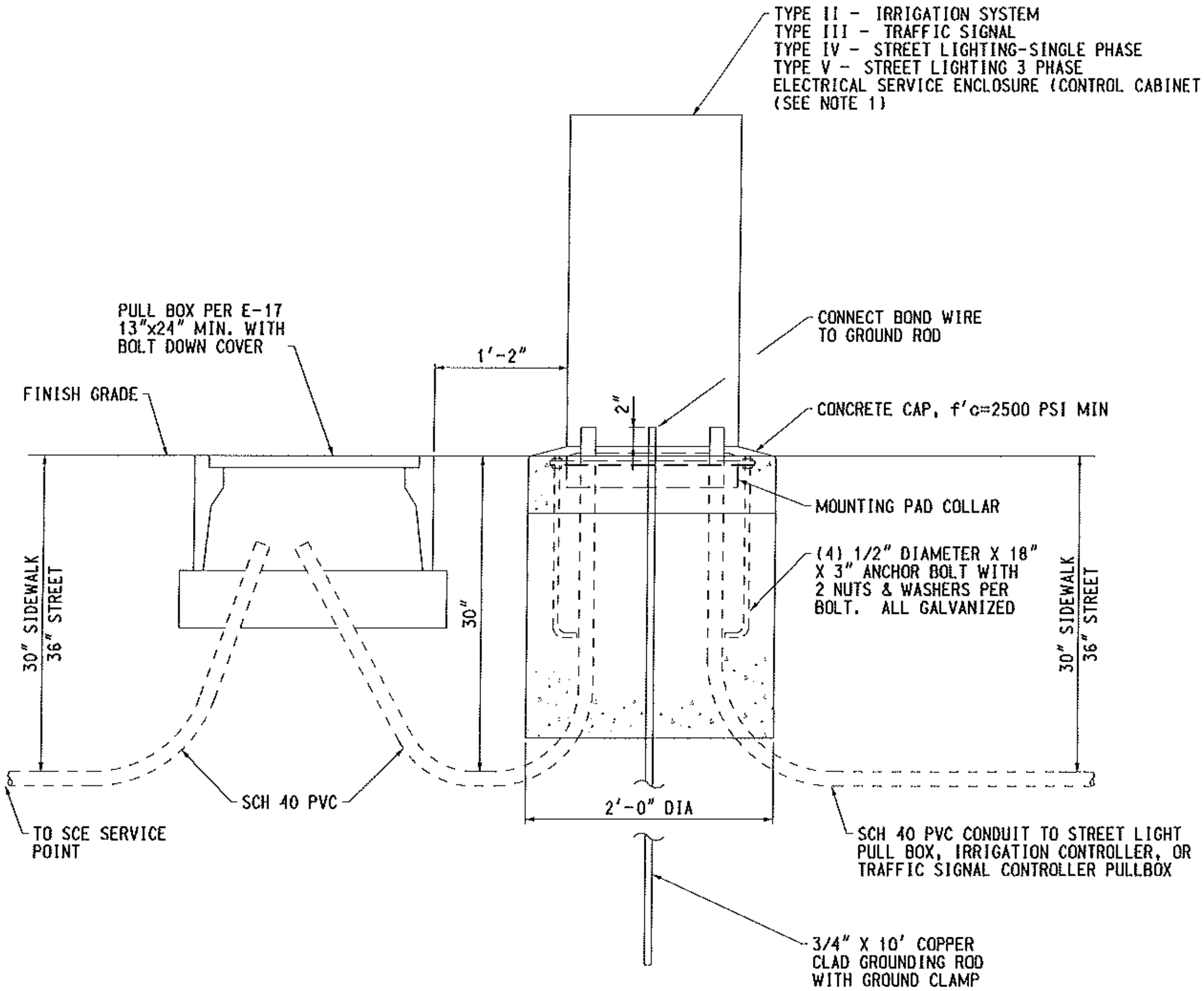


WIRING DIAGRAM (SINGLE PHASE)

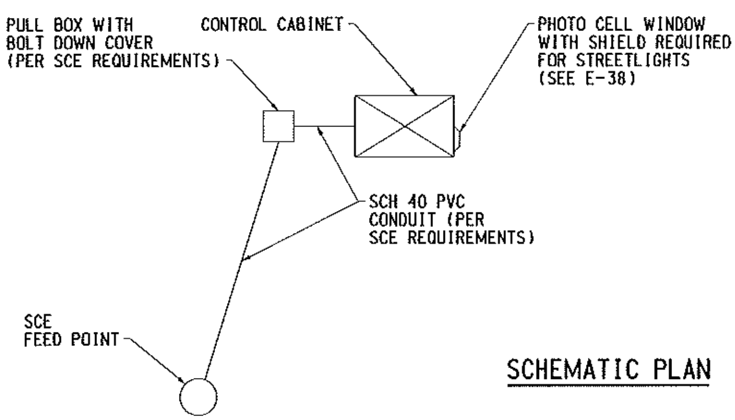


WIRING DIAGRAM (THREE PHASE)

Port of LONG BEACH The Green Port	STREET LIGHTING SERVICE CONTROL CABINET WIRING DIAGRAM	STANDARD PLAN E-38
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16		1 OF 1



ELEVATION

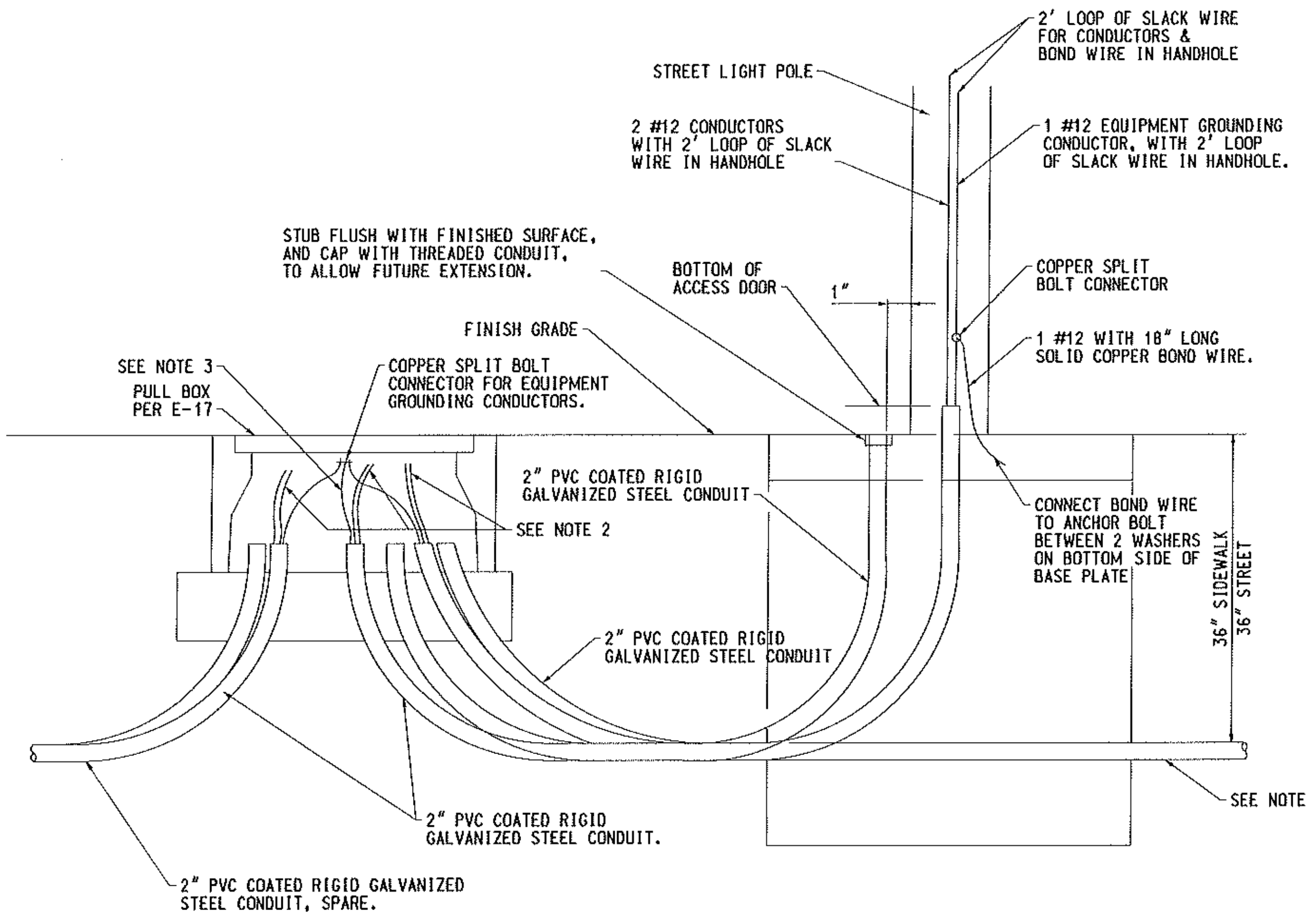


SCHEMATIC PLAN

NOTES:

1. ALL CONTROL CABINETS WITH UTILITY METERS SHALL MEET SCE ELECTRICAL SERVICE REQUIREMENTS.

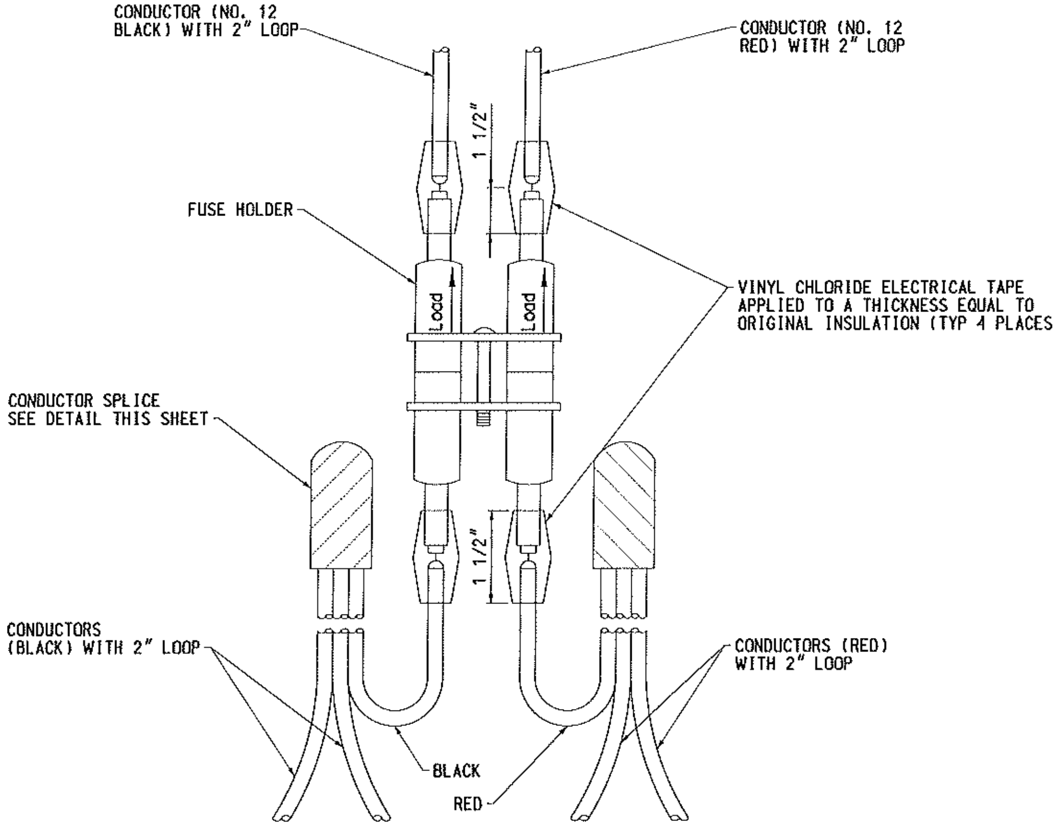
Port of LONG BEACH The Green Port	ELECTRICAL SERVICE CONTROL CABINET	STANDARD PLAN E-39
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1

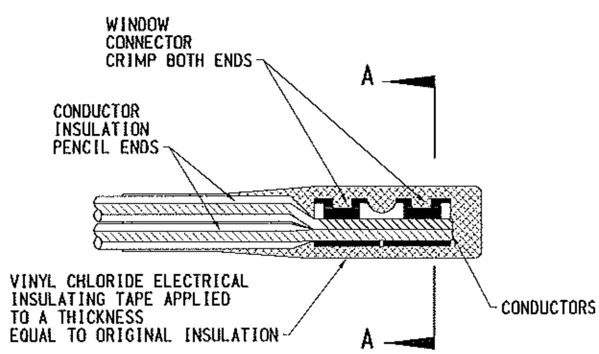


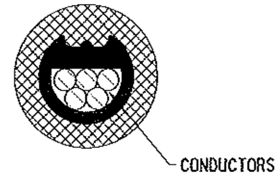
NOTES:

1. PULL BOX SHALL BE INSTALLED ADJACENT TO ALL STREET LIGHTS SIZE AS REQUIRED BY NEC, AND STANDARD PLAN E-17.
2. CONNECT CONDUCTORS TO FUSE HOLDER IN PULL BOX. (SEE POLB STD PLAN E-41)
3. EQUIPMENT GROUNDING CONDUCTOR SHALL BE SAME SIZE AS BRANCH CIRCUIT CONDUCTOR BETWEEN STREET LIGHT PULL BOXES.

Port of LONG BEACH The Green Port	PULL BOX AND STREET LIGHT CONDUIT AND CONDUCTOR DETAILS	STANDARD PLAN E-40
APPROVED BY: R. R. CHAVDARIAN SR. ELECTRICA ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1





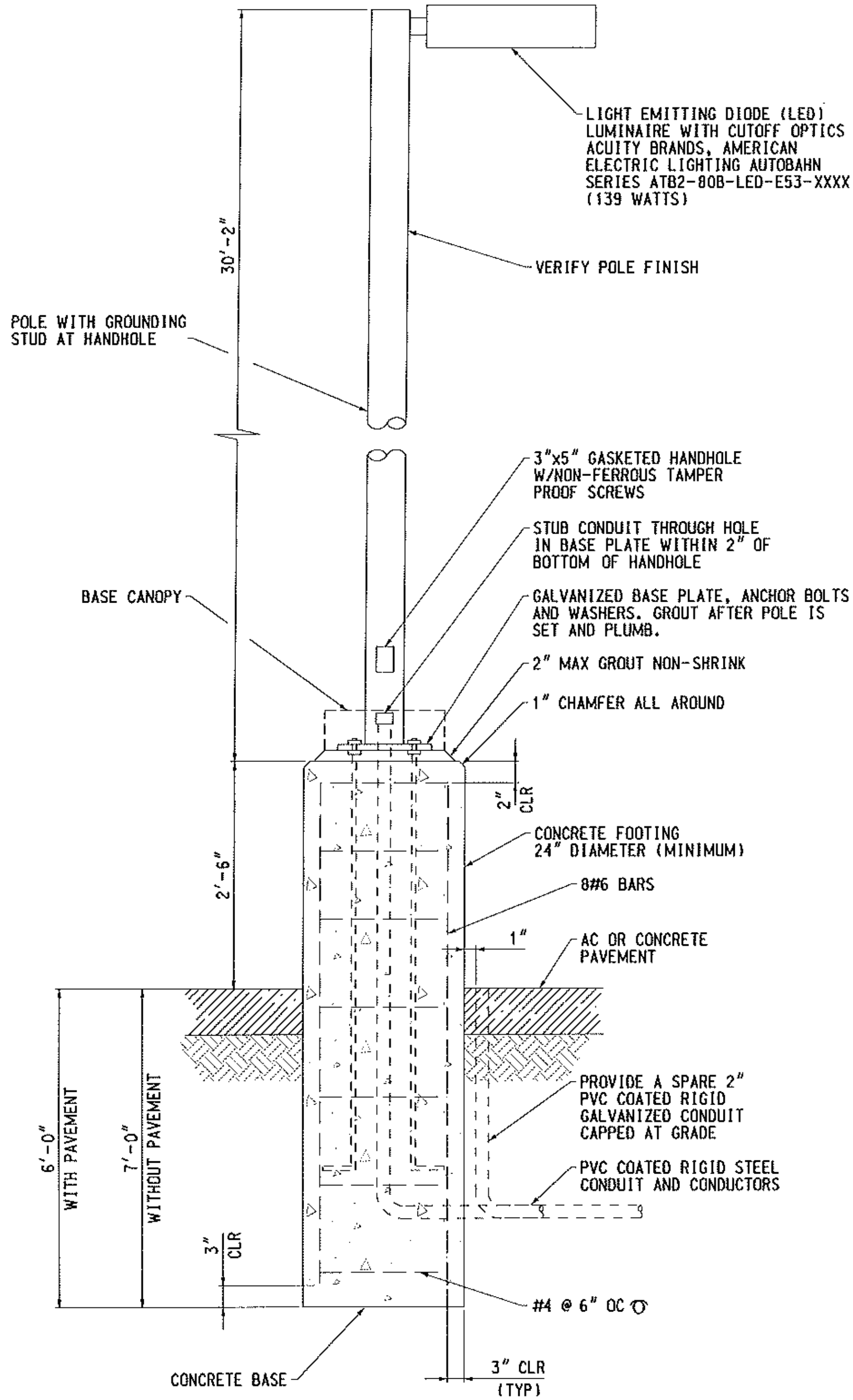


SECTION A-A

CONDUCTOR SPLICE DETAIL

NOT TO SCALE

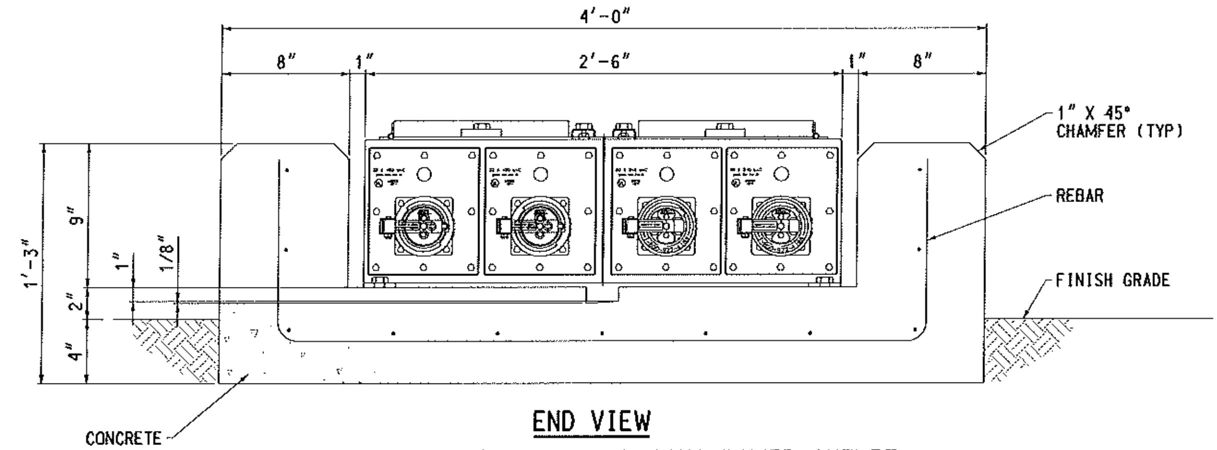
Port of LONG BEACH The Green Port	FUSE HOLDER DETAIL	STANDARD PLAN E-41
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1



NOTES:

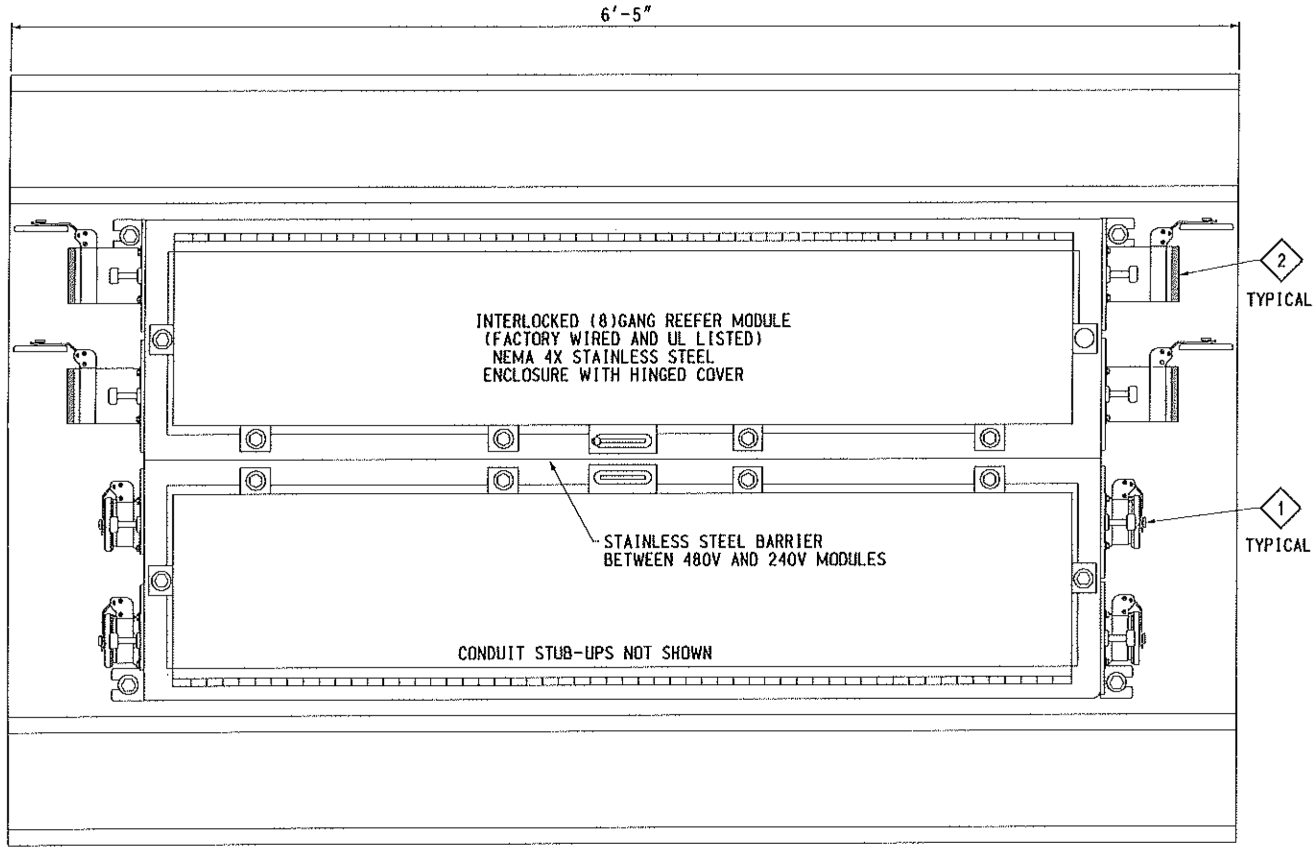
1. CONCRETE f'c =4000 PSI (MINIMUM), W/C=0.40 MAX
2. REINFORCING STEEL = ASTM615, GRADE 60 OR ASTM A706, GRADE 60
3. COHESIONLESS SOIL, FIXED HEAD CONDITION, UNIFORM SOIL PROFILE
4. WATER TABLE DEPTH 7'-0" BELOW FG, WATER DENSITY=62.4 PCF
5. 1'-0" DEPTH FROM FG IGNORED FOR PASSIVE PRESSURE.
6. SOIL DENSITY=110 PCF MIN., SOIL FRICTION ANGLE =30° MIN.
7. WIND SPEED=100 MPH (3-SECOND GUST)

Port of LONG BEACH The Green Port	PARKING LOT LIGHT POLE DETAIL	STANDARD PLAN E-42
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1



END VIEW

BUNKER FOR 480V/240V 8-GANG POWER OUTLET



PLAN VIEW

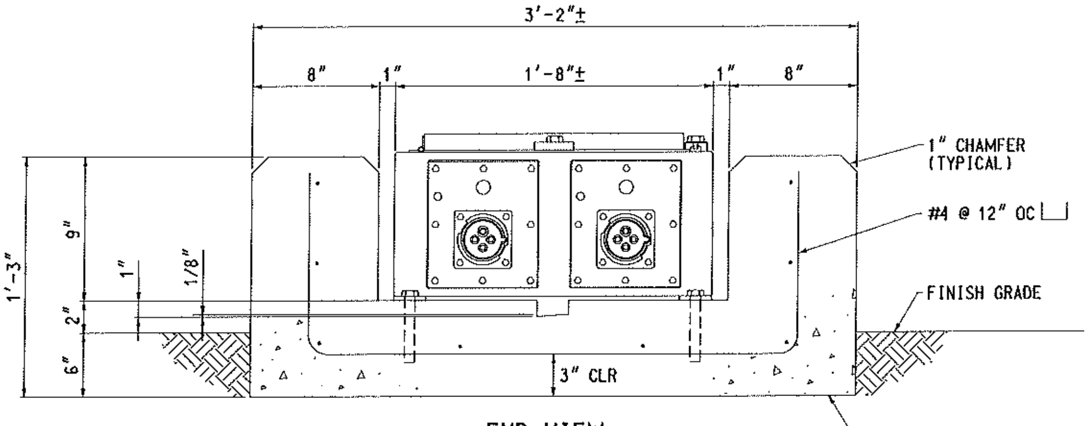
BUNKER FOR 480V/240V 8-GANG POWER OUTLET

NOTE:

1. INTERLOCKED 480V REEFER MODULE WITH CIRCUIT BREAKER.
2. INTERLOCKED 240V REEFER MODULE WITH CIRCUIT BREAKER.
3. CONCRETE SHALL BE CLASS 560-C-3250 WITH A MAXIMUM SLUMP OF 5", FC'=3250 P.S.I. COMPRESSIVE STRENGTH AT 28 DAYS, UON ON THE CONTRACT PLANS, REINFORCING STEEL IF REQUIRED SHALL BE DEFORMED REBARS WITH Fy EXCEEDING 60,000 P.S.I., ASTM A615 AND ASTM A706, GRADE 60. PLACING OF REINFORCEMENT AND SPLICING LENGTH SHALL CONFORM TO ACI CODES 318-13.

FOR INFORMATION ONLY

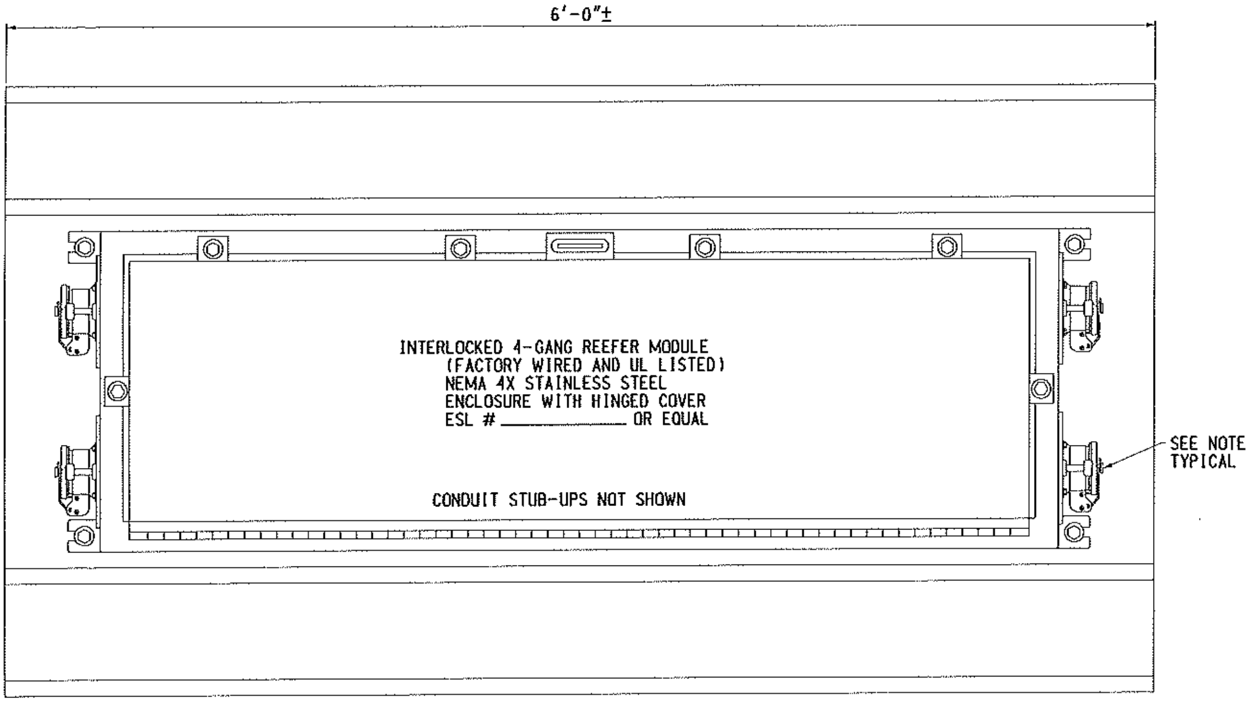
Port of LONG BEACH The Green Port	BUNKER FOR 480V/240V 8-GANG POWER OUTLET	STANDARD PLAN E-49
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16		1 OF 1



END VIEW

CONCRETE FOUNDATION

BUNKER FOR 480V 4-GANG POWER OUTLET



PLAN VIEW

BUNKER FOR 480V 4-GANG POWER OUTLET

NOTES:

1. INTERLOCKED 480V REEFER MODULE WITH CIRCUIT BREAKER.
2. RECEPTACLE COVER SHALL BE SNAP TYPE (SCREW TYPE NOT ACCEPTABLE).
3. CONCRETE SHALL BE CLASS 560-C-3250 WITH A MAXIMUM SLUMP OF 5", FC'=3250 P.S.I. COMPRESSIVE STRENGTH AT 28 DAYS, UNLESS OTHERWISE NOTED ON THE CONTRACT PLANS. REINFORCING STEEL IF REQUIRED SHALL BE DEFORMED REBARS WITH Fy EXCEEDING 60.000 P.S.I., ASTM A615 AND ASTM A706, GRADE 60. PLACING OF REINFORCEMENT AND SPLICING LENGTH SHALL CONFORM TO ACI CODE, LATEST EDITION.

Port of LONG BEACH
The Green Port

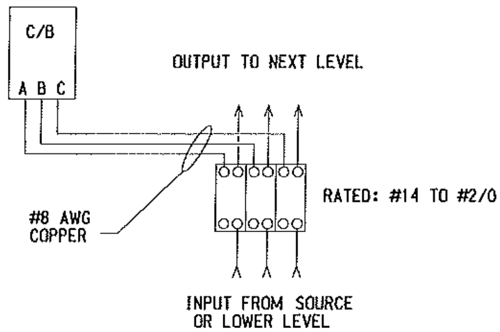
BUNKER MOUNTED
4-GANG REEFER OUTLET ASSEMBLY

STANDARD PLAN

E-50

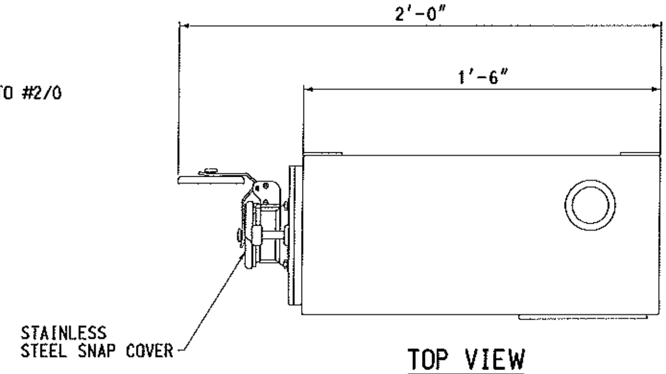
APPROVED BY: R. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

1 OF 1

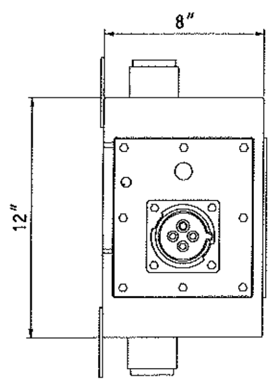


WIRING DIAGRAM

(FOR 1-GANG)

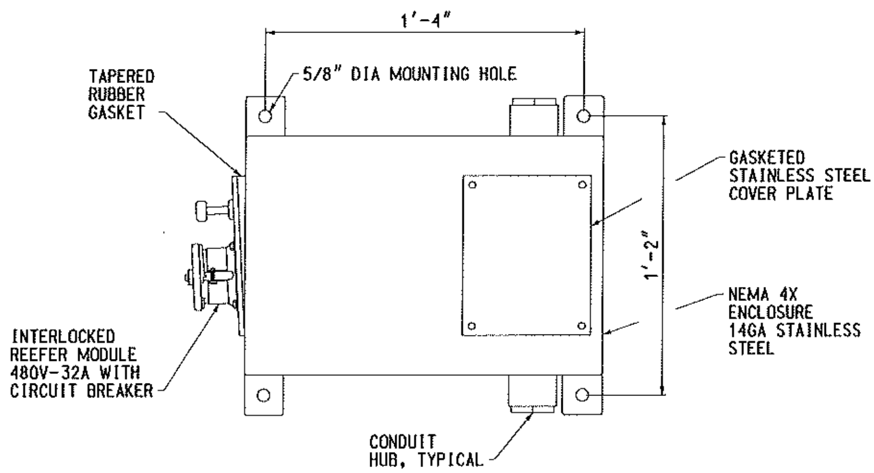


TOP VIEW



SIDE VIEW

(SNAP COVER NOT SHOWN)

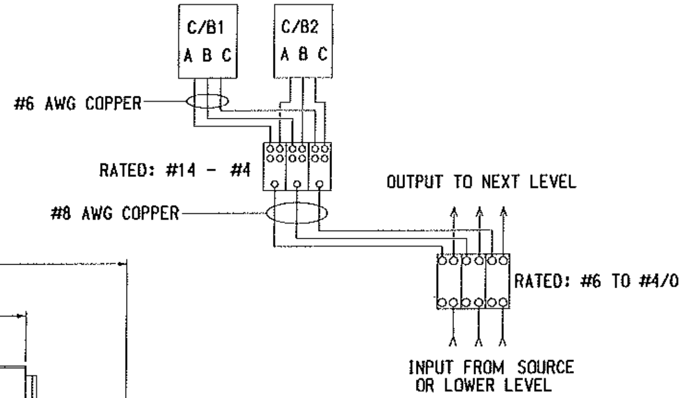


FRONT VIEW

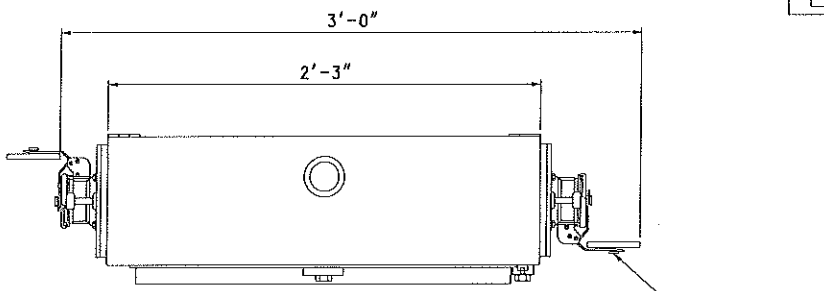
NOTES:

1. SHALL BE FACTORY WIRED AND UL LISTED
2. SPECIFY AIC REQUIREMENTS

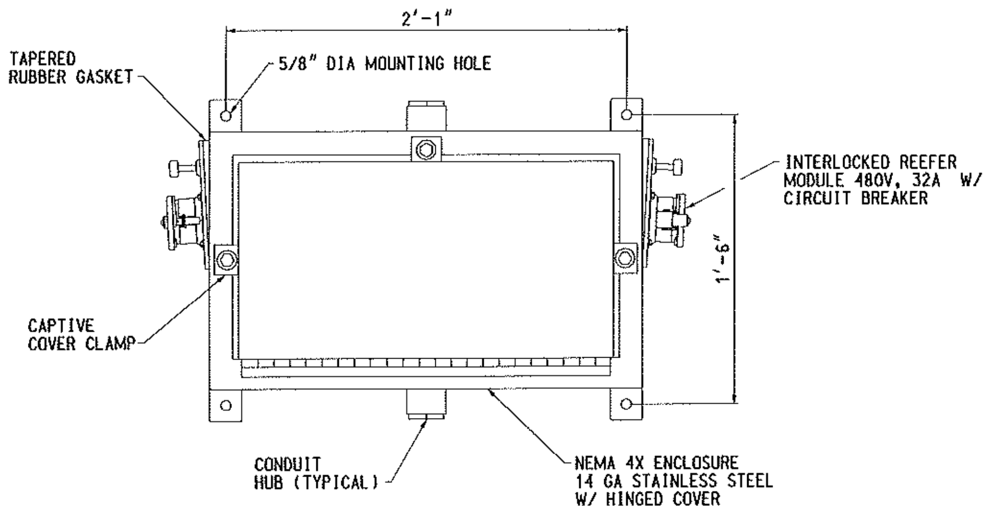
Port of LONG BEACH The Green Port	1-GANG RACK MOUNTED REEFER OUTLET ASSEMBLY	STANDARD PLAN E-51
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1

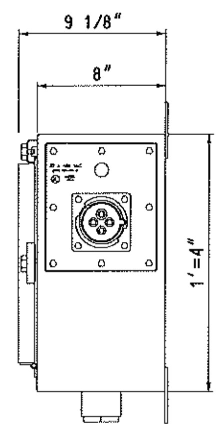


WIRING DIAGRAM
(FOR 2-GANG)



TOP VIEW





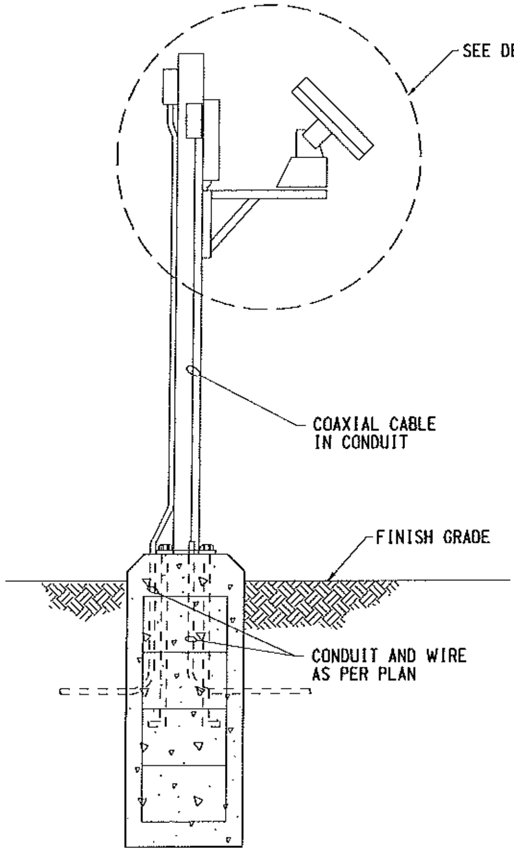
SIDE VIEW
(SNAP COVER NOT SHOWN)

FRONT VIEW

NOTES:

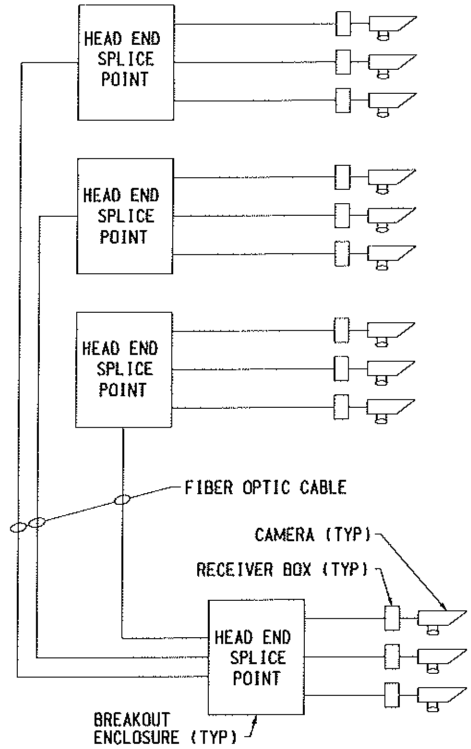
1. SHALL BE FACTORY WIRED AND UL LISTED
2. AIC RATING OF BREAKERS SHALL BE 65,000A UON

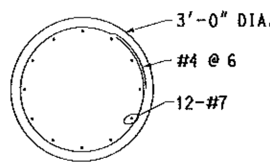
Port of LONG BEACH The Green Port	2-GANG RACK MOUNTED REEFER OUTLET ASSEMBLY	STANDARD PLAN E-52
APPROVED BY: P.R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1



NOTES:

1. INSTALL BASE PLATE & ANCHOR BOLTS PER POLE SUPPLIER'S REQUIREMENTS.
2. FOOTING DIMENSIONS AND DESIGN TO BE VERIFIED, BASED ON PROPOSED POLE DIMENSIONS.

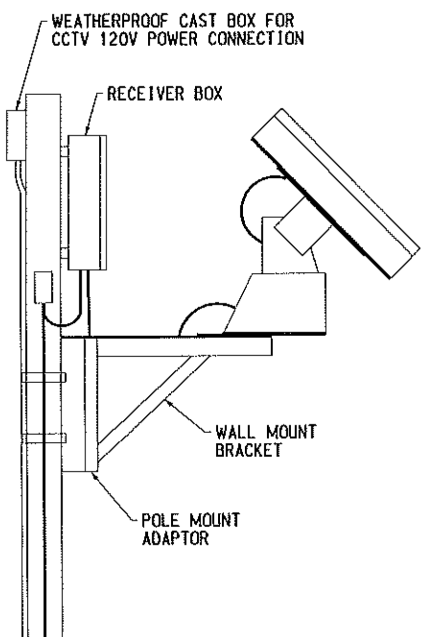


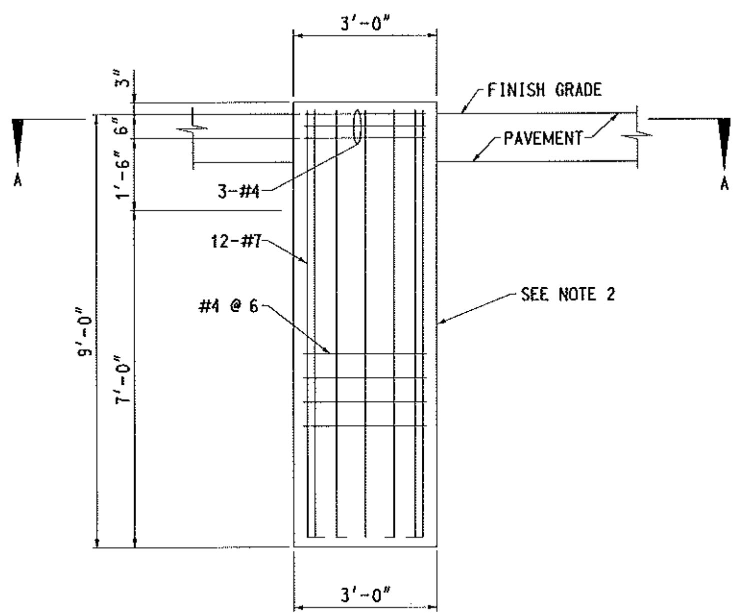


SECTION A-A

CCTV DIAGRAM

SECTION





CAMERA DETAIL

EMBEDDED FOUNDATION FOR CAMERA POLE
(VERIFY DIMENSIONS)

Port of LONG BEACH
The Green Port

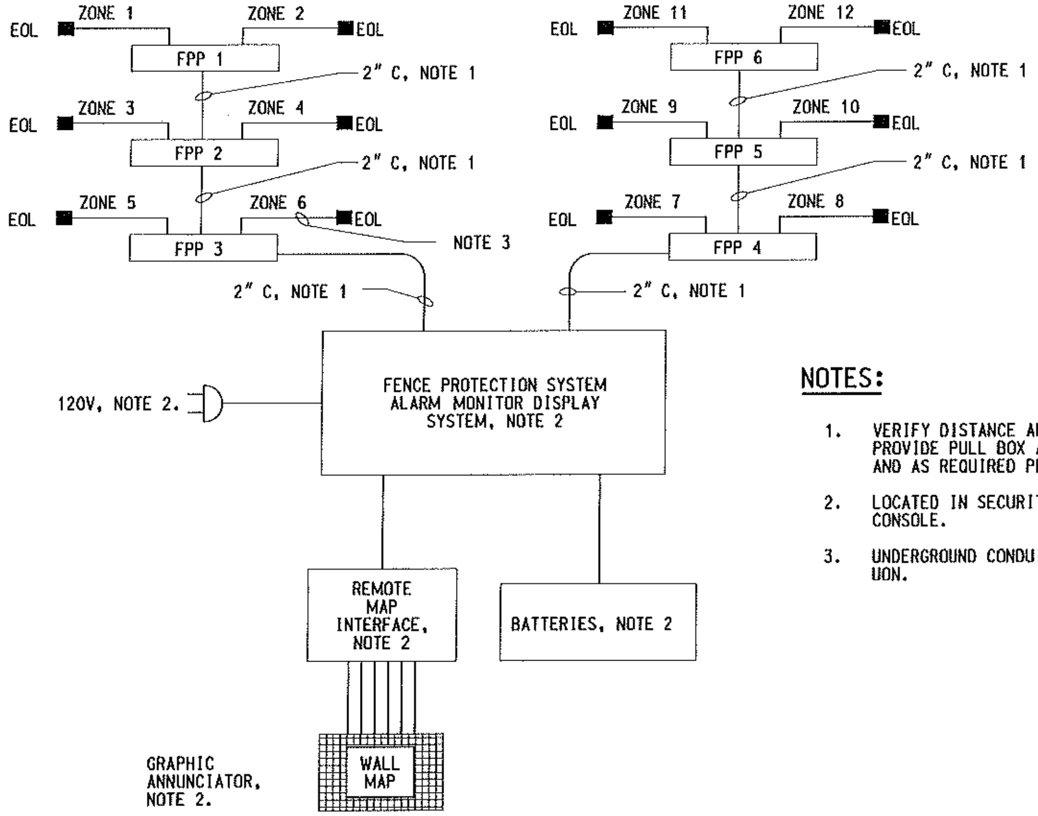
CAMERA POLE AND CAMERA MOUNTING DETAILS

STANDARD PLAN

E-60

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 0131-16

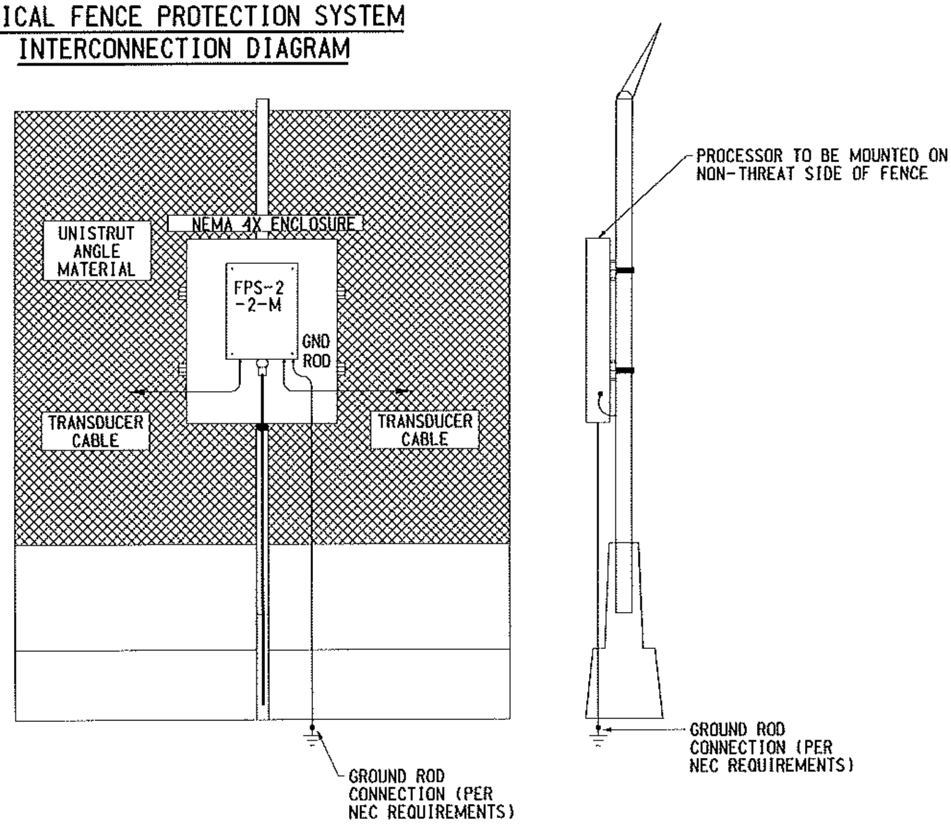
1 OF 1



NOTES:

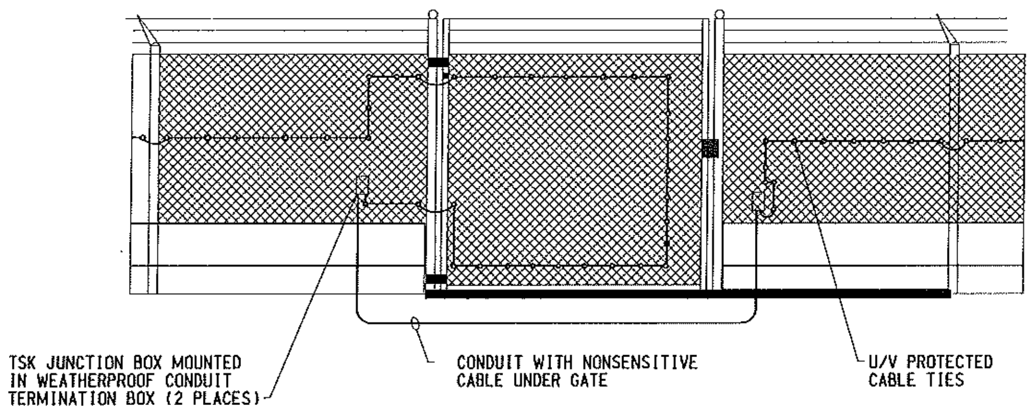
1. VERIFY DISTANCE AND ROUTING IN THE FIELD. PROVIDE PULL BOX AS SHOWN ON CONTRACT PLANS AND AS REQUIRED PER NEC STANDARDS.
2. LOCATED IN SECURITY BUILDING SECURITY CONSOLE.
3. UNDERGROUND CONDUITS AT RAIL GATES ARE 1" UON.

TYPICAL FENCE PROTECTION SYSTEM INTERCONNECTION DIAGRAM

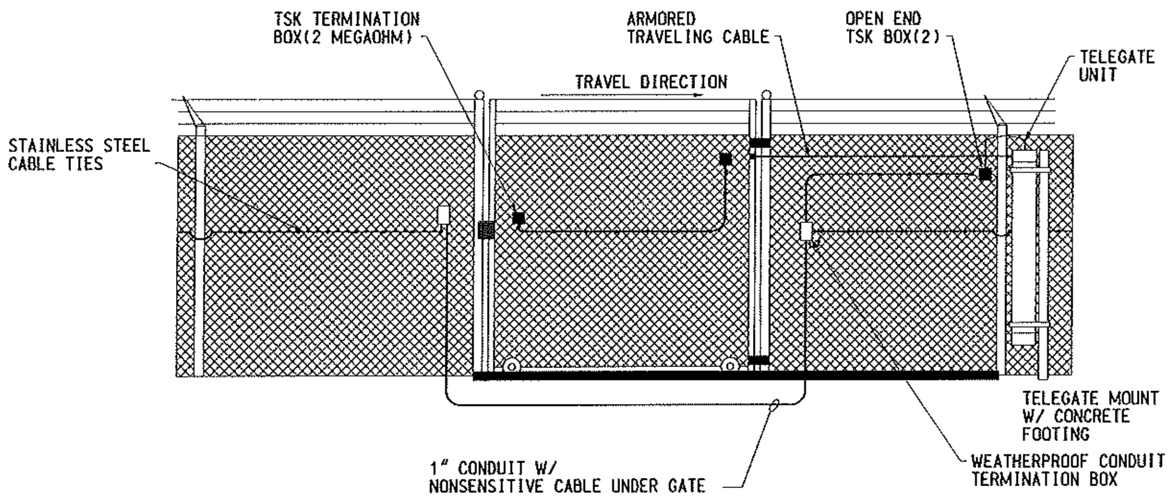


FENCE PROTECTION PROCESSOR ELEVATION

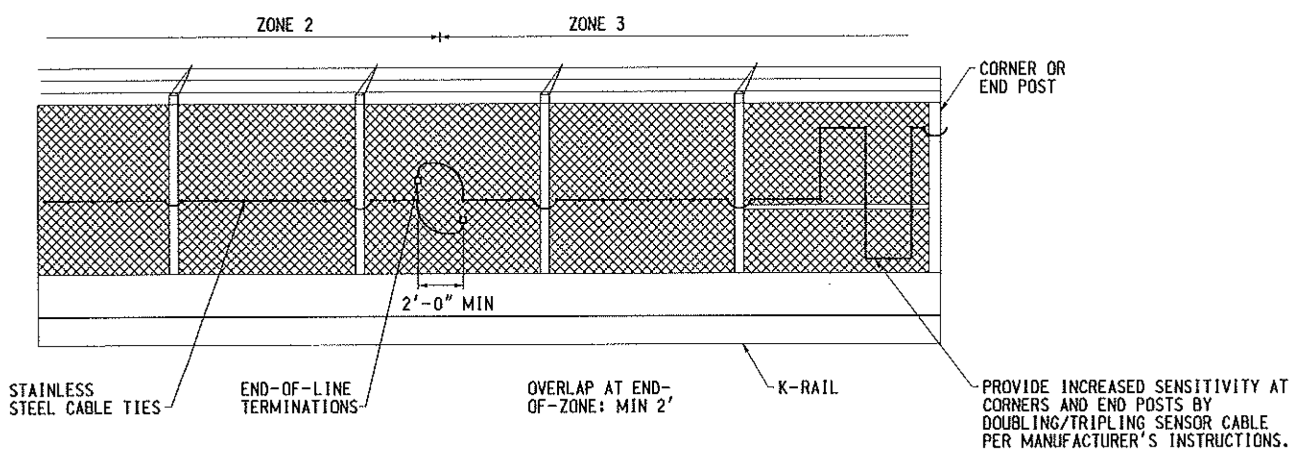
Port of LONG BEACH The Green Port	FENCE PROTECTION SYSTEM DETAILS	STANDARD PLAN E-61
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16		1 OF 2



SWINGING GATE HELISENSOR CABLE INSTALLATION

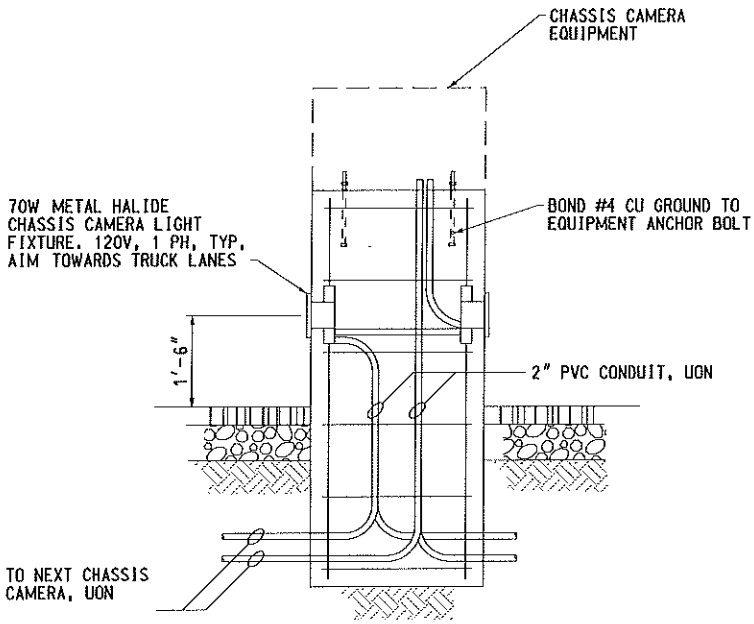


HELISENSOR CABLE AT GATE ELEVATION



HELISENSOR CABLE ELEVATION

Port of LONG BEACH The Green Port	FENCE PROTECTION SYSTEM DETAILS	STANDARD PLAN E-61
APPROVED BY: P.R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	2 OF 2



Port of LONG BEACH
The Green Port

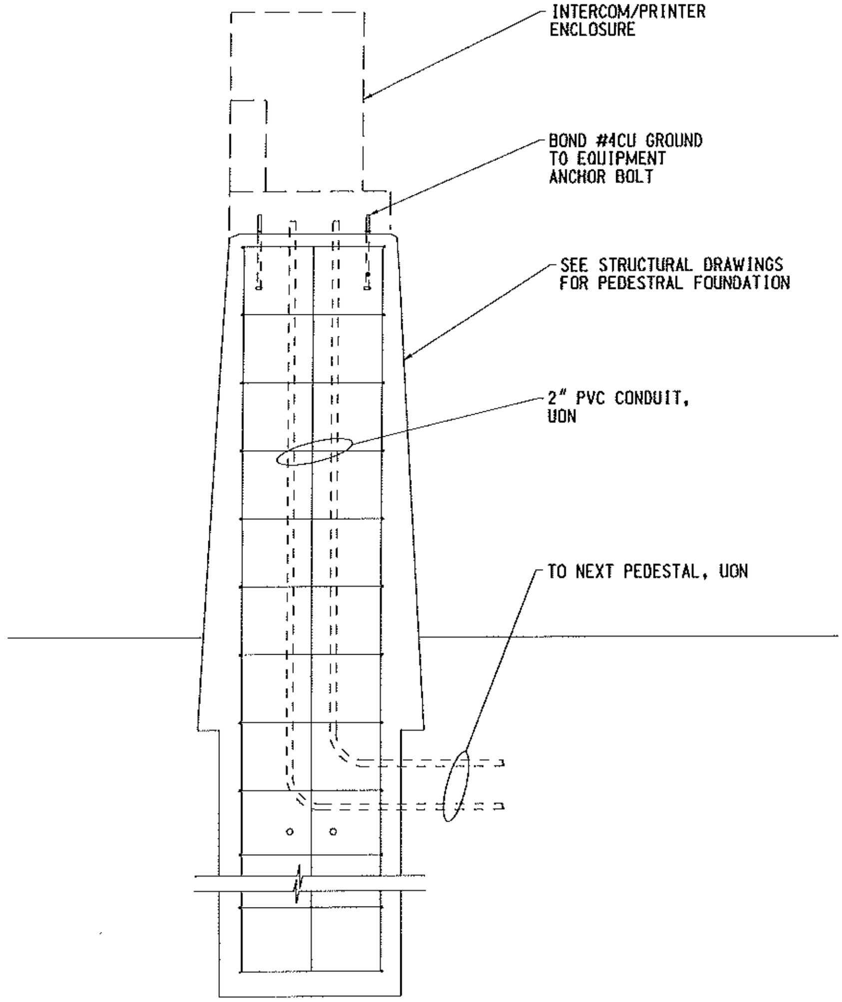
CHASSIS CAMERA DETAIL

STANDARD PLAN

E-63

1 OF 1

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16



Port of LONG BEACH
The Green Port

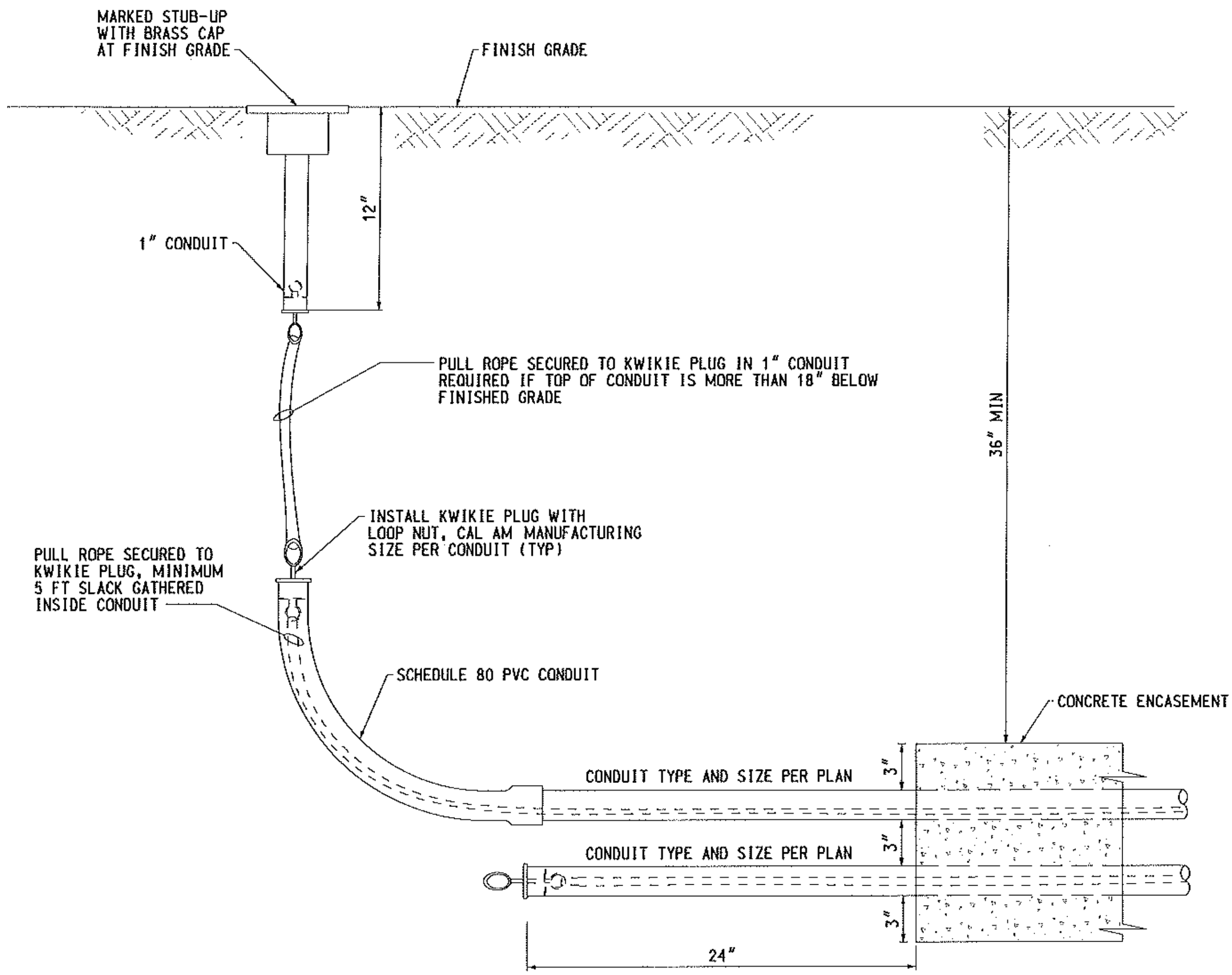
INTERCOM PEDESTAL DETAIL

STANDARD PLAN

E-64

1 OF 1

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-16-31



NOTE:

1. ENGRAVE BRASS CAP INDICATING FUNCTION, CONDUIT QTY AND SIZE. RECORD ALL ACTUAL STUB-OUT LOCATIONS ON RECORD DRAWINGS.
2. NOT TO SCALE

Port of LONG BEACH
The Green Port

CONDUIT STUB DETAIL - SECTION

STANDARD PLAN

E-70

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

1 OF 1

RACEWAY & CONDUCTOR SCHEDULE

NO.	VOLTS	RACEWAY	CONDUCTOR	FROM	TO	NOTES

Port of LONG BEACH
The Green Port

RACEWAY & CONDUCTOR SCHEDULE

STANDARD PLAN
E-80

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER   P.E. NO.: E-8410   DATE: 01-31-16

UNDERGROUND PULL BOX SCHEDULE				
DESIGNATION	SIZE	REFERENCE DETAIL	COVER MARKING	REMARKS

Port of LONG BEACH
The Green Port

UNDERGROUND PULL BOX SCHEDULE

STANDARD PLAN

E-81

APPROVED BY: P. R. Chav
P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER
P.E. NO.: E-8410
DATE: 01-31-16

LIGHT POLE SCHEDULE

POLE NUMBER	POLE HEIGHT	REFERENCE DETAIL	FIXTURE TYPE	NO. OF FIXTURES	LAMP WATTAGE	TOTAL POLE VA

Port of LONG BEACH
The Green Port

LIGHT POLE SCHEDULE

STANDARD PLAN

E-82

1 OF 1

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

LIGHT FIXTURE SCHEDULE							
SYMBOL	MANUFACTURER		MOUNTING	VOLTAGE	TOTAL VA	NO. OF LAMPS	LAMP
	NAME	CATALOG NO.					

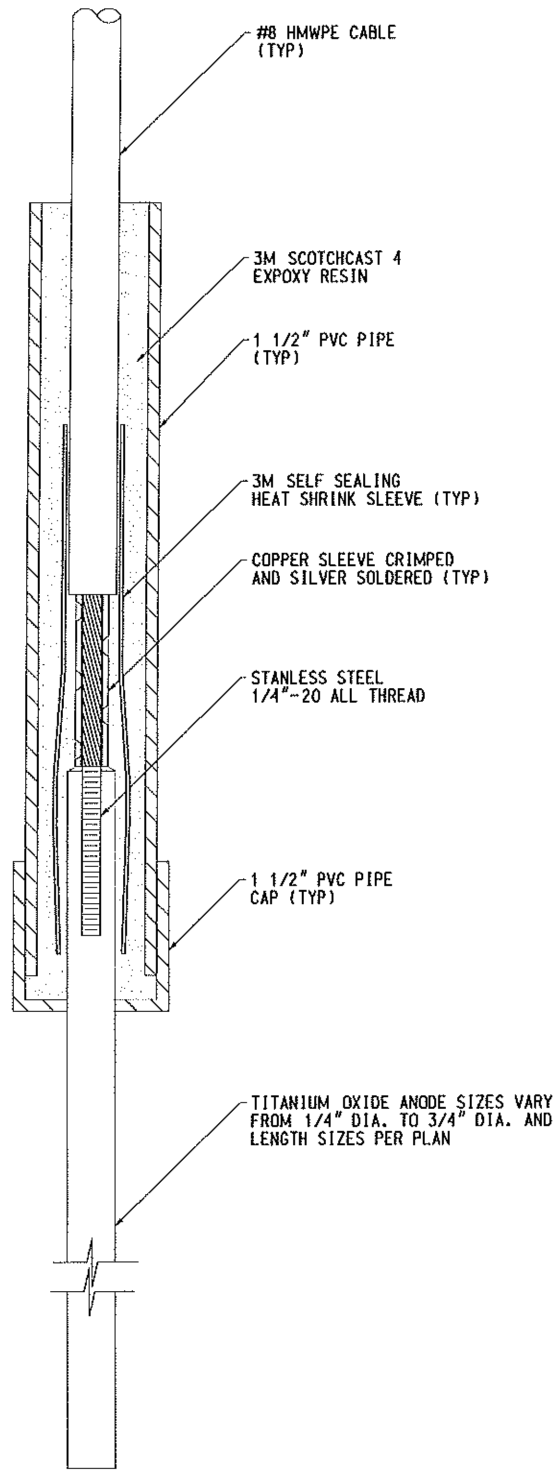
Port of LONG BEACH
The Green Port

LIGHT FIXTURE SCHEDULE

STANDARD PLAN

E-83

APPROVED BY: P. R. Chavdarian
P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER
P.E. NO.: E-8410
DATE: 01-31-16



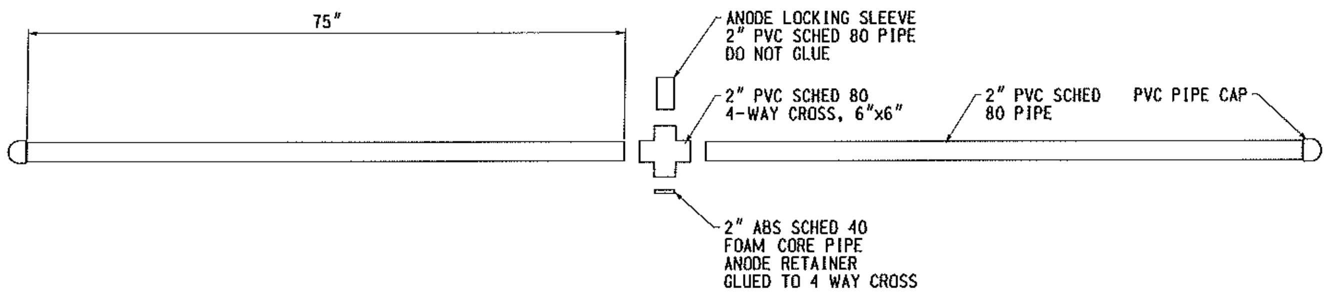
ANODE ASSEMBLY

NOT TO SCALE

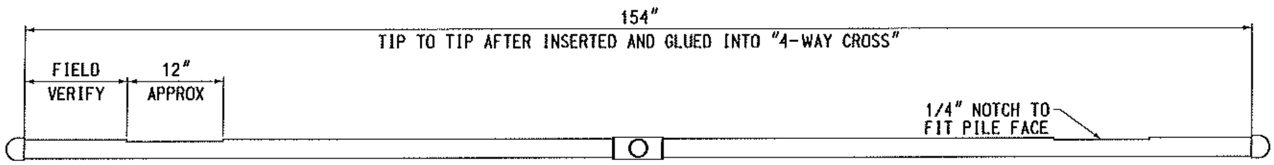
NOTE:

1. ANODE ASSEMBLY (CABLE, HEAD & ROD) ASSEMBLED & MANUFACTURED BY OTHERS.
2. DO NOT SCALE DRAWINGS

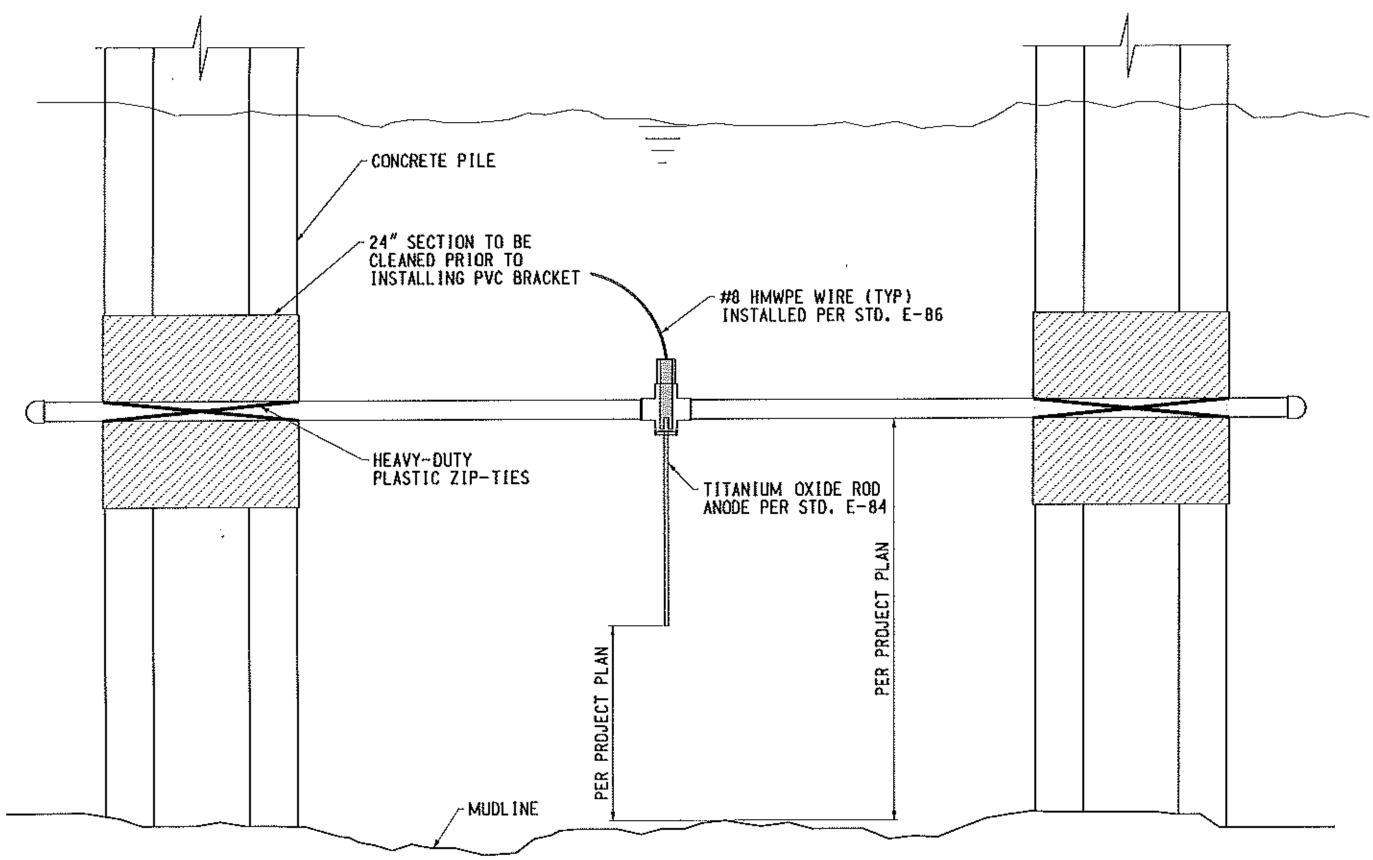
Port of LONG BEACH The Green Port	TYPICAL TITANIUM OXIDE ROD ANODE CONNECTION DETAIL	STANDARD PLAN E-84
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1



ELEVATION



PLAN VIEW ASSEMBLED



CONSTRUCTED
ELEVATION

NOTE:
DO NOT SCALE DRAWINGS

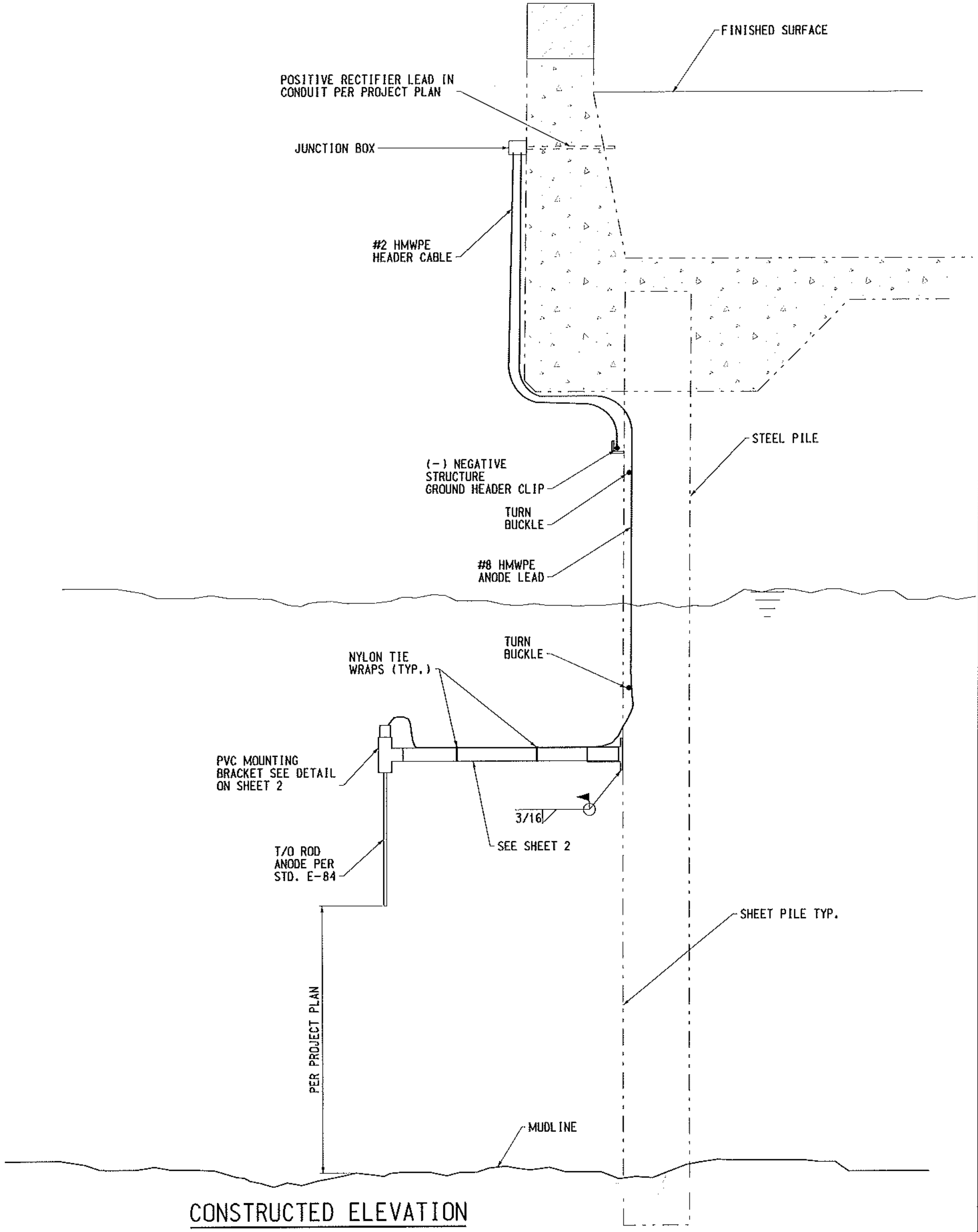
Port of
LONG BEACH
The Green Port

ANODE BRACKET SYSTEM BETWEEN PILES

STANDARD PLAN
E-85

APPROVED BY: R. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

1 OF 1



CONSTRUCTED ELEVATION

DO NOT SCALE

Port of LONG BEACH
The Green Port

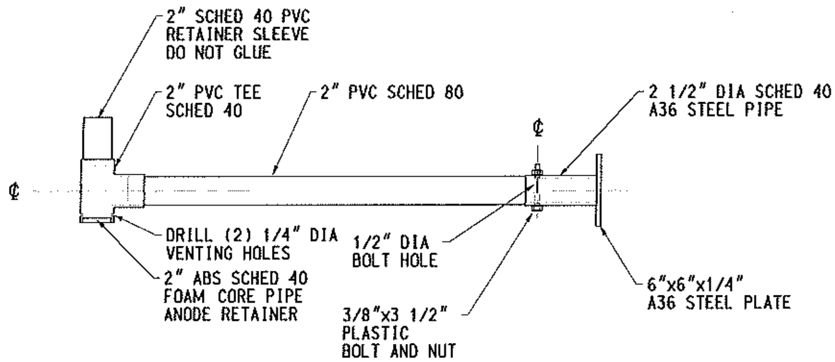
ANODE BRACKET SYSTEM AT STEEL BULKHEAD

STANDARD PLAN

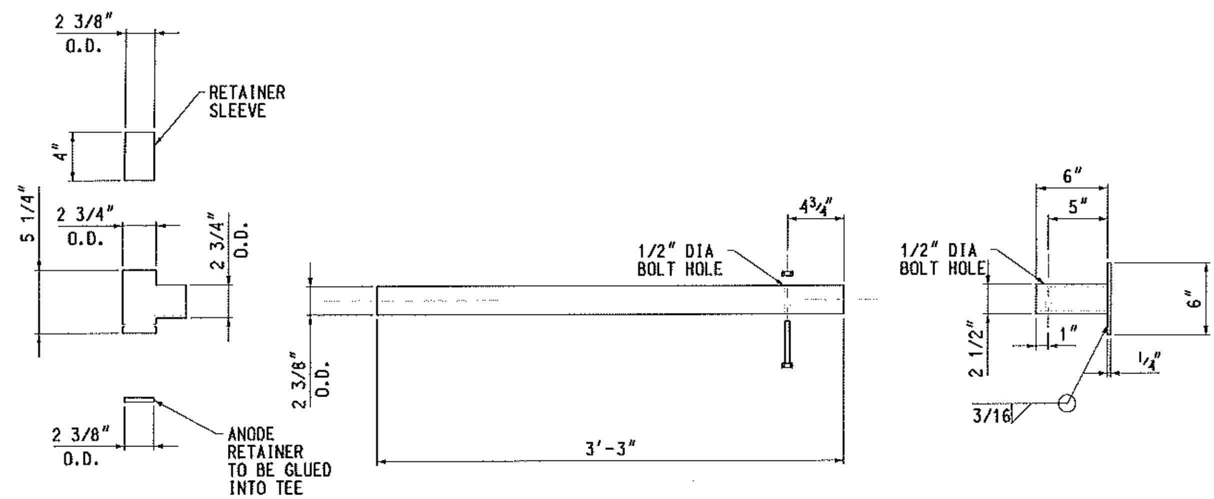
E-86

1 OF 2

APPROVED BY: B. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16



ELEVATION (ASSEMBLED)



ELEVATION (PRE-ASSEMBLED)

Port of LONG BEACH
The Green Port

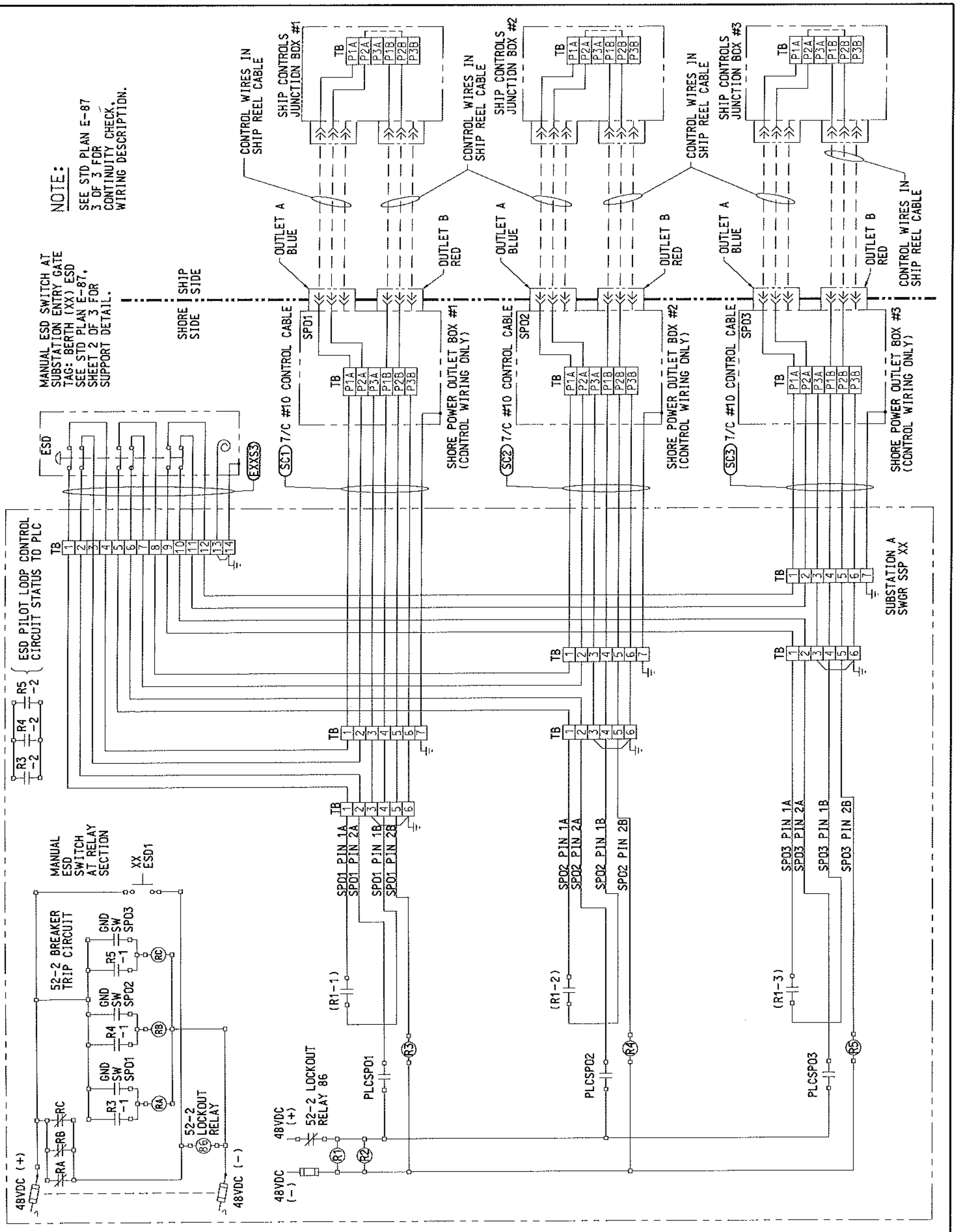
PVC MOUNTING BRACKET

STANDARD PLAN

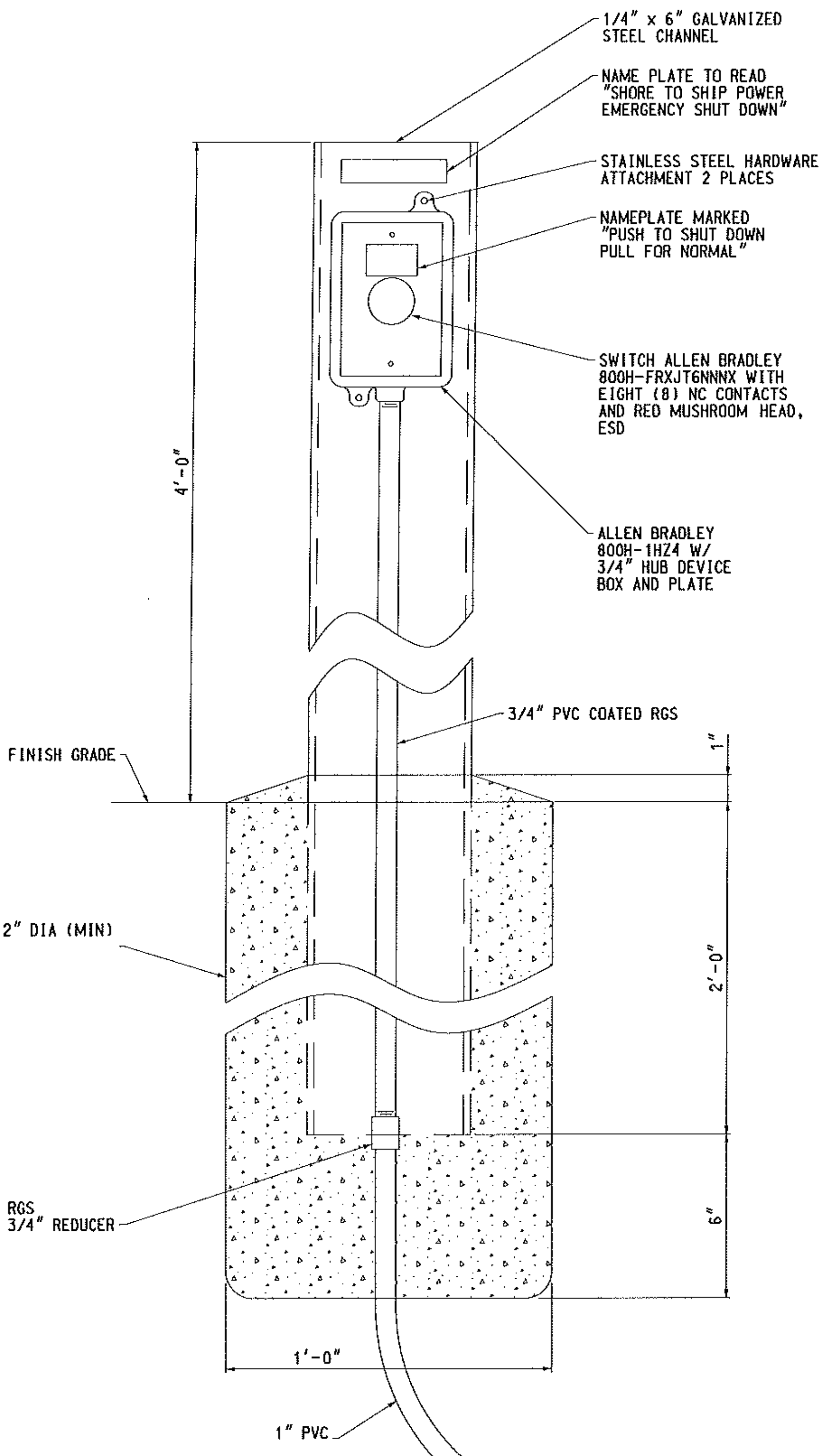
E-86

APPROVED BY: R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

2 OF 2



Port of LONG BEACH The Green Port	SHORE TO SHIP POWER, PILOT LOOP CONTINUITY CHECK WIRING DIAGRAM	STANDARD PLAN E-87
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 4



NOTES:

1. IF ESD REQUIRED TO OPERATE WITH MORE THAN (8) NC CONTACTS SWITCH MUST BE SPECIALLY ORDERED.
2. FOR WIRING DIAGRAM OF ESD, SEE STANDARD PLAN E-87, SHEET 1 OF 3.

ESD SUPPORT DETAIL

Port of LONG BEACH The Green Port	SHORE TO SHIP POWER, PILOT LOOP CONTINUITY CHECK WIRING DIAGRAM	STANDARD PLAN E-87
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	2 OF 4

PILOT LOOP CONTINUITY CHECK WIRING DESCRIPTION:

ALL POWER DELIVERY SYSTEM INTERLOCKS, SWITCHGEAR CONTROL AND PROTECTION STATUS SHALL BE MONITORED AND RECORDED BY THE PROGRAM LOGIC CONTROLLER (PLC). STATUS OF THE MONITORED COMPONENTS SHALL BE PROVIDED FOR REAL TIME REVIEW AT THE HUMAN MACHINE INTERFACE (HMI)(PLC & HMI NOT SHOWN IN WIRING DIAGRAM 1 OF 3).

48VDC TO THE 52-2 BREAKER TRIP CIRCUIT AND PILOT LOOP CIRCUIT COMES DIRECTLY FROM BATTERIES AND IS ENERGIZED AT ALL TIMES.

1. INITIAL CONDITIONS WHEN SHIP AT BERTH AND IS NOT CONNECTED TO SPO, THE STATUS OF THE COMPONENTS IN THE WIRING DIAGRAM ARE:

   1.1 GROUND SWITCHES (NOT SHOWN IN WIRING DIAGRAM 1 OF 3) FOR SPO1, SPO2, & SPO3 ARE "CLOSED"

   1.1.1 CONTACTS GND SW SPO1, GND SW SPO2 & GND SW SPO3 ARE "CLOSED"

   1.1.2 RELAYS RA, RB & RC ARE "ENERGIZED"

   1.1.3 CONTACTS RA, RB & RC ARE "OPEN"

   1.1.4 52-2, LOCKOUT RELAY 86 IS "DE-ENERGIZED"

   1.1.5 52-2, LOCKOUT RELAY 86 SWITCH IS IN THE "RESET" POSITION

   1.1.6 CONTACT 52-2, LOCKOUT RELAY 86 SWITCH IS "CLOSED"

   1.1.7 RELAY R1 AND R2 ARE "ENERGIZED"

   1.1.8 CONTACTS R1-1, R1-2, R1-3, R1-4, R2-1, R2-2, R2-3 & R2-4 ARE "CLOSED". (RELAY CONTACTS R1-4, R2-1, R2-2, R2-3 & R2-4 ARE NOT SHOWN IN WIRING DIAGRAM 1 OF 3)

   1.1.9 RELAY R3 IS "DE-ENERGIZED"

   1.2 CONTACTS R3-1 AND R3-2 ARE "OPEN"

   1.2.1 RELAY R4 IS "DE-ENERGIZED"

   1.2.2 CONTACTS R4-1 AND R4-2 ARE "OPEN"

   1.2.3 RELAY R5 IS "DE-ENERGIZED"

   1.2.4 CONTACTS R5-1 AND R5-2 ARE "OPEN"

   1.2.5 CONTACTS PLCSPO1, PLCSPO2 & PLCSPO3 ARE "OPEN"

   1.2.6 6.6kV BREAKER IS "OPEN" AND RACKED IN. (NOT SHOWN IN WIRING DIAGRAM 1 OF 3)

2. CONDITION, SHIP AT BERTH: SPO1 TO BE ENERGIZED

   2.1 SHIP PLUGS ARE INSERTED INTO SPO1 OUTLETS (OUTLET A BLUE AND OUTLET B RED)

   2.1.1 SHIP PILOT LOOP IS CONTINUOUS TO SHIP CONTROLS JUNCTION BOX #1 IN THE CONTINUITY CHECK WIRING DIAGRAM

   2.1.2 SPO1 SELECTED TO POWER SHIP AT HMI (NOT SHOWN IN WIRING DIAGRAM 1 OF 3) AFTER PLC TIME DELAY OF 10 SECONDS CONTACT PLCSPO1 IS "CLOSED" COMPLETING THE SHORE PILOT LOOP IN THE CONTINUITY CHECK WIRING DIAGRAM

   2.1.3 RELAY R3 IS "ENERGIZED"

   2.1.4 CONTACT R3-1 IS "CLOSED" (RELAY RA WILL NOW REMAIN ENERGIZED WHEN GROUND SWITCH SPO1 "OPENED")

   2.1.5 CONTACT R3-2 IS "CLOSED" (INDICATES TO PLC THAT THE PILOT LOOP CONTINUITY CHECK WIRING IS CONTINUOUS)

   2.1.6 GROUND SWITCH SPO1 IS "OPENED" (NOT SHOWN IN WIRING DIAGRAM 1 OF 3)

   2.1.7 CONTACT GND SW SPO1 IS "OPENED"

   2.1.8 AFTER ALL OTHER CONDITIONS (NOT SHOWN IN WIRING DIAGRAM 1 OF 3) ARE MET, BREAKER 52-2 MAY BE CLOSED

3. ANY BREAK IN THE PILOT LOOP CONTINUITY CHECK WIRING WILL TRIP BREAKER 52-2. THE SEQUENCE OF OPERATION ARE:

   3.1 RELAY R3 WILL "DE-ENERGIZE"

   3.1.1 CONTACT R3-2 WILL "OPEN" (INDICATES TO PLC THAT THE PILOT LOOP CONTINUITY CHECK WIRING IS OPEN AND PLC WILL INITIATE A TRIP SIGNAL TO BREAKER 52-2 (NOT SHOWN IN WIRING DIAGRAM 1 OF 3)

   3.1.2 SIMULTANEOUSLY CONTACT R3-1 WILL "OPEN"

   3.1.3 RELAY RA WILL "DE-ENERGIZE"

   3.1.4 CONTACT RA WILL "CLOSE"

   3.1.5 52-2 LOCKOUT RELAY 86 WILL "ENERGIZE" AND TRIP BREAKER 52-2

   3.1.6 52-2 LOCKOUT RELAY 86 CONTACT WILL "OPEN" AND 52-2 LOCKOUT RELAY 86 WILL PHYSICALLY NEED TO BE "RESET" PRIOR TO THE 52-2 BREAKER BEING RECLOSED

   3.1.7 RELAYS R1 & R2 WILL "DE-ENERGIZE"

   3.1.8 CONTACTS R1-1, R1-2, R1-3, R1-4, R2-1, R2-2, R2-3 & R2-1 WILL "OPEN" (CONTACTS R1-4, R2-1, R2-2, R2-3 &R2-4 ARE NOT SHOWN IN THE WIRING DIAGRAM 1 OF 3)

   3.1.9 CONTACT R1-1 WILL "OPEN" SHIP SIDE PILOT LOOP CONTINUITY CHECK WIRING

DRAWING NOTES:

1. SHIPSIDE PILOT LOOP CONTROL WIRING IS THE RESPONSIBILITY OF THE SHIP OPERATOR AND IS NOT SHOWN ON DRAWING.
2. AFTER COMPLETION OF TESTING AND COMMISSIONING OF THE PILOT LOOP CONTROL CIRCUIT PERMANENT WIRING SHALL BE PROVIDED BY SHIP OPERATOR FOR SHIPSIDE PILOT LOOP CONTROL.
3. USE BELOW TO DESIGNATE RELAYS AND CONTACTS ON DRAWINGS.
4. XXSPOX

    SPO NUMBER
    SHORE POWER OUTLET
    SUBSTATION NUMBER

Port of LONG BEACH
The Green Port

SHORE TO SHIP POWER, PILOT LOOP CONTINUITY CHECK WIRING DIAGRAM

STANDARD PLAN

E-87

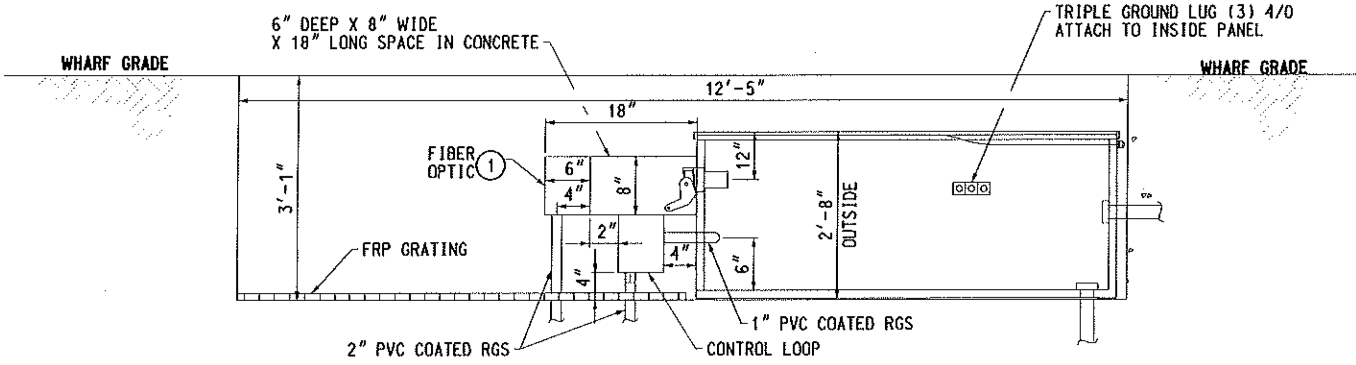
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

GENERAL NOTES

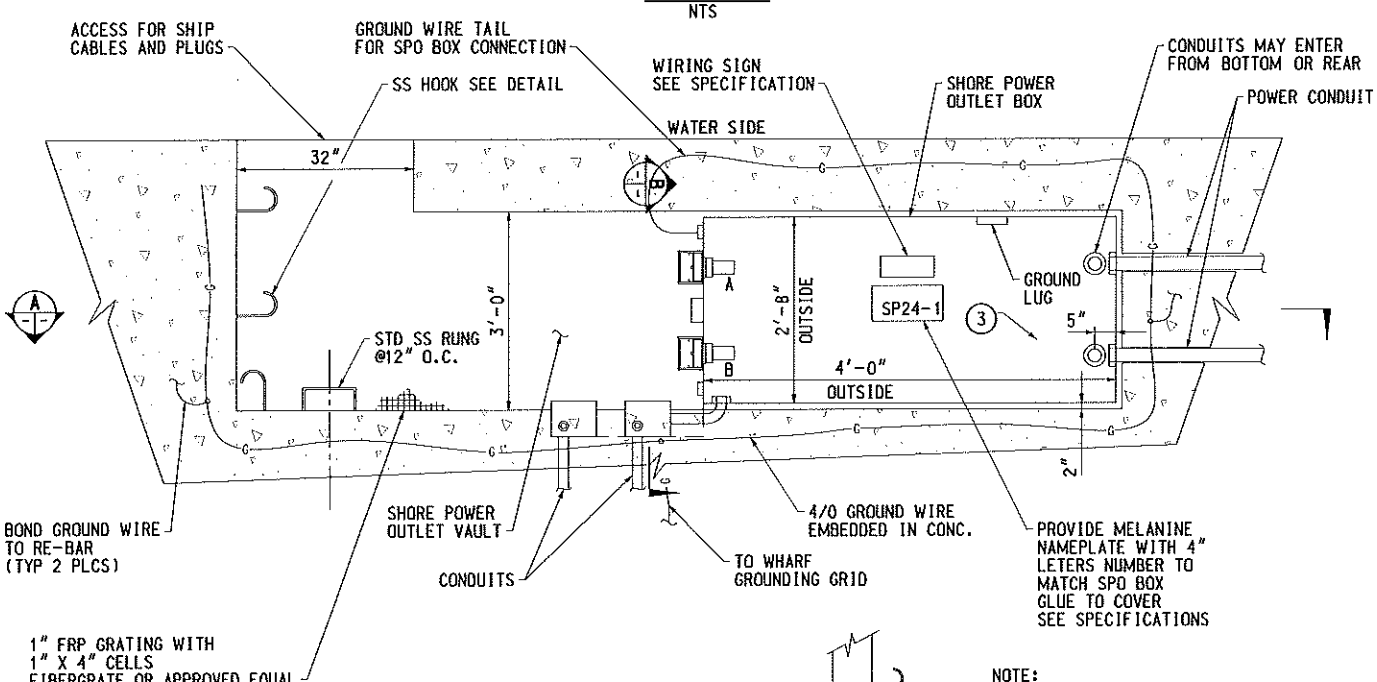
1. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING A TEMPLATE TO THE MANUFACTURER OF THE SHORE POWER OUTLET BOXES TO PRE-PUNCH THE OUTLET BOX CONDUIT HOLES. IF THE CONTRACTOR DOES NOT SUPPLY THE TEMPLATE, THEY SHALL BE RESPONSIBLE FOR THE FIELD CONSTRUCTION OF THE CONDUIT HOLES.
2. SHORE POWER OUTLET BOX SHALL BE AISI 304 STAINLESS AND ALL HARDWARE SHALL BE 316 STAINLESS STEEL.
3. CAVOTEC SYSTEM IS SHOWN TO SET MINIMUM REQUIRED STANDARD. SHORE POWER OUTLET RECEPTACLES ARE SPECIFIED TO MATE WITH TENANT VESSEL SHORE POWER PLUGS. IF ANY SUBSTITUTION OF MATERIALS FOR THE SPECIFIED SYSTEM IS PROPOSED, THE SUBSTITUTE MUST BE PHYSICALLY PROVIDED TO THE ENGINEER FOR PREVIEW PRIOR TO APPROVAL BY THE ENGINEER. TENANT'S WRITTEN CONCURRENCE OF SUBSTITUTION IS NECESSARY AND REQUIRED BEFORE THE CITY WILL APPROVE SUBSTITUTION. THESE SUBMITTAL REQUIREMENTS ARE IN ADDITION TO ALL OTHER PROJECT SUBMITTAL REQUIREMENTS. THE CONTRACTOR SHALL BE RESPONSIBLE TO COORDINATE WITH ALL PARTIES INVOLVED TO SECURE WRITTEN APPROVAL.

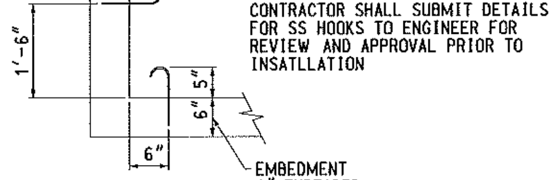
CONSTRUCTION NOTES

1. PULLBOX (TYP) – 8"x6"x6" CAST ALUMINUM FLANGED RECESSED COVER BOX COMPLETE WITH BACKPLATE, GASKET, AND STAINLESS STEEL HARDWARE. 6" ABOVE VAULT FLOOR. PROVIDE 2" CONDUIT INTO SIDE OF SHORE POWER OUTLET BOX FROM PULLBOX.
2. PLACE MEMBRANE AROUND 8"x6"x6" BOXES TO PROTECT FROM CONCRETE. FIBER OPTIC BOX TO BE PROVIDED BY CAVOTEC. 2" PVC COATED RGS CONDUIT MAY ENTER 8"x6"x6" BOXES FROM BOTTOM OR EITHER SIDE.
3. SHALL HAVE WARNING SIGN ON SPO, "DANGER-HIGH VOLTAGE-KEEP OUT".



SECTION A
NTS

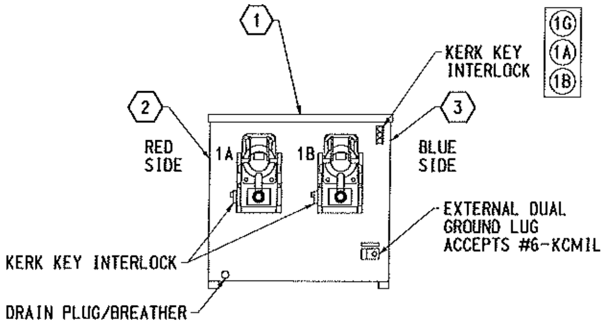




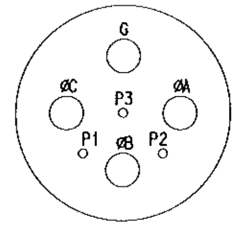
NOTE:
CONTRACTOR SHALL SUBMIT DETAILS FOR SS HOOKS TO ENGINEER FOR REVIEW AND APPROVAL PRIOR TO INSATLLATION

DETAIL
NTS

Port of LONG BEACH The Green Port	SHORE TO SHIP POWER POWER OUTLET VAULT ENCLOSURE	STANDARD PLAN E-88
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 2



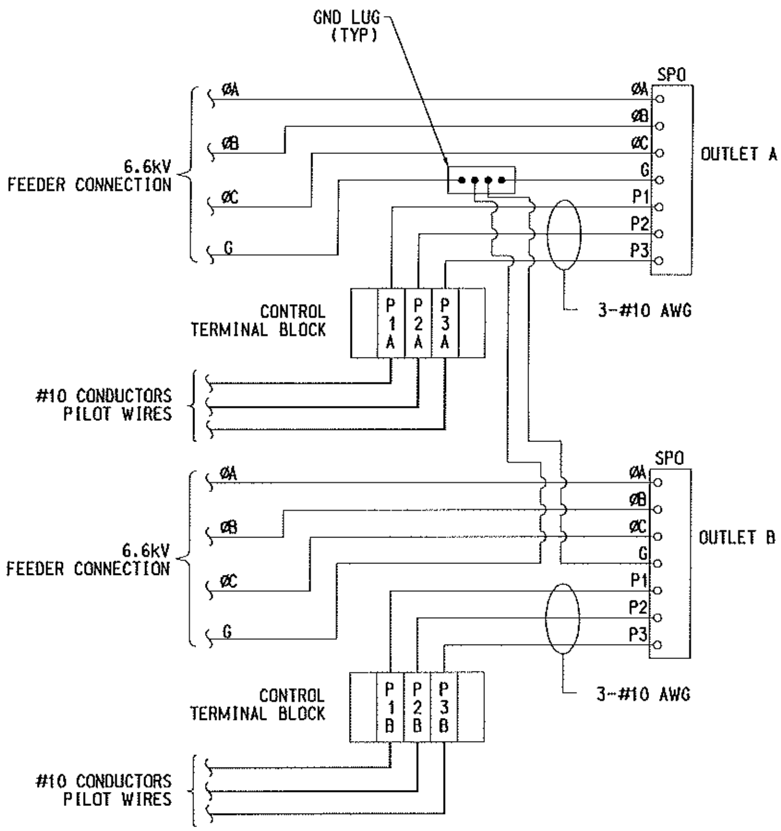
SECTION B



SHORE POWER OUTLET
FACE CONFIGURATION
PHASE SEQUENCE:
ABC COUNTERCLOCKWISE

CAVOTEC PART NUMBERS AND REQUIREMENTS

1. COMPLETE SYSTEM PC5-AX04-K1855 INCLUDES BOX SOCKETS, INTERNAL WIRING AND COMPONETS.
2. RED FEMALE SOCKET PC5-VX04-K18503KL-6MT0, 350AMP, 16KAIC
3. BLUE FEMALE SOCKET PC5-VX04-K18503KL-MT1, 350AMP, 16KAIC



SHORE POWER OUTLET BOX INTERNAL WIRING

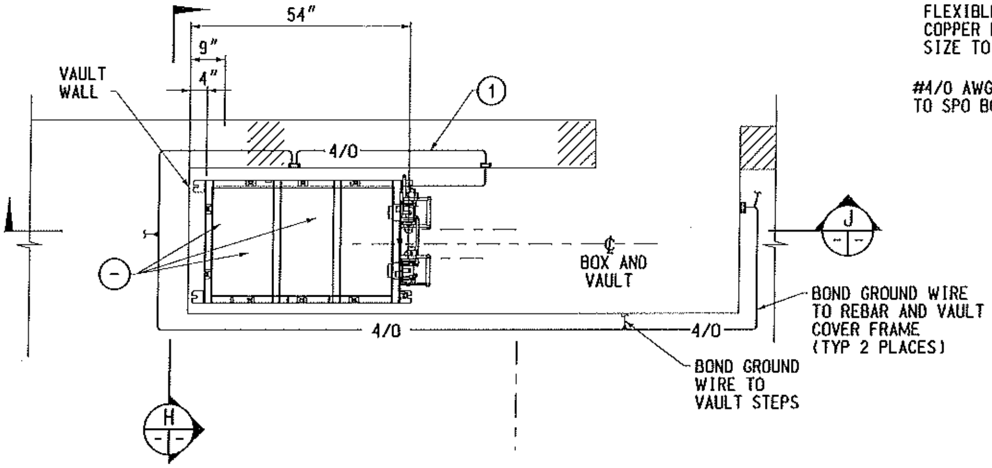
Port of LONG BEACH
The Green Port

SHORE TO SHIP POWER
POWER OUTLET VAULT ENCLOSURE

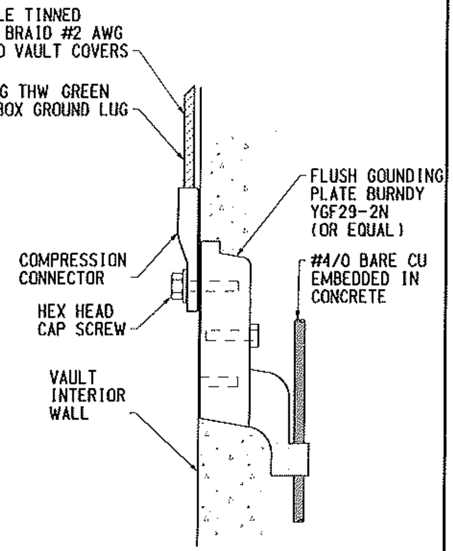
STANDARD PLAN

E-88

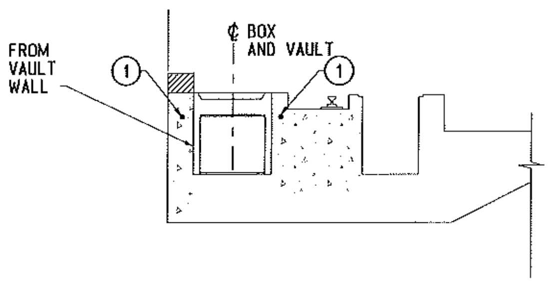
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER   P.E. NO.: E-8410   DATE: 01-31-16



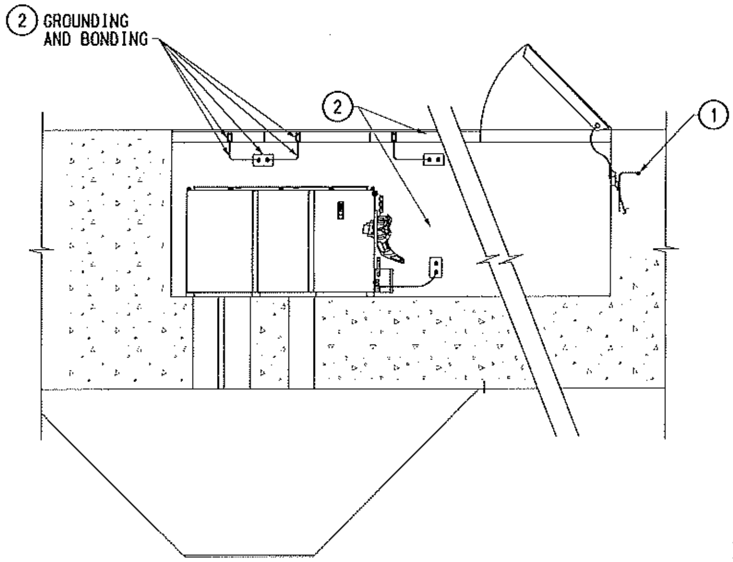
1 PLAN VIEW
SCALE: NONE



2 FLUSH MOUNTING GROUND PLATE
SCALE: NONE



H SPO VAULT GROUNDING ELEVATION
SCALE: NONE



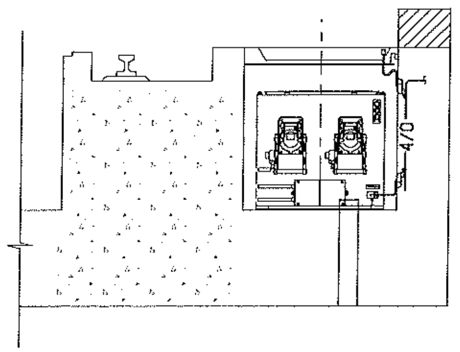
J INSIDE SPO VAULT GROUNDING
SCALE: NONE

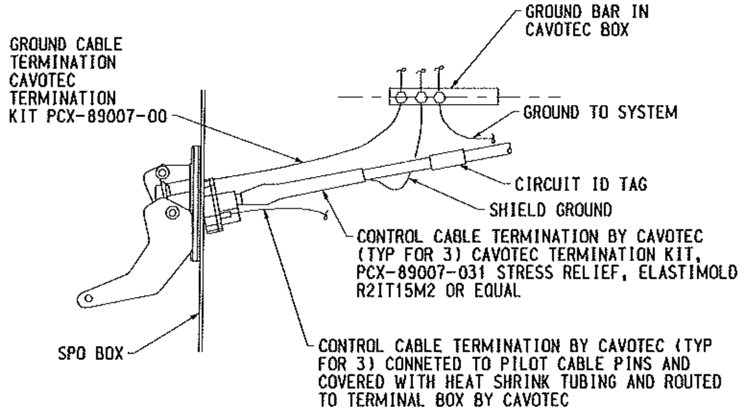
CONSTRUCTION NOTES:

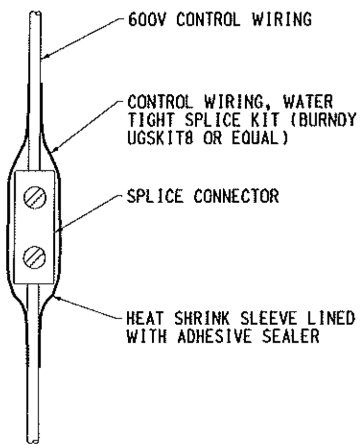
1. PROVIDE #4/0 BARE CU GROUND WIRE EMBEDDED IN CONCRETE AND CONNECT TO FLUSH MOUNTED GROUNDING PLATES IN VAULT WALL. BOND EMBEDDED GROUND WIRE TO REBAR, VAULT COVER FRAME AND VAULT STEPS. CONNECT #4/0 CU GREEN WIRE FROM GROUNDING PLATE TO GROUND LUG ON CAVOTEC BOX. CONNECT FLEXIBLE TINNED COPPER BRAID FROM GROUNDING PLATE TO VAULT COVERS. LOOP BRAID TO ALLOW FOR OPENING OF COVERS.

2. GROUND PLATES FOR VAULT COVER BONDING TO BE MOUNTED WITH TOP EDGE OF PLATE 1" BELOW BOTTOM OF FRAME COVER.

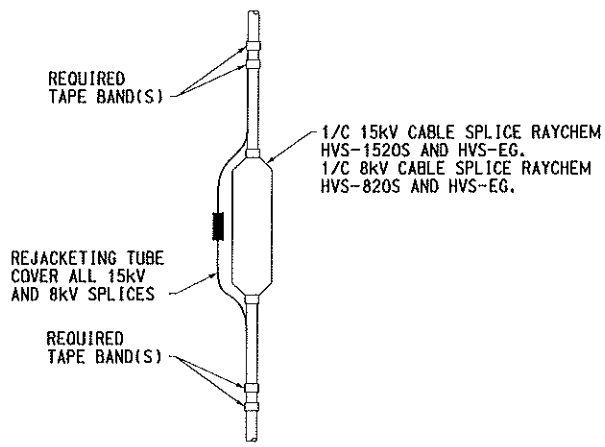
Port of LONG BEACH The Green Port	SHORE POWER OUTLET GROUNDING DETAILS	STANDARD PLAN E-89
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 2







1 600V CONTROL WIRING SPLICE
SCALE: NONE



2 15kV AND 8kV IN LINE SPLICE
SCALE: NONE

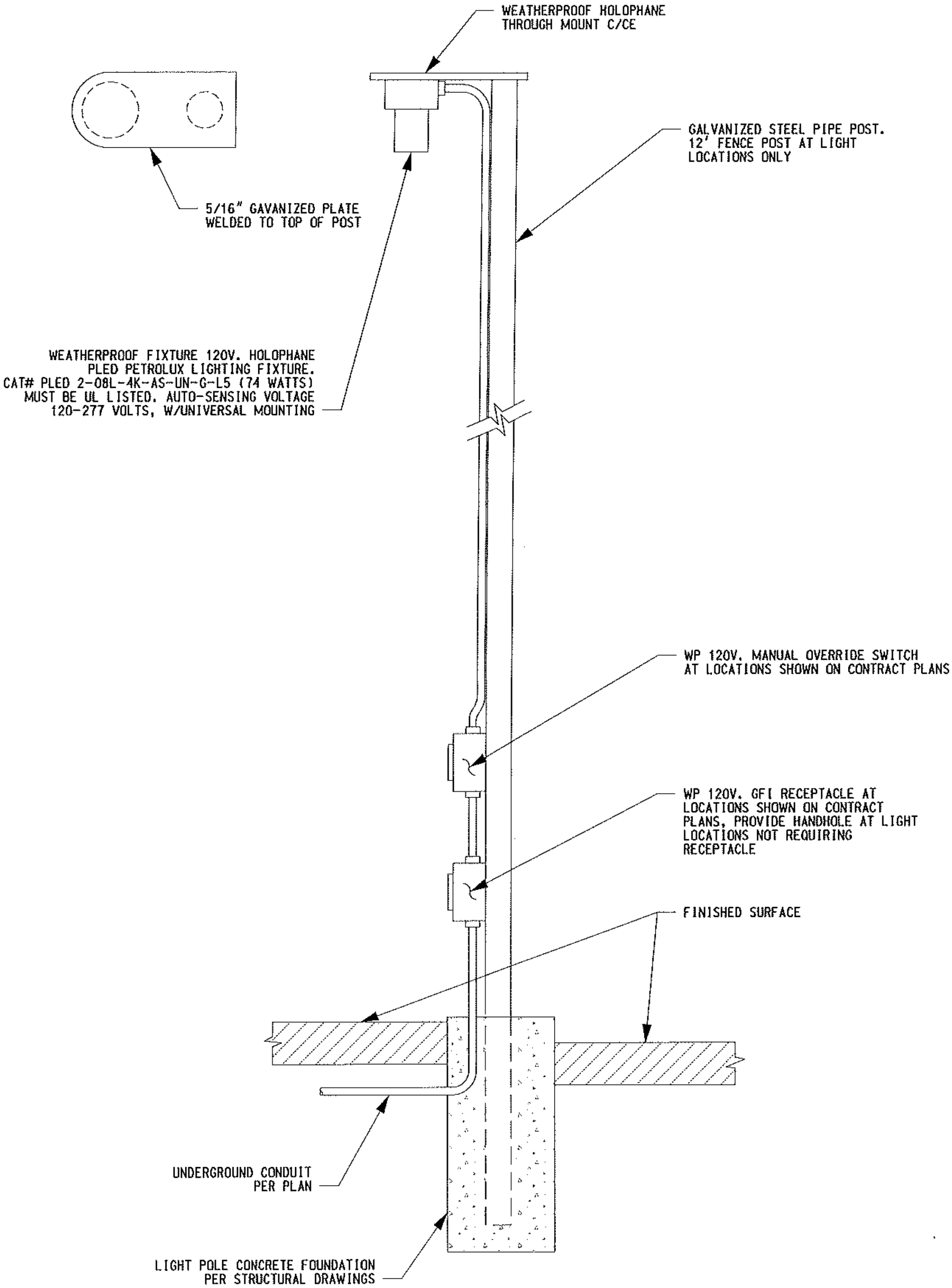
Port of LONG BEACH
The Green Port

SHORE POWER OUTLET GROUNDING DETAILS

STANDARD PLAN
E-89

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

2 OF 2



ELEVATION
NTS

Port of LONG BEACH
The Green Port

TYPICAL SUBSTATION LIGHT POLE

STANDARD PLAN
E-90

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

1 OF 1

Project:		Page:
Location:		Date:
Contract:		SN:
Engineer:	Study Case:	Revision:
Filename:		Config:

Arc Fault at Bus:
Bolted Fault Current:

Nominal kV = Prefault Voltage = 100% of nominal bus kV System Grounding =
Base kv = 100% of Base kV

Total Arcing Fault Current: = kA FCT = Seconds For Protective Device
Total Bolted Fault Current: = KA = Cycles Relay: Type:

Working Distance = 18.00 inch Harzard/Risk Level =
Incedent Energy = cal/cm² Flash Protection Boundary =

Device		Individual Contribution			Incident Energy					
ID	Type	Bolted (kA)	Arcing (kA)	FCT (cycles)	Arcing (kA)	FCT (cycles)	Protective Device IDforFCT	Incident E (cal/cm²)	FPB (fT)	Hazard Risk Level

ARC FLASH CACULATION RESULTS

Port of LONG BEACH *The Green Port*

TYPICAL ARC FLASH CALCULATIONS

STANDARD PLAN

E-91

APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16

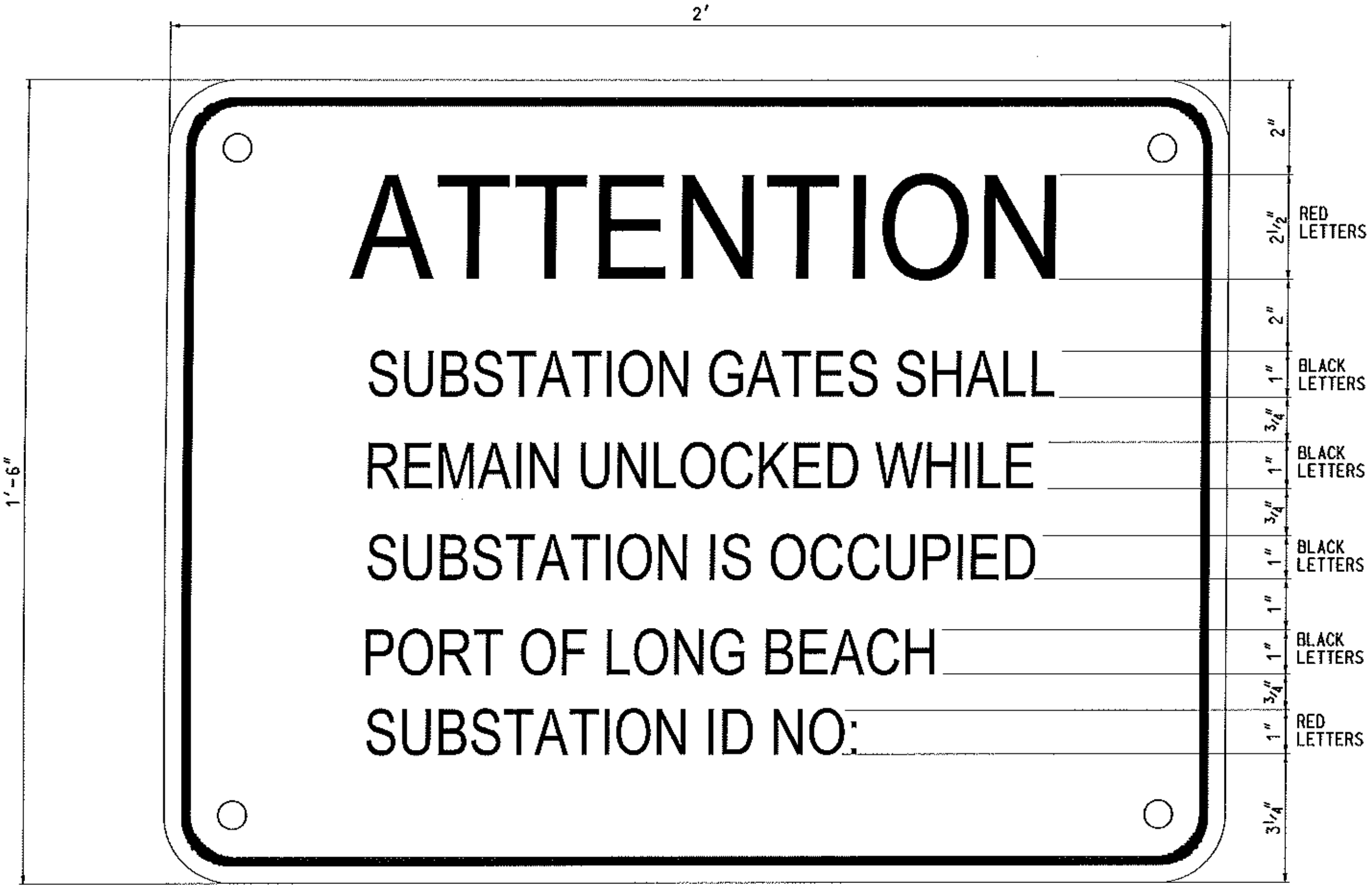
1 OF 1

SUBSTATION GATE STANDARD

GATES ON PORT OF LONG BEACH SUBSTATION FENCING ARE NORMALLY LOCKED AND ACCESSIBLE TO QUALIFIED PERSONS ONLY. THEY ARE UNLOCKED ONLY WHEN QUALIFIED PERSONS ARE WITHIN THE SUBSTATION FENCING.

PERSONNEL GATES WILL NOT HAVE CLOSERS, LATCHES OR PANIC HARDWARE. THE GATES WILL BE EQUIPPED WITH A CUT-OUT FOR KNOX PADLOCK AND CHAIN FOR SECURING WHEN QUALIFIED PERSONNEL ARE NOT PRESENT. THE GATES WILL SWING FREELY WHEN UNLOCKED AND CHAIN IS REMOVED.

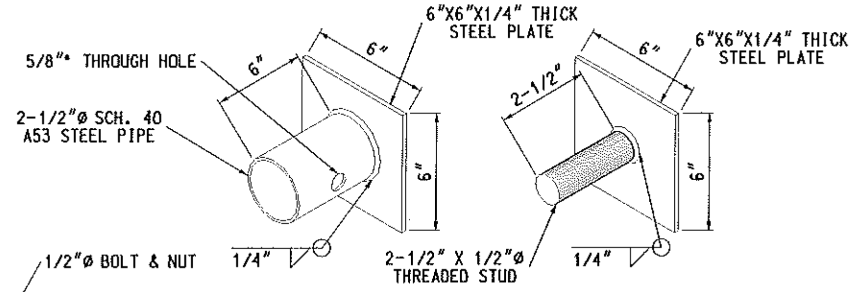
ALL OUTDOOR SUBSTATIONS WILL HAVE WARINING SIGNS AS REQUIRED BY NEC 110.34(C) AND SIGNAGE AS IDENTIFIED BELOW INDICATING THAT SUBSTATION GATES SHALL REMAIN UNLOCKED WHILE SUBSTATION IS OCCUPIED.



GENERAL NOTES:
CONTRACTOR SHALL PROVIDE:

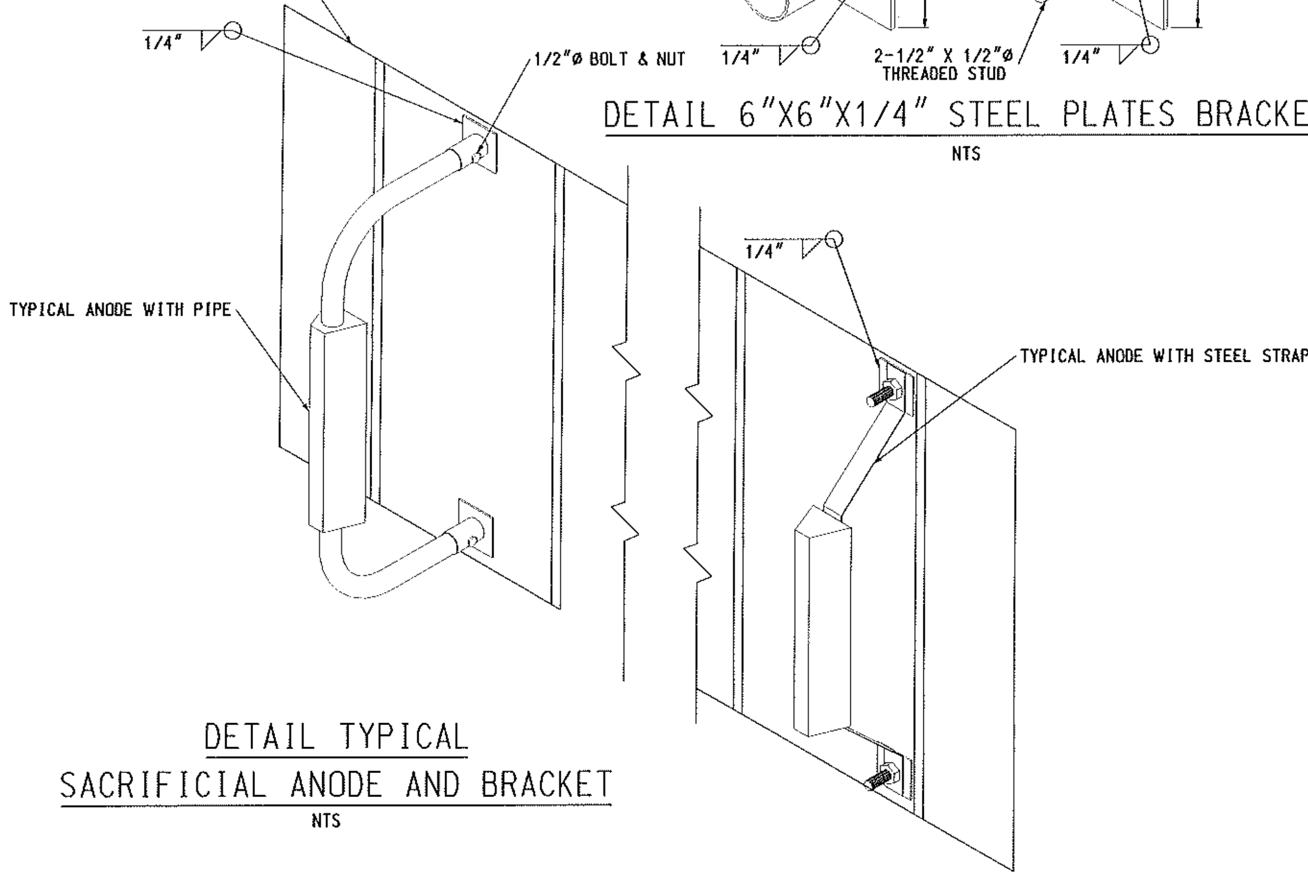
1. SIZE: 18" X 24"
   MATERIAL: SINGLE SHEET 0.08" ALUMINUM PANEL WITH HIGH INTENSITY RETRO REFLECTIVE BACKGROUND WITH ANTI-GRAFFITI COATING
2. DIMENSIONS, COLORS AND TYPE OF LETTERS AS SHOWN
3. SUBSTATION ID SHALL BE PROVIDED TO THE MANUFACTURER AT THE TIME OF ORDER

Port of LONG BEACH The Green Port	SUBSTATION GATE STANDARD	STANDARD PLAN E-92
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER P.E. NO.: E-8410 DATE: 01-31-16		1 OF 1



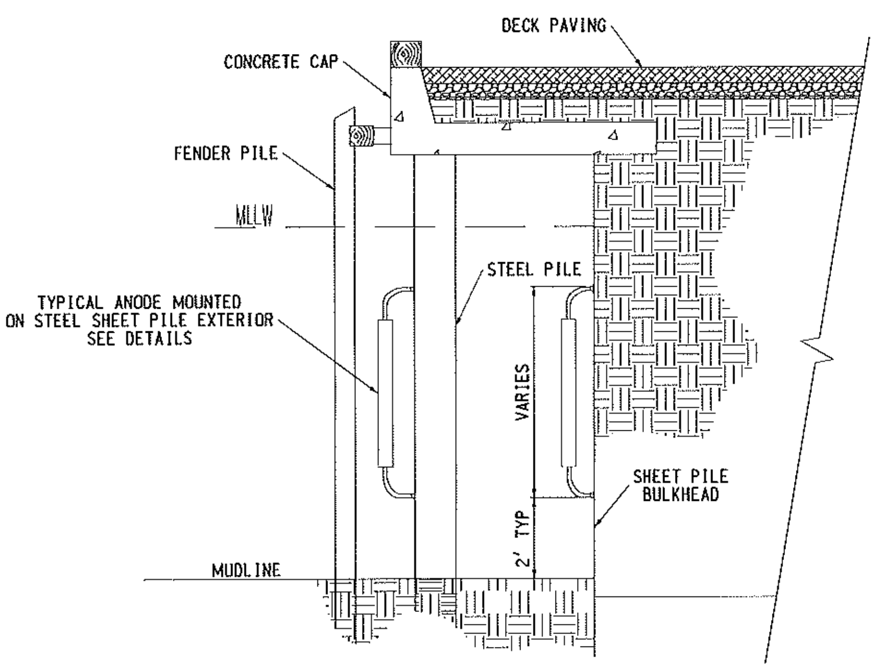
DETAIL 6"X6"X1/4" STEEL PLATES BRACKET

NTS



DETAIL TYPICAL
SACRIFICIAL ANODE AND BRACKET

NTS



ELEVATION TYPICAL ALUMINUM ANODES

NTS

Port of LONG BEACH The Green Port	SACRIFICIAL ANODE BRACKET SYSTEM FOR STEEL PILE AND SHEET PILE	STANDARD PLAN E-93
APPROVED BY: P. R. CHAVDARIAN SR. ELECTRICAL ENGINEER	P.E. NO.: E-8410 DATE: 01-31-16	1 OF 1

Project:		Page:	1
Location:		Date:	02-02-2009
Contract:		SN:	P2S-ENGIN
Engineer:		Revision:	Base
Filename: PierC_Cold_Ironing	Study Case: PIER C SC	Config.:	Normal

Arc Fault at Bus: SUB 3

Bolted Fault Current: 1/2 Cycle

Nominal kV = 12.000   Prefault Voltage = 100% of nominal bus kV
Base kV = 12.000   = 100% of base kV   System Grounding = Grounded

Total Arcing Fault Current = 11.154 kA   FCT = 0.508 Seconds   For Protective Device: CB4 @ Ia = 11.154 kA
Total Bolted Fault Current = 11.520 kA   = 30.505 cycles   Relay: SUB3 RELAY Type: Overcurrent

Working Distance = 18.00 inch   Hazard/Risk Level* = 3
Incident Energy = 13.63 cal/cm²   Flash Protection Boundary = 5.05 ft

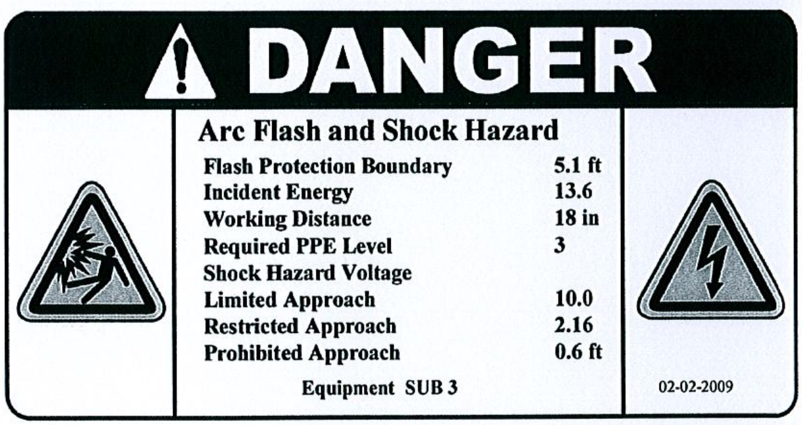
Device		Individual Contribution			Incident Energy					
ID	Type	Bolted (kA)	Arcing (kA)	FCT (cycles)	Arcing (kA)	FCT (cycles)	Protective Device ID for FCT	Incident E (cal/cm²)	FPB (ft)	Hazard Risk Level*

ARC FLASH CALCULATION RESULTS - TYP

SCALE: NTS

NOTES:

1. THIS IS A SAMPLE REPORT, SHOWING THE MINIMUM DATA AS A RESULT OF ARC FLASH CALCULATIONS, IN ACCORDANCE WITH IEEE STD. 1584.
2. CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE THIS DATA AND SUPPORTING CALCULATIONS PRIOR TO SUBMITTING LABELS FOR ARC FLASH WARNING.



ARC FLASH LABEL - TYP

SCALE: NTS

NOTES:

1. CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE LABELS, COMPLETE WITH DATA BASED ON AND SUPPORTED BY CALCULATIONS, AND MOUNT ON APPROPRIATE EQUIPMENT.
2. SUBMIT PROPOSED LABELS TO THE CITY AND OBTAIN APPROVAL OF THE CITY PRIOR TO RELEASING ORDER TO LABEL MANUFACTURER.

ELECTRICAL REVIEW CHECK LIST - WHARF

ELECTRICAL SUBMITTAL REQUIREMENTS

- ☐ Electrical plans showing power and lighting & location of main switchgear, switchboards/ panelboards.
- ☐ Electrical panel schedules showing individual loads in VA or KVA and the A.I.C. rating.
- ☐ Single Line diagram with wire and raceway size, type, and grounding methods.
- ☐ Electrical load calculations, including a load summary showing connected loads and all Demand/diversity factors.
- ☐ Fault current calculations and arc flash calculations through the subpanel board level.

Selective coordination of existing electrical system.

Electrical Load Calculations

- ☐ Breakdown of connected loads into proper CEC categories (lighting, receptacles,
- ☐ etc.)
- ☐ CEC demand factors applied to each category of load.
- ☐ Total connected load in VA or KVA.
- ☐ Total calculated load in amps and KVA.
- ☐ Panelboard load calculation worksheet completed for all panelboards. Panelboard imbalance shall not exceed 25%.

Fault Current Summary

- ☐ Starting nodes for fault current in a cascading format as they relate to the one line diagram.
- ☐ Starting fault current at the beginning of each conductor.
- ☐ Ending fault current at the ending of the conductor.
- ☐ Conductor's impedance, size and length.

- ☐ Conduit type (Metallic or Non-Metallic)
- ☐ A.I.C. rating of the service, panelboards, and overcurrent devices.
- ☐ Utility transformer size in KVA, impedance (%Z), and available fault current. (if applicable)
- ☐ Complete the fault current information through the subpanelboard level or provide calculations to below the minimum AIC rating of the electrical equipment and overcurrent devices.
- ☐ Available fault current shown on the one line diagram for all nodes

Single Line Diagram

- ☐ Clearly identify service point/point of connection.
- ☐ Identify voltages
- ☐ Service conduit(s) size & type, number of parallel runs, conductor(s) size & type, insulation type, and number of conductors.
- ☐ Service equipment ampacity, A.I.C. rating and the A.I.C. ratings of the overcurrent protection.
- ☐ Indicating points (nodes) at line and load points along the one line diagram. The nodes should state the AIC levels at key points of terminations of electrical equipment.
- ☐ Indication of ground fault protection of equipment when required.
- ☐ Size of the grounded service conductor for the maximum unbalanced load.
- ☐ Grounding electrode system, including concrete encased electrode, the sizing of the grounding electrode conductor, and main bonding jumper for the service equipment.
- ☐ Feeder(s) conduit size & type, conductor size & type, and number of conductors.
- ☐ Type of equipment grounding conductor and equipment bonding jumper for feeder(s), Size if applicable.
- ☐ Panelboard(s) ampacity, A.I.C. rating and overcurrent protection.
- ☐ Transformer(s) secondary tap conductor length to overcurrent protective device.
- ☐ Grounding electrode system and grounding electrode conductor for transformer(s).

- ☐ Size of equipment bonding jumper and system bonding jumper for the transformer(s).
- ☐ Overcurrent protection of transformer(s) complies with NEC 450-3.
- ☐ Identify all fuse types (class type)

- ☐ Panelboard(s) are identified.
- ☐ Panelboard busbar rating in amps shown.
- ☐ Panelboard voltage rating is shown.
- ☐ Main breaker size or main lug only is shown.
- ☐ Panel schedule denotes double lugs or feed-through lugs.
- ☐ Description or coding is provided for each branch circuit.
- ☐ Connected load of each branch circuit is shown in VA or KVA.
- ☐ Total connected load is shown in VA or KVA.
- ☐ A.I.C. rating of the panelboard and overcurrent devices

Time/current curves showing compliance with the selective coordination requirements

Peak Demand Records

- ☐ Starting and ending dates of the metering.
- ☐ Highest reading of the metering period clearly shown.
- ☐ Power factor adjustment shown, when necessary.
- ☐ Explain the details of seasonal and occupancy adjustment factors.
- ☐ Utility demand records or recordings of demand metering for the peak period must accompany the submittal.
- ☐ Signature of the "administrator or engineer" who took the readings.

Arc Flash Calculation

- ☐ Provide**:** (1) the incident energy level calculation in cal/cm squared at 18” from the flash hazard,(2) the flash hazard category, and (3) the flash hazard boundary for each service, distribution board, and panel.

  Provide this in a cascading format relating to the one line or riser showing:

  - the device rating and identification
  - the voltage
  - the arc gap
  - the bolted fault current or the available fault current

ELECTRICAL REVIEW CHECK LIST – SHORE TO SHIP POWER

ELECTRICAL SUBMITTAL REQUIREMENTS

- ☐ Electrical plans showing power distribution equipment, location of main switchgear, power transformers, switchboards/ panelboards. Workspace and means of egress from the workspace is identified.

- ☐ Electrical panel schedules showing individual loads in VA or kVA and the A.I.C. rating.

- ☐ Single Line diagram with wire and raceway size, type, and grounding methods.

- ☐ Electrical load calculations, including a load summary showing connected loads and all Demand/diversity factors. Except where CEC Section 220.87 applies, the basis for all industrial demand/diversity factors shall be cited.

- ☐ Preliminary fault current calculations and arc flash calculations through the subpanel board level.

Selective coordination of existing electrical system.

Electrical Load Calculations

- ☐ Breakdown of connected loads into proper CEC categories (lighting, receptacles,
- ☐ etc.)

- ☐ CEC demand factors applied to each category of load.

- ☐ Total connected load in VA or kVA.

- ☐ Total calculated load in amps and kVA.

- ☐ Panelboard load calculation worksheet completed for all panelboards. Panelboard imbalance shall not exceed 25%.

Fault Current Summary

- ☐ Starting nodes for fault current in a cascading format as they relate to the one line diagram.

- ☐ Starting fault current at the beginning of each conductor.
- ☐ Ending fault current at the ending of the conductor.
- ☐ Conductor's impedance, size and length.
- ☐ Conduit type (Metallic or Non-Metallic)
- ☐ A.I.C. rating of the service, panelboards, and overcurrent devices.
- ☐ Utility transformer size in kVA, impedance (%Z), and available fault current. (if applicable)
- ☐ Complete the fault current information through the subpanelboard level or provide calculations to below the minimum AIC rating of the electrical equipment and overcurrent devices.
- ☐ Available fault current shown on the one line diagram for all nodes

Single Line Diagram

- ☐ Clearly identify service point/point of connection.
- ☐ Identify voltages
- ☐ Service conduit(s) size & type, number of parallel runs, conductor(s) size & type, insulation type, and number of conductors.
- ☐ Service equipment ampacity, A.I.C. rating and the A.I.C. ratings of the overcurrent protection.
- ☐ Indicating points (nodes) at line and load points along the one line diagram. The nodes should state the AIC levels at key points of terminations of electrical equipment.
- ☐ Indication of ground fault protection of equipment when required.
- ☐ Clearly indicate that the system Grounding Electrode Conductor originates from the grounded side of the Neutral Grounding Resistor and terminates on closest Grounding Electrode.

- Also clearly indicate the system bonding jumper is a non-interrupted conductor that also originates on the grounded side of the Neutral Grounding Resistor and terminates on the grounding bus of the first disconnecting means on the transformer secondary.

- Size of the grounded service conductor for the maximum unbalanced load. Note: where the system uses a Neutral Grounding Resistor, (the general standard) there will be no grounded service conductor.

- Grounding electrode system, including concrete encased electrode, the sizing of the grounding electrode conductor, and main bonding jumper for the service equipment.

- Feeder and branch circuit(s) conduit size & type, conductor size & type, and number of conductors.

- Type of equipment grounding conductor and equipment bonding jumper for feeder and branch circuit(s), Size if applicable.

- Panelboard(s) ampacity, A.I.C. rating and overcurrent protection.

- Transformer(s) secondary tap conductor length to overcurrent protective device.

- Grounding electrode system and grounding electrode conductor for transformer(s).

- Size of equipment bonding jumper and system bonding jumper for the transformer(s).

- Overcurrent protection of transformer(s) complies with NEC 450-3.

- Identify all fuse types (class type)

- Panelboard(s) are identified.

- Panelboard busbar rating in amps shown.

- Panelboard voltage rating is shown.

- Main breaker size or main lug only is shown.

- Panel schedule denotes double lugs or feed-through lugs.

- Description or coding is provided for each branch circuit.

- Connected load of each branch circuit is shown in VA or kVA.

- Total connected load is shown in VA or kVA.
- A.I.C. rating of the panelboard and overcurrent devices

Time/current curves showing compliance with the selective coordination requirements

Peak Demand Records

- Starting and ending dates of the metering.
- Highest reading of the metering period clearly shown.
- Power factor adjustment shown, when necessary.
- Explain the details of seasonal and occupancy adjustment factors.
- Utility demand records or recordings of demand metering for the peak period must accompany the submittal.
- Signature of the “administrator or engineer” who took the readings.

Arc Flash Calculation

- Provide**:** (1) the incident energy level calculation in cal/cm squared at 18” from the flash
  hazard,(2) the flash hazard category, and (3) the flash hazard boundary for each service, distribution board, and panel.

  Provide this in a cascading format relating to the one line or riser showing:

  - the device rating and identification
  - the voltage
  - the arc gap
  - the bolted fault current or the available fault current

ELECTRICAL REVIEW CHECK LIST - BUILDINGS

ELECTRICAL SUBMITTAL REQUIREMENTS

- ☐ Electrical plans showing power, lighting and fire alarm for each floor of building & location of main switchboards/ panelboards.
- ☐ Electrical panel schedules showing individual loads in VA or KVA and the A.I.C. rating.
- ☐ Single Line diagram with wire and raceway size, type, and grounding methods.
- ☐ Electrical load calculations, including a load summary showing connected loads and all Demand/diversity factors.
- ☐ Fault current calculations and arc flash calculations through the subpanel board level.
- ☐ Title 24 Part 6 and photometric calculations
- ☐ Selective coordination information for Emergency, Legally Required, and Elevator systems.

Electrical Load Calculations

- ☐ Breakdown of connected loads into proper CEC categories (lighting, receptacles, motors, HVAC, kitchen equipment, appliances, etc.)
- ☐ CEC demand factors applied to each category of load.
- ☐ Total connected load in VA or KVA.
- ☐ Total calculated load in amps and KVA.
- ☐ Panelboard load calculation worksheet completed for all panelboards. Panelboard imbalance shall not exceed 25%.
- ☐ Starting loads for the worst case (max. starting loads with everything starting that is required to start at the same time) and any starting variables (soft start, variable frequency drives, etc.) for the Emergency, Legally Required, and Optional Standby systems.

Fault Current Summary

- ☐ Starting nodes for fault current in a cascading format as they relate to the one line diagram.

- ☐ Starting fault current at the beginning of each conductor.
- ☐ Ending fault current at the ending of the conductor.
- ☐ Conductor's impedance, size and length.
- ☐ Conduit type (Metallic or Non-Metallic)
- ☐ A.I.C. rating of the service, panelboards, and overcurrent devices.
- ☐ Utility transformer size in KVA, impedance (%Z), and available fault current. (if applicable)
- ☐ Complete the fault current information through the subpanelboard level or provide calculations to below the minimum AIC rating of the electrical equipment and overcurrent devices.
- ☐ Available fault current shown on the one line diagram for all nodes
- ☐ Series rated systems - indicate on the one line or the panel schedules the circuit breaker model numbers for every panel or switchboard involving a series rated system. Also, please provide corresponding series rating charts from the manufacturer (with arrows indicating the breaker types) so the series rated system can be verified. This information should be provided in a systematic way as it relates to the one line diagram, down to the point in the system that the fault current is less than the fully rated or series rated overcurrent protective device and gear.

<u>Single Line Diagram</u>

- ☐ Clearly identify service point/point of connection.
- ☐ Identify voltages
- ☐ Service conduit(s) size & type, number of parallel runs, conductor(s) size & type, insulation type, and number of conductors.
- ☐ Service equipment ampacity, A.I.C. rating and the A.I.C. ratings of the overcurrent protection.
- ☐ Indicating points (nodes) at line and load points along the one line diagram. The nodes should state the AIC levels at key points of terminations of electrical equipment.
- ☐ Indication of ground fault protection of equipment when required.
- ☐ Size of the grounded service conductor for the maximum unbalanced load.
- ☐ Grounding electrode system, including concrete encased electrode, the sizing of the grounding electrode conductor, and main bonding jumper for the service equipment.

- ☐ Feeder(s) conduit size & type, conductor size & type, and number of conductors.
- ☐ Type of equipment grounding conductor and equipment bonding jumper for feeder(s), Size if applicable.
- ☐ Panelboard(s) ampacity, A.I.C. rating and overcurrent protection.
- ☐ Transformer(s) secondary tap conductor length to overcurrent protective device.
- ☐ Grounding electrode system and grounding electrode conductor for transformer(s).
- ☐ Size of equipment bonding jumper and system bonding jumper for the transformer(s).
- ☐ Overcurrent protection of transformer(s) complies with NEC 450-3.
- ☐ Identify all fuse types (class type)

Floor Plan (Lighting)

- ☐ Electrical plans denote the type and location of all lighting fixtures.
- ☐ Electrical plans denote all required switch locations.
- ☐ Home-run conduit(s) showing size, type, and number of conductors.
- ☐ Branch circuit(s) properly sized for the load.
- ☐ Emergency lighting clearly denoted on plans.
- ☐ Unit equipment used for egress lighting complies with CEC 700.
- ☐ Photometric plans for Egress lighting. Please provide, for each level of building parking, photometric drawings of the emergency egress lighting per 2003 IBC section 1006.4, showing 1 ft. candle average and .1 ft. candle minimum, in a pathway down each drive isle leading to each exit.
- ☐ Fill out lighting forms required by Title 24 Part 6.

Energy Code Compliance

- ☐ Electrical plans correspond to the lighting summary; including number and wattage of the lighting fixtures, type of lighting fixture, the occupancy type, and the watts per square foot allowed.
- ☐ Lighting control complies with California Energy Code (Title 24 Part 6)

- ☐ Completed copies of a Title 24 lighting forms.

Floor Plan (Power)

- ☐ Electrical plans denoting the location of all switchboard(s), panelboard(s), and transformer(s).
- ☐ All electrical equipment has working clearance shown as required by CEC Article 110.
- ☐ Receptacle outlet locations. Receptacles required by local amendments, for rooftops, for show windows, etc., and as required by CEC.
- ☐ Electrical equipment schedule.
- ☐ Locations denoted on electrical plans for all motors, compressors, heaters, stationary appliances, etc.
- ☐ Homerun conduit(s) showing size, type, and number of conductors.
- ☐ Branch circuit(s) properly sized for the load.
- ☐ Diagram of any transformer vaults including drain pipes, curbing, venting, and fire ratings

Panel Schedules

- ☐ Panelboard(s) are identified.
- ☐ Panelboard busbar rating in amps shown.
- ☐ Panelboard voltage rating is shown.
- ☐ Main breaker size or main lug only is shown.
- ☐ Panel schedule denotes double lugs or feed-through lugs.
- ☐ Description or coding is provided for each branch circuit.
- ☐ Connected load of each branch circuit is shown in VA or KVA.
- ☐ Total connected load is shown in VA or KVA.
- ☐ A.I.C. rating of the panelboard and overcurrent devices
- ☐ Time/current curves showing compliance with the selective coordination requirements for elevators and escalators

This shall be shown to the next common overcurrent device (common to more than one driving machine) above the elevator overcurrent device to the level of .01 time line.

Floor Plan (Fire Alarm)

- ☐ Fire Alarm plan showing fire alarm wiring legend, abbreviations, equipment legend with CSFM listings and fire alarm notes

- ☐ Fire alarm plan showing location of initiating devices and indicating devices, fire alarm panel, tamper and fire flow switches, PIV locations, wiring and conduit details and fire alarm circuit details

- ☐ Voltage drop calculations for all indicating device circuits

- ☐ Fire Alarm Riser Diagram matches fire alarm plans

- ☐ Fire Alarm details showing initiating and indicating devices wiring diagrams, height of initiating and indicating devices and fire alarm control panel details

- ☐ Battery calculations for fire alarm control panel and power extender panels

- ☐ Site plan showing connection of fire alarm control panel to a central network system

Emergency, Legally Required Standby, or Optional Standby Systems

See also the section on Equipment System Designations, which follows this section.

- ☐ Generator capacity and voltage.

- ☐ UPS capacity and voltage.

- ☐ System properly sized for the load.

- ☐ Indicate that the room, that houses the emergency generating system, has a 2 hour fire rating (NFPA 20)

- ☐ Emergency system is totally separate from all other systems.

- ☐ Individual transfer switches required.

- ☐ Grounding electrode conductor properly sized (When required for separately derived systems). State the number of "poles" in the transfer switch.

- ☐ Signage as required by CEC is denoted on plans.

- ☐ Selective coordination of overcurrent protective devices for Emergency and Legally Required systems down to the .01 timeline – overlaid time/current curves for each branch from each power source to each branch circuit overcurrent protective device on one sheet.

- ☐ Provide 2 hour protection of the pressurization fan(s) circuit(s) from the emergency generator to the fan.

- ☐ Provide separation of the pressurization circuits from other electrical system components

- ☐ On a high-rise building, if there are electrical fire pumps, they need to be calculated into the generator load calculation and service load calculation

Peak Demand Records

- ☐ Starting and ending dates of the metering.

- ☐ Highest reading of the metering period clearly shown.

- ☐ Power factor adjustment shown, when necessary.

- ☐ Explain the details of seasonal and occupancy adjustment factors.

- ☐ Utility demand records or recordings of demand metering for the peak period must accompany the submittal.

- ☐ Signature of the "administrator or engineer" who took the readings.

Arc Flash Calculation

- ☐ Provide**:** (1) the incident energy level calculation in cal/cm squared at 18" from the flash hazard,(2) the flash hazard category, and (3) the flash hazard boundary for each service, distribution board, and panel.

  Provide this in a cascading format relating to the one line or riser showing:

  - the device rating and identification

  - the voltage

  - the arc gap

  - the bolted fault current or the available fault current