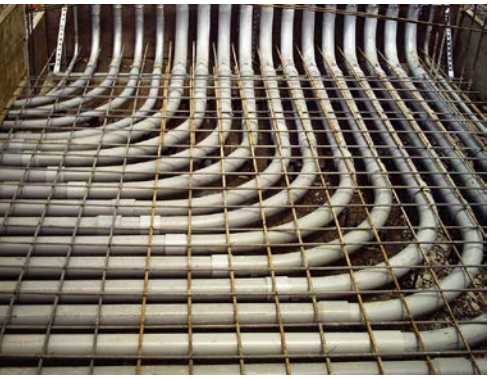
VA | U.S. Department of Veterans Affairs





Electrical Design Manual

December 2015

CONTENTS

This page intentionally left blank.

CHAPTER 1: GENERAL REQUIREMENTS

1.1 PURPOSE

This manual is a guide for electrical engineers and designers (hereafter referred as A/E) for the planning and design of the electrical power distribution and related systems (hereinafter referred to as systems) at Department of Veterans Affairs (VA) facilities.

It is expected that systems designed with the use of this manual shall meet their primary objective of providing a safe, reliable, and energy efficient installation. In order to provide the latitude needed for new technologies and concepts, technical deviations from the stipulations of this manual may be made only if a safe, reliable, and energy-efficient design shall result. Such deviations must be approved by VA. Deviations are not permitted from those requirements included in public laws, federal regulations, executive orders, and all applicable codes.

1.2 RESPONSIBILITY

The A/E shall provide all necessary professional services to perform planning and design of the systems for the project. The A/E is responsible and liable for the content of the construction contract document. The A/E is responsible and liable for the professional design in accordance with the contract, good engineering practices, VA standards, VA project-specific requirements (if any), and applicable codes.

1.3 AUTHORITY HAVING JURISDICTION

Unless otherwise directed by VA, the Authority Having Jurisdiction is the VISN Safety Officer.

1.4 COORDINATION

(a) The A/E shall coordinate planning and design work with the architectural, structural, civil, site utility & site work, telecommunications / data, HVAC, plumbing, medical air, fire protection / alarm system, and LEED/Sustainable designs, as applicable. Of particular focus shall be concealed and underground areas, and site utility coordination. Provide adjustable frequency drives for motors as required on the mechanical drawings; provide branch circuit power to terminal units, terminal unit fans, smoke dampers, control panels, and other auxiliaries; and provide fire alarm design as required for the mechanical systems.

(b) Utility Coordination:

(1) For projects requiring new electrical service, the A/E shall coordinate requirements with the local utility service company. The Contractor’s scope of work, as it relates to the service, shall be detailed in the Construction Documents. The A/E shall forward copies of all correspondence and minutes of meetings with the utility company's representatives to the Project Manager regarding negotiations for new services or making changes to the existing services.

(2) For renovations of and/or additions to existing buildings, the A/E shall investigate the existing electrical service/distribution system and determine whether sufficient capacity is available to accommodate the new loads. If applicable, the A/E shall inform the electric utility company of the new service requirements and additional loads.

(3) Major site distribution components, such as medium voltage and low voltage power feeders, ductbanks, and manholes, shall be shown on the civil utility plans for coordination purposes.

(c) Pre-Design Site Survey: For renovation projects, the A/E shall perform the following tasks:

(1) Electrical Load Monitoring: Investigate the existing electrical service/distribution system and determine whether sufficient capacity is available to accommodate the new loads. Determining of existing loads shall be as required by NEC.

(2) Existing Electrical Installation: Investigate all existing field electrical installations such as existing concealed conduit runs, conduit types/sizes, cable types/sizes, panelboard types/sizes, electrical equipment locations, etc., which potentially impact the new installation.

1.5 VA DESIGN CRITERIA

Latest pertinent standards of VA's Office of Construction and Facilities Management Technical Information Library (TIL) shall be used and complied with for the design. Some of the major standards are:

1.5.1 MASTER SPECIFICATIONS (PG-18-1)

Located in Technical Information Library

http://www.cfm.va.gov/TIL/spec.asp

Purpose

Defines a standardized method for the A/E to ensure that the contractor provides equipment and systems that meet the design intent in terms of performance, quality, and cost.

The Specifications accomplish this by:

- Providing specific narrative descriptions of required equipment, salient elements, and system construction
- Listing applicable standards and codes and references
- Requiring individual submittal of equipment and systems for review and approval prior to contractor purchase
- Defining specific installation methods to be used

1.5.2 DESIGN AND CONSTRUCTION PROCEDURES (PG-18-3)

Located in Technical Information Library

http://www.cfm.va.gov/TIL/cPro.asp

Purpose

Establishes minimum consistent design/construction practices.

The Procedures accomplish this by:

- Referencing applicable codes and policies
- Describing standard drawing formats
- Listing security strategies
- Including miscellaneous design details

1.5.3 NATIONAL CAD STANDARD, VHA APPLICATION GUIDE & STANDARD DETAILS (PG-18-4)

Located in Technical Information Library

http://www.cfm.va.gov/TIL/sDetail.asp

Purpose

VHA Application Guide adopts the NIBS National CAD Standard, establishes VA-specific drafting standards for the preparation of design and construction documents, and provides utility and sheet template files and standard construction details, organized by discipline, for use in design and construction documents for VA projects.

1.5.4 EQUIPMENT GUIDE LIST (PG-18-5)

Located in Technical Information Library

http://www.cfm.va.gov/TIL/equip.asp

Purpose

Information for planning and developing requirements for contractor purchased and installed equipment for VA construction projects.

1.5.5 DESIGN MANUALS (PG-18-10)

Located in Technical Information Library

http://www.cfm.va.gov/til/dManual.asp

Purpose

To convey the general and specific VA design philosophy for medical and support facilities.

The Manuals accomplish this by:

- Explaining specific design methodologies
- Listing acceptable system types
- Setting the overall energy consumption target
- Codifying certain code interpretations
- Listing values for design parameters
- Referencing certain sections of the Master Specification and Standard Details
- Containing examples of certain design elements

Note: The A/E shall submit to VA a list of Design Manuals along with the TIL posted dates that were in effect on the date of contract award.

1.5.6 DESIGN GUIDES (PG-18-12)

Located in Technical Information Library

http://www.cfm.va.gov/til/dGuide.asp

Purpose

Provides the A/E with specific layout templates and medical equipment lists for all types of spaces/uses, and specific design parameters for structural, electrical, and mechanical service.

The Design Guides accomplish this by:

- Publishing design narrative
- Including functional diagrams and layout plates
- Listing standards

1.5.7 DESIGN SUBMISSION INSTRUCTIONS (PG-18-15)

Located in Technical Information Library

http://www.cfm.va.gov/til/aeDesSubReq.asp

Purpose

To provide a staged listing of tasks in various design categories to define the A/E scope in order to ensure thorough and timely completion of the final design package and bid documents.

The Instructions accomplish this by:

- Progressively listing tasks as Schematic, Design Development, and Construction Documents stages
- Requiring task completion and submission for each stage according to a Critical Path Method (CPM) calendar
- Implementation of a QA/QC process to ensure a quality design product
- Requiring life-cycle analysis of alternatives in order to optimize the design/cost tradeoff
- Listing and detailing all the drawings, calculations, and specifications required for a complete design package
- Indicating the final distribution of bid documents

1.5.8 DESIGN REVIEW CHECKLISTS

Located in Technical Information Library

http://www.cfm.va.gov/til/aeDesSubReq.asp

Purpose

Provides the VA Peer Reviewer with a minimum list of critical items, which must be included in each A/E submission.

The Checklist accomplishes this by:

- Referring to all applicable VA design tools which apply to the specific project
- Detailing certain Life Safety and coordination requirements

1.5.9 DESIGN ALERTS

Located in Technical Information Library

http://www.cfm.va.gov/til/alertDesign.asp

Purpose

Communicates current design issues and solutions.

The Design Alerts accomplish this by:

- Publishing periodic alert memos
- Summarizing design solutions

1.5.10 QUALITY ALERTS

Located in Technical Information Library

http://www.cfm.va.gov/til/alert.asp

Purpose

Communicates quality deficiencies from recent A/E design submissions.

The Quality Alerts accomplish this by:

- Publishing checklists of design details often missed
- Including references to technical resources

1.5.11 PHYSICAL SECURITY DESIGN MANUAL FOR VA FACILITIES - MISSION CRITICAL FACILITIES & LIFE SAFETY PROTECTED FACILITIES

Located in Technical Information Library
http://www.cfm.va.gov/til/spclRqmts.asp#PHS

Purpose
Sets physical security standards for facilities required to continue operation during a natural or man-made extreme event and for facilities that are required to protect the life safety of patients and staff in an emergency.

The Manuals accomplish this by:

- Setting objectives for physical security

- Providing strategies for use in design and construction to provide protection to VA facilities
- Providing cost-effective design criteria

1.5.12 COST ESTIMATING MANUAL

Located in Technical Information Library

http://www.cfm.va.gov/cost/

Purpose

To convey the general and specific VA cost estimating philosophy for medical facilities.

The Manual accomplishes this by:

- Explaining specific estimating methodologies
- Presenting examples of certain design elements

1.5.13 SUSTAINABLE DESIGN MANUAL

Located in Technical Information Library

http://www.cfm.va.gov/til/sustain.asp

Purpose

This manual identifies the seven sustainability goals outlined in the Federal Mandates, and maps each goal to the appropriate LEED strategy for implementation. Possible methods to achieve the goals, budget considerations, case studies, and checklists are also included.

The Manual accomplishes this by:

- Prescribing the use of integrated design practices
- Providing strategies for optimization of energy performance
- Providing strategies for protection and conservation of water resources
- Providing strategies for enhancement of indoor environmental quality
- Providing strategies for reduction of environmental impact of materials

1.5.14 SEISMIC DESIGN REQUIREMENTS (H-18-8)

Located in Technical Information Library

http://www.cfm.va.gov/til/seismic.asp

Purpose

Policies established to ensure that all new and existing VA hospital facilities in seismic areas are designed to remain operational after an earthquake.

1.5.15 FIRE PROTECTION DESIGN MANUAL

Located in Technical Information Library

http://www.cfm.va.gov/til/spclRqmts.asp#FS

Purpose

Provides fire protection design criteria, including fire alarm requirements.

1.5.16 VA HOSPITAL BUILDING SYSTEM

The VA Hospital Building System (VAHBS) is a methodology based on a modular concept for planning, designing, and constructing hospitals.

The methodology has been used nationwide with success in capital and operating cost containment, shortened delivery schedules, and improved space utilization flexibility. All new and replacement VA hospital buildings should use the VAHBS system. Also consider using this system for major additions to existing hospitals where future adaptability is an important factor.

The A/E will find that systems schematic/design development efforts will occur much earlier in the overall planning/design process, due to the modular concept. Equipment selection and main distribution sizing should be evaluated as soon as the size and number of modules is determined.

See VHA Program Guide PG-18-3, Design and Construction Procedures, Topic 3, VA Hospital Building System for further guidance. The complete reference for the VAHBS is contained in the 1976 Development Study (called the Redbook) and the 2006 Supplement.

1.5.17 COMPUTER AIDED FACILITIES MANAGEMENT REQUIREMENTS (CAFM)

VA intends to implement Computer Aided Facility Management (CAFM) systems in all new and replacement hospital construction, and in all existing hospitals, as feasible. The CAFM concept requires that all pertinent data regarding a facility be contained in a master digital database, accessible by facilities personnel at their workstations for use in operations, energy/cost management, and maintenance, and for planning modifications in facility infrastructure due to space utilization changes.

1.6 OTHER DESIGN CRITERIA

1.6.1 ENERGY CONSERVATION

The need to conserve energy is mandated by the Federal Government by Executive Order and by Law enacted by Congress. In addition, 19 Federal Agencies have signed a Memorandum of Understanding (MOU) outlining specific goals and targets for energy conservation and sustainable design. VA is one of the signatory agencies. In the following paragraphs, references and details of various requirements are given.

1.6.2 DOE INTERIM FINAL RULE

In the Federal Register (Volume 71, No. 232), dated December 4, 2006, the Department of Energy (DOE) issued mandatory energy conservation guidelines, as the interim final rule for implementing provisions in the Energy Policy Act (EPACT 2005). Provisions of the interim final rule are as follows:

1.6.2.1 ASHRAE Standard 90.1

Lighting systems shall be designed to comply with the ANSI/ASHRAE/IESNA Standard 90.1 – for Buildings except Low-Rise Residential Buildings. This Standard is a component of the DOE *interim final rule.* By reference, DOE has incorporated Standard 90.1- into 10 CFR Part 433. Also, the US Congress has prescribed this standard in Section 109 of the Energy Policy Act of 2005 (EPACT). Provisions of this standard are mandatory and are not repeated here to avoid duplication. However, at appropriate places in the text, this standard is referenced.

The A/E is expected to fully comprehend and implement the practices dictated in ASHRAE 90.1. Refer to VA Sustainable Design Manual for required edition.

1.6.2.2 Additional Mandated Energy Conservation Measures

In addition to complying with the ASHRAE Standard, DOE has mandated that a new Federal building must be designed to achieve an energy consumption level that is at least 30% below the level achieved under Standard 90.1-, ***if life-cycle cost effective***. Use the Performance Rating Method – Appendix G of ASHRAE Standard 90.1.

(a) Life-Cycle Cost Analysis (LCCA) (Requirements): If an additional 30% reduction in energy consumption is not life-cycle cost-effective, the A/E must evaluate alternate designs; at successive decrements (say, 25%, 20%, or lower) in order to identify the most energy-efficient design that is life-cycle cost-effective. To do so, the A/E must consider and evaluate all readily available energy conservation measures with which the industry is generally familiar.

DOE further stipulates that the "agencies must estimate the life-cycle costs and energy consumption of the planned building as designed and those of an otherwise building just meeting the minimum criteria set forth in the baseline ASHRAE Standard." This measure is meant to demonstrate and record the extent of the mandated compliance. When developing a Life-Cycle Cost Analysis (LCCA), design teams must use an analysis approach consistent with the requirements of Title 10, CFR 436 or NIST Handbook 135. Refer to VA Sustainable Design Manual for LCCA requirements.

1.6.3 EXECUTIVE ORDER 13423 DATED JANUARY 26, 2007

Mandatory energy conservation requirements are also published in the above Executive Order. The MOU is mentioned in Section 2, paragraph f of the Executive Order. The MOU was signed under the Federal Leadership in High Performance and Sustainable Buildings.

The stated goals and objectives of the MOU are as follows:

1.6.3.1 New Construction

For new construction, reduce the energy cost budget by 30% compared to the baseline performance rating of ASHRAE Standard 90.1.

VA Policy

Reduction in the lighting energy cost budget shall be implemented as the reduction in energy consumption measured as volt-amperes (VA).

1.6.3.2 Major Renovations

For major renovations, reduce the energy cost budget by 30% below pre-renovations 2003 baseline. In the event pre-renovation 2003 baseline data is not available, the A/E shall calculate the lighting energy consumption before renovation, compare it with the energy consumption after renovation, and document the mandated saving. It is assumed that the use of the facility shall remain similar before and after the renovation. A project classified as “major renovation” shall meet the following two criteria:

(a) For a facility selected for renovation, the area of renovation is greater than 50% of the total area.

(b) A project is planned that significantly extends the building’s useful life through alterations or repairs and totals more than 30% of the replacement value of the facility.

VA Policy

Reduction in the lighting energy cost budget shall be implemented as the reduction in energy consumption measured as volt-amperes (VA).

1.6.3.3 Additional Measures (MOU)

MOU also addresses related issues, such as commissioning and measurement and verification. These issues are described below.

1.6.4 COMMISSIONING

Employ total building commissioning practices tailored to the size and complexity of the building and its system components in order to verify performance of building components and systems and help ensure that design requirements are met. This should include a designated commissioning authority, the inclusion of commissioning requirements in construction documents, a commissioning plan, verification of the installation and performance of systems to be commissioned, and a commissioning report.

1.6.5 MEASUREMENTS AND VERIFICATION

Per DOE Guidelines issued under Section 103 of EPACT, install building level utility meters in new major construction and renovation projects to track and continuously optimize performance. MOU mandates that the actual performance data from the first year of operation shall be compared with the energy design target. After one year of occupancy, measure all new major installations using the Energy Star® Benchmarking Tool for building and space types covered by ENERGY STAR® or FEMP designated equipment.

1.7 APPLICABLE CODES AND STANDARDS

1.7.1 GENERAL

Latest pertinent Codes, Standards and Executive Orders shall be used and complied with for the design. Refer to PG-18-3, Topic 1, Codes, Standards and Executive Orders. Unless otherwise indicated by VA criteria, use the latest Codes and Standards of the following organizations:

(a) American National Standards Institute (ANSI)

(b) American Society for Testing Materials (ASTM)

(c) Illuminating Engineering Society of North America (IESNA)

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

(e) International Organization for Standardization (ISO), Standards for Protocols and Interfaces that include Open System Interconnections (OSI)

(f) Joint Commission on Accreditation of Healthcare Organizations (JCAHO), Environment of Care Guidelines and Standards

(g) National Fire Protection Association (NFPA): A/E shall pay particular attention to the following publications:

- NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection
- NFPA 70 – National Electrical Code
- NFPA 70 B – Recommended Practice for Electrical Equipment Maintenance
- NFPA 70 E – Standard for Electrical Safety in the Workplace
- NFPA 72 – National Fire Alarm and Signaling Code
- NFPA 77 – Recommended Practice on Static Electricity
- NFPA 99 – Health Care Facilities Code
- NFPA 101 – Life Safety Code
- NFPA 110 – Standard for Emergency and Standby Power Systems
- NFPA 111: Standard on Stored Electrical Energy Emergency and Standby Power Systems
- NFPA 780 – Standard for the Installation of Lightning Protection Systems

(h) National Electrical Manufacturers Association (NEMA)

(i) Underwriters' Laboratories, Inc. (UL)

(j) ANSI/TIA/EIA-942 – Telecommunications Infrastructure Design for Data Centers

1.7.2 LOCAL CODES AND CONDITIONS

The A/E shall bring local and regional climatic and geographic conditions, and provisions of local building codes that are significantly different from the codes and standards listed above to the attention of VA and shall provide specific information on how the proposed design will reflect these conditions and codes. Of particular focus shall be local codes, code amendments, and/or conditions related to coastal, hurricane-prone, arctic, or seismically-active regions, or other climatic or regional conditions that warrant additional measures to protect the integrity of systems.

1.7.3 LOCAL UTILITY

The A/E shall follow the rules and regulations of the local electric company, where applicable. The A/E shall investigate potential rebates, etc., offered by the local electric company for the use of energy saving equipment.

1.8 DESIGN REQUIREMENTS

(a) All conductors, all transformer windings, and all bussing in electrical power distribution system components shall be copper.

(b) Motors rated 1/2 HP and higher shall be 3-phase. Design and specifications shall be based upon 200V (volt) motors for 208V systems and 460V motors for 480V systems.

(c) Provide detailed schedules for switchgear, switchboards, panelboards, and motor control centers on the drawings. At a minimum, the schedules shall indicate equipment ratings, enclosure type, load descriptions, interrupting ratings, breaker/starter sizes, and connected and demand loads in kVA by phase. The A/E shall determine probable equipment sizes from several manufacturers, and ascertain that the electrical rooms are sufficiently sized. Consider largest and/or heaviest dimensions and weights so that working clearance requirements, space for future installations, and structural requirements are satisfied.

(d) Specifications and CAD Standard Details:

- VA Master Specifications have been developed for typical electrical work. The A/E shall edit the appropriate sections to meet the project scope of work and specific project requirements, and latest applicable codes at the time of project design.
- The A/E shall carefully coordinate specifications with the drawings so that all work required by the drawings is included in the specifications. Specification content that does not apply to the project shall be deleted.
- The A/E shall develop specifications for any system or equipment not addressed by the VA Master Specifications.

- VA Master Electrical CAD Standard Details (PG-18-4 Division 26) have been developed for typical electrical work. The A/E shall edit appropriate standard detail(s) to be consistent with the project's specifications, specific project requirements, and latest applicable codes at the time of project design.

1.9 CRITERIA UNIQUE TO VA

1.9.1 DRAWINGS

(a) Refer to VA Design and Construction Procedures (PG-18-3), Topic 2 – Drawings, and the VA NCS Application Guide, for general drawing requirements.

(b) Consolidate notes and place them on the right-hand side of the sheet.

(c) Show scale, compass point, orientation, key plan, title, column grids and numbers, matchlines, room numbers, and titles corresponding to the Architectural drawings.

(d) Provide large-scale (minimum 1/4"=1') partial plans for areas such as Electrical Rooms, Generator Rooms, Main Computer Room, Telephone Equipment Room, Telecommunications Rooms, and Mechanical Equipment Rooms.

(e) It is mandatory to show the number of wires in each branch circuit conduit on the plans. Include the number of wires in all interconnecting conduits for all wiring devices, fixtures, and equipment.

(f) Provide 1/4-inch scale details of special equipment spaces, such as Laboratories, Radiology, Dietetic Areas, Surgical Rooms, Electrical Rooms, and Telecommunications Rooms.

(g) Conduit runs for all feeder circuits shall be shown on plans as close to the location of final installations as possible to avoid field installation conflicts which are likely to cause costly construction change orders and delays. These conduit runs shall be shown to run in parallel with the building outline, and be coordinated with existing field conditions and new installations of electrical and other systems. These conduit runs shall have the appropriate number of pullboxes located at appropriate distances to facilitate efficient installation and maintenance.

(h) Branch circuit homeruns shall not have more than three circuits. Combining circuits is prohibited.

(i) At a minimum, the construction documents shall contain diagrams of the following systems:

- Essential Electrical System Distribution (Riser Diagram)
- Primary Service and Primary System Distribution (One-line Diagram)
- Grounding Systems and components for the medium/low voltage service switchgears/switchboards to the low voltage distribution panels (One-line Diagram), including but not limited to grounding electrodes, grounding electrode conductors, grounded conductors, ground bus, bonding jumpers, and equipment grounding conductors

- Secondary System Distribution (Riser Diagram)
- Secondary System Distribution (One-line Diagram)
- Grounding Riser Diagram for Essential and Normal Power Systems
- Protective Relaying System, Power Monitoring, and Control System (One-line Diagram)

1.9.2 SEQUENCE OF ELECTRICAL DRAWINGS

- Symbols and Abbreviations
- Demolition Plans
- Electrical Site Plan(s)
- Lighting Plans
- Power Plans
- Lightning Protection Plans (may be combined with roof and ground floor/site power plans on projects with few lightning protection components)
- Signal or Other Plans
- One-line Diagrams and Riser Diagrams
- Details
- Schedules, Summary Load Studies, Lighting Fixture Schedule

1.9.3 ABBREVIATIONS AND SYMBOLS

Use only the abbreviations and symbols shown in the VA Standard Details (PG-18-4) and the NCS Application Guide.

1.9.4 PROPRIETARY ITEMS

Do not use trade names or other indications that identify a product of an individual manufacturer on any project, unless specifically approved and as follows:

- Where necessary to identify existing equipment.
- Where an existing system is to be extended and competitive manufacturers cannot meet performance or dimensional requirements.
- Where required by a public utility or municipal system as a condition of its services, construction specifications developed by the A/E shall state this condition.

1.10 CALCULATIONS

1.10.1 GENERAL

It is the responsibility of the A/E to prepare and submit, or specify calculations, study and analysis as required by the type of design work performed. Calculations shall justify electrical designs; size of each conductor, raceway, overcurrent protective device, equipment bus, generator, transformer, etc.; setting of each overcurrent protective device with adjustable characteristic; required PPE to meet arc flash energy levels; etc. It is the responsibility of the A/E to determine which calculations to perform and which calculations to specify for the Contractor to perform. Not all calculation types shall be required for all projects. VA reserves the right to request additional calculations to suit the project.

The selection of specific electrical power equipment manufacturer in the design phase is likely to occur only in unusual circumstances with the intent to mitigate urgent VA needs. If specific electrical power equipment manufacturer is selected during the design phase, the A/E shall prepare and perform Fault Current, Protective Device Coordination, and Arc Flash calculations, study and analysis. The A/E shall use the Master Specification Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY, as a basis to perform these tasks. The A/E shall provide written reports of all calculations, study and analysis to VA and the Contractor. The A/E shall coordinate and collaborate with VA, the Contractor, and the selected equipment manufacturer in setting and adjusting the electrical power equipment according to the results of the calculations, study and analysis. The purpose is to ensure that the manufacturer's equipment functions and operates safely as intended.

However, in a typical VA major and renovation project, electrical power equipment manufacturer is not selected during the design phase. Selection of electrical power equipment manufacturer occurs during the construction phase, and this information is not available to the A/E during the design phase. Due to the different electrical characteristics of different manufacturers of the same equipment, not knowing the selected equipment manufacturer during the design phase impedes the A/E's ability to perform the Protective Device Selective Coordination and Arc Flash calculations and analysis effectively. In order to mitigate this issue, the A/E shall include Master Specification Section 26 05 73 in the construction contract document, and follow additional guidance listed in Sections 1.10.2, 1.10.3 and 1.10.4.

1.10.2 FAULT CURRENT CALCULATIONS

The A/E shall prepare and submit calculations for all new projects, and renovation projects to existing electrical distribution systems at the design phase. The available fault currents shall be included on the one line diagram and/or riser diagrams, and shall show the available fault current (expressed in amperes, RMS symmetrical) at each bus and electrical equipment such as switchgears, switchboards, distribution panelboards, panelboards, overcurrent protective device and transformer in the system. Supporting calculations (such as those resulting from a SKM PowerTools™ analysis) that justify the summary available fault currents on the one line diagram and/or riser diagrams may be submitted to VA separately in 8.5" x 11" format.

1.10.3 PROTECTIVE DEVICE COORDINATION CALCULATIONS

Unlike Fault Current calculations, Protective Device Coordination calculations and study is dependent on specific electrical data produced by the selected electrical equipment manufacturer. The A/E is unlikely to perform this task accurately and effectively without knowing the selected electrical equipment manufacturer in the design phase. Therefore, in a typical VA major and renovation project, the A/E is not required to perform the Protective Device Coordination calculations and study during the design phase. However, the A/E shall include the Specification Section 26 05 73 in the construction contract document.

During the submittal review period in the construction phase, the A/E shall perform submittal review and analyze contractor's submittals required in the Specification Section 26 05 73. The A/E shall inform VA of any deficiency in calculations and reports shown in the submittals that potentially affect the safety and function of the systems. The A/E shall recommend mitigating actions to VA, if needed. The A/E shall coordinate and collaborate with VA, the Contractor, and the selected equipment manufacturer in setting and adjusting of the protective devices and related equipment to ensure safe and functional systems.

1.10.4 ARC FLASH CALCULATIONS

Arc Flash calculations and analysis is dependent on the results of the Protective Device Coordination calculations and study. Notably, the actual protective device clearing time is essential for Arc Flash calculations and analysis. Therefore, in a typical VA major and renovation project, the A/E is not required to perform the Arc Flash calculations and analysis during the design phase. However, the A/E shall include the Specification Section 26 05 73 in the construction contract document.

During the submittal review period in the construction phase, the A/E shall perform submittal review and analyze the Contractor's submittals required in the Specification Section 26 05 73. The A/E shall inform VA of any deficiency in calculations and reports shown in the submittals that potentially affect the safety and function of the systems. The A/E shall recommend mitigating actions to VA. The A/E shall coordinate and collaborate with VA, the Contractor and selected equipment manufacturer in the process of finalizing information for arc flash calculation and analysis.

1.10.5 LOAD CALCULATIONS

Prepare and submit load calculations that justify the size of each branch circuit and feeder, overcurrent protective device, transformer, and equipment bus (panelboard, switchboard, switchgear, automatic transfer switch, etc.). Calculations shall be performed at all voltage levels. The method of calculation shall be clearly presented in the drawings, including all applicable NEC diversity factors and non-coincident loads and their employment at various levels of the electrical system, as well as the capacity reserved for future load. Calculations may be in panel schedule and switchboard schedule format. It shall be possible for the VA reviewer to follow the load flow from the lowest level to the highest level of the riser and one-line diagrams.

1.10.6 GENERATOR SIZING CALCULATIONS

Prepare and submit calculations that justify the size of each generator or paralleled fleet of generators, including but not limited to all loads downstream of the generator set(s) and the sizing impacts of proposed load steps, significant motor loads, non-linear loads, and capacity reserved for future loads. If applicable under NEC Article 517, prudent demand factors and historical data used to justify generator set(s) sizing shall be clearly presented.

1.10.7 VOLTAGE DROP CALCULATIONS

Prepare and submit calculations demonstrating compliance with the following voltage drop limits: 2% for feeders and 3% for branch circuits, taken at design load.

1.10.8 HARMONIC DISTORTION CALCULATIONS

For Energy Center projects only. Prepare and submit calculations estimating the voltage and current total harmonic distortion (THD) for buses rich in non-linear loads, typically Energy Center switchboards which feed large horsepower pump motors controlled by adjustable speed drives. Use these calculations to justify active or passive components to mitigate harmonic distortion.

1.10.9 LIGHTNING PROTECTION CALCULATIONS

Prepare and submit calculations as described in Annex L Lightning Risk Assessment of NFPA 780.

1.11 SEISMIC BRACING

1.11.1 REFERENCES

Refer to H-18-8, "VA Seismic Design Requirements." ***Coordinate with the Structural Engineer so that seismic bracing is provided as required***.

1.11.2 DRAWINGS

Contract drawings shall show the detail methods of anchoring electrical equipment. Drawings shall include the size, number, and type of anchors and fasteners to be used to secure the equipment against the seismic forces and to meet codes. Calculations for equipment anchoring shall be performed by a registered structural engineer.

1.11.3 EQUIPMENT BRACING

Refer to Section 13 05 41 for seismic bracing requirements. Typically, all lighting and power equipment, and related enclosures shall be seismically braced and/or anchored.

1.12 TRANSPORT SYSTEMS

Refer to PG-18-10, TRANSPORT SYSTEMS DESIGN MANUAL FOR HOSPITAL PROJECTS for requirements. Refer to PG-18-10, FIRE PROTECTION DESIGN MANUAL for fire alarm connection requirements.

1.13 FIRE ALARM SYSTEMS

Refer to PG-18-10, FIRE PROTECTION DESIGN MANUAL for requirements.

1.14 RENOVATION TO EXISTING SITES AND BUILDINGS

1.14.1 DRAWINGS

For renovation projects, separate demolition drawings are required for all areas involved in the project. Specific detailing of interfaces between renovated and existing-to-remain conditions shall be clearly indicated on the drawings. The A/E shall fully describe existing equipment affected by a renovation project, including but not limited to existing equipment manufacturer, model, voltage, amperage, and A/C ratings, description, new devices installed, new wires and cables terminated, etc.

1.14.2 MODIFICATION VERSUS REPLACEMENT

Where equipment must be modified to be physically utilized in a project, the following items must be evaluated:

(a) Can the government look to one manufacturer for final responsibility of the modified equipment?

(b) Is there a legitimate cost saving by modifying the existing equipment rather than installing new equipment? If yes, then modification should be considered.

(c) What is the impact on operation and safety during and after construction?

(d) Will the equipment retain a valid UL-listing after modification? If no, the equipment shall be replaced.

1.14.3 AGE AND PHYSICAL CONDITION

(a) The length of time in service and physical condition of wiring, devices, and equipment shall be reviewed prior to considering reuse.

(b) The equipment shall be capable of remaining in use for a minimum of 15 years of additional life or having 60% of remaining life. If not, the equipment shall be replaced.

(c) Where equipment has been in operation for a number of years, physical inspection of terminals, insulation, switching contacts, control wiring, etc., shall be performed by the A/E, The A/E shall make recommendations for use of the equipment to VA.

1.14.4 PARTS AVAILABILITY

(a) After the A/E's site surveys, the availability of spare parts for existing equipment shall be determined.

(b) Where the project involves extending an existing system but the existing equipment spare parts are not available, the A/E shall inform the VA Project Manager in writing. Specific directions shall be given at that time.

1.14.5 CONDUIT AND BOXES

(a) Conduit and boxes shall be removed from existing walls that are to be demolished.

(b) Conduit and boxes in existing walls that are to remain shall be abandoned in place (if not reused) and the boxes shall be provided with blank covers.

(c) Conduit not intended for reuse in existing or new ceilings shall be removed back to the power, telecommunications, or signal system source from which it originates.

(d) Conduit run in the existing concrete slab shall be saw-cut off as it enters the slab, and then sealed to prevent moisture access.

1.14.6 CONDUCTORS

(a) The A/E may wish to have the existing conductors meggered to ensure insulation integrity. Conductors with known deteriorated or damaged insulation shall be replaced with new.

(b) All abandoned conductors or conductors not deemed reusable shall be removed back to the nearest junction box. Where the entire circuit is to be removed, the conductors shall be removed back to the power, telecommunications, or signal system source from which they originate.

(c) New conductors shall not be installed in existing conduit with existing conductors.

1.14.7 WIRING DEVICES

(a) Remove devices that are not to be re-used. Wiring is to be removed in its entirety. Boxes shall be blanked.

(b) Existing receptacles and switches in good operating condition, located at acceptable places, may be reused. Non-Hospital Grade receptacles shall be replaced in all-patient areas with Hospital Grade receptacles.

(c) Existing GFCI receptacles shall be replaced with new GFCI receptacles with self-test feature.

1.14.8 LIGHTING FIXTURES

(a) Lighting fixtures that cannot be reused shall be removed, including their associated wiring to ceiling-mounted junction boxes.

(b) Per Master Construction Specification requirements, fluorescent fixtures determined to be reusable in new or existing ceilings shall be cleaned, re-lamped, re-lensed, and re-ballasted prior to being put back to service. LED fixtures shall be replaced with new. Where existing exit signs are non-LED type, they shall be removed and replaced with an LED-type fixture.

1.14.9 PANELBOARDS

(a) Consider panelboards for reuse if physical condition, voltage, current and interrupting ratings, and circuit capacity requirements are met.

(b) Panelboards shall be installed in new or existing electrical rooms and closets. Corridor-mounted panelboards shall not be installed without specific approval from VA. Refer to other sections of this manual for requirements.

(c) In major secondary distribution renovation projects, existing panelboard backboxes may be used as pullboxes for branch circuit transfer. All branch circuit conductors shall be tagged to identify the circuit number to which they are being transferred in the new panel. Provide clear requirements in the contract documents directing the Contractor to revise the circuit numbers on all junction and device boxes and wall plates for the entire run.

1.14.10 GOVERNMENT RETAINED EQUIPMENT

After consulting with the VA Medical Center, determine if the following items shall be retained by government:

- Disconnects of 100A (amperes) Motors and larger
- Fire Alarm Devices
- Panelboards and Circuit Breakers
- Special Lighting Fixtures
- Special Receptacles
- Transformers
- Power components installed to provide temporary construction electrical service (if not the property of the Contractor)

1.14.11 CONTINUITY OF SERVICE

(a) Services passing through areas of remodeling shall be maintained throughout the construction period.

(b) Circuits serving areas adjacent to the construction area that are modified as part of a remodeling project, shall be re-circuited as part of the project.

(c) Provide temporary and/or modify existing lighting and power, and related services as required for construction-period Interim Life Safety measures.

1.14.12 COMPATIBILITY

(a) Equipment installed shall be compatible with existing components and systems to which it interfaces.

(b) Electrical sequence of phasing and frequency for 3-phase system shall be compatible with existing electrical power distribution system.

CHAPTER 2: RACEWAYS, WIRING, AND EQUIPMENT

This page intentionally left blank.

2.1 RACEWAYS

Install all wiring in raceways. Open wiring is prohibited. Raceways shall be as specified in PG-18-1, Master Specifications. Raceway shall comply with the definition of the NEC Article 100.

2.1.1 CONCEALED AND EXPOSED

(a) Exposed conduit is acceptable where finished ceilings are not provided. Wherever it is impractical to conceal conduits, due to economic considerations or the need to accommodate existing field conditions, the A/E shall consult with VA to determine acceptable alternatives.

(b) Electrical conduits may be installed in concrete walls and floors.

(c) Surface metal raceways shall not be installed on the floor. Services to equipment in open non-patient care areas shall be served from under the slab or through tele/power poles wired from the ceiling.

(d) Primary-voltage feeders shall not be exposed on the exterior of buildings.

2.1.2 UNDERGROUND DUCTS AND CONDUITS

(a) Generally, encase underground ducts and conduits in concrete. Direct burial conduit may be used for outdoor lighting and power branch circuits.

(b) The A/E shall make project-specific recommendations for reducing the concrete encasement requirement, taking into account the importance and physical security needs of the conduit(s) involved. Conduits containing Essential Electrical System wiring shall not be exempt from the concrete encasement requirement.

2.1.3 SPARE CONDUITS

Where electrical capacity is reserved for future use, such as bussed space in panelboards, motor control centers, switchboards, and switchgear of all voltage levels, and where under-slab or underground conduit is used, the A/E shall provide spare under-slab or underground conduits to an accessible point. The number and size of conduits shall be appropriate to the equipment and amount of bussed space served.

2.1.4 UNDERFLOOR DUCT SYSTEMS

(a) For new construction of large office areas, provide underfloor power, telecommunications, and signal systems ducts for the following areas:

- Personnel Division
- Registrar Division
- Fiscal Division
- Supply Division
- Other - Any large open office spaces where future flexibility is desirable

(b) Provide duplex receptacle and telecommunications outlet fittings on the underfloor duct to suit the furniture layout.

(c) Space the underfloor ducts 5 ft [1.5 M] on centers. In structural steel frame buildings, use trench header and utilize the cellular steel as the raceway. Coordinate with the structural engineer to ensure that the proper cells are enclosed for raceway use.

2.1.5 RADIOLOGY ROOMS

(a) Radiology rooms typically require a manufacturer-specific conduit and wiring trough system. If VA Medical Center has selected a manufacturer, the A/E may base the design on the manufacturer's shop drawings. If the equipment list is not manufacturer-specific, the A/E shall base the design on a typical radiology system for bidding purposes.

(b) The A/E shall provide the following details on the electrical plans for the Radiology Room(s):

- **Power and Signal Plan:** A/E shall show complete design for general use receptacles, communication, and signal outlets. A/E shall show main circuit and related equipment servicing the radiology equipment. A/E shall confirm radiology equipment power requirement with radiology shop drawings.
- **Lighting Plan:** A/E shall show complete lighting design. A/E shall coordinate lighting locations with radiology shop drawings and drawings from other trades to avoid conflict in field installation. Also, refer to VA Lighting Design Manual.
- **Radiology Raceway Layout Plans:** A/E shall show all surface-mounted and/or recess-mounted raceway systems. A/E shall show wiring tags for all raceway runs. A/E shall coordinate existing field conditions, locations, sizes, and quantities of raceways and cables shown on radiology shop drawings with drawings from other trades to avoid conflict in field installation.
- **Radiology Wiring Schedule:** A/E shall show a schedule for all wiring tags indicating wiring destinations and locations/sizes/types/quantities of all raceways and wirings.
- A/E shall verify that the proposed radiology equipment installation as shown on radiology shop drawings meets all applicable codes, regulations, and existing building conditions.

2.1.6 POKE-THRUS/POWER POLES

In renovation projects for large administrative areas, use fire-rated poke-thru devices and/or power poles, as determined by VA.

2.1.7 ETHYLENE OXIDE STERILIZATION AREA

Determine the extent of the NEC-classified area (if any) in the vicinity of ethylene oxide sterilizers and provide an appropriate raceway system and devices.

2.2 GROUNDING

The grounding system shall be shown complete on the one-line diagram with all components and descriptions from the medium- or low-voltage service to the low-voltage panels, as applicable for each project. The grounding system shall be shown complete on the One-line Diagram for the Normal, Standby, and/or Essential Electrical Systems, including but not limited to generators, automatic transfer switches, electrical equipment, etc.

2.2.1 GROUNDING ELECTRODES

Galvanized steel or copper-clad steel electrodes may be used. All electrodes are to be of the same material for the entire project.

2.2.2 EQUIPMENT GROUNDING CONDUCTORS

All raceways shall contain an equipment grounding conductor. Coordinate with VA Master Specifications and show on the drawings.

2.2.3 METAL CURTAIN WALL GROUNDING

(a) To help ensure that personnel are not exposed to electrical shock, all exterior metal sheathing of buildings shall be grounded.

(b) For buildings with perimeters not exceeding 250 ft [76 M], the sheathing perimeters shall be grounded at diagonally opposite corners of the building.

(c) For buildings with perimeters exceeding 250 ft [76 M], the sheathing perimeters shall be grounded such that the spacing between grounding points does not exceed 100 ft [30 M].

(d) A ground point shall consist of a driven ground rod and brazed connection to the building sheath. A No. 6 AWG bare copper conductor shall be used to connect the sheath to the ground rod.

(e) Where a lightning protection system is provided for the building, the sheath shall also be bonded at each down conductor location.

2.3 LIGHTNING PROTECTION SYSTEM

(a) Lightning protection is mandatory for all Mission Critical buildings. For non-Mission Critical buildings, perform risk analysis per NFPA 780, Annex L, and provide a lightning protection system where $N_d > N_c$. Submit calculations to VA.

(b) Lightning protection systems shall comply with NFPA 780 – Standard for the Installation of Lightning Protection Systems and NFPA 70 – National Electrical Code.

2.4 MOTOR DISCONNECT SWITCHES

Provide all motors with a local disconnect switch (unfused unless required otherwise) located at the motor or a maximum of 5 ft [1.5 M] away, within sight. Clearly indicate this requirement on the Contract Drawings.

CHAPTER 3: RECEPTACLE AND POWER REQUIREMENTS

This page intentionally left blank.

3.1 GENERAL

(a) "Receptacle" refers to power receptacles, except where signal types are specifically noted. Provide safety receptacles, ground fault current interrupter receptacles, or other special purpose receptacles, as required for the project. All receptacles shall be duplex NEMA 5-20R unless otherwise noted or not commercially available in a particular size. In patient care buildings, all receptacles shall be UL-listed as Hospital Grade, in the size, type, and configuration required.

(b) The A/E shall refer to the appropriate Design Guide, where most receptacle requirements are shown.

3.2 ESSENTIAL ELECTRICAL SYSTEM CIRCUITS

Refer to CHAPTER 4, "ESSENTIAL AND STANDBY ELECTRICAL POWER SYSTEMS," for devices to be backed by an alternate source of power.

3.3 RECEPTACLE CIRCUITS

No more than six receptacles shall be installed on a single branch circuit for general use.

3.4 SPECIFIC APPLICATIONS

3.4.1 GROUND FAULT CIRCUIT INTERRUPTER RECEPTACLES

(a) GFCI receptacles shall have self-test feature.

(b) Provide GFCI receptacles at all locations required by NFPA 70 and 99. GFCI receptacles shall not serve other receptacles from their loadside terminals.

3.4.2 SURGICAL/OPERATING ROOMS

(a) Refer to Surgical Service Design Guide.

(b) Isolated Power System (IPS):

(1) In renovation projects that affect existing isolated power systems, the A/E shall coordinate with the VA Project Manager and the Medical Center to determine whether to modify an existing isolated power system, or remove it and install new isolated power system and components. Normal power and Critical branch of the EES shall be on its own isolated power system.

(2) In new projects, isolated power system and components shall be designed and installed to render a complete, safe and operational system complying with NFPA 70 and 99. Selected receptacles (served by either Normal or Critical branch of the EEs) shall be connected to the appropriate isolated power system (connected either to Normal or Critical branch of the EES).

(3) In specific case where members of VA healthcare governing body (i.e. VHA Healthcare Technology Management, clinical, safety and engineering staff etc.) unanimously and definitively determines that the surgical/operating room is not considered wet procedure area as required and defined in the NFPA 99, the isolated power system design and installation is optional. If such case occurs, A/E shall obtain a written waiver from the VA healthcare governing body and inform the project design team and VA Project Manager.

(c) Each receptacle shall be connected to an isolated power panel on a dedicated circuit in a dedicated homerun conduit, except for those receptacles mounted in the service columns, which may be wired two to a circuit. Multiwire circuits are prohibited.

(d) GFCI receptacles are prohibited in surgical/operating rooms.

(e) Wall-mounted receptacles shall be 18 in [450 mm] above the floor. Receptacles shall be mounted in a combined power and ground modules. This module is a combination of receptacles and ground jacks.

(f) The need for special receptacles for surgical lasers or portable equipment shall be determined on a project-by-project basis.

3.4.3 ICU-CCU FOOT-WALL RECEPTACLES

Provide two receptacles on the footwall or side wall near the foot of beds in Intensive Care cubicles or Isolation Rooms. Feed these receptacles from different circuits in the respective Prefabricated Bedside Patient Unit (PBPU). Refer to CHAPTER 6 for PBPU requirements.

3.4.4 EXTERIOR ELECTRICAL RECEPTACLES

Provide exterior weatherproof GFCI receptacles mounted in NEMA 3R weatherproof enclosures with 75 ft [25 m] spacing maximum, at the following locations. Branch circuits for the receptacles may feed more than one receptacle, but shall not also feed interior receptacles.

- Exterior walls of penthouses for maintenance of roof areas
- Major entrances to buildings
- Courtyards and enclosed (or partially enclosed) garden areas
- Loading docks and maintenance yards
- Major mechanical equipment enclosures
- Cooling towers
- Major service equipment enclosures
- Near sanitary sewer cleanouts close to building walls.

3.4.5 WAITING, LOUNGE AND LOBBY AREAS

Provide tamper-resistant receptacles every 8 ft [2.4 M] in waiting, lounge, and lobby areas.

3.4.6 ANIMAL SURGERY ROOMS (RESEARCH)

(a) Design operating rooms for non-flammable anesthetics only.

(b) Provide non-explosion proof, locking receptacles at ceiling locations and Hospital Grade receptacles at wall locations.

(c) Provide eight single Hospital Grade power receptacles for general use at each table: four flush-mounted in the ceiling (two at each end of the table), and four distributed along the permanent wall(s) associated with the table.

(d) Provide one power receptacle on each wall mounted at 4 ft [1.2 M] above the floor.

(e) Provide portable X-ray outlet at 4 ft [1.2 M] above the floor.

(f) Provide X-ray film viewers at 4 ft [1.2 M] above the floor to the bottom of the unit.

3.4.7 SELF-ILLUMINATED EMERGENCY RECEPTACLES

In rooms without general illumination on emergency power, emergency receptacles shall be of the self-illuminated type. Night lights, pilot lights, and instrument lights are not considered general illumination.

3.4.8 CORRIDORS

Provide receptacles for cleaning machines at no more than 75 ft [23 M] spacing, except those in Nursing Unit corridors, where receptacles shall be a maximum of 40 ft [12 M] apart. These receptacles shall be on a dedicated circuit serving only corridor receptacles.

3.4.9 KITCHENS

(a) Coordinate requirements with kitchen equipment list. Provide appropriate receptacles for each cord-connected piece of kitchen equipment. Other equipment shall be permanently wired using liquid tight flexible conduit.

(b) For equipment located on an island, provide island-mounted, waterproof, floor pedestal type receptacles.

(c) Provide a means to disconnect electrical power to all equipment beneath Type I hoods if the fire suppression is activated.

3.4.10 OFFICES AND ADMINISTRATIVE AREAS

(a) Small Rooms: Provide receptacles with 10 linear ft [3 M] maximum spacing as measured around the floor line, excluding doorways. For all linear wall space 5 ft [1.5 M] and greater, provide at least one receptacle for general and computer uses.

(b) Open Spaces and Large Rooms: Install receptacles for large administrative rooms in underfloor raceways or in Tele/Power poles. Refer to SECTION 2.1.4, UNDERFLOOR DUCT SYSTEMS.

3.4.11 LABORATORIES AND RESEARCH FACILITIES

Refer to Research Laboratory Design Guide.

3.4.12 PHYSICAL MEDICINE AND REHABILITATION SERVICE

(a) Occupational Therapy Preparation and Treatment Rooms, Occupational Therapy Clinics, and Manual Arts Therapy Clinics: Provide heavy-duty multiple surface metal raceway 208V (volt) and 120V receptacles at 48 in [1200 mm] intervals on walls, with their centerlines located 40 in [1000 mm] above the finished floor.

(b) Educational Therapy Classrooms: Provide light-duty 120V surface metal raceway receptacles at 36 in [900 mm] intervals on all walls, with centerlines located 40 in [1000 mm] above the finished floor.

(c) Other Receptacles: When appropriate, provide safety receptacles for other services in the RMS Area. Flush-mount all floor receptacles in treatment areas with appropriate removable covers.

3.4.13 PSYCHIATRIC PATIENT ROOMS

Provide GFCI tamper-resistant receptacles with beveled, metal-edged cover plates in psychiatric patient rooms. Psychiatric patient room receptacles shall be on a dedicated circuit such that they may be shut off independently, without affecting other rooms.

3.4.14 STAIRWELLS

Provide a receptacle for vacuum-cleaning on every other floor landing.

3.4.15 INTERSTITIAL SPACES

Provide receptacles every other column. Where catwalks are installed instead of a walk-on platform, provide receptacles along the catwalks at 40 ft [12 M] spacing maximum. In addition, provide receptacles at each entrance to the interstitial space.

3.4.16 TV/CCTV POWER RECEPTACLES

Provide a receptacle in conjunction with each CCTV camera, CCTV monitor, and TV receiver. Such receptacles are not necessary where the equipment is low-voltage, powered by headend equipment or Power over Ethernet (PoE).

3.4.17 ELECTRICAL CLOSETS

Provide a receptacle with its centerline located 40 in [1000 mm] above the finished floor adjacent to the room door.

3.4.18 MOTORIZED TREADMILLS

If not provided integral to the treadmill, provide an in-line circuit interrupter at the treadmill unit which requires manual resetting to restore power in the event of a power interruption.

CHAPTER 4: ESSENTIAL AND STANDBY ELECTRICAL POWER SYSTEMS

This page intentionally left blank.

4.1 GENERAL

This section covers the Essential Electrical Systems and Standby Electrical Systems.

4.2 MIXED ESSENTIAL AND STANDBY ELECTRICAL POWER SYSTEMS

(a) For facilities where full standby power is required, it is permissible for the Standby Electrical System generators to provide power to the Essential Electrical System if the Standby Electrical System, as a whole, meets the requirement of the NFPA 99, NFPA 110, and other applicable codes.

(b) Refer to APPENDIX A, DRAWINGS for more information on possible system topologies.

4.3 COMMISSIONING

(a) In addition to installation acceptance testing specified in NFPA 110, a commissioning plan shall be developed, specified, documented, and executed to ensure proper operation of the Essential Electrical System, both its individual components and the system as a whole. The commissioning plan shall include, but not be limited to, all sources of power, paralleling switchgear, transfer switches, fueling systems, and tank leak detection, interconnections to other systems, annunciators, load shedding, exercise functions, peak shaving, and communications pathways between equipment.

(b) The A/E shall prepare control and operation drawing(s) or stipulate that the Contractor prepare them, as part of system commissioning and operations and maintenance documents. The drawings shall show all elements of the system and their interrelationships, including both power and control interconnections and sequences of operation. Physical locations of equipment shall be included.

4.4 EQUIPMENT AND RATINGS

4.4.1 GENERATORS

Generators used for the Standby Electrical System shall be rated as Limited Running Time prime power. If separate from the Standby Electrical System generators, generators dedicated to the Essential Electrical System shall be rated as standby.

4.4.2 AUTOMATIC TRANSFER SWITCHES (ATS)

ATS shall be 4-pole where the neutral circuit conductor is transferred by the transfer equipment, and the Standby or Essential Electrical System is designed as a separately derived system. ATS shall include the bypass isolation option. ATS shall be open transition switches. ATS shall be limited to 800A (amperes) maximum size and located to provide the highest practicable reliability in service to the load, which generally entails minimizing the switch-to-load distance.

4.4.3 CONTROL NETWORK

ATS, generator remote alarm systems, load shedding controls, and other interconnecting control components of the Standby Electrical System and/or the Essential Electrical System shall be networked over a fiber-optic communications network, which shall be installed in

dedicated raceways and shall not be used to transport information of other systems. The ATS shall be such that it can be monitored, tested, and operated from a single location; typically the paralleling switchgear.

4.4.4 DIESEL FUEL STORAGE

Diesel storage tank(s) shall be provided with leak detection, and a means to prevent degradation of stored fuel due to oxidation, microorganism growth, and corrosion.

4.4.5 LOCATION

(a) Do not locate the first level of distribution of the Standby Electrical System or Essential Electrical System, such as the generators and paralleling switchgear, in the same room with other power systems.

(b) In the generator paralleling switchgear or distribution switchboard, Life Safety Branch overcurrent protective devices shall occupy a dedicated section or sections.

4.5 EXISTING FACILITIES

(a) Variations in wiring arrangements in existing facilities are acceptable if the performance and reliability specified in VA Master Construction Specifications and criteria herein are not compromised. Such variations may particularly occur with certain wiring in separate or common raceways, with certain functions connected to one or another system or branch, or with certain provisions for automatically or manually delayed restoration of power from the alternate (emergency) source of power.

(b) The A/E shall submit a narrative describing the existing conditions and how the new design best meets the intent of applicable codes and provides an equivalent degree of performance and reliability.

(c) When adding the ATS to an existing Essential Electrical System, the A/E shall match the existing pole switching configuration in terms of equipment and design, i.e., 3-pole or 4-pole transfer switches.

4.6 ESSENTIAL ELECTRICAL SYSTEMS FOR HOSPITALS

The Essential Electrical System for hospitals shall comply with the Type 1 system as defined in NFPA 99.

4.6.1 ENFORCING CODES

All requirements for the Emergency System shall comply with NFPA 70, 99, and 110.

4.6.1.1 Life Safety Branch

Shall supply power to loads per NFPA 70 and 99, including:

- **Alarm and alerting systems:** Fire and Medical Gas Alarm Systems, and other required alarm systems
- **Automatic doors:** Used for building egress
- **Elevator cab**: Lighting and control system
- **Means of Egress**: Exit signs and egress lighting
- **Generator set and transfer switch locations:** Task illumination, battery charger for emergency battery-powered lighting units, and selected receptacles
- **Generator set accessories:** As required for generator performance
- **Telecommunications and Special Telecommunications** Systems**:** where used for issuing instructions during emergency conditions, including public address and Code Blue systems and Disaster Control or Emergency Communication Centers.
- **Fire Pump**: Connected to generator through integral ATS in the fire pump controller.

4.6.1.2 Critical Branch

Shall supply power to loads per NFPA 70 and 99, and as described below:

- **Acute Nursing:** Task illumination and selected receptacles
- **Stepdown Units:** Task illumination and selected receptacles
- **Anesthetizing Locations:** Task illumination, selected receptacles, and fixed equipment; task illumination includes battery back-up
- **Angiographic Laboratories:** Task illumination, selected receptacles, and selected power circuits
- **Blood, Bone, Eye, and Tissue Banks:** Task illumination, selected receptacles, and refrigerators
- **Cardiac Catheterization Laboratories and Rooms**: Task illumination, selected receptacles, selected power circuits and X-ray unit
- **Coronary Care Unit:** Task illumination, selected receptacles, selected power circuits and PBPUs
- **Emergency Room Treatment Areas and Life Support Rooms:** Task illumination, selected receptacles, selected power circuits and PBPUs
- **General Patient Bedrooms:** Night lights, an alcove or a lavatory mirror light, one receptacle per bedwall, preferably in the PBPU, if available, and a bathroom light
- **Hemodialysis Rooms:** Task illumination and one receptacle for each dialysis unit PBPU
- **Human Physiology Labs:** Task illumination, selected receptacles, and selected circuits
- **Intensive Care Units:** Task illumination, selected receptacles, selected power circuits and PBPUs
- **Isolated power systems in special environments**
- **Medication Rooms and Medication Preparation Areas:** Task illumination, selected receptacles, and refrigerators
- **Minor Operating Rooms:** Task illumination and selected receptacles
- Nurse Call systems
- **Nurses Stations:** Task illumination and selected receptacles
- **Pharmacy Dispensing Area (including Satellite Pharmacies):** Power files, laminar flow hoods, refrigerators, copier for transmittal of physicians' orders, task illumination, and selected receptacles
- **Psychiatric Bedrooms:** Task illumination (ceiling only)
- **Surgical Operating Rooms:** Task illumination (50% of the general fluorescent fixtures above the surgery table including battery backup within two of these fixtures), all X-ray units, and one film processor per suite

- **Surgical Recovery Rooms:** Lighting fixture over each bed, one receptacle for each bed (or PBPU), night lights for each bed (or PBPU), and emergency alarm circuits
- **Main Computer Room, Backup Computer Room, Telecommunications Rooms, Telephone Operators Room, and Antenna Headend Equipment Room:** All UPS equipment, lighting, and receptacles.
- **Ward Treatment Rooms:** Task illumination and selected receptacles
- **Dental Suites:** Each ceiling track operatory surgical light, each dental operating unit, one duplex receptacle in each treatment area, and a storage refrigerator
- **Electrical Rooms:** 50% of lighting and 50% of receptacles; also provide additional battery-powered lighting main electrical room
- **Engineering Control Center and Mechanical Equipment Rooms:** UPS equipment, task illumination, and selected receptacles for operating and controlling internal auxiliary power, data gathering panels, control air compressors, dryers, and any electric control for heating, ventilating, and air-conditioning (HVAC) systems
- **Laboratory Service:** Task illumination, selected receptacles in areas used to continue essential functions or critical experiments in the event of power failure, fume hoods, exhaust fans, and refrigerators
- **Pharmacy Delivery Systems and Delivery Areas:** Task illumination, selected receptacles, dumbwaiter for delivery of STAT requests, and pneumatic tube system for STAT requests if no other delivery system is readily available
- **Respiratory Care Beds:** PBPUs; when PBPU is not provided, task illumination and one receptacle for each bed
- **Security Station:** Monitoring security alarm systems, task illumination, one receptacle, intrusion and duress alarms at agent cashier, pharmacy, drug storage room in warehouse, canteen office, canteen retail store room, and canteen storage
- **Special Procedure Rooms (Radiology):** Task illumination and X-ray unit
- HVAC for Surgical Suites, Intensive Care, Coronary Care, and Emergency Treatment Spaces, and other areas as deemed necessary by VA
- Medical dispensing equipment

4.6.2 EQUIPMENT BRANCH

Shall supply power to loads per NFPA 70, 99, and 110.

4.6.2.1 Equipment Branch Non-Delayed Automatic Connection

Arrange the following generator accessories for non-delayed automatic connection to the alternate power source:

- Electrically operated louvers
- Other generator accessories essential for generator operation
- Transfer fuel pump

4.6.2.2 Equipment Branch Delayed-Automatic Connection

Arrange the following equipment for delayed-automatic connection to the alternate power source, including necessary controls:

- Central suction systems, vacuum pumps and oral evacuation pumps serving medical and surgical functions, including controls

- Sump pumps and other equipment such as associated control systems and alarms required for the safety of major equipment that may be exposed to water
- Medical and dental air compressors serving medical and surgical functions, including controls (such systems may be connected to the Critical Branch; the A/E shall coordinate with the Chief Engineer at the facility)
- Smoke control and stair pressurization systems
- Kitchen hood supply and/or exhaust systems, if required to operate during a fire in or under the kitchen hood
- Uninterruptible Power Supply (UPS) equipment serving other than telecommunications equipment
- Medical and laboratory refrigerators and freezers as required
- Oxygen storage control panel
- Equipment and control systems for each elevator bank: Design control systems to operate at least one elevator at a time and designate one elevator to serve the Surgical Suite during emergencies
- Jockey pump, and make-up pump for water-based fire protection systems; air compressor for dry-type fire protection systems; lighting and selected receptacles in fire pump room
- Hyperbaric facilities
- Hypobaric facilities
- Automatic operated doors
- Autoclaving equipment (shall be permitted to be arranged for either delayed-automatic or manual connection to the alternate source)
- **Administrative Areas:** Task illumination and selected receptacles in the hospital Director's, Engineering, and VA Police Operations
- Closed-loop water chilling equipment for linear accelerator
- **Domestic Water Pumps:** Equipment, control system, light fixture, and receptacle near the pump
- Electric tape for heat tracing of piping requiring freeze protection
- Heating, ventilating and air-conditioning (HVAC) systems:
    - **Heating Equipment:** Operating Suites, Recovery, Intensive Care, Coronary Care, Infection and/or Isolation Rooms, Emergency Treatment Spaces, and General Patient Rooms; under certain conditions, NFPA 99 may not require heating of General Patient Rooms and Infection Isolation Rooms
    - Air-conditioning equipment, lubricating oil pumps for centrifugal compressors, control air compressors, air dryer and absorption machine refrigerant pump to draw down lithium chloride before crystallization (omit for machines accomplishing this manually)
    - Chillers, chilled water circulating pumps, fans, and controls for surgical suites, recovery rooms, intensive care, and coronary care units
    - Chillers, chilled water circulating pumps, fans, and controls for animal research facilities
    - HVAC equipment for Bone Marrow Transplant (BMT) areas
    - HVAC equipment for Magnetic Resonance Imaging (MRI) Suites and Computerized Topographic (CT) Scanners
    - HVAC equipment serving emergency areas in outpatient clinics in seismic and high-risk hurricane areas
    - HVAC equipment for Main Computer Room, Telecommunications Rooms, Telephone Operators Room, and Antenna Headend Equipment Room
    - Exhaust fans serving Autopsy Rooms, reagent-grade Water Treatment Rooms, Orthotic Laboratory special exhaust systems, battery charging areas, flammable storage rooms, and illustration rooms (Medical Media)

  - Supply, return, and exhaust ventilating systems for Infection Isolation Rooms, Protective Environment Rooms, and exhaust fans for laboratory fume hoods and nuclear medicine areas where radioactive material is used, ethylene oxide evacuation and anesthesia evacuation. These systems are permitted on delayed automatic system only, and shall not be served via manual system. Some systems may be placed on the Critical Branch. Coordinate with VA.
  - Ventilation, cooling, and control equipment for electrical rooms
  - Ventilation, cooling, and control equipment for elevator machine rooms
- **Hot Water Circulatory and Steam Condensate Return Pumps:** Equipment, controls, and light fixture and receptacle near the pumps
- **Hot Water Generator:** Equipment, controls, and light fixture and receptacle near the generator
- **Kitchen:** Illumination and minimum equipment to feed patients during extended outage; freezers and refrigerators
- **Laboratory Air Compressors and Vacuum Pumps:** Equipment, controls, and light fixture and receptacle near the compressors and pumps
- Animal Ward lighting
- **Mortuary Refrigerator or Cold Room:** Refrigeration equipment and task illumination
- **Radiology Suite:** Task illumination, one automatic X-ray film processor, and one X-ray unit
- **Refrigerated Medical Storage:** Refrigeration equipment
- **Sewage Pumps:** Equipment, controls, and light fixture and receptacle near the pumps
- **Supply, Processing, and Distribution (SPD):**
  - Task illumination and selected receptacles in the following areas: core, sterile storage, non-sterile storage, preparation, and decontamination
  - One ultrasonic cleaner, one ethylene oxide gas sterilizer, one steam sterilizer, one washer sterilizer, and one gas generator
  - Equipment in warehouse areas necessary to preserve subsistence drugs and X-ray film materials that may be subjected to damage from infestation, humidity, or temperature
- **Water and Sewage Treatment Plant:** Lighting, receptacles, and equipment needed during emergency

4.6.3 ALTERNATE SOURCE OF POWER

(a) The alternate source of power shall be one or more diesel engine-driven generator sets. Provide physical space for one additional generator; paralleling switchgear shall be appropriately provisioned. Refer also to the Physical Security Design Manual.

(b) Coordinate location(s) for generator remote alarm annunciator(s) with VA. The preferred locations are in the Energy Center control room and in the Security office or Telephone Operators Room (whichever is continuously staffed).

4.7 ESSENTIAL ELECTRICAL SYSTEM FOR NURSING HOMES AND LIMITED CARE FACILITIES

The Essential Electrical System for nursing homes and limited care facilities shall comply with the Type 2 system, as defined in NFPA 99.

4.7.1 LIFE SAFETY BRANCH

Shall supply power to loads per NFPA 70 and 99.

4.7.2 CRITICAL BRANCH

(a) Shall supply power to loads per NFPA 70 and 99.

(b) In addition, connect the following items to the Critical Branch, arranged for delayed-automatic connection to the alternate power system:

- Nurse Call System
- **Patient Bedrooms:** Bathroom light, an alcove or lavatory mirror light, night light, and one receptacle per bed wall
- **Electrical Rooms and Closets:** 50% of lighting and one receptacle
- **Main Computer Room, Backup Computer Room, Telecommunications Rooms, Telephone Operators Room, and Antenna Headend Equipment Room:** All UPS equipment, lighting, and receptacles.
- **Mechanical Rooms:** Task illumination and one receptacle

4.7.3 ALTERNATE SOURCE OF POWER

The alternate source of power shall consist of a diesel engine-driven generator set.

4.8 ESSENTIAL ELECTRICAL SYSTEM FOR OTHER HEALTHCARE FACILITIES

The Essential Electrical System for other healthcare facilities shall comply with the Type 3 system as defined in NFPA 99. If electrical life support equipment is required or critical care areas are present in the facility, the Essential Electrical System shall comply with the Type 1 system as defined in NFPA 99. If a Type 1 system is required, connect the functions/items listed above in SECTION 4.6 to the Essential Electrical System.

4.8.1 TYPE 3 LOADS

The Type 3 Essential Electrical System shall supply power for the task illumination and limited power service that is related to life safety, and as necessary for the safe cessation of procedures in progress.

4.8.2 ALTERNATE SOURCE OF POWER

Per NFPA 70 and 99.

4.9 ESSENTIAL ELECTRICAL SYSTEM FOR OTHER FACILITIES

4.9.1 BOILER PLANT AND ENERGY CENTER

Provide emergency power for task illumination and equipment necessary for emergency operations during an extended power outage. These buildings generally have their own diesel engine-driven generator set.

4.9.2 FIRE STATION

Provide emergency power for lighting and communication circuits necessary to sustain operation during power outages. If emergency generator power from an adjacent Boiler Plant or Energy Center is not available, provide auxiliary battery-powered lighting and communication devices.

4.10 STANDBY ELECTRICAL SYSTEM FOR MISSION CRITICAL FACILITIES

4.10.1 REQUIREMENTS

(a) A Standby Electrical System may be required to provide full power backup for Mission Critical facilities. The Standby Electrical System shall be sized for full load operation of the entire electrical system, and must be capable of sustaining operation of all electrical loads for a minimum four-day period during which the electric utility source is not available. Additional sustainability time may be required for hurricane-prone areas, arctic areas, high-seismic areas, areas vulnerable to other natural disasters, Continuity of Operation (COOP) facilities, or for other locations as specified by VA.

(b) The Standby Electrical System may be sized, if required by VA to provide power for other new or existing buildings or loads in addition to the Mission Critical facility.

4.10.2 STANDBY SOURCE OF POWER

(a) The source of power shall be one or more indoor diesel generator sets that generate at the utility service entrance voltage, typically 5kV or 15kV nominal. The point of connection shall typically be the utility service entrance point. The generators shall be rated Limited Running Time prime power, with a suggested limit of 750 hours of yearly operation at this rating.

(b) Provide physical space for one additional generator; paralleling switchgear shall be appropriately provisioned.

(c) Investigate peak shaving, cogeneration, or load interruption incentives with the serving electrical utility and submit an analysis narrative with recommendations to VA. Unless an advantageous interconnection agreement is obtained, the standby power system shall not parallel with the utility.

(d) The location of the standby power system, including switchgear and diesel fuel storage, shall comply with the Electrical Design Manual, the Physical Security Design Manual, and applicable Codes.

CHAPTER 5: ELECTRICAL POWER DISTRIBUTION

This page intentionally left blank.

5.1 UTILITY SERVICE

(a) Any utility service that enters VA property to access VA service equipment shall be installed underground in a concrete-encased duct bank.

(b) Primary (medium-voltage) service is preferred. The service voltage should not exceed 15 kV. The use of higher voltages up to 35 kV shall be considered for approval by VA, if cost-effective and in compliance with the utility company's rules and regulations.

(c) For Mission Critical facilities, it is required that there are two primary utility sources, as electrically and physically separated as possible. If it is cost inhibitive or almost impossible for the Utility Power Company to meet this requirement, A/E shall inform the VA in writing of the situation, recommend solutions, and obtain VA's authorization to deviate from this requirement. Refer to the Physical Security Design Manual for more information. Provide a cost opinion for the second utility service to aid VA in determining the cost-effectiveness of this requirement. For non-Mission Critical facilities, a single primary source is adequate; however, consider two utility sources if utility reliability is in question and it can be justified as cost-effective.

Ensure that required easements for utility conductors and equipment are provided in accordance with the requirements of the serving utility.

5.2 PRIMARY DISTRIBUTION

5.2.1 GENERAL

(a) Distribution topology shall typically be primary selective, secondary radial. Primary radial systems are acceptable with VA approval for non-Mission Critical facilities.

(b) Refer to APPENDIX A, DRAWINGS for possible system topologies. These diagrams are intended for general design guidance purposes, not as a basis of design for specific projects.

(c) Refer to the Physical Security Design Manual for more information.

5.2.2 PRIMARY SWITCHGEAR

(a) Primary switchgear for Mission Critical facilities shall be located indoors, in a secure, protected location that complies with the Physical Security Design Manual. The area shall have the necessary ventilation or cooling systems to maintain indoor temperature as required for proper operation of the equipment, as well as access control. Equipment shall be located above grade and above the 100-year floodplain.

(b) Primary switchgear for Mission Critical facilities shall be metal clad. Circuit protective devices shall be electrically operated, draw-out type circuit breakers with electronic relays for all Mission Critical facilities. Fused switch switchgear is acceptable for indoor and outdoor use at non-Mission Critical facilities.

Refer to the Physical Security Design Manual for feeder protection and routing requirements.

(c) Primary switchgear for non-Mission Critical facilities may be located outdoors, and may be pad-mounted fused-switch type.

5.2.3 PRIMARY CABLING

(a) Primary cabling shall be installed underground, in concrete-encased ductbanks. Each ductbank shall contain ducts for planned future expansion, as well as 25% additional ducts for unplanned future expansion. Route ductbanks to avoid possible locations of future building foundations or other structures. To the extent practical, normal and standby power feeders should be physically separated and not routed in the same ductbank.

(b) Consider the use of 15kV cable for 5kV projects.

5.2.4 BUILDING PRIMARY-VOLTAGE DISCONNECTING MEANS

If a building contains more than one substation, and the substations are not located in a common room, provide air switches as necessary so that all power to the building can be disconnected from a common location.

5.3 SECONDARY DISTRIBUTION

5.3.1 GENERAL

Healthcare, Research, Clinical and Ambulatory Care Facilities, and Essential Buildings with l000 kVA or Larger Demand Load: The total building load (calculated demand kVA plus future growth) shall be served by multiple single-ended unit substations. Low-voltage feeders between buildings shall be underground.

5.3.2 MEDIUM-TO-LOW VOLTAGE TRANSFORMERS

(a) The maximum transformer size for 208Y/120V systems shall be 750kVA. The maximum transformer size for 480Y/277V systems shall be 2500kVA. Transformers may be dry or liquid-filled.

(b) Outdoor pad-mounted transformers are permitted for non-Mission Critical facilities.

5.3.3 LOW VOLTAGE TRANSFORMERS

(a) The A/E shall consider harmonic-mitigating dry-type transformers to serve building areas rich in non-linear loads.

(b) VA discourages the design, installation and use of low-voltage step-up dry-type transformers (i.e. 208Volt – 3 phase primary stepping up to 480/277Volt – 3 phase or 480Volt – 3 phase secondary). However, in the situation where it is unavoidable that step-up dry-type transformer has to be incorporated into the design, the A/E shall design and specify only transformers listed for such application by UL and the equipment manufacturers. The

practice of “reverse-feeding” to achieve step-up voltage of low-voltage dry-type transformers not listed by UL and equipment manufacturers shall be prohibited.

5.3.4 SWITCHBOARDS, SWITCHGEAR, AND MOTOR CONTROL CENTERS

(a) Provide switchboards, switchgear, and motor control centers with 25% space for additional overcurrent protective devices. Horizontal bussing should be fully rated for length of switchboard.

(b) As a guideline, power circuit breakers are preferred for 1600A and above; molded case circuit breakers for below 1600A. Select electronic trip functions for low-voltage circuit breakers so as to achieve selective coordination.

5.3.5 PANELBOARDS

Provide panelboards with 30% space for additional circuit breakers.

5.3.6 TYPE 2 SURGE-PROTECTIVE DEVICES (TYPE 2 SPD)

(a) Type 2 SPD, as defined by NEC, is mandatory for buildings equipped with a lightning protection system.

(b) Integrated, cascaded Type 2 SPD is mandatory at all Mission Critical buildings at the highest secondary voltage ("service entrance") level, at downstream panelboards that serve sensitive electronic equipment, and at individual receptacle locations by the use of SPD receptacles. Type 2 SPD is recommended at these locations in non-Mission-Critical buildings.

5.3.7 LOADS FED FROM UNINTERRUPTIBLE POWER SUPPLY (UPS)

(a) UPS equipment is necessary for electronic equipment or any equipment that performs critical functions and requires continuous regulated power for operation.

(b) At a minimum, the following loads should be protected by UPS equipment: Main Computer Room equipment, Telephone Equipment Room equipment, telecommunications equipment, HVAC control equipment, and any other mission-essential equipment necessary for continuity of service that is not tolerant of the transfer time between utility and generator power.

(c) UPS equipment shall be arranged so that the required runtime is achieved by paralleled combinations of shorter runtime battery cabinets.

5.4 POWER MONITORING AND METERING

5.4.1 GENERAL

(a) Power monitoring and metering are in addition to utility metering.

(b) At a minimum, power monitoring and metering equipment shall be provided for both normal and essential electrical systems: for medium-voltage switchgear on each main and distribution feeder circuit breaker, unit substation transformer secondary low-voltage main circuit breakers, generator paralleling switchboards, plug-in busways, and low-voltage switchboards and major distribution panelboards. The power monitoring and metering system shall have the capability of communication with a VA-centralized remote metering station via a data backbone.

(c) At a minimum, power monitoring and metering equipment shall record, store, and trend voltage, current, kW, kWh, kVA, kVAR, power factor, as well as voltage and current total harmonic distortion.

5.4.2 ENERGY CENTERS

(a) Provide power monitoring and metering for chilled water plants and boiler plants.

(b) If medium-voltage chillers are used, install power monitoring equipment for each chiller.

5.4.3 EXISTING FACILITIES

If feasible, renovation projects shall install power monitoring equipment on any major electrical equipment directly affected or modified by the renovation.

5.5 ELECTRICAL ROOMS AND CLOSETS

5.5.1 GENERAL

(a) An electrical room is an area in a building or structure which contains one or more of the following: medium-voltage switchgear, medium-to-low-voltage transformers, low voltage transformers, low-voltage distribution equipment, and panelboards. An electrical closet is an area in a building that contains one or more of the following: low voltage transformers and low-voltage distribution and branch circuit panelboards.

(b) The location, protection, and access to electrical room and closets shall comply with the Physical Security Design Manual.

(c) Electrical rooms shall be located above the Base Flood Elevation. Electrical rooms shall not be located beneath toilets, showers, laboratories, kitchens, sinks, open courtyards, planters, roof drain leaders, or other areas where water service is provided.

(d) Electrical equipment spaces shall be designed to allow maintenance equipment access, and to facilitate equipment replacement without significant demolition and reconstruction.

(e) Any pipe or duct system foreign to the electrical installation shall not enter or pass through an electrical space. The A/E shall ensure that foreign piping such as water pipes, steam pipes, medical gas pipes, sanitary waste pipes, roof drains, A/C ducts, and other unrelated piping systems containing liquids or gases are not installed, nor pass through, electrical

rooms. Sprinkler piping shall not be routed through electrical rooms, unless it serves to protect the electrical installation.

(f) Electrical spaces shall have the necessary mechanical ventilation or cooling system to maintain the indoor temperature range required for proper operation of the equipment.

(g) No telecommunications equipment, other than telecommunications outlets, shall be placed within electrical rooms.

(h) Provide appropriate construction for the type of transformer(s) installed.

(i) Electrical closets shall stack vertically, and shall not be further than 150 ft [46 M] apart, to limit maximum 120V circuit length to approximately 75 ft [23 M].

5.5.2 SPACE FOR FUTURE EQUIPMENT

(a) Rooms that contain freestanding electrical equipment shall be sized so that sufficient space is provided to add one additional section to each unit of freestanding equipment. Provide extended pad space and spare conduits to facilitate future installation of equipment and conductors. Spare space shall be indicated on drawings.

(b) Electrical closets shall have 20% spare wall space for future installation of similar electrical equipment.

5.6 ELECTRICAL FACILITIES FOR SURGICAL/OPERATING ROOMS

(a) Refer to Design Guides (PG-18-12), Surgical Series.

5.7 ELECTRICAL FACILITIES FOR ELEVATORS

Refer to Transport Systems Design Manual for Hospital Projects. This manual specifies power, lighting, and telecommunications requirements for elevator machine rooms and hoistways.

This page intentionally left blank.

CHAPTER 6:SPECIAL MEDICAL AND ALARM SYSTEMS

This page intentionally left blank.

6.1 GENERAL

VA uses nonflammable anesthetics in Operating Rooms in Surgical Service and Medical Research Service. Installations in these areas shall conform to the portions of NFPA 99 that pertain to nonflammable anesthetics.

6.2 PATIENT WALL SYSTEMS

In certain intermediate and critical care areas, VA requires the installation of patient wall systems (referred to as Prefabricated Bedside Patient Unit (PBPU)) in patient bedrooms/areas. The PBPUs shall be installed as described in this design manual.

6.3 PREFABRICATED BEDSIDE PATIENT UNIT (PBPU)

(a) Each OEM produced-PBPU contains a specific UL Rating, Listing, and Labeling for severe medical applications. Under no circumstance shall any second party equipment be attached or installed in the PBPU without written authorization from the PBPU OEM.

(b) During installation or VA Proof of Performance testing and certification: if a PBPU is found to have equipment installed or attached that violates its UL ratings, it shall be the responsibility and expense of the contractor to restore the respective UL rating(s) per the written instructions of the PBPU OEM and the UL. Once the corrections are made, each affected unit shall be reinspected by SMCS-005OP2H3 at the Contractor's Expense. Contact VA's AHJ SMCS-005OP2H3 Refer to TDM for information.

(c) Install PBPU(s) as required. Refer to VA Master Specification 10 25 13 for specific requirements.

6.4 PBPU INSTALLATION

(a) All PBPUs shall be surface-mounted on the patient headwall.

(b) All installations in one bedroom shall be at the head and to the corridor side of the bed.

(c) All PBPUs to be located between a pair of beds in multi-bed areas shall be centered between the beds. If an odd bed remains, apply the one-bedroom concept.

6.5 PBPU APPLICATION

Table 6-5 describes the type and quantity of PBPUs in different bed areas.

Table 6-5 PBPU Application

BED AREA	TYPE	QUANTITY
ALCOHOL TREATMENT UNIT		Not Required
AMBULATORY CARE		
Observation and Treatment Room	PBPU-Style A1	Each Bed
Life Support	PBPU-Style C	Each Bed

BED AREA	TYPE	QUANTITY
Minor Operating Room		Not Required
DOMICILIARY UNIT		Not Required
DRUG DEPENDENCY TREATMENT UNIT		Not Required
DIALYSIS CENTER		
One-Bed Room	PBPU-Style B2	Each Bed
Multi-Bed Room	PBPU-Style B2	Each Bed
INTENSIVE CARE UNITS		
Coronary	PBPU-Style C	Each Bed
Surgical	PBPU-Style C	Each Bed
Medical	PBPU-Style C	Each Bed
General Purpose	PBPU-Style C	Each Bed
NURSING HOME CARE UNIT		Not Required
NURSING UNITS		
Intermediate Care	PBPU-Style A1	Each Single Bed
Intermediate Care	PBPU-Style A2 (25% of total beds in unit)	Between Each Pair of Beds
MS&N (Medical, Surgical Neurological, Ortho., and RHMS)	PBPU-Style A1	Each Single Bed
MS&N (Medical, Surgical Neurological, Ortho., and RHMS)	PBPU-Style A2	Between Each Pair of Beds
PSYCHIATRIC		Not Required
RESPIRATORY CARE	PBPU-Style B1 (90% of total beds in unit)	Each Bed
Monitored Beds	PBPU-Style C (10% of total beds in unit)	Each Bed
SPINAL CORD INJURY UNIT	PBPU-Style A1	Each Bed
Medical Isolation	PBPU-Style C	Each Bed
Acute/Respiratory Care	PBPU-Style C	Each Bed
SURGICAL RECOVERY ROOM	PBPU-Style B1	Each Bed

6.6 MEDICAL GAS, VACUUM, AND AIR ALARM SYSTEMS

(a) Provide two master alarm signal panels for nonflammable medical gas, medical-surgical vacuum, and laboratory air and laboratory vacuum systems in separate warning locations. Provide master alarm panels at the Telephone Switchboard and Engineering Control Center. If an Engineering Control Center is not provided, install master alarm panels at the Security Office or other suitable continuously staffed location.

(b) Provide area alarms at Nurse Stations in locations where nonflammable medical gas and medical-surgical vacuum systems are installed.

(c) NFPA 99 allows one of the two required alarm systems to be computerized. If this option is chosen by the A/E, VA prefers the computerized system to be the HVAC control system, if it

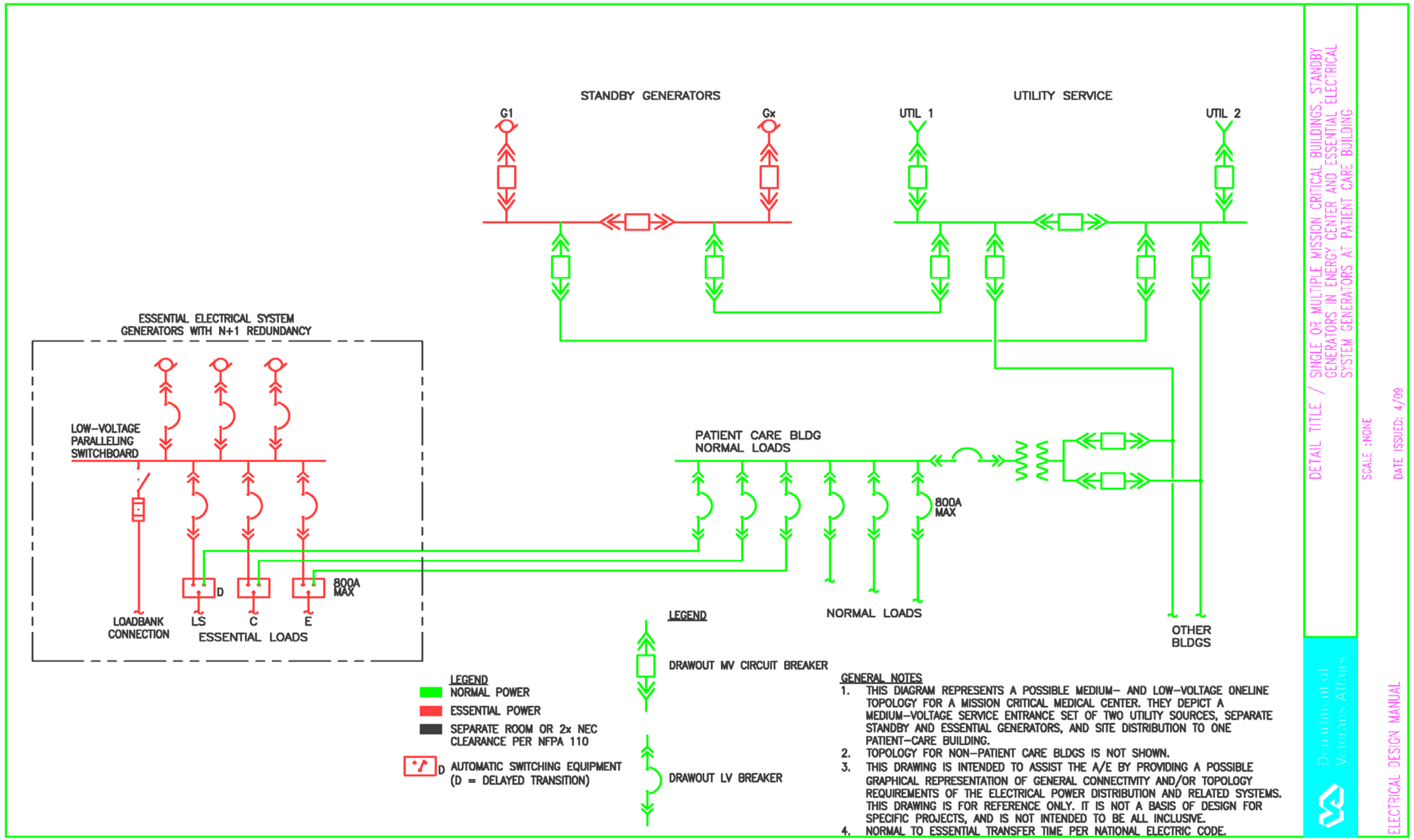
is UL-listed for this application. Addressable fire alarm systems shall be permitted to monitor medical gas alarms provided that the alarm signals are programmed as a supervisory signal and do not initiate the building fire alarm system.

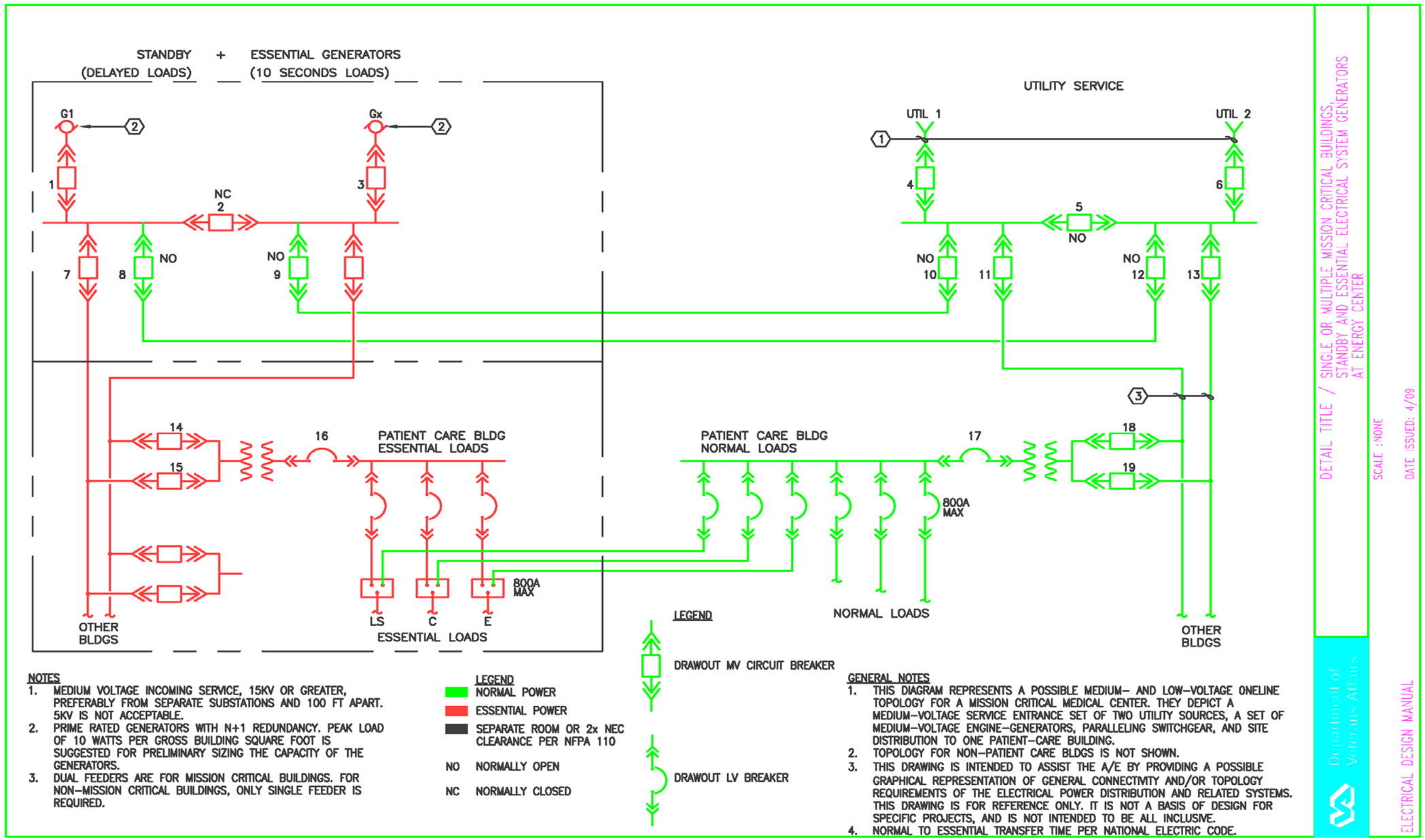
This page intentionally left blank.

APPENDIX A: DRAWINGS

The drawings show two possible topologies for normal and essential electrical system equipment, and a possible topology based on the telecommunications conduit connectivity requirements.

This page intentionally left blank.


STANDBY GENERATORS
G1
Gx
UTILITY SERVICE
UTIL 1
UTIL 2
ESSENTIAL ELECTRICAL SYSTEM
GENERATORS WITH N+1 REDUNDANCY
LOW-VOLTAGE
PARALLELING
SWITCHBOARD
PATIENT CARE BLDG
NORMAL LOADS
800A
MAX
D
800A
MAX
LOADBANK
CONNECTION
LS
C
E
ESSENTIAL LOADS
NORMAL LOADS
OTHER
BLDGS
LEGEND
NORMAL POWER
ESSENTIAL POWER
SEPARATE ROOM OR 2x NEC
CLEARANCE PER NFPA 110
D AUTOMATIC SWITCHING EQUIPMENT
(D = DELAYED TRANSITION)
LEGEND
DRAWOUT MV CIRCUIT BREAKER
DRAWOUT LV BREAKER
GENERAL NOTES
1. THIS DIAGRAM REPRESENTS A POSSIBLE MEDIUM- AND LOW-VOLTAGE ONELINE TOPOLOGY FOR A MISSION CRITICAL MEDICAL CENTER. THEY DEPICT A MEDIUM-VOLTAGE SERVICE ENTRANCE SET OF TWO UTILITY SOURCES, SEPARATE STANDBY AND ESSENTIAL GENERATORS, AND SITE DISTRIBUTION TO ONE PATIENT-CARE BUILDING.
2. TOPOLOGY FOR NON-PATIENT CARE BLDGS IS NOT SHOWN.
3. THIS DRAWING IS INTENDED TO ASSIST THE A/E BY PROVIDING A POSSIBLE GRAPHICAL REPRESENTATION OF GENERAL CONNECTIVITY AND/OR TOPOLOGY REQUIREMENTS OF THE ELECTRICAL POWER DISTRIBUTION AND RELATED SYSTEMS. THIS DRAWING IS FOR REFERENCE ONLY. IT IS NOT A BASIS OF DESIGN FOR SPECIFIC PROJECTS, AND IS NOT INTENDED TO BE ALL INCLUSIVE.
4. NORMAL TO ESSENTIAL TRANSFER TIME PER NATIONAL ELECTRIC CODE.
DETAIL TITLE / SINGLE OR MULTIPLE MISSION CRITICAL BUILDINGS, STANDBY GENERATORS IN ENERGY CENTER AND ESSENTIAL ELECTRICAL SYSTEM GENERATORS AT PATIENT CARE BUILDING
SCALE: NONE
DATE ISSUED: 4/09
Department of Veterans Affairs
ELECTRICAL DESIGN MANUAL


STANDBY + ESSENTIAL GENERATORS
(DELAYED LOADS) (10 SECONDS LOADS)
G1
Gx
UTILITY SERVICE
UTIL 1
UTIL 2
NC
NO
PATIENT CARE BLDG
ESSENTIAL LOADS
PATIENT CARE BLDG
NORMAL LOADS
800A MAX
LS
C
E
ESSENTIAL LOADS
NORMAL LOADS
OTHER BLDGS
OTHER BLDGS
LEGEND
DRAWOUT MV CIRCUIT BREAKER
DRAWOUT LV BREAKER
NOTES
1. MEDIUM VOLTAGE INCOMING SERVICE, 15KV OR GREATER, PREFERABLY FROM SEPARATE SUBSTATIONS AND 100 FT APART. 5KV IS NOT ACCEPTABLE.
2. PRIME RATED GENERATORS WITH N+1 REDUNDANCY. PEAK LOAD OF 10 WATTS PER GROSS BUILDING SQUARE FOOT IS SUGGESTED FOR PRELIMINARY SIZING THE CAPACITY OF THE GENERATORS.
3. DUAL FEEDERS ARE FOR MISSION CRITICAL BUILDINGS. FOR NON-MISSION CRITICAL BUILDINGS, ONLY SINGLE FEEDER IS REQUIRED.
LEGEND
NORMAL POWER
ESSENTIAL POWER
SEPARATE ROOM OR 2x NEC CLEARANCE PER NFPA 110
NO NORMALLY OPEN
NC NORMALLY CLOSED
GENERAL NOTES
1. THIS DIAGRAM REPRESENTS A POSSIBLE MEDIUM- AND LOW-VOLTAGE ONELINE TOPOLOGY FOR A MISSION CRITICAL MEDICAL CENTER. THEY DEPICT A MEDIUM-VOLTAGE SERVICE ENTRANCE SET OF TWO UTILITY SOURCES, A SET OF MEDIUM-VOLTAGE ENGINE-GENERATORS, PARALLELING SWITCHGEAR, AND SITE DISTRIBUTION TO ONE PATIENT-CARE BUILDING.
2. TOPOLOGY FOR NON-PATIENT CARE BLDGS IS NOT SHOWN.
3. THIS DRAWING IS INTENDED TO ASSIST THE A/E BY PROVIDING A POSSIBLE GRAPHICAL REPRESENTATION OF GENERAL CONNECTIVITY AND/OR TOPOLOGY REQUIREMENTS OF THE ELECTRICAL POWER DISTRIBUTION AND RELATED SYSTEMS. THIS DRAWING IS FOR REFERENCE ONLY. IT IS NOT A BASIS OF DESIGN FOR SPECIFIC PROJECTS, AND IS NOT INTENDED TO BE ALL INCLUSIVE.
4. NORMAL TO ESSENTIAL TRANSFER TIME PER NATIONAL ELECTRIC CODE.
DETAIL TITLE / SINGLE OR MULTIPLE MISSION CRITICAL BUILDINGS, STANDBY AND ESSENTIAL ELECTRICAL SYSTEM GENERATORS AT ENERGY CENTER
SCALE : NONE
DATE ISSUED: 4/09
Department of Veterans Affairs
ELECTRICAL DESIGN MANUAL

INDEX

This page intentionally left blank.