# 2 SITE CHARACTERISTICS EVALUATION FOR DRY STORAGE FACILITIES (SL)

## 2.1 Review Objective

The objective of the U.S. Nuclear Regulatory Commission's (NRC's) review of the site characteristics for dry storage facilities (DSFs) is to provide reasonable assurance that the applicant's safety analysis report (SAR) (1) properly identifies the external natural and human-induced phenomena for inclusion in the design basis and that the design basis levels are adequate, (2) adequately characterizes local land and water use and population so that the reviewer can identify important individuals and populations likely to be affected, and (3) adequately characterizes the transport processes that could move any released contamination from the facility to the maximally exposed real individuals and populations, in compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste." The results of this review will determine the acceptability of site-derived design bases.

## 2.2 Applicability

This chapter applies to the review of applications for specific licenses for an independent spent fuel storage installation (ISFSI) or a monitored retrievable storage (MRS) facility, categorized as DSFs. The title of this chapter is denoted as "**(SL)**" to make it readily apparent that this chapter applies only to the review of an application for a specific license.

## 2.3 Areas of Review

This chapter addresses the following areas of review:

- geography and demography
- nearby industrial, transportation, and military facilities
- meteorology
- surface hydrology
- subsurface hydrology
- geology and seismology

## 2.4 Regulatory Requirements and Acceptance Criteria

This section summarizes those parts of 10 CFR Part 72 that are relevant to the review areas addressed by this chapter. The NRC staff reviewer should refer to the exact language in the regulations. Table 2-1 matches the relevant regulatory requirements to the areas of review covered in this chapter. The reviewer should refer to the language in the regulations and verify the association of the regulatory requirements with the areas of review presented in the table to ensure that no requirements are overlooked as a result of unique applicant design features.

**Table 2-1 Relationship of Regulations and Areas of Review for a DSF**

| Areas of Review | 10 CFR Part 72 Regulations | | | | |
|---|---|---|---|---|---|
| | 72.24 (a)(c)(e) | 72.40 (a)(1)(2)(3) | 72.90 | 72.92 | 72.94 |
| Geography and Demography | ● | ● | ● | | |
| Nearby Industrial, Transportation, and Military Facilities | ● | ● | | | ● |
| Meteorology | ● | ● | ● | ● | |
| Surface Hydrology | ● | ● | ● | ● | |
| Subsurface Hydrology | ● | ● | | | |
| Geology and Seismology | ● | ● | ● | ● | |

| Areas of Review | 10 CFR Part 72 Regulations (cont.) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 72.96 | 72.98 | 72.100 | 72.102 | 72.103 | 72.104 (a) | 72.106 | 72.122 (b)(c)(e) |
| Geography and Demography | ● | ● | ● | | | ● | ● | ● |
| Nearby Industrial, Transportation, and Military Facilities | | ● | ● | | | | | (e) |
| Meteorology | | ● | | | | | | ● |
| Surface Hydrology | | ● | | | | | | ● |
| Subsurface Hydrology | | ● | | | | | | ● |
| Geology and Seismology | | ● | | ● | ● | | | ● |

### 2.4.1 Geography and Demography

2.4.1.1 *Site Location*

The SAR should provide information on the site location of the proposed ISFSI or MRS and nearby facilities, including the site's host State and county and the site's latitude and longitude. Maps and aerial photographs of the site should be presented with radial coverage extending a minimum of 16 kilometers (km) (10 miles (mi)) from the site. A detailed map of the site area should show adjacent buildings, roads, railroads, transmission lines, wetlands, and surface water bodies. The reviewer should be aware of the limitations on ISFSI and MRS siting that are listed in 10 CFR 72.96, "Siting Limitations," and the potential changes to these limitations that may have been enacted by Congress.

2.4.1.2 *Site Description*

The SAR should include a site map that shows the site boundary and the controlled area boundary, controlled area access points, and the distances from the boundary to significant features of the installation. The SAR should discuss the applicant's legal responsibilities for the properties described, such as ownership, lease, or easements. Topographic maps should depict the site topography and surface drainage patterns, as well as roads, railroads, transmission lines, wetlands, and surface water bodies on the site. The SAR should describe vegetative cover and surface soil characteristics to facilitate evaluation of fire hazards and erosion. Other activities the applicant conducts within the controlled area should be identified, as well as the potential interactions with ISFSI or MRS operations.

#### 2.4.1.3 *Population Distribution and Trends*

The SAR should present current population data and projections. This information may include such items as a sector map of the population in the surrounding area, extending to an adequate distance from the DSF. If appropriate, the sector map may divide the area within a 16-km (10-mi) radius of the site by concentric circles with radii of 1.5, 3, 5, 6.5, and 16 km (approximately 1, 2, 3, 4, and 10 mi), and by 22.5-degree segments, each centered on one of the 16 compass points. The map should provide current and projected populations in each sector. The population data should overlay a base map that shows cities or towns.

The maximally exposed real individual(s) should be specifically identified with a rationale for their selection (e.g., nearest well, closest person downwind in the predominant wind direction).

#### 2.4.1.4 *Land and Water Use*

The SAR should describe the use of land and water within the surrounding area. It should present residential, farming, dairy, industrial, and recreational uses of land and water in sufficient detail to allow estimates of radiation doses to populations from any airborne or liquid effluents.

### 2.4.2 Nearby Industrial, Transportation, and Military Facilities

As required by 10 CFR 72.94, "Design basis external man-induced events," the SAR must include an examination of past and present man-made facilities and activities that might endanger the proposed ISFSI or MRS. Therefore, the SAR should indicate the locations of nearby industrial, transportation, military, nuclear, and radioactive materials installations on a map that shows their distance and relationship to the ISFSI or MRS. All facilities within the surrounding nearby area and all relevant facilities at greater distances should be included. The SAR should describe the products or materials produced, stored, or transported for each facility, and any potential hazards to the ISFSI or MRS from activities or materials at the facilities. Finally, the SAR should discuss any effect of these facilities on the specific ISFSI or MRS design basis.

### 2.4.3 Meteorology

As required by 10 CFR 72.92, "Design basis external natural events," the SAR must include an evaluation of any natural phenomena that may exist or that can occur in the region of a proposed site. Therefore, the SAR should describe the meteorological conditions at the DSF and vicinity and identify the conditions that could influence the design and operation of the facility. The SAR should state the sources of all information cited. Sufficient information should be provided to permit the NRC staff to independently evaluate atmospheric diffusion characteristics of the site area. The SAR should also provide sufficiently detailed information to permit the NRC staff to determine the basis for the high winds (either straight line or tornado winds) and high temperature used in the design basis.

#### 2.4.3.1 *Regional Climatology*

The SAR should describe the climate of the region, including temperature, precipitation, relative humidity, general airflow, pressure patterns, cloud cover, average wind speeds, and prevalent wind direction, as well as the ranges and seasonal variations of these parameters. The SAR should mention climate characteristics attributable to terrain and present data on the frequency, intensity, and duration of severe weather. For example, the SAR should address temperature, wind, and precipitation extremes; hurricanes, tropical storms, tornadoes, lightning strikes; and snow, ice, and hail storms. The SAR should discuss all data sources and the reliability of the sources. The SAR should present the design-basis winds and temperature and explain a rationale for their selection.

#### 2.4.3.2 *Local Meteorology*

The SAR's description of local meteorology should summarize data on temperature, wind speed and direction, and relative humidity collected on site as well as at nearby weather stations. The SAR should discuss any data collected offsite and whether the data are representative of the onsite conditions. If such offsite data adequately represent onsite conditions, then onsite data may not be necessary. For the purpose of evaluating atmospheric diffusion, the SAR should provide topographic maps at two different scales: One should show detailed topographic features, as modified by the facility, within an 8-km (5-mi) radius around the site; a smaller-scale map should show topography out to a 16-km (10-mi) radius around the site. This map should be accompanied by profiles of maximum elevation over distance from the center of the installation out to 16-km for each of the 22.5-degree compass-point sectors.

#### 2.4.3.3 *Onsite Meteorological Measurement Program*

Unless offsite data adequately represent onsite conditions, the SAR should include meteorological data collected onsite, adequate for the NRC staff to conduct independent atmospheric dispersion estimates for both postulated accidents and expected routine releases of gaseous effluents. The meteorological data should be provided in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class. The SAR should state the measurements made, the locations and elevations of measurements, descriptions of the instruments used, instrument performance specifications, calibration and maintenance procedures, and data analysis procedures. Any onsite program and any programs to be used during operations to estimate offsite concentrations of airborne effluents should be described. Regulatory Guide (RG) 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants," provides guidance related to an acceptable onsite meteorological measurements program and the format for presenting stability class data.

If no onsite measurement program exists, the SAR should provide justification for using data from nearby stations as long as those stations conform to the criteria of RG 1.23.

### 2.4.4 Surface Hydrology

As required by 10 CFR 72.98, "Identifying regions around an ISFSI or MRS site," the SAR must include an evaluation of the regional extent of external phenomena, man-made or natural, that are used as a basis for the design of the ISFSI or MRS. Therefore the SAR should contain adequate information for an independent review of all surface hydrology-related design bases, performance requirements, and operating procedures important to safety.

#### 2.4.4.1 *Hydrologic Description*

The SAR should characterize the surface hydrologic features of the region, area, and site because this information is the basis for hydrologic engineering analyses. Specifically, the SAR should describe the location, size, and hydrologic characteristics of all streams, rivers, lakes, and adjacent shore regions that influence or may influence the site or facilities under severe hydrologic conditions. It should include topographic maps of the area and the site to give a clear understanding of these features. A map of the site area should indicate any proposed change to the natural drainage features. If the site is vulnerable to river flooding, any river control structures, upstream or downstream of the site, should be identified.

The SAR should identify the sources of the hydrologic information, the types of data collected, and the methods and frequency of collection. The SAR should also list the structures important to safety, including their exterior accesses, and equipment and systems that may be affected by hydrologic features. The SAR should note any surface waters that could potentially be affected by normal or accident effluents from the site. A listing of any population groups that use such surface waters as a potable water supply should be provided, as well as the size of these population groups, their location, and water-use rates.

#### 2.4.4.2 *Floods*

The SAR should adequately support any claim that the proposed site is flood-dry, that is, with structures important to safety so high above potential sources of flooding that safety is obvious or can be documented with little analysis, as indicated in American National Standards Institute/American Nuclear Society (ANSI/ANS) 2.8, “Determining Design Basis Flooding at Power Reactor Sites.”

If the DSF site is not flood-dry, then the SAR should identify the design-basis flood and provide a rationale for this specific design basis. Such a rationale should contain a synopsis of the flood history of the site, including dates and maximum water levels. Causes of past and potential future flooding, such as river or stream floods, surges, tsunami, dam failures, and ice jams, should be provided. The remainder of Section 2.4.4 of this SRP describes the required detailed analysis of the flooding potential of the site. This information should be detailed enough for the NRC staff to perform an independent flood analysis of the site, as described in RG 1.59, “Design Basis Floods for Nuclear Power Plants,” and referenced in RG 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)," RG 3.62, “Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks,” and RG 1.102, “Flood Protection for Nuclear Power Plants.”

#### 2.4.4.3 *Probable Maximum Flood on Streams and Rivers*

As required by 10 CFR 72.122(a), the applicant must evaluate the structures, systems, and components (SSCs) important to safety to withstand the effect of floods. Therefore, the SAR must consider the effects of the probable maximum flood (PMF) on adjacent streams and rivers in its detailed flood analysis. If the SAR did not follow the approach in ANSI/ANS 2.8 for assessing PMFs, then it should describe the alternative approach used. The SAR should describe the steps taken to derive the probable maximum precipitation (PMP) over the applicable drainage area, the precipitation losses, the amount of runoff, and the PMF, and include a topographic map that identifies drainage basins. The SAR should include the estimated discharge hydrograph for the PMF at the site and, if applicable, a similar hydrograph without the effects of an upstream reservoir. The conversion of the PMF peak discharge into water elevation at the site should be described. Wind-wave activity that could coincide with the PMF should be discussed. Finally, the SAR should summarize the locations and associated water levels for which PMF determinations have been made.

### 2.4.4.4 *Potential Dam Failures (seismically induced)*

If potential dam failures are necessary to identify flood design bases, then the SAR should discuss the effects of potential seismically induced dam failures (both upstream and downstream) on the water levels of streams and rivers. The SAR should describe existing or proposed dams and reservoirs that could influence conditions at the site and include seismic design criteria for dams. The potential dam failure modes that lead to the most critical consequences for the site (flood or low reservoir level) should be described, and domino-type or cascading dam failures from floodwaves should be considered when applicable. Finally, the SAR should address the reliability of the water-level estimate.

### 2.4.4.5 *Probable Maximum Surge and Seiche Flooding*

If the site is at risk of inundation from surge or seiche flooding, the SAR should describe these hazards. It should describe water bodies that could impact the site and provide the surge and seiche history of the site. The SAR should describe the frequency and magnitudes of potential causes of surges, such as hurricanes, wind storms, squall lines, and other mechanisms and include a graph of the calculated maximum surge hydrograph. The potentially coincident wind-generated waves and the possibility of wave oscillation at natural frequencies should be described. The SAR should provide estimates of potential wave run-up, erosion, and sedimentation and any site facilities designed to guard against these processes.

### 2.4.4.6 *Probable Maximum Tsunami Flooding*

If the site abuts a coastal area, the SAR should analyze the hazards associated with tsunami. The SAR should include an analysis of the history of tsunami in the region, whether recorded, translated, or inferred from the geologic record. The analysis should include all potential tsunami generators, such as specific faults, fault zones, volcanoes, and potential landslide areas. The maximum tsunami height from these causes should be estimated at the source, in deep water, offshore from the site, and onshore. A probable maximum tsunami should be derived from these analyses. Near-shore routing, wave breaking, bore formation, and resonance effects of the probable maximum tsunami should be discussed. The SAR should describe any structures designed to protect against tsunami flooding.

### 2.4.4.7 *Ice Flooding*

The SAR should indicate whether the site is subject to flooding caused by ice jams. If it is, the SAR should provide an analysis of this hazard. The SAR should describe the history of ice-jam formation in the region and the location of ice-generating mechanisms relative to the facility, as well as any structures designed to protect against flooding from ice jams. If the site is not subject to flooding from ice jams, the SAR should provide a brief statement of explanation.

### 2.4.4.8 *Flood Protection Requirements*

The SAR should describe the static and dynamic consequences of all types of flooding on each facility structure and component important to safety if the previous flooding analyses indicate that the structure or component is subject to flooding. The design bases required to ensure that all structures and components can survive all design flood conditions should be included.

2.4.4.9 *Environmental Acceptance of Effluents*

The SAR should describe the ability of the surface water and ground water environment to disperse, dilute, or concentrate normal and inadvertent liquid releases of radioactive effluents for the full range of anticipated operating conditions, including accident scenarios leading to worst-case releases. The SAR should identify all potential surface water and ground water pathways by which radionuclides could reach existing and potential water users. Any potential for water recirculation, sediment concentration, or hydraulic short-circuiting of cooling ponds should be assessed in anticipation of normal or accidental releases of radionuclides.

### 2.4.5 Subsurface Hydrology

As required in 10 CFR 72.122(b)(4), if the ISFSI or MRS is located over an aquifer which is a major water resource, measures must be taken to preclude the transport of radioactive materials to the environment through this potential pathway. Therefore, the SAR should contain adequate information for an independent review of all subsurface hydrology-related design bases and compliance with radiological dose and exposure standards.

If the site is located over an aquifer that is a source of well water, the SAR should describe the ground water aquifer(s) beneath the site, the associated hydrologic units, and their recharge and discharge areas. The SAR should provide the results of a survey of ground water users, well locations, source aquifers, water uses, static water levels, pumping rates, and drawdown. A water table contour map showing surface water bodies, recharge and discharge areas, and locations of monitoring wells to detect leakage from storage structures should also be provided. Information on monitoring wells should include wellhead elevation, screened interval, installation method, and representative hydrochemical analyses. In addition, the SAR should provide an analysis bounding the potential ground water contamination from site operations and a graph of time versus radionuclide concentration at the closest existing or potential downgradient well.

### 2.4.6 Geology and Seismology

The SAR should identify conditions that may influence the design and operation of the facility and state the sources of all information. It should provide enough information for an independent evaluation of the potential ground vibrations and the seismic and fault displacement hazards at the site area, in accordance with 10 CFR 72.102, "Geological and seismological characteristics for applications before October 16, 2003 and applications for other than dry cask modes of storage," and 10 CFR 72.103, "Geological and seismological characteristics for applications for dry cask modes of storage on or after October 16, 2003." Design bases for ground vibration, surface faulting, subsurface material stability, and slope stability should also be provided. Information on nearby and recent volcanic activity should also be identified, if appropriate or applicable.

2.4.6.1 *Basic Geologic and Seismic Information*

The SAR should provide basic geologic and seismic characteristics of the site and vicinity. The description of the geologic history of the area should include its lithologic, stratigraphic, and structural conditions. A large-scale geologic map of the site area showing the surface geology and the location of major facilities should be provided, as well as a stratigraphic column and cross sections. A geologic map showing bedrock surface contours should identify planar and linear features of structural significance such as folds, faults, synclines, anticlines, basins, and domes. The SAR's description of the site geomorphology should include areas of potential landsliding or subsidence and include a topographic map showing geomorphic features and principal site facilities. It should provide the results of pertinent geophysical investigations in the area, such as seismic refraction, seismic reflection, aeromagnetic, or geoelectrical surveys.

The SAR should evaluate geologic features from an engineering geology perspective. Detailed static and dynamic engineering properties of soil and rock underlying the site should be provided, with the results integrated to provide a comprehensive understanding of the surface and subsurface conditions. A small-scale map should show major features of the installation and the locations of all borings, trenches, and excavations. Small-scale cross sections should demonstrate relationships between major foundations and subsurface materials, structures, and the water table. Finally, the SAR should present any physical evidence concerning the behavior of surficial site materials during previous earthquakes.

#### 2.4.6.2 *Ground Vibration*

The SAR should present the design-basis ground vibration and explain a rationale for its selection. The rationale should list historical earthquakes that could have affected the site and their dates, epicenter locations, and magnitudes. This listing of events is not constrained by distance and may include entries for distant structures, such as the New Madrid fault system. All faults and epicenters should be displayed on maps of appropriate scales. The fault map should include all potentially significant faults or parts of faults within 161 km (100 mi) of the site, regardless of capability. The SAR should identify and adequately describe all capable faults (as defined in Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants,” to 10 CFR Part 100, “Reactor Site Criteria”) that may be of significance in establishing the design-basis ground vibration for the site. The maximum ground vibration at the site should be derived from the potential earthquakes from all capable faults and from floating earthquakes (i.e., those not associated with a previously identified structure).

#### 2.4.6.3 *Surface Faulting*

The SAR should describe surface faulting at the site and any underlying tectonic structures that have caused or might cause faulting. In addition, the SAR should describe the capability of any mapped faults 300 meters (1,000 feet) or longer within 8 km (5 mi) of the site. The SAR should describe in detail those faults judged to be capable, with special attention to their displacement history and their relationship to any regional tectonic structures.

#### 2.4.6.4 *Stability of Subsurface Materials*

The SAR should describe the stability of the rock, defined as having a shear wave velocity of at least 1,166 meters per second (3,500 feet per second) and soil beneath the foundations of the facility structures while subjected to the design-basis ground vibration. The description should include the geologic features that could affect the foundations, such as areas of potential uplift or collapse, or zones of deformation, alteration, structural weakness, or irregular weathering. The SAR should describe the static and dynamic engineering properties of the materials underlying the site, as well as the physical properties of foundation materials. A plot plan showing the locations of all borings, trenches, seismic lines, piezometers, geologic cross sections, and excavations, with all installation structures superimposed, should be provided. Plans and profiles showing the extent of excavations and backfill, as well as compaction criteria, should be provided. Further, the water table history and anticipated ground water conditions beneath the site during facility construction and operation should be described. The SAR should provide analyses of soil and rock responses to dynamic loading and discuss potential liquefaction beneath the site. It should discuss criteria, references, or methods of design used, along with safety factors.

2.4.6.5 *Slope Stability*

The SAR should describe the stability of all natural and human-made slopes, both cut and fill, whose failure could adversely affect the site. The description should provide cross sections of the slopes and a summary of the static and dynamic properties of embankment and foundation soil and rock underlying the slopes. The design criteria and analyses used to determine slope stability should be described.

## 2.5 <u>Review Procedures</u>

Figure 2-1 shows the interrelationship between the site characteristics evaluation and the other areas of review described in this SRP.

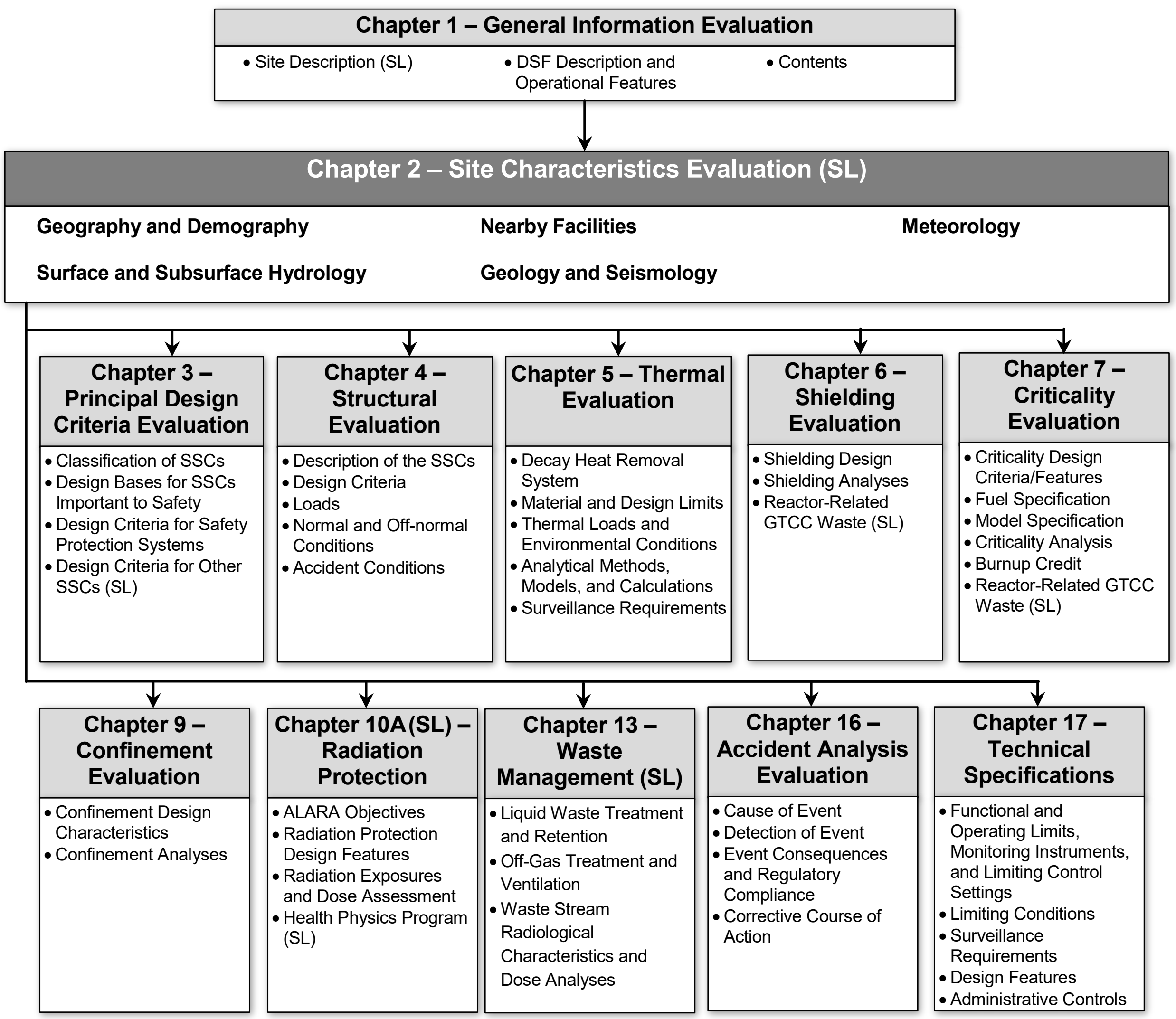


**Figure 2-1 Overview of Site Characteristics Evaluation**

### 2.5.1 Geography and Demography

#### 2.5.1.1 *Site Location*

Confirm that the site location, its relationship to political boundaries, and the natural and anthropogenic features of the area are properly described. Use U.S. Geological Survey (USGS) topographic maps, aerial photos, or other verifiable methods (obtained either independently or from the applicant) to verify the location described in the SAR.

#### 2.5.1.2 *Site Description*

Ensure that the site maps clearly delineate the site, controlled areas, and their boundaries. Confirm that the SAR accurately reports distances between the controlled area boundaries and the facility structures, including the storage location, as well as other possible effluent release points. These distances should agree with those used in the SAR discussion of accident analyses. Verify that the SAR indicates that the minimum distance from the DSF to the controlled area boundary is at least 100 meters (328 feet) per the requirements in 10 CFR 72.106, "Controlled area of an ISFSI or MRS." Check that the SAR indicates that access to the controlled area will be adequately restricted to protect members of the public, consistent with the requirements in 10 CFR Part 72.104. Ensure that the orientation of facility structures with respect to nearby roads, railways, and waterways is shown, and that there are no obvious ways by which transportation routes within the controlled areas can interfere with normal ISFSI or MRS operations

#### 2.5.1.3 *Population Distribution and Trends*

Confirm that the source of the population data used in the SAR is appropriate and that the basis for population projections is reasonable. The population data can be compared with other data available from local or State agencies, councils of government, U.S. Census Bureau records and projections, or any Bureau of Economic Analysis special census. Note significant differences from SAR data that may require clarification.

Determine whether the rationale for identifying the maximally exposed real individual located at or beyond the controlled area boundary is consistent with local meteorology and patterns of land and water use.

#### 2.5.1.4 *Land and Water Use*

Compare land use information provided in the SAR to existing data on land use, land use controls such as zoning, potential for growth, and other factors that may encourage or hinder population growth between the facility and the nearest population. Confirm the identification of any bodies of water or aquifers used by humans, livestock, or farms within the region surrounding the site. Compare SAR information with available independent data on water use and any projections of future water use in the vicinity of the site. Consider the level of detail appropriate to the projected distance of the nearest future population center to the site and the level of projected water withdrawal within the region surrounding the site.

### 2.5.2 Nearby Industrial, Transportation, and Military Facilities

Review the potential hazards associated with nearby facilities. In addition to obvious industrial, nuclear, or radioactive materials facilities in the area, consider other anthropogenic features that could conceivably pose a hazard, such as transportation routes, railroads, and airports. Confirm the accuracy of the information provided in the SAR by referring to USGS maps, aerial photos, or other documents, such as applications from any nearby nuclear plants. Use contacts with local, State, and other Federal agencies.

Review specific information relating to types of potentially hazardous material expected to be transported in the area, including distance, quantity, and frequency of shipment. The hazards from nearby facilities may include, but are not limited to, explosions of chemicals, flammable material, or munitions; detonation of explosives stored at mines or quarries; structure, petrochemical, brush, or forest fires; and release of toxic gases. Consider aircraft size, velocity, weight, and fuel load in assessing the hazards of aircraft crashes on an installation near an airport. Analyze the effects of any airborne pollutants from nearby facilities and the effects of a possible collapse of any discharge stacks on site. Determine if the methods documented in the application to quantify offsite hazards are consistent with the guidance in Chapter 16, “Accident Analysis Evaluation,” of this SRP. Identify potential accidents that cannot be eliminated from consideration as design-basis events because the consequences could affect facility safety features. Ensure that such accidents are adequately considered in the design criteria of described in the SAR.

### 2.5.3 Meteorology

#### 2.5.3.1 *Regional Climatology*

Review the SAR’s description of climate parameters against standard references listed in NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Section 2.3.1(II), under the heading “SRP Acceptance Criteria,” for verifying meteorological discussions and data. Confirm that the data sources are reliable and that the level of detail in the database is appropriate. Ensure that climate data are based on long-term data gathered at National Weather Service stations and other sites with reliable meteorological monitoring equipment. Review the information on severe weather, especially strong wind and wind-borne missiles, and check for consistency with the values used to develop structural design criteria in the SAR.

Ensure the regional meteorological conditions identified as site characteristics for ISFSI or MRS license applications include the following:

- the weight of the 100-year return period snowpack and the weight of the 48-hour probable maximum winter precipitation for use in determining the weight of snow and ice on safety-related structures

- the tornado parameters (including maximum wind speed, translational speed, rotational speed, and maximum pressure differential with the associated time interval) to be used in establishing pressure and tornado missile loadings on structures, systems, and components (SSCs) important to safety

- the 100-year return period (straight-line) 3-second gust wind speed to be used in establishing wind loading on safety-related structures

2.5.3.2 *Ambient Temperature and Humidity*

Ambient temperature and humidity statistics (e.g., 2 percent and 1 percent annual exceedance and 100-year maximum dry bulb temperature and coincident wet bulb temperature; 2 percent and 1 percent annual exceedance and 100-year maximum wet bulb temperature (noncoincident); 98 percent and 99 percent annual exceedance and 100-year minimum dry bulb temperature) for use in establishing heat loads for the design of heat sink systems Local Meteorology

Use maps and site visits to become familiar with the locations of all primary meteorological stations. Review the topographic maps for the accurate location of features and confirm the accurate portrayal of topography on the topographic profiles. Review summaries of the meteorological data for adequacy and completeness of the database. Whenever possible, review the onsite wind speed and atmospheric stability data that are used to model atmospheric diffusion because airflow and vertical temperature structure can vary substantially over short horizontal distances. If only offsite data are available, determine how well the data represent site conditions. Consult references in NUREG-0800, Section 2.3.2(II), under the heading “Acceptance Criteria,” to evaluate whether the meteorological data from the weather stations and periods of record adequately represent onsite conditions. Data summaries from nearby stations with long periods of records should well represent long-term meteorological extremes. Ensure consistency between these extreme values and those used to develop structural and thermal design criteria.

2.5.3.3 *Onsite Meteorological Measurement Program*

Review two areas in this section, the instruments gathering the meteorological data and the data itself, by examining instrument siting, meteorological sensors, recordings of meteorological sensor output, instrument surveillance, and data acquisition and reduction, as discussed in detail in RG 1.23 and NUREG-0800, Section 2.3.3, “Onsite Meteorological Measurements Programs.”

Review the joint frequency distributions of wind speed, wind direction, and atmospheric stability. Ensure that measurement heights and data recording periods are appropriate. In addition, determine the climatic representativeness of the joint frequency distribution by comparing with data from nearby stations that have collected reliable meteorological data over a long period, such as 10–20 years. Ensure that the meteorological measurement program is consistent with gaseous effluent release structures and systems design. Verify that the effluent release structures and systems design are commensurate with the degree of risk to public health and safety.

### 2.5.4 Surface Hydrology

2.5.4.1 *Hydrologic Description*

Ensure that the SAR addresses and properly describes all relevant hydrologic features by using USGS topographic maps and available independent hydrologic reports for this verification. Determine whether hydrologic features that influence or may influence the site under severe hydrologic conditions (e.g., a flood) have been adequately described. Review the criteria governing the operation of any upstream or downstream river control structures for scenarios of problems in river management. Examine any proposed alterations to the natural drainage pattern of the site. Ensure that the design of any SSCs important to safety can accommodate the effects of these alterations. Review local hydrologic reports to confirm the SAR’s identity of population groups getting potable water from the described hydrologic features. Use references in NUREG-0800, Section 2.4.1(II), under the heading “Acceptance Criteria,” to verify information in the application.

### 2.5.4.2 *Floods*

Review any claim that the site is flood-dry. Consider that a descriptive statement of circumstances and relative elevations may be enough to complete such a review. Evaluate the bases of any analogy with comparable watersheds for which PMF levels have been determined or approximations of PMF levels used. Require details only to the level needed to prove that SSCs important to safety are safe from flooding. Ensure that conservatism is used in all methods and assumptions. Consult ANSI/ANS 2.8 for descriptions of acceptable procedures to demonstrate flood-dry status.

If the site is not clearly flood-dry, review in detail the flood analyses. Determine whether the SAR chapter on principal design criteria adequately addresses the design-basis flood.

### 2.5.4.3 *Probable Maximum Flood on Streams and Rivers*

Review the SAR derivation of the PMF. Rely on information from actual storms in the region of the drainage basin. Consider storm configurations, maximum storm precipitation amounts (compare these with National Weather Service and U.S. Army Corps of Engineers determinations), time distributions, orographic effects, storm centering, seasonal effects, antecedent storm sequences, and antecedent snowpack. Confirm by calculations that the maximum storm precipitation distribution for the drainage basin is conservative. Review the SAR analysis of the absorption capability of the drainage basin. Ensure that assumptions of initial losses, infiltration rates, and antecedent precipitation are reasonable and justified. Review the SAR model for calculating runoff, as well as the input data such as hydrologic response characteristics of the watershed. Check that subbasin drainage areas and topographic features are mapped properly, and review the tabulation of drainage areas, runoff, and reservoir and channel-routing coefficients. Confirm that the PMF hydrograph represents the flow from the PMP and any possible coincident snowmelt.

Determine whether the PMF analysis considers any existing or proposed upstream dams or river structures and their ability to withstand a PMF. Confirm the maximum water flows from breaches if they are not designed to withstand a PMF. Review the PMF stream course response model and its ability to compute floods of various magnitudes up to the severity of a PMF. Review any reservoir and channel-routing assumptions, and the assessment of initial conditions, outlet works, spillways, coincident wind-wave action, wave protection, and reservoir design capacity. Review the process of translating PMF discharge to peak water level at the site by such means as topographic profiles, reconstitution of historical floods, standard step methods, roughness coefficients, bridge and other losses, extrapolation of coefficients for the PMF, estimates of PMF water surface profiles, and flood outlines. Review the SAR discussion of the effects on structures from run-up and the static and dynamic effects of wave action that may occur coincidentally with the PMF peak water level.

Perform an independent analysis of the PMF by using alternative data and interpretations when available. Request additional justification if the SAR analyses are more than 5 percent less conservative than independent NRC estimates.

Consult the following documents in reviewing SAR data and analyses:

- RG 1.59 for guidance on estimating the PMF design basis
- RG 1.102 for a description of acceptable flood protection for safety-related facilities

- National Weather Service and Army Corps of Engineers (USACE) documents (e.g., NWS 1978, 1982; USACE 1984, 1987, 1991, 1998) for estimating PMF discharge and water-level conditions at the site

2.5.4.4 *Potential Dam Failures (seismically induced)*

Review the SAR to determine whether the applicant considered all relevant dams and reservoirs that could affect the site in the event of failure. Review the drainage areas above reservoirs, and ensure that all dam structures, appurtenances, and ownership are completely described. Review the reservoir elevation and storage relationships and short- and long-term storage allocations. Ensure that the discussion of dam failures considers all factors, including landslides, antecedent reservoir levels, domino-type multiple dam failures, and base-river flow coincident with the flood peak, but not necessarily the simultaneous occurrence of the PMF with a seismic dam failure. Ensure that the applicant used a conservative analysis and that the analysis assumes that the maximum earthquake (based on historical seismicity) coincides with full reservoirs and either a flood half the size of the PMF or a standard-project flood as defined by the Army Corps of Engineers. Review for conservatism the basis for selecting the maximum earthquake that can lead to dam failure.

Review the calculations used to derive the peak flow rate and water level at the site that could result from the worst-possible dam failure. Examine all methods and coefficients used in these calculations, and ensure that the analytical methods apply to such artificially large floods. Review the discussion of static and dynamic effects of the floodwave at the site. Examine the assumptions used to attenuate the wave if credit is taken for downstream attenuation of a floodwave. Ensure that wind waves that may coincide with the flood are properly considered.

Conduct a more refined analysis, as described in NUREG-0800, Section 2.4.4(III), if this flooding analysis indicates a potential flooding problem. To the extent possible, conduct an independent analysis of the flooding effects from a seismically induced dam failure by using simplified, conservative procedures according to guidance in ANSI/ANS 2.8. Require additional justification if the SAR analyses are more than 5 percent less conservative than independent NRC estimates.

2.5.4.5 *Probable Maximum Surge and Seiche Flooding*

Review the descriptions of potential surge and seiche sources, ensuring that they address the most severe combination of reasonable meteorological parameters, including storm track, wind fields, wind fetch, and bottom effects. Use NUREG-0800, Section 2.4.5(III), for its discussion of methods to develop the maximum hurricane parameters for a site, to estimate the maximum surge still water elevations at coastal sites, and to estimate coincident wind-generated waves and run-up. Use National Oceanic and Atmospheric Administration Technical Report NWS-23 (NWS 1979), ""Meteorological Criteria for the Standard Project Hurricane and Probable Maximum Hurricane Windfields, Gulf and East Coasts of the United States," for its descriptions of the meteorological characteristics of the probable maximum hurricane for the East and Gulf Coasts, the most severe combination of meteorological parameters of moving squall lines for the Great Lakes, and the most severe combination of meteorological parameters capable of producing high storm-induced tides for the West Coast.

Confirm that ambient water levels, including tides and sea-level anomalies, are conservatively estimated. Use NUREG-0800, Section 2.4.5(III), for its discussion of water-level estimation methods that follow the National Oceanic and Atmospheric Administration and USACE guidance. Ensure that the method of developing the surge hydrograph from the meteorological, hydrological, and site-specific information is appropriate. Review the information on wave action that may coincide with surges. Ensure that estimates of wave height and run-up are adequately conservative and, if appropriate, include breaking waves. Review the analysis of wave resonance within any lakes or harbors near the site.

To the extent possible, conduct an independent analysis of the water level and wave height for surges and seiches by using alternative data and interpretations when available. Request additional justification if the SAR analyses are more than 5 percent less conservative than independent NRC estimates.

#### 2.5.4.6 *Probable Maximum Tsunami Flooding*

Review the historical tsunami information provided in the SAR for completeness. Review for completeness the tabulation of source areas capable of generating tsunami at the site. Evaluate the seismic characteristics of the tsunami generators, including fault location and orientation, as well as amplitude and areal extent of potential vertical displacement to ensure the application uses conservative values. Examine this information for consistency with that provided in the SAR geology and seismology section. Review the tabulation of maximum tsunami wave heights that can be generated at each local source and the maximum deep-water heights generated by distant sources. Review the process used to identify the source of the probable maximum tsunami for transparency. Examine the method used to translate tsunami waves from deep-water, offshore locations to the site. Review the analysis of local factors that may affect the magnitude of tsunami flooding, such as coastline shape, offshore land areas, hydrography, and stability of the coastal area. Ensure the reasonableness of assumptions and the inclusion of appropriate bathymetric data in the analysis. For the probable maximum tsunami, review the analysis of potential breaking wave formation, bore formation, resonance effects, or other factors that can affect the maximum height of the tsunami water level. Use NUREG-0800, Section 2.4.6(III), for references for evaluating ambient tide and wave conditions, oscillation of waves at natural periodicity, and the adequacy of protection from flooding.

To the extent possible, conduct an independent analysis of the source of the probable maximum tsunami and its resulting water height at the site by using alternative data and interpretations when available. Request additional justification if the SAR analyses are more than 5 percent less conservative than independent NRC estimates.

#### 2.5.4.7 *Ice Flooding*

Determine whether ice flooding poses a threat to the site on the basis of a review of the applicable literature describing historical occurrences of icing in the region, and, if so, ensure the adequacy of the SAR historical description. Use NUREG-0800, Section 2.4.7(III), for references in researching the history and potential for ice formation in the region. Ensure that the SAR properly considers all ice-related hazards, such as ice-jam floods, wind-driven ice ridges, and ice-produced forces that could affect the site. If feasible, conduct an independent analysis of the ice flooding hazard by using independent data and assumptions.

#### 2.5.4.8 *Flood Protection Requirements*

Compare the estimated design-basis flood level (both SAR and any independent estimates) with the locations and elevations of SSCs important to safety to confirm whether flood protection at the site is necessary and, if so, to what levels. If flood protection is necessary, review the facility flood design basis for compatibility with the positions in RG 1.59. Appropriate flood protection measures must protect against both static and dynamic flooding effects; RG 1.102 provides guidance for implementing 10 CFR 72.92(a). Review the SAR for flood protection measures based on standard engineering practices, such as those developed by the Federal Emergency Management Agency (e.g., FEMA 1999, FEMA 2013), in positive flood control and shoreline protection.

#### 2.5.4.9 *Environmental Assessment of Effluents*

Evaluate scenarios for routine, anticipated (or off-normal), and accidental releases to ensure consideration of worst-case releases of radionuclides into surface water or ground water. Examine the physical parameters used in calculating the transport paths and times of liquid effluent between the release point and receptors downstream or downgradient. Confirm that mathematical models used in the application to analyze flow and transport have been verified by field data and have used conservative input parameters. Ensure that any site-specific data sources used in modeling the transport of radionuclides through water are adequately described and referenced.

Use independent data and assumptions to the extent possible to assess the transport capabilities and potential contamination pathways of the surface water and ground water environments. Focus this independent assessment on transport to existing and possible future water users under normal, anticipated (or off-normal), and accident conditions. Use NUREG-0800, Section 2.4.13(III) for its descriptions of simplified, calculation procedures for models used to assess effluent transport through surface water and ground water.

### 2.5.5 Subsurface Hydrology

Review the descriptions of hydrogeologic units beneath the site. For each hydrogeologic unit, ensure the proper representation of potentiometric level, hydraulic gradient and conductivity, effective porosity, storage coefficient, recharge and discharge areas, and potential for ground water flow reversal. For the water table aquifer, ensure that the application has conservatively bounded seasonal fluctuations in the water level. Compare the SAR chemical analyses, including major ions, acidity/alkalinity, electrical potential, and presence of radionuclides, with independent analyses.

Review the information on existing ground water use, such as withdrawal points, pumping rates, source aquifers, and drawdown. Use reports by USGS or a State geological survey in reviewing site hydrogeology and water withdrawal downgradient of the site.

Review the analysis of the potential effects of the facility on any ground water recharge areas within the site, including dewatering during construction. Ensure that this analysis uses conservative assumptions and input values. Confirm that estimated ground water withdrawal volumes during facility operation are conservative and that drawdown or other effects on the aquifer(s) are addressed.

Review the transport characteristics of aquifers that are subject to radionuclide contamination. Ensure that the application adequately describes any contamination pathways and that the models and codes used to predict radionuclide migration are appropriate for the site. Ensure that potential future ground water uses are conservatively estimated. If warranted, conduct an independent analysis of radionuclide migration by using an alternative transport model or independent data.

### 2.5.6 Geology and Seismology

#### 2.5.6.1 *Basic Geologic and Seismic Information*

Verify the documentation of the results from all independent surveys, geophysical studies, borings, trenches, and other investigations. Review the descriptions of techniques, graphic logs, photographs, laboratory results, and identification of principal investigators. Review the reports cited in the SAR, such as published reports and dissertations, as well as other relevant reports on local geology.

Review the SAR discussion of basic site characteristics that may be problematic in siting a DSF, such as high seismic activity or recent volcanic activity. Scrutinize any SAR statement that the presence of unstable geologic characteristics will not have a deleterious effect on the facility or that the effects are within the design bases of all facility components important to safety.

Examine the geologic maps, cross sections, and stratigraphic columns in the SAR. For each lithologic unit, review the origin, unit thickness, physical characteristics, mineral composition, and degree of consolidation. Use the summary logs of borings, excavations, and trenches in reviewing the lithology. Compare the geologic map for the site area with other available published maps. If the SAR interpretations differ substantially from the published literature, ensure that the differences are noted and that the SAR interpretations are adequately justified. Review the bedrock contour map to confirm that the application accurately represents all relevant structural features. Review the description of the site geomorphology to ensure that all significant landforms, including the geologic processes that engendered them, are properly described. Ensure that the application identifies all locations of potential landsliding, subsidence, or uplift resulting from natural or anthropogenic processes and evaluates any associated hazards.

Review the results of any geophysical surveys, paying particular attention to the methods by which the data were gathered. Compare the interpretations of stratigraphy and structures with other cross sections. Require that discrepancies be explained. Examine any values of compressional and shear wave velocities for reasonableness.

Review the plan showing the locations of all major features of the facility, as well as the locations of all borings, trenches, and excavations. Examine the cross sections showing the relationships of engineered structures to subsurface material. Ensure that the application accurately represents the water table (and fluctuation range) and that ground water cannot have an adverse effect on these structures. Review the profile drawings that show the extent of excavation and backfill, as well as the compaction criteria for the engineered backfill. Ensure that compaction criteria meet appropriate engineering standards. Determine whether the SAR conservatively evaluates the effects of deformation zones, such as shears, joints, fractures, faults, or folds, on structural foundations. Ensure that the SAR addresses alteration zones, irregular weathering profiles, and zones of structural weakness composed of crushed or disturbed materials in terms of engineering geology.

Examine the tabulation of the static and dynamic engineering soil and rock properties of the various 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. Ensure that the data are substantiated with appropriate representative laboratory test records. Give extra attention to mechanical properties of aquifer materials and any fine-grained materials associated with the uppermost confined or semiconfined aquifer.  Scrutinize any site materials that may have an adverse response to seismic shaking, as well as any rocks or soils that may be unstable because of their mineral composition, lack of consolidation, or water content.  For those that may respond adversely to seismic shaking, ensure that the SAR uses conservative estimates for seismic response characteristics, such as liquefaction, thixotropy, differential consolidation, cratering, and fissuring.  Review the SAR for the inclusion of available data on the behavior of site geologic materials during previous earthquakes.  Review the analytical techniques and safety factors used in evaluating the stability of foundations for all structures and embankments under normal operating and extreme environmental conditions.

#### 2.5.6.2 *Ground Vibration*

Examine the provided maps of earthquake epicenters and faults in the region.  Confirm that the epicenter map adequately represents the locations of the tabulated historical earthquakes. Ensure that the earthquake tabulation comes from a credible source; compare it with an alternative earthquake catalog if available.  Confirm that the SAR uses sound practices in estimating the magnitudes of historical earthquakes that predate seismological instrumentation. Consider differences in soil and bedrock properties between the site and the location where earthquake intensity was reported.  Review the descriptions of any capable faults, including length, relationship to regional tectonic structures and the regional stress regime, and the nature and amount of the maximum displacement per event during the Quaternary.  Ensure that the SAR uses suitable methods, such as those outlined by Slemmons (1977), to determine fault capability. Ensure that fault studies used photogeologic work and field investigations.  Compare the SAR findings to any published alternative interpretations.  Review any justification of noncapability for any fault within 161 km (100 mi) of the site that, if it produced its maximum magnitude earthquake at its closest distance to the site, would produce site ground acceleration greater than or equal to the design value.  Confirm that field investigations and conservative assumptions justify the classification of such a fault as noncapable.  Use trench excavations in determining capability if a fault is overlain by Late Pleistocene sediments.

Review the SAR calculation of the ground motion design-basis value as defined by a response spectrum corresponding to the peak horizontal ground acceleration.  A standardized design-basis earthquake described by an appropriate response spectrum anchored at 0.25 g may be used for the site if it meets three criteria:  (1) located east of the Rocky Mountain front; (2) not in a seismically active region (e.g., New Madrid, Missouri; Charleston, South Carolina; or Attica, New York); and (3) not subject to ground motion above 0.2 g (per an appropriate response spectrum) as shown by reconnaissance investigation.  Alternatively, for sites that do not meeting the three criteria, ensure that the application references 10 CFR Part 100, Appendix A, to develop a ground motion design-basis value.

Review the ground motion value derived from the methods in 10 CFR Part 100, Appendix A, by using the following procedures.

- Ensure that all capable faults have been considered as seismic sources, with the maximum magnitude earthquake occurring on the fault at its nearest approach to the site.

- Ensure that the maximum magnitude event is based on an accepted fault length-to-magnitude relationship, such as Slemmons et al. (1982) or Bonilla et al. (1984).

- Use a next-generation attenuation (NGA) model to ensure that the peak ground acceleration at the site is calculated from the earthquake magnitude and the site-to-source distance. For the western United States, next-generation attenuation models include those of Chiou and Youngs (2014), Campbell and Bozorgnia (2014), Abrahamson et al. (2014), and Boore et al. (2014). Pending completion of the next-generation attenuation East Project, for the central and eastern United States, use the model described in Electric Power Research Institute (2013).

- Ensure that the SAR analysis considered a floating earthquake, that it based the floating earthquake magnitude on the seismological history of the tectonic province, and that it used 15 km (9 mi) as the site-to-source distance for calculating ground acceleration at the site. Ensure that the SAR considered adjacent provinces and their characteristic floating earthquakes if the site is near a tectonic province boundary. Ensure that the site-to-source distance for a floating earthquake in an adjacent province is 15 km or the closest approach of the province to the site, whichever is greater.

- Ensure that the site-specific response spectrum used to derive the peak horizontal ground acceleration from the design-basis earthquake considers the specific engineering properties of the material underlying the site, including seismic wave velocities, density, water content, porosity, and strength. Ensure that the design criteria in the SAR consider the design ground motion value.

#### 2.5.6.3 *Surface Faulting*

Review the SAR evaluation of tectonic structures underlying the site. Consider whether the application uses boreholes or geophysical surveys to reveal buried structures. Determine the need for geophysical or other studies to establish the presence or absence of such structures if local geology investigations provide some evidence that buried, potentially active structures may underlie the site. Ensure that the SAR evaluation of onsite structures considers the effects of human activities, such as mining activity, loading effects from dams or reservoirs, and pumping fluids out of or into the subsurface, and the proclivity of faults to slip. Confirm that the SAR includes a capability assessment of all faults longer than 300 meters (1,000 feet) and passing within 8 km (5 mi) of the site. Examine these assessments to ensure that the conclusions are based on sound geologic principles and practices and, in cases where capability remains equivocal, a preponderance of the available geologic evidence. Review the information provided on fault length and relationship to regional tectonic structures, the nature and amount of Quaternary displacement, and the magnitude of the maximum Quaternary displacement event for those faults that are deemed capable. Ensure that the SAR identifies the outer limits of the fault or fault zone along the trace 16 km (10 mi) in either direction of the point where the fault makes its closest approach to the site. Ensure that any fault displacement, if the site is subject to surface faulting, does not exceed the design criteria. Ensure the safety margin is sufficient if critical facilities are to be located in areas subject to displacement because fault displacement is a difficult phenomenon to assess.

#### 2.5.6.4 *Stability of Subsurface Materials*

Review the description of geologic features to ensure that the application has not overlooked any natural features that could affect foundation stability during ground shaking. Examine the tabulations of the physical and engineering properties for the foundation materials underlying the site. Ensure that foundation material properties include 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. Compare selected values against representative laboratory test results to confirm the accuracy of the values of selected properties.

Examine the SAR plans and profiles of the locations of investigative studies and facility structures. Confirm that the plans include all appropriate boreholes, trenches, and other excavations. Ensure that the profiles accurately show the relationships between structure foundations and subsurface materials and the ground water and engineering characteristics of the subsurface materials. Review the SAR plans and profiles that show excavation and backfill activity to ensure that compaction criteria are substantiated with representative laboratory or field-test records. Examine the tables and profiles of the compressional and shear wave velocities in the soil and rock beneath the site. Ensure that these data were gathered by appropriate methods. Examine any graphic logs of boreholes, trenches, or other excavations for accuracy. Ensure that the SAR analyses of the soil and rock responses to dynamic loading are conservative.

Review the discussion of the liquefaction potential of material beneath the site. Conduct an independent analysis to verify a claim that liquefaction-susceptible soils are absent beneath the site. Ensure that the discussion of soil zones with the potential for liquefaction includes 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 ground water elevation fluctuations.

Ensure that the SAR analysis for soil stability uses the appropriate response spectra in determining the design ground motion from the design-basis earthquake. Ensure that the static analyses address settlement and lateral pressures and are accompanied by representative laboratory data. Review the SAR specifications for any techniques, such as grouting, vibraflotation, rock bolting, or anchors, required to improve unstable subsurface conditions. Ensure that designs follow proper engineering standards. Examine the safety factors and the criteria, references, or methods of design used in ensuring that the facility can withstand seismic ground motion and surface faulting.

#### 2.5.6.5 *Slope Stability*

Examine the slope cross-section drawings for accuracy. Review the static and dynamic properties of the embankment and foundation soil and rock beneath the slope to ensure that the values are reasonable and substantiated with representative laboratory test data. Ensure that stability assessments address the potential effects of erosion, deposition, and seismicity, either individually or in combination. Ensure that erosional processes discuss sheet and rill flow, mass wasting, and valley widening. Ensure that the compaction specifications are based on representative laboratory analyses. Review the logs of core borings and test pits taken in these areas for any proposed borrow areas. Ensure that the analyses supporting the slope and erosional stability findings use conservative methods and assumptions.

## 2.6 Evaluation Findings

The NRC reviewer should prepare evaluation findings upon satisfaction of the regulatory requirements in Section 2.4 of this SRP. If the documentation submitted with the application fully supports positive findings for each of the regulatory requirements, the statements of findings should be similar to the following:

F2.1 The SAR provides an acceptable description and safety assessment of the site on which the [ISFSI/MRS] is to be located, in accordance with 10 CFR 72.24(a).

F2.2 The proposed site complies with the criteria in 10 CFR Part 72, Subpart E, "Siting Evaluation Factors," as required in 10 CFR 72.40(a)(2).

The reviewer should provide a summary statement similar to the following:

> As set forth above, the applicant has presented and substantiated information to establish the site characteristics. The staff has reviewed the information provided and, for the reasons given above, concludes that it is sufficient for the staff to evaluate compliance with the requirements in 10 CFR Part 72. The staff further concludes that the applicant provided sufficient details about the site characteristics to allow the staff to evaluate, as documented in this safety evaluation report, whether the applicant has met the relevant requirements of 10 CFR Part 72 with respect to determining the acceptability of the site.

## 2.7 References

10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste."

10 CFR Part 20, "Standards for Protection Against Radiation,"

10 CFR Part 100, "Reactor Site Criteria."

Abrahamson, N.A., W.J. Silva, and R. Kamai, "Summary of the ASK14 Ground Motion Relation for Active Crustal Regions," *Earthquake Spectra*, 30:1025–1055, 2014.

American National Standards Institute/American Nuclear Society 2.8, "Determining Design Basis Flooding at Power Reactor Sites."

Bonilla, M.G., R.K. Mark, and J.J. Lienkaemper, "Statistical Relations among Earthquake Magnitude, Surface Rupture Length, and Surface Fault Displacement," *Bulletin of the Seismological Society of America*, 74:2379-2411, 1984.

Boore, D.M., J.P. Stewart, E. Seyhan, and G.M. Atkinson, "NGA-West2 Equations for Predicting PGA, PGV, and 5%-damped PSA for Shallow Crustal Earthquakes," *Earthquake Spectra*, 30:1057–1085, 2014.

Campbell, K.W. and Y. Bozorgnia, "NGA-West2 Ground Motion Model for the Average Horizontal Components of PGA, PGV, and 5%-Damped Linear Acceleration Response Spectra," *Earthquake Spectra*, 30:1087–1115, 2014.

Chiou, B-S.J. and R.R. Youngs, "Update of the Chiou and Youngs NGA Ground Motion Model for Average Horizontal Component of Peak Ground Motion and Response Spectra," *Earthquake Spectra*, 30:1117–1153, 2014.

Electric Power Research Institute, "Ground Motion Model (GMM) Review Project," Final Report, 2013.

Federal Emergency Management Agency (FEMA), "Protecting Building Utilities from Flood Damage, Principles and Practices for the Design and Construction of Flood Resistant Building Utility Systems," First Edition, FEMA 348, November 1999.

FEMA, "Floodproofing Non-Residential Buildings," FEMA P-936, July 2013.

National Weather Service (NWS), "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydro-meteorological Report No. 51, National Oceanic and Atmospheric Administration, Washington, DC, June 1978.

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NWS, "Application of Probable Maximum Precipitation Estimates—United States East of the 105th Meridian," Hydrometeorological Report No. 52, National Oceanic and Atmospheric Administration, Washington, DC, April 1982.

NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition."

Regulatory Guide 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants."

Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants."

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

Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)."

Regulatory Guide 3.62, "Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks."

Slemmons, D.B., "State-of-the-Art for Assessing Earthquake Hazards in the United States: Report 6, Faults and Earthquake Magnitude," Miscellaneous Paper S-73-1, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS, 1977.

Slemmons, D.B., P. O'Malley, R.A. Whitney, D.H. Chung, and D.L. Bernreuter, "Assessment of Active Faults for Maximum Credible Earthquakes of the Southern California-Northern Baja

Region," Lawrence Livermore National Laboratory (LLNL), University of California, LLNL Publication No. UCID 19125, 1982.

U.S. Army Corps of Engineers (USACE), "Probable Maximum Flood Estimation—Eastern United States," Technical Paper 100, Hydrologic Engineering Center, Davis, CA, September 1984.

USACE, "HMR52 Probable Maximum Storm (Eastern United States) User's Manual," CPD-46, Hydrologic Engineering Center, Davis, CA, April 1987.

USACE, "HEC-2 Water Surface Profiles—User's Manual," CPD-2A, Hydrologic Engineering Center, Davis, CA, September 1991.