U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

14.3.6[1] ELECTRICAL SYSTEMS (Tier 1)

This SRP section for electrical systems was developed for evolutionary light water reactor designs which typically involve a significant amount of reliance on AC electrical power for accomplishing safety functions. Because the designs of passive reactors involve much less reliance on AC electric power for accomplishing their safety functions, deviations from this SRP guidance may be anticipated for application to passive plants.

REVIEW RESPONSIBILITIES

Primary - Electrical Engineering Branch (EELB)

Secondary - None

I. AREAS OF REVIEW

EELB reviews the Tier 1 portion of the Design Control Document (DCD) submitted by the applicant. EELB has primary review responsibility for the station electrical systems in Tier 1. Review responsibilities may be consistent with those contained in Appendix A to SRP Section 14.3. The scope of the electrical review includes the entire Class 1E portion of the electrical system as well as a major portion of the non-Class 1E electrical system. It also includes portions of the plant lighting system. In addition, EELB has responsibility for the review of selected definitions, interface requirements of the standard design with the site, and site parameters for the design, that pertain to electrical issues.

USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

Review Interfaces

SRP Section 14.3 provides general guidance on review interfaces. EELB performs related reviews and coordination activities, as requested by other branches, for Tier 1 systems using Class 1E power. In addition, EELB coordinates other branches' evaluations that interface with the overall review of the systems as follows:

1. The Plant Systems Branch (SPLB) determines the acceptability of Tier 1 information regarding qualification of equipment to withstand harsh environments in SRP Section 14.3.7.

2. The Civil Engineering and Geosciences Branch (ECGB) determines the acceptability of Tier 1 information regarding qualification of equipment for seismic environments in SRP Section 14.3.2.

II. ACCEPTANCE CRITERIA

The acceptance criteria for ITAAC are based on meeting 10 CFR 52.97(b)(1), which sets forth the comprehensive requirements for ITAAC. For design certification reviews, the scope of ITAAC is limited to the scope of the certified design as required by 10 CFR 52.47(b).

In establishing the top level requirements for the electrical design, the reviewer should use the Code of Federal Regulations including the GDC of Appendix A and Parts 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," and 50.63, "Loss of All Alternating Current Power," as the main bases. In addition, IEEE nuclear standards should be used, as appropriate, to further establish top level requirements. These are discussed below. The reviewer should use the review checklists provided in Appendix C to SRP Section 14.3 as an aid for establishing consistency and comprehensiveness in the review of the systems. Also, the reviewer should consider significant lessons learned from operating experience problems and insights gained from the PRA for the standard design.

1. GDC 17, in part, requires that an onsite and an offsite electric power system be provided to permit functioning of structures, systems and components important to safety. It further requires that the onsite electric power system have independence and redundancy and the electric power supplied by the offsite system be supplied by two physically independent circuits.

2. 10 CFR 50.49 requires that certain electrical equipment be qualified for accident (referred to as harsh) environments.

3. 10 CFR 50.63 requires that a nuclear power plant be able to withstand and recover from a station blackout event.

4. IEEE 308 "IEEE Standard Criteria for Class 1E power Systems for Nuclear Power Generating Stations," in conjunction with other related IEEE standards, establish specific design criteria for nuclear power plant electrical systems and equipment.

The staff's review of the standard plant is conducted to ensure, in part, that Tier 1 contains top level design, fabrication, testing, and performance requirements for SSCs important to safety. Design descriptions and ITAAC should be established to verify that these top level requirements (or design commitments) are met when the plant is built.

Class 1E Electrical Systems

The standard design Class 1E electrical systems may include: (1) the Class 1E electrical power distribution system, (2) the emergency diesel generators, (3) the Class 1E direct current power supply, and (4) the Class 1E vital ac and Class 1E instrument and control power supplies. Using the above regulations, IEEE standards, operating experience, and PRA as its bases, the applicant should establish top-level design commitments for the Class 1E electrical systems of the standard design to be included in the design descriptions and verified by ITAAC. The top-level design commitments for the Class 1E electrical systems include design aspects related to:

1. Equipment qualification for seismic and harsh environment

   To ensure that the seismic design requirements of GDC 2 and the environmental qualification requirements of 10 CFR 50.49 have been adequately addressed, a "basis configuration" standard ITAAC may be established for applicable systems to verify these design aspects of electrical equipment important to safety.

   The design description should identify that Class 1E equipment is seismic Category 1 and equipment located in a harsh environment is qualified. The basic configuration standard ITAAC may be used to verify these areas.

2. Redundancy and independence

   To ensure that the Class 1E electric systems meet the single failure requirements of GDC 17 (and other GDC), ITAAC may be established to verify the redundancy and independence of the Class 1E portion of the electrical design.

   For the electrical systems, ITAAC should verify the Class 1E divisional assignments and independence of electric power by both inspections and tests. The independence may be established by both electrical isolation and physical separation. Identification of the Class 1E divisional equipment should be included to aid in demonstrating the separation. (The detailed requirements are specified in Tier 2. For example, separation distances and identification are outlined in Tier 2.) These attributes should be verified all the way to the electrically powered loads by a combination of the electrical system ITAAC and the ITAAC of the individual fluid, I&C, and HVAC systems which also cover the electrical independence and divisional power supply requirements.

3. Capacity and capability

   To ensure that the electrical systems have the capacity and capability to supply the safety-related electrical loads, ITAAC may be established to verify the adequate sizing of the electrical system equipment and its ability to respond (e.g., automatically in the times

needed to support the accident analyses) to postulated events. This includes the Class 1E portion and the non-Class 1E portion to the extent that it is involved in supporting the Class 1E system.

ITAAC should be included to analyze the as-built electrical system and installed equipment (diesel generators, transformers, switchgear, batteries, etc.) to verify its ability to power the loads. In addition, the ITAAC should also include tests to demonstrate the operation of the equipment.

To ensure that the Class 1E portions of the electrical power system have the capability to respond to postulated events including LOCA, loss of normal preferred power, and degraded voltage conditions, ITAAC should be established to verify the initiation of the Class 1E equipment necessary to mitigate the event.

ITAAC should be included to analyze the as-built electrical power system for its response to a LOCA, loss of voltage, combinations of LOCA and loss of voltage, and degraded voltage. In addition, tests should be included to demonstrate the actuation of the electrical equipment in response to postulated events.

4. Electrical protection features

To ensure that the electrical power system is protected against potential electrical faults, ITAAC should be established to verify the adequacy of the electrical circuit protection included in the design. Operating experience and NRC Electrical Distribution System Functional Inspections (EDSFIs) have indicated some problems with the short circuit rating of some electrical equipment and breaker and protective device coordination.

ITAAC should be included to analyze the as-built electrical system equipment for its ability to withstand and clear electrical faults. ITAAC should also be included to analyze the protection feature coordination to verify its ability to limit the loss of equipment due to postulated faults.

5. Displays/controls/alarms

To help ensure that the electrical power system is available when required, ITAAC should be included to verify the existence of monitoring and controls for the electrical equipment. The minimum set of displays, alarms, and controls is based on the emergency procedure guidelines. In some cases, additional displays, alarms, and controls may be specified based on special considerations in the design and/or operating experience.

ITAAC should be included to inspect for the ability to retrieve the information (displays and alarms), and to control the electrical power system in the main control room and/or at locations provided for remote shutdown.

Other Electrical Equipment Important to Safety

In addition to the Class 1E systems addressed above, other aspects of the electrical design that are deemed to be important to safety and the top-level design commitments are included in Tier 1.

1. Offsite Power

   To ensure that the requirements of GDC 17 for the adequacy and independence of the preferred offsite power sources within the standard design scope were met, ITAAC should verify the capacity and capability of the offsite sources to feed the Class 1E divisions, and the independence of those sources.

   ITAAC should be included to inspect the direct connection of the offsite sources to the Class 1E divisions and to inspect for the independence/separation of the offsite sources. Lightning protection and grounding features are inspected as part of the basic configuration ITAAC.

   In addition, the design description includes "interface" requirements for the portions of the offsite power outside of the standard design scope; however, no ITAAC are included for the interfaces. The interfaces define the requirements that the offsite portion of the design (that is out-of-scope) must meet to support and not degrade the in-scope design (See also Appendix A to SRP Section 14.3).

2. Containment Electrical Penetrations

   To ensure the containment electrical penetrations (both those containing Class 1E circuits and those containing Non Class 1E circuits) do not fail due to electrical faults and potentially breach the containment, ITAAC should verify that all electrical containment penetrations are protected against postulated currents greater than their continuous current rating.

3. Combustion Turbine Generator

   To ensure the availability of the combustion turbine generator (CTG) as an alternate AC source for station blackout events, the ITAAC should verify, through inspection and testing, the CTG's and its auxiliaries inclusion in the design and its independence from other AC sources. In addition, the standard design's PRA should be used for an indication of the importance of the CTG from a risk perspective.

4. Lighting

   To ensure that portions of the plant lighting remain available during power failures, ITAAC should be developed to verify the continuity of power sources for the lighting systems.

Electrical Power For Non-Safety Plant Systems

To ensure that electrical power is provided to support the non-safety plant systems, Design Descriptions cover portions of the non-Class 1E electrical systems. A basic configuration ITAAC may be utilized to verify the functional arrangement and Tier 1 design commitments for these areas.

Technical Rationale:

In addition to meeting the requirements for ITAAC under 10 CFR Part 52, the technical rationale for application of the above acceptance criteria to Tier 1 is discussed in the following paragraphs.

1. Compliance with GDC 17, in part, requires that an onsite and an offsite electric power system be provided to permit functioning of structures, systems and components important to safety. It further requires that the onsite electric power system have independence and redundancy and the electric power supplied by the offsite system be supplied by two physically independent circuits. This provides a reasonable assurance that the facility will function reliably in the event of a fault in an area of the electrical design.

2. Compliance with 10 CFR 50.49 requires that certain electrical equipment be qualified for accident (referred to as harsh) environments. This provides a reasonable assurance that the equipment needed in the event of an accident will perform its intended function.

3. Compliance with 10 CFR 50.63 requires that a nuclear power plant be able to withstand and recover from a station blackout event. This ensures that the plant can withstand and recover from this event safely.

4. Compliance with IEEE 308 "IEEE Standard Criteria for Class 1E power Systems for Nuclear Power Generating Stations," in conjunction with other related IEEE standards, establish specific design criteria for nuclear power plant electrical systems and equipment. This provides a reasonable assurance that the electrical systems will perform their intended function in the anticipated operational environment.

III. REVIEW PROCEDURES

1. Follow the general procedures for review of Tier 1 contained in the Review Procedures section of SRP Section 14.3. Ensure that the DCD is consistent with Appendix A to SRP Section 14.3. Review responsibilities may be consistent with those in Appendix B to SRP Section 14.3.

2. Ensure that all Tier 1 information is consistent with Tier 2 information. Figures and diagrams should be reviewed to ensure that they accurately depict the functional arrangement and requirements of the systems. Reviewers should use the Review

Checklists in Appendix C to SRP Section 14.3 as an aid in establishing consistent and comprehensive treatment of issues.

3. Ensure that the electrical systems are clearly described in Tier 1, including the key performance characteristics and safety functions of SSCs based on their safety significance.

4. The reviewer should ensure that appropriate guidance is provided to other branches such that electrical issues in Tier 1 are treated in a consistent manner among branches.

5. Ensure that the standard ITAAC entries related to electrical systems are included in the appropriate systems of the design. In particular, the reviewer should coordinate with SPLB for the review of equipment qualification in the basic configuration ITAAC, and with ECGB for the review of seismic qualification of electrical components in the basic configuration ITAAC. The reviewer should ensure consistent application and treatment of the standard ITAAC entries for divisional power supply, physical separation, and independence for electrical and I&C systems in Tier 1.

6. Ensure that design features from the resolutions of selected technical and policy issues are adequately addressed in Tier 1, based on safety significance. Ensure that the appropriate Commission guidance, requirements, bases and resolutions for these items are documented clearly in the SER.

7. Ensure that definitions, legends, interface requirements, and site parameters that pertain to electrical issues are treated consistently and appropriately in Tier 1.

IV. EVALUATION FINDINGS

Each review branch verifies that sufficient information has been provided to satisfy the requirements of this SRP section, and concludes that Tier 1 is acceptable. A finding similar to that discussed in the Evaluation Findings section of SRP Section 14.3 should be included in a separate section of the SER.

In addition, if interface requirements for site-specific systems are established in the DCD, a finding of the following type should be made.

> "The staff concludes that the interface requirements (and site parameters, if applicable) in Tier 1 meet the requirements for design certification applications in 10 CFR 52.47, and are acceptable."

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of design certification and combined license applications submitted by applicants pursuant to 10 CFR 52.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.

VI. REFERENCES

1. 10 CFR Part 52, §52.47 "Contents of Applications."

2. 10 CFR Part 52, §52.97 "Issuance of Combined Licenses."

3. 10 CFR Part 50, §50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."

4. 10 CFR Part 50, §50.63, "Loss of All Alternating Current Power."

5. 10 CFR Part 50, Appendix A, General Design Criterion 17, "Electric Power Systems."

6. NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor", Volumes 1 and 2, July 1994.

7. NUREG-1462, "Final Safety Evaluation Report Related to the Certification of the System 80+ Design," Volumes 1 and 2, August 1994.

8. IEEE Std. 308, "Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations."

SRP Draft Section 14.3.61
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	**Integrated Impact 1539**	The scope and content of this proposed SRP section is derived from the requirements of 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," as well as the guidance in staff SECY papers related to design certification and combined license reviews, and the staff positions established in the Final Safety Evaluation Reports (FSERs) for the evolutionary reactor designs.SRP Section 14.3.6 provides guidance specific to the review of plant electrical systems design information and related inspections, tests, analyses, and acceptance criteria (ITAAC) provided in applications submitted in accordance with the requirements of 10 CFR 52.

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SRP Draft Section 14.3.61

Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
1539	Develop Acceptance Criteria and Review Procedures for review of Certified Design Material (CDM) including associated inspections, tests, analyses and acceptance criteria (ITAAC) for plant electrical systems.	All