# 2.0 SITE CHARACTERISTICS

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# 2.0 SITE CHARACTERISTICS

This chapter of the application describes the site-specific characteristics that could affect the safe design and siting of the plant.

## 2.1S Geography and Demography

### 2.1S.1 Site Location and Description

#### 2.1S.1.1 *Introduction*

This section of the Final Safety Analysis Report (FSAR) addresses the site boundaries and location of the site with respect to prominent natural and manmade features. This information demonstrates that the applicant has accurately described and appropriately used site characteristics in the plant design and operating criteria.

#### 2.1S.1.2 *Summary of Application*

Section 2.1 of the South Texas Project (STP) Units 3 and 4 combined license (COL) FSAR incorporates by reference Section 2.1 of the certified Advanced Boling-Water Reactor (ABWR) design control document (DCD) Revision 4, referenced in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor," with no departures. In addition, in FSAR Section 2.1S.1, the applicant provides site-specific information on site location and a description that addresses COL License Information Item 2.3 as summarized below:

*COL License Information Item*

- COL License Information Item 2.3 Site Location and Description

COL License Information Item 2.3 addresses the provision of site-specific information including political subdivisions, natural and manmade features, population, highways, railways, waterways, and other significant features of the area.

This site-specific supplement included in the FSAR describes the following:

- Specification of State, county, and political subdivisions, in which the site is located, and location of the site with respect to natural and manmade prominent features (i.e., rivers, lakes; industrial, military, and transportation facilities); and

- Universal Transverse Mercator (UTM) co-ordinates (zone number, northing, and easting), meters; and latitude and longitude.

- Site Area Map consisting of the following:

  - Plant property lines, stating the area of plant property (in square kilometers [$km^2$] [acres]);

- Location of site boundary, and location and orientation of principal plant structures within the site area (e.g., reactor building, auxiliary building, and turbine building);

- Location of any industrial, military, or transportation facilities and commercial, institutional, recreational, or residential structures within site area;

- Exclusion area distance (meters/feet) in all 16 cardinal compass directions;

- Scale that permits measurement of distances;

- True north; and

- Prominent natural and manmade features in the site area.

### 2.1S.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling-Water Reactor Design," (FSER related to the ABWR DCD).

In addition, the relevant requirements of the Commission regulations for the site location and description, and the associated acceptance criteria, are in Section 2.1.1 of NUREG–0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, (LWR Edition)," the Standard Review Plan (SRP). The regulatory basis for reviewing COL License Information Item 2.3 is in Section 2.1.1 of NUREG–0800.

NRC staff considered the following regulatory requirements in reviewing the applicant's discussion of site location and description:

1. 10 CFR Part 50, "Domestic Licensing Of Production And Utilization Facilities," and 10 CFR Part 52, as applicable in the final safety analysis report (FSAR) of a detailed description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design (10 CFR 50.34(a)(1) and 10 CFR 52.79(a)(1)).

2. 10 CFR Part 100, "Reactor Site Criteria," as it relates to the following: (1) defining an exclusion area and setting forth requirements regarding activities in that area (10 CFR 100.3), (2) addressing and evaluating factors that are used in determining the acceptability of the site as identified in 10 CFR 100.2(b), (3) determining an exclusion area such that certain dose limits would not be exceeded in the event of a postulated fission product release as identified in 10 CFR 50.34(a)(1) as it relates to site evaluation factors identified in 10 CFR Part 100, and (4) requiring that the site location and the engineered features included as safeguards against the hazardous consequences of an accident, should one occur, should ensure a low risk of public exposure.

Additional Regulatory Requirements include:

1. Specification of Location: The information submitted by the applicant is adequate and meets the requirements in 10 CFR 50.34(a)(1) and 10 CFR 52.79(a)(1) if it describes highways, railroads, and waterways that traverse the exclusion area in sufficient detail to allow the reviewer to determine that the applicant has met the requirements in 10 CFR 100.3.

2. Site Area Map: The information submitted by the applicant adequate and meets the requirements in 10 CFR 50.34(a)(1) and 10 CFR 52.79(a)(1) if it describes the site location, including the exclusion area and the location of the plant within the area, in sufficient detail to enable the reviewer to evaluate the applicant's analysis of a postulated fission product release, thereby allowing the reviewer to determine (in SRP Sections 2.1.2 and 2.1.3 and in SRP Chapter 15) that the applicant has met the requirements in 10 CFR 50.34(a)(1) and 10 CFR 100.3.

### 2.1S.1.4 *Technical Evaluation*

As documented in NUREG–1503, NRC staff reviewed and approved Section 2.1 of the certified ABWR DCD. The staff reviewed Section 2.1S.1 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ABWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to geography and demography.

The staff reviewed the information in the COL FSAR:

*COL License Information Item*

- COL License Information Item 2.3 Site Location and Description

Specific information provided by the applicant to address COL License Information Item 2.3 includes:

    - The site layout and boundary for the proposed STP Units 3 and 4 to be built on the site with respect to the existing STP Units 1 and 2

    - The site location with respect to political subdivisions and prominent natural and manmade features of the area within the 8.0-km (5-mile [mi]) low population zone (LPZ), 4.8-km (3-mi) LPZ and 80.5-km (50-mile) population zones

NRC staff independently estimated and verified the latitude and longitude and UTM coordinates of the proposed STP Units 3 and 4 as provided in the FSAR.

Based on the staff's review of the information addressed in the STP Units 3 and 4 FSAR, and also the staff's confirmatory review of pertinent information generally available in literature and information collected during a site visit, the staff found that the applicant has provided information with regard to the site location that is adequate and acceptable.

The applicant provided the following information regarding the site area description:

- The topography and characteristics of the land surrounding the site for the proposed units

- The commercial, industrial, institutional, recreational, and residential structures located within the site area

1 See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

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

- The distance of proposed STP Units 3 and 4 to be built from regional, Federal, and State highways, railroads, and waterways that traverse or lie adjacent to the site. There are no recreational areas located within the STP site.

Except for STP Units 1 and 2, no commercial, industrial, institutional, recreational, or residential structures are located within the STP site area.

No highways, railroads, or waterways traverse the exclusion area. No commercial, industrial, institutional, recreational, or residential structures are located within the STP site area. Therefore, there is no likelihood of any interference with normal plant operations from these sources.

Based on the staff's review of the site area information addressed in the FSAR, observations of the surrounding area of the STP site, and a review of the general information collected from the local officials during the site visit, the applicant's information with regard to the site location and area description is considered adequate and acceptable to allow the staff to evaluate whether the applicant meets the relevant requirements of 10 CFR 52.79 (a) (1) and 10 CFR Part 100 and satisfies the acceptance criteria specified in Section 2.1.1 of NUREG–0800. The staff verified that the EAB distance is consistent with the distance the applicant has used in the radiological consequence analyses described in Chapter 15 and in Section 13.3 of the FSAR.

The staff reviewed the applicant's proposal using the review procedures described in Section 2.1.1 of NUREG–0800.

### 2.1S.1.5 *Post Combined License Activities*

There are no post COL activities related to this section.

### 2.1S.1.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the site location and description that were incorporated by reference have been resolved.

The staff's review confirmed that the applicant has adequately addressed the COL license information item in accordance with Section 2.1.1 of NUREG–0800, which can be considered closed.

The staff concluded that the applicant has provided sufficient information to support the determination of the acceptability of the site.

## 2.1S.2 Exclusion Area Authority and Control

### 2.1S.2.1 *Introduction*

This section of the FSAR addresses the exclusion area authority and control. The applicant's legal authority to determine and control activities within the designated exclusion area is described. This authority establishes that the applicant has the authority to determine all activities, including exclusion and removal or personnel and property from the area. This section also describes mineral rights and easements within the area.

### 2.1S.2.2 *Summary of Application*

In Section 2.1S.2 of the STP Units 3 and 4 COL FSAR, the applicant provides site-specific information on exclusion area authority and control to address COL License Information Item 2.4 as summarized below.

*COL License Information Item*

- COL License Information Item 2.4 Exclusion Area Authority and Control

COL License Information Item 2.4 addresses the provision of site-specific information related to activities that may be permitted within the designated exclusion area.

The site-specific supplement included in the FSAR describes the following:

- Establishment of authority, which determines the legal authority of the land, mineral rights, and easements
- Legal authority over all activities, including exclusion and removal of personnel and property from the area
- Minimum distance and direction of EABs for present and proposed ownership
- Activities unrelated to plant operation that are permitted in the EAB—their location, the nature of the activities, number of people involved, and plans for evacuation in the event of an emergency
- Traffic control arrangements on highways, railroads and waterways traversing through the EAB in the event of an emergency
- Procedures for abandonment, relocation, and understandings with other authorities for control

### 2.1S.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1503. In addition, the relevant requirements of the Commission regulations for the exclusion area authority and control, and the associated acceptance criteria, are in Section 2.1.2 of NUREG-0800. The regulatory basis for reviewing COL License Information Item 2.4 is in Section 2.1.2 of NUREG–0800.

The staff considered the following regulatory requirements in reviewing the applicant's discussion of exclusion area authority and control:

1. 10 CFR Part 50 and 10 CFR Part 52, as they relate to the inclusion in the FSAR of a detailed description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design (10 CFR 50.34(a)(1), 10 CFR 52.79(a)(1), and 10 CFR 52.79(a)(1))

2. 10 CFR Part 100, as it relates to the following: (1) defining an exclusion area and setting forth requirements regarding activities in that area (10 CFR 100.21(a), 10 CFR 100.3), (2) addressing and evaluating factors that are used in determining the acceptability of the site as identified in 10 CFR 100.20(b), and (3) determining an exclusion area such that certain dose limits would not be exceeded in the event of a postulated fission product release as identified in 10 CFR 50.34(a)(1) as it relates to site evaluation factors identified in 10 CFR Part 100

Specific regulatory requirements include:

1. Establishment of Authority: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 50.33, 10 CFR 50.34(a)(1), 10 CFR 52.79, and 10 CFR Part 100 if it provides sufficient detail to enable the staff to evaluate the applicant's legal authority within the designated exclusion area.

2. Exclusion or Removal of Personnel and Property: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 50.33, 10 CFR 50.34(a)(1), 10 CFR 52.79, and 10 CFR Part 100 if it provides sufficient detail to enable the staff to evaluate the applicant's legal authority for the exclusion or removal of personnel or property from the exclusion area.

3. Proposed and Permitted Activities: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 50.33, 10 CFR 50.34(a)(1), 10 CFR 52.79, and 10 CFR Part 100 if it provides sufficient detail to enable the staff to evaluate the applicant's legal authority over all activities within the designated exclusion area.

### 2.1S.2.4 *Technical Evaluation*

As documented in NUREG–1503, NRC staff reviewed and approved Section 2.1 of the certified ABWR DCD. The staff reviewed Section 2.1S.2 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ABWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to exclusion area authority and control.

The staff reviewed the information in the COL FSAR:

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

*COL License Information Item*

- COL License Information Item 2.4 Exclusion Area Authority and Control

The NRC staff's review of COL License Information Item 2.4 follows. Specific information provided by the applicant to address the COL license information item includes:

- Complete legal authority to regulate access and activity within the entire plant exclusion area
- Identification of facilities within the EAB that have authorized activities unrelated to plant operation, and emergency planning
- Arrangements for traffic control
- Abandonment or relocation of roads

The STP participants (NRG Energy, CPS, City of Austin) own the land, including the mineral rights within the site boundary except for the rights of way for the public roads (Farm-to-Market Road [FM] 521, County Road 392 extending from FM 521 and adjacent to the western boundary of the site, and County Road 360, branching off the northeast corner of FM 521 as it loops around the site for meteorological tower access). The site boundary encompasses the designated EAB for STP Units 3 and 4. STP participants have delegated to the STP Nuclear Operating Company (STPNOC) the authority to determine all activities within the EAB, including the exclusion and removal of personnel and property. STPNOC has authority over the EAB in the event of an emergency for the protection of public health and safety.

NRC staff verified the applicant's description of the exclusion area and the authority under which all activities within the exclusion area can be controlled. The staff also verified for consistency the EAB that is being considered for the radiological consequences in Chapter 15 and Section 13.3 of the FSAR by the applicant. The staff concluded that the applicant has the required authority to control all activities within the designated exclusion area.

No person or entity is allowed to reside, build, or conduct other activities within the designated EAB for STP Units 3 and 4 without STPNOC's approval. The applicant stated that the facilities within the EAB in which authorized activities occur are the Visitor Center, which is located inside the Nuclear Training Facility, and the Nuclear Training Facility itself. The Nuclear Training Facility is located inside the owner-controlled area and the EAB, but outside of the guard posts. All non-essential individuals in the EAB, including those in the Visitor Center, will be evacuated consistent with emergency planning procedures in the event of an emergency.

The staff verified that the emergency procedures for the EAB are addressed in Chapter 13.3 of this safety evaluation report (SER).

No Federal, State, or county roads or railways traverse the STP EAB. Therefore, there is no need for arrangements for traffic control.

Since there are no public roads within the STP Units 3 and 4 EAB, there is no need to consider abandonment or relocation of roads. The staff reviewed the applicant's proposal using the review procedures described in Section 2.1.2 of NUREG–0800.

#### 2.1S.2.5 *Post Combined License Activities*

There are no post COL activities related to this section.

#### 2.1S.2.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the exclusion area authority and control that were incorporated by reference have been resolved.

The staff's review confirmed that the applicant has adequately addressed the COL license information item in accordance with Section 2.1.2 of NUREG–0800.

The staff concluded that the applicant has provided sufficient information for satisfying 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100.

### 2.1S.3 Population Distribution

#### 2.1S.3.1 *Introduction*

This section of the FSAR addresses the population distribution in the site vicinity. The review covers the following specific areas: population data, exclusion area, LPZ, nearest population center boundary, and population density.

#### 2.1S.3.2 *Summary of Application*

In Section 2.1S.3 of the STP Units 3 and 4 COL FSAR, the applicant provides site-specific information on population distribution to address COL License Information Item 2.5 as summarized below.

<u>*COL License Information Item*</u>

- COL License Information Item 2.5 Population Distribution

This site-specific supplement included in the FSAR describes the following:

- Population data in the site vicinity, including transient populations
- Population projections in the year of plant approval and 5 years thereafter
- Population data consisting of information that includes the following:
    - Maps showing concentric circles with distances 1.6, 3.2, 4.8, 6.4, 8.0, and 16.1 km (1, 2, 3, 4, 5, and 10 mi) from the center of reactor units having background identifying cities, towns, and counties within around 16.1 km (10 mi); the circles are divided into 16 cardinal directions (e.g., true north through north-northwest)
    - A table providing current resident population with each area of the map formed by concentric circles and radial distances within 16.1 km (10 mi)

- Projected population within 16.1 km (10 mi) in similar tabular form for the first year of plant operation

- Decennial projected population within 16.1 km (10 mi) through plant life in similar tabular form-description of the basis of and methodology for population projections and population data sources, including projections

Tables and maps of suitable scale will depict the population distribution, including projections at 16.1-km (10-mi) intervals between 16.1- and 80.5-km (10- and 50-mi) radii from the center of the units for the first year of operation through plant life on the same decennial basis.

Also included are:

- Descriptions of seasonal variations in population due to activities, such as recreational and industrial activities, and inclusion of this population in current and projected population determinations

- Evacuation plans for any residents

- Evacuation plans in case of a potential accident

- Nearest population center boundary (having 25,000 or more residents) is at least one and one-third times the distance from the reactor units to the outer boundary of the LPZ

- Population density within 32.2 km (20 mi) is less than 193 people per square kilometer (500 people per square mile) to be consistent with the guidelines in Regulatory Position C.4 of Regulatory Guide (RG) 4.7, Revision 2, "General Site Suitability Criteria for Nuclear Power Stations."

This site-specific supplement addresses COL License Information Item 2.5 of the ABWR DCD. COL License Information Item 2.5 from the certified ABWR DCD addresses the provision of population data for the site environs.

### 2.1S.3.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is in NUREG–1503. In addition, the relevant requirements of the Commission regulations for the population distribution, and the associated acceptance criteria, are in Section 2.1.3 of NUREG–0800. In particular, the relevant regulatory requirements are in 10 CFR Part 100.

The staff considered the following regulatory requirements in reviewing the applicant's discussion of site location and description:

1. 10 CFR 50.34(a)(1), as it relates to consideration of the site evaluation factors identified in 10 CFR 100.3, 10 CFR Part 100 (including consideration of population density), 10 CFR 52.79, as they relate to provisions from the applicant in the FSAR of the existing and projected future population profile of the area surrounding the site.

2. 10 CFR 100.20 and 10 CFR 100.21, as they relate to determining the acceptability of a site for a power reactor. In 10 CFR 100.3, 10 CFR 100.20(a), and 10 CFR 100.21(b), the NRC

provides definitions and other requirements for determining an exclusion area, an LPZ, and population center distances

Specific acceptance criteria include:

1. Population Data: The population data supplied by the applicant in the FSAR is acceptable under the following conditions: (1) the FSAR contains population data from the latest census and projected populations in the year of plant approval and 5 years thereafter, in the geographical format 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)," and in accordance with RG 1.206 "Combined License Applications for Nuclear Power Plants (LWR Edition)," (2) the SAR describes the methodology and sources used to obtain the population data, including the projections; (3) the SAR includes information on transient populations in the site vicinity.

2. Exclusion Area: The exclusion area should either not contains any residents or residents should be subject to immediate evacuation, if necessary as cited in NUREG–0800, Section 2.1.3.

3. Low-Population Zone: 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 as cited in NUREG–0800, Section 2.1.3.

4. Nearest Population Center Boundary: The nearest boundary of the closest population center containing 25,000 or more residents is at least one and one-third times the distance from the reactor to the outer boundary of the LPZ as cited in NUREG–0800, Section 2.1.3.

5. Population Density: If the population density exceeds the guidelines given in Regulatory Position C.4 of RG 4.7, the applicant must give special attention to the consideration of alternative sites with lower population densities.

### 2.1S.3.4 *Technical Evaluation*

As documented in NUREG–1503, the staff reviewed and approved Section 2.1 of the certified ABWR DCD. The staff reviewed Section 2.1S.3 of the STP Units 3 and 4 COL FSAR and checked the referenced ABWR DCD to ensure that the combination of the information in the COL FSAR and the information in the ABWR DCD appropriately represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference address the required information relating to population distribution.

The staff reviewed the information in the COL FSAR:

*COL License Information Item*

- COL License Information Item 2.5 Population Distribution

The staff reviewed the specific information provided by the applicant to address COL License Information Item 2.5.

[1] See *"Finality of Referenced NRC Approvals"* in SER Section 1.1.3, for a discussion on the staff's review related to verification of the scope of information to be included in a COL application that references a design certification

The staff noted that there are no residents in the exclusion area. The staff also reviewed the projected population data provided by the applicant. The population projections have been verified for consistency with the population projections addressed in Section 13.3 of this SER as part of emergency planning and preparedness. The staff also made confirmatory population projection estimates. The staff found the applicant's methodology for estimating population projections appropriate, reasonable, and acceptable.

Due to uncertainty in estimating the transient population between 16.1 and 80.5 km (10 and 50 mi) of the site and also due to the relatively small size of the expected transient population, the transient population is assumed to be insignificant compared with the residential population within an 80.5-km (50-mile) radius. Therefore, no transient population is considered between 16.1 and 80.5 km (10 and 50 mi) from the site. The staff found the applicant's estimate reasonable and acceptable.

The staff reviewed and confirmed the following information supplied by the applicant related to the LPZ for STP Units 3 and 4.

- The LPZ for STP Units 3 and 4 is the same as the LPZ for STP Units 1 and 2, and consists of the area within a 4.8-km (3-mi) radius of a point 93 meters (m) (305 feet [ft]) directly west of the center of the Unit 2 containment.
- No towns, facilities, or institutions requiring special considerations for emergency planning purposes such as schools, nursing homes, hospitals, prisons, or major employers (other than STP) are known to exist within the LPZ or out to a distance of 8 km (5 mi).
- No transient or seasonal populations were identified in the LPZ. STP Units 3 and 4 FSAR Figure 2.1S26 shows topographical features of the LPZ.
- The total population within the LPZ for the years 2000 through 2080 can be seen in FSAR Figures 2.1S-7 through 2.1S-15.
- The applicant evaluated representative design-basis accidents (DBAs) in Chapter 15 of Units 3 and 4 COL FSAR, as discussed in Chapter 15 of this SER, to demonstrate that the radiological consequences of DBAs at the proposed site are within the dose limits in 10 CFR 50.34(a)(1) as required by 10 CFR 100.21(c).

NRC staff verified that the closest population center having a population greater than 25,000 is Bay City, Texas, located approximately 19.2 km (12 mi) north-northeast of the STP site (well in excess of one and one-third times the distance of 4.8 km (3 mi) from the reactor to the outer boundary of the LPZ [10 CFR 100.21(b)]). Therefore, the staff concluded that the proposed site meets the population center distance requirement as defined in 10 CFR Part 100, Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications On or After January 10, 1997."

Based on the staff's verification of the applicant's projected population data and population densities, assuming initial plant approval in the year 2015 and the start of plant operation in 2020, the staff found that the population density is well below the population density criterion of 193 persons per $km^2$ (500 persons per $mi^2$) averaged out to 32.2 km (20 mi) from the STP site. Therefore, the staff found that the application is consistent with Regulatory Position C.4 of RG 4.7, Revision 2.

#### 2.1S.3.5 *Post Combined License Activities*

There are no post COL activities related to this section.

#### 2.1S.3.6 *Conclusion*

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. NRC staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix A, Section VI.B.1, all nuclear safety issues relating to the population distribution that were incorporated by reference have been resolved.

The staff's review confirmed that the applicant has adequately addressed the COL license information item in accordance with Section 2.1.3 of NUREG–0800.

The staff concluded that the applicant has addressed the relevant information for satisfying 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100.

## 2.2S <u>Nearby Industrial, Transportation, and Military Facilities</u>

### 2.2S.1 Locations and Routes and Descriptions (Related to RG 1.206 Section C.I.2.2.1, "Locations and Routes," and Section C.I.2.2.2, "Descriptions")

#### 2.2S.1.1 *Introduction*

Sections 2.2S.1, "Locations and Routes," and 2.2S.2, "Descriptions," of the FSAR address the identification of potential hazards in the site vicinity. These sections describe potential external hazards or hazardous materials that are present or may reasonably be expected to be present during the projected lifetime of the proposed plant.

#### 2.2S.1.2 *Summary of Application*

In Sections 2.2S.1 and 2.2S.2 of the COL FSAR, the applicant provides site-specific information on locations and routes to address COL License Information Item 2.6 as summarized below.

<u>*COL License Information Item*</u>

- COL License Information Item 2.6 Identification of Potential Hazards in Site Vicinity

COL License Information Item 2.6 addresses the provision for information about industrial, military, and transportation facilities and routes to establish the presence and magnitude of potential external hazards.

The applicant identifies and addresses the potential hazard facilities and routes within the vicinity (8 km [5 mi]) of STP Units 3 and 4 and airports within 16.1 km (10 mi) of the STP, along with other significant facilities beyond 8 km (5 mi), in accordance with RG 1.206 and relevant sections of 10 CFR Parts 50 and 100.

This site-specific supplement included in the FSAR addresses information that describes the following:

- Maps showing the location and distances from the nuclear units of all significant manufacturing plants, chemical plants, storage facilities, transportation routes (air, land, and water), transportation facilities, oil and gas pipelines, drilling operations, and extraction wells

- Maps showing the facilities handling toxic, flammable, and explosive substances; nearby aircraft flight, holding, and landing patterns that may have the potential for adverse effects

- A concise description of:

    - information on each facility including its primary function, major products, and the number of persons employed

    - the products and materials regularly handled, stored, used, or transported in the vicinity of the plant or on site

    - hazardous materials, including toxicity limits

    - statistical data on the amounts involved; modes of transportation; frequency of shipment; and the maximum quantity of hazardous materials likely to be processed, stored, or transported

    - pipelines; indication of pipe size, age, operating pressure, depth of burial, location, and type of isolation valves and type of gas or liquid being transported

    - navigable waterway information, including location of intake structures in relation to the shipping channel; the depth of the channel; the location of locks; the types of ships or barges using the waterway; and any nearby docks and anchorages

    - major highways and/or other roadways including the types of hazardous materials, the frequency of the transports, and the quantities being transported by truck in the vicinity of the STP site

    - identification of nearby railroads and information on the frequency and quantities of hazardous materials transported in the vicinity of the site

    - information on the length and orientation of runways, types of aircraft using the facility, number of operations per year by aircraft type, and the flying patterns associated with the airport

    - all airports within 8 km (5 mi) of the site

    - airports with projected operations greater than 500 x $d^2$ (where “d” is distance in miles from the site) movements per year within 16.1 km (10 mi) of the plant; and

    - airports with projected operations greater than 1,000 x $d^2$ (where “d” is distance in miles from the site) movements per year beyond 16.1 km (10 mi) from the plant.

Equivalent information is included for aviation routes, pilot training areas, and landing and approach paths to airports and military facilities.

### 2.2S.1.3 *Regulatory Basis*

The regulatory requirements of the Commission regulations for the nearby industrial, transportation, and military facilities, and the associated acceptance criteria, are in Section 2.2.1-2.2.2 of NUREG–0800. In particular the regulatory requirements are 10 CFR 100.20(b) and 10 CFR 52.79(a)(1)(iv).

Also, the acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements in 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100.

The staff considered the following regulatory requirements in reviewing the applicant's discussion of site location and description:

> 10 CFR 100.20(b), which requires that the nature and proximity of human-related hazards (e.g., airports, dams, transportation routes, military and chemical facilities) be evaluated to establish site parameters for use in determining whether plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low
>
> 10 CFR 52.79(a)(1)(iv), as it relates to the factors to be considered in the evaluation of sites that require the location and description of industrial, military, or transportation facilities and routes, and of 10 CFR 52.79(a)(1)(vi) as it relates to compliance with 10 CFR Part 100

Specific acceptance criteria include:

> Data in the FSAR adequately describe the locations of and distances from the plant of nearby industrial, military, and transportation facilities and that such data are in agreement with data obtained from other sources, when available.
>
> Descriptions of the nature and extent of activities conducted at the site and in its vicinity, including the products and materials likely to be processed, stored, used, or transported, are adequate to permit identification of the possible hazards cited in Subsection III of Section 2.2.1-2.2.2 of NUREG–0800.
>
> Sufficient statistical data with respect to hazardous materials are provided to establish a basis for evaluating the potential hazards to the plant or plants considered at the site.

### 2.2S.1.4 *Technical Evaluation*

NRC staff reviewed the FSAR, Sections 2.2S.1 and 2.2S.2 using the review procedures described in Section 2.2.1-2.2.2 of NUREG–0800.

*COL License Information Item*

- COL License Information Item 2.6 Identification of Potential Hazards in Site Vicinity

**Locations and Routes**

The applicant identified and provided information of potential external hazard facilities and operations within 8 km (5 mi) of STP Units 3 and 4 which include five industrial facilities, five natural gas transmission pipelines, five chemical pipelines, four natural gas gathering pipelines, and five active natural gas and/or oil fields with active extraction wells. Major transportation routes within the vicinity of the site include four roads, two airways, and one navigable waterway.

The location of these facilities and road and waterway transportation routes are shown in STP Units 3 and 4, FSAR Figure 2.2S-1 and include:

- Industrial Facilities Within 8 km (5 mi) of the site
  - OXEA Corporation (formerly known as Celanese)
  - Port of Bay City Operations
  - Gulfstream Terminal and Marketing
  - GulfMark Energy
  - STP Units 1 and 2

- transportation routes within 8 km (5 mi)
  - FM 521
  - FM 1095
  - FM 1468
  - FM 3057
  - Colorado River (Waterway).

The location of natural gas and chemical pipelines and active natural gas and/or oil extraction fields are illustrated in STP Units 3 and 4, FSAR Figure 2.2S-2, and include:

- Natural Gas Transmission pipelines
  - Dow Pipeline Company
  - Houston Pipeline Company, L.P.
  - Penn Virginia Oil & Gas, L.P.
  - Texas Eastern Transmission, L.P.
  - Enterprise Products Operating, L.P.

- Chemical Pipelines
  - Seadrift Pipeline Corporation (ethylene gas)
  - OXEA Corporation (propylene)
  - OXEA Corporation (oxygen)
  - OXEA Corporation (nitrogen)
  - OXEA Corporation (ethylene)

- Natural Gas Gathering Pipelines
  - Acock/Anaqua Operating Co., L.P.
  - Houston Pipeline Company, L.P.
  - Kinder Morgan Tejas Pipeline, L.P.
  - Santos USA Corporation

- Natural Gas/Oil Extraction Fields
  - Duncan Slough

- Cane Island
- Petrucha
- Grand Slam
- Wadsworth

STP Units 3 and 4 FSAR Figure 2.2S-1 illustrates industrial facilities and transportation routes within 16.1 km (10 mi) of the site and includes industrial facilities within 8.0 to 16.1 km (5 to 10 mi), Equistar Industries, and the Matagorda Waste Disposal and Water Supply Corporation (WWTP).

STP Units 3 and 4 FSAR Figure 2.2S-3 illustrates airports and airway routes within 16.1 km (10 mi) of the site and includes airport and airway routes within 16.1 km (10 mi) of the site, the STP Corporate Helipad, Airway V-70, and Airway V-20.

**Descriptions**

The industrial facilities and transportation routes identified and addressed above are described as follows:

*Descriptions of Facilities*

The six facilities described include: STP Units 1 and 2, OXEA Corporation, Gulfstream Terminal and Marketing LLC, GulfMark Energy, Equistar, and Matagorda Waste Disposal and Waste Water Supply Corporation. FSAR Table 2.2S-1 provides concise descriptions of and information about each facility.

*Descriptions of Products and Materials*

STP Units 1 and 2 are located approximately 457 m (1,500 ft) southeast of STP Units 3 and 4. There are approximately 1,300 people currently employed at STP Units 1 and 2. The chemicals identified for possible analysis and their locations at STP Units 1 and 2 are presented in FSAR Table 2.2S-2.

OXEA Corporation is a chemical manufacturing facility located approximately 6.9 km (4.3 mi) north-northeast of STP Units 3 and 4. A variety of chemical products are produced at the site, including organic chemicals (basic and industrial), cyclic organic crudes, organic dyes, and pigments. OXEA employs 260 persons. FSAR Table 2.2S-3 summarizes the quantity of hazardous materials currently stored at the plant and the applicable toxicity limits.

OXEA Corporation receives and ships materials by rail, truck, barge, and pipeline. The facility ships tank rail cars on the Union Pacific rail line spur that travels from Bay City to Blessing. Tank rail cars are also shipped on the Burlington Northern Santa Fe rail line that runs east from the plant’s main line and then to Bay City. The tank trucks are shipped and received via FM 3057 and FM 2668. Neither the truck nor the rail transport routes approach closer to STP Units 3 and 4 than the storage location of the chemicals at OXEA. OXEA Corporation also ships materials in barges along the Colorado River. Approximately 360 barges per year transit the Colorado River. There are four pipelines that carry products into the plant.

The Port of Bay City is a port facility located adjacent to OXEA Corporation along the Colorado River, approximately 7.4 km (4.6 mi) north-northeast of STP Units 3 and 4. There are two facilities located at this Port: Gulfstream Terminal and Marketing LLC and GulfMark Energy.

Gulfstream Terminal and Marketing LLC receives barge shipments of refined petroleum products such as gasoline and diesel fuel and stores the products until they are delivered by truck to retail terminals. FSAR Table 2.2S-3 summarizes the maximum quantity of potentially hazardous materials stored at the terminal and the applicable toxicity limits. Gulfstream employs four workers.

GulfMark Energy is also located 7.4 km (4.6 mi) north-northeast of STP Units 3 and 4 at Bay City. This terminal is used to receive, store, and transfer petroleum crude oil and condensate. The facility has an average monthly inventory of 1987.5 $m^3$ (12,500 barrels). The oil is offloaded in 28.6 $m^3$ (180-barrel [7,560 gallon]) truckloads. FSAR Table 2.2S-3 summarizes the maximum quantity of potentially hazardous materials stored at the terminal and the applicable toxicity limits.

Equistar Chemicals (Equistar), a subsidiary of Lyondell Chemical Company, is located 11.3 km (7 mi) east of STP Units 3 and 4. Equistar employs 194 people and produces high-density polyethylene (HDPE) plastic resins. This facility receives and ships materials by both rail and truck. Truck transport is via State Highway 60 due to bridge limitations on FM 521. Chemicals are stored or situated at distances greater than 8 km (5 mi) from the plant.

Matagorda Waste Disposal and Water Supply Corporation are located approximately 14.5 km (9 mi) southeast of STP Units 3 and 4. Matagorda employs 3 workers and receives chemicals for treatment by truck transport via State Highway 60. Chemicals are stored or situated beyond 8 km (5 mi) from the STP site.

*Descriptions of Pipelines and Natural Gas/Oil Fields*

There are five natural gas transmission pipelines, five chemical pipelines, four natural gas gathering pipelines, and five natural gas and/or oil fields with active extraction wells within 8 km (5 mi) of STP Units 3 and 4 as depicted in FSAR Figure 2.2S-2. Information pertaining to these pipelines is also presented in FSAR Table 2.2S-4.

The natural gas transmission pipelines that may also serve the following gas and/or oil fields—Duncan Slough, Cane Island, Petrucha, Grand Slam, and Wadsworth—are described below:

Dow Chemical Company operates two natural gas transmission pipelines at the closest distance of 3.2 km (2 mi) northwest of STP Units 3 and 4. Dow Collegeport has a 32.4-centimeter (cm) (12.75-inch [in.]) diameter pipeline with an operating pressure of 3.25 megapascals gauge (MPaG) (471 pounds per square inch gauge [psig]), and Dow Powderhorn has a 40.6-cm (16-in.) diameter pipeline with an operating pressure of 5.2 MPaG (760 psig). Both are buried at a depth of 0.9 to 3.0 m (3 to 10 ft).

The Houston Pipeline Company operates a natural gas transmission pipeline that passes within 4.5 km (2.8 mi) north of STP Units 3 and 4. The pipeline is 21.9 cm (8.63 in.) in diameter with an operating pressure of 4.0 MPaG (575 psig). The pipeline is buried at a depth of 0.6 to 0.9 m (2 to 3 ft) with a distance of 11.3 to 12.9 km (7 to 8 mi) between isolation valves.

The Penn Virginia Oil & Gas operates a natural gas transmission pipeline 11.4 cm (4.5 in.) in diameter that passes within 6.1 km (3.8 mi) northeast of STP Units 3 and 4.

Texas Eastern Transmission operates a 76.2-cm (30-in.) natural gas transmission pipeline that passes within 6.8 km (4.2 mi) north of STP Units 3 and 4.

Enterprise Products Operating operates a 21.9-cm (8.63-in.) natural gas transmission pipeline that passes within 6.8 km (4.2 mi) north of STP Units 3 and 4, with an operating pressure of 5.2 MPaG (750 psig). The pipeline is buried at an average depth of 94 cm (37 in.).

The chemical pipelines include the following:

- Seadrift Pipeline Company operates an 11.4-cm (4.5-in.) diameter nitrogen pipeline buried at a depth of 0.9 to 3.0 m (3 to 10 ft), with an operating pressure of 10.3 MPaG (1,494 psig), 5.6 km (3.5 mi) north of STP Units 3 and 4.

- OXEA Corporation owns a 16.8-cm (6.63-in.) propylene line buried at a depth of 96.5 to 101.6 cm (38 to 40 in.), with an operating pressure of 6.0 MPaG (875 psig). The pipeline delivers products into the OXEA plant and passes within 6.9 km (4.3 mi) north-northeast of STP Units 3 and 4.

- Air Liquide operates a 32.4-cm (12.75-in.) oxygen pipeline to the OXEA plant, buried at a depth of 96.5 to 101.6 cm (38 to 40 in.) with an operating pressure of 6.0 MPaG (875 psig). The pipeline passes within 6.9 km (4.3 mi) north-northeast of STP Units 3 and 4. Air Liquide also operates another 27.3-cm (10.75-in.) nitrogen pipeline to the OXEA plant.

- Equistar operates a 27.3-cm (10.75-in.) ethylene pipeline to the OXEA plant buried at a depth of 1.2 to 1.8 m (4 to 6 ft), with an operating pressure of 6.9 to 9.0 MPaG (1,000 to 1,300 psig). The pipeline passes within 6.9 km (4.3 mi) north-northeast of STP Units 3 and 4.

The natural gas gathering pipelines are described as follows:

- Acock/Anaqua Operating Company operates an 11.4-cm (4.5-in.) natural gas gathering pipeline serving the South Duncan Slough field that terminates 2.1 km (1.3 mi) northwest of STP Units 3 and 4.

- The Houston Pipeline Company operates an 11.4-cm (4.5-in.) natural gas gathering pipeline serving the Duncan Slough field and passing within 5.3 km (3.3 mi) north of STP Units 3 and 4.

- The Kinder Morgan Tejas Pipeline Company operates 40.6-cm (16-in.) natural gas gathering pipeline that passes within 7.1 km (4.4 mi) northwest of STP Units 3 and 4.

- The Santos USA Corporation operates an 11.4-cm (4.5-in.) natural gas gathering pipeline that passes within 4.8 km (3 mile) north-northwest of STP Units 3 and 4.

*Descriptions of Waterways*

The STP site with Units 3 and 4 is located approximately 5.1 km (3.2 mi) from the west bank of the Colorado River, a navigable waterway. From the Gulf Intracoastal Waterway, the river winds along a 25.1 km (15.6-mi) stretch until it approaches the turning basin located at the Port of Bay City facility, approximately 7.4 km (4.6 mi) north-northeast of STP Units 3 and 4. The Port of Bay City is the only dock/anchorage located within 8 km (5 mi) of the STP site.

The Colorado River is used primarily for barge traffic. During 2005, there was a total of 208 barge and 314 tanker inbound trips, and 211 barge and 322 tanker outbound trips are recorded.

These vessels primarily used the river for the transportation of raw and finished materials to local industrial facilities, predominantly OXEA Corporation and the Port of Bay City terminals. These commodities included 50,802 metric tons (56,000 short tons) of crude petroleum, 907 metric tons (1,000 short tons) of residual fuel oil, 115,212 metric tons (127,000 short tons) of alcohols, and 287,578 metric tons (317,000 short tons) of carboxylic acids. FSAR Table 2.2S-5 details the total quantity of hazardous materials transported on the Colorado River in the vicinity of STP Units 3 and 4.

*Descriptions of Highways*

Matagorda County is traversed by several highways. There are four FMs within 8 km (5 mi) of STP Units 3 and 4, as depicted in FSAR Figure 2.2S-1. FM 521 is the road with the closet approach to STP Units 3 and 4. At its closest point, FM 521 is approximately 0.6 km (0.4 mi) from STP Units 3 and 4 and runs in an east-west direction parallel to the STP site's northern fence. To the north of the STP site, FM 1468 runs in a north-south direction and intersects FM 521 approximately 1.6 km (1 mi) from STP Units 3 and 4. FM 521 intersects FM 1095, which also runs in a north-south direction and is approximately 6.8 km (4.2 mi) to the west of STP Units 3 and 4. Another road located in the vicinity of STP Units 3 and 4 is FM 3057, which runs in an east-west direction and is located north-northeast of STP Units 3 and 4. FM 3057 links OXEA Corporation with FM 2668. Each of the on-site chemicals that have the potential to explode or form a flammable or toxic vapor cloud was analyzed to determine a safe distance. FM 521 closest approach to the nearest safety-related structure is 595.9 m (1,955 ft), and to the nearest control room is 869.6 m (2,853 ft). The distance from the on-site chemical storage is closer compared to the distance from FM 521 to either the identified safety-related structure or control room.

*Descriptions of Railroads*

There are no railroads in the vicinity (8 km [5 mi]) of STP Units 3 and 4.

*Descriptions of Airports*

Only one helipad, the STP helipad, is located within the vicinity (8 km [5 mi]) of STP Units 3 and 4. An average of two to three corporate flights per year use the helipad.

There are no airports located within 8 km (5 mi) of the STP site. In addition, there are no airports within 16.1 km (10 mi) of the site with projected operations greater than 500 $d^2$ per year, or beyond 16.1 km (10 mi) with projected operations greater than 1,000 $d^2$ per year, where "d" is distance in statue miles from the site. The closest municipal airport is Palacios Municipal Airport with 3,000 operations per year. Although small, private airstrips may be present in this area, the flights are sporadic and do not pose a threat to the STP site.

The center line of Airway V-70 is approximately 5.6 km (3.5 mi) northwest of the STP site, and the center line of Airway V-20 is approximately 15.4 km (9.6 mi) northwest of the STP site, as depicted in FSAR Figure 2.2S-3. The width of a federal airway is 14.8 km (eight nautical miles), 6.4 km (4 mi) on each side of the center line, and this places the V-70 airway closer to the plant than 3.2 km (2 mi) to the nearest edge. Therefore, the probability of aircraft accidents due to operations along this Airway V-70 that could possibly result in radiological consequences for the STP site was estimated and met the NUREG–0800 criterion of about $10^{-7}$ per year.

*Projections of Industrial Growth*

Based on the Office of Economic Development and the NRC staff contact from the Chamber of Commerce, it is assumed that there are no known major plans to develop any industrial facilities within 8 km (5 mi) of the STP site. However, there would be some growth potential expected due to the construction and operation of STP Units 3 and 4.

#### 2.2S.1.5 *Post Combined License Activities*

There are no post COL activities related to this subsection.

#### 2.2S.1.6 *Conclusion*

The staff reviewed the information in Sections 2.2S.1 and 2.2S.2 of the COL FSAR against 10 CFR 100.20b and 10 CFR 52.79(a)(1)(iv) and found that the applicant has provided sufficient information with respect to the identification of potential hazards in the site vicinity.

The staff confirmed that the applicant has evaluated the nature and extent of activities involving potentially hazardous materials that are conducted at nearby industrial, military, and transportation facilities to identify any such activities that have the potential for adversely affecting plant safety-related structures.

The staff's review confirmed that the applicant has adequately addressed COL License Information Item 2.6 in accordance with Section 2.2.1-2.2.2 of NUREG–0800, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

Based on an evaluation of information in the COL FSAR as well as information that the staff independently obtained, the staff concluded that all potentially hazardous activities on site and in the vicinity of the plant have been identified. The hazards associated with these activities have been reviewed and are discussed in Sections 2.2S.3, 3.5.1.5, and 3.5.1.6 of this SER.

### 2.2S.2 Descriptions

This section of the FSAR is evaluated in SER Section 2.2S.1.

### 2.2S.3 Evaluation of Potential Accidents

#### 2.2S.3.1 *Introduction*

This section of the FSAR addresses the applicant's identification and evaluation of potential accident situations in the vicinity of the plant. The application includes probability analyses of potential accidents involving hazardous materials or activities on site and in the vicinity of the proposed site.

#### 2.2S.3.2 *Summary of Application*

In Section 2.2S.3 of the COL FSAR, the applicant provides a site-specific evaluation of information identified in COL FSAR Sections 2.2S.1 and 2.2S.2 for the potential accidents that should be considered as design-basis events, and potential effects of these accidents on the nuclear plant to address COL License Information 2.7 as summarized below.

*COL License Information Item*

- COL License Information Item 2.7 Evaluation of Potential Accidents

COL License Information Item 2.7 addresses the evaluation of potential accidents and their effects on the operation of STP Units 3 and 4.

Section 2.2S.3 of the STP Units 3 and 4 COL FSAR provides the following:

The applicant identifies and evaluates information regarding potential accidents considered as DBAs that may affect the STP Units 3 and 4 in terms of design parameters (e.g., overpressure or missile energies) and physical phenomena (e.g., concentration of flammable or toxic vapor clouds outside of the building structures). DBAs internal and external to the nuclear plant are defined as those accidents that have a probability of occurrence on the order of magnitude of $10^{-7}$ per year or greater with potential consequences serious enough to affect the safety of the plant to the extent that the guidelines in 10 CFR Part 100 could be exceeded.

This site-specific supplement included in the FSAR describes the following:

- Evaluation of hazards associated with nearby industrial activities, such as manufacturing, processing, or storage facilities

- Evaluation of hazards associated with nearby military activities, such as military bases, training areas, or aircraft flights

- Evaluation of hazards associated with nearby transportation routes (airways, highways, railways, navigable waters, and pipelines)

The principal types of hazards considered for evaluation with respect to each of the above areas include the following:

1. Toxic vapors or gases and their potential for incapacitating nuclear power plant control room operators

2. Overpressure resulting from explosions or detonations involving materials such as munitions, industrial explosives, or explosive vapor clouds resulting from the atmospheric release of gases with the potential for ignition and explosion

3. Missile effects attributable to mechanical impacts such as aircraft impacts, explosion debris, and impacts from waterborne items such as barges

4. Thermal effects attributable to fires

Based on the information provided in FSAR Sections 2.2S.1 and 2.2S.2 pertaining to the identification of potential hazards, the applicant determines the potential accidents that are to be considered DBAs and identifies the potential effects on the plant from those accidents in terms of design parameters (e.g., overpressure, missile energies) or physical phenomena (e.g., the concentration of a flammable or toxic cloud outside of the building structures).

Accident categories for selecting design-basis events include explosions, flammable vapor clouds, toxic chemicals, fires, collisions with intake structures, and liquid spills and cover the following:

Accidents involving detonations of high explosives, munitions, chemicals, or liquid and gaseous fuels for facilities and activities in the vicinity of the plant or on site, where materials are processed, stored, used, or transported in quantity are considered.

Accidental releases of flammable liquids or vapors that result in the formation of unconfined vapor clouds are considered.

Assuming no explosion occurs, the calculation of the extent of the cloud and concentration of gas that could reach the plant under the worst-case meteorological conditions is determined.

The releases of toxic chemicals from on-site storage facilities and nearby mobile and stationary sources are evaluated under the worst meteorological conditions. These calculated chemical concentrations are considered in the evaluation of control room habitability in Section 6.4 of the FSAR.

Accidents leading to high heat fluxes or smoke and nonflammable gas or chemical release as the consequence of fires in the vicinity of the plant are evaluated. Evaluation of fires in adjacent industrial and chemical plants, storage facilities, oil and gas pipelines, brush and forest fires, and fires from transportation accidents that lead to high heat fluxes or the formation of clouds are evaluated under the worst meteorological conditions. These calculated concentrations are considered in the evaluation of control room habitability in Section 6.4 of the FSAR.

For the navigable waterways, the evaluation considers the probability of and potential effects of impact on the plant cooling water intake structure and enclosed pumps from passing barges or ships, including any explosions incident to the collision.

The release of oil or liquids due to spills could affect the plant's safe operation are considered.

Particular attention is given to potential accidental explosions that could produce a blast overpressure of 6.9 kilopascals (kPa) (1 pound per square inch [psi]) or greater, using quantity-distance relationships.

This site-specific supplement addresses COL License Information Items 2.7, 2.8, and 2.42 from the ABWR DCD.

- COL License Information Item 2.7 Evaluation of Potential Accidents

This COL license information item identifies potential accident scenarios in the vicinity of the plant and the bases for which these potential accidents are or are not accommodated in the design.

- COL License Information Item 2.8 External Impact Hazards

This COL license information item addresses the review and evaluation of the effects on the protection criteria of some external impact hazards, such as general aviation or nearby explosions.

- COL License Information Item 2.42 CRAC 2 Computer Code Calculations

This COL license information item addresses the use of the CRAC-2 computer code to verify compliance with acceptance criteria, data input, and severe accident analyses for the determination of ABWR site acceptability for severe accidents. CRAC 2 computer code is replaced with MACCS2 computer code through Departure STD DEP 2.2-5, which in turn is evaluated in Chapter 19 of this SER.

### 2.2S.3.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the evaluation of potential accidents, and the associated acceptance criteria, are in Section 2.2.3 of NUREG–0800 and RG 1.91. The regulatory requirements for reviewing the COL license information items is 10 CFR 52.79(a)(1)(iv).

In particular, the staff considered the following regulatory requirements in reviewing the applicant's discussion of potential accidents:

10 CFR 52.79(a)(1)(iv) as it relates to the factors to be considered in the evaluation of sites, which require the location and description of industrial, military, or transportation facilities and routes and the requirements in 10 CFR 52.79(a)(1)(vi) as they relate to compliance with 10 CFR Part 100.

Specific regulatory requirements include:

<u>Event Probability</u> The identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant or plants of a specified type is acceptable, if all postulated types of accidents are included for which the expected rate of occurrence of potential exposures resulting in radiological dose in excess of the 10 CFR 50.34(a)(1) limits, as it relates to the requirements of 10 CFR Part 100, is estimated to exceed the NRC staff objective of an order of magnitude of $10^{-7}$ per year.

<u>Design-Basis Events</u> The effects of design-basis events have been adequately considered, in accordance with 10 CFR 100.20(b), if analyses of the effects of those accidents on the safety-related features of the plant or plants of a specified type have been performed and measures have been taken (e.g., hardening, fire protection) to mitigate the consequences of such events.

### 2.2S.3.4 *Technical Evaluation*

NRC staff reviewed the FSAR Section 2.2S.3 using the review procedures described in Section 2.2.3 of NUREG–0800.

*COL License Information Items*

- COL License Information Item 2.7 Evaluation of Potential Accidents
- COL License Information Item 2.8 External Impact Hazards

**Determination of Design-Basis Events**

The applicant analyzed postulated accidents for various types and considered the identified sources and locations of accidents in FSAR Section 2.2S.1, which includes the following:

- Explosions
- Flammable Vapor Clouds
- Release of Hazardous Chemicals (Toxic Chemicals)
- Fires
- Collision with Intake Structures
- Liquid Spills
- Radiological Hazards

*Explosions*

The applicant considers the potential for explosions resulting in blast overpressures due to detonation of explosives, munitions, chemicals, liquid fuels, and gaseous fuels for facilities and activities either on site or within the site vicinity of the proposed plant. The blast overpressure of 6.9 kPa (1 psi) that could adversely affect the plant operation or would prevent the safe shutdown of the plant from explosions from nearby railways, highways, navigable waterways, or facilities to safety-related structures were evaluated by the applicant. The value of 6.9 kPa (1 psi) of peak positive incident overpressure was considered based on RG 1.91, Revision 1, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants," below which no significant damage would be expected.

Onsite chemicals, offsite chemicals, and hazardous materials transported on navigable waterways are addressed in the STP Units 3 and 4 COL FSAR and in Tables 2.2S-6, 2.2S-7, and 2.2S-8, respectively. The applicant evaluates hazardous materials potentially transported on FM 521 and natural gas transported in pipelines to ascertain which hazardous materials have the potential to explode. The applicant states that the evaluations are in accordance with RG 1.91, Revision 1, conservative assumptions in NUREG–1805, "Fire Dynamics Tools (FTDs) Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program," and FSAR Reference FM Global ("Guidelines for Evaluating the Effects of Vapor Cloud Explosions Using a TNT Equivalency Method," Factory Mutual Insurance Company, May 2005). The effects of these explosion events in terms of minimum safe distances from internal and external sources are summarized in STP Units 3 and 4, FSAR Table 2.2S-9.

NRC staff conducted an independent analysis using RG 1.91, Revision 1, and the results were not comparable to the results submitted by the applicant. The staff issued a request for information (RAI) 02.02.03-1 asking for a more detailed explanation of the methodology the applicant used to perform the explosion analyses. The applicant's response to this RAI, dated May 29, 2008 (ML081560702), provides a detailed methodology that will be included as an appendix to the FSAR. The applicant's response points out that the use of RG 1.91 for atmospheric liquids is overly conservative, and the accompanying detailed methodology provides an alternative approach.

NRC staff reviewed the applicant's response to RAI 02.02.03-1 and found the approach to be generally reasonable. The staff performed confirmatory calculations using more conservative assumptions. With the more conservative assumptions, some of the results had greater minimum safe distances at which 6.9 kPa (1 psi) overpressure would not be exceeded than the applicant's calculated distances. Nevertheless, the staff's calculated distances were less than the corresponding minimum separation distance from the safety-related structure as indicated in RG 1.91, Revision 1. Therefore, the staff found that the chemicals, their quantities, and locations identified in the application pose no threat to the safe operation of the plant and confirmed the applicant's conclusion. The staff considers this RAI closed.

*Flammable Vapor Clouds (Delayed Ignition)*

Flammable materials in the liquid or gaseous state can form an unconfined vapor cloud that can drift toward the plant before an ignition event. Flammable chemicals released into the atmosphere can form vapor clouds, dispersing as they travel downwind, and the portion of the cloud in between the lower flammable limit (LFL) and upper flammable limit (UFL) may burn if the cloud encounters an ignition source. This encounter may lead to an explosion.

The applicant considered the potential chemicals pertaining to on-site and offsite chemical storage; hazardous materials transported on navigable waterways (presented in STP Units 3 and 4 FSAR Tables 2.2S-6, 2.2S-7, and 2.2S-8); and hazardous materials transported on FM 521. The applicant conducted an evaluation to ascertain which materials had the potential to form flammable vapor clouds and vapor cloud explosions. The applicant uses ALOHA and DEGADIS models in determining the distances for the vapor cloud to be present in the flammable range and the potential minimum distance not to exceed 6.9 kPa (1 psi) overpressure due to this vapor cloud explosion. The applicant presents the results of these analyses in STP Units 3 and 4 FSAR, Table 2.2S-10. The applicant concludes that a flammable vapor cloud with the possibility of ignition or explosion from any of the above addressed facilities and transportation routes will not adversely affect the safe operation or shutdown of STP Units 3 and 4.

To be able to perform independent confirmatory analyses for all of the chemicals/hazardous materials that the applicant addressed, NRC staff required further information regarding the inputs the applicant used in its modeling. RAI 02.02.03-2 and follow-up RAI 02.02.03-3 requested this additional information from the applicant. The applicant's responses to RAI 02.02.03-2, dated May 29, 2008 (ML081560702), and to RAI 02.02.03-3, dated October 27, 2008 (ML083040527), allowed the staff to perform the analyses using the ALOHA model (ALOHA, 2007). The staff used conservative assumptions in formulating the scenario and also in the ALOHA model analyses. The meteorological inputs used in the ALOHA modeling included F (stable) stability class with a wind speed of 1 m (3,3 ft) per second (representing the worst 5 percent of meteorological conditions); an ambient temperature of 25 degrees Celsius (C) (77 degrees Fahrenheit [F]); relative humidity of 50 percent; and a cloud cover of 50 percent. For each of the identified chemicals in the liquid state, the staff conservatively assumed that the entire contents of the vessel leaked, forming a 1-cm-thick (0.4-in.-thick) puddle. This assumption provided a significant surface area from which to maximize the evaporation and formation of a vapor cloud. Since the ALOHA model is limited by the maximum surface area of 31,400 $m^2$ (7.76 acres), for those chemical inventories that gave a 1-cm (0.4-in.) puddle greater than this limiting surface area, the calculated evaporation rate based on the limiting surface area of 31,400 $m^2$ (7.76 acres) was adjusted to reflect the actual inventory of the chemical and was modeled further as a direct source option. For each of the identified chemicals in a gaseous state, it was conservatively assumed that the entire contents were released over a 10-minute period as a continuous direct source. The results of these analyses were comparable or sometimes higher than those of the applicant's results. However, the minimum distance calculated due to an explosion of a flammable chemical vapor cloud for the incident pressure of 6.9 kPa (1 psi) did not exceed the respective nearest distance to a safety-related structure. Therefore, NRC staff found that the potential explosion of a flammable vapor cloud from any of the facilities and transportation routes addressed would not have an adverse impact on the safe operation of STP Units 3 and 4.

*Toxic Chemicals*

Accidents involving the release of toxic chemicals from on-site storage facilities and nearby mobile and stationary sources were considered. The applicant considers the potentially hazardous chemicals pertaining to on-site and offsite chemical storage; hazardous materials transported on navigable waterways (presented in STP Units 3 and 4 FSAR Tables 2.2S-6, 2.2S-7, and 2.2S-8); and hazardous materials transported on FM 521. The applicant performed an evaluation to ascertain which materials had the potential to form a toxic vapor cloud following an accidental release. The applicant mainly uses the ALOHA model, and the toxic dispersion model only was used for barge transport of gasoline, to predict the concentrations of toxic chemical clouds as they disperse downwind for all facilities.
The maximum distance a cloud could travel before it disperses enough to fall below the immediate danger to life and health (IDLH) concentrations in the vapor cloud is determined using the ALOHA model. The ALOHA model is also used to predict the concentration of the chemical in the control room following a chemical release to ensure that, under the worst-case scenarios, control room operators would have sufficient time to take appropriate protective action. The applicant presents the results of these analyses in STP Units 3 and 4 FSAR Table 2.2S-11, and concludes that the formation of a toxic vapor cloud, following an accidental release from any of the above addressed facilities and transportation routes, will not adversely affect the safe operation or shutdown of STP Units 3 and 4.

To be able to perform independent confirmatory analyses for the applicant's addressed chemicals/hazardous materials, NRC staff required further information regarding the inputs the applicant had used in the modeling. RAIs 02.02.03-4 and 02.02.03-5 requested additional information from the applicant. The applicant's responses to RAI 02.02.03-4, dated November 20, 2008 (ML083290340), and to RAI 02.02.03-5, dated October 27, 2008 (ML083040527), allowed the staff to perform the analyses using the ALOHA model (ALOHA, 2007). The staff used conservative assumptions in formulating the scenario and also in the ALOHA model analyses. The meteorological inputs used in the ALOHA modeling included F(stable) stability class with a wind speed of 1 m (3.3 ft) per second (which represented the worst 5 percent of meteorological conditions); an ambient temperature of 25 degrees C (77 degrees F), a relative humidity of 50 percent; and a cloud cover of 50 percent. For each of the identified chemicals in the liquid state, it was conservatively assumed that the entire contents of the vessel leaked, forming a 1-cm-thick (0.4-in.-thick) puddle.
This assumption provided a significant surface area from which to maximize the evaporation and formation of a toxic vapor cloud. Since the ALOHA model is limited by the maximum surface area of 31,400 $m^2$ (7.76 acres), for those chemical inventories that gave a 1-cm (0.4-in.) puddle greater than this limiting surface area, the calculated evaporation rate based on the limiting surface area of 31,400 $m^2$ (7.76 acres) was adjusted to reflect the actual inventory of the chemical and was modeled further as a direct source option.

For each of the identified chemicals in a gaseous state, the staff conservatively assumed that the entire contents were released over a 10-minute period as a continuous direct source. The results of these analyses were comparable or sometimes higher than were the applicant's results. The calculated concentrations of acetic acid and gasoline from water transport; gasoline and sodium hypochlorite from on-site storage, and 1-hexene, acetic acid, sodium chlorite, and ethylene exceeded IDLH concentrations at the outside of the control room. Because those concentrations pose a potential hazard to control room habitability, further analyses were required in Section 6.4, with the exception of 1-hexene from offsite storage at the OXEA Corporation.

NRC staff issued RAIs 02.02.03-6 and 02.02.03-7 pertaining to the analysis performed for 1-hexene. The applicant responded on November 20, 2008 (ML083290340), by providing a reanalysis that considers a berm near the 1-hexene storage tank. This analysis demonstrates that the distance to IDLH (the temporary emergency exposure limit [TEEL]) concentration is 2,092 m (6,864 ft), which is well short of the 6,962 m (22,841 ft) to the control room. Based on the independent confirmatory calculations performed by the staff and documented in this section and in Section 6.4 of this SER, the staff found that none of the chemicals pose a threat to control room habitability. Therefore, RAIs 02.02.03-4 through 02.02.03-7 are closed.

*Fires*

The applicant considers accidents that could occur in the vicinity of the STP and could lead to high heat fluxes, smoke and nonflammable gas, or chemical-bearing clouds from the release of materials as a consequence of fires. The applicant considers and addresses fires in adjacent industrial plants, storage facilities, pipelines, brush and forest fires, and fires from transportation accidents. Based on review of the applicant's information, independent analyses performed by the staff regarding potential explosions and flammable vapor clouds, and a perception safety zone around STP Units 3 and 4, the staff found that no hazardous effects are expected to affect the safe operation of STP Units 3 and 4 from fires or heat fluxes associated with wild fires, fires in adjacent industrial plants, or from fires in on-site storage facilities.

*Collisions with Intake Structure*

The applicant addresses the effects of nearby navigable waterways with the intake structures. NRC staff reviewed the applicant's presented information. Based on a review of the information and consideration of a separate ultimate heat sink that provides water for safe shutdown and does not depend on this intake structure for makeup water, the staff found that potential damage to the Colorado River makeup water intake structure would not affect the safe shutdown of STP Units 3 and 4.

*Liquid Spills*

The accidental release of oil or liquids that may be corrosive, cryogenic, or a coagulant may affect the safe shutdown of the plant if drawn into the plant's makeup water for the circulating water system. However, a separate ultimate heat sink provides water for the safe shutdown and does not depend on the intake structure for makeup water for the safe shutdown of the plant. Therefore, the staff found a spill will not have any effect on the safe shutdown of the plant.

*Radiological Hazards*

The control room habitability system for the ABWR provides the capability to detect and protect main control room personnel from airborne activity. The ABWR control room is designed to withstand the effects of radiological events and consequential releases.

#### 2.2S.3.5 *Post Combined License Activities*

There are no post COL activities related to this section.

#### 2.2S.3.6 *Conclusion*

NRC staff reviewed the information in Section 2.2S.3 of the COL FSAR and found the applicant has identified potential accidents related to the presence of hazardous materials or activities in the site vicinity that could affect a nuclear power plant or plants of the specified type that might be constructed on the proposed site. The applicant has also appropriately determined those that should be considered design-basis events and has demonstrated that the plant is adequately protected and can be operated with an acceptable degree of safety with regard to the DBAs.

The staff's review confirmed that the applicant has adequately addressed the COL License Information Items 2.7 and 2.8 in accordance with Section 2.2.3 of NUREG–0800, RG 1.91, the relevant requirements of CFR 52.79(a)(1)(iv) as they relate to the factors to be considered in the evaluation of sites, which require the location and description of industrial, military, or transportation facilities and routes, and the requirements of10 CFR 52.79(a)(1)(vi) as they relate to compliance with 10 CFR Part 100, and that no outstanding information is expected to be addressed in the COL FSAR related to this section.

The staff's review concluded that the applicant has established that the construction and operation of a nuclear power plant or plants of the specified type on the proposed site location is acceptable.

## 2.3S Meteorology

To ensure that a nuclear power plant can be designed, constructed, and operated on an applicant's proposed site in compliance with the Commission's regulations, 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 on 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 the Commission's guidelines.

### 2.3S.1 Regional Climatology

#### 2.3S.1.1 *Introduction*

This section of the FSAR addresses the averages and extremes of climatic conditions and regional meteorological phenomena that could affect the safe design and siting of the plant. The information describes the general climate, severe weather phenomena, meteorological data for evaluating the ultimate heat sink (UHS), design-basis dry- and wet-bulb temperatures, restrictive dispersion conditions, and climate change.

### 2.3S.1.2 *Summary of Application*

This site-specific supplement in the FSAR describes the following:

- Data sources used to characterize the regional climatological conditions pertinent to the proposed site
- The general climate of the region with respect to types of air masses, synoptic features (high- and low-pressure systems), general airflow patterns (wind direction and speed), temperature and humidity, and precipitation (rain, snow, freezing rain, and sleet)
- Frequencies and descriptions of severe weather phenomena that have affected the proposed site including extreme winds, tornadoes, tropical cyclones, precipitation extremes, hail, freezing rain, sleet, winter precipitation (snow), thunderstorms, and lightning
- Meteorological conditions for evaluating the UHS
- Design-basis dry- and wet-bulb temperatures for the proposed site
- The potential for restrictive air dispersion conditions and high air pollution levels at the proposed site

In addition, in FSAR Section 2.3S.1.5, the applicant provides the following:

*Tier 1 Departure*

- STP DEP T1 5.0-1 Site Parameter

The applicant identifies one-percent maximum coincident and noncoincident wet-bulb temperatures and the zero-percent maximum noncoincident wet-bulb temperature as departures from ABWR DCD Tier 1, Table 5.0 and Tier 2, Table 2.0-1, “Site Parameters.”

*COL License Information Item*

- COL License Information Item 2.1 Non-Seismic Design Parameters

This site-specific supplement addresses COL License Information Item 2.1 from the certified DCD, which states that “compliance with the envelope of standard plant site non-seismic design parameters of DCD Tier 2, Table 2.0-1 shall be demonstrated for design-bases events.”
DCD Tier 2, Section 2.2.1 further states that for design-basis events, the site is acceptable if all of the site characteristics fall within the envelope of ABWR standard plant site design parameters given in DCD Tier 2, Table 2.0-1. For cases where a characteristic exceeds its envelope, it will be necessary for the COL applicant to submit analyses to demonstrate that the overall set of site characteristics does not exceed the capability of the design. The DCD Tier 2, Table 2.0-1 envelope of ABWR standard plant site design parameters includes extreme wind, tornado, precipitation (for roof design), maximum snow load, and ambient design temperature site parameters.

### 2.3S.1.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the regional climatology, and the associated acceptance criteria, are in Section 2.3.1 of NUREG–0800. In particular, the regulatory requirements are 10 CFR 52.79(a)(1)(iii), 10 CFR 100.20(c)(2) and 100.21(d).

NRC staff considered the following regulatory requirements in reviewing the applicant's discussion of regional climatology:

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying the most severe of the natural phenomena historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated

- 10 CFR 100.20(c) (2) and 100.21(d), with respect to consideration of the regional meteorological characteristics of the site

NUREG–0800, Section 2.3.1 specifies that an application meets the above requirements if the application satisfies the following criteria:

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

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

- The tornado parameters should be based on RG 1.76, Revision 1, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants." Alternatively, an applicant may specify any tornado parameters that are appropriately justified, provided that a technical evaluation of site-specific data is conducted.

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

- UHS meteorological data, as stated in RG 1.27, Revision 2, "Ultimate Heat Sink for Nuclear Power Plants (For Comment)," should be based on long-period regional records that represent site conditions.

- The 100-year, ground-level snowpack or snowfall, whichever is greater, should be based on data recorded at nearby representative climatic stations or obtained from appropriate standards with suitable corrections for local conditions. The 48-hour probable maximum winter precipitation (PMWP) should be determined in accordance with reports published by NOAA's Hydrometeorological Design Studies Center.

- Ambient temperature and humidity statistics should be derived from data recorded at nearby representative climatic stations or obtained from appropriate standards with suitable corrections for local conditions.

- Information depicting the potential for high air pollution levels should be based on U.S. Environmental Protection Agency (EPA) studies.

- All other meteorological and air quality conditions identified by the applicant as design and operating bases should be documented and substantiated.

Generally, the information should be presented and substantiated in accordance with acceptable practices and data promulgated by NOAA, industry standards, and regulatory guides.

Subsequent to the publication of SRP Section 2.3.1, the staff issued proposed interim staff guidance (ISG) document DC/COL-ISG-7, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures," for public comment on August 22, 2008 (73 *FR* 49712) (ML081980084). The purpose of the document is to clarify the staff's position on identifying winter precipitation events as site characteristics and site parameters for determining normal and extreme winter precipitation loads on the roofs of seismic Category I structures. The final version of DC/COL-ISG-7 was issued on July 1, 2009 (74 *FR* 31470) (ML091490565).

To the extent that the data are applicable to the acceptance criteria outlined above, the applicant applies the following NRC-endorsed meteorological information selection methodologies and techniques:

- RG 1.23, Revision 1, "Meteorological Monitoring Programs for Nuclear Power Plants," provides criteria for an acceptable onsite meteorological measurements program that can be used to monitor regional meteorology site characteristics.

- RG 1.27 provides criteria for selecting the UHS meteorological data that would result in maximum evaporation and drift loss of water and minimum water cooling.

- RG 1.76 provides criteria for selecting the design-basis tornado parameters.

- RG 1.206 describes the type of regional meteorological data that should be in FSAR Tier 2, Section 2.3S.1.

- RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," provides criteria for selecting the design-basis hurricane wind speed.

When independently assessing the veracity of the information presented by the applicant in FSAR Tier 2, Section 2.3S.1, NRC staff applied the same methodologies and techniques cited above.

In accordance with Section VIII, "Processes for Changes and Departures," of "Appendix A to Part 52--Design Certification Rule for the U.S. Advanced Boiling Water Reactor," the applicant identifies one Tier 1 departure related to this SER section. Tier 1 departures require prior NRC approval and are subject to the requirements of 10 CFR Part 52, Appendix A, Section VIII.A.4.

### 2.3S.1.4 *Technical Evaluation*

NRC staff reviewed the application and the applicant's responses to the RAIs to verify the accuracy, completeness, and sufficiency of the information presented by the applicant regarding regional climatology. The staff followed the procedures described in Section 2.3.1 of NUREG-0800 as part of the review.

The staff reviewed the information in the COL FSAR:

*Tier 1 Departure*

In general, the Tier 1 Departure identified by the applicant in this section requires prior NRC approval in the form of an exemption and the full scope of their technical impact may be evaluated in the other sections (and chapters) of this SER. For more information, refer to COL application Part 07, Section 5.0 for a listing of all FSAR sections affected by this Tier 1 departure.

- STP DEP T1 5.0-1 Site Parameter

This departure is evaluated in Section 2.3S.1.4.5 of this SER.

*COL License Information Item*

- COL License Information Item 2.1 Non-Seismic Design Parameters

NRC staff's review of the climatological "Non-Seismic Design Parameters" (i.e., extreme wind, tornado, precipitation [for roof design], maximum snow load, and ambient design temperature site parameters) is summarized below.

#### 2.3S.1.4.1 Data Sources

The applicant characterizes the regional climatology of the proposed STP Units 3 and 4 site using data from the National Climatic Data Center (NCDC); including the first order NWS station in Victoria, Texas, and 14 other nearby cooperative observation stations. All of these observation stations are located in the Texas Upper Coast climatic division (TX-8) except for the Aransas Wildlife Refuge observation station, which is in the Texas South Central climatic division (TX-7). The regional climatic observation stations used by the applicant are listed in FSAR Tier 2, Table 2.3S.1-1.

The applicant states that the selection criteria used for the observation stations include the following:

- Proximity to the STP site (i.e., within an approximate 50-km [31.25 mi] radius)
- Coverage in all directions surrounding the site (to the extent possible)
- Selection of a station if it contributed one or more extreme conditions (e.g., rainfall, snowfall, maximum and/or minimum temperatures) for that given direction relative to the site where more than one station exists for a given direction

The applicant also states that if an overall extreme precipitation or temperature condition was identified for a station located within a reasonable distance beyond the 50-km (31.1-mi) radius, and that extreme condition was considered to be reasonably representative of the site area, that station was also included.

The applicant also obtained information on mean and extreme regional climatological phenomena from a variety of sources, such as publications by the NOAA, NCDC, American Society of Civil Engineers (ASCE), Structural Engineering Institute (SEI), American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), NOAA Air Resources Laboratory, NOAA Coastal Services Center (CSC), NOAA National Severe Storms Laboratory (NSSL), U.S. Department of Agriculture Pacific Wildland Fire Sciences Lab, and the U.S. Department of Agriculture Rural Utilities Service.

The staff found the applicant's sources for regional climatological data to be appropriate because the sources include NOAA and industry standards, as specified in SRP Section 2.3.1.

#### 2.3S.1.4.2 General Climate

The applicant describes the general climate of the proposed STP site as maritime subtropical (or humid subtropical), which is characterized by mild, short winters; long periods of mild sunny weather in autumn; windy but mild weather in spring; and long hot summers. Maritime tropical air mass characteristics prevail much of the year, especially during the summer with the establishment of the Bermuda High and the Gulf of Mexico High. This circulation pattern is occasionally disrupted by the passage of synoptic- and meso-scale weather systems during the transitional seasons (spring and autumn) and winter months. During winter, cold air masses originating in the continental interior around Colorado or Canada may briefly intrude into the region. These systems may result in a variety of precipitation events that include rain, sleet, and/or freezing rain. Larger persistent outbreaks of very cold, dry air associated with massive high-pressure systems that move southward out of Canada also occasionally affect the site region. However, these weather conditions tend to be modified significantly as land modification warms the cold air that reaches the proposed STP site.

The applicant states that monthly precipitation exhibits a cyclical pattern, with the predominate maximum occurring in May and a secondary maximum occurring in September. Strong winds associated with tropical cyclones can have a significant effect on the site area due to its proximity to the Gulf of Mexico.

The staff agreed with the applicant's description of the general climate of the region. The staff relied on the NCDC narrative, "Local Climatological Data, Annual Summary with Comparative Data for Victoria, Texas," to reach this conclusion. NRC staff issued RAI 02.03.01-1 requesting the applicant to discuss the influence of the Gulf of Mexico and the resulting land and sea breezes on regional climatology. The applicant's response to RAI 02.03.01-1 dated May 29, 2008 (ML081560317), states that the land/sea temperature contrast during summer days creates a circulation forming a sea breeze where cooler, more saturated air pushes inland as the warm air rises inland. The opposite occurs at night, where inland plains cool rapidly while the sea stays relatively warmer, thus causing a breeze to push off-shore into the Gulf of Mexico. The applicant has incorporated this information into Revision 3 of the FSAR. Therefore, RAI 02.03.01-1 is considered closed.

### 2.3S.1.4.3 Severe Weather

#### 2.3S.1.4.3.1 *Extreme Winds*

ABWR DCD Tier 2, Section 3.3.1 states that the design wind pressures and forces for buildings, components and cladding, and other structures at various heights above the ground were obtained in accordance with ASCE 7–88, "Minimum Design Loads for Buildings and Other Structures." Figure 1 of ASCE 7–88 provides a plot of "basic wind speeds" for the contiguous states, which it defines as the fastest-mile wind speed at 10 m (33 ft) above the ground for terrain Exposure Category C [2] and associated with an annual probability of occurrence of 0.02 (i.e., 50-year mean recurrence interval). To account for the degree of hazard to human life and damage to property, ASCE 7-88 suggests scaling these fastest-mile basic wind speeds by an importance factor of 1.11 for essential facilities located at hurricane coastlines, which accounts for an increase in the recurrence interval from 50 to 100 years.

As described in ABWR DCD Tier 2, Section 3.3.1, the basic wind speeds used for the ABWR wind loading design are 177 km per hour (km/h) (110 miles per hour [mph]) with a recurrence interval of 50 years, and 197 km/h (122 mph) with a recurrence interval of 100 years. ABWR DCD Tier 1, Table 5.0 and Tier 2, Table 2.0-1 identify these wind speed values as extreme wind "basic wind speed" site design parameters, with further clarifications that the 177 km/h (110 mph) value is used for the design of non-safety-related structures and the 197 km/h (122 mph) value is used for the design of safety-related structures. The COL license information item in ABWR DCD Tier 2, Section 3.3.3.1, states that the site-specific, design-basis wind shall not exceed these design-basis wind parameters.

A more recent 2005 version of ASCE 7–88, ASCE/SEI 7–05, incorporated substantial changes in defining wind loads, including (1) redefining the basic wind speed as the 3-second gust speed (instead of the fastest-mile speed) at 10 m (33 ft) above the ground in exposure Category C, and (2) revising the map of basic wind speeds to reflect a newer analysis of hurricane wind speeds. The applicant defines the STP extreme wind basic wind speed site characteristics as 3-second gusts using a linear interpolation from the map of basic wind speeds in ASCE/SEI 7–05 for the portion of the United States that includes the proposed STP site. The ASCE/SEI 7–05 plot of 3-second gust basic wind speeds is associated with a mean recurrence interval of 50 years. Using this plot, the applicant defined the 50-year return period 3-second gust basic wind speed for the proposed STP site as 201 km/h (125 mph). Using a conversion factor of 1.07, which is listed in Table C6-3 of ASCE/SEI 7–05 as the ratio of the peak gust wind speed 100-year to 50-year mean recurrence interval values, the applicant derived a 100-year return period 3-second gust basic wind speed site characteristic value of 215 km/h (134 mph).

NRC staff notes that according to Table C6-2 of ASCE/SEI 7–05, the applicant's 100-year return period of a 3-second gust basic wind speed site characteristic value of 215 km/h (134 mph) is equivalent to a Saffir-Simpson Category 3 hurricane. A discussion on the occurrence of tropical cyclones in the STP site region is in FSAR Tier 2, Subsection 2.3S.1.3.3.

In order to compare the ABWR fastest-mile basic wind speed site design parameters to the STP's 3-second gust basic wind speed site characteristics, the applicant converted the ABWR fastest-mile basic wind speed site design parameter values to the equivalent of 3-second gust

[2] ASCE 7-88 defines Exposure C as open terrain with scattered obstructions having heights generally less than 30 feet, including open country and grasslands.

wind speed values. The applicant states that the ABWR fastest-mile extreme wind basic wind speed site design parameters of 177 km/h (110 mph) and 197 km/h (123 mph) convert to 3-second gust values of 203 km/h (126 mph) and 224 km/h (139 mph), respectively. The staff performed a similar conversion using the relationship among wind speed averaging times shown in Figure C6-4 of ASCE/SEI 7–05 and obtained similar results (e.g., within 1.6 km/h [1 mi/h]). This conversion demonstrates that the ABWR extreme wind basic wind speed standard plant site design parameters bound the corresponding extreme wind site characteristics chosen by the applicant, thus satisfying COL License Information Item 2.1 with respect to extreme winds.

In FSAR Tier 2, Revision 0, Section 2.3S.1.3.3 states that one Category 5, four Category 4, and nine Category 3 hurricanes were reported by NOAA-CSC to have tracked within a 185-km (100-nautical mile [nmi]) radius of the STP Units 3 and 4 sites during the period from 1851 to 2006. Using this same NOAA-CSC database for this same period of record, the staff identified 11 hurricanes that were classified as major (i.e., Saffir-Simpson Category 3 or higher) at the time they may landfall within 185 km (100 nm) of the STP site. For each of these 11 major hurricanes, the staff used the sustained wind speeds reported in the NOAA-CSC database at landfall along with information presented in Table C6-2 of ASCE/SEI 7–05 to estimate the corresponding 3-second gust wind speed over land at landfall. Because hurricane wind speeds typically decrease as storms move inland, and the STP site is located approximately 24 km (15 mi) inland from the Gulf of Mexico, the staff reduced the gust wind speed at landfall by 8 km/h (5 mi/h) based on the 8 km/h (5 mph) reduction in basic wind speed from the coastline to the inland location of the STP site, as shown in Figure 6-1A of ASCE/SEI 7–05. The staff found that 8 out of the 11 major landfall hurricanes had projected gust wind speed values that exceeded the applicant's selected extreme wind basic wind speed site characteristic value of 215 km/h (134 mph) for safety-related structures. The highest gust wind speed of 297 km/h (184 mph) was associated with an unnamed storm in August 20, 1886. The staff subsequently issued RAI 02.03.01-4 requesting the applicant to justify why the extreme wind basic wind speed site characteristic value for safety-related structures is not based on the most severe hurricanes historically reported for the site and the surrounding area.

The applicant's response to RAI 02.03.01-4 dated May 29, 2008 (ML081560702), states that it provided the 100-year return period 3-second gust wind speed as the extreme wind basic wind speed site characteristic value for consideration in evaluating the design and operation of the proposed facility, in accordance with RG 1.206, Regulatory Position C.I.2.3.1.2. Furthermore, the applicant states that the 100-year return period 3-second gust wind speed site characteristic value was determined in accordance with the acceptance criteria specified in SRP Section 2.3.1.

In a follow-up to the applicant's response to RAI 02.03.01-4, NRC staff issued RAI 02.03.01-21 requesting the applicant to revise the FSAR to identify the extreme wind basic wind speed site characteristic value for the STP site and surrounding area based on the most severe hurricanes historically reported for that area. 10 CFR 52.79(a) (iii) states (in part) that the COL FSAR shall include the meteorological characteristics of the proposed site with an appropriate consideration of the most severe of the natural phenomena historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated. In order to be compliant with 10 CFR 52.79(a)(iii), the staff believed the extreme wind basic wind speed site characteristic value for the STP site and surrounding area should consider the most severe hurricanes historically reported for the STP site and surrounding area.

In the response to RAI 02.03.01-21 dated May 26, 2009 (ML091490166), the applicant proposes a revision to extreme winds in FSAR Tier 2, Subsection 2.3S.1.3.1. The proposed revision repeats the previous statements that the design extreme wind loading is based on a basic wind speed, which is the 3-second gust at 10 m (33 ft) above the ground in Exposure Category C, as defined in ASCE/SEI 7–05. The proposed revision also states that the applicant has reviewed the NOAA CSC historical record of tropical cyclone tracks and intensities near the STP Units 3 and 4 sites from 1851 to the present. This review identifies eleven tropical cyclones with wind speeds that exceed a design-basis extreme wind loading for the STP Units 3 and 4 sites calculated in accordance with ASCE/SEI 7–05. The applicant further states that the wind speeds identified during this review were bounded by the 322 km/h (200 mph) maximum tornado wind speed site characteristic value: therefore, those speeds do not represent a threat to the integrity of any STP Units 3 and 4 SSCs.[4]

Initially, the U.S. Atomic Energy Commission (predecessor to the NRC) considered tornadoes to be the bounding extreme wind events and issued the original version of RG 1.76 in April 1974. The selection of the design-basis tornado wind speeds was premised on the probability that a tornado exceeding those speeds would be on the order of $10^{-7}$ per year per nuclear power plant. In March 2007, the NRC issued Revision 1 of RG 1.76, which relied on the Enhanced Fujita Scale that was implemented by the NWS in February 2007. The Enhanced Fujita Scale is a revised assessment relating tornado damage to wind speed, which resulted in a decrease in design-basis tornado wind speed criteria in Revision 1 of RG 1.76. Because the design-basis tornado wind speeds decreased as a result of the analysis that was performed to update RG 1.76, it was no longer clear that the revised tornado design-basis wind speeds would bound design-basis hurricane wind speeds in all areas of the United States. This uncertainty prompted an investigation into extreme wind gusts during hurricanes and their relation to design-basis hurricane wind speeds, which resulted in issuing RG 1.221 in October 2011. RG 1.221 defines the design-basis hurricane as having the same $10^{-7}$ per year exceedance frequency as the design-basis tornado. The staff subsequently issued RAI 02.03.01-24 requesting, in part, that the applicant identify a design-basis hurricane wind speed for the STP site, given that RG 1.221 describes a method that the staff considers acceptable for selecting site-specific design-basis hurricane wind speeds.

The applicant's response to RAI 02.03.01-24 dated January 12, 2012 (ML12018A387), identifies a STP site-specific design-basis hurricane wind speed of 388 km/h (210 mph) for a 3-second gust wind speed, based on the guidance in RG 1.221. To ensure that the STP Units 3 and 4 design reflects the guidance in RG 1.221, the applicant revised FSAR Tier 2, Table 2.0-2 to include 388 km/h (210 mph) as a site-characteristic hurricane wind speed for STP Units 3 and 4.

The staff confirmed that the applicant's 388 km/h (210 mph) site-specific design-basis hurricane wind speed derived from RG 1.221 is correct. Because the highest historic hurricane gust wind speed projected by the staff (297 km/h [184 mph]) as discussed above is bounded by the 388 km/h (210 mph) hurricane wind speed site characteristic value that the applicant identified, the staff found the applicant's response to RAI 02.03.01-24 acceptable. In addition, the applicant has committed in its response to RAI 02.03.01-24 to ensuring that the STP Units 3 and 4 design reflects this 388 km/h (210 mph) hurricane wind speed site characteristic value. Therefore, RAIs 02.03.01-4, 02.03.01-21, and 02.03.01-24 are closed.

[4] The "extreme wind basic wind speed" and the "maximum tornado wind speed" site parameters are used with different load factors and load combinations in the ABWR DCD to evaluate the capacity of SSCs to withstand wind pressures.

### 2.3S.1.4.3.2 *Tornadoes*

The staff issued RAI 02.03.01-2 requesting the applicant to provide statistics on the frequency of tornadoes in the STP site region. The applicant's response to RAI 02.03.01-2 dated May 29, 2008 (ML091490166) identifies 902 tornado occurrences in the counties that are either totally or partially within a 125.5-km (78-mi) radius of the STP site.[5] The applicant uses the NCDC Storm Events database for the period January 1950 through August 2006. The applicant has incorporated this information into Revision 3 of the FSAR. The staff reviewed the same NCDC database for the period January 1950 through April 2008 and identified a slightly lower number (823) of tornado occurrences for this same region. Because the applicant's estimated tornado frequency bounds that of the staff's, the staff considers RAI 02.03.01-2 closed.

NUREG/CR–4461, Revision 2, "Tornado Climatology of the Contiguous United States," provides the basis for the design-basis tornado wind speed in Revision 1 to RG 1.76. Appendix C to NUREG/CR–4461 contains estimates of strike probabilities by one-degree latitude and longitude boxes. The STP is located about N 28.8 degree latitude and W 96.1 degree longitude, near the corners of four of these one-degree boxes. The average expected strike probability per year among these four one-degree boxes (weighted by the faction each one-degree box area is assumed to be covered by land) for a structure with a characteristic dimension of 61 m (200 ft) is 1.75E-04, which corresponds to a mean recurrence interval of approximately 5,710 years.

ABWR DCD Tier 2, Section 3.3.1 states that the design-basis tornado is described (in part) by the following parameters:

- A maximum tornado wind speed of 483 km/h (300 mph) at a radius of 45.7 m (150 ft) from the center of the tornado
- A maximum translational velocity of 97 km/h (60 mph)
- A maximum tangential velocity of 386 km/h (240 mph) based on the translational velocity of 97 km/h (60 mph)
- A maximum atmospheric pressure drop of 13.8 kPa (2 psi) with a rate of the pressure change of 8.3 kPa per second (kPa/s) (1.2 psi per second [psi/s])

These design-basis tornado parameters are listed in ABWR DCD Tier 2, Table 2.0-1 as standard plant site design parameters; the maximum tornado wind speed and maximum pressure drop parameters are listed in ABWR DCD Tier 1, Table 5.0 as site parameters.

The applicant chose the tornado site characteristics based on Revision 1 to RG 1.76. RG 1.76 provides design-basis tornado characteristics for three tornado intensity regions throughout the United States, each with a $10^{-7}$ per year probability of occurrence. The proposed STP site is located in tornado-intensity Region II. The applicant has chosen to use the design-basis tornado characteristics from Region II and, correspondingly, proposes the following tornado site characteristics:

- A maximum wind speed of 322 km/h (200 mph)

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5 According to the applicant, the 125.5-km (78-mi) radius covers the same area as a 2-degree longitude-by-latitude box surrounding the STP site.

- A translational speed of 64 km/h (40 mph)
- A maximum rotational speed of 257 km/h (160 mph)
- The radius of a maximum rotational speed of 45.7 m (150 ft)
- A pressure drop of 6.2 kPa (0.9 psi)
- A rate of pressure drop of 2.8 kPa/s (0.4 psi/s)

Because the applicant's design-basis tornado site characteristics are based on RG 1.76, the staff concluded that the applicant has chosen acceptable tornado site characteristics.

FSAR Tier 2, Table 2.0-2 compares the ABWR tornado site parameters to the STP Units 3 and 4 tornado site characteristics. Because the ABWR tornado standard plant site design parameters bound the corresponding STP tornado site characteristics, COL License Information Item 2.1 with respect to tornadoes is resolved.

#### 2.3S.1.4.3.3 *Tropical Cyclones*

In FSAR Tier 2, Revision 0, Section 2.3S.1.3.3 states that during the period between 1851 and 2006, 142 tropical cyclones centers or storm tracks passed within a 185-km (100-nmi) radius of the proposed STP Units 3 and 4 site. The applicant used the NOAA-CSC historical tropical database to derive these results. Using the same database, the staff was able to verify 75 tropical cyclones centers or storm tracks passed within a 185-km (100-nmi) radius of the proposed STP site.

NRC staff also reviewed the 2007 and 2008 tropical cyclone reports published by the NWS National Hurricane Center (NHC) to determine whether any additional tropical cyclones tracked within a 185-km (100-nmi) radius of the proposed STP site with hurricane force winds during this time period. The staff found that Hurricane Ike made landfall along the upper Texas coast at the upper end of Category 2 intensity in September 2008.

"Major hurricane" is a term utilized by NHC for hurricanes that reach maximum sustained 1-minute surface winds of at least 179 km/h (111 mph). This speed is equivalent to at least a Category 3 hurricane on the Saffir-Simpson scale. The NOAA-CSC database shows that a total of 11 major hurricanes have impacted the 185-km (100-nmi) area surrounding the proposed STP site between 1851 and 2006. These data translate to a reoccurrence rate of 0.07 per year, or one major hurricane every 14.2 years.

Tropical systems can also cause significant amounts of rainfall. The applicant reports that one-third of the individual 24-hour rainfall records were associated with tropical cyclones that passed within a 185-km (100-nmi) radius of the STP site. The staff independently confirmed these statistics.

The staff issued RAI 02.03.01-16 requesting the applicant to confirm the number of tropical cyclone storm tracks that have passed near the STP site and to revise, as necessary, FSAR Tier 2, Section 2.3S.1.3.3.

The applicant's response to RAI 02.03.01-16 dated December 18, 2008 (ML083570395), states that a recount of the tropical cyclone inventory taken from the NOAA-CSC database produces statistics similar to those compiled by the staff. The applicant reports that one Category 5, six Category 4, four Category 3, five Category 2, and twenty-two Category 1 hurricane tracks (on the Saffir-Simpson Hurricane scale) have passed within a 185-km (100-nmi) radius of the STP site between 1851 and 2006. The applicant includes these revised tropical cyclone statistics in Revision 3 to the FSAR. Therefore, RAI 02.03.01-16 is closed.

#### 2.3S.1.4.3.4 *Precipitation Extremes*

This discussion is intended to provide a general climatic understanding of the severe weather phenomena in the site region. However, the discussion does not generate site characteristics for use as design or operating bases.

The applicant uses historical climate data from 15 nearby observation stations, which are listed in FSAR Tier 2, Table 2.3S-1, to identify precipitation extremes (rainfall and snowfall) observed near the proposed STP site. Based on the distribution of the observation stations around the site, these data can be used to adequately represent precipitation extremes that might be expected to occur at the site.

Although some of the recorded precipitation extremes are associated with the occurrence of tropical cyclones, the overall highest 24-hour rainfall total is not. On October 19, 1983, the 24-hour rainfall record in the area surrounding the proposed STP site was set at the Bay City Waterworks, when 53 cm (20.85 in.) fell. The overall highest monthly total, 80.3 cm (31.61 in.) during September 1979 at Freeport 2NW observation station, was partially attributed to Tropical Storm Elena.

The applicant states that snow accumulation is a rare occurrence in the vicinity of the STP site. According to the applicant, most winters bring no accumulation of snowfall and storms that produce large measurable amounts of snow are rare. A staff review of the NCDC Daily Surface Snowfall data for the 15 climatic stations listed in FSAR Tier 2, Table 2.3S-3 indicate that average daily snowfall totals equal to or greater than 2.54 cm (1 in.) are recorded once every 14 years. A Christmas storm in 2004 was responsible for the highest overall 24-hour and monthly snowfall totals recorded in the site region—26.7 cm (10.5 in.) at the Davevang 1W observation station—located approximately 32 km (19.9 mi) north-northwest of the STP site. The applicant states that it is reasonable to assume that this snowfall did not remain for more than a few days, because the high temperatures for the following few days exceeded the freezing mark.

The staff concluded that the applicant has adequately identified precipitation extremes that might be expected to occur in the vicinity of the site. FSAR Tier 2, Table 2.3S-3 lists the highest precipitation extremes in the vicinity of the site.

In FSAR Tier 2, Table 2.3S-3, the applicant provides climatic extremes for each of the utilized observation stations (when available), including maximum 24-hour and monthly rainfall and snowfall. The staff independently verified these rainfall records using the NCDC Climate Data Online (CDO) Daily (TD3200/3210) and Monthly Surface Data (DS-3220). The staff found some discrepancies and issued RAI 02.03.01-18 requesting the applicant to confirm several of the rainfall statistics in FSAR Tier 2, Table 2.3S-3. The applicant's response to RAI 02.03.01-18 dated December 18, 2008, revises several of the rainfall statistics in Revision 3 of the FSAR. Consequently, the staff considers RAI 02.03.01-18 closed.

#### 2.3S.1.4.3.5 *Hail, Freezing Rain, and Sleet*

The following discussion on hail, freezing rain, and sleet is intended to provide a general climatic understanding of the severe weather phenomena in the site region. However, the discussion does not generate site characteristics for use as design or operating bases.

The online NWS Glossary defines hail as showery precipitation in the form of irregular pellets or balls of ice, more than 5 millimeters (mm) (0.2 in.) in diameter, falling from a cumulonimbus or thunderstorm cloud. Hail generally occurs during the spring and can be a major weather hazard that causes significant damage to crops and property.

The applicant used the NOAA "Climate Atlas of the United States" CD-ROM to estimate that around the proposed STP site area, the annual mean number of days with hail of 19 mm (0.75 in.) or greater in diameter is approximately one day per year. The applicant also used the online NCDC Storm Event Database for Texas to identify the maximum hail events observed in Matagorda County and surrounding counties. The applicant states that the maximum diameter of hail observed in Matagorda County is approximately 50.8 mm (2 in.) Hailstorm events for surrounding counties have reported maximum hail stone diameters ranging between 50.8 to 114.3 mm (2.0 and 4.5 in.) The applicant states that hail the size of grapefruit (approximately 114.3 mm [4.5 in.] in diameter) was observed on two occasions at two different locations in the general STP site area: (1) on April 11, 1995, in Calhoun, Texas (in Calhoun County), approximately 108 km (67 mi) north-northwest of the STP site; and (2) on June 20, 1996, in Egypt, Texas (in Wharton County), approximately 69 km (43 mi) north-northwest of the STP site. The staff noted that NOAA's National Severe Storms Laboratory's Severe Thunderstorm Climatology Web site reports that, on average, there are 3 to 4 days per year with hail at least 19 mm (0.75 in.) in diameter and one-fourth to one-half days per year with hail at least 50.8 mm (2 in.) in diameter occurring within 40 km (25 mi) of the STP site.

Sleet is defined as pellets of ice composed of frozen or mostly frozen raindrops or refrozen, partially melted snowflakes that usually bounce after hitting the ground or other hard surfaces. Freezing rain is defined as rain that falls as a liquid but freezes into a glaze upon contact with the ground. Depending on the temperature characteristics of the air mass, snow events are often accompanied by or alternate between sleet and freezing rain. The applicant states that according to the NOAA "Climate Atlas of the United States" CD-ROM, freezing precipitation occurs approximately 2.5 to 5.4 days per year at the STP site.

The applicant also states that there have been no reported records of probable annual frequency of dust storms at the STP site area. The staff expects that dust and sand storms would be a rare occurrence due to the abundance of ground vegetation in the STP site region.

The staff verified the hail and freezing precipitation statistics presented by the applicant by reviewing the NCDC online "Climatic Atlas of the United States" and "Storm Event Database for Texas." In Technical Report 2002-01, "The Development of a U.S. Climatology of Extreme Ice Loads," the NCDC also reports a 50-year return period uniform radial ice thickness of 12.7 mm (0.5 in.) because of freezing rain, with a concurrent 3-second gust wind speed of 48 km/h (30 mph) for the proposed STP site area.

#### 2.3S.1.4.3.6 *Winter Precipitation Loads*

Section 2.3.1 of NUREG–0800 states that the winter precipitation loads included in the combination of normal live loads considered in the design of a nuclear power plant that might be constructed on a proposed COL site 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 included in the combination of extreme live loads considered in the design of a nuclear power plant that might be constructed on a proposed COL site, 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 applicant may choose to justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall on nor remain on top of the snowpack and/or building roofs.

In FSAR Tier 2, Section 2.3S.1.3.4, the applicant states that the evaluation of normal and extreme live snow loads on the roofs of safety-related structures does not appear to be warranted for STP Units 3 and 4 because of the infrequent occurrence of snowfall events, and the fact that snowfall events do not appear to persist for any appreciable period of time as ground level snowpack. Consequently, the applicant identifies a 100–year return period value for ground level snowpack at zero-pound force per square foot ($lbf/ft^2$) for the proposed STP site, which is in accordance with ASCE/SEI 7–02.

NRC staff issued RAI 02.03.01-5 requesting the applicant to explain why the maximum snow load site characteristic value is not based on the highest snowfall value historically reported for the site and the surrounding area. The applicant's response to RAI 02.03.01-5 dated May 29, 2008 (ML081560702), states that the highest snowfall value historically reported for the site vicinity was 26.7 cm (10.5 in.) of snow recorded at Danevang 1W on December 25, 2004. Using a water-equivalent ratio of 10 percent, the applicant estimated that this 26.7-cm (10.5-in.) snowfall had a liquid water equivalent of 2.7 cm (1.05 in.), which is equal to a weight of 0.263 kPa (5.5 pounds force per square foot [$lbf/ft^2$]). The applicant lists 0.263 kPa (5.5 $lbf/ft^2$) as the maximum ground level snow load in Revision 3 to FSAR Tier 2, Table 2.0-2. The staff found this response acceptable and considers RAI 02.03.01-5 closed.

Also, the applicant did not identify a 48-hour PMWP value for the STP site in Revision 0 to the FSAR. Consequently, the staff issued RAI 02.03.01-6 requesting the applicant to identify a 48-hour PMWP site characteristic value for the STP site and to describe the additional resulting weight on the roof if all the roof drains are clogged by snow and/or ice. The applicant's response to this RAI, dated May 29, 2008 (ML081560702), identifies a 48-hour PMWP of 86.4 cm (34 in.) of liquid precipitation based on an interpolation of data in NUREG/CR–1486, "Hydrometeorological Report No. 53, Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, United States East of the 105$^{th}$ Meridian." The staff performed an independent 48-hour PMWP evaluation using the NUREG/CR–1486 data. The staff obtained similar results (i.e., within 3 percent). Because the applicant had determined this value in accordance with NUREG/CR–1486, the staff concluded that a 48-hour PMWP site characteristic value of 86.4 cm (34 in.) of water is acceptable.

In the response to RAI 02.03.01-6 (ML081560702), the applicant states that the standard ABWR seismic Category I structures have roofs without parapets or parapets with scuppers to supplement roof drains, so that large inventories of water cannot accumulate. The applicant also notes that the roof structure of the site-specific seismic Category I structures (i.e., reactor service water pump houses) are designed without parapets so that excessive ponding of water cannot occur. RAI 02.03.01-6 is therefore closed.

The staff issued RAI 02.03.01-14 requesting the applicant to revise FSAR Tier 2, Section 2.3S.1 to identify the normal winter precipitation event, the extreme frozen winter precipitation event, and the extreme liquid precipitation event as site characteristics in accordance with DC/COL-ISG-7.

The staff issued the proposed DC/COL-ISG-7 for public comment on August 22, 2008 (73 *FR* 49712). The intent was to clarify the staff's position on identifying winter precipitation events as site characteristics and site parameters for determining normal and extreme winter precipitation loads on the roofs of seismic Category I structures. DC/COL-ISG-7 revises the previously issued NRC staff guidance discussed in SRP Section 2.3.1.

DC/COL-ISG-7 states that normal and extreme winter precipitation events should be identified in SRP Section 2.3.1 as COL site characteristics for use in SRP Section 3.8.4 to determine the normal and extreme winter precipitation loads on the roofs of seismic Category I structures. The normal winter precipitation roof load is a function of the normal winter precipitation event. The extreme winter precipitation roof loads are based on the weight of the antecedent snowpack resulting from the normal winter precipitation event plus the larger resultant weight from either (1) the extreme frozen winter precipitation event, or (2) the extreme liquid winter precipitation event. Whereas the extreme frozen winter precipitation event is assumed to accumulate on the roof on top of the antecedent normal winter precipitation event, the extreme liquid winter precipitation event may or may not accumulate on the roof—that accumulation depends on the geometry of the roof and the type of drainage provided. DC/COL-ISG-7 further states:

- The normal winter precipitation event should be the highest ground-level weight (in $lbf/ft^2$) among (1) the 100-year return period snowpack, (2) the historical maximum snowpack, (3) the 100-year return period two-day snowfall event, or (4) the historical maximum two-day snowfall event in the site region.
- The extreme frozen winter precipitation event should be the higher ground-level weight (in $lbf/ft^2$) between (1) the 100-year return period two-day snowfall event, and (2) the historical maximum two-day snowfall event in the site region.
- The extreme liquid winter precipitation event is defined as the theoretically greatest depth of precipitation (in inches of water) for a 48-hour period that is physically possible over a 25.9-square-kilometer (10-square-mile) area at a particular geographical location during those months with the historically highest snowpacks.

The applicant's response to RAI 02.03.01-14 dated December 18, 2008 (ML083570395), proposes a revision to FSAR Tier 2, Section 2.3S.1.3.4, which states that the ground level weight of the normal winter precipitation event and the weight of the extreme frozen winter precipitation event would both be 0.26 kPa (5.5 $lbf/ft^2$). The staff found this revision acceptable because the value is the historic maximum snowfall in the site region and exceeds the calculated 100–year return period for a ground level snowpack value of zero $lbf/ft^2$.
The applicant also identifies the extreme liquid winter precipitation event to be 86.4 cm (34 in.), which is the same value previously identified by the applicant as the 48-hour PMWP site characteristic. As stated previously, the staff also found this value acceptable because the applicant determined the value in accordance with NUREG/CR–1486. The applicant has incorporated this information into Revision 3 of the FSAR. Therefore RAI 02.03.01-14 is closed.

Both ABWR DCD Tier 1, Table 5.0 and Tier 2, Table 2.0-1 list a precipitation (for roof design) maximum snow load site parameter value of 2.39 kPa (50 $lbf/ft^2$). The combined ground level weight of the normal winter precipitation event and the extreme frozen winter precipitation event is 0.53 kPa (11.0 $lbf/ft^2$). As explained in Revision 4 of COL FSAR Tier 2,

Subsection 3H.6.4.3.3.5, the applicant converts this ground load to a roof load of 0.63 kPa (13.2 $lbf/ft^2$), which is less than the roof maximum snow load site parameter value of 2.39 kPa (50 $lbf/ft^2$). The applicant also states in Revision 4 of COL FSAR Tier 2, Table 2.0-2 that the parapet height of the ABWR standard plant structures will be limited to 22.9 cm (9 in.). This amount of standing water is equivalent to a weight of approximately 2.25 kPa (47 $lbf/ft^2$). This limit should ensure that the roof maximum snow load site parameter value of 2.39 kPa (50 $lbf/ft^2$) will not be exceeded if an extreme liquid winter precipitation event occurs on an antecedent snowpack that has clogged the roof drains and scuppers. In Revision 4 of COL FSAR Tier 2, Subsection 3H.6.4.3.3.5, the applicant states that because site-specific seismic Category I structures are designed without parapets, the roof load of the extreme liquid winter precipitation event cannot exceed the normal winter precipitation event and the extreme frozen winter precipitation event roof load of 0.63 kPa (13.2 $lbf/ft^2$) for these structures.
Because the ABWR precipitation (for roof design) maximum snow load standard plant site design parameter value bounds the corresponding STP site characteristics, COL License Information Item 2.1 is satisfied with respect to maximum snow load.

#### 2.3S.1.4.3.7 *Thunderstorms and Lightning*

This discussion is intended to provide a general climatic understanding of the severe weather phenomena in the site region. However, the discussion does not generate site characteristics for use as design or operating bases.

The applicant estimates that, on average, there are approximately 56 days with thunderstorms per year in the site area. This frequency is taken from the NCDC local climatological annual summary data with comparative data for Victoria. The staff confirmed that the statistics provided by the applicant are correct.

Nearly 70 percent of these thunderstorms occurred between May and September.
The applicant estimates approximately 7 flashes per square kilometer (17 flashes to earth per square mile) per year for the STP site area. The staff found this number appropriate based on similar values from NUREG/CR–3759, "Lightning Strike Density for the Contiguous United States from Thunderstorm Duration Records," an estimated mean annual ground flash density of 6 to 8 flashes per square kilometer (15 to 21 flashes per square mile), and the NWS Lightning Safety Web page[6] and a recorded flash density of 2 to 4 flashes per square kilometer (5 to 10 flashes per square mile) per year between 1996 and 2000.

### 2.3S.1.4.4 Meteorological Data for Evaluating the Ultimate Heat Sink

A description of the STP Units 3 and 4 UHS is in FSAR Tier 2, Section 9.2.5. The UHS is designed to provide sufficient cooling water to the reactor service water (RSW) system to permit a safe shutdown and cooling down of each unit and to maintain each unit in a safe shutdown condition. In the event of an accident, the UHS is designed to provide sufficient cooling water to the RSW system to safely dissipate the heat for the accident. The UHS is sized so that makeup water is not required for at least 30 days following an accident and design-basis temperature and chemistry limits for safety-related equipment are not exceeded. The UHS is designed to perform its safety function during periods of adverse site conditions, resulting in maximum water consumption and minimum cooling capability.

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6 NWS Lightning Safety Web page accessed on February 6, 2008, and is at: http:/www.lightningsafety.noaa.gov/lightning_map.htm.

Each unit has its own UHS water storage basin. Above the basin is a counterflow mechanically induced draft cooling tower with six cooling tower cells. Two of these cells are dedicated to each of the three RSW divisions to remove heat from their respective reactor building cooling water (RCW)/RSW divisions. The RSW is pumped from the UHS water storage basin to the RCW heat exchangers for the removal of heat. The heated water is returned to the mechanically induced draft cooling tower where the heat is dissipated to the atmosphere by evaporation and conduction.

The UHS provides a source of cooling water that is available at all times for reactor operation, shutdown cooling, and accident mitigation. During normal plant operation, all three divisions are in operation with one cooling tower cell per division. When the heat load is increased during a cool down, shutdown, or accident, all cooling tower cells are in operation.

RG 1.27 specifies that applicants should ensure that design-basis temperatures of safety-related equipment are not exceeded and that a 30-day cooling supply is available. Consequently, applicants should identify the meteorological conditions that result in minimum water cooling as well as maximum 30-day evaporation and drift loss.

The applicant presents the results of the UHS thermal performance in FSAR Tier 2, Section 9.2.5.5. The applicant determines the worst-case meteorological conditions from a 45 year period (1961–2005) of sequential hourly wet-bulb, dry-bulb, and station atmospheric pressure data from Victoria. The applicant identifies the meteorological conditions resulting in minimum water cooling as a 1-day (24-hour) period occurring between September 16 and 17, 1996, which resulted in the UHS basin water's maximum temperature. The applicant also identifies the meteorological conditions for maximum water usage as a 30-day (720-hour) period occurring between July 9 and August 7, 1982.

NRC staff issued RAI 02.03.01-7 requesting the applicant to discuss the meteorological data used to evaluate the UHS performance. In particular, the staff was interested in the methodology used by the applicant to screen meteorological data in selecting the minimum water cooling and maximum water usage conditions for use in evaluating the UHS thermal performance.

The applicant's response to RAI 02.03.01-7 dated May 29, 2008 (ML091490166), states that the applicant reviewed the 45-year period (1961–2005) of sequential hourly wet-bulb, dry-bulb, and station atmospheric pressure data from Victoria to determine three sets of data (the highest average dry-bulb temperature, the highest average wet-bulb temperature, and the highest average evaporation potential, where evaporation potential was defined as the difference between the moisture content of saturated air at the dry-bulb temperature minus the actual moisture content of the air) for two time periods (a consecutive 30-day period and a 1-day period). The applicant then conducted a UHS thermal performance analysis using these three sets of data to determine the maximum 30-day evaporation and the maximum one-day basin water temperature. The applicant incorporated this information into Revision 3 of FSAR Tier 2, Subsection 2.3S.1.4.

The staff performed an independent evaluation of the applicant's analysis by reviewing the 1973 to 2005 Victoria data available in DS-3505 format from the NCDC Web site. The staff identified the highest 24-hour average wet-bulb temperature (e.g., worst one-day meteorological condition that maximizes water temperature) and the highest 720-hour average evaporation potential (e.g., the worst 30-day meteorological condition that maximizes water usage). Although the staff did identify different time periods containing the highest 24-hour average wet-bulb temperature and 720-hour average evaporation potential values, the staff's resulting highest wet-bulb temperature and evaporation potential values were similar to those of the applicant. Therefore, the staff considers RAI 02.03.01-7 closed.

The staff issued RAI 02.03.01-8a requesting the applicant to justify not including meteorological data from the Palacios, Texas, Municipal Airport Weather Station in the selection of the minimum water cooling and maximum water usage conditions for evaluating the UHS thermal performance. In issuing this RAI, the staff pointed out that FSAR Tier 2, Subsection 2.3S.3.4.1.4, states that Palacios is considered to be representative of the STP site, and data collected at Palacios from 1997 through 2001 were used to predict cooling tower plume impacts resulting from the operation of the STP Units 3 and 4 RSW mechanical draft cooling towers. The staff also noted that hourly data for the period 1988 to 2007 were available from the NCDC Web site.

The applicant's response to RAI 2.3.1-8a dated June 26, 2008 (ML081970231), states that the UHS performance evaluation uses an 18-year period of data (1988 to 2005) from Palacios. The applicant finds that (1) maximum water usage would be bounded by the results of the analysis using the Victoria data, and (2) maximum water temperature would be 0.3 degrees C (0.5 degrees F) higher than the results from the Victoria data but would still remain below the design limit cold water temperature of 35 degrees C (95 degrees F). The applicant summarizes the effects from using the Palacios data on the UHS performance in Revision 3 of COL FSAR Tier 2, Subsections 2.3S.1.4 and 9.2.5.5. By the applicant incorporating this information into the FSAR, the staff considers RAI 02.03.01-8a closed.

The staff concluded that the applicant has identified appropriate meteorological conditions for evaluating the UHS performance by examining long-term regional records (i.e., 45 years of Victoria data and 18 years of Palacios data) and identifying meteorological conditions representing maximum evaporation and drift loss of water and minimum water cooling.

#### 2.3S.1.4.5 Design-basis Dry- and Wet-Bulb Temperatures

ABWR DCD Tier 1, Table 5.0 and Tier 2, Table 2.0-1 list zero-percent exceedance (i.e., historical maximum limit) and 1-percent exceedance of dry-bulb and coincident and noncoincident wet-bulb temperatures as well as 99-percent exceedance and 100-percent exceedance (i.e., historical minimum limit) of dry-bulb temperatures as ambient design temperature site parameters.[7] Consequently, the applicant compiled zero-percent exceedance dry-bulb and coincident and noncoincident wet-bulb temperatures and 100-percent exceedance dry-bulb temperatures as STP Units 3 and 4 ambient design temperature site characteristics based on data recorded for Victoria during the period 1971 to 2000. The applicant also identified one-percent exceedance dry-bulb and coincident and noncoincident wet-bulb temperatures and 99-percent exceedance dry-bulb temperatures as STP Units 3 and 4 ambient design temperature site characteristics based on statistical data published by ASHRAE for Palacios Municipal Airport for the period 1987 to 2001. FSAR Tier 2, Table 2.0-2 presents both the ABWR DCD ambient design temperature site parameters and the corresponding STP Units 3 and 4 ambient design temperature site characteristics chosen by the applicant.

Palacios is the closest climatic observation station to the STP Units 3 and 4 site (located approximately 21 km [13 mi] to the west-southwest) with hourly temperature and humidity data.

[7] The data presented in the ABWR DCD as minimum 1-percent exceedance and 0-percent exceedance values are also referred to by the staff as 99-percent exceedance and 100-percent exceedance values, respectively.

Because Palacios is located at approximately the same elevation as the STP Units 3 and 4 site and is approximately the same distance from the Gulf of Mexico, the staff expects that the temperature and humidity data recorded at Palacios should be generally representative of STP Units 3 and 4 site conditions. In order to confirm this hypothesis, the staff generated 1997, 1999, and 2000 Palacios dry-bulb statistics from the NCDC online database and compared them with similar statistics generated from the applicant's 1997, 1999, and 2000 onsite meteorological database. The results of this comparison are as follows:

| DRY-BULB STATISTIC | 1997 | | 1999 | | 2000 | |
|---|---|---|---|---|---|---|
| | PALACIOS | STP | PALACIOS | STP | PALACIOS | STP |
| Maximum | 35.0 °C | 33.2 °C | 36.1 °C | 35.6 °C | 41.1 °C | 39.8 °C |
| 1% Exceedance | 32.8 °C | 31.3 °C | 32.8 °C | 32.1 °C | 33.9 °C | 32.5 °C |
| Median | 22.2 °C | 21.2 °C | 22.8 °C | 22.7 °C | 22.8 °C | 23.4 °C |
| 99% Exceedance | 2.2 °C | 1.4 °C | 3.9 °C | 4.3 °C | 2.8 °C | 3.3 °C |
| Minimum | -1.1 °C | -1.2 °C | 0.0 °C | 0.0 °C | -2.2 °C | 0.5 °C |
| °C=degrees Celsius. | | | | | | |

NRC staff also compiled and compared 2007 hourly Palacios dew point statistics with the 2007 hourly onsite dew point data in the applicant's response to **RAI 02.03.02-2**:

| DEW POINT STATISTIC | 2007 | |
|---|---|---|
| | PALACIOS | STP |
| Maximum | 27.2 °C | 26.7 °C |
| 1% Exceedance | 26.1 °C | 25.4 °C |
| Median | 18.9 °C | 19.7 °C |

This comparison shows that the Palacios dry-bulb and dew point (humidity) data are generally representative (i.e., within 1 degree C [1.8 degree F]) of or slightly more conservative than the STP Units 3 and 4 data.

The staff compared the applicant's 1-percent exceedance dry-bulb and coincident and noncoincident wet-bulb temperatures and 99-percent exceedance dry-bulb temperature STP

Units 3 and 4 ambient design temperature site characteristics with the Palacios data statistics published by ASHRAE. The staff confirmed that the statistics provided by the applicant are correct. The staff also calculated 100-year return period maximum and minimum dry-bulb and maximum wet-bulb statistics using 1988 to 2007 Palacios data and algorithms based on the Gumbel Type 1 extreme value distribution, as defined in Chapter 27 of the 2001 ASHRAE Handbook – “Fundamentals” for comparison with the Victoria zero-percent exceedance dry-bulb and noncoincident wet-bulb temperatures and 100-percent exceedance dry-bulb temperatures identified by the applicant as STP Units 3 and 4 ambient design temperature site characteristics. The staff found that the Victoria zero-percent and 100-percent exceedance dry-bulb temperatures presented by the applicant bound the Palacios 100-year return maximum and minimum dry-bulb values calculated by the staff, but the Victoria 100-percent exceedance wet-bulb value identified by the applicant was approximately 1.4 degrees C (2.5 degrees F) lower (i.e., less conservative) than the Palacios 100-year return period maximum wet-bulb value calculated by the staff.

The applicant also generated 100-year return period maximum and minimum dry-bulb and maximum wet-bulb statistics through linear regression of individual daily maximum and minimum dry-bulb temperatures and daily maximum wet-bulb temperatures recorded during a 30-year period (1971 to 2000) at Victoria. The staff found that the Victoria 100-year return period maximum and minimum dry-bulb values calculated by the applicant (44 degrees C [111.3 degrees F] and -15.8 degrees C [3.6 degrees F], respectively) bound the Palacios 100-year return period maximum and minimum dry-bulb values calculated by the staff. The staff also found that the Victoria 100-year return period maximum wet-bulb value calculated by the applicant (30 degrees C [86.1 degrees F]) was within 0.5 degrees C (0.9 degrees F) of the Palacios 100-year return period maximum wet-bulb value calculated by the staff.

The applicant also presented 0.4-percent exceedance and two-percent exceedance dry-bulb and coincident and non-coincident wet-bulb temperatures and 99.6-percent exceedance and 100-percent exceedance dry-bulb temperatures based on 1987-2001 Palacios Municipal Airport data published by ASHRAE. The staff compared the applicant’s Palacios data against the published ASHRAE data to confirm that these statistics provided by the applicant are correct.

Because the Palacios 100-year return period maximum wet-bulb value appeared to exceed the Victoria 100-percent exceedance wet-bulb value, the staff issued RAI 02.03.01-8b requesting the applicant to justify not including meteorological data from Palacios in the selection of zero-percent exceedance coincident and noncoincident wet-bulb temperatures and the 100-year return period maximum wet-bulb temperature ambient design temperature site characteristics discussed in FSAR Tier 2, Section 2.3S.1.5.

The applicant’s response to RAI 02.03.01-8b, dated June 26, 2008 (ML081970231), states that the applicant analyzed twenty years (1988–2007) of hourly meteorological data collected at Palacios and found the following:

- A maximum recorded dry-bulb temperature of 41.1 degrees C (106 degrees F) with a coincident wet-bulb temperature of 25.4 degrees C (77.8 degrees F)
- A maximum recorded noncoincident wet-bulb temperature of 30.1 degrees C (86.1 degrees F)
- A 100-year return period maximum noncoincident wet-bulb temperature of 31.3 degrees C (88.3 degrees F)

Although the Palacios maximum recorded and 100-year return period noncoincident wet-bulb temperatures exceeded the corresponding Victoria wet-bulb temperatures, the applicant chose not to include the Palacios data in the FSAR because the exceedances were slight.

The staff subsequently issued RAI 0 2.03.01-22 requesting the applicant to (1) revise the STP Units 3 and 4 zero-percent exceedance maximum dry-bulb and concurrent wet-bulb ambient design temperature site characteristics to include the higher of either the maximum historic dry-bulb value or the maximum 100-year return period dry-bulb value for Victoria; (2) revise the STP Units 3 and 4 zero-percent exceedance maximum wet-bulb ambient design temperature site characteristic to include the higher of either the maximum historic wet-bulb value or the 100-year return period wet-bulb value for Palacios; and (3) revise the STP Units 3 and 4 zero-percent exceedance minimum dry-bulb ambient design temperature site characteristics to include the lower of either the minimum historic dry-bulb value or the minimum 100-year return period dry-bulb value for Victoria.

In RAI 02.03.01-22, the staff explained that 10 CFR 52.79(a) (1) (iii) states that COL applicants must identify the meteorological characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and period of time for which the historical data have been accumulated. In order to be compliant with 10 CFR 52.79(a)(1)(iii), the staff believes ambient design temperature site characteristics should be based on the higher of either the historic or 100-year return period values. The staff considered temperatures based on a 100-year return period as providing a sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, as required by the regulation.

The applicant's response to RAI 02.03.01-22, dated May 26, 2009 (ML091490166), emphasizes that the presentation of temperature data in Revision 0 to FSAR Tier 2, Section 2.3S.1.5 satisfies the requirements of 10 CFR 52.79(a)(1)(iii). The staff evaluated the response as summarized below:

- The applicant's RAI response states that because ABWR DCD Tier 1, Table 5.0 and Tier 2, Table 2.0-1 define zero-percent exceedance as a historical limit, there is no requirement in the ABWR DCD for the STP COL application to use 100-year return period temperatures as site characteristic values. However, 10 CFR 52.79(a)(1)(iii) states that the most severe temperatures reported for the site and surrounding area as historical limits shall include a sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated. The staff considers temperatures based on a 100-year return period to provide a sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated as required by the regulation.
- The applicant's RAI response also states that the applicant used data from Victoria instead of Palacios to calculate the zero-percent exceedance noncoincident wet-bulb temperatures because the applicant believed regulatory guidance specifies the minimum requirements for the amount of historical data necessary to develop the required projections and the minimum required amount of historical data were not available for Palacios. However, the staff believes the 20 years of recent Palacios data should not be discounted just because the minimum required amount of historical data (e.g., 30 years), as specified by the applicant, is not available.

Subsequently, the staff has asked the applicant in RAI 02.03.01-23 to make the following changes to the FSAR:

a. Revise FSAR Tier 2, Section 2.3S.1.5 to include the Palacios maximum recorded and 100-year return period dry-bulb and wet-bulb temperature site characteristic values presented in the response to RAI 02.03.01-8b.

b. Revise FSAR Tier 2, Table 2.0-2 to include the zero-percent exceedance maximum dry-bulb ambient design temperature site characteristic value based on the higher of either the maximum recorded dry-bulb value or the maximum 100-year return period dry-bulb value for either Palacios or Victoria and provide an estimate of the concurrent wet-bulb value based on the resulting dry-bulb value.

c. Revise FSAR Tier 1, Table 5.0 and Tier 2, Table 2.0-2 to include the zero-percent exceedance maximum nonconcurrent wet-bulb ambient design temperature site characteristic value based on the higher of either the maximum recorded noncoincident wet-bulb value or the 100-year return period non-coincident wet-bulb value for either Palacios or Victoria.

d. Revise FSAR Tier 2, Table 2.0-2 to include the zero-percent exceedance minimum dry-bulb ambient design temperature site characteristic value based on the lower of either the minimum recorded dry-bulb value or the minimum 100-year return period dry-bulb value for either Palacios or Victoria.

The applicant agrees to implement the requested FSAR changes in its response to RAI 02.03.01-23 dated October 29, 2009 (ML093430299). The implementation of these FSAR changes was tracked as Confirmatory Item 02.03.01-23 in the SER with open items.

The staff confirmed that COL FSAR Tier 2, Revision 4, includes the requested FSAR changes. Accordingly, the staff found that the applicant has adequately addressed this issue and, therefore, Confirmatory Item 02.03.01-23 is closed. Thus, RAIs 02.03.01-8b, 02.03.01-22, and 02.03.01-23 are closed.

- STD DEP 5.0-1 Site Parameter

FSAR Tier 2, Table 2.0-2 shows that the ABWR DCD zero-percent exceedance noncoincident and the one-percent exceedance coincident and noncoincident wet-bulb temperatures do not bound the corresponding STP Units 3 and 4 site characteristics. This finding is identified as Departure STP DEP T1 5.0-1 and is addressed in SER Section 9.4.6.

### 2.3S.1.4.6 Restrictive Dispersion Conditions

Based on NOAA Air Resources Laboratory “Air Stagnation Climatology for the United States (1948–1998),” (Wang and Angell, 1999), the applicant estimates that high-pressure stagnation conditions, usually accompanied by light and variable wind conditions, can be expected at the proposed STP Units 3 and 4 site about 30 days per year or about six cases per year, with a mean duration of about 5 days for each case. Stagnation conditions usually occur from May through October, with the highest incidences recorded between July and September.
This 3-month period also coincides with the lowest monthly mean wind speeds during the year, as reported by the local climatological data summary for Victoria.

The applicant also notes that from a climatological standpoint, the lowest morning mixing heights occur in the autumn and are highest during the spring. Conversely, afternoon mixing heights reach a seasonal minimum in the winter and a maximum during the summer, which is expected because of more intense summer heating. The applicant presents mixing height data compiled from the USDA Forest Service Ventilation Climate Information System, which reports statistical mean monthly morning and afternoon mixing heights and wind speeds for the contiguous United States as a function of longitude and latitude.

NRC staff confirmed by the review of NOAA Air Resources Laboratory "Air Stagnation Climatology for the United States (1948–1998)," (Wang and Angell, 1999) and data compiled from the USDA Forest Service Ventilation Climate Information System that the information presented by the applicant regarding restrictive dispersion conditions is correct. Section 2.3S.2 of this SER discusses the proposed STP Units 3 and 4 site air quality conditions for design and operating considerations. Sections 2.3S.4 and 2.3S.5 of this SER discuss atmospheric dispersion site characteristics used to evaluate short-term, post-accident airborne releases and long-term routine airborne releases, respectively.

#### 2.3S.1.4.7 Climate Changes

As specified in NUREG–0800, the applicability of data used to discuss severe weather phenomena that may impact the proposed COL site during the expected period of reactor operation should be substantiated. Long-term environmental changes and changes to the region resulting from human or natural causes may affect the applicability of the historical data to describe the site's climate characteristics. The staff believes current climate trends should be analyzed for potential ongoing environmental changes.

The applicant analyzed normal temperature and rainfall trends during a 70-year period for successive 30-year intervals by decade for the climate division in which the STP site is located. The applicant states that the normal (i.e., 30-year average) temperature has increased only slightly (0.17 degrees C [0.3 degrees F]) during the last decade (i.e., the 1961 to 1990 normal temperature versus the 1970 to 2000 normal temperature) and the normal rainfall has trended upward by approximately 11.4 cm (4.5 in.) during these periods in the last two decades.

The U.S. Global Change Research Program (USGCRP) released a report to the President and Members of Congress in June 2009 titled, "Global Climate Change Impacts in the United States," (ML100580077). This report was produced by an advisory committee chartered under the Federal Advisory Committee Act. The report summarizes the science of climate change and the impacts of climate change on the United States.

The USGCRP report found that the average annual temperature of the Southeast (which includes the Texas coastline where the STP Units 3 and 4 site is located) did not change significantly during the past century as a whole, but the annual average temperature has risen about 1.1 degrees C (2 degrees F) since 1970, with the greatest seasonal increase in temperature occurring during the winter months. Climate models predict continued warming in all seasons across the Southeast and an increase in the rate of warming throughout the end of the 21$^{st}$ century. Under a low heat-trapping gas emission scenario average temperatures along the Texas coastline are projected to rise 1.1–1.7 degrees C (2–3 degrees F) from a 1961-1979 baseline by mid-century (2040-2059), while a higher emissions scenario yields a 1.7–2.2 degrees C (3–4 degrees F) increase in average warming.

The USGCRP report also states that there is a 5 to 10 percent increase in observed annual average precipitation from 1958 to 2008 in the region in the proposed location of the STP Units 3 and 4. Future changes in total precipitation are more difficult to project than changes in temperature. Model projections of future precipitation generally indicate that southern areas of the United States will become drier. Except for indications that the amount of rainfall from individual hurricanes will increase, climatic models provide divergent results for future precipitation for most of the Southeast.

The applicant states that the occurrence of all tropical cyclones within a 185-km (100-nmi) radius of the STP site has been somewhat cyclical during the available period of record (1851-2006), with a peak occurring in the 1940s and a secondary peak in the 1880s. The USGCRP reports that the force and frequency of Atlantic hurricanes have increased substantially in recent decades, but the number of North American mainland hurricanes reaching land does not appear to have increased in the past century. The USGCRP reports that likely changes in the future for the United States and surrounding coastal waters include more intense hurricanes with related increases in wind and rain, but not necessarily an increase in the number of storms that make landfall.

The applicant states that the number of recorded tornado events has generally increased since detailed records were routinely kept, beginning around 1950. However, some of this increase is due to a growing population, greater public awareness and interest, and technological advances in detection. The USGCRP reaches the same conclusion. The USGCRP further states that there is no clear trend in the frequency or strength of tornadoes since the 1950s for the United States as a whole.

The USGCRP reports that the distribution by intensity of the strongest 10 percent of hail and wind reports has changed little and there is no evidence of an observed increase in the severity of such events. Climate models project future increases in the frequency of environmental conditions favorable to severe thunderstorms. But the inability to adequately model the small-scale conditions involved in thunderstorm development remains a limiting factor in projecting the future character of severe thunderstorms and other small-scale weather phenomena.

In conclusion, NRC 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. There is a level of uncertainty in projecting future conditions because the assumptions regarding the future level of emissions of heat-trapping gases depends on projections of population, economic activity, and choice of energy technologies. If it becomes evident that long-term climatic change is influencing the most severe natural phenomena reported at the site, the COL holders have a continuing obligation to ensure that their plants stay within the licensing basis.

### 2.3S.1.5 *Post Combined License Activities*

There are no post COL activities related to this section.

### 2.3S.1.6 *Conclusion*

NRC staff reviewed the application and found that the applicant has presented and substantiated information to establish the regional meteorological characteristics. The staff's review confirmed that the applicant has established the meteorological characteristics at the site and in the surrounding area acceptable to meet the requirements of 10 CFR 100.20(c) (2) and 100.21(d) with respect to determining the acceptability of the site.

The staff found that the applicant has considered the most severe natural phenomena historically reported for the site and surrounding area in establishing its site characteristics. Specifically, the staff accepted the methodologies used to analyze these natural phenomena and determine the severity of the weather phenomena reflected in these site characteristics. Because the applicant has correctly implemented these methodologies, as described above, the staff has determined that the applicant has considered these historical phenomena with margin sufficient for the limited accuracy, quantity, and period of time in which the data have been accumulated.

The staff concluded that the identified site characteristics meet the requirements of 10 CFR 52.79(a)(1)(iii), with respect to identifying the most severe of the natural phenomena historically reported for the site and surrounding area; and with a sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

The staff's review confirmed that the applicant has adequately addressed COL License Information Item 2.1 in accordance with Section 2.3.1 of NUREG–0800, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

### 2.3S.2 Local Meteorology

#### 2.3S.2.1 *Introduction*

This section of the FSAR addresses the local (site) meteorological characteristics, assessments of the potential influence of the proposed plant and its facilities on local meteorological conditions, the impact of these modifications on plant design and operation, and a topographical description of the site and its environs.

#### 2.3S.2.2 *Summary of Application*

This site-specific supplement in the FSAR describes the following:

- Summaries of the local (site) meteorology in terms of airflow, (average wind direction and wind speed, wind direction persistence), atmospheric stability, temperature, atmospheric water vapor (e.g., wet-bulb temperature, dew point temperature, or relative humidity), precipitation, fog, atmospheric stability, and air quality;
- A topographical description of the site and its environs, as modified by the plant structures, including the site boundary, exclusion zone, and low population zone
- An assessment of the construction and operation impacts of the plant and its facilities on the local meteorological parameters listed above; impacts include the effects of plant structures, terrain modification, and heat and moisture sources due to plant operation.

In addition, in FSAR Tier 2, Section 2.3S.2, the applicant provides the following:

*COL License Information Item*

- COL License Information Item 2.9 Local Meteorology

This site-specific supplement addresses COL License Information Item 2.9 from the certified ABWR DCD, which states that COL applicants will provide local meteorology for NRC review.

### 2.3S.2.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the local meteorology, and the associated acceptance criteria, are in Section 2.3.2 of NUREG--0800. In particular, the regulatory requirements are 10 CFR 52.79(a)(1)(iii), 10 CFR 100.20(c)(2) and 100.21(d).

NRC staff considered the following regulatory requirements in reviewing the applicant's discussion of the local meteorology:

- 10 CFR 52.79(a)(1)(iii), as it relates to identifying the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated
- 10 CFR 100.20(c)(2) and 100.21(d), with respect to the consideration that has been given to the local meteorological and air quality characteristics of the site and other physical characteristics of the site that can influence the local meteorology

NUREG–0800, Section 2.3.2 specifies that an application meets the above requirements if the application satisfies the following criteria:

- Provides local summaries of meteorological data that are based on onsite measurements in accordance with RG 1.23 and National Weather Service station summaries (or other standard installation summaries) from appropriate nearby locations (e.g., within 80.5 km [50 mi]) and are presented as specified RG 1.206, Regulatory Position C.I.2.3.2.1.
- Provides a complete topographical description of the site and environs to a distance of 80.5 km (50 mi) from the plant, as described in RG 1.206, Regulatory Position C.I.2.3.2.2.
- Provides a discussion and evaluation of the influence of the plant and its facilities on the local meteorological and air quality conditions.
- Identifies potential changes in the normal and extreme values resulting from plant construction and operation.
- Provides a description of local site airflow that includes wind roses and annual joint frequency distributions of wind speed and wind direction by atmospheric stability for all measurement levels using the criteria in RG 1.23.

When independently assessing the veracity of the information presented by the applicant in FSAR Tier 2, Section 2.3S.2, the staff applied the same methodologies and techniques cited above.

### 2.3S.2.4 *Technical Evaluation*

NRC staff reviewed the application and the applicant's responses to the RAIs to verify the accuracy, completeness, and sufficiency of the information presented by the applicant regarding local meteorology. The staff followed the procedures in Section 2.3.2 of NUREG–-0800 as part of this review.

The staff reviewed the information in the COL FSAR:

*COL License Information Item*

- COL license Information Item 2.9 Local Meteorology

The staff reviewed the site-specific information describing the local meteorology of the site and vicinity surrounding STP Units 3 and 4. The staff's findings are presented below:

### 2.3S.2.4.1 Data Sources

The applicant used data from the existing STP Units 1 and 2 meteorological monitoring program and 15 surrounding NWS observation stations listed in FSAR Tier 2, Table 2.3S-1 to describe local meteorology. The applicant used data from the onsite meteorological monitoring program to describe wind speed, wind direction, and atmospheric stability conditions. The applicant used data from surrounding offsite observation stations for temperature, atmospheric moisture, precipitation, and fog conditions.

### 2.3S.2.4.2 Normal, Mean, and Extreme Values of Meteorological Parameters

The applicant presents means and historical extremes of temperature, rainfall, and snowfall data in FSAR Tier 2, Tables 2.3S-3 and 2.3S-5 from the 15 offsite observation stations listed in FSAR Tier 2, Section 2.3S.1. NRC staff evaluated the information submitted by the applicant for local meteorological conditions. The staff used data from the STP Units 1 and 2 onsite meteorological monitoring system, as well as climatic data reported by the NCDC described below.

#### 2.3S.2.4.2.1 *Average Wind Direction and Wind Speed Conditions*

The applicant provides hourly wind data from the STP Units 1 and 2 onsite meteorological monitoring program, described in FSAR Tier 2, Section 2.3S.3, from 1997, 1999, and 2000. The applicant also presents monthly, seasonal, and annual wind roses based on 10-m and 60-m (33- and 197-ft) observation heights.

NRC staff confirmed that the wind directions from both levels are fairly similar. The prevailing annual wind direction for the site is generally from the south-southeast, with nearly 40 percent of the winds blowing from the southeast-through-south sectors. During the winter months, a bimodal direction distribution is exhibited with northerly winds (from the north-northwest through the north-northeast sectors) occurring with about the same frequency as winds from the southeast-through-south sectors. Winds from the southeast quadrant predominate during the spring and summer, with prevailing seasonal directions shifting from the southeast to the south as spring moves into summer. Autumn is predominated by winds from the southeast and northeast quadrants. The applicant reports that information from Victoria also indicates a prevailing south-southeasterly wind on an annual basis.

The applicant states that annual average wind speeds at the 10- and 60-m (33- and 197-ft) observation levels are 4.1 m/s and 6.0 m/s (13.5 ft/s and 19.7 ft/s), respectively, which is generally consistent with the 6.1-m (20.0 ft) measurement height average wind speed of 4.3 m/s (14.1 ft/s) reported for Victoria for the period 1971 to 2000.

Palacios is the closest climatic observation station to the STP Units 3 and 4 site (located approximately 21 km (13 mi) to the west-southwest), with hourly wind speed and direction data. Because of the proximity of Palacios to the proposed STP site and because of the similarity of topographic features at both locations (i.e., flat terrain and proximity to the Gulf of Mexico), the staff expects the wind data recorded at Palacios to be generally representative of STP Units 3 and 4 site conditions.

In order to confirm this hypothesis, the staff generated a comparison of annual wind direction frequencies among the STP, Palacios, and Victoria hourly data for the years 1997, 1999, and 2000. This comparison, shown in SER Figure 2.3S.2-1, indicates a similar distribution among all three sites. The staff also compared annual average wind speeds among all three sites for the same three-year time period. The staff found that the STP 10-m (33-ft) level average wind speed of 4.1 m/s (13.5 ft/s) is consistent with the 6.1-m (20.0-ft) level average wind speed of 4.1 m/s (13.5 ft/s) at Victoria but somewhat lower than the 5.0 m/s (16.4 ft/s) average wind speed recorded at Palacios. The staff issued RAI 02.03.02-4a requesting the applicant to justify not including meteorological data from Palacios in the review of average wind direction and wind speed conditions discussed in Revision 0 of FSAR Tier 2, Section 2.3S.2.2.1.

The applicant's response to RAI 02.03.02-4a dated June 26, 2008 (ML081970231), states that the applicant evaluated a five-year period (1995 to 1999) of wind measurements from Palacios. Wind roses based on this data set showed reasonably similar characteristics in predominant directions on an annual basis, when compared to the annual onsite wind rose. The applicant also found that mean wind speeds at Palacios were similar, although somewhat higher, throughout the year when compared to the lower level wind speeds at the STP and Victoria. The applicant included this information on Palacios wind data in Revision 4 of COL FSAR Tier 2, Subsection 2.3S.2.2.1.

The staff agreed with the applicant that the winds for the proposed STP Units 3 and 4 site are predominately from the southeast-through-south sectors. The staff also agreed with the applicant's documented annual average wind speeds of 4.1 m/s and 6.0 m/s (13.5 and 19.7 ft/s) at 10 and 60 m (33 and 197 ft). The staff's conclusions are based on a comparison between the STP onsite meteorological wind data and nearby hourly data reported at Palacios and Victoria. RAI 02.03.02-4a is therefore closed.

#### 2.3S.2.4.2.2 *Wind Direction Persistence*

The applicant presents wind direction persistence and wind speed distribution summaries based on measurements at the STP site for the 3-year preoperational period of record (1997, 1999, and 2000). The summaries account for consecutive hours of wind direction from the same 22½-degree sector. The applicant reports in Revision 0 to FSAR Tier 2, Section 2.3S.2.2.2 that the longest persistence periods for each measurement height were 30 hours at the 10-m (33-ft) level (southeast sector) and 30 hours at the 60-m (197-ft) level (north and east-northeast sectors). NRC staff performed an independent analysis of these statistics and found two longer persistence periods at the 60-m (197-ft) level (a 32-hour period and a 33-hour period). The staff subsequently issued RAI 02.03.02-5 asking the applicant to confirm the length of the longest wind direction persistence period for the 60-m (197-ft) level and to revise the FSAR if necessary.

The applicant's response to RAI 02.03.02-5 dated December 18, 2008 (ML083570395), explains that the hour listed in the FSAR wind direction persistence tables (FSAR Tier 2, Tables 2.3S-7 and 2.3S-8) is the lower limit within a period. In other words, the 30-hour frequency count identified in the persistence tables is for winds that persisted for at least 30 hours. The applicant clarifies this topic in Revision 3 of the FSAR. Consequently, RAI 02.03.02-5 is closed.

#### 2.3S.2.4.2.3 *Atmospheric Stability*

The applicant classifies atmospheric stability in accordance with the guidance in RG 1.23. Atmospheric stability is a critical parameter for estimating dispersion characteristics in FSAR Tier 2, Sections 2.3S.4 and 2.3S.5. The dispersion of effluents is greatest for extremely unstable atmospheric conditions (i.e., Pasquill Stability Class A) and decreases progressively through extremely stable conditions (i.e., Pasquill Stability Class G). The applicant based the stability classification on temperature change with height (i.e., vertical temperature difference or delta-T) between the 60-m (197-ft) and 10-m (33-ft) height, as measured by the STP onsite meteorological monitoring program during 1997, 1999, and 2000.

The applicant provides seasonal and annual frequencies of atmospheric stability classes for the onsite preoperational 3-year period of record. According to the applicant, there is a predominance of neutral stability (Pasquill Stability Class D) and slightly stable (Pasquill Stability Class E) conditions at the proposed STP site, which range from approximately 45 percent of the time during the autumn to approximately 63 percent of the time during the winter and spring. Extremely unstable conditions (Pasquill Stability Class A) occur most frequently during the summer and least frequently during the winter. Conditions that are extremely and moderately stable (Pasquill Stability Classes G and F, respectively) occur most frequently during the autumn and winter months.

The frequency of occurrence for each stability class is one of the inputs to the dispersion models used in FSAR Tier 2, Sections 2.3S.4 and 2.3S.5. The applicant includes these data in the form of a joint frequency distribution (JFD) of wind speed and direction data as a function of the stability class. A comparison of a JFD developed by the staff from the hourly data submitted by the applicant with the JFD developed by the applicant showed reasonable agreement.

Based on the stability data for the meteorological conditions at various US sites, a predominance of neutral (Pasquill Stability Class D) and slightly stable (Pasquill Stability Class E) conditions at the proposed STP site is generally consistent with expected meteorological conditions. A further discussion of the staff's review of the STP atmospheric stability data is in SER Subsection 2.3S.3.4.1.7.

#### 2.3S.2.4.2.4 *Temperature*

The applicant characterizes normal and extreme temperatures for the site based on the 15 surrounding observation stations listed in FSAR Tier 2, Section 2.3S.2.1. The extreme maximum temperatures recorded near the site range from 39 to 44 degrees C (102 to 112 degrees F). The extreme minimum temperatures recorded near the site range from -15.6 to -10.6 degrees C (4 to 13 degrees F). Annual average temperatures for the 15 surrounding observation stations in the site vicinity, which are based on average daily mean maximum and minimum temperatures, range from 20.4 to 21.7 degrees C (68.8 to 71.1 degrees F).
The applicant states that the annual average diurnal (day-to-night) temperature differences in the site vicinity range from -11.4 to -5.7 degrees C (11.4 to 21.7 degrees F). In general, the

greater diurnal temperature ranges occur at stations farther from the Gulf of Mexico and adjacent bays.

Using NCDC data, NRC staff reviewed the daily mean temperatures, extreme temperatures, and diurnal temperature ranges presented by the applicant. The staff issued RAI 02.03.01-17 requesting the applicant to confirm several of the extreme temperature statistics in FSAR Tier 2, Table 2.3S-3. Similarly, the staff issued RAI 02.03.01-20 requesting the applicant to confirm several of the mean temperature statistics in FSAR Tier 2, Table 2.3S-5. The applicant's response to RAIs 02.03.01-17 and 02.03.01-20 dated December 18, 2008 (ML083570395), revises several of the temperature statistics in FSAR Tier 2, Tables 2.3S-3 and 2.3S-5. The applicant includes these revised statistics in Revision 3 of the FSAR. Therefore, the staff considers RAIs 02.03.01-17 and 02.03.01-20 closed.

#### 2.3S.2.4.2.5 *Atmospheric Water Vapor*

The applicant presents wet-bulb temperature, dew-point temperature, and relative humidity data summaries from the Victoria NWS observation station in Revision 0 to FSAR Tier 2, Subsection 2.3S.2.2.5 to characterize the typical atmospheric moisture conditions near the proposed STP site.

Based on 20 consecutive years of recorded data, the applicant indicates a mean annual wet-bulb temperature at Victoria of 18.1 degrees C (64.5 degrees F). The highest monthly mean wet-bulb temperature is 24.6 degrees C (76.2 degrees F) during July and the lowest is 10 degrees C (50.0 degrees F) during January. The applicant also indicates a mean annual dew-point temperature at Victoria of 16.1 degrees C (60.9 degrees F), which also reaches its maximum during summer and minimum during winter. The highest monthly mean dew-point temperature is 22.8 degrees C (73.1 degrees F) during July and August and the lowest is 7.8 degrees C (46.0 degrees F) during January.

Based on 30 consecutive years of recorded data, the applicant indicates that the annual relative humidity averages 76 percent at Victoria. The average early morning relative humidity levels exceed 90 percent from May through November, and they are not much lower during the remaining months of the year. Typically, the relative humidity values reach their diurnal maximum in the early morning and diurnal minimum during the early afternoon.

NRC staff verified the applicant's Victoria wet-bulb temperature, dew-point temperature, and relative humidity data by comparing the data with the NCDC "2006 Local Climatological Data, Annual Summary with Comparative Data, Victoria, Texas (KVCT)," (NOAA, 2007).

Palacios is the closest climatic observation station to the STP Units 3 and 4 site with hourly temperature and humidity data. Because of the proximity of Palacios to the proposed STP site and because Palacios and the STP site are both located near warm bodies of water (Tres Palacios Bay and the main cooling reservoir, respectively), the staff expects the Palacios atmospheric moisture data to be typical of the atmospheric moisture conditions in the proposed STP site region. SER Subsection 2.3S.1.4.5 compares Palacios dew-point data with onsite dew-point data that support this conclusion. Therefore, the staff issued RAI 02.03.02-4b asking the applicant to justify not including meteorological data from Palacios in the review of atmospheric water vapor discussed in FSAR Tier 2, Subsection 2.3S.2.2.5.

The applicant's response to RAI 02.03.02-4b dated June 26, 2008 (ML081970231), states that the applicant reviewed 20 years (1988 to 2007) of hourly Palacios data. The applicant found that (1) the mean annual wet-bulb temperature at Palacios (19.1 degrees C [66.3 degrees F]) is higher than the Victoria temperature (18.1 degrees C [64.5 degrees F]); (2) the mean annual dew-point temperature at Palacios (17.3 degrees C [63.2 degrees F]) is higher than the Victoria temperature (16.1 degrees C [60.9 degrees F]); and (3) the annual average relative humidity at Palacios (80 percent) is higher than the 76 percent recorded at Victoria. However, the applicant did not provide a justification for not including this information in the FSAR. Consequently, as part of RAI 02.03.01-23, the staff asked the applicant to revise FSAR Tier 2, Subsection 2.3S.2.2.5 to include the Palacios wet-bulb, dew-point, and relative humidity data presented in the response to RAI 02.03.02-4b. The applicant agreed to implement the requested FSAR changes in its response to RAI 02.03.01-23 dated October 29, 2009 (ML093430299). The implementation of these FSAR changes was tracked as a Confirmatory Item 2.3.1-23 in the SER with open items.

The staff confirmed that FSAR Tier 2, Revision 4 includes the proposed changes. Accordingly, the staff found that the applicant has adequately addressed this issue. Therefore, Confirmatory Item 02.03.01-23 and RAI 02.03.02-4b and RAI 02.03.01-23 are closed.

### 2.3S.2.4.2.6 *Precipitation*

Based on data from the 15 surrounding observation stations, the applicant states that the average annual precipitation (water equivalent) totals vary substantially (ranging from 88.3 to 145.4 cm [34.78 to 57.24 in.]). The applicant states that the total annual rainfall tends to decrease more from east to west as a function of distance inland from the Gulf of Mexico and adjacent bay waters. The closest climatological stations to the STP site, which are all within 32 km (19.9 mi), have similar average rainfall totals ranging from 111.1 cm to 122 cm (43.75 in. to 48.03 in.). The applicant states that the long-term average annual total rainfall at the STP Units 3 and 4 site could reasonably be expected to be within this range.

According to the applicant, snowfall is rare. Normal annual totals range from a trace to 0.5 cm (0.2 in.). SER Subsection 2.3S.1.4.3.4 discusses snowfall in the vicinity of the proposed STP site in greater detail.

Using daily snowfall and rainfall data from NCDC, NRC staff independently verified the precipitation statistics in Revision 0 to FSAR Tier 2, Section 2.3S.2. The staff issued RAI 02.03.01-19 requesting the applicant to confirm several of the extreme snowfall historical statistics in FSAR Tier 2, Table 2.3S-3. Similarly, the staff issued RAI 02.03.01-20 requesting the applicant to confirm several of the mean snowfall statistics in FSAR Tier 2, Table 2.3S-5. The applicant's response to RAIs 02.03.01-19 and 02.03.01-20 dated December 18, 2008 (ML083570395), revised several snowfall statistics in FSAR Tier 2, Tables 2.3S-3 and 2.3S-5. The applicant included these revised statistics in Revision 3 of the FSAR. Consequently, the staff considers RAIs 02.03.01-19 and 02.03.01-20 closed.

### 2.3S.2.4.2.7 *Fog*

In Revision 0 to FSAR Tier 2, Section 2.3S.2.4.2.7, the applicant states that Victoria is the closest station to the proposed STP site that makes fog observations. The applicant notes that, based on 43 consecutive years of recorded data, Victoria averages about 41.7 days per year of heavy fog conditions (e.g., visibility is reduced to 0.4 km [0.25 mi] or less). The peak frequency occurs during January, averaging approximately 7 days per month. Heavy fog occurs least often during the summer, averaging less than one day per month during June, July, and August.

NRC staff confirmed the applicant's statement that the Victoria NWS station reports 41.7 days per year with heavy fog observations. However, Palacios is a closer climatic observation station to the STP Units 3 and 4 site with hourly fog data. Because of the proximity of Palacios to the proposed STP site and because Palacios and the STP site are both located near bodies of water (Tres Palacios Bay and the main cooling reservoir, respectively), the staff expects the Palacios fog data to be typical of fog conditions in the proposed STP site region. Therefore, the staff issued RAI 02.03.02-4c asking the applicant to explain not including meteorological data from Palacios in the review of fog data discussed in FSAR Tier 2, Subsection 2.3S.2.2.6.

The applicant's response to RAI 02.03.02-4c dated June 26, 2008 (ML081970231), states that the record of fog data at Palacios is not as much or as complete as the data available from Victoria. Palacios started collecting fog data in late 2000, whereas the Victoria fog data reported by the applicant in FSAR Tier 2, Subsection 2.3S.2.2.7 covers 43 consecutive years of recorded data. The applicant reports an average annual frequency of about 29 days per year of heavy fog conditions at Palacios compared to an average of 42 days per year at Victoria. Nonetheless, the applicant still considers the frequency of heavy fog conditions at Victoria to be a reasonable indicator of the conditions that may be expected to occur at the STP site. Although the staff believes that the Palacios fog data are more representative of STP site conditions, the staff accepted the applicant's Victoria fog data because those data predict a higher (more conservative) frequency of heavy fog conditions. Therefore, RAI 02.03.02-4c is closed.

#### 2.3S.2.4.3 Topographic Description

The proposed STP Units 3 and 4 site is located in Matagorda County, Texas, approximately 19 km (12 mi) south-southwest of the city limits of Bay City, Texas. The applicant provides maps of topographical features within a 8-km and a 80.5-km (5-mi and a 50-mi) radius of the site. The applicant also provides terrain elevation profiles along each of the 16 standard 22½-degree compass radials to a distance of 80.5 km (50 mi). Based on these profiles, the applicant characterizes the proposed STP site terrain as basically flat to the northeast and southwest of the site, decreasing to sea level to the south toward the Gulf of Mexico and adjacent waters, and increasing gradually to the northwest to a maximum elevation of 50 m (164 ft) within 80.5 km (50 mi).

Based on topography data from the USGS and on a site visit, the staff agreed with this terrain characterization. NRC staff concluded that the applicant has provided the necessary topographic information.

#### 2.3S.2.4.4 Potential Influence of the Plant and Related Facilities on Meteorology

The applicant states that the associated paved, concrete, or other improved surfaces resulting from the construction of the proposed nuclear facility are insufficient to generate discernible, long-term effects to local or micro-scale meteorological conditions. Wind flow may be altered immediately adjacent to and downwind of larger site structures, but these effects will likely dissipate within 10 structure heights downwind. SER Section 2.3S.3 discusses the effects of these larger structures on wind flow.

The applicant states that although temperature may increase above altered surfaces, the effects will be too limited in their vertical profile and horizontal extent to alter local- or regional-scale ambient temperature changes. Site clearing, grubbing, excavation, leveling, and landscape activities associated with plant construction will be localized and will not represent a significant change to the gently rolling topographic character of the site and its surrounding site area.

NRC staff agreed that the activities discussed above are too small-scale to impact the local meteorological characteristics of the site.

STP Units 1 and 2 use the main cooling reservoir as a means of heat dissipation. Under normal operation, STP Units 3 and 4 will also use the main cooling reservoir to dissipate waste heat rejected from the main condenser via the circulating water system (CWS). Mechanical draft cooling towers will also be used to remove heat load from the STP Units 3 and 4 RSW system. The applicant states in Revision 0 to FSAR Tier 2, Section 2.3S.2.4 that the potential meteorological effects due to the operation of the main cooling reservoir and these cooling towers may include enhanced ground-level fogging and icing, cloud shadowing and precipitation enhancement, and increased ground-level humidity.

The staff issued RAI 02.03.02-1 asking the applicant to describe the potential impacts of the main cooling reservoir and the RSW system mechanical draft cooling towers on the plant's design and operation. In particular, the staff asked the applicant to address the effects of local increases in ambient temperature, moisture content, and salt deposition on electrical transmission lines; electrical equipment (including transformers and switchyard); and heating, ventilation, and air conditioning (HVAC) intakes. The applicant's response to RAI 02.03.02-1 dated May 29, 2008 (ML081560702), describes the potential effects from increases in ambient temperature, moisture, and salt deposition on STP Units 3 and 4 plant design and operation.

The applicant's response to RAI 02.03.02-1 addresses the potential impacts from the main cooling reservoir. The applicant states that salt deposition from the main cooling reservoir is not expected to affect HVAC systems and electrical equipment; most salt deposition resulting from the evaporation of main cooling reservoir water will remain in the pond. The additional water flow from STP Units 3 and 4 to the main cooling reservoir will increase ambient moisture as a result of higher pond temperatures and evaporation. However, the applicant expects no adverse effects on plant features because HVAC intakes, transmission lines, and onsite electrical equipment are designed for outdoor operation, which includes environmental conditions such as fog and rain. Because the safety-related HVAC systems are designed for an outdoor summer temperature of 46.1 degrees C (115 degrees F), and the predicted maximum monthly main cooling reservoir discharge temperature for four-unit operation from 2003 to 2005 is 44.6 degrees C (112.3 degrees F) (from COL application Part 3, "Environmental Report," Table 3.4-3), the applicant states that added heat from the main cooling reservoir is also not expected to adversely affect the HVAC systems. The staff concurred with these conclusions.

The applicant's response to RAI 02.03.02-1 also addresses potential impacts on STP Units 3 and 4 plant design and operation due to local increases in salt deposition and moisture from the RSW system using the Seasonal/Annual Cooling Tower Impact (SACTI) code. However, the applicant was in the process of modifying the UHS design at the time of this RAI response, and the revised design could impact the potential effects of the RSW system cooling towers on plant design and operation. Consequently, the staff issued RAI 02.03.02-7 requesting the applicant to update the information in the response to RAI 02.03.02-1 to reflect the revised UHS design. The staff also issued RAI 02.03.02-8 requesting the applicant to describe the assumptions and provide a copy of the SACTI input and output files that were used to estimate the fogging and drift impacts from the operation of the modified RSW system cooling towers.

The applicant's response to RAI 02.03.02-7 dated April 14, 2009 (ML091070289), addresses potential impacts on the STP Units 3 and 4 plant design and operation due to local increases in salt deposition and moisture from the modified RSW system using the SACTI code.
The applicant states that the maximum salt deposition rates at the bounding location for electrical equipment and transmission lines (i.e., the Unit 4 transformers located approximately 380 m (1,247 ft) north-northwest of the UHS) will be between 1,100 and 4,200 kilograms per square kilometer (6,268 and 23,955 pounds per square mile) per month. The applicant states that this amount represents a medium to heavy contamination environment, according to Institute of Electrical and Electronics Engineers (IEEE) Standard C57.19.100-1995, "IEEE Guide for Application of Power Apparatus Bushings," reaffirmed December 9, 2003. However, the applicant also states these salt deposition rates are expected to be lower because they were calculated assuming the RSW system will be running at full capacity when in reality it is expected to run closer to half capacity. SER Section 8.2 addresses the countermeasures that will be taken by the applicant to prevent insulator and bushing failures on offsite power system equipment, as a result of salt deposits.

Because the SACTI model predicted no hours of fogging annually in any location, there should be little increase in ambient moisture operation affecting plant features. The applicant also states that added heat from the UHS is also not expected to adversely affect HVAC systems because the safety-related HVAC systems are designed for an outdoor summer temperature of 46.1 degrees C (115 degrees F), and the temperature of the exhaust plume from the UHS will not exceed the RSW return water temperature of 43.0 degrees C (109.4 degrees F).

The applicant's response to RAI 02.03.02-8 dated April 14, 2009, states that the cooling tower plume impacts were modeled with SACTI using 1997, 1999, and 2000 onsite wind speed, wind direction, and dry-bulb temperature data and concurrent total sky clearness, dew-point temperature, and ceiling height data from Palacios. FSAR Tier 2, Subsection 2.3S.3.2.1.2 states that relative humidity and temperature instrumentation were added to the 10-m and 60-m (33-ft and 197-ft) levels of the onsite meteorological tower in 2006, for the calculation of dew-point temperature to support estimates of the environmental impacts due to the operation of the STP Units 3 and 4 RSW cooling towers. The staff issued RAI 02.03.03-2 asking the applicant to provide a copy of the onsite dew-point temperature database, once a contiguous year of data has been collected, and to compare these data to the Palacios dew-point data that were used to evaluate cooling tower plume impacts.

The applicant's response to RAI 02.03.02-2 dated June 26, 2008 (ML081970231), provides the staff with a copy of a January 2007 through April 2008 hourly onsite dew-point temperature database. The applicant compared frequency distributions of the 2007 onsite data with 1997, 1999, and 2000 Palacios data and concluded that the Palacios data are generally consistent with the onsite dew-point temperature data. The staff performed an independent verification that compared the onsite 2007 dew-point temperature data with the 2007 Palacios dew-point temperature data and came to a similar conclusion that is explained in SER Subsection 2.3S.1.4.5. Consequently, the staff found the Palacios dew-point temperature data to be reasonably representative of onsite conditions and therefore acceptable for use in evaluating cooling tower plume impacts. For this reason, the staff considers RAI 02.03.02-2 resolved.

The staff reviewed the SACTI computer code inputs and outputs provided by the applicant and concurred with the applicant's analysis. Therefore, RAIs 02.03.02-1 and 02.03.02-8 are considered closed. The applicant revised Revision 3 to FSAR Tier 2, Subsection 2.3S.2.4 to describe the potential impacts of the main cooling reservoir and the RSW system mechanical draft cooling towers on plant design and operation discussed above. Therefore, the staff considers RAI 02.03.02-7 closed.

#### 2.3S.2.4.5 Current and Projected Site Air Quality

The applicant states in Revision 0 to FSAR Tier 2, Subsection 2.3S2.5.1 that the proposed STP Units 3 and 4 site is located in the Metropolitan Houston-Galveston Intrastate Air Quality Control Region (AQCR 216). The applicant also notes that the counties within this region, including Matagorda County, have been designated as in attainment with or unclassified for all EPA air pollutant criteria (ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead), except for a number of counties to the northeast or north-northeast of Matagorda County, which have been designated as "moderate" non-attainment with respect to the 8-hour ozone standard.

NRC staff issued RAI 02.03.02-6 asking the applicant to confirm the STP site's air quality status designations. In particular, the staff believed that (1) the attainment status for AQCR 216 had not been designated for lead, and (2) the EPA had proposed to grant a request by the Governor of the State of Texas to voluntarily reclassify the AQCR 216 ozone nonattainment area from a moderate 8-hour ozone nonattainment area to a severe 8-hour ozone nonattainment area (72 *FR* 74252, December 31, 2007). The applicant's response to RAI 02.03.02-6 dated December 18, 2008 (ML083570395), confirms that (1) the EPA granted a request from the Governor of the State of Texas to reclassify parts of AQCR-216 as a severe ozone nonattainment area to be effective October 31, 2008; and (2) the attainment status for lead has not been designated for most of the State of Texas. The applicant has incorporated this information into Revision 3 of the FSAR. Therefore, the staff considers RAI 02.03.02-6 closed.

According to the applicant, the proposed nuclear steam supply system (NSSS) and other radiological systems related to the proposed facility will not be sources of criteria pollutants or other air toxic emissions. Other proposed supporting equipment (e.g., emergency diesel generators, fire pump engines, combustion turbine) and other non-radiological emission-generating sources (e.g., storage tanks) or activities are not expected to be, in the aggregate, a significant source of criteria pollutant emissions.

Because the EPA has designated the proposed STP Units 3 and 4 site area as in attainment or unclassified for all air pollutant criteria, and the new facility is not expected to be a significant source of air pollutants, the staff found that the STP Units 3 and 4 site air quality conditions should not be a significant factor in the design and operating bases for the facility.

### 2.3S.2.5 *Post Combined License Activities*

There are no post COL activities related to this section.

### 2.3S.2.6 *Conclusion*

NRC staff reviewed the application and found that the applicant has presented and substantiated information describing the local meteorological, air quality, and topographic characteristics important to evaluating the adequacy of the design and siting of this plant. The staff reviewed the information provided and, for the reasons given above, concludes that the identification and consideration of the meteorological, air quality, and topographical characteristics of the site and the surrounding area are acceptable and meet the requirements of 10 CFR 100.20(c)(2) and 10 CFR 100.21(d), with respect to determining the acceptability of the site.

The staff found that the applicant has considered the appropriate site phenomena in establishing the site characteristics. Specifically, the staff has generally accepted the methodologies used to determine the meteorological, air quality, and topographic characteristics as documented in safety evaluation reports for previous licensing actions. Because the applicant has correctly implemented these methodologies, as described above, the staff has determined 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.

The staff concluded that the identified site characteristics meet the requirement of 10 CFR 52.79(a)(1)(iii), with respect to identifying the most severe of the natural phenomena historically reported for the site and surrounding area and with a sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

The staff's review confirmed that the applicant has adequately addressed COL License Information Item 2.9, in accordance with Section 2.3.2 of NUREG–0800, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

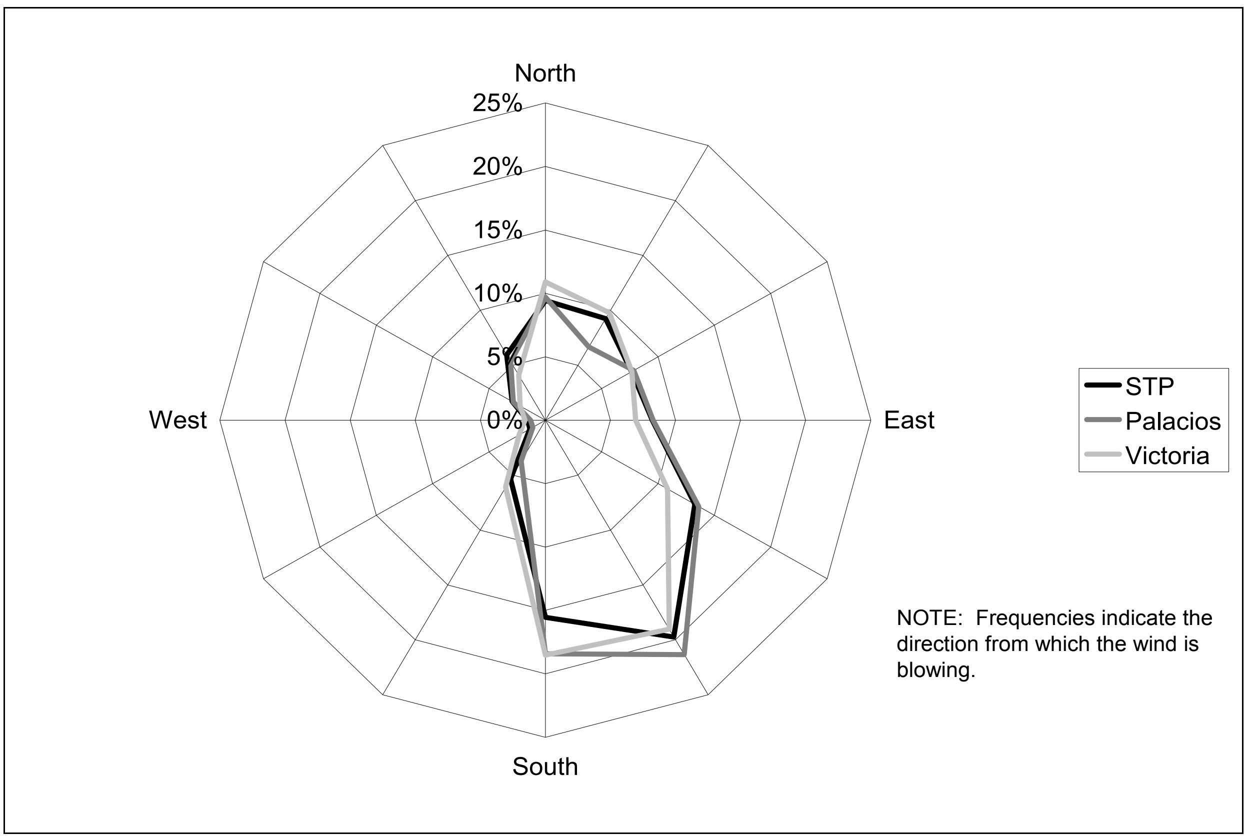


**Figure 2.3S.2-1. Comparison of 1997, 1999, and 2000 Wind Direction Frequency Distributions**

## 2.3S.3 Onsite Meteorological Measurements Program

### 2.3S.3.1 *Introduction*

This section of the FSAR addresses the onsite meteorological monitoring program and the resulting data.

### 2.3S.3.2 *Summary of Application*

This site-specific supplement included in the FSAR describes the following:

- A description of the pre-operational and operational meteorological monitoring program instrumentation, including the siting of sensors, sensor type and performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, and data acquisition and reduction procedures
- The resulting meteorological database presented in the form of a joint frequency distribution of wind speed and direction by atmospheric stability class, and an hour-by-hour listing of the hourly-averaged parameters

In addition, in FSAR Section 2.3S.3, the applicant provides the following:

<u>*COL License Information Item*</u>

- COL License Information Item 2.10 Onsite Meteorological Measurements Program

This site-specific supplement addresses COL License Information Item 2.10 from the certified ABWR DCD, which states that COL applicants will provide a description of the onsite meteorological measurements program.

### 2.3S.3.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the onsite meteorological measurements program, and the associated acceptance criteria, are in Section 2.3.3 of NUREG–0800. In particular, the regulatory requirements are 10 CFR Part 20, 10 CFR Part 50, 10 CFR 52.79, 10 CFR 100.20 and 10 CFR 100.21.

NRC staff considered the following regulatory requirements in reviewing the applicant's discussion of the site's location and description of the onsite meteorological measurements program:

- 10 CFR Part 20, Subpart D, "Radiation Dose Limits for Individual Members of the Public," with respect to the meteorological data used to demonstrate compliance with dose limits for individual members of the public
- 10 CFR Part 50, Paragraphs 50.47(b)(4), 50.47(b)(8), and 50.47(b)(9), as well as Section IV.E.2 of Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," with respect to the onsite meteorological information available for determining the magnitude and continuously assessing the impact of the releases of radioactive materials into the environment during a radiological emergency

- 10 CFR Part 50, Appendix A, “General Design Criterion (GDC) 19”, "Control room," with respect to the meteorological data used to evaluate the personnel exposures inside the control room during radiological and airborne hazardous material accident conditions
- 10 CFR Part 50, Appendix I, ‘Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion ”As Low As Reasonably Achievable” for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents’ with respect to meteorological data used in determining the compliance with numerical guides for design objectives and limiting conditions for operation to meet the requirement that radioactive material in effluents released to unrestricted areas be kept as low as is reasonable achievable (ALARA).
- 10 CFR 52.79(a)(1)(vi) with respect to a safety assessment of the site, including consideration of major SSCs of the facility and site meteorology, to evaluate the offsite radiological consequences at the EAB and LPZ.
- 10 CFR 100.20(c)(2) with respect to the meteorological characteristics of the site that are necessary for safety analysis or that may have an impact upon plant design in determining the acceptability of a site for a nuclear power plant.
- 10 CFR 100.21(c) with respect to the meteorological data used to evaluate site atmospheric dispersion characteristics and establish dispersion parameters such that (1) radiological effluent release limits associated with normal operation can be met for any individual located off site, and (2) radiological dose consequences of postulated accidents meet prescribed dose limits at the EAB and LPZ.

NUREG–0800, Section 2.3.3 specifies that an application meets the above requirements if the application provides the following information:

- The pre-operational and operational monitoring program should be described, including (1) a site map (drawn to scale) that shows tower location and true north with respect to man-made structures, topographic features, and other features that may influence site meteorological measurements, (2) distances to nearby obstructions of flow in each downwind sector, (3) measurements made, (4) elevations of measurements, (5) exposure of instruments, (6) instrument descriptions, (7) instrument performance specifications, (8) calibration and maintenance procedures and frequencies, (9) data output and recording systems, and (10) data processing, archiving, and analysis procedures.
- Meteorological 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. There should be an hour-by-hour listing of the hourly-averaged parameters in the format described in RG 1.23. If possible, evidence of how well these data represent long-term conditions at the site, possibly through a comparison with offsite data.
- At least two consecutive annual cycles (and preferably 3 or more whole years), including the most recent 1-year period. The applicant should use these data to calculate (1) the short-term atmospheric dispersion estimates for accident releases discussed in FSAR Tier 2, Section 2.3S.4, and (2) the long-term atmospheric dispersion estimates for routine releases discussed in FSAR Tier 2, Section 2.3S.5.

The applicant should identify and explain any deviations from the guidance in RG 1.23.

When independently assessing the veracity of the information presented by the applicant in FSAR Tier 2, Section 2.3S.3, NRC staff applied the same methodologies and techniques cited above.

### 2.3S.3.4 *Technical Evaluation*

NRC staff reviewed the application and the applicant's responses to the RAIs to verify the accuracy, completeness, and sufficiency of the information presented by the applicant regarding the onsite meteorological measurements program. The staff followed the procedures described in Section 2.3.3 of NUREG–0800 as part of this review.

The staff reviewed the information in the COL FSAR:

*COL License Information Item*

- COL License Information Item 2.10 Onsite Meteorological Measurements Program

NRC staff reviewed the preoperational and operational meteorological monitoring programs for STP Units 3 and 4, including a description and site map showing tower locations with respect to manmade structures, topographic features, and other site features that can influence site meteorological measurements.

The staff's findings are summarized below.

#### 2.3S.3.4.1 Preoperational Meteorological Measurement Program

The preoperational meteorological monitoring program was based on the pre-existing operational meteorological monitoring program and equipment used for STP Units 1 and 2. The applicant states that the STP Units 1 and 2 Meteorological Monitoring Program are conducted in conformance with Revision 1 to RG 1.23.

##### 2.3S.3.4.1.1 *Tower Location*

A 60-m (197-ft) guyed meteorological tower served as the primary data collection system and a 10-m (33-ft) freestanding tower served as a backup to the primary system. The backup meteorological system was a completely independent system installed and maintained for the purpose of providing redundant site-specific meteorological information at the 10-m (33-ft) level (i.e., wind speed, wind direction, temperature, wind direction standard deviation [sigma theta]). The primary tower was located approximately 2.1 km (1.3 mi) east of STP Units 3 and 4, and the backup tower was located approximately 671 m (2,200 ft) south of the primary tower.

RG 1.23 states that to the extent practical, meteorological measurements should be made in locations that can provide data representative of the atmospheric conditions into which material will be released and transported. The tower or mast should be sited at approximately the same elevation as finished plant grade. Wind measurements should be made at locations and heights that avoid airflow modifications by obstructions such as large structures, trees, and nearby terrain. The sensors should be located over level, open terrain at a distance of at least 10 times the height of any nearby obstruction, if the height of the obstruction exceeds one-half of the height of the wind measurement.

The applicant states that both the primary and backup tower locations are clear of manmade and natural obstructions that could influence the collection of meteorological data. The bases of both the primary and backup towers were at an elevation of approximately 8.5 m (27.9 ft) mean sea level (MSL), while the finished plant grade of STP Units 3 and 4 will range between 9.8 m (32.2 ft) and 10.4 m (34.1 ft) MSL. The terrain surrounding both meteorological towers is generally flat. Both towers are located in open fields with grassy surfaces, where the closest trees and brush range from 4.6 m to 9.2 m (15 ft to 30 ft) tall and are mostly 91 m (300 ft) or more from the towers. The nearby environmental shelters that house the processing and recording equipment are less than 5 m (16.4 ft) high, which is less than half of the lower level wind measurement height of 10 m (32.8 ft).

The applicant provides a map showing the locations of the meteorological towers with respect to the existing STP Units 1 and 2 units. The tallest existing buildings are located more than 1.6 km (l mi) from the meteorological towers, so that the separation between these buildings and the meteorological towers is much greater than 10 times the building heights.

The STP Units 1 and 2 main cooling reservoir is approximately 1.6 km (1 mi) southwest of the primary meteorological tower. The potential impact of the main cooling reservoir on the primary tower measurements is discussed in SER Subsection 2.3S.3.4.1.7.

An NRC staff visit to the STP meteorological towers during a pre-application site audit (on June 25 through 26, 2007) confirmed the applicant's description of the general tower exposure.

The tower locations are consistent with the recommendations in RG 1.23. Therefore, the staff found the locations acceptable.

#### 2.3S.3.4.1.2 *Tower Design*

The STP primary meteorological tower is a 60-m (197-ft), two level (60-m and 10-m [197-ft and 33-ft]) guyed triangular open lattice tower with a side width of approximately 111.8 cm (44 in.). Wind sensors are mounted on a boom extending 2.4 m (8 ft) outward on the upwind side of the tower to minimize tower structure influence.

The primary tower's open lattice design is consistent with the recommendations in RG 1.23. Therefore, the staff found the design is acceptable.

#### 2.3S.3.4.1.3 *Instrumentation*

The primary tower is instrumented with wind speed, wind direction, and ambient temperature at the 10-m and 60-m (33-ft and 197-ft) levels above ground level. Precipitation is measured at ground level near the base of the primary tower. Solar radiation is also monitored at 2.5 m (8.2 ft) above ground level. The vertical temperature difference (delta-T) is calculated as the difference between the temperatures measured at 60 m and 10 m (197 ft and 33 ft).
The dew-point temperature was also measured at the 3-m (10-ft) level. The applicant states that additional relative humidity and temperature instrumentation were added to the 10-m and 60-m (33-ft and 197-ft) levels in 2006, for the calculation of the dew-point temperature to support estimates of the environmental impacts due to the operation of the STP Units 3 and 4 RSW mechanical draft cooling towers.

RG 1.23 states that wind speed, wind direction, and vertical temperature differences should be measured at 10 and 60 m (33 ft and 197 ft) and at a third and higher level for stack releases of 85 m (279 ft) or higher. The highest release point is the 76-m (249-ft) reactor building plant stack. Therefore, the 10-m and 60-m (33-ft and 197-ft) measurement levels in the application are acceptable. The STP meteorological monitoring program also measures ambient temperature, precipitation, and atmospheric moisture, as specified in RG 1.23. Consequently, the applicant's primary tower meteorological parameters are consistent with the guidelines in RG 1.23.

The wind instrumentation consists of cup anemometers and wind vanes whose starting thresholds meet the 0.45 m/s (1.0 mph) criterion specified in RG 1.23. The ambient temperature sensors are platinum resistance temperature devices mounted in fan-aspirated radiation shields to minimize the impact of thermal radiation and precipitation. The rain gauge consists of a tipping bucket equipped with wind shields to minimize the loss of precipitation caused by the wind. The solar radiation sensor is a copper constantan thermopile. The relative humidity/temperature sensors, which were added in 2006 to determine the dew-point temperature, are capacitive polymer humidity and temperature sensors.

The applicant provides system performance specifications (e.g., system accuracy, measurement resolution) for the meteorological monitoring instrumentation that meet the criteria specified in RG 1.23. Because the instrumentation is consistent with the recommendations of RG 1.23, the staff found the instrumentation to be acceptable.

#### 2.3S.3.4.1.4 *Instrumentation Maintenance and Surveillance Schedules*

RG 1.23 states that meteorological instruments should be inspected at a frequency that will ensure data recovery of at least 90 percent on an annual basis. Channel checks should be performed daily for operational monitoring programs and channel calibrations should be performed semiannually for both preoperational and operational programs, unless the operating history of the equipment indicates that either more or less frequent calibration is necessary.

The applicant states that channel checks were performed daily and system calibrations were performed semiannually on both the primary and backup towers. Data recoverability for the 1997, 1999, and 2000 onsite meteorological database submitted in support of the STP Units 3 and 4 COL application exceeded the RG 1.23 annual goal of 90 percent.

The instrument maintenance and surveillance schedules are consistent with the recommendations in RG 1.23. Therefore, the staff found the schedules are acceptable.

#### 2.3S.3.4.1.5 *Data Reduction and Compilation*

RG 1.23 states that meteorological monitoring systems should use electronic digital data acquisition systems as the primary data recording system. The digital sampling of data should be at least once every 5 seconds and the digital system should be compiled and archived as hourly values for use in historical climatic and dispersion analyses.

The applicant states that independent microprocessors are used as the primary data collection system for the primary and backup meteorological towers, with digital data recorders used as a backup data collection system. The microprocessors sampling rate is once per second for each parameter, except for precipitation. Water collected by the rain gauge is automatically drained and counted each time an internal bucket filled with 0.25 mm (0.01 in.) of rainfall.
The microprocessors compile 15-minute and 60-minute data averages and compute sigma theta (wind direction standard deviation) data as well. The data are collected and electronically transmitted to various plant computers for data validation, screening, display, storage, and report generation. Computer programs are used in the screening process to identify recurring types of data errors, and the data are edited accordingly. Data reduction and compilation are consistent with the recommendations in RG 1.23 and are therefore acceptable to NRC staff.

#### 2.3S.3.4.1.6 *Deviations to Guidance from Regulatory Guide 1.23*

The applicant did not report any deviations to the guidance in RG 1.23.

#### 2.3S.3.4.1.7 *Resulting Meteorological Data*

The applicant provides joint frequency distributions of wind speed, wind direction, and atmospheric stability for both the 10-m and 60-m (33-ft and 197-ft) levels on the primary tower. The data are based on hourly measurements taken during 1997, 1999, and 2000. The applicant notes that the 1999 to 2000 24-month period of data was determined to be the most defensible (i.e., using validated data with the least amount of data substitution); representative (i.e., tower and sensor siting in accordance with RG 1.23); and complete (i.e., annual data recovery rates in excess of 90 percent). No data were older than 10 years. Because RG 1.23 specifies that three or more years of data are preferable, the applicant also provides a third year—1997 data. The applicant provides a copy of the 1997, 1999, and 2000 hourly database to the staff.

NRC staff issued RAI 02.03.03-1 asking the applicant to describe in general terms any data substitution used to create the 1997, 1999, and 2000 onsite meteorological database. The applicant's response to RAI 02.03.02-1 dated June 12, 2008 (ML081710126), notes that 204 hours of missing delta-T data are replaced with estimates using various techniques. Because these 204 hours represent a small fraction (less than 1 percent) of the total number of hours of delta-T data collected during 1997, 1999, and 2000, the staff found that the delta-T data substitution should not have a significant impact on the resulting onsite database. Consequently, the staff considers RAI 02.03.02-1 closed.

The staff performed a quality review of the 1997, 1999, and 2000 hourly meteorological database using the methodology described in NUREG–0917, "Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data," issued in July 1982. The staff used computer spreadsheets to further review the data. As expected, the staff's examination of the data revealed generally stable and neutral atmospheric conditions at night and unstable and neutral conditions during the day. Wind speed and wind direction frequency distributions for each measurement channel were reasonably similar from year to year. The staff issued RAI 02.03.03-4 asking the applicant to explain the variation in onsite G Stability Class (extremely stable) frequency, which ranged from a maximum of 12.3 percent in 1999 to a minimum of 6.1 percent in 2000. The applicant's response to RAI 02.03.03-4 dated June 12, 2008, states that the applicant reviewed 7 years of onsite stability class frequency distributions and found several similar year-to-year variations. Therefore, the applicant attributes the G stability class frequency differences to year-to-year variations, which are within the norm of the yearly variation. The staff found this response acceptable and considers RAI 02.03.03-4 closed.

In a comparison between the lower and upper JFDs in FSAR Tier 2, Tables 2.3S-10 and 2.3S-11 and staff-generated JFDs from the hourly database provided by the applicant, the two sets of JFDs are similar.

In order to show how well the 1997, 1999, and 2000 data set represents long-term conditions at the site, the staff compared the 1997, 1999, and 2000 10-m (33-ft) wind direction; 10-m (33-ft) wind speed; and delta-T stability class frequency distributions with frequency distributions derived from the onsite data summaries in Section 2.3 of the STP Units 1 and 2 UFSAR. The STP Units 1 and 2 UFSAR data summaries are based on data collected onsite from

July 21, 1973, through July 20, 1976; and from October 1, 1976, through September 30, 1977. Although the two data sets are more than 30 years apart, there is a close correlation in wind direction with predominant winds from the south-southeast (see SER Figure 2.3S.3-1). There is also reasonable agreement in wind speed (see SER Figure 2.3S.3-2), with the median wind speed for the earlier data set slightly higher than the median wind speed for the later data set (4.3 m/s versus 3.8 m/s [14.1ft/s versus 12.5 ft/s]).

The stability class frequency distribution for both data sets in SER Figure 2.3S.3-3 also show reasonable agreement. Nonetheless, the staff issued RAI 02.03.03-3 asking the applicant to explain the 6 percent frequency increase of onsite Stability Class A (extremely unstable) conditions from the original data set to the current data set (see SER Figure 2.3S.3-3).

The applicant's response to RAI 02.03.03-3 dated May 29, 2008 (ML081710126), states that heat transfer from the main cooling reservoir will increase the lower level ambient temperature, enhance thermal instability, and result in more unstable atmospheric conditions. Commercial operation of STP Units 1 and 2 commenced in August 1988 and June 1989, respectively. Therefore, the 1973 to 1977 data represent the STP Units 1 and 2 pre-operational conditions; the 1997, 1999, and 2000 data represent the STP Units 1 and 2 post-operational period. The main cooling reservoir is located approximately 1.6 km (1 mi) south-southwest of the main cooling reservoir. SER Figure 2.3S.3-4 shows that Stability Class A increased primarily in the south-through-southwest wind direction sectors for the STP Units 1 and 2 post-operational period. Therefore, the applicant mainly attributes the 6 percent frequency increase of onsite Stability Class A to the thermal instability contributed by the main cooling reservoir. The staff found this assessment reasonable and considers RAI 02.03.03-3 closed.

The staff subsequently issued RAI 02.03.03-5 stating the response to the RAI 02.03.03-3 assertion that an increase in measured onsite Stability Class A between the STP Units 1 and 2 pre-operational period (1973–1977) and the STP Units 1 and 2 post-operational period (1997, 1999, and 2000) is attributed to thermal instability contributed by the main cooling reservoir is in apparent conflict with the statement in Revision 0 to FSAR Tier 2, Subsection 2.3S.3.2.1.3. This subsection states that the influence of the main cooling reservoir on ambient temperature instrumentation is expected to be minimal due to the large separation in distance between the meteorological tower and the main cooling reservoir. In response to RAI 02.03.03-5 dated November 20, 2008 (083290340), the applicant revised Subsection 2.3S.3.2.1.3 to address the impact on the meteorological tower by the main cooling reservoir in COL FSAR Revision 3. Therefore, the staff considers RAI 02.03.03-5 closed.

Based on (1) an independent quality review of the onsite meteorological data, (2) a comparison with the onsite data summaries in the STP Units 1 and 2 UFSAR, and (3) a comparison with offsite wind data in SER Subsection 2.3S.2.4.2.1, the staff accepted the 3 years of onsite data from the applicant as representative of the site. The staff also found the data to be an acceptable basis for estimating atmospheric dispersion for design-basis accidents and routine releases in FSAR Tier 2, Sections 2.3S.4 and 2.3S.5.

The staff notes that the operation of STP Units 3 and 4 could further increase the main cooling reservoir water temperatures. This increase would increase thermal instability, which could enhance the dispersion of releases occurring near the plant site beyond the prediction in FSAR Tier 2, Sections 2.3S.4 and 2.3S.5.

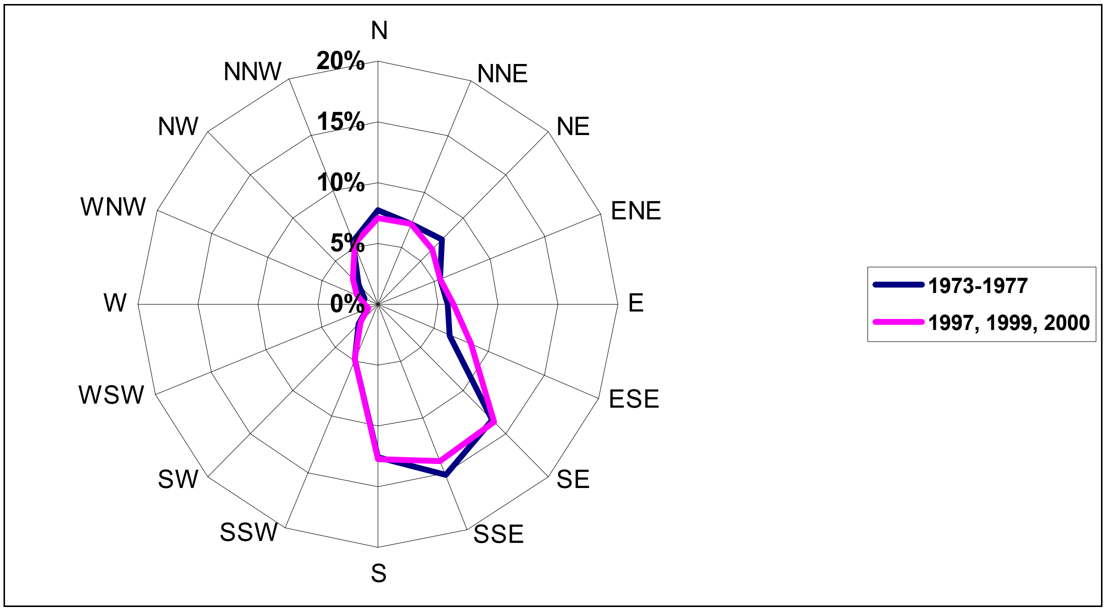


**Figure 2.3S.3-1. STP 10m Wind Direction Frequency Distributions**

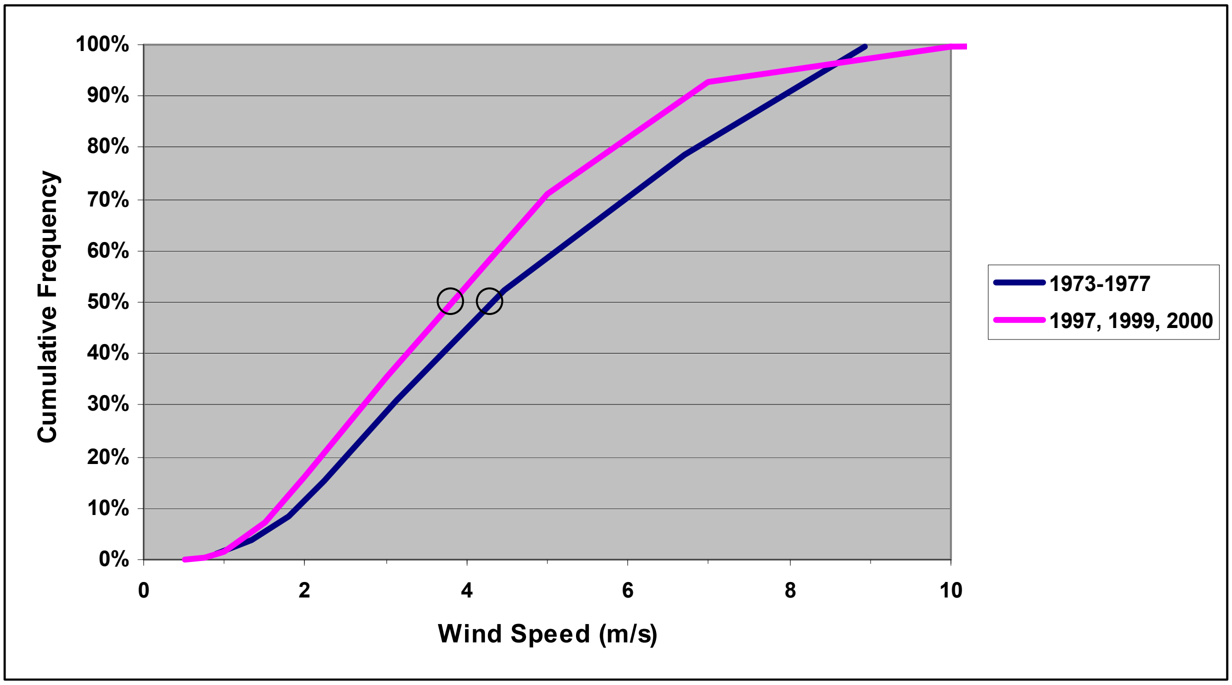


**Figure 2.3S.3-2. STP 10m Wind Speed Frequency Distributions**

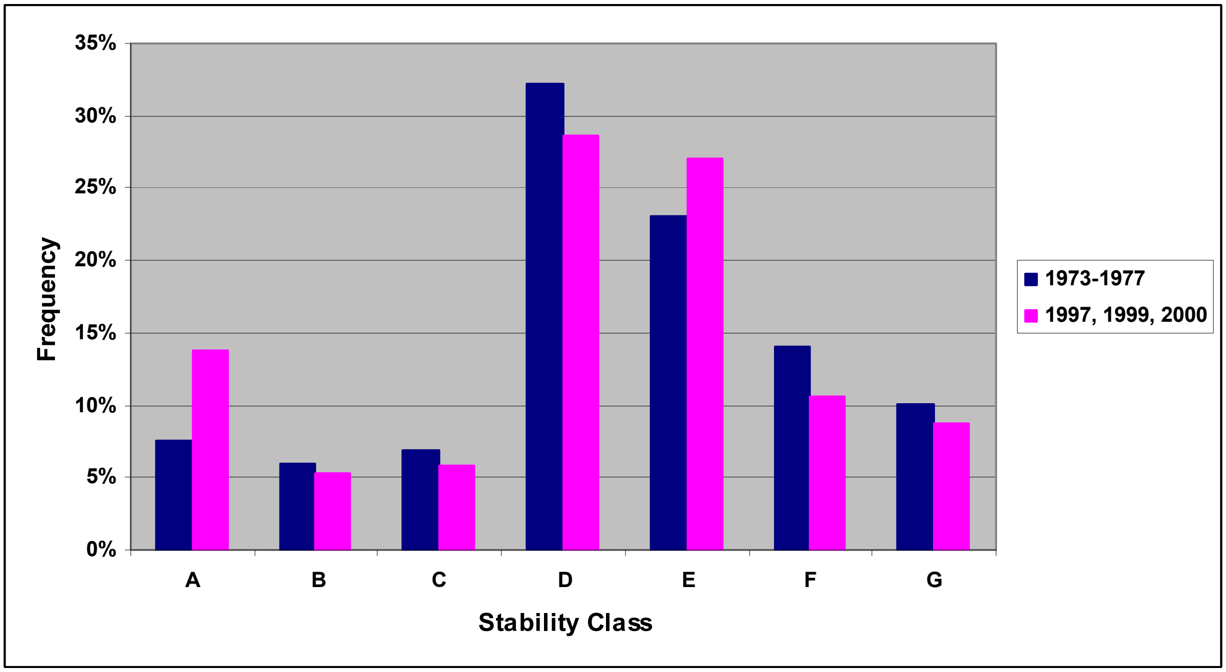


**Figure 2.3S.3-3. STP Stability Class Frequency Distributions**

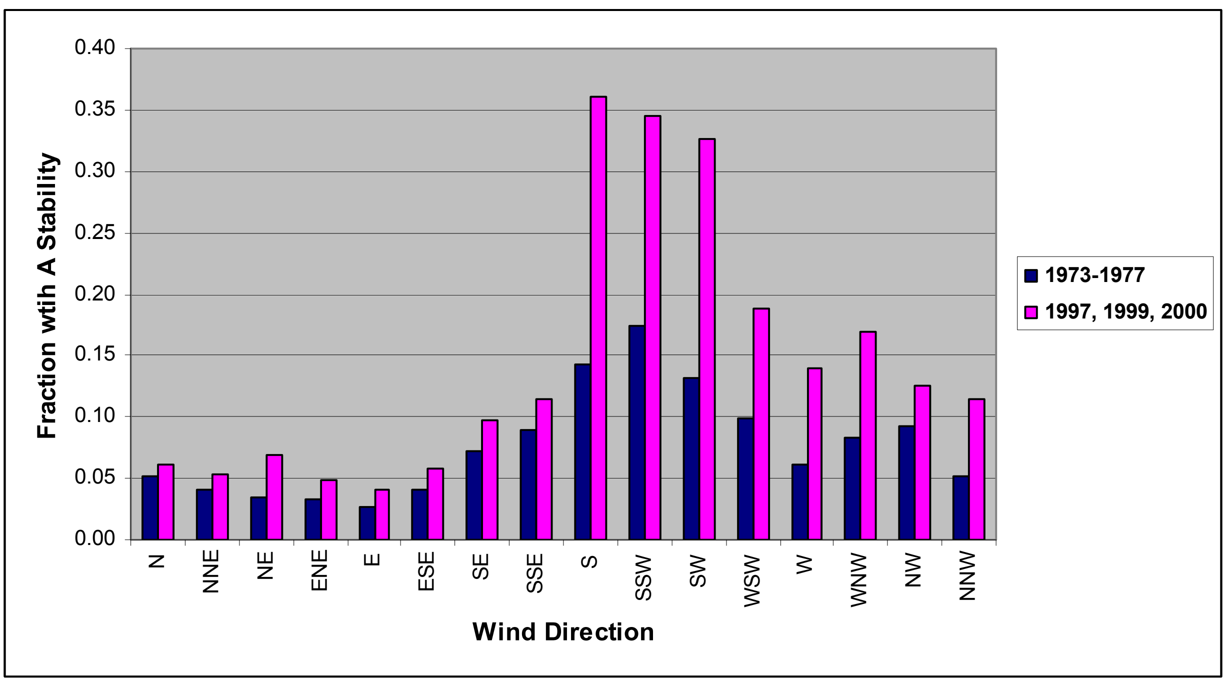


**Figure 2.3S.3-4. STP Stability Class A Frequency Distribution**

#### 2.3S.3.4.2 Operational Meteorological Measurement Program

In Revision 0 to FSAR Tier 2, Subsection 2.3S.3.3, the applicant states that the current meteorological system for STP Units 1 and 2 will continue to be used during the operational phase for all four units. The staff issued RAI 02.03.03-6 asking the applicant to confirm whether the calibration and maintenance procedures described in FSAR Tier 2, Subsection 2.3S.3.2.3, and the data display, processing, archiving, and analysis in FSAR Tier 2, Subsection 2.3S.3.2.5 for the preoperational meteorological monitoring program will continue for the operational meteorological monitoring program. In response to RAI 02.03.03-6 dated December 18, 2008 (ML083570395), the applicant revised Revision 3 to FSAR Tier 2, Subsection 2.3S.3.3. This revision affirms that the STP Units 1 and 2 onsite meteorological monitoring program calibration and maintenance procedures described in FSAR Tier 2, Subsection 2.3S.3.2.3 and the data display, processing, archiving, and analysis procedures described in FSAR Tier 2, Subsection 2.3S.3.2.5 will continue to be used as the operational onsite meteorological monitoring program for STP Units 3 and 4. Therefore, NRC staff considers RAI 02.03.03-6 closed.

The applicant provides a map showing the locations of the meteorological towers with respect to the existing STP Units 1 and 2 units and the proposed STP Units 3 and 4 units. The tallest existing and planned buildings for all four units are located more than 1.6 km (1 mi) from the meteorological towers, so that the separation between these buildings and the meteorological towers is much greater than 10 times the building heights. The proposed cooling system for STP Units 3 and 4 includes the existing main cooling reservoir and two banks of mechanical draft cooling towers. The main cooling reservoir is approximately 1.6 km (1 mi) southwest of the primary meteorological tower and the cooling towers are located approximately 1.9 km (1.3 mi) west of both meteorological towers. The potential impact of the main cooling reservoir on the primary meteorological tower's delta-T measurements was discussed previously. The potential impact of the cooling towers on the primary meteorological tower's ambient temperature, dew-point, and relative humidity instrumentation is expected to be minimal because of the cooling tower's plume rise and because of the large separation distance between the cooling towers and the meteorological towers.

Since completing the collection of the preoperational meteorological data, the cup anemometers and wind vanes on both the primary and backup towers were replaced in 2005 with ultrasonic wind sensors. Some of the electronic microprocessors and data loggers have also been replaced. The system performance specifications (e.g., system accuracy and measurement resolution) continue to meet the criteria specified in RG 1.23. The data sampling rate continues to be once per second, and the data continue to be compiled into 15-minute and 60-minute averages. The 15-minute averaged data are compiled for real-time display in the STP Units 3 and 4 control room, technical support center, and emergency operations facility. Emergency response dose assessments will be performed using the most recent 15-minute averaged data.

RG 1.23 states that provisions should be in place to obtain representative meteorological data (e.g., wind speed and direction representative of the 10-m (33-ft) level and an estimate of atmospheric stability) from alternative sources during an emergency, if the site meteorological program is unavailable. The backup tower measures wind speed, wind direction (including sigma theta for atmospheric stability class determination), and temperature at the 10-m (33-ft) level above ground level. Consequently, the backup tower meteorological parameters are also consistent with the guidelines in RG 1.23.

The applicant states that provisions are currently in place to obtain representative regional meteorological data from the NWS or from a meteorological subcontractor during an emergency, if the site meteorological system becomes unavailable. The applicant also states that the current (or similar) emergency plan procedures and monitoring system arrangements will continue to be used for STP Units 3 and 4. The proposed operational meteorological measurement program complies with the recommendations in RG 1.23. Therefore, the staff found the program to be acceptable.

### 2.3S.3.5 *Post Combined License Activities*

Section 4 of Part 9 of the COL application contains emergency planning inspection, test, analysis, and acceptance criteria (EP-ITAAC). The following two EP-ITAAC involve demonstrating that the operational onsite meteorological monitoring program appropriately supports the STP Units 3 and 4 emergency plan:

- EP-ITAAC 7.3: The means exists to continuously assess the impact of the release of radioactive materials into the environment, accounting for the relationship between effluent monitor readings and onsite and offsite exposures and contamination for various meteorological conditions. The acceptance criteria are (1) the means exists to continuously assess the impact of the release of radioactive materials into the environment, accounting for the relationship between effluent monitor readings and onsite and offsite exposures and contamination for various meteorological conditions; and (2) the Emergency Plan Implementing Procedures and the Offsite Dose Calculation Manual calculate the relationship between effluent monitor readings and offsite exposure and contamination for various meteorological conditions.
- EP-ITAAC 7.4: The means exists to acquire and evaluate meteorological information. The acceptance criterion is that the means exists to acquire and evaluate meteorological information in that the following parameters are to be displayed in the technical support center and control room: wind speed (10 and 60 m [33 and 197 ft]), wind direction (10 and 60 m [33 and 197 ft]), vertical temperature difference (between 10 and 60 m [33 and 197 ft]), ambient temperature (10 m [33 ft]), and precipitation.

The EP and EP-ITAAC are addressed in SER Section 13.3, "Emergency Planning."

### 2.3S.3.6 *Conclusion*

NRC staff reviewed the information in Section 2.3S.3 of the COL FSAR and confirmed that the applicant has presented and substantiated information pertaining to the onsite meteorological monitoring program and the resulting database. The staff's review found that the applicant has established the structure for the onsite meteorological monitoring program and the resulting database, which are acceptable and meet the requirements of 10 CFR 100.20 and 10 CFR 100.21 with respect to determining the acceptability of the site.

The staff concluded that the onsite data also provide an acceptable basis for estimating atmospheric dispersion for design-basis accident and routine releases from the plant. The data meet the requirements of GDC 19, 10 CFR 100.20, 10 CFR 100.21, 10 CFR Part 20, and Appendix I to 10 CFR Part 50. Finally, the equipment for measuring meteorological parameters during the course of accidents is sufficient to reasonably predict atmospheric dispersion of airborne radioactive materials, in accordance with 10 CFR 50.47(b) and Appendix E to 10 CFR Part 50.

The staff's review confirmed that the applicant has adequately addressed COL License Information Item 2.10 in accordance with Section 2.3.3 of NUREG–0800.

### 2.3S.4 Short-Term Atmospheric Dispersion Estimates for Accident Releases

#### 2.3S.4.1 *Introduction*

This section of the FSAR addresses the conservative atmospheric dispersion factor (χ/Q or relative concentration) estimates at the EAB, the outer boundary of the LPZ, the control room, and technical support center (TSC) for postulated design-basis accidental radioactive airborne releases.

Dispersion estimates from the onsite and/or offsite airborne releases of hazardous materials, such as flammable vapor clouds, toxic chemicals, and smoke from fires, are reviewed in SER Section 2.2.3.

#### 2.3S.4.2 *Summary of Application*

This site-specific supplement in the FSAR describes the following:

- Atmospheric dispersion models to calculate atmospheric dispersion factors for postulated accidental radioactive airborne releases
- Meteorological data and other assumptions used as inputs to atmospheric dispersion models
- Derivation of diffusion parameters ($\sigma_y$ and $\sigma_z$)
- Determination of conservative χ/Q values used to assess the consequences of postulated design-basis atmospheric radioactive releases to the EAB, LPZ, control room, and TSC

In addition, in FSAR Tier 2, Section 2.3S.4, the applicant provides the following:

*<u>COL License Information Items</u>*

- COL License Information Item 2.1 Non-Seismic Design Parameters

This site-specific supplement addresses COL License Information Item 2.1 from the certified ABWR DCD, which states that "compliance with the envelope of standard plant site non-seismic design parameters of DCD Tier 2, Table 2.0-1 shall be demonstrated for design-bases events." DCD Tier 2, Section 2.2.1 further states that for design-basis events, the site is acceptable if all of the site characteristics fall within the envelope of ABWR standard plant site design parameters given in DCD Tier 2, Table 2.0-1. For cases where a characteristic exceeds its envelope, it will be necessary for the COL applicant to submit analyses to demonstrate that the overall set of site characteristics do not exceed the capability of the design. The DCD Tier 2, Table 2.0-1 envelope of ABWR standard plant site design parameters includes maximum 2-hour 95-percentile meteorological dispersion parameters for the EAB and maximum 2-hour 95-percentile and maximum annual average (8760 hours) meteorological dispersion parameters for the LPZ.

- COL License Information Item 2.11 — Short-Term Atmospheric Diffusion Estimates for Accident Releases

This site-specific supplement addresses COL License Information Item 2.11 from the certified ABWR DCD, which states that COL applicants will provide site-specific, short-term dispersion estimates for NRC review to ensure that the envelope values of relative concentrations are not exceeded. Relative concentrations are located in the following tables from the ABWR DCD: Tables 15.6-3, "Instrument Line Break Accident Results"; 15.6-7, "Main Steamline Break Meteorology Parameters and Radiological Effects"; 15.6-13, "Loss of Coolant Accident Meteorology and Offsite Dose Results"; 15.6-14, "Loss of Coolant Accident Meteorology and Control Room Dose Results"; and 15.6-18, "Clean Up Water Line Break Meteorology and Dose Results."

### 2.3S.4.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the short-term atmospheric dispersion estimates for accident releases, and the associated acceptance criteria, are in Section 2.3.4 of NUREG–0800. In particular, the regulatory requirements are 10 CFR Part 50, 10 CFR 52.79 and 10 CFR 100.21.

NRC staff considered the following regulatory requirements in reviewing the applicant's discussion of short-term atmospheric dispersion estimates:

- 10 CFR Part 50, Appendix A, GDC 19 with respect to the meteorological considerations used to evaluate the personnel exposures inside the control room during radiological accident conditions
- 10 CFR 52.79(a)(1)(vi), with respect to a safety assessment of the site, including consideration of major SSCs of the facility and site meteorology, to evaluate the offsite radiological consequences at the EAB and LPZ
- 10 CFR 100.21(c)(2), with respect to the atmospheric dispersion characteristics used in the evaluation of EAB and LPZ radiological dose consequences for postulated accidents

NUREG–0800, Section 2.3.4 specifies that an application meets the above requirements if the application provides the following information:

- A description of the atmospheric dispersion models used to calculate χ/Q values for accidental releases of radioactive and hazardous materials into the atmosphere
- Meteorological data used for the evaluation (as inputs to the dispersion models), which represent annual cycles of hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release
- A discussion of atmospheric diffusion parameters, such as lateral and vertical plume spread ($\sigma_y$ and $\sigma_z$), as a function of distance, topography, and atmospheric conditions, should be related to measured meteorological data
- Hourly cumulative frequency distributions of χ/Q values from the effluent release point(s) to the EAB and LPZ constructed to describe the probabilities that these χ/Q values will be exceeded
- Atmospheric dispersion factors used for the assessment of consequences related to atmospheric radioactive releases to the control room for design-basis and other accidents

- For control room habitability analysis, a site plan drawn to scale showing true North and potential atmospheric accident release pathways, control room intake, and unfiltered in leakage pathways

In addition, the short-term atmospheric dispersion estimates for accident releases should be consistent with the appropriate sections from the following regulatory guides:

- RG 1.23 provides criteria for an acceptable onsite meteorological measurements program; these data are used as inputs to atmospheric dispersion models.
- RG 1.145, Revision 1, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," presents criteria that characterize atmospheric dispersion conditions and evaluate the consequences of radiological releases to the EAB and LPZ.
- RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," presents criteria that characterize atmospheric dispersion conditions and evaluate the consequences of radiological releases to the control room.

When independently assessing the veracity of the information presented by the applicant in FSAR Tier 2, Section 2.3S.4, NRC staff applied the same methodologies, models, and techniques cited above.

### 2.3S.4.4 *Technical Evaluation*

NRC staff reviewed the application and the applicant's responses to RAIs to verify the accuracy, completeness, and sufficiency of the information presented by the applicant regarding short-term atmospheric dispersion estimates for accident releases. The staff followed the procedures described in Section 2.3.4 of NUREG–0800 as part of this review.

The staff reviewed the information in the COL FSAR:

<u>*COL License Information Items*</u>

- COL License Information Item 2.1 — Non-Seismic Design Parameters

NRC staff's review of the meteorological dispersion "Non-Seismic Design Parameters" is summarized below.

- COL License Information Item 2.11 — Short-Term Atmospheric Diffusion Estimates for Accident Releases

NRC staff's review of the "Short-Term Atmospheric Dispersion Estimates for Accident Releases" is summarized below:

### 2.3S.4.4.1 Postulated Accidental Radioactive Releases

#### 2.3S.4.4.1.1 *Offsite Dispersion Estimates*

a. Atmospheric Dispersion Model

The applicant uses 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”) to estimate χ/Q values at the EAB and at the outer boundary of the LPZ for potential accidental releases of radioactive material. The PAVAN model implements the methodology outlined in RG 1.145.

The PAVAN code estimates χ/Q values for various time-averaged periods ranging from 2 hours to 30 days. The meteorological input to PAVAN consists of a JFD of hourly values of wind speed and wind direction by atmospheric stability class. The χ/Q values calculated through PAVAN are based on the theoretical assumption that material released into the atmosphere will be normally distributed (Gaussian) about the plume centerline. A straight-line trajectory is assumed between the point of release and all distances for which χ/Q values are calculated.

For each of the 16 downwind direction sectors (N, NNE, NE, ENE, etc.), PAVAN calculates χ/Q values for each combination of wind speed and atmospheric stability at the appropriate downwind distance (i.e., the EAB and the outer boundary of the LPZ). The χ/Q values calculated for each sector are then placed in order from the greatest to the smallest, and an associated cumulative frequency distribution is derived based on the frequency distribution of wind speed and stabilities for each sector. The smallest χ/Q value in a distribution will have a corresponding cumulative frequency equal to the wind direction frequency for that particular sector. PAVAN determines for each sector an upper envelope curve based on the derived data (plotted as χ/Q versus probability of being exceeded), so that no plotted point is above the curve. From this upper envelope, the χ/Q value, which is equaled or exceeded 0.5 percent of the total time, is obtained. The maximum 0.5 percent χ/Q value from the 16 sectors becomes the 0–2 hour “maximum sector χ/Q value.”

Using the same approach, PAVAN also combines all χ/Q values independent of wind direction into a cumulative frequency distribution for the entire site. An upper envelope curve is determined, and the program selects the χ/Q value that is equaled or exceeded no more than 5 percent of the total time. This value is known as the 0–2 hour “5-percent overall site χ/Q value.”

The larger of the two χ/Q values, either the 0.5-percent maximum sector value or the 5-percent overall site value, is selected from the PAVAN output by the user to represent the χ/Q value for the 0–2 hour time interval. Note that this resulting χ/Q value is based on 1-hour averaged data, but it is conservatively assumed to apply for 2 hours.

To determine LPZ χ/Q values for longer time periods (e.g., 0–8 hours, 8–24 hours, 1-4 days, and 4–30 days), PAVAN performs a logarithmic interpolation between the 0-2 hour χ/Q values and the annual average (8,760 hours) χ/Q values for each of the 16 sectors and the overall site. For each time period, the highest among the 16-sector and overall site χ/Q values is identified and becomes the short-term site characteristic χ/Q value for that time period.

b. Meteorological Data Input

The meteorological input to PAVAN used by the applicant consisted of a JFD of wind speed, wind direction, and atmospheric stability based on hourly onsite data from 1997, 1999, and 2000. The wind data were obtained from the 10-m (33-ft) level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-T) measurements taken between the 60-m and 10-m (197-ft and 33-ft) levels on the onsite meteorological tower.

As discussed in SER Section 2.3S.3, NRC staff considers the 1997, 1999, and 2000 onsite meteorological database suitable for input to the PAVAN model.

c. Diffusion Parameters

The applicant chooses to implement the diffusion parameter assumptions, outlined in RG 1.145 as a function of atmospheric stability, for the PAVAN model runs. Both the EAB and outer boundary of the LPZ extend over the main cooling reservoir in the southeast clockwise to the south-southwest sectors. NRC staff consequently issued RAI 02.03.04-4 asking the applicant to describe the impact of reduced surface roughness resulting from over-water trajectories on the resulting short-term offsite atmospheric dispersion estimates. The applicant's response to RAI 02.03.04-4 dated November 20, 2008 (ML083290340), states that the reduced surface roughness induced by the main cooling reservoir will result in less mechanical turbulence and higher $\chi/Q$ values for those portions of the EAB and LPZ that extend over the main cooling reservoir. The applicant also states that reduced surface roughness will also increase ambient wind speed slightly and will subsequently minimize the net effect of reduced surface roughness on the offsite short-term atmospheric dispersion estimates. The staff also believes that low-level turbulent vertical mixing may be enhanced due to the warm water temperatures in the main cooling reservoir, which would also counteract the reduced surface roughness from over-water trajectories. Therefore, the staff finds the applicant's use of diffusion parameter assumptions, as outlined in RG 1.145, acceptable and considers RAI 02.03.04-4 closed.

d. Resulting Relative Concentrations

The applicant modeled one ground-level release point and did not take credit for building wake effects. Ignoring building wake effects for a ground-level release decreases the amount of atmospheric turbulence assumed to be in the vicinity of the release point, resulting in higher (i.e., more conservative) $\chi/Q$ values for a flat terrain site such as STP Units 3 and 4. A ground-level release assumption that does not take credit for building wake effects is therefore acceptable to the staff.

FSAR Tier 2, Section 2.1S.2 states that the STP Units 3 and 4 facilities are located within the EAB and LPZ already designated for STP Units 1 and 2. The EAB is an oval with a minimum distance of approximately 1,430 m (4,692 ft) from the center of each of the STP Units 1 and 2 reactor containment buildings. The center of the exclusion area "oval" is a point approximately 93 m (305 ft) directly west of the center of the Unit 2 reactor containment building. This point is also the center of the existing LPZ, which is a circle with a radius of 4.8 km (3 mi). Because the distances to the EAB and LPZ from STP Units 3 and 4 are different for each directional sector, the applicant states in Revision 0 to FSAR Tier 2, Section 2.3S.4.2 that the shortest distances in each direction were used.

Regulatory Position C.1.2 of RG 1.145 states that for each of the 16 direction sectors, the distances to the EAB and LPZ to be used in the χ/Q calculations should be the minimum distance from the stack or, in the case of releases through vents or building penetrations, the nearest point on the building to the EAB or LPZ, within a 45-degree sector centered on the compass direction of interest. The staff issued RAI 02.03.04-3 asking the applicant to confirm that this approach was also used to derive the distances to the EAB and LPZ used in the χ/Q calculations.

The applicant's response to RAI 02.03.04-3 dated June 12, 2008 (ML081710126), states that the releases to the EAB and the LPZ are assumed to be located at the center of either Unit 3 or Unit 4 and not the nearest point on the building complex to the EAB or LPZ, as discussed in RG 1.145. The applicant's response further states that the shortest distance to the EAB is in the northwest direction (930 meters [3,051 ft]), and the difference in the distance from the edge of the reactor building to the EAB is approximately 41 m (134.5 ft) shorter than if measured from the center of Unit 4. The applicant believes this 41-meter (134.5-ft) difference in distance does not significantly affect the χ/Q values predicted at the EAB.

FSAR Tier 2, Figure 2.3S-23 shows the assumed design-basis accident release locations. One of these locations is the turbine building truck door, which is located at the NW corner of the turbine building. The staff estimated that this release location is approximately 120 m (394 ft) closer to the EAB in the northwest direction compared to the northwest edge of the reactor building. Therefore, the applicant's alternative approach to calculating downwind distances to the EAB and LPZ using the shortest distance from the center of either STP Unit 3 or Unit 4, as described in the response to RAI 02.03.04-3, was not convincing evidence that the calculation is conservative. NRC staff consequently issued RAI 02.03.04-5.

The applicant's response to RAI 02.03.04-5 dated January 28, 2009 (ML090300648), revises the approach for calculating distances to the EAB and LPZ by defining a power block envelope that encloses the STP Units 3 and 4 reactor buildings and turbine buildings. The applicant then determines the shortest distances from the power block envelope to the EAB and LPZ within 45-degree sectors centered on the compass directions of interest, in accordance with RG 1.145. Note that the revised set of distances showed that the shortest distance to the EAB was reduced from 930 m to 695 m (3,051ft to 2,280 ft) in the northwest direction. The applicant uses these revised distances in the PAVAN analysis to update the EAB and LPZ χ/Q values. The applicant proposes revisions to FSAR Tier 2, Section 2.3S.4 to reflect this revised approach for calculating distances to the EAB and LPZ. The staff found that the applicant's revised approach for calculating distances to the EAB and LPZ is consistent with the guidance of RG 1.145. This approach is therefore acceptable and RAI 02.03.04-3 is closed.

The applicant provided a revised response to RAI 02.03.04-5 on July 30, 2009 (ML092150966). The response states that the EAB and LPZ χ/Q values are being revised using a slightly larger power block footprint. The applicant incorporates its revised set of EAB and LPZ χ/Q values into Revision 3 of the FSAR. The staff confirmed these revised atmospheric dispersion estimates by running the PAVAN computer model using information in the FSAR and the applicant's response to RAI 02.03.04-5 and obtained similar results. The staff found that the applicant's results bounded the staff's values. The staff therefore accepted the revised short-term EAB and LPZ χ/Q values presented by the applicant and consider RAI 02.03.04-5 closed.

In accordance with COL License Information Item 2.1, FSAR Tier 2, Table 2.0-2 compares the site-specific EAB and LPZ χ/Q values with the ABWR standard plant meteorological dispersion site design parameters, which are listed in DCD Tier 2, Table 2.0-1. Note that FSAR Tier 2,

Table 2.0-2 compares the PAVAN-generated, 0–2 hour 0.5 percent maximum sector χ/Q values and the 5 percent overall site χ/Q values with the ABWR DCD 0–2 hour 95 percentile meteorological dispersion site design parameters, which are χ/Q values that are expected to be exceeded no more than 5 percent of the time.

FSAR Tier 2, Table 2.0-2 concludes that the ABWR DCD EAB and LPZ χ/Q values are not exceeded. Smaller χ/Q values are associated with a greater dilution capability, resulting in lower radiological doses. When comparing a DCD site parameter χ/Q value and a site characteristic χ/Q value, the site is acceptable for the design if the site characteristic χ/Q value is smaller than the site parameter χ/Q value. Such a comparison shows that the site has better dispersion characteristics than the reactor design requires. The staff noticed in the applicant's response to RAI 02.03.04-5 that the revised PAVAN-predicted maximum 0–2 hour EAB and LPZ χ/Q values (2.74E-04 s/$m^3$ and 5.27E-05 s/$m^3$, respectively), which are in the proposed revision to FSAR Tier 2, Subsection 2.3S.4.2.1.1, differ from those χ/Q values listed in the proposed revision to FSAR Tier 2, Table 2.0-2 as STP Units 3 and 4 site characteristic values (1.62E-04 s/$m^3$ and 3.99E-05 s/$m^3$, respectively) for comparison to the ABWR DCD EAB and LPZ χ/Q values. The staff issued RAI 02.03.04-9 requesting the applicant to explain this apparent discrepancy and update the FSAR if necessary.

The applicant's response to RAI 02.03.04-9 dated October 29, 2009 (ML093430299), explains that the ABWR maximum 2-hour 95-percentile EAB χ/Q site parameter value of 1.37E-03 s/$m^3$ is compared in FSAR Tier 2, Table 2.0-2 to the PAVAN-generated 5-percent overall site EAB χ/Q site characteristic value of 1.62E-04 s/$m^3$; likewise, the ABWR maximum 2-hour 95-percentile LPZ χ/Q site parameter value of 4.11E-04 s/$m^3$ is compared to the PAVAN-generated 5-percent overall site LPZ χ/Q site characteristic value of 3.99E-05 s/$m^3$. The applicant adds that FSAR Tier 2, Table 2.0-2 will be updated to list both the PAVAN 0-2 hour, 0.5 percent maximum sector EAB and LPZ values and the PAVAN 0-2 hour, 5 percent overall site EAB and LPZ values. Therefore, the response to RAI 02.03.04-9 was tracked as Confirmatory Item 02.03.04-9 in the SER with open items.

The staff confirmed that FSAR Tier 2, Revision 4 includes the proposed changes. Accordingly, the staff found that the applicant has adequately addressed this issue. Therefore, Confirmatory Item 02.03.04-9 is closed and RAI 02.03.04-9 is closed.

As a result of its review of the applicant's response to RAI 02.03.04-9, the staff issued RAI 02.03.04-11 requesting that the applicant revise its proposed footnotes to FSAR Tier 2, Table 2.0-2 to more accurately label the 0.5 percent maximum sector χ/Q values and the 5.0 percent overall site χ/Q values being presented in the table. The applicant's response to RAI 02.03.04-11 dated March 1, 2010 (ML100620824), explains that it will update the proposed footnotes as requested by the staff. Therefore, the response to RAI 02.03.04-11 was tracked as Confirmatory Item 02.03.04-11 in the SER with open items.

The staff confirmed that FSAR Tier 2, Revision 4 includes the proposed footnote, per the applicant's commitment in the RAI response. Accordingly, the staff found that the applicant has adequately addressed this issue. Therefore, Confirmatory Item 02.03.04-11 is closed and RAI 02.03.04-11 is closed.

In accordance with COL License Information Item 2.11, FSAR Tier 2, Table 15.6.5S-1 compares the site-specific EAB and LPZ χ/Q values with the ABWR EAB and LPZ χ/Q values from DCD Tier 2, Tables 15.6-3, 15.6-7, 15.6-13, and 15.6-18. Table 15.6.5S-1 shows that the ABWR DCD offsite χ/Q values are not exceeded.

#### 2.3S.4.4.1.2 *Control Room Dispersion Estimates*

a. Atmospheric Dispersion Model

The applicant uses the computer code ARCON96 (NUREG/CR–6331, “Atmospheric Relative Concentrations in Building Wakes”) to estimate χ/Q values at the CR and the TSC for potential accidental releases of radioactive material. The ARCON96 model implements the methodology outlined in RG 1.194.

The ARCON96 code estimates χ/Q values for various time-averaged periods ranging from 2 hours to 30 days. The meteorological input to ARCON96 consists of hourly values of wind speed, wind direction, and atmospheric stability class. The χ/Q values calculated through ARCON96 are based on the theoretical assumption that material released into the atmosphere will be normally distributed (Gaussian) about the plume centerline. A straight-line trajectory is assumed between the release points and receptors. The diffusion coefficients account for an enhanced dispersion under low wind speed conditions and in building wakes.

The hourly meteorological data are used to calculate hourly relative concentrations. The hourly relative concentrations are then combined to estimate concentrations ranging in duration from 2 hours to 30 days. Cumulative frequency distributions are prepared from the average relative concentrations and the relative concentrations that are exceeded no more than 5 percent of the time for each averaging period are selected.

b. Meteorological Data Input

The meteorological input to ARCON96 used by the applicant consisted of hourly onsite wind speed, wind direction, and atmospheric stability data from 1997, 1999, and 2000. The wind data were obtained from the 10-m and 60-m (33-ft and 197-ft) levels of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-T) measurements taken between the 60-m and 10-m (197-ft and 33-ft) levels on the onsite meteorological tower.

As discussed in SER Section 2.3S.3, NRC staff considers the 1997, 1999, and 2000 onsite meteorological database suitable for input to the ARCON96 model.

c. Diffusion Parameters

The diffusion coefficients used in ARCON96 have three components. The first component, the diffusion coefficient, is used in other NRC models such as PAVAN. The other two components are corrections to account for the enhanced dispersion under low wind speed conditions and in building wakes. These components are based on an analysis of diffusion data collected in various building wake diffusion experiments, under a wind range of meteorological conditions. Because the diffusion occurs at short distances within the plant’s building complex, the ARCON96 diffusion parameters are not affected by nearby topographic features, such as bodies of water. Therefore, NRC staff found that the applicant’s use of the ARCON96 diffusion parameter assumptions is acceptable.

d. Resulting Relative Concentrations

FSAR Tier 2, Figure 2.3S-23 is a map showing potential atmospheric accident release pathways and control room and TSC receptors. As discussed in ABWR DCD Tier 2, Subsection 15.6.5.5.3, the control room may be contaminated from two sources: the reactor building stack base and the turbine building truck doors. The applicant treats both the reactor building stack base and the turbine building truck doors as ground level sources. For STP Units 3 and 4, each unit has two control room air intakes and one TSC air intake. The applicant treats these three intakes as receptors for the ARCON96 modeling. The applicant chose the highest χ/Q values among these three intakes for comparison to the ABWR control room χ/Q values from DCD Tier 2, Table 15.6-14, in compliance with COL License Information Item 2.11.

FSAR Tier 2, Table 2.3S-25 presents the resulting χ/Q values determined by the applicant's ARCON96 dispersion modeling at the control room and TSC air intakes for releases from the reactor building plant stack and turbine building truck doors. NRC staff issued RAI 02.03.04-1 asking the applicant to describe the inputs used to execute the ARCON96 atmospheric dispersion model, for each source-receptor combination, to derive the control room and TSC χ/Q values presented in Revision 0 to FSAR Tier 2, Table 2.3S-25. The applicant's response to RAI 02.03.04-1 dated May 29, 2008 (ML081560702), describes the inputs used to execute ARCON96 for the χ/Q values presented in Revision 0 to FSAR Tier 2, Table 2.3S-25.

The applicant revised the control room and TSC χ/Q values presented in FSAR Tier 2, Table 2.3S-25 in the response to RAI 15.00.03-1 dated October 26, 2009 (ML093030297), and then submitted a revised response to RAI 15.00.03-1 dated November 30, 2009 (ML093360204). In order to review the applicant's revised control room and TSC χ/Q values, the staff issued RAI 02.03.04-10 requesting that the applicant to provide the revised set of inputs used to rerun the ARCON96 model.

The applicant's response to RAI 02.03.04-10 dated December 21, 2009(ML093580191), provides a description of the revised inputs used to execute the ARCON96 dispersion model. The applicant states that the revised inputs result from updated information regarding the location and specifications for the release points and receptors. The most signification revisions result from the following:

- Reduction of the release height of the plant stack from 76 m (249 ft) to 26.2 m (86 ft). (The release is assumed to occur at the stack base instead of the top of the stack in accordance with the release descriptions provided in the DCD Tier 2, Subsection 15.6.5.5.3.2.)

- Reduction of distances from sources to the TSC air intakes. (The TSC air intakes are conservatively assumed to be located at the TSC southwest corner for the reactor building stack releases and the TSC northwest corner for the turbine building truck door releases.)

The applicant also agrees in the response to RAI 02.03.04-10 to revise the turbine building truck door χ/Q values presented in FSAR Tier 2, Table 2.3S-25 to show three significant digits. This precision is necessary to compare site-specific χ/Q values to the DCD χ/Q values since the DCD χ/Q values are presented to the third significant digit. This proposed revision to FSAR Tier 2, Table 2.3S-25 was tracked as Confirmatory Item 02.03.04-10 in the SER with open items.

The staff confirmed that FSAR Tier 2, Revision 4 includes the proposed changes, per the applicant's commitment in the RAI response. Accordingly, the staff found that the applicant has adequately addressed this issue. Therefore, Confirmatory Item 02.03.04-10 is closed and RAI 02.03.04-10 is closed.

The staff reviewed the applicant's inputs to the ARCON96 code and found them consistent with site configuration drawings and the guidance in RG 1.194. The staff confirmed the applicant's atmospheric dispersion estimates by running the ARCON96 computer model and generating the same results. The staff therefore accepts the control room and TSC χ/Q values presented by the applicant. Therefore, RAI 02.03.04-1 is closed.

In accordance with COL License Information Item 2.11, FSAR Tier 2, Table 15.6.5S-1 compares the site-specific control room and TSC χ/Q values with the ABWR control room χ/Q values from DCD Tier 2, Table 15.6-14. Table 15.6.5S-1 concludes that with two exceptions, the ABWR DCD control room χ/Q values are not exceeded. The two exceptions are in regards to (1) the calculated 4–30 day χ/Q value for a turbine building release ($9.15\times10^{-5}$ s/m$^3$) that exceeded the corresponding ABWR DCD χ/Q value ($8.53\times10^{-5}$ s/m$^3$); and (2) the calculated 4–30 day χ/Q value for a reactor building release ($5.59\times10^{-4}$ s/m$^3$) that exceeded the corresponding ABWR DCD χ/Q value ($5.12\times10^{-4}$ s/m$^3$). SER Section 15.6 discusses the consequences of these two exceptions.

#### 2.3S.4.4.2 Hazardous Material Releases

The atmospheric dispersion models used by the applicant to calculate atmospheric dispersion for hazardous material releases are discussed in FSAR Tier 2, Section 2.2S.3. SER Section 2.2.3 discusses the NRC staff's technical evaluation of the applicant's dispersion estimates associated with accidental onsite and offsite hazardous material releases.

### 2.3S.4.5 *Post Combined License Activities*

There are no post COL activities related to this section.

### 2.3S.4.6 *Conclusion*

NRC staff reviewed the application and found that the applicant has presented and substantiated information regarding short-term atmospheric dispersion estimates for accident releases. The staff reviewed the information and, for the reasons stated above, concluded that the applicant's atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR 100.21(c)(2). This conclusion is based on the conservative assessments of post-accident atmospheric dispersion conditions that have been made by the applicant and the staff from the applicant's meteorological data and appropriate dispersion models. These atmospheric dispersion estimates are appropriate for the assessment of consequences from radioactive releases for DBAs, in accordance with 10 CFR 52.79(a)(1)(vi) and GDC 19.

In addition, the staff compared the supplemental information in the application to the relevant NRC regulations, the guidance in Section 2.3.3 of NUREG–0800, and other NRC regulatory guides. The staff's review confirmed that the applicant has adequately addressed COL License Information Items 2.1 and 2.11 in accordance with Section 2.3.4 of NUREG–0800, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

## 2.3S.5 Long-Term Atmospheric Dispersion Estimates For Routine Releases

### 2.3S.5.1 *Introduction*

This FSAR section addresses the atmospheric dispersion ($\chi$/Q or relative concentration) and dry deposition (D/Q or relative deposition) estimates to a distance of 80.5 km (50 mi) from the plant for routine releases of radiological effluents into the atmosphere during normal plant operation for use in annual average release limit calculations and offsite dose estimates.

### 2.3S.5.2 *Summary of Application*

This site-specific supplement in the FSAR describes the following:

- Atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material into the atmosphere
- The characteristics assumed for each release point and the location of potential receptors for dose computations
- Meteorological data and other assumptions used as inputs to the atmospheric dispersion models
- Diffusion parameters ($\sigma_z$)
- Relative concentration factors and relative deposition factors used to assess the consequences of routine airborne radioactive releases

In addition, in FSAR Section 2.3S.5, the applicant provides the following:

<u>*COL License Information Item*</u>

- COL License Information Item 2.12 Long-Term Atmospheric Dispersion Estimates For Routine Releases

This site-specific supplement addresses COL License Information Item 2.12 from the certified ABWR DCD, which states that COL applicants will provide annual average atmospheric dispersion values for routine releases for NRC to review.

### 2.3S.5.3 *Regulatory Basis*

The relevant requirements of the Commission regulations for the long-term atmospheric dispersion estimates for routine releases, and the associated acceptance criteria are in Section 2.3.5 of NUREG–0800. In particular, the regulatory requirements are 10 CFR Part 20, 10 CFR 50.34a, 10 CFR Part 50 Appendix I and 10 CFR 100.21.

NRC staff considered the following regulatory requirements in reviewing the applicant's discussion of long-term atmospheric dispersion estimates:

- 10 CFR Part 20, Subpart D, with respect to establishing atmospheric dispersion site characteristics for demonstrating compliance with dose limits for individual members of the public
- 10 CFR 50.34a and Sections II.B, II.C and II.D of Appendix I of 10 CFR Part 50, with respect to establishing atmospheric dispersion site characteristics for evaluating the numerical

guides for design objectives and limiting conditions for operation to meet the requirements that radioactive material in effluents released to unrestricted areas be kept as low as is reasonably achievable

- 10 CFR 100.21(c)(1), with respect to establishing atmospheric dispersion site characteristics so that radiological effluent release limits associated with normal operation can be met for any individual located offsite

NUREG–0800, Section 2.3.5 specifies that an application meets the above requirements if the application provides the following information:

- A detailed description of the atmospheric dispersion and deposition models used by the applicant to calculate annual average concentrations in the air and the amount of material deposited as a result of routine releases of radioactive materials into the atmosphere
- A discussion of atmospheric diffusion parameters, such as a vertical plume spread ($\sigma_z$), as a function of distance, topography, and atmospheric conditions
- Meteorological data summaries (onsite and regional) used as input to the dispersion and deposition models
- Points of routine release of radioactive material into the atmosphere, including the characteristics (e.g., location and release mode) of each release point
- The specific location of potential receptors of interest (e.g., nearest vegetable garden, nearest resident, nearest milk animal, and nearest meat cow in each 22½-degree direction sector within a 8-km [5-mi] radius of the site)
- The $\chi$/Q and D/Q values to be used for assessing the consequences of routine airborne radiological releases described in Regulatory Position C.I.2.3.5.2 of RG 1.206:
  (1) Maximum annual average $\chi$/Q values and D/Q values at or beyond the site boundary and at specific locations of potential receptors of interest utilizing appropriate meteorological data for each routine venting location, and

  (2) Estimates of annual average $\chi$/Q values and D/Q values for 16 radial sectors to a distance of 80.5 km (50 mi) from the plant using appropriate meteorological data.

In addition, the long-term atmospheric dispersion estimates for routine releases should be consistent with appropriate sections from the following regulatory guides:

- RG 1.23 provides criteria for an acceptable onsite meteorological measurements program; the program data are used as inputs to atmospheric dispersion models.
- RG 1.109, Revision 2, "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," present criteria for identifying specific receptors of interest.
- RG 1.111, Revision 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," provides acceptable methods for characterizing atmospheric transport and diffusion conditions and for evaluating the consequences of routine effluent releases.
- RG 1.112, Revision 1, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," provides criteria for identifying release points and release characteristics.

When independently assessing the veracity of the information presented by the applicant in FSAR Tier 2, Section 2.3S.5, NRC staff applied the same methodologies, models, and techniques cited above.

### 2.3S.5.4 *Technical Evaluation*

NRC staff reviewed the application and the applicant's responses to RAIs to verify the accuracy, completeness, and sufficiency of the information presented by the applicant regarding long-term atmospheric dispersion estimates for routine releases. The staff followed the procedures described in Section 2.3.5 of NUREG–0800 as part of this review.

The staff reviewed the information in the COL FSAR:

<u>*COL License Information Item*</u>

- COL License Information Item 2.12 Long-Term Atmospheric Dispersion Estimates For Routine Releases

NRC staff's review of the "Long-Term Atmospheric Dispersion Estimates for Routine Releases" is summarized below.

#### 2.3S.5.4.1 Atmospheric Dispersion Model

The applicant uses the NRC-sponsored computer code XOQDOQ (described in NUREG/CR-2919, "XOQDOQ Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations") to estimate χ/Q and D/Q values resulting from routine releases. The XOQDOQ model implements the constant mean wind direction model methodology outlined in RG 1.111.

The XOQDOQ model is a straight-line Gaussian plume model based on the theoretical assumption that material released into the atmosphere will be normally distributed (Gaussian) about the plume centerline. In predictions of χ/Q and D/Q values for long time periods (i.e., annual averages), the plume's horizontal distribution is assumed to be evenly distributed within the downwind direction sector (e.g., "sector averaging"). A straight-line trajectory is assumed between the release point and all receptors.

Because geographic features such as hills, valleys, and large bodies of water can potentially influence dispersion and airflow patterns, terrain recirculation factors can be used to adjust the results of a straight-line trajectory model such as XOQDOQ to account for terrain-induced flows, recirculation, or stagnation. NRC staff issued RAI 02.03.05-1 asking the applicant to discuss the influence of the Gulf of Mexico and the resulting land and sea breezes on the routine release atmospheric dispersion estimates in FSAR Tier 2, Section 2.3S.5. The applicant's response to this RAI dated May 29, 2008 (ML081560702) states that sea breezes from the Gulf of Mexico will tend to increase routine release χ/Q and D/Q values due to the potential for local air recirculation. In order to account for possible sea breeze and land breeze effects from Matagorda Bay and the Gulf of Mexico on the long-term atmospheric dispersion estimates for routine releases, the applicant used default open terrain correction factors from the XOQDOQ dispersion model. This calculation means that all χ/Q and D/Q values out to a distance of 1 km (0.6 mi) are multiplied by a factor of four and all χ/Q and D/Q values between 1 and 10 km (0.6 and 6.2 mi) are multiplied by a factor that deceases logarithmically from four at 1 km (0.6 mi) to one at 10 km (6.2 mi).

The staff agreed with the applicant that the use of the default XOQDOQ open terrain correction factors conservatively account for possible recirculation due to land-water boundaries at the proposed STP Units 3 and 4 site. The staff therefore considers RAI 02.03.05-1 closed.

#### 2.3S.5.4.2 Release Characteristics and Receptors

The applicant models one ground level release point that assumes a minimum building cross-sectional area of 2,134 $m^2$ (22,970 $ft^2$) and a building height of 37.7 m (123.7 ft). The applicant states that the minimum building cross-sectional area and height are based on the dimensions of the ABWR reactor building structure.

ABWR DCD Tier 2, Section 11.3.10 states that the primary release point for the ABWR plant is the reactor building stack, which is a roof-mounted, 2.4-m (7.9 ft) diameter circular stack extending to a height of 76 m (149.3 ft) above ground level. A ground level release is a conservative assumption that a flat-terrain site such as STP Units 3 and 4 results in higher χ/Q and D/Q values when compared to a mixed-mode (e.g., part-time ground, part-time elevated) release or a 100-percent elevated release, as discussed in RG 1.111. A ground level release assumption is therefore acceptable to the staff.

Revision 0 to the FSAR states that the applicant executed XOQDOQ using the shortest distance from either the STP Unit 3 reactor building to the EAB or the STP Unit 4 reactor building to the EAB for each downwind sector. Likewise, the applicant also states in Revision 0 to the FSAR that the shortest distances are used from the STP Units 3 and 4 reactor buildings to the various receptors of interest (i.e., nearest resident, meat animal, and vegetable garden) in each directional sector. NRC staff asked the applicant in RAI 02.03.05-8 to review an apparent discrepancy between the special receptor distances listed in FSAR Tier 2, Table 2.3S-26 and the Land Use Census results reported in the STP 2006 Annual Environmental Operating Report. The applicant's response to RAI 02.03.05-8 dated December 18, 2008 (ML083570395), states that the long-term atmospheric dispersion estimates for routine releases are being recalculated, and the special receptor distances listed in FSAR Tier 2, Table 2.3S-26 will be revised to be consistent with information in Revision 15 of the STP Offsite Dose Calculation Manual (ODCM). The ODCM reflects the distances to the receptors of interest reported in the Land Use Census results presented in the STP Units 1 and 2 2006 Radiological Environmental Operating Report. The revised special receptor distances listed in FSAR Tier 2, Table 2.3S-26, along with the resulting revised χ/Q and D/Q values, are provided by the applicant in a response to RAI 02.03.04-5 dated January 28, 2009 (ML090300648). Therefore, the staff considers RAI 02.03.05-8 closed.

The applicant's response to RAI 02.03.04-5 dated January 28, 2009 (ML090300648), revises the approach for calculating distances to the EAB and receptors of interest by defining a power block envelope that encloses the STP Units 3 and 4 reactor buildings and turbine buildings. The applicant then determines the shortest distances from the power block envelope to the EAB and various receptors of interest for each directional sector. The applicant uses these revised distances in the XOQDOQ analysis to propose updates to the EAB and special receptor χ/Q values. The applicant proposes revisions to FSAR Tier 2, Section 2.3S.5 to reflect this revised approach for calculating distances to the EAB and special receptors and to present the revised set of routine release χ/Q values.

In a revised response to RAI 02.03.04-5 dated July 30, 2009 (ML092150966), the applicant states that the long-term atmospheric dispersion estimates are being revised based on a release from either the Unit 3 or Unit 4 reactor building stack, whichever is closest to the site

boundary and receptors of interest, instead of from the power block envelope. The applicant updated the receptor distances to be consistent with Revision 15 of the ODCM and recalculated the long-term χ/Q and D/Q values. The revised long-term χ/Q and D/Q values are then incorporated into Revision 3 to the FSAR. NRC staff therefore considers RAI 02.03.04-5 closed. However, the revised response to RAI 02.03.04-5 presented, for the first time, maximum annual χ/Q and D/Q values for the site boundary as well as for the EAB.
In RAI 02.03.05-11, the staff requested the applicant to revise the FSAR to provide the downwind distances to the site boundary and EAB in each sector used to derive the revised set of maximum annual site boundary and EAB χ/Q and D/Q values. In response to RAI 02.03.05-11 dated October 29, 2009 (ML093430299), the applicant provides a proposed revision to FSAR Tier 2, Section 2.3S.5 which includes tables that provide the requested downwind distances to the EAB and site boundary in each sector. This proposed revision to FSAR Tier 2, Section 2.3S.5 was tracked as Confirmatory Item 02.03.05-11 in the SER with open items.

The staff confirmed that FSAR Tier 2, Revision 4 includes the proposed changes to Section 2.3S.5. Accordingly, the staff found that the applicant has adequately addressed this issue. Therefore, Confirmatory Item 02.03.05-11 is closed and RAI 02.03.05-11 is closed.

The staff noticed that Revision 3 of FSAR Tier 2, Section 2.3S.5.2 states that the maximum annual average no-decay χ/Q value for the EAB is $8.1 \times 10^{-6}$ s/m$^3$ in the northwest sector at a distance of 1.11 km (0.69 mi). This appears to conflict with the information presented in FSAR Tier 2, Table 2.3S-27, which shows that the maximum no-decay χ/Q value for the EAB is $1.5 \times 10^{-5}$ s/m$^3$ in the northwest sector at a distance of 0.84 km (0.52 mi). The staff issued RAI 02.03.05-12 requesting that the applicant revise the FSAR to address this apparent conflict. The applicant proposes a revision to the FSAR resolving this conflict in its response to RAI 02.03.05-12 dated March 1, 2010 (ML100620824). Verification of the proposed changes was tracked as Confirmatory Item 2.3.5-12 in the SER with open items.

The staff confirmed that FSAR Tier 2, Revision 4 includes the proposed changes, per the applicant's commitment in the RAI response. Accordingly, the staff found that the applicant has adequately addressed this issue. Therefore, Confirmatory Item 02.03.04-12 is closed and RAI 02.03.05-12 is closed.

Note that no residential milk cows were identified within 8 km (5 mi) of the STP site. The applicant assumed that all residents have a vegetable garden and are fattening a calf for residential consumption. The staff found these to be conservative assumptions and therefore acceptable.

#### 2.3S.5.4.3 Meteorological Data Input

The meteorological input to the XOQDOQ model consists of a joint frequency distribution of wind speed, wind direction, and atmospheric stability based on hourly onsite data from the three-year period of 1997, 1999, and 2000. The wind data were obtained from the 10-m (33-ft) level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-T) measurements taken between the 60-m and 10-m (197-ft and 33-ft) levels on the onsite meteorological tower.

As discussed in SER Section 2.3S.3, the staff considers the 1997, 1999, and 2000 onsite meteorological database suitable for input to the XOQDOQ model.

### 2.3S.5.4.4 Diffusion Parameters

The applicant chooses to implement the diffusion parameter assumptions, outlined in RG 1.111, as a function of atmospheric stability for the XOQDOQ model runs. Due to the location and size of the main cooling reservoir, overwater trajectories in the south-southeast to the south-southwest downwind sectors average approximately 5 km (3 mi). NRC staff asked the applicant in RAI 02.03.05-6 to describe the impact of reduced surface roughness resulting from the main cooling reservoir over-water trajectories on the resulting long-term, offsite atmospheric dispersion estimates. The applicant's response to RAI 02.03.05-6 dated November 20, 2008 (ML08390340), states that the reduced surface roughness induced by the main cooling reservoir will result in less mechanical turbulence and higher χ/Q values. The decrease in mechanical turbulence is offset by an increase in thermal turbulence due to the heating from below the overwater trajectories. The applicant also states that reduced surface roughness will also increase ambient wind speed slightly, thus increasing dispersion. The net effect leads to minimal changes in annual average χ/Q values. Therefore, the applicant's use of diffusion parameter assumptions outlined in RG 1.111 is acceptable to the staff and RAI 02.03.05-6 is closed.

### 2.3S.5.4.5 Resulting Relative Concentration and Relative Deposition Factors

FSAR Tier 2, Table 2.3S-27 lists the long-term atmospheric dispersion and deposition estimates for the EAB, site boundary, and special receptors of interest that the applicant derived from the XOQDOQ modeling results. The χ/Q values in FSAR Tier 2, Table 2.3S-27 reflect several plume radioactive decay and deposition scenarios. Regulatory Position C.3 of RG 1.111 states that radioactive decay and dry deposition should be considered in radiological impact evaluations of potential annual radiation doses to the public that result from routine releases of radioactive materials in gaseous effluents. Regulatory Position C.3.a of RG 1.111 states that an overall half-life of 2.26 days is acceptable for evaluating the radioactive decay of short-lived noble gases, and an overall half-life of 8 days is acceptable for evaluating the radioactive decay for all iodine released into the atmosphere. Definitions for the χ/Q categories listed in the headings of FSAR Tier 2, Table 2.3S-27 are as follows:

- No Decay χ/Q values are χ/Q values used to evaluate ground level concentrations of long-lived noble gases, tritium, and carbon-14. The plume is assumed to travel downwind, without undergoing dry deposition or radioactive decay.
- 2.26-Day Decay χ/Q values are χ/Q values used to evaluate ground-level concentrations of short-lived noble gases. The plume is assumed to travel downwind, without undergoing dry deposition, but is decayed, assuming a half-life of 2.26 days, based on the half-life of xenon-133m.
- 8.00-Day Decay χ/Q values are χ/Q values used to evaluate ground level concentrations of radioiodine and particulates. The plume is assumed to travel downwind, with dry deposition, and is decayed, assuming a half-life of 8.00 days based on the half-life of iodine-131.

NRC staff asked the applicant in RAI 02.03.05-5 to clarify whether the no-decay and 2.26-day decay χ/Q values in FSAR Tier 2, Table 2.3S-27 assume no dry deposition, and whether the 8-day decay χ/Q values in the same table assume dry deposition. The applicant's response to RAI 02.03.05-5 dated June 12, 2008 (ML081710126), confirms these assumptions.
The applicant revised the FSAR in Revision 3 to state that the no-decay and 2.26-day decay χ/Q values in Table 2.3S-27 assume no dry deposition, and the 8-day decay χ/Q values in the same table assume dry deposition. Therefore, RAI 02.03.05-5 is considered closed.

FSAR Tier 2, Tables 2.3S-28 and 2.3S-29 list the applicant's long-term atmospheric dispersion and deposition estimates for all 16 radial sectors from the site boundary to a distance of 80.5 km (50 mi) from the proposed facility.

The staff reviewed the XOQDOQ computer code inputs and outputs provided by the applicant in the response to environmental RAI 05.04.02-1 dated September 22, 2009 (ML092710535), and reran the model using the applicant's revised distances to the EAB, site boundary, and receptors of interest provided in the responses to RAIs 02.03.04-5 and 02.03.05-11. The staff's results were consistent with the applicant's results presented in the FSAR.

### 2.3S.5.5 *Post Combined License Activities*

There are no post COL activities related to this section.

### 2.3S.5.6 *Conclusion*

NRC staff reviewed the application and found that the applicant has presented and substantiated information regarding long-term atmospheric dispersion estimates for routine releases. The staff reviewed the information and, for the reasons stated above, concluded that the applicant's atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR 100.21(c)(1). Representative atmospheric dispersion and deposition factors have been calculated for 16 radial sectors from the site boundary to a distance of 80.5 km (50 mi) as well as for specific locations of potential receptors of interest.
The characterization of atmospheric dispersion and deposition conditions is appropriate for the evaluation to demonstrate compliance with the numerical guides for doses in Subpart D of 10 CFR Part 20 and Appendix I to 10 CFR Part 50.

The staff's review confirmed that the applicant has adequately addressed COL License Information Item 2.12 in accordance with Section 2.3.5 of NUREG–0800, the applicant has addressed the relevant information, and no outstanding information is expected to be addressed in the COL FSAR related to this section.

### *References*

ALOHA 2007, "Areal Locations of Hazardous Atmospheres", U.S. Environmental Protection Agency, Office of Emergency Management, Washington DC, February 2007.

NOAA, 2007 "2006 Local Climatological Data, Annual Summary with Comparative Data, Victoria, Texas (KVCT)," National Climatic Data Center (NCDC), National Environmental Satellite Data and Information Service (NESDIS)

U.S. Global Change Research Program (USGCRP), 2009. "Global Climate Change Impacts in the United States," T.R. Karl, J.M. Melillo, and T.C. Peterson (eds.), Cambridge University Press, New York, (Accession No. ML100580077).

Wang, X.L., and J.K., Angell, "Climatology for the United States (1948-1998)," Air Stagnation NOAA Air Resources Laboratory Atlas No. 1, Air Resources Laboratory, Environmental Research Laboratories, Office of Oceanic and Atmospheric Research, Silver Spring, Maryland, April 1999.