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U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 8.3.1 A-C POWER SYSTEMS (ONSITE)

REVIEW RESPONSIBILITIES

Primary - Electrical, Instrumentation and Control Systems Branch (EICSB)

Secondary - Auxiliary and Power Conversion Systems Branch (APCSB)
Containment Systems Branch (CSB)
Mechanical Engineering Branch (MEB)
Quality Assurance Branch (QAB)
Reactor Systems Branch (RSB)

I. AREAS OF REVIEW

The descriptive information, including functional logic diagrams, functional piping and instrument diagrams, electrical single line diagrams, physical arrangement drawings, and electrical schematics, for the a-c onsite power system, presented in the applicant's safety analysis report (SAR), are reviewed. The intent of the review is to determine that the a-c onsite power system satisfies applicable acceptance criteria and will perform its intended functions during all plant operating and accident conditions.

The a-c onsite power system is referred to in industry standards and regulatory guides as the "standby power system." It includes those power sources, distribution systems, and vital supporting systems provided to supply power to safety-related equipment and capable of operating independently of the offsite power system (referred to as the preferred power system). Diesel generator sets have been widely used as the power source for the standby power supplies and will be covered in this review plan. Other power sources such as nearby hydroelectric, nuclear, or fossil units including gas turbine-generator sets will not be addressed herein. These power sources will continue to be evaluated on an individual case basis until staff technical positions applicable to them are developed. In addition, those interface areas between the standby and preferred power systems at the station distribution system level are within the scope of review of this plan insofar as they relate to the independence of the standby power system.

The EICSB will pursue the following phases in the review of the standby power system during both the construction permit (CP) and operating license (OL) stages of the licensing process:

1. System Redundancy Requirements

The standby power system is reviewed to determine that the required redundancy of safety-related components and systems is maintained in the standby power system with regard to both power sources and associated distribution systems. This will include an examination of the standby power network configuration including the power supply feeders, switchgear arrangement, loads supplied from each bus, and power connections to the instrumentation and control devices of the power system.

2. Conformance with the Single Failure Criterion

In establishing the adequacy of this system to meet the single failure criterion, both electrical and physical separation of redundant power sources and associated distribution systems are examined to assess the independence between redundant portions of the system. This will include a review of interconnections between redundant buses, buses and loads, and buses and power supplies; physical arrangement of redundant switchgear and power supplies; and criteria and bases governing the installation of electrical cables for redundant power systems. Should the proposed design provide for sharing of the standby power system between units at ths same site, the adequacy of such a design to meet the single failure criterion is reviewed.

3. Standby and Preferred Power Systems Independence

In evaluating the independence of the standby power system with respect to the preferred power system, the scope of review extends to the station distribution load centers which are powered from the unit auxiliary transformers and the startup transformers (considered for the purposes of this plan as the offsite or preferred power sources). It includes the supply breakers connecting the "low" side of these transformers to the distribution buses. This evaluation includes a review of the electrical protective relaying circuits and power supplies to assure that in the event of a loss of preferred power, the independence of the standby power system is established through prompt opening of isolation-feeder breakers. Also, the capability of the preferred power system circuits to deliver power to the safety-related buses is reviewed to assure that no single failure will result in loss of the minimum required redundancy of the preferred power circuits to the safety-related buses.

4. Standby Power Supplies

Design information and analyses demonstrating the suitability of the diesel generators as standby power supplies are reviewed to assure that the diesel generators have sufficient capacity, capability, and reliability to perform their intended function. This will include an examination of the characteristics of each load and the length of time each load is required, the combined load demand connected to each diesel generator during the "worst" operating condition, automatic and manual loading and unloading of each diesel generator, voltage and frequency recovery characteristics of the diesel generators, continuous and short-term ratings for the diesel generators, acceptance criteria with regard to the number of successful diesel generator tests and allowable failures to demonstrate acceptability, and starting and load shedding circuits. In addition, where the proposed design provides for the connection of non-safety loads to the diesel generators or sharing of diesel generators between nuclear units at the same site, particular review emphasis is given to the possibility of marginal capacity and degradation of reliability that may result from such design provisions.

5. Identification of Cables, Cable Trays, and Terminal Equipment

The means proposed for identifying the standby power system cables, cable trays, and terminal equipment as safety-related equipment in the plant are reviewed. Also, the identification scheme used to distinguish between redundant cables, cable trays, and terminal equipment of the power system is reviewed.

6. Vital Supporting Systems

The instrumentation, control circuits, and power connections of vital supporting systems are reviewed to determine that they are designed to the same criteria as those for the Class IE loads and 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.

7. System Testing and Surveillance

Preoperational and initial start-up test programs and periodic onsite testing capabilities are reviewed. The means proposed for automatically monitoring the status of system operability are reviewed.

8. Other Review Areas

Other areas of review associated with this system that are covered elsewhere are as follows:

a. Environmental design and qualification testing of electrical equipment are addressed in Standard Review Plan (SRP) 3.11.
b. Onsite d-c control power feeds to the standby power system are addressed in SRP 8.3.2.
c. Technical specification requirements imposed upon the operation of the standby power system are discussed in Chapter 16 of the SAR. Assistance and consultation are provided in accordance with the review procedures in SRP 8.1.
d. The APCSB, under the 9.5 standard review plans, will identify and evaluate the adequacy of those auxiliary systems that are vital to the proper operation of the standby power system and its connected Class IE loads. These include such systems as the heating and ventilation systems for switchgear and diesel generator rooms and all diesel generator auxiliary systems such as the cooling water system, combustion air supply system, starting system, fuel oil storage and transfer system, and fire detection and protection system. In particular, it will determine that the piping, ducting, and valving arrangement of redundant vital auxiliary supporting systems meet the single failure criterion. In addition, the APCSB will examine the physical arrangement of components and structures for Class IE systems and their supporting auxiliary systems, and determine that single events and accidents will not disable redundant features.

e. The CSB, under the 6.2 standard review plans, will identify those containment ventilation systems provided to maintain a controlled environment for safety-related instrumentation and electrical equipment located inside the containment.

f. The MEB, under SRP 3.10, will review the criteria for seismic qualification and the test and analysis procedures and methods to assure the operability of Category I instrumentation and electrical equipment, including cable trays, switchgear, control room boards, and instrument racks and panels, in the event of a seismic occurrence.

g. The QAB, under SRP 17.1 and 17.2, will verify the adequacy of the quality assurance program for the installation, inspection, and testing of Class IE instrumentation and electrical equipment and will coordinate the requirements for the technical specifications.

h. The RSB, under the 5.4, 6.3, and 15.0 standard review plans, will identify the engineered safety feature (ESF) and safe shutdown loads and systems and will verify that the minimum time intervals for the connection of ESF loads to the standy power system during accident conditions are satisfactory.

II. ACCEPTANCE CRITERIA

In general, the standby power system is acceptable when it can be concluded that this system has the required redundancy, meets the single failure criterion, and has the capacity, capability, and reliability to supply power to all required safety loads. Table 8-1 lists general design criteria (GDC), standards of the Institute of Electrical and Electronic Engineers (IEEE), regulatory guides, and branch technical positions utilized as the bases for arriving at this conclusion. Also, Table 8-1 includes those evaluation guides used by the reviewer as aids in ascertaining that the criteria have been met. Section III of this plan discusses the application of these evaluation guides to the review. The application of the acceptance criteria to the areas of review described in Section I of this plan is as follows:

1. System Redundancy Requirements

GDC 33, 34, 35, 38, 41, and 44 set forth requirements with regard to the safety systems that must be supplied by the standby power system. Also, these criteria state that safety system redundancy should be such that for standby power system operation (assuming preferred power is not available), the system safety function can be accomplished assuming a single failure. The acceptability of the standby power system with regard to redundancy is based on conformance to the same degree of redundancy required of safety-related components and systems by these GDC.

2. Conformance with the Single Failure Criterion

As required by GDC 17, the standby power system must be capable of performing its safety function assuming a single failure. To meet this requirement, electrical independence between redundant portions of this system must be maintained. An acceptable design in this regard is one that conforms to IEEE Std 308 and follows the recommendations of Regulatory Guide 1.6. Should the proposed design provide for sharing of the standby power system between units at the same site, the governing criteria stated in IEEE Std 308 are not explicit enough to be used as the basis for acceptance. Therefore, the accep ability of such a design to meet the single failure criterion is based on the design satisfying the recommendations of Regulatory Guide 1.81. This Guide sets forth acceptable bases for implementing the requirements of GDC 5, "Sharing of Structures, Systems, and Components." To assure that physical independence of redundant equipment, including cables and cable trays, is maintained in accordance with meeting the requirements of GDC 2, 3, and 4, an acceptable design arrangement must satisfy the requirements set forth in IEEE Std 384, as augmented by Regulatory Guide 1.75.

3. Standby and Preferred Power Systems Independence

The basis for acceptance is that no single failure including single protective relay interlock, or switchgear failure, causing the loss of preferred power, will prevent the separation of the preferred power system from the standby power system or limit the standby power system in accomplishing its intended function. To assure the independence of the standby power system in the event of a failure in the preferred power system, an acceptable design must satisfy the requirements of GDC 17. In addition, the preferred and standby power supplies should not have common failure modes, as required by Section 5.2.1 (5) of IEEE Std 308. In assuring that the design of the preferred power circuits to the safety-related buses is consistent with satisfying the power availability requirements of GDC 17, as supplemented by GDC 34, 35, 38, 41 and 44, an acceptable design must be capable of withstanding the effects of a single failure without a reduction of the capability of the preferred power circuits to less than the minimum required for safety.

4. Standby Power Supplies

a. The capacity, capability, and reliability of the standby power supply diesel generator sets are acceptable if the basis for selection of the diesel generator sets follows the recommendations of Regulatory Guide 1.9.

b. If the proposed design provides for sharing of the standby power system between units at the same site, the acceptance criteria utilized in determining that such a design complies with the requirements of GDC 5 are given in Regulatory Guide 1.81. This guide sets forth two principal positions. Position 2 is being applied to reviews for all operating license and construction permit applications docketed prior to June 1, 1973. In essence, Position 2 permits sharing if the standby power system has sufficient capacity and capability to supply the minimum ESF loads in any unit and also the equipment needed to safely shut down the remaining units. The capacity and capability are acceptable if system safety functions can be accomplished in the event of an accident in one unit, assuming a single failure or a spurious or false accident signal from another unit and loss of preferred power. Position 3 is being applied to construction permit applications docketed after June 1, 1973. It prohibits the sharing of standby power systems between nuclear units.

c. Should the proposed design provide for the connection and disconnection of non-class IE loads to and from the Class IE standby power supplies, it should conform to IEEE Std 384, as augmented by Regulatory Guide 1.75, with respect to the role isolation devices play in this regard. The design must be such as to assure that the interconnections and the added non-class IE loads will not result in any degradation of the Class IE system.

d. Diesel generator qualification testing programs are acceptable if they satisfy Position 5 of Regulatory Guides 1.6 and 1.9, as augmented by Branch Technical Position EICSB 2.

e. Regarding the design of thermal overload protection for motors of motor-operated safety-related valves, the acceptability of the design is based on Branch Technical Position EICSB 27.

5. Identification of Cables, Cable Trays, and Terminal Equipment

The method used for identifying standby power system cables, cable trays, and terminal equipment as safety-related equipment in the plant, and the identification scheme used to distinguish between redundant cables, cable trays, and terminal equipment are acceptable if in accordance with IEEE Std 384 as supplemented by Regulatory Guide 1.75.

6. Vital Supporting Systems

The instrumentation, controls, and electrical equipment for those supporting systems identified as vital to the proper functioning of Class IE systems are acceptable if the design conforms to the same criteria as for the Class IE systems supported.

7. System Testing and Surveillance

To assure that the preoperational and initial startup test programs for the standby power system meet the requirements of GDC 1, they must be in accordance with Regulatory Guide 1.68, as augmented by Regulatory Guide 1.41. To assure that the periodic onsite testing capabilities satisfy the requirements of GDC 18 and 21, an acceptable testing program should include the positions of Regulatory Guide 1.22. With regard to surveillance of the standby power system operability status, an acceptable design should satisfy the positions of Regulatory Guide 1.47, as augmented by Branch Technical Position EICSB 21.

8. Fire Stops and Seals

The basis for acceptance of fire stops and seals is the use of noncombustible and heat resistant materials as described in GDC 3 at all penetrations of walls and floors and at specified intervals of longer cable runs. In addition, it should be acceptably demonstrated that the means provided for fire detection and extinguishment will prevent a fire in one system from propagating to another redundant system within the time frame constraints of the fire stops themselves.

9. Other Review Areas

For those areas of review identified as being the responsibility of other branches, the acceptance criteria and their application to the areas of review are included in the appropriate standard review plans. However, there are some acceptance criteria that are commonly used by both primary and secondary review branches as the basis for determining that a design is acceptable. For the standby power system, these criteria and their application to the areas of review are as follows:

a. Seismic Design Requirements

In determining the adequacy of the seismic design of Category I instrumentation and electrical equipment, both the MEB and EICSB will perform reviews in this regard to ascertain that the proposed design satisfies such standards as IEEE Std 344, "Guide for Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations," as supplemented by Branch Technical Position EICSB 10, "Electrical and Mechanical Equipment Seismic Qualification Program."

b. Quality Assurance

To assure that the requirements of GDC 1 are met in the standby power system, the quality assurance program for the Class IE instrumentation and electrical equipment must satisfy the requirements of such standards as IEEE Std 336, "Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment during the Construction of Nuclear Power Generating Stations," as augmented by Regulatory Guide 1.30, "Quality Assurance Requirements for the Installation, Inspection and Testing of Instrumentation and Electric Equipment." Both the QAB and EICSB will perform reviews in this regard to ascertain that the proposed quality assurance program is consistent with the acceptance criteria.

III. REVIEW PROCEDURES

The main objectives in the review of the standby power system are to determine that this system has the required redundancy, meets the single failure criterion, and has the capacity, capability, and reliability to supply power to all required safety loads. In the CP review, the descriptive information, including the design bases and their relation to the acceptance criteria, preliminary analyses, electrical single line diagrams, functional logic diagrams, preliminary functional piping and instrumentation diagrams (P&IDs), and preliminary physical arrangement drawings are examined to determine that there is reasonable assurance that the final design will meet these objectives. At the OL stage, these objectives are verified during the review of final electrical schematics, functional P&IDs, and physical arrangement drawings and are confirmed during a visit to the site. To assure that these objectives have been met in accordance with the requirements of the criteria, the review is performed as detailed below.

In addition to the review procedures of the EICSB, this section identifies those aspects of the review that will be accomplished by the secondary review branches.

1. System Redundancy Requirements

Based on the information provided by the RSB with regard to the required redundancy of safety-related components and systems (GDC 33, 34, 35, 38, 41, and 44), the descriptive information including electrical single line diagrams (CP and OL stage), functional P&IDs (CP and OL stage), and electrical schematics (OL stage) is reviewed to verify that this redundancy is reflected in the standby power system with regard to both power sources and associated distribution systems. Also, it is verified that redundant safety loads are distributed between redundant distribution systems, and that the instrumentation and control devices for the Class IE loads and power system are supplied from the related redundant distribution systems.

2. Conformance with the Single Failure Criterion

In evaluating the adequacy of this system in meeting the single failure criterion (GDC 17), both electrical and physical separation of redundant power sources and distribution systems, including their connected loads, are reviewed to assess the independence between redundant portions of the system.

To assure electrical independence, the design criteria, analyses, description, and implementation as depicted on functional logic diagrams, electrical single line diagrams, and electrical schematics are reviewed to determine that the design meets the requirements set forth in IEEE Std 308 and satisfies the positions of Regulatory Guide 1.6. Additional guidance in evaluating this aspect of the design is derived from IEEE Std 379, "Guide for the Application of the Single-Failure Criterion to Nuclear Power Generating Station Protection Systems," as augmented by Regulatory Guide 1.53, "Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems." Since IEEE Std 308 does not set forth specific criteria governing the design of the circuits that initiate and control standby power, the reviewer utilizes IEEE Std 279 as an evaluation guide to ascertain that the designs of these circuits satisfy the same single failure requirements as protection systems. Other aspects of the design where special review attention is given to ascertain that the electrical independence has not been compromised are as follows:

a. Should the proposed design provide for sharing of the standby power system between units at the same site, the criteria of IEEE Std 308 governing the sharing of this system between units are not specific enough to be used as the basis for assessing the adequacy of the design in meeting the requirements of GDC 5 and satisfying the single failure criterion. Therefore, the acceptability of such a design is determined by reviewing the proposed system design criteria and electrical schematics and analyses substantiating the adequacy of the design to withstand the consequences of electrical faults and failures in one unit with the respect to the others. Generally, the reviewer is guided by the requirements set forth in Position 2 of Regulatory Guide 1.81, "Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants," for CP applications docketed before June 1, 1973 and for OL applications. Position 3 of this Regulatory Guide prohibits the sharing of standby power systems between nuclear units for construction permit applications docketed after June 1, 1973. Further details of the review with regard to Position 2 on sharing of the standby power system between units are covered in Item 4, below.

b. The interconnections between redundant load centers through bus tie breakers and multi-feeder breakers used to connect extra redundant loads to either of the redundant distribution systems are examined to assure that no single failure in the interconnections will cause the paralleling of the standby power supplies. To assure this, the control circuits of the bus tie breakers or multi-feeder breakers must preclude automatic transferring of load centers or loads from the designated supply to the redundant counterpart upon loss of the designated supply (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 Class IE systems which is discussed below. Further, the interconnection of redundant load centers must be accomplished only manually. With respect to the interconnections through the multi-feeder breakers supplying power to extra redundant loads, the review relates to the utilization of the extra redundant unit as one of the required operating units (if the substituted for normal unit is inoperable). If this is the selected mode of operation prior to an accident concurrent with the loss of offsite power, it is verified by reviewing the breaker arrangement and associated control circuits that no single failure in the feeder breaker which is not connected to the extra redundant unit could cause the closing of this breaker resulting in the paralleling of the power supplies. To assure against compromising the independence of the redundant power systems under this situation, an acceptable design for connecting extra redundant loads to either distribution system will provide for at least dual means for connecting and isolating each load from each redundant bus. Such a design must also meet the acceptance criteria for electrical and physical separation of Class IE systems. In addition, the provisions of the design to automatically break all the interconnections (e.g., open tie and multi-feeder breakers) between redundant load centers immediately following an accident condition concurrent with the loss of offsite power are reviewed to ascertain that the independence of the redundant portions of this system is established given a single failure.

c. To assure physical independence, the criteria governing the physical separation of redundant equipment, including cables and cable trays, and their implementation as depicted on preliminary (CP stage) or final (OL stage) physical arrangement drawings are reviewed to determine that the design arrangements satisfy the requirements set forth in IEEE Std 384 as augmented by Regulatory Guide 1.75. This standard and regulatory guide set forth acceptance criteria for the separation of circuits and electrical equipment contained in or associated with the Class IE power system. In essence, the review objective is to determine that the design provides for redundant portions of this system to be located in physically separated seismic Category I structures (GDC 2). It is verified that each structure has independent heating and ventilation (H&V) systems (including supply and exhaust pipes or ducts) to assure against single events and accidents from disabling redundant features (GDC 3, 4). The APCSB has primary responsibility in the review of the design arrangement of the Class IE systems and their vital supporting systems, except for the cable design which is the responsibility of the EICSB. Within the scope of review of this area, the APCSB will also verify the adequacy of physical barriers such as doors separating redundant portions of this system to assure that events such as fire and flooding in one structure will not be propagated to other redundant equipment structures (GDC 3, 4). To determine that the independence of the redundant cable installation is consistent with satisfying the requirements set forth in IEEE Std 384 as supplemented by Regulatory Guide 1.75, the proposed design criteria governing the separation of Class IE cables and raceways are reviewed including such criteria as those for cable derating; cable tray filling; cable routing in containment, penetration areas, cable spreading rooms, control rooms and other congested areas; sharing of cable trays with non-safety-related cables or with cables of the same system or other systems; prohibiting cable splices in conduits and trays; control wiring and components associated with Class IE electric systems in control boards, panels, and relay racks; and fire barriers and separation between redundant trays. With regard to determining the adequacy of the physical independence of redundant cables through penetration areas, the reviewer utilizes, in addition to IEEE Std 384 and Regulatory Guide 1.75, IEEE Std 317 as augmented by Regulatory Guide 1.63 as evaluation guides to ascertain that the electric penetration assemblies are designed in accordance with the requirements for Class IE equipment.

3. Standby and Preferred Power Systems Independence

In ascertaining the independence of the standby power system with respect to the preferred power system, the electrical ties between these two systems as well as the physical arrangement of the interface equipment are reviewed to assure that no single failure will prevent the separation of the redundant portions of the standby power system from the preferred power system when required. The scope of review extends to the supply breakers connecting the low side of the unit auxiliary transformers and start-up transformers (referred to as the offsite or preferred power supplies) to the station non-Class IE distribution buses through which power is made available to the Class IE buses. The number of electrical circuits from the preferred power supplies to the safety buses are to be consistent with satisfying the requirements of redundancy and independence of GDC 34, 35, 38, 41, and 44. That is, for preferred power system operation (assuming standby power is not available), the system safety function can be accomplished assuming a single failure.

To determine that the physical independence of the preferred power circuits to the Class IE buses is consistent with satisfying the requirements of GDC 17 and Section 5.2.1(5) of IEEE Std 308, the physical arrangement drawings are examined to verify that each circuit is physically separate and independent from its redundant counterparts. In addition, the final feeder-isolation breaker in each circuit through which preferred power is supplied to the safety buses must be designed and physically separated in accordance with the requirements for Class IE systems. Following the loss of preferred power, the safety buses are powered solely from the standby power supplies. Under this situation, the design of the feeder-isolation breaker in each preferred power circuit must preclude the automatic connection of preferred power to the respective safety bus upon the loss of standby power. In this regard, an acceptable design will include the capability for restoring preferred power to the respective safety bus by manual actuation only.

In assessing the adequacy of the electrical ties between the standby and preferred power systems, and the capability of the preferred power circuits to deliver power to the safety-related buses, both primary and secondary backup protective relaying schemes and their coordination, relay settings, and assigned control power supplies are reviewed to assure that in the event of an electrical fault, occurring between the preferred power transformer supply breakers and the safety buses, no single failure will result in reducing the number of preferred power cirucits to less than the minimum required for safety, or prevent the separation of the affected circuit from the respective redundant portion of the standby power system. In addition, it is verified that no single protective relay or interlock failure will prevent separation of the required redundant portions of the standby power system from the preferred power system upon loss of the latter.

In reviewing the mode of operation where both power systems are being operated in parallel (such is the case during full load testing of standby power supply diesel generator sets), the interlock scheme including electrical protective relay coordination and settings are closely examined to verify that the independence of the required redundant portions of the standby power system is established upon a failure in the preferred power system. The event of concern under this mode of operation is an accident concurrent with a loss of offsite power and a single failure preventing the opening of the feeder-isolation breaker through which the paralleling of the power systems was being accomplished. Because the signal to start the diesel generator sets is normally derived from undervoltage relays and under this situation the voltage is maintained above the trip relay settings by the diesel generator under test, the remaining redundant diesel generators will not be commanded to start running. Consequently, the added capacity resulting from the connection of non-Class IE loads to the diesel generator under test will cause the tripping of this diesel due to overload. The end result could be the total loss of power to the safety buses. However, this power interruption could be of momentary duration if the remaining redundant diesel generators are commanded automatically to start by undervoltage relay action immediately after total power is lost. The diesel generator under test will be inoperable due to the self-locking feature preventing restarting after an overload trip condition. The reviewer ascertains that the time delay introduced in making power available to the safety buses as a result of this event is within the response time limits assumed in the accident analyses. Included is verification that subsequent failures such as those resulting from improper electrical relaying coordination and self-locking features will not impair the automatic starting of the remaining redundant diesel generators required to meet minimum safety requirements. If the time delay introduced in making power available to the safety buses is not tolerable, it must be demonstrated that either the probability of occurrence of this event is low when compared to the frequency and duration of testing each diesel, or the design must provide diverse automatic signals, other than undervoltage, to assure the availability of standby power to the safety buses.

As an outcome of reviewing the parallel operation of the preferred and standby power systems, the use of the standby power supply diesel generator sets to supply power to the electrical system during peak load demand periods was found by the staff to be unacceptable. The basis for this conclusion is that the required frequent interconnections of the preferred and standby power supplies do not minimize the probability of their coincident loss (GDC 17) nor can the design be made immune to common failure modes (Section 5.2.1(5) of IEEE Std 308). Further details amplifying the basis for this conclusion are included in Branch Technical Position EICSB 8 which sets forth the basis for prohibiting the use of diesel generator sets for purposes other than emergency standby power supplies.

4. Standby Power Supplies

In assuring that the requirements of GDC 17 and IEEE Std 308 have been met with regard to the standby power supply diesel generator sets having sufficient capacity, capability, and reliability to supply the required distribution system loads, the design bases, design criteria, analyses, description, and implementation as depicted on electrical drawings and functional P&IDs are reviewed to verify that the bases for selection of the diesel generator sets satisfy the positions of Regulatory Guide 1.9. Supplemental guidance for evaluating the suitability of the diesel generators as standby power supplies is obtained from IEEE Std 387, "Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations." Specifically, the reviewer first becomes familiar with the purpose and operation of each safety system, including system component arrangement as depicted on functional P&IDs, expected system performance as established in the accident analyses, modes of system operation and their interactions during normal and accident conditions, and interactions between systems. Following this, it is verified that the tabulation of all safety-related loads to be connected to each diesel generator is consistent with the information establishing the safety-related systems and loads and their required redundancy. The characteristics of each load (such as motor horsepower, volt-amp rating, 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 load (such as motor nameplate rating, pump run-out condition, or estimated load under expected flow and pressure) are utilized to verify the calculations establishing the combined load demand to be connected to each diesel during the "worst" operating condition. In applying this combined load demand to the selection of each diesel generator capacity, an acceptable design must satisfy Positions 1 and 2 of Regulatory Guide 1.9.

To assure that each diesel generator is capable of starting and accelerating to rated speed all the connected loads in the required sequence and within the minimum time intervals established by the accident analyses, the reviewer examines for each diesel generator the loading profile curves, voltage and frequency recovering characteristic curves, and the response time of the excitation system to load variations. This examination must verify that the capability of each diesel generator to respond to voltage and frequency variations satisfies Position 4 of Regulatory Guide 1.9. In addition, the adequacy of the circuit design for starting and disconnecting and connecting safety loads from and to each diesel generator is checked. This includes a review of the starting initiating circuits; manual and automatic sequential loading and unloading circuits; interrupting capacity of switchgear, load centers, control centers, and distribution panels; grounding requirements; and electrical protective relaying circuits including their coordination, relay settings, and assigned control power supplies for each load and each diesel generator. In reviewing the criteria governing the design of the thermal overload protection for motors of motor-operated safety-related valves, the reviewer is guided by Branch Technical Position EICSB 27.

Regarding the review of the electrical protective trip circuits of the diesel generator sets, Branch Technical Position EICSB 17 is utilized as an evaluation guide. Although this guide sets forth specific recommendations for a particular plant, it can be used to ascertain that the design of these circuits are consistent with minimizing the likelihood of false diesel generator trips during emergency conditions. The capability of the automatic sequential loading circuits to reset during a sustained low voltage condition on the diesel generators is reviewed to assure that upon restoration of normal voltage, the Class IE loads can be connected in the prescribed sequence. Otherwise, the reconnection of all the loads at the same time could result in an overload condition causing the trip of the respective diesel generator. In assuring that those Class IE loads being powered through latched-type breakers are capable of being reconnected to their respective buses after restoration of power, the design must provide for resetting the breaker anticyle feature when there is an undervoltage condition. The normal function of this feature is to prevent immediate reclosure of a breaker following a trip.

Where the proposed design provides for the sharing of diesel generators between units at the same site, and connection and disconnection of non-Class IE loads to and from the Class IE distribution buses, particular attention is given in the review to assure that the implementation of such design provisions does not compromise the capacity, capability, or reliability of the standby power supplies.

GDC 5 prohibits sharing unless it can be shown that the diesel generators are capable of performing all required safety functions in the event of an accident in one unit and an orderly shutdown and cooldown of the remaining units. In assuring that the proposed design for sharing diesel generators between units meets the requirements of GDC 5 and 17 as supplemented by GDC 34, 35, 38, 41, and 44 and satisfies the positions of Regulatory Guide 1.9, the reviewer is guided by Regulatory Guide 1.81. This guide sets forth two principal positions. Position 3 applies to those construction permit applications docketed after June 1, 1973, and prohibits the sharing of standby power systems between units. Conformance of the design with Position 3 is verified by reviewing the descriptive information including electrical drawings to assure that the standby power system of each unit is electrically independent with respect to the standby power system of other units.

Position 2 establishes acceptable bases under which sharing of standby power systems between units is permitted. Conformance with Position 2 as regards the adequacy of diesel generator capacity and capability under the sharing mode of operation is verified by following the procedure discussed above for tabulating and summing all loads. In particular, the load tabulation and calculations establishing the diesel generator capacity are examined to assure that the selected capacity is sufficient to power the minimum ESF loads in any unit and safely shut down the remaining units, in the event of an accident in one unit and a single failure or spurious or false accident signal from another unit and loss of preferred power to all the units. In addition, the physical arrangement of instrumentation and control devices on control room panels and consoles in one unit with respect to the other units is examined to assure that the design minimizes the coordination needed between unit operators to accomplish sharing of the standby power systems.

In the absence of specific criteria in IEEE Std 308 governing the connection and disconnection of non-Class IE loads to and from the Class IE distribution buses, the review of the interconnections will consider isolation devices as defined in IEEE Std 384 and augmented by Regulatory Guide 1.75 to determine the adequacy of the design. In assuring that the interconnections between non-Class IE loads and Class IE buses will not result in the degradation of the Class IE system, the isolation device through which standby power is supplied to the non-Class IE load, including control circuits and connections to the Class IE bus, must be designed to meet Class IE requirements. Should the standby power supplies not have been sized to accommodate the added non-Class IE loads during emergency conditions, the design must provide for the automatic disconnection of those non-Class IE loads upon the detection of the emergency condition. This action must be accomplished whether or not the load was already connected to the power supply. Further, the design must also prevent the automatic or manual connection of these loads during the transient stabilization period subsequent to this event.

The description of the qualification test program (CP stage) and the results of such tests (OL stage) for demonstrating the suitability of the diesel generators as standby power supplies are judged to be acceptable if they satisfy the acceptance criteria stated in Section II.4 of this SRP. In the event that diesel generators have not been selected for a particular plant, a commitment from the applicant to obtain diesel generators of a design that have been previously qualified for use in nuclear power plant applications, or to perform qualification tests on diesel generators of a new design in accordance with the acceptance criteria is considered acceptable at the CP stage of review.

The APCSB will review the adequacy of the non-electrical aspects of the design for those auxiliary systems that have been identified as essential to the operation of Class IE loads and power supplies. This will include verification that there is seismic Cagegory I onsite fuel oil storage capacity for operation at full rated load of one redundant diesel generator for at least seven days.

5. Identification of Cables, Cable Trays, and Terminal Equipment

The identification scheme used for Class IE cables, raceways, and terminal equipment in the plant and Class IE internal wiring in the control boards is reviewed to see that it is consistent with IEEE Std 384 as supplemented by Regulatory Guide 1.75. This includes the criteria for differentiating between safety-related cables, cable trays, and terminal equipment of different channels or divisions, non-safety-related cable which is run in safety trays, non-safety-related cable which is not associated physically with any safety division, and safety-related cables, raceways, and terminal equipment of one unit with respect to the other units at a multi-unit site.

6. Vital Supporting Systems

The APCSB and EICSB will review those auxiliary systems identified as being vital to the operation of Class IE loads and systems. The EICSB reviews the instrumentation, control, and electrical aspects of the vital supporting systems to assure that their design conforms to the same criteria as those for the Class IE systems that they support. Hence, the review procedure to be followed for ascertaining the adequacy of the vital supporting systems is the same as that discussed herein for Class IE systems. In essence, the reviewer first becomes familiar with the purpose and operation of each vital supporting system, including its component arrangement as depicted on functional P&IDs. Subsequently, the design criteria, analyses, and description and implementation of the instrumentation, control, and electrical equipment as depicted on electrical drawings, are reviewed to verify that the design is consistent with satisfying the acceptance criteria for Class IE systems. In addition, it is verified that the vital supporting system loads have been accounted for in the calculations for sizing the Class IE power supplies. Further, the power feed assignments for the vital supporting system redundant instrumentation, control devices, and loads are examined to verify that they are powered from the same redundant distribution system as the Class IE system that they support.

The APCSB reviews the non-electrical aspects of the vital supporting systems to verify that the design, capacities, and physical independence of these systems are adequate for their intended functions. Included is a review of the heating and ventilation (H&V) systems identified as necessary to Class IE systems, such as the H&V systems for the electrical switchgear and diesel generator rooms. The APCSB will verify the adequacy of the H&V system design to maintain the temperature and level of humidity in the room required for proper operation of the safety equipment during both normal and accident conditions. It will also verify that redundant H&V systems, as well as other redundant vital supporting systems such as the ones associated with the diesel generator units (i.e., cooling water system, combustion air supply system, starting system, fuel oil storage and transfer system, and fire detection and protection system) 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 Class IE systems they support. Other aspects of the review by the APCSB are to determine that the diesel generator combustion air quality is such that it will not impair the starting and continuous running reliability of the unit and whether or not it is necessary to maintain the cooling water and lubricating oil warm while the diesel engine is on standby to enhance the starting reliability of the unit.

7. System Testing and Surveillance

The proposed preoperational and initial startup test programs for the standby power system including its vital supporting systems are reviewed to verify that the proposed programs are consistent with Regulatory Guides 1.68 and 1.41. In assuring that the proposed periodic onsite testing capabilities of Class IE systems satisfy the requirements of GDC 18 and 21, the descriptive information (CP and OL stages) functional logic diagrams (CP and OL stages), and electrical schematics (OL stage) are reviewed to verify that the design has the built-in capability to permit integral testing of Class IE systems on a periodic basis when the reactor is in operation. The reviewer is guided by the positions in Regulatory Guide 1.22 in determining an acceptable periodic testing program for actuation devices (e.g., breakers) and actuated equipment. Since IEEE Std 308 does not include requirements for periodic testing of the circuits that initiate and control standby power, the reviewer utilizes IEEE Std 279 and IEEE Std 338 as evaluation guides to ascertain that the testing of these circuits, including electrical protective relays, permissives, bypasses, and control devices, is in accordance with the basic requirements for protection systems.

The descriptive information (CP and OL stages) and the design implementation as depicted on electrical drawings (OL stage) of the means proposed for automatically indicating at the system level a bypassed or deliberately inoperative status of a redundant portion of a Class IE system are reviewed to ascertain that the design is consistent with Regulatory Guide 1.47 and Branch Technical Position EICSB 21. This position establishes the basis to be considered in arriving at an acceptable design for the inoperable status indication system.

8. Fire Stops and Seals

In assuring that the requirements of GDC 3 have been met with regard to the fire stops and seals, the list of materials, their characteristics with regard to flammability and fire retardancy, and their fire underwriters rating should be reviewed. All cable and cable tray penetrations through walls and floors as well as any other types of cable ways or conduits should have fire stops installed. A review of the design criteria for fire stops should reveal the maximum physical vertical and horizontal distances between stops on longer cable runs and the testing that demonstrates the fire stops and seals will perform their intended function. Fire barriers are generally rated for a given temperature and a given time interval. The reviewer should determine if the rating of the fire stops is sufficient to allow extinguishment of the fire before it can affect a redundant cabling system. This will require coordination with Auxiliary Power and Conversion Systems Branch, in conjunction with SRP Section 9.5.1.

9. Other Review Areas

For those areas of review identified as being the responsibility of other branches, the review procedures are included in the appropriate standard review plans. However, there are some areas that are commonly reviewed by both primary and secondary review branches. For the standby power system, the review procedures for these areas are as follows:

a. Seismic Design Requirements

The MEB has primary responsibility in assuring that the seismic design of Category I instrumentation and electrical equipment satisfies the MEB acceptance criteria, which include IEEE Std 344. The EICSB supplements the MEB by reviewing the description of the seismic qualification test program (CP stage) and the results of such tests and analyses (OL stage) for demonstrating the capability of Class IE instrumentation, control devices, and associated circuits to withstand the effects of a seismic event. The adequacy of the seismic design for major electrical apparatus (such as the switchgear, motors, and diesel generator sets) and their supports will be determined by the MEB. The EICSB utilizes IEEE Std 344 as supplemented by Branch Technical Position EICSB 10 as the basis for acceptable seismic designs.

b. Quality Assurance

In assuring that the quality of Class IE equipment is commensurate with present codes and standards (GDC 1), the QAB will review the proposed quality assurance program to ascertain that it is consistent with satisfying the QAB acceptance criteria. The EICSB is guided by the requirements set forth in IEEE Std 336, as augmented by Regulatory Guide 1.30, to ascertain that the proposed quality assurance program for Class IE instrumentation and electrical equipment is acceptable.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that the review supports conclusions of the following type, to be included in the staff's safety evaluation report:

"The standby power system includes the onsite power sources, distribution systems, vital auxiliary supporting systems, instrumentation, and controls utilized to supply power to safety-related components and systems. The scope of review included the descriptive information (CP and OL), functional logic diagrams (CP and OL), functional piping and instrument diagrams (CP and OL), electrical single line diagrams (CP and OL), preliminary (CP) and final (OL) physical arrangement drawings, and electrical schematics (OL) for the standby power system and for those auxiliary systems that are vital to the proper operation of the Class IE standby power system and its connected Class IE loads. The review has included the applicant's design bases and their relation to the proposed design criteria for the standby power system and for the vital supporting systems and the applicant's analyses of the adequacy of those criteria and bases. The review also has included the applicant's proposed means for identifying safety-related cables, cable trays, and terminal equipment in the plant; the preoperational and initial startup test programs and periodic onsite testing capabilities; the qualification test programs (CP) and the results (OL) demonstrating the suitability of the diesel generators as standby power supplies; the seismic qualification test program (CP) and the results and analyses (OL); and the quality assurance programs for the standby power system."

"The basis for acceptance in our review has been conformance of the applicant's designs, design criteria, and design bases for the standby power system and vital supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, branch technical positions, and industry standards. These are listed in Table 8-1.

"On the basis of our review, we have concluded that the standby power system conforms to applicable regulations, guides, technical positions, and industry standards and is acceptable."

V. REFERENCES

1. Standard Review Plan Table 8-1, "Acceptance Criteria for Electric Power."

SRP 8.3.2