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REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 3.44
(Task CE 403-4)

STANDARD FORMAT AND CONTENT FOR THE SAFETY ANALYSIS REPORT FOR AN INDEPENDENT SPENT FUEL STORAGE INSTALLATION (WATER-BASIN TYPE)

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INTRODUCTION

Section 72.24, "Contents of Application: Technical Information," of 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste," states that each application for a license under this part must include a safety analysis report (SAR). The minimum information to be included in the SAR is specified in § 72.24, but the format is not. This regulatory guide provides guidance on preparing an SAR, and the NRC staff recommends its use for preparing and presenting the required information.

There are important functional differences between the storage of aged spent fuels and other types of licensed activities. As a result, the safety features for spent fuel storage in an independent spent fuel storage installation (ISFSI) will be different from those required for a fuel reprocessing plant and even more different from those required for a nuclear power plant. The applicant should develop the safety assessment of the design bases of an ISFSI in a manner consistent with the safety considerations applicable to such installations. To obtain guidance on the detail and depth of analysis required, the applicant is invited to confer with the NRC staff prior to preparing the SAR.

This guide presents a Standard Format acceptable to the NRC staff for the SAR required for the license application. Conformance with this Standard Format, however, is not mandatory. License applications with different SAR formats will be acceptable to the staff if they provide an adequate basis for the findings required for the issuance of a license. However, because it may be more difficult to locate needed information, staff review time may be longer, and there is a greater likelihood that the NRC staff may regard the report as incomplete.

This regulatory guide is concerned with spent fuel stored in a water basin at an ISFSI. Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation (Dry Storage)," provides guidance for preparing the SAR for a dry-type ISFSI. Both Regulatory Guides 3.48 and this guide were developed for a "stand-alone" type installation, one not collocated with another nuclear facility. Regulatory Guide 3.62, "Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks," provides guidance for dry cask storage at an ISFSI that is collocated at another nuclear facility; it recommends extensive cross-referencing to the facility's docketed final safety analysis report to minimize duplication of information. This regulatory guide could also be used for developing the SAR for collocated facilities; however, modification of the format and content would be required.

Any information collection activities mentioned in this regulatory guide are contained as requirements in 10 CFR Part 72, which provides the regulatory basis for this guide. The information collection requirements in 10 CFR Part 72 have been cleared under OMB Clearance No. 3150-0132.

PURPOSE, APPLICABILITY, AND USE OF THIS STANDARD FORMAT

This Standard Format has been prepared to identify for applicants the type of information needed in the SAR to facilitate an orderly review. The information identified herein represents the minimum that should be provided. Not all areas identified in this guide may be applicable to a specific ISFSI. If an area is not applicable, a statement to this effect is sufficient.

The SAR serves as the principal technical communication between the applicant and the NRC. It documents the nature of the ISFSI and the plans for its use. Each applicant should provide in the SAR information that will enable the NRC staff to determine that, for the operations to be performed, the operating procedures, the plant and equipment, and the applicant's capability collectively provide reasonable assurance of protection of the health and safety of the public and operating personnel.

Additional information may be requested if needed for the NRC staff review. If any changes in the installation design are made after the submittal of the SAR and prior to the issuance of a license, the SAR must be updated. The completed SAR must reflect the actual plans for the installation.

In the SAR, the applicant should analyze the installation in terms of potential hazards and the means employed to protect against these hazards, including the associated margins of safety. This includes evaluating:

1. The site and its vulnerability to accidents from natural phenomena

2. Radiation shielding

3. Confinement and control of radioactive materials

4. The projected quantities and concentration of radioactive materials in effluents

5. The treatment of effluents containing radioactive materials

6. Reliability of the systems that are important to safety

7. The radiological impact associated with normal operations, off-normal conditions, and accidents.

The SAR should demonstrate the degree of skill, care, and effort used by the applicant in planning all aspects of the project. The applicant may elect to provide in-depth analyses of some subjects in supplemental reports, which are then incorporated in the SAR by reference.

The SAR should set forth a description (including all pertinent technical information) and safety assessment of the design bases of the principal structures, systems, and components of the installation in sufficient detail that the staff can make an independent determination that there is reasonable assurance that safe operation will be achieved. A safety analysis of the offsite shipping casks used to transport the spent fuel to and from the ISFSI is not required, but the SAR should include an analysis of the shipping and receiving facilities. A detailed description of the quality assurance program associated with the design and construction activities, including identification of the components, systems, and structures to which it will be applied, is required.

A detailed presentation on the conduct of operations should be included in the SAR covering

1. Preoperational testing
2. Startup and normal operation
3. Emergency plans
4. Organizational structure
5. Personnel qualifications
6. Operator training
7. Quality assurance (including operations)
8. Management and administrative policies, procedures, and controls
9. Proposed license conditions, including technical specifications
10. Decommissioning plan.

SUPPLEMENTAL INFORMATION

Because of the diversity of design possibilities for spent fuel storage installations, the age of the fuels to be stored, and the required storage conditions, the applicant may wish to include appendices to the SAR to provide detailed supplemental information not explicitly identified in this Standard Format. The following are examples:

a. Supplementary information regarding assumed analytical models, calculational methods, or design alternatives used by the applicant or its agents with particular emphasis on rationale and detailed examples used to develop the bases for criticality safety,

b. Technical information in support of new or novel design features of the installation, and

c. Reports furnished to the applicant by consultants.

PROPRIETARY INFORMATION

Proprietary information should be submitted separately. When submitted, it should be clearly identified and accompanied with the applicant's detailed reasons and justifications for requesting its being withheld from public disclosure, as specified by § 2.790, "Public Inspections, Exemptions, Requests for Withholding," of 10 CFR Part 2, "Rules of Practice for Domestic Licensing Proceedings."

STYLE AND COMPOSITION

The applicant should strive for clear, concise presentation of the information provided in the SAR.

The SAR should follow the numbering systems of this Standard Format at least down to the level of subsections, e.g., 4.2.2 Installation Layout.

References, including author, date, and page number, should be cited within the text if this is important to the meaning of the statement. References used should appear either as footnotes to the page where referenced or at the end of each chapter.

A table of contents and an index of key items should be included in each volume of the SAR.

When numerical values are stated, the number of significant figures given should reflect the accuracy or precision to which the number is known. If appropriate, estimated limits of errors or uncertainty should be given.

Abbreviations should be consistent throughout the SAR and should be consistent with generally accepted usage. Any abbreviations, symbols, or special terms not in general use or unique to the proposed installation should be defined when they first appear in the SAR. NUREG-0544, "A Handbook of Acronyms and Initialisms," may be useful.

Graphic presentations such as drawings, maps, diagrams, sketches, and tables should be employed when the information may be presented more adequately or conveniently by such means. Due concern should be taken to ensure that all information so presented is legible, that symbols are defined, and that drawings are not reduced to the extent that visual aids are necessary to interpret pertinent items of information. These graphic presentations should be located with the section in which they are primarily referenced.

PHYSICAL SPECIFICATIONS

Paper size

1. Text pages: 8-1/2 x 11 inches.
2. Drawings and graphics: 8-1/2 x 11 inches is preferred; however, a larger size is acceptable provided the finished copy when folded does not exceed 8-1/2 x 11 inches.

Paper stock and ink. Suitable quality in substance, paper color, and ink density for handling and reproduction by microfilming or image-copying equipment.

Page margins. A margin of no less than 1 inch should be maintained on the top, bottom, and binding side of all pages submitted.

Printing

1. Composition: Text pages should be single spaced.
2. Type face and style: Should be suitable for microfilming or image-copying equipment.
3. Reproduction: May be mechanically or photographically reproduced. All pages of text should be printed on both sides with image printed head to head.

Binding. Pages should be punched for standard 3-hole loose-leaf binders.

Page numbering. Pages should be numbered with the two digits corresponding to the chapter and first-level section numbers followed by a hyphen and a sequential number within the section, i.e., the third page in Section 4.1 of Chapter 4 should be numbered 4.1-3. Do not number the entire report sequentially. (Note that because of the small number of pages in many sections, this Standard Format is numbered sequentially within each chapter.)

PROCEDURES FOR UPDATING OR REVISING PAGES

Data and text should be updated or revised by replacing pages. "Pen and ink" or "cut and paste" changes should not be used. The changed or revised portion on each page should be highlighted by a "change indicator" mark consisting of a bold vertical line drawn in the margin opposite the binding margin. The line should be the same length as the portion actually changed.

All pages submitted to update, revise, or add pages to the report should show the date of change and a change or amendment number in the lower right-hand corner. A guide page listing the pages to be inserted and the pages to be removed should accompany the revised pages.

1. INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

Provide introductory information such as the purpose for and the general description of the installation. The information in this chapter should enable the reader to obtain a basic understanding of the installation and the protection afforded the public health and safety without having to refer to subsequent chapters. Review of the detailed chapters that follow can then be accomplished with better perspective and with recognition of the relative safety importance of each individual item to the overall design of the installation.

1.1 Introduction

Present briefly the principal function and design features of the installation. Discuss the reason or need for the installation. Include a brief description of the proposed location and the estimated time schedules for construction and operation.

1.2 General Description of Installation

Include a summary description of the principal characteristics of the site and a general description of the installation. The description should include a brief discussion of the principal design criteria; the nominal capacity of the installation; the type, form, quantities, and potential sources of the spent fuel to be stored; and the waste products generated during ISFSI operations. The arrangement of major structures and equipment should be indicated on plan and elevation drawings in sufficient number and detail to provide a reasonable understanding of the general layout of the installation. Any additional features likely to be of special interest because of their relationship to safety should be identified.

1.3 General Systems Description

A summary description of the storage arrangement to be used, including pertinent background information, should be presented. Include a brief description of the operating systems; fuel handling, decay heat removal, and other auxiliary systems; and the site-generated waste treatment system. Provide sufficient detail in the discussion and accompanying charts and tables to provide an understanding of the systems involved.

1.4 Identification of Agents and Contractors

Identify the prime agents or contractors for the design, construction, and operation of the installation. All principal consultants and outside service organizations, including those providing quality assurance services, should be identified. The division of responsibility among the designer, architect-engineer, constructor, and licensee should be delineated.

1.5 Material Incorporated by Reference

This section should provide a tabulation of all topical reports that are incorporated by reference as part of the SAR. In this context, topical reports are defined as reports that have been prepared by architect-engineers or other organizations and filed separately with the NRC in support of this application or of other applications or of product lines. For each topical report, this tabulation should include the title, the report number, the date submitted to the NRC (or AEC), and the sections of the SAR in which this report is referenced. For any topical reports that have been withheld from public disclosure pursuant to paragraph 2.790(b) of 10 CFR Part 2 as proprietary documents, nonproprietary summary descriptions of the general content of such reports should also be referenced. This section should include a tabulation of any documents submitted to the NRC in other applications that are incorporated in whole or in part in this application by reference. If any information submitted in connection with other applications is incorporated by reference in this SAR, summaries of such information should be included in appropriate sections of this SAR.

2. SITE CHARACTERISTICS

Provide information on the location of the installation and a description of the geographical, demographical, meteorological, hydrological, seismological, and geological characteristics of the site and surrounding vicinity. The objective is to identify the site characteristics that influence installation design. An evaluation of the site characteristics from a safety viewpoint should be developed. Identify any assumptions that need to be applied in making the safety appraisal, and cross-reference as appropriate to the criteria developed in Chapter 4, "Installation Design," and to the design bases selected in subsequent chapters to meet these criteria. Any material in this chapter that is covered in the applicant's Environmental Report (ER) may be referenced to the appropriate material in the ER.

If the proposed ISFSI will be located at or in the vicinity of an existing licensed site such as a nuclear power plant, much of the required siting information may be available in previous submittals to the NRC. In such cases, it is particularly important that the applicant confer with the NRC staff prior to preparing the SAR to determine the applicability of such information.

2.1 Geography and Demography of Site Selected

Information concerning the site geography, population, access transportation routes, and land use should be provided in support of the safety evaluation.

2.1.1 Site Location

The site location should be described by specifying the latitude and longitude to the nearest second and the Universal Transverse Mercator coordinates* to the nearest 100 meters. The State and county in which the site is to be located should be identified, as well as the location of the site relative to prominent natural and man-made features such as rivers, lakes, and the local road network. Maps and aerial photographs should be provided to present this information. The general location map should encompass an 8-kilometer (5-mile) radius. Additional maps should be provided to present detail near the site to establish orientation of buildings, roads, railroads, streams, ponds, transmission lines, and neighboring structures. This section may be referenced in subsequent chapters to minimize repetition.

2.1.2 Site Description

A map of the site should be included and should be of suitable scale to clearly define the boundary of the site and the distance from significant features of the installation to the site boundary. The area to be considered as the controlled area should be clearly delineated if its boundaries are not the same as the boundaries of the site.

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*As found on U.S. Geological Survey topographical maps.

The application should include a description of the applicant's legal responsibilities with respect to the properties described (ownership, lease, easements, etc.).

The topography of the site and vicinity should be described by suitable contour maps that indicate the character of surface drainage patterns. Vegetative cover and surface soil characteristics should be described sufficiently to indicate potential erosion and fire hazards.

Traffic and transportation routes and onsite transmission lines should be identified.

2.1.2.1 Other Activities Within the Site Boundary. For any activity conducted within the area controlled by the applicant but not related to the operation of the ISFSI, identify the activities involved, the boundaries within which the applicant will control such activities, and any potential interaction of such activities and the operation of the ISFSI.

2.1.2.2 Boundaries for Establishing Effluent Release Limits. Identify the controlled area boundary, and demarcate the area to which access will be actively controlled for purposes of protection of individuals from exposure to radiation and radioactive materials. The degree of access control required is that which enables the licensee to comply with the requirements of § 72.104 of 10 CFR Part 72. The site map (discussed in Section 2.1.2) may be used to identify this area, or a separate map of the site may be used. Indicate the location of the boundary with respect to nearby rivers and lakes. The minimum distance from a proposed storage location, as well as from other effluent release points, to the controlled area boundary should be clearly presented.

2.1.3 Population Distribution and Trends

Population information based on the most recent census data should be presented to show the population distribution as a function of distance and direction from the installation. On a map of suitable scale that identifies places of significant population grouping such as cities and towns within the 8-kilometer (5-mile) radius, concentric circles should be drawn, using the installation as the center point, with radii of 1.5, 3, 5, 6.5, and 8 kilometers (approximately 1, 2, 3, 4, and 5 miles). The circles should be divided into 22-1/2-degree segments with each segment centered on one of the 16 compass points (e.g., true north, north-northeast). Within each area thus formed by the concentric circles and radial lines, the current resident population, as well as projected future population changes, should be specified. The basis for the projection should be described. Significant transient or seasonal population variations should also be identified and discussed.

2.1.4 Uses of Nearby Land and Waters

Uses of nearby land and waters within an 8-kilometer (5-mile) radius should be described. Sufficient characterization of farming, dairy, industrial, residential, and recreational activities should be presented to permit estimates to be made of potential population radiation dose commitments resulting from both airborne and liquid effluents. The local population in facilities such as schools and institutions should be identified with respect to location and number of persons.

2.2 Nearby Industrial, Transportation, and Military Facilities

Provide the location and identification of other major nuclear facilities within an 8-kilometer (5-mile) radius.

Identify nearby industrial, transportation, and military installations on a map that clearly shows their distance and relationship to the installation. All activities within 8 kilometers (5 miles) of the site should be considered. Activities at greater distances should be described and evaluated as appropriate to their significance. As appropriate for each, provide a description of products or materials produced, stored, or transported and the maximum quantities for each with detailed emphasis on those items that could present a hazard to the safe operation of the installation.

Summarize items that may present a hazard to the installation from nearby activities of the types identified above. The following are typical considerations to be evaluated:

1. The effects of explosion of chemicals, flammable gases, or munitions;

2. The effects of explosions of large natural gas pipelines that cross or pass close to the installation;

3. The effects of detonation of the maximum amount of explosives permitted to be stored at mines or stone quarries near the site;

4. The effects of

   a. Fires in adjacent oil and gasoline plants or storage facilities,
   b. Fires in adjacent industries,
   c. Fires from transportation accidents, and
   d. Brush and forest fires;

5. The effects of accidental releases of toxic gases from nearby industries and transportation accidents;

6. The effects of expected airborne pollutants on important features of the installation.

If tall structures such as discharge stacks are used on site, evaluate the potential for damage to equipment or structures important to safety in the event that these structures collapse.

2.3 Meteorology

This section should provide a meteorological description of the site and its surrounding area. Meteorological conditions that influence the design and operation of the installation should be identified. Sufficient information should be included to permit an independent evaluation by the NRC staff of atmospheric diffusion characteristics of the local area. The sources of the information and the data supplied should be stated.

2.3.1 Regional Climatology

2.3.1.1 Data Sources. Discuss the sources of the data used during the climatology analysis. Identify the subjects discussed in the various references.

2.3.1.2 General Climate. Describe the climate of the region, pointing out characteristics attributable to the terrain. Indicate seasonal weather conditions, including temperature, precipitation, relative humidity, and prevalent wind direction.

2.3.1.3 Severe Weather. Provide data on severe weather conditions that may occur within the region and that could affect the design or operation of the ISFSI. If a condition is not considered severe (e.g., fog), it should be included in Section 2.3.1.2. The frequency, intensity, and duration of the following conditions should be provided:

1. Maximum and minimum temperatures
2. Extreme winds
3. Tornadoes
4. Hurricanes and tropical storms
5. Precipitation extremes
6. Thunderstorms and lightning strikes
7. Snow storms
8. Hail and ice storms
9. Other conditions used in design consideration (e.g., blowing dust, stagnant air).

2.3.2 Local Meteorology

2.3.2.1 Data Sources. Provide onsite data summaries and nearby weather summaries, identifying the methods and frequencies of collection and pointing out the data collection undertaken specifically for this SAR. Onsite data may not be necessary if data from nearby sources are shown to be adequate for the proposed installation.

2.3.2.2 Topography. Provide a large-scale map showing detailed topographic features (as modified by the facility) within an 8-kilometer (5-mile) radius of the site. A smaller scale map showing the topography of the installation and a plot of maximum elevation vs. distance from the center of the installation should also be provided.

2.3.3 Onsite Meteorological Measurement Program

Provide joint frequency distributions of wind speed, wind direction, and atmospheric stability, based on appropriate meteorological measurement heights and data-reporting periods. If an onsite meteorological measurement program exists, describe the program being conducted to develop local data and the programs to be used during operations to estimate offsite concentrations of airborne effluents. If an onsite meteorological measurement program does not exist, provide justification for using data from nearby sources.

The information provided should include measurements made, locations and elevations of instruments, descriptions of the instruments used, instrument performance specifications, calibration and maintenance procedures, and data analysis procedures. The meteorological measurement program should be consistent with gaseous effluent release structures and systems design. The effluent release structure and system design is assumed to be commensurate with the degree of risk to the health and safety of the public.

2.3.4 Diffusion Estimates

2.3.4.1 Basis. Provide estimates of atmospheric diffusion at the controlled area boundary for routine releases.

2.3.4.2 Calculations. Describe the diffusion equations and the parameters used in the diffusion estimates.

2.4 Surface Hydrology

Sufficient information should be provided to allow an independent review of all hydrologically related design bases, performance requirements, and operating procedures that are important to safety. Describe the hydrologic features of the region, area, and site, and include additional topographic maps of the site and area as needed for clarity. Identify the sources of the hydrologic information, the types of data collected, and the methods and frequency of collection.

2.4.1 Hydrologic Description

Describe hydrologic features that influence the site or may influence the site or facilities under severe hydrometeorological or geologic conditions. Include all streams, rivers, lakes, and shore regions adjacent to or running through the site. Identify population groups that use as a potable supply surface water subject to normal or accidental effluents from the plant, and provide the size, use rates, and location of the population groups.

Include a drainage plot of the site and adjacent areas. Reference the topographic maps provided in Section 2.1.2, and identify the location of the installation and other engineered features such as water supply ponds and retention basins. If applicable, include the location and description of upstream and downstream flow control structures, and explain the criteria governing their operation.

2.4.1.1 Site and Structures. Describe the site and all structures, exterior accesses thereto, and equipment and systems that are important to safety from the standpoint of hydrologic considerations. Indicate any proposed changes to natural drainage features on the topographic map of the site.

2.4.1.2 Hydrosphere. A description should be provided of the location, size, shape, and other hydrologic characteristics of streams, rivers, lakes, shore regions, and groundwater environments influencing the site. Include a description of upstream and downstream river control structures, and provide a regional topographic map showing the major hydrologic features. List the owner, location, and rate of use of surface water users whose intakes could be adversely affected by accidental or normal releases of contaminants from the installation. Refer to Section 2.5.1 for the tabulation of groundwater users.

2.4.2 Floods

Provide evidence that the proposed site is a flood-dry site, as defined in Section 5.1.3 of ANSI/ANS 2.8-1981, "Determining Design Basis Flooding for Power Reactor Sites."* ANSI/ANS 2.8-1981 defines a flood-dry site as one where structures that are important to safety are so high above potential sources of flooding that safety is obvious or can be documented with minimum analysis. A descriptive statement of circumstances and relative elevations may be sufficient. Analogy may be drawn with comparable watersheds for which probable maximum flood (PMF) levels have been determined. Approximations of PMF levels may be used. Flood studies for dry sites should be carried only to the degree of detail required to prove that structures that are important to safety are safe from flooding. All methods and assumptions should be conservative. Procedures that can be used are described in ANSI/ANS 2.8-1981.

If the proposed site is not clearly floodfree, a detailed analysis should be made, following the procedures outlined in the following sections through Section 2.4.8. Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," provides further guidance on specific analytical procedures that are pertinent to this analysis.

2.4.2.1 Flood History. Provide a synopsis of the flood** history (date, level, peak discharge, etc.) for the site. Provide frequency, intensity, and cause information for past flooding and other water inundation occurrences, such as tidal or windblown flood waters that may or may not be coincident with one another, with respect to the influence of such occurrences on the site. Include river or stream floods, surges, tsunami, dam failures, ice jams, and similar events.

2.4.2.2 Flood Design Considerations. Discuss the general capability of structures, systems, and equipment important to safety to withstand floods, floodwaves, and wave-action erosion. The design flood-protection level for structures that are important to safety necessary to protect the installation from floods, erosion, and wave action should be based on the highest calculated floodwater-level elevations and floodwave effects resulting from analysis of several different hypothetical floods. Possible flood conditions, up to and including the highest and most critical flood level, resulting from any of

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*Copies may be obtained from the American Nuclear Society, 555 North Kensington Avenue, La Grange Park, Illinois 60525.

**A "flood" is defined as any abnormally high water stage or overflow from a stream, floodway, lake, or coastal area that results in significantly detrimental effects.

several different probable maximum events should be considered as the basis for the design protection level for structures of the installation that are important to safety.

The probable maximum water level from a stream flood, surge, combination of surge and stream flood in estuarial areas, wave action, or tsunami (whichever is applicable and greatest) is that which may cause the highest water level. Other possibilities are the flood level resulting from the most severe floodwave at the site caused by landslide, dam failure, dam breaching resulting from a seismic or foundation disturbance, or inadequate design capability. The effects of coincident wind-generated wave action should be superimposed on the applicable flood level. The assumed hypothetical conditions should be evaluated both statically and dynamically to determine the design flood-protection level and dynamically induced loadings. The topical information required is generally outlined in Sections 2.4.3 through 2.4.7, but the type of events considered and the controlling event should be summarized in this section.

<u>2.4.2.3 Effects of Local Intense Precipitation</u>. Describe the effects of local probable maximum precipitation (PMP) (see Section 2.4.3.1) on adjacent drainage areas and site drainage systems, including drainage from the roofs of structures that are important to safety. Tabulate rainfall intensities for the selected and critically arranged time increments, provide characteristics and descriptions of runoff models, and estimate the resulting water levels. Summarize the design criteria for site drainage facilities, and provide analyses that demonstrate the capability of site drainage facilities to prevent flooding of structures, systems, and components important to safety due to local PMP. Estimates of precipitation based on publications of the National Oceanic and Atmospheric Administration (NOAA) (formerly U.S. Weather Bureau) of the U.S. Department of Commerce with the time distribution based on critical distributions such as those employed by the Corps of Engineers usually provide acceptable bases. Sufficient detail should be provided to (1) allow an independent review of rainfall and runoff effects on facilities that are important to safety and (2) judge the adequacy of design criteria.

Describe the design bases for ice accumulations on the roofs of structures important to safety and on exposed equipment that is important to safety. Discuss any effects on the operational capabilities of the structures, the equipment within, and any other exposed equipment that are important to safety. In addition, discuss the effect of ice accumulation on site structures where such accumulation could coincide with local probable maximum (winter) precipitation and thus cause flooding or other damage to structures important to safety. Finally, compare the above ice and snow design bases with historical maximum events in the region, and discuss the consequences of exceeding the design bases for structures important to safety (including available design margin).

2.4.3 Probable Maximum Flood on Streams and Rivers

Indicate whether, and if so how, the guidance given in ANSI/ANS 2.8-1981 has been followed. If it has not been followed, describe the specific alternative approach used. Summarize the locations and associated water levels for which the PMF determinations have been made.

<u>2.4.3.1 Probable Maximum Precipitation (PMP)</u>. The PMP is the theoretical precipitation over the applicable drainage area that would produce flood flows

that have virtually no risk of being exceeded. These estimates usually involve analyses of actual storms in the general region of the drainage basin under study. They also involve certain modifications and extrapolations of historical data to reflect more severe rainfall-runoff conditions than actually recorded, insofar as those conditions are deemed "reasonably possible" on the basis of hydrometeorological reasoning.

Discuss considerations of storm configuration (orientation of areal distribution), maximized precipitation amounts (include a description of maximization procedures and/or studies available for the area such as reference to National Weather Service and Corps of Engineers determinations), time distributions, orographic effects, storm centering, seasonal effects, antecedent storm sequences, antecedent snowpack (depth, moisture content, areal distribution), and any snowmelt model. The selected maximized storm precipitation distribution (time and space) should be presented.

2.4.3.2 Precipitation Losses. Describe the absorption capability of the drainage basin, including consideration of initial losses, infiltration rates, and antecedent precipitation. Verification of those assumptions should be provided by reference to regional studies or by presenting detailed local storm-runoff studies.

2.4.3.3 Runoff Model. Describe the hydrologic response characteristics of the watershed to precipitation (such as unit hydrographs), verification from historic floods or synthetic procedures, and the nonlinearity of the model at high rainfall rates. Provide a description of subbasin drainage areas (including a map), their sizes, and topographic features of watersheds. Include a tabulation of all drainage areas, runoff, and reservoir and channel-routing coefficients.

2.4.3.4 Probable Maximum Flood Flow. Present the PMF runoff hydrograph (as defined) that results from the PMP (and snowmelt, if pertinent), considering the hydrologic characteristics of the potential influence of existing and proposed upstream dams and river structures for regulating or increasing the water level. If such dams or structures are designed to withstand a PMF, their influence on the regulation of water flow and levels should be considered. However, if they are not designed or constructed to withstand the PMF (or inflow from an upstream dam failure), the maximum water flows and resulting static and dynamic effects from their failure by breaching should be included in the PMF estimate (see Section 2.4.4.2).

Discuss the PMF stream course response model and its ability to compute floods of various magnitudes up to the severity of a PMF. Present any reservoir and channel-routing assumptions with appropriate discussions of initial conditions, outlet works (both uncontrolled and controlled), spillways (both uncontrolled and controlled), the ability of any dams to withstand coincident reservoir wind-wave action (including discussions of setup, the significant wave height, the maximum wave height, and runup), the wave protection afforded, and the reservoir design capacity (i.e., the capacity for PMF and coincident wind-wave action). Finally, provide the estimated PMF discharge hydrograph at the site and, when available, provide a similar hydrograph without upstream reservoir effects to allow evaluation of reservoir effects and a regional comparison of the PMF estimate.

2.4.3.5 Water Level Determinations. Describe the translation of the estimated peak PMF discharge to elevation, using (when applicable) cross-sectional and profile data, reconstitution of historical floods (with consideration of high-water marks and discharge estimates), standard step methods, roughness coefficients, bridge and other losses, verification, extrapolation of coefficients for the PMF, estimates of PMF water surface profiles, and flood outlines.

2.4.3.6 Coincident Wind-Wave Activity. Discuss the runup, wave heights, and resultant static and dynamic effects of wave action on each structure important to safety from wind-generated activity that may occur coincidently with the peak PMF water level.

2.4.4 Potential Dam Failures (Seismically Induced)

Discuss the evaluation of the effects of potential seismically induced dam failures on the upper limit of flood capability for sites along streams and rivers. Consider the potential influence of upstream dams and river structures on regulating or increasing the water level. The maximum water flow and level resulting from failure of a dam or dams by seismically induced breaching under the most severe probable modes of failure should be taken into account. Also consider the potential for subsequent downstream domino-type failures due to floodwaves where such dams cannot be shown to be capable of withstanding severe earthquakes.

The simultaneous occurrence of the PMF and an earthquake capable of failing the upstream dams should not be considered since each of these events considered singly has a low probability of occurrence. The suggested worst conditions at the dam site may be evaluated by considering the following: a standard-project flood (as defined by the Corps of Engineers) or one-half the PMF, with full reservoirs, coincident with the maximum earthquake determined on the basis of historic seismicity; and a 25-year flood, with full reservoirs, coincident with the maximum earthquake determined on the basis of historic seismicity. Where downstream dams also regulate water supplies, their potential seismically induced failures should be discussed herein. The basis for the earthquake used in this evaluation should be presented.

2.4.4.1 Reservoir Description. Include a description of the locations of existing or proposed dams (both upstream and downstream) that influence conditions at the site. Tabulate drainage areas above reservoirs, and provide descriptions of types of structures, all appurtenances, ownership, seismic design criteria, and spillway design criteria. Provide the elevation-storage relationships for pertinent reservoirs, and tabulate short- and long-term storage allocations.

2.4.4.2 Dam Failure Permutations. Discuss the locations of dams (both upstream and downstream), potential modes of failure, and results of seismically induced and other types of dam failures (e.g., fault rupture hazard) that could cause the most critical conditions (floods or low water) with respect to the site for such an event (see Section 2.4.3.4). Consideration should be given to possible landslides, antecedent reservoir levels, and river flow coincident with the flood peak (base flow). Present the determination of the peak flow rate at the site for the worst possible dam failure, and summarize an analysis to show that the presented condition is the worst permutation. Include a description of all coefficients and methods used.

2.4.4.3 Unsteady Flow Analysis of Potential Dam Failures. In determining the effect of dam failures at the site (see Section 2.4.4.2), the analytical methods presented should be applicable to artificially large floods with appropriately acceptable coefficients and should also consider floodwaves through reservoirs downstream of failures. Domino-type failures due to floodwaves should be considered when applicable. Discuss estimates of coincident flow and other assumptions used to attenuate the dam failure floodwave downstream. Discuss static and dynamic effects of the attenuated wave at the site.

2.4.4.4 Water Level at Installation Site. Describe the backwater, unsteady flow, or other computation leading to the water elevation estimate (see Section 2.4.4.2) for the most critical upstream dam failure, and discuss its reliability. Superimpose wind-wave conditions that may occur simultaneously in a manner similar to that described in Section 2.4.3.6.

2.4.5 Probable Maximum Surge and Seiche Flooding

2.4.5.1 Probable Maximum Wind and Associated Meteorological Parameters. This mechanism is defined as a hypothetical hurricane or other cyclonic-type windstorm that might result from the most severe combinations of meteorological parameters considered "reasonably possible" in the region involved if the hurricane or other type windstorm should move along a critical path at optimum rate of movement. Present in detail the determination of probable maximum meteorological winds. This presentation involves detailed analyses of actual historical storm events in the general region and certain modifications and extrapolations of data to reflect a more severe meteorological wind system than actually recorded, insofar as these events are deemed reasonably possible on the basis of meteorological reasoning. The probable maximum conditions are the most severe combinations of hydrometeorological parameters considered reasonably possible that would produce a surge or seiche that has virtually no risk of being exceeded (e.g., the meteorological characteristics of the probable maximum hurricane as reported by NOAA in their technical report NWS-23* for the East and Gulf Coasts, or the most severe combination of meteorological parameters of moving squall lines for the Great Lakes, or the most severe combination of meteorological parameters capable of producing high storm-induced tides on the West Coast). This hypothetical event is postulated along a critical path at an optimal rate of movement from correlations of storm parameters of record. Sufficient bases and information should be provided to ensure that the parameters presented are the most severe combination.

2.4.5.2 Surge and Seiche History. Discuss the proximity of the site to large bodies of water for which surge- or seiche-type flooding can reach structures that are important to safety. The probable maximum water level (surges) for shore areas adjacent to large water bodies is the peak of the hypothetical surge- or seiche-stage hydrograph (stillwater levels) and coincident wave effects. It should be based on relatively comprehensive hydrometeorological analyses and the application of probable maximum meteorological criteria (such as hurricanes,

*NOAA Technical Report NWS-23, "Meteorological Criteria for the Standard Project Hurricane and Probable Maximum Windfields, Gulf and East Coasts of the United States," is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

moving squall lines, or other cyclonic wind storms), in conjunction with the critical hydrologic characteristics, to estimate the probable maximum water level at a specific location. The effects of the probable maximum meteorological event should be superimposed on the coincident maximum annual astronomical and ambient tide levels (and associated wave action) to determine the effects of water level and wave action on structures. Provide a description of the surge and/or seiche history in the site region.

2.4.5.3 Surge and Seiche Sources. Discuss considerations of hurricanes, frontal-type (cyclonic) wind storms, moving squall lines, and surge mechanisms that are possible and applicable to the site. Include (1) the antecedent water level (with reference to the spring tide for coastal locations, the average monthly recorded high water for lakes, and a forerunner or ambient water level where applicable), (2) the determination of the controlling storm surge or seiche (consider the probable maximum meteorological parameters such as the storm track, wind fields, the fetch or direction of approach, bottom effects, and verification with historic events), (3) the method used, and (4) the results of the computation of the probable maximum surge hydrograph (graphical presentation).

2.4.5.4 Wave Action. Discuss the wind-generated activity that can occur coincidently with a surge or seiche, or independently thereof. Estimates of the wave period, the significant wave height and elevations, and the maximum wave height and elevations, with the coincident water level hydrograph, should be presented. Give specific data on the largest breaking-wave height, setup, and runup that can reach each structure, system, and component that is important to safety.

2.4.5.5 Resonance. Discuss the possibility of oscillations of waves at natural periodicity, such as lake reflection and harbor resonance phenomena, and any resulting effects at the site.

2.4.5.6 Runup. Provide estimates of wave runup on the site structures. Include a discussion of the water levels on each affected structure and the protection to be provided against static effects, dynamic effects, and splash. Refer to Section 2.4.5.4 for breaking waves.

2.4.5.7 Protective Structures. Discuss the location and design criteria for any special water-control structures for the protection of structures important to safety against surges, seiches, wave reflection, and other wave action.

2.4.6 Probable Maximum Tsunami Flooding

For sites adjacent to coastal areas, discuss historical tsunami (either recorded or translated and inferred) that provide information for use in determining the probable maximum water levels and the geoseismic generating mechanisms available, with appropriate references to Section 2.6.

2.4.6.1 Probable Maximum Tsunami. This event is defined as the most severe tsunami at the site that has virtually no risk of being exceeded. Consideration should be given to the most reasonably severe geoseismic activity possible in determining the limiting tsunami-producing mechanism (e.g., fractures, faults, landslide potential, and volcanism). Such considerations as the orientation of the site relative to the earthquake epicenter or generating mechanism, shape of the coastline, offshore land areas, hydrography, and stability of the coastal area should be presented in the analysis.

2.4.6.2 Historical Tsunami Record. Provide local and regional historical tsunami information.

2.4.6.3 Tsunami Wave Height by Source. Provide estimates of the maximum tsunami wave height possible at each major local generating source considered and the maximum offshore deepwater tsunami height from distant generators. Discuss the controlling generators for both locally and distantly generated tsunami.

2.4.6.4 Tsunami Height Offshore. For each major generator, provide estimates of the tsunami height in deep water adjacent to the site or before bottom effects appreciably alter wave configuration.

2.4.6.5 Hydrography and Harbor or Breakwater Influences on Tsunami. Present the routing of the controlling tsunami. Include breaking-wave formation, bore formation, and any resonance effects (natural frequencies and successive wave effects) that result in the estimate of the maximum tsunami runup on each pertinent structure important to safety. Also include a discussion of the analysis used to translate tsunami waves from offshore generator locations, or in deep water, to the site and a discussion of antecedent conditions. Provide, where possible, verification of the techniques and coefficients used by reconstituting tsunami of record.

2.4.7 Ice Flooding

Present design criteria for the protection of structures, systems, and components that are important to safety from the most severe ice jam floods, wind-driven ice ridges, or ice-produced forces that are reasonably possible and could affect structures important to safety with respect to adjacent rivers, streams, or lakes. Include the location and proximity of such facilities to ice-generating mechanisms. Describe the regional ice and ice jam formation history.

2.4.8 Flooding Protection Requirements

Describe the static and dynamic consequences of all types of flooding on each pertinent component that is important to safety. Present the design bases required to ensure that components important to safety will be capable of surviving all design flood conditions. Reference appropriate discussions in other sections of the SAR where these design bases are implemented.

2.4.9 Environmental Acceptance of Effluents

Describe the ability of the surface water and groundwater environment to disperse, dilute, or concentrate normal and inadvertent or accidental liquid releases of radioactive effluents for the full range of anticipated operating conditions as such releases may relate to existing or potential future use of surface water or groundwater resources. Describe any effects of normal or accidental releases of radionuclides on surface waters and groundwaters, e.g., any potential for recirculation, sediment concentration, and hydraulic short circuiting of cooling ponds, if applicable.

2.5 Subsurface Hydrology

2.5.1 Regional Characteristics

If local ground water is a major water resource, the ground-water system may be of importance beyond an ISFSI site. If so, describe the principal ground-water aquifers and associated hydrogeologic units and their recharge and discharge points in relationship to the site location. For each hydrogeologic unit identified, discuss the flow directions, hydraulic gradients, potential for reversibility of ground-water flow, and potential effects of future use on ground-water recharge areas within the influence of the installation. Provide a survey of ground-water users, including location, uses, static water levels, pumping rates, drawdown, and source aquifers.

2.5.2 Site Characteristics

Provide data on ground-water potentiometric levels; hydraulic characteristics, including hydraulic conductivity, effective porosity, and storage coefficient; and hydraulic gradients at the site. The proposed ground-water sources and usage anticipated by the installation should also be given. Provide a water-table contour map showing surface water bodies, recharge and discharge points, and the location of any monitoring wells or other leak-detection systems used to evaluate possible leakage from storage pools. If monitoring wells are used, provide information on the elevations of the top of casings, the screened interval, and methods of installation. Identify any potential ground-water recharge areas within the influence of the installation, and discuss the effects of construction, including dewatering, on such areas. Provide information on the hydrochemistry of the water table to include major ions, pH-Eh values, and presence of radionuclides.

2.5.3 Contaminant Transport Analysis

By use of the information collected to describe the regional and site characteristics, provide an analysis that indicates the bounds of potential contamination from the site operations to the ground-water system. Include in the analysis a graph of time versus concentration of the radionuclide migration at the location of the nearest existing or potential future user.

2.6 Geology and Seismology

The geologic and seismic characteristics of the area and site, the nature of investigations performed, results of investigations, conclusions, and identification of information sources should be provided. Supplement the written description with tables and legible graphics, as appropriate.

2.6.1 Basic Geologic and Seismic Information

The basic geologic and seismic information for the site should be presented. Information obtained from published reports, dissertations, maps, private communications, or other sources should be referenced. Data from surveys, geophysical investigations, borings, trenches, or other investigations should be adequately documented by descriptions of techniques, graphic logs, photographs, laboratory results, identification of principal investigators, and other data.

If possible, areas of potential seismic or volcanic activity or surface offset should be avoided for the siting of an ISFSI. The methods used to determine that the site meets the design criteria of Part 72 should be presented.

Material in this section may be included, as appropriate, in Section 2.6.3 and cross-referenced in this section.

1. Describe the site geomorphology. A site topographic map showing the locations of the principal facilities should be included. Describe the configuration of the land forms, and relate the history of geologic changes that have occurred. Areas that are significant to the site of actual or potential landsliding, surface or subsurface subsidence, uplift, or collapse resulting from natural features (such as tectonic depressions and cavernous or karst terrains) and from man's activities (such as withdrawal or addition of subsurface fluids or mineral extraction) should be evaluated.

2. Discuss the geologic history of the site, and describe the lithologic, stratigraphic, and structural geologic conditions of the site. A stratigraphic column should be included. Describe the thicknesses, physical characteristics, mineral composition, origin, and degree of consolidation of each lithologic unit. Furnish summary logs of borings and excavations such as trenches used in the geologic evaluation.

3. Identify specific structural features of significance to the site, e.g., folds, faults, joints, synclines, anticlines, domes, and basins. Provide a large-scale structural geology map of the site showing bedrock surface contours (structure contour maps) and the location of structures.

4. Furnish a large-scale geologic map of the site area that shows surface geology and includes the locations of major structures of the installation. Areas of direct observations of bedrock outcrop should be distinguished from areas that are covered and about which geologic interpretation has been extrapolated (i.e., outcrop map). When the interpretation differs substantially from the published geologic literature on the area, the differences should be noted and documentation for the differing conclusions presented.

5. Furnish a plot plan showing the locations of major structures of the installation and the locations of all borings, trenches, and excavations. Also include a description, logs, and maps of the borings, trenches, and excavations as necessary to indicate the results.

6. Provide geologic profiles that show the relationship of major foundations to subsurface materials, including groundwater. Describe the significant engineering characteristics of the subsurface materials.

7. Provide plan and profile drawings showing the extent of excavations and backfill planned at the site. Describe compaction criteria for all engineered backfill.

8. Include an evaluation from an engineering-geology standpoint of the local geologic features that could affect ISFSI structures.

a. Describe available physical evidence concerning the behavior during previous earthquakes of the surface geologic materials and the substrata underlying the site. This determination may require lithologic, stratigraphic, and structural geologic studies.

b. Identify and evaluate deformation zones, such as shears, joints, fractures, and folds, or combinations of these features, relative to structural foundations.

c. Describe and evaluate zones of alteration or irregular weathering profiles and zones of structural weakness composed of crushed or disturbed materials.

d. Describe all rocks or soils that might be unstable because of their mineral composition, lack of consolidation, water content, or potentially undesirable response to seismic or other events. Seismic response characteristics to be considered include liquefaction, thixotropy, differential consolidation, cratering, and fissuring.

9. Define site groundwater conditions and their relationship to regional groundwater conditions. Include the properties of aquifer materials and any fine-grained materials associated with the uppermost unconfined or semiconfined aquifer.

10. Provide profiles and tables showing the results of any geophysical surveys (e.g., seismic refraction, seismic reflection, acoustic, and aeromagnetic) conducted to evaluate the stratigraphic structure and bedrock and showing subsurface material characteristics of the site. Results of compressional and shear wave velocity surveys and crosshole and uphole velocity surveys, where performed, should be provided.

11. Furnish in detail static and dynamic engineering soil and rock properties of the materials underlying the site, including grain-size classification, Atterberg limits, water content, unit weight, shear strength, relative density, shear modulus, Poisson's ratio, bulk modulus, damping, consolidation characteristics, seismic wave velocities, density, porosity, strength characteristics, and strength under cyclic loading. These data should be substantiated with appropriate representative laboratory test records. The results should be interpreted and integrated to provide a comprehensive understanding of the surface and subsurface conditions.

12. Discuss the analysis techniques used and the factors of safety for foundation materials for evaluating the stability of foundations for all structures and for all embankments under normal operating and extreme environmental conditions.

2.6.2 Vibratory Ground Motion

Information should be presented to describe how the data were selected for determining the design basis for vibratory ground motion. The following specific information and determinations should also be included to the extent necessary to clearly establish the design basis for vibratory ground motion. Information presented in other sections may be cross-referenced and need not be repeated.

2.6.2.1 Engineering Properties of Materials for Seismic Wave Propagation and Soil-Structure Interaction Analyses. Describe the static and dynamic engineering properties of the materials underlying the site. Included should be properties needed to determine the behavior of the underlying material during earthquakes and the characteristics of the underlying material in transmitting earthquake-induced motions to the foundations of the plant, e.g., seismic wave velocities, density, water content, porosity, and strength.

2.6.2.2 Earthquake History. List all historically reported earthquakes that have affected or could be reasonably expected to have affected the site. The listing should include the date of occurrence, the magnitude or highest intensity, and a plot of the epicenter or region of highest intensity. Include all historically reported earthquakes that could have caused a maximum ground acceleration of at least one-tenth the acceleration of gravity (0.1 g) at ground surface in the free field.

Since earthquakes have been reported in terms of various parameters such as magnitude, intensity at a given location, and effect on ground, structures, and people at a specific location, some of these data may have to be estimated by use of appropriate empirical relationships. Where appropriate, the comparative characteristics of (1) the material underlying the epicentral location or region of highest intensity and (2) the material underlying the site in transmitting earthquake vibratory motion should be considered.

2.6.2.3 Earthquake Probabilities. Develop or determine a site-specific earthquake g value associated with a mean 500-year recurrence interval. As an alternative, this value may be developed by the deterministic methods developed for the siting of nuclear power plants as outlined in Section 2.6.2.4.

2.6.2.4 Procedures to Determine the Design Earthquake. The design earthquake for the ISFSI structures that are important to safety should be defined by response spectra corresponding to the maximum horizontal ground motion accelerations. An ISFSI may be designed to a response spectrum anchored at 0.25 g if the site is not located in an area of known seismic activity (e.g., New Madrid, Missouri; Charleston, South Carolina; Attica, New York) and is east of the Rocky Mountain Front (east of approximately 104° west longitude). Alternatively, a site-specific g value and response spectra may be determined by the following procedure:

1. Identification of Capable Faults. For faults, any part of which are within 161 kilometers (100 miles) of the site and which may be of significance in establishing the design criteria for earthquake protection, determine whether these faults should be considered.

2. Description of Capable Faults. For any part of faults that are within 161 kilometers (100 miles) of the site and may be of significance in establishing the earthquake criteria and may be considered as capable faults, the following should be determined: the length of the fault; the relationship of the fault to regional tectonic structures; and the nature, amount, and geologic history of the maximum Quaternary displacement related to any one earthquake along the fault.

3. Maximum Earthquake. Determine the historic earthquakes of greatest magnitude or intensity that have been correlated with tectonic structures. For

capable faults, the earthquake of greatest magnitude related to the faults should be determined, taking into account geologic evidence. The vibratory ground motion at the site should be determined assuming the epicenters of the earthquakes are situated at the point closest to the site.

Where epicenters or regions of highest intensity of historically reported earthquakes cannot be related to tectonic structures but are identified with adjacent or nearby tectonic provinces, determine the accelerations at the site assuming that the epicenters or regions of highest intensity of these earthquakes are located at the closest point to the site on the boundary of the tectonic province or region.

2.6.3 Surface Faulting

Information that describes surface faulting at the site should be presented if the method or approach of 10 CFR Part 100 is used. The following specific information and determinations should also be included. Information presented in Section 2.6.1 may be cross-referenced and need not be repeated.

2.6.3.1 Evidence of Fault Offset. Determine the geologic evidence of fault offset at or near the ground surface at or near the site.

2.6.3.2 Identification of Capable Faults. For faults greater than 300 meters (1000 ft) long, any part of which is within 8 kilometers (5 mi) of the site, determine whether these faults should be considered as capable faults.

2.6.4 Stability of Subsurface Materials

Information should be presented concerning the stability of rock (defined as having a shear wave velocity of 1166 m/sec (3500 ft/sec) or greater) and soil underneath the facility foundations during the vibratory motion associated with earthquake design criteria. Evaluate the following geologic features that could affect the foundations. Information presented in other sections may be cross-referenced and need not be repeated.

2.6.4.1 Geologic Features. Describe the following geologic features:

1. Areas of actual or potential surface or subsurface subsidence, uplift, or collapse resulting from

   a. Natural features such as tectonic depressions and cavernous or karst terrains, particularly those underlain by calcareous or other soluble deposits,

   b. Man's activities such as withdrawal or addition of subsurface fluids or mineral extraction, or

   c. Regional warping.

2. Deformational zones such as shears, joints, fractures, and folds or combinations of these features;

3. Zones of alteration or irregular weathering profiles and zones of structural weakness composed of crushed or disturbed materials;

4. Stresses in bedrock; and

5. Rocks or soils that might be unstable because of their mineral composition, lack of consolidation, water content, or potentially undesirable response to seismic or other events. Seismic response characteristics to be considered include liquefaction, differential consolidation, cratering, and fissuring.

2.6.4.2 Properties of Underlying Materials. Describe in detail the static and dynamic engineering properties of the materials underlying the site. Furnish the physical properties of foundation materials such as grain-size classification, consolidation characteristics, water content, Atterberg limits, unit weight, shear strength, relative density, shear modulus, damping, Poisson's ratio, bulk modulus, strength under cyclic loading, seismic wave velocities, density, porosity, and strength characteristics. These data should be substantiated with appropriate representative laboratory test records.

2.6.4.3 Plot Plan. Provide a plot plan (or plans) showing the locations of all borings, trenches, seismic lines, piezometers, geologic profiles, and excavations, and superimpose the locations of all plant structures. Furnish profiles showing the relationship of the foundations of structures to subsurface materials, including groundwater and significant engineering characteristics of the subsurface materials.

2.6.4.4 Soil and Rock Characteristics. Provide the results by means of tables and profiles of compressional and shear wave velocity surveys performed to evaluate the characteristics of the foundation soils and rocks. Provide graphic core boring logs and the logs of trenches or other excavations.

2.6.4.5 Excavations and Backfill. Furnish plan and profile drawings showing the extent of excavations and backfill planned at the site and compaction criteria for all engineered backfill. The criteria should be substantiated with representative laboratory or field test records. Where possible, these plans and profiles may be combined with profiles in Sections 2.6.4.3 or 2.6.4.4.

2.6.4.6 Groundwater Conditions. Provide a history of groundwater fluctuations beneath the site and a discussion of anticipated groundwater conditions during construction of the installation and during its expected life.

2.6.4.7 Response of Soil and Rock to Dynamic Loading. Furnish analyses of the response of soil and rock to dynamic loading.

2.6.4.8 Liquefaction Potential. Provide a discussion of the liquefaction potential of material beneath the site. Either demonstrate that there are no liquefaction-susceptible soils beneath the site or provide the following information regarding soil zones where the possibility for liquefaction exists: relative density, void ratio, ratio of shear stress to initial effective stress, number of load cycles, grain-size distribution, degrees of cementation and cohesion, and groundwater elevation fluctuations.

2.6.4.9 Earthquake Design Basis. The analysis for soil stability should be based on the design earthquake and response spectra used.

2.6.4.10 Static Analyses. Discuss the static analyses, such as settlement analyses (with appropriate representative laboratory data), and lateral pressures (with backup data).

2.6.4.11 Techniques to Improve Subsurface Conditions. Discuss and provide specifications for required techniques to improve subsurface conditions such as grouting, vibraflotation, rock bolting, and anchors.

2.6.4.12 Criteria and Design Methods. List and furnish a brief discussion of the criteria, references, or methods of design employed (or to be employed) and factors of safety (documented by test data).

2.6.5 Slope Stability

Information and appropriate substantiation should be presented concerning the stability of all slopes, both natural and man-made (both cut and fill), the failure of which could adversely affect the installation.

2.6.5.1 Slope Characteristics. Cross sections of the slopes should be provided along with a summary of the static and dynamic properties of embankment and foundation soil and rock underlying the slope. Substantiate with representative laboratory test data.

2.6.5.2 Design Criteria and Analyses. The design criteria and analyses used to determine slope stability should be described. Include factors of safety, along with the adverse conditions considered in the analyses, such as sudden drawdown, earthquake, and steady seepage at anticipated pool levels.

2.6.5.3 Logs of Core Borings. Furnish logs of core borings and test pits taken in proposed borrow areas.

2.6.5.4 Compaction Specifications. Provide compaction specifications along with representative laboratory data on which they are based.

2.7 Summary of Site Conditions Affecting Construction and Operating Requirements

Summarize all factors developed in this chapter that are deemed significant to the selection of design bases for the installation.

3. PRINCIPAL DESIGN CRITERIA

Principal design criteria are established by the applicant in the SAR. The NRC staff analyzes these design criteria for adequacy before the application is approved. Changes in the criteria are not anticipated after that approval is granted. Therefore, the criteria selected should encompass all considerations for alternatives that the applicant may choose.

3.1 Purposes of Installation

Describe in general terms the installation, its functions, operation, and storage capacity, and the types of fuel to be stored.

3.1.1 Materials To Be Stored

A detailed description of the physical, thermal, and radiological characteristics of the spent fuels to be stored should be provided. Include spent fuel characteristics such as specific power, burnup, decay time, and heat generation rates.

3.1.2 General Operating Functions

Provide information related to the overall functioning of the installation as a storage operation. Information should be included on onsite-generated waste processing, waste packaging and storage areas, transportation, and utility and water supplies.

3.2. Structural and Mechanical Safety Criteria

Based on the site selected, identify and quantify the environmental and geologic features that are used as design criteria for identified structures, systems, and components that are important to safety.

3.2.1 Tornado and Wind Loadings

3.2.1.1 Applicable Design Parameters. The design parameters applicable to the design tornado such as translational velocity, rotational velocity, and the design pressure differential and its associated time interval should be specified. Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants," contains guidance that may be helpful.

3.2.1.2 Determination of Forces on Structures. Describe the methods used to convert the tornado and wind loadings into forces on the structures, including the distribution across the structures and the combination of applied loads. If factored loads are used, the basis for selection of the load factor used for tornado loading should be furnished.

3.2.1.3 Ability of Structures To Perform Despite Failure of Structures Not Designed for Tornado Loads. Information should be presented to show that the failure of any structure not being designed for tornado loads will not affect the ability of other structures or systems that are important to safety to perform their intended design functions.

3.2.1.4 Tornado Missiles. The design bases should include tornado missiles, unless it can be shown that structures, systems, and components important to safety will not be affected. The dimensions, mass, energy, velocity, and other parameters should be selected for a potential tornado-driven missile.* An analysis should be presented to show the potential effect of such a missile on structures, systems, and components important to safety.

3.2.2 Water Level (Flood) Design

If the facility is not to be located on a flood-dry site, discuss the design loads from forces developed by the maximum probable flood, including water height and dynamic phenomena such as velocity. By reference, relate the design criteria to data developed in Section 2.4.

3.2.2.1 Flood Elevations. The flood elevations that will be used in the design of each structure for buoyancy and static water force effects should be provided.

3.2.2.2 Phenomena Considered in Design Load Calculations. The phenomena (e.g., flood current, wind wave, hurricane, or tsunami) that are being considered if dynamic water force is a design load for any structure should be identified and discussed.

3.2.2.3 Flood Force Application. Describe the manner in which the forces and other effects resulting from flood loadings are applied.

3.2.2.4 Flood Protection. Describe the flood protection measures for structures, systems, and components that are important to safety and are located below grade or below flood level.

3.2.3 Seismic Design

From data developed in Chapter 2, "Site Characteristics," present the design criteria to be used in construction of the installation and its associated equipment. Sufficient detail should be presented to allow an independent evaluation of the criteria selected. For clarity, cross-reference appropriate information presented in Section 2.6.

3.2.3.1 Input Criteria. This section should discuss the input criteria for seismic design of the installation, including the following specific information:

1. Design Response Spectra. Design response spectra should be provided for the design earthquake (DE). A discussion of effects of the following parameters should also be included:

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*Section 3.5.1.4 (paragraph 4 of Section III) of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation), contains information that may be helpful in developing these data. A copy of Section 3.5.1.4 is available for inspection and copying for a fee at the NRC Public Document Room, 2020 L Street NW., Washington, DC, under Task CE 301-4.

a. Earthquake duration,

b. Earthquake distance and depths between the seismic disturbances and the site, and

c. Existing earthquake records and the associated amplification response range where the amplification factor is greater than one.

2. Design Response Spectra Derivation. If response spectral shapes other than those in Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," are proposed for design of the storage structures or other structures that are important to safety or for the determination of liquefaction potential, these should be justified and the earthquake time functions or other data from which these were derived should be presented. For all the damping values that are used in the design, submit a comparison of the response spectra derived from the time history and the design response spectra. The system period intervals at which the spectra values were calculated should be identified. The response spectra applied at the finished grade in the free field or at the various foundation locations of structures that are important to safety should be provided.

3. Design Time History. For any time-history analyses, the response spectra derived from the actual or synthetic earthquake time-motion records should be provided. A comparison of the response spectra obtained in the free field at the finished grade level and the foundation level (obtained from an appropriate time history at the base of the soil-structure interaction system) with the design response spectra should be submitted for each of the damping values to be used in the design of structures, systems, and components. Alternatively, if the design response spectra are applied at the foundation levels of structures that are important to safety, a comparison of the free-field response spectra at the foundation level (derived from an actual or synthetic time history) with the design response spectra should be provided for each of the damping values to be used in the design. The period intervals at which the spectra values were calculated should be identified.

4. Use of Equivalent Static Loads. The basis for load factors used on the seismic design of structures, systems, and components that are important to safety in lieu of the use of a seismic-system multimass dynamic analysis method should be identified. For example, dynamic soil pressures can be adequately estimated by using modifications to the Mononobe-Okabe theory.

5. Critical Damping Values. The specific percentage of critical damping values used for identified structures, systems, components, and soil should be provided. For example, damping values for the type of construction or fabrication and the applicable allowable design stress levels for these installation features should be submitted.

6. Bases for Site-Dependent Analysis. The bases for a site-dependent analysis, if used to develop the shape of the design response spectra from bedrock time history or response spectra input, should be provided. Specifically, the bases for use of in situ soil measurements, soil layer location, and bedrock earthquake records should be provided. If the analytical approach used to determine the shape of the design response spectra neglects vertical amplification and

possible slanted soil layers, these assumptions as well as the influence of the effect of possible predominant thin soil layers on the analytical results should be discussed.

7. Soil-Supported Structures. A list of all soil-supported structures that are important to safety should be provided. This list should include the depth of soil over bedrock for each structure listed.

8. Soil-Structure Interaction. For nonbedrock sites, soil-structure interaction is to be treated in the same manner as for the Safe Shutdown Earthquake (SSE) at nuclear power plants. Describe any soil-structure interaction techniques used in the analyses of the structures. Nonlinear, or equivalent linear, finite element techniques should be used as the analytical tools for soil-structure interaction analyses for all structures where the foundations are deeply embedded in soil. For shallowly embedded structures on deep, uniform soil strata, the soil spring model based on the elastic half-space theory is adequate. For shallowly embedded structures with shallow soil overburden over rock or layered soil with varying soil properties, the finite element approach or multiple shear beam spring approach should be used.

3.2.3.2 Seismic-System Analyses. This section should discuss the seismic-system analyses applicable to structures, systems, and components that are important to safety. The following specific information should be included:

1. Seismic Analysis Methods. For all structures, systems, and components identified in Section 3.2 that are important to safety, the applicable methods of seismic analysis (e.g., modal analysis response spectra, modal analysis time history, equivalent static load) should be identified in the SAR. Applicable stress or deformation criteria and descriptions (sketches) of typical mathematical models used to determine the response should be specified. All methods of seismic analyses used should also be described in the SAR.

2. Natural Frequencies and Response Loads. A summary of natural frequencies and response loads (e.g., in the form of critical mode shapes and modal responses) determined by the seismic-system analysis should be provided.

The design earthquake is considered a faulted condition as is the SSE for nuclear power plants. Dynamic or equivalent static loads are to be treated as outlined in Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation (Water-Basin Type)."

3. Procedure Used To Lump Masses. Provide a description of the procedure used to lump masses for the seismic-system analyses (ratio of system mass and compliance to component mass and compliance and the ratio of floor mass and compliance to supported equipment mass and compliance).

4. Rocking and Translational Response Summary. If a fixed base in the mathematical models for the dynamic system analyses is assumed, a summary of the rocking and translational responses should be provided. A brief description should be included of the method, mathematical model, and damping values (rocking, vertical, translation, and torsion) that have been used to consider the soil-structure interaction.

5. Methods Used To Couple Soil with Seismic-System Structures. Describe the methods and procedures used to couple the soil and the seismic-system structures and components in the event that a finite element analysis for the layered site is used.

6. Method Used To Account for Torsional Effects. The method used to consider the torsional modes of vibration in the seismic analysis of the structures should be described. The use of static factors to account for torsional accelerations in the seismic design structures or, in lieu of the use of a combined vertical, horizontal, and torsional multimass system, dynamic analysis should be indicated.

7. Methods for Seismic Analysis of Dams. A description should be provided of the analytical methods and procedures used for the seismic-system analysis of dams that impound bodies of water, if the dams are important to safety.

8. Methods to Determine Overturning Moments. A description of the dynamic methods and procedures used to determine structure overturning moments should be provided, including a description of the procedures used to account for soil reactions and vertical earthquake effects.

9. Analysis Procedure for Damping. The analysis procedure followed to account for the damping in different elements of a coupled system model should be described, including the criteria used to account for composite damping in a coupled system with different elements.

10. Seismic Analysis of Overhead Cranes. Describe the provisions taken to ensure that all overhead cranes and fuel transfer machines that are important to safety will not be dislodged from their rails in the event of the design earthquake.

11. Seismic Analysis of Specific Safety Features. Discuss the integrity of specific design features that are important to safety (e.g., spent fuel storage racks) in the event of an earthquake.

3.2.4 Snow and Ice Loadings

Describe design load criteria used to ensure that maximum snow and ice loads can be accommodated.

3.2.5 Combined Load Criteria

For combined loads, describe the criteria selected to provide mechanical and structural integrity. The loads and loading combinations to which the facility is subjected should be defined, including the load factors selected for each load component where a factored load approach is used. The design approach used with the loading combination and any load factors should be specified. Describe the loads acting on the structures such as dead loads, live loads, and earth pressure loads, as well as the design basis accident loads and loads resulting from natural phenomena such as earthquakes, floods, tornadoes, hurricanes, and missile effects unique for the site. The design loading combinations used to examine the effects on localized areas such as penetrations, structural discontinuities, prestressing tendon anchor zones, crane girder brackets, and local areas of high thermal gradients should be provided together with time-dependent loading such as the thermal effects, effects of creep and shrinkage, and other related effects. Provide an explanation of the use of an ultimate strength approach with a load factor of 1.0.

3.3 Safety Protection Systems

3.3.1 General

Identify items requiring special consideration in design because of site selection, operating conditions, or other requirements.

3.3.2 Protection by Multiple Confinement Barriers and Systems

3.3.2.1 Confinement Barriers and Systems. Discuss each method of confinement that will be used to ensure that there will be no uncontrolled release of radioactivity to the environment. Include for each:

1. Criteria for protection against any postulated internal accident or external natural phenomena,

2. Design criteria selected for vessels, piping, effluent systems, and backup confinement, and

3. Delineation for each case of the extent to which the design is based on achieving the lowest practical level of releases from the operation of the installation.

Where the release limits selected are consistent with proven practice, a referenced statement to that effect will suffice; where the limits extend beyond present practice, an evaluation and an explanation based on developmental work and/or analysis should be provided. Those criteria may be expressed as explicit numbers or as general conditions.

3.3.2.2 Ventilation--Offgas. Describe the criteria selected for providing suitable ventilation by showing capacity standards for normal and off-normal conditions, zone interface flow velocity and differential pressure standards, the flow pattern, and control instrumentation.

Establish the criteria for the design of the ventilation and offgas systems, including (1) airflow patterns and velocity with respect to contamination control, (2) minimum negative pressures at key points in the system to maintain proper flow control, (3) interaction of offgas systems with ventilation systems, (4) minimum filter performance with respect to particulate removal efficiency and maximum pressure drop, (5) minimum performance of other radioactivity removal equipment, and (6) minimum performance of dampers and instrumented controls.

3.3.3 Protection by Equipment and Instrumentation Selection

3.3.3.1 Equipment. Itemize design criteria for key equipment items that have been specifically selected to provide protection.

3.3.3.2 Instrumentation. Discuss the design criteria for instrumentation selected with particular emphasis on features to provide testability and contingency for safety purposes.

3.3.4 Nuclear Criticality Safety

Supply all pertinent criteria relating to the appropriate safety margins provided to ensure that a subcritical situation exists at all times.

3.3.4.1 Control Methods for Prevention of Criticality. Present the methods to be used to ensure subcritical situations in operations and storage under the worst credible conditions.

3.3.4.2 Error Contingency Criteria. To support the above information, define the error contingency criteria selected.

3.3.4.3 Verification Analyses. Present the criteria for verifying models or programs used in the analysis.

3.3.5 Radiological Protection

A portion of the radiological protection design criteria was discussed in Section 3.3.2. Present any additional radiological protection design criteria.

3.3.5.1 Access Control. Describe the methods and procedures to be designed into the installation for limiting access, as necessary, to minimize exposure of people to radiation and radioactive materials.

3.3.5.2 Shielding. Provide an estimate of collective doses (in person-rem) per year in each area and for various operations. When special provisions such as time and distance are to be included, determine the design dose rate in occupancy areas. Show that further reduction of collective doses is not practicable.

3.3.5.3 Radiological Alarm Systems. Describe the criteria used for action levels from radiological alarm systems. Describe the systems that will be used to ensure personnel and environmental protection from radiation and airborne radioactivity.

3.3.6 Fire and Explosion Protection

Provide the design criteria selected to ensure that all safety functions will successfully withstand credible fire and explosion conditions.

3.3.7 Materials Handling and Storage

3.3.7.1 Spent Fuel Handling and Storage. Describe the design criteria for spent fuel handling and storage systems. Specifically discuss cooling requirements, criticality, and contamination control and pool water treatment for water basins. Also discuss criteria for handling damaged fuel elements, i.e., encapsulation.

3.3.7.2 Radioactive Waste Treatment. Describe the facilities to be used for the treatment and storage of radioactive wastes generated as a result of the ISFSI operations, including (1) reduction in volume, (2) control of releases of radioactive materials during treatment, (3) conversion to solid forms, (4) suitability of product containers for storage or shipment to a disposal or storage site, (5) safe confinement during onsite storage, (6) monitoring during onsite storage to demonstrate safe confinement, and (7) final decontamination, retrieval, and disposal of stored wastes during decommissioning.

3.3.7.3 Waste Storage Facilities. Describe the facilities associated with the onsite storage of waste generated as a result of the ISFSI operations.

3.3.8 Industrial and Chemical Safety

Any specific design criteria that are important to personnel and plant safety should be described. Effects of various industrial accidents (e.g., fire, explosion) and potentially hazardous chemical reactions (e.g., spontaneous ignition of ion exchange resins) should be presented.

3.4 Classification of Structures, Components, and Systems

Provide a classification of the structures, components, and systems selected in the design according to their importance as to the safety function they perform, the seismic design considerations, and the relationship of the quality requirements of an item with respect to its function and performance. As appropriate, this classification presentation should relate to details in Chapter 4, "Installation Design," Chapter 5, "Operation Systems," and Chapter 11, "Quality Assurance."

Define the criteria for selecting the categories used for the classifications related to safety, seismic considerations, and quality assurance.

3.5 Decommissioning Considerations

The applicant should discuss the consideration given in the design of the facility and its auxiliary systems to facilitating eventual decommissioning. Examples of subjects to be included are (1) the provisions made for the decontamination and removal of potentially contaminated components of a water circulating system such as filters, coolers, valves, and piping and (2) the components of waste treatment and packaging systems.

3.6 Summary of Design Criteria

Provide a summary of the design criteria for all structures, systems, and components that are important to safety. This may be presented in tabular form. It should include, as a minimum, the following items:

1. Maximum load capacity of cranes and other handling equipment

2. Maximum dimensions of loads that can be handled

3. Criticality safety

4. Maximum dose rates (e.g., from pool surface, heat exchangers, incoming casks)

5. Ambient temperature
6. Ambient humidity
7. Tornado wind velocities (rotational and translational)
8. Tornado pressure drop
9. Maximum winds
10. Design earthquake peak acceleration
11. Explosion peak overpressure
12. Flood elevations
13. Water purity (ionic and radiological).

4. INSTALLATION DESIGN

Provide descriptive information on the buildings and other installed features of the installation and their locations on the site. Use drawings and maps as appropriate. Describe and evaluate each part of the installation with emphasis on those features that serve functions that are important to safety. Describe and evaluate special design features employed to withstand environmental forces and accident forces. Identify those features that are covered by the quality assurance program.

4.1 Summary Description

4.1.1 Location and Layout of Installation

Identify the location of the buildings and other installed facilities on a map or drawing to scale. Also include roadways, railroad lines, and utility and water service locations.

4.1.2 Principal Features

4.1.2.1 Site Boundary. Show the boundary that encompasses the area owned or controlled by the applicant.

4.1.2.2 Controlled Area. Show the controlled area established by the criteria in § 72.106 of 10 CFR Part 72.

4.1.2.3 Site Utility Supplies and Systems. Identify the utility supplies and systems, including the sources of water. Include the location of test wells and coolers.

4.1.2.4 Storage Facilities. Show the location of holding ponds, chemical and gas storage vessels, or other open-air tankage on or near the site that may be associated with ISFSI operations.

4.1.2.5 Stack. Show the location of any stacks in relation to the other facilities.

4.2 Storage Structures

Provide the design bases for the storage pools, including (1) analysis and design procedures for tornado, earthquake, fire, explosion, and differential subsidence effects, (2) the general analysis and design procedures for normal, off-normal, and special loadings and load combinations, (3) allowable foundation loads and deflections and deformation stresses for structures, (4) provisions and methods for making connections between the proposed structures and future modifications and additions, and (5) consideration given to combination stress loadings.

4.2.1 Structural Specifications

Describe the bases and engineering design specifications for the storage pools. Discuss applicable nationally recognized codes and standards, the materials of construction, and the fabrication and inspection to be used, and itemize in tabular form activities that will be covered by the quality assurance program discussed in Chapter 11, "Quality Assurance."

4.2.2 Installation Layout

4.2.2.1 Building Plans. Provide engineering drawings, plans, and elevations, showing the layout of the functional features of buildings. Show sufficient detail to identify all features to be discussed in this chapter. Include spatial and equipment identification data directly on the layouts with suitable designations in tabular listings.

4.2.2.2 Building Sections. Include sectional drawings to relate all features to be discussed in this chapter.

4.2.2.3 Confinement Features. Identify and discuss general layout criteria for the installation that have been included in the design to ensure confinement of radioactivity. This should be a general discussion with details to be presented in the appropriate part of this chapter. Include in the discussion ventilation, filters, pool water treatment, piping, and other physical means such as barriers, encasements, liners, and protective coatings. Identify the interfaces between the systems, and discuss the safety aspects of the interfaces. Details on ventilation systems should be presented in Chapter 7, "Radiation Protection."

4.2.3 Individual Unit Description

List each operational unit sequentially from the receipt of spent fuel through the various operations. The following are typical items: shipping cask receiving and inspecting, cask unloading, spent fuel transfer, spent fuel storage, pool water treatment, and control locations. Show the location of each by use of engineering drawings.

4.2.3.1 Function. Describe the function of the individual operational areas, and discuss the performance objectives.

4.2.3.2 Components. Discuss the components in the area under discussion. Use individual equipment sketches, layouts of equipment location to identify aspects of the components that must be relied on, and limits imposed on the design to achieve safety objectives.

4.2.3.3 Design Bases and Safety Assurance. Present the design codes used and additional specifications necessary to provide a sufficient margin of safety under normal and accident conditions to ensure that a single failure will not result in the release of significant radioactive material. Detail on backup provisions and interfaces with other areas should be included. Include a discussion of the features used to ensure that operating personnel are protected from radiation and contamination and that criticality will not occur.

4.3 Auxiliary Systems

Provide information on auxiliary systems that are important to safety for the installation. Emphasis should be placed on provisions for coping with unscheduled occurrences in a manner that will preclude an unsafe condition. Define the design bases, codes, specifications, and standards that will provide a safety margin to ensure that a single failure within an auxiliary system will not result in releases of radioactive materials.

For certain auxiliary systems involving building ventilation, electric power, air, and water, three categories of loads are possible:

1. Loads determined by normal operations,

2. Load situations resulting from primary failure and/or accident conditions, and

3. Emergency load (defined as the minimum requirement for the total safety of a shutdown operation, including its surveillance requirements).

Minimum loads are further defined as the design characteristics for the confinement systems that are required for such systems to prevent the release of radioactive materials under design basis accident conditions.

Describe the location of the various auxiliary systems in relationship to their functional objectives. This section should refer to drawings presented in Section 4.2.2 and should present additional details to identify the detailed physical arrangement. For each auxiliary system, as appropriate, provide single line drawings and a narrative description of its operating characteristics and safety considerations.

4.3.1 Ventilation and Offgas Systems

Describe the design, operating features, and limitations for performance of the ventilation-filtration systems in detail to show that there will be sufficient backup, excess capacity, repair and replacement capability, and structural integrity to ensure controlled airflow in all credible circumstances to minimize release of radioactive particulates. Supplement the discussion with appropriate drawings to show the flow distribution, pressure differentials, flow quantity, velocity, and filter and fan housing arrangements. Identify each of the areas serviced and the interfaces among areas in the following sections:

4.3.1.1 Major Components and Operating Characteristics. Present the design bases selected for the building and unit ventilation systems. Present detailed discussions justifying these bases, the system designs, and operating characteristics.

Describe the components making up each system and the relationship of the various systems to one another. Describe each system in terms of air supply, its collection and distribution systems, modes of gas conditioning, jetting, sequence of filtration, filter protection, the exhaust fans, and the stack. For clarity, provide and reference in the discussion appropriate engineering drawings and sketches.

Emphasize the design features that ensure confinement of radioactive particulates under conditions of power failure, adverse natural phenomena, breakdown of equipment, fire and explosion, improper flow of air, contaminated spills, and loss of filter integrity.

4.3.2 Electrical Systems

4.3.2.1 Major Components and Operating Characteristics. Discuss the source and characteristics of the primary electrical system providing normal power to the installation. Provide a description of the source of the secondary system, if applicable.

Describe the design providing for the emergency power source or sources and the means for ensuring uninterruptible service to those items requiring it. For each item of equipment and system serviced by emergency power, list the location, required kilowatts, and type of startup system.

4.3.2.2 Safety Considerations and Controls. Itemize and discuss the mechanisms and the sequence and timing of events that will occur in the event of a partial loss of normal power and in the event of a total loss of normal power to ensure safe storage conditions and shutdown of handling operations. Present the design features pertinent to the use of emergency power. Also describe the procedure for subsequent reestablishment of normal load service.

4.3.3 Air Supply Systems

4.3.3.1 Compressed Air. Present the design for supplying the compressed air needs of the installation, the components, and their location and operating characteristics. Include a description of the compressors, receivers and dryers, and distribution systems.

4.3.3.2 Breathing Air. Present the design for supplying the breathing air needs of the installation. Include a description of the compressors, receivers and dryers, alarms and safety systems, and distribution systems. Discuss in detail the backup provisions for the breathing air system and its ability to function during emergency situations.

4.3.4 Steam Supply and Distribution System

4.3.4.1 Major Components and Operating Characteristics. Present the design for supplying steam to the installation, including a discussion of the fuel supply and boiler type.

4.3.4.2 Safety Considerations and Controls. Discuss features of the steam supply system with respect to continuity of operations that are important to safety, if applicable.

4.3.5 Water Supply System

4.3.5.1 Major Components and Operating Characteristics. For the water supply, discuss the primary source, alternative sources, storage facilities, and supply system. Itemize design considerations to demonstrate the continuity of the water supply. Also itemize by service (cooling, potable, operations such as cask washdown, and fire) the quantities of water used under normal and off-normal conditions.

4.3.5.2 Safety Considerations and Controls. Discuss the effects of loss of water supply source, failure of main supply pumps or supply lines, and power failure. Also discuss the means for coping with drought and flood conditions.

4.3.6 Sewage Treatment System

4.3.6.1 Sanitary Sewage. Describe the sanitary sewage handling system to show that no radioactive material can be discharged in this effluent.

4.3.6.2 Chemical Sewage. Describe any system that may be used for handling and treatment of other nonradioactive liquid effluents.

4.3.7 Communication and Alarm Systems

4.3.7.1 Major Components and Operating Characteristics. Discuss the systems for external and internal communications with particular emphasis on the facilities to be used under emergency conditions.

4.3.7.2 Safety Considerations and Controls. Describe the functioning of the communication systems and alarms in response to normal and off-normal operations and under accident conditions.

4.3.8 Fire Protection System

4.3.8.1 Design Bases

1. Identify the fires that could indirectly or directly affect structures, systems, and components that are important to safety. Describe and discuss those fires that provide the bases for the design of the fire protection system, i.e., fires considered to be the maximum fire that may develop in local areas assuming that no manual, automatic, or other firefighting measures have been started and the fire has passed flashover and is reaching its peak burning rate before firefighting can start. Consider fire intensity, location, and (depending on the effectiveness of fire protection) the duration and effect on adjacent areas.

2. Discuss fire characteristics, such as maximum fire intensity, flame spreading, smoke generation, production of toxic contaminants, and the contribution of fuel to the fire for all individual installation areas that have combustible materials and are associated with structures, systems, and components that are important to safety. Include in the discussion the use and effect of noncombustible and heat-resistant materials. Provide a list of the dangerous and hazardous combustibles and the maximum amounts estimated to be present. State where these will be located in the installation in relationship to safety systems.

3. Discuss and list the features of building and installation arrangements and the structural design features that provide for fire prevention, fire extinguishing, fire control, and control of hazards created by fire. List and describe in the discussion the egress, fire barriers, fire walls, and the isolation and confinement features provided for flame, heat, hot gases, smoke, and other contaminants.

4. List the codes and standards considered and used for the design of the fire protection systems, including published standards of the National Fire Protection Association.

4.3.8.2 System Description

1. Provide a general description of the fire protection system, including drawings showing the physical characteristics of the installation location and outlining the fire prevention and fire suppression systems to be provided for all areas associated with physical security and structures, systems, and components that are important to safety.

2. Discuss the protection and suppression systems provided in the control room and other operating areas containing security equipment and other equipment that is important to safety.

3. Describe the design features of detection systems, alarm systems, automatic fire suppression systems, and manual, chemical, and gas systems for fire detection, confinement, control, and extinguishing. Discuss the relationship of the fire protection system to the onsite ac and dc power sources.

4. Discuss smoke, heat, and flame control; combustible and explosive gas control; and toxic contaminant control, including the operating functions of the ventilating and exhaust systems during the period of fire extinguishing and control. Discuss the fire annunciator warning system, the appraisal and trend evaluation systems provided with the alarm detection system in the proposed fire protection systems, and the backup or public fire protection if this is to be provided in the installation. Include drawings and a list of equipment and devices that adequately define the principal and auxiliary fire protection systems.

5. Describe electrical cable fire protection and detection and the fire confinement, control, and extinguishing systems provided. Define the integrity of the essential electric circuitry needed during the fire for safe shutdown of operations and for firefighting. Describe the provisions made for protecting this essential electrical circuitry from the effects of fire-suppressing agents.

4.3.8.3 System Evaluation. Provide an evaluation for those fires identified in Section 4.3.8.1. This evaluation should consider the quantities of combustible materials present, the installation design, and the fire protection systems provided. Describe the estimated severity, intensity, and duration of the fires and the hazards created by the fires. Indicate for each of the postulated events the total time involved and the time for each step from the first alert of the fire hazard until safe control or extinguishment is accomplished.

Provide a failure mode and effects analysis to demonstrate that operation of the fire protection system in areas containing security and operational safety features would not produce an unsafe condition or preclude safe shutdown of operations. An evaluation of the effects of failure of any portion of the fire protection system not designed to seismic requirements should be provided with regard to the possibility of damaging other equipment. Include an analysis of the fire detection and protection system with regard to design features to withstand the effects of single failures.

4.3.8.4 Inspection and Testing Requirements. List and discuss the installation, testing, and inspection planned during construction of the fire protection systems to demonstrate the integrity of the systems as installed. Describe the operational checks, inspection, and servicing required to maintain this integrity. Discuss the routine testing necessary to maintain a highly reliable alarm detection system.

4.3.8.5 Personnel Qualification and Training. State the qualification requirements for the fire protection engineer or consultant who will assist in the design and selection of equipment, inspect and test the completed physical aspects of the system, develop the fire protection program, and assist in the firefighting training for the operating installation. Discuss the initial training and the updating provisions such as fire drills provided for maintaining the competence of the station firefighting and operating crew, including personnel responsible for maintaining and inspecting the fire protection equipment.

4.3.9 Maintenance Systems

4.3.9.1 Major Components and Operating Characteristics. Provide the design bases, locations, and modes of operation related to the maintenance programs for the installation. Emphasis should be placed on provisions for maintenance of remotely operated equipment and ventilation system components; pool and cooler repairs; decontamination and disposal of contaminated equipment, piping, and valves; quality control; and testing.

4.3.9.2 Safety Considerations and Controls. Discuss the means for conducting required maintenance with a minimum of personnel radiation exposure or injury as a result of designing for accessibility for maintenance and ensuring the confinement of contaminated materials.

4.3.10 Chemical Systems

Describe the major components and operating characteristics of facilities that will be used in association with chemical operations. If hazardous chemicals or materials are involved, discuss the provisions for mitigating accidents. Itemize the chemicals and materials to be used and their quantities, indicate where they will be used, and codify them with respect to hazard. Also discuss the potential impact on the storage system in the event of an accident involving their use.

4.3.11 Air Sampling Systems

Discuss the various types of air sampling systems; include design and operating features for each system. Include limitations for performance of the air sampling systems in detail to show there will be sufficient vacuum and back-up capability to ensure that proper sampling will be conducted in all credible circumstances. Supplement the discussion with appropriate drawings to show flow quantity, fixed-head and constant air monitor placements, and vacuum pump and exhaust arrangements. Identify each of the areas serviced and how each area is interconnected.

4.3.11.1 Major Components and Operating Characteristics. Present the design selected for the room and area air sampling systems. Present detailed discussions justifying the system design and operating characteristics.

Describe the components of each system and the relationship of the various systems to each other. Describe each system in terms of vacuum supply, collection system, and exhaust points. For clarity, provide and reference in the discussion the appropriate engineering drawings.

4.3.11.2 Safety Considerations and Controls. Discuss features of the air sampling systems with respect to continuity of operations to ensure that sampling is conducted during off-normal conditions.

4.3.12 Pool Water System

4.3.12.1 Major Components and Operating Characteristics. Provide the design bases for the systems and components required to provide for water purification, decay heat removal, and other operating needs. Also provide information on cooling ponds or towers and the means for maintaining water quality.

4.3.12.2 Safety Considerations and Controls. Discuss the implications and methods of control that will be used if there is an interruption of the water supply, loss of components of the cooling systems, and need for cooling emergency auxiliary systems.

4.4 Decontamination Systems

4.4.1 Equipment Decontamination

Describe the design and operating features of the equipment decontamination system. Discuss the various decontamination techniques that will be available as part of this system and the limitations of each technique.

4.4.1.1 Major Components and Operating Characteristics. Present the design selected for the equipment decontamination system. Present detailed discussions justifying this design and operating characteristics.

Describe the components of this system and how this system interacts with the other service and utility systems. Discuss the ventilation requirements for this system. For clarity, provide and reference in the discussion the appropriate engineering drawings.

4.4.1.2 Safety Considerations and Controls. Emphasize the design features that ensure confinement of radioactive waste generated by this system. Discuss the design features that ensure that radiation exposure received by workers during the decontamination operations will be as low as is reasonably achievable.

4.4.2 Personnel Decontamination

Describe the design and operating features of the personnel decontamination system. Discuss the type of decontamination that will be available and the limitations of this system.

Describe actions that will be taken if decontamination requirements exceed the limitations of this system.

4.5 Shipping Cask Repair and Maintenance

Indicate the location of the shipping cask repair and maintenance facility or area on a plot plan of the ISFSI. Provide an engineering drawing of the shop layout with major items of equipment identified. This activity may be incorporated into other maintenance areas or facilities.

Describe planned modes of operation with emphasis on contamination control and occupational radiation exposure reduction.

5. OPERATION SYSTEMS

5.1 Operation Description

In this chapter, provide a detailed description of all operations, including systems, equipment, and instrumentation and their operating characteristics. Identify potentially hazardous operation systems. Provisions made for operation safety features to ensure against a hazard should be so designated in the details presented. The latter information should include, but not be limited to, listing systems necessary for curtailing operations under normal and off-normal conditions, maintaining the installation in a safe condition, secondary confinement, and backup or standby features. In addition to describing the operations, reference the items that will require continuing attention with respect to the quality assurance program after installation startup. For each system, describe the considerations used to achieve as low as is reasonably achievable (ALARA) levels of radioactive material in the installation effluents and to ensure safe nuclear conditions at all times. The SAR should show a definition of limits and parameters for developing the Technical License Conditions (Technical Specifications).

5.1.1 Narrative Description

Describe the proposed operation, and relate it to the equipment and associated controls. Include in this discussion ancillary activities as pertinent, i.e., preparation of reactants, offgas handling, volume reduction of site-generated wastes, and decontamination. In the description, identify the interfaces between systems, and discuss the safety aspects of the interfaces.

5.1.2 Flowsheets

In support of the description above, supply flowsheets showing the sequence of operations and their controls. Provide identification of each step in sufficient detail so that an independent review can be made to ensure a safe operation. Provide the flow input and output characteristics for effluent control equipment for effluent streams to show the efficiencies obtained.

Sufficient detail should be given to provide source terms for radiation exposure determinations to be developed in Chapter 7, "Radiation Protection." Include equipment descriptions with dimensions, design and operating characteristics, materials of construction, special design features, and operating limitations. Appropriate engineering and operating instrumentation details should be provided.

5.1.3 Identification of Subjects for Safety Analysis

Identify subjects for safety analysis. Reference this part of the chapter, as applicable, in subsequent discussions of design and operating features.

5.1.3.1 Criticality Prevention. Provide a summary description of the principal design features, procedures, and special techniques used to preclude criticality in all portions of the installation.

5.1.3.2 Chemical Safety. Provide a summary description of any chemical hazards and the approaches used to preclude associated accidents.

5.1.3.3 Operation Shutdown Modes. Describe the general conditions and surveillance needs in various shutdown modes (extended, short-term, emergency). Indicate the time required to shut down and start up for each mode.

5.1.3.4 Instrumentation. Provide a summary description of the instruments used to monitor operating conditions and the systems used to control operations. The description should include testability, redundancy, and failure conditions. Also describe effluent and process monitors and data loggers.

5.1.3.5 Maintenance Techniques. Discuss the rationale and outline the techniques to be used for major maintenance tasks. This should include a statement of areas where specific techniques apply. Include system and component spares.

5.2 Spent Fuel Handling

Each of the following sections is intended to provide an understanding of the functions, design bases, and pertinent design features of the operating system as they relate to installation or environmental safety. To the extent pertinent, sketches should be used to describe unique equipment or design features.

5.2.1 Spent Fuel Receipt, Handling, and Transfer

Describe the systems associated with receipt, transfer, and removal from the storage pool for shipment. From the design criteria, present the provisions for cooling and maintaining fuel assemblies in subcritical arrays and the provisions for shielding.

5.2.1.1 Functional Description. Present a flow diagram and functional description of the spent fuel receiving, handling, transfer, and retrieval systems, including provisions for handling defective fuel assemblies. Include drawings or references to drawings as needed.

5.2.1.2 Safety Features. Describe all features, systems, or special handling techniques that are important to safety if they are included in the system to provide for the safety of the operation under both normal and off-normal conditions. Include the limits selected for a commitment to action.

5.2.2 Spent Fuel Storage

Describe the operations used for transfer of spent fuel assemblies to the storage position, the storage surveillance program, and removal from the storage position.

5.2.2.1 Safety Features. Describe all features, systems, and special techniques that are important to safety if they are included in the system to provide for the safety of the operation under both normal and off-normal conditions. Include the limits selected for a commitment to action.

5.3 Other Operating Systems

Each operating system should be related to the process description and appropriate flowsheets. Where appropriate, identify the system as a source of effluents and onsite-generated wastes, discussed in Chapter 6, "Site-Generated Waste Confinement and Management," and Chapter 7, "Radiation Protection." Reference the physical layout presentations discussed in Chapter 4, "Installation Design." Use subsections to present the information on each operating system.

5.3.1 Operating System

Name the actual operating system described in this section. Continue additional systems sequentially (e.g., 5.3.1.1, 5.3.1.2...).

5.3.1.1 Functional Description. Describe the portion of the operations to be discussed, its function, and how the function will be accomplished.

5.3.1.2 Major Components. If more than one component is included in a particular system, explain the interrelationship of the individual components and the means by which these are combined within the system.

5.3.1.3 Design Description. Discuss the design bases; design capacity, including materials of construction; pressure and temperature limits; corrosion allowances; and standards or codes used. Itemize material and fabrication specifications pertaining to the system in sufficient detail to relate, as appropriate, to Chapter 9, "Conduct of Operations," and Chapter 11, "Quality Assurance." Describe the layout of equipment from the standpoint of minimizing personnel exposures to radiation during operations and maintenance. With suitable cross-reference, it will not be necessary to duplicate this information in Chapter 9, "Conduct of Operations," or in Chapter 11, "Quality Assurance."

5.3.1.4 Safety Criteria and Assurance. From the parameters discussed in the preceding sections, summarize the criteria for the means of ensuring a safe system as constructed, operated, and maintained. Summarize those limits selected for commitment to action. Identify those items that can be characterized as being operation safety features that are considered necessary beyond normal operation and control. Emphasis should be placed on personnel exposure considerations.

5.3.1.5 Operating Limits. Identify limits, conditions, and performance requirements in sufficient detail to make possible an evaluation as to whether a Technical License Condition may be necessary. The relationship to other systems should be clearly described.

5.3.2 Component/Equipment Spares

Describe in detail design features that include installation of spare or alternative equipment to provide continuity of safety under normal and off-normal conditions. Particular emphasis is needed on design provisions to minimize exposure to radiation for maintenance operations. Describe the bases for inspection, preventive maintenance, and testing programs to ensure continued safe functioning.

5.4 Operation Support Systems

Although effluent handling systems may be considered operation support, these systems should be discussed in Chapter 6, "Site-Generated Waste Confinement and Management." Describe any chemical systems used to monitor or control the operations described in Chapter 4, "Installation Design." Principal auxiliary backup equipment should be discussed in Chapter 4.

5.4.1 Instrumentation and Control Systems

By means of instrumentation engineering flowsheets of the operations, discuss the instrumentation and control features associated with operation control, monitors and alarms, and the relationship of one to the other. Identify those aspects relied on to establish that adequate reliability is provided and that provisions have been included in the design to ensure continued safe operation or safe curtailment of operations under accident conditions. Relate these to the design criteria presented in Chapter 3, "Principal Design Criteria."

Discuss how instrumentation and control systems monitor variables and operating systems that are important to safety over anticipated ranges for normal operation, off-normal operation, accident conditions, and safe shutdown. Describe the redundancy of safety features necessary to ensure adequate safety of spent fuel storage operations. For a water basin, examples of the variables and systems that are important to safety and that need constant surveillance and control are the pool water level, water temperature, water and air radioactivity levels, and pool leakage rates.

Discuss the provisions for in situ testability of the instrumentation and control systems, particularly for sumps, sump pumps, sump liquid level monitors, and other hard-to-get-at equipment. Describe how instrumentation and control systems are designed to be fail-safe or to assume a state demonstrated to be acceptable if conditions such as disconnection, loss of energy or motive power, or adverse environments are experienced. For each, provide the following information:

5.4.1.1 Functional Description
5.4.1.2 Major Components
5.4.1.3 Detection System and Locations
5.4.1.4 Operating Characteristics
5.4.1.5 Safety Criteria and Assurance

5.4.2 System and Component Spares

Describe in detail the installation of spare or alternative instrumentation designed to provide continuity of operation under normal and off-normal conditions. Also describe the bases for inspection, preventive maintenance, and testing programs to ensure continued safe functioning.

5.5 Control Room or Control Areas

Discuss how a control room or control areas are to be designed to permit occupancy and actions to be taken to safely operate the installation under both normal and off-normal conditions. Describe the redundancy that allows the installation to be put into a safe condition and then be monitored if any control room or control area is removed from service.

5.6 Analytical Sampling

Provisions for obtaining samples for analysis and controls necessary to ensure that operations are within prescribed limits should be discussed. Describe the facilities and analytical equipment that will be available to perform the analyses as well as the destination of laboratory wastes.

Discuss provisions for obtaining samples during off-normal conditions to ensure that prescribed limits have not been violated.

6. SITE-GENERATED WASTE CONFINEMENT AND MANAGEMENT

By reference to Chapter 3, "Principal Design Criteria," provide the primary design bases and supporting analyses for demonstrating that all radioactive waste materials generated as a result of ISFSI operations will be safely contained until disposal. The considerations for offsite disposal of solid waste materials and contaminated equipment should be included. The waste confinement objectives, equipment, and program should implement, in part, the considerations necessary for protection against radiation, as described in Chapter 7, "Radiation Protection."

All reference to waste in this chapter is to waste that is generated as a result of the ISFSI operation.

6.1 Onsite Waste Sources

Classify all anticipated radioactive wastes with respect to source, chemical and radiological composition, method and design for treatment and handling, and mode of storage prior to disposal. Previous flowsheets and diagrams may be cross-referenced.

Waste sources other than those containing radioactive materials should also be identified if they constitute a potential safety problem. Account for combustion products as well as chemical wastes leaving the installation. This information should be included to assist the NRC staff in ascertaining that no radioactive material will be added to such sources, particularly effluents.

6.2 Offgas Treatment and Ventilation

For all offgas and ventilation systems, indicate those radioactive wastes that will be produced as a result of their removal from the gases cleaned by those systems. Items that collect wastes, such as filters and scrubbers, should be discussed to indicate the destination of the wastes upon regeneration or replacement. If the wastes enter other waste treatment systems, indicate how such transfers are made and any possible radiological effects of the transfer. The actual operation of the gas-cleaning equipment and its minimum expected performance should be discussed in this section.

6.3 Liquid Waste Treatment and Retention

Show how all liquid wastes are generated and how they enter liquid treatment systems. Include such items as filter backwashes, laboratory wastes, cask washdown, liquid spills, decontamination, and cleanup solutions. As part of the design objectives, a statement should be made concerning the inventory levels expected, provisions for temporary storage, and identification of those streams that will be processed to achieve volume reduction or solidification. Relate the discussion on process and equipment to the radiation levels of the various types of wastes to be handled. A description of the solidification of liquid wastes should be presented.

6.3.1 Design Objectives

Describe the design objectives for the system under discussion. In particular, identify criteria that incorporate backup and special features to ensure that the waste will be safely contained and personnel doses will be minimized.

6.3.2 Equipment and System Description

Provide a description of the equipment and systems to be installed. Accompany the description with appropriate drawings to show location of equipment, flow paths, piping, valves, instrumentation, and other physical features. Describe features, systems, or special handling techniques that are important to safety included in the systems to provide for the safety of the operation.

6.3.3 Operating Procedures

Provide a narrative description of the procedures associated with operation of the systems. State whether the procedures will include performance tests, action levels, action to be taken under normal and off-normal conditions, and methods for testability to ensure functional operation.

6.3.4 Characteristics, Concentrations, and Volumes of Solidified Wastes

Describe the physical, chemical, and thermal characteristics of the solidified wastes, and provide an estimate of concentrations and volumes generated.

6.3.5 Packaging

Describe the means for packaging the solidified wastes, and identify aspects that will be incorporated in the operating quality assurance program. The package itself should be described in detail to show (1) materials of construction, including welding information, (2) maximum temperatures for waste and container at the highest design heat loads, (3) homogeneity of the waste contents, (4) corrosive characteristics of the waste on the materials of construction, (5) means to prevent overpressurization of the package, and (6) confinement provided by the package under off-normal conditions.

6.3.6 Storage Facilities

Describe the operation of the storage facilities, demonstrating that the likelihood of accidental puncture or other damage to a package from natural phenomena or other causes is very low. Discuss external corrosion of the package from storage surroundings, if applicable. Show how packages will be moved safely into and out of storage locations and how the packages will be monitored over their storage life on site.

6.4 Solid Wastes

List and characterize all solid wastes that are produced during installation operation. Describe the systems used to treat, package, and contain these solid wastes.

6.4.1 Design Objectives

Describe the objectives of the methods and the equipment selected for minimizing the generation of solid wastes and for safe management of the solid waste that is generated.

6.4.2 Equipment and System Description

Provide a description of the equipment and systems to be installed. Accompany the description with appropriate engineering drawings to show location of the equipment and associated features that will be used for volume reduction, confinement or packaging, storage, and disposal.

6.4.3 Operating Procedures

Describe the procedures associated with operation of the equipment, including performance tests, process limits, and means for monitoring and controlling to these limits.

6.4.4 Characteristics, Concentrations, and Volumes of Solid Wastes

Describe the physical, chemical, and thermal characteristics of the solid wastes, and provide an estimate of concentrations and volumes generated.

6.4.5 Packaging

Describe the means for packaging the solid wastes where required, and identify aspects that will be incorporated in the operating quality assurance program.

6.4.6 Storage Facilities

For solid wastes to be retained on site for extended periods of time, show in detail the confinement methods used. Discuss corrosion aspects and monitoring of the confinement. Show how these wastes will be handled at the time the installation is permanently decommissioned.

6.5 Radiological Impact of Normal Operations - Summary

For the gaseous and liquid effluents and solid wastes, provide the following:

1. A summary identifying each effluent and type of waste;

2. Amount generated per metric ton (MT) of spent fuel handled and stored per unit of time;

3. Quantity and concentration of each radionuclide in each stream;

4. Identification of the locations beyond the restricted areas (as defined in paragraph 20.3(a)(14) of 10 CFR Part 20) and beyond the controlled area* that are potentially impacted by radioactive materials in effluents;

*The "controlled area" means that area immediately surrounding an ISFSI or monitored retrievable storage installation (MRS) for which the licensee exercises authority over its use and within which ISFSI or MRS operations are performed (§ 72.3 of 10 CFR Part 72).

5. For the locations identified in item 4, the amount of each radionuclide and its person-rem contribution of radiation dose to human occupants that can accrue under normal operating conditions;

6. Discussion and sample calculations showing the reliability of the estimated values presented; and

7. For each effluent, the constraints imposed on process systems and equipment to ensure a safe operation.

7. RADIATION PROTECTION

This chapter of the SAR should provide information on methods for radiation protection and on estimated radiation exposures to operating personnel during normal operation and anticipated operational occurrences (including all types of radioactive material handling, transfer, processing, storage, and disposal; maintenance; routine operational surveillance; inservice inspection; and calibration). This chapter should also provide information on layout and equipment design, the planning and procedures programs, and the techniques and practices employed by the applicant in meeting the standards of 10 CFR Part 20 for protection against radiation and the guidance given in the applicable regulatory guides. Reference to other chapters for information needed in this chapter should be specifically made where required.

7.1 Ensuring That Occupational Radiation Exposures Are As Low As Is Reasonably Achievable (ALARA)

7.1.1 Policy Considerations

Describe the management policy and organizational structure for ensuring that occupational exposures to radiation and radiation-producing sources are ALARA. Describe the applicable activities to be conducted by the individuals who have responsibility for radiation protection. Describe policy with respect to designing and operating the installation to achieve ALARA objectives. Indicate whether, and if so how, the guidance given in Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable," and, where appropriate, Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," will be followed. If this guidance will not be followed, indicate the specific alternative approaches to be used.

7.1.2 Design Considerations

Describe layout and equipment design considerations that are directed toward ensuring that occupational radiation exposures are ALARA. Describe how experience from any past designs is used to develop improved design for ensuring that occupational radiation exposures are ALARA and that contamination incidents are minimized. Include any design guidance (both general and specific) given to the individual designers. Describe how the design is directed toward reducing the (1) need for maintenance of equipment, (2) radiation levels and time spent where maintenance is required, and (3) contamination control in handling, transfer, and storage of all radioactive materials. These descriptions should be detailed in the SAR, including an indication of whether, and if so how, the applicable design consideration guidance in Regulatory Position 2 of Regulatory Guide 8.8 will be followed. If it will not be followed, indicate the specific alternative approaches to be used. The SAR should also state whether, and if so how, relevant design experience from existing facilities is being used.

Discuss the arrangements and plans for decontamination of the installation and individual items of equipment in case of need.

Discuss how the ALARA goals are to be met and the alternatives considered with regard to occupational exposures to radiation.

7.1.3 Operational Considerations

Describe the methods used to develop the detailed plans and procedures for ensuring that occupational exposures to radiation are ALARA and that operational safeguards are provided to ensure that contamination levels are ALARA. Describe how these plans, procedures, and safeguards will impact on the design of the installation and how such planning has incorporated information from other designs and follows the applicable guidance given in Regulatory Position 4 of Regulatory Guide 8.8. If the guidance will not be followed, describe the specific alternative approaches to be used.

Identify and describe procedures and methods of operation that are used to ensure that occupational radiation exposures are ALARA, such as those pertinent procedures in Regulatory Position 4 of Regulatory Guide 8.8 and in Regulatory Guide 8.10. Describe how operational requirements are reflected in the design considerations described in Section 7.1.2 and the radiation protection design features described in Section 7.3. Provide the criteria or conditions under which various procedures and techniques are implemented for ensuring that occupational exposures to radiation are ALARA and residual contamination levels are ALARA for all systems that contain, collect, store, or transport radioactive solids and liquids generated as a result of the ISFSI operations, including those from the radioactive waste treatment, handling, and storage systems.

7.2 Radiation Sources

7.2.1 Characterization of Sources

The sources of radiation that are the bases for the radiation protection design and the bases for their curie values should be described as input to the shielding design calculations. For shielding calculations, the description should include a tabulation of radiation sources by isotopic composition, X-ray and gamma ray energy groups, and geometry of the radiation source. In addition to the spent fuel in storage, the sources should include radioactive materials contained in equipment and storage containers or tanks throughout the installation. Indicate the physical and chemical forms of all sources.

7.2.2 Airborne Radioactive Material Sources

The sources of radioactive material that may become airborne in areas easily accessible to, or normally occupied by, operating personnel should be described with the provisions made for personnel protective measures. The description should include a tabulation of the calculated concentrations of airborne radioactive material by nuclides expected during normal operation and anticipated operational occurrences in areas normally occupied by operating personnel. Provide the models and parameters for calculating airborne concentrations of radioactive materials.

7.3 Radiation Protection Design Features

7.3.1 Installation Design Features

Describe equipment and installation design features used for ensuring that occupational exposures to radiation are ALARA and a high degree of integrity is obtained for the confinement of radioactive materials. Indicate whether, and if so how, the applicable design feature guidance given in Regulatory Position 2 of Regulatory Guide 8.8 has been followed. If it was not followed, describe the specific alternative approaches used.

Provide illustrative examples of the features used in the design as applied to the systems addressed in Section 7.1.3. An illustrative example should be provided for components of each of the following systems: shipping cask receiving, preparation, and transfer; cask decontamination and unloading; fuel transfer; storage pools; pool water purification and cooling, including filter and cooler maintenance; and waste treatment packaging, storage, and shipment. Reference other chapters and sections as appropriate.

Provide scaled layout and arrangement drawings of the installation showing the locations of all sources described in Section 7.2. Include specific activity, physical and chemical characteristics, and expected concentrations. Provide on the layouts the radiation area designations, including area boundaries and type of interface (e.g., partitions, locked doors, barriers).

The layouts should show shield wall thicknesses, controlled access areas, personnel and equipment decontamination areas, contamination control areas and type of controls, traffic patterns, location of the health physics facilities, location of airborne radioactive material and area radiation monitors, location of control panels for radiological waste equipment and components, location of the onsite laboratory for analysis of chemical and radioactive samples, and location of the counting room. Provide the design radiation dose rate for each area and activity. Describe the facilities and equipment involved, including any special equipment provided specifically for radiation protection.

Describe the function and performance objectives of the building ventilation systems. Discuss the areas and equipment serviced and the design for each unit system. Include in the description, by referring to drawings, the interface considerations between systems. Discuss the design limits selected for operation and the performance limits that must be met for safety. Discuss the program for measuring the efficiency of filters and other gaseous effluent treatment devices over the lifetime of the installation. Provide criteria for changing the filters. Discuss how the ventilation system design will allow filter changes to be compatible with the ALARA principle.

Estimate the concentrations and quantities of radioactive materials discharged by each system. List source terms by type of material, concentration, activity, and total quantity per unit time to be used in determining radiation exposure data presented in Section 7.4. Provide a detailed discussion of the evaluations made to show that unit ventilation systems by themselves and in conjunction with other ventilation systems will be operable. Show that sufficient margins exist so that a single component failure will not result in an uncontrolled release of radioactivity.

Reference the discussions of offgas treatment in Section 4.3.1 and appropriate equipment and process flow drawings to further show that:

1. ALARA radioactivity releases will be achieved during normal operation;
2. Capacity is sufficient to confine radioactive material during projected operating conditions;
3. Provisions are incorporated to adequately monitor performance; and
4. Satisfactory design features are incorporated to interface with other effluent and ventilation systems.

7.3.2 Shielding

Provide information on the shielding for each of the radiation sources identified in Section 7.2. Show the design of penetrations, the material, the method by which the shield parameters (e.g., attenuation coefficients, buildup factors) were determined, and the assumptions, codes, and techniques used in the calculations. Describe special protective features that use shielding, geometric arrangement (including equipment separation), or remote handling to ensure that occupational exposures to radiation will be ALARA in normally occupied areas. Describe the use of portable shielding, if applicable.

7.3.3 Ventilation

The personnel protection features incorporated in the design of the ventilation systems should be described by amplifying the discussions on building ventilation and offgas treatment provided in Chapters 4, "Installation Design," and 5, "Operation Systems," to show that the designs selected will satisfy the ALARA provisions of paragraph 20.1(c) of 10 CFR Part 20 and of appropriate regulatory guides. The discussion should also show that expenditures for additional design work and equipment will not result in an accompanying reduction of released radioactive materials or personnel dose.

Reference the discussion on building ventilation in Section 4.3.1 and appropriate engineering drawings to further show the interrelationship of component parts and controls to the following:

1. Maintaining levels of exposure radiation ALARA;
2. Preventing spread of radioactive materials and controlling contamination between areas;
3. Interfacing with process offgases (e.g., waste treatment, cask venting); and
4. Limiting the spread of radioactive materials within the ventilation systems.

7.3.4 Area Radiation and Airborne Radiation Monitoring Instrumentation

Describe the fixed area radiation monitors and continuous monitoring instrumentation for airborne radiation and the placement of each. Describe the criteria and methods used for determining setpoints for alarms from the radiation monitoring system.

Provide information on the auxiliary and emergency power supply, range, sensitivity, accuracy, calibration methods and frequency, alarm setpoints, recording devices, and location of detectors, readouts, and alarms for the monitoring instrumentation. Also provide the location of the continuous airborne monitor sample collectors, and give details of sampling line pump location and for obtaining representative samples of effluent monitors.

7.4 Estimated Onsite Collective Dose Assessment

Provide the estimated annual occupancy times for each installation radiation area, including the storage area, during normal operation and anticipated operational occurrences. For areas with expected airborne concentrations of radioactive material (as identified in Section 7.2.2), provide estimated maximum individual and total person-hours of occupancy. Also provide the objectives and criteria for design dose rates in various areas and an estimate of the annual collective person-rem doses associated with major functions, such as spent fuel transfer and storage operations, and ancillary activities (e.g., offgas handling, waste treatment), maintenance, radwaste handling, decontamination, and inservice inspection. Supply the bases, models, and assumptions for the above values.

The estimated annual occupancy for each radiation area in the installation should be tabulated and the bases for the values provided. Provide estimates of annual collective doses (person-rem) for the functions listed above and the assumptions used in determining these values.

7.5 Health Physics Program

7.5.1 Organization

Describe the administrative organization of the health physics program, including the authority and responsibility of each position identified. Indicate whether, and if so how, the applicable guidance in Regulatory Position 2 of Regulatory Guide 8.8 and in Regulatory Guide 8.10 has been followed. If it was not followed, describe the specific alternative approaches used. Describe the experience and qualifications of the personnel responsible for the health physics program and for handling and monitoring radioactive materials.

7.5.2 Equipment, Instrumentation, and Facilities

Describe portable and laboratory equipment and instrumentation for (1) performing radiation and contamination surveys, (2) sampling airborne radioactive material, (3) monitoring area radiation, and (4) monitoring personnel during normal operation, anticipated operational occurrences, and accident conditions. Describe the instrument storage, calibration, and maintenance facilities. Describe the health physics facilities, laboratory facilities for radioactive material analyses, protective clothing, respiratory protective equipment, decontamination facilities (for equipment and personnel), and other contamination control equipment and areas that will be available. Indicate how the guidance provided by Regulatory Guides 8.4, "Direct-Reading and Indirect-Reading Pocket Dosimeters," and 8.9, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program," will be followed. If it is not followed, describe the specific alternative methods to be used.

Describe the location of the respiratory protective equipment, protective clothing, and portable and laboratory equipment and instrumentation. Describe the type of detectors and monitors and the quantity, sensitivity, range, and frequency and methods of calibration for all the equipment and instrumentation mentioned above.

7.5.3 Procedures

Describe the methods, frequencies, and plans for conducting radiation surveys. Describe the health physics plans that have been developed for ensuring that occupational radiation exposures will be ALARA. Describe the physical and administrative measures for controlling access and stay time for designated radiation areas. Reference may be made to Section 7.1, as appropriate. Describe the bases and methods for monitoring and controlling personnel, equipment, and surface contamination. Describe radiation protection training programs. Indicate how the guidance given in Regulatory Guides 8.9, 8.10, and 8.15, "Acceptable Programs for Respiratory Protection," will be followed. If it will not be followed, describe the specific alternative approaches to be used.

Describe the methods and plans for personnel dosimetry, including methods for recording and reporting results. Describe how dosimetric results are used as a guide to operational planning. The criteria for performing bioassays and routine and nonroutine whole-body and lung counting should be provided. Describe the methods and procedures for evaluating and controlling potential airborne radioactive material concentrations, including any requirements for special air sampling. Discuss the use of respiratory protective devices, including programs for fitting the respiratory protective equipment and training of personnel.

7.6 Estimated Offsite Collective Dose Assessment

Describe the program and the analytical approach taken to monitor the radioactive material content of the effluent streams of the installation. Relate the monitoring program to process flow diagrams and the discussions presented in Chapter 5, "Operation Systems," and Chapter 6, "Site-Generated Waste Confinement and Management." An estimate of the contribution by the operations of the ISFSI to the offsite radiation level should be provided.

7.6.1 Effluent and Environmental Monitoring Program

The program for monitoring and estimating the contribution of radioactive materials to the environment should be described.

7.6.1.1 Gas Effluent Monitoring. Describe the features of the sampling systems to be used, their locations, and the items to be monitored. For each system, show the expected reliability and sensitivity for each device. The selection of each system and instrument should be justified. The frequency of sampling, the limits for action, and the plans to be used to maintain continued integrity of analyses should also be discussed.

7.6.1.2 Liquid Effluent Monitoring. As with gas effluent monitoring, describe the features of the liquid sampling systems to be used, their locations, and the items to be monitored. For each system, show the expected reliability and sensitivity for each device. The selection of each system and instrument should be justified. The frequency of sampling, the limits for action, and the plans to be used to maintain continued integrity of analyses should also be discussed.

7.6.1.3 Solid Waste Monitoring. Describe the procedures, equipment, and instrumentation used to monitor all site-generated solid waste that contains radioactive materials.

7.6.1.4 Environmental Monitoring. Describe in detail the program that will provide measurements of radiation and radioactive materials in those pathways that lead to the highest potential radiation exposures of individuals resulting from ISFSI operations. Provide a table showing the type of sample, number of samples, sample location, collection frequency, and sample analysis performed and its frequency. Identify the sampling locations on a map of suitable scale to show distance and direction of monitoring stations, with the site boundary also indicated on this map. This section should include the program for continuing meteorological data collection and evaluation to supplement the estimates previously developed.

7.6.2 Analysis of Multiple Contribution

An analysis should be presented of incremental collective doses that would result from present or projected nuclear facilities in the vicinity (i.e., within an 8-kilometer (5-mile) radius) and should be compared with the collective doses (person-rem) from background for the same population.

7.6.3 Estimated Dose Equivalents

Present the annual collective doses (person-rem) estimated to be attributable to installation effluents in each of 16 compass sectors about the installation between each of the arcs at radii of 1.5, 3, 5, 6.5, and 8 kilometers (approximately 1, 2, 3, 4, and 5 miles). Provide details of assumptions, and give sample calculations with emphasis on critical pathways to man. Relate to the meteorological data presented in Chapter 2, "Site Characteristics," and the radioactive material release rates in Chapter 6, "Site-Generated Waste Confinement and Management." In addition to the person-rem whole-body determinations, details on uptakes by the critical organ should be provided.

7.6.3.1 Identification of Sources. For each radioisotope that contributes more than 10 percent of total dose, include a description of the characteristics of the isotope pertinent to its release and eventual biological impact.

7.6.3.2 Analysis of Effects and Consequences. An analysis of effects and the attendant consequences should be supported by information that includes the following:

1. Joint frequency distribution of wind speed, wind direction, and atmospheric stability;

2. Methods, assumptions, and conditions employed;

3. Biological pathways and the critical organ; and

4. Dose models.

The consequences should be given for each isotope that contributes more than 10 percent of total dose and for the critical organ in terms of maximum dose commitment (rem) per year, average dose commitment (rem) per year, and total collective dose (person-rem) per year for the population within an 8-kilometer (5-mile) radius.

The considerations of uncertainties in the calculational methods and equipment performance should be discussed. Conservatism existing in assumptions should also be described. Reference published data associated with the analysis.

Any digital computer programs or analog simulation used in the analysis should also be identified. Adequate figures should be included on the analytical model, computer listing, and input data. Reference to computer models already available to the NRC may be made by summary only.

7.6.4 Liquid Release

Describe radioactive liquid effluents. Refer to Chapter 6, "Site-Generated Waste Confinement and Management," for a discussion of how liquid wastes are treated. Describe the contribution that the liquid discharged to the atmosphere as water vapor makes to the gaseous radioactive source terms. Describe the radioactive site-generated wastes from the following sources, and include the same type of information (as applicable) as described in Section 7.6.3.2.

8. ACCIDENT ANALYSES

The evaluation of the safety of an ISFSI is accomplished in part by analyzing the response of the installation to postulated accident events in terms of minimizing (1) the causes of such events, (2) the quantitative identification and mitigation of the consequences, and (3) the ability to cope with each situation if it occurs. These analyses are an important aspect of the reviews made by the NRC prior to issuing a license to store spent fuel in an ISFSI.

An in-depth discussion of accident analysis should be presented in the SAR. This analysis should be updated to present details that have been revised or developed since the initial submittal.

In previous chapters, features important to safety have been identified and discussed. The purpose of this chapter is to identify and analyze a range of credible accident occurrences (from minor to the design basis accidents) and their causes and consequences. For each situation, reference should be made to the appropriate chapter and section describing the considerations to prevent or mitigate the accident.

ANSI/ANS 57.7-1981, "Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)," defines four categories of design events that may be used in establishing design requirements to satisfy operational and safety criteria. The first design event is associated with normal operations; the second and third apply to events that are expected to occur during the life of the installation. The fourth design event is concerned with natural phenomena or low probability events.

8.1 Off-Normal Operations

In this section, design events of the first and second type as defined in ANSI/ANS 57.7-1981 are considered. They may include malfunctions of systems, minor leakage, limited loss of external power, or operator error. In general, the consequences of the events discussed in this section would not have a significant effect beyond the controlled area. The following format should be used to present the desired detail.

8.1.1 Event

Identify the event, including the location of the event, type of failure or maloperation, and system or systems involved.

8.1.1.1 Postulated Cause of Event. Describe the sequence of occurrences that could initiate the event under consideration and the bases upon which credibility or probability of each occurrence in the sequence is determined.

The following should be provided:

1. Starting conditions and assumptions;

2. A step-by-step sequence of the course of each event, identifying all protection systems required to function at each step; and

3. Identification of any operator actions necessary.

The discussion should show the extent to which protective systems should function, the effect of failure of protective functions, and the credit taken for operation safety features. The performance of backup protection systems during the course of the event should be analyzed. The discussion also should include credit taken for the functioning of other systems and consequences of their failure.

The analysis given should permit an independent evaluation of the adequacy of the protection system as related to the event under study. The results can be used to determine which functions, systems, interlocks, and controls are important to safety and what actions are required by the operator under anticipated operational occurrence and off-normal conditions.

8.1.1.2 Detection of Event. Discuss the means or methods to be provided to detect the event, such as visual or audible alarms or routine inspections performed on a stated frequency. For each event, provide an assessment of response time.

8.1.1.3 Analysis of Effects and Consequences. Analyze the effects and particularly any radiological consequences of the event. The analysis should:

1. Show the methods, assumptions, and conditions used in estimating the course of events and the consequences;

2. Identify the time-dependent characteristics and release rate of radioactive materials within the confinement system that could escape to the environment; and

3. Describe the margin of protection provided by whatever system is depended on to limit the extent or magnitude of the consequences.

8.1.1.4 Corrective Actions. For each event, give the corrective actions necessary to return to a normal situation.

8.1.2 Radiological Impact from Off-Normal Operations

The capability of the installation to operate safely within the range of anticipated operating variations, malfunctions of operating equipment, and operator error should be shown. The information may be presented in tabular form with the situations analyzed listed in one column accompanied by other columns that identify:

1. Estimated doses (person-rem);

2. Method or means available for detecting the respective situations,

3. Causes of the particular situation,

4. Corrective actions, and

5. Effects and consequences.

8.2 Accidents

Provide a rigorous analysis of accident potential for the proposed ISFSI. Include any incident that would potentially result in a dose of $\geq$25 mrem beyond the controlled area. If there are no such credible potential accidents, show that this is true. Such analyses should address situations wherein direct radiation or radioactive materials may be released in such quantity as to endanger personnel within the controlled area. Design events of the third and fourth types as defined in ANSI/ANS 57.7-1981 are included in this section.

The following format should be used to provide the desired detail.

8.2.1 Accidents Analyzed

Identify the accident, the location or portion of the facility involved, and the type of accident. Discuss each accident sequentially (e.g., 8.2.2, 8.2.3 ...).

8.2.1.1 Cause of Accident. For each accident analyzed, describe and list the sequence of events leading to the initiation of the accident. Identify with respect to natural phenomena, human error, equipment malfunction, or equipment failure. Include an estimate of probability and how this probability estimate was determined.

8.2.1.2 Accident Analysis. Analyze the effects and particularly any radiological consequences of each accident. Show the methods, assumptions, and conditions used in estimating the consequences, the recovery from the consequences, and steps used to mitigate each accident. Assess the consequences of the accident to persons and property both onsite and offsite.

In addition to the assumptions and conditions employed in the course of events and consequences, support the following by sufficient information:

1. The mathematical or physical models employed, including a description of any simplification introduced to perform the analyses. Identify assumptions used that are known to differ from those used by the NRC staff.

2. Identification of any digital computer program or analog simulation used in the analysis with principal emphasis on the input data and the extent or range of variables investigated. This information should include figures showing the analytical models, flow path identification, actual computer listing, and complete listing of input data. The detailed description of mathematical models and digital computer programs or listings may be included by reference with only summaries provided in the SAR.

3. The physical or mathematical models used in the analyses and the bases for their use with specific reference to:

   a. The distribution and fractions of the radioactive material inventory assumed to be released from the source into offgas systems;

b. The concentrations of airborne radioactive materials in the confinement atmosphere and buildup on filters during the postaccident time intervals analyzed; and

c. The conditions, including meteorology and topography, considered in the analyses.

4. The time-dependent characteristics, activity, and release rate of transmissible radioactive materials within the confinement system that could escape to the environment via leakages in the confinement boundaries and leakage through lines that could exhaust to the environment.

5. The considerations of uncertainties in calculational methods, equipment performance, instrumentation response characteristics, or other indeterminate effects that should be taken into account in the evaluation of the results.

6. The conditions and assumptions associated with the events analyzed, including any reference to published data or research and development investigations in substantiation of the assumed or calculated conditions.

7. The extent of system interdependency (confinement system and other engineered safety features) contributing directly or indirectly to controlling or limiting leakages from the confinement systems or other sources such as the contribution of confinement air systems and air purification and cleanup systems.

8. The results and consequences derived from each analysis and the margin of protection provided by whatever system is depended on to limit the extent or magnitude of the consequences.

8.2.1.3 Accident Dose Calculations

1. For each accident analyzed, provide and discuss the results of conservative calculations of potential integrated whole-body and critical-organ doses to an individual from exposure to radiation as a function of distance and time after the accident. Present in terms of a 50-year dose commitment. Discuss the results and consequences derived from the analysis and the margin of protection provided by whatever system is depended on (i.e., remains operative) to limit the extent or magnitude of the consequences.

2. For each accident analyzed, provide and discuss the results of conservative calculations of potential integrated whole-body and critical-organ integrated population doses from exposure to radiation as a function of population distribution at the time of initial operation to a distance of 8 kilometers (5 miles). Present results in terms of a 50-year dose commitment.

8.3 Site Characteristics Affecting Safety Analysis

Describe in summary form the site characteristics that have a bearing on the safety analysis, and show how these have been considered in developing suitable margins of safety.

9. CONDUCT OF OPERATIONS

The plan for operation of the installation should be described. Sufficient detail should be provided to indicate how the applicant intends to conduct all operations to ensure that a technically competent staff will be maintained to provide continued implementation of administrative and operating procedures and programs, all of which are considered necessary to ensure safe operation.

9.1 Organizational Structure

The following format should be used to present the organizational structure through the construction phase and through the preoperational testing, startup, installation operation, and decommissioning phases of the project.

9.1.1 Corporate Organization

Describe the corporate arrangement or organization responsible for the installation. If the corporation is made up of two or more existing entities, the relationship and responsibilities between each should be explained. As required by § 72.22 of 10 CFR Part 72, provide sufficient information to demonstrate the financial capabilities for construction, operation, and decommissioning of the installation.

9.1.1.1 Corporate Functions, Responsibilities, and Authorities. Describe corporate functions, responsibilities, and authorities with respect to installation engineering and design, construction, quality assurance, testing, operation, and other applicable activities.

9.1.1.2 Applicant's In-House Organization. A description should be provided of the applicant's management and technical staffing and in-house organizational relationships established for the design and construction review and quality assurance functions and of the responsibilities and authorities of personnel and organizations described in Section 9.1.1.1. Establish the extent of dependence on offsite personnel.

9.1.1.3 Interrelationships with Contractors and Suppliers. The working interrelationships and organizational interfaces among the applicant, the architect-engineer, and other suppliers and contractors should be described.

9.1.1.4 Applicant's Technical Staff. The applicant's technical staff, specifically that supporting the engineering, construction, and operation of the ISFSI, should be described. Include a description of the duties, responsibilities, and authority of the engineering technical staff; and state the numbers of personnel, qualifications, educational backgrounds (disciplines), and technical experience. Indicate technical support for the applicant's technical staff to be provided by outside consultants. If such arrangements are to be used, the specific areas of responsibility and functional working arrangements of these support groups should be provided.

9.1.2 Operating Organization

This section should describe the structure, functions, and responsibilities of the operating organization. The following specific information should be included:

9.1.2.1 Onsite Organization. Provide a comprehensive description of the organizational arrangement of the facility showing the title of each position, the flow of responsibility as depicted by an organization chart, and the number of personnel in each unit. Describe the organizational arrangement for ensuring safe operation, the mode of operation, and assigned responsibilities.

9.1.2.2 Personnel Functions, Responsibilities, and Authorities. Describe the functions, responsibilities, and authorities of major personnel positions, including a discussion of specific succession of responsibility for overall operation of the facility in the event of absences, incapacitation, or other emergencies.

9.1.3 Personnel Qualification Requirements

Describe the proposed minimum qualification requirements for onsite personnel and the qualifications of available supporting personnel. The following specific information should be included:

9.1.3.1 Minimum Qualification Requirements. The minimum qualification requirements should be stated for major operating, technical, and maintenance supervisory personnel.

9.1.3.2 Qualifications of Personnel. The qualifications of the individuals assigned to the managerial and technical positions described should be presented in resume form. The resumes should identify individuals by position title and, as a minimum, should describe the formal education, training, and pertinent experience of the individuals.

9.1.4 Liaison with Outside Organizations

Discuss arrangements made with outside organizations, including those providing expertise on technical facets of details concerning site selection and evaluation, installation design and construction, process and equipment selection or development, and safety evaluations. Additionally, any arrangements made with other government agencies should be presented. The method or system used to monitor the interfaces between each participant should be included.

9.2 Preoperational Testing and Operation

Describe the preoperational testing and operating startup plans. Emphasize those plans demonstrating that the layout, equipment, and planned operations meet safety and design criteria discussed in previous chapters. Test plans should be presented to verify the integrity of the structures and equipment and to substantiate the safety analysis. Results obtained from carrying out the planned tests are to be reported as a supplement to the SAR.

9.2.1 Administrative Procedures for Conducting Test Program

Describe the system used for (1) preparing, reviewing, approving, and executing all testing procedures and instructions and (2) evaluating, documenting, and approving the test results, including the organizational responsibilities and personnel qualifications of the applicant and the applicant's contractors.

Describe the administrative procedures for incorporating any needed system modifications or procedure changes, based on the results of the tests (e.g., test procedure inadequacies or test results contrary to expected test results).

9.2.2 Test Program Description

Describe the test objectives and the general methods for accomplishing these objectives, the acceptance criteria that will be used to evaluate the test results, and the general prerequisites for performing the tests, including special conditions to simulate normal and off-normal operating conditions of the tests listed.

9.2.2.1 Physical Facilities. For the physical facilities, components, and equipment, identify the items to be tested, type of test, response, and validation.

9.2.2.2 Operations. Identify those operations to be tested, type of test, response, and validation.

9.2.3 Test Discussion

For each preoperational test:

1. Describe the purpose of the test.

2. Define the response expected in terms of design bases and criteria discussed in previous chapters, and indicate the margin of difference acceptable for safe operation.

3. Discuss the necessary corrective action if the results of the preoperational test do not confirm the expected response.

9.3 Training Programs

9.3.1 Program Description

Describe the proposed training program, including the scope of training in (1) installation operations and design, instrumentation and control, methods of dealing with operating malfunctions, decontamination procedures, and emergency procedures and (2) health physics subjects such as the nature and sources of radiation, methods of controlling contamination, interactions of radiation with matter, biological effects of radiation, use of monitoring equipment, and principles of criticality hazards control. Identify personnel classification with level of instruction.

9.3.2 Retraining Program

Describe the program for continued training that provides additional materials and refresher training.

9.3.3 Administration and Records

Identify personnel in the organization responsible for the training programs and maintaining up-to-date records on the status of trained personnel, training of new employees, and refresher or upgrading training of present personnel.

9.4 Normal Operations

9.4.1 Procedures

The applicant should make a commitment to conduct operations that are important to safety in accordance with detailed written procedures. Include a list of procedures that, by title or subject, clearly indicates their purpose and applicability. Also include a description of the review, change, and approval practices for all installation operating, maintenance, and testing procedures.

9.4.2 Records

Present the detailed management system for maintaining records relating to the historical operation of the installation. This system should include quality assurance records; operating records, including principal maintenance, alterations, or additions made; records of off-normal occurrences and events associated with radioactive releases; environmental survey records; and the identity and pertinent information of the spent fuel stored.

9.5 Emergency Planning

The applicant should submit, as a separate document, a plan for coping with emergencies.

9.6 Decommissioning Plan

Describe initial plans for decommissioning to ensure that at the end of the facility's useful life decommissioning will be carried out in a safe and efficient manner. Information should be provided on the decommissioning method that has been tentatively selected and on the plans for facilitating the decommissioning process. The plan should be in sufficient detail to provide the basis for an estimate of the decommissioning costs. Such cost estimates are to be used in conjunction with financial qualification requirements to provide reasonable assurance for obtaining funds for decommissioning.

9.7 Physical Security and Safeguards Contingency Plans

Physical security and safeguards contingency plans should be submitted as separate documents. Subpart H of 10 CFR Part 72 sets forth requirements for the content of these plans.

10. OPERATING CONTROLS AND LIMITS

Throughout the previous chapters of this guide, the need to identify safety limits, limiting conditions, and surveillance requirements has been indicated. It is from such information that the operating controls and limits and supporting bases should be developed.

The operating controls and limits for spent fuel storage in an ISFSI are derived from the safety assessment of the installation and include all aspects of installation operation that are important to safety.

The safety and environmental analyses should support the conclusion that the health and safety of the public and operating personnel and the environmental values will be protected during installation operation if all operations are performed within certain prescribed limits. These limits are defined and established in the operating controls and limits.

Except for changes that involve license conditions or safety questions that have not been reviewed, changes can be made without amending the license unless a change in operating controls and limits is involved. Such changes would require NRC staff review and approval before being instituted. For additional information concerning changes, refer to § 72.48 of 10 CFR Part 72.

The operating controls and limits should be proposed in the application. These are reviewed by the NRC and issued in the form of license conditions that include technical specifications.

10.1 Proposed Operating Controls and Limits

Identify and justify the selection of those variable conditions or other items based on the design criteria of the installation or determined, as a result of safety assessment and evaluation, to be probable subjects of operating controls and limits for the installation.

The operating controls and limits and bases proposed by an applicant should be included in Chapter 10 of the SAR. The operating controls and limits should be complete, i.e., to the fullest extent possible, numerical values and other pertinent data should be provided, including the technical and operating conditions supporting the selection. For each control or limit, the applicable sections of the SAR that develop, through analysis and evaluation, the details and bases for the control or limit should be referenced.

Each license to store spent fuel in an ISFSI will contain technical operating limits, conditions, and requirements imposed upon the conduct of operations in the interest of the health and safety of the public. The operating controls and limits are proposed by the applicant. A statement of the bases or reasons for proposed controls or limits should be included in the SAR. After review by the NRC staff, they are modified as necessary before becoming part of the license.

10.1.1 Content of Operating Controls and Limits

Operating controls and limits should include both technical and administrative matters. Operating controls and limits related to technical matters should consist of those features of the installation that are of controlling importance to safety (operating variables, systems, or components). In addition, operating controls and limits related to technical matters should include effluent and environmental monitoring and controls or limits addressed to the attainment of ALARA levels of releases and exposures. Operating controls and limits related to administrative matters should be addressed to those organizational and functional requirements that are important to the achievement and maintenance of safe operation of the installation.

10.1.2 Bases for Operating Controls and Limits

When an operating control and limit has been selected, the bases for its selection and its significance to safety of operation should be defined. This can be done by the provision of a summary statement of the technical and operational considerations justifying the selection. The SAR should fully develop, through analysis and evaluation, the details of these bases. Therefore, the physical format for operating controls and limits assumes importance since the collection of controls or limits and their written bases forms a document that delineates those features and actions important to the safety of the operation, the reasons for their importance, and their relationships to each other.

10.2 Development of Operating Controls and Limits

Refer to § 72.44, "License Conditions," of 10 CFR Part 72 for guidance on the categories of activities and conditions requiring operating controls and limits. Additional categories may be designated by the applicant or the NRC if deemed necessary to ensure the protection of the environment or public health and safety.

10.2.1 Functional and Operating Limits, Monitoring Instruments, and Limiting Control Settings

Controls or limits of this category apply to operating variables that are important to safety and that are observable and measurable (e.g., temperatures and cooling water flow rates). Control of such variables is directly related to the performance and integrity of equipment and confinement barriers.

10.2.2 Limiting Conditions for Operation

This category of operating controls and limits covers two general classes, (1) equipment and (2) technical conditions and characteristics of the installation necessary for continued operation, as discussed below.

10.2.2.1 Equipment. Operating controls and limits should establish the lowest acceptable level of performance for a system or component and the minimum number of components or the minimum portion of the system that should be operable or available.

10.2.2.2 Technical Conditions and Characteristics. Technical conditions and characteristics should be stated in terms of allowable quantities, e.g., temperature, level, and radioactive materials contained in water in storage pools; area radiation levels; or allowable configurations of equipment and spent fuel assemblies during transfer operations.

10.2.3 Surveillance Requirements

Major emphasis in surveillance specifications should be placed on those systems and components essential to safety during all modes of operation or necessary to prevent or mitigate the consequences of accidents. Tests, calibrations, or inspections should verify performance and availability of important equipment and should detect incipient deficiencies.

10.2.4 Design Features

These operating controls and limits cover design characteristics of special importance to each of the physical barriers and to the maintenance of safety margins in the design. The principal objective of this category is to control changes in the design of essential equipment.

10.2.5 Administrative Controls

The SAR should contain a full description and discussion of organization and administrative systems and procedures, recordkeeping, review and audit, and the reporting necessary to ensure that the operations involved in the storage of spent fuel are performed in a safe manner.

10.2.6 Suggested Format for Operating Controls and Limits

1. Title (e.g., activity level of storage pool water).

2. Specification (limits).

3. Applicability: Systems or operations to which the control or limit applies should be clearly defined.

4. Objective: The reasons for the control or limit and the specific unsafe conditions it is intended to prevent.

5. Action: What is to be done if the control or limit is exceeded; clearly define specific actions.

6. Surveillance Requirements: What maintenance and tests are to be performed and when.

7. Bases: The SAR should contain all pertinent information and an explicit detailed analysis and assessment supporting the choice of the item and its specific value or characteristics. The basis for each control or limit should contain a summary of the information in sufficient depth to indicate the completeness and validity of the supporting information and to provide justification for the control or limit. The following subjects may be appropriate for discussion in the bases section:

a. Technical Basis. The technical basis is derived from technical knowledge of the process and its characteristics and should support the choice of the particular variable as well as the value of the variable. The results of computations, experiments, or judgments should be stated, and analysis and evaluation should be summarized.

b. Equipment. A safety limit often is protected by or closely related to certain equipment. Such a relationship should be noted, and the means by which the variable is monitored and controlled should be stated.

For controls or limits in categories referenced in Sections 10.2.2 through 10.2.4, the bases are particularly important. The function of the equipment and how and why the requirement is selected should be noted here. In addition, the means by which surveillance is accomplished should be noted. If surveillance is required periodically, the basis for frequency of required action should be given.

c. Operation. The margins and the bases that relate to the safety limits and the normal operating zones should be stated. The roles of operating procedures and of protective systems in guarding against exceeding a limit or condition should be stated. Include a brief discussion of such factors as system responses, process or operational transients, malfunctions, and procedural errors. Reference to related controls or limits should be made.

11. QUALITY ASSURANCE

Subpart G of Part 72 requires that a quality assurance (QA) program be established, maintained, and executed for structures, systems, and components important to safety. The QA program to be applied to the spent fuel storage system should be described. The applicant should identify the systems and components that are important to safety and that will be covered by the QA program. The QA program should be applied to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification of structures, systems, and components identified as important to safety. The applicable QA criteria should be executed commensurate with their importance to safety.

A QA program that has been accepted by the NRC as meeting Appendix B to 10 CFR Part 50 or Subpart G of 10 CFR Part 72 may be applied to the spent fuel storage system. The applicant should state the intent to apply this QA program, the date on which the QA program was submitted to the NRC, the docket number, and the date of NRC acceptance.

A document entitled "Standard Review Plan for Quality Assurance Programs for an Independent Spent Fuel Storage Installation (ISFSI) 10 CFR 72"* has been developed by the NRC staff for reviewing quality assurance programs submitted by applicants. This document could be applied to a QA program for an independent spent fuel storage installation of a water-basin type.

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*A copy of this document is available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street, NW., Washington, DC, under Task CE 301-4. Single copies may be obtained by writing to the Advanced Fuel and Spent Fuel Licensing Branch, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

VALUE/IMPACT STATEMENT

A draft value/impact statement was published with the proposed Revision 2 to Regulatory Guide 3.44 (Task CE 403-4) when the draft guide was published for public comment in November 1986. No changes were necessary so a separate value/impact statement for this final guide has not been prepared. A copy of the draft value/impact statement is available for inspection and copying for a fee at the Commission's Public Document Room at 2120 L Street NW., Washington, DC, under Task CE 403-4.

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