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ELECTRICAL SYSTEMS

TECHNICAL GUIDE

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CAPITAL IMPROVEMENTS SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

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Electrical Systems Technical Guide

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- **Introduction**

- **Intent**

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

- **Criteria**

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

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

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

(1) National Fire Protection Association (NFPA)

(2) NFPA 70, National Electrical Code

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

(4) NFPA 780, Lightning Protection Code

(5) Underwriters' Laboratories (UL)

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

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

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

(9) American National Standards Institute (ANSI)

(10) National Electrical Safety Code (ANSI C2)

(11) California Public Utility Commission General Order 95.

(12) California Public Utility Commission General Order 128.

(13) Federal Specifications (FS)

(14) Insulated Cable Engineers Association (ICEA)

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

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

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

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

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

(20) Electronic Industries Alliance (EIA)

(21) Telecommunications Industry association (TIA)

(22) Occupational Safety and Health Act

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

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

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

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

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

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

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

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

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

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

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

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

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

(k) DM 13.02, Commercial Intrusion Detection

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

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

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

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

(27) Underwriter Laboratory Standards

(28) Unified Facility Guide Specifications (UFGS)

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

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

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

(32) SOUTHWEST DIVISION A-E GUIDE

(33) NAVSEA OP-5

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

- **Standards**

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

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

- ## General Design Guidelines

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

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

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

Panelboards, backboards or distribution cabinets shall serve equipment/devices on the same floor.

Locate major items of equipment such as electrical panels in dedicated spaces (electrical rooms) that have no other use.

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

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

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

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

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

Use of plastic raceway systems in interior of building shall not be permitted above the 1st floor slab (First Floor Finish Floor Line).

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

Color coding of all wiring shall be provided.

Junction boxes on opposite sides of common walls shall not be placed between the same two studs or back to back in concrete walls.

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.

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

Provide construction phasing and outage plans.

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

a. Maximum transformer size is 100KVA.
b. Per transformer, do not serve more than 6 single dwelling units; 4 duplexes; or 2 quadraplexes.
c. Not applicable
d. Provide grounding at the service entrance in accordance with the latest NEC.
e. All conductors (primary and secondary) shall be in conduit.
f. Maximum length of service conductors (240/120V single phase) from the distribution transformer to the service entrance device (or meter base) shall be 220LF [67m].
g. Show typical and unique secondary situations on single line diagrams.

- ## Electrical Service and Distribution

  - ### Switchboards

    The switchboards shall be NEMA PB.1 and UL 891, dead-front metal enclosed, self-supported type.

    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.

    The switchboards shall be factory assembled and tested to meet the latest applicable requirements if AIEE, ASA and NEMA.

    Switchboards/main distribution panel served from a transformer shall be rated the same or greater than the transformer's full load rating.

    Switchboard bus bar shall be copper with silver plated contact surfaces. Devices shall be front accessible and shall be completely isolated between sections by vertical steel barriers.

    The switchboard shall be securely anchored to a one inch high by two-inch channel base, which shall be finished complete by the switchboard manufacturer. This base shall be drilled and tapped to receive the switchboard and shall be fastened to the floor. After the frame has been leveled and anchored to the floor, fill the entire frame with grout and finish smooth.

    Distribution circuit shall be molded case, quick make, quick breaker, thermal magnetic, trip free. Circuit breaker shall have a short circuit current rating of the available amperes RMS symmetrical at the rated voltage.

    Ground fault protection shall be provided as an integral part of the breaker. The ground fault pick-up shall be adjustable with the maximum setting of 1200 amps in compliance with the NEC. The time delay shall be adjustable in three discrete bands for maximum system selective coordination. Devices shall be provided with up to three visual indicators to indicate the automatic tripping mode of the breaker including:

    1. Overload
    2. Short Circuit
    3. Ground Fault

    Series rated circuit breakers are not acceptable.

    Fusible switchboards shall not be used.

- ## Panelboards

    When spare circuit capacity is provided in flush-mounted panelboards, also provide additional conduit capacity to avoid tearing out of walls. The additional conduit capacity may consist of empty conduit (with pull wire) runs to covered boxes above

    the ceiling or beneath the floor. Provide one spare conduit for every three (3) spare circuits.

Number circuits by pole number on single pole breakers and by first pole number on two and three pole breakers.

Indicate load in amperes, not kW or kVA.

Do not use fusible panelboards.

When more than 42 poles are required, provide separate panelboards. Do not use dual section panelboards.

Provide 10% spare breakers and 10% space only for all panelboards. The minimum spare capacity including spare breakers and spaces shall be 20% minimum.

Provide bolt-on circuit breakers.

Series rated and plug –in circuit breakers are unacceptable.

- ## Overcurrent Devices

All over current devices shall be suitable and UL listed for the application. All breakers shall be bolt on type, with an interrupting rating suitable for the system.

The use of series rated breakers is not acceptable.

The use of fused switches is not acceptable.

- ## Dry Type Transformers

Transformers shall be open self-cooled dry-type, designed for natural circulation of air through the windings, with a 220 degree C insulation system not to exceed at 80 degree C rise at a maximum ambient temperature of 40 degrees C. Windings, core, and coil assembly shall be moisture resistant. Provide ventilated enclosure with a corrosion resisting finish. Provide internal noise isolation pads between the enclosure, core, and coil assembly.

Windings shall be copper.

Sound Requirements:

1. Sound levels shall be a least 3 decibels below recommended values established by ANSI Standard "C-89".

2. An integral sound absorbing system shall be provided so that special sound reduction installations are not required.

Transformers shall have a minimum of four (4) full load rated taps in the primary voltage winding. Taps in the higher voltage windings shall be in 2-1/2% increments above and below nominal voltage (FCAN/FCBN).

- ## Grounding

Proper grounding is essential both for safety and for the correct operation of sophisticated systems. Provide grounding systems in accordance with NFPA 70, ANSI C2, MIL-STD-188-124, “Grounding, Bonding and Shielding for Common Long Haul/Tactical Communication Systems; “MIL-HDBK-419A “Grounding, Bonding, and

Shielding for Electronic Equipment and Facilities; "MIL-HDBK-1012/1, "Electronic Facilities Engineering; "NAVSEA OP-5, "Ammunition and Explosives Ashore;" and other criteria as applicable.

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

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. Refer to NFPA 70, National Electrical Code.

Provide an insulated ground wire in all raceways for systems operating at greater those 50 volts.

Computer equipment should be grounded as part of the branch circuit connection per manufactures recommended practices.

All raised access floors shall be grounded.

Ground planes should be grounded to a nearby electrical panel.

- ## Green building considerations

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

Maximize use variable speed drives.

- ## Cable Assemblies

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

- ## Wall plates

Material for finished spaces: Satin-finished stainless steel or unbreakable thermoplastic white in color.

Material for unfinished spaces: stainless steel.

- ## Switches

Toggles switches shall be specification grade, quiet type, white in color, and rated minimum 20A. Handles shall be white. Wiring terminals shall be screwed-type, side wired.

- ## Receptacles

General building convenience outlets/receptacles shall be 20A, 120V, and duplex grounding type and shall be located as follows:

a. Mechanical Equipment: Provide receptacle within 25 ft [7620 mm] of mechanical equipment on the interior and exterior of a building.

b. Office and staff support spaces: One for every 10 ft [3050 m] of wall space at floor line. When less than 10 ft [3050 mm] of wall at the floor line, provide a minimum of two receptacles spaced appropriately to anticipate furniture relocations.

c. Corridors: One every 50 ft [153 m] 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 ft [1220 mm] of countertop, but no less than one at countertops less than 4 ft [1220 mm]. Provide GFI protection of outlets when located within 6 ft [1830mm] of plumbing fixtures.

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

h. Kitchen: One for each 10 ft [3050 mm] of wall space at the floor line. Provide GFCI protection when located within 6 ft [1830 mm] of plumbing fixture.

i. Child occupied spaces (including toilets): One for every 12 ft [3660 mm] 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 ft [3660 mm] 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 ft [7620 mm] of wall space at the floor line. When less than 25 ft [7620 mm] 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.

- ## Conductors

Conductors shall be copper installed in conduit. Minimum size of conductors shall be 12 AWG. Conductors shall meet the applicable requirements of NFPA 70 and UL for the type and insulation, and jacket. Conductors manufactured more than 12 months prior to date of delivery to site shall not be used. No. 8 AWG and smaller diameter shall be solid copper. For class 2 low-energy, remote control and signal circuits minimum conductor size shall be No, 16 AWG.

• Conduits

Minimum size conduit shall be 1/2 inch [16 mm].

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

All conduits shall be installed parallel and perpendicular to walls, beams, and columns

- **Rigid Steel Conduit**

  Rigid steel standard weight conduit shall be exclusively used for all runs in masonry or concrete walls and slabs, exposed to the weather or exposed where subject to mechanical injury.

- **Electrical Metallic Tubing**

  Electrical metallic tubing (EMT) may be used for branch circuits and feeders above suspended ceilings or exposed, subject to the requirements of rigid steel conduit.

- **Flexible Metallic Conduit**

  Flexible metallic conduit shall be between 3 and 6 ft [915 mm and 1830 mm] used only for making motor connections, conduit drop from remote junction boxes to fixtures installed in the suspended ceiling, and for wiring to outlets installed in movable partitions.

- **Aluminum Conduit**

  Aluminum conduit may only be used for feeder conduits 1-1/4 inch [35 mm] and larger, except where rigid conduit is specifically required. Do not install underground or encased in concrete or masonry. Do not use brass or bronze fittings.

- **Polyvinyl Chloride**

  Polyvinyl chloride conduit (PVC) shall be used for underground primary service conduits from the service utility to the substation or underground below floor slabs. Wherever PVC conduits are used outside of building line, the PVC shall be encased with 3 inch [76 mm] (min.) of concrete.

- **Connectors**

  Use insulated throat steel compression connectors. All connectors and couplings for EMT shall be of the thread-less, steel, rain-tight. Crimp-on or setscrew type connectors are not acceptable

- **Hazardous (Classified) Locations**

  Define in accordance with NFPA 70, “National Electrical Code.” Clearly show boundaries of hazardous locations on the plans and identify the type of hazard by class, division, and group.

• Motor Control Equipment

- **Equipment Selections**

  The choice between using motor control centers (MCC's), motor starter panels, combination starters, and individual starters and disconnects must be evaluated. Several points for consideration are:

  Centralized control location necessary or required.

  Quantity of motors and equipment to be controlled.

  Sizes of motors and equipment.

- **Selection Guidance**

  Individual motor starters and disconnects are preferred over combination starters and are usually more cost effective.

  Individual motor starters and disconnects are usually preferred and are more economical than MCC's and motor starter panels, especially where small motors and scattered loads are involved.

  Motor starter panels would be preferred over MCC's where a centralized control location is required, where NEMA Size 0 starters can be used, or where a wall mounted versus floor mounted equipment panel is desirable.

  MCC's would be used where a centralized location is required and where the quantity of equipment and/or the starter sizes (NEMA Size 1 and larger) would justify the additional expense.

  Buses shall be copper, silver-plated.

  Interconnecting wires shall be copper.

  Copper ground bus shall be full width of motor control center.

  Neutral bus shall be insulated, full rated and extend continuously through the motor control center.

  Do not use fuses as overcurrent protection devices.

  Provide spare capacity (bus and overcurrent protection) for future motor loads.

- **3-Phase Motor Controllers**

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.

Interior Lighting

- **Design Criteria**

  MIL-HDBK-1004/4; MIL-HDBK-1190, "Facility Planning and Design Guide"; MIL-HDBK-1013/1, "Physical Security of Fixed Facilities"; and OPNAVINST 5530.14, "Physical Security and Loss Prevention."

- **General Guidelines**

  Provide illumination levels consistent with MIL-HDBK-1190 recommendations and with customer needs. Design to conserve energy, but provide a pleasant and comfortable work environment.

  In general, all lighting circuits located in office areas shall be controlled by individual switches located in each space.

  Strongly consider a central power source in lieu of numerous discrete batteries.

  Provide occupancy sensors to control lighting in laundry, toilets, and storage rooms, janitor closets and other low-use spaces.

  Utilize such techniques as the following to obtain a balance between energy conservation and customer needs:

  Multiple switching of fixture groups to permit lights to be turned off in unoccupied workstations

  Multilevel switching

  Time switch and/or photoelectric control of outdoor lighting

  More efficient lighting sources, fixtures, and lamps

  Grid-type ceilings with the capability of interchanging re-locatable panels and lighting fixtures without rewiring

  Occupancy sensors

  Delighting sensors and controls

- **Fixture Considerations**

  Provide energy efficient fluorescent lamps and energy saving electronic ballasts. Use energy-efficient lamps with high power factor ballasts, which are CBM (Certified Ballast Manufacturers) approved and have low harmonic characteristics.

  Minimize fixture types and lamp types to reduce maintenance inventories.

  Provide fixtures that are appropriate for the intended applications.

  In office areas utilize 18 or 27 cell, deep cell parabolic fixtures type fluorescent luminaries. Finish shall not be gold.

Use LED style exit fixtures.

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

Reduce general office illumination from 50-footcandles [538 lux] to 30-footcandles [323 lux] using dimming ballasts with photoelectric control, manual "on" control, occupancy sensor "off" control and task lights controlled by power strips with occupancy sensors.

Maximize use of indirect lighting.

In facilities where there may be an abundance of daylight, dim the lighting system. Install photocell controlled dimming lighting systems in all spaces being daylighted.

For typical indoor spaces maximize use of T-5, T-8 fluorescent and compact fluorescent lamps with electronic ballasts.

Minimize use of incandescent lighting.

Use HPS in high bay areas where color rendition is not critical.

Calculations shall show design foot-candle levels within 20% of criteria.

Utilize energy-efficient T-8 or T-5 lamps and electronic ballasts throughout the building.

When designing exterior lighting systems, consider glare, cutoff, and light trespass.

- **Systems Furniture**

  Many office spaces are currently being designed utilizing a Systems Furniture approach. Please adhere to the following guidelines when utilizing this approach:

  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 harness configuration is either 5-wire (3 circuit conductors, 1 oversized neutral conductor and 1 equipment grounding conductor) or 8-wire (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; connect each circuit to a different phase and balance loads between phases. Serve 8-wire harnesses with 4 separate circuits; balance loads between both circuits and phases.

  A single circuit should serve no more than three cubicles (computer stations).

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

Consider using K-rated transformers and panelboards with 200% neutrals.

- **Design Guidance:**

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

• Telecommunications and Security

• Telecommunications (Voice and Data) Systems

- **Criteria**

  MIL-HDBK-1012/3, "Telecommunications Premises Distribution Planning, Design, and Estimating."

- **Physical Description**

  Cable and Pathway – Provide Category 5e Unshielded Twisted Pair (UTP) copper cable for building backbones not exceeding 295 ft [90 m] and for horizontal cable runs; provide fiber optic cable for data backbones exceeding 295 ft [90 m]. Cable pathways shall be conduit and cable tray. Special conditions, user requirements, and economic considerations may warrant exceptions to be taken in regards to the previous two sentences. Size voice backbone cable for one active pair per outlet served plus at least 50 percent spare capacity. Data backbone cable typically runs between LAN equipment locations and shall have a minimum of four copper pairs or four optic fibers.

  Telecommunications Closets and Rooms – Provide telecommunications closets, equipment rooms, and entrance rooms in accordance with MIL-HDBK-1012/3. Provide at least one telecommunications closet on each building floor; additional closets may be required to insure that no horizontal cable run exceeds 295 ft [90 m] in length. In multi-story buildings, locate telecommunications closets one above the other. Equipment rooms and entrance rooms may be combined with telecommunications closets if there is adequate space for the required equipment. A minimum of two walls in each closet shall be covered with ¾ inch [19 mm] plywood in accordance with MIL-HDBK-1012/3. Cabinets may be used instead of closets in small buildings with 1000 square feet or less of useable space.

  Cross-Connects and Entrance Protectors – Provide type 110 cross-connect blocks to terminate copper pairs and provide type SC optical patch panels to terminate fiber optic cable. Do not provide cross-connect jumpers and patch cords. Provide a building entrance protector assembly to protect all outside cable pairs.

  Telecommunications Outlets – Provide workstation telecommunications outlets having a minimum of two RJ-45 (8 position) ports, one Category 5e voice port and one Category 5e data port. Provide a separate four-pair Category 5e UTP cable to each port from the respective voice or data field of a telecommunications closet cross-connect. Where special conditions require fiber to the outlet,

provide type SC connectors. All telecommunication outlets shall be served by a single 1inch [27 mm] conduit back to the cable tray system or directly back to the equipment rack. Daisy chaining tele/data cabling and outlets is not permitted. The maximum number of conduit bends shall not exceed 270 degrees total.

Power Receptacles – Provide a minimum of two dedicated non-switched 3-wire 120 volt, 20-ampere duplex receptacles in each telecommunications closet. Each dedicated receptacle shall be on a separate 20-ampere branch circuit serving only that receptacle. Additional convenience receptacles shall be provided at six-foot [1830 mm] intervals around the perimeter walls.

Telecommunications Grounding System – Provide explicit grounding requirements in accordance with NEC, ANSI/EIA/TIA 607, and IEEE 1100. Provide a minimum of one copper ground bar in each telecommunications closet, including a main ground bar at the telecommunications service entrance. Interconnect all ground bars with number 6 AWG insulated copper conductor routed with the backbone cable. Connect the main ground bar to the building grounding electrode system, preferably to the ground bus within the electrical service equipment enclosure. Bond ground conductor in conduit to both ends of the conduit. Bond the telecommunications grounding system to any lightning protection system that may be located on the premises per NFPA 780, "Lightning Protection Code".

- **Design Consideration**

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

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

- **Testing**

  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 are to be tested by optical time domain reflectometer (OTDR) in both directions. All testing data (for fiber and copper) is to be submitted (in hard copy and on digital media) to the ROICC.

- **Communication Rooms**

  All buildings shall have at least one communications room per floor sized in accordance with EIA/TIA standards with rack and patch panels for termination of horizontal and backbone cabling.

  Locate centrally and stack vertically on multi-story buildings.

- **Frames**

  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 20amp circuit and a quadraplex receptacle for each 19-inch [483 mm] vertical section.

- **Communications Racks and Patch Panels**

  (1) Locate communications racks in conditioned spaces.

  (2) Provide separate 84-inch x 19-inch [2134mm x 483mm] racks for data and voice. Arrange data and voice cables separately. Provide terminations and cross connect jumper cables for CAT 5e and fiber optic plant to allow all communication cross connects capability plus 10%.

  (3) Provide an adequate number of spare racks, not less than two, for the purpose of mounting government purchased and installed LAN equipment.

  (4) Provide one dedicated 20A-branch circuit receptacle per rack. Provide an 18-inch x 4-inch x ¼ inch [457 mm x 102 mm x 6 mm] copper insulated ground bus bar mounted at 18 inch [457mm] AFF in each communications room. Ground each communications rack. Connect the (IDF) Communications Room grounding bus bars to the (MDF) Main Communications Room grounding bus bar with a #1/0 bare copper conductor. Connect the (MDF) grounding conductor to the building service entrance grounding electrode conductor with a #3/0 AWG bare copper conductor.

  (5) 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 in [483 mm] racks. Segregate voice and data terminations on the racks. Provide trained 20ft [6100 mm] service loops for all backbone cables. Provide excess horizontal cable to facilitate future re-termination.

- **Pathways**

  Install a cable tray above corridor ceilings or in another central location as the telecommunications backbone. Use conduit from the tray to the outlet. . The conduits shall be run concealed in all finished spaces. Provide service entrance conduit system and pathways between communication rooms as required by EIA/TIA-569.

- **Backbone Cabling**

  Provide 12/12 multimode/singlemode (tight buffered riser rated) fiber optic cable backbones between MDF and IDFs for data.

  Provide voice backbone cable of multiple 25-pair CAT 5e cables.

  For twisted pair media, provide solid-state type primary protectors with sneak current protection.

  Provide backbone cables to fully support all pairs in horizontal cables.

  For voice circuits terminate all horizontal and backbone communication conductors on RJ-45, CAT 5e, jackplug type, rack-mounted cross connect panels.

For data circuits provide rack mounted RJ-45 type patch panels for both horizontal and backbone terminations.

- **Workstation Outlets**

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

  Each workstation shall have at least one communications outlet.

  Permanently installed offices and system furniture cubicles larger than 64 SF [5.95 SM] shall have two communications outlets at a minimum. These outlets shall be located to facilitate future furniture locations.

  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.

  Provide workstation outlets for all ancillary office equipment such as printers, faxes and plotters based on 1 per 600 square feet [55.74 square meter].

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

- **BEQ/BOQ Housing**

  In each living or sleeping room provide a telephone/data outlet for every resident served with 2-4 pair UTP category 5e cables.

  A third party vendor provides non-official phone service. Provide a conduit to 5 ft [1530 mm] outside of the building for use by this vendor. Completely wire the building interior conforming to the standards listed above.

  Coordinate and provide the official outside plant phone service with Base Communications Officer (BCO).

  In every living room and sleeping room provide CATV outlet per the requirements below for Cable Television (CATV) Systems.

- **Family Housing**

  Follow ANSI/EIA/TIA 570-A. Grade 2 wiring for all dwelling units.

  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 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.

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

  In every living room and sleeping room provide CATV outlet per the requirements below for Cable Television (CATV) Systems.

- ## Public Address and Music Systems

  An Intercom/Public address/Music system shall have speakers in common spaces and shall have exterior speakers for outside activity spaces. Coordinate locations with the end users. The system shall utilize telephone handsets for announcements. Provide zone and volume control for all areas.

- ## Intercommunication Systems and Paging

  Refer to Public Address and Music Systems paragraph above.

- ## Television Systems

  A complete CCTV system shall be provided. Provide conduit system with RG/59U 95% copper cable and control wiring from each camera location back to the CCTV equipment rack location. Cameras shall be located provide full coverage.

  Monitoring of all cameras shall occur at the reception desk. Provide rack or console mounted equipment. Provide a complete system with duplex multiplexer, 17 inch [432mm] monitor, and 24 hour “real-time” VCR. System shall be capable of recording all cameras. Provide VCR to record all cameras.

  For cable TV system provide a backbone consisting of backboards/cabinets and wire and conduit with outlets and jacks in all offices, and other locations as required by the user. Assume [30] outlet locations. The inputs to this system shall be conduit and wire for a cable service and to an antenna location. Wire using RG-6 cable in a star topology. Provide calculations to show a minimum 10dMmv signal at all outlets. Coordinate cable service with local provider.

- ## Cable Television (CATV) Systems

  Unless directed otherwise, provide a complete system to be owned and maintained by the government. System shall be designed in accordance with BICSI, “Building Industry Consulting Service International”, NFPA 70, “National Electrical Code”, and shall be coordinated with the local CATV service provider.

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

- ## Intrusion Detection Systems (IDS)

  Provide in accordance with DM-13.02. “Commercial Intrusion Detection System (IDS).”

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

  The design requirement for the Intrusion Detection System is a complete design for the intrusion detection system - even though this may require funding from another source and coordination with other government agencies. Coordinate with our project manager.

  Provide an intrusion detection system (IDS) to sense all perimeter doors and windows and the interior volume in at least two locations. System shall have 90-

minute battery back-up and annunciate both locally and at the Base Security Office via a telephone dialer. System shall have entry/exit timer. Provide wall mounted keypad control at 2 locations.

- **Other Electrical Systems**

- **Emergency Lights, Exit Lights, and Fire Protection Systems**

Provide power for emergency lights, exit lights, and fire protection systems, ***per NFPA 70***, in the following manner:

Provide unit equipment (equipment with self-contained rechargeable battery, battery charging means, and automatic transfer to and from battery) for emergency lights, exit lights, and fire protection systems. Specify LED type exit lights.

The branch circuit feeding the emergency lights and exit lights shall be the same branch circuit as that serving the normal lighting in the area and connected ahead of any local switches.

Provide power for the fire protection systems from the MDP.

(1) 208Y/120 V or 120/240V system
Provide lock-on breaker in the MDP.
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 MDP.

(2) 408Y/277 V systems
Provide circuit from the MDP (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 MDP where practical.

(4) In all cases paint the lock-on breaker in the MDP and the dedicated emergency panel enclosure red. At the MDP, in addition to the panel nameplate, provide a label with the following inscription: "Emergency Breaker Within." Label shall be constructed and fastened identical to the panel nameplate, except the label shall be red laminated plastic with white center core.

(5) Electrical service to fire pump(s) shall be in accordance with NFPA 70, Article 695.

If significant amounts of emergency power are required for loads other than lighting and fire protection systems, provide a second source of emergency power in accordance with NFPA 70, Article 700.

For systems that require emergency power sources, such as generators or uninterruptible power systems (UPS), these sources shall be incorporated into the design.

- ## Transient Voltage Surge Suppression (TVSS)

  TVSS equipment shall 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.

- ## Lightning Protection

  Provide in accordance with MIL-HDBK-1004/6, "Lightning Protection."

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

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

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

  Provide a complete system designed and installed in accordance with NFPA 780 and UL 96A. The installation shall be tested and a UL Master Label attached to the building before it will be accepted.

- ## 400 Hertz Systems

  - **Design Criteria**

    MIL-HDBK-1004/5, "400 Hz Medium-Voltage Conversion/Distribution and Low Voltage Utilization Systems."

  - **Nominal Utilization Voltage**

    The nominal ac utilization voltage is 200Y/115V, three phase, 4 Wire.
    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.

  - **Techniques for Minimizing Voltage Drop**

    (1) Use rigid aluminum or PVC conduit except that aluminum shall not be used in concrete.

    (2) Use only copper conductors.

    (3) Use thin-wall insulation type (THWN, THHN, XHHW, etc., should be considered).

    (4) Use multi-conductor cables.

    (5) Use smaller paralleled conductors in lieu of larger single conductors.

    (6) Use line drop compensators.

- **Isolating 400 HZ Systems**

  The 400 Hz system shall be completely separate from other systems (i.e., a 400 Hz circuit shall not be installed in the same box or cabinet as a 60 Hz circuit unless barriers are used to separate sections).

- **Equipment Rating**

  Circuit breakers, panelboards, etc., shall 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.

- **Frequency Converters**

  Frequency converters shall be specified using our guide specification 16268, "400 Hertz (HZ) Solid State Frequency Converter." The guide specifications shall be used in its entirety for specifying operational parameters and selection of components and accessories. Use the default settings in the guide where no other guidance is provided. Use solid state converters with 12 pulse rectifiers, minimum.

  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. The converter shall have a voltage tolerance of plus or minus 2 percent. Use the default settings in our guide specification to procure the system. Converter shall include a NEMA 3R enclosure and be located on the outside of the hangar wall adjacent to the hangar door. Connect the converter to an explosion-proof locking type receptacle located on the inside of the hangar wall.

  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.

  The aircraft service cable shall be located adjacent to the converter unit, but on the inside hanger wall. 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.

- **Overcurrent Equipment**

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

- **Raceway**

  Use rigid aluminum conduit except use PVC in concrete.

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

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

- **Voltage Regulation**

  The utilization voltage is 200Y/115. Regulate the system from 112 to 118 volts at the aircraft receptacle. These limits modify the limits in MIL-STD-704E.

• Direct Current (DC) Systems

Provide in accordance with MIL-STD-704, "Aircraft Electric Power Characteristics."

- Voltage Regulation

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

• Uninterruptible Power Systems (UPS)

Provide in accordance with MIL-HDBK-1004/1 and MIL-HDBK-1012/1.

• High Altitude Electromagnetic Pulse Protection (HEMP)

Provide in accordance with MIL-HDBK-423, "High-Altitude Electromagnetic Pulse (HEMP) Protection for Fixed and Transportable Ground-Based Facilities" (draft) and MIL-STD-188-125, "High-Altitude Electromagnetic Pulse (HEMP) Protection for Ground-Based C^4I Facilities Performing Critical, Time-Urgent Missions."

• Ordnance Facilities

Provide in accordance with NAVSEA OP-5.