U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

8.3.2 DC POWER SYSTEMS (ONSITE)

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of onsite dc power systems

Secondary - None

I. AREAS OF REVIEW

The review addresses the descriptive information, analyses, and referenced documents, including electrical single-line diagrams, electrical control and schematic, functional piping and instrumentation diagrams (P&IDs), logic diagrams, tables, and physical arrangement drawings for the direct current (dc) onsite power system presented in the applicant's safety analysis report (SAR). The intent of the review is to determine whether the dc onsite power system satisfies the requirements of General Design Criteria (GDCs) 2, 4, 5, 17, 18, and 50 and will perform its intended functions during all plant operating, accident, and station blackout (SBO) conditions.

The dc power systems include those dc power sources and their distribution systems and vital supporting systems that are provided to supply motive or control power to safety-related equipment and to equipment used to respond to an SBO event. Batteries and battery chargers serve as the power sources for the dc power system, and inverters convert dc from the dc distribution system to alternating current (ac) instrumentation and control power, as required. These three components, when combined, provide an uninterruptible power system (UPS) that furnishes a continuous, highly reliable source of ac supply.

USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

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The specific areas of review are as follows:

1. System Redundancy Requirements. The staff will review the onsite dc power system to determine whether the required redundancy of components and subsystems is provided such that the system safety function can be accomplished, assuming a single failure. This requires an examination of the dc power system configuration regarding both power sources and their associated distribution systems, including the batteries, battery chargers, power supply feeders, panel arrangements, loads supplied from each battery, and power connections to the inverters and connections to the instrumentation and control devices of the system.

2. Conformance with the Single-Failure Criterion. In determining the adequacy of this system to meet the single-failure criterion, the reviewer will examine the electrical and physical separation of redundant dc power sources and associated distribution systems to assess the independence between redundant portions of the system. This will include a review of the interconnections between redundant buses, buses and loads, and buses and power supplies; proposed sharing of the dc power system between units at the same site; design criteria and bases governing the installation of electrical cable for redundant portions of the systems; and physical arrangement of redundant switchgear and power supplies.

3. Power Supplies. The staff will review design information and analyses demonstrating the suitability of batteries and battery chargers as dc power supplies and of inverters that convert dc to ac for instrumentation and control power to ensure that they have sufficient capacity and capability to perform their intended functions, including the ability to cope with an SBO event. This will require an examination of (a) the characteristics and design requirements of each load (such as motor horsepower, volt-amp rating, in-rush current, starting volt-amps, and torque), (b) the length of time each load is required, (c) the combined load demand connected to each dc supply during the worst operating conditions, (d) the voltage recovering characteristics of batteries, and (e) the performance characteristic curves (e.g., voltage profile curves, discharge rate curves, and temperature effect curves) that illustrate the response of the batteries to the most severe loading conditions at the plant. The reviewer should ensure that the capacity of the battery charger is based on an evaluation of the largest combined demands of the various continuous steady-state loads plus charging capacity to restore the battery from the design minimum charge state to the fully charged state within the time stated in the design basis, regardless of the status of the plant when these demands occur.

   If the proposed design provides for the connection of nonsafety-related loads to the dc power system or for sharing of batteries and battery chargers between units at the same site, the reviewer should particularly emphasize ensuring against marginal capacity and degradation of reliability that may result from implementing such design provisions.

   Regulatory Position C.1 of Regulatory Guide 1.81 states that dc systems in multiunit sites should not be shared. For new applications licensed under 10 CFR Part 52, the review should ensure that units do not share safety-related dc power systems (batteries, chargers, or inverters).
   In addition, if the proposed design relies on portions of the onsite dc power system to cope with an SBO event, the staff will review the capacity and capability of the dc power system to withstand and recover from an SBO of specified duration to ensure conformance to 10 CFR 50.63.

4 Identification of Cables, Raceways, and Terminal Equipment. The staff will review the proposed means for identifying the plant's dc power system components, including cables, raceways, and terminal equipment. The reviewer should also evaluate the identification scheme used to distinguish among redundant Class 1E systems, associated circuits assigned to redundant Class 1E divisions, non-Class 1E systems, and their associated cables and raceways without the necessity for consulting reference materials.

5. Vital Supporting Systems. The staff will review the instrumentation, control circuits, and power connections of vital supporting systems to determine whether they are designed to the same criteria as those for the safety-related loads and the power systems that they support. This will include an examination of the vital supporting system component redundancy; power feed assignment to instrumentation, controls, and loads; initiating circuits; load characteristics; equipment identification scheme; and design criteria and bases for the installation of redundant cables.

6. System Testing and Surveillance. The staff will review the proposed means for monitoring the status of the dc power system and vital supporting system operability to ensure that these systems perform their intended functions. In addition, the staff will review the onsite testing capability to ensure conformance to the requirements of GDC 18.

7. Other Review Areas. The reviewer will determine whether the dc system and vital supporting systems meet the following:

   A. The systems and their components have the appropriate seismic design classification.

   B. The systems and their components are housed in a seismic Category I classified structure.

   C. The systems and their components are designed to withstand environmental conditions associated with normal operation, natural phenomena, and postulated accidents.

   D. The systems and their components have a Class 1E quality assurance classification.

   E. The systems and their components are of sufficient capacity and capability to cope with an SBO, as required by 10 CFR 50.63.

8. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

9. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

   For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

1. The organization responsible for onsite dc power systems reviews the adequacy of the offsite and onsite ac power system, including ac power sources, safety-related ac distribution systems, and ac instrumentation and control power systems, as part of its primary review responsibility for SRP Sections 8.2 and 8.3.1.

2. In accordance with SRP Section 8.4, the organization responsible for onsite dc power systems reviews overall compliance with 10 CFR 50.63 requirements, including the adequacy of the SBO analysis; the length of time that the plant can either withstand or cope with, and recover from, an SBO event; and the adequacy of dc system power supplies that are not a part of the onsite dc power system reviewed under this SRP section regarding the specified SBO event/duration.

3. The organization responsible for onsite dc power systems reviews the adequacy of the environmental qualification of safety-related electrical equipment, as part of its primary review responsibility for SRP Section 3.11. This includes a review of the capability of safety-related electrical equipment to perform its intended safety functions when subjected to the effects of (a) accident environments such as loss-of-coolant accidents (LOCAs) and/or steamline breaks, (b) abnormal environments that may temporarily exceed equipment continuous-duty design parameters such as temperature and humidity, (c) abnormal environments caused by degradation or loss of heating, ventilation, and/or air conditioning systems, (d) seismic shaking, and (e) normal design environments on redundant safety-related electrical equipment that does not include design diversity (e.g., redundant components manufactured and designed by the same supplier).

4. The organization responsible for the review of plant ventilation systems evaluates the adequacy of those auxiliary supporting ventilation systems that are vital to the proper operation and/or protection of the dc power system, as part of its primary review responsibility for SRP Sections 9.4.1 through 9.4.5. This includes systems such as the heating and ventilation systems for load center, battery, battery charger, and inverter rooms. In particular, the organization responsible for the review of plant ventilation systems determines whether the piping, ducting, and valving arrangements of redundant auxiliary supporting systems meet the single-failure criterion.

5. The organization responsible for the review of plant structures examines the physical arrangement of the dc power system and its supporting auxiliary system components and associated structures to confirm that single events and accidents will not disable redundant features, as part of its primary review responsibility for SRP Sections 3.4.1, 3.5.1.1, 3.5.2, and 3.6.1.

6. The organization responsible for the review of engineered safety feature systems identifies those system components that require electric power as a function of time for each mode of reactor operation and accident condition, as part of its primary review responsibility for SRP Sections 6.5.1, 6.7, 9.1.3, 9.1.4, 9.2.1, 9.2.2, 9.2.4, 9.2.5, 9.2.6, 9.3.1, 9.3.3, 9.4.1 through 9.4.5, 9.5.1, 10.4.5, 10.4.7, and 10.4.9.

7. The organization responsible for fire protection examines the fire detection and fire protection systems for the dc power system and its vital supporting systems to ensure that the adverse effects of fire are minimized, as part of its primary review responsibility for SRP Section 9.5.1. This review includes assessing the adequacy of protection provided for redundant safe-shutdown circuits to confirm that a single design-basis fire will not disable both redundant circuits.

8. The organization responsible for the review of reactor coolant and auxiliary process systems identifies those system components that require electric power as a function of time for each mode of reactor operation and accident condition, as part of its primary review responsibility for SRP Sections 5.4.8, 9.2.3, 9.3.2, and 9.3.4.

9. The organization responsible for the review of containment systems and severe accidents evaluates the adequacy of those containment ventilation systems provided for maintaining a controlled environment for safety-related electrical equipment located inside the containment, as part of its primary review responsibility for SRP Section 6.2.2. The organization responsible for the review of containment systems and severe accidents identifies those system components that require electric power as a function of time for each mode of reactor operation and accident condition, as part of its primary review responsibility for SRP Sections 6.2.2, 6.2.3, 6.2.4, and 6.2.5.

10. The organization responsible for the review of reactor coolant and reactivity systems identifies those system components that require electric power as a function of time for each mode of reactor operation and accident condition, as part of its primary review responsibility for SRP Sections 4.6, 5.4.6, 5.4.7, 5.4.12, 6.3, and 9.3.5.

11. The organization responsible for the review of instrumentation and controls identifies those system components that require electric power as a function of time for each mode of reactor operation and accident condition, as part of its primary review responsibility for SRP Sections 7.2 through 7.7. In addition, the organization responsible for the review of instrumentation and controls verifies the adequacy of safety-related display instrumentation, alarms, and other instrumentation systems (including bypass indication, status of batteries, and status of battery chargers required for safety), as part of its primary review responsibility for SRP Sections 7.5 and 7.6.

12. The organization responsible for the review of quality assurance ~~and maintenance~~ determines the acceptability of the preoperational and initial startup tests and programs, as part of its primary review responsibility for SRP Section 14.2.

13. The organization responsible for quality assurance ~~coordinates and~~ performs the reviews of design, construction, and operations phase quality assurance programs, including general methods for addressing periodic testing, ~~maintenance, and reliability assurance~~ under SRP ~~Section~~ ~~Chapter~~ 17~~.5.~~ ~~The organization responsible for quality assurance also reviews the regulatory treatment of nonsafety systems (RTNSS) in passive plant designs, as part of its primary review responsibility for SRP Section 17.5.~~

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In addition, while conducting regulatory audits in accordance with Office Instruction NRR-LIC-111 or NRO-REG-108, "Regulatory Audits," the technical staff may identify quality-related issues. If this occurs, then the technical staff should contact the organization responsible for quality assurance to determine if an inspection should be conducted.

14. The organization responsible for mechanical engineering reviews the criteria for seismic qualification and the test and analysis procedures and methods to ensure the mechanical survivability of Category I instrumentation and electrical equipment (including raceways, switchgear, control room boards, and instrument racks and panels) if a seismic event occurs, as part of its primary review responsibility for SRP Chapter 3.

15. The organization responsible for the review of technical specifications coordinates and performs reviews for technical specifications as part of its primary review responsibility for SRP Section 16.0. Technical specification reviews will include evaluations of surveillance requirements and limiting conditions of operation for the use of interconnections, including those between safety-related dc power systems for multiunit stations.

16. The organization responsible for human performance, as part of its primary review responsibility for SRP Sections 13.5.1.1 and 13.5.2.1, reviews the adequacy of administrative, maintenance, testing, and operating procedure programs.

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. GDC 2, as it relates to the ability of dc power system SSCs to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapter 3 of the SAR and reviewed by organizations with primary responsibility for the reviews of plant systems, civil engineering and geosciences, and mechanical engineering.

2. GDC 4, as it relates to the ability of dc power system SSCs to withstand the effects of missiles and environmental conditions associated with normal operation and postulated accidents, as established in Chapter 3 of the SAR and reviewed by the organizations with primary responsibility for the reviews of plant systems, materials, and chemical engineering.

3. GDC 5, as it relates to sharing dc power system SSCs.

4. GDC 17, as it relates to (a) the capacity and capability of the onsite dc power system to enable the functioning of SSCs important to safety and (b) the independence and

redundancy of the onsite dc power system in performing its safety function, assuming a single failure.

5. GDC 18, as it relates to the testability of the onsite dc power system.

6. GDCs 33, 34, 35, 38, 41, and 44 as they relate to the operation of the onsite electric power system, encompassed in GDC 17 to ensure that the safety functions of the systems described in GDCs 33, 34, 35, 38, 41, and 44 are accomplished.

7. GDC 50, as it relates to the design of containment electrical penetrations containing circuits of safety-related and nonsafety-related dc power systems.

8. 10 CFR 50.63, as it relates to the ability of the onsite dc power system to support the plant in withstanding or coping with, and recovering from, an SBO event.

9. 10 CFR 50.55a(h), as it relates to the incorporation of Institute for Electrical and Electronics Engineers (IEEE) Standard (Std) 603-1991 (including the correction sheet dated January 30, 1995) and IEEE Std. 279 for protection and safety systems.

10. 10 CFR 50.65(a)(4), as it relates to the assessment and management, before the performance of maintenance activities, of the increase in risk that may result from proposed maintenance activities. These activities include, but are not limited to, surveillances, postmaintenance testing, and corrective and preventive maintenance. Compliance with the maintenance rule, including verification that appropriate maintenance activities are covered therein, is reviewed under SRP Chapter 17.

11. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations;

12. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Branch technical positions and regulatory guides that provide information, recommendations, and guidance and in general describe a basis acceptable to the staff that may be used to implement the requirements of GDCs 2, 4, 5, 17, 18, and 50 are identified in SRP Section 8.1, Table 8.1.

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical

techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

1. Regulatory Guide 1.6 positions D.1, D.3, and D.4, as they relate to the independence between redundant onsite dc power sources and between their distribution systems.

2. Regulatory Guide 1.32, as it relates to the design, operation, and testing of the safety-related portions of the onsite dc power system. Except for sharing of safety-related dc power systems in multi-unit nuclear power plants, RG 1.32 endorses IEEE Std. 308-2001.

3. Regulatory Guide 1.75, as it relates to the physical independence of the circuits and electrical equipment that comprise or are associated with the onsite dc power system.

4. Regulatory Guide 1.81, as it relates to the sharing of structures, systems, and components of the dc power system. Regulatory Position C.1 states that multi-unit sites should not share dc systems.

5. Regulatory Guide 1.128, as it relates to the installation of vented lead-acid storage batteries in the onsite dc power system.

6. Regulatory Guide 1.129, as it relates to maintenance, testing, and replacement of vented lead-acid storage batteries in the onsite dc power system.

7. Regulatory Guide 1.118, as it relates to the capability to periodically test the onsite dc power system.

8. Regulatory Guide 1.153, as it relates to the design, reliability, qualification, and testability of the power, instrumentation, and control portions of safety systems of nuclear plants, including the application of the single failure criterion in the onsite dc power system. As endorsed by Regulatory Guide 1.153, IEEE Std. 603 provides a method acceptable to the staff to evaluate all aspects of the electrical portions of the safety-related systems, including basic criteria for addressing single failures. However, as stated in 10 CFR 55a(h), all plants are not required to comply with IEEE Std. 603. Only applications filed on or after May 13, 1999, for preliminary and final design approvals (10 CFR Part 52, Appendix O), design certification, and construction permits; operating licenses and combined licenses that do not reference a final design approval or design certification must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995. Operating nuclear power plants are encouraged, but not required to, comply with IEEE Std. 603 for future system-level modifications.

9. Regulatory Guide 1.53, as it relates to the application of the single-failure criterion.

10. Regulatory Guide 1.63, as it relates to the capability of electric penetration assemblies in containment structures to withstand a loss of coolant accident without loss of mechanical integrity and the external circuit protection for such penetrations.

11. Regulatory Guide 1.155, as it relates to the capability and the capacity of the onsite dc power system for an SBO, including batteries associated with the operation of the alternate ac (AAC) power source(s) (if used).

12. The guidelines of Regulatory Guide 1.160, as they relate to the effectiveness of maintenance activities for dc power systems. Compliance with the maintenance rule, including verification that appropriate maintenance activities are covered therein, is reviewed under SRP Chapter 17.

13. The guidelines of Regulatory Guide 1.182, as they relate to conformance to the requirements of 10 CFR 50.65(a)(4) for assessing and managing risk when performing maintenance.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. Compliance with GDC 2 requires that nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena such as earthquake, tornado, hurricane, flood, tsunami, or seiche without losing the capability to perform their intended safety functions.

   With regard to the dc power system, this criterion requires that the capability for the onsite dc power system to perform its functions must be retained during the most severe natural phenomena that historically have been reported for the site and surrounding area. Therefore, the dc power system and its components must normally be located in seismic Category I structures that provide protection from the effects of tornadoes, tornado missiles, and floods. Equipment and components composing the onsite dc power system must also generally be seismically designed and/or qualified to perform their functions in the event of an earthquake.

   Meeting this requirement will provide assurance that equipment and structures will be designed to withstand the effects associated with natural phenomena, thus decreasing the probability that seismically and/or climatologically related natural phenomena could initiate accidents or prevent equipment from performing its safety function during an accident.

2. Compliance with GDC 4 requires that SSCs important to safety (a) be designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents and (b) be appropriately protected against dynamic effects that may result from equipment failures, including missiles.

   The dc power system must provide power to systems important to safety during normal, abnormal, accident, and postaccident conditions.
   Meeting these requirements will provide assurance that the dc power system will supply the electric power required for the operation of systems important to safety, even if or when they are subject to adverse environmental conditions and/or dynamic effects.

3. Compliance with GDC 5 requires that SSCs important to safety shall not be shared among nuclear power units unless such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

   This criterion requires that component parts of the dc power system must not be shared among units without sufficient justification, thereby ensuring that an accident in one unit of a multiunit facility can be mitigated by using an available complement of mitigative features, including required dc power, irrespective of conditions in the other units and without creating conditions that are unduly adverse to safety in another unit. This SRP section cites Regulatory Guides 1.32 and 1.81 to establish acceptable guidance related to the sharing of onsite dc power system SSCs. Regulatory Position C.1 of Regulatory Guide 1.81 recommends that dc systems in multiunit nuclear power plants should not be shared.

4. Compliance with GDC 17 requires the provision of onsite and offsite electrical power to facilitate the functioning of SSCs important to safety. Each electric power system, assuming that the other system is not functioning, must provide sufficient capacity and capability to ensure that (a) specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (b) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

   GDC 17 further requires that the supply of electric power from the transmission network to the onsite electric distribution system must come from two physically independent circuits that are designed and located to minimize the likelihood of their simultaneous failure under operating, postulated accident, and postulated environmental conditions. Each of these circuits must be designed to be available, following a loss of all onsite ac power supplies and the other offsite electric power circuit, in sufficient time to ensure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded. One of these circuits also must be designed to be available within a few seconds after a LOCA to ensure that core cooling, containment integrity, and other vital safety functions are maintained.

   Provisions must also be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.

   GDC 17 also requires that the onsite power supplies and the onsite electrical distribution system have sufficient independence, redundancy, and testability to perform their safety functions, assuming a single failure. Therefore, no single failure will prevent the onsite power system from supplying electric power, thereby enabling safety functions and other vital functions that require electric power to be performed after any single failure in the power system.

   This SRP section cites Regulatory Guides 1.6, 1.32, 1.53,1.75, 1.128, and 1.153 as establishing acceptable guidance for meeting the requirements of GDC 17. SRP Sections 8.1, 8.2, 8.3.1, and 8.4 include additional information related to the review of compliance with GDC 17.

Meeting the requirements of GDC 17 provides assurance that a reliable dc power supply will be provided for all facility operating modes, including anticipated operational occurrences and design-basis accidents, to permit the performance of safety functions and other vital functions, even in the event of a single failure.

5. Compliance with GDC 18 requires that electric power systems important to safety be designed to permit appropriate periodic inspection and testing of key areas and features to assess their continuity and the condition of their components. These systems shall be designed to test periodically (a) the operability and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses, and (b) the operability of the systems as a whole and, under conditions as close to design as practical, the full operation sequence that brings the systems into operation, including operation of applicable portions of the protection system and the transfer of power among the nuclear power unit, the offsite power system, and the onsite power system.

   This criterion requires that the dc power system provide the capability to perform integral periodic testing of Class 1E systems. This SRP section cites Regulatory Guides 1.32, 1.47, 1.118, 1.129, and 1.153 and Branch Technical Position 8-5 as establishing acceptable guidance for meeting the requirements of this criterion.

   Meeting the requirements of GDC 18 provides assurance that, when required, onsite dc power systems can be appropriately and unobtrusively accessed for required periodic inspection and testing, enabling verification of important system parameters, performance characteristics, and features, as well as detection of degradation and/or impending failure under controlled conditions.

6. GDCs 33, 34, 35, 38, 41, and 44 set requirements for the safety systems for which access to both offsite and onsite power sources must be provided. Compliance with these criteria requires provision of this capability for reactor coolant makeup during small breaks, residual heat removal, emergency core cooling, containment heat removal, containment atmosphere cleanup, and cooling water for SSCs important to safety. These systems must be available during normal and accident conditions, as required by the specific system.

   GDCs 33, 34, 35, 38, 41, and 44 require safety system redundancy such that, for onsite power system operation (assuming offsite power is unavailable), the system safety function can be accomplished, assuming a single failure. Redundancy must be reflected in the standby power system with regard to both power sources and associated distribution systems. In addition, redundant safety loads must be distributed between redundant distribution systems, and associated redundant distribution systems must supply the instrumentation and control devices for the Class 1E loads and power system. For the dc power system, these requirements are met if the minimum design required by GDC 17 is provided.

   Meeting the requirements of these criteria, as encompassed by GDC 17, provides assurance that required dc power will be provided for all facility operating modes, including transients and design-basis accidents, so that the safety functions required in these criteria may be performed, even in the event of any single failure.

7. Compliance with GDC 50 requires that the reactor containment structure—including access openings, penetrations, and containment heat removal systems—be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any LOCA. Containment electric penetrations must therefore be designed to accommodate, without exceeding their design leakage rate, the calculated pressure and temperature conditions resulting from a LOCA.

   This criterion, as it applies to this SRP section, relates specifically to ensuring the integrity of containment electrical penetrations in the event of design-basis LOCA conditions. This SRP section cites Regulatory Guide 1.63 as guidance acceptable to the staff for meeting the requirements of this criterion.

   Meeting the requirements of GDC 50 provides assurance that a LOCA will not cause a containment structure, including its electrical penetrations, to exceed the design leakage rate, thus limiting the consequences of a LOCA.

8. Compliance with 10 CFR 50.63 requires that each light-water-cooled nuclear power plant be able to withstand and recover from an SBO of specified duration. As required by 10 CFR 50.63, electrical systems must be of sufficient capacity and capability to ensure that the core is cooled and that appropriate containment integrity is maintained in the event of an SBO.

   The capacity of any onsite dc sources required for SBO response must be verified as adequate to address the worst-case SBO load profile and specified duration. For new advanced light-water reactor applications that use passive safety systems (such as the AP1000) and do not include a spare, full-capacity alternate ac power source for coping with an SBO, the reviewer should ensure that (a) all safety-related functions can be performed without relying on ac power for 72 hours after the initiating event, and (b) the applicant has implemented an RTNSS process that conforms to Chapter C.IV.10 of RG 1.206. For COL applicants who reference a certified design, that certification addresses the implementation of the RTNSS process. Regulatory Guide 1.155 and SRP Section 8.4 describe guidance acceptable to the staff for meeting the requirements of 10 CFR 50.63.

   Meeting the requirements of 10 CFR 50.63 provides assurance that nuclear power plants will be able to withstand or cope with, and recover from, an SBO by providing capability for maintaining core cooling and an appropriate level of containment integrity.

III. REVIEW PROCEDURES

The primary objective in the review of the dc power system is to determine whether this system satisfies the acceptance criteria in Subsection II and will perform its design functions during normal plant operations, anticipated operational occurrences, accident conditions, and SBO events. To ensure that the acceptance criteria in Subsection II are satisfied, the review is performed as detailed below.

The primary reviewer will coordinate this review with the other branch areas of review, as stated in Subsection I. The primary reviewer obtains and uses such input as required to ensure that this review procedure is complete.

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

Although IEEE Std. 946, IEEE Std. 1375, and IEEE Std. 1184 furnish additional technical supporting information related to the design of onsite dc power systems, a regulatory guide has not formally endorsed these standards. Therefore, they are included here as additional sources of information only.

1. System Redundancy Requirements. GDCs 33, 34, 35, 38, 41, and 44 set requirements regarding safety-related systems that must be supplied by the onsite ac and dc power systems. In addition, these criteria state that safety-related system redundancy shall be such that, for onsite power system operation (assuming offsite power is not available), the system safety function can be accomplished, assuming a single failure. The acceptability of the onsite dc power system with regard to redundancy is based on conformance to the same degree of redundancy as that needed for safety-related components and systems required by these criteria. As endorsed by Regulatory Guide 1.153, IEEE Std. 603 provides a method acceptable to the staff to evaluate all aspects of the electrical portions of safety-related systems and the onsite power system, including criteria addressing redundancy. Compliance with IEEE Std. 603-1991 is only required for plants with construction permits issued after May 13, 1999. Operating nuclear power plants are encouraged, but not required, to comply with IEEE Std. 603 for future system-level modifications. The staff will review the descriptive information—including electrical single-line diagrams, functional P&IDs, and electrical control and schematics—to verify that the dc power system reflects this redundancy, both in power sources and in associated distribution systems. The reviewer will also coordinate with other branches to verify that (a) redundant safety-related loads are distributed between redundant distribution systems and (b) the instrumentation and control devices for the safety-related loads and power system are supplied from the related redundant distribution systems. The review verifies that reactor core cooling is maintained after the loss of any one dc power supply or bus and a single independent active failure in any other system required for shutdown cooling.

2. Conformance with the Single-Failure Criterion. As required by GDC 17, the dc power system must be capable of performing its safety function, assuming a single failure. In evaluating the adequacy of this system to meet the single-failure criterion, the staff will review both electrical and physical separation of redundant power sources and distribution systems, including their connected loads, to assess the independence between redundant portions of the system.

   To ensure electrical independence, the staff will review the design criteria, analyses, description, and implementation—as depicted on functional logic diagrams, electrical single-line diagrams, and electrical control and schematics—to determine whether the design meets the positions of Regulatory Guides 1.153, 1.53, 1.32, and 1.6. As endorsed by Regulatory Guide 1.153, IEEE Std. 603 provides a method acceptable to the staff for evaluating all aspects of the electrical portions of safety-related systems and the onsite power system. For guidance related to the application of the single-failure

criterion, IEEE Std. 603 references IEEE Std. 379. In addition, as endorsed by Regulatory Guide 1.53, IEEE Std. 379 provides an acceptable methodology for satisfying the Commission's regulations for the application of the single-failure criterion to onsite dc power systems. The following aspects of the design need special review attention to confirm that the electrical independence and physical separation have not been compromised:

A. The reviewer will examine interconnections between redundant load centers through bus tie breakers and multifeeder breakers used to connect extra redundant loads to either of the redundant distribution systems to ensure that no single failure in the interconnections or inadvertent closure of interconnecting devices will compromise division independence in a manner that will cause the paralleling of the dc power supplies. To ensure this, the control circuits of the bus tie breakers or multifeeder breakers must preclude automatic transferring of load centers or loads from the designated supply to the redundant counterpart upon loss of the designated supply (Regulatory Position 4 of Regulatory Guide 1.6). Regarding the interconnections through bus tie breakers, an acceptable design will provide for two tie breakers connected in series and physically separated from each other in accordance with the acceptance criteria for separation of safety-related systems, as discussed below. Furthermore, the interconnection of redundant load centers must be accomplished only manually.

B. To ensure physical independence, the staff will review the criteria governing the physical separation of redundant equipment, including cables and cable trays and their implementation as depicted on preliminary or final physical arrangement drawings, to confirm that the design arrangement satisfies the requirements of IEEE Std. 384 and the positions of Regulatory Guide 1.75. These guides and standards set acceptance criteria for the separation of circuits and electrical equipment contained in, or associated with, the safety-related dc power system. To determine whether the independence of the redundant cable installation is consistent with the requirements in IEEE Std. 384 and the positions in Regulatory Guide 1.75, the staff will review the proposed design criteria governing the separation of safety-related cables and raceways, including criteria such as those for cable derating; raceway filling; cable routing in containment penetration areas, cable spreading rooms, control rooms, and other congested areas; sharing raceways with nonsafety-related cables or with cables of the same system or other systems; prohibiting cable splices in raceways; spacing power and control wiring and components associated with safety-related electric systems in control boards, panels, and relay racks; and fire barriers and separation between redundant raceways.

3. Power Supplies and Distribution Systems. To ensure that the requirements of GDC 17 have been met regarding the dc power system having sufficient capacity and capability to supply the required distribution system loads, the staff will review the design bases, design criteria, analyses, description, and implementation (as depicted on electrical drawings and performance characteristic curves). As endorsed by Regulatory Guide 1.32, IEEE Std. 308 describes a method acceptable to the NRC staff for complying with the NRC's regulations for the design, operation, and testing of dc power systems in nuclear power plants.

To establish that the capacity of the dc supply is adequate to power the prescribed loads, reviewer checks the nameplate capacity claimed in the design bases against the loads identified in electrical distribution diagrams. The staff will review the capability of the system by evaluating the performance characteristic curves that illustrate the response of the supplies to the most severe loading conditions at the plant. The performance characteristic curves would include voltage profile curves, discharge rate curves, and temperature effect curves. IEEE Std. 485 provides a method acceptable to the staff for sizing stationary lead acid batteries. The capacity of the dc supplies should be ensured by periodic discharge tests of the batteries, as described in IEEE Std. 450 and Regulatory Guide 1.129.

Regulatory Guide 1.128 and IEEE Std. 484 provide the basis for the review of design practices and procedures for storage, location, mounting, ventilation, instrumentation, preassembly, assembly, and charging of large lead storage batteries.

In coordination with other branches, the reviewer becomes familiar with the purpose and operation of each safety system, including system component arrangements as depicted on functional P&IDs, expected system performance as established in the accident and/or other relevant analyses (e.g., for SBO), modes of system operation and interactions during normal and accident conditions, and interactions among systems.

Subsequently, the reviewer will verify that the tabulation of all safety-related loads to be connected to each dc supply is consistent with the information obtained in coordination with other branches.

The characteristics of each load (such as motor horsepower and volt-amp ratings, inrush current, starting volt-amps, and torque), the length of time each load is required, and the basis used to establish the power required for each safety-related load (such as motor name plate rating, pump runout condition, or estimated load under expected flow and pressure) are used to verify the calculations establishing the combined load demand to be connected to each dc supply during the worst operating conditions. In reviewing the design of the thermal overload protection for motors of motor-operated safety-related valves, the reviewer uses Regulatory Guide 1.106.

If the proposed design provides for the sharing of dc supplies between units at the same site and for connection and disconnection of nonsafety-related loads to and from the safety-related distribution buses, the review gives particular attention to ensuring that the implementation of such design provisions does not compromise the capacity, capability, or reliability of these supplies. Regulatory Position C.1 of Regulatory Guide 1.81 recommends that dc systems in multiunit nuclear power plants should not be shared. Because sharing of dc power systems and their interactions between units could compromise safe shutdown, Regulatory Guide 1.32 does not endorse the IEEE Std. 308-2001 criteria for sharing safety-related dc power systems in multiunit nuclear power plants.

If the proposed design provides for the connection and disconnection of nonsafety-related loads to and from the safety-related distribution buses, the review of the interconnections will consider isolation devices, as defined in Regulatory Guide 1.75, and engineering judgment to determine the adequacy of the design. To ensure that the interconnections between nonsafety-related loads and safety-related buses will not result in the degradation of the safety-related system, the isolation device through which

dc power is supplied to the nonsafety-related load, including control circuits and connections to the safety-related bus, must be designed to meet safety Class 1E requirements. If the dc power supplies have not been sized to accommodate the added nonsafety-related loads during emergency conditions, the design must provide for the automatic disconnection of those nonsafety-related loads upon detection of the emergency condition. This action must be accomplished regardless of whether the load was already connected to the power supply. For new applications licensed under 10 CFR Part 52, the review should ensure that dc power systems are not shared between units.

4. Identification of Cables, Raceways, and Terminal Equipment. The staff will review the identification scheme used for safety-related cables, raceways, and terminal equipment in the plant and internal wiring in the control boards to confirm that it is consistent with IEEE Std. 384, as augmented by Regulatory Guide 1.75. This includes the criteria for differentiating among (a) safety-related cables, raceways, and terminal equipment of different channels or divisions, (b) nonsafety-related cable that is run in safety raceways, (c) nonsafety-related cable that is not associated physically with any safety division, and (d) safety-related cables, raceways, and terminal equipment of one unit with respect to the other units at a multiunit site.

5. Vital Supporting Systems. The reviewer will evaluate supporting systems identified as vital to the operation of safety-related loads and systems. As endorsed by Regulatory Guide 1.153, IEEE Std. 603 provides a method acceptable to the staff to evaluate all aspects of the instrumentation, control, and electrical portions of auxiliary supporting systems and features, including basic requirements that call for auxiliary supporting systems and features to satisfy the same criteria as the supported safety systems. Compliance with IEEE Std. 603-1991 is only required for plants with construction permits issued after May 13, 1999. Operating nuclear power plants are encouraged, but not required, to comply with IEEE Std. 603 for future system-level modifications.

   The staff will review the instrumentation, control, and electrical aspects of the vital supporting systems and features to ensure that their design conforms to the same criteria as those for the systems that they support. Hence, the review procedure for ascertaining the adequacy of these systems and features is the same as that discussed herein for the onsite systems. In essence, the reviewer first becomes familiar with the purpose and operation of each vital supporting system and feature, including its component arrangement as depicted on functional P&IDs. Subsequently, the reviewer evaluates the design criteria, analyses, and description and the implementation of the instrumentation, control, and electrical equipment, as depicted on electrical drawings, to verify that the design is consistent with satisfying the acceptance criteria for Class 1E systems. In addition, the reviewer verifies that the vital supporting system redundant instrumentation, control devices, and loads are powered from the same redundant distribution system as the system that they support. The reviewer will also verify that the vital supporting systems that are associated with the emergency diesel engines, such as the provisions for dc control power, are in accordance with the acceptance criteria.

   The organization responsible for the review of plant ventilation systems evaluates the other aspects of the vital supporting systems to verify that the design, capacities, and physical independence of these systems are adequate for their intended functions. This review includes an assessment of the heating, ventilation, and air conditioning (HVAC) systems identified as necessary to Class 1E systems, such as the HVAC systems for the

electrical switchgear, battery, charger, and inverter rooms. The organization responsible for the review of plant ventilation systems will verify the adequacy of the HVAC system design to maintain temperature and relative humidity in the room as required for proper operation of the safety equipment during both normal and accident conditions. This organization will also verify that redundant HVAC systems are located in the same enclosure as the redundant unit they serve or are separated in accordance with the same criteria as those for the systems they support.

6. System Testing and Surveillance. To ensure that the proposed periodic onsite testing capabilities of the safety-related dc power system satisfy the requirements of GDC 18 and the positions of Regulatory Guides 1.32 and 1.118, the staff will review the descriptive information, functional logic diagrams, and electrical control and schematics to verify that the design has the built-in capability to permit integral periodic testing of safety-related dc systems when the reactor is in operation. The reviewer will also verify the built-in capability for the testing recommended in Regulatory Guide 1.129 (see also IEEE Std. 450). IEEE Std. 603, as endorsed by Regulatory Guide 1.153, also describes a method acceptable to the staff for reviewing the surveillance and testability of the safety-related aspects of the onsite dc power system. Compliance with IEEE Std. 603-1991 is only required for plants with construction permits issued after May 13, 1999. Operating nuclear power plants are encouraged, but not required, to comply with IEEE Std. 603 for future system-level modifications.

   The staff will review the descriptive information and design implementation, as depicted on electrical drawings, of the means proposed for automatically indicating at the system level a bypassed or deliberately inoperative status of a redundant portion of a safety-related system to ascertain that the design is consistent with Regulatory Guide 1.47 and Branch Technical Position 8-5. This position establishes the basis to consider in arriving at an acceptable design for the inoperable status indication system.

7. Station Blackout Events. To ensure that plant systems have the capability and capacity to withstand an SBO event of a specified minimum duration, the review of the onsite dc power systems should confirm that the requirements of 10 CFR 50.63 regarding onsite dc system capability and capacity are met. The reviewer verifies, as applicable for portions of the onsite dc power system that are required for SBO, that the guidelines of Regulatory Positions C.3.2.2 and/or C.3.3.1 and C 3.3.5 of Regulatory Guide 1.155 have been implemented.

8. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

   For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The dc power systems include those dc power sources and their distribution systems and auxiliary supporting systems provided to supply motive or control power to safety-related equipment and to equipment used to cope with an SBO event. Batteries and battery chargers serve as the power sources for the dc power system, and inverters convert dc from the dc distribution system to ac instrumentation and control power, as required. These three components, when combined, provide a UPS that furnishes a continuous, highly reliable source of ac supply.

The review of the dc power system for the (name of plant) plant covered the single-line diagrams, station layout drawings, electrical control and schematic diagrams, and descriptive information. The basis for acceptance of the dc power system in the review was conformance of the design criteria and bases to the Commission's regulations in 10 CFR 50.63 and the GDC of Appendix A to 10 CFR Part 50. The staff concludes that the plant design is acceptable and meets the requirements of GDCs 2, 4, 5, 17, 18, and 50 and of 10 CFR 50.63. This conclusion is based on the following:

1. The applicant has met the requirements of GDC 2 with respect to structures, systems, and components of the dc power systems that are capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods because the dc power system and components are located in seismic Category I structures, which provide protection from the effects of tornadoes, tornado missiles, and floods. In addition, the dc power system and components have a quality assurance designation of Class 1E.

2. The applicant has met the requirements of GDC 4 with respect to structures, systems, and components of the dc power system that are capable of withstanding the effects of missiles and environmental conditions associated with normal operation and postulated accidents because of an adequate plant design and an equipment qualification program.

3. The applicant has met the requirements of GDC 5 with respect to structures, systems, and components of the dc power system. Physically separate seismic Category I structures house the dc power system and components associated with the multi-unit design, and they are not shared between units. Acceptability was based on the applicant meeting Regulatory Position C.2.a of Regulatory Guide 1.32 and Regulatory Position C.1 of Regulatory Guide 1.81.

4. The applicant has met the requirements of GDC 17 with respect to the onsite dc power system's (a) capacity and capability to permit the functioning of structures, systems, and components important to safety, (b) the independence and redundancy necessary to perform their safety functions, assuming a single failure, and (c) provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of,

or coincident with, the loss of power generated by the nuclear power unit or the loss of power from the transmission network. Acceptability was based on the applicant's design of the dc power systems meeting the guidelines of Regulatory Positions D.1, D.2, and D.4 of Regulatory Guide 1.6 and the guidelines of Regulatory Guides 1.32, 1.75, 1.53, 1.128, 1.129, and 1.153.

5. The applicant has met the requirements of GDC 18 with respect to the onsite dc power system. The dc power system is designed to be testable during operation of the nuclear power generating station as well as during those intervals when the station is shut down. Acceptability was based on the applicant meeting the test capability guidelines of Regulatory Guide 1.32 and the guidelines of Regulatory Guides 1.118, 1.129, and 1.153.

6. The applicant has met the requirements of GDC 50 with respect to penetrations containing circuits of the safety- and nonsafety-related dc power system. Containment electric penetrations have been designed to accommodate, without exceeding their design leakage rate, the calculated pressure and temperature conditions resulting from any LOCA concurrent with the maximum short-circuit current versus time condition that could occur given single random failures of circuit overload protective devices. This meets the positions of Regulatory Guide 1.63.

7. The applicant has met the requirements of 10 CFR 50.63 with respect to the onsite dc power system. The dc power systems have adequate capability and capacity to enable the plant to withstand and recover from an SBO event of specified duration. Acceptability is based on meeting the relevant positions of Regulatory Guide 1.155. Sections 8.2 and 8.4 of the SER further detail the applicant's compliance with the requirements of 10 CFR 50.63.

8. The applicant has met the requirements of 10 CFR 50.55a(h), as it relates to the incorporation of IEEE Std. 603-1991 (including the correction sheet dated January 30, 1995) and IEEE Std. 279 for protection and safety systems. Acceptability is based on meeting the relevant positions of Regulatory Guide 1.153.

9. The applicant has met the requirements of 10 CFR 50.65(a)(4) with respect to the onsite dc power system. The acceptability is based on meeting the relevant positions of Regulatory Guide 1.182.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

5. Standard Review Plan, Section 8.1, Table 8-1, "Acceptance Criteria and Guidelines for Electric Power Systems." (See Table 8-1 for a detailed list of acceptance criteria and guidance references for all SRP Chapter 8 sections.)

6. Standard Review Plan, Appendix 8-A, "General Agenda, Station Site Visits."

7. Branch Technical Position 8-5, "Supplemental Guidance for Bypass and Inoperable Status Indication for Engineered Safety Features Systems."

8. NUREG-0933, "A Prioritization of Generic Safety Issues," November 2005.

9. NUREG-1793, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," September 2004.

10. Regulatory Guide 1.6, "Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems."

7. Regulatory Guide 1.32, "Criteria for Power Systems for Nuclear Power Plants."

8. Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants."

9. Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems."

10. Regulatory Guide 1.53, "Application of the Single Failure Criterion to Safety Systems."

11. Regulatory Guide 1.75, "Criteria for Independence of Electrical Safety Systems."

12. Regulatory Guide 1.81, "Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants."

13. Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems."

14. Regulatory Guide 1.128, "Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants."

15. Regulatory Guide 1.129, "Maintenance, Testing, and Replacement of Vented Lead-Acid Storage Batteries for Nuclear Power Plants."

16. Regulatory Guide 1.153, "Criteria for Safety Systems."

17. Regulatory Guide 1.155, "Station Blackout."

18. Regulatory Guide 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.”

19. Regulatory Guide 1.182, “Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants.”

20. Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition).”

21. NRC Information Notice 97-21, “Availability of Alternate AC Power Source Designed for Station Blackout Event,” April 18, 1997

22. NUMARC-9700, Rev. 0, “Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors,” November 1987.

23. IEEE Std. 308-2001, “Criteria for Class 1E Power Systems for Nuclear Power Generating Stations.”

24. IEEE Std 379-2000, “Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems.”

25. IEEE Std 450-2002, “Recommended Practice for Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications.”

26. IEEE Std 484-2002, “Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications.”

27. IEEE Std. 485-1997, “Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.”

28. IEEE Std. 603-1991, “Criteria for Safety Systems for Nuclear Power Generating Stations.”

29. IEEE Std. 946-2004, “Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Stations.”

30. IEEE Std. 1375-1998, “Guide for the Protection of Stationary Battery Systems.”

31. IEEE Std. 1184-2006, “Guide for Batteries for Uninterruptible Power Supply Systems.”

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

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