TINKER AIR FORCE BASE
ELECTRICAL STANDARDS

2026 Edition

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TAFB ELECTRICAL STANDARDS
Tinker Air Force Base, Oklahoma
2026

1. General

1.1 References

As a minimum, all electrical work performed on Tinker AFB shall conform to the latest edition of the following codes/standards, and all applicable UFCs, AFMANs, and AFIs:

(1) NFPA 70, *National Electrical Code (NEC)*

(2) NFPA 70E, *Standard for Electrical Safety in the Workplace*

(3) NFPA 72, *National Fire Alarm and Signaling Code*

(4) NFPA 101, *Life Safety Code*

(5) NFPA 170, *Standard for Fire Safety and Emergency Symbols*

(6) NFPA 780, *Standards for Installation of Lightning Protection Systems*

(7) IEEE C2, *National Electric Safety Code (NESC)*

~~UFC 3-260-01, Airfield and Heliport Planning and Design~~

~~UFC 3-460-01, Design: Petroleum Fuel Facilities~~

(8) UFC 3-501-01, *Electrical Engineering*

(9) UFC 3-520-01, *Interior Electrical Systems*

(10) UFC 3-530-01, *Interior and Exterior Lighting Systems*

(11) UFC 3-535-01, *Visual Air Navigation Facilities*

(12) UFC 3-540-01, *Engine-Driven Generator Systems for Prime and Standby Power Applications*

(13) UFC 3-550-01, *Exterior Electrical Power Distribution*

(14) UFC 3-560-01, *O&M: Electrical Safety*

(15) UFC 3-570-01, *Cathodic Protection*

(16) UFC 3-570-06, *O&M Cathodic Protection Systems*

(17) UFC 3-575-01, *Lightning and Static Electricity Protection Systems*

(18) UFC 3-580-01, *Information and Communications Technology Infrastructure Planning and Design*

(19) UFC 3-600-01, *Fire Protection Engineering for Facilities*

(20) UFC 3-601-02, *Fire Protection Systems Inspection, Testing and Maintenance*

(21) UFC 4-010-01, *DOD Minimum Antiterrorism Standards for Buildings*

(22) UFC 4-010-06, *Cybersecurity for Facility-Related Control Systems*

(23) UFC 4-021-01, *Design and O&M: Mass Notification Systems*

(24) UFC 4-211-01, *Aircraft Maintenance Hangars*

(25) ANSI/NETA ATS, *Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems*

(26) ANSI/NETA MTS, *Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems.*

(27) ANSIA/TIA/EIA 568-C, *Series of Telecommunication Standards.*

(28) ANSIA/TIA/EIA 569-B, *Commercial Building Telecommunications Cabling Standard.*

(29) ANSIA/TIA/EIA 607, *Generic Telecommunications Grounding and Bonding (Earthing) for Customer Premises.*

(30) NEIS, National Electrical Installation Standards

- NECA 1, *Good Workmanship in Electrical Contracting*
- NECA 90, *Commissioning Building Electrical Systems*
- NECA 100, *Symbols for Electrical Construction Drawings (ANSI)*
- NECA 101, *Installing Steel Conduits (Rigid, IMC, EMT)*
- NECA/NEMA 105, *Standard for Installing Metal Cable Tray Systems (ANSI)*
- NECA 111, *Installing Nonmetallic Raceways (RNC, ENT, LFNC)*
- NECA/NACMA 120, *Installing Armored Cable (AC) and Metal-Clad Cable (MC)*
- NECA 169, *Standard for Installing and Maintaining Arc-Fault Circuit Interrupters*
- NECA 200, *Temporary Electric Power*
- NECA 202, *Installing Industrial Heat Tracing Systems*
- NECA 230, *Electric Motors and Motor Controllers*
- ~~NECA/FOA 301, *Installing and Testing Fiber Optic Cables*~~
- NECA 305, *Standard for Fire Alarm System Job Practices*
- NECA 331, *Standard for Building and Service Entrance Grounding and Bonding*
- NECA 400, *Installing and Maintaining Switchboards*
- NECA 402, *Installing and Maintaining Motor Control Centers*
- NECA/EGSA 404, *Installing Generator Sets*
- NECA 407, *Installing Panelboards*
- NECA 408, *Installing and Maintaining Busways*
- NECA 409, *Installing and Maintaining Dry-Type Transformers*
- NECA 410, *Installing and Maintaining Liquid-Filled Transformers*
- NECA 411, *Standard for Installing and Maintaining Uninterruptible Power Supplies* (UPS) (ANSI)
- ~~NECA 420, *Standard for Fuse Applications (ANSI)*~~
- NECA 430, *Standard for Installing Medium-Voltage Metal-Clad Switchgear*
- NECA/IESNA 500, *Installing Indoor Commercial Lighting Systems*

- NECA/IESNA 501, *Installing Exterior Lighting Systems*
- NECA/IESNA 502, *Installing Industrial Lighting Systems*
- NECA 505, *Standard for Installing and Maintaining High Mast, Roadway and Area Lighting*
- NECA/BICSI 568, *Installing Commercial Building Telecommunications Cabling*
- NECA/MACSCB 600, *Installing and Maintaining Medium-Voltage Cable*
- NECA/NEMA 605, *Installing Underground Nonmetallic Utility Duct*
- NECA 607, *Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings*
- NECA 700, *Standard for Installing Overcurrent Protection to Achieve Selective Coordination*

1.2 Design

(1) As a minimum, all electrical design shall conform to the latest edition of the above codes/standards.

(2) To the extent possible, Unified Facility Guide Specifications (UFGS) and standard detail shall be utilized in the design. All specifications and general notes shall have the non-applicable parts edited.

(3) Existing as-built drawings (if available) may be used as guidelines, but "information must be verified by field investigation." The Designer shall be responsible for the verification of all dimensions, measurements, and location of existing facilities, utilities, equipment and other existing conditions that may affect the design.

(4) The following items shall be taken into consideration and included as part of the design analysis:

(a) Exterior – Primary circuit availability and location.
(b) Exterior – Primary circuit loading (generally, existing primary loops at TAFB are designed for loads of 400A or less. Future loops may be designed for higher capacities as long as analysis shows that existing switchgear/substations can support the higher requirement).
(c) Existing equipment age and condition.
(d) Transformer/panelboard/switchgear loading (existing and future).
(e) Non-linear loads (Lighting, computers, variable frequency drives, etc.).
(f) Energy Analysis.
(g) When designing/installing new electrical distribution systems, the designer shall account for future load growth for components of the system supporting space conditioning, water heating, cooking, and laundry systems.

(5) All new building wiring systems shall consider using 480Y/277V unless uneconomical to accomplish. Designer shall make recommendations for building voltages at the design analysis phase of each project.

(6) All new electrical transformers and distribution equipment shall have a Fault Current Calculations and Arc-Flash analysis performed IAW NFPA 70E Annex "D". Calculations shall

be performed using “Easy Power” software and submitted to 72ABW/CENMP for review and approval prior to equipment installation.

(a) Contractor shall confirm the Easy Power Software Version requirement with Contracting Officer at the beginning of the project.
(b) All Data fields in the software shall be filled out.
(c) Available Fault Current data shall be provided to the designer by 72ABW/CENMP upon request, if available.
(d) Complex projects shall be provided with separate drawing sets for One-Line Information and Fault Current / Arc-Flash Data.
(e) Design/Build Projects

- Coordination study, fault-current calculations and arc-flash analysis shall be included no later than the 95% design submission to the Gov’t for review and approval of design/build Projects.
- Once the coordination and arc-flash analysis are approved by the Government, the contractor shall coordinate with the user(s) and adjust breaker settings accordingly.

(f) A&E Design only projects

- Fault Current calculations One-Line must be submitted using Easy Power software with the assumption clearly stated that all upstream overcurrent protection devices are in proper working condition and have been maintained and certified. For systems which no certification of the maintenance can be produced, the requirement to perform the maintenance and certification must be included in the design package for the contractor to perform this work as part of the project.
- The (*.dez) file shall be included in the construction contractor’s package to complete the Fault Current calculations and Arc Flash Analysis based on the electrical distribution equipment being provided.
- For construction only projects, the Easy Power Model One-Line drawing shall be provided by the A&E designer and completed using Easy Power software by the construction contractor based on the approved electrical equipment being provided.

(g) Use the 0.5-sec maximum arc time as a conservative, but more realistic, value when doing arc flash calculations for 208V systems which are fed from step down transformers less than 125KVA.
(h) A copy of the Easy Power Model (*.dez) and One-Line Drawings shall be submitted with other material submittals prior to Construction Start.

(7) Arc-Flash labeling shall be installed on all newly installed electrical transformers, disconnects and distribution equipment.

(a) All Arc Flash Labeling shall be “Easy Power” containing the following information.

- Company Name
- Date of Arc-Flash Analysis
- Equipment Identification
- Required PPE

- Arc-Flash Hazard Risk Category
- Incident Energy (Cal/cm2)
- Shock Protection
- Limited Approach Boundary
- Restricted Approach Boundary

1.3 Installation

(1) As a minimum, all electrical installations shall conform to the latest edition of the above codes/standards.

(2) NEIS shall be used for quality and reliability standards for construction. These criteria will be used to define acceptable industry practices for installations.

(3) Only state licensed journeymen electricians or registered apprentices under the direct supervision of journeymen will be permitted to install, alter, or repair electrical systems.

(4) Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. All materials in the same category shall be produced by a single manufacturer. Equipment from discontinued product lines shall not be accepted in new installation.

(5) All conductors shall be color-coded at panelboards, switchboard, terminations, junction boxes, manholes, hand holes, etc. Factory-applied color-impregnated insulation is required for all sizes unless waived by 72ABW/CENMP or 76 MXSG/MXDEJ. Equipment grounding conductors (EGC) shall have factory-applied color-impregnated insulation for all sizes. A green equipment-grounding conductor shall be installed with all branch circuits. Circuit conductors shall be color coded as follows:

(a) ALL CONFIGURATIONS: EGC, Green.

Exception: Where an isolated ground is required the isolated ground shall be identified as green with a yellow stripe.

(b) 120V, 2-WIRE CIRCUIT: Grounded conductor (neutral), White; Ungrounded leg, Black.
(c) 240/120V, 1-PHASE, 3-WIRE CIRCUIT: Grounded conductor (neutral), White; Phase A, Black; Phase B, Red.
(d) 208Y/120V, 3-PHASE, 4-WIRE CIRCUIT: Grounded conductor (neutral), White; Phase A, Black; Phase B, Red; Phase C, Blue.
(e) 208V, 3-PHASE, 3-WIRE CIRCUIT: Phase A, Black; Phase B, Red; Phase C, Blue.
(f) 480Y/277V, 3-PHASE, 4-WIRE CIRCUIT: Grounded conductor (neutral), Gray; Phase A, Brown; Phase B, Orange; Phase C, Yellow.
(g) 480V, 3-PHASE, 3-WIRE CIRCUIT: Phase A, Brown; Phase B, Orange; Phase C, Yellow.

(6) All new floor mounted electrical equipment installed in damp or wet locations shall be installed on a housekeeping pad a minimum of 3-1/2” A.F.F. Any exposed edges shall be 3/4” chamfered. Electrical Equipment installed in dry areas, such as Electrical Vaults and Comm. rooms, does not require a housekeeping pad.

1.4 Metering

1.4.1 Digital Metering

(1) Advanced Digital Metering (ADM) shall be installed in each switchboard or switchboard section (for double-ended applications) for billing and energy monitoring & reduction purposes. Advanced meters are electronic meters that have the capability to measure and record interval data and communicate that data to an Advanced Metering System (AMS).

(2) The ADM may also be remotely mounted at 72" Above Finished Floor (AFF) to the center of the display. ADM shall conform to Unified Facilities Guide Specification (UFGS) 26 27 13.10 30, except numbered terminal wiring sequence and case size may be the manufacturer's standard.

(3) All setup parameters required by the electronic monitor shall be stored in non-volatile memory and retained in the event of a control power interruption. Any battery or other device used to provide non-volatile memory shall be user serviceable from the front of the monitor and servicing shall not require removing the monitor from the gear in which it is mounted.

(4) The ADM monitor shall maintain in non-volatile memory maximum and minimum values for each of the instantaneous values reported as well as the time and date that the minimum or maximum was set.

(5) The ADM monitor shall have the ability to communicate information to a remote data collection system.

   (a) An exterior CAT 6 connect point must be provided within 12" of center of ADM for each new meter so accessing the interior of the ADM enclosure is not required.

(6) All new ADM shall be a Schneider ION 8650 series or next generation equivalent.

(7) All necessary instrument transformers (CTs/PTs) shall be provided in the switchgear.

(8) At the time of installation, the Meter shall be calibrated to the specific Transformer/CTs and installed providing a 'Calibration Certification' document for Government acceptance. Meter shall be calibrated to measure usage in KW, not Watts.

(9) The monitor shall be listed according to UL 508, and have an over-current withstand rating of 500 amps for 1 second.

(10) The monitor shall provide true RMS metered values accurate for distorted, non-sinusoidal wave-shapes beyond the 30th harmonic (fundamental of 60 hertz).

(11) The monitor shall be accurate to $\pm$ 0.25% of reading $\pm$ 0.05% of full scale for voltage and current metering, and $\pm$1.0% for all power and energy functions. The accuracy shall be maintained for both light and full loads. No annual re-calibration by users shall be required to maintain these accuracies.

(12) Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

(13) The monitor shall be equipped with an integral, continuous duty, long-life display to provide local access to the following metered quantities as well as the minimum and maximum value since last reset of each quantity:

(a) Current (RMS), per phase and neutral.
(b) Voltage, phase-to-phase and phase-to-neutral.
(c) Real power, per phase and 3-phase total.
(d) Reactive power, per phase and 3-phase total.
(e) Apparent power, per phase and 3-phase total.
(f) Power factor, per phase and 3-phase total.
(g) Frequency.
(h) Demand current, per phase and three phase average.
(i) Demand real power, 3-phase.
(j) Demand apparent power, 3-phase.
(k) Accumulated Energy, (MWH and MVARH).
(l) THD, current and voltage, per phase.
(m) K-factor, current, per phase.

(14) The following demand readings shall be included as local display access and also reported by the monitoring system:

(a) Average KW demand current, per phase.
(b) Peak KW demand current, per phase.
(c) Average demand for real power, reactive power, and apparent power.
(d) Predicted demand for real power, reactive power, and apparent power.
(e) Peak demand for real power, reactive power, and apparent power.
(f) The default demand calculations method shall be 15-minute sliding window.

(15) Where ADM is to be connected to the VLAN, contractor shall install conduit with pull string to the nearest Comm Rack as specified in the project SOW and/or drawings.

(a) The User and/or the Facility Manager must submit a CIPS request to 72 ABW/SC for installation of Cat 6 Cabling and connections to the Comm Equipment.
(b) When LAN drop is completed, a notification shall be sent to the COINE support team to configure Network Connection and Meter Security.

(16) All ADM installed indoors and outdoors must be hardware connected to the nearest CE-COINE connection point such as the nearest facility Communication Rack. There are no approved wireless options for Tinker AFB at this time. In addition, meter boxes shall be installed in accordance with the 'Meter Can Configuration for Network Connection' diagram.

(17) IP addresses, Ethernet gateways, and subnet masks for the ADM will be configured by 72 ABW/SC ICS support.

(18) A standard local digital meter (Volt, Amp, and Demand Amp) shall be installed on circuit breakers 600 amp and larger to include all main service switchgear and secondary switchgear branch circuits.

(a) The digital meter shall maintain in non-volatile memory maximum and minimum values for each of the values as well as the time and date that the minimum or maximum was set.

(19) Commissioning

(a) Installation contractor shall be required to provide documentation verifying proper meter commissioning and verifying proper operation/readings for all digital metering during commissioning of the equipment IAW MXSG meter commissioning checklist. Commissioning checklist must be approved and accepted by MXSG prior to project.

(b) Verification of acceptable communications will be established by 72 ABW/SC ICS support.

2. Exterior Electrical

(1) Any project performed by OG&E or their sub-contractors shall install all Medium Voltage (MV) systems and equipment IAW OG&E specifications.

(2) All other MV systems installed on TAFB shall comply with the following requirements.

2.2 General

(1) All exterior pad mounted equipment shall be installed in accordance with (IAW) the Base Facility Standard for Architectural Compatibility.

(2) Medium Voltage Transformer Pads shall be installed by the contractor per OG&E supplied specifications.

(a) Forms and Reinforcement shall be inspected and approved by OG&E prior to pouring concrete.

(3) All exterior pad mounted equipment shall have permanently affixed identification labels. Labels shall be weather resistant, engraved, Laminated Plastic. Labels shall indicate equipment identification, rating, and circuit designation. Information for new equipment identification and circuit designation will be provided by 72ABW/CENMP.

(4) All exterior underground cables shall have permanent identification tag installed at each manhole, hand hole, pull box, or termination. Labels shall be weather resistant, engraved, metal or Laminated Plastic. Labels shall indicate at a minimum the circuit designation and To/From information. Information for circuit designation shall be provided by 72ABW/CENMP.

(5) Disconnects for mechanical and other equipment on the outside of buildings shall be served from the rear (through the wall feeder) or bottom (below grade feeder).

(6) All busbar systems in electrical equipment shall be copper.

(7) Utility Lines and Structures.

(a) Place utilities underground and screen above-ground equipment to minimize their visual impact.

(b) Exposed conduits, cables, and wires are prohibited.

(c) Construct underground utility system components as elements of any new or renovated facilities. When this is unfeasible, locate screened equipment on the least visible side of the building.

2.3 Underground Electrical Distribution

2.3.1 Concrete Encased Duct Bank

(1) Concrete-encased conduits shall have minimum spacing between conduits as specified by NFPA 70 and UFC 3-550-01 with a minimum of 3 inches of concrete protecting them on top, bottom, and sides.

(2) The top of the concrete encasement shall be a minimum of 30” below finished grade.

(3) All concrete encased duct banks shall have a 1/0 bare copper counterpoise system installed immediately above the duct bank (6” or less) and continuous the length of the duct bank. Counterpoise shall be connected to a 3/4” x 10’ grounding electrode in each manhole and at each transformer and switching-station installation (including primary substations). Where duct bank terminates at a pole riser, counterpoise shall be connected to a 3/4” x 10’ grounding electrode and bonded to the pole grounding system.

2.3.2 Direct Buried Conduit

(1) For 600V and below, where direct buried service or feeder conduit is specified in the project documents, direct buried conduit shall be Schedule-80 PVC conduit a minimum of 30” below grade. Direct buried conduit supplying individual branch circuits, such as exterior lighting or power receptacles, may be Schedule 40 PVC conduit installed at a minimum depth of 24” below grade. All conduits shall be encased with sand and compacted prior to backfilling with other materials.

(2) When PVC is used underground, all conduit which extends from excavations to above finished grade shall be galvanized rigid conduit starting from minimum depth as specified and include the 90-degree elbow. All metallic conduit which contacts the earth shall have a Factory Applied PVC Coating. PVC tape may only be used to protect threaded areas and where adapting to PVC.

Exception: Fiberglass conduit may be used in lieu of PVC Coated GRC with 72ABW/CENMP approval for real property electrical systems or 76 MXSG/MXDEJ approval for non-real property electrical systems.

(3) High Density Polyethylene (HDPE) conduit may be utilized for approved Boring applications with prior written approval by 72ABW/CENMP for real property electrical systems or 76 MXSG/MXDEJ for non-real Property electrical systems.

2.3.3 Road/Driveway Crossing

(1) All utility road and driveway crossings shall be bored and sleeved with single schedule 80 PVC or 1/4”-wall steel sleeve. Roadways and driveways shall not be crossed by open cut unless approved. Wherever boring is impractical, street crossings shall be limited to three (3) days maximum (including trenching, compaction, and replacement of existing pavements). Contractor shall provide sufficient steel matting to carry the traffic load of the excavated area.

2.3.4 Marking

(1) All underground electrical and communication installations (conduit, duct bank, etc.) shall be identified using marking tape. Tape shall have the following characteristics:

(a) 5-mil plastic.
(b) Brightly colored (electric – red; communication – orange).
(c) Minimum 3-inch width.
(d) Suitably inscribed at not more than 10-feet on center.
(e) Continuous metallic backing and a corrosion resistant 1-mil metallic foil core to permit easy location of duct line.
(f) Tape shall be placed 12-inches below finished grade.

2.3.5 Open Conduits

(1) The open ends of all Underground Electrical Conduit being installed must be temporarily sealed at the end of each workday to prevent ground water or condensation from entering the conduit and associated electrical equipment.

2.3.6 Penetrations through Vapor Barrier

(1) Seal around conduits at penetrations thru vapor barrier. Use NECA NEIS 1 Table 2a (Minimum Raceway Spacing) to determine under floor slab conduit spacing unless greater spacing is required elsewhere, such as the project specifications.

2.4 Medium Voltage Distribution

2.4.1 General

(1) Install distribution conductors in underground ducts in lieu of direct burial and/or overhead.

(2) Air vacuum type switches are required in lieu of oil insulated. SF6 switches may be used in areas where equipment size is a concern with 72ABW/CENMP approval.

(3) All primary loop switches shall be equipped with Directional Fault Indication.

2.4.2 Primary Loop Feeders

(1) Medium voltage cable shall be (minimum) 15kV-500 kcmil copper, XLP/XLPE or EPR, with 100/133% insulation, wire shield or separator tape, and an ozone/sunlight resistant PVC jacket. Concentric neutral cable shall not be used.

(2) Grounding conductor shall be (minimum) 600V - #4/0 AWG copper.

(3) Conductors shall be protected by a (minimum) 5-inch diameter concrete-encased Schedule-40.

(4) Cables shall be routed and racked inside manhole to allow the longest possible length of spare cable in each manhole possible (minimum of 1 full loop around the interior of the manhole).

2.4.3 Primary Radial Feeders

(1) Medium voltage cable shall be (minimum) 15kV - #2 AWG copper, XLP/XLPE or EPR, with 100/133% insulation, wire shield, separator tape, and an ozone/sunlight resistant PVC jacket. Concentric neutral cable shall not be used.

(2) Grounding conductor shall be (minimum) 600V - #2 AWG.

(3) Conductors shall be protected by a minimum 5” diameter concrete-encased Schedule-40.

(4) Cables shall be routed and racked inside manhole to allow the longest possible length of spare cable in each manhole possible.

2.4.4 Medium Voltage Branch Circuits Installed Inside Buildings

(1) Medium Voltage Branch Circuits Installed Inside Buildings shall meet the following requirements.

(a) All Conductors shall be Class B compressed stranded copper.
(b) Conductor shield shall be 16 mils minimum extruded semi-conducting, thermosetting compound.
(c) Insulation shall be 220 mils average Extruded Ethylene Propylene Rubber.
(d) Insulation shield shall be 32mil minimum and 60 mils maximum extruded semi-conducting, thermosetting compound.
(e) Metallic Shield shall be 5 mil bare copper tape, helically applied with minimum 25% overlap.
(f) Galvanized Steel Interlocked Armor with overall 85 mil minimum average thick PVC Jacket.
(g) Aluminum Armor Jacket may be approved by 72ABW/CENMP on a case-by-case basis.

2.4.5 Medium Voltage Cable Terminations and Splices

(1) Terminations and splices shall be of the preformed type only, tape type is not acceptable.

(2) All cable splices and terminations shall be installed in accordance with the manufacturer’s specifications.

2.4.6 Medium Voltage Cable Testing

(1) Testing requirements shall be coordinated during design of each project.

(2) Approved testing methods are Hi-Pot and Very Low Frequency (VLF) High-Voltage testing.

(3) All new cable being hi-pot tested shall be in accordance with manufacturer’s recommendations, but not to exceed 3-times the cable voltage rating. Testing shall be performed in accordance with the methodology described in the applicable IEEE, ICEA, or AEIC standards.

(4) Existing cable being reused, or spliced into, shall be hi-pot tested at its rated insulation voltage. Testing shall be performed in accordance with the methodology described in the applicable IEEE, ICEA, or AEIC standards.

(5) Cable testing performed using VLF procedures shall be in accordance with IEEE Std. 400.2.

(6) All cable testing must be coordinated with the 72ABW/CE electric shop in advance.

(7) Cable test data and results shall be documented and signed by both the testing technician and the job supervisor. Copies of the test data/certification/results shall be submitted to 72ABW/CE for review and approval.

(8) For new construction, the recorded test data must be submitted to and approved by the Contracting Officer.

2.5 Low Voltage Distribution

(1) Conductors shall be 600V-rated copper, with thermoplastic insulation (unless specified otherwise on the design drawings or specifications).

(2) Conductors to be installed in wet locations must be UL listed for the application.

(3) Conductors shall be sized as appropriate for the application.

(4) New feeder conductors shall be installed without splices.

(5) Existing feeder conductors must be replaced in full when electrical distribution equipment and panels are required to be replaced or relocated.

Exception: Splicing of feeder conductors may be performed on a case-by-case basis with prior written approval at the design phase of the project by 72ABW/CENMP for real property electrical systems or 76 MXSG/MXDEJ for non-real property electrical systems.

2.6 Transformers

(1) New building transformers shall be either unit substation or fully enclosed pad mounted (in lieu of pole mounted).

(2) Unit substations: Based on existing site conditions and availability of medium-voltage feeders, transformers shall be either:

(a) Radial type fed with integral single, metal-enclosed, fused, load-interrupter switch.
(b) Loop-fed type with integral dual, metal-enclosed, fused, load-interrupter switches.
(c) Incoming section shall include surge arrestors.
(d) Outgoing sections shall be as specified in the project documents.
(e) Gear shall have copper bussing and windings.
(f) All unit substations shall be equipped with forced fan cooling, temperature monitoring with local alarm, and remote alarm capability. Power for cooling fans shall be integrally derived from the unit substation secondary power.

(3) Pad-mounted: Pad-mounted transformers shall meet the following criteria.

(a) Transformers shall be loop-feed type.
(b) Transformers shall be dead front type with separable load break connectors, surge arrestors, and parking bushings.
(c) Transformers shall have load break switches and primary fuses mounted inside the enclosure. Transformer fusing shall be oil-immersed, bayonet type, overload fuses in series with partial range current-limiting fuses. Fuses shall be interlocked with primary load break switches.
(d) Transformers shall have copper windings.
(e) Transformers shall have, as a minimum, four (4) 2.5% taps (2+, 2- nominal voltage).

(4) Each transformer shall be fed from a dedicated disconnect switch with overcurrent protection. The switch shall be located in the same general area as the equipment being served.

(5) Transformer primary feeders shall not be t-spliced into existing feeders in manholes or hand holes.

(6) The main primary feeder (12.47KV and larger) shall be concrete encased in underground duct bank.

(7) Transformer output voltage shall be verified at commissioning of system and load taps adjusted to provide voltage +/- 2.5% of nominal.

(8) Oil filled transformers shall utilize Mineral Insulating Oil per ASTM D3487-00 and shall be equipped with relief valves and, if pad mounted, a means of sampling the oil.

(9) Oil filled transformer installations shall comply with IEEE 979 regarding fire protection. Oil filled transformers may be physically separated from building surfaces or other oil filled transformers or may be separated by appropriate fire rated barriers. Space limitations may dictate the method of fire protection employed.

(10) Field-testing, pre-energizing, or manufacturer's field service report shall be required unless specifically stated in project definition.

2.7 Emergency/Standby Generators

(1) Emergency/standby power generators shall only be installed for facilities authorized by AFCEC as required by UFC 3-540-01, and AFMAN 32-1062, Chapter 3. No emergency or standby power generator shall be installed on TAFB without prior written approval from AFCEC.

(2) The following information shall be submitted to 72ABW/CENMP for approval of the following criteria prior to ordering or installing any generator on TAFB.

(a) A letter of justification, signed by the Commanding Officer of the submitting group, stating the applicable criteria which qualify the system to be supported by generator as listed in AFMAN 32-1062, Chapter 3. This letter of justification will be needed to facilitate the required formal request for approval from AFCEC.

(b) All generators shall comply with the requirements contained in AFMAN 32-1062 and UFC 3-540-01.

(c) All generators installed on TAFB must be manufactured by Cummins IAW AFCEC/CO Memorandum of Record dated 27 Jun 22.

(d) In addition, all generators shall be equipped with the following.

- Weather protective and sound attenuated enclosure.
- Engine block heater with thermostatic control.
- In-line fuel heater with thermostatic control.

(e) A design analysis shall be performed prior to the installation of any generator demonstrating sizing compliance with AFMAN 32-1062, whether new or replacement.

(f) Generator engines must be in compliance with all applicable regulations and permits (40 CFR 63, Subpart ZZZZ, 40 CFR 60, Subpart IIII, Title V Permit, etc.).

(g) Generator engines shall be equipped with a non-resettable runtime hour meter.

(h) Environmental approval of the engine emission must be received prior to ordering. Submittal approval by 72ABW/CEIE shall contain the following.

- Engine Manufacturer/Make/Model/Year.
- Engine Full Load Rating (not generator output).
- Engine Specific EPA Emissions Certification Data.

(i) Fuel storage tanks shall be double wall construction.
(j) Integral fuel-storage tanks shall provide 24 hours of service, based on maximum engine consumption.
(k) The contractor is responsible for providing adequate fuel to perform the manufacturer's commissioning, Gov't acceptance requirements, and shall turn over the generator to the Gov't with a full tank of fuel.

(3) Static Grounding of fuel tank shall comply with NFPA 30 and UFC 3-460-01, Design: Petroleum Fuel Facilities, paragraph 2-11.3.

(4) The one-line diagram for the emergency/standby power system shall be posted at the generator location.

(5) The one-line Diagram shall contain the following information.

(a) Generator Model #, Serial #, Voltage, and Size (KVA & KW).
(b) Transfer Switch Size (KVA & KW), Voltage Rating, Number of Poles, Open or Closed Transition, and Location of Transfer Switch (Bldg. & Room #), if not mounted locally at the generator.
(c) Normal Power Source (Bldg. #, Room #, Panel Name), Circuit Number, and Breaker Size.
(d) Emergency/standby power distribution Panel Identification and Location (Bldg. & Room #), if not mounted locally at the generator.
(e) Conductor Sizes (between Normal Power, Generator, Transfer Switch and Panels).

(6) Provide combination automatic transfer switches with integral manual bypass. All transfer switches shall be 4-pole with switched neutral for each permanent generator installation.

(7) Emergency/standby power generator installations shall be placed in existing equipment yards or provided with suitable enclosure (fenced yard) to hide from public view. Where suitable enclosure cannot be provided, generators shall be factory painted a base standard color as determined by 72ABW/CENMP Architects, which may not be a manufacturer's standard color.

(8) Provide a non-fused disconnect and 4-pole three-way Manual Transfer Switch (MTS) on the outside of the facility for portable generator connection when authorized by AFMAN 32-1062 and with prior written approval from 72ABW/CENMP.

(a) All MTSs shall be equipped with Cam-Lock style connectors for connection of Portable Generator (EAID).

- All Cam-Lok style connectors shall be rated at 200A.
- All Cam-Lok style Connectors shall be properly color coded for the generator application.
- For MTS rated 200A and below: Provide one (1) set of four (4) connectors for three phase and one (1) set of three (3) connectors for single phase with one (1) dedicated Cam-Lok style connection with properly sized EGC connector for individual cables IAW UFC 3-540-01.
- For MTS rated 200A to 600A: Provide parallel sets of Cam-Lok style connectors for individual cables IAW UFC 3-540-01 as required; up to three (3) sets of 4

connectors for three phase and three (3) sets of 3 connectors for single phase with one (1) dedicated Cam-Lok style connector with properly sized EGC per set.

(9) Permanently installed generators of all sizes shall be provided with the capability of connecting a load bank for generator full-load testing compliance.

(a) All Automatic Transfer Switches (ATS) shall be equipped with Cam-Lock style connectors between the Permanently Installed Generator and the ATS.

- All Cam-Lok style connectors shall be rated at 200A.
- All Cam-Lok style Connectors shall be properly color coded for the generator application.
- For ATS rated 1200A and below: The total load bank connection shall be rated at least 50% of rated ATS. Provide Cam-Lok style connection box for individual cables IAW UFC 3-540-01. Maximum shall be 3 sets of (12 connectors) for three phase and (9 connectors) for single phase with one (1) dedicated Cam-Lok style connector with properly sized EGC per set.
- For ATS rated more than 1200A: Provide one (1) Cam-Lok style connection box with three (3) sets of (12 connectors) for three phase and (9 connectors) for single phase and one (1) dedicated Cam-Lok style connection per set for EGC rated for 200A for individual cables IAW UFC 3-540-01.

2.8 Exterior Lighting – Parking Lot, Roadway, Fitness Trails, and Walking Paths

(1) Exterior lighting is a system that has direct and indirect impacts on the visual qualities of the base. During the day the fixtures and poles are visible. At night the light becomes dominant to signify safety and security and to enhance the visual character of the base. The use of consistent lighting components and the reduction of overhead utilities will help unify the base appearance.

(2) Keep mounting heights low to control spillover light near residential areas. Any lighting fixtures mounted over 30-feet high require special review by 72ABW/CENMP.

(3) Use only round aluminum or steel poles, taking into consideration the economics and aesthetics.

(4) All power and light poles, steel support structures and their foundations, shall be designed for NESC Heavy Loading District conditions and 100 mph wind loads on bare structure face.

(5) All New and Replacement High Mast Lighting Poles (60 feet and Taller) installed on TAFB shall be ABACUS Hydraulic Style.

(6) All parking/roadway lighting fixtures shall be supplied with Light Emitting Diode (LED) fixtures unless a written waiver from 72ABW/CENMP is obtained.

(a) LED Fixtures shall comply with current UFC 3-530-01 requirements.
(b) Color temperature shall be 4000K.

(7) Photoelectric controls with over-ride astronomical timers shall be used for energy conservation, unless specifically deleted in project requirements (such as for security lighting).

(a) All exterior building fixtures providing security illumination and at personnel entrances shall be equipped with integral motion sensor for 30% / 100% illumination control for energy conservation.

(8) Where a grounding electrode is specified to be installed at light poles, the connection of the bonding conductor at the grounding electrode, and at the concrete encased reinforcement of the base, shall be either exothermic weld process, or irreversible compression connector listed for the purpose. Mechanical lugs or connections shall not be allowed.

(9) A minimum of 100 hours of "Burn-in time" shall be performed before acceptance and final inspection.

3. Interior Electrical

3.1 General

(1) Riser and one-line diagrams show vertical and electrical relationships. Riser shall include voltage, amperage, and short circuit interrupting capacity at each transformer, switchboard, panelboard, and motor control center. Devices shall also indicate the room location they are installed.

(2) A framed One-Line Drawing shall be posted by the contractor in the Main Building Service room and/or any distribution switchgear room where new electrical equipment is installed, or modifications are made.

(3) All new electrical equipment shall be flush mounted unless noted otherwise in the design plans.

3.2 Grounding Requirements

(1) Provide 1/4" thick x 2" tall grounding bus bar in all electrical rooms/vaults for interconnection of panels, transformers, etc. to the main building grounding electrode system.

(2) All grounding electrodes shall be copper clad with a minimum size of 3/4" diameter x 10' long.

(a) The connection of the bonding conductor at the grounding electrode shall be either exothermic weld process, or irreversible compression connector listed for the purpose. Mechanical lugs or connections shall not be allowed.

(3) The Main Building Grounding Electrode Conductor (GEC) for new construction, and GEC for all switchgear associated with electrical vaults renovations, shall be identified with a military grade heat shrinkable Tyco TMS-SCE type wire identification sleeve for testing IAW AFI 32-1065.

(a) Where the GEC is concealed inside of a switchgear compartment and not readily accessible from the exterior, a permanent label shall be affixed to the compartment door where the GEC is terminated.

3.3 Interior Wiring System

3.3.1 General

(1) Each branch circuit shall be installed with a dedicated neutral conductor, if a neutral conductor is required.

(2) Junction box covers shall be clearly identified with the following information.

(a) Panelboard from which the power originates.
(b) Panelboard Circuit numbers.
(c) Voltage present within the junction box.

(3) All wiring devices (receptacles, switches, etc.) shall have a minimum rating of 20 amps.

(4) All wiring device cover plates shall be clearly identified with a Brady Label Maker, or equal, printer 1/4" tall, black characters on white or clear tape label, containing the following information.

(a) Panelboard from which the power originates.
(b) Panelboard Circuit number(s).

(5) Plug-Tail type receptacles are not allowed on TAFB.

(6) Combination receptacles with USB charger are not allowed on TAFB. Receptacles installed and/or included as a part of equipment (i.e. system/modular/executive furniture) are exempted from this requirement.

3.3.2 Raceways

(1) All power, communications, electronic safety and security systems, and controls wiring shall be installed in metallic raceway. Wiremold is a suitable metallic raceway for interior installations where surface mounting in finished spaces is required.

(2) Indoor medium-voltage (primary) wiring shall be in appropriately marked galvanized rigid metal conduit or cable tray.

(3) Secondary voltage wiring may be in galvanized rigid metal conduit, rigid aluminum conduit, or Electrical Metallic Tubing (EMT). Electrical Non-metallic Tubing (ENT) shall not be used.

(4) All metallic conduit fittings shall be Compression Type. No Set Screw fittings are allowed to be installed on TAFB.

(5) Flexible metal conduit (FMC) shall only be used for equipment connections (appliances, luminaries), and to fish into existing walls. FMC shall not be used for general wiring applications.

(6) Equipment that requires flexibility at connections, to include but not limited to motors and transformers, shall utilize liquid-tight flexible metal conduit (LFMC). LFMC used outdoors shall be listed and identified on the outer shield as "sun light resistant" or similar verbiage.

(7) When PVC is used underground, all conduits which extend from excavations above finished grade shall be galvanized rigid conduit, starting from minimum depth as specified and include the 90-degree elbow. All metallic conduit which contacts the earth shall have

a Factory Applied PVC Coating. PVC tape may only be used to protect threaded areas and where adapting to PVC.

Exception: Fiberglass conduit and 90-degree elbows may be used in lieu of PVC Coated GRC with prior written approval from 72ABW/CENMP for real property electrical systems or 76 MXSG/MXDEJ for non-real property electrical systems.

(8) No metal-clad cable, (Type MC), shall be permitted.

Exception: Metal Clad (MC) cable shall be allowed for Flexible Light Fixture Whips whether field installed or provided by the manufacturer with new luminaires. Exceptions must be approved by 72ABW/CENMP for real property electrical systems or 76 MXSG/MXDEJ for non-real property electrical systems.

(9) Raceways shall not be supported by suspended ceiling or suspended ceiling support wires. Only wires installed and approved per the NEC shall be permitted for supporting raceway.

(10) All raceways shall be concealed above ceiling, under floor, or in walls, except where noted on the design plans. No exposed raceways shall be permitted on exterior building surfaces without a Written Waiver of these requirements by 72ABW/CENMP.

(11) Where possible, raceways to roof mounted equipment shall be routed beneath the roof structure to a penetration immediately adjacent to the equipment.

(12) Exposed conduit on exterior of buildings and on roofs, where approved, shall be galvanized rigid conduit or rigid aluminum conduit. Exposed conduit on exterior walls shall be painted to match the building colors.

(a) All Exterior Conduit Fittings shall be Weatherproof Rated.
(b) The contractor must provide materials approved and suitable for roof applications.

(13) All raceway penetrations through established fire barriers shall be sealed with an approved fire stopping material.

(14) All unused conduit in renovated areas shall be removed to the source.

Exception: Conduit installed in concrete or masonry walls and underground may be abandoned in place with 72ABW/CENMP approval.

(15) Factory expansion fittings are required for conduit, cable tray, and bus duct when crossing building expansion joints or changes in temperature of greater than 25 degrees F from one area to the other. LTFMC may be used between Bus Duct tap boxes with prior design submittal review and written approval by 72ABW/CENMP for real property electrical systems or 76 MXSG/MXDEJ for non-real property electrical systems.

(16) Reinforced Thermosetting Resin Conduit may be used with 72ABW/CENMP or 76 MXSG/MXDEJ Approval.

3.3.3 Conductors

(1) Insulated conductors shall be copper, type THHN, unless otherwise specified on the design plans or as code requires.

(2) Insulated conductors to be installed in wet locations (i.e. below grade) shall be type THWN, THWN-2, XHHW, or an approved equal.

(3) Insulated conductors used for a new service mast or a new utility pole riser shall be identified on the outer insulation layer as “sunlight resistant”.

(4) Conductors shall be stranded for all sizes.

Exception: Branch circuit feeders for general purpose wiring #12 may be solid for ease of wiring device termination, however #12 stranded may be used for ease of installation, only if an approved crimp termination is used at the wiring device.

(5) All unused conductors in renovated areas shall be removed back to the source.

(6) All conductor testing shall be performed IAW ANSI/NETA ATS or ANSI/NETA MTS as applicable.

(a) Licensed Electricians shall perform all conductor testing IAW NETA Testing Standards.

3.3.4 Busways

(1) Grounding shall be integral type, utilizing the case of the busway as the equipment grounding conductor with approved splicing and joint construction.

(2) Neutral bus, where required, shall be rated at 100% of the current-carrying bus bar rating.

3.4 Transformers

3.4.1 General

(1) All transformers shall have copper bussing and windings. Transformers 75KVA and below may have aluminum windings if approved by 72ABW/CENMP or 76 MXSG/MXDEJ.

(2) Transformers shall have, as a minimum, four (4) 2.5% taps (2+, 2- nominal voltage).

(3) Transformers serving non-linear loads shall have appropriate K-factor rating.

3.4.1 Transformer installation

(1) Conductor sizing (primary and secondary) for new transformer installations shall be rated not less than 125% of the transformer rated current.

(2) All transformers shall have primary and secondary overcurrent protection sized per article 450 of the National Electrical Code.

(3) Where K-rated transformers are utilized. Neutral conductors shall be up-sized as required.

(4) Ventilation (distance from walls) shall be as specified by the manufacturer. Normally the recommended clearances are listed on the transformer data plate.

(5) Transformers shall be secured to floors using the four mounting holes provided by the manufacturer.

(6) All new raceway installations to/from new/existing transformers shall have insulated grounding bushings installed.

(7) There shall be no modification (i.e. drilling bigger holes) of connectors being used for conductor terminations to the transformer bushings.

(8) Connections to the MV primary bushings shall comprise of bronze bolts, bronze flat washers, bronze lock washers and bronze nuts. Bronze or cadmium bolts, flat washers, lock washers and nuts may be used on the secondary bushings.

(9) The bolts used to secure the MV cable terminations to the transformer bushing shall be of the same diameter as the manufactures hole in the transformer bushing.

(10) Conductor terminations for low voltage transformers (600 volts and less) shall be made utilizing compression style terminations.

(11) Conduit entries into transformer housings shall be made at the lower portion of the housing as indicated by the manufacturer to avoid excess heating of the primary and secondary conductors.

(12) All bolts used to secure the cable terminations to the transformer bushings shall be tightened to the torque specified for that particular diameter of bolt. Tightening shall be performed using a calibrated torque wrench. After tightening, each connection shall be marked per industry standards using a grease pen or permanent marker.

(13) All ground terminations secured to the transformer case shall have the factory paint removed prior to the installation of the ground lug. The diameter of the removed paint area shall exceed the mounting surface area of the termination to allow for inspection.

(14) All ground terminations secured to the transformer case shall comprise of a drilled hole (same diameter hole as in the ground lug), bronze bolt, bronze flat washer, bronze lock washer and bronze nut. Ventilation openings on the bottom of transformers shall not be used as bolt holes for the securing of any ground termination/bus.

(15) Bolts used to secure ground lugs to the transformer case shall be tightened to the torque specified for that particular diameter of bolt. Tightening shall be performed using a calibrated torque wrench. After tightening, each connection shall be marked per industry standards using a grease pen or permanent marker.

(16) Transformer output voltage shall be verified at commissioning of system and load taps adjusted to provide voltage ± 2% of nominal.

(17) All Transformers shall be installed with a primary disconnecting means at the transformer.

Exception: If the transformer is located in the same room as, or within sight of the feeder breaker, a local disconnecting means is not required.

3.4.2 Transformer Bonding

(1) Transformer bonding shall be completed in strict compliance with Article 250 of the NEC.

(2) Resistance readings shall be obtained, officially documented, and become a matter of record on all new grounding electrode system installations. This same requirement shall apply to any existing transformer installation to be altered/tapped due to new electrical design requirements.

(3) New transformer installations and existing transformers that have been altered or tapped shall not be energized until the grounding system has been inspected and approved by a government representative.

(4) All grounding electrode conductor (GEC) connections to grounding electrodes, building steel and metal bar joists shall comprise of the exothermic welding process or an approved irreversible compression connector listed for the purpose. Mechanical lugs shall only be allowed with waiver by 72ABW/CENMP or 76 MXSG/MXDEJ.

(5) All GEC connections to fire sprinkler piping, steam piping and water piping shall comprise of a pipe clamp listed for the purpose. Mechanical piping systems utilizing Victaulic connections shall not be used as a grounding electrode.

(6) All Bonding Conductors shall be stranded copper.

(7) Grounding conductor bonding terminations shall be made utilizing compression style terminations.

(8) The penetration for the GEC into the new/existing transformer shall comprise of listed bushings or metal fitted locknut. Drilling a hole or using the ventilation openings on the bottom of the transformer to install the new GEC shall not be allowed.

(9) As required for physical protection, the GEC shall be installed within a raceway. The raceway shall be either electrical metallic tubing (EMT) or rigid metal conduit (RMC). Grounding bushings shall be installed (on both ends) of the new raceway. PVC raceways shall not be used for the physical protection of a GEC.

(10) All transformers directly feeding distribution panels shall bond the neutral at the transformer X0 terminal and to building ground reference. Neutral buss bonding is also required at the first point of service in the building.

3.5 Panelboards, Switchboards, Safety Switches, Motor Control Centers

(1) Panelboards, switchboards, safety switches and motor control centers (MCCs) shall be provided with a dedicated space equal to the width and depth of the equipment and extending from the floor to a height of 6 feet above the equipment (per NEC) or to the structural ceiling, whichever is lower. No piping, ducts, or equipment foreign to the electrical installation shall be located in this space. Sprinkler protection shall be permitted if the electrical equipment is protected from water leakage.

(2) All Electrical Distribution Equipment serving outdoor electrical and mechanical equipment shall be provided with a properly sized Surge Protective Device (SPD).

(a) All Panelboards shall be Door-in-Door Construction.
(b) Both doors shall be equipped with lockable lever/handle.

(3) Each lockable device shall be provided with two keys.

(4) All electrical distribution equipment rated 1200amps and larger shall incorporate Arc Mitigating construction and/or other Arc Energy Mitigation techniques, such as Maintenance Switching with local status indicator, which meet the intent of NFPA 70 Art. 240.87.

(5) Every circuit and circuit modification shall be legibly identified as to its clear, evident, and specific purpose or use. The identification shall include sufficient detail to allow each circuit to be distinguished from all others.

(a) Circuits for panelboards shall be identified using a directory located inside the panel door (mounted behind a clear protective cover/holder). In addition, panelboard directories shall also indicate panel identifier (provided by 72ABW/CENMP), “Fed from” information, and the date of installation.
(b) A new typewritten panel schedule shall be supplied for any additions or modifications to the circuitry. Handwritten changes to the panel schedule are not acceptable.

(c) Circuits for switchboards and MCCs shall be identified using an engraved Laminated Plastic label at each switch position. In addition, switchboards and motor control centers shall also include an engraved Laminated Plastic label indicating switchboard/MCC identifier (provided by 72ABW/CENMP), “Fed from” information, and the date of installation.

(6) All replacement panelboards shall be identified using an engraved Laminated Plastic Nameplate.

(a) Equipment Nameplates shall be 1/4-in. thick x 2-in. tall x 5-in. wide custom engraved tile, laminated plastic, black nameplate with white letters, to include the following information.

- Equipment Name (3/8 in).
- UID Identification Name (1/8 in).

  Note: Only Replacement Panelboards require the UID name to be listed on the Laminated Plastic Nameplate. New Panelboards shall not include the UID # on the engraved nameplate.
- Voltage, Ampacity Rating and Type (1/8-in).
- Equipment AIC Rating (1/8-in).
- Feeder Source of Supply description and location (1/8 in).
- Installation Date MM/DD/YYYY (1/8 in).
- Mounting shall be made utilizing Stainless-Steel Screws or Stainless-Steel Pop-Rivets.
- Mounting holes shall be sealed with silicone rubber for exterior and damp applications.
- Example

PANEL “PP1”

UID Identification Name
480Y/277 VOLT, 30, 4W, 400A/3P MCB
18kAIC RATING
FED FROM MDP-12 IN ROOM E101
INSTALLED DD/MM/YYYY

(7) All new panelboards shall be equipped with a properly sized Molded Case Switch (MCS) if feeder conductors have proper over-current protection. A Main Circuit Breaker (MCB) is required when providing over-current protection for the secondary of a transformer or when the panel is fed from an overhead bus switch.

Exception: If the panelboard is located in the same room as, or within sight of, the feeder breaker, an MCB or MCS is not required.

(8) All new panelboards shall have copper buses.

(9) All new panelboards fed from K-rated transformers shall be rated for non-linear loads (200% neutral).

(10) All new panelboards and switchboards shall be supplied with 20% prepared spaces for future breakers, based on the maximum number of panel breaker spaces.

(11) Half-Size and Tandem Breakers are not allowed to be installed on TAFB without prior approval of 72 ABW/CENMP.

(12) A separate, listed grounding equipment bar kit (not bonded to the neutral bus) shall be provided in all new panelboards.

(13) All new panelboards shall contain provisions for bolt-on type branch circuit breakers or Square D I-Line style (by Schneider Electric).

(14) All new circuit breakers shall be bolt-on type. Exception shall be made for Square-D I-Line panels.

(15) The circuit breaker servicing any mechanical equipment being replaced which is older than ten (10) years must also be replaced or rebuilt and recertified, whichever costs less. A minimum of two spare 3/4" conduits shall be stubbed and capped off from each new flush mounted branch circuit panel to above ceiling and below accessible floor.

(16) All new safety switches shall be listed for heavy-duty (HD) use and NEMA rated in accordance with the application.

(17) Grounding conductor bonding terminations shall be made utilizing compression style terminations.

(18) All new conductor termination points in new panelboards, switchboards, safety switches and motor control centers shall have the bolts tightened to the torque specified on the label attached by the manufacturer within the equipment.

(19) All conduit fittings utilizing "Concentric Knock-outs" shall have grounding bushings installed for systems 250 volts or higher.

3.6 Motors and Motor Controls

(1) Premium efficiency motors shall be utilized for all applications 25 HP or larger.

(2) All motors controlled by an Adjustable Speed Drive (ASD) shall be Inverter Duty Rated.

(3) Provide phase loss relay for each motor 25 HP or larger in size. The phase loss relay shall be integral part of starter and shall NOT require a separate enclosure.

(4) Conductors for motors shall be sized in accordance with the NEC amperage x 125%, not the data plate full load amps.

Exception: HVAC equipment.

(5) Motor Conductor Terminations for all voltages of #6 conductors and smaller shall be made utilizing crimp-on style ring terminals with bolt, nut washers and lock washers. Proper insulating tape per NEIS motor terminations shall be used. Twist-On style terminations are not allowed. Motors with #4 or larger conductors may be made utilizing "Insul-Lug" style mechanical multi barrel lug. The size of the insulated lugs must be selected accordingly with the size of the conductor.

(6) Motor overloads (heaters) shall be sized utilizing the motor's nameplate full load amps and service factor.

(7) All ASDs shall be supplied with manual integral bypass for emergency operation in the event of an ASD failure. The Bypass shall be constructed so that the ASD may be safely serviced and/or repaired while the ASD bypass is energized.

(8) No Disconnecting Means shall be installed between an ASD and the Motor it controls.

3.7 Systems Furniture

The requirements listed below are the minimum for standard office furniture units. The term "system furniture" used below is applicable to cubical office furniture, demountable wall, furniture wall, and/or similar system/items.

(1) User organizations will be responsible for providing designer with the proposed new system furniture layout (scaled drawing) and specifications on the system furniture to be purchased. Design information shall include but not limited to, wiring (type and size), raceways (type and size), j-boxes (size, wall or ceiling mounted), volt amps and voltage of each unit for connection of the system furniture. Refer to NEC Handbook, Article 605 Office Furnishings.

(a) Modular Furniture units must be provided with 8-wire harness consisting of 3 circuit conductors, 3 neutral conductors and 2 separate equipment grounding conductors or 10-wire harness consisting of 4 circuit conductors, 4 neutral conductors and 2 separate equipment grounding conductors.

(b) New system furniture which has multi-wires or sharing neutral are prohibited to connect to facility/building power.

(2) Each "cubicle" (or walled office) shall be provided with one designated computer duplex isolated ground receptacle (Orange) on a separate circuit. Circuit may be shared among multiple cubicles or offices; however, never more than four (4) designated computer duplex receptacles will share a single circuit. For electrical calculation purposes, for update of an existing panelboard directory, or to construct a new panelboard directory, a load of 480 volt-amps (VA) shall be used for each computer duplex receptacle.

(3) Each cubicle (or renovated walled office) shall be provided with a minimum of two (2) additional general use duplex receptacles. Duplex receptacles may share a single circuit or be provided with separate circuits. Circuits may be shared among multiple cubicles; however, never more than Eight (8) duplex receptacles will share a single circuit. For electrical calculation purposes, for update of an existing panelboard directory, or to construct a new panelboard directory, a load of 180 VA shall be used for each of the eight duplex receptacles for circuit load calculations.

(4) All modular furniture receptacles shall have a minimum rating of 20 amps IAW 3.3.1 (c) above.

(5) Each circuit must have a separate neutral conductor. Where more than one neutral conductor terminates in a junction box, each neutral conductor shall be identified with its corresponding circuit number.

(6) Due to harmonics generated by computer power supplies, the neutral conductor shall be considered current carrying for all wire sizing (de-rating) calculations.

(7) If Systems Furniture power is provided by Tele-Power Pole, a label must be installed on the Tele-Power Pole IAW 3.3.1 (d) above

(8) Each Systems Furniture receptacle must have a label installed IAW 3.3.1 (d) above.

(9) Electrical receptacle shall not be installed in modular office furniture to support appliances of any kind, which is also applicable to cubical office furniture, demountable wall, furniture wall, and/or similar system/items furniture or partition wall panels.

(10) All new breakroom areas housing appliances (i.e. coffee makers, microwaves, refrigerators, etc.) are considered to be Real Property and must be permanently constructed.

3.8 Interior Lighting

3.8.1 General

(1) Illumination Levels - General illumination levels shall not exceed the intensities shown in the latest edition of UFC-3-530-01 Interior and Exterior Lighting and Controls. Where lighting intensities are not indicated in UFC-3-530-01, the IES Lighting Handbook shall be used.

(2) Lighting shall be installed using 277V where available.

(3) Overhead lighting fixtures for buildings (interior lighting) shall comply with design requirements of UFC 4-010-01, paragraphs 3-16 and 3-20, antiterrorism provisions.

(4) Provide luminaire supports that are independent of the ceiling system and ceiling supports for suspended or grid ceilings. Attach safety and seismic supports for luminaires to main structure, concrete or steel floor deck, beams, columns, etc. Safety supports for luminaire components, such as reflectors, may be attached to the luminaire itself.

(5) Flexible Light Fixture Whips, whether provided by the fixture manufacturer or by the contractor, are required to be 3/8” flexible metallic conduit or MC cable with approved fittings.

(6) Fixture whips must be supported independently of the ceiling grid. Coiling of the fixture whip and placing on top of the fixture is not permitted.

(7) Test instruments used to measure both normal and emergency illumination levels shall contain a current calibration sticker that indicates the current calibration date and the date due for the next calibration.

(8) Emergency Lighting:

(a) Emergency lighting must be provided in accordance with latest edition of NFPA 101.
(b) Emergency lighting is required along paths of egress.
(c) Emergency battery backup shall be provided in all lighting fixtures in mechanical and electrical equipment rooms.
(d) Emergency lighting shall be provided in interior windowless conference rooms, classrooms, and large office areas.
(e) All Emergency lighting fixtures installed in High Bay Areas (higher than 10’ A.F.F.) must be provided with a remote test switch installed @ 6’ A.F.F. A Single Remote Test Switch shall be installed for all Emergency lighting fixtures serving a specified area.

(f) Twin head “lunchbox” style light fixtures shall not be used.

Exception: Use of lunchbox style fixtures in warehouses and manufacturing areas may be approved on a case-by-case basis by 72ABW/CENMP or 76 MXSG/MXDEJ.

(g) All new emergency light installation testing shall be witnessed as outlined in NFPA 101. The test shall comprise of turning off the branch circuit and allowing the emergency lights to burn for at least 90 minutes. Illumination level readings shall be taken during and at the end of the test. The illumination level readings shall comply with NFPA 101. The test results shall be documented and become a matter of official record.

(h) Emergency/exit lighting ballasts/batteries shall include self-testing/self-diagnostic features, which meet the requirements of NFPA 101 for testing. Ballasts shall include an indicator light and audible alarm to indicate battery/charger status and test results.

(i) All exit light fixtures shall be of the diffused LED type with red lettering and have emergency battery backup, and self-diagnostic feature.

(j) Where a single bank battery UPS style “emergency lighting system” is used, the requirement for a self-contained diagnostics and individual battery packs in (g) and/or (h) of this section will be waived. The emergency lighting system shall be required to have a diagnostic feature.

3.8.2 Lighting Fixture Requirements

(1) All new high bay lighting shall be provided by Light Emitting Diode (LED) fixtures or as specified in the Statement of Work for each project. LED Fixtures shall comply with current UFC 3-530-01 requirements.

(2) All High Bay Lighting Fixtures shall be equipped and installed utilizing flexible cord w/ twist locking style plug and receptacle.

(3) All new lighting for general office areas, classrooms, corridors, conference rooms, and lobbies shall be provided by Light Emitting Diode (LED) fixtures or as specified in the Statement of Work for each project. LED Fixtures shall comply with current UFC 3-530-01 requirements.

(4) All LED lighting color temperature shall be 4000K, or as specified in the Statement of Work for each project.

(5) Manufacturer’s Published Photometric Data shall be used for lighting calculations.

(6) Fluorescent fixtures may be installed for renovation projects to match surrounding area fixtures with a written waiver from 72ABW/CENMP or 76 MXSG/MXDEJ. If approved, fluorescent fixtures shall use T-5 or T-8 lamps, electronic ballast with high power factor (greater than .9) and low harmonic distortion (less than 10%).

(7) Acrylic lens shall be a minimum .156 inches thick.

(8) For energy efficient interior lighting schemes, lighting systems should be designed to allow reduction of lighting levels by appropriately banking lighting circuits. Dual Technology Motion Detection sensors shall be used for lighting controls in restrooms, storage rooms, office areas, hallways and warehouses.

(9) Any proposed Wireless Lighting Control Systems must be submitted to the 72ABW/SC Spectrum group for review and approval prior to including in the project design.

(10) Consideration should also be given for any task lighting that might be provided by systems furniture, and overhead lighting should be reduced accordingly.

(11) An un-switched lighting circuit phase conductor shall be provided and installed to serve self-contained emergency battery packs in new fixtures installed or where these units are shown to be installed in existing fixtures. This un-switched phase conductor shall be on the same lighting branch circuit serving switched lamps and installed in existing lighting branch circuit conduit system.

3.9 Communications/LAN

(1) All Communication/LAN Room construction and Cable installations shall comply with the latest version of the 72 ABW/SC COMM.RM-STANDARD.

(2) The User and/or the Facility Manager must submit a CIPS request to 72 ABW/SC for any installation or demolition of cabling and connections to the Communications Equipment.

4. Fire Protection

All Fire Alarm and Mass Notification must comply with the latest version of the Tinker Air Force Base Fire Protection Standard.

5. Intrusion Detection Systems (IDS)

(1) Intrusion Detection will be designed and installed in accordance with the most current version of ICD/ICS 705-1, UFC 4-021-02, DOD 5200.1-R, AFI 31-101, NFPA 731, NFPA 70, and UFC 4-010-05.

(a) All materials must be listed in the current approved CMD Equipment List.

(2) Only Honeywell Vindicator model VPC shall be installed on TAFB. PL4 level Vindicator systems shall be provided with Fiber Media converter for communication with the Base Security Monitoring System. PL1 – PL3 level, SAPF, and SCIF systems shall be provided with a base approved switch at site and SFP Module at head end for communication with the Base Security Monitoring System.

(3) Intrusion Security Systems maps shall show device locations, point numbers and shall be configured for use in the VAC, VSC, and the VCC. Each map will be sized appropriately for each device.

(a) All VCC sites will then be updated on the Global Tinker System.

(4) And Intrusion Security Systems Riser diagram shall show all devices with room number (and address if addressable) for each device included.

(5) The system will have tamper switches on all devices that would disable the detection device which will transmit all tamper alarms to the Base Security Forces.

(6) Circuit conductors for Intrusion Detection Systems shall be stranded #22 AWG and 18/2 AWG for power provided to all accessory devices.

(7) Circuit conductors for new Intrusion Detection Systems installation shall be installed without splices and joints. It shall be allowed to install pull boxes as necessary and as required by code, however, the pull boxes shall only be used for conductor pulling purposes and not for the splicing or joining of conductor.

(a) All splices or joining of conductors shall be made utilizing crimp style connections.

(8) All IDS field system devices are required to have resistors packs installed at IDS device. Stage devices can utilize a single resistor.

(9) All IDS projects must have a kickoff meeting with Security Forces, Alarm Shop, and User prior to construction to review all prints and approved codes for current job.

(10) Device info for programming and Alarm Point Range will be given on site after kickoff meeting has taken place.

(11) All testing requires 48-hour prior notice.

(a) Contractor must complete all pre-testing before scheduling alarm test with SFS, Alarm Shop, and User. – Test plan shall be submitted at this time.
(b) All alarm points will be tested.
(c) 24-hour Battery Test.
(d) 72 HOUR Burn In.
(e) Completion Paperwork and As-Builts must be turned over upon acceptance.

6. Lightning Protection Systems (LPS)

6.1 General

(1) LPS shall be installed IAW UFC 3-575-01, AFMAN 32-1065, and NFPA 780 whichever is more restrictive.

(2) Provide dedicated grounding electrode for each down conductor.

(a) Each down conductor grounding electrode must be bonded to the building grounding system.
(b) Provide Test Well at each down conductor termination, but no farther apart than 200 feet. Test wells for hangar door spans may be located on each side of the hangar door.

(3) All LPS grounding electrodes shall be bonded to facility grounding electrodes (i.e. service entrance grounding electrode or facility ground ring/loop).

(4) Bonding of conductors and grounding electrodes to facility grounding electrodes shall be below grade.

(5) All connectors shall be high compression or exothermic-weld type connectors except the connections to air terminals.

(6) Provide 2/0 AWG bare copper down conductors for any structure exceeding 75 feet (23m)

6.2 Design and shop drawing submittal

Dedicated sheet(s) shall be provided for LPS. Provide overall LPS layout which should include all LPS components, i.e., air terminal(s), test well(s), SPD(s) location, grounding system, etc.

7. Cathodic Protection

(1) All metallic structures installed underground (i.e. piping, valves, underground storage tanks, etc.) or in contact with the ground (i.e. above ground storage tanks) shall have cathodic protection (CP) for control of corrosion.

(2) Design and installation of CP systems shall be in accordance with UFC 3-570-01, Cathodic Protection, and UFC 3-570-06, Operation and Maintenance: Cathodic Protection Systems.

(3) CP requirements development, pre-design surveys, system designs, and acceptance surveys must be accomplished under the supervision of a NACE International certified Corrosion Specialist or Cathodic Protection Specialist with a minimum of five years of experience in the applicable CP system being designed.

(4) CP design shall be a complete design and not a performance specification.

(5) General soil conditions at Tinker AFB are very conducive to corrosion of underground metal structures.

(a) The soil varies from sandy silt to sandy clay with areas of stratification of the various types.
(b) Soil resistivity varies from a high of 26,100 ohm-cm to a low of 529 ohm-cm. soil resistivity data available at the base.
(c) Designer shall take readings at the locations of structures and paths of utilities having cathodic protection.
(d) Design analysis shall contain a map showing the sites of such readings, type of instrument used and a table containing location designation and soil resistivity.