2. SITE CHARACTERISTICS

2.1 Geography and Demography

2.1.1 Site Location and Description

2.1.1.1 Technical Information in the Application

In Section 2.1.1.1 of the site safety analysis report (SSAR) for the Grand Gulf Nuclear Station (GGNS) early site permit (ESP) site, the applicant presented information concerning site location and site area that could affect the design of structures, systems, and components (SSCs) important to the safety of a nuclear power plant(s) falling within the applicant's plant parameter envelope (PPE) that might be constructed on the proposed ESP site.

The applicant provided the following information on site location and site area:

- the site boundary for a new unit(s) in the proposed ESP site with respect to the location of GGNS, Unit 1

- the site location with respect to political subdivisions and prominent natural and manmade features of the area within the 2-mile low-population zone (LPZ) and 50-mile population zone

- the topography surrounding the proposed ESP site

- the distance from the proposed ESP site to the nearest exclusion area boundary (EAB), including the direction and distance

- the location of potential radioactive material release points associated with a proposed new unit(s)

- the distance of the proposed site from regional U.S. and State highways

- confirmation that no physical characteristics unique to the proposed ESP site were identified that could pose a significant impediment to the development of emergency plans

2.1.1.2 Regulatory Evaluation

Sections 1.4 and 2.1.1 of the SSAR identify the applicable U.S. Nuclear Regulatory Commission (NRC) regulations and guidance regarding site location and description, as defined in Title 10, Section 52.17, "Contents of Applications," of the *Code of Federal Regulations* (10 CFR 52.17); 10 CFR Part 100, "Reactor Site Criteria"; and 10 CFR 50.34(a)(1), as well as NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits," issued May 2004. The staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified above.

The staff considered the following regulatory requirements in reviewing the site location and site area:

- 10 CFR Part 100, insofar as it requires consideration of factors relating to the size and location of sites

- 10 CFR 52.17, insofar as it requires the applicant's submission of information needed to evaluate factors involving the characteristics of the site environs

According to Section 2.1.1 of RS-002, an applicant has submitted adequate information if it satisfies the following criteria:

- The site location, including the exclusion area and the proposed location of a nuclear power plant(s) of specified type falling within a PPE that might be constructed on the proposed site, is described in sufficient detail to determine that the requirements of 10 CFR Part 100 and 10 CFR 52.17 are met, as discussed in Sections 2.1.2, 2.1.3, and 3.3 of this safety evaluation report (SER).

- Highways, railroads, and waterways that traverse the exclusion area are sufficiently distant from planned or likely locations of any structures of a nuclear power plant(s) of specified type falling within a PPE that might be constructed on the proposed site to ensure that routine use of these routes is not likely to interfere with normal plant operation.

2.1.1.3 Technical Evaluation

The proposed new ESP site is located within the existing GGNS site property boundary. Figure 2.1-2 of the SSAR depicts the site boundary for a new unit(s) in the proposed ESP site with respect to the existing GGNS. The applicant identified the universal transverse mercator (UTM) grid coordinates for the new unit(s) in the proposed ESP site as N3,542,873 meters and E684,021 meters. In Request for Additional Information (RAI) 2.1-1, the staff asked the applicant to provide the latitude and longitude of the proposed new reactor site, complete with UTM zone numbers. In response, the applicant stated that the UTM coordinates for UTM Zone 15 correspond to a latitude and longitude of 32E00N23.5654150 N and 91E03N06.4209080 W using the International Ellipsoid.

The applicant elected to define the EAB as a circular radius of 2760 feet (0.52 miles) and the LPZ as a circular radius of 2 miles, both from the circumference of a 630-foot circle encompassing the proposed powerblock housing the reactor containment structure for new unit(s). The EAB of a new unit(s) is wholly contained within the GGNS site property boundary. The applicant established the EAB and the LPZ to ensure that the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) and the siting evaluation factors in Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997," of 10 CFR Part 100 are met. No residents are within the proposed EAB. The staff has verified that the exclusion area distance is consistent with the distance used in the radiological consequence analyses performed by the applicant in Section 3.3 of the SSAR.

The existing GGNS and the proposed ESP site are in Claiborne County in southwestern Mississippi. The proposed ESP site is on the east side of the Mississippi River about 25 miles south of Vicksburg, Mississippi, and 37 miles north-northeast of the town of Natchez, Mississippi. The town of Port Gibson is about 6 miles southeast of the proposed ESP site. The GGNS site, which includes one existing nuclear power unit and the proposed ESP site, encompasses approximately 2100 acres. The largest community within 50 miles of the proposed ESP site is Vicksburg with a 2000 population of 26,407. No highways, railroads, and waterways traverse the proposed ESP exclusion area site boundary.

The applicant stated that the gaseous effluent release point is assumed to be within the proposed construction area designated for the new facility powerblock, and the liquid effluent release point for the new units would apply at the river downstream of the new facility intake to preclude recirculation to the embalmment area and intake pipes. The staff finds that these release points are acceptable for determining that the radiation exposures to the public to meet the criterion "as low as is reasonably achievable," cited in Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable,' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." (See discussion of this subject in Section 5.9 of the staff's environmental impact statement for the Grand Gulf ESP application.)

For the reasons set forth in Section 13.3 of this SER, the staff further finds that the applicant did not identify any physical characteristics unique to the proposed ESP site that could pose a significant impediment to the development of emergency plans.

2.1.1.4 Conclusions

As set forth above, the applicant has provided and substantiated information concerning site location and site area that could affect the design of SSCs important to safety of a nuclear power plant(s) of specified type falling within the applicant's PPE that might be constructed on the proposed ESP site. The staff has reviewed the applicant's information as described above and concludes that it is sufficient for the staff to evaluate compliance with the siting evaluation factors in 10 CFR Part 100 and 10 CFR 52.17, as well as with the radiological consequence evaluation factors in 10 CFR 50.34(a)(1). The staff further concludes that the applicant provided sufficient details about the site location and site area to allow the staff to evaluate, as documented in Sections 2.1.2, 2.1.3, and 3.3 of this SER, whether the applicant has met the relevant requirements of 10 CFR Part 100 and 10 CFR 52.17.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 Technical Information in the Application

In SSAR Section 2.1.2.1, the applicant presented information concerning its plan to obtain legal authority to determine all activities within the designated exclusion area, if it decides to proceed with the development of a new reactor unit(s) at the proposed ESP site. The applicant stated the following:

> For all practical purposes, SERI (the applicant) controls the surface right, and The applicant has authorized Entergy Operations (for GGNS, Unit 1) to maintain control of ingress to and egress from the exclusion area and provides for

> evacuation of individuals from the area in the event of an accident.... A similar arrangement would be made for exercise of authority over the area within the exclusion area for the new facility on the site property....

In RAI 2.2-1, the staff asked the applicant for additional information regarding its approach for making such arrangements before issuing the Grand Gulf ESP. In its response, the applicant stated that, “this arrangement would not be made prior to issuance of the Grand Gulf ESP. Such arrangement would be made associated with a Combined License application.”

2.1.2.2 Regulatory Evaluation

In SSAR Table 1.4-1 and in RAI 1.4-1, the applicant identified the applicable NRC regulations and regulatory guidance regarding exclusion area authority and control related to Subpart A, “Early Site Permits,” of 10 CFR Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants,” and 10 CFR Part 100.

In reviewing the applicant’s legal authority to determine all activities within the designated exclusion area, the staff considered the relevant requirements of 10 CFR 100.3, “Definitions,” which state the following:

> Exclusion area means that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad, or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety.... Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

2.1.2.3 Technical Evaluation

Figure 2.1-1 of the SSAR depicts the boundary lines of the current exclusion area and of the proposed exclusion area for the new unit(s). The exclusion area for the new unit(s) is larger than the current GGNS exclusion area and includes a majority of the GGNS exclusion area. The EAB for the new unit(s) consists of a circle of approximately 2760-feet radial distance from the circumference of a 630-foot circle encompassing the proposed powerblock housing the reactor containment structure for the new unit(s). No U.S. or State highways, railways, or waterways traverse the proposed ESP exclusion area for the new unit(s).

One county road (Grand Gulf Road) runs through the GGNS plant site property and another county road (Bald Hill Road) traverses the proposed ESP EAB. The applicant stated that Entergy Operations currently allows access to parts of the plant site property for recreational purposes and that arrangements have been made for control of traffic on the county road during a declared emergency involving GGNS Unit 1. With respect to the proposed exclusion area, the applicant stated that it would make similar arrangements with the appropriate law enforcement authorities for control of traffic on the county road in the event of a declared emergency involving the new unit(s). The emergency plan (see Section 13.3.3.3 of this SER) describes these arrangements in more detail. The applicant further stated that because the portion of Bald Hill Road that traverses the exclusion area is also located within a potential construction usage area, it may become necessary to relocate that portion of the road during construction of any new nuclear units.

The applicant stated that it has authorized Entergy Operations to maintain control of ingress and egress from the current exclusion area for GGNS Unit 1 and to evacuate individuals from the area in the event of an emergency. The applicant further stated that it would make a similar arrangement to authorize the operator of the new unit(s) to maintain control of ingress to and egress from the new proposed ESP exclusion area and to provide for evacuation of individuals from the new proposed ESP exclusion area in the event of an emergency.

The applicant has surface ownership of the land within the plant site property boundary, with certain exceptions described herein. South Mississippi Electric Power Association (SMEPA) maintains a 10-percent undivided ownership interest in the property associated with the existing GGNS power plant and support facilities. SMEPA also maintains certain easement rights associated with the property. Pursuant to the Grand Gulf Nuclear Station Operating Agreement, signed on June 6, 1990, Systems Energy Resources, Inc. (SERI), is authorized to act as the general agent for SMEPA with respect to construction and operation of GGNS.

Additionally, Entergy Mississippi, Inc., owns the 52-acre plant switchyard area, which is partially located within the plant exclusion area. The applicant, however, has authority to exercise complete control and determine all activities in the exclusion area, including exclusion of Entergy Mississippi, Inc., personnel and third parties. The applicant has transferred such rights to Entergy Operations. The applicant stated that it would arrange to authorize the operator of the new unit(s) to exercise similar control in the exclusion area. Entergy Mississippi, Inc., also has easements or rights of way for two transmission lines, neither of which are located within the proposed exclusion area.

The applicant owns most of the mineral interests within the exclusion area. However, no evidence exists to suggest that third parties will exercise their rights to such minerals. Therefore, based on its review, the staff concludes that it is extremely unlikely that such third party interests would ever be exercised so as to create an exception to the applicant and Entergy Operation’s control of the exclusion area.

The applicant has stated that for all practical purposes, it controls the surface rights within the ESP exclusion area. The applicant has further stated that at such time as it elects to apply for a combined license (COL), it intends to have entered into an agreement with the selected operator of the new unit(s) to authorize the operator to exercise complete control and determine all activities within the exclusion area, including maintaining control of ingress to and egress from the exclusion area, and to provide for the evacuation of individuals from the area in the event of an emergency. The applicant stated that this agreement will be similar to its agreement with Entergy Operations, the operator of GGNS Unit 1. The applicant stated that at the time an application for a COL is submitted, arrangements would also be in place with the selected operator and the appropriate State and local law enforcement authorities for control of traffic on county roads traversing the ESP exclusion area in the event of an emergency.

To meet the exclusion area control requirements of 10 CFR 100.21(a) and 10 CFR 100.3, the applicant does not need to demonstrate total control of the property before issuance of the

ESP. In the draft safety evaluation review (DSER), the NRC staff stated that the applicant must provide reasonable assurance that it can acquire the required control (i.e., that it has the legal right to obtain control of the exclusion area). The staff had not then obtained information sufficient to enable it to determine whether the applicant had such a legal right. Accordingly, the NRC staff identified DSER Open Item 2.1-1, which required the applicant to demonstrate that it "has control over the exclusion area or has a right to obtain such control."

In its response to the open item, the applicant indicated that at the time it applies for a COL referencing the Grand Gulf ESP to construct and operate any new unit(s) at the Grand Gulf ESP site, it will have arrangements in place authorizing the operator of the new unit(s) to exercise control within the ESP exclusion area, to maintain control of ingress to and egress from the ESP exclusion area, and to evacuate individuals from the exclusion area in the event of an emergency.

Based on the above information, the staff concludes that the applicant appears to have sufficient authority to determine all activities in the exclusion area, including the ability to exclude or remove individuals and property from the area. The staff has determined that the applicant is prepared to secure the arrangements described above, and there does not appear to be any reason why the ESP holder could not obtain control of the exclusion area in this manner. In addition, there does not appear to be any legal impediment to the applicant securing the described arrangements.

Accordingly, the NRC staff will include a condition in any ESP that might be issued regarding the Grand Gulf site to govern exclusion area control as **Permit Condition 1**. This permit condition requires an applicant for a COL referencing this ESP to demonstrate that it has been granted the right to exercise sufficient control within the exclusion area identified in the ESP, including the authority to maintain ingress to and egress from the exclusion area and to evacuate individuals from the exclusion area in the event of an emergency. The permit condition also requires a COL applicant referencing this ESP to secure any necessary arrangements to provide, in the event of a declared emergency, for the control of traffic on county roads and the evacuation of individuals within the ESP exclusion area. The condition requires that these arrangements be obtained and executed before the granting of an application referencing the ESP. Therefore, DSER Open Item 2.1-1 is closed.

2.1.2.4 Conclusions

As set forth above, the applicant has provided information concerning its plan to obtain legal authority to determine all activities within the designated exclusion area. The staff has reviewed the applicant's information and concludes that it is sufficient to assure compliance with the exclusion area control requirements of 10 CFR 100.21(a) and 10 CFR 100.3. In addition, the applicant has appropriately described the exclusion area and the methods by which it will control access and occupancy of this exclusion area during normal operation and in the event of an emergency situation.

The applicant has demonstrated that it currently has the authority to determine all activities, including exclusion or removal of personnel and property from the proposed exclusion area, as required by 10 CFR Part 100. Additionally, the staff concludes that the proposed permit condition provides reasonable assurance that if the ESP is referenced as part of an application for a COL or construction permit (CP), the applicant has adequate control of the exclusion area.

2.1.3 Population Distribution

2.1.3.1 Technical Information in the Application

In SSAR Section 2.1.3, the applicant estimated and provided the population distribution surrounding the proposed ESP site, up to a 50-mile radius from the center of the proposed powerblock location for a new facility on the proposed ESP site, based on the most recent U.S. census. The applicant also provided in this section the resident population distribution within the LPZ, the nearest population center, and population densities up to a 30-mile radius from the proposed ESP site.

The population distribution provided by the applicant encompasses 9 concentric rings at various distances up to 50 miles and 16 directional sectors from the proposed ESP site. The applicant projected population estimates up to 2070, 5 years beyond the projected year for end of new plant life. The applicant also estimated and provided transient population based on recreational use of Grand Gulf Military Park, Warner-Tully YMCA camp, Lake Claiborne, hunting camps, and fishing.

The applicant described the LPZ and illustrated it in Figure 2.1-5 of the SSAR. The LPZ for a new unit(s) includes a 2-mile radial distance measured from the circumference of a 630-foot circle encompassing the proposed powerblock location for a new unit. The applicant listed facilities and institutions within 5 miles of the proposed ESP site in SSAR Table 2.1-3. In Tables 2.1-1 and 2.1-2 of the SSAR, the applicant provided the cumulative population in 2002 and the projected cumulative population in 2070, as functions of the 10-mile to 50-mile radial distance from the proposed ESP site.

In Tables 2.1-5 and 2.1-6 of the SSAR, the applicant provided the population densities in 2030 and 2070 at distances of 10, 20, and 30 miles from the proposed ESP site. In RAI 2.1.3-3, the staff requested that the applicant clarify whether the current and projected population data shown in SSAR Tables 2.1-1 and 2.1-2 include the weighted transient population. In its response dated August 16, 2004, the applicant stated that the data do not include the weighted transient population.

Subsequently, in its response to the Grand Gulf ESP DSER open items dated June 21, 2005, the applicant provided projections of estimated total population for 2002, 2030, and 2070, including weighted transient population, for the Grand Gulf ESP site.

The applicant described the LPZ in Section 2.1.3.4 of the SSAR. The LPZ is defined in 10 CFR 100.3 as “the area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident.” The LPZ for the ESP site is essentially the same as the LPZ for the existing GGNS Unit 1; it consists of a circle with a radius of 2 miles measured from the circumference of a 630-foot circle encompassing the proposed powerblock location for a new unit. The LPZ for GGNS Unit 1 is a circle with a radius of 2 miles centered on the GGNS Unit 1 reactor.

The applicant described the population center in Section 2.1.3.5 of the SSAR. The population center is defined in 10 CFR 100.3 as a densely populated area containing more than 25,000 residents. The applicant stated that the nearest population center with a population greater than 25,000 people that is likely to exist over the lifetime of the proposed ESP site is the city of Vicksburg, Mississippi, with a 2000 population of 26,407. The closest point of Vicksburg, Mississippi, is 25 miles north-northeast of the ESP site. The next closest population center is Jackson, Mississippi, which is 55 miles to the northeast of the proposed ESP site and has a population of 184,256.

In RAI 2.1.3-2, the staff asked the applicant to describe appropriate protective measures that could be taken on behalf of the populace in the LPZ in the event of a reactor accident. In its response, the applicant stated that offsite protective measures are the responsibility of the applicable State and local governments and referred to the emergency plan included in its June 3, 2004, submission to the staff.

2.1.3.2 Regulatory Evaluation

In SSAR Table 1.4-1 and in its response to RAI 1.4-1, the applicant identified the applicable NRC regulations and regulatory guidance regarding population distribution, as described in 10 CFR 52.17; 10 CFR Part 100; Regulatory Guide (RG) 4.7, Revision 1, "General Site Suitability Criteria for Nuclear Power Stations," issued April 1998; and RS-002. The staff finds that the applicant correctly identified the applicable regulations and guidance.

The staff considered the following regulatory requirements in its review of this section of the SSAR:

- 10 CFR 52.17, as it relates to each applicant providing a description and safety assessment of the site, with special attention to the site evaluation factors identified in 10 CFR Part 100

- 10 CFR Part 100, insofar as it establishes requirements with respect to population density

In particular, the staff considered the population density and use characteristics of the site environs, including the exclusion area, LPZ, and population center distance. The regulations in 10 CFR Part 100 also provide definitions and other requirements for determining an exclusion area, LPZ, and population center distance.

As stated in Section 2.1.3 of RS-002, the applicable requirements of 10 CFR 52.17 and 10 CFR Part 100 are deemed to have been met if the population density and use characteristics of the site meet the following criteria:

- Either there are no residents in the exclusion area, or if residents do exist, they are subject to ready removal, in case of necessity.

- The specified LPZ is acceptable if it is determined that appropriate protective measures could be taken on behalf of the enclosed populace in the event of a serious accident.

- The population center distance is at least 1 1/3 times the distance from the reactor to the outer boundary of the LPZ. The population center distance is defined in 10 CFR 100.3 as "the distance from the reactor to the nearest boundary of a densely populated center consisting of more than about 25,000 residents."

- The population center distance is acceptable if there are no likely concentrations of greater than 25,000 people over the lifetime (plus the term of the ESP) of a nuclear power plant(s) of specified type or falling within a PPE that might be constructed on the proposed site closer than the distance designated by the applicant as the population center distance. The boundary of the population center will be determined upon considerations of population distribution. Political boundaries are not controlling.

- The population data supplied by the applicant in the safety assessment are acceptable if (1) they contain population data for the latest census, projected year(s) of startup of a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site (such date or dates reflecting the term of the ESP), and projected year(s) of end-of-plant life, all in the geographical format given in Section 2.1.3 of RG 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants—LWR Edition," issued November 1978, (2) they describe the methodology and sources used to obtain the population data, including the projections, (3) they include information on transient populations in the site vicinity, and (4) the population data in the site vicinity, including projections, are verified to be reasonable by other means, such as U.S. Census Bureau publications, publications from State and local governments, and other independent projections.

- If the population density at the ESP stage exceeds the guidelines given in RG 4.7, special attention to the consideration of alternative sites with lower population densities is necessary. A site that exceeds the population density guidelines of Regulatory Position C.4 of RG 4.7, can nevertheless be selected and approved if, on balance, it offers advantages compared with available alternative sites when all of the environmental, safety, and economic aspects of the proposed and alternative sites are considered.

2.1.3.3 Technical Evaluation

The staff reviewed the data on the population in the site environs, as presented in the applicant's SSAR, to determine whether the exclusion area, LPZ, and population center distance for the proposed ESP site comply with the requirements of 10 CFR Part 100 and the acceptance criteria in Section 2.1.3.2 of this SER. The staff also evaluated whether, consistent with Regulatory Position C.4 of RG 4.7, the applicant should consider alternative sites with lower population densities. The staff also reviewed whether appropriate protective measures could be taken on behalf of the enclosed populace within the emergency planing zone (EPZ), which encompasses the LPZ, in the event of a serious accident.

The staff compared and verified the applicant's population data against U.S. Census Bureau Internet data. As documented in Section 13.3 of this SER, the staff reviewed the projected population data provided by the applicant, including the weighted transient population for 2002, 2030, and 2070. If the NRC were to approve and issue the ESP in 2006, assuming a COL application is submitted near the end of the ESP term, with a projected startup of new units in about 2025 and an operational period of 40 years for the new units, the projected year for end-of-plant life is about 2065. Accordingly, the staff finds that the applicant’s projected population data cover an appropriate number of years and are reasonable.

The staff reviewed the transient population information provided by the applicant in SSAR Section 2.1.3.3. The transient population is based on recreational use of Grand Gulf Military Park, Warner-Tully YMCA camp, Lake Claiborne, hunting camps, and fishing. In RAI 2.1.3-3, the staff requested that the applicant clarify whether the current and projected population data shown in Tables 2.1-1 and 2.1-2 of the SSAR include the weighted transient population. In its response, the applicant stated that they do not include the weighted transient population. This was the Grand Gulf DSER Open Item 2.1-2.

Subsequently, in its response to the Grand Gulf ESP DSER open items dated June 21, 2005, the applicant provided projections of estimated total population for 2002, 2030, and 2070, including weighted transient population for the Grand Gulf ESP site. Tables 2.1-5 and 2.1-6 of the GGNS SSAR, Revision 2, present this information. Therefore, DSER Open Item 2.1-2 is closed.

The staff reviewed the transient population data provided by the applicant. The transient population up to a 10-mile radius includes transient work force, recreation transients, and special facilities. GGNS Unit 1 is the most significant employer within the 10-mile EPZ. Therefore, the majority of the transient workforce within 10 miles of the ESP site commutes to GGNS. No other major industry, employing more than 250 people, is located within a 10-mile radius of GGNS. Recreational transients include visitors to Grand Gulf State Park, Lake Claiborne, various other recreation areas, and hunters/fishermen. Special facilities include schools and nursing homes. The transient population up to a 30-mile radius of the ESP site includes the Vicksburg National Military Park, the National Cemetery, the historic downtown area, and numerous gambling facilities docked on the Mississippi or Yazoo Rivers.

The applicant collected information concerning transient population from a number of organizations involved in monitoring recreational tourist traffic, the Vicksburg Convention and Visitor’s Bureau, and the Louisiana Office of Tourism. Based on this information, the staff finds that the applicant’s estimate of the transient population is reasonable.

The applicant evaluated representative design-basis accidents (DBAs) in Section 3.3 of the SSAR. The staff independently verified the applicant’s evaluation in Section 3.3 of this SER to demonstrate that the radiological consequences of DBAs at the proposed LPZ would be within the dose consequence evaluation factors set forth in 10 CFR 50.34(a)(1).

The nearest population center with a population greater than 25,000 people which is likely to exist over the lifetime of the proposed ESP site is the city of Vicksburg, Mississippi, with a 2000 population of 26,407. The closest point of Vicksburg, Mississippi, is 25 miles north-northeast of the ESP site. The next closest population center is Jackson, Mississippi, which is 55 miles to the northeast of the proposed ESP site and has a population of 184,256. The distances to Vicksburg and Jackson, the nearest population centers, are well in excess of the minimum population center distance of 2.7 miles (1 1/3 times the distance of 2.06 miles from the reactor to the outer boundary of the LPZ). In addition, no population centers are closer than the population center distance specified by the applicant.

Therefore, the staff concludes that the proposed ESP site meets the population center distance requirement, as defined in 10 CFR Part 100. The staff has determined that no realistic likelihood exists that there will be a population center with 25,000 people within the 7.8-mile

minimum population center distance during the lifetime of any new unit(s) that might be constructed on the site. The staff based this conclusion on projected cumulative resident and transient population within 10 miles of the site during the lifetime of any new unit(s) (i.e., 2025–2065).

The staff evaluated the site against the criterion in Regulatory Position C.4 of RG 4.7 regarding whether it is necessary to give special attention to the consideration of alternative sites with lower population densities. The criterion is whether the population densities in the vicinity of the proposed site, including weighted transient population, projected at the time of initial site approval and within about 5 years thereafter, would exceed 500 persons per square mile averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the area at that distance).

The staff determined that such population densities for the proposed site would be well below this criterion. Therefore, the staff concludes that the site conforms to Regulatory Position C.4 in RG 4.7. Based on the assumption that construction of a new nuclear reactor(s) at the proposed site would begin near the end of the term of the ESP, as well as its review of the applicant's population density data and projections, the staff finds that the site also meets the guidance of RS-002 regarding population densities over the lifetime of facilities that might be constructed at the site because the population density over that period would be expected to remain below 500 persons per square mile averaged out to 20 miles from the site.

The staff reviewed information provided by the applicant regarding its ability to take appropriate protective measures on behalf of the populace in the LPZ in the event of a serious accident. In RAI 2.1.3-2, the staff asked The applicant to describe appropriate protective measures that could be taken on behalf of the populace in the LPZ in the event of a reactor accident. In its response, the applicant stated that offsite protective measures are the responsibility of the applicable State and local governments and referred to the emergency plan included in its June 3, 2004, submission to the staff.

The staff finds that the applicant's response is satisfactory because it is consistent with emergency planning for the 10-mile plume exposure EPZ. The LPZ is located entirely within the 10-mile EPZ. Comprehensive emergency planning for the protection of all persons within the 10-mile EPZ, as addressed in Section 13.3 of this SER, would include those persons within the LPZ. Based on the information the applicant presented on this subject, and on the staff's conclusions discussed in Section 13.3 of this SER, the staff concludes that appropriate protective measures could be taken on behalf of the enclosed populace within the LPZ in the event of a serious accident.

2.1.3.4 Conclusions

As set forth above, the applicant has provided an acceptable description of current and projected population densities in and around the site. These densities projected at the time of initial plant operation (if one were to be constructed on the site), and within about 5 years thereafter, are within the guidelines of Regulatory Position C.4 of RG 4.7. The applicant has properly specified the LPZ and population center distance. The staff finds that the proposed LPZ and population center distance meet the definitions in 10 CFR 100.3. Therefore, the staff concludes that the applicant's population data and population distribution are acceptable and meet the requirements of 10 CFR 52.17 and 10 CFR Part 100. In Chapter 15 of this SER, the staff documents that the radiological consequences of bounding DBAs at the outer boundary of the LPZ meet the requirements of 10 CFR 52.17.

2.2 Nearby Industrial, Transportation, and Military Facilities

2.2.1–2.2.2 Identification of Potential Hazards in Site Vicinity

For its ESP application, the applicant provided information on the relative location and separation distance of the site from industrial, military, and transportation facilities and routes. Such facilities and routes include air, ground, and water traffic; pipelines; and fixed manufacturing, processing, and storage facilities. Section 2.2 of the SSAR presents information concerning the industrial, transportation, and military facilities in the vicinity of the proposed ESP site. The NRC staff focused its review on potential external hazards or hazardous materials that are present or which may reasonably be expected to be present during the projected lifetime of a nuclear power plant(s) that might be constructed on the proposed site. The staff has prepared Sections 2.2.1–2.2.2 and 3.5.1.6 of this SER in accordance with the procedures described in RS-002 using information presented in SSAR Section 2.2, responses to staff RAIs, and the reference materials described in the applicable sections of RS-002.

2.2.1.1–2.2.2.1 Technical Information in the Application

In SSAR Section 2.2, the applicant presented information concerning the industrial, transportation, and military facilities in the vicinity of the proposed ESP site. The applicant further stated that the proposed site is located in Claiborne County, Mississippi, which is a rural and agricultural area where forest products are the leading industry. In Section 2.2.1 of the SSAR, the applicant stated that no military installations, industrial facilities, mining operations, or airports exist within 5 miles of the ESP site. Table 2.2-6 of the SSAR details the location of commercial or municipal airports in the wider region around the ESP site. The applicant stated that the Mississippi River passes 1.1 miles west of the proposed ESP facility location, and State Route 61 passes within 4.75 miles of the ESP site. The applicant also identified several airports in the region, located from 11 to 65 miles from the ESP site, as well as two commercial airways, V245 and V417, that cross the wider region around the ESP site. Airway V245 passes closest to the ESP site, about 10 miles to the southeast.

In Section 2.2.2.1 of the SSAR, the applicant stated that the closest operating industrial facilities are located 6 miles to the southeast of the ESP site in southeast Port Gibson. In Section 2.2.2.2 and Table 2.2-4 of the SSAR, the applicant reported the amount of hazardous chemicals transported by river in 2000. The applicant also discussed the operation of Port Claiborne, a small barge port at river mile 404.8, used for shipping forest and agricultural products. In SSAR Table 2.2-5, the applicant detailed the storage of hazardous chemicals at the GGNS site, including significant volumes of gaseous and liquid hydrogen, sulfuric acid, and diesel fuel, among other substances. In SSAR Table 2.2-3, The applicant identified the shipments of hazardous materials on State Route 61.

Section 2.2.2.3 of the SSAR described a 4-inch natural gas underground pipeline that passes as close as 4.75 miles to the east of the ESP site. No other pipelines are located within 5 miles of the ESP site. In SSAR Section 2.2.2.4, the applicant noted that Mississippi River water would be withdrawn at river mile 406 for many uses, including cooling tower and service water cooling system makeup. In Section 2.2.2.6 of the SSAR, The applicant stated that there are no plans at this time for industrial expansion or development in the ESP site vicinity or for hazardous materials handling industries within 50 miles of the ESP site.

2.2.1.2–2.2.2.2 Regulatory Evaluation

In SSAR Section 2.2, the applicant identified the following applicable NRC guidance regarding potential hazards in the vicinity of the proposed ESP site:

- RG 1.91, Revision 1, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plant Sites," issued February 1978

- RG 1.78, Revision 1, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Chemical Release," issued December 2001

- RG 1.70

In SSAR Section 2.2, the applicant referenced the GGNS Updated Final Safety Analysis Report (UFSAR). The staff considered the following regulatory requirements in reviewing information regarding potential site hazards that could affect the safe design and siting of a nuclear power plant(s) falling within the applicant's PPE that might be constructed at the proposed site:

- 10 CFR 52.17(a)(1)(vii), with respect to information on the location and description of any nearby industrial, military, or transportation facilities and routes

- 10 CFR 100.20(b), with respect to information on the nature and proximity of human-related hazards

- 10 CFR 100.21(e), with respect to the evaluation of potential hazards associated with nearby transportation routes and industrial and military facilities

The following RGs identify methods acceptable to the NRC staff to meet the Commission's regulations identified above:

- RG 1.91
- RG 1.78

Sections 2.2.1–2.2.2, 2.2.3, and 3.5.1.6 of RS-002, as well as RG 1.70, provide guidance on the information appropriate for identifying, describing, and evaluating potential manmade hazards.

2.2.1.3–2.2.2.3 Technical Evaluation

The staff evaluated the potential for manmade hazards in the vicinity of the proposed ESP site by reviewing (1) the information provided by the applicant in SSAR Section 2.2.1–2.2.2, (2) the applicant's responses to the staff's RAIs, (3) information obtained during a visit to the proposed ESP site and its vicinity, and (4) other publicly available reference material, including topographic maps (see DeLorme, *Louisiana Atlas and Gazetteer*, issued 2003, and *Mississippi Atlas and Gazetteer*, issued 1998), airport data (see GCR and Associates, "5010: Airport Summary and Activity Data," which includes 2004 data from the Federal Aviation Administration

(FAA) National Flight Data Center), aerial imagery (see Topozone 2004), and geographic information system coverage files (see the Platts POWERmap GIS spatial data, issued 2004, which include map layers depicting natural gas pipelines, railroads, and electric transmission lines).

The staff reviewed the applicant's identification of potential hazards in the vicinity of the ESP site and finds that potential hazards exist from the onsite storage of hazardous and explosive materials at GGNS. The applicant identified a potential hazard in the river water intake, disruption of which could potentially affect plant operations. Section 3.5.1.6 of the SER describes the evaluation of aircraft hazards, and SER Section 2.2.3 evaluates all other manmade hazards.

2.2.1.4–2.2.2.4 Conclusions

As set forth above, the applicant provided information in the SSAR on potential site hazards, in accordance with the requirements of 10 CFR 52.17 and the guidance of RG 1.70, thereby allowing the staff to evaluate the applicant's compliance with the requirements of 10 CFR 100.20, "Factors to be Considered When Evaluating Sites," and 10 CFR 100.21, "Non-Seismic Site Criteria." The staff reviewed the nature and extent of activities involving potentially hazardous materials that are conducted at industrial, military, and transportation facilities located near the ESP site to identify any potential hazards from such activities that might pose an undue risk to the type of facility proposed under this ESP. Figure 2.2-1 of the SER illustrates the locations of such facilities in reference to the ESP site. On the basis of its evaluation of the SSAR, as well as information obtained independently, the staff concludes that the applicant has identified all potentially hazardous activities on and in the vicinity of the site.

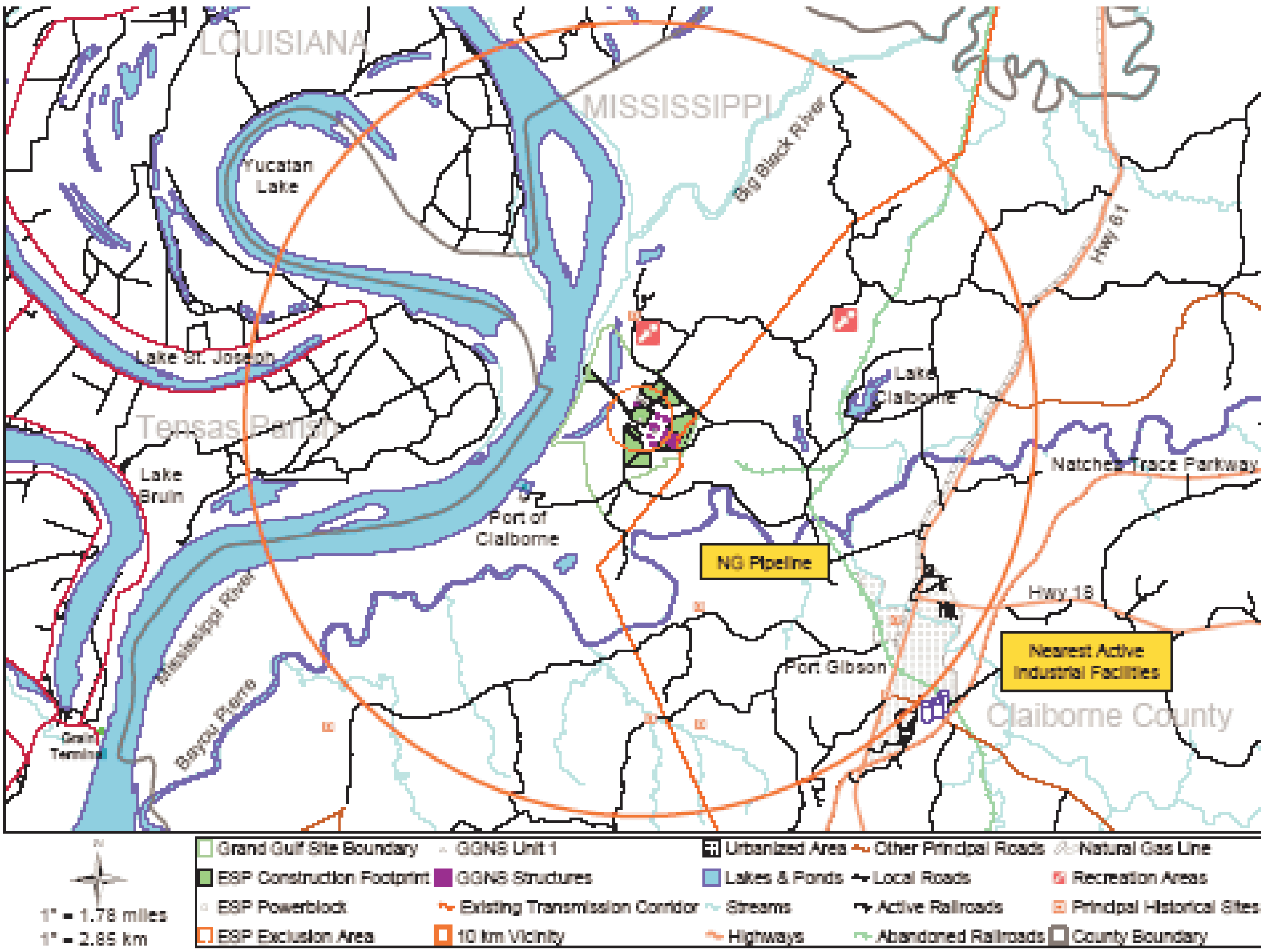

Figure 2.2-1 Industrial, military, and transportation facilities near the GGNS ESP site

2.2.3 Evaluation of Potential Accidents

In SSAR Section 2.2.3, the applicant identified potential accident situations on and in the vicinity of the ESP site. The staff reviewed this information to determine its completeness, as well as the bases upon which these potential accidents may need to be considered in the design of a nuclear power plant(s) that might be constructed on the proposed site (see SER Section 2.2.1–2.2.2).

The applicant elected to use the PPE approach for analyzing potential accidents. As such, it has not determined the specific design of the ESP facility, including control room habitability systems. Some potential accidents on or in the vicinity of the ESP site may have the ability to affect control room habitability (e.g., toxic or asphyxiating gases). The design of the actual facility that might be constructed on the proposed site must address those accidents that are to be accommodated on a design basis (as determined through a review conducted using Section 2.2.3 of RS-002). The staff will review these potential accidents at the COL stage using the guidance in Section 6.4 of NUREG-0800, Revision 3, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," issued July 1981 (also referred to as the Standard Review Plan (SRP)).

The staff reviewed the applicant's analyses of the probability of potential accidents involving hazardous materials or activities on and in the vicinity of an ESP facility that might be constructed on the proposed site to determine whether these analyses used the appropriate data and analytical models. The staff also reviewed the analyses of the consequences of accidents involving nearby industrial, military, and transportation facilities to determine if any should be identified as design-basis events (DBEs).

2.2.3.1 Technical Information in the Application

Section 2.2.3 of the SSAR presents information concerning potential accidents, including flammable vapor clouds, toxic chemicals, fires, collisions with the intake structure, and liquid spills. With one exception, the applicant found that the separation distances between the ESP site and the potential hazards identified in Section 2.2.1–2.2.2 of the SSAR are large enough that the effects of potential accidents would not affect the safety-related systems of the ESP facility. The exception is with respect to barges carrying hazardous commodities on the Mississippi River, which will be discussed later in this section as well as in Technical Evaluation, Section 2.2.3.3.

In SSAR Section 2.2.3.1.1, the applicant stated that, because of the separation distance between the closest point of State Route 61 and the ESP site (4.5 miles), under the conservative assumption of an accident involving delayed detonation of a flammable vapor cloud, the peak reflected pressure would be well below 1 pound per square inch (psi) at the ESP site.

The applicant determined that the separation distance between the 4-inch, 225-psi natural gas line and the ESP site (closest approach of 4.75 miles) is great enough that the pipeline would pose no hazard to proposed facilities at the ESP site.

The applicant also evaluated the case of onsite delivery of liquified hydrogen by truck and determined that delivery operations would be separated from the proposed ESP facility by at least 400 feet, which is less than the minimum safe distance of 1285 feet given in R.G. 1.91. However, the applicant estimated the probability of an explosive event in such a case to be 4.1×10^{-7}, which falls below the RG 1.91 threshold for considering trucked liquid hydrogen as a DBE. The applicant also evaluated the effects of onsite storage of 20,000 gallons of liquid hydrogen at the GGNS site. On the basis of analyses performed for the GGNS UFSAR, the applicant reported minimum separation distances of 737 feet for a tank explosion and 1340 feet for a gaseous cloud formation based on a pipe break or leak. The applicant indicated that the proposed ESP powerblock location and the locations of the safety-related systems are beyond these minimum distances.

Section 2.2.3.1.2 of the SSAR describes the applicant’s analysis of potential accidents involving toxic chemicals. The applicant noted that no significant industrial facilities or toxic chemical storage facilities currently exist within 6 miles of the ESP site. In response to staff RAIs, the applicant analyzed toxic chemical hazards using the following guidelines in RG 1.78:

- chemicals transported on routes (including river routes) within a 5-mile radius of the site, at a frequency of 10 or more per year, and with weights outlined in RG 1.78; and

- chemicals stored within 0.3 miles of the control room in quantities greater than 100 pounds.

For the first case above, on the basis of analyses in the UFSAR, the applicant found that the large separation distance between the ESP site and the nearest highway would mitigate any highway transportation accidents involving the release of toxic chemicals. SSAR Table 2.2-4 indicates the amount of hazardous material transported past the ESP site on the Mississippi River in the year 2000. The applicant based its assessment of accidents involving river barges on barge mishap analyses presented in the UFSAR. In addition, the applicant submitted additional analyses that estimated the likelihood of a barge accident leading to an explosion and an overpressure in excess of 1 psi at the proposed site. The applicant also considered fuel fires from barge accidents, chlorine spills, and toxic chemical releases. In the case of gaseous chemical or hot plumes from fuel fires, the applicant stated that the separation distance and topographic barriers are sufficient to eliminate these types of accidents from further consideration. The applicant estimated that the probability of a significant chlorine spill in the river is 1.8×10^{-7} per year.

For the second case, SSAR Table 2.2-5 lists the hazardous materials stored at GGNS. The specific chemicals to be stored at the ESP facility are not currently known and will be evaluated at the time of the COL application. The applicant relied on the GGNS UFSAR to postulate the explosion of an underground diesel fuel storage tank at GGNS, concluding that, because of plume rise from fire conditions, the control room habitability systems would be affected only if extreme wind events accompanied the explosion. The UFSAR analysis of hazards from other stored chemicals at GGNS resulted in estimated concentrations affecting control room habitability that are within RG 1.78 limits. The applicant also found, on the basis of analyses in the GGNS UFSAR, that a hydrogen or oxygen release from the GGNS hydrogen water chemistry system would not adversely affect control room habitability.

In SSAR Section 2.2.3.1.3, The applicant stated that forest fires originating locally from accidents could produce a maximum concentration of 45 pounds of particulate matter per ton and that the toxicity of such fires falls well below the acceptable limits for the GGNS control room air intake system. In SSAR Section 2.2.3.1.4, the applicant noted that the water intake structure in the Mississippi River is positioned away from the shipping channel, and that it did not consider ship impact a DBE. In Section 2.2.3.1.5 of the SSAR, the applicant found that chemical spills in the river could force the shutdown of the water intake of the ESP facility and thus the shutdown of the ESP facility itself. Such an event would require spilling toxic chemicals that would sink below the river surface and reach the water intake. The applicant stated that it will develop appropriate procedures to ensure safe shutdown in the event that raw water makeup is unavailable.

The applicant found that some commodities being shipped by barge on the Mississippi River past the site may exceed the R.G. 1.91 criterion of 1 psi overpressure due to insufficient separation distance between the potential explosions of hazardous substances and the proposed site. However, the applicant claimed there was sufficient reduction in overpressure due to the existence of a 65-foot elevation bluff between the river and the proposed site. The applicant submitted a revised analysis of the explosion hazards associated with barge shipments of hazardous cargoes on the Mississippi River. The revision was in response to the staff's view that there was insufficient quantitative evidence for the overpressure reduction that could be credited to the existence of a 65-foot elevation bluff between the river and the proposed site. The revised analysis was based on a best estimate assessment of hazardous cargo shipments in terms of quantities, shipping frequencies, barge accident rates, and the estimation of potential explosion overpressures of specific commodities. The latter included modeling of on-board confined explosions as well as vapor cloud formation ensuing a spill leading to ignition and an explosion. The applicant's analysis indicates that the likelihood of a barge mishap leading to an explosion that could exceed 1 psi overpressure at the proposed site is on the order of 10^{-8} per year.

2.2.3.2 Regulatory Evaluation

In SSAR Section 2.2, The applicant identified the following applicable NRC guidance regarding potential hazards in the vicinity of the proposed ESP site:

- RG 1.91
- RG 1.78
- RG 1.70

In SSAR Section 2.2, the applicant referenced the GGNS UFSAR and RG 1.70. The staff considered the following regulatory requirements in its review of information regarding potential accidents that could affect the safe design and siting of a nuclear power plant(s) falling within the applicant's PPE that might be constructed at the proposed site:

- 10 CFR 52.17(a)(1)(vii), with respect to information on the location and description of any nearby industrial, military, or transportation facilities and routes

- 10 CFR 100.20(b), with respect to information on the nature and proximity of human-related hazards

- 10 CFR 100.21(e), with respect to the evaluation of potential hazards associated with nearby transportation routes and industrial and military facilities

The following RGs identify methods acceptable to the NRC staff to meet the Commission's regulations identified above:

- RG 1.91
- RG 1.78

Sections 2.2.1–2.2.2, 2.2.3, and 3.5.1.6 of RS-002, as well as RG 1.70, provide guidance on the information appropriate for identifying, describing, and evaluating potential accidents.

2.2.3.3 Technical Evaluation

The staff evaluated potential accidents in the vicinity of the proposed ESP site by reviewing (1) the information provided by the applicant in SSAR Section 2.2.3, (2) the applicant's responses to staff RAIs, (3) information obtained during a visit to the proposed ESP site and its vicinity, and (4) other publicly available reference material, including topographic maps (see DeLorme 2003 and *Mississippi Atlas and Gazetteer* 1998), airport data (see GCR and Associates), aerial imagery (Topozone 2004), and GIS coverage files (see the Platts POWER map GIS spatial data, 2004).

Section 2.2.1–2.2.2 of this SER describes potential hazards that might be identified in the future in association with a currently vacant industrial development in Claiborne County Port, just south-west of the ESP site.

The staff reviewed the applicant's analysis of the effects of potential explosions and the formation of flammable vapor clouds. Using the guidance provided in RG 1.91, the staff found that the distance of U.S. Highway 61 is sufficiently far from the potential ESP facility that no significant damage is expected with respect to safety-related SSCs that may be located on the ESP site for the worst-case truck-tank explosion accident scenario.

Table 2.2-4 of the SSAR characterizes the type of commodities typically transported on the Mississippi River by listing specific hazardous materials and quantities. The hazards posed by these materials are potential explosions, fires, or the release of airborne gases that are toxic.

The proposed ESP site would be about 1.1 miles from the nearest bank of the river. At this distance, an explosion of a 5000 ton TNT-equivalent charge (representing a bounding quantity of explosive cargo) would produce a peak positive normal reflected pressure of about 4 psi. On this basis, the hazardous cargo explosion hazard exceeds the acceptance criteria of RG 1.91. The applicant initially postulated an overpressure reduction due to the existence of a 65-foot elevation bluff between the river and the proposed site. However, there was insufficient basis for quantifying this effect. Hence, the applicant submitted additional analyses that estimated the likelihood of exceeding a 1 psi overpressure at the proposed site on the basis of actual shipment quantities and shipping frequencies.

The revised analyses considered available historical data on barge shipments on the Mississippi River in terms of type of hazardous commodities, quantities, and shipping frequencies. In estimating the likelihood of a barge mishap leading to a spill and explosion that would exceed 1 psi at the proposed site, the applicant estimated the likelihood of a major spill in the event of a barge mishap, as well as the probability of an explosion given a spill. Specifically, for each identified hazardous commodity the applicant evaluated the likelihood of a series of sequential events (i.e., barge mishap, spill, and an explosion leading to an overpressure at the proposed site in excess of 1 psi). Explosion modeling included consideration of confined explosions at the mishap site as well as vapor cloud formation and subsequent ignition. The applicant estimated the total probability of exceeding a 1 psi overpressure at the proposed site to be on the order of magnitude of 10^{-8} per year.

In estimating the likelihood of spill frequencies and explosion probabilities the applicant's analyses used some assumptions that are difficult to verify. Hence, the staff did a confirmatory analysis regarding the explosion hazard of barge shipments on the Mississippi River. The staff's confirmatory analysis is described below. The staff used information provided by the applicant, as well as data from independent sources.

With respect to barge mishaps leading to confined onboard explosions, the applicant's analyses indicate that none of the commodities have the potential of exceeding a 1 psi overpressure at the proposed site. The staff reviewed the applicant's analyses of confined explosions. The staff confirmed that the analyses contained the upper bound blast energy potentially available recommended by Regulatory Guide 1.91. The staff also confirmed that the licensee calculated distances from a confined blast to a 1 psi overpressure were less than the 1.1 miles from ESP site to the Mississippi river. Accordingly, the staff finds the analysis to be reasonable. Hence, the staff concludes that potential onboard confined explosions would not pose an undue hazard with respect to the proposed site.

The two other types of explosion hazards identified by the applicant are associated with delayed ignition of an unconfined vapor cloud in the vicinity of the proposed site and unconfined cloud explosions where ignition takes place before the cloud can drift away from the barge mishap site.

With respect to delayed ignition of unconfined vapor clouds, the applicant's analyses identify only one specific commodity, acetylene, that has the potential of exceeding 1 psi overpressure at the proposed site. This commodity is identified by the applicant as a subset of the general category identified as Acyclic Hydrocarbons (Table E-1 of Attachment 1 of the applicant's letter to USNRC - Response to Request for Additional Information Regarding the Grand Gulf Early Site Permit Final Safety Evaluation Report (ADAMS Accession No. ML060760443), dated February 22, 2006). The shipping frequency of Acyclic Hydrocarbons was 14 barges per year in 2003 and 9 barges per year in 2004. To account for possible variations in shipping frequency, the staff conservatively assumed 20 shipments of acetylene per year. An added conservatism is that acetylene is only a subset of this group of commodities (that is, not every shipment of Acyclic Hydrocarbons contains acetylene). An independent study of barge accident rates (Saricks, C., and T. Kvitek, 1994, "Longitudinal Review of State-Level Accident Statistics for Carriers of Interstate Freight, ANL-ESD/TM-68) shows barge accident rates for inland waterways and the Mississippi River to be about 3.9×10^{-6} accidents per mile. On this basis, the staff assumed an order-of-magnitude rate of 10^{-5} mishaps per river mile for the barge mishap rate.

With respect to the likelihood of a spill in the event of a mishap, the applicant has presented U.S. Coast Guard data (Ref. 37 in the applicant's SERI letter to USNRC - Response to Request for Additional Information Regarding the Grand Gulf Early Site Permit Final Safety Evaluation Report (ADAMS Accession No. ML060760443), dated February 22, 2006, on spill frequency of combustible materials on the Mississippi River. Page 24, Equation 1 and Figure H-1 in the applicant's analyses present a linear curve fit for the spill frequency versus spill size. Using the maximum barge capacity of 4260 tons of acetylene, the spill frequency is estimated from Equation 1 to be about 1.98×10^{-5} spills/river mile-year. Also, using the same U.S. Coast Guard data, the applicant estimates the mishap rate for barges on the Mississippi in the vicinity of the proposed site to be about 0.009 collisions/river mile-year. The staff estimated the spill rate per mishap from the ratio of these two quantities, that is

$$\frac{1.98 \times 10^{-5} \dfrac{spills}{river\ mile - year}}{0.009 \dfrac{collisions}{river\ mile - year}} = 2.20 \times 10^{-3} \frac{spills}{collision}$$

The applicant estimates the explosion probability as 0.008 explosions per spill on the basis of one reported boiling liquid expanding vapor explosion (BLEVE) on the Mississippi or Ohio Rivers. However, the applicant reduces this value by a factor of ten, yielding a value of 0.0008, on the basis that "there is no evidence that all the fuel detonated in that event." While the possibility that not all the fuel detonated may add to the conservatism in using the 0.008 rate, there is no apparent means of verifying that the factor of ten reduced value of 0.0008 is appropriate. Hence, the staff's analysis assumes the 0.008 rate is applicable. The length of river (referred to as 'at risk length') that needs to be considered is determined by the modelling of a vapor cloud plume and estimating the furthest distance from the site at which a 1 psi overpressure may be exceeded. The applicant estimated the at risk length for acetylene as 2.74 miles.

On the basis of the above, the staff estimated the annual frequency of exceeding 1 psi due to barge mishaps near the proposed site involving the release and an explosion of acetylene to be

$$P \frac{\text{explosions}}{\text{year}} = F_1 \frac{\text{haz. barges}}{\text{year}} * F_2 \frac{\text{mishaps}}{\text{haz. barge - river mile}} * F_3 \frac{\text{spills}}{\text{mishap}} * F_4 \frac{\text{explosions}}{\text{spill}} * L_{\ river\ mile}$$

$$P = (20) * \left(10^{-5}\right) * (2.2E - 3) * (0.008) * (2.74) \cong 1 \times 10^{-8} \frac{\exp losions}{year}$$

With respect to unconfined vapor cloud explosions occurring at the barge mishap location, the applicant's analyses determined that some hazardous commodities that pass the plant have the potential for exceeding a 1 psi overpressure at the proposed site. Based upon the following description of the staff analysis, the staff calculated the probability of an unconfined vapor cloud explosion exceeding 1 psi overpressure at the proposed site. The staff used the results of this calculation to assess the applicant's calculation.

The staff reviewed the applicant's list of identified commodities and confirmed the applicant's calculated values for the distances to yield a 1 psi overpressure at the proposed site. The staff notes that the applicant has not included LNG shipments in the screening analysis on the basis that LNG detonation exceeding 1 psi overpressure at the proposed site, while possible, is not credible on the basis of low likelihood. Specifically, the applicant notes that a) it takes a substantial amount of initiating energy (significantly more, for example, than that associated with a spark) for detonation to occur, and b) transition from deflagration to detonation is unlikely due to relatively slow flame propagation velocities observed even with maximum laboratory induced flame acceleration. The staff agrees that there is no reasonable basis for postulating sources of ignition of sufficient size in the vicinity of the barge or the site. However, the relative likelihood of deflagration transition to detonation for LNG is difficult to assess. Furthermore, explosions other than true detonations may have the potential for significant overpressures. Therefore, in assessing explosion hazards, the staff also considered LNG in addition to the crude petroleum, gasoline, naphtha, acyclic hydrocarbons, benzene and toluene considered by the applicant.

The staff estimated the shipping frequency (F_1) using the maximum yearly frequency for each commodity passing the proposed site during 2003 and 2004. The staff estimated the spill frequency for each of these commodities using the applicant's correlation between spill frequency and spill size.

The staff noted that the applicant’s correlation uses the midpoints of variable spill size bins and midpoint representations for each interval in establishing a linear representation of spill size and frequency. To check the results the applicant obtained using this correlation, the staff determined the spill frequency distribution by constructing a Weibull and a lognormal probability plot of the data provide in Table H-1 of the applicant’s submittal. A comparison of the two approaches indicates that the applicant’s and staff’s approaches produce similar spill frequency estimates. In addition, the staff also checked the validity of the applicant’s model relating the size of the barge and the likelihood of a spill by estimating the spill frequency for a selected spill size. Specifically, the staff calculated the frequency of a 100,000 gallon spill (300 tons at 0.72 specific gravity) using the applicant's model. The staff compared this value to the applicant's review of nine years of U.S. Coast Guard (USCG) Safety Management System data. The staff calculated value of 1.6 spills per year is conservative, with respect to the actual number of 100,000 gallon spills on the Mississippi river (zero spills) during the nine years researched. In view of the above, although the applicant’s correlation is not a valid statistical model, the results are not significantly different from those obtained using a Weibull or lognormal probability distribution.

In applying the applicant’s correlation, the staff used the maximum barge cargo size for each commodity passing the proposed site during 2003 and 2004. The spill rate for each commodity was divided by 0.009 collisions/river mile-year, discussed above, to determine the spill rate per collision (F_2). The staff used the barge mishap rate of 10^{-5} per year (F_3) and the conditional probability of explosion of 0.008 (F_4) discussed above. Finally, the staff determined the length along the river (L) that exposes the plant to a postulated 1 psi overpressure assuming a vapor cloud explosion at the river.

Using the equation above for the estimated annual frequency of exceeding 1 psi due to barge mishaps (P), the staff estimated the probability for each commodity. The total probability of exceeding a 1 psi overpressure, obtained by summing over all of the analyzed commodities, is about 10^{-6} per year.

The staff performed checks of the parameters used to determine this probability. First, the staff determined the sensitivity of the analysis to assumed barge size. The staff performed another calculation assuming the mass of each barge is 70% of the maximum barge size of each commodity. This calculation determined that for this smaller cargo barge, the decrease in river length (exposing the plant to a 1 psi overpressure) approximately offsets the increased likelihood of a smaller spill. Therefore, based upon this calculation, the probability is relatively insensitive to the assumed mass size of the barges.

Lastly, the likelihood of a collision or grounding on the Mississippi river in the area of the proposed site appears to be low as compared to other areas along the river. The applicant stated that the proposed site is adjacent to the river between river mile marker 406 and 407. Except for sedimentation control dikes on the west bank (down river of marker 405), there are no bridges within several miles of the proposed site. The nearest bridges are at Vicksburg and Natchez. The staff concurs with the licensee’s assessment that obstructions create a higher probability of collisions. Quantitatively, this view is supported by the applicant’s review of USCG incident data which indicated that there were no spills events reported for this area of the river in the last four years. Therefore, the staff agrees with the applicant that this area of the river should be exposed to fewer accidents than other areas of the river included in the above analysis.

On the basis of the above analysis, the information provided by the applicant and the staff's calculated total probability of exceeding a 1 psi overpressure of about 10^{-6} per year for all commodities considered above, the staff agrees with the applicant’s conclusions that the explosion hazard due to barge traffic on the Mississippi River meets the acceptance criterion of RS-002 (Chapter 2.2.3, “Evaluation of Potential Accidents," Section II, “Acceptance Criteria”).

With respect to potential fires caused by accidental releases of flammable substances on the river, the staff estimates that the incident thermal flux is sufficiently low so as not to pose a hazard to safety-related structures. Specifically, using the methodology of NUREG/CR-3330, “Vulnerability of Nuclear Power Plant Structures to Large External Fires,” dated August 1983, the staff estimates that the incident thermal flux at 1.1 miles from a large gasoline vapor cloud fire would be less than 5 kilowatts per square meter (kW/m^2). At this thermal flux, the allowable wall exposure time is well in excess of 12 hours in duration. Hence, potential fires caused by accidents on the river do not pose a significant hazard to a plant on the proposed ESP site.

The staff reviewed the applicant’s analysis of potential toxic chemical accidents. The applicant used the UFSAR inventory of toxic chemicals in its analysis. The staff notes that the principal commodities posing a potential hazard are shipments of anhydrous ammonia and chlorine. The applicant analyzed the potential for the release of these chemicals for GGNS and found the estimated toxicity levels at the control room to be acceptably low. However, the staff finds that, since the PPE does not specify a control room design, it cannot make a determination with respect to control room habitability in the event of a toxic chemical accident at the site or in its vicinity. Accidents involving such materials cannot be evaluated for the ESP facility at the ESP stage without a specific set of plant design parameters. Therefore, the staff will evaluate such accidents at the COL application stage. This is **COL Action Item 2.2-1**.

2.2.3.4 Conclusions

As set forth above, the applicant identified potential accidents related to the presence of hazardous materials or activities on or near the proposed ESP site that could affect a nuclear power plant(s) falling within the applicant's PPE. The staff finds that the applicant selected those potential accidents that should be considered as DBEs at the COL stage, in accordance with 10 CFR Part 100. The applicant identified and evaluated hazards from nearby facilities and the staff concludes that such facilities pose no undue risk to the type of facility proposed for the site, subject to confirmation at the COL stage regarding design-specific hazard interactions. Therefore, the staff concludes that the ESP site location is acceptable with regard to potential accidents that could affect such a facility or facilities built on the site, and that it meets the requirements of 10 CFR 52.17(a)(1)(vii), 10 CFR 100.20(b), and 10 CFR 100.21(e).

2.3 <u>Meteorology</u>

To ensure that a nuclear power plant or plants could be designed, constructed, and operated on an applicant's proposed ESP site in compliance with the Commission's regulations, the NRC staff evaluates regional and local climatological information, including climate extremes and severe weather occurrences that may affect the design and siting of a nuclear plant. The staff reviews information concerning the atmospheric dispersion characteristics of a nuclear power plant site to determine whether the radioactive effluents from postulated accidental releases, as well as routine operational releases, are within Commission guidelines. The staff has prepared Sections 2.3.1 through 2.3.5 of this SER in accordance with the review procedures described in RS-002, using information presented in SSAR Section 2.3, responses to staff RAIs and open items, and generally available reference materials, as described in the applicable sections of RS-002.

2.3.1 Regional Climatology

2.3.1.1 Technical Information in the Application

In Section 2.3.1 of the SSAR, the applicant presented information concerning the averages and the extremes of climatic conditions and regional meteorological phenomena that could affect the design and siting of a nuclear power plant that falls within the applicant's PPE and that might be constructed on the proposed site. Specifically, the applicant provided the following information:

- a description of the general climate of the region 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, and sleet), and relationships between synoptic-scale atmospheric processes and local (site) meteorological conditions

- seasonal and annual frequencies of severe weather phenomena, including tornadoes, thunderstorms, lightning, hail (including probable maximum size), and high air pollution potential

- meteorological site characteristics to be used as minimum design and operating bases, including the following:

  — the maximum snow and ice load (water equivalent) on the roofs of safety-related structures

  — the ultimate heat sink (UHS) meteorological conditions resulting in the maximum evaporation and drift loss of water and minimum water cooling

  — the tornado parameters, including translational speed, rotational speed, and the maximum pressure differential with the associated time interval

  — the 100-year return period straight-line winds

  — other meteorological conditions to be used for design- and operating-basis considerations

The applicant characterized the regional climatology pertinent to the Grand Gulf ESP site using data reported by the National Weather Service (NWS) at the Vicksburg, Mississippi, and Jackson, Mississippi, first-order weather stations, as well as the Port Gibson, Mississippi, cooperative observer station. The applicant also used data recorded by the GGNS onsite meteorological tower. The applicant considered the Vicksburg and Jackson weather stations to be representative of the climate at the Grand Gulf ESP site because of topographic considerations and their proximity to the site. Since Vicksburg is the closer of the two stations and borders the Mississippi River, the applicant based the climatic summaries primarily on Vicksburg data when the period of record and observational procedures were considered adequate. Otherwise, it presented Jackson data. The applicant also obtained information on severe weather, including extreme conditions, from a variety of sources, such as publications by the National Climatic Data Center (NCDC), the Structural Engineering Institute (SEI), the American Society of Civil Engineers (ASCE), and the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

The Grand Gulf ESP site is located in the southwest climatic division of Mississippi. The applicant described the climate as humid and subtropical with a short cold season and a relatively long warm season. The predominant air mass over the region during most of the year is maritime tropical with origins over the Gulf of Mexico. In the winter, occasional southward movements of continental polar air from Canada bring colder and drier air into Mississippi. However, cold spells seldom last more than 3 or 4 days.

The applicant noted that the westward extension of the Bermuda High, a subtropical, semipermanent anticyclone, dominates the region in summer. The prevailing southerly winds provide a generous supply of moisture, and this, combined with thermal instability, produces frequent afternoon and evening showers and thundershowers over the region. The convective thundershowers of the summer season are more numerous than the frontal-type thunderstorms. However, the thunderstorms associated with the occasional polar front activity in late winter and early spring are more severe, sometimes producing tornadoes.

The applicant stated that Mississippi is south of the average track of winter cyclones, but occasionally one moves over the State. In some winters, a succession of such cyclones will develop in the Gulf of Mexico or in Texas and move over or near the State. Mississippi is also occasionally in the path of tropical storms or hurricanes.

The applicant noted that, for the most part, the general synoptic conditions predominate with regard to the climactic characteristics of the site region. However, the applicant considered the Vicksburg humidity data to be more appropriate for site estimates than the Jackson data, because of Vicksburg's proximity and similar location relative to the Mississippi River. A slight tendency exists for lower level winds at the Grand Gulf ESP site to be channeled along the Mississippi River.

The applicant stated that the general airflow over the Grand Gulf ESP site region is from the southerly sectors during much of the year, although the prevailing direction may be from one of the northerly sectors during some months. The average wind speed at the Grand Gulf ESP site ranged from 3.7 miles per hour (mi/h) to 4.4 mi/h between 1996 and 2003, whereas the average wind speed at Vicksburg ranged from 7.0 mi/h to 7.6 mi/h between 1997 and 2003.

Revision 0 of the SSAR presented various dry-bulb and wet-bulb temperature statistics for Jackson, Vicksburg, and the GGNS site. These statistics included 97.75 and 99 percent maximum summer exceedance dry-bulb and wet-bulb temperatures and 97.75 and 99 percent minimum winter exceedance dry-bulb temperatures. The applicant based the percentage exceedances on the summer months of June through September (2928 total hours) and the winter months of December through February (2160 total hours). In RAI 2.3.1-5, the staff asked the applicant to provide various dry-bulb and wet-bulb temperature statistics based on annual exceedances (for example, the dry-bulb temperatures that will be exceeded no more than 2.0 and 0.4 percent of the time annually). By doing so, these data will be more consistent with the recent ASHRAE design guidelines, "2001 ASHRAE Handbook—Fundamentals," issued July 2001, for the design of heating, ventilation, air-conditioning, and dehumidification equipment.

In response to RAI 2.3.1-5, the applicant provided the requested temperature and humidity statistics, including the historic highest and lowest dry-bulb temperatures (107 EF and !5 EF, respectively) recorded at Jackson during the 108-year period 1896–2003. The applicant used these historic dry-bulb temperatures to represent 100-year return period temperatures for the Grand Gulf ESP site. The staff found a higher temperature, 110 EF, that was recorded at Vicksburg (August 31, 2000) during the 38-year period 1967–2004, and a lower temperature, !8 EF, that was recorded at St. Joseph, Louisiana (January 27, 1940), during the 72-year period 1930–2001. In Open Item 2.3-1, the staff stated that the applicant had not conservatively identified the historic highest and lowest dry-bulb temperatures recorded in the Grand Gulf ESP site region for use as the 100-year return period temperatures.

In its submittal dated June 21, 2005, the applicant responded to Open Item 2.3-1 by statistically generating 100-year return period temperatures (108 EF and !6 EF) using data recorded at Port Gibson during the 73-year period 1930–2001. The applicant proposed using the 108 EF and !6 EF values as the 100-year return period temperature site characteristics. The applicant also noted that the maximum and minimum temperatures recorded at Port Gibson during this same period were 105 EF and !6 EF, respectively. The applicant discussed this information in Section 2.3.2.1.2 of Revision 2 to the SSAR.

Table 2.3.1-1 presents the applicant's proposed ambient air temperature and humidity site characteristics.

Table 2.3.1-1 Applicant's Proposed Ambient Air Temperature and Humidity Site Characteristics

SITE CHARACTERISTIC		VALUE
Maximum Dry-Bulb Temperature	98% annual exceedance	92 EF
	99.6% annual exceedance	95 EF
	average of annual highest	98 EF
	100-year return period	108 EF
Minimum Dry-Bulb Temperature	99% annual exceedance	25 EF
	99.6% annual exceedance	21 EF
	average of annual lowest	14 EF
	100-year return period	!6 EF
Maximum Wet-Bulb Temperature	98% annual exceedance	78 EF
	99.6% annual exceedance	80 EF

Using the exceedance criteria in Table 2.3.1-1, the applicant also evaluated the GGNS site 2000–2003 dry-bulb and 2001–2003 wet-bulb temperature data and found that the site values generally match the Jackson values, except that the minimum dry-bulb temperatures reported for Jackson are several degrees cooler than the compatible minimum dry-bulb temperatures reported for GGNS. The applicant attributed the slightly warmer GGNS minimum dry-bulb temperatures to the mitigating effects of the Mississippi River at the GGNS site.

The applicant reported that the relative humidity in the Grand Gulf ESP site region is high throughout the year, with an annual average relative humidity of approximately 75 percent recorded at Vicksburg during the period 1997–2001. The highest relative humidities occur in the early morning hours (00:00–06:00) during the summer (June–August), averaging more than 90 percent. The lowest relative humidities occur during the afternoon hours (12:00–18:00) in the autumn (September–November), averaging less than 55 percent.

The applicant reported that, while snowfall is not of much economic importance, it is not a rare event in Mississippi. During the 65 years from 1898–1957 and 1997–2001, measurable snow or sleet fell on some part of the State in all but 3 years. Along the latitude of the site (about 32E N), snow fell during approximately 30 percent of the years.

According to the applicant, 117 hurricanes affected the Middle Gulf Coast (Florida, Alabama, Mississippi, Louisiana, and Texas) during the period 1899–2000. Table 2.3.1-2 presents the storm classifications and respective frequencies of these hurricane occurrences over this period.

Table 2.3.1-2 Frequency of Hurricanes for the States of Florida, Alabama, Mississippi, Louisiana, and Texas from 1899–2000

CLASSIFICATION	NUMBER OF OCCURRENCES	MAXIMUM SUSTAINED WIND SPEED RANGE
Category 5 Hurricane	2	> 155 mi/h
Category 4 Hurricane	10	131–155 mi/h
Category 3 Hurricane	36	111–130 mi/h
Category 2 Hurricane	30	96–110 mi/h
Category 1 Hurricane	39	74–95 mi/h

Tropical storms, including hurricanes, lose strength as they move inland from the coast. Typically, the greatest concern for an inland site, such as the Grand Gulf ESP site, is possible flooding resulting from excessive rainfall. As an example, the applicant reported that the small-diameter, extremely intense hurricane Camille (August 1969) had top winds estimated at more than 170 mi/h at the coast, but, as the center passed less than 10 miles to the east of Jackson, it only generated gusts of 67 mi/h at Jackson.

The applicant reported that a total of 108 tornadoes touched down in the vicinity of Claiborne, Warren, and Hinds Counties in Mississippi and Tenasa Parish in Louisiana from 1950 to April 2002. The applicant used these data to calculate a tornado mean recurrence interval of 2860 years. The applicant also noted that a highly destructive tornado struck Vicksburg in December 1953, and a tornado struck the GGNS site while the plant was under construction in April 1978.

The applicant estimated that, on average, 66 thunderstorm-days occur per year in the site area, resulting in an estimated 33 lightning flashes to earth per square mile per year. Hail often accompanies severe thunderstorms and can be a major weather hazard, causing damage to crops and property. The applicant reported that 279 hailstorms occurred in the region (Claiborne, Warren, and Hinds Counties in Mississippi and Tenasa Parish in Louisiana) from 1955 through April 2002. Property damage occurred infrequently, with only 26 events recorded during this period.

Large-scale episodes of atmospheric stagnation are not common in the site region. The applicant noted that 36 cases of 4 days or more of atmospheric stagnation over southwest Mississippi were reported in the 35-year period from 1936–1970.

The applicant indicated that three ice storms and one heavy snowstorm were reported in the three counties and one parish around the Grand Gulf ESP site for 1993–2001. From these data, the applicant estimated that the frequency of ice storms in the Grand Gulf ESP site area is 4 storms in 8 years or 0.5 per year.

The applicant stated that the occurrence of dust, blowing dust, or blowing sand is a comparatively rare phenomenon in the Grand Gulf ESP site area. Vicksburg did not record any hours of blowing dust or blowing sand in the period 1997–2001. However, Jackson reported 33 hours of blowing dust during the period 1955–1964. Using the Jackson data, the percent frequency of occurrence of dust, blowing dust, or blowing sand is 0.04.

In Revision 0 of the SSAR, the applicant estimated a 100-year return period snowpack of 11 inches based on historic maximum regional snowfall data. Using a conservative estimate of 0.20 inches of water per inch of snowpack, the applicant estimated that the water equivalent of the 100-year return period snowpack of 11 inches is 2.2 inches of water, which equals a weight of 11.44 lbf/ft^2. In its submittal dated June 21, 2005, the applicant revised its estimated weight of the 100-year return period snowpack to 6.1 lbf/ft^2, based on SEI/ASCE 7-02, "Minimum Design Loads for Buildings and Other Structures," issued 2002, and the maximum 24-hour snowfall of 10.6 inches reported for Jackson for a recent 83-year data period. Because snow melts and/or evaporates quickly, usually within 48 hours and before additional snow is added, the applicant believes that the Jackson maximum 24-hour snowfall is indicative of the 100-year return period snowpack.

In Revision 0 of the SSAR, the applicant estimated the weight of the 48-hour probable maximum winter precipitation (PMWP) as 36.4 lbf/ft^2, based on 7.0 inches (water equivalent) of precipitation. The figure of 7.0 inches of precipitation represents a 100-year return period value derived by the applicant using a statistical extrapolation of the maximum 48-hour winter (November–March) precipitation values reported each year at Jackson during the period 1960–1975.

In Open Item 2.3-2, the staff stated that the applicant had not provided an appropriate 48-hour PMWP value that can be used to define the extreme winter precipitation roof loads. As discussed in the staff's branch position on winter precipitation loads (see memorandum from H.R. Denton to R.R. Maccary, dated March 24, 1975), the 48-hour PMWP should be developed in accordance with the guidance provided in the National Oceanic and Atmospheric Administration (NOAA) hydrometeorological reports (HMRs) (e.g., HMR 53, "Seasonal Variation of 10-Square Mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," issued April 1980). In its submittal dated June 21, 2005, the applicant responded to Open Item 2.3-2 by identifying a 48-hour PMWP value of 35 inches of rainwater based on HMR 53. However, the applicant contended that because this PMWP is in the form of rainfall, it would not remain on rooftops. Instead, the applicant proposed a 48-hour "frozen" PMWP value of 1.9 inches of frozen precipitation (equivalent to 9.9 lbf/ft^2), based on a 100-year return period frozen precipitation value that was statistically extrapolated by the applicant from four ice storms recorded in nearby counties and parishes during the 11-year period 1993–2003.

In the same June 21, 2005, submittal, the applicant proposed defining the snow load for extreme live loads to be considered for roof structural design purposes as 16 lbf/ft^2, which represents the sum of the 100-year return period snowpack (6.1 lbf/ft^2) and the 48-hour frozen PMWP (9.9 lbf/ft^2).

Table 2.3.1-3 presents the applicant's proposed snow load site characteristics.

Table 2.3.1-3 Applicant's Proposed Snow Load Site Characteristics

SITE CHARACTERISTIC	VALUE	DESCRIPTION
48-Hour PMWP (Rainfall)	35 inches of rainfall	The 48-hour 10-square-mile probable maximum winter-month precipitation from HMR 53
48-Hour PMWP (Frozen)	1.9 inches of ice	The 48-hour probable maximum frozen winter precipitation
100-Year Snowpack	6.1 lbf/ft^2	Weight, per unit area, of the 100-year return period snowpack
Extreme Live Winter Precipitation Load	16 lbf/ft^2	The combination of the 48-hour probable maximum frozen winter precipitation and the 100-year snowpack (to be used in determining extreme winter precipitation loads for roofs)

According to the applicant, the wet-bulb temperature and the coincident dry-bulb temperature are the controlling parameters for the type of UHS it selected (e.g., mechanical draft cooling towers with water storage basins). The applicant calculated the worst 1-, 5-, and 30-day daily average wet-bulb temperatures and coincident dry-bulb temperatures as UHS site characteristic values.

Revision 0 of the SSAR presented UHS meteorological site characteristic values for maximum evaporation and minimum water cooling based on wet-bulb and dry-bulb temperatures recorded at Jackson during the period 1948–1975. In RAI 2.3.1-3, the staff noted that the SSAR states that Vicksburg humidity data are considered to be more appropriate for site estimates than the Jackson data because of the proximity and similar location relative of the Mississippi River. Therefore, the staff asked the applicant to use temperature and humidity data from Vicksburg to determine the site characteristics for evaluating UHS performance. In its response to this RAI, the applicant examined temperature and humidity data from Jackson (1948–1975), Vicksburg (July 1996–December 2000), and the GGNS onsite meteorological monitoring program (2001–2003) to determine bounding meteorological design conditions for the UHS in accordance with RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," issued January 1976. Table 2.3.1-4 presents these results.

In Open Item 2.3-3, the staff identified the need for an additional UHS meteorological site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility, a phenomenon which would reduce the amount of water available for used by the UHS. In its submittal dated June 21, 2005, the applicant responded to Open Item 2.3-3 by proposing a cumulative degree-day below freezing site characteristic value of 98 EF degree days (i.e., 98 accumulated freezing degree days), based on the worst case freezing spell recorded at Port Gibson for the period 1930–2001.

Table 2.3.1-4 Applicant's Proposed UHS Site Characteristics

SITE CHARACTERISTIC	VALUE
Worst 1-Day Daily Average of Wet-Bulb Temperatures and Coincident Dry-Bulb Temperatures	81.0 EF wet-bulb temperature with coincident 86.3 EF dry-bulb temperature
Worst 5-Day Daily Average of Wet-Bulb Temperatures and Coincident Dry-Bulb Temperatures	80.2 EF wet-bulb temperature with coincident 86.2 EF dry-bulb temperature
Worst 30-Day Daily Average of Wet-Bulb Temperatures and Coincident Dry-Bulb Temperatures	78.5 EF wet-bulb temperature with coincident 83.1 EF dry-bulb temperature
Worst Accumulated Freezing Degree Days	98 EF

Revision 0 of the SSAR presented tornado site characteristics based on the staff's interim position on the design-basis tornado for the region in which the Grand Gulf ESP site is located (see letter from L.S. Rubinstein to E.E. Kintner, dated March 25, 1988). In its submittal dated June 21, 2005, the applicant revised the tornado maximum wind speed site characteristic based on the recently published Revision 1 to NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," issued April 2005. The applicant also revised the remaining tornado site characteristics to be consistent with the staff's interim position on the design-basis tornado for a tornado with a maximum wind speed of 300 mi/h. Table 2.3.1-5 shows the applicant's proposed tornado site characteristics.

Table 2.3.1-5 Applicant's Proposed Tornado Site Characteristics

SITE CHARACTERISTIC	VALUE
Maximum Wind Speed	300 mi/h
Maximum Translational Speed	60 mi/h
Rotational Speed	240 mi/h
Radius of Maximum Rotational Speed	150 feet
Pressure Drop	2.0 lbf/in.^{2}
Rate of Pressure Drop	1.2 lbf/in.^{2}/s

The applicant reported that the highest "fastest-mile" wind speed recorded at Jackson, corrected to a standard height of 30 feet above ground level, is 64 mi/h. The applicant selected a basic fastest-mile wind speed site characteristic of 83 mi/h, which it considers to represent a "fastest mile of wind" at 30 feet above the ground with a 100-year return period. In Open Item 2.3-4, the staff asked the applicant to also identify a 3-second gust wind speed that represents a 100-year return period for the ESP site. The 3-second gust wind speed site characteristic value potentially represents a typical design parameter input for new reactor designs. In its submittal dated June 21, 2005, the applicant responded to Open Item 2.3-4 by proposing a 100-year return period 3-second gust site characteristic value of 96 mi/h. Table 2.3.1-6 shows the applicant's selected basic wind speed site characteristics.

Table 2.3.1-6 Applicant's Proposed Basic Wind Speed Site Characteristic

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Basic Wind Speed (fastest mile)	83 mi/h	Highest "fastest mile of wind" at 30 feet above the ground with a 100-year return period
Basic Wind Speed (3-s gust)	96 mi/h	100-year return period 3-second gust wind speed at 33-ft elevation

2.3.1.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant noted that the NRC regulations that apply to the evaluation of an ESP include 10 CFR 100.20 and 10 CFR 100.21. The staff notes that 10 CFR 100.20(c) and 100.21(d) are the applicable 10 CFR Part 100 regulations with respect to the consideration of the site's regional meteorological characteristics.

In SSAR Sections 1.0, 1.4, and 2.3.1 and in its response to RAI 2.3.1-3, the applicant identified the following applicable NRC guidance regarding regional climatology:

- RG 1.27, with respect to the meteorological conditions that should be considered in the design of the UHS
- RG 1.70, with respect to the type of general climate and regional meteorological data that should be presented
- RG 1.76, "Design Basis Tornado for Nuclear Power Plants," issued April 1974, with respect to the characteristics of the design-basis tornado[1]

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

Section 2.3.1 of RS-002 and Section 2.3.1 of RG 1.70 provide the following guidance on information appropriate for determining regional climatology:

- The description of the general climate of the region should be based on standard climatic summaries compiled by NOAA. Consideration of the relationships between regional synoptic-scale atmospheric processes and local (site) meteorological conditions should be based on appropriate meteorological data.

[1] In SSAR Table 1.4-1, the applicant noted that the staff developed an interim position modifying the design-basis tornado criteria presented in RG 1.76.

- Data on severe weather phenomena should be based on standard meteorological records from nearby representative NWS, military, or other stations recognized as standard installations that have long periods of data on record. The ability of these data to represent site conditions during the expected period of reactor operation should be substantiated.

- Tornado site characteristics may be based on RG 1.76 or the staff's interim position on design-basis tornado characteristics. An ESP applicant may specify any tornado wind speed site characteristics that are appropriately justified, provided that a technical evaluation of site-specific data is conducted.

- Basic (straight-line) wind speed site characteristics should be based on appropriate standards, with suitable corrections for local conditions.

- The UHS meteorological site characteristics, as stated in RG 1.27, should be based on long-period regional records which represent site conditions. Suitable information may be found in climatological summaries for the evaluation of wind, temperature, humidity, and other meteorological data used for UHS design.

- Freezing rain estimates should be based on representative NWS station data.

- High air pollution potential information should be based on U.S. Environmental Protection Agency studies.

- All other meteorological and air quality data identified as climatic site characteristics should be documented and substantiated.

2.3.1.3 Technical Evaluation

The staff evaluated regional meteorological conditions using information reported by NWS, NCDC, the National Severe Storms Laboratory (NSSL), the Southern Regional Climate Center (SRCC), ASHRAE, SEI, and ASCE. The staff reviewed statistics for the following climatic stations located in the vicinity of the Grand Gulf ESP site:

- Port Gibson, Mississippi, located approximately 5 miles east-southeast of the ESP site
- St. Joseph, Louisiana, located approximately 11 miles west-southwest of the ESP site
- Vicksburg, Mississippi, located approximately 26 miles north-northeast of the ESP site
- Jackson, Mississippi, located approximately 61 miles east-northeast of the ESP site

The staff concurs with the applicant's description of the general climate of the region, which is consistent with the SRCC narrative, "Climate Synopsis for Mississippi," as well as the NCDC narrative, "Jackson, Mississippi, 2003 Local Climatological Data, Annual Summary with Comparative Data." The NCDC climatic data summary for Jackson shows an annual mean wind speed of 6.8 mi/h, and the annual prevailing wind direction is from the south-southeast.

The applicant based the maximum annual 98 percent and 99.6 percent exceedance dry-bulb and wet-bulb temperatures and the minimum annual 99 percent and 99.6 percent exceedance dry-bulb temperatures on Jackson data that ASHRAE published in its July 2001 handbook.[2] The applicant also evaluated the GGNS site data using these same exceedance criteria and found that the site values generally match the Jackson values, except that the Grand Gulf ESP site is slightly warmer than the Jackson data would indicate at cold temperatures. Therefore, the staff agrees with the annual exceedance temperature and humidity site characteristics presented by the applicant.

In its response to RAI 2.3.1-5, the applicant reported the historic highest and lowest dry-bulb temperatures recorded at Jackson during the 108-year period 1896–2003 as 107 EF and !5 EF, respectively, and proposed using these historic dry-bulb temperatures to represent 100-year return period temperatures for the Grand Gulf ESP site. The staff did not believe that the applicant had conservatively identified the historic extreme dry-bulb temperatures recorded in the Grand Gulf ESP site region for use as the 100-year return period temperatures. The staff found a higher temperature, 110 EF, that was recorded at Vicksburg (August 31, 2000) during the 38-year period 1967–2004 in SRCC, "Vicksburg Military Park, Mississippi Period of Record General Climate Summary—Temperature." The staff also found a lower temperature, !8 EF, that was recorded at St. Joseph (January 27, 1940) during the 72-year period 1930–2001 in NCDC, "Cooperative Summary of the Day TD 3200 POR—2001 Data CDROM, Central United States." This concern resulted in Open Item 2.3-1.

In its response to Open Item 2.3-1, the applicant statistically generated 100-year return period temperatures (108 EF and !6 EF) using data recorded at Port Gibson during the 73-year period 1930–2001 and proposed using these values as the 100-year return period temperature site characteristics. The staff believes that the Port Gibson temperature data, collected at a similar grade elevation approximately 5 miles from the Grand Gulf ESP site, are representative of the Grand Gulf ESP site. The staff performed an equivalent analysis with the same Port Gibson data set and obtained similar results. The staff also used the Port Gibson data to generate mean annual highest and lowest temperatures and obtained results similar to the applicant. Therefore, the staff agrees with the 100-year return period temperature site characteristics presented by the applicant.

During the period 1900–2000, 35 hurricanes directly hit either Mississippi or Louisiana or both States at hurricane-storm intensity with maximum sustained winds of 74 mi/h or greater. According to Jarrell, et al. (2003), 18 of these storms were classified as major hurricanes (Category 3 or higher on the Saffir/Simpson hurricane scale) with maximum sustained winds of 111 mi/h or greater. These hurricanes typically weaken as they move inland, so wind damage tends to be confined to the coastal regions while damage inland comes primarily from heavy rain and flooding. During this period, the most intense hurricane to affect the Mississippi and Louisiana coasts was Hurricane Camille in August 1969. Hurricane Camille was classified as a Category 5 hurricane on the Saffir/Simpson hurricane scale with maximum sustained winds exceeding 155 mi/h as it crossed the coastline. However, according to Simpson, et al. (1970), Hurricane Camille only generated gusts of 67 mi/h as it passed 10 miles east of Jackson.

[2] The data presented by the applicant as the maximum 98 percent and 99.6 percent temperatures are equivalent to (1) the ASHRAE 2 percent and 0.4 percent exceedance values and (2) the 2 percent and 0.4 percent exceedance values identified by the staff as regional climatic site characteristics in SER Table 2.3.1-7.

According to NSSL, "Severe Thunderstorm Climatology, Total Threat," dated August 29, 2003, the mean number of days per year with the threat of tornadoes occurring within 25 miles of the Grand Gulf ESP site is approximately 1.0 to 1.2 days per year for any tornado, approximately 0.30 to 0.35 days per year for a significant tornado (F2 or greater; wind speeds in excess of 113 mi/h), and approximately 0.020 to 0.025 days per year for a violent tornado (F4 or greater; wind speeds in excess of 207 mi/h).

At the direction of the NRC, J.V. Ramsdell, Jr., of Pacific Northwest National Laboratory prepared a report titled, "Technical Evaluation Report on Design-Basis Tornadoes for the Grand Gulf ESP Site," dated November 9, 2004, which derived a best-estimate annual tornado strike probability of 7.4×10^{-4}, based on tornado data from January 1950 through August 2003. This probability corresponds to a mean recurrence interval of 1350 years. Using a different methodology and period of record, the applicant calculated a less conservative tornado return period of 2860 years.

A tornado struck the GGNS site shortly after 11:00 p.m. on April 17, 1978. Two units were under construction at the time; GGNS Unit 1 was 50 percent complete and GGNS Unit 2 was 10 percent complete. The tornado initially touched down approximately 9 miles west-southwest of the GGNS site and traveled to the site where the centerline passed just to the right of the cooling tower and crossed the concrete batch plant area and the northeast corner of the switchyard. The damage path at the plant site was approximately 1500–1800 feet wide, and the highest onsite wind speeds were estimated to be in the 125–150 mi/h range (indicative of an F2 tornado). After leaving the plant site, the storm intensified into an F3 tornado for approximately 1.3 miles and continued for approximately 7 miles before dissipating. According to Fujita (1978) and McDonald (1978), the collapse of construction cranes caused major damage to the power plant facility; high winds also extensively damaged the switchyard installation.

The following discussion on thunderstorms, lightning, hail, and ice events provides a general climatic understanding of the severe weather phenomena in the site region but does not result in the generation of site characteristics for use as design- or operating-basis considerations.

The applicant estimated that 66 thunderstorm-days per year occur in the site area. This frequency is compatible with the 68 thunderstorm-days per year reported by NCDC in 2003 for Jackson. The majority of these thunderstorm days occur from May through August. The applicant estimated that approximately 33 flashes to earth per square mile per year occur around the site area. This estimate is conservative compared to the mean annual ground flash density of 23 flashes per square mile presented in NUREG/CR-3759, "Lightning Strike Density for the Contiguous United States from Thunderstorm Duration Records," issued May 1984, for the Grand Gulf ESP site region. Considering a flash frequency of 33 flashes to earth per square mile per year and the 1.3 square mile exclusion area, the applicant estimated the expected frequency of lightning flashes within the Grand Gulf ESP site EAB as 43 flashes per year.

Hail often accompanies severe thunderstorms and can be a major weather hazard, which causes damage to crops and property. The NCDC Storm Event Database, "Storm Events for Mississippi, Query Results, Hail Event(s) Reported in Claiborne County, Mississippi Between 01/01/1950 and 09/30/2004," reports that a total of 20 hail events with hail 0.75 inches or greater occurred in Claiborne County from January 1984 through December 2003. Ten of these events had hail 1.75 inches or greater in diameter. According to NSSL, "Severe Thunderstorm Climatology, Total Threat," the threat of hail occurring within 25 miles of the Grand Gulf ESP site is approximately 3–4 days per year for damaging hail or hail 0.75 inches in diameter or greater and 0.50–0.75 days per year for hail 2 inches or more in diameter.

The NCDC Storm Event Database, "Storm Events for Mississippi, Query Results, Snow & Ice Event(s) Reported in Claiborne County, Mississippi Between 01/01/1950 and 09/30/2004," lists two ice events for Claiborne County for the period January 1993 through December 2003. In Jones, et al. (2002), the NCDC reports a 50-year return period uniform radial ice thickness of 0.5 inches because of freezing rain, with a concurrent 3-second gust wind speed of 30 mi/h for the Grand Gulf ESP site area.

Large-scale episodes of atmospheric stagnation are not common in the site region. During the 40-year period between 1936 and 1975, high-pressure stagnation conditions, lasting for 4 days or more, occurred approximately 40 times, averaging 4.6 stagnation days per case. Korshover (1976) reports that two of these stagnation cases lasted 7 days or longer. The above discussion on atmospheric stagnation provides a general climatic understanding of the air pollution potential in the region. Section 2.3.2 of this SER discusses the ESP air quality conditions for design- and operating-basis considerations. Sections 2.3.4 and 2.3.5 of this SER present the atmospheric dispersion site characteristics used to evaluate short-term postaccident airborne releases and long-term routine airborne releases, respectively.

Both the weight of the 100-year return period snowpack and the weight of the 48-hour PMWP are specified in RG 1.70 to assess the potential snow loads on the roofs of safety-related structures. The staff's branch position on winter precipitation loads provides clarification as to the load combinations to be used in evaluating the roofs of safety-related structures. Consistent with the staff's branch position on winter precipitation loads, the winter precipitation loads to be included in the combination of normal live loads to be considered in the design of a nuclear power plant that might be constructed on a proposed ESP should be based on the weight of the 100-year snowpack or snowfall, whichever is greater, recorded at ground level. Likewise, the winter precipitation loads to be included in the combination of extreme live loads to be considered in the design of a nuclear power plant that might be constructed on a proposed ESP should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour PMWP at ground level for the month corresponding to the selected snowpack. A COL or CP applicant may choose and justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall nor remain on the top of the snowpack and/or building roofs.

The applicant has identified a 100-year return period snowpack of 6.1 lbf/ft^2, which it based on the guidance in SEI/ASCE 7-02. The staff agrees with the applicant's comment that the Grand Gulf ESP site is not in a heavy snowload region, in that snow typically melts and/or evaporates within 48 hours before additional snow is added. According to SRCC, "Monthly Total Snowfall, Jackson 4 NW, Mississippi" and "Monthly Total Snowfall, Jackson WSFO Airport, Mississippi," the highest monthly total snowfall reported for Jackson during the period 1930–2000 is 10.6 inches in January 1940. According to the NCDC database "Cooperative Summary of the Day TD 3200 POR—2001 Data CDROM, Eastern United States, Puerto Rico, and Virgin Islands," issued November 2002, this 10.6 inches of snow fell on January 22 and

January 23, 1940, during which time 0.78 inches of equivalent liquid precipitation (equivalent to 4.1 lbf/ft^2) was recorded. Because the applicant performed its analysis in accordance with the appropriate guidance and the results bound the estimated weight of the maximum monthly snowfall for Jackson, the staff concludes that a 100-year return period snowpack site characteristic value of 6.1 lbf/ft^2 is acceptable.

In Open Item 2.3-2, the staff stated that the applicant had not provided an appropriate 48-hour PMWP value that can be used with the 100-year snowpack to define the extreme winter precipitation roof loads. As discussed in the staff's branch position on winter precipitation loads, the 48-hour PMWP should be developed in accordance with the guidance provided in HMR 53. The applicant responded to Open Item 2.3-2 by proposing a 48-hour PMWP value of 35 inches of water based on HMR 53. Because the applicant determined this value in accordance with HMR 53, the staff concludes that a 48-hour PMWP site characteristic value of 35 inches of water is acceptable.

In its submittal dated June 21, 2005, the applicant contended that the HMR 53 48-hour PMWP value of 35 inches is in the form of rainwater that would not remain on rooftops. Instead, the applicant proposed a 48-hour frozen PMWP value of 1.9 inches of frozen precipitation (equivalent to 9.9 lbf/ft^2) for use in defining extreme live loads for roof design purposes. The applicant's 48-hour frozen PMWP value represents a 100-year return period value statistically extrapolated from four ice storms recorded in nearby counties and parishes during the 11-year period 1993–2003. The applicant proposed defining the snow load for extreme live loads to be considered for roof structural design purposes as 16 lbf/ft^2, which represents the sum of the 100-year return period snowpack (6.1 lbf/ft^2) and the 48-hour frozen PMWP (9.9 lbf/ft^2).

The staff believes that the 11-year period of record used to derive the 48-hour frozen PMWP value of 9.9 lbf/ft^2 is too short, resulting in an unacceptably large uncertainty in the resulting value. In addition, the staff contends that the temporary roof load contributed by a heavy rain on top of an existing snowpack can be significant. Its magnitude will depend on the duration and intensity of the design rainstorm, the drainage characteristics of the snow on the roof, the geometry of the roof, and the type of drainage provided. Where adequate slope to drain does not exist, or where drains are blocked by ice, snow meltwater, and rainwater may pond in low areas on the roof. As rainwater or snow meltwater flows to such low areas, these areas tend to deflect increasingly, allowing a deeper pond to form. If the structure does not possess enough stiffness to resist this progression, failure by localizing overloading can result. This mechanism has been responsible for several roof failures under combined rain and snow loads.

Therefore, the staff contends that, until a roof design has been established, the "default" winter precipitation loads to be included in the combination of extreme live loads to be considered in the design of a nuclear power plant that might be constructed at the Grand Gulf ESP site should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour PMWP. Once the roof design has been established, a COL or CP applicant may then choose and justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall nor remain on the top of the snowpack and/or building roofs based on the design of the roof and its drains.

To verify the applicant's UHS meteorological site characteristics for maximum evaporation and minimum water cooling, the staff examined 30 years (1961–1990) of hourly temperature and humidity data from Jackson using NCDC, "Solar and Meteorological Surface Observational Network (SAMSON) for Eastern U.S. CDROM," issued September 1993. The staff calculated running 1-, 5-, and 30-day average wet-bulb temperatures from the hourly data, and it selected the periods with the highest average wet-bulb temperatures as the worst periods. The resulting maximum 1-, 5-, and 30-day average wet-bulb temperature values are similar to the values presented by the applicant.

In Open Item 2.3-3, the staff identified the need for an additional UHS meteorological site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility, a phenomenon which would reduce the amount of water available for use by the UHS. The applicant responded to Open Item 2.3-3 by proposing a cumulative degree-day below freezing site characteristic value of 98 EF degree days (i.e., 98 accumulated freezing degree days), based on daily minimum and maximum temperatures recorded at Port Gibson for the period 1930–2001. Because the average winter temperature at the Grand Gulf ESP site is well above freezing, the applicant derived this site characteristic value by evaluating the Port Gibson data for the worst case cold spell.

The staff performed a similar analysis using the 1930–2001 Port Gibson daily minimum and maximum temperature data contained in the NCDC database, "Cooperative Summary of the Day TD 3200 POR—2001 Data CDROM, Eastern United States, Puerto Rico, and Virgin Islands." The staff calculated daily average temperatures by averaging the daily minimum and maximum temperatures and defining a cold spell as one or more consecutive days where the average daily temperature was below freezing. The worst-case cold spell was then determined by identifying the cold spell with the highest accumulated freezing degree days. The staff's results were similar to those of the applicant.

Based on the discussion presented above, the staff concludes that the UHS meteorological site characteristics proposed by the applicant are acceptable.

The applicant chose the tornado maximum wind speed site characteristic of 300 mi/h based on the recently published Revision 1 to NUREG/CR-4461. The applicant's remaining tornado site characteristics (e.g., pressure drop and rate of pressure drop) are consistent with staff's interim position on design-basis tornado characteristics for a tornado with a maximum wind speed of 300 mi/h. Therefore, the staff concludes that the tornado site characteristic parameters proposed by the applicant are acceptable.

The applicant's proposed site characteristic basic wind speed of 83 mi/h is compatible with the fastest-mile wind speed having a 1-percent annual probability of being exceeded (100-year mean recurrence interval) for the Grand Gulf ESP site area, as derived by the staff from American National Standards Institute (ANSI) A58.1-1982, "Minimum Design Loads for Buildings and Other Structures," dated March 10, 1982. Figure 1 of ANSI A58.1-1982 shows a basic wind speed of approximately 78 mi/h for the Grand Gulf ESP site, which, by definition, has a 2-percent annual probability of being exceeded or a 50-year mean recurrence interval. According to ANSI A58.1-1982, Section A6.5.2, the ratio of the 100-year to 50-year mean recurrence interval values is typically 1.07, which means that the 50-year return period basic wind speed value of 78 mi/h corresponds to a 100-year return period basic wind speed value of 83 mi/h. Therefore, the staff concludes that a site characteristic fastest-mile basic wind speed value of 83 mi/h is acceptable.

In Open Item 2.3-4, the staff asked the applicant to identify a 3-second gust wind speed that represents a 100-year return period for the ESP site. The applicant responded to Open Item 2.3-4 by proposing a 100-year return period 3-second gust site characteristic value of 96 mi/h. The applicant determined this value in accordance with the guidance provided by SEI/ASCE 7-02. Therefore, the staff concludes that a 3-second gust wind speed site characteristic of 96 mi/h is acceptable.

The staff will include the regional climatology site characteristics listed in Table 2.3.1-7 in any ESP that it might issue for the Grand Gulf ESP site.

Table 2.3.1-7 Staff's Proposed Regional Climatology Site Characteristics

SITE CHARACTERISTIC		VALUE	DESCRIPTION
Ambient Air Temperature and Humidity			
Maximum Dry-Bulb Temperature	2% annual exceedance	92 EF	The ambient dry-bulb temperature that will be exceeded 2% of the time annually
	0.4% annual exceedance	95 EF	The ambient dry-bulb temperature that will be exceeded 0.4% of the time annually
	average annual highest	98 EF	The average of the maximum temperatures recorded each year
	100-year return period	108 EF	The ambient dry-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Minimum Dry-Bulb Temperature	99% annual exceedance	25 EF	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 1% of the time annually
	99.6% annual exceedance	21 EF	The ambient dry-bulb temperature below which dry-bulb temperature will fall 0.4% of the time annually
	average annual lowest	14 EF	The average of the minimum temperatures recorded each year
	100-year return period	!6 EF	The ambient dry-bulb temperature for which a 1% annual probability of a lower dry-bulb temperature exists (100-year mean recurrence interval)
Maximum Wet-Bulb Temperature	2% annual exceedance	78 EF	The ambient wet-bulb temperature that will be exceeded 2% of the time annually
	0.4% annual exceedance	80 EF	The ambient wet-bulb temperature that will be exceeded 0.4% of the time annually
Basic Wind Speed			
Fastest-mile		83 mi/h	The fastest-mile wind speed to be used in determining wind loads, defined as the fastest-mile wind speed at 33 feet above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)

SITE CHARACTERISTIC	VALUE	DESCRIPTION
3-Second Gust	96 mi/h	The 3-second gust wind speed to be used in determining wind loads, defined as the 3-second gust wind speed at 33 feet above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Tornado		
Maximum Wind Speed	300 mi/h	Maximum wind speed resulting from passage of a tornado having a probability of occurrence of 10^{-7} per year
Translational Speed	60 mi/h	Translation component of the maximum tornado wind speed
Maximum Rotational Speed	240 mi/h	Rotation component of the maximum tornado wind speed
Radius of Maximum Rotational Speed	150 feet	Distance from the center of the tornado at which the maximum rotational wind speed occurs
Pressure Drop	2.0 lbf/in.^{2}	Decrease in ambient pressure from normal atmospheric pressure resulting from passage of the tornado
Rate of Pressure Drop	1.2 lbf/in.^{2}/s	Rate of pressure drop resulting from the passage of the tornado
Winter Precipitation		
100-Year Snowpack	6.1 lbf/ft^2	Weight of the 100-year return period snowpack (to be used in determining normal precipitation loads for roofs)
48-Hour Probable Maximum Winter Precipitation	35 inches of water	Probable maximum precipitation during the winter months (to be used in conjunction with the 100-year snowpack in determining extreme winter precipitation loads for roofs)
Ultimate Heat Sink		
Meteorological Conditions Resulting in the Minimum Water Cooling during Any 1 Day	81.0 EF wet-bulb temperature with coincident 86.3 EF dry-bulb temperature	Historic worst 1-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in the Minimum Water Cooling during Any Consecutive 5 Days	80.2 EF wet-bulb temperature with coincident 86.2 EF dry-bulb temperature	Historic worst 5-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in the Maximum Evaporation and Drift Loss during Any Consecutive 30 Days	78.5 EF wet-bulb temperature with coincident 83.1 EF dry-bulb temperature	Historic worst 30-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in Maximum Water Freezing in the UHS Water Storage Facility	98 EF degree days below freezing	Historic maximum cumulative degree days below freezing

The staff acknowledges that long-term climatic change resulting from human or natural causes may introduce changes into the most severe natural phenomena reported for the site. However, no conclusive evidence or consensus of opinion is available on the rapidity or nature of such changes. If in the future the ESP site is no longer in compliance with the terms and conditions of the ESP (e.g., if new information shows that the climate has changed and that the climatic site characteristics no longer represent extreme weather conditions), the staff may seek to modify the ESP or impose requirements on the site in accordance with the provisions of 10 CFR 52.39, "Finality of Early Site Permit Determinations," if necessary, to bring the site into compliance with Commission requirements to assure adequate protection of the public health and safety.

2.3.1.4 Conclusions

As set forth above, the applicant has presented and substantiated information relative to the regional meteorological conditions important to the safe design and siting of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site. The staff has reviewed the available information provided and, for the reasons given above, concludes that the identification and consideration of the regional and site meteorological characteristics set forth above meet the requirements of 10 CFR 100.20(c) and 10 CFR 100.21(d).

The staff finds that the applicant has considered the most severe regional weather phenomena in establishing the above site characteristics. The staff has generally accepted the methodologies used to determine the severity of the weather phenomena reflected in these site characteristics as documented in SERs for previous licensing actions. Accordingly, the staff concludes that the use of these methodologies results in site characteristics containing margin sufficient for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the site characteristics previously identified are acceptable for use as part of the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

The applicant has conformed with a technical assessment of tornado wind speed data and, in part, with the staff's interim position on design-basis tornado characteristics. Therefore, the staff concludes that the identification and consideration of tornadoes are acceptable and that the resulting tornado site characteristics are acceptable for the tornado used for the generation of missiles.

The staff reviewed the applicant's proposed site characteristics related to climatology for inclusion in an ESP for the applicant's site, should one be issued, and finds these characteristics to be acceptable. The staff has also reviewed the applicant's proposed design parameters (PPE values) for inclusion in such an ESP (SSAR Section 1.3) and finds them to be reasonable. The staff did not perform a detailed review of these parameters.

2.3.2 Local Meteorology

2.3.2.1 Technical Information in the Application

In Section 2.3.2 of the SSAR, the applicant presented local (site) meteorological information. This SSAR section also addresses the potential influence of construction and operation of a nuclear power plant or plants falling within the applicant's PPE on local meteorological conditions that might in turn adversely impact such a plant or plants or the associated facilities. Finally, the applicant provided a topographical description of the site and its environs. Specifically, the applicant provided the following information:

- a description of the local (site) meteorology in terms of airflow, temperature, atmospheric water vapor, precipitation, fog, atmospheric stability, and air quality

- an assessment of the influence on the local meteorology of construction and operation of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site and its facilities, including the effects of plant structures, terrain modification, and heat and moisture sources resulting from plant operation

- a topographical description of the site and its environs, as modified by the structures of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site

The applicant used data from the GGNS onsite meteorological monitoring system, as well as data from Vicksburg and Jackson, Mississippi, and St. Joseph, Louisiana, to characterize local meteorological conditions. The applicant considered the data from the GGNS monitoring station to be the most representative of the Grand Gulf ESP site because of the station's proximity to the site.

The applicant presented wind data from Vicksburg for the period 1997–2001. The Vicksburg wind data indicate that the predominant wind directions are from the north and south (about 14 percent of the time for each sector). The mean wind speed is 7.4 mi/h.

Revision 0 of the SSAR presents wind data from the 33-foot level on the GGNS meteorological tower for the period 1996–2001. The staff noted a lack of easterly winds for the period 1996–2000, as compared to the August 1972 through July 1974 GGNS data presented in the GGNS UFSAR and the 2001 GGNS data presented in the SSAR. The staff subsequently reviewed the GGNS onsite meteorological monitoring program during a site visit and identified that the use of a wide (4-foot by 6-foot) scaffolding tower to collect the 1996–2000 data probably contributed to this phenomenon. In early 2001, a narrower triaxial tower replaced the rectangular scaffolding tower. Consequently, in RAI 2.3.2-5, the staff asked the applicant to provide wind data summaries for the data collected with the newer, narrower tower. In its response to this RAI, the applicant provided a copy of the 1996–2003 GGNS hourly meteorological database.

The newer GGNS 2001–2003 wind data set indicates that the predominant wind directions are from the northeast (about 10 percent of the time) and southeast (about 8–9 percent of the time). The average wind speed is 4.3 mi/h. The longest single-sector wind direction persistences tend to be from the northeast sector. Seasonal variations are also evident from the data, with higher wind speeds during the winter and lower wind speeds during the summer. The prevailing wind direction is from the north during the winter, from the south during the spring, and from the northeast during the summer and autumn.

The SSAR presents dry-bulb temperature data from Vicksburg for the period 1997–2001 and from the GGNS onsite monitoring program for the period 2000–2001. The average dry-bulb temperature recorded at Vicksburg is 65.6 EF, ranging from a low monthly mean value of 47.2 EF in December to a high monthly mean value of 82.5 EF in July. The average dry-bulb temperature recorded at GGNS is 65.1 EF, ranging from a low monthly mean value of 46.2 EF in December to a high monthly mean value of 81.4 EF in July. Temperature extremes at Vicksburg range from 16 EF to 107 EF, whereas temperature extremes at GGNS range from 17.3 EF to 104.2 EF. Other observed temperature extremes include 110 EF for the Vicksburg Military Park 1967–2004 database, 107 EF and !5 EF for the Jackson 1896–2003 database, and !8 EF for the St. Joseph 1930–2001 database. The applicant statistically extrapolated 100-year return period extreme temperatures of 108 EF and !6 EF from the Port Gibson 1930–2001 database.

According to the applicant, all of Mississippi experiences high humidity during much of the year. The average relative humidity recorded at Vicksburg during the period 1997–2001 is 75 percent, with relative humidity values of 90 percent or higher occurring at any hour of the day.

The SSAR presents precipitation data recorded on site during the period 2000–2001 and at Vicksburg during the period 1997–2001. The annual average precipitation recorded on site is 44.85 inches, with monthly mean totals ranging from 8.58 inches in March to 1.65 inches in October. The annual average precipitation recorded at Vicksburg is 49.56 inches, with monthly mean totals ranging from 6.89 inches in March to 1.98 inches in August. The applicant also presented maximum short period precipitation estimates ranging from 30-minute to 10-day durations. In RAI 2.3.2-1, the staff asked the applicant to update the 30-minute and 1-hour precipitation estimates using the latest data generated by NWS, and the applicant complied with this request. The resulting 100-year recurrence interval 1-hour and 24-hour maximum precipitation estimates are 4.3 inches and 9.9 inches, respectively.

The applicant estimated the annual average snowfall in the Grand Gulf ESP site area as 1–2 inches. The applicant reported that the highest monthly amount of snowfall recorded at Jackson is 10.6 inches, which fell in a 24-hour period. The highest seasonal amount of snowfall recorded at Jackson is 11.6 inches.

The SSAR presents a precipitation wind rose for Jackson, which shows that precipitation occurs most often with winds from the southeast through south and north-northwest through northeast. A precipitation wind rose for GGNS site shows a similar pattern.

The applicant stated that Vicksburg recorded an average of 93 hours of fog per year during the period 1997–2001, with the greatest frequency of fog occurring between October and March. The applicant considered the Vicksburg fog data to be representative of the Grand Gulf ESP site because of its proximity and similar location relative to the Mississippi River. During this same period, Vicksburg reported an average of 194 hours of haze but had no reports of heavy fog, smoke, duststorms, or sandstorms.

The SSAR presents atmospheric stability data based on wind data observations from the GGNS tower and sky cover data from Vicksburg. These data show that neutral (Pasquill type "D") conditions predominated, occurring about 23 percent of the time. Moderately stable

(Pasquill type “F”) and extremely stable (Pasquill type “G”) conditions occurred about 17 percent and 19 percent of the time, respectively, most often during the summer.

The applicant presented inversion height statistics based on twice daily weather balloon data at Jackson during the period 1992–2000. These data show that inversions (defined as three weather balloon elevation readings below 3000 meters showing consecutive increases in temperature with height) occurred during approximately 60 percent of the mornings and 25 percent of the afternoons. The average morning and afternoon inversion heights are 685 meters and 1490 meters, respectively. A separate study of mixing height data from Jackson for the period 1992–2001 shows that monthly mixing heights range from an average low of 320–330 meters during August and October mornings to an average high of 1820 meters during August afternoons. Ground-based inversion statistics using Jackson hourly surface observations show that ground-based inversions occurred approximately 39 percent of the time, with the longest durations lasting 16 hours.

The SSAR also presents inversion data based on GGNS onsite delta-temperature measurements taken during the periods August 1972 through July 1974 and January 1976 through December 1976. These data show inversions occurring approximately 47 percent of the time, most frequently during August (approximately 58 percent of the time) and least frequently during January (approximately 35 percent of the time). The longest durations last 14 hours.

In RAI 2.3.2-3, the staff asked the applicant to identify the air quality characteristics of the site that it would include in the design and operating bases for a nuclear power plant or plants that might be constructed on the Grand Gulf ESP site. The applicant responded that no air quality parameters exist that require consideration for the proposed ESP facility’s design and operating bases.

The applicant stated that the only aspects of the Grand Gulf ESP site that could be categorized as a unique microclimate result from the site’s proximity to the Mississippi River. The proximity of the river increases local humidity a small amount and creates a slight tendency for lower level winds to be channeled along the river.

In RAI 2.3.2-4, the staff asked the applicant to describe potential modifications to local meteorological conditions as the result of the presence and operation of a nuclear power plant or plants falling within the PPE specified in the SSAR. The applicant responded that it does not expect new construction at the site to significantly impact the local climate. Although some ground leveling will occur, it will not change any of the significant climate-shaping topographic features. Some trees will be removed, but the trees within the construction footprint are few in number compared to the surrounding forested land. The site already contains numerous buildings, large parking areas, and traffic; the impact of more structures, facilities, and activities is not expected to be noticeable in terms of local meteorology.

In its response to RAI 2.3.2-4, the applicant also stated that operation of a new facility at the Grand Gulf ESP site could affect local climate by increasing particulate emissions to the atmosphere, producing thermal discharges to the Mississippi River, and adding heat and moisture to the atmosphere through the use of cooling towers. The increase in particulate emissions during plant operation would result from a modest increase in automobile traffic and infrequent operation of diesel generators. The applicant noted that the net increase in particulate emissions would be negligible and would not cause any noticeable climatic effects.

Likewise, in its response, the applicant stated that the amount of heat rejected to the high volumetric flow of the Mississippi River would be relatively small, causing an incidentally small impact on local meteorology. The applicant's evaluation of the surface thermal plumes resulting from the discharge of blowdown water into the Mississippi River predicts a steam fog occurrence probability of only a few percent higher than over ambient river water.

The SSAR evaluates the atmospheric impact for two different options for providing normal heat sink cooling capability to the proposed facility—(1) four natural draft cooling towers and (2) four 20-cell linear mechanical draft cooling towers. These cooling systems would create visible plumes under certain atmospheric conditions, which can cause shadowing of nearby lands, salt deposition, fogging, and icing. The predicted seasonal average plume lengths for the natural draft cooling towers range from 0.93 miles in the summer to 2.32 miles in the winter. The predicted plume lengths for the mechanical draft cooling towers are generally 40 percent less, but the plumes would be closer to the ground, resulting in increased salt deposition and the possibility of fog. The applicant's plume study shows that no fogging would occur for the natural draft cooling tower option, whereas the study predicts that the mechanical draft cooling towers would cause minimal fogging (on the order of 15 hours per year). The applicant considered ground-level icing insignificant because of the low probabilities of ground-level plumes from either type of tower and freezing conditions. Except for the limited potential for fogging, the applicant determined that the use of either cooling system option would have no significant impact on meteorological conditions outside the site boundary.

In the SSAR, the applicant noted that the proposed location for the new facility site lies about 6300 feet east of the Mississippi River at an elevation of approximately 132.5 feet above mean sea level (MSL). The applicant described the surrounding terrain as generally hilly and wooded to the south and east, with several hilltops more than 350 feet above MSL to the south. To the north and west, the terrain is generally flat and wooded, lying less than 100 feet above MSL. Numerous lakes of various sizes and isolated marshes dot the landscape. A rather abrupt (irregular) 100- to 200-foot rise in terrain occurs approximately 1 mile east of the riverbank.

2.3.2.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant stated that the NRC regulations that apply to evaluating an ESP include 10 CFR 100.20 and 10 CFR 100.21. The staff notes that 10 CFR 100.20(c) and 10 CFR 100.21(d) are the applicable 10 CFR Part 100 regulations with respect to the consideration that has been given to the regional meteorological characteristics of the site.

In SSAR Sections 1.0 and 1.4, the applicant identified the following applicable NRC guidance regarding local meteorology:

- RG 1.3, Revision 2, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors," issued June 1974, with respect to acceptable methods for modeling radiological releases

- RG 1.23, "Onsite Meteorological Programs," issued February 1972, with respect to providing the criteria for an acceptable onsite meteorological measurements program

- RG 1.70, with respect to the type of local meteorological data that should be presented

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

Section 2.3.2 of RS-002 and Section 2.3.2 of RG 1.70 provide the following guidance on information appropriate for a presentation on local meteorology:

- Local meteorological data based on onsite measurements and data from nearby NWS stations or other standard installations should be presented in the format specified in Section 2.3.2 of RG 1.70. RG 1.23 provides guidance related to onsite meteorological measurements.

- A topographical description of the site and environs should be provided. Section 2.3.2.2 of RG 1.70 provides guidance on the topographical description.

- A discussion and evaluation of the influence of a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site and its facilities on local meteorological and air quality conditions should be provided. Potential changes in the normal and extreme values resulting from plant construction and operation should be discussed.

2.3.2.3 Technical Evaluation

The staff evaluated local meteorological conditions using data from the GGNS onsite meteorological monitoring system, as well as climatic data reported by NWS, NCDC, and SRCC. The staff reviewed statistics for the following climatic stations located in the vicinity of the Grand Gulf ESP site:

- Port Gibson, Mississippi, located approximately 5 miles east-southeast of the ESP site
- St. Joseph, Louisiana, located approximately 11 miles west-southwest of the ESP site
- Vicksburg, Mississippi, located approximately 26 miles north-northeast of the ESP site
- Jackson, Mississippi, located approximately 61 miles east-northeast of the ESP site

As discussed in Section 2.3.2.1 of this SER, the GGNS 33-foot level wind data presented in Revision 0 of the SSAR for the period 1996–2000 lack easterly winds as compared to the August 1972 through July 1974 GGNS data presented in the GGNS UFSAR and the 2001 GGNS data given in the SSAR. In response to RAI 2.3.2-5, the applicant provided a copy of the 1996–2003 GGNS hourly meteorological database.

The staff's review of the applicant's 33-foot wind data from August 1972 through July 1974 and January 2002 through December 2003 shows that the data from these two periods are compatible. The predominant wind directions for the 1972–1974 data are from the east-northeast clockwise to south-southeast (43 percent of the time), as compared to the predominant northeast clockwise to southeast (42 percent of the time) wind directions for the 2001–2003 time period. The wind speed frequency distributions between the two time periods are similar as well, with average wind speeds of 4.4 mi/h and 4.3 mi/h for the 1972–1974 and 2001–2003 time periods, respectively.

According to NCDC, “Southeast Mississippi Divisional Normals—Temperature, Period 1971–2000,” dated June 15, 2002, the 1971–2000 normal climatic data for the southwest climatic division of Mississippi indicate an annual mean temperature of 64.6 EF, ranging from a low monthly mean value of 46.6 EF in January to a high monthly mean value of 80.8 EF in July. These climatic division mean temperature values are compatible with the mean temperature values recorded on site during the period 2000–2001 (e.g., annual mean temperature of 65.1 EF with a low monthly mean value of 46.2 EF in December and a high monthly mean value of 81.4 EF in July).

The staff presents an evaluation of the applicant’s 100-year return period extreme temperatures in Section 2.3.1.3 of this SER.

The annual mean wet-bulb temperature at Jackson is 58.6 EF and ranges from a high monthly mean value of 74.3 EF in July to a low monthly mean value of 41.5 EF in January. As reported in NCDC, “Jackson, Mississippi, 2003 Local Climatological Data, Annual Summary with Comparative Data,” the annual mean relative humidity is 75 percent.

As stated in NCDC, “Southeast Mississippi Divisional Normals—Precipitation, Period 1971–2000,” dated June 15, 2002, precipitation for the southwest Mississippi climatic division averages 61.37 inches per year, with monthly climate division normals ranging from a minimum of 3.62 inches in October to a maximum of 6.51 inches in March. The annual average precipitation recorded at Port Gibson during 2000–2001 is 54.57 inches, compared to 44.85 inches noted at the GGNS site during the same period, as reported in SRCC, “Monthly Precipitation, Port Gibson 1 NW, Mississippi.” According to NWS, “NWS Jackson, MS—St. Joseph 3N Climate,” maximum and minimum monthly amounts of precipitation observed in the area are 21.80 inches in April 1940 and 0 inches in October 1952 at St. Joseph. One of the highest 24-hour precipitation totals recorded for the site region is 9.85 inches at St. Joseph on April 4, 1940, according to NCDC, “Cooperative Summary of the Day TD 3200 POR–2001 Data CDROM, Central United States.” Precipitation wind roses provided by the applicant for Jackson and the GGNS site show that rain occurs most often with wind from the southeast through south and north-northwest through northeast.

The average seasonal snowfall at Port Gibson for the period 1929–1930 through 2003–2004 is 1.1 inches. Measurable snowfall was reported during 23 seasons out of this 75-season period, with measurable snowfall recorded during November through March. According to SRCC, “Monthly Total Snowfall, Port Gibson 1 NW, Mississippi,” the highest monthly and seasonal total snowfalls reported for Port Gibson are 9.0 inches for January 1940 and 10.0 inches for the 1967–1968 season.

The SSAR presents atmospheric stability data based on delta-temperature measurements between the 162-foot and 33-foot levels on the GGNS meteorological tower for the period 2001–2002. Neutral (Pasquill type “D”) and slightly stable (Pasquill type “E”) conditions were predominant, occurring about 35 percent and 26 percent of the time, respectively. Moderately stable (Pasquill type “F”) and extremely stable (Pasquill type “G”) conditions occurred about 10 and 11 percent of the time, respectively. The onsite data presented in the GGNS UFSAR for the period 1972–1976 show similar stability frequencies. Neutral and slightly stable conditions were predominant in the 1972–1976 data set, occurring about 29 and 22 percent of the time, respectively. Moderately stable and extremely stable conditions occurred about 10 and 14 percent of the time, respectively.

In summary, the staff reviewed the applicant's description of the local meteorology and determined that it represents the conditions at and near the site. The applicant based the wind, temperature, precipitation, and atmospheric stability data on onsite data recorded by the GGNS meteorological monitoring system. Section 2.3.3 of this SER discusses the representativeness of the GGNS onsite data. Additional meteorological summaries are based on data from nearby stations with long periods of record. The staff's review of the recorded extreme values shows that the site characteristics presented in SSAR Section 2.3.1 reflect these values.

The staff reviewed the topographic information provided in the SSAR and concluded that it can readily extract the information needed.

Because of the limited and localized nature of the expected terrain modifications associated with the development of the ESP facility, the staff finds that these terrain modifications, along with the resulting plant structures and associated improved surfaces, will not have enough of an impact on local meteorological conditions to affect plant design and operation. The use of natural draft cooling towers, mechanical draft cooling towers, or both, would create visible plumes under certain atmospheric conditions, which can cause shadowing of nearby lands, salt deposition, and fogging. Ground-level icing would be insignificant because of the low probabilities of both ground-level plumes from either type of tower and freezing conditions. The staff finds that these atmospheric impacts will not have enough of an impact on local meteorological conditions to affect plant design and operation.

The Grand Gulf ESP Environmental Report (ER) states that the air quality in the vicinity of the ESP site is generally good, reflecting the predominantly rural character of the region. The Grand Gulf ESP site region has been designated as in attainment of the national ambient air quality standards. Therefore, the staff finds that the Grand Gulf ESP site air quality conditions should not be a significant factor in the design and operating bases for the ESP facility.

2.3.2.4 Conclusions

As set forth above, the applicant has presented and substantiated information on local meteorological, air quality, and topographic characteristics of importance to the safe design and operation of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site. The staff has reviewed the available information provided and, for the reasons given, concludes that the applicant's identification and consideration of the meteorological, air quality, and topographical characteristics of the site and the surrounding area meet the requirements of 10 CFR Part 100, 10 CFR 100.20(c), and 10 CFR 100.21(d) and are sufficient to determine the acceptability of the site.

The staff also reviewed available information relative to severe local weather phenomena at the site and in the surrounding area. As set forth above, the staff concludes that the applicant has identified the most severe local weather phenomena at the site and surrounding area.

2.3.3 Onsite Meteorological Measurements Program

2.3.3.1 Technical Information in the Application

In Section 2.3.3 of the SSAR, the applicant presented information concerning its onsite meteorological measurements program, including instrumentation and measured data. Specifically, the applicant provided the following information:

- a description of meteorological instrumentation, including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, and data acquisition and reduction procedures

- meteorological data, including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions

The applicant used the existing onsite meteorological measurements program for the GGNS facility to collect data for the Grand Gulf ESP site. According to the applicant, data collection (except for the humidity data) has been compliant with the applicable requirements of RG 1.23 since the startup of the GGNS onsite monitoring system in 1972.

The GGNS meteorological monitoring program has evolved over the years. A 162-foot tower was first installed before plant construction in August 1972. The tower was located approximately 5300 feet north-northwest of the center of the GGNS Unit 1 reactor and approximately 3600 feet north of the center of the proposed Grand Gulf ESP powerblock area. The tower structure consisted of approximately 4-foot-wide by 6-foot-long scaffolding with a set of climbing stairs running up the center. The instrumentation on this tower was upgraded and a 33-foot backup tower was installed approximately 300 feet south-southwest of the primary tower in 1983 as part of the initial licensing conditions for GGNS Unit 1.

Wind speed and direction were measured at the 33-foot and 162-foot elevations. Ambient temperature and dew point were measured at the 33-foot elevation, and vertical temperature difference (delta-temperature) was measured between the 162-foot and 33-foot elevations. Precipitation was monitored at the ground level.

Because of concerns that the width of the primary tower would affect the wind speed and direction measurements, the wind sensors on the primary tower had redundant/duplicate sensors located on the opposite face of the tower. Strip chart recorders located in the instrument shed near the base of the tower recorded data; in addition, data from one set of instruments were sent to the plant data system (PDS) for data display and recording.

The primary and backup tower structures were replaced in March 2001. A 162-foot guyed, triaxial, open lattice (18-inch-wide) tower was installed at the location of the 33-foot backup tower, and a 33-foot open lattice backup tower was installed at the location of the 162-foot scaffolding tower. Instrumentation on both towers was also replaced as part of the 2001 system upgrade. The new primary tower sensors are located at the same heights as on the previous tower (i.e., at the 33-foot and 162-foot levels). However, unlike the previous primary tower, the new primary tower has only one set of wind sensors. Redundant wind instrumentation is no longer necessary since the new tower's structure should have little to no effect on the wind measurements (because of the new tower structure's narrower face). The 33-foot dew point sensor was also replaced with a relative humidity sensor as part of the instrumentation upgrade.

The wind sensors on the new tower are mounted on 6-foot booms and are oriented towards the west. The temperature and relative humidity sensors are housed in motor-aspirated shields to insulate them from the effects of precipitation and thermal radiation.

Before 2001, the meteorological data were recorded in both digital and analog form. Digital data averages were calculated each hour from 1-second readings. The analog traces recorded on strip charts served as a backup and verification for the digital data. Beginning in 2001, the meteorological data are recorded digitally from readings taken at least once every 10 seconds. Data averages are calculated every 15 minutes and every hour. The applicant used the resulting 2002–2003 hourly digital database to perform the atmospheric dispersion analyses presented in Sections 2.3.4 and 2.3.5 of the SSAR.

The meteorological monitoring system is calibrated at least semiannually. The data recovery for the 2002–2003 period of record used to evaluate atmospheric dispersion is more than 90 percent.

In RAI 2.3.2-2, the staff asked the applicant to specify the proposed locations of the two different options under consideration for normal heat sink cooling (i.e., the four natural draft cooling towers and the four mechanical draft cooling towers) and identify their potential influence on the onsite meteorological measurement system. In its response to this RAI, the applicant stated that the closest natural draft cooling tower at its proposed location would be approximately 1400 feet from the current meteorological tower location. The applicant also stated that wake effects and potential plume interaction could affect the meteorological tower if the natural draft cooling towers were to be constructed at their proposed locations and the existing meteorological tower were to remain at its current location. The natural draft cooling tower option would be the only option with potential for wake effects.

In RAI 2.3.2-5, the staff asked the applicant to provide an hourly listing of the onsite meteorological database used to generate the SSAR Section 2.3.4 short-term diffusion estimates and the SSAR Section 2.3.5 long-term diffusion estimates. In its response to this RAI, the applicant provided a copy of the hourly database for 1996–2003.

2.3.3.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant stated that the NRC regulations that apply to evaluation of an ESP include Appendix I to 10 CFR Part 50, 10 CFR 100.20, and 10 CFR 100.21. The staff notes that 10 CFR 100.20(c), 10 CFR 100.21(c), and 10 CFR 100.21(d) are the applicable 10 CFR Part 100 regulations as they relate to meteorological data collected for use in characterizing the site's meteorological characteristics. The staff also notes that Appendix I to 10 CFR Part 50 pertains to the meteorological data used to determine compliance with the numerical guides for doses in meeting the criterion of "as low as is reasonable achievable" (ALARA).

In SSAR Sections 1.0, 1.4, and 2.3.3, the applicant identified the following applicable NRC guidance regarding onsite meteorological measurements programs:

- RG 1.23, with respect to criteria for an acceptable onsite meteorological measurements program

- RG 1.70, with respect to describing the meteorological measurements at the site and providing joint frequency distributions of wind speed and direction by atmospheric stability class

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

Both RG 1.23 and RS-002, Section 2.3.3, document the criteria for an acceptable onsite meteorological measurements program. The onsite meteorological measurements program should produce data that describe the meteorological characteristics of the site and its vicinity for the purpose of making atmospheric dispersion estimates for both postulated accidental and expected routine airborne releases of effluents, and for comparison with offsite sources to determine the appropriateness of climatological data used for design considerations.

Section 2.3.3 of RS-002 and Section 2.3.3 of RG 1.70 provide guidance on information appropriate for presentation on an onsite meteorological measurements program. As set forth in this guidance, at least one annual cycle of onsite meteorological data should be provided. These data should be presented in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class in the format described in RG 1.23. If a site has a high occurrence of low wind speeds, a finer category breakdown should be used for the lower speeds so data are not clustered in a few categories. A listing of each hour of the hourly averaged data should also be provided on electronic media in the format described in Appendix A to Section 2.3.3 of RS-002. Evidence of how well these data represent long-term conditions at the site should be discussed.

2.3.3.3 Technical Evaluation

The staff evaluated the onsite meteorological measurements program by reviewing the description presented in the SSAR and conducting a site visit. During the site visit, the staff reviewed the meteorological monitoring system location and exposure, sensor type and performance specifications, data transmission and recording, data acquisition and reduction, and instrumentation maintenance and calibration procedures. In addition, the staff reviewed hourly listings of the 2002–2003 meteorological database provided by the applicant in its response to RAI 2.3.2-5. The applicant used the 2002–2003 database to generate the SSAR Section 2.3.4 short-term diffusion estimates and the SSAR Section 2.3.5 long-term diffusion estimates.

The Grand Gulf ESP site is within the existing GGNS site, and the proposed ESP facility is intended to be in close proximity to the existing GGNS facility. The GGNS primary tower is located far enough away from existing plant structures to preclude any adverse impact on measurements. Since the 2001 system upgrade, the wind sensors are mounted on 6-foot booms to preclude tower influence on the wind measurements. The temperature and relative humidity sensors are housed in motor-aspirated shields to insulate them from the effects of precipitation and thermal radiation. The ground cover at the base of the tower consists primarily

of native grasses. Trees 50 feet tall are located approximately 362 feet to the west of the primary tower, and 50-foot to 60-foot trees are located approximately 396 feet to the east and 489 feet to the south of the primary tower. RS-002, Section 2.3.3, states that wind sensors should be at least 10 obstruction heights away from any obstructions (such as trees) to avoid potential influence on wind measurements. Although these trees are located within 10 times their height from the primary tower, their influence is not considered to be significant in that they are at least 6 times their height from the tower. According to the applicant, all trees within a 900-foot radius of the primary tower are scheduled to be trimmed back in the near future.

The staff evaluated the types and heights of the meteorological variables measured and found them to be compatible with the criteria of RG 1.23. During the site visit, the staff reviewed the sensor types and performance specifications, data transmission, and recording methods, as well as the inspection, maintenance, and calibration procedures and frequencies, and found them to be consistent with the guidance in RG 1.23.

The applicant based the short-term and long-term diffusion estimates presented in Revision 0 of SSAR Sections 2.3.4 and 2.3.5 on onsite meteorological data recorded from January 1996 through December 2000. However, a review of this meteorological data set by the staff revealed that wind data collected during this period show an apparent lack of easterly winds as compared to the August 1972 through July 1974 GGNS onsite meteorological data set presented in the GGNS UFSAR.

This apparent lack of easterly winds in the 1996–2000 data set may be the result of tower “shadowing” from the wide scaffolding tower used during this period. Although redundant/duplicate wind sensors were located on the opposite face of the tower, the PDS recorded only one set of these data during this period. The data recorded by the PDS were a function of an A/B switch located in the instrument shed at the base of the tower, and its setting was probably never changed during the 1996–2000 recording period. It appears that data from both sets of wind instruments were appropriately used to compile the 1972–1974 wind data presented in the GGNS UFSAR. These earlier data probably predate the use of the PDS and were most likely compiled from the strip charts.

Therefore, since the narrower triaxial tower replaced the wide scaffolding tower in March 2001, the staff asked the applicant in RAI 2.3.2-5 to recalculate the short-term and long-term diffusion factors presented in SSAR Sections 2.3.4 and 2.3.5 using meteorological data collected by the GGNS monitoring program since the 2001 system upgrade. In its response to RAI 2.3.2-5, the applicant revised the requested atmospheric diffusion factors using GGNS site meteorological data for 2002–2003.

The staff performed a quality review of the 2002–2003 hourly meteorological database provided by the applicant using the methodology described in NUREG-0917, “Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data,” issued July 1982. The staff performed further review using computer spreadsheets. As expected, its examination of the data revealed generally stable and neutral atmospheric conditions at night and unstable and neutral conditions during the day. Wind speed, wind direction, and stability class frequency distributions for each measurement channel were reasonably similar from year to year and generally consistent with the 1972–1976 data presented in the GGNS UFSAR. A comparison between the joint frequency distribution used by the applicant as input to the PAVAN and XOQDOQ atmospheric dispersion computer codes and a staff-generated joint frequency distribution from the hourly database provided by the applicant showed that they were similar.

For the reasons cited above, the staff considers the meteorological data collected by the GGNS monitoring program since the 2001 system upgrade to be representative of the dispersion conditions at the Grand Gulf ESP site.

In its response to RAI 2.3.2-2, the applicant stated that, should natural draft cooling towers be constructed in the proposed location and the existing meteorological tower remain in its current location, the meteorological tower could experience wake effects, potential plume interactions, and other impacts. Therefore, the issue of interaction between the existing meteorological tower and the proposed facility's cooling towers should be evaluated following the finalization of the cooling tower design and placement. This is **COL Action Item 2.3-1.**

2.3.3.4 Conclusions

As set forth above, the applicant has provided and substantiated information regarding the onsite meteorological measurements program. The staff has reviewed the available information relative to the meteorological measurements program and the data collected by the program. On the basis of this review and as set forth above, the staff concludes that the system provides data adequate to represent onsite meteorological conditions, as required by 10 CFR 100.20. The onsite data collected from 2002–2003 provide an acceptable basis for (1) making estimates of atmospheric dispersion for DBA and routine releases from a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site and (2) meeting the requirements of 10 CFR Part 100 and Appendix I to 10 CFR Part 50.

2.3.4 Short-Term Diffusion Estimates

2.3.4.1 Technical Information in the Application

In Section 2.3.4 of the SSAR, the applicant presented information on atmospheric dispersion estimates for postulated accidental airborne releases of radioactive effluents to the EAB and LPZ. Specifically, the applicant provided the following information:

- atmospheric transport and diffusion models to calculate dispersion estimates (atmospheric dispersion factors or χ/Q values) for postulated accidental radioactive releases
- meteorological data summaries used as input to dispersion models
- specification of diffusion parameters

- probability distributions of χ/Q values

- determination of χ/Q values used for assessment of consequences of postulated radioactive atmospheric releases from design-basis and other accidents

The applicant used the computer code PAVAN (NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design-Basis Accidental Releases of Radioactive Materials

from Nuclear Power Stations," issued November 1982) to estimate χ/Q values at the EAB and LPZ for potential accidental releases of radioactive material. The PAVAN model implements the methodology outlined in RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," issued November 1982.

The PAVAN code estimates χ/Q values for various time-averaging periods ranging from 2 hours to 30 days. The meteorological input to PAVAN consists of a joint frequency distribution of wind speed, wind direction, and atmospheric stability data. The PAVAN code computes χ/Q values at the EAB and LPZ for each combination of wind speed and atmospheric stability for each of the 16 downwind direction sectors. The code then ranks χ/Q values for each sector in descending order, and it derives an associated cumulative frequency distribution based on the frequency distribution of wind speed and stabilities for that sector. The χ/Q value that is equaled or exceeded 0.5 percent of the total time is determined for each sector, and the highest 0.5 percentile χ/Q value among the 16 sectors becomes the maximum sector-dependent χ/Q value. The code also ranks χ/Q values independent of wind direction into a cumulative frequency distribution for the entire site. The PAVAN program then selects the χ/Q value that is equaled or exceeded 5 percent of the total time. The larger of the two values, the maximum sector-dependent 0.5-percent χ/Q value or the overall site 5-percent χ/Q value, is used to represent the χ/Q value for a 0–2-hour time period.

To determine χ/Q values for longer time periods, PAVAN calculates annual average χ/Q values. Logarithmic interpolation is then used between the 0–2-hour χ/Q values and the annual average χ/Q values to calculate the values for intermediate time periods (i.e., 8 hours, 16 hours, 72 hours, and 624 hours).

In RAI 2.3.4-2, the staff asked the applicant to provide a copy of the PAVAN computer code input and output files used to generate the EAB and LPZ χ/Q values presented in SSAR Section 2.3.4. The applicant complied with this request in its response to this RAI.

The applicant used the following input data and assumptions in applying the PAVAN model to the Grand Gulf ESP site:

- Revision 0 to the SSAR presents PAVAN results using a joint frequency distribution of wind speed, wind direction, and atmospheric stability data based on onsite meteorological data from January 1996 through December 2000. The wind data were obtained from the 33-foot level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 162-foot and 33-foot levels of the GGNS onsite meteorological tower. As discussed in Section 2.3.3.3 of this SER, a review of this data set by the staff revealed that wind data collected during this period show an apparent lack of easterly winds as compared to the August 1972 through July 1974 GGNS onsite meteorological data set presented in the GGNS UFSAR. In RAI 2.3.2-5, the staff asked the applicant to recalculate the short-term dispersion estimates presented in SSAR Section 2.3.4 using meteorological data collected by the GGNS monitoring program since the 2001 system upgrade. In its response to this RAI, the applicant revised the requested short-term atmospheric dispersion estimates using GGNS site meteorological data for 2002–2003.

- The applicant modeled one ground-level release point and did not take credit for building wake effects.

- SSAR Section 2.1.2 states that the EAB for the new facility consists of a circle of approximately 0.52-mile (841-meter) radial distance from the circumference of a 630-foot (192-meter) radius circle encompassing the proposed powerblock location for the new facility. Thus, the minimum distance to the EAB from any individual new reactor sited within the 630-foot circle would be 0.52 miles (841 meters). Therefore, the applicant used an EAB distance of 841 meters as input to the PAVAN computer code.

- Likewise, SSAR Section 2.1.3.4 states that the LPZ for the new facility consists of a circle of approximately 2-mile (3219-meter) radial distance from the circumference of a 630-foot (192-meter) radius circle encompassing the proposed powerblock location for the new facility. Thus, the minimum distance to the LPZ from any individual new reactor sited within the 630-foot (192-meter) circle would be 2 miles (3219 meters). Therefore, the applicant used an LPZ distance of 3219 meters as input to the PAVAN computer code.

Based on the PAVAN modeling results, the applicant proposed the short-term atmospheric dispersion site characteristics presented in Table 2.3.4-1 for inclusion in an ESP, should one be issued for the applicant's proposed Grand Gulf ESP site.

Table 2.3.4-1 Applicant's Proposed Short-Term (Accident Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
0–2-H χ/Q Value @ EAB (5%)	$5.95\times10^{!4}$ s/m^3	The atmospheric dispersion factors used in the safety analysis to estimate dose consequences of accidental airborne releases
0–8-H χ/Q Value @ LPZ (5%)	$8.83\times10^{!5}$ s/m^3	
8–24-H χ/Q Value @ LPZ (5%)	$6.16\times10^{!5}$ s/m^3	
1–4-Day χ/Q Value @ LPZ (5%)	$2.82\times10^{!5}$ s/m^3	
4–30-Day χ/Q Value @ LPZ (5%)	$9.15\times10^{!6}$ s/m^3	

2.3.4.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant stated that the NRC regulations that apply to the evaluation of an ESP include 10 CFR 100.21. The staff notes that 10 CFR 100.21 is the applicable NRC regulation regarding short-term (accident release) dispersion estimates with respect to the meteorological considerations used in the evaluation to determine an acceptable exclusion area and LPZ.

In SSAR Sections 1.0, 1.4, and 2.3.4, the applicant identified the following applicable NRC guidance regarding short-term dispersion estimates:

- RG 1.23, with respect to criteria for an acceptable onsite meteorological measurements program
- RG 1.70, with respect to providing conservative estimates of atmospheric dispersion at the EAB and LPZ, based on the most representative meteorological data and impacts caused by local topography

- RG 1.145, with respect to acceptable methods for choosing χ/Q values for evaluating the consequences of potential accidents

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

In SSAR Sections 1.4 and 2.3.4, the applicant identified RG 1.145 as describing methods acceptable to the staff for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of DBA releases. Use of the PAVAN model described in NUREG/CR-2858 is acceptable.

Section 2.3.4 of RS-002 and Section 2.3.4 of RG 1.70 provide guidance on information appropriate for a presentation on short-term (accident release) dispersion estimates. According to this guidance, the application should present the following:

- conservative estimates of atmospheric transport and diffusion conditions at appropriate distances from the source for postulated accidental releases of radioactive materials to the atmosphere

- a description of the atmospheric dispersion models used to calculate χ/Q values in air resulting from accidental releases of radioactive material to the atmosphere, with models documented in detail and substantiated within the limits of the model so that the staff can evaluate their appropriateness to site characteristics, plant characteristics (to the extent known), and release characteristics

- the meteorological data used for the evaluation (as input to the dispersion models) that represent annual cycles of hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release

- an explanation of the variation of atmospheric diffusion parameters used to characterize lateral and vertical plume spread (σ_y and σ_z) as a function of distance, topography, and atmospheric conditions, as related to measured meteorological parameters, and a description of a methodology for establishing these relationships that is appropriate for estimating the consequences of accidents within the range of distances that are of interest with respect to site characteristics and established regulatory criteria

- cumulative probability distributions of χ/Q values and the probabilities of exceeding these χ/Q values, presented for appropriate distances (e.g., the EAB and LPZ) and time periods as specified in Section 2.3.4.2 of RG 1.70, as well as an adequate description of the methods used for generating these distributions

- the χ/Q values used for assessing the consequences of atmospheric radioactive releases from design-basis and other accidents

2.3.4.3 Technical Evaluation

The applicant generated its atmospheric dispersion estimates for postulated accidental airborne releases of radioactive effluents to the EAB and LPZ using the staff-endorsed computer code PAVAN. The staff evaluated the applicability of the PAVAN model and concluded that no unique topographic features preclude the use of PAVAN for the Grand Gulf ESP site. The staff also reviewed the applicant's input to the PAVAN computer code, including the assumptions used concerning plant configuration and release characteristics, and the appropriateness of the meteorological data input. The staff found that the applicant made conservative assumptions by ignoring building wake effects and treating all releases as ground-level releases. The staff independently evaluated the resulting atmospheric dispersion estimates by running the PAVAN computer model and obtained similar results.

From this review, the staff concludes that the applicant has used an adequately conservative atmospheric dispersion model and appropriate meteorological data to calculate χ/Q values for appropriate offsite (EAB and LPZ) distances and directions from postulated release points for accidental airborne releases of radioactive materials.

In order to evaluate atmospheric dispersion characteristics with respect to radiological releases to the control room, detailed design information (e.g., vent heights, intake heights, distance and direction from release vents to the room) is necessary. Because little detailed design information is available for the nuclear power plant or plants that might be constructed on the proposed site, the COL or CP applicant should assess the dispersion of airborne radioactive materials to the control room at the COL or CP stage. This is **COL Action Item 2.3-2.**

The staff intends to include the short-term (accident release) atmospheric dispersion estimates listed in Table 2.3.4-2 as site characteristics in any ESP permit that might be issued for the site.

Table 2.3.4-2 Staff's Proposed Short-Term (Accident Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
0–2-H χ/Q Value @ EAB	5.95×10^{-4} s/m^3	The 0–2-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the EAB
0–8-H χ/Q Value @ LPZ	8.83×10^{-5} s/m^3	The 0–8-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
8–24-H χ/Q Value @ LPZ	6.16×10^{-5} s/m^3	The 8–24-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
1–4-Day χ/Q Value @ LPZ	2.82×10^{-5} s/m^3	The 1–4 day-atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
4–30-Day χ/Q Value @ LPZ	9.15×10^{-6} s/m^3	The 4–30-day atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ

2.3.4.4 *Conclusions*

As set forth above, the applicant has made conservative assessments of post-accident atmospheric dispersion conditions using its meteorological data and appropriate dispersion models. The applicant has calculated representative atmospheric transport and diffusion conditions for the EAB and the LPZ. The staff has reviewed the applicant's proposed short-term atmospheric dispersion site characteristics for inclusion in an ESP for the applicant's site, should one be issued, and, as discussed above, finds these characteristics to be acceptable. Therefore, the staff concludes that the applicant's atmospheric dispersion estimates are appropriate for the assessment of consequences from radioactive releases for postulated (i.e., design-basis) accidents, in accordance with 10 CFR 100.21.

Based on these considerations, the staff concludes that the applicant's short-term atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR Part 100. The staff will address atmospheric dispersion estimates used to evaluate radiological doses for the control room in its review of any COL or CP application that references this information.

2.3.5 Long-Term Diffusion Estimates

2.3.5.1 *Technical Information in the Application*

In Section 2.3.5 of the SSAR, the applicant presented its atmospheric dispersion estimates for routine releases of effluents to the atmosphere. Specifically, the applicant provided the following information:

- the atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material to the atmosphere
- the meteorological data used as input to diffusion models
- diffusion parameters
- relative concentration (χ/Q) and relative deposition (D/Q) values used to assess the consequences of routine airborne radioactive releases
- points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations

The applicant used the NRC-sponsored computer code XOQDOQ (NUREG/CR-2919, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," issued September 1977) to estimate χ/Q and D/Q values resulting from routine releases. The XOQDOQ model implements the methodology outlined in RG 1.111, Revision 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," issued July 1977.

In RAI 2.3.5-1, the staff asked the applicant to provide a copy of the XOQDOQ computer code input and output files used to generate the χ/Q values presented in SSAR Section 2.3.5. The applicant complied with this request.

The applicant used the following input data and assumptions in applying the XOQDOQ model for the Grand Gulf ESP site:

- Revision 0 to the SSAR presents XOQDOQ results using a joint frequency distribution of wind speed, wind direction, and atmospheric stability data based on onsite meteorological data from January 1996 through December 2000. The wind data were obtained from the 33-foot level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 162-foot and 33-foot levels of the GGNS onsite meteorological tower. As discussed in Section 2.3.3.3 of this SER, a review of this data set by the staff revealed that wind data collected during this period show an apparent lack of easterly winds as compared to the August 1972 through July 1974 GGNS onsite meteorological data set presented in the GGNS UFSAR. In RAI 2.3.2-5, the staff asked the applicant to recalculate the long-term dispersion estimates presented in SSAR Section 2.3.5 using meteorological data collected by the GGNS monitoring program since the 2001 system upgrade. In its response to this RAI, the applicant revised the requested long-term atmospheric dispersion estimates using GGNS site meteorological data for 2002–2003.
- The applicant modeled one ground-level release point and took no credit for building wake effects.

In Revision 0 to the SSAR, the applicant presented annual average undepleted/no decay and depleted/no decay χ/Q values and D/Q values for the site boundary and special receptors of interest (e.g., nearest home and garden within 5 miles in each downwind sector), as determined from the locations given in the GGNS 2001 Land Use Census. In Open Item 2.3-5, the staff noted that the receptor locations listed in SSAR Table 3.2-3A include the nearest milk cow and the nearest meat cow and requested that the applicant provide the χ/Q and D/Q values for these receptor locations. The applicant provided the requested information in its response to Open Item 2.3-5.

Table 2.3.5-1 lists the long-term atmospheric dispersion estimates that the applicant derived based on the XOQDOQ modeling results.

Table 2.3.5-1 Applicant's Long-Term (Routine Release) Dispersion Estimates

TYPE OF LOCATION	X/Q VALUE (s/m^3)		D/Q VALUE (1/m^2)
	NO DECAY UNDEPLETED	NO DECAY DEPLETED	
Site Boundary	8.8×10^{-6} (0.85 mi WSW)	7.8×10^{-6} (0.85 mi WSW)	1.2×10^{-8} (0.58 mi N)
Nearest Home	2.2×10^{-6} (0.81 mi N)	1.9×10^{-6} (0.81 mi N)	7.0×10^{-9} (0.64 mi NNE)

Nearest Garden	2.0×10^{-6} (1.05 mi SSW)	1.7×10^{-6} (1.05 mi SSW)	5.4×10^{-9} (0.63 mi ENE)
Nearest Milk Cow	7.0×10^{-8} (10 mi SSW)	4.7×10^{-8} (10 mi SSW)	8.7×10^{-11} (10 mi SSW)
Nearest Meat Cow	1.4×10^{-7} (4 mi S)	1.1×10^{-7} (4 mi S)	4.0×10^{-10} (4 mi S)

2.3.5.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant stated that the NRC regulations that apply to the evaluation of an ESP include Appendix I to 10 CFR Part 50 and 10 CFR 100.21. The staff notes that Appendix I to 10 CFR Part 50 is the applicable NRC regulation regarding the demonstration of compliance with the numerical guides for doses contained in this appendix by characterizing atmospheric transport and diffusion conditions in order to estimate the radiological consequences of routine releases of materials to the atmosphere. The staff also notes that 10 CFR 100.21 requires that site atmospheric dispersion characteristics be evaluated and dispersion parameters be established such that radiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site can be met for any individual located off site.

In SSAR Sections 1.0, 1.4, and 2.3.5, the applicant identified the following applicable NRC guidance regarding long-term dispersion estimates:

- RG 1.70 relates to providing realistic estimates of annual average atmospheric transport and diffusion characteristics to a distance of 50 miles from the plant, including a detailed description of the model used and a calculation of the maximum annual average χ/Q values at or beyond the site boundary for each venting location.

- RG 1.109, Revision 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," issued October 1977, presents identification criteria to be used for specific receptors of interest (applicable at the ESP stage to the extent the applicant provides receptors of interest).

- RG 1.111 describes acceptable methods for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine releases. Use of the XOQDOQ model described in NUREG/CR-2919 is acceptable.

The staff finds that the applicant should have also identified RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," issued May 1977, with respect to the criteria to be used to identify release points and release characteristics (applicable to the extent the applicant provides release points and release characteristics at the ESP stage).

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

Section 2.3.5 of RS-002 and Section 2.3.5 of RG 1.70 provide the following guidance on information appropriate for a presentation on long-term (routine release) atmospheric dispersion estimates:

- The applicant should provide a description of the atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material to the atmosphere. The models should be sufficiently documented and substantiated to allow a review of their appropriateness for site characteristics, plant characteristics (to the extent known), and release characteristics.

- The applicant should discuss the relationship between atmospheric diffusion parameters, such as vertical plume spread (σ_z), and measured meteorological parameters. The applicant should substantiate the use of these parameters in terms of the appropriateness of their use in estimating the consequences of routine releases from the site boundary to a radius of 50 miles from the plant site.

- The applicant should provide the meteorological data used as input to the dispersion models. Data used for this evaluation should represent hourly average values of wind speed, wind direction, and atmospheric stability, which are appropriate for each mode of release. The data should reflect atmospheric transport and diffusion conditions in the vicinity of the site throughout the course of a year.

- The applicant should provide the χ/Q and D/Q values used for assessing the consequences of routine radioactive gas releases, as described in Section 2.3.5.2 of RG 1.70.

- The applicant should identify points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations (if available at the ESP stage). Bounding values for these parameters may be provided at the ESP stage. In such a case, the applicant will need to confirm, at the COL or CP stage, that the parameters provided at the ESP stage bound the actual values provided at the COL or CP stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.

2.3.5.3 Technical Evaluation

The applicant generated its atmospheric diffusion estimates for routine airborne releases of radioactive effluents to the site boundary and special receptors of interest using the staff-endorsed computer code XOQDOQ. The staff evaluated the applicability of the XOQDOQ model and concluded that no unique topographic features preclude the use of the XOQDOQ model for the Grand Gulf ESP site. The staff also reviewed the applicant's input to the XOQDOQ computer code, including the assumptions it used concerning plant configuration and release characteristics and the appropriateness of the meteorological data input. The staff found that the applicant made conservative assumptions by treating all releases as ground-level releases and ignoring building wake effects. The staff made an independent evaluation of the resulting atmospheric diffusion estimates by running the XOQDOQ computer model and obtaining similar results.

From this review, the staff concludes that the applicant used an appropriate atmospheric dispersion model and adequate meteorological data to calculate χ/Q and D/Q values at appropriate distances from postulated release points for the evaluation of routine airborne releases of radioactive material. Any COL or CP applicant referencing this information should verify that the specific release point characteristics (e.g., release height and building wake dimensions) and specific locations of receptors of interest (e.g., distance and direction to nearest home, garden, meat animal, and milk animal) used to generate the ESP long-term (routine release) atmospheric dispersion site characteristics bound the actual values provided at the COL or CP stage. This is **COL Action Item 2.3-3.**

The staff intends to include the long-term (routine release) atmospheric dispersion and deposition factors listed in Table 2.3.5-2 as site characteristics in any ESP that the NRC might issue for the Grand Gulf ESP site.

Table 2.3.5-2 Staff's Proposed Long-Term (Routine Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average Undepleted/No Decay χ/Q Value @ Site Boundary	8.8×10^{-6} s/m^3	The maximum annual average site boundary undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Site Boundary	7.8×10^{-6} s/m^3	The maximum annual average site boundary depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Site Boundary	1.2×10^{-8} 1/m^2	The maximum annual average site boundary D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Home	2.2×10^{-6} s/m^3	The maximum annual average home undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Home	1.9×10^{-6} s/m^3	The maximum annual average home depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Home	7.0×10^{-9} 1/m^2	The maximum annual average home D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Garden	2.0×10^{-6} s/m^3	The maximum annual average garden undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Garden	1.7×10^{-6} s/m^3	The maximum annual average garden depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Garden	5.4×10^{-9} 1/m^2	The maximum annual average garden D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Milk Cow	7.0×10^{-8} s/m^3	The maximum annual average milk cow undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Milk Cow	4.7×10^{-8} s/m^3	The maximum annual average milk cow depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average D/Q Value @ Nearest Milk Cow	8.7×10^{-11} 1/m^2	The maximum annual average milk cow D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Meat Cow	1.4×10^{-7} s/m^3	The maximum annual average meat cow undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Meat Cow	1.1×10^{-7} s/m^3	The maximum annual average meat cow depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Meat Cow	4.0×10^{-10} 1/m^2	The maximum annual average meat cow D/Q value for use in determining gaseous pathway doses to the maximally exposed individual

2.3.5.4 Conclusions

As set forth above, the applicant has provided meteorological data and an atmospheric dispersion model that are appropriate for the characteristics of the site and release points. The applicant has calculated representative atmospheric transport and diffusion conditions for 16 radial sectors from the site boundary to a distance of 50 miles, as well as for specific receptor locations. The staff has reviewed the long-term atmospheric dispersion estimates that the applicant proposed for inclusion as site characteristics in an ESP for its site (should one be issued) and, for the reasons set forth above, finds these estimates to be acceptable. Therefore, the staff concludes that the applicant has provided the information needed to address the requirements of 10 CFR 100.21(c)(1).

Based on these considerations, the staff concludes that the applicant's characterization of long-term atmospheric transport and diffusion conditions is appropriate for use in demonstrating compliance with the numerical guides for doses contained in Appendix I to 10 CFR Part 50.

The applicant provided bounding values for points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations. Any COL or CP applicant must confirm that the parameters provided at the ESP stage bound the actual values provided at the COL or CP stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.