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UNIFIED FACILITIES CRITERIA (UFC)

Final Draft

DESIGN: GENERAL ELECTRICAL REQUIREMENTS

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UNIFIED FACILITIES CRITERIA (UFC)

DRAFT DESIGN: GENERAL ELECTRICAL REQUIREMENTS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

U.S. ARMY CORPS OF ENGINEERS

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

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FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD(AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate.

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CHAPTER 1 INTRODUCTION

1-1 **PURPOSE AND SCOPE.** The purpose of this UFC is to provide technical guidance and outline technical requirements for the more typical aspects of the architectural and interior design portion of Architect/Engineer (A/E) contracts for the Naval Facilities Engineering Command (NAVFAC). The information provided in this guide must be utilized by electrical engineers in the development of the plans, specifications, calculations, and Design/Build Request for Proposals (RFP) and must serve as the minimum electrical design requirements. Project conditions may dictate the need for design that exceeds these minimum requirements.

1-2 **APPLICABILITY.** This UFC applies to all Agencies of the U.S. Department of the Navy (DON) and their contractors that are preparing construction contract documents and specifications for all projects on military installations under the Naval Facilities Engineering Command. It is applicable to the traditional electrical services customary for Design-Bid-Build construction contracts and for Design-Build construction contracts.

1-3 **REFERENCES.** Appendix A contains the list of references used in this document. Furthermore, this document references UFC 1-200-01*, Design: General Building Requirements,* except as modified herein. This document contains requirements for facilities and services for the Navy only.

1-4 **COMMUNICATIONS.** Direct communication with the Government project manager and electrical reviewer is encouraged. This may avoid unnecessary re-submittal of plans and specifications due to a misunderstood comment. The reviewer's name, phone number and email address can be found on the comment sheets.

1-5 **ADDITIONAL REQUIREMENTS.** When performing work for different Activities, regional requirements may differ from those included herein. Refer to Appendices B through E for regional requirements that take precedent over the guidance included herein.

1-6 **DESIGN STANDARDS.** The electrical designer must satisfy each of the following for each project:

1. Fully indicate the Scope of Work in the Contract documents.
2. Comply with all applicable codes, regulations and laws.
3. Provide a facility within funding limits.
4. Provide a facility within Scope of Work limits.
5. Provide an effective barrier against the elements.
6. Provide a facility of acceptable appearance within Navy standards.

7. Provide a facility with coordinated systems (structural, mechanical, electrical, etc.)
8. Provide complete, accurate, and coordinated construction documentation for the Project.
9. Provide a facility considerate of the ecological, physical and visual features of the site.
10. Provide a fully coordinated Comprehensive Interior Design (CID).
11. Compliance with applicable environmental requirements.
12. Provide a facility that is designed in accordance with sustainable design principles.

1-7 **PERMITS-CONSTRUCTION, ENVIRONMENTAL & OTHER.** Identify the permits necessary for environmental, construction and operation of facilities. Identify fees associated with each permit. Refer to UFC 3-200-10N, *Design: General Civil / Geotechnical / Landscape Requirements,* for more information."

1-8 **SAFETY**. Design electrical transmission and distribution systems in accordance with UFC 3-560-10N "Safety of Electrical Transmission and Distribution Systems".

CHAPTER 2 DESIGN REQUIREMENTS

2-1 **GENERAL GUIDANCE.** Design the electrical system consisting of power, lighting, and telecommunications to meet the needs of the activity and supporting facilities.

To the extent possible, do not design around unusual or non-standard equipment. Electrical equipment specified must be manufacturer's standard catalog products and must conform to the latest published industry and technical society standards at the date of contract award. Equipment specified must be listed and labeled suitable for the specific purpose, environment, and application. Use of shop or field fabricated electrical equipment assemblies that are not manufacturer's standard catalog or conforming to the industry and technical society standards are not acceptable.

Size electrical services, feeders and branch circuits in accordance with NFPA 70 and standard utility engineering practice.

Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

2-1.1 **Hazardous Materials and Waste.** Demolition or replacement of existing electrical equipment may involve hazardous materials and waste. Refer to UFC 3-800-10N for additional guidance concerning hazardous waste testing and removal requirements. Equipment of concern includes, but is not necessarily limited to the following:

- Pad Mounted Transformers – Dielectric fluid containing PCBs, lead paint on the exterior
- Pad Mounted Switches – Dielectric fluid containing PCBs, lead paint on the exterior
- Capacitors - Dielectric fluid containing PCBs
- Pole Mounted Transformers - Dielectric fluid containing PCBs
- Fluorescent Ballast – Dielectric fluid containing PCBs
- Fluorescent and HID Lamps – Mercury
- Manholes and Handholes – Asbestos Fireproofing

2-1.1.1 **Removal of Equipment Containing Dielectric Fluid**. Determine the PCB content of each item of electrical equipment. If the equipment is labeled PCB filled, or not labeled at all, then it must be assumed to contain PCBs and the following steps must be taken:

Identify and request in writing that the activity test a sample of dielectric fluid for each piece of equipment in question. Do **NOT** test fluorescent lamp ballasts; testing is more expensive than disposal. Unless the ballasts are specifically labeled as "NON PCB", dispose of them as if PCB contaminated.

Use the test results to identify the equipment as follows:

- "Non-PCB" – Contains less than 50 ppm.
- "PCB" – Contains 50 ppm or greater.

Capacitors must be identified as follows:

- Capacitors containing less than 1.4 kg (3 lbs) of dielectric fluid – Not required to be identified.
- Capacitors containing 1.4 kg (3 lbs) or more of dielectric fluid and made prior to 1978 – Identify as "PCB".
- Capacitors containing 1.4 kg (3 lbs) or more of dielectric fluid and made in 1978 or later – Identify as "Non-PCB."

The contract specifications require that PCB equipment, after removal from service, but before being moved from equipment location and regardless of equipment condition, be drained of fluids and that the fluids are containerized. On individual projects, verify with the Project Manager whether PCB equipment and fluids are to be turned over to the Government for disposal or are to be removed and disposed of under the construction contract.

2-1.2 **Removal of Existing Cables.** When a project requires removal of existing cables enclosed in either duct or conduit, these cables must be physically removed and **NOT** simply abandoned in place. Associated ducts or conduits, if concealed and not in the way of new construction, may be abandoned in place. Existing direct buried cables must also normally be abandoned in place.

2-1.3 **Modification to Existing Electrical Equipment.** Existing equipment to be "Modified" or "Added to" must be identified by the manufacturer's name and other pertinent manufacturer's identification (e.g., serial number, model number, style, etc.).

2-1.4 **Salvaged Materials and Equipment.** Demolition projects may require equipment to be salvaged for, or by the Government. Identify all salvageable equipment by the manufacturer's name and other pertinent manufacturer's identification including serial number, model number, style, physical dimensions and weight if possible. Indicate who is responsible for removal, storage and transportation.

2-1.5 **Scheduling and Sequencing Outages.** Typically, outages are at the discretion of the Contractor. Applicable lockout/tagout requirements of EM-385-1 and UFGS 01525, paragraph 3.2, apply. However, when it is required that an activity remain in operation during construction, include specific directions for the Contractor to follow concerning outages and downtime. Do **NOT** use vague phrases such as "The activity will remain in operation during the entire construction period". Include the following as applicable:

- Include a specific and detailed Sequence of Construction.
- Specifically identify required power outages including maximum downtime or duration, specific dates and times.
- Identify preparations and precautions required of the contractor prior to starting specific phases of work or implementing power outages.
- Specify any preliminary operations and testing requirements.
- Specify to provide temporary power either by temporary wiring or portable equipment and identify the Contractor's responsibility for operation, maintenance and repair, and to demonstrate reliability of the equipment provided.

2-1.6 **Government Furnished Equipment (GFE).** It is imperative that the Contractor's responsibility for any GFE is thoroughly specified, either in the specifications or directly on the drawings. Include the following information as applicable:

- Identify all GFE, including associated auxiliary equipment and any special connection requirements, by the manufacturer's name and other pertinent identification (e.g., serial number, model number, style, etc.). Require the Contractor to field verify the data after contract award. Identify who is responsible for the start-up and testing of GFE. Require the services of a qualified person, such as a manufacturer's representative.
- Indicate when the equipment will be available, where the equipment is located, who is responsible for transportation, and any temporary storage requirements. If the equipment is on line, require the Contractor to field test prior to removal to verify it works. Have field test witnessed by the Government.
- Include a Submittal requirement for the contractor to provide an interconnecting wiring diagram showing connections and compatibility between the GFE and Contractor provided equipment. Require a statement from the manufacturer that the Contractor's connections are accurate.

2-1.7 **Calculations**.

2-1.7.1 **Load Analysis**. Indicate connected and demand loads using the appropriate demand factors listed in UFC 3-501-03N, "Table 1 - Factors for Individual Facilities by Navy Category Code" and "Table 2 - Demand Factors for Specific Loads." For residential and small commercial type projects, use the National Electrical Code NFPA 70 in lieu of the UFC.

Fire pump loads will be assigned a demand factor of 0 percent for all demand calculations. A factor of 25 percent for future or anticipated load growth will be applied to demand load calculations using the UFC criteria but not to demand calculations using NFPA 70. The load growth factor will be used for sizing the facility main service equipment (the main distribution panelboard or switchboard bus including appropriate space.) Design incoming facility main service conduit(s) to accommodate the calculated load growth. Standard design practice will use 100 percent rated main overcurrent device for sizes 400 ampere and larger. The facility transformer will be sized at a minimum of 100 percent of the calculated demand load. It will not consider any load growth. The incoming facility main service conductors will be sized at a minimum of 100 percent of the transformer full load capacity.

2-1.7.2 **Short Circuit**: Provide an impedance diagram with calculated fault and impedance values in accordance with IEEE STD 399 and include the following:

a) Include the utility system data as well as data of the distribution system. Contact the applicable EFA/EFD/FEC or BOS for the utility system data and available faults on the primary side of medium voltage equipment. When accurate data does not exist, the Designer of Record must assume that maximum available fault exist, up to possible infinite bus, and design the system assuming such conditions.

b) Systematically calculate the fault impedance to determine the available short circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.

c) For anything other than very small systems, the study must be calculated by means of a digital computer. Incorporate pertinent data and the rationale employed in developing the calculations in the introductory remarks of the study. Calculation methods must meet the requirements of IEEE Std. 399 and ANSI C37.

d) Where diagrams will not fit on standard letter size paper, present the data determined by the short circuit study in a table format. Include the following:

(1) Device identification
(2) Operating voltage
(3) Protective device
(4) Device rating

(5) Calculated short circuit current

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-1.7.3 **Voltage Drop**. Size service and feeder conductors for a maximum voltage drop of 2 percent at full connected load. Size branch circuits for a maximum drop of 3 percent at full connected load. In general, voltage drops should not exceed 2%. Interior lighting branch circuits should be restricted to 1% and interior power circuits to 2%. Exterior lighting circuits may be sized for a voltage drop of 5% if fed directly from the service entrance point. However, for optimum performance 3% is recommended.

Calculate voltage drop at the highest expected load current over the life of the installation. Where appropriate, factor in future expansion. Experience shows that feeders, in non-residential facilities, become more fully populated over time.

Always check with the equipment manufacturer to determine the changes in performance caused by voltage drop. These changes can be significant. For a linear power circuit such as electric heating, a 10% voltage drop causes a 20% reduction in heat output. In the case of incandescent lamps, the loss is even greater. A 10% voltage drop reduces light output by 30%. For fluorescent lamps the decrease in light output is approximately 1% for each 1% of voltage drop. For HID lamps, check with the manufacturer as the type of ballast will have an effect on light output as a function of voltage.

If your conductors must be increased in size due to voltage drop, **DO NOT** increase the size of the overcurrent protection device for the circuit. The overcurrent protection device may be protecting downstream equipment and increasing the size of the overcurrent setting may defeat the equipment protection. However, if you increase the conductor size for voltage drop, you must also increase the size of the equipment grounding conductor proportional to the circular mil increase of the phase conductor.

Power Factor correction capacitors are also affected by voltage drop. A voltage drop of 10% to the capacitor reduces the corrective capacity by approximately 20%.

2-1.7.4 **Motor Starting/Flicker Analysis**. Motor calculations must account for both starting and running current. Starting load current is generally four to five times running current (FLA). As a result, a 2% voltage drop at running current may result in 10% or more voltage drop during motor start. NEMA Standard 1 requires that motor voltage not vary more than 10% for both running and starting. Motor starting torque is also reduced as voltage drops. Motors suffer both reduced efficiency and life as supply voltage decreases. A 10% reduction in voltage during starting reduces the starting torque approximately 20% and also increases the heating of the motor. For maximum life of

motors that experience frequent starts keep the voltage drop during starting at 5% or less.

For motors 40 hp and greater, provide motor starting/flicker analysis for distribution in housing areas utilizing electrical HVAC systems. Conduct voltage flicker analysis to show the voltage drop at the service conductors does not exceed 5 percent.

2-1.7.5 **Lighting.** Provide calculations for Interior and Exterior lighting systems in accordance with UFC 3-530-01. Design all lighting systems and provide calculations for "**MAINTAINED"** values. See IES Handbook for maintained calculations and factors.

2-1.7.6 **Manhole Design**. Provide calculations verifying that selected manhole size is adequate for training and splicing of contained cables.

2-1.7.7 **Cable Pulling Tension Calculations**. Provide cable pulling tension calculations for all medium voltage cable.

2-1.7.8 **Sag, Tension, and Guying Analysis**. Provide for overhead distribution systems.

2-1.7.9 **Cathodic Protection Calculations**. Provide calculation for all designs. Include environmental resistivities and justify all assumptions.

2-1.7.10 **CATV Network Loss Calculations**. Provide in accordance with BICSI.

2-1.8 **Non-Linear Loads.** Design secondary electrical systems to mitigate the harmonic effects of non-linear loads as a result of connections to electronic loads, including computer work stations, file servers, UPS, electronic ballasts, etc.

Harmonics are the result of non-linear loads associated with computer work stations, file servers, UPS, electronic ballasts, adjustable frequency drives, uninterruptible power supplies, large battery chargers, and electric discharge lighting to name a few. Currently there are no devices to completely eliminate harmonics, however they can be mitigated substantially to control their effect. Techniques typically include:

- Increasing Feeder Neutral Sizes
- Installing Separate Neutrals For Single-Phase Branch Circuits
- Using K-Rated Transformers
- Using Panelboards Listed For Non-linear Loads
- Passive Filters
- Insuring Proper Grounding

- Using Isolation Transformers
- Oversizing Equipment

The techniques above generally only accommodate harmonics. Designers must strive to eliminate or isolate the production of harmonics to reduce their effect on the rest of the system. When dealing with non-linear loads, it is imperative that the designer of record obtains accurate load information and precisely designs system components based on the load information obtained. Refer to UFC 3-520-01 for additional guidance.

2-1.9 **Sustainable Design.** The designer must incorporate to the extent possible, systems in the facility that will result or aide in developing high-performance, sustainable buildings. This includes:

- Use premium efficiency motors. Efficiencies must meet the minimum requirements of ASHRAE 90.1-1999, Table 10.2. Maximize use of variable speed drives.
- Lighting must be in accordance with ASHRAE 90.1-1999, Section 9.
- Maximize the use of indirect lighting
- In facilities where there may be an abundance of daylight, automatically reduce artificial lighting by dimming or on/off control.
- Reduce general office illumination from 550 lux (50 fc) to 325 lux (30 fc) using dimming ballasts with photoelectric control, manual “on” control, occupancy sensor “off” control and task lights controlled by power strips with occupancy sensors.
- For emergency lighting systems, consider a central power source in lieu of numerous discrete batteries for extremely large systems.
- Power Factor: 90 percent or greater. Use electronic ballasts to the extent possible.
- Increase feeder conductor sizes when Life Cycle Cost Analysis results in a reasonable payback period. Refer to UFC 3-520-01 for further guidance, including examples and calculations.
- Refer to LEED Rating System Version 2.1 (November 2002) for additional information.

2-1.10 **Anti-Terrorism Standards.** Design the facility to comply with UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings* and UFC 4-020-01, *DoD Security Engineering Facilities Planning Manual*.

2-1.11 **Coordination Of Overcurrent Protective Devices.** Design, furnish, and install the electrical system such that any fault in the system will be isolated by the selective operation of only the overcurrent-protective device closest to the faulted condition. The Designer of Record must be responsible for the selective coordination of overcurrent protective devices, including protective relays and medium voltage protective devices, high side transformer protection for distribution transformers, main secondary breakers, and secondary feeder protective devices.

During the design, the Designer of Record must discuss proposed relay protection schemes, including selection of relays and current transformer ratios, with the applicable EFA/EFD/FEC to ensure compatibility with any existing distribution apparatus.

The Designer of Record must ensure that construction contract documents require the Contractor to submit manufacturer's published time-current curves (on full size logarithmic paper) of primary fuses, relays, main secondary breakers, and secondary feeder protective devices. It must be stressed that this information is required during the submittal process, as it will be near impossible to obtain it at a later date when the Contractor is ready to energize the system. Using the curve information, the Designer of Record must perform a coordination study in accordance with UFC 3-520-01 and the following paragraphs to ensure that circuit components are adequately protected against short circuits and ground faults and that protective devices are properly coordinated.

Upon completion of the coordination study and successful shop drawing review, the Designer of Record must provide to the Contractor, settings for relays, main secondary breakers, secondary feeder protective devices, and any other protective devices in the circuit.

2-1.11.1 **Coordination Study**. The coordination study will typically be completed after construction is started and shop drawings have been submitted with equipment and curve data. Usually, the study is started during the design phase as several of the following required calculations will be determined from the system layout required to do the study. The complete study must include a system one-line diagram, short circuit and ground fault analysis, and protective coordination plots.

2-1.11.2 **One-line Diagram (s)**. Show, on the one-line diagram, all electrical equipment and wiring to be protected by the overcurrent devices including both breakers and fuses. Multiple one-line diagrams may be used if required to clearly present all of the required data. Also, show on the one-line diagram the following specific information:

a) Calculated fault impedance, X/R ratios, and short circuit values at the utility connection and the switchgear main bus.

b) Breaker and fuse ratings.

c) Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections

d) Identification and voltage at each bus.

e) Conduit material, feeder sizes, length, and X/R ratios.

f) Additional switching diagram:

In addition to the one-line diagram described above, provide a separate one-line diagram for station wide distribution systems that includes only the minimum required switching information for maintenance personnel. Coordinate the minimum required information with the applicable EFA/EFD/FEC or BOS. This requirement only applies when there are extensive modifications or additions to a complete station wide distribution system.

2-1.11.3 **Short Circuit Study**. The short circuit study must be part of the required coordination study. Provide in accordance with paragraph 2-1.7, CALCULATIONS.

2-1.11.4 **Coordination Curves**. Prepare the coordination curves to determine the required settings of protective devices to assure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between series devices, including the utility company upstream device where applicable. Plot the specific time-current characteristics of each protective device in such a manner that all applicable upstream devices will be clearly depicted on one sheet. Show the following specific information on the coordination curves:

a) Device identification

b) Voltage and current ratios for curves

c) 3-phase and 1-phase ANSI damage points for transformer directly fed from the switchgear

d) Minimum melt and total clearing curves for fuses

e) Cable damage curves

f) Transformer inrush points including total connected kVA inrush for feeder circuits

g) Maximum short circuit cutoff point

2-1.11.5 **Settings**. Develop a table to summarize the settings selected for each protective device. Include in the table the following:

a) Device identification and breaker or load controlled

b) Relay CT ratios and electronic set point equivalents for relay tap, time dial, and instantaneous pickup points

c) Circuit breaker sensor rating

d) Fuse rating and type

e) Ground fault pickup and time delay

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-1.11.6 **Analysis**. Analyze the short circuit calculations, and highlight any equipment that is determined to be under-rated as specified or designed. Propose approaches to effectively protect the underrated equipment. Provide minor modifications to conform with the study (Examples of minor modifications are trip sizes within the same frame, the time curve characteristics of induction relays, CT ranges, etc.). After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

2-1.11.7 **Final Report**. Summarize the results of the power system study in a final report. The report must include the following sections.

a) Introduction, executive summary, recommendations and assumptions.

b) Tabulations of equipment ratings versus calculated short circuit values and X/R ratios.

c) Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings and fuse selection.

d) Engineering analysis, commentary and recommendations.

2-1.12 **Environmental Projects**.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-1.13 **Electrical Enclosures in Coastal Areas**.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-2 **SITE ELECTRICAL UTILITIES.** The site electrical distribution must 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 must be compatible with the existing system and must meet the requirements of the applicable EFA/EFD/FEC.

Where the site service is derived from an existing primary feeder, the designer must verify that the existing circuit can support the new loads. The designer must confer with EFA/EFD/FEC or Base operating Support (BOS) group to verify the existing circuit capacity.

All primary distribution systems must be designed as four wire, multi-grounded systems which are Wye connected at the source transformer. A system grounded neutral conductor must be provided throughout the system. Equipment intended to interrupt current at fault levels must have interrupting ratings sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment.

Note: See Appendix C for additional **NAVFAC PACIFIC** Regional Specific requirements.

2-2.1 **Overhead Power Distribution.** Overhead designs must be in accordance with IEEE C2, UFC 3-501-3Nand MIL-HDBK-1004/2. Match existing base construction methods or those used by local utility. Where new overhead distribution is required, route along roadways and other major topographical features.

Connect underground extensions to pad-mounted transformers, secondary unit substations, and other primary devices to the overhead system neutral with a 600 volt insulated system neutral which must extend to all transformers, substations, and other primary devices and be connected to the grounding system of the load or other device.

Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

2-2.1.1 **Pole Details**. Use NAVFAC pole details OH-1.1 through OH-41 whenever applicable. In situations where an applicable pole detail has not been developed, provide detail(s) as required. Designer developed details must contain a level of detail equivalent to NAVFAC pole details and include material requirements. NAVFAC pole details are available at the Whole Building Design Guide's DoD page: http://dod.wbdg.org/.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.
Note: See Appendix C for additional **NAVFAC PACIFIC** Regional Specific requirements.
Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.
Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

2-2.1.2 **Overhead Conductors**. 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 EFA/EFD/FEC or BOS.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.
Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-2.1.3 **Conductor Sag & Tension**. Design power line conductors and wires in accordance with sag and tension charts and the following:

- 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. Limit the maximum design tension for any conductor to 21.1 kN (4,750 lbs).
- Provide clearance requirements using final sag values in conformance with IEEE C2 for the maximum conductor temperature. Base all clearance values on the following maximum conductor temperatures:

  a. Copper phase conductors – 75 degrees C (167 degrees F)
  b. Aluminum/Aluminum alloy phase conductors – 90 degrees C (194 degrees F)
  c. Neutral conductors for all multi-phase circuits – 50 degrees C (122 degrees F)
  d. The maximum conductor temperature for single-phase neutral conductors must be identical to the phase conductors.

2-2.1.4 **Pole Mounted Transformers**. Use only single-phase transformers. For single phase installations and when banking single phase transformers for three phase applications, primary connections must be Phase-To-Neutral unless connected on three wire distribution systems.

2-2.1.5 **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. Bond all metal, non-current carrying parts of the switch will be bonded to the pole ground conductor in accordance with IEEE C2.

2-2.1.6 **Surge Arresters and Fused Cutouts**. Provide the following information:

- Arrester kV rating

- Cutout kV and ampere rating
- Fuse link type and ampere rating

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
- Underground primary metering installations connected to and served from overhead lines

Provide surge arresters on the line and load sides of:

- Gang operated airbreak switches on overhead lines
- Primary metering applications on overhead lines
- Recloser/Sectionalizer applications on overhead lines

2-2.1.7 **Fuse Protection**. Provide backup current limiting fuses for overhead distribution transformers on voltage systems that are:

- Greater than 15 kV
- 15kV and lower 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 must be ANSI Type K to provide this coordination.

Specify:

- ANSI Type K fuse links sized as indicated on the drawing
- Testing of backup current limiting fuse in series with expulsion fuse according to ANSI C37.41

- Backup current limiting fuses manufactured by A.B. Chance Co., Cooper Industries, or an approved equal.

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.

2-2.2 **Underground Electrical Systems.** Underground electrical systems must comply with NFPA 70, IEEE C2, UFC 3-501-3N, and " UFC 3-550-03N. Use underground construction in areas where the existing distribution system is underground, where overhead construction will be operationally hazardous, or where required to feed pad-mounted transformers. Do not route primary underground utilities under buildings.

Use ductbank/manhole systems in developed areas where utilities are congested. Direct buried systems are acceptable in large open areas. Designer must get approval from applicable EFA/EFD/FEC or BOS before proceeding with a direct buried system.

All splices must be in manholes or handholes. Individually fireproof medium voltage cables in all manholes and handholes. Tag all underground cables in all accessible locations such as in manholes, transformers, switches and switchgear. Install a detectable locator tape above all buried underground circuits. Marking must meet the base utility standards.

The terms conduit, duct and ductbank used herein may be interchanged. Generally, the terms duct and ductbank are referring to a concrete encased system. The term conduit is generally referring to a direct buried system.

Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

2-2.2.1 **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. Do **NOT** use handholes for splicing shielded power cables.

Specify H20 highway loading for most locations. Structures subject to aircraft loading must be indicated to the Contractor. Design decks and covers subject to aircraft loadings per FAA AC-150/5320-6 except as follows:

a. Design covers for 45,000 kg (100,000 lb) wheel loads with 1.72 MPa (250 psi) tire pressure.

b. For spans of less than 0.6 m (2 feet) in the least direction, use a uniform live load of 2.24 Mpa (325 psi).

c. For spans of 0.6 m (2 feet) or greater in the least direction, the design must be based on the number of wheels which will fit the span. Use wheel loads of 34,000 kg (75,000 pounds) each.

Determine the size of power manholes by the number of circuits, voltage ratings and splicing requirements of the cables within. Manholes shall be a minimum 2 m (78 in) deep. Provide cable racks in all new manholes. When reworking cables in existing manholes, provide racks for new cables.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

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

2-2.2.2 **Locating Manholes (MH) and Handholes (HH)**. Provide MH/HH where splices are required, where duct lines change direction and within 30 m (100 ft) of every riser pole, pad mounted transformer, or unit substation unless a calculation is provided to justify a greater distance. The distance must not exceed 60 m (200ft).

MH separation on straight runs must not exceed 120 m (400 ft). In situations where greater separation is desired and this greater separation is not prohibited by either excessive pulling tension or site requirements, MH separation of up to 180 m (600 ft) may be permitted. Coordinate with EFA/EFD/FEC Electrical Engineer and provide calculations to verify allowable cable pulling tensions.

2-2.2.3 **Underground Duct**. Concrete encased ductbanks must utilize Type EB Schedule 20 PVC conduits with 75 mm (3 in) of concrete encasement. Direct buried ductbanks must utilize minimum schedule 40 PVC conduit. When additional crushing strength is needed, specify schedule 80. Bury ductbanks at a minimum depth of 450 mm (18 in) below grade except that under roads and pavement ductbanks must be 600 mm (24 in). Provide 75 mm (3 in) clearance between conduits utilizing interlocking plastic spacers. Provide spare ducts such that at least 1/3 of the ductbank contains empty ducts. Include pull wires in all spare ducts.

Minimum duct size must be as follows:

- Primary Distribution Ducts - 129 mm (5 in)
- Secondary Distribution Ducts – 103 mm (4 in)
- Telecommunication Ducts - 103 mm (4 in)

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-2.2.4 **Direct Buried Wiring**. Direct buried wiring for secondary systems is acceptable in large open areas only. When this option is considered, Designer of Record must coordinate with the EFA/EFD/FEC or BOS in writing and confirm with each the use of such wiring.

Generally, direct buried wiring for medium voltage systems is not allowed, but certain situations may justify its use. When considering medium voltage direct buried system, the Designer of Record must get written approval prior to proceeding with any design.

Direct buried wiring must comply with the following:

- Sleeve all direct buried circuits under roads, paved areas and railroad tracks. Under new roads, use concrete encased conduits extending 1500 mm (5 ft) beyond the edge of the pavement.
- Where direct buried wiring utilizes conduit, use galvanized rigid steel or Schedule 40 PVC conduit only. Schedule 40 PVC may be used in and under ground level concrete slabs. When additional crushing or impact strength is needed, specify Schedule 80.
- The minimum depth requirements for direct buried wiring must be in accordance with NFPA 70.
- Direct buried 600 volt conductors, whether in conduit or not, must have Type USE or Type THWN insulation only.

2-2.2.5 **Medium Voltage Cable**. Specify medium voltage cables to meet the following requirements:

- Cable Description – Include conductor size, number of conductors, insulation voltage rating, insulation level and type on the drawings.
- Cable Jacket - PVC or polyethylene jacket suitable for wet conditions. The year of manufacture must 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.
- Insulation Type - Provide ethylene propylene rubber (EPR) for new cable. Use paper insulated lead covered (PILC) only where special conditions justify.

- Insulation Level - The insulation level must be either 100% or 133% based on the system voltage level and grounding configuration, and must be coordinated with the EFA/EFD/FEC project engineer to ensure proper insulation level.
- Cable Shields - Use tape shielded cables and ensure minimum bending radii of 12 times the overall cable diameter. Use wire shielded cables only where existing manholes are utilized and the minimum cable bending radii of tape shielded cables cannot be realized. Refer to NEMA WC 8 for cable bending radii.
- Number of Conductors - Use 1/C cable as a general rule. 3/C cable may be used only when splicing to existing 3/C cable.
- Medium voltage cable must be copper.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.
Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.
Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

2-2.2.6 **Existing Conditions**. Match underground conductors with existing circuits so as to not degrade the load carrying capacity of the existing distribution system. 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. Refer to paragraph entitled “Hazardous Materials and Waste”.

2-2.3 **Regulators.** Maintain voltage at the activity within a range that will permit equipment to operate properly. Voltage regulators must be used to vary the source voltage to the user by the proper amount to keep the voltage within the limits in accordance with ANSI C84.1.

When voltage regulation is required, specify the following minimum 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.

2-2.4 **Capacitors.** When the power factor of a system is a problem, reactive kilovolt-amperes can be supplied to the electrical system by connecting banks of capacitors to the distribution circuits in substations or out on the distribution lines to neutralize the effect of user inductive loads. Occasionally capacitors may be installed inside the facility, but very rarely. When required, coordinate power factor correction with the EFA/EFD/FEC. Refer to UFC 3-520-01 for guidance in sizing capacitors for power factor correction.

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. Identify and define control and switching methods of capacitor banks. Connect capacitors ungrounded Wye, unless otherwise instructed.

When power factor correction is required, specify the following minimum 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

2-2.5 **Metering.** Meter all services by one of the following methods:

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

For all other services, provide 5 digit electronic programmable watt-hour meters with solid-state demand registers. Include necessary KYZ initiation hardware for Energy Monitoring and Control System (EMCS) coordinated with the mechanical Direct Digital

Control System (DDC). Locate watt-hour meters directly on pad mounted transformers or integral to unit substations.

2-2.5.1 Instrumentation and Relaying. Instrumentation and relaying requirements for medium voltage switchgear will vary according to the activity requirements. Coordinate with the Base Operating Support (BOS) group for specific activity requirements or preferences.

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

Provide the following minimum information using ANSI designation numbers:

- Function such as overcurrent, voltage, differential, etc.
- Quantity of each and location

2-2.5.2 Potential (PT) and Current (CT) Transformers. Coordinate connection and ratio of CTs and PTs when required for metering and relaying. Provide separate CTs and PTs for relaying and metering. Metering CTs must be single ratio.

2-2.6 **Concrete for Underground Electrical Systems.** Concrete for encasement of underground ducts must be 20 Mpa (3000 psi), minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts must be 30 Mpa (4000 psi), minimum 28-day compressive strength unless specified otherwise.

2-2.7 **Medium Voltage Switchgear.** Confirm system characteristics with BOS. Provide specific design information for the following:

- Nominal System Voltage
- Solid, resistance or reactance grounding
- Short Circuit Ratings
- Maximum Voltage Ratings
- Basic Impulse Level (BIL)
- Main Bus Ampacity
- Provide single-line, plan and elevation drawings with full details of instrumentation and relaying.

Contact the applicable EFA/EFD/FEC or BOS for the utility system data and available faults on the primary side of medium voltage equipment.When accurate data does not exist, the Designer of Record must assume that maximum available fault exists, up to possible infinite bus, and design the medium voltage system assuming such conditions.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-2.7.1 Metal Clad Switchgear. Metal-clad switchgear with Type SF-6 or vacuum style breakers must consist of a single section or multiple section line-up of NEMA 1 or NEMA 3R and may be walk-in or non-walk-in construction. Medium voltage metal-clad switchgear may be used with unit sub construction or as stand-alone switchgear. The sections must contain the vacuum breakers and the necessary accessory components. The equipment must be factory-assembled (except for necessary shipping splits) and operationally checked.

Provide adequate space for fuse handling when applicable.

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

2-2.7.2 Metal Enclosed Switchgear. Provide three-pole, single-throw, metal enclosed, load interrupter switches comprised of an integrated assembly of switches, bus and fuses which are coordinated electrically and mechanically for medium voltage circuit protection. Metal Enclosed Switchgear may be installed separately or as an integral part of unit substations. Provide adequate space for fuse handling when applicable.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-2.8 **Primary Unit Substations.** Specify primary unit substations to distribute underground medium voltage circuits. Primary unit substations must consist of incoming metal enclosed switchgear, a transformer section, and a medium voltage metal clad switchgear outgoing section. Designer of Record must coordinate closely with the EFA/EFD/FEC and BOS for all primary distribution projects.

Contact the applicable EFA/EFD/FEC or BOS for the utility system data and available faults on the primary side of medium voltage equipment. When accurate data does not exist, the Designer of Record must assume that maximum available fault exist, up to possible infinite bus, and design the medium voltage system assuming such conditions.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-2.9 **Secondary Unit Substations.** Specify secondary unit substations when secondary currents exceed 2000 amps. Secondary unit substations must consist of incoming metal enclosed switchgear, a transformer section, and a secondary metal clad switchgear outgoing section. Locate a minimum of 10 meters (33 ft) from buildings (or openings in buildings). Provide concrete pad and bollards when subject to physical damage.

Contact the applicable EFA/EFD/FEC or BOS for the utility system data and available faults on the primary side of medium voltage equipment. When accurate data does not exist, the Designer of Record must assume that maximum available fault exist, up to possible infinite bus, and design the medium voltage system assuming such conditions.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-2.10 **Pad-Mounted Transformers.** Use dead-front construction for pad-mounted transformers up to and including 750 kVA on 5 kV systems and up to and including 1500 kVA on 15 and 25 kV systems. Use pad-mounted transformers, separately protected with vacuum fault interrupter equipped switches for 34.5 kV systems. 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 must be in a secondary unit substation configuration.

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 percent of the 480 volt service transformer. Select system voltage carefully. Always connect equipment at highest available voltage to minimize the capital cost and losses of transformation equipment.

When using a pad-mounted transformer, select the applicable pad-mounted transformer detail from Appendix G, Attachments 2 through 5, supply the missing data, and incorporate that detail onto the contract drawings. Attachments represent typical situations but may not meet all requirements. Modify transformer details as required to indicate the actual requirements for each particular installation.

Appendix G, Attachments 2 through 4, depict three phase radial feed units utilizing “dead front construction” which is a typical design application. In rare cases when “live front construction” is required due to equipment ratings (available system fault current values), modify the contract documents accordingly. Likewise, Appendix G, Attachment 5 depicts single phase transformers. Appropriate contract specific details must be

provided when single-phase pad-mounted transformers are required. Do **NOT** use the pad-mounted transformer details to depict secondary unit substations.

NOTE: See Appendix D for additional SOUTHDIV Regional Specific Requirements.

2-2.10.1 Location. Transformer location with respect to buildings must meet requirements of UFC 3-600-01 and NFPA 70. Locate flammable, oil-filled transformers a minimum of 10 meters (33 ft) from buildings (or openings in buildings) when required to comply with 4-010-01. Provide concrete pad and bollards when subject to physical damage. Ensure a minimum of 3 m (10 ft) clear workspace in front of pad-mounted transformers for stick work.

2-2.10.2 Description. Specify voltage ratings in accordance with IEEE STD. C57.12.00 (example: 11.5 kV-208Y/120 volt). Transformer must have a minimum of four full 2.5 percent voltage taps, two above and two below rated primary voltage. Base and cabinets of all transformers must be corrosion resistant and be fabricated of stainless steel. Provide stainless steel tanks for transformers in coastal areas. Bases, cabinets and tanks must be factory painted Munsell green.

Pad-mounted transformers must be loop-feed type transformer with 6 bushings. Provide load break loop feed sectionalizer switches (three, two position, oil immersed type) to permit closed transition loop feed and sectionalizing. Install elbow type arresters on three bushings when used in a radial configuration in accordance with paragraph “Surge Protection”. Provide a spare conduit in the high voltage section 1500 mm (5 ft) out from the transformer pad.

Specify energy efficient transformers. Do not size transformer over 130 VA/m^2 (12 VA/ft^2) unless approved by the applicable EFA/EFD/FEC Engineer.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.
Note: See Appendix C for additional **NAVFAC PACIFIC** Regional Specific requirements.
Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.
Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

2-2.10.3 Surge Protection. Provide arrestors at the ends of all radials and in normally open locations in loops. Provide arrestors for all voltage levels.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-2.11 **Pad-Mounted Switches.** Provide SF-6 insulated, vacuum break, dead-front switches. Specify switches that have operating handles located on the opposite side of

the tank from the cable entrance bushings such that switch operating personnel will not 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 stainless steel cabinets and hardware in coastal areas.

Contact the applicable EFA/EFD/FEC or BOS for the utility system data and available faults on the primary side of medium voltage equipment. When accurate data does not exist, the Designer of Record must assume that maximum available fault exist, up to possible infinite bus, and design the medium voltage system assuming such conditions. See Pad-Mounted Transformer paragraphs for information pertaining to load break elbows.

Foundation must be 200 mm (8 in) thick with the same requirements as pad mounted transformer. Ensure a minimum of 3 m (10 ft) clear workspace in front of pad-mounted switches for stick work. Provide grounding similar to transformer requirements. Provide bollards in areas where equipment is subject to vehicular damage.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.
Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-2.12 **Pad-Mounted Sectionalizing Termination Cabinet.** When medium voltage cables are required to be accessible or tapped, and switching is not required, pad mounted sectionalizing cabinets may be used. Sectionalizing cabinets are available up to 35 kV. Specify low profile sectionalizing termination cabinets. Use stainless steel cabinets and hardware in coastal areas.

Contact the applicable EFA/EFD/FEC or BOS for the utility system data and available faults on the primary side of medium voltage equipment. When accurate data does not exist, the Designer of Record must assume that maximum available fault exist, up to possible infinite bus, and design the medium voltage system assuming such conditions. See Pad-Mounted Transformer paragraphs for information pertaining to load break elbows.

Foundation must be 200 mm (8 in) thick with the same requirements as pad mounted transformer. Ensure a minimum of 3 m (10 ft) clear workspace in front of pad-mounted switches for stick work. Provide grounding similar to transformer requirements. Provide bollards in areas where equipment is subject to vehicular damage.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-2.13 **Pad-Mounted Equipment Fault Current Ratings.** The 200A load-break separable insulated connector normally specified for use on dead-front pad-mounted transformers and switches 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 requires 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. Live-front pad-mounted transformers or secondary unit substations may also be alternatives.

The Load Break Oil Switches (LBOR’s) normally specified for use as inherent equipment on pad-mounted transformers are available with a maximum make and latch rating of 10,000 RMS amperes symmetrical. Locating the current limiting fuses ahead of the load break switch as indicated in Appendix G attachment 2 through 5 will limit the available fault current to less that 10,000 Amps.

A 38KV, 300 ampere LBOR switch is available with a 12,000 RMS ampere symmetrical rating. If used, the specification for the LBOR needs to be edited to incorporate all the 38KV switch ratings.

Contact the applicable EFA/EFD/FEC or BOS for the utility system data and available faults on the primary side of medium voltage equipment. When accurate data does not exist, the Designer of Record must assume that maximum available fault exist, up to possible infinite bus, and design the medium voltage system assuming such conditions.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-2.14 **Warning Signs.** Provide warning signs for all enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, and switchgear having a nominal rating exceeding 600 volts in accordance with NFPA 70 and IEEE C2.

2-2.15 **Housing Distribution.** Serve single dwelling units, duplexes and quadra-plexes in housing areas by single-phase, 240/120V transformers. Refer to tables F7, F8, and F9 in Appendix F for typical dwelling unit load and demand data. The following must apply unless approved otherwise by the EFA/EFD/FEC:

a) Maximum transformer size must be 50 kVA.

b) Do not serve more than 6 single dwelling units; 4 duplexes; or 2 quadra-plexes per transformer.

c) Minimum conductor size from the transformer to the service entrance equipment must be #4/0 aluminum (or copper equivalent) in conduit.

d) Provide grounding at the service entrance in accordance NFPA 70.

e) All conductors (primary and secondary) must be in conduit.

f) Maximum length of service lateral conductors (240/120V single phase) from the distribution transformer to the service entrance device (or meter base) must be 67 m (220 ft).

g) Design the distribution system such that the available fault current at the service equipment will be less than 10, 000 amps.

h) Show typical and unique secondary situations on single line diagrams.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-2.16 **Distribution System Grounding.** All power distribution must be grounded in accordance with NFPA 70 and IEEE C2. Ground rods must be copper clad steel with diameter adequate to permit driving to full length of the rod, but not less than 19 mm (3/4 in) diameter and 3050 mm (10 ft) long.

A pole ground wire will be run continuously (no breaks or sharp bends allowed) from the top of the pole to the ground rod, stapled to the pole at approximately 600 mm (24 in) intervals and protected by a plastic molding to approximately 2400 mm (96 in) from the surface of the ground. The pole ground wire will be bonded to surge arrester ground leads and to all non-current carrying parts, such as equipment tanks and guy wires.

Install driven electrodes on all poles and or structures supporting transformers, meters, switching devices, underground dips, arrester installations, and other equipment of this type. Driven electrodes must consist of one or more stacked and bonded rods or a system of rods at a single location bonded together. The top of the rod must be 450 mm (18 in) below the surface of the ground. All connections to ground rods must be by exothermic weld. When multiple driven electrodes are required, they must be driven in-line with the overhead pole line. Spacing for driving additional grounds must be a minimum of 3050 mm (10 ft). Bond these driven electrodes together with a minimum of No. 4 AWG soft drawn Bare Copper wire buried to a depth of at least 450 mm (18 in). Attain a ground resistance of 25 ohms or less at each pole where driven electrodes are required. See Table F10-Grounding Electrode Table for additional information.

On service drops to pad-mounted or substation type transformers, provide a neutral conductor to the transformer and grounded to the high voltage compartment ground pad. Do this on grounded Wye and Delta primary connected transformers.

Non-current-carrying metallic parts associated with electrical equipment must have a maximum resistance to solid earth ground not exceeding the following values:

Secondary Unit Substations	
500 kVA or less	5 ohms
500 kVA to 1000 kVA	5 ohms
1000 kVA or over	3 ohms
Pad-mounted transformers without protective fences	5 ohms
Ground in manholes, handholes, and vaults	5 ohms
Grounding other metal enclosures of primary voltage electrical and electrically-operated equipment	5 ohms
Pole Grounds	25 ohms
Grounded secondary distribution system neutral and non-current-carrying metal parts associated with distribution systems and grounds not otherwise covered	5 ohms

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.
Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-2.17 **Exterior Site Lighting.** Exterior lighting levels must be in accordance with IES HDBK, MIL-HDBK-1190, and MIL-HDBK-1013/1A. Design all exterior lighting to "**MAINTAINED"** values. Apply the most stringent when there are conflicts in the criteria.

2-2.17.1 General Guidelines. Illuminate exterior areas with pole mounted fixtures for large areas, parking and roadways and building mounted fixtures for service areas. When designing exterior lighting systems, consider glare, cutoff, and light trespass. 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). Minimize fixture types and lamp types to reduce maintenance inventories. Provide fixtures that are appropriate for the intended application.

2-2.17.2 Fixture and Pole Considerations. Use NAVFAC details XL-1 through XL-34 where possible. NAVFAC details are available at the Whole Building Design Guide's DoD page: http://dod.wbdg.org/. All fixtures and poles must be commercial grade, designated for high abuse area, and polycarbonate lens. Luminaries must be cut off type to reduce light pollution of either HPS or LPS lamps. Ballasts must be multi-voltage type.

For parking areas, specify fixtures with 150-watt HPS, mounted at 9100 mm (30 ft), and 6 lux (0.5 fc), average illumination, maintained with a 6/1 average to minimum uniformity. Where geometry permits, use 2 fixtures per pole. In parking lots and areas subject to vehicular traffic, provide concrete bases extending 760 mm (30 in) above the finished grade.

Equip high intensity discharge light source lamps such that momentary power interruptions must not cause complete loss of illumination where safety is an issue.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-2.17.3 **Wiring.** Conductors must be copper and installed in conduits or direct buried when approved. The minimum underground conduit size must be 27 mm (1 in). The minimum conductor size must be #10 AWG. Provide a separate insulated equipment grounding conductor for all site lighting circuits.

2-2.17.4 Controls. Control exterior lighting with photocell switches in conjunction with programmable time clock controllers such that lighting may be both, manually controlled or operate automatically. Coordinate with specific activity requirements.

2-2.17.5 Grounding. In addition to the equipment grounding conductor routed with circuit wiring, ground all pole mounted fixtures with a ground rod located adjacent to the pole.

2-2.17.6 Exterior Sports Illumination. Unless specifically directed otherwise, outdoor sports lighting must be in accordance with Appendix F, “Table F3-Sports Lighting Requirements.”

2-2.18 **Site Communications and Security.**

2-2.18.1 General. Overhead and Underground Communications and Security systems must meet the requirements of the Base Communications Officer (BCO) and UFC 3-580-10. Coordinate data service with the Base NMCI Representative.

Pole construction must conform to IEEE C2 and 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 local utility or published Public Utilities Standards for the particular state or area.

Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

2-2.18.2 Outside Plant. Provide voice, data, and LAN service to each facility. The Designer of Record must coordinate with BCO for copper and fiber requirements.

Unless directed otherwise by the BCO, size outside category 3 copper cable for a minimum of one pair per 9.3 m^2 (100 ft^2) of building and provide a minimum of one 12strand single-mode fiber optic cable for each facility. Coordinate cable selection and point of connection with the BCO and specify using RUS specifications.

Provide solid-state type primary communication circuit protectors with sneak current protection for all twisted pair media terminating inside a building from an overhead or underground outside plant. Locate the protector at the point of entrance in accordance with NFPA 70.

Install Underground telecommunications wiring in conduit to a depth of 610 mm (24 in). Specify concrete encased conduits for telecommunications systems when associated power conduits are also concrete encased.

2-2.18.3 BEQ/BOQ Housing. A third party vendor typically provides **non-official** phone service to housing. Provide a conduit to 1500 mm (5 ft) outside of the building for use by this vendor. Coordinate and provide the **official** outside plant phone service with the BCO.

2-2.19 **Cathodic Protection Systems.** Provide in accordance with UFC 3-570-02N. Include the following in the system design:

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.

Provide test stations along the route of pipelines for structure-to-electrolyte testing of pipelines. Include test stations every 300 m (1000 ft) 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.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-3 **INTERIOR DISTRIBUTION SYSTEMS.** UFC 3-520-01 addresses Interior Electrical Systems thoroughly and must be considered referenced in addition to specific references indicated throughout this section.

Locate interior electrical distribution equipment in electrical rooms/closets in central locations close to mechanical equipment and other major loads. Panelboards, backboards or distribution cabinets must serve equipment/devices on the same floor. Locate panels on the floor they serve. Locate major items of equipment such as electrical panels in dedicated spaces (electrical rooms) that have no other use. Equipment intended to interrupt current at fault levels must have interrupting ratings sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment.

Provide laminated plastic nameplates for each switchboard, switchgear, panelboard, equipment enclosure, motor controller, relay, switch, and device. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 3 mm (0.125 inch) thick, white with black center core.

Optimize equipment layout and circuit arrangement. All homeruns (identifying conduit and wiring back to panel) must be shown on the design drawings exactly as they are to be installed. Combine one-pole branch circuits to minimize number of homeruns. Do **NOT** show more than a 3-phase circuit; or 3 phase conductors, a neutral conductor and an equipment grounding conductor in a single conduit. When more conductors are required, provide detailed calculations showing compliance with NFPA 70 for derating conductors and conduit fill.

2-3.1 **Service Entrance and Distribution Equipment.** Size service entrance equipment in accordance with NFPA 70 and utilize one of the three options below. Size service entrance equipment early in the design process to ensure that electrical rooms and spaces are sized properly to provide the required working clearances in accordance with NFPA 70. It will be hard to get extra space at the end of the project.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-3.1.1 Switchboards. Specify switchboards for service entrance equipment when the service is over 1200 amps and branch and feeder circuits are combined sizes from 20 amps up to 600 and 800 amps. Utilize switchboards throughout the distribution system where feeders are greater than 1200 amps.

Switchboards must be dead-front metal enclosed, self-supported type and be factory assembled and tested to meet the latest applicable requirements in AIEE, ASA and NEMA. Each individual section of the switchboards must bear the Underwriters' Laboratories, Inc. label and the manufacturer's label and must comply with the applicable codes.

Bus bar must be copper or aluminum. Devices must be front accessible and must be completely isolated between sections by vertical steel barriers. Circuit breakers must have short circuit current ratings of the available amperes RMS symmetrical at the rated voltage. Provide ground fault protection for main breakers of 480-volt switchboards in accordance with NFPA 70. Specify adjustable trip breakers for all branch and distribution breakers larger than 125 amps. Do not use series rated circuit breakers and fusible switchboards.

Note: See Appendix C for additional **NAVFAC PACIFIC** Regional Specific requirements.
Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

Provide 100 mm (4 in) housekeeping pads for all switchboards. Designer of Record must size switchboards early in the design phase to ensure adequate workspace around the equipment.

2-3.1.2 Switchgear. Specify metal clad switchgear for service entrance equipment when the service is over 1200 amps and all branch and feeder circuits are large, such as 600 and 800 amps each.

The circuit breakers must be stationary or draw-out 600 volt, electrically operated with an interrupting rating not less than the available symmetrical amperes at the rated voltage. All breakers must be UL listed for application in their intended enclosure. Provide ground fault protection for main breakers of 480-volt switchgear in accordance with NFPA 70. The switchgear and circuit breakers must be the product of the same manufacturer. The switchboard must consist of the number and size of vertical frames required to support the number of feeder circuits required.

All bus bar must be copper or aluminum. Brace all bus bars to withstand the available short circuit stress at the rated voltage.

Note: See Appendix C for additional **NAVFAC PACIFIC** Regional Specific requirements.
Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

Provide 100 mm (4 in) housekeeping pads for all switchgear. Designer of Record must size switchgear early in the design phase to ensure adequate workspace around the equipment.

2-3.1.3 Panelboards. Specify panelboards for service entrance equipment when the service is less than 1200 amps and feeder circuits will fit in one panelboard. Equip panelboards with separate ground bus bars and insulated neutral bus bars. Panelboards for non-linear loads must have 200 percent rated neutral bus and have nameplates marked “Suitable for Non-Linear Loads”.

Overcurrent devices must be suitable and UL listed for the application. Circuit breakers must be bolt-on type, with an interrupting rating suitable for the system. Do **NOT** use series rated breakers or fusible panelboards.

- Mark circuit breakers, for HVAC equipment having motors (group or individual), for use with HACR type and UL listed as HACR type.

- Provide Ground Fault Interrupting (GFI) breakers to serve locations required by NFPA 70. Consider BEQ and Personnel Support Housing as dwelling units as defined by NFPA 70. In lieu of GFI breakers, ground fault protection may be accomplished by using GFI receptacles at the appropriate locations.

- Provide Arc Fault Interrupter (AFI) breakers to serve locations required by NFPA 70. Consider BEQ and Personnel Support Housing as dwelling units as defined by NFPA 70.

- Mark breakers used as switches for 120- and 277-Volt fluorescent fixtures as "SWD" or “HID”. Mark breakers used to switch HID lighting as“HID”.

Number circuits by pole number on single pole breakers and by the first pole number on two and three pole breakers such that the numbering scheme of the panel will remain intact if two or three pole breakers are replaced by single pole breakers in the future. See Appendix G, Attachments 32 and 33 for examples. When more than 42 poles are required, provide separate panelboards. Do **NOT** use dual section panelboards.

Provide 10 percent spare breakers and 10 percent empty space for all panelboards. For flush-mounted panelboards, provide spare conduits extending up above the ceiling and down below raised floors when applicable. Provide one spare conduit for every three (3) spare circuits or empty spaces.

Use load centers with plug-in breakers in housing units and BEQ/BOQ rooms. However, use panelboards for service entrance equipment and electrical distribution in BEQ/BOQ facilities.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-3.2 **Transient Voltage Surge Suppression (TVSS).** Provide TVSS to protect sensitive or critical electronic equipment or when specifically required by the EFA/EFD/FEC or BOS. When a lightning protection system is included, typically a TVSS is required on the service entrance equipment to meet the Master Label requirements.

TVSS equipment must be Listed by Underwriters Laboratories UL 1449 (Second Edition) and UL 1283, and designed, manufactured, tested and installed in compliance with ANSI C62.41, ANSI C62.45, NFPA 70, NFPA 75, and NFPA 780.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-3.2.1 Transient Voltage Surge Suppression (TVSS)- Tailor the exposure level of the building's equipment and the ampacity of the service entrance. For buildings with high concentrations of electronics equipment, employ a two stage or cascaded system. Coordinate multiple stage suppression.

Install on the load side of a 3-pole breaker and locate as close as practical to the main breaker/lugs. Provide leads as short as possible. Twist leads. Maximum lead length: 900 mm (3 ft), or for cascaded systems: 1500 mm (5 ft) for service panels and 900 mm (3 ft) for branch panels.

Provide the following specification requirements for TVSS on the service entrance equipment.

a. Use TVSS to protect the electrical service entrance equipment.
b. The manufacturer must provide written specifications showing the clamping voltage in accordance with NEMA LS-1 and with 150 mm (6 in) leads external to the enclosure, must be no higher than:

		Voltage C3 (20kV, 10kA, combination wave)
120/208	L-N	700
	L-G	700
	N-G	775
	L-L	975

277/480	L-N	1150
	L-G	1100
	N-G	1250
	L-L	1950

c. Per mode single pulse surge current rating for an 8x20 ms waveform must be no less than:

L-N	200kA
L-G	200kA
N-G	200kA
L-L	200kA

d. Protection Mode: All ten modes, have discrete suppression circuitry in L-G, L-N, N-G, and L-L and have bi-directional, positive, and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified.
e. Fusing: Individually fuse suppression components. Do not use single fuses that protect multiple suppression. Do not render the entire suppression device inoperative because of a failure of a fuse or suppression component.
f. MCOV: 115% of nominal voltage.
g. Surge Life: Greater than 6500 surges of repetitive sequential ANSI/IEEE C62.41 Category C3 waveforms with less than 10% degradation of clamping voltage.
h. Listing: The total unit as installed must be UL 1283 and UL 1449 Second Edition listed, and not merely the components or modules.
i. Validation: Independent laboratory verification of performance and durability.
j. Warranty: Not less than a 5-year warranty and include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period.
k. Diagnostics: Visual indication unit has malfunctioned or requires replacement. Provide Form C dry contacts for remote monitoring.

Provide the following specification requirements for TVSS on all the branch panelboards for facilities requiring cascaded suppression system protection.

a. Use a TVSS to protect the distribution branch panelboards.
b. The manufacturer must provide written specifications showing the clamping voltage in accordance with NEMA LS-1 and with 150 mm (6 in) leads external to the enclosure, must be no higher than:

Voltage C1 (6kV, 3kA, combination wave)		
120/208	L-N	450
	L-G	450
	N-G	500

	L-L	800
277/480	L-N	900
	L-G	875
	N-G	925
	L-L	1700

c. Per mode single pulse surge current rating for an 8x20 ms waveform must be no less than:

L-N	100kA
L-G	100kA
N-G	100kA
L-L	100kA

d. Protection Mode: All ten modes, have discrete suppression circuitry in L-G, L-N, N-G, and L-L and have bi-directional, positive, and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified.
e. Fusing: Individually fuse suppression components. Single fuses that protect multiple suppression devices must not be used. The suppression device must not become inoperative because of a failure of a fuse or suppression component.
f. MCOV: 115% of nominal voltage.
g. Surge Life: Greater than 4500 surges of repetitive sequential ANSI/IEEE C62.41 Category C3 waveforms with less than 10% degradation of clamping voltage.
h. Listing: The total unit as installed must be UL 1283 and UL 1449 Second Edition listed, and not merely the components or modules.
i. Validation: Independent laboratory verification of performance and durability.
j. Warranty: Not less than a 5-year warranty and include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period.
k. Diagnostics: Visual indication unit has malfunctioned or requires replacement. Provide Form C dry contacts for remote monitoring.

2-3.2.2 Transient Voltage Surge Suppression (TVSS)- For Dwelling Units Only (1-4 unit buildings). Install as close as practical to the main breaker/lugs. All leads must be as short as possible. No leads must be longer than 610 mm (24 in). Provide the following specification requirements for TVSS equipment.

a) The unit must have a 35 kA per mode (70 kA per phase) or greater single pulse surge current capacity.
b) MCOV: 150 V or greater.
c) Listing: U.L.
d) Testing: Tested in all modes per ANSI C62.41 and C62.45.

e) Warranty: Not less than a 10-year warranty.

Diagnostics: Visual indication unit has malfunctioned or requires replacement.

2-3.3 **Dry Type Transformers.** Use ventilated self-cooled dry-type, transformers designed for natural circulation of air through the windings, with a 220 degree C (428 degrees F) insulation system not to exceed at 80 degree C (176 degrees F) rise at a maximum ambient temperature of 40 degrees C (104 degrees F). Use moisture resistant windings, core, and coil assembly. Provide ventilated enclosure with a corrosion resisting finish. Provide internal noise isolation pads between the enclosure, core, and coil assembly. Windings must be copper.

When transformer is located in finished areas and sound is a factor, specified sound levels must be a least 3 decibels below recommended values established by NEMA ST-20.

Specify transformers with high side taps consistent with industry standards for the kVA rating of the transformer.

To the extent possible, minimize the size and quantity of dry-type transformers throughout the facility. The total capacity of dry-type transformers must not be larger than 40 percent of the service transformers.

Note: See Appendix C for additional **NAVFAC PACIFIC** Regional Specific requirements.

2-3.4 **Wiring Devices.** Wiring devices and faceplate colors must match and be consistent with the interior wall types and colors. Wiring terminals must be screwed-type, side wired only. Use grounding type wiring devices. Outlet boxes must not be placed back to back. Provide a minimum of 12 inch (300 mm) of separation between outlet boxes located on opposite sides on common walls.

2-3.4.1 Switches. Toggle switches must be specification grade, quiet type, and rated minimum 277V, 20A, totally enclosed with bodies of thermoplastic and/or thermoset plastic and mounting strap with grounding screw. Use silver-cadmium contacts and one-piece copper alloy contact arm.

Pilot lights must be integrally constructed as a part of the switch's handle. Use switches rated 20 amps with voltage ratings to meet system requirements.

Use heavy duty type safety switches. Use fused switches which utilize Class R fuseholders and fuses. Switches serving as motor-disconnect means must be horsepower rated. Unless otherwise directed use NEMA 4X stainless steel switches for switches located on building exteriors in coastal areas.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-3.4.2 Receptacles. General purpose convenience outlets must be specification grade, 20A, 120V, duplex, grounding type and must be located in accordance with NFPA 70 as a minimum. When ground fault protection is required by NFPA 70, protection may be accomplished using GFI breakers or GFI receptacles. It is the designer's responsibility to work with the architect and the user to provide a functional and usable facility. It is not the intent of the government to provide above normal density of outlets unless otherwise specified or requested by the end user. Locate general purpose and dedicated outlets in accordance with the following guidelines:

a) Mechanical Equipment: Provide receptacle within 7600 mm (25 ft) of mechanical equipment on the interior and exterior of buildings.

b) Office and staff support spaces: One receptacle for each workstation with a minimum of one for every 3050 mm (10 ft) of wall space. When less than 3500 mm (10 ft) of wall at the floor line, provide a minimum of two receptacles spaced appropriately to anticipate furniture relocations. Limit loads to a maximum of four (4) workstations per 20 amp circuit. See Appendix F, Table F5 for workstation load data.

c) Corridors: One every 15 m (50 ft) with a minimum of one per corridor.

d) Stairwells: One for each floor.

e) Janitor's closet and toilet rooms: One GFI receptacle per closet. Provide GFI receptacles at counter height for each counter in toilets such that there is a minimum of one outlet for each two sinks.

f) Space with counter tops: One for every 1200 mm (4 ft) of countertop, with a minimum of one outlet. Provide GFI protection of outlets when located within 1800 mm (6 ft) of plumbing fixtures.

g) Building Exterior: One for each wall, GFI protected and weatherproof.

h) Kitchen Non Residential: One for each 3050 mm (10 ft) of wall space at the floor line. Provide GFI protection when located within 1800 mm (6 ft) of plumbing fixture.

i) Child occupied spaces (including toilets): One for every 3600 mm (12 ft) of wall space. Use child safety type such as those that require rotating an integral surface cover plate to access current. Removable caps and plugs are not acceptable.

j) Conference Rooms: One for every 3600 mm (12 ft) of wall space at the floor line. Ensure one receptacle is located next to each voice/data outlet. Provide one receptacle above the ceiling to support video projection device. When it is expected that a conference room table will be specifically dedicated to floor

space in a conference room, locate a floor-mounted receptacle under the table. This receptacle may be part of combination power/communications outlet.

k) All other rooms: One for every 7600 mm (25 ft) of wall space at the floor line. When less than 7600 mm (25 ft) of wall at the floor line exists in a room, provide a minimum of two receptacles spaced appropriately to anticipate furniture relocations.

l) Provide power outlets throughout the building to serve all proposed equipment, including government furnished equipment, and allow for future reconfiguration of equipment layout. Provide power connections to all ancillary office equipment such as printers, faxes, plotters, and shredders. Provide dedicated circuits where warranted.

m) Housing/ Dwelling Units(including BEQ/BOQ): Provide outlets in accordance with NFPA 70. Provide AFI protected circuits in bedrooms.

n) Special Purpose Receptacles: Designer of Record must coordinate with the user to provide any special purpose outlets required. Provide outlets to allow connection of equipment in special use rooms.

o) In each telecommunications room provide a dedicated 20 amp circuit with a receptacle adjacent to each rack or backboard for each of the following:

- CCTV for training systems
- CCSTV for security systems
- CATV
- Voice systems
- Data systems

p) Provide dedicated receptacles as required throughout the facility for television monitors. These outlets will typically be located at the ceiling level for wall mounted television monitors.

q) Provide a dedicated receptacle in each conference room and training room for ceiling mounted drop down projector power. Locate outlet above drop ceiling in the center of the room. Extend circuit to wall location for connection to motorized screen.

r) Provide dedicated receptacles as required throughout the facility for tape players and disc players.

s) Provide additional convenience receptacles at 1800 mm (6 ft) intervals around the perimeter walls.

t) Provide a duplex outlet for each workstation, printer, and fax location.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-3.5 **Raceways.** Install all wiring in conduit unless specifically indicated otherwise. Minimum size conduit must be 16 mm (1/2 in). Provide an insulated green equipment grounding conductor for all circuit(s) installed in conduits and raceways. Conceal conduit in finished spaces. Conduits may be run exposed in unfinished spaces. Install exposed conduits parallel and perpendicular to walls, beams, and columns. Do **NOT** use wiring gutters in lieu of conduits.

Do not use Electrical Non-Metallic Tubing (ENT) or Flexible Non-Metallic Tubing and associated fittings.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-3.5.1 Galvanized Rigid Steel Conduit (GRS). Specify GRS conduit for all runs in masonry or concrete walls and slabs, exposed to the weather or exposed where subject to physical damage, exposed conduits on exterior of buildings and when specifically required by NFPA 70. For high salt areas, use PVC coated GRS.

2-3.5.2 Intermediate Metal Conduit (IMC). IMC may be used in lieu of GRS as allowed by NFPA 70 and when approved by EFA/EFD/FEC or BOS.

2-3.5.3 Electrical Metallic Tubing (EMT). Specify EMT for branch circuits and feeders above suspended ceilings or exposed where not subject to physical damage. Do **NOT** use EMT underground, encased in concrete, mortar or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors. Use thread-less, die-cast, raintight connectors and couplings for EMT. Do **NOT** use crimp-on or setscrew type connectors.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.
Note: See Appendix E for additional **SWDIV** Regional Specific requirements.

2-3.5.4 Flexible Metallic Conduit. Specify flexible metallic conduit, between 900 mm (3 ft) and 1800 mm (6 ft), for making motor connections, conduit drop from remote junction boxes to fixtures installed in the suspended ceiling, for vibration purposes, and for wiring to outlets installed in movable partitions. Specify liquid tight flexible metal conduit for wet and damp locations. Do **NOT** use liquid-tight flexible non-metallic conduits in the Continental United States (CONUS). In overseas locations, only use when allowed by the authority having jurisdiction.

2-3.5.5 Aluminum Conduit. Specify aluminum conduit for 400-Hertz circuits installed above grade. Do **NOT** install aluminum conduit underground or encased in concrete or masonry. Do **NOT** use brass or bronze fittings with aluminum conduit. Specify PVC conduit for 400-Hertz circuits when installed underground or encased in concrete or masonry.

2-3.5.6 Polyvinyl Chloride (PVC). Specify Schedule 40, polyvinyl chloride conduit (PVC) for service entrance conduits from the service utility to the substation or underground below floor slabs and when required for 400-Hertz circuits as indicted above. Do **NOT** use PVC above the first floor slab of buildings. Encase PVC conduits used outside of the building line with 75 mm (3 in) of concrete. When ambient temperatures are expected to vary by 14 degrees C (25 degrees F) or more, specify expansion joints for PVC conduit.

2-3.5.7 Surface Metal Raceways. Specify two-piece painted steel, totally enclosed, snap-cover type, multiple outlet-type raceway with devices as necessary.

Use surface metal raceways only in special applications including shops, laboratories, and medical facilities.

2-3.6 **Conductors.** Only use copper conductors installed in conduit. Do **NOT** use cable assemblies, types AC, MC or MI, in lieu of conduit and wire. Minimum size of conductors must be #12 AWG. Conductors must meet the applicable requirements of NFPA 70 and UL for the type and insulation, and jacket. For class 2 low-energy, remote control and signal circuits minimum conductor size must be #16 AWG. Specify color coding for all wiring.

Use 600-volt, type THWN power and lighting wires. Remote control and signal circuits may be Type TW or TF. Where lighting fixtures require 90^{o} C (194^{o} F) conductors, provide only XHHW conductors with 90^{o} C (194^{o} F) insulation or better. Provide Type USE insulation for service entrance conductors.

Do **NOT** use metal-clad cable, armored cable or flat conductor cables.

2-3.6.1 Conductors For Housing Units. Use non-metallic sheathed cable (NMC) in housing units consisting of wood or metal stud construction. Provide insulating grommets where cables pass through holes in aluminum studs.

2-3.6.2 **Note:** See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

2-3.7 **Busway.** Busway must be copper, unventilated, totally enclosed low-impedance type busway. Use circuit breaker type plug-in units. Provide a hook stick of

suitable length for operating plug-in units from the floor. Busways must include integral ground bus. Use metallic enclosures. Use plated hardware or otherwise protected to resist corrosion. Use one-bolt type Joints with through-bolts, which can be checked for tightness without de-energizing system. Maximum hot spot temperature rise at any point in busway at continuous rated load must not exceed 55^{o} C (131^{o} F) above maximum ambient temperature of 40^{o} C (104^{o} F) in any position. Provide internal barriers to prevent movement of superheated gases.

2-3.8 **Television Systems.** Television systems may be fully wired systems or only an empty conduit system for use by the activity. Coordinate all requirements with the applicable EFA/EFD/FEC and Project Manager.

2-3.8.1 Closed Circuit Television (CCTV) for Training Systems. CCTV for training is typically required in facilities where classrooms and training takes place. The systems consist of a rack or shelf mounted VCR or CD player in a central location and training programs broadcast to specific rooms or locations. The VCR and CD equipment will generally be furnished by the user. In the design include all associated conduits and wiring throughout the facility. Provide a complete cabling system similar to the CATV requirements below from the central location to each dedicated monitor outlet. Coordinate all requirements with the Project Manager and user.

For ceiling mounted drop down projectors provide a system of conduits for control wiring between each camera and motorized screen, including a wall mounted junction box for pushbutton controls. Provide a conduit from each camera location to the telecommunications closet of the floor level on which the cameras are located.

Provide a 480 mm (19 in) equipment rack in the main electrical room and in each additional telecommunications closet. Dedicate the rack to the CCTV system. Provide conduit connections between all electrical equipment rooms, sized based on the total number of cables expected but not smaller than 53 mm (2 in).

2-3.8.2 Closed Circuit Television (CCTV) for Security Systems. CCTV for Security Systems generally consist of an empty conduit system with supporting equipment and connections for a user furnished system. Typically the design consist of a system of cable supporting structures, including empty conduits with pull strings, junction boxes, outlet boxes, outlet connectors, and cover plates. Provide a power circuit to each location requiring a pan-and-tilt camera or provide single low voltage power supplies sized to feed multiple cameras from central locations and conduits to each camera location for low voltage wiring. Provide a power circuit for each power supply. Provide an empty conduit and pullstring from each closed circuit camera location to the telecommunications closet of the floor level on which the cameras are located.

Provide a void-free, fine-rated, interior grade plywood 1200 mm by 2400 mm (4 ft by 8 ft) backboard panel in the main telecommunications equipment room and 1200 mm by

1200 mm (4 ft by 4 ft) plywood backboard panels in each additional telecommunications closet. Dedicate backboard panels to the CCTV system. Provide empty conduit and pullstring connections between all telecommunications rooms, sized based on the total number of cables expected but not smaller than 53 mm (2 in). Show all camera locations on floor plans and include a riser diagram of the complete system.

When a complete system is required, provide CCTV system complete with RG/59U 95% copper cable and control wiring from each camera location back to the CCTV equipment rack location. Locate cameras to provide full coverage of the facility. All camera monitoring must occur at a central location or Quarterdeck. Provide rack or console mounted equipment. Provide a complete system with duplex multiplexer, 430 mm (17 in) monitor, and 24 hour “real-time digital recording system. System must be capable of recording all cameras. Provide digital recording for all cameras.

2-3.8.3 Community Antenna Television (CATV) Systems. Community Antenna Television Systems are generally referred to as Cable TV. Where required, provide a complete system to be owned and maintained by the government including backbone consisting of backboards/cabinets and wire and conduit with outlets and jacks in all offices, and other locations as required by the user.

Design system in accordance with BICSI, NFPA 70, and coordinate with the local CATV service provider. System must include headend amplifier when required by the local provider, amplifiers, splitters, combiners, line taps, cables, outlets, tilt compensators and all other parts, components, and equipment necessary to provide a complete and usable system. System must provide a high quality signal to all outlets with a return path for interactive television and cable modem access. Design the system to operate within the 5 to 1000 MHz bandwidth using 1000 MHz passive devices and a minimum of 750 MHz active devices. Each outlet must have a minimum signal level of 0 decibel millivolts (dBmV) (1000 microvolts) and a maximum of 15 dBmV at 55 and 750 MHz.

Use a star topology distribution system with each outlet connected to a communications closet with a feeder cable or a drop cable and each communications closet connected to the headend equipment with a trunk cable.

Provide cable installed in conduit as follows:

a. Trunk Cable, RG-11

b. Feeder cable, RG-11

c. Drop Cable, RG-6

Provide void-free, fire rated interior grade plywood, 1200 mm by 2400 mm by 19 mm (4 ft by 8 ft by 3/4 in) backboard panel in the main telecommunications equipment room and 1200 mm by 1200 mm by 19 mm (4 ft by 4 ft by 3/4 in) plywood backboard panels in each additional telecommunications closet. Dedicate backboard panels to the CATV system. Provide conduit connections between all telecommunications rooms, sized based on the total number of cables expected but not smaller than 53 mm (2 in).

Coordinate exterior cable installation with local service provider and Base Communications Officer (BCO). Provide a conduit and pull wire from a point of connection to the base system and the main distribution equipment.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-3.9 **Intrusion Detection Systems (IDS).** Coordinate IDS requirements with the Project Manager and provide in accordance with DM-13.02 when required. System requirements range from an empty conduit system to a complete installation. Typically, when required, IDS will sense all perimeter doors and windows and the interior volume in at least two locations. System must have 90-minute battery back-up and annunciate both locally and at the Base Security Office via a telephone dialer, an entry/exit timer, and wall mounted keypad control at 2 locations as minimum requirements.

2-3.10 **Lightning Protection Systems.** For new buildings procure the lightning protection system using a performance specification. The drawings must show air terminal installation details, roof penetration details, details to show concealed components of the system and details necessary to maintain the integrity of the building envelope.

When considering a lightning protection system for an addition, or modification to an existing building, or when special conditions such as connections to existing buildings occur, in order to comply with UL requirements, the designer must obtain a ruling from UL at http://www.ul.com/lighting in order to determine the extent of work required to obtain master label. This may require updating the existing systems to be in compliance with UL requirements. Test all installations and attach a UL Master Label to the building before it will be accepted.

2-3.10.1 Ordinary Structures. Perform a Lightning Risk Assessment in accordance with Appendix H of NFPA 780 to determine the risk of damage due to lightning and use the results to determine the need for protection. Provide lightning protection systems for all results indicating a system “Should” be installed. When the results indicate a system is “Optional”, the Designer of Record must make the decision whether or not to install a

system using good engineering judgement. Provide in accordance with NFPA 780, UL 96A and MIL-HDBK-1004/6.

2-3.10.2 Munitions Storage/Handling Facilities. Provide in accordance with NFPA 780, NAVSEA OP-5 and MIL-HDBK 1004/6.

2-3.10.3 Hazardous/Flammable Storage Facilities. Provide in accordance with NFPA 780 and UFGS-13100N.

2-3.11 **SCIF Facilities.** Provide wiring in accordance with DCID 6/9.

2-3.12 **Instrumentation and Controls Systems.** Instrumentation and Control Systems are generally designed by the mechanical engineer for HVAC and complicated process systems. The electrical engineer is responsible for providing power to control panels throughout the system. Coordinate all power requirements with the mechanical systems and ensure proper connections for equipment.

2-3.13 **High Altitude Electromagnetic Pulse Protection (HEMP) and TEMPEST Protection.** Refer to UFC 3-520-01 for guidance.

2-3.14 **Ordinance Facilities Systems.** Refer to NAVSEA OP-5 for guidance.

2-3.15 **28 VDC Systems.** Provide 28 VDC power in electrical test bench locations in accordance with MIL-STD-704E. Aircraft and avionics nominal utilization voltage is 28 volts. Design the feeder and branch circuits for a 4-volt drop.

2-3.16 **Hazardous Locations.** Coordinate wiring and equipment in hazardous locations with NFPA 70. Show boundaries of hazardous locations on the plans and identify the type of hazard by class, division, and group.

2-3.17 **Systems Furniture.** When systems furniture is utilized, thorough coordination between the electrical designer, the architect, and the interior designer is critical during the design process. Systems furniture is typically specified and ordered when construction is nearing completion; therefore, if proper coordination has not occurred during the design process, field interface problems could be very costly.

Systems Furniture is pre-wired to a wiring harness. The standard wiring harness will generally meet one of the following configurations:

- 5-wire harness consisting of 3 circuit conductors, 1 oversized neutral conductor and 1 equipment grounding conductor
- 8-wire harness consisting of 4 circuit conductors, 1 oversized neutral conductor, 1 full sized neutral conductor and 2 separate equipment grounding conductors

Typically, a 5-wire harness is adequate for up to 9 cubicles and an 8-wire harness is adequate for up to 12 cubicles.

Serve 5-wire harnesses with 3 separate circuits and 8-wire harnesses with 4 separate circuits. Provide oversized neutrals to match the harness configuration and balance loads between circuits and phases. A single circuit must not serve more than 4 cubicles under any circumstances. . See Appendix F, Table F5 for workstation load data.

Provide a junction box detail on the drawings showing the interface between the Systems Furniture wiring harness and the branch circuit wiring.

2-3.18 **400 Hertz Systems.** 400 Hertz systems are utilized for aircraft ground power and required wherever aircraft are parked or maintained. 400 hertz power systems must be in accordance with UFC 3-555-01N and MIL-HDBK-1028/6.

The nominal system voltage is 200Y/115V, 3P, 4 W. Aircraft are equipped with Electric Power Monitors and the system output power needs to be tightly regulated at the aircraft connection to be in tolerance with the power monitor. Aircraft power characteristics and power monitor performance are specified in MIL-STD-704E and MIL-PRF-24021K respectively. The Designer of Record must specify converters strictly in accordance with UFGS 16268N. Characteristics and monitor requirements are fully covered in the specification.

The aircraft manufacturer must recommend the converter size. The converter must be located as close as practical to the load. Aircraft power requirements are increasing and many new military aircraft require separate power sources for each aircraft. In addition, some aircraft have two connections. Closely coordinate all requirements with Activity and manufacturer's recommendations. The trend is to use individual converters for each aircraft due to the increase in aircraft power quality and load requirements and limitations of a distributed system.

2-3.18.1 400-Hertz Voltage Drop. Voltage drop with 400 hertz systems is typically 5 to 6 times that of standard 60 hertz systems and must be compensated for in all wiring systems. Utilize the following techniques to minimize voltage drop:

a) Use rigid aluminum or PVC conduit

b) Use only copper conductors

c) Use line drop compensators

2-3.18.2 Equipment Ratings. When a distributed system is used, 400 hertz power will be routed through the facility utilizing conduit and panelboards. Circuit breakers, panelboards, etc., must be rated, calibrated, and labeled by the manufacturer, and indicated on the contract drawings as 400 Hz equipment. However, the manufacturer, at

his option, may use 60 Hz equipment if the 60 Hz equipment is properly de-rated for 400 Hz operation and if the 60 Hz equipment contains the manufacturer's label stating that the equipment has been properly de-rated and is satisfactory for 400 Hz operation. When a distributed type system is required, provide detailed voltage drop calculations to verify voltage requirements throughout the system. Completely separate the 400 Hz systems from other systems (i.e., do not install a 400 Hz circuit in the same box or cabinet as a 60 Hz circuit unless barriers are used to separate sections).

2-3.18.3 Aircraft Ground Power Cables. Aircraft ground power cables must be six around one construction, designed specifically for 400-Hertz systems. Locate the aircraft service cable adjacent to the converter unit. Provide an aircraft service cable storage rack adjacent to the converter, large enough to support the cable. Match plugs with aircraft receptacle and converter unit receptacle.

Note: Aircraft plugs for Navy projects require a jumper between pins E and F. Coordinate requirements for all other projects.

2-3.18.4 Converter Input Power. Typically, 400 hertz converters have a large inrush current and branch circuit breakers feeding converters need to be sized accordingly to eliminate nuisance tripping. Typically breakers need to be rated at 200 percent or more of full load amps to avoid this problem. When upgrading the breaker, feeder wires also need to be upsized. Manufacturer's can design units that limit the inrush to the full load amp rating of the unit at a cost. When installing units in existing facilities with limited power or existing breakers, this option should be considered in lieu of upgrading the entire power system. For new construction, the large inrush is acceptable but needs to be compensated for in the design. Coordinate requirements with manufacturer where possible. If adequate information is unavailable, design for the worst case.

2-3.19 **Emergency Power Systems.** Emergency electric services are required for protection of life, property, or business where loss might be the result of an interruption of the electrical service. The extent of the emergency services required depends on the type of occupancy, the consequences of a power interruption, and the frequency and duration of the expected power interruptions.

2-3.19.1 Exit and Emergency Lighting. Because of the importance of lighting and the rate at which lighting technology changes, a separate UFC manual is being developed for lighting design and control, and will cover emergency and exit lighting. Refer to UFC 3-520-01 Appendix F until the new UFC is issued.

2-3.19.2 Fire Alarm Systems. Fire alarm systems may include fire alarm panels, sprinkler control panels, foam suppression control panels, to name a few, and must be coordinated with the fire protection engineer. Generally the complete systems are installed under Fire Protection but it is the electrical engineers responsibility to provide

power at all control panels. Provide power for the fire protection systems from the service entrance equipment as follows:

(1) 208Y/120 V or 120/240V systems:

Provide lock-on breaker in the service equipment. If more than one fire protection circuit is required, provide a dedicated emergency panel (sized for a minimum of six circuits) powered from the lock-on breaker in the service equipment.

(2) 480Y/277 V systems:

Provide circuit from the service entrance equipment (as above) to a dedicated emergency panel through a step-down transformer. Consider using a packaged power supply for this transformer/emergency panel combination. Size the emergency panel for a minimum of six circuits.

(3) Locate the dedicated emergency panel near the service entrance equipment where practical.

(4) In all cases paint the lock-on breaker in the service entrance equipment and the dedicated emergency panel enclosure red. At the service entrance equipment, in addition to the panel nameplate, provide a label with the following inscription: “Emergency Breaker Within.” Construct and fasten the label identical to the panel nameplate, except the label must be red laminated plastic with white center core.

(5) The electrical requirements for electric-drive fire pumps are discussed in detail in NFPA 20. NFPA 70 also supplements these requirements. Coordinate all pump sizes and locations with the fire protection engineer and connect in accordance with appropriate NFPA requirements.

2-3.19.3 Emergency Generator. If significant amounts of emergency power are required for loads other than emergency lighting and fire protection systems, provide a second source of emergency power in accordance with NFPA 70, IEEE 446 and NFPA 110.

For operational conditions where loads are affected by momentary loss of power, or where operational conditions require transfer loads without interruption of power, use closed-transition type automatic transfer switches. For other conditions where momentary loss of power is acceptable, use open transition switches. All switches must be 4-pole bypass-isolation type switches. Engine-generator sets must have electronic governors for paralleling. Refer to UFC 3-520-01 for additional guidance.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-3.19.4 Uninterruptible Power Supplies (UPS). UPS units are typically authorized only for the support of critical automatic data processing, communications, electronic security, and safety equipment and systems that require continuous electrical power for proper operation. Coordinate with the Project Manager and when required, provide in accordance with UFC 3-520-01.

2-3.20 **Intercommunications Systems.** Include Intercom and Public Address/ Paging systems for intercommunications systems. Coordinate locations with the end users. With the exception of a Maintenance Control Intercommunications System indicated below, intercommunications systems may, and in most cases should, interface and utilize telephone handsets for announcements. This type of system requires newer standard office type telephone desk sets with various option buttons and features. When utilizing the telephone system, designer must specify the interface device and ensure it is compatible with the telephone system.

2-3.20.1 Intercom Systems. Intercom Systems must provide two-way communications between all office spaces, locker rooms, storage areas, Department Heads, Commanding Officer, Executive Officer, Officers Ready Rooms, Maintenance Control Rooms, Administration Offices and Maintenance Administration Offices. Two way hands free operation speakers should be utilized for spaces such as locker rooms, etc.

2-3.20.2 Public Address/Paging Systems. Public Address/Paging Systems must have speakers in common spaces and exterior speakers for outside activity spaces. Coordinate locations with the end user. Provide zone and volume control for all areas. In hangar spaces and other large open maintenance areas, provide an individual handset type microphone dedicated to speakers in that space only. Interface the Public Address System with the Mass Notification System when feasible. Provide zone and volume control for all areas. Coordinate locations with the end users.

2-3.20.3 Maintenance Control Intercom Systems. Maintenance Control Intercom Systems must provide two-way communications between the Maintenance Control Office and all shop spaces. This system must stand alone and be completely independent from the telephone system. Provide zone and volume control for all areas. Coordinate locations with the end users. The system must not utilize telephone handsets for announcements.

2-3.21 **Battery Rooms.** Battery rooms (or rooms or areas in which batteries are charged) must be provided with ventilation sufficient to prevent the accumulation of over 2 percent gaseous hydrogen by volume. Battery rooms must not be located in hazardous areas and will not be required to be classified as hazardous areas. Refer to UFC 3-520-01 for additional guidance.

2-3.22 **Grounding Systems.** Provide grounding systems in accordance with NFPA 70, IEEE 142, IEEE C2, and MIL-STD-188-124; "MIL-HDBK-1012/1, NAVSEA OP-5 and other criteria as applicable. The most stringent must apply where there is a conflict in criteria. Isolated grounds are not allowed unless required by NFPA 70.

Provide detailed grounding requirements in the construction documents including a separate grounding plan for extensive requirements. Include a Grounding Diagram similar to those depicted in Appendix G, Attachments 29 through 31.

2-3.22.1 Power Systems Grounding. Provide a Grounding Electrode Conductor for each service entrance in accordance with NFPA 70 and as a minimum, bond three connections to any of the following:

- Metal Water Pipe
- Concrete encased electrode
- Metal building frame
- Driven ground rod

Provide an insulated equipment grounding conductor in all raceways for systems operating at greater than 50 volts. Do **NOT** include an equipment grounding conductor with service entrance conductors.

2-3.22.2 Electronic Equipment Grounding. Provide in accordance with IEEE 1100, NFPA 70, and , "MIL-HDBK-419A (as applicable).

2-3.23 **Structured Cabling Systems.** Provide a design for a completely cabled, terminated and protected system in a star topology including voice, data, and video telecommunications that will support a multi-product, multi-vendor, and multi-media environment. The design must be in accordance with BICSI Telecommunications Distribution Methods Manual (TDMM) except where other requirements herein deviate from the BICSI guidance. MIL-HDBK-1012/3 and the Navy and Marine Corps Intranet (NMCI) requirements in UFC 3-580-10 must be used to provide specific guidance on the methodologies to be followed during the design of facilities. Designs will also incorporate the latest applicable technological requirements in the current EIA/TIA industry standards. Designs for facilities large enough to require more than one telecommunications room must be performed and stamped by an RCDD.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

The Designer of Record must identify all spaces required for the structured cabling system early in the design. The number of rooms and the minimum area required needs to be coordinated with the floor plans to ensure adequate space is provided.

Appendix G, Attachment 1 is a Telecommunications Coordination and Responsibility Chart, and is provided to help the designer coordinate his/her effort with the appropriate government personnel.

2-3.23.1 Telecommunication Spaces. Provide Entrance Facilities, Equipment Rooms and Telecommunications Rooms for each facility. Size telecommunications rooms, equipment rooms, and entrance facilities in accordance with UFC 3-580-10. UFC 3-580-10 also includes information on mechanical, electrical, and structural requirements. When sizing the telecommunications spaces, consideration must be given to NMCI, Voice, Legacy Systems, and other required systems such as CATV, Intrusion Detection, mass notification, public address, CCTV. Provide dedicated space for each system. Cover a minimum of 2 walls in all rooms with 19 mm (3/4 in) fire-rated plywood.

Provide at least one telecommunications room on each building floor; additional rooms may be required if usable floor space exceeds 930 m^2 (10,000 ft^2) or when horizontal cable runs exceed 90 m (295 ft) in length. The telecommunication room must be located as close as practical to the center of the area being served, and preferably in the core of the building. In multi-story facilities, telecommunications rooms must be stacked. Early coordination with the Architect is required to insure proper locations and adequate space is provided. Equipment rooms and entrance facilities may be combined with telecommunications rooms for small systems and only when there is adequate space for the required equipment. Lockable cabinets may be used instead of rooms in buildings with 92 m^2 (1000 ft^2) or less of useable space.

Provide NMCI/Telecom spaces with independent heating & cooling systems, refer to UFC 3-580-10 for requirements. Mechanical designers may not be familiar with this requirement and may need direction from the telecommunications designer.

2-3.23.2 Distribution Frames. Equip telecommunication rooms with distribution frames for terminating all telecommunication cables. Terminate all entrance, horizontal and backbone cabling. All cabinets, racks, and brackets must be compatible with 482 mm (19 inch) equipment. Provide all cross-connecting hardware and patch cords.

a. Provide all terminations on racks or lockable cabinets. Typically, racks in a lockable room are sufficient. Provide lockable cabinets for locations and equipment that require additional security. Provide racks with vertical and horizontal cable management channels and top and bottom cable troughs, grounding lug and 6-receptacle surge protected power strip. Provide cabinets with grounding bar, roof mounted 15 m^3/min (525 CFM) fan, 6-receptacle surge protected power strip, removable/lockable side panels, front and rear doors.

b. Provide separate termination fields/patch panels for different voice/data systems. Provide terminations and cross connect jumper cables (i.e. patch

cords) to allow all communication cross connects capability plus 25 percent. Patch panels must be modular to 110 and have a maximum of 48 non-keyed RJ-45 ports.

c. Wall mounted, Type 110 cross-connect blocks for termination of voice systems may be substituted for rack mounted patch panels when approval is received from the Authority Having Jurisdiction. Final voice system cross connects will be performed by the Government.

d. NMCI Contractor will furnish separate freestanding lockable cabinets for NMCI terminations. Refer to UFC 3-580-10 for requirements.

e. Provide 100 percent spare rack capacity based on the amount of rack capacity utilized by the patch panels provided. This is for the mounting of government purchased and installed LAN equipment.

f. Provide a trained service loop at all terminations for future modifications.

g. Provide a building entrance protector assembly to protect all outside copper media cable pairs entering the facility.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-3.23.3 Backbone Cable and Pathways. Provide pathways for backbone cabling in accordance with EIA/TIA-569 and UFC 3-580-10.

Provide and terminate voice backbone cables to support all horizontal voice cables. Utilize Category 5e Unshielded Twisted Pair (UTP) copper cable for voice backbones. Size voice backbone cable for one active pair per outlet served plus at least 50 percent spare capacity.

Provide data backbone cabling in accordance with one of the following:

- If a legacy network is required, provide 6/6 multi-mode/single-mode fiber optic data backbone cable from each intermediate cross-connect (IC) back to the main cross-connect (MC). Terminate all cabling on patch panels as indicated above.
- For NMCI, provide a data backbone pathway in accordance with UFC 3-580-10. The NMCI contractor must provide the backbone cable for the NMCI system.

2-3.23.4 Horizontal Cable and Pathways. Provide pathways for both voice and data horizontal cabling in accordance with EIA/TIA-569. Horizontal pathways must be conduit or a combination of conduit and cable tray. When cable trays are utilized, provide cable tray above corridor ceilings or other central locations. Coordinate installation of cable tray with other trades to ensure a minimum of 300 mm (12 in) headroom for future access. Use conduit from the tray to individual outlets. Run concealed conduits in all

finished spaces except that Protected Distribution Systems (PDS) must comply with paragraph 2-3.24. Protected Distribution Systems (PDS). Ground all conduit and cable tray pathways in accordance with NFPA 70 and J-STD-607.

Voice and data cabling will be Category 5e Unshielded Twisted Pair (UTP) copper cable, not exceeding 90 m (295 ft) in accordance with EIA/TIA 568-B.1 for horizontal cable runs. As a minimum, horizontal cabling must consist of one Voice and one Data cable. Provide additional cabling as required for legacy system and special Voice or Data requirements. Terminate all horizontal cabling on rack or cabinet mounted patch panels. Horizontal voice cabling may be terminated on wall mounted Type 110 cross-connect blocks when approval is received from the Authority Having Jurisdiction.

Terminate data horizontal cabling in accordance with one of the following:

- When legacy system is required, terminate all data horizontal cabling on rack or cabinet mounted patch panels.
- For NMCI, terminate all data horizontal cabling on jacks and provide service loop at cabinet furnished by NMCI. Refer to UFC 3-580-10 for specific requirements.

2-3.23.5 Workstation Outlets. Provide workstation outlets (same as Work Area Outlets in UFC 3-580-10) consisting of a minimum of 1 Voice + 1 Data (1V + 1D) Category 5e, RJ-45, 8 position jacks contained in a single quad-4 position faceplate in accordance with UFC 3-580-10. Provide additional voice, data jacks, and outlets as required for legacy and special data or voice systems.

a) Provide workstation outlets as required by user and as required to provide general coverage to facilitate equipment and personnel relocations without adding outlets.

b) Provide at least one outlet at each workstation. Provide a minimum of two communications outlets for permanently installed offices and system furniture cubicles larger than 6 m^2 (64 ft^2). Locate outlets to facilitate future furniture locations.

c) When specific information is unavailable, provide dedicated workstation outlets for all ancillary office equipment such as printers, faxes and plotters based on 1 per 55 m^2 (600 ft^2) of office or floor space.

d) Provide a workstation outlet adjacent to DDC Panels for mechanical system controls.

e) In conference rooms, provide a work station outlet above the ceiling for computer driven video projection equipment. Provide junction boxes at the

ceiling and wall, and an empty 27 mm (1 in) conduit with pull strings for future use between the boxes. Provide floor workstation outlets under conference tables in dedicated conference rooms. These outlets may be part of a combination power/communications box. Provide an additional Video Teleconferencing (VTC) outlet containing a minimum of 3 RJ-45 jacks in all conference rooms located as required.

2-3.23.6 Telecommunications Grounding. Provide telecommunications grounding in accordance with NFPA 70 and UFC 3-580-10.

2-3.23.7 Telecommunications Power. The NMCI contractor may require a dedicated power panel in each telecommunications room in accordance with UFC 3-580-10. Power system must have the capacity to support NMCI requirements. Provide breaker space in the nearest electrical panel and an empty conduit with pull wire to the telecommunications space sized in accordance with the requirements in UFC 3-580-10 when a dedicated power panel is required.

2-3.23.8 BEQ/BOQ Housing. Completely wire the building interior conforming to UFC 4-721-10 and applicable EIA/TIA standards. In BEQ/BOQ housing, the communication room may be located every three floors provided cabling distances are within EIA/TIA standards.

2-3.23.9 Family Housing. Provide a complete structured telecommunications system in accordance with TIA/EIA/570-A. Provide Grade 1 wiring for units with less than 140 m^2 (1500 ft^2) and Grade 2 wiring (excluding optical fiber) for units with 140 m^2 (1500 ft^2) or more. Locate the distribution device adjacent to the residential load center. In addition to outlet locations required by TIA-570B, provide two outlets on opposite walls in the living room, family/great room, den/study, and each bedroom. Provide one outlet in dining room and garage if provided.

2-3.23.10 Testing. The specification must require specific tests in accordance with the EIA/TIA standards. Media Testing must be performed using the latest EIA/TIA guidance including annexes and technical bulletins. Emphasize these requirements in the specification. Do NOT use the phrase, “Test in accordance with EIA/TIA standards.” The OTDR must test all fibers in both directions.

2-3.24 **Protected Distribution Systems (PDS).** Protected distributed systems are used to protect the transmission of unencrypted classified information such as the Secret Internet Protocol Router Network (SIPRNET), and are required throughout many industrial and administration type facilities. Coordinate requirements with the activity and Project Manager. When a PDS is required, provide in accordance with UFC 3-580-10.

2-3.25 **HVAC Systems.** The mechanical engineer will determine which equipment will have integral magnetic contactors and/or disconnect switches and which equipment will require separate magnetic motor controllers and disconnect switches. In general, packaged refrigeration equipment has integral magnetic contactors and in some instances will have an integral disconnect switch also. Air-handling units and pumps usually require separate magnetic motor controllers and disconnect switches.

The electrical engineer, in conjunction with the mechanical engineer, will determine the location of motor controllers and disconnect switches. Place motor controllers and disconnects in readily accessible locations as defined by NFPA 70.

The electrical engineer must **NOT** provide any magnetic motor controller information for mechanical equipment on the electrical drawings, but must determine the type of controller required (full voltage, reduced voltage, reversing, multi-speed, NEMA size, and NEMA enclosure type) and furnish it to the mechanical engineer for incorporation in mechanical equipment schedules. Mechanical equipment schedules must also include electrical characteristics of motor and packaged equipment; e.g., voltage, full load amperes or minimum circuit amperes, number of phases, horsepower, and frequency. Note integral disconnects, if provided, in the mechanical equipment schedules and coordinated with the electrical drawings. Require integral disconnects be furnished with thermal overloads where appropriate for small fractional horsepower motors. The mechanical specifications must be coordinated with the mechanical equipment schedules and mechanical plans.

2-3.25.1 Motor ratings. All motors 1/2 HP and larger must be 3-phase. Operate motors at full capacity with voltage variations of plus or minus 10 percent motor voltage rating. Provide power factor correction for motors where required to maintain system power factor.

Note: See Appendix B for additional **NAVFAC ATLANTIC** Regional Specific requirements.

2-3.25.2 Motor Control Equipment. Use Motor Control Centers (MCC) only when there is a centralized location for the control of a large number of motors. Use individual motor starters for all other applications.

MCC must be factory assembled, dead front units, totally enclosed, free-standing type, with structures joined to form one assembly but designed so that the units may readily be removed and other structures added as required in the future. List and brace the entire assembly for maximum fault available, with equipment busing connections, and with the following minimum provisions:

- Means for locking each circuit separately.

- Class A, factory wired, complete including breakers, contactors, starters, relays, transformers, and other required items.

- Lifting angles or eyebolts to facilitate hoisting and placing.

- Each structure with two horizontal wiring spaces, one at the top and one at the bottom, which will line up with the adjacent units to convenient wiring raceways the entire length of the control center.

- Copper bus throughout with a separate ground bus bar the entire length of the motor control center.

Provide controllers with 120-volt controls including accessories and auxiliary contacts for automatic or remote operation. Controllers must have thermal overload protection in each phase and must have one spare normally open and one spare normally closed auxiliary contact. Magnetic-type motor controllers must have under-voltage protection when used with momentary-contact pushbutton stations or switches and must have under-voltage release when used with maintained-contact pushbutton stations or switches. When used with pressure, float, or similar automatic-type or maintained-contact switch, controller must have Hand/Off/Automatic selector switch. Control circuit connections to Hand/Off/Automatic selector switches or to more than one automatic regulatory control device must be made in accordance with manufacturer's approved wiring diagram.

Provide controllers for 3-phase motors rated 1 HP and above with phase voltage monitors designed to protect motors from phase loss and over/under voltage. Provide means to prevent automatic restart by a time-adjustable restart. For packaged equipment, the manufacturer must provide controllers with the required monitors and timed restart.

Multiple-Speed And Reversible Motor Controllers must be across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers must have compelling relays and must be multiple-button, station-type with pilot lights for each speed.

Provide reduced voltage starters for motors 25 horsepower and larger. Reduced-voltage starters must be single-step, closed transition either autotransformer or solid state-type, and must have adjustable time interval between application of reduced and full voltages to motors. Wye-delta reduced voltage starter or part winding increment starter having adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced-voltage starters for starting of centrifugally operated equipment, or reciprocating compressors provided with automatic unloaders.

Use Manual Motor Starters for fractional horsepower motors 1/8 hp and larger. Starters must be single or double pole designed for flush or surface mounting as required with overload protection. Include pilot lights when used with motors above ceilings and controller is located at floor level. Typically, manual starters should be located adjacent to the motor they serve.

Provide VFD to control the speed of induction motors when required or indicated by the mechanical design. Use separate enclosures for VFD that are not integral to Motor Control Centers.

2-3.26 **Interior Lighting Systems.** Because of the importance of lighting and the rate at which lighting technology changes, a separate UFC manual is being developed for lighting design and control, and will cover emergency and exit lighting. Refer to UFC 3-520-01 Appendix F until the new UFC is issued. Design all lighting systems to **"MAINTAINED"** VALUES.

Note: See Appendix D for additional **SOUTHDIV** Regional Specific requirements.

CHAPTER 3 SUBMITTAL REQUIREMENTS

3-1 **GENERAL.** This chapter defines minimum information that must be provided at the various submittal levels of design. During the design submittal process, the Designer of Record must clarify major comments with a phone call to the appropriate Government reviewer, rather than wait until the next submittal to respond. Whenever possible, the Designer of Record is encouraged to try and meet with the reviewer in person to discuss comments.

The information included herein, is intended to provide a consistency in designs, formats and submittal packages to help the process flow smoothly. If both designers and reviewers follow this format, reviews should be easier and comments fewer. Refer to UFC 1-300-09N for drawing and specification preparation procedures.

3-2 **DESIGN ANALYSIS.** The Design Analysis is a presentation of facts to demonstrate the concept of the project is fully understood and the design is based on sound engineering principles. Include the following information as a minimum in the Design Analysis.

3-2.1 **Basis of Design.** Provide a written narrative accurately depicting the electrical and telecommunication design and address the design approach to all electrical systems. Include a complete list of all design standards and references used in the decision making process. Update the Basis of Design for each submittal to accurately depict the current state of the design.

It should be noted that designers tend to skimp on this requirement, seeing it as a waste of time. On the contrary, this document will follow the design from start to finish and will be your documentation of why or when decisions were made concerning the design, including names of persons directing you.

Include the following information as a minimum:

3-2.1.1 Exterior Distribution Systems. Describe the primary source of power including location, adequacy and characteristics. Estimate load, transformer size and service size.

A. Existing Primary Power Source - Identify the location of the point of connection into the existing primary system. Address the characteristics of this primary system, including voltage, phase, number of conductors, available fault current, and voltage regulation. Address the adequacy of the primary system; if inadequate, state measures proposed to correct the inadequacy.

B. Estimated Electrical Project Load - Provide an estimate of total connected load and the resulting kilowatt demand load.

C. Voltage Selection - Provide basis for selection of primary and/or secondary voltages.

D. Conductors - Indicate conductor material and where proposed to be used. Indicate type of insulation on cable systems.

E. Standards of Design - Describe pertinent standards of design, such as voltage drop, equipment ratings, types of luminaires and luminance values.

F. Special Systems - Identify any special systems, such as Intrusion Detection Systems (IDS) or Cable Television (CATV). Describe how and where the facility will connect to the basewide Mass Notificaton System.

G. Telecommunications System - Identify point of connection into base telephone system. Describe modifications, if required, to existing base telephone system.

H. Materials - Manufacturer's data sheets and product data for equipment chosen or designed around.

3-2.1.2 Interior Distribution Systems. Concisely describe the Electrical Systems including the following: Lighting systems, Power systems, Emergency lighting, Emergency power, Grounding system or systems, Telephone system, Other systems such as television, paging, call, etc., Physical and electronic security features such as IDS, lighting access control, tempest, etc.

A. Electrical Characteristics - Describe the electrical system to be provided and justify its selection. Indicate voltage, phase, and number of conductors.

B. Estimated Electrical Loads - Provide a breakdown, by category, of the estimated loads. Include lighting, convenience outlet, mechanical equipment, special operating equipment, user equipment, and miscellaneous in load categories.

C. Wiring Methods - Indicate the type of wiring method, such as rigid conduit, electrical metallic tubing, cable tray, nonmetallic sheathed cable, etc., and where proposed to use.

D. Conductors - Indicate the type of conductors and insulation material such as CU, AL, THW, XHHW, etc., and where proposed to use.

E. Standards of Design - Describe the proposed standards of design, such as voltage drop, illuminance values, type of light sources, and, if applicable, a statement regarding the use of selective switching or other energy conserving features.

F. Special Systems - Describe the proposed type of systems. Indicate each system's function and the interrelationships between systems, when applicable. Identify government-furnished equipment, if any. Special systems include such systems as Cable Television (CATV), Closed Circuit Television (CCTV), Intercom, Sound, Nurse Call, Security, Uninterruptible Power Supplies (UPS), etc.. Identify special security requirements, such as Tempest, Red/Black criteria, etc.. Identify special physical security requirements.

G. Telecommunications Systems - Describe system/systems to be used. Identify space required for telecommunication equipment, and size of incoming duct/conduit. Include statement relative to interface provision for multi-use systems (i.e., intercom, voice, data, etc.). Include documentation concerning telecommunications room sizes. Keep records of whom this information was given to early in the design.

H. Materials - Manufacturer's data sheets and product data for equipment chosen or designed around.

3-2.1.3 **Instrumentation and Controls**. The mechanical engineer generally designs the Instrumentation and Controls associated with HVAC and process systems. Coordinate all requirements with mechanical and indicate where any connections will be provided, either empty conduits or power wiring as required.

3-2.2 **Electrical Calculations.** The Designer of Record must provide calculations to verify proper design and operation of the facility to the point of connection to the existing electrical systems. Calculations must be in accordance with Chapter 2, "Design Requirements."

Assumptions and given data must be clearly indicated. Calculations must be described fully and must be written clearly and must lead the reviewer through the design by stating all assumptions and decisions. Computer printouts are acceptable only if accompanied by explanations to allow adequate review of calculation methods and results.

Calculations must provide complete analysis with supporting data. Analysis must cover system arrangement, voltage selection, and major equipment selections including load analysis and equipment sizing calculations. Whenever the sizing of electrical transformers, breakers, electric cables, etc., is to be performed, provide calculations to verify proper facility design. When specific calculations are not applicable, Basis Of Design must so state. The following calculations are required:

1. Load Analysis
2. Short Circuit
3. Voltage Drop
4. Motor Starting / Flicker Analysis

5. Lighting
6. Manhole Design
7. Cable Pulling Tension
8. Sag, Tension and Guying Analysis
9. Cathodic Protection Calculation
10. CATV Network Loss Calculations

3-2.3 **Drawings General.** Provide adequate plans, including demolition, existing conditions, and new work, legends, details, diagrams, etc., to clearly define the work to be accomplished. Coordinate construction drawings and specifications. Try to show information only one time in one place to avoid conflicts.

Provide a General Note at the beginning of the Electrical Drawings clarifying the work to be accomplished. The following note is recommended for most jobs:

"**ALL ELECTRICAL WORK AND MATERIAL IS NEW AND MUST BE PROVIDED BY THE CONTRACTOR UNLESS INDICATED OTHERWISE**".

A. Arrangement

Arrange the Electrical Drawings in the following order:

Legends and Abbreviations
Demolition Plan(s)
Site Plan(s)
Lighting Plan(s)
Power and Communications Plan(s)
Grounding Plan
Roof Plan
Lightning Protection Plan
One-Line/Riser Diagrams
Schedules and Elevations
Details/Diagrams
Lighting Fixture Details
Pole Details

B. Presentation

Drawings must be clear and consistent in presentation and format.

Follow the NFPA 70 Metric Designations (mm) and Trade Sizes (inches) for conduit.

C. Multiple Conduit/Cable Runs

To avoid misinterpretation as to the quantity of cables and conduit required in multiple conduit and cable runs, use one of the following acceptable descriptions:

- Acceptable: Two 91C, each containing four 500 kcmil and one #2 Gnd
- Acceptable: Two 91C, each with four 500 kcmil and one #2 Gnd
- Acceptable: Two 91C, with four 500 kcmil and one #2 Gnd in each conduit
- Unacceptable: Two sets of four 500 kcmil and one #2 Gnd in 91C
- Unacceptable: Parallel Service: Four 500 kcmil and one #2 Gnd in 91C

3-2.3.1 Legends and Abbreviations. Locate legend on the first electrical sheet. Use multiple legends where required; carefully identify the specific use of each legend. Use different legends for new and existing work. Avoid using composite legends that include all symbols but fail to indicate which symbols are to be used where. See UFC 3-500-10N for standard legends and abbreviations.

3-2.3.2 Site Plans. Show utility point of connectivity to the base power and telecommunications systems on the site plan. Provide explicit direction on method of entering existing manholes. Provide all details including composition of duct banks and depth and configurations of the duct banks.

Electrical Site Plans must be separate and distinct from other utility site plans and must be included with the electrical drawings. However, when project requires only minor utility work, electrical and civil site plans may be combined. Coordinate with the electrical engineering reviewer before combining the electrical and civil site plans.

The orientation of electrical drawings must be consistent with the civil drawings. In addition, the orientation of partial building or site plans must be identical to the orientation of the larger plan from which the partial was taken. Indicate the exact title of each particular detail, partial plan or elevation as identified on the cross-referenced sheet.

For overhead distribution use a separate symbol for each individual circuit; define each circuit by voltage level as well as number, size and type of conductors. Coordinate guying and conductor sag information shown on the drawings with that shown in the specifications.

When in doubt as how to show overhead distribution work carefully review the information contained on Details OH-1.1 through OH-1.5a available at www.navfac.navy.mil. Do not describe proposed work by referencing sketch numbers

instead of pole detail designation symbols. Do not use pole detail designation symbols to describe existing facilities to be removed.

When using pole details, place a note referencing the pole detail designation symbols (similar to the following) on the drawings:

“XFB, 15FR3-N, etc., are pole detail designation symbols. Refer to Sketches OH-1.1 through OH-41 on Sheets _____ for an explanation of the use and description of equipment provided by these symbols.”

To maintain the integrity of the pole details, do **NOT** modify pole details; include any required exceptions or modifications as supplemental information with the pole detail designation symbols.

Indicate conductor initial sag values. Provide initial sag values at ambient temperatures in 10 degree C (15 degree F) increments for a temperature range, which includes the outside summer and winter design temperature values. Clearly indicate each different calculated ruling span on the plans and provide initial sag for one span in the calculated ruling span.

Provide appropriate detail indicating the use of backup current limiting fuses with the device being protected. Use the appropriate transformer symbol for current limiting fuses when using the poles sketches. Indicate the ampere rating of the ANSI Type K expulsion fuse link as well as the voltage rating and current designation of the backup current limiting fuse.

Locate Pad-Mounted Transformers with respect to buildings in accordance with UFC 3-600-01 and NFPA 70.

Provide the following transformer descriptive information:

- Transformer type (e.g., pad-mounted, pole mounted, station type, unit-sub)
- KVA, Single or Three Phase
- Voltage ratings per IEEE STD. C57.12.00 (e.g., 11.5KV – 208Y/120 volt)
- Primary and secondary connection (when using single-phase units for three-phase service; specifically indicate how the units are to be connected, i.e., connect Delta-Wye grounded for 208Y/120 volt secondary service)

Include the following information about surge arresters and fused cutouts:

- Arrester kV rating

- Cutout kV and ampere rating
- Fuse link type and ampere rating.

Profiles may be required for ductbank runs. Discuss profile requirements with the electrical reviewer. Indicate structure (manhole and handhole) tops, ductbank elevations, slopes and diameters. Coordinate structure numbers with plan sheets. Show and label all crossing utility lines, both existing and new. If depths of existing utilities are unknown, indicate the horizontal location of the utility and indicate the vertical location with a line representing the anticipated range of elevations where the utility will be found in the field. Indicate the method of new utility installation routing above or below conflicts.

Provide a cable/ductbank schedule indicating cable identification, description, conduit size and remarks.

Provide manhole foldout details or exploded views for all multiple-circuit primary systems and all primary systems requiring splices. Indicate the entrance of all conduits and the routing of all conductors in the manholes.

3-2.3.3 Demolition Plan(s). Provide “Demolition” plans separate and distinct from “New Work” plans, except where only minor demolition work is required. Clearly show what is to be demolished, at an appropriate scale. Indicate the beginning and ending points of circuit removals.

For modification of or additions to existing equipment, provide the manufacturer’s name and other pertinent manufacturer’s identification (e.g., serial number, model number, style, and any other manufacturer’s identifying markings).

Provide a sequence of demolition; if necessary, include any known requirement for continuous operation and limited shutdown requirements. Identify these in the special scheduling paragraphs of the specifications.

Indicate the quantity of lighting ballasts that contain PCB’s and the quantity of lamps that contain mercury.

3-2.3.4 Lighting Plans. Do not show lighting and power on the same floor plan, unless the scale of the plan is 1:50 (¼” = 1’ – 0”) or larger. Provide a Lighting Fixture Schedule as illustrated in Appendix G, Attachment 23.

3-2.3.5 Power Plans. Show all power requirements and points of connections. Specifically identify each piece of HVAC and mechanical equipment (e.g., unit heater No. 1, unit heater No. 2, etc.). See Appendix G, Attachments 24 and 25 for typical illustrations of how to properly display equipment on the contract drawings.

3-2.3.6 Communications Plans. Show locations of voice and data outlets in each room, closets, equipment spaces, etc. Detail all outlet, cable tray and backboard or distribution frames.

Note: Power and communication systems may be shown on the same floor plans provided the design is small, the electrical designer and the telecommunications RCDD are the same person, and combining the drawings is approved by the EFA/EFD/FEC engineer. However, when there is extensive communication work to be shown, show power and communication systems on separate plans.

3-2.3.7 Grounding Plan. Provide grounding plans and details at an appropriate scale.

3-2.3.8 Roof Plan. When roof mounted HVAC equipment cannot be adequately shown on the Power Plan, provide an appropriately scaled roof plan.

3-2.3.9 Lightning Protection Plan. Provide lightning protection plan and details at an appropriate scale. Procure lightning protection systems using a performance specification. Plan must indicate locations and number of system components required. Show air terminal installation details, roof penetration details, details to show concealed components of the system and details necessary to maintain the integrity of the building envelope.

3-2.3.10 Hazardous Location Plan. Identify on the drawings the boundaries and classifications of all hazardous locations in accordance with NFPA 70.

3-2.3.11 Power One-Line/Riser Diagrams. Provide a Power One-Line Diagram for:

(1) Medium-voltage distribution systems, including substations and switching stations.

(2) Systems involving generation, either low voltage or medium voltage.

(3) Building switchgear, switchboards, and main distribution panels (MDP's).

See Appendix G, Attachment 27 for a typical one-line diagram. The diagram must show all components (including metering, protective relaying, etc.), and must indicate sizes of bus, feeders and conduits. Connections of transformers, PT's, CT's, capacitors, etc., must be shown on the one-line diagram by means of the proper symbol. Show potential and current transformer ratios. Indicate relay quantity and function (overcurrent, voltage, differential, etc.) using ANSI designation numbers.

On most projects, it would be appropriate to combine the one-line diagram with a riser diagram. The one-line diagram would begin with the medium voltage system and continue through the transformer up to and including the main breaker and feeder

breakers within the MDP. Sub-panels beyond the MDP would be shown in the riser diagram format. Appendix G, Attachment 28 illustrates a combined one-line/riser diagram.

Indicate kV ratings for surge arresters, and kV and ampere rating for cutouts. Indicate fuse link type and ampere rating. For capacitors indicate 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.

Show the following on the single line diagram when a transformer is indicated. Show primary switches, wye or delta connection, loadbreak elbows, lightning arrestors, full load rating, secondary voltage, transformer identification number, industry standard impedance, meter type, CT sizes, and fuse sizes. Show all pertinent information on the transformer and the service entrance on the one line as opposed to the specifications. The service entrance grounding electrode system and the bonding jumper per NFPA 70 must be shown. Do **NOT** use sweeping statements such as “Install grounding in accordance with the NEC.”

Show the following on the single line when padmounted switchgear is indicated: spare ways, protective devices, loadbreak elbows and switch identification number.

Show the following on the single line when a new primary is indicated: in-line splices in manholes, normally open points, number and sizes of phase, neutral and ground cables, and conduit sizes.

If there is demolition involved or work is to be done to existing equipment, the Designer of Record must provide an existing single line showing the current arrangement of the gear and then show a new single line indicating by line weights what is existing or new.

Insure that information shown on the one line is not duplicated elsewhere in the construction package, as this will likely cause conflict if changes are necessary. Indicate on the electrical legend the exact nomenclature used to indicate conductor and conduit sizing. Provide a schedule for feeder runs. Medium voltage single lines for stations and distribution systems must have a geographic affiliation to the actual constructed distribution system.

3-2.3.12 Telecommunications Riser Diagram. Clearly indicate service entrance cable and duct, entrance protector assemblies, and connections to existing outside cable plant.

Cross-connects. Indicate by notation that voice and data cables terminate in separate fields. Indicate method of cross connecting – patch panel or connector block.

Telecommunications outlets – include room numbers.

Cable for building backbone and horizontal distribution system.

Pathway, including conduit and cable tray for backbone and horizontal distribution system.

Telecommunications grounding system.

3-2.3.13 Intercommunication/Paging Riser Diagram. Show power source, master station with associated equipment, speakers, outlets, etc. – include room numbers, wiring/conduit between components

3-2.3.14 Fire Alarm Riser Diagram. Include only when separate Fire Protection Drawings are not included in the design. See the Fire Protection Design Guide for specific guidance.

3-2.3.15 Other Riser Diagrams. Provide other riser diagrams in similar way as telephone or intercommunication/paging.

3-2.3.16 Schedules and Elevations. Provide panelboard schedules on the drawings in the format shown in Appendix G, Attachments 32 and 33. Schedule must reflect the actual circuit breaker and bus arrangement. Include the following:

- Panelboard designation
- Voltage, phase, frequency, number of poles and maximum interrupting rating
- Main amperes indicating main breakers or lugs only
- Surface or flush mounting
- Circuit number, wire size, breaker trip, connected load, and identification of load associated with each branch or feeder. Note that identification of load must be specific. For example, the directory marking must not merely indicate “Lighting,” but rather “Lighting, Room 102.”
- Total connected load
- Any special breaker requirements such as GFI or SWD

Provide plan and elevation or isometric drawings for switchboards and switchgear, showing compartments, their intended use, and instruments and controls. Clearly show contents of all sections including whether or not breakers are individually or group mounted and indicate that switchboards and switchgear must be mounted on 100 mm (4 in) elevated concrete pads. Coordinate design of pad with structural engineer.

Provide plan and elevation or isometric drawings for Motor Control Centers (MCCs) identifying compartments. Provide schedule listing each compartment. Schedule must include (for each compartment) description of load, load in amperes, load in horsepower, NEMA size and type of starter, breaker size, conductor and conduit size, control devices, and other special requirements.

- Indicate, on plans or in specifications, enclosure type, bus rating, bus material, bus bracing, NEMA class and wiring type, service voltage, control voltage and source, and top or bottom feed.
- Indicate on the drawings MCCs must be mounted on 100 mm (4 in) elevated concrete pads. Coordinate design of pad with structural engineer.
- Provide elevation of control panels, indicating front panel devices, such as indicator lights, pushbuttons, gauges, switches, etc.

3-2.3.17 Lighting Fixture Details. Provide lighting fixtures details NL-1 thru NL-61 for interior lighting and XL-1 thru XL-34 available at www.ccb.org, wherever possible. In order to maintain the integrity of the details, do **NOT** modify details; make any required exceptions or modifications in the remarks column of the lighting fixture schedule and not on the details themselves. Provide applicable lighting fixture type symbol(s) with each lighting fixture sketch/detail. When using fixture(s) not included in the database, detail the fixture(s) on the drawings providing the following minimum information:

- Fixture type (e.g., high bay, fluorescent, industrial, downlight, roadway type, floodlight, etc.)
- Physical construction including housing material and fabrication method, description of lens, reflector, refractor, etc.
- Electrical data including number of lamps, lamp type, ballast data, operating voltage, etc.
- Mounting (surface, suspended, flush, etc.) and mounting height
- Special characteristics such as wet label, specific hazardous classification, air handling, etc.

Note: Instructions to View/Print Lighting Plates

1. Go to www.ccb.org
2. Choose Browse CCB Libraries.
3. Choose Specifications Library.
4. Choose NAVFAC Specifications.
5. Choose NAVY Specifications Graphics.
6. Choose NAVY Graphics Table of Contents
7. Go to Guide Spec 16510 Interior Lighting or 16520 Exterior Lighting

8. Click on the needed graphic/table.

3-2.3.18 **Details/Diagrams**. Detail all telecommunications outlets, cable tray and backboard/distribution frames. Provide elevations of pertinent communication room walls. Indicate additional details as required.

3-2.3.19 **Grounding Diagrams**. Provide a Grounding Diagram with explicit grounding requirements beginning with the medium-voltage system and continuing through the transformer up to and including the Service entrance equipment, step down transformers, sub-panels and telecommunications systems grounding. See Appendix G, Attachments 29, 30 and 31 for examples of grounding diagrams.

3-2.3.20 **Pole Details**. Indicate overhead distribution pole details on the drawings utilizing NAVFAC pole details OH-1.1 through OH-41 whenever applicable. NAVFAC pole details are available at www.ccb.org. Provide details in situations where an applicable pole detail has not been developed. Designer developed details must contain the same level of detail equivalent to the NAVFAC pole details and include material requirements.

Note: Instructions to View/Print Pole Plates

9. Go to www.ccb.org
10. Choose Browse CCB Libraries.
11. Choose Specifications Library.
12. Choose NAVFAC Specifications.
13. Choose NAVY Specifications Graphics.
14. Choose NAVY Graphics Table of Contents
15. Go to UFGS 16301N, Overhead Transmission and Distribution
16. Click on the needed graphic/table.

3-2.3.21 **Cathodic Protection Plan**. Provide cathodic protection plans and details at appropriate scales. Indicate on the drawing the location of all rectifiers, anode beds, structures protected by cathodic protection system(s) and all structures that may be affected by stray current corrosion as a result of cathodic protection of the specific structure within the affected area of cathodic protection. A Registered Corrosion Control Engineer must prepare cathodic protection drawings.

GLOSSARY

Acronyms and Abbreviations

1/C	One Conductor
3/C	Three Conductor
AC	Armored Cable or Alternating Current
AAC	All Aluminum Conductor
AAAC	All Aluminum Alloy Conductor
ACSR	Aluminum Conductor Steel Reinforced
ADO	Auxiliary Disconnect Outlet
A/E	Architect/Engineer
AFI	Arc Fault Interrupter
AL	Aluminum
ANSI	American National Standards Institute
AT	Anti-Terrorism
AWG	American Wire Gauge
BCO	Base Communications Officer
BEQ/BOQ	Bachelor Enlisted Quarters/Bachelor Officer Quarters
BICSI	Building Industry Consulting Services International
BIL	Basic Insulation Level
BOS	Base Operating Support
CATV	Community Antenna Television
CBM	Certified Ballast Manufacturers
CCTV	Closed Circuit Television
CT	Current Transformer
CU	Copper
DD	Distribution Device
DDC	Direct Digital Control
Degrees C	Degrees Centigrade
Degrees F	Degrees Fahrenheit
EFA	Engineering Field Activity
EFD	Engineering Field Division
EPR	Ethylene Propylene Rubber
EMCS	Energy Monitoring and Control System
EMT	Electrical Metallic Tubing
GFE	Government Furnished Equipment
GFI	Ground Fault Interrupter
GRS	Galvanized Rigid Steel
HH	Handhole
HVAC	Heating Ventilation and Air Conditioning
HP	Horsepower
HPS	High Pressure Sodium
IDF	Intermediate Distribution Frame

IDS	Intrusion Detection System
kVA	kilo-Volt-Amp
kVAR	kilo-Volt-Amp-Reactive
LAN	Local Area Network
LPS	Low Pressure Sodium
MC	Metal Clad
MCC	Motor Control Center
MCOV	Maximum Continuous Operating Voltage
MDF	Main Distribution Frame
MH	Manhole or Metal Halide
MI	Mineral Insulated
MNS	Mass Notification System
NAVFAC	Naval Facilities Engineering Command
NFPA	National Fire Protection Association
NMC	Non-Metallic Sheathed Cable
NMCI	Navy and Marine Corps Intranet
OTDR	Optical Time Domain Reflectometer
PC	Personal Computer
PCB	Polychlorinated Biphenyls
PDS	Protected Distribution System
PILC	Paper Insulated Lead Covered
POC	Point of Contact
PT	Potential Transformer
PVC	Polyvinyl Chloride
RCDD	Registered Communications Distribution Designer
RFP	Request for Proposal
RMS	Root Means Squared
SCIF	Secret Compartmented Information Facility
SCR	Silicon Controlled Rectifier
SIPRNET	Secret Internet Protocol Router Network
SOUTHDIV	Southern Division Naval Facilities Engineering Command
SOW	Statement of Work
SWD	Switch Duty
SWDIV	Southwest Division Naval Facilities Engineering Command
TVSS	Transient Voltage Surge Suppression
UFC	Unified Facilities Criteria
UL	Underwriter’s Laboratories
VA	Volt-Amp

Terms

Activity – The end user of a facility.

Auxiliary Disconnect Outlet – A device installed as part of a residential telecommunications wiring system, usually located within the tenant or living unit used to terminate the ADO or backbone cable.

Average Life - As pertains to lamps, time after which 50 percent will have failed and 50 percent will have survived under normal operations.

Building Distribution Frame - A structure with terminations for connecting backbone, campus, and horizontal cabling. The BDF generally includes a cross connect, equipment support frame, and wooden backboard or terminal cabinet. The BDF must include building protector assemblies when used for campus backbone or SP cabling.

Base Communications Officer (BCO) - The person(s) responsible for the telephone and data infrastructure for a base or facility.

Coastal Area – Any area within 40 km (25 miles) of the coast, a bay or a harbor.

Community Antenna Television System (CATV) – A network of cables, headend and electronic components that process and amplify television and frequency-modulated (FM) radio signals for distribution from one central location to outlets throughout a facility.

Contractor – Person(s) doing actual construction portion of a project.

Clamping Voltage – The voltage that appears across transient suppressor terminals when the suppressor is conducting transient current.

Closed Circuit Television (CCTV) – A network of cables and equipment to monitor and transmit video signals throughout a facility.

Designer of Record – The engineer responsible for the actual preparation of the construction documents.

Distribution Device – A facility located within a dwelling unit for interconnection or cross connection of interior telecommunications wiring. Passive cross connect facilities enable the termination of cable elements and their interconnection or cross-connection by means of jumpers and patchcords.

Ground Line Section - The portion between 300 mm (1 ft) above and 610 mm (24 in) below the ground line.

Green Building Considerations - Design aspects that result in buildings that are environmentally responsible, profitable and healthy places to live and work.

Intermediate Distribution Frame - An intermediate termination point for horizontal wiring and cross connections within telecommunications closets or wiring closets.

K-Rated Transformer – A transformer designed to withstand the harmonic currents associated with non-linear loads without exceeding the temperature rating of the insulation system.

Main Distribution Frame - A physical structure at a central location for terminating permanent backbone cables to interconnect with service provider (SP) equipment at the entrance facility. The MDF generally includes vendor specific components to support voice and data circuits, building surge protector assemblies, main cross connect blocks, equipment support frames, and wood backboard (if MDF is wall mounted). Depending upon local site conditions, the MDF and BDF may be identical.

Metal-Clad Switchgear – Metal enclosed power switchgear typically characterized by removable interrupting devices, all live parts are enclosed by grounded metal barriers, bus is covered with insulating material throughout.

Metal-Enclosed Switchgear - Metal enclosed power switchgear typically characterized by interrupter switches, power fuses, non-insulated bus and connections.

Non-Linear Loads – Loads that convert AC to DC and contain some kind of rectifier.

Project Manager – NAVFAC engineer charged with the administration of the project.

Residential Gateway – A pre-manufactured stand-alone box that combines digital modem cards, home networking chips, a processor and other circuitry. The gateway enables e-mail, the Internet and other broadband services to be interconnected and distributed throughout the home on both coaxial and copper pair cabling. The data is distributed to two or more PCs or other household systems via a home network.

Series Rated Circuit Breaker – Short circuit interrupting rating assigned to a combination of two or more circuit breakers connected in series, where the upstream breaker is rated for the system fault, but the downstream breaker may not be fully rated for the systems available fault.

Service - The conductors and equipment for delivering electrical energy from the serving utility or Government-owned system to the wiring system of the premises served.

Specification Grade – A wiring device that meets federal government specifications.

Site Electrical Utilities - Site Electrical 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.

Star Topology – A hierarchical series of distribution levels in which telecommunications cables are distributed from a central point.

Structured Cabling System – An information technology (IT) infrastructure that provides direction for cabling system design for Voice and Data cabling systems that supports a multi-product, multi-vendor, and multi-media environment where there is little or no knowledge of the active equipment to be installed.

Switched Way – As pertains to pad mounted switches, a switched way is considered a three-phase circuit entrance to the bus through a switch. For single-phase switches, it is a single-phase entrance to the bus through a switch.

Systems Furniture – Modular prewired office furniture.

Telecommunications Room - An enclosed space for telecommunications equipment, terminations, and cross-connect wiring for horizontal cabling.

Total Harmonic Distortion - The root mean square (RMS) of all the harmonic components divided by the total fundamental current.

UL Master Label – Certification by UL that a lightning protection system has been designed and installed in accordance with the applicable standards.

APPENDIX A REFERENCES

Note: Unless otherwise specified, the most recent edition of referenced publications and criteria applies.

GOVERNMENT PUBLICATIONS:

Note: See information at the end of this list for web sites where Government publications are available.

Naval Facilities Engineering Command (NAVFAC) Atlantic

http://dod.wbdg.org/

DM 13.02, Commercial Intrusion Detection System (IDS)
"For Official Use Only"

MIL-HDBK-419A, Grounding, Bonding, and Shielding for Electronic Equipment and Facilities

MIL-HDBK-423, High-Altitude Electromagnetic Pulse (HEMP) Protection for Fixed and Transportable Ground-Based Facilities (Draft)

MIL-HDBK-1004/6, Lightning Protection

MIL-HDBK-1012/1, Electronic Facilities Engineering

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

MIL-HDBK-1013/1A, Physical Security of Fixed Facilities

MIL-HDBK 1190, Facility Planning and Design Guide

MIL-HDBK 1191, Medical and Dental Treatment Facilities Design and Construction Criteria

Defense Standardization Program http://assist.daps.dla.mil/online/start/	MIL-STD-188-124B, Grounding, Bonding and Shielding for Common Long Haul/Tactical Communication Systems MIL-STD-188-125, High-Altitude Electromagnetic Pulse (HEMP) Protection for Ground-Based C^4I Facilities Performing Critical, Time-Urgent Missions MIL-STD-704F, Aircraft Electric Power Characteristics MIL-PRF-24021K, Performance Specifications, Electric Power Monitors, External Aircraft
Central Intelligence Agency (CIA) http://www.cia.gov/	DCID 6/9, Director of Central Intelligence Directive (DCID) 6/9, Physical Security Standards for Sensitive Compartmented Information Facilities (SCIF)
Navy Electronic Directives System http://neds.daps.dla.mil/	OPNAVINST 5530.14, Physical Security and Loss Prevention
Naval Sea Systems Command www.navsea.navy.mil	NAVSEA OP-5, Ammunition and Explosives Ashore
United States Corps of Engineers http://www.hnd.usace.army.mil/techinfo/	TI 809-04, Seismic Design for Buildings
Department of Defense Unified Facilities Criteria Program http://dod.wbdg.org/	UFC 1-200-01, Design: General Building Requirements UFC 1-300-03, Policy and Procedures for Project Drawing and Specification Preparation UFC 3-100-10N, Design: General

Architectural Requirements

UFC 3-200-10N, Design: General Civil / Geotechnical / Landscape Requirements

UFC 3-300-10N, Design: General Structural and Seismic Requirements

UFC 3-400-10N, Design: General Mechanical Requirements

UFC 3-501-03N, Electrical Engineering Preliminary Design Considerations

UFC 3-520-01, Interior Electrical Systems

UFC 3-530-01, Design: Interior and Exterior Lighting and Controls

UFC 3-550-03N, Design: Power Distribution Systems

UFC 3-555-01N, 400 Hz Power Systems

UFC 3-570-02N, Design: Electrical Engineering Cathodic Protection

UFC 3-580-10, Design: Navy and Marine Corps Intranet (NMCI) Standard Construction Practices

UFC 3-600-01, Design: Fire Protection Engineering for Facilities

UFC 3-600-10N, Design: General Fire Protection Requirements

UFC 3-800-10N, Design: General Environmental Requirements

UFC 4-10-01, Anti-Terrorism Standards for Buildings

	UFC 4-021-01, Mass Notification Systems (MNS)
	UFGS 13100N, Lightning Protection System
	UFGS 16268N, 400 Hertz (HZ) Solid State Frequency Converter
Chief of Naval Operations	IA PUB-5239-22, Information Assurance Protected Distribution System (PDS) Guidebook, **"For Official Use Only"**
http://infosec.navy.mil	

NON-GOVERNMENT PUBLICATIONS:

Note: See information at the end of this list for addresses and phone numbers where Non-Government publications are available.

ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 720 Tully Circle Atlanta, GA 30335 (800) 527-4723 http://www.ashrae.org/	ASHRAE 90.1I-P, Energy Standards for Buildings Except Low Rise Residential Buildings
ANSI American National Standards Institute 25 West 43rd Street, 13th Floor New York, NY 10036 (212) 642-4900 www.ansi.org	ANSI C37.41, Design Test for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fused Disconnecting Switches, and Accessories ANSI C62.41, Surge Voltages in Low Voltage AC Power Circuits ANSI C62.45, Low Voltage AC Power Circuits, Guide on Surge Tests ANSI C84.1, Electric Power Systems and Equip-Voltage Ratings (60 Hz)
BICSI Building Industry Consulting Services International 8610 Hidden River Parkway Tampa, FL 33637-1000 (800) 242-7405 http://www.bicsi.org	TDMM, Telecommunications Distribution Methods Manual
California Public Utility Commission 505 Van Ness Ave., San Francisco, CA 94102-3298	California Public Utility Commission General Order 95 California Public Utility Commission General Order 128

http://www.cpuc.ca.gov/

EIA/TIA Electronic Industries Alliance/Telecommunications Industry Association 2500 Wilson Blvd. Arlington, VA 22201-3834 (703) 907-7500 http://www.eia.org/ http://www.tiaonline.org/	EIA/TIA-568-B, Commercial Building Telecommunications Cabling Standard EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces TIA-570B, Residential Telecommunications Infrastructure Standard EIA/TIA-606-A, The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings J-STD-607-A, Commercial Building Grounding and Bonding Requirements for Telecommunications
IEEE Institute of Electrical and Electronic Engineers 3rd Park Avenue New York, NY 10001 (212) 419-7900 http://www.ieee.org	IEEE C2, National Electrical Safety Code IEEE Std. 141-1993, Recommended Practice for Electrical Power Distribution for Industrial Plants (Red Book) IEEE Std. 142-1991, Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book) IEEE Std. 241-1990, Recommended Practice for Electrical Power Systems in Commercial Buildings (Grey Book) IEEE Std. 242-2001, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book) IEEE Std. 399-1997, Recommended Practice for Industrial and Commercial Power Systems Analysis

	IEEE Std. 446-1995, Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book)
	IEEE Std. 493-1997, Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book)
	IEEE Std. 739-1995, Recommended Practice for Energy Conservation and Cost-Effective Planning in Industrial Facilities (Bronze Book)
	IEEE Std. 1100-1999, Recommended Practice for Power and Grounding Sensitive Electronic Equipment (Emerald Book) IEEE Std. C57.12.00, General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IESNA Illuminating Engineering Society of North America 120 Wall Street New York, NY 10005 (212) 248-5000 http://www.iesna.org	IES HDBK, IES Lighting Handbook
NFPA National Fire Protection Association One Batterymarch Park, P.O. Box 9101 Quincy, MA 02269 (617) 770-3000 http://www.nfpa.org	NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection NFPA 70, National Electrical Code NFPA 72, National Fire Alarm Code NFPA 75, Standard for Protection of Information Technology Equipment

	NFPA 110, Standard for Emergency and Standby Power Systems
	NFPA 780 Standard for the Installation of Lightning Protection Systems
NEMA National Electrical Manufacturer's Association 1300 N. 17th Street, Suite 1847 Rosslyn, VA 22209 (703) 841-3200 http://www.nema.org	NEMA ST-20, Dry Type Transformers for General Applications NEMA LS-1, Low Voltage Surge Protection Devices NEMA WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
UL Underwriters' Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062 (847) 272-8800 http://ul.com	UL 96A, Installation Requirements for Lightning Protection Systems UL 1449, Standard for Safety for Transient Voltage Surge Suppressors (Second Edition) UL 1283, Electromagnetic Interference Filters
U.S Green Building Council http://usgbc.org/	LEED Rating System Version 2.1

APPENDIX B NAVFAC ATLANTIC REGIONAL SPECIFIC REQUIREMENTS AND EXCEPTIONS

The following specific requirements and exceptions apply to all projects designed for the Naval Facilities Engineering Command Atlantic (NAVFAC Atlantic).

B.2-1.11.5 **Settings (Breakers and Relays).** The Designer of Record must discuss proposed relay protection schemes, including selection of relays and current transformer ratios, with Public Works Code PW6 during the design process.

The Designer of Record must ensure that construction contract documents require that the contractor submit manufacturer's published time-current curves (on full size logarithmic paper) of primary fuses, relays, main secondary breakers, and secondary feeder protective devices.

Upon completion of successful shop drawing review, the Designer of Record must provide settings for main secondary breakers and secondary feeder protective devices. The Designer of Record must ensure that circuit components are adequately protected against short circuits and ground faults and that protective devices are properly coordinated. Public Works Code PW6 will be available to assist the designer if required.

Public Works Code PW6 must be directly responsible for providing settings for protective relays and primary protective devices (except that high side transformer protection for distribution transformers 1500 kVA and smaller must be selected by the designer). The coordination study must be done under the same or under a separate contract. Contact Public Works Code PW6 for direction. When Public Works Code PW6 is responsible for settings, the designer upon completion of successful shop drawing review must forward all required information to them.

Promptly determine fuse selections and breaker/relay settings and immediately forward to the Contracting Officer.

Please note that protective relays associated with Air Force and Army bases are not the responsibility of Public Works Code PW6; the Designer of Record must provide settings for these relays and coordinate with the appropriate command.

B.2-1.12 **Environmental Projects.** Sealed Bid Environmental Contracts administered by Code EV must demonstrate the same level of electrical design effort as any normal Design-Bid-Build project and must be in total compliance with this design guide.

Environmental Contracts administered by Code EV must demonstrate a complete electrical design from the designated point of connection on the existing electrical distribution system to a main disconnect means at each secondary service. Require a

complete electrical design for any building that will ultimately be owned by the government; electrical designs must include any and all electrical systems not directly related to an environmental system and that will not be removed by the Environmental Contractor. Electrical designs must provide adequate electrical service for all equipment being provided by the Environmental Contractor and specifically, size transformers to carry all loads. The electrical design must be in total compliance with this design guide.

B.2-2.1.1 **Pole Details.** For all overhead distribution projects at Camp Lejeune, contact Public Works Design Branch in Building 1005 (910-451-3658) at Camp Lejeune for direction on each design project. In general, design overhead systems at Camp Lejeune using “armless construction” instead of “crossarm construction” as described by NAVFAC pole sketches.

B.2-2.1.2 **Overhead Conductors.** Do NOT use aluminum-conductor steel-reinforced (ACSR) conductor for any overhead wiring.

B.2-2.2.1 **Manholes and Handholes.** For circuits greater than 15kV, manholes must be a minimum of 9 feet wide by 12 feet long.

B.2-2.2.5 **Medium Voltage Cable.** Do NOT use “T” or “Y” splices for medium voltage distribution systems greater than 15 kV.

B.2-2.7 **Medium Voltage Switchgear.** Portions of the 4.16KV system at Dam Neck and all of the 11.5KV system at Norfolk Naval Shipyard have fault current in excess of 10,000 RMS amperes symmetrical. The designer must check with Public Works Code PW6 to obtain the available fault duty of the system in question.

B.2-2.7.2 **Metal Enclosed Switchgear.** Use Metal Enclosed Switchgear in Unit Substation construction only.

B.2-2.8 **Primary Unit Substations.** Portions of the 4.16KV system at Dam Neck and all of the 11.5KV system at Norfolk Naval Shipyard have fault current in excess of 10,000 RMS amperes symmetrical. The designer must check with Public Works Code PW6 to obtain the available fault duty of the system in question.

B.2-2.9 **Secondary Unit Substations.** Portions of the 4.16KV system at Dam Neck and all of the 11.5KV system at Norfolk Naval Shipyard have fault current in excess of 10,000 RMS amperes symmetrical. The designer must check with Public Works Code PW6 to obtain the available fault duty of the system in question.

B.2-2.10.2 **Pad Mounted Transformer Description.** Use stainless steel tanks on piers over water only.

B.2-2.10.3 **Surge Arrestors in Pad Mounted Transformers.** For systems less than 15 kV, provide surge arresters within the transformer if the transformer is located at the end of the primary circuit. If the transformer is loop feed with the circuit extending beyond the transformer, do not provide surge arresters.

For systems greater than 15 kV, provide surge arresters in all transformers.

For systems less than 5 kV, do NOT provide surge arresters in pad-mounted transformers.

B.2-2.11 **Pad Mounted Switches.** Portions of the 4.16KV system at Dam Neck and all of the 11.5KV system at Norfolk Naval Shipyard have fault current in excess of 10,000 RMS amperes symmetrical. The designer must check with Public Works Code PW6 to obtain the available fault duty of the system in question.

B.2-2.12 **Pad Mounted Sectionalizing Termination Cabinet. DO NOT** use sectionalizing cabinets for voltages greater than 15 kV.

B.2-2.13 **Pad Mounted Equipment Fault Current Ratings.** Portions of the 4.16KV system at Dam Neck and all of the 11.5KV system at Norfolk Naval Shipyard have fault current in excess of 10,000 RMS amperes symmetrical. The designer must check with Public Works Code PW6 to obtain the available fault duty of the system in question.

B.2-2.15 **Housing Distribution.** The 50 KVA limit on the transformer size does not apply to NAVFAC Atlantic housing distribution projects.

B.2-2.16 **Distribution System Grounding.** Use 6100 mm (20 feet) ground rods at the Naval Regional Medical Center, Portsmouth VA.

B.2-2.19 **Cathodic Protection Systems.** Historical soil resistivity data may be available from the applicable Facility Corrosion Program Coordinator.

B.2-3.1.3 **Panelboards.** In panelboard schedules on drawings, indicate load in amperes, NOT kW or kVA. However, if SKM software is used throughout the design, then the panelboard schedules generated by SKM in kVA are acceptable.

B.2-3.8.3 **Community Antenna Television (CATV) Systems.** For CATV systems at Camp Lejeune, provide a 21 mm (3/4 in) conduit with a pull wire from each room desiring cable TV to the telephone room. In the room, provide an outlet box with cover with an F-type connector. In the telephone room, provide a plywood backboard for future use. From the telephone room, provide a 78 mm (3 in) conduit with pull wire to the outside of building. If possible, terminate the conduit beside an existing power pole.

If all utilities are designed to be located in duct banks, provide a duct for CATV in the new telephone manholes.

B.2-3.19.3 **Emergency Generator.** The Electrical Engineering Office (Code CIEE) will typically design systems involving multiple units with complex parallel and synchronization schemes.

B.2-3.23.2 **Distribution Frames.** Do NOT provide cross-connect jumpers and patch cords for voice or data frames.

B.2-3.25.1 **Motor Ratings on Drawings.** Electrical drawings must show motors rated in Horsepower on both English and Metric projects. On Metric projects, Mechanical Equipment Schedules must indicate ratings in kW output with the corresponding standard horsepower rating shown in parenthesis. Conversion factor from standard motor horsepower ratings to kW ratings must be 0.746.

APPENDIX C NAVFAC PACIFIC REGIONAL SPECIFIC REQUIREMENTS AND EXCEPTIONS

The following specific requirements and exceptions apply to all projects designed for the Naval Facilities Engineering Command Pacific (NAVFAC Pacific).

C.2-2 **Site Electrical Utilities.** For projects in the Hawaiian Islands, the Designer of Record must be responsible for coordination with the Hawaiian Electric Company (HECO). HECO contact is Mr. Eric Shimono (phone 543-7590). The Designer of Record must be responsible for scheduling HECO's work and obtaining approval for HECO's schedule from the Contracting Officer. In addition to other references listed herein, designs must conform to Order Numbers 6 and 10, Public Utilities Commission, State of Hawaii. The Designer of Record must be responsible for obtaining HECO standards from HECO and for obtaining HECO approvals for designs.

C.2-2.1.1 **Pole Details.** For projects in the Hawaiian Islands, the Designer of Record must be responsible for obtaining and using HECO pole standards.

C.2-2.10.2 **Description (Pad Mounted Transformers).** Provide copper windings only.

C.2-3.1.1 **Switchboards.** Provide copper bus only.

C.2-3.1.2 **Switchgear.** Provide copper bus only.

C.2-3.3 **Dry Type Transformers.** Provide a Life Cycle Cost Analysis comparing copper to aluminum windings and specify copper or aluminum accordingly.

APPENDIX D SOUTHERN DIVISION REGIONAL SPECIFIC REQUIREMENTS AND EXCEPTIONS

The following specific requirements and exceptions apply to all projects designed for the Southern Division Naval Facilities Engineering Command (SOUTHDIV).

D.2-1.7.2 **Short Circuit Study.** When calculating short circuit values on the secondary side of transformers, assume infinite bus on the primary side for all calculations.

D.2-1.13 **Electrical Enclosures in Coastal Areas.** Coastal areas are defined as locations within 25 miles of the coast, a bay, or a harbor. All outdoor metallic electrical enclosures in coastal areas must be stainless steel. This includes voltage regulators, medium voltage switchgear, substations, pad mounted transformers, pad mounted switches, and pad mounted sectionalizing termination cabinets.

D.2-2.1.1 **Pole Details.** Provide pole details similar to those used by the local utility company for the project.

D.2-2.1.2 **Overhead Conductors.** Do NOT use aluminum-conductor steel-reinforced (ACSR) in coastal areas. Coastal area is defined as any area within 40 km (25 miles) of the coast, a bay or a harbor.

D.2-2.2.3 **Underground Duct.** Use Schedule 40 PVC for all underground direct buried and concrete encased ductbank construction.

D.2-2.2.5 **Medium Voltage Cable.** Use Type UD, aluminum or copper single conductor cables with EPR insulation and PVC outer protective jacket. Coordinate conductor material with the station standard or EFD counterpart.

Use 1/3 concentric neutral for 3 phase circuits and full concentric neutral for 1-phase circuits. Show on a detail how cables will be arranged to allow for the effects of low temperature contraction.

When using Type UD cable, the neutral will be inherently provided in the Type UD cable. Should there be a requirement or a SOUTHDIV approved reason that MV-90 cables be used, provide a fourth cable with 600V insulation sized to match the phase conductors.

Do NOT use “T” or “Y” splices for any medium voltage wiring.

Provide single phase type fault indicators on all medium voltage cable terminations.

D.2-2.10 **Pad -mounted Transformers**. Desired connection is grounded wye-grounded wye. Connect all transformers with this connection after verifying all phases and the neutral are available. The neutral must be continuous back to the source.

D.2-2.10.2 **Description (Pad Mounted Transformers).** Provide dead front, loop feed transformers with three two-position switches as standard. If the transformer is intended to operate as an open point in the loop, then each bushing is required to have feed thru inserts with dead front arresters. Do not use three two-position switches at the end of radial runs where the transformer is small and future build-out is not likely.

Specify energy efficient transformers. Do not size transformers over 130 VA/m^2 (12 VA/ft^2) unless approved by the assigned EFA/EFD engineer.

D.2-2.11 **Pad Mounted Switches.** Provide stainless steel switches and cabinets in coastal regions.

D.2-2.16 **Distribution System Grounding.** Ground all power distribution work. Grounds and grounding system must have resistance to solid ground in accordance with the National Electric Code (NEC). Ground rods must be copper clad steel with diameter adequate to permit driving to full length of the rod, but not less than 19 mm (3/4 in) diameter and 3050 mm (10 ft) long.

All new poles must have a butt wrap ground at installation. The pole ground wire will be run continuously (no breaks or sharp bends allowed) from the top of the pole to the butt wrap, stapled to the pole at approximately 600 mm (24 in) intervals and protected by a plastic molding to approximately 2400 mm (96 in) from the surface of the ground. The pole ground wire will be bonded to surge arrester ground leads and to all non-current carrying parts, such as equipment tanks and guy wires.

The butt wrap is made from a continuous length of bare #4 Copper Soft Drawn wire stapled to the length of a wood pole, wrapped like a coil and stapled to the butt of the pole before it is set. A portion of the #4 Cu wire must pass through the coil and be stapled in place to prevent unwanted inductive effects caused by a coil. At least 3600 mm (12 ft) of wire must be below the ground level and in contact with the soil when the pole is set.

Install driven electrodes on all poles and or structures supporting transformers, meters, switching devices, underground dips, arrester installations, and other equipment of this type. Driven electrodes must consist of one or more stacked and bonded copperclad 19 mm x 3050 mm (3/4 in x 10 ft) rods or a system of rods at a single location bonded together. The top of the rod must be 450 mm (18 in) below the surface of the ground. All connections to ground rods will be by exothermic weld. Where driven electrodes are required, place at least one driven electrode in addition to the butt wrap. If the butt wrap qualifies as a half made electrode (ground resistivity of 50 ohms or less as measured by

a hand-held clamp-on type meter) locate the driven electrode at least 3050 mm (10 ft) from the pole/structure; otherwise, install at least two driven electrodes with one electrode located 300 mm (12 in) from the pole. When multiple driven electrodes are required, they will be driven in-line with the overhead pole line. Spacing for driving additional grounds must be a minimum of 3050 mm (10 ft). Bond these driven electrodes together with a minimum of No. 4 AWG soft drawn Bare Copper wire buried to a depth of at least 450 mm (18 in). Reach a ground resistance of 25 ohms or less at each pole where driven electrodes are required. See appendix F, Table F10-Grounding Electrode Table for additional information.

Grounding for transformers and electrical gear requires two rods on the girdle and a 6100 mm (20 feet) ground rod in the pad window.

D.2-2.17.2 **Fixture and Pole Considerations.** Use of painted steel poles is not permitted.

D.2-3.1 **Service Entrance Equipment.** Use of main circuit breaker is required.

D.2-3.2 **Transient Voltage Suppression Systems (TVSS).** Provide TVSS for all service entrance equipment including both residential and non-residential.

D.2-3.4.1 **Switches.** Use of fused safety switches is not permitted.

D.2-3.4.2 **Receptacles.** Provide 2 duplex receptacles at workstation outlets.

D.2-3.5 **Raceways.** Use of wiring gutters is not permitted.

D.2-3.5.3 **Electrical Metallic Tubing (EMT).** Use steel compression couplings and insulated throat, steel compression connectors for EMT.

D.2-3.6.2 **Conductors**. All homeruns must contain no more than 3 phase conductors.

D.2-3.23 **Structured Cabling Systems.** Designs must be performed and stamped by an RCDD.
D.2-3.26 **Interior Lighting Systems.** Do not use fluorescent fixtures with molded lenses (i.e. wraparound type).

For fixtures with linear fluorescent lamps use flat acrylic lenses 0.156” or thicker.

Use of refractor style wall packs must be limited to service areas of buildings. Exterior wall mounted fixtures must have no horizontal or higher light output components.

TABLE D-1, NOMINAL SYSTEM VOLTAGES AT SOUTHDIV ACTIVITIES

Barsdale AFB	12470Y/7200		NAS Saufley	12470Y/7200
Blount Island	26400Y/15240		NAS Whiting Field	4160Y/2400
Cape Canaveral	12470Y/7200		NASC Louisville	12470Y/7200
Charleston AFB	12470Y/7200		NCBC Gulfport	22860Y/13200
CSS Panama City	12470Y/7200		NH Beaufort	4160Y/2400
DFSP Charleston	12470Y/7200		NH Charleston	13200Y/7620
Great Lakes Complex	34500Y/19920 12470Y/7200 4160Y/2400 2400D		NISE	12470Y/7200
Keesler AFB	22860Y/13200		NPC Frindley	12470Y/7200
MCAS Beaufort	12470Y/7200		NS Ingleside	12470Y/7200
MCLB Albany	12470Y/7200		NS Mayport	26400Y/15240
MCRD Parris Island	12470Y/7200 4160Y/2400		NS Pascagoula	13800Y/7970
NAS Atlanta	12470Y/7200		NSA NOLA East Bank	13800Y/7970
NAS Corpus Christi	12470Y/7200		NSA NOLA West Bank	13200Y/7620 4160Y/2400
NAS JRB Fort Worth	12470Y/7200		NSB Kings Bay GA	12470Y/7200 230KV
NAS Jacksonville	26400Y/15240		NTTC Corry	12470Y/7200
NAS Key West	13800 4160Y/2400		NWS Charleston	13800Y/7970 4160Y/2400
NAS Kingsville	12470Y/7200		NSWC Crane	12470Y/7200
NAS Memphis	12470Y/7200		Selfridge ANG	12470Y/7200
NAS Meridian	12470Y/7200		Shaw AFB	12470Y/7200 4160Y/2400
NAS JRB New Orleans	13800Y/7970		Stennis Space Center	13800Y/7970
NAS Pensacola	12470Y/7200			

Note: Portions of many of the grounded WYE systems do not have a neutral, static, or ground wire and cannot be considered “effectively grounded”.

APPENDIX E SOUTHWEST DIVISION REGIONAL SPECIFIC REQUIREMENTS AND EXCEPTIONS

The following specific requirements and exceptions apply to all projects designed for the Southwest Division Naval Facilities Engineering Command (SWDIV).

E.2-1 **General Guidance.** For projects in California, the design and construction must comply with and exceed California Title-24 energy standard baseline by at least 10 percent.

E.2-2.1 **Overhead Power Distribution.** For projects located in the State of California and under the guidance of SWDIV, CALPUC G.O. 95 must apply. For SWDIV projects located outside of California, use the equivalent published Public Utilities Standards for the particular state.

E.2-2.1.1 **Pole Details.** Use CALPUC G.O 95 and the Utility company, whose area of responsibility covers the Base, criteria and sketches whenever applicable.

E.2-2.2 **Underground Electrical Systems.** For projects located in the State of California and under the guidance of SWDIV, designs must additionally comply with CALPUC G.O. 128, Rules for Construction of Underground Electric Supply & Telecommunications Systems and other applicable State Standards. For projects outside of California, use the equivalent published Public Utilities Standards for the particular state.

E.2-2.2.5 **Medium Voltage Cable.** Do NOT use “T” or “Y” splices for any medium voltage distribution systems.

E.2-2.10.2 **Description (Pad Mount Transformers).** Provide copper windings only.

E.2-2.18.1 **General (Site Communications and Security).** For projects in the State of California and under the direction of SWDIV, maintain minimum clearances between conductors/systems as defined by 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, use the equivalent published Public Utilities Standards for the particular state.

E.2-3.1.1 **Switchboards.** Provide copper bus only.

E.2-3.1.2 **Switchgear.** Provide copper bus only.

E.2-3.5.3 **Electrical Metallic Tubing (EMT).** Use steel compression couplings and insulated throat, steel compression connectors for EMT.

APPENDIX F DESIGN DATA TABLES

TABLE F1 - DOD / IES CROSS REFERENCE OF FACILITIES

DOD Facility Designation – Name of Function	IES Tables Designation – Name of Function
Administrative Areas	Offices, Drafting, Conference, and Accounting Rooms
Chapels	Churches and Synagogues
Classroom Buildings	Schools
Dining Facilities	Food Service Facilities
Exchange Facilities	Stores
Guard Houses and Brigs	Municipal Buildings – Fire and Police
Parking for Military Vehicles (minor repair areas)	Parking Areas and Service Stations
Service Clubs	Applicable Areas of Auditoriums, Food Service Facilities, Offices, Schools and Stores
Unaccompanied Personnel Housing	Hotels
Vehicle Maintenance Facilities	Garages and Service Stations
Warehouses	Storage Rooms or Warehouses

TABLE F2 - ILLUMINATION IN WAREHOUSES

Types of Warehousing	lux	fc
Active – Bulk [1]	110	10
Bin [2]	55	5
Inactive	55	5
Mechanical Material handling:		
Accumulation Conveyor Lines (unmanned)	110	10
Control Centers and Stations	330	30
Loading and Unloading Areas	220	20
Rack	220	20

Footnotes:
1 Main aisles may be lighted to 160 lux (15 fc).
2 Specialized lighting designed to illuminate the bins, as required.

TABLE F3 - SPORTS LIGHTING REQUIREMENTS

Sports Activity	lux	fc
Baseball & Softball Infield	220	20
Baseball & Softball Outfield	110	10
Tennis, Volleyball & Basketball – Outdoors	110–220	10-20
Basketball – Indoors	330-440	30-40
Handball & Racquetball – Indoor	550	50

Note:
All values are for maintained foot-candles. Use metal halide light sources where color rendering is important. See IES Lighting Handbook for more details on color rendering of light sources.

TABLE F3A – IES SPORTS CLASSIFICATIONS

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

TABLE F4 - ILLUMINATION IN FUNCTIONAL AREAS OF OTHER FACILITIES

Functional Areas	lux	fc
Accounting Rooms	800	75
Auditoriums	220	20
Cafeterias	270	25
Computer Rooms	550	50
Conference Rooms	330	30
Corridors	110	10
Drafting Rooms	800	75
Elevator Machine Rooms	160	15
Emergency Generator Rooms	160	15
Garage Driving and Parking Areas	55	5
Garage Entrances	330	30
General Office Space	550	50
Janitor’s Closet	550	5
Kitchens	760	70
Lobbies	160	15
Lounges	160	15
Mechanical and Electrical Equip Rooms	160	15
Parking Lots	5	0.5
Stairways	220	20
Storage Rooms	55	5
Switchgear Rooms	160	15
Toilet Facilities	220	20
Transformer Vaults	160	15

TABLE F5 – TYPICAL LOADING FOR PERSONAL COMPUTER SYSTEMS

Component	Measured Load
Pentium 550 MHz Computer with Monitor	1.48 amps
Pentium 200 MHz Computer with Monitor	1.45 amps
HP LaserJet 4000 printer	0.25 amps idle, 5 amps printing

TABLE F6 – LOAD DATA FOR PRELIMINARY DEMAND CALCULATIONS

Facility Type	VA/m^2	VA/ft^2
BEQ	21-64	2-6
Commissary/Exchange	75- 97	7-9
Café/Mess Hall	75-108	7-10
Administration Building	64-108	6-10
Craft/Hobby/Golf Pro	43-54	4-5
SIMA	64-108	6-10
BOQ	22-64	2-6
Warehouse/Exchange	43	4
Child Care	64	6
Chapel	54-75	5-7
Applied Instruction Building	64-108	6-10

Design Guidance:
Information obtained from utility metering by SOUTHDIV Public Works Department. Use this information to aid in estimating demand for transformer sizing for preliminary calculations. As design progresses, update demand calculations to reflect actual load of the building.

Dwelling Unit Demand Data for Electrical Calculations

Note:
These Tables are provided to aid the Designer of Record in estimating the total demand for "**ALL ELECTRIC**" dwelling units (including diversity). Size all distribution systems for dwellings for "**ALL ELECTRIC**". Use the data below for sizing distribution transformers, service lateral voltage drops and flicker calculations, etc. These tables are not to be used for sizing the service laterals or service entrance conductors.

TABLE F7 – Dwelling Demand KVA per A/C Size

# of Units	HVAC Diversity	2 TONS		2.5 TONS		3 TONS		3.5 TONS		4 TONS	
		FE	TOTAL	FE	TOTAL	FE	TOTAL	FE	TOTAL	FE	TOTAL
1	1.0	3.89	6.42	4.09	7.25	4.29	8.08	4.93	9.35	5.67	10.72
2	0.85	6.61	10.91	6.95	12.33	7.29	13.74	8.38	15.9	9.64	18.22
3	0.82	8.64	14.91	9.08	16.95	9.52	18.96	10.94	21.95	12.59	25.16
4	0.80	10.27	18.37	10.8	20.91	11.33	23.45	13.02	27.16	14.97	31.13
5	0.77	11.86	21.61	12.47	24.64	13.08	27.68	15.04	32.05	17.29	36.74
6	0.75	13.3	24.69	13.99	20.21	14.67	31.73	16.86	36.75	19.39	42.12
7	0.73	14.7	27.63	15.46	31.61	16.22	35.58	18.64	41.22	21.43	47.24
8	0.72	16.2	30.76	17.01	35.22	17.85	39.68	20.51	45.97	23.59	52.68

TABLE F8 –Typical A/C Size for Dwelling Units

Dwelling Type	A/C (Tons)	Typical m^2	Typical ft^2
Mobile Home, Small House	2	93	1000
Townhouse, House	2.5	116	1250
Townhouse, Condominium	3	140	1500
Condo, House	3.5	163-186	1750-2000
House	4	186-279	2000-3000

TABLE F9 –Demand for Electric Strip Heat

KW Rating of Strip	KVA Demand
5	5
10	8
15	10.5
20	14

FE (Full Electric) is the demand value (with diversity pre-calculated) of the load **without** a summer (air conditioning) or winter (heat strip) HVAC mechanical load included. **"Total**" is the demand which **includes** a summer air conditioner load **(Total = FE + air conditioning load).** "Total" does not include the demand associated with resistive heat elements (which may drive the need for larger transformers). **HVAC diversity** = the diversity factor to use for winter HVAC unit demand calculations. It is incumbent of the electrical designer to address loads that are larger than those associated with the summer load. **Size the transformer for the summer load unless the winter load calculation is more than 140% of the summer calculation.**

Example: A new underground distribution system is being designed for a housing development of duplexes. Each dwelling unit is 140 m^2 (1500 ft^2) with a 3-ton heat pump and 5 kW of strip heat. "Total" load for 8 dwellings (max 4 duplexes per transformer – See paragraph “Housing Distribution”) and 3 ton units = 39.68 kVA (Table F7). A check of the winter load = FE (Table F7) + # of strip units x heat strip demand (Table F9) x HVAC diversity (Table F7). Winter load = 17.85 + 8 x 5 kW x 0.72 or 46.65 kVA. Summer to Winter load ratio = 46.65/39.68 or 1.18. Size the transformer for the summer load (39.68 kVA). Thus, each 50 kVA pad-mounted transformer must feed 4 duplexes.

TABLE F10 –Grounding Electrode Table

SOIL TYPE	NO. OF ELECTRODES BEFORE MEASURING	NO. OF 3050 mm (10 ft) RODS PER STACKED ELECTRODE	MAXIMUM NO. OF ELECTRODES TO INSTALL
In or near swamps, marshes, loamy wet soils	1	2	6
Level, high, sandy, dry, coarse soils	2	3	9
Level or sloping areas loamy with clay soils	2	3	9
Inland sand hills	3	4	12
Clay soils	2	3	9
Rocky areas	2	2	8

Note 1:
Direct Contractor to make a reasonable effort to drive the number of stacked rods called for. When soil conditions prohibit, the contractor must be directed to drive the number of stacked rods possible.

Note 2:
In areas of rock at or near the surface, it may be impossible to drive even one rod at the locations specified. In these cases extend the trench until a place is found where ground rods can be driven or 15 m (50 ft) whichever comes first. Terminate the wire in a ground rod of at least 2400 mm (8 ft) in length. Ensure poles in or near moist areas are well grounded.

APPENDIX G DESIGN DETAILS

Some are available from
https://portal.navfac.navy.mil/portal/page?_pageid=181,3459453,181_3459470&_dad=portal&_schema=PORTAL

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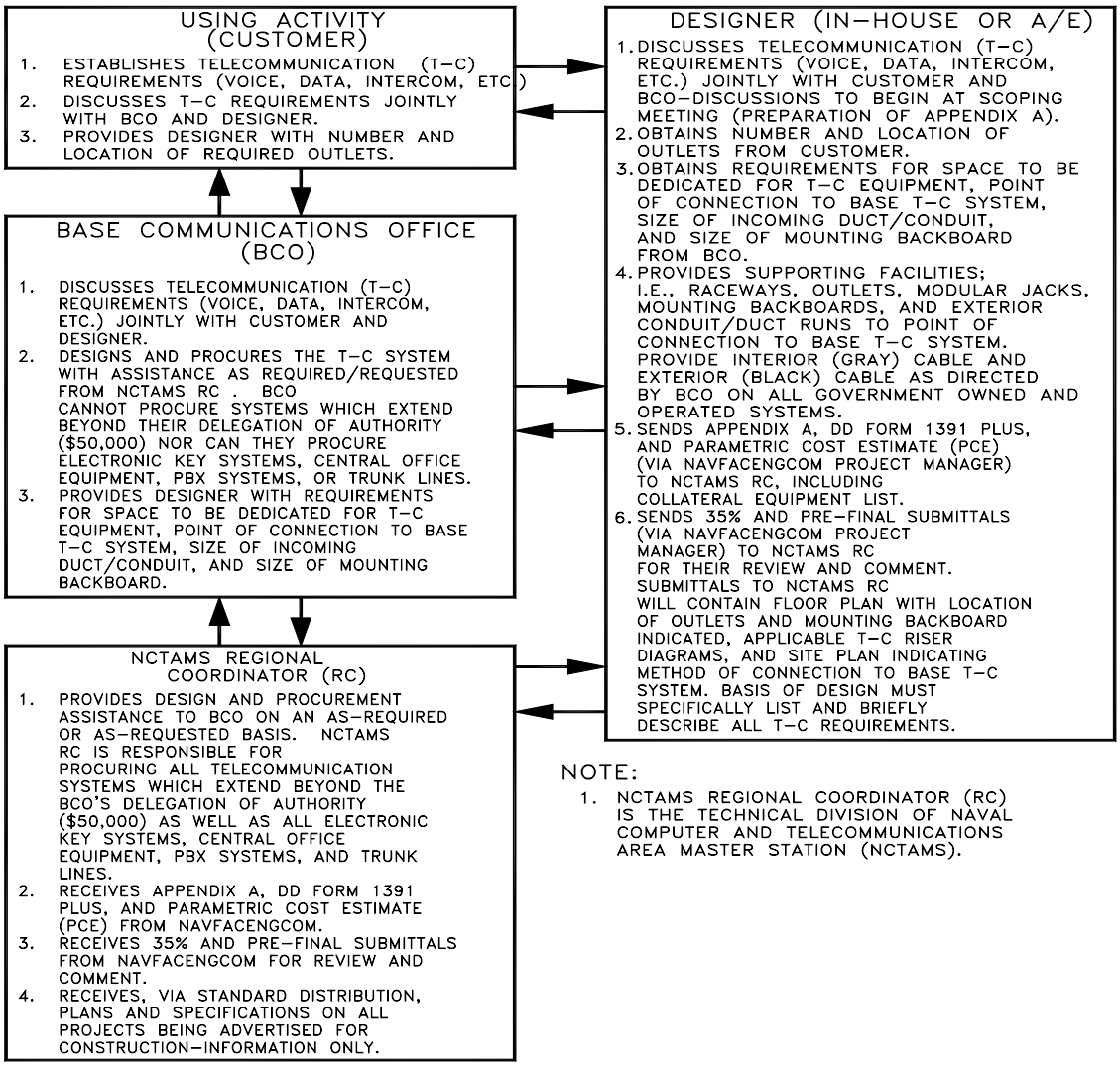
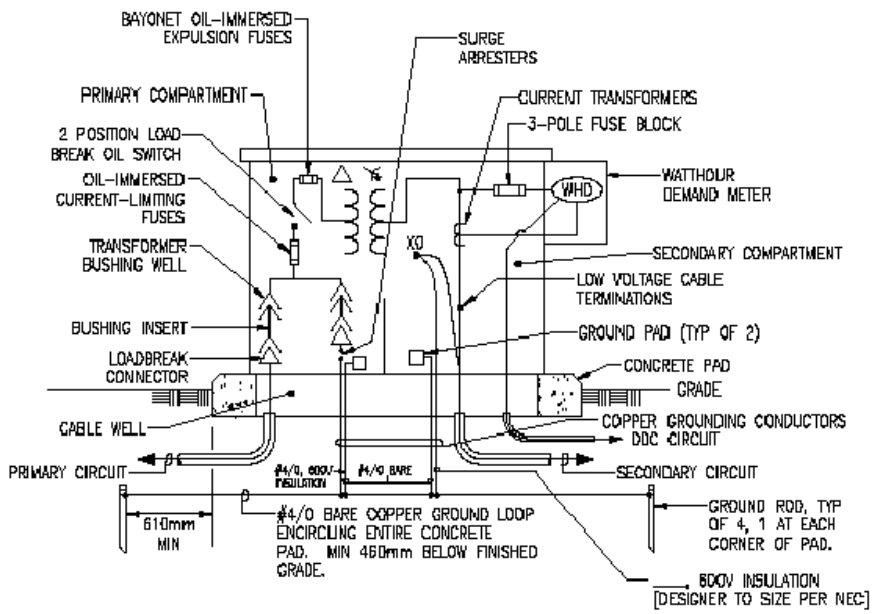
TELECOMMUNICATIONS COORDINATION AND RESPONSIBILITY CHART



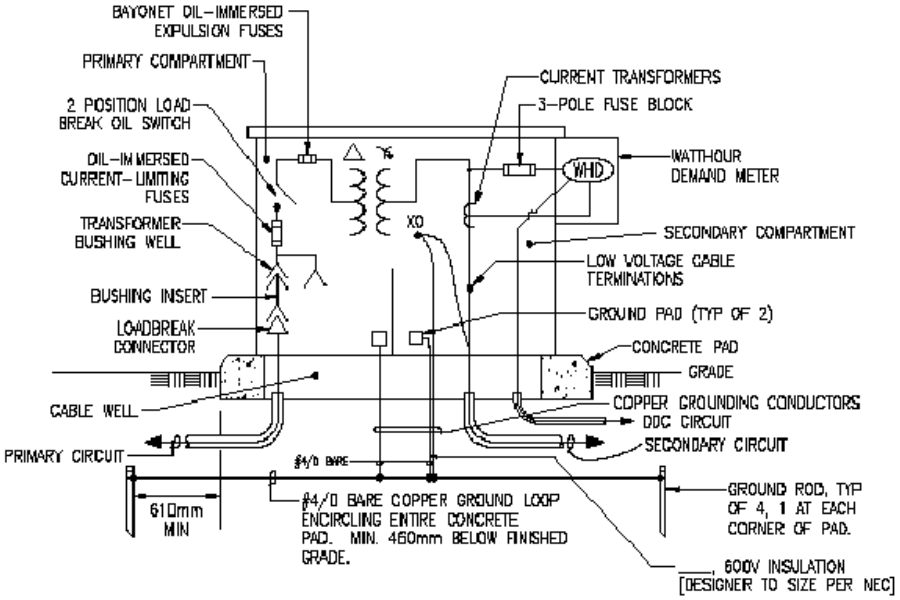
ATTACHMENT 1



PAD-MOUNTED TRANSFORMER DETAIL

NOT TO SCALE

[UNGROUNDED OR SINGLE GROUNDED PRIMARY SYSTEM – WITH SURGE ARRESTERS]

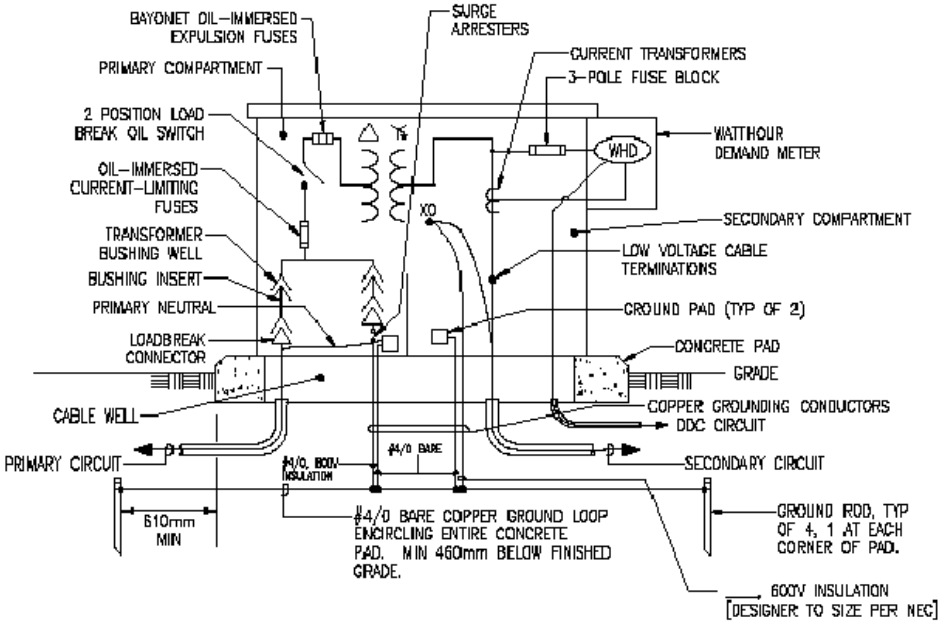


PAD-MOUNTED TRANSFORMER DETAIL

NOT TO SCALE

[UNGROUNDED OR SINGLE GROUNDED PRIMARY SYSTEM – WITHOUT SURGE ARRESTERS]

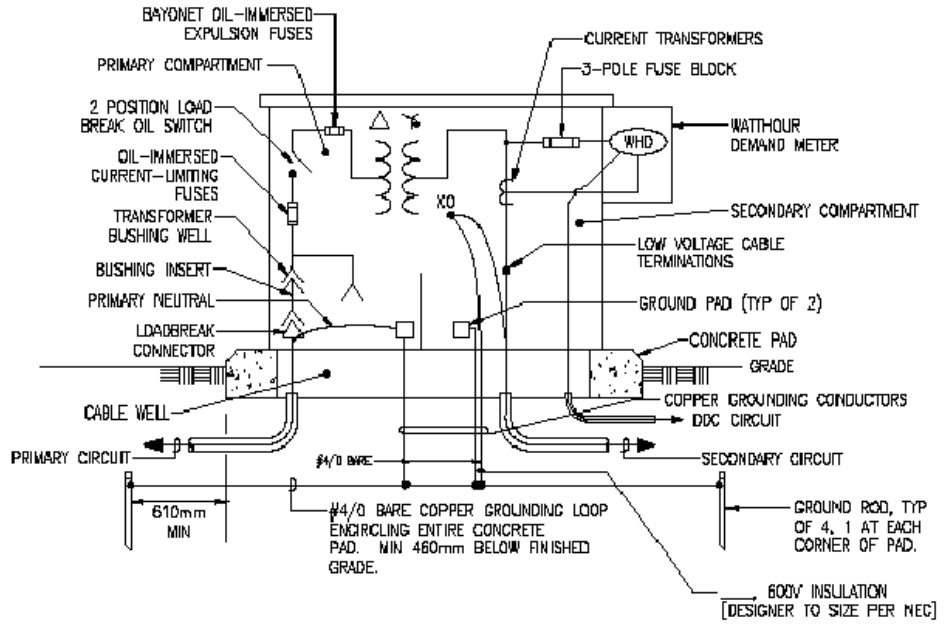
ATTACHMENT 2



PAD-MOUNTED TRANSFORMER DETAIL

NOT TO SCALE

[MULTI-GROUNDED PRIMARY SYSTEM (DELTA-WYE) - WITH SURGE ARRESTERS]

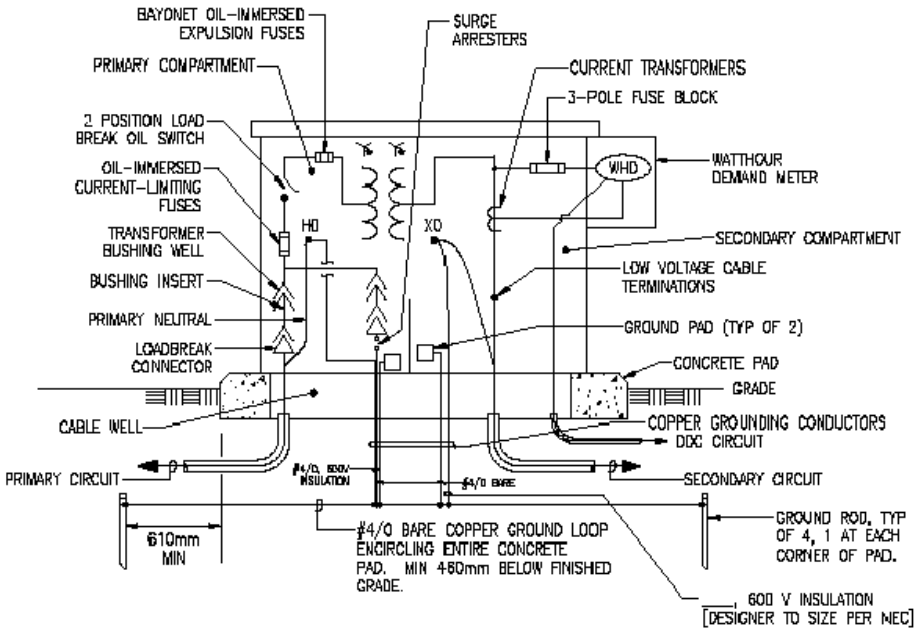


PAD-MOUNTED TRANSFORMER DETAIL

NOT TO SCALE

[MULTI-GROUNDED PRIMARY SYSTEM (DELTA-WYE) - WITHOUT SURGE ARRESTERS]

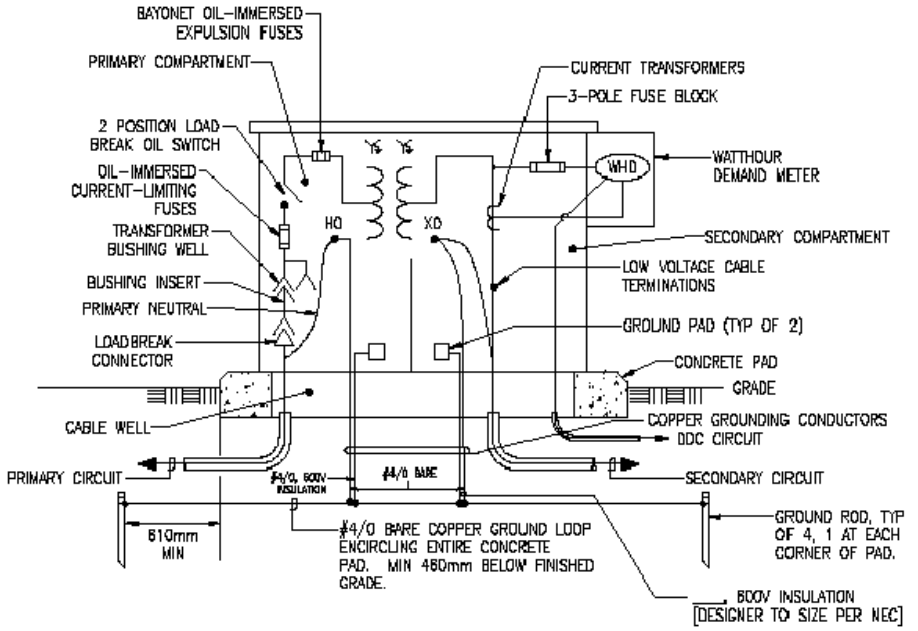
ATTACHMENT 3



PAD-MOUNTED TRANSFORMER DETAIL

NOT TO SCALE

[MULTI-GROUNDED PRIMARY SYSTEM (WYE-WYE) - WITH SURGE ARRESTERS]



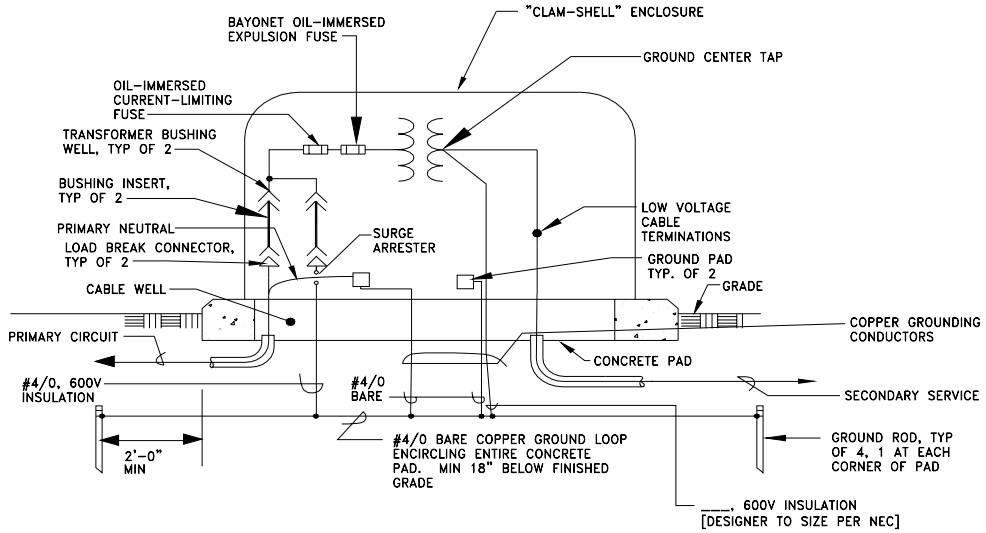
PAD-MOUNTED TRANSFORMER DETAIL

NOT TO SCALE

[MULTI-GROUNDED PRIMARY SYSTEM (WYE-WYE) - WITHOUT SURGE ARRESTERS]

ATTACHMENT 4

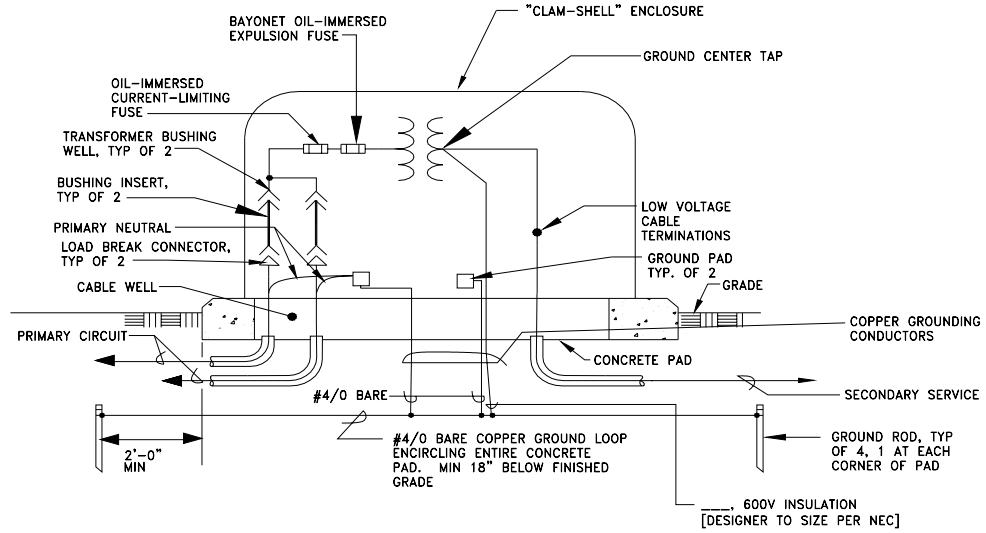
7/02



SINGLE PHASE PAD-MOUNTED TRANSFORMER DETAIL

NOT TO SCALE

[PHASE-NEUTRAL CONNECTION SHOWN]
[DEAD FRONT LOOP FEED CONFIGURATION (ONE CIRCUIT W/ARRESTER)]



SINGLE PHASE PAD-MOUNTED TRANSFORMER DETAIL

NOT TO SCALE

[PHASE-NEUTRAL CONNECTION SHOWN]
[DEAD FRONT LOOP FEED CONFIGURATION (FEED-THRU CIRCUIT)]

ATTACHMENT 5

7/02

ELEC. GUIDE LEGEND – (INTERIOR)

SYMBOL	DESCRIPTION
	FLUORESCENT LIGHTING FIXTURE.
	FLUORESCENT EMERGENCY AND/OR NIGHT LIGHTING FIXTURE.
	INCANDESCENT OR HIGH INTENSITY DISCHARGE LIGHTING FIXTURE.
	EXIT LIGHTING FIXTURE. ARROW, WHEN USED, INDICATES DIRECTION.
	LIGHTING FIXTURE TYPE. SEE LIGHTING FIXTURE SCHEDULE ON SHEET E-__
	EMERGENCY BATTERY POWERED LIGHTING UNIT.
	DUPLEX CONVENIENCE RECEPTACLE. 15 A., 125 VAC. MOUNT__ AFF UON
	DOUBLE DUPLEX CONVENIENCE RECEPTACLE. 15 A., 125 VAC. MOUNT __ AFF UON.
 GFI	DUPLEX CONVENIENCE RECEPTACLE WITH INTERNAL GROUND FAULT PROTECTION. __ A., 125 VAC. MOUNT__ AFF UON
	SINGLE RECEPTACLE. __ A.,___VAC. MOUNT __ AFF UON
	FLUSH FLOOR DUPLEX RECEPTACLE. 15 A., 125 VAC.
	FLUSH FLOOR SINGLE RECEPTACLE. __ A., 125 VAC.
	CLOCK OUTLET, 15A., 125 VAC MOUNT__ AFF
	SPECIAL PURPOSE RECEPTACLE. ___ A.,__ POLE, __ WIRE, ___VAC. MOUNT __ AFF UON NOTE TO DESIGNER: USE SAME SYMBOL & FORMAT AS ABOVE FOR ADDITIONAL SPECIAL PURPOSE OUTLETS/RECEPTACLES. DIFFERENTIATE BETWEEN TYPE BY USING SUBSCRIPT.
S	SINGLE POLE SWITCH. 20A., 120/277V.
S_A	SINGLE POLE SWITCH. 20A., 120/277V. LOWER CASE SUBSCRIPT, WHEN USED, INDICATES FIXTURES CONTROLLED.
S_2	DOUBLE POLE SWITCH. 20A., 120/277V.
S_3	THREE-WAY SWITCH. 20A., 120/277V.
S_4	FOUR-WAY SWITCH. 20A., 120/277V.
S_D	DIMMER SWITCH. _____ WATTS UON
S_A	KEY OPERATED SWITCH.
S_M	[MOTOR RATED SWITCH][MANUAL MOTOR STARTER SWITCH] WITH OVERLOADS.
S_P	SWITCH WITH PILOT LIGHT.

ATTACHMENT 6

4/98

SYMBOL	DESCRIPTION
(E)	EQUIPMENT CONNECTION AS NOTED.
(J)	JUNCTION BOX.
(M) 1/2	MOTOR CONNECTION, HP INDICATED.
	MAGNETIC MOTOR CONTROLLER.
3P 60/40	DISCONNECT SWITCH. ___V IN NEMA __ ENCLOSURE UON 3P = NO. OF POLES, 60 = SWITCH RATING, 40 = FUSE RATING (NF INDICATES NON-FUSIBLE).
	ELECTRICAL PANELBOARD (208Y/120 VOLT).
	ELECTRICAL PANELBOARD (480Y/277 VOLT).
W/W	WIREWAY.
OR	BRANCH CIRCUIT OR FEEDER WIRING IN CONDUIT. NO TICK MARKS INDICATE 2 #12 CONDUCTORS & 1 #12 GND. IN 1/2" CONDUIT UON. TICK MARKS, WHEN SHOWN, INDICATE NUMBER OF #12 CONDUCTORS IF OTHER THAN THREE; (✓) INDICATES GROUND. CONDUIT LARGER THAN 1/2" & WIRE LARGER THAN #12 SHALL BE AS INDICATED.
A-1,3,5	HOMERUNS TO PANEL. PANEL & CIRCUIT DESIGNATIONS AS INDICATED.
	INDICATES A CONDUIT RUN CONCEALED IN CEILING, WALL, FLOOR, OR ABOVE SUSPENDED CEILING UON. NOTE TO DESIGNER: INDICATE BY NOTE ON DRAWINGS WHERE EXPOSED CONDUITS ARE TO BE USED.
	CONDUIT TURNED UP.
	CONDUIT TURNED DOWN.
	CONDUIT SEAL.
	TELEPHONE TERMINAL BACKBOARD.
	TELEPHONE OUTLET, MOUNT __ AFF
P	PAY TELEPHONE OUTLET. MOUNT __ AFF

ATTACHMENT 7

4/98

SYMBOL	DESCRIPTION
TV	TELEVISION SYSTEM OUTLET, MOUNT __ AFF
S	SPEAKER.
△IC	INTERCOM OUTLET, MOUNT __ AFF
(T)	LINE VOLTAGE THERMOSTAT, MOUNT __ AFF
CS	CONTROL STATION.
●	PUSH BUTTON.
T	DRY TYPE TRANSFORMER.
T/S	TIME SWITCH
(P)	PHOTO-ELECTRIC CONTROL.
FACP	FIRE ALARM CONTROL PANEL (FACP).
F	FIRE ALARM MANUAL STATION, MOUNT __ AFF
▷F c	FIRE ALARM STROBE/CHIME, MOUNT __ AFF
▷F m	FIRE ALARM MINI-HORNS, MOUNT __ AFF
▷F	FIRE ALARM STROBE/HORN, MOUNT __ AFF
F	FIRE ALARM __-INCH BELL, MOUNT __ AFF
FCT	FIRE ALARM SYSTEM CODED TRANSMITTER.
F	MASTER FIRE ALARM BOX WITH LOCATION LIGHT.
V	FIRE ALARM SYSTEM VISUAL STROBE, MOUNT __ AFF
(S)F	FIRE ALARM SYSTEM SMOKE DETECTOR. MOUNT ON CEILING UON SUBSCRIPT "F", WHEN USED, INDICATES DETECTOR UNDER RAISED FLOOR.
(D)	DUCT SMOKE DETECTOR.
⟨S⟩	120-VAC SINGLE-STATION SMOKE DETECTOR, HARD WIRED INTO THE ELECTRICAL SOURCE AS INDICATED.
⟨T⟩	SPRINKLER SYSTEM TAMPER SWITCH.
(H)	FIRE ALARM SYSTEM HEAT DETECTOR.
⟨F⟩	SPRINKLER SYSTEM FLOW SWITCH.
⟨P⟩	SPRINKLER SYSTEM PRESSURE SWITCH.
⟨K⟩	KITCHEN HOOD FIRE EXTINGUISHING SYSTEM SWITCH.
T	REMOTE FIRE ALARM SYSTEM TROUBLE BELL (OR BUZZER).
M	MAGNETIC DOOR HOLDER.

ATTACHMENT 8

4/98

IDS SYMBOLS:

SYMBOL	DESCRIPTION
AS	ACCESS SWITCH
BS	BALANCED MAGNETIC SWITCH
CR	CARD READER WITHOUT KEY PAD
CK	CARD READER WITH KEY PAD
CP	CENTRAL PROCESSING UNIT
CU	CONTROL UNIT
DA	DURESS ALARM
DR	DOOR STRIKE
K	KEY PAD
MU	MONITORING UNIT
PI	PASSIVE INFARED SENSOR
R	REQUEST TO EXIT SWITCH

ATTACHMENT 9

4/98

ABBREVIATIONS

AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
ARF	ABOVE RAISED FLOOR
C	CONDUIT
CB	CIRCUIT BREAKER
CKT	CIRCUIT
EC	EMPTY CONDUIT
EQUIP	EQUIPMENT
EWC	ELECTRIC WATER COOLER
EWH	ELECTRIC WATER HEATER
EXIST	EXISTING
EXP	INDICATES EXPLOSION PROOF EQUIPMENT
GFCI	GOVERNMENT FURNISHED CONTRACTOR INSTALLED
GFGI	GOVERNMENT FURNISHED GOVERNMENT INSTALLED
GFI	GROUND FAULT INTERRUPTER
GND	GROUND
HID	HIGH INTENSITY DISCHARGE
MLO	MAIN LUGS ONLY
MT	MOUNT
MTG HT	MOUNTING HEIGHT
MCB	MAIN CIRCUIT BREAKER
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE

ATTACHMENT 10

4/98

ABBREVIATIONS

PNL	PANEL
PNLBD	PANELBOARD
RECEPT	RECEPTACLE
REQ'D	REQUIRED
XFMR	TRANSFORMER
UON	UNLESS OTHERWISE NOTED
WP	INDICATES WEATHERPROOF EQUIPMENT

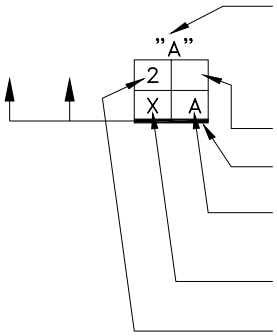
NOTES:

1. WHERE BLANK SPACES OCCUR, INSERT APPROPRIATE DATA.
2. WHERE DATA IS ENCLOSED IN BRACKETS [ ], A CHOICE MUST BE MADE. DELETE INAPPLICABLE DATA.
3. THIS LEGEND PROVIDES BASIC SYMBOLS. MODIFY LEGEND AS REQUIRED TO PROPERLY DIFFERENTIATE BETWEEN "NEW", "EXISTING TO REMAIN" & "EXISTING REMOVE".

ATTACHMENT 11

4/98

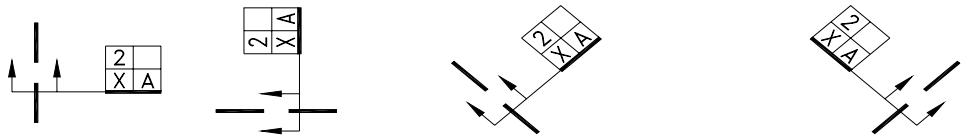
ELEC. GUIDE LEGEND—(EXTERIOR UNDERGROUND)

SYMBOL	DESCRIPTION
	UNDERGROUND DUCTBANK, CONCRETE ENCASED UON. DESCRIPTION AS INDICATED.
	EXISTING UNDERGROUND DUCTBANK, CONCRETE ENCASED UON. DESCRIPTION AS INDICATED.
	SYMBOL REFERS TO SPECIFIC DUCTBANK SECTION DETAIL. (SEE NOTE 1)
	DUCTBANK SECTION LOOKING IN DIRECTION OF ARROWS. (SEE NOTE 2)
	SPARE DUCT (TYPICAL)
	HEAVY LINE INDICATES BOTTOM OF DUCT
	EXIST. CABLE DESIGNATION (TYPICAL) DESCRIPTION PER CABLE SCHEDULE. (SEE NOTE 3)
	OCCUPIED DUCT, UNIDENTIFIED CABLE.
	NEW CABLE DESIGNATION (TYPICAL) DESCRIPTION PER CABLE SCHEDULE. (SEE NOTE 3)

DUCTBANK NOTES TO DESIGNER:

1— USE THIS SYMBOL ONLY WHEN SPECIFIC DUCTBANK SECTIONS ARE REQUIRED TO INDICATE SPECIAL CONDITIONS, SUCH AS STEEL REINFORCING, WHICH WOULD INVALIDATE THE DUCT SPACING AND CONCRETE ENCASEMENT INFORMATION GIVEN IN THE GUIDE SPECIFICATIONS. INCLUDE THE REQUIRED DUCTBANK SECTIONS ON THE DRAWINGS AND MODIFY THE SPECIFICATIONS.

2— DISPLAY DUCTBANK SECTIONS IN ANY OF THE FOLLOWING ACCEPTABLE WAYS:



3— PROVIDE A CABLE SCHEDULE CONTAINING CABLE DESIGNATION SYMBOLS, CABLE DESCRIPTIONS, CONDUIT SIZES, ROUTING AND OTHER INFORMATION THAT MAY BE NECESSARY. THIS INFORMATION SHOULD NOT BE REPEATED ELSEWHERE ON THE DRAWINGS. IDENTIFY CABLE SHOWN ON SITE PLANS, FLOOR PLANS, RISER DIAGRAMS, ETC. BY ITS CABLE DESIGNATION SYMBOL ONLY.

ATTACHMENT 12

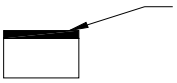
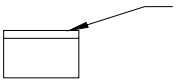
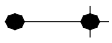
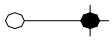
4/98

SYMBOL	DESCRIPTION
——— UP ———	UNDERGROUND CONDUIT, CONCRETE ENCASED UON. DESIGNER TO DESCRIBE CABLE AND CONDUIT. EXAMPLE: 3–1/C 500 KCMIL (15KV) & 1 500 KCMIL NEUTRAL (600V) IN 5" C.
— — US — —	EXISTING UNDERGROUND CONDUIT, CONCRETE ENCASED UON DESIGNER TO DESCRIBE CABLE AND CONDUIT. EXAMPLE: 4 #2 (600V) IN 3" C.
⤫ ⤫USL⤫ ⤫	REMOVE EXISTING CIRCUIT. ABANDON CONDUIT IN PLACE UON. DESIGNER TO DESCRIBE CABLE. EXAMPLE: 3–1/C, 120 VOLT STREET LIGHT CABLE.
TYPICAL DESIGNATIONS TO BE USED IN CONJUNCTION WITH CONDUIT SYMBOLS	UP– UNDERGROUND PRIMARY US– UNDERGROUND SECONDARY UT– UNDERGROUND TELEPHONE UFA– UNDERGROUND FIRE ALARM USL– UNDERGROUND STREET LIGHTING UTV– UNDERGROUND TELEVISION CABLE
——— G ———	GROUNDING CONDUCTOR. DESIGNER TO DESCRIBE.
▣	MANHOLE OR HANDHOLE, AS NOTED.
▣	EXISTING MANHOLE OR HANDHOLE AS NOTED.
▣▣	EXISTING COMBINATION POWER/COMMUNICATION MANHOLE.

NOTE TO DESIGNER: REQUEST MANHOLE & HANDHOLE DESIGNATION NUMBERS FROM THE ACTIVITY. DO NOT USE ARBITRARILY ASSIGNED NUMBERS UNLESS STATION PROVIDED NUMBERS ARE NOT AVAILABLE. IF NUMBERS ARE NOT AVAILABLE, PRE–FINAL SUBMITTAL MUST STATE THIS FACT AND INDICATE INDIVIDUAL (NAME AND TELEPHONE NUMBER) AT THE ACTIVITY WHO WAS CONTACTED.

ATTACHMENT 13

4/98

SYMBOL	DESCRIPTION
	INDICATES FRONT. PAD MOUNTED TRANSFORMER. DESIGNER TO PROVIDE DESCRIPTION. EXAMPLE: 75KVA, 3 PHASE, 12KV–208Y/120 VOLTS.
	INDICATES FRONT. EXISTING PAD MOUNTED TRANSFORMER. DESIGNER TO PROVIDE DESCRIPTION. EXAMPLE: 25KVA, 1 PHASE, 2.4KV–120/240 VOLTS. NOTE TO DESIGNER: FOR UNIT SUBSTATIONS AND OTHER MAJOR PIECES OF ELECTRICAL EQUIPMENT SHOW APPROXIMATE EQUIPMENT OUTLINE ON PLANS, PROPERLY IDENTIFY, INDICATE FRONT OF EQUIPMENT.
	PAD MOUNTED SWITCH. DESIGNER TO PROVIDE DESCRIPTION. EXAMPLE: 15KV, 3 WAY, 600 AMP NON–FUSED, OIL.
	EXISTING PAD MOUNTED SWITCH. DESIGNER TO PROVIDE DESCRIPTION. EXAMPLE: 5KV, 4 WAY, 200 AMP FUSED, AIR.
	AREA/STREET LIGHTING POLE WITH LUMINAIRE. DESIGNER TO PROVIDE DESCRIPTION. EXAMPLE: 400 WATT, 120 V. WITH 6' MOUNTING ARM.
	EXISTING AREA/STREET LIGHTING POLE WITH LUMINAIRE. DESIGNER TO PROVIDE DESCRIPTION. EXAMPLE: 400 WATT, 120 V. WITH 6' MOUNTING ARM.
	EXISTING AREA/STREET LIGHTING POLE WITH EXISTING LUMINAIRE. DESIGNER TO PROVIDE DESCRIPTION.
	LIGHTING FIXTURE TYPE. SEE LIGHTING FIXTURE SCHEDULE ON SHEET E–__

ABBREVIATIONS

C	CONDUIT
HH	HANDHOLE
MH	MANHOLE
UG	UNDERGROUND
XFMR	TRANSFORMER
UON	UNLESS OTHERWISE NOTED

ATTACHMENT 14

4/98

ELEC. GUIDE LEGEND–(EXTERIOR–OVERHEAD)

SYMBOL	DESCRIPTION
●	POWER POLE (HEIGHT AND CLASS AS INDICATED).
●R	REMOVE EXISTING AND PROVIDE NEW POWER POLE (HEIGHT AND CLASS AS INDICATED).
○	EXISTING POWER POLE (HEIGHT AND CLASS AS INDICATED).
⊗	REMOVE EXISTING POWER POLE (HEIGHT AND CLASS AS INDICATED).
	NOTE TO DESIGNER: REQUEST POLE NUMBERS FROM THE ACTIVITY. DO NOT USE ARBITRARILY ASSIGNED NUMBERS UNLESS STATION PROVIDED NUMBERS ARE NOT AVAILABLE. IF NUMBERS ARE NOT AVAILABLE, PRE–FINAL SUBMITTAL MUST STATE THIS FACT AND INDICATE INDIVIDUAL (NAME AND TELEPHONE NUMBER) AT THE ACTIVITY WHO WAS CONTACTED.
2	DOWN GUY AND ANCHOR – QUANTITY AS INDICATED IF OTHER THAN ONE.
	EXISTING DOWN GUY AND ANCHOR – PROVIDE ADDITIONAL DOWN GUY TO EXISTING ANCHOR.
2	EXISTING DOWN GUY AND ANCHOR – QUANTITY AS INDICATED IF OTHER THAN ONE.
2	REMOVE EXISTING DOWN GUY AND ANCHOR – QUANTITY AS INDICATED IF OTHER THAN ONE.
2	SPAN GUY – QUANTITY AS INDICATED IF OTHER THAN ONE.
2	EXISTING SPAN GUY – QUANTITY AS INDICATED IF OTHER THAN ONE.
2	REMOVE EXISTING SPAN GUY – QUANTITY AS INDICATED IF OTHER THAN ONE.
▲ 25	POLE MOUNTED TRANSFORMER – SINGLE PHASE WITH KVA AS INDICATED.
△ 25	EXISTING POLE MOUNTED TRANSFORMER – SINGLE PHASE WITH KVA AS INDICATED.
25	REMOVE POLE MOUNTED SINGLE PHASE TRANSFORMER – KVA AS INDICATED.

ATTACHMENT 15

4/98

SYMBOL	DESCRIPTION
——13.2——	13.2 KV, 3 PHASE, 3 WIRE CIRCUIT # 1/0 B. ALUM. UNLESS OTHERWISE NOTED. NOTE TO DESIGNER: MODIFY UNDERLINED DATA TO MATCH CIRCUIT VOLTAGE, SYSTEM AND CONDUCTOR CHARACTERISTICS. PROVIDE TICKMARKS, IF DESIRED, TO FURTHER INDICATE NUMBER OF CONDUCTORS. TYPICAL COMMENT FOR ALL CIRCUIT SYMBOLS.
— —13.2— —	EXISTING 13.2 KV, 3 PHASE, 3 WIRE CIRCUIT — #4 W.P. CU.
✕ ✕13.2✕ ✕	REMOVE 13.2 KV, 3 PHASE, 3 WIRE CIRCUIT — 477 B. ALUM.
—— N ——	ONE WIRE COMMON NEUTRAL — #4 B. CU.
— — N — —	EXISTING ONE WIRE COMMON NEUTRAL — #4/0 B. ALUM.
✕ ✕ N ✕ ✕	REMOVE ONE WIRE COMMON NEUTRAL — #4 W.P. CU.
— — G — —	EXISTING ONE WIRE GROUND (STATIC) — 3/8" STEEL.
✕ ✕ G ✕ ✕	REMOVE ONE WIRE GROUND (STATIC) — 5/16" STEEL.
—— SL ——	2 WIRE SERIES TYPE STREET LIGHTING CIRCUIT — #6 W.P. CU.
— — SL — —	EXISTING 1 WIRE SERIES TYPE STREET LIGHTING CIRCUIT —#4 B. CU.
✕ ✕ SL ✕ ✕	REMOVE 2 WIRE SERIES TYPE STREET LIGHTING CIRCUIT — #6 B. CU.
—— FA ——	2 WIRE FIRE ALARM CIRCUIT — #8 W.P. CU.
— — FA — —	EXISTING 2 WIRE FIRE ALARM CIRCUIT — #8 W.P. CU.
✕ ✕ FA ✕ ✕	REMOVE 2 WIRE FIRE ALARM CIRCUIT — #8 W.P. CU.
—— S ——	OPEN 3 WIRE 120/240 VOLT SECONDARY CIRCUIT.
— — S — —	EXISTING OPEN 3 WIRE 480Y/277 VOLT SECONDARY CIRCUIT.
✕ ✕ S ✕ ✕	REMOVE EXISTING OPEN 3 WIRE 240/480 VOLT SECONDARY CIRCUIT.

ATTACHMENT 16

4/98

SYMBOL	DESCRIPTION
—— SD ——	120 VOLT SECONDARY (DUPLEX) CIRCUIT – #4 ALUM INSULATED PHASE CONDUCTOR WITH #4 B. ALUM NEUTRAL CONDUCTOR.
– – SD – –	EXISTING 240 VOLT SECONDARY (DUPLEX) CIRCUIT – #4 COPPER.
×× SD ××	REMOVE 120 VOLT SECONDARY (DUPLEX) CIRCUIT – #4 COPPER.
—— ST ——	120/240 VOLT SECONDARY (TRIPLEX) CIRCUIT – #2 COPPER INSULATED PHASE CONDUCTORS WITH #2 B. CU. NEUTRAL CONDUCTOR.
– – ST – –	EXISTING 120/240 VOLT SECONDARY (TRIPLEX) CIRCUIT – #2 ALUM.
×× ST ××	REMOVE 120/240 VOLT SECONDARY (TRIPLEX) CIRCUIT – #4/0 ALUM.
—— SQ ——	208Y/120 VOLT SECONDARY (QUADRUPLEX) CIRCUIT – #1/0 ALUMINUM INSULATED PHASE CONDUCTORS WITH #1/0 B. ALUM NEUTRAL CONDUCTOR.
– – SQ – –	EXISTING 208Y/120 VOLT SECONDARY (QUADRUPLEX) CIRCUIT – #1/0 ALUM.
×× SQ ××	REMOVE 208Y/120 VOLT SECONDARY (QUADRUPLEX) CIRCUIT – #1/0 B. ALUM.
—— TD ——	120/240 VOLT TRIPLEX SERVICE DROP – #2 COPPER INSULATED PHASE CONDUCTORS WITH #2 B. COPPER NEUTRAL CONDUCTOR.
– – TD – –	EXISTING 120/240 VOLT TRIPLEX SERVICE DROP – #1/0 COPPER.
×× TD ××	REMOVE 120/208 VOLT TRIPLEX SERVICE DROP – #1/0 ALUM.
—— QD ——	208Y/120 VOLT QUADRUPLEX SERVICE DROP – #1/0 ALUM.INSULATED PHASE CONDUCTORS WITH #1/0 B. ALUM. NEUTRAL CONDUCTOR.
– – QD – –	EXISTING 208Y/120 VOLT QUADRAPLEX SERVICE DROP – #4/0 ALUM.
×× QD ××	REMOVE 208Y/120 VOLT QUADRUPLEX SERVICE DROP – #2 COPPER.

ATTACHMENT 17

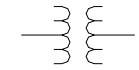
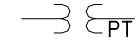
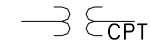
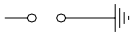
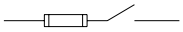
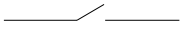
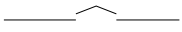
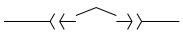
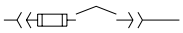
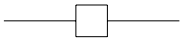
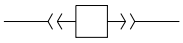
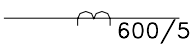
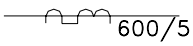
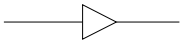
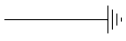
4/98

SYMBOL	DESCRIPTION
— — D — —	EXISTING 120/240 VOLT OPEN WIRE SERVICE DROP – 3 #4 W.P. CU. .
⤫ ⤫ D ⤫ ⤫	REMOVE 120/240 VOLT OPEN WIRE SERVICE DROP – 3 #1/0 W.P. CU. .
—— T ——	100 PAIR TELEPHONE CABLE.
— — T — —	EXISTING 26 PAIR TELEPHONE CABLE.
⤫ ⤫ T ⤫ ⤫	REMOVE 100 PAIR TELEPHONE CABLE.
—— TV ——	CABLE OR CLOSED CIRCUIT TELEVISION CABLE.
— — TV — —	EXISTING CABLE OR CLOSED CIRCUIT TELEVISION CABLE.
⤫ ⤫ TV ⤫ ⤫	REMOVE CABLE OR CLOSED CIRCUIT TELEVISION CABLE.
—— A ——	SECURITY ALARM OR ANNUNCIATOR CIRCUIT– CHARACTERISTICS AS INDICATED.
— — A — —	EXISTING SECURITY ALARM OR ANNUNCIATOR CIRCUIT – CHARACTERISTICS AS INDICATED.
⤫ ⤫ A ⤫ ⤫	REMOVE SECURITY ALARM OR ANNUNCIATOR CIRCUIT – CHARACTERISTICS AS INDICATED.
—— C ——	12 CONDUCTOR, #10 AWG COPPER, 600 VOLT CONTROL CABLE.
— — C — —	EXISTING 18 CONDUCTOR, #12 AWG COPPER, 300 VOLT CONTROL CABLE.
⤫ ⤫ C ⤫ ⤫	REMOVE 6 CONDUCTOR, #14 AWG COPPER, 600 VOLT CONTROL CABLE.
——●— △A	AREA/STREET LIGHTING FIXTURE – TYPE △A PER LIGHTING FIXTURE SCHEDULE ON SHEET E– .
——○—	EXISTING 120 VOLT, 250 WATT, AREA/STREET LIGHTING FIXTURE.
——⊗—	REMOVE EXISTING 120 VOLT, 400 WATT, AREA/STREET LIGHTING FIXTURE.

ATTACHMENT 18

4/98

ELEC. GUIDE LEGEND (ONE-LINE DIAGRAMS)

SYMBOLS	DESCRIPTION
	POWER TRANSFORMER.
	POTENTIAL TRANSFORMER.
	CONTROL POWER TRANSFORMER.
	SURGE ARRESTER.
	FUSED SWITCH.
	DISCONNECT SWITCH.
	MOLDED CASE CIRCUIT BREAKER.
	LOW VOLTAGE DRAW-OUT POWER CIRCUIT BREAKER.
	FUSED LOW VOLTAGE DRAW-OUT POWER CIRCUIT BREAKER.
	MEDIUM VOLTAGE POWER CIRCUIT BREAKER.
	MEDIUM VOLTAGE POWER DRAW-OUT CIRCUIT BREAKER.
	DELTA CONNECTION.
	GROUNDED WYE CONNECTION.
	CURRENT TRANSFORMER – SINGLE RATIO AS SHOWN.
	CURRENT TRANSFORMER – MULTI RATIO (FULL RATIO SHOWN).
	MEDIUM VOLTAGE CABLE TERMINATION.
	EXISTING MEDIUM VOLTAGE CABLE TERMINATION.
	CAPACITOR.
	GROUNDING ELECTRODE CONNECTION.
	CABLE OR BUS, TYPE AND CHARACTERISTICS AS INDICATED.
	EXISTING CABLE OR BUS, TYPE AND CHARACTERISTICS AS INDICATED.

ATTACHMENT 19

4/98

SYMBOL	DESCRIPTION
—x—x—x—	REMOVE CABLE OR BUS, TYPE AND CHARACTERISTICS AS INDICATED.
(A)	AMMETER.
(V)	VOLTMETER.
(W)	WATTMETER.
(WH)	WATTHOUR METER.
(WHD)	WATTHOUR METER WITH DEMAND REGISTER.
(VAR)	VARMETER.
(F)	FREQUENCY METER.
(PF)	POWER FACTOR METER.
(S)	SYNCHROSCOPE.
[AS]	AMMETER SWITCH.
[VS]	VOLTMETER SWITCH.
◇K	KIRK KEY INTERLOCK.
[S]	SHUNT TRIP.
(GFP)	GROUND FAULT PROTECTION.
(GEN)	GENERATOR.
(L)	INDICATING LAMP.
—|||—	BATTERY.
(51) 3	RELAY AND ANSI CONTROL FUNCTION SYMBOL. NUMBER OUTSIDE CIRCLE INDICATES QUANTITY IF GREATER THAN ONE.

ATTACHMENT 20

4/98

TYPICALLY USED ANSI CONTROL FUNCTION SYMBOLS

01	CONTROL SWITCH.
2	TIME DELAY RELAY.
15	SPEED OR FREQUENCY MATCHING RELAY.
25	SYNCHRONIZING RELAY.
27	UNDER VOLTAGE RELAY.
32	REVERSE POWER RELAY.
43	SELECTOR SWITCH.
46	NEGATIVE SEQUENCE CURRENT RELAY.
50	INSTANTANEOUS OVERCURRENT RELAY.
51	TIME OVERCURRENT RELAY.
52	AC CIRCUIT BREAKER.
59	OVERVOLTAGE RELAY.
63	SUDDEN PRESSURE RELAY.
67	DIRECTIONAL OVERCURRENT RELAY.
74	ALARM RELAY.
79	AC RECLOSING RELAY.
81	FREQUENCY RELAY.
86	LOCK–OUT RELAY.
87	DIFFERENTIAL RELAY.

ATTACHMENT 21

4/98

ABBREVIATIONS

X	AUXILIARY.
LTC	LOAD TAP CHANGER.
AUTO	AUTOMATIC.
AF	AMP FRAME.
AT	AMP TRIP.
CPT	CONTROL POWER TRANSFORMER.
N	NEUTRAL.

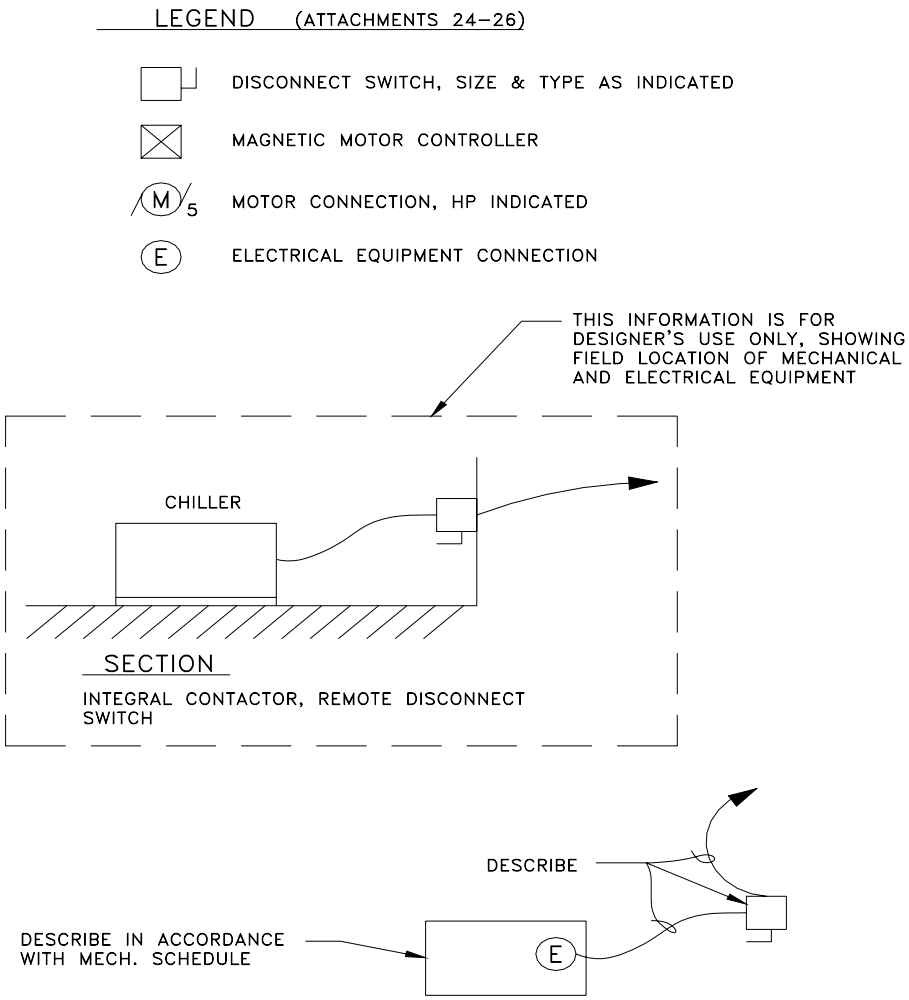
ATTACHMENT 22

4/98

LIGHTING FIXTURE SCHEDULE					
FIXTURE SYMBOL	SKETCH NO. & TYPE	NUMBER AND TYPE OF LAMPS	VOLTAGE	MOUNTING	NOTES
A	NL-1, TYPE A	2-F32/T8	120	SURFACE	
B	NL-3, TYPE C	2-F32/T8	120	RECESSED	
C	NL-57, TYPE B	1-13W DOUBLE TWIN TUBE FLUOR.	120	RECESSED	
D	NL-4, TYPE A	2-F17/T8	120	WALL 6" AFF	
E	DETAIL "D" SEE SHEET E-6	2-F32/T8	120	SUSPENDED W/1/2" C 12' AFF	
F	NL-9, TYPE E	4-F32/T8	120	RECESSED	32 CELL NATURAL FINISH
G	NL-25, TYPE A	1-70W HPS	120	WALL 10' AFF	
H	NL-51	2-12W HALOGEN	120	WALL 7' AFF	
I	NL-61	LED	120	WALL 7' AFF	

ATTACHMENT 23

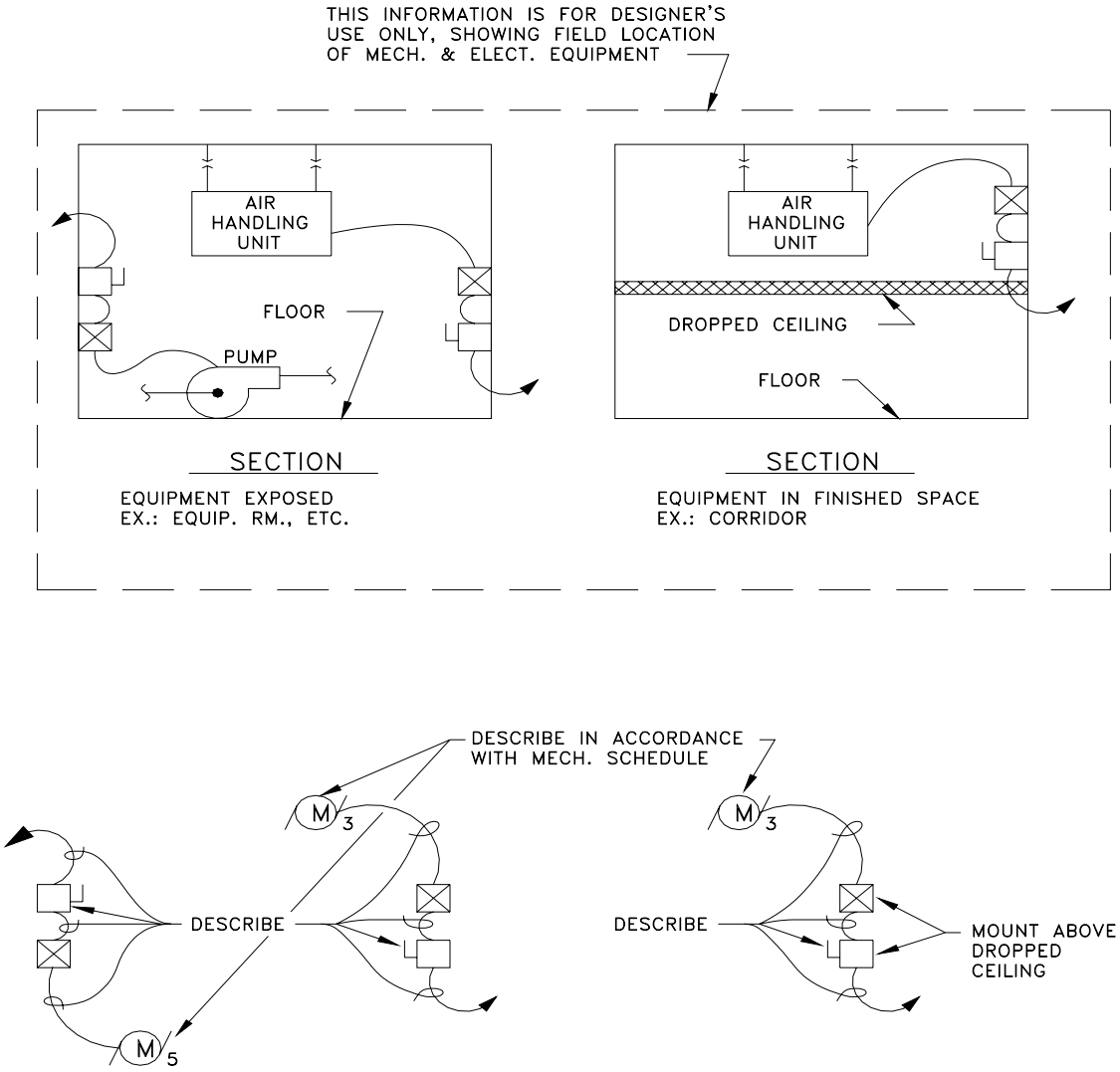
4/98



EQUIPMENT CONNECTION ILLUSTRATIONS

ATTACHMENT 24

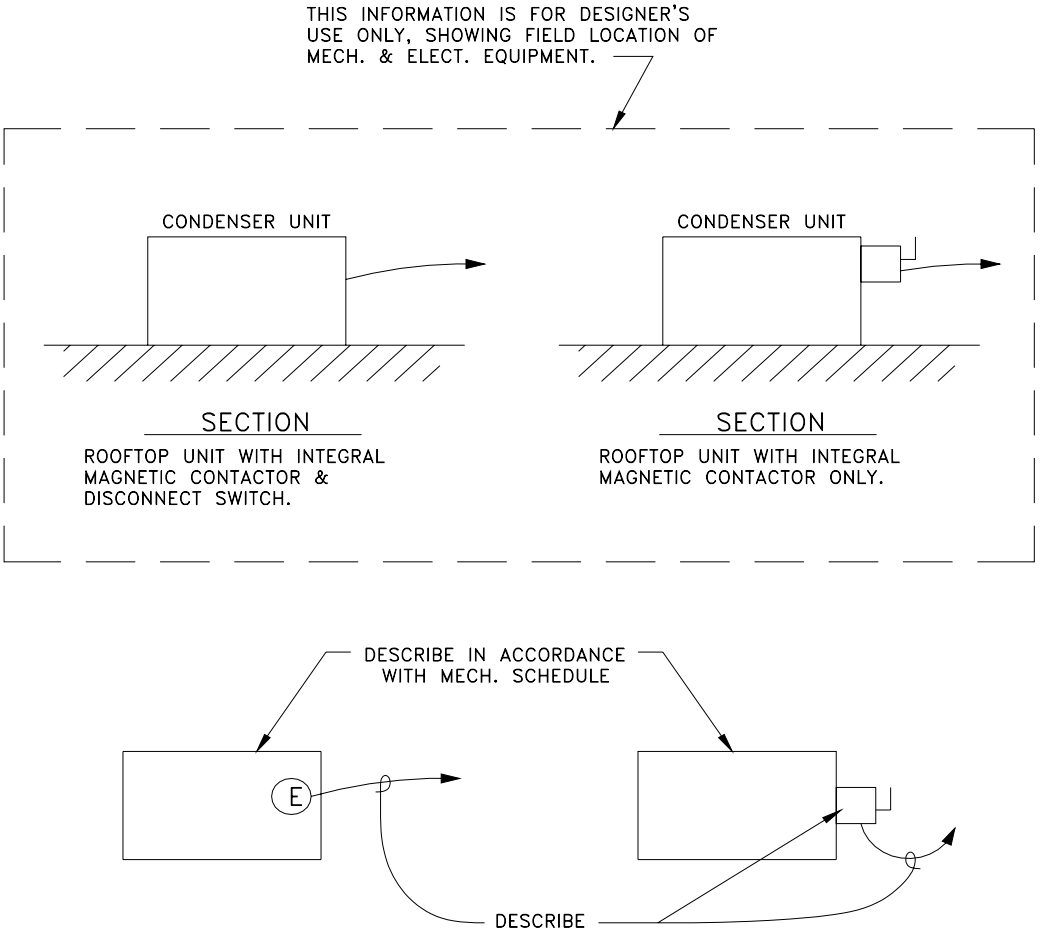
4/98



EQUIPMENT CONNECTION ILLUSTRATIONS

ATTACHMENT 25

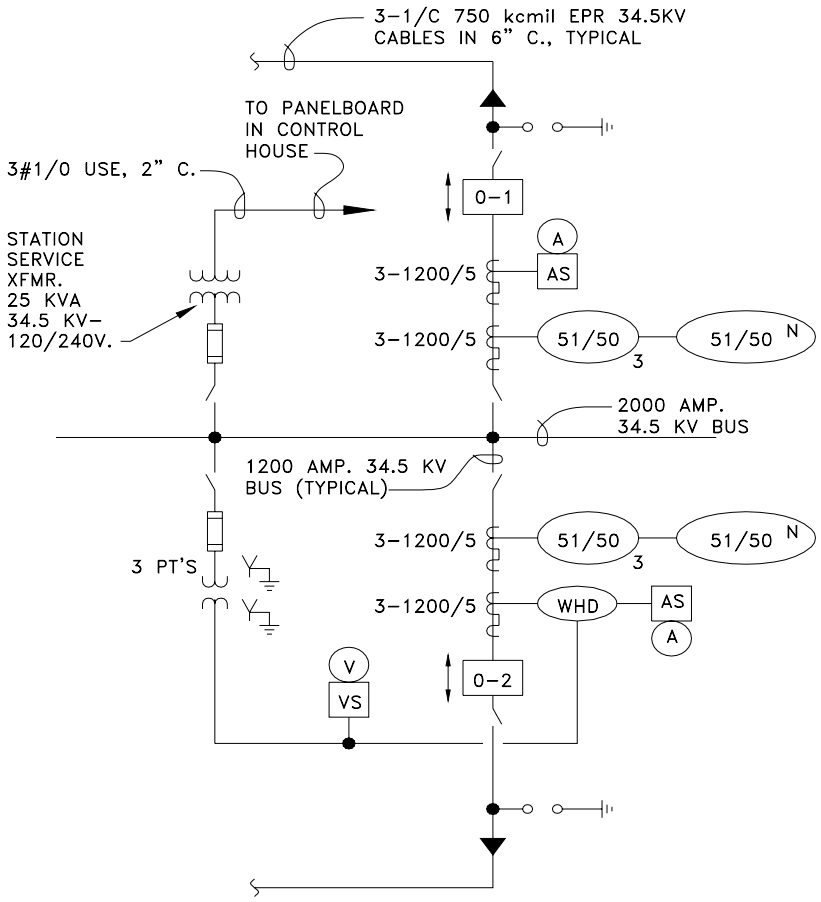
4/98



EQUIPMENT CONNECTION ILLUSTRATIONS

ATTACHMENT 26

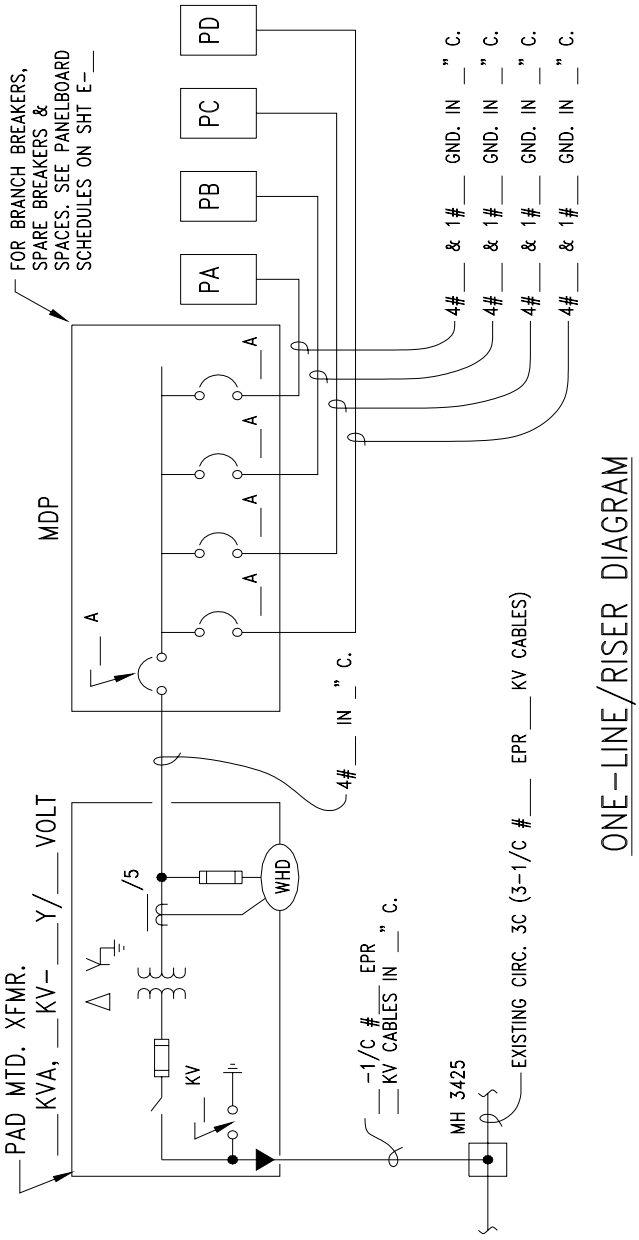
4/98



ONE-LINE DIAGRAM

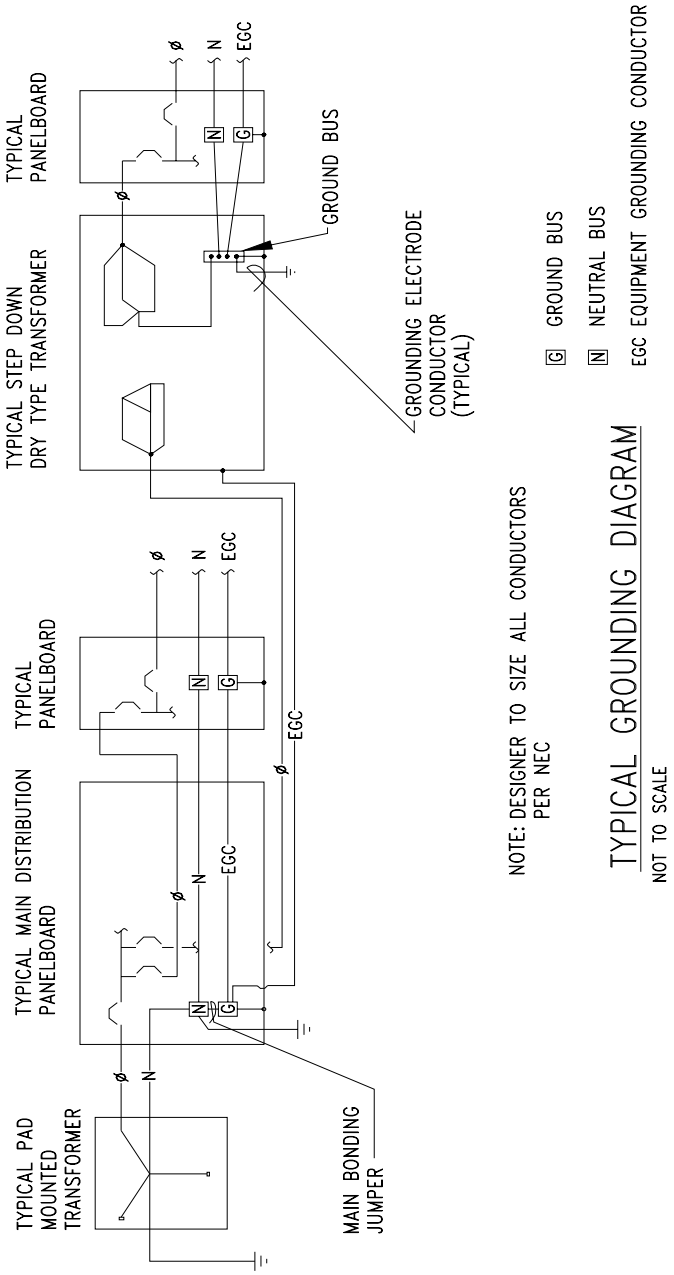
ATTACHMENT 27

4/98



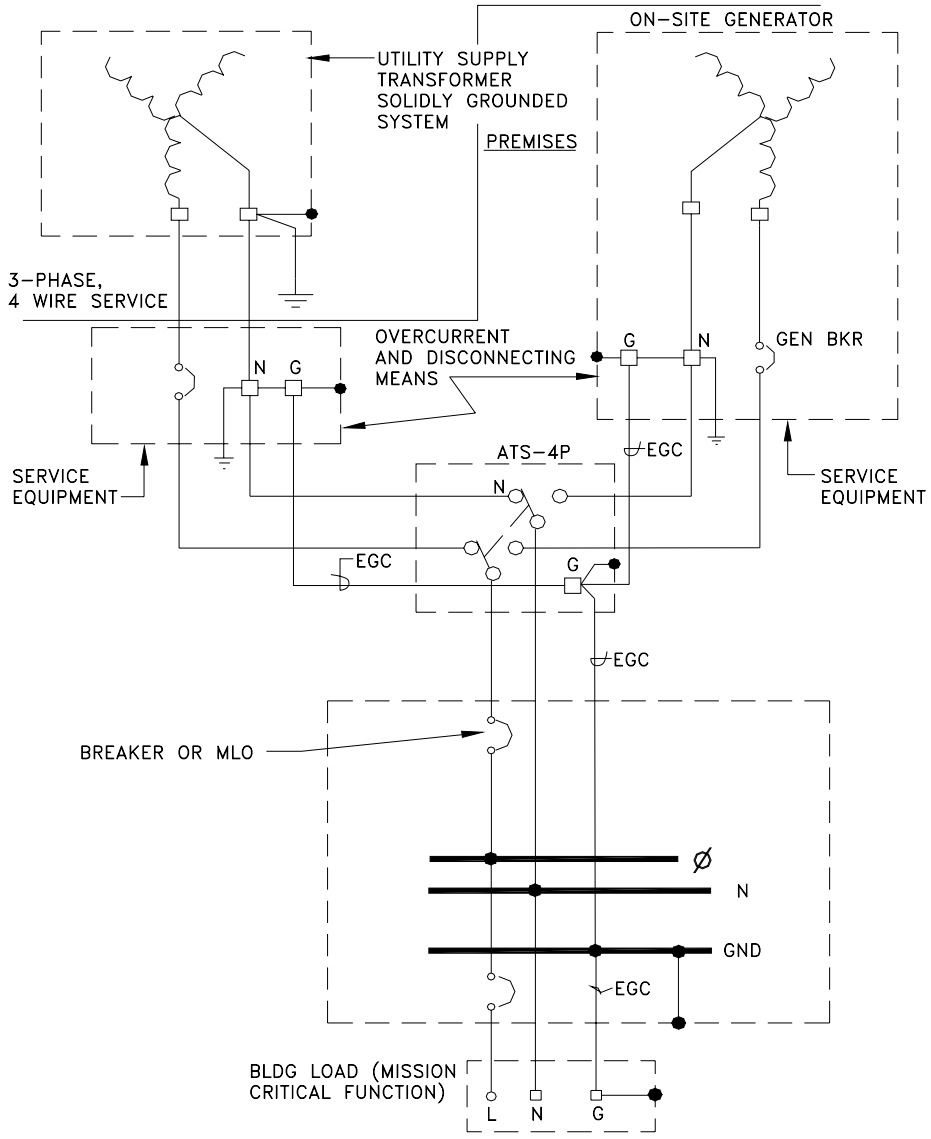
ATTACHMENT 28

6/99



ATTACHMENT 29

4/98

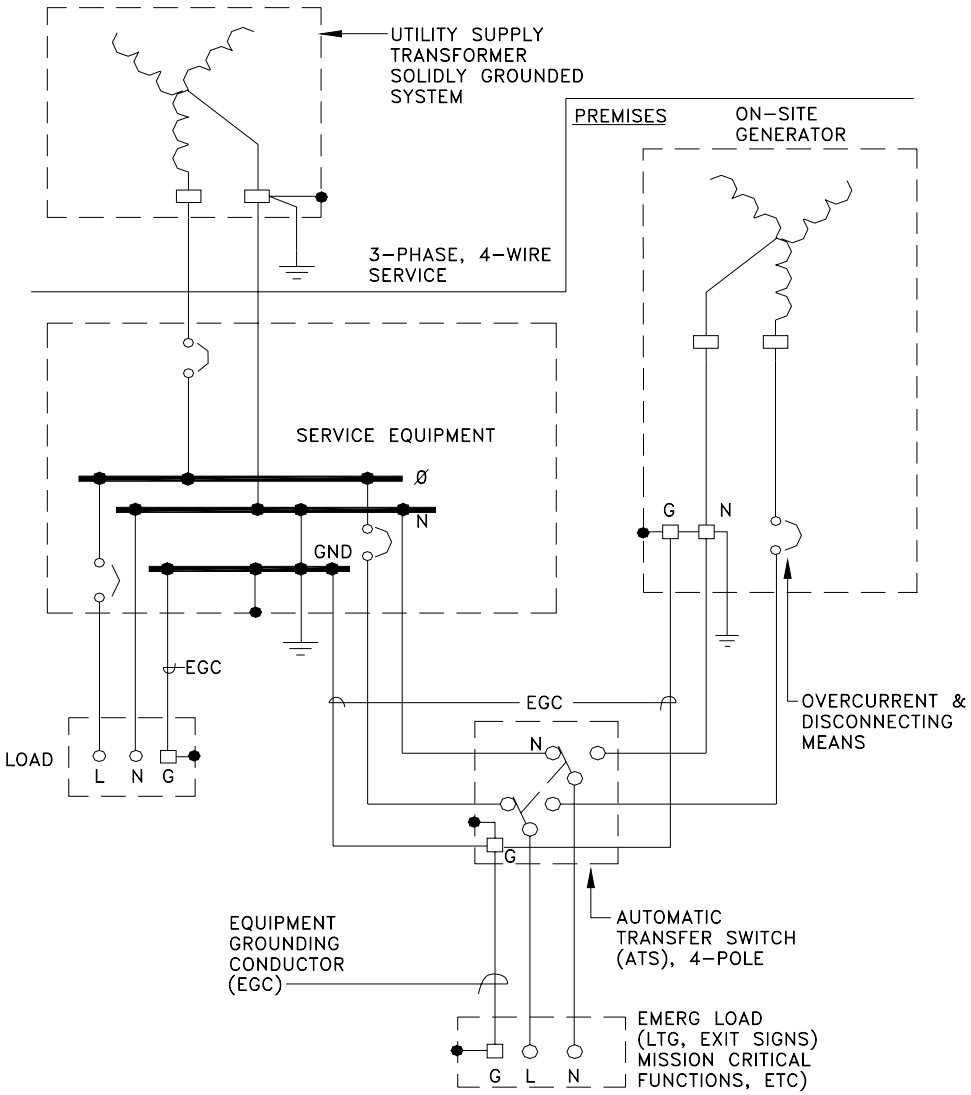


GROUNDING DIAGRAM

ALL BUILDING LOADS PROVIDED WITH BACK-UP
EMERGENCY GENERATION

ATTACHMENT 30

4/98



GROUNDING DIAGRAM

SELECTED BUILDING LOADS PROVIDED WITH BACK-UP EMERGENCY GENERATION

ATTACHMENT 31

4/98

PANELBOARD MDP SCHEDULE (1)

600 A. MAINS W/400A M.C.B., 208Y/120 V., 3 PHASE, 4 WIRE, 10 KAIC MINIMUM, FLUSH MOUNT

LOAD SERVED	LOAD (AMPS) A	B	C	BKR. TRIP	WIRE SIZE	CKT. NO.	PHASE A B C	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
UH-1 & EF-1 RM. 101	1.5			20	12	1		2	12	20	5.1			UNIT HEATERS RM 105
EF-2 RM. 102		1.6		20	12	3		4	12	20		3.5		UNIT HEATERS RM. 107
EF-5 RM. 103			.58	20	12	5		6	12	20			2	FACP (2)
SPARE				20		7		8		20				SPARE
SPARE				20		9		10		20				SPARE
SPACE						11		12						SPACE
SPACE						13		14						SPACE
BAY DOORS RM. 105		11		20	12	15		16						SPACE
			11					18						SPACE
PANEL A	173			100	3	19		20						SPACE
		164												
			168											
ACU-1 RM. 104	6			20	12	25		26	8	50	137			PANEL B
		6										135		
			6										136	
EF-3 RM 107	6			20	12	31		32	8	50	108			PANEL C
		6										113		
			6										137	
EF-4 RM. 106	4.1			20	12	37		38	12	20	4.1			H&V-1 ISSUE RM.
		4.1										4.1		
			4.1										4.1	
TOTAL	191	193	196								254	256	279	TOTAL
TOTAL CONNECTED AMPS A: 445 B: 451 C: 475														

(1) PROVIDE SERVICE RATED PANEL. PROVIDE RED LAMINATED PLASTIC LABEL WITH WHITE CENTER CORE WITH THE FOLLOWING INSCRIPTION "EMERGENCY BREAKER WITHIN"

(2) PROVIDE LOCK-ON BREAKER PAINTED RED

PANELBOARD C SCHEDULE

225 A., MAIN LUGS ONLY, 208Y/120V., 3 PHASE, 4 WIRE, 10 KAIC MINIMUM, FLUSH MOUNT

LOAD SERVED	LOAD (AMPS) A	B	C	BKR. TRIP	WIRE SIZE	CKT. NO.	PHASE A B C	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
LIGHTING RM. 100	10.4			20	12	1		2	12	20	10.4			LIGHTING RM. 107
LIGHTING RM. 101		16.0		20	12	3		4	12	20		16.0		LIGHTING RM. 108
LIGHTING RM. 102			16.0	20	12	5		6	12	20			16.0	LIGHTING RM. 109
LIGHTING RM. 103	5.8			20	12	7		8	12	20	10.4			LIGHTING RM. 110
LIGHTING RM. 104		10.4		20	12	9		10	12	20		16.0		LIGHTING RM. 111
LIGHTING RM. 105			10.4	20	12	11		12	12	20			16.0	LIGHTING RM. 112
LIGHTING RM. 106	15.0			20	12	13		14	12	20	10.4			LIGHTING RM. 113
SPARE				20		15		16		20				SPARE
SPARE				20		17		18		20				SPARE
SPACE						19		20						SPACE
SPACE						21		22						SPACE
RECEPTACLES RM. 100			10.4	20	12	23		24	12	20			10.5	RECEPTACLES RM. 107
RECEPTACLES RM. 101	10.4			20	12	25		26	12	20	12.0			RECEPTACLES RM. 108
RECEPTACLES RM. 102		15.0		20	12	27		28	12	20		9.0		RECEPTACLES RM. 109
RECEPTACLES RM. 103			14.2	20	12	29		30	12	20			9.0	RECEPTACLES RM. 110
RECEPTACLES RM. 104	10.4			20	12	31		32	12	20	10.5			RECEPTACLES RM. 111
RECEPTACLES RM. 105		16.0		20	12	33		34	12	20		15.0		RECEPTACLES RM. 112
RECEPTACLES RM. 106			16.0	20	12	35		36	12	20			7.5	RECEPTACLES RM. 113
SPACE						37		38	12	20	2			TELEPHONE BACKBOARD
SPACE						39		40						SPACE
SPACE						41		42						SPACE
TOTAL	52.0	57.4	67.0								55.7	56.0	69.5	TOTAL
TOTAL CONNECTED AMPS A: 107.7 B: 113.4 C: 136.5														

ATTACHMENT 32

4/98

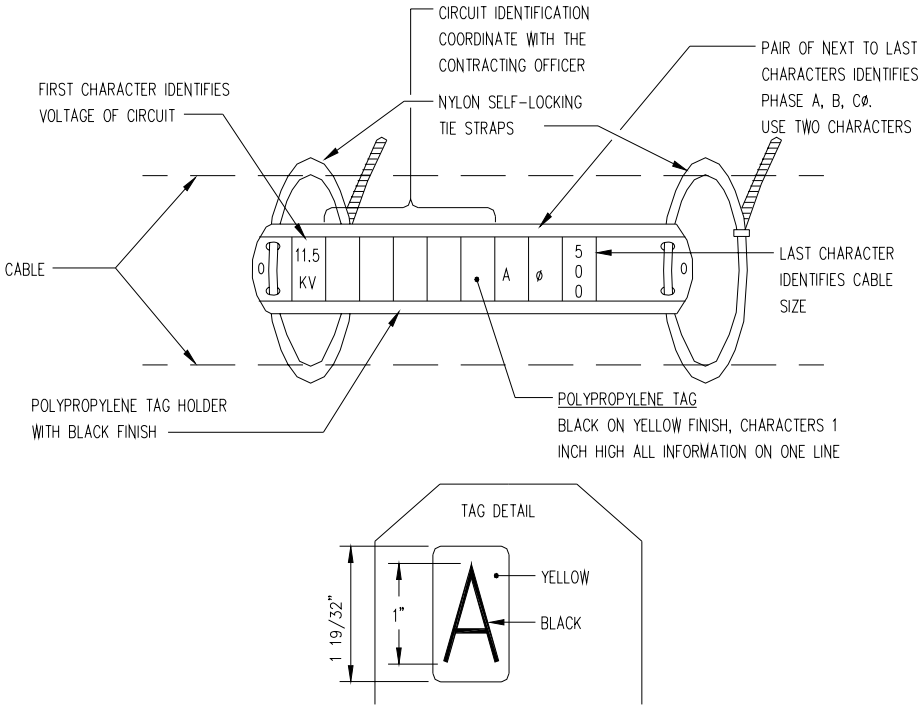
PANELBOARD I SCHEDULE

100 A. MAIN LUGS ONLY, 120/240 V., 1 PHASE, 3 WIRE, 10 KAIC MINIMUM, SURFACE MOUNT

LOAD SERVED	LOAD (AMPS) A	LOAD (AMPS) B	BKR. TRIP	WIRE SIZE	CKT. NO.	PHASE A B	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	LOAD (AMPS) B	LOAD SERVED
DRILL PRESS	6		20	12	1		2	12	20	6		DRILL PRESS
		6									6	
GRINDER	8		20	12	5		6	12	20	10		ARC WELDER
		8									10	
TABLE SAW	9		20	12	9		10	12	20	9		TABLE SAW
		9									9	
RADIAL ARM SAW	6		20	12	13		14	12	20	6		SANDER
		6									6	
BAND SAW	5		20	12	17		18	12	20	7		MASONRY SAW
		5									7	
PLANER	6		20	12	21		22	12	20	5		SHAPER
		6									5	
SPARE			20		25		26		20			SPARE
SPACE					29		30					SPACE
SPACE					33		34					SPACE
SPACE					35		36					SPACE
SPACE					37		38					SPACE
SPACE					39		40					SPACE
SPACE					41		42					SPACE
TOTAL	40	40								43	43	TOTAL

TOTAL CONNECTED AMPS A: 83 B: 83

ATTACHMENT 33



CABLE IDENTIFICATION TAG DETAIL

APPENDIX H ELECTRICAL DESIGN CHECKLIST

General

Y	N	N/A	
❑	❑	❑	Did the designer discuss the design with project engineer at the activity?
❑	❑	❑	Did you check that all equipment shown matches mechanical and architectural drawings?
❑	❑	❑	Is there proper working clearances for all electrical equipment?
❑	❑	❑	Did you check Architect's typical elevations and details for coordination with electrical equipment, devices and lighting layout?
❑	❑	❑	Does electrical floor plan match architectural and mechanical plans?
❑	❑	❑	Have all notes and references been verified?
❑	❑	❑	Verify that locations of conduit runs, floor trenches, etc. do not conflict with structural layout.
❑	❑	❑	Verify structural supports are provided for roof top equipment.
❑	❑	❑	Coordinated exterior electrical equipment with site paving, grading and landscaping.
❑	❑	❑	Does electrical lighting plan match architectural reflected ceiling plan?
❑	❑	❑	Check that there are no panelboards recessed in fire rated walls.

Basis of Design

Y	N	N/A	
❑	❑	❑	Did you coordinate Basis of Design with Plans and Specifications?
❑	❑	❑	Is the electrical system fully described, wiring methods, conductors?
❑	❑	❑	Did the designer connect all equipment to the highest available voltage?
❑	❑	❑	Are standards and applicable criteria listed?
❑	❑	❑	Did the designer include the electrical characteristics?
❑	❑	❑	Does the BOD include a breakdown of loads?
❑	❑	❑	Are special systems described?
❑	❑	❑	Is the telecommunications system fully described, room sizes?
❑	❑	❑	Have telecommunications requirements been coordinated with NMCI?

❑ ❑ ❑ Does BOD have product data to backup electrical room sizes?

Power

Y N N/A

❑ ❑ ❑ Did the designer provide rationale for primary overhead versus underground?

❑ ❑ ❑ Is the transformer shown per activity requirements?

❑ ❑ ❑ Did the designer specify mineral oil filled transformers?

❑ ❑ ❑ Did the designer prohibit air-insulated equipment like DTT (dry type transformers) and medium voltage switches outside?

❑ ❑ ❑ Did the designer specify 80 degree rise dry-type transformers and ensure efficiencies greater than NEMA TP-1?

❑ ❑ ❑ Did the designer detail all poles?

❑ ❑ ❑ Is the metering per activity requirements? Metering on switchboards is acceptable.

❑ ❑ ❑ Is there a single main overcurrent device?

❑ ❑ ❑ Is total kVA of Dry Type Transformers less than or equal to 40 percent of the service transformer kVA?

❑ ❑ ❑ Did the designer minimize the number of DTTs?

❑ ❑ ❑ Did the designer prohibit overcurrent devices in series with same size overcurrent devices?

❑ ❑ ❑ Did the designer prohibit wiring gutters?

❑ ❑ ❑ Did the designer adequately show the proper connections to large items such as chillers?

❑ ❑ ❑ Did the designer indicate a main overcurrent device ahead of an automatic transfer switch?

❑ ❑ ❑ Did the designer indicate a closed transition transfer switch?

❑ ❑ ❑ Did the designer indicate the grounding properly?

❑ ❑ ❑ Did the designer indicate the generator connections?

❑ ❑ ❑ Did the designer indicate an electronic governor for the generator?

❑ ❑ ❑ Did the designer prohibit use of “T” and “Y” splices on the medium voltage system in accordance with regional requirements?

❑ ❑ ❑ Did the designer specify SF-6 insulated medium voltage switches?

❑ ❑ ❑ Did the designer follow Green Building requirements?

❑ ❑ ❑ Did the designer indicate the manufacturer's name, model number and serial number of panelboards and switchboards where new circuit breakers are being installed?

❑ ❑ ❑ Did the designer include the test procedures for the equipment provided such as transformers, generators, SF-6 switches and conductors?

❑ ❑ ❑ Do panelboards on floor plans match riser diagrams?

Lighting

Y N N/A

❑ ❑ ❑ Does lighting layout match reflected ceiling plan?

❑ ❑ ❑ Did the designer provide exterior calculations when required, 6 lux (0.5 fc) average maintained-usually 150W HPS on 9.1 m (30 ft) or 10.6 m (35 ft) poles?

❑ ❑ ❑ Did the designer use interior maintenance factor - 0.7 to 0.8?

❑ ❑ ❑ Did the designer use IES tables (or MIL-HDBK 1191 for Medical facilities) for lighting levels?

❑ ❑ ❑ Did the designer keep design foot-candle levels within minus 0% to plus 20% of criteria?

❑ ❑ ❑ Did the designer follow Green Building requirements?

❑ ❑ ❑ Did the designer select the proper fixture to support color rendition requirements (HPS or MH)?

❑ ❑ ❑ Did the designer limit special effect type lighting?

❑ ❑ ❑ Did the designer standardize fixtures and locate fixtures in accessible locations?

❑ ❑ ❑ Did the designer provide 320 lux (30 fc) of illumination in living and sleeping areas in BQs (permanently installed)?

❑ ❑ ❑ Did the designer follow criteria for corridors?

❑ ❑ ❑ Did the designer comply with Title 24 for projects located in California?

Calculations

Y N N/A

❑ ❑ ❑ Did the designer provide short circuit calculations?

❑ ❑ ❑ Did the designer provide voltage drop calculations?

❑ ❑ ❑ Did the designer provide a load analysis indicating130 VA per m^2 (12 VA per ft^2) or less for service transformers?

❑ ❑ ❑ Did the designer properly size large circuits like mechanical equipment, feeders, and service size?

❑ ❑ ❑ Did the designer provide a lightning risk assessment?

❑ ❑ ❑ Did the designer provide calculations indicating telecommunication room sizes required?

Telecommunications

Y N N/A

❑ ❑ ❑ Was the design performed by a RCDD?

❑ ❑ ❑ Does NMCI have a presence on site?

❑ ❑ ❑ If above is Yes, have all NMCI requirements been addresed?

❑ ❑ ❑ Is there dedicated space for NMCI, regardless of their presence?

❑ ❑ ❑ Did the designer use Category 5e UTP?

❑ ❑ ❑ Did the designer show wire termination blocks and protectors at the backboards?

❑ ❑ ❑ Have you included documentation for backbone cable sizing?

❑ ❑ ❑ Did the designer show the cable tray and raceway system?

❑ ❑ ❑ Did the designer provide quad plates with RJ-45 jacks in each workstation outlet?

❑ ❑ ❑ Did the designer provide specifications with testing the cables?

❑ ❑ ❑ Did the designer coordinate with systems furniture?

❑ ❑ ❑ Did the designer indicate exterior cable required?

❑ ❑ ❑ Did the designer provide central location for the electrical and communication equipment rooms.

Systems Furniture – Power

Y N N/A

❑ ❑ ❑ Did the designer provide oversized neutrals, #10 AWG?

❑ ❑ ❑ Did the designer coordinate with architectural and interior designer requirements for furniture to ensure proper connection and locations?

❑ ❑ ❑ Did the designer provide junction box details showing interface between branch wiring and furniture?

❑ ❑ ❑ Have calculations been performed to determine any need for K-Rated transformers?

Grounding

Y N N/A

❑ ❑ ❑ Did the designer place separately derived systems as close to load as possible?

❑ ❑ ❑ Did the designer provide grounding per NFPA 70 - no deviation?

❑ ❑ ❑ Did the designer prohibit isolated grounds?

❑ ❑ ❑ Did the designer connect electronic equipment to circuit ground?

❑ ❑ ❑ Did the designer connect ground planes to electrical ground?

❑ ❑ ❑ Did the designer connect ground planes to lightning protection grounding?

❑ ❑ ❑ Did the designer connect lightning protection systems to electrical systems?

❑ ❑ ❑ Did the designer provide structured cabling grounding in accordance with EIA/TIA standards?

Lighting Details

Y N N/A

❑ ❑ ❑ Did the designer provide all steel end plates on industrials and strips?

❑ ❑ ❑ Did the designer provide T-5 and T-8 lamps with electronic ballasts?

❑ ❑ ❑ Did the designer provide LED exit fixtures?

❑ ❑ ❑ Did the designer use HPS for exterior lighting and high bay lighting?

❑ ❑ ❑ Did the designer use MH for medium height applications?

Specifications

Y N N/A

❑ ❑ ❑ Is all equipment specified Non-Proprietary? If not explain.

❑ ❑ ❑ Did the designer choose materials to be incorporated into the project carefully?

❑ ❑ ❑ Did the designer check wiring methods - type wire and type conduit?

❑ ❑ ❑ Did the designer check temperature rise on dry type transformers?

❑ ❑ ❑ Did the designer check on energy efficient transformer, etc.?

❑ ❑ ❑ Did the designer use T-5 and T-8 lamps and electronic ballasts?

❑ ❑ ❑ Did the designer check exterior lighting to see if pole specification agrees with plans?

Force Protection

Y N N/A

❑ ❑ ❑ Did the designer attach interior mounted electrical fixtures and conduits to supporting structural, use seismic mounting methods, and provide appropriate supporting calculations?

❑ ❑ ❑ Did the designer avoid routing key utilities through or on common walls to mailrooms?

❑ ❑ ❑ Did the designer provide proper emergency shut off switches?

❑ ❑ ❑ Did the designer provide the required emergency audible alarm system?

❑ ❑ ❑ Did the designer provide the required lighting?

❑ ❑ ❑ Did the designer locate utilities in secure locations and at least 9100 mm (30 ft) away from the building?

All questions must have “Y” or “N/A” answers or explanations and reasons why not complying.