NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 8.1 ELECTRIC POWER - INTRODUCTION

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - Auxiliary Systems Branch (ASB)
Containment Systems Branch (CSB)
Instrumentation and Control Systems Branch (ICSB)
Reactor Systems Branch (RSB)

I. AREAS OF REVIEW

The PSB reviews the applicant's description of the offsite power grid and system with regard to the interrelationships between the nuclear unit, the utility grid and the interconnecting grids. PSB also reviews the identification of all safety-related electrical loads.

The review includes evaluation of the proposed technical specifications (SAR Chapter 16) to assure their adequacy with regard to limiting safety system settings, limiting conditions for operation, and periodic surveillance testing.

The secondary review branches (ASB, CSB, ICSB and RSB) review the listing of safety loads for completeness, i.e., to verify that all safety loads within their respective areas of primary review responsibility have been identified. If loads other than those identified are deemed to be safety-related, this information is transmitted to PSB.

II. ACCEPTANCE CRITERIA

The description of the power grid and offsite power system is acceptable when it can be concluded that the interrelationships between the nuclear unit, the utility grid, and the interconnecting grids are clearly defined. The identification of safety loads is acceptable when it can be concluded that all systems and devices that require electric power (a-c or d-c) to perform safety functions are identified.

Table 8-1, "Acceptance Criteria for Electric Power," lists the criteria currently applied by the staff to safety-related electric power systems. Implementation of these criteria will provide assurance that safety-related electric power systems will perform design safety functions as required. The applicant's list of design criteria for safety-related electric power systems is acceptable if it includes the items in Table 8-1, and if the SAR contains a statement to the effect that these criteria will be implemented (at the construction permit stage) or are implemented (at the operating license stage) in the design of the electrical power systems.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

The fundamental bases for acceptance of the proposed technical specifications are that the limiting conditions for operation (LCOs) are such that sufficient equipment will be available for operation to meet the single failure criterion; that equipment outages, permissible for a short period of time, still leave available sufficient equipment to provide the protective function assuming no failures; and that the provisions of the technical specifications are compatible with the safety analyses. The operating procedures and restrictions which should be implemented if the available electric power sources are less than the LCO are discussed in Regulatory Guide 1.93.

III. REVIEW PROCEDURES

The PSB reviews Section 8.1 of the SAR to assure the following items are included: a brief description of the utility grid and its interconnections to other grids and to the nuclear unit (referred to as the preferred power system); a brief general description of the onsite power system (referred to as the standby power system); identification of the safety loads (i.e., the systems and devices that require electric power to perform safety functions); identification of the function performed by each load (e.g., emergency core cooling, containment cooling); the type of electric power (a-c or d-c) required by each load; and the design bases, criteria, standards, regulatory guides, and technical positions that will be implemented in the design of the safety-related electric power systems, including a discussion describing the extent to which these criteria are followed and a positive statement with regard to conformance of the design to each of these criteria.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The review is performed as follows:

1. PSB will establish that the utility grid is adequately described, and that the interconnections between the nuclear unit, the utility grid, and other grids are clearly defined. The descriptions should state whether facilities are existing or planned; if planned, the respective completion dates should be provided. The descriptions should not conflict with the more detailed information in subsequent sections of Chapter 8 of the SAR, and may reference these sections.

2. PSB confirms that the description of the onsite power system (standby power system) is not in conflict with the more detailed information on this system in subsequent sections of Chapter 8, and descriptions may reference these sections.

3. PSB will establish that all the devices and systems that require electric power to perform safety functions are identified, and that this identification does not conflict with the more detailed information provided in other sections of the SAR, particularly in Chapters 7 and 8. The definitions of safety-related systems in SRP Section 7.1 should be used as an aid in assessing the completeness of the identification of safety loads. Care should be exercised to assure that those loads required to maintain the plant within the envelope of operating conditions postulated in the accident analysis are identified as safety loads. Requests for evaluation should be made to the secondary review branches when there are novel designs or significant differences of opinion with regard to designations of safety loads.

4. The secondary review branches (ASB, CSB, ICSB and RSB) will confirm the identification of all safety loads within their respective areas of primary review responsibility. If loads other than those identified are deemed to be safety-related, this information should be transmitted to PSB.

5. PSB will confirm that the criteria identified as being applicable to the design of safety-related electric power systems include those listed in Table 8-1. This will assure that the identification requirements of General Design Criterion (GDC) 1 of Appendix A to 10 CFR Part 50 are met. GDC 1 also requires that "structures, systems and components important to safety shall be designed, fabricated, erected and tested to quality standards commensurate with the importance of the safety function to be performed." Therefore, the SAR should include a discussion regarding the applicability of the criteria listed and a statement to the effect that the criteria will be implemented (CP) or are implemented (OL) in the design of safety-related electrical power systems.

6. The proposed plant technical specifications (Chapter 16 of the SAR) are reviewed by PSB and the secondary review branches to:

   a. Confirm the suitability of the limiting safety system settings and the limiting conditions for operation, including the proposed time limits and reactor operating restrictions for periods when system equipment is inoperable due to repairs and maintenance.

   b. Verify that the frequency and scope of periodic surveillance testing is adequate.

For a construction permit (CP) review, it is only necessary to confirm that the applicant has identified those variables, conditions, or other items which have been determined to be probable subjects of the technical specifications (see 10 CFR 50.34(a)(5)). The applicant's justification for the selection of those items is evaluated, with special attention to any that may significantly influence the final design. The specific provisions of the proposed technical specifications are not approved during the CP review. However, any specific provisions which are known to be unacceptable or which may influence acceptance of the preliminary design of the plant should be brought to the applicant's attention and, if appropriate, included in that portion of the staff's evaluation findings pertaining to the design of the affected systems.

For an operating license (OL) review, the proposed technical specifications are reviewed and evaluated in depth in accordance with the requirements of 10 CFR 50.36. For the PSB areas of review, a check is made that the limiting conditions for operation (LCO) correspond to the surveillance requirements; i.e., for each system or component that is the subject of an LCO, there must be corresponding surveillance requirements. Each system or component that performs a function for which credit is taken in the accident analyses should be the subject of an LCO. The limiting safety system settings should agree with the values assumed in the accident analyses, including appropriate allowances for instrument error, drift, etc. If the acceptance of the design of a particular system is based upon required plant conditions or particular operating procedures, such requirements should be included in the final technical specifications and, if appropriate, noted in that portion of the staff's evaluation findings pertaining to the design of the affected system. Operating procedures and restrictions which should be implemented if the available electric power sources have less than the LCO are presented in Regulatory Guide 1.93.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information is presented in the SAR and that his review supports conclusions of the following type, to be included in the staff's Safety Evaluation Report:

> "The applicant has identified safety-related electric power systems, safety loads, and applicable power system criteria, and has documented his intent to design and construct these systems in accordance with the criteria. It is concluded that design and construction of safety-related electric power systems in accordance with the criteria provide assurance that these systems will perform as designed."

V. REFERENCES: None

TABLE 8-1

ACCEPTANCE CRITERIA FOR ELECTRIC POWER

Table 8-1 identifies the acceptance criteria and their applicability for the SRP sections of Chapter 8. These acceptance criteria include the applicable general design criteria, IEEE standards, regulatory guides, and branch technical positions (BTPs) used by the Power Systems Branch (PSB). The table was prepared for use in reviewing Chapter 8 of the SAR and for use by the secondary review branch reviewers. The BTPs listed in Table 8-1 are contained in Appendix 8-A to Chapter 8 of the SRP.

Rev. 1

ACCEPTANCE CRITERIA FOR ELECTRIC POWER - TABLE 8-1

CRITERIA	TITLE	APPLICABILITY (SAR Section) 8.1	8.2	8.3.1	8.3.2	REMARKS
1. 10 CFR Part 50						
a. 10 CFR §50.34	Contents of Applications: Technical Information	X	X	X	X	
b. 10 CFR §50.36	Technical Specifications	X	X	X	X	
c. 10 CFR §50.55a	Codes and Standards	X	X	X	X	
2. General Design Criteria (GDC), Appendix A to 10 CFR Part 50						
a. GDC-1	Quality Standards and Records	X	X	X	X	
b. GDC-2	Design Bases for Protection Against Natural Phenomena	X	X	X	X	
c. GDC-3	Fire Protection	X	X	X	X	
d. GDC-4	Environmental and Missile Design Bases	X	X	X	X	
e. GDC-5	Sharing of Structures, Systems, and Components	X	X	X	X	
f. GDC-13	Instrumentation and Control	X	X	X	X	
g. GDC-17	Electric Power Systems	X	X	X	X	
h. GDC-18	Inspection and Testing of Electrical Power Systems	X	X	X	X	
i. GDC-21	Protection System Reliability and Testability	X	X	X	X	
j. GDC-22	Protection System Independence	X			X	

TABLE 8-1 (CONTINUED)

CRITERIA		TITLE	APPLICABILITY (SAR Section)				REMARKS
			8.1	8.2	8.3.1	8.3.2	
k.	GDC-33	Reactor Coolant Makeup	X	X	X	X	
l.	GDC-34	Residual Heat Removal	X	X	X	X	
m.	GDC-35	Emergency Core Cooling	X	X	X	X	
n.	GDC-38	Containment Heat Removal	X	X	X	X	
o.	GDC-41	Containment Atmosphere Cleanup	X	X	X	X	
p.	GDC-44	Cooling Water	X	X	X	X	
3.	Institute of Electrical and Electronics Engineers (IEEE) Standards:						
a.	IEEE Std 279 (ANSI N42.7)	Criteria for Protection Systems for Nuclear Power Generating Stations	X		X	X	See 10 CFR §50.55a(h) and Reg. Guide 1.62
b.	IEEE Std 308	Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations	X	X	X	X	See Reg. Guide 1.32
c.	IEEE Std 317	Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations	X		X	X	See Reg. Guide 1.63
d.	IEEE Std 323	Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations	X		X	X	See Reg. Guide 1.89
e.	IEEE Std 334	Standard for Type Test of Continuous Duty Class 1E Motors for Nuclear Power Generating Stations	X		X		See Reg. Guide 1.40
f.	IEEE Std 336 (ANSI N45.2.4)	Installation, Inspection and Testing Requirements for Instrumentation and Electric Equipment During the Construction of Nuclear Power Generating Stations	X	X	X	X	See Reg. Guide 1.30
g.	IEEE Std 338	Criteria for the Periodic Testing of Nuclear Power Generating Station Protection Systems	X	X	X	X	See Reg. Guide 1.118

TABLE 8-1 (CONTINUED)

CRITERIA	TITLE	APPLICABILITY (SAR Section)				REMARKS
		8.1	8.2	8.3.1	8.3.2	
h. IEEE Std 344 (ANSI N41.7)	Guide for Seismic Qualification of Class I Electrical Equipment for Nuclear Power Generating Stations	X		X	X	See Reg. Guide 1.100
i. IEEE Std 379 (ANSI N41.2)	Guide for the Application of the Single Failure Criterion to Nuclear Power Generating Station Protection Systems	X		X	X	See Reg. Guide 1.53
j. IEEE Std 382	Trial-Use Guide for the Type-Test of Class 1 Electric Valve Operators for Nuclear Power Generating Stations (ANSI N416)	X		X		See Reg. Guide 1.73
k. IEEE Std 383	Standard for Type Test of Class 1E Electric Cable Field Splices, and Connections for Nuclear Power Generating Stations	X		X	X	
l. IEEE Std 384 (ANSI N41.14)	Criteria for Separation of Class 1E Equipment and Circuits	X		X	X	See Reg. Guide 1.75
m. IEEE Std 387 (ANSI N41.13)	Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Stations	X		X		
n. IEEE Std 415	Planning of Pre-Operational Testing Programs for Class 1E Power Systems for Nuclear Power Generating Stations, IEEE Guide for	X		X	X	
o. IEEE Std 420	Trial-Use Guide for Class 1E Control Switchboards for Nuclear Power Generating Stations (ANSI N41.7)	X		X	X	
p. IEEE Std 450	Recommended Practice for Maintenance, Testing and Replacement of Large Stationary Type Power Plant and Substation Lead Storage Batteries	X			X	See Reg. Guide 1.129
q. IEEE Std 484	Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants	X			X	See Reg. Guide 1.128

TABLE 8-1 (CONTINUED)

CRITERIA	TITLE	APPLICABILITY (SAR Section) 8.1	8.2	8.3.1	8.3.2	REMARKS
4. Regulatory Guides (RG)						
a. RG 1.6	Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems	X		X	X	
b. RG 1.9	Selection of Diesel Generator Set Capacity for Standby Power Supplies	X		X		
c. RG 1.29	Seismic Design Classification	X		X	X	
d. RG 1.30	Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment	X	X	X	X	
e. RG 1.32	Use of IEEE Std 308, "Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations"	X	X	X	X	
f. RG 1.40	Qualification Tests for Continuous-Duty Motors Installed Inside the Containment of Water Cooled Nuclear Power Plants	X		X		
g. RG 1.41	Preoperational Testing of Redundant Onsite Electric Power Systems to Verify Proper Load Group Assignments	X	X	X	X	
h. RG 1.47	Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems	X	X	X	X	
i. RG 1.53	Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems	X		X	X	
j. RG 1.63	Electric Penetration Assemblies in Containment Structures for Water-Cooled Nuclear Power Plants	X		X	X	
k. RG 1.68	Preoperational and Initial Startup Test Programs for Water-Cooled Power Reactors	X	X	X	X	

TABLE 8-1 (CONTINUED)

CRITERIA	TITLE	APPLICABILITY (SAR Section) 8.1	8.2	8.3.1	8.3.2	REMARKS
l. RG 1.70	Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants	X	X	X	X	
m. RG 1.73	Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants	X		X		
n. RG 1.75	Physical Independence of Electric Systems	X		X	X	
o. RG 1.81	Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants	X		X	X	
p. RG 1.89	Qualification of Class 1E Equipment for Nuclear Power Plants	X		X	X	
q. RG 1.93	Availability of Electric Power Sources	X	X	X	X	
r. RG 1.100	Seismic Qualification of Electric Equipment for Nuclear Power Plants	X		X	X	
s. RG 1.106	Thermal Overload Protection for Electric Motors on Motor-Operated Valves	X		X		
t. RG 1.108	Periodic Testing of Diesel Generators Used As Onsite Power Systems at Nuclear Power Plants	X		X		
u. RG 1.118	Periodic Testing of Electric Power and Protection Systems		X	X	X	
v. RG 1.120	Fire Protection Guidelines for Nuclear Power Plants	X	X	X	X	
w. RG 1.128	Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants	X			X	
x. RG 1.129	Maintenance, Testing and Replacement of Large Lead Storage Batteries for Nuclear Power Plants	X			X	

TABLE 8-1 (CONTINUED)

CRITERIA	TITLE	APPLICABILITY (SAR Section)				REMARKS
		8.1	8.2	8.3.1	8.3.2	
5. Branch Technical Positions (BTP) ICSB						
a. BTP ICSB 2 (PSB)	Diesel-Generator Reliability Qualification Testing	X		X		
b. BTP ICSB 6 (PSB)	Capacity Test Requirements of Station Batteries-Technical Specifications	X			X	
c. BTP ICSB 8 (PSB)	Use of Diesel-Generator Sets for Peaking	X		X		
d. BTP ICSB 11 (PSB)	Stability of Offsite Power Systems	X	X			
e. BTP ICSB 15 (PSB)	Reactor Coolant Pump Breaker Qualification		X			
f. BTP ICSB 17 (PSB)	Diesel Generator Protective Trip Circuit Bypasses	X		X		
g. BTP ICSB 18 (PSB)	Application of the Single Failure Criterion to Manually-Controlled Electrically-Operated Valves			X		
h. BTP ICSB 21	Guidance for Application of RG 1.47	X	X	X	X	

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 8.2 OFFSITE POWER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - Auxiliary Systems Branch (ASB)
Reactor Systems Branch (RSB)

Instrumentation and Control Systems Branch (ICSB)

I. AREAS OF REVIEW

The descriptive information, analyses, and referenced documents, including electrical single line diagrams, electrical schematics, logic diagrams, tables, and physical arrangement drawings for the offsite power systems, presented in the applicant's safety analysis report (SAR), are reviewed. The intent of the review is to determine that this system satisfies applicable acceptance criteria and will perform its design functions during plant normal operation, anticipated operational occurrences, and in accident conditions. The information provided at the construction permit (CP) stage should show that the design will be in conformance with the acceptance criteria and should support a statement to this effect to be included in the staff's construction permit safety evaluation report. At the operating license (OL) stage, review of the final design information and a site visit should establish that the design criteria have been correctly implemented, that the design meets the requirements of the safety analyses and conforms to the acceptance criteria, and should support a statement to this effect to be included in the staff's operating license safety evaluation report.

The offsite power system is referred to in industry standards and regulatory guides as the "preferred power system." It includes two or more identified power sources capable of operating independently of the onsite or standby power sources and encompasses the grid, transmission lines (overhead or underground), transmission line towers, transformers, switchyard components and control systems, switchyard battery systems, the main generator, and disconnect switches, provided to supply electric power to safety-related and other equipment.

The PSB will review the following features of the preferred power system.

1. The preferred power system arrangement is reviewed to determine that the required minimum of two separate circuits from the transmission network to the standby power distribution system is provided. In determining the adequacy of this system, the

independence of the two (or more) circuits is examined to see that both electrical and physical separation exists so as to minimize the chance of simultaneous failure. This includes a review of the assignment of power sources from the grid, location of rights-of-way, transmission lines and towers, transformers, switchyard interconnections (breakers and bus arrangements), switchyard control systems and power supplies, location of switchgear (in-plant), interconnections between switchgear, cable routings, main generator disconnect, and the disconnect control system and power supply.

2. The independence of the preferred power system with respect to the standby power system is evaluated. The scope of review extends to the safety-related distribution system buses that are capable of being powered by standby power sources. It does not include the supply breakers of the safety-related distribution system buses. This evaluation will include a review of the electrical protective relaying and breaker control circuits and power supplies to assure that loss of one preferred system circuit will not cause or result in loss of the redundant counterpart, nor any standby power system sources.

3. Design information and analyses demonstrating the suitability of the power sources, transmission lines, breakers, and transformers used for supplying preferred power from a distant source are reviewed to assure that each path has sufficient capacity, capability, and reliability to perform its intended function. This will require examination of loads required to be powered for each plant operating condition; continuous and fault ratings of breakers, transformers, and transmission lines; loading, unloading, and transfer effects on equipment; and power capacity available from each source.

4. The instrumentation required for monitoring and indicating the status of the preferred power system is reviewed to assure that any change in the preferred power system which would prevent it from performing its intended function will be immediately identified by the control room operator. Also, all instrumentation for initiating safety actions associated with the preferred power system is reviewed.

5. Preoperational and initial startup tests and programs and periodic testing capabilities are reviewed.

6. The PSB will also review the following:
   a. Environmental conditions such as those resulting from floods, hurricanes, high and low atmospheric temperatures, rain, and snow are considered in the review of the preferred power system to determine any effects on function.

   b. Quality group classifications of equipment of the preferred power system are reviewed.

c. The equipment and functions of the preferred power systems that are used as a basis for assumptions in the accident analyses are reviewed to assure that they conform to the requirements of those assumptions.

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

a. Environmental design and qualification testing of electrical equipment are addressed in SRP Section 3.11.

b. Technical specification requirements imposed upon the operation of the preferred power system are discussed in Chapter 16 of the applicant's safety analysis report (SAR). The review of technical specifications for the preferred power systems is covered in SRP Section 8.1.

c. The ASB will evaluate the adequacy of those auxiliary systems required for the proper operation of the preferred power system in connection with the review of SAR Chapters 9 and 10. These include such systems as heating and ventilation systems for switchgear in the circuits from the preferred power sources to the standby power distribution system buses and main generator auxiliary systems such as the cooling water system, hydrogen cooling system, electro-hydraulic system, air supply system, and fire protection system.

d. The ASB will examine the physical arrangements of components and structures of the preferred power system to assure that the paths from the preferred power sources to the standby power distribution system buses will not experience simultaneous failure under operating or postulated accident environmental conditions.

e. The RSB and ASB will be consulted as required to assure proper identification of the electrical equipment and systems required as a function of time for each mode of reactor operation and accident condition.

f. The ICSB will evaluate, on request, portions of the preferred power system instrumentation and controls.

g. The QAB, under SRP Sections 17.1 and 17.2, will verify the adequacy of the quality assurance program for the installation, inspection, and testing of the preferred power system electric equipment.

II. ACCEPTANCE CRITERIA

In general, the preferred power system is acceptable when it can be concluded that two separate paths from the transmission network to the standby power distribution system are provided in accordance with General Design Criterion 17; adequate physical and electrical separation exists; and the system has the capacity, capability, and reliability to supply power to all safety loads and other required equipment.

Table 8-1 lists General Design Criteria, standards of the Institute of Electrical and Electronic Engineers (IEEE), regulatory guides, and staff technical positions utilized as the bases for arriving at this conclusion. In addition, the references include documents used by the reviewer as aids in ascertaining that the criteria have been met. Subsection III discusses the application of these documents to the review.

Details of the application of the acceptance criteria to the areas of review described in subsection I are as follows:

1. System Design Requirements
   a. General Design Criteria 33, 34, 35, 38, 41 and 44 set forth requirements for the safety systems whose source of power is the preferred power system. These criteria state that safety system redundancy shall be such that, for preferred power system operation (assuming standby power is not available), the system safety function can be accomplished assuming a single failure. To utilize this requirement, the single failure is assumed to occur downstream of the preferred power feed breakers at the safety buses, i.e., in the safety-related distribution system. The acceptability of the preferred power system design in this regard is based on its conformance with General Design Criterion 17 and its capability to supply the redundant safety components and systems required by these General Design Criteria.

   b. General Design Criterion 17 requires two physically independent circuits from the offsite grid, one of which is designed to be available within a few seconds following a loss-of-coolant accident.

   c. The preferred power system must be independent of the standby power system. The basis for acceptance is that no single event, including a single protective relay, interlock, or switchgear failure, in the event of loss of standby power, will prevent the separation of the preferred power system from the standby power system or prevent the preferred power system from accomplishing its intended functions. The design must satisfy the requirements of General Design Criterion 17 in this regard. In addition, the preferred and standby power supplies should not have common failure modes, as required by IEEE Std 308. To assure that the preferred power system satisfies the requirements of General Design Criterion 17, as supplemented by General Design Criteria 33, 34, 35, 38, 41 and 44, an acceptable design must be capable of restoring the preferred power supply after the loss of either circuit in a time period such that the plant can be safely shutdown, taking into account the effects of a single failure in the safety-related distribution system.

2. Testing, Quality Assurance, and System Operability Surveillance
   a. To assure that the requirements of General Design Criterion 1 are met in the preferred power system, the quality assurance program must satisfy the requirements of IEEE Std 336, as augmented by Regulatory Guide 1.30.

b. Preoperational and initial startup test programs should 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 General Design Criterion 18, an acceptable testing program must satisfy Regulatory Guide 1.118.

c. With regard to the surveillance of system operability status, an acceptable design must satisfy the positions of Regulatory Guide 1.47, as augmented by Branch Technical Position ICSB 21.

3. Secondary Review Branches

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The general objectives in the review of the preferred power system are to determine that this system satisfies the acceptance criteria and can reliably and adequately perform the functions that are assumed and used as bases in the accident analyses for normal and abnormal plant conditions. In the CP review, the descriptive information, including the design bases and their relation to the acceptance criteria, preliminary analyses, electrical single line diagrams, and preliminary physical arrangement and layout drawings are examined to determine that the final design will meet this objective if properly implemented. During the OL review, this objective is verified by examination of final electrical schematics, physical arrangement and layout drawings, and equipment ratings identified in the SAR and confirmed during a visit to the site (SRP Appendix 8-B). To assure that the applicable criteria of Table 8-1 are satisfied, the review of the proposed design is performed as described below.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. An understanding of the design bases, normal and abnormal operation modes, accident analyses, and plant equipment is required to evaluate the design and acceptability of the preferred power system. This information is gained by reading the SAR and in discussions with the applicant.

2. To assure that the requirements of General Design Criterion 17 are satisfied, the following review steps should be taken (as applicable for a CP or OL review):

   a. The electrical schematics should be examined to assure that at least two separate circuits from the transmission network to the standby power distribution system buses are provided (a switchyard may be common to these paths).

b. The routing of transmission lines should be examined on the station layout drawings and verified during the site visit to assure that at least two independent circuits from the offsite grid to the safety-related distribution buses are physically separate and independent. Preferably these lines should enter the station on separate rights-of-way, ideally on opposite sides of the switchyard, should leave the switchyard on opposite sides, and should terminate at transformers located on opposite sides of the reactor or turbine building. No other line should cross these two circuits. As physical separation becomes less than the ideal, attention should be directed towards assuring that no single event such as a tower falling or a line breaking can simultaneously affect both circuits in such a way that neither can be returned to service in time to prevent fuel design limits or design conditions of the reactor coolant pressure boundary from being exceeded.

c. As the switchyard may be common to both circuits from the offsite grid to the safety-related distribution buses, the electrical schematics of the switchyard breaker control system and power supply and the breaker arrangement itself should be examined for the possibility of simultaneous failure of both circuits from single events such as a breaker not operating during fault conditions, loss of a control circuit power supply, etc.

d. The design is examined to determine that one of the two required circuits can immediately provide power to safety-related equipment following a loss-of-coolant accident. General Design Criterion 17 does not require this circuit in itself to be single failure-proof for this accident. However, it is required that each circuit be available in sufficient time to prevent fuel design limits and design conditions of the reactor coolant pressure boundary from being exceeded. Therefore, the switchyard control system design and implementation should be such that any incoming line, switchyard bus, or any path to the safety-related distribution bus can be isolated. This is generally achieved by separated and redundant breaker tripping and closing devices, with each circuit independent of its redundant counterpart including control circuit power supplies. Designs that do not provide redundant control circuits must be justified by an analysis which shows the period of time that the station can remain in a safe condition assuming no a-c power is available. The time established in this analysis must be greater than the time required to reestablish a-c power from the offsite grid to the safety-related distribution bus for each single failure event. These designs sometimes depend on manual operation of the switchyard breakers, which involves an operator going to the yard and manually actuating valves controlling high pressure air stored in accumulators to open the breakers. It has been found in past reviews that several designs were such that the breakers could not be manually released by this action or by other means. Other items to be evaluated concern the consequences of shorting of switchyard buses, battery failures, status of breaker air accumulators, breaker failures, routing of control circuits and power supplies, shorting of transmission lines, and the design of a backfeed path through the main generator transformer if provided in the design.

e. Each of the circuits from the offsite grid to the safety-related distribution buses should have the capacity and capability to supply the loads assigned to the bus or buses it is connected to during normal or abnormal operating conditions, accident conditions, or plant shutdown conditions. Therefore, the loads to be supplied during these conditions should be determined from information provided by the RSB as to the equipment required to be operable for each condition. The capacity and electrical characteristics of transformers, breakers, buses, transmission lines, and the offsite grid power source for each path should be evaluated to assure that there is adequate capability to supply the maximum connected load during all plant conditions. The design should be examined to assure that during transfer from one power source to another the design limits of equipment are not exceeded.

f. The results of the grid stability analysis must show that loss of the largest single supply to the grid does not result in the complete loss of preferred power. The analysis should consider the loss, through a single event, of the largest capacity being supplied to the grid or removal of the largest load from the grid. This could be the total output of the station, the largest station on the grid, or possibly several large stations if these use a common transmission tower, transformer, or a breaker in a remote switchyard or substation. The station layout and the grid system layout drawings are reviewed to determine that all events were included in the analysis.

The applicant should include in the grid stability analysis the consideration of failure modes that could result in frequency variations exceeding the maximum rate of change determined in the accident analysis for loss of reactor coolant flow.

g. During the review of the electrical schematics, it should be determined that loss of standby power will not result in loss of preferred power, loss of one preferred power circuit will not result in loss of the other circuit, and loss of the main generator will not result in loss of either preferred power circuit.

3. To assure that the requirements of General Design Criterion 18 and Regulatory Guide 1.118 are satisfied, the electrical schematics should be examined to determine that the design includes provisions for testing the transfer of power to the safety-related distribution system from the main generator supply to the preferred power system, or to any other supply. It should also be established that the circuitry required to perform these transfer functions has the capability of being tested during plant operation.

4. To assure that the requirements of General Design Criteria 33, 34, 35, 38, 41 and 44 are satisfied, the electrical schematics of the systems required for reactor coolant makeup, residual heat removal, emergency core cooling, containment heat removal, containment atmosphere cleanup, and cooling water should be examined to assure that the circuits from the preferred power system can supply these systems assuming a single failure in these systems. Each of the circuits should be physically separate and independent of the other. If the minimum design required by General Design Criterion 17 is provided, the immediately available preferred circuit must be made available to the redundant portions of these systems.

5. To assure that the requirements of General Design Criterion 1 are satisfied, it should be determined that the design criteria and quality group classifications for all equipment conform to current codes and standards. The QAB will determine the adequacy of the quality assurance program.

6. To assure that the requirements (excluding seismic) of General Design Criterion 2 are satisfied for the facility being considered, the HMB will provide upon request information on the design basis flood, wave runup, high and low atmospheric temperatures, high wind, tornadoes and rain and snow conditions. This information will be considered during the review to assure that the design minimizes the effects of these conditions. Items such as switchyard and transformer locations and associated transmission lines could be affected by these conditions.

7. To assure that the requirements of General Design Criterion 3 are satisfied, it should be determined that the equipment of the preferred power system is designed and located to minimize, consistent with other safety requirements, the probability and effects of fires and explosions. The review of the design criteria for the equipment should ascertain this. The ASB will review the fire detection and fire fighting systems in the preferred power system areas to assure that adverse effects of fire are minimized. They will also examine ruptures of the fire fighting system to assure that they do not degrade the safety capability of structures, systems, and components to a condition where essential functions are lost.

8. To assure that the requirements of General Design Criterion 4 are satisfied, the ASB will review the location of structures, systems, and components of the preferred power system to determine the protection provided against dynamic effects, including effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the station. This information will be used to determine the possibility of simultaneous loss of both paths of preferred power.

9. To assure that the requirements of General Design Criterion 5 are satisfied, the structures, systems, and components of the preferred power systems will be examined to identify any that are shared between units of a multi-unit station. These will be reviewed to ascertain that they are capable of performing all required safety

functions in the event of an accident in one unit, with a simultaneous orderly shutdown and cooldown of the remaining units. Review of the design criteria should establish that the capacity and capability of incoming lines, power sources, and transformers for each required circuit have margin to achieve this. Spurious or false accident signals should not overload these circuits. SRP Section 8.3 further discusses spurious or false accident signal considerations.

10. To assure that the requirements of General Design Criterion 13 are satisfied, the preferred power system instrumentation provided to monitor variables and systems over anticipated ranges for normal operation, anticipated abnormal occurrences, and accident conditions should be identified during the electrical schematic and system description review. It should be ascertained that these instruments present status information that can be used to determine the condition of the preferred power system at all times. Review of the electrical schematics should determine that controls (automatic and manual) are provided to maintain these variables and systems within prescribed operating ranges. It should also be determined during the review of the electrical schematics that single failures of these controls and instruments will not violate the requirements of General Design Criterion 17.

11. The review of the automatic load dispatch system should ascertain that load dispatch system actions (including normal and postulated failure modes of operation) will not interfere with safety actions that may be required of the reactor protection system. This system should also be reviewed to assure that no failure mode of the load dispatch system will cause an incident at the generating station which would require protective action.

12. When a specific need is identified, ICSB will review the instrumentation and controls provided for the preferred power system in accordance with procedures given in the SRP section for which it has primary responsibility.

In certain instances, it will be the reviewer's judgment that, for a specific case under review, emphasis should be placed on specific aspects of the design, while other aspects of the design need not receive the same emphasis and in-depth review. Typical reasons for such a nonuniform placement of emphasis are the introduction of new design features or the utilization in the design of design features previously reviewed and found 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 offsite power system includes two or more identified power sources from the grid, transmission lines (overhead and underground), transmission line towers, transformers, switchyards and switchyard component control systems, switchyard battery systems, the main generator, and disconnect switches used to supply electric power to safety-related and other equipment. The review of the offsite power system for the ____________ plant covered single line diagrams (CP and OL), station layout drawings (CP and OL) and schematic diagrams (OL), and descriptive information. The review included the applicant's proposed design criteria and design bases for the offsite power system and his analyses of the adequacy of those criteria and bases. The review also included the applicant's analyses of the manner in which the design of the offsite power system conforms to the proposed design criteria.

"The basis for acceptance in the staff review has been conformance of the applicant's designs, design criteria, and design bases for the offsite power system to the Commission's regulations as set forth in the General Design Criteria, and to applicable regulatory guides, staff technical positions, and industry standards. These are listed in Table 8-1. (Table 8-1 should be included in the safety evaluation report, either at this point in Section 8.2 or in Section 8.1.)

"The staff concludes that the design of the offsite power system conforms to applicable regulations, guides, technical positions, and industry standards and is acceptable."

V. <u>REFERENCES</u>

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

2. Standard Review Plan Appendix 8-B, "General Agenda, Station Site Visits."

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 - Power Systems Branch (PSB)

Secondary - Auxiliary Systems Branch (ASB)
Containment Systems Branch (CSB)
Mechanical Engineering Branch (MEB)
Quality Assurance Branch (QAB)
Reactor Systems Branch (RSB)
Instrumentation and Control Systems Branch (ICSB)

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), is 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 SRP section. Other power sources such as nearby hydroelectric, nuclear, or fossil units including gas turbine-generator sets will not be addressed herein. These power sources, when proposed, will be evaluated on an individual case basis. 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 SRP section insofar as they relate to the independence of the standby power system.

The PSB will review the following features 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 the 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 SRP section 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, Raceways, and Terminal Equipment

The means proposed for identifying the standby power system cables, raceways, and terminal equipment as safety-related equipment in the plant are reviewed. Also, the identification scheme used to distinguish between redundant cables, raceways, 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 1E 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, qualification of this equipment, and design criteria and bases for the installation of redundant cables.

7. System Testing and Surveillance

Preoperational and initial startup 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 SRP Section 3.11.

b. Onsite d-c control power feeds to the standby power system are addressed in SRP Section 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 Section 8.1.

d. The ASB, under SRP Section 9.4, will evaluate the adequacy of the heating and ventilation systems for switchgear and diesel generator rooms. In particular, ASB will determine that the piping, ducting, and dampering for these heating and ventilation systems are adequate. In addition, the ASB will examine the physical arrangement of components and structures for Class 1E systems and their supporting auxiliary systems, and determine that single events and accidents will not disable redundant features.

e. The CSB, under SRP Section 6.2, 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 Section 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 raceways, switchgear, control room boards, and instrument racks and panels, in the event of a seismic occurrence.

g. The QAB, under SRP Sections 17.1 and 17.2, will verify the adequacy of the quality assurance program for the installation, inspection, and testing of Class 1E instrumentation and electrical equipment and will coordinate the requirements for the technical specifications.

h. The RSB, under SRP Sections 5.4, 6.3 and 15.0, 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.

i. The ICSB, under SRP Section 7.3, will verify that the accident signals are properly configured into the diesel genrator starting circuits. This will include an examination of the design criteria and bases for the installation of associated redundant electrical cables.

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, is testable, 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. Subsection III discusses the application of these evaluation guides to the review. The application of the acceptance criteria to the areas of review described in subsection I is as follows:

1. System Redundancy Requirements

General Design Criteria 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 General Design Criteria.

2. Conformance with the Single Failure Criterion

As required by General Design Criterion 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 acceptability 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 General Design Criterion 5, "Sharing of Structures, Systems, and Components." To assure that physical independence of redundant equipment, including cables and raceways, is maintained in accordance with meeting the requirements of General Design Criteria 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 General Design Criterion 17. In addition, the preferred and standby power supplies should not have common failure modes. In assuring that the design of the preferred power circuits to the safety-related buses is consistent with satisfying the power availability requirements of General Design Criterion 17, as supplemented by General Design Criteria 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 General Design Criterion 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 1E loads to and from the Class 1E 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 1E loads will not result in any degradation of the Class 1E system.

d. Diesel generator qualification testing programs are acceptable if they satisfy Position 5 of Regulatory Guide 1.6, Regulatory Guide 1.9, and Branch Technical Position ICSB 2 (PSB).

e. The diesel generator system design is acceptable with regard to testability if the applicable positions of Regulatory Guide 1.108 are satisfied.

f. Regarding the design of thermal overload protection for motors of motor-operated safety-related valves, the acceptability of the design is based on Regulatory Guide 1.106.

5. <u>Identification of Cables, Raceways, and Terminal Equipment</u>
The method used for identifying standby power system cables, raceways, and terminal equipment as safety-related equipment in the plant, and the identification scheme used to distinguish between redundant cables, raceways, and terminal equipment, are acceptable if they are in accordance with IEEE Std 384 as augmented by Regulatory Guide 1.75.

6. <u>Vital Supporting Systems</u>
The instrumentation, controls, and electrical equipment for those supporting systems identified as vital to the proper functioning of Class 1E systems are acceptable if the design conforms to the same criteria as for the Class 1E systems they support.

7. <u>System Testing and Surveillance</u>
To assure that the preoperational and initial startup test programs for the standby power system meet the requirements of General Design Criterion 1, they must be in accordance with Regulatory Guides 1.68 and 1.41. To assure that the periodic onsite testing capabilities satisfy the requirements of General Design Criteria 18 and 21, an acceptable testing program should include the positions of Regulatory Guides 1.22 and 1.108. With regard to surveillance of the operability status of the standby

power system, an acceptable design should satisfy the positions of Regulatory Guide 1.47, as augmented by Branch Technical Position ICSB 21.

8. Fire Protection for Cable Systems

The basis for acceptance of fire protection for cable systems is given in SRP Section 9.5.1. In addition, it should be acceptably demonstrated that cable derating and raceway fill are in accordance with accepted industry practices.

9. Other Review Areas

For those areas of review identified in subsection I as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches. 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, control and electrical equipment, the MEB ICSB and PSB will perform reviews in this regard to ascertain that the proposed design satisfies such standards as IEEE Std 344, "Standard for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," and Regulatory Guide 1.100. Additional criteria are provided in SRP Section 3.10.

b. Quality Assurance

To assure that the requirements of General Design Criterion 1 are met in the standby power system, the quality assurance program for the Class 1E 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," and Regulatory Guide 1.30, "Quality Assurance Requirements for the Installation, Inspection and Testing of Instrumentation and Electric Equipment." The QAB, ICSB and PSB 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, is testable, 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 PSB, this section identifies those aspects of the review that will be accomplished by the secondary review branches. Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. System Redundancy Requirements

   Based on the information provided by the RSB with regard to the required redundancy of safety-related components and systems (General Design Criteria 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 by the PSB that redundant safety loads are distributed between redundant distribution systems, and that the instrumentation and control devices for the Class 1E 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 (General Design Criterion 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 General Design Criterion 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 PSB 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 1E 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 1E 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 raceways, 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 1E 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 (General Design Criterion 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 (General Design Criteria 3, 4). The ASB has primary responsibility in the review of the design arrangement of the Class 1E systems and their vital supporting systems, except for the cable design which is the responsibility of the PSB. Within the scope of review of this area, the ASB 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 (General Design Criteria 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 augmented by Regulatory Guide 1.75, the proposed design criteria governing the separation of Class 1E cables and raceways are reviewed including such criteria as those for cable derating; raceway filling; cable routing in containment, penetration areas, cable spreading rooms, control rooms and other congested areas; sharing of raceways with nonsafety-related cables or with cables of the same system or other systems; prohibiting cable splices in raceways; control wiring and components associated with Class 1E electric systems in control boards, panels, and relay racks; and fire barriers and separation between redundant raceways. 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 1E equipment.

3. <u>Standby and Preferred Power Systems Independence</u>

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 the review for independence extends from the supply breakers connected to the low side of the unit auxiliary transformers and startup transformers (referred to as the offsite or preferred power supplies) to the station safety-related distribution system. The number and capability of electrical circuits from the preferred power supplies to the safety buses are to be consistent with satisfying the requirements (one immediate and one delayed access circuit, as a minimum) of General Design Criterion 17. Then, downstream of the preferred power breakers at the safety buses, the design must satisfy the requirements for redundancy and independence of General Design Criteria 34, 35, 38, 41 and 44; that is, for standby power system operation (assuming preferred 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 1E buses is consistent with satisfying the requirements of General Design Criterion 17 and 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 1E 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 by PSB 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 circuits 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 1E 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 (General Design Criterion 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 ICSB 8 (PSB) 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 General Design Criterion 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, in-rush 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 PSB 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 Regulatory Guide 1.106.

Regarding the review of the electrical protective trip circuits of the diesel generator sets, Branch Technical Position ICSB 17 (PSB) 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 is 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 1E 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 1E 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 1E loads to and from the Class 1E 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.

General Design Criterion 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 General Design Criteria 5 and 17 as supplemented by General Design Criteria 34, 35, 38, 41 and 44 and satisfies the positions of Regulatory Guide 1.9, the PSB 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 of Regulatory Guide 1.81 establishes acceptable bases under which sharing of standby power systems between units is permitted. Conformance with Position 2 with regard to 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 1E loads to and from the Class 1E 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 1E loads and Class 1E buses will not result in the degradation of the Class 1E system, the isolation device through which standby power is supplied to the non-Class 1E load, including control circuits and connections to the Class 1E bus, must be designed to meet Class 1E requirements. Should the standby power supplies not have been sized to accommodate the added non-Class 1E loads during emergency conditions, the design must provide for the automatic disconnection of those non-Class 1E 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 subsection II.4. 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 has 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 PSB will also verify that there is seismic Category I onsite fuel oil storage capacity for operation at full rated load of one redundant diesel generator for at least seven days.

5. <u>Identification of Cables, Raceways, and Terminal Equipment</u>
The identification scheme used for Class 1E cables, raceways, and terminal equipment in the plant and Class 1E internal wiring in the control boards is reviewed to see that it is consistent with IEEE Std 384 as augmented by Regulatory Guide 1.75. This includes the criteria for differentiating between safety-related cables, raceways and terminal equipment of different channels or divisions, nonsafety-related cable which is run in safety raceways, nonsafety-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. <u>Vital Supporting Systems</u>
The PSB will review those auxiliary systems identified as being vital to the operation of Class 1E loads and systems. The PSB 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 1E 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 1E systems. In essence, the reviewer first becomes familiar with the purpose and operation of each vital supporting system, including its components 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 1E systems. In addition, it is verified that 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 1E system that they support. The PSB will also verify that the vital supporting systems which are associated with the emergency diesel engine such as the fuel oil storage and transfer system, cooling water system, starting air and lubrication systems are in accordance with the acceptance criteria.

The ASB reviews 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. Included is a review of the heating and ventilation (H&V) systems identified as necessary to Class 1E systems, such as the H&V systems for the electrical switchgear and diesel generator rooms. The ASB will verify the adequacy of the H&V system design to maintain the temperature and relative 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 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 1E systems they support.

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, 1.41 and 1.108. In assuring that the proposed periodic onsite testing capabilities of Class 1E systems satisfy the requirements of General Design Criteria 18 and 21, and Regulatory Guide 1.108 and 1.118, 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 1E systems on a periodic basis when the reactor is in operation.

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 1E system are reviewed to ascertain that the design is consistent with Regulatory Guide 1.47 and Branch Technical Position ICSB-21. This position establishes the basis to be considered in arriving at an acceptable design for the inoperable status indication system.

8. Fire Protection for Cable Systems

In assuring that the requirements of General Design Criterion 3 have been met, ASB will review the design of the fire stops and seals, including the materials, their characteristics with regard to flammability and fire retardancy, and their fire underwriters rating in accordance with SRP Section 9.5.1. 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. PSB will review cable derating and raceway fill to assure compliance with accepted industry practices.

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 SRP sections. 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 ICSB and PSB 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 1E 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.

b. Quality Assurance

In assuring that the quality of Class 1E equipment is commensurate with present codes and standards (General Design Criterion 1), the QAB will review the proposed quality assurance program to ascertain that it is consistent with satisfying the QAB acceptance criteria. The PSB 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 1E 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, and instrumentation and controls required 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 1E standby power system and its connected Class 1E 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, raceways, 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."

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 8.3.2 D-C POWER SYSTEMS (ONSITE)

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - Auxiliary Systems Branch (ASB)
Containment Systems Branch (CSB)
Mechanical Engineering Branch (MEB)
Reactor Systems Branch (RSB)
Quality Assurance Branch (QAB)
Instrumentation and Control Systems Branch (ICSB)

I. AREAS OF REVIEW

The d-c power systems include those d-c power sources and their distribution systems and vital supporting systems provided to supply motive or control power to safety-related equipment. Batteries and battery chargers are used as the power sources for the d-c power system, and inverters are used to convert d-c from the d-c distribution system to a-c instrumentation power as required. Information on the d-c power system presented in the applicant's safety analysis report (SAR) is reviewed by the staff to determine that the d-c power system required for safe operation during all operating and accident conditions meets the requirements of General Design Criteria (GDC) 17 and 18 and are consistent with Regulatory Guide 1.32, applicable industry standards, and staff positions as listed in Table 8-1. For construction permit (CP) applications the descriptive information presented for the d-c power system should include commitments to meet the acceptance criteria listed in Subsection II or adequate justification for exceptions taken, preliminary single line diagrams illustrating the redundancy of d-c power supplies, preliminary load assignments, and preliminary physical arrangement drawings illustrating the independence of redundant batteries and distribution circuits. For operating license (OL) applications, the descriptive information presented should include final single line diagrams, electrical schematics, final physical arrangement drawings, and complete load distribution diagrams, as are needed to determine that the d-c power system has sufficient capacity and capability to meet its functional requirements and otherwise satisfy the General Design Criteria.

The PSB will pursue the following phases in the review of the d-c power system:

1. The system is reviewed to determine that the required redundancy of components and subsystems is provided. This will require an examination of the d-c power system configuration including power supply feeders, load center arrangements, loads supplied from each bus, and power connections to the instrumentation and control devices of the system.

2. In determining the adequacy of this system to meet the single failure criterion, the 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 the interconnections between redundant buses, buses and loads, and buses and power supplies; proposed sharing of the d-c power system between units at the same site; and the design criteria and bases governing the installation of electrical cable for redundant portions of the systems.

3. Design information and analyses demonstrating the suitability of batteries and battery chargers as d-c power supplies are reviewed to assure that they have sufficient capacity, capability, and reliability to perform their intended functions. This will require an examination of the characteristics of each load; the length of time each load is required; the combined load demand connected to each battery or battery charger during the "worst" operating condition; the voltage recovering characteristics of the battery and battery chargers; and the continuous and short term ratings for the battery and battery chargers.

   In addition, where the proposed design provides for the connection of nonsafety-related loads to the d-c power system and sharing of batteries and battery chargers between units at the same site, particular review emphasis is given to assuring against marginal capacity and degradation of reliability that may result from implementing such design provisions.

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

5. 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 1E loads and power systems that they support. This will include an examination of the vital supporting system component redundancy, power feed assignment to instrumentation, control of loads, initiating circuits, load characteristics, equipment identification scheme, and design criteria and bases for the installation of redundant cables.

6. 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.

7. Other areas of review associated with these systems which are covered elsewhere are as follows:
   a. Environmental design and qualification testing of electrical equipment are addressed in SRP Section 3.11.
   b. Technical specification requirements imposed upon the operation of the d-c power system are discussed in Chapter 16 of the SAR. Assistance and consultation on technical specifications for the d-c power system are provided in accordance with the procedures stated in SRP Section 8.1.

The ASB will evaluate the adequacy of those auxiliary systems that are vital to the proper operation and/or protection of the d-c power system. These include such systems as the heating and ventilation systems for load center, battery, battery charger, and inverter rooms, and fire detection and protection systems. In particular, the ASB will determine that the piping, ducting, and valving arrangements of redundant vital auxiliary supporting systems meet the single failure criterion. In addition, the ASB will examine the physical arrangement of the d-c power system and its supporting auxiliary system components and associated structures, except cables, to determine that single events and accidents will not disable redundant features.

The CSB will identify those containment ventilation systems provided for maintaining a controlled environment for safety-related electrical equipment located inside the containment.

The MEB reviews the criteria for seismic qualification analyses, and the test and analysis procedures and methods to assure the operability of instrumentation and electrical equipment in the event of a seismic occurrence.

The RSB will identify any differences or changes in the safety related loads and systems from those stated in the SAR that are needed to assure sufficient capacity.

The QAB will verify the adequacy of the quality assurance program for this system.

The ICSB will evaluate, on request, portions of the Class 1E d-c systems instrumentation and control.

II. ACCEPTANCE CRITERIA

The d-c power system is acceptable if 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 d-c power to all safety related loads required by the accident analyses. Table 8-1 lists the criteria that are utilized as the bases for arriving at this conclusion. In addition, the references include those evaluation guides used by the reviewer as aids in ascertaining that the criteria have been met. Subsection III discusses the application of these evaluation guides to the review. The application of most of the acceptance criteria to the areas of review described in Subsection I is detailed below. The applicability of other criteria listed in

Table 8-1 but not specifically addressed above is considered to be self-evident, and their application in the review process is considered self-explanatory.

1. <u>System Redundancy Requirements</u>
   GDC 22, 33, 34, 35, 38, 41, and 44 set forth requirements with regard to safety-related systems that must be supplied by the onsite (a-c and d-c) power systems. Also, these criteria state that safety-related system redundancy shall be such that for onsite power system operation (assuming preferred power is not available) the system safety function can be accomplished assuming a single failure. The acceptability of the onsite d-c power system with regard to redundancy is based on conformance to the same degree of redundancy required of safety-related components and systems required by these GDC.

2. <u>Conformance with the Single Failure Criterion</u>
   As required by GDC 17, the d-c power system must be capable of performing its safety function assuming a single failure. To meet this requirement, physical and electrical independence between redundant portions of this system must be maintained. An acceptable design in this regard must meet the requirements of IEEE Std 308 and satisfy the positions of Regulatory Guide 1.6. To assure that physical independence of redundant equipment, including cables and raceways, is maintained in accordance with the requirements of GDC 2, 3, and 4, an acceptable design arrangement should satisfy the requirements of IEEE Std 384 and the positions of Regulatory Guides 1.75 and ASB BTP 9.5-1.

3. <u>Power Supplies and Distribution Systems</u>
   a. The capacity, capability, and reliability of the d-c power supplies and distribution systems is acceptable if the basis for their selection satisfies the requirements of IEEE Std 308.
   b. Should the proposed design provide for sharing of the d-c 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 acceptability of such a design is based on the design satisfying the recommendations of Regulatory Guide 1.81. This position sets forth acceptable bases for implementing the requirements of GDC 5, "Sharing of Structures, Systems, and Components."
   c. Should the proposed design provide for the connection and disconnection of nonsafety-related loads to and from the standby d-c power supplies, it should conform to 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 nonsafety-related loads will not compromise the independence between redundant systems nor degrade either redundant system below an acceptable level.
   d. Regarding the design of thermal overload protection for motors of motor-operated safety-related valves, the acceptability of the design is based on Regulatory Guide 1.106.

4. Identification of Cables and Raceways

The method used for identifying d-c power system cables and raceways as safety-related equipment in the plant, and the identification scheme used to distinguish between redundant cables and raceways are acceptable if in accordance with Regulatory Guide 1.75.

5. Vital Supporting Systems

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

6. System Testing and Surveillance

To assure that the preoperational and initial start-up test programs for the d-c power system meet the requirements of GDC 1, they must be in accordance with Regulatory Guides 1.68 and 1.41. To assure that the periodic onsite testing capabilities satisfy the requirements of GDC 18, an acceptable testing program should include the battery capacity tests described in Section 5 of IEEE Std 450 and the positions of Regulatory Guide 1.118. With regard to surveillance of the d-c power system operability status, an acceptable design should satisfy the positions of Regulatory Guide 1.47.

7. Other Review Areas

For those areas of review identified in Subsection I of this SRP as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches. However, there are some acceptance criteria that are commonly used by both primary and secondary branches as the basis for determining that a design is acceptable. For the d-c 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 PSB will perform reviews in this regard to ascertain that the proposed design satisfies such standards as IEEE Std 344, "Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."

b. Quality Assurance

To assure that the requirements of GDC 1 are met in the d-c power system, the quality assurance program for the safety-related instrumentation and electrical equipment must satisfy the requirements of IEEE Std 336, "Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment During the Construction of Nuclear Power Generating Stations," and Regulatory Guide 1.30, "Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment." Both the QAB and PSB 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 d-c 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 d-c power to all required safety-related 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 certain instances, it will be the reviewer's judgement that for a specific case under review, emphasis should be placed on specific aspects of the design, while other aspects of the design need not receive the same emphasis and in-depth review. Typical reasons for such placement of emphasis are the introduction of new design features or the utilization in the design of design features previously reviewed and found acceptable.

In addition to the review procedures of the PSB, this section identifies those aspects of the review that will be accomplished by the secondary review branches. Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in Subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

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 stages), functional P&IDs (CP and OL stages), and electrical schematics (OL stage) is reviewed to verify that this redundancy is reflected in the d-c power system with regard to both power sources and associated distribution systems. Also, it is verified that redundant safety-related loads are distributed between redundant distribution systems, and that the instrumentation and control devices for the safety-related 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 to meet 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. Since IEEE Std 308 does not set forth specific criteria governing the design of the circuits that initiate and control d-c power, the reviewer utilizes IEEE Std 279, "Criteria for Protection Systems for Nuclear Power Generating Stations," as an evaluation guide to ascertain that the designs of these circuits satisfy the basic single failure requirements of 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:

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 d-c 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 safety-related systems which is discussed below. Further, the interconnection of redundant load centers must be accomplished only manually.

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 arrangement satisfies the requirements of IEEE Std 384 and positions of Regulatory Guides 1.75 and ASB BTP 9.5-1. These guides and standards set forth acceptance criteria for the separation of circuits and electrical equipment contained in or associated with the safety-related 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 ASB has primary responsibility in the review of the design arrangement of the Class 1E systems and their vital supporting systems, except for the cable design which is the responsibility of the PSB. The ASB 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 the requirements set forth in IEEE Std 384 and the position set forth in Regulatory Guide 1.75 and ASB BTP 9.5-1, the proposed design criteria governing the separation of safety-related cables and raceways are reviewed including such criteria as those for cable derating; raceway filling; cable routing in containment penetration areas, cable spreading rooms, control rooms, and other congested areas; sharing of raceways with nonsafety-related cables or with cables of the same system or other systems; prohibiting cable splices in raceways; spacing of 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 trays. With regard to determining the adequacy of the physical independence of redundant cables through penetration areas, the reviewer utilizes Regulatory Guides 1.75, 1.63, ASB BTP 9.5-1, and IEEE Std 317 as evaluation guides to ascertain that the electric penetration assemblies are designed in accordance with the requirements for safety-related equipment.

3. D-C Power Supplies and Distribution Systems

In assuring that the requirements of GDC 17 and IEEE Std 308 have been met with regard to the d-c power system 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 performance characteristic curves are reviewed. To establish that the capacity of the d-c supply is adequate to power the prescribed loads, the nameplate capacity claimed in the design bases is checked against the loads identified in electrical distribution diagrams. The capability of the system is reviewed 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. The reliability of the d-c supplies should be assured by periodic discharge tests of the batteries as described in IEEE Std 450 and Regulatory Guide 1.129.

The reviewer first becomes familiar with the purpose and the operation of each safety system, including system component arrangements as depicted on functional P&IDs, expected system performance as established in the accident analyses, modes of system operation and 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 d-c supply is consistent with the information provided by the RSB.

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 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 d-c 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 is guided by Regulatory Guide 1.106.

Where the proposed design provides for the sharing of d-c supplies between units at the same site, and connection and disconnection of nonsafety-related loads to and from the safety-related 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 these supplies.

In the absence of specific criteria in IEEE Std 308 governing 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 judgement to determine the adequacy of the design. In assuring 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 d-c 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. Should the d-c power supplies not have 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 whether or not the load was already connected to the power supply.

The description of the qualification test program (CP stage) and the results of such tests (OL stage) for demonstrating the suitability of the batteries and battery charger as d-c power supplies are judged to be acceptable if they satisfy the acceptance criteria listed in Subsection II.3 or Table 8-1.

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 d-c power system includes the batteries, battery chargers, and distribution centers used to supply power to d-c operated safety-related equipment. The scope of review of the d-c power system included single line diagrams (CP and OL), schematic diagrams (OL), and descriptive information for the d-c power system and for those auxiliary supporting systems that are essential to the operation of the d-c power system. The review has included the applicant's proposed design criteria and his analyses of the adequacy of those criteria and bases. The review also has included the applicant's analyses of the manner in which the design of the d-c power system conforms to the proposed design criteria. The basis for acceptance in the staff review has been conformance of the applicant's design, design criteria, and design bases for the d-c power system 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.

"The staff concludes that the design of the d-c power system conforms to applicable regulations, guides, technical positions, and industry standards and is acceptable."

V. REFERENCES

1. Table 8-1 of Standard Review Plan 8.1, "Electric Power - Introduction."

2. Branch Technical Position ASB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants."

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

Appendix 8-A BRANCH TECHNICAL POSITIONS (PSB)*

The PSB Branch Technical Positions (BTPs) represent guidelines intended to supplement the acceptance criteria established in Commission Regulations and regulatory guides, and in applicable IEEE standards. As technical problems or questions of interpretation arise in the detailed reviews of plant designs, the staff must determine an acceptable resolution for each such case to complete its review of a particular application. Where the same technical problem or question of interpretation arises in several cases, the staff's determination on the point at issue is formalized in a BTP. The BTP is primarily an instruction to staff reviewers that outlines an acceptable approach to the particular issue and ensures a uniform treatment of the issue by staff reviewers. The approaches taken in the BTPs, like the recommendations of regulatory guides, are not mandatory, but do provide defined, acceptable, and immediate solutions to some of the technical problems and questions of interpretation that arise in the review process. In some instances, regulatory guides may be developed from BTPs after sufficient experience in their use has accumulated. All PSB BTPs applicable to Chapter 8 of the Standard Review Plan (except ICSB (PSB)-21) have been included in this appendix for convenience. They are listed below:

BTP ICSB (PSB)	Branch Technical Positions of the PSB
2	Diesel-Generator Reliability Qualification Testing
4	Requirements on Motor-Operated Valves in the ECCS Accumulator Lines
8	Use of Diesel-Generator Sets for Peaking
11	Stability of Offsite Power Systems
15	Reactor Coolant Pump Breaker Qualification
17	Diesel-Generator Protective Trip Circuit Bypasses
18	Application of the Single Failure Criterion to Manually-Controlled Electrically-Operated Valves
21**	Guidance for Application of Regulatory Guide 1.47 (attached to Standard Review Plan Appendix 7-A)

* These BTPs are formerly EICSB BTPs which are now in the area of review responsibility of the Power Systems Branch (PSB). Their EICSB (now ICSB) number has been retained in order to provide continuity and correlation with completed reviews.

**ICSB primary responsbility.

BRANCH TECHNICAL POSITION ICSB 2 (PSB)
DIESEL-GENERATOR RELIABILITY QUALIFICATION TESTING

A. BACKGROUND

The increase in standby electrical generating capacity required for safety loads of the current large water-cooled power reactors has caused several applicants to propose standby power source designs using diesel-generators or diesel-generator configurations not previously used. The staff concluded that qualification testing of these larger capacity machines or configurations would be required to demonstrate a capability and reliability at least equivalent to that of machines currently used for nuclear plant standby applications.

The proposals of nonstandard diesel-generator arrangements for Sequoyah, Fort St. Vrain, Hutchinson Island, and Fitzpatrick made it necessary to develop a consistent approach for determining acceptability. Regulatory Guides 1.6 and 1.9 were utilized as the bases.

B. BRANCH TECHNICAL POSITION

A start and load reliability test program should be required for all diesel-generator sets of a type or size not previously used as standby emergency power sources in nuclear power plant service. The objective of this program should be to establish a 0.99 reliability for starting and accepting design load in the desired time. An acceptable test program should include the following requirements:

1. At least two full-load and margin tests acceptable to the staff should be performed on each diesel-generator set to demonstrate the start and load capability of the units with some margin in excess of the design requirements. Proposed full-load and margin testing should be evaluated on an individual case basis to take account of the differences in unit design.

2. Prior to initial fuel loading, at least 300 valid start and load tests should be performed with no more than three failures allowed. At least 90% of these start tests shall be made from design cold ambient conditions (design hot standby conditions if standby temperature control system is provided) and 10% from design hot equilibrium temperature conditions. This would include all valid tests performed offsite. A valid start and load test shall be defined as a start from the specified temperature conditions with loading to at least 50% of continuous rating within the required time intervals, and continued operation until temperature equilibrium is attained.

3. A failure rate in excess of one per hundred should require further testing as well as review of the system design adequacy.

BRANCH TECHNICAL POSITION ICSB 4 (PSB)
REQUIREMENTS ON MOTOR-OPERATED VALVES IN THE ECCS ACCUMULATOR LINES

A. BACKGROUND

For many postulated loss-of-coolant accidents, the performance of the emergency core cooling system (ECCS) in pressurized water reactor plants depends upon proper functioning of the safety injection tanks (also referred to as "accumulators" or "flooding tanks" in some applications). In these plants, a motor-operated isolation valve (MOIV) and two check valves are provided in series between each safety injection tank and the reactor coolant (primary) system.

The MOIVs must be considered to be "operating bypasses" because, when closed, they prevent the safety injection tanks from performing the intended protective function. IEEE Std 279 has a requirement for "operating bypasses" which states that the bypasses of a protective function will be removed automatically whenever permissive conditions are not met. This Branch Technical Position provides specific guidance in meeting the intent of IEEE Std 279 for safety injection tank MOIVs.

It should be noted that BTP ICSB 18 (PSB), "Application of the Single Failure Criterion to Manually-Controlled Electrically-Operated Valves," also applies to these isolation valves and should be used in conjunction with this position.

B. BRANCH TECHNICAL POSITION

The following features should be incorporated in the design of MOIV systems for safety injection tanks to meet the intent of IEEE Std 279:

1. Automatic opening of the valves when either primary coolant system pressure exceeds a preselected value (to be specified in the technical specifications), or a safety injection signal is present. Both primary coolant system pressure and safety injection signals should be provided to the valve operator.

2. Visual indication in the control room of the open or closed status of the valve.

3. An audible and visual alarm, independent of item 2., above, that is actuated by a sensor on the valve when the valve is not in the fully-open position.

4. Utilization of a safety injection signal to remove automatically (override) any bypass feature that may be provided to allow an isolation valve to be closed for short periods of time when the reactor coolant system is at pressure (in accordance with provisions of the technical specifications).

C. REFERENCES

1. Arkansas 1, Unit 1, Safety Evaluation Report, January 23, 1973.

2. IEEE Std 279, "Criteria for Protection Systems for Nuclear Power Generating Stations."

3. BTP ICSB 18 (PSB), "Application of the Single Failure Criterion to Manually-Controlled Electrically-Operated Valves."

BRANCH TECHNICAL POSITION ICSB 8 (PSB)
USE OF DIESEL-GENERATOR SETS FOR PEAKING

A. BACKGROUND

General Design Criterion 17 requires that provisions be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, loss of the main generator, loss of power from the grid, or loss of standby power supplies. Additionally, IEEE Std 308 requires that the preferred (offsite) and standby power supplies shall not have a common failure mode. Common failure mode is defined as "a mechanism by which a single design basis event can cause redundant equipment to be inoperable." Although IEEE Std 308 does not preclude the use of emergency diesels for nonsafety purposes, the staff concludes that the potential for common failure modes should preclude interconnection of onsite and offsite power sources except for short periods for the purpose of load testing.

Review of the use of emergency diesel-generator sets for peaking service leads to the conclusion that the required frequent interconnection of the preferred and standby power supplies increases the probability of their common failure.

B. BRANCH TECHNICAL POSITION

General Design Criterion 17 and IEEE Std 308 should be interpreted as prohibiting the use of plant emergency power diesel-generator sets for purposes other than that of supplying standby power when needed. In particular, emergency power diesel-generator sets should not be used for peaking service.

C. REFERENCES

None.

BRANCH TECHNICAL POSITION ICSB 11 (PSB)
STABILITY OF OFFSITE POWER SYSTEMS

A. BACKGROUND

The staff has traditionally required each applicant to perform stability studies for the electrical transmission grid which would be used to provide the offsite power sources to the plant. The basic requirement is that loss of the largest operating unit on the grid will not result in loss of grid stability and availability of offsite power to the plant under consideration. In some cases, such as plants on the island of Puerto Rico, the plant is connected to an isolated power system of limited generating capacity. These kinds of isolated power systems are inherently less stable than equivalent systems with supporting grid interties. It is also obvious that limited systems are more vulnerable to natural disasters such as tornadoes or hurricanes.

B. BRANCH TECHNICAL POSITION

1. The staff has concluded, from a review of appropriate reliability data, that power systems with supporting grid interties meet the grid availability criterion with some margin. This conclusion is applicable to the review of most plants located on the U.S. mainland.

2. There is also strong indication that an isolated system large enough to justify inclusion of a nuclear unit will also meet this criterion. However, as a conservative approach, the staff will examine the available generating capacity of a system, including interties if available, to withstand outage of the largest unit. If the available capacity is judged marginal to provide adequate stability of the grid, additional measures should be taken. These may include provisions for additional capability and margin for the onsite power system beyond the normal requirements, or other measures as may be appropriate in a particular case. The additional measures to be taken should be determined on an individual case basis.

C. REFERENCES

None.

BRANCH TECHNICAL POSITION ICSB 15 (PSB)
REACTOR COOLANT PUMP BREAKER QUALIFICATION

A. BACKGROUND

An assumption usually made in accident analyses is that for complete loss of forced reactor coolant flow (resulting from a failure of the main coolant pump power supply that is presaged by an underfrequency condition), a reactor trip is initiated along with disengagement of the reactor coolant pumps from the power grid to assure that the pumps' kinetic energy is available for flow coastdown. Therefore, unless the pump breakers are Class 1E and are housed in a seismic Category I structure, the required disengagement of the pump motors from the power grid when it experiences the underfrequency condition might not occur. It is the intent of this Branch Technical Position to provide guidance in meeting this concern.

B. BRANCH TECHNICAL POSITION

1. If credit is taken for reactor coolant pump coastdown in the accident analyses, the pump breakers must be qualified in accordance with the requirements of IEEE Std 279 and IEEE Std 308. Further, they must be located in a seismic Category I structure.

2. Any reactor pump system trip sensors associated with these breakers should meet the requirements of IEEE Std 279, regardless of whether or not credit is taken for pump coastdown. If credit is not taken for pump coastdown, the building or structure housing these breakers does not have to be seismic Category I. It has been tentatively established that unless the applicant can demonstrate by analysis that an underfrequency rate of 15 Hz/sec will not prevent the pumps from performing their coastdown function, the tripping of the reactor coolant pump breakers will be considered a required safety action.

C. REFERENCES

1. Vogtle Safety Evaluation Report, December 18, 1973.

2. IEEE Std 279, "Criteria for Protection Systems for Nuclear Power Generating Stations."

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

BRANCH TECHNICAL POSITION ICSB 17 (PSB)
DIESEL-GENERATOR PROTECTIVE TRIP CIRCUIT BYPASSES

A. BACKGROUND

Where protective trips are provided to protect the standby diesel-generators from possible damage or degradation, these protective trips could interfere with the successful functioning of the diesel-generators when they are most needed, i.e., during an accident condition. In nuclear power plant applications, the criterion should be to provide standby power when needed to mitigate the effects of an accident condition, rather than to protect the diesel-generators from possible damage or degradation.

B. BRANCH TECHNICAL POSITION

1. The design of standby diesel generator systems should retain only the engine overspeed and the generator differential trips and bypass all other trips under an accident condition. All those trips that are bypassed for an accident condition may be retained for the diesel-generator routine tests. This concept will reduce the probability of spurious trips during accident conditions and will also reduce the exposure of the equipment to damage from malfunctions during routine tests.

2. The design should include capability for testing the status and operability of the bypass circuits and should alarm abnormal values of all the bypassed parameters in the control room.

3. If other trips, in addition to the engine overspeed and generator differential, are retained for accident conditions, an acceptable design should provide two or more independent measurements of each of these trip parameters. Trip logic should be such that diesel-generator trip would require specific coincident logic.

4. The bypass circuitry for the diesel-generator protective trips should be designed to meet the requirements of IEEE Std 279.

C. REFERENCES

1. SERs for St. Lucie Units 1 and 2 (operating license and construction permit).

2. SER for SWESSAR-P1, Stone and Webster Corporation Standard Plant Design.

3. IEEE Std 279, "Criteria for Protection Systems for Nuclear Power Generating Stations."

BRANCH TECHNICAL POSITION ICSB 18 (PSB)

APPLICATION OF THE SINGLE FAILURE CRITERION TO MANUALLY-CONTROLLED ELECTRICALLY-OPERATED VALVES

A. BACKGROUND

Where a single failure in an electrical system can result in loss of capability to perform a safety function, the effect on plant safety must be evaluated. This is necessary regardless of whether the loss of safety function is caused by a component failing to perform a requisite mechanical motion, or by a component performing an undesirable mechanical motion.

This position establishes the acceptability of disconnecting power to electrical components of a fluid system as one means of designing against a single failure that might cause an undesirable component action. These provisions are based on the assumption that the component is then equivalent to a similar component that is not designed for electrical operation, e.g., a valve that can be opened or closed only by direct manual operation of the valve. They are also based on the assumption that no single failure can both restore power to the electrical system and cause mechanical motion of the components served by the electrical system. The validity of these assumptions should be verified when applying this position.

B. BRANCH TECHNICAL POSITION

1. Failures in both the "fail to function" sense and the "undesirable function" sense of components in electrical systems including valves and other fluid system components should be considered in designing against a single failure, even though the valve or other fluid system component may not be called upon to function in a given safety operational sequence.

2. Where it is determined that failure of an electrical system component can cause undesired mechanical motion of a valve or other fluid system component and this motion results in loss of the system safety function, it is acceptable, in lieu of design changes that also may be acceptable, to disconnect power to the electric systems of the valve or other fluid system component. The plant technical specifications should include a list of all electrically-operated valves, and the required positions of these valves, to which the requirement for removal of electric power is applied in order to satisfy the single failure criterion.

3. Electrically-operated valves that are classified as "active" valves, i.e., are required to open or close in various safety system operational sequences, but are manually-controlled, should be operated from the main control room. Such valves may not be included among those valves from which power is removed in order to meet the single failure criterion unless: (a) electrical power can be restored to the valves from the main control room, (b) valve operation is not necessary for at least ten minutes following occurrence of the event requiring such operation, and

(c) it is demonstrated that there is reasonable assurance that all necessary operator actions will be performed within the time shown to be adequate by the analysis. The plant technical specifications should include a list of the required positions of manually-controlled, electrically-operated valves and should identify those valves to which the requirement for removal of electric power is applied in order to satisfy the single failure criterion.

4. When the single failure criterion is satisfied by removal of electrical power from valves described in 2. and 3., above, these valves should have redundant position indication in the main control room and the position indication system should, itself, meet the single failure criterion.

5. The phrase "electrically-operated valves" includes both valves operated directly by an electrical device (e.g., a motor-operated valve or a solenoid-operated valve) and those valves operated indirectly by an electrical device (e.g., an air-operated valve whose air supply is controlled by an electrical solenoid valve).

C. REFERENCES

None.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.1.1 NEW FUEL STORAGE

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Mechanical Engineering Branch (MEB)
Structural Engineering Branch (SEB)
Materials Engineering Branch (MTEB)
Core Performance Branch (CPB)
Radiological Assessment Branch (RAB)

I. AREAS OF REVIEW

Nuclear reactor plants include storage facilities for the storage of new fuel. The quantity of new fuel to be stored varies from plant to plant, depending upon the specific design of the plant and the individual refueling requirements. The safety function of the storage facility is to maintain the new fuel in a subcritical array during all credible storage conditions in accordance with General Design Criteria 2, 3, 4, 5, 61, 62, and 63. The ASB reviews the new fuel storage facility design including the fuel assembly storage racks and storage vault with respect to the following:

1. The quantity of fuel to be stored.
2. The design and arrangement of the storage racks for maintaining a subcritical array during all storage conditions.
3. The degree of subcriticality, and the supporting analysis and associated assumptions.
4. The effects of external loads and forces on the new fuel storage racks and vault (e.g., safe shutdown earthquake, crane uplift forces).
5. The effects of sharing in multi-unit complexes, and failures of other plant equipment close to the new fuel storage facility.
6. The use of applicable codes and standards are consistent with the assigned seismic classification.

Secondary reviews are performed by other branches and the results used by the ASB to complete the overall evaluations of the system. The secondary reviews are as follows: the

SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of facility structures to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), tornadoes and tornado missiles. The MEB reviews the seismic qualification of components and confirms that components and structures are designed in accordance with applicable codes and standards. The MTEB verifies, upon request, the compatability of the materials of construction with service conditions. The CPB verifies, upon request, that the K_{eff} of loaded storage racks is acceptable. The RAB reviews the adequacy of the radiation monitoring system.

II. ACCEPTANCE CRITERIA

Acceptability of the new fuel storage facility design as described in the applicant's safety analysis report (SAR) is based on specific general design criteria and regulatory guides, and on independent calculations and staff judgments with respect to facility functions and component selection. The design of the new fuel storage facility is acceptable if the integrated design is in accordance with the following criteria:

1. General Design Criterion 2, as related to the ability of structures housing the facility and the facility components to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 3, as related to protection against fire hazards.

3. General Design Criterion 4, with respect to structures housing the facility and the facility components being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks, such that safety functions will not be precluded.

4. General Design Criterion 5, as related to shared structures, systems and components important to safety being capable of performing required safety functions.

5. General Design Criterion 61, as related to the facility design for fuel storage.

6. General Design Criterion 62, as related to the prevention of criticality by physical systems or processes utilizing geometrically safe configurations.

7. General Design Criterion 63, as it relates to monitoring systems provided to detect excessive radiation levels.

8. Regulatory Guide 1.29, as related to the seismic design classification of facility components.

9. Fuel storage capacity and criticality limits as discussed in subsections III.1 and III.2 below.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) application review to determine that the applicant's design criteria and bases and the preliminary design meet the acceptance criteria given in subsection II. For operating license (OL) applications, the review procedures and acceptance criteria are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The review procedures given are for a typical storage system. Any variance of the review, to adjust to a proposed unique design, is such as to assure that the facility design conforms to the criteria in subsection II. The reviewer selects and emphasizes material from this SRP section as may be appropriate for a particular case.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. The quantity of new fuel to be stored onsite forms the basis for the design capacity of the vault and the number of storage racks provided. The SAR is reviewed to determine that the facility description includes the storage capacity provided by the design. The SAR's for recent light water reactor applications have stated that the storage space provided is consistent with the number of new fuel assemblies used during the refueling cycle. In general, storage capacity for approximately one-third of a core is usually provided for each unit of a plant (e.g., 1/3 core for single unit design and 2/3 core for a dual unit design).

2. The information provided in the SAR pertaining to criticality safety of the new fuel storage facility is evaluated by CPB upon request. The facility design criteria, safety evaluation, system description, and the layout drawings for the storage vault and racks are reviewed to verify that:

   a. Criticality information (including the associated assumptions and input parameters) in the SAR must show that the spacing between fuel assemblies in the storage racks is sufficient to maintain the array, when fully loaded and flooded with nonborated water, in a subcritical condition, i.e., K_{eff} of less than about 0.95. Furthermore, the design of the new fuel storage racks will be such that the K_{eff} will not exceed 0.98 with fuel of the highest anticipated reactivity in place assuming optimum moderation. Credit may be taken for neutron absorbing materials.

   b. The design is such that a fuel assembly cannot be inserted anywhere in the racks other than in the design locations and provisions for drainage are made in the vault design.

c. Failures of nonsafety-related systems or structures not designed to seismic Category I criteria that are located in the vicinity of the new fuel storage facility are reviewed to assure that they will not cause an increase in K_{eff} beyond the maximum allowable. The SAR description section, the general arrangement and layout drawings, and the tabulation of seismic design classifications for structures and systems are reviewed and evaluated to assure that this condition is met. A statement in the SAR establishing the above condition as a design criterion is acceptable at the CP review stage.

d. Design calculations should show that the storage racks and the anchorages can withstand the maximum uplift forces available from the crane without an increase in K_{eff}. A statement in the SAR that excessive forces cannot be applied due to the design of the crane handling system is acceptable if justification is presented. The evaluation procedures identified in SRP section 9.1.4 are used to validate this statement.

e. The vault and racks have been designed to preclude damage from dropped heavy objects.

f. Sharing of a storage facility in multi-unit plants does not result in any added potential for increasing the K_{eff} of the storage array.

3. The reviewer verifies that the safety function of the facility will be maintained, as required, if the facility is subjected to natural phenomena such as earthquakes, tornadoes, hurricanes, and floods. In making this determination, the reviewer considers the following points:

a. The facility design basis and criteria, and the component classification tables presented in the SAR are reviewed to verify that the new fuel storage facility, including the storage vault and racks, have been classified and will be designed to seismic Category I requirements.

b. The essential portions of the new fuel racks and storage vault are reviewed to verify that protection from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles is provided. Flood protection and missile protection criteria are discussed in the appropriate 3.0 sections of the SRP. The reviewer utilizes the procedures of those SRP sections, as appropriate, to assure that the analyses presented are valid. A statement to the effect that the storage will be located in a seismic Category I structure that is designed to withstand the effects of tornado missiles and floods or that components of the system will be located in individual rooms that will withstand the effects of both flooding and missiles is an acceptable commitment at the CP stage.

IV. EVALUATION FINDINGS

The reviewer verifies that the information provided and his review support conclusions of the following type to be included in the staff's safety evaluation report:

"The new fuel storage facility includes the fuel assembly storage racks, the concrete storage vault that contains the storage racks, and auxiliary components. Based on the review of the applicant's proposed design criteria, design bases and safety classification for the new fuel storage facility regarding the provisions necessary to maintain a subcritical array, the staff concludes that the design of the new fuel storage facility and supporting systems is in conformance with the Commission's regulations as set forth in the General Design Criterion 2, "Design Bases for the Protection Against Natural Phenomena"; General Design Criterion 3, "Fire Protection"; General Design Criterion 4, "Environmental and Missile Design Bases"; General Design Criterion 5, "Sharing of Structures, Systems, and Components"; General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control"; General Design Criterion 62, "Prevention of Criticality in Fuel Storage and Handling"; General Design Criterion 63, "Monitoring Fuel Waste and Storage"; and meets the guidelines of Regulatory Guide 1.29, "Seismic Design Classification" and, therefore, is acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 3, "Fire Protection."

3. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

4. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

5. 10 CFR Part 50, Appendix A, General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control."

6. 10 CFR Part 50, Appendix A, General Design Criterion 62, "Prevention of Criticality in Fuel Storage and Handling."

7. 10 CFR Part 50, Appendix A, General Design Criterion 63, "Monitoring Fuel Waste and Storage."

8. Regulatory Guide 1.29, "Seismic Design Classification."

classification for the new fuel storage facility regarding the provisions necessary to maintain a subcritical array, the staff concludes that the design of the new fuel storage facility and supporting systems is in conformance with the Commission's regulations as set forth in the General Design Criterion 2, "Design Bases for the Protection Against Natural Phenomena"; General Design Criterion 3, "Fire Protection"; General Design Criterion 4, "Environmental and Missile Design Bases"; General Design Criterion 5, "Sharing of Structures, Systems, and Components"; General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control"; General Design Criterion 62, "Prevention of Criticality in Fuel Storage and Handling"; General Design Criterion 63, "Monitoring Fuel Waste and Storage"; and meets the guidelines of Regulatory Guide 1.29, "Seismic Design Classification" and, therefore, is acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 3, "Fire Protection."

3. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

4. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

5. 10 CFR Part 50, Appendix A, General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control."

6. 10 CFR Part 50, Appendix A, General Design Criterion 62, "Prevention of Criticality in Fuel Storage and Handling."

7. 10 CFR Part 50, Appendix A, General Design Criterion 63, "Monitoring Fuel Waste and Storage."

8. Regulatory Guide 1.29, "Seismic Design Classification."

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.1.2 SPENT FUEL STORAGE

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Mechanical Engineering Branch (MEB)
Structural Engineering Branch (SEB)
Materials Engineering Branch (MTEB)
Core Performance Branch (CPB)
Radiological Assessment Branch (RAB)

I. AREAS OF REVIEW

Nuclear reactor plants include storage facilities for the wet storage of spent fuel assemblies. The safety function of the spent fuel pool and storage racks is to maintain the spent fuel assemblies in a subcritical array during all credible storage conditions and to provide a safe means for the confinement and cask loading of the assemblies.

The ASB reviews the spent fuel storage facility design including the spent fuel storage racks, the spent fuel storage pool that contains the storage racks, the spent fuel pool liner plate, and the associated equipment storage pits to assure conformance with the requirements of General Design Criteria 2, 3, 4, 5, 61, 62, and 63. The cooling and cleanup systems are reviewed independently in SRP Section 9.1.3.

1. The facility and components are reviewed with respect to the following:
   a. The quantity of fuel to be stored.

   b. The design and arrangement of the storage racks for maintaining a subcritical array during all conditions.

   c. The degree of subcriticality provided along with the analysis and associated assumptions.

   d. The effects of external loads and forces on the spent fuel storage racks, pool, and liner plate (e.g., safe shutdown earthquake, crane uplift forces, missiles, and dropped objects).

   e. Design codes, materials compatibility, and shielding requirements.

   f. The use of applicable codes and standards consistent with the assigned seismic classification.

2. The provisions to preclude dropping the spent fuel shipping cask into the pool are reviewed separately in conjunction with the review of the cask loading pit area in SRP Section 9.1.4.

3. The ASB review of the provisions for maintaining the pool level and cooling is discussed in conjunction with the spent fuel cooling system review in SRP Section 9.1.3.

4. The applicant's proposed technical specifications are reviewed at the operating license (OL) stage, as they relate to areas covered in this SRP section.

Secondary reviews are performed by other branches and the results used by the ASB to complete the overall evaluation of the facility. The secondary reviews are as follows: the SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of structures housing the facility to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), tornados and tornado missiles. The MEB reviews the seismic qualification of components in SRP Sections 3.9.2 and 3.10 and confirms that components and structures are designed in accordance with applicable codes and standards in SRP Section 3.9.3. The MTEB verifies, upon request, the compatibility of the materials of construction with service conditions. The CPB verifies, upon request, that the k_{eff} of loaded storage racks is acceptable. The RAB reviews the adequacy of the shielding design and the radiation monitoring system.

II. ACCEPTANCE CRITERIA

Acceptability of the spent fuel storage facility design as described in the applicant's safety analysis report (SAR) is based on specific general design criteria and regulatory guides, and on independent calculations and staff judgments with respect to system functions and component selection. The design of the spent fuel storage facility is acceptable if the integrated design is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the facility and the facility itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 3, as related to protection against fire hazards.

3. General Design Criterion 4, as related to structures housing the facility and the facility itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks, such that safety functions will not be precluded.

4. General Design Criterion 5, as related to shared structures, systems and components important to safety being capable of performing required safety functions.

5. General Design Criterion 61, as related to the facility design for fuel storage and handling of radioactive materials.

6. General Design Criterion 62, as related to the prevention of criticality by physical systems or processes utilizing geometrically safe configurations.

7. General Design Criterion 63, as it relates to monitoring systems provided to detect conditions that could result in the loss of decay heat removal capabilities, to detect excessive radiation levels, and to initiate appropriate safety actions.

8. Regulatory Guide 1.13, as it relates to the fuel handling and storage facility design to prevent damage resulting from the SSE, to prevent loss of water from the fuel pool that could uncover the fuel, and to protect the fuel from mechanical damage.

9. Regulatory Guide 1.29, as related to the seismic design classification of facility components.

10. Regulatory Guide 1.102, as related to the protection of structures, systems, and components important to safety from the effects of flooding.

11. Regulatory Guide 1.115, as related to the protection of structures, systems, and components important to safety from the effects of turbine missiles.

12. Regulatory Guide 1.117, as related to the protection of structures, systems, and components important to safety from the effects of tornado missiles.

13. Fuel storage capacity and criticality limits as discussed in III.1 and III.2 below.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) application review to determine that the design criteria and bases and the preliminary design meet the acceptance criteria given in subsection II. For the review of the operating license (OL) application, the review procedures and acceptance criteria will be utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design. The OL review includes verification that the content and intent of the technical specifications prepared by the applicant are in agreement with requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The review procedures given below are for a typical storage system. Any variance of the review, to take account of a proposed unique design, will be such as to assure that the facility design conforms to the criteria in subsection II. The reviewer selects and emphasizes material from this SRP section as may be appropriate for a particular case.

1. The quantity of spent fuel to be stored onsite forms the basis for the design capacity of the fuel pool and the number of storage racks provided. The SAR is reviewed to determine that the design basis and facility description section has stated the storage capacity provided by the design. The SARs for light water reactor applications have stated that the storage space provided is consistent with the maximum number of spent fuel assemblies unloaded from the core during the refueling cycle plus the fuel contained in a full core load (e.g., 1-1/3 core for a single unit plant and 1-2/3 core for a dual unit facility). Recent light water reactor applications use high density storage racks to increase storage capacity because of an increased demand on storage space for spent fuel assemblies. ASB reviews high density storage on a case-by-case basis.

2. The information provided in the SAR pertaining to criticality safety of the spent fuel storage facility is evaluated by CPB upon request. The facility design criteria, safety evaluation, system description and the layout drawings for the spent fuel pool and storage racks are reviewed to verify that:

   a. Criticality information (including the associated assumptions and input parameters) in the SAR must show that the center-to-center spacing between fuel assemblies in the storage racks is sufficient to maintain the array, when fully loaded and flooded with nonborated water, in a subcritical condition. A k_{eff} of less than about 0.95 for this condition is acceptable.

   b. The design of the storage racks is such that a fuel assembly cannot be inserted anywhere other than in a design location.

   c. Failures of nonsafety-related systems or structures not designed to seismic Category I that are located in the vicinity of the spent fuel storage facility are reviewed to assure that their failure will not cause an increase in K_{eff} to exceed the maximum allowable. The SAR description section, the general arrangement and layout drawings, and the tabulation of seismic design classifications for structures and systems are reviewed and evaluated to assure that this condition is met. A statement in the SAR establishing the above condition as a design criterion is acceptable at the CP review stage.

d. Design calculations should show that the storage racks and the anchorages can withstand the maximum uplift forces available from the crane without an increase in k_{eff} or a decrease in pool water inventory. A statement in the SAR that excessive forces cannot be applied due to the design of the crane handling system is acceptable if justification is presented. The evaluation procedures identified in SRP Section 9.1.4 are used to validate this statement.

e. The spent fuel storage pool and racks are designed to preclude damage from dropped heavy objects.

f. Sharing of storage facilities in multi-unit plants will not increase the potential for the loss of pool water or decrease the degree of subcriticality provided.

3. The reviewer verifies that the safety function of the facility will be maintained, as required, if the facility is subjected to adverse natural phenomena such as earthquakes, tornadoes, hurricanes, and floods. In making this determination, the reviewer considers the following points:

a. The facility design basis and criteria and the component classification tables are reviewed to verify that the spent fuel storage facility including the storage pool, pool liner and racks have been classified and designed to seismic Category I requirements. The ASB will accept a statement that the facility will be designed and constructed as a seismic Category I system. (CP)

b. If the spent fuel pool liner plate will not be designed and constructed to seismic Category I requirements, the spent fuel pool liner plate is reviewed to verify that a failure of the liner plate as a result of an SSE will not cause any of the following:[1]

1. Significant releases of radioactivity due to mechanical damage to the fuel;

2. Significant loss of water from the pool which could uncover the fuel and lead to release of radioactivity due to heat-up;

[1]The implementation of this item reflects current regulatory practice. The methods of review described herein will be used in the evaluation of submittals for operating license or construction permit applications docketed after November 17, 1977, which is based on the first application to which this method was specifically applied. Implementation for applications docketed prior to November 17, 1977 is not considered necessary since stresses induced in the fuel pool liner plate welds due to an SSE will usually be well below the maximum allowable stress levels and therefore liner failure is not considered a likely event. Even in the event that a liner plate failed, it would not likely block the coolant outlet of spent fuel assemblies completely and sufficient cooling of stored spent fuel would be maintained. Therefore, the spent fuel pool liner plate seismic design is not considered a significant safety issue and backfit is not required.

3. Loss of ability to cool the fuel due to flow blockage caused by a portion or one complete section of the liner plate falling on top of the fuel racks;

4. Damage to safety-related equipment as a result of the pool leakage; and

5. Uncontrolled release of significant quantities or radioactive fluids to the envi ons.

c. The essential portions of the spent fuel storage system are reviewed to verify that protection from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles is provided. Flood protection and missile protection criteria are discussed in sections of the SRP contained in Chapter 3. The reviewer utilizes the procedures of those SRP sections, as appropriate, to assure that the analyses presented are valid. ASB will accept a statement to the effect that the storage facility is located in a seismic Category I structure that is tornado missile and flood protected.

4. The wet storage of spent fuel assemblies for safe handling also necessitates the underwater transfer of spent fuel to a loading area for shipment in spent fuel casks. The SAR is reviewed to verify that the design basis and facility description section has stated that a separate spent fuel shipping cask loading area (pit) has been provided adjacent to the spent fuel pool. The loading pit, by virtue of its proximity to the spent fuel pool, is subjected to the same adverse environmental phenomena. Accordingly, the reviewer verifies that the loading pit has been designed so that the safety function of the integrated system will be maintained during these environmental conditions. In addition, the reviewer verifies that the following are included in the design:

a. An interconnecting canal between the fuel pool and the loading pit should be provided to permit the underwater transfer of fuel to the shipping cask, with provisions for isolating from the fuel pool. A statement in the SAR that these elements are included in the design is acceptable. The reviewer uses engineering judgment to assure himself that the means provided meet the stated intent.

b. The SAR safety evaluations, results of design calculations, and the general arrangement and layout drawings should show that the spent fuel loading pit has been designed to withstand the loads from dropped heavy objects including the shipping cask, and that the loading area is not an integral part of the storage pool floor so that if a dropped object should breach the pit area, loss of fuel pool water would not result in an unacceptable level. The review of cranes and other elements of the fuel handling system to assure that the design of these components minimizes the likelihood of dropping heavy loads is done under SRP Section 9.1.4.

IV. EVALUATION FINDINGS

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

"The spent fuel storage facility includes the spent fuel storage racks, the spent fuel storage pool that contains the storage racks, and the associated equipment storage pits. Based on the review of the applicant's proposed design criteria, design bases and safety classification for the spent fuel storage facility and the provisions necessary to maintain a subcritical array, the staff concludes that the design of the spent fuel storage facility and supporting systems is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for the Protection Against Natural Phenomena," General Design Criterion 3, "Fire Protection," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 5, "Sharing of Structures, Systems, and Components," General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control," General Design Criterion 62, "Prevention of Criticality in Fuel Storage and Handling," General Design Criterion 63, "Monitoring Fuel Waste and Storage," and meets the guidelines of Regulatory Guide 1.13, "Fuel Storage Facility Design Basis," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles," and Regulatory Guide 1.117, "Tornado Design Classification," and, therefore, is acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 3, "Fire Protection."

3. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

4. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

5. 10 CFR Part 50, Appendix A, General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control."

6. 10 CFR Part 50, Appendix A, General Design Criterion 62, "Prevention of Criticality in Fuel Storage and Handling."

7. 10 CFR Part 50, Appendix A, General Design Criterion 63, "Monitoring Fuel and Waste Storage."

8. Regulatory Guide 1.13, "Fuel Storage Facility Design Basis."

9. Regulatory Guide 1.29, "Seismic Design Classification."

10. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

11. Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles."

12. Regulatory Guide 1.117, "Tornado Design Classification."

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.1.3 SPENT FUEL POOL COOLING AND CLEANUP SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Electrical, Instrumentation and Control Systems Branch (EICSB)
Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Reactor Systems Branch (RSB)

I. AREAS OF REVIEW

All nuclear reactor plants include a spent fuel pool for the wet storage of spent fuel assemblies. The methods used to provide cooling for the removal of decay heat from the stored assemblies vary from plant to plant depending upon the individual design. The safety function to be performed by the system in all cases remains the same; that is, the spent fuel assemblies must be cooled and must remain covered with water during all storage conditions. Other functions performed by the system, not related to safety, include water cleanup for the spent fuel pool, refueling canal, refueling water storage tank and other equipment storage pools; means for filling and draining the refueling canal and other storage pools; and surface skimming to provide clear water in the storage pool.

The APCSB review of the spent fuel pool cooling and cleanup system covers the system from inlet to and exit from the storage pool and pits, the seismic Category I water source and piping used for fuel pool makeup, the cleanup system filter-demineralizers and the regenerative process to the point of discharge to the radwaste system.

1. The capability of the spent fuel pool cooling and cleanup system to provide adequate cooling to the spent fuel during all operating conditions is reviewed including the following considerations:
   a. The quantity of fuel to be cooled, including the corresponding requirements for continuous cooling during normal, abnormal, and accident conditions.
   b. The ability of the system to maintain pool water levels.
   c. The ability to provide alternate cooling capability and the associated time required for operation.

d. Provisions to provide adequate make-up to the pool.

e. Provisions to preclude loss of function resulting from single active failures or failures of non-safety-related components or systems.

f. The means provided for the detection and isolation of system components that could develop leaks or failures.

g. The instrumentation provided for initiating appropriate safety actions.

h. The ability of the system to maintain uniform pool water temperature conditions and minimize corrosion products, fission products, and impurities in the water.

The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this review plan.

Secondary reviews are performed by other branches and the results used by the APCSB to complete the overall evaluation of the system. The secondary reviews are as follows: The SEB determines the acceptability of the design analyzes, procedures, and criteria used to establish the ability of structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB reviews the seismic qualification of components and confirms that the system is designed in accordance with applicable codes and standards. The RSB determines that the assigned seismic and quality group classifications for the system components are acceptable. The MTEB verifies that inservice inspection requirements are met for system components and upon request, verifies the compatability of the materials of construction with service conditions. The EICSB upon request, determines the adequacy of the design, installation, inspection, and testing of all essential electrical components required for proper operation.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the spent fuel pool cooling and cleanup system, as described in the applicant's safety analysis report (SAR), including related sections of Chapters 2 and 3 of the SAR is based on specific general design criteria and regulatory guides, and on independent calculations and staff judgments with respect to system functions and component selection. Listed below are specific criteria related to the spent fuel pool cooling and cleanup systems.

1. The design of the spent fuel pool cooling and cleanup system is acceptable if the integrated design is in accordance with the following criteria:

   a. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR.

   b. General Design Criterion 4, with respect to structures housing the systems and the system being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

c. General Design Criterion 5, as related to shared systems and components important to safety being capable of performing required safety functions.

d. General Design Criterion 44, to include:

   (1) The capability to transfer heat loads from safety-related structures, systems, and components to a heat sink under both normal operating and accident conditions.
   (2) Suitable redundancy of components so that safety functions can be performed assuming a single active failure of a component coincident with the loss of all offsite power.
   (3) The capability to isolate components, systems, or piping, if required, so that the system safety function will not be compromised.

e. General Design Criterion 45, as related to the design provisions to permit periodic inspection of safety-related components and equipment.

f. General Design Criterion 46, as related to the design provisions to permit operational functional testing of safety-related systems or components to assure structural integrity and system leak tightness, operability, and adequate performance of active system components, and the capability of the integrated system to perform required functions during normal, shutdown, and accident situations.

g. General Design Criterion 61, as related to the system design for fuel storage and handling of radioactive materials, including the following elements:

   (1) The capability for periodic testing of components important to safety.
   (2) Provisions for containment.
   (3) Provisions for decay heat removal.

h. The capability to prevent reduction in fuel storage coolant inventory under accident conditions.

i. General Design Criterion 63, as it relates to monitoring systems provided to detect conditions that could result in the loss of decay heat removal, to detect excessive radiation levels, and to initiate appropriate safety actions.

j. Regulatory Guide 1.13, as it relates to the system design to prevent damage resulting from the SSE.

k. Regulatory Guide 1.26 as it relates to quality group classification of the system and its components.

l. Regulatory Guide 1.29, as related to the seismic design classification of system components.

m. Branch Technical Position APCSB 3-1, as it relates to breaks in high and moderate energy piping systems outside containment.

An additional basis for determining the acceptability of the spent fuel pool cooling and cleanup system is the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience.

III. REVIEW PROCEDURES

The procedures set forth below are used during the construction permit (CP) application review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in Section II of this review plan. For the review of operating license (OL) applications, the review procedures and acceptance criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The review procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

The review procedures given below are for a typical system. Any variance of the review, to take account of a proposed unique design, will be such as to assure that the system meets the criteria of Section II. In the review, the spent fuel pool cooling and cleanup system is evaluated with respect to its capability to perform the necessary safety functions during all conditions, including normal operation and refueling, abnormal storage conditions, and accident conditions.

1. The safety function of the system for refueling and normal operations is identified by reviewing the information provided in the SAR pertaining to the design bases and criteria and the safety evaluation section. The SAR section on the system functional performance requirements is also reviewed to determine that it describes the minimum system heat transfer and system flow requirements for normal plant operation, component operational degradation requirements (i.e., pump leakage, etc.) and describes the procedures that will be followed to detect and correct these conditions should degradation become excessive. The reviewer, using failure modes and effects analyses, determines that the system is capable of sustaining the loss of any active component and evaluates, on the basis of previously approved systems or independent calculations, that the minimum system requirements (cooling load and flow) are met for these failure conditions. The system piping and instrumentation diagrams (P&IDs), layout drawings, and component descriptions are then reviewed for the following points:
   a. Essential portions of the system are correctly identified and are isolable from the nonessential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical division between each portion and indicate required classification changes. System drawings are also reviewed to see that they show the means for accomplishing isolation and the system description is reviewed to identify minimum performance requirements for the isolation valves. For the typical system, the drawings and description are reviewed to verify that automatically operated isolation valves separate nonessential portions and components from the essential portions.
   b. Heat exchangers, pumps, valves and piping for the cooling portion of the system are designed to quality group and seismic Category I requirements in accordance with applicable criteria, as described in the system design bases and criteria, and the component classification tables. The APCSB will accept a statement that the system will be designed and constructed as a seismic category I system.

c. The stated quantity of fuel to be cooled by the spent fuel cooling system is consistent with the quantity of fuel stored, as stated in Section 9.1.2 of the SAR.

d. For the maximum heat load with normal cooling systems in operation the temperature of the pool should be kept at or below 140°F and the liquid level in the pool is maintained. The associated parameters for the decay heat load of the fuel assemblies, the temperature of the pool water, and the heatup time or rate of pool temperature rise for the stated storage conditions are reviewed on the basis of independent analyses or comparative analyses of pool conditions that have been previously found acceptable.

e. The spent fuel pool and cooling systems have been designed so that in the event of failure of inlets, outlets, piping, or drains, the pool level will not be inadvertently drained below a point approximately 10 feet above the top of the active fuel. Pipes or external lines extending into the pool that are equipped with siphon breakers, check valves, or other devices to prevent drainage are acceptable as a means of implementing this requirement.

f. A seismic Category I makeup system and an appropriate backup method to add coolant to the spent fuel pool are provided. The APCSB evaluates the component seismic classification table to assure that the primary makeup system is designed as a seismic Category I system. The secondary (backup) system need not be a permanently installed system, nor Category I, but must take water from a Category I source. Engineering judgment and comparison with plants of similar design are used to determine that the makeup capacities and the time required to make associated hookups are consistent with heatup times or expected leakage from structural damage.

g. Design provisions have been made that permit appropriate inservice inspection and functional testing of system components important to safety. It will be acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around pumps or isolation valves that would be required by this program.

2. The review verifies that the system has been designed so that system functions will be maintained, as required, in the event of adverse natural phenomena such as earthquakes, tornadoes, hurricanes, and floods. The reviewer evaluates the system, using engineering judgment and the results of failure modes and effects analyses to determine the following:

a. The failure of portions of the system, or of other systems not designed to seismic Category I standards systems and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the pool and cooling system, will not preclude essential functions. Reference to SAR Chapter 2, describing site features and the general arrangement and layout drawings, will be necessary as well as to the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR to the effect that the above conditions are met are acceptable. (CP)

b. The essential portions of the spent fuel pool cooling system are protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under the standard review plans for Chapter 3 of the SAR.

The reviewer utilizes the procedures identified in these plans to assure that the analyses presented are valid. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable. The location and design of the system, structures, and pump rooms (cubicles) are reviewed to determine that the degree of protection provided is adequate.

3. The system design information and drawings are analyzed to assure that the following features will be incorporated. A statement that these features will be included in the design by some appropriate means is a basis for acceptance. (CP)
   a. A leakage detection system is provided to detect component or system leakage. An adequate means for implementing this requirement is to provide sumps or drains with adequate capacity and appropriate alarms in the immediate area of the system.
   b. Components and headers of the system are designed to provide individual isolation capabilities to assure system function, control system leakage, and allow system maintenance.
   c. Design provisions are made to assure the capability to detect leakage of radioactivity or chemical contamination from one system to another and to preclude long-term corrosion, organic fouling, or the spreading of radioactivity. Radioactivity monitors and conductivity monitors located in the system discharge lines are acceptable means for implementing this requirement.

4. The essential portions of the system must be protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the system, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR, and the procedures for reviewing this information are given in the corresponding review plans.

5. The SAR descriptive information, P&IDs, layout drawings, and system analyses are reviewed to assure that essential portions of the system will function following design basis accidents, assuming a concurrent single active component failure. The reviewer evaluates failure mode and effects analyses presented in the SAR to assure function of required components, trace the availability of these components on system drawings, and check that minimum system flow, makeup, and heat transfer requirements are met for each degraded situation over the required time spans. For each case the design will be acceptable if minimum system requirements are met.

6. The spent fuel pool cleanup system and various auxiliary systems are designated as non-safety-related systems and are designed accordingly (non-seismic Category I). These systems are evaluated to assure that their failure cannot affect the functional performance of any safety-related system or component. The relationship and proximity between the non-safety system and safety-related systems or components are determined by reviewing the integrated structure and component layout diagrams. Independent analyses, engineering judgement, and comparisons with previously approved systems

are used to verify that where a non-safety-related system interconnects or interfaces with the cooling system, its failure by any event or malfunction will not preclude adequate functional performance of the cooling system.

7. The cleanup system is also reviewed to assure that it has been designed with the capability to maintain acceptable pool water conditions. The P&IDs and associated information provided in the SAR is reviewed to verify the following:
   a. A means has been provided for mixing to produce a uniform temperature throughout the pool.
   b. The cleanup components have the capacity and capability to remove corrosion products, fission products, and impurities so that water clarity and quality will enable safe operating conditions in the pool.
   c. The capability for processing the refueling canal coolant during refueling operations has been provided.
   d. Provisions to preclude the inadvertent transfer of spent filter and demineralized media to any place other than the radwaste facility have been provided.

IV. EVALUATION FINDINGS

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

"The spent fuel pool cooling and cleanup system includes all components and piping of the system from inlet to and exit from the storage pool and pits, the seismic Category I water source and piping used for fuel pool makeup, the cleanup system filter-deminerlizers and the regenerative process to the point of discharge to the radwaste system. The scope of review of the spent fuel pool cooling and cleanup system for the ____________________ plant included layout drawings, process flow diagrams, piping and instrumentation diagrams, and descriptive information for the system and the supporting systems that are essential to safe operation. [The review has determined the adequacy of the applicant's proposed design criteria and design bases for the spent fuel pool cooling and cleanup system regarding the requirements for continuous cooling during normal, abnormal, and accident conditions. (CP)] [The review has determined that the applicant's analysis of the design of the spent fuel pool cooling and cleanup systems and supporting systems is in conformance with the design criteria and design bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs, design criteria, and design bases for the spent fuel pool cooling and cleanup systems and its 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.

"The staff concludes that the design of the spent fuel pool cooling and cleanup system conforms to all applicable regulations, guides, staff positions, and industry standards and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 44, "Cooling Water."

5. 10 CFR Part 50, Appendix A, General Design Criterion 45, "Inspection of Cooling Water System."

6. 10 CFR Part 50, Appendix A, General Design Criterion 46, "Testing of Cooling Water System."

7. 10 CFR Part 50, Appendix A, General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control."

8. 10 CFR Part 50, Appendix A, General Design Criterion 63, "Monitoring Fuel and Waste Storage."

9. Regulatory Guide 1.13, "Fuel Storage Facility Design Basis."

10. Regulatory Guide 1.26, "Quality Group Classification and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants."

11. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.

12. Branch Technical Position APCSB 3-1, "Protection Against Postulated Piping Failure in Fluid Systems Outside Containment," attached to Standard Review Plan 3.6.1.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.1.4 FUEL HANDLING SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Instrumentation and Control Systems Branch (ICSB)
Radiological Assessment Branch (RAB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The ASB reviews the fuel handling system (FHS) consisting of all components and equipment used in moving fuel from the receiving of the new fuel through the shipping of the spent fuel from the plant site to assure conformance with the requirements of General Design Criteria 2 and 5. The design layout, which shows the functional geometric layout of the handling equipment, including the areas of movement over and around the fixed locations of safety-related facilities during fuel handling, is reviewed to determine that the various handling operations can be performed safely. The main emphasis in the FHS review is on critical load handling in which inadvertent operations or equipment malfunctions, either separately or in combination, could cause a release of radioactivity or prevent safe shutdown of the reactor.

1. The ASB reviews the transporting, hoisting, and rigging operations in the fuel handling system as to methods, selection of handling equipment, and safety devices.

2. The ASB reviews the design of the FHS with respect to the following aspects of individual components and the integrated system:

   a. Performance and load handling requirements specified for equipment.

   b. Handling control features.

   c. The methods and equipment for transferring fuel assemblies from the reactor core to the storage location.

   d. The methods and equipment for transferring stored fuel to the spent fuel shipping cask.

e. Design codes and standards used for the handling and transportation mechanisms.

The applicant's proposed technical specifications are reviewed for operating license applications, as they relate to areas covered in this SRP section.

Secondary reviews will be performed by other branches where necessary and as requested by ASB to complete the overall evaluation of the FHS. The secondary reviews are as follows. The SEB will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as a safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic qualification testing and operability of components and confirm that the components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB will verify that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions. The ICSB and PSB will determine the adequacy of the design, installation, inspection, and testing of all essential electrical components (sensing, control, and power). The RAB reviews the design of the fuel handling system and the spent fuel transfer process to determine whether occupational radiation exposures during spent fuel handling will be as low as practicable.

II. ACCEPTANCE CRITERIA

Acceptability of the FHS design, as described in the applicant's safety analysis report (SAR) including related sections of Chapters 2 and 3 of the SAR, is based on specific general design criteria, regulatory guides, and safety standards and engineering codes. Listed below are specific criteria as they relate to the FHS.

The FHS is acceptable if the integrated design of the structural, mechanical, and electrical elements, the manual and automatic operating controls, and the safety devices provide adequate system control for the specific procedures of handling operations, if the redundancy and diversity needed to protect against malfunctions or failures are provided, and if the design conforms to the following criteria:

1. General Design Criterion 2, as related to the ability of structures, equipment, and mechanisms to withstand the effects of natural phenomena such as earthquakes, tornadoes, floods, and hurricanes.

2. General Design Criterion 5, as related to the capability of shared equipment and components important to safety.

3. Regulatory Guide 1.29, as related to the seismic design classification of components.

4. ANSI standards for components, machinery, and subsystems.

5. Engineering society design standards, codes, or industry standard specifications applicable to the selection of components and subsystems.

6. Branch Technical Position ASB 9-1, as related to:
   a. Cranes whose purpose is to handle heavy loads such as the reactor vessel head or the vessel internals should be designed so that the dropped load will not result in unacceptable damage to the reactor vessel, to the fuel contained within the vessel, or to essential components located under the equipment handling pathway. If the impact of dropped loads could cause damage to safety-related components or could result in the release of radioactive materials, then the crane should be designed (including associated rigging and connections to the load) to be "single failure-proof" so that the load could not fall in the event of a single failure.

   b. Cranes used for handling the spent fuel cask should be designed so that movement over spent fuel is prohibited. The consequences of a load drop should not cause fuel damage, affect the ability of the plant to be shut down, or result in the release of significant amounts of radioactive materials.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The fuel handling system provides for handling of fuel assemblies, spent fuel casks, and other critical loads. The general objective of the review is to confirm that the FHS design precludes system malfunctions or failures that would prevent safe shutdown of the reactor or cause a release of radioactivity. There are variations in the designs of proposed handling systems; hence, there will be variations in system requirements and the type and number of critical loads to be handled. For the purpose of this review, the FHS is assumed to include the crane used to handle heavy loads inside containment and the crane used to handle the spent fuel cask.

The procedures listed here are used in the construction permit (CP) review to determine that the FHS design criteria and bases and the preliminary FHS design described in the SAR meet the acceptance criteria given in subsection II. For operating license (OL) reviews the procedures are used to verify that the design criteria and bases have been appropriately implemented in the FHS final design.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The reviewer will select and emphasize material from this SRP section, as may be appropriate for a particular case.

1. The system performance requirements for the FHS are reviewed to determine that they cover the handling system concept used in the design, and describe the component and subsystem functions within the integrated system. The performance requirements should also define any degradation considered for components and describe the procedures that are followed to detect and correct degraded conditions.

2. The performance specifications required as part of the design and described in the SAR are reviewed to determine that the design, material selection, manufacturing, installation, testing, and operating procedures are in accordance with state-of-the-art practice. The reviewer verifies that the consensus standards, engineering codes, and industrial or manufacturing association standards selected and used are adequate and appropriate for the FHS.

3. Crane information presented in the SAR is reviewed to determine that the specific arrangement of the system and subsystems and the load handling paths to be used are described with respect to locations of essential equipment. The reviewer determines that the fuel cask will not be transported over spent fuel or safety-related equipment. For overhead cranes and other lifting devices with load limitations or that are separated from essential equipment, the reviewer covers the following points:

   a. The size, shape, and dimensions of the potentially most damaging load (the load which, if dropped by the crane, will cause the most damage), its weight and center of gravity, lifting points, stability, and handling speeds, are compared with the performance specifications to determine the compatibility of the design with load handling and movement requirements. The reviewer uses the requirements of codes and standards and, if required, performs an independent analysis to determine acceptability of the system.

   b. The instrumentation and control system, including the limit and safety devices provided for automatic and manual operation for both normal and emergency conditions, that are required to operate to maintain safety in the event of a failure of the system, are reviewed. The results of failure modes and effects analyses are used by the reviewer to determine that the control system adequately limits loads or limits crane load movement, assuming a single failure, without affecting the function of essential equipment or causing the release of radioactivity.

   c. The description of operating and test procedures presented in the SAR is reviewed to determine that load proof-testing, design-rated load testing, nondestructive testing, preventative checks, and examinations of hookup are in accordance with the requirements of the safety standards set forth in ANSI standards.

4. For cranes that have been designed to be single failure-proof, the reviewer determines that the design conforms to Branch Technical Position ASB 9-1.

5. The information presented in the SAR for the fuel handling equipment, including the equipment storage areas, is reviewed to determine that a seismic event cannot result in damage to spent fuel or essential equipment.

6. The fuel transfer carriage design is reviewed to determine the means of preventing damage to fuel assemblies due to movement of the carriage when the "upender" is in the vertical position.

7. The review for OL applications includes a determination that the content and intent of the technical specifications are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

IV. EVALUATION FINDINGS

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

"The fuel handling system includes all components and equipment used in moving fuel from the receiving of new fuel to the shipping of spent fuel from the plant site. Based on the review of the applicant's proposed design criteria and design bases for the FHS, and the requirements for safe operation of the FHS, the staff concludes that the design of the FHS and supporting systems is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for the Protection Against Natural Phenomena," General Design Criterion 5, "Sharing of Structures, Systems, and Components," and meets the guidelines in Regulatory Guide 1.29, "Seismic Design Classification," and Branch Technical Position ASB 9-1, "Overhead Handling Systems for Nuclear Power Plants," and therefore is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems and Components."

3. Regulatory Guide 1.29, "Seismic Design Classification."

4. Branch Technical Position ASB 9-1, "Overhead Handling Systems for Nuclear Power Plants," attached to this SRP section.

BRANCH TECHNICAL POSITION ASB 9-1

OVERHEAD HANDLING SYSTEMS FOR NUCLEAR POWER PLANTS

A. BACKGROUND

Overhead handling systems are used for handling heavy items at nuclear power plants. The handling of heavy loads such as a spent fuel cask raises the possibility of damage to the load and to safety-related equipment or structures under and adjacent to the path on which it is transported should the handling system suffer a breakdown or malfunction.

Two methods are used in nuclear power plants to prevent damage to safety features or release of radioactive material due to dropping of heavy loads. One is protection by physical design of the facility to preclude damage to spent fuel and safety-related systems if a heavy load should be dropped. The other is to provide an overhead handling system that is designed so that a connected load would not fall in the event of a failure or malfunction. The following options are considered acceptable for design of fuel handling systems:

1. Overhead handling systems used to handle the spent fuel cask should be designed such that travel directly over spent fuel storage or safety-related equipment is not possible, and verified by analysis that the physical structure under all cask handling pathways will be adequately designed so that unacceptable damage to spent fuel storage facility or safety-related equipment will not occur in the event of a load drop.

2. Overhead handling systems used to handle heavy loads inside containment that have been designed (including associated rigging and connections to the load) to meet the single failure criterion need not have their path of travel restricted.

3. Overhead handling systems used to handle heavy loads inside containment need not be single failure-proof if by analysis it can be shown that the consequences of a load drop would not affect the ability of the plant to be shut down or not result in the release of significant amounts of radioactive material.

An overhead handling system includes all the structural, mechanical, and electrical components that are needed to lift and transfer a load from one location to another. Primary load-bearing components, equipment, and subsystems such as the driving equipment, drum, rope reeving, control, and braking systems require special attention. Proper support of the rope drums ensures that they would be retained and prevented from falling or disengaging from the braking and control system in case of a shaft or bearing failure. If the hoisting system (raising and lowering) includes two mechanical holding brakes, each with better than full-load stopping capacity, that are automatically activated when electric power is off or when mechanically tripped by overspeed or overload devices, a critical load will be safely held or controlled in case of failure in the individual load-bearing parts of the hoisting machinery. Failure of the bridge or trolley travel to stop when power is shut off or an overspeed or overload condition due to malfunction or failure in the drive system can be prevented and controlled by appropriate safety and limit devices and brake systems.

Since the crane industry has not yet developed codes or standards that adequately cover the design, operation, and testing for a "single failure-proof" crane, the ASB has developed a branch position to provide a consistent basis for reviewing equipment and components for such overhead handling systems. The position below delineates acceptable codes and standards and supplements them with specific recommendations on features that will prevent, control, or stop inadvertent operation or malfunction of the mechanical supporting and moving components of the handling system.

(The next page is 9.1.4-7)

B. BRANCH TECHNICAL POSITION

Overhead handling systems intended to provide single failure-proof handling of loads should be designed so that no single failure or malfunction will result in dropping or loosing control of the heaviest (critical) loads to be handled. Such handling systems should be designed, fabricated, installed, inspected, tested, and operated in accordance with the following:

1. General Performance Specifications

a. Separate performance specifications should be prepared for a permanent crane which is to be used for construction prior to use for plant operation. The allowable design stress limits should be identical for both cases, and the sum total of simultaneously applied loads should not result in stress levels causing any permanent deformation other than that due to localized stress concentrations.

b. The operating environment, including maximum and minimum pressure, temperature, humidity, and rates of change of these parameters, should be specified to determine the venting and drainage required for box girder sections. The specifications should also state the corrosive and hazardous conditions that may occur during operation. Fracture toughness for the steel structural materials should be considered. Plate thickness, with a margin for the lowest operating temperatures, should determine the type of steel that can be used with or without toughness tests. The selection of steel materials will be reviewed on a case-by-case basis.

c. The crane should be classified as seismic Category I and should be capable of retaining the maximum design load during a safe shutdown earthquake, although the crane may not be operable after the seismic event. The bridge and trolley should be provided with means for preventing them from leaving their runways with or without the design load during operation or under seismic loadings. The design rated load plus operational and seismically-induced pendulum and swinging load effects on the crane should be considered in the design of the trolley, and they should be added to the trolley weight for the design of the bridge.

d. All weld joints for load-bearing structures, including those susceptible to lamellar tearing, should be inspected by nondestructive examinations for soundness of the base metal and weld metal.

e. A fatigue analysis should be considered for critical load-bearing structures and components of the crane handling system. The cumulative fatigue usage factors should reflect effects of cyclic loadings from both the construction and operating periods.

f. Preheat and postheat treatment temperatures for all weldments should be specified in the weld procedures. For low-alloy steel, the recommendations of Regulatory Guide 1.50 should be followed.

2. <u>Safety Features</u>

a. The automatic and manual controls and devices required for normal crane operation should be designed such that a malfunction of these controls and devices, and possible subsequent effects during load handling, will not prevent the handling system from being maintained at a safe neutral holding position.

b. Auxiliary systems, dual components, or ancillary systems should be provided such that in case of subsystem or component failure the load will be retained and held in a safe position.

c. Means should be provided for devices which can be used in repairing, adjusting, or replacing failed components or subsystems when failure of an active component or subsystem has occurred and the load is supported and retained in the safe (temporary) position with the system immobile. As an alternative to repairing the crane in place, means may be provided for moving the handling system with load to a laydown area that has been designed for accepting the load and making the repairs.

3. <u>Equipment Selection</u>

a. Dual load attaching points should be provided on the load block or lifting device, designed so that each attaching point will be able to support a static load of 3W (W is weight of the design rated load), without permanent deformation other than that due to localized stress concentrations in areas for which additional material has been provided for wear.

b. Lifting devices such as lifting beams, yokes, laddle or trunnion type hooks, slings, toggles, or clevises should be of redundant design with dual or auxiliary devices or combinations thereof. Each device should be designed to support a static load of 3W without permanent deformation.

c. The vertical hoisting (raising and lowering) mechanism which uses rope and consists of upper sheaves (head block), lower sheaves (load block), and rope reeving system, should be designed with redundant means for hoisting. Maximum hoisting speed should be no greater than 5 fpm.

d. The head and load blocks should be designed to maintain a vertical load balance about the center of lift from the load block through the head block, and should have a dual reeving system. The load block should maintain alignment and a position of stability with either system and be able to support 3W and maintain load stability and vertical alignment from the center of the head block through all hoisting components to the center of gravity of the load.

e. The design of the rope reeving system should be dual, with each system providing separately the load balance on the head and load blocks through the configuration of ropes and rope equalizers. Selection of the hoisting rope or running rope should consider the size, construction, lay, and means or type of lubrication to maintain efficient working of the individual wire strands as the rope passes over sheaves during the hoisting operation. The effects of impact loadings, acceleration and emergency stops should be included in selection of the rope and reeving system. The wire rope should be 6 x 37 Iron Wire Rope Core (IWRC) or comparable classification.

The stress in the lead line to the drum during hoisting at the maximum design speed with the design rated load should not exceed 20% of the manufacturer's rated strength of the rope. The static stress in rope (load is stationary) should not exceed 12-1/2% of the manufacturer's rated strength. Line speed during hoisting (raising or lowering) should not exceed 50 fpm.

f. The maximum fleet angle from drum to lead sheave in the load block should not exceed 3-1/2 degrees at any point during hoisting and there should be only one 180° reverse bend for each rope leaving the drum and reversing on the first or lead sheave on the load block, with no other reverse bends other than at the equalizer if a sheave-type equalizer is used. The fleet angles for rope between individual sheaves should not exceed 1-1/2 degrees. Equalizers may be beam or sheave type. For the recommended 6 x 37 IWRC classification wire rope, pitch diameter of the lead sheave should be 30 times rope diameter for the 180° reverse bend, 26 times rope diameter for running sheaves, and 13 times rope diameter for equalizers. The pitch diameter is measured from the center of the rope in the sheave groove through the sheave center. The dual reeving system may be a single rope from each end of a drum terminating at a beam-type load and rope stretch equalizer with each rope designed for total load, or a 2-rope system may be used from each drum or separate drums with a sheave or beam equalizer, or any other combination which provides two separate and complete reeving systems.

g. The vertical hoisting system components, which include the head block, rope reeving system, load block, and dual load attaching device, should each be designed to sustain a load of 2W (W is the weight of the design rated load). A 2W static load test should be performed for each reeving system and load attaching point at the manufacturer's plant. Each reeving system and each one of the load attaching devices should be assembled with approximately a 6 inch clearance between head and load blocks and should support 200% of the design rated load without degradation of the components or permanent deformation other than that due to localized stress concentrations. Measurements of the geometric configuration of the attaching points should be made before and after test followed by nondestructive examination, which should consist of combinations of magnetic particle, ultrasonic, radiographic, and dye penetrant examinations to verify the soundness of fabrication and assure the integrity of this portion of the hoisting system. The results of examinations should be documented and recorded for the hoisting system for each overhead crane.

h. Means should be provided to sense such items as electric current, temperature, overspeed, overloading, and overtravel. Controls should be provided to stop the hoisting movement within 3 inches maximum of vertical travel through a combination of electrical power controls and mechanical braking and torque control systems should one rope of the dual reeving system fail.

i. The control systems may be designed as combination electrical and mechanical systems and may include such items as contractors, relays, resistors, and thyristors in combination with mechanical devices and mechanical braking systems. The electric controls should be selected to provide a maximum breakdown torque limit of 175% of the required rating for a-c motors or d-c motors (series or shunt wound) used for the hoisting drive motors. Compound wound d-c motors should not be used. The control systems provided should consider hoisting (raising and lowering) of all loads, including the design rated load, and the effects of inertia of the rotating hoisting machinery such as motor armatures, shafts and couplings, gear reducers, and drums.

j. The mechanical and structural components of the hoisting system should have the required strength to resist failure should "two-blocking"[1/] or "load hangup"[2/] occur during hoisting. The designer should provide means to absorb or control the kinetic energy of rotating machinery in the event of two-blocking or load hangup. The location and type of mechanical brakes and controls should provide positive and reliable means to stop and hold the hoisting drums for these occurrences. The hoisting system should be able to withstand the maximum torque of the driving motor, if a malfunction occurs and power to the driving motor cannot be shut off at the time of load hangup or two-blocking.

k. The load hoisting drum on the trolley should be provided with structural and mechanical safety devices to prevent the drum from dropping, disengaging from its holding brake system, or rotating, should the drum or any portion of its shaft or bearings fail.

l. To preclude excessive breakdown torque, the horsepower rating (HP) of the electrical motor drive for hoisting should provide no more than 110% of the calculated HP requirement to hoist the design rated load at the maximum design hoist speed.

m. The minimum hoist braking system should include one power control braking system (not mechanical or drag brake-type) and two mechanical holding brakes. The holding brakes should be activated when power is off and should be automatically tripped by mechanical means on overspeed to the full holding position if a malfunction occurs in the electrical brake controls. Each holding brake should be designed to 125% - 150% of maximum developed torque at the point of application (location of the brake in the mechanical drive). The minimum design requirements for braking

[1/] "Two-blocking" is an inadvertently continued hoist which brings the load and head block assemblies into physical contact, thereby preventing further movement of the load block and creating shock loads to rope and reeving system.

[2/] "Load hangup" occurs when the load block or load is stopped during hoisting by entanglement with fixed objects, thereby overloading the hoisting system.

systems that will be operable for emergency lowering after a single brake failure should be two holding brakes for stopping and controlling drum rotation. Provisions should be made for manual operation of the holding brakes. Emergency brakes or holding brakes which are to be used for manual lowering should be capable of operation with full load and at full travel and provide adequate heat dissipation. Design for manual brake operation during emergency lowering should include features to limit the lowering speed to less than 3.5 fpm.

n. The dynamic and static alignment of all hoisting machinery components including gearing, shafting, couplings, and bearings should be maintained throughout the range of loads to be lifted with all components positioned and anchored on the trolley machinery platform.

o. Increment drives for hoisting may be provided by stepless controls or inching motor drives. Plugging[3/] should not be permitted. Controls to prevent plugging should be included in the electrical circuits and the control system. Floating point[4/] in the electrical power system, when required for bridge or trolley movement, should be provided only for the lowest operating speeds.

p. To avoid the possibility of overtorque within the control system, the horsepower rating of the driving motor and gear reducer for trolley and bridge motion of an overhead bridge crane should not exceed 110% of the calculated requirement at maximum speed and with the design rated load. Incremental or fractional inch movements, when required, should be provided by such items as variable speed or inching motor drives. Control and holding brakes should each be rated at 100% of maximum drive torque at the point of application. If two mechanical brakes are provided, one for control and one for holding, they should be adjusted with one brake in each system for both the trolley and bridge leading the other and should be activated by release or shutoff of power. The brakes should also be mechanically tripped to the "on" or "holding" position in the event of a malfunction in the power supply or an overspeed condition. Provisions should be made for manual operation of the brakes. The holding brake should be designed so that it cannot be used as a foot-operated slowdown brake. Drag brakes should not be used. Opposite wheels on bridges or trolleys which support the bridge or trolley on the runways should be matched and have identical diameters. Trolley and bridge speeds should be limited. A maximum speed of 30 fpm for the trolley and 40 fpm for the bridge is recommended.

q. The complete operating control system and provisions for emergency controls for the overhead crane handling system should be located in the main cab on the

---

[3/] Plugging is the momentary application of full line power to the drive motor for the purpose of promoting a limited movement.

[4/] The point in the lowest range of movement control at which power is on, brakes are off, and motors are not energized.

bridge. Additional cabs located on the trolley or lifting devices should have complete control systems similar to the bridge cab. Manual controls for hoisting and trolley movement may be provided on the trolley. Manual controls for the bridge may be located on the bridge. Remote controls or pendant controls for any of these motions should be the same as those provided in the bridge cab control panel. Provisions should be made in the design for devices for emergency control or operations. Limiting devices, mechanical and electrical, should be provided to indicate, control, and prevent overtravel and overspeed of hoist (raising or lowering) and for trolley and bridge travel movements. Buffers for bridge and trolley travel should be included.

r. Safety devices such as limit type switches provided for malfunction, inadvertent operation, or failure should be in addition to and separate from the control devices provided for operation.

s. The operating requirements for all travel movements (vertical and horizontal movements or rotation, singly or in combination) for permanent plant cranes should be clearly defined in the operating manual for hoisting and for trolley and bridge travel. The designer should establish the maximum working load (MWL). The MWL should not be less than 85% of the design rated load (DRL) capacity for the new crane at time of operation. The redundancy provided, design factors, selection of components, and balance of auxiliary-ancilliary and duel items in the design and manufacture should be taken into account in setting the maximum working load for the critical load handling crane system(s). The MWL should not exceed the DRL for overhead crane handling systems.

t. When the permanent plant crane is to be used for construction and the operating requirements for construction are not identical to those required for permanent plant service, the construction operating requirements should be defined separately. The crane should be designed structurally and mechanically for the construction loads, plant service loads, and the functional performance requirements for each. At the end of the construction period, the crane handling system should be adjusted for the performance requirements of permanent plant service. The conversion or adjustment may include the replacement of such items as motor drives, blocks, and reeving system. After construction use, the crane should be thoroughly inspected using nondestructive examinations and should be performance tested. If the load and performance requirements are different for construction and plant service periods, then the crane should be tested for both phases. The crane integrity should be verified by the designer and manufacturer and load testing to 125% of the design rated load required for the operating plant should be done before the crane is used as permanent plant equipment.

u. Installation instructions should be provided by the manufacturer. These should include a full explanation of the crane handling system, its controls, and the limitations for the system, and should cover the requirements for installation, testing, and preparations for operation.

4. Mechanical Checks, Testing, and Preventive Maintenance

a. A complete mechanical check of all crane systems as installed should be made to verify the method of installation and to prepare the crane for testing. During and after installation the proper assembly of electrical and structural components should be verified. The integrity of all control, operating, and safety systems is to be verified as to satisfaction of installation and design requirements.

The crane designer and crane manufacturer should provide a manual of information and procedures for use in checking, testing, and crane operation. The manual should also describe a preventive maintenance program based on the approved test results and information obtained during the testing; it should include such items as servicing, repair, and replacement requirements, visual examinations, inspections, checking, measurements, problem diagnosis, nondestructive examination, crane performance testing, and special instructions.

Information concerning proof testing on components and subsystems as required and performed at the manufacturer's plant to verify component or subsystem ability to perform should be available for the checking and testing performed at the place of installation of the crane system.

b. The crane system should be prepared for the static test of 125% of the design rated load. The tests should include all positions of hoisting, lowering, and trolley and bridge travel with the 125% rated load and other positions as recommended by the designer and manufacturer. After satisfactory completion of the 125% static test and adjustments required as a result of the test, the crane handling system should be given full performance tests with 100% of the design rated load for all speeds and motions for which the system is designed. This should include verifying all limiting and safety control devices. The crane handling system should demonstrate the ability to lower and move the design rated load by manual operation and with the use of emergency operating controls and devices which have been included in the handling system.

The complete hoisting machinery should be allowed to two-block during the hoisting test (load block limit and safety devices are bypassed). This test should be conducted without load and at slow speed, to provide assurance of the integrity of the design, equipment, controls, and overload protection devices. The test should demonstrate that the maximum torque that can be developed by the driving system, including the inertia of the rotating parts at the overtorque condition, will be absorbed or controlled prior to two-blocking.

The complete hoisting machinery should be tested for ability to sustain a load hangup condition by a test in which the load block attaching points are secured to a fixed anchor or excessive load. The drum should be capable of one full revolution before starting the hoisting test.

c. The preventive maintenance program recommended by the designer and manufacturer should also prescribe and establish the MWL for which the crane will be used. The maximum working load should be plainly marked on each side of the crane for each hoisting unit. It is recommended that critical load handling cranes should be continuously maintained at 95% of DRL capacity for the MWL capacity.

C. <u>REFERENCES</u>

1. Regulatory Guide 1.50, "Control of Preheat Temperature for Welding of Low-Alloy Steel."

2. "Table of Engineering, Manufacturing, and Operating Standards, Practices, and References," attached to this position.

TABLE OF
ENGINEERING, MANUFACTURING, AND OPERATING STANDARDS,
PRACTICES, AND REFERENCES

AISE	Association of Iron and Steel Engineers (Std. No. 6). General items for overhead cranes and specifically for drums, reeving systems, blocks, controls, and electrical, mechanical, and structural components.
AISC	American Institute of Steel Construction, "Manual of Steel Construction." Runway and bridge design loadings for impact, and structural supports.
ASME	American Society of Mechanical Engineers. References for testing, materials, and mechanical components.
ASTM	American Society for Testing Materials. Testing and selection of materials.
ANSI	American National Standards Institute (A10, B3, B6, B15, B29, B30 and N45 series). N series of ANSI standards for quality control. ANSI consensus standards for design, manufacturing, and safety.
IEEE	Institute of Electrical and Electronics Engineers. Electrical power and control systems.
AWS	American Welding Society (D1.1.72 - 73/74 revisions). Fabrication requirements and standards for crane structure and weldments.
EEI	Edison Electrical Institute. Electrical systems.
SAE	Society of Automotive Engineers, "Standards and Recommended Practices." Recommendations and practices for wire rope, shafting, lubrication, fasteners, materials selection, and load stability.
CMAA	Crane Manufacturers Association of America (CMAA 70). Guide for preparing functional and performance specifications and component selection.
NEMA	National Electrical Manufacturers Association. Electrical motor, control, and component selections.
WRTB	Wire Rope Technical Board and their manufacturing members. Selection of rope reeving system, and reeving efficiencies.
MHI	Materials Handling Institute and their member associations and association members such as American Gear Manufacturing Association for gears and gear reducers and Antifriction Bearing Manufacturers Association for bearings selection.
WRC	Welding Research Council, "Control of Steel Construction to avoid Brittle Fracture," and Bulletin #168, "Lamellar Tearing."

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.2.1 STATION SERVICE WATER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Reactor Systems Branch (RSB)
Instrumentation and Control Systems Branch (ICSB)
Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The service water system (SWS) provides essential cooling to safety-related equipment and may also provide cooling to nonsafety-related auxiliary components that are used for normal plant operation. The ASB reviews the system from the service water pump intake to the points of cooling water discharge to assure conformance with the requirements of General Design Criteria 2, 4, 5, 44, 45 and 46. The ultimate heat sink (reviewed under SRP Section 9.2.5) provides the intake source of water to the SWS for long-term cooling of station features required for plant shutdown and also any special equipment required to prevent or mitigate the consequences of postulated accidents and as such is an interface system to the SWS. The SWS pump performance characteristics will be compared to the high and low water levels of the ultimate heat sink to assure that pumping capability can be provided for extended periods of operation following postulated events.

1. The ASB reviews the characteristics of the SWS components (pumps, heat exchangers, pipes, valves) with respect to their functional performance as affected by adverse environmental occurrences including cold weather protection, by abnormal operational requirements, and by accident conditions such as a loss-of-coolant accident (LOCA) with the loss of offsite power. Since the SWS normally has requirements that relate to cooling functions during normal plant operation as well as for safety functions, the review will include an evaluation of the capability of the system to perform these multiple functions.

2. The ASB reviews the system to determine that a malfunction, a failure of a component, or the loss of a cooling source will not reduce the safety-related functional performance capabilities of the system. Specifically, the system is reviewed to verify that:

a. System components and piping have sufficient physical separation or shielding to protect the essential portions of the system from missiles, pipe whip, and jet impingement that may result from piping cracks or breaks.

b. Design code requirements, as applicable to the assigned quality group and seismic category, are met.

c. Effects of failure of the non-seismic Category I equipment, structure, or components of safety-related portions of the SWS are taken into account in the design. In addition, the review includes the consequences of postulated pipe breaks in high and moderate energy fluid systems.

3. The ASB also reviews the design of the SWS with respect to:

   a. Functional capability during abnormally high water levels; i.e., adequate flood protection during the probable maximum flood.

   b. The capability for detection, control, and isolation of system leakage including the capability for detection and control of radioactive leakage into and out of the system and prevention of accidental releases to the environment.

   c. Measures to preclude long-term corrosion and organic fouling that would tend to degrade system performance.

   d. Provisions for system and component operational testing, including the instrumentation and control features that determine and verify that the system is operating in a correct mode (i.e., valve position, pressure and temperature indication).

4. The ASB reviews the SWS capability to flood the reactor containment should this be required in a post-accident recovery situation.

5. The applicant's proposed technical specifications are reviewed for operating license applications, as they relate to areas covered in this SRP section.

Secondary reviews are performed by other branches and the results used by the ASB to complete the overall evaluation of the system. The RSB identifies essential components associated with the reactor coolant system and the emergency core cooling systems that are required for operation during normal operations or accident conditions. The RSB establishes accident cooling load functional requirements and minimum time intervals. The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic qualification of components and confirm that components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB will verify that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions. The ICSB and PSB will evaluate the system controls, instrumentation, and power sources with respect to capabilities, capacity, and reliability for supplying power during normal and emergency conditions to safety-related pumps, valves and other components.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the service water system, as described in the applicant's safety analysis report (SAR), including related sections of Chapters 2 and 3 of the SAR is based on specific general design criteria and regulatory guides. Listed below are specific criteria as they relate to the SWS.

The design of the service water system is acceptable if the integrated system design is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to the capability of shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 44, to assure:

   a. The capability to transfer heat loads from safety-related structures, systems, and components to a heat sink under both normal operating and accident conditions.
   b. Component redundancy so that the safety function can be performed assuming a single active component failure coincident with the loss of offsite power.
   c. The capability to isolate components, subsystems, or piping if required so that the system safety function will not be compromised.

5. General Design Criterion 45, as related to design provisions to permit inservice inspection of safety-related components and equipment.

6. General Design Criterion 46, as related to design provisions to permit operational functional testing of safety-related systems and components.

7. Regulatory Guide 1.26, as related to the quality group classification of systems and components.

8. Regulatory Guide 1.[illegible], as related to the seismic design classification of system components.

9. Regulatory Guide 1.102, as related to the protection of structures, systems, and components important to safety from the effects of flooding.

10. Regulatory Guide 1.117, as related to the protection of structures, systems, and components important to safety from the effects of tornado missiles.

11. Branch Technical Position ASB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures set forth below are used during the construction permit (CP) application review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For review of operating license (OL) applications, the review procedures and acceptance criteria are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The review procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

As a result of the various SWS designs provided, there will be variations in system requirements. For the purpose of this SRP section, a typical system is assumed which has fully redundant systems, with each of the systems having an identical essential (safety features) portion and an identical non-essential portion (used for normal operation). For cases where there are variations from the typical arrangement, the reviewer will adjust the review procedures given below. However, the system design will be required to meet the acceptance criteria given in subsection II. Also, the reviewer will need to refer to SRP sections for other systems that would interface with the SWS, depending upon the nature and conditions of the ultimate heat sink cooling water (e.g., salt water).

1. The SAR is reviewed to determine that the system description and piping and instrumentation diagrams (P&IDs) show the SWS equipment that is used for normal operation, and the minimum system heat transfer and flow requirements for normal plant operation. The system performance requirements will also be reviewed to determine thatthey describe component allowable operational degradation (e.g., pump leakage) and describe the procedures that will be followed to detect and correct these conditions when they become excessive.

2. The reviewer, using the results of failure modes and effects analyses as appropriate, comparisons with previously approved systems, or independent calculations, determines that the system is capable of sustaining the loss of any active component and meeting minimum system requirements (cooling load and flow) for the degraded conditions. The system P&IDs, layout drawings, and component descriptions and characteristics are then reviewed for the following points:

   a. Essential portions of the SWS are correctly identified and are isolable from the non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical division between each portion and indicate the required classification changes. System drawings are also reviewed to see that they show the means for accomplishing isolation and the system description is reviewed to identify minimum performance requirements for the isolation valves. The drawings and descriptions are reviewed to verify that automatically operated isolation valves separate non-essential portions and components from the essential portions.
   b. Essential portions of the SWS, including the isolation valves separating essential and non-essential portions, are classified Quality Group C and seismic Category I. Components and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above seismic and safety classifications have been included, and that the P&IDs indicate any points of change in piping quality group classification.
   c. Design provisions have been made that permit appropriate inservice inspection and functional testing of system components important to safety. It will be acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around pumps or isolation valves that would be required by this program.

3. The reviewer determines that the safety function of the system will be maintained, as required, in the event of adverse environmental phenomena such as earthquakes, tornadoes, hurricanes, and floods, or in the event of certain pipe breaks or loss of offsite power. The reviewer uses engineering judgment, the results of a failure mode and effects analyses, and the results of reviews performed under other SRP sections to verify the following:

   a. The failure of portions of the system or of other systems not designed to seismic Category I and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the SWS, will not preclude operation of the essential portions of the SWS. Reference to SAR Chapter 2 describing site features and the general arrangement and layout drawings will be necessary as well as the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR that verify that the above conditions are met are acceptable. (CP)

b. The essential portions of the SWS are protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under the Section 3 series of the SRP. The reviewer will utilize the procedures identified in these SRP sections to assure that the analyses presented are valid. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable. The location and the design of the system, structures, and pump rooms (cubicles) are reviewed to determine that the degree of protection provided is adequate.

c. The SWS pumps will have sufficient available net positive suction head (NPSH) at the pump suction locations, considering low water levels. Reference to SRP Section 2.4, which indicates the lowest probable water level of the heat sink, and to drawings indicating the elevation of service water pump impellers will be necessary. An independent calculation verifying the applicant's conclusion will be necessary for acceptance.

d. Provisions are made in the system to detect and control leakage of radioactive contamination into and out of the system. It will be acceptable if the system P&IDs show radiation monitors located on the system discharge and at components susceptible to leakage, and these components can be isolated by one automatic and one manual valve in series.

e. The essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the SWS, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and the procedures for reviewing this information are given in the corresponding SRP sections.

f. Essential components and subsystems necessary for safe shutdown can function as required in the event of loss of offsite power. The system design will be acceptable if the SWS meets minimum system requirements as stated in the SAR assuming a concurrent failure of a single active component, including a single failure of an auxiliary electric power source. The SAR is reviewed to determine that for each SWS component or subsystem affected by the loss of offsite power, system flow and heat transfer capability meet or exceed minimum requirements. The results of failure modes and effects analyses are considered in assuring that the system meets these requirements. This will be an acceptable verification of system functional reliability.

g. Provisions are made for protection of the essential service water supply from potential failures or malfunctions caused by freezing, icing, and other adverse environmental conditions. Statements in the SAR that would indicate that safety grade heating sources will be used for this purpose, considering the equipment necessary for safe shutdown, will be acceptable.

3. The descriptive information, P&IDs, SWS drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the system can function following design basis accidents assuming a concurrent single active component failure. The reviewer evaluates the failure mode and effects analysis presented in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum system flow and heat transfer requirements are met for each accident situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The service water system (SWS) includes all components and piping from the SWS pump intake to the points of cooling water discharge. Based on the review of the applicant's proposed design criteria, design bases and safety classification for the service water system regarding the requirements for continuous cooling of safety-related components necessary for a safe plant shutdown, the staff concludes that the design of the service water system is in conformance with the Commission's regulations as set forth in the General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 5, "Sharing of Structures Systems, and Components," General Design Criterion 44, "Cooling Water," General Design Criterion 45, "Inspection of Cooling Water Systems," and General Design Criterion 46, "Testing of Cooling Water Systems," and meets the guidelines of Regulatory Guide 1.26, "Quality Group Classification and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," Regulatory Guide 1.117, "Tornado Design Classification," and Branch Technical Position ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," and therefore is acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 44, "Cooling Water."

5. 10 CFR Part 50, Appendix A, General Design Criterion 45, "Inspection of Cooling Water System."

6. 10 CFR Part 50, Appendix A, General Design Criterion 46, "Testing of Cooling Water Systems."

7. Regulatory Guide 1.26, 'Quality Group Classification and Standards For Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants."

8. Regulatory Guide 1.29, "Seismic Design Classification."

9. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

10. Regulatory Guide 1.117, "Tornado Design Classification."

11. Branch Technical Position ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1.

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.2.2 REACTOR AUXILIARY COOLING WATER SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Reactor Systems Branch (RSB)
Electrical, Instrumentation and Control Systems Branch (EICSB)
Mechanical Engineering Branch (MEB)
Structural Engineering Branch (SEB)
Materials Engineering Branch (MTEB)

I. AREA OF REVIEW

The APCSB reviews reactor auxiliary cooling systems that are required for safe shutdown during normal, operational transient, and accident conditions, and for mitigating the consequences of an accident, or preventing the occurrence of an accident. These include closed loop auxiliary cooling systems for reactor system components, reactor shutdown equipment, ventilation equipment, and components of the emergency core cooling system (ECCS).

The review of these systems includes the pumps, heat exchangers, valves and piping, expansion tanks, makeup piping, and points of connection or interfaces with other systems. Emphasis is placed on the cooling systems for safety-related components such as ECCS equipment, ventilation equipment, and reactor shutdown equipment.

1. The APCSB reviews the capability of the auxiliary cooling systems to provide adequate cooling water to safety-related ECCS components and reactor auxiliary equipment for all planned operating conditions. The review includes the following points:

   a. The functional performance requirements of the system including the ability to withstand adverse environmental occurrences, operability requirements for normal operation, and requirements for operation during and subsequent to postulated accidents.

   b. Multiple performance functions (if required) assigned to the system and the necessity of each function for emergency core cooling and safe shutdown.

   c. The capability of the system to cope with liquid expansion or provide necessary makeup as required.

d. The requirements for adequate net positive suction head (NPSH) for the auxiliary cooling pumps.

e. The sizing of the system for core cooling and decay heat loads and the associated design margin.

2. The APCSB review verifies that system components and piping have sufficient physical separation or shielding to protect essential portions of the system from missiles and pipe whip or from jet impingement that may result from piping cracks or breaks.

3. Other system aspects that are reviewed are:

   a. The use of design and fabrication codes consistent with the assigned quality group classification and seismic category.

   b. The effects of non-seismic Category I component failures on the seismic Category I portion of the system.

   c. The provisions for detection, collection, and control of system leakage and the means provided to detect leakage of activity from one system to another and preclude its release to the environment.

   d. The provisions to control long-term corrosion and organic fouling.

   e. The requirements for operational testing and inservice inspection of the system.

   f. Instrumentation and control features necessary to accomplish design functions, including isolation of components to deal with leakage or malfunctions, and actuation requirements for redundant equipment.

4. The applicant's proposed technical specifications will be reviewed for operating license applications as they relate to areas covered in this review plan.

The review of the cooling water systems will involve secondary reviews performed by other branches. The results are used by the APCSB to complete overall evaluation of the system. The secondary reviews are as follows: the RSB will identify engineered safety feature components associated with the reactor coolant system and the emergency core cooling systems that are required for operation during normal operations and accident conditions. RSB will establish cooling load functional requirements and minimum time intervals and assure that the seismic and quality group classifications for system components are acceptable. The SEB will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic qualification of components and confirm that the system is designed in accordance with applicable codes and standards. The MTEB will verify that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions. The EICSB will determine the adequacy of the design, installation, inspection, and testing of all essential electrical components required for proper operation.

II. ACCEPTANCE CRITERIA

Acceptability of the designs of cooling water systems as described in the applicant's safety analysis report (SAR), including related sections of Chapters 2 and 3 of the SAR, is based on specific general design criteria and regulatory guides, and on independent calculations and staff judgments with respect to system functions and component selection. Listed below are specific criteria as they relate to the cooling water systems.

The design of a cooling water system is acceptable if the integrated system design is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 44, to include:

   a. The capability to transfer heat loads from safety-related structures, systems, and components to a heat sink under both normal operating and accident conditions.

   b. Component redundancy so that safety functions can be performed assuming a single active component failure coincident with the loss of offsite power.

   c. The capability to isolate components, systems, or piping if required so that the system safety function will not be compromised.

5. General Design Criterion 45, as related to the design provisions to permit inservice inspection of safety-related components and equipment.

6. General Design Criterion 46, as related to the design provisions to permit operational functional testing of safety-related systems or components to assure:

   a. Structural integrity and system leak tightness.

b. Operability and adequate performance of active system components.

c. Capability of the integrated system to perform required functions during normal, shutdown, and accident situations.

7. Regulatory Guide 1.26, as related to the quality group classification of systems and components.

8. Regulatory Guide 1.29, as related to the seismic design classification of system components.

9. Branch Technical Position APCSB 3-1, as related to high and moderate energy breaks in piping systems outside containment.

An additional basis for determining the acceptability of a cooling water system will be the degree of similarity of the design with that of previously reviewed plants with satisfactory operating experience.

III. REVIEW PROCEDURES

The procedures set forth below are used during the construction permit (CP) application review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in Section II of this plan. For the review of operating license (OL) applications, the review procedures and acceptance criteria will be utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

The procedures for OL reviews include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

One of the main objectives in the review of a cooling water system (CWS) is to determine its function with regard to safety. Some cooling systems are designed as safety-related systems in their entirety, others have only portions of the system that are safety related, and others are classified as non-safety-related because they do not perform any safety function. In order to determine the safety category of a cooling water system, the APCSB will evaluate its necessity for achieving safe reactor shutdown conditions or for accident prevention or accident mitigation functions. The safety functions to be performed by these systems in all designs are essentially the same, however, the method used varies from plant to plant depending upon the individual designer.

In view of the various designs provided, the procedures set forth below are for a typical cooling water system designed entirely as a safety-related system. Any variance of the review procedures to take account of a proposed unique design will be such as to assure that the system meets the criteria of Section II. The reviewer will select and emphasize material from this review plan, as may be appropriate for a particular case.

1. The information provided in the SAR pertaining to the design bases and design criteria, and the system description section are reviewed to verify that the equipment used and the minimum system heat transfer and flow requirements for normal plant operations are identified. A review of the system piping and instrumentation diagrams (P&IDS) will show which components of the system are utilized to:

   a. Remove heat from the reactor primary coolant system equipment necessary to achieve a safe reactor shutdown.

   b. Provide essential cooling for containment components or systems such as the sprays, ventilation coolers, or sump equipment.

   c. Provide cooling for decay heat removal equipment.

   d. Provide cooling for emergency core cooling pump bearings or other emergency core cooling equipment necessary to prevent or mitigate the consequences of an accident.

2. The system performance requirements section is reviewed to determine that it limits allowable component operational degradation (e.g., pump leakage) and describes the procedures that will be followed to detect and correct these conditions when degradation becomes excessive.

3. The reviewer, using the results of failure modes and effects analyses, determines that the system is capable of sustaining the loss of any active component and, on the basis of previously approved systems or independent calculations, that the minimum system requirements (cooling load and flow) are met for these failure conditions. The system P&IDs layout drawings, and component descriptions and characteristics are then reviewed for the following points:

   a. Essential portions of the CWS are correctly identified and are isolable from the non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical division between each portion and indicate required classification changes. System drawings are reviewed to see that they show the means for accomplishing isolation and the SAR description is reviewed to identify minimum performance of the isolation valves. The drawings and description are reviewed to verify that automatically operated isolation valves separate non-essential portions and components from the essential portions.

   b. Essential portions of the CWS, including the isolation valves separating seismic Category I portions from the non-seismic portions, are Quality Group C or higher and seismic Category I. System design bases and criteria, and the component classification tables are reviewed to verify that the heat exchangers, pumps, valves and piping of essential portions of the system will be designed to seismic Category I requirements in accordance with the applicable criteria.

c. The system is designed to cope with liquid expansion or to provide water makeup as necessary. Where the cooling water systems are closed loop systems, surge tanks are generally provided to accommodate liquid volume changes due to changes in temperature or leakage and to receive system makeup water as required. The surge tank and connecting piping are reviewed to assure that makeup water can be supplied to either header in a split header system. Redundant surge tanks (one to each header) or a divided surge tank design are acceptable to assure that in the event of a header rupture the loss of the entire contents of the surge tank will not result.

d. Net positive suction head (NPSH) requirements for the cooling water pumps are met during normal operations and accident conditions, including conditions of extreme low water levels. The review of the system design information and the system and station drawings locating the cooling water system in the facility identifies the components and water levels necessary to provide NPSH for the cooling water pump. Independent analyses and engineering judgment are used in conjunction with pump performance curves to assure that the design and the location of the pump and components are such as to maintain appropriate NPSH requirements.

e. The system is designed for removal of heat loads during normal operation and of emergency core cooling heat loads during accident conditions, with appropriate design margins to assure adequate operation. A comparative analysis is made of the system flow rates, heat levels, maximum temperature, and heat removal capabilities with similar designs previously found acceptable. To verify performance characteristics of the system, an independent analysis may be made.

f. Design provisions are made that permit appropriate inservice inspection and functional testing of system components important to safety. It will be acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around pumps or isolation valves that would be required by this program.

g. Essential portions of the system are protected from the effects of high energy and moderate energy line breaks. The system description and layout drawings will be reviewed to assure that no high or moderate energy piping systems are close to essential portions of the CWS or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR, and the procedures for reviewing this information are given in the corresponding review plans.

h. Essential components and subsystems (i.e., those necessary for safe shutdown) can function as required in the event of a loss of offsite power. The system design will be acceptable in this regard if the essential portions of the CWS meet minimum system requirements as stated in the SAR assuming a concurrent failure of a single active component, including a single failure of any auxiliary electric power source. The SAR is reviewed to determine that for each CWS component or subsystem affected by the loss of offsite power, system flow and heat transfer capability exceed minimum requirements. The results of failure modes and effects analyses are considered in assuring that the system meets these requirements. This will be an acceptable verification of system functional reliability.

3. The system design information and drawings are analyzed to assure that the following features will be incorporated.

   a. A leakage detection system is provided to detect component or system leakage. An adequate means for implementing this criterion is to provide sumps or drains with adequate capacity and appropriate alarms in the immediate area of the system.

   b. Components and headers of the system are designed to provide individual isolation capabilities to assure system function, control system leakage, and allow system maintenance.

   c. Design provisions are made to assure the capability to detect leakage of radioactivity or chemical contamination from one system to another, to preclude long-term corrosion, organic fouling, or the spreading of radioactivity. Radioactivity monitors and conductivity monitors should be located in the system component discharge lines to detect leakage. An alternate means is to prevent leakage from occurring by operating the system at higher pressure to assure that leakage is in the preferred direction.

4. The reviewer verifies that the system has been designed so that system functions will be maintained, as required, in the event of adverse environmental phenomena such as earthquakes, tornadoes, hurricanes, and floods. The reviewer evaluates the system using engineering judgment and the results of failure modes and effects analyses to determine the following:

   a. The failure of portions of the system or of other systems not designed to seismic Category I standards and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the CWS, will not preclude essential functions. The review will identify these non-seismic category components or piping and assure that appropriate criteria are incorporated to provide isolation capabilities in the event of failure. Reference to SAR Chapter 2, describing site features, and the general arrangement and layout drawings will be necessary as well as to the SAR tabulation of seismic design classifications for structures and systems.

   b. The essential portions of the CWS are protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under the standard review plans for Chapter 3 of the SAR. The reviewer will utilize the procedures identified in these review plans to assure that the analyses presented are valid. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable. The location and design of the system, structures, and pump rooms (cubicles) are reviewed to determine that the degree of protection provided is adequate.

5. The descriptive information, P&IDs CWS drawings, and failure modes and effects analysis in the SAR are reviewed to assure that essential portions of the system will function following design basis accidents assuming a concurrent single active component failure. The reviewer evaluates the failure mode and effects analysis presented in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR information contains verification that minimum system flow and heat transfer requirements are met for each accident situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The reactor auxiliary cooling water systems include pumps, heat exchangers, valves and piping, expansion tanks, makeup piping, and the points of connection or interfaces with other systems. The scope of review of the cooling water systems for the __________ plant included layout drawings, process flow diagrams, piping and instrumentation diagrams, and descriptive information for the cooling water systems and the auxiliary supporting systems that are essential to operation of the cooling water systems. [The review has included the applicant's proposed design criteria and design bases for the cooling water systems, the adequacy of those criteria and bases, and the requirements for continuous cooling (if necessary) during all conditions of plant operation. (CP)] [The review has included the applicant's analysis of the manner in which the design of the cooling water systems and auxiliary supporting systems demonstrates conformance to the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs and design criteria for the cooling water systems and necessary auxiliary supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

"The staff concludes that the design of the cooling water systems conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR 50, Appendix A, General Design Criterion 44, "Cooling Water."

5. 10 CFR Part 50, Appendix A, General Design Criterion 45, Inspection of Cooling Water System."

6. 10 CFR Part 50, Appendix A, General Design Criterion 46, "Testing of Cooling Water System."

7. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants."

8. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.

9. Branch Technical Position APCSB 3-1, "Protection Against Postulated Piping Failure in Fluid Systems Outside Containment," attached to Standard Review Plan 3.6.1.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.2.3 DEMINERALIZED WATER MAKEUP SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Effluent Treatment Systems Branch (ETSB)
Instrumentation and Control Systems Branch (ICSB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The ASB reviews the demineralized water makeup system (DWMS) from the supply connection of the service or municipal water source to the points of discharge. The capability to provide an adequate supply of treated water of reactor coolant purity to other systems as makeup, and to provide other plant demineralized water requirements is reviewed. The design of the DWMS is generally not safety-related; the review is primarily directed toward assuring that a failure or malfunction of the system could not adversely affect essential systems requirements in accordance with General Design Criteria 2, 4 & 5.

1. The ASB review of the DWMS system includes the following considerations:
   a. Capability of the system to effectively store, handle, and dispense all chemicals utilized in the demineralizing and regeneration process.
   b. Capability of the DWMS to operate within the environment to which it is exposed.
   c. Provisions for the regeneration wastes to be directed to a suitable point in the radwaste system or other specified areas for subsequent processing prior to discharge to the environment and instrumentation and isolation capabilities provided, including the ability to detect corrosive solutions and the valving necessary to isolate the system.

2. The ASB reviews the system function relative to other safety-related systems to determine whether portions of the system are safety-related and to determine whether a seismic Category I make-up source is required.

3. The DWMS is also reviewed to assure that a malfunction or failure of a component will not have an adverse effect on any safety-related system or components.

Secondary reviews are performed by other branches and the results used by the ASB to complete the overall evaluation of the system. The secondary reviews are as follows.

The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB reviews the seismic qualification of components and confirms that the components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB verifies that inservice inspection requirements are met for system components and, upon request, verifies the compatibility of the materials of construction with service conditions. The ICSB & PSB determine the adequacy of the design, installation, inspection, and testing of all essential electrical components (sensing, control, and power) required for proper operation. The ETSB verifies that the limits for radioactivity concentrations are met.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the DWMS, as described in the applicant's safety analysis report (SAR), is based on design criteria or regulatory guides that apply directly to the safety-related functional performance requirements for the DWMS. The ASB assures that the system is capable of providing the required supply of reactor coolant purity water to all systems.

Several general design criteria and regulatory guides are used to evaluate the system design for those cases when a failure or malfunction of the DWMS could adversely effect essential systems or components (i.e., those necessary for safe shutdown or accident prevention or mitigation). These are as follows:

1. General Design Criterion 2, as related to the safety-related portions of the system being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, or floods.

2. General Design Criterion 4, with respect to the system being capable of withstanding the effects of internally generated missiles.

3. General Design Criterion 5, in regards to the effect of sharing in multiple unit facilities.

4. Regulatory Guide 1.26, as related to the quality group classifications of components & systems.

5. Regulatory Guide 1.29, Position C-1, if any portion of the system is deemed to be safety-related, and Position C-2 for nonsafety-related functions.

6. Appendix 1 of Regulatory Guide 1.56, for an acceptable standard for purity of the demineralized water produced by the DWMS.

7. Regulatory Guide 1.102, as related to the flood protection provided for nuclear power plants.

8. Regulatory Guide 1.117, as related to the missile protection provided for nuclear power plant's structures, systems and components.

9. Branch Technical Position ASB 3-1, as it relates to high and moderate energy breaks or cracks in piping systems outside containment.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures set forth below are used during the construction permit (CP) application review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license applications, the review procedures and acceptance criteria are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The reviewer selects and emphasizes material from this SRP section, as may be appropriate for a particular case. A determination will be made as to whether the DWMS or portions thereof are safety-related, including whether a seismic Category I make-up source is required for safe shutdown or for accident conditions. In confirming this design aspect, an analysis is made in which it is assumed that any DWMS pipe fails or component malfunctions or fails in such a manner as to cause maximum damage to other equipment located nearby. The system will be considered nonsafety-related if its failure does not affect the ability of the reactor facility to achieve and maintain safe shutdown conditions.

1. The ASB evaluates the system design information and drawings and, utilizing engineering judgment, operational experience, and performance characteristics of similar, previously approved systems, to verify that:
   a. The system is capable of fulfilling the requirements of the facility for makeup water on a day-to-day basis.
   b. The component redundancy necessary for the system to perform its design function is provided.
   c. Precautions are taken or incorporated into the system design to properly store, handle, and dispense corrosive and toxic chemicals effectively and

safely so that a hazardous condition does not result from mishandling or leakage.

d. The components utilized are compatible with the associated chemicals.
e. The potential for leakage and accidental spills has been minimized.
f. In the event of a leak or spill, there would not be an adverse effect on safety-related systems or components.
g. Instrumentation (e.g., a conductivity monitor) has been provided together with the capability to isolate the system should planned operating conditions be exceeded.
h. Piping has been provided as necessary to direct solutions and regenerative wastes to the radwaste system or other specified areas for processing and disposal.

IV. EVALUATION FINDINGS

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

"The demineralized water makeup system includes all components and piping associated with the system from the service or municipal water source to the points of discharge to other systems or to a discharge canal. [The review has determined the adequacy of the applicant's proposed design criteria and design bases for the demineralized water makeup system, regarding safety-related requirements (if any) for an adequate supply of reactor coolant purity water during all conditions of plant operation. (CP)] [The review has determined that the applicant's analysis of the designs of the demineralized water makeup system and auxiliary supporting systems is in conformance with the design criteria and bases. (OL)]"

"The basis for acceptance in the staff review has been conformance of the applicant's designs and design criteria for the demineralized water makeup system and necessary auxiliary supporting systems to the commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards and is acceptable."

V. REFERENCES

1. General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. General Design Criterion 4, "Environmental and Missile Design Bases."

3. General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

5. Regulatory Guide 1.29, "Seismic Design Classification."

6. Regulatory Guide 1.56, Appendix, "Maintenance of Water Purity in Boiling Water Reactors."

7. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

8. Regulatory Guide 1.117, "Tornado Design Classification."

9. Branch Technical Position ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment, attached to SRP section 3.6.1.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.2.4 POTABLE AND SANITARY WATER SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - None

I. AREAS OF REVIEW

At the construction permit (CP) stage of review, ASB reviews the information in the applicant's safety analysis report (SAR) in the specific areas that follow. At the operating license (OL) stage, ASB review consists of confirming the design accepted at the CP stage.

1. The system descriptions for the potable and sanitary water systems (PSWS) are reviewed. The piping and instrumentation drawings (P&IDs) are reviewed at the OL stage.

2. System design criteria to prevent connection to systems having the potential for containing radioactive material are reviewed.

II. ACCEPTANCE CRITERIA

1. ASB accepts the PSWS design if there are no interconnections between the PSWS and systems having the potential for containing radioactive material.

2. Where necessary the potable water system should be protected by an air gap.

III. REVIEW PROCEDURES

The reviewer selects and emphasizes material from this SRP section, as may be appropriate for a particular case.

In the review of the PSWS, ASB considers the design criteria to prevent cross connections, as described in the SAR. The P&ID's are reviewed at the OL stage to verify the absence of the potential for contamination of the PSWS with radioactive materials.

IV. EVALUATION FINDINGS

ASB determines 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 potable and sanitary water systems (PSWS) include all components and piping from the supply connection to the municipal or other water source to all points of discharge to sewage facilities or other plant systems."

"Based on our review of the applicant's design criteria, and design bases for the potable and sanitary water systems, we conclude that acceptable design provisions have been made to prevent the inadvertent contamination of the systems with radioactive material, and therefore find the proposed design of the potable and sanitary water systems to be acceptable."

V. REFERENCES

None

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.2.5 ULTIMATE HEAT SINK

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Reactor Systems Branch (RSB)
Mechanical Engineering Branch (MEB)
Structural Engineering Branch (SEB)
Materials Engineering Branch (MTEB)
Hydrology-Meteorology Branch (HMB)
Instrumentation and Control Systems Branch (ICSB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The ultimate heat sink (UHS) is the source of cooling water provided to dissipate reactor decay heat and essential cooling system heat loads after a normal reactor shutdown or a shutdown following an accident, including LOCA. The design of the UHS must satisfy the requirements of General Design Criteria 2, 4, 5, 44, 45 and 46.

The ASB reviews the water sources which make up the ultimate heat sink. This includes the size, type of cooling water supply (e.g., ocean, lake, natural or man-made reservoir, river, or cooling tower), makeup sources to the ultimate heat sink, and the capability of the heat sink to deliver the required flow of cooling water at appropriate temperatures for normal, accident, or shutdown condition of the reactor. The UHS is reviewed to determine that design code requirements, as applicable to the assigned quality classifications and seismic categories, are met. A related area of review is the conveying system, which is generally the service water pumping system. The service water system is reviewed under SRP Section 9.2.1.

1. The ultimate heat sink is reviewed with respect to the following considerations:
   a. The type of cooling water supply.

   b. The ability to dissipate the total essential station heat load.

   c. The effect of environmental conditions on the capability of the UHS to furnish the required quantities of cooling water, at appropriate temperatures and with any required chemical and purification treatment, for extended times after shutdown.

   d. The effect of earthquakes, tornadoes, missiles, floods and hurricane winds on the availability of the source water. The UHS is also reviewed to assure that adverse environmental conditions including freezing will not preclude the safety function of the UHS.

e. Sharing of cooling water sources in multi-unit stations.

f. Applicable design requirements such as the high and low water levels of the source to determine their compatibility with the service water system.

2. ASB reviews the station heat input provided in the SAR for the design of the UHS with respect to reactor system heat, sensible heat, and pump work, and station auxiliary system individual and total heat loads.

3. The proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this SRP section.

Secondary reviews will be performed by other branches and the results used by the ASB to complete overall evaluation of the UHS. The RSB confirms heat loads transmitted to the UHS from the reactor coolant and emergency core cooling systems. The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB reviews the seismic qualification of components and confirms that the system is designed in accordance with applicable codes and standards. The MTEB verifies that inservice inspection requirements are met for system components and, upon request, verifies the compatibility of the materials of construction with service conditions. The ICSB and PSB determines the adequacy of the design, installation, inspection, and testing of electrical components and instrumentation required for UHS operation. The HMB verifies the ultimate heat sink water levels, meteorological and natural phenomena criteria and transient analysis of the cooling water inventory as detailed in SRP Section 2.4 series.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the ultimate heat sink, as described in the applicant's Safety Analysis Report (SAR), including related sections of Chapters 2 and 3 of the SAR, is based on specific general design criteria and regulatory guides and on independent calculations and staff judgments with respect to system adequacy.

The design of the ultimate heat sink is acceptable if the system and the associated complex of water sources, including retaining structures and canals or conduits connecting the sources with the station, are in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, relative to structures housing the systems and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with high and moderate energy pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 44, as related to:
   a. The capability to transfer heat loads from safety-related structures, systems, and components to the heat sink under both normal operating and accident conditions.

   b. Suitable component redundancy so that safety functions can be performed assuming a single active component failure coincident with loss of offsite power.

   c. The capability to isolate components, systems, or piping if required so that safety functions are not compromised.

5. General Design Criterion 45, as related to the design provisions to permit inservice inspection of safety-related components and equipment.

6. General Design Criterion 46, as related to the design provisions to permit operation functional testing of safety-related systems or components.

7. Regulatory Guide 1.26, as related to quality group classification of system components.

8. Regulatory Guide 1.27, as related to the design and functional requirements of the ultimate heat sink.

9. Regulatory Guide 1.29, as related to the seismic design classification of system components.

10. Regulatory Guide 1.72, as related to plastic piping used in ultimate heat sink's spray pond.

11. Regulatory Guide 1.102, as related to the protection of structures, systems, and components important to safety from the effects of flooding.

12. Regulatory Guide 1.117, as related to the protection of structures, systems, and components important to safety from the effects of tornado missiles.

13. Branch Technical Position ASB 9-2, as related to the methods for calculating heat release due to fission product and heavy element decay.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For operating license (OL) reviews, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

The review procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

Availability of an adequate supply of water for the ultimate heat sink is a basic requirement for any nuclear power plant. There are various methods of satisfying the requirement, e.g., a large body of water such as an ocean, lake, or natural or man-made reservoir, a river, or cooling ponds or towers, or combinations thereof. The design of the ultimate heat sink tends to be unique for each nuclear plant, depending upon its particular geographical location. For the purpose of this SRP section, typical procedures are established for use in identifying the essential features of an ultimate heat sink. For installations where these general procedures are not completely adequate, the reviewer supplements them as necessary.

1. The SAR is reviewed for the overall arrangement and type of ultimate heat sink proposed. The reviewer verifies that the UHS is designed so that system function is maintained as required when subjected to adverse environmental phenomena including freezing and to a loss of offsite power. The reviewer evaluates the system to determine that:

   a. The heat inputs that are used in the design of the UHS are conservative. The reviewer makes an independent evaluation of the applicant's calculated heat loads. The UHS heat loads include heat due to decay of radioactive material, sensible heat, pump work, and the heat load from the operation of the station auxiliary systems serving and dependent upon the UHS.

b. Operational data from plants of similar design confirm, where possible, the heat input values given for sensible heat, pump work, and station auxiliary systems.

2. The reviewer verifies that:

a. The total essential station heat load and system flow requirements of the service water system are compatible with the heat rejection capability of the UHS.

b. The UHS has the capability to dissipate the maximum possible total heat load, including LOCA under the worst combination of adverse environmental conditions including freezing and has provisions for cooling the unit (or units, including LOCA for one unit for a multi-unit station with one heat sink) for a minimum of 30 days without makeup unless acceptable makeup capabilities can be demonstrated. This capability is verified by independent check calculations.

c. The connecting channels, structures, man-made embankments and dams, and conduits to and from the UHS are capable of withstanding design basis natural phenomena in combination with other site-related events and that a single failure of any man-made feature resulting from such phenomena or events cannot prevent adequate cooling water flow or adversely effect the temperature of the water from the sink.

3. Plants utilizing cooling towers as the ultimate heat sink are reviewed as described above and in addition the reviewer determines that:

a. The tower structure and basin design bases in the SAR include requirements for withstanding design basis natural phenomena or combinations of such phenomena at historically observed intensities. The natural phenomena to be considered include tornadoes, tornado missiles, hurricane winds, floods and the SSE.

b. The results of failure modes and effects analyses show that the mechanical systems (fans, pumps, and controls) can withstand a single active failure in any of these systems, including failure of any auxiliary electric power source, and not prevent delivery of water in the quantities and at temperatures required for safe shutdown.

c. Adequate net positive suction head (NPSH) can be provided to all essential pumps considering variations of water level in the basis. This is verified by performing independent calculations.

d. The towers can provide the design cooling water temperature under the worst combination of adverse environmental conditions including freezing, and that the supply of water in the basins can provide a 30-day capability for long-term cooling at the required temperature without makeup unless acceptable makeup capabilities can be demonstrated. This is verified by independent calculations.

e. Cooling towers or spray ponds used as a UHS and designed to withstand the effects of tornado missiles need not be designed to seismic Category I if another UHS is also available that is designed to meet the seismic classification guidelines of Regulatory Guide 1.27.

4. Reactor sites that utilize large natural or man-made water sources which for all practical purposes have an infinite supply of water are reviewed as described in items 1 and 2, above, and in addition the reviewer determines:

a. By evaluation of the SAR information or independent calculations, that the water source is adequate taking into account the effects of design basis natural phenomena such as tornadoes, hurricane winds, probable maximum floods, tsunami, seiches, and the SSE.

b. By reviewing the SAR preliminary site and plant arrangement sketches (CP) and (OL) site drawings and plant arrangement drawings that the design of the intake and outlet conduits (open or closed type) are properly separated to prevent recirculation or water temperature stratification.

c. That man-made earth dam, dike, or other structure design bases in the SAR include requirements for withstanding the design basis natural phenomena or combinations of such phenomena at historically observed intensities. In the event of failure of a dam, dike, or other structure not designed to withstand the design basis natural phenomena (particularly the SSE), sufficient water must remain in the source pool to assure a cooling water supply for a minimum of 30 days, with adequate cooling capability so that the required cooling water temperature to the service water system inlet is not exceeded.

5. The reviewer verifies that essential portions of the UHS are classified seismic Category I, Quality Group C, and are tornado missile protected.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and his review supports conclusions of the following type, to be included in the staff's Safety Evaluation Report:

"The ultimate heat sink review included the size, type of cooling supply (i.e., large body of water, ocean, lake, natural or man-made reservoir, river, pond, or cooling tower), and makeup sources to the ultimate heat sink. Based on the review of the applicant's proposed design criteria, design bases and safety classification for the ultimate heat sink and the requirements for delivering cooling water for a safe shutdown during normal and accident conditions, the staff concludes that the design of the ultimate heat sink is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 5, "Sharing of Structures, Systems, and Components," General Design Criterion 44, "Cooling Water Systems," General Design Criterion 45, "Inspection of Cooling Water Systems," and General Design Criterion 46, "Testing of Cooling Water Systems," and meets the guidelines contained in Regulatory Guide 1.26, "Quality Group Classification and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants," Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.72, "Spray Pool Plastic Piping," Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," Regulatory Guide 1.117, "Tornado Design Classification," and Branch Technical Position ASB 9-2, "Residual Decay Energy for Light Water Reactors for Long-Term Cooling," and therefore is acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 44, "Cooling Water System."

5. 10 CFR Part 50, Appendix A, General Design Criterion 45, "Inspection of Cooling Water System."

6. 10 CFR Part 50, Appendix A, General Design Criterion 46, "Testing of Cooling Water System."

7. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water, Steam, and Radioactive Waste-Containing Components of Nuclear Power Plants.

8. Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants."

9. Regulatory Guide 1.29, "Seismic Design Classification."

10. Regulatory Guide 1.72, "Spray Pond Plastic Piping."

11. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

12. Regulatory Guide 1.117, "Tornado Design Classification."

13. Branch Technical Position ASB 9-2, "Residual Decay Energy for Light Water Reactors for Long-Term Cooling."

RESIDUAL DECAY ENERGY FOR LIGHT WATER REACTORS FOR LONG-TERM COOLING

A. BACKGROUND

The Auxiliary Systems Branch has developed acceptable assumptions and formulations that may be used to calculate the residual decay energy release rate for light water cooled reactors for long-term cooling of the reactor facility.

Experimental data (Refs. 1 and 2) on total beta and gamma energy releases for long half-life (> 60 seconds) fission products from thermal neutron fission of U-235 have been considered reliable for decay times of 10^3 to 10^7 seconds. Over this decay time, even with the exclusion of short-lived fission products, the decay heat rate can be predicted to within 10 percent of experimental data (Refs. 3, 7, and 8).

The short-lived fission products contribute appreciably to the decay energy for decay times less than 10^3 seconds. Although consistent experimental data are not as numerous (Refs. 4 and 5) and the results of various calculations differ, the effect of all uncertainties can be treated in the zero to 10^3 second time range by a suitably conservative multiplying factor.

B. BRANCH TECHNICAL POSITION

1. Fission Product Decay

For finite reactor operating time (t_o) the fraction of operating power, $\frac{P}{Po}(t_o, t_s)$, to be used for the fission product decay power at a time t_s after shutdown may be calculated as follows:

$$\frac{P}{Po}(\infty, t_s) = \frac{1}{200}\sum_{n=1}^{n=11} A_n \exp(-a_n t_s) \qquad (1)$$

$$\frac{P}{Po}(t_o, t_s) = (1 + K)\frac{P}{Po}(\infty, t_s) - \frac{P}{Po}(\infty, t_o + t_o) \qquad (2)$$

where:

$\frac{P}{Po}$ = fraction of operating power

t_o = cumulative reactor operating time, seconds

t_s = time after shutdown, seconds

K = uncertainty factor; 0.2 for $o \le t_s \le 10^3$ and 0.1 for $10^3 \le t_s \le 10^7$

A_n, a_n = fit coefficients having the following values:

n	A_n	a_n (sec^{-1})
1	0.5980	1.772×10^{0}
2	1.6500	5.774×10^{-1}
3	3.1000	6.743×10^{-2}
4	3.8700	6.214×10^{-3}
5	2.3300	4.739×10^{-4}
6	1.2900	4.810×10^{-5}
7	0.4620	5.344×10^{-6}
8	0.3280	5.716×10^{-7}
9	0.1700	1.036×10^{-7}
10	0.0865	2.959×10^{-8}
11	0.1140	7.585×10^{-10}

The expressions for finite reactor operation may be used to calculate the decay energy from a complex operating history; however, in accident analysis a suitably conservative history should be used. For example, end of first-cycle calculations should assume continuous operation at full power for a full cycle time period, and end of equilibrium cycle calculations should assume appropriate fractions of the core to have operated continuously for multiple cycle times.

An operating history of 16,000 hours is considered to be representative of many end-of-first or equilibrium cycle conditions and is, therefore, acceptable. In calculating the fission produce decay energy, a 20 percent uncertainty factor (K) should be added for any cooling time less than 10^3 seconds, and a factor of 10 percent should be added for cooling times greater than 10^3 but less than 10^7 seconds.

2. Heavy Element Decay Heat

The decay heat generation due to the heavy elements U-239 and N_p-239 may be calculated according to the following expressions (Ref. 6):

$$\frac{P\ (U\text{-}239)}{Po} = 2.28 \times 10^{-3}\ C\ \frac{\sigma_{25}}{\sigma_{f25}}\ [1 - \exp(-4.91 \times 10^{-4}\ t_o)]\ [\exp(-4.91 \times 10^{-4}\ t_s)] \qquad (3)$$

$$\frac{P(N_p\text{-}239)}{Po} = 2.17 \times 10^{-3}\ C\ \frac{\sigma_{25}}{\sigma_{f25}} \Big\{ 0.007\ [1 - \exp(-4.91 \times 10^{-4}\ t_o)]$$

$$\cdot\ [\exp(-3.41 \times 10^{-6}\ t_s) - \exp(-4.91 \times 10^{-4}\ t_s)]$$

$$+\ [1 - \exp(-3.41 \times 10^{-6}\ t_o)]\ [\exp(-3.41 \times 10^{-6}\ t_s)] \Big\} \qquad (4)$$

where:

$\frac{P\ (U\text{-}239)}{P_o}$ = fraction of operating power due to U-239

$\frac{P\ (N_p\text{-}239)}{P_o}$ = fraction of operating power due to N_p-239

t_o = cumulative reactor operating time, seconds

t_s = time after shutdown, seconds

C = conversion ratio, atoms of Pu-239 produced per atom of U-235 consumed

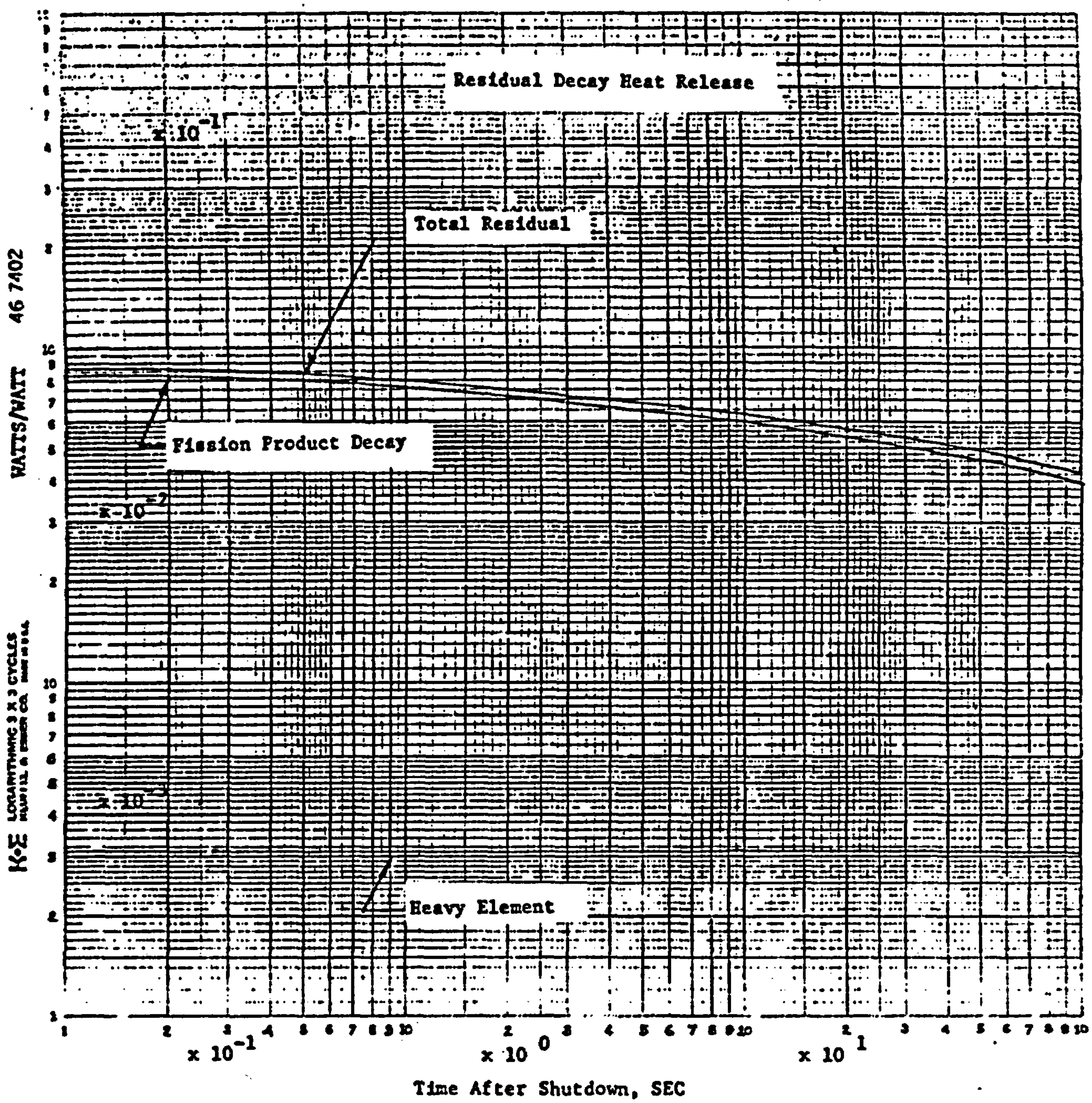
σ_{25} = effective neutron absorption cross section of U-235

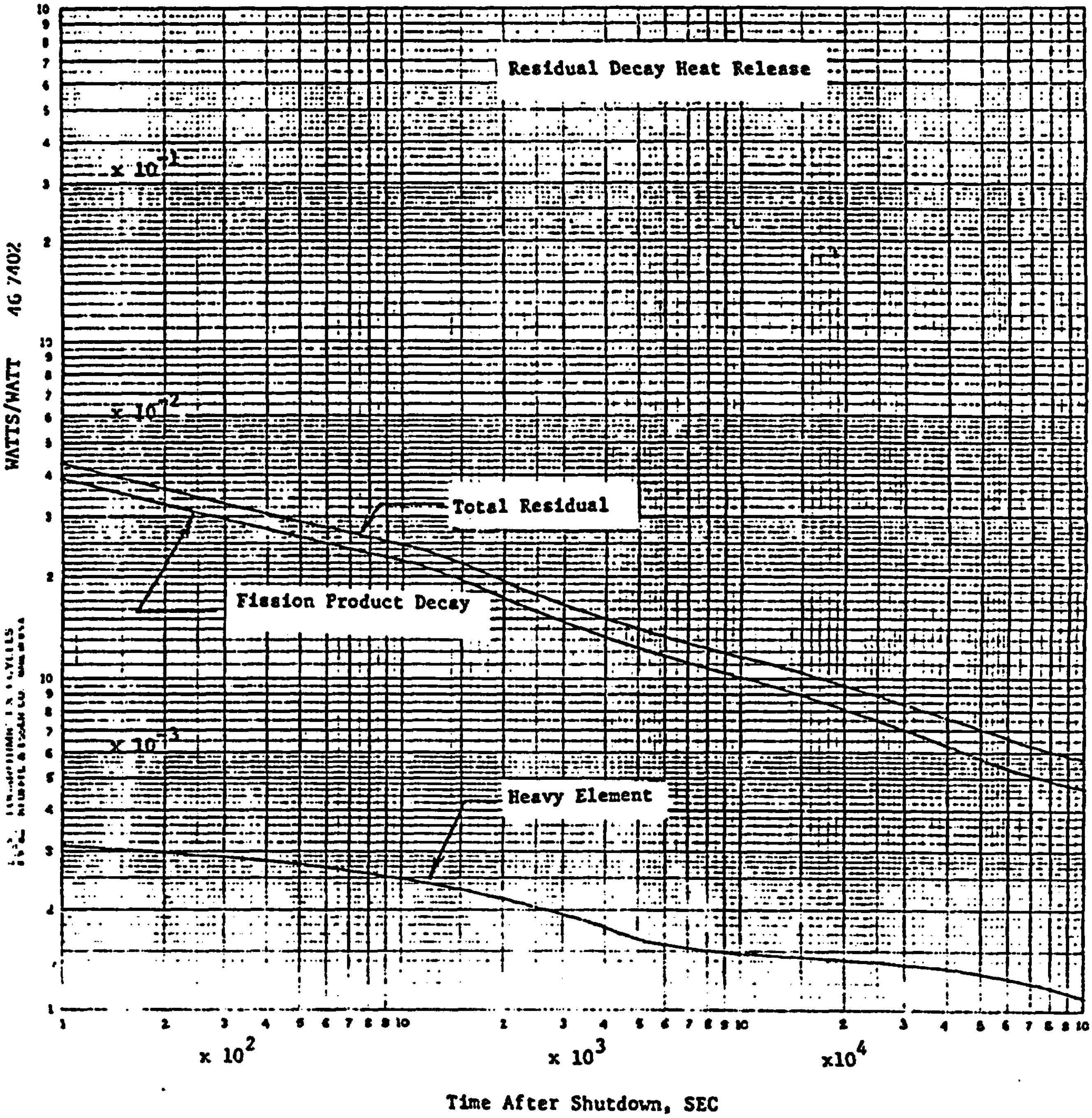
σ_{f25} = effective neutron fission cross section of U-235

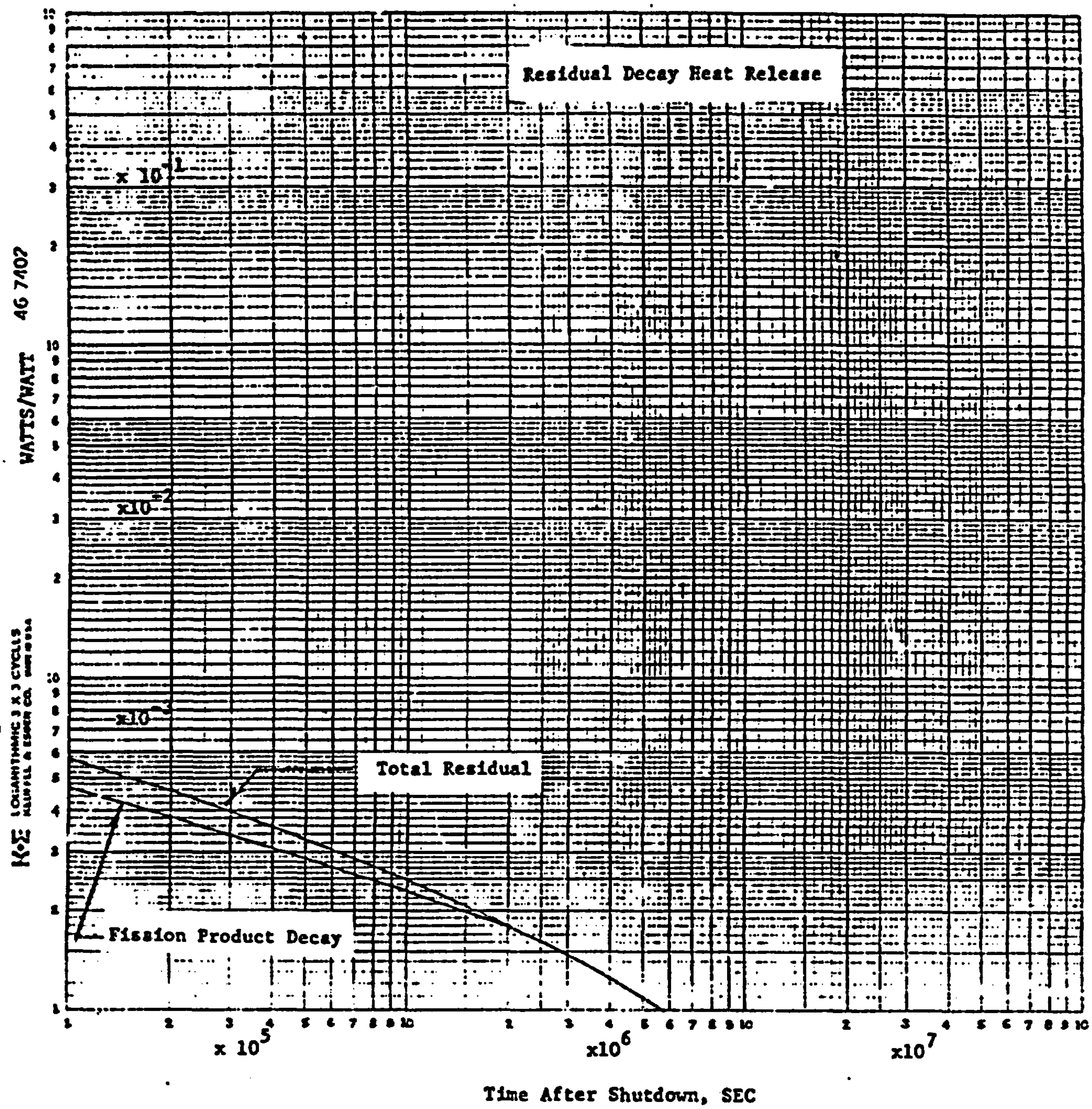
The product of the terms $C \cdot \frac{\sigma_{25}}{\sigma_{f25}}$ can be conservatively specified as 0.7.

The nuclear parameters for energy production by the heavy elements U-239 and N_p-239 are relatively well known. Therefore, the heavy element decay heat can be calculated with a conservatively estimated product term of $C \cdot \frac{\sigma_{25}}{\sigma_{f25}}$ without applying any other uncertainty correction factor.

3. Figures 1, 2, and 3 give the residual decay heat release in terms of fractions of full reactor operating power based on a reasonably realistic reactor operating time of 16,000 hours.


Residual Decay Heat Release
Total Residual
Fission Product Decay
Heavy Element
WATTS/WATT
46 7402
x 10^-1
x 10^-2
x 10^0
x 10^1
Time After Shutdown, SEC


Residual Decay Heat Release
WATTS/WATT
x 10^-1
x 10^-2
x 10^-3
Total Residual
Fission Product Decay
Heavy Element
x 10^2
x 10^3
x10^4
Time After Shutdown, SEC


Residual Decay Heat Release
WATTS/WATT
46 7402
x 10^-1
x10^-2
x10^-3
Total Residual
Fission Product Decay
x 10^5
x10^6
x10^7
Time After Shutdown, SEC

C. REFERENCES

1. J. F. Perkins and R. W. King, "Energy Release From the Decay of Fission Products, Nuclear Science and Engineering," Vol. 3, 726 (1958).

2. A. M. Perry, F. C. Maienschein, and D. R. Vondy, "Fission-Product Afterheat: A Review of Experiments Pertinent to the Thermal-Neutron Fission of ^{235}U," ORNL-TM-4197, Oak Ridge National Laboratory, October 1973.

3. A. Tobias, "The Energy Release From Fission Products," Journal of Nuclear Energy, Vol. 27, 725 (1973).

4. J. Scobie, R. D. Scott, and H. W. Wilson, "Beta Energy Release Following the Thermal Neutron Induced Fission of ^{233}U and ^{235}U," Journal of Nuclear Energy, Vol. 25, 1 (1971).

5. L. Costa and R. de Tourreil, "Activite β et α Des Products d'une Fission de ^{235}U et ^{239}Pu," Journal of Nuclear Energy, Vol. 25, 285 (1971).

6. Proposed ANS Standard, "Decay Energy Release Rates Following Shutdown of Uranium - Fueled Thermal Reactors," American Nuclear Society, October 1973.

7. J. Scobie and R. D. Scott, "Calculation of Beta Energy Release Rates Following Thermal Neutron Induced Fission of ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu," Journal of Nuclear Energy, Vol. 25, 339 (1971).

8. K. Shure, "Fission Product Decay Energy," WAPD-BT-24, Westinghouse Electric Corporation, December 1961.

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.2.6 CONDENSATE STORAGE FACILITIES

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Reactor Systems Branch (RSB)
Effluent Treatment Systems Branch (ETSB)
Materials Engineering Branch (MTEB)
Instrumentation and Control Systems Branch (ICSB)
Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Radiological Assessment Branch (RAB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The condensate storage facility (CSF) is provided to serve as a receiver for excess water generated by other systems such as the main condenser hotwell, the liquid radwaste low activity reprocessed condensate, and the makeup water treatment system, and also to serve as the water supply or makeup source for various auxiliary systems. Depending upon its specific function in the plant under review, the CSF may or may not be safety-related. The ASB review covers the CSF from the condensate storage tank up to the connections or interfaces with other systems to assure conformance with the requirements of General Design Criteria 2, 4, 5, 44, 45 and 46.

1. The ASB reviews the capability of the CSF to supply water to various auxiliary systems and to receive return water from other systems.

2. The ASB reviews the CSF to verify that:
   a. Failures of CSF components connected to the emergency core cooling system (ECCS) or other safety-related systems do not adversely affect the safety function of the ECCS or other safety-related systems.

   b. The essential portions of the CSF are protected from the effects of natural phenomena, including cold weather protection, so that the event will not adversely affect the safety function of the system.

   c. Component redundancy necessary to assure CSF safety functions is provided.

   d. System components meet design code requirements consistent with the component quality group and seismic design classifications.

e. Provisions for mitigating the environmental effects of system leakage or storage tank failure are provided.

f. Provisions for safe handling of storage tank overflow, the associated instrumentation necessary to detect high or low water level, and isolation means are provided.

g. Provisions for automatically transferring from a normal water supply that is nonsafety-related to an assured seismic Category I source if required.

3. The applicant's proposed technical specifications are reviewed for operating license applications, as they relate to areas covered in this SRP section.

Secondary reviews are performed by other branches and the results used by the ASB to complete the overall evaluation of the CSF. The secondary reviews are as follows. The RSB will identify essential portions of the facilities that are required to function during normal operations and accident conditions, and assist in establishing the basis for minimum condensate storage capacity. The ETSB will verify that the limits for radioactivity concentrations are not exceeded. The SEB will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic qualification of components and confirm that components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB will verify that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions. The ICSB and PSB will verify the adequacy of the design, installation, inspection, and testing of all electrical systems (sensing, control, and power) required for proper operation. RAB reviews the facility design to assure that radiation levels exposure to personnel will be maintained as low as is reasonably achievable.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the condensate storage facility, as described in the applicant's Safety Analysis Report (SAR), is based on specific general design criteria and regulatory guides.

1. For reactor systems where the condensate storage facility is an ultimate means of water supply for safe shutdown or accident mitigation, the CSF is acceptable if the integrated facility design is in accordance with the following criteria:

a. General Design Criterion 2, as related to the system being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes and floods.

b. General Design Criterion 4, with respect to the system being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

c. General Design Criterion 5, as related to the capability of shared systems and components to perform required safety functions.

d. General Design Criterion 44, to assure:

(1) Redundancy of components so that under normal and accident conditions the safety function can be performed assuming a single active component failure coincident with the loss of offsite power.

(2) The capability to isolate components, subsystems, or piping if required so that the system safety function will not be compromised.

(3) The capability to provide sufficient makeup water to safety-related cooling systems.

e. General Design Criterion 45, as related to design provisions made to permit inservice inspection of safety-related components and equipment.

f. General Design Criterion 46, as related to design provisions made to permit operational functional testing of safety-related systems and components to assure structural integrity, system leak tightness, operability and performance of active components, and capability of the integrated system to function as intended during normal, shutdown, and accident conditions.

g. Regulatory Guide 1.26, as related to the quality group classifications of components and systems.

h. Regulatory Guide 1.29, as related to the seismic design classification of system components.

i. Regulatory Guide 1.102, as related to the flood protection provided for nuclear power plants.

j. Regulatory Guide 1.117, as related to the tornado missile protection provided for nuclear power plant's structures, systems and components.

k. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

l. If a changeover from a nonsafety-related condensate storage source to a safety-related water source is required for safe shutdown or accident mitigation, then the changeover feature (automatic) should meet all the requirements for a safety-related system or component.

2. For reactor systems where the condensate storage facility is not an ultimate means of water supply for safe shutdown or accident mitigation, the design of the CSF is acceptable if the integrated facility design is in accordance with the following criterion:

   Branch Technical Position ETSB 11-1, as related to a nonsafety-related storage facility for low activity liquids waste.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. <u>REVIEW PROCEDURES</u>

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For operating license (OL) reviews, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

The review of OL applications includes a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The condensate storage facility (CSF) may be designed either as a safety-related facility or as a nonsafety-related facility, depending on the plant. The safety function performed by the facility is to ensure an adequate supply of water to the auxiliary feedwater system in the event that it is required for the safe shutdown of the reactor. Normal plant system functions performed by the CSF, such as makeup to the condenser hotwells and other auxiliary systems of the plant are reviewed to verify that failure will not have an adverse effect on the safety-related functions of the facility.

The review procedures given below are for a typical CSF system of the safety-related type. For cases where there are variations from this typical arrangement, the reviewer will adjust the review procedures given below. However, the system design will be required to meet the acceptance criteria given in subsection II.

1. The Safety Analysis Report is reviewed to determine that the facility description, and piping and instrumentation diagrams (P&IDs) delineate the CSF equipment that is used for normal operation, abnormal operation, and accident conditions as follows:

a. The facility functional requirements and the minimum flow requirements for supplying water to the auxiliary feedwater system and other safety-related systems are described.

b. Component allowable operational degradation (e.g., pump leakage) and the procedures that will be followed to detect and correct degraded conditions when they become excessive are described. The reviewer, using failure modes and effects analyses, or independent calculations, determines that the facility is capable of sustaining the loss of any active component and of meeting minimum flow requirements to the safety-related systems.

2. The facility P&IDs, layout drawings, and component descriptions and characteristics are reviewed to determine the following:

a. Essential portions of the CSF are correctly identified and are isolable from the non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical division between each portion. System drawings are also reviewed to see that they show the means for accomplishing isolation, and the facility description is reviewed to identify minimum performance requirements for the isolation valves.

b. Essential portions of the CSF, including the isolation valves separating seismic Category I portions from the nonseismic portions, are classified Quality Group C and seismic Category I.

c. Design provisions have been incorporated that permit appropriate inservice inspection and functional testing of system components important to safety. It will be acceptable if the SAR delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around pumps or isolation valves that would be required by this program.

3. The reviewer verifies that the system has been designed so that facility functions are maintained, as required, in the event of adverse natural phenomena such as tornadoes, hurricanes, and floods, and a loss of offsite power. The reviewer evaluates the facility, using engineering judgment and the results of failure modes and effects analyses to determine the following:

a. The failure of portions of the facility or of other systems not designed to seismic Category I standards and located close to essential portions of the facility, or non-seismic Category I structures that house, support, or are close to essential portions of the CSF, does not preclude essential functions. Reference to SAR Chapter 2, describing site features and the general arrangement and layout drawings, as well as to the SAR tabulation of seismic design classifications for structures and facilities, will be necessary. Statements in the SAR to the effect that the above conditions are met are acceptable. (CP)

b. The essential portions of the CSF are protected from the effects of floods, cold weather conditions, hurricanes, tornadoes, and internally- or externally-generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under the SRP sections for Chapter 3 of the SAR. The location and design of the facility and structures are reviewed to determine that the degree of protection provided is adequate. A statement to the effect that the facility is located in a seismic Category I structure that is tornado, missile and flood protected, or that components of the facility will be located in individual structures that will withstand the effects of freezing, flooding and missiles is acceptable.

c. The CSF provides sufficient net positive suction head (NPSH) at safety-related pump suction locations considering low condensate storage tank water levels. The SAR should indicate the minimum water level of the condensate storage tank and the elevation of the pump impellers. An independent calculation verifying the applicant's conclusion regarding pump NPSH may be necessary.

d. The condensate storage tank is equipped with instrumentation to monitor the water level in the tank and alarm when the water level reaches the low level setpoint which indicates the minimum reserve condensate storage for safety-related system supply.

e. The condensate storage tank overflow piping is connected to the radwaste system. The outdoor storage tank has a dike or retention basin capable of preventing runoff in the event of a tank overflow or tank failure; for a nonsafety-related storage facility, the need for a seismic Category I dike or retention basin is reviewed.

f. The essential portions of the facility are protected from the effects of high and moderate energy line breaks or cracks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the CSF, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR, and the procedures for reviewing this information are given in the corresponding SRP sections.

g. Functions of the essential components and subsystems of the CSF (i.e., those necessary for plant safe shutdown) will not be precluded by a loss of offsite power. The CSF design will be acceptable in this regard if minimum system requirements are met with onsite power.

h. The condensate storage tank has design provisions that automatically transfer, as required, from a normal nonsafety-related source to a seismic Category I source.

4. The descriptive information, P&IDs, system drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the CSF will function as needed following design basis accidents, assuming a concurrent single active component failure. The reviewer evaluates the information presented in the SAR to determine the ability of required components to function, traces the availability of these components on system drawings, and checks that the SAR contains verification that system flow requirements are met for each accident situation for the required time spans. For each case, the design will be acceptable if minimum system flow requirements are met.

IV. EVALUATION FINDINGS

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

"The condensate storage facility (CSF) includes all components and piping associated with the facility to the points of connection or interfaces with other systems. [The review has determined the adequacy of the applicant's proposed design criteria and bases for the condensate storage facility and the requirements for sufficient water supply to safety-related systems during normal, abnormal, and accident conditions (CP).] [The review has determined that the design of the condensate storage facility and auxiliary supporting systems is in conformance with the design criteria and bases (OL).]

"The basis for acceptance in the staff review has been conformance of the applicant's designs, design criteria, and design bases for the condensate storage facility and supporting systems to the Commission's regulations as set forth in the applicable general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

"The staff concludes that the design of the condensate storage facility conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 44, "Cooling Water."

5. 10 CFR Part 50, Appendix A, General Design Criterion 45, "Inspection of Cooling Water System."

6. 10 CFR Part 50, Appendix A, General Design Criterion 46, "Testing of Cooling Water System."

7. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

8. Regulatory Guide 1.29, "Seismic Design Classification."

9. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

10. Regulatory Guide 1.117, "Tornado Design Classification."

11. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

12. Branch Technical Position ETSB 11-1, "Design Guidance for Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants," attached to SRP Section 11.2.

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.3.1 COMPRESSED AIR SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Electrical, Instrumentation and Control Systems Branch (EICSB)

I. AREAS OF REVIEW

The compressed air system (CAS) provides air to safety-related equipment, and also to plant equipment used only for normal facility operation. APCSB reviews the entire compressed air system since there may be cases where two systems or subsystems are provided, i.e., a safety-related control air system (SRCAS), and a station service system for non-safety-related equipment. If the two systems are interconnected, then the area of review will extend from the safety-related portion to the outermost isolation valve on all interconnections between the two systems. If the systems are not connected, then the review will be limited to the SRCAS.

1. APCSB reviews the systems to identify the safety-related air operated devices that are supplied by the system, and whether each requires a source of supply air in order to perform the safety-related function.

2. APCSB then reviews to determine that:

   a. A failure of a component, or the loss of a compressed air source does not negate the safety-related functional performance of the system.

   b. The system components and pipes have sufficient physical separation or barriers to protect the essential portions of the system from missiles, and from the effects of breaks and cracks in high and moderate energy fluid system piping close to the SRCAS.

3. The APCSB reviews the system to determine that the effects of failure of non-seismic Category I equipment or components will not affect the functioning of the SRCAS.

4. APCSB reviews the design of the SRCAS with respect to the following:

   a. Capability to isolate portions or components of the system in case of component malfunction.

   b. Instrumentation and control features provided to determine and verify that the system is operating in a correct mode (e.g., valve position indication, pressure).

   c. Functional capability of the system in the event of adverse environmental phenomena, abnormal operational requirements, or accident conditions such as a loss-of-coolant accident (LOCA) or main steam line break concurrent with loss of offsite power.

5. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this plan.

Secondary reviews are performed by other branches and the results used by the APCSB to complete the overall review of the system. The secondary reviews are as follows. The SEB will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic qualification of components and confirm that the system is designed in accordance with applicable codes and standards. The EICSB will determine the adequacy of the design, installation, inspection, and testing of all essential electrical components.

II. ACCEPTANCE CRITERIA

The acceptability of the design of the safety-related control air system, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides. An additional basis for determining acceptability of the system will be the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience. The design of the SRCAS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapter 2 of the SAR.

2. General Design Criterion 4, with respect to structures housing the systems and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to the capability of shared systems and components important to safety to perform required safety functions.

4. Regulatory Guide 1.26, as related to the quality group classification of systems and components.

5. Regulatory Guide 1.29, as related to the seismic design classification of system components.

6. Branch Technical Positions APCSB 3-1 and MEB 3-1, as related to breaks in high energy piping or cracks in moderate energy piping systems outside containment.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in Section II of this plan. For operating license (OL) reviews, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The procedures for OL reviews include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

As a result of various CAS designs provided for different plants, there will be variations in system requirements. For the purpose of this plan, a typical system is assumed which has two independent systems, the plant service air system, and a safety-related control air system (SRCAS). For cases where there are variations from this arrangement, the reviewer adjusts the review procedures given below. However, the system design would be required to meet the acceptance criteria in Section II. The reviewer will select and emphasize material from this plan as appropriate for a particular case.

1. The SAR is reviewed to identify from information in the system description section and the piping and instrumentation diagrams (P&IDs) the SRCAS equipment used for normal operation and for safety feature operation. The reviewer determines that the system design is acceptable, taking into account the worst expected component operational degradation (e.g., wet or dirty air). The procedures to be followed to detect and correct these conditions when degradation becomes excessive are also reviewed.

2. The reviewer, using the results of failure modes and effects analyses, determines that the system, when operating in the normal mode, is capable of sustaining the loss of any active component. The reviewer determines, on the basis of previously approved systems or independent calculations, that the minimum system requirements (as stated in the SAR) are met for these failure conditions.

3. The system P&IDs, layout drawings, and component descriptions and characteristics are reviewed to determine the following:

   a. Essential portions of the SRCAS are correctly identified and are isolable from the non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical division between each portion. System drawings are also reviewed to verify that they show the means for accomplishing isolation and the system description is reviewed to identify minimum performance requirements of the isolation valves. For the typical system, the drawings and descriptions are reviewed to verify that two automatically operated isolation valves in series separate non-essential portions and components from the essential portions.

b. Essential portions of the SRCAS, including the isolation valves separating essential from non-essential portions, are classified Quality Group C or higher and seismic Category I. Component and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above classifications have been included, and that the P&IDs indicate points of change in any design classification.

4. The reviewer verifies that the system has been designed so that system function will be maintained, as required, in the event of adverse environmental phenomena, certain pipe breaks, or a loss of offsite power. The reviewer evaluates the system, using engineering judgment and the results of failure modes and effects analyses to determine that:

a. The failure of non-essential portions of the system or of other systems not designed to seismic Category I standards and located close to essential portions of the SRCAS, or of non-seismic Category I structures that house, support, or are close to the SRCAS, will not preclude operation of the essential portions of the SRCAS. Reference to SAR Chapter 2 (which describes site features) and the general arrangement and layout drawings, as well as to the SAR tabulation of seismic design classifications for structures and systems will be necessary. Statements in the SAR to the effect that the above conditions are met are acceptable.

b. The essential portions of the SRCAS are protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles. Seismic design, flood protection, and missile protection criteria are discussed in detail in Chapter 3 of the SAR. The location and the design of the system, structures, or cubicles are reviewed to determine that the degree of protection is adequate. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of tornado winds, flooding, and missiles is acceptable.

c. An adequate SRCAS air supply source is available, considering the loss of offsite power. The system design will be acceptable if minimum performance requirements, as stated in the SAR, are met assuming a concurrent failure of a single active component, including an emergency power source. The SAR information is reviewed to verify that for each SRCAS component or subsystem affected by the loss of offsite power, system capability meets or exceeds the minimum requirements. Statements in the SAR and the results of failure modes and effects analyses are considered to assure that the system meets these requirements. This will be acceptable verification of system functional reliability.

d. The essential components of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the SRCAS, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR, and procedures for reviewing the information are given in the corresponding review plans.

5. The descriptive information, P&IDs, SRCAS drawings, and failure modes and effects analyses in the SAR are reviewed to assure that the SRCAS will function following design basis accidents assuming a concurrent single active failure. The reviewer evaluates failure modes and effects analyses presented in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum compressed air flow requirements are met for each degraded situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The compressed air system includes all components and piping and the points of connection or interfaces with other systems. The scope of the review of the compressed air system for the ______________ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for operation of essential portions of the system. [The review has determined the adequacy of the applicant's proposed design criteria and design bases for the system with regard to the need to maintain a contInous air supply to safety-related components during all conditions of plant operation. (CP)] [The review has determined that the applicant's design of the compressed air system and auxiliary supporting systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs and design criteria for the compressed air system and necessary auxiliary 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.

"The staff concludes that the design of the compressed air system conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards For Water-, Steam- and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 1.

5. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.

6. Branch Technical Positions APCSB 3-1, "Protection Against Postulated Piping Failures In Fluid Systems Outside Containment," attached to Standard Review Plan 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to Standard Review Plan 3.6.2.

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.3.2 PROCESS SAMPLING SYSTEM

Primary - Effluent Treatment Systems Branch (ETSB)

Secondary - None

I. AREAS OF REVIEW

ETSB reviews the following information in the applicant's safety analysis report (SAR):

1. The design objectives and design criteria for the process sampling system (PSS) are reviewed at the construction permit (CP) stage. During the operating license (OL) stage of review, ETSB review consists of confirming the design accepted at the CP stage and evaluating the adequacy of the applicant's technical specifications in these areas. The review includes identification of the process streams to be sampled and the parameters to be determined through sampling (e.g., gross beta-gamma concentration, boric acid concentration).

2. The system description for the PSS is reviewed at the operating license (OL) stage. The review includes (a) piping and instrumentation diagrams (P&IDs), (b) provisions for obtaining representative samples, (c) location of sampling points and sample stations, and (d) provisions for purging sampling lines.

3. The seismic design and quality group classifications of piping and equipment, and the bases for the classifications chosen are reviewed at the CP stage. At the OL stage, the review includes design and expected temperatures and pressures and materials of construction of components of the system.

4. The isolation provisions for the system and the means provided to limit radioactive releases by limiting reactor coolant losses are reviewed at the CP stage.

Sampling and monitoring systems for radwaste processing systems are reviewed by ETSB under SRP Section 11.5. Secondary reviews are performed by the following branches: CSB, under SRP Section 6.2.4, reviews the design of isolation provisions of those portions of the PSS that penetrate primary containment; and ASB, under SRP 3.6.1, reviews the design with respect to the effects of externally or internally generated missiles, pipe whip, and jet impingement forces associated with postulated pipe breaks in high energy fluid systems or leakage cracks in moderate energy fluid systems.

II. ACCEPTANCE CRITERIA

1. The applicant's design should be such that the PSS has the capability for sampling all normal process systems and principal components, including provisions for obtaining samples from at least the following points:

   a. For a pressurized water reactor (PWR):

      Reactor coolant.
      Refueling (borated) water storage tank.
      ECCS core flooding tank.
      Concentrated boric acid storage tank.
      Boric acid mix tank.
      Boron injection tank.
      Chemical additive tank.
      Spent fuel pool.
      Secondary coolant.
      Pressurizer tank.
      Steam generator blowdown (if applicable).
      Secondary coolant condensate treatment waste.
      Sumps inside containment.
      Containment atmosphere.
      Offgas storage tanks.

   b. For a boiling water reactor (BWR):

      Main condenser evacuation system offgas.
      Reactor coolant.
      Standby liquid control system tank.
      Sumps inside containment.
      Spent fuel pool.
      Drywell atmosphere (Mark I & II).
      Cryogenic still inlet line.

   Other sample points that may be included in the PSS but do not require remote sampling are given in SRP Section 11.5.

   The required analysis and frequencies should be given in the plant technical specifications.

2. ETSB will use the following guidelines for determining the acceptability of the system functional design:

   a. Provisions should be made to assure representative samples from liquid process streams and tanks. For tanks, provisions should be made to sample the bulk volume of the tank and to avoid sampling from low points or from potential sediment traps. For process stream samples, sample points should be located in turbulent flow zones. Provisions for sampling should be in accordance with the guidelines in Regulatory Guide 1.21, position C.6.

b. Provisions should be made to assure representative samples from gaseous process streams and tanks in accordance with ANSI N13.1-1969.

c. Locations of sampling points should be described in the SAR at the OL stage and should be shown on P&IDs describing the system to be sampled.

d. Provisions should be made for purging sampling lines and for reducing plateout in sample lines (e.g., heat tracing).

e. Provisions should be made to purge and drain sample streams back to the system or origin or to an appropriate waste treatment system.

f. Isolation valves should fail in the closed position.

g. Passive flow restrictions to limit reactor coolant loss from a rupture of the sample line should be provided.

3. The seismic design and quality group classification of sampling lines and components should conform to the classification of the system to which each sampling line and component is connected (e.g., a sampling line connected to a Quality Group A and seismic Category I system should be designed to Quality Group A and seismic Category I classifcation) as described in Regulatory Guides 1.26, 1.29 and 1.143. Components and piping downstream of the second isolation valve can be designed to Quality Group D and nonseismic Category I requirements.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from this review plan, as may be appropriate for a particular case.

1. In the review of the process sampling system, ETSB compares the list of process sampling points contained in the SAR with the sampling points identified in Subsection II.1, above, to assure that the required process sampling points have been provided.

2. ETSB compares the capability of the system to obtain representative samples of process fluids and the locations of sampling points with the guidelines for obtaining representative samples of fluids contained in position C.6 of Regulatory Guide 1.21 and with the principles for obtaining representative samples of gases contained in ANSI N13.1-1969.

3. ETSB compares the seismic design and quality group classifications of the PSS to the classifications of the fluid systems to which the sampling system is connected.

4. ETSB reviews the technical specifications for process sampling to determine that the content and intent of the technical specifications are in agreement with the requirements developed as a result of the staff's review.

5. ETSB verifies that provisions have been made to limit the potential for reactor coolant loss from the rupture of a sample line and provides AAB with estimates of RCS fluid losses that would result from sample line rupture.

IV. EVALUATION FINDINGS

ETSB 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 process sampling system includes piping, valves, heat exchangers, and other components associated with the system from the point of sample withdrawal from a fluid system up to the analyzing station, sampling station, or local sampling point. Our review included the provisions proposed to sample all principal fluid process streams associated with plant operation and the applicant's proposed design of these systems. The review has included descriptive information for the process sampling system and the location of sampling points, as shown on piping and instrumentation diagrams.

"The basis for acceptance in our review has been conformance of the applicant's design for the process sampling system to applicable regulations, guides, and industry standards. Based on our evaluation, we find the proposed system to be acceptable."

V. REFERENCES

1. Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants."

2. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

3. Regulatory Guide 1.29, "Seismic Design Classification."

4. ANSI N13.1-1969, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute (1969).

5. Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures and Components Installed in Light-Water-Cooled Nuclear Reactor Power Plants."

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.3.3 EQUIPMENT AND FLOOR DRAINAGE SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Effluent Treatment Systems Branch (ETSB)
Containment Systems Branch (CSB)
Radiological Assessment Branch (RAB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The equipment and floor drainage system (EFDS) is designed to assure that waste liquids, valve and pump leakoffs, and tank drains are directed to the proper area for processing or disposal. The ASB reviews the equipment and floor drainage system, including the collection and disposal of liquid effluents outside containment. This includes piping and pumps from equipment or floor drains to the sumps, and any additional equipment that may be necessary to route effluents to the drain tanks and then to the radwaste system.

1. The ASB reviews the EFDS capability to collect and dispose of all waste liquid effluents so that they will be processed in a controlled and safe manner. ASB will determine that:

   a. The system is capable of handling the volume of leakage expected, including the capacities of the sumps, drain tanks, and sump pumps.

   b. The system is capable of preventing a backflow of water that might result from maximum flood levels to areas of the plant containing safety-related equipment.

   c. There is no potential for inadvertent transfer of contaminated fluids to a non-contaminated drainage system.

2. The seismic design and quality group classifications of piping and equipment, and the bases for the classifications chosen are reviewed.

Secondary reviews will be performed by other branches and the results used by the ASB to complete the overall evaluation of the system. The secondary reviews are as follows. The ETSB will provide verification that the radwaste system is capable of collecting, sampling, analyzing, and processing the effluents from the EFDS consistent with the requirements for disposal of radwaste material. The CSB will verify that portions of the drain system penetrating the containment barrier are designed with acceptable isolation features to maintain containment integrity for all operating conditions including accidents. RAB will verify that the system will meet occupational radiation protection criteria of Regulatory Guide 8.8. PSB verifies that power supplies for safety-related portions of the EFDS meet criteria appropriate to its safety function.

II. ACCEPTANCE CRITERIA

1. Acceptability of the design of the equipment and floor drainage system, as described in the applicant's safety analysis report (SAR) is based on the system being designed to prevent the flooding of areas housing safety-related equipment and to prevent the inadvertent transfer of contaminated fluids to non-contaminated drainage systems for disposal.

2. There are no general design criteria or regulatory guides that are directly applicable to the safety-related performance requirements for the EFDS. The ASB uses the following criteria to determine if portions of the EFDS are safety-related:

   a. If the system is capable of detecting leaks in safety systems that utilize the drainage system sumps, and is the only means for such leakage detection, it is considered safety-related in this regard.

   b. If the system can cause the inundation of safety-related areas due to drain backflow that may result from malfunction of active components, blockage or the probable maximum flood, it is considered safety-related in this area.

   c. If the system is connected so that an inadvertent transfer of contaminated fluids to non-contaminated drainage systems can occur, it is considered safety-related in this area.

3. The general design criteria and regulatory guides utilized in review of those portions of the system where failure or malfunction could result in adverse effects on essential systems or components (i.e., necessary for safe shutdown, accident prevention, or accident mitigation) are as follows:

   a. General Design Criterion 2, as related to the capability of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

b. General Design Criterion 4, with respect to the capability of withstanding the effects of external missiles and internally generated missiles, pipe whip and jet impingement forces associated with pipe breaks.

c. Regulatory Guide 1.29, as related to the seismic design classification of components.

d. Regulatory Guide 8.8, as related to maintaining occupational radiation exposure as low as practicable.

e. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

For those areas of review identified in subsection 1 of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For review of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The reviewer will select and emphasize material from this SRP section, as may be appropriate for a particular case.

1. The SAR is reviewed to see that the EFDS description section, layout drawings, and piping and instrumentation diagrams (P&IDs) show the EFDS layout and equipment, including pumps and valves necessary for routing effluents, the minimum drain tank capacity system flow requirements, connections to areas containing safety-related equipment or to non-contaminated drain systems, and any use made of the EFDS for leakage detection for safety-related systems. The reviewer determines which portions of the EFDS have safety functions or can adversely affect safety-related systems, using the criteria of subsection II.2, above. These "essential" portions of the EFDS are then reviewed on the basis of the criteria of subsection II.3, as is described in the paragraphs that follow.

2. The EFDS performance requirements section of the SAR is reviewed to confirm that it describes component allowable operational degradation (e.g., drain blockage, sump pump leakage, or failures) for safety-related portions of the system and describes the procedures that will be followed to detect and correct these conditions if they become excessive. The reviewer determines that essential portions of the system can sustain the loss of any active component and meet minimum system requirements. The system P&IDs, layout drawings, and component descriptions and characteristics are then reviewed for the following points:

   a. Essential portions of the EFDS are correctly identified and are isolable from the non-essential portions of the system to the extent required by system performance requirements.

   b. Essential portions of the EFDS are classified Quality Group C or higher and seismic Category I. Components and system descriptions in the SAR are reviewed to verify that the seismic and safety classifications have been included, and that the P&IDs indicate any points of change in piping quality group classification.

3. The reviewer verifies that the system safety functions will be maintained, as required, in the event of adverse environmental phenomena such as earthquakes, tornadoes, hurricanes, and floods, or in the event of certain pipe breaks. The reviewer evaluates the system, using engineering judgment, failure modes and effects analyses, and the results of reviews performed under other SRP sections, to determine that:

   a. Failure of non-essential portions of the system, or of other systems not designed to seismic Category I Standards and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the EFDS, will not preclude operation of the essential portions of the EFDS. Reference to SAR Chapter 2 (which describes site features) and the general arrangement and layout drawings will be necessary. Statements in the SAR to the effect that the above conditions are met are acceptable.

   b. System capability to prevent drain or flood water from backing up in the drainage system into areas housing safety-related equipment has been incorporated. Statements in the SAR that this capability is provided are acceptable.

   c. Provisions are made in the system to control and direct the flow of radioactive waste fluids to the radwaste area. It will be acceptable if the system P&IDs and design criteria show that the potential for inadvertent transfer of contaminated fluids to noncontaminated drainage system for disposal has been precluded.

d. Essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the EFDS, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR, and the procedures for reviewing this information are given in the corresponding SRP sections.

4. The descriptive information, P&IDs, EFDS drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the system can function as required following design basis accidents, assuming a concurrent failure of a single active component. The reviewer evaluates the analyses presented in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum system flow requirements are met for each accident situation for the required time spans. For each case, the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The equipment and floor drainage system includes all piping from equipment or floor drains to the sump, the sump pumps, and the associated pumps and piping network necessary to route effluents to the drain tanks and then to the radwaste system. [The review has determined the adequacy of the applicant's proposed design criteria and bases for the equipment and floor drainage system, and the requirements for continuous removal of liquids from areas containing safety-related equipment during normal, abnormal, and accident conditions. (CP)] [The review has determined that the applicant's design of the equipment and floor drainage systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs and design criteria for the essential portions of the equipment and floor drainage system and necessary auxiliary supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

"The staff concludes that the design of the equipment and floor drainage system conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. Regulatory Guide 1.29, "Seismic Design Classification."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards For Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

5. Regulatory Guide 8.8, "Information Relevant to Maintaining Occupational Radiation Exposure As Low As Practicable (Nuclear Reactors)."

6. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.3.4 CHEMICAL AND VOLUME CONTROL SYSTEM (PWR) (INCLUDING BORON RECOVERY SYSTEM)

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Core Performance Branch (CPB)
Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Effluent Treatment Systems Branch (ETSB)
Instrumentation and Control Systems Branch (ICSB)
Radiological Assessment Branch (RAB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

Pressurized water reactor (PWR) plants include a chemical and volume control system (CVCS) and boron recovery system (BRS). These systems maintain the required water inventory and quality in the reactor coolant system (RCS), provide seal-water flow to the reactor coolant pumps, control the boron neutron absorber concentration in the reactor coolant, and control the primary water chemistry. Further, the system provides recycled coolant for the demineralized water makeup system for normal operation and the design may also provide high pressure injection flow to the emergency core cooling system in the event of postulated accidents. The review is performed to assure conformance with the requirements of General Design Criteria 2, 4, 5, 26, 27, 29 and 33.

1. The ASB reviews the systems from the letdown line of the primary system to the charging lines that provide makeup to the primary system and the reactor coolant pump seal-water system. The system is reviewed to the interfaces with the demineralized water makeup system and radioactive waste system.

2. The ASB reviews the functional performance characteristics of CVCS components and reviews the effects of adverse environmental occurrences, abnormal operational requirements, or accident conditions such as those due to a loss-of-coolant accident (LOCA).

3. The ASB reviews the system to determine that a malfunction, a single failure of an active component, or the loss of a cooling source will not reduce the safety-related functional performance capabilities of the system.

4. The system is reviewed with respect to the effects of postulated breaks or leakage cracks in high and moderate energy piping outside containment.

5. The system is reviewed to determine that quality group and seismic design requirements are met. The effects of failure of equipment or components not designed to withstand seismic events on safety-related functions of the system are evaluated.

6. The ASB reviews the system design with respect to the capability to detect, collect, and control system leakage and to isolate portions of the system in case of excessive leakage or component malfunctions. RAB reviews the system with respect to maintaining occupational radiation exposure as low as practicable.

7. The ASB reviews the system features provided to prevent precipitation of boric acid in components and lines containing boric acid solutions, and the adequacy of the system design to protect personnel from the effects of toxic, irritating, or explosive chemicals that may be used.

8. Provisions for operational testing are evaluated, as are the instrumentation and control features that determine and verify that the system is operating in the correct mode.

9. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this SRP section.

10. The RSB, in accord with SRP Section 15.4.6, reviews the system features to assure that a decrease in boron concentration in the reactor coolant will not result in a violation of the fuel damage limits or the system pressure criteria and that adequate time is available for the reactor operator to terminate any dilution that may occur before the shutdown margin has been lost.

Secondary reviews are performed by other branches and the results used by the ASB to complete overall evaluation of the system. The secondary reviews are as follows. The CPB determines the adequacy of the specified boron concentrations in the primary coolant for normal and accident conditions. The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB reviews the seismic qualification of components and confirms that components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB verifies that inservice inspection requirements are met for system components and upon request will verify the compatibility of the materials of construction with service conditions. The ICSB and PSB evaluate the controls and instrumentation, and power sources, respectively, with regard to their capability, capacity, and reliability to perform safety-related functions during normal and emergency conditions. The ETSB reviews the CVCS and BRS to determine the source terms for possible radioactive releases and the processing of radioactive effluent from the BRS by the waste management systems. The RAB will verify that the system meets radiation protection criteria.

II. ACCEPTANCE CRITERIA

Acceptability of the CVCS and BRS design, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides. Listed below are the specific criteria related to the CVCS and BRS.

The design of the CVCS and BRS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the facility and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 26, as related to the CVCS capability to control the rate of reactivity changes resulting from normal power changes and the capability to maintain the reactor core subcritical under cold conditions.

5. General Design Criterion 27, as related to the CVCS capability to control reactivity changes so that under postulated accident conditions, and with appropriate margin for a stuck control rod, the capability to cool the core is maintained.

6. General Design Criterion 29, as related to the reliability of the CVCS to perform its safety-related function.

7. General Design Criterion 33, as related to the CVCS capability to supply reactor coolant makeup in the event of small breaks or leaks in the reactor coolant pressure boundary so that specified fuel design limits are not exceeded.

8. Regulatory Guide 1.26, as related to quality group classifications.

9. Regulatory Guide 1.29, as related to seismic design classifications.

10. Regulatory Guide 1.102, as related to the protection of structures, systems, and components important to safety from the effects of flooding.

11. Regulatory Guide 1.117, as related to the protection of structures, systems, and components important to safety from the effects of tornado missiles.

12. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

The procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such inputs as required to assure that this review procedure is complete.

For the purpose of this SRP section, a typical system is assumed for use as a guide since the design of the CVCS will vary with each reactor plant supplier. It is assumed that the typical system consists of a regenerative heat exchanger to cool the letdown flow from the RCS before processing through the demineralizers and to reheat it prior to reinjection into the RCS, demineralizers and filters for removal of suspended and dissolved impurities, high pressure charging pumps to inject makeup flow into the RCS, a volume control tank for system surge capacity and makeup volume, a boron makeup and storage system to provide neutron absorber to the RCS as needed, evaporators and tanks for boron recovery and demineralized water makeup, and a boron thermal regeneration subsystem to minimize the quantity of waste water and allow reactivity control by varying the temperature of demineralizers so as to remove or add boron to the CVCS. For cases where there are variations from this system, the reviewer would adjust the review procedures given below. However, the system design would be required to meet the acceptance criteria given in subsection II.

1. The SAR is reviewed to determine that the system description and piping and instrumentation diagrams, P&IDs, show the CVCS equipment that is used for normal operation, and the minimum system heat transfer and flow requirements for normal plant operation. The system performance requirements will also be reviewed to determine that it limits expected component operational degradation (e.g., pump leakage, heat exchanger scaling, resin deterioration) and describes the procedures that will be

followed to detect and correct these conditions when they become excessive. The reviewer, using the results of failure modes and effects analyses, comparisons with previously approved systems, or independent calculations, as appropriate, determines that the system can sustain the loss of any active component and meet the minimum system requirements for site shutdown or accident mitigation. The system P&IDs, layout drawings, and component descriptions and characteristics are then reviewed for the following points:

a. Essential portions of the CVCS are correctly identified and are verified to be isolable from the non-essential portions of the system. The P&IDs will be reviewed to verify that they clearly indicate physical divisions between such portions and indicate design classification changes. System drawings are also reviewed to see that they show the means for accomplishing isolation and the system description is reviewed to identify minimum performance requirements for the isolation valves.

b. Essential portions of the CVCS, including the isolation valves separating essential portions from non-essential portions, are classified Quality Group C and seismic Category I. Component and system descriptions in the SAR are reviewed to verify that the above seismic and safety classifications have been included, and that the P&IDs indicate any points of change in piping quality group classification.

c. Design provisions have been made that permit appropriate inservice inspection and functional testing of system components important to safety. It will be acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the connections and special piping and equipment required by this program.

d. The system description and drawings are reviewed in conjunction with the reactor coolant system to determine that the CVCS has sufficient pumping capacity to maintain the RCS water inventory within the allowable pressurizer level range for all normal modes of operation, including startup from cold shutdown, full power operation, and plant cooldown. It is further ascertained from a review of the P&IDs that makeup to the RSC can be accomplished via two redundant appropriately designed flow paths.

e. Using the results of evaluations performed by the CPB, the ASB verifies the adequacy of the system for reactivity control in the following areas:

   (1) Boration of the reactor coolant system is accomplished through either of two flow paths and from either of two boric acid sources. This is verified from the review of P&IDs and system description.

(2) The amount of boric acid stored in the CVCS exceeds the amount required to borate the reactor coolant system to cold shutdown concentration, assuming that the control assembly with the highest reactivity worth is held in the fully withdrawn position, and to compensate for subsequent xenon decay during any part of core life. This is verified from a review of the SAR.

(3) The CVCS is capable of counteracting the inadvertent positive reactivity insertion caused by the maximum boron dilution accident.

f. The adequacy of the CVCS for control of water chemistry is verified by examination of the information provided in the SAR, i.e., the allowable ranges for primary coolant activity, total dissolved solids, pH, and maximum allowable oxygen and halide concentrations.

g. The adequacy of resin overtemperature protection is verified by reviewing the system description and drawings to determine that temperature sensors are provided that will actuate the demineralizer bypass or isolation valves.

h. The boron thermal regeneration subsystem is reviewed to determine the maximum change in primary coolant boron concentration due to equipment or control errors as determined from failure modes and effects analyses.

i. The operating procedures and controls for boron addition and primary coolant dilution are reviewed for adequacy.

j. The system P&IDs are examined to determine that all components and piping that can contain boric acid will either be heat traced or will be located within heated rooms to prevent precipitation of boric acid.

2. The reviewer verifies that the safety function of the system will be maintained as required in the event of adverse environmental phenomena such as earthquakes, tornadoes, hurricanes, and floods, or in the event of certain pipe breaks or loss of offsite power. The reviewer uses engineering judgment, failure modes and effects analyses, and the results of reviews performed under other SRP sections, as applicable, to determine the following:

a. The failure of portions of the system or of other systems not designed to seismic Category I standards and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the CVCS, will not preclude operation of the essential portions of the CVCS. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR that verify that the above conditions are met are acceptable. (CP)

b. The essential portions of the CVCS are protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under the SRP Section 3 series. The location and the design of the system, structures, and pump rooms (cubicles) are reviewed to determine that the degree of protection provided is adequate. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable.

c. Essential portions of the system are protected from the effects of high energy line breaks and moderate energy line cracks. Layout drawings of the system are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the CVCS, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing this information are given in SRP Section 3.6.

d. Essential components and subsystems (i.e., those necessary for safe shutdown) can function as required in the event of loss of offsite power. The system design will be acceptable if the CVCS meets minimum system requirements as stated in the SAR assuming a failure of a single active component, within the system or in the auxiliary electric power source, which supplies the system. The SAR is reviewed to verify that for each CVCS component or subsystem affected by the loss of offsite power, boric acid addition and coolant charging capabilities meet or exceed minimum requirements. Statements in the SAR and the results of failure modes and effect analyses are considered in assuring that the system meets these requirements. This will be an acceptable verification of system functional reliability.

3. The descriptive information, P&IDs, layout drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the system will function following design basis accidents assuming a single active component failure. The reviewer evaluates the analyses presented in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum system flow and heat transfer requirements are met for each accident situation for the required time spans. For each case, the design will be acceptable if minimum system requirements are met.

4. The boron recovery system is not required for safe shutdown, or for the prevention or mitigation of postulated accidents. The BRS will be reviewed for the following: If the system tankage is of non-seismic Category I design, the results of analyses which postulate the rupture of tanks are reviewed to verify that the accident

releases are in accordance with safe limits. The facility design, including P&IDs, are reviewed to assure that safety-related equipment will not be adversely affected by flooding.

IV. EVALUATION FINDINGS

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

"The chemical and volume control system (including boron recovery system) includes components and piping associated with the system from the letdown line of the primary system to the charging lines that provide makeup to the primary system and the reactor coolant pump seal water system. Based on the review of the applicant's proposed design criteria, design bases and safety classification for the chemical and volume control system, and the requirements for system performance of necessary functions during normal, abnormal, and accident conditions, the staff has determined that the design of the chemical and volume control system and supporting systems is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 5, "Sharing of Structures, Systems, and Components," General Design Criterion 26, "Reactivity Control System Redundancy and Capability," General Design Criterion 27, "Combined Reactivity Control Systems Capability," General Design Criterion 29, "Protection Against Anticipated Operational Occurrences," General Design Criterion 33, "Reactor Coolant Makeup," and meets the guidelines contained in Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," Regulatory Guide 1.117, "Tornado Design Classification," Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," and Branch Technical Positions ASB 3-1 and MEB 3-1 and, therefore, is acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 26, "Reactivity Control System Redundancy and Capability."

5. 10 CFR Part 50, Appendix A, General Design Criterion 27, "Combined Reactivity Control Systems Capability."

6. 10 CFR Part 50, Appendix A, General Design Criterion 29, Protection Against Anticipated Operational Occurrences."

7. 10 CFR Part 50, Appendix A, General Design Criterion 33, "Reactor Coolant Makeup."

8. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

9. Regulatory Guide 1.29, "Seismic Design Classification."

10. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

11. Regulatory Guide 1.117, "Tornado Design Classification."

12. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.3.5 STANDBY LIQUID CONTROL SYSTEM (BWR)

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Core Performance Branch (CPB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Structural Engineering Branch (SEB)
Instrumentation and Control Systems Branch (ICSB)
Reactor Systems Branch (RSB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

Boiling water reactor (BWR) plants include a standby liquid control system (SLCS) that provides backup capability for reactivity control independent of the control rod system. The SLCS functions by injecting a boron solution into the reactor to effect shutdown. This system has the capability for controlling the reactivity difference between the steady-state operating condition at any time in core life and the cold shutdown condition. The review covers the SLCS design to the point where the system connects to the reactor coolant system (RCS). The ASB reviews the system to determine its adequacy to perform the shutdown function to assure conformance with the requirements of General Design Criteria 2, 4, 21, 26 and 27. Other points reviewed by ASB are as follows:

1. The functional performance characteristics of SLCS components and the effects of adverse environmental occurrences, abnormal operational conditions, or accident conditions such as those due to a loss-of-coolant accident (LOCA).

2. The system to determine that a malfunction or a single failure of a component will not reduce the safety-related functional performance capabilities of the system.

3. The system with respect to the effects of postulated breaks and cracks in high and moderate energy piping.

4. To determine that quality group and seismic design requirements are met for the system.

5. The system design with respect to the capability to detect, collect, and control system leakage and the capability to isolate portions of the system in case of excessive leakage or component malfunctions.

6. The capability of the system to prevent precipitation of the neutron absorber in components and lines containing the absorber solutions.

7. The provisions for operational testing and the instrumentation and control features that verify that the system is available to operate in the correct mode.

8. The applicant's proposed technical specifications for operating license applications as they relate to areas covered in this SRP section.

Secondary review evaluations are performed by other branches to complete the overall evaluation of the system. The secondary reviews are as follows. The CPB determines the adequacy of the specified boron neutron absorber quantities and concentrations required in the primary coolant to assure that the plant can be brought from rated power to cold shutdown at any time in core life with the control rods withdrawn in the rated power pattern. The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB reviews the seismic qualification testing of components and confirms that components, piping, and structures are designed in accordance with applicable codes and standards. The RSB verifies that the redundant reactivity control systems are not vulnerable to common mode failures. The MTEB verifies that inservice inspection requirements are met for system components and upon request verifies the compatibility of the materials of construction with service conditions. The ICSB and PSB determine the adequacy of the design, installation, inspection, and testing of electrical components (sensing, control, and power) required for proper operation.

II. ACCEPTANCE CRITERIA

Acceptability of the SLCS design, as described in the applicant's Safety Analysis Report (SAR), is based on specific general design criteria and regulatory guides. Listed below are specific acceptance criteria related to the SLCS.

The design of the SLCS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 21, as related to system design requirements for high functional reliability, inservice testability, and capability to meet the single failure criterion.

4. General Design Criterion 26, as related to the requirement that two independent reactivity control systems of different design principles be provided, and the requirement that one of the systems shall be capable of holding the reactor subcritical in the cold condition.

5. General Design Criterion 27, as related to the SLCS capability to control the rate of reactivity changes resulting from normal power changes and the capability to maintain the reactor core subcritical under cold conditions.

6. Regulatory Guide 1.26, as related to the quality group classification of system components.

7. Regulatory Guide 1.29, as related to the seismic design classification of system components.

8. Regulatory Guide 1.102, as related to the protection of structures, systems and components important to safety from the effects of flooding.

9. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

10. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside the drywell.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

The procedures for OL applications include a determination that the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

For the purpose of this SRP section, a typical system is assumed for use as a guide. It is assumed that the SLCS consists of a boron solution tank, a test water tank, two positive displacement pumps, two explosive valves, and associated local valves and controls. For cases where there are variations from this system, the reviewer would adjust the review procedures given below. However, the system design would be required to meet the acceptance criteria given in subsection II.

1. The SAR is reviewed to determine that the system description and piping and instrumentation diagrams (P&IDs) delineate the SLCS equipment. The reviewer, using the results of failure modes and effects analyses, comparisons with previously approved systems, or independent calculations, as appropriate, determines that the system can sustain the loss of any active component and meet the minimum system requirements for the safe shutdown and accident mitigation. The system P&IDs, layout drawings, and component descriptions and characteristics are reviewed to determine the following:

   a. The SLCS is classified Quality Group B and seismic Category I. Component and system descriptions in the SAR should verify that these classifications have been included, and the P&IDs should indicate any points of change in piping quality group classification.

   b. Design provisions have been made that permit appropriate inservice inspection and functional testing of the system. It will be acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the connections and special piping and equipment required by this program.

   c. Using the results of the evaluation performed by the Core Performance Branch, the ASB determines that the system has the capability to store the required quantity of neutron absorber in solution and that the injection rate is sufficient to bring the reactor from rated power to cold shutdown at any time in core life with the control rods remaining withdrawn in the rated power pattern, taking into account the reactivity gains from complete decay of the rated power xenon inventory, an allowance for imperfect mixing and leakage, and dilution by the residual heat removal system.

   d. The system P&IDs indicate that adequate means are provided to maintain the system temperature above the saturation temperature of the neutron absorber solution.

e. The controls and the summary of operating and test procedures for neutron absorber addition are adequate.

2. The reviewer verifies that the safety function of the system will be maintained as required in the event of adverse environmental phenomena such as earthquakes, tornadoes, hurricanes, and floods, or in the event of certain pipe breaks or loss of offsite power. The reviewer uses engineering judgment, failure modes and effects analyses, and the results of reviews performed under other SRP sections, as applicable, to determine the following:

   a. The failure of systems not designed to seismic Category I standards and located close to essential portions of the system, or of non-seismic structures that house, support, or are close to essential portions of the SLCS, will not preclude operation of the SLCS. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR that verify that the above conditions are met are acceptable. (CP)

   b. The SLCS is protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missles. Flood protection and missile protection criteria are discussed and evaluated in detail under the SRP Section 3 series. The location and the design of the system, structures, and pump rooms (cubicles) are reviewed to determine that the degree of protection provided is adequate. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable.

   c. Essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings of the system are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the SLCS or that protection from the effects of failure is provided. The means of providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing the information presented are given in SRP Section 3.6.

   d. Essential components and subsystems (i.e., those necessary for safe shutdown) can function as required in the event of loss of offsite power. The system design is acceptable if the SLCS meets minimum system requirements as stated in the SAR assuming a failure of a single active component within the system or in the auxiliary electric power source which supplies the system. Statements in the SAR and the results of failure modes and effects analyses are considered in assuring that the system meets these requirements. This will be an acceptable verification of system functional reliability.

3. The descriptive information, P&IDs, layout drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the system will function following design basis accidents assuming a single active component failure. The reviewer evaluates the information in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum system flow requirements are met for each accident situation for the required time spans. For each case, the design will be acceptable if minimum systems requirements are met.

IV. EVALUATION FINDINGS

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

"The standby liquid control system (SLCS) includes storage tanks, pumps, valves, and piping to the point where the system connects to the reactor coolant boundary. The SLCS is provided on BWRs only. Based on the review of the applicant's proposed design criteria, the design bases and safety classifications for the standby liquid control system, and the requirements for system functions to provide reactivity control during accident conditions, the staff concludes that the design of the standby liquid control system is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for the Protection Against Natural Phenomena," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 21, "Protection System Reliability and Testing," General Design Criterion 26, "Reactivity Control System Redundancy and Capability," General Design Criterion 27, "Combined Reactivity Control Systems Capability," and meets the guidelines contained in Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," Regulatory Guide 1.117, "Tornado Design Classification," and Branch Technical Positions ASB 3-1 and MEB 3-1, and, therefore, is acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 21, "Protection System Reliability and Testability."

4. 10 CFR Part 50, Appendix A, General Design Criterion 26, "Reactivity Control System Redundancy and Capability."

5. 10 CFR Part 50, Appendix A, General Design Criterion 27, "Combined Reactivity Control Systems Capability."

6. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

7. Regulatory Guide 1.29, "Seismic Design Classification."

8. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

9. Regulatory Guide 1.117, "Tornado Design Classification."

10. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.4.1 CONTROL ROOM AREA VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Instrumentation and Control Systems Branch (ICSB)
Mechanical Engineering Branch (MEB)
Structural Engineering Branch (SEB)
Materials Engineering Branch (MTEB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The function of the control room area ventilation system (CRAVS) is to provide a controlled environment for the comfort and safety of control room personnel and to assure the operability of control room components during normal operating, anticipated operational transient, and design basis accident conditions.

The ASB reviews the CRAVS from the air intake to the point of discharge where the system connects to the gaseous cleanup and treatment system or station vents to assure conformance with the requirements of General Design Criteria 2, 4, 5 and 19. The review includes components such as air intakes, ducts, air conditioning units, filters, blowers, isolation dampers or valves, and exhaust fans. The review of the CRAVS covers the control room, switchgear and battery room, access control area, control building heating, ventilating, and air conditioning (HVAC) equipment room, and computer room.

1. The ASB reviews the CRAVS to determine the safety significance of the system. Based on this determination, the safety-related portions of the system are reviewed with respect to the functional performance requirements to maintain the habitability of the control room area and other safety-related areas served by the control room ventilation system during adverse environmental occurrences, during normal operation, anticipated operational occurrences, and subsequent to postulated accidents. The review includes the effects of radiation, combustion and other toxic products, and the coincidental loss of offsite power. The ASB reviews safety-related portions of the system to assure that:

    a. A single active failure cannot result in loss of the system functional performance capability.

    b. Components and piping have sufficient physical separation or barriers to protect essential portions of the system from missiles, pipe whip, and fires.

c. Failures of non-seismic Category I equipment or components will not affect the CRAVS.

2. The ASB also reviews safety-related portions of the CRAVS with respect to the following:

   a. The ability of the control room heating and cooling subsystems to maintain a suitable ambient temperature for control room personnel and equipment.

   b. The ability to detect, filter, or expedite safe discharge of airborne contaminants inside the control room.

   c. The provisions for the detection and isolation of portions of the system in the event of fires, failures, or malfunctions.

   d. The ability of essential equipment being serviced by the ventilation system to function under the worst anticipated degraded CRAVS performance.

   e. To determine that the quality group and seismic design requirements are met for the system.

3. The Accident Analysis Branch (AAB) evaluates the concentrations of airborne contaminants in the vicinity of the intake and exhaust vents resulting from accidental release on the plant site, and the AAB also has primary responsibility for the control room ventilation system with respect to verifying that the control room habitability is maintained (see SRP Section 6.4).

4. The Effluent Treatment Systems Branch (ETSB) evaluates the effectiveness of the CRAVS filters to remove airborne contaminants prior to discharge to the environment (see SRP Section 6.5.1).

5. The applicant's proposed technical specifications are reviewed for operating license applications, as they relate to areas covered in this SRP section.

Secondary reviews are performed by other branches and the results used by the ASB to complete the overall evaluation of the system. The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB, upon request, reviews the seismic qualification of components and confirms that components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB verifies that inservice inspection requirements are met for system components and upon request will verify the compatibility of the materials of construction with service conditions. The

ICSB and PSB determine the adequacy of the design, installation, inspection, and testing of all essential electrical components (sensing, control and power) required for proper operation.

II. ACCEPTANCE CRITERIA

Acceptability of the CRAVS design, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides.

The design of safety-related portions of the CRAVS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety.

4. General Design Criterion 19, as related to providing adequate protection to permit access and occupancy of the control room under accident conditions.

5. Regulatory Guide 1.26, as related to the quality group classification of systems and components.

6. Regulatory Guide 1.29, as related to the seismic design classification of system components.

7. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

8. Branch Technical Position ASB 9.5-1, as related to capability of the system to remove smoke.

9. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The procedures for OL reviews include a determination that the content and intent of the proposed technical specifications are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

As a result of various CRAVS designs proposed by applicants, there will be variations in system requirements. For the purpose of this SRP section, a typical system with redundant subsystems is assumed with each subsystem having an identical essential (safety features) portion. For cases where there are variations from this typical arrangement, the reviewer would adjust the review procedures given below. However, the system design would be required to meet the acceptance criteria given in subsection II. The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

1. The SAR is reviewed to verify that the system description and piping and instrumentation diagrams (P&IDs) show the CRAVS equipment used for normal and emergency operations, and the ambient temperature limits for the areas serviced. The system performance requirements section is reviewed to determine that it describes allowable component operational degradation (e.g., loss of cooling function, damper leakage) and describes the procedures that will be followed to detect and correct these conditions. The reviewer, using results from failure modes and effects analyses, determines that the safety-related portion of the system is capable of functioning in spite of the loss of any active component.

2. The system P&IDs, layout drawings, and component descriptions and characteristics are then reviewed to determine that:

    a. Essential portions of the CRAVS are correctly identified and are isolable from non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate physical divisions between such portions and indicate design classification changes. System drawings are also reviewed to verify that they show the means for accomplishing isolation and the system description is reviewed to identify minimum performance requirements for the isolation dampers. For the typical system, the drawings and description are reviewed to verify that two automatically operated isolation dampers in series separate non-essential portions and components from the essential portions.

b. Essential portions of the CRAVS, including the isolation dampers separating essential from non-essential portions are classified Quality Group C and seismic Category I. Component and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above classifications have been included and that the P&IDs indicate points of change in design classification.

c. Design provisions have been made that permit appropriate inservice inspection and functional testing of system components important to safety. It is acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around pumps or isolation valves that would be required by this program.

3. The reviewer verifies that the system has been designed so that system function will be maintained as required in the event of adverse environmental phenomena or in the event of certain pipe breaks or loss of offsite power. The reviewer evaluates the system, using engineering judgment and the results of failure modes and effects analyses to determine that:

a. The failure of non-essential portions of the system or of other non-essential systems, structures or components located close to essential portions of the system will not preclude operation of the essential portions of the CRAVS. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR that verify that the above conditions will be met are acceptable at the CP stage.

b. The essential portions of the CRAVS are protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under Section 3 series of the SRP. The location and the design of the system, structures, and pump rooms (cubicles) are reviewed to determine that the degree of protection is adequate. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual seismic Category I cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable.

c. The total system has the capability to detect and control leakage of airborne contamination into the system. It is acceptable if the following conditions are met:

(1) The system P&IDs show monitors located in the system intakes that are capable of detecting radiation, smoke, and toxic chemicals. The monitors should actuate alarms in the control room.

(2) The capability for isolation of non-essential portions of the CRAVS by two automatically actuated dampers in series is shown on the P&IDs.

(3) The CRAVS has provisions for an internal recirculation filtering mode of operation or can discharge airborne contaminants from the control room area using a once-through ventilation mode, as applicable.

(4) Provisions for isolation of the control room upon smoke detection at the air intakes are shown on the P&IDs. The isolation may be actuated manually for most cases. Automatic isolation may be required in special cases such as for fires resulting from aircraft crashes.

d. The essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the CRAVS, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing this information are given in SRP Section 3.6.1.

e. Essential components and subsystems can function as required in the event of loss of offsite power. The system design will be acceptable if the CRAVS meets minimum system requirements as stated in the SAR assuming a failure of a single active component within the system itself or in the auxiliary electric power source which supplies the system. The SAR is reviewed to see that for each CRAVS component or subsystem affected by the loss of offsite power, the resulting system operation will not affect safety of control room personnel or the performance of any essential equipment. Statements in the SAR and the results of failure modes and effects analyses are considered in verifying that the system meets these requirements. This will be an acceptable verification of system functional reliability.

f. Essential portions of the CRAVS are protected from the effects of fire. The design bases and criteria for providing acceptable protection from the effects of fires are reviewed under SRP Section 9.5.1.

4. The descriptive information, P&IDs, CRAVS drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the system can function following design basis accidents assuming a concurrent single active failure. The reviewer evaluates the analyses presented in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum system

isolation or filtration requirements are met for each accident situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The control room area ventilation system (CRAVS) includes all components and ducting from the intake vents to the exhaust structure. Based on the review of the applicant's proposed design criteria, the design bases, and safety classification for the control room area ventilation system, and the requirements for system performance to maintain a suitable environment during normal, abnormal, and accident conditions, the staff concludes that the design of the control room area ventilation system and auxiliary supporting systems is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 5, "Sharing of Structures, Systems and Components," General Design Criterion 19, "Control Room," and meets the guidelines contained in Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.117, "Tornado Design Classification," Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," and Branch Technical Positions ASB 3-1 and MEB 3-1 and is, therefore, acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 19, "Control Room."

5. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

6. Regulatory Guide 1.29, "Seismic Design C'assification."

7. Regulatory Guide 1.117, "Tornado Design Classification."

8. Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," attached to SRP Section 9.5.1.

9. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.4.2 SPENT FUEL POOL AREA VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Structural Engineering Branch (SEB)
Instrumentation and Control Systems Branch (ICSB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The function of the spent fuel pool area ventilation system (SFPAVS) is to maintain ventilation in the spent fuel pool equipment areas, to permit personnel access, and to control airborne radioactivity in the area during normal operation, anticipated operational transients, and following postulated fuel handling accidents.

The ASB reviews the SFPAVS from air intake to the point of discharge where the system connects to the gaseous cleanup and treatment system or the station vents to assure conformance with the requirements of General Design Criteria 2, 4 and 5. The review includes components such as air intakes, ducts, air conditioning units, filters, blowers, isolation dampers, and exhaust fans. The review of the SFPAVS covers all areas containing or adjacent to the spent fuel pool, including the spent fuel cooling pump room.

1. The ASB reviews the SFPAVS to determine the safety significance of the system. Based on this determination, the safety-related part of the system is reviewed with respect to functional performance requirements during normal operation, during adverse environmental occurrences, and subsequent to postulated accidents including the loss of offsite power. The ASB reviews safety-related portions of the system to assure that:

    a. A single active failure cannot result in loss of the system functional performance capability.

    b. Components and piping or ducting have sufficient physical separation or barriers to protect essential portions of the system from missiles, pipe whip, and fires.

c. Failures of non-seismic Category I equipment or components will not affect the SFPAVS.

2. The ASB also reviews safety-related portions of the SFPAVS with respect to the following:

   a. The capability to direct ventilation air from areas of low radioactivity to areas of potentially higher radioactivity.

   b. The capability to detect the need for isolation and to isolate portions of the system in the event of failures or malfunctions.

   c. The capability to actuate components not normally operating that are required to operate during accident conditions, and to provide necessary isolation.

   d. To determine that the quality group and seismic design requirements are met for the system.

3. The Effluent Treatment Systems Branch (ETSB) evaluates the effectiveness of the SFPAVS filters to remove airborne contaminants prior to discharge to the environment in SRP Section 6.5.1.

4. The Accident Analysis Branch (AAB) evaluates the radiological consequences of airborne contaminants resulting from a postulated fuel handling accident in SRP Section 15.7.4.

5. The Radiological Assessment Branch (RAB) reviews and evaluates the capability of the SFPAVS to detect and control leakage of radioactive contamination from the system, as well as radiation protection criteria described in SRP Section 12.3.

6. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this SRP section.

Secondary reviews are performed by other branches and the results used by the ASB to complete the overall evaluation of the system. The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing or supporting the system to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will, upon request, review the seismic qualification of components and confirm that the components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB verifies that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions. The ICSB and PSB determine the adequacy of the design, installation, inspection, and testing of all essential electrical components (sensing, control and power) required for proper operation.

II. ACCEPTANCE CRITERIA

Acceptability of the SFPAVS design, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides.

The design of safety-related portions of the SFPAVS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety.

4. Regulatory Guide 1.13, as related to the system capability to limit releases of radioactive contaminants to the environment.

5. Regulatory Guide 1.26, as related to the quality group classification of systems and components.

6. Regulatory Guide 1.29, as related to the seismic design classification of system components.

7. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

8. Branch Technical Position ASB 9.5-1, as related to capability of the system to remove smoke.

9. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the Preliminary Safety Analysis Report meet the acceptance criteria given in subsection II.

For the review of operating license (OL) applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The procedures for OL reviews include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such inputs as required to assure that this review procedure is complete.

As a result of various SFPAVS designs proposed by applicants, there will be variations in system requirements. For the purpose of this SRP section, a typical system is assumed which has fully redundant subsystems, each having an identical essential (safety features) portion. For cases where there are variations from this typical arrangement, the reviewer would adjust the review procedures given below. However, the system design would be required to meet the acceptance criteria given in subsection II. The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

1. The SAR is reviewed to verify that the system description section and piping and instrumentation diagrams (P&IDs) show the SFPAVS equipment used for normal operation and the ambient temperature limits for the area serviced. The system performance requirements section is reviewed to determine that it describes allowable component operational degradation (e.g., loss of cooling function, damper leakage) and describes the procedures that will be followed to detect and correct these conditions. The reviewer, using results from failure modes and effects analyses as appropriate, determines that the safety-related portion of the system is capable of functioning in spite of the loss of any active component.

2. The system P&IDs, layout drawings, and component descriptions and characteristics are then reviewed to determine that:

   a. Essential portions of the SFPAVS are correctly identified and are isolable from non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical divisions between such portions and indicate design classification changes. System drawings are also reviewed to verify that they show the means for accomplishing isolation and the system description is reviewed to identify minimum performance requirements for the isolation dampers. For the typical system, the drawings and description are reviewed to verify that two automatically operated isolation dampers in series separate non-essential portions and components from the essential portions.

b. Essential portions of the SFPAVS, including the isolation dampers separating essential from non-essential portions, are classified Quality Group C and seismic Category I. Component and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above classifications have been included, and that the P&IDs indicate any points of change in design classification.

c. Design provisions have been made that permit appropriate inservice inspection and functional testing of system components important to safety. It is acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around fans or isolation dampers that would be required by this program.

3. The reviewer verifies that the system has been designed so that system function will be maintained as required in the event of adverse environmental phenomena or in the event of certain pipe breaks or loss of offsite power. The reviewer evaluates the system, using engineering judgment and failure modes and effects analyses, to determine that:

a. The failure of non-essential portions of the system or of other systems not designed to seismic Category I standards and located close to essential portions of the system, or of non-seismic Category I structures that house, support or are close to essential portions of the SFPAVS, will not preclude operation of the essential portions of the SFPAVS. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems.

b. The essential portions of the SFPAVS are protected from the effects of floods, hurricanes, tornadoes, and internally- and externally-generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under Section 3 series of the SRP. The location and the design of the system, structures, and fan rooms (cubicles) are reviewed to determine that the degree of protection is adequate. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles, is acceptable.

c. The total system has the capability to detect and control leakage of radioactive contamination from the system. It is acceptable if the following conditions are met:

(1) The capability for isolating non-essential portions of the SFPAVS by two automatically actuated dampers in series is shown in the P&IDs.

(2) The SFPAVS has provisions to filter radioactive contaminants from the spent fuel area by automatically isolating the normal ventilation system and actuating the emergency exhaust system before the first contaminated airborne particles and gases reach the normal ventilation exhaust ducts. A statement in the SAR that the technical specifications will require that the SFPAVS be operating whenever fuel handling operations are in progress is required.

d. The essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the SFPAVS, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing this information are given in SRP Section 3.6.

e. Components and subsystems necessary for preventing the release of radioactive contaminants can function as required in the event of loss of offsite power. The system design will be acceptable if the SFPAVS meets minimum system requirements as stated in the SAR assuming a failure of a single active component, within the system itself or in the auxiliary electric power source which supplies the system. The SAR is reviewed to see that for each SFPAVS component or subsystem affected by the loss of offsite power, the resulting system flow capacity will not cause the loss of air flow from areas of low potential radioactivity to areas of higher potential radioactivity. Statements in the SAR and the results of failure modes and effects analyses are considered in verifying that the system meets these requirements. This will be an acceptable verification of system functional reliability.

4. The descriptive information, P&IDs, SFPAVS drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the system can function following design basis accidents assuming a concurrent single active failure. The reviewer evaluates the analyses presented in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum system isolation or filtration requirements are met for each accident situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The spent fuel pool area ventilation system (SFPAVS) includes all components and ductwork from air intake to the point of discharge where the system connects to the gaseous cleanup and treatment system or station vents. Based on the review of the applicant's proposed design criteria, the design bases, and safety classification for the spent fuel pool area ventilation system and the requirements for system performance to prevent an unacceptable release of contaminants to the environment during normal, abnormal, and accident conditions, the staff concludes that the design of the spent fuel pool area ventilation system and supporting systems is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 5, "Sharing of Structures, Systems and Components," and meets the guidelines contained in Regulatory Guide 1.13, "Fuel Storage Facility Design Basis," Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.117, "Tornado Design Classification," Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," and Branch Technical Positions ASB 3-1 and MEB 3-1 and is, therefore, acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. Regulatory Guide 1.13, "Fuel Storage Facility Design Basis."

5. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

6. Regulatory Guide 1.29, "Seismic Design Classification."

7. Regulatory Guide 1.117, "Tornado Design Classification."

8. Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," attached to SRP Section 9.5.1.

9. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.4.3 AUXILIARY AND RADWASTE AREA VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Instrumentation and Control Systems Branch (ICSB)
Mechanical Engineering Branch (MEB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The ASB reviews the auxiliary and radwaste area ventilation system (ARAVS) from air intake to the point of discharge where the system connects to the gaseous cleanup and treatment system or station vents to assure conformance with the requirements of General Design Criteria 2, 4 and 5. The review includes components such as air intakes, ducts, air conditioning units, blowers, isolation dampers, and roof exhaust fans. The review of the ARAVS covers the radwaste areas and controlled access nonradioactive areas and their relationship to safety-related areas in the auxiliary building.

1. The ASB reviews the functional performance requirements and the air treatment equipment for the ARAVS to determine whether the ventilation system or portions of the system have been designed or need to be designed as a safety-related system. Based on this determination, the safety-related part of the system is reviewed with respect to functional performance requirements during normal operation, during adverse environmental occurrences, and during and subsequent to postulated accidents, including the loss of offsite power. The ASB reviews safety-related portions of the system to assure that:

   a. A single active failure cannot result in loss of the system functional performance capability.

   b. Components and piping have sufficient physical separation or shielding to protect essential portions of the system from missiles, pipe whip, and fires.

   c. Failures of non-seismic Category I equipment or components will not result in unfiltered releases of radioactive contaminants.

2. The ASB also reviews safety-related portions of the ARAVS with respect to the following:

a. The capability to direct ventilation air from areas of low radioactivity to areas of progressively higher radioactivity.

b. The capability to detect the need for isolation and to isolate safety-related portions of the system in the event of fires, failures, or malfunctions, and the capability of the isolated system to function under such conditions.

c. To determine that the quality group and seismic design requirements are met for the system.

3. The Effluent Treatment Systems Branch (ETSB) evaluates the ARAVS's functional performance to assure that the system meets acceptable limits for radioactive releases during normal operations under SRP Section 11.3.

4. The Radiological Assessment Branch (RAB) reviews and evaluates the capability of the ARAVS to detect and control leakage of radioactive contamination from the system, as well as radiation protection criteria as described in SRP Section 12.3.

5. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this SRP section.

Secondary reviews are performed by other branches and the results used by the ASB to complete the overall evaluation of the system. The MEB will, upon request, review the seismic qualification of components and confirm that the components, piping, and structures are designed in accordance with applicable codes and standards. The ICSB and PSB will determine the adequacy of the design, installation, inspection, and testing of all electrical components (sensing, control and power) required for proper operation.

II. ACCEPTANCE CRITERIA

Acceptability of the ARAVS design, as described in the applicant's Safety Analysis Report (SAR), is based on specific general design criteria and regulatory guides. The design of safety-related portions of the ARAVS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety.

4. Regulatory Guide 1.26, as related to quality group classification of systems and components.

5. Regulatory Guide 1.29, as related to seismic design classification of system components.

6. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

7. Branch Technical Position ASB 9.5-1, as related to capability of the system to remove smoke.

8. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the Preliminary Safety Analysis Report meet the acceptance criteria given in subsection II. For the review of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the Final Safety Analysis Report. The procedures for OL reviews include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such inputs as required to assure that this review procedure is complete.

As a result of various ARAVS designs proposed by applicants, there will be variations in system requirements. For the purpose of this SRP section, a typical system is assumed which has fully redundant subsystems, each having an identical essential (safety features) portion. For cases where there are variations from this typical arrangement, the reviewer would adjust the review procedures given below. However, the system design would be required to meet the acceptance criteria given in subsection II. The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

1. The SAR is reviewed to verify that the system description and piping and instrumentation diagrams (P&IDs) show the ARAVS equipment used for normal operation, and

the ambient temperature limits for the areas serviced. The system performance requirements are reviewed to determine that allowable component operational degradation (e.g., loss of function, damper leakage) and the procedures that will be followed to detect and correct these conditions are adequately described. The reviewer, using results from failure modes and effects analyses as appropriate, determines that the safety-related portion of the system is capable of functioning in spite of the failure of any active component.

2. The system P&IDs, layout drawings, and component descriptions and characteristics are then reviewed to determine that:

   a. Essential portions of the ARAVS are correctly identified and are isolable from non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical divisions between such portions and indicate design classification changes. System drawings are also reviewed to verify that they show the means for accomplishing isolation and the description is reviewed to identify minimum performance requirements for the isolation dampers. For the typical system, the drawings and description are reviewed to verify that two automatically operated isolation dampers in series separate non-essential portions and components from the essential portions.

   b. Essential portions of the ARAVS, including the isolation dampers separating essential from non-essential portions, are classified seismic Category I and Quality Group C. Component and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above seismic classification has been included, and that the P&IDs indicate any points of change in design classification.

3. The reviewer verifies that the essential portion of the system has been designed so that system function will be maintained as required in the event of adverse environmental phenomena or in the event of certain pipe breaks or loss of offsite power. The reviewer evaluates the system, using engineering judgment and the results of failure modes and effects analyses to determine that:

   a. The failure of non-essential portions of the system or of other systems not designed to seismic Category I standards and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the ARAVS, will not preclude operation of the essential portions of the ARAVS. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR that verify that the above conditions are met are acceptable. (CP)

   b. The essential portions of the ARAVS are protected from the effects of floods, hurricanes, tornadoes, and internally and externally generated missiles.

Flood protection and missile protection criteria are discussed and evaluated in detail under the Section 3 series of the SRP. The location and the design of the system, structures, and fan rooms (cubicles) are reviewed to determine that the degree of protection provided is adequate. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable.

c. The essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the ARAVS, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing this information are given in SRP Section 3.6.

d. Components and subsystems, necessary for preventing the release of radioactive contaminants, can function as required in the event of loss of offsite power. The system design will be acceptable if the ARAVS meets minimum system requirements as stated in the SAR assuming a failure of a single active component within the system or in the auxiliary electric power source which supplies the system. The SAR is reviewed to see that for each ARAVS component or subsystem affected by the loss of offsite power, the resulting system flow capacity will not cause the loss of preferred direction of air flow from areas of low potential radioactivity to areas of higher potential radioactivity. Statements in the SAR and the results of failure modes and effects analyses are considered in verifying that the system meets these requirements. This will be an acceptable verification of system functional reliability.

4. The descriptive information, P&IDs, ARAVS drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the system can function following design basis accidents assuming a concurrent single active failure. The reviewer evaluates the analyses presented in the SAR to assure functioning of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum system isolation or filtration requirements are met for each accident situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

The reviewer determines that sufficient information has been provided and his review supports conclusions of the following type, to be included in the staff's Safety Evaluation Report:

"The auxiliary and radwaste area ventilation system (ARAVS) includes all components and ductwork from air intake to the point of discharge where the system connects to the gaseous cleanup and treatment system or station vents. Based on the review of the applicant's proposed design criteria, design bases, and safety classification for the auxiliary and radwaste area ventilation system and the requirements for system performance to preclude an unacceptable release of contaminants to the environment during normal, abnormal, and accident conditions, the staff concludes that the design of the auxiliary and radwaste area ventilation system and auxiliary supporting systems is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 5, "Sharing of Structures, Systems and Components," and meets the guidelines contained in Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.117, "Tornado Design Classification," Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," and Branch Technical Positions ASB 3-1 and MEB 3-1 and is, therefore, acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

5. Regulatory Guide 1.29, "Seismic Design Classification."

6. Regulatory Guide 1.117, "Tornado Design Classification."

7. Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," attached to SRP Section 9.5.1.

8. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.4.4 TURBINE AREA VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Instrumentation and Control Systems Branch (ICSB)
Mechanical Engineering Branch (MEB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The ASB reviews the turbine area ventilation system (TAVS) from air intake to the point of discharge to assure conformance with the requirements of General Design Criteria 2, 4 and 5. The review includes components such as air intakes, ducts, cooling units, blowers, isolation dampers, and roof exhaust fans. The review of the TAVS includes systems contained in the turbine building and their relationship, if any, to safety-related equipment areas.

1. The ASB reviews the functional performance requirements and the methods and equipment provided for air treatment for the TAVS to determine whether the ventilation system or portions of the system have been designed or need to be designed as a safety system. In making this determination, systems provided for heating, ventilating, and air conditioning of the turbine area, designed to normal industrial standards, and those systems that provide for control and filtration of small quantities of radioactive gas leakage in the turbine area during normal plant operation, are not considered safety-related for the purpose of this SRP section. Based on this determination, any safety-related portions of the system are reviewed with respect to funtional performance requirements during adverse environmental occurrences, during normal operation, and subsequent to postulated accidents, including the loss of offsite power, to assure conformance with the requirements of General Design Criteria 2, 4 and 5. The ASB reviews the safety-related portions of the system to assure that:

   a. A single active failure cannot result in loss of the system functional performance capability.

   b. Components and piping have sufficient physical separation or barriers to protect essential portions of the system from missiles, pipe whip and fires.

c. Failures of non-seismic Category I equipment or components will not result in an unacceptable release of radioactive contaminants.

2. The ASB also reviews safety-related portions of the TAVS with respect to the following:

   a. The capability of the system to direct ventilation air from areas of low radioactivity to areas of higher radioactivity levels.

   b. The capability to detect the need for isolation and to isolate safety-related portions of the system in the event of fires, failures, or malfunctions, and the capability of the isolated system to function under these conditions.

   c. To determine that the quality group and seismic design requirements are met for the system.

3. The Effluent Treatment Systems Branch (ETSB) evaluates the TAVS's functional performance to assure that the system meets acceptable limits for radioactive releases during normal operations (see SRP Section 11.3).

4. The Radiological Assessment Branch (RAB) reviews and evaluates the capability of the TAVS to meet radiation protection criteria and the radiological monitoring systems that may be associated with the TAVS (see SRP Section 12.3).

5. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this SRP section.

Secondary reviews are performed by other branches and the results used by the ASB to complete the overall evaluation of the system. The MEB will, upon request, review the seismic qualification of components and confirm that the components, piping, and structures are designed in accordance with applicable codes and standards. The ICSB and PSB will, upon request, determine the adequacy of the design, installation, inspection, and testing of all electrical components (sensing, control and power) required for proper operation.

II. ACCEPTANCE CRITERIA

Acceptability of the TAVS design, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides. The design of safety-related portions of the TAVS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety.

4. Regulatory Guide 1.26, as related to the quality group classification of systems and components.

5. Regulatory Guide 1.29, as related to seismic design classification of systems and components.

6. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

7. Branch Technical Position ASB 9.5-1, as related to capability of the system to remove smoke.

8. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license (OL) applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The procedures for OL reviews include a determination that the proposed technical specifications are in agreement with the requirements for testing, minimum performance, and surveillance developed by the staff.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such inputs as required to assure that this review procedure is complete.

As a result of various TAVS designs proposed by applicants, there will be variations in system requirements. For the purpose of this SRP section, a typical system is assumed which has fully redundant subsystems, each having an identical essential (safety-related) portion. For cases where there are variations from this typical arrangement, the reviewer adjusts the review procedures given below. However, in such cases, the system design must still meet the acceptance criteria given in subsection II. The reviewer selects and emphasizes material from this SRP section as may be appropriate for a particular case.

1. The SAR is reviewed to verify that the system description and piping and instrumentation diagrams (P&IDs) show the TAVS equipment used for normal operation, and the ambient temperature limits for the areas serviced. The system performance requirements are reviewed to determine the allowable component operational degradation (e.g., loss of function, damper leakage) and the procedures that will be followed to detect and correct these conditions. The reviewer, using results from failure modes and effects analyses as appropriate, determines that the system is capable of sustaining the failure of any active component that is required for the prevention of unacceptable releases of radioactive contaminants to the environment.

2. The system P&IDs, layout drawings, and component descriptions and characteristics are then reviewed to determine that:

   a. Essential portions of the TAVS are correctly identified and are isolable from non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical divisions between each portion and indicate the changes in design classification. System drawings are also reviewed to verify the means provided for accomplishing isolation and to identify minimum performance requirements for the isolation dampers. For the typical system, the drawings and descriptions are reviewed to verify that two automatically operated isolation dampers in series separate non-essential portions and components from the essential portions.

   b. Essential portions of the TAVS, including the isolation dampers separating essential from non-essential portions, are classified Quality Group C and seismic Category I. Component and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above seismic classifications have been included, and that the P&IDs indicate any points of change in design classification.

3. The reviewer verifies that the safety-related portion of the system has been designed so that system function will be maintained as required, in the event of adverse environmental phenomena or in the event of certain pipe breaks or loss of offsite power. The reviewer evaluates the system, using engineering judgment and the results of failure modes and effects analyses to determine that:

   a. The failure of non-essential portions of the system or of other systems not designed to seismic Category I standards and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the TAVS, will not preclude operation of the essential portions of the TAVS. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems. A commitment in the SAR confirming that the above conditions are met is acceptable. (CP)

b. The essential portions of the TAVS are protected from the effects of floods, hurricanes, tornadoes, and internally and externally generated missiles. Seismic design, flood protection, and missile protection criteria are discussed and evaluated in detail under the Section 3 series of the SRP. The location and design of the system, structures, and fan rooms (cubicles) are reviewed to determine that the degree of protection provided is adequate. A commitment in the SAR to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles, is acceptable.

c. The essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the TAVS or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing this information are given in Section 3.6 of the SRP.

d. Components and subsystems necessary for preventing unacceptable releases of radioactive contaminants can function as required in the event of loss of offsite power. The system design will be acceptable if the TAVS meets minimum system requirements as stated in the SAR assuming a failure of a single active component, within the system itself, or in the auxiliary electric power source which supplies the system. The SAR is reviewed to see that, for each TAVS component or subsystem affected by loss of offsite power, the resulting system flow capacity will not cause the loss of direction of air flow from areas of low potential radioactivity to areas of higher potential radioactivity. Statements in the SAR and the results of failure modes and effects analyses are considered in verifying that the system meets these requirements. This will be an acceptable verification of system functional reliability.

4. The descriptive information, P&IDs, TAVS drawings, and failure modes effects analyses in the SAR are reviewed to assure that essential portions of the system can function following design basis accidents assuming a concurrent single active failure. The reviewer evaluates the analyses presented in the SAR to assure the function of required components, traces the availability of these components on

system drawings, and checks that the SAR contains verification that minimum system isolation or filtration requirements are met for each accident situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The turbine area ventilation system (TAVS) includes all components and ducting from air intake to the point of discharge. Based on the review of the applicant's proposed design criteria, the design bases and safety classification for the turbine area ventilation system and the requirements (if any) for system performance to preclude any adverse effect on safety-related functions during all conditions of plant operation, the staff concludes that the design of the turbine area ventilation system and auxiliary supporting systems is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 5, "Sharing of Structures, Systems and Components," and meets the guidelines contained in Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.117, "Tornado Design Classification," Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," and Branch Technical Positions ASB 3-1 and MEB 3-1 and is, therefore, acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

5. Regulatory Guide 1.29, "Seismic Design Classification."

6. Regulatory Guide 1.117, "Tornado Design Classification."

7. Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," attached to SRP Section 9.5.1.

8. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.4.5 ENGINEERED SAFETY FEATURE VENTILATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Instrumentation and Control Systems Branch (ICSB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Structural Engineering Branch (SEB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The function of the engineered safety feature ventilation system (ESFVS) is to provide a suitable and controlled environment for engineered safety feature components following certain anticipated transients and design basis accidents.

The ASB reviews the ESFVS from air intake to the point of discharge to the atmosphere to assure conformance with the requirements of General Design Criteria 2, 4 and 5. The review includes components such as air intakes, ducts, air conditioning units, flow control devices, isolation dampers, exhaust vents, and exhaust fans.

The review of the ESFVS covers all ventilation systems utilized to maintain a controlled environment in areas containing safety-related equipment. These include the service water pump house, diesel generator area, emergency core cooling system (ECCS) pump rooms, component cooling water pump room, auxiliary feedwater pump area, and other areas containing equipment essential for the safe shutdown of the reactor or necessary to prevent or mitigate the consequences of an accident.

1. The ASB reviews the ESFVS to determine the safety significance of the various portions and subsystems. Based on this determination, the safety-related portions of the system are reviewed with respect to functional performance requirements associated with engineered safety feature areas during normal operation, during adverse environmental occurrences, and during and subsequent to postulated accidents, including the loss of offsite power. The ASB reviews safety-related portions of the system to assure that:

   a. A single active failure cannot result in loss of the system functional performance capabilities.

b. Components and piping or ducting have sufficient physical separation or barriers to protect essential portions of the system from missiles, pipe whip and fires.

c. Failures of non-seismic Category I equipment or components will not result in damage to essential portions of the ESFVS.

2. The ASB also reviews safety-related portions of the ESFVS with respect to the following:

a. The ability of the heating and cooling systems to maintain a suitable ambient temperature range in the areas serviced, assuming proper performance of equipment contained in these areas.

b. Provisions to detect the need for isolation and to isolate portions of the system in the event of failures or malfunctions.

c. The ability of the safety features equipment in the areas being serviced by the ventilation system to function under the worst anticipated degraded ESFVS system performance.

d. Capability of the system to circulate sufficient air to prevent accumulation of inflammable or explosive gas or fuel-vapor mixtures from components such as storage batteries and stored fuel.

e. The capability of the system to automatically actuate components not operating during normal conditions, or to actuate standby components (redundant equipment) in the event of a failure or malfunction, as needed.

f. To determine that the quality group and seismic design requirements are met for the system.

3. The Accident Analysis Branch (AAB) evaluates the radiological consequences of airborne contaminants resulting from accident conditions (see Appendix B to SRP Section 15.6.5).

4. The Effluent Treatment Systems Branch (ETSB) evaluates the effectiveness of the ESFVS filters to remove airborne contaminants prior to discharge to the environment (see SRP Section 6.5.1). ETSB also reviews and evaluates the capability of the ESFVS to detect and control leakage of radioactive contamination from the system, as described in SRP Section 11.5.

5. The Radiological Assessment Branch (RAB) reviews and evaluates the radiation protection criteria of the ESFVS, as described in SRP Section 12.3.

6. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this SRP section.

Secondary reviews are performed by other branches and the results are used by the ASB to complete the overall evaluation of the system. The SEB determines the acceptability of design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB reviews the seismic qualification of components and confirms that components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB will verify that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions. The ICSB and PSB determine the adequacy of the design, installation, inspection, and testing of all electrical components (sensing, control and power) required for proper operation.

II. ACCEPTANCE CRITERIA

Acceptability of the ESFVS design, as described in the applicant's Safety Analysis Report (SAR), is based on specific general design criteria and regulatory guides.

The design of safety-related portions of the ESFVS is acceptable if the integrated design of the systems is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety.

4. Regulatory Guide 1.26, as related to the quality group classification of system components.

5. Regulatory Guide 1.29, as related to the seismic design classification of system components.

6. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

7. Branch Technical Position ASB 9.5-1, as related to capability of the system to remove smoke.

8. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The procedures for OL reviews include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such inputs as required to assure that this review procedure is complete.

As a result of various ESFVS designs proposed by applicants, there will be variations in system requirements. For the purpose of this SRP section, a typical system is assumed which has fully redundant subsystems, each having an identical essential (safety features) portion. For cases where there are variations from this typical arrangement, the reviewer would adjust the review procedures given below. However, the system design would be required to meet the acceptance criteria given in subsection II. The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

1. The SAR is reviewed to verify that the system description and piping and instrumentation diagrams (P&IDs) show the ESFVS equipment used for normal operation, and the ambient temperature limits for the areas serviced. The system performance requirements are reviewed to determine that they limit allowable component operational degradation (e.g., loss of function, damper leakage) and describe the procedures that will be followed to detect and correct these conditions. The reviewer, using results from failure modes and effects analyses as appropriate, will determine that the safety-related portion of the system is capable of sustaining the failure of any active component.

2. The system P&IDs, layout drawings, and component descriptions and characteristics are then reviewed to determine that:

   a. Essential portions of the ESFVS are correctly identified and are isolable from non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical divisions between such portions and indicate design classification changes. System drawings are also reviewed to see that they show the means for accomplishing isolation, and the system description is reviewed to identify minimum performance requirements for the isolation dampers. For the typical system, the drawings and description are reviewed to verify that two automatically operated isolation dampers in series separate non-essential portions and components from the essential portions.

   b. Essential portions of the ESFVS, including the isolation dampers separating essential from non-essential portions, are classified Quality Group C and seismic Category I. Component and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above classifications have been included, and that the P&IDs indicate points of change in design classification.

   c. Design provisions have been made that permit appropriate inservice inspection and functional testing of system components important to safety. It is acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around fans or isolation dampers that would be required by this program.

3. The reviewer verifies that the system has been designed so that system function will be maintained as required in the event of adverse environmental phenomena or in the event of certain pipe breaks or loss of offsite power. The reviewer evaluates the system, using engineering judgment and the results of failure modes and effects analyses to determine that:

   a. The failure of non-essential portions of the system or of other non-seismic systems, components or structures located close to essential portions of the system will not preclude operation of the essential portions of the ESFVS. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems.

   b. The essential portions of the ESFVS are protected from the effects of floods, hurricanes, tornadoes, and internally and externally generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under Section 3 series of the SRP. The location and the design of the system, structures, and fan rooms (cubicles) are reviewed to determine that the degree of protection provided is adequate. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable.

c. The total system has the capability to detect and control leakage of airborne contamination from the system. It is acceptable if the following conditions are met:

(1) The system P&ID shows monitors and alarms located in the system that are capable of smoke detection in the event of a fire. Provisions should be made for manual control of the ventilation system to facilitate smoke removal if necessary for fire fighting operations.

(2) The capability for isolating nonessential portions of the ESFVS by two automatically actuated isolation dampers in series is shown on the P&IDs.

(3) The ESFVS has provisions to actuate ventilation equipment in the engineered safety feature areas before ambient temperatures exceed design rated temperatures of components.

d. The essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the ESFVS or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing this information are given in SRP Section 3.6.

e. Essential components and subsystems can function as required in the event of loss of offsite power. The system design will be acceptable if the ESFVS meets minimum system requirements as stated in the SAR assuming a failure of a single active component within the system itself or in the auxiliary electric power source which supplies the system. The SAR is reviewed to see that for each ESFVS component or subsystem affected by the loss of offsite power, the resulting system performance will not affect the capability of any engineered safety feature equipment. Statements in the SAR and results of failure modes and effects analyses are considered in verifying that the system meets these requirements. This will be an acceptable verification of system functional reliability.

4. The descriptive information, P&IDs, ESFVS drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the system can function following des'gn basis accidents assuming a concurrent single active

failure. The reviewer evaluates the analyses presented in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum system isolation or filtration requirements are met for each accident situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The engineered safety feature ventilation system (ESFVS) includes all components and ducting associated with the system from air intake to the point of discharge to the atmosphere. Based on the review of the applicant's proposed design criteria, design bases, and safety classification for the engineered safety feature ventilation system, and the requirements for system performance to preclude equipment malfunction in the engineered safety feature areas due to a failure of the system during normal, abnormal, and accident conditions, the staff concludes that the design of the engineered safety feature ventilation system and supporting systems is in conformance with the Commission's regulations as set forth in General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," General Design Criterion 4, "Environmental and Missile Design Bases," General Design Criterion 5, "Sharing of Structures, Systems and Components," and meets the guidelines contained in Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Regulatory Guide 1.29, "Seismic Design Classification," Regulatory Guide 1.117, "Tornado Design Classification," Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," and Branch Technical Positions ASB 3-1 and MEB 3-1 and is, therefore, acceptable.

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

5. Regulatory Guide 1.29, "Seismic Design Classification."

6. Regulatory Guide 1.117, "Tornado Design Classification."

7. Branch Technical Position ASB 9.5-1, "Fire Protection for Nuclear Power Plants," attached to SRP Section 9.5.1.

8. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.5.1 FIRE PROTECTION PROGRAM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Instrumentation and Control Systems Branch (ICSB)
Power Systems Branch (PSB)

I. AREAS OF REVIEW

The purpose of the fire protection program (FPP) is to provide assurance, through a defense-in-depth design, that a fire will not prevent the performance of necessary safe plant shutdown functions and will not significantly increase the risk of radioactive releases to the environment in accordance with General Design Criteria 3 and 5. The fire protection program consists of fire detection and extinguishing systems and equipment, administrative controls and procedures, and trained personnel.

The ASB review of the fire protection program includes a review of the evaluation of potential fire hazards described in the applicant's Safety Analysis Report (SAR), and a review of the description of the fire protection system design showing the system characteristics and layout which define the "fire prevention" and "fire protection" portions of the program.

The ASB reviews the total fire protection program described in the applicant's Safety Analysis Report (SAR) with respect to the criteria of Branch Technical Position ASB 9.5-1 attached to this SRP section, specifically with respect to the following:

1. Overall fire protection program requirements, including the degree of involvement and assigned responsibility of management; fire protection administrative controls and quality assurance program; fire brigade training activities and coordination with offsite fire fighting organizations, including their capability in assisting in the extinguishment of plant fires.

2. Evaluation of potential fire hazards for safety-related areas throughout the plant and the effect of postulated fires relative to maintaining the ability to perform safe shutdown functions, and minimizing radioactive releases to the environment.

3. Plant layout, egress routes, facility arrangements, and structural design features which control separation or isolation of redundant safety systems and selection of the methods for fire detection, control and extinguishing; control of fire hazards; fire barriers and walls; use of noncombustible materials; floor drains, ventilation, emergency lighting and communication systems.

4. The functional performance of the fire fighting systems, extinguishing agents, including the detection, alarm, suppression, control, and extinguishing systems described in the SAR to verify the adequacy of the FPP to protect safety-related equipment.

5. The fire protection system piping and instrumentation diagrams (P&IDs); including redundancy of equipment; the FPP design criteria and failure modes and effects analysis (impairment).

6. On multiple unit applications, the additional fire protection and control provisions during construction of the remaining units will be reviewed to verify that the integrity and operability of the fire protection system is maintained.

7. Quality Assurance Branch (QAB) will evaluate the adequacy of the QA program under SRP section 17 and e organizational arrangements under SRP section 13.1.

8. Emergency Planning Branch (EPB) will evaluate the adequacy of the offsite emergency planning under SRP section 13.3.

9. Operating License Branch (OLB) will evaluate the fire protection brigade training programs under SRP section 13.2 and plant procedures under SRP section 13.5.

10. The Technical Specifications prepared by the applicant for fire protection are reviewed at the operating license stage (FSAR).

Secondary reviews are performed by other branches and the results are used by ASB to complete the overall evaluation of the fire protection program.

ICSB and PSB will review the electric power, and instrumentation and control features of the design of the FPP, with the exception of detector sensitivity and location. Review elements include power sources, provisions for safe cold shutdown, testing, and technical specifications. ICSB and PSB will evaluate the consequences of failure of the FPP on safety-related electrical equipment and cables, the adequacy of electrical cable construction and cable raceways including trays, and adequacy of safety divisional separation criteria. Review elements include the consequences of Class IE equipment exposure to fire fighting medium as well as fire effects. SEB will, upon request, verify the acceptability of the design analyses, procedures and criteria used for seismic Category I supporting structures for the FPP, and for externally imposed system loads resulting from less severe natural phenomena. MEB will, upon request, review that portion of the hose standpipe system which should remain functional following a postulated SSE, and confirm that system components, piping and structures are designed in accordance with applicable seismic design criteria.

II. ACCEPTANCE CRITERIA

The applicant's fire protection program is acceptable if it is in accordance with the following criteria:

1. General Design Criterion 3, as related to fire prevention, the design and operation of fire detection and protection systems, and administrative controls provided to protect safety-related structures, systems and components of the reactor facility.

2. General Design Criterion 5, as related to fire protection for shared safety-related structures, systems and components to assure the ability to perform their intended safety function.

3. Applicable provisions of Branch Technical Position (BTP) ASB 9.5-1 and Appendix A to Branch Technical Position ASB 9.5-1 (attached). See Implementation section of BTP ASB 9.5-1.

4. Regulatory Guide 1.78, as related to habitable areas such as the control room and the use of specific fire extinguishing agents.

5. Regulatory Guide 1.101, as related to fire protection emergency planning.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I of this SRP section. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

1. ASB reviews the SAR to determine that the appropriate level of management and trained, experienced personnel are responsible for the design and implementation of the fire protection program in accordance with BTP ASB 9.5-1.

2. ASB reviews the analysis in the SAR of the fire potential in safety-related plant areas and the hazard of fires to these areas to determine that the proposed fire protection program is able to maintain the ability to perform safe shutdown functions and to minimize radioactive releases to the environment.

3. ASB reviews the FPP P&IDs and plant layout drawings to verify that facility arrangement, buildings, and structural and compartmentation features which affect the methods used for fire protection, fire control, and control of hazards are acceptable for the protection of safety-related equipment.

4. ASB determines that design criteria and bases for the detection and suppression systems for smoke, heat and flame control are in accord with the BTP guidelines and provide adequate protection for safety-related structures, systems and components. The reviewer determines that fire protection support systems, such as emergency lighting and communication systems, floor drain systems, and ventilation and exhaust systems are designed to operate consistent with this objective. ASB reviews the results of an FPP failure modes and effect analysis (impairment) to assure that the entire fire protection system for one safety-related area cannot be impaired by a single failure.

5. For multiple unit sites, ASB determines that protection is provided to operating units during concurrent construction of other units. This includes an evaluation of the total fire protection program for each plant, the overall program for the site, including division of responsibility on fire protection matters.

6. ASB reviews the technical specifications proposed by the applicant for fire protection (OL). The reviewer will determine that the limiting conditions for operation and surveillance requirements of the technical specifications are in agreement with the requirements developed as a result of the staff's review.

IV. EVALUATION FINDINGS

"Based on our evaluation, we conclude that the proposed fire protection program design criteria and bases are in conformance with General Design Criteria 3 and 5; Regulatory Guides 1.78 and 1.101; Branch Technical Position ASB 9.5-1 (or Appendix A to BTP ASB 9.5-1 for applications dated prior to July 1, 1974), as well as applicable industry standards. The acceptance basis is the design and location of safety-related structures and systems to minimize the probability and effect of fires and explosions; use of noncombustible and heat resistant materials whenever practical; and provision of fire detection and fire fighting systems of appropriate capacity and capability to minimize adverse effects of fire on safety-related systems. We, therefore, find the proposed fire protection program acceptable."

V. <u>REFERENCES</u>

1. 10 CFR Part 50, Appendix A, General Design Criterion 3, "Fire Protection."

2. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems and Components."

3. Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release."

4. Regulatory Guide 1.101, "Emergency Planning for Nuclear Power Plants."

5. Branch Technical Position ASB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants."

6. Appendix A to Branch Technical Position ASB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants Docketed Prior to July 1, 1976."

BRANCH TECHNICAL POSITION ASB 9.5-1

GUIDELINES FOR

FIRE PROTECTION FOR NUCLEAR POWER PLANTS

TABLE OF CONTENTS

A. INTRODUCTION

General Design Criterion 3, "Fire Protection," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that structures, systems and components important to safety be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat-resistant materials are required to be used wherever practical throughout the unit, particularly in locations such as the containment and control room. Criterion 3 also requires that fire detection and suppression systems of appropriate capacity and capability be provided and designed to minimize the adverse effect of fires on structures, systems and components important to safety and that firefighting systems be designed to ensure that their failure, rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems and components.

This Branch Technical Position (BTP) presents guidelines acceptable to the NRC staff for implementing this criterion in the development of a fire protection program for nuclear power plants. The purpose of the fire protection program is to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition and to minimize radioactive releases to the environment in the event of a fire. It implements the philosophy of defense-in-depth protection against the hazards of fire and its associated effects on safety-related equipment. If designs or methods different from the guidelines recommended herein are used, they must provide equivalent fire protection. Suitable bases and justification should be provided for alternative approaches to establish acceptable implementation of General Design Criterion 3.

This BTP addresses fire protection programs for safety-related systems and equipment and for other plant areas containing fire hazards that could adversely affect safety-related systems. It does not give guidance for protecting the life or safety of the site personnel or for protection against economic or property loss. This document supplements Regulatory Guide 1.75, "Physical Independence of Electrical Systems," in determining the fire protection for redundant cable systems.

B. DISCUSSION

There have been 32 fires in operating U.S. nuclear power plants through December 1975. Of these, the fire on March 22, 1975 at Browns Ferry nuclear plant was the most severe. With approximately 250 operating reactor years of experience, one may infer a frequency on the order of one fire per ten reactor years. Thus, on the average, a nuclear power plant may experience one or more fires of varying severity during its operating life. Although WASH-1400, "Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," dated October 1975, concluded that the Browns Ferry fire did not affect the validity of the overall risk assessment, the staff concluded that cost-effective fire protection measures should be instituted to significantly decrease the frequency and severity of fires and consequently initiated the development of this BTP. In this development, the staff made use of many national standards and other publications related to fire protection. The documents discussed below were particularly useful.

A document entitled "The International Guidelines for the Fire Protection of Nuclear Power Plants" (IGL), 1974 Edition, Second Reprint, published on behalf of the National Nuclear Risks Insurance Pools and Association, provides a step-by-step approach to assessing the fire risk in a nuclear power plant and describes protective measures to be taken as a part of the fire protection of these plants. It provides useful guidance in this important area. The Nuclear Energy Liability and Property Insurance Association (NELPIA) and the Mutual Atomic Energy Reinsurance Pool (MAERP) have prepared a document entitled "Specifications for Fire Protection of New Plants," which gives general conditions and valuable criteria. A special review group organized by NRC under Dr. Stephen H. Hanauer, Technical Advisor to the Executive Director for Operations, to study the Browns Ferry fire, issued a report, NUREG-0050, "Recommendations Related to Browns Ferry Fire," in February 1976, which contains recommendations applicable to all nuclear power plants. This BTP uses the applicable information contained in these documents.

The fire protection program for a nuclear power plant presented in this BTP consists of design features, personnel, equipment and procedures that provide the defense-in-depth protection of the public health and safety. The purpose of the program is to prevent significant fires, to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition, and to minimize radioactive releases to the environment in the event of a significant fire. To meet this objective, it is essential that management participation in the program begin with early design concepts and plant layout work and continue through plant operation and that a qualified staff be responsible for engineering and design of fire protection systems that provide fire detection, annunciation, confinement and suppression for the plant. The staff should also be responsible for fire prevention activities, maintenance of fire protection systems, training, and manual firefighting activities. It is the combination of all these that provides the needed defense-in-depth protection of the public health and safety.

Some of the major conclusions that emerged from the Browns Ferry fire investigations warrant emphasis and are discussed below.

1. Defense-in-Depth

Nuclear power plants use the concept of defense-in-depth to achieve the required high degree of safety by using echelons of safety systems. This concept is also applicable to fire safety in nuclear power plants. With respect to the fire protection program, the defense-in-depth principle is aimed at achieving an adequate balance in:

a. Preventing fires from starting;

b. Detecting fires quickly, suppressing those fires that occur, putting them out quickly, and limiting their damage; and

c. Designing plant safety systems so that a fire that starts in spite of the fire prevention program and burns for a considerable time in spite of fire protection activities will not prevent essential plant safety functions from being performed.

No one of these echelons can be perfect or complete by itself. Strengthening any one can compensate in some measure for weaknesses, known or unknown, in the others.

The primary objective of the fire protection program is to minimize both the probability and consequences of postulated fires. In spite of steps taken to reduce the probability of fire, fires are expected to occur. Therefore, means are needed to detect and suppress fires with particular emphasis on providing passive and active fire protection of appropriate capability and adequate capacity for the systems necessary to achieve and maintain safe plant shutdown with or without offsite power. For other safety-related systems, the fire protection should ensure that a fire will not cause the loss of function of such systems, even though loss of redundancy within a system may occur as a result of the fire. Generally, in plant areas where the potential fire damage may jeopardize safe plant shutdown, the primary means of fire protection should consist of fire barriers and fixed automatic fire detection and suppression systems. Also, a backup manual firefighting capability should be provided throughout the plant to limit the extent of fire damage. Portable equipment consisting of hoses, nozzles, portable extinguishers, complete personnel protective equipment, and air breathing equipment should be provided for use by properly trained firefighting personnel. Access for effective manual application of fire extinguishing agents to combustibles should be provided. The adequacy of fire protection for any particular plant safety system or area should be determined by analysis of the effects of the postulated fire relative to maintaining the ability to safely shut down the plant and minimize radioactive releases to the environment in the event of a fire.

Fire protection starts with design and must be carried through all phases of construction and operation. A quality assurance (QA) program is needed to identify and rectify errors in design, construction and operation and is an essential part of defense-in-depth.

2. Use of Water on Electrical Cable Fires

Experience with major electrical cable fires shows that water will promptly extinguish such fires. Since prompt extinguishing of the fire is vital to reactor safety, fire and water damage to safety systems is reduced by the more efficient application of water from fixed systems spraying directly on the fire rather than by manual application with fire hoses. Appropriate firefighting procedures and fire training should provide the techniques, equipment and skills for the use of water in fighting electrical cable fires in nuclear plants, particularly in areas containing a high concentration of electric cables with plastic insulation.

This is not to say that fixed water systems should be installed everywhere. Equipment that may be damaged by water should be shielded or relocated away from the fire hazard and the water. Drains should be provided to remove any water used for fire suppression and extinguishment to ensure that water accumulation does not incapacitate safety-related equipment.

3. Establishment and Use of Fire Areas

Separate fire areas for each division of safety-related systems will reduce the possibility of fire-related damage to redundant safety-related equipment. Fire areas should be established to separate redundant safety divisions and isolate safety-related systems from fire hazards in nonsafety-related areas. Particular design attention to the use of separate isolated fire areas for redundant cables will help to avoid loss of redundant safety-related cables. Separate fire areas should also be employed to limit the spread of fires between components that are major fire hazards within a safety division. Where redundant systems cannot be separated by fire barriers, as in containment and the control room, it is necessary to employ other measures to prevent a fire from causing the loss of function of safety-related systems.

Within fire areas containing components of a safety-related system, special attention should be given to detecting and suppressing fires that may adversely affect the system. Measures that may be taken to reduce the effects of a postulated fire in a given fire area include limiting the amount of combustible materials, installing fire-resistant construction, providing fire stops or fire-retardant coating in cable trays, installing fire detection systems and fixed fire suppression systems, or providing other protection suitable to the installation. The fire hazard analysis will be the mechanism to determine that fire areas have been properly selected.

Suitable design of the ventilation systems can limit the consequences of a fire by preventing the spread of the products of combustion to other fire areas. It is important that means be provided to ventilate, exhaust or isolate the fire area as required and that consideration be given to the consequences of failure of ventilation systems due to fire causing loss of control for ventilating, exhausting or isolating a given fire area. The capability to ventilate, exhaust or isolate is particularly important to ensure the habitability of rooms or spaces that must be attended in an emergency. In the design, provision should be made for personnel access to and escape routes from each fire area.

4. Definitions

For the user's convenience, some of the terms related to fire protection are presented below with their definitions as used in this BTP.

Approved - tested and accepted for a specific purpose or application by a nationally recognized testing laboratory.

Automatic - self-acting, operating by its own mechanism when actuated by some impersonal influence such as a change in current, pressure, temperature or mechanical configuration.

Combustible Material - material that does not meet the definition of noncombustible.

Control Room Complex - the zone served by the control room emergency ventilation system (see SRP Section 6.4, "Habitability Systems").

Fire Area - that portion of a building or plant that is separated from other areas by boundary fire barriers.

Fire Barrier - those components of construction (walls, floors and their supports), including beams, joists, columns, penetration seals or closures, fire doors and fire dampers that are rated by approving laboratories in hours of resistance to fire and are used to prevent the spread of fire.

Fire Stop - a feature of construction that prevents fire propagation along the length of cables or prevents spreading of fire to nearby combustibles within a given fire area or fire zone.

Fire Brigade - the team of plant personnel assigned to firefighting and who are equipped for and trained in the fighting of fires.

Fire Detectors - a device designed to automatically detect the presence of fire and initiate an alarm system and other appropriate action (see NFPA 72E, "Automatic Fire Detectors"). Some typical fire detectors are classified as follows:

Heat Detector - a device that detects a predetermined (fixed) temperature or rate of temperature rise.

Smoke Detector - a device that detects the visible or invisible products of combustion.

Flame Detector - a device that detects the infrared, ultraviolet or visible radiation produced by a fire.

Line-Type Detector - a device in which detection is continuous along a path, e.g., fixed-temperature, heat-sensitive cable and rate-of-rise pneumatic tubing detectors.

Fire Protection Program - the integrated effort involving components, procedures and personnel utilized in carrying out all activities of fire protection. It includes system and facility design, fire prevention, fire detection, annunciation, confinement, suppression, administrative controls, fire brigade organization, inspection and maintenance, training, quality assurance and testing.

Fire Rating - the endurance period of a fire barrier or structure; it defines the period of resistance to a standard fire exposure before the first critical point in behavior is observed (see NFPA 251).

Fire Suppression - control and extinguishing of fires (firefighting). Manual fire suppression is the use of hoses, portable extinguishers, or manually-actuated fixed systems by plant personnel. Automatic fire suppression is the use of automatically actuated fixed systems such as water, Halon or carbon dioxide systems.

Fire Zones - the subdivisions of fire areas in which the fire suppression systems are designed to combat particular types of fires.

Noncombustible Material

a. Material, no part of which will ignite and burn when subjected to fire.

b. Material having a structural base of noncombustible material, as defined in a., above, with a surfacing not over 1/16-inch thick that has a flame spread rating not higher than 50 when measured using ASTM E-84 Test "Surface Burning Characteristics of Building Materials "

Raceway - refer to Regulatory Guide 1.75.

Restricted Area - any area to which access is controlled by the licensee for purposes of protecting individuals from exposure to radiation and radioactive materials.

Safety-Related Systems and Components - systems and components required to shut down the reactor, mitigate the consequences of postulated accidents, or maintain the reactor in a safe shutdown condition.

Secondary Containment - a structure that completely encloses primary containment, used for controlling containment leakage.

Sprinkler System - a network of piping connected to a reliable water supply that will distribute the water throughout the area protected and will discharge the water through sprinklers in sufficient quantity either to extinguish the fire entirely or to prevent its spread. The system, usually activated by heat, includes a controlling valve and a device for actuating an alarm when the system is in operation. The following categories of sprinkler systems are defined in NFPA 13, "Standard for the Installation of Sprinkler Systems":

- Wet-Pipe System
- Dry-Pipe System
- Preaction System
- Deluge System
- Combined Dry-Pipe and Preaction System
- On-Off System

Standpipe and Hose Systems - a fixed piping system with hose outlets, hose and nozzles connected to a reliable water supply to provide effective fire hose streams to specific areas inside the building.

Water Spray System - a network of piping similar to a sprinkler system except that it utilizes open-head spray nozzles. NFPA 15, "Water Spray Fixed Systems," provides guidance on these systems.

C. POSITION

1. Overall Requirements of the Fire Protection Program

a. Personnel

Responsibility for the overall fire protection program should be assigned to a designated person in the upper level of management who has management control over the organizations involved in fire protection activities. This person should retain ultimate responsibility even though formulation and assurance of program implementation is delegated. Such delegation of authority should be to a staff composed of personnel prepared by training and experience in fire protection and personnel prepared by training and experience in nuclear plant safety to provide a balanced approach in directing the fire protection program for the nuclear power plant.

The staff should be responsible for:

(1) Coordination of fire protection program requirements, including consideration of potential hazards associated with postulated fires, with building layout and systems design.

(2) Design and maintenance of fire detection, suppression and extinguishing systems.

(3) Fire prevention activities.

(4) Training and manual firefighting activities of plant personnel and the fire brigade.

(5) Prefire planning.

On sites where there is an operating reactor and construction or modification of other units is underway, the superintendent of the operating plant should have the lead responsibility for site fire protection.

(NOTE: NFPA 6, "Recommendations for Organization of Industrial Fire Loss Prevention," contains useful guidance for the organization and operation of the entire fire loss prevention program.)

b. Fire Hazard Analysis

The overall fire protection program should allow the plant to maintain the ability to perform safe shutdown functions and minimize radioactive releases to the environment in the event of a fire. A major element of this program should be the evaluation of potential fire hazards throughout the plant and the effect of postulated fires on safety-related plant areas.

Fire initiation should be postulated at the location that will produce the most severe fire, assuming an ignition source is present at that point. Fire development should consider the potential for involvement of other combustibles, both fixed and transient, in the fire area. Where automatic suppression systems are installed, the effects of the postulated fire should be evaluated with and without actuation of the automatic suppression system.

(1) A detailed fire hazard analysis should be made during initial plant design to reflect the proposed construction arrangement, materials and facilities. This analysis should be revised periodically as design and construction progress and before and during major plant modifications.

(2) The fire hazard analysis should be a systematic study of (a) all elements of the fire protection program being proposed to ensure that the plant design has included adequate identification and evaluation of potential fire hazards, and (b) the effect of postulated fires relative to maintaining the ability to perform safe shutdown functions and minimizing radioactive releases to the environment.

(3) Experienced judgment is necessary to identify fire hazards and the consequences of a postulated fire starting at any point in the plant. Evaluation of the consequences of the postulated fire on nuclear safety should be performed by persons thoroughly trained and experienced in reactor safety. The person conducting the analysis of fire hazards should be thoroughly trained and experienced in the principles of industrial fire prevention and control and in fire phenomena from fire initiation, through its development, to propagation into adjoining spaces. The fire hazard analysis should be conducted by or under the direct supervision of an engineer who is qualified for Member grade in the Society of Fire Protection Engineers.

(4) The fire hazard analysis should separately identify hazards and provide appropriate protection in locations where safety-related losses can occur as a result of:

(a) Concentrations of combustible contents, including transient fire loads due to combustibles expected to be used in normal operations such as refueling, maintenance and modifications;

(b) Continuity of combustible contents, furnishings, building materials, or combinations thereof in configurations conducive to fire spread;

(c) Exposure fire, heat, smoke or water exposure, including those that may necessitate evacuation from areas that are required to be attended for safe shutdown;

(d) Fire in control rooms or other locations having critical safety-related functions;

(e) Lack of adequate access or smoke removal facilities that impede fire extinguishment in safety-related areas;

(f) Lack of explosion-prevention measures;

(g) Loss of electric power or control circuits; and

(h) Inadvertent operation of fire suppression systems.

(5) The fire hazard analysis should verify that the fire protection program guidelines of this BTP have been met. To that end, the report on the analysis should list

applicable elements of the program, with explanatory statements as needed to identify location, type of system, and design criteria. The report should identify any deviations from the regulatory position and should present alternatives for staff review. Justification for deviations from the regulatory position should show that an equivalent level of protection will be achieved. Deletion of a protective feature without compensating alternative protective measures generally will not be acceptable, unless it is clearly demonstrated that the protective measure is not needed because of the design and arrangement of the particular plant.

c. Fire Suppression System Design Basis

(1) Total reliance should not be placed on a single fire suppression system. Appropriate backup fire suppression capability should be provided.

(2) A single active failure or a crack in a moderate-energy line (pipe) in the fire suppression system should not impair both the primary and backup fire suppression capability. For example, neither the failure of a fire pump, its power supply or controls, nor a crack in a moderate-energy line in the fire suppression system, should result in loss of function of both sprinkler and hose standpipe systems in an area protected by such primary and backup systems.

(3) As a minimum, the fire suppression system should be capable of delivering water to manual hose stations located within hose reach of areas containing equipment required for safe plant shutdown following the safe shutdown earthquake (SSE). In areas of high seismic activity, the staff will consider on a case-by-case basis the need to design the fire detection and suppression systems to be functional following the SSE.

(4) The fire protection systems should retain their original design capability for (a) natural phenomena of less severity and greater frequency than the most severe natural phenomena (approximately once in 10 years) such as tornadoes, hurricanes, floods, ice storms, or small-intensity earthquakes that are characteristic of the geographic region, and (b) potential man-created site-related events such as oil barge collisions or aircraft crashes that have a reasonable probability of occurring at a specific plant site. The effects of lightning strikes should be included in the overall plant fire protection program.

(5) The consequences of inadvertent operation of or a crack in a moderate energy line in the fire suppression system should meet the guidelines specified for moderate-energy systems outside containment in SRP Section 3.6.1.

d. Simultaneous Events

(1) Fires need not be postulated to be concurrent with nonfire-related failures in safety systems, other plant accidents, or the most severe natural phenomena.

(2) On multiple-reactor sites, unrelated fires need not be postulated to occur simultaneously in more than one reactor unit. The effects of fires involving facilities shared between units and fires due to man-created site-related events that have a reasonable probability of occurring and affecting more than one reactor unit (such as an aircraft crash) should be considered.

e. Implementation of Fire Protection Programs

(1) The fire protection program (plans, personnel and equipment) for buildings storing new reactor fuel and for adjacent fire areas that could affect the fuel storage area should be fully operational before fuel is received at the site. Such adjacent areas include those whose flames, hot gases, and fire-generated toxic and corrosive products may jeopardize safety and surveillance of the stored fuel.

(2) The fire protection program for an entire reactor unit should be fully operational prior to initial fuel loading in that reactor unit.

(3) On reactor sites where there is an operating reactor and construction or modification of other units is under way, the fire protection program should provide for continuing evaluation of fire hazards. Additional fire barriers, fire protection capability, and administrative controls should be provided as necessary to protect the operating unit from construction fire hazards.

2. Administrative Procedures, Controls and Fire Brigade

a. Administrative procedures consistent with the need for maintaining the performance of the fire protection system and personnel in nuclear power plants should be provided.

Guidance is contained in the following publications:

NFPA 4 - Organization for Fire Services
NFPA 4A - Organization of a Fire Department
NFPA 6 - Industrial Fire Loss Prevention
NFPA 7 - Management of Fire Emergencies
NFPA 8 - Management Responsibility for Effects of Fire on Operations
NFPA 27 - Private Fire Brigades
NFPA 802 - Recommended Fire Protection Practice for Nuclear Reactors

b. Effective administrative measures should be implemented to prohibit bulk storage of combustible materials inside or adjacent to safety-related buildings or systems during operation or maintenance periods. Regulatory Guide 1.39 provides guidance on housekeeping, including the disposal of combustible materials.

c. Normal and abnormal conditions or other anticipated operations such as modifications (e.g., breaching fire barriers or fire stops, impairment of fire detection and suppression systems) and transient fire load conditions such as those associated with refueling activities should be reviewed by appropriate levels of management and the fire protection staff. Appropriate special action and procedures such as fire watches or temporary fire barriers should be implemented to ensure adequate fire protection and reactor safety. In particular:

(1) Work involving ignition sources such as welding and flame cutting should be done under closely monitored conditions that are controlled by a permit system. Procedures governing such work should be reviewed and approved by persons trained and experienced in fire protection. Persons performing and directly assisting in such work should be trained and equipped to prevent and combat fires. If this is not possible, a person trained in firefighting techniques and plant emergency procedures should directly monitor the work and function as a fire watch. In instances where such operations may produce flame, sparks or molten metal through walls or penetrations, care should be taken to inspect both rooms or areas (see NFPA-51B, "Cutting and Welding Processes").

(2) Leak testing and similar procedures such as airflow determination should use one of the commercially available techniques. Open flames or combustion-generated smoke should not be permitted.

(3) Use of combustible material, e.g., HEPA and charcoal filters, dry ion-exchange resins, or other combustible supplies, in safety-related areas should be controlled. Use of wood inside buildings containing safety-related systems or equipment should be permitted only when suitable noncombustible substitutes are not available. If wood must be used, only fire-retardant treated wood (scaffolding, lay-down blocks) should be permitted. Such materials should be allowed into safety-related areas only when they are to be used immediately. Their possible and probable use should be considered in the fire hazard analysis to determine the adequacy of the installed fire protection systems and the effects on safety-related equipment.

(4) Disarming of fire detection or fire suppression systems should be controlled by a permit system. Fire watches should be established in areas where systems are so disarmed.

d. The plant should be designed to be self-sufficient with respect to firefighting activities to protect safety-related plant areas. Public fire department response should be provided for in the overall fire protection program for supplemental and backup capability.

e. The need for good organization, training, and equipping of fire brigades at nuclear power plant sites requires that effective measures be implemented to ensure proper discharge of these functions. The guidance in Regulatory Guide 1.101, "Emergency Planning for Nuclear Power Plants," should be followed as applicable.

(1) Successful firefighting requires testing and maintenance of the fire protection equipment and the emergency lighting and communication, as well as practice as brigades for the people who must utilize the equipment. A test plan that lists the individuals and their responsibilities in connection with routine tests and inspections of the fire detection and protection systems should be developed. The test plan should contain the types, frequency and detailed procedures for testing. Procedures should also contain instructions on maintaining fire protection during those periods when the fire protection system is impaired or during periods of plant maintenance, e.g., fire watches or temporary hose connections to water systems.

(2) Basic training is a necessary element in effective firefighting operation. In order for a fire brigade to operate effectively, it must operate as a team. All members must know what their individual duties are. They must be familiar with the layout of the plant and with equipment location and operation in order to permit effective firefighting operations during times when a particular area is filled with smoke or is insufficiently lighted. Such training can only be accomplished by conducting drills and classroom instruction several times a year (at least quarterly) so that all members of the fire brigade have had the opportunity to train as a team testing itself in the major areas of the plant. The drills should include the simulated use of equipment in each area and should be preplanned and postcritiqued to establish the training objective of the drills and determine how well these objectives have been met. These drills should provide for local fire department participation periodically (at least annually). Such drills also permit supervising personnel to evaluate the effectiveness of communications within the fire brigade and with the on-scene fire team leader, the reactor operator in the control room, the plant physical security organization, and any other command post.

(3) To have proper coverage during all phases of operation, members of each shift crew should be trained in fire protection. Training of the plant fire brigade should be coordinated with the local fire department so that responsibilities and duties are delineated in advance. This coordination should be part of the training course and should be included in the training of the local fire department staff. The plant fire brigade should not include any of the plant physical security personnel required to be available to fulfill the response requirements of paragraph 73.55(h)(2) of 10 CFR Part 73, "Physical Protection of Plants and Materials." Local fire departments should be provided training in operational precautions when fighting fires on nuclear power plant sites and should be made aware of the need for radiological protection of personnel and the special hazards associated with a nuclear power plant site.

(4) NFPA 27, "Private Fire Brigade," should be followed in organization, training and fire drills. This standard also is applicable for the inspection and maintenance of

firefighting equipment. Among the standards referenced in this document, NFPA 197, "Training Standard on Initial Fire Attacks," should be utilized as applicable. NFPA booklets and pamphlets listed in NFPA 27 may be used as applicable for training references. In addition, courses in fire prevention and fire suppression that are recognized or sponsored by the fire protection industry should be utilized.

3. Quality Assurance Program

The quality assurance (QA) programs of applicants and contractors should ensure that the guidelines for design, procurement, installation and testing and the administrative controls for the fire protection systems for safety-related areas are satisfied. The QA program should be under the management control of the QA organization. This control consists of (1) formulating a fire protection QA program that incorporates suitable requirements and is acceptable to the management responsible for fire protection or verifying that the program incorporates suitable requirements and is acceptable to the management responsible for fire protection, and (2) verifying the effectiveness of the QA program for fire protection through review, surveillance and audits. Performance of other QA program functions for meeting the fire protection program requirements may be performed by personnel outside of the QA organization. The QA program for fire protection should be part of the overall plant QA program. It should satisfy the specific criteria listed below.

a. Design and Procurement Document Control

Measures should be established to ensure that the guidelines of the regulatory position of this guide are included in design and procurement documents and that deviations therefrom are controlled.

b. Instructions, Procedures and Drawings

Inspections, tests, administrative controls, fire drills, and training that govern the fire protection program should be prescribed by documented instructions, procedures or drawings and should be accomplished in accordance with these documents.

c. Control of Purchased Material, Equipment and Services

Measures should be established to ensure that purchased material, equipment and services conform to the procurement documents.

d. Inspection

A program for independent inspection of activities affecting fire protection should be established and executed by or for the organization performing the activity to verify conformance with documented installation drawings and test procedures for accomplishing the activities.

e. Test and Test Control

A test program should be established and implemented to ensure that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. The tests should be performed in accordance with written test procedures; test results should be properly evaluated and acted on.

f. Inspection, Test and Operating Status

Measures should be established to provide for the identification of items that have satisfactorily passed required tests and inspections.

g. Nonconforming Items

Measures should be established to control items that do not conform to specified requirements to prevent inadvertent use or installation.

h. Corrective Action

Measures should be established to ensure that conditions adverse to fire protection, such as failures, malfunctions, deficiencies, deviations, defective components, uncontrolled combustible material and nonconformances, are promptly identified, reported, and corrected.

i. Records

Records should be prepared and maintained to furnish evidence that the criteria enumerated above are being met for activities affecting the fire protection program.

j. Audits

Audits should be conducted and documented to verify compliance with the fire protection program, including design and procurement documents, instructions, procedures and drawings, and inspection and test activities.

4. General Plant Guidelines

a. Building Design

(1) Fire barriers with a minimum fire resistance rating of three hours should be used, except as noted in other paragraphs, to:

(a) Isolate safety-related systems from any potential fires in nonsafety-related areas that could affect their ability to perform their safety function;

(b) Separate redundant divisions or trains of safety-related systems from each other so that both are not subject to damage from a single fire hazard; and

(c) Separate individual units on a multiple-unit site unless the requirements of General Design Criterion 5 can be met with respect to fires.

(2) Appropriate fire barriers should be provided within a single safety division to separate components that present a fire hazard to other safety-related components or high concentrations of safety-related cables within that division.

(3) Each cable spreading room should contain only one redundant safety division. Cable spreading rooms should not be shared between reactors. Cable spreading rooms should be separated from each other and from other areas of the plant by barriers having a minimum fire resistance of three hours.

(4) Interior wall and structural components, thermal insulation materials, radiation shielding materials, and soundproofing should be noncombustible. Interior finishes should be noncombustible or listed by a nationally recognized testing laboratory such as Factory Mutual or Underwriters Laboratory, Inc., for:

(a) Surface flamespread rating of 50 or less when tested under ASTM E-84, and

(b) Potential heat release of 3500 Btu/lb or less when tested under ASTM D-3286 or NFPA 259.[1]

Materials that are acceptable for use as interior finish without evidence of test and listing by a nationally recognized laboratory are the following:

- Plaster, acoustic plaster
- Gypsum plasterboard (gypsum wallboard)
- Any of the above, plain, wallpapered, or painted with oil- or water-base paint
- Ceramic tile, ceramic panels

[1]The concept of using a potential heat release limit of 3500 Btu/lb is similar to the "limited combustible" concept with its like limit, as set forth in NFPA 220.

- Glass, glass blocks

- Brick, stone, concrete blocks, plain or painted

- Steel and aluminum panels, plain, painted, or enameled

- Vinyl tile, vinyl-asbestos tile, linoleum, or asphalt tile on concrete floors.

(5) Metal deck roof construction should be noncombustible, listed as "acceptable for fire" in the UL Building Materials Directory, or listed as Class I in the Factory Mutual System Approval Guide.

(6) Suspended ceilings and their supports should be of noncombustible construction. Concealed spaces should be devoid of combustibles except as noted in Position C.6.b.

(7) Transformers installed inside fire areas containing safety-related systems should be of the dry type or insulated and cooled with noncombustible liquid. Where transformers filled with combustible fluid are located in nonsafety-related areas, there should be no openings in the fire barriers separating such transformers from areas containing safety-related systems or equipment.

(8) Buildings containing safety-related systems should be protected from exposure or spill fires involving outdoor oil-filled transformers by providing oil spill confinement or drainage away from the buildings and:

- Locating such transformers at least 50 feet distant from the building, or

- Ensuring that such building walls within 50 feet of oil-filled transformers are without openings and have a fire resistance rating of at least three hours.

(9) Floor drains sized to remove expected firefighting waterflow without flooding safety-related equipment should be provided in those areas where fixed water fire suppression systems are installed. Floor drains should also be provided in other areas where hand hose lines may be used if such firefighting water could cause unacceptable damage to safety-related equipment in the area (see NFPA-92, "Waterproofing and Draining of Floors"). Where gas suppression systems are installed, the drains should be provided with adequate seals or the gas suppression system should be sized to compensate for the loss of the suppression agent through the drains. Drains in areas containing combustible liquids should have provisions for preventing the spread of the fire throughout the drain system. Water drainage

from areas that may contain radioactivity should be collected, sampled and analyzed before discharge to the environment.

(10) Floors, walls and ceilings separating fire areas should have a minimum fire rating of three hours. Openings through fire barriers around conduit or piping should be sealed or closed to provide a fire resistance rating at least equal to that required of the barrier itself. Door openings should be protected with equivalently rated doors, frames and hardware that have been tested and approved by a nationally recognized laboratory. Such doors should be normally closed and delay-alarmed with alarm and annunciation in the control room, locked closed, or equipped with automatic self-closing devices using magnetic hold-open devices that are activated by smoke or rate-of-rise heat detectors protecting both sides of the opening. The status of doors equipped with magnetic hold-open devices should be indicated in the control room. Fire barrier openings for ventilation systems should be protected by a "fire door damper" having a rating equivalent to that required of the barrier (see NFPA-80, "Fire Doors and Windows"). Flexible air duct coupling in ventilation and filter systems should be noncombustible.

(11) Personnel access routes and escape routes should be provided for each fire area. Stairwells outside primary containment serving as escape routes, access routes for firefighting, or access routes to areas containing equipment necessary for safe shutdown should be enclosed in masonry or concrete towers with a minimum fire rating of two hours and self-closing Class B fire doors.

(12) Fire exit routes should be clearly marked.

b. Control of Combustibles

(1) Safety-related systems should be isolated or separated from combustible materials. When this is not possible because of the nature of the safety system or the combustible material, automatic fire suppression should be provided to limit the consequences of a fire.

(2) Use and storage of compressed gases (especially oxygen and flammable gases) inside buildings housing safety-related equipment should be controlled. Bulk storage of flammable gas should not be permitted inside structures housing safety-related equipment and should be sufficiently remote that a fire or explosion will not adversely affect any safety-related systems or equipment (see NFPA 6, "Industrial Fire Loss Prevention").

(3) It is recognized that halogenated compounds are used to improve the fire retardancy of cable insulation; insulating and jacketing materials should be chosen to have a high flame resistance and low smoke and offgas characteristics without degrading the required electrical and physical properties. However, plastic materials should not be used for other applications unless suitable noncombustible materials are not available.

(4) Storage and usage of flammable liquids should, as a minimum, comply with the requirements of NFPA 30, "Flammable and Combustible Liquids Code."

c. Electrical Cable Construction, Cable Trays and Cable Penetrations

(1) Only metal should be used for cable trays. Only metallic tubing should be used for conduit. Thin-wall metallic tubing should not be used. Flexible metallic tubing should only be used in short lengths to connect to equipment. Other raceways should be made of noncombustible material.

(2) Redundant safety-related cable systems outside the cable spreading room should be separated from each other and from potential fire exposure hazards in nonsafety-related areas by fire barriers with a minimum fire rating of three hours. These cable trays should be provided with continuous line-type heat detectors and should be accessible for manual firefighting. Cables should be designed to allow wetting down with fire suppression water without electrical faulting. Manual hose stations and portable hand extinguishers should be provided. Safety-related equipment in the vicinity of such cable trays that does not itself require fixed water suppression systems but is subject to unacceptable damage from water should be protected.

Safety-related cable trays of a single division that are separated from redundant divisions by a fire barrier with a minimum rating of three hours and are normally accessible for manual firefighting should be protected from the effects of a potential exposure fire by providing automatic water suppression in the area where such a fire could occur. Automatic area protection, where provided, should consider cable tray arrangements and possible transient combustibles to ensure adequate water coverage for areas that could present an exposure hazard to the cable system. Manual hose standpipe systems may be relied upon to provide the primary fire suppression (in lieu of automatic water suppression systems) for safety-related cable trays of a single division that are separated from redundant safety divisions by a fire barrier with a minimum rating of three hours and are normally accessible for manual firefighting if all of the following conditions are met:

(a) The number of equivalent[2] standard 24-inch-wide cable trays (both safety-related and nonsafety-related) in a given fire area is six or less;

(b) The cabling does not provide instrumentation, control or power to systems required to achieve and maintain cold shutdown; and

(c) Smoke detectors are provided in the area of these cable routings, and continuous line-type heat detectors are provided in the cable trays.

[2]Trays exceeding 24 inches should be counted as two trays; trays exceeding 48 inches should be counted as three trays, regardless of tray fill.

Safety-related cable trays that are not accessible for manual fighting should be protected by a zoned automatic water system with open-head deluge or open directional spray nozzles arranged so that adequate water coverage is provided for each cable tray. Such cable trays should also be protected from the effects of a potential exposure fire by providing automatic water suppression in the area where such a fire could occur.

In such plant areas as primary and secondary containment or other areas where it may not be possible because of other overriding design features necessary for reasons of nuclear safety to separate redundant safety-related cable systems by three-hour-rated fire barriers, cable trays should be protected by an automatic water system with open-head deluge or open directional spray nozzles arranged so that adequate water coverage is provided for each cable tray. Such cable trays should also be protected from the effects of a potential exposure fire by providing automatic water suppression in the area where such a fire could occur. The capability to achieve and maintain safe shutdown considering the effects of a fire involving fixed and potential transient combustibles should be evaluated with and without actuation of the automatic suppression system and should be justified on a suitably defined basis.

(3) Cable and cable tray penetration of fire barriers (vertical and horizontal) should be sealed to give protection at least equivalent to that required of the fire barrier. The design of fire barrier penetrations for horizontal and vertical cable trays should be qualified by tests.[3] The penetration qualification tests should use the time-temperature exposure curve specified by ASTM E-119, "Fire Test of Building Construction and Materials." Openings inside conduit larger than four inches in diameter should be sealed at the fire barrier penetration; these seals should be qualified by tests as described above. Openings inside conduit four inches or less in diameter should be sealed at the fire barrier and should be qualified by tests as described above unless the conduit extends at least five feet on each side of the fire barrier and is sealed either at both ends or at the fire barrier with noncombustible material to prevent the passage of smoke and hot gases. Fire barrier penetrations that must maintain environmental isolation or pressure differentials should be qualified by test to maintain the barrier integrity under the conditions specified above.

(4) Fire stops should be installed every 20 feet along horizontal cable routings in areas that are not protected by automatic water systems. Vertical cable routings should have fire stops installed at each floor/ceiling level. Between levels or in vertical cable chases, fire stops should be installed at the midheight if the vertical run is 20 feet or more but less than 30 feet or at 15-foot intervals in vertical runs of 30 feet or more unless such vertical cable routings are protected by automatic water systems directed on the cable trays. Individual fire stop designs should prevent the propagation of a fire for

[3]Penetration qualification test criteria are under development. Guidance is currently available in the form of a draft standard, "Standard for Cable Penetration Fire Stop Test Procedure," being developed by Task Force 12-40 of the IEEE Insulated Conductors Committee.

a minimum period of thirty minutes when tested for the largest number of cable routings and maximum cable density.

(5) Electric cable constructions should, as a minimum, pass the flame test in the current IEEE Std 383. (This does not imply that cables passing this test will not require fire protection.)

(6) Cable raceways should be used only for cables.

(7) Miscellaneous storage and piping for flammable or combustible liquids or gases should not create a potential exposure hazard to safety-related systems.

d. Ventilation

(1) The products of combustion and the means by which they will be removed from each fire area should be established during the initial stages of plant design. Consideration should be given to the installation of automatic suppression systems as a means of limiting smoke and end heat generation. Smoke and corrosive gases should generally be discharged directly outside to an area that will not affect safety-related plant areas. The normal plant ventilation system may be used for this purpose if capable and available. To facilitate manual firefighting, separate smoke and heat vents should be provided in specific areas such as cable spreading rooms, diesel fuel oil storage areas, switchgear rooms, and other areas where the potential exists for heavy smoke conditions (see NFPA 204 for additional guidance on smoke control).

(2) Release of smoke and gases containing radioactive materials to the environment should be monitored in accordance with emergency plans as described in the guidelines of Regulatory Guide 1.101, "Emergency Planning for Nuclear Power Plants." Any ventilation system designed to exhaust potentially radioactive smoke or gases should be evaluated to ensure that inadvertent operation or single failures will not violate the radiologically controlled areas of the plant design. This requirement includes containment functions for protecting the public and maintaining habitability for operations personnel.

(3) Special protection for ventilation power and control cables may be required. The power supply and controls for mechanical ventilation systems should be run outside the fire area served by the system where practical.

(4) Engineered safety feature filters should be protected in accordance with the guidelines of Regulatory Guide 1.52. Any filter that includes combustible materials and is a potential exposure fire hazard that may affect safety-related components should be protected as determined by the fire hazard analysis.

(5) The fresn air supply intakes to areas containing safety-related equipment or systems should be located remote from the exhaust air outlets and smoke vents of other fire

areas to minimize the possibility of contaminating the intake air with the products of combustion.

(6) Stairwells should be designed to minimize smoke infiltration during a fire.

(7) Self-contained breathing apparatus using full-face positive-pressure masks approved by NIOSH (National Institute for Occupational Safety and Health--approval formerly given by the U.S. Bureau of Mines) should be provided for fire brigade, damage control, and control room personnel. Control room personnel may be furnished breathing air by a manifold system piped from a storage reservoir if practical. Service or rated operating life should be a minimum of one-half hour for the self-contained units.

At least two extra air bottles should be located on site for each self-contained breathing unit. In addition, an onsite six-hour supply of reserve air should be provided and arranged to permit quick and complete replenishment of exhausted supply air bottles as they are returned. If compressors are used as a source of breathing air, only units approved for breathing air should be used; compressors should be operable assuming a loss of offsite power. Special care must be taken to locate the compressor in areas free of dust and contaminants.

(8) Where total flooding gas extinguishing systems are used, area intake and exhaust ventilation dampers should be controlled in accordance with NFPA 12, "Carbon Dioxide Systems," and NFPA 12A, "Halon 1301 Systems, to maintain the necessary gas concentration.

e. Lighting and Communication

Lighting and two-way voice communication are vital to safe shutdown and emergency response in the event of fire. Suitable fixed and portable emergency lighting and communication devices should be provided as follows:

(1) Fixed self-contained lighting consisting of fluorescent or sealed-beam units with individual eight-hour minimum battery power supplies should be provided in areas that must be manned for safe shutdown and for access and egress routes to and from all fire areas. Safe shutdown areas include those required to be manned if the control room must be evacuated.

(2) Suitable sealed-beam battery-powered portable hand lights should be provided for emergency use by the fire brigade and other operations personnel required to achieve safe plant shutdown.

(3) Fixed emergency communications independent of the normal plant communication system should be installed at preselected stations.

(4) A portable radio communications system should be provided for use by the fire brigade and other operations personnel required to achieve safe plant shutdown. This system should not interfere with the communications capabilities of the plant security force. Fixed repeaters installed to permit use of portable radio communication units should be protected from exposure fire damage. Preoperational and periodic testing should demonstrate that the frequencies used for portable radio communication will not affect the actuation of protective relays.

5. Fire Detection and Suppression

a. Fire Detection

(1) Area fire detection systems should be provided for all areas that contain, or present potential fire exposure to, safety-related equipment.

(2) Fire detection systems should, as a minimum, comply with the requirements of Class A systems as defined in NFPA 72D, "Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems," and Class I circuits as defined in NFPA 70, "National Electrical Code."

(3) Fire detectors should, as a minimum, be selected and installed in accordance with NFPA 72E, "Automatic Fire Detectors." Preoperational and periodic testing of pulsed line-type heat detectors should demonstrate that the frequencies used will not affect the actuation of protective relays.

(4) Fire detection systems should give audible and visual alarm and annunciation in the control room. Where zoned detection systems are used in a given fire area, local means should be provided to identify which detector zone has actuated. Local audible alarms should sound in the fire area.

(5) Fire alarms should be distinctive and unique so they will not be confused with any other plant system alarms.

(6) Primary and secondary power supplies should be provided for the fire detection system and for electrically operated control valves for automatic suppression systems. Such primary and secondary power supplies should satisfy provisions of Section 2220 of NFPA 72D. This can be accomplished by:

(a) Using normal offsite power as the primary supply with a four-hour battery supply as secondary supply; and

(b) Having capability for manual connection to the Class 1E emergency power bus within four hours of loss of offsite power. Such connection should follow the applicable guidelines in Regulatory Guides 1.6, 1.32 and 1.75.

b. Fire Protection Water Supply Systems

(1) An underground yard fire main loop should be installed to furnish anticipated water requirements. NFPA 24, "Standard for Outside Protection," gives necessary guidance for such installation. It references other design codes and standards developed by such organizations as the American National Standards Institute (ANSI) and the American Water Works Association (AWWA). Type of pipe and water treatment should be design considerations with tuberculation as one of the parameters. Means for inspecting and flushing the systems should be provided. Approved visually indicating sectional control valves such as post indicator valves should be provided to isolate portions of the main for maintenance or repair without shutting off the supply to primary and backup fire suppression systems serving areas that contain or expose safety-related equipment.

The fire main system piping should be separate from service or sanitary water system piping, except as described in Position C.5.c.(4).

(2) A common yard fire main loop may serve multiunit nuclear power plant sites if cross-connected between units. Sectional control valves should permit maintaining independence of the individual loop around each unit. For such installations, common water supplies may also be utilized. For multiple-reactor sites with widely separated plants (approaching 1 mile or more), separate yard fire main loops should be used.

(3) If pumps are required to meet system pressure or flow requirements, a sufficient number of pumps should be provided to ensure that 100% capacity will be available assuming failure of the largest pump or loss of offsite power (e.g., three 50% pumps or two 100% pumps). This can be accomplished, for example, by providing either:

(a) Electric motor-driven fire pump(s) and diesel-driven fire pump(s); or

(b) Two or more seismic Category I Class IE electric motor-driven fire pumps connected to redundant Class IE emergency power buses (see Regulatory Guides 1.6, 1.32 and 1.75).

Individual fire pump connections to the yard fire main loop should be separated with sectionalizing valves between connections. Each pump and its driver and controls should be located in a room separated from the remaining fire pumps by a fire wall with a minimum rating of three hours. The fuel for the diesel fire pump(s) should be separated so that it does not provide a fire source exposing safety-related equipment. Alarms indicating pump running, driver availability, failure to start, and low fire-main pressure should be provided in the control room.

Details of the fire pump installation should, as a minimum, conform to NFPA 20, "Standard for the Installation of Centrifugal Fire Pumps."

(4) Two separate, reliable freshwater supplies should be provided. Saltwater or brackish water should not be used unless all freshwater supplies have been exhausted. If tanks are used, two 100% (minimum of 300,000 gallons each) system capacity tanks should be installed. They should be so interconnected that pumps can take suction from either or both. However, a leak in one tank or its piping should be isolable so that it will not cause both tanks to drain. Water supply capacity should be capable of refilling either tank in eight hours or less.

Common tanks are permitted for fire and sanitary or service water storage. When this is done, however, minimum fire water storage requirements should be dedicated by passive means, for example, use of a vertical standpipe for other water services.

(5) The fire water supply should be calculated on the basis of the largest expected flow rate for a period of two hours, but not less than 300,000 gallons. This flow rate should be based (conservatively) on 750 gpm for manual hose streams plus the largest design demand of any sprinkler or deluge system as determined in accordance with NFPA 13 or NFPA 15. The fire water supply should be capable of delivering this design demand over the longest route of the water supply system.

(6) Freshwater lakes or ponds of sufficient size may qualify as sole source of water for fire protection but require at least two intakes to the pump supply. One hundred percent capacity should be available following the loss of any one intake. When a common water supply is permitted for fire protection and the ultimate heat sink, the following conditions should also be satisfied:

(a) The additional fire protection water requirements are designed into the total storage capacity, and

(b) Failure of the fire protection system should not degrade the function of the ultimate heat sink.

(7) Outside manual hose installation should be sufficient to provide an effective hose stream to any onsite location where fixed or transient combustibles could jeopardize safety-related equipment. To accomplish this, hydrants should be installed approximately every 250 feet on the yard main system. A hose house equipped with hose and combination nozzle and other auxiliary equipment recommended in NFPA 24, "Outside Protection," should be provided as needed, but at least every 1,000 feet. Alternatively, mobile means of providing hose and associated equipment, such as hose carts or trucks, may be used. When provided, such mobile equipment should be equivalent to the equipment supplied by three hose houses.

Threads compatible with those used by local fire departments should be provided on all hydrants, hose couplings, and standpipe risers.

c. Water Sprinkler and Hose Standpipe Systems

(1) Sprinkler systems and manual hose station standpipes should have connections to the plant underground water main so that no single active failure or crack in a moderate-energy line can impair both the primary and backup fire suppression systems. Alternatively, headers fed from each end are permitted inside buildings to supply both sprinkler and standpipe systems, provided steel piping and fittings meeting the requirements of ANSI B31.1, "Power Piping," are used for the headers up to and including the first valve supplying the sprinkler systems where such headers are part of the seismically analyzed hose standpipe system. When provided, such headers are considered an extension of the yard main system. Hose standpipe and automatic water suppression systems serving a single fire area should have independent connections to the yard main systems. Each sprinkler and standpipe system should be equipped with OS&Y (outside screw and yoke) gate valve or other approved shutoff valve and waterflow alarm. Safety-related equipment that does not itself require sprinkler water fire protection but is subject to unacceptable damage if wet by sprinkler water discharge should be protected by water shields or baffles.

(2) Control and sectionalizing valves in the fire water systems should be electrically supervised or administratively controlled. The electrical supervision signal should indicate in the control room. All valves in the fire protection system should be periodically checked to verify position (see NFPA 26, "Supervision of Valves").

(3) Fixed water extinguishing systems should, as a minimum, conform to requirements of appropriate standards such as NFPA 13, "Standard for the Installation of Sprinkler Systems," and NFPA 15, "Standard for Water Spray Fixed Systems."

(4) Interior manual hose installation should be able to reach any location that contains, or could present a fire exposure hazard to, safety-related equipment with at least one effective hose stream. To accomplish this, standpipes with hose connections equipped with a maximum of 100 feet of 1-1/2-inch woven-jacket, lined fire hose and suitable nozzles should be provided in all buildings on all floors. Individual standpipes should be at least four inches in diameter for multiple hose connections and 2-1/2 inches in diameter for single hose connections. These systems should follow the requirements of NFPA 14, "Standpipe and Hose Systems," for sizing, spacing, and pipe support requirements.

Hose stations should be located as dictated by the fire hazard analysis to facilitate access and use for firefighting operations. Alternative hose stations should be provided for an area if the fire hazard could block access to a single hose station serving that area.

Provisions should be made to supply water at least to standpipes and hose connections for manual firefighting in areas containing equipment required for safe plant shutdown in the event of a safe shutdown earthquake. The piping system serving such hose stations should be analyzed for SSE loading and should be provided with supports to ensure system pressure integrity. The piping and valves for the portion of hose standpipe system affected by this functional requirement should, as a minimum, satisfy ANSI B31.1, "Power Piping." The water supply for this condition may be obtained by manual operator actuation of valves in a connection to the hose standpipe header from a normal seismic Category I water system such as the essential service water system. The cross connection should be (a) capable of providing flow to at least two hose stations (approximately 75 gpm per hose station), and (b) designed to the same standards as the seismic Category I water system; it should not degrade the performance of the seismic Category I water system.

(5) The proper type of hose nozzle to be supplied to each area should be based on the fire hazard analysis. The usual combination spray/straight-stream nozzle should not be used in areas where the straight stream can cause unacceptable mechanical damage. Fixed fog nozzles should be provided at locations where high-voltage shock hazards exist. All hose nozzles should have shutoff capability. (Guidance on safe distances for water application to live electrical equipment may be found in the "NFPA Fire Protection Handbook.")

(6) Certain fires, such as those involving flammable liquids, respond well to foam suppression. Consideration should be given to use of mechanical low-expansion foam systems, high-expansion foam generators, or aqueous film-forming foam (AFFF) systems, including the AFFF deluge system. These systems should comply with the requirements of NFPA 11, NFPA 11A and NFPA 11B as applicable.

d. Halon Suppression Systems

Halon fire extinguishing systems should, as a minimum, comply with the requirements of NFPA 12A and NFPA 12B, "Halogenated Fire Extinguishing Agent Systems - Halon 1301 and Halon 1211." Only UL-listed or FM-approved agents should be used. Provisions for locally disarming automatic Halon systems should be key locked and under strict administrative control. Automatic Halon extinguishing systems should not be disarmed unless controls as described in Position C.2.c. are provided.

In addition to the guidelines of NFPA 12A and 12B, preventive maintenance and testing of the systems, including check-weighing of the Halon cylinders, should be done at least quarterly.

Particular consideration should also be given to:

(1) Minimum required Halon concentration, distribution, soak time, and ventilation control;

(2) Toxicity of Halon;

(3) Toxicity and corrosive characteristics of the thermal decomposition products of Halon; and

(4) Location and selection of the activating detectors.

e. Carbon Dioxide Suppression Systems

Carbon dioxide extinguishing systems should, as a minimum, comply with the requirements of NFPA 12, "Carbon Dioxide Extinguishing Systems." Where automatic carbon dioxide systems are used, they should be equipped with a predischarge alarm system and a discharge delay to permit personnel egress. Provisions for locally disarming automatic carbon dioxide systems should be key locked and under strict administrative control. Automatic carbon dioxide extinguishing systems should not be disarmed unless controls as described in Position C.2.c. are provided.

Particular consideration should also be given to:

(1) Minimum required CO_2 concentration, distribution, soak time, and ventilation control;

(2) Anoxia and toxicity of CO_2;

(3) Possibility of secondary thermal shock (cooling) damage;

(4) Conflicting requirements for venting during CO_2 injection to prevent overpressurization versus sealing to prevent loss of agent; and

(5) Location and selection of the activating detectors.

f. Portable Extinguishers

Fire extinguishers should be provided in areas that contain, or could present a fire exposure hazard to, safety-related equipment in accordance with guidelines of NFPA 10, "Portable Fire Extinguishers, Installation, Maintenance and Use." Dry chemical extinguishers should be installed with due consideration given to possible adverse effects on safety-related equipment installed in the area.

6. Guidelines for Specific Plant Areas

a. Primary and Secondary Containment

(1) Normal Operation - Fire protection requirements for the primary and secondary containment areas should be provided for hazards identified by the fire hazard analysis.

Examples of such hazards include lubricating oil or hydraulic fluid system for the primary coolant pumps, cable tray arrangements and cable penetrations, and charcoal filters. Because of the general inaccessibility of primary containment during normal plant operation, protection should be provided by automatic fixed systems. The effects of postulated fires within the primary containment should be evaluated to ensure that the integrity of the primary coolant system and the containment is not jeopardized assuming no action is taken to fight the fire.

Operation of the fire protection systems should not compromise the integrity of the containment or other safety-related systems. Fire protection activities in the containment areas should function in conjunction with total containment requirements such as ventilation and control of contaminated liquid and gaseous release.

In primary containment, fire detection systems should be provided for each fire hazard. The type of detection used and the location of the detectors should be the most suitable for the particular type of fire hazard identified by the fire hazard analysis.

A general area fire detection capability should be provided in the primary containment as backup for the above-described hazard detection. To accomplish this, suitable smoke or heat detectors compatible with the radiation environment should be installed.

For secondary containment areas, cable fire hazards that could affect safety should be protected as described in Position C.4.c(2). The type of detection system for other fire hazards identified by the fire hazard analysis should be the most suitable for the particular type of fire hazard.

(2) Refueling and Maintenance - Refueling and maintenance operations in containment may introduce additional hazards such as contamination control materials, decontamination supplies, wood planking, temporary wiring, welding, and flame cutting (with portable compressed-gas fuel supply). Possible fires would not necessarily be in the vicinity of fixed detection and suppression systems. Management procedures and controls necessary to ensure adequate fire protection for transient fire loads are discussed in Position C.1.

Manual firefighting capability should be permanently installed in containment. Standpipes with hose stations and portable fire extinguishers should be installed at strategic locations throughout containment for any required manual firefighting operations. The containment penetrations of the standpipe system should meet the isolation requirements of General Design Criterion 56 and should be seismic Category I and Quality Group B.

Adequate self-contained breathing apparatus should be provided near the containment entrances for firefighting and damage control personnel. These units should be independent of any breathing apparatus or air supply systems provided for general plant activities and should be clearly marked as emergency equipment.

b. <u>Control Room Complex</u>

The control room complex (including galleys, office spaces, etc.) should be protected against disabling fire damage and should be separated from other areas of the plant by floors, walls, and roof having minimum fire resistance ratings of three hours. Peripheral rooms in the control room complex should have automatic fire suppression and should be separated from the control room by noncombustible construction with a fire resistance rating of one hour. Ventilation system openings between the control room and peripheral rooms should have automatic smoke dampers that close on operation of the fire detection or suppression system. If a carbon dioxide flooding system is used for fire suppression, these dampers should be strong enough to support the pressure rise accompanying carbon dioxide discharge and seal tightly against infiltration of carbon dioxide into the control room.

Manual firefighting capability should be provided for:

(1) Fire originating within a cabinet, console, or connecting cables; and

(2) Exposure fires involving combustibles in the general room area.

Portable Class A and Class C fire extinguishers should be located in the control room. A hose station should be installed immediately outside the control room.

Nozzles that are compatible with the hazards and equipment in the control room should be provided for the manual hose station. The nozzles chosen should satisfy actual firefighting needs, satisfy electrical safety, and minimize physical damage to electrical equipment from hose stream impingement.

Smoke detectors should be provided in the control room, cabinets, and consoles. If redundant safe-shutdown equipment is located in the same control room cabinet or console, additional fire protection measures should be provided. Alarm and local indication should be provided in the control room.

Breathing apparatus for control room operators should be readily available.

The outside air intake(s) for the control room ventilation system should be provided with smoke detection capability to alarm in the control room to enable manual isolation of the control room ventilation system and thus prevent smoke from entering the control room.

Venting of smoke produced by fire in the control room by means of the normal ventilation system is acceptable; however, provision should be made to permit isolation of the recirculating portion of the normal ventilation system. Manually operated venting of the control room should be available to the operators.

All cables that enter the control room should terminate in the control room. That is, no cabling should be simply routed through the control room from one area to another. Cables in the control room should be kept to the minimum necessary for plant operation.

Cables in underfloor and ceiling spaces should meet the separation criteria given in Regulatory Guide 1.75. Air-handling functions should be ducted separately from cable runs in such spaces; i.e., if cables are routed in underfloor or ceiling spaces, these spaces should not be used as air plenums for ventilation of the control room. Fully enclosed electrical raceways in such underfloor and ceiling spaces, if over one square foot in cross-sectional area, should have automatic fire suppression inside. Area automatic fire suppression should be provided for underfloor and ceiling spaces if used for cable runs unless all cable is run in 4-inch or smaller steel conduit or the cables are in fully enclosed raceways internally protected by automatic fire suppression.

c. Cable Spreading Room

The primary fire suppression in the cable spreading room should be an automatic water system such as closed-head sprinklers, open-head deluge system, or open directional water spray system. Deluge and open spray systems should have provisions for manual operation at a remote station; however, there should be provisions to preclude inadvertent operation. Location of sprinkler heads or spray nozzles should consider cable tray arrangements and possible transient combustibles to ensure adequate water coverage for areas that could present exposure hazards to the cable system. Cables should be designed to allow wetting down with water supplied by the fire suppression system without electrical faulting.

Open-head deluge and open directional spray systems should be zoned.

The use of foam is acceptable.

Automatic gas systems (Halon or CO_2) may be used for primary fire suppression if they are backed up by a fixed water spray system.

Cable spreading rooms should have:

(1) At least two remote and separate entrances for access by fire brigade personnel;

(2) An aisle separation between tray stacks at least three feet wide and eight feet high;

(3) Hose stations and portable extinguishers installed immediately outside the room;

(4) Area smoke detection; and

(5) Continuous line-type heat detectors for cable trays inside the cable spreading room.

Drains to remove firefighting water should be provided. When gas systems are installed, drains should have adequate seals or the gas extinguishing systems should be sized to compensate for losses through the drains.

A separate cable spreading room should be provided for each redundant division. Cable spreading rooms should not be shared between reactors. Each cable spreading room should be separated from the others and from other areas of the plant by barriers with a minimum fire rating of three hours.

The ventilation system to each cable spreading room should be designed to isolate the area upon actuation of any gas extinguishing system in the area. Separate manually actuated smoke venting that is operable from outside the room should be provided for the cable spreading room.

d. Plant Computer Rooms

Computer rooms for computers performing safety-related functions that are not part of the control room complex should be separated from other areas of the plant by barriers having a minimum fire resistance rating of three hours and should be protected by automatic detection and fixed automatic suppression. Computers that are part of the control room complex but not in the control room should be separated and protected as described in Position C.6.b. Computer cabinets located in the control room should be protected as other control room equipment and cable runs therein. Nonsafety-related computers outside the control room complex should be separated from safety-related areas by fire barriers with a minimum rating of three hours and should be protected as needed to prevent fire and smoke damage to safety-related equipment. Manual hose stations and portable fire extinguishers should be provided in areas that contain, or could present a fire exposure hazard to, safety-related equipment.

e. Switchgear Rooms

Switchgear rooms containing safety-related equipment should be separated from the remainder of the plant by barriers with a minimum fire rating of three hours. Redundant switchgear safety divisions should be separated from each other by barriers with a three-hour fire rating. Automatic fire detectors should alarm and annunciate in the control room and alarm locally. Cables entering the switchgear room that do not terminate or perform a function there should be kept at a minimum to minimize the combustible loading. These rooms should not be used for any other purpose. Fire hose stations and portable fire extinguishers should be readily available outside the area.

Equipment should be located to facilitate access for manual firefighting. Drains should be provided to prevent water accumulation from damaging safety-related equipment (see NFPA 92M, "Waterproofing and Draining of Floors"). Remote manually actuated ventilation should be provided for venting smoke when manual fire suppression effort is needed (see Position C.4.d).

f. Remote Safety-Related Panels

Redundant safety-related panels remote from the control room complex should be separated from each other by barriers having a minimum fire rating of three hours. Panels providing remote shutdown capability should be separated from the control room complex by barriers having a minimum fire rating of three hours. The general area housing remote safety-related panels should be provided with automatic fire detectors that alarm locally and alarm and annunciate in the control room. Combustible materials should be controlled and limited to those required for operation. Portable extinguishers and manual hose stations should be readily available in the general area.

g. Safety-Related Battery Rooms

Safety-related battery rooms should be protected against fires and explosions. Battery rooms should be separated from each other and other areas of the plant by barriers having a minimum fire rating of three hours inclusive of all penetrations and openings. DC switchgear and inverters should not be located in these battery rooms. Automatic fire detection should be provided to alarm and annunciate in the control room and alarm locally. Ventilation systems in the battery rooms should be capable of maintaining the hydrogen concentration well below 2 vol-%. Loss of ventilation should be alarmed in the control room. Standpipe and hose and portable extinguishers should be readily available outside the room.

h. Turbine Building

The turbine building should be separated from adjacent structures containing safety-related equipment by a fire barrier with a minimum rating of three hours. Openings and penetrations in the fire barrier should be minimized and should not be located where the turbine oil system or generator hydrogen cooling system creates a direct fire exposure hazard to the barrier. Considering the severity of the fire hazards, defense in depth may dictate additional protection to ensure barrier integrity.

i. Diesel Generator Areas

Diesel generators should be separated from each other and from other areas of the plant by fire barriers having a minimum fire resistance rating of three hours.

Automatic fire suppression should be installed to combat any diesel generator or lubricating oil fires; such systems should be designed for operation when the diesel is running without affecting the diesel. Automatic fire detection should be provided to alarm and annunciate in the control room and alarm locally. Hose stations and portable extinguishers should be readily available outside the area. Drainage for firefighting water and means for local manual venting of smoke should be provided.

Day tanks with total capacity up to 1100 gallons are permitted in the diesel generator area under the following conditions:

(1) The day tank is located in a separate enclosure with a minimum fire resistance rating of three hours, including doors or penetrations. These enclosures should be capable of containing the entire contents of the day tanks and should be protected by an automatic fire suppression system, or

(2) The day tank is located inside the diesel generator room in a diked enclosure that has sufficient capacity to hold 110% of the contents of the day tank or is drained to a safe location.

j. <u>Diesel Fuel Oil Storage Areas</u>

Diesel fuel oil tanks with a capacity greater than 1,100 gallons should not be located inside buildings containing safety-related equipment. If above-ground tanks are used, they should be located at least 50 feet from any building containing safety-related equipment or, if located within 50 feet, they should be housed in a separate building with construction having a minimum fire resistance rating of three hours. Potential oil spills should be confined or directed away from buildings containing safety-related equipment. Totally buried tanks are acceptable outside or under buildings (see NFPA 30, "Flammable and Combustible Liquids Code," for additional guidance).

Above-ground tanks should be protected by an automatic fire suppression system.

k. <u>Safety-Related Pumps</u>

Pump houses and rooms housing redundant safety-related pump trains should be separated from each other and from other areas of the plant by fire barriers having at least three-hour ratings. These rooms should be protected by automatic fire detection and suppression unless a fire hazard analysis can demonstrate that a fire will not endanger other safety-related equipment required for safe plant shutdown. Fire detection should alarm and annunciate in the control room and alarm locally. Hose stations and portable extinguishers should be readily accessible.

Floor drains should be provided to prevent water accumulation from damaging safety-related equipment (see Position C.4.a.(9)).

Provisions should be made for manual control of the ventilation system to facilitate smoke removal if required for manual firefighting operation (see Position C.4.d).

1. New Fuel Area

Hand portable extinguishers should be located within this area. Also, hose stations should be located outside but within hose reach of this area. Automatic fire detection should alarm and annunciate in the control room and alarm locally. Combustibles should be limited to a minimum in the new fuel area. The storage area should be provided with a drainage system to preclude accumulation of water.

The storage configuration of new fuel should always be so maintained as to preclude criticality for any water density that might occur during fire water application.

m. Spent Fuel Pool Area

Protection for the spent fuel pool area should be provided by local hose stations and portable extinguishers. Automatic fire detection should be provided to alarm and annunciate in the control room and to alarm locally.

n. Radwaste and Decontamination Areas

Fire barriers, automatic fire suppression and detection, and ventilation controls should be provided unless the fire hazard analysis can demonstrate that such protection is not necessary.

o. Safety-Related Water Tanks

Storage tanks that supply water for safe shutdown should be protected from the effects of an exposure fire. Combustible materials should not be stored next to outdoor tanks.

p. Records Storage Areas

Records storage areas should be so located and protected that a fire in these areas does not expose safety-related systems or equipment (see Regulatory Guide 1.88, "Collection, Storage and Maintenance of Nuclear Power Quality Assurance Records").

q. Cooling Towers

Cooling towers should be of noncombustible construction or so located and protected that a fire will not adversely affect any safety-related systems or equipment. Cooling towers should be of noncombustible construction when the basins are used for the ultimate heat sink or for the fire protection water supply.

r. Miscellaneous Areas

Miscellaneous areas such as shops, warehouses, auxiliary boiler rooms, fuel oil tanks, and flammable and combustible liquid storage tanks should be so located and protected that a fire or effects of a fire, including smoke, will not adversely affect any safety-related systems or equipment.

7. Special Protection Guidelines

a. Storage Acetylene-Oxygen Fuel Gases

Gas cylinder storage locations should not be in areas that contain or expose safety-related equipment or the fire protection systems that serve those safety-related areas. A permit system should be required to use this equipment in safety-related areas of the plant (also see Position C.2).

b. Storage Areas for Ion-Exchange Resins

Unused ion exchange resins should not be stored in areas that contain or expose safety-related equipment.

c. Hazardous Chemicals

Hazardous chemicals should not be stored in areas that contain or expose safety-related equipment.

d. Materials Containing Radioactivity

Materials that collect and contain radioactivity such as spent ion exchange resins, charcoal filters, and HEPA filters should be stored in closed metal tanks or containers that are located in areas free from ignition sources or combustibles. These materials should be protected from exposure to fires in adjacent areas as well. Consideration should be given to requirements for removal of decay heat from entrained radioactive materials.

D. IMPLEMENTATION

1. Plants for which construction permit applications were docketed after March 1, 1978 should follow the guidelines of this position.

2. Plants for which CP applications were docketed after July 1, 1976 but before March 1, 1978 should follow the guidelines of either (a) BTP APCSB 9.5-1 dated May 1, 1976, or (b) this position.

3. Plants for which (a) CP applications were docketed prior to, but were not issued a CP, by July 1, 1976; or (b) construction permits or operating licenses were issued prior to July 1, 1976, should follow the guidelines of either (a) Appendix A (dated August 23, 1976) to BTP APCSB 9.5-1; or (b) BTP APCSB 9.5-1 dated May 1, 1976; or (c) this position.

REFERENCES

National Fire Protection Association Codes and Standards

NFPA 4-1977, "Organization of Fire Services."

NFPA 4A-1969, "Fire Department Organization."

NFPA 6-1974, "Industrial Fire Loss Prevention."

NFPA 7-1974, "Fire Emergencies Management."

NFPA 8-1974, "Effects of Fire on Operations, Management Responsiblity."

NFPA 10-1975, "Portable Fire Extinguishers, Installation, Maintenance and Use."

NFPA 11-1975, "Foam Extinguishing Systems."

NFPA 11A-1970, "High Expansion Foam Systems."

NFPA 11B-1974, "Synthetic Foam and Combined Agent Systems."

NFPA 12-1973, "Carbon Dioxide Systems."

NFPA 12A-1973, "Halon 1301 Systems."

NFPA 12B-1973, "Halon 1211 Systems."

NFPA 13-1976, "Sprinkler Systems."

NFPA 14-1974, "Standpipe and Hose Systems."

NFPA 15-1973, "Water Spray Fixed Systems."

NFPA 20-1973, "Centrifugal Fire Pumps."

NFPA 24-1973, "Outside Protection."

NFPA 26-1958, "Supervision of Valves."

NFPA 27-1975, "Private Fire Brigade."

NFPA 30-1973, "Flammable Combustible Liquids Code."

NFPA 51B-1976 "Cutting and Welding Processes."

NFPA 69-1973, "Explosion Prevention Systems."

NFPA 70-1975, "National Electrical Code."

NFPA 72D-1975, "Proprietary Protective Signaling Systems."

NFPA 72E-1974, "Automatic Fire Detectors."

NFPA 80-1975, "Fire Doors and Windows."

NFPA 92M-1972, "Waterproofing and Draining of Floors."

NFPA 197-1966, "Initial Fire Attack, Training, Standard On."

NFPA 204-1968, "Smoke and Heat Venting Guide."

NFPA 220-1975, "Types of Building Construction."

NFPA 251-1975, "Fire Tests, Building Construction and Materials."

NFPA 259-1976, "Test Method for Potentential Heat of Building Materials."

NFPA 8021974, "Recommended Fire Protection Practice for Nuclear Reactors."

<u>U.S. Nuclear Regulatory Commission Documents</u>

NUREG-0050, "Recommendations Related to Browns Ferry Fire," Report by Special Review Group, February 1976.

WASH-1400 (NUREG-75/014), "Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," October 1975.

NUREG-75/087, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants."

Section 9.5.1, "Fire Protection Program."

Section 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment."

Section 6.4, "Habitability Systems."

Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," General Design Criterion 3, "Fire Protection."

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

Regulatory Guide 1.32, "Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants."

Regulatory Guide 1.39, "Housekeeping Requirements for Water-Cooled Nuclear Power Plants."

Regulatory Guide 1.52, "Design, Testing and Maintenance Criteria for Engineered Safety Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

Regulatory Guide 1.75, "Physical Independence of Electrical Systems."

Regulatory Guide 1.88, "Collection, Storage and Maintenance of Nuclear Power Plant Quality Assurance Records."

Regulatory Guide 1.101, "Emergency Planning for Nuclear Power Plants."

Other Documents

ANSI Standard B31.1-1973, "Power Piping."

ASTM D-3286, "Test for Gross Calorific Value of Solid Fuel by the Isothermal-Jacket Bomb Calorimeter (1973)."

ASTM E-84, "Surface Burning Characteristics of Building Materials (1976)."

ASTM E-119, "Fire Test of Building Construction and Materials (1976)."

IEEE Std 383-1974, "IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations," April 15, 1974.

MAERP-NELPIA, "Specifications for Fire Protection of New Plants."

Factory Mutual System Approval Guide - Equipment, Materials, Services for Conservation of Property.

"International Guidelines for the Fire Protection of Nuclear Power Plants," National Nuclear Risks Insurance Pools, 2nd Report (IGL).

NFPA Fire Protection Handbook.

Underwriters Laboratories Rating List.

Underwriters Laboratories, "Building Materials Directory."

APPENDIX A* TO BRANCH TECHNICAL POSITION APCSB 9.5-1 "GUIDELINES FOR FIRE PROTECTION FOR NUCLEAR POWER PLANTS DOCKETED PRIOR TO JULY 1, 1976" (AUGUST 23, 1976)

This Appendix A provides guidance on the preferred and, where applicable, acceptable alternatives to fire protection design for those nuclear power plants for which applications for construction permits were docketed prior to July 1, 1976.

The provisions of this appendix will apply to the following categories of nuclear power plants:

(1) Plants for which application for construction permits were docketed prior to July 1, 1976, but have not received a construction permit;

(2) Plants for which construction permits were issued prior to July 1, 1976, and operating plants.

This appendix modifies, as deemed appropriate, the guidelines in Branch Technical Position (BTP) APCSB 9.5-1, "Fire Protection for Nuclear Power Plants" which are intended for plants whose application for construction permit is docketed after July 1, 1976. The guidelines of the above cited BTP were adopted for this appendix and are preferred in all instances. Alternative acceptable fire protection guidelines are identified in this appendix for areas where, depending on the construction or operation status of a given plant, application of the guidelines per se could have significant impact, e.g., where the building and system designs are already finalized and construction is in progress, or where the plant is in operation. These alternative guidelines are intended to provide adequate and acceptable fire protection consistent with safe plant shutdown requirements without a significant impact on plant design, construction, and operation.

Particular sections that are intended to apply only to plants under review, under construction or operating are identified under the appropriate column.

Although this appendix provides specific guidance, alternatives may be proposed by applicants and licensees. These alternatives will be evaluated by the NRC staff on a case-by-case basis where such departures are suitably justified. Among the alternatives that should be considered is the provision of a "dedicated" system for assuring continued safe shutdown of the plant. This dedicated system should be completely independent of other plant systems, including the power source; however, for fire protection, it is not necessary for the system to be designed to seismic Category I criteria or meet single failure criteria. Manual fire fighting capability to protect the other safety related systems would still be required.

*This document includes the changes listed in the Errata Sheet dated November 18, 1976, as indicated by a vertical line in the margin.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

Positions (Application docketed but construction permit not received as of 7/1/76)

A. Overall Requirements of Nuclear Plant Fire Protection Program

1. Personnel

Responsiblity for the overall fire protection program should be assigned to a designated person in the upper level of management. This person should retain ultimate responsibility even though formulation and assurance of program implementation is delegated. Such delegation of authority should be to staff personnel prepared by training and experience in fire protection and nuclear plant safety to provide a balanced approach in directing the fire protection programs for nuclear power plants. The qualification requirements for the fire protection engineer or consultant who will assist in the design and selection of equipment, inspect and test the completed physical aspects of the system, develop the fire protection program, and assist in the fire-fighting training for the operating plant should be stated. Subsequently, the FSAR should discuss the training and the updating provisions such as fire drills provided for maintaining the competence of the station fire-fighting and operating crew, including personnel responsible for maintaining and inspecting the fire protection equipment.

The fire protection staff should be responsible for:

(a) coordination of building layout and systems design with fire area

Positions (Plants under construction and operating plants)

A. Overall Requirements of Nuclear Plant Fire Protection Program

1. Personnel

SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
requirements, including consideration of potential hazards associated with postulated design basis fires, (b) design and maintenance of fire detection, suppression, and extinguishing systems, (c) fire prevention activities, (d) training and manual fire-fighting activities of plant personnel and the fire brigade. (NOTE: NFPA 6 - Recommendations for Organization of Industrial Fire Loss Prevention, contains useful guidance for organization and operation of the entire fire loss prevention program.)	
2. Design Bases The overall fire protection program should be based upon evaluation of potential fire hazards throughout the plant and the effect of postulated design basis fires relative to maintaining ability to perform safety shutdown functions and minimize radioactive releases to the environment.	2. Design Bases SAME
3. Backup Total reliance should not be placed on a single automatic fire suppression system. Appropriate backup fire suppression capability should be provided.	3. Backup SAME
4. Single Failure Criterion A single failure in the fire suppression system should not impair both the primary and backup fire suppression capability. For example, redundant fire water pumps with independent power supplies and controls should be provided. Postulated fires or	4. Single Failure Criterion A single failure in the fire suppression system should not impair both the primary and backup fire suppression capability. For example, redundant fire water pumps with independent power supplies and

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

fire protection system failures need not be considered concurrent with other plant accidents or the most severe natural phenomena. However, in the event of the most severe earthquake, i.e., the Safe Shutdown Earthquake (SSE), the fire suppression system should be capable of delivering water to manual hose stations located within hose reach of areas containing equipment required for safe plant shutdown. The fire protection systems should, however, retain their original design capability for (1) natural phenomena of less severity and greater frequency (approximately once in 10 years) such as tornadoes, hurricanes, floods, ice storms, or small intensity earthquakes which are characteristic of the site geographic region and (2) for potential man-created site related events such as oil barge collisions, aircraft crashes which have a reasonable probability of occurring at a specific plant site. The effects of lightning strikes should be included in the overall plant fire protection program.

5. Fire Suppression Systems

Failure or inadvertent operation of the fire suppression system should not incapacitate safety related systems or components. Fire suppression systems that are pressurized during normal plant operation should meet the guidelines specified in APCSB Branch Technical Position 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment."

6. Fuel Storage Areas

The fire protection program (plans, personnel and equipment) for buildings storing new reactor fuel and for adjacent fire zones which could affect the fuel storage zone should be fully operational before fuel is received at the site.

controls should be provided. Postulated fires or fire protection system failures need not be considered concurrent with other plant accidents or the most severe natural phenomena.

The effects of lightning strikes should be included in the overall plant fire protection program.

5. Fire Suppression Systems

SAME

6. Fuel Storage Areas

Schedule for implementation of modifications, if any, will be established on a case-by-case basis.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
7. Fuel Loading The fire protection program for an entire reactor unit should be fully operational prior to initial fuel loading in that reactor unit.	7. Fuel Loading Schedule for implementation of modifications, if any, will be established on a case-by-case basis.
8. Multiple-Reactor Sites On multiple-reactor sites where there are operating reactors and construction of remaining units is being completed, the fire protection program should provide continuing evaluation and include additional fire barriers, fire protection capability, and administrative controls necessary to protect the operating units from construction fire hazards. The superintendent of the operating plant should have the lead responsibility for site fire protection.	8. Multiple-Reactor Sites SAME
9. Simultaneous Fires Simultaneous fires in more than one reactor need not be postulated, where separation requirements are met. A fire involving more than one reactor unit need not be postulated except for facilities shared between units.	9. Simultaneous Fires SAME
B. Administrative Procedures, Controls and Fire Brigade 1. Administrative procedures consistent with the need for maintaining the performance of the fire protection system and personnel in nuclear power plants should be provided. Guidance is contained in the following publications: NFPA 4 - Organization for Fire Services	B. Administrative Procedures, Controls, and Fire Brigade 1. SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
NFPA 4A - Organization for Fire Department NFPA 6 - Industrial Fire Loss Prevention NFPA 7 - Management of Fire Emergencies NFPA 8 - Management Responsibility for Effects of Fire on Operations NFPA 27 - Private Fire Brigades	
2. Effective administrative measures should be implemented to prohibit bulk storage of combustible materials inside or adjacent to safety related buildings or systems during operation or maintenance periods. Regulatory Guide 1.39, "Housekeeping Requirements for Water-Cooled Nuclear Power Plants", provides guidance on housekeeping, including the disposal of combustible materials.	2. SAME
3. Normal and abnormal conditions or other anticipated operations such as modifications (e.g., breaking fire stops, impairment of fire detection and suppression systems) and refueling activities should be reviewed by appropriate levels of management and appropriate special actions and procedures such as fire watches or temporary fire barriers implemented to assure adequate fire protection and reactor safety. In particular: (a) Work involving ignition sources such as welding and flame cutting should be done under closely controlled conditions. Procedures governing such work should be reviewed and approved by persons	3. SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

trained and experienced in fire protection. Persons performing and directly assisting in such work should be trained and equipped to prevent and combat fires. If this is not possible, a person qualified in fire protection should directly monitor the work and function as a fire watch.

(b) Leak testing, and similar procedures such as air flow determination, should use one of the commercially available aeresol techniques. Open flames or combustion generated smoke should not be permitted.

(c) Use of combustible material, e.g., HEPA and charcoal filters, dry ion exchange resins or other combustible supplies, in safety related areas should be controlled. Use of wood inside buildings containing safety related systems or equipment should be permitted only when suitable non-combustible substitutes are not available. If wood must be used, only fire retardant treated wood (scaffolding, lay down blocks) should be permitted. Such materials should be allowed into safety related areas only when they are to be used immediately. Their possible and probable use should be considered in the fire hazard analysis to determine the adequacy of the installed fire protection systems.

4. Nuclear power plants are frequently located in remote areas, at some distance from public fire departments. Also, first response fire departments are often volunteer. Public fire department response should be con-

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
sidered in the overall fire protection program. However, the plant should be designed to be self-sufficient with respect to fire fighting activities and rely on the public response only for supplemental or backup capability.	
5. The need for good organization, training and equipping of fire brigades at nuclear power plant sites requires effective measures be implemented to assure proper discharge of these functions. The guidance in Regulatory Guide 1.101, "Emergency Planning for Nuclear Power Plants", should be followed as applicable.	5. SAME
(a) Successful fire fighting requires testing and maintenance of the fire protection equipment, emergency lighting and communication, as well as practice as brigades for the people who must utilize the equipment. A test plan that lists the individuals and their responsibilities in connection with routine tests and inspections of the fire detection and protection systems should be developed. The test plan should contain the types, frequency and detailed procedures for testing. Procedures should also contain instructions on maintaining fire protection during those periods when the fire protection system is impaired or during periods of plant maintenance, e.g., fire watches or temporary hose connections to water systems.	(a) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
(b) Basic training is a necessary element in effective fire fighting operation. In order for a fire brigade to operate effectively, it must operate as a team. All members must know what their individual duties are. They must be familiar with the layout of the plant and equipment location and operation in order to permit effective fire-fighting operations during times when a particular area is filled with smoke or is insufficiently lighted. Such training can only be accomplished by conducting drills several times a year (at least quarterly) so that all members of the fire brigade have had the opportunity to train as a team, testing itself in the major areas of the plant. The drills should include the simulated use of equipment in each area and should be preplanned and post-critiqued to establish the training objective of the drills and determine how well these objectives have been met. These drills should periodically (at least annually) include local fire department participation where possible. Such drills also permit supervising personnel to evaluate the effectiveness of communications within the fire brigade and with the on scene fire team leader, the reactor operator in the control room, and the offsite command post.	(b) SAME
(c) To have proper coverage during all phases of operation, members of each shift crew should be trained in fire protection. Training of the plant fire brigade should be coordinated with the	(c) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
local fire department so that responsibilities and duties are delineated in advance. This coordination should be part of the training course and implemented into the training of the local fire department staff. Local fire departments should be educated in the operational precautions when fighting fires on nuclear power plant sites. Local fire departments should be made aware of the need for radioactive protection of personnel and the special hazards associated with a nuclear power plant site.	
(d) NFPA 27, "Private Fire Brigade" should be followed in organization, training, and fire drills. This standard also is applicable for the inspection and maintenance of fire fighting equipment. Among the standards referenced in this document, the following should be utilized: NFPA 194, "Standard for Screw Threads and Gaskets for Fire Hose Couplings," NFPA 196, "Standard for Fire Hose," NFPA 197, "Training Standard on Initial Fire Attacks," NFPA 601, "Recommended Manual of Instructions and Duties for the Plant Watchman on Guard." NFPA booklets and pamphlets listed on page 27-11 of Volume 8, 1971-72 are also applicable for good training references. In addition, courses in fire prevention and fire suppression which are recognized and/or sponsored by the fire protection industry should be utilized.	(d) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

C. Quality Assurance Program

Quality assurance (QA) programs of applicants and contractors should be developed and implemented to assure that the requirements for design, procurement, installation, and testing and administrative controls for the fire protection program for safety related areas as defined in this Branch Position are satisfied. The program should be under the management control of the QA organization. The QA program criteria that apply to the fire protection program should include the following:

1. Design Control and Procurement Document Control

   Measures should be established to assure that all design-related guidelines of the Branch Technical Position are included in design and procurement documents and that deviations therefrom are controlled.

2. Instructions, Procedures and Drawings

   Inspections, tests, administrative controls, fire drills and training that govern the fire protection program should be prescribed by documented instructions, procedures or drawings and should be accomplished in accordance with these documents.

3. Control of Purchased Material, Equipment and Services

   Measures should be established to assre that purchased material, equipment and services conform to the procurement documents.

C. Quality Assurance Program

SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

4. Inspection

A program for independent inspection of activities affecting fire protection should be established and executed by, or for, the organization performing the activity to verify conformance with documented installation drawings and test procedures for accomplishing the activities.

5. Test and Test Control

A test program should be established and implemented to assure that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. The tests should be performed in accordance with written test procedures; test results should be properly evaluated and acted on.

6. Inspection, Test and Operating Status

Measures should be established to provide for the identification of items that have satisfactorily passed required tests and inspections.

7. Non-Conforming Items

Measures should be established to control items that do not conform to specified requirements to prevent inadvertent use of installation.

8. Corrective Action

Measures should be established to assure that conditions adverse to fire protection, such as failures, malfunctions, deficiencies, deviations, defective components, uncontrolled combustible material and non-conformances are promptly identified, reported and corrected.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
9. <u>Records</u> Records should be prepared and maintained to furnish evidence that the criteria enumerated above are being met for activities affecting the fire protection program.	
10. <u>Audits</u> Audits should be conducted and documented to verify compliance with the fire protection program including design and procurement documents; instructions; procedures and drawings; and inspection and test activities.	
D. <u>General Guidelines for Plant Protection</u>	D. <u>General Guidelines for Plant Protection</u>
1. <u>Building Design</u>	1. <u>Building Design</u>
(a) Plant Layouts should be arranged to:	
(1) Isolate safety related systems from unacceptable fire hazards, and	(1) SAME
(2) Separate redundant safety related systems from each other so that both are not subject to damage from a single fire hazard.	(2) Alternatives: (a) Redundant safety related systems that are subject to damage from a single fire hazard should be protected by a combination of fire retardant coatings and fire detection and suppression systems, or (b) a separate system to perform the safety function should be provided.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
(b) In order to accomplish 1.(a) above, safety related systems and fire hazards should be identified throughout the plant. Therefore, a detailed fire hazard analysis should be made. The fire hazards analysis should be reviewed and updated as necessary.	(b) SAME - Additional fire hazards analysis should be done after any plant modification.
(c) For multiple reactor sites, cable spreading rooms should not be shared between reactors. Each cable spreading room should be separated from other areas of the plant by barriers (walls and floors) having a minimum fire resistance of three hours. Cabling for redundant safety divisions should be separated by walls having three hour fire barriers.	(c) Alternative guidance for constructed plants is shown in Section E.3, "Cable Spreading Room."
(d) Interior wall and structural components, thermal insulation materials and radiation shielding materials and sound-proofing should be non-combustible. Interior finishes should be non-combustible or listed by a nationally recognized testing laboratory, such as Factory Mutual or Underwriters' Laboratory, Inc. for flame spread, smoke and fuel contribution of 25 or less in its use configuration (ASTM E-84 Test), "Surface Burning Characteristics of Building Materials").	(d) SAME
(e) Metal deck roof construction should be non-combustible (see the building materials directory of the Underwriters Laboratory, Inc.) or listed as Class I by Factor Mutual System Approval Guide.	(e) SAME. Where combustible material is used in metal deck roofing design, acceptable alternatives are (i) replace combustibles with non-combustible materials, (ii) provide an automatic sprinkler system, or (iii) provide ability to cover roof exterior and interior with adequate water volume and pressure.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
(f) Suspended ceilings and their supports should be of non-combustible construction. Concealed spaces should be devoid of combustibles.	(f) SAME. Adequate fire detection and suppression systems should be provided where full implementation is not practicable.
(g) High voltage - high amperage transformers installed inside buildings containing safety related systems should be of the dry type or insulated and cooled with non-combustible liquid.	(g) SAME. Safety related systems that are exposed to flammable oil filled transformers should be protected from the effects of a fire by: (i) replacing with dry transformers or transformers that are insulated and cooled with non-combustible liquid; or (ii) enclosing the transformer with a three-hour fire barrier and installing automatic water spray protection.
(h) Buildings containing safety related systems should be protected from exposure or spill fires involving oil filled transformers by: •locating such transformers at least 50 feet distant; or •ensuring that such building walls within 50 feet of oil filled transformers are without openings and have a fire resistance rating of at least three hours.	(h) Buildings containing safety related systems, having openings in exterior walls closer than 50 feet to flammable oil filled transformers should be protected from the effects of a fire by: (i) closing of the opening to have fire resistance equal to three hours, (ii) constructing a three-hour fire barrier between the transformers and the wall openings; or

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
	(iii) closing the opening and providing the capability to maintain a water curtain in case of a fire.
(i) Floor drains, sized to remove expected fire fighting water flow should be provided in those areas where fixed water fire suppression systems are installed. Drains should also be provided in other areas where hand hose lines may be used if such fire fighting water could cause unacceptable damage to equipment in the area. Equipment should be installed on pedestals, or curbs should be provided as required to contain water and direct it to floor drains. (See NFPA 92M, "Waterproofing and Draining of Floors.") Drains in areas containing combustible liquids should have provisions for preventing the spread of the fire throughout the drain system. Water drainage from areas which may contain radioactivity should be sampled and analyzed before discharge to the environment.	(i) SAME. In operating plants or plants under construction, if accumulation of water from the operation of new fire suppression systems does not create unacceptable consequences, drains need not be installed.
(j) Floors, walls and ceilings enclosing separate fire areas should have minimum fire rating of three hours. Penetrations in these fire barriers, including conduits and piping, should be sealed or closed to provide a fire resistance rating at least equal to that of the fire barrier itself. Door openings should be protected with equivalent rated doors, frames and hardware that have been tested and approved by a nationally recognized laboratory. Such doors	(j) SAME. The fire hazard in each area should be evaluated to determine barrier requirements. If barrier fire resistance cannot be made adequate, fire detection and suppression should be provided, such as: (i) water curtain in case of fire, (ii) flame retardant coatings, (iii) additional fire barriers.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
should be normally closed and locked or alarmed with alarm and annunciation in the control room. Penetrations for ventilation system should be protected by a standard "fire door damper" where required. (Refer to NFPA 80, "Fire Doors and Windows.")	
2. Control of Combustibles	2. Control of Combustible
(a) Safety related systems should be isolated or separated from combustible materials. When this is not possible because of the nature of the safety system or the combustible material, special protection should be provided to prevent a fire from defeating the safety system function. Such protection may involve a combination of automatic fire suppression, and construction capable of withstanding and containing a fire that consumes all combustibles present. Examples of such combustible materials that may not be separable from the remainder of its system are: (1) Emergency diesel generator fuel oil day tanks (2) Turbine-genrator oil and hydraulic control fluid systems (3) Reactor coolant pump lube oil system	(a) SAME
(b) Bulk gas storage (either compressed or cryogenic), should not be permitted inside structures housing safety-related equipment. Storage of flammable gas such as hydrogen, should be located outdoors or in separate detached buildings so that a fire or explosion will not adversely affect any safety related systems or equipment.	(b) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
(Refer to NFPA 50A, "Gaseous Hydrogen Systems.") Care should be taken to locate high pressure gas storage containers with the long axis parallel to building walls. This will minimize the possibility of wall penetration in the event of a container failure. Use of compressed gases (especially flammable and fuel gases) inside buildings should be controlled. (Refer to NFPA 6, "Industrial Fire Loss Prevention.")	
(c) The use of plastic materials should be minimized. In particular, haloginated plastics such as polyvinyl chloride (PVC) and neoprene should be used only when substitute non-combustible materials are not available. All plastic materials, including flame and fire retardant materials, will burn with an intensity and BTU production in a range similar to that of ordinary hydrocarbons. When burning, they produce heavy smoke that obscures visibility and can plug air filters, especially charcoal and HEPA. The haloginated plastics also release free chlorine and hydrogen chloride when burning which are toxic to humans and corrosive to equipment.	(c) SAME
(d) Storage of flammable liquids should, as a minimum, comply with the requirements of NFPA 30, "Flammable and Combustible Liquids Code."	(d) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
3. <u>Electric Cable Construction, Cable Trays and Cable Penetrations</u>	3. <u>Electric Cable Construction, Cable Trays and Cable Penetrations</u>
(a) Only non-combustible materials should be used for cable tray construction.	(a) SAME
(b) See Section E.3 for fire protection guidelines for cable spreading rooms.	(b) SAME
(c) Automatic water sprinkler systems should be provided for cable trays outside the cable spreading room. Cables should be designed to allow wetting down with deluge water without electrical faulting. Manual hose stations and portable hand extinguishers should be provided as backup. Safety related equipment in the vicinity of such cable trays, that does not itself require water fire protection, but is subject to unacceptable damage from sprinkler water discharge, should be protected from sprinkler system operation of malfunction.	(c) SAME. When safety related cables do not satisfy the provisions of Regulatory Guide 1.75, all exposed cables should be covered with an approved fire retardant coating and a fixed automatic water fire suppression system should be provided.
(d) Cable and cable tray penetration of fire barriers (vertical and horizontal) should be sealed to give protection at least equivalent to that fire barrier. The design of fire barriers for horizontal and vertical cable trays should, as a minimum, meet the requirements of ASTM E-119, "Fire Test of Building Construction and Materials," including the hose stream test.	(d) SAME. Where installed penetration seals are deficient with respect to fire resistance, these seals may be protected by covering both sides with an approved fire retardant material. The adequacy of using such material should be demonstrated by suitable testing.
(e) Fire breaks should be provided as deemed necessary by the fire hazards analysis. Flame or flame retardant coatings may be used as a fire break for grouped electrical cables to limit spread of fire in cable ventings. (Possible cable derating owing to use of such	(e) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
coating materials must be considered during design.)	
(f) Electric cable constructions should as a minimum pass the current IEEE No. 383 flame test. (This does not imply that cables passing this test will not require additional fire protection.)	(f) SAME. For cable installation in operating plants and plants under construction that do not meet the IEEE No. 383 flame test requirements, all cables must be covered with an approved flame retardant coating and properly derated.
(g) To the extent practical, cable construction that does not give off corrosive gases while burning should be used.	(g) Applicable to new cable installations.
(h) Cable trays, raceways, conduit, trenches, or culverts should be used only for cables. Miscellaneous storage should not be permitted, nor should piping for flammable or combustible liquids or gases be installed in these areas.	(h) SAME. Installed equipment in cable tunnels or culverts, need not be removed if they present no hazard to the cable runs as determined by the fire hazards analysis.
(i) The design of cable tunnels, culverts and spreading rooms should provide for automatic or manual smoke venting as required to facilitate manual fire fighting capability.	(i) SAME
(j) Cables in the control room should be kept to the minimum necessary for operation of the control room. All cables entering the control room should terminate there. Cables should not be installed in floor trenches or culverts in the control room.	(j) SAME. Existing cabling installed in concealed floor and ceiling spaces should be protected with an automatic total flooding halon system.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
4. Ventilation	4. Ventilation
(a) The products of combustion that need to be removed from a specific fire area should be evaluated to determine how they will be controlled. Smoke and corrosive gases should generally be automatically discharged directly outside to a safe location. Smoke and gases containing radioactive materials should be monitored in the fire area to determine if release to the environment is within the permissible limits of the plant Technical Specifications.	(a) SAME. The products of combustion which need to be removed from a specific fire area should be evaluated to determine how they will be controlled.
(b) Any ventilation system designed to exhaust smoke or corrosive gases should be evaluated to ensure that inadvertent operation or single failures will not violate the controlled areas of the plant design. This requirement includes containment functions for protection of the public and maintaining habitability for operations personnel.	(b) SAME
(c) The power supply and controls for mechanical ventilation systems should be run outside the fire area served by the system.	(c) SAME
(d) Fire suppression systems should be installed to protect charcoal filters in accordance with Regulatory Guide 1.52, "Design Testing and Maintenance Criteria for Atmospheric Cleanup Air Filtration."	(d) SAME
(e) The fresh air supply intakes to areas containing safety related equipment or systems should be located remote from the exhaust air outlets and smoke vents of other fire areas to minimize the possibility of contaminating the intake air with the products of combustion.	(e) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
(f) Stairwells should be designed to minimize smoke infiltration during a fire. Staircases should serve as escape routes and access routes for fire fighting. Fire exit routes should be clearly marked. Stairwells, elevators and chutes should be enclosed in masonry towers with minimum fire rating of three hours and automatic fire doors at least equal to the enclosure construction, at each opening into the building Elevators should not be used during fire emergencies.	(f) SAME. Where stairwells or elevators cannot be enclosed in three-hour fire rated barrier with equivalent fire doors, escape and access routes should be established by pre-fire plan and practiced in drills by operating and fire brigade personnel.
(g) Smoke and heat vents may be useful in specific areas such as cable spreading rooms and diesel fuel oil storage areas and switch-gear rooms. When natural-convection ventilation is used, a minimum ratio of 1 sq. foot of venting area per 200 sq. feet of floor area should be provided. If forced-convection ventilation is used, 300 CFM should be provided for every 200 sq. feet of floor area. See NFPA No. 204 for additional guidance on smoke control.	(g) SAME
(h) Self-contained breathing apparatus, using full face positive pressure masks, approved by NIOSH (National Institute for Occupational Safety and Health - approval formerly given by the U. S. Bureau of Mines) should be provided for fire brigade, damage control and control room personnel. Control room personnel may be furnished breathing air by a manifold	(h) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

system piped from a storage reservoir if practical. Service or operating life should be a minimum of one half hour for the self-contained units.

At least two extra air bottles should be located onsite for each self-contained breathing unit. In addition, an onsite 6-hour supply of reserve air should be provided and arranged to permit quick and complete replenishment of exhausted supply air bottles as they are returned. If compressors are used as a source of breathing air, only units approved for breathing air should be used. Special care must be taken to locate the compressor in areas free of dust and contaminants.

(i) Where total flooding gas extinguishing systems are used, area intake and exhaust ventilation dampers should close upon initiation of gas flow to maintain necessary gas concentration. (See NFPA 12, "Carbone Dioxide Systems", and 12A, "Halon 1301 Systems.")

(i) SAME

5. <u>Lighting and Communication</u>

Lighting and two way voice communication are vital to safe shutdown and emergency response in the event of fire. Suitable fixed and portable emergency lighting and communication devices should be provided to satisfy the following requirements:

(a) Fixed emergency lighting should consist of sealed beam units with individual 8-hour minimum battery power supplies.

5. <u>Lighting and Communication</u>

SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
(b) Suitable sealed beam battery powered portable hand lights should be provided for emergency use.	
(c) Fixed emergency communication should use voice powered head sets at pre-selected stations.	
(d) Fixed repeaters installed to permit use of portable radio communication units should be protected from exposure fire damage.	
E. Fire Detection and Suppression	E. Fire Detection and Suppression
1. Fire Detection	1. Fire Detection
(a) Fire detection systems should as a minimum comply with NFPA 72D, "Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems."	SAME. Deviations from the requirements of NFPA 72D should be identified and justified.
(b) Fire detection system should give audible and visual alarm and annunciation in the control room. Local audible alarms should also sound at the location of the fire.	
(c) Fire alarms should be distinctive and unique. They should not be capable of being confused with any other plant system alarms.	
(d) Fire detection and actuation systems should be connected to the plant emergency power supply.	
2. Fire Protection Water Supply Systems	2. Fire Protection Water Supply Systems
(a) An underground yard fire main loop should be installed to furnish anticipated fire water requirements. NFPA 24 - Standard for Outside Protection - gives necessary guidance for such installation. It references other design	(a) SAME. Visible location marking signs for underground valves is acceptable. Alternative valve position indicators should also be provided.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
codes and standards developed by such organizations as the American National Standards Institute (ANSI) and the American Water Works Association (AWWA). Lined steel or cast iron pipe should be used to reduce internal tuberculation. Such tuberculation deposits in an unlined pipe over a period of years can significantly reduce water flow through the combination of increased friction and reduced pipe diameter. Means for treating and flushing the systems should be provided. Approved visually indicating sectional control valves, such as Post Indicator Valves, should be provided to isolate portions of the main for maintenance or repair without shutting off the entire system.	
The fire main system piping should be separate from service or sanitary water system piping.	For operating plants, fire main system piping that can be isolated from service or sanitary water system piping is acceptable.
(b) A common yard fire main loop may serve multi-unit nuclear power plant sites, if cross-connected between units. Sectional control valves should permit maintaining independence of the individual loop around each unit. For such installations, common water supplies may also be utilized. The water supply should be sized for the largest single expected flow. For multiple reactor sites with widely separated plants (approaching 1 mile or more), separate yard fire main loops should be used.	(b) SAME. Sectionalized systems are acceptable.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
(c) If pumps are required to meet system pressure or flow requirements, a sufficient number of pumps should be provided so that 100% capacity will be available with one pump inactive (e.g., three 50% pumps or two 100% pumps). The connection to the yard fire main loop from each fire pump should be widely separated, preferably located on opposite sides of the plant. Each pump should have its own driver with independent power supplies and control. At least one pump (if not powered from the emergency diesels) should be driven by non-electrical means, preferably diesel engine. Pumps and drivers should be located in rooms separated from the remaining pumps and equipment by a minimum three-hour fire wall. Alarms indicating pump running, driver availability, or failure to start should be provided in the control room. Details of the fire pump installation should as a minimum conform to NFPA 20, "Standard for the Installation of Centrifugal Fire Pumps."	(c) SAME
(d) Two separate reliable water supplies should be provided. If tanks are used, two 100% (minimum of 300,000 gallons each) system capacity tanks should be installed. They should be so interconnected that pumps can take suction from either or both. However, a leak in one tank or its piping should not cause both	(d) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
tanks to drain. The main plant fire water supply capacity should be capable of refilling either tank in a minimum of eight hours. Common tanks are permitted for fire and sanitary or service water storage. When this is done, however, minimum fire water storage requirements should be dedicated by means of a vertical standpipe for other water services.	
(e) The fire water supply (total capacity and flow rate) should be calculated on the basis of the largest expected flow rate for a period of two hours, but not less than 300,000 gallons. This flow rate should be based (conservatively) on 1,000 gpm for manual hose streams plus the greater of: (1) all sprinkler heads opened and flowing in the largest designed fire area; or (2) the largest open head deluge system(s) operating.	(e) SAME
(f) Lakes or fresh water ponds of sufficient size may qualify as sole source of water for fire protection, but require at least two intakes to the pump supply. When a common water supply is permitted for fire protection and the ultimate heat sink, the following conditions should also be satisfied:	(f) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
(1) The additional fire protection water requirements are designed into the total storage capacity; and	
(2) Failure of the fire protection system should not degrade the function of the ultimate heat sink.	
(g) Outside manual hose installation should be sufficient to reach any location with an effective hose stream. To accomplish this hydrants should be installed approximately every 250 feet on the yard main system. The lateral to each hydrant from the yard main should be controlled by a visually indicating or key operated (curb) valve. A hose house, equipped with hose and combination nozzle, and other auxiliary equipment recommended in NFPA 24, "Outside Protection", should be provided as needed but at least every 1,000 feet. Threads compatible with those used by local fire departments should be provided on all hydrants, hose couplings and standpipe risers.	(g) SAME
3. <u>Water Sprinklers and Hose Standpipe Systems</u>	3. <u>Water Sprinklers and Hose Standpipe Systems</u>
(a) Each automatic sprinkler system and manual hose station standpipe should have an independent connection to the plant underground water main. Headers fed from each end are permitted inside buildings to supply multiple sprinkler and standpipe systems. When provided, such headers are considered an extension of the yard main system. The header arrangement should be such that no single failure can impair both the	(a) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
primary and backup fire protection systems. Each sprinkler and standpipe system should be equipped with OS&Y (outside screw and yoke) gate valve, or other approved shut off valve, and water flow alarm. Safety related equipment that does not itself require sprinkler water fire protection, but is subject to unacceptable damage if wetted by sprinkler water discharge should be protected by water shields or baffles.	
(b) All valves in the fire water systems should be electrically supervised. The electrical supervision signal should indicate in the control room and other appropriate command locations in the plant (See NFPA 26, "Supervision of Valves.")	(b) SAME. When electrical supervision of fire protection valves is not practicable, an adequate management supervision program should be provided. Such a program should include locking valves open with strict key control; tamper proof seals; and periodic, visual check of all valves.
(c) Automatic sprinkler systems should as a minimum conform to requirements of appropriate standards such as NFPA 13, "Standard for the Installation of Sprinkler Systems", and NFPA 15, "Standard for Water Spray Fixed Systems."	(c) SAME
(d) Interior manual hose installation should be able to reach any location with at least one effective hose stream. To accomplish this, standpipes with hose connections, equipped with a maximum of 75 feet of 1-½-inch	(d) Interior manual hose installation should be able to reach any location with at least one effective hose steam. To accomplish this, standpipes with hose connections

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
woven jacket-lined fire hose and suitable nozzles should be provided in all buildings, including containment, on all floors and should be spaced at not more than 100-foot intervals. Individual standpipes should be of at least 4-inch diameter for multiple hose connections and 2-½-inch diameter for single hose connections. These systems should follow the requirements of NFPA 14, "Standpipe and Hose Systems" for sizing, spacing and pipe support requirements.	equipped with a maximum of 75 feet of 1-½ inch woven jacket lined fire hose and suitable nozzles should be provided in all buildings, including containment, on all floors and should be spaced at not more than 100-foot intervals. Individual standpipes should be of at least 4-inch diameter for multiple hose connections and 2-½-inch diameter for single hose connections. These systems should follow the requirements of NFPA No. 14 for sizing, spacing and pipe support requirements (NELPIA).
Hose stations should be located outside entrances to normally unoccupied areas and inside normally occupied areas. Standpipes serving hose stations in areas housing safety related equipment should have shut off valves and pressure reducing devices (if applicable) outside the area.	Hose stations should be located outside entrances to normally unoccupied areas and inside normally occupied areas. Standpipes serving hose stations in areas housing safety related equipment should have shut off valves and pressure reducing devices (if applicable) outside the area.
Provisions should be made to supply water at least to standpipes and hose connections for manual fire fighting in areas within hose reach of equipment required for safe plant shutdown in the event of a Safe Shutdown Earthquake (SSE). The standpipe system serving such hose stations should be analyzed for SSE loading and should be provided with supports to assure system pressure integrity. The piping and valves	

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
for the portion of hose standpipe system affected by this functional requirement should at least satisfy ANSI Standard B31.1, "Power Piping." The water supply for this condition may be obtained by manual operator actuation of valve(s) in a connection to the hose standpipe header from a normal Seismic Category I water system such as Essential Service Water System. The cross connection should be (a) capable of providing flow to at least two hose stations (approximately 75 gpm/hose station), and (b) designed to the same standards as the seismic Category I water system; it should not degrade the performance of the Seismic Category I water system.	
(e) The proper type of hose nozzles to be supplied to each area should be based on the fire hazard analysis. The usual combination spray/straight-stream nozzle may cause unacceptable mechanical damage (for example, the delicate electronic equipment in the control room) and be unsuitable. Electrically safe nozzles should be provided at locations where electrical equipment or cabling is located.	(e) SAME
(f) Certain fires such as those involving flammable liquids respond well to foam suppression. Consideration should be given to use of any of the available foams for such specialized protection application. These include the more common chemical and mechanical low expansion foams, high expansion foam and the relatively new aqueous film forming foam (AFFF).	(f) SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

4. Halon Suppression Systems

The use of Halon fire extinguishing agents should as a minimum comply with the requirements of NFPA 12A and 12B, "Halogenated Fire Extinguishing Agent Systems - Halon 1301 and Halon 1211." Only UL or FM approved agents should be used.

In addition to the guidelines of NFPA 12A and 12B, preventative maintenance and testing of the systems, including check weighing of the Halon cylinders should be done at least quarterly.

Particular consideration should also be given to:

(a) minimum required Halon concentration and soak time

(b) toxicity of Halon

(c) toxicity and corrosive characteristics of thermal decomposition products of Halon.

4. Halon Suppression Systems (Plants under construction and operating plants)

SAME

5. Carbon Dioxide Suppression Systems

The use of carbon dioxide extinguishing systems should as a minimum comply with the requirements of NFPA 12, "Carbon Dioxide Extinguishing Systems."

Particular consideration should also be given to:

(a) minimum required CO_2 concentration and soak time;

(b) toxicity of CO_2;

(c) possibility of secondary thermal shock (cooling) damage;

(d) offsetting requirements for venting during CO_2 injection to prevent overpressurization versus sealing to prevent loss of agent;

5. Carbon Dioxide Suppression Systems (Plants under construction and operating plants)

SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

(e) design requirements from over-pressurization; and

(f) possibility and probability of CO_2 systems being out-of-service because of personnel safety consideration. CO_2 systems are disarmed whenever people are present in an area so protected. Areas entered frequently (even though duration time for any visit is short) have often been found with CO_2 systems shut off.

6. Portable Extinguishers

Fire extinguishers should be provided in accordance with guidelines of NFPA 10 and 10A, "Portable Fire Extinguishers Installation, Maintenance and Use." Dry chemical extinghishers should be installed with due consideration given to cleanup problems after use and possible adverse effects on equipment installed in the area.

6. Portable Extinguishers

SAME

F. Guidelines for Specific Plant Areas

1. Primary and Secondary Containment

(a) Normal Operation

Fire protection requirements for the primary and secondary containment areas should be provided on the basis of specific identified hazards. For example:

- Lubricating oil or hydraulic fluid system for the primary coolant pumps
- Cable tray arrangements and cable penetrations
- Charcoal filters

F. Guidelines for Specific Plant Areas

1. Primary and Secondary Containment

(a) SAME except as noted.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
Because of the general inaccessability of these areas during normal plant operations, protection should be provided by automatic fixed systems. Automatic sprinklers should be installed for those hazards identified as requiring fixed suppression.	Fire suppression systems should be provided based on the fire hazards analysis. Fixed fire suppression capability should be provided for hazards that could jeopardize safe plant shutdown. Automatic sprinklers are preferred. An acceptable alternate is automatic gas (Halon or CO_2) for hazards identified as requiring fixed suppression protection.
Operation of the fire protection systems should not compromise integrity of the containment or the other safety related systems. Fire protection activities in the containment areas should function in conjunction with total containment requirements such as control of contaminated liquid and gaseous release and ventilation.	An enclosure may be required to confine the agent if a gas system is used. Such enclosures should not adversely affect safe shutdown, or other operating equipment in containment.
Fire detection systems should alarm and annunciate in the control room. The type of detection used and the location of the detectors should be most suitable to the particular type of fire that could be expected from the identified hazard. A primary containment general area fire detection capability should be provided as backup for the above described hazard detection. To accomplish this, suitable smoke detection (e.g., visual obscuration, light scattering and particle counting) should be installed in the air recirculation system ahead of any filters.	Automatic fire suppression capability need not be provided in the primary containment atmospheres that are inerted during normal operation. However, special fire protection requirements during refueling and maintenance operations should be satisfied as provided below

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
Automatic fire suppression capability need not be provided in the primary containment atmospheres that are inerted during normal operation. However, special fire protection requirements during refueling and maintenance operations should be satisifed as provided below.	
(b) Refueling and Maintenance	(b) Refueling and Maintenance
Refueling and maintenance operations in containment may introduce additional hazards such as contamination control materials, decontamination supplies, wood planking, temporary wiring, welding and flame cutting (with portable compressed fuel gas supply). Possible fires would not necessarily be in the vicinity of fixed detection and suppression systems.	SAME
Management procedures and controls necessary to assure adequate fire protection are discussed in Section 3a.	
In addition, manual fire fighting capability should be permanently installed in containment. Standpipes with hose stations, and portable fire extinguishers, should be installed at strategic locations throughout containment for any required manual fire fighting operations.	Equivalent protection from portable systems should be provided if it is impractical to install standpipes with hose stations.
Adequate self-contained breathing apparatus should be provided near the containment entrances for fire fighting and damage control personnel. These units should be independent of any breathing apparatus or air supply systems provided for general plant activities.	

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
2. Control Room	2. Control Room
The control room is essential to safe reactor operation. It must be protected against disabling fire damage and should be separated from other areas of the plant by floors, walls and roofs having minimum fire resistance ratings of three hours.	SAME
Control room cabinets and consoles are subject to damage from two distinct fire hazards:	
(a) Fire originating within a cabinet or console; and	
(b) Exposure fire involving combustibles in the general room area.	
Manual fire fighting capability should be provided for both hazards. Hose stations and portable water and Halon extinguishers should be located in the control room to eliminate the need for operators to leave the control room. An additional hose piping shut off valve and pressure reducing device should be installed outside the control room.	Hose stations adjacent to the control room with portable extinguishers in the control room are acceptable.
Hose stations adjacent to the control room with portable extinguishers in the control room are acceptable.	
Nozzles that are compatible with the hazards and equipment in the control room should be provided for the manual hose station. The nozzles chosen should satisfy actual fire fighting needs, satisfy electrical safety and minimize physical damage to electrical equipment from hose stream impingement.	

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
Fire detection in the control room cabinets, and consoles should be provided by smoke and heat detectors in each fire area. Alarm and annunciation should be provided in the control room. Fire alarms in other parts of the plant should also be alarmed and annunciated in the control room.	
Breathing apparatus for control room operators should be readily available. Control room floors, ceiling, supporting structures, and walls, including penetrations and doors, should be designed to a minimum fire rating of three hours. All penetration seals should be air tight.	
The control room ventilation intake should be provided with smoke detection capability to automatically alarm locally and isolate the control room ventilation system to protect operators by preventing smoke from entering the control room. Manually operated venting of the control room should be available so that operators have the option of venting for visibility.	Manually operated ventilation systems are acceptable.
Cables should not be located in concealed floor and ceiling spaces. All cables that enter the control room should terminate in the control room. That is, no cabling should be simply routed through the control room from one area to another.	If such concealed spaces are used, however, they should have fixed automatic total flooding halon protection.
Safety related equipment should be mounted on pedestals or the control room should have curbs and drains to direct water away from such equipment. Such drains should be provided with means for closing to maintain integrity of the control room in the event of other accidents requiring control room isolation.	Not applicable.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76

3. Cable Spreading Room

The primary fire suppression in the cable spreading room should be an automatic water system such as closed head sprinklers, open head deluge, or open directional spray nozzles. Deluge and open spray systems should have provisions for manual operation at a remote station; however, there should be provisions to preclude inadvertent operation. Location of sprinkler heads or spray nozzles should consider cable tray sizing and arrangements to assure adequate water coverage. Cables should be designed to allow wetting down with deluge water without electrical faulting.

Open head deluge and open directional spray systems should be zoned to that a single failure will not deprive the entire area of automatic fire suppression capability.

The use of foam is acceptable, provided it is of a type capable of being delivered by a sprinkler or deluge system, such as an Aqueous Fil.n Forming Foam (AFFF).

An automatic water suppression system with manual hoses and portable extinguisher backup is acceptable, provided:

(a) At least two remote and separate entrances are provided to the room for access by fire brigade personnel; and

(b) Aisle separation provided between tray stacks should be at least three feet wide and eight feet high.

PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

3. Cable Spreading Room

(a) The preferred acceptable methods are:

1. Automatic water system such as closed head sprinklers, open head deluge, or open directional spray nozzles. Deluge and open spray systems should have provisions for manual operation at a remote station; however; there should also be provisions to preclude inadvertent operation. Location of sprinkler heads or spray nozzles should consider cable tray sizing and arrangements to assure adequate water coverage. Cables should be designed to allow wetting down with deluge water without electrical faulting. Open head deluge and open directional spray systems should be zoned so that a single failure will not deprive the entire area of automatic fire suppression capability. The use of foam is acceptable, provided it is of a type capable of being delivered by a sprinkler or deluge system, such as an Aqueous Film Forming Foam (AFFF).

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

Alternately, gas systems (Halon or CO_2) may be used for primary fire suppression if they are backed up by an installed water spray system and hose stations and portable extinguishers immediately outside the room and if the access requirements stated above are met.

Electric cable construction should, as a minimum, pass the flame test in IEEE Std 383, "IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations."

Drains to remove fire fighting water should be provided with adequate seals when gas extinguishing systems are also installed.

Redundant safety related cable division should be separated by walls with a three-hour fire rating.

(2) Manual hoses and portable extinguishers should be provided as backup.

(3) Each cable spreading room of each unit should have divisional cable separation, and be separated from the other and the rest of the plant by a minimum three-hour rated fire wall (Refer to NFPA 251 or ASTM E-119 for fire test resistance rating).

(4) At least two remote and separate entrances are provided to the room for access by fire brigade personnel; and

(5) Aisle separation provided between tray stacks should be at least three feet wide and eight feet high.

b. For cable spreading rooms that do not provide divisional cable separation of a(3), in addition to meeting a(1), (2), (4), and (5) above, the following should also be provided:

(1) Divisional cable separation should meet the guidelines of Regulatory Guide 1.75, "Physical Independence of Electric Systems."

(2) All cabling should be covered with a suitable fire retardant coating.

(3) As an alternate to a(1) above, automatically initiated gas systems (Halon or CO_2) may be

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

used for primary fire suppression, provided a fixed water system is used as a backup.

(4) Plants that cannot meet the guidelines of Regulatory Guide 1.75, in addition to meeting a(1), (2), (4), and (5) above, an auxiliary shutdown system with all cabling independent of the cable spreading room should be provided.

For multiple-reactor unit sites, cable spreading rooms should not be shared between reactors. Each cable spreading room of each unit should have divisional cable sepration as stated above and be separated from the other and the rest of the plant by a wall with a minimum fire rating of three hours. (See NFPA 251, "Fire Tests, Building Construction and Materials", or ASTM E-119, "Fire Test of Building Construction and Materials", for fire test resistance rating.)

The ventilation system to the cable spreading room should be designed to isolate the area upon acutation of any gas extinguishing system in the area. In addition, smoke venting of the cable spreading room may be desirable. Such smoke venting systems should be controlled automatically by the fire detection or suppression system as appropriate. Capability for remote manual control should also be provided.

4. Plant Computer Room

Safety related computers should be separated from other areas of the plant by barriers having a minimum three-hour fire resistant rating. Automatic fire detection

4. Plant Computer Room

SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
should be provided to alarm and annunciate in the control room and alarm locally. Manual hose stations and portable water and halon fire extinguishers should be provided.	
5. Switchgear Rooms	5. Switchgear Rooms
Switchgear rooms should be separated from the remainder of the plant by minimum three-hour rated fire barriers, if practicable. Automatic fire detection should alarm and annunciate in the control room and alarm locally. Fire hose stations and portable extinguishers should be readily available.	Switchgear rooms should be separated from the remainder of the plant by minimum three-hour rated fire barriers to the extent practicable. Automatic fire detection should alarm and annunciate in the control room and alarm locally. Fire hose stations and portable extinguishers should be readily available.
Acceptable protection for cables that pass through the switchgear room is automatic water or gas agent suppression. Such automatic suppression must consider preventing unacceptable damage to electrical equipment and possible necessary containment of agent following discharge.	Acceptable protection for cables that pass through the switchgear room is automatic water or gas agent suppression. Such automatic suppression must consider preventing unacceptable damage to electrical equipment and possible necessary containment of agent following discharge.
6. Remote Safety Related Panels	6. Remote Safety Related Panels
The general area housing remote safety related panels should be provided with automatic fire detectors that alarm locally and alarm and annunciate in the control room. Combustible materials should be controlled and limited to those required for operation. Portable extinguishers and manual hose stations should be provided.	SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
7. <u>Station Battery Rooms</u> Battery rooms should be protected against fire explosions. Battery rooms should be separated from each other and other areas of the plant by barriers having a minimum fire rating of three-hours inclusive of all penetrations and openings. (See NFPA 69, "Standard on Explosion Prevention Systems.") Ventilation systems in the battery rooms should be capable of maintaining the hydrogen concentration well below 2 vol. % hydrogen concentration. Standpipe and hose and portable extinguishers should be provided. Alternatives: (a) Provide a total fire rated barrier enclosure of the battery room complex that exceeds the fire load contained in the room. (b) Reduce the fire load to be within the fire barrier capability of 1-1/2 hours. OR (c) Provide a remote manual actuated sprinkler system in each room and provide the 1-1/2 hour fire barrier separation.	7. <u>Station Battery Rooms</u> SAME
8. <u>Turbine Lubrication and Control Oil Storage and Use Areas</u> A blank fire wall having a minimum resistance rating of three hours should separate all areas containing safety related systems and equipment from the turbine oil system	8. <u>Turbine Lubrication and Control Oil Storage and Use Areas</u> SAME. When a blank wall is not present, open head deluge protection should be provided for the turbine oil hazards and automatic open head water curtain protection should be provided for wall openings.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

9. Diesel Generator Areas

Diesel generators should be separated from each other and other areas of the plant by fire barriers having a minimum fire resistance rating of three hours.

Automatic fire suppression such as AFFF foam, or sprinklers should be installed to combat any diesel generator or lubricating oil fires. Automatic fire detection should be provided to alarm and annunciate in the control room and alarm locally. Drainage for fire fighting water and means for local manual venting of smoke should be provided.

Day tanks with total capacity up to 1100 gallons are permitted in the diesel generator area under the following conditions:

(a) The day tank is located in a separate enclosure, with a minimum fire resistance rating of three hours, including doors or penetrations. These enclosures should be capable of containing the entire contents of the day tanks. The enclosure should be ventilated to avoid accumulation of oil fumes.

(b) The enclosure should be protected by automatic fire suppression systems such as AFFF or sprinklers.

9. Diesel Generator Areas

SAME

When day tanks cannot be separated from the diesel-generator one of the following should be provided for the diesel generator area:

(a) Automatic open head deluge or open head spray nozzle system(s)

(b) Automatic closed head sprinklers

(c) Automatic AFFF that is delivered by a sprinkler deluge or spray system

(d) Automatic gas system (Halon or CO_2) may be used in lieu of foam or sprinklers to combat diesel generator and/or lubricating oil fires.

10. Diesel Fuel Oil Storage Areas

Diesel fuel oil tanks with a capacity greater than 1100 gallons should not be located inside the

10. Diesel Fuel Oil Storage Areas

SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
buildings containing safety related equipment. They should be located at least 50 feet from any building containing safety related equipment, or if located within 50 feet, they should be housed in a separate building with construction having a minimum fire resistance rating of three hours. Buried tanks are considered as meeting the three hour fire resistance requirements. See NFPA 30, "Flammable and Combustible Liquids Code", for additional guidance.	
When located in a separate building, the tank should be protected by an automatic fire suppression system such as AFFF or sprinklers.	
Tanks, unless buried, should not be located directly above or below safety related systems or equipment regardless of the fire rating of separating floors or ceilings.	In operating plants where tanks are located directly above or below the diesel generators and cannot reasonably be moved, separating floors and main structural members should, as a minimum, have fire resistance rating of three hours. Floors should be liquid tight to prevent leaking of possible oil spills from one level to another. Drains should be provided to remove possible oil spills and fire fighting water to a safe location.
	One of the following acceptable methods of fire protection should also be provided:
	(a) Automatic open head deluge or open head spray nozzle system(s)

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
	(b) Automatic closed head sprinklers; or (c) Automatic AFFF that is delivered by a sprinkler system or spray system.
11. Safety Related Pumps Pump houses and rooms housing safety related pumps or other safety related equipment should be separated from other areas of the plant by fire barriers having at least three-hour ratings. These rooms should be protected by automatic sprinkler protection unless a fire hazards analysis can demonstrate that a fire will not endanger other safety related equipment required for safe plant shutdown. Early warning fire detection should be installed with alarm and annunciation locally and in the control room. Local hose stations and portable extinguishers should also be provided. Equipment pedestals or curbs and drains should be provided to remove and direct water away from safety related equipment. Provisions should be made for manual control of the ventilation system to facilitate smoke removal if required for manual fire fighting operation.	11. Safety Related Pumps Pump houses and rooms housing safety related pumps should be protected by automatic sprinkler protection unless a fire hazards analysis can demonstrate that a fire will not endanger other safety related equipment required for safe plant shutdown. Early warning fire detection should be installed with alarm and annunciation locally and in the control room. Local hose stations and portable extinguishers should also be provided.
12. New Fuel Area Hand portable extinguishers should be located within this area. Also, local hose stations should be located outside but within hose reach of this area. Automatic fire detection should	12. New Fuel Area SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
alarm and annunciate in the control room and alarm locally. Combustibles should be limited to a minimum in the new fuel area. The storage area should be provided with a drainage system to preclude accumulation of water. The storage configuration of new fuel should always be so maintained as to preclude criticality for any water density that might occur during fire water application.	
13. Spent Fuel Pool Area	13. Spent Fuel Pool Area
Protection for the spent fuel pool area should be provided by local hose stations and portable extinguishers. Automatic fire detection should be provided to alarm and annunciate in the control room and to alarm locally.	SAME
14. Radwaste Building	14. Radwaste Building
The radwaste building should be separated from other areas of the plant by fire barriers having at least three-hour ratings. Automatic sprinklers should be used in all areas where combustible materials are located. Automatic fire detection should be provided to annunciate and alarm in the control room and alarm locally. During a fire, the ventilation systems in these areas should be capable of being isolated. Water should drain to liquid radwaste building sumps. Acceptable alternative fire protection is automatic fire detection to alarm and annunciate in the control room, in addition to manual hose stations and portable extinguishers consisting of hand held and large wheeled units.	SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
15. Decontamination Areas The decontamination areas should be protected by automatic sprinklers if flammable liquids are stored. Automatic fire detection should be provided to annunciate and alarm in the control room and alarm locally. The ventilation system should be capable of being isolated. Local hose stations and hand portable extinguishers should be provided as backup to the sprinkler system.	15. Decontamination Areas SAME
16. Safety Related Water Tanks Storage tanks that supply water for safe shutdown should be protected from the effects of fire. Local hose stations and portable extinguishers should be provided. Portable extinguishers should be located in nearby hose houses. Combustible materials should not be stored next to outdoor tanks. A minimum of 50 feet of separation should be provided between outdoor tanks and combustible materials where feasible.	16. Safety Related Water Tanks SAME
17. Cooling Towers Cooling towers should be of non-combustible construction or so located that a fire will not adversely affect any safety related systems or equipment. Cooling towers should be of non-combustible construction when the basins are used for the ultimate heat sink or for the fire protection water supply.	17. Cooling Towers SAME. Cooling towers of combustible construction, so located that a fire in them could adversely affect safety related systems or equipment should be protected with an open head deluge system installation with hydrants and hose houses strategically located.

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS

18. Miscellaneous Areas

Miscellaneous areas such as records storage areas, shops, warehouses, and auxiliary boiler rooms should be so located that a fire or effects of a fire, including smoke, will not adversely affect any safety related systems or equipment. Fuel oil tanks for auxiliary boilers should be buried or provided with dikes to contain the entire tank contents.

G. Special Protection Guidelines

1. Welding and Cutting, Acetylene - Oxygen Fuel Gas Systems

This equipment is used in various areas throughout the plant. Storage locations should be chosen to permit fire protection by automatic sprinkler systems. Local hose stations and portable equipment should be provided as backup. The requirements of NFPA 51 and 51B are applicable to these hazards. A permit system should be required to utilize this equipment. (Also refer to 2f herein.)

2. Storage Areas for Dry Ion Exchange Resins

Dry ion exchange resins should not be stored near essential safety related systems. Dry unused resins should be protected by automatic wet pipe sprinkler installations. Detection by smoke and heat detectors should alarm and annunciate in the control room and alarm locally. Local hose stations and portable extinguishers should provide backup for these areas. Storage areas of dry resin should have curbs and drains. (Refer to NFPA 92M, "Waterproofing and Draining of Floors.")

18. Miscellaneous Areas

SAME

G. Special Protection Guidelines

1. Welding and Cutting, Acetylene - Oxygen Fuel Gas Systems

SAME

2. Storage Areas for Dry Ion Exchange Resins

SAME

APPLICATION DOCKETED BUT CONSTRUCTION PERMIT NOT RECEIVED AS OF 7/1/76	PLANTS UNDER CONSTRUCTION AND OPERATING PLANTS
3. Hazardous Chemicals Hazardous chemicals should be stored and protected in accordance with the recommendations of NFPA 49, "Hazardous Chemicals Data." Chemicals storage areas should be well ventilated and protected against flooding conditions since some chemicals may react with water to produce ignition.	3. Hazardous Chemicals
4. Materials Containing Radioactivity Materials that collect and contain radioactivity such as spent ion exchange resins, charcoal filters, and HEPA filters should be stored in closed metal tanks or containers that are located in areas free from ignition sources or combustibles. These materials should be protected from exposure to fires in adjacent areas as well. Consideration should be given to requirements for removal of isotopic decay heat from entrained radioactive materials.	4. Materials Containing Radio-Activity SAME

NOV 1 6

ERRATA SHEET

FOR

Appendix A to Branch Technical Position APCSB 9.5-1,
"Guidelines for Fire Protection for Nuclear Power Plants"

Tabulated below are corrections to errors noted in Appendix A to Branch Technical Position APCSB 9.5-1.

1. Page 9.5.1-65 - Under B. add 1.
2. Page 9.5.1-69 - Change 3. to (c)
3. Page 9.5.1-70 - Change 4. to (d)
4. Page 9.5.1-83 - Line 4 change "have" to "hour."
5. Page 9.5.1-84 - Change C. to E.
6. Page 9.5.1-93 - Line 3 under 6. After 10A add "Installation" after "Portable Fire Extinguishers"
7. Page 9.5.1-93 - Change D. to F.
8. Page 9.5.1-108 - Change E. to G.

Also for your convenience, attached is a comparison of the Table of Contents for Branch Technical Position 9.5-1, Appendix A to BTP 9.5-1 and Regulatory Guide 1.120. It should be noted that (1) while the BTP and the Regulatory Guide contain almost verbatim identical information, the format and sequence of information presented in the two documents differ somewhat, and (2) the information sequence in Appendix A to BTP 9.5-1 parallels that in Regulatory Guide 1.120 rather than BTP 9.5-1.

ATTACHMENT

BRANCH TECHNICAL POSITION 9.5-1	APPENDIX A TO BTP 9.5-1	REGULATORY GUIDE 1.120
I. Definitions		
II. Introduction		A. Introduction
III. Discussion		B. Discussion
IV. Positions	Positions	C. Regulatory Position
A. Overall Requirements of a Nuclear Plant Fire Protection Program	A. Overall Requirements of Nuclear Plant Fire Protection Program	1. Overall Requirements of the Fire Protection Program
	B. Administrative Procedures, Controls and Fire Brigade	2. Administrative Procedures, Controls, and Fire Brigade
	C. Quality Assurance Program	3. Quality Assurance Program
B. General Guidelines for Plant Protection	D. General Guidelines for Plant Protection	4. General Plant Guidelines
1. Building Design	1. Building Design	a. Building Design
2. Control of Combustibles	2. Control of Combustibles	b. Control of Combustibles
3. Electrical Cable Construction, Cable Trays and Cable Penetrations	3. Electric Cable Construction, Cable Trays and Cable Penetrations	c. Electrical Cable Construction, Cable Trays, and Cable Penetrations
4. Ventilation	4. Ventilation	d. Ventilation
5. Lighting and Communications	5. Lighting and Communications	e. Lighting and Communications
6. Administrative Procedures, Controls and Fire Brigade		
7. Quality Assurance		
C. Fire Detection and Suppression	E. Fire Detection and Suppression	5. Fire Detection and Suppression
D. Guidelines for Specific Plant Areas	F. Guidelines for Specific Plant Areas	6. Guidelines for Specific Plant Areas
E. Special Protection Guidelines	G. Special Protection Guidelines	7. Special Protection Guidelines
		D. Implementation
V. References		References

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.5.2 COMMUNICATIONS SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - None

I. AREAS OF REVIEW

The PSB review of the communication system is limited to that portion of the system used in intra-plant and plant-to-offsite communications during transient, fire and accident conditions. The system is reviewed with respect to the following considerations: capability of the system to provide effective intra-plant communications and effective plant-to-offsite communications during transient, fire and accident conditions, including loss of offsite power.

The Emergency Planning Branch (EPB) verifies that the offsite communication system provided will satisfy emergency plan requirements, including notification of personnel and implementation of evacuation procedures (SRP Section 13.3).

II. ACCEPTANCE CRITERIA

Acceptability of the design of the communication system, as described in the applicant's safety analysis report (SAR), is based in part on the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience. There are no general design criteria or regulatory guides that directly apply to the safety-related performance requirements for the communication system. The PSB will use the following criterion to assess the system design capability: the communication system is acceptable if the integrated design of the system will provide effective communication between plant personnel in all vital areas during the full spectrum of accident or incident conditions (including fire) under maximum potential noise levels. Communications systems for fire fighting are acceptable if they meet the requirements of Branch Technical Position ASB 9.5-1.

III. REVIEW PROCEDURES

The information provided in the SAR pertaining to the design of the communication system will be evaluated to determine that intra-plant communication equipment needed in vital areas during recovery actions from transient, fire or accident conditions is provided. The reviewer will select and emphasize material from this SRP section, as may be appropriate for a particular case.

The design basis, design criteria, system description sections, and the analyses that demonstrate the effectiveness of the system when maximum plant noise levels are being generated during incident and accident conditions are reviewed to verify that the communication system will function effectively. The reviewer uses engineering judgment and compares the system capabilities with equipment provided for previously approved plants. The PSB will accept the communication system if a statement in the SAR commits the applicant to perform a functional test under conditions that simulate the maximum plant noise levels being generated during the various operating conditions, including fire and accident condition, to demonstrate system capabilities.

IV. EVALUATION FINDINGS

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

"The communication system includes all components for intra-plant and plant-to-offsite communications. The scope of review of the communications system for the ____________ plant included verification that offsite equipment is capable of providing for notification of personnel and implementation of evacuation procedures, and verification that onsite communications are adequate in the event of an emergency. [The review has determined the adequacy of the applicant's proposed design criteria and bases for the communication system and the requirements for all plant operation, fire and accident conditions. (CP)] [The review has determined that the design of the communications system and auxiliary supporting systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs, design criteria and design bases for the communications system and necessary auxiliary supporting systems to staff positions and industry standards, and the ability of the systems to provide effective communications between plant personnel in all vital areas during the full spectrum of accident or incident conditions under maximum potential noise levels.

"The staff concludes that the design of the communications system conforms to all applicable guides, staff positions and industry standards and is acceptable."

V. REFERENCES

1. Branch Technical Position ASB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants" (attached to SRP 9.5-1).

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.5.3 LIGHTING SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - None

I. AREAS OF REVIEW

The PSB review of the lighting system is limited to the emergency or supplementary lighting systems. The system is reviewed with respect to the following considerations: capability of the system to provide adequate emergency lighting during all operating conditions, including fire, transients and accident conditions, and the effect of the loss of offsite power on the emergency lighting system.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the lighting system, as described in the applicant's safety analysis report (SAR), is based in part on the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience. There are no general design criteria or regulatory guides that directly apply to the safety-related performance requirements for the lighting system. The PSB will use the following criterion to assess the system design capability: the emergency lighting system is acceptable if the integrated design of the system will provide adequate emergency station lighting in all areas, from onsite power sources, required for fire fighting, control and maintenance of safety-related equipment and the access routes to and from these areas. Emergency lighting for fire fighting is acceptable if it meets the requirements of Branch Technical Position ASB 9.5-1.

III. REVIEW PROCEDURES

The information provided in the SAR pertaining to the design of the emergency lighting system is evaluated to determine that the lighting in vital areas and essential passageways to and from these areas is adequate. Engineering judgment, in conjunction with a comparison to equipment provided on previously approved plants, is used as a basis for determining acceptability.

IV. EVALUATION FINDINGS

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

"The lighting system includes all components necessary to provide adequate lighting during both emergency and normal operating conditions. The scope of review of the lighting system for the ____________ plant included assessment of the adequacy of the emergency power sources and verification of adequacy during fire, transient and accident conditions. [The review has determined the adequacy of the applicant's proposed design criteria and design bases regarding the requirements for lighting during fire, transient and accident conditions. (CP)] [The review has determined that the design of the emergency lighting system and auxiliary supporting systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs and design criteria for the emergency lighting system and necessary auxiliary supporting systems to staff positions and industry standards.

"The staff concludes that the design of the lighting system conforms to all applicable staff positions and industry standards, and is acceptable."

V. REFERENCES

1. Branch Technical Position ASB 9.51, "Guidelines for Fire Protection for Nuclear Power Plants" (attached to SRP Section 9.5-1).

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.5.4 EMERGENCY DIESEL ENGINE FUEL OIL STORAGE AND TRANSFER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - Auxiliary Systems Branch (ASB)
Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)

I. AREAS OF REVIEW

Nuclear power plants are required to have redundant onsite emergency power sources of sufficient capacity to power safety-related equipment. In almost all cases, the onsite power sources include diesel engine-driven generator sets. SRP sections numbered 9.5.4 through 9.5.8 cover the review of various essential elements of the emergency diesel engine sets. This SRP Section 9.5.4 deals with the fuel oil storage and transfer system for these diesel engines up to the engine housing.

The PSB review of the emergency diesel engine fuel oil storage and transfer system (EDEFSS) is performed to assure conformance with the requirements of General Design Criteria 2, 4, 5 and 17 and includes all piping up to the connection to the engine, the fuel oil storage tanks, the fuel oil transfer pumps, day tanks and the tank storage vaults. In addition, the review includes the quality and the quantity of fuel oil stored on site, and the availability and procurement of additional fuel from offsite sources.

1. The diesel engine fuel oil storage and transfer system is reviewed to determine that:

    a. The system meets appropriate seismic design requirements.
    b. The system will be designed, fabricated, erected, and tested to acceptable quality standards.
    c. Sufficient space has been provided to permit inspection, cleaning, maintenance, and repair of the system.
    d. A minimum of seven days supply of fuel oil, for each redundant diesel generator system, has been provided onsite to meet the engineered safety feature load requirements following a loss of offsite power and a design basis accident.

e. Adequate and acceptable sources of fuel oil are available, including the means of transporting and recharging the fuel storage tank, following a design basis accident (DBA) so as to enable each redundant diesel generator system to supply uninterrupted emergency power for as long as may be required.

f. Seismic Category I structures housing the system protect it from natural phenomena and external missiles.

2. The PSB verifies that suitable precautions will be taken to prevent deleterious material from degrading the stored fuel and that periodic tests will be performed to verify that fuel degradation does not proceed to the point where engine performance is affected.

3. The PSB will determine the adequacy of the design, installation, inspection and testing of all electrical components required for reliable operation of the system, including interlocks.

4. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this section.

The review of the diesel engine fuel oil storage and transfer system will involve secondary review evaluations performed by other branches. Their evaluations are used by the PSB to complete the overall system evaluation. The evaluations performed by other branches are as follows. The SEB will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of structures to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic design qualification of components and confirm that components, piping, and structures are designed in accordance with applicable codes and standards. The ASB will determine that the assigned seismic and quality group classifications for system components are acceptable. The ASB also determines that the EDEFSS is in accordance with Branch Technical Positions ASB 3-1 and MEB 3-1 for cracks and breaks in high energy and moderate energy piping systems outside containment. The MTEB will verify that inservice inspection requirements are met for system components and upon request will verify the compatibility of the materials of construction with service conditions.

II. ACCEPTANCE CRITERIA

Acceptability of the diesel engine fuel oil storage and transfer system, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria, regulatory guides and industry standards. The review will also utilize information obtained from other federal agencies and reports, industry standards, military specifications, available technical literature, and operational performance data obtained from similarly designed systems at other plants having satisfactory operational experience.

The design of the diesel engine fuel oil storage and transfer system is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to the ability of structures housing the system and the system itself to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to the capability of shared systems and components important to safety to perform required safety functions.

4. General Design Criterion 17, as related to the capability of the fuel oil system to meet independence and redundancy criteria.

5. Regulatory Guide 1.26, as related to quality group classification of the system components.

6. Regulatory Guide 1.29, as related to the seismic design classification of the system.

7. Regulatory Guide 1.68, as related to preoperational and startup testing of the diesel engine fuel oil storage and transfer system.

8. Regulatory Guide 1.102, as related to the protection of structures, systems and components important to safety from the effects of flooding.

9. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

10. Regulatory Guide 1.137, as related to fuel oil systems design, fuel oil quality and tests.

11. Branch Technical Position ASB 9.5-1, as related to fuel oil system fire protection.

12. ANSI Standard N195, "Fuel Oil Systems for Standby Diesel Generators."

13. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

14. Branch Technical Position ICSB-17 (PSB), as related to diesel engine fuel oil system protective interlocks during accident conditions.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design meet the acceptance criteria given in Section II. For the review of operating license (OL) applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design. The OL review includes verification that the content and intent of the technical specifications prepared by the applicant are in agreement with requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Plant-to-plant variations in the design of fuel oil storage and transfer systems will occur due to the number of architect-engineering companies having design responsibility in this area. Differences may occur in the number of redundant systems, in piping interconnections between diesel engines, and in sharing requirements between units. The reviewer will select and emphasize material from the paragraphs below to fit the particular design under review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. The SAR is reviewed to verify that the diesel engine fuel oil storage and transfer system description and related diagrams clearly indicate all modes of system operation, including the means for indicating, controlling, and monitoring fuel oil level, temperature, and pressure as required for uninterrupted operation.

2. The reviewer verifies that the system is designed to withstand the effects of seismic events, other design basis, natural phenomena, and internally- and externally-generated missiles. The review of internally-generated missiles will consider the relative locations and orientation of components as placed in the facility.

3. Piping and interconnections between systems are reviewed to verify that single active failures will not cause unacceptable results. The associated drawings are examined to ascertain that sufficient space has been provided around the components to permit inspection, cleaning, maintenance, and repair.

4. The reviewer verifies that the design is such as to minimize the chance of deleterious material entering the system during recharging, or by operator error, or due to natural phenomena. The reviewer will ascertain that provisions or a program have been incorporated to assure that the quality of the stored fuel oil meets minimum requirements at all times.

5. The descriptive information and drawings in the SAR are reviewed to verify that:

   a. Each storage tank is equipped with an outside fill and vent line, located so as to minimize the chance of damage, and with the fill and vent point higher than the PMF flood level.
   b. The minimum onsite inventory of fuel oil for each redundant diesel generator system is sufficient to enable the diesel generators to power required engineered safety features for a period of seven days following any design basis accident and loss of offsite power.
   c. The day or integral tank associated with each diesel generator set is located at an elevation to assure a slight positive pressure at the engine fuel pumps.
   d. A day or integral tank o[illegible] line is provided to return excess fuel oil delivered by the transfer pump back to the fuel oil storage tank.
   e. A low level alarm is provided to enable the operator to accomplish minor repairs or maintenance before all fuel in the day or integral tank is consumed (assuming full power operation).

6. The reviewer verifies that suitable precautions will be taken, once the fuel oil tank has been filled, to exclude sources of ignition such as open flames or hot surfaces, and that protective measures such as compartmentation of redundant elements are used to minimize the potential causes and consequences of fires and explosions.

7. The reviewer verifies that the system function will be maintained as required in the event of failure of non-seismic Category I systems or structures located near the system. Reference to the SAR sections describing site features and the general arrangement and layout drawings will be necessary in this determination. Plant arrangement features, in conjunction with the protection obtained by location and the design of the system and structures, are considered in determining the ability of the system to maintain function in the event of such failures.

8. The diesel engine fuel oil storage and transfer system is reviewed to verify that protection from the effects of breaks in high and moderate energy lines has been provided. Layout drawings are reviewed to assure that no high or moderate energy piping systems are located close to the fuel oil system, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and the procedures for reviewing this information are given in the corresponding SRP sections.

9. The descriptive information, related system drawings, and the results of failure modes and effects analyses in the SAR are reviewed to verify that minimum system requirements will be met following design basis accidents assuming a concurrent single active component failure. For each case the design will be acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The diesel engine fuel oil storage and transfer system includes storage tanks, fill, vent, drain, and overflow return lines, fuel oil transfer pumps, strainers, filters, valves, day tanks, and all components and piping up to the connections to the engine. The scope of review of the diesel engine fuel oil storage and transfer system for the ____________________ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and auxiliary supporting systems essential to its operation. [The review has determined the adequacy of the applicant's proposed design criteria and design bases for the diesel engine fuel oil storage and transfer system, and the requirements for system performance during normal, abnormal, and accident conditions. (CP)] [The review has determined that the design of the diesel engine fuel oil storage and transfer system and auxiliary supporting systems is in conformance with the proposed design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's design criteria and bases for the diesel engine fuel oil storage and transfer system and necessary auxiliary supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

"The staff concludes that the design of the diesel fuel oil storage and transfer system conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCE

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 17, "Electric Power Systems."

5. Regulatory Guide 1.26, "Quality Group Classifications and Standards For Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

6. Regulatory Guide 1.29, "Seismic Design Classification."

7. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

8. Regulatory Guide 1.117, "Tornado Design Classification."

9. Regulatory Guide 1.137, "Diesel Generator Fuel Oil Systems."

10. Regulatory Guide 1.68, "Initial Test Programs for Water Cooled Reactor Power Plants."

11. ANSI Standard N195, "Fuel Oil Systems for Standby Diesel Generators," American National Standards Institute.

12. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

13. Branch Technical Position ASB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants" (attached to SRP Section 9.5-1)

14. Branch Technical Position ICSB-17 (PSB), "Diesel-Generator Protective Trip Circuit Bypasses."

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.5.5 EMERGENCY DIESEL ENGINE COOLING WATER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - Auxiliary Systems Branch (ASB)
Materials Engineering Branch (MTEB)
Mechanical Engineering Branch (MEB)
Structural Engineering Branch (SEB)

I. AREAS OF REVIEW

The emergency diesel engine cooling water system (EDECWS) provides cooling water to the station emergency diesel engines and is reviewed to assure conformance with General Design Criteria 2, 4, 5, 44, 45 and 46. The PSB review includes those portions of the EDECWS that receive heat from components essential for proper operation of the diesel engines and that are housed within their respective diesel engine compartments, and those additional parts of the system that transfer the heat to a heat sink. The system includes all valves, heat exchangers, pumps and piping up to the engine housing.

1. The PSB reviews the functional performance characteristics of the EDECWS and the effects on those characteristics of adverse environmental occurrences, abnormal operational requirements, accident conditions, and loss of offsite power.

2. The system is reviewed to determine that a malfunction or single failure of a component, or the loss of a cooling source, will not reduce the safety-related functional performance capabilities of the system. The PSB verifies that:

    a. System components and piping have sufficient physical separation or shielding to protect the system from internally- or externally-generated missiles and from pipe whip and jet impingement caused by cracks or breaks in high and moderate energy piping.

    b. System components are designed in accordance with the design codes required by the assigned quality group and seismic category classifications.

    c. The system is housed in structures designed to seismic Category I requirements.

    d. Failures of non-seismic Category I structures and components would not affect the safety-related functions of the EDECWS.

3. The PSB reviews the design of the EDECWS with respect to the following:

   a. Functional capability during periods of abnormally high water levels (the probable maximum flood).

   b. Capability to detect and control system leakage, including isolating portions of the system in the event of excessive leakage or component malfunction.

   c. Measures to preclude long-term corrosion and organic fouling that would degrade system cooling performance, and the compatibility of any corrosion inhibitors or antifreeze compounds used with the materials of the system.

   d. The capacity of the EDECWS with regard to the manufacturer's recommended engine temperature differentials under adverse operating conditions.

   e. Provision of proper instruments and testing systems to permit operational testing of the system.

   f. Provisions to assure that normal protective interlocks do not preclude engine operation during emergency conditions.

4. The PSB will determine the adequacy of design installation, inspection and testing of all electrical components (sensing, control and power) required for proper operation of the system, including interlocks.

5. The PSB will review the applicant's proposed technical specifications for operating license applications as they relate to areas covered in this SRP section.

Secondary reviews will be performed by other branches and the results used by the PSB to complete the overall evaluation of the system. The secondary reviews are as follows. The SEB will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of the Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as a safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic qualification testing of components and will determine that components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB will verify that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions. The ASB will determine that the seismic and quality group classifications for system components are acceptable. The ASB also determines that the EDECWS is in accordance with Branch Technical Positions ASB 3-1 and MEB 3-1 for cracks and breaks in high energy and moderate energy piping system outside containment.

II. ACCEPTANCE CRITERIA

Acceptability of the diesel engine cooling system design, as described in the applicant's safety analysis report (SAR), is based on specific General Design Criteria and regulatory guides. An additional basis for determining the acceptability of the system will be the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience. Listed below are the specific criteria as they relate to the EDECWS.

The system is acceptable if the design is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to the capability of shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 44, to assure:

    a. The capability to transfer heat from systems and components to a heat sink under transient or accident conditions.

    b. Redundancy of components so that under accident conditions the safety function can be performed assuming a single active component failure.

    c. The capability to isolate components of the system or piping, if required to maintain the system safety function.

5. General Design Criterion 45, as related to design provisions to permit periodic inspection of safety-related components and equipment of the system.

6. General Design Criterion 46, as related to design provisions to permit appropriate functional testing of safety-related systems or components to assure structural integrity and leaktightness, operability and performance of active components, and the capability of the system to function as intended under accident conditions.

7. Regulatory Guide 1.26, as related to the quality group classification of system components.

8. Regulatory Guide 1.29, as related to the seismic design classification of system components.

9. Regulatory Guide 1.68, as related to preoperational and startup testing of the diesel engine cooling water system.

10. Regulatory Guide 1.102, as related to the protection of structures, systems and components important to safety from the effects of flooding.

11. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

12. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

13. Branch Technical Position ICSB-17 (PSB), as it relates to engine cooling water protective interlocks during accident conditions.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license (OL) applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The procedures for OL reviews include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

The design of the diesel engine cooling water system may vary considerably from plant to plant due to the requirements of various diesel engine manufacturers, the number and type of secondary cooling loops used for heat removal, and the number of intermediate cooling loops required to transfer the rejected heat to the ultimate heat sink. Variations in design may also occur due to preferences of various architect-engineer firms. Therefore, for the purpose of this SRP section, a typical system is assumed. Any variance in the review procedure, to suit a particular design, will be such that the system review areas in subsection I are covered, and the system will meet the criteria in subsection II.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. The SAR is reviewed to establish that the EDECWS description and related diagrams clearly delineate system operation, individual and total heat removal rates required by components, and the margin in the design heat removal rate capability. The reviewer verifies the following:

   a. Failure of a piping interconnection, as shown on system piping and instrumentation diagrams (P&IDs), between subsystems does not cause total degradation of the EDECWS. The results of failure modes and effects analyses are used as a basis of acceptance.

   b. Provisions have been made to permit inspection of components, as shown on system layout drawings.

   c. The performance and water chemistry of the EDECWS is in conformance with the engine manufacturer's recommendations.

   d. The engine "first try" starting reliability has been increased by providing an independent loop for circulating heated water while the engine is in the standby mode.

   e. Temperature sensors have been provided to alert the operator when cooling water temperatures exceed the limits recommended by the manufacturer. Protective interlocks in this system are acceptable if the SAR indicates that the interlocks are in conformance with Branch Technical Position ICSB-17 (PSB).

2. The reviewer verifies that the EDECWS can be vented to assure that all spaces are filled with water. Statements in the SAR to the effect that the system design satisfies the above requirement are acceptable.

3. The reviewer verifies that system function will be maintained in the event of adverse environmental phenomena and loss of offsite power. The reviewer evaluates the system, using engineering judgment and the results of failure modes and effects analyses to determine that:

   a. Failure of non-essential portions of the system or of other systems not designed to seismic Category I requirements and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the EDECWS, will not preclude essential functions. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR to the effect that the above conditions are met are acceptable.

   b. The essential portions of the system are protected from the effects of floods, hurricanes, tornadoes, and internally- and externally-generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under the SRP sections for Chapter 3 of the SAR. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles, is acceptable.

4. The reviewer verifies that there are no high or moderate energy piping systems located close to the EDECWS or that the EDECWS is protected from the effects of postulated breaks in these systems. The means of providing such protection are given in Chapter 3 of the SAR and procedures to review the information presented are given in the SRP sections for that chapter.

5. The descriptive information, P&IDs, onsite emergency power supply drawings, and system analyses are reviewed to assure that essential portions of the system will function following design basis accidents, assuming a concurrent single active component failure. The reviewer evaluates the results of failure modes and effects analyses presented in the SAR to ensure the functioning of required portions of the system.

6. The performance requirements of the diesel engine are reviewed to determine the time available to provide cooling water to the diesels and the other systems that have to operate to assure onsite power capability.

7. The reviewer verifies that the EDECWS and the diesel generator can perform during periods when less than full electrical power generation is required.

IV. EVALUATION FINDINGS

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

"The emergency diesel engine cooling water system includes all piping, valves, heat exchangers, and pumps up to the points where the cooling water piping connects to the engine housings. The scope of review of the diesel engine cooling water system for the _______________ plant included layout drawings, process flow diagrams, piping and instrumentation diagrams, and descriptive information for the system and auxiliary supporting systems that are essential to its operation. [The review has determined the adequacy of the applicant's proposed design criteria and bases for the emergency diesel engine cooling water system, and the requirements for continuous cooling during all conditions of plant operation. (CP)] [The review has determined that the design of the diesel engine cooling water system and auxiliary supporting systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs and design criteria for the diesel engine cooling water system and necessary auxiliary 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.

"The staff concludes that the design of the diesel engine cooling water system conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 44, "Cooling Water System."

5. 10 CFR Part 50, Appendix A, General Design Criterion 45, "Inspection of Cooling Water System."

6. 10 CFR Part 50, Appendix A, General Design Criterion 46, "Testing of Cooling Water System."

7. Regulatory Guide 1.26, "Quality Group Classifications and Standards For Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

8. Regulatory Guide 1.29, "Seismic Design Classification."

9. Regulatory Guide 1.68, "Initial Test Programs for Water Cooled Reactor Power Plants."

10. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

11. Regulatory Guide 1.117, "Tornado Design Classification."

12. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

13. Branch Technical Position ICSB-17 (PSB), "Diesel-Generator Protective Trip Circuit Bypasses."

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.5.6 EMERGENCY DIESEL ENGINE STARTING SYSTEM

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - Auxiliary Systems Branch (ASB)
Mechanical Engineering Branch (MEB)
Structural Engineering Branch (SEB)
Materials Engineering Branch (MTEB)

I. AREAS OF REVIEW

The PSB review of the emergency diesel engine starting system EDESS includes those system features necessary to assure reliable starting of the emergency diesel engine following a loss of offsite power to assure conformance with the requirements of General Design Criteria 2, 4 and 5. The review includes the system air compressors, air receivers, devices to crank the diesel engine, valves, piping, filters, and associated ancillary instrumentation and control systems.

1. The PSB reviews the EDESS to verify that:

   a. Each emergency diesel engine has reliable, redundant starting systems of adequate starting capacity.

   b. The system complies with appropriate seismic requirements and quality standards, and has been properly designed, fabricated, erected, and tested.

   c. Essential portions of the system are housed within seismic Category I structures capable of protecting the system from extreme natural phenomena, missiles, and the effects of pipe whip or jet impingement from high and moderate energy pipe breaks.

2. The PSB will determine the adequacy of design, installation, inspection and testing of all electrical components (sensing, control and power) required for proper operation of the system, including interlocks.

3. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this SRP section.

Secondary reviews are performed by other branches and the results used by the PSB to complete the overall evaluation of the system. The evaluations performed by others are as follows. The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of structures housing the system to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB reviews the seismic qualification testing of components and confirms that components, piping, and structures are designed in accordance with applicable codes and standards. The ASB determines that the assigned seismic and quality group classifications for system components are acceptable. The ASB also determines that the EDESS is in accordance with Branch Technical Positions ASB 3-1 and MEB 3-1 for breaks in high energy and moderate energy piping systems outside containment. The MTEB verifies that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions.

II. ACCEPTANCE CRITERIA

Acceptability of the diesel engine starting system, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides. An additional basis for acceptability is the similarity of the EDESS design with that of previously reviewed plants having satisfactory operating experience.

The design of the EDESS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to the ability of structures housing the system to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR.

2. General Design Criterion 4, with respect to structures housing the systems and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to the capability of shared systems and components important to safety to perform required safety functions.

4. Regulatory Guide 1.26, as related to quality group classification of the system components.

5. Regulatory Guide 1.29, as related to the system seismic design classification.

6. Regulatory Guide 1.68, as related to preoperational and startup testing of the air starting system.

7. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

8. Branch Technical Position ICSB-17 (PSB), as related to engine air starting system protective interlock during accident conditions.

9. The EDESS should also meet the following specific criteria:

   a. Each diesel engine should be provided with an air compressor and with independent and redundant starting systems, each consisting of two air receivers, injection lines and valves, and devices to crank the engine.

   b. As a minimum, each of the redundant starting systems should be capable of cranking a cold diesel engine five times without recharging the receivers. Each cranking cycle duration should be approximately three seconds, or consist of two to three engine revolutions, whichever cranking cycle time interval is larger.

   c. Alarms should be provided which alert operating personnel if the air receiver pressure falls below the minimum allowable value.

   d. Provisions should be made for the periodic or automatic blowdown of accumulated moisture and foreign material in the air receivers.

For those areas of review identified in subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license (OL) applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The review procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed during the review. The reviewer will select and emphasize material from the paragraphs below, as may be appropriate for a particular case.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. The reviewer establishes that the EDESS description and piping and instrumentation drawings (P&IDs) clearly delineate all modes of operation and include the means for monitoring, indicating, and controlling receiver air pressure as required by the engine starting service. The P&IDs are reviewed to determine that each receiver has been provided with a pressure gauge, relief valve, drain valve, an automatic

means of maintaining the receiver pressure within an allowable range, and suitable low pressure alarms. If there are piping interconnections between shared systems, they are reviewed to verify that failure could not lead to the loss of starting of more than one diesel engine. The building layout drawings are examined to ascertain that sufficient space has been provided around the components to permit inspection. The reviewer verifies that essential portions of the EDESS are classified seismic Category I.

2. The SAR is reviewed to assure that each diesel engine has its own compressor and that the compressor capacity is adequate with respect to the air receiver capacities of the redundant starting systems.

3. The reviewer verifies that the system has been designed to be operated and maintained in the event of adverse environmental conditions such as hurricanes, tornadoes, or floods, and is protected against the effects of internally- or externally-generated missiles.

4. The reviewer determines that the failure of non-seismic Category I systems, structures, or components located close to the EDESS will not preclude operation of the system.

5. The reviewer determines that essential portions of the EDESS are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to the system, or that protection from the effects of failure are provided. The means of providing such protection are discussed in Section 3.6 of the SAR and the procedures for reviewing this information are given in the corresponding SRP sections.

6. The SAR information, P&IDs, related system drawings, and failure modes and effects analyses are reviewed to assure that minimum requirements of the system will be met following design bases accidents, assuming a concurrent single active failure and loss of offsite power. The analyses presented in the SAR are reviewed to assure function of required components following postulated accidents. Utilizing the descriptions, related drawings, and analyses, the reviewer verifies that minimum system requirements are met for each degraded situation over the required time spans. For each case the design is considered acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The emergency diesel engine starting system includes the features necessary to assure that the system will be available and capable of starting the diesel engine following a loss of offsite power. The scope of review of the system for the ______________

_____________ plant included layout drawings, flow diagrams, piping and instrumentation diagrams, and descriptive information for the emergency diesel engine starting system and supporting systems essential to its operation. [The review has determined the adequacy of the applicant's proposed design criteria and design bases for the system, and the provisions necessary for diesel engine starting during all conditions of plant operation. (CP)] [The review has determined that the design of the emergency diesel engine starting system and supporting systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the review has been conformance of the applicant's designs and design criteria for the emergency diesel engine starting system and necessary supporting systems to the Commission's regulations as set forth in the General Design Criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

"The staff concludes that the design of the emergency diesel engine starting system conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. <u>REFERENCES</u>

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards For Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

5. Regulatory Guide 1.29, "Seismic Design Classification."

6. Regulatory Guide 1.68, "Initial Test Programs for Water Cooled Reactor Power Plants."

7. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

8. Branch Technical Position ICSB-17 (PSB), "Diesel Generator Protective Trip Circuit Bypasses," attached to SRP Appendix 8-A.

NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.5.7 EMERGENCY DIESEL ENGINE LUBRICATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - Mechanical Engineering Branch (MEB)
Structural Engineering Branch (SEB)
Materials Engineering Branch (MTEB)
Auxiliary Systems Branch (ASB)

I. AREAS OF REVIEW

The emergency diesel engine lubrication system (EDELS) provides essential lubrication to the components of the emergency diesel engines. The PSB reviews the EDELS and associated auxiliary systems to assure conformance with the requirements of GDC 2, 4 and 5. The review includes system piping, pumps, components, and associated ancillary equipment essential for system operation up to the engine housing.

1. The PSB reviews the characteristics of the EDELS and system components with respect to the effect on functional performance of adverse environmental occurrences, abnormal operational requirements, and accident conditions.

2. The PSB determines that a malfunction or failure of a component, or the loss of a cooling source does not reduce the safety-related functional performance capabilities of the emergency powered systems. Further, the PSB review assures that:

   a. System components and piping have sufficient physical separation or barriers to protect the system from internally and externally generated missiles.

   b. The system is protected from the effects of pipe cracks or breaks in high and moderate energy piping.

   c. System components are designed in accordance with the design codes required by the assigned quality group and seismic category classifications.

   d. The system is housed in structures designed to seismic Category I requirements.

   e. Failure of non-seismic Category I structures or components will not affect the safety-related functions of the system.

3. The PSB will also review the design of the EDELS with respect to the following:

   a. Functional capability during abnormally high site water levels (probable maximum flood).

   b. Capability for detection and control of system leakage.

   c. Measures to assure the quality of the lubricating oil.

   d. Capability for isolating portions of the system in the event of excessive leakage or component malfunction.

   e. Instrumentation and control features provided to permit operational testing of the system and to assure that normal protective interlocks do not preclude engine operation during emergency conditions.

4. The PSB will determine the adequacy of the design, installation, inspection and testing of all electrical components (sensing, control, and power) required for proper operation of the system, including interlocks.

5. The PSB will review the applicant's proposed technical specifications for operating license applications as they relate to areas covered in this SRP Section.

Secondary reviews will be performed by other branches and the results of their reviews will be used by the PSB to complete the overall evaluation of the system. The secondary reviews are as follows. The SEB will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic qualification testing of components and will determine that the components, piping, and structures are designed in accordance with applicable codes and standards. The ASB will determine that the seismic and quality group classifications for system components are acceptable. The ASB also determines that the EDELS is in accordance with Branch Technical Position ASB 3-1 and MEB 3-1 for breaks in high energy and cracks in moderate energy piping systems outside containment. The MTEB will verify that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions.

II. ACCEPTANCE CRITERIA

Acceptability of the emergency diesel engine lubrication system, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides. The reviewer will also utilize information obtained from other sources such as other federal agencies, published reports, industry standards, military specifications, and technical literature on commercially available products.

An additional basis for the acceptability of the system will be the degree of similarity with systems in previously reviewed plants with satisfactory operating experience.

The design of the EDELS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety being capable of performing required safety functions.

4. Regulatory Guide 1.26, as related to quality group classification of the system components.

5. Regulatory Guide 1.29, as related to the seismic design classification of system components.

6. Regulatory Guide 1.68, as related to preoperational and startup testing of the diesel engine lubrication oil system.

7. Regulatory Guide 1.102, as related to the protection of structures, systems and components important to safety from the effects of flooding.

8. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

9. Branch Technical Positions ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping outside containment.

10. Specific design criteria as follows:

    a. The operating pressure, temperature differentials, flow rate, and heat removal rate of the system external to the engine are in accordance with recommendations of the engine manufacturer.

    b. The system has been provided with sufficient protective measures to maintain the required quality of the oil during engine operation.

c. Protective measures (such as relief ports) have been taken to prevent unacceptable crankcase explosions and to mitigate the consequences of such an event.

d. The temperature of the lubricating oil is automatically maintained above a minimum value by means of an independent recirculation loop including its own pump and heater, to enhance the "first try" starting reliability of the engine in the standby condition.

11. Branch Technical Position ASB 9.5-1, as related to lube oil system fire protection.

12. Branch Technical Position ICSB-17 (PSB), as it relates to diesel engine lubrication system protective interlocks during accident conditions.

For those areas of review identified in Subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

The OL review includes a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in Subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

1. The SAR is reviewed to establish that the EDELS description and related diagrams clearly delineate system operation, including the means provided for indicating and monitoring oil levels, temperatures, and pressures required for continuous operation of the system. The reviewer verifies the following:

a. Failure of a piping interconnection, as shown on the system piping and instrumentation diagrams (P&IDs) between subsystems will not cause total degradation of the lube oil system function. The results of failure modes and effects analyses will be used in this determination.

b. The system layout drawings are examined to ascertain that sufficient space has been provided to permit inspection of components.

c. The system has been designed to preclude the entry of deleterious material into the system due to operator error or extreme natural phenomena during recharging or normal operation. The system is acceptable if it is shown in the SAR that the system is locked closed, or if entry is administratively controlled.

d. The design contains an independent circulation loop to maintain the temperature of the crankcase oil above a minimum value during the standby mode.

e. The system P&IDs indicate the temperature, pressure, and level sensors which alert the operator when these parameters exceed the ranges recommended by the engine manufacturer.

f. Essential portions of the EDELS are classified seismic Category I.

2. The reviewer determines that the system is designed to maintain function under adverse environmental phenomena. The reviewer, using engineering judgment and the results of failures modes and effects analyses, determines that:

a. The failure of systems not designed to seismic Category I requirements or of non-seismic Category I structures that house, support, or are close to the EDELS, will not preclude functioning of the system. Chapters 2 and 3 of the SAR describe related site features and provide the general structural arrangement and layout drawings and a tabulation of seismic design classifications for the structures and systems. Statements in the SAR to the effect that the above design requirements are met are acceptable.

b. The essential portions of the system are protected from the effects of floods, hurricanes, tornadoes, and internally and externally generated missiles.

3. The review verifies that the EDELS is protected from the effects of breaks in high and moderate energy lines. The system description in the SAR is reviewed to verify that there are no high or moderate energy piping systems close to the lube oil system, or that protection from effects of failure will be provided. The means of providing such protection are given in Chapter 3 of the SAR and

procedures to review the information presented are given in the corresponding SRP sections.

4. The descriptive information, P&IDs, related system drawings, and system analyses in the SAR are reviewed to assure that essential portions of the system will function following design basis accidents, assuming a concurrent single active component failure. The reviewer evaluates the results of failure modes and effects analyses presented in the SAR to assure functioning of required components, traces the availability of these components on system drawings, and checks that minimum system requirements are met for each degraded situation over required time spans. For each case, the design is acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

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

"The emergency diesel engine lubrication system includes the pumps, heat exchangers, valves, piping, makeup piping, and the points of connection or interfaces with other systems. The scope of review of the emergency diesel engine lubrication system for the ______________________ plant included layout drawings, flow diagrams, piping and instrumentation diagrams, and descriptive information for the system and supporting systems that are essential to its operation. [The review has determined the adequacy of the applicant's proposed design criteria and bases for the emergency diesel engine lubrication system and the requirements for system performance under all conditions of plant operation. (CP)] [The review has determined that the design of the emergency diesel engine lubrication system and auxiliary supporting systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs and design criteria for the emergency diesel engine lubrication system and necessary supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

"The staff concludes that the design of the emergency diesel engine lubrication system conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards For Water, Steam, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

5. Regulatory Guide 1.29, "Seismic Design Classification."

6. Regulatory Guide 1.68, "Initial Test Programs for Water Cooled Reactor Power Plants."

7. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

8. Regulatory Guide 1.117, "Tornado Design Classification."

9. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to the SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

10. Branch Technical Position ASB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Stations" (attached to SRP 9.5-1).

11. Branch Technical Position ICSB-17 (PSB), "Diesel-Generator Protective Trip Circuit Bypasses," attached to SRP section Appendix 8A.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.5.8 EMERGENCY DIESEL ENGINE COMBUSTION AIR INTAKE AND EXHAUST SYSTEM

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - Auxiliary Systems Branch (ASB)
Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)

I. AREAS OF REVIEW

The emergency diesel engine combustion air intake and exhaust system (EDECAIES) supplies combustion air of reliable quality to the diesel engines, and exhausts the products of combustion from the diesel engines to the atmosphere. The PSB reviews the system from the outside air intake to the combustion air supply lines connected to the diesel engines, and from the exhaust connections at the diesel engines to the discharge point outside the building to assure conformance with General Design Criteria 2, 4 and 5.

1. The PSB reviews the EDECAIES to verify that:

   a. The system design meets appropriate seismic design classification requirements and the components are designed, fabricated, erected, and tested to acceptable quality standards.

   b. The essential portions of the system are housed in or on a seismic Category I structure that is capable of protecting the system from extreme natural phenomena and external missiles.

   c. Each diesel engine has an independent combustion air intake and exhaust system.

   d. The consequenes of a single active failure in an engine combustion air intake or exhaust system will not lead to the loss of function of more than one diesel generator.

2. The PSB will determine the adequacy of the design, installation, inspection and testing of all electrical systems (sensing, control and power) required for proper system operation.

3. The applicant's proposed technical specifications are reviewed by PSB for operating license applications, as they relate to areas covered in this SRP section.

Secondary reviews will be performed by other branches and the results used by the PSB to complete the overall evaluation of the system. The secondary reviews are as follows. The SEB will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic qualification of components and confirm that system components, piping, and structures are designed in accordance with applicable codes and standards. The ASB will determine that the seismic and quality group classifications for system components are acceptable. The ASB also determines that the EDECAIES is in accordance with Branch Technical Position ASB 3-1 and MEB 3-1 for cracks and breaks in high energy and moderate energy piping systems outside containment. The MTEB will verify that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the emergency diesel generator combustion air intake and exhaust system, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides. An additional basis for determining the acceptability of the EDECAIES will be the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience.

The design of the EDECAIES is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to the ability of structures housing the system and system components to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the systems and the system components being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as related to shared systems and components important to safety being capable of performing required safety functions.

4. Regulatory Guide 1.26, as related to quality group classification of the system components.

5. Regulatory Guide 1.29, as related to the seismic design classification of system components.

6. Regulatory Guide 1.68, as related to preoperational and startup testing of the combustion air and exhaust system.

7. Regulatory Guide 1.102, as related to the protection of structures, systems and components important to safety from the effects of flooding.

8. Regulatory Guide 1.117, as related to the protection of structures, systems and components important to safety from the effects of tornado missiles.

9. Each emergency diesel engine should be provided with an independent and reliable combustion air intake and exhaust system. The system should be sized and physically arranged such that no degradation of engine function will be experienced when the diesel generator set is required to operate continuously at the maximum rated power output.

10. The combustion air intake system shall be provided with a means of reducing airborne particulate material over the entire time period that emergency power is required assuming the maximum airborne particulate concentration at the combustion air intake.

11. Suitable design precautions have been taken to preclude degradation of the diesel engine power output due to exhaust gases and other dilutents that could reduce the oxygen content below acceptable levels.

12. Branch Technical Position ASB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping outside containment.

13. Branch Technical Position ICSB 17 (PSB), as it relates to diesel engine air intake and exhaust system protective interlocks during accident conditions.

For those areas of review identified in Subsection I of this SRP section as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in Subsection II. For the review of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

The review procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the secondary review branches will provide input for the areas of review stated in Subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The reviewer will select and emphasize material from the paragraphs below, as may be appropriate for a particular case.

1. The SAR is reviewed to determine that the EDECAIES description and related diagrams clearly delineate the system components and the modes of system operation. The reviewer verifies that essential portions of the EDECAIES are designed to appropriate seismic and quality group classification standards.

2. The SAR is reviewed to ascertain that sufficient space has been provided around the components to permit inspection of the system components.

3. The SAR is reviewed to assure that the arrangement and location of the combustion air intake and exhaust are such that dilution or contamination of the intake air by exhaust products or other gases that may intentionally or accidentally be released on site will not preclude operation of the diesel engines at rated power output.

4. The SAR is reviewed to verify that if the intake air flow or engine exhaust is dependent upon the actuation of flow control devices (louvers, dampers), the EDECAIES will function if there is a failure of an active component.

5. The SAR is reviewed to assure that system components exposed to atmospheric conditions (rain, ice, snow) are protected from possible clogging during standby or operation of the system.

6. The review verifies that the system will function as required in the event of other adverse natural phenomena. The reviewer evaluates the system, using engineering judgment and failure modes and effects analyses to determine that:

   a. The failure of nonessential portions of the system or of other systems not designed to seismic Category I requirements and located close to essential portions of the system, or of non-seismic Category I structures that house, support, or are close to essential portions of the EDECAIES, will not preclude operation of the system. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR that verify that the above conditions are met are acceptable.

b. The essential portions of the system are protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under the SRP sections for Chapter 3 of the SAR. The location and the design of the systems and structures are reviewed to determine that the degree of protection provided is adequate. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable.

c. The essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to the essential portions of the system, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing this information are given in the corresponding SRP sections.

7. The descriptive information, P&IDs, EDECAIES layout drawings, and failure modes and effects analyses in the SAR are reviewed to assure that functional requirements of the system will be met following design basis accidents assuming a concurrent single active component failure. The reviewer evaluates the effects of failure of components, traces the availability of redundant components on system drawings, and checks that the SAR contains verification that the system functional requirements are met.

IV. EVALUATION FINDINGS

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

"The emergency diesel generator combustion air intake and exhaust system (EDECAIES) includes all components and piping of the air intake system from the atmospheric air intake to its connection to the engine and all components and piping of the exhaust system from its connection to the engine to the point where it exhausts to the atmosphere. The scope of the review of the EDECAIES for the _______________ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and auxiliary supporting systems that are essential to its safe operation. [The review has determined the adequacy of the applicant's proposed design criteria and bases for the emergency diesel generator combustion air intake and exhaust system and requirements for safe operation of the system during normal, abnormal and accident conditions. (CP)] [The review has determined that the design of the emergency diesel generator combustion air intake and exhaust system and auxiliary supporting systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs, design criteria, and design bases for the emergency diesel generator combustion air intake and exhaust system and its 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.

"The staff concludes that the design of the emergency diesel generator combustion air intake and exhaust system conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. Regulatory Guide 1.26, "Quality Group Classifications and Standards For Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

5. Regulatory Guide 1.29, "Seismic Design Classification."

6. Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Reactor Power Plants."

7. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."

8. Regulatory Guide 1.117, "Tornado Design Classification."

9. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

10. Branch Technical Position ICSB-17 (PSB) Diesel-Generator Protective Trip Circuit Bypasses.