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Deletions are shown with the following attributes and color:
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C.I.2 Site Characteristics

Chapter 2 of the ~~final safety analysis report (~~FSAR~~)~~ should provide information concerning the geological, seismological, hydrological, and meteorological characteristics of the site and vicinity, in conjunction with present and projected population distribution and land use and site activities and controls. The purpose ~~is to indicate how these~~of this information is to demonstrate that the applicant has accurately described the site characteristics ~~have influenced~~and appropriately used them in the plant design and operating criteria ~~and to show the adequacy of the site characteristics from a safety viewpoint.~~

~~Identify.~~

COL applicants should identify the applicable regulatory requirements and discuss how these requirements are met for the site characteristics specified below. ~~I~~Applicants should identify the regulatory guidance followed and explain and justify any deviations from this guidance. ~~P~~They should also provide justification for any alternative methods that are used. ~~C~~Applicants should clearly describe the data collected, analyses performed, results obtained, and any previous analyses and results cited to justify any of the conclusions presented in the FSAR.

C.I.2.1 Geography and Demography

C.I.2.1.1 *Site Location and Description*

C.I.2.1.1.1 *Specification of Location*

~~T~~Applicants should specify the location of each reactor at the site ~~should be specified~~ by latitude and longitude to the nearest second~~,~~ and by Universal Transverse Mercator Coordinates ~~[Zone N~~(zone number, ~~N~~northing, and ~~E~~easting, as found on topographical maps prepared by the ~~United States~~U.S. Geological Survey (USGS)~~]~~) to the nearest 100~~-~~ meters (328 feet). ~~The~~They should consult the USGS map index ~~should be consulted~~ for the specific names of the 7½-minute quadrangles that bracket the site area. This section should also identify the State and county (or other political subdivision) in which the site is located, as well as the location of the site with respect to prominent natural features (such as rivers and lakes~~,~~) and man~~-~~made features (such as industrial, military, and transportation facilities).

C.I.2.1.1.2 *Site[1] Area Map*

This section should include a map of ~~the site area of~~ suitable scale depicting the site area (with explanatory text as necessary). This map should clearly show the following attributes:

(1) ~~P~~plant property lines~~. T~~, stating the area of the plant property (in acres) ~~should be stated.~~

(2) ~~L~~location of the site boundary~~. I~~, stating if the site boundary lines are the same as the plant property lines~~; this should be stated.~~

[1] "Site" means the contiguous real estate on which nuclear facilities are located and for which one or more licensees has the legal right to control access by individuals and to restrict land use for purposes of limiting potential doses from radiation or radioactive material during normal operation of the facilities.

(3) ~~L~~location and orientation of principal plant structures within the site area~~. These principal structures should be~~, identified by function (e.g., reactor building, auxiliary building, turbine building)~~.~~

(4) ~~L~~location of any industrial, military, or transportation facilities~~,~~ and commercial, institutional, recreational, or residential structures within the site area~~.~~

(5) ~~S~~scaled plot plan of the exclusion area ~~[as defined in Title 10, Section 100.3, of the Code of Federal Regulations (10 CFR 100.3)]~~(as defined in 10 CFR 100.3, "Definitions"), which permits distance measurements to the ~~exclusion area boundary~~EAB in each of the 22½-degree segments centered on the 16 cardinal compass points~~.~~

(6) ~~S~~scale that permits the measurement of distances with reasonable accuracy~~.~~

(7) ~~T~~true ~~N~~north~~.~~

(8) ~~H~~highways, railroads, and waterways that traverse or are adjacent to the site~~.~~

(9) ~~P~~prominent natural and man~~-~~made features in the site area~~.~~

~~**C.I.2.1.1.3 *Boundaries for Establishing Effluent Release Limits***~~

~~The site description should define the boundary lines of the restricted area (as defined in 10 CFR 20.1003), and should describe how access to this area is controlled for radiation protection purposes, including how the applicant will be made aware of individuals entering the area and will control such access.~~

~~If the applicant proposes to set limits higher than those established by 10 CFR 20.1301 [and related to "as low as reasonably achievable" (ALARA) provisions], this section should also include the information specified in Appendix I 10 CFR Part 50. The site map discussed above may be used to identify this area, or a separate map of the site may be used. Indicate the location of the boundary line with respect to the water's edge of nearby rivers and lakes. Distances from plant effluent release points to the boundary line should be clearly defined.~~

~~**C.I.2.1.2**~~

C.I.2.1.2 *Exclusion Area Authority and Control*

C.I.2.1.2.1 *Authority*

This section should include a specific description of the applicant's legal rights with respect to all areas that lie within the designated exclusion area. As specified by 10 CFR 100.21(a), this description should establish that the applicant has the authority to determine all activities, including exclusion and removal of personnel and property from the area. ~~T~~It should also address the status of mineral rights and easements within this area ~~should also be addressed~~.

If the applicant has not obtained ownership of all land within the exclusion area, it should use a scaled map of the exclusion area to clearly describe those parcels of land not owned within the area. The applicant should ~~be~~also clearly ~~described by means of a scaled map of the exclusion area, and~~describe the status of proceedings and the schedule to obtain ownership or the required authority over the land for the life of the plant. This section should ~~be specifically described. M~~give the minimum distance to and direction of ~~exclusion area boundaries should~~

~~be given~~EABs for both present and proposed ownership. If the exclusion area extends into a body of water, the application should specifically address the bases upon which it has been determined that the applicant holds (or will hold) the authority required by 10~~-~~ CFR~~-~~ 100.21(a).

C.I.2.1.2.2 *Control of Activities Unrelated to Plant Operation*

~~A~~The applicant should describe any activities unrelated to plant operation ~~which are to~~that will be permitted within the exclusion area (aside from transit through the area)~~ should be described~~ with respect to the nature of such activities, the number of persons engaged in them, and the specific locations within the exclusion area where such activities will be permitted. ~~Describe~~This section should include a description of the limitations to be imposed on such activities and the procedure~~ to be followed to ensure~~(s) for ensuring that the applicant is aware of such activities
and has made appropriate arrangements to evacuate persons engaged in such activities~~,~~ in the event of an emergency.

C.I.2.1.2.3 *Arrangements for Traffic Control*

Where ~~the exclusion area is traversed by~~ a highway, railroad, or waterway traverses the exclusion area, the application should describe the arrangements made (or to be made) to control traffic in the event of an emergency.

C.I.2.1.2.4 *Abandonment or Relocation of Roads*

If ~~there are~~ any public roads ~~traversing~~traverse the proposed exclusion area ~~which, because of their location,~~that will have to be abandoned or relocated, the applicant should provide (1) specific information ~~should be provided~~ regarding the authority possessed under State laws to effect abandonment~~;~~, (2) the necessary procedures ~~that must be followed~~ to achieve abandonment~~;~~, (3) the ~~identity~~identities of the public authorities who will make the final determination~~;~~, and (4) the status of the proceedings completed to date and the schedule to obtain abandonment. If a public hearing is required ~~prior to~~before abandonment, the applicant should specify the type of hearing (e.g., legislative or adjudicatory)~~ should be specified~~. If the public road will be relocated rather than abandoned, this section should provide specific information ~~as described above should be provided with regard to~~ on
the relocation and the status of and schedule for obtaining any lands required for relocation.

C.I.2.1.3 *Population Distribution*

~~P~~This section should present population data~~ presented should be~~ based on the latest census data. The following sections discuss the information that applicants should~~ be~~ present~~ed~~ on population distribution.

C.I.2.1.3.1 *Population Within 10 Miles*

On a map of suitable scale that identifies places of significant population grouping (such as cities and towns) within a radius of 10 miles (16.09 kilometers (km)), applicants should draw concentric circles~~ should be drawn~~, with the reactor at the center point, at distances of 1, 2, 3, 4, 5, and 10 miles (1.61, 3.22, 4.83, 6.44, 8.05, and 16.09 km). The circles should be divided into ~~22 ½ -degree segments~~22½-degree sectors, with each ~~segment~~sector centered on one of the 16 compass points (e.g., true north, north-northeast, northeast). A table appropriately

keyed to the map should provide the current ~~residential~~resident population within each area of the map formed by the concentric circles and radial lines. The applicant should use the same table, or separate tables, ~~should be used~~ to provide the projected population within each area (1) for the expected first year of plant operation~~,~~ and (2) by census decade (e.g., 2000) through the projected plant life. The tables should provide population totals for each segment and annular ring~~,~~ and a total for the ~~0-10 mile~~0–10-mile (0~~–~~16.09 km) enclosed population. The applicant should describe the basis for population projections ~~should be described. The applicant should~~and provide the methodology and sources used to obtain the population data, including the projection.

C.I.2.1.3.2 *Population Between 10 and 50 Miles*

~~A~~The applicant should use a map of suitable scale and appropriately keyed tables ~~should be used~~ in the same manner discussed ~~above~~in Section C.I.2.1.3.1 of this guide to describe the population and its distribution at 10 mile (16.09-km) intervals between the 10- and 50-mile (16.09- and 80.47-km) radii from the reactor.

C.I.2.1.3.3 *Transient Population*

~~S~~This section should generally describe seasonal and daily variations in population and population distribution resulting from land uses (such as recreational or industrial) ~~should be generally described~~ and appropriately ~~keyed~~key them to the areas and population numbers contained on the maps and tables in Sections 2.1.3.1 and 2.1.3.2 of the FSAR. If the plant is located in an area where significant population variations attributable to transient land use are expected, the applicant should provide additional tables of population distribution ~~should be provided~~ to indicate peak seasonal and daily populations. The additional tables should cover projected~~,~~ as well as current populations.

C.I.2.1.3.4 *Low Population Zone*

~~The~~This section should specify the low population zone (LPZ), as defined in 10 CFR Part 100~~)~~, "Reactor Site Criteria," which should be ~~specified and~~ determined in accordance with the guidance provided in ~~Regulatory Guide~~RG 4.7, "General Site Suitability Criteria for Nuclear Power Stations~~,~~," ~~Revision 2, dated April 1998. A~~ The applicant should provide a scaled map of the zone ~~should be provided~~ to illustrate topographic features; highways, railroads, waterways, and any other transportation routes that may be used for evacuation purposes; and locations of all facilities and institutions such as schools, hospitals, prisons, beaches, and parks. ~~F~~The applicant should identify, out to a distance of 5 miles (8.05 km), any facilities and institutions beyond the LPZ ~~which~~that, because of their nature, may require special consideration when evaluating emergency plans~~, should be identified out to a distance of 5 miles (8.05 km)~~. A table of population distribution within the LPZ should provide estimates of peak daily, as well as seasonal transient, population within the zone, including estimates of transient population in the identified facilities and institutions. The applicant should determine the LPZ so that appropriate protective measures could be taken on behalf of the enclosed populace in the event of an emergency.

C.I.2.1.3.5 *Population Center*

The applicant should identify the nearest population center (as defined in 10 CFR Part 100) ~~should be identified~~ and specify its population, direction, and distance from the reactor ~~specified~~. The distance from the reactor to the nearest boundary of the population center (not

necessarily the political boundary) should be related to the LPZ radius to demonstrate compliance with the requirements in 10 CFR Part 100 and the guidance in Regulatory Guide RG 4.7. The applicant should also provide the bases for the selected boundary should also be provided. Indicate, indicating the extent to which it considered the transient population has been considered in establishing the population center. In addition to specifying the distance to the nearest boundary of a population center, the applicant should discuss the present and projected population distribution and population density within and adjacent to local population groupings.

C.I.2.1.3.6 *Population Density*

PThe applicant should provide a plot out to a distance of at least 20 miles (32.20 km) showing the cumulative resident population (including the weighted transient population) at the time of the projected COL approval and within about five years5 years thereafter. DThe applicant should demonstrate that the resulting uniform population density (defined as the cumulative population at a distance divided by the circular area at that distance) from the cumulative populations averaged over any radial distance out to 20 miles (32.20 km) does not exceed 500 persons/mile^2 persons/square mile (200 persons/km^2). D and demonstrate that the population density is in accordance with the guidance in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations."

C.I.2.2 RG 4.7.

C.I.2.2 Nearby Industrial, Transportation, and Military Facilities

The purpose of this section is to establish (1) whether the effects of potential accidents in the vicinity[2] of the site from present and projected industrial, transportation, and military installations and operations should be used as design-basis events (DBE) and to establish(2) the design parameters related to the accidents so selected.

ICOL applicants should identify the applicable regulatory requirements and discuss how these requirements are met for the site characteristics specified below. IThey should identify the regulatory guidance followed and explain and justify any deviations from this guidance. Provide justification and for any alternative methods that are used. ClearlyThey should also describe the data collected, analyses performed, results obtained, and any previous analyses and results cited to justify any of the conclusions presented in the FSAR.

C.I.2.2.1 *Locations and Routes*

PThe applicant should provide maps showing the location and distance from the nuclear plant of all significant manufacturing plants; chemical plants; refineries; storage facilities; mining and quarrying operations; military bases; missile sites; transportation routes (air, land, and water); transportation facilities (docks, anchorages, and airports); oil and gas pipelines, drilling operations, and wells; and underground gas storage facilities. Show aAny other facilities that, because of the products manufactured, stored, or transported, may warrant consideration with respect to possible adverse effects on the plant should be shown on the maps. Typically, adverse effects may be produced by toxic,

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[2] A Applicants should consider all facilities and activities within 5 miles (8.05 km) of the nuclear plant should be considered. Fand include facilities and activities at greater distances should be included as appropriate tobased on their significance.

flammable, and explosive substances~~. Examples include~~, such as chlorine, ammonia, compressed or liquid hydrogen, liquid oxygen, and propane~~. Also~~, ~~show~~may produce adverse effects as may any military firing or bombing ranges and any nearby aircraft flight, holding, and landing patterns.

The maps should be legible and of suitable scale to enable the easy location of the facilities and routes in relation to the nuclear plant. ~~All~~Applicants should identify in legends or tables all symbols and notations used to depict the locations of facilities and routes. The maps should ~~be identified in legends or tables. Topographic~~depict topographic features ~~should be included on the maps~~ in sufficient detail to adequately illustrate the information presented.

C.I.2.2.2 ***Descriptions***

The descriptions of the nearby industrial, transportation, and military facilities identified in accordance with Section C.I.2.2.1 of this guide should include the information indicated in the following sections.

C.I.2.2.2.1 ***Description of Facilities***

~~A~~The applicant should provide a concise description, in tabular form, of each facility, including its primary function and major products~~,~~ as well as the number of persons employed~~, should be provided in tabular form~~.

C.I.2.2.2.2 ***Description of Products and Materials***

~~A description of~~This section should describe the products and materials regularly manufactured, stored, used, or transported in the vicinity of the nuclear plant or ~~onsite~~on site. It should ~~be provided. Emphasis should be placed on~~emphasize the identification and description of any hazardous materials. ~~S~~The applicant should provide statistical data ~~should be provided~~ on the amounts involved, modes of transportation, frequency of shipment, and maximum quantity of hazardous material likely to be processed, stored, or transported at any given time. ~~T~~Applicants should also provide the applicable toxicity limits ~~should also be provided~~ for each hazardous material.

C.I.2.2.2.3 ***Description of Pipelines***

For pipelines, the applicant should indicate the pipe size, age, operating pressure, depth of burial, location and type of isolation valves, and type of gas or liquid presently carried. ~~I~~The applicant should also indicate whether the pipeline is used for gas storage at higher-than-normal pressure~~,~~ and discuss the possibility that the pipeline may be used in the future to carry a different product ~~other than the one presently being carried~~ (e.g., propane instead of natural gas).

C.I.2.2.2.4 ***Description of Waterways***

If the site is ~~located~~ adjacent to a navigable waterway, the applicant should provide information on the location of the intake structure(s) in relation to the shipping channel, the depth of channel, the locations of locks, the types of ships and barges using the waterway, and any nearby docks and anchorages.

C.I.2.2.2.5 ***Description of Highways***

~~Describe~~The applicant should describe nearby major highways or other roadways, as appropriate,

in terms of the frequency and quantities of hazardous substances that may be transported by truck in the vicinity of the plant site.

C.I.2.2.2.6 *Description of Railroads*

~~Identify~~The applicant should identify nearby railroads~~,~~ and provide information on the frequency and quantities of hazardous materials that may be transported in the vicinity of the plant site.

C.I.2.2.2.7 *Description of Airports*

For airports, the applicant should provide information regarding the length and orientation of runways, types of aircraft using the facility, number of operations per year by aircraft type, and the flying patterns associated with the airport. ~~P~~This section should also provide plans for future ~~utilization~~use of the airport, including possible construction of new runways, increased traffic, or ~~utilization~~use by larger aircraft~~, should also be provided~~. In addition, the applicant should provide statistics on aircraft accidents[3] for the following three categories:

(1) all airports within 5 miles (8.05 km) of the nuclear plant

(2) airports with projected operations greater than 500d[4] movements per year within 10 miles (16.1 km) of the plant

(~~2~~3) airports with projected operations greater than ~~500d[2]~~1000d[4] movements per year ~~within 10 miles~~ outside 10 miles (16.1 km)[4]

~~(3) airports with projected operations greater than 1000d[2] movements per year outside 10 miles (16.1 km)[4]~~

~~Provide equivalent~~ of the plant

Equivalent information describing any other aircraft activities in the vicinity of the plant should be provided. These should include aviation routes, pilot training areas, and landing and approach paths to airports and military facilities.

C.I.2.2.2.8 *Projections of Industrial Growth*

For each of the ~~above~~ categories given in Section C.I.2.2.2.7 of this guide, the applicant should provide projections of the growth of present activities and new types of activities in the vicinity of the nuclear plant that can reasonably be expected based on economic growth projections for the area.

C.I.2.2.3 *Evaluation of Potential Accidents*

~~O~~The applicant should determine on the basis of the information provided in FSAR Sections 2.2.1 and 2.2.2, ~~determine~~ the potential accidents to be considered as ~~design-basis events~~DBAs and identify the potential effects of those accidents on the nuclear plant~~,~~ in terms of design parameters (e.g., ~~over pressure~~overpressure, missile energies) or physical phenomena (e.g., concentration of flammable or toxic cloud outside building structures).

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[3] ~~A~~ The applicant should provide in Section 3.5 of the FSAR an analysis of the probability of an aircraft collision at the nuclear plant and the effects of the collision on the safety-related components of the plant ~~should be provided in Section 3.5 of the FSAR~~.

[4] The variable "d" represents the distance in miles from the site.

C.I.2.2.3.1 *Determination of Design-Basis Events*

~~Design-basis events~~DBAs internal and external to the nuclear plant are defined as those accidents that have a probability of occurrence on the order of magnitude of 10^{-7} per year or greater~~,~~ and potential consequences serious enough to affect the safety of the plant to the extent that the guidelines in 10~~-~~ CFR ~~Part~~ 100 could be exceeded. ~~Determination of t~~The probability of occurrence of potential accidents should be determined based on analysis of the available statistical data on the frequency of occurrence for the type of accident under consideration, as well as on the transportation accident rates for the mode of transportation used to carry the hazardous material. If the probability of such an accident is on the order of magnitude of 10^{-7} per year or greater, the ~~accident~~applicant should ~~be consider~~ed it a ~~design-basis event,~~DBA and provide a detailed analysis of its effects on the plant's safety-related structures and components ~~should be provided~~. Because ~~of the~~it is difficult~~y of assigning~~ to assign accurate numerical values to the expected rate of low-frequency hazards considered in this guide, judg~~e~~ment must be used as to the acceptability of the overall risk presented. Data for low~~-~~probability events are often not available to permit accurate calculations. Accordingly, the expected rate of occurrence exceeding the guidelines in 10~~-~~ CFR~~-~~ Part~~-~~ 100 (on the order of magnitude of 10^{-6} per year) is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower. ~~T~~Applicants should consider the following accident categories ~~should be considered~~ in selecting design~~-~~basis events:

(1) Explosions~~-~~: ~~Accidents~~Applicants should consider accidents involving detonations of high explosives, munitions, chemicals, or liquid and gaseous fuels ~~should be considered~~ for facilities and activities in the vicinity of the plant or ~~onsite~~on site, where such materials are processed, stored, used, or transported in quantity. ~~Attention~~Applicants should ~~be given~~give particular attention to potential accidental explosions that could produce a blast ~~over pressure~~overpressure on the order of ~~one pound~~1 pound force per square inch (1 psi) equivalent of 51.7 mmHg or greater at the nuclear plant, using recognized quantity-distance relationships.[5] ~~M~~If the blast overpressure criterion is not met or if the probability of occurrence of the subject event is greater than 10^{-7}/year, applicants should also consider missiles generated by the explosion ~~should also be considered, and~~and provide an analysis ~~should be provided~~ in ~~Section 3~~Section 3.5 of the FSAR. ~~Regulatory Guide~~RG 1.91, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants," provides guidance for evaluating postulated explosions on transportation routes near nuclear facilities.

(2) Flammable Vapor Clouds (~~D~~delayed ~~i~~gnition)~~-~~: ~~Accidental~~Applicants should consider the accidental releases of flammable liquids or vapors that result in the formation of unconfined vapor clouds ~~should be considered~~. Assuming that no immediate explosion occurs, applicants should determine the extent of the cloud and the concentrations of gas that could reach the plant under ~~"worst-case"~~worst-case meteorological conditions. Applicants should ~~be determined. A~~provide an evaluation of the effects on the plant of explosion and deflagration of the vapor cloud. If the probability of occurrence of the subject event is greater than 10^{-7}/year, Section 3.5 of the FSAR should ~~be~~ provide~~d. A~~ an analysis of the missiles generated by the explosion ~~should be provided in Section 3.5 of the FSAR~~.

(3) Toxic Chemicals~~-~~: ~~Accidents~~Applicants should consider accidents involving the release of toxic chemicals (e.g., chlorine) from onsite storage facilities and nearby mobile and stationary sources ~~should be considered~~. If toxic chemicals are known or projected to be present ~~onsite~~on site or in the vicinity of a nuclear plant, or to be frequently transported in the vicinity of the plant, applicants should evaluate releases of those chemicals ~~should be evaluated~~. For each postulated

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5 One acceptable reference is the U.S. Department of the Army Technical Manual TM 5-1300, "Structures to Resist the Effects of Accidental Explosions," Revision 1, issued 1990, for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

event, applicants should determine a range of concentrations at the site ~~should be determined~~ for a spectrum of meteorological conditions. ~~T~~Applicants should use these toxic chemical concentrations ~~should be used in evaluating~~to evaluate control room habitability in Section 6.4 of the FSAR.

(4) Fires~~:~~. ~~Accidents~~Applicants should consider accidents leading to high heat fluxes or smoke~~,~~ and nonflammable gas- or chemical-bearing clouds from the release of materials as the consequence of fires in the vicinity of the plant. They should ~~be considered. F~~evaluate fires in adjacent industrial and chemical plants and storage facilities and in oil and gas pipelines, brush and forest fires, and fires from transportation accidents ~~should be evaluated~~ as events that could lead to high heat fluxes or to the formation of such clouds. ~~A~~The dispersal analysis should include a spectrum of meteorological conditions ~~should be included in the dispersal analysis when~~for determining the concentrations of nonflammable material that could reach the site. ~~T~~Applicants should use these concentrations ~~should be used~~ in Section 6.4 of the FSAR to evaluate control room habitability and in Section 9.5 of the FSAR to evaluate the operability of diesels and other equipment.

(5) Collisions with Intake Structure~~:~~. For nuclear power plant sites located on navigable waterways, the evaluation should consider the probability and potential effects of impact on the plant cooling water intake structure and enclosed pumps by the various sizes, weights, and types of barges or ships that normally pass the site, including any explosions incident to the collision. ~~T~~Applicants should use this analysis ~~should be used~~ in Section 9.2.5 of the FSAR to determine whether an additional source of cooling water is required.

(6) Liquid Spills~~:~~. ~~T~~Applicants should consider the accidental release of oil or liquids that may be corrosive, cryogenic, or coagulant ~~should be considered~~ to determine ~~if~~ the potential ~~exists~~ for such liquids to be drawn into the plant's intake structure and circulating water system or otherwise to affect the plant's safe operation.

C.I.2.2.3.2 *Effects of Design-Basis Events*

~~P~~Applicants should provide an analysis of the effects of the ~~design-basis events~~DBAs identified in Section 2.2.3.1 of the FSAR on the safety-related components of the nuclear plant and discuss the steps taken to mitigate the consequences of those accidents, including such things as the addition of ~~engineered safety feature~~ESF equipment and the reinforcing of plant structures~~,~~ as well as the provisions made to lessen the likelihood and severity of the accidents ~~themselves~~.

C.I.2.3 Meteorology

This section should provide a meteorological description of the site and its surrounding areas. ~~S~~It should include sufficient data ~~should be included~~ to permit an independent evaluation by the staff.

C.I.2.3.1 *Regional Climatology*

C.I.2.3.1.1 *General Climate*

~~The~~This section should describe the general climate of the region ~~should be described~~ with respect to types of air masses, synoptic features (high- and low-pressure systems and frontal systems), general airflow patterns (wind direction and speed), temperature and humidity, precipitation (rain, snow, sleet, and freezing rain), potential influences from regional topography, and relationships between synoptic-scale atmospheric processes and local (site) meteorological conditions. ~~Identify~~It should also

identify the state climatic division of the site. P and provide references that indicate the climatic atlases and regional climatic summaries used.

C.I.2.3.1.2 ***Regional Meteorological Conditions for Design and Operating Bases***

PIn this section, the applicant should provide annual (and seasonal, if available) frequencies of severe weather phenomena, including hurricanes, tornadoes and waterspouts, thunderstorms, severe wind events, lightning, hail (including probable maximum size), and high air pollution potential. Provide tThe probable maximum annual frequency of occurrence, amount, and time duration of freezing rain (ice storms) and dust (sand) storms where applicable should also be provided in this section. DescribeA description of the site's air quality, including identifyingidentification of the site's Interstate Air Quality Control Region and its attainment designation with respect to sState and national air quality standards should also be provided.

Identify aAll the regional meteorological and air quality conditions, including those listed below, that should be classified as climatic site characteristics for consideration in evaluating the design and operation of the proposed facility. Include should be identified and be references to other applicable sections of the FSAR in which these conditions are used.

(1) Provide should provide be included. The applicant should provide:

(1) estimates of the weight of the 100-year return period snowpack and the weight of the 48-hour probable maximum winter precipitation for the site vicinity for use in determining the weight of snow and ice on the roof of each safety-related structure.

(2) Provide the meteorological data used to evaluate the performance of the ultimate heat sink (UHS), with respect to (1) maximum evaporation and drift loss, (2) minimum water cooling, and (3) if applicable, the potential for water freezing in the ultimate heat sinkUHS water storage facility. (See Regulatory GuideRG 1.27, "Ultimate Heat Sink for Nuclear Power Plants"). T; identification of the period of record examined should be identified, andand a description of and justification for the bases and procedures used to select of the critical meteorological data should be provided and justified.

(3) Provide site characteristic tornado parameters, including translational speed, rotational speed, and maximum pressure differential with its associated time interval. GRG 1.76, "Design Basis Tornado and Tornado Missiles for Nuclear Power Plants," contains guidance on appropriate site characteristic tornado parameters is presented in Regulatory Guide 1.76, "Design-Basis Tornado for Nuclear Power Plants." Identify and justify any deviations from the guidance provided in Regulatory GuideRG 1.76.

should be identified and justified

(4) Provide the 100-year return period 3-second gust wind speed.

(5) Provide ambient temperature and humidity statistics (e.g., 0.4 percent, 2 percent, 99 percent2-percent and 99.6 percent1-percent annual exceedance dry-bulb temperaturesand 100-year maximum dry bulb temperature and coincident wet bulb temperature; 0.4 percent2-percent and

1-percent annual exceedance ~~wet-bulb~~and 100-year maximum wet bulb temperature~~; 100-year return period maximum dry-bulb and wet-bulb temperatures; 100-year return period minimum dry-bulb~~ (non-coincident);
98-percent and 99-percent annual exceedance and 100-year minimum dry bulb temperature) for use in establishing heat loads for the design of plant heat sink systems and plant heating, ventilation, and air conditioning (HVAC) systems~~.~~

C.I.2.3.2 *Local Meteorology*

C.I.2.3.2.1 *Normal and Extreme Values of Meteorological Parameters*

~~P~~The applicant should provide monthly and annual summaries ~~[~~based on both long-term data from nearby reasonably representative locations (e.g., within ~~80 km (~~50 miles (80 km)) and shorter-term onsite data~~]~~ for the following parameters:

(1) ~~M~~monthly and annual wind roses using the wind speed classes provided in ~~Regulatory Guide~~RG 1.23, ~~"Onsite Meteorological~~ "Meteorological Monitoring Programs for Nuclear Power Plants," and wind direction persistence summaries at all heights at which wind characteristics data are applicable or have been measured~~.~~

(2) ~~M~~monthly and annual air temperature and atmospheric water vapor (e.g., wet bulb temperature, dewpoint temperature, or relative humidity) summaries, including averages, measured extremes, and diurnal range~~.~~

~~(3) Monthly and annual extremes of atmospheric water vapor (e.g., relative humidity) including averages, measured extremes, and diurnal range.~~

(~~4~~3) ~~M~~monthly and annual summaries of precipitation, including averages and measured extremes, number of hours with precipitation, rainfall rate distribution~~,~~ (i.e., maximum ~~1-hr, 2-hr, … 24-hr~~distributions for 1-hour intervals up to 24 hours), and monthly precipitation wind roses with precipitation rate classes~~.~~

(~~5~~4) ~~M~~monthly and annual summaries of fog (and smog), including expected values and extremes of frequency and duration~~.~~

(~~6~~5) ~~M~~monthly and annual summaries of atmospheric stability defined by vertical temperature gradient or other well-documented parameters that have been substantiated by diffusion data~~.~~

(~~7~~6) ~~M~~monthly mixing height data, including frequency and duration (persistence) of inversion conditions~~.~~

(~~8~~7) ~~A~~annual joint frequency distributions of wind speed and wind direction by atmospheric stability for all measurement levels~~.~~

~~This information~~The applicant should ~~be~~ fully document~~ed~~ and ~~substantiated as to the validity of its representation of~~substantiate that this information validly represents conditions at and near the site. For example, the applicant should identify deviations from regional to local meteorological conditions caused by local topography, nearby bodies of water, or other unique site characteristics. This information should ~~be identified. R~~include references ~~should be provided~~ to the National Oceanic and Atmospheric Administration (NOAA), National Weather Service, station summaries from nearby locations, and ~~to~~ other meteorological data that were used to describe site characteristics.

C.I.2.3.2.2 *Potential Influence of the Plant and Its Facilities on Local Meteorology*

~~D~~The applicant should discuss and provide an evaluation of the potential modification of the normal and extreme values of meteorological parameters described in Section ~~C.I.~~2.3.2.1 of the FSAR as a result of the presence and operation of the plant (e.g., the influence of plant structures, terrain modifications, and cooling towers or water impoundment features on meteorological conditions)~~. P~~ and provide a map showing the detailed topographic features (as modified by the plant) within a 5-mile (8 km) radius of the plant. ~~Also~~In addition, the applicant should provide a smaller scale map showing topography within a 50-mile (80-km) radius of the plant, as well as a plot of maximum elevation versus distance from the center of the plant in each of the ~~sixteen 22½ -degree~~22½-degree sectors centered on one of the 16 compass ~~point sectors~~points (~~centered on~~e.g., true ~~N~~north, ~~North-Northeast~~north-northeast, ~~N~~northeast~~, etc.~~) radiating from the plant to a distance of 50 miles (80 km).

C.I.2.3.2.3 *Local Meteorological Conditions for Design and Operating Bases*

~~P~~The applicant should provide all local meteorological and air quality conditions used for design~~-~~ and ~~operating- basis~~operating-basis considerations and their bases, except for those conditions addressed in Sections C.I.2.3.4 and C.I.2.3.5 of this guide. ~~R~~The applicant should include references ~~should be included~~to t~~o~~he FSAR sections in which these conditions are used.

C.I.2.3.3 *Onsite Meteorological Measurements Program*

~~The~~This section should describe the pre~~-~~operational and operational programs for meteorological measurements at the site, including offsite satellite facilities~~, should be described~~. This description should include a site map showing tower location with respect to man~~-~~made structures, topographic features, and other site features that may influence site meteorological measurements~~. I~~ and should indicate distances to nearby obstructions to flow in each downwind sector~~s~~. ~~In addition, describe~~The description should also include measurements made~~;~~, elevations of measurements~~;~~, exposure of instruments~~;~~, descriptions of instruments used~~;~~, instrument performance specifications~~;~~, calibration and maintenance procedures~~;~~, data output and recording systems and locations~~;~~, and data processing, archiving, and analysis procedures. ~~A~~This section should similarly identify, in as much detail as possible, additional sources of meteorological data for consideration in the description of airflow trajectories from the site to a distance of 50 miles (80 km)~~ should be similarly described in as much detail as possible~~, particularly measurements made, locations and elevations of measurements, exposure of instruments, descriptions of instruments used, and instrument performance specifications. These additional sources of meteorological data may include National Weather Service stations and other meteorological programs that are well-maintained and well-exposed (e.g., other nuclear facilities~~;~~ and university and private meteorological programs). ~~G~~(RG 1.23 contains guidance on acceptable onsite meteorological programs ~~is presented in Regulatory Guide 1.23. Identify~~ and ~~justify~~ any deviations from the guidance provided in ~~Regulatory Guide~~RG 1.23 should be identified and justified.)

In a supplemental submittal to the application, the applicant should provide an electronic copy of (1) the joint frequency distributions of wind speed and direction by atmospheric stability class based on appropriate meteorological measurement heights and data reporting periods, in the format described in ~~Regulatory Guide~~RG 1.23, and (2) an hour-by-hour listing of the ~~hourly-averaged~~hourly averaged onsite meteorological database in the format shown in ~~Regulatory Guide~~RG 1.23.

~~A~~The applicant should provide meteorological data from at least two consecutive annual cycles (and preferably ~~three~~3 or more entire years), including the most recent 1-year period, ~~should be provided at docketing.~~

~~Evidence should be provided~~at the time of application submittal. If 2 years of onsite data are not available at the time the application is submitted, the applicant should provide at least one annual cycle of meteorological data collected on site with the application. The applicant should use these data to calculate (1) the short-term atmospheric dispersion estimates for accident releases discussed in Section 2.3.4 of the FSAR and (2) the long-term atmospheric dispersion estimates for routine releases discussed in Section 2.3.5 of the FSAR. The applicant should continue to monitor the data and submit the complete 2-year data set when it has been collected. The supplemental submittal should also include a reanalysis of the Section 2.3.4 and 2.3.5 atmospheric dispersion estimates based on the complete 2-year data set.

The applicant should provide evidence to show how well these data represent long-term conditions at the site.

C.I.2.3.4 ***Short-Term Atmospheric Dispersion Estimates for Accident Releases***

C.I.2.3.4.1 ***Objective***

~~P~~The COL applicant should provide, for appropriate time periods up to 30 days after an accident, conservative estimates of atmospheric dispersion factors (χ/Q values) at the site boundary (exclusion area), at the outer boundary of the LPZ, and at the control room for postulated accidental radioactive airborne releases. ~~A~~The applicant should also~~,~~ describe any atmospheric dispersion modeling used in Section 2.2.3 or Section 6.4 of the FSAR to evaluate potential ~~design-basis events~~DBAs resulting from the onsite and/or offsite airborne releases of hazardous materials (e.g., flammable vapor clouds, toxic chemicals, and smoke from fires).

C.I.2.3.4.2 ***Calculations***

~~D~~The applicant should base dispersion estimates ~~should be based~~ on the most representative (preferably onsite) meteorological data~~. E~~ and present evidence ~~should be provided to show~~showing how well these dispersion estimates represent conditions that would be estimated from anticipated long-term conditions at the site. ~~The~~This section should discuss the effects of topography and nearby bodies of water on short-term dispersion estimates ~~should be discussed~~. ~~Enough~~The information provided should be ~~provided~~sufficient to allow the staff to perform its own confirmatory calculations.

(1) ~~P~~For postulated ~~A~~accidental ~~R~~radioactive ~~R~~releases, the applicant should provide the following estimates:

(a) Offsite Dispersion Estimates~~:~~ ~~P~~The applicant should provide hourly cumulative frequency distributions of χ/Q values, using onsite data at appropriate distances from the effluent release point(s), such as the minimum site boundary distance (exclusion area). The applicant should report the χ/Q values from each of these distributions that are exceeded 5 percent of the time ~~should be reported~~. For the outer boundary of the LPZ, it should provide cumulative frequency of χ/Q estimates for (1) the 8-hour time period from 0 to 8 hours; (2) the 16-hour period from 8 to 24 hours; (3) the 3-day period from 1 to 4 days; and (4) the 26-day period from 4 to 30 days. ~~R~~It should report the worst condition and the 5-percent probability level conditions. ~~Guidance on appropriate diffusion models for estimating offsite χ/Q values is presented in Regulatory Guide 1~~RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants~~." Identify and justify any~~," provides guidance on appropriate dispersion models for estimating offsite χ/Q values. Any deviations from the guidance provided in ~~Regulatory Guide~~RG 1.145~~:~~ should be identified and justified

(b) Control Room Dispersion Estimates~~.~~: ~~P~~The applicant should provide control room χ/Q values that are not exceeded more than 5 percent of the time for all potential accident release points. ~~A~~For the purposes of control room radiological habitability analyses, it should provide a site plan showing true ~~N~~north and indicating locations of all potential accident release pathways and control room intake and unfiltered in-leakage pathways~~ should be provided~~. ~~Guidance on appropriate dispersion models for estimating control room χ/Q values is presented in Regulatory Guide~~RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants~~." Identify and justify any~~," provides guidance on appropriate dispersion models for estimating control room χ/Q values. Any deviations from the guidance provided in ~~Regulatory Guide 1.194.~~

~~(2) Hazardous Material Releases~~

~~Provide~~RG 1.194 should be identified and justified

(2) For hazardous material releases, the applicant should provide a description of the atmospheric dispersion modeling used in evaluating potential ~~design-basis events~~DBAs to calculate concentrations of hazardous materials (e.g., flammable or toxic clouds) outside building structures resulting from the onsite and/or offsite airborne releases of such materials~~. I~~ and should justify the appropriateness of the use of the models with regard to release characteristics, plant configuration, plume density, meteorological conditions, and site topography. ~~Guidance on hazardous chemical atmospheric dispersion modeling is provided in Regulatory Guide~~RG 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release~~.~~," ~~Identify and justify a~~provides guidance on hazardous chemical dispersion modeling. Any deviations from the guidance provided in ~~Regulatory Guide~~RG 1.78 should be identified and justified.

C.I.2.3.5 *Long-Term Atmospheric Dispersion Estimates for Routine Releases*

C.I.2.3.5.1 *Objective*

~~P~~The COL applicant should provide realistic estimates of annual average atmospheric dispersion (χ/Q values) and deposition (D/Q values) to a distance of 50 miles (80 km) from the plant for annual average release limit calculations and person-rem estimates.

C.I.2.3.5.2 *Calculations*

~~P~~The applicant should provide a detailed description of the model used to calculate realistic annual average χ/Q and D/Q values~~. D~~ and should discuss the accuracy and validity of the model, including the suitability of input parameters, source configuration, and topography. ~~Provide t~~The meteorological data (onsite and regional) used as input to the models should be provided. ~~Guidance on acceptable atmospheric transport and dispersion models is presented in Regulatory Guide~~RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors~~." Identify and justify any~~," provides guidance on acceptable atmospheric transport and dispersion models. Any deviations from the guidance provided in ~~Regulatory Guide 1.111. Enough information should be provided~~RG 1.111 should be identified and justified. The information provided should be sufficient to allow the staff to perform its own confirmatory calculations.

For each venting release point, the applicant should use appropriate meteorological data to provide a calculation of the annual average χ/Q and D/Q values at appropriate locations (e.g., site boundary, nearest vegetable garden, nearest residence, nearest milk animal, and nearest meat cow in each 22½~~-~~degree direction sector within a 5-mile radius of the site) for use in ~~Section~~Chapter 11 of the FSAR

to estimate the dose to a hypothetical maximally exposed member of the public from gaseous effluents in accordance with Appendix I to 10 CFR Part 50. EThe calculations provided should also include estimates of annual average χ/Q and D/Q values for 16 radial sectors to a distance of 50 miles (80 km) from the plant using appropriate meteorological data should also be provided.

EvidenceThe applicant should be providedprovide evidence to show how well these estimates represent conditions that would be estimated from climatologically representative data.

C.I.2.4 Hydrologic Engineering

PThe applicant should provide sufficient information to permit an independent hydrologic engineering review of all hydrologically related site characteristics, performance requirements, and bases for operation of structures, systems, and components (SSCs) important to safety, considering the following phenomena or conditions:

(1) probable maximum precipitation, onsiteon site and on the contributing drainage area

(2) runoff floods for streams, reservoirs, adjacent drainage areas, and site drainage, and flood waves resulting from dam failures induced by runoff floods

(3) surges, seiches, and wave action

(4) tsunami

(5) non-runoff-induced flood waves attributable to dam failures or landslides, and floods attributable to failure of on-onsite or near-site water control structures

(6) blockage of cooling water sources by natural events

(7) ice jam flooding

(8) combinations of flood types

(9) low water and/or drought effects (including setdown resulting from surges, seiches, frazil and anchor ice, or tsunami) on safety-related cooling water supplies and their dependability

(10) channel diversions of safety-related cooling water sources

(11) capacity requirements for safety-related cooling water sources

(12) dilution and dispersion of severe accidental releases to the hydrosphere relating to existing and potential future users of surface water and groundwaterground water resources

The level of analysis that this section should be presented may range from very conservative, based on simplifying assumptions, to detailed analytical estimates of each facet of the bases being studied. The staff suggests the former approach is suggested infor evaluating phenomena that do not influence the selection of site characteristics, or where the adoption of very conservative site characteristics does not adversely affect plant design.

C.I.2.4.1 *Hydrologic Description*

C.I.2.4.1.1 *Site and Facilities*

~~D~~The applicant should describe the site and all safety-related elevations, structures, exterior accesses, equipment, and systems from the standpoint of hydrologic considerations (both surface and subsurface). ~~P~~ and provide a topographic map of the site that shows any proposed changes to natural drainage features.

C.I.2.4.1.2 *Hydrosphere*

~~D~~The applicant should describe the location, size, shape, and other hydrologic characteristics of streams, lakes, shore regions, and ~~groundwater~~ground water environments influencing plant siting. ~~I~~ and should include a description of existing and proposed water control structures, both upstream and downstream, that may influence conditions at the site. For these structures, the applicant should perform the following tasks:

(1) tabulate contributing drainage areas

(2) describe types of structures, all appurtenances, ownership, seismic design criteria, and spillway design criteria

(3) provide elevation-area-storage relationships and short-term and long-term storage allocations for pertinent reservoirs

~~P~~The applicant should provide a regional map showing major hydrologic features. ~~L~~The applicant should list the owner, location, and rate of use of surface water users whose intakes could be adversely affected by accidental release of contaminants. ~~Refer to~~ (Section 2.4.13.2 of the FSAR ~~for the~~provides a tabulation of ~~groundwater~~ground water users.)

C.I.2.4.2 *Floods*

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

C.I.2.4.2.1 *Flood History*

~~P~~The applicant should provide the date, level, peak discharge, and related information for major historical flood events in the site region. ~~Include s~~Stream floods, surges, seiches, tsunami, dam failures, ice jams, floods induced by landslides, and similar events should be included.

C.I.2.4.2.2 *Flood Design Considerations*

~~D~~The applicant should discuss the general capability of safety-related facilities, systems, and equipment to withstand floods and flood waves. ~~S~~It should show how the design flood protection for safety-related components and structures of the plant is based on the highest calculated flood water level elevations and flood wave effects (site-characteristic flood) resulting from analyses of several different hypothetical causes. ~~D~~The applicant should discuss how any possible flood condition, up to and including the highest and most critical flood level resulting from any of several different events, affects the basis for the design protection level for safety-related components and structures of the plant.

~~D~~The applicant should discuss the flood potential from streams, reservoirs, adjacent watersheds, and site drainage, including (1) the probable maximum water level from a stream flood, surge, seiche, combination of surge and stream flood in estuarial areas, wave action, or tsunami (whichever is applicable and/or greatest), and (2) the flood level resulting from the most severe flood wave at the plant site caused by an upstream or downstream landslide, dam failure, or dam breaching resulting from a hydrologic, seismic, or foundation disturbance. ~~D~~It should also discuss the effects of superimposing the coincident wind-generated wave action on the applicable flood level~~. E~~ and evaluate the assumed hypothetical conditions both statically and dynamically to determine the design flood protection level. ~~Summarize t~~The types of events considered, as well as the controlling event or combination of events, should be summarized.

C.I.2.4.2.3 *Effects of Local Intense Precipitation*

~~D~~The applicant should describe the effects of local probable maximum precipitation (see Section C.I.2.4.3.~~1of~~1 of this guide) on adjacent drainage areas and site drainage systems, including drainage from the roofs of structures. ~~T~~It should tabulate rainfall intensities for the selected and critically arranged time increments, provide characteristics and descriptions of runoff models, and estimate the resulting water levels. ~~S~~It should summarize the design criteria for site drainage facilities and provide analyses that demonstrate the capability of site drainage facilities to prevent flooding of safety-related facilities resulting from local probable maximum precipitation. ~~P~~The applicant should provide sufficient details concerning the site drainage system to permit the following actions:

(1) ~~an~~ independent review of rainfall and runoff effects on safety-related facilities

(2) ~~a~~ judg~~e~~ment concerning the adequacy of design criteria

(3) ~~an~~ independent review of the potential for blockage of site drainage as a result of ice, debris, or similar material

~~P~~The applicant should provide a discussion of the effects of ice accumulation on site facilities where such accumulation could coincide with local probable maximum (winter) precipitation and cause flooding or other damage to safety-related facilities.

C.I.2.4.3 *Probable Maximum Flood ~~(PMF)~~ on Streams and Rivers*

~~D~~The applicant should describe how the hydrological site characteristics affect any potential hazard to the plant's safety-related facilities as a result of the effect of the probable maximum flood (PMF) on streams and rivers. ~~Summarize t~~The locations and associated water levels for which PMF determinations have been made should be summarized.

C.I.2.4.3.1 *Probable Maximum Precipitation ~~(PMP)~~*

~~D~~The applicant should discuss considerations of storm configuration (orientation of areal distribution), maximized precipitation amounts (~~include~~including a description of maximization procedures and/or studies available for the area, such as by reference to National Weather Service and U.S. Army 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 in defining the probable maximum precipitation (PMP). ~~Present t~~The selected maximized storm precipitation distribution (time and space) should be presented.

C.I.2.4.3.2 *Precipitation Losses*

~~D~~The applicant should describe the absorption capability of the basin, including consideration of initial losses, infiltration rates, and antecedent precipitation~~. P~~ and provide verification of these assumptions by reference to regional studies or by ~~presenting~~presentation of detailed applicable local storm-runoff studies.

C.I.2.4.3.3 *Runoff and Stream Course Models*

~~D~~The applicant should describe the hydrologic response characteristics of the watershed to precipitation (such as unit ~~hydro graphs~~hydrographs), provide verification from historical floods or synthetic procedures, and identify methods adopted to account for nonlinear basin response at high rainfall rates. ~~P~~It should also provide a description of watershed sub~~-~~basin drainage areas (including a map), their sizes, and topographic features. ~~Include a~~A tabulation of all drainage areas~~. Discuss~~ should be included as should a discussion of the stream course model and its ability to compute floods up to the severity of the PMF. ~~P~~The applicant should present any reservoir and channel routing assumptions and coefficients and their bases with appropriate discussion of initial conditions, outlet works (controlled and uncontrolled), and spillways (controlled and uncontrolled).

C.I.2.4.3.4 *Probable Maximum Flood Flow*

~~P~~The applicant should present the controlling PMF runoff ~~hydro graph~~hydrograph at the plant site that would result from rainfall (and snowmelt if pertinent). ~~D~~It should discuss how the analysis considered all appropriate positions and distributions of the PMP and the potential influence of existing and proposed upstream and downstream dams and river structures~~. P~~ and present analyses and conclusions concerning the ability of any upstream dams that may influence the site to withstand PMF conditions combined with setup, waves, and runup from appropriate coincident winds (see Section C.I.2.4.3.6 of this guide). If failures are likely, the applicant should show the flood ~~hydro graphs~~hydrographs at the plant site resulting from the most critical combination of such dam failures, including domino-type failures of dams upstream of the plant site. When credit is taken for flood lowering at the plant site as a result of failure of any downstream dam during a PMF, ~~support~~ the conclusion that the downstream dam has a very high likelihood of failure should be supported. Finally, ~~provide~~ the estimated PMF discharge ~~hydro graph~~hydrograph at the site and, when available, ~~provide~~ a similar ~~hydro graph~~hydrograph without upstream reservoir effects to allow an evaluation of reservoir effects and a regional comparison of the PMF estimate to be made should be provided.

C.I.2.4.3.5 *Water Level Determinations*

~~D~~The applicant should describe the translation of the estimated peak PMP discharge to elevation using (when applicable) cross-section and profile data, reconstitution of historical floods (with consideration of high water marks and discharge estimates), standard step methods, transient flow methods, roughness coefficients, bridge and other losses, verification, extrapolation of coefficients for the PMF, estimates of PMF water surface profiles, and flood outlines.

C.I.2.4.3.6 *Coincident Wind Wave Activity*

~~D~~The applicant should discuss setup, significant (average height of the maximum ~~33⅓%~~33⅓ percent of all waves) and maximum (average height of the maximum ~~1%~~1 percent of all waves) wave heights, runup, and resultant static and dynamic effects of wave action on each safety-related facility from wind~~-~~-generated activity that may occur coincidently with the peak PMF water level~~. P~~ and provide a map and analysis showing that the most critical fetch has been used to determine wave action.

C.I.2.4.4 *Potential Dam Failures~~, Seismically Induced~~*

~~D~~The applicant should describe how the hydrological site characteristics consider any potential hazard to the plant's safety-related facilities as a result of the seismically induced failure of upstream and downstream water control structures. ~~D~~It should also describe the worst combination failure (domino or simultaneous) that affects the site with respect to the maximum flood.

C.I.2.4.4.1 *Dam Failure Permutations*

~~D~~The applicant should discuss the locations of dams (~~both~~ upstream and downstream), potential modes of failure, and results of seismically induced dam failures that could cause the most critical conditions (floods or low water) with respect to the safety-related facilities for such an event (see Section C.I.2.4.3.4 of this guide). ~~D~~The applicant should also discuss how consideration was given to possible landslides, pre~~-~~seismic-event reservoir levels, and antecedent flood flows coincident with the flood peak (base flow). ~~P~~It should present the determination of the peak flow rate at the site for the worst dam failure (or combination of dam failures) reasonably possible, and should summarize all analyses to show that the presented condition is the worst permutation. ~~Include d~~Descriptions of all coefficients and methods used and their bases should be included. ~~Also discuss h~~How consideration was given to the effects on plant safety of other potential concurrent events such as blockage of a stream~~,~~ and waterborne missiles~~;~~ should a~~nd l~~so ~~forth~~be discussed.

C.I.2.4.4.2 *Unsteady Flow Analysis of Potential Dam Failures*

In determining the effect of dam failures at the site (see Section C.I.2.4.4.1 of this guide), the applicant should describe how the analytical methods presented (1) are applicable to artificially large floods with appropriately acceptable coefficients~~,~~ and (2) consider flood waves through reservoirs downstream of failures. If applicable, ~~discuss~~a discussion of how the applicant considered domino-type failures resulting from flood waves ~~were considered~~should be provided. ~~Discuss e~~Estimates of coincident flow and other assumptions used to attenuate the dam-failure flood wave downstream~~.~~ ~~Discuss~~ should be discussed as should static and dynamic effects of the attenuated wave at the site.

C.I.2.4.4.3 *Water Level at the Plant Site*

~~D~~The applicant should describe the backwater, unsteady flow, or other computational method ~~leading~~used to estimate the water elevation ~~estimate~~ (see Section C.I.2.4.4.1 of this guide) for the most critical upstream dam failure(s), and discuss its verification and reliability. ~~Superimpose w~~Wind and wave conditions that may occur simultaneously should be superimposed in a manner similar to that described in Section C.I.2.4.3.6 of this guide.

C.I.2.4.5 *Probable Maximum Surge and Seiche Flooding*

C.I.2.4.5.1 *Probable Maximum Winds and Associated Meteorological Parameters*

~~P~~The applicant should present the determination of probable maximum meteorological winds in detail. ~~D~~It should describe the analysis of actual historical storm events in the general region and the modifications and extrapolations of data made to reflect a more severe meteorological wind system than actually recorded, insofar as such are deemed "reasonably possible" to occur on the basis of meteorological reasoning. Where this has been done previously or on a generic basis (e.g., Atlantic and Gulf Coast probable maximum hurricane characteristics reported in NOAA Technical Report NWS 23, "Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Windfields, Gulf and East Coasts of the United States," 1979), ~~reference that work~~ that work should be referenced with a brief description. ~~Provide s~~Sufficient bases and information to ensure that the parameters presented represent the most severe combination should be provided.

C.I.2.4.5.2 ***Surge and Seiche Water Levels***

~~P~~The applicant should provide historical data related to surges and seiches~~. D~~ and discuss considerations of hurricanes, frontal (cyclonic) type windstorms, moving squall lines, and surge mechanisms that are possible and applicable to the site. ~~Include t~~The antecedent water level (the ~~10%~~10-percent exceedance high tide, including initial rise for coastal locations, or the 100-year recurrence interval high water for lakes), the determination of the controlling storm surge or seiche (~~include~~with the parameters used in the analysis, such as storm track, wind fields, fetch or direction of wind approach, bottom effects, and verification of historic events), a detailed description of the methods and models used, and the results of the computation of the probable maximum surge ~~hydro graph~~hydrograph (graphical presentation)~~. Provide~~ should be provided as should a detailed description of the (1) bottom profile and (2) shoreline protection and safety-related facilities.

C.I.2.4.5.3 ***Wave Action***

~~D~~The applicant should discuss the wind-generated wave activity that can occur independently or coincidently with a surge or seiche~~, or independently~~. ~~P~~It should present estimates of the wave period and the significant (average height of the maximum ~~33⅓%~~33⅓ percent of all waves) and maximum (average height of the maximum ~~1%~~1 percent of all waves) wave heights and elevations with the coincident water level ~~hydro graph~~hydrograph. ~~Present s~~Specific data on the largest breaking wave height, setup, runup, and the effect of overtopping in relation to each safety-related facility~~. Include~~ should be presented and a discussion of the effects of the water levels on each affected safety-related facility and the protection to be provided against hydrostatic forces and dynamic effects of splash should be included.

C.I.2.4.5.4 ***Resonance***

~~D~~The applicant should 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.

C.I.2.4.5.5 ***Protective Structures***

~~D~~The applicant should discuss the location of, and design criteria for, any special facilities for the protection of intake, effluent, and other safety-related facilities against surges, seiches, and wave action.

C.I.2.4.6 ***Probable Maximum Tsunami ~~Flooding~~Hazards***

For sites that may be subject to tsunami or tsunami-like waves, the applicant should discuss historical tsunami, either recorded or translated and inferred, that provide information for ~~use in~~ determining the probable maximum water levels and the geo-seismic generating mechanisms available, with appropriate references to Section 2.5 of the FSAR.

C.I.2.4.6.1 ***Probable Maximum Tsunami***

~~P~~The applicant should present the determination of the probable maximum tsunami~~. Discuss~~, discussing consideration given to the most reasonably severe geo-seismic activity possible (resulting from, for example, fractures, faults, landslides, or volcanism) in determining the limiting tsunami-producing mechanism. ~~Summarize t~~The geo-seismic investigations used to identify potential tsunami sources and mechanisms and the resulting locations and mechanisms that could produce the controlling maximum tsunami at the site (from both local and distant generating mechanisms) should be summarized. ~~D~~The applicant should discuss ~~how~~ 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 (proneness of sliding) ~~were~~and how the applicant considered these factors in ~~the~~its analysis. Also ~~discuss~~ hill-slope failure-generated tsunami-like waves on inland sites~~. Discuss~~ and the potential of an earthquake-induced tsunami on a large body of water, if relevant for the site, should be discussed.

C.I.2.4.6.2 ***Historical Tsunami Record***

~~P~~The applicant should provide local and regional historical tsunami information, including any relevant paleo-tsunami evidence.

C.I.2.4.6.3 ***Source Generator Characteristics***

~~P~~The applicant should provide detailed geo-seismic descriptions of the controlling local and distant tsunami generators, including location, source dimensions, fault orientation (if applicable), and maximum displacement.

C.I.2.4.6.4 ***Tsunami Analysis***

~~P~~The applicant should provide a complete description of the analysis procedure used to calculate tsunami wave height and period at the site~~. Describe~~ and of all models used in the analysis in detail, including the theoretical bases of the models, their verification, and the conservatism of all input parameters.

C.I.2.4.6.5 ***Tsunami Water Levels***

~~P~~The applicant should provide estimates of maximum and minimum (low water) tsunami wave heights from both distant and local generators. ~~D~~It should describe the ambient water levels, including tides, sea level anomalies, and wind waves assumed to be coincident with the tsunami.

C.I.2.4.6.6 ***Hydrography and Harbor or Breakwater Influences on Tsunami***

~~P~~The applicant should present the routing of the controlling tsunami, including 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 safety-related facility. ~~Include a~~A discussion of both the analysis used to translate tsunami waves from offshore generator locations (or in deep water) to the site, and antecedent conditions~~. P~~ should be provide~~, w~~d. Where

possible, verification of the techniques and coefficients used by reconstituting the tsunami of record should be provided.

C.I.2.4.6.7 ***Effects on Safety-Related Facilities***

~~D~~The applicant should discuss the effects of the controlling tsunami on safety-related facilities~~,~~ and ~~discuss~~ the design criteria for ~~the tsunami protection and mitigation to be provided.~~

~~**C.I.2.4.7 Ice Effects**~~

~~Describe~~measures to protect against and mitigate the effects of tsunami.

C.I.2.4.7 ***Ice Effects***

The applicant should describe potential icing effects and design criteria for protecting safety~~-~~related facilities from the most severe ice sheets, ice jam flood, wind-driven ice ridges, or other ice-produced effects and forces that are reasonably possible and could affect safety-related facilities with respect to adjacent water bodies, such as streams~~,~~ or lakes~~, etc.~~, for both high and low water levels. ~~Include t~~The location and proximity of such facilities to the ice-generating mechanisms~~. Describe~~ should be included and the regional ice and ice jam formation history with respect to water bodies should be described. ~~D~~The applicant should also describe the potential for formation of frazil and anchor ice at the site~~. D~~ and should discuss the effects of ice-induced reduction in capacity of water storage facilities as they affect safety~~-~~related SSCs.

C.I.2.4.8 ***Cooling Water Canals and Reservoirs***

~~P~~The applicant should present the design bases for the capacity and operating plan for safety~~-~~related cooling water canals and reservoirs (see Section C.I.2.4.11 of this guide). ~~D~~If the source of water for the UHS or other safety-related needs relies on cooling water canals or reservoirs and is dependent on a nearby stream, river, estuary, lake, or ocean, the availability of safety-related cooling water may be affected by low-water conditions caused by low streamflow and low water level resulting from draw-down caused by hurricanes, seiches, and tsunamis. The applicant should discuss and provide bases for protecting the canals and reservoirs against wind waves, flow velocities (including allowance for freeboard), and blockage, and describe (where applicable) ~~describe~~ the facility's ability to withstand a related event, such as a probable maximum flood~~,~~ or surge~~, etc~~.

~~D~~It should discuss the emergency storage evacuation of reservoirs (low-level outlet and emergency spillway)~~. D~~ and describe verified runoff models (e.g., unit ~~hydro graphs~~hydrographs), flood routing, spillway design, and outlet protection.

C.I.2.4.9 ***Channel Diversions***

~~D~~The applicant should discuss the potential for upstream diversion or rerouting of the source of cooling water (resulting from, for example, channel migration, river cutoffs, ice jams, or subsidence) with respect to seismic, topographical, geologic, and thermal evidence in the region. ~~Present t~~The history of flow diversions and realignments in the region~~. Discuss~~ should be presented and their potential for adversely affecting safety-related facilities or water supply~~, and describe a~~ should be discussed. Available alternative safety-related cooling water sources in the event that diversions are possible should be described.

C.I.2.4.10 *Flooding Protection Requirements*

~~D~~The applicant should describe the static and dynamic consequences of all types of flooding on each pertinent safety-related facility. ~~P~~It should present the design bases required to ensure that safety-related facilities will be capable of surviving all design flood conditions, and reference appropriate discussions in other sections of the FSAR where the design bases are implemented. ~~Describe v~~Various types of flood protection used and the emergency procedures to be implemented (where applicable).

~~C.I.2.4.11~~ should be described. COL applicants may provide a reference to emergency procedures discussed in FSAR Section 13.5, as applicable.

C.I.2.4.11 *Low Water Considerations*

C.I.2.4.11.1 *Low Flow in Rivers and Streams*

~~E~~The applicant should estimate and provide the ~~design-basis~~design basis for the flow rate and water level resulting from the most severe drought considered reasonably possible in the region, if such conditions could affect the ability of safety-related facilities, particularly the ~~ultimate heat sink~~UHS, to perform adequately. ~~Include c~~Considerations of downstream dam failures (see Section C.I.2.4.4 of this guide) should be included. For ~~non-safety related~~nonsafety-related water supplies, ~~demonstrate that~~ the supply ~~will be~~ adequa~~te~~cy during a 100-year drought should be demonstrated.

C.I.2.4.11.2 *Low Water Resulting from Surges, Seiches, or Tsunami*

~~D~~The applicant should determine the surge-, seiche-, or tsunami-caused low water level that could occur from probable maximum meteorological or geo-seismic events, if such level could affect the ability of safety-related features to function adequately. ~~Include a~~A description of the probable maximum meteorological event (its track, associated parameters, and antecedent conditions) and the computed low water level~~,~~ or a description of the applicable tsunami conditions should be included. ~~Also consider, w~~Where applicable, ice formation or ice jams causing low flow should be considered, since such conditions may affect the safety-related cooling water source.

C.I.2.4.11.3 *Historical Low Water*

If statistical methods are used to extrapolate flows and/or levels to probable minimum conditions, ~~discuss~~ historical low water flows and levels and their probabilities (unadjusted for historical controls and adjusted for both historical and future controls and uses) should be discussed.

C.I.2.4.11.4 *Future Controls*

~~P~~The applicant should provide the estimated flow rate, durations, and levels for drought conditions considering future uses, if such conditions could affect the ability of safety-related facilities to function adequately. ~~Substantiate a~~Any provisions for flow augmentation for plant use should be substantiated.

C.I.2.4.11.5 *Plant Requirements*

~~P~~The applicant should present the minimum safety-related cooling water flow, the sump invert elevation and configuration, the minimum design operating level, pump submergence elevations (operating heads), and design bases for effluent submergence, mixing, and dispersion. ~~Discuss t~~The capability of cooling water pumps to supply sufficient water during periods of low water resulting from ~~the~~a 100-year drought should be discussed. ~~Refer to~~ Sections 9.2.1, 9.2.5, and 10.4.5 of the FSAR may be referenced where applicable~~. Identify or refer to~~ as may institutional restraints on water use.

C.I.2.4.11.6 *Heat Sink Dependability Requirements*

~~I~~The applicant should identify all sources of normal and emergency shutdown water supply and related retaining and conveyance systems.

~~I~~The applicant should identify site characteristics used to compare minimum flow and level estimates with plant requirements, and describe any available low water safety factors (see Sections C.I.2.4.4 and C.I.2.4.~~11~~6 of this guide). ~~D~~It should describe the ~~design-bases~~design bases (or refer to Section 9.2.5 of the FSAR) for operation and normal or accidental shutdown and cooldown during the following three scenarios:

(1) ~~the~~ most severe natural and site-related accident phenomena
(2) reasonable combinations of less severe phenomena
(3) single failures of man~~-~~made structural components

~~D~~The applicant should describe the design bases to protect all structures related to the ~~ultimate heat sink~~UHS during the above events~~. I~~ and identify the sources of water and related retaining and conveyance systems that will be designed for each of the above bases or situations.

~~D~~The applicant should describe the facility's ability to provide sufficient warning of impending low flow or low water levels to allow switching to alternative sources where necessary. ~~Identify~~It should identify conservative estimates of heat dissipation capacity and water losses (such as drift, seepage, and evaporation)~~. I~~ and indicate whether~~,~~ and ~~if so~~ how, if applicable, the guidance in ~~Regulatory Guide (RG)~~RG 1.27~~, "Ultimate Heat Sink for Nuclear Power Plants,"~~ has been followed; if such guidance has not been followed, ~~describe~~ the specific alternative approaches used and suitable justification for their use should be provided.

~~I~~The applicant should identify or refer to descriptions of any other uses of water drawn from the ~~ultimate heat sink~~UHS, such as fire water or system charging requirements. If interdependent water supply systems (such as an excavated reservoir within a cooling lake or tandem reservoirs) are used, ~~describe~~ the ability of the principal portion of the system to survive the failure of the secondary portion~~. D~~ should be describe~~ and provide the bases for t~~d. The measures to be taken (dredging or other maintenance) to prevent loss of reservoir capacity as a result of sedimentation should be described and their bases provided.

C.I.2.4.12 ~~Groundwater~~*Ground Water*

~~Present~~The applicant should provide all ~~groundwater~~ground water data or cross-reference the ~~groundwater~~ground water data ~~presented~~provided in Section 2.5.4 of the FSAR.

C.I.2.4.12.1 *Description and Onsite Use*

~~D~~The applicant should describe the regional and local ~~groundwater~~ground water aquifers, formations, sources, and sinks, as well as the type of ~~groundwater~~ground water use, wells, pumps, storage facilities, and flow requirements of the plant. If ~~groundwater is to be used~~the plant will use ground water as a safety-related source of water, ~~compare~~ the design-basis protection from natural and accident phenomena should be compared with RG 1.27 criteria. ~~I~~The applicant should indicate whether~~, and if so how, the RG 1.27 guidelines have been followed; if RG 1.27 guidelines were not followed,~~ and how, if applicable, it followed the guidelines of RG 1.27 and if it did not, it should describe the specific alternative approaches used, including the bases and sources of data.

C.I.2.4.12.2 ***Sources***

~~D~~The applicant should describe the present and projected future regional water use. ~~T~~It should tabulate existing users (amounts, water levels and elevations, locations, and drawdown)~~. T~~ and tabulate or illustrate the history of ~~groundwater~~ground water or piezometric level fluctuations beneath and in the vicinity of the site. ~~P~~It should provide ~~groundwater~~ground water or piezometric contour maps of aquifers beneath and in the vicinity of the site to indicate flow directions and gradients. ~~D~~It should discuss the seasonal and long-term variations of these aquifers~~. I~~ and indicate the range of values and the method of determination for vertical and horizontal permeability and total and effective porosity (specific yield) for each relevant geologic formation beneath the site. ~~D~~It should discuss the potential for reversibility of ~~groundwater~~ground water flow resulting from local areas of pumping for both plant and non-plant use~~. D~~ and describe the effects of present and projected ~~groundwater~~ground water use (wells) on gradients and ~~groundwater~~ground water or piezometric levels beneath the site. ~~Note a~~Any potential ~~groundwater~~ground water recharge area, such as lakes or outcrops within the influence of the plant, should be noted.

C.I.2.4.12.3 ***Subsurface Pathways***

~~P~~The applicant should provide a conservative analysis of ~~all groundwater~~critical ground water pathways for a liquid effluent release at the site~~. E~~ and evaluate (where applicable) the dispersion, ion-exchange, and dilution capability of the ~~groundwater~~ground water environment with respect to present and projected users. ~~I~~The applicant should identify potential pathways of contamination to nearby ~~groundwater~~ground water users and to water bodies such as springs, lakes, or streams~~, etc~~. ~~Determine groundwater~~Ground water and radionuclide (if necessary) travel time to the nearest downgrading ~~groundwater~~ground water user or surface body of water should be determined. ~~Include a~~All methods of calculation, data sources, models, and parameters or coefficients used, such as dispersion coefficients, dispersivity, distribution (adsorption) coefficients, hydraulic gradients, and values of permeability, total and effective porosity, and bulk density along contaminant pathways, should be included.

C.I.2.4.12.4 ***Monitoring or Safeguard Requirements***

~~Present~~The applicant should provide and discuss plans, procedures, safeguards, and monitoring programs to be used to protect present and projected ~~groundwater~~ground water users.

C.I.2.4.12.5 ***Site Characteristics for Subsurface Hydrostatic Loading***

(1) For plants not employing permanent dewatering systems, the applicant should describe the site characteristics, including the maximum operational ground water level, for ground-water-induced hydrostatic loadings on subsurface portions of safety-related ~~structures, systems, and components~~SSC. ~~D~~The applicant should discuss the development of these site characteristics. Where dewatering during construction is critical to the integrity of safety-related structures, the

applicant should describe the bases for subsurface hydrostatic loadings assumed during construction and the dewatering methods to be employed in achieving these loadings. Where wells are proposed for safety-related purposes, the applicant should discuss the hydrodynamic design bases for protection against seismically induced pressure waves.

(2) For plants employing permanent dewatering systems, the applicant should:

(a) Provide a description of the proposed dewatering system, including drawings showing the proposed locations of affected structures, components, and features of the system. It should provide information related to the hydrologic design of all system components. Where the dewatering system is important to safety, provide a discussion of its expected functional reliability, including comparisons of proposed systems and components with the performance of existing and comparable systems and components for applications under site conditions similar to those proposed, should be provided.

(b) Provide estimates and their bases for soil and rock permeabilities, total porosity, effective porosity (specific yield), storage coefficient, and other related parameters used in the design of the dewatering system. If available, it should provide the results of monitoring pumping rates and flow patterns during dewatering for the construction excavation.

(c) Provide analyses and their bases for estimates of groundwaterground water flow rates in the various parts of the permanent dewatering system, the area of influence of drawdown, and the shapes of phreatic surfaces to be expected during operation of the system.

(d) Provide analyses, including their bases, to establish conservative estimates of the time available to mitigate the consequences of the system degradation that could cause groundwaterground water levels to exceed design bases. The applicant should document the measures thatit will be taken to repair the system or to provide an alternative dewatering system that would become operational before the site-characteristic maximum groundwaterground water level is exceeded.

(e) Provide both the site-characteristic maximum and normal operation groundwaterground water levels for safety-related structures, systems, and componentsSSCs. It should describe how the site-characteristic maximum groundwaterground water level reflects abnormal and rare events [(such as an occurrence of the safe-shutdown earthquake (SSE), failure of a circulating water system pipe, or single failure within the system]) that can cause failure or overloading of the permanent dewatering system.

(f) Ppostulate a single failure of a critical active feature or component during any design-basis event. Unless it can be documented that the potential consequences of the failure will not result in dose guidelines exceeding those in RG 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste Containing Components of Nuclear Power Plants," and RG 1.29, "Seismic Design Classification," it should either (1) document by pertinent analyses that groundwaterground water level recovery times are sufficient to allow other forms of dewatering to be implemented before the site-characteristic maximum groundwaterground water level is exceeded, discuss the measures to be implemented and equipment needed, and identify the amount of time required to accomplish each measure, or (2) show how all system components are designed for all severe phenomena and events.

(g) Wwhere appropriate, document the bases that ensure the ability of the system to withstand various natural and accidental phenomena such as earthquakes, tornadoes, surges, floods, and a single failure of a component feature of the system (such as a failure of any cooling water pipe penetrating, or in close proximity to, the outside walls of safety-related

buildings where the ~~groundwater~~ground water level is controlled by the system). ~~P~~It should provide an analysis of the consequences of pipe ruptures on the proposed ~~under drain~~underdrain system, including consideration of postulated breaks in the circulating system pipes at, in, or near the dewatering system building either independently of, or as a result of, the SSE.

(h) ~~S~~state the maximum ~~groundwater~~ground water level the plant structures can tolerate under various significant loading conditions in the absence of the ~~under drain~~underdrain system.

(~~i~~I) ~~P~~provide a description of the proposed ~~groundwater~~ground water level monitoring programs for dewatering during plant construction and for permanent dewatering during plant operation. ~~P~~It should provide (1) the general arrangement in plans and profile with approximate elevation of piezometers and observation wells to be installed, (2) intended zone(s) of placement, (3) type(s) of piezometer (closed or open system), (4) screens and filter gradation descriptions, (5) drawings showing typical installations and limits of filter and seals, (6) observation schedules (initial and time intervals for subsequent readings), (7) plans for evaluation of recorded data, and (8) plans for alarm devices to ensure sufficient time for initiation of corrective action. ~~Describe t~~The implementation program, including milestones, for the construction and operational ~~groundwater~~ground water level monitoring programs for dewatering, should be described.

(j) ~~P~~provide information ~~regarding~~on the outlet flow monitoring program~~. The information required includes~~, including (1) the general location and type of flow measurement device(s) and (2) the observation plan and alarm procedure to identify unanticipated high or low flow in the system and the condition of the effluent. ~~Describe t~~The implementation program, including milestones, for the outlet flow monitoring program, should be described.

(k) ~~D~~describe how information gathered during dewatering for construction excavation will be used to implement or substantiate assumed design bases.

(l) ~~P~~provide a technical specification (TS) for periods when the dewatering system may be exposed to sources of water not considered in the design. An example of such a situation would be the excavation of surface seal material for repair of piping such that the ~~under drain~~underdrain would be exposed to direct surface runoff. In addition, where the permanent dewatering system is ~~safety-related~~safety related, is not completely redundant, or is not designed for all ~~design-basis events~~DBAs~~, provide~~ the bases for a ~~technical specification~~TS with action levels; the remedial work required and the estimated time that it will take to accomplish the work; the sources, types of equipment, and manpower required; and the availability of the above under potentially adverse conditions, should be provided.

(m) ~~W~~where wells are proposed for safety-related purposes~~, discuss~~ the hydrodynamic design bases for protection against seismically~~-~~induced pressure waves~~-~~, should be discussed

C.I.2.4.13 ~~Pathways~~*Accidental Releases of Radioactove Liquid Effluents in Ground and Surface Waters*

~~D~~The applicant should describe the ability of the ground and surface water environment to delay, disperse, dilute, or concentrate liquid effluents, as related to existing or potential future water users. ~~Discuss t~~The bases used to determine dilution factors, dispersion coefficients, flow velocities, travel times, adsorption, and pathways of liquid contaminants~~. Refer~~ should be discussed and references to the

locations and users of surface waters listed in Section 2.4.1.2 of the FSAR, as well as the release points identified in Section 11.2.3 of the FSAR, provided.

C.I.2.4.14 ***Technical Specification and Emergency Operation Requirements***

DThe applicant should describe any emergency protective measures designed to minimize the impact of adverse hydrology-related events on safety-related facilities. Describe tThe manner in which the applicant will incorporate these requirements will be incorporated into appropriate technical specificationsTSs and emergency procedures. Discuss and the need for any technical specificationsTSs for plant shutdown to minimize the consequences of an accident resulting from hydrologic phenomena such as floods or the degradation of the ultimate heat sinkUHS should be discussed. Inf the eventapplicant will use emergency procedures are to be used to meet safety requirements associated with hydrologic events, identify the event, present should be identified, and appropriate water levels and lead times available, indicate what should be provided. The type of action that would be taken, and discuss the time required to implement each procedure.

C.I.2.5 should be discussed. The applicant should develop specific details on (1) controlling hydrological events, as determined in previous hydrology-related sections of the FSAR, to identify bases for emergency actions required during these events; (2) the amount of time available to initiate and complete emergency procedures before onset of conditions during the controlling hydrological events that may prevent such action; and (3) how TSs related to all emergency procedures required to ensure adequate plant safety from controlling hydrological events are reviewed by the organization responsible for the review of issues related to TSs.

C.I.2.5 Geology, Seismology, and Geotechnical Engineering

PThe applicant should provide sufficient information regarding the seismic and geologic characteristics of the site and the region surrounding the site to permit an adequate evaluation of the proposed site, to provide sufficient information to support evaluations performed to arrive at estimates ofestimate the SSEsite-specific ground motion response spectrum (GMRS), and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. Provide aA summary that includes a synopsis of Sections 2.5.1 through 2.5.5 of the FSAR, including a brief description of the site, the investigations performed, results of investigations, conclusions, and a statement as toidentification of who did the work should be provided.

C.I.2.5.1 ***Basic Geologic and Seismic Information***

BThe following sections request basic geologic and seismic information is requested throughout the following sections to provide a basis for evaluation. In some cases, this information applies to more than one section. The information may be presentedappear under this section, under the following sections, or as appendices to this section, provided that the applicant supplies adequate cross-references are provided in the appropriate sections.

RThe applicant should reference information obtained from published reports, maps, private communications, or other sources. Document iInformation from surveys, geophysical investigations, borings, trenches, or other investigations should be documented by providing descriptions of techniques, graphic logs, photographs, laboratory results, identification of principal investigators, and other data necessary to assess the adequacy of the information.

C.I.2.5.1.1 *Regional Geology*

~~D~~The applicant should discuss all geologic, seismic, tectonic, non-tectonic, and manmade hazards within the site region. ~~Provide a~~A review of the regional tectonics, with emphasis on the quaternary period, structural geology, seismology, paleoseismology, physiography, geomorphology, stratigraphy, and geologic history within a distance of 200 miles (320 km) from the site (site region) should be provided. ~~D~~The applicant should discuss, document (by appropriate references), and illustrate such hazards as subsidence, cavernous or karst terrain, irregular weathering conditions, and landslide potential by presenting ~~such~~ items such as a regional physiographic map, surface and subsurface geologic maps, isopach maps, regional gravity and magnetic maps, stratigraphic sections, tectonic and structure maps, fault maps, a site topographic map, a map showing areas of mineral and hydrocarbon extraction, boring logs, and aerial photographs~~. Include~~, as well as maps showing superimposed plot plans of the plant facilities.

~~Discuss the regional~~The applicant should discuss the relationship between the regional and the site physiography. ~~Include a~~A regional physiographic map showing the site location should be included. ~~Identify and describe t~~Tectonic structures~~,~~ such as folds, faults, basins, and domes underlying the region surrounding the site~~,~~ should be identified and ~~include~~described a ~~discussion of~~nd their geologic history discussed. ~~I~~The applicant should include a regional tectonic map showing the site location~~. P~~ and provide detailed discussions of the regional tectonic structures of significance to the site. ~~Include d~~Detailed analyses of faults to determine their capacity for generating ground motions at the site and to determine the potential for surface faulting in FSAR Sections 2.5.2 and 2.5.3 ~~of the FSAR,~~ respectively, should be included.

~~D~~The applicant should describe the lithologic, stratigraphic, and structural geologic conditions of the region surrounding the site and their relationship to the site region's geologic history. ~~Provide g~~Geologic profiles showing the relationship of the regional and local geology to the site location should be provided. ~~I~~The applicant should indicate the geologic province within which the site is located and ~~the~~its relationship to other geologic provinces~~. I~~, and should include regional geologic maps indicating the site location and showing both surface and bedrock geology.

C.I.2.5.1.2 *Site Geology*

~~P~~The applicant should provide a description of the site-related geologic features, seismic conditions, and conditions caused by human activities, at appropriate levels of detail within areas approximately defined by radii of 25 miles (40 km), 5 miles (8 km), and 0.6 miles (1 km) around the site. ~~M~~Section 2.5.4 of the FSAR may include cross-references to material on site geology included in this section ~~may be cross-referenced in Section 2.5.4 of the FSAR~~.

~~D~~The applicant should describe the site physiography and local land forms, and discuss the relationship between the regional and site physiography~~. I~~ and include a site topographic map showing the locations of the principal plant facilities. ~~Describe t~~The configuration of the land forms should be described, and ~~relate~~ the history of geologic changes that have occurred should be related. ~~E~~The applicant should evaluate areas that are significant to the site ~~of~~for actual or potential landsliding, surface or subsurface subsidence, uplift, or collapse resulting from natural features, such as tectonic depression and cavernous or karst terrains.

~~D~~The applicant should describe significant historical earthquakes, as well as evidence (or lack of evidence) of paleoseismology. ~~Also describe t~~The local seismicity, including historical and instrumentally recorded earthquakes, should also be described.

~~D~~The applicant should describe the detailed lithologic and stratigraphic conditions of the site and the relationship to the regional stratigraphy~~. D~~ and should describe the thicknesses, physical characteristics, origins, and degree of consolidation of each lithologic unit, including a local stratigraphic column. ~~Furnish s~~Summary logs or borings and excavations, such as trenches used in the geologic evaluation, should be provided. ~~B~~This section may reference boring logs included in Section 2.5.4 of the FSAR ~~may be referenced~~.

~~P~~The applicant should provide a detailed discussion of the structural geology in the vicinity of the site~~. I~~, and include the relationship of site structures to regional tectonics, with particular attention to specific structural units of significance to the site, such as folds, faults, synclines, anticlines, domes, and basins. ~~Provide a~~A large-scale structural geology map ~~(1:24,000)~~ of the site, showing bedrock surface contours and including the locations of ~~S~~seismic Category I structures~~. Furnish~~, and a large-scale geologic map ~~(1:24,000)~~ of the region within 5 miles (8 km) of the site that shows surface geology and includes the locations of major structures of the nuclear power plant, including all ~~S~~seismic Category I structures, should be provided.

~~D~~The applicant should distinguish areas of bedrock outcrop from which geologic interpretation has been extrapolated from areas in which bedrock is not exposed at the surface. When the interpretation differs substantially from the published geologic literature on the area, ~~note and document~~ the differences for the new conclusions presented should be noted and documented. ~~Discuss t~~The geologic history of the site~~;~~ should be discussed and relate ~~it~~d, to the regional geologic history.

~~Include~~

The applicant should include an evaluation from an engineering-geology standpoint of the local geologic features that affect the plant structures. ~~D~~The applicant should describe in detail the geologic conditions underlying all ~~S~~seismic Category I structures, dams, dikes, and pipelines~~. D~~, and describe the dynamic behavior of the site during prior earthquakes. ~~Identify d~~Deformational zones such as shears, joints, fractures, and folds, or combinations of these features~~;~~ should be identified and ~~evaluate~~ these zones relative ~~to structural~~ foundations, should be evaluated. ~~D~~The applicant should describe and evaluate zones of alteration or irregular weathering profiles, zones of structural weakness, unrelieved residual stresses in bedrock, and all rocks or soils that might be unstable because of their mineralogy or unstable physical or chemical properties. ~~Evaluate t~~The effects of ~~man's~~human activities in the area, such as withdrawal or addition of subsurface fluids or mineral extraction at the site, should be evaluated.

~~D~~The applicant should describe the site's ~~groundwater~~ground water conditions. ~~I~~This section may reference information included in Section 2.4.13 of the FSAR ~~may be referenced in this section of the FSAR~~.

C.I.2.5.2 *Vibratory Ground Motion*

~~P~~The applicant should present the criteria and describe the methodology used to establish the ~~SSE ground motion and the controlling earthquakes for the site~~GMRS.

C.I.2.5.2.1 ***Seismicity***

~~Provide~~

The applicant should provide a complete list of all historically reported earthquakes that could have reasonably affected the region surrounding the site, including all earthquakes of ~~M~~modified Mercalli ~~I~~intensity ~~(MMI)~~ greater than or equal to IV or of magnitude greater than or equal to 3.0 that have been reported within 200 miles (320 km) of the site. Also, the applicant should report large earthquakes outside of this area that would impact the ~~SSE~~GMRS. ~~P~~The applicant should present a regional-scale map showing all listed earthquake epicenters, supplemented by a larger-scale map showing

earthquake epicenters within 50 miles (80 km) of the site. ~~Provide the following information concerning~~For each earthquake, information, whenever ~~it is~~ available, on the epicenter coordinates, depth of focus, date, origin time, highest intensity, magnitude, seismic moment, source mechanism, source dimensions, distance from the site, and any strong-motion recordings, should be provided. ~~Identify~~The sources ~~from which~~of the information ~~was obtained~~should be identified. ~~I~~The applicant should identify all magnitude designations such as m_b, M_L, M_s, or M_w. In addition, the applicant should completely describe any earthquake-induced geologic failure, such as liquefaction (including paleoseismic evidence of large prehistoric earthquakes), landsliding, land spreading, and lurching, including the estimated level of strong motion that induced failure and the physical properties of the materials.

C.I.2.5.2.2 *Geologic and Tectonic Characteristics of the Site and Region*

~~I~~The applicant should identify each seismic source, any part of which is within 200 miles (320 km) of the site. For each seismic source, the applicant should describe the characteristics of the geologic structure, tectonic history, present and past stress regimes, seismicity, recurrence, and maximum magnitudes that distinguish the various seismic sources and the particular areas within those sources where historical earthquakes have occurred. ~~D~~The applicant should discuss any alternative regional tectonic models derived from the literature. ~~Augment t~~The discussion in this section of the FSAR ~~by~~should be augmented with a regional-scale map showing the seismic sources, earthquake epicenters, locations of geologic structures, and other features that characterize the seismic sources. In addition, the applicant should provide a table of seismic sources that contains maximum magnitudes, recurrence parameters, a range of source-to-site distances, alternative source models (including probability weighting factors), and any notable historical earthquakes or paleoseismic evidence of large prehistoric earthquakes.

C.I.2.5.2.3 *Correlation of Earthquake Activity with Seismic Sources*

~~P~~The applicant should provide a correlation or association between the earthquakes discussed in Section 2.5.2.1 of the FSAR and the seismic sources identified in Section 2.5.2.2 of the FSAR. Whenever an earthquake hypocenter or concentration of earthquake hypocenters can be reasonably correlated with geologic structures, ~~provide~~ the rationale for the association considering the characteristics of the geologic structure (including geologic and geophysical data, seismicity, and tectonic history) and regional tectonic model, should be provided. ~~I~~The applicant should include a discussion of the method used to locate the earthquake hypocenters, an estimation of their accuracy, and a detailed account that compares and contrasts the geologic structure involved in the earthquake activity with other areas within the seismotectonic province.

C.I.2.5.2.4 *Probabilistic Seismic Hazard Analysis and Controlling Earthquake*

~~D~~The applicant should describe the probabilistic seismic hazard analysis (PSHA), including the underlying assumptions and methodology, and how they follow or differ from the guidance in NUREG/CR-6372, "Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts," ~~D~~dated April 1, 1997. The applicant should describe how the results of the site investigations were used to update the seismic source characterizations in the PSHA or to develop additional seismic sources. ~~Provide t~~The rationale for any minimum magnitude or other ground motion parameters (such as cumulative absolute velocity) used in the PSHA should be provided. ~~D~~The applicant should describe the ground motion attenuation models used in the PSHA, including the rationale for including each model, consideration of uncertainty, model weighting, magnitude conversion, distance measure adjustments, and ~~the~~ model parameters for each spectral frequency. ~~D~~The applicant

should describe and show how logic trees for seismic source parameters (maximum magnitude, recurrence, source geometry) and attenuation models were used to incorporate ~~of~~ model uncertainty.

~~P~~The applicant should provide 1~~5~~6th, median, mean, and 8~~5~~4th fractile PSHA hazard curves for 1, 2.5, 5, 10, 25, and ~~100~~100 Hertz (~~PGA)~~ Hz) frequencies both before and after correcting for local site amplification. ~~S~~The applicant should show and explain the relative contributions of each of the main seismic sources to the median and mean hazard curves~~. Also~~, as well as show and explain the effects of other significant modeling assumptions (source or ground motion attenuation) on the mean and median hazard curves. In addition, the applicant should provide both the 10^{-4} and 10^{-5} mean and median uniform hazard response spectra (UHRS) derived from the PSHA hazard curves.

If the applicant used the performance-based approach ~~is used~~, as described in ~~American Society of Civil Engineers (ASCE) Standard 43-05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities," for seismic design bases (SDB) Category 5D,~~RG 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," it should provide the controlling earthquake magnitudes and distances for the mean 10^{-4}, 10^{-5}, and 10^{-6} hazard levels at spectral frequencies of 1 and 2.5 Hz (~~low-frequency~~low frequency) and 5 and 10 Hz (~~high-frequency~~high frequency). If the applicant used the reference probability approach ~~is used~~, as described in ~~Regulatory Guide (RG) 1~~RG 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," it should provide the controlling earthquake magnitudes and distances for the reference probability hazard level at spectral frequencies of 1 ~~and~~, 2.5 ~~Hz (low-frequency) and~~, 5, and 10 Hz ~~(high-frequency)~~. ~~D~~The applicant should describe the methodology used and how it either follows or differs from the procedure outlined in Appendix C to RG 1.165~~. P~~ and provide bar graph plots of both the ~~low-frequency~~low- and high-frequency deaggregation results for each of the hazard levels~~. P~~ and provide a table showing each of the low- and high-frequency controlling earthquakes.

~~C~~The applicant should compare the controlling earthquake magnitudes and distances for the site with ~~the controlling earthquakes and ground motions used in licensing (1) other licensed facilities at the site, (2) nearby plants, or (3) plants licensed in similar seismogenic regions. In addition, compare the controlling earthquakes to~~ the historical earthquake record, any prehistoric earthquakes based on paleoseismic evidence, and the earthquake potential associated with each seismic source.

C.I.2.5.2.5 *Seismic Wave Transmission Characteristics of the Site*

~~Describe~~The application should include a description of the site response analyses, including the method used to represent the uncertainty and variability across the site~~. Present~~, and a presentation of the following material properties for each stratum under the site:~~–~~

- thickness~~,~~~~–~~
- seismic compressional and shear velocities~~,~~~~–~~
- bulk densities~~,~~~~–~~
- soil index properties and classification~~,~~~~–~~
- shear modulus and damping variations with strain level~~, and the~~
- water table elevation and its variations~~. D~~

The applicant should describe the methods used to determine these properties, including the variability in each of these properties and the methods used to model the variability~~. P~~, and provide the shear modulus and damping relationships, including a comparison between the test results performed on site borings and the modulus and damping curves. ~~Describe~~A description of the site material properties to the depth that corresponds to the hard rock conditions assumed by the ground motion attenuation

models used in the PSHA should be provided. In addition, the applicant should provide the rationale for any assumed nonlinear rock behavior.

PThe applicant should provide the response spectra for each of the controlling earthquakes after scaling the spectra to the appropriate low- or high-frequency 0spectralspectral acceleration value. DThe applicant should describe the method used, if necessary, to extend the response spectra beyond the range of frequencies defined for the ground motion attenuation models. P, and provide a description of the method used to develop the time histories for the site response analysis, including the time history database. Provide fFigures showing the initial time histories and final time histories, for which the response spectra have been scaled to the target earthquake response spectra.
Provide a description of should be provided.

The applicant should describe the method used to compute the site amplification function for each controlling earthquake. D, and describe the computer program used to compute the site amplification functions. In addition, the applicant should provide a figure showing the final site transfer function and a table of the results for frequencies ranging from 0.1 to 100 Hz.

C.I.2.5.2.6 *Safe-Shutdown Earthquake Ground Motion Response Spectrum*

DThe applicant should describe the methodology used to determine both the horizontal and vertical SSE ground motionGMRS. If the applicant used the performance-based approach is used, as described in ASCE Standard 43-05 for SDB Category 5DRG 1.208, provide a table with the mean 10^{-4}, 10^{-5} UHRS values, design factors, and horizontal SSEGMRS should be provided. If the applicant used the reference-probability approach is used, as described in RG 1.165, provide figures showing how the horizontal SSEGMRS envelopes the low- and high-frequency controlling earthquake response spectra should be provided. PThe applicant should provide the SSE ground motion spectrumGMRS at a sufficient number of frequencies (at least 25) such that it adequately represents the local and regional seismic hazards. Provide tThe vertical to horizontal (V/H) response spectral ratios used to determine the vertical SSEGMRS from the horizontal SSEGMRS should also be provided.

PThe applicant should provide plots of both the horizontal and vertical SSEGMRS. In addition, provide a table with the horizontal SSEGMRS, V/H ratios, and vertical SSEGMRS should be provided.

C.I.2.5.3 *Surface Faulting*

PThe applicant should provide information describing whether a potential exists for surface deformation exists that could affect the site. Describe tThe detailed surface and subsurface geological, seismological, and geophysical investigations performed around the site to compile this information should be described.

C.I.2.5.3.1 *Geological, Seismological, and Geophysical Investigations*

Provide
The applicant should provide a description of the quaternary tectonics, structural geology, stratigraphy, geochronological methods used, paleoseismology, and geological history for the site, and Ddescribe the lithologic, stratigraphic, and structural geologic conditions of the site and the area surrounding the site, including its geologic history. IThe applicant should include site and regional maps and profiles constructed at scales adequate to clearly illustrate the surficial and bedrock geology, structural geology, topography, and the relationship of the safety-related foundations of the nuclear power plant to these features.

C.I.2.5.3.2 ***Geological Evidence, or Absence of Evidence, for Surface Deformation***

~~Provide~~

The applicant should provide sufficient surface and subsurface information, supported by detailed investigations, to either confirm the absence of surface tectonic deformation (i.e., faulting) or, if surface deformation is present, demonstrate the age of its most recent displacement and ages of previous displacements. If tectonic deformation is present in the site vicinity, ~~define~~ the geometry, amount and sense of displacement, recurrence rate, and age of latest movement should be defined. In addition to geologic evidence that may indicate faulting, ~~document~~ linear features interpreted from topographic maps, low- and high-altitude aerial photographs, satellite imagery, and other imagery should be documented.

C.I.2.5.3.3 ***Correlation of Earthquakes with Capable Tectonic Sources***

~~P~~The applicant should provide an evaluation of all historically reported earthquakes within 25 miles (40 km) of the site with respect to hypocenter accuracy and source origin~~.~~ ~~P~~, and provide an evaluation of the potential ~~to cause~~for causing surface deformation for all capable tectonic sources that could, based on their orientations, extend to within 5 miles (8 km) of the site. ~~P~~In addition, the applicant should provide a plot of earthquake epicenters superimposed on a map showing the local capable tectonic structures.

C.I.2.5.3.4 ***Ages of Most Recent Deformations***

~~Present~~

The applicant should present the results of the investigation of identified faults or folds associated with blind faults, any part of which is within 5 miles (8 km) of the site. ~~P~~It should also provide estimates of the age of the most recent movement and identify geological evidence for previous displacements, if such evidence exists. ~~Describe t~~The geological and geophysical techniques used should be described, and ~~provide~~ an evaluation of the sensitivity and resolution of the exploratory techniques used for each investigation provided.

C.I.2.5.3.5 ***Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures***

~~Discuss~~

The applicant should discuss the structure and generic relationship between site area faulting or other tectonic deformation and the regional tectonic framework. ~~In~~For regions ~~of~~with active tectonics, the applicant should discuss any detailed geologic and geophysical investigations conducted to demonstrate the structural relationships of site area faults with regional faults known to be seismically active.

C.I.2.5.3.6 ***Characterization of Capable Tectonic Sources***

For all potential capable tectonic sources such as faults, or folds associated with blind faults, within 5 miles (8 km) of the site, the applicant should provide the geometry, length, sense of movement, amount of total offset, amount of offset per event, age of latest and any previous displacements, recurrence, and limits of the fault zone.

C.I.2.5.3.7 ***Designation of Zones of Quaternary Deformation in the Site Region***

~~Demonstrate~~

The applicant should demonstrate that the zone requiring detailed faulting investigation is of sufficient length and breadth to include all quaternary deformation significant to the site.

C.I.2.5.3.8 ***Potential for Surface Tectonic Deformation at the Site***

Where the site is located within a zone requiring detailed faulting investigation, the applicant should provide the details and results of investigations substantiating that ~~there are~~ no geologic hazards that could affect the safety-related facilities of the plant exist. The information may be in the form of boring logs, detailed geologic maps, geophysical data, maps and logs of trenches, remote sensing data, and seismic refraction and reflection data.

C.I.2.5.4 ***Stability of Subsurface Materials and Foundations***

~~Present~~

The applicant should present information concerning the properties and stability of all soils and rock that may affect the nuclear power plant facilities, under both static and dynamic conditions, including the vibratory ground motions associated with the ~~SSE ground motion~~GMRS. ~~D~~The applicant should demonstrate the stability of these materials as they influence the safety of ~~S~~seismic Category I facilities~~. P~~ and present an evaluation of the site conditions and geologic features that may affect nuclear power plant structures or their foundations. ~~I~~This section should cross-reference, rather than duplicate, any information presented in other ~~sections~~chapters of the FSAR ~~should be cross-referenced rather than repeated~~.

C.I.2.5.4.1 ***Geologic Features***

~~D~~The applicant should describe geologic features, including the following information:

(1) areas of actual or potential surface or subsurface subsidence, solution activity, uplift, or collapse~~, as well as~~ and the causes of these conditions~~s~~

(2) zones of alteration or irregular weathering profiles~~,~~ and zones of structural weakness

(3) unrelieved residual stresses in bedrock~~,~~ and their potential for creep and rebound effects

(4) rocks or soils that might be unstable because of their mineralogy, lack of consolidation, water content, or potentially undesirable response to seismic or other events

(5) history of deposition and erosion, including glacial and other pre~~-~~loading influence on soil deposits

(6) estimates of consolidation and pre~~-~~consolidation pressures~~,~~ and methods used to estimate these values

~~Relate~~The applicant should provide descriptions, maps, and profiles of the site stratigraphy, lithology, structural geology, geologic history, and engineering geology ~~in order to provide an integrated characterization of the site subsurface~~.

C.I.2.5.4.2 ***Properties of Subsurface Materials***

~~Describe~~

The applicant should describe in detail the properties of underlying materials, including the static and dynamic engineering properties of all soils and rocks in the site area. ~~Describe~~A discussion of the type, quantity, extent, and purpose of all site explorations should be provided. A description of the testing techniques used to determine the classification and engineering properties of soils and rocks~~. Provide a detailed description of any~~ should be included in the application. The applicant should indicate the extent to which the procedures used ~~to perform~~in field investigations to determine the engineering properties of soil and rock materials ~~that are not described in~~ conform to RG 1.132, "Site Investigations for Foundations of Nuclear Power Plants." Likewise, the applicant should indicate the extent to which the procedures used ~~to perform~~in laboratory investigations of soils and rocks conform to RG 1.138, "Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants."

~~P~~The applicant should provide summary tables and plots that show the important test results ~~and provide references to the data sets, used to create the tables and plots. Also provide~~. In addition, a detailed discussion of laboratory sample preparation when applicable should be provided. For critical laboratory tests, the applicant should provide a complete description (e.g., how saturation of the sample was determined and maintained during testing~~,~~ and how the pore pressures changed).

~~P~~The applicant should provide a detailed and quantitative discussion of the criteria used to determine that the samples were properly taken and tested in sufficient manner to define all critical soil parameters for the site. For sites underlain by saturated soils and sensitive clays, the applicant should show that all zones that could become unstable as a result of liquefaction of strain-softening phenomena have been adequately sampled and tested. ~~D~~The applicant should describe the relative density of soils at the site~~. S~~ and show that the consolidation behavior of the soils, as well as their static and dynamic strength, have been adequately defined. ~~E~~The applicant should explain how the developed data are used in the safety analysis, how the test data are enveloped by the design, and why the design envelope is conservative. ~~Present v~~Values of the parameters used in the analyses should be presented.

C.I.2.5.4.3 ~~*Exploration*~~

~~*Describe the field exploration program used to characterize the site. Provide a justification for the selected exploratory methods, the locations for exploration, and the depth to which the exploration was conducted. Describe any changes to the site characterization plan as a result of any initial findings and describe the initial findings.*~~

~~*Describe the methods of sample collection, storage, and transportation. Describe the measures used to ensure that the samples remain undisturbed. Describe any measures taken to correlate site specific stratification with CPT data, if CPT data are used to extend the site subsurface profile.*~~

~~*Provide*~~*Foundation Interfaces*

The applicant should provide plot plans that graphically show the location of all site explorations, such as borings, trenches, seismic lines, piezometers, geologic profiles, and excavations, with the locations of the safety-related facilities superimposed thereon. ~~Include all formations of engineering significance and identify their areal extent across the boundaries of the site exploration. Also,~~In addition, the applicant should provide profiles illustrating the detailed relationship of the foundations of all ~~S~~seismic Category I and other safety-related facilities to the subsurface materials.

~~P~~The applicant should provide logs of all core borings and test pits. ~~Furnish l~~Logs and maps of exploratory trenches and geologic maps and photographs of the excavations for the facilities of the nuclear power plant should be furnished.

C.I.2.5.4.4 ***Geophysical Surveys***

~~P~~The applicant should provide a description of the geophysical investigations performed at the site to determine the dynamic characteristics of the soil or rock and geophysical features of the site~~.~~, and ~~P~~provide the results of compressional and shear wave velocity surveys performed to evaluate the occurrence and characteristics of the foundation soils and rocks in tables and profiles. ~~Discuss~~A discussion of other geophysical methods used to determine foundation conditions should be included.

C.I.2.5.4.5 ***Excavations and Backfill***

~~D~~The applicant should discuss the following data concerning excavation, backfill, and earthwork analyses at the site:

(1) ~~S~~sources and quantities of backfill and borrow~~. Describe~~, including a description of exploration and laboratory studies and the static and dynamic engineering properties of these materials in the same fashion ~~described~~detailed in Sections C.I.2.5.4.2 and C.I.2.5.4.3 of this guide~~.~~

(2) ~~E~~extent (horizontally and vertically) of all ~~S~~seismic Category I excavations, fills, and slopes~~. Show~~, including the locations and limits of excavations, fills, and backfills on plot plans and geologic sections and profiles~~.~~

(3) ~~C~~compaction specifications and embankment and foundation designs~~.~~

(4) ~~D~~dewatering and excavation methods and control of ~~groundwater~~ground water during excavation to preclude degradation of foundation materials~~. Also discuss~~, including a discussion of proposed quality control and ~~quality assurance~~QA programs related to foundation excavation,

and subsequent protection and treatment~~. Discuss~~, and measures to monitor foundation rebound and heave~~.~~

C.I.2.5.4.6 ~~*Groundwater*~~*Ground Water Conditions*

~~D~~The applicant should discuss ~~groundwater~~ground water conditions at the site, including the following information:

(1) ~~groundwater~~ground water conditions relative to the foundation stability of the safety-related nuclear power plant facilities

(2) plans for dewatering during construction

(3) plans for analysis and interpretation of seepage and potential piping conditions during construction~~,~~

(4) records of field and laboratory permeability tests

(5) history of ~~groundwater~~ground water fluctuations, as determined by periodic monitoring of local wells and piezometers, including flood conditions

~~Describe~~

If the applicant has not completed the analysis of ground water at the site as discussed in this chapter at the time the applicant files a COL application, a description of the implementation ~~plan~~program, including milestones, should be included.

C.I.2.5.4.7 *Response of Soil and Rock to Dynamic Loading*

~~Provide a description of~~The applicant should describe the response of soil and rock to dynamic loading, including the following ~~considerations~~information:

(1) any investigations to determine the effects of prior earthquakes on the soils and rocks in the vicinity of the site, including evidence of ~~paleoliquefaction~~liquefaction and sand cone formation

(2) compressional and shear (P and S) wave velocity profiles, as determined from field ~~geophysical~~seismic surveys (surface refraction and reflection and in-hole and cross-hole seismic explorations), including data and interpretation of the data

(3) results of dynamic tests in the laboratory on samples of the soil and rock ~~to determine the shear modulus and damping degradation with strain~~

~~(4) results of soil-structure interaction analysis~~

~~Describe how the high to medium strain results have been incorporated in the soil column analysis to simulate the straining level during seismic wave passage. Describe any parametric studies undertaken to establish the location of the input motion based on the soil column studies. In addition, describe the selection of the soil columns to be used in the SSI analysis and the approaches taken to account for variability of the soil properties in these columns.~~

~~Material on~~

Section 2.5.2.5 of the FSAR may cross-reference material concerning site geology included in this ~~section may be cross-referenced in Section 2.5.2.5 of the FSAR~~chapter.

C.I.2.5.4.8 ***Liquefaction Potential***

~~Describe~~

If the foundation materials at the site adjacent to and under safety-related structures are saturated soils or soils that have a potential to become saturated and the water table is above bedrock, the applicant should provide an appropriate state-of-the-art analysis of the potential for ~~the~~ liquefaction ~~of~~ occurring at the site ~~soils under SSE ground motion~~. ~~I~~The applicant should indicate the extent to which the guidance provided in RG 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites," was followed. ~~Provide a description of any secondary methods used to confirm the potential for liquefaction.~~

C.I.2.5.4.9 ***Earthquake Site Characteristics***

~~P~~The applicant should provide a brief summary of the derivation of the SSE ground motion, including a reference to Section 2.5.2.6 of the FSAR.

C.I.2.5.4.10 ***Static Stability***

~~D~~The applicant should describe an analysis of the stability of all safety-related facilities for static loading conditions~~. D~~, and should describe the analysis of foundation rebound, settlement, differential settlement, and bearing capacity under the dead loads of fills and plant facilities. ~~Include a~~A discussion and evaluation of lateral earth pressures and hydrostatic ~~groundwater~~ground water loads acting on plant facilities should be included. ~~D~~The applicant should discuss field and laboratory test results~~. D~~, and discuss and justify the design parameters used in stability analyses. ~~Provide s~~Sufficient data and analyses so that the staff may make an independent interpretation and evaluation should be provided.

C.I.2.5.4.11 ***Design Criteria***

~~P~~The applicant should provide a brief discussion of the design criteria and methods of design used in the stability studies of all safety-related facilities and how they compare to the geologic and seismic site characteristics. ~~I~~The applicant should identify required and computed factors of safety, assumptions, and conservatisms in each analysis. ~~Provide references to the analytical methods and the field or laboratory data used. Provide a description of all computer programs used in developing the design along with the validation package~~References should be provided and computer analyses used should be explained and verified.

C.I.2.5.4.12 ***Techniques To Improve Subsurface Conditions***

~~D~~The applicant should discuss and provide specifications for measures to improve foundations, such as ~~dynamic compaction, chemical~~ grouting, ~~piling~~vibroflotation, dental work, rock bolting, ~~stone columns, or other stabilization methods. Discuss~~and anchors; and discuss a verification program designed to permit a thorough evaluation of the effectiveness of foundation improvement measures. If the applicant has not completed the foundation improvement verification program discussed in this section ~~has not been completed~~ at the time the applicant files a COL application ~~is filed, describe~~, a description of the implementation program, including milestones, should be included.

C.I.2.5.5 ***Stability of Slopes***

PThe applicant should present information concerning the static and dynamic stability of all natural and man-made earth or rock slopes, (such as cuts, fills, embankments, and dams, etc.) for which failure, under any of the conditions to which they could be exposed during the life of the plant, could adversely affect the safety of the nuclear power plant facilities. Include aA thorough evaluation of site conditions, geologic features, and the engineering properties of the materials comprising the slope and its foundation should be included. Present tThe results of slope stability evaluations using classic and contemporary methods of analyses: should be presented. Include, wWhenever possible, comparative field performance of similar slopes should be included. All information related to defining site conditions, geologic features, engineering properties of materials, and design criteria should be of the same scope as that provideddiscussed in Section C.I.2Section 2.5.4 of this guide. CThe applicant may use cross-references may be used where appropriate. For the stability evaluation of man-made slopes, include summary data and a discussion of construction procedures, record testing, and instrumentation monitoring to ensure high-quality earthwork should be included.

C.I.2.5.5.1 *Slope Characteristics*

DThe applicant should describe and illustrate slopes and related site features in detail. Provide aA plan showing the limits of cuts, fills, or natural undisturbed slopes, and show their relation and orientation relative to plant facilities should be provided. CThe applicant should clearly identify benches, retaining walls, bulkheads, jetties, and slope protection. Provide dDetailed cross-sections and profiles of all slopes and their foundations should be provided. Discuss cExploration programs and local geologic features should be discussed. DescribeA description of the groundwaterground water and seepage conditions that exist and those assumed for analysis purposes. Describe; a description of the type, quantity, extent, and purpose of exploration; and show the locations of borings, test pits, and trenches on all drawings should be included.

DThe applicant should discuss the sampling methods used. Identify mMaterial types and the static and dynamic engineering properties of the soil and rock materials comprising the slopes and their foundations. Identify t should be identified. The presence of any weak zones, such as seams or lenses of clay, mylonites, or potentially liquefiable materials. Discuss should be identified and presentthe results of the field and laboratory testing programs, discussed and justify spresented. Selected design strengths should be justified.

C.I.2.5.5.2 *Design Criteria and Analyses*

DThe applicant should describe the design criteria for the stability and design of all safety-related and Sseismic Category I slopes. PIt should present valid static and dynamic analyses to demonstrate the reliable performance of these slopes throughout the lifetime of the plant. DIt should describe the methods used for static and dynamic analyses, and indicate the reasons for selecting them. Indicate aAssumptions and design cases analyzed with computed factors of safety should be indicated. Present tThe results of stability analyses in tables identifying design cases analyzed, strength assumptions for materials, forces acting on the slope and pore pressures acting within the slope, and the type of failure surface. For aAssumed failure surfaces, show them should be shown graphically on cross-sections, and appropriately identify themidentified in both the tables and sections. In addition, describe adverse conditions, such as high water levels attributable to the PMF, sudden drawdown, or steady seepage at various levels should be described. Explain and justify cComputer analyses should be explained and justified, and provide an abstract of computer programs used, provided.

Where liquefaction is possible, ~~present~~ the results of the analysis of major dam foundation slopes and embankments should be shown by state-of-the-art finite-~~-~~element or finite-difference methods of analysis. Where there are liquefiable soils, the applicant should indicate whether changes in pore pressure attributable to cyclic loading were considered in the analysis to assess the potential for liquefaction, as well as the effect of pore pressure increase on the stress-strain characteristic of the soil and the post-~~-~~earthquake stability of the slopes.

C.I.2.5.5.3 *Logs of Borings*

~~P~~The applicant should present the logs of borings, test pits, and trenches that were completed for the evaluation of slopes, foundations, and borrow materials to be used for slopes. Logs should indicate elevations, depths, soil and rock classification information, ~~groundwater~~ground water levels, exploration and sampling method, recovery, rock quality designation ~~(RQD)~~, and blow counts from standard penetration tests. ~~D~~The applicant should discuss drilling and sampling procedures, and indicate on the logs where samples were taken ~~on the logs~~.

C.I.2.5.5.4 *Compacted Fill*

~~P~~The applicant should provide a description of the excavation, backfill, and borrow material planned for any dams, dikes, and embankment slopes. ~~D~~The applicant and should describe planned construction procedures and control of earthworks. This information should be similar to that outlined in Section C.I.2.5.4.5 of this guide. ~~Discuss t~~The quality control techniques and documentation during and following construction should be discussed, and ~~reference~~ the applicable ~~quality assurance~~QA sections of the FSAR should be referenced.