CHAPTER 12
ELECTRICAL CRITERIA

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CHAPTER 12
ELECTRICAL CRITERIA

1. GENERAL. The criteria presented in this chapter is intended to assist the designer in preparing a design that meets the user requirements for a professionally designed electrical system that:

a. Insures compliance with minimum standards.

b. Provides a safe, reliable, and maintainable system.

c. Assures a durable system.

d. Includes provisions for growth.

e. Assures energy conscious design. Refer to Chapter 11 for energy conservation guidelines that impact the electrical design, particularly selection of motors and lighting methods.

f. Achieves this design in an economical manner.

g. Assures an aesthetically pleasing installation.

2. SPECIFICATIONS. The policy and procedures for preparation of the technical clauses of construction specifications for military construction is set forth in ER 1110-345-700 (reference 12-1). Equipment and materials will conform to the Corps of Engineers guide specifications (CEGS) and commercial standards as promulgated by such organizations as the Underwriters' Laboratories, Inc.; National Electrical Manufacturers Association; Institute of Electrical and Electronic Engineers; and American National Standards Institute.

3. SPACE CRITERIA.

a. Equipment Space Allocation. Facility designs will provide dedicated space for the housing of electrical and electronic/communications equipment and components. Electrical and electronic/communications equipment rooms and closets, as appropriate, will be provided separately from spaces used to house mechanical and other non-electrical and non-electronic equipment and components.

b. Space Conditioning. Electrical and electronic/communications equipment rooms and closets will be provided with the environmental air quality necessary to maintain proper temperature and, where necessary, relative humidity levels required for the safe and effective operation of the equipment to be housed therein without deterioration of that equipment. Where rated ambient temperatures cannot be economically controlled within the equipment ratings, and no heat-related damage to the equipment will result if equipment were derated, such equipment may be derated where it is more economical to do so, as opposed to providing such temperature limitations. Where it is not economically feasible to maintain relative humidity levels within the ratings of equipment, and moisture-related damage to the equipment will otherwise result, such equipment will be installed in another location within the facility where such levels are already available. In general, electrical rooms will normally require ventilation, while electronic/communications rooms will require heat and/or air conditioning.

c. Clearances. Clear space will be provided around electrical switchboards, panel boards, transformers, switches, and controllers, electronic consoles, equipment, and other items, for normal maintenance and operation as required by NFPA 70, National Electrical Code (reference 12-2). Clearances will be maintained from the floor to the bottom of wall-or ceiling-mounted equipment, such as annunciators, clocks, and lighting fixtures, so as not to

interfere with the passage of personnel or equipment. Panel boards and cabinets located in narrow corridors or passages will be recessed when practicable.

d. Accessibility. All junction boxes, pull boxes, and similar points will be accessible. Clearly identified access panels will be provided as necessary for the proper maintenance and operation of the electrical distribution system when wiring runs are above ceilings or corridors, or in pipe chases or in trenches.

4. EXTERIOR ELECTRICAL.

a. General. TM 5-811-1, Electrical Power Supply and Distribution (reference 12-3), provides baseline design criteria, standards, policy and guidance for the design of electrical power supply and distribution systems. Designs will be compatible with existing construction provided this does not conflict with criteria, standards and policy in TM 5-811-1. For Army projects the power procurement engineer at the Corps of Engineers Center for Public Works (CECPW-C, telephone number 703-355-7362) will be contacted regarding power procurement requirements, regulations and standards.

b. Codes and Standards. Electrical systems and installation requirements will adhere to the current editions of ANSI C2, National Electrical Safety Code (reference 12-4), and NFPA 70, National Electric Code. In addition, transformers will be installed in accordance with the guidance provided in MIL-HDBK 1008A, Fire Protection for Facilities (reference 12-5).

c. External Appearance and Location. Electrical service and copper and fiber optic communications cables will be in keeping with the character and function of the building. Underground service will be provided to those buildings on an installation when overhead service would conflict with the desired architectural effect; to avoid interference with overhead equipment, such as cranes; or when the building service exceeds 600 volts. Transformers, substations, poles, meters, and other electrical equipment will be located such that they do not detract from the appearance of the facility, particularly a nonindustrial facility. When necessary, architectural screening may be used to provide a pleasing appearance, but the screening must assure no loss in the equipment efficiency. Electrical equipment will be mounted to the windward side of water spray or heat-producing mechanical equipment, such as cooling towers, evaporators condensers, and air-cooled condensers.

d. Distribution Systems. The siting of distribution lines shall conform to the guidance provided in Chapter 3 of this Instruction. When practicable, overhead electrical distribution lines will be located along roads and streets. New distribution systems and extensions of existing systems will provide for the proper coordination of protective devices. Coordination studies are part of the design analysis. Refer to TM 5-811-14, Coordinated Power Systems Protection (reference 12-6), for guidance on protective coordination studies and the selection of protective devices.

e. Transformers. TM 5-811-1 discusses the policy, guidance and application of transformers. Power transformers normally will not be installed within buildings unless the size of the loads and length of the secondary feeders would make the arrangement advantageous. Air-cooled transformers may be installed in adequately ventilated spaces where required. Transformers will be selected such that the combination of no load, partial load, and full load losses is minimized without compromising the electrical system. Transformers should not be sized larger than 10-25% more than calculated loads.

f. Copper and Fiber Optic Communications Cables. Follow the provisions of the ANSI C2, National Electrical Safety Code, in terms of grounding, protective requirements, clearances and separation requirements for overhead and underground installations of electric lines and copper and fiber optic communications cables.

g. UMCS/EMCS Interface with Electrical Supply. Connections for monitoring electrical consumption (both post-wide and individual building) will be in accordance with TM 5-815-2 (reference 12-7).

h. Metering. Enclosed meter sockets will be provided for each building having a connected load of 250kVA or greater to permit check metering. See the Energy Conservation Criteria chapter of this document for other metering requirements. Refer to the Family Housing AEI for metering requirements for family housing units.

5. INTERIOR ELECTRICAL DISTRIBUTION.

a. Codes. Electric lighting and power systems within buildings and facilities will be installed according to the latest revisions to the applicable National Fire Protection Association (NFPA) Codes. Electrical floor plans will either show the locations of fire walls or reference the contract drawings which identify the firewall locations.

b. System Characteristics. System characteristics will provide for the most economical and efficient distribution of energy.

(1) Frequencies. Where other than 60 Hz power is supplied, for example 50 Hz, the frequency supplied will be used where practical. Where frequencies other than that locally available are required for technical purposes, frequency conversion equipment may be provided, or if economically justified, generation equipment may be installed. Such equipment normally will be provided by the user of the facility.

(2) Voltages. Voltages will be of the highest order consistent with the load served. Single-phase 120/240 or three-phase 120/208-Y volt systems will generally be used to serve combined incandescent and fluorescent, high-intensity discharge lighting, and small power loads. Where practical and economically feasible, a three-phase 277/480-Y volt system will be used. Other voltages may be used where required. The neutral conductor of all distribution systems operating at phase-to-phase voltages of 600 volts or less will be solidly grounded, except where ungrounded-neutral systems are required by the NEC or other applicable criteria. Delta-connected systems with the mid-point of one phase grounded will not be used except as specifically authorized by the Using Agency on an individual project basis.

(3) Normal Source Systems. Normal source systems will consist of radial distribution configurations consisting of a single transformer for each building or group of buildings for loads of 500 kVA or less at 208 volts, or 2,000 kVA or less at 480 volts. An economic analysis will be provided for 208-volt systems larger than 500 kVA or serving motors larger than 18.7 kW (25 horsepower). For facilities having loads in excess of the above, secondary-selective configurations, consisting of double-ended transformer installations with normally open, interlocked bus-ties will be used. In such instances, each transformer of the double-ended system will be sized to serve approximately 60 to 80 percent of the total demand load served.

(4) Services. The service entrance location will be coordinated with the exterior distribution system to ensure that service and feeder circuit lengths are as short as practicable. Multiple service disconnects will be avoided, except where major economies can be realized in large capacity services or where multiple service voltage requirements exist.

(5) Transformers. Distribution-class transformers used for facility power supply will normally be located exterior to such facilities. Criteria for exterior transformer installations are given in the EXTERIOR ELECTRICAL paragraph of this chapter. Distribution-class transformers may be located within large buildings at centers of load to avoid long low-voltage feeders and to attain a more economical installation. Transformers will not be designed to be normally operated in parallel, without a detailed justification. Interior transformers having a primary voltage of 600 volts or less, for the supply of lower voltages, will be of the ventilated-dry-type and will not exceed 500 kVA capacity.

(6) Nonlinear Loads. The increasing presence of solid state switching mode power supply components in electrical equipment requires the designer to consider the equipment to be supplied by the distribution system and to make provisions for nonlinear loads. These loads generate harmonics which can overload conventionally-sized

conductors or equipment causing safety hazards and premature failures. Typical design approaches include separation of different load types, over sizing of neutral conductors and buses, and the use of isolation or k-rated transformers or line filters. Instrumentation and protective devices employed on circuits carrying nonlinear loads must employ true RMS sensing.

c. System Reliability. The interior distribution system must be designed to provide the reliability required by the facility mission. An analysis must be performed in conjunction with the exterior electrical design and will require effective communication with the Using Agency. Some specific loads within the facility may require a higher degree of reliability, such as life safety or critical mission systems. Methods of improving interior reliability include alternate power sources, multiple feeders and double-ended switchgear.

d. Interior/Exterior Transitions. Transitions between interior and exterior electrical work is an area of potential contractual ambiguity. The specifications must be clearly edited and sometimes supplemented to describe the applicable methods. Drawing details are frequently necessary for sufficient clarity.

e. Surge Protection.

(1) In some locations, power spikes from lightning surges, utility switching operations or other sources may require the use of surge protection at the facility service. Some users, such as the Air Force, require this protection as a standard policy.

(2) Surges can also emanate from sources within the facility. In new facilities, these sources may be part of the original construction contract or User equipment installed after facility turnover. The designer must coordinate with the User to identify these sources and then provide a design that protects the rest of the distribution system from these sources.

f. Design Analysis. The design analysis of electrical systems will show all calculations used in determining capacities of electrical systems. Methods and tabulations used in sizing conductors, conduit, protective devices, trip ratings, battery systems and other equipment required to complete a system will be included. All calculations will be clearly shown so that any changes that become necessary may be made efficiently. When tables used in the design are taken from publications, the title, source, and date of the publication will be plainly indicated. The model number and manufacturer of each major piece of equipment on which space allocations are determined will be indicated in the analysis.

g. Motors.

(1) Generally, motors of more than 0.37 kW (1/2 horsepower) rating will be polyphase when such service is available. Smaller motors will be single-phase. Motors with a starting current that will cause more than a 30% transient voltage dip will have reduced-voltage or current-limiting controllers.

(2) Motors will have efficiencies not less than indicated in CEGS-16415. These efficiencies are intended to comply with Department of Energy requirements whenever non-proprietary products are available. Some users may require motor efficiencies higher than those in CEGS-16415 in order to meet their base-wide energy consumption guidelines. It is necessary to coordinate with the User on this issue throughout the design process.

(3) The selection of motors and motor controls should be done in a systemic manner, with consideration of the overall efficiency of the system. This requires coordination with the mechanical or other discipline designers who are selecting equipment that is motor-driven or equipped. In general, if a mechanical system specifies an overall efficiency requirement, compliance with that overall requirement removes the necessity for individual motors within that system to comply with the efficiency guidelines of CEGS-16415.

(4) Multi-speed motors or adjustable speed drive (ASD) controlled motors may be energy saving approaches for some applications. New technologies should be considered, but an accurate analysis is needed to predict actual energy savings. For example, in the case of ASD driven motors, the analysis should recognize that system efficiency might be significantly reduced due to harmonics and losses within the drive, particularly at lower speeds. The specifics of the application are critical to the selection process.

(5) Power factor correction will be employed when economically justified.

h. Environment. It is necessary to coordinate with other designers to assure that electrical equipment is provided a suitable environment for reliable operation and normal life expectancy. Key factors are cleanliness, temperature and moisture.

i. Wiring.

(1) General. In general, wiring will consist of insulated conductors installed in Rigid Steel (RS) conduit, Intermediate Metal Conduit (IMC), Electrical Metallic Tubing (EMT), or nonmetallic conduit and tubing or of suitable cable systems. Aluminum conduit will not be used underground or embedded in concrete or masonry. The use of electrical nonmetallic tubing and boxes is permitted in accordance with the National Electrical Code limitations. Metal-enclosed feeder or plug-in busways or surface metal raceways may be used when required. Flexible metallic armored or nonmetallic sheathed cables may be provided for concealed branch circuits installed in areas not subject to mechanical injury in frame and hollow block construction above finished grade. The wiring methods permitted in various parts of the facility must be clearly identified on the contract drawings. Conductors will be copper, except that aluminum is permitted to be used in sizes equivalent to No. 6 AWG copper and larger, as allowed by the National Electrical Code. Some Users may have justifications for exclusion of aluminum conductors, based on their local experience.

(2) Ducting and Cabling System. Under floor ducts or overhead raceways for electrical wiring and information systems cabling will be provided in administrative facilities with requirements too extensive to be served by wall outlets. The ducts or raceways will also be sized to accommodate installation of fiber optic cable between the main distribution frame, all intermediate distribution frames, and telephone closets. Under floor electrical ducts or raceways or raised floors will be used in electronic data processing (EDP) or automated data processing (ADP) machine rooms, in research facilities and other similar areas when anticipated changes or large equipment requirements can justify their use.

(3) Prewired Work Stations. In projects using prewired work stations, it is critical to coordinate early in the design process with the architectural designer and the User concerning the necessary electrical characteristics of the work station wiring systems. In order to facilitate a non-proprietary procurement of work stations, it may be necessary to provide alternative electrical distribution schemes to match the various methods used in potential suppliers' manufactured products. Points of service to the work stations must be similarly addressed.

j. Hazardous Locations. Project construction drawings will outline the extent of each hazardous location, describing the applicable vertical and horizontal limits of the hazards and identifying each hazardous location by NEC Class, Division and Group. Designation of either specific maximum operating temperatures of equipment or temperature ranges will also be indicated. Every effort will be made to locate electrical equipment in nonhazardous areas of facilities having hazardous locations.

6. COORDINATED POWER SYSTEM PROTECTION.

a. Criteria. The distribution system requires short circuit calculations to assure proper bracing of equipment and analysis to assure proper coordination of protective devices. These analyses are to be performed in accordance with TM 5-811-14 Coordinated Power Systems Protection.

b. Analysis Requirements. The analysis requirements vary with each project according to the system voltage level, power system grounding scheme and the number and type of protective devices to be provided by the project. It is important to discuss design goals with the User to establish facility priorities and preferences. Some of the situations requiring studies are:

(1) Where new facilities requiring protective devices are to be installed.

(2) When the available short-circuit current from the power supply is increased.

(3) Where new sources of short-circuit current are added such as generators or synchronous motors.

(4) When new large loads are added.

(5) When existing equipment is replaced with larger equipment or with equipment which has a significantly different impedance characteristics.

(6) When protective devices are being upgraded.

c. Maximum Calculated Short Circuit Current Values. Maximum calculated short circuit current values are used for selecting interrupting devices of adequate short circuit rating, to check the ability of components of the system to withstand mechanical and thermal stresses and to determine the time current coordination of protective relays. Minimum calculated short-circuit current values are used to establish the required sensitivity of protective relays.

d. Desired Envelope of Coordination. The desired envelope of coordination for which the contractor is to be responsible must be shown on the drawings. Special coordination requirements should be noted. Some of these requirements might be protective devices which should trip first or mission critical elements which should only trip during specified extreme circumstances. Situations where complete coordination is not achievable due to device limitations must be noted on the drawings.

e. Contract Documents. The contract documents must include the information necessary for the contractor to perform the studies. This information includes: the single-line diagram of the system; system voltage characteristics; source available fault capacity (MVA) and impedance at an indicated location; X/R ratio of existing system equipment; identification of the existing source protective devices (manufacturer, model, configurations, ratings, settings, CT ratios).

f. Contract Specifications. The contract specifications must be edited to include only those calculations which are meaningful. Delete the requirement for submission of line-ground maximum and minimum short-circuit calculations for solidly-grounded and impedance-grounded systems unless coordination of protective devices under a ground relay is desired to provide selective tripping or protection for arcing faults is desired.

7. POWER SUPPLY.

a. Primary Power Source. Normally the source of electrical power will be the commercial power company. The purchasing, metering and characteristics of the electrical supply will be in accordance with AR 420-49, Facility Engineering Utility Services (reference 12-8), and with the criteria in Chapter 11 of this Instruction. Under special circumstances, such as lack of a commercial power source, National Security requirements, or where justified by cost analysis, prime power may supplied by an alternative power source. The engineering data and criteria for designing electric power plants is found in TM 5-811-6, Electric Power Plant Design (reference 12-9). Capacity of the power source shall be for 100% of the demand load. Spare capacity for a minimum of 10% load growth will be

provided. The design of the power supply will ensure maximum continuity of operation, especially for primary mission requirements. Reliability and availability requirements of the power system will be analyzed and design tradeoffs made to determine the optimum equipment configuration. The use of dual utility feeds versus a single utility feed and standby generators will be analyzed to determine if this approach would be cost effective and meet mission requirements. Provisions will be made for maintenance needs and for connections to portable generators where required.

(1) Total Energy (TE) Systems. When the standby power requirements of any new facility or complex exceed 70% of the total power requirement and the standby power is redundant, a detailed study will be made to determine if it would be more economical to provide 100% standby and a TE system. Such systems will be provided if economical. A realistic review will also be made of the long-term availability of electric energy in the area of the proposed construction. The Federal Energy Regulatory Commission will be consulted regarding the availability of electric power in any particular area. Consideration should be given to TE for major additions and alterations of existing facilities or complexes that operate 24 hours per day and use large amounts of electric power.

(2) Selective Energy (SE) System. In any area where gaseous or liquid fuels are economical in relation to electric energy, where there may be a question regarding the reserves of the commercial source, or where natural disasters such as high winds, ice and sleet, or seismic events are severe threats to power continuity, a study will be made to determine whether the critical load requirements should be served by a SE system with the remainder of the facility served by a commercial source. The selected system will be based on the results of the study.

b. Alternate Power Sources. Alternate power sources consist of prime-mover-driven electric power generators (including gas, diesel, steam, or wind), photovoltaic systems, or batteries. The type of source selected will be based on the economics, feasibility, and requirements of the application. Spare generator sets, fixed or portable, are not authorized for backup to alternate power sources. Refer to Chapter 11 of this Instruction for the special studies, which must be conducted to determine if wind or photovoltaic systems can be used.

(1) Authorized Locations. Refer to AR 420-49 for applications where alternate power sources are authorized. Loads served by alternate power sources will be limited to those required to directly support essential or mission-critical equipment, illumination, environmental control, safety, alarm, shutdown and start up equipment necessary for mission accomplishment.

(2) Other Applications of Alternate Power Sources. Every effort will be made to utilize alternate power sources to save energy and decrease electric costs. A detailed analysis will be conducted to determine the cost effectiveness and practicability of the application.

(3) Load Consolidation. Loads within different structures or at various locations will be consolidated so as to be served by the same alternate power source when practicable. When existing alternate power sources are to be replaced for such reasons as age or insufficient capacity or when mission changes result in an emergency load decrease beyond 50% of the initial requirement upon which the alternate source capacity for that mission was based, load consolidation will be done provided it is cost effective and practicable. The practicability of load consolidation will be based upon a survey of all emergency loads and other alternate sources in the immediate area of the affected sources. When load consolidation is practicable, excess alternate power sources will be removed. When load consolidation is not practicable, alternate power source capacity will be appropriately reduced.

(4) Battery Rooms. Battery rooms (or rooms or areas in which batteries are charged) will be provided with ventilation sufficient to prevent the accumulation of over 2% gaseous hydrogen by volume. Battery rooms will not be located in hazardous areas and will not require hazardous location wiring or equipment.

c. Code Required Alternate or Emergency Power Systems. Refer to NFPA 70, National Electrical Code, for requirements of emergency systems required to provide electric power when the normal source of power is interrupted. For further information regarding the performance of emergency and standby power systems refer to NFPA 110, Emergency and Standby Power Systems (reference 12-10).

d. Applications. Every effort shall be made to utilize alternate power sources, where practical, to save energy and reduce costs. Techniques which may be considered include peak shaving (demand limiting), co-generation, and interrupted power and other demand side management programs. Close coordination with the utility company is required where there is any possibility that the alternate power source may be paralleled with the utility power source, even for a very short time. A detailed and comprehensive analysis must be conducted to determine the feasibility of using one of these approaches. This analysis shall include, but not necessarily be limited to, a determination as to:

(1) Whether or not use of the alternative power equipment for these types of applications is consistent with the mission of the facility.

(2) The availability of operations and maintenance personnel.

(3) Life cycle costs.

(4) Future loads/requirements for the alternative power equipment.

8. UNINTERRUPTIBLE POWER SYSTEMS.

a. General. Uninterruptible Power Systems (UPS) units are authorized only for the support of critical automatic data processing, communications, electronic security, and safety equipment and systems that require continuous (no-break) electrical power for proper operation.

b. Classification. UPS equipment may be classified as either installed building equipment (real property) or equipment in place. See AR 735-5, Equipment Authorization and Utilization Policies and Criteria and Common Tables of Allowances (reference 12-11), and AR 415-15, Army Military Construction Program Development and Execution (reference 12-12), for guidance in this area. AR 420-49, Facilities Engineering Utility Services, provides additional policy and guidance on the use of UPS systems.

9. LIGHTNING AND STATIC ELECTRICITY PROTECTION. Lightning and static electricity protection will be provided in accordance with TM 5-811-3, Electrical Design, Lightning and Static Electricity Protection (reference 12-13).

10. LIGHTING.

a. Design Requirements. The design of interior, exterior, and sports lighting at Army installations will be according to the fundamentals and recommendations of the IES Lighting Handbook (reference 12-14), published by the Illuminating Engineering Society (IES), subject to the modifications and clarifications noted below.

b. Lighting Intensities for Facilities. Maintained lighting intensities will conform to those recommended in the current edition of the IES Lighting Handbook, except as modified in this chapter. The IES intensities were published as minimums for specific tasks. However, the IES intensities will be considered as target design levels not to be changed significantly. The upper lighting levels shall be considered as maximum design levels.

(1) Lighting Level Selection. The IES Handbook indicates specific criteria to follow in the selection of lighting intensities from a range of three levels. Consideration should be given to interpolating between the three ranges. For example, for a given range of 20-30-50 footcandles in a case where speed and accuracy of the task

are normally important and worker age is in the older category, the weight factor would be +1 to +2, and a level of 35 to 40 footcandles would be selected. For administrative areas, typical guidelines for average worker age are 35 years in open offices and 55 years in enclosed (private) offices. These figures should be used if more specific information is not available. Provision for later installation of task lighting should be considered for persons who may need additional light.

(2) General and Task Illumination. The recommended intensities required for the predominant specific visual tasks in an area may be provided by general illumination. However, maintained general illumination will not exceed 810 lx (75 footcandles) in any area, unless otherwise indicated in this chapter. Additional light, if required, should normally be provided by task lighting. When incorporating task lighting, the general illumination level should be reduced to approximately 380 lx (35 footcandles). Brightness ratios between general and task illumination will not exceed those recommended by the IES (normally 3:1). Task lighting will normally be provided by the user of the facility. However, power for such lighting will be provided by the facility.

(3) Modular Workstation Furniture. The use of modular furniture and task lighting can be integrated into the general lighting scheme. Open office lighting designs should consider the effect of workstation partitions on lighting levels at the work surface. Task lighting can eliminate the shadowing effect caused by partition and furniture system equipment.

c. Energy Conservation. Lighting systems shall be designed to achieve the lowest life cycle cost, which meets the project requirements. Life cycle costs, including construction, energy and maintenance, must be analyzed on a project-specific basis due to variations in energy costs, facility usage patterns and burning hours for different locations and types of facilities. Lighting system energy use should be discussed with the user, since energy conservation goals may differ by site. Normally, general illumination levels in administrative areas will not exceed 540 lx (50 footcandles) at work stations, 320 lx (30 footcandles) in work areas, and 110 lx (10 footcandles) in nonworking areas. These illumination levels will be obtained by the most life cycle cost-effective techniques including, but not limited to, the following:

(1) Multiple switching fixture groups in large rooms to permit lights to be turned off at unoccupied work stations. A minimum of one control will be provided for each space enclosed by walls or ceiling high partitions. However, if the space is greater than 42 square meters (450 square feet) or requires more than 1500 watts, then provide one control for an average 42 square meters (450 square feet) or 1500 watts. Multiple switching of multi-lamp fixtures or multi-level ballasts may be used in areas where the primary task changes and may require different light levels at different times. This method will not however be provided as an energy conservation measure because it has been found to be ineffective for this purpose.

\23\(2) Lighting Controls:

(a) Failure to turn off the lights in certain unoccupied areas of many facilities is an energy conservation problem caused by users feeling no direct “ownership” of these particular areas. All new Army facility designs for construction or renovation must include occupancy sensors for control of lighting in all “non-ownership” areas, including, as a minimum: lavatories, hallways, stairwells, conference rooms and utility rooms. Identification of additional areas requiring automatic control should be coordinated with the user.

(b) Daylighting, with an automatic dimming to supplement the daylight, is the preferred lighting method when economically justified.

(c) Time clock or photoelectric control must be used for general outdoor lighting. Coordinate with security requirements./23/

(3) T8 linear fluorescent and compact fluorescent lamps shall be used where applicable in new and

remodeled projects. Lamps which have been or will be removed from circulation by EPAct-1992 or any subsequent federal regulation shall not be used. These include the following:

Common Fluorescent Lamps	**Color Designations**
F96T12	CW, W, WW, SW, WWX, D
F96T12/HO	CW, LW, W, WW, D
F40T12	CW, WW, SW, WWX, D
F40T12/U/6	CW, W, WW, WWX, D
F40T12/U/3	CW, W, WW, WWX, D

Common Incandescent Lamps	**Wattages**
R30	50, 75, 100
R40	75, 100, 150
PAR38	65, 75, 85, 100, 120, 150

(4) Buildings not having a separate programmable or automatically controlled lighting system and having a Utility/Energy Monitoring and Control System (UMCS) will have the contacts and wiring incorporated into the electrical design, if economically justified.

(5) Fixture types will be chosen for operating efficiency and life cycle cost effectiveness. The most cost effective fluorescent troffers are the 300 by 1200 mm (1' x 4') and 600 by 1200 mm (2' x 4') sizes because of their high efficiency and low relamping cost. The 600 by 600 mm (2' x 2') fluorescent troffers are efficient, but have a higher relamping cost. Three and four lamp fixtures typically provide excessive light immediately beneath the fixture and not enough in between, and therefore should only be considered in high ceiling areas. Inefficient shielding, such as lensed and small cell parabolic or eggcrate fixtures should be used only where their benefits in specific applications, such as kitchens or computer areas, outweigh their lower efficiency. Open large cell parabolic troffers and recessed compact fluorescent downlights should be the norm.

d. Ballasts. Two, three and four lamp fluorescent fixtures will be powered from multi-lamp ballasts. Single lamp fixtures will be master/slaved where practical to allow the use of multi-lamp ballasts.

(1) Electronic ballasts shall be the standard for each project which uses fluorescent lighting. Magnetic ballasts will be used only where electronic ballasts are not practical. Electronic ballasts are the most efficient available. They eliminate flicker. They are quiet. As many as four lamps may be operated from a single ballast.

(2) Utility rebates may be available for the use of electronic ballasts. If so it is important to be aware of the criteria for the rebate. Some utilities stipulate a particular harmonic distortion limit for rebate eligibility. There may be other requirements. Some rebate programs may require undesirable specifications (i.e., ballasts with THD below 10 percent). It is important not to select ballasts with poor operating characteristics just to obtain a rebate. Check with the utility company in the area of the project for active programs.

(3) Electronic ballasts promise longer life and greater long term reliability, however, they do have a greater infant mortality than magnetic ballasts. These failures are almost exclusively within the early portion of the warranty period. Warranties should cover both parts and labor.

(4) Electronic ballasts are available in both series and parallel wiring for rapid start or instant start operation. Many lamps are not designed for instant start operation and can fail prematurely if matched with an instant start ballast. Selection of rapid start ballasts is recommended to avoid maintenance problems.

(5) The commitment of the User is important in properly maintaining an electronic ballasted lighting system. It is critical to the efficiency of the system that ballasts and lamps are properly matched. The User will be required to stock additional types of lamps and ballasts for system maintenance and to take care to properly replace lamps and ballasts to sustain the energy savings.

(6) Electronic ballasts, like magnetic ballasts, can generate harmonic distortion. This can combine with the distortion from other non-linear loads in a building and introduce noise/interference related problems to some sensitive electronic systems. This area should be closely coordinated with the User. Tighter specifications or shielding of the ballasts may be alternatives in these cases. Care should be taken before specifying any ballast with THD below 10 percent. Less than 10 percent THD offers no practical benefits. Ballasts so specified can have very high inrush currents, which may cause nuisance tripping of overcurrent devices or welding of the contacts in extreme cases.

e. Environmental Factors. The lighting design will be coordinated with the interior design and architectural features to provide the proper color rendition and color temperature to enhance the selected materials. If the materials are unknown at the time of selection, a standard of 75 CRI, 3,500 degree Kelvin fluorescent lamps will normally be used. These lamps provide a neutral white light with good color rendition. They are also readily available from many manufacturers. A 3,000 degree Kelvin lamp tends to have a yellowing effect on colors. They are more acceptable when a warm color palette is used. A 4,000 degree Kelvin lamp tends to have a blueing effect. They render cool colors better than warm colors. The 3,500 degree Kelvin lamp is neutral, rendering both warm and cool colors well. Lighting equipment and layout will be coordinated with other building design features to prevent interferences and to promote a good appearance.

f. Cross-Reference of DA Facilities to IES Tables. In some instances, the names and functions of facilities used by the Department of the Army are not the same names and functions of similar facilities given in the IES Tables of Recommended Levels of Illumination, IES Lighting Handbook (reference 12-14). For the purpose of comparison, the following cross-references of types of facilities are shown in table 12-1.

g. Hangar Illumination. The maintained general illumination level of hangars will not exceed 810 lx (75 footcandles), measured at 800 mm (30 in) above the floor.

h. Warehouse Illumination. The general illumination level in warehouses will not exceed the values shown in table 12-2 as measured at 1200 mm (4 ft) above the finished floor.

TABLE 12-1 DA-IES CROSS-REFERENCE OF FACILITIES

DA Facility Designation - Name or Function	IES Tables Designation - Name or Function
Administrative Areas	Offices, Drafting, Conference, and Accounting Rooms
Chapels	Churches and Synagogues
Classroom Buildings	Schools

TABLE 12-1 DA-IES CROSS-REFERENCE OF FACILITIES	
DA Facility Designation - Name or Function	IES Tables Designation - Name or Function
Confinement Facilities	Municipal Buildings - Fire and Police
Dining Facilities	Food Service Facilities
Parking for Military Vehicles (with minor repair areas)	Parking Areas and Service Stations
Service Clubs	Applicable Areas of Auditoriums, Food Service Facilities, Offices, Schools, and Stores
Unaccompanied Personnel Housing	Hotels
Vehicle Maintenance Facilities	Garages and Service Stations
Warehouses	Storage Rooms or Warehouses

TABLE 12-2 ILLUMINATION IN WAREHOUSES		
	Intensity	
Types of Warehousing	lux	(footcandles)
Active-Bulk [1]	110	(10)
Bin [2]	50	(5)
Inactive	50	(5)
Mechanical Material Handling:		
Accumulation Conveyor Lines (Unmanned)	110	(10)
Control Centers and Stations	320	(30)
Loading and Unloading Areas	220	(20)
Rack	220	(20)

[1] Main aisles may be lighted to 160 lx (15 footcandles).

[2] Specialized lighting designed to illuminate the bins, as required, will be provided by the building user.

i. Exterior Sports Illumination. Outdoor sports lighting will conform to the classifications stated in the IES Lighting Handbook (reference 12-14), as shown in table 12-3.

TABLE 12-3 IES SPORTS CLASSIFICATIONS	
Sports Activity	IES Classification
Baseball	Municipal and Semiprofessional
Football	Class III or IV
Softball	Industrial League
Other	Recreational

j. Illumination in Functional Areas of Other Facilities. The general illumination levels in functional areas of other facilities will not exceed the intensities shown in table 12-4.

TABLE 12-4 ILLUMINATION IN FUNCTIONAL AREAS OF OTHER FACILITIES			
	Intensity		
Functional Areas	lux	(footcandles)	Control
Accounting Rooms Paper-Based Computer-Based	 810 320	 (75) (30)	Switched
Auditoriums	220	(20)	Dimmed
Cafeterias	270	(25)	Switched
Computer Rooms Paper-Based Computer-Based	 540 320	 (50) (30)	Switched
Conference Rooms	320	(30)	Occ. Sensor
Corridors	110	(10)	Switched
Drafting Rooms Paper-Based Computer-Based	 810 320	 (75) (30)	Switched
Elevator Machine Rooms	160	(15)	Switched
Emergency Generator Rooms	160	(15)	Switched
Garage Driving Areas Parking Areas	 50 20	 (5) (2)	Automatic or Central Control

TABLE 12-4 ILLUMINATION IN FUNCTIONAL AREAS OF OTHER FACILITIES

Functional Areas	Intensity lux	(footcandles)	Control
Garage Entrances Day Night	 320 110	 (30) (10)	Automatic or Central Control
General Office Spaces Paper-Based Computer-Based	 540 320	 (50) (30)	Switched or Occ Sensor
Janitor's Closets	50	(5)	Occ. Sensor
Kitchens	750	(70)	Switched
Lobbies	160	(15)	Switched
Lounges	160	(15)	Dimmer
Mechanical & Electrical Rooms	160	(15)	Switched
Electronic Communications Rooms	540	(50)	Switched
Parking Lots	5	(0.5)	Automatic
Stairways	220	(20) at landings	
Storage Rooms	50	(5)	Occ. Sensor
Switchgear Rooms	160	(15)	Switched
Toilet Facilities	215	(20)	Occ. Sensor
Transformer Vaults	160	(15)	Switched

k. Special Facility Illumination. When fluorescent or high-intensity discharge lighting is prohibited and the required intensity exceeds 320 lx (30 footcandles), the general lighting system should be designed for halogen or high-efficiency incandescent lighting of 320 lx (30 footcandles) with supplementary halogen or incandescent lighting for specific tasks where required.

l. Computer Tasks. Where computer tasks are the norm, careful consideration will be given to lighting intensity, fixture location and orientation. Fixture positioning is critical to the avoidance of veiling reflections in the computer screen. Wherever possible, fixtures should be placed to avoid reflecting in monitors. Where this is not possible, a fixture with very low brightness at high angles should be used.

m. Emergency Lighting. Emergency lighting systems will be provided in accordance with the requirements of NFPA 101, National Fire Protection Association Life Safety Code (reference 12-15). Provisions will be made to

transfer the exit lighting system to a standby generating source in facilities with standby electric power systems. Emergency supplementary incandescent or fluorescent lighting of 10 lx (1 footcandle) will be provided along aisles and walkways in high-bay areas where high-intensity discharge lighting is used. See subparagraph Exit Lighting below.

n. Exit Lighting. Exit lighting and exit signs will conform to NFPA 101. Exit signs will normally utilize LED illumination. The application of tritium gas filled self-illuminating exit signs and markers is not authorized due to the radioactive nature of tritium gas. Exits, exterior steps and ramps will be adequately lighted to prevent accidents. Separate lighting will not be provided if street or other permanent lighting provides at least 10 lx (1 footcandle) at the exit, exterior steps or ramps. Energy conservation is of particular concern for fixtures which are illuminated 24 hours/day.

o. Maintenance Area Lighting. Crawl spaces with utility services, interior utility tunnels, and walk-in pipe chases will be lighted as required at approximately 10 lx (1 footcandle) for the safety of maintenance personnel. Occupancy sensors, if used, must be applied with care. Ultrasonic sensors must not be subjected to excessive vibration. In machine rooms, mechanical spaces and similar areas, sensors should switch only some fixtures to prevent inadvertent shutoff of all illumination while the room is occupied. manual switches will be equipped with pilot lights and located in areas that are normally visible. Keyed switches may be used if required. Receptacles will be located at reasonable intervals in these maintenance areas for temporary work lights and portable tools.

p. Street, Area, and Security Lighting.

(1) Street and Area Lighting. Streets, parking areas, and walks in administrative, community support, and residential areas will be lighted to provide safe pedestrian and vehicular circulation. Lights will be at street intersections and between intersections at a spacing in accordance with IES RP8, which conforms to manufacturers= spacing requirements to achieve the maximum illumination ration required for proper visibility (6:1, maximum to minimum). Walks and steps in public walks, not adjacent to streets, will be separately lighted. Control of exterior street and area lighting normally will be by automatic timers equipped with a 24-hour minimum backup mechanism for short power outages or photoelectric cells, or both.

(2) Security Lighting. Since most security lighting must meet specialized requirements, the lighting will be designed to meet the needs of the users, using the most energy-efficient lighting practicable.

q. Installation Requirements.

(1) Unaccompanied Enlisted Personnel Housing (UEPH).

(a) Open Sleeping Area Type. In open sleeping areas, low-level night lights will be located so that beds are not directly illuminated. Sleeping rooms may have a night light or a secondary room light of low illumination located to facilitate moving about during night hours without disturbing sleeping occupants, and will have one or more switches conveniently located inside the room to control the general room illumination. UEPH with open sleeping areas or partial partitions will have separate switches in an easily accessible location for each subarea. Switches will be located so that access is not blocked by double-decked beds or lockers. Luminaries used in UEPH with open areas, or UEPH with partial partitions, will direct the light into the area served by each switch so that spillage into adjacent areas is held to a minimum.

(b) Individual Living/Sleeping Area Type. Lighting in this type of UEPH is to produce a residential atmosphere using energy-efficient fixed fixtures suitable for a flexible arrangement of furniture.

(2) Communications Facilities. General lighting will be arranged parallel to equipment aisles, when possible, to provide maximum illumination and to avoid overhead cable trays. In areas where manual equipment

is used, operator efficiency must be assured by carefully positioning luminaries to avoid glare and excessive light on the face of the equipment, while maintaining a reasonable light level on the horizontal surfaces. Supplementary lighting may be provided over work benches in maintenance and test areas.

(3) Officers' Open Messes, NCO Open Messes, and Service Clubs. Ballrooms and lounges serving multiple functions will have the general lighting arranged for multiple-switch control so that different intensities may be selected. Small hand-operated dimmers may be used, in lieu of multiple-switch control, provided that the costs are comparable. Facilities will be provided to permit connections of portable spots, floods, or accent lights as required. For the general lighting, ballrooms may be provided with dimmers controlled from the bandstand and main entrance.

(4) Training Facilities.

(a) Classroom lighting immediately in front of the lecture platform may be controlled from a point convenient to the speaker's platform and also at the entrance to the room. Auditorium lighting may be controlled by dimmers from the platform (off stage) and the main entrance to facilitate use of audio-visual aids. Lighting may also be controlled from those points by switches. Low-level lighting capability will be provided so that notes may be taken during the use of visual aids.

(b) Indoor rifle ranges will be provided with indirect or low-brightness luminaries in the firing area to avoid undesirable reflections. Target luminaries and those luminaries in the firing lanes will be protected by shields from stray bullets.

(5) Warehouse Facilities.

(a) Lighting arrangements will suit the employed warehousing techniques. For pallet storage, the general lighting may be confined to the aisles with supplementary lighting units provided in the aisles and directed to illuminate the storage areas. Storage area lighting will be controlled separately from the aisle lighting. Trolley-mounted luminaries may be employed where the shifting of the luminaries is practicable. Lights will be controlled from panel boards, except that lights at aisle intersections and intermediate key points may be remotely controlled by low-voltage switches from multiple points to permit passage of security guards and access to panel boards. Use of occupancy sensors is encouraged for energy conservation.

(b) Provisions will be made at loading platform doors for supplementary or portable lighting for the illumination of truck or rail car interiors.

(6) Weapons Systems Control Areas. Lighting for weapons systems control areas will be specially engineered. Low levels of lighting may be required to permit observation of luminous panels without reflected glare or undesirable contrasts in brightness. Separately controlled luminaries will be provided for normal illumination operations and cleaning purposes.

r. Luminaries. Generally, luminaries will be standard commercial types and will conform to the applicable Underwriters' Laboratories, Inc., Standards (reference 12-16).

(1) Architectural Considerations. Luminaries will be integrated with the interior design of rooms or areas. The correct use of luminaries is of special importance in large rooms or areas with high or sloping ceilings, or both. Therefore, the type and hanging of luminaries will ensure that the desired architectural effect and function of the space are not impaired. Sway bracing must be coordinated with the architect. In each case, either an architectural detail will be provided in the contract drawings or the contractor will be required to provide a proposed sway bracing installation detail for approval. Where facilities are modified for different uses, luminaries will be

installed at the most economical height and manner to provide for the new functions.

(2) Metric Recessed Lighting Fixtures. In the case of metric recessed lighting fixtures, public law permits them to be specified as hard metric only if necessary for repair or replacement, or if they are the industry standard or if needed to coordinate with a metric ceiling system, provided this is not more expensive than an all non-metric system. Our recessed lighting designs are to be shown as metric, but the contractor is to be given the option of providing a non-metric ceiling and light fixtures. This makes it necessary to provide the specific lighting design criteria and assumptions in the contract documents, so the contractor can design a comparable system. It is important to maintain life cycle cost considerations throughout this process.

(3) Specialized Luminaries. Specialized luminaries may be provided when required by the seeing task or architectural treatment of the building. For specific areas, explosion-proof, dust-tight, dust-ignition proof, or weatherproof luminaries will be provided according to the requirements of NFPA 70, National Electrical Code.

11. INFORMATION SYSTEMS.

a. Premises Distribution System.

(1) Definition. The premises distribution system (PDS), also referred to as a signal distribution system, includes the entire inside cabling plant from the entry facility to each workstation outlet. For most projects it will be an integrated voice and data signal distribution system, including the cable, outlets, entry facility, and all intermediate cross-connects and other signal distribution hardware within a building or facility.

(2) Design Policy. A complete and integrated premises distribution system for the information system (consisting of the voice telephone system and the data network, where required) will be designed and installed as an integral part of Army military construction projects, per ER 1110-3-110, Information Systems Design in Support of Military Construction (reference 12-17). The Information Systems Engineering Command (ISEC) has overall responsibility for voice and data communications systems on all Army facilities, and they must be involved in the design and review of all information systems designs included in a Corps construction contract. The Information Systems Engineering Command is responsible for design review and approval, and all design submittals must be sent to them for review. The address is: HQUSAISEC, ATTN: AMSEL-IE-DE-IN-CO (Bldg 143), 138 Malbrouk Ave, Ft. Ritchie, MD 21719-4013. The Director of Information Management (DOIM) at the installation is generally responsible for providing information systems requirements and assuring that they are in section 17 of the project DD Form 1391. Since several agencies outside the Corps are involved in information systems design, ER 1110-3-110 requires that a letter of intent be prepared and signed by all interested parties for all projects that include information systems. The letter of intent will be prepared by the design district and signed by all involved parties before any design effort is expended on the information system. To assure that all user requirements are met, and the new systems are compatible with the existing information system, extensive coordination with the user, the installation DOIM, and ISEC is required during project design and development.

(3) Design Guidance. The premises distribution system will be designed in accordance with Military Handbook 1012/3, Telecommunications Premises Distribution Planning, Design, and Estimating (reference 12-18). The physical layout of the premises distribution system, and all components, will be in accordance with TIA/EIA 568-A, Commercial Building Telecommunications Cabling Standard (reference 12-19). For most facilities, the telecommunications closets, rooms, entry facilities, and spaces for raceways and conduits will be designed and provided per EIA/TIA 569, Commercial Building Standard for Telecommunications Pathways and Spaces (reference 12-20). These documents prescribe the maximum floor area that a single telecommunications closet can support, the maximum cable distance between any workstation and the supporting telecommunications closet, the minimum specifications of the cable and connecting hardware, and other pertinent requirements. EIA/TIA 569 was developed for commercial office buildings, and should be applied to all similar facilities that have substantial voice and data communications requirements, such as administrative buildings, brigade and battalion

headquarters, laboratories, CIDC operations Facilities, army chapels and family life centers, religious education facilities, unaccompanied officers quarters, and barracks. For special purpose facilities that have limited communications requirements, such as warehouses, central issue facilities, recreational and physical fitness facilities, child development centers, and company operations facilities, it is not necessary to apply all of the requirements of EIA/TIA 569. For those facilities, the general intent of EIA/TIA 569 should be followed, such as telecommunications closet sizes and maximum cable lengths, but the number of closets and the maximum floor space serviced by each closet should be modified to suit the application. Additional design guidance can be obtained from Rural Utilities Services (RUS), formerly Rural Electrification Agency (REA). They have published many design guides and other useful criteria for designing and installing communications systems and these are now available on their home page on the Internet at www.usda.gov/rus/.

b. Backbone Cable. Both copper and fiber optic cable will be used for the backbone cable system to extend voice and data service from the entrance facility to all communications equipment rooms and other intermediate distribution rooms and telecommunications closets. Typically, fiber optic cable will be used for data service and copper cable will be used for voice service.

c. Horizontal Cable and Connectors. Category 5 unshielded twisted pair cable and connectors, per TIA/EIA 568-A, will be used for both the voice and data horizontal cable system from the telecommunications closet or equipment room to each workstation. Fiber optic cable will not be installed to the outlets unless the user has a validated current requirement for fiber optic connectivity. If fiber optic cables are not installed to the outlets, provisions for future fiber optic requirements will be in accordance with paragraph 12, Fiber Optics, below.

d. Telecommunications Equipment. Typically, ISEC will program and provide OPA funds to the DOIM and/or other information systems agencies to provide the telephone instruments and any required telephone switch upgrades or modifications. If ISEC elects to include telecommunications equipment procurement and installation in the construction contract, they will be responsible for providing the specifications. For those projects where a data network is identified in the DD Form 1391, the Corps is responsible for designing and installing only the premises distribution portion of the data network. The design and procurement of the remainder of the network, i.e. LAN equipment, is the responsibility of the user and/or ISEC as delineated in Appendix L of AR 415-15.

e. Outside Cable Plant. Exterior cable from the closest point of presence, as identified in the project DD Form 1391, to the new facility will be included in the design. Coordination with the DOIM is required to assure that the necessary cable capacity is available, to reserve those cable pairs for the project, and to determine the type of outside cable required (buried, duct bank, aerial, etc). Fiber optic cable will normally be provided for new data service and possibly for new or expanded voice service. If copper pairs are available in the vicinity of the proposed project, the copper cables will be extended to the new facility. If insufficient copper pairs are available to service the facility, an economic analysis will be conducted to determine if additional fiber optic cable or additional copper cable will be used for the voice service.

f. Radio, Public Address, and Intercommunication Systems. Radio, public address, and intercommunication systems may be provided where functionally required for the efficient operation of facilities, including dining and activity areas of service clubs and hospitals. Radio systems will provide for both AM and FM reception and will include an antenna installation. Public address systems will be provided in training facilities and elsewhere as required to provide mass voice-only communications on a regular basis. Generally, intercommunication functions should be implemented using the capabilities inherent in the administrative telephone system, when practicable.

g. Entertainment Television (TV). Entertainment television will be installed in unaccompanied personnel housing projects so as to provide an individual TV outlet for each occupant per appropriate standard designs and DoD standards, and other facilities as required. In most cases entertainment TV will be provided by the local commercial cable television (CATV) company. When CATV is provided, the complete signal distribution system within the facility, including conduit or raceway system, cable, and outlets will be provided with construction funds.

The local CATV company will be responsible for providing cable to the building entry point and all signal processing and distribution equipment. In those cases where CATV is unavailable, a master TV antenna and cable distribution system should be provided.

12. FIBER OPTICS. Fiber optic cable will be used to the maximum extent possible to provide voice and data communications between and within Army facilities. For facilities that have very minimal voice and data communications requirements, fiber optic cable should be used only if it is economically justified. Fiber optics used in premises distribution systems will be designed and installed in accordance with TIA/EIA 568-A. For data network applications, fiber optic cable will generally be used for backbones while voice backbones will usually be copper. Fiber optic cables will normally be provided for all voice and data communications between facilities, unless adequate copper pairs are available nearby, in which case the copper cables should be extended to the new facility. Unless there is an immediate requirement for fiber optic cables to individual outlets, the fiber optics will terminate at the building telecommunications closets and will not be extended to the workstation outlets. For most applications, Category 5 unshielded twisted pair cables will be provided from the telecommunications equipment closets to the individual voice and data outlets. Additional space will be provided in all raceway systems to allow future installation of fiber optic cables in all facilities that have significant voice and/or data communications requirements.

13. ELECTRONIC SECURITY SYSTEMS.

a. Design Requirements. Electronic security systems are comprised of automated intrusion detection, electronic entry control, and closed circuit television assessment and surveillance systems. The application of these systems are usually dictated by regulation. There are many existing Army and DoD regulations that cover the electronic security measures required for various Army assets. AR 190-13, The Army Physical Security Program (reference 12-21), is always applicable, but for certain types of assets, such as arms, ammunition, and explosives, narcotics, Army museums, etc, more stringent requirements are prescribed by regulations written specifically for those assets. The installation commander, or his or her designated representative, has the authority to increase the security requirements above and beyond the regulatory requirements. This determination is usually based on local threat, risk, or vulnerability studies that indicate additional security measures are required for certain assets or areas of his or her installation. When determining electronic security system requirements for a project, close coordination with the installation security officer or Provost Marshall is required to determine both the regulatory and local electronic security system needs. A site survey should be performed (or validated if a recent survey has been performed) in accordance with AR 190-13 to determine the exact electronic security system requirements. TM 5-853-4, Security Engineering - Electronic Security Systems (reference 12-22), Appendix C, provides comprehensive site survey procedures for electronic security systems.

b. Power Requirements. Applicable security regulations and local policy require extremely reliable and uninterruptible power for most electronic security systems. Electronic security systems usually consist of a central computer, with appropriate peripheral equipment installed at the monitoring area (typically the police station), and a number of local processors installed at widely scattered locations. The area at most Army installations where the electronic security system monitoring equipment will be installed has, or is required to have, a standby generator, and therefore the uninterruptible power supply for this equipment generally will not be required to power the equipment for an extended period of time. On the other hand, the local processors and related equipment will generally not have standby power available, and therefore the uninterruptible power supply for this equipment will be required to power the equipment for an extended period of time, typically 4 to 24 hours. The exact standby and uninterruptible power requirements shall be determined during the site survey or site survey validation.

c. Design Process.

(1) The Electronic Security Systems Mandatory Center of Expertise (ESS-MCX) at Huntsville Engineering Support Center provides electronic security related mandatory design and construction services to all USACE districts. When a Code 2 or 3 design directive is issued for a project that includes an electronic security system, the responsible USACE district will contact the ESS-MCX before starting any design effort on the electronic security system. As a minimum the responsible district will:

(a) Assure that funding is available for MCX review and other mandatory activities.

(b) Submit all design and contract package submittals for projects that include electronic security systems of six or more zones to the ESS-MCX for review. The design review process will allow adequate time for review and disposition of the ESS-MCX comments.

(c) Assure that the ESS-MCX is involved in the technical evaluation of electronic security project proposals.

(d) Submit all electronic security system test procedures and plans to the ESS-MCX for review and assure that the contractor does not begin any formal testing prior to approval by the ESS-MCX.

(e) Assure that the ESS-MCX witnesses all pre-delivery, performance verification, and other acceptance tests. The ESS-MCX will provide acceptance/rejection advice to the contracting officer or his representative at the conclusion of each phase of testing.

(2) All electronic security system designs will be developed in accordance with TM 5-853-4. All electronic security system project specifications will be developed using the appropriate Corps of Engineers Guide Specifications (CEGS).

(3) Design AE Selection. The ESS-MCX has established procedures for developing the scope of work and selecting the design AE for the design of electronic security projects. Prior experience in designing DoD electronic security and similar systems is an important consideration in AE selection. A standard statement of work and design checklist is available from the ESS-MCX and will be used to prepare the solicitation for the design contract and review of all subsequent submittals for electronic security projects.

(4) Contracting Services. The ESS-MCX maintains indefinite delivery, indefinite quantity (IDIQ) contracts that can be utilized by all Corps districts to streamline the procurement process. The IDIQ contract can be used for all phases of electronic security systems such as design, procurement of hardware, or complete design, installation, testing, and maintenance services.

(5) Additional information on the ESS-MCX and the requirement to use their services is available on the Corps homepage, at: **http://www.usace.army.mil/centers/**.

(6) The address and phone number for the ESS-MCX is:

US Army Engineer Support Center, Huntsville
ATTN: CEHNC-ED-ME-T
P.O. Box 1600
Huntsville, Alabama 35807-4301
Phone: Commercial: 205 895-1740
DSN: 788-1740

14. ELECTROMAGNETIC SHIELDING.

a. General. Design of electromagnetic shielded facilities will use the following guidance: Engineering Pamphlet EP 1110-3-2, Electromagnetic Pulse (EMP) and TEMPEST Protection for Facilities (reference 12-23), and MIL HDBK 423, HEMP Protection for Fixed and Transportable Ground Based C4I Facilities (reference 12-24).

b. Shielding. Electromagnetic shielding provides protection from all types of electromagnetic effects (EME). High-altitude electromagnetic pulse (HEMP) is produced from the detonation of a nuclear weapon high above the earth's surface. While this threat is not as great as it once was, other EME threats are evolving. The current threats are from "non-lethal" EMP, such as high power microwaves (HPMW). Ongoing research will determine the requirements for electromagnetic shields which will withstand the wide variety of EME in the electromagnetic effects environment (E3). EP 1110-3-2 provides available background information on E3 and protective countermeasures.

c. TEMPEST Requirements. The reference that covers TEMPEST facilities is the Confidential “National Security Telecommunications and Information Systems Security Instruction (NSTISSI) 7000, TEMPEST Countermeasures for Facilities”, Dated 29 November 1993. This instruction establishes guidelines and procedures for determining the applicable countermeasures for national security systems. It applies to all federal departments and agencies.

NSTISSI 7000 establishes the requirement to review the TEMPEST posture of certain facilities where national security information is processed. If a facility falls within the criteria of paragraph 10 of NSTISSI 7000 then a TEMPEST countermeasure review must be conducted by or validated by a CTTA (Certified TEMPEST Technical Authority). If a facility does not meet the requirements of paragraph 10, then there are no TEMPEST countermeasures required, and to apply any would violate National TEMPEST policy.

A CTTA is an experienced, technically qualified U.S. government employee who has met established certification requirements in accordance with NSTISSC-APPROVED CRITERIA AND HAS BEEN APPOINTED BY A U.S. Government Department or Agency to fulfill CTTA responsibilities. If a facility belongs to the Army Materiel Command the CTTA to contact is Mr. Richard A. Henson at telephone number (703) 617-0081. For facilities belonging to the rest of the Army, the CTTA to contact is Mr. Don Bell at telephone number (301) 677-2041 of the 902 Military Intelligence Group.

d. Mandatory Center of Expertise. Engineering Regulation ER 1110-3-109 (reference 12-25) outlines the functions and responsibilities of the Corps-Wide Centers of Expertise. The Protective Design Mandatory Center of Expertise (PD-MCX), CEMRO-ED-ST, 215 N. 17th St., Omaha, NE, 68102-4978, will review all (MCA, OMA, and other agencies) project designs which include electromagnetic shielding.

15. CATHODIC PROTECTION.

a. General. Design of cathodic protection systems shall incorporate guidance from TM 5-811-7, Electrical Design, Cathodic Protection (reference 12-26), and shall be provided as required by ETL 1110-3-474, Cathodic Protection (reference 12-27). A CP system shall be provided where applicable; project design and construction without considering CP is not acceptable. CP is a functional requirement for virtually all projects involving new aboveground water tanks, direct buried or submerged metallic structures, or the repair or replacement of similar existing structures.

b. Contractor Requirements. The Contractor shall obtain the services of a corrosion engineer to supervise and inspect the installation of the cathodic protection system. A Corrosion Engineer refers to a person who, by reason of his knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control

on buried or submerged metallic piping systems and metallic tanks. Such person may be a licensed professional engineer or may be a person certified as being qualified by the National Association of Corrosion Engineers if such licensing or certification includes suitable experience in corrosion control. The corrosion engineer shall insure that the cathodic protection system is installed, tested, and placed in service in accordance with the requirements specified.

c. System Requirements. Certain types of systems, used for fuels and natural gas, pose safety problems if cathodic protection is not installed and maintained. Department of Transportation guidance as stated in 49 CFR, Part 192, (reference 12-28) requires that all ferrous metallic natural gas piping be coated and cathodically protected regardless of the soil resistivity. Corrosion control is mandated for all metallic underground storage tanks (UST) storing petroleum or hazardous substances by 40 CFR, Part 280 (reference 12-29) and AR 200-1, Environmental Protection and Enhancement, (reference 12-30) and on Hazardous Liquid Pipelines,(e.g., liquid fuel) by 49 CFR, Part 195 (reference 12-31).

(1) Guidance. TM 5-811-7, Electrical Design, Cathodic Protection, provides general criteria for the design and application of durable and maintainable CP systems. Other guidance, such as the CEGS and ETLs give specific directions on actual design procurement and installation of CP systems.

(2) LCCA. A life cycle cost analysis (LCCA) will be performed if more than one pipe material (e.g., copper v. steel v. non-metallic) is considered during design. The cost analysis will follow the guidance in ETL 1110-3-474. If the ferrous metallic system requires CP, the cost of that CP design and installation must be included in the LCCA comparison.

16. UTILITY MONITORING AND CONTROL SYSTEMS.

a. Design Requirements. Utility monitoring and control systems (UMCS) includes centralized computer based monitoring and control systems which sense and control the physical environment in real time, including UMCS, energy monitoring and control systems (EMCS), supervisory control and data acquisition (SCADA) systems, and all similar systems. Local controls for individual pieces of equipment or systems are not included. A field survey will be performed per TM 5-815-2 (reference 12-32) prior to any design effort to determine site specific requirements and verify the working cost estimate.

b. Design Process.

(1) The UMCS Mandatory Center of Expertise (UMCS-MCX) at Huntsville Engineering and Support Center provides UMCS related mandatory design and construction services to all USACE commands. When a Code 2 or 3 design directive is issued for a project that includes an UMCS or a related system, the responsible USACE command will contact the UMCS-MCX before starting any design effort on the UMCS. As a minimum, the responsible district will:

(a) Assure that funding is available for MCX review and other mandatory activities

(b) Submit all design and contract package submittals for the UMCS portion of the project to the UMCS-MCX for review. The design review process will allow adequate time for review and disposition of the UMCS-MCX comments.

(c) Assure that the UMCS-MCX is involved in the technical evaluation of UMCS project proposals.

(d) Submit all UMCS test procedures to the UMCS-MCX for review and assure that the contractor does not begin any formal testing prior to approval by the UMCS-MCX.

(e) Assure that the UMCS-MCX witnesses all factory, performance verification, and other acceptance tests. The UMCS-MCX will provide acceptance/rejection advice to the contracting officer or his representative at the conclusion of each phase of testing.

(2) All UMCS and related systems designs will be developed in accordance with TM 5-815-2. All UMCS and related systems project specifications will be developed using the appropriate Corps of Engineers Guide Specifications (CEGS). Test requirements and procedures will be developed using Mil Std 2202, EMCS Factory Test Procedures (reference 12-33) and Mil Std 2203, EMCS Performance Verification and Endurance Test Procedures (reference 12-34).

(3) Design AE Selection. The UMCS-MCX has established procedures for developing the scope of work and selecting the design AE for the design of UMCS projects. Prior experience in designing DoD UMCS and similar systems is an important consideration in AE selection. A standard statement of work and design checklist is available from the UMCS-MCX and will be used to prepare the solicitation for the design contract and review of all subsequent submittals for UMCS projects.

(4) Typical Drawings. The UMCS-MCX has developed a set of typical UMCS drawings to aid the UMCS designer. The package includes typical installation details for various sensors and controls, data transmission media, system block diagram, installation details, typical building floor plans with flow diagrams, and equipment sequences of operation. The drawing package should be used to the maximum extent possible to minimize cost and increase standardization. The drawings are available in blueline hard-copy and in Microstation version 5.0 and DXF files for use on CADD systems.

(5) Contracting Services. The UMCS-MCX maintains indefinite delivery, indefinite quantity (IDIQ) contracts that can be utilized by all Corps districts to streamline the procurement process. The IDIQ contracts can be used for all phases of UMCS and related systems such as design, procurement of hardware, or complete design, installation, testing, and maintenance services.

(6) Additional information on the UMCS-MCX and the requirement to use their services is available on the Corps homepage, at: **http://www.usace.army.mil/centers/**.

(7) The address and phone number for the UMCS-MCX is:

U.S. Army Engineering and Support Center, Huntsville
ATTN: CEHNC-ED-ME-T
P.O. Box 1600
Huntsville, Alabama 35807-4301
Phone: Commercial (205) 895-1740, DSN 788-1740

17. REFERENCES.

12-1ER 1110-345-700, Design Analysis, Drawings, and Specifications

12-2NFPA 70, National Electrical Code

12-3TM 5-811-1, Electric Power Supply and Distribution

12-4ANSI C2, National Electrical Safety Code

12-5MIL-HDBK 1008A, Fire Protection for Facilities

12-6TM 5-811-14, Coordinated Power Systems Protection

12-7TM 5-815-2, Energy Monitoring and Control Systems

12-8AR 420-493, Facilities Engineering Utility Services

12-9TM 5-811-6, Electric Power Plant Design

12-10 NFPA 110, Emergency and Standby Power Systems

12-11 AR 735-5, Equipment Authorization and Utilization Policies and Criteria, and Common Tables of Allowances

12-12 AR 415-15, Army Military Construction Program Development and Execution

12-13 TM 5-811-3, Electrical Design, Lightning and Static Electricity Protection

12-14 Illuminating Engineering Society (IES) Lighting Handbook

12-15 NFPA 101, National Fire Protection Associates, Life Safety Code

12-16 Underwriter Laboratories, Incorporated

12-17 ER 1110-3-110, Information Systems Design in Support of Military Construction

12-18 MIL-HDBK 1012/3, Telecommunications Premises Distribution Planning, Design, and Estimating

12-19 EIA/TIA 568A, Commercial Building Telecommunications Cabling Standard

12-20 EIA/TIA 569, Commercial Building Standard for Telecommunications Pathways and Spaces

12-21 AR 190-13, The Army Physical Security Program

12-22 TM 5-853-4, Security Engineering - Electronic Security Systems

12-23 EP 1110-3-2, Electromagnetic Pulse (EMP) and TEMPEST Protection for Facilities

12-24 MIL HDBK 423, HEMP Protection for Fixed and Transportable Ground Based C4I Facilities

12-25 ER 1110-3-109, Corps-Wide Centers of Expertise Assigned to Major Subordinate Commands and Districts

12-26 TM 5-811-7, Electrical Design, Cathodic Protection

12-27 ETL 1110-3-474, Cathodic Protection

12-28 49 CFR, Part 192

12-29 40 CFR, Part 280

12-30 AR 200-1, Environmental Protection & Enhancement

12-31 49 CFR, Part 195

12-32 TM 5-815-2, Energy Monitoring and Control Systems

12-33 Mil Std 2202, EMCS Factory Test Procedures

12-34 Mil Std 2203, EMCS Performance Verification and Endurance Test Procedures