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SITE ELECTRICAL UTILITIES SYSTEMS

TECHNICAL GUIDE

Prepared by:

CAPITAL IMPROVEMENTS SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

SAN DIEGO, CA. 92132-5190

SWDIV GD5000tg
Site Electrical Utilities Systems Technical Guide

Introduction

Intent

The purpose of this document is to provide technical guidance and outline technical requirements for the more typical aspects of the site electrical utilities engineering design portion of Architect/Engineer (A/E) contracts for Southwest Division, Naval Facilities Engineering Command. The information provided in this guide shall be utilized by electrical engineers in the development of their portion of the plans, specifications and calculations, and Design/Build Request for Proposal (RFP) and shall serve as minimal electrical engineering design requirement. This is not intended to cover every situation. Where situations are not address in this manual the latest industry standards and codes shall apply.

Criteria

Requirements listed in this technical guide shall apply to all project electrical systems design and construction, except that electrical design and construction for projects on bases in the San Diego metropolitan area, whose utility systems are owned and maintained by the Navy Public Works Center San Diego, shall also comply with standard Navy Public Works Center San Diego specifications and details which may be viewed at the links immediately below. In the event of a conflict between the requirements cited in this technical guide and the standard Navy Public Works Center San Diego specifications and details, the standard Navy Public Works Center San Diego specifications and details shall apply.

NPWC SD Specifications Section 16001
NPWC-14DB.pdf
NPWC-21DB.pdf
NPWC-22DB.pdf
NPWC-25DB.pdf
NPWC-26DB.pdf
NPWC-33DB.pdf
NPWC-34DB.pdf
NPWC-35DB.pdf
NPWC-54DB.pdf

All work shall comply with the latest edition of all applicable criteria, standards, and codes including, but not limited to, the following:

(1) National Fire Protection Association (NFPA)

(2) NFPA 70, National Electrical Code

(3) NFPA 75, Standard for Protection of Electronic Computer/Data Processing Equipment

(4) NFPA 780, Lightning Protection Code

(5) Underwriters' Laboratories (UL)

(6) UL 96A, Installation requirements for Lightning Protection Systems

(7) UL 1449 (Second Edition), Standard for Safety for Transient Voltage Surge Suppressors.

(8) National Electrical Manufacturer's Association (NEMA)

(9) American National Standards Institute (ANSI)

(10) National Electrical Safety Code (ANSI C2)

(11) California Public Utility Commission General Order 95.

(12) California Public Utility Commission General Order 128.

(13) Federal Specifications (FS)

(14) Insulated Cable Engineers Association (ICEA)

(15) Institute of Electrical and Electronic Engineers (IEEE)

(16) IEEE Std. 400 IEEE Guide for Making High-Direct Voltage Tests on Power Cables in the Field

(17) IEEE/ANSI standards for substations, relays, switchgear, etc.

(18) ANSI/IEEE C62.41, "IEEE Recommended Practice of Power Circuits."

(19) ANSI/IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

(20) Electronic Industries Alliance (EIA)

(21) Telecommunications Industry association (TIA)

(22) Occupational Safety and Health Act

(23) NETA Acceptance Testing Specifications for Electrical Distribution Equipment and Systems

(24) Illuminating Engineering Society of North America (IESNA) lighting Handbook

(25) Military Handbooks/Standards ***including, but is not limited to the following***

(a) MIL-HDBK-1004/1, Electrical Engineering; Preliminary Design Considerations

(b) MIL-HDBK-1004/2A, Power Distribution Systems

(c) MIL-HDBK-1004/3, Switchgear and relaying with Changes

(d) MIL-HDBK-1004/4, Electrical Utilization Systems with Changes

(e) MIL-HDBK-1004/5, 400 Hertz Medium-Voltage Conversion/Distribution and Low Voltage Utilization Systems

(f) MIL-HDBK-1004/6, Lightning Protection

(g) MIL-HDBK-1008C, Fire Protection for Facilities, Engineering, Design and Construction.

(h) DM 1013/1A, Design Guidelines for Physical Security of Facilities

(i) MIL-HDBK 1190, Facility Planning and Design Guide

(j) MIL-HDBK 1012/3, Telecommunications Premise Distribution Planning, Design and Estimating

(k) DM 13.02, Commercial Intrusion Detection

(l) MIL-HDBK 1190, Facility Planning and Design Guide

(m) MIL-HDBK 1028/6, Aircraft Fixed Point Utility Systems

(n) MIL-STD 704E, Aircraft Electric Power Characteristics

(26) Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM)

(27) Underwriter Laboratory Standards

(28) Unified Facility Guide Specifications (UFGS)

(29) UFGSN-16272N, Three-Phase Padmounted Transformer

(30) UFGS-16268N, 400 (HZ) Solid State Frequency Converter

(31) UFGS-16341N, Padmounted SF6 Insulated Interrupter Switches

(32) SOUTHWEST DIVISION A-E GUIDE

(33) NAVSEA OP-5

Use the latest Code or standard edition applicable at the time of award of contract. Where there is a conflict between Naval Criteria and National Codes follow Naval Criteria. Refer to CCB for other applicable criteria. Comply with the required and advisory portions.

- ## Standards

Electrical equipment provided shall be manufacturer's standard catalog products and shall conform to the latest published industry and technical society standards of organizations such as American National Standards Institute, American Society for Testing and Materials, National Electrical Manufacturers Association and Underwriters Laboratories at the date of contract award. Equipment provided shall be listed and labeled suitable for the specific purpose, environment, and application.

Use of shop or field fabricated electrical equipment assemblies that are not included in the manufacturer's standard catalog or in conformance with the above industry and technical society standards is not acceptable.

- ## General Design Guidelines

The electrical system consisting of power, lighting, and telecommunications shall be designed to meet the needs of the Activity and supporting facilities.

To minimize double transformations, to reduce energy consumption and to minimize items of equipment, consider two oil-filled pad-mounted transformers in lieu of one 480/277 volt service, if the required 120/208 volt load using dry-type transformers exceeds 40% of the 480 volt service transformer.

Minimize size and quantity of dry-type transformers. Total capacity of dry-type transformers shall never be larger than 40% of the service transformers.

Locate all electrical distribution equipment in dedicated spaces such as electrical rooms/closets in good central locations close to mechanical equipment and other major loads.

Optimize equipment layout and circuit arrangement. Combine one pole branch circuits to minimize number of homeruns. Never show more than a 3-phase circuit; or 3 phase conductors, a neutral conductor and equipment grounding conductor in a conduit.

Provide branch circuits and final connections for all Contractor and Government Furnished Equipment (GFE). Coordinate power requirements of all equipment.

Identify the limits of all areas requiring explosion proof wiring and devices.

For projects in California, the design and construction shall comply with and exceed California Title-24 energy standard baseline by at least 10%.

Equipment provided shall be listed and labeled suitable for the specific purpose, environment, and application.

Select system voltage carefully. Always connect equipment at highest available voltage to minimize the capital cost and losses of transformation equipment.

All wiring shall run concealed in conduit in finished spaces. Wiring may run in conduit exposed in unfinished spaces such as mechanical, and electrical rooms.

Color coding of all wiring shall be provided.

Services shall be sized in accordance with the NEC and standard utility engineering practice.

Provide construction phasing and outage plans.

For distribution in housing areas where single dwellings, duplexes and quadraplexes are being served by single-phase, 240/120V transformers, the following shall apply:

a. Maximum transformer size is 100KVA.
b. Per transformer, do not serve more than 6 single dwelling units; 4 duplexes; or 2 quadraplexes.
c. Minimum conductor size from the transformer to the service entrance equipment shall be #4/0 aluminum (or copper equivalent) in conduit.
d. Provide grounding at the service entrance in accordance with the latest NEC.
e. All conductors (primary and secondary) shall be in conduit.

f. Maximum length of service conductors (240/120V single phase) from the distribution transformer to the service entrance device (or meter base) shall be 220 LF (76 m).
g. Show typical and unique secondary situations on single line diagrams.

• Site Electrical Utilities

Electrical Site Utilities are the primary electric power distribution to the facilities and other electrical loads, all exterior lighting not attached to the building; and all telecommunication services (fiber optic, copper cable, CATV, etc.) required by the Facilities.

The site electrical distribution shall be connected to the existing base distribution system. In some cases, the facility service will be derived directly from the local utility company. The site utility distribution system shall be compatible with the existing system and shall meet the requirements of the local Public Works Office/Department (PWC/PWD).

Where the site service is derived from an existing primary feeder, the designer shall verify that the existing circuit can support the new loads. The designer shall confer with PWC to verify the existing circuit capacity.

• Pad-Mounted Switches

Use SF-6 insulated, vacuum break, dead-front switches. Provide switches that have operating handles located on the opposite side of the tank from the cable entrance bushings and will not require the switch operating personnel to be exposed to the switch cable entrance bushings, terminations and cable.

When over current protection is needed use SF-6 insulated-vacuum re-settable circuit breakers using electronic trip circuits.

Do not use air-insulated or fused switches.

Use of dead-front sectionalizers is acceptable.

• Pad-Mounted Transformers

Pad-mounted transformers shall be specified using our guide specifications 16272, “Three-Phase Pad-Mounted Transformers” and 16273, “Single Phase Pad-Mounted transformers”. The guide specifications shall be used in its entirety for specifying operational parameters and selection of components and accessories. Use the default settings in the guide where no other guidance is provided.

Use pad-mounted transformers (properly protected with bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses) for kVA ratings up to and including 750 kVA on 5 kV systems and for kVA ratings up to and including 1500 kVA on 15 and 25 kV systems.

Primary connectors and switches are not currently available for 34.5 kV, 200 kV BIL systems; therefore, for these systems, use either secondary unit substations or pad-mounted transformers, separately protected with vacuum fault interrupter equipped switches.

The 200A load-break separable insulated connector normally specified for use on dead-front pad-mounted transformers will accommodate a maximum cable size of

No. 4/0 AWG and has a fault-closure current rating of 10,000 amperes and a short-time current rating of 10,000 amperes for 0.17 seconds. On systems which require a primary cable larger than No. 4/0 AWG or which require a short-time rating in excess of 10,000 amperes, a 600A separable insulated connector would be the preferred alternative. The 600A connector is dead-break and has a short-time current rating of 25,000 amperes for 0.17 seconds. The 600A connector is physically larger than the 200A connector and may require a deeper transformer compartment; UFGS-16272N, "Three-Phase Pad-Mounted Transformers", which is based on 200A connectors, will require significant modifications. Secondary unit substations may also be alternatives.

The use of pad-mounted transformers with secondary currents exceeding 2000 amperes is discouraged due to the size and quantity of secondary conductors; therefore, transformers above 750 kVA serving 208Y/120 volt loads and transformers above 1500 kVA serving 480Y/277 volt loads should be in a secondary unit substation configuration.

For outdoor construction, use single-phase pole types, single-phase pad-mounted types, three phase pad-mounted types to 1500 KVA or substation types over 1500 KVA. Use dead-front construction for pad mounted transformers. Use mineral oil insulation. The designing professional engineer is responsible for specifying the transformer primary connection. The engineer shall note that a delta primary connection will not be used in a situation where Ferro resonance may occur and the grounded wye primary connection will not be used without first explicitly determining the supplying circuit is a multi-grounded 4 wire circuit back to its source. Pole type transformers will not be installed at ground level for new or permanent construction.

Transformer shall have a minimum of four full 2.5 percent voltage taps, two above and two below rated primary voltage.

Pad-mounted transformers shall be loop-feed type transformer with 6 bushings. Install three elbow type arresters on three bushings. Provide load break loop feed sectionalizer switches (three, two position, oil immersed type) to permit closed transition loop feed and sectionalizing. Provide stub out conduit for the spare way 5 ft [1520 mm] out from the transformer pad.

Fuse pad-mount transformers with bayonet expulsion fuses in series with oil-immersed partial–range current limiting fuses.

Specify energy efficient transformers.

Base and cabinets of transformers shall be corrosion resistant and shall be fabricated of stainless steel.

Bases, cabinets and tanks shall be factory painted Munsell green.

Provide concrete pad and bollards.

All services shall be metered. Use 3 stator meters with demand registers for 3 phase metering. Mount on or near transformers. Specify meter voltage class for operation at transformer secondary voltage. In addition, metering and utility control system (UCS) shall comply with the requirements of the Base standards.

- **Transformer Locations**

Transformer location with respect to buildings shall meet requirements of MIL-HDBK-1008, "Fire Protection for Facilities Engineering Design and Construction" and NFPA 70.

Locate flammable, oil-filled transformers a minimum of 25 feet from buildings (or openings in buildings).

- **Description**

  Use IEEE STD. C57.12.00 "General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers" designation of voltage ratings (example: 11.5 kV – 208Y/120 volt).

• Regulators

Provide voltage regulation with automatic tap changers to regulate the voltage at +/- 10%.

Provide the following information:

KVA, voltage, phase

Line current at full regulation

Regulator type (e.g., step-voltage, induction, etc.)

Style (e.g., station type, distribution, etc.)

Insulation type (e.g., oil, etc.)

BIL Rating

Temperature rise

Percent regulation

Number and percent steps (e.g., 32-5/8% steps)

Line drop compensation

Special features as needed

Provide bypass and disconnect switches with regulators.

• Capacitors

Fuse or otherwise protect capacitors to prevent case rupture. Provide the fuse (or other protective device) curve plotted against the case rupture curve on full size logarithmic paper. Also show the full load and fault currents for a faulted capacitor unit on the same sheet.

Connect capacitors ungrounded wye, unless otherwise instructed.

Provide the following information:

Capacitor type (e.g., outdoor, etc.)

Mounting (e.g., rack mounted, etc.)

KVAR per unit

Number of units per bank

Voltage (voltage rating of units, not the system voltage)

Phase (e.g., three-phase or single-phase units)

Fuse size and type

- ## Watt-Hour Meters

Provide watt-hour meters with 15-minute interval sweep-hand type kW demand register for all buildings, except housing units.

Supply housing units with meter sockets only. Sockets shall be single phase, four terminal, and ring-less with manual bypass device and polycarbonate blank cover plate.

Place meters and meter sockets in accessible locations.

- ## PT'S and CT'S

Carefully coordinate connection and ratio of potential transformers with relay and meter requirements.

Provide separate current transformers for relaying and metering.

- ## Instrumentation

Thoroughly identify requirements. Instrumentation requirements will vary per the project requirements. PWC shall determine any instrumentation requirements for the project.

- ## Relaying

Provide protective relays per ANSI standards for over-current, ground fault, differential voltage and voltage. Provide wiring diagrams for each relay type and function. All protective relays shall utilize the ANSI designation numbers (i.e. 51N).

Provide the following minimum information:

Function (overcurrent, voltage, differential, etc.) using ANSI designation numbers.

Quantity.

- ## Metalclad Switchgear

The metal-enclosed switchgear with Type SF-6 or vacuum style breakers shall consist of a single section or multiple section line-ups be of NEMA 1 or NEMA 3 non-

walk-in construction. The sections shall contain the vacuum breakers and the necessary accessory components. The equipment shall be factory-assembled (except for necessary shipping splits) and operationally checked. The assembly shall be a self-supporting, floor-mounted bay and shall be securely bolted to the transformer to form an integrated structure.

The complete assembly shall be constructed in accordance with applicable provisions of ANSI/IEEE C37.20.3 and the minimum construction standards of the manufacturers of the major components such as power fuses or potential transformers. Provide adequate space for fuse handling when applicable.

System Characteristics shall be confirmed with the Public Works Center (PWC) office. Provide specific design information for the following:

System Voltage: [__ kV], 3-phase, solidly grounded, 3 phase, 3-wire or 3 phase, 4-wire.

Operating Frequency: 60 Hz.

Maximum Short Circuit Current: [__] kA rms symmetrical.

Maximum Design Voltage: [__]kV.

Basic Impulse LEVEL (BEL): [__] kV.

Power Frequency Withstand: [__] kV.

Short-time Current (two second): [__] kA.

Main Bus Ampacity: [__] amps, continuous.

Provide batteries for dc tripping of circuit breakers. Do not use direct trip, ac trip, or capacitor trip.

Provide single-line, plan and elevation drawings with full details of instrumentation and relaying.

- **Pad-Mounted Sectionalizing Termination Cabinet**

Provide 3-phase, 15KV Class, low profile sectionalizing termination cabinets.

Enclosure shall comply with ANSI C57.12.28, one piece, continuous seam welded, 12 gage, mild steel cabinets with lockable, tamper-proof door. Paint cabinets Munsell 7G3.29/1.5 green, and stainless steel hardware.

Provide mounting plates with 4-point junctions for each phase, one parking stand for each phase, one ground clamp nut welded in place for each phase, insulated standoff parking bushings, IEEE 386, rated 200 amps, 95 KV BIL, 15 KV Class. Provide for parking load-break connector on parking stand.

Provide insulated protective caps, IEEE386, 200 amps, 95KV BIL, 15KV Class. Provide insulated protective cap (not shipping cap) for insulating and sealing out moisture from insulated parking bushing. Provide insulated medium-voltage load-break connectors.

Foundation shall be 8 inches thick with same requirements as pad mounted transformer. Provide grounding similar to transformer requirements.

In areas where equipment is subject to vehicular damage, provide bollards.

- ## Switchgear

Low Voltage switchgear shall have been tested in a recognized testing laboratory to prove adequate mechanical and electrical capabilities. All major components shall have been individually tested and guaranteed by the manufacturer.

The switchboard shall consist of the number and size of vertical frames required to support the number of feeder circuits required.

All bussing shall be electrical grade copper bus bar, plated of the rating necessary. Current density shall not exceed 1000 amperes per square inch. All bus bars shall be braced to withstand the available short circuit stress at the rated voltage.

The circuit breakers shall be stationary or draw-out 600 volt, electrically operated with an interrupting rating not less than the available amperes (Sym) at the rated voltage.

All breakers shall be UL listed for application in their intended enclosure.

- ## Overhead Power Distribution

  - **Overhead Construction**

    Match existing base construction methods or those used by local utility. Where new overhead distribution is required, route along roadways.

  - **Criteria/General Guidance**

    ANSI C2, "National Electrical Safety Code," MIL-HDBK-1004/1, MIL-HDBK 1004/2, CALPUC G.O. 95 (State of California), and UFGS-16301N, "Overhead Transmission & Distribution. For projects outside of California, the use the equivalent published Public Utilities Standards for the particular state.

  - **Pole Sketches and Conductors**

    Use CALPUC G.O 95 and the Utility company, whose area of responsibility covers the Base, criteria and sketches whenever applicable.

    Use bare all aluminum conductors (AAC), bare all aluminum alloy conductors (AAAC), bare copper conductors or aluminum-conductor steel-reinforced (ACSR) to match the existing base system or the requirements of the Public Works Center. Do not use ACSR near salt laden atmosphere.

    Standard design criteria for sag & tension shall:

    (1) Limit the initial loaded conductor tension to a maximum of 50% of the conductor rated breaking strength. Lesser tension limits are permissible and may be preferable.

(2) Provide clearance requirements using final sag values in conformance with the NESC, "National Electrical Safety Code" for the maximum conductor temperature.

(3) Limit the maximum design tension for any conductor to 4,750 pounds. All clearance values shall be based on the following maximum conductor temperatures:

Copper phase conductors – 167 degrees F.

Aluminum/Aluminum alloy phase conductors – 194 degrees F.

Neutral conductors for all multi-phase circuits – 120 degrees

The maximum conductor temperature for single-phase neutral conductors shall be identical to the phase conductors.

- **Fuse Protection**

Provide backup current limiting fuses for overhead distribution transformers on voltage systems: (a) above 15 kV and (b) on lower voltage systems that have available fault currents equal to or greater than 7,000 asymmetrical amperes.

The purpose of the backup current limiting fuse is to protect the transformer from high-level fault currents that can rupture the transformer tank and result in catastrophic damage. The expulsion fuse link is required for overload and low level fault current protection. The two protective devices must be coordinated to function together; expulsion fuse links should be ANSI Type K to provide this coordination.

Exercise care when using fused cutouts at line taps and at underground terminations. The maximum interrupting rating of a fused cutout is 12,500 symmetrical amperes. Whenever system fault currents exceed this value, protect the fused cutout with a backup current limiting fuse or use an adequately rated power fuse.

Specify:

(1) ANSI Type K fuse links.

(2) Testing of backup current limiting fuse in series with expulsion fuse according to ANSI C37.41, "Design Test for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fused Disconnecting Switches, and Accessories."

- **Pole Mounted Transformers**

Use only single-phase transformers.

For single phase installations and when banking single phase transformers for three phase applications, primary connections should be phase-to-neutral - unless connected on three wire distribution systems.

- **Pole Top Switches**

Where ground operated, gang type, three phase, air break switches are used with non insulated operator handles, a metal plate or grate will be provided at ground level for the operator to stand on when operating the switch. The metal plate or grate will be connected to the pole ground conductor as well as through a braided conductor connection to the switch handle mechanism. The ground accessible switch handle will have provisions for locking in the open and closed position. Per the National Electric Safety Code, all metal, non-current carrying parts of the switch will be bonded to the pole ground conductor.

- **Surge Arresters and Fused Cutouts**

  Provide the following information:

  Arrester kV rating

  Cutout kV and ampere rating

  Fuse link type and ampere rating

  Recloser/Sectionalizer applications.

  Provide surge arresters on the line side of:

  Pole mounted transformers

  Overhead to underground terminal poles

  All “normally open” switch ways of pad-mounted sectionalizing switches connected to and served from overhead lines

  All primary metering installations connected to and served from overhead lines

  Provide surge arresters on line and load sides of:

  Gang operated air switches on overhead lines

  Primary metering applications on overhead lines

  Recloser/Sectionalizer applications on overhead lines

• Underground Power Distribution

- **Underground Construction**

  Use underground construction in areas where the existing distribution system is underground, where overhead will be operationally hazardous, or where required feed pad-mounted transformers.

- **Criteria/General Guidance**

  MIL-HDBK-1004/1, “Preliminary Design Considerations,” MIL-HDBK-1004/2, “Power Distribution Systems,” UFGS-16302N, “Underground Electrical Work,” and CALPUC G.O. 128, Rules for Construction of Underground Electric Supply & Telecommunications Systems and other applicable State Standards. For

projects outside of California, the use the equivalent published Public Utilities Standards for the particular state.

For the purposes of this guide, an underground conduit or duct run consisting of a single conduit or duct shall be defined as a conduit run; an underground conduit or duct run consisting of two or more conduits or ducts shall be defined as a duct bank or duct run.

- **Manholes (MH) and Handholes (HH)**

  Avoid use of combination power and communication manholes; however, when power and communication duct lines follow the same route, use a common trench and locate power and communication manholes in close proximity to one another. Use manholes for main duct runs and wherever shielded medium-voltage cable is installed. Handholes may be used for airfield lighting circuits, for other non-shielded medium-voltage circuits, and on building laterals for low-voltage and communication lines. Don't use handholes for splicing multi-pair communication cables or shielded power cables.

  Determine size of power manholes by number of circuits and by voltage ratings and splicing requirements of the cables within. Size manholes to accommodate splices. Minimum size manhole for circuits greater than 15kv shall be 9 ft wide x 12 ft long [2740 mm x 3660 mm].

  Size communications manholes for equipment and splices contained, including future projections. Manholes shall accommodate racking of splice closure of largest multi-pair cable while keeping cable-bending radii greater than 10 times cable diameter.

  Manholes shall be minimum 6'-6" [1980 mm] inside clear height deep and meet the Base utility standards.

  Provide manhole foldout details indicating the entrance of all conduits and the routing of all conductors in the manholes.

- **Locating Manholes (MH) and Handholes (HH)**

  Provide MH/HH where duct lines change direction and where spacing exceeds 400 linear feet [122 m].

  Provide a MH/HH within 100 feet [31 m] of every riser pole, pad mounted transformer, or unit substation unless a calculation is provided to justify a greater distance – under no circumstances shall this greater distance exceed 200 feet [61 m].

- **Duct Banks**

  Minimum duct size for power distribution circuits in all duct runs shall be 5 in [127 mm] and minimum duct size for main runs of telecommunication cables shall be 4 in [100 m].

  In duct-banks provide a 3 in [76 mm] clearance between conduits. Provide at least 33% spare ducts in a duct bank (minimum one spare duct). Provide pull wire in all empty conduits.

Provide detectable aluminum foiled plastic-backed tape or detectable magnetic plastic manufactured specifically for warning and identification of buried cable and conduit.

All primary underground circuits shall be installed in PVC conduits with 3 in [76 mm] of concrete encasement buried at a minimum depth of 18 in [457 mm] below grade except that under roads and pavement it shall be 24 in [610 mm].

- **Medium-Voltage Cable**

  Primary conductors shall be copper and sized to match existing circuit so as to not degrade the load carrying capacity of existing distribution system. In-line splices to medium voltage cables are acceptable. "T" or "Y" splices are never acceptable. Do not use.

  Primary Conductors shall have the following properties: 133% insulation level with both conductor and insulation shielding, and a PVC or polyethylene jacket. Cable shall meet NEMA WC8 and AEIC CS6 for ethylene-propylene-rubber insulation, and shall be suitable for wet conditions. The year of manufacture shall be durably marked on the outer surface of each cable at regular intervals throughout cable length. This cable is not a standard manufacturer's product, and may require special ordering.

- **Description**

  Provide the following minimum information:

  Conductor size

  Number of conductors

  Insulation voltage rating (e.g., 5 kV, 15 kV, etc.)

  Insulation type

- **Insulation Type**

  Provide ethylene propylene rubber (EPR) for new cable.

- **Cable Shields**

  Use tape shielded cables and ensure minimum bending radii of 12 times the overall cable diameter; use wire shielded cables (see NEMA WC 8, "Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy," for minimum cable bending radii) only where existing manholes are utilized and the minimum cable bending radii of tape shielded cables cannot be realized. Please note that the minimum cable bending radii refers to the inner surface of the cable and not to the axis of the cable.

- **Number of Conductors**

  Use 1/c cable.

- **Existing Conditions**

  Ensure that new cables and specified splicing methods are compatible with existing cables. Provide the same information (e.g., insulation type, insulation rating, conductor type, and number of conductors) for existing cables as required for new cables. Caution: Existing cable may be fireproofed with asbestos in manholes.

- **Marking**

  Require all insulated medium voltage cables be tagged in all accessible locations such as in manholes, transformers, switches and switchgear. Install locator tape above all buried underground circuits. Marking shall meet the base utility standards.

Site Lighting

General

The lighting level of illumination design shall meet the requirements of the IES unless the Base and/or MIL-HDBK-1190, and/or DM-1013/1A have specific requirements that differ.

Exterior areas shall be illuminated with pole mounted fixtures or fixture mounted on the facility, provided such mounting permits meeting illumination levels. Design the lighting system to minimize horizontal and vertical glare outside of the roadway areas.

Specify fixtures and poles conforming to the Base Exterior Architectural Plan (BEAP).

In parking lots and areas subject to vehicular traffic, provide concrete bases extending 30 in [760mm] above the finished grade.

- **Fixtures**

  All fixtures shall be commercial grade, designated for high abuse area, have vandal proof hardware and polycarbonate lens.

  Luminaries shall be individual photocell switched controlled.

  Luminaries shall be cut off type to reduce light pollution of either High Pressure Sodium (HPS) or Low Pressure Sodium (LPS) lamps. Ballast shall be multi-voltage type for operation at 208V, 240V, 277V or 480V.

  High intensity discharge light sources lamps shall be so equipped that momentary power interruptions shall not cause complete loss of illumination.

- **Wiring Conduits and Duct Bank**

  Conductors shall be copper and installed in conduits. The minimum conduit size shall be ¾ in [21mm]. The minimum conductor size shall be 12 AWG.

  Provide pull wire in all empty conduits.

  Provide a handhole external to the pole base where the branch circuit enters the pole base. Label the handhole concrete cover “Street Lighting”.

- **Controls**

  Parking lot fixtures shall be individual photocell switched controlled and fused protected. Address specific Base requirements.

  General purpose, building perimeter, sidewalk, and walkway lighting shall be photocell switched.

  The circuits shall be capable of being time switched and manually switched controlled

- **Grounding**

  All fixtures and poles shall be grounded with a ground rod located in the handhole.

  Provide an insulated green equipment grounding conductor for circuit(s) installed in conduit and raceway.

- **Exterior Sports Illumination**

  Unless specifically directed otherwise, outdoor sports lighting shall conform to the classifications stated in the IES Lighting Handbooks as indicated below:

Sport	IES Classification
Baseball	Municipal and Semi-Professional
Softball	Industrial League
Football	Class III or IV
Other	Recreational

• Site Communications and Security

• General

Overhead and Underground Communications shall meet the requirements of Base Telecom or the Public Works Center for telecommunications and security.

Overhead construction shall conform to the requirements for overhead power distribution in this document. Where joint poles are used for both power and telephone/communications, maintain minimum clearances between conductors/systems as defined by the CALPUC G.O. 95 and the Utility company, whose area of responsibility covers the Base, criteria and sketches whenever applicable. For projects outside of California, the use the equivalent published Public Utilities Standards for the particular state.

• Outside Plant

Provide outside copper cable with size based on one pair per 100 square feet [9.29 square meter] of building. Cable shall be specified using RUS specifications. As a minimum, the cable shall be filled and installed to a depth of 36 in [915 m] in a schedule 40 PVC duct. Provide 50% spare conduits. Coordinate point of connection to the station system and further requirements with the Base Communication Office (BCO).

Provide voice, data, LAN service to the facility. The minimum duct system shall be 2-4 in [100mm] conduits. The designer must coordinate with Base Telephone/Telecommuncations Department.

For twisted pair media terminating inside a building from an overhead or underground outside plant, provide solid-state type primary communication circuit protectors with sneak current protection. Locate protector at point of entrance per NEC Article 800.30.

Provide detectable aluminum foiled plastic-backed tape or detectable magnetic plastic manufactured specifically for warning and identification of buried cable and conduit.

For fiber optic cable installations, provide innerducts in the conduit.

Provide pull wires in all empty conduits/innerducts.

- **Voice**

  Provide PE-39 telecommunications cable from a point of connection to the base system and the MDF.

- **Data**

  Provide PE-39 telecommunications cable and/or FO cable from a point of connection to the base system and the MDF.

- **Cable Television**

  Coordinate cable television service with local provider and base communications officer (BCO). Provide a conduit from a point of connection to the base system and the main distribution equipment.

- **Grounding**

  All new power and telecommunications distribution work shall be grounded. Provide grounding requirements in accordance with NEC, ANSI/EIA/TIA 607, and IEEE 1100.

  Grounds and grounding system shall have resistance to solid ground in accordance with the National Electric Code (NEC). Ground rods shall be copper clad steel with diameter adequate to permit driving to full length of the rod, but not less than ¾ in [19 mm] diameter and 10 ft [3050 mm] long. All connections to ground rods shall be by exothermic weld.

  Provide surge protection devices at the transition point(s) from overhead to underground distribution lines and both ends of the distribution system.

- **Other Site Electrical Utilities**

  - **Cathodic Protection**

    Provide in accordance with MIL-HDBK-1004/10, “Electrical Engineering Cathodic Protection.” System design shall include the following:

Location of all existing and new rectifiers, anode beds, structures protected by cathodic protection system(s) and all structures which may be affected by stray current corrosion as a result of cathodic protection of the specific structure within the affected area of cathodic protection.

Test stations along the route of pipelines for structure-to-electrolyte testing of pipelines. Include test stations every 1000 feet [305 m] along paved route of pipelines. Include permanent reference electrodes, i.e., copper-copper sulfate, at test stations for periodic monitoring of system.

Include independent permanent reference electrodes, i.e., copper-copper sulfate, not associated with automatic potential control circuits, at various locations below mean low water level for independent monitoring of system. Provide test access handholes around the roof circumference of on-ground water storage tanks for structure-to-electrolyte testing of structure and provide a minimum of two reference electrodes in the tank. Provide a minimum of three reference electrodes in the bowl and two reference electrodes in the riser of elevated water storage tanks.

Obtain soil resistivity data for the specific site of the structure under protection and for the location of anode beds. Utilize the 4-pin method for soil resistivity measurement and provide all readings with the design calculations. Historical soil resistivity data may be obtained from the SOUTHWESTDIV Corrosion Program Coordinator.