Safety Evaluation Report

NUREG-0315

U. S. Nuclear Regulatory Commission

related to the preliminary design of the

Office of Nuclear Reactor Regulation

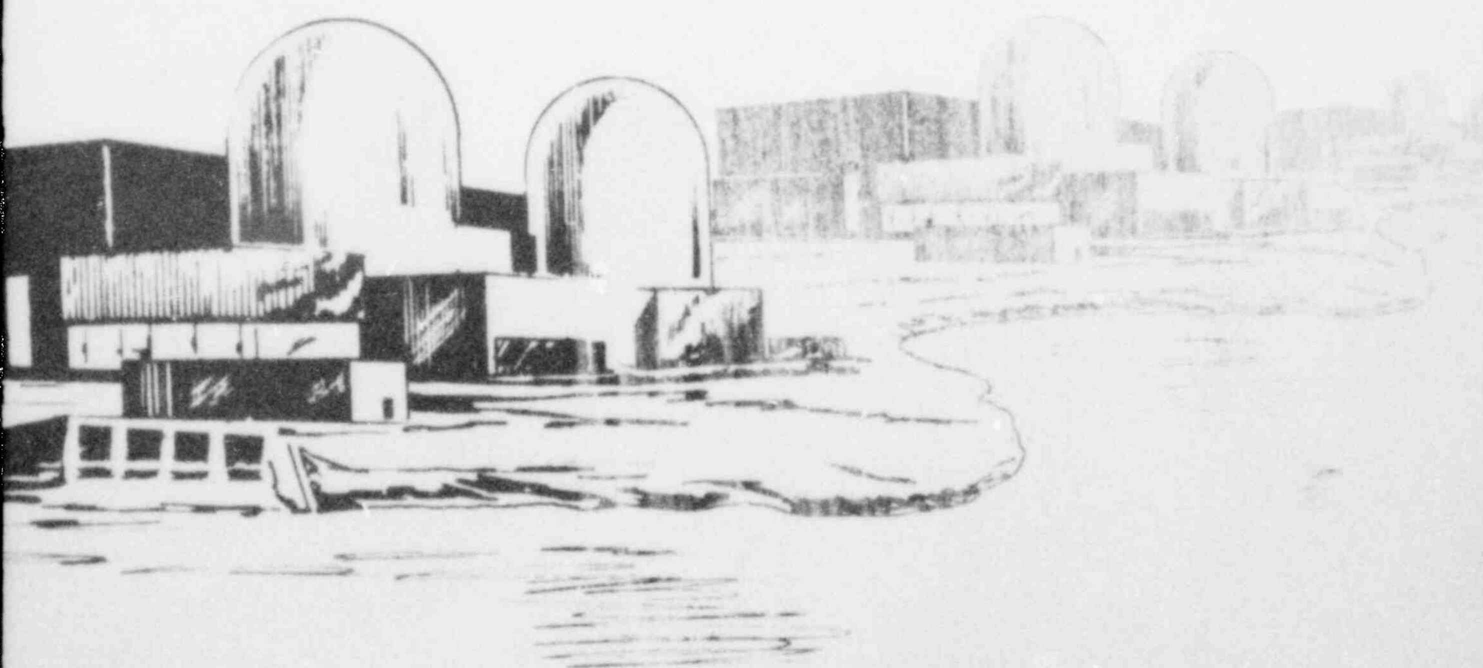
Balance of Plant Standard Safety Analysis Report (BOPSSAR)

Docket No. STN 50-560

August 1977

(and its relationship to the RESAR-41 Standard Reference System)

Fluor Pioneer Inc.



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NUREG-0315

August 17, 1977

SAFETY EVALUATION REPORT

BY THE

OFFICE OF NUCLEAR REACTOR REGULATION

IN THE MATTER OF

FLUOR PIONEER INC.

BALANCE OF PLANT STANDARD SAFETY ANALYSIS REPORT

BOPSSAR

(AND ITS RELATIONSHIP TO THE RESAR-41 STANDARD NSSS DESIGN)

DOCKET NO. STN 50-560

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1.0 INTRODUCTION AND GENERAL DISCUSSION

1.1 Introduction

Fluor Pioneer Inc. (hereinafter referred to as Fluor Pioneer) tendered on November 17, 1975, with the United States Nuclear Regulatory Commission (the Commission), a proposed preliminary standard design for the balance-of-plant portion, designated as BOPSSAR, of a pressurized water reactor nuclear power plant. This submittal was in the form of an application for a Preliminary Design Approval by the Commission in response to Option 1 of the Commission's standardization policy, WASH-1341, "Programmatic Information for the Licensing of Standardized Nuclear Power Plants." Option 1 allows for the review of a "reference system" that involves an entire facility design or major fraction of a facility design outside the context of a license application. The application was docketed on January 27, 1976 under Docket No. STN 50-560.

In August 1974, the Commission issued its standardization program plan, WASH-1341. Amendment 1 to WASH-1341, discussing "options" and "overlaps," was issued January 16, 1975. The regulations governing the submittal and review of standard designs under the "reference system" option are stated in Appendix O to Part 50 and Section 2.110 of Part 2 of Title 10 of the Code of Federal Regulations (hereinafter referred to as 10 CFR).

A safety analysis report, "Balance of Plant Standard Safety Analysis Report, BOPSSAR," was submitted with the application, and is referred to in this report as BOPSSAR. The information in BOPSSAR has been supplemented by Amendments 1 through 14. BOPSSAR and its amendments are available for public inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C.

The preliminary design and analyses of structures, systems, and components that comprise the balance-of-plant portion of a standard pressurized water reactor nuclear plant are presented in BOPSSAR. The BOPSSAR design does not include a nuclear steam supply system, but the application includes by reference the standard pressurized water reactor nuclear steam supply system described in the report "Reference Safety Analysis Report, RESAR-41," (hereinafter referred to as RESAR-41), a design by Westinghouse Electric Corporation. Our evaluation of RESAR-41 (Docket No. STN 50-480) is presented in our Safety Evaluation Report for RESAR-41 (NUREG-75/103), issued in December 1975. A Preliminary Design Approval for RESAR-41 was issued on December 31, 1975. RESAR-41 is designed for a core thermal power of 3800 megawatts.

This report presents our evaluation of the BOPSSAR design and its relationship to the RESAR-41 standard nuclear steam supply system design. We have referenced RESAR-41 in this report as appropriate to clarify or support our evaluation of BOPSSAR. This report delineates the technical matters considered in our evaluation of the radiological safety aspects of the BOPSSAR design. The application is not related to a specific site for the construction of the BOPSSAR plant and does not include specific site information. We, therefore, have not performed an environmental review of the BOPSSAR design and have not written an environmental impact statement. We will evaluate the environmental impact of the BOPSSAR design at a specific site during our review of an application for a construction permit which references the BOPSSAR design.

Based on our evaluation, we conclude that the proposed BOPSSAR preliminary design of a standard balance-of-plant can be combined with the RESAR-41 standard nuclear steam supply system design, can be incorporated by reference in a construction permit application, and can be constructed without endangering the health and safety of the public. Our detailed conclusions are presented in Section 19.0 of this report.

The review and evaluation presented in this report is the first stage of our continuing review of the design, construction, and operating features of the BOPSSAR design. Prior to a decision on issuance of an operating license for any application referencing BOPSSAR, we will review the final BOPSSAR design to determine that all of the Commission's safety requirements have been met in accordance with Appendix O to 10 CFR Part 50. The specific facility can then be operated only in accordance with the terms of the operating license for that facility and the Commission's regulations under the continued surveillance of the Commission's staff.

In the course of our review of the application, we held meetings with representatives of Fluor Pioneer to discuss the plant design and analysis. During our review, we requested Fluor Pioneer to provide additional information that we needed for our evaluation. This additional information was provided in amendments to BOPSSAR. As a result of our review, a number of changes were made in the facility design. These changes are described in the amendments to the BOPSSAR application and are discussed in appropriate sections of this report.

A chronology of the principal actions relating to the processing of the BOPSSAR application is included as Appendix A to this report; a bibliography is included as Appendix B; our discussion of the generic items delineated by the Advisory Committee on Reactor Safeguards is included as Appendix C; and the report of the Advisory Committee on Reactor Safeguards is included as Appendix D.

The BOPSSAR design does not include all portions of a nuclear power plant facility. It includes by reference the RESAR-41 standard nuclear steam supply system design. The BOPSSAR design is, therefore, based on safety-related interface requirements that are established in RESAR-41. The BOPSSAR design does not include portions of the facility that must be matched to the characteristics of a specific site or to a specific utility applicant. Fluor Pioneer has, therefore, established interface requirements for those systems or programs that are not within the scope of BOPSSAR and which must be addressed by a utility applicant that references the BOPSSAR design in its application for a construction permit. The status of our review of the interface information is described in Section 1.8 of this report.

The proposed design of the balance-of-plant described in BOPSSAR does not include any of the systems that have been identified as optional in the RESAR-41 application and that are addressed in Appendix A of our RESAR-41 Safety Evaluation Report. Fluor Pioneer, however, has taken two exceptions to the interface requirements of RESAR-41. These exceptions, which are the new and spent fuel storage racks and the power supply to the residual heat removal pumps, are discussed in Sections 9.1.1 and 8.3.1.2, respectively, of this report. With these exceptions, the BOPSSAR design is compatible with the standard nuclear steam supply system described in RESAR-41 that is within the scope of a standard nuclear steam supply system design as defined in Amendment 1 to WASH-1341.

1.2 General Plant Description

The BOPSSAR standard balance-of-plant design discussed in this report complements the RESAR-41 standard nuclear steam supply system design which is incorporated by reference in BOPSSAR. With the exception of site-related aspects, such as the ultimate heat sink and service water pump house, and with the exception of utility-related aspects, such as the preoperational test program and the utility applicant's selection of turbine generator, the combination of the BOPSSAR design with the RESAR-41 design results in a complete nuclear power plant. A listing of the major structures, systems, components, and services within the scope of BOPSSAR is presented in Table 1-1 of this report. A more detailed listing is presented in Table 1.7-1 of BOPSSAR which, in addition, lists the major structures, systems, components, and services within the scope of RESAR-41 and the utility applicant.

The proposed BOPSSAR design application is for a Preliminary Design Approval for a plant with a maximum core thermal power level of 3800 megawatts in accordance with the guidelines of Regulatory Guide 1.49, "Power Levels of Nuclear Power Plants," resulting in an electrical output of approximately 1300 megawatts. The analysis of the engineered safety features within the scope of BOPSSAR has been performed for a maximum core thermal power of 4100 megawatts. These power levels are consistent with the maximum design power level and application power level of 4100 megawatts and 3800 megawatts, respectively, for the RESAR-41 nuclear steam supply system.

The RESAR-41 design for the nuclear steam supply system portion of the plant includes the reactor coolant system, emergency core cooling system, emergency boration system, reactor control and protection systems, engineered safety features actuation system, chemical and volume control system, boron recycle system, residual heat removal

TABLE 1-1

MAJOR STRUCTURES, SYSTEMS, COMPONENTS, AND SERVICES WITHIN THE SCOPE OF BOPSSAR

Structures

- Reactor Building
- Auxiliary Building
- Control Building
- Diesel Generator Building
- Fuel Handling Building
- Turbine Building

Systems

- Auxiliary Feedwater System
- Containment Spray System
- Containment Hydrogen Control System
- Onsite Power Systems
- Liquid, Gaseous, and Solid Waste Management Systems
- Service Water System
- Component Cooling Water System
- Spent Fuel Pool Cooling System
- Essential Chilled Water System
- Reactor Makeup Water System
- Ventilation Systems
- Instrument Air System
- Primary and Steam Generator Blowdown Sampling Systems
- Reactor Coolant Pressure Boundary Leakage Detection System
- Gross Failed Fuel Detection System
- Fire Protection System
- Main Steam and Feedwater System

Components

- Steam Systems Equipment
- Reactor Makeup Water Pumps
- Sump Pumps
- Reactor Makeup Water Storage Tank
- Refueling Water Storage Tank
- Recycle Holdup Tank
- Boric Acid Tanks
- Resin Fill Tank
- Piping, Except for Reactor Coolant System Shop-Fabricated Sections and Plant Plumbing
- Valves, Including Operators, for Balance-of-Plant Scope Systems
- Equipment and Piping Supports, Except for Reactor Coolant System

Embedded Anchorage for Reactor Coolant System Supports
Miscellaneous Instrumentation and Control Systems Equipment
Plant Electrical Equipment, Except for Certain Nuclear Steam Supply System Power Supplies and Motors
Fuel Handling Equipment
Remote Filter Handling Equipment
Piping Heat Tracing
Equipment and Piping Insulation
Miscellaneous Plant Utilities

Services

Preservice Inspection for Class 1, 2, and 3 Reactor Coolant System Components
Nuclear Equipment Supports and Piping Stress and Movement Analysis, Except for Reactor Coolant System
Containment Pressure and Temperature Analyses for Postulated Reactor Coolant System Breaks

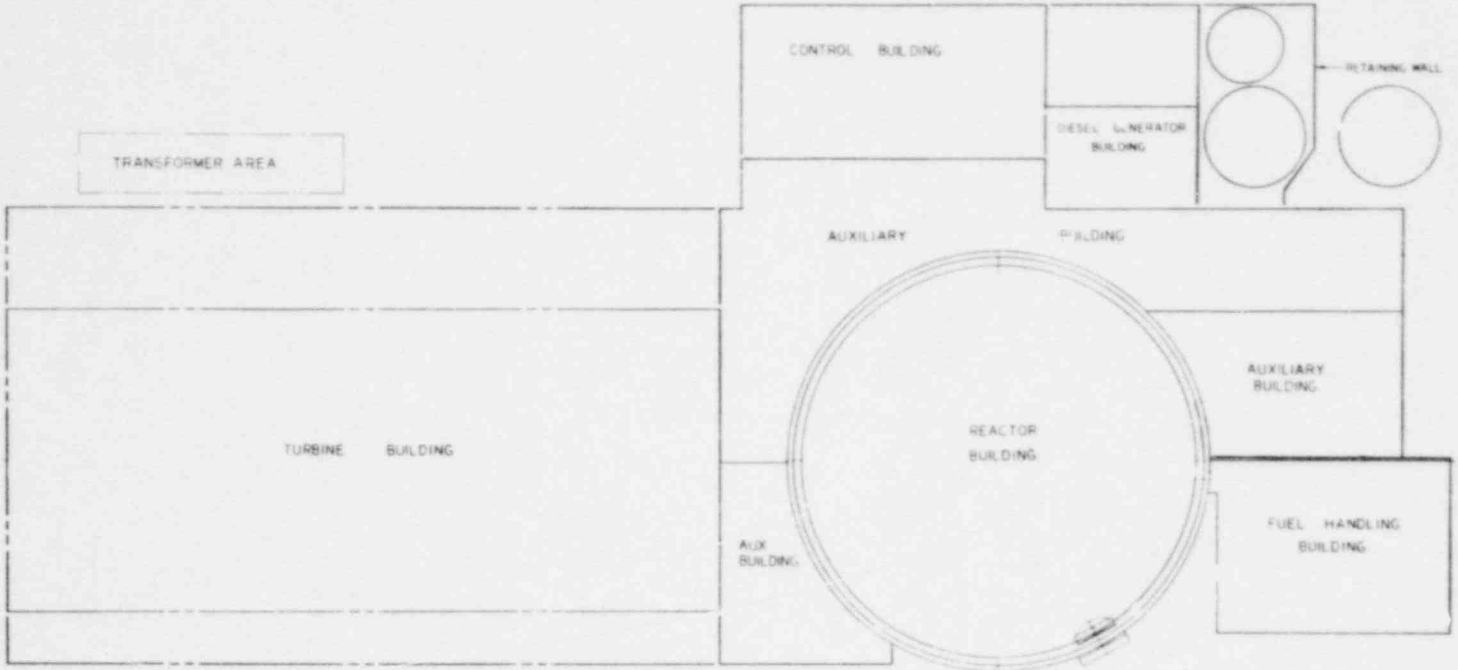
system, special handling equipment for fuel and reactor vessel internals, and related systems and features. The RESAR-41 design requires three independent onsite emergency power sources each of which can supply the power requirements of one of the engineered safety features trains, and requires four battery power sources to supply power to each of the four channels of the reactor protection system. The interface requirements of RESAR-41, which must be met by the balance-of-plant design, have been identified in BOPSSAR. The subject of interfaces is discussed further in Section 1.8 of this report.

The layout of the major structures of the proposed BOPSSAR plant is shown in Figure 1-1. The containment building will be a spherical steel vessel which will house the nuclear steam supply system. The vessel will be surrounded by a reinforced concrete shield building that will provide biological shielding and protection for the containment vessel and safety-related equipment. The shield building will be separated from the steel containment vessel by an annular space. The annular space will be divided into two annulus regions by a floor at about 50 feet above the base mat of the shield building. The annulus region above the dividing floor is referred to as the passive annulus region and the region below this floor is referred to as the active annulus region. The active annulus region will house portions of the engineered safety features systems and auxiliary systems. Both the active and the passive annulus regions will be provided with a ventilation system to maintain the annulus regions at a negative pressure relative to the outside atmospheric pressure following a postulated loss-of-coolant accident. Under postulated accident conditions, any contaminated air which may leak through the steel containment into the annulus areas will be filtered before release to the environment. The shield building thus will form a secondary containment.

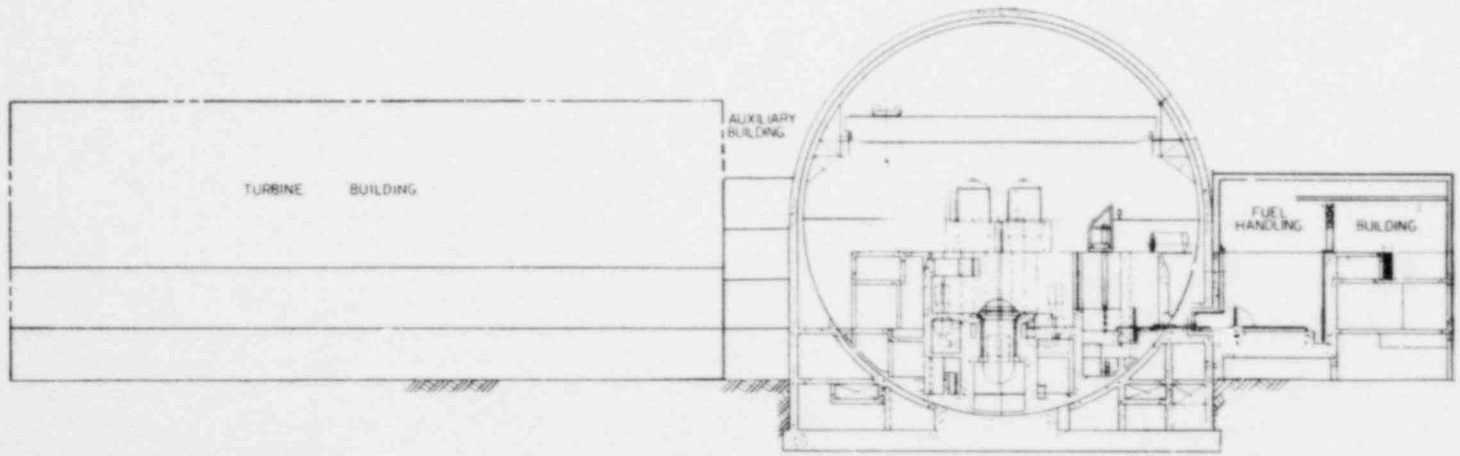
The steam and power conversion system will be designed to produce electrical power from the heat produced by the nuclear steam supply system. The high energy main steam and feedwater piping for the four RESAR-41 steam generators will be routed through two pairs of steam lines from the containment building, through the shield building and auxiliary building, and to the turbine building.

The service water system will supply cooling for the heat loads which are necessary for the safe shutdown of the reactor or to mitigate the consequences of postulated accidents. The service water system will also supply cooling water to various plant systems during normal operation and during plant shutdown.

The component cooling water system will act as an intermediate fluid barrier between the radioactive systems and the service water system. The system will provide a continuous supply of cooling water to remove residual and sensible heat from the reactor during normal shutdown, and will remove heat loads from engineered safety features after a postulated accident. It will also remove heat from various other plant components during normal operation.



PLAN VIEW



ELEVATION VIEW

Figure 1-1 Layout of Structures and Buildings

The BOPSSAR design will include three diesel generators located in separate rooms in the diesel generator building, with their associated independent safety feature busses to provide adequate power to each of the three engineered safety feature trains for a safe shutdown under accident conditions with a concurrent loss of offsite power. Direct current power to the four channels of the reactor protection system will be provided by four redundant 125 volt busses and their associated battery banks.

The proposed design is for a single-unit facility, and our evaluation and conclusions presented in this report are for a single-unit facility only. We will require a utility applicant referencing BOPSSAR for a multi-unit facility to provide additional information in its application for a construction permit regarding the multi-unit facility, for example, the physical arrangement for the entire facility as related to the potential damage from postulated turbine missiles.

Fluor Pioneer has identified in Table 1.7-4 of BOPSSAR those systems, components, and operational programs that are dependent on the characteristics of a specific site or on the operation by a utility applicant referencing the BOPSSAR design. The major items that are not within the scope of BOPSSAR and that must be addressed by a utility applicant in its application for a construction permit which references BOPSSAR are listed in Table 1-2 of this report.

1.3 Comparison with Similar Facility Designs

In Table 1.3-1 of BOPSSAR, Fluor Pioneer has provided a comparison of the principal engineering and architectural features of the design of BOPSSAR with those balance-of-plant designs of other facilities which we have previously reviewed. These principal features are identified and described in the paragraphs below.

The reactor containment for the BOPSSAR design will be similar to that of Duke Power Company's Perkins Unit Nos. 1, 2, and 3 and Cherokee Unit Nos. 1, 2, and 3 (Docket Nos. STN 50-488, 489, 490, 491, 492, and 493).

The containment spray system, containment hydrogen control, and auxiliary feedwater system will be similar to the designs utilized in the South Texas Project, Unit Nos. 1 and 2 (Docket Nos. STN 50-498 and 499). Also, such systems as the onsite power sources, fuel handling, service water system, and component cooling water system will be similar to those designed for the South Texas Project.

To the extent feasible and appropriate, we have made use of our previous evaluations during our review of those features that are similar to the BOPSSAR design. Where this has been done, we have identified in this report the specific Commission's safety evaluation reports involved. These safety evaluation reports are available for public inspection at the Commission's Public Document Room at 1717 H Street, N.W., Washington, D.C.

TABLE 1-2

MAJOR ITEMS TO BE ADDRESSED BY A UTILITY APPLICANT REFERENCING BOPSSAR

(1) Site characteristics (description and verification that parameters are within envelopes specified in BOPSSAR).

(2) Onsite meteorological measurements program.

(3) Ultimate heat sink.

(4) Inservice inspection program.

(5) Hydrogen recombiner (access to second unit must be provided).

(6) Offsite power system (including grid frequency decay rate analysis).

(7) Diesel generators (utility applicant will select manufacturer) and auxiliary systems.

(8) Spent fuel shipping cask.

(9) Service water pump house.

(10) Makeup water treatment system.

(11) Demineralized makeup water system.

(12) Fire protection system (source of water, maintenance, training, and administrative controls).

(13) Heating system.

(14) Miscellaneous gas system.

(15) Atmospheric vents.

(16) Station air system.

(17) Potable and sanitary water system.

(18) Plant plumbing.

(19) Secondary sampling system (except for steam generator blowdown portion).

(20) Turbine generator (utility applicant will select manufacturer; BOPSSAR design can accommodate Allis-Chalmers, General Electric, or Westinghouse units).

(21) Environmental monitoring program.

(22) Health physics program.

(23) Emergency plan.

(24) Industrial security plan.

(25) Initial test program.

(26) Technical specifications.

1.4 Identification of Agents and Contractors

Fluor Pioneer will design the balance-of-plant described in BOPSSAR and is on its own behalf the applicant for a Preliminary Design Approval of the design. No other agents or contractors are associated with this application. While Fluor Pioneer has incorporated the RESAR-41 standard nuclear steam supply system by reference into the BOPSSAR application, Fluor Pioneer does not act in any form as a representative for the Westinghouse Electric Corporation with regard to the RESAR-41 design or in any other matter associated with this application. Similarly, the Westinghouse Electric Corporation does not act as an agent or contractor for Fluor Pioneer in this application.

The prime agents or contractors selected by the utility applicant that references BOPSSAR in its application for a construction permit will be identified in the utility applicant's safety analysis report, and the division of responsibility among the reactor designer, architect-engineer, constructor, and plant operator will be delineated.

1.5 Requirements for Further Technical Information

Fluor Pioneer states that there are no requirements for further technical information to support or confirm the adequacy of the BOPSSAR design. However, based on our review, we determined that certain matters require further technical information to support the BOPSSAR design and its relationship to the RESAR-41 design. These matters require exchange of information between Westinghouse and Fluor Pioneer to ensure compatibility of the BOPSSAR design in relationship to the RESAR-41 design and to ensure proper integration of the information into the proposed design combination of BOPSSAR and RESAR-41. Since neither of these two parties act as agents or representatives of the other in this application, the development of the necessary information has been identified by Fluor Pioneer as an interface requirement on the utility applicant or as a utility applicant's responsibility to be addressed in the utility applicant's safety analysis report. We have determined that this information can, as a matter of practicability, be provided by a future utility applicant referencing the BOPSSAR design. Therefore, while we do not require that this information be made available prior to our decision concerning the issuance of a Preliminary Design Approval for BOPSSAR, we do require that it be provided by a utility applicant in its application for a construction permit which references BOPSSAR. These matters are enumerated (1) through (4) in Table 1-3 of this report along with references to the sections in this report in which each matter is discussed.

At our request, Fluor Pioneer committed to perform a test program to confirm the coefficient of friction used in the design of the containment against sliding under earthquake loading. We have determined that this information can be provided for our review during the course of our review of a utility applicant's application for a construction permit referencing BOPSSAR. This matter, which is listed as item 5 in Table 1-3 of this report, is discussed in Section 3.8.1 of this report.

TABLE 1-3

MATTERS TO BE ADDRESSED BY UTILITY APPLICANT IN ORDER TO SUPPORT THE BOPSSAR DESIGN

(1) Test program to confirm the coefficient of friction used in the design of the containment against sliding under earthquake loading (Section 3.8.1).

(2) Analyses of loadings on structures and nuclear steam supply system component supports inside containment resulting from postulated reactor coolant system pipe breaks (Sections 6.2.1 and 6.3).

(3) Reevaluation of the performance of the emergency core cooling system to verify acceptability with regard to the minimum backpressure in containment (Section 6.3).

(4) Environmental qualification of Class IE electrical equipment inside containment to the temperature profile established by the postulated main steam line break (Section 7.6.1).

(5) Reactor coolant pump operation upon loss of component cooling water (Section 9.2.2).

1.6 Summary of Principal Review Matters

Our technical review and evaluation of the information submitted by Fluor Pioneer in support of the BOPSSAR application considered the principal matters summarized below.

We reviewed the postulated values of site parameters, including seismology, hydrology, and meteorology, to determine that appropriate consideration was given to the development of the site parameter envelope which will be used for the siting of a nuclear power plant based on the BOPSSAR design. In this regard, Fluor Pioneer has based the design on the guidelines for site parameters that is presented in WASH-1361, "Safety-Related Site Parameters for Nuclear Power Plants," dated January 1975.

We reviewed the design criteria and expected performance characteristics of the facility structures, systems, and components important to safety to determine that they are in accordance with the Commission's General Design Criteria, Quality Assurance Criteria, regulatory guides, and other appropriate codes and standards, and that any departures from these criteria, guides, codes, and standards have been identified and justified.

We evaluated the response of the structures, systems, and components within the scope of the BOPSSAR design to certain anticipated operating transients and postulated accidents. We considered the potential consequences of a few highly unlikely postulated accidents identified as design basis accidents in Section 15.0 of this report. We performed conservative analyses of these design basis accidents to determine that the calculated potential offsite doses that might result in the very unlikely event of their occurrence would be within the Commission's guidelines for site acceptability as given in 10 CFR Part 100 for the site envelope conditions identified in BOPSSAR.

We evaluated the plans and measures described in BOPSSAR regarding the industrial security aspect of the design to determine that these plans and measures can be incorporated into the industrial security plan by a future utility applicant referencing BOPSSAR in its application for a construction permit.

We evaluated the design of the systems provided for control of the radioactive effluents from the facility to determine that these systems can reasonably be expected to control the release of radioactive wastes from the facility within the limits specified in 10 CFR Part 20.

1.7 Resolution of Outstanding Issues

In our Report to the Advisory Committee on Reactor Safeguards on BOPSSAR, we identified several outstanding issues in our review which must be resolved in an acceptable manner before a Preliminary Design Approval could be issued for the BOPSSAR design. These issues, which have been resolved in acceptable manner, and the sections in this report in which their resolutions are discussed are (1) the design analysis for containment sliding under earthquake loads (Section 3.8.1), (2) the analyses for differential pressure response of containment subcompartments to postulated pipe ruptures (Section 6.2.1), and (3) the analysis for the radiological consequences of a postulated fuel handling accident inside containment (Section 15.2.4).

1.8 Interfaces

Fluor Pioneer has identified in BOPSSAR two types of safety-related interfaces; those which consist of requirements placed on the BOPSSAR design by Westinghouse in RESAR-41, and those which consist of requirements placed on a future utility applicant's site-related design by Fluor Pioneer in BOPSSAR. These interfaces are identified in Section 1.7 of BOPSSAR. Table 1.7-1 of BOPSSAR contains a listing of the structures, systems, components, services, and analyses with the responsibilities delineated between Westinghouse Electric Corporation, Fluor Pioneer Incorporated, and a future utility applicant. Also, the utility applicant interface requirements are delineated in Appendices 2A, 5A, 6A, 8A, 9A, 10A, and 11A of BOPSSAR.

We reviewed the information provided by Fluor Pioneer in BOPSSAR with respect to RESAR-41 interface requirements and determined that these requirements of RESAR-41 have been adequately defined in the BOPSSAR application, and that the BOPSSAR design can support in a compatible manner the safety-related systems and components of the RESAR-41 design, taking into consideration the matters identified in Section 1.5 of this report. We previously concluded in our Safety Evaluation Report for RESAR-41 that the interface requirements established by Westinghouse Electric Corporation and by us are sufficient to determine the compatibility of the safety-related systems and components within the scope of RESAR-41 with a balance-of-plant design referencing RESAR-41.

We also reviewed the interface requirements of the BOPSSAR design as it relates to the siting and operation of a nuclear power plant facility based on the BOPSSAR design. We conclude that this information is sufficient to determine the compatibility of the BOPSSAR design with the site and operation related aspects of the facility.

Based on our review and the determinations stated above, we conclude that the interface information provided in BOPSSAR is acceptable for the issuance of a Preliminary Design Approval.

As stated in Section 1.4 of this report, Fluor Pioneer is acting on its own behalf in this application, and that Westinghouse does not act as an agent for Fluor Pioneer with regard to the design of RESAR-41 which is referenced in this application. During the course of our review of BOPSSAR, we have not had the opportunity to discuss and review the integrated design with Fluor Pioneer and Westinghouse in joint conference, nor do we have available documented verification by Westinghouse of its review and approval of the manner of integrating its RESAR-41 nuclear steam supply system into the BOPSSAR balance-of-plant design. The utility applicant referencing the BOPSSAR design and the RESAR-41 design will, therefore, be responsible for demonstrating that all portions of the design will be properly integrated. At such time we will evaluate and determine that the integration of the BOPSSAR design and the RESAR-41 design in an entire nuclear power plant, including site-related aspects, will be accomplished in an acceptable manner.

1.9 ACRS Generic Items

The Advisory Committee on Reactor Safeguards periodically issues a report listing various generic safety-related matters applicable to light water reactors. Our discussion of these matters is provided in Appendix C to this report which includes references to sections of this report where more specific discussions of the status of the generic matters in relation to the BOPSSAR design are presented.

2.0 SITE CHARACTERISTICS

BOPSSAR does not include the characteristics of a specific site. This information will be provided by a future utility applicant in its application for a construction permit which references the BOPSSAR design. However, Fluor Pioneer has established in BOPSSAR an envelope of meteorological, hydrological, seismological, and soils foundation site conditions for the BOPSSAR design. These site conditions provide an indication, in advance of the examination of a specific site, of the type of site for which the BOPSSAR design is suitable. Fluor Pioneer has discussed in Section 2.0 of BOPSSAR, and has summarized in Appendix 2A of BOPSSAR, the interface requirements that a utility applicant must consider in order to demonstrate the compatibility of the BOPSSAR design with a specific site.

The interface requirements and site conditions are discussed in the following sections of this report. We will evaluate the characteristics of a specific site selected by the utility applicant referencing BOPSSAR and described in its application for a construction permit in order to confirm that the specific site characteristics fall within the envelope of conditions reviewed and evaluated for the BOPSSAR application.

2.1 Geography and Demography

Detailed geographical and demographical characteristics of a specific site will be provided by a future utility applicant referencing BOPSSAR in its application for a construction permit. Fluor Pioneer has, however, provided a description of the geographical and demographical conditions that will be used as the bases for the BOPSSAR design. These bases are discussed in the following paragraphs.

In general, the BOPSSAR design assumes a site location within the continental United States with access to a river, lake, or ocean as a cooling water source or as a source of make-up water for cooling towers.

For the purpose of demonstrating the acceptability of the BOPSSAR design from the standpoint of offsite doses from postulated design basis accidents, Fluor Pioneer assumed a minimum exclusion distance of 650 meters. This value is in agreement with the minimum exclusion distance given in WASH-1361, "Safety-Related Site Parameters for Nuclear Power Plants."

For the purpose of demonstrating the acceptability of the BOPSSAR design from the standpoint of offsite doses, Fluor Pioneer assumed a low population zone distance of 1600 meters. This value is well within that of 4800 meters discussed in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations." The limiting values of atmospheric dispersion factors needed to limit the calculated postulated doses within the Commission's criteria (see Section 15.0 of this report) are well above the dispersion factor values that would be applicable to the assumed exclusion distance and low population zone distances noted above.

2.2 Nearby Industrial, Transportation, and Military Facilities

This subject is not within the scope of BOPSSAR and will be addressed by a future utility applicant referencing BOPSSAR in its application for a construction permit.

2.3 Meteorology

2.3.1 Regional Climatology

The regional climatology is not within the scope of BOPSSAR, and will be addressed by a future utility applicant referencing BOPSSAR in its application for a construction permit. Fluor Pioneer has however, provided an adequate description of the meteorological conditions used as the bases for the safe design and siting of a nuclear power plant referencing BOPSSAR.

The design basis tornado for the BOPSSAR design is stated by Fluor Pioneer to be in conformance with the tornado characteristics recommended in Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants," for Region I. This tornado has characteristics of a maximum wind speed of 360 miles per hour consisting of a maximum rotational wind speed of 290 miles per hour and a maximum translational wind speed of 70 miles per hour, a maximum pressure drop of three pounds per square inch, and a maximum pressure drop rate of two pounds per square inch per second. The design basis tornado characteristics are sufficient for all regions of the contiguous United States since Region I represents the most severe tornado intensity characteristics described in Regulatory Guide 1.76.

The operating basis sustained wind speed (fastest mile) for the BOPSSAR design will be 130 miles per hour at a height of 30 feet above ground level. This design basis is consistent with the value specified in WASH-1361, and equals or exceeds accepted values at nuclear power plant sites in the United States, except exposed coastal locations on the Gulf of Mexico and Cape Hatteras.

The BOPSSAR design criterion for snow accumulation on the roofs of safety-related structures is based on 80 pounds per square foot pressure on a horizontal surface. This value is consistent with the value specified in WASH-1361, and according to WASH-1361, structures that can support this loading should be suitable any place in the contiguous United States except in mountainous regions or other areas where unusually high accumulations of snow may occur.

The BOPSSAR design for ambient air temperatures will be based on a dry bulb temperature range of minus 30 degrees Fahrenheit to plus 105 degrees Fahrenheit, and a wet bulb temperature of plus 81 degrees Fahrenheit. Areas in the contiguous United States in which the minimum dry bulb temperature of minus 30 degrees Fahrenheit is expected to occur more frequently than one percent of the time includes northern portions of the mid-western United States. Areas where the maximum dry bulb temperature of plus 105 degrees Fahrenheit may be exceeded more frequently than one percent of the time includes portions of California and the desert southwest. These occurrence intervals are derived from "Engineering Weather Data," Reference 21 of Appendix B of this report.

2.3.2 Local Meteorology

This subject is not within the scope of BOPSSAR and will be addressed by a future utility applicant referencing BOPSSAR in its application for a construction permit.

2.3.3 Onsite Meteorological Measurements Program

This subject is not within the scope of BOPSSAR and will be addressed by a future utility applicant referencing BOPSSAR in its application for a construction permit.

2.3.4 Short-Term (Accident) Dispersion Estimates

The BOPSSAR design does not include the atmospheric dispersion characteristics for a specific site. Fluor Pioneer, has, however, evaluated the suitability of the proposed design for potential sites as related to offsite doses from postulated accidents using the zero to two-hour atmospheric dispersion factor value of 2.0×10^{-3} seconds per cubic meter, as recommended in WASH-1361, and the 30-day atmospheric dispersion factor values recommended by Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized Water Reactors." We have independently estimated a two-hour atmospheric dispersion factor of 1.7×10^{-3} seconds per cubic meter as a limiting value to keep the radiological consequences of a postulated loss-of-coolant accident within the recommended values of Regulatory Guide 1.4. The utility applicant referencing BOPSSAR will provide in its application for a construction permit at least one annual cycle of onsite meteorological data to estimate the atmospheric dispersion characteristics associated with the postulated accidental releases from the plant buildings and vents as related to distances to the actual exclusion area boundary and low population zone. We will evaluate this information to determine that the site dispersion characteristics so determined are acceptable.

2.3.5 Long-Term (Routine) Dispersion Estimates

To evaluate the suitability of the proposed design for potential sites, Fluor Pioneer assumed an annual average atmospheric dispersion factor value of 2.0×10^{-5} seconds per cubic meter for its evaluation of offsite doses from routine releases. The utility applicant referencing BOPSSAR will provide in its application for a construction permit meteorological data collected onsite in accordance with the recommendations of Regulatory Guide 1.23, "Onsite Meteorological Programs," to estimate the atmospheric dispersion characteristics that will be used in evaluating offsite doses from routine releases. We will evaluate this information to determine that site dispersion characteristics so determined are acceptable.

2.4 Hydrology

The BOPSSAR design assumes a site location with access to a river, lake, or ocean as a cooling water source or as a source of make-up water for cooling towers. Detailed hydrological characteristics for a specific site will be provided by the utility applicant referencing BOPSSAR in its application for a construction permit. Fluor Pioneer has, however, provided a description of the hydrological conditions that will be used as the bases for the BOPSSAR design. These bases are discussed in the following paragraphs.

2.4.1 Floods

Fluor Pioneer proposes that the yard grade for safety-related structures will be located above the water level that can be reached by the design basis flood events, including coincident wind-generated wave effects, that are calculated according to the recommendations of Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants." We consider that this design basis is generally within the position recommended in Regulatory Guide 1.59 and is, therefore, acceptable.

Fluor Pioneer further states in Section 3.4.1 of BOPSSAR that additional incorporated flood barriers may be utilized by the utility applicant referencing BOPSSAR to protect the plant from flood levels up to ten feet above the finished plant grade without exceeding structural design margins. If additional incorporated or exterior barriers are used by the utility applicant in its application for a construction permit, we will require that the barriers be designed to meet the criteria recommended in Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants." We will review any proposed barriers during our review of the utility applicant's construction permit application which references BOPSSAR.

Fluor Pioneer states that the roofs of all seismic Category I structures will be designed for the conditions of four inches per hour of rainfall water runoff and 16 inches per hour overflow, and that all roofs where parapets or other structures permit rainfall to accumulate will be designed to limit and to support a total maximum depth of accumulation of nine inches. These criteria are in agreement with the safety-related site parameters for a standard design as stated in WASH-1361, and are, therefore, acceptable.

2.4.2 Low Water Considerations and Ultimate Heat Sink

These subjects are not within the scope of BOPSSAR and will be addressed by the utility applicant referencing BOPSSAR in its application for a construction permit. Fluor Pioneer has, however, specified the design bases interface requirements in BOPSSAR that are related to the ultimate heat sink. One of the specified interface requirements is that the service water intake temperature be 95 degrees Fahrenheit or less during normal plant operation, and can be allowed to reach 100 degrees Fahrenheit during plant shutdown and post-accident conditions. We will review the capability of the ultimate heat sink for a specific site to meet this functional requirement for the time period and environmental conditions recommended in Regulatory Guide 1.27, "Ultimate Heat Sink," during our review of an application for a construction permit referencing BOPSSAR.

2.4.3 Groundwater

The determination of the groundwater level is not within the scope of BOPSSAR. However, Fluor Pioneer states that lateral and horizontal hydrostatic pressure loads, with the application of appropriate load factors and in combination with loads specified in Sections 3.8.4 and 3.8.5 of BOPSSAR, will be calculated assuming completely saturated soil below finished plant grade. We consider this to be an acceptable design basis because it provides a clear definition of the envelope of groundwater levels for potential sites. We will evaluate the groundwater level for a specific site based on the information to be provided in the construction permit application of the utility applicant referencing BOPSSAR.

2.5 Geology and Seismology

Geology, seismology, and foundation engineering characteristics are not within the scope of BOPSSAR and will be provided for a specific site by a future utility applicant referencing BOPSSAR in its application for a construction permit. However, the plant design will be based on the following envelope of site characteristics: (1) the safe shutdown earthquake horizontal ground acceleration for seismic design will be 0.3 times the normal gravitational acceleration, (2) the operating basis earthquake horizontal ground acceleration for seismic design will be 0.15 times the normal gravitational acceleration, and (3) there will be no surface faulting on and in the vicinity of the site that must be considered in the plant design.

We find these conditions acceptable. The seismic design value of 0.3 times the normal gravitational acceleration for the safe shutdown earthquake is adequate for about 70 percent of the potential sites east of the Rocky Mountains. We will evaluate the seismological and geological characteristics of a specific site selected by the utility applicant referencing BOPSSAR in its application for a construction permit to confirm that the site characteristics fall within the above envelope conditions for the BOPSSAR design. We will also evaluate the geology, seismology, and foundation engineering characteristics, as required by Appendix A to 10 CFR Part 100, of each individual site for which the BOPSSAR design will be used.

3.0 DESIGN CRITERIA FOR STRUCTURES, SYSTEMS, AND COMPONENTS

3.1 Conformance with General Design Criteria

Fluor Pioneer has stated that the structures, systems, and components of the BOPSSAR design will be designed in accordance with the Commission's General Design Criteria for nuclear power plants, and has discussed in Section 3.1 of BOPSSAR the compliance with each criterion applicable to the design. On the basis of our review of the information provided in BOPSSAR, we conclude that the BOPSSAR standard balance-of-plant can be designed to meet the requirements of the applicable General Design Criteria of Appendix A to 10 CFR Part 50.

3.2 Classification of Structures, Systems, and Components

3.2.1 Seismic Classification

Criterion 2 of the General Design Criteria requires that nuclear power plant structures, systems, and components important to safety be designed to withstand the effects of earthquakes without loss of capability to perform their safety function. These plant features are those necessary to assure (1) the integrity of the reactor coolant pressure boundary, (2) the capability to shut down the reactor and maintain it in a safe shutdown condition, or (3) the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of 10 CFR Part 100.

We reviewed the structures, systems, and components important to safety that are within the scope of BOPSSAR and that will be designed to withstand the effects of a safe shutdown earthquake and remain functional. They have been identified in an acceptable manner as seismic Category I items, in conformance with Regulatory Guide 1.29, "Seismic Design Classification." All other structures, systems and components that may be required for operation of the facility will be designed to other than seismic Category I requirements. Included in this classification are those portions of seismic Category I systems which are not required to perform a safety function. Structures, systems, and components important to safety that will be designed to withstand the effects of a safe shutdown earthquake and remain functional are identified in an acceptable manner in Table 3.2-2 of BOPSSAR.

The basis for acceptance in our review has been conformance of Fluor Pioneer's designs, design criteria, and design bases for structures, systems, and components important to safety with Criterion 2 of the General Design Criteria, Regulatory Guide 1.29, staff technical positions, and industry codes and standards.

We conclude that structures, systems, and components important to safety that are within the scope of BOPSSAR and will be designed to withstand the effects of a safe shutdown earthquake and remain functional, have been properly classified as seismic Category I items and are in conformance with the Commission's regulations, applicable regulatory guides, and industry codes and standards, and are, therefore, acceptable.

3.2.2 System Quality Group Classification

Criterion 1 of the General Design Criteria requires that nuclear power plant systems and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed.

We reviewed Fluor Pioneer's classification system for pressure-retaining components that are within the scope of BOPSSAR such as pressure vessels, heat exchangers, storage tanks, pumps, piping, and valves in fluid systems important to safety and the assignment by Fluor Pioneer of safety classes to those portions of systems required to perform safety functions.

Fluor Pioneer utilizes a classification system (1M, 2M, 3M, 3M(-), NNS(+), and NNS) which is based on the classification system of the American Nuclear Society. This classification system generally corresponds to the Commission's Quality Groups A, B, C, and D in Regulatory Guide 1.26, "Quality Group Classifications and Standards," and applies to those fluid containing components which are part of the reactor coolant pressure boundary and other fluid systems important to safety where reliance is placed on these systems: (1) to prevent or mitigate the consequences of accidents and malfunctions originating within the reactor coolant pressure boundary, (2) to permit shutdown of the reactor and maintain it in the safe shutdown condition, and (3) to contain radioactive material. As delineated in Table 3.2-1, 3.2-2, 3.2-3, and 3.2-4 of BOPSSAR, these fluid system components are classified in an acceptable manner in conformance with Regulatory Guide 1.26. Piping and valves for these fluid systems are also classified in an acceptable manner on system piping and instrumentation diagrams in BOPSSAR and by reference to RESAR-41.

Fluid systems pressure-retaining components important to safety that are classified Quality Group A, B, C, or D will be constructed to the ASME Boiler and Pressure Vessel Code (hereinafter referred to as the ASME Code) as follows:

Quality Group	Fluor Pioneer Safety Class	Component Code ASME Section III, Division 1
A	1M	Class 1
B	2M	Class 2
C	3M	Class 3
	3M(-)	Class 3
D	NNS	ASME Section VIII, Division 1 ANSI B31.1-1973, API-620 API-650, AWWAD100 or ANSI B96.1
	NNS(+)	As above, augmented by Branch Technical Position ETSB 11-1 (Revision 1)

All components classified by Fluor Pioneer as Safety Class 1M, 2M, or 3M will also be designed to seismic Category I requirements. Those components classified as Safety Class 3M(-), NNS, or NNS(+) will not be designed to remain functional during or after the safe shutdown earthquake (non-seismic Category I).

Quality Group A components will comply with Section 50.55a of 10 CFR Part 50. Quality Groups B and C components will comply with Subsection NA-1140 of the ASME Code.

The basis for acceptance in our review has been conformance of Fluor Pioneer's designs, design criteria, and design bases for pressure-retaining components such as pressure vessels, heat exchangers, storage tanks, pumps, piping, and valves in fluid systems important to safety with Criterion 1 of the General Design Criteria, Regulatory Guide 1.26, staff technical positions, and industry codes and standards.

We conclude that fluid systems pressure-retaining components important to safety that are within the scope of BOPSSAR and will be designed, fabricated, erected, and tested to quality standards are in conformance with the Commission's regulations, the applicable regulatory guide, and industry codes and standards and are, therefore, acceptable.

3.3 Wind and Tornado Design Criteria

3.3.1 Wind Design Criteria

All seismic Category I structures exposed to wind forces will be designed to withstand the effects of the operating basis design wind. The specified operating basis design wind has a velocity of 130 miles per hour based on a recurrence of 100 years. This recurrence interval provides reasonable assurance that the operating design value will not be exceeded during the expected plant life. The wind velocity will be transformed into pressure loadings on structures and into the associated vertical distribution of wind pressures and gust factors in accordance with the American Society of Civil Engineers Paper No. 3269, "Wind Forces on Structures," and American National Standards Institute A58.1-1972, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," which we find acceptable.

The procedures that will be utilized to determine the loadings on seismic Category I structures induced by the design wind specified for the plant are acceptable since these procedures provide a conservative basis for engineering design to assure that the structures will withstand such environmental forces.

The use of these procedures provides reasonable assurance that in the event of design basis winds, the structural integrity of seismic Category I structures will not be impaired and, consequently, seismic Category I systems and components located within these structures will be adequately protected and will perform their intended safety functions if needed. Conformance with these procedures is an acceptable basis for satisfying the applicable requirements of Criterion 2 of the General Design Criteria.

3.3.2 Tornado Design Criteria

All seismic Category I structures exposed to potential tornado forces and needed for the safe shutdown of the plant will be designed to resist a tornado of 290 miles per hour tangential wind velocity and a 70 miles per hour translational wind velocity. The simultaneous atmospheric pressure drop will be assumed to be three pounds per square inch at the rate of two pounds per square inch per second. These tornado characteristics are in accordance with the values specified in Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants," for Region I.

The procedures that will be used to transform the tornado wind velocity into pressure loadings are similar to those used for the design wind loadings as discussed in Section 3.3.1 of this report. The tornado missile effects will be determined using procedures discussed in Section 3.5 of this report. The total effect of the design tornado on seismic Category I structures will be determined by appropriate combinations of the individual effects of the tornado wind pressure, pressure drop, and tornado-generated missiles. Structures will be arranged on the plant site and protected in such a manner that collapse of structures not designed for the design basis tornado will not affect other safety-related structures.

The procedures that will be used to determine the loadings on structures induced by the design basis tornado specified for the plant are acceptable since the procedures provide a conservative basis for engineering design to assure that the structures will withstand such environmental forces.

The use of these procedures provides reasonable assurance that in the event of a design basis tornado, the structural integrity of the plant structures that have to be designed for tornadoes will not be impaired and, consequently, safety-related systems and components located within these structures will be adequately protected and may be expected to perform necessary safety functions as required. Conformance with these procedures is an acceptable basis for satisfying the applicable requirements of Criterion 2 of the General Design Criteria.

3.4 Water Level (Flood) Design

The hydrostatic effect of the design flood and the dynamic loading effects of wave action will be considered in the design of all seismic Category I structures. For design analysis procedures, Fluor Pioneer originally proposed that for floods at or above grade, the wind wave effects associated with the pool level of the probable maximum flood would be treated as hydrostatic loads. At our request, Fluor Pioneer modified this design criterion to include the dynamic loads of wave action using procedures in accordance with or similar to those delineated in the U.S. Army Coastal Engineering Research Center Technical Report No. 4, "Shore Protection Planning and Design," 3rd Edition, 1966 which we find acceptable.

Fluor Pioneer proposes to design the walls of the structures housing safety-related equipment to withstand the hydrostatic pressure and wave action resulting from a flood level up to ten feet above plant grade for any combination of still water plus waves to the ten-foot level above plant grade.

The external walls of safety-related structures that are below the plant grade will be protected from ingress of flood waters by waterproofing. The piping penetrations into safety-related structures that are below plant grade will be provided with flood seals. Horizontal and vertical construction joints in exterior walls up to yard grade will be provided with water seals to protect equipment from ingress of flood waters. The means for protection against ingress of flood waters above plant grade will be described by the utility applicant referencing BOPSSAR in its application for a construction permit.

The use of these procedures will provide reasonable assurance that in the event of floods or high groundwater, the structural integrity of seismic Category I structures will not be impaired and, consequently, seismic Category I systems and components located within these structures will be adequately protected and may be expected to perform necessary safety functions, as required. Conformance with these design procedures is an acceptable basis for satisfying the applicable requirements of Criterion 2 of the General Design Criteria.

As a result of our review, we conclude that the design criteria and bases for the protection of essential equipment from flooding are acceptable. Acceptability of additional protection against a design basis flood above finished plant grade will be determined during our review of a specific site and the design of additional flood protection as described by the utility applicant in its application for a construction permit which references the BOPSSAR design.

3.5 Missile Protection

3.5.1 Missile Protection Criteria

Criteria 2 and 4 of the General Design Criteria require that a nuclear power plant be designed against internally and externally generated missiles to assure no loss of function or damage to safety-related equipment essential for safe plant shutdown. Revision 1 of Section 3.5.1.4 of the Standard Review Plan specifies the tornado missile spectrum against which a nuclear power plant must be protected. Missile protection will be provided to ensure safe shutdown capability of the reactor facility. Pressurized components and rotating machinery have the potential to become internal missile sources. Protection against missiles will be achieved by proper orientation of components and systems, by use of missile barriers, and by physically separating redundant safety-related systems or components from each other and from non-safety related systems.

Based on our review, we conclude that the design criteria and bases for protection against the effects of internally generated missiles conform to (1) Criterion 4 of the General Design Criteria as it relates to structures housing essential systems and to the systems being capable to withstand the effects of internally generated missiles, (2) Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis," as it relates to protection of spent fuel pool systems and spent fuel assemblies from internal missiles, and (3) Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants," as it relates to the design of the intake structure to withstand the effects of internal missiles and are, therefore, acceptable.

With regard to tornado missiles, Fluor Pioneer has committed to protect equipment essential for safe plant shutdown against the missile spectrum in Revision 1 of Section 3.5.1.4 of the Standard Review Plan. BOPSSAR specifies that the shield building, auxiliary building, fuel handling building, control building, diesel generator building, auxiliary feedwater storage tank, service water pumps, service water strainers, and diesel fuel storage tanks are to be protected against tornado missiles. We conclude that the plant design will provide adequate protection against tornado missiles as outlined in Revision 1 of Section 3.5.1.4 of the Standard Review Plan, and is, therefore, acceptable.

In the BOPSSAR design, the turbine generator will be oriented radially with respect to the containment and the surrounding safety-related structures. Safety-related systems will not be within the strike zone of potential low trajectory turbine missiles. With the peninsular layout for a multiple unit facility, some of the safety-related structures including the containment, can be within the strike zone (generally within a relatively small angle) of some of the low pressure end wheels of the turbine of the adjacent unit. We will evaluate this issue during our review of the construction permit application for a multiple unit facility by a future utility applicant referencing BOPSSAR. For a single unit facility, the overall probability that turbine missiles would damage the plant and lead to consequences in excess of the 10 CFR Part 100 exposure guidelines is acceptably low, so that the plant essential systems will be adequately protected against potential turbine missile damage.

3.5.2 Barrier Design Procedures

Information has been provided in BOPSSAR regarding the procedures that will be used in the design of the structures, shields, and barriers to resist the effects of missiles. The analysis of structures, shields, and barriers to determine the effects of missile impact will be accomplished in two steps. In the first step, the potential damage that could be done by the missile in the immediate vicinity of impact will be investigated. This will be accomplished by estimating the depth of penetration of the missile into the impacted structure. Furthermore, secondary missiles will be prevented by fixing the target wall thickness above that determined for penetration. In the second step of the analysis, the overall structural response of the target when impacted by a missile will be determined using the Williamson and Alvy procedure except for the automobile missile. We find this acceptable. We will also consider the use of other suitably justified procedures for predicting the overall response of barriers to frangible missiles such as the wood plank and the utility pole. The equivalent loads of missile impact, whether the missile is environmentally (externally) generated or accidentally generated within the plant, will be combined with other applicable loads as is discussed in Section 3.8 of this report.

With regard to the procedure for barrier design against the automobile missile, Fluor Pioneer indicated that a time-history dynamic analysis method will be used to determine the response of the barrier, and that the analytical procedure will be modeled as an idealized elasto-plastic single degree of freedom system. During the course of our review, we requested Fluor Pioneer to clarify the method of analysis. Fluor Pioneer provided further information to clarify the method of analysis. We reviewed this information and determined that the method of analysis is acceptably conservative.

We conclude that the use of these procedures provides reasonable assurance that in the event of design basis missiles striking seismic Category I structures or other missile shields and barriers, the structural integrity of the structures, shields, and barriers will not be impaired or degraded to an extent that will result in a loss of required protection. Seismic Category I systems and components protected by these structures will, therefore, be adequately protected against the effects of missiles. Conformance with these procedures is an acceptable basis for satisfying the applicable requirements of Criteria 2 and 4 of the General Design Criteria.

3.6 Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping

3.6.1 Postulated Pipe Rupture Inside Containment

Fluor Pioneer has identified and will apply criteria for postulating rupture of piping and protection against associated dynamic effects that are consistent with the criteria contained in Regulatory Guide 1.46, "Protection Against Pipe Whip Inside Containment," for systems inside the containment that are within the scope of BOPSSAR. A list of the safety-related systems are tabulated in Section 1.7.1 of BOPSSAR and responsibility for overall design, component design, piping layout, and stress analysis, and other significant activities are clearly identified for each case where BOPSSAR interfaces with RESAR-41. Effectively, Fluor Pioneer's criteria for postulated pipe rupture and associated protection inside the containment will apply to all safety-related systems since Fluor Pioneer maintains overall responsibility for the Class 1, 2, and 3 systems inside containment.

The proposed piping arrangements and applicable design considerations for high and moderate energy fluid systems inside containment will provide adequate assurance that the unaffected system components, and those systems important to safety which are in close proximity to the systems in which postulated pipe failures are assumed to occur, will be protected. The design will be of a nature to mitigate the consequences of a pipe break so that the reactor can be safely shut down and maintained in a safe shutdown condition in the event of a postulated failure of a pipe carrying a high or moderate energy fluid inside containment.

We conclude that the criteria and analytical methods that will be used to design and evaluate the piping systems for postulated ruptures and associated dynamic effects provide an acceptable basis in meeting the requirements of Criteria 1, 2, and 4 of the General Design Criteria and, therefore, are acceptable.

3.6.2 Postulated Pipe Rupture Outside Containment

We reviewed the adequacy of Fluor Pioneer's proposed design criteria and design bases necessary to protect safety-related equipment from the effects of pipe failure outside containment. The design includes criteria to accommodate the effects of postulated pipe breaks and cracks, including pipe whip, jet effect, and environmental effects. The means used to protect safety-related systems and components includes separation by remote location, pipe enclosures, pipe whip restraints, and equipment shields. Fluor Pioneer will provide protection against pipe failure outside containment in conformance with the criteria contained in Branch Technical Positions APCSB 3-1, "Protection Against Piping Failures in Fluid Systems Outside Containment," and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," which are contained in Sections 3.6.1 and 3.6.2 respectively of the Standard Review Plan. Fluor Pioneer will analyze high energy piping systems for the effects of pipe whip, jet impingement, and environmental effects on safety-related systems and structures. For moderate energy systems, the jet and environmental effects due to critical cracks will be considered.

The plant design basis will include the ability to sustain a high energy pipe break coincident with a single active failure and retain the capability for safe cold shutdown. For postulated pipe failures, the resulting environmental effects will not preclude the habitability of the control room, the accessibility of other areas that have to be manned during an accident condition, or the loss of function of electric power supplies, controls, and instrumentation needed to complete a safety action.

Based on our review, we conclude that the design basis and criteria that will be used to protect safety-related equipment from the effects of pipe failure outside the containment conform to Branch Technical Positions APCSB 3-1 and MEB 3-1 and, therefore, are acceptable.

3.7 Seismic Design

Criterion 2 of the General Design Criteria requires that structures, systems and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes. We reviewed the BOPSSAR structures, systems, and components important to safety and identified as seismic Category I structures, systems and components, to determine their ability to withstand the effects of the operating basis earthquake and the safe shutdown earthquake.

3.7.1 Seismic Input

The input seismic design response spectra that will be applied in the design of seismic Category I structures, systems, and components comply with the recommendations of Regulatory Guide 1.60, "Design Response Spectra for Nuclear Power Plants." The specific percentage of critical damping values to be used in the seismic analysis of Category I structures, systems and components are in conformance with Regulatory Guide 1.61, "Damping Values for Seismic Analysis of Nuclear Power Plants."

The synthetic time history to be used for seismic design of Category I plant structures, systems, and components will be adjusted in amplitude and frequency content to obtain response spectra that envelop, for all damping values, the design response spectra specified by Regulatory Guide 1.60 and normalized to the maximum ground accelerations of 0.30 times the normal gravitational acceleration for the safe shutdown earthquake.

Conformance with the requirements of Regulatory Guides 1.60 and 1.61 provides reasonable assurance that the seismic inputs to the design analysis of seismic Category I structures, systems, and components will be adequately defined to assure a conservative basis for the design of such structures, systems, and components to withstand the consequent seismic loadings.

3.7.2 Seismic System Analysis

The scope of review of the seismic system and subsystem analysis included the seismic analysis methods for all seismic Category I structures, systems, and components. It included review of procedures for modeling, seismic soil-structure interaction, development of floor response spectra, inclusion of torsional effects, evaluation of seismic Category I structure overturning, and determination of composite damping. The review included design criteria and procedures for evaluating the interaction of non-seismic Category I structures and piping with seismic Category I structures and piping and effects of parameter variations on floor response spectra.

The system and subsystem analyses will be performed on an elastic basis. Modal response spectrum multidegree of freedom and time history methods will form the bases for the analyses of all major seismic Category I structures, systems, and components. When the modal response spectrum method is used, governing response parameters will be combined by the square root of the sum of the squares rule. However, methods described in Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," will be used in combining modal responses for modes with closely spaced frequencies. The square root of the sum of the squares of the maximum codirectional responses will be used in accounting for three components of the earthquake motion for both the time history and response spectrum methods. Floor spectra inputs to be used for design and test verifications of structures, systems, and components will be generated from the time history method, taking into account variation of parameters by peak widening. A vertical seismic system dynamic analysis will be employed for all structures, systems, and components where analyses show significant structural amplification in the vertical direction. Torsional effects and stability against overturning will be considered.

The lumped soil spring approach will be used to evaluate soil-structure interaction effects upon seismic responses. A separate confirmatory finite element analysis considering appropriate nonlinear stress-strain and damping relationships for the soil will be made for each utility applicant's site. The effect of adjacent structures will be included at that time. Maximum loads or stresses for all parts of the plant will be determined and presented in a future utility applicant's safety analysis report together with the envelope response data. To the extent that the envelope response spectra envelop and encompass the site-dependent seismic response spectra, the BOPSSAR design will be acceptable for this site.

With respect to generation of design envelope responses for seismic Cateogry I structures, systems, and components, dynamic analyses will be performed for structures assuming the values of subgrade shear wave velocities equal to 500, 1000, 1500, 2000, 3000, and 4000 feet per second. Dynamic analysis will also be performed for the fixed base case for seismic Category I structures.

Using the soil spring approach for the soil and three dimensional lumped multimass model for the structure, a parametric study will be made to obtain the enveloping forces and moments in the structure and the enveloping broad band floor spectra for the design of the seismic subsystems and components. In this parametric study, which will consist of six independent analyses, the properties of the structural model will be kept constant and only the soil spring properties will be varied.

Based on our review, we conclude that the seismic system and subsystem analysis procedures and criteria proposed by Fluor Pioneer provide an acceptable basis for the seismic design.

3.7.3 Seismic Instrumentation Program

The type, number, location, and utilization of strong motion accelerographs to record seismic events and to provide data on the frequency, amplitude, and phase relationship of the seismic response of the containment structure comply with Regulatory Guide 1.12, "Instrumentation for Earthquakes." Supporting instrumentation will be installed on seismic Category I structures, systems, and components in order to provide data for the verification of the seismic responses determined analytically for such seismic Category I items.

The installation of the specified seismic instrumentation in the reactor containment structure and at other seismic Category I structures, systems, and components constitutes an acceptable program to record data on seismic ground motion as well as data on the frequency and amplitude relationship of the response of major structures and systems. A prompt readout of pertinent data at the control room can be expected to yield sufficient information to guide the operator on a timely basis for the purpose of evaluating the seismic response in the event of an earthquake. Data obtained from such installed seismic instrumentation will be sufficient to determine that the seismic analysis assumptions and the analytical model used for the design of the plant are adequate and that allowable stresses are not exceeded under conditions where continuity of operation is intended. Provision of such seismic instrumentation complies with Regulatory Guide 1.12 and is, therefore, acceptable.

3.8 Design of Seismic Category I Structures

3.8.1 Reactor Containment

The containment will consist of a free-standing steel shell located within a separate reinforced concrete shield building. The containment will be designed, fabricated, constructed, and tested as a Class MC vessel in accordance with Subsection NE of the ASME Code, Section III, Division 1. Design loads will include an appropriate combination of dead and live loads, thermal loads, seismic and postulated loss-of-coolant accident induced loads including pressure and jet forces. A seismic Category I concrete shield building will protect the steel containment from the effects of wind, tornadoes, and tornado generated missiles.

In its preliminary design of the steel containment vessel, Fluor Pioneer originally proposed to install a narrow band of compressible material between the outside face of the vessel and the extended concrete support. The purpose of the compressible material was to eliminate excessive bearing loads at this critical juncture and to provide a smooth transition to the zone where the steel vessel is fully embedded in concrete. Fluor Pioneer subsequently modified this design to eliminate the compressible material. The transition will now be accomplished by using a thicker section of steel plate at this critical juncture.

The analysis of the containment will be based on elastic thin shell theory. For external pressure loading the allowable compressive stress will be obtained from the corresponding buckling stress limit which accounts for the biaxial state of stress and imperfections of the thin shell.

With regard to the proposed design of the steel containment vessel against sliding under the action of earthquake loads, Fluor Pioneer will use a maximum coefficient of friction of 0.7 between the steel and concrete internal structures, reduced at our request by 25 percent to a value of 0.525 to compensate for wetness between the surfaces. We consider that this value is acceptably conservative for this particular design case where the concrete will be cast against the steel surface of the containment vessel. However, we requested and Fluor Pioneer agreed to conduct tests to confirm the value of the coefficient of friction. The results of these tests may also be used to justify the use of a value of the coefficient of friction higher than 0.525. The results of these tests will be submitted for our review during the course of our review of a utility applicant's application for a construction permit referencing BOPSSAR.

The criteria that will be used in the analysis, design, and construction of the steel containment structure for anticipated loadings and postulated conditions that may be imposed upon the structure during its service lifetime are in conformance with established criteria, codes, standards, and guides acceptable to us.

The use of these criteria as defined by applicable codes, standards, and guides; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials, quality control programs, and special construction techniques provide reasonable assurance that, in the event of earthquakes and various postulated accidents occurring within and outside the containment, the structure will withstand the specified conditions without impairment of structural integrity or safety function. We conclude that conformance with these criteria constitutes an acceptable basis for satisfying the applicable requirements of Criteria 2, 4, 16, and 50 of the General Design Criteria.

3.8.2 Concrete and Structural Steel Internal Structures

The containment interior structures will consist of a shield wall around the reactor, secondary shield walls, and other interior walls, compartments, and floors. The principal code to be used in the design of concrete internal structures will be the 318-71 Code of the American Concrete Institute, "Building Code Requirements for Reinforced Concrete." For steel internal structures, the American Institute of Steel Construction Specification, "Specification for the Design, Fabrication, and

Erection of Structural Steel for Buildings," of the American Institute of Steel Construction will be used. For equipment supports, Subsection NF of the ASME Code will be used.

The containment concrete and steel internal structures will be designed to resist various combinations of dead and live loads, accident induced loads, including pressure and jet loads, and seismic loads. The load combinations to be used include all loads likely to occur and all loads which may act simultaneously. The design and analysis procedures that will be used for the internal structures are in accordance with procedures delineated in the American Concrete Institute 318-71 Code and in the American Institute of Steel Construction Specification for concrete and steel structures, respectively.

The containment internal structures will be designed and proportioned to remain within limits established by us under the various load combinations. These limits are, in general, based on the American Concrete Institute 318-71 Code and on the American Institute of Steel Construction Specification for concrete and steel structures, respectively, modified as appropriate for load combinations that are considered extreme. The materials of construction, including their fabrication, construction, and installation, will be in accordance with the American Concrete Institute 318-71 Code and the American Institute of Steel Construction Specification for concrete and steel structures, respectively.

We conclude that the criteria to be used in the design, analysis, and construction of the containment internal structures to account for anticipated loadings and postulated conditions that may be imposed upon the structures during their service lifetime are in conformance with established criteria, and with codes, standards, and specifications, and are, therefore, acceptable.

The use of these criteria as defined by applicable codes, standards, and specifications; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials, quality control programs, and special construction techniques; and the testing and inservice surveillance requirements provide reasonable assurance that, in the event of earthquakes and various postulated accidents occurring within the containment, the interior structures will withstand the specified design conditions without impairment of structural integrity or the performance of required safety functions. We conclude that conformance with these criteria constitutes an acceptable basis for satisfying the requirements of Criteria 2 and 4 of the General Design Criteria.

3.8.3 Other Seismic Category I Structures

All seismic Category I structures other than containment and its interior structures will be of structural steel and concrete. The structural components will consist of slabs, walls, beams, and columns. The principal code to be used in the design of concrete seismic Category I structures will be the American Concrete Institute

318-71 Code, "Building Code Requirements for Reinforced Concrete." For steel seismic Category I structures, the principal code to be used will be the American Institute of Steel Construction Specification, "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings."

The concrete and steel seismic Category I structures will be designed to resist various combinations of dead loads, live loads, environmental loads including winds, tornadoes, earthquakes, and loads generated by postulated ruptures of high energy pipes such as reactor and jet impingement forces, compartment pressures, and impact effects of whipping pipes.

The design and analysis procedures that will be used for these seismic Category I structures are in accordance with procedures delineated in the American Concrete Institute 318-71 Code and in the American Institute of Steel Construction Specification for concrete and steel structures, respectively.

The various seismic Category I structures will be designed and proportioned to remain within limits established by us under the various load combinations. These limits are, in general, based on the American Concrete Institute 318-71 Code and on the American Institute of Steel Construction Specification for concrete and steel structures, respectively, modified as appropriate for load combinations that are considered extreme. The materials of construction, including their fabrication, construction, and installation will be in accordance with the American Concrete Institute 318-71 Code and the American Institute of Steel Construction Specification for concrete and steel structures, respectively.

We conclude that the criteria that will be used in the analysis, design, and construction of seismic Category I structures to account for anticipated loadings and postulated conditions that may be imposed upon each structure during its service lifetime are in conformance with established criteria, codes, standards, and specifications and are, therefore, acceptable.

The use of these criteria as defined by applicable codes, standards, and specifications; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials quality control and special construction techniques provide reasonable assurance that, in the event of winds, tornadoes, earthquakes, and various postulated accidents occurring within the structures, the structures will withstand the specified design conditions without impairment of structural integrity or the performance of required safety functions. We conclude that conformance with these criteria, codes, specifications, and standards in the design of seismic Category I structures, other than the containment structure, constitutes an acceptable basis for satisfying the requirements of Criteria 2 and 4 of the General Design Criteria.

3.8.4 Foundations

The foundations of seismic Category I structures other than the containment structure for the BOPSSAR design will be reinforced concrete, primarily of the mat type design. The principal code for the design of these concrete mat foundations will be the American Concrete Institute 318-71 Code. These concrete foundations will be designed to resist various combinations of dead loads, live loads, environmental loads including winds, tornadoes, and earthquakes, and loads generated by postulated ruptures of high energy pipes.

The design and analysis procedures that will be used for these seismic Category I foundations are in accordance with procedures delineated in the American Concrete Institute 318-71 Code. The various seismic Category I foundations will be designed and proportioned to remain within limits established by us under the various load combinations. These limits are, in general, based on the American Concrete Institute 318-71 Code modified as appropriate for load combinations that are considered extreme. The materials of construction and their fabrication, construction, and installation will be in accordance with the American Concrete Institute 318-71 Code.

The criteria that will be used in the analysis, design, and construction of seismic Category I foundations to account for anticipated loadings and postulated conditions that may be imposed upon each foundation during its service lifetime are in conformance with established criteria, codes, standards, and specifications and are, therefore, acceptable.

The use of these criteria as defined by applicable codes, standards, and specifications; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials quality control and special construction techniques provide reasonable assurance that, in the event of winds, tornadoes, earthquakes, and various postulated events, the seismic Category I foundations will be able to withstand the specified design conditions without impairment of structural integrity and stability or the performance of required safety functions. We conclude that conformance with these criteria, codes, specifications, and standards constitutes an acceptable basis for satisfying the requirements of Criteria 2 and 4 of the General Design Criteria.

3.9 Mechanical Systems and Components

3.9.1 Dynamic System Analysis and Testing

Fluor Pioneer has described a preoperational vibration test program for ASME Code Class 1, 2, and 3 piping systems that will be conducted by a future utility applicant under simulated transients that are credible within the normal and upset operating modes of the systems. Definition of this test program and organization of the staff required to conduct the program are within the scope of a future utility applicant referencing BOPSSAR.

We reviewed Fluor Pioneer's information and discussion of responsibility to verify that adequate technical guidance will be provided to the utility applicant. Total acceptance of the program will require a compatibility review based on the utility applicant's treatment of the program.

The preoperational vibration test program described by Fluor Pioneer which will be conducted during startup and initial operation on all safety-related piping systems, restraints, components, and component supports classified as ASME Code Class 1, 2, and 3 is an acceptable program. The tests will provide adequate assurance that the piping and piping restraints of the system have been designed to withstand vibrational dynamic effects due to valve closures, pump trips, and other operating modes associated with the design basis operational transients. The planned tests will develop loads similar to those experienced during reactor operation. Compliance with this test program will constitute an acceptable basis for fulfilling the requirements of Criterion 15 of the General Design Criteria.

Proper functioning of safety-related mechanical equipment is essential to assure the capability of such equipment to perform protective actions in the event of a safe shutdown earthquake. The dynamic testing and analysis procedures which will be implemented to confirm that all seismic Category I mechanical equipment will function during and after an earthquake of magnitude up to and including the safe shutdown earthquake, and that all equipment support structures are adequately designed to withstand seismic disturbances, are acceptable.

Subjecting the equipment and its supports to these dynamic testing and analysis procedures provides reasonable assurance that in the event of an earthquake at the site, the seismic Category I mechanical equipment as identified in BOPSSAR will continue to function during and after a seismic event, and the combined loading imposed on the equipment and its supports will not exceed applicable code allowable design stress and strain limits. Limiting the stresses of the supports under such loading combinations provides an acceptable basis for the design of the equipment supports to withstand the dynamic loads associated with seismic events, as well as operational vibratory loading conditions without gross loss of structural integrity.

Implementation of these dynamic testing and analysis procedures will constitute an acceptable basis for satisfying the applicable requirements of Criteria 2 and 14 of the General Criteria.

3.9.2 ASME Code Class 1, 2 and 3 Components

All safety-related ASME Code Class 1, 2 and 3 systems, components, and equipment will be designed to sustain normal loads, anticipated transients, the operating basis earthquake and the safe shutdown earthquake within design limits which are consistent with those outlined in Regulatory Guide 1.48, "Design Limits and Loading Conditions." The specified design basis combinations of loading as applied to the design of the safety-related ASME Code Class 1, 2 and essure-retaining components in systems classified as seismic Category I proviae reasonable assurance that in the event (a) an earthquake should occur at the site, or (b) other upset, emergency, or faulted plant transients should occur during plant operation, the resulting combined stresses imposed on the system components may be expected not to exceed the allowable design stress and strain limits for the materials of construction. Limiting the stresses under such loading combinations provides a conservative basis for the design of the system components to withstand the most adverse combinations of loading events without gross loss of structural integrity.

Fluor Pioneer's design load combinations and associated stress and deformation limits specified for all ASME Code Class 1, 2, and 3 components constitute an acceptable basis for design in satisfying Criteria 1, 2, and 4 of the General Design Criteria.

The conduct of Fluor Pioneer's proposed operability assurance program will provide adequate assurance of the capability of active pumps and valves in seismic Categor I systems to withstand postulated seismic loads in combination with other significant loads without loss of structural integrity, and to perform "active" functions such as pump operation and valve closure or opening, when a safe plant shutdown is to be effected or the consequences of an accident are to be mitigated. The specified component operability assurance procedures constitute an acceptable basis for meeting the requirements of Criteria 1, 2, and 4 of the General Design Criteria as related to operability of active valves and pumps.

The criteria to be used for the design analysis and installation of ASME Code Class 1, 2, and 3 safety and relief valves are consistent with the recommendations of Regulatory Guide 1.67, "Installation of Overpressure Protection Devices," for open discharge systems; for closed systems Fluor Pioneer has provided a commitment to perform a conservative dynamic analysis of the complete system. The description of the calculational procedures and methods to be used in the analyses includes the development of transient hydraulic forcing functions and their application to determine the dynamic responses of the system. The time history analysis will account for valve opening time and water slug effects where loop seals are part of the system.

Using these criteria in developing the design and mounting of ASME Class 1, 2, and 3 safety and relief valves will provide adequate assurance that, under discharging conditions, the resulting stresses will not exceed the allowable design stress and strain limits for the materials of construction. Limiting the stresses under the loading combinations associated with the actuation of these pressure relief devices provides a conservative basis for the design of the system components to withstand these loads without loss of structural integrity and impairment of the overpressure protection function.

We conclude that the application of these criteria in the design, analysis, and installation of ASME Code Class 1, 2, and 3 overpressure relief devices constitutes an acceptable basis for meeting the applicable requirements of Criteria 1, 2, 4, 14, and 15 of the General Design Criteria.

Fluor Pioneer states that the design of BOPSSAR will provide for an inservice test program for all ASME Code Class 1, 2, and 3 pumps and valves which will meet the requirements of the ASME Code, Section XI, Subsections IWP 3000 and IWV 3000, respectively. Compliance with these code requirements will constitute an acceptable basis for satisfying the applicable portions of Criteria 37, 40, 43, and 46 of the General Design Criteria.

3.9.3 Fracture Toughness Requirements for ASME Code Class 2 and 3 Ferritic Components

Fluor Pioneer has stated in Section 10.3.7.1 of BOPSSAR that ASME Code Class 2 and 3 ferritic components within the balance-of-plant scope of supply, except those described in paragraphs NC/ND-2311(b) (1) through (7), of the ASME Boiler and Pressure Vessel Code, 1974 Edition, Section III, shall be tested for fracture toughness according to the procedures, requirements and acceptance standards of NC/ND-2320 through NC/ND-2360 of the ASME Code with the following additional requirements:

(1) For materials with thickness exceeding 2-1/2 inches, except those covered below, the lowest service temperature as described in NC/ND-2332(d) shall not be lower than RT_{NDT}+100°F unless a lower temperature is justified by methods similar to those contained in Appendix G of the ASME Code.

(2) Code Class 2 and Class 3 passive pressure retaining components with wall thickness exceeding 2-1/2 inches as described in NC/ND-2332 may meet the following requirements: the lowest service temperature shall not be lower than RT_{NDT}+30°F unless a lower temperature is justified by methods similar to those contained in Appendix G of the ASME Code as stated in NC/ND-2332(d) rather than the RT_{NDT}+100°F required above, provided that the shop hydrotest required by paragraph NC/ND-6221(a) shall be conducted at or below the lowest service temperature as defined in NC/ND-2331(a).

Passive pressure retaining components are defined as vessels, tanks, piping, tubes, pumps, valves and fittings not part of an active reactor system required for normal operation, including startup and shutdown, but are on standby, and maintain a constant pressure at all times, such that when called upon to perform their safety-related function there is no increase in pressure stress or thermal stress.

The fracture toughness tests and properties required by the ASME Code, and the additional requirements as stated above, provide reasonable assurance that safety margins against the possibility of nonductile behavior or rapidly propagating fracture can be established for the pressure-retaining ferritic materials of Code Class 2 and 3 ferritic components, and are, therefore, acceptable.

3.10 Seismic Qualification of Seismic Category I Instrumentation and Electrical Equipment

Instrumentation and electrical components required to perform a safety function will be designed to meet seismic Category I design criteria. Seismic requirements established by the seismic system analysis will be incorporated into equipment specifications to assure that the equipment purchased or designed will meet seismic requirements equal to or in excess of the requiremants for seismic Category I components, either by appropriate analysis or by qualification testing.

Fluor Pioneer has proposed a seismic qualification program referencing IEEE Standard 344-1975 that will be implemented for seismic Category I instrumentation and electrical equipment and the associated supports for this equipment to provide assurance that such equipment can be expected to function properly and that structural integrity of the supports will not be impaired during the excitation and vibratory forces imposed by the safe shutdown earthquake and the conditions of post-accident operation. We conclude that this program constitutes an acceptable basis for satisfying the applicable requirements of Criterion 2 of the General Design Criteria.

3.11 Environmental Design of Mechanical and Electrical Equipment

Our evaluation of the environmental design of mechanical and electrical equipment is discussed in Section 7.6.1 of this report.

4.0 REACTOR

The reactor, as part of the nuclear steam supply system, is not within the scope of BOPSSAR. BOPSSAR includes by reference the Westinghouse standard nuclear steam supply system RESAR-41. Our evaluation of the RESAR-41 design is discussed in our Safety Evaluation Report for RESAR-41.

5.0 REACTOR COOLANT SYSTEM AND CONNECTED SYSTEMS

5.1 General Information

The reactor coolant system in its entirety is designed and analyzed by Westinghouse as described in RESAR-41 and is not within the scope of BOPSSAR. Fluor Pioneer has established the criteria for material selection and construction of systems that are within the scope of BOPSSAR and that are related or connected to the reactor coolant pressure boundary. Fluor Pioneer has tabulated the components and structures in Table 3.2-1 of BOPSSAR showing their source of supply, safety classification, seismic category, and quality group classification. Fluor Pioneer has identified in Section 5A of BOPSSAR the utility applicant's interface requirements for the reactor coolant system. Our general review of ASME Code Class 1, 2, and 3 components is contained in Section 3.9.2 of this report.

Certain areas associated with the reactor coolant system and connected systems are within the scope of the balance-of-plant and are discussed below. These areas are (1) the material considerations for piping connected to the reactor coolant system, (2) the leakage detection system for the reactor coolant pressure boundary, (3) the inservice inspection program for the reactor coolant system, and (4) the loose parts monitoring program.

5.2 Integrity of the Reactor Coolant Pressure Boundary

5.2.1 General Material Considerations

The materials considerations for the reactor coolant pressure boundary are properly addressed by Westinghouse in RESAR-41, and our evaluation of these materials considerations is contained in our Safety Evaluation Report on RESAR-41. Fluor Pioneer has provided information in BOPSSAR related to the materials considerations for piping and fittings that are within the scope of BOPSSAR and that are required to meet the interface materials requirements specified in RESAR-41.

These interface requirements are related to (1) the materials specifications for piping and fittings to be connected to the fluid systems of RESAR-41; (2) field welding of austenitic stainless steel at the piping interfaces, including contamination protection and cleaning procedures to be performed before, during, and after field welding of austenitic stainless steel; (3) procedures regarding sensitization of field welds; (4) procedures regarding control of delta ferrite; (5) field welding of ferritic steel components and austenitic steel components and interfaces; and (6) field welding of steam generators at the interfaces, including contamination protection and cleaning procedures before, during and after field welding installation of steam generators.

Based on our review, we determined that the interface requirements specified in RESAR-41 will be satisfied by the BOPSSAR design, and conclude that the materials for the reactor coolant pressure boundary within the scope of BOPSSAR are acceptable.

5.2.2 Reactor Coolant Pressure Boundary Leakage Detection System

Reactor coolant leakage within the containment may be an indication of a small through-wall flaw in the reactor coolant pressure boundary. The leakage detection system will include diverse leak detection methods, will have sufficient sensitivity to measure small leaks, will identify the leakage source to the extent practical, and will be provided with suitable control room alarms and readouts. The system will consist of the containment radiation monitors (gas and particulate), sump level measuring system, and the recirculation fan cooler system. Indirect indication of leakage will be obtained from the containment pressure and temperature monitors. Intersystem leakage will be detected by abnormal readings from radioactivity monitors in the secondary system. The leakage detection systems proposed to detect leakage from components and piping of the reactor coolant pressure boundary will be in accordance with the recommendations of Regulatory Guide 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems," and provide reasonable assurance that any structural degradation resulting in leakage during service will be detected in time to permit corrective actions. Conformance with the recommendations of Regulatory Guide 1.45 constitutes an acceptable basis for satisfying the requirements of Criterion 30 of the General Design Criteria.

5.2.3 Inservice Inspection Program

To ensure that no deleterious defects of the reactor coolant pressure boundary develop during service, selected welds and weld heat-affected zones will be designed to be inspected periodically. Fluor Pioneer states that all ASME Code Class 1, 2, and 3 pressure-retaining system piping, pumps, valves, and components which require inservice inspection, as defined by Section XI of the ASME Code will be installed so as to provide accessibility for inspection in compliance with the requirements of Section XI and applicable addenda determined by Section 50.55a(g) of 10 CFR Part 50. Remote inspection equipment will be used to inspect those areas not readily accessible to inspection personnel. Details of the inservice inspection program and equipment will be provided in a future utility applicant's application for a construction permit referencing BOPSSAR.

The conduct of periodic inspections and hydrostatic testing of pressure-retaining components in the reactor coolant pressure boundary in accordance with the requirements of Section XI of the ASME Code provides reasonable assurance that evidence of structural degradation or loss of leaktight integrity occurring during service will be detected in time to permit corrective action before the safety function of a component is compromised. Compliance by a future utility applicant with the inservice inspections required by this Code constitutes an acceptable basis for satisfying the requirements of Criteria 32, 36, 39, 42, and 45 of the General Design Criteria.

5.3 Loose Parts Monitoring Program

Occasionally, miscellaneous items such as nuts, bolts, and other items have become loose parts within reactor coolant systems. In addition to causing operational inconvenience, such loose parts can damage components within the system or be an indication of undue wear or vibration.

For such reasons, for the past few years we have required many applicants to initiate a program or to participate in an ongoing program, the objective of which was the development of a functional, loose parts monitoring system within a reasonable period of time. Recently, prototype loose parts monitoring systems have been developed and are presently in operation or being installed at several plants.

Fluor Pioneer states in BOPSSAR that a loose parts monitoring system will be provided within the scope of supply of BOPSSAR. We conclude that this commitment is acceptable.

6.0 ENGINEERED SAFETY FEATURES

6.1 Design Considerations

The purpose of the various engineered safety features is to provide protection for the plant personnel and the public by limiting the radiation exposure that could result from a postulated major accident in the plant. In this section, we discuss the engineered safety features systems proposed for the BOPSSAR balance-of-plant design. Certain of these systems or parts of these systems will have functions for normal plant operation as well as serving as engineered safety features.

We reviewed the proposed systems and components designated as engineered safety features within the scope of the BOPSSAR design. These systems and components will be designed to be capable of assuring safe shutdown of the reactor under the adverse conditions of the various postulated design basis accidents. They will be designed, therefore, to seismic Category I requirements and must function with complete loss of offsite power.

Components and systems will be provided in sufficient redundancy so that a single failure of any component or system will not result in the loss of the capability to achieve safe shutdown of the reactor. These design requirements are in accordance with the General Design Criteria.

The engineered safety features which are within the scope of BOPSSAR, and discussed in this section, are the primary containment, secondary containment, containment heat removal system, containment isolation system, combustible gas control system, control room habitability system, engineered safety features filter system, and the auxiliary feedwater system, which is discussed in Section 10.7 of this report.

In addition to the engineered safety features identified above, certain components of the emergency core cooling system and the emergency boration system, which are within the scope of RESAR-41, are within the scope of BOPSSAR. In particular the refueling water storage tank and the containment recirculation sumps, which are water sources for the emergency core cooling system, are within the scope of BOPSSAR. Also, the heat tracing for the emergency boration system is within the scope of BOPSSAR and is discussed in Section 7.3.4 of this report.

6.2 Containment Systems

The containment systems for the BOPSSAR balance-of-plant design will include a reactor containment structure as the primary containment, a secondary containment structure, containment heat removal systems, containment isolation systems, a containment combustible gas control system, and provisions for containment leak testing.

6.2.1 Containment Functional Design

The primary containment will consist of a free standing, spherical steel vessel having a net free volume of 3.4 million cubic feet. The containment vessel will house the nuclear steam supply system, which includes the reactor vessel, reactor coolant piping, reactor coolant pumps, pressurizer, and steam generators, as well as certain components of the plant engineered safety feature systems. The containment vessel will be designed for an internal pressure of 49 pounds per square inch gauge and a temperature of 267 degrees Fahrenheit.

Fluor Pioneer has described in BOPSSAR the analytical models used for the containment vessel pressure response analysis, including the assumptions made regarding the availability of heat removal systems and structural heat sinks. Fluor Pioneer analyzed reactor coolant system pipe break accidents for a spectrum of break locations and sizes. The CONTEMPT-LT computer code was used for the containment vessel pressure response analysis. The postulated double-ended break of the pump suction in the cold leg of the reactor coolant system resulted in the highest calculated pressure of 44.5 pounds per square inch gauge. The containment vessel design pressure (49 pounds per square inch gauge) provides a margin of ten percent above the peak calculated pressure.

Fluor Pioneer provided in BOPSSAR the mass and energy release data used in the containment analysis. The mass and energy release data were calculated using methods and assumptions that were previously found acceptable in RESAR-41, but based on an assumed containment backpressure of 45 pounds per square inch gauge. Since the assumed containment backpressure of 45 pounds per square inch gauge is greater than the calculated containment backpressure of 44.5 pounds per square inch gauge, the mass and energy release data used in the containment analysis are acceptable. We performed a confirmatory analysis of the containment vessel pressure response to a postulated double-ended break of the cold leg (pump suction) piping in the reactor coolant system using the CONTEMPT-LT MOD 26 computer code. Our confirmatory analysis was based on the mass and energy release data, containment structural heat sink data, and spray system performance data provided by Fluor Pioneer. Containment heat removal system performance was based on the assumption that two of the three containment spray pumps are operable. Conservative condensing heat transfer coefficients were also used for transfer of heat to the structures inside containment. The results of our analysis confirm the pressure calculated by Fluor Pioneer. We, therefore, conclude that the containment vessel design pressure is acceptable for the design basis loss-of-coolant accident since it provides a ten percent margin above the peak calculated pressure.

Fluor Pioneer has also analyzed the containment vessel pressure response to a spectrum of postulated main steam line break accidents and to a feedwater line break accident. The analytical model used to calculate the mass and energy release data for these postulated accidents has been accepted by the staff.

Following a postulated main steam line break inside containment, steam will initially be discharged from all four steam generators. Flow from the steam generators in the unbroken loops will be terminated following the main steam line isolation signal. Flow from the steam generator in the broken loop will continue until all the fluid is discharged.

The mass and energy available to flow into the containment is the mass of fluid initially in the steam generators and the additional water added by the feedwater system. For the RESAR-41 steam generators the initial water mass is greatest at hot standby. Feedwater flow is proportional to the power level.

For the long term mass and energy release calculations used to verify the containment design temperature and pressure, Fluor Pioneer has performed a bounding calculation designed to maximize the total mass and energy release. In the bounding calculation the steam generator water mass is set at the hot standby value; however, feedwater is assumed to flow at 150 percent of the full power value. A double-ended break was assumed and, following isolation of the steam isolation valves and the redundant valves in the feedwater lines, the entire inventory of the ruptured steam generator was added to the containment as steam. The primary system is assumed to provide an infinite heat source for this process. The flow rate to the containment was maximized by use of the Moody critical flow correlation. We determined that this method is conservative for verification of the containment design temperature and pressure.

We agree with Fluor Pioneer that the rupture of a main feedwater line will produce lower containment temperatures and pressures than the rupture of a main steam line. This is because the area of flow restrictor in the feedwater nozzle is only 16 percent of the steam pipe flow restrictor area, and the lower elevation of the feedwater inlet to the steam generator would result in substantial liquid entrainment with a consequent reduction in total energy release in the case of a rupture of a main feedwater line.

Fluor Pioneer calculated a maximum containment vessel pressure and temperature of 41.3 pounds per square inch gauge and 383 degrees Fahrenheit, respectively, for the postulated double-ended rupture of a main steam line. The failure of a main steam isolation valve to close was determined to be the limiting single failure.

We performed a confirmatory analysis of the main steam line break using the CONTEMPT-LT/026 computer code. Our analysis predicted a temperature of 375 degrees Fahrenheit and a pressure of 38.3 pounds per square inch gauge.

RESAR-41 specifies that a peak temperature of 340 degrees Fahrenheit will be used in the environmental qualification testing of safety-related mechanical and electrical equipment within Westinghouse's scope of supply. Since the calculated peak temperature in containment is not compatible with the RESAR-41 environmental qualification temperature, we will require a future utility applicant referencing the BOPSSAR design to provide verification that the equipment inside containment within the scope of RESAR-41 will be qualified to the temperature profile established by the postulated main steam line break analysis in BOPSSAR. This matter is discussed further in Section 7.6.1 of this report.

Fluor Pioneer has analyzed the pressure response of compartments inside the containment to the postulated high energy line breaks identified in RESAR-41. The compartments investigated include the steam generator compartments, the pressurizer compartment, and the reactor cavity. Fluor Pioneer has committed to increase the calculated peak differential pressures for all subcompartments by a factor of 1.4 to establish the design differential pressures for the subcompartments in accordance with acceptance criteria specified in Section 6.2.1.2 of the Standard Review Plan (NUREG-75/087). We find this acceptable.

The subcompartment analysis was performed using the RELAP-4-EM/085 computer code. The mass and energy release data for postulated reactor coolant system pipe breaks were obtained from the information provided in RESAR-41. For the main steam and feedwater line breaks, Fluor Pioneer provided bounding calculations for short term mass and energy release rates following a postulated double-ended rupture of a steam or feedwater pipe. For the feedwater pipe rupture analysis the flow rate is maximized by use of the Henry-Fauske correlation when the flow was subcooled and the Moody correlation thereafter. The short term steam line break calculation utilized the Moody correlation throughout. No credit was taken for flow reduction caused by steam generator pressure decay. Liquid entrainment was assumed since for short term calculations this assumption maximized mass and energy release rates. We therefore conclude that this method of calculating short term mass and energy releases is conservative for subcompartment analysis. The results of Fluor Pioneer's subcompartment analysis are summarized as follows:

Pipe Break Location	Postulated Pipe Break	Peak Calculated Differential Pressure
Reactor Cavity	150 square inch cold leg limited displacement rupture	273 pounds per square inch
Steam Generator Compartment	Double-ended cold leg rupture	37 pounds per square inch
Pressurizer Compartment	Double-ended surge line rupture	110 pounds per square inch

We performed a confirmatory analysis of the reactor cavity, steam generator compartment, and pressurizer compartment using the RELAP-3 computer code. Our results confirm the peak differential pressures calculated by Fluor Pioneer for the steam generator compartment and the pressurizer compartment. Our calculated peak differential pressure for the reactor cavity is 305 pounds per square inch, which is about 12 percent greater than the pressure calculated by Fluor Pioneer. Fluor Pioneer has revised its proposed design to use the peak differential pressure of 305 pounds per square inch, increased by a factor of 1.4, for the reactor cavity. On the basis of our confirmatory analyses, we conclude that the peak differential pressures to be used by Fluor Pioneer for the design of containment subcompartments are acceptable.

With regard to containment subcompartment analyses for predicting the loadings on structures and component supports due to asymmetric pressure differentials, we will require a future utility applicant referencing the BOPSSAR design to provide confirmatory analyses for use in determining the design loadings. The reason for this is that the asymmetric differential pressures in containment subcompartments that act across vessels and result in loadings on structures and component supports is one of three categories of loadings. The other two categories are vessel internals reaction loads and fluid jet thrust loads which are determined by Westinghouse. These three loadings are combined to calculate the total loading as a function of time. Information must be exchanged between Fluor Pioneer and Westinghouse in order to assure that the analysis is conservatively derived and that the limiting case break size and location is identified. Consequently, we will require that this matter be addressed by the utility applicant in its application for a construction permit referencing the BOPSSAR design and that the exchange of information be properly integrated into the design of structures and component supports.

Fluor Pioneer has analyzed the consequences of inadvertent actuation of the containment spray system in the containment. The initial conditions of the containment atmosphere were assumed to be 14.7 pounds per square inch absolute and 120 degrees Fahrenheit. All six fan/coil heat removal units were assumed to be actuated, and the spray water was assumed to be at its lowest temperature of 65 degrees Fahrenheit. Vacuum relief valves will be provided, which are designed to open when a differential pressure of 0.8 pounds per square inch occurs across them. Fluor Pioneer has calculated a maximum pressure differential of 0.91 pounds per square inch for this event. Based on our review of Fluor Pioneer's method of analysis and assumptions of the consequences of inadvertent actuation of the containment spray system, we conclude that the containment vessel design pressure differential of 1.3 pounds per square inch is acceptable.

6.2.2 Secondary Containment Functional Design

The secondary containment (shield building) will be a reinforced concrete structure surrounding the steel containment vessel. The shield building annulus will be divided into two regions, an active region and a passive region, which will collectively have a net free volume of 1.56 million cubic feet. Following a postulated loss-of-coolant accident, the active and passive annulus cleanup systems, which are independent subsystems of the reactor building annulus heating, ventilation, air conditioning, and cooling system, will maintain both annulus regions at a negative pressure to assure the collection of any leakage from the containment.

The active and passive annulus cleanup systems will each consist of two independent, 100 percent capacity trains. The systems will be actuated by a safety injection signal.

Fluor Pioneer has performed an analysis of the pressure response in both the active and passive annulus regions following a postulated loss-of-coolant accident. Fluor Pioneer calculated that a negative pressure of two inches of water gauge will be established within 2.5 minutes in the passive annulus region and within 1.25 minutes in the active annulus region. In the analysis, one of the two independent ventilation trains was conservatively assumed to be inoperable. Based on our review of Fluor Pioneer's analysis, we conclude that the analysis was performed in a conservative manner and is acceptable.

Fluor Pioneer has described the functional tests to be performed by a future utility applicant, to periodically demonstrate that the system will be capable of achieving the pressure transient predicted by the analysis.

Fluor Pioneer has identified potential leak paths from the containment vessel which bypass the volumes treated by the active and passive annulus cleanup systems. The potential bypass leak paths were determined using the guidelines of Branch Technical Position CSB 6-3, "Determination of Bypass Leakage in Dual Containment Plants." Based on our review, we conclude that the bypass leak paths have been correctly identified. BOPSSAR will be designed to limit the total allowable bypass leakage rate to ten percent of the maximum allowable containment leakage rate. The bypass leak paths will be designed to be tested in accordance with the requirements of 10 CFR Part 50, Appendix J for local (Type B and Type C) leak tests.

We reviewed the functional design of the secondary containment system and the proposed periodic operability test program. Based on our review, we conclude that they are acceptable.

6.2.3 Containment Heat Removal System

The containment heat removal system will include three redundant containment spray trains. The system will reduce the containment pressure and temperature following a postulated high energy line break accident. The containment spray system will serve only as an engineered safety feature and will perform no normal operating function. It will be a seismic Category I system consisting of redundant heat exchangers, piping, valves, pumps, and spray headers. All active components of the system will be located outside the containment to facilitate maintenance operations. Protection against internally generated missiles will be provided by direct shielding or physical separation of equipment.

The containment spray pump recirculation intake in each of the containment emergency sumps will be enclosed by a screen assembly to prevent the entry of debris which could clog the spray nozzles. The protection screen assembly design is consistent with the guidelines of Regulatory Guide 1.82, "Sumps for Emergency Core Cooling and Containment Spray Systems."

A containment pressure signal from the engineered safety features actuation system will automatically actuate the containment spray system. The system design will permit manual operation of pumps and valves from the control room. The spray will initially take suction from the refueling water storage tank. When the tank reaches a low level, a switchover from injection to recirculation will be initiated automatically.

Sufficient net positive suction head will be available to the spray pumps for both the injection and recirculation modes of operation. Fluor Pioneer's evaluation of the available net positive suction head is consistent with the guidelines of Regulatory Guide 1.1, "Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps."

Based on our review of the containment heat removal systems, we conclude that the systems will be designed in accordance with the requirements of Criteria 38, 39, and 40 of the General Design Criteria, and are, therefore, acceptable.

6.2.4 Containment Air Cleanup System

The containment spray system will be used for fission product removal from the containment atmosphere following a postulated loss-of-coolant accident. To enhance the iodine scrubbing effectiveness of the spray, sodium hydroxide will be added to the spray solution by the spray tank and additive injection pump for each of the three 50 percent capacity spray tanks. The system will be designed to maintain a spray solution pH of between 8.5 and 11 under all modes of operation, including a single active failure in the system or any of its support systems.

We calculated first order removal rate coefficients of 22 and 0.8 per hour for elemental and particulate iodine respectively, in an effective volume of 96,000 cubic meters, which comprises 86 percent of the containment free volume. In the loss-of-coolant accident dose calculations discussed in Section 15.0 of this report, however, we used the maximum elemental iodine removal rate coefficient compatible with the plate-out assumptions of Regulatory Guide 1.4, i.e., ten per hour. The elemental iodine removal effectiveness of the system was assumed to diminish after the initial concentration of this form of iodine in the containment atmosphere has been reduced by a factor of 100. The long term equilibrium pH of 8.5 assures that this decontamination factor of 100 can be maintained. We evaluated this system and find it will be effective for the removal of the elemental and particulate forms of iodine and is, therefore, acceptable.

6.2.5 Containment Isolation System

The containment isolation system will be designed to automatically isolate the containment atmosphere from the outside environment under postulated accident conditions. Double barrier protection, in the form of closed systems and isolation valves, will be provided to assure that no single failure will result in the loss of containment integrity. The containment isolation provisions will be designed as seismic Category I equipment and will be protected against potential missiles. The Fluor Pioneer design of the containment isolaticn system will incorporate the provisions for certain system lines and the isolation signals described in RESAR-41. We reviewed the interface requirements in RESAR-41 and conclude that they will be met by the Fluor Pioneer design.

We reviewed the closure times for the isolation valves. Valve closure times are established on the basis of minimizing the release of containment atmosphere to the environment under accident conditions, to mitigate the offsite radiological consequences, and to assure that the emergency core cooling system effectiveness is not degraded by a reduction in containment backpressure. We conclude that the closure times for the isolation valves are acceptable.

Our review of the containment isolation system also included a review of the functional capability of the proposed containment purge system and the containment supply and exhaust system, which will function to reduce airborne radioactivity in the containment, limit radiation exposure to operating personnel, and provide outside air to the containment during extended periods of occupancy. The containment supply and exhaust system will consist of a high capacity system and a low capacity system. The high capacity system will be operated only during cold shutdown and refueling operations. Therefore, the isolation valves in the high capacity system will be closed during all other modes of plant operation.

The low capacity system will provide the purging capability of the containment during normal plant operations. Fluor Pioneer has provided an analysis of the consequences of a postulated loss-of-coolant accident while purging the containment using the guidelines of Branch Technical Position CSB 6-4, "Containment Purging During Normal Plant Operations." In this analysis, Fluor Pioneer has assumed a five-second closure time for the purge isolation valves. During the course of our review, we requested Fluor Pioneer to modify the design of the containment purge system to assure that valve closure will not be prevented by debris which could potentially become entrained in the escaping air and steam following a postulated pipe rupture. Fluor Pioneer has modified the proposed design to prevent debris from entering the purge system. We reviewed the modification to the proposed design and determined that the modification will prevent debris from entering the purge system.

Based on our review, we conclude that the design of the containment isolation system conforms to Criteria 54, 55, 56, and 57 of the General Design Criteria and to the recommendations of Regulatory Guide 1.11, and is, therefore, acceptable.

6.2.6 Combustible Gas Control System

Following a postulated loss-of-coolant accident, hydrogen may accumulate inside the containment as a result of (1) chemical reaction between the fuel rod cladding and the steam resulting from vaporization of emergency core cooling water, (2) corrosion of construction materials by the alkaline spray solution, and (3) radiolytic decomposition of the cooling water in the reactor core and the containment sumps.

Redundant thermal hydrogen recombiner systems will be located outside the containment and a backup purge system will be provided to mitigate the consequences of hydrogen accumulation in the containment. Each of the 100 percent capacity recombiners and the backup purge system will be capable of processing the containment atmosphere at a rate of 50 standard cubic feet per minute. The recombiner system will incorporate several design features to assure the capability of the systems to remain operable in the event of an accident. Among these are: (1) seismic Category I design, (2) missile protection, and (3) redundancy to the extent that no single component failure will disable both recombiner systems.

Redundant, permanently installed hydrogen analyzers will be provided that will be capable of continuously monitoring the containment hydrogen concentration and operating independently of the hydrogen recombiners.

Two, 100 percent capacity dome recirculation fans will provide mixing of the containment atmosphere to assure that localized concentrations of hydrogen will not occur.

Fluor Pioneer has performed an analysis of the post-accident production and accumulation of hydrogen within the containment that is consistent with the guidelines of Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a Loss of Coolant Accident," and Branch Technical Position CSB 6-2, "Control of Combustible Gas Concentrations in Containment Following Loss-of-Coolant Accident." For the analysis, Fluor Pioneer assumed that five percent of the fuel cladding mass reacted with steam instantaneously to produce hydrogen. The analysis indicates that the hydrogen concentration in the containment will not reach the lower flammability limit of four volume percent until about 26 days after a postulated loss-of-coolant accident. However, hydrogen recombiner operation will be initiated before the lower flammability limit is reached.

Our confirmatory analysis has verified the acceptability of the hydrogen generation analysis presented by Fluor Pioneer, and the effectiveness of the combustible gas control systems to maintain the hydrogen concentration in the containment within acceptable limits.

The combustible gas control system will not be required to operate until a relatively long period of time after a postulated loss-of-coolant accident. Therefore, Fluor Pioneer has proposed sharing the combustible gas control equipment between units at a site and between sites. We will require that utility applicants referencing BOPSSAR provide assurance that the shared equipment can be transported to the affected unit or site on an appropriate time scale and that the recombiners be tested to assure transportability. In addition, we will require utility applicants to describe the design and procedural provisions for sharing, periodic maintenance, and testing.

We reviewed the proposed combustible gas control system with regard to the requirements of Criteria 41, 42, and 43 of the General Design Criteria and the recommendations of Regulatory Guide 1.7. We conclude that the system, as described in BOPSSAR, for combustible gas control following a postulated loss-of-coolant accident is acceptable.

6.2.7 Containment Leakage Testing Program

We reviewed Fluor Pioneer's proposed containment leakage testing program as presented in Sections 6.2 and 16.4 of BOPSSAR for compliance with the containment leakage testing requirements specified in Appendix J to 10 CFR Part 50, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors." Compliance with these requirements by a utility applicant referencing BOPSSAR will provide adequate assurance that the containment leak-tight integrity can be verified throughout service lifetime in order to provide reasonable assurance that, in the event of any radioactivity release within the containment, the loss of the containment atmosphere through leak paths will not be in excess of the limits specified for the site.

Specifically, we reviewed Fluor Pioneer's leakage testing program to assure that containment penetrations and system isolation valve arrangements will be designed to provide leak testing capability as required by Appendix J. Fluor Pioneer has tabulated all penetrations and isolation valves in Table 6.2-19 of BOPSSAR. This table identifies those systems which will be vented and drained to expose isolation valves to the containment integrated leak rate test pressure. For those systems that will not be vented and drained, Fluor Pioneer has provided justification in accordance with the requirements of Appendix J. Table 6.2-19 also identified the isolation valves that will not be leakage tested and provides justification in accordance with the definitions of Appendix J.

Fluor Pioneer has stated that Type B tests will be conducted to determine leakage from bellows on mechanical penetrations, cannisters and sleeves of electrical penetrations, and seals on airlocks and the fuel transfer tube. Included in the table are those leakage paths which constitute bypass leakage, i.e., leakage paths which penetrate both primary and secondary containment barriers. We reviewed Table 6.2-19 and its supplementary information and find it to be in compliance with Appendix J with regard to system venting and draining, isolation valve leak testing, and penetration leak testing, and conclude that adequate design provisions will be made for leakage testing individual isolation valves and the personnel airlocks.

Fluor Pioneer has stated that the containment integrated leak rate (Type A) periodic test frequency, acceptance criteria, and testing procedures will be discussed by utility applicant's referencing the BOPSSAR design. We find this acceptable.

On the basis of our review, we conclude that the containment leakage testing program complies with the requirements of Appendix J to 10 CFR Part 50, and that compliance with these requirements constitutes an acceptable basis for satisfying the requirements of Criteria 52, 53, and 54 of the General Design Criteria.

6.3 Emergency Core Cooling System

The design and analysis of the emergency core cooling system is not within the scope of BOPSSAR, but is within the scope of RESAR-41. Our evaluation of the emergency core cooling system described in RESAR-41 is presented in Section 6.3 of our RESAR-41 Safety Evaluation Report. However, certain balance-of-plant features do have a bearing on the design of the emergency core cooling system. The BOPSSAR commitment to fully satisfy Regulatory Guide 1.79, "Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors," requirements for preoperational sump testing is acceptable at the Preliminary Design Approval stage of our review. In addition, certain aspects of the minimum containment pressure calculation as related to the emergency core cooling system evaluation are within the scope of Fluor Pioneer as discussed below.

Appendix K to 10 CFR Part 50 of the Commission's regulations requires that the effect of operation of all installed pressure reducing systems and processes be included in the emergency core cooling system evaluation.

For this evaluation, it is conservative to minimize the containment pressure since this will increase the resistance to steam flow in the reactor coolant loops and reduce the reflood rate in the core.

Following a postulated loss-of-coolant accident, the pressure in the containment building will be increased by the addition of steam and water from the primary reactor system to the containment atmosphere. After initial blowdown, heat transfer from the core, primary metal structures, and steam generators to the emergency core cooling system water, will produce additional steam. This steam, together with any emergency core cooling system water spilled from the primary reactor system, will flow through the postulated break and into the containment. This energy will be released to the containment during both the blowdown and subsequent emergency core cooling system operational phases; i.e., the reflood and post-reflood phases.

Energy removal will occur within the containment by several means. Steam condensation on the containment walls and internal structures, which serve as passive heat sinks, becomes effective early in the blowdown transient. Subsequently, the operation of the containment heat removal systems such as containment sprays will remove steam from the containment atmosphere. When the steam removal rate exceeds the rate of steam addition from the primary system, the containment pressure will decrease from its maximum value.

The emergency core cooling system containment pressure calculations were performed for the RESAR-41 design on that application with the Westinghouse emergency core cooling system evaluation model. As stated in Section 6.3.4 of our RESAR-41 Safety

Evaluation Report, we have reviewed this model and concluded that it is acceptable for the RESAR-41 emergency core cooling system evaluation. The minimum containment pressure analysis for the RESAR-41 emergency core cooling system evaluation included assumptions for the containment net free volume, passive heat sinks, and operation of the containment heat removal system with regard to conservatism for the emergency core cooling system analysis. The data for the passive heat sinks are conservative in comparison with the recommendations in Branch Technical Position CSB 6-1, "Minimum Containment Pressure Model for PWR ECCS Performance Evaluation."

We concluded, in Section 6.3.4 of the RESAR-41 Safety Evaluation Report, that the plant-dependent input information for the minimum containment pressure analysis in RESAR-41 is reasonably conservative and that the analysis conforms with Appendix K to 10 CFR Part 50 of the Commission's regulations. We also concluded that each applicant referencing the RESAR-41 emergency core cooling system evaluation must demonstrate that the significant containment parameters for the balance-of-plant design are conservative when compared with those used in RESAR-41.

Fluor Pioneer has determined that calculation of the minimum containment pressure response using plant dependent input parameters for the BOPSSAR containment will result in a lower pressure than that calculated by Westinghouse in RESAR-41. We, therefore, conclude that the BOPSSAR design is not compatible with the emergency core cooling system analysis provided in RESAR-41. The resolution of this matter will require further analysis to verify the acceptability of the lower pressure for the RESAR-41 design. Accordingly, we require that this matter be specifically addressed by the utility applicant in its construction permit application. The utility applicant will be required to provide the results of reevaluation of the emergency core cooling system performance using containment pressure input information which has been calculated using the plant dependent containment parameters for the BOPSSAR design.

With regard to passive failures of fluid components of the emergency core cooling system during long-term cooling while operating in the recirculation mode of operation, Westinghouse identified in RESAR-41 the failure of a pump seal as a postulated failure. This postulated failure could result in the loss of core cooling water at a rate of 50 gallons per minute. However, RESAR-41 does not include this item as a design interface requirement for the balance-of-plant. Consequently, we requested Fluor Pioneer to provide a design which will mitigate the consequences of such a failure.

Fluor Pioneer has provided a design in BOPSSAR which will utilize sump pump level alarms to alert the plant operator of rising water level in the safeguards area in the event of leakage of core cooling water in this area as a consequence of a failed fluid component. The design will also provide about 30 minutes of time for plant operator action to isolate the failed component and thus terminate the leakage of cooling water before any degradation occurs in the performance of the emergency core cooling system. We reviewed the proposed design and determined that it is acceptable.

6.4 Control Room Habitability

The emergency protection provisions of the control room related to the accidental release of radioactivity or toxic gases are evaluated in this section. Relevant portions of the control room atmosphere cleanup and control room ventilation system are described here and are described and evaluated further in Sections 6.5.3 and 9.4 of this report.

Fluor Pioneer proposes to meet Criterion 19 of the General Design Criteria by use of concrete shielding and by installing redundant 4000 cubic feet per minute emergency air recirculation filter trains incorporating a charcoal filter having a two-inch depth of charcoal and by installing redundant air pressurization and filtration trains. The original design for pressurization of the control room was modified based on our concern regarding insufficient pressurization of the control room during emergencies. Fluor Pioneer corrected this deficiency by increasing the make-up rate from 150 cubic feet per minute to 600 cubic feet per minute. Upon a safety injection signal or high radiation detection at the outside air intakes, the control room will be automatically placed in the emergency mode. In this mode, the emergency filter train will be placed into operation supplying 600 cubic per minute of filtered outside air to the control room and 4000 cubic feet per minute of filtered recirculated air.

We calculated operator doses using assumed control room outside air intake location and assumed site meteorology. The resultant doses after a postulated loss-of-coolant accident were calculated and found to be below the guideline values. Fluor Pioneer states that the inlet locations will be established based on site specific considerations including meteorology. Final acceptability will be dependent upon specific site meteorology and location of control room air intakes.

Control room habitability following a postulated toxic gas release is required to ensure that operators can continue to fulfill their required functions. The BOPSSAR design has considered all the guidelines contained in Regulatory Guides 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," and 1.95, "Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release," related to toxic gas protection. The plant is designed for protection against the release of chlorine. Provisions such as quick acting chlorine detectors and self-contained breathing apparatus will be provided.

The BOPSSAR design has incorporated all the required elements for toxic gas protection. Final acceptability will be dependent upon the evaluation of the specific sites to identify the toxic gases, if any, that according to the guidelines of Regulatory Guide 1.78 require special protection provisions.

6.5 Engineered Safety Features Filter Systems

6.5.1 Summary Description

The engineered safety feature filter systems for BOPSSAR will consist of process equipment and instrumentation to control the release of radioactive materials in gaseous effluents (radioactive iodine and particulate matter) following a design basis accident. In the BOPSSAR design, three filtration systems are designed for this purpose: the reactor building annulus cleanup system, the control room atmosphere cleanup system, and fuel handling building atmosphere cleanup system.

6.5.2 Reactor Building Annulus Cleanup System

The function of the reactor building annulus cleanup system, which consists of the active annulus cleanup system and passive annulus cleanup system, is to control the release of radioactive materials in gaseous effluents from the containment structure following a postulated loss-of-coolant accident. The system will be designed to maintain a partial vacuum of two inches water in the annulus atmosphere and all areas contiguous to the containment structure following a postulated loss-of-coolant accident. The system is a 100 percent redundant system.

Each redundant train will include the following sequential components: demister, high efficiency particulate air filter, electric heater, two carbon adsorbers, a second high efficiency particulate air filter, and fan. The equipment and components will be designed to Quality Group C and seismic Category I requirements and will be located in a seismic Category I structure. Following a loss-of-coolant accident, both trains will be initiated on the receipt of a safety injection signal. Operator action will be required to determine which filter train will remain in operation.

We conclude that the annulus cleanup system will be designed in accordance with the guidelines of Regulatory Guide 1.52 and will be capable of controlling the release of radioactive materials in gaseous effluents to the environment following a postulated loss-of-coolant accident. We, therefore, find the system acceptable.

6.5.3 Control Room Atmosphere Cleanup System

The function of the control room atmosphere cleanup system is to supply nonradioactive air to the control room after a design basis accident and to maintain the control room under positive pressure.

This will permit operating personnel to safely remain in the control room following a design basis accident. Each train of the redundant system will have a design capacity of 600 cubic feet per minute while operating in the emergency mode and will include the following sequential components: electric air heater, air reheater, prefilter, high efficiency particulate air filter, carbon adsorber, a second high efficiency particulate air filter, and fan. The equipment and components will be designed to Quality Group C and seismic Category I requirements and will be located in a seismic Category I structure.

Following a postulated accident, the pressurization system will be automatically initiated by a signal from redundant radiation monitors located in the inlet ducts, or a signal from safety injection. The system may also be initiated manually.

We conclude that the system will be designed in accordance with the guidelines of Regulatory Guide 1.52 and will be capable of maintaining a suitable control room environment following a postulated loss-of-coolant or fuel handling accident. We, therefore, conclude that the system design is acceptable.

6.5.4 Fuel Handling Building Atmosphere Cleanup System

The function of the fuel handling building atmosphere cleanup system is to control the release of radioactive materials in gaseous effluents from the fuel handling building following a postulated fuel handling accident. The system will be designed to maintain the building pressure slightly below atmospheric pressure.

The dual train system will include the following sequential components: demister, prefilter, high efficiency particulate air filter, heater, carbon adsorber, a second high efficiency particulate air filter, and fan. The equipment and components will be designed to Quality Group C and seismic Category I requirements and will be located in a seismic Category I structure. Following a postulated fuel handling accident, the system will be initiated on a signal from the area radiation monitors located in the fuel building exhaust air duct. The initiating signal will also isolate the normal ventilation system exhaust. We conclude that the system design is in accordance with the guidelines of Regulatory Guide 1.52 and, therefore, is acceptable.

6.5.5 Conclusions

Our review of the atmosphere cleanup systems included an evaluation of these systems with respect to the guidelines of Regulatory Guide 1.52. We reviewed the system descriptions and design criteria for the reactor building annulus cleanup system, control room atmosphere cleanup system, and the fuel handling building atmosphere cleanup system. The basis for acceptance in our review has been conformance of the designs, design criteria, and design bases for the air filtration units to the applicable regulations, guides, technical positions, and industry standards. Based on our evaluation, we find the proposed reactor building annulus cleanup system, control room atmosphere cleanup system, and fuel handling building atmosphere cleanup system acceptable.

6.6 Engineered Safety Features Materials

The mechanical properties of materials selected for the balance-of-plant engineered safety features will satisfy Appendix I of Section III of the ASME Code, and Parts A, B, or C, of Section II of the Code, and our position that the yield strength of cold worked stainless steel shall be less than 90,000 pounds per square inch.

The controls on the pH of the reactor containment spray and the emergency core cooling water following a postulated loss-of-coolant accident are adequate to ensure freedom from stress corrosion cracking of the austenitic stainless steel components and welds of the containment spray and emergency core cooling systems throughout the duration of the postulated accident to completion of cleanup. The controls on the use and fabrication of the austenitic stainless steel of the systems satisfy the recommendations of Regulatory Guides 1.31, "Control of Stainless Steel Welding," and 1.44, "Control of the Use of Sensitized Stainless Steel." Fabrication and heat treatment practices that will be performed in accordance with these requirements provide added assurance that stress corrosion cracking will not occur during the postulated accident time interval. The control of the pH of the sprays and cooling water, in conjunction with controls on selection of containment materials, in accordance with the requirements of Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident," provide assurance that the sprays and cooling water will not give rise to excessive hydrogen gas evolution by corrosion of containment metal, or cause serious deterioration of the containment. The controls placed on concentrations of leachable impurities in nonmetallic thermal insulation used on austenitic stainless steel components of the engineered safety features are in accordance with the recommendations of Regulatory Guide 1.36, "Nonmetallic Thermal Insulation for Austenitic Stainless Steel."

Conformance with the codes and regulatory guide recommendations mentioned above, with our position on the allowable maximum yield strength of cold worked austenitic stainless steel, and with our position on the minimum level of pH of the containment sprays and emergency core cooling water, constitute an acceptable basis for meeting the requirements of Criteria 35, 38, and 41 of the General Design Criteria.

7.0 INSTRUMENTATION AND CONTROLS

7.1 General

The BOPSSAR instrumentation and control systems have been reviewed utilizing the Commission's General Design Criteria, standards of the Institute of Electrical and Electronics Engineers (IEEE) including IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations," interface requirements resulting from the review of RESAR-41, applicable regulatory guides, and applicable branch technical positions as noted in Table 7-1 of the Standard Review Plan.

7.2 Reactor Trip System

The reactor trip system is within the scope of the RESAR-41 design except for the following three reactor trip inputs which are within the BOPSSAR scope: (1) reactor coolant pump underfrequency trip, (2) reactor coolant pump undervoltage trip, and (3) turbine trip.

The reactor coolant pump underfrequency and undervoltage trips are required for reactor coolant system low flow protection as indicated in the RESAR-41 accident analyses. Westinghouse, in RESAR-41, states that the conformance of these two trips with IEEE Standard 279-1971 and seismic criteria will be discussed in the preliminary safety analysis report of a balance-of-plant design. In our RESAR-41 Safety Evaluation Report, we required that any inputs of the reactor trip system, including those which are outside the RESAR-41 scope, should not in any way result in a degradation of the overall reactor trip system. We, therefore, required that the underfrequency and undervoltage trip inputs, including the sensors, be designed to satisfy without exception all requirements of IEEE Standard 279-1971.

Fluor Pioneer provided, at our request, additional information regarding the reactor coolant pump underfrequency and undervoltage trips including the following: (1) identification of all components within the Fluor Pioneer scope of supply which will be used for these trips inputs, (2) design criteria for these components and associated connections, and (3) a description of how these components and associated items will be arranged to conform to the design criteria, including their physical locations and the routing of interconnecting wiring. We reviewed this additional information and conclude that the proposed BOPSSAR design for the reactor coolant pump underfrequency and undervoltage trip inputs are consistent with the interface requirements specified in our RESAR-41 Safety Evaluation Report, satisfy the requirements of IEEE Standard 279-1971, and are, therefore, acceptable.

We also reviewed the information provided in BOPSSAR concerning the turbine trip input. Based on our review of this information, we conclude that the proposed design for the turbine trip input within the scope of BOPSSAR meets our requirements as identified in Section 7.1 of this report, including the RESAR-41 interface requirements, and is, therefore, acceptable.

7.3 Engineered Safety Features Systems

Most of the engineered safety features actuation system, which automatically initiates the engineered safety features systems and their auxiliary supporting systems or subsystems, are outside the BOPSSAR design scope. However, Fluor Pioneer has provided in Section 7.3 of BOPSSAR supplemental information for those engineered safety features systems and their supporting auxiliary systems that are within the scope of BOPSSAR.

We reviewed the information contained in BOPSSAR concerning the engineered safety features within the BOPSSAR scope. This review included functional logic diagrams, testing provisions, interface requirements, design criteria, and design bases, and the analyses provided by Fluor Pioneer on the adequacy of these criteria and bases. We conclude that the preliminary design of the instrumentation and controls associated with the engineered safety features systems and their auxiliary supporting systems satisfies the requirements noted in Section 7.1 of this report and is, therefore, acceptable.

7.3.1 Containment Spray System

The containment spray system is an engineered safety features system which is entirely within the scope of the BOPSSAR design. However, a major part of the initiating circuitry for this system is within the RESAR-41 scope of supply. The system will serve as a containment heat removal system for containment depressurization following a postulated loss-of-coolant accident and will be used to reduce the airborne radioactivity concentration of fission products inside containment following postulated design bases accidents.

The containment spray system for the BOPSSAR design will be a three-train system compatible with the RESAR-41 emergency core cooling system. The system will be initiated automatically on a high-high-high containment pressure signal generated by four pressure transmitters with a two-out-of-four logic and associated circuitry. The system can also be initiated manually at the system level.

The changeover function from the injection mode to the recirculation mode will be accomplished automatically when the refueling water storage tank level reaches a level less than a low level setpoint. This signal will be generated by the RESAR-41 scope equipment and the composite design for the electrical power, instrumentation, and controls which will be provided to accomplish the changeover to the recirculation mode will meet the requirements of IEEE Standards 279-1971 and

308-1971, "Criteria for Class IE Electric Systems for Nuclear Power Generating Stations" and the interface requirements specified in RESAR-41.

We reviewed the design description of the containment spray system including the chemical addition portion, functional logic diagrams, design bases, and the analysis regarding the adequacy of these criteria and bases. We conclude that the instrumentation and controls associated with the containment spray system will satisfy our requirements identified in Section 7.1 of this report and are, therefore, acceptable.

7.3.2 Main Steam and Feedwater Isolation

The main steam and feedwater systems, except for the steam generators, selected piping, and certain associated instrumentation and controls, are within the scope of the BOPSSAR design. This includes the piping and valve arrangements as well as certain actuation controls provided for isolation of selected feedlines following a high energy line break.

The analysis of the rupture of a main steam line is presented in RESAR-41, where the following interface requirements are identified: (1) the electrical instrumentation and controls for the power-operated relief valves must be independent and designed such that no single failure can cause opening of more than one power-operated relief valve, (2) any single failure in the electrical instrumentation and controls for the main steam isolation valves should not cause a failure of valves downstream of the main steam isolation valves, and (3) failure in any single valve in either the upstream or downstream side of the main steam isolation valves should not result in steam flow in excess of the amount established in the RESAR-41 accident analysis.

Fluor Pioneer has incorporated in the BOPSSAR design these requirements regarding single failure in the main steam system. Based on our review of the information provided in BOPSSAR, we conclude that the proposed design of the electrical instrumentation and controls pertaining to the main steam system valves satisfies the RESAR-41 interface requirements and, therefore, is acceptable.

To mitigate the consequences of a high energy line break, Westinghouse has taken credit fo proper functioning of certain equipment and circuits, most of which are in the scope of the BOPSSAR design. Fluor Pioneer has provided additional information for the instrumentation and controls pertaining to the main feedwater system equipment listed in Table 15.4-21 of RESAR-41. We require that the instrumentation and controls for this equipment be designed to the requirements of IEEE Standards 279-1971 and 308-1971. This equipment, as listed in Table 15.4-21 of RESAR-41, is identified as (1) main feedwater control valves (trip close), (2) bypass feedwater control valves (trip close), (3) Circuits and/or equipment required to trip the main feedwater pumps, and (4) main feedwater isolation valves (trip close).

The bypass feedwater control valves are not utilized in the BOPSSAR design. Also, the BOPSSAR design does not utilize the main feedwater pump trip, since the main feedwater control and isolation valves will provide redundant means for isolation of feedwater flow to the steam generators during high energy pipe break accidents. For isolation of steam generator blowdown through the feedwater line, the main feedwater isolation and check valves will provide redundant isolation means. Fluor Pioneer originally stated that the requirements of IEEE Standard 308-1971 are not applicable to the main feedwater control and isolation valves power supply since these valves require no power for actuation (i.e., an absence of power condition causes these valves to close and thus perform the isolation function). We determined that this aspect of the feedwater isolation originally did not conform to the assumptions and requirements stipulated by the high energy line rupture analysis in RESAR-41 and thus we required that the power supply for these valves satisfy the requirements of IEEE Standard 308-1971. Subsequently, Fluor Pioneer provided additional information which states that the power supply for these valves will conform to the requirements of IEEE Standard 308-1971. Accordingly, we conclude that the instrumentation and controls associated with the main steam and feedwater isolation functions will satisfy the requirements identified in Section 7.1 of this report and are, therefore, acceptable.

7.3.3 Emergency Core Cooling System Interface Requirements

The emergency core cooling system is within the RESAR-41 scope. However, the balance-of-plant design will supply power to components in this system.

In the RESAR-41 design of the emergency core cooling system, nine manually-controlled, motor-operated valves are identified that should not move from their normal alignment during certain phases of a postulated loss-of-coolant accident. To meet our concerns with regard to spurious movement of these valves, Westinghouse, in RESAR-41, elected to lock out the power to these valves. In responding to the interface requirements identified by the staff in the RESAR-41 Safety Evaluation Report, Fluor Pioneer has included the following design features with regard to these manually-controlled, motor-operated valves: (1) the 480 volt power will be removed from the three high head injection valves in the hot leg injection lines, three low head safety injection valves in the hot leg injection lines, and the three accumulator isolation valves; (2) the capability will be provided to restore the 480 volt power to the six hot leg injection valves from the control room; and (3) redundant position indication will be provided for all of the nine valves.

Based on our review of the information provided in BOPSSAR, we conclude that the BOPSSAR electrical design meets the RESAR-41 interface requirements for lockout of power to the nine motor-operated valves in the emergency core cooling system and is, therefore, acceptable.

7.3.4 Emergency Boration System

The emergency boration system is within the scope of the RESAR-41 design. However, in order to maintain the fluid temperature in the emergency boration system within the prescribed limits, RESAR-41 requires that the balance-of-plant design provide 100 percent redundant separate heat tracing systems for all piping, valves, and flanges for the system. In the proposed BOPSSAR design, the power for the redundant heat tracing system is to be supplied from the redundant engineered safety features buses. A design requiring termination of redundant engineered safety features power sources at single components like a common pipe or valve might compromise the physical and electrical independence required between the plant redundant engineered safety features power sources. We, therefore, developed the following additional requirements during our review of the emergency boration system in RESAR-41 as discussed in Section 7.3.3 of the RESAR-41 Safety Evaluation Report:

(1) The emergency boration system heat tracing requirements should be consistent with the physical and electrical independence requirements between redundant engineered safety features power sources as discussed and recommended in Regulatory Guide 1.75, "Physical Independence of Electric Systems."

(2) The temperature monitoring system for the emergency boration system should be consistent with all the safety criteria implemented in the emergency boration system itself.

With respect to our first requirement, Fluor Pioneer has documented in BOPSSAR that the system will be disconnected by an accident signal from the Class IE system at the time of an accident. Also, the minimum physical distance between redundant Class IE systems as specified in IEEE Standard 384-1974 and augmented in Regulatory Guide 1.75 will not be maintained in the emergency boration system redundant heat tracing subsystems. We will require that an analysis be submitted by Fluor Pioneer at the Final Design Approval stage of our review to establish that the actual physical separation to be used between the redundant heat tracing systems is adequate and will not compromise the independence of redundant Class IE systems and circuits in the plant. We conclude that this design approach adopted in BOPSSAR is in conformance with the provisions and requirements in Section 5.1.1.2 of IEEE Standard 384-1974 as augmented by Regulatory Guide 1.75 with regard to the establishment of the physical independence of redundant Class IE circuits and is, therefore, acceptable.

With respect to our second requirement, Fluor Pioneer has included in BOPSSAR information concerning the temperature monitoring system for the emergency boration system. This includes a commitment that a temperature monitoring system consistent with all safety criteria delineated for the emergency boration system in the RESAR-41 Safety Evaluation Report will be supplied, and on this basis and on the basis of our review, we conclude that the temperature monitoring system is acceptable.

7.3.5 Auxiliary Feedwater System

The auxiliary feedwater system for the BOPSSAR design will consist of three motor-operated pump trains and one steam turbine-driven pump train. Power for each motor-driven pump train and its associated motor-operated valves will be supplied from a separate emergency alternating current bus.

The turbine-driven pump train will contain a motor-operated stop valve and a modulating valve in the steam line to the turbine. The pump discharge side will contain a flow control valve and an isolation valve. The inadvertent closure of any of these valves could negate the assumptions made in the loss of feedwater flow/loss of all alternating current power accident analysis. In response to our concern in this regard, Fluor Pioneer provided the following explicit design criteria in BOPSSAR with regard to the turbine-driven auxiliary feedwater train:

(1) The turbine-driven pump and its controls will not rely on any alternating current power source and the turbine control system will be powered from the Class IE direct current power system.

(2) Each of the two alternating current motor-operated valves will be provided with a valve position limit switch to the engineered safety features bypass display panel. Any departure from the fully open position of either valve will be automatically indicated on this panel. The monitoring system design satisfies the recommendations of Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems."

(3) The closed position of these alternating current motor-operated valves will be governed by the technical specifications which will be included in the final safety analysis report for applications referencing the BOPSSAR design.

(4) The auxiliary feedwater flow requirements of RESAR-41 will be satisfied without modulation of any alternating current powered valve.

These provisions provide additional assurance that the auxiliary feedwater system will perform its intended safety function.

The containment pressure analysis contained in Section 6.2 of BOPSSAR assumes that the auxiliary feedwater flow path associated with the steam generator which has a ruptured main steam line is isolated within ten minutes following a postulated steam line break within containment. The BOPSSAR design originally provided only manual means for isolating this flow path, relying on the control room operator to actuate this protective action. Since this isolation is assumed to occur within ten minutes following this event, it was questionable if the operator could recognize and perform the appropriate action within this limited time period. In response to this concern, Fluor Pioneer submitted information which provides a commitment that this isolation function will be accomplished automatically and that the design of the control and instrumentation for this isolation function will conform to the requirements of IEEE Standards 279-1971 and 308-1971.

With this commitment and based on our review, we conclude that the proposed design of the electrical instrumentation and controls for the auxiliary feedwater system satisfies the requirements identified in Section 7.1 of this report and is, therefore, acceptable.

7.3.6 Containment Hydrogen Control System

The containment hydrogen control system for the BOPSSAR design will consist of two redundant, parallel, full capacity loops, each comprised of a suction header inside the containment, a hydrogen recombiner, and hydrogen analyzer outside the containment, and interconnecting piping and test connections. Fluor Pioneer states that the hydrogen recombiners are to be supplied by Atomics International and will be qualified to meet the requirements of IEEE Standards 344-1975 and 323-1974. We conclude that these commitments are acceptable.

7.3.7 Periodic Testing of Engineered Safety Features Systems

The periodic testing of those portions of the engineered safety features systems within the BOPSSAR scope will be in conformance with the recommendations of Regulatory Guide 1.22, "Periodic Testing of Protection System Actuation Functions." Fluor Pioneer has provided information in BOPSSAR which identifies six safety feature components which will not be testable during normal reactor operations. These components are the main steam isolation valves, feedwater isolation valves, component cooling water containment isolation valves, instrument air containment isolation check valve, makeup water containment isolation check valve, and main steam relief valves. However, for the main steam and feedwater isolation valves, provisions will be included in the design for periodic partial stroke testing during reduced power operation. For the remaining components identified above, Fluor Pioneer has provided the bases for exclusion from testing during normal reactor operation. The bases stated are in conformance with the recommendations provided in Regulatory Guide 1.22. Based on our review of the information provided, we conclude that the criteria for the periodic testing of protection systems within the BOPSSAR scope satisfy the requirements identified in Section 7.1 of this report and are, therefore, acceptable.

With regard to periodic testing of sensor response times, we will require a utility applicant referencing the BOPSSAR design to submit in its application for an operating license a program for system and sensor response time testing of those portions of the reactor trip system and the engineered safety features systems that are within the scope of BOPSSAR. The scope of this test program will include safety-related systems and sensors within the scope of BOPSSAR, including the reactor coolant pump undervoltage and underfrequency sensors, chlorine monitors, radiation monitors, and containment temperature sensors.

Based on our review of the information provided, we conclude that the criteria for periodic testing of safety systems within the BOPSSAR scope with regard to response time testing satisfy our requirements and are, therefore, acceptable. We will review the adequacy of the test procedures for periodic response time testing during the operating license stage review of any application referencing the BOPSSAR design.

7.4 Systems Required for Safe Shutdown

Fluor Pioneer has referenced the RESAR-41 Standard Safety Analysis Report for information on systems required for safe shutdown. In addition, this information has been supplemented by Fluor Pioneer to include additional information concerning design provisions necessary for safe shutdown that are within the BOPSSAR scope of supply. To meet the requirements of Criterion 19 of the General Design Criteria, the BOPSSAR design includes provisions to control and monitor vital functions required for hot shutdown of the reactor from outside of the control room. A remote shutdown panel located in the auxiliary building will be provided. This panel will contain all the controls and indicators as required by RESAR-41. Fluor Pioneer has identified in Table 7.4-1 of BOPSSAR all controls and indicators provided by the design. Additionally, controls and instrumentation for the auxiliary feedwater system, atmospheric steam dump system, pressurizer backup heaters, and boric acid transfer pumps will be provided on this panel. After hot shutdown conditions have been achieved, a cold shutdown condition can be accomplished with the controls and instrumentation provided on the remote panel and elsewhere throughout the plant.

We reviewed the proposed electrical instrumentation, and controls associated with the systems required to achieve a safe shutdown condition of the plant from outside the main control room. We conclude that the proposed design of these aspects within the scope of BOPSSAR will conform to the requirements identified in Section 7.1 of this report and are, therefore, acceptable.

7.5 Safety-Related Display Instrumentation

The safety-related display instrumentation will provide the plant operator with information to enable the operator to perform appropriate manual safety functions for post-accident and incident surveillance. We reviewed the safety-related display instrumentation within the scope of BOPSSAR for post-accident and incident surveillance. Our evaluation and conclusions regarding this instrumentation is contained in the following paragraphs.

7.5.1 Bypassed and Inoperable Status Indication for Safety Systems

The safety systems and their auxiliary supporting systems which are included in the scope of the bypassed and inoperable status indication system are identified in BOPSSAR. The implementation of the recommendations of Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," has been discussed.

We reviewed the information provided and conclude that the proposed design of the bypassed and inoperable status indication system is consistent with the recommendations of Regulatory Guide 1.47 and is, therefore, acceptable.

7.5.2 Post-Accident and Incident Monitoring System

The proposed BOPSSAR design will include post-accident and incident monitors that will provide the operator with the following information: (1) containment atmospheric radiation (gaseous/particulate), (2) containment ambient temperature, (3) containment pressure, (4) refueling water storage tank water level, (5) steam generator water level, (6) pressurizer water level, (7) reactor coolant temperature, (8) reactor coolant pressure, and (9) steam line pressure.

The monitors for items (1) and (2) above will be supplied by Fluor Pioneer whereas monitors for the remaining items will be supplied by Westinghouse in the RESAR-41 scope. These parameters will be monitored with redundant channels and at least one channel will be recorded continuously. The redundant channels will maintain their physical and electrical independence and will be powered from the onsite emergency power supplies. In addition, the monitors and their associated recorders supplied by Fluor Pioneer will be qualified to operate after, but not necessarily during an earthquake of the magnitude of a safe shutdown earthquake, without requiring any maintenance actions on the monitors or their associated recorders. We reviewed the criteria for the proposed instrumentation and electrical design of the post-acciden and incident monitoring system and conclude that the proposed design within the BOPSSAR scope is in conformance with our requirements and is, therefore, acceptable.

7.6 Other Instrumentation Systems and Requirements for Safety

7.6.1 Environmental Qualification of Class IE Electrical Equipment

Fluor Pioneer has identified in BOPSSAR that the Class IE electrical equipment within its scope will be qualified according to IEEE Standard 323-1974, "Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations," as modified by Regulatory Guide 1.89, "Qualification of Class IE Equipment for Nuclear Power Plants." Also, in specific instances where problems emerge when attempting to implement the aging requirements of the above standard, one of the following methods, singularly or in combination, will be implemented to validate the qualification of Class IE equipment: (1) analyses based upon environmental tests, (2) operating experience (taking into consideration inservice inspection, periodic tests, and preventive maintenance), (3) type tests utilizing qualitative aging techniques (e.g., environmental cycling, operational cycling, and elevated stress techniques), and (4) ongoing or pacing tests.

In addition to IEEE Standard 323-1974, motors for safety class mechanical components will be type tested in accordance with IEEE Standard 334-1974, "IEEE Standard Type Test of Continuous-Duty Class IE Motors for Nuclear Power Generating Stations," as modified by Regulatory Guide 1.40, "Qualification Tests of Continuous-Duty Motors Installed Inside the Containment of Water-Cooled Nuclear Power Plants." Electric valve operators for safety class valves will be type tested according to IEEE Standard 382-1972, "Guide for Type Test of Class 1 Electric Valve Operators for Nuclear Power Generating Stations," as modified by Regulatory Guide 1.73, "Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants." Safety class cable and electrical connectors will be type tested according to IEEE Standard 383-1974, "Type Tests of Class IE Electric Cables, Field Splices, and Connectors for Nuclear Power Generating Stations." Electrical containment penetrations will be designed and tested according to IEEE Standard 317-1972, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations," as modified by Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Water-Cooled Nuclear Power Plants."

All of the initiating instruments located inside containment which are needed to respond to the main steamline break accident are within the Westinghouse scope of supply. As stated in Section 6.2.1 of this report, Fluor Pioneer calculated a peak containment temperature of 383 degrees Fahrenheit for the postulated main steam line rupture, whereas RESAR-41 specifies a temperature of 340 degrees Fahrenheit for the environmental qualification program. We will require a future utility applicant referencing the BOPSSAR design to provide verification that the equipment will be qualified to the temperature profile specified in BOPSSAR.

Based on our review of the above commitments, we conclude that the proposed criteria for the qualification of Class IE equipment within the scope of BOPSSAR can facilitate the development of a qualification program consistent with the objectives established and that the above commitments provide a basis for the acceptance of the Class IE equipment qualification program. The details for the development of the program, including the acceptance criteria, have been defined as an interface matter to be addressed in the application for a construction permit by a future utility applicant referencing the BOPSSAR design.

7.6.2 Physical Independence and Identification of Safety-Related Equipment

We reviewed the proposed design criteria for the separation of redundant safety-related equipment and their physical identification as described in BOPSSAR. We have concluded that these criteria meet the requirements of IEEE Standard 384-1974 as augmented by Regulatory Guide 1.75, "Physical Independence of Electric Systems," and are, therefore, acceptable.

7.6.3 Residual Heat Removal System Interface Requirements

The residual heat removal system is within the RESAR-41 scope of supply. However, since the balance-of-plant will provide power to components in this system, we have identified certain interface requirements for the balance-of-plant design in the RESAR-41 Safety Evaluation Report. These requirements are (1) to maintain the electrical power independence and pressure interlock independence for residual heat removal system isolation valves, the power assignment for the redundant trains of the residual heat removal system shall satisfy the interface requirements provided in Table 8.1-2 of RESAR-41, and (2) the balance-of-plant interfaces for the residual heat removal system at the nuclear steam supply system boundary shall satisfy all the criteria identified in Table 7-1 of the RESAR-41 Safety Evaluation Report.

We reviewed the information provided in BOPSSAR concerning the above requirements and concluded that the balance-of-plant design for the residual heat removal system satisfies these interface requirements and is, therefore, acceptable.

7.6.4 Manual Initiation of Protective Actions

Fluor Pioneer has documented that the BOPSSAR design complies with Regulatory Guide 1.62, "Manual Initiation of Protective Actions." Additionally, all protective functions may be manually initiated from the control room except for the hydrogen control system which will be operated from a local control panel in the auxiliary building. The systems level manual initiation of protective action is within the RESAR-41 scope, whereas, many of the component level manual initiation of protective actions are within the BOPSSAR scope. Controls for manual initiation of component level protective actions will be located on the main control panel, the remote shutdown panel and/or locally at the component.

Based on our review of the information provided, we conclude that the proposed design for manual initiation of protective actions within the scope of BOPSSAR satisfies our requirements identified in Section 7.1 of this report and is, therefore, acceptable.

7.7 Control Systems Not Required for Safety

Fluor Pioneer has identified non-nuclear safety control systems for the following systems within the BOPSSAR scope: (1) reactor makeup water system, (2) instrument air system, (3) samplings system (except for containment isolation valves), (4) fire protection system (except for containment isolation valves), (5) turbine generator, (6) condenser, (7) condenser evacuation system, (8) turbine gland sealing system, (9) steam dump system, (10) liquid waste management system, and (11) solid waste management system.

ıne control systems will be designed to assure proper system performance and will not be required for any safeguard action. Based on our review of the information provided, we conclude that failures in these control systems are not expected to degrade the capabilities of the plant safety systems to any significant degree or lead to plant conditions more severe than those for which the safety systems will be designed to protect against. We conclude that the control and instrumentation systems not required for safety satisfy our requirements, and are, therefore, acceptable.

7.8 Instrumentation and Controls Interface Requirements

Fluor Pioneer has included in BOPSSAR the interface design criteria and information concerning the instrumentation and control systems for compatibility with RESAR-41. The conformance of the criteria between the RESAR-41 and the BOPSSAR systems at their interfaces facilitates validation of the assumptions made in analyzing the consequences of design basis accidents and provides reasonable assurance that the total instrumentation and controls for a specific plant application referencing the BOPSSAR design can satisfy the requirements identified in Section 7.1 of this report. We evaluated this information and conclude that the interface criteria for the instrumentation and controls presented in BOPSSAR are acceptable.

8.0 ELECTRIC POWER

8.1 General

The electric power systems for the BOPSSAR design were evaluated with regard to their adequacy on the bases of Criteria 17 and 18 of the General Design Criteria; Standards of the Institute of Electrical and Electronics Engineers (IEEE) including IEEE Standard 308-1971, "Criteria for Class IE Electric Systems for Nuclear Generating Stations," as listed in Appendix B to this report; and Regulatory Guides 1.6, "Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems," 1.9, "Selection of Diesel Generator Set Capacity for Standby Power Supplies," and 1.32, Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants." In addition, we reviewed the BOPSSAR design with regard to the RESAR-41 interface requirements for the electric power systems.

8.2 Offsite Power System

The offsite power system is outside the scope of the BOPSSAR design and will be presented in the safety analysis report of a future utility applicant referencing the BOPSSAR design. However, Fluor Pioneer has provided in BOPSSAR a design description of the connections from the switchyard buses to the BOPSSAR plant alternating current distribution system and appropriate interface requirements with regard to the offsite power system to meet certain requirements imposed by the RESAR-41 design.

Three circuits will be needed to connect the onsite distribution system to the switchyard. One circuit will connect the main transformers to the 345 kilovolt switchyard bus and will deliver plant power output to the network. A second circuit will connect the startup transformers to the 230 kilovolt switchyard bus and will provide a startup power source to the plant auxiliary buses and one offsite power source to the Class IE buses. This second circuit will consist of two startup transformers. One of these startup transformers will have a 230 kilovolt primary side with two 6.9 kilovolt secondary sides. with each 6.9 kilovolt secondary side feeding one of the two main coolant pump motor buses. The other startup transformer will have a 230 kilovolt primary side with two 4.16 kilovolt secondary sides, with one of the two 4.16 kilovolt secondary sides feeding the Class IE buses and the other 4.16 kilovolt secondary side feeding the 4.16 kilovolt non-safety-related buses. The third circuit, rated at 13.8 kilovolts, will connect the reserve transformer to the switchyard bus and will provide a second offsite power source to the Class IE buses. This circuit will include a 13.8 kilovolt/4.16 kilovolt reserve transformer. The offsite power connections will provide power to the non-safety-related loads on 6.9 kilovolt and 4.16 kilovolt buses by the way of the startup transformers during startup and shutdown operations of the plant.

For normal plant operation, the power for the non-safety related 6.9 kilovolt and 4.16 kilovolt buses will be derived through the auxiliary transformers from the main generator. On unit trip conditions, the 4.16 kilovolt non-safety-related buses will be transferred immediately from an auxiliary transformer to the startup transformer by an automatic fast bus transfer. This is also true of the 6.9 kilovolt non-safety-related buses provided that a turbine thrust bearing failure, generator fault, or system fault condition is present. However, if none of these conditions are present, the automatic fast bus transfer for the 4.16 kilovolt and the 6.9 kilovolt buses will be delayed for 30 seconds. The loads on the engineered safety features buses normally will be fed directly from the offsite power system, thereby eliminating the dependency of these loads for power on the plant main turbine generator unit availability and preventing interruption of power to the engineered safety features s on a unit trip.

The proposed design of the offsite power distribution system within the scope of BOPSSAR will be in accordance with the requirements of Criterion 17 and 18 of the General Design Criteria and the recommendations of Regulatory Guide 1.32, and is therefore acceptable.

8.2.1 Offsite Power System Interface Requirements

With regard to the offsite power system interface requirements, RESAR-41 stipulates that the nuclear steam supply system is designed such that no fuel damage will occur if the plant sustains a grid frequency decay rate of up to five Hertz per second without reactor coolant pump breaker trip based on a reactor trip setpoint on under-frequency of 57 Hertz, and for decay rates less than five Hertz per second, an under-frequency trip setpoint of less than 57 Hertz may be considered. In order to meet this requirement, Fluor Pioneer stipulates that a utility applicant will perform a stability study to determine the maximum grid frequency decay rate. If the rate is five Hertz per second or less, the present design, which does not include a reactor coolant pump underfrequency trip, is acceptable based on a 57 Hertz underfrequency reactor trip setpoint. However, if the results of the study indicate a grid decay rate greater than five Hertz per second, then the 2-out-of-4 reactor coolant pump bus underfrequency trip signal shown on RESAR-41 Figure 7.2-1, Sheet 5 shall be applied to 6.9 kilovolt switchgear buses 1 and 2. Actuation train A will trip reactor coolant pumps 1 and 3 and 6.9 kilovolt bus 2 main breakers from transformers M1 and S1, and actuation train C will trip reactor coolant pumps 2 and 4 and 6.9 kilovolt bus 1 main breakers from transformers M1 and S1.

We will evaluate this stability analysis during our review of the safety analysis report of a future applicant referencing the BOPSSAR design. We will also evaluate the configuration of the incoming transmission lines to the switchyard of the plant and the arrangement of the buses and breakers in the switchyard to assure that the proposed design will satisfy the "two-out-of-three" safety bus requirements for the RESAR-41 design interface requirement consistent with the requirements of Criterion 17 of the General Design Criteria.

As noted in our RESAR-41 Safety Evaluation Report, the bases for the correlation between the grid frequency decay rate and the limiting underfrequency trip setpoint for the reactor to assure adequate reactor coolant pump coastdown capability is being reviewed. Upon completion of this evaluation, if it is determined that design changes are required, we will require that these changes be identified and implemented in any operating license application referencing the BOPSSAR design. We conclude that the proposed offsite power system design within the BOPSSAR scope is in conformance with the RESAR-41 interface requirements and satisfies the requirements identified in Section 8.1 of this report and is, therefore, acceptable.

8.3 Onsite Power Systems

8.3.1 Alternating Current Power System

The proposed alternating current emergency onsite power system for the BOPSSAR design will have three redundant and independent engineered safety features distribution systems which will normally receive power from the offsite power system. On the loss of offsite power, each of the redundant engineered safety features distribution systems will receive power from a completely independent diesel generator unit. Each distribution system will include 4160, 480, and 120 volt sources to provide power to the various safety loads. Each of the redundant load groups will consist of the complement of safety equipment needed to achieve safe plant shutdown and/or to mitigate the consequences of a design basis accident.

The three emergency diesel generators to be used in the BOPSSAR design will be further described in the utility applicant's safety analysis reports subsequent to manufacturer selection. The loads as presently tabulated in Table 8.3-2 of BOPSSAR indicate that 5388 kilowatts is the largest load that a diesel generator will be required to carry and has been determined from load design point brake horsepower requirements and engineering judgment. As the detailed design of BOPSSAR progresses, the demand and, hence, the diesel generator loads may be revised. The final sizing of the diesel generators will be based on a continuous rating that will be consistent with the recommendations of Regulatory Guide 1.9.

For those diesel generator units which have not been previously qualified and used as a standby power source at a nuclear plant, the following prototype qualification test will be performed:

(1) At least two full-load and margin tests will be performed on each diesel generator set to demonstrate the start and load capability of each unit with margin over the unit's design requirements.

For the BOPSSAR design, a delay of the high-high-high containment pressure signal can result in a demand signal to start the containment spray pump at later than the planned Step 3 of Table 8.3-2 of BOPSSAR. To preclude the possibility that the concurrent loading of the containment spray pump with a subsequent load step creates a load step greater than the diesel generator can handle, Fluor Pioneer has documented that the diesel generators will be procured with a specification including such a requirement and the utility applicant's preoperational test program will verify that Step 3 can occur concurrent with Steps 4, 5, or 6 without exceeding the voltage and frequency dips allowed by Regulatory Guide 1.9. Accordingly, we will review the details concerning this matter at the operating license review stage of applications which reference the BOPSSAR design.

(2) Prior to initial fuel loading, at least 300 valid start and load tests will be performed. This will include valid start and load tests performed offsite and may be performed all on one unit or distributed over a number of like units. A valid start and load test will be a start from specified temperature conditions with loading within the required time interval to at least 50 percent of the continuous diesel generator rating and continued operation until temperature equilibrium is attained. The specified temperature conditions shall be hot standby for at least 90 percent of the start test and from hot operating equilibrium temperature for 10 percent of the start tests.

(3) A failure rate in excess of one per hundred will require further testing as well as a review of unit design adequacy.

(4) Other onsite tests as detailed in IEEE Standard 387-1972, "Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations."

Each diesel generator unit will be housed in a separate room of the seismic Category I diesel generator building. Each diesel engine will have an independent ventilation system, an independent air starting system, an independent air intake and exhaust system, and an independent and separate seismic Category I fuel oil storage and transfer system. Each storage tank will contain a seven day supply of fuel for one diesel generator system to operate continuously at rated load. Also, each day tank will contain sufficient fuel for two hours of continuous full load diesel operation.

We reviewed the design description, design criteria, design bases, and logic diagrams for the alternating current onsite power system and the analysis provided by Fluor Pioneer regarding the adequacy of these criteria and bases. The proposed design of the alternating current onsite power system conforms with the requirements of Criteria 17 and 18 of the General Design Criteria, IEEE Standard 308- 971, and the recommendations contained in Regulatory Guides 1.6 and 1.9. We conclude that the proposed design of the onsite alternating current power system is compatible with the RESAR-41 requirements, that the system will meet the requirements identified in Section 8.1 of this report, and is, therefore, acceptable.

8.3.1.1 Electrical Protective Trips for Engineered Safety Features Systems and Equipment

During our review of the BOPSSAR design, we requested Fluor Pioneer to provide additional information for the electrical protective devices with regard to the potential of these devices to spuriously trip out engineered safety feature system components at a time when they are required to mitigate the effects of an accident in the plant. We also stated our position that all electrical protective trips for engineered safety feature system components, which remain operative for accident conditions shall meet the following requirements: (1) all thermal overload protective trips retained for accident conditions shall be tested every three months, and (2) all other trips retained for accident conditions shall be tested every year. The objectives of the periodic tests are to verify the trip setpoint, to ascertain trip setpoint drift, if any, and to establish the repeatability of the trip at its set value.

Fluor Pioneer has provided additional information in BOPSSAR which states that the protective trips to be utilized for the diesel generators, the 4160 and 480 volt power sources, and all other Class IE circuit protective devices that are retained for accident conditions will be tested every year. Also, all thermal overload trip devices on continuous duty Class IE motors will be setpoint tested every three months. We reviewed the additional information provided and conclude that the proposed periodic testing of Class IE protective devices satisfies our requirements and is, therefore, acceptable.

8.3.1.2 Electrical Penetration Assemblies in Containment Structures

The BOPSSAR design o the electrical penetration assemblies in the containment structure will be in accordance with the recommendations of Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Water-Cooled Nuclear Power Plants." Additionally, the design will comply with IEEE Standard 317-1972, "Standard for Electrical Penetration Assemblies in Containment Structures for Nuclear Fueled Power Generating Stations."

Our review of electrical penetration assemblies in containment structures specifically concentrated on low and high energy circuits which are the two types of electrical circuits that penetrate the primary containment.

The low energy circuits will consist of instrumentation and control cables. These circuits will be analyzed for the particular instrumentation and control systems to be used to assure that the associated containment electrical penetrations will carry sustained fault currents without impairing the integrity of the containment. The analysis shall consider short circuits in the instrumentation or control circuit created by faults (single or multiple within the same circuit) of conductors to ground or to each other. We will require Fluor Pioneer to provide this analysis at the Final Design Approval stage of our review.

The high energy circuits which will penetrate the containment will consist of the 6.9 kilovolt power circuits required for the reactor coolant pumps. The proposed design of the 6.9 kilovolt circuit will conform fully to the recommendations contained in Regulatory Guide 1.63 which includes the requirement for meeting the single failure criterion. In addition, Fluor Pioneer has documented that all fault current interruption devices which will be used for electrical penetration overload protection shall be fully qualified as Class IE equipment.

Fluor Pioneer originally proposed to power the residual heat removal pumps, located inside containment, from the 4.16 kilovolt power circuit which is a high energy circuit. This original design was in accordance with the RESAR-41 design interface requirement for these pumps. As such, the original design would have been a high energy circuit penetrating containment.

However, it was noted that the 4.16 kilovolt switchgear required for the residual heat removal pumps would be tripped by direct current control power and for these pumps, the control power for the pump feeder breaker originated from the same Class IE 125 volt direct current battery supply as that of the 4.16 kilovolt bus main breaker (it is noted that this design provided redundant fault protective devices). However, to maintain the electrical division assignments, the same 125 volt direct current power source would be used to control both the main breaker for the 4.16 kilovolt buses and the residual heat removal pump feeder breaker. Hence, the main breaker fault protection circuitry was not totally independent of the residual heat removal pump feeder breaker fault protection circuitry. Accordingly, the single failure criterion as recommended in Regulatory Guide 1.63 was not met due to a common control tripping power source for the above fault protection circuits. For this reason, the proposed design employed power fuses as an additional backup fault interruptor for the 4.16 kilovolt residual heat removal pump power circuits. We were concerned about the testability of these devices as well as provisions for a cable integrity verification program which would be used each time prior to energizing the residual heat removal pumps to assure that faults do not exist in the pump power feeder circuitry.

Following discussions relating to the above concerns, Fluor Pioneer modified the design so as to power the residual heat removal pumps from the 480 volt Class IE switchgear buses (these buses are located in the control building). This modified design, which provides for 480 volt power to the residual heat removal pumps, is an exception to the RESAR-41 interface requirement. For this design, a 480 volt electrically operated breaker serves as the primary fault interrupter and 480 volt switchgear bus main or bus-tie breakers serve as the backup fault interrupter. This primary and backup fault protection is provided for each of the three residual heat removal pumps. The 480 volt electrically operated breakers in this design are tripped by the energy of the fault and are not dependent upon any control or power source other than the energy of the fault current being passed through the device for static overcurrent relay action and release of stored energy in the tripping spring. Thus this design conforms to the single failure criterion of Regulatory Guide 1.63.

We conclude that the proposed electrical design provided by Flour Pioneer for the electrical penetrations assemblies is acceptable. We also conclude that the exception taken to the RESAR-41 interface requirement as noted above is acceptable.

8.3.1.3 Class IE Underground Cables

Two underground Class IE cable installations will be required in the BOPSSAR design. Both of these are within the utility applicant's scope because the design of the installation is highly dependent upon the terrain of the site and the location of the equipment being fed. These cable installations will be associated with the ultimate heat sink service water pump house and the diesel generator fuel oil storage tank.

For these two cable installations Fluor Pioneer has identified the design criteria as interface requirements to be addressed by the utility applicant referencing BOPSSAR in its application for a construction permit.

8.3.1.4 Fire Stops and Seals for Cable Systems

The fire detection and protection system for the BOPSSAR design is addressed in Section 9.5.1 of this report. The design includes fire stops and seals to control fires in electrical cable systems and to assure that a fire in one system will not propagate to another redundant system. Fluor Pioneer has provided, at our request, additional information on the design provisions and criteria for fire stops and seals in cable systems. The design criteria for the fire stops include the following:

(1) The fire rating of the fire stop shall be compatible with the required fire rating of the penetrated structure.

(2) The fire stop shall provide a means for cable addition through the penetration without affecting significantly the integrity of the fire stop.

(3) The materials used for fire stop construction shall be noncombustible.

(4) Leak sealing shall be provided where the penetration is through a structure forming the boundary between ventilation zones.

(5) The fire stop will withstand the maximum differential pressure across the penetrated structure.

Additional information which will be required to be provided by Fluor Pioneer at the Final Design Approval stage of our review will include the following:

(1) A list of materials to be used in the fire stops, their flammability and fire retardancy characteristics, and their underwriter's rating.

(2) The qualification testing of the fire stops and seals to demonstate adequacy over the life of the plant.

The installation procedure will be dependent on the type of material to be used. These procedures will be determined and documented in Fluor Pioneer's application for a Final Design Approval for BOPSSAR. The location of the fire stops and seals will also be documented in Fluor Pioneer's application for a Final Design Approval.

The following additional information will be required to be i cluded in the construction permit application by a future utility applicant referencing the BOPSSAR design:

(1) The quality assurance and test procedures to be used to verify that penetration fire stops and seals have been properly installed.

(2) The administrative procedures and controls that will be followed when it becomes necessary to breach a completed fire stop or seal.

(3) The periodic inspections to be performed to identify open or deteriorated fire stops and seals.

We will review an' evaluate the details of this information in the construction permit application of a utility applicant referencing the BOPSSAR design. We conclude that the criteria with regard to cable fire stops and seals provide acceptable design bases for the BOPSSAR preliminary design.

8.3.2 Direct Current Power System

The onsite direct current power system of the BOPSSAR design will consist of four redundant and independent 125 volt direct current supplies, each consisting of a battery with its own charger and direct current bus. A mobile spare charger will be provided to backup any one of the four fixed main chargers. The independence of redundant direct current systems will be maintained by housing the redundant system components in four discrete rooms in the control building, which will be a seismic Category I structure. Each of the four Class IE battery rooms will have 100 percent capacity redundant ventilation systems. The two ventilation subsystems for each battery room will be powered from redundant Class IE alternating current power trains.

The 498 ampere-hour capacity of each 125 volt direct current battery will be suitable for supplying all safety-related loads under design bases accident conditions for a period of 30 minutes without assistance from its battery charger and under loss of onsite and offsite alternating current power conditions for a period of two hours. Non-safety-related loads will not be supplied by the Class IE 125 volt direct current system.

The proposed 125 volt Class IE direct current power system design conforms with Criteria 17 and 18 of the General Design Criteria, with the requirements of IEEE Standard 308-1971, and with the recommendations of Regulatory Guides 1.6 and 1.32.

Four redundant 120 volt alternating current instrument main distribution buses will be provided to supply power to plant protection system instrumentation and related circuits. Each of these buses will be fed from an independent static inverter which in turn normally will be fed from a 480 volt alternating current emergency bus. Should the normal alternating current power source fail, the static inverter automatically will be powered from its associated battery. The 120 volt alternating current instrument main distribution bus systems will be designed to comply with IEEE Standard 308-1971.

We reviewed the design description, design criteria, design bases, and single line diagrams for the direct current onsite power system and the 120 volt alternating current instrument main distribution bus system and the analysis provided regarding these criteria and bases. On the basis of our review, we conclude that the proposed design for the Class IE direct current onsite power and 120 volt alternating current instrument main distribution bus systems is compatible with the RESAR-41 requirements and is acceptable.

8.4 Interface Requirements for Electric Power Systems

Fluor Pioneer has included in BOPSSAR the interface design criteria or information for the electric power systems to assure compatibility with RESAR-41. Additionally, Fluor Pioneer has documented interface criteria and/or information which must be addressed by a utility applicant referencing the BOPSSAR design. The conformance of the design to these interface criteria and/or information at the systems interfaces validates the assumptions made in the accident analysis and provides reasonable assurance that the total electric power system for a specific plant application referencing the BOPSSAR design can satisfy the requirements identified in Section 8.1 of this report.

Based on our evaluation of the information and interface design criteria, we concluded that the interface information in BOPSSAR is acceptable.

9.0 AUXILIARY SYSTEMS

The auxiliary systems within the scope of BOPSSAR that are necessary to ensure safe plant shutdown will include the service water system; the component cooling water system; portions of the heating, ventilation, and air conditioning systems for the control building, reactor building annulus area, and diesel generator building; the diesel generator fuel oil storage and transfer system; the diesel generator auxiliary systems; the auxiliary feedwater system; and the fire protection system.

The systems necessary to assure safe handling of fuel and adequate cooling of the spent fuel pool will include new and spent fuel storage facilities, the fuel pool cooling and cleanup system, the fuel handling system, and the fuel handling ventilation system.

We reviewed the equipment and floor drainage system whose failure would not prevent safe shutdown but could indirectly be a potential source of a radiological release to the environment.

We also reviewed those auxiliary systems whose failure would neither prevent safe shutdown nor result in potential radioactive release to the environment. These include the demineralized water system, the instrument air system, the ventilation systems for non-safety-related areas, and the communication and lighting systems. The acceptability of these systems was based on our review which determined that: (a) where the system interfaces or connects to a seismic Category I system or components, seismic Category I isolation valves will be provided to physically separate the nonessential portions from the essential system or component, and (b) the failure of non-seismic systems or portions of the systems will not preclude the operation of safety-related systems or components located in close proximity. We find the above listed systems meet our criteria and, therefore, find them acceptable.

9.1 Fuel Storage and Handling

9.1.1 New and Spent Fuel Storage

Fluor Pioneer has taken exception to the use of the RESAR-4, new and spent fuel storage racks. Instead, the BOPSSAR design will utilize the new and spent fuel storage rack design described in Westinghouse's "Reference Safety Analysis Report, RESAR-3S" in which both the new and spent fuel storage racks will be located in a single underwater storage facility.

The new fuel storage racks will have a minimum center-to-center spacing of 14.2 inches and will include storage for one-third of a core. The racks will have a spacing which is sufficient to maintain the effective multiplication factor below

0.95, assuming the highest anticipated enrichment fuel (3.5 weight percent uranium-235), flooded unborated water, or optimum moderation. The spent fuel storage racks will also have a minimum center-to-center spacing of 14.2 inches and will include storage for one and one-third cores of spent fuel. The new and spent fuel racks will be designed to seismic Category I requirements. The spent fuel storage racks will be designed to withstand the maximum uplift forces of the spent fuel pool bridge hoist

The fuel pool will be made of reinforced concrete construction, designed to seismic Category I requirements and will have a stainless steel liner. The facility will be designed so that the cask handling crane cannot travel over or near the fuel pool.

Based on our review, we conclude that the design criteria and bases for the new and spent fuel storage facilities are in conformance with the requirements of Criterion 62 of the General Design Criteria and the recommendations of Regulatory Guides 1.13, "Fuel Storage Facility Design Basis," and 1.29, "Seismic Design Classification," including the positions on seismic design, missile protection design, compatibility with the handling of the fuel cask in the fuel handling building and are, therefore, acceptable.

9.1.2 Spent Fuel Pool Cooling and Cleanup System

The spent fuel pool cooling and cleanup system will be designed to maintain the quality and clarity of the water in the refueling cavity, spent fuel pool, transfer canal, and the refueling water storage tank. It will also be designed to remove the decay heat generated by the stored spent fuel assemblies. The cooling system will consist of two 50 percent capacity spent fuel pool cooling pumps and two 50 percent capacity heat exchangers. The spent fuel cooling system will be designed to seismic Category I requirements. The capability to supply emergency makeup to the pool will be provided by a permanently installed seismic Category I connection to the refueling water storage tank. (The service water system can supply makeup water to the fuel pool through temporary connections.) In addition, the fuel pool piping will be arranged so that the pool cannot be inadvertently drained to uncover the stored fuel. All lines that enter the pool will be equipped with anti-siphon holes.

During the normal heat load conditions (1/3 of a core stored in the fuel pool), one pump and one heat exchanger will be used to maintain the pool temperature below 120 degrees Fahrenheit. During the design maximum heat load condition of 1-1/3 cores stored in the pool, two pumps and two heat exchangers will maintain the fuel pool water temperature below 150 degrees Fahrenheit. In the event that only one pump and one heat exchanger is available, the spent fuel pool temperature will rise to 180 degrees Fahrenheit for the heat load from 1-1/3 cores. We accept these temperature limits on the basis that the first condition above represents the maximum normal heat load and the maximum expected temperature (120 degrees Fahrenheit) is within our acceptance limit of 140 degrees Fahrenheit. The other two conditions represented above are considered abnormal and are acceptable since they are below atmospheric boiling (212 degrees Fahrenheit).

We evaluated the spent fuel cooling and cleanup system design and have determined that the essential portions of the system are correctly identified and can be isolated from the nonessential portions of the system and that the cooling subsystem meets the single active failure criterion and the intent of the applicable positions of Regulatory Guides 1.13, "Spent Fuel Storage Facility Design Basis," and 1.29, "Seismic Design Classification." We, therefore, conclude that the spent fuel pool cooling and cleanup system is acceptable.

9.1.3 Fuel Handling System

The fuel handling system will provide the means of transporting and handling fuel from the time it reaches the plant in an unirradiated condition until it leaves the plant after it has been removed from the reactor. Major portions of the fuel handling system, including the components required for transferring fuel from the reactor to the spent fuel pool, are within the scope of RESAR-41. The major equipment that is within the scope of BOPSSAR are the cask handling system, fuel handling building overhead crane, and cask transfer cranes.

The spent fuel cask handling system will consist of the following major components: the spent fuel cask transporter with cask tank, the inner and outer bellows seal assemblies, the transporter drive unit, and the cask transfer crane. This system concept has been approved previously for the South Texas Project and for the Allens Creek Nuclear Generating Station.

The cask will be placed in a watertight tank and positioned under the cask loading pool thus precluding a potential cask drop accident. A watertight connection will be made between the tank and a port at the bottom of the cask loading pool. The cask handling system will include redundant leakage barriers, each capable of retaining the water from the cask loading pool. During the cask loading operation, the spent fuel cask will be held in position by four seismic restraints. The spent fuel cask, bellows assemblies, cask adapter, and other components needed to form a leak tight envelope during spent fuel cask loading will be designed to seismic Category I requirements.

The transporter will be designed such that a collision with the spent fuel pool wall will not occur assuming a single failure. Limit switches will be provided to de-energize the transporter drive unit to prevent such a collision. Snubbers will be provided to prevent a collision should the limit switches fail. Thus, a cask handling system malfunction should not result in any fuel pool damage.

Cask lift and cask travel over the safety-related systems will be physically precluded. Cask damage to this fuel pool will be precluded by adequate separation between the pool and the cask handling crane. Because of these design considerations, the spent fuel cask crane need not be designed as a Seismic Category I component.

The fuel handling building overhead crane will be used to handle new fuel assembly shipping containers and new fuel assemblies, the fuel loading pool hatch, and the cask head when the hatch is open. The building design will preclude movement of this crane over the spent fuel pool.

Based on our review, we conclude that the fuel handling system design criteria and bases are in conformance with the positions of Regulatory Guide 1.13, including the recommendation regarding protection of the spent fuel facility from the impact of unacceptable heavy loads carried by overhead cranes, and the RESAR-41 interface requirements and are, therefore, acceptable.

9.2 Water Systems

9.2.1 Service Water System

The service water system will be designed to provide cooling water to safety-related plant systems such as the component cooling water heat exchangers. The service water system, in conjunction with the component cooling water system, will supply cooling water to remove heat from plant auxiliaries which are required for normal shutdown, following loss of offsite power, and following a postulated loss-of-coolant accident.

The service water system will consist of three parallel cross-connected full capacity trains. Each train will be composed of one full capacity pump, strainers, and associated piping, valves, and instrumentation. Essential portions of the service water system will be designed to seismic Category I requirements and protected to withstand adverse environmental occurrences. Each train of the service water system will be powered from a separate emergency alternating current bus.

Certain interface requirements are imposed on the service water pump house of the system which is not within the scope of BOPSSAR and which will be discussed in the safety analysis report of a utility applicant. The BOPSSAR design requires the service water pump house to be a seismic Category I structure and to provide protection against tornadoes and tornado-generated missiles to safety-related equipment located within the pump house. Since the water level for flood design for the service water pump house may be different from the level for the structures within the scope of BOPSSAR, the design against flood conditions for the pump house will be addressed in the utility applicant's safety analysis report. The service water pumps must be protected from foreign material which could have a deleterious effect on the operation of the system. The chemistry control of the service water system is also site-related and will be discussed in the safety analysis report of a future utility applicant referencing the BOPSSAR design.

Based on our review, we conclude that the design criteria and bases for the service water system meet the requirements of Criterion 44 of the General Design Criteria regarding its ability to transfer heat from safety-related components to the ultimate heat sink, and Criteria 45 and 46 of the General Design Criteria regarding tests and inspections. We, therefore, conclude that the design of the service water system is acceptable.

9.2.2 Component Cooling Water System

The component cooling water system will provide cooling water to selected nuclear auxiliary components during normal plant operation and cooling water to safety-related systems during postulated accidents.

The component cooling water system will consist of three parallel trains. Each train will consist of two pumps and two component cooling heat exchangers. The system design includes one surge tank for each train. Two trains will provide the necessary cooling water for normal operation, cooldown, refueling, and postulated accidents.

The essential portions of the system will be designed to seismic Category I requirements. The nonessential portions of the system will be separated from the essential portions of the system by seismic Category I isolation valves. The system trains will be powered by redundant emergency buses.

The component cooling water system heat loads for the conditions of normal operations, shutdown, design basis accident, and loss of offsite power, as identified in RESAR-41, are included in the total heat load of the component cooling water system. Component cooling water will be supplied at 105 degrees Fahrenheit during normal operation and below 120 degrees Fahrenheit during accident and shutdown conditions as required by RESAR-41.

The design of the component cooling water system will provide for two supply and return lines for cooling water to the four reactor coolant pumps. These lines will be designed as Quality Group C and seismic Category I and will contain one motor-operated valve for containment isolation of the supply header and one motor-operated valve for isolation of the return header.

Inadvertent failure or closure of either of these motor-operated valves would terminate the coolant flow to the seals and bearings of two pumps, and could potentially result in fuel damage due to a multi-pump seizure without flow coastdown or a limited loss-of-coolant accident due to pump seal failure. At our request, Fluor Pioneer committed to provide Class IE instrumentation to detect loss of flow to each reactor coolant pump with annunciation in the control room to alert the operator to this condition. In addition, Fluor Pioneer identified as an interface requirement that the utility applicant referencing the BOPSSAR design shall supply reactor coolant pumps that shall be demonstrated to be capable of operating for more than 30 minutes without component cooling water flow and consequent loss of pump capability. If the utility applicant does not supply such pumps, then the Class IE flow instrumentation shall be modified to initiate automatic protection of the plant, or the component cooling water supply to the pump shall be capable of withstanding a single active failure or a moderate energy line crack as defined in Branch Technical Position APCSB 3-1, "Protection Against Postulated Failures in a Fluid System Outside Containment," which is contained in Section 3.6.1 of the Standard Review Plan.

Based on our review, we conclude that the system criteria and bases are in conformance with the requirements of General Design Criterion 44 regarding the ability to transfer heat from safety-related components to the ultimate heat sink under normal and accident conditions and, with the exception discussed above, meets the single failure criterion. We further conclude that the system design criteria and bases meet the requirements of Criteria 45 and 46 of the General Design Criteria with respect to the system design that allows the performance of periodic inspections and tests, including functional testing and confirmation of heat transfer capabilities. The system design also satisfies the RESAR-41 interface requirements and is acceptable.

9.2.3 Ultimate Heat Sink

The ultimate heat sink is related to a specific site and, therefore, is not within the scope of BOPSSAR. The ultimate heat sink will be addressed by a utility applicant in its application for a construction permit which references the BOPSSAR design. Fluor Pioneer has, however, identified the utility applicant interface requirements for the ultimate heat sink as discussed in Section 2.4.2 of this report.

9.3 Process Auxiliaries

9.3.1 Process Sampling System

The process sampling system will be designed to collect, transfer, analyze, and return fluid samples from the primary and secondary systems. The system will include piping, valves, heat exchangers, and other components associated with the system from the point of sample withdrawal up to the sample room analyzing station. The components and sample lines will be designed to the seismic design and quality group classification of the system to which each sample line and component is connected.

Our review included the provision proposed to sample all principal fluid process streams associated with the plant operation and the proposed design. The review included descriptive information for the process sampling system and the location of sampling points, as shown on piping and instrumentation diagrams. Based on the conformance of the system design to the applicable design criteria, regulatory guides, and industry standards, we find the proposed process sampling system to be acceptable.

9.3.2 Equipment and Floor Drainage System

The equipment and floor drainage system will collect and transport liquid wastes for processing and disposal. The equipment and floor drain system will be comprised of two subsystems: (a) the miscellaneous plant utilities system, and (b) the sump pump system. The miscellaneous plant utilities system will be composed of the following subsystems: the reactor coolant drains, equipment drains, floor drains, and atmospheric vents. The sump pumps to be located in the auxiliary building and fuel handling building will transfer the collected leakage to the liquid waste management system.

The system will provide the necessary segregation of various categories of liquid wastes as required by the liquid waste management system. Potential radioactive liquid waste will be directed to the miscellaneous waste hold up tank and non-radioactive liquid waste will be directed to the turbine building floor drain sump.

Based on our determinatic that the system will be 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, we conclude that the equipment and floor drainage system is acceptable.

9.4 Air Conditioning, Heating, Cooling and Ventilation Systems

9.4.1 Control Building Ventilation System

The control building ventilation system will consist of the following subsystems: the control room ventilation system, safeguard battery rooms ventilation system, cable spreading and switchgear rooms ventilation system, and the control building equipment floor ventilation system.

The control room ventilation system will be designed to maintain the control room within the thermal and air quality limits required for operation of plant controls and uninterrupted safe occupancy of required manned areas during normal operation, shutdown, and post-accident conditions.

The control room ventilation system will consist of two 100 percent capacity air conditioning systems and two 100 percent capacity emergency filtration units. During accident conditions, the control air will be automatically recirculated through the air filtration units. The entire control room ventilation and filtration system will be designed to seismic Category I requirements and all outside louvers will be missile and tornado protected.

The control room ventilation system will be designed to maintain the control room under positive pressure. Redundant radiation detectors and hazardous chemical detectors will monitor the outside air supply with alarms in the control room. Initiation of the radiation alarm will automatically isolate the normal outside air supply to the control room and start the emergency air pressurization and air filtration units. Initiation of the hazardous chemical alarm will automatically isolate the outside air supply and the air conditioning subsystem will run in the recirculation mode. The hazardous chemicals that will be monitored are site-related and will be described in the utility applicant's safety analysis report.

We reviewed the design criteria and bases for the control room ventilation system and conclude that the design criteria and bases meet the requirements set forth in Criterion 19 of the General Design Criteria with respect to the capability to operate the plant from the control room during normal and accident conditions, and the applicable positions set forth in 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." We, therefore, conclude that the system design is acceptable.

The safeguard battery room ventilation system will consist of redundant 100 percent capacity subsystems designed to seismic Category I requirements. The two redundant systems will be started automatically during emergency operation. Information provided to the control room will include abnormal temperature alarm and system running status. We determined that the design of the safeguard battery room ventilation system for the battery rooms will contain sufficient component redundancy and physical separation to meet the single failure criterion so that ventilation will be assured during anticipated operating conditions. Based on our review of the design criteria and bases for the system, we conclude that the system is acceptable.

The cable spreading and switchgear rooms ventilation system will consist of a central station air handling unit and redundant recirculation air coolers. The central air handling unit will be used under normal conditions during which time the recirculating air coolers are not used. The recirculation air coolers will be on separate safety trains, and will be used under emergency conditions to maintain temperature control with 100 percent recirculated air. Safety-related components will be designed to seismic Category I requirements. We reviewed the system design criteria and bases for the cable spreading and switchgear rooms ventilation system and conclude that they are acceptable.

The control building equipment floor ventilation system will be designed to maintain the room temperature limits for proper operation of equipment and personnel health, safety, and comfort under normal and emergency conditions. This system will be designed to seismic Category I requirements. System redundancy will be provided so that the systems or components cooled by the ventilation system will be capable of performing their safety function considering a single failure. Based on our review of the control building equipment floor ventilation system, we conclude that the system is acceptable.

9.4.2 Fuel Handling Building Ventilation System

The fuel building ventilation system will be designed to control the fuel building atmosphere within acceptable temperature and humidity limits for personnel and equipment, to maintain the building at a negative pressure, and to mitigate the consequences of a fuel handling accident by filtration of the exhaust air as discussed in Section 6.5.4 of this report.

The exhaust from the fuel handling area during normal operation will be discharged through a missile protected roof vent exhaust system after passing through the fuel handling building filter assembly. Upon high radiation detection in the fuel handling building ventilation system, the fuel handling building exhaust will be directed through high efficiency particulate air and charcoal filter assemblies before discharge through the roof exhaust. The system will be designed to seismic Category I requirements.

Based on our review, we conclude that the design criteria and bases for the fuel building ventilation system meet the single failure criterion and the recommendations of Regulatory Guide 1.13, and are, therefore, acceptable.

9.4.3 Auxiliary Building Ventilation System

The control rod drive equipment room ventilation system will be designed to maintain the control rod drive equipment rooms within the environmental limits required for safe operation during normal, shutdown, and accident conditions and will be designed to seismic Category I requirements. The system will be designed to meet the single failure criterion by providing two 100 percent capacity redundant recirculating fan coil units. Based on our review and evaluation of the design criteria and bases for the system, we conclude that the system is acceptable.

9.4.4 Reactor Building Annulus Ventilation System

The reactor building annulus ventilation system will provide the ventilation and air conditioning for engineered safety features and other essential equipment rooms. The system will be designed to provide an adequate supply of cooled air to safety-related and emergency equipment that is required to remain operable during a design basis accident and to be capable of functioning during post-accident conditions. The three redundant annulus fan coil recirculation units which serve the active annulus area will be designed to seismic Category I requirements and to meet the single failure criterion. Each fan coil unit will be supplied from a Class IE alternating current power source. Air exhausted from the active annulus area will be passed through filter units and its activity will be monitored prior to discharge to the atmosphere. Based on our review and evaluation of the reactor building annulus ventilation system, we conclude that the system is acceptable.

9.4.5 Diesel Generator Building Ventilation System

The diesel generator building ventilation system will be designed to maintain a suitable environment for the operation of the diesel generators and their auxiliary components during all modes of plant operation, including accident conditions. Independent diesel generator heating and ventilation systems, and air supply and exhaust systems will be provided for each of the three diesel generators to satisfy the required environmental conditions and combustion air requirements during diesel operation. The diesel generator room ventilation system will be designed to seismic Category I requirements and to maintain the diesel generator rooms below 130 degrees Fahrenheit whenever the diesel generators are in operation.

We reviewed the diesel generator building ventilation system design criteria and bases and find that they are acceptable.

9.5 Other Auxiliary Systems

9.5.1 Fire Protection System

The BOPSSAR fire protection system will be designed to provide automatic or manual fire extinguishing capability, to provide fire detection and alarm equipment in the plant essential areas, and to comply with the intent of the guidelines contained in Appendix A to Branch Technical Position APCSB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants Docketed Prior to July 1, 1976," which is contained in Section 9.5.1 of the Standard Review Plan.

The BOPSSAR application was submitted for our review prior to the issuance of Branch Technical Position APCSB 9.5-1. After receiving APCSB 9.5-1, Fluor Pioneer completely revised and resubmitted its fire protection system design, in accordance with our guidelines.

Certain items are not within the scope of BOPSSAR and will be the dir responsibility of the utility applicant, such as maintenance of the fire protection system administrative controls, training of the fire brigade, operations on multi-reactor sites where there are operating reactors and construction activity, and those items that are site related such as the fire protection water supply. Such items will be reviewed in the utility applicant's application referencing BOPSSAR.

We reviewed the overall fire protection program to ensure that potential fire hazards throughout the plant were identified and to ensure that the effects of postulated design basis fires were identified relative to maintaining ability to perform safe shutdown functions and to minimize radioactive releases to the environment.

We reviewed the BOPSSAR fire hazards analysis to ensure that the major fire hazards were identified early in the review process so that appropriate fire protection measures could be incorporated into the design. Fluor Pioneer has committed to performing a more detailed fire hazards analysis at the final design stage of our review when additional information concerning installed or transient hazards are known.

We also reviewed Fluor Pioneer's design concepts with respect to building design, control of combustibles, electric cable construction, cable trays and cable penetrations, ventilation, and lighting and communications to ensure that they are compatible with our guidelines.

In order to reduce the fire potential, noncombustible and heat resistant materials will be used throughout the plant wherever practical. With the exception of the control room and inside containment, areas that are essential for safe shutdown or contain safety-related equipment will be separated from their redundant counterparts by three-hour rated fire barriers. All penetrations through fire barriers will be sealed with fire stops with a rating equivalent to that required for the fire barrier that they penetrate to reduce the possibility of fire propagation. Heating, ventilation, and air conditioning system ducts that penetrate fire walls will contain fire dampers. To reduce the possibility for fires propagating along electrical cables, only cable insulation materials that conform to the requirements of IEEE Standard 383 will be used.

Fluor Pioneer committed to provide automatic sprinkler protection for cable concentrations outside the cable spreading room as required by the detailed fire hazards analysis. Inside the cable spreading room, Fluor Pioneer committed to provide tiered automatic sprinklers to insure that all stacked trays will be covered.

The water fire protection system will utilize a site-related water source. Two full capacity 2500 gallon per minute fire pumps, one electric driven and one diesel driven, and one 40 gallon per minute jockey pump will provide water at the necessary pressure and flow to the yard loop and a double-ended header inside the auxiliary building. The yard loop and supply lines will contain sectionalizing isolation valves so that a break in the yard loop piping can be isolated. The double-ended header running through the auxiliary building has been analyzed for a safe shutdown earthquake loading and will be provided with supports to assure system integrity following a safe shutdown earthquake. This header will supply sprinkler systems and hose standpipes in the auxiliary building, the diesel generator building, the fuel handling building, and the control building. The header will be capable of being supplied with water from the seismic Category I service water system through a permanently installed manual cross-connection to provide fire hose coverage to safety-related plant areas following a postulated safe shutdown earthquake. The turbine generator building fire protection system will have two separate connections to the underground yard main.

The water fire protection systems for the containment and the reactor building annulus will consist of automatic sprinklers and hose stations supplied from either the reactor makeup water storage tank by two reactor building fire pumps or from the service water system. The reactor building jockey fire pump will maintain system pressure for both the reactor building containment and reactor building annulus fire protection systems. Inside containment, automatic sprinklers will be provided for containment cable penetration areas, concentrations of cable trays, and the reactor coolant pump lube oil sumps.

Those portions of the fire protection system that will be installed above safety-related equipment will be supported in accordance with seismic Category I requirements. This system will be designed to assure that a rupture or inadvertent operation will not impair the capability of safety-related systems and components.

The fire detection system will consist of zones, independent and mutally exclusive of each other. Both ionization and heat actuated detectors will be used. A central processing unit will be provided to monitor the fire detection system. A signal received from any detector will be alarmed in the control room indicating the affected zone. Actuation of any fire protection system or component will also alarm in the control room. In either case, the alarm will be sounded throughout the plant by the plant paging system.

Fluor Pioneer committed to perform a more detailed fire hazards analysis at the final design review stage. We will review the results of this analysis to insure that adequate fire protection features have been provided and to insure that any changes to the plant design are reflected in the fire protection program.

In particular we will evaluate the hazard posed by cables that will be run underneath the control room floor and through the ceiling spaces of the control room when the details of installation are available. The decision on the acceptability of automatic or manual fire protection features for these areas will be made based upon the detailed fire hazards analysis for these areas.

Fluor Pioneer proposed to install fire breaks in vertical runs of cabling at intervals equivalent to floor spacing. We will evaluate the need for additional protection features for these cases, based upon the results of the detailed fire hazards analysis for the specific areas involved.

Based on our review, we conclude that the design criteria and bases meet the guidelines of Criterion 3 of the General Design Criteria and, with the exceptions listed and justified in Section 9.5.1 of BOPSSAR, the guidelines contained in Appendix A to Branch Technical Position APCSB 9.5-1 and are, therefore, acceptable.

9.5.2 Diesel Generator Fuel Oil Storage and Transfer System

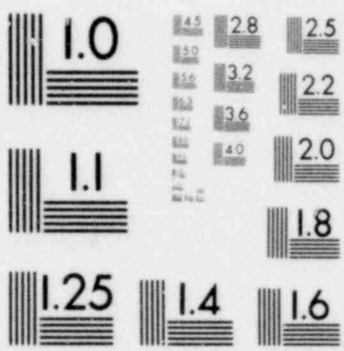
The fuel oil system will be designed to provide fuel oil storage and transfer capability to allow operation of each standby diesel generator for at least seven days. The fuel oil system will consist of three separate and independent trains, one for each diesel generator. Each system will include a day tank that will hold a two hour supply of fuel oil for each standby diesel. The fuel oil system will be designed to seismic Category I requirements. The fuel oil storage tanks will be buried and the transfer pumps will be located on top of the fuel oil storage tank. The fuel oil transfer pumps will be powered from separate emergency buses. Based on our independent evaluation, we determined that the design of the fuel oil system meets the single failure criterion.

Based on our review of the diesel generator fuel oil system design criteria and bases, we conclude that the system will have adequate capacity to perform its designated safety functions, and is, therefore, acceptable.

9.5.3 Diesel Generator Auxiliary Systems

The diesel generator auxiliary systems will include the diesel generator cooling water system, diesel generator starting system, the diesel generator lubrication system, and the diesel generator combustion air intake and exhaust system.

IMAGE EVALUATION TEST TARGET (MT-3)



6"

MICROCOPY RESOLUTION TEST CHART

The diesel generator cooling water system, the lubrication system, and the combustion air intake and exhaust system will be an integral part of the diesel generator which is not within the scope of supply of BOPSSAR, but will be selected by a utility applicant and will be described in its application for a construction permit. The interface design criteria for these systems have been identified in the interface design information section of BOPSSAR.

The diesel generator air starting system will provide independent air starting systems for each diesel generator. The starting air systems will be designed to seismic Category I requirements. Each air start system will consist of two storage tanks capable of starting a cold diesel five times without recharging, and a separate line from each storage tank to the air start mechanism.

Based on our review of the diesel generator air starting system design criteria and bases, we conclude that the system is acceptable.

1C .AM AND POWER CONVERSION SYSTEM

10.1 Summary Description

The steam and power conversion system will be of conventional design operating on a modified Rankine cycle with moisture separation and multistage reheat. Heat addi'ion to the cycle will take place by generating steam in the four RESAR-41 steam generators. Output will be in the form of electrical energy from the steam turbine driven generator. Heat rejection from the cycle, which will take place in the condenser, will be to the circulating water system. The entire system will be designed for the maximum licensed thermal output from the RESAR-41 nuclear steam supply system. The steam and power conversion system will provide the load following capability required by the RESAR-41 nuclear steam supply system and will be designed within the limits to be specified by the turbine generator manufacturer. At our request, Fluor Pioneer has addressed in BOPSSAR those features of the turbine generator and turbine building that could have an impact on safety.

10.2 Turbine Generator

A utility applicant referencing BOPSSAR will select a turbine generator and provide the appropriate design details in its safety analysis report. Fluor Pioneer states that the BOPSSAR design can accommodate turbine generator units manufactured by Allis-Chalmers Corporation, General Electric Company, or Westinghouse Electric Corporation. We will evaluate the turbine generator during our review of a construction permit application by a utility applicant referencing the BOPSSAR design.

10 Main Steam Supply System

The steam produced in the steam generators will be routed to the high pressure turbine by means of four main steam lines. Each main steam line will contain one main steam isolation valve. The portions of the main steam lines from the steam generators, through the containment, and up to and including the main steam isolation valves will be Safety Class 2 and seismic Category I.

The main steam isolation valves will be designed to close within ten seconds after a major steam line break. Since the closure signal will reach the actuator within five seconds. the main steam isolation valves will be designed to close in five seconds upon receipt of a signal from the nuclear steam supply system vendor supplied main steam flow, pressure, and steam generator level instrumentation for protection and control of the system. The valves will be designed to close for the condition of the maximum mass flow rate in the event of a double-ended steam line break in either direction. Failure of one main steam isolation valve to close, coincident with a steam line break, will not result in the uncontrolled blowdown of more than one steam generator.

Based on our review, we conclude that the main steam supply system design criteria and bases are in conformance with the single failure criterion, the position of Regulatory Guide 1.29, "Seismic Design Classification," related to seismic design, and valve closure time requirements and are, therefore, acceptable. Our evaluation of the separation criteria regarding protection against dynamic effects from piping failure outside containment is discussed in Section 3.6.2 of this report.

10.4 Main Condenser Evacuation System

The main condenser evacuation system will be designed to establish and maintain main condenser vacuum by transferring noncondensible gases from the condenser through auxiliary building high efficiency particulate air and charcoal adsorbers to the plant vent. The components of the system will be designed to Quality Group D and to a non-seismic design classification.

The scope of our review included the system capability to transfer radioactive gases to the ventilation system and the design provisions incorporated to monitor and control releases of radioactive materials in gaseous effluents. Based on our evaluation, we find the proposed main condenser evacuation system acceptable. The basis for our acceptance has been conformance of designs, design criteria, and design bases for the main condenser evacuation system to Criteria 60 and 64 of the General Design Criteria.

10.5 Turbine Gland Sealing System

The turbine gland sealing system will be designed to control radioactive steam leakage from, and air inleakage into, the turbine and large steam valve shaft seal glands. The components of the system will be designed to Quality Group D and to a non-seismic design classification. Steam will be supplied to the shaft seals from the main steam system during load operations. The gland seal condenser will condense sealing steam and exhaust the noncondensible gases to the plant vent through auxiliary building high efficiency particulate air and charcoal adsorbers.

Our review included the source of sealing steam and the provisions incorporated to monitor and control releases of radioactive material in gaseous effluents. Based on our evaluation, we find the proposed turbine gland sealing system acceptable. The basis for acceptance in our review has been conformance of the design, design criteria, and design bases for the turbine gland sealing system to Criteria 60 and 64 of the General Design Criteria.

10.6 Circulating Water System

The circulating water system, which is not safety-related, will remove the heat rejected by the condenser. The system is not within the scope of the BOPSSAR design, but wil` be provided by a utility applicant referencing the BOPSSAR design and will be addressed in its safety analysis report. The utility applicant will be required to determine the type of circulating water system, the heat load to be removed from the condenser by the system, and the need for a vacuum primary system. Fluor Pioneer has specified as interface requirements for this system that its malfunction will not prevent the ultimate heat sink or the service water system from performing their design functions and that its failure will not cause the failure of any safety-related systems. We find these requirements acceptable for the design of the system. We will evaluate the system during our review of a construction permit application of a utility applicant referencing the BOPSSAR design.

10.7 Auxiliary Feedwater System

The auxiliary feedwater system will be designed to supply water to the steam generators for reactor coolant system sensible and decay heat removal when the normal feedwater system is not available. The system will be utilized during certain periods of normal startup and shutdown, in the event of malfunctions such as loss of offsite power, and in the event of accidents.

Pump redundancy will be provided by using three 100 percent capacity (500 gallons per minute) motor-driven pumps and one 100 percent capacity (500 gallons per minute) turbine-driven pump. The motor-driven pumps will be aligned to separate diesel power sources and the turbine-driven pump will be powered by steam from a main steam line. All the valves required for operating the turbine driven pump will be operated from direct current power sources. Any one of the pumps will be capable of removing the heat load of the reactor system for a safe shutdown. Normally, the pumps will take suction from seismic Category I auxiliary feedwater storage tanks. The valves on the four suction lines will be normally open. A backup water source for the auxilia[illegible] [illegible]dwater pumps will be the service water system. The system will, therefore, be provided with system diversity and meets Branch Technical Position APCSB 10-1, "Design Guidelines for Auxiliary Feedwater System Pump Drive and Power Supply Diversity for Pressurized Water Reactor Plants," which is contained in Section 10.4.9 of the Standard Review Plan.

The system discharge piping will utilize separate lines to each steam generator from the motor-driven pumps and the turbine-driven pump. Crossover lines with fail-closed air operated valves will be provided between each auxiliary feedwater pump discharge. Pump suction headers and all downstream piping, valves, and equipment will be designed to seismic Category I requirements and will be protected from tornado missiles. The auxiliary feedwater pumps and associated piping will be physically separated from each other and protected from flooding.

We reviewed the adequacy of Fluor Pioneer's design of the auxiliary feedwater system for safe operation of the plant during normal, abnormal, and accident conditions. We conclude that the design conforms with our positions regarding diversity of power sources, system flexibility, and redundancy, including the combination of single active failure and high energy line breaks and is, therefore, acceptable. The system design criteria and bases also meet the interface requirements specified in RESAR-41. We conclude that the system design criteria and bases are acceptable.

We are currently evaluating design and operating conditions that could result in damage to feedwater system piping as a consequence of pressure waves (water hammer) resulting from flow instabilities in the feedwater system. The results of this investigation may result in further requirements being imposed on the RESAR-41 standard nuclear steam supply system design and/or on the BOPSSAR design of the feedwater system so that unacceptable damage will not result from potential feedwater hammer. We will require that the BOPSSAR design be modified if the resolution of this design aspect so dictates and we will review any such required changes during our review of an application for an operating license by a utility applicant referencing the BOPSSAR design.

10.8 Steam and Feedwater System Materials

The mechanical properties of materials selected for the Class 2 and 3 components of the steam and feedwater systems will satisfy Appendix I of Section III of the ASME Code, and Parts B or C of Section II of the Code as appropriate. The fracture toughness properties of the ferritic materials will satisfy the testing requirements of the ASME Code, 1974 Edition, and the additional requirements stated in Section 3.9.3 of this report.

The controls to be imposed upon austenitic stainless steel are in conformance with the recommendations of Regulatory Guide 1.31, "Control of Stainless Steel Welding," and Regulatory Guide 1.44, "Control of the Use of Sensitized Stainless Steel." Fabrication and heat treatment practices that will be performed in accordance with these recommenendations provide added assurance that stress corrosion cracking will not occur during the design life of the plant. The controls to be placed upon concentrations of leachable impurities in nonmetallic thermal insulation used on austenitic stainless steel components of the steam and feedwater systems are in accordance with the recommendations of Regulatory Guide 1.36, "Nonmetallic Thermal Insulation for Austenitic Stainless Steel."

The welding procedures that will be used in limited access areas satisfy the intent of the recommendations of Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility." The onsite cleaning and cleanliness controls to be applied during fabrication satisfy the positions given in Regulatory Guide 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants," and the requirements of American National Standards Institute Standard N45.2.1-1973, "Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants." The precautions to be taken in controlling and monitoring the preheat and interpass temperatures during welding of carbon and low alloy steel components conform to the recommendations of Regulatory Guide 1.50, "Control of Preheat Temperature for Welding of Low-Alloy Steel."

We [illegible]e that conformance with the codes, standards, and regulatory guide recommendations constitutes an acceptable basis for assuring the integrity of steam and feedwater systems, and for meeting the requirements of Criterion 1 of the General Design Criteria.

11.0 RADIOACTIVE WASTE MANAGEMENT

11.1 Summary Description

The radioactive waste system for the BOPSSAR standard balance-of-plant design will consist of the liquid, gaseous, and solid waste systems. The system will be designed to provide for controlled handling and treatment of all liquid, gaseous, and solid wastes. We evaluated the radioactive waste system for a single unit station. Separate systems will be provided for each unit of a multi-unit station.

The following aspects of the system were not considered in our review because they are dependent on the characteristics of a specific site:

(1) The capability of the liquid and gaseous waste systems to meet the dose design objectives of Appendix I to 10 CFR Part 50 and the limits of 10 CFR Part 20.

(2) The cost-benefit analysis required by Appendix I to 10 CFR Part 50.

(3) The consequences of a component failure that could result in the release of radioactive liquids to site-related potable water supplies and nearby surface water.

We will evaluate these aspects during our review of a construction permit application by a utility applicant referencing BOPSSAR design.

The system will be designed to process and control the radioactive waste materials and flowrates from the nuclear steam supply system that are specified in RESAR-41 as interface requirements. During our review of the BOPSSAR radioactive waste system, we determined that the interface requirements of the RESAR-41 design have been identified in the BOPSSAR application and are met by the BOPSSAR design.

The liquid waste system will process wastes from equipment and floor drains and decontamination, laboratory, and laundry wastes. The gaseous waste system will provide delay capacity to decay short-lived noble gases stripped from the primary coolant and treatment of ventilation exhaust air through high efficiency particulate air filters and charcoal adsorbers as necessary to reduce releases of radioactive materials. The solid waste system will provide for the solidification, packaging, and storage of radioactive wastes generated during station operation prior to shipment for offsite burial. Solid packaged wastes will be shipped to a licensed facility for burial.

In our evaluation of the waste management systems, we considered (1) the capability of the systems to control the levels of radioactive materials in liquid effluents based on expected radwaste inputs over the life of the plant, (2) the capability of the systems to control releases during periods of fission product leakage at design levels from the fuel, (3) the capability of the systems to meet the processing demands of the station during anticipated operational occurrences, (4) the quality group and seismic design classification applied to the system design, (5) the design features incorporated to preclude uncontrolled releases of radioactive materials due to tank overflows, and (6) the provisions to preclude a hydrogen explosion in the gaseous radwaste system.

In our evaluation of the solid radwaste treatment system, we also considered: (1) system design objectives in terms of expected types, volumes, and activities of waste processed for shipment offsite, (2) waste packaging and conformance to applicable Federal packaging regulations, and provisions for controlling potentially radioactive airborne dusts during baling operations, and (3) provisions for onsite storage prior to shipping.

In our evaluation of the process and effluent monitoring system, we considered the system's capability (1) to control the release of radioactive materials to the environment, (2) to monitor all normal and potential pathways for release of radioactive materials to the environment, and (3) to monitor the performance of process equipment and detect radioactive material leakage between systems.

We determined the quantities of radioactive materials estimated to be released in the liquid and gaseous effluents and the quantity of material expected to be shipped offsite as solid waste for burial during normal operations including anticipated operational occurrences.

In making these determinations, we considered waste flows and activities and equipment performance consistent with expected normal plant operation, including anticipated operational occurrences, over the 30-year life of the plant. Liquid and gaseous source terms were calculated using models and methodology described in NUREG-0017, "Calculation of Releases of Radioactive Material in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWR)," dated April 1976.

Based on our evaluation as described in detail below, we find the proposed liquid, gaseous, and solid radwaste systems and associated process and effluent monitoring systems to be acceptable.

11.2 System Description and Evaluation

11.2.1 Liquid Radwaste Treatment System

The liquid radioactive waste treatment system will consist of process equipment and instrumentation necessary to collect, process, monitor, and recycle or dispose of liquid radioactive wastes. The liquid radioactive waste will be processed on a batch basis for optimum control of releases. Prior to being released, samples will be analyzed to determine the types and amounts of radioactivity present. Based on the results of the analysis, the waste will be retained for further processing, recycled for eventual use in the plant, or released under controlled conditions.

The liquid radwaste treatment system will collect and process waste based on the chemical purity relative to the primary coolant, as determined by the origin of the waste in the plant, and will consist of three subsystems - the miscellaneous waste, clean waste, and detergent waste systems.

In addition to the above systems, the condensate polishing system and the steam generator blowdown system were considered in our evaluation. The condensate polishing system will use demineralization to process secondary system condensate which becomes radioactive due to primary to secondary leakage. The backwashed spent resin of the demineralizers will be processed in the solid radwaste system. The steam generator blowdown will be used in conjunction with the feedwater system and the condensate polishing system to control the concentration of radioactivity and solids in the steam generators. Design parameters of principal components considered in our evaluation of the liquid radioactive waste system are listed in Table 11-1 of this report.

The liquid radwaste system will process miscellaneous low-purity wastes collected in floor and laboratory drains and building sumps by filtration, evaporation and demineralization. We estimate that ten percent of the evaporator distillate from these wastes will be discharged. The system will also process, by filtration, evaporation, and demineralization, clean wastes in a separate processing train, and will route the evaporator distillate to the condenser. We estimate, as a result of anticipated operational occurrences, ten percent of the evaporator distillate will be discharged to the environment. The system will also process, by reverse osmosis in a separate processing train, laundry wastes collected in the detergent waste holdup tanks. We estimate that 100 percent of the processed waste from these wastes will be discharged.

Turbine building floor drain waste will normally be monitored and discharged without treatment. If the radioactivity exceeds a predetermined limit, the stream will be processed through the liquid radwaste system. The design flow capacity for each of the two radwaste evaporators (one standby) is 43,200 gallons per day.

We calculated the average expected waste flow to the radwaste evaporator to be 1400 gallons per day. The difference between the design and expected flow capacity for radwaste evaporator will provide adequate reserve capacity for processing surge flows. We consider the design and the capacity of the liquid radwaste system to be adequate for meeting the demands of the plant during any anticipated operational occurrences.

TABLE 11-1

DESIGN PARAMETERS OF PRINCIPAL COMPONENTS
FOR LIQUID, GASEOUS, AND SOLID RADWASTE SYSTEMS

Radioactive Liquid Waste System	Number	Capacity Each	Quality Group[(a)]
Miscellaneous Waste Holdup Tanks	4	26,000 gallons	
Chemical Waste Holdup Tanks	2	6,200 gallons	D
Waste Evaporator Feed Tank	1	26,000 gallons	D
Waste Evaporator	2	30 gallons per minute	D
Waste Demineralizer	4	100 gallons per minute	D
Radioactive Gaseous Waste System			
Waste Gas Compressors	2	3 standard cubic feet per minute	D
Waste Gas Return Compressor	4	41 standard cubic feet per minute	D
Waste Gas Recycle Compressor	2	5 standard cubic feet per minute	D
Waste Gas Storage Tanks	3	450 cubic feet	C
Cryogenic Package	1	3 standard cubic feet per minute	D
Radioactive Solid Waste System			
Waste Concentrates Tank	1	5,000 gallons	D
Spent Resin Storage Tanks	1	750 cubic feet	D
Steam Generator Blowdown System			
Flash Tank	1	10,000 gallons	D
Secondary Waste Demineralizer	4	100 gallons per minute	D

[(a)]Quality Group D design criteria include additional quality assurance provisions in accordance with Branch Technical Position ETSB 11-1, Revision 1.

The steam generator blowdown will blow down water to a flash tank where the steam will be routed to the feedwater heaters and the condensate will be routed to the main condenser hotwell. The average expected blowdown rate will be approximately 72,000 gallons per day. We consider the system design capacity to be adequate for meeting the needs of the plant.

The quality group designations of the equipment, which are consistent with our guidelines, are listed in Table 11-1 of this report. The system will also be designed to preclude the uncontrolled release of radioactive materials due to overflows from indoor and outdoor tanks. Level instrumentation will alarm in the control room, and curbs and retention walls will collect liquid spillage and retain it for processing. We consider these provisions to be capable of preventing the uncontrolled release of radioactive materials to the environment. We conclude that the proposed system design is acceptable in accordance with Revision 1 to Branch Technical Position ETSB 11-1, "Design Guidance for Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Reactor Power Plants," which is contained in Section 11.2 of the Standard Review Plan. We will require a utility applicant referencing the BOPSSAR design to demonstrate in its construction permit application that the doses, associated with the postulated failure of non-seismic Category I components of the liquid radwaste systems, will not exceed the limits set forth in 10 CFR Part 20.

We determined that during normal operation the proposed BOPSSAR liquid radwaste treatment system with a RESAR-41 nuclear steam supply system will reduce the release of radioactive materials in the liquid effluents to approximately 0.4 curies per year, excluding tritium and dissolved gases, and 450 curies per year of tritium.

11.2.2 Gaseous Radioactive Waste Treatment Systems

The gaseous radwaste treatment system will be designed to process gaseous plant wastes based on the origin of the wastes in the plant and their expected activity levels. The gaseous waste treatment system will process gases stripped from the primary coolant and miscellaneous tank cover gases through a three standard cubic foot per minute compressor, three decay tanks (450 cubic feet, 350 pounds per square inch gauge design pressure), a gas dryer, and a cryogenic distillation unit and will provide a 90-day holdup time for decay.

The system will include redundant waste gas dryers, redundant compressors, and a 1000 cubic foot per day capacity cryogenic distillation package, to assure that the system will have adequate capacity and redundancy to allow operation during periods of equipment downtime. We consider the system capacity and the system design to be adequate for meeting processing demands during normal operations and anticipated operational occurrences.

The system design will include two oxygen analyzers which will initiate an alarm if oxygen concentrations exceed the design concentration limits. In this manner, the potential for explosive hydrogen-oxygen mixtures will be minimized.

We find the system quality group and seismic design classification and the design provisions incorporated to reduce the potential of hydrogen explosion to be acceptable. The principal components in the gaseous radioactive waste treatment system, along with their principal design criteria, are listed in Table 11-1 of this report.

The gaseous waste treatment system will be located in a seismic Category I structure. The gaseous waste treatment system will be designed to quality group and seismic design, compatible with Revision 1 to Branch Technical Position ETSB 11-1.

The offgas from the main condenser evacuation system will be processed through the auxiliary building high efficiency particulate air filter and charcoal adsorber.

Ventilation exhausts from the reactor building annulus, auxiliary building, and control building will also be continuously processed through high efficiency particulate air and charcoal adsorbers prior to release to the environment. Containment purges during plant shutdown will be processed through high efficiency particulate air filters and charcoal adsorbers prior to release to the environment. In addition, the containment building atmosphere will be recirculated through high efficiency particulate air filters and charcoal adsorbers prior to purging to the ventilation exhaust system at reactor shutdown. The turbine building ventilation exhaust will be released to the environment without treatment.

The plant ventilation systems will be designed to induce air flows from potentially less radioactively contaminated areas to areas having a greater potential for radioactive contamination. Potentially contaminated building areas will be maintained at a slightly negative pressure with respect to the exterior pressure to promote collection of radioactive materials by the ventilation system and allow dispersion through plant vent exhausts while reducing exfiltration. The ventilation system will have adequate capacity to limit radioactive material concentrations in areas within the plant that are accessible during operation to below the limits in 10 CFR Part 20.

We determined that the proposed gaseous radwaste treatment systems and plant ventilation system will be capable of reducing the release of radioactive materials in gaseous effluents to approximately 1200 curies per year of noble gases, 0.022 curies per year of iodine-131, 1200 curies per year of tritium, 8 curies per year of carbon-14, and 0.004 curies per year of particulates.

11.2.3 Solid Radwaste Treatment System

The radioactive solid waste system will be designed to collect and process wastes based on their physical form and need for solidification prior to packaging. Wet solid wastes, consisting of spent demineralizer resins, reverse osmosis concentrates, and evaporator bottoms will be combined with cement to form a solid matrix and will be sealed in 55-gallon drums for shipment to an offsite disposal facility.

Dry solid wastes, consisting of ventilation air filters, contaminated clothing and paper, and miscellaneous items such as tools and glassware, will be compacted into steel drums with a capacity of 55 gallons. Miscellaneous solid wastes, such as irradiated primary system components will be handled on a case-by-case basis considering their size and activity. Expected solid waste volumes and activities shipped offsite will be 15,000 cubic feet per year of wet solid waste containing approximately 2,000 curies total activity and 520 drums per year of dry solid waste containing less than five curies total activity. Design parameters of the solid radioactive waste system considered in our evaluation are listed in Table 11-1 of this report.

Drum filling operations will be controlled remotely from consoles located outside the drum fill area. Drumming operations will have interlock features to prevent overfilling of containers. In addition, the system will be designed so that any spills will be collected in curbed cubicles. Bailing of dry wastes will be carried out in an area which is exhausted through a high efficiency particulate air filter and then to the plant vent.

The solid radwaste system containing radioactive liquids will be located on a seismic Category I foundation. The quality group classification of the equipment, which is consistent with our guidelines, are listed in Table 11.1 of this report. Packaged solid waste drums will be stored in the shielded 275 square foot auxiliary building floor (with the capability of stacking the filled drums). Based on our estimate of 15,000 cubic feet per year, the expected onsite residence time will be approximately one month, and we find the storage capacity adequate. Wastes will be packaged in accordance with requirements of 10 CFR Part 20, 10 CFR Part 71, and 49 CFR Parts 170-178, and shipped to a licensed burial site in accordance with regulations of the Commission and the Department of Transportation.

11.2.4 Process and Effluent Radiological Monitoring

The process and effluent radiological monitoring system will be designed to provide information concerning radioactivity levels in systems throughout the plant, indicate radioactive leakage between systems, monitor equipment performance, and monitor and control radioactivity levels in plant discharges to the environs. Westinghouse has identified in RESAR-41 the liquid and gaseous streams to be monitored as listed in Table 11-2 of this report. Monitors on containment purge and the gaseous radwaste system gaseous effluent release lines, and on the turbine building drain and liquid radwaste system liquid effluent release lines, will automatically terminate discharges should radiation levels exceed a predetermined value. Systems which are not amenable to continuous monitoring, or for which detailed isotopic analyses are required, will be periodically sampled and analyzed in the plant laboratory.

TABLE 11-2

MONITOR: G OF PROCESS AND EFFLUENT STREAMS

A. Liquid

Reactor plant component cooling water

Liquid waste release

Plant discharge line

Turbine building drains

Service water

Steam generator blowdown sample

B. Gaseous

Process vent

Process gas

Ventilation vent

Containment purge air exhaust

Steam jet air ejector

We reviewed the locations and types of effluent and process monitoring to be provided. Based on the plant design and on the continuous monitoring locations and intermittent sampling locations, we conclude that all normal and potential release pathways will be monitored. We also determined that the sampling and monitoring provisions will be adequate for detecting radioactive material leakage to normally uncontaminated systems and for monitoring plant processes which affect radioactivity releases. On this basis we consider that the monitoring and sampling provisions meet the requirements of Criteria 13, 60, and 64 of the General Design Criteria and the guidelines of 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."

11.3 Conclusions

Our review of the radioactive waste management systems included: (1) system capabilities to process the types and volumes of wastes expected during normal operations and during anticipated operational occurrences, (2) the design provisions incorporated to control releases of radioactive materials in accordance with Criterion 60 of the General Design Criteria, and (3) the conformance of the quality group and seismic design classification of the systems in accordance with the guidelines of Revision 1 to Branch Technical Position ETSB 11-1. We reviewed the system descriptions, process flow diagrams, piping and instrumentation diagrams, and design criteria for the components of the radwaste treatment system. We performed an independent calculation of the releases of radioactive materials in liquid and gaseous effluents.

Our review of the radiological monitoring systems included: (1) the provisions for sampling and monitoring all plant effluents in accordance with Criterion 64 of the General Design Criteria, (2) the provisions for automatic termination of effluent releases and assuring control over discharges in accordance with Criterion 60 of the General Design Criteria and Regulatory Guide 1.21, (3) the provisions for sampling and monitoring plant waste process streams for process control in accordance with Criterion 13 of the General Design Criteria, (4) the provisions for conducting sampling and analytical programs in accordance with the guidelines in Regulatory Guide 1.21, and (5) the provisions for monitoring process and effluent streams during postulated accidents. The review included piping and instrumentation diagrams, process flow diagrams and interface requirements for the liquid, gaseous, and solid radwaste systems and ventilation system, and the location of monitoring points relative to effluent release points on the site plot diagram.

The basis for acceptance has been conformance of the design, design criteria, and design bases for the radioactive waste treatment and monitoring system to the applicable regulations and guides referenced above, as well as to staff technical positions and industry standards.

We find the liquid radwaste system and the gaseous radwaste system will be capable of controlling the release of radioactive materials in liquid and gaseous effluents during periods of equipment downtime and design bases fuel leakage in accordance with Criterion 60 of the General Design Criteria. The proposed seismic and quality group classification of the systems are in accordance with Revision 1 to Branch Technical Position ETSB 11-1, and the design of the systems contain adequate provisions to control releases of radioactive materials. These aspects of the systems are acceptable.

The capability of the proposed liquid and gaseous radwaste systems to meet the dose design objectives of Appendix I to 10 CFR Part 50 and the limits of 10 CFR Part 20 is site dependent and will be reviewed for individual applications that reference the BOPSSAR design.

We find the solid radwaste system will have adequate capacity to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences, in accordance with Criterion 60 of the General Design Criteria, and is, therefore, acceptable.

We find the radiological monitoring systems capable of monitoring all major process effluent pathways, in accordance with Criteria 13 and 64 of the General Design Criteria and of controlling suitably the release of radioactive materials in liquid and gaseous effluents, in accordance with Criterion 60 of the General Design Criteria and, therefore, acceptable.

12.0 RADIATION PROTECTION

We evaluated the proposed radiation protection program presented in Section 12 of BOPSSAR. BOPSSAR does not contain a complete description of the radiation protectio program. Sections not within the scope of BOPSSAR will be provided by the utility applicant in applications referencing BOPSSAR. These sections include operational procedures, health physics programs, and site-related dose assessments. The radiation protection measures incorporated in BOPSSAR are intended to ensure that internal and external occupational radiation exposures and exposure of the population due to station conditions, including anticipated operational occurrences, will be as low as is reasonably achievable and within the limits of 10 CFR Part 20.

Acceptability of the radiation protection program is based on the criterion that doses to personnel will be maintained within the established limits of 10 CFR Part 20. The radiation protection design and program features must also be consistent with the guidelines of Regulatory Guide 8.8, "Information Relevant to Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable." In response to our requests, Fluor Pioneer provided considerable additional information concerning its implementation of design features for assuring that occupational radiation exposures are as low as is reasonably achievable. The reduction of potential crud traps in pipe runs carrying radioactive fluid and the placement of shielding to allow access and minimize radiation exposure during inservice inspections are two such personnel dose reduction measures.

On the basis of our review, we conclude that implementation of the radiation protection measures incorporated in the BOPSSAR design will provide reasonable assurance that personnel doses will be maintained as low as is reasonably achievable and below the limits established by 10 CFR Part 20. Further, Fluor Pioneer's radiation design features will be consistent with the guidelines of Regulatory Guide 8.8. Categories not addressed in Section 12 of BOPSSAR, including policy and operational considerations, plant staffing requirements, site specific annual radiation doses, and a description of the health physics program, will be described in the utility applicant's safety analysis report. Acceptability of these items will be made on an individual basis at that time.

12.1 Assuring That Occupational Radiation Exposures Are As Low As Is Reasonably Achievable

To ensure that occupational exposures will be kept as low as is reasonably achievable according to Regulatory Guide 8.8 criteria, all plant radioactive systems and shielding design will be reviewed, updated, and modified as necessary during all phases of the plant design. Shielding engineers and supervisors will be responsible for the various shielding design phases. The finalized shielding designs will then be reviewed by health physics personnel and integrated with mechanical, ventilation, and radiation monitoring design and health physics procedures to ensure that radiation exposures are as low as is reasonably achievable.

The primary design objective of the plant radiation shielding is to protect plant personnel and the general public from various sources of ionizing radiation in the plant during normal operation and anticipated operational occurrences. This design objective will be accomplished by designing radiation shielding to ensure that (1) inplant radiation exposure will be maintained as far below the limits set forth in 10 CFR Part 20 as is reasonably achievable; (2) offsite radiation exposure to the general public during normal operations and anticipated operational occurrences will be maintained within the limits specified in 10 CFR Part 20; (3) control room personnel will be adequately protected in the event of a reactor accident as specified in Criterion 19 of the General Design Criteria; and (4) activation of components will be minimized so as to reduce personnel exposure during refueling, maintenance, and inspection operations. These design objectives have been chosen by Fluor Pioneer to insure that occupational radiation exposures will be as low as is reasonably achievable. These design objectives are consistent with the guidance given in Section C.3 of Regulatory Guide 8.8 and are, therefore, acceptable.

The following design criteria will be used to meet the shielding design objectives. Radioactive components and piping will be located in separate cubicles to minimize radiation exposure during maintenance and inspection activities. Shielded valve stations and motor operated or diaphragm operated valves will be used whenever feasible. Manually operated valves will be operated remotely from shielded corridors using reach rods. Radiation damage to equipment will be limited through proper materials selection as well as by the use of shielding structures. Suitable nuclear grade coatings will be provided on equipment, floors, and walls that have a potential for becoming contaminated with radioactive materials. Additional measures that will be taken to reduce exposures include floor drains with properly sloping floors, display and control instrumentation located in low radiation areas, and provisions to remove components located in high radiation areas for repair work. In response to our request concerning radiation exposure during inservice inspections, Fluor Pioneer agreed to (1) provide inspection or maintenance platforms to facilitate work; (2) allow clearances around system components to allow for the conduct of examinations; and (3) provide shielding for major radiation sources to allow access and minimize radiation exposure of personnel. These shielding design criteria are consistent with the guidelines of Regulatory Guide 8.8 and are, therefore, acceptable.

The detailed operational considerations for assuring that occupational radiation exposures are as low as is reasonably achievable are not within the scope of BOPSSAR. These will be provided in the utility applicant's safety analysis report, and conformance with the guidelines of Section C.4 of Regulatory Guide 8.8 and Section C.2 of Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Practicable," will be evaluated during our review of an application for a construction permit by a utility applicant referencing BOPSSAR.

12.2 Radiation Sources

BOPSSAR incorporates the reactor core source terms contained in RESAR-41 in its radiation protection design calculations. The primary sources of contained radiation inside the reactor containment building are expected to be the core itself and the piping and equipment of the reactor coolant system which will contain nitrogen-16, fission products from fuel clad defects, and activated nuclei and corrosion products. In the auxiliary buildings, the systems which will contain radioactivity during operation are the chemical and volume control system, the boron recycle system, and the waste processing systems. The shielding thicknesses in the auxiliary buildings will be determined by the amount of radiation sources in these systems, as well as by the adjacent radiation access zones. BOPSSAR also includes a tabulation of the expected airborne concentrations of radioactive material by nuclides for the containment, annulus, and auxiliary buildings. The radioactive airborne concentrations in these buildings (after cleanup and purge of the containment) are a small fraction of 10 CFR Part 20 limits. We find the use of these source terms acceptable.

12.3 Radiation Protection Design Features

The following equipment and facility design features will be used to ensure that occupational radiation exposures are as low as is reasonably achievable. Canned pumps will be used in the waste processing system to eliminate the potential for leaks. Air operated valves will be used instead of motor operated valves in high radiation areas. Cubicles containing radioactive components will be provided with vent and drain systems. Decontamination water hose stations will be located throughout the facility for use in decontaminating potentially contaminated areas. Remote handling equipment and other special tools will be provided, when necessary, to reduce external radiation exposure. Other design features which have been added to BOPSSAR as a result of our review are (1) the reduction of potential crud traps in pipes carrying radioactive fluid; (2) the insertion of oil interceptors in floor drain sumps to prevent any leaking pump bearing oil from entering and fouling the liquid radwaste treatment system; and (3) the use of low maintenance items in high radiation areas to reduce maintenance personnel exposures. These design features are consistent with those contained in Regulatory Guide 8.8 and are, therefore, acceptable.

The facility, equipment, and radiation shielding will be designed to provide protection against the radiation for operating personnel, both inside and outside the plant, and for the general public. Vital to the facility and radiation shielding is the radiation zoning philosophy used in the development of the unit arrangements. This zoning philosophy will allow for arrangements of radioactive equipment that are in accordance with the requirements of 10 CFR Part 20 and the guidelines of Regulatory Guide 8.8. There are five radiation zone classifications. The dose rate criterion for each of these five zones (based on the radiation sources in each compartment within the zone) will be used as the bases for the radiation shielding design. We find the zone criteria acceptable.

Fluor Pioneer used basic shielding data and several common shielding computer codes in determining shield wall thicknesses. The QAD-P5 code was used in the design of the secondary shield, shielding for the components in the auxiliary systems, the spent fuel pool, and the control room, to ensure that the 30 day exposure to control room personnel will be below the limits specified in Criterion 19 of the General Design Criteria. The ANISN code was used in the primary shield design to predict the radial distributions of dose rate due to neutrons emanating from the core and due to gamm rays arising both from the core and from neutron interactions in the primary shield. The two-dimensional discrete ordinates code, DOT, was used to solve two-dimensional problems, such as streaming along pipe penetrations in the primary shield. All concrete shield walls will be constructed in compliance with Regulatory Guide 1.69, "Concrete Radiation Shields for Nuclear Power Plants." We find the codes used by Fluor Pioneer in the shielding analysis acceptable.

Fluor Pioneer's ventilation system will be designed to protect personnel and equipment from extreme thermal environmental conditions and to ensure that personnel are not inadvertently exposed to airborne concentrations exceeding those given in 10 CFR Part 20. Fluor Pioneer intends to meet these objectives and maintain personnel exposures as low as is reasonably achievable by (1) maintaining air flow from areas of lesser potential airborne contamination to areas of progressively greater potential airborne contamination; (2) using once-through exhaust systems with prefilter and high efficiency particulate air filter banks in the fuel handling and auxiliary buildings; and (3) ensuring negative or positive pressures to prevent exfiltration and infiltration of potential contaminants respectively. To ensure that total exposures are kept as low as is reasonably achievable, equipment cubicles where a potential for significant releases of radioactive materials exists will be surveyed prior to entry by plant personnel. These design criteria are in accordance with those given in Regulatory Guide 8.8 and are acceptable. The air filtration in the control room will be designed to limit radiation exposure to control room personnel in accordance with Criterion 19 of the General Design Criteria. Fluor Pioneer's ventilation system design complies completely with 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."

Continuous air monitors will provide data for estimating concentrations of radioactivity for occupational exposure to assure compliance with 10 CFR Part 20.103. The criteria for the number of continuous air monitors deployed and their locations in the facility will be supplied by the utility applicant in its safety analysis report. We will evaluate the conformance of the airborne radioactivity monitoring system to Regulatory Guides 1.52 and 8.8 during our review of a future utility applicant's application for a construction permit.

The area radiation monitoring system will be designed to provide plant personnel with a continuous record and indication in the control room of gamma radiation levels at selected locations within various plant buildings where radioactive materials may be present or may be inadvertently introduced. All radiation detectors will be housed in weather-proof containers to protect them from water spray and will be mounted as close as practical to the most probable radiation sources.

All radiation detectors will be equipped with annunciators in the control room and local alarms at the detector locations, as well as with meter indicators in both locations. Radiation detectors will be located in areas where (1) personnel perform regular duties in radiation areas; (2) personnel perform infrequent duties in areas, but where significant changes in radiation levels could occur; and (3) the probability of radiation exposure is low but where surveillance is desired. The objectives and location criteria of Fluor Pioneer's area radiation monitoring system are in conformance with 10 CFR Parts 50 and 70 and Regulatory Guide 8.8 and are, therefore, acceptable.

12.4 Dose Assessment

Fluor Pioneer has based its dose assessment associated with normal plant operations on nuclear steam supply system vendor data and recent publications. Doses to plant personnel working in radiation areas will be maintained below 10 CFR Part 20 limits by the use of administrative controls and controlled access. Areas with radiation levels exceeding 100 millirem per hour will be classed as Zone 5 areas and will be normally inaccessible.

Fluor Pioneer estimates an annual dose of 220 man-rem and provides a breakdown of this dose by job function. This value is based on data from six operating pressurized water reactor plants, information presented in NUREG 75-032, "Occupational Radiation Exposure at Light Water Cooled Power Reactors, 1969-1974," and improvements in design of systems to maintain in-plant radiation levels as low as is reasonably achievable. This estimate of 220 man-rem is lower than the average collective dose associated with present-day pressurized water reactor plants. However, Fluor Pioneer's estimate does not include exposures due to unexpected major equipment outages. It also takes into account many exposure saving equipment and design features including the RESAR-41 rapid refueling process. Even though the projected annual dose is less than the current average experience, we find the bases for Fluor Pioneer's exposure estimate consistent with the acceptance criteria in our Standard Review Plan and, therefore, acceptable.

Fluor Pioneer provides a tabulation of the maximum expected radioactive airborne concentrations, as well as estimates of the inhalation and submersion dose equivalent rates to plant personnel inside major plant buildings. The tritium whole body dose for all applicable areas is also listed. The dose equivalent rates are derived from the airborne radioactivity source terms given in Section 11 of BOPSSAR.

12.5 Health Physics Program

A complete description of the utility applicant's health physics program will be presented in Section 12 of the utility applicant's safety analysis report. We will evaluate the adequacy of the utility applicant's health physics program during our review of the application for a construction permit by a utility applicant referencing BOPSSAR in its application.

13.0 CONDUCT OF OPERATIONS

Information relating to the conduct of operations is not within the scope of BOPSSAR. This information will be provided in each application that references the BOPSSAR design.

We reviewed the information provided in BOPSSAR related to industrial security. Fluor Pioneer has provided a general description of the design features for protecting the balance-of-plant against potential acts of sabotage. We determined that the proposed BOPSSAR design conforms to the applicable design recommendations set forth in Regulatory Guide 1.17, "Protection of Nuclear Power Plants Against Industrial Sabotage," and that the proposed physical protection features provide an adequate design base which can be used by a utility applicant to develop an acceptable security program in accordance with existing regulatory requirements. We conclude that the Fluor Pioneer design and arrangements of the BOPSSAR plant for protection against acts of industrial sabotage are acceptable.

During the course of our review of an application for a construction permit referencing BOPSSAR, we will review the utility applicant's plans, including design features, for providing protection against acts of industrial sabotage in accordance with the requirements of Section 73.55 of 10 CFR Part 73.

Fluor Pioneer, through its parent companies, has acquired considerable experience in the design of non-nuclear electric generating stations as well as a number of nuclear facilities including the Pathfinder, Prairie Island, and Kewaunee Nuclear Plants. Fluor Pioneer also provides design services to the operating units designed by its parent companies as well as by others.

Based on the following:

(1) Fluor Pioneer's organizational structure,

(2) Fluor Pioneer's management and technical experience levels,

(3) Fluor Pioneer's performance during the licensing review process, and

(4) Fluor Pioneer's past performance in the design of nuclear power plants,

we conclude that Fluor Pioneer is technically qualified to design the proposed BOPSSAR standard balance of plant.

14.0 INITIAL TESTS AND OPERATIONS

The definition of the program for initial tests and operation is not within the scope of BOPSSAR but is the responsibility of the utility applicant referencing the BOPSSAR design. Fluor Pioneer has provided in Section 14.0 of BOPSSAR a list of the engineered safety features and engineered safety feature support systems within the BOPSSAR scope, which require preoperational testing. We have determined that the preliminary design of the facility will permit testing in accordance with the guidance provided in the regulatory guides applicable to initial test programs which are listed below.

1. Regulatory Guide 1.41, "Preoperational Testing of Redundant On-Site Electric Power Systems to Verify Proper ~ad Group Assignments."

2. Regulatory Guide 1.68, "Preoperational and Initial Startup Test Programs for Water-Cooled Power Reactors."

3. Regulatory Guide 1.79, "Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors."

4. Regulatory Guide 1.80, "Preoperational Testing of Instrument Air Systems."

On the basis of our review, we conclude that an acceptable startup and test program can be conducted. Because of changes that may result during the refinement of the preliminary designs of either BOPSSAR or RESAR-41, we will conduct our detailed review of the initial test program during the operating license review stage of each application that references BOPSSAR.

15.0 ACCIDENT ANALYSES

15.1 Introduction

Our evaluation of the capability of the RESAR-41 nuclear steam supply system to withstand abnormal operational transients and postulated accidents is presented in Section 15.0 of our RESAR-41 Safety Evaluation Report. Therefore, the discussion below is limited to radiological consequences of postulated accidents related to the BOPSSAR design in combination with the RESAR-41 design.

15.2 Radiological Consequences of Accidents

15.2.1 General

Fluor Pioneer has analyzed the offsite radiological consequences for postulated accidents based on a maximum core thermal power level of 4100 megawatts. As stated in Section 1.2 of this report, the BOPSSAR application is for a thermal power level of 3800 megawatts. We have reviewed the accident analyses presented in BOPSSAR and have performed independent calculations of the offsite radiological consequences resulting from a postulated loss-of-coolant accident, a radioactive waste gas decay tank rupture accident, a fuel handling accident, and a control rod ejection accident. These evaluations are discussed in separate subsections below, and the results are presented in Table 15-1 of this report. The doses in this table were calculated using the limiting value of the site exclusion boundary two-hour atmospheric dispersion factor for the postulated loss-of-coolant accident.

On the basis of our experience in evaluating steam line break and steam generator tube rupture accidents for pressurized water reactor nuclear power plants, we have concluded that the radiological consequences of these accidents can be controlled in a BOPSSAR plant, as they are in other pressurized water reactor plants, by limiting the permissible radioactivity concentrations in the primary and secondary coolant system such that the potential offsite doses will be small. During our review of an operating license application referencing the BOPSSAR design, we will include in the technical specifications for the plant appropriate limits on the primary and secondary coolant activity concentrations.

15.2.2 Loss-of-Coolant Accident

For the purpose of evaluating the suitability of the proposed design, we evaluated the radiological consequences of a postulated loss-of-coolant accident to determine the value for the two-hour atmospheric dispersion factor that will limit the loss-of-coolant accident doses to the 150 rem thyroid and 20 rem whole body dose guidelines of Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors," at the

TABLE 15-1

RADIOLOGICAL CONSEQUENCES OF DESIGN BASIS ACCIDENTS*

Accident	Two-Hour Dose to Thyroid (rem)	Two-Hour Dose to Whole Body (rem)
Loss-of-Coolant	150	3
Waste Gas Decay Tank Rupture	---	less than 1
Fuel Handling	48	7
Rod Ejection (Leakage through secondary system)	145	1

*Based on limiting atmospheric dispersion factor of 2.1×10^{-3} seconds per cubic meter for the loss-of-coolant accident with no containment purging during operation.

The limiting atmospheric dispersion factor for the postulated loss-of-coolant accident will be 1.7×10^{-3} seconds per cubic meter for containment purging during plant operation.

site exclusion boundary. The assumptions used in the evaluation are listed in Table 15-2 of this report. We determined that a maximum two-hour exclusion boundary atmospheric dispersion factor of 2.1×10^{-3} seconds per cubic meter will result in a calculated dose of 150 rem to the thyroid. As discussed in WASH-1361, atmospheric dispersion factor values of this magnitude can be expected for exclusion area radii of the order of several hundred meters or greater; the median value for all plants licensed prior to 1975 is 7×10^{-4} seconds per cubic meter. The corresponding whole body dose calculated at the exclusion boundary is 3 rem.

Fluor Pioneer will provide the capability to purge the containment during normal plant operation and has provided an analysis of the radiological consequences of a postulated loss-of-coolant accident while purging the containment. We have independently calculated the additional release of radioactivity through the purge line. This additional release would result in a dose at the site boundary of 30 rem to the thyroid. In order to limit the dose at the site boundary to 150 rem, taking into consideration the calculated release from the purge line, the limiting atmospheric dispersion factor would be 1.7×10^{-3} seconds per cubic meter.

To evaluate low population zone doses over the 30-day period following a postulated loss-of-coolant accident we used the median value five percent worst time dependent atmospheric dispersion factor values for 80 approved and proposed sites, calculated at a zone boundary distance of three kilometers. Using this value, the calculated doses for the 30-day period were 47 rem to the thyroid and 0.7 rem to the whole body. However, we have not evaluated the limiting dispersion characteristics for the BOPSSAR plant regarding potential offsite doses at the low population zone distance during the 30 day period following the postulated loss-of-coolant accident. These characteristics are determined by different dispersion factors for four consecutive time intervals during the 30 day period, such that the combination of these factors as a set rather than any individual factors for a particular time interval will establish the limiting characteristics. Based on comparisons with other plants that we have reviewed, we do not expect these meteorological conditions to be more limiting than the short term atmospheric dispersion factors.

15.2.3 Radioactive Waste Gas Decay Tank Rupture Accident

We calculated the radiological consequences of the total loss of the contents of one decay tank, assuming this loss to occur at the exact end of the filling cycle with no decay time. We assumed that the contents of the tank are 5.1×10^{4} Curies of xenon-133 equivalent. The resulting dose is listed in Table 15-1 of this report and was calculated to be less than one rem to the whole body.

15.2.4 Fuel Handling Accident

We evaluated the radiological consequences of a fuel handling accident in the fuel handling building using assumptions consistent with Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling

TABLE 15-2

ASSUMPTIONS AND INPUT PARAMETERS TO DETERMINE LIMITING ATMOSPHERIC DISPERSION FACTOR VALUE

Loss-of-Coolant Accident

Power Level	4100 megawatts thermal
Fraction of Core Inventory Available for Leakage	
Iodines	25 percent
Noble Gases	100 percent
Initial Iodine Composition in Containment	
Elemental	91 percent
Organic	4 percent
Particulate	5 percent
Containment Leak Rate	
0-24 hours	0.1 percent per day
24 hours - 30 days	.05 percent per day
Bypass Leakage	
0-2.5 minutes	0.1 percent per day
2.5 minutes - 24 hours	0.01 percent per day
Over 24 hours	0.005 percent per day
Containment Volume	96,000 cubic meters (86% sprayed)
Removal Coefficients	
Elemental Iodine	10 per hour
Particulate Iodine	0.5 per hour
Purge Line Release Direct to Environment	607 kilograms of primary coolant containing 36.4 Curies of Iodine-131 equivalent

Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors." We assumed that the accident occurred 20 hours after shutdown following a long period of operation at 4100 megawatts thermal power. The accident was assumed to involve 0.52 percent of the fuel with a power peaking factor of 1.65, such that 0.85 percent of the core fission product inventory was contained in the damaged fuel. The calculated doses are listed in Table 15-1 of this report.

With regard to a postulated fuel handling accident inside the reactor containment, Fluor Pioneer has provided the results of an analysis of the radiological consequences of such a postulated accident utilizing assumptions comparable to those given in Regulatory Guide 1.25. The analysis indicates that the calculated dose is a small fraction of the guideline values of 10 CFR Part 100. The analysis, however, assumes significant mixing in the containment atmosphere. We conservatively evaluated the potential for mixing in the containment atmosphere and, based on diffusion as the only means of mixing, determined that a significant fraction of the activity will be isolated. We conclude, therefore, that the doses resulting from a postulated fuel handling accident inside containment will be well within the guideline values of 10 CFR Part 100 and are acceptable.

15.2.5 Rod Ejection Accident

We evaluated the radiological consequences of a control rod ejection accident conservatively assuming all activity is released through the secondary system. The resulting dose and the assumptions used in this evaluation are presented in Tables 15-1 and 15-3 of this report, respectively. This evaluation cannot be compared directly to the limiting loss-of-coolant accident dose since limits on steam generator leakage rate will be established at the operating license stage. However, our analysis has demonstrated that the consequences of a rod ejection accident for the BOPSSAR design can be made acceptably low th... appropriate technical specifications developed for a site-specific application referencing BOPSSAR.

15.3 Anticipated Transients Without Scram

Fluor Pioneer did not directly address the matter of anticipated transients without scram in BOPSSAR. We concluded in Section 15.5.7 of our Safety Evaluation Report for RESAR-41 that because our generic review of this matter was not complete, it would be premature to require specific design changes to be made to RESAR-41. We also stated in RESAR-41 that we would require any design changes indicated to be needed by the results of approved analyses to be incorporated in a timely manner.

We still have not completed our review of this generic matter. Therefore we have defined the matter of anticipated transients without scram, insofar as it impacts the balance-of-plant design, as an interface matter and will require any changes that need be made on the basis of approved analyses to be incorporated into the

TABLE 15-3

ASSUMPTIONS USED IN DOSE ESTIMATE OF CONTROL ROD ASSEMBLY EJECTION ACCIDENT

(1) All assumptions listed in Appendix B to Regulatory Guide 1.77, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors."

(2) Reactor power = 4100 megawatts thermal.

(3) Steam generator operating pressure = 1100 pounds per square inch absolute.

(4) Maximum absolute set pressure for lowest set safety valves = 1350 pounds per square inch bsolute.

(5) Enough water storage is available to provide plant cooldown under blackout conditions when auxiliary feedwater pumps are operated.

(6) Auxiliary feedwater pumps are capable of pumping feedwater into the steam generators when the safety valves are discharging; these pumps start automatically and reach full flow within 60 seconds.

(7) Maximum auxiliary feedwater and safety injection water enthalpy = 80 British thermal units per pound mass.

(8) Minimum auxiliary feedwater flow rate = 500 gallons per minute.

(9) Secondary system piping design is capable of isolating flow to any secondary system pipe break.

(10) Primary coolant volume = 367 cubic meters.

(11) Steam generator secondary side volume = 162 cubic meters.

(12) Primary system operating conditions = 311 degrees Centigrade, 2235 pounds per square inch gauge.

(13) Ten percent of fuel cladding fails as a result of the accident.

(14) 0.25 percent of fuel melts as a result of the accident.

(15) Pressure is equalized between primary and secondary systems 40 minutes after accident.

(16) Steam generator leak rate = one gallon per minute.

BOPSSAR design in a timely manner. We will issue a Preliminary Design Approval for BOPSSAR on this basis. We conclude that this interface requirement provides an acceptable basis for a Preliminary Design Approval for the BOPSSAR design.

16.0 TECHNICAL SPECIFICATIONS

The technical specifications in an operating license define certain features, characteristics, and conditions governing operation of a facility that cannot be changed without prior approval of the Commission. Final technical specifications will be developed and evaluated at the final design review stage. However, in accordance with Paragraph 3 of Appendix O to 10 CFR Part 50, an application for a Preliminary Design Approval of a standard design is required to include preliminary technical specifications. The regulations require an identification and justification for the selection of those variables, conditions, or other items which are determined, as a result of the preliminary safety analysis and evaluation, to be probable subjects of technical specifications, with special attention given for those items which may significantly influence the final design.

We reviewed the proposed technical specifications presented in Section 16 of BOPSSAR in conjunction with our review of Sections 1 through 15 of BOPSSAR with the objective of identifying those items that would require special attention at the preliminary design review stage, to preclude the necessity for any significant change in design to support the final technical specifications.

On the basis of our review, we conclude that the proposed preliminary technical specifications are acceptable.

17.0 QUALITY ASSURANCE

17.1 General

Section 17 of BOPSSAR describes Fluor Pioneer's quality assurance program by reference to the latest approved version of Topical Report FPI-1, "Fluor Pioneer Inc. Quality Assurance Program", which presently is Topical Report FPI-1A, Revision 1. This program covers the design and procurement of safety-related balance-of-plant systems and components for nuclear power plants. Our evaluation of this quality assurance program is based on a review of the material provided in Topical Report FPI-1A, Revision 1, plus discussions and meetings with Fluor Pioneer to determine how its quality assurance program complies with the requirements of Appendix B to 10 CFR Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," and the applicable regulatory guides which are listed in Table 17.0.2-1 of Topical Report FPI-1A, Revision 1.

17.2 Organization

The Fluor Pioneer corporate organization is shown in Figure 17.1. The Vice-President, Engineering and Construction, is responsible for the establishment of quality assurance policies, goals, and objectives. Reporting directly to the Vice-President, Engineering and Construction is the Director of Quality Assurance/Quality Compliance. Figure 17.1 shows the Director of Quality Assurance/Quality Compliance to be free of prime responsibility for schedule and cost and to be on the same organizational level as those whose work he verifies. This results in a corporate organization structure where the quality assurance organization has adequate independence and reports at a sufficiently high management level to accomplish its objectives.

The Director of Quality Assurance/Quality Compliance directs and executes the program described in Topical Report FPI-1A, Revision 1. He is responsible for developing the quality assurance program and monitoring its implementation and effectiveness. The quality assurance program is approved by the Director of Quality Assurance/Quality Compliance with the concurrence of the Vice-President, Engineering and Construction. The program is implemented through quality assurance procedures, instructions, standards, specifications, and forms which provide the details of how each of the Appendix B criteria will be met. Within Fluor Pioneer, an internal policy statement signed by the President makes the requirements of quality assurance policies, procedures, and manuals mandatory on all personnel performing quality activities on safety-related equipment.

Fluor Pioneer is organized on a project basis as shown in Figure 17.1. The Quality Assurance/Quality Compliance Department implements its quality assurance functions

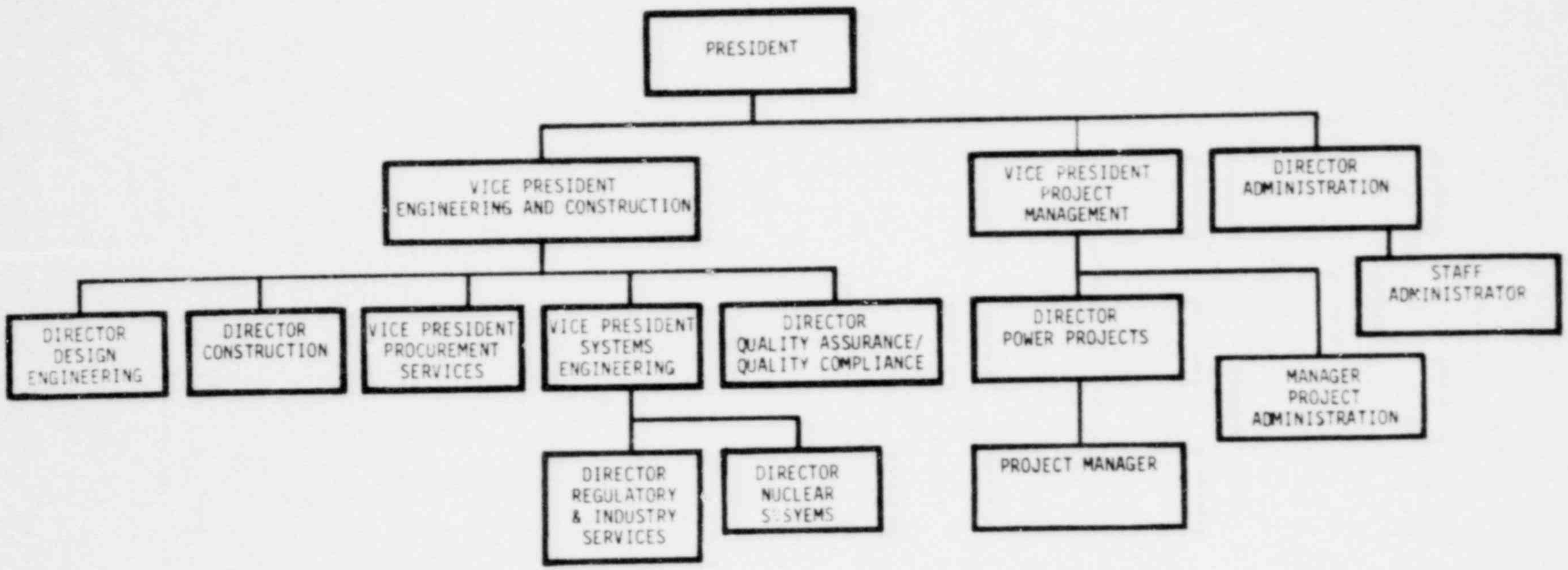


Figure 17.1 Fluor Pioneer Organization for Quality Assurance

through (1) a multiproject Quality Assurance/Quality Compliance Services Division supervised by a Quality Assurance/Quality Compliance Manager which handles those functions common to all projects and (2) project divisions assigned to a specific project supervised by a Project Quality Assurance Supervisor which handles all those quality assurance functions peculiar to a specific project. The quality assurance/quality compliance organization has the authority to identify quality problems, recommend or provide solutions through designated channels, and verify implementation of solutions. The Director of Quality Assurance/Quality Compliance, the Manager of Quality Assurance/Quality Compliance Services, and the individual Project Quality Assurance Supervisors for each project have stop work authority to prevent unsatisfactory work.

To assess the effectiveness of the quality assurance program, Fluor Pioneer performs planned periodic management audits. Team members, or third party consultants, are selected by the President in consultation with officers and department directors. In addition, significant nonconformance reports, audit reports, and associated corrective action reports, together with major supplier evaluations are forwarded to the Director of Quality Assurance/Quality Compliance and other management levels for review and appropriate action.

Our evaluation of the Fluor Pioneer quality assurance/quality compliance organization is that it is free of responsibility for schedule or cost; it is independent of the organization whose work it verifies; it has corporate level management involvement; it has clearly defined authorities and responsibilities; it is so organized that it can identify quality problems in the other organizations performing quality-related work; it can initiate, recommend, or provide solutions; it can verify implementation of solutions; and it can prevent further processing, shipment, installation, or utilization of nonconforming items until proper dispositioning has occurred. We conclude that the Fluor Pioneer quality assurance/quality compliance organization complies with the requirements of Appendix B to 10 CFR Part 50 and is, therefore, acceptable.

Topical Report FPI-1A, Revision 1 provides a listing of the documented company management guidelines and department procedures cross-indexed to the criteria of Appendix B to 10 CFR Part 50. These guidelines and department procedures are used to define and administer the quality assurance program and to coordinate the quality assurance activities of various departments within Fluor Pioneer that are responsible for engineering, procurement, project management, and services. Based on our review of this list, we conclude that each criterion of Appendix B to 10 CFR Part 50 has been addressed within Fluor Pioneer's documented guidelines and procedures.

Fluor Pioneer has committed to comply with the requirements of Appendix B to 10 CFR Part 50 and to implement the regulatory positions provided in Regulatory Guides 1.28, Revision 0 (6-72); 1.30, Revision 0 (8-72); 1.37, Revision 0 (3-73); 1.38, Revision 1 (10-76); 1.39, Revision 1 (10-76); 1.54, Revision 0 (6-73); 1.58, Revision 0 (8-73);

1.64, Revision 2 (6-76); 1.70.6, Revision 0 (7-74); 1.74, Revision 0 (2-74); 1.88, Revision 2 (10-76); 1.94, Revision 1 (4-76); 1.116, Revision 0 (6-76); 1.123, Revision 0 (10-76); and ANSI Standard N45.2.12, Draft 3, Revision 4 (2-74). We find this commitment and Fluor Pioneer's definition of its guidelines and procedures acceptable.

The structures, systems, and components comprising the safety items subject to BOPSSAR have been identified in BOPSSAR and will also be identified in the utility applicant's safety analysis report.

Fluor Pioneer will assure that its principal contractors and subcontractors have adequate quality assurance programs, that inspections will be performed to documented inspection instructions by qualified personnel, and that results will be recorded. Fluor Pioneer will assure by surveillance and audits that personnel performing inspections are free from undue cost and schedule pressures of the project.

Fluor Pioneer has established program requirements on itself and on its contractors which assure there will be a documented system of records attesting to quality.

Fluor Pioneer has developed a detailed indoctrination and training program to ensure that personnel performing quality-related activities are trained and qualified in the principles and techniques of the assigned activities and are instructed as to the purpose, scope, and implementation of quality-related manuals and procedures.

A system of planned and documented audits, described in Topical Report FPI-1A, Revision 1, will be used by Fluor Pioneer to verify compliance with all aspects of the quality assurance program and to assess the program's effectiveness. Audits will be conducted by appropriately trained quality assurance engineers of the Quality Assurance/Quality Compliance Department and may include, where appropriate, engineers of other disciplines, consultants, or other outside agencies. Audit results will be documented and reported to appropriate levels of management for corrective action. Responses to audit findings will be verified for implementation and effectiveness by follow-up audits.

Based on our review of the descriptions of the quality assurance program contained in Topical Report FPI-1A, Revision 1, we find procedures addressing each of the 18 criteria of Appendix B to 10 CFR Part 50, a commitment to our quality assurance guidance, assurance of an independent inspection program, an adequately defined training program, a documented system of records attesting to quality, an audit system to inform management of the effectiveness of the quality assurance program, management assessment of the quality assurance program, and an acceptable quality assurance program description.

17.3 Implementation of Quality Assurance Program

The Commission's Office of Inspection and Enforcement has conducted inspections to examine the implementation of the Fluor Pioneer quality assurance program commitments described in Fluor Pioneer's previous quality assurance topical report, Topical Report [illegible], which was previously reviewed by us and found to be acceptable and which does not differ significantly from Topical Report FPI-1A, Revision 1. Based on its inspections and assessment, the Office of Inspection and Enforcement concluded that the commitments described in Topical Report FPI-1 were being implemented by Fluor Pioneer. An inspection of the adequacy of the implementation of the commitments included in Topical Report FPI-1A, Revision 1, or latest approved version of Topical Report FPI-1 will be performed by the Office of Inspection and Enforcement when a utility applicant has contracted for the services provided by Fluor Pioneer associated with BOPSSAR.

17.4 Conclusion

We evaluated the Fluor Pioneer quality assurance program described in Topical Report FPI-1A, Revision 1. Based on our review, we conclude (1) that Fluor Pioneer has described an acceptable organization, (2) that its quality assurance program complies with Appendix B to 10 CFR Part 50 and applicable guides and standards, and (3) that its quality assurance program is acceptable for the design and procurement of the balance-of-plant portion of nuclear power plants.

18.0 REVIEW BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

During its 207th meeting on July 14-15, 1977, the Advisory Committee on Reactor Safeguards completed its review of Fluor Pioneer's application for a Preliminary Design Approval for its proposed BOPSSAR standard balance of plant. A copy of the Committee's report on BOPSSAR, dated July 20, 1977, which contains certain comments and recommendations, is included as Appendix D to this report. The actions we have taken or plan to take in response to the Committee's comments and recommendations are described in the following paragraphs.

(1) The Committee stated that the arrangement of BOPSSAR provides extensive physical separation of critical safety-related equipment to protect against common mode failures associated with fires or other operational contingencies. However, complete design details for BOPSSAR have not been developed and the concept has not yet been applied to a complete nuclear power plant design. Consequently, the Committee recommended that further review of the physical separation arrangement should be made prior to the Final Design Approval or when BOPSSAR is proposed for a nuclear power plant for which a construction permit is being sought.

We will review the detailed physical separation of critical safety-related equipment to protect against common mode failures associated with fires or other operational contingencies during the course of our review of the final design of BOPSSAR. During the course of our review of an application for a construction permit referencing BOPSSAR, we will review those matters concerning the physical separation of critical safety-related equipment within the utility applicant's scope of responsibility.

(2) The Committee stated its belief that the safety-related interface requirements between the BOPSSAR and RESAR-41 nuclear steam supply system designs, and between BOPSSAR and the custom-designed site-related structures and components, are satisfactory for a Preliminary Design Approval. However, the Committee recommended that we and the applicant examine these interface requirements in greater depth when a construction permit application is received.

During the course of our review of an application for a construction permit referencing BOPSSAR, we will review the safety-related interface requirements between the BOPSSAR and RESAR-41 nuclear steam supply system designs and between BOPSSAR and the custom-designed site-related structures and components. As discussed in Section 1.8 of this report, the utility applicant referencing the BOPSSAR/RESAR-41 design combination will be responsible for demonstrating that all portions of the design will be integrated in an entire nuclear power plant in an acceptable manner.

(3) The Committee stated its belief that the coordination of interdependent instrumentation and controls of the nuclear steam supply system and balance of plant will require attention at the time when BOPSSAR is used as a portion of a nuclear power plant license application. The Committee recommended that these matters be included in our Standard Review Plan.

During the course of our review of an application for a construction permit referencing BOPSSAR, we will review the coordination of interdependent instrumentation and controls of the nuclear steam supply system and balance of plant. We will consider the Committee's recommendation to include these matters in our Standard Review Plan and will inform the Committee of our decision.

(4) The Committee stated its belief that although BOPSSAR and RESAR-41 include provisions for protection against industrial sabotage, further steps can be taken beyond those provided. The Committee recommended that before a construction permit referencing BOPSSAR and RESAR-41 is issued for a nuclear power plant, the utility-applicant be required to demonstrate that acceptable provisions to preclude or to mitigate the consequences of industrial sabotage will be incorporated into the plant design.

As discussed in Section 13.0 of this report, during the course of our review of an application for a construction permit referencing BOPSSAR, we will review the utility applicant's plans, including design features, for providing protection against acts of industrial sabotage in accordance with the requirements of Section 73.55 of 10 CFR Part 73. In addition, we are considering the matter of design features to control sabotage on a generic basis. The status of our resolution of this matter is reported in our status report to the Advisory Committee on Reactor Safeguards dated January 31, 1977.

(5) The Committee noted that the BOPSSAR design includes some provisions which anticipate the maintenance, inspection, and operational needs of the plant throughout its service life, including cleaning and decontamination of the primary coolant system, and eventual decommissioning. However, the Committee stated its belief that when BOPSSAR is used as a portion of a nuclear power plant license application, we and the applicant should further review methods and procedures for removing accumulated contamination whereby maintenance and inspection programs and ultimate decommissioning can be more effectively and safely carried out.

We have transmitted the Committee's recommendations to Fluor Pioneer for its consideration in proceeding with the BOPSSAR design. We are considering the matters of maintenance and inspection of plants and decontamination and decommissioning of reactors on a generic basis. The status of our resolution of these matters is reported in our status report to the Advisory Committee on Reactor Safeguards dated January 31, 1977.

(6) The Committee noted that generic problems related to large water reactors are discussed in the Committee's report dated February 24, 1977. The Committee recommended that those problems relevant to BOPSSAR and RESAR-41 be dealt with appropriately by us and the utility applicant as solutions are found.

We have transmitted the Committee's recommendations to Fluor Pioneer for its consideration in proceeding with the BOPSSAR design. The status of our resolution of these matters as they pertain to BOPSSAR are discussed in Appendix C to this report. We plan to deal with these generic matters as appropriate as solutions are found.

19.0 CONCLUSIONS

Based on our evaluation of the proposed BOPSSAR standard balance-of-plant design we conclude that:

(1) Fluor Pioneer has described, analyzed, and evaluated the proposed BOPSSAR design including, but not limited to, the principal architectural and engineering criteria for the design; the interface information necessary to assure compatibility between the submitted BOPSSAR standard balance-of-plant design and (a) a RESAR-41 standard nuclear steam supply design and (b) the site and utility applicant related design aspects; the envelope of site parameters postulated for the design; the quality assurance program to be applied to the design, procurement, and fabrication of safety-related features of the BOPSSAR design; the design features that affect plans for coping with emergencies in the operation of the reactor or major portion thereof; and has identified the major features and components incorporated therein for the protection of the health and safety of the public.

(2) Such further technical or design information as may be required to complete the safety analysis will be supplied prior to or in the final design application, or in a future utility applicant's application for a construction permit referencing the BOPSSAR design.

(3) On the basis of the foregoing, there is reasonable assurance that: (a) safety questions will be satisfactorily resolved at or before the issuance of the operating license for the first nuclear power plant utilizing the BOPSSAR design; and (b) taking into consideration the site criteria contained in 10 CFR Part 100, a facility can be constructed and operated without undue risk to the health and safety of the public provided the site characteristics conform to the site parameters specified in BOPSSAR as discussed above, and otherwise conform to the 10 CFR Part 100 requirements, and provided further that the site and utility applicant related systems of the nuclear power plant are properly designed and constructed in conformity with the interface requirements specified in BOPSSAR and in this report, as discussed above.

(4) Fluor Pioneer is technically qualified to design the proposed BOPSSAR standard balance-of-plant.

APPENDIX A

CHRONOLOGY OF REVIEW OF BALANCE-OF-PLANT STANDARD SAFETY ANALYSIS REPORT BOPSSAR

DOCKET NO. STN 50-560

Note: Documents referenced in this chronology are available for public inspection and copying for a fee at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C.

February 6, 1975	Meeting with Fluor Pioneer to discuss the general form and content of the proposed submittal of BOPSSAR and the role that topical reports will have regarding this submittal.
February 18, 1975	Meeting with Fluor Pioneer to discuss the extent that detailed drawings will be required in BOPSSAR to satisfy our information requirements regarding the turbine hall systems and associated interfaces.
March 21, 1975	Meeting with Fluor Pioneer to discuss seismic design analysis for BOPSSAR.
May 19, 1975	Letter to Fluor Pioneer transmitting the seismic design requirements for radioactive waste management systems and structures housing these systems.
July 18, 1975	Letter from Fluor Pioneer announcing its plan to submit an application under the Commission's standardization policy for a standard balance-of-plant design on November 17, 1975.
September 3, 1975	Meeting with Fluor Pioneer to discuss the proposed submittal of BOPSSAR on November 17, 1975.
September 17, 1975	Meeting with Fluor Pioneer to discuss seismic design analysis.
September 19, 1975	Meeting with Flour Pioneer to discuss procedures for the review and inspection of the quality assurance program.

October 1, 1975	Meeting with Fluor Pioneer to discuss the proposed submittal of a topical report on quality assurance that will be referenced in BOPSSAR.
November 17, 1975	Submittal of the BOPSSAR application for acceptance review.
December 18, 1975	Meeting with Fluor Pioneer to discuss the results of our acceptance review of the BOPSSAR application.
January 19, 1976	Meeting with Fluor Pioneer to discuss seismic design criteria and tornado missile protection criteria.
January 20, 1976	Submittal of balance of information required to complete the BOPSSAR application.
January 22, 1976	Letter to Fluor Pioneer advising that BOPSSAR is acceptable for docketing.
January 26, 1976	Submittal of the required number of copies of BOPSSAR incorporating the additional information for docketing.
January 27, 1976	Application for a Preliminary Design Approval for BOPSSAR was docketed and assigned Docket No. STN 50-560.
February 19, 1976	Letter to Fluor Pioneer advising that the quality assurance program described in the topical report that is referenced in BOPSSAR is acceptable.
February 27, 1976	Submittal of Amendment No. 1 to BOPSSAR in response to request for information developed during the acceptance review.
March 22, 1976	Letter to Fluor Pioneer advising of the establishment of the review schedule for BOPSSAR.
April 9, 1976	Letter to Fluor Pioneer transmitting first round request for additional information.
April 15, 1976	Letter to Fluor Pioneer transmitting the balance of first round request for additional information.
April 28, 1976	Meeting with Fluor Pioneer to discuss first round request for additional information related to containment systems.
May 3, 1976	Letter to Fluor Pioneer transmitting a copy of revised Standard Review Plan Section 9.5.1.

May 20, 1976	Submittal of Amendment No. 2 to BOPSSAR in response to our first round request for information in our letter dated April 9, 1976.
May 27, 1976	Submittal of Amendment No. 3 to BOPSSAR in response to our first round request for information in our letter dated April 15, 1976.
May 27, 1976	Letter to Fluor Pioneer requesting information related to the design of the emergency core cooling system and the interfaces with the nuclear steam supply system.
June 18, 1976	Submittal of Amendment No. 4 to BOPSSAR containing information on fire protection system.
June 21, 1976	Meeting with Fluor Pioneer to discuss implementation of the quality assurance program.
July 1, 1976	Submittal of Amendment No. 5 to BOPSSAR containing information related to radioactive waste management systems internal missiles, and interfaces with the nuclear steam supply systems as requested in our letter of May 27, 1976.
July 30, 1976	Letter to Fluor Pioneer transmitting second round request for information and staff positions.
August 12, 1976	Meeting with Fluor Pioneer to discuss second round request for information and staff positions.
August 13, 1976	Letter to Fluor Pioneer transmitting the balance of second round request for information and staff positions.
August 19, 1976	Meeting with Fluor Pioneer to discuss fire protection and containment functional design.
August 27, 1976	Meeting with Fluor Pioneer to discuss fire protection and electrical, instrumentation, and control systems design.
September 15, 1976	Submittal of Amendment No. 6 to BOPSSAR in response to our second round request for information and staff positions in our letters dated July 30, 1976 and August 13, 1976.
September 30, 1976	Letter to Fluor Pioneer transmitting Appendix A to Branch Technical Position 9.5-1 and requesting a reevaluation of the fire protection program for BOPSSAR.

September 30, 1976	Submittal of Amendment No. 7 to BOPSSAR containing information related to containment purging and other items of clarification.
October 25, 1976	Letter from Fluor Pioneer in response to our request for reevaluation of fire protection program in our letter dated September 30, 1976.
December 10, 1976	Meeting with Fluor Pioneer to discuss fire protection.
December 21, 1976	Meeting with Fluor Pioneer to discuss containment functional design and containment purging during plant operation.
January 12, 1977	Letter from Fluor Pioneer summarizing proposed changes to the BOPSSAR design regarding fire protection.
January 21, 1977	Letter to Fluor Pioneer concerning the status of review of outstanding issues.
February 3, 1977	Letter to Fluor Pioneer regarding the classification of structures and components.
February 9, 1977	Submittal of Amendment No. 8 to BOPSSAR containing information in response to our letter of January 21, 1977.
March 8, 1977	Letter to Fluor Pioneer regarding outstanding issues addressed in Amendment No. 8 to BOPSSAR.
March 22, 1977	Letter from Fluor Pioneer containing information to supplement Amendment No. 8 to BOPSSAR.
March 23, 1977	Letter to Fluor Pioneer regarding the updating of BOPSSAR for Regulatory Guides.
March 29, 1977	Meeting with Fluor Pioneer to discuss structural engineering design.
March 30, 1977	Letter to Fluor Pioneer requesting additional information on outstanding issues.
April 5, 1977	Letter from Fluor Pioneer regarding the updating of BOPSSAR for Regulatory Guides.
April 7, 1977	Letter to Fluor Pioneer concerning changes to the review schedule for BOPSSAR.
April 20, 1977	Submittal of Amendment 9 to BOPSSAR containing information previously submitted by letters dated March 22 and April 5, 1977, and information requested by our letter dated March 30, 1977.

May 20, 1977	Submittal of Amendment 10 to BOPSSAR containing information related to the automobile missile impact analysis and seismic analysis.
May 24, 1977	Letter to Fluor Pioneer requesting information related to a postulated fuel handling accident inside containment.
June 2, 1977	Letter from Fluor Pioneer regarding design basis flood levels.
June 3, 1977	Issuance of Report to the Advisory Committee on Reactor Safeguards.
June 14, 1977	Letter to Fluor Pioneer advising that the revised quality assurance program described in Topical Report FPI-1A, Revision 1 is acceptable.
June 14, 1977	Meeting with Fluor Pioneer on outstanding issues on BOPSSAR.
June 28, 1977	Meeting with the Advisory Committee on Reactor Safeguards Subcommittee on BOPSSAR.
July 5, 1977	Letter to the Advisory Committee on Reactor Safeguards and Fluor Pioneer regarding corrections to the Report to the Advisory Committee on Reactor Safeguards.
July 14, 1977	Meeting with the Advisory Committee on Reactor Safeguards on BOPSSAR.
July 20, 1977	Report by the Advisory Committee on Reactor Safeguards on BOPSSAR issued.
July 26, 1977	Meeting with Fluor Pioneer on outstanding issues identified in the Report to the Advisory Committee on Reactor Safeguards.
July 26, 1977	Submittal of Amendment 11 to BOPSSAR containing information concerning the design bases for the ultimate heat sink, flood, and reactor cavity pressure.
July 27, 1977	Submittal of Amendment 12 to BOPSSAR identifying those pages in BOPSSAR that pertain specifically to RESAR-41.
August 2, 1977	Submittal of Amendment 13 to BOPSSAR containing information related to the outstanding issues identified in the Report to the Advisory Committee on Reactor Safeguards.
August 4, 1977	Submittal of Amendment 14 to BOPSSAR containing information related to reactor coolant pump operation without component cooling water.

APPENDIX B

BIBLIOGRAPHY

NOTE: Documents referenced in or used to prepare this report, excluding those listed in BOPSSAR, may be obtained at the source stated in the Bibliography or, where no specific source is given, at most major public libraries. Documents submitted by the applicant and the Commission's Rules and Regulations and Regulatory Guides may be inspected and copied for a fee at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C. Specific documents relied upon by the Commission's staff and referenced in this report are as follows:

STRUCTURAL ENGINEERING

(1) American Institute of Steel Construction, "Specification for Design, Fabrication and Erection of Structural Steel Buildings," Sixth Edition, 1969, 101 Park Avenue, New York, New York.

(2) American Concrete Institute, "Building Code Requirements for Reinforced Concrete," ACI 318-1971, P.O. Box 4754, Redford Station, Detroit, Michigan.

(3) American National Standards Institute, "American National Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," A58.1, 1972.

(4) "Wind Forces on Structures," Final Report of the Task Committee on Wind Forces of the Committee on Load and Stresses of the Structural Division, Transactions of the American Society of Civil Engineers, 345 East 47th Street, New York, New York.

(5) Williamson, R. A., and Alvy, R. R., "Impact Effects of Fragments Striking Structural Elements," Holmes and Narver, Revised Edition, 1973.

(6) American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, Division 1, and Addenda, United Engineering Center, 345 East 47th Street, New York, New York.

MATERIALS ENGINEERING

(7) American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, 1974 Edition including Addenda through Summer 1974, Paragraphs NB-2121 and NB-2122, United Engineering Center, 345 East 47th Street, New York, New York.

(8) American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section II, 1974 Edition including Addenda through Summer 1974, United Engineering Center, 345 East 47th Street, New York, New York.

(9) American Society of Mechanical Engineers, "Protection Against Non-Ductile Failure," ASME Boiler and Pressure Vessel Code, Section III, 1974 Edition including Addenda through Summer 1974, including Appendix G, United Engineering Center, 345 East 47th Street, New York, New York.

(10) American Society of Mechanical Engineers, "Methods and Definitions for Mechanical Testing of Steel Products," ASME Specification SA 370-71b, 1974 Edition including Addenda through Summer 1974, Section II, Part A - Ferrous, United Engineering Center, 345 East 47th Street, New York, New York.

(11) American Society for Testing Materials, "Notched Bar Impact Testing of Metallic Materials," ASTM E 23-73, Annual Book of ASTM Standards, Part 31, 1916 Race Street, Philadelphia, Pennsylvania, July 1973.

(12) American Society for Testing Materials, "Standard Method for Conducting Dropweight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels," ASTM E 208-69, Annual Book of ASTM Standards, Part 31, 1916 Race Street, Philadelphia, Pennsylvania, July 1973.

(13) American Society for Testing Materials, "Copper-Copper Sulfate-Sulfuric Acid Test for Detecting Susceptibility to Intergranular Attack in Stainless Steels," ASTM A 262-70, Annual Book of ASTM Standards, Part 3, 1916 Race Street, Philadelphia, Pennsylvania, April 1973.

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(15) American National Standards Institute, "Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants," ANSI N45.2.1-1973, Draft 2, Revision 0, November 1973.

(16) American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section XI, 1974 Edition, United Engineering Center, 345 East 47th Street, New York, New York.

ELECTRICAL INSTRUMENTATION AND CONTROL SYSTEMS

(17) Standards of the Institute of Electrical and Electronic Engineers, United Engineering Center, 345 East 47th Street, New York, New York:

(a) IEEE Standard 279-1971 - "Criteria for Protection Systems for Nuclear Power Generating Stations."

(b) IEEE Standard 308-1974 - "Criteria for Class IE Electric Systems for Nuclear Power Generating Stations."

(c) IEEE Standard 317-1972 - "Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations."

(d) IEEE Standard 323-1974 - "IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations."

(e) IEEE Standard 334-1974 - "Type Test of Continuous Duty Class IE Motors for Nuclear Power Generating Stations."

(f) IEEE Standard 336-1971 - "Installation, Inspection and Testing Requirements for Instrumentation and Electric Equipment During the Construction of Nuclear Power Generating Stations."

(g) IEEE Standard 338-1971 - "Trial-Use Criteria for the Periodic Testing of Nuclear Power Generating Station Protection Systems."

(h) IEEE Standard 344-1975 - "Seismic Qualification of Class I Electrical Equipment for Nuclear Power Generating Stations."

(i) IEEE Standard 379-1972 - "Trial-Use Guide for Application of the Single Failure Criterion to Nuclear Power Generating Stations Protection Systems."

(j) IEEE Standard 382-1972 - "Trial-Use Guide for Type Test of Class I Electric Valve Operators for Nuclear Power Generating Stations."

(k) IEEE Standard 383-1974 - "Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations."

(l) IEEE Standard 384-1974 - "Trial-Use Standard: Criteria for Separation of Class IE Equipment and Circuits."

(m) IEEE Standard 387-1972 - "Trial-Use Standard: Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations."

(n) IEEE Standard 450-1972 - "Recommended Practice for Maintenance, Testing, and Replacement of Large Stationary Type Power Plant and Substation Lead Storage Batteries."

SITE CHARACTERISTICS

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(26) American National Standards Institute, "Power Piping," ANSI B31.1-1973.

(27) American Petroleum Institute, "Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks," API Standard 620, Fifth Edition, 1973.

(28) American Petroleum Institute, "Welded Steel Tanks for Oil Storage," API Standard 650, Fifth Edition, 1973.

(29) American Water Works Association, "AWWA Standard for Steel Tanks - Standpipes, Reservoirs, and Elevated Tanks for Water Storage," AWWA D100-73, 1973.

(30) American National Standards Institute, "Specification for Welded Aluminum-Alloy Field-Erected Storage Tanks," ANSI B96.1-1973, 1973.

APPENDIX C

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS GENERIC ITEMS

The Advisory Committee on Reactor Safeguards periodically issues a report listing various generic matters applicable to large light-water reactors. These are items which the Committee and the Commission's staff, while finding present plant designs acceptable, believe have the potential of adding to the overall safety margin of nuclear power plants, and as such should be considered for application to the extent reasonable and practicable as solutions are found, recognizing that such solutions may occur after completion of the plant. This is consistent with our continuing efforts toward reducing still further the already small risk to the public health and safety for nuclear power plants. The most recent such report concerning these generic items was issued on February 24, 1977.

The status of staff efforts leading to resolution of all these generic matters is contained in our status report on generic items periodically transmitted to the Committee. The latest such status report is contained in a letter dated January 31, 1977.

For many of the items, we have provided in this report specific discussions particularizing for the proposed facility the generic status in our status report. These items are listed below with the appropriate section numbers of this report where such discussions are to be found. The numbering corresponds to that in the February 24, 1977 report of Committee.

For those items applicable to the proposed facility which have not progressed to where specific action can be initiated relevant to individual plants, our status report on generic items referred to above provides the appropriate information.

Group II - Resolution Pending

(1) Turbine Missiles. Resolved for BOPSSAR by turbine orientation for a single-unit facility. For a multi-unit facility, the matter will be addressed in utility applicant's safety analysis report (Section 3.5.1).

(2) Effective Operation of Containment Sprays in a LOCA. Resolved for BOPSSAR by use of sodium hydroxide additive to sprays (Section 6.2.4).

(3) Possible Failure of Pressure Vessel Post-LOCA by Thermal Shock. This item is within the scope of RESAR-41 and is not within the scope of BOPSSAR.

(4) Instruments to Detect (Severe) Fuel Failures. This item is not within the scope of BOPSSAR, but is within the scope of RESAR-41.

(5) Monitoring for Excessive Vibration or Loose Parts Inside the Pressure Vessel. This item is resolved for BOPSSAR by proposed installation of loose parts monitor (Section 5.3).

(6) Non-Random Multiple Failures. This item is under generic review as indicated in our status report to ACRS dated January 31, 1977.

(7) Behavior of Reactor Fuel Under Abnormal Conditions. This item is not within the scope of BOPSSAR but is within the scope of RESAR-41.

(8) BWR Recirculation Pump Overspeed During LOCA. This item is not applicable to BOPSSAR which will be a pressurized water reactor facility.

(9) The Advisability of Seismic Scram. A seismic scram is not proposed for BOPSSAR and the NRC will not require such a scram.

(10) Emergency Core Cooling System Capability for Future Plants. This item is not within the scope of BOPSSAR but is within the scope of RESAR-41.

Group IIA Resolution Pending - Items Since December 18, 1972

(1) Control Rod Drop Accident (BWR's). This item is not applicable to BOPSSAR which will be a pressurized water reactor facility.

(2) Ice Condenser Containments. This item is not applicable to BOPSSAR which will not utilize an ice condenser containment.

(3) Rupture of High Pressure Lines Outside Containment. This item is resolved for BOPSSAR by compliance with criteria specified in the Standard Review Plan (Section 3.6.2).

(4) PWR Pump Overspeed During a LOCA. This item is not within the scope of BOPSSAR but is within the scope of RESAR-41.

(5) Isolation of Low Pressure from High Pressure Systems. This item is resolved for BOPSSAR by compliance with interface requirements for RESAR-41 (Section 7.6.3).

(6) Steam Generator Tube Leakage. This item is not within the scope of BOPSSAR, but is within the scope of RESAR-41 and the utility applicant's scope for inservice inspection.

(7) ACRS/NRC Periodic 10-Year Review of All Power Reactors. This item is under generic review as indicated in our status report to ACRS dated January 31, 1977.

Group IIB Resolution Pending - Items Added Since February 13, 1974

(1) Computer Reactor Protection System. This item is not applicable to BOPSSAR but would be within the scope of the nuclear steam system supplier.

(2) Qualification of New Fuel Geometries. This item is not within the scope of BOPSSAR but is within the scope of RESAR-41.

(3) Behavior of BWR Mark III Containments. This item is not applicable to BOPSSAR which will be a pressurized water reactor facility.

(4) Stress Corrosion Cracking in BWR Piping. This item is not applicable to BOPSSAR which will be a pressurized water reactor facility.

Group IIC Resolution Pending - Items Added Since March 12, 1975

(1) Locking Out of ECCS Power Operated Valves. This item is resolved for BOPSSAR by compliance with interface requirements of RESAR-41 (Section 7.3.3).

(2) Design Features to Control Sabotage. This item is resolved for BOPSSAR by compliance with current NRC staff requirements (Section 13.0).

(3) Decontamination and Decommissioning of Reactors. This item is under generic review as indicated in our status report to ACRS dated January 13, 1977.

(4) Vessel Support Structures. This item will be addressed by the utility applicant referencing BOPSSAR (Section 6.2.1).

(5) Water Hammer. This item is under generic review as indicated in our status report to the ACRS dated January 31, 1977 and as indicated in Section 10.7 of this report.

(6) Maintenance and Inspection of Plants. This item is resolved for BOPSSAR by compliance with current NRC requirements (Section 12.0).

(7) Behavior of BWR Mark I Containments. This item is not applicable to BOPSSAR which will be a pressurized water reactor facility.

Group IID Resolution Pending - Items Added Since April 16, 1976

(1) Safety-Related Interfaces Between Reactor Island and Balance-of-Plant. This item is resolved for BOPSSAR (Section 1.8). Items that require further information are discussed in Section 1.5 of this report.

(2) Assurance of Continuous Long-Term Capability of Hermetic Seals on Instrumentation and Electrical Equipment. This item is not addressed in BOPSSAR or in this report except as a general requirement for environmental qualification of equipment (Section 7.6.1).

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

July 20, 1977

United States Nuclear
Regulatory Commission
Washington, DC 20555

SUBJECT: REPORT ON THE FLUOR PIONEER, INC. BALANCE OF PLANT STANDARD SAFETY ANALYSIS REPORT (BOPSSAR) AS APPLIED TO THE WESTINGHOUSE ELECTRIC CORPORATION RESAR-41 NSSS DESIGN

Dear Commissioners:

During its 207th meeting, July 14-15, 1977, the Advisory Committee on Reactor Safeguards completed its review of the application of Fluor Pioneer, Inc. for Preliminary Design Approval of its BOPSSAR, a standardized nuclear balance of plant (BOP) design that would interface with a single unit Westinghouse Electric Corporation, RESAR-41 pressurized-water reactor nuclear steam supply system (NSSS). A review of the RESAR-41 design was completed at the 185th meeting of the Committee and was discussed in its report of September 18, 1975. A Subcommittee meeting was held with representatives of Fluor Pioneer, Inc. and the Nuclear Regulatory Commission (NRC) Staff in Washington, DC on June 28, 1977. During its review the Committee had the benefit of discussions with the Applicant and the NRC Staff and of the documents listed.

The arrangement of BOPSSAR provides extensive physical separation of critical safety-related equipment to protect against common mode failures associated with fires or other operational contingencies. However, complete design details for BOPSSAR have not been developed and the concept has not yet been applied to a complete nuclear power plant design. Consequently, further review of the physical separation arrangement should be made prior to the Final Design Approval or when BOPSSAR is proposed for a nuclear power plant for which a construction permit is being sought.

The Committee believes that the safety-related interface requirements between BOPSSAR and RESAR-41 NSSS designs, and between BOPSSAR and the custom-designed site-related structures and components, are satisfactory for a Preliminary Design Approval, but expects the NRC Staff and the Applicant to examine them in greater depth when a construction permit application is received.

The coordination of interdependent instrumentation and controls of the NSSS and BOP will require attention at the time when BOPSSAR is used as a portion of a nuclear power plant license application. The Committee recommends that these matters be included in the NRC Staff's Standard Review Plan.

Although BOPSSAR and RESAR-41 include provisions for protection against industrial sabotage, the Committee believes that further steps can be taken beyond those provided. Before a construction permit referencing BOPSSAR and RESAR-41 is issued for a nuclear power plant, the Utility-Applicant should be required to demonstrate that acceptable provisions to preclude or to mitigate the consequences of industrial sabotage will be incorporated into the plant design.

The BOPSSAR design includes some provisions which anticipate the maintenance, inspection, and operational needs of the plant throughout its service life, including cleaning and decontamination of the primary coolant system, and eventual decommissioning. However, when BOPSSAR is used as a portion of a nuclear power plant license application the Committee believes that the NRC Staff and the Applicant should further review methods and procedures for removing accumulated contamination whereby maintenance and inspection programs and ultimate decommissioning can be more effectively and safely carried out.

Generic problems related to large water reactors are discussed in the Committee's report dated February 24, 1977. Those problems relevant to BOPSSAR and RESAR-41 should be dealt with appropriately by the NRC Staff and the Utility-Applicant as solutions are found.

The Advisory Committee on Reactor Safeguards believes that the items mentioned above should be given further consideration during the plant licensing process and that, if due consideration is given to the foregoing, Preliminary Design Approval of BOPSSAR for use in conjunction with RESAR-41 can be granted in accord with the spirit and purposes set forth in the Commission's policy statement on standardization of nuclear power plants.

Sincerely yours,

M. Bender

M. Bender
Chairman

References

1. Fluor Pioneer, Inc. Balance of Plant Standard Safety Analysis Report, BOPSSAR, Volumes 1 through 8 and Amendments 1 through 10
2. Report to the Advisory Committee on Reactor Safeguards in the Matter of Fluor Pioneer, Inc. Balance of Plant Standard Safety Analysis Report June 3, 1977 by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation

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