SOUTHDIV-TG-1004
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TECHNICAL GUIDANCE

FOR

ELECTRICAL DESIGN

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SECTION 1 GENERAL

PART 1 GENERAL

1.1 References

1.1.1 If you are performing a design contract read P-141, Guide for Architect-Engineer (A/E) firms, the Statement of Work portion of your contract with us, and our guide specifications.

1.1.2 Follow the National Codes. Where there is a conflict between Naval Criteria and National Codes follow Naval Criteria.

1.1.3.1 Follow SouthDiv's TG-1004 document which is available on the SouthDiv web site,

http://www.efdsouth.navfac.navy.mil/FacAcq/criteria/FILES/TG-1004.pdf

1.1.4.1 You can obtain NAVFAC guide specifications from its web site,

http://www.efdlant.navfac.navy.mil/Lantops_15/GuideSpecs/home.htm

Note: See "Graphics" for tables of transformer losses.

1.2 Drawings and Specifications

1.2.1 Coordinate assembly drawings and specifications. Try to show information only one time in one place to avoid conflicts.

1.2.2 Clearly show demolition and new work. Use two plans if necessary for clarity and use different legend symbols for existing and new.

1.2.3 Place legend on the first electrical sheet. Edit legend for project being designed.

1.2.4 Place detail sheets after plan sheets.

PART 2 PRODUCTS

2.1 Standards

2.1.1 Electrical equipment provided shall be manufacturer’s standard catalog products.

2.1.2 Use of shop or field fabricated electrical equipment assemblies that are not manufacturer’s standard catalog products are not acceptable.

PART 3 EXECUTION

3.1 Communication

3.1.1 Discuss technical decisions as the design develops with your counterpart at SOUTHDIV.

3.2 Basis of Design

3.2.1 Update this narrative for every submittal. Accurately depict the current state of the electrical design. Address design approach to all electrical systems.

3.3 Calculations

3.3.1 Lead reviewer through design by stating assumptions and decisions.

3.3.2 Provide complete analysis with supporting calculations. Analysis should cover system arrangement, voltage selection, and major equipment selections including load analysis and equipment sizing calculations. Calculations must include short circuit, interior and exterior lighting, service and feeder sizing, sizing of all circuits over 20 amps and voltage drop.

3.3.3 Motor starting/flicker analysis for motors 40 hp and larger, pulling tension, sag and tension analysis and coordination shall be provided. Provide motor starting/flicker analysis for distribution in housing areas utilizing electrical HVAC systems. Voltage flicker analysis shall be conducted to show the voltage drop at the service conductors does not exceed 5%.

3.3.4 All service conductors from the distribution transformer to the service entrance or meter base shall be sized for a maximum voltage drop of 2%. Loads used to calculate this voltage drop shall be the ampacity of the overcurrent protection device on the service disconnect equipment.

SECTION 2 LOW VOLTAGE SYSTEMS

PART 1 GENERAL

1.1 References

NFPA 70 - National Electrical Code

1.2 Drawings

1.2.1 For switchboards provide plan and elevation views or an isometric view. Clearly show contents of all sections including whether or not breakers are individually or group mounted.

1.2.2 For motor control centers provide plan and elevation views or an isometric view.

1.2.3 Show all homeruns exactly like you want contractor to install.

1.2.4 Provide a single line diagram showing sizes and ratings of all major items of material and equipment.

1.2.5 Identify on the drawings the boundaries of all hazardous areas.

PART 2 PRODUCTS

2.1 Panelboard

2.1.1 Do not use dual section panelboards.

2.1.2 Provide 10% spare breakers and 10% space only for all panelboards.

2.1.3 Use bolt-on type circuit breakers unless specifically permitted to use plug-in type. Bolt-on circuit breakers are defined as breakers attached to the panelboard with fasteners.

2.2 Overcurrent/Short Circuit Protection Devices

2.2.1 Use a service entrance main circuit breaker.

2.2.2 Do not install overcurrent devices of the same rating in series.

2.2.3 Series rated circuit breakers are unacceptable.

2.2.4 Do not use fuses.

2.3 Gutters

2.3.1 Do not use.

2.4 Dry Type Transformers

2.4.1 Specify use of energy efficient dry type transformers. Use 80°C rise type for lower losses. Efficiencies should exceed NEMA TP-1 Class 1 efficiency. Do not use taps for voltage drop compensation.

2.5 Emergency Power

2.5.1 Engine-generator sets shall have electronic governors for paralleling.

2.5.2 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 shall be bypass-isolation type switches.

2.6 Green building considerations.

2.6.1 Use premium efficiency motors. Efficiencies shall meet the minimum requirements of ASHRAE 90.1-1999, Table 10.2.

2.6.2 Feeder conductors shall be sized for a maximum voltage drop of 2% at full connected load. Branch circuits shall be sized for a maximum drop of 3% at full connected load.

2.6.3 Maximize use of variable speed drives.

2.7 Cable Assemblies

2.7.1 Do not use cable assemblies, types AC, MC or MI, in lieu of conduit and wire.

2.8 EMT

2.8.1 Use insulated throat steel compression connectors.

2.9 Plastic Raceways

2.9.1 Only use schedule 40 PVC conduit for underground circuits. Schedule 40 PVC conduit may be used in and under ground level concrete slabs.

2.10 Transient Voltage Surge Suppression (TVSS)-non residential

2.10.1 Provide transient voltage surge suppression (TVSS) equipment on all facilities. 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 so that it is properly coordinated.

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

a. The electrical service entrance equipment shall be protected by a TVSS.

b. The manufacturer shall provide written specifications showing the clamping voltage in accordance with NEMA LS-1 and with 6" leads external to the enclosure, shall 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 μsec waveform shall be no less than:

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

d. Protection Mode: All modes, have discrete suppression circuitry in L-G, L-N, and N-G, 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: Suppression components shall be individually fused. Single fuses that protect multiple suppression devices shall not be used. Failure of a fuse or suppression component shall not render the entire suppression device inoperative.

f. MCOV: The maximum continuous operating voltage: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 U.L. 1283 and U.L. 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.

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

a. The distribution branch panelboards shall be protected by a TVSS.

b. The manufacturer shall provide written specifications showing the clamping voltage in accordance with NEMA LS-1 and with 6" leads external to the enclosure, shall 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 µsec waveform shall be no less than:

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

d. Protection Mode: See 2.10.2.d.

e. Fusing: See 2.10.2.e.

f. Maximum continuous operating voltage: See 2.10.2.f.

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: See 2.10.2.h.

i. Validation: See 2.10.2.i.

j. Warranty: See 2.10.2.j.

k. Diagnostics: See 2.10.2.k.

2.11 Transient Voltage Surge Suppression (TVSS)- residential

2.11.1 Electrical service entrance equipment shall be protected by transient voltage surge suppression (TVSS) equipment on residential facilities.

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

a. The unit shall have a 35 kA per mode (70 kA per phase) or greater single pulse surge current capacity.

b. MCOV: The maximum continuous operating voltage shall be 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.

f. Diagnostics: Visual indication unit has malfunctioned or requires replacement.

2.12 3-Phase Motor Controllers

2.12.1 Provide controllers for 3-phase motors rated 1hp 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 shall provide controllers with the required monitors and timed restart.

2.12.2 Where motor starting/flicker analysis requires “soft start,” provide stepless, solid-state type reduced voltage starters with adjustable time interval between application of reduced voltage and full voltage. SCR type soft start units shall include a bypass contractor that shorts the SCRs when the motor reaches full speed.

2.12.3 Use "Soft start" starters for motors 40 HP and larger.

PART 3 EXECUTION

3.1 Design Requirements

3.1.1 Locate all electrical distribution equipment in electrical rooms/closets in good central locations close to mechanical equipment and other major loads. Locate panels on the floor they serve.

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

3.1.3 Voltage: Select system voltage carefully. Always connect equipment at highest available voltage to minimize the capital cost and losses on transformation equipment.

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

3.1.5 Services shall be sized in accordance with the NEC and standard utility engineering practice. Underground services shall utilize copper conductors in conduit.

3.1.6 Duplex Receptacles (120v):

a. Mechanical Equipment: Provide receptacle within 25 ft of mechanical equipment on the interior and exterior of a building.

b. Office and staff support spaces: One for every 10 feet of wall space at floor line. When less than 10 feet of wall at the floor line, provide a minimum of two receptacles spaced appropriately to anticipate furniture relocations.

c. Corridors: One every 50 ft of corridor with a minimum of one per every corridor.

d. Stairwells: One for each floor.

e. Janitor’s closet and toilet rooms: One GFI receptacle per closet and one GFI receptacle at counter height for each counter in toilet rooms.

f. Space with counter tops: One for every 4 feet of countertop, but no less than one at countertops less than 4 feet. Provide GFI protection of outlets when located within 6 feet of plumbing fixtures.

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

h. Kitchen: One for each 10 feet of wall space at the floor line. Provide GFCI protection when located within 6 feet of plumbing fixture.

i. Child occupied spaces (including toilets): One for every 12 feet 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 12 feet of wall space at the floor line. Ensure one receptacle is located next to the telecommunications workstation outlet. Provide one receptacle in the ceiling to support a video projection device.

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

l. Special use rooms for fixed and mobile equipment: Provide outlets to allow connection of equipment expected to be used in special use rooms. It is the designer's responsibility to work with the architect and the user to provide functionality. It is not the intent of the government to provide above normal density of outlets unless otherwise specified.

3.1.7 Do not use plastic raceway systems above the 1st floor slab of buildings.

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

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

a. Maximum transformer size is 100 kVA.

b. Per transformer, do not serve more than 6 single dwelling units, 4 duplexes, or 2 quadraplexes. See Dwelling Unit demand data for Electrical Calculations in Section 12 for sizing.

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

d. Provide grounding at the service entrance in accordance with the latest NEC.

e. All conductors (primary and secondary) shall be in conduit. Primary conductors shall not be run under buildings.

f. Maximum length of service conductors (240/120V single phase) from the distribution transformer to the service entrance device (or meter base) shall be 220LF.

g. Show typical and unique secondary situations on single line diagrams.

3.1.10 Provide construction phasing and outage plans.

3.1.11 Provide dedicated circuits to each piece of equipment. Taps are unacceptable.

3.1.12 Transient Voltage Surge Suppression (TVSS):

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

b. Residential. Install as close as practical to the main breaker/lugs. All leads shall be as short as possible. No leads shall be longer than 2 feet.

SECTION 3 LIGHTING

PART 1 GENERAL

1.1 References

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

See Tables 1-4 at the end of this section

1.2 Drawings

1.2.1 Provide fixture details on the drawings.

PART 2 PRODUCTS

Use high power factor ballasts. For metal halide use pulse start ballasts.

2.1 Exterior

2.1.1 For parking area use 150-watt high-pressure sodium (HPS) on poles to provide 30′ mounting height and 0.5 footcandles (FC), average, maintained.

2.1.2 Where geometry permits, use 2 fixtures per pole in lieu of one fixture on each of 2 poles.

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

2.2 Interior

2.2.1 Fluorescent Fixtures: Use electronic ballasts on all fixtures. Do not use wraparound fluorescents. Use full solid steel end plates on strip and industrial fluorescents. Use 0.156″ or thicker acrylic lenses on fluorescent troffers.

2.2.2 Metal halide (MH): Use in medium height applications such as gyms and racket ball courts.

2.2.3 Exit Fixtures: Use LED style.

2.2.4 Hangar fire protection systems are regularly tested. Be sure equipment is suitably resistant.

2.3 Green building considerations.

2.3.1 Design and Application: Lighting shall be in accordance with ASHRAE 90.1-1999, Section 9.

2.3.2 Indirect lighting: Maximize use.

2.3.3 Automatic Dimming: In facilities where there may be an abundance of daylight, automatically reduce artificial lighting by dimming or on/off control.

2.3.4 Reduce general office illumination from 50-foot candles to 30-foot candles using dimming ballasts with photoelectric control, manual “on” control, occupancy sensor “off” control and task lights controlled by power strips with occupancy sensors.

2.3.5 Power Factor: 90 percent or greater. Ballasts for circline and compact fluorescent lamps and for low-wattage high-intensity discharge lamps of 100 watts or less are exempt as well as dimming ballasts.

PART 3 EXECUTION

3.1 Design Requirements

3.1.1 Fluorescent Fixtures: For typical indoor spaces maximize use of T-8 fluorescent lamps.

3.1.2 Incandescent Lighting: Minimize use of incandescent lighting. A good use for incandescent lighting is a dimmable system in classrooms and conference rooms.

3.1.3 Color Rendition: Use HPS in high bay areas where color rendition is not critical. Use MH in areas where color rendition is critical.

3.1.4 Special Effects: Do not use luminous ceilings. Limit cove lighting to feature or special accent applications.

3.1.5 Standardization: Minimize the number of different lamps used in a facility.

3.1.6 Maintenance: Mount fixtures in accessible locations so they can be easily serviced.

3.1.7 Bachelor Quarters: Provide permanently installed lighting equipment to produce 30 FC of illumination in living and sleeping areas.

3.1.8 Calculations should show design foot-candle levels within 20% of criteria. See TABLES 1 through 4 in this section or MIL-HDBK 1191 for illumination levels for medical and dental facilities.

3.1.9 In reasonably clean locations use a total maintenance factor of 0.75 or justify.

3.1.10 Only use wall packs to illuminate service areas/yards.

TABLE 1

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 (with 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 2

ILLUMINATION IN WAREHOUSES

Types of Warehousing	Foot-candles
Active – Bulk[1]	10
Bin[2]	5
Inactive	5
Mechanical Material handling:	
Accumulation Conveyor Lines (unmanned)	10
Control Centers and Stations	30
Loading and Unloading Areas	20
Rack	20

1 Main aisles may be lighted to 15 foot-candles.

2 Specialized lighting designed to illuminate the bins, as required.

TABLE 3

SPORTS LIGHTING REQUIREMENTS

Sports Activity	Foot-candles
Baseball & Softball Infield	20
Baseball & Softball Outfield	10
Tennis, Volleyball & Basketball – Outdoors	10 – 20
Basketball – Indoors	30 – 40
Handball & Racquetball – Indoor	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 4

ILLUMINATION IN FUNCTIONAL AREAS OF OTHER FACILITIES

Functional Areas	Foot-candles
Accounting Rooms	75
Auditoriums	20
Cafeterias	25
Computer Rooms	50
Conference Rooms	30
Corridors	10
Drafting Rooms	75
Elevator Machine Rooms	15
Emergency Generator Rooms	15
Garage Driving and Parking Areas	5
Garage Entrances	30
General Office Space	50
Janitor’s Closet	5
Kitchens	70
Lobbies	15
Lounges	15
Mechanical and Electrical Equipment Rooms	15
Parking Lots	0.5
Stairways	20
Storage Rooms	5
Switchgear Rooms	15
Toilet Facilities	20
Transformer Vaults	15

SECTION 4 TELECOMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 References

MIL-HDBK 1012/3	Military Handbook, Premise Distribution-Estimating, Planning and Design
EIA/TIA-568-B	Commercial Building Telecommunications Cabling Standard
EIA/TIA-569	Commercial Building Standard for Telecommunications Pathways and Spaces
EIA/TIA-570-A	Residential Telecommunications Cabling Standard
EIA/TIA-606	The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
EIA/TIA-607	Commercial Building Grounding and Bonding Requirements for Telecommunications
NFPA 70	National Electrical Code
IEEE 1100	Power and Grounding Sensitive Electronic Equipment

1.2 Drawings

1.2.1 Show point of connectivity to the base system on the site plan. Provide explicit direction on method of entering existing manholes. Provide all details on composition of ductbanks, depth and configurations of the ductbanks, etc.

1.2.2 Detail all outlet, cable tray and backboard/distribution frames. Provide elevations of all pertinent communication room walls.

1.2.3 Provide a riser diagram showing all system components.

1.2.4 Provide explicit grounding requirements. Provide grounding in accordance with NEC, ANSI/EIA/TIA 607, and IEEE 1100.

1.2.5 Isolated grounding systems shall not be designed. Main grounding conductors from the remote IDFs or cross connects to the MDF shall be stranded #1/0. Grounding conductor from the MDF to the building grounding electrode shall be #3/0. Run grounding conductors with the backbone cable plant. Bond racks, conduits, raceways, trays, etc. in accordance with the NEC and ANSI/TIA/EIA standards. Insure the grounding conductors and the raceways are compatible. Bond grounding bus bars in the communications room to local electrical distribution panel ground buses and to local building steel with min. #6 AWG copper. Protect all grounding and bonding conductors from mechanical damage.

1.3 Design

1.3.1 The design shall follow all referenced criteria including the EIA/TIA standards.

1.3.2 The design shall be performed and stamped by a qualified RCDD.

1.4 Testing

1.4.1 The specification should require specific tests in accordance with the EIA/TIA standards. Media Testing shall be performed using the latest EIA/TIA guidance (including annexes and technical bulletins). Emphasize these requirements in the specification. Provide a testing spec. Do not use the phrase “Test in accordance with ANSI/TIA/EIA standards.” All fibers to be tested by optical time domain reflectometer (OTDR) in both directions. All testing data (for fiber and copper) to be submitted (in hard copy and on digital media) to the ROICC.

PART 2 PRODUCTS

2.1 Communication Rooms

2.1.1 All buildings shall have at least one communications room per floor. All new buildings shall have communications rooms (min. 7’x9’) per 10,000 SF. Locate centrally and stack vertically on multi-story buildings.

2.1.2 In BEQ/BOQ housing, the communication room may be located every three floors provided cabling distances are within EIA/TIA standards.

2.2 Frames

2.2.1 Equip communication rooms with main distribution frames and intermediate distribution frames (or cross-connects) for terminating all communication cables. Provide all cross-connecting hardware including 100% connection capability of all patch cords. Provide a dedicated 20 amp circuit and a quadraplex receptacle for each 19” vertical section.

2.3 Pathways

2.3.1 Install a cable tray above corridor ceilings or in another central location as the telecommunications backbone. Use conduit from the tray to the outlet. Provide service entrance conduit system and pathways between communication rooms as required by EIA/TIA-569.

2.4 Outside Plant

2.4.1 Provide outside category 3 copper cable with size based on one pair per 100 square feet of building. Cable selection shall be coordinated with the Base Communication Office (BCO) and specified using RUS specifications. As a minimum, the cable shall be installed to a depth of 36” in a schedule 40 PVC duct. Provide 50% spare conduits. Coordinate point of connection to the station system with the BCO.

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

2.5 Backbone Cabling

2.5.1 Provide 12/12 multimode/singlemode fiber backbones between MDF and IDFs for data. Provide copper category 5e, 25 pair cables for the voice backbone.

2.6 Workstation Outlets

2.6.1 The outlet shall be served with 2-4 pair UTP category 5e cables each terminated in category 5e, RJ-45, 8 position jacks, one for telephone and one for LAN.

2.6.2 Provide workstation outlets for printers, plotters and fax machines based on 1 per 600SF.

2.6.3 Provide workstation outlet adjacent to DDC Panels for mechanical system controls.

2.7 Television

2.7.1 Interior wiring shall be RG-6 wired in a star topology. Coordinate exterior cable installation with local service provider.

2.8 BEQ/BOQ Housing

2.8.1 In each living or sleeping room provide an outlet for every resident served with 2-4 pair UTP category 5e cables.

2.9 Family Housing

2.9.1 Follow ANSI/EIA/TIA 570-A. Provide Grade 1 wiring for dwelling units with less than 1500 SF and Grade 2 wiring for dwelling units with 1500 or more SF.

2.9.2 Provide a Residential Gateway. Terminate interior cabling and local service provider cabling in the gateway. The Residential Gateway is a pre-manufactured stand-alone box that combines digital modem cards, home networking chip, 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.

2.10 **Conference Rooms**

2.10.1 Provide provisions for computer driven video projection device by installing a workstation wall outlet, a Cat 5e outlet in the ceiling, empty 4” square boxes with covers at the ceiling and wall, and an empty 1” conduit with pull strings for future use between the 4” square boxes.

PART 3 EXECUTION

NMCI. If the Navy Marine Corps Intranet (NMCI) contractor has a presence at a base and the funding claimant plans to order data seats on that contract, provide a complete voice system using one cat 5e cable per outlet and stub conduits clear of paving for outside data cable. All other work is part of the NMCI contract. For reserve centers, check with claimant to see if they are planning to use the NMCI contract, then proceed accordingly.

3.1 Design Requirements

3.1.1 Provide a design for a completely cabled, terminated and protected system in a star topology.

3.1.2 Each workstation shall have at least one communications outlet. Permanently walled offices and system furniture cubicles larger than 64 SF shall have two communications outlets, minimum. These outlets shall be located to facilitate future furniture locations.

3.1.3 Main Distribution Frames and Intermediate Distribution Frames (or cross connections) - All communications cables for the inside plant shall be terminated in/on patch panels mounted on 19” racks. Segregate voice and data terminations on the racks. Provide trained 20’ service loops for all backbone cables. Provide excess horizontal cable to facilitate future re-termination.

3.2 BEQ and BOQ Requirements

3.2.1 Non-official phone service is provided by a third party vendor. Provide a conduit to 5’ outside of the building clear of paving for use by this vendor. Completely wire the building interior.

3.2.2 Coordinate and provide the official outside plant phone service with BCO.

SECTION 5 GROUNDING SYSTEM

PART 1 GENERAL

1.1 References

NFPA 70	National Electrical Code (NEC)
IEEE 1100	Powering and Grounding Sensitive Electronic Equipment (Emerald Book)

1.2 Drawings

1.2.1 Detail requirements for main service.

1.2.2 Detail requirements for separately derived systems.

1.2.3 Detail requirements for signal reference planes.

1.3 Testing

1.3.1 Do not require impedance testing of grounds beyond the requirements of the NEC.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 Service

3.1.1 Do not install a ground conductor between the exterior transformation equipment and the main service equipment.

3.1.2 Minimum service entrance ground shall be three connections to any combination of the following: metal water pipe, concrete encased electrode, metal building frame or driven ground rod. See NEC 252-81 and 250-83.

3.2 Isolated Grounds

3.2.1 Do not use isolated grounds.

3.3 Raceway Systems

3.3.1 Install an insulated ground wire in all raceways.

3.4 Ground Planes

3.4.1 Computer equipment should be grounded as part of the branch circuit connection.

3.4.2 Ground plane should be grounded to a nearby electrical panel.

3.5 Communications Grounding

3.5.1 Provide grounding in accordance with NEC, ANSI/EIA/TIA 607, and IEEE 1100. Isolated grounding systems shall not be designed. Main grounding conductors from the remote IDFs or cross connects to the MDF shall be stranded #1/0. Grounding conductor from the MDF to the building grounding electrode shall be #3/0. Run grounding conductors with the backbone cable plant. Bond racks, conduits, raceways, trays, etc. in accordance with the NEC and ANSI/TIA/EIA standards. Insure the grounding conductors and the raceways are compatible. Bond grounding bus bars in the communications room to local electrical distribution panel ground buses and to local building steel with min. #6 AWG copper. Protect all grounding and bonding conductors from mechanical damage.

SECTION 6.1 LIGHTNING PROTECTION FOR BUILDINGS OTHER THAN MUNITION STORAGE/HANDLING FACILITIES AND HAZARDOUS/FLAMMABLE STORAGE FACILITIES

PART 1 GENERAL

1.1 References

NFPA 780 Lightning Protection Code

1.2 Drawings

1.2.1 Perform a risk assessment in accordance with appendix H of NFPA 780. If the risk assessment is greater than 7, provide a lightning protection system. Use the eastern United States factor for locations east of the Mississippi River. Use a factor of 0.5 for the states of Alabama, Georgia, Florida, Mississippi, North Carolina, South Carolina and Tennessee. Use a factor of 1.0 for the states of Illinois, Indiana, Kentucky, Michigan, Ohio and Wisconsin.

1.2.2 For new buildings the lightning protection system shall be procured using a performance specification. The drawings should 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.

1.2.3 For additions to existing buildings provide a complete design for the lightning protection system.

1.3 Acceptance

1.3.1 For new buildings the installation must be tested and an UL Master Label attached to the facility before it will be accepted.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 Field Work

3.1.1 Field determine the soil resistivity so the grounding system can be selected.

SECTION 6.2 LIGHTNING PROTECTION FOR MUNITIONS STORAGE/HANDLING FACILITIES AND HAZARDOUS/FLAMMABLE STORAGE FACILITIES.

PART 1 GENERAL

1.1 References

NFPA 780	Lightning Protection Code
NAVSEA OP-5	Ammunitions and Explosives Ashore Safety Regulations for Handling, Storing, Production, Renovation and Shipping
MIL-HDBK 1004/6	Lightning Protection

1.2 Drawings

1.2.1 Follow NFPA 780, NAVSEA OP-5 and MIL-HDBK 1004/6 for Munitions Storage/Handling Facilities.

1.2.2 Follow NFPA 780 and NAVFAC Guide Specification 13100 for Hazardous/Flammable Storage Facilities.

1.3 Acceptance

1.3.1 The installation must be tested and a UL Certificate of Conformance must be issued before the system can be accepted.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 Field Work

3.1.1 Field determine the soil resistivity so the grounding system can be selected.

SECTION 7 INTRUSION DETECTION SYSTEMS

PART 1 GENERAL

1.1 Drawings

1.1.1 On projects requiring an intrusion detection system the minimum design should be a concealed raceway system.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 Design Requirement

3.1.1 Our design requirement is for you to provide a complete design for the intrusion detection system - even though this may require funding from another source and coordination with other government agencies. For large MILCON projects, interface and interaction with Naval Criminal Investigative Services during the project development should be clearly defined early. Coordinate through our project manager.

SECTION 8 400 HERTZ SYSTEMS

PART 1 GENERAL

1.1 Reference

MIL-STD 704E	Aircraft Electric Power Characteristics
MIL-HDBK 1004/5	400 Hertz Medium-Voltage Conversion/ Distribution and Low-Voltage Utilization Systems
MIL-HDBK 1028/6	Aircraft Fixed Point Utility Systems
NFGS 16268	400-Hertz (Hz) Solid State Frequency Converter

PART 2 PRODUCTS

2.1 Specification

2.1.1 Use guide specification NFGS 16268 and all the default values shown.

2.2 Frequency Converters

2.2.1 Provide solid-state frequency converter (400-Hertz) to serve aircraft. Converter size shall be as recommended by aircraft manufacturer for basic functions like folding the wings and operating the canopy, but not exceeding 10 KVA, unless noted otherwise.

2.2.2 The utilization voltage is 200Y/115.5. For systems supplying power to aircraft, the design and component selection should regulate the voltage from 113 to 118 volts at the aircraft receptacle from no load to full load conditions. This could require frequency converters with output voltage compensation capability to make up for resistive and inductive cable voltage drop between the converter and the receptacle.

2.2.3 Converter shall include Aircraft Interlock Circuit, which will energize 400-Hertz output contactor only after pins E and F of the aircraft service cable is plugged into aircraft receptacle.

2.3 Equipment

2.3.1 Circuit breakers and panelboards shall be rated, calibrated and labeled by the manufacturer for 400-hertz operation.

2.4 Raceway

2.4.1 Use rigid aluminum conduit except use PVC in concrete.

2.4.2 Use copper conductor with thin insulation types (i.e. THWN, THHN, XHHW, etc.)

2.4.3 For extreme voltage drop problems use multi-conductor cables or paralleled smaller conductors in lieu of single larger conductors.

PART 3 EXECUTION

3.1 System Configuration

3.1.1 Converter shall include a NEMA 3R enclosure and be located as close as practical to the load

3.1.2 Locate aircraft service cable adjacent to the converter unit. This cable shall be six conductor with outer sheath; four for power and two for aircraft interlock circuit, pins E & F. Include an aircraft service cable storage rack located on the inside hangar wall adjacent to the converter unit receptacle. Plugs shall match aircraft receptacle and converter unit receptacle.

SECTION 9 DC SYSTEM

PART 1 GENERAL

1.1 References

MIL-STD-704E Aircraft Electrical Power Characteristics

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 Voltage Regulation

3.1.1 Aircraft and avionics nominal utilization voltage is 28 volts. Design the feeder and branch circuits for a 4-volt drop.

SECTION 10 MEDIUM VOLTAGE SYSTEMS (2.4 KV - 34.5 KV)

PART 1 GENERAL

1.1 References

ANSI C2	National Electrical Safety Code
NFGS 16272	Three-Phase Pad-Mounted Transformer
NFGS 16273	Single-Phase Pad-Mounted Transformers
NFGS 16301	Overhead Transmission and Distribution
NFGS 16360	Secondary Unit Substations
NFGS 16361	Primary Unit Substation

1.2 Drawings

Provide a single line diagram of all medium voltage work. Show sizes and ratings of all items of material and equipment.

PART 2 PRODUCTS

2.1 Overhead Construction

2.1.1 Use wood or concrete poles.

2.1.2 Use aluminum or copper conductors. Do not use ACSR near salt-laden atmospheres.

2.1.3 Route lines along roads and other major topographical features.

2.1.4 On service drops to pad-mounted or substation type transformers, a neutral conductor will always be provided to the transformer and grounded to the high voltage compartment ground pad. This will be done on grounded wye and delta primary connected transformers.

2.2 Underground Construction

2.2.1 Use type UD aluminum or copper single conductor cables with EPR or XLP insulation and PVC outer protective jacket. 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.

2.2.2 In-line splices to medium voltage cables are acceptable. “T” or “Y” splices are never acceptable. Do not use.

2.2.3 For direct buried construction with PVC schedule 40 conduit and without conduit, bury 36” deep, minimum.

2.2.4 For ductbank/manhole construction use PVC schedule 40 conduit. Use manholes - not handholes. Minimum inside clear height for manholes shall be 6’-6”. In ductbanks provide a 3” clearance between conduits. Provide at least 33% spare ducts in a ductbank (minimum one spare duct).

2.2.5 Use 5” conduits, minimum, on medium voltage circuits.

2.3 Transformers

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

2.3.2 Pad-mounted transformers shall be loop-feed type transformer with 6 bushings. Install three elbow type arresters on three bushings.

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

2.3.4 Specify energy efficient transformers. Follow our guide specifications. Edit only bracketed portions.

2.3.5 Transformers in coastal areas shall have stainless steel tanks. Coastal is within 25 miles of the coast, a bay or a harbor.

2.4 Meters

2.4.1 All services shall be metered.

2.4.2 Use 3 stator meters with demand registers for 3 phase metering. Mount on or near transformers. Specify meter voltage class for operation at transformer secondary voltage.

2.5 Switches

2.5.1 Padmounted

2.5.1.1 Use SF-6 insulated, vacuum break, dead-front switches. Provide switches that have operating handles located on the opposite side of the tank from the cable entrance bushings and will not require the switch operating personnel to be exposed to the switch cable entrance bushings, terminations and cable. See testing requirements in 3.3.

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

2.5.1.3 Do not use air-insulated or fused switches.

2.5.1.4 Use of dead-front sectionalizers is acceptable. Sectionalizers shall be stainless steel.

2.5.2 Pole Top

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

2.6 Metalclad Switch Gear

2.6.1 Use SF-6 or vacuum style breakers.

2.6.2 Use batteries for operation.

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

2.7 Marking

2.7.1 Provide a marking schedule for use in tagging medium voltage cables.

PART 3 EXECUTION

3.1 Overhead Construction

Maximize use of overhead construction. Match existing construction methods or those used by local utility.

3.2 Underground Construction

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

3.2.1 Direct buried systems are acceptable in large open areas.

3.2.2 Use duct bank/manhole systems in developed areas where utilities are congested.

3.2.3 Under new roads use concrete encased conduits extending 5’ beyond pavement.

3.2.4 Do not route primary underground utilities under buildings.

3.2.5 Perform DC High Potential test and submit using the report in Section 12. Each length of cable shall be tested separately.

3.3 Pad mounted SF_6 switches - Medium voltage Vacuum Fault Interrupters (VFI)in SF_6.

3.3.1 Visual and Mechanical Inspection

3.3.1.1 Compare equipment nameplate data with drawings and specifications.

3.3.1.2 Inspect physical and mechanical condition.

3.3.1.3 Confirm correct application of manufacturer’s recommended lubricants.

3.3.1.4 Inspect anchorage and grounding

Verify bushing well inserts have been properly grounded.

3.3.1.5 Inspect and verify adjustments of mechanism in accordance with manufacturer's published data.

3.3.1.6 Verify correct SF_6 gas pressure.

3.3.1.7 Inspect all bolted electrical connections for high resistance using one of the following methods:

a. Use of low-resistance ohmmeter in accordance with Section 7.6.2.4.2 (Electrical Tests).

b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 10.12.

3.3.1.8 Perform manual closing and opening of each switch way.

3.3.2 Electrical Tests

3.3.2.1 Perform a contact resistance test. Test from each phase bushing of switch way one to corresponding phase bushing of all other switch ways.

3.3.2.2 Prior to energizing switch, verify open and close operation from all control or initiation devices (if switch includes motor operators). Provide temporary power to conduct this test. Document tests as pass/fail.

3.3.2.3 Close all switch ways. Perform over potential test of entire switch bus for each phase with other phases connected to ground. Provide corona suppression (i.e. insulated bushing caps) for bushings connected to buses that are being tested. Hold over potential tests for one minute. Leakage current shall be documented for all buses. Maximum DC test voltages for testing shall be in accordance with NETA ATS Table 10.2 (for metal enclosed interrupter switchgear). Values for Table 10.2 are as follows:

5 KV class – 20KV DC test voltage

15KV class – 37KV DC test voltage

25 KV class - 52KV DC test voltage

35 KV class – Manufacturer’s recommended DC test voltage

3.3.2.4 Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable, in accordance with Section 7.6.2.4.1 (Visual and Mechanical Inspection).

3.3.2.5 Perform vacuum bottle integrity (over potential) test across each vacuum bottle with the switch in the open position. Test voltage shall be in strict accordance with manufacturer’s published data. Do not exceed maximum voltage stipulated for this test. Provide adequate barriers and protection against x-radiation during this test. Be aware that some dc high-potential test sets are half-wave rectified and may produce peak voltages in excess of the switch manufacturer’s recommended maximum. Test all vacuum bottles in open position and document all bottles as pass/fail.

3.3.2.6 Perform primary current injection tests for each VFI way. Test shall be conducted in accordance with the following as a minimum:

a. Log initial controller settings.

b. VFI controller shall be set in accordance with the coordination study (with proper curve type, minimum setpoints for long time, ground fault, time delays, etc.)

c. Log settings after configuration of VFI controller to coordination study. Special note: The primary current injection tests below are not required to be run at the settings specified by the coordination study (as higher current interruptions may reduce the life of the contact devices).

d. Using primary current injection test set, test each function of each electronic controller (long time, short time, instantaneous, ground fault, etc.), with the controller set on the curve type selected by the coordination study, perform primary current injection tests. Tests for long time shall (as a minimum) be performed per phase at 3, 4, and 5 times minimum device setting of controller (to verify that trip times are in accordance with the manufacturer’s time current curve). Testing to confirm operation of short time, ground fault, instantaneous and other device functions shall be conducted at settings below coordination study setting levels (as higher current interruptions may reduce the life of the contact devices). All tests shall be documented. Any test conducted that confirms that the unit is not in conformance with the manufacturer's curves shall also be identified in the test report.

e. Log "as-left" controller settings. These setting shall be in accordance with settings delineated in the coordination study.

3.3.3 Test Values.

3.3.3.1 Contact resistance tests shall show that the switch conforms to the manufacturer's published minimum resistance values. In addition, values for each switch way shall not deviate from similar connections by more than 50 percent of the lowest value.

3.3.3.2 For bus over potential test, measured leakage current should be close to the following: 5KV class – 20 micro amps leakage current; 15KV class – 7.4 micro amps leakage current; 25KV class 2.6 micro amps leakage current. Investigate and mitigate leakage currents that exceed those above by more than 50%.

5 KV class – 20 micro amps leakage current

15KV class – 7.4 micro amps leakage current

25 KV class - 2.6 micro amps leakage current

35 KV class – 2.6 micro amps leakage current

3.3.3.3 Compare bolted connection resistance to values of similar connections. Investigate and rectify any values which deviate from similar connections by more than 50 percent of the lowest value.

3.3.3.4 Bolt-torque levels should be in accordance with NETA ATS 1999 Table 10.12 unless otherwise specified by manufacturer.

3.3.3.5 Investigate and mitigate any values which deviate from similar connections by more than 50 percent of the lowest value.

3.3.3.6 Compare time data with manufacturer's published data.

3.3.3.7 The insulation shall withstand the over potential test voltage applied.

3.4 System Configuration

3.4.1 A current carrying neutral will always be provided on all primary voltage power systems. On overhead construction, a static wire will be installed when it is standard station practice to use one or when it is the standard practice of the local supplying power company to use one. On underground construction, 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, a fourth cable with 600V insulation sized to match the phase conductors shall be provided.

3.5 Marking

3.5.1 Require all insulated medium voltage cables be tagged in all accessible locations such as in manholes, transformers, switches and switchgear. Install locator tape above all buried underground circuits.

3.6 Transformers

3.6.1 Location: Locate flammable, oil-filled transformers a minimum of 30 feet from buildings (or openings in buildings).

3.6.2 Sizing: Follow guidance in Section 12. Do not size transformer over 12 VA/SF (130 VA/M2) unless approved by SOUTHNAVFACENGCOM Code CI42.

3.7 Grounding - Overhead Distribution

3.7.1 All new poles shall have a butt wrap (see Section 12, Figure 5) 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 2’ intervals and protected by a plastic molding to approximately 8’ 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.

3.7.2 Driven electrodes shall be installed on all poles/structures supporting transformers, meters, switching devices, underground dips, arrester installations, and other equipment of this type. Driven electrodes shall consist of one or more stacked and bonded copperclad 3/4” x 10’ rods or a system of rods at a single location bonded together. The top of the rod shall be 18” below the surface of the ground. All connections to ground rods will be by exothermic weld, i.e. CADWELD©. Where driven electrodes are required, at least one driven electrode shall be placed 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) the driven electrode shall be located at least 10’ from the pole/structure; otherwise, at least two driven electrodes shall be installed with one electrode located 12” 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 shall be a minimum of 10’. These driven electrodes shall be bonded together with a minimum of No. 4 AWG soft drawn Bare Copper wire buried to a depth of at least 18”. A ground resistance of 25 ohms or less shall be reached at each pole where driven electrodes are required. (See the table below for maximum number of driven electrodes).

GROUNDING ELECTRODE TABLE

SOIL TYPE	NO. OF ELECTRODES BEFORE MEASURING	NO. OF 10’ 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 sandhills	3	4	12
Clay soils	2	3	9
Rocky areas	2	2	8 **

* Contractor shall be directed to make a reasonable effort to drive the number of stacked rods called for. When soil conditions prohibit, the contractor shall directed to drive the number of stacked rods possible.

** 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 50’ whichever comes first. Terminate the wire in a ground rod of at least 8’ in length. Ensure poles in or near moist areas are well grounded.

3.8 Grounding - Underground Distribution

3.8.1 See section 12 (Padmounted transformer grounding detail).

3.9 Medium Voltage Single line

3.9.1 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 #, industry standard impedance, meter type, CT sizes, and fuse sizes.

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

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

SECTION 11 ANTI-TERRORISM/FORCE PROTECTION (AT/FP)

PART 1 GENERAL

1.1 References

Naval Facilities Engineering Command, Norfolk VA Ltr 550 Ser 15/cmm dated 19 Jan 2000, Subj: NAVFAC Interim Technical Guidance, DOD Anti-Terrorism Force Protection Interim Anti-Terrorism/Force Protection Construction Standards.

1.2 Drawings

1.2.1 Show sufficient detail to demonstrate construction standard requirements are met.

1.3 Design

1.3.1 For AT/FP designated structures, the design shall meet the requirements referenced.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 Design Requirement

3.1.1 Design/install electrical equipment and services are in accordance with AT/FP requirements. The following are highlights of AT/FP requirements and should not be construed as all requirements.

a. Attach interior mounted electrical fixtures and conduits to the supporting structural system. Use seismic mounting methods.

b. Avoid routing key utilities through or on common walls to mailrooms.

c. Billeting and primary gathering structures require an emergency announcing system. Provide a unique announcing system that is distinguishable from fire or other alarm annunciation. System should be annunciated from within the building and a remote 24-hour monitored site. Coordinate selection of the recognizable alarm with project manager.

d. Lighting. Provide lighting to support assessment and appropriate security response.

e. Base or Facility perimeter entrance lighting. Provide color rendering. Provide 2 fc at 6 inches above ground for entry areas and 20 fc at 6 inches above ground for inspection areas. Locate and aim fixtures such that secure areas are illuminated without disclosing security personnel.

f. Utilities. Locate electric utilities in a secure location where practical. Locate electrical equipment greater than 6 inches in height at least 30 feet from the building.

3.2 Calculations

3.2.1 Lead reviewer through design by stating assumptions and decisions.

3.2.2 Provide analysis with supporting calculations to demonstrate that installation meets seismic and lighting requirements.

SECTION 12 SKETCHES AND DATA

SINGLE LINE DIAGRAM

One Line notes:

1. This one line is provided to indicate to designers what information should be shown on the single line diagram. As a minimum, the single line should show all conductor sizing, panel board sizing and ratings, grounding, CT sizing, splices and locations, termination types, motor sizes, all current interrupting devices and locations in the circuit, all transformer information (such as minimum impedance, size, both winding connections, switching arrangements, etc.) and metering specifics, etc.
2. If there is demolition involved or work is to be done to existing equipment, the designer shall 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.
3. The service entrance grounding electrode system and the bonding jumper per NEC 250 must be shown. No sweeping statements indicating to “install grounding in accordance with the NEC.”
4. The designer shall 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.
5. All pertinent information on the transformer and the service entrance shall be shown on the one line as opposed to the specifications.
6. The designer shall indicate on the electrical legend the exact nomenclature used to indicate conductor and conduit sizing. Provide a schedule for feeder runs.

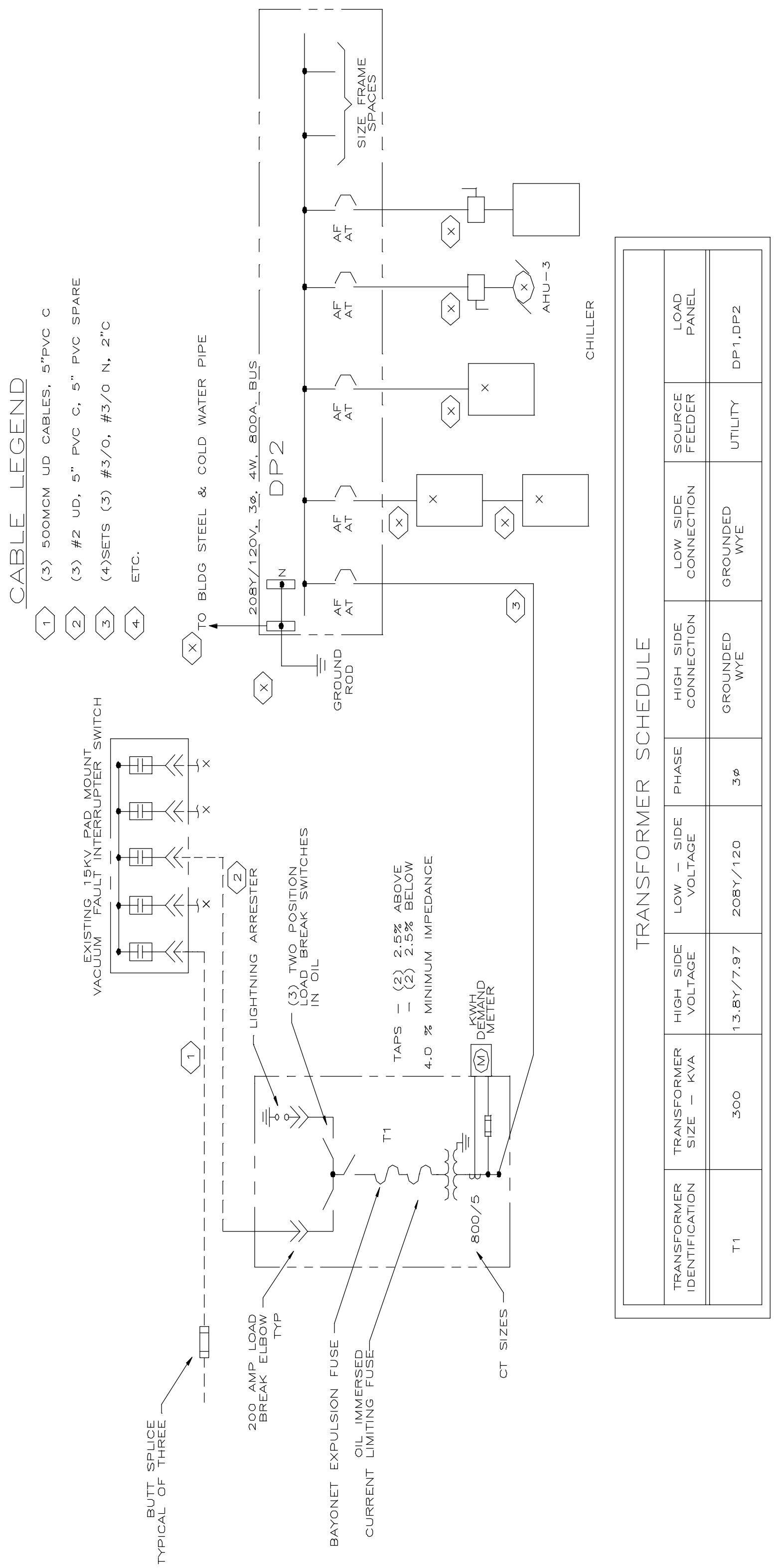
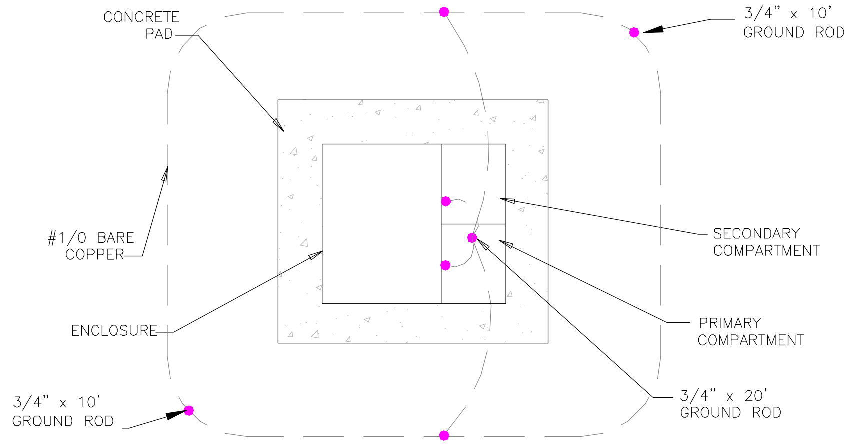

CABLE LEGEND
1 (3) 500MCM UD CABLES, 5"PVC C
2 (3) #2 UD, 5" PVC C, 5" PVC SPARE
3 (4)SETS (3) #3/0, #3/0 N, 2"C
4 ETC.
TO BLDG STEEL & COLD WATER PIPE
208Y/120V, 3ø, 4W, 800A. BUS
DP2
GROUND ROD
SIZE FRAME SPACES
AF AT
AHU-3
CHILLER
EXISTING 15KV PAD MOUNT VACUUM FAULT INTERRUPTER SWITCH
LIGHTNING ARRESTER
(3) TWO POSITION LOAD BREAK SWITCHES IN OIL
TAPS – (2) 2.5% ABOVE – (2) 2.5% BELOW
4.0 % MINIMUM IMPEDANCE
KWH DEMAND METER
T1
800/5
BUTT SPLICE TYPICAL OF THREE
200 AMP LOAD BREAK ELBOW TYP
BAYONET EXPULSION FUSE
OIL IMMERSED CURRENT LIMITING FUSE
CT SIZES
TRANSFORMER SCHEDULE
TRANSFORMER IDENTIFICATION
TRANSFORMER SIZE – KVA
HIGH SIDE VOLTAGE
LOW – SIDE VOLTAGE
PHASE
HIGH SIDE CONNECTION
LOW SIDE CONNECTION
SOURCE FEEDER
LOAD PANEL
T1
300
13.8Y/7.97
208Y/120
3ø
GROUNDED WYE
GROUNDED WYE
UTILITY
DP1,DP2

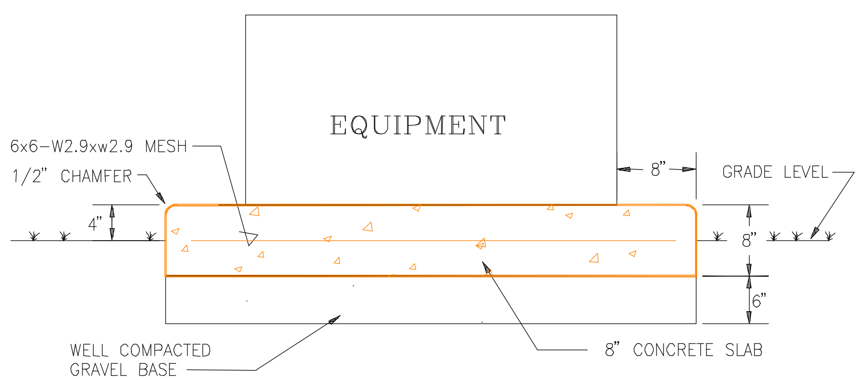
Figure 1



NOTES:

1. PROVIDE A #1/0 BARE COPPER GIRDLE PLACED 3' AWAY AND BURIED A MINIMUM OF 18" DEEP.
2. CHECK CONTINUITY BUT MAKE NO GROUND RESISTANCE MEASUREMENTS.
3. MAKE ALL CONNECTIONS USING EXOTHERMIC WELDS.
4. GROUND BUSHING WELL INSERTS PER MANUFACTURER'S INSTRUCTIONS.

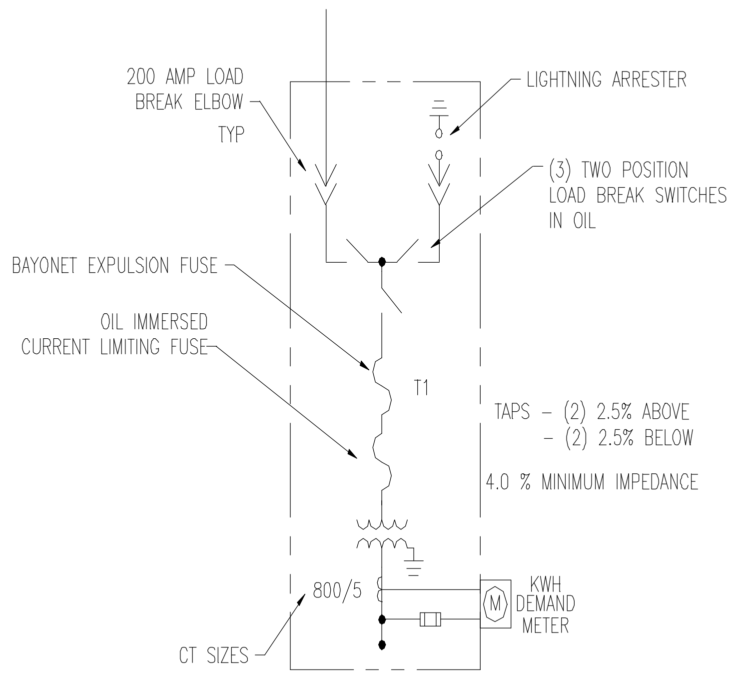
Figure 2



NOTE:
PROVIDE CONDUIT TURN-UPS, CUT OFF 3" ABOVE SLAB AND INSTALL BUSHINGS. SEAL VOIDS AROUND CONDUIT WITH WATER AND OIL RESISTANT CALKING OR SEALANT.

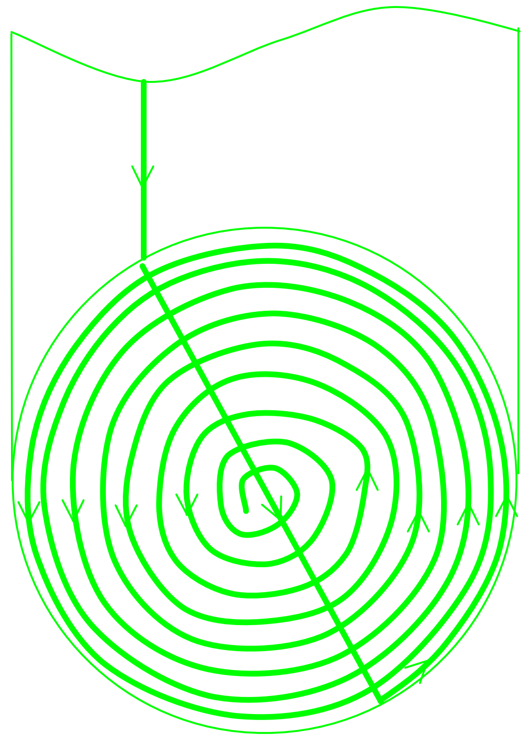
TRANSFORMER PAD DETAIL
NTS

Figure 3



SINGLE LINE DIAGRAM FOR LOOP FEED, DEAD FRONT PADMOUNTED TRANSFORMER (SINGLE PRIMARY FEEDS)

Figure 4



The butt wrap is made from a continuous length of bare #4 Cu. 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 should pass through the coil and be stapled in place to prevent unwanted inductive effects caused by a coil. At least 12 feet of wire must be below the ground level and in contact with the soil when the pole is set.

Figure 5

TYPICAL LOADING FOR PERSONAL COMPUTER SYSTEMS

COMPONENT	MEASURED LOAD
Pentium 550MHz Computer w/monitor	1.48 amps max
Pentium 200MHz Computer w/monitor	1.45 amps max. or (1.5 amps)
HP LaserJet 4000 Printer	0.25 amps idle, 5 amps RMS while printing

Design Guidance:

For new systems furniture installations it is recommended that not more than two printers or six workstations be connected to a single circuit. Where other loads such as coffee pots exist, connect four workstations to a circuit.

Load Data for Ballpark Demand Calculations*

Facility Type	VA/SF	Facility Type	VA/SF
BEQ	2-6	BOQ	2-6
Commissary/exchange	7-9	Warehouse/exchange	4
Café/mess hall	7-10	Child care	6
Admin. Building	6-10	Chapel	5-7
Craft/hobby/golf pro	4-5	Applied Instruction Bldg.	6-10
SIMA	6-10		

*Information obtained from utility metering by SOUTHNAVFAC Public Works Department. This information should be used to aid in estimating demand for transformer sizing.

NOMINAL SYSTEM VOLTAGES AT ACTIVITIES

Barksdale 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 2400 delta	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	12470Y/7200
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 delta
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 Ctr	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."

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" dwellings units (including diversity). All distribution systems for dwellings shall be sized for "all electric". Use the data below for sizing distribution transformers, service lateral voltage drops and flicker calcs, etc. These tables are not to be used for sizing the service laterals or service entrance conductors. **Warning: Single phase transformers 75KVA and above (120/240v) have large fault currents that the designer shall take into consideration.**

Table 1 DWELLING DEMAND KVA PER A/C SIZE

NO. OF UNITS	HVAC div	2 TONS		2.5 TONS		3 TONS		3.5 TONS		4 TONS	
		FE	Total	FE	Total	FE	Total	FE	Total	FE	Total
1	1	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	15.90	9.64	18.22
3	0.83	8.64	14.91	9.08	16.95	9.52	18.96	10.94	21.95	12.59	25.16
4	0.8	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	16.18	30.76	17.01	35.22	17.85	39.68	20.51	45.97	23.59	52.68

Table 2 Typical A/C sizes for Dwelling Units

DWELLING TYPE	A/C (TONS)	TYPICAL SQ. FT.
Mobile Home, small house	2	1000
Townhouse , House	2.5	1250
Townhouse, Condominium	3	1500
Condo, House	3.5	1750-2000
House	4	2000-3000

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 div** = 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.**

Table 3 Demand for Electric strip Heat

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

Example: A new underground distribution system is being designed for a housing development of duplexes. Each dwelling unit is 1500 sq. ft. with a 3 ton heat pump and 5KW of strip heat. "Total" load for 8 dwellings (max 4 duplexes per transformer - TG1004 section 2 - 3.1.9) and 3 ton units = 39.68 KVA *(table 1)*. A check of the winter load = FE*(from table 1)* + # of strip units x heat strip demand*(per table 3)* x HVAC div*(per table 1)*. Winter load = 17.85 + 8 x 5KW x .72 or 46.65 kva. Summer to Winter load ratio = 46.65/39.68 or 1.18. The transformer should be sized for the summer load (39.68KVA). Thus, each 50 KVA pad mounted transformer should feed 4 duplexes.

D-C HIGH VOLTAGE CABLE TEST REPORT

Date ____________

Contract & Work Location ____

Contract (Project) No. ____

Circuit Identification ____
(Dwg. Title, Number and Ckt. Number)

Test Equipment ____
(Make, Model, Serial No., Etc.)

Applied Test Voltage ________________Conductor Polarity____

Normal Oper. Voltage ________________

Cable Installation: New ______________________________Used __________________________________
(Date) (No. Years)

Temperature ______________________(°F) Humidity __________________ Wind ____________ (MPR)

D. C. TEST DATA

TIME Allotted Minutes	% Test Volt	KV	CURRENT (Microamperes) Phase A	Phase B	Phase C
	20				
	40				
	60				
	80				
1	100				
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
KVDC after 1 minute delay					

CABLE

AWG size ________(Copper/Alum)
Length ___________(Ft.)
Rated ____________(KV)
Manufacturer _________________
Grounded ______Ungrounded ____
Type Stranding ________________
(Concentric, Sector, Annular, Bunch, etc.)
Insulation: Type _______________
Avg. Thickness ________________
Jacket/Sheath: Type ____________
Shield Type ___________________
Conductors per cable ___________
(single or multiple)
Splice: Type & Location:
____
____
____
____
____
____

Termination Type:
____
____
____

Remarks and Fault Location:

Tested By ____

Witness ____

Witness ____

Testing Firm ______________________________________

SECTION 13 SUBMITTALS

PART 1 GENERAL

1.1 Orientation

1.1.1 All designers are required to be oriented by a SOUTHNAVFACENGCOM electrical designer prior to beginning any project.

1.1.2 To establish your counterpart at SOUTHDIV call Bill Dean at 843-743-7575 x5090 or Robert Lemacks at 843-743-7575 x5093.

1.2 Reviews

1.2.1 This guide describes minimum information that must be provided.

1.2.2 A/E must always clarify major comments with a phone call to SOUTHNAVFACENGCOM reviewer, rather than wait until next submittal to respond.

1.3 Calculations

1.3.1 All assumptions and given data will be clearly provided. Quote sources of calculations. Calculations will be fully described and clearly written.

1.3.2 Computer printouts are acceptable only if accompanied by explanation to allow adequate review of calculation methods and results.

PART 2 PRODUCTS

2.1 Schematic Submittal

2.1.1 Existing Site and Demolition Plan

2.1.1.1 This plan should include all existing site information such as buildings, pavements and utilities.

2.1.1.2 All electrical demolition should be shown on this drawing and indicated by legend.

2.1.1.3 Demolished features should not be shown on subsequent drawings.

2.1.2 Site Plan

2.1.2.1 This plan should show new and remaining aboveground and underground electrical lines and equipment.

2.1.2.2 Show other utilities in proximity to electrical utilities. Information on existing conditions should be complete and field checked.

2.1.3 Single Line Diagram (Not a Riser)

2.1.3.1 Existing distribution to a point of connection.

2.1.3.2 Primary feeder to project.

2.1.3.3 Padmounted transformer or substation with primary and secondary protective devices.

2.1.3.4 Secondary feeders to major items of equipment.

2.1.4 Basis of Design

2.1.4.1 Primary Distribution: Describe the primary source of power including location, adequacy and characteristics. Estimate load, transformer size and service size. Describe the basis for selection of secondary voltage.

2.1.4.2 Describe the facility service.

2.1.4.3 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.

2.1.4.4 List design standards and references.

2.1.5 Electrical Design Check List

2.2 35% Design Submittal

2.2.1 Previous Submittal

2.2.1.1 Submittal shall include all requirements of the previous submittal plus additional detail to bring them to the specified completion percentage.

2.2.2 Existing Site and Demolition Plan

2.2.2.1 This plan should be developed to approximately 50% completion.

2.2.3 Site Plan

2.2.3.1 This plan should be developed to approximately 50% completion.

2.2.4 Lighting Plan(s)

2.2.4.1 These plans should show a building's full floor plan (first, second, etc.) with the layout and type of fixtures to be used.

2.2.4.2 Scale should be 1/8" minimum.

2.2.5 Power Plan(s)

2.2.5.1 These plans should show a building's full floor plan (first, second, etc.) with the location of receptacles, panelboards, switchboards, motor control centers, transformers and any other major equipment.

2.2.6.2 Scale should be 1/8" minimum.

2.2.6 Single Line Diagram

2.2.6.1 This drawing should be developed to approximately 50% completion showing all panels, switchboards, motor control centers, transformers and other major electrical loads such as motors, chillers, etc.

2.2.7 Additional Plans/Risers

2.2.7.1 Show location of devices: Telephone, IDS, others as required.

2.2.8 Electrical Basis of Design

2.2.8.1 See paragraph 2.1.4 for requirements.

2.2.9 Design Calculations

2.2.9.1 Lighting: Interior and Exterior Foot-candles.

2.2.9.2 Load Analysis: A/E shall indicate the VA/sq ft for the transformer selected. Do not size transformer over 12 VA/SF (130 VA/M2) unless approved by SOUTHNAVFACENGCOM Code CI42.

2.2.9.3 Service size

2.2.9.4 Feeder size

2.2.9.5 Larger special circuit sizes (all HVAC 5 HP and above)

2.2.9.6 Lightning Risk Assessment

2.2.10 Response to Previous Submittal Review Comments

2.2.11 Electrical Design Checklist

2.3 Interim Submittal

2.3.1 The Statement of Work (SOW), which will indicate the required completion percentage (e.g., 60% interim submittal), will sometimes require interim submittals. Specific submittal items will be identified in the SOW; which will indicate the required completion percentage (e.g., 60% interim submittal.) Submittal shall include all requirements of the previous submittal plus additional detail to bring them to the specified completion percentage.

2.4 100% Electrical Submittal

2.4.1 Previous Submittal

2.4.1.1 Submittal shall include all requirements of the previous submittal plus additional detail to bring them to the specified completion percentage.

2.4.2 Legend

2.4.3 Existing Site and Demolition Plan

2.4.5 Lighting Plans and Details

2.4.6 Power Plans and Details

2.4.7 Power - Single Line Diagram

2.4.8 Telephone Riser Diagram

2.4.9 Fire Alarm Riser Diagram (See TG-1008)

2.4.10 Intercommunication Riser Diagram

2.4.11 Other Riser Diagrams for Television, Security, Etc.

2.4.12 Panel Schedules

2.4.13 Switchboards and Motor Control Center Schedules

2.4.14 Lighting Fixture Details

2.4.15 Updated Basis of Design

2.4.16 Calculations

2.4.16.1 Updated previous submittal calculations.

2.4.16.2 Coordination and Short Circuit: Provide an impedance diagram with calculated fault values and impedance values. Refer to IEEE STD 399-1980.

2.4.16.3 Voltage Drop

2.4.16.4 Motor starting/flicker analysis. For motors 40HP and greater and residential distribution. Refer to IEEE Brown Book and MIL-HDBK-1004/4.

2.4.16.5 Sag and Tension Analysis: For all overhead distribution systems.

2.4.16.6 Pulling Tensions for Conductors in Underground Conduit Runs.

2.4.17 Conflicts

2.4.17.1 Your completed design will be free of conflicts between the contract drawings and the specifications.

2.4.18 Response to Previous Submittal Review Comments

2.4.19 Electrical Design Check List

2.5 Final Submittal

2.5.1 Corrections/Clarifications

2.5.1.1 The final submission shall incorporate the corrections and clarifications noted on the 100% submittal.

SECTION 14 ELECTRICAL DESIGN CHECK LIST

❑ **General**

❑ Did you discuss the design with his counterpart at SOUTHDIV?

❑ **Basis of Design**

❑ Did you coordinate basis of design with Plans and Specifications?

❑ Did the designer provide reasons for his solutions?

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

❑ Did the designer provide an analysis for the voltage selected?

❑ Did the designer connect all equipment to the highest available voltage?

❑ **Power**

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

❑ Did the designer show the transformer per SDIV TG-1004?

❑ 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°C rise Dry-Type Transformers and ensure efficiencies greater than NEMA TP-1?

❑ Did the designer detail all poles?

❑ Is the metering per SDIV TG-1004? Metering on switchboards is acceptable.

❑ Did the designer prohibit the use of PTs for metering at pad mounted transformers.

❑ Did the designer provide a single main overcurrent device?

❑ Did the designer provide total kVA of DTT < or = 40% 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 provide motor disconnects with non-fused switches?

❑ Did the designer use enclosed circuit breakers instead of fused disconnect switches?

❑ 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?

❑ 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?

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

❑ Did the designer follow Green Building requirements?

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

❑ **Lighting**

❑ Did the designer provide exterior calculations when required (0.5 FC average maintained)-usually 150W HPS on 30-35′ poles?

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

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

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

- ❑ Did the designer follow criteria for corridors?

- ❑ 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 30 FC of illumination in living and sleeping areas in BQs (permanently installed)?

❑ Calculations

- ❑ Did the designer provide short circuit calculations?

- ❑ Did the designer provide voltage drop calculations?

- ❑ Did the designer provide a load analysis $\leq$12 VA/SF 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?

❑ Telecommunications

- ❑ Did the designer use Category 5e, 2-4 pair UTP?

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

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

- ❑ Did the designer provide two RJ-45 jacks in each phone outlet?

- ❑ Did the designer provide specifications with testing the cables?
- ❑ Did the designer coordinate with systems furniture?
- ❑ Did the designer indicate exterior cable required?

❑ Systems Furniture - Power

- ❑ Did the designer provide neutrals - super (#10 AWG)?
- ❑ Did the designer omit eight wire circuit, 3∅, 3N, 2G (proprietary - do not specify)?

❑ Grounding

- ❑ Did the designer place separately derived systems as close to load as possible?
- ❑ Did the designer provide grounding per NEC - 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?

❑ Lighting Details

- ❑ Did the designer prohibit wrap-a-rounds?
- ❑ Did the designer provide all steel end plates on industrials and strips?
- ❑ Did the designer provide 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

- ❑ 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 check on T-8 lamps and electronic ballasts?

- ❑ Did the designer check exterior lighting to see if pole specification agrees with plans?

❑ Force Protection

- ❑ 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 30 feet away from the building?

All questions should have “Yes” answers.