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LIST OF FIGURES

No figures were included in this chapter.

LIST OF TABLES

2 SITE CHARACTERISTICS

2.0 Site Characteristics

2.0.1 Introduction

This chapter of the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 Final Safety Analysis Report (FSAR) describes the characteristics of the site, including the population distribution, land use, and site activities and controls. In addition, meteorological, hydrological, geological, and seismological characteristics of the site are also incorporated into this chapter of the Combined License (COL) FSAR.

COL FSAR Chapter 2 is divided into the following five sections:

- Section 2.1, "Geography and Demography"
- Section 2.2, "Nearby Industrial, Transportation, and Military Facilities"
- Section 2.3, "Meteorology"
- Section 2.4, "Hydrologic Engineering"
- Section 2.5, "Geology, Seismology, and Geotechnical Engineering"

The staff's evaluation of Chapter 2 follows the format and guidance contained in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (hereafter referred to as NUREG-0800 or the SRP) for COL FSAR Chapter 2. The Nuclear Regulatory Commission (NRC) staff review focused on on-site characteristics and site-related design characteristics that enabled staff to reach a conclusion on safety matters related to siting of CCNPP Unit 3. This COL application references the U.S. EPR design certification Tier 2 FSAR; therefore, the review also focused on the COL applicant's demonstration that the characteristics of the site fall within the site parameters specified in the U.S. EPR Tier 2 FSAR or, if outside these parameters, that the design satisfies the requirements imposed by the specific site parameters and conforms to the design commitments and acceptance criteria described in the U.S. EPR Tier 2 FSAR.

The COL applicant provided additional information in COL FSAR Section 2.0 to address the following COL Information Item No. 2.0-1 from U.S. EPR FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items."

> A COL applicant that references the U.S. EPR design certification will compare site-specific data to the design parameter data in Table 2.1-1. If the specific data for the site falls within the assumed design parameter data and characteristics in Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific design parameter data or characteristics that are outside the bounds of the assumptions presented in Table 2.1-1, the COL applicant will confirm that the U.S. EPR design acceptably meets any additional requirements that may be imposed by the more limiting site-specific design parameter data or characteristic, and that the design maintains conformance to the design commitments and acceptance criteria described in this FSAR.

In response to this COL information item, the COL applicant stated that the site-specific parameters and characteristics have been reviewed and compared to determine if they are within the bounds of the assumed parameters and characteristics of the U.S. EPR. This comparison is provided in COL FSAR Tables 2.0-1, "U.S. EPR Site Design Envelope Comparison," and 2.0-2, "Comparison of Inventory of Radionuclides Which Could Potentially Seep Into the Groundwater." For the site-specific parameters or characteristics that are outside the bounds of the conservative limiting assumptions presented in COL FSAR Tables 2.0-1 and 2.0-2, justification of the acceptability of these conditions is provided in the associated section of COL FSAR Chapter 3, "Design of Structures, Components, Equipment and Systems," or as specified in the table. The staff's evaluations of the COL applicant's justification for the acceptability of these conditions are documented in corresponding sections of this evaluation.

The staff reviewed the information in U.S. EPR FSAR Tier 2, Chapter 2 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the site characteristics incorporated by reference in the COL FSAR have been documented in the staff's Safety Evaluation Report (SER) on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. **Request for additional information (RAI) 222, Question 01-5 is being tracked as an open item** as part of this chapter. The staff will update Chapter 2 of this report to reflect the final disposition of the design certification application.

2.1 Geography and Demography

COL FSAR Section 2.1 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.1, "Geography and Demography."

In addition, in COL FSAR Section 2.1, the COL applicant provided the following:

Combined License Information Items

The COL applicant provided additional information in COL FSAR Section 2.1 to address COL Information Item No. 2.1-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information related to site location and description, exclusion area authority and control, and population distribution.

The COL applicant's response to this COL information item is provided in COL FSAR Sections 2.1.1, "Site Location and Description," 2.1.2, "Exclusion Area Authority and Control," and 2.1.3, "Population Distribution." Similarly, the staff's evaluation of the COL applicant's response to this COL information item is provided in Sections 2.1.1, 2.1.2, and 2.1.3 of this report.

2.1.1 Site Location and Description

2.1.1.1 *Introduction*

The descriptions of the site area and reactor location are used to assess the acceptability of the reactor site. The review covers the following specific areas: (1) Specification of reactor location with respect to latitude and longitude, political subdivisions; and prominent natural and manmade features of the area; (2) site area map to determine the distance from the reactor to

the boundary lines of the exclusion area, including consideration of the location, distance, and orientation of plant structures with respect to highways, railroads, and waterways that traverse or lie adjacent to the exclusion area; and (3) any additional information requirements prescribed within the "Contents of Application" sections of the applicable Subparts to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52. The purpose of the review is to ascertain the accuracy of the COL applicant's description for use in independent evaluations of the exclusion area authority and control, the surrounding population, and nearby manmade hazards.

2.1.1.2 *Summary of Application*

U.S. EPR FSAR Tier 2, Section 2.1.1, "Site Location and Description," states that the site location and description is site-specific and should include:

- Specific location by longitude and latitude, Universal Traverse Mercator (UTM) coordinates, and political subdivisions; the site's relative location with respect to natural and manmade features of the area such as highways, railways, and waterways; and local population distribution

- A map of the site area of suitable scale (with explanatory text as necessary) showing relevant features such as the plant property lines, site and exclusion area boundaries, location and orientation of principal plant structures within the site area, and highways, railways, and waterways that traverse or are adjacent to the site

COL FSAR Section 2.1.1 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.1.1.

In addition, in COL FSAR Section 2.1.1, the COL applicant provided the following:

Combined License Information Items

- The COL applicant provided additional information in COL FSAR Sections 2.1.1.1, "Specification of Location"; 2.2.1.2, "Site Area Map"; and 2.1.1.3, "Boundary for Establishing Effluent Release Limits"; to address COL Information Item No. 2.1-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

The additional information provided in COL FSAR Sections 2.1.1.1 through 2.1.1.3 to address this COL information item includes site area maps, global coordinate information, and a description of the natural surroundings, including forested areas, waterways, shorelines, residential areas, and military installations. A description of the exclusion area boundary is also provided. Specifically, the COL applicant specified the location of each reactor at the site by latitude and longitude to the nearest second and by UTM coordinates (zone number, northing, and easting, as found on topographical maps prepared by the U.S. Geological Survey (USGS)) to the nearest 100 m (328 ft). The COL applicant included a map to suitable scale depicting the site area.

2.1.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the Final Safety Evaluation Report (FSER) related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the site location and description, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.1.1, "Site Location and Description."

The applicable regulatory requirements for the site location and description are as follows:

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, as they relate to the description and safety assessment of the site, with appropriate attention to features affecting facility design, per 10 CFR 50.34(a)(1), "Contents of applications; technical information"; and 10 CFR 52.79(a)(1).

2. 10 CFR Part 100, "Reactor Site Criteria", as it relates to:

    - Exclusion area (10 CFR 100.3, "Definitions")
    - Site acceptability (10 CFR 100.20(b), "Factors to be considered when evaluating sites")
    - Exclusion area selection relative to dose limits in the event of a postulated fission product release as identified in 10 CFR 50.34(a)(1)
    - Population density and use characteristics relative to hazardous consequences of accidents and risk to the public, per 10 CFR 100.20(b) and 10 CFR 100.21, "Non-seismic siting criteria"

2.1.1.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 2.1.1 and checked the applicable sections of the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the COL application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 2.1.1 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to the site location and description has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

Combined License Information Items

The staff reviewed COL Information Item No. 2.1-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.1.1.

The staff reviewed the resolution to the site-specific items related to the site location and description included under COL FSAR Section 2.1. The staff has independently estimated and verified the site latitude and longitude coordinates and the UTM coordinate system coordinates provided by the COL applicant in the COL FSAR. Using maps readily available in most libraries and on the internet, the NRC verified the political subdivisions and prominent manmade features of the area provided by the COL applicant.

The staff verified that COL FSAR Figure 2.1-1, “Site Area Map,” provided by the COL applicant, showed the distance from the reactor to the boundary lines of the CCNPP Unit 3 exclusion area. The staff verified that no public roads or railroads cross or lie adjacent to the exclusion area and that the only public thoroughfare that crosses or lies adjacent to the exclusion area is a major shipping lane of Chesapeake Bay that lies just outside the CCNPP Unit 3 exclusion area.

On the basis of the staff’s review of the information addressed in the CCNPP Unit 3 COL application, and also the staff’s confirmatory review of pertinent information generally available in literature and on the internet, the information provided by the COL applicant with regard to the site location and description is considered adequate and acceptable.

2.1.1.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.1.1.6 *Conclusions*

The staff reviewed the application and checked the referenced U.S. EPR FSAR. The staff’s review confirmed that the COL applicant addressed the required information relating to the site location and description, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

As set forth above, the COL applicant has presented and substantiated information to establish the site location and description. The staff has reviewed the information provided and, for the reasons specified above, concludes that it is sufficient for the staff to evaluate compliance with the siting evaluation factors in 10 CFR Part 100.3, as well as with the radiological consequence evaluation factors in 10 CFR 52.79(a)(1). The staff further concludes that the COL applicant provided sufficient details about the site location and site description to allow the staff to evaluate, as documented in Sections 2.1.2, 2.1.3, and 13.3 and Chapters 11 and 15 of this report, whether the COL applicant has met the relevant requirements of 10 CFR Part 52.79(a)(1) and 10 CFR Part 100 with respect to determining the acceptability of the site.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 *Introduction*

The descriptions of exclusion area authority and control are used to verify the COL applicant’s legal authority to determine and control activities within the designated exclusion area and are sufficient to enable the reviewer to assess the acceptability of the reactor site. The review covers the following specific areas: (1) Establishment of the COL applicant’s legal authority to determine all activities within the designated exclusion area; (2) the COL applicant’s authority and control in excluding or removing personnel and property in the event of an emergency; (3) establish that proposed or permitted activities in the exclusion area unrelated to operation of the reactor do not result in a significant hazard to public health and safety; and (4) any additional information requirements prescribed within the “Contents of Application” sections of the applicable Subparts to 10 CFR Part 52.

2.1.2.2 *Summary of Application*

U.S. EPR FSAR Tier 2, Section 2.1.2, “Exclusion Area Authority and Control,” states that the authority for control of activities in the site exclusion area is site-specific and will be addressed by the COL applicant. This information will describe activities unrelated to plant operations that are permitted within the exclusion area.

COL FSAR Section 2.1.2 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.1.2.

In addition, in COL FSAR Section 2.1.2, the COL applicant provided the following:

Combined License Information Items:

The COL applicant provided additional information in COL FSAR Sections 2.1.2.1, “Authority”; 2.1.2.2, “Control of Activities Unrelated to Plant Operations”; 2.1.2.3, “Arrangements for Traffic Control”; and 2.1.2.4, “Abandonment or Relocation of Roads”; to address COL Information Item No. 2.1-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

The additional information provided in COL FSAR Sections 2.1.2.1 through 2.1.2.4 to address this COL information item includes maps and exclusion area description, ownership definition, control of activities unrelated to reactor operation, and traffic control. Specifically, the COL applicant:

- Provided a specific description of its legal rights with respect to all areas that lie within the designated exclusion area.
- Obtained ownership of all land within the exclusion area.
- Described any activities unrelated to plant operation that will be permitted within the exclusion area, aside from transit through the area.
- No highway or railroad traverses the exclusion area. However, the COL applicant described the arrangements made to control traffic on the portions of Chesapeake Bay included in the exclusion area in the event of an emergency.
- No public roads traverse the proposed exclusion area that will have to be abandoned or relocated.

2.1.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for exclusion area authority and control, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.1.2, “Exclusion Area Authority and Control.”

The applicable regulatory requirements for exclusion area authority and control are as follows:

1. 10 CFR Part 50 and 10 CFR Part 52, as they relate to the description and safety assessment of the site, with appropriate attention to features affecting facility design, per 10 CFR 50.34(a)(1), 10 CFR 52.17(a)(1), and 10 CFR 52.79(a)(1).

2. 10 CFR 100, as it relates to:

   - Exclusion area (10 CFR 100.3)
   - Site acceptability (10 CFR 100.20(b)
   - Exclusion area selection relative to dose limits in the event of a postulated fission product release as identified in 10 CFR 50.34(a)(1)

2.1.2.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 2.1.2 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 2.1.2 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to exclusion area authority and control has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

Combined License Information Items

The staff reviewed COL Information Item No. 2.1-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.1.2.

The staff reviewed the COL applicant's proposed resolution to the COL information item related to the exclusion area authority and control, including size of the area and activities that may be permitted within the designated exclusion area, using the review procedures described in NUREG-0800, Section 2.1.2.

The COL applicant provided the information concerning the following:

- Complete legal authority to regulate access and activity within the exclusion area boundary (EAB)
- Identification of any facilities within the EAB that have activities unrelated to plant operation being controlled and considered for emergency planning
- Arrangements for traffic control

The staff verified the COL applicant's description of the exclusion area, as well as the authority under which all activities within the exclusion area can be controlled. The staff also verified for consistency that the EAB is the same as that being considered for the radiological consequences in COL FSAR Chapter 15, "Transient and Accident Analysis," and COL FSAR

Section 13.3, “Emergency Planning,” by the COL applicant. The staff concludes that the COL applicant has acquired authority to control all activities within the designated exclusion area.

The property is clearly posted and includes actions to be taken in the event of emergency conditions at the plant. The CCNPP Unit 3 EAB is greater than 0.8 kilometers (km) (0.5 miles (mi)) from the potential release points and, therefore, bounds the U.S. EPR FSAR site parameter exclusion area distance identified in U.S. EPR FSAR Tier 2, Table 2.1-1 and meets the requirements of 10 CFR 50.34(a)(1)(ii)(D)(1) and 10 CFR 52.79(a)(1).

2.1.2.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.1.2.6 *Conclusions*

The staff reviewed the COL application and checked the referenced U.S. EPR FSAR. The staff’s review confirmed that the COL applicant addressed the required information relating to exclusion area authority and control, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff’s technical evaluation of the information related to exclusion area authority and control incorporated by reference in the COL FSAR have been documented in the staff’s safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update Section 2.1.2 of this report to reflect the final disposition of the design certification application.

As set forth above, the COL applicant has provided and substantiated information concerning its legal authority and control of all activities within the designated exclusion area. The staff has reviewed the information provided and, for the reasons specified above, concludes that the COL applicant’s exclusion area is acceptable to meet the requirements of 10 CFR 50.34(a)(1), 10 CFR Part 52.79(a)(1), 10 CFR Part 100, and 10 CFR 100.3 with respect to determining the acceptability of the site. This conclusion is based on the COL applicant having appropriately described the plant exclusion area, the authority under which all activities within the exclusion area can be controlled, and the methods by which access and occupancy of the exclusion area can be controlled during normal operation and in the event of an emergency situation. In addition, the COL applicant has the required authority to control activities within the designated exclusion area, including the exclusion and removal of persons and property, and has established acceptable methods for control of the designated exclusion area.

2.1.3 Population Distribution

2.1.3.1 *Introduction*

The description of population distributions addresses the need for information about: (1) Population in the site vicinity, including transient populations; (2) population in the exclusion area; (3) whether appropriate protective measures could be taken on behalf of the populace in the specified low-population zone (LPZ) in the event of a serious accident; (4) whether 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; and (5) whether the population density in the site vicinity is in conformance with the guidelines specified in Regulatory Guide (RG) 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Regulatory Position C.4.

This section of the COL FSAR addresses the population data in the vicinity of the plant, including inhabitants within the exclusion area, surrounding population zones, and population density.

2.1.3.2 *Summary of Application*

The U.S. EPR FSAR Tier 2, Section 2.1.3, "Population Distribution," states that the distribution of the population in the vicinity of the site is site-specific and will be addressed by the COL applicant.

COL FSAR Section 2.1.3 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.1.3.

In addition, in COL FSAR Section 2.1.3, the COL applicant provided the following:

Combined License Information Items

The COL applicant provided additional information in COL FSAR Sections 2.1.3.1, "Population Within 10 Mi (16 km)"; 2.1.3.2, "Population Between 10 and 50 Mi (16 and 80 km)"; 2.1.3.3, "Transient Population"; 2.1.3.4, "Low Population Zone"; 2.1.3.5, "Population Center"; and 2.1.3.6, "Population Density"; to address COL Information Item No. 2.1-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

The additional information provided in COL FSAR Sections 2.1.3.1 through 2.1.3.6 to address this COL information item includes population distribution maps, tables listing commuter patterns, recreational facilities, and population growth projections. The site LPZ, defined to be within a 2.4 km (1.5 mi) radius of the reactor unit, is described relative to population and emergency preparedness. Specifically, the COL applicant:

- Provided a description of the population within 16.1 km (10 mi) of the plant
- Provided a description of the population between 16.1 and 80.5 km (10 and 50 mi) of the plant
- Provided a description of the seasonal and daily variations in population and population distribution resulting from land uses
- Specified the low-population zone
- Identified the nearest population center
- Provided a plot out to a distance of at least 32.2 km (20 mi) showing the cumulative resident population

2.1.3.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the population distribution, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.1.3, "Population Distribution."

The applicable regulatory requirements for the population distribution are as follows:

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 100 (population density), 10 CFR 52.17, and 10 CFR 52.79, as they relate to provision in the COL FSAR of existing and future population in the surrounding vicinity of the plant site.

2. 10 CFR 100.20 and 10 CFR 100.21, as they relate to determining the acceptability of the site. 10 CFR 100.3, 10 CFR 100.20, and 10 CFR 100.21 provide definitions and other requirements for determining an exclusion area, LPZ, and population center distance.

The related regulatory guidance to meet the above requirements is follows:

1. RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)"

2. RG 4.7, "General Site Suitability for Nuclear Power Stations"

2.1.3.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 2.1.3 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 2.1.3 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to the population distribution has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

Combined License Information Items

The staff reviewed COL Information Item No. 2.1-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.1.3.

The staff reviewed the COL applicant's proposed resolution to the COL information item related to the population distribution around the site environs included in COL FSAR Section 2.1.3, using the review procedures described in NUREG-0800, Section 2.1.3.

The staff reviewed the data on the population in the site environs, as presented in the COL FSAR, to determine whether the exclusion area, LPZ, and population center distance for the proposed ESP site comply with the requirements of 10 CFR Part 100. The staff also evaluated whether, in conformance with RG 4.7, Regulatory Position C.4, the COL applicant should consider alternative sites with lower population densities. The staff also reviewed whether appropriate protective measures could be taken on behalf of the enclosed populace within the emergency planning zone (EPZ), which encompasses the LPZ, in the event of a serious accident. The staff compared and verified the COL applicant's population data against U.S. Census Bureau data. The staff reviewed the projected population data provided by the COL applicant, including the weighted transient population for 2010, 2015, 2020, 2030, 2040, 2050, 2055, and 2060. The staff reviewed the extensive transient population data provided by the COL applicant. Based on this information, the staff finds that the COL applicant's estimate of the transient population is reasonable.

The staff verified the distances to the nearest population centers are well in excess of the minimum population center distance of 3.2 km (2 mi) (one and one third times the distance from center point to the outer boundary of the LPZ). The CCNPP Unit 3 LPZ is defined as a circle with a 2.4 km (1.5 mi) radius from the CCNPP Unit 3 site center point. As a conservative move, the COL applicant has added the area contained in the CCNPP Units 1 and 2 LPZs to be included as part of the CCNPP Unit 3 LPZ. The nearest population center, as defined by 10 CFR 100.3, is St. Charles, Maryland (MD). The distance to St. Charles' urban boundary, as defined by U.S. Census files, is 41.8 km (26 mi) west-northwest of the Unit 3 center point. This distance is approximately 13 times greater than the one and one third times the distance from the reactor center point to the boundary of the low population zone as recommended by NUREG-0800 and conforms to the guidance provided in RG 4.7. Therefore, the staff concludes that the proposed site meets the population center distance requirement as defined in 10 CFR Part 100, Subpart B.

The staff evaluated the site population density against the criterion in RG 4.7, Revision 2, Regulatory Position C.4, regarding whether it is necessary to consider alternative sites with lower population densities. The staff concluded that the population densities at the time of initial site approval (assumed 2010) and 5 years thereafter, would not exceed the criteria of 500 persons per 259 hectare (square mile) averaged over any radial distance out to 32.2 km (20 mi) (cumulative population within a distance of up to 32.2 km (20 mi) divided by the area of the same radius circle). As a conservative move, instead of dividing by the area of the circle as described above and in the guidelines of RG 4.7, the COL applicant subtracted the water surface area from the area of the radius circle before dividing it into the total population within the circle and still met the criteria of less than 500 persons per hectare (square mile).

Therefore, the staff concludes that the CCNPP Unit 3 site conforms to RG 4.7, Revision 2, Regulatory Position C.4.

2.1.3.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.1.3.6 *Conclusions*

The staff reviewed the application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the COL applicant addressed the required information relating to the

population distribution, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the population distribution incorporated by reference in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update Section 2.1.3 of this report to reflect the final disposition of the design certification application.

As set forth above, the COL applicant has provided an acceptable description of current and projected population densities in and around the site. The staff has reviewed the information provided and, for the reasons specified above, concludes that the population data provided is acceptable to meet the requirements of 10 CFR 50.34(a)(1), 10 CFR 52.79(a)(1), 10 CFR 100.20(a), 10 CFR 100.20(b), 10 CFR Part 100, and 10 CFR 100.3. This conclusion is based on the COL applicant having provided an acceptable description and safety assessment of the site, which contains present and projected population densities that are within the guidelines of RG 4.7, Regulatory Position C.4 and properly specified the low-population zone and population center distance. In addition, the staff has reviewed and confirmed, by comparison with independently obtained population data, the COL applicant's estimates of the present and projected populations surrounding the site, including transients. As described further in Chapter 15 of this report, the staff finds that the COL applicant also has calculated the radiological consequences of design-basis accidents at the outer boundary of the low-population zone. Therefore, the staff finds it has reasonable assurance that appropriate protective measures can be taken within the low-population zone to protect the population in the event of a radiological emergency. This adequately addresses COL Information Item No. 2.1-1.

2.2 Nearby Industrial, Transportation, and Military Facilities

COL FSAR Section 2.2, "Nearby Industrial, Transportation, and Military Facilities," identifies and describes the locations and routes of nearby industrial, transportation, and military facilities relative to the potential hazards they could pose to safe operation of the reactor. This section also provides an evaluation of the potential hazards associated with the nearby industrial, transportation, and military facilities, including the effects of toxic vapors or gases, explosions, fires, and missiles (aircraft impact). U.S. EPR FSAR Tier 2, Section 2.2, "Nearby Industrial, Transportation, and Military Facilities," indicates that a COL applicant that references the U.S. EPR design certification will provide the aforementioned information (COL Information Item No. 2.2-1 in U.S. EPR FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items"). The staff's assessment of the adequacy of this COL information item can be found in Section 2.2.1 of this report.

COL FSAR Section 2.2 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.2, with no departures.

2.2.1 Location and Routes

2.2.1.1 *Introduction*

This section of the staff's safety evaluation report documents the staff's review of COL FSAR Sections 2.2.1, "Location and Routes," and 2.2.2, "Descriptions."

COL FSAR Section 2.2.1 identifies the locations of, and transportation routes associated with, nearby industrial, transportation, and military facilities relative to the potential hazards they could pose to safe operation of the reactor. Descriptions of the nearby industrial, transportation, and military facilities are presented in COL FSAR Sections 2.2.2.1, "Description of Facilities," through 2.2.2.7, "Aircraft and Airways," including a description of the products and materials associated with each facility, plus a description of the pipelines, waterways, highways, railroads, and airways. In addition, the possibility of industrial growth is also addressed.

2.2.1.2 *Summary of Application*

COL FSAR Sections 2.2.1 and 2.2.2 incorporate by reference U.S. EPR FSAR Tier 2, Sections 2.2.1, "Location and Routes," and 2.2.2, "Descriptions."

In addition, in COL FSAR Sections 2.2.1 and 2.2.2, the COL applicant provided the following:

Combined License Information Items:

The COL applicant provided additional information in COL FSAR Section 2.2 to address COL Information Item No. 2.2-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information related to the identification of potential hazards stemming from nearby industrial, transportation, and military facilities within the site vicinity, including an evaluation of potential accidents (such as explosions, toxic chemicals, and fires).

The disposition of COL Information Item No. 2.2-1 is provided in COL FSAR Sections 2.2.1 and 2.2.2.

In addition, these sections determine whether the effects of potential accidents in the vicinity of the CCNPP Unit 3 site from present and projected industrial, transportation, and military installations and operations should be used as design-basis events for plant design parameters related to the selected accidents. Significant facilities and activities within 8 km (5 mi) and major airports within 16 km (10 mi) of the CCNPP Unit 3 site were identified. These facilities and activities, and significant facilities at greater distances, were evaluated.

The COL applicant's investigation of potential external hazard facilities and operations within 8 km (5 mi) of the site identified one significant industrial facility; one airport and two helipads; three marinas; and a natural gas pipeline for further evaluation. CCNPP Units 1 and 2, and their associated onsite chemical storage facilities, were identified as industrial hazard facilities for further evaluation. An evaluation of major transportation routes within the vicinity of the site identified: One highway with commercial traffic, two airways within the vicinity of the site, and a navigable waterway for further evaluation.

The additional information provided in the COL FSAR to support the COL information item includes identification and map locations of nearby airfields, helipads, liquid natural gas pipelines, marinas, and a naval air station.

2.2.1.2.1 Location and Routes

The U.S. EPR FSAR includes the following COL information item in Tier 2, Section 2.2.1:

The site-specific location and routes for nearby industrial, transportation, and military facilities are addressed by the COL applicant. The potential external hazard facilities and operations within 8 km (5 mi) of CCNPP Unit 3 include one significant industrial facility, one airport, two helipads, two marinas, and a natural gas pipeline; and CCNPP Units 1 and 2 and its associated onsite chemical storage facilities are included as industrial hazard facilities for evaluation. The major transportation routes within the vicinity of CCNNP Unit 3 include one highway with commercial traffic, two airways, and a navigable waterway for evaluation.

The location of the facilities and transportation routes within 8 km (5 mi) of CCNPP Unit 3 include the following, which are shown in COL FSAR Figure 2.2-1, "5 mi (8 km) Site Vicinity Map."

- Dominion Cove Point Liquid Natural Gas (DCPLNG) Terminal
- DCPLNG Pipeline
- DCPLNG Helipad
- MD State Highway 2/4 – MD 2/4
- Mears Creek Airfield
- CCNPP Units 1 and 2
- CCNPP Corporate Helipad
- Vera's White Sands Marina
- Flag Harbor Yacht Haven

The facilities and transportation routes within 16 km (10 mi) of CCNPP Unit 3 include one military installation (Patuxent River Naval Air Station (NAS) and three airports.

The airports and airway routes within 16 km (10 mi) of CCNNP Unit 3 include the following, which are shown on COL 3 FSAR Figure 2.2-2, "Airports/Airways Within 10 mi (16 km) of Site."

- CCNPP Corporate Helipad
- DCPLNG Helipad
- Patuxent River NAS
- Chesapeake Ranch Airpark
- Captain Walter Francis Duke Regional Airport
- Mears Creek Airfield
- Airway V-31
- Airway V-93

- Airway V-16-157-213-229
- Airway J-191

2.2.1.2.2 Descriptions

The U.S. EPR FSAR includes a COL information item that states a COL applicant that references the U.S. EPR will provide (in COL FSAR Section 2.2) site-specific information related to the identification and description of potential hazards stemming from nearby industrial, transportation, and military facilities within the site vicinity. The COL information item includes the descriptions of the industrial, transportation, and military facilities located in the vicinity of the CCNPP Unit 3 site. The description of facilities and detailed description of products and materials are addressed in COL FSAR Section 2.2.1. COL FSAR Table 2.2-1, "Description of Facilities, Products, and Materials," provides a concise description of the facilities, including the functions and major products, as well as number of persons employed. The detailed descriptions are provided in COL FSAR Sections 2.2.2.2.1, "CCNPP Units 1 and 2," through 2.2.2.2.5, "Mining Activities." The detailed descriptions of the facilities would help evaluate the potential accidents in COL FSAR Section 2.2.3, "Evaluation of Potential Accidents." A brief description of each of the facilities identified is provided below.

<u>CCNPP Units 1 and 2</u>

The centerlines of the existing CCNPP Units 1 and 2 reactors are located approximately 722.7 m (2,371 ft) and 666.6 m (2,187 ft) north, respectively, and 355.1 m (1,165 ft) and 299 m (981 ft) west, respectively, of the centerline of the CCNPP Unit 3 reactor. The chemicals used for CCNPP Units 1 and 2 are presented in COL FSAR Table 2.2-2, "CCNPP Units 1, 2 and 3 Onsite Chemical Storage." The analysis of these chemicals is addressed in COL FSAR Section 2.2.3, and results are summarized in COL FSAR Table 2.2-5, "Onsite Chemical Disposition."

<u>Dominion Cove Point Liquefied Natural Gas Facility</u>

The DCPLNG Facility is located approximately 5.15 km (3.2 mi) south of the CCNPP Unit 3 site. DCPLNG receives liquefied natural gas (LNG) from LNG tanker ships, stores the LNG onshore in tanks, transforms it back to gas, and delivers it to a pipeline for distribution. The Federal Energy Regulatory Commission (FERC) has approved an application for expansion of the DCPLNG facility, and the details are available in COL FSAR Section 2.2.2.4.2, "Dominion Cove Point Liquefied Natural Gas Facility."

<u>Patuxent River NAS</u>

The Patuxent River NAS is located approximately 16 km (10 mi) south of the CCNPP Unit 3 site. There are no live bombing ranges on the station. Weapons separation testing is performed approximately 4.8 to 8 km (3 to 5 mi) east of the airport; however, live ordnance is not used for this activity.

<u>Marinas</u>

Vera's White Sands Marina, located in Lusby, and Flag Harbor Yacht Haven, located in St. Leonard, are within 8 km (5 mi) of the CCNPP Unit 3 site. These marinas are primarily used for recreation with no cargo handling.

Mining Activities

There are no mining activities within 8 km (5 mi) of the CCNPP Unit 3 site.

Pipelines

DCPLNG facility operates a pipeline corridor within 8 km (5 mi) of the CCNPP Unit 3 site as depicted in COL FSAR Figure 2.2-1. The Cove Point pipeline extends approximately 142 km (88 mi) from the LNG terminal to connections with several interstate pipelines in Loudon and Fairfax Counties, Virginia (VA). The DCPLNG facility has a peak send-out capacity of 28.3 million m^3/day (1 billion ft^3/day).

Description of Waterways

CCNPP Unit 3 will be located about 305 m (1,000 ft) from the western shore of the Chesapeake Bay. The Port of Baltimore and the DCPLNG facility are located along the Chesapeake Bay navigable waterway and are used for the transport of potentially hazardous cargo. The Port of Baltimore is located 96.6 km (60 mi) north of the CCNPP Unit 3 site, and the DCPLNG facility is located 5.1 km (3.2 mi) south of the CCNPP Unit 3 site. There were a total of 6,860 inbound and 6,820 outbound trips recorded for vessels to and from the Port of Baltimore during 2004, and could be assumed as typical annual volume of freight. These vessels transported a total of over 42.637 x 10^9 kilograms (kg) (47 million tons) of commodities. COL FSAR Table 2.2-3, "Hazardous Chemical Waterway Freight, Port of Baltimore," details the total quantities of petroleum and hazardous chemicals pertaining to freight traffic at the Port of Baltimore. The FERC has approved an application for expansion of the DCPLNG facility. It is estimated that 90 LNG tankers per year currently transiting the Chesapeake Bay to the DCPLNG facility would increase to 200 LNG tankers per year. The total storage capacity at the terminal would increase from 373,000 m^3 to 693,000 m^3 (99 million gallons (gal) to 183 million gal).

Highways

Calvert County has one main four-lane road, MD 2/4, bisecting the county north to south with smaller roads running from the main road to the water on each side. The CCNPP Unit 3 is located approximately 1.93 km (1.2 mi) from MD 2/4 at its closest approach. COL FSAR Table 2.2-6, "Hazardous Material, Roadway Transportation, Disposition," details the hazardous materials that are potentially transported on MD 2/4, and the hazards evaluation of these materials are addressed in COL FSAR Section 2.2.3.

Railroads

There are no railroads within 8 km (5 mi) of the CCNPP Unit 3 site.

Airports and Airways

One airport and two helipads are within 8 km (5 mi) of the CCNPP Unit 3 site. Information pertaining to airports located within 16 km (10 mi) of the site is presented in COL FSAR Table 2.2-4, "Aircraft Operations – Significant Factors," and detailed description of the airports is presented in COL FSAR Section 2.2.2.7.1, "Airports." The Captain Walter Francis Duke Regional Airport (with estimated annual operations of 52,618) and the Patuxent River NAS (with estimated annual operations of 52,626) located approximately 16 km (10 mi) from the CCNPP Unit 3 site have annual operations greater than the plant-to-airport distance acceptance criteria

of 50,000 annual operations. In addition, as shown in COL FSAR Figure 2.2-2, the centerline of Airway V-31 is approximately 3.54 km (2.2 mi) west of the CCNPP Unit 3 site, and the centerline of Airway V-93 and high altitude airway J-191 are about 7.4 km (4.6 mi) east of the CCNPP Unit 3 site. The centerline of V-16-157 is approximately 12.1 km (7.5 mi) from the CCNPP Unit 3.

Projections of Industrial Growth

Based on the review of county planning documents, no major industrial, military, or transportation facilities are expected other than the future developments at existing CCNPP and the DCPLNG sites.

2.2.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for locations, routes, and descriptions of nearby industrial, transportation, and military facilities, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.2.1-2.2.2, "Identification of Potential Hazards in Site Vicinity."

The applicable regulatory requirements for locations, routes, and descriptions of nearby industrial, transportation, and military facilities are as follows:

1. 10 CFR 100.20(b), "Factors to be considered when evaluating sites," which requires that the nature and proximity of manmade hazards be evaluated to establish site parameters for use in determining whether the plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low.

2. 10 CFR 52.79(a)(1)(iv), "Contents of applications; technical information in final safety analysis report," as it relates to the factors to be considered in the evaluation of the location and description of industrial, transportation, and military facilities.

3. 10 CFR 52.79(a)(1)(vi), as it relates to compliance with 10 CFR Part 100, "Reactor Site Criteria."

2.2.1.4 *Technical Evaluation*

The staff reviewed COL FSAR Sections 2.2.1 and 2.2.2 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Sections 2.2.1 and 2.2.2 have been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to locations, routes, and descriptions of nearby industrial, transportation, and military facilities has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

The staff reviewed the COL FSAR using the review procedures described in NUREG-0800, Section 2.2.1-2.2.2.

In COL FSAR Revision 2, Section 2.2.2.7.2, "Aircraft and Airways," the applicant stated that the edge of the closest high altitude airway, J-191, is located further than 3.22 km (2 mi) from CCNPP Unit 3. However, COL FSAR Figure 2.2-2 showed J-191 is within 3.22 km (2 mi) of CCNPP Unit 3. Therefore, in RAI 10, Question 02.02.01-02.02.02-1, the staff requested that the COL applicant either justify excluding J-191 from its hazard analysis or provide an analysis. In an October 6, 2008, response to RAI 10, Question 02.02.01-02.02.02-1, the COL applicant stated that the airway J-191 was incorrectly labeled on COL FSAR Figure 2.2-2, and is actually located approximately 12 km (7.5 mi) from CCNPP Unit 3. The width of a Federal airway is typically 7.4 km (4 nautical mi) on each side of the centerline, and the edge of airway J-191 is approximately 5.6 km (3.5 mi) from CCNPP Unit 3 at its nearest point. Therefore, the COL applicant stated that no further analysis of J-191 was performed. A revised Figure 2.2-2 is presented in Revision 6 of the COL FSAR. The staff determined that the COL applicant's response is acceptable because the edge of J-191 is not within two miles of CCNPP Unit 3. Therefore, the staff considers RAI 10, Question 02.02.01-02.02.02-1 resolved.

In COL FSAR Revision 6, Section 2.2.7.2, the COL applicant identified two airways (V-31 and V-93) for which the CCNPP Unit 3 would not be at least two statute miles beyond the nearest edge of a Federal airway, as described in NUREG-0800, Section 3.5.1.6, "Aircraft Hazards." Therefore, the COL applicant provided an estimate of the total aircraft impact probability of 6.13×10^{-6}/yr. The COL applicant referred to airways V-93 and V-16-157 for this probability determination, but the staff's review that indicated the airways to be V-31 and V-93. Therefore, in RAI 10, Question 02.02.01-02.02.02-2, the staff requested that the COL applicant clarify or correct the analysis, as appropriate. The staff also requested that the COL applicant furnish the parameters used in its analysis, such as total number of annual flight operations for the airways, effective area of plant, width, and other parameters used in determining the probability. In an October 6, 2008, response to RAI 10, Question 02.02.01-02.02.02-2, the COL applicant stated that J-191 is further away than 3.22 km (2 mi), and the probability determination is based on V-31 and V-93. In RAI 48, Question 03.05.01.06-1, the staff requested that the COL applicant provide additional information pertaining to the use of aircraft crash rates in determining the aircraft impact frequency. In a February 26, 2009, response to RAI 48, Question 03.05.01.06-1, the COL applicant provided adequate information and, based on the review of that information, the staff concluded that the COL applicant's response is acceptable because the data is taken from the referenced U.S. DOE document. Because the total aircraft hazard impact frequency is calculated to be greater than 1×10^{-7}/year, the COL applicant stated that a probabilistic risk assessment considering core damage frequency and containment release frequency was evaluated and presented in COL FSAR Section 19.1.5, "Safety Insights from the External Events PRA for Operations at Power." The staff's evaluation of these events is summarized in Chapter 19 of this report.

2.2.1.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.2.1.6 *Conclusions*

The staff reviewed the COL application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the COL applicant addressed the required information relating to

locations, routes, and descriptions of nearby industrial, transportation, and military facilities, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the locations, routes, and descriptions of nearby industrial, transportation, and military facilities incorporated by reference in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update Section 2.2.1 of this report to reflect the final disposition of the design certification application.

As set forth above, the COL applicant has presented and substantiated information to establish an identification of potential hazards in the site vicinity. The staff has reviewed the information provided and, for the reasons specified above, concludes that the COL applicant has provided information with respect to identification of potential hazards in accordance with the requirements of 10 CFR 52.79(a)(1)(iv), 10 CFR 52.79(a)(1)(vi), and 10 CFR 100.20(b) for compliance evaluation. The nature and extent of activities involving potentially hazardous materials that are conducted at nearby industrial, military, and transportation facilities have been evaluated to identify any such activities that have the potential for adversely affecting plant safety-related structures. Based on an evaluation of information in the COL FSAR, as well as information that the staff independently obtained, the staff has concluded that all potentially hazardous activities on site and in the vicinity of the plant have been identified. The hazards associated with these activities are discussed in Sections 2.2.3, 3.5.1.5, and 3.5.1.6 of this report.

2.2.2 Descriptions of Location and Routes

The staff's review of COL FSAR Section 2.2.2 is documented in Section 2.2.1 of this report.

2.2.3 Evaluation of Potential Accidents

2.2.3.1 *Introduction*

COL FSAR Section 2.2.3 addresses the COL applicant's evaluation of potential hazards associated with nearby industrial, transportation, and military facilities, including the effects of toxic vapors or gases, explosions, fires, and missiles (aircraft impact). The COL applicant's probability analyses of potential accidents involving hazardous materials or activities on site and in the vicinity of the proposed site are provided.

2.2.3.2 *Summary of Application*

COL FSAR Section 2.2.3 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.2.3, "Evaluation of Potential Accidents."

In addition, in COL FSAR Section 2.2.3, the COL applicant provided the following:

Combined License Information Items:

The COL applicant provided additional information in COL FSAR Section 2.2.3 to address COL Information Item No. 2.2-2 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will provide information concerning site-specific evaluations to determine the consequences that potential accidents at nearby industrial, transportation, and military facilities could have on the site. The information provided by the COL applicant will include specific changes made to the U.S. EPR design to qualify the design of the site against potential external accidents with an unacceptable probability of severe consequences.

This site-specific supplementary information provided by the COL applicant in COL FSAR Section 2.2.3 addresses the evaluation of potential accidents on the basis of information provided in COL FSAR Sections 2.2.1 and 2.2.2. These potential accidents are considered as design-basis events, and the potential effects of those accidents on the nuclear plant, in terms of design parameters (e.g., overpressure, missile energies) or physical phenomena (e.g., impact, flammable and/or toxic vapor clouds) are identified.

The following types of hazardous events potentially attributable to nearby industrial, transportation, and military facilities are addressed in COL FSAR Section 2.2.3: Explosion, vapor cloud delayed ignition, toxic chemical release, fire, collision with the plant intake structure, liquid spills, and radiological release. Only an aircraft impact event is identified as requiring further analysis as a design-basis event.

2.2.3.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the evaluation of potential accidents, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.2.3, “Evaluation of Potential Accidents.”

The applicable regulatory requirements for evaluation of potential accidents are as follows:

1. 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.

2. 10 CFR 52.79(a)(1)(vi), as it relates to compliance with 10 CFR Part 100.

3. 10 CFR 50.34(a)(1), as it relates to event probability and compliance with 10 CFR Part 100.

4. 10 CFR 100.20(b), as it relates to design basis events.

The related regulatory guidance to meet the above requirements is as follows:

1. RG 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room during a Postulated Hazardous Chemical Release"

2. RG 1.91, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants"

2.2.3.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 2.2.3 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 2.2.3 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to the evaluation of potential accidents has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

The staff reviewed the COL FSAR using the review procedures described in NUREG-0800, Section 2.2.3.

The COL applicant has performed the site-specific evaluations and provided the added information in COL FSAR Sections 2.2.3, 2.2.3.1, "Determination of Design-Basis Events," and 2.2.3.2, "Effects of Design-Basis Events," as supplement to the U.S. EPR FSAR.

<u>Determination of Design-Basis Events</u>

Design-basis events internal and external to the nuclear plant are defined as those accidents that have a probability of occurrence on the order of magnitude of 1×10^{-7} per year, or greater, with potential consequences serious enough to affect the safety of the plant to the extent that the guidelines of 10 CFR Part 100 could be exceeded. The accident categories considered in selecting design-basis events include explosions, flammable vapor clouds (delayed ignition), toxic chemicals, fires, collisions with intake structure, liquid spills, and radiological hazards.

The COL applicant analyzed the postulated accidents at the following facility locations:

- Nearby transportation routes MD 2/4, the Chesapeake Bay navigable waterway, and DCPLNG pipeline

- Nearby chemical and fuel storage facilities (DCPLNG)

- Onsite chemical storage (CCNPP Units 1, 2, and 3)

In COL FSAR Revision 2, Section 2.2.3, the COL applicant stated that the Maryland Power Plant Research Program (PPRP), under Maryland Department of Natural Resources (MDNR) conducted an independent risk study to assess the risks associated with the expansion of the DCPLNG facility. On the basis of this study, the COL applicant concluded that the probability of

occurrence of a fatality from hazardous events associated with the existing DCPLNG facility of 2.3 x 10^{-9} per year would increase to 6.6 x 10^{-9} per year for the proposed expansion of the facility, with the probability of occurrence of physical damage to the CCNPP site estimated to be still lower. The COL applicant's quantitative assessment of overpressure hazards at the CCNPP Unit 3 site, due to the existing as well as expanded DCPLNG facility, is limited to estimates of fatalities of 2.3 x 10^{-9} and 6.6 x 10^{-9} per year, for existing and expanded operations, respectively (COL FSAR Section 2.2.3.1.) The probability of occurrence of physical damage to CCNPP Unit 3 is stated to be lower, without any quantification or supporting analysis. Therefore, in RAI 9, Question 02.02.03-1, the staff requested that the COL applicant provide a quantitative estimate and supporting analyses associated with the overpressure hazards to CCNPP Unit 3 due to the DCPLNG facility. In a November 11, 2008, response to RAI 9, Question 02.02.03-1, the COL applicant provided the information with modeled results and proposed revisions to the COL FSAR. The COL applicant demonstrated that the overpressure, jet fire, and flash fire safe distances are significantly less than the distance from the pipeline to the CCNPP Unit 3 site and, therefore, concluded that a flammable vapor cloud ignition or explosion from rupture in the DCPLNG pipeline would not adversely affect the operation of CCNPP Unit 3. The staff reviewed the applicant-referenced PPRP study, and performed confirmatory assessment of the impacts of proposed expanded DCPLNG facility On CCNPP Units 1 and 2, and concluded that the proposed expansion of the DCPLNG facility does not present undue hazard to the safe operation of the Calvert Cliffs facility. On the basis of the COL applicant's information and staff's independent confirmatory analysis, based on information presented in PPRP study and the COL applicant's November 11, 2008, response, the staff considers the COL applicant's analysis and conclusion acceptable. The staff has confirmed that COL FSAR, Revision 6, dated September 30, 2009, was revised as committed in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 9, Question 02.02.03-1 resolved.

Explosions

The COL applicant evaluated the accidents involving potential explosions from nearby highways, navigable waterways, or facilities to critical plant structures. Minimum safe distance not to exceed 6.89 kilo pascals (kPa) (1 psi) peak incident pressure is determined and presented in COL FSAR Table 2.2-8, "Explosion Event Analysis." The COL applicant stated that the RG 1.91, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants," Revision 1 methodology was used to determine the minimum safe distances. However, for the liquid chemicals stored (i.e., gasoline, toluene, etc) the COL applicant considered only the in-vessel confined vapor amount for potential for explosion, and the amount of vapor in the air was determined based on the equivalent of the upper flammability limit. The COL applicant stated that this conforms to the methodology in NUREG-1805, "Fire Dynamics Tools (FDT^s) Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program." The staff's determination of safe distance, which involved conservatively assuming the total amount of stored chemicals based on guidance in RG 1.91 gave different results. Therefore, in RAI 9, Question 02.02.03-3, the staff requested that the COL applicant provide the details of its approach and methodology. In an October 6, 2008, response to RAI 9, Question 02.02.03-3, the COL applicant provided the requested information. The staff reviewed the COL applicant's response, and determined that the COL applicant's approach and methodology were reasonable and the results and conclusions are acceptable as the analyses followed general guidance. Thus, the analyses presented in this section demonstrate that peak positive overpressure of 6.89 kPa (1 psi) will not be exceeded at any safety-related CCNPP Unit 3

structure for any of the postulated explosion event scenarios. Therefore, the staff considers RAI 9, Question 02.02.03-3 resolved.

Flammable Vapor Clouds (Delayed Ignition)

The COL applicant evaluated the chemicals to determine the possible effects of a flammable vapor cloud explosion. The COL applicant used the ALOHA model with wind speed of 1 m/s (3.28 ft/s), F stability, ambient temperature of 25 ˚C (77 °F), relative humidity of 50 percent, and cloud cover of 50 percent assuming that the entire chemical contents are spilled forming a 1 centimeter (cm) (0.39 inch (in.)) deep puddle. The staff requested that the COL applicant provide additional information to provide a sensitivity analysis to demonstrate that the assumed meteorological conditions were conservative. In addition, in RAI 9, Question 02.02.03-4, the staff requested that the COL applicant describe how it accounted for each of the total inventory (i.e., 2,400,000 kg (5,200,000 pounds (lbs)) of gasoline, benzene, and toluene in ALOHA modeling with 1 cm (0.39 in.) deep puddle when "the maximum allowable surface area of the spill that ALOHA would allow for was 31,400 m^2." In an August 10, 2009, response to RAI 9, Question 02.02.03-4, the COL applicant provided adequate information. The COL applicant has performed the vapor cloud explosion analysis to obtain minimum separation distances (i.e., safe distances) for the identified chemicals. With the exception of a postulated release from an onsite delivery gasoline tanker truck, the results indicate that the minimum separation distance not exceeding 6.89 kPa (1 psi) overpressure due to explosion are less than the shortest distance to a safety-related CCNPP Unit 3 structure from the potential location of chemical explosion. Therefore, the staff considers RAI 9, Question 02.02.03-4 resolved.

The results pertaining to analyses of the flammable vapor clouds are provided in COL FSAR Table 2.2-9, "Flammable Vapor Cloud Events (Delayed Ignition) and Vapor Cloud Explosion Analysis." With the exception of a postulated release from a gasoline tanker, the results indicate that the minimum safe distance for an explosion to have less than 6.89 kPa (1 psi) peak incident pressure is less than the shortest distance to a safety-related CCNPP Unit 3 structure from each facility considered. The minimum separation distance calculated for the 13,249 l (3,500 gal) delivery gasoline tank truck is 198 m (648 ft) which exceeded the distance to the nearest safety-related CCNPP Unit 3 structure of 94.5 m (310 ft). Therefore, as stated in COL FSAR Section 2.2.3.1.2, the COL applicant determined the probability of an accident occurring involving a gasoline refueling tanker truck to be 2.03×10^{-7} per year. However, the COL applicant did not provide a description of how the probability of the accident was calculated.. Therefore, in RAI 9, Question 02.02.03-5, the staff requested that the COL applicant provide the details such as accident frequency, release rate, and other assumed parameters used in estimating the probability. In a November 11, 2008, response to RAI 9, Question 02.02.03-5, the COL applicant provided adequate information. The staff also performed independent probability calculations by using Maryland State Highway Administration reported accident rate data involving large trucks for Calvert County, MD assuming 100 percent release, considering 12 deliveries per year. The staff calculated probability is comparable to the probability calculated by the applicant. Based on the staff's review of the information provided by the COL applicant and an independent confirmatory analysis, the staff determined that the COL applicant's evaluation is reasonable, and the conclusion that a flammable vapor cloud ignition or explosion involving the identified chemicals would not adversely affect the safe operation of CCNPP Unit 3 is acceptable. Therefore, the staff considers RAI 9, Question 02.02.03-5 resolved.

Toxic Chemicals

The COL applicant evaluated accidents involving the release of toxic chemicals to determine whether they have the possible effects on control room habitability that is being evaluated in Section 6.4, "Habitability Systems," of this report. The chemicals released from potential accidents having concentration in excess of Immediate Danger to Life and Health (IDLH) and which may not be screened out on the basis of accident probability less than $1x10^{-7}$ per year are identified and further evaluated in Section 6.4 of this report. The COL applicant used the ALOHA model with a wind speed of 1 m/sec (3.28 ft/sec), F stability, ambient temperature of 25 °C (77 °F), relative humidity of 50 percent, cloud cover of 50 percent, and conservative effective air exchange rate of 0.45 air changes per hour assuming that entire chemical content is spilled forming a 1 cm (0.39 in.) deep puddle. In RAI 9, Question 02.02.03-6, the staff requested that the COL applicant explain why different quantities of gasoline, benzene, toluene, and ammonia were analyzed for the potential to form flammable vapor cloud than for the toxic vapor concentration due to waterway (Chesapeake Bay) transport. The staff also requested that the COL applicant explain how the total inventory of each chemical was accounted for when considering the ALOHA model 31,400 m^2 (37,554 yd^2) spill surface area limitation, and how ALOHA model results with this limitation compared with the results with HABIT EXTRAN model. In a November 11, 2008, response to RAI 9, Question 02.02.03-6, the COL applicant provided adequate information. On the basis of the staff's review of the COL applicant's response, the staff determined that the COL applicant's approach is reasonable and acceptable as it conforms to the acceptance criteria provided in NUREG-0800, Section 2.2.3 and RG 1.78. Therefore, the staff considers RAI 9, Question 02.02.03-6 resolved.

The results pertaining to analyses of toxic chemicals are provided in COL FSAR Table 2.2-10, "Toxic Vapor Cloud Analysis." The ammonium hydroxide concentration due to a transportation accident on Maryland Routes 2/4 exceeded the immediate danger to life and health (IDLH) concentration at the control room air intake but is lower than the IDLH in the control room. The concentration of ammonia due to a waterway transportation accident exceeded the IDLH concentration at the control room air intake. However, based on there being only five waterway shipments of ammonia per year, this chemical is screened out based on guidance in RG 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release." Accordingly, with the exceptions of postulated releases from an ammonium hydroxide storage tank and a gasoline tanker truck, the results indicate that the maximum control room concentration of each toxic chemical is less than the IDLH concentration of respective chemical. The ammonium hydroxide concentration in the control room is estimated to be 704 parts per million (ppm) compared to the limiting IDLH concentration of 300 ppm. The gasoline concentration in the control room from a 13,249 l (3,500 gal) gasoline delivery tanker truck is estimated to be 343 ppm compared to the limiting IDLH concentration of 300 ppm. Therefore, the COL applicant performed a probabilistic analysis for these two chemicals. The probability of an accident occurring involving a gasoline delivery tanker truck was estimated as 2.66×10^{-7} per year. The probability of the ammonia hydroxide tank spill was estimated to be 5×10^{-7} per year. However, the COL applicant did not provide details regarding how these probabilities were determined. Therefore, in RAI 9, Question 02.02.03-7, the staff requested that the COL applicant provide details in determining these probabilities. In a November 11, 2008, response to RAI 9, Question 02.02.03-7, the COL applicant provided adequate information. The staff also performed independent probability calculations by using Maryland State Highway Administration reported accident rate data involving large trucks for Calvert County, Maryland assuming 100% release, considering 12 deliveries per year. The staff calculated probability is comparable to the probability calculated by the applicant. On the basis

of the staff's review of the information provided by the COL applicant for probability calculations, the staff determined that the COL applicant's approach is reasonable, and the conclusion is acceptable as it conforms to the acceptance criteria provided in NUREG-0800, Section 2.2.3. Among all the chemicals listed by the COL applicant chemicals given (COL FSAR Table 2.2-10), ammonium hydroxide (from truck transport), ammonium hydroxide (from water transport), ammonium hydroxide (from onsite storage), gasoline (from delivery tanker truck onsite) exceeded IDLH concentration outside the control room, but the probability of the accidents for the release of these chemicals is determined to be less than the acceptable criteria of 1×10^{-6} per year. Therefore, these are not further evaluated in Section 6.4 of this report for control room habitability.

The staff's confirmatory analysis showed that accidents involving sodium hypochlorite and hydrochloric acid could also result in concentrations higher than respective IDLH concentrations at the control room air intake, as well as inside the control room. Therefore, in RAI 146, Question 02.02.03-8, the staff requested that the COL applicant clarify the assumptions and methodology used in modeling these chemicals by providing the model inputs used. In an October 15, 2009, response to RAI 146, Question 02.02.03-8, the COL applicant provided adequate information with proposed changes to COL FSAR, Section 2.2.3.1.3. The staff reviewed the response and noted that the hydrochloric acid concentration of 52.9 parts per million (ppm) outside the control room exceeded the IDLH concentration of 50 ppm, and sodium hypochlorite concentration would be below the IDLH value outside the control room. On the basis of the staff's review of the COL applicant's response, the staff concluded that of the additional two chemicals staff identified, only hydrochloric acid has the potential to exceed the IDLH concentration inside the control room and, therefore, this chemical is further evaluated for the control room habitability in Section 6.4 of this report. The staff has confirmed that COL FSAR, Revision 6, dated September 30, 2009, was revised as committed in the RAI response. Accordingly, the staff finds that the COL applicant has adequately addressed this issue and, therefore, the staff considers RAI 146, Question 02.02.03-8 resolved.

The staff evaluated the information pertaining to toxic chemicals from onsite and offsite stationary and mobile sources identified by the COL applicant in COL FSAR Section 2.2.1-2.2.2 and addressed in COL FSAR Section 2.2.3, for the COL applicant's analysis of control room habitability in COL FSAR Section 6.4.

The staff reviewed the COL applicant's inventory of chemicals from the above sources, and screening out of toxic chemicals that do not pose a threat to control room habitability. Based on evaluation of the information presented in the above sections of the COL application, confirmatory analyses, and review of the responses to the RAIs, the staff determines if any additional toxic chemicals need to be evaluated further in Section 6.4 of this report along with the COL applicant's identified (COL FSAR Table 2.2-10) list of toxic chemicals for control room habitability.

The additional chemical hydrochloric acid identified in this section is evaluated further in Section 6.4 of this report for control room habitability.

Fires

The COL applicant has evaluated the potential for fires at adjacent to industrial plants and storage facilities, and oil and gas pipelines; brush and forest fires; and fires from transportation accidents that could lead to high heat fluxes or to form vapor clouds and concluded that the impact from such fires would not affect the safe operation of the nuclear plant. Based on the

staff's review of the COL FSAR information, quantitative risk numbers, cleared area from the plant, and safe distances to structures from potential fire breaks, the staff considers the COL applicant's conclusion is reasonable and acceptable.

Collisions with Intake Structure

Because the CCNPP site is located on a navigable waterway, the COL applicant has performed an evaluation to address the potential effects of impact on the plant cooling water intake structure and enclosed pumps. The COL applicant concluded by saying that the location of the safety-related ultimate heat sink makeup water intake structure for CCNPP Unit 3 is well protected, and the depth of the intake channel in the vicinity of the intake structure is sufficiently shallow that any vessel of significant size would run aground before it could impact the intake structure. Therefore, the safety-related ultimate heat sink makeup intake structure will not result in severe consequences. This qualitative argument demonstrates that the probability of this external hazard to be less than 1E-06 per year. The staff considers this acceptable.

Liquid Spills

The CCNPP Unit 3 circulating water intake pumps draw water from a submerged concrete structure -6.25 m (-20.5 ft) mean sea level (msl), and the chemicals spilled generally will float and would not be drawn into the intake system. The COL applicant stated that among the chemicals identified in its assessment, asphalt and sulfuric acid would not float. The COL applicant stated that in the unlikely event of an asphalt spill, the asphalt would solidify in the waterway and would be removed by the bar screen or traveling screen in the intake structure system. The COL applicant stated that sulfuric acid would be diluted in the Chesapeake Bay and, with the intake structure set back from the shore, most of the acid would travel past the intake structure. The staff finds that these are reasonable qualitative arguments which demonstrate that the realistic probability of these external hazards resulting in a radiological dose in excess of 10 CFR 50.34(a)(1) is less than 10^{-6} occurrences per year, in accordance with the acceptance criteria in NUREG-0800, Section 2.2.3.

Radiological Hazards

The COL applicant stated that the release of radioactive material from CCNPP Units 1 and 2 due to normal operations or an unanticipated event would not threaten the safety of the plant or personnel at CCNPP Unit 3. As justification for this conclusion, the COL applicant described design features of the proposed CCNPP Unit 3 that will reduce the realistic probability that radiological hazards will result in a radiological dose from accidents at the proposed CCNPP Unit 3 in excess of 10 CFR 50.34(a)(1) to less than 10^{-6} occurrences per year. These are: (1) The control room habitability system for CCNPP Unit 3; and (2) safety-related structures, systems, and components that have been designed to withstand the effects of radiological events. The staff finds that these are reasonable qualitative arguments which demonstrate that the realistic probability of these external hazards resulting in a radiological dose in excess of 10 CFR 50.34(a)(1) is less than 10^{-6} occurrences per year, in accordance with the acceptance criteria in NUREG-0800, Section 2.2.3.

2.2.3.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.2.3.6 *Conclusions*

The staff reviewed the COL application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the COL applicant addressed the required information relating to evaluation of potential accidents, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the evaluation of potential accidents incorporated by reference in the COL FSAR has been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update Section 2.2.3 of this report to reflect the final disposition of the design certification application.

As set forth above, the COL 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, has appropriately determined those that should be considered as 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 design-basis accidents. The staff has reviewed the information provided and, for the reasons specified above, concludes that the COL 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 to meet the requirements of 10 CFR 52.79(a)(1)(iv), 10 CFR 52.79(a)(1)(vi), and 10 CFR 100.20(b) for compliance with respect to determining the acceptability of the site.

In conclusion, the COL applicant has provided sufficient information for satisfying the applicable regulatory requirements.

2.3 Meteorology

To ensure that a nuclear power plant or plants can be designed, constructed, and operated on an applicant's proposed site in compliance with NRC regulations, the 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 also reviews the COL applicant's onsite meteorological monitoring program and 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 NRC guidelines.

The staff prepared Sections 2.3.1 through 2.3.5 of this report in accordance with the review procedures described in NUREG-0800, using information presented in COL FSAR Section 2.3, responses to staff RAIs pertaining to earlier revisions of the COL FSAR, as specified in each section below, and generally available reference materials (e.g., as cited in applicable sections of NUREG-0800).

U.S. EPR FSAR Tier 2, Section 2, "Site Characteristics," states that a COL applicant that references the U.S. EPR design certification will compare site-specific data to the design parameter data in U.S. EPR FSAR Table 2.1-1. If the specific data for the site falls within the assumed design parameter data and characteristics in U.S. EPR FSAR Table 2.1-1, then the

U.S. EPR standard design is bounding for the site. For site-specific design parameter data or characteristics that are outside the bounds of the assumptions presented in U.S. FSAR Table 2.1-1, the COL applicant will confirm that the U.S. EPR design acceptably meets any additional requirements that may be imposed by the more limited site-specific design parameter data or characteristic, and that the design maintains conformance to the design commitments and acceptance criteria described in the U.S. EPR FSAR (COL Information Item No. 2.0-1 in U.S. EPR FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items"). The staff's assessment of this COL information item can be found in Sections 2.3.1, 2.3.4, and 2.3.5 of this report.

U.S. EPR FSAR Tier 2, Section 2.3, "Meteorology," states that if a COL applicant that references the U.S. EPR design certification identifies site-specific meteorology values outside the range of the design parameters in U.S. EPR FSAR Tier 2, Table 2.1-1, then the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of the Combined License application (COL Information Item No. 2.3-1 in U.S. EPR FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items"). The staff's assessment of this COL information item can be found in Sections 2.3.1, 2.3.4, and 2.3.5 of this report.

2.3.1 Regional Climatology

2.3.1.1 *Introduction*

COL FSAR Section 2.3.1, "Regional Climatology," addresses observed averages and measured and probabilistic extremes of climatic conditions and regional meteorological phenomena that could affect the safe design and siting of the plant, including information describing the general climate of the region, severe weather phenomena, meteorological data for evaluation of the ultimate heat sink (UHS), and other climatological conditions to be used for design- and operating-basis considerations.

2.3.1.2 *Summary of Application*

COL FSAR Section 2.3 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.3.1, "Regional Climatology."

In addition, in COL FSAR Section 2.3.1, the COL applicant provided the following:

Combined License Information Items

COL Information Item No. 2.3-2

The COL applicant provided additional information in COL FSAR Section 2.3.1.1, "Basis for Meteorological Parameters," to address COL Information Item No. 2.3-2 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will provide site-specific characteristics for regional climatology.

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

- Data sources used to characterize the regional climatological conditions pertinent to the proposed site

- A description of 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 wind, tornadoes, tropical cyclones, precipitation extremes, winter precipitation (snowstorms, and ice storms), hail, and thunderstorms (including lightning)
- Meteorological conditions for evaluating the UHS
- A description of design-basis dry- and wet-bulb temperatures for the proposed site
- The potentiality for restrictive air dispersion conditions and high air pollution at the proposed site

COL Information Item No. 2.3-10

The COL applicant provided additional information in COL FSAR Section 2.3.1.2, "Meteorological Data for Evaluating the Ultimate Heat Sink," to address COL Information Item No. 2.3-10 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will describe the means for providing UHS makeup sufficient to meet the maximum evaporative and drift water loss after 72 hours through the remainder of the 30-day period consistent with RG 1.27

The COL applicant stated that this COL information item is addressed in COL FSAR Section 2.3.1.2.2.13, "Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink."

Also related to COL FSAR Section 2.3.1 is:

COL Information Item No. 2.3-1

The COL applicant provided additional information in COL FSAR Section 2.3 to address COL Information Item No. 2.3-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> If a COL applicant that references the U.S. EPR design certification identifies site-specific meteorology values outside the range of the design parameters in Table 2.1-1, then the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of the COL application.

To address this COL information item, the COL applicant stated:

> The Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 site-specific meteorology values have been reviewed and compared to determine if they are within the bounds of the assumed meteorology values for a U.S. EPR. This comparison is provided in Table 2.0-1. The CCNPP Unit 3 site-specific meteorology

parameters are within the bounds of the conservative limiting meteorology values presented in Table 2.0-1.

COL FSAR Section 2.3.1 includes additional supplemental information on air quality and severe weather phenomena, such as tornadoes, hurricanes, thunderstorms, lightning, droughts, high winds, hail, snow and ice storms, high air pollution, and snow/loads on roofs of safety-related structures.

2.3.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for regional climatology, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.3.1, "Regional Climatology."

The applicable regulatory requirements for regional climatology are as follows:

1. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Section 52.79(a)(1)(iii), "Contents of applications; technical information in final safety analysis report," 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 sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

2. 10 CFR Part 100, "Reactor Site Criteria," Sections 100.20(c)(2) and 100.21(d) with respect to the consideration specified to the regional meteorological characteristics of the site.

The related regulatory guidance is as follows:

1. RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," Revision 2, January 1976, which provides criteria for selecting the UHS meteorological data that would result in the maximum evaporation and drift loss of water and minimum water cooling.

2. RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1, March 2007, which provides criteria for selecting the design-basis tornado parameters.

RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," June 2007, which describes the type of regional meteorological data that should be presented in FSAR Section 2.3.1.Subsequent to SRP Section 2.3.1, the staff issued Interim Staff Guidance (ISG) DC/COL-ISG-7, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures," (74 *Federal Register* (FR) 31470) 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.

2.3.1.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 2.3.1 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 2.3.1 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to regional climatology has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

The staff relied upon the review guidance presented in SRP Section 2.3.1, and the regulatory guides referred to in the preceding section, to independently assess the technical sufficiency of the information presented by the COL applicant.

The climate-related topics evaluated in this report section, for the most part, are organized in the same sequence that they were presented in COL FSAR Section 2.3.1. However, section numbering is consistent with the organization of this report.

Combined License Information Items

COL Information Item No. 2.3-1

The staff reviewed COL Information Item No. 2.3-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.3. The staff notes that, contrary to the COL applicant's assertion that the CCNPP Unit 3 site-specific meteorological parameters are within the bounds of the corresponding site parameters presented in COL FSAR Table 2.0-1, there is one site-specific air temperature site characteristic value (0 percent exceedance maximum non-coincident wet bulb temperature of 29.2 °C (85 °F)) that is not within the bounds of the corresponding site parameter value presented in U.S. EPR FSAR Table 2.1-1. This departure regarding the UHS design temperature value is not addressed in Part 7 of the COL application. Therefore, in RAI 250, Question 02.03.01-34, the staff requested that the COL applicant revise COL FSAR Section 2.3 to incorporate a revised response to COL Information Item No. 2.3-1, and revise Part 7 of the COL application to address the additional departure.

In an August 19, 2010, response to RAI 250, Question 02.03.01-34, the COL applicant provided proposed revisions to: COL FSAR Section 1.8.2, "Departures"; COL FSAR Table 2.0-1, "U.S. EPR Site Design Envelope Comparison"; COL FSAR Section 2.3, "Meteorology"; COL FSAR Section 9.2.1, "Essential Service Water System"; and COLA Part 7, "Departures and Exemption Requests," Sections 1.1 and 1.1.9. In the proposed revisions, the departure from the UHS design temperature site parameter is addressed. Therefore, that portion of RAI 250, Question 02.03.01-34 pertaining to the identification of a departure from the UHS temperature site parameters is resolved. The staff's evaluation of the acceptability of the departure is provided in Section 9.2 of this report.

COL Information Item No. 2.3-2

The staff reviewed COL Information Item No. 2.3-2 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.3.1.1. The staff's review of the COL applicant's response to this COL information item is documented in the remaining portion of Section 2.3.1.4 of this report.

COL Information Item No. 2.3-10

The staff reviewed COL Information Item No. 2.3-10 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.3.1.2. The staff's evaluation of the COL applicant's response to this COL information item is documented in Section 2.3.1.4.3.13 of this report.

2.3.1.4.1 Basis for Meteorological Parameters

In COL FSAR Section 2.3.1.1, the COL applicant described the general climate of the CCNPP Unit 3 site region in terms of air masses and synoptic features, winds, storm tracks, temperatures, and precipitation patterns, and the influence of major topographic features. The discussion was based on a narrative description of Maryland's climate from the Office of the Maryland State Climatologist (OMSC).

The staff compared the COL applicant's description of the general climate of the CCNPP Unit 3 site region and area to the description provided by the OMSC and to historical temperature and precipitation (rainfall and snowfall) summaries available through the Southeast Regional Climate Center (SERCC). The staff has also verified, based on information from the National Weather Service Climate Prediction Center, that the CCNPP Unit 3 site is located in Maryland Climate Division 18-03. The staff finds that the COL applicant's description of the general climate is based on standard climatic summaries as described in the first acceptance criteria of NUREG-0800, Section 2.3.1, "Standard Review Plan for the Review of the Safety Analysis Reports for Nuclear Power Plants: LWR Edition," and, therefore, finds this description acceptable.

2.3.1.4.2 Regional Air Quality

The COL applicant's description of regional air quality provides information on the air quality conditions in the site region but does not result in the generation of site characteristics for use as design or operating bases.

In COL FSAR Section 2.3.1.2.1, "Regional Air Quality," the COL applicant stated that Calvert County, MD, is part of the Southern Maryland Intrastate Air Quality Control Region (AQCR). The staff verified that to be the case as specified in the regulations under 40 CFR Part 81, "Designation of Areas for Air Quality Planning Purposes," in particular at 40 CFR 81.156 (as cited by the COL applicant).

The COL applicant also stated that as of December 5, 2006, Calvert County was in attainment for all the National Ambient Air Quality Standards (NAAQS), except for the 8-hour ozone standard. The staff evaluated regional air quality in the context of the potential for high air pollution, which is addressed below in Section 2.3.1.4.3.11 of this report.

2.3.1.4.3 Severe Weather Phenomena

The staff's evaluation of the COL applicant's description of severe weather phenomena is provided in the following subsections. As described further in each subsection below, for each severe weather phenomena, the staff evaluated whether the COL applicant provided data on severe weather phenomena based on standard meteorological records from nearby representative National Weather Stations (NWS), military, or other stations recognized as standard installations that have long periods of data on record, as described in the second acceptance criteria of NUREG-0800, Section 2.3.1."

2.3.1.4.3.1 *Tornadoes and Waterspouts*

The COL applicant's description of regional tornadoes and waterspouts provides information on these severe weather phenomena in the site region but does not result in the generation of site characteristics for use as design or operating bases. The staff's evaluation of design basis tornado site characteristics is provided in Section 2.3.1.4.3.14 of this report.

In COL FSAR, Revision 0, Section 2.3.1.2.2.1, "Tornadoes and Waterspouts,", the COL applicant stated that 12 tornadoes were reported in Calvert County, MD, between January 1, 1950, and December 31, 2006. The COL applicant compiled this information from data available through the National Climatic Data Center (NCDC). The COL applicant also stated, based on a methodology attributed to a study in the Journal of Weather and Forecasting (published by the American Meteorological Society (AMS)), that late July is the date of maximum tornado threat for the part of Maryland that includes the CCNPP Unit 3 site.

The staff reviewed COL FSAR, Revision 0, and in RAI 5, Question 02.03.01-1, the staff requested that the COL applicant provide the addition of a reference to COL FSAR Section 2.3.1.2.2.1, supporting the COL applicant's statements that about 25 percent of the total number of tornadoes in Maryland occur in Southern Maryland and that approximately 70 percent of the tornadoes occur between 2:00 p.m. and 9:00 p.m. with most occurring from 3:00 p.m. to 6:00 p.m. The COL applicant provided the requested citation in COL FSAR, Revision 3. Therefore, RAI 5, Question 02.03.01-1 is resolved.

The COL applicant also stated that no waterspouts were reported in Calvert County, MD, between January 1, 1950, and December 31, 2006. The staff agrees that the occurrence of waterspouts in the Chesapeake Bay area is an infrequent event. However, the staff notes that the 57-year period of record (POR) cited by the COL applicant is incorrect. The COL applicant cites the NCDC on-line "Storm Events" database as the source, and for this weather element (i.e., waterspouts), as well as a number of others, the "Storm Events" database is not currently populated with observations prior to 1993, although the output header from queries for these severe weather events indicates (incorrectly) that the POR extends from January 1, 1950, to date.

The staff evaluated the COL applicant's statements of the number and intensity of tornados and waterspouts that have occurred in the region by searching the NCDC Storm Events database over a geographic area which included six nearby counties in Maryland (St. Mary's, Charles, Prince George's, Anne Arundel, Talbot, and Dorchester). The staff determined that data from adjacent counties is comparable to the Calvert County data with respect to the range of tornado intensity and frequency. With regard to waterspouts, the staff determined that there were three waterspout events recorded in the Storm Events database for the counties of Anne Arundel (January 1999), Talbot (July 2000), and Dorchester (August 1999). However, the staff

determined that the intensity of these events (which either didn't come ashore or resulted in minor property damage) does not warrant generation of site characteristics for use in establishing design or operating bases for the facility beyond those specified in RG 1.76 (see Section 2.3.1.4.3.14 of this report). Therefore, the staff finds the COL applicant's description of tornado and waterspout events in the region to be acceptable.

2.3.1.4.3.2 *Tropical Cyclones*

The COL applicant's description of regional tropical cyclones provides information on the various storm classifications referred to as tropical cyclones that affect the site region. This information provides context for evaluating the site characteristic wind loads on safety-related structures (discussed further in Section 2.3.1.4.3.15 of this report).

This information also provides some context for extreme rainfall amounts that are discussed from a design-basis standpoint in COL FSAR Section 2.4.2, "Floods," and, in a more general sense, on the relationships between synoptic-scale processes and meteorological conditions in the site area in conformance with RG 1.206 (Section C.I.2.3.1.1 and Section C.I.2.3.2.1, Item 3) and SRP Section 2.3.1, Section I (Areas of Review), Item 1.

In COL FSAR, Revision 3, Section 2.3.1.2.2.2, "Hurricanes," the COL applicant stated (based on information from the National Hurricane Center) that hurricanes rarely pass entirely over the CCNPP Unit 3 area, indicating that only two direct hits on Maryland occurred between 1851 and 2004. The staff finds this acceptable based on its review of data available on line from the National Oceanographic and Atmospheric Administration – Coastal Services Center (NOAA-CSC). In COL FSAR, Revision 3, Table 2.3-2, "Total and Average Numbers of Tropical Storms and Hurricanes," the COL applicant presented statistics on the total and average monthly frequencies of occurrence of hurricanes and tropical storms in the United States, indicating that these types of storms occur most often in September.

The COL applicant also provided information on the frequencies of occurrence of different intensity hurricanes. COL FSAR Section 2.3.1.2.2.2 also stated that hurricanes within this area have occurred during the months of August, September, and October, and that tropical storms were recorded in all months from July through October.

In RAI 5, Question 02.03.01-2, which pertained to Revision 3 of the COL FSAR, the staff requested that the COL applicant provide additional information regarding the various tropical cyclone classifications, and measured or estimated precipitation amounts associated with some of these storms. The questions pertained to:

- The number of tropical cyclones the COL applicant estimated using the NOAA-CSC database. The staff requested an explanation of how the values were determined, and noted that the NOAA-CSC database lists the same storm multiple times if it falls within the selected radius on multiple days.

- The number of subtropical storms passing within 185 km (100 nautical mi) of Calvert County from 1851 through 2005.

- The precipitation estimates from the remnants of Tropical Storms Ernesto, Bill, and Allison.

- Why the remnants of Tropical Storms Ernesto, Bill, and Allison were used to describe precipitation from tropical systems in Calvert County, but other more severe storms, such as the remnants of Hurricane Floyd, were not.

In an October 30, 2008, response to RAI 5, Question 02.03.01-2, the COL applicant provided revised estimates of the number of hurricanes and tropical storms queried from the NOAA-CSC database, extending the POR to include 2006; changed the area evaluated from a radius of 185 km (100 nautical mi) to 161 km (100 statute mi); corrected the previous double counting of storms with multiple classifications as they passed through the revised radial area (and in those cases assigning the more intense storm classification); declined to provide a count of subtropical storms on the basis that the applicable regulatory guidance did not require such information; deleted the previously reported frequencies of extra-tropical storms, tropical depressions, and subtropical depressions; and stated that rainfall amounts for Calvert County, MD, were not included in the NCDC "Storm Events" database for the remnants of Hurricane Floyd and were, therefore, unavailable for inclusion in the COL FSAR.

The staff reviewed the response to RAI 5, Question 02.03.01-2 and determined that the RAI is resolved but had a number of follow-up questions that remained unresolved. To address these questions, the staff issued follow-up RAI 141, Questions 02.03.01-14, 02.03.01-15, and 02.03.01-16.

The staff issued RAI 141, Question 02.03.01-14, which included the following observations regarding the COL applicant's proposed revisions to Paragraph 3 of COL FSAR Section 2.3.1.2.2.2:

- The COL applicant's consideration of tropical cyclone events was limited to those events that were classified as hurricanes or tropical storms. The staff believes that not considering tropical cyclone events just below the tropical storm wind speed criterion may result in understating high wind and rainfall potential.

- The COL applicant's use of the NOAA-CSC historical hurricane tracks online database was not consistent and appeared to have resulted in an undercounting of events.

The staff noted that extreme wind and/or precipitation (rainfall) events in the site area were not fully considered by the COL applicant, because certain tropical cyclone events, other than those classified as hurricanes or tropical storms were excluded from consideration.

The staff independently confirmed the tropical cyclone counts in Tables 1 and 2 of the COL applicant's response to RAI 5, Question 02.03.01-2, by querying by place name (Calvert County) in the NOAA-CSC database. However, regarding Table 3 of that response, the staff's query resulted in 28 events (64 line entries), whereas Table 3 lists only 19 of those events (39 line entries). The staff believes that Hurricane Floyd; Tropical Storms Cindy and Camille; Tropical Depressions Beryl and Dennis; Extra-Tropical Storms Hazel, Danny, and Charley; and, Subtropical Depression Allison should also be considered by the COL applicant in its analysis.

Therefore, in RAI 141, Question 02.03.01-14, the staff requested that the COL applicant update COL FSAR Section 2.3.1.2.2.2 and/or any related table(s) to either:

- Provide the rationale for excluding the nine additional events identified by the staff in its query to verify the contents of Table 3 of the COL applicant's response or

- Confirm the frequency of tropical cyclone occurrences within 161 km (100 statute mi) of Calvert County for the period of record 1950 to date as reported in Table 3 of the response using a consistent query type as was used in Tables 1 and 2 of the response and the staff's independent confirmation.

If the latter was the case, the staff requested the COL applicant to determine whether any new information changes the assessment of the design or siting of the plant considering extreme climatic conditions and regional meteorological phenomena.

In a September 30, 2009, response to RAI 141, Question 02.03.01-14, the COL applicant committed to update the COL FSAR with its revised assessment of the number of tropical storms during the period from 1952 through 2006, which includes nine additional storms cited by the staff in RAI 141, Question 02.03.01-14. The COL applicant also concluded that the updated information did not change its assessment of the design or siting of the plant. The staff finds this acceptable because the COL applicant's description will provide data on severe weather phenomena based on standard records over a long period of record. **RAI 141, Question 02.03.01-14 is being tracked as a confirmatory item**.

In RAI 141, Question 02.03.01-15, the staff requested that the COL applicant address the absence of a discussion of extreme wind conditions associated with tropical cyclone events that have occurred within 161 km (100 statute mi) of Calvert County, MD. The staff noted, for example, that some tropical cyclone-related wind speeds appear to have exceeded the site characteristic 3-second gust wind speeds.

The staff independently identified several tropical cyclone events that have occurred within 161 km (100 statute mi) of Calvert County, MD, over the 156-year POR (1851 through 2006) queried from the NOAA-CSC online database. These events include three unnamed hurricanes (Category 3 - in August 1879, Category 2 - in October 1878, and Category 1 - in October 1893) and a then-downgraded extra-tropical cyclone in October 1954 (formerly Hurricane Hazel, at times classified as a Category 4 and Category 3 storm). The maximum sustained wind speeds associated with these events are reported as 185 km/hr (115 mph, or 100 knots), 167 km/hr (104 mph, or 90 knots), 148 km/hr (92 mph, or 80 knots), and 148 km/hr (92 mph, or 80 knots), respectively, and likely have 3-second gust wind speeds greater than the site characteristic values of 160.93 km/hr (101.65 mph) for the 100-year return period 3-second gust, as stated in COL FSAR, Revision 3, Section 2.3.1.2.2.15, "100 Year Return Period 3 Second Wind Gust,", and 153 km/hr (95 mph) for the 50-year return period 3-second gust, as stated in Revision 3 of COL FSAR, Revision 3, Section 2.3.1.2.2.15, and COL FSAR Table 2.0-1, "U.S. EPR Site Design Envelope Comparison."

The staff notes that the hurricane with the highest sustained wind speed appears to have occurred on the perimeter of the 161 km (100 statute mi) radial area and need not be considered further as it did not make landfall within this radial area. However, the hurricane with the second highest sustained wind (167 km/hr (104 mph, or 90 knots)) was over land during its entire traverse of this radial area and its track was within about 64.4 km (40 mi) of the CCNPP Unit 3 site. NOAA defines "maximum sustained wind" as a one minute averaging time and states that the value of the maximum 3-second gust over a one-minute period is on the order of 1.3 times (i.e., 104 mph sustained wind = 135 mph 3-second gust). The staff further notes that an observed gust of 204 km/hr (127 mph, or 110 kilotons) was reported in the NCDC's International Station Meteorological Climate Summaries for the Patuxent River NAS in October 1954.

Therefore, in RAI 141, Question 02.03.01-15, the staff requested that the COL applicant update COL FSAR Section 2.3.1.2.2.2, Section 2.3.1.2.2.15, and COL FSAR Table 2.0-1 to either:

- Provide the rationale for excluding extreme wind speed events associated with the passage of tropical cyclones in the site area; or
- Determine the controlling site characteristic 3-second gust wind speed for the site and surrounding area by also taking into consideration extreme wind speed events associated with the passage of tropical cyclones in the site area and evaluating whether the magnitude of such events changes the assessment of the design or siting of the plant considering extreme climatic conditions and regional meteorological phenomena.

If the latter were the case, and a 3-second gust wind speed is estimated from a maximum reported sustained wind speed (e.g., from the NOAA-CSC database), the COL applicant was requested to explain the method used to determine the estimated value.

In a September 30, 2009, response to RAI 141, Question 02.03.01-15, the COL applicant explained that the basic wind speeds provided in American Society of Concrete Engineers (ASCE) 7-05, "Minimum Design Loads for Buildings and Other Structures," Figure 6-1, include the results of an analysis of hurricane wind speeds. The COL applicant also justified use of ASCE 7-05 on the basis that acceptance criteria in NUREG-0800, Section 2.3.1.I.6.d states that the 100-year return period (straight line) 3-second gust wind speed is an acceptable basis for establishing wind loading on plant structures. Also, NUREG-0800, Section II, Acceptance Criteria 4 states that the basic (straight line) 100-year return period 3-second gust wind speed should be based on appropriate standards, with suitable corrections for local conditions. The staff agrees that since ASCE 7-05 considers the results of an analysis of hurricane winds, and the historical sustained winds of storms in the vicinity area are only marginally higher than the applicable ASCE 7-05 3-second gust, which is used as the site characteristic non-tornado wind speed, the ASCE 7-05 3-second gust wind speed is an acceptable basis for establishing wind loading on plant structures at the Calvert Cliffs site. The staff also notes that since the non-tornado winds are bounded by the 200 mph maximum tornado wind speed site characteristic value, these non-tornado wind speeds do not represent a threat to the integrity of any CCNPP structures, systems, and components (SSCs). The COL applicant committed to update the COL FSAR with additional text in Section 2.3.1.2.2.15 which explains that ASCE 7-05, Figure 6.1 includes the results of an analysis of hurricane winds. **RAI 141, Question 02.03.01-15 is being tracked as a confirmatory item**.

The staff also evaluated COL FSAR, Revision 3, Section 2.3.1.2.2.2, Paragraph 4, and Paragraphs 6 and 7 of the COL applicant's response to RAI 5, Question 02.03.01-2 with respect to rainfall totals associated with the passage of tropical cyclones within 100 statute mi of Calvert County, MD. The staff evaluated whether the COL applicant understated the rainfall totals in COL FSAR, Revision 3, Section 2.3.1.2.2.2, and the number of tropical cyclone events that produced extreme amounts of rainfall in the site area. This is because for this weather element (i.e. rainfall), as for several other weather elements, the "Storm Events" database is not currently populated with observations prior to 1993, although the output header from queries for these severe weather events indicates (incorrectly) that the POR extends from January 1, 1950, to date.

However, other NCDC records indicate that significant rainfall events, associated with the passage of tropical cyclones, have been recorded in the site area prior to the earliest date available through the "Storm Events" database. In addition, the staff believes that the area

queried from the database (i.e., Calvert County) does not reasonably represent a regional characterization of this type of event for the purpose of identifying extreme rainfall amounts that may be expected to occur at or affect the site.

Based on the NCDC's TD3200/3210 (Surface Summary of the Day) data files and information available online from the SERCC for the State of Maryland, the staff independently identified several significant and/or record 24-hour rainfall totals at observing stations within 40 km (25 mi) of the site that were not identified in COL FSAR, Revision 3, Section 2.3.1.2.2.2, or elsewhere in COL FSAR Section 2.3, "Meteorology." These extreme rainfall events occurred as a result of tropical cyclones passing both within and beyond the 161 km (100 statute mi) radius around Calvert County, MD, and include:

- For tropical cyclones within 161 km (100 statute mi), several historical 24-hour record totals at nearby cooperative observing stations – 21.8 cm (8.60 in.) at the Blackwater Refuge and 18.9 cm (7.43 in.) at the Prince Frederick 1 N stations due to Tropical Storm Connie; 20.6 cm (8.10 in.) at the Mechanicsville 5 NE station due to then Extra-Tropical Cyclone Ernesto; and 20.1 cm (7.90 in.) at the Royal Oak 2 SSW station due to Hurricane Floyd

- For tropical cyclones beyond 161 km (100 statute mi), several significant 24-hour totals at nearby cooperative stations, including 26.2 cm (10.30 in.) at the Cambridge Water Treatment Plant (station record) and 18.8 cm (7.40 in.) at the Solomons station (second highest for that location) due to an unnamed Category 1 hurricane and tropical cyclone.

Therefore, in RAI 141, Question 02.03.01-16, the staff requested that the COL applicant update COL FSAR Section 2.3.1.2.2.2 to either:

- Provide the rationale for excluding extreme rainfall events that occurred prior to 1993 and/or that are associated with tropical cyclone tracks farther than 161 km (100 statute mi) from Calvert County, MD.

- Identify historical tropical cyclone-related extreme rainfall events that have occurred in the site area, regardless of a storm's track within or beyond 161 km (100 statute mi) of Calvert County, MD, using data sources that cover longer PORs.

If the latter, the staff requested that the COL applicant expand the data resources evaluated beyond the limited "Storm Events" database by considering, among others: The NCDC Daily Surface Data (TD3200/3210) listings (Reference 17 in SRP Section 2.3.1); the NCDC Climatography of the United States No. 20 (noting that the highest daily total rainfall is limited to a specified station's available digital record); the SERCC Historical Climate Summaries for Maryland; and the NCDC monthly publication "Storm Data," predecessor to the on-line "Storm Events" database, which provides narrative coverage of severe weather events back to January 1959 (Reference 8 in SRP Section 2.3.1).

The staff also requested that the COL applicant expand the area used to determine whether a tropical cyclone-related extreme rainfall event may be reasonably expected to occur at the CCNPP Unit 3 site (in conformance with RG 1.206, Section C.I.2.3.2.1, which calls for "long-term data from nearby reasonably representative locations (e.g., within 50 mi (80 km)" to be considered), or to justify an alternative size area for the selection of reasonably representative locations for obtaining data.

In a September 30, 2009, response to RAI 141, Question 02.03.01-16, the COL applicant included historical tropic cyclone-related extreme rainfall events that have occurred in the site area, using data sources identified by the staff. In so doing, the COL applicant identified 16 locations over a period from September 1935 through September 2006, which received from 11.7 cm (4.6 in.) to 26.2 cm (10.3 in.) of rainfall as a result of tropical cyclone-related events. The COL applicant committed to adding a table of these events, descriptive text, and associated references to the COL FSAR. The staff finds this acceptable, because the COL applicant's revised description will provide data on severe weather phenomena based on standard records over a long period of record from reasonably representative locations. **RAI 141, Question 02.03.01-16 is being tracked as a confirmatory item**.

The staff finds that the COL applicant's description of the annual frequencies and intensities of regional tropical cyclones is based on nearby representative stations based on a long periods of record, and, therefore, represents site conditions during the expected period of reactor operations. The staff finds this description acceptable, contingent upon resolution of the confirmatory items described above.

2.3.1.4.3.3 *Thunderstorms*

The COL applicant's description of regional thunderstorms provides information on this severe weather phenomenon in the site region but does not result in the generation of site characteristics for use as design or operating bases.

In COL FSAR, Revision 3, Section 2.3.1.2.2.3, "Thunderstorms," the COL applicant stated that thunderstorms are reported at any specified station in the vicinity of Calvert County, MD, on an average of 30 to 40 days per year with the majority (75 percent to 80 percent) occurring from May through August, most likely during the afternoon and evening hours. Consistent with NUREG-0800, Section 2.3.1, the COL applicant compiled this information from the NCDC's 2002 Local Climatological Data (LCD) Annual Summary with Comparative Data for the first-order NWS stations at Baltimore, Maryland, and at Norfolk and Richmond, VA.

Using both 2002 and 2006 LCD summaries for these NWS stations, the staff determined that thunderstorms occur, on average, about 27 to 36 days per year, which is essentially the same as the range of values reported in COL FSAR Table 2.3-3, "Monthly Mean Number of Days with Thunderstorms." These LCDs also show that the majority of thunderstorms do occur in May through August although, again, at a slightly lower frequency than indicated in COL FSAR Section 2.3.1.2.2.3.

Therefore, in RAI 5, Question 02.03.01-3, the staff requested that the COL applicant provide an explanation of how the COL applicant determined the frequency of thunderstorms from May through August. In a July 28, 2008, response to RAI 5, Question 02.03.01-3, the COL applicant provided a reference to the NCDC publication, "Climatography of the United States No. 60, Climate for Maryland," indicating that the identified reference would be included in a future revision of the CCNPP Unit 3 COL FSAR. The staff confirmed that Revision 6 of the COL FSAR, dated September 30, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the COL applicant has adequately addressed this issue and, therefore, the staff considers RAI 5, Question 02.03.01-3 resolved.

The staff finds that the COL applicant's description of the frequency of regional thunderstorms acceptable, because it is based on nearby representative stations over a long period of record.

2.3.1.4.3.4 *Lightning*

The COL applicant's description of regional lightning events provides information on this severe weather phenomenon in the site region but does not result in the generation of site characteristics for use as design or operating bases.

In COL FSAR Section 2.3.1.2.2.4, "Lightning," the COL applicant stated that there are four flashes to earth per year per km^2 in the vicinity of the proposed CCNPP Unit 3 site, as illustrated in COL FSAR Figure 2.3-12, "5-Year Lightning Flash Density Map." The staff independently determined similar values from:

- A 15-year flash density map prepared by Vaisala, Incorporated (i.e., two to four flashes to earth per km^2) included in National Fire Protection Association Standard 780 "Standard for the Installation of Lightning Protection Systems," 2008

- A 1999 paper by G. Huffines and R.E. Orville, titled, "Lightning Ground Flash Density and Thunderstorm Duration in the Continental United States: 1989-96" (three to five flashes to earth per km^2)

Thus, the staff considers the COL applicant's estimated frequency of lightning strikes to earth in the CCNPP Unit 3 site area to be reasonable.

Based on this lightning frequency, the COL applicant estimated that the lightning strike frequency at the CCNPP Unit 3 site is 0.44 flashes per year. The staff has reviewed the methodologies presented by J.L. Marshall for estimating lightning strike frequencies, which includes consideration of the attractive area of structures, and finds the COL applicant provided an adequate description of regional lightning events based on representative data over a long period of record. Therefore, the staff finds the COL applicant's description acceptable.

2.3.1.4.3.5 *Droughts*

The COL applicant's description of regional droughts provides information on this severe weather phenomenon in the site region but does not result in the generation of site characteristics associated with COL FSAR Section 2.3 for use as design or operating bases.

In RAI 5, Question 02.03.01-4, the staff requested that the COL applicant add a reference to COL FSAR Section 2.3.1.2.2.5, "Droughts," to support the statements that annual precipitation deficits of over 40.6 cm (16 in.) have occurred during extreme droughts of the 1930s, 1960s, and in the period from 1998 to 2002. In a July 28, 2008, response to RAI 5, Question 02.03.01-4, the COL applicant provided a reference to the NCDC publication, "Climatography of the United States No. 60, Climate for Maryland," indicating that the identified reference would be included in a future revision of the CCNPP Unit 3 COL FSAR. The staff confirmed that Revision 6 of the COL FSAR, dated September 30, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the COL applicant has adequately addressed this issue and, therefore, the staff considers RAI 5, Question 02.03.01-4 resolved.

For this weather element, as is the case for waterspouts, the "Storm Events" database is not currently populated with observations prior to 1993; although the output header from queries for these severe weather events indicates that the POR extends from January 1, 1950, to date. The staff notes that there were 12 reports of drought conditions from the "Storm Events"

database between August 31, 1995, and August 1, 2007. However, those entries appear to document only three separate events:

- One entry associated with one event in 1995 from mid-August to mid-September
- The next nine entries indicating a period of drought extending from about July 1998 to September 1999
- The last two entries indicating an event from mid-July to mid-August 2007

The staff also believes that the area queried from the database (i.e., Calvert County only) does not reasonably represent a regional characterization of this type of event for the purpose of identifying drought conditions that may be expected to occur at or affect the site. However, because drought conditions are not addressed from a design standpoint under COL FSAR Section 2.3, the staff did not review this characterization further.

2.3.1.4.3.6 *High Winds*

The COL applicant's description of regional high winds provides information on this severe weather phenomenon in the site region. This information provides context for design-basis wind loads on safety-related structures, which are discussed further in Section 2.3.1.4.3.15 of this report.

In COL FSAR Section 2.3.1.2.2.6, "High Winds," the COL applicant stated that 17 high wind events were reported in Calvert County, MD, between June 2, 1980 and December 31, 2006. Wind speeds ranged from 93 km/hr (58 mph, or 50 knots) to 167 km/hr (104 mph, or 90 knots). The COL applicant compiled this information from data available through the NCDC "Storm Events" database.

Using the same database, the staff independently confirmed the information provided by the COL applicant in COL FSAR Section 2.3.1.2.2.6 and corresponding Table 2.3-4, "High Winds by Storm Type for Calvert County." In evaluating the COL applicant's data, the staff also examined data from adjacent or nearby counties of St. Mary's Talbot, and Dorchester. Data from these additional counties include a few events of similar magnitude to the 167 km/hr (104 mph, or 90 knots) value reported in COL FSAR Table 2.3-4 (e.g., a 165 km/hr (102.4 mph, or 89 knot) wind reported for St. Mary's County on June 26, 1988). These values only slightly exceed both the site characteristic wind speed reported in COL FSAR Table 2.0-1 of 153 km/hr (95 mph) and the 100-year return period 3-second wind gust value of 163.59 km/hr (101.65 mph) cited in COL FSAR Section 2.3.1.2.2.15.

The staff finds the information on regional high winds in COL FSAR Section 2.3.1.2.2.6 to be acceptable on the basis of its independent evaluation of data contained in the NOAA "Storm Events" database.

2.3.1.4.3.7 *Hail*

The COL applicant's description of regional hail provides information on this severe weather phenomenon in the site region but does not result in the generation of site characteristics for use as design or operating bases.

In COL FSAR Section 2.3.1.2.2.7, “Hail,” the COL applicant stated that 20-hail events were reported in Calvert County, MD, between October 9, 1962, and December 31, 2006. Hail stone diameters ranged from 1.9 cm (0.75 in.) to 5 cm (2 in.). The COL applicant compiled this information from data available through the NCDC “Storm Events” database.

Using the same database, the staff independently confirmed the information provided by the COL applicant. As part of the staff’s evaluation, the staff also reviewed data from the “Storm Events” database for adjacent or nearby counties (i.e., St. Mary’s, Talbot, and Dorchester Counties). The data from these counties indicate similar frequencies of occurrence, with Dorchester County reporting one event with hailstones measuring 6.4 cm (2.5 in.) in diameter. The staff finds that the COL applicant has provided an adequate description of hail events from representative data stations over a sufficiently long period to represent site conditions during the expected period of reactor operations.

2.3.1.4.3.8 *Dust/Sand Storms*

The COL applicant’s description of regional dust/sand storms provides information on these severe weather phenomena in the site region but does not result in the generation of site characteristics for use as design or operating bases.

In COL FSAR Section 2.3.1.2.2.8, “Dust/Sand Storms,” the COL applicant stated that no dust/sand storms were reported in Calvert County, MD, between January 1, 1993, and December 31, 2005. The COL applicant compiled this information from data available through the NCDC “Storm Events” database. The staff agrees that the occurrence of dust or sand storms in the CCNPP Unit 3 site area is a rare event on the basis of its independent evaluation of information in the “Storm Events” database, which shows there has been only one recorded storm among the five States of Maryland, Delaware, New Jersey, Pennsylvania, and Virginia. This one storm was located about 106 km (66 mi) away near Frederica, Delaware, over the same time period. The staff finds that the COL applicant provided an adequate description of dust and sand storms from representative data stations over a sufficiently long period of record to represent site conditions during the expected period of reactor operations.

2.3.1.4.3.9 *Ice Storms*

The COL applicant’s description of regional ice storms provides information on this severe weather phenomenon in the site region. This information provides context for evaluating the estimates of normal and extreme winter precipitation loads on the roofs of safety-related structures, which are discussed in Section 2.3.1.4.3.12 of this report.

In COL FSAR, Revision 6, Section 2.3.1.2.2.9, “Ice Storms,” the COL applicant stated that five ice storm events were reported in Calvert County, MD, between January 14, 1999, and December 31, 2006. Ice thickness ranged from 0.5 cm (0.2 in.) to 2.5 cm (1 in.). The COL applicant compiled this information from data available through the NCDC “Storm Events” database. Using the same database, the staff independently confirmed the information provided by the COL applicant.

However, for this weather element (i.e., ice storms), as well as several others mentioned previously, the “Storm Events” database is not currently populated with observations prior to 1993, although the output header from queries for these severe weather events indicates (incorrectly) that the POR extends from January 1, 1950, to date. Without qualification, this infers that no such events occurred prior to the earliest date returned from the query.

The staff does not consider a 14-year POR to be climatologically representative because of its relatively short duration. Furthermore, the staff believes that the area queried from the database (i.e., Calvert County only) does not reasonably represent a regional characterization of this type of event for the purpose of identifying ice storms that may be expected to occur at the site. As a result, in RAI 142, Question 02.03.01-19, the staff requested that the COL applicant update COL FSAR Section 2.3.1.2.2.9 by expanding:

- The POR used to characterize the occurrence of ice storm events. The staff identified several other data sources, including: The NCDC monthly publication "Storm Data," the predecessor to the online "Storm Events" database, which provides narrative coverage of severe weather events back to January 1959 (Reference 8 in SRP Section 2.3.1), and the NCDC Climate Atlas of the United States (Reference 5 in SRP Section 2.3.1) for the general monthly variation of ice storm events in the site region.

- The area used to determine whether an ice storm event may be reasonably expected to occur at the CCNPP Unit 3 site (in conformance with RG 1.206, Section C.I.2.3.2.1 which calls for "long-term data from nearby reasonably representative locations (e.g., within 50 mi (80 km)" to be considered), or to justify an alternative size area for the selection of reasonably representative locations for obtaining data.

In a September 30, 2009, response to RAI 142, Question 02.03.01-19, the COL applicant expanded the geographic region or area in which ice storm events were assessed, in conformance with RG 1.206, Section C.I.2.3.2.1, and both expanded the period of record and relied upon additional data sources to identify additional ice storm events within a 80 km (50 mi) radius of the site. The COL applicant further committed to updating COL FSAR Section 2.3.1.2.2.9, Table 2.3-6, "Ice Storm Events in Calvert County," and associated references in Section 2.3.1.2.3, "References," with the results of this expanded assessment. The staff finds that the COL applicant's consideration of both a longer POR and an expanded area of representative locations are acceptable. **RAI 142, Question 02.03.01-19 is being tracked as a confirmatory item**.

2.3.1.4.3.10 *Snow Storms*

The COL applicant's description of regional snow storms provides information on this severe weather phenomenon in the site region. As with ice storms, this information provides context for evaluating the reasonability of inputs to the estimates of normal and extreme winter precipitation loads on the roofs of safety-related structures, which are discussed in Section 2.3.1.4.3.12 of this report.

In COL FSAR, Revision 6, Section 2.3.1.2.2.10, "Snow Storms," the COL applicant refers to a summary of snow storm events in COL FSAR Table 2.3-7, "Snow Storm Events in Calvert County," that have impacted Calvert County, MD, between December 28, 1993, and December 31, 2006. Snow amounts ranged from less than 2.5 cm (1 in.) to 41.9 cm (16.5 in.). The COL applicant compiled this information from data available through the NCDC "Storm Events" database. Using the same database, the staff independently confirmed the information provided by the COL applicant in COL FSAR Section 2.3.1.2.2.10 and related Table 2.3-7 for the range of dates covered by the "Storm Events" query.

However, for this weather element (i.e., snow storms), as well as several others mentioned previously, the "Storm Events" database is not currently populated with observations prior to 1993, although the output header from queries for these severe weather events indicates

(incorrectly) that the POR extends from January 1, 1950 to date. Without qualification, this implies that no such events occurred prior to the earliest date returned from the query. Other NCDC records, however, indicate that significant snowfall events have been recorded several times in the site area prior to the earliest date reported by the COL applicant.

The staff does not consider a 14-year POR to be climatologically representative because of its relatively short duration. Furthermore, the staff believes that the area queried from the database (i.e., Calvert County only, although two observations from St. Mary's County are included among the 25 reports) does not reasonably represent a regional characterization of this type of event for the purpose of snow storms that may be expected to occur at the site. As a result, in RAI 142, Question 02.03.01-18, the staff requested that the COL applicant update COL FSAR Section 2.3.1.2.2.10 by expanding:

- The POR used to characterize the occurrence of snow storm events. The staff identified several other data sources, including: The NCDC publication, "Storm Data," the predecessor to the online, "Storm Events," database, which provides narrative coverage of severe weather events back to January 1959 (Reference 8 in SRP Section 2.3.1); the NCDC Daily Surface Data (TD3200/3210) listings (Reference 17 in SRP Section 2.3.1); the "NCDC Climatography of the United States No. 20"; "Southeast Regional Climate Center Historical Climate Summaries for Maryland"; and the "NCDC Climate Atlas of the United States" (Reference 5 in SRP Section 2.3.1) for the general monthly variation of snow storm events in the site region.

- The area used to determine whether a snow storm event may be reasonably expected to occur at the CCNPP Unit 3 site (in conformance with RG 1.206, Section C.I.2.3.2.1 which calls for "long-term data from nearby reasonably representative locations (e.g., within 50 mi (80 km)" to be considered), or to justify an alternative size area for the selection of reasonably representative locations for obtaining data.

In a September 30, 2009, response to RAI 142, Question 02.03.01-18, the COL applicant expanded the geographic region or area in which snow events were assessed, in conformance with RG 1.206, Section C.I.2.3.2.1, and both expanded the period of record and relied upon additional data sources to determine the record 1-day snowfall events within a 80 km (50 mi) radius of the site. The COL applicant further committed to updating COL FSAR Section 2.3.1.2.2.10, Table 2.3-7, and associated references in COL FSAR Section 2.3.1.2.3 with the results of this expanded assessment. The staff agrees with the COL applicant's consideration of both a longer POR and an expanded area of representative locations. **RAI 142, Question 02.03.01-18 is being tracked as a confirmatory item**.

2.3.1.4.3.11 *High Air Pollution Potential*

The COL applicant's description of regional high air pollution potential provides information on the meteorological conditions associated with high air pollution levels or episodes in the site region but does not result in the generation of site characteristics for use as design or operating bases.

In COL FSAR Section 2.3.1.2.2.11, "High Air Pollution Potential," the COL applicant stated that 12 air stagnation days occur per year in the vicinity of the CCNPP Unit 3 site, and that most air stagnation events happen in an extended summer season from May to October as a result of weaker pressure and temperature gradients and the associated weaker wind circulations.

COL FSAR Section 2.3.1.2.2.11 also states that the eastern U.S. has a prolonged but weaker air stagnation season than the rest of the country.

The staff confirmed this information based on its review of, "Air Stagnation Climatology for the United States (1948-1998)," from NOAA Air Resources Laboratory Atlas No. 1 (Reference 25 in SRP Section 2.3.1), the same reference cited by the COL applicant as, "NOAA, 1999." The staff notes that the site region experiences two to four air stagnation events on an annual basis (an air stagnation event being defined as persistence of stagnation conditions for four or more consecutive days).

COL FSAR Section 2.3.1.2.2.11 also reports mean annual morning and afternoon mixing height depths over the CCNPP Unit 3 site as approximately 600 m (2,000 ft) and 1,400 m (4,600 ft), respectively, and mean annual wind speeds through the morning and afternoon mixing layers as approximately 5.5 m/s (12 mph) and 7.0 m/s (16 mph). The staff confirmed these values based on its review of the U.S. Environmental Protection Agency (EPA) report, "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States," (Reference 24 in SRP Section 2.3.1), the same reference cited by the COL applicant.

The staff finds that the COL applicant provided information on high air pollution potential based on U.S. EPA studies, that the potential for high air pollution is low, and that, therefore, the COL applicant's consideration of whether such potential should affect operating or design bases at the proposed facility is acceptable.

2.3.1.4.3.12 *Snow/Ice Load on Roofs of Safety-Related Structures*

In COL FSAR, Revision 3, Section 2.3.1.2.2.12, "Snow/Ice Load on Roofs of Safety Related Structures," the COL applicant followed the methodology in the "Site Analysis Branch Position – Winter Precipitation Loads," March 24, 1975, for the design of nuclear power plants. In so doing, the COL applicant calculated a 100-year return period ground snow load using ASCE 7-98 (1,436 N/m^2 or 30 lb$_f$/ft^2), and the 48-hour PMWP using Hydrometeorological Report (HMR) No. 33, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas From 10 to 1000 Square Miles and Durations of 6, 12, 24, and 48 Hours." In determining the winter precipitation load to be included in the combination of extreme live loads, the COL applicant used 25 percent of the PMWP (the COL applicant's estimated PMWP load was 92 lb$_f$/ft^2 or 4,405 N/m^2, plus the 100-year return period ground snow load to estimate an overall design ground snow load of 53 lb$_f$/ft^2 or 2,538 N/m$^{2.}$ The COL applicant's basis for reducing the PMWP was that hourly temperatures were below 0 ^{o}C (32 ^{o}F) only 10 percent of the time, as measured over a 6-year POR (2000-2005).

In RAI 5, Question 02.03.01-5, the staff requested that the COL applicant revise COL FSAR Section 2.3.1.2.2.12 by determining the 48-hour PMWP value over a 26 km^2 (10 mi^2) area in accordance with HMR Number 53, "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," (Reference 19 in SRP Section 2.3.1). In an October 30, 2008, response to RAI 5, Question 02.03.01-5, the COL applicant estimated the 48-hour PMWP value from a plot of 6-, 24-, and 72-hour probable maximum precipitation values (taken from that report) for the site area over the period from December through February, resulting in a 48-hour PMWP of 57.2 cm (22.5 in.). Based on the revised analysis, the COL applicant determined an overall design ground snow load of 2,825 N/m^2 (59 lb$_f$/ft$^{2)}$, and concluded that the site characteristic value is bounded by the U.S. EPR design value. The COL applicant indicated that a future revision of the COL FSAR would include updates to COL FSAR Section 2.3.1.2.2.12 and COL FSAR Table 2.3-8,

"Probable Maximum Winter Precipitation (PMWP) Values," along with a new COL FSAR Figure 2.3-222.

In RAI 5, Question 02.03.01-6, the staff requested that the COL applicant explain the technical basis for the assumption in COL FSAR Section 2.3.1.2.2.12 that 25 percent of the PMWP combines with the 100-year mean recurrence ground snow load to define the overall ground snow load. In a July 28, 2008, response to RAI 5, Question 02.03.01-6, the COL applicant reiterated part of the discussion in COL FSAR Section 2.3.1.2.2.12, regarding the frequency of temperatures above 0 ^{o}C (32 ^{o}F), stating that it would be overly conservative to assume that all of the PMWP would occur as snow and that it would also be unlikely that the PMWP would either fall or remain entirely on top of the antecedent snowpack in this situation.

The staff reviewed the responses to RAI 5, Questions 02.03.01-5 and 02.03.01-6 and determined that these RAIs are resolved, but had a number of questions that remained unresolved. To address these unresolved questions, the staff issued a follow-up RAI 142, Question 02.03.01-17.

In RAI 142, Question 02.03.01-17, the staff stated that the approach used by the COL applicant to determine the pre-adjusted 48-hour PMWP in its response to RAI 5, Question 02.03.01-5 is acceptable. However, the staff believes that the COL applicant's assumption that only 25 percent of the 48-hour PMWP total combines with the 100-year return period ground snow load is not well substantiated. The staff observes that the COL applicant's justification for this reduction of the estimated 48-hour PMWP value appears to be based on average (as opposed to extreme) temperature and precipitation statistics from a 6-year period of onsite data. The staff does not consider a 6-year POR to be climatologically representative because of its relatively short duration. As a result, the analysis does not adequately demonstrate that the 48-hour PMWP total could not fall or that only 25 percent of that amount would combine with the 100-year return period ground snow load.

Furthermore, the staff stated that the design-basis winter precipitation load analysis in COL FSAR, Revision 3, Section 2.3.1.2.2.12, does not reflect the guidance in DC/COL-ISG-07 for assessment of normal and extreme winter precipitation loads.

As a result, in RAI 142, Question 02.03.01-17, the staff requested that the COL applicant update COL FSAR, Revision 3, Section 2.3.1.2.2.12, by developing site characteristics, in conformance with the guidance in ISG-07, for input to determining normal and extreme winter precipitation roof loads, or by justifying an alternative approach.

In RAI 142, Question 02.03.01-17, the staff also provided additional clarification of the guidance in DC/COL/ISG-07, including:

- Identification of appropriate data sources for the various winter precipitation parameters to be determined and the limitations of several of those data sources

- Types of observing stations to be considered (i.e., first-order NWS stations as well as NCDC cooperative network stations)

- The size of the area used to determine whether a normal or extreme winter precipitation event may be reasonably expected to occur at the CCNPP Unit 3 site (in conformance with RG 1.206, Section C.I.2.3.2.1 which calls for "long-term data from nearby reasonably representative locations (e.g., within 50 mi (80 km))" to be considered).

Finally, pursuant to SRP Section 2.3.1, Section I (Areas of Review), Item 6, the staff also requested that the COL applicant provide cross-references to any COL FSAR sections that utilize this design-basis winter precipitation load information.

In a September 30, 2009, response to RAI 142, Question 02.03.01-17, the COL applicant committed to revise COL FSAR Section 2.3.1.2.2.12 to reflect the guidance in DC/COL/ISG-07. In the proposed COL FSAR text contained in the September 30, 2009, response, the COL applicant calculated both the normal and extreme roof loads. In so doing, the COL applicant assumed that since there are no parapets on the roofs of any Seismic Category I structures to impede drainage, the extreme frozen winter precipitation event, rather than the extreme liquid winter precipitation event, is used as the extreme winter precipitation event. The design loads thus derived (which are 32.4 lb_f/ft^2 or 1,551 N/m^2 for normal live load, and 38 lb_f/ft^2 or 1,819 N/m^2 extreme winter precipitation live load) are bounded by the U.S. EPR design values. The staff confirmed that Revision 6 of the COL FSAR, dated September 30, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the COL applicant has adequately addressed this issue and, therefore, the staff considers RAI 142, Question 02.03.01-17 resolved.

The staff finds that the COL applicant has identified the controlling site characteristic value, which is bounded by the corresponding winter precipitation-related site parameter value, and is therefore acceptable.

2.3.1.4.3.13 *Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink*

This section addresses the staff's evaluation of temperature and moisture-related site characteristics presented by the COL applicant in COL FSAR Section 2.3.1.2.2.13 for consideration in the design of the CCNPP Unit 3 UHS.

Table 2.3-1 of this report provides a summary of the COL applicant's site characteristic temperature values that were included in COL FSAR, Revision 3, Section 2.3.1.2.2.13.

The staff issued a series of RAIs regarding these site temperature characteristics in which the staff requested that the COL applicant clarify the representativeness and use of the information. A synopsis of each RAI and the corresponding response from the COL applicant is provided below.

Table 2.3-1 Original Site Characteristic Temperatures for CCNPP Unit 3 in the COL FSAR

Site Characteristics	Value	
Monthly design wet bulb and mean coincident dry bulb, 0.4% exceedance (July)	27.4 °C (81.3 °F)	32.7 °C (90.8 °F)
Monthly design wet bulb and mean coincident dry bulb, 1.0% exceedance (July)	26.8 °C (80.3 °F)	32.2 °C (89.9 °F)
Monthly design wet bulb and mean coincident dry bulb, 2.0% exceedance (July)	26.4 °C (79.6 °F)	31.8 °C (89.2 °F)
Non-coincident wet bulb, 0.4% exceedance	26.2 °C (79.2 °F)	
Non-coincident wet bulb, 1.0% exceedance	25.4 °C (77.8 °F)	
Non-coincident wet bulb, 2.0% exceedance	24.7 °C (76.5 °F)	
Maximum one hour dry bulb (Baltimore, 1951-2002)	40.6 °C (105 °F)	
100-year return period max dry bulb and mean coincident wet bulb	30.1 °C (86.1 °F)	40.3 °C (104.6 °F)
100-year return period min dry bulb	-22.8 °C (-9.1 °F)	
100-year return period non-coincident wet bulb	34.9 °C (94.8 °F)	
1% exceedance coldest wind speed and dry bulb temperature	38.9 km/hr (24.2 mph)	-0.11 °C (31.8 °F)

- In RAI 5, Question 02.03.01-7 the staff requested that the COL applicant provide justification for the use of Baltimore, MD, data to obtain the maximum 1 hour dry bulb, and a 100-year return period dry bulb temperature site characteristic of 40.3 °C (104.6 °F) when higher temperatures have been recorded at stations that are closer to the site than Baltimore, MD, such as Colonial Beach, VA.

  In a July 28, 2008, response to RAI 5, Question 02.03.01-7, the COL applicant provided additional justification for use of the Baltimore, MD, data on the basis of its proximity to the Chesapeake Bay, whereas Colonial Beach, VA is on a smaller water body (Potomac River) further inland. The staff determined that the COL applicant's response was acceptable. Therefore, the staff considers RAI 5, Question 02.03.01-7 resolved.

- In RAI 5, Question 02.03.01-8 the staff requested that the COL applicant provide explanations for several different aspects of the site characteristic temperature values, including: A discrepancy between COL FSAR Sections 2.3 and 9.2, "Water Systems," in the stated POR for data from Patuxent River NAS; and how the data summarized in Table 2.3-1 above were used to show that the site parameter values in the U.S. EPR FSAR Tier 2, Tables 2.1-3, "Design Values for Maximum Evaporation and Drift Loss of Water from the UHS," and 2.1-4, "Design Values for Minimum Water Cooling in the UHS," (i.e., 72 hourly measurements of wet bulb temperatures and coincident dry bulb temperatures, and 24 consecutive hourly measurements of wet bulb temperature and coincident dry bulb temperatures, respectively) were bounded.

In an October 30, 2008, response to RAI 5, Question 02.03.01-8, the COL applicant explained that it had re-evaluated the Patuxent River NAS data over a 30-year POR. The COL applicant also explained that the 2 percent and 0.4 percent exceedance values and the 100-year return period values are not applicable to design of the UHS, and it committed to remove these values from the COL FSAR. The COL applicant also explained that it will use zero percent exceedance values for UHS design. Regarding the 72 hrs and 24 hrs of consecutive hourly temperature values, the COL applicant explained that the data was selected on the basis of it representing the highest evaporation potential and minimum cooling, respectively. Regarding the staff question regarding what site characteristic temperature was used by the COL applicant after 72 hrs, the COL applicant stated that it assumed that the 72-hour evaporation loss rate bounds the loss rate after 72 hrs until 720 hrs (30 days), and is, therefore, used to calculate makeup flow rate through the end of the 30-day bounding design-basis accident scenario.

The staff reviewed the COL applicant's responses to RAI 5, Questions 02.03.01-7 and 02.03.01-8 and determined that these RAIs are resolved, but the staff had a number of follow-up questions. To address these questions, the staff has issued the follow-up RAIs described below. Brief synopses of the staff's questions and the COL applicant's corresponding responses are also provided below. The staff's evaluation of all of these responses, unless otherwise noted, follows the discussion of RAI 185, Question 02.03.01-33:

- As a follow-up to RAI 5, Question 02.03.01-7 and RAI 5, Question 02.03.01-8, in RAI 151, Question 02.03.01-21, the staff requested that the COL applicant explain aspects of the COL FSAR discussion on the meteorological conditions resulting in the potential for water freezing in the UHS water storage facility. Namely, the staff requested explanations for: How the one percent exceedance values are applicable to design, considering that ice formation requires persistence of sub-freezing temperatures and that a one percent (or any percentile) exceedance value represents a discrete statistical value; why a wind speed parameter is relevant, specified that the cooling tower basins are relatively enclosed structures; and how the discussion in COL FSAR Section 2.3 relates to the discussion in COL FSAR Section 2.4.7.6, "Surface Ice Sheet," which describes the parameter "accumulated freezing degree-days" as a means of representing persistence.

- In an October 19, 2009, response to RAI 151, Question 02.03.01-21, the COL applicant committed to revise COL FSAR Section 2.3.1.2.2.13, Paragraph 14, by deleting the prior version in its entirety, and cross-referencing the discussion of potential ice effects on the UHS and other plant systems contained in COL FSAR Section 2.4.7. These proposed changes are acceptable to the staff. **RAI 151, Question 02.03.01-21 is being tracked as a confirmatory item**. The staff's evaluation of potential ice effects on the UHS is provided in Section 2.4 of this report.

- As a follow-up to RAI 5, Questions 02.03.01-7 and 02.03.01-8, in RAI 151, Question 02.03.01-22, the staff requested that the COL applicant provide clarification for committing to delete some site temperature characteristics for UHS design (such as 2 percent and 0.4 percent exceedance and 100-year return period data), but retaining other site temperature characteristics without a discussion that establishes its applicability to design (such as one percent exceedance monthly design values).

In an October 19, 2009, response to RAI 151, Question 02.03.01-22, the COL applicant explained that one percent exceedance values are not used in UHS design, and that this information would also be removed from the COL FSAR.

- As a follow-up to RAI 5 Questions 02.03.01-7 and 02.03.01-8, in RAI 151, Questions 02.03.01-23, and 02.03.01-24, the staff requested that the COL applicant more fully describe the 72 hours and 24 hours of consecutive hourly data that the COL applicant provided in COL FSAR Section 2.3.1.2.2.13, which are used by the COL applicant in evaluations of maximum evaporation and minimum cooling in the UHS, respectively, and to explain, among other things, how the data were processed and what criteria were used by the COL applicant to conclude that the site characteristics are enveloped by the site parameter values in the U.S. EPR FSAR.

  In an April 14, 2010, response to RAI 151, Question 02.03.01-23, which pertained to the hourly temperature and humidity values for maximum evaporation, the COL applicant explained that the data were derived from hourly dry bulb temperatures, dew point temperatures and atmospheric pressure values taken from 1976 to 2006. The COL applicant also explained its procedures for handling non-hourly and missing data. The COL applicant explained that, since the 72 pairs of sequential hourly wet bulb and dry bulb temperatures for both the U.S. EPR FSAR and CCNPP Unit 3 are based on the same data set from the Patuxent River NAS, the evaporative losses would be the same, and, as such, the U.S. EPR site parameters bound the CCNPP Unit 3 site characteristics.

  In an April 14, 2010, response to RAI 151, Question 02.03.01-24, which pertained to the hourly temperature and humidity values for minimum cooling, the COL applicant explained that the data are the same 24 hours of temperature data provided in the U.S. EPR FSAR.

- As a follow-up to RAI 5, Question 02.03.01-8, in RAI 151, Question 02.03.01-25, the staff requested that the COL applicant explain the relationship between the 0 percent exceedance temperature values and the 72 and 24 consecutive hourly temperature measurements provided in COL FSAR Section 2.3.1.2.2.13. The staff also requested that the COL applicant reconcile two different definitions of the zero percent exceedance value which appear in COL FSAR Section 9.2.1.1, “Design Bases,” and in Table 1.2-6 of the Electric Power Research Institute’s Advanced Light Water Reactor Utility Requirements Document (URD), Volume III, Chapter 1, Revision 8, March 1999. The staff also requested that the COL applicant explain why it provided monthly one percent design temperature values as site characteristics, since the site parameter values in the U.S. EPR FSAR are one percent exceedance maximum temperature values, which are fundamentally different. The staff also requested the COL applicant to identify the equipment or components for which the zero percent and one percent exceedance temperatures are used in design.

  In an April 14, 2010, response to RAI 151, Question 02.03.01-25, the COL applicant clarified that there is no direct relationship between the 72-hour controlling period for maximum evaporation and the zero percent exceedance maximum dry bulb and coincident wet bulb temperature site characteristic values, although zero percent exceedance values were considered during the design of the UHS. The COL applicant also clarified that the zero percent exceedance non-coincident wet bulb temperature

of 29.4 °C (85 °F) is the controlling factor for establishing tower basin temperature, and is actually included in the 24-hour profile of the worst case meteorological conditions for minimum cooling. The COL applicant explained that the zero percent exceedance value is defined as the value that can occur for consecutive hours (two or more) and can only be exceeded 1 hour at a time. The COL applicant also explained that the July, one percent exceedance value is not used in the UHS design and committed to remove it from the COL FSAR. The COL applicant also described the safety-related, non-safety-related, and non-safety-related augmented quality SSCs for which zero percent and one percent exceedance temperatures are used in design.

- As a follow-up to RAI 5, Question 02.03.01-7, in RAI 185, Question 02.03.01-33, the staff requested that the COL applicant explain the relevance of the maximum 1-hour dry bulb temperature to the UHS design. In an October 29, 2009, response to RAI 185, Question 02.03.01-33, the COL applicant explained that the information is not relevant to UHS design and committed to delete this information in a future revision of the COL FSAR.

A summary of the applicable temperature and humidity site characteristics, which reflect the RAI responses described above, is provided below in Table 2.3-2 of this report.

Table 2.3-2 CCNPP Unit 3 UHS Temperature and Humidity Site Parameter and Characteristics

Parameter Description		Site Parameter Value	Site Characteristic Value
0% exceedance	Maximum	46.1 °C (115 °F) DB 26.7 °C (80 °F) MCWB	38.9 °C (102 °F) DB 26.7 °C (80 °F) MCWB
		27.2 °C (81 °F) NCWB	29.4 ° (85 °F) NCWB[1]
	Minimum	-40 °C (-40 °F) DB	-17.8 °C (0 °F) DB

DB – dry bulb; MCWB – mean coincident wet bulb; NCWB – non-coincident wet bulb
[1] Departure

The staff evaluated the COL applicant's responses to RAI 151, Questions 02.03.01-22 through 02.03.01-25 and RAI 185, Question 02.03.01-33. With regard to the responses to RAI 151, Question 02.03.01-22 and RAI 185, Question 02.03.01-33, the staff's evaluation of which meteorological parameters should be used for design of the UHS is provided in Section 9.3 of this report. Therefore, for purposes of this report section, the explanation that certain site temperature and humidity characteristics are not site parameters used for design of the UHS, and will be removed from that part of the COL FSAR, is acceptable. The staff finds the COL applicant's responses to RAI 151, Questions 02.03.01-23 and 02.03.01-24 acceptable, because the COL applicant provided sufficient information for the staff to understand the source and methodology for obtaining the hourly values provided by the COL applicant. The staff also finds the COL applicant's response to RAI 151, Question 02.03.01-25 acceptable, because the COL applicant has explained how the remaining temperature and humidity site parameter values are used to show that the UHS meets maximum evaporation and minimum cooling guidance provided in RG 1.27, as described in the fifth acceptance criteria of NUREG-0800, Section 2.3.1. Changes to the COL FSAR to incorporate responses to **RAI 151,**

Questions 02.03.01-22 through 02.03.01-25 and RAI 185, Question 02.03.01-33 are being tracked as confirmatory items.

With regard to COL Information Item 2.3-10, the COL applicant also described safety-related equipment that provides makeup water from the Chesapeake Bay to the Essential Service Water system to meet the maximum evaporative and drift water losses for the period from 72 hours post-accident up to 30 days post-accident. Design bases for the UHS Makeup Water System are addressed in COL FSAR Section 9.2.5. The staff's evaluation of the design bases for the UHS Makeup Water is provided in Section 9.2 of this report.

2.3.1.4.3.14 *Tornado Parameters*

In COL FSAR Section 2.3.1.2.2.14, "Tornado Parameters," the COL applicant chose tornado site characteristics based on RG 1.76, Revision 1, in conformance with SRP Section 2.3.1, Section II (Acceptance Criteria), SRP Acceptance Criterion (3). This regulatory guide provides design-basis tornado characteristics for three tornado intensity regions throughout the U.S., each with a 10^{-7} probability of occurrence. The CCNPP Unit 3 site is located in Tornado Intensity Region II. The COL applicant proposed the following tornado site characteristics given in COL FSAR Table 2.3-9, "Design Basis Tornado Characteristics for CCNPP Unit 3":

Maximum Wind Speed	322 km/hr (200 mph)
Translational Speed	64 km/hr (40 mph)
Maximum Rotational Speed	257 km/hr (160 mph)
Radius of Maximum Rotational Speed	46 m (150 ft)
Pressure Drop	6,200 N/m^2 (0.9 lb$_a$/in.^{2})
Rate of Pressure Drop	2,800 N/m^2/s (0.4 lb$_a$/in.^{2}/s)

Because the COL applicant correctly identified those design-basis tornado site characteristics presented in RG 1.76, Revision 1 for Tornado Intensity Region II, the staff concludes that the COL applicant has chosen acceptable tornado site characteristics for the CCNPP Unit 3 site. These site characteristic values are less than the corresponding site-parameter values given in COL FSAR Table 2.0-1 and U.S. EPR FSAR Tier 2, Section 3.3.2.1, "Applicable Tornado Design Parameters," which also includes the rate of pressure drop design parameter.

2.3.1.4.3.15 *100-Year Return Period 3-second Wind Gust*

In COL FSAR, Revision 3, Section 2.3.1.2.2.15, the COL applicant identified a 100-year return period 3-second wind gust speed site characteristic in conformance with SRP Section 2.3.1, Section II (Acceptance Criteria), SRP Acceptance Criterion (4). The COL applicant estimated the 100-year return period value based on ASCE Standard 7-05 (Reference 10 in SRP Section 2.3.1). The COL applicant stated that the 50-year return period 3-second gust for the CCNPP site is 42 mps (95 mph) and used a conversion factor of 1.07 (from Table C6-7 of the cited reference) to determine the 100-year return period 3-second gust of 45.4 m/sec (101.65 mph).

In RAI 5, Question 02.03.01-9, the staff requested that the COL applicant provide clarification about two Importance Factors that were provided in COL FSAR Table 2.0-1 (i.e., 1.15 and

1.07). The former, given as a site-parameter value, is referred to as an Importance Factor and is used to adjust the wind velocity pressure to different annual probabilities of being exceeded (based on ASCE Standard 7-05, Section C.6.5.5 and Table 6-1). In contrast, the latter, given as a site characteristic value, is referred to as a conversion factor and is used to adjust the design-basis wind speed to different annual probabilities (based on ASCE Standard 7-05, Table C6-7). In RAI 5, Question 02.03.01-9, the staff explained the relationship between the two factors and requested that the applicant provide clarification as to whether the Importance Factors should be numerically the same (i.e., 1.15). In an October 30, 2008, response to RAI 5, Question 02.03.01-9, the COL applicant confirmed that the conversion factor (i.e., 1.07) is used to adjust 50-year return period 3-second wind gust values to a 100-year return period, stated that both Importance Factors should be shown as, "1.15," and stated that COL FSAR Table 2.0-1 would be updated in Revision 4 of the COL FSAR. The staff confirmed that Revision 5 of the COL FSAR, dated June 30, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the COL applicant has adequately addressed this issue and, therefore, the staff considers RAI 5, Question 02.03.01-9 resolved.

The staff considered the COL applicant's response to RAI 5, Question 02.03.01-9 to be acceptable. However, the staff issued follow-up RAI 142, Question 02.03.01-20 to request that the applicant provide one additional clarification to the site parameter and site characteristic Importance Factor entries, and one correction to terminology in COL FSAR Table 2.0-1. In particular:

- The site parameter and site characteristic wind speed values in COL FSAR Table 2.0-1 represent 50-year mean recurrence interval values. The 100-year return period wind speed value only appears in COL FSAR Section 2.3.1.2.2.15 along with the 50- to 100-year return period wind speed conversion factor.

U.S. EPR FSAR Tier 2, Section 3.3.1.2 provides the method for estimating the effective wind design velocity pressure using the basic wind speed. The "basic" wind speed is associated with a 50-year mean recurrence interval. The non-tornado wind speed-related values presented in COL FSAR Table 2.0-1 are in compliance with that methodology. To avoid confusion, the staff requested that the COL applicant clarify the parenthetical statements that accompany the Importance Factor entries in COL FSAR Table 2.0-1 to state the purpose of this factor (i.e., adjustment of the velocity pressure from a 50-year to a 100-year mean recurrence interval for safety- and quality-related structures).

- The left-hand row designator for the wind-related site parameter and site characteristic entries in COL FSAR Table 2.0-1 reads, "Maximum Sustained Speed." The site parameter and site characteristic wind speed values in Table 2.0-1 represent 3-second gust speeds, a fundamentally different statistic. The staff requested that the COL applicant correct the left-hand row designator to properly indicate the wind speed values being presented.

In a September 30, 2009, response to RAI 142, Question 02.03.01-20, the COL applicant committed to update COL FSAR Table 2.0-1 to include explanatory text regarding the meaning and purpose of the Importance Factor, and to clarify that the appropriate design basis straight wind is the ASCE 7-05 Basic Wind Speed (3-second gust). The staff finds this clarification acceptable, because the description of the site characteristic will be more accurate. **RAI 142, Question 02.03.01-20 is being tracked as a confirmatory item**.

The staff also notes that the COL applicant has made a conforming change to the COL FSAR in Table 2.0-1 by changing the term, "Maximum Sustained Speed," to, "Maximum Speed (other than Tornado)." This change is in response to the staff's RAI 256, Question 02.03.01-02 in its review of the U.S. EPR FSAR.

The staff finds that the COL applicant has provided an acceptable basic (straight-line) 100-year return period 3-second gust wind speed based on appropriate standards, as described in the fourth acceptance criteria of NUREG-0800, Section 2.3.1.

2.3.1.4.3.16 *Temperature and Humidity for Heating, Ventilation, and Air Conditioning*

This section addresses the staff's evaluation of temperature and humidity conditions presented by the COL applicant in COL FSAR Revision 3, Section 2.3.1.2.2.16, "Temperature and Humidity for Heating, Ventilation and Air Conditioning," for consideration in the design of safety-related heating, ventilation, and air conditioning (HVAC) systems.

In COL FSAR Section 2.3.1.2.2.16, the COL applicant identified several design-related temperature and moisture statistics, including: 1 percent and 2 percent annual exceedance dry - and coincident wet-bulb temperatures; 1 percent and 2 percent annual exceedance wet - and coincident dry-bulb temperatures; and annual 99.6 percent and 99 percent dry-bulb temperatures, based on observations at the Patuxent River NAS over the period 1982 to 2001 as reported by ASHRAE. This information was extracted from a variety of heating and cooling, humidification and dehumidification statistics presented in COL FSAR Table 2.3-10, "Annual Heating and Humidification Design Conditions for Patuxent River Naval Air Station, Maryland (1982-2001)," through Table 2.3-15, "Monthly Mean Daily Temperature Range for Patuxent River Naval Air Station, Maryland (1982-2001)," (primarily Tables 2.3-10 and 2.3-11, "Annual Cooling, Dehumidification, and Enthalpy Design Conditions for Patuxent River Naval Air Station, Maryland (1982-2001)"). COL FSAR Section 2.3.1.2.2.16 also identified temperature and moisture-related statistics associated with a 100-year return period, including: Maximum and minimum dry-bulb temperatures; a maximum wet-bulb temperature coincident with the 100-year return period dry-bulb temperature; and a 100-year return period maximum non-coincident wet-bulb temperature.

However, the COL applicant did not state which of these values was used in the design of safety-related HVAC systems at the CCNPP Unit 3 site or provide cross-references to other sections in the COL FSAR or the U.S. EPR FSAR, in conformance with the guidance in RG 1.206, Section C.I.2.3.1.2, Paragraph 2.

The staff had a number of questions on COL FSAR, Revision 0, that it presented in a series of RAI questions, including:

- In RAI 5, Question 02.03.01-10, the staff requested that the COL applicant provide a description whether meteorological data from the Patuxent River NAS are representative of conditions at the CCNPP Unit 3 site.

  In a July 28, 2008, response to RAI 5, Question 02.03.01-10, the COL applicant explained that both the CCNPP and Patuxent River NAS are located in climate division MD-03, Lower Southern, within 18 km (11 mi) of each other on the Chesapeake Bay. The staff finds that the proximity of the Patuxent River NAS, and the fact that both the Patuxent NAS and the CCNPP sites are on the Chesapeake Bay, ensures that data are

sufficiently representative. The staff accepts this explanation and, therefore, considers RAI 5, Question 02.03.01-10 resolved.

- In RAI 5, Question 02.03.01-11, the staff noted that it was unable to verify the 100-year return period maximum wet-bulb temperature coincident with the 100-year return period maximum dry-bulb value of 30.1 °C (86.1 ºF), or the 100-year return period maximum wet-bulb temperature (non-coincident) of 34.9 °C (94.8 ºF) using the reference cited in COL FSAR Sections 2.3.1.2.2.13 and 2.3.1.2.2.16 (ASHRAE, 2005). The staff requested that the COL applicant explain how these values were determined.

  In a July 28, 2008, response to RAI 5, Question 02.03.01-11, the COL applicant explained the methodology for calculating the 100-year return period maximum wet-bulb temperature and coincident dry bulb temperature, and the 100-year maximum wet bulb temperature (non-coincident) using information provided in ASHRAE Weather Data Viewer Version 3.0. As noted in the acceptance criteria in SRP Section 2.3.1, the ASHRAE methodology for calculating 100-year return period extreme temperature values is acceptable to the staff. Therefore, the staff considers RAI 5, Question 02.03.01-11 resolved. However, the COL applicant committed to removing the 100-year return period data from the COL FSAR, as described more fully below in the description of RAI 5, Question 02.03.01-13.

- In RAI 5, Question 02.03.01-12, the staff noted that SRP Section 2.3.1, states that historical data used to characterize a site should extend over a significant time interval to capture cyclical extremes. The staff also noted 20 yrs of data from the Patuxent River NAS was used in COL FSAR Sections 2.3.1.2.2.13 and 2.3.1.2.2.16 to determine temperature and humidity site characteristics for HVAC design. The staff requested that the COL applicant justify why this is a long enough period to capture cyclical extremes and potential climatic changes at the CCNPP Unit 3 site.

  In an October 30, 2008, response to RAI 5, Question 02.03.01-12, the COL applicant re-evaluated temperature and humidity site characteristics for HVAC design using 30 yrs of data from Patuxent River NAS. The COL applicant stated that it believes that the use of 30 yrs of data is considered to represent a sufficient period to capture cyclical extremes. The COL applicant cited NUREG-0800, Section 2.3.1, SRP Acceptance Criterion 5 and RG 1.27, Regulatory Position C.1.b as justifications for its position. The staff's evaluation of this response is provided below as part of its evaluation of subsequent RAIs.

- In RAI 5, Question 02.03.01-13, the staff requested that the COL applicant provide additional information regarding the zero percent and one percent exceedance dry-bulb and wet-bulb temperatures presented in COL FSAR Table 2.0-1, including:

  - A discussion in COL FSAR Section 2.3.1 of how the site characteristic temperatures presented in COL FSAR Table 2.0-1 were determined

  - A more detailed description of how the maximum zero percent exceedance dry-bulb temperature of 46.1 ºC (115 ºF) and coincident wet-bulb temperature of 26.7 ºC (80 ºF) were determined noting that COL FSAR Section 9.2.1, "Essential Service Water System," indicates that the CCNPP Unit 3 site-specific temperatures were determined using the guidance in RG 1.27 and 30 yrs of climatology data from the Patuxent River NAS

- An explanation of the apparent discrepancy between the zero percent exceedance wet-bulb temperature listed in COL FSAR Table 2.0-1 as 27.2 ºC (81 ºF) and the zero percent exceedance wet-bulb temperature stated in COL FSAR Section 9.2.1.1 as 29.4 ºC (85 ºF)

In addition, in RAI 5, Question 02.03.01-13, the staff reiterated the requirements in 10 CFR 52.79(a)(1)(iii) regarding the need for the COL applicant to consider the most severe of the natural phenomena that have been historically reported for the site and surrounding area with sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated, and the guidance in SRP Section 2.3.1 which states that historical data used to characterize a site should extend over a significant time interval to capture cyclical extremes.

Finally, in RAI 5, Question 02.03.01-13, the staff noted that COL FSAR Section 2.3.1.2.2.16 presented the one percent exceedance temperatures for Patuxent River NAS, but that instead of listing these site characteristic temperatures, COL FSAR Table 2.0-1, stated that the zero percent exceedance values bound the one percent exceedance values which, by definition, must be true. As a result, the staff requested that the COL applicant clarify why the one percent exceedance dry-bulb and wet-bulb temperatures were not given in COL FSAR Table 2.0-1, and to list any SSCs and the corresponding COL FSAR section(s) that rely on the one percent exceedance temperature information.

In an October 30, 2008, response to RAI 5, Question 02.03.01-13, the COL applicant cited its responses to RAI 5, Question 02.03.01-8 and RAI 5, Question 02.03.01-12, and reiterated that zero percent and one percent exceedance dry and wet bulb temperature values were determined using 30 yrs of meteorological data (1978-2007) recorded at Patuxent River NAS. The COL applicant also reiterated its justification for using 30-year data versus 100-year return period temperatures, as described in an October 30, 2008, response to RAI 5, Question 02.03.01-12. The COL applicant explained that zero percent exceedance values for the UHS are used for cooling tower design, and that the thermal performance of the conceptual design of the tower was evaluated with the worst case DBA heat load with site characteristic non-coincident wet bulb temperatures (29 ^{o}C (85 ^{o}F)). The conceptual design was determined to perform its safety function under worst case ambient conditions while maintaining cooling water return temperatures less than the 35 ^{o}C (95 ^{o}F) maximum value.

- The COL applicant also explained that the following structures, systems, or components rely on the one percent exceedance temperature information:

  - Circulating water system (CWS) cooling tower conceptual design is based on 1 percent exceedance conditions of 37.8 ^{o}C (100 ^{o}F) dry bulb temperature coincident with 25 ^{o}C (77 ^{o}F) wet bulb temperature (25.6 ^{o}C (78 ^{o}F) inlet air wet bulb temperature), as described in FSAR Section 10.4.5, “Circulating Water System.”

  - Balance of plant HVAC systems including the Turbine Building Area Ventilation System (FSAR Section 9.4.4) and the Circulating Water Pump Building Ventilation System (FSAR Section 9.4.12).

The staff had a number of questions after considering the COL applicant's responses to RAI 5, Questions 02.03.01-12 and 02.03.01-13 and the revised information proposed to be incorporated in COL FSAR Section 2.3.1.2.2.16. As a follow-up, the staff issued a series of follow-up RAIs, which are summarized below. The staff's evaluation of RAI responses, unless otherwise noted, is provided after the description of RAI 152, Question 02.03.01-32.

- The staff acknowledged that the COL applicant intended to remove two percent exceedance values from the COL FSAR. Therefore,in RAI 152, Question 02.03.01-28,, the staff requested that the COL applicant explain the relevance of other site characteristic values, including extreme annual design wind speed, extreme annual maximum and/or minimum wet- and dry-bulb temperature data, and the 10-, 20- and 50-year return interval extreme maximum and minimum dry-bulb temperatures presented in COL FSAR Table 2.3-12, "Extreme Annual Design Conditions for Patuxent River Naval Air Station, Maryland 1982-2001."

  In an April 14, 2010, response to RAI 152, Question 02.03.01-28, the COL applicant indicated that COL FSAR Table 2.3-12 was deleted in COL FSAR, Revision 5.

- In RAI 152, Question 02.03.01-29, the staff requested that the COL applicant (1) verify that zero percent and one percent exceedance maximum dry-bulb and coincident wet-bulb site characteristic temperatures in the U.S. EPR FSAR and COL FSAR were developed on the same basis (i.e., clarify whether these are monthly, seasonal, or annual values), (2) clarify whether the coldest month zero percent and one percent exceedance minimum dry-bulb site characteristic temperature should be December or January, (3) provide site characteristics values of zero percent and one percent exceedance temperature values in COLFSAR Table 2.0-1 for comparison with U.S. EPR site parameter values, (4) explain the criteria by which the various temperature site parameters are shown to bound the temperature site characteristics, and (5) identify the specific COL and/or U.S. EPR FSAR sections where these temperatures are used.

  In an April 14, 2010, response to RAI 152, Question 02.03.01-29, the COL applicant explained that zero percent and one percent exceedance values used in both the U.S. EPR FSAR and COL FSAR are seasonal values (not monthly values), and that monthly values (e.g., December and July) cited in the COL FSAR would be changed to seasonal values. In an April 14, 2010, response to RAI 152, Question 02.03.01-30 described below, the COL applicant also provided cross-references between COL FSAR Section 2.3.1 site parameter or site characteristic temperature values and COL and/or U.S. EPR FSAR sections where these temperature conditions are used.

- The staff explained that the staff considers site characteristics based on a 100-year return period to provide the "sufficient margin" cited in 10 CFR 52.79(a)(1)(iii) to account for situations where the historical data used to characterize the site may not adequately capture cyclical climatic events. As a result, in RAI 152, Question 02.03.01-30, the staff requested that the COL applicant update COL FSAR Section 2.3.1.2.2.16 and COL FSAR Table 2.0-1 to provide zero percent exceedance values based on the conservative estimates of 100-year return period values and historic extreme values, whichever is bounding.

  In an April 14, 2010, response to RAI 152, Question 02.03.01-30, the COL applicant calculated 100-year return period and extreme annual site values and provided revised

text of the COL FSAR that addresses these values. However, the COL applicant asserts that one percent and zero percent exceedance values were determined to be appropriate design values for HVAC systems, based on (1) the standard use of ASHRAE climatic design information for HVAC design, which involves annual percentiles, (2) the fact that extreme annual conditions do not have persistence data associated with their determination (as opposed to the 0 percent value, which is based on a 2-hour persistence period), (3) 100-year return period values are also not associated with any persistence period, (4) 100-year return period values are based on extrapolation beyond available data, which introduces uncertainty associated with the assumptions and methods used, and (5) 100-year return period coincident wet bulb values are based on an extrapolated relationship to dry bulb temperatures, in addition to the extrapolation from historical measurements, which introduces additional sources of uncertainty.

- In RAI 152, Question 02.03.01-31. the staff requested that the COL applicant update COL FSAR Section 2.3.1.2.2.16 to explain: The relevance of a parenthetical statement regarding 50-year return period values; and a statement in Paragraph 4 to the effect that the use of any data set containing less than 100 yrs of reliable, sequential hourly meteorological data to estimate 100-year return period values would result in overly conservative values that exceed values in available 30-year data sets. The staff also requested the COL applicant to: Expand the area used to characterize the occurrence of extreme temperature events beyond Calvert County, MD; identify any historical maximum or minimum dry bulb temperatures that exceed the corresponding 100-year return period site characteristic values; and reconcile any site characteristic 100-year return period or historical maximum temperature values that exceed the corresponding zero percent temperature values.

  In an April 14, 2010, response to RAI 152, Question 02.03.01-31, the COL applicant explained that the parenthetical statement was irrelevant and would be deleted and the statement regarding sequential hourly data will be removed. The COL applicant also provided extreme temperature values for six stations within 40 km (25 mi) of the CCNPP site (obtained from the Southeast Regional Climate Center (2009), and identified the maximum temperature of 41 °C (106 ^{o}F) from Cambridge Water Treatment Plant, MD, and the minimum temperature of – 26 °C (- 14 ^{o}F) from the Blackwater Refuge, MD, as extreme maximum and minimum annual site temperatures. The COL applicant also explained that design values for HVAC systems are based on zero percent and one percent exceedance values, as described above in the discussion regarding the COL applicant's response to RAI 152, Question 02.03.01-30.

- In RAI 152, Question 02.03.01-32 the staff requested that the COL applicant cross-reference to other sections of the COL FSAR or the U.S. EPR FSAR where the safety-related SSCs are designed to the one percent exceedance temperature and to clarify the column headings in COL FSAR Table 2.0-1 to better distinguish site characteristics from site parameters.

  In an April 14, 2010, response to RAI 152, Question 02.03.01-32, the COL applicant reiterated, as stated above regarding responses to RAI 151, Questions 02.03.01-22 through 02.03.01-25, that one percent exceedance values are not used in the design of the UHS and that safety-related HVAC systems are designed to the U.S. EPR FSAR zero percent exceedance site parameter values, rather than site characteristic values.

The COL applicant also reiterated its commitment, as stated in its response to RAI 152, Question 02.03.01-29, that site characteristic monthly-basis one percent exceedance temperature values will be replaced with seasonal-basis values. The COL applicant will also revise COL FSAR Table 2.0-1 headings to read "U.S. EPR FSAR Design Parameter Value," and "CCNPP Unit 3 Site Characteristic Value," as shown in its response to RAI 152, Question 02.03.01-29.

A summary of the applicable temperature and humidity site characteristics, which reflect the RAI responses described above, are provided below in Tables 2.3-3 and 2.3-4 of this report.

Table 2.3-3 Design Basis HVAC Temperature and Humidity Site Parameters and Characteristics

Parameter Description		Site Parameter Value	Site Characteristic Value
0% exceedance	Maximum	46.1 °C (115 °F) DB 26.7 °C (80 °F) MCWB	38.9 °C (102 °F) DB 26.7 °C (80 °F) MCWB
		27.2 °C (81 °F) NCWB[1]	29.4 °C (85 °F) NCWB[1,2]
	Minimum	-40 °C (-40 °F) DB	-17.8 °C (0 °F) DB
1% exceedance	Maximum	37.8 °C (100 °F) DB 25 °C (77 °F) MCWB	33.9 °C (93 °F) DB 24.9 °C (76.8 °F) MCWB
		26.7 °C (80 °F) NCWB	26.7 °C (80 °F) NCWB
	Minimum	-23.3 °C (-10 °F) DB	-10 °C (14 °F) DB

DB – dry bulb; MCWB – mean coincident wet bulb; NCWB – non-coincident wet bulb
[1] 0 percent exceedance maximum NCWB is only used for UHS design
[2] Site characteristic exceeds site parameter NCWB temperature value.

Table 2.3-4 Local 100-year Return Period and Historical Extreme Dry Bulb Temperatures

Parameter Description		Site Characteristic Value
100-year[1]	Maximum	40.4 ° (104.8 °F) DB 27.1 ° (80.8 °F) MCWB 30.3 °C (86.6 °F) NCWB
	Minimum	-20.6 °C (-5 °F) DB
Extreme[2]	Maximum	41.1 °C (106 ºF) DB[3]
	Minimum	-25.6 °C (-14 ºF) DB[4]

DB – dry bulb; MCWB – mean coincident wet bulb; NCWB – non-coincident wet bulb
[1]Source: Patuxent River NAS (1978-2007)
[2]Source: Southeast Regional Climate Center; sites within 40.2 km (25 mi) of CCNPP Unit 3
[3]Cambridge Water Treatment (July 21, 1930) and Owings Ferry Landing (August 6, 1918)
[4]Blackwater Refuge (January 11, 1942)

The following is the staff's evaluation of the COL applicant's responses to RAI 5, Questions 02.03.01-12 and 02.03.01-13, RAI 152, Questions 02.03.01-28, 02.03.01-29, 02.03.01-30, 02.03.01-31, and 02.03.01-32.

The staff evaluated whether the temperature and humidity site characteristic information provided by the COL applicant, which is summarized in Table 2.3-3 and Table 2.3-4 of this report, meets the requirement in 10 CFR 52.79(a)(1)(iii), which stipulates that the COL FSAR include meteorological characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

The COL applicant has considered several temperature statistics: The most severe temperature and humidity data that have been historically reported within a 25 mi radius of the CCNPP Unit 3 site; the calculated 100-year return period values based on data from the nearby Patuxent River NAS; and zero percent and one percent exceedance values, also based on 30-years of data from the nearby Patuxent River NAS. The staff finds that the COL applicant's rationale for choosing zero percent and one percent exceedance values is sound, because: (1) The zero percent value takes into consideration the duration of temperature excursions (which is not the case for extreme values), (2) the marginal difference between the site characteristic zero percent and one percent exceedance values and the site characteristic 100-year return period values, and; (3) the fact that safety-related HVAC systems will be designed to zero percent exceedance site parameter values which, with the exception of the non-coincident wet bulb temperatures, provide design margin from temperature/humidity statistics derived from any of the three bases (100-year return period, extreme, and zero percent exceedance site characteristic values). As a result, the staff finds that the COL applicant has specified appropriate consideration of the most severe temperature and humidity data for HVAC design, with sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated. The staff further finds that this data was recorded at nearby representative climate stations, as described in the eighth acceptance criteria of NUREG-0800, Section 2.3.1.

The COL applicant proposed to update COL FSAR Table 2.0-1 to include new site parameter and site characteristic temperature and humidity data and to revise COL FSAR Section 2.3.1.2.2.16 to describe the basis for the new values. The COL applicant's proposed revisions to the COL FSAR are acceptable to the staff. **RAI 152, Question 02.03.01-32 is being tracked as a confirmatory item**.

2.3.1.4.3.17 *Climate Changes*

NUREG-0800, Section 2.3.1, Section II (Acceptance Criteria), SRP Acceptance Criterion (2), which establishes criteria the staff uses to evaluate COL applications, states, in part, that the applicability of data on severe weather phenomena used to represent site conditions during the expected period of reactor operation should be substantiated. SRP Section 2.3.1, Section III (Review Procedures), Item 2, Paragraph 2 states, in part, that "[t]he historical data used to characterize a site should extend over a significant time interval to capture cyclical extremes," and that "[c]urrent literature on possible changes in the weather in the site region should also be reviewed to be confident that the methods used to predict weather extremes are reasonable."

COL FSAR, Revision 3, Section 2.3.1 did not address possible changes in the weather conditions in the CCNPP Unit 3 site region in relation to the general climatic characteristics

described throughout this section or, more specifically, the data on severe weather phenomena and other observed climatological extremes used as design bases for SSCs important to safety at the plant site.

As a result, in RAI 151, Question 02.03.01-27, the staff requested that the COL applicant update COL FSAR Section 2.3.1 to include a discussion on possible changes in climate conditions in the site region during the expected period of reactor operation and any potential impact on the proposed climate-related site characteristics addressed in COL FSAR Section 2.3.1 or other related COL FSAR sections that utilize this information.

In an April 14, 2010, response to RAI 151, Question 02.03.01-27, the COL applicant proposed a new Subsection 2.3.1.2.2.17 of the COL FSAR that addresses possible climate change and potential impact on related site characteristics. In this subsection, the COL applicant discusses its consideration of a 2008 report by the Maryland Commission on Climate Change, which predicts increases in temperature, modest increases in winter and spring precipitation, and increases in hurricane winds. However, the COL applicant concludes that an assessment of the potential impact on design site characteristics is inherently limited. The COL applicant's proposed revisions to the COL FSAR are acceptable to the staff. **RAI 151, Question 02.03.01-27 is being tracked as a confirmatory item**.

The staff acknowledges that long-term climate change resulting from human or natural causes may include changes in the most severe natural phenomena reported for the proposed site. However, no conclusive evidence or consensus of opinion is available on the rate of change or magnitude of changes. Further, there is a high level of uncertainty in projecting future world-wide or regional conditions because the assumptions regarding the future level of world-wide emissions of heat trapping gases depend on projections of population, economic activity, and choice of energy technologies. If it becomes evident that long-term climate change is influencing the most severe natural phenomena reported at the site, the licensees have a continuing obligation to ensure that their plants stay within the licensing basis.

2.3.1.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.3.1.6 *Conclusions*

The staff reviewed the application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the COL applicant addressed the required information relating to regional climatology, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to regional climatology incorporated by reference in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update Section 2.3.1 of this report to reflect the final disposition of the design certification application.

However, as a result of the open and/or confirmatory item(s), the staff is unable to finalize its conclusions on regional climatology in accordance with the requirements of 10 CFR 52.79(a)(1)(iii) and 10 CFR Part 100 Sections 100.20(c)(2) and 100.21(d).

2.3.2 Local Meteorology

2.3.2.1 *Introduction*

COL FSAR Section 2.3.2, "Local Meteorology," addresses local (site) meteorological site characteristics, assesses the potential influence of the plant and its facilities on local meteorological conditions and the impact of these modifications on plant design and operations, and provides a topographical description of the site and its environs.

2.3.2.2 *Summary of Application*

COL FSAR Section 2.3 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.3.2, "Local Meteorology."

In addition, in COL FSAR Section 2.3.2, the COL applicant provided the following:

Combined License Information Items

The COL applicant provided additional information in COL FSAR Section 2.3.2 to address COL Information Item No. 2.3-3 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will provide site-specific characteristics for local meteorology.

COL FSAR Section 2.3.2 cites COL Information Item No. 2.3-3, and further states that COL FSAR Sections 2.3.2.1, "Normal and Extreme Values of Meteorological Parameters," through 2.3.2.4, "References," are added as a supplement to the U.S. EPR FSAR.

COL FSAR Section 2.3.2.1 presents a summary of local meteorological characteristics based on onsite measurements and NWS station summaries from appropriate nearby locations. The information contained in COL FSAR Section 2.3.2.1 includes: Wind speed and direction (Section 2.3.2.1.1); temperature and humidity (Section 2.3.2.1.2); precipitation and fog (Section 2.3.2.1.3); atmospheric stability (Section 2.3.2.1.4); and mixing height and temperature inversion characteristics (Section 2.3.2.1.5).

COL FSAR Section 2.3.2.2, "Potential Influence of the Plant and its Facilities on Local Meteorology," briefly discusses the topographic characteristics within 1.6, 8, and 80 km (one-, five-, and 50-mi) of the CCNPP Unit 3 site, indicates that construction activity will meet all pertinent Federal and State air quality regulations, and summarizes the expected effects of operating the waste heat removal system (a closed-cycle, wet-cooling system consisting of a single hybrid mechanical draft cooling tower) in terms of plume fogging, icing, shadowing, and drift deposition. COL FSAR Section 2.3.2.2 also states that CCNPP Unit 3 is not expected to cause any significant influence on local meteorology.

The COL applicant stated that the onsite meteorological data used for the CCNPP Unit 3 COL FSAR was obtained from the monitoring program for Units 1 and 2. The COL applicant also stated that: The existing onsite program was designed and operated in accordance with Safety Guide 23, "Onsite Meteorological Programs," (1972); the pre-operational monitoring program also conforms to the recommendations in RG 1.23, Revision 1, "Meteorological Monitoring Programs for Nuclear Power Plants," March 2007, noting several deviations from

that guidance; and that the 90 percent data recovery goal was met for each year of the 6-year POR (2000 through 2005) of onsite data used.

COL FSAR Section 2.3.2.3, "Local Meteorological Conditions for Design and Operating Bases," cross-references COL FSAR Section 2.3.1.2 for a discussion of these conditions, while COL FSAR Section 2.3.2.4 contains a list of reference materials that the COL applicant used to prepare COL FSAR Section 2.3.2.

COL FSAR Section 2.3.2 concludes that local meteorological values used for design and operating bases are bounded by those in the U.S. EPR FSAR. The staff notes that unlike COL FSAR Section 2.3.1, there are no safety-related site parameters and corresponding site characteristic values presented in COL FSAR Section 2.3.2 and/or COL FSAR Table 2.0-1 that are related to local meteorological conditions. Nevertheless, two types of meteorological data are summarized in COL FSAR Section 2.3.2 that provide input to the COL applicant's safety-related atmospheric dispersion modeling in COL FSAR Sections 2.3.4 and 2.3.5, that is, meteorological data, including wind speed, wind direction, and atmospheric stability class (based on onsite measurements), and mixing height data (based on regional observations). Other meteorological information presented in COL FSAR Section 2.3.2 provides a general indication of whether the corresponding conditions discussed in COL FSAR Section 2.3.1 are reasonable.

2.3.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the local meteorology, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.3.2, "Local Meteorology."

The applicable regulatory requirements for evaluating local meteorological and climatological information are as follows:

1. 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 sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

2. 10 CFR Part 100, Section 100.20(c)(2), and 10 CFR 100.21(d) with respect to the consideration specified to the local meteorological characteristics of the site.

The related regulatory guidance is as follows:

1. RG 1.23, which provides criteria for establishing and operating an onsite meteorological measurements program for the collection of basic meteorological data needed to support plant licensing and operation

2. RG 1.206, which describes the types of local meteorological data that should be presented in COL FSAR Section 2.3.2.

2.3.2.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 2.3.2 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 2.3.2 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to local meteorological and climatological information has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

Combined License Information Items

The staff reviewed COL Information Item No. 2.3-3 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.3.2.

The staff relied upon the review guidance presented in SRP Section 2.3.2, and the regulatory guides referred to in the preceding section, to independently assess the technical sufficiency of the information presented by the COL applicant.

The topics related to meteorology, air quality, and topography that are evaluated in this SER section are organized in the same sequence that they were presented in COL FSAR, Revision 6, Section 2.3.2. However, section numbering is consistent with the organization of this report.

2.3.2.4.1 Normal and Extreme Values of Meteorological Parameters

2.3.2.4.1.1 *Wind Speed and Direction*

In COL FSAR, Revision 3, Section 2.3.2.1.1, "Wind Speed and Direction," the COL applicant provided wind speed and wind direction data summaries based on a 6-year POR of onsite meteorological data (2000 through 2005), from the existing monitoring program at the CCNPP site. These summaries were in the form of annual and monthly wind rose plots for the 10 m (33 ft) and 60 m (197 ft) wind measurement levels for the composite 6-year POR, tabular summaries of wind direction persistence frequencies at each wind measurement level for the individual years and the composite 6-year POR, and annual and monthly joint frequency distributions (JFDs) of wind speed and wind direction by atmospheric stability class for the composite POR.

For comparison, the COL applicant also presented wind rose plots for three first-order NWS stations in the region - Baltimore-Washington International (BWI) airport in Maryland; and Norfolk and Richmond international airports in Virginia – covering a 9-year period from 1984 through 1992 at all stations (with the exception of BWI, for which data from 1989 were not included). The information was provided in COL FSAR Figures 2.3-40, "BWI Annual Wind Rose," 2.3-41, "Norfolk Annual Wind Rose," and 2.3-42, "Richmond Annual Wind Rose," respectively. The offsite data were obtained from the U.S. EPA Support Center for Regulatory Air Models. The staff considers this an acceptable source of meteorological data for generating the offsite wind rose plots.

The COL applicant stated that the prevailing wind direction (i.e., the direction from which the wind blows most often) at the CCNPP Unit 3 site is from the southwest at both the 10 m (33 ft) and 60 m (197 ft) levels, on an annual basis. By comparison, annual winds prevail from the west at BWI, from the southwest at Norfolk, and from the south-southwest at Richmond. The COL applicant noted that these differences may be due to: The stations' respective locations to the Chesapeake Bay – the CCNPP site being located directly on the Chesapeake Bay, BWI about 6.4 km (4 mi) inland, Norfolk about 3.2 km (2 mi) inland; and Richmond about 80 km (50 mi) from the Chesapeake Bay; and the use of different types of wind instruments. The COL applicant also stated that the sea/land breeze phenomenon is stronger at the coastline than further inland.

In RAI 4, Question 02.03.02-1, the staff requested that the COL applicant explain why onsite wind speed and wind direction data summaries in COL FSAR Section 2.3.2.1.1 were not compared against data from the nearby Patuxent River NAS. In an October 30, 2008, response to RAI 4, Question 02.03.02-1, the COL applicant added a wind rose plot (COL FSAR Figure 2.3-223, "Patuxent River NAS Annual Wind Rose (2000 through 2005)") based on a 6-year POR that corresponded to the same period upon which the CCNPP data summaries were based (i.e., 2000 through 2005). The COL applicant obtained the Patuxent River NAS data from the NCDC's integrated surface hourly observations dataset (a reliable source of data and an extension of Reference 15 in NUREG-0800, SRP Section 2.3.1). The COL applicant also provided a figure showing a wind speed class frequency distribution for the Patuxent River NAS data.

In an October 30, 2008, response to RAI 4, Question 02.03.02-1, the COL applicant also stated that the annual prevailing wind direction is from the north at the Patuxent River NAS (which is also a prevalent wind direction at the CCNPP site), and that the frequencies of winds from the southwest through west sectors and from the northeast through east sectors were similar to those at the CCNPP site. The COL applicant stated that the difference in the prevailing wind directions for the CCNPP site and the Patuxent River NAS may be due to the two sites' different orientations with respect to the Chesapeake Bay – CCNPP with the Chesapeake Bay to the east and Patuxent River NAS with the Chesapeake Bay to the north.

The COL applicant stated that the proposed revisions to COL FSAR Section 2.3.2.1.1, including the annual wind rose plot and wind speed frequency distribution, would be provided in a future revision to the CCNPP Unit 3 COLA, along with the addition to COL FSAR Section 2.3.2.4, of a reference for the NCDC data source on which this information was based. The staff confirmed that Revision 6 of the COL FSAR, dated September 30, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the COL applicant has adequately addressed this issue and, therefore, the staff considers RAI 4, Question 02.03.02-1 resolved.

The staff noted that seasonal comparisons between wind direction frequencies from the Patuxent River NAS and onsite data from the CCNPP site show several differences, especially the percent occurrence of calm conditions. Therefore, in RAI 4, Question 02.03.02-2, the staff requested that the COL applicant describe the significance of the seasonal wind speed and direction differences between the two locations and the representativeness of the onsite wind speed and direction measurements. In a July 28, 2008, response to RAI 4, Question 02.03.02-2, the COL applicant stated that these differences were due to the orientation of these two locations with respect to the Chesapeake Bay. The COL applicant attributed the difference in the frequencies of calm conditions to the use of different instrumentation. The staff accepts these explanations and considers RAI 4,

Question 02.03.02-2 resolved. However, the staff issued several follow-up questions, as explained below.

The staff issued RAI 149, Questions 02.03.02-11 and, 02.03.02-12 regarding a number of follow-up questions resulting from the staff's consideration of the COL applicant's responses to RAI 4, Question 02.03.02-1 and RAI 4, Question 02.03.02-2, the original discussion of wind conditions in COL FSAR, Revision 3, Section 2.3.2.1.1, and the proposed revisions to that section.

In RAI 149, Question 02.03.02-11, the staff raised questions about a lack of context for the wind information presented in FSAR Section 2.3.2.1.1 and the COL applicant's proposed revisions to it, the interpretation of that data, and the discussion of the relationships between and limitations of the wind data measured onsite and at other nearby observing stations. Consequently, the staff requested that the COL applicant provide additional information to support its conclusion that the onsite data is representative of conditions within an 80 km (50 mi) radius of the site. In RAI 149, Question 02.03.02-11, the staff also stated that the COL applicant had not substantiated the related statement in COL FSAR Section 2.3.5.2, "Calculations," that the onsite meteorological data used in the dispersion analysis has been shown to be representative of the region.

Pursuant to RG 1.206, Sections C.I.2.3.2.1, C.I.2.3.3, C.I.2.3.4.2, and C.I.2.3.5.2, the staff considers it necessary to establish the relationships (and/or to address the lack thereof) among the wind roses and other wind data summaries presented in COL FSAR Section 2.3.2.1.1 and, where applicable, other parts of COL FSAR Section 2.3 where these data are used. The staff requested that the COL applicant update COL FSAR Section 2.3.2.1.1 to include:

- An explanation of why the onsite wind data are considered to be representative of near-field plume transport conditions; that is, between hypothetical accident and routine release points and the Exclusion Area Boundary, the outer boundary of the Low Population Zone, and at other receptors of interest (e.g., nearest residence, vegetable garden, milk, and meat animals)

- An explanation for the limitations of the onsite wind data in terms of how well they represent (or do not represent) far-field plume transport conditions (i.e., relative concentration and deposition values estimated out to a distance of 80 km (50 mi) from the potential routine release points at the CCNPP Unit 3 site) considering the variation in topography and several land-water interfaces over the 80 km (50 mi) radius area, and the use of a straight-line dispersion model

In evaluating wind data applicability in the context of far-field plume transport conditions, the staff also requested that the COL applicant update COL FSAR Section 2.3.2.1.1 by identifying, verifying, or addressing:

- Distances and directions of the Patuxent River NAS, and BWI, Richmond, and Norfolk international airports from the CCNPP Unit 3 site

- Distances from the Chesapeake Bay to each of the three NWS stations

- Orientation of the Chesapeake Bay coastline at BWI and Norfolk relative to the orientation of the coastline at the CCNPP Unit 3 site and the potential influence of these orientations on the wind roses presented for those locations

- Predominant topographic influence(s) on the Richmond and BWI annual wind roses, which are inland monitoring locations, as compared to those at the CCNPP Unit 3 site

And finally, in characterizing the onsite wind measurements, the staff requested that the COL applicant update COL FSAR Section 2.3.2.1.1 by:

- Demonstrating, using the onsite wind data and/or JFDs at both wind measurement levels, the presence or absence of land breeze/bay breeze circulations on a seasonal and diurnal basis

- Discussing how well the period of record of onsite data used for these wind summaries and as input to the dispersion analyses represent long-term conditions in the site area

- Cross-referencing related aspects of the dispersion modeling discussions in COL FSAR Sections 2.3.4 and 2.3.5 (e.g., meteorological input data, representativeness of terrain recirculation factors, interpretation of dispersion modeling results)

In an October 19, 2009, response to RAI 149, Question 02.03.02-11, the COL applicant explained that the onsite data is sufficiently representative of the near-field plume transport for two reasons: The onsite program is designed and operated in accordance with guidance provided in NRC RG 1.23; and the distance from the plant within which compliance with NRC requirements must be shown is generally limited to distances less than 4.8 km (3 mi). The regulations for which compliance is demonstrated within a 4.8 km (3 mi) distance include those for both design-basis accidents and routine release assessments. The COL applicant explained that the Exclusion Area Boundary and outer boundary of the Low Population Zone, for example, lie well within a 4.8 km (3 mi) radius from the plant.

With regard to suitability of wind data collected onsite for use in far-field plume transport modeling, the COL applicant stated that, generally, such suitability depends on the intended purpose of the data. Specifically, the COL applicant stated that the purpose of modeling dispersion in the far-field using onsite wind data is to show that the requirements of 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," are met. For example, such modeling supports analyses that compare the relative cost-benefit between plant equipment options to ensure public doses remain as low as is reasonably achievable (ALARA). Since comparisons between different technological or procedural options would rely on relative, and not absolute, differences in far-field doses, the onsite wind data need not be precisely representative of downwind conditions, so long as the same onsite wind data are used to compare different options.

The COL applicant also provided distances and directions to nearby NWS stations, and revised distances to the Chesapeake Bay from each of these stations. The COL applicant also described the orientation of the Chesapeake Bay coastline at BWI and Norfolk relative to the orientation at Calvert Cliffs, and the potential influence of these orientations on the respective wind roses for these locations. The COL applicant described topographic influences on the Richmond and Calvert Cliffs sites.

With regard to the existence of land and bay breeze circulations, the COL applicant stated that such circulations are assumed based on the existence of the land/water interface. The COL applicant stated that recirculation patterns can cause effluent radionuclide concentrations to

increase, which it accounted for by use of recirculation factors (i.e., default open terrain factors) that were presented in RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 0, in the AEOLUS-3 computer code. The COL applicant also described how it accounted for terrain height differences in each downwind sector. The staff's evaluation of the anticipated influence of the Chesapeake Bay on atmospheric dispersion is provided in Section 2.3.5.4.4 of this report.

The staff agrees that, for the reasons explained by the COL applicant, the onsite wind data are adequately representative of the region, and the COL FSAR changes proposed by the COL applicant are acceptable. **RAI 149, Question 02.03.02-11 is being tracked as a confirmatory item**.

The staff further evaluated the original discussion of offsite wind speed conditions at the BWI, Norfolk, and Richmond international airports in COL FSAR, Revision 3, Section 2.3.2.1.1, and in RAI 149, Question 02.03.02-12, the staff requested that the COL applicant provide additional information regarding what appeared to be incomplete and/or inaccurate descriptions of the relationships between this offsite information and the wind conditions described for the CCNPP Unit 3 site.

In an October 19, 2009, response to RAI 149, Question 02.03.02-12, the COL applicant committed to revise the COL FSAR using the average and maximum wind speeds for BWI, Norfolk, and Richmond based on 25-year PORs available in the 2008 National Climatic Data Center's Local Climatological Data summaries. This is acceptable to the staff. **RAI 149, Question 02.03.02-12 is being tracked as a confirmatory item**.

The COL applicant summarized wind direction persistence frequencies at both wind measurement levels for each year in the 2000 through 2005 POR of onsite data and for the composite 6-year POR in COL FSAR, Revision 3, Tables 2.3-42, "CCNPP 33 Feet Wind Direction Persistence Summary for Year 2000," through 2.3-48, "CCNPP 33 Feet Average Wind Direction Persistence Summary for Years 2000-2005," (10 m (33 ft) level) and in COL FSAR Tables 2.3-49, "CCNPP 197 Feet Wind Direction Persistence Summary for Year 2000," through 2.3-55, "CCNPP 197 Feet Average Wind Direction Persistence Summary for Years 2000-2005," (60 m (197 ft) level). In RAI 149, Question 02.03.02-13, the staff requested that the COL applicant verify cumulative percent of occurrence values in COL FSAR Table 2.3-48 and COL FSAR Table 2.3-55 which summarize average wind direction persistence periods for the composite 6-year POR for the 10 m (33 ft) level and 60 m (197 ft) level onsite wind measurement levels, respectively.

In an October 19, 2009, response to RAI 149, Question 02.03.02-13, the COL applicant clarified that the tables, which were generated by a safety-related code, present the average cumulative percent of occurrence. The COL applicant also stated that the values were verified by the COL applicant as correct. The COL applicant further committed to revise COL FSAR Section 2.3.2.1.1 by explaining that the persistence period is a comparison of hourly wind direction sector values, with the number of persistence events tracked along with a running count of event duration. Since persistence data is not used directly in evaluations of plant safety, the staff did not review this information further, but nevertheless considers RAI 149, Question 02.03.02-13 to be resolved. The revision of the COL FSAR to include the information provided in the COL applicant's response to **RAI 149, Question 02.03.02-13 is being tracked as a confirmatory item**.

In RAI 149, Question 02.03.02-14, the staff expressed its concerns over the inclusion of wind and atmospheric stability data summaries associated with COL FSAR, Revision 3, Sections 2.3.2.1.1 and/or 2.3.2.1.4, "Atmospheric Stability," and related tables, without a discussion that establishes its context or use. RG 1.206, Section C.I.2 indicates that COL FSAR Chapter 2 should provide information (including the meteorological characteristics of the site and vicinity) to demonstrate that the COL applicant has accurately described these characteristics and appropriately used them in the plant design and operating criteria. Further, RG 1.206, Section C.I.2.3.2.1, Item (7) only calls for annual joint frequency distributions of wind speed and wind direction by atmospheric stability class for all measurement levels.

As a result, the staff requested that the COL applicant update COL FSAR Section 2.3.2.1.1 by explaining the relevance of the monthly JFDs presented in COL FSAR, Revision 3, Tables 2.3-18, "CCNPP 33 ft (10 m) January JFD (2000-2005)," through 2.3-29, "CCNPP 33 ft (60 m) December JFD (2000-2005)," for the 10 m (33 ft) wind measurement level and in COL FSAR Tables 2.3-30, "CCNPP 33 ft (10 m) [sic] January JFD (2000-2005)," through 2.3-41, "CCNPP 197 ft (60 m) December JFD (2000-2005)," for the 60 m (197 ft) wind measurement level (e.g., by discussing if these specific data are used to illustrate some dispersion-related characteristic such as the presence or absence of land breeze/bay breeze circulations, to describe a relationship between the upper and lower wind measurement levels, or used as input directly to a dispersion model). The staff also requested that the COL applicant correct the wind measurement level in the title of COL FSAR Table 2.3-30.

In an October 19, 2009, response to RAI 149, Question 02.03.02-14, the COL applicant explained that COL FSAR, Revision 6, Tables 2.3-12, "CCNPP 33 ft (10 m) January JFD (2000-2005)," through 2.3-35, "CCNPP 197 ft (60 m) December JFD (2000-2005)," are not used in any design-related or operations-related applications and will be removed from the COL FSAR. The COL applicant will renumber affected remaining tables and update the COL FSAR text accordingly. These proposed changes to the COL FSAR are acceptable to the staff. **RAI 149, Question 02.03.02-14 is being tracked as a confirmatory item**.

The staff finds that the COL applicant has provided: A summary of local meteorological data based on onsite measurements in accordance with RG 1.23; a complete topographical description of the environs out to 80 km (50 mi); and a description of local site wind roses and annual JFDs. Therefore, the COL applicant's description of local wind speed and direction is acceptable, because it meets the first and fourth acceptance criteria of NUREG-0800, Section 2.3.2, that pertain to summaries of data collected in accordance with RG 1.23.

2.3.2.4.1.2 *Temperature and Humidity*

In COL FSAR, Revision 3, Section 2.3.2.1.2, "Temperature and Humidity," and related COL FSAR Tables 2.3-56, "CCNPP Monthly Mean Temperatures (2000-2005)," through 2.3-62, "CCNPP Minimum Hourly Temperatures (2000-2005)," the COL applicant provided monthly and annual temperature data summaries based on a 6-year POR of onsite meteorological data (2000 through 2005) from the existing monitoring program at the CCNPP site. These summaries were in the form of monthly and annual average temperatures, mean daily maximum and minimum temperatures, and maximum and minimum recorded hourly temperatures. For comparison, temperature summaries for several nearby first-order NWS and NCDC cooperative network stations in the general site area were presented in COL FSAR, Revision 3, Tables 2.3-64, "Monthly Mean Temperatures (1971-2000) at Sites Around CCNPP," through 2.3-68, "Monthly Mean Dew Point Temperatures (1983-2000) at Sites Around CCNPP,"

including: Monthly and annual average and mean daily maximum and minimum dry-bulb temperatures covering the 30-year POR from 1971 through 2000, and monthly and annual average wet-bulb and dewpoint temperatures covering the 18-year POR from 1983 through 2000.

The COL applicant stated that the monthly mean temperatures measured at the CCNPP Unit 3 site show good correspondence with the mean temperatures from the offsite stations. The staff agrees that the annual mean temperature and the range of monthly mean temperatures from the 6-year POR at the site demonstrate that regional data used for design are representative.

COL FSAR Section 2.3.2.1.3, "Precipitation and Fog," indicates that measurements of atmospheric moisture (e.g., wet-bulb or dewpoint temperature, relative humidity) are not currently taken at the CCNPP site. The COL applicant summarized monthly and annual average wet-bulb and dewpoint temperatures, and percent relative humidity for the NWS stations at BWI airport in Maryland, and at Norfolk and Richmond international airports in Virginia, in COL FSAR, Revision 3, Tables 2.3-67, "Monthly Mean Wet Bulb Temperatures (1983-2000) at Sites Around CCNPP," 2.3-68, "Monthly Mean Dew Point Temperatures (1983-2000) at Sites Around CCNPP," and 2.3-73, "Monthly Mean Relative Humidity at Sites Around CCNPP." The staff reviewed monthly and annual average dewpoint temperatures and morning and afternoon relative humidity values for the nearby Patuxent River NAS based on the NCDC's International Station Meteorological Climate Summaries for this station covering a 51-year POR from 1945 through 1995. Of the three NWS stations summarized in COL FSAR Tables 2.3-68 and 2.3-73, the dewpoint temperature and relative humidity values for the Patuxent River NAS are most similar to the observations from BWI and Richmond international airport; dewpoint and relative humidity values are consistently higher at Norfolk International airport.

The staff concludes that the monthly and annual mean wet-bulb and dewpoint temperatures and the relative humidity values in COL FSAR Tables 2.3-67, 2.3-68, and 2.3-73 bracket the atmospheric moisture conditions expected at the CCNPP Unit 3 site.

In RAI 4, Question 02.03.02-3, the staff requested that the COL applicant provide clarification on the monthly and annual temperature values presented in COL FSAR, Revision 3, Tables 2.3-56 through 2.3-63, "CCNPP Number of Hourly Temperature Values Greater Than or Less Than Indicated Value (2000-2005)," for the CCNPP site based on the 6-year POR of onsite meteorological data. The staff also requested that the COL applicant provide a definition for the terms "mean extreme" maximum and minimum temperatures in COL FSAR, Revision 3, Tables 2.3-57, "CCNPP Monthly Mean Extreme Maximum Temperatures (2000-2005)," and 2.3-58, "Monthly Mean Extreme Minimum Temperatures (2000-2005)," respectively, and to clarify how these values were determined. In addition, based on its review of the onsite meteorological data set, the staff identified potential discrepancies in several of these temperature summaries, including: The mean daily maximum and minimum temperatures for December and the composite 6-year (or annual) period in COL FSAR, Revision 3 Tables 2.3-59, "CCNPP Monthly Mean Daily Maximum Temperatures (2000-2005)," and 2.3-60, "CCNPP Monthly Mean Daily Minimum Temperatures (2000-2005)"; the maximum hourly temperature for December in COL FSAR, Revision 3, Table 2.3-61, "CCNPP Maximum Hourly Temperatures (2000-2005)"; and the minimum hourly temperature for May in COL FSAR, Revision 3, Table 2.3-62, "CCNPP Minimum Hourly Temperatures (2000-2005)."

In an October 30, 2008, response to RAI 4, Question 02.03.02-3, the COL applicant explained that the monthly mean extreme maximum and minimum temperatures represent, respectively, the highest and the lowest of the monthly average values over the data period (i.e., the 2000 through 2005 POR of onsite data). The monthly average temperature for each month of each year was calculated and then the maximum or minimum monthly average temperature value was identified, as appropriate, for each month over the composite data period. The COL applicant stated that the "Annual" values in COL FSAR, Revision 3, Tables 2.3-59 and 2.3-60 represent the highest or lowest of the monthly values. Although not mentioned, the staff notes that this approach appears to apply to all such "annual" entries in COL FSAR, Revision 3, Tables 2.3-57 through 2.3-62.

The staff reviewed the responses to RAI 4, Question 02.03.02-3 and determined that the RAI is resolved, but had a number of questions that remained unresolved. To address these questions, the staff issued a follow-up RAI 149, Question 02.03.02-15. The staff requested that the COL applicant address the following issues:

- The staff understands the definitions for the "monthly mean extreme" maximum and minimum temperatures in COL FSAR, Revision 3, Tables 2.3-57 and 2.3-58 to mean that the values simply represent either the highest or lowest of the average daily maximum or average daily minimum temperatures determined for each month from among each of the years in the 6-year POR of onsite measurements. The staff believes that referring to these highest or lowest mean values as "extreme" conditions is misleading and that the information in these tables does not represent typical climatological summaries for temperature.

  If the staff's understanding is correct, the COL applicant was requested to revise the titles of COL FSAR, Revision 3, Tables 2.3-57 and 2.3-58 and update the proposed revisions to COL FSAR Section 2.3.2.1.2 to more accurately indicate what the summaries actually represent, for example, "CCNPP Extreme Monthly Mean Maximum…" <u>or</u> "CCNPP Highest Monthly Mean Maximum…." If not, the COL applicant was requested to provide additional clarification of the definitions and table titles, or, as an alternative, delete the tables.

- Given the proposed deletion of COL FSAR, Revision 3, Tables 2.3-10, "Annual Heating and Humidification Design Conditions for Patuxent River Naval Air Station, Maryland (1982-2001)," 2.3-11, "Annual Cooling, Dehumidification, and Enthalpy Design Conditions for Patuxent River Naval Air Station, Maryland (1982-2001)," 2.3-13, "Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperature Values for Patuxent River Naval Air Station, Maryland (1982-2001)," 2.3-14, "Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperature Values for Patuxent River Naval Air Station, Maryland (1982-2001)," and 2.3-15, "Monthly Mean Daily Temperature Range for Patuxent River Naval Air Station, Maryland (1982-2001)," and the proposed revisions to COL FSAR Section 2.3.1.2.2.16 based on the COL applicant's response to RAI 5, Question 02.03.01-12, the staff requested that the COL applicant explain the relevance of the monthly design wet-bulb and mean coincident dry bulb temperatures, in COL FSAR, Revision 3, Tables 2.3-74, "Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperature Values for Patuxent River Naval Air Station, Maryland (1982-2001)," 2.3-75, "Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperature Values for Salisbury Wicomico County Airport, Maryland (1982-2001)," and 2.3-76, "Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperature Values

for Baltimore, Maryland (1982-2001)," to characterizing atmospheric moisture conditions at the site and surrounding area. The staff noted that the design of safety-related cooling towers and/or HVAC systems has already been addressed under COL FSAR Section 2.3.1 using different data summaries. The staff believes that COL FSAR Tables 2.3-67, 2.3-68, and 2.3-73 sufficiently characterize general atmospheric moisture conditions in the site area.

In an October 19, 2009, response to RAI 149, Question 02.03.02-15, the COL applicant proposed to re-title COL FSAR, Revision 3, Tables 2.3-57, "CCNPP Monthly Mean Extreme Maximum Temperatures (2000-2005)," and 2.3-58, "CCNPP Monthly Mean Extreme Minimum Temperatures (2000-2005)" to clarify that the tables contain the "CCNPP Highest Monthly Mean Maximum Temperatures (2000-2005)," and the "CCNPP Lowest Monthly Mean Maximum Temperatures (2000-2005)," respectively. (Note that these tables were relocated to COL FSAR, Revision 6, Tables 2.3-15 and 2.3-51.) In addition, the COL applicant committed to removing the description in COL FSAR, Revision 3, Section 2.3.2.1.2 regarding COL FSAR Tables 2.3-74, through 2.3-76. The staff finds this acceptable, because the revised table headings clarify the data being presented, and the removal of data that is not used in the safety analysis and which is not related to facility design improves the clarity of the COL FSAR. **RAI 149, Question 02.03.02-15 is being tracked as a confirmatory item**.

In RAI 4, Question 02.03.02-4, the staff requested that the COL applicant provide references for the temperature data for Annapolis, Cambridge, Princess Anne, Patuxent River NAS, and Mechanicsville, MD, as presented in COL FSAR, Revision 0, Tables 2.3-49, "Monthly Mean Temperatures (1971-2000) at Sites Around CCNPP," through 2.3-51, "Monthly Mean Minimum Temperatures (1971-2000) at Sites Around CCNPP." In a July 28, 2008, response to RAI 4, Question 02.03.02-4, the COL applicant stated that the tables referred to in RAI 4, Question 02.03.02-4, correspond to COL FSAR Tables 2.3-64 through 2.3-66 in Revision 3 of the COLA for CCNPP Unit 3. The COL applicant's response also identified source of monthly mean temperature data associated with these tables: The NCDC publication, "Climatography of the United States No. 81, Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971-2000," for Maryland and Virginia. The staff concurs with the use of the NCDC reference for Maryland, but notes that temperature data for Virginia is not included in COL FSAR, Revision 3, Tables 2.3-64 through 2.3-66, nor was a commitment made by the COL applicant to update COL FSAR Section 2.3.2.1.2 or annotate these tables.

The staff reviewed the response to RAI 4, Question 02.03.02-4 and determined that this RAI is resolved, but had a number of questions that remained unresolved. Consistent with RG 1.206, Section C.I.2.3.2.1, the staff issued RAI 149, Question 02.03.02-16 as a follow-up to the COL applicant's response to RAI 4, Question 02.03.02-4, requesting that the COL applicant:

- Annotate COL FSAR, Revision 3, Tables 2.3-64 through 2.3-66, and update the reference list for COL FSAR Section 2.3.2.

- Identify the references corresponding to the temperature and atmospheric moisture data presented in COL FSAR, Revision 3, Tables 2.3-67 through 2.3-73 for the NWS stations at BWI airport in Maryland, and at Norfolk and Richmond international airports in Virginia; annotate these tables; and update the reference list for COL FSAR Section 2.3.2.

In an October 19, 2009, response to RAI 149, Question 02.03.02-16, the COL applicant committed to update the list of references for COL FSAR, Revision 3, Tables 2.3-64 through

2.3-66, and 2.3-67 through 2.3-73 (which are renumbered Tables 2.3-58 through 2.3-60, and 2.3-61 through 2.3-67 in COL FSAR, Revision 6). **RAI 149, Question 02.03.02-16 is being tracked as a confirmatory item**.

With respect to maximum and minimum temperature data given in COL FSAR, Revision 3, Tables 2.3-69, "Number of Days with Maximum Hourly Temperature Value Greater Than or Equal to 90 °F at Sites Around CCNPP," through 2.3-72, "Number of Days with Minimum Temperature Value Less Than or Equal to 0 °F at Sites Around CCNPP," in RAI 4, Question 02.03.02-5, the staff requested that the COL applicant explain why 2002 LCD summaries from the NCDC were used instead of the most recent climate summaries. In a July 28, 2008, response to RAI 4, Question 02.03.02-5, the COL applicant stated that the 30-year mean data (not the annual data) from these reports were used and that the long-term average data do not change appreciably from year to year. The staff accepted that part of the COL applicant's response which indicates that long-term average data do not change appreciably from year to year. "Normals," or 30-year averages, are updated after each decade and so the POR covered in the LCDs should extend from 1971 through 2000. However, in the case of the 2002 LCDs used by the COL applicant, the 30-year averages were revised in the 2003 LCDs for these NWS stations and differ somewhat from the values given in COL FSAR Tables 2.3-69 through 2.3-72. Nevertheless, the staff accepts the temperature values reported in these tables as being reasonable. Therefore, the staff considers RAI 4, Question 02.03.02-5 resolved.

2.3.2.4.1.3 *Precipitation and Fog*

In COL FSAR, Revision 3, Section 2.3.2.1.3, the COL applicant provided precipitation information based on a 6-year POR of onsite meteorological data (2000 through 2005), from the existing monitoring program at the CCNPP site, and longer-term measurements recorded at NWS and NCDC cooperative observing stations in the site area. Onsite data were summarized in COL FSAR, Revision 3, Tables 2.3-77, "CCNPP Monthly and Annual Precipitation (2000-2005)," and 2.3-78, "CCNPP Monthly and Annual Percent Frequency of Precipitation Occurrence (2000-2005)," on a monthly and annual basis as mean totals and percent frequencies (of possible) hours, and in COL FSAR, Revision 3, Tables 2.3-79, "CCNPP Hourly Rainfall Rate Distribution (2000-2005)," and 2.3-80, "CCNPP Measured Extreme Precipitation Hourly Values (2000-2005)," as an hourly rainfall rate distribution and extreme hourly recorded values. Offsite data summaries were presented in COL FSAR Tables 2.3-81, "Mean Monthly and Annual Precipitation (1971-2000) At Sites Around CCNPP," through 2.3-83, "Monthly Mean Number of Days with Precipitation (1961-1990) At Sites Around CCNPP," as 30-year mean monthly and annual rainfall and snowfall totals, and as mean number of days with precipitation.

The staff noted that the annual average precipitation totals recorded at the CCNPP Unit 3 site given in COL FSAR, Revision 3, Table 2.3-77, were markedly less than the annual totals at all of the offsite stations given in COL FSAR Table 2.3-81, ranging from about 17.8 to 30.5 cm (7 to 12 in.) lower. Further, in considering whether onsite precipitation measurements are representative of long-term conditions, the staff compared annual precipitation totals measured at the CCNPP site (during each year of the 6-year POR) with the corresponding annual totals recorded at several first-order NWS stations in the general site area, that is, Washington National Airport (DCA) in Arlington, VA; Baltimore-Washington International (BWI) airport in Maryland; and Richmond (RIC) and Norfolk (ORF) international airports in Virginia. The annual totals for these NWS stations were obtained from the LCD summaries available for each station from the NCDC.

In RAI 4, Question 02.03.02-6, the staff requested that the COL applicant address the significance and potential causes for the discrepancies in the annual precipitation amounts between the onsite measurements and the four NWS stations.

In a July 28, 2008, response to RAI 4, Question 02.03.02-6, the COL applicant stated that precipitation can be irregular in distribution, especially if the rainfall event is convective in nature, and also suggested that this explains the data variability noted by the staff in its review. The COL applicant also stated that the rain gauge at the CCNPP site is calibrated on a semi-annual basis and has been determined to be within the accuracy requirements of the regulatory guidance.

In an October 30, 2008, response to RAI 4, Question 02.03.02-3, the COL applicant included a table of monthly and annual average precipitation totals for the CCNPP Unit 3 site based on a 15-year POR from 1992 through 2006, along with a comparison between this information and longer-term data from the Patuxent River NAS in COL FSAR, Revision 3, Table 2.3-81. The comparison indicated poor agreement between the two sites. The COL applicant indicated that this information will be provided in a future update to COL FSAR Section 2.3.2.1.3. The staff confirmed that Revision 6 of the COL FSAR, dated September 30, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the COL applicant has adequately addressed this issue and, therefore, the staff considers RAI 4, Question 02.03.02-6 resolved.

The staff does not agree with the COL applicant's explanation that the differences between precipitation measured onsite and offsite can be attributed to the localized nature of convective storms and rapid changes in the intensity of such events. These effects should not be reflected in long-term averages. The staff independently reviewed annual rainfall totals from several cooperative observing stations within 40 km (25 mi) of the CCNPP site (i.e., Solomons, Prince Frederick 1 N, Blackwater Refuge, Owings Ferry Landing, and Royal Oak 2 SSW) available online through the SERCC for the State of Maryland and found the annual rainfall totals for these stations range from about 102 to 117 cm per year (40 to 46 in. per year). These data, along with the annual precipitation totals for the stations given in COL FSAR, Revision 3, Table 2.3-81 (which is Table 2.3-75 in COL FSAR Revision 6), lead the staff to believe that the 15-year POR of onsite measurements understates annual total precipitation for the site and surrounding area by about 25 cm (10 in.)

Therefore, after considering the COL applicant's response to RAI 4, Question 02.03.02-6 and the applicable part of the response to RAI 4, Question 02.03.02-3, the staff issued a follow-up RAI 149, Question 02.03.02-17, requesting that the COL applicant update COL FSAR Section 2.3.2.1.3 and related tables by:

- Discussing the general uniformity of annual average rainfall totals over the site area (which also cover longer PORs) as opposed (or in addition) to the 15-year annual average total reported for the CCNPP site

- Confirming whether the annual data recoveries for precipitation over the 15-year POR of onsite data reported in the response to RAI 4, Question 02.03.02-3 is a possible cause for this marked discrepancy in total annual rainfall compared to all other stations in the site area

- Identifying the references that correspond to the data presented in COL FSAR, Revision 3, Tables 2.3-81 through 2.3-83 for monthly and annual average precipitation

(rainfall) and snowfall totals and updating the reference list for COL FSAR Section 2.3.2 in conformance with RG 1.206, Section C.I.2.3.2.1

In an October 19, 2009, response to RAI 149, Question 02.03.02-17, the COL applicant acknowledged that average annual precipitation for various stations in the vicinity of CCNPP are generally uniform and more than 102 cm (40 in.), with one exception: Crisfield Somers Cove, with an average annual precipitation of 92.30 cm (36.34 in.). The COL applicant believes that low data recoveries are an unlikely cause for the discrepancy in average annual rainfalls between CCNPP and nearby weather stations. The more likely cause, according to the COL applicant, as already stated in COL FSAR Section 2.3.2.1.3, is the lack of a wind screen on the site monitoring rain gauge. The COL applicant also committed to providing the references in the COL FSAR that correspond to the data presented in COL FSAR, Revision 3, Tables 2.3-81 through 2.3-83. The staff agrees with the COL applicant's explanation for the discrepancy in average rainfall values between the CCNPP and nearby weather stations. To confirm the update of the references for Tables 2.3-81 through 2.3-83 in the COL FSAR, **RAI 149, Question 02.03.02-17, is being tracked as a confirmatory item**.

In addition, in RAI 149, Question 02.03.02-18, the staff raised several concerns over the inclusion of what appears to be precipitation-related information and data, associated with COL FSAR, Revision 3, Section 2.3.2.1.3, without a discussion that establishes its context or use. RG 1.206, Section C.I.2 indicates that COL FSAR Chapter 2 should provide information (including the meteorological characteristics of the site and vicinity) to demonstrate that the COL applicant has accurately described these characteristics and appropriately used them in the plant design and operating criteria.

The staff requested that the COL applicant explain the relevance of the monthly precipitation wind roses for various rainfall rate classes as presented in COL FSAR, Revision 3, Figures 2.3-45, "CCNPP 33' (10 m) January Precipitation Wind Rose for Rate Class 0.0-0.1 in/hr," through 2.3-128, "CCNPP 33' (10 m) December Precipitation Wind Rose for All Rate Classes," for the 33-ft (10-m) wind measurement level and COL FSAR, Revision 3, Figures 2.3-129, "CCNPP 197' (60 m) January Precipitation Wind Rose for Rate Class 0.0-0.1 in/hr," through 2.3-212, "CCNPP 197' (60 m) December Precipitation Wind Rose for All Rate Classes," for the 197-ft (60-mi) wind measurement level. If retained, the COL applicant was requested to update COL FSAR Section 2.3.2.1.3 by discussing:

- Any design-or operational-related applications of this information (with appropriate cross-references provided)
- If the data are used in the dispersion modeling analyses in COL FSAR Sections 2.3.4 and/or 2.3.5 to account for wet removal of radioactive particulate material in the plume from accidental and/or routine releases from CCNPP Unit 3
- The basis for the selected rainfall rate classes
- The relationships between the 10 m (33 ft) and 60 m (197 ft) precipitation wind roses

In an October 19, 2009, response to RAI 149, Question 02.03.02-18, the COL applicant explained that monthly precipitation wind roses for various rainfall rate classes are called for in RG 1.206, Section C.I.2.3.2.1(3). However, the COL applicant committed to delete these tables principally because the figures have no design- or operational-related applications and the figures are not used in dispersion modeling. The COL applicant has committed to deleting the

corresponding paragraph in Section 2.3.2.1.3 in a future revision of the COL FSAR. The staff accepts this response. **RAI 149, Question 02.03.02-18 is being tracked as a confirmatory item**.

Finally, COL FSAR, Revision 3, Section 2.3.2.1.3 reported the average number of days per year with heavy fog conditions (i.e., visibility less than or equal to 0.4 km (0.25 mi)) for several first-order NWS stations in the general site area as follows: Baltimore (about 24 days); Richmond (about 27 days); and Norfolk (about 20 days), based on the respective LCD summaries for those stations through 2002. Except to note that fog observations are not made as part of the CCNPP onsite meteorological monitoring program, the COL applicant did not discuss which of these frequencies are more applicable to the CCNPP Unit 3 site.

Based on the 30-year POR from 1961 through 1990 reflected in the NCDC Climate Atlas of the United States (SRP Section 2.3.1, Reference 5) and specified the site's location directly adjacent to the Chesapeake Bay, the staff estimates that the CCNPP Unit 3 site is prone to about 25 to 30 days per year with heavy fog conditions. Therefore, the staff finds that the frequencies of occurrence reported by the COL applicant are acceptable.

2.3.2.4.1.4 *Atmospheric Stability*

In COL FSAR Section 2.3.2.1.4, atmospheric stability was determined using the delta temperature method, in conformance with RG 1.23, Revision 1 based on the difference between the temperature measurements at the 60 m (197 ft) and the 10 m (33 ft) observation levels. Six years of onsite meteorological data (2000 through 2005), from the existing monitoring program at the CCNPP site, was used to develop atmospheric stability persistence summaries for each year and for the composite 6-year period for the 10 m (33 ft) and the 60 m (197 ft) wind measurement levels. These stability persistence summaries are presented in COL FSAR, Revision 3, Tables 2.3-85, "CCNPP 33 ft (10 m) Annual Stability Persistence Summary for Year 2000," through 2.3-91, "CCNPP 33 ft (10 m) Annual Stability Persistence Summary for Years 2000-2005," (for 10 m (33 ft) level winds) and in COL FSAR, Revision 3, Tables 2.3-92, "CCNPP 197 ft (60 m) Annual Stability Persistence Summary for Year 2000," through 2.3-98, "CCNPP 197 ft (60 m) Annual Stability Persistence Summary for Years 2000-2005," (for 60 m (197 ft) level winds).

In RAI 4, Question 02.03.02-7, the staff requested that the COL applicant update COL FSAR Section 2.3.2.1.4 by providing monthly and annual summaries (e.g., frequencies of occurrence) of atmospheric stability class, in conformance with RG 1.206. The COL applicant responded by providing a summary table of stability class frequencies, by percent occurrence and by count of hours, covering the 2000 through 2005 POR, indicating that this information will be provided in a future update to Section 2.3.2.1.4. The staff confirmed that Revision 6 of the COL FSAR, dated September 30, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the COL applicant has adequately addressed this issue and, therefore, the staff considers RAI 4, Question 02.03.02-7 resolved.

The staff subsequently issued RAI 149, Question 02.03.02-19, identifying what appears to be erroneous cumulative percent of occurrence values in COL FSAR, Revision 3, Tables 2.3-91 and 2.3-98. The staff noted that the cumulative percent values are seen to decrease after reaching the maximum 100 (or for some stability classes 99 or 98) percent for subsequent persistence durations. The staff also noted that the same errors do not appear in the summary tables for individual years (i.e., COL FSAR, Revision 3, Tables 2.3-85 through 2.3-90 for the

10 m (33 ft) wind measurement level, and COL FSAR, Revision 3, Tables 2.3-92 through 2.3-97 for the 60 m (197 ft) wind measurement level). The staff requested that the COL applicant:

- Correct COL FSAR Tables 2.3-91 and 2.3-98
- Confirm that the cumulative percent values given in COL FSAR Tables 2.3-85 through 2.3-90 and Tables 2.3-92 through 2.3-97 of Revision 3 of the COL FSAR for CCNPP Unit 3 have been determined correctly

Finally, the COL applicant was requested to update COL FSAR Section 2.3.2.1.4 by explaining the criteria that define a stability persistence period (e.g., the conditions resulting in the end of a persistence period, whether each persistence period is viewed as a discrete event or running sequences of hours), and to clarify COL FSAR Tables 2.3-85 through 2.3-98 by indicating that the percent values for each stability class represent cumulative percentages.

In an October 19, 2009, response to RAI 149, Question 02.03.02-19, the COL applicant explained that COL FSAR Tables 2.3-91 and 2.3-98 (now COL FSAR Tables 2.3-85 and 2.3-92 in COL FSAR, Revision 6) represent the average cumulative percent of occurrence and that they will be re-titled accordingly. Because persistence data are not considered in atmospheric dispersion calculations and are, therefore, not directly relevant to the staff's safety finding, the staff did not review this further. The staff accepts this response and, therefore, the staff considers RAI 149, Question 02.03.02-19 resolved.

2.3.2.4.1.5 *Monthly Mixing Height Data and Inversion Summary*

In COL FSAR, Revision 3, Section 2.3.2.1.5, "Monthly Mixing Height Data and Inversion Summary," the COL applicant summarized the determination of monthly average mixing height values based on twice daily mixing height data obtained from the NCDC for the Wallops Island (upper air) and the Patuxent River NAS (surface) observing stations. The data covered a 10-year period from 1996 through 2005. The COL applicant discussed the number of months with invalid (or missing) data over the 10-year POR (i.e., 17 out of 120 months, with 15 of the 17 months occurring during 2006 and 2007) and stated that these missing data periods did not adversely impact the determination of the monthly and annual average mixing height values. The staff agrees with this conclusion as there was no particular bias among the missing months of data.

COL FSAR, Revision 3, Tables 2.3-99, "Monthly and Annual Average Mixing Height Values (m)," and 2.3-100, "Monthly and Annual Average Mixing Height Values (ft)," gave monthly average mixing heights for each year of the 10-year POR and for the composite 10-year period, along with a composite 10-year annual average value. COL FSAR, Revision 3, Figure 2.3-213, "Monthly Average Mixing Heights," illustrated the month-to-month variation of the composite 10-year average mixing height values. The staff compared the annual average mixing height values in COL FSAR, Revision 3, Tables 2.3-99 and 2.3-100 (748 m and 2,452 ft, respectively), to the average of the mean annual morning and afternoon mixing heights derived from plots presented by Holzworth (Reference 24 in SRP Section 2.3.1); that is, about 600 m (2,000 ft) and 1,350 m (4,400 ft), respectively, or a daily average of about 975 m (3,200 ft). From an atmospheric dispersion modeling standpoint, a lower mixing height typically represents a relatively conservative assumption. The annual average mixing height values reported in COL FSAR, Revision 3, Tables 2.3-99 and 2.3-100 (which have been relabeled as Table 2.3-99 in COL FSAR, Revision 6) are less than the annual average estimated by the staff and are, therefore, considered to be acceptable.

In RAI 4, Question 02.03.02-8, the staff requested that the COL applicant add a reference to COL FSAR Section 2.3.2.4 for the twice daily mixing height data discussed in COL FSAR Section 2.3.2.1.5. In its review of the COL applicant's July 28, 2009, response to RAI 4, Question 02.03.02-8, the staff notes that the response does not pertain to that RAI question. Further, the staff notes that the response to RAI 4, Question 02.03.02-8 is virtually the same as the COL applicant's response to RAI 4, Question 02.03.03-5, which pertains to the onsite meteorological monitoring program and the temperature data discussed in COL FSAR Section 2.3.2.1.2.

This issue was documented in RAI 149, Question 02.03.02-20, in which the staff requested that the COL applicant provide an appropriate response to RAI 4, Question 02.03.02-8. As further follow-up, in RAI 149, Question 02.03.02-20, the staff requested that the COL applicant update COL FSAR Section 2.3.2.1.5 and related tables by addressing several additional issues regarding the mixing height data associated with that section, including:

- Identifying the reference(s) that correspond to the monthly and annual average mixing in conformance with RG 1.206, Section C.I.2.3.2.1, and updating the reference list for COL FSAR Section 2.3.2

- Specifying the distance and direction of the Wallops Island upper air station and the Patuxent River NAS surface observation station from the CCNPP Unit 3 site

- Explaining the relevance of these mixing height data to the AEOLUS-3 dispersion modeling analyses in COL FSAR Sections 2.3.4 or 2.3.5, or both

In an October 19, 2009, response to RAI 149, Question 02.03.02-20, the COL applicant committed to citing the source of mixing height data (i.e., the NCDC) in a future revision of the COL FSAR. The staff finds that these additional details are responsive to staff RAIs, and considers RAI 4, Question 02.03.02-8 resolved. **RAI 149, Question 02.03.02-20 is being tracked as a confirmatory item**. The COL applicant also provided the distance and direction information for the Wallops Island Airport and Patuxent NAS, and explained the relevance of the mixing height data to the AEOLUS-3 dispersion model analyses in COL FSAR Sections 2.3.4 and 2.3.5.

COL FSAR, Revision 3, Section 2.3.2.1.5 also briefly discussed the frequency and persistence of temperature inversion conditions at the CCNPP Unit 3 site based on 6 years of data from the existing onsite monitoring program (from 2000 through 2005). These statistics were presented in COL FSAR, Revision 3, Tables 2.3-101, "Temperature Inversion Frequency and Persistence, Year 2000," through 2.3-106, "Temperature Inversion Frequency and Persistence, Year 2005," (incorrectly identified in COL FSAR, Revision 3, Section 2.3.2.1.5 as Tables 2.3-100 through 2.3-105). As presented, the results indicate that the maximum duration for a temperature inversion was 31 hrs, and that approximately two-thirds of the inversions lasted less than 9 hrs.

In RAI 149, Question 02.03.02-21, the staff requested that the COL applicant provide additional information in COL FSAR, Revision 3, Section 2.3.2.1.5 to better explain onsite temperature inversion frequency and persistence. The staff requested that the COL applicant to update COL FSAR Section 2.3.2.1.5 and COL FSAR, Revision 3, Tables 2.3-101 through 2.3-106 by:

- Explaining the criteria that define an inversion persistence period (e.g., conditions resulting in the end of a persistence period) and whether each persistence period is viewed as a discrete event or running sequences of hours

- Correcting one entry and providing a missing entry for the 19-hour persistence period in COL FSAR, Revision 3, Table 2.3-102, "Temperature Inversion Frequency and Persistence, Year 2001"

- Resolving the discrepancy between the table numbers called out in COL FSAR Section 2.3.2.1.5 (i.e., Table 2.3-100 through Table 2.3-105) and the tables as numbered (i.e., Table 2.3-101 through Table 2.3-106 and as given in the Table of Contents). The staff notes that these table numbers are among those to have been corrected in Revision 3 of the CCNPP Unit 3 COL FSAR based on the COL applicant's response to RAI 4, Question 02.03.03-4.

In an October 19, 2009, response to RAI 149, Question 02.03.02-21, the COL applicant explained that each inversion for a specific duration is a discrete event, and further explained the calculation which is used to develop the information in COL FSAR, Revision 6, Tables 2.3-101 through 2.3-106. The COL applicant also committed to correct COL FSAR Table 2.3-102, which shows a typographical error for the 19 hour-inversion frequency. The COL applicant also explained that the discrepancy in table numbers between COL FSAR Section 2.3.2.1.5 and the actual tables has been corrected in COL FSAR, Revision 6. **RAI 149, Question 02.03.02-21 is being tracked as a confirmatory item**.

2.3.2.4.1.6 *Air Quality*

The discussion in COL FSAR, Revision 3, Section 2.3.2.1.6, "Air Quality," regarding the attainment status of Calvert County, MD, with respect to the NAAQS, is similar to corresponding information presented in COL FSAR Section 2.3.1.2.1.

In COL FSAR, Revision 3, Section 2.3.2.1.6, the COL applicant stated that Calvert County, MD, is part of the Southern Maryland Intrastate AQCR and that as of December 5, 2006, Calvert County, MD, was in attainment for all the NAAQS, except for the 8-hour ozone standard. As stated in Section 2.3.1.4.2 of this report, the staff verified these statements. However, the staff notes a conflicting statement in COL FSAR Section 2.3.2.1.6 which indicates that Calvert County, MD, is in attainment for the 8-hour ozone standard.

In RAI 4, Question 02.03.02-9, the staff requested that the COL applicant discuss the potential impact on the plant of the stated non-attainment status of Calvert County, MD, with respect to the 8-hour ozone standard. In a July 28, 2008, response to RAI 4, Question 02.03.02-9, the COL applicant stated:

- In 2004, U.S. EPA designated Calvert County, MD, as a "moderate nonattainment" area for the 8-hour ozone NAAQS.

- A State Implementation Plan for the Washington, D.C. region, which includes Calvert County, MD, was required by the U.S. EPA to achieve attainment of the 8-hour ozone standard by reducing emissions of ozone precursor pollutants (e.g., nitrogen oxides (NO_x) and volatile organic compounds (VOCs)).

- Emissions of NO_x and VOCs from CCNPP Unit 3 would also be subject to restrictions imposed under air permits issued by the Maryland Department of the Environment.

The COL applicant's response also stated that operation of CCNPP Unit 3 will not result in significant generation of NO_x or VOC emissions, that typical sources of NO_x emissions "during

construction and operation" of the plant (e.g., vehicle operation and periodic operation of diesel generators for backup power) are small sources whose operation would be intermittent, and that their contribution to regional ozone levels will be insignificant. The COL applicant also identified the minor source trigger levels for NO_x and VOC emissions in an ozone non-attainment area as 25 tons per year and that emissions from CCNPP Unit 3 for both pollutants will be less than these trigger levels; indicating, therefore, that the plant would be defined as a minor source for these pollutants and as precursors for ozone.

Finally, the COL applicant's July 28, 2008, response to RAI 4, Question 02.03.02-9 concluded that non-attainment with the 8-hour ozone standard will not have a potential safety impact on construction or operation of CCNPP Unit 3.

After considering the COL applicant's response to RAI 4, Question 02.03.02-9, the guidance in SRP Section 2.3.2, Section III, "Review Procedures," Item 3e, which indicates that air quality conditions used for design and operating basis considerations should be addressed in the Safety Analysis Report, and the guidance in SRP Section 2.3.2, Section II, "Acceptance Criteria," SRP Acceptance Criterion 3 which calls for a discussion and evaluation of the influence of the plant and its facilities on the local meteorological and air quality conditions to be provided, in follow-up RAI 149, Question 02.03.02-22, the staff requested that the COL applicant update COL FSAR Section 2.3.2.1.6 by:

- Discussing the applicability of the attainment and non-attainment status designations on the design and operation of CCNPP Unit 3 (e.g., similar to the response to RAI 4, Question 02.03.02-9)

- Confirming that portion of the July 28, 2008, response to RAI 4, Question 02.03.02-9 which indicates that ozone pre-cursor emissions (i.e., NOx and VOCs) will be less than the 25 tons per year minor source trigger level for both pollutants and that non-attainment with the U.S. EPA 8-hour ozone standard will not have a potential impact on construction, considering Tables 5.5-3 and 5.5-5 under Section 5 of the "Technical Report in Support of Application …for Certificate of Public Convenience and Necessity…for Authorization to Construct Unit 3 at Calvert Cliffs Nuclear Power Plant…", which gives an estimated maximum annual emission rate of 161.9 tons per year of NO_x (as NO_2) due to equipment fuel combustion during Construction Year 2

- Citing the reference(s) that provide the basis for these (or revised) statements and updating the accompanying reference list for COL FSAR Section 2.3.2

In a December 18, 2009, response to follow-up RAI 149, Question 02.03.02-22, the COL applicant clarified that the ozone nonattainment designation for Calvert County, MD, will not impact the operation of CCNPP Unit 3. With regard to construction activities, however, the COL applicant concluded that onsite NO_x and VOC emissions during construction will exceed the applicable thresholds of 100 tons per year NO_x and 50 tons per year VOC, above which NRC will be required to complete a conformity determination.

In a December 18, 2009, response to RAI 149, Question 02.03.02-22, the COL applicant also committed to: Resolve conflicting statements in COL FSAR Sections 2.3.2.1.6 and 2.3.1.2.1 regarding the area designated as a moderate nonattainment area for the 8-hour ozone standard; and update the list of references used for statements in COL FSAR Sections 2.3.2.1.6 and 2.3.1.2.1. The staff finds that the information provided supports the COL applicant's conclusion that low emission of criteria pollutants will not have an impact on operation of

CCNPP Unit 3. Therefore, the staff considers RAI 4, Question 02.03.02-9 resolved. **RAI 149, Question 02.03.02-22 is being tracked as a confirmatory item**.

2.3.2.4.2 Potential Influence of the Plant and its Facilities on Local Meteorology

In COL FSAR, Revision 3, Section 2.3.2.2, the COL applicant summarized the topographic characteristics of the CCNPP Unit 3 site and surrounding area, indicating that the site consists of low rolling hills with elevations that range from 0 m (0 ft) above mean sea level (MSL) at the shoreline of the Chesapeake Bay to about 46 m (150 ft) above MSL. Two hills are located to the southeast (about 33.5 m (110 ft) above MSL) and to the south-southeast of CCNPP Units 1 and 2; the latter will be graded to an elevation of about 25.6 m (84 ft) above MSL as part of the development of CCNPP Unit 3. The COL applicant also indicated that the Chesapeake Bay lies in the north through the southwest sectors and that the terrain falls off steeply to the shore. The highest terrain in the vicinity of the site is said to be in the west through north-northwest sectors.

The COL applicant presented maps of terrain features within a 1.6 km (1 mi), 8 km (5 mi), and 80 km (50 mi) radius of the CCNPP Unit 3 site (as COL FSAR Figures 2.3-215, "Topography Within a 1 Mile (1.6 km) Radius of the Site," through 2.3-217, "Topography Within a 50 mi (80 km) Radius of the Site"), which appear to have been adapted from U.S. Geological Survey topographic maps. The 1-mi radius map shows the relative locations of existing CCNPP Units 1 and 2 and CCNPP Unit 3, along with the location of the existing meteorological tower.

In COL FSAR Figure 2.3-218, "Topography Within a 50 mi (80 km) Radius of the Site," the COL applicant also provided a plot of maximum terrain heights in each of the sixteen 22.5-degree compass sectors centered on true north, north-northeast, northeast, etc., out to a distance of about 80 km (50 mi) from CCNPP Unit 3. Terrain heights are relative to plant grade for CCNPP Unit 3 at 25.3 m (83 ft). The staff finds this acceptable because the terrain information meets the second acceptance criteria of NUREG-0800, Section 2.3.2, that pertains to topographical descriptions.

COL FSAR Section 2.3.2.2 also addressed cooling tower plume-related effects in terms of fogging, icing, shadowing, and drift deposition. The analysis was based on the COL applicant's implementation of the Seasonal/Annual Cooling Tower Impact (SACTI) computer model developed for the Electric Power Research Institute.

In RAI 4, Question 02.03.02-10, the staff requested that the COL applicant provide a copy of the SACTI model input files in order for the staff to conduct a confirmatory analysis. In a July 28, 2008, response to RAI 4, Question 02.03.02-10, the COL applicant stated that the design for the circulating water supply system heat dissipation system had changed from a wet mechanical draft cooling tower to a hybrid, wet/dry mechanical draft cooling tower with a high efficiency mist eliminator and corresponding reduction in the drift rate from 0.005 to 0.0005 percent. In addition, the COL applicant stated that the cycles of concentration for the Essential Service Water System (ESWS) cooling towers also changed from 2 to 10.

As a result, the original plume effects analysis performed using only the SACTI model (in support of the COL Environmental Report) was revised by the COL applicant as follows:

- Salt deposition was estimated with a U.S. EPA-approved dispersion model (AERMOD) instead of the SACTI code, because the SACTI model is only applicable to wet cooling tower plumes.

- Salt emissions from both the CWS cooling tower and the ESWS cooling towers were included in the AERMOD analysis for completeness (whereas salt emissions from only the CWS cooling tower had been considered in the original SACTI analysis based on the COL applicant's expectation that the relative contribution from the ESWS cooling towers was negligible).

- Salt deposition rates were estimated by AERMOD at an array of receptors around the CWS cooling tower, including the location of the existing substation for CCNPP Units 1 and 2, and the planned location for the CCNPP Unit 3 electrical substation.

- The fogging, icing, and visible plume analysis using the SACTI model was revised, excluding the CWS cooling tower plume (because of the tower design change), but now accounting for the plumes from two of the four ESWS cooling towers (the worst-case operating scenario), whereas the original SACTI modeling did not include the ESWS cooling towers, because the CWS cooling tower exhaust was far greater than that from the ESWS cooling towers.

The COL applicant provided modeled source parameters for both types of cooling towers, as well as the computer dispersion modeling files for the AERMOD and revised SACTI analyses.

With respect to the remodeled salt deposition rates using AERMOD, the COL applicant stated that the ESWS contribution to the total salt deposition was expected, and later confirmed, to be negligible compared to that from the CWS cooling tower. With regards to the revised plume effects analysis with the SACTI model, the COL applicant stated that the results indicated a low probability of occurrence of visible plumes from the ESWS cooling towers, with the highest frequency of occurrence limited to a distance of 100 m (328 ft) from the location of the ESWS units. Beyond 100 m, the SACTI modeling results showed the plume dissipating rapidly and the plume frequency dropping to a range of 0 percent to 2.1 percent depending on distance and direction.

The COL applicant stated that the COLFSAR would be updated in a future revision to the CCNPP Unit 3 COLA to reflect the use of the higher efficiency drift eliminators for the CWS cooling tower and the higher cycles of concentration for the ESWS cooling tower. **RAI 4, Question 02.03.02-10 is being tracked as a confirmatory item**. The staff also found that the maximum salt deposition rate on a monthly basis at the CCNPP Unit 3 switchyard indicates that it is less than half of the lower limit of the contamination level referred to as "light" in Institute of Electrical and Electronics Engineers (IEEE) Standard (Std) C57.19.100-1995, "Guide for Application of Power Apparatus Bushings."

The staff reviewed the information provided by the COL applicant and determined that the potential influence of the plant and its facilities on local meteorology is negligible. Therefore, the staff finds this acceptable because it meets the third acceptance criteria of NUREG-0800, Section 2.3.2 regarding the evaluation of the plant's influence on local meteorology.

2.3.2.4.3 Local Meteorological Conditions for Design and Operating Bases

Meteorological conditions for design and operating bases are discussed in COL FSAR Section 2.3.1.2 – in particular Section 2.3.1.2.2.12, Section 2.3.1.2.2.13, Section 2.3.1.2.2.14, Section 2.3.1.2.2.15, and Section 2.3.1.2.2.16.

Related information also appears in COL FSAR Section 2.3.1.2.2.2, Section 2.3.1.2.2.6, Section 2.3.1.2.2.9, and Section 2.3.1.2.2.10.

2.3.2.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.3.2.6 *Conclusions*

The staff reviewed the application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the COL applicant addressed the required information relating to local meteorological and climatological information, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the local meteorology incorporated by reference in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update Section 2.3.2 of this report to reflect the final disposition of the design certification application.

However, as a result of the confirmatory items, the staff is unable to finalize its conclusions on local meteorology in accordance with the requirements of 10 CFR 52.79(a)(1)(iii) and 10 CFR Part 100, Sections 100.20(c)(2) and 100.21(d).

2.3.3 Onsite Meteorological Measurement Program

2.3.3.1 *Introduction*

COL FSAR Section 2.3.3, "Onsite Meteorological Measurement Program," of the CCNPP Unit 3 COL FSAR discusses the preoperational and operational onsite meteorological measurements programs and the resulting data. The staff's review covers the following specific areas: Meteorological instrumentation, including siting of sensors, sensor type and performance specifications, methods, and equipment for recording sensor output, the quality assurance program for sensors and recorders, data acquisition and reduction procedures, and special considerations for complex terrain sites.

The staff's review also evaluated the resulting onsite meteorological database (for the preoperational monitoring phase) including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions.

2.3.3.2 *Summary of Application*

COL FSAR Section 2.3 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.3.3, "Onsite Meteorological Measurement Program."

In addition, in COL FSAR Section 2.3.3, the COL applicant provided the following:

Combined License Information Items

The COL applicant provided additional information in COL FSAR Section 2.3.3 to address COL Information Item No. 2.3-4 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> A COL applicant that references the U.S. EPR design certification will provide the site-specific, onsite meteorological measurement program.

In response to this COL information item, the COL applicant stated that COL FSAR Sections 2.3.3.1, "Preoperational Meteorological Measurement Program," through 2.3.3.3, "References" are added as a supplement to the U.S. EPR FSAR.

COL FSAR Sections 2.3.3.1 and 2.3.3.2, "Operational Meteorological Measurement Program," describe the preoperational and operational phase monitoring programs, respectively, including: The location of the meteorological tower; tower design characteristics; descriptions of instrumentation, instrument maintenance, and surveillance schedules; data reduction and compilation activities; and the potential effects of nearby obstructions to air flow. For the CCNPP Unit 3 COL FSAR, preoperational phase onsite data summaries were based on measurements from the existing operational phase meteorological monitoring program operated in support of CCNPP Units 1 and 2 over a 6-year POR from 2000 through 2005. The same monitoring system will be shared by CCNPP Units 1 and 2 and CCNPP Unit 3 during their respective operational phases. Consequently, the discussions in COL FSAR Section 2.3.3.1 and Section 2.3.3.2 are similar.

Onsite measurements include: Wind speed and wind direction at two levels on a 60-m (197-ft) tall, open lattice, guyed meteorological tower – 10 m (33 ft) and 60 m (197 ft); duplicate sets of temperature sensors at the 10 m (33 ft) and 60 m (197 ft) levels; a rain gauge near the base of the tower; and a barometric pressure sensor in the nearby tower shelter.

The preoperational phase monitoring program was designed and maintained in accordance with the guidance in Safety Guide 23 (1972). The COL applicant also stated that the program meets the guidance in RG 1.23, Revision 1, since it has upgraded the equipment for CCNPP Unit 3. Deviations from the guidance in RG 1.23, Revision 1, were also identified.

The staff notes that, like COL FSAR Section 2.3.2, there are no safety-related site parameters and corresponding site characteristic values presented in COL FSAR Section 2.3.3 or COL FSAR Table 2.0-1 that are related to the onsite meteorological measurements program. However, as noted in Section 2.3.2.2 of this report, onsite meteorological data are summarized in COL FSAR Section 2.3.2. Onsite data are used in the COL applicant's safety-related atmospheric dispersion modeling in COL FSAR Sections 2.3.4 and 2.3.5.

2.3.3.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the onsite meteorological measurements program, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.3.3, "Onsite Meteorological Measurements Programs."

The applicable regulatory requirements for the onsite meteorological measurements program are as follows:

1. 10 CFR Part 20, “Standards for protection against radiation,” 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.

2. 10 CFR 50.47, “Emergency Plans,” Paragraphs (b)(4), (b)(8), and (b)(9), as well as of 10 CFR Part 50, Appendix E, “Emergency Planning and Preparedness for Production and Utilization Facilities,” Section IV, “Content of Emergency Plans,” E, “Emergency Facilities and Equipment,” Item 2 with respect to the onsite meteorological information available for determining the magnitude and continuously assessing the impact of the releases of radioactive materials to the environment during a radiological emergency.

3. 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 19, “Control Room,” with respect to the meteorological considerations used to evaluate the personnel exposures inside the control room during radiological and airborne hazardous material accident conditions.

4. 10 CFR Part 50, Appendix I with respect to meteorological data used in determining the compliance with the 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 ALARA.

5. 10 CFR Part 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.

6. 10 CFR Part 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.

The related regulatory guidance is as follows:

1. RG 1.23, Revision 1, March 2007 which provides criteria for establishing and operating an onsite meteorological measurements program for the collection of basic meteorological data needed to support plant licensing and operation.

2. RG 1.206, Revision 0, June 2007 which essentially reiterates the types of information, identified in SRP Section 2.3.3, that a COL applicant should provide in FSAR Section 2.3.3 when describing the preoperational and operational phase onsite meteorological monitoring programs.

2.3.3.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 2.3.3 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and

incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 2.3.3 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to the onsite meteorological measurements program has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

Combined License Information Items

The staff reviewed COL Information Item No. 2.3-4 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.3.3.

The staff relied upon the review guidance presented in SRP Section 2.3.3, and the regulatory guides referred to in the preceding section, to independently assess the technical sufficiency of the information presented by the COL applicant. In the staff's evaluation that follows, the staff also describes instances in which certain facts stated in the FSAR were confirmed during a pre-application site visit held on June 5, 2007, "Calvert Cliffs Pre-Application Site Visit: Review of the Pre-operational and Operational Onsite Meteorological Monitoring Program." The purpose of the site visit was to: (1) Become familiar with the COL applicant's site and site selection process, plans, schedules, and initiatives; (2) observe and review the preoperational phase onsite meteorological monitoring program; and (3) review the COL applicant's plans for its operational phase onsite monitoring program.

The topics related to the siting and instrumentation associated with the CCNPP Unit 3 onsite meteorological monitoring programs; the operation, maintenance, and calibration of its systems; and the processing of the collected data, that are evaluated in this section are, for the most part, organized in the same sequence that they were presented in COL FSAR, Revision 3, Section 2.3.3. However, section numbering is consistent with the organization of this report. Similarly, section titles are the same as in COL FSAR Section 2.3.3.

2.3.3.4.1 Preoperational Meteorological Measurement Program

In COL FSAR Section 2.3.3.1, the preoperational phase meteorological measurement program, which provided onsite data used in COL FSAR Section 2.3 of the CCNPP Unit 3 COLA, was based on the existing operational phase meteorological monitoring program operated in support of CCNPP Units 1 and 2. The COL applicant stated that CCNPP Unit 3 is located about 610 m (2,000 ft) south of CCNPP Units 1 and 2.

As such, the monitoring program was originally designed and maintained in accordance with the guidance in Safety Guide 23 (1972), although the COL applicant also stated that the program meets the guidance of RG 1.23, Revision 1, with several deviations. The staff notes that deviations from that guidance are identified in and evaluated further in Section 2.3.3.4.1.7 of this report.

The staff finds that both the preoperational and operational phase monitoring programs were described by the COL applicant, as described in the first acceptance criterion of NUREG-0800, Section 2.3.3, "Standard Review Plan for the Review of the Safety Analysis Reports for Nuclear Power Plants: LWR Edition."

2.3.3.4.1.1 *Tower Location*

In COL FSAR, Revision 6, Section 2.3.3.1.1, "Tower Location," the COL applicant stated that the meteorological tower is located on level, open terrain with an elevation at its base of about 38.1 m (125 ft) above MSL. The staff observed, during the CCNPP Unit 3 pre-application site visit, that natural vegetation (i.e., grass) surrounds the base of the tower.

COL FSAR Section 2.3.3.1.1 also states that the tower is located at a distance of at least 10 times the height of any nearby obstruction that exceeds one-half the height of the wind measurement level. However, the COL applicant noted one potential exception, that is, trees located to the south of the tower. The COL applicant stated that tree heights and distances will be calculated and an evaluation performed to determine whether the trees should be removed.

In RAI 3, Question 02.03.03-1, the staff requested that the COL applicant provide the results of the COL applicant's determination of the heights of these trees and their distances from the meteorological tower, and its evaluation of whether they should be removed. In a July 28, 2008, response to RAI 3, Question 02.03.03-1, the COL applicant indicated that the determination and evaluation was expected to be completed by the end of 2008 and that the results will be made available to the staff upon completion. In a follow-up RAI 261, Question 02.03.03-10, the staff requested that the COL applicant provide the evaluation of whether trees should be removed or topped, and a confirmation of whether the removal and/or topping activity has been completed. **RAI 261, Question 02.03.03-10 is being tracked as an open item**.

The staff also evaluated the distance of the tower from existing Calvert Cliffs Units 1 and 2 and the existing Turbine Building (which is 760 m (2,500 ft), as noted in Figure 2.3-2 of Revision 15 of the updated safety analysis report (USAR) for the Calvert Cliffs independent spent fuel storage installation (ISFSI)), and determined that the RG 1.23 criterion for separation from nearby obstructions is met for these structures.

The tower location complies with the recommendations provided in Regulatory Position 3 of RG 1.23, Revision 1, and is, therefore, acceptable to the staff.

2.3.3.4.1.2 *Tower Design*

In COL FSAR, Revision 6, Section 2.3.3.1.2, "Tower Design," the COL applicant stated that the meteorological tower is 60 m (197 ft) tall with a lattice frame capable of withstanding wind speeds up to 44.7 m/s (100 mph). During the pre-application site visit, the staff confirmed the specified tower design. The tower is a 60 m (197 ft), dual observation level (60 m and 10 m), guyed, Rohn Model 55G, with an instrument elevator system.

The tower design complies with the general recommendations provided in Regulatory Position 2 of RG 1.23 and is, therefore, acceptable to the staff.

2.3.3.4.1.3 *Instrumentation*

In COL FSAR, Revision 3, Section 2.3.3.1.3, "Instrumentation," the COL applicant stated that the instrumentation on the meteorological tower consists of wind speed, wind direction, and duplicate sets of aspirated temperature sensors located at 60 m (197 ft) and 10 m (33 ft) above ground level; that a tipping bucket rain gauge is located approximately 9.1 m (30 ft) from the tower in an open field; and that a barometric pressure sensor is located in the nearby meteorological building (Met Building). The COL applicant also stated that atmospheric

moisture (e.g., dewpoint or wet-bulb temperature, relative humidity) is not directly measured onsite.

Data acquisition and processing is accomplished by redundant data loggers – each collecting data from the instruments and performing various calculations and data averaging. The primary data logger transmits averaged data values to a personal computer, dedicated to the meteorological measurement system, located in the nearby Met Building. The backup data logger is connected to a dial-up modem allowing for remote data retrieval. The primary data logger and plant equipment are isolated from the telephone connection to the backup data logger.

In COL FSAR Section 2.3.3.1.3, the COL applicant also stated that the meteorological monitoring instrumentation was replaced in December 2005; that the specifications of the previous instruments met or exceeded the accuracy and resolution guidance in of RG 1.23; Revision 1, and that the instruments were positioned on the tower in accordance with the guidance in RG 1.23.

During the CCNPP Unit 3 pre-application site visit, the staff noted that the wind and temperature sensors on the 60 m (197 ft) tower were mounted on 2.4 m (8 ft) instrument booms on the west side of the tower, which, according to the COL applicant, is oriented into the prevailing westerly winds. The staff also noted that the wind sensors were mechanical-type cup and vane-sets. Based on the 10 m (33 ft) and 60 m (197 ft) composite annual wind rose plots (in COL FSAR Figures 2.3-14, "CCNPP 33' (10 m) Annual Wind Rose (2000-2005)," and 2.3-15, "CCNPP 197' (60 m) Annual Wind Rose (2000-2005)," respectively), which cover the 6-year POR of onsite measurements from 2000 through 2005, the staff: (1) Concurs that wind directions at both levels have a predominantly westerly component; and (2) believes that tower-induced wake effects should generally be minimal specified instrument boom length and orientation. Consequently, siting of the wind and temperature sensors on the 60 m (197 ft) meteorological tower is in accordance with the recommendations in Regulatory Position 3 of RG 1.23, Revision 1, and is, therefore, acceptable to the staff.

During the pre-application site visit, the COL applicant also stated that the vertical temperature difference is determined for each set of upper and lower temperature sensors (the duplicate sets referred to as the "A" and "B" trains), by a subtraction routine in the data logger based on the difference between the temperature measurements at the 60 m (197 ft) and 10 m (33 ft) levels on the tower. This approach is in conformance with the definition for vertical temperature difference (or delta T) in Regulatory Position 1 of RG 1.23, Revision 1, and is, therefore, acceptable to the staff.

In lieu of onsite measurements of atmospheric moisture-related data, the COL applicant used concurrent moisture and/or dry-bulb temperature data from the nearby Patuxent River NAS to characterize site conditions and for evaluating the design of the CCNPP Unit 3 ultimate heat sink and safety-related HVAC systems. Sections 2.3.1.4.3.13 and 2.3.1.4.3.16 of this report discuss the staff's evaluation of this alternate data source.

During the pre-application site visit, the staff noted that the precipitation gauge does not include a wind shield to minimize wind-caused loss of precipitation. In Section 2.3.2.4.1.3 of this report, the staff concluded that, over the 6-year POR from 2000 through 2005, the annual average precipitation total for the CCNPP site ranged from about 7 to 30.5 cm (2.8 to 12.0 in.) less than the longer-term annual average totals at the six offsite observing stations given in COL FSAR, Revision 6, Table 2.3-75. However, the COL applicant does not rely on precipitation data

collected on site to develop site characteristics as discussed in Section 2.4 of this report. This deviation is discussed further in Section 2.3.3.4.1.7 and Section 2.3.3.4.2.7 of this report.

Pre-application site visit activities also included the review of various documents associated with the design and operation of the meteorological monitoring system, and an evaluation of the instrument accuracies given in COL FSAR Table 2.3-108, "Tower Instrument Specifications and Accuracies for Meteorological Monitoring Program (Preoperational and Operational)." As a result, in RAI 3, Question 02.03.03-2, the staff requested that the COL applicant describe how the accuracy specification for the vertical temperature difference was calculated. In a July 28, 2008, response to RAI 3, Question 02.03.03-2, the COL applicant stated that the accuracy for the vertical temperature difference was based on the accuracy of the platinum resistance temperature detectors (RTDs) used in the measurement system (i.e., ±0.05 ^{o}C (±0.106 °F)). The COL applicant also indicated that the temperature difference for the "A" and "B" temperature systems was based on the difference between the 10 m (33 ft) temperature and the 60 m (197 ft) temperature for a specified system ("A" or "B"). The staff agrees with the approach used by the COL applicant. Therefore, the staff considers RAI 3, Question 02.03.03-2 resolved.

2.3.3.4.1.4 *Instrument Maintenance and Surveillance Schedules*

In COL FSAR Section 2.3.3.1.4, "Instrument Maintenance and Surveillance Schedules," the COL applicant stated that the meteorological instruments are inspected and serviced at a frequency that assures at least a 90 percent data recovery rate for all parameters, including the combination of wind speed, wind direction, and delta temperature. The instruments are channel checked on a daily basis and instrument calibrations are performed semi-annually. The instrument maintenance and surveillance schedules comply with the recommendations provided in Regulatory Position 5 of RG 1.23. In addition, no issues were identified as a result of the staff's review of the Calvert Cliffs "Meteorological Calibration" procedure and a separate annual preventive maintenance procedure during the pre-application site visit.

Further, the COL applicant stated in COL FSAR Section 2.3.2 that the data recovery goal of 90 percent was met for each year of the 6-year POR during the preoperational monitoring phase. As an indicator of the effectiveness of these activities, the staff independently calculated the data recovery rates for individual parameters during this POR. The staff's calculated values are shown below in Table 2.3-5. The individual data recovery rates for wind speed, wind direction, and atmospheric stability are such that the joint recovery of these three parameters is likewise greater than the 90 percent acceptance criterion in RG 1.23.

Table 2.3-5 Meteorological Data Recovery Rates for 2000-2005

Parameter	2000	2001	2002	2003	2004	2005
WD (60 meters)	98.0	99.5	98.8	98.0	99.1	98.1
WS (60 meters)	98.6	100.0	99.7	99.3	99.1	97.8
Temp (60 meters)	99.4	99.7	99.9	97.9	99.9	98.6
WD (10 meters)	97.3	98.2	96.7	98.1	97.8	97.1
WS (10 meters)	99.0	100.0	99.7	99.4	99.0	98.0
Temp (10 meters)	99.4	99.6	100.0	99.9	99.9	98.6
ΔT (60-10 meters)	98.8	99.5	99.8	97.7	99.5	98.5
Precip	91.4	100.0	100.0	97.9	100.0	100.0

Notes: WD = Wind Direction; WS = Wind Speed; Temp = Ambient Temperature;
ΔT = Delta-Temperature difference 60 m and 10 m measurement levels; Precip = Precipitation

Therefore, the staff considers the adequacy of the instrument maintenance and surveillance, and calibration activities, at least as implemented during the preoperational phase of meteorological monitoring, to be acceptable.

2.3.3.4.1.5 *Data Reduction and Compilation*

In COL FSAR Section 2.3.3.1.5, "Data Reduction and Compilation," the COL applicant stated that wind and temperature data are averaged over 15-minute periods. The data loggers employ a validation mode that monitors the various sensors, activates alarms as necessary, and compares the data values from the 10 m (33 ft) and 60 m (197 ft) levels of the meteorological tower. The data loggers also perform a daily check of the processor cards and alarm if the values are outside specified limits. Software collects averaged data values, maximum and minimum ambient temperatures, and calculated wind direction variance data (or sigma-theta). Hourly data values are determined from the 15-minute average values.

COL FSAR Section 2.3.3.1.5 also indicated that the 15-minute averaged data are available to support radiological emergency assessments pursuant to 10 CFR 50.47 and 10 CFR Part 50, Appendix E, and that the hourly averaged data are available for determining:

- Whether radiological effluent release limits associated with normal operations are met for any individual located off site
- Whether radiological dose consequences of postulated accidents meet prescribed limits at the EAB and LPZ
- Compliance with the numerical guides for design objectives and limiting conditions for operation to ensure that radioactive materials in effluents released to unrestricted areas are kept as low as is reasonably achievable
- Compliance with dose limits for individual members of the public

- Personnel exposures in the Control Room during radiological and airborne hazardous material accident conditions

The staff notes that these applications of the hourly onsite meteorological data are responsive to the requirements, respectively, in: 10 CFR 100.21(c) (first and second items); 10 CFR Part 50, Appendix I; 10 CFR Part 20, SubPart D; and GDC 19 in 10 CFR Part 50, Appendix A. For the onsite meteorological data acquired during the preoperational monitoring phase, these applications are reflected in the atmospheric dispersion modeling analyses in COL FSAR Section 2.3.4 and 2.3.5, and in the radiological dose assessments in related COL FSAR Chapters 6, 11, and 15.

The staff also notes that data archival is addressed only in terms of the availability of annual JFD summaries which are maintained on site.

Based upon its review of COL FSAR, Revision 3, Section 2.3.3.1.5 in RAI 3, Question 02.03.03-3, the staff requested that the COL applicant provide the digital sampling rate for the meteorological data as part of the preoperational and operational phase onsite meteorological measurements programs. In a July 28, 2008, response to RAI 3, Question 02.03.03-3, the COL applicant stated that the sampling rate is every 10 seconds (sec), that such data are used to create 15-minute averages, and that the 15-minute sample on the hour is used to create the hourly average. The staff finds that the 10 sec sampling rate is sufficiently close to the 5-sec rate recommended in RG 1.23, Revision 1. Therefore, the staff considers RAI 3, Question 02.03.03-3 resolved.

COL FSAR, Revision 3, Section 2.3.3.1.5 also provided a cross-reference to COL FSAR Section 2.3.2 regarding the presentation of joint frequency distributions of wind speed and wind direction by atmospheric stability class based on onsite measurements over the 6-year POR from 2000 through 2005, and wind rose plots for three NWS stations in the general site area. COL FSAR Section 2.3.3.1.5 also compared:

- The prevailing (annual) wind directions for the CCNPP site and the NWS station at Norfolk, VA (noting that of the three NWS stations, Norfolk is the closest to the Chesapeake Bay)

- The frequency of occurrence of wind speeds, at both locations, within certain ranges for the prevailing wind direction (stated as being from the south-southwest) and for the most prevalent wind speed classes at each location

The COL applicant concluded that the CCNPP Unit 3 onsite data represent long-term conditions at the site on the basis of these comparisons.

In RAI 3, Question 02.03.03-7, the staff noted that RG 1.206, Section C.I.2.3.3, calls for a COL applicant to provide evidence showing how well onsite meteorological measurements represent long-term conditions at the site. The staff also pointed out that COL FSAR Section 2.3.3.1.5 presented a comparison using onsite and offsite data sources for wind speed and wind direction, but that there was no discussion regarding onsite temperature measurements. As a result, the staff requested that the COL applicant demonstrate how well onsite temperature measurements represent long-term conditions at the site.

In a July 28, 2008, response to RAI 3, Question 02.03.03-7, the COL applicant indicated that monthly mean temperatures measured at the CCNPP Unit 3 site and at surrounding observing

stations show good correspondence. The COL applicant also stated that a future revision of the CCNPP Unit 3 COLA would include an update to COL FSAR Section 2.3.3.1.5 by appending a cross-reference to COL FSAR Section 2.3.2.1.2, regarding this comparison of temperature data, to a discussion of onsite and offsite wind data. This cross-reference is included in COL FSAR, Revision 6. Therefore, the staff considers RAI 3, Question 02.03.03-7 resolved.

2.3.3.4.1.6 *Nearby Obstructions to Air Flow*

In COL FSAR Section 2.3.3.1.6, "Nearby Obstructions to Air Flow," the COL applicant briefly discussed nearby natural and manmade obstructions to air flow in relation to the location of the onsite meteorological tower and the potential influence of those obstructions on the measurements made during the preoperational monitoring phase. The COL applicant stated that the highest terrain elevations within about 0.8 km (0.5 mi) of the onsite meteorological tower are located to the north and north-northwest; the lowest terrain elevations are to the northeast, east-northeast, and east (i.e., the Chesapeake Bay). The COL applicant also stated that the two tallest structures for the U.S. EPR design are the Reactor Building and the Turbine Building, that finished grade elevation will be about 25 m (83 ft) above MSL at both buildings, and that the grade elevation at the meteorological tower is about 38 m (125 ft) above MSL.

The COL applicant also provided information regarding the heights of three nearby structures, as an inset to COL FSAR Section 2.3.3.1.6, as shown below in Table 2.3-6.

Table 2.3-6 Heights of Structures Near the Onsite Meteorological Tower

Structure	Height (above grade)	Distance to Meteorological Tower
CCNPP Unit 3 Reactor Building	62 m (203 ft)	850 m (2,789 ft)
CCNPP Unit 3 Turbine Building	55 m (180 ft)[b]	773 m (2,535 ft)
ISFSI[a] for CCNPP Units 1 and 2	7 m (23 ft)[b]	206 m (676 ft)

[a] – Independent Spent Fuel Storage Installation

[b] – Height of structure above grade is estimated.

As stated in Section 2.3.3.4.1.1 of this report, the tower location complies with the recommendations provided in Regulatory Position 3 of RG 1.23, Revision 1, and is, therefore, acceptable to the staff.

2.3.3.4.1.7 *Deviations to Guidance from Regulatory Guide 1.23*

In COL FSAR, Revision 6, Section 2.3.3.1.7, "Deviations to Guidance from Regulatory Guide 1.23," the COL applicant identified the following deviations from the guidance in RG 1.23, Revision 1, for the CCNPP Unit 3 preoperational phase meteorological monitoring program:

- No onsite atmospheric moisture measurements are taken.

- The meteorological tower is not sited at approximately the same elevation as the finished plant grade for CCNPP Unit 3.

- Inspections of the tower, guy wires, and anchors are performed once every 5 years instead of an annual inspection for the tower and guy wires, and inspection of the anchors once every 3 years.

The staff notes that these deviations relate to the guidance in Regulatory Positions 2.5, 3, and 5, respectively, in RG 1.23.

The staff believes that, for the preoperational monitoring phase, the COL applicant has adequately justified the noted deviations from RG 1.23. Regarding the first deviation, atmospheric moisture (and temperature) data, used in the analysis of the UHS and safety-related HVAC system design, and for evaluating cooling tower-related effects, were obtained from a nearby, reasonably representative site (i.e., the Patuxent River NAS located about 18 km (11 mi) south of the CCNPP site).

Regarding the second deviation, the difference between plant grade and the meteorological tower is only 12 m (40 ft). Since the increased height occurs over a gentle slope upwards, one could reasonably expect similar wind speeds and direction at both plant grade and the meteorological tower. Further, with the possible exception of nearby trees, as noted above in Section 2.3.3.4.1.1 of this report, the COL applicant sited the tower to assure that it was located on level, open terrain at a distance of at least 10 times the height of any nearby obstruction that exceeds one-half the height of the wind measurement level. Finally, regarding the third deviation, the regulatory guidance pertaining to inspections of the meteorological tower, guy wires, and tower anchors represent new guidance in RG 1.23, Revision 1; and Safety Guide 23 (1972) is silent on such inspection provisions.

2.3.3.4.1.8 *Special Considerations for Complex Terrain Sites*

The discussions under COL FSAR, Revision 3, Section 2.3.3.1 did not specifically address the implications (if any) of the CCNPP Unit 3 site's location adjacent to the Chesapeake Bay in terms of the scope of the preoperational phase meteorological monitoring program and the representativeness of the resulting data. Therefore, in RAI 3, Question 02.03.03-5, the staff noted that SRP Section 2.3.3 states that a site near a large body of water may need additional measuring points to determine airflow patterns and spatial variations of atmospheric stability (i.e., wind and temperature instrumentation). As a result, the staff requested that the COL applicant discuss, in COL FSAR Section 2.3.3, the need (or lack thereof) for having additional meteorological instruments on site due to the influences of the Chesapeake Bay.

In a July 28, 2008, response to RAI 3, Question 02.03.03-5, the COL applicant provided its justification for it not having to make measurements at additional locations based on two points: (1) The monitoring program established for CCNPP Units 1 and 2 has operated successfully throughout the operating life of those units without the need for additional meteorological measuring points; and (2) the similarity between mean temperature conditions measured on site and at several nearby NWS (and NCDC cooperative observing network) stations. The COL applicant also indicated that a future revision of the CCNPP Unit 3 COLA would include an update to COL FSAR Section 2.3.3.1 by including a reference to COL FSAR Section 2.3.2.1.2. The COL applicant updated COL FSAR, Revision 6 to include this cross-reference. The staff finds this acceptable. The staff's evaluation of the anticipated influence of the Chesapeake Bay

on atmospheric dispersion is provided in Section 2.3.5.4.4 of this report. Therefore, the staff considers RAI 3, Question 02.03.03-5 resolved.

2.3.3.4.1.9 *Evaluation of Preoperational Monitoring Phase Meteorological Data*

Consistent with SRP Section 2.3.3, Section II (Acceptance Criteria), SRP Acceptance Criterion (2)(b), and RG 1.206, Section C.I.2.3.3 (Paragraphs 2 and 3), the COL applicant provided:

- Joint frequency distributions of wind speed and wind direction by atmospheric stability class in a format called for by Regulatory Position 6 as specified in RG 1.23, Revision 1, Table 3

- Sequential, hourly-averaged meteorological data in a format called for by Regulatory Position 6 as specified in RG 1.23, Revision 1, Appendix A

The JFDs appear as a series of tables associated with COL FSAR Section 2.3 (see COL FSAR Tables 2.3-10, "CCNPP 33 ft (10 m) Annual JFD," through 2.3-35, "CCNPP 197 ft (60 m) December JFD (2000-2005)." These JFDs represented composite annual and monthly summaries for the 10 m (33 ft) and 60 m (197 ft) wind measurement levels covering the 6-year POR from 2000 through 2005 of the preoperational monitoring program phase. The hourly-averaged meteorological data, covering the same POR, were provided as electronic files in a supplemental submittal to the COLA. The hourly data, and the JFDs on which they were based, provided input to various onsite data summaries in COL FSAR Sections 2.3.1 and 2.3.2.

In a July 28, 2008, response to RAI 3, Question 02.03.04-3, the COL applicant provided JFDs covering the 7-year POR from 2000 through 2006, and sequential hourly data for calendar year 2006, in the same formats as the initial supplemental submittal covering the POR from 2000 through 2005. Data from the 2000 through 2006 POR was used in the dispersion modeling analyses addressed in COL FSAR Sections 2.3.4 and 2.3.5.

The staff reviewed the sequential hourly data sets for the 2000 through 2005 POR using a program based on NUREG-0917, "Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data," July 1982, and a desktop computer spreadsheet. The output from these applications provided information to examine the quality and validity of an applicant's hourly meteorological data. As stated in Section 2.3.3.4.1.3 of this report, barometric pressure data were not provided to the staff and so are not considered further.

Section 2.3.3.4.1.4 of this report addresses the individual and joint data recovery rates for this period of record, all of which are greater than the 90 percent acceptance criterion in Regulatory Position 5 of RG 1.23.

After evaluating the long-term representativeness of the atmospheric stability classifications for the 6-year POR presented in various summaries in COL FSAR Section 2.3.2, the staff issued RAI 3, Question 02.03.03-6, in which the staff requested that the COL applicant explain the lack of agreement between stability class frequencies based on information provided in the COL application and frequencies from Revision 34 of the CCNPP Units 1 and 2 updated final safety analysis report (UFSAR), as summarized below in Table 2.3-7.

Table 2.3-7 Comparison of the Frequency of Occurrence of Stability Classes A-G as Presented in the CCNPP Final Safety Analysis Report for Unit 3 FSAR and the Updated Final Safety Analysis Report for CCNPP Units 1 and 2

	A and B	C	D	E	F	G
Unit 3	16.50%	5.03%	34.61%	26.72%	10.69%	6.44%
Units 1 & 2	2.60%	10.40%	63.20%	11.80%	8.00%	4.00%

In a July 28, 2008, response to RAI 3, Question 02.03.03-6, the COL applicant stated that the stability classes in the CCNPP Units 1 and 2 UFSAR were determined using the Pasquill−Turner method (as stated on Page 2.3-2 of the UFSAR), that this method uses wind speed, solar insulation, and cloud cover to estimate the stability class, and that this methodology differs from the current NRC approach. The COL applicant noted that the methodology currently endorsed by the NRC in RG 1.23, Revision 1, Section 2.2, is based on delta-temperature measurements. The COL applicant also referenced the, "Handbook on Atmospheric Dispersion," (1982) for further information on the limitations of the Pasquill-Turner method. The staff accepts the COL applicant's response and, therefore, considers RAI 3, Question 02.03.03-6 resolved.

In RAI 3, Question 02.03.03-8, the staff requested that the COL applicant explain:

- The discrepancies between the counts for each of stability classes "F" and "G," based on the counts indicated in the composite JFD for the 2000 through 2005 POR and the counts obtained from the sequential hourly meteorological data set for the same POR (see Table 2.3-8 below).

- Any impacts on the short-term accident and long-term routine (release) atmospheric dispersion estimates presented in COL FSAR Sections 2.3.4 and 2.3.5.

Table 2.3-8 Staff Comparison of the Number of Hours of Class F and Class G Atmospheric Stability Using Hourly Data Versus Joint Frequency Distributions Provided by the COL Applicant

RG 1.23 Stability Classifications	Hourly Data	JFD	Difference
F: $1.5<\Delta T\leq 4.0$	5,614	5,344	270
G: $\Delta T>4.0$	3,422	3,692	-270

In a July 28, 2008, response to RAI 3, Question 02.03.03-8, the COL applicant stated that the counts specified by the staff could not be reproduced, and provided a table comparing the counts for each of the seven stability classes ("A" through "G"). The COL applicant provided an explanation of possible reasons for these differences including: The exclusion of hours from the JFD summary if all three parameters (i.e., wind speed, wind direction, and atmospheric stability class) are not valid for a specified hour; and perhaps different levels of data precision in the COL applicant's program that determines stability class versus the spreadsheet used by the staff (which may have an effect at the breakpoints between stability classes).

The staff accepts these reasons specified by the COL applicant with regards to the data count discrepancies based on the JFD summary and the hourly dataset. The staff also notes that the

total difference in data counts based on the hourly data comparison, at least for stability classes "F" and "G" (which are associated with the most restrictive dispersion conditions), is only about 0.1 percent with respect to all hours, only about 0.7 percent with respect to hours classified as "F" and "G," and a higher total for these classes based on the COL applicant's evaluation as opposed to the staff's. Therefore, the staff considers RAI 3, Question 02.03.03-8 resolved.

The staff finds that, with the exception of open items and confirmatory items described above, the COL applicant has provided a description of the preoperational program consistent with acceptance criteria 1 – 4 in NUREG-0800, Section 2.3.3.

2.3.3.4.2 Operational Meteorological Measurement Program

In COL FSAR, Revision 3,Section 2.3.3.2, the COL applicant indicated that the operational phase of the onsite meteorological measurement program for CCNPP Unit 3 is based on the operational phase monitoring program operated in support of CCNPP Units 1 and 2, including the instrumentation upgrades made in December 2005 to comply with RG 1.23, Revision 1. The staff notes that deviations from that guidance are identified in and evaluated further in Section 2.3.3.4.2.7 of this report.

As described in further detail in the subsections below, the staff finds that the COL applicant has provided a description of the operational program that is consistent with acceptance criteria 1–4 in NUREG-0800, Section 2.3.3.

2.3.3.4.2.1 *Tower Location*

Discussions of the meteorological tower location in COL FSAR Section 2.3.3.2.1, "Tower Location," and COL FSAR Section 2.3.3.1.1 are essentially the same. The same meteorological monitoring system will be shared by CCNPP Units 1 and 2 and CCNPP Unit 3 during their respective operational phases. Therefore, as discussed in Section 2.3.3.4.1.1 of this report; the tower location complies with the recommendations provided in Regulatory Position 3 of RG 1.23, Revision 1, and is, therefore, acceptable to the staff.

2.3.3.4.2.2 *Tower Design*

The brief introductory discussions regarding meteorological tower design in COL FSAR Section 2.3.3.2.2, "Tower Design," and COL FSAR Section 2.3.3.1.2 are essentially the same. As indicated in the preceding section, the same meteorological monitoring system will be shared by CCNPP Units 1 and 2 and CCNPP Unit 3 during their respective operational phases. Therefore, consistent with Section 2.3.3.4.1.2 of this report, the tower design conforms to the general recommendations provided in Regulatory Position 2 of RG 1.23 and is, therefore, acceptable to the staff.

2.3.3.4.2.3 *Instrumentation*

In COL FSAR Section 2.3.3.2.3, "Instrumentation," the COL applicant's discussion of tower-mounted instrumentation and related equipment for the operational phase of the onsite meteorological monitoring program for CCNPP Unit 3 is very similar to the description for the preoperational phase in COL FSAR Section 2.3.3.1.3. Instrumentation and equipment for the operational phase currently represent the system upgrades made in December 2005 and include: Wind speed, wind direction, and duplicate sets of aspirated temperature sensors located at 60 m (197 ft) and 10 m (33 ft) above ground level; a tipping bucket rain gauge located

about 9.1 m (30 ft) from the meteorological tower in an open field; and a barometric pressure sensor installed in the nearby Met Building.

The measurement of atmospheric moisture is not mentioned as part of the operational-phase monitoring scope. This is in conformance with Regulatory Position 2.5 in RG 1.23, Revision 1, which indicates that these measurements need not be continued following the preoperational phase unless specified by the plant's environmental protection program pursuant to 10 CFR 50.36b, "Environmental Conditions," or 10 CFR 51.50, "Environmental Report − Construction Permit, Early Site Permit, or Combined License Stage," and is acceptable to the staff.

The COL applicant's description of the primary and backup data logger systems is the same as in COL FSAR Section 2.3.3.1.3. However, the discussion for the operational phase monitoring program also states that the averaged data values are transmitted to the appropriate locations for operational and emergency response purposes, including:

- CCNPP Unit 3 Control Room, Technical Support Center, and Emergency Operations Facility
- NRC Emergency Response Data System as required by 10 CFR Part 50, Appendix E, Section VI

As such, this is acceptable to the staff. See also Section 2.3.3.5 of this report.

2.3.3.4.2.4 *Instrument Maintenance and Surveillance Schedules*

The staff notes that the brief summaries in COL FSAR Section 2.3.3.2.4, "Instrument Maintenance and Surveillance Schedules," and COL FSAR Section 2.3.3.1.4, of instrument maintenance and surveillance schedules and calibration activities are the same for the operational and preoperational phases of the CCNPP Unit 3 onsite monitoring program, respectively.

As discussed in Section 2.3.3.4.1.4 of this report, the staff finds the description of the instrument maintenance and surveillance, and calibration activities to be acceptable.

2.3.3.4.2.5 *Data Reduction and Compilation*

The staff notes that the discussions in COL FSAR Section 2.3.3.2.5, "Data Reduction and Compilation," and COL FSAR Section 2.3.3.1.5, regarding data reduction and compilation, are essentially the same for the operational and preoperational phases of the CCNPP Unit 3 onsite meteorological monitoring program, respectively.

In COL FSAR Section 2.3.3.1.5, the COL applicant indicated that the 15-minute averaged data are available to support radiological emergency assessments pursuant to 10 CFR 50.47 and 10 CFR Part 50, Appendix E, and that the hourly averaged data are available for determining:

- Whether radiological effluent release limits associated with normal operations are met for any individual located off site
- Whether radiological dose consequences of postulated accidents meet prescribed limits at the EAB and LPZ

- Compliance with the numerical guides for design objectives and limiting conditions for operation to ensure that radioactive materials in effluents released to unrestricted areas are kept as low as is reasonably achievable

- Compliance with dose limits for individual members of the public

- Evaluation of personnel exposures in the Control Room during radiological and airborne hazardous material accident conditions

The staff notes that these applications of the hourly onsite meteorological data are responsive to the requirements, respectively, in: 10 CFR 100.21(c) (first and second items); 10 CFR Part 50, Appendix I; 10 CFR Part 20, Subpart D; and GDC 19 in 10 CFR Part 50, Appendix A.

2.3.3.4.2.6 *Nearby Obstructions to Air Flow*

In COL FSAR Section 2.3.3.2.6, "Nearby Obstructions to Air Flow," the COL applicant reiterated the discussion from COL FSAR Section 2.3.3.1.6, regarding natural obstructions to air flow and identification of the direction sectors with the highest and lowest terrain elevations within 0.8 km (0.5 mi) of the onsite meteorological tower. COL FSAR Section 2.3.3.2.6 also cross-references: COL FSAR Section 2.3.3.2.1 (which discusses the location of the 60 m (197 ft) meteorological tower); COL FSAR Table 2.3-109, "Distances from Meteorological Tower to Nearby Obstructions to Air Flow," (which lists distances, by direction sector, from the meteorological tower to nearby obstructions to air flow); and COL FSAR Figures 2.3-219, "CCNPP Site Map with Meteorological Tower Location," and 2.3-220, "Detailed Topography within 8 km (5 mi)," (which illustrate topographic features within a radius of 1.6 km (1 mi) and 8 km (5 mi) of CCNPP Unit 3, the location of Units 1 and 2, and of Unit 3, and the location of the meteorological tower). Based on this information, the COL applicant concluded, in COL FSAR Section 2.3.3.1.6, that there are no significant obstructions to air flow.

As indicated in Section 2.3.3.4.1.1 of this report, the tower location (referring to the 60 m (197 ft) meteorological tower) complies with the recommendations in Regulatory Position 3 of RG 1.23, Revision 1, and is, therefore, acceptable to the staff.

2.3.3.4.2.7 *Deviations to Guidance from Regulatory guide 1.23*

In COL FSAR Section 2.3.3.2.7, "Deviations to Guidance from Regulatory Guide 1.23," Revision 3, the COL applicant identified the following deviation from the guidance in RG 1.23, Revision 1, for the CCNPP Unit 3 operational phase meteorological monitoring program:

- The meteorological tower is not sited at approximately the same elevation as the finished plant grade for CCNPP Unit 3.

The staff notes that this deviation relates to the guidance in Regulatory Position 3 of RG 1.23.

The staff finds that, for the operational phase, the COL applicant has adequately justified the noted deviation from RG 1.23. The difference between plant grade and at the base of the meteorological tower is only 12 m (40 ft). Since the increased height occurs over a gentle slope, there would be similar wind speeds and direction at both plant grade and the meteorological tower. Further, the COL applicant sited the tower to assure that it was located on level, open terrain at a distance of at least 10 times the height of any nearby obstruction that exceeds one-half the height of the wind measurement level.

In RAI 196, Question 02.03.03-9, the staff requested that the COL applicant clarify COL FSAR Section 2.3.3.2.7, with a discussion of why the other two deviations from the guidance in RG 1.23, Revision 1, as given in COL FSAR Section 2.3.3.1.7 for the preoperational phase of the CCNPP Unit 3 monitoring program, no longer applied during the operational phase.

The staff noted that COL FSAR Section 2.3.3.2.3, as written, implies that no moisture measurements will be made during the operational phase. This is in conformance with Regulatory Position 2.5 in RG 1.23, Revision 1 which indicates that these measurements need not be continued following the preoperational phase unless specified by the plant's environmental protection program pursuant to 10 CFR 50.36b or 10 CFR 51.50, and is acceptable to the staff. The staff also noted that COL FSAR Section 2.3.3.2.7, as written, implies that inspections of the tower, guy wires, and anchors will be performed at the intervals in Regulatory Position 5 of RG 1.23 (i.e., annually for the tower and guy wires, and once every 3 years for the anchors).

In RAI 196, Question 02.03.03-9, the staff also requested that the COL applicant clarify whether it intends to use a wind shield on the precipitation gauge to minimize wind-caused loss of precipitation, as recommended in Regulatory Position 3 of RG 1.23, Revision 1).

In a February 1, 2010, response to RAI 196, Question 02.03.03-9, the COL applicant clarified that the guidance in RG 1.23, Revision 1, will be followed during the pre-operational monitoring program with the following deviations:

1. There will be no atmospheric moisture measurements.

2. The tower is not sited at plant grade.

3. There will be no wind shield installed.

4. The guyed wires and anchors will be inspected every 5 yrs.

5. Digital sampling will occur at a rate of once every 10 sec.

In the same RAI response, the applicant explained that during the operational monitoring program, the guidance in RG 1.23, Revision 1, will be followed with deviations for only Items 2 and 5 given above. The staff finds the first program deviation acceptable, because atmospheric moisture measurements required for design bases at CCNPP Unit 3 were taken from the nearby Patuxent River NAS. The staff's evaluation of atmospheric moisture data is provided in Section 2.3.1 of this report. The staff finds the second deviation acceptable, because the tower is located on gently sloping ground only vertical 12 m (40 ft) above plant grade, and there are few obstructions upwind that would cause modification or disruption of airflow. The third deviation is acceptable, because site precipitation data is not used as design or operating bases, and the COL applicant has installed a wind shield in June 2009, that will improve data quality during the operational monitoring program. The staff finds the fourth deviation to be acceptable, because the licensing basis for the pre-operational tower did not include the inspection frequency guidance in RG 1.23, Revision 1. The staff also finds that the 10 sec sampling rate is sufficiently close to the rate described in RG 1.23, Revision 1, and is therefore acceptable.

The COL applicant proposed revisions to COL FSAR Sections 2.3.2, 2.3.3.1, 2.3.3.1.7, and 2.3.3.2.7, as well as COL FSAR Table 1.9.1, to incorporate clarifying changes described above.

RAI 196, Question 02.03.03-9, which is associated with the above request, is being tracked as a confirmatory item.

2.3.3.4.2.8 *Special Considerations for Complex Terrain Sites*

The discussions under COL FSAR Section 2.3.3.2 did not specifically address the implications (if any) of the CCNPP site's location adjacent to the Chesapeake Bay in terms of the scope of the operational phase meteorological monitoring program and the representativeness of the resulting data. The staff's evaluation of land and bay breezes caused by the nearby Chesapeake Bay is provided in Section 2.3.5.4.4 of this report.

2.3.3.4.2.9 *Operational Onsite Meteorological Monitoring Program Support for CCNPP Unit 3 Emergency Planning*

CCNPP Unit 3 COL application, Part 10, Table 2.3-1, "Emergency Planning ITAAC," contains emergency planning (EP) inspection, test, analysis, and acceptance criteria (ITAAC). The following three EP-ITAAC involve demonstrating that the operational onsite meteorological monitoring program appropriately supports the CCNPP Unit 3 emergency plan:

- EP Program Element 5.2: The COL applicant has established an Emergency Operations Facility (EOF). Acceptance Criterion 5.2.1.3 states that the CCNPP Unit 3 EOF plant information system can retrieve and display radiological, meteorological, plant system data for the parameters specified in the CCNPP Unit 3 U.S. EPR FSAR EAL Technical Basis Manual and ITAAC Acceptance Criterion 1.1.1.

- EP Program Element 6.3: The means exist to continuously assess the impact of the release of radioactive materials to the environment, accounting for the relationship between effluent monitor readings, and onsite and offsite exposures and contamination for various meteorological conditions. ITAAC Acceptance Criterion 6.3.1 states that a methodology has been established accounting for the relationship between effluent monitor readings and onsite and offsite exposures and contamination for various radiological conditions. ITAAC Acceptance Criterion 6.3.2 states that the continuous assessment of the impact of the release of radioactive materials to the environment is addressed in ITAAC Acceptance Criterion 6.1.

- EP Program Element 6.4: The means exists to acquire and evaluate meteorological information. ITAAC Acceptance Criterion 6.4 indicates that the CCNPP Unit 3 Control Room, Technical Support Center (TSC), and EOF can acquire wind speed data (at 10 m and 60 m); wind direction data (at 10 m and 60 m); and ambient air temperature data (at 10 m and 60 m).

EP and EP-ITAAC are addressed in Section 13.3, "Emergency Planning," of this report.

2.3.3.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.3.3.6 *Conclusions*

The staff reviewed the application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that the COL applicant addressed the required information relating to the

onsite meteorological measurements program. Except for an open item related to RAI 261, Question 02.03.03-10, there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the onsite meteorological measurements program incorporated by reference in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update Section 2.3.3 of this report to reflect the final disposition of the design certification application.

However, as a result of the open and confirmatory items, the staff is unable to finalize its conclusions on the onsite meteorological measurements program in accordance with the requirements of 10 CFR Part 20, Subpart D; 10 CFR 50.47 (b)(4), (b)(8), and (b)(9); GDC 19; 10 CFR Part 50, Appendix I; 10 CFR Part 100.20(c)(2); and 10 CFR Part 100.21(c).

2.3.4 Short Term Atmospheric Dispersion Estimates for Accident Releases

2.3.4.1 *Introduction*

COL FSAR Section 2.3 of the CCNPP Unit 3 COLA addresses: Conservatively-derived estimates of the short-term atmospheric dispersion factors (χ/Q values) at the exclusion area boundary, the outer boundary of the low population zone, and the control room (CR) for postulated design-basis accidental releases of radioactive material; realistically-derived estimates of χ/Q values at the EAB and LPZ; and atmospheric dispersion modeling for hazardous materials.

2.3.4.2 *Summary of Application*

COL FSAR Section 2.3.4 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.3.4, "Short-Term Atmospheric Dispersion Estimates for Accident Releases."

In addition, in COL FSAR Section 2.3.4, the COL applicant provided the following:

Combined License Information Items

The COL applicant provided additional information in COL FSAR Section 2.3.4 to address COL Information Item Nos. 2.3-5, 2.3-6, and 2.3-7 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

COL Information Item No. 2.3-5

> A COL applicant that references the U.S. EPR design certification will provide a description of the atmospheric dispersion modeling used in evaluating potential design basis events to calculate concentrations of hazardous materials (e.g., flammable or toxic clouds) outside building structures resulting from the onsite and/or offsite airborne releases of such materials.

COL Information Item No. 2.3-6

> A COL applicant that references the U.S. EPR design certification will confirm that site-specific χ/Q values, based on site-specific meteorological data, are bounded by those specified in Table 2-1 at the EAB, LPZ, and the control room. For site-specific χ/Q values that exceed the bounding χ/Q values, a COL applicant that references the U.S. EPR design certification will demonstrate that the radiological consequences associated with the controlling design basis accident continue to meet the dose reference values specified in 10 CFR 50.34 and the control room operator dose limits given in GDC 19 using site-specific χ/Q values.

COL Information Item No. 2.3-7

> A COL applicant that references the U.S. EPR design will provide χ/Q values for each cumulative frequency distribution which exceeds the median value (50 percent of the time) as part of the assessment of the postulated impact of an accident on the environment.

The COL applicant stated that these COL information items are addressed in COL FSAR Section 2.3.4.2.1, "Conservative Short-Term (Accident Release) Atmospheric Dispersion Estimates for EAB and LPZ," through 2.3.4.3, "Input Details for Computer Codes AEOLUS3 (Version 1)." COL FSAR Section 2.3.4.1, "Objectives," indicates that this section provides, for appropriate time periods up to 30 days after an accident, conservative estimates of χ/Q values at the EAB, at the outer boundary of the LPZ, and at the control room for postulated accidental radioactive airborne releases. This section also addresses atmospheric dispersion modeling used in COL FSAR Section 2.2.3 to evaluate potential design-basis events resulting from the onsite and/or offsite airborne releases of hazardous materials (e.g., flammable vapor clouds, toxic chemicals, and smoke from fires).

COL FSAR Section 2.3.4.2, "Calculations," covers a broad range of information, including:

- Identification of the atmospheric dispersion model used - AEOLUS-3, Version 1, a proprietary computer code
- The onsite meteorological data input to the modeling analysis (i.e., a 7-year POR from 2000 through 2006) and an annual average inversion layer height based on regional data; that is, an input parameter unique to the AEOLUS-3 model
- Summaries of model capabilities, input options (not necessarily indicating those that were chosen), and types of output
- Type of routine release from the CCNPP Unit 3 plant stack (i.e., mixed mode) and assumed release characteristics
- Summaries of the modeling results at various receptor locations including identification of an estimated χ/Q value at the EAB that exceeds the corresponding site parameter value in U.S. EPR FSAR Tier 2, Table 2.1-1

COL FSAR Section 2.3.4.3 identifies assumptions made for AEOLUS3 modeling. Specific design input parameters and values are provided in COL FSAR Table 2.3-117, "AEOLUS3 Design Input."

Also related to COL FSAR Section 2.3.1 is:

COL Information Item No. 2.3-1

The COL applicant provided additional information in COL FSAR Section 2.3 to address COL Information Item No. 2.3-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> If a COL applicant that references the U.S. EPR design certification identifies site-specific meteorology values outside the range of the design parameters in Table 2.1-1, then the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of the COL application.

To address this COL information item, the COL applicant stated:

> The CCNPP Unit 3 site-specific meteorology values have been reviewed and compared to determine if they are within the bounds of the assumed meteorology values for a U.S. EPR. This comparison is provided in Table 2.0-1. The CCNPP Unit 3 site-specific meteorology parameters are within the bounds of the conservative limiting meteorology values presented in Table 2.0-1.

U.S. EPR FSAR Departures and Exemptions

In CCNPP Unit 3 COL Application, Part 7, "Departures and Exemption Requests," Section 1.1.4, "Accident Atmospheric Dispersion Factor (0-2 hr, Low Population Zone, 1.5 mi)," and Section 1.2.4, "Accident Atmospheric Dispersion Factor (0-2 hr, Low Population Zone, 1.5 mi)," the COL applicant proposed the following U.S. EPR FSAR departures and exemption requests:

> The U.S. EPR FSAR identifies the 0-2 hour Accident Atmospheric Dispersion Factor (Low Population Zone, 1.5 mi) of ≤1.75E-4 sec/m^3. The corresponding CCNPP Unit 3 value is 2.151E-04 sec/m^3, as referenced in COL FSAR Table 2.3.4-1, "Site-Specific EAB/LPZ Accident χ/Q Values for Ground Level Releases."

The Departure is identified in COL FSAR Table 2.0-1, COL FSAR Section 2.3.4.2.1, COL FSAR Table 2.3-110, "Site-Specific EAB/LPZ Accident χ/Q Values for Ground Level Release," COL FSAR Section 15.0.3, "Radiological Consequences of Design Basis Accidents," and COL FSAR Table 15.0-1, "CCNPP Unit 3 LPZ Atmospheric Dispersion Factors." The COL Unit 3 FSAR departs from the following U.S. EPR FSAR sections and tables: FSAR Tier 1, Table 5.0-1, "Site Parameters for the U.S. EPR Design"; FSAR Tier 2, Table 2.1-1; FSAR Tier 2, Section 2.3.4, and FSAR Tier 2, Section 15.0.3, "Radiological Consequences of Design Basis Accidents." An exemption is required from 10 CFR Part 52. The site-specific χ/Q values were used in the calculation of site-specific doses resulting from the design-basis accident scenarios specified in U.S. EPR FSAR Section 15.0.3, and in each case, the resulting LPZ doses were determined to be below the regulatory limits.

2.3.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the short-term accident atmospheric dispersion factors, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.3.4, "Short Term Dispersion Estimates for Accident Releases."

The applicable regulatory requirements for short-term accident atmospheric dispersion information are as follows:

1. 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 and airborne hazardous material accident conditions.

2. 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.

3. 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.

The related regulatory guidance is as follows:

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

2. RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Revision 1, February 1983.

3. RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," May 2003.

2.3.4.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 2.3.4 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 2.3.4 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to short-term accident atmospheric dispersion factors has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

Combined License Information Items

COL Information Item No. 2.3-1

The staff reviewed COL Information Item No. 2.3-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.3. The staff notes that, contrary to the COL applicant's assertion that the CCNPP Unit 3 site-specific meteorological parameters are within the bounds of the corresponding site parameters presented in COL FSAR Table 2.0-1, there is one site specific accident atmospheric dispersion site characteristic value (i.e., the 0-2 hour χ/Q value for the LPZ) that is not within the bounds of the corresponding site parameter value presented in U.S. EPR FSAR Table 2.1-1. This exception was identified by the COL applicant as a departure and an exemption as discussed below. However, in RAI 250, Question 02.03.01-34, the staff requested that the COL applicant revise COL FSAR Section 2.3 to incorporate a revised response to COL Information Item No. 2.3-1 indicating that the 0-2 hour χ/Q value for the LPZ is not within the bounds of the limiting meteorological values presented in COL FSAR Table 2.0-1.

In an August 19, 2010, response to RAI 250, Question 02.03.01-34, the COL applicant provided proposed revisions to: COL FSAR Section 1.8.2, "Departures"; COL FSAR Table 2.0-1, "U.S. EPR Site Design Envelope Comparison"; COL FSAR Section 2.3, "Meteorology"; COL FSAR Section 9.2.1, "Essential Service Water System"; and COLA Part 7, "Departures and Exemption Requests," Sections 1.1 and 1.1.9. However, in the COL applicant's proposed revision to COL FSAR Section 2.3, the departure and exemption required for the 0-2 hour short-term χ/Q site parameter value is not addressed. Therefore, to clarify that portion of RAI 250, Question 02.03.01-34 which addresses COL Information Item No. 2.3-1 related to the exemption and departure from the 0-2 hour short-term χ/Q site parameter value, **RAI 250, Question 02.03.01-34 is being tracked as an open item.**

COL Information Item No. 2.3-5

The staff reviewed COL Information Item No. 2.3-5 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.3.4.2.4. The staff's evaluation of the COL applicant's response to this COL information item is documented in Section 2.2.3 of this report.

COL Information Item No. 2.3-6

The staff reviewed COL Information Item No. 2.3-6 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Sections 2.3.4.2.1 and 2.3.4.2.3. The staff's evaluation of the COL applicant's generation of site-specific χ/Q values is provided in Sections 2.3.4.4.1, 2.3.4.4.2, and 2.3.4.4.4 of this report. The staff also confirmed that site-specific χ/Q values, based on site-specific meteorological data, are bounded by those specified in COL FSAR Table 2.0-1 at the EAB, LPZ, and the control room, except for except for the 0-2 hr value for the LPZ. This exception was identified by the COL applicant as a departure and an exemption as discussed below.

<u>COL Information Item No. 2.3-7</u>

The staff's review of COL Information Item No. 2.3-7 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.3.4.2.2 is provided in the Final Environmental Impact Statement.

U.S. EPR FSAR Departures and Exemptions

The COL applicant evaluated a departure and exemption in Part 7 of the COL application. Specifically, the COL applicant calculated a site characteristic, 0 – 2-hour LPZ χ/Q value of 2.151E-04 sec/m^3 in COL FSAR Table 2.3-110, as compared to a site parameter value in U.S. EPR FSAR Tier 2, Table 2.1-1 of 1.75E-04 sec/m^3. The COL applicant determined that the higher χ/Q value does not result in a site-specific accident dose above regulatory limits. The staff's evaluation of this departure is addressed in Section 15.0.3 of this report.

The staff relied upon the review guidance presented in SRP Section 2.3.4, and the regulatory guides and other guidance documents referred to in the preceding section, to independently assess the technical sufficiency of the information presented by the COL applicant. The staff' also verified certain information provided in the FSAR during an audit held on February 11 and 12, 2009. The purpose of the audit was to examine and evaluate technical, procedural, and process information related to the AEOLUS-3 atmospheric dispersion modeling analyses, with the intent of:

- Gaining a better understanding of the proprietary AEOLUS-3 dispersion model and possible reasons for differences between the staff's initial evaluation of the COL applicant's modeling results
- Verifying information presented in COL FSAR Sections 2.3.4 and 2.3.5
- Identifying documentation that supports regulatory decisions

The COL applicant's descriptions of the dispersion model and its capabilities, input data and assumptions, modeling results, and potential effects on atmospheric dispersion due to the plant's proximity to the Chesapeake Bay, that are evaluated in this section, are organized in the same sequence that they were presented in COL FSAR Section 2.3.4. However, section numbering is consistent with the organization of this report.

In RAI 2, Question 02.03.04-1, the staff requested that the COL applicant address the effects of topography and nearby bodies of water; namely the Chesapeake Bay, on short-term dispersion estimates. In a July 28, 2008, response to RAI 2, Question 02.03.04-1, the COL applicant committed to update COL FSAR Section 2.3.4.1 to include a cross-reference to COL FSAR Section 2.3.5.4, which includes a description on the anticipate effects of the Chesapeake Bay. This cross-reference was provided in COL FSAR, Revision 6. The staff's evaluation of the anticipated influence of the Chesapeake Bay on atmospheric dispersion is provided in Section 2.3.5.4.4 of this report. Therefore, the staff considers RAI 2, Question 02.03.04-1 resolved.

2.3.4.4.1 Calculations

The COL applicant stated that AEOLUS-3, Version 1 implements the methodology outlined in RG 1.145. Similar to the NRC-sponsored computer code PAVAN, described in NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design-Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations," the AEOLUS-3 model is a straight-line Gaussian plume model based on the theoretical assumption that material released to the atmosphere will be normally distributed (Gaussian) about the plume centerline. The staff finds that the COL applicant provided a description of its atmospheric dispersion model, meteorological data, diffusion parameters, and χ/Q values for both downwind

receptors and the control room in accordance with the acceptance criteria of NUREG-0800, Section 2.3.4.

Both the AEOLUS-3 and PAVAN codes estimate χ/Q values for various time-average periods ranging from 2 hours to 30 days. Consistent with SRP Section 2.3.4, the staff evaluated the COL applicant's χ/Q values using PAVAN, which implements the guidance provided in RG 1.145.

Short-term atmospheric dispersion estimates for the control room were determined by the COL applicant using the NRC-sponsored computer code ARCON-96, which implements the guidance provided in RG 1.194.

2.3.4.4.2 Conservative Short-Term χ/Q Values for EAB and LPZ

The COL applicant stated that it used the modeling guidance provided in RG 1.145. As stated in COL FSAR Section 2.3.4.3, the COL applicant assumed a ground level release, with the release point and receptor at the same elevation. The COL applicant did not credit building wake effects, but did account for low wind speed plume meander.

In RAI 2, Question 02.03.04-3, the staff requested that the COL applicant provide the 2006 meteorological data which was used, in addition to the 2000-2005 data, to determine both the short-term and long-term χ/Q values. In an October 30, 2008, response to RAI 2, Question 02.03.04-3, the COL applicant provided this data in RG 1.23 hourly format and as joint frequency distributions. The staff found the COL applicant's response acceptable. Therefore, the staff considers RAI 2, Question 02.03.04-3 resolved.

Other parameter values, including wind speed group upper limits and mixing layer height are provided by the COL applicant in FSAR Table 2.3-117, "AEOLUSS Design Input."

The staff used PAVAN to independently calculate χ/Q values at the EAB and outer boundary of the LPZ using the same 7 years of wind data and other parameters, as described by the COL applicant. The staff found that the COL applicant's values are slightly larger (more conservative) than values calculated by the staff. Therefore, the staff accepts the COL applicant's values provided in COL FSAR Table 2.3-110.

2.3.4.4.3 Realistic Short-Term χ/Q Values

The COL applicant described its method of calculating realistic (50th percentile) χ/Q values using AEOLUS-3 and 7 years of onsite meteorological data. The staff's evaluation of realistic χ/Q values, which are used to calculate environmental impacts of potential accidents, is provided in the Final Environmental Impact Statement (FEIS).

2.3.4.4.4 Conservative Short-Term χ/Q Values for the Control Room

The COL applicant calculated short-term χ/Q values for the control room using ARCON96, Version 1.0 and 7 years of meteorological data (2000 through 2006) from the onsite monitoring program. The COL applicant's assumptions are provided in COL FSAR Table 2.3-118, "ARCON96 Design Inputs." The staff evaluated the assumptions by comparing specific distances given in COL FSAR Table 2.3-118 to other information provided in the COL FSAR, such as COL FSAR Figures 2.1-5, "CCNPP Unit 3 Enlargement," 2.1-1, "Site Area Map," and 2.3-221, "CCNPP Unit 3 Control Room Location," and finds them to be acceptable.

In RAI 2, Question 02.03.04-2, the staff requested that the COL applicant clarify why control room χ/Q values for unfiltered inleakage, as given in U.S. EPR FSAR Tier 2, Table 2.3-2, were not provided in COL FSAR Section 2.3.4.2.3, "Short-Term (Accident Release) Atmospheric Dispersion Estimates for the Control Room." (The staff notes that the U.S. EPR FSAR Tier 2, Table 2.3-2 control room χ/Q values for unfiltered inleakage were later incorporated into U.S. EPR FSAR Tier 2, Table 2.1-1). In an October 30, 2008, response to RAI 2, Question 02.03.04-2, the COL applicant stated that since it had demonstrated that control room intake χ/Q values were bounded by the U.S. EPR FSAR control room intake χ/Q values, and the same meteorological data would be used in the evaluation of unfiltered inleakage, then the unfiltered χ/Q values are also bounded by the U.S. EPR FSAR unfiltered inleakage χ/Q values, and these values were not specifically calculated. The staff agrees that unfiltered inleakage χ/Q values would also be bounded by the corresponding site parameters values, given that the same site-specific meteorological data used for the control room intakes would be used for the unfiltered intake locations, and both the inleakage and control room intake locations are located on the same side of the facility on the Division 2 and 3 Safeguard Buildings. This explanation is provided in COL FSAR, Revision 6, Section 2.3.4.2.3, and is acceptable to the staff. Therefore, the staff considers RAI 2, Question 02.03.04-2 resolved.

The staff also used ARCON96 to verify the χ/Q values for the minimum distance between the control room and a release point. This distance is 30.1 m (98.75 ft) between "Canopy Pt. 1" near the depressurization shaft (Safeguard Building 4) and the control room air intake. The staff calculated with values less than five percent difference from values reported by the COL applicant. Therefore, the staff finds the COL applicants short-term χ/Q values to be acceptable.

2.3.4.4.5 Atmospheric Dispersion Modeling for Hazardous Materials

A review of the identification of onsite and offsite hazardous materials that could threaten control habitability is performed in Sections 2.2.1, 2.2.2, and 2.2.3 of this report. The accident scenarios, including release characteristics and model descriptions are also found in these sections.

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

2.3.4.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.3.4.6 *Conclusions*

The staff reviewed the application and checked the referenced U.S. EPR FSAR. Except for an open item related to RAI 250, Question 02.03.01-34 which pertains to the fact that the COL applicant has not fully addressed COL Information Item No. 2.3-1, the staff's review confirmed that the COL applicant addressed the required information relating to short-term accident atmospheric dispersion factors, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to short-term accident atmospheric dispersion factors incorporated by reference in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update Section 2.3.4 of this report to reflect the final disposition of the design certification application.

The staff concludes that the COL 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 COL applicant and the staff from the COL applicant's meteorological data and appropriate diffusion models.

These atmospheric dispersion estimates are appropriate for the assessment of consequences from radioactive releases for design-basis accidents in accordance with GDC 19, 10 CFR 52.79(a)(1)(vi), and 10 CFR 100.21(c)(2).

2.3.5 Long-Term Atmospheric Dispersion Estimates for Routine Releases

2.3.5.1 *Introduction*

COL FSAR Section 2.3.5, "Long-Term Atmospheric Dispersion Estimates for Routine Releases," addresses atmospheric dispersion and dry deposition estimates for routine releases of radiological effluents to the atmosphere.

2.3.5.2 *Summary of Application*

COL FSAR Section 2.3 incorporates by reference U.S. EPR FSAR Tier 2, Section 2.3.5, "Long-Term Atmospheric Dispersion Estimates for Routine Releases."

In addition, in COL FSAR Section 2.3.5, the COL applicant provided the following:

Combined License Information Items

The COL applicant provided additional information in COL FSAR Section 2.3.5 to address COL Information Item Nos. 2.3-8 and 2.3-9 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

COL Information Item No. 2.3-8

> A COL applicant that references the U.S. EPR design certification will provide the site-specific, long-term diffusion estimates for routine releases. In developing this information, the COL applicant should consider the guidance provided in RG 1.23, RG 1.109 "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," Revision 1, October 1977, RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, September 1977, and RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," Revision 1, March 1977. [The maximum annual average χ/Q value at the site boundary, provided in Table 2.1-1, is used to calculate radionuclide concentrations associated with routine gaseous effluent releases, addressed in Section 11.3, for comparison with environmental

release limits and dose limits specified in 10 CFR Part 20. If a reactor site has an annual average χ/Q value that exceeds the reference value, then a site-specific evaluation will be performed][1].

COL Information Item No. 2.3-9

A COL applicant that references the U.S. EPR design certification will also provide estimates of annual average atmospheric dispersion (χ/Q values) and deposition (D/Q values) for 16 radial sectors to a distance of 50 mi (80 km) from the plant as part of its environmental assessment.

The COL applicant stated that COL FSAR Sections 2.3.5.1, "Objective," through 2.3.5.5, "References," were added as a supplement to U.S. EPR FSAR to address these two COL information items.

COL FSAR Section 2.3.5.2 describes the following:

- Description of the atmospheric dispersion model used by the COL applicant; AEOLUS-3, Version 1, a proprietary computer code
- The onsite meteorological data input to the modeling analysis (i.e., a 7-year POR from 2000 through 2006) and an annual average inversion layer height based on regional data (an input parameter to the AEOLUS-3 model)
- Summaries of model capabilities, input options, and types of output - χ/Q and D/Q values, and gamma χ/Qs (the latter not called for by the regulatory guidance)
- Type of routine release from the CCNPP Unit 3 plant stack (i.e., mixed mode) and assumed release characteristics
- Summaries of the modeling results at various receptor locations including identification of an estimated χ/Q value at the EAB that exceeds the corresponding site parameter value in U.S. EPR FSAR Tier 2, Table 2.1-1

COL FSAR Section 2.3.5.3, "Site-Specific Evaluation of Maximum Annual Average χ/Q," further describes the maximum estimated χ/Q value at the EAB, identifying the downwind direction sector and distance of its location, presenting justification for the acceptability of this result even though it exceeds the limiting χ/Q value in U.S. EPR FSAR Table 2.1-1, and concludes that the dose limits in 10 CFR Part 50, Appendix I for the maximally exposed individual will not be exceeded.

Finally, COL FSAR Section 2.3.5.4, "Anticipated Influence of Chesapeake Bay on Atmospheric Dispersion," discusses the anticipated influence of the Chesapeake Bay on atmospheric dispersion, focusing on over-water dispersion and the distance to potential receptors across the Chesapeake Bay, rather than receptor locations inland of CCNPP Unit 3 that would be affected by a bay breeze circulation. However, the COL applicant noted that the dispersion modeling

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[1] Additional bracketed text is not part of COL Information Item 2.3-8, but was included in COL FSAR Section 2.3.5.

accounted for potential recirculation of normal effluent releases, and concluded that the modeling results for CCNPP Unit 3 were therefore acceptable.

Also related to COL FSAR Section 2.3.1 is:

COL Information Item No. 2.3-1

The COL applicant provided additional information in COL FSAR Section 2.3 to address COL Information Item No. 2.3-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> If a COL applicant that references the U.S. EPR design certification identifies site-specific meteorology values outside the range of the design parameters in Table 2.1-1, then the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of the COL application.

To address this COL information item, the COL applicant stated:

> The Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 site-specific meteorology values have been reviewed and compared to determine if they are within the bounds of the assumed meteorology values for a U.S. EPR. This comparison is provided in Table 2.0-1. The CCNPP Unit 3 site-specific meteorology parameters are within the bounds of the conservative limiting meteorology values presented in Table 2.0-1.

U.S. EPR FSAR Departures and Exemptions

In CCNPP COL Application, Part 7, Section 1.1.3, "Maximum Annual Average Atmospheric Dispersion Factor (0.5 Mile – limiting sector)," and CCNPP COL Application, Part 7, Section 1.2.3, "Maximum Annual Average Atmospheric Dispersion Factor (0.5 Mile – limiting sector)," the COL applicant proposed the following U.S. EPR FSAR departures and exemption request:

> The U.S. EPR FSAR identifies the Maximum Annual Average Atmospheric Dispersion Factor (0.5 mi – limiting sector) of ≤4.973E-6 sec/m^3. The corresponding CCNPP Unit 3 value is 5.039E-06 sec/m^3, as referenced in CCNPP Unit 3 FSAR Table 2.3.5-1, CCNPP Unit 3 Normal Effluent Annual Average, Undecayed, Undepleted χ/Q Values for Mixed Mode Release Using 242,458 cfm Flow Rate for Grid Receptors, NE Sector at 0.5 mile.

The departure is identified in COL FSAR Table 2.0-1, COL FSAR Section 2.3.5, and COL FSAR Table 2.3-119, "Normal Effluent Annual Average, Undecayed, Undepleted χ/Q Values for Mixed Mode Release Using 242,458 cfm Flow Rate for Grid Receptors." The COL FSAR departs from the following U.S. EPR FSAR table and section: U.S. EPR FSAR Tier 2, Table 2.1-1, and U.S. EPR FSAR Tier 2, Section 2.3.5. The COL applicant states that an exemption is required from 10 CFR Part 52. The NE sector of the EAB (0.5 mi radius centered on Reactor Building) intersects with the Site Area Boundary (0.28 mi) at the shoreline of the Chesapeake Bay. The maximum annual average atmospheric dispersion factor (χ/Q) value is computed at 0.8 km (0.5 mi) which is located approximately 0.35 km (0.22 mi) off shore in the Chesapeake Bay. As a result, the COL applicant concluded that it is extremely unlikely that the dose limits of 10 CFR Part 50, Appendix I for the maximally exposed individual in this sector would be exceeded.

2.3.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the long-term atmospheric dispersion estimates for routine releases, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.5.5, “Long-Term Atmospheric Dispersion Estimates for Routine Releases.”

The applicable regulatory requirements for long-term atmospheric dispersion estimates for routine releases are as follows:

1. 10 CFR Part 20, Subpart D, with respect to establishing atmospheric dispersion-related site characteristics for demonstrating compliance with dose limits for individual members of the public.

2. 10 CFR 50.34a, “Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors,” and 10 CFR Part 50 , Appendix I, Sections II.B, II.C, and II.D with respect to establishing atmospheric dispersion-related site characteristics for evaluating compliance with 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.

3. 10 CFR 100.21(c)(1) with respect to establishing atmospheric dispersion-related site characteristics such that radiological effluent release limits associated with normal operation can be met for any individual located off site.

The related regulatory guidance is as follows:

1. RG 1.23, Revision 1, which includes guidance on the measurement and processing of onsite meteorological data for use as input to atmospheric dispersion models in support of plant licensing and operation.

2. RG 1.109, Revision 1, which includes guidance on identifying the location of potential receptors of interest.

3. RG 1.111, Revision 1, which discusses different types of atmospheric transport and diffusion models and criteria for characterizing atmospheric dispersion and deposition conditions for evaluating the consequences of routine releases.

4. RG 1.112, Revision 0, which is cited in COL FSAR Section 2.3.5.5. However, current revision is Revision 1, “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors,” which includes guidance on identifying release point characteristics.

5. RG 1.206, Revision 0, which summarizes the types of information, identified in SRP Section 2.3.5, that an applicant should provide in COL FSAR Section 2.3.5 regarding the estimation of annual average χ/Q and D/Q values used for annual average release limit calculations and person-rem estimates.

2.3.5.4 *Technical Evaluation*

The staff reviewed COL FSAR Section 2.3.5 and checked the referenced design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 2.3.5 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to long-term atmospheric dispersion estimates for routine releases has been documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

The staff's review of the information contained in the COL FSAR is discussed as follows:

Combined License Information Items

COL Information Item No. 2.3-1

The staff reviewed COL Information Item No. 2.3-1 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Section 2.3. The staff notes that, contrary to the COL applicant's assertion that the CCNPP Unit 3 site-specific meteorological parameters are within the bounds of the corresponding site parameters presented in COL FSAR Table 2.0-1, there is one atmospheric dispersion site characteristic value (the maximum annual average χ/Q value) that is not within the bounds of its corresponding site parameter. This exception was identified by the COL applicant as a departure and an exemption as discussed below. However, in RAI 250, Question 02.03.01-34, the staff requested that the COL applicant revise COL FSAR Section 2.3 to incorporate a revised response to COL Information Item No. 2.3-1 indicating that the maximum annual average χ/Q value is not within the bounds of the limiting meteorological values presented in COL FSAR Table 2.0-1.

In an August 19, 2010, response to RAI 250, Question 02.03.01-34, the COL applicant provided proposed revisions to: COL FSAR Section 1.8.2, "Departures"; COL FSAR Table 2.0-1, "U.S. EPR Site Design Envelope Comparison"; COL FSAR Section 2.3, "Meteorology"; COL FSAR Section 9.2.1, "Essential Service Water System"; and COLA Part 7, Departures and Exemption Requests," Sections 1.1 and 1.1.9. However, in the applicant's proposed revision to COL FSAR Section 2.3, the departure and exemption required for the maximum annual average χ/Q site parameter value is not addressed. Therefore, to clarify that portion of RAI 250, Question 02.03.01-34 which addresses COL Information Item No. 2.3-1 related to the exemption and departure from the maximum annual average χ/Q site parameter value**, RAI 250, Question 02.03.01-34 is being tracked as an open item.**

COL Information Items No. 2.3-8 and 2.3-9

The staff reviewed COL Information Items No. 2.3-8 and 2.3-9 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR Sections 2.3.5.2 and 2.3.5.3. The staff's evaluation of the COL applicant's generation of long-term site-specific χ/Q values is provided in Sections 2.3.5.4.2 and 2.3.5.4.3 of this report.

U.S. EPR FSAR Departures and Exemptions

The staff's evaluation of the COL applicant's proposed departure and exemption related to the maximum annual average atmospheric dispersion factor is provided in Section 2.3.5.4.3 of this report.

The staff relied upon the review guidance presented in SRP Section 2.3.5, and the regulatory guides and other related guidance documents referred to in the preceding section, to independently assess the technical sufficiency of the information presented by the COL applicant. The staff' also verified certain information provided in the FSAR during an audit, held on February 11 and 12, 2009, to examine and evaluate non-docketed technical, procedural, and process information related to the AEOLUS-3 atmospheric dispersion modeling analyses, with the intent of:

- Gaining a better understanding of the proprietary AEOLUS-3 dispersion model and possible reasons for differences between the staff's initial evaluation of the COL applicant's modeling results
- Verifying information presented in COL FSAR Sections 2.3.4 and 2.3.5
- Identifying documentation that will require docketing to support the basis of licensing and regulatory decisions

The COL applicant's description of the dispersion model, its capabilities, input data and assumptions, its assessment of the modeling results, and discussion of the potential effects on atmospheric dispersion due to the plant's proximity to the Chesapeake Bay are addressed in the same sequence as presented in COL FSAR, Revision 3, Section 2.3.5. However, section numbering is consistent with the organization of this report.

2.3.5.4.1 Objective

COL FSAR Section 2.3.5.1 states that the objective of the long-term atmospheric dispersion analysis for routine releases was to provide realistic estimates of annual average χ/Q and D/Q values to a distance of 80 km (50 mi) for annual average release limit calculations and person-rem estimates.

2.3.5.4.2 Calculations

2.3.5.4.2.1 *Atmospheric Dispersion Model*

COL FSAR Section 2.3.5.2 states that site-specific annual average χ/Q and D/Q values were determined using AEOLUS-3, Version 1. The COL applicant also states that the program is based on a straight-line trajectory Gaussian plume model that computes: Plume standard deviations in the horizontal and vertical dimensions (σ_y and σ_z, respectively) using the analytical expressions from the NRC-sponsored XOQDOQ computer program; and an effective plume height which accounts for the physical release height, aerodynamic downwash, plume rise, and terrain heights.

In addition, COL FSAR Section 2.3.5.2 states that the AEOLUS-3 dispersion model includes options that can account for:

- Plume depletion by wet deposition, dry deposition, and radioactive decay
- Plume recirculation or stagnation
- Plume-meander effects and wind speed extrapolation

In COL FSAR Section 2.3.5.2, the COL applicant states that the AEOLUS-3 dispersion model produces: χ/Q values (used to determine airborne concentrations and inhalation doses at offsite receptors of interest as well as gamma air doses); gamma χ/Q values (which can be used to compute external gamma radiation from the finite clouds of radioactive material and as an alternative methodology for determining gamma air doses), and deposition factor D/Q values (used as a measure of relative deposition of released radioactivity). The COL applicant states that only the concentration (χ/Q) and deposition factor (D/Q) values were used to calculate doses due to "postulated" normal effluent releases from CCNPP Unit 3.

The COL applicant also states that the AEOLUS-3 code has been used in past licensing submittals, and its results have been found to be acceptable by the NRC, citing correspondence from 2005 related to the issuance of an amendment for the Pilgrim Nuclear Power Station.

The COL applicant states that the AEOLUS-3 model implements the methodology outlined in RG 1.111. Similar to 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," the AEOLUS-3 model is a straight-line Gaussian plume model based on the theoretical assumption that material released to 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 (i.e., sector averaging).

The staff finds that the COL applicant provided a detailed description of its atmospheric dispersion and deposition model, meteorological data, and diffusion parameters in accordance with the first and second acceptance criteria of NUREG-0800, Section 2.3.5.

Consistent with SRP Section 2.3.5, the staff evaluated the COL applicant's values using XOQDOQ, which implements the guidance provided in RG 1.111.

2.3.5.4.2.2 *Input Data and Assumptions*

COL FSAR Section 2.3.5.2 states that points of routine release to the atmosphere and their characteristics, and potential receptors of interest, were determined following the guidance in RG 1.112, Revision 0-R, and RG 1.109, Revision 1, respectively. Regarding specific inputs to the AEOLUS-3 dispersion model (other than meteorological data) and related assumptions, COL FSAR Section 2.3.5.2, and COL FSAR Tables 2.3-117 and 2.3-130, "Specific Locations of Receptors of Interest," state that the COL applicant:

- Modeled a mixed mode release from the CCNPP Unit 3 stack (cross-referencing U.S. EPR FSAR, Tier 2, Table 2.3-1 for the location of the plant stack)
- Took credit for building wake effects

- Assumed that the Reactor Building cross-sectional area is 2,940 m^2 (31,600 ft^2) to account for building wake effects and that the height of the Reactor Building is 60 m (197 ft)

- Assumed that the release point will be 62 m (203 ft) above grade and 2 m (6.6 ft) above the Reactor Building

- Used a nominal stack flow rate of 114 m^3/s (242,458 ft^3 per minute) (which the COL applicant considered to be conservative, since the actual flow rate for normal operations is expected to be higher)

- Estimated terrain height values (see COL FSAR Table 2.3-117) for receptor locations based on U.S. Geological Survey topographical maps

- Identified receptor locations of interest (i.e., site boundary, nearest resident, nearest garden) (see COL FSAR Table 2.3-130) from the annual CCNPP site land use census - the COL applicant stated that at the time of the analysis, there were no meat cow or milk animal receptors reported within 8 km (5 mi) of the plant

Finally, COL FSAR Section 2.3.5.4 also states that recirculation of normal effluent was accounted for in the long-term, routine release dispersion modeling analysis. The staff's evaluation of the effects of the Chesapeake Bay is provided in Section 2.3.5.4.4 of this report.

These modeling assumptions are in conformance with the procedures outlined in RG 1.111 and NUREG/CR-2919; thus, the staff accepts the COL applicant's assumptions. The staff also finds that the COL applicant has documented and described suitable input parameters for use in AEOLUS-3, Version 1, and the staff finds this acceptable.

In RAI 1, Question 02.03.05-1, the staff requested that the COL applicant resolve a discrepancy in the distance provided for the nearest garden in the west-southwest (WSW) sector. COL FSAR Table 2.3-130 had given the distance as 2,414 m (7,920 ft); whereas, a 2006 Land Use Survey lists the distance as 2,253 m (7,392 ft). In an October 30, 2008, response to RAI 1, Question 02.03.05-1, the COL applicant corrected COL FSAR Table 2.3-130. The corrected value is also reflected in COL FSAR Tables 2.3-120, "Normal Effluent Annual Average, Undecayed, Undepleted χ/Q Values for Mixed Mode Release Using 242,458 cfm Flow Rate for Special and Additional Receptors," 2.3-123, "Normal Effluent Annual Average, Depleted χ/Q Values for Mixed Mode Release Using 242,458 cfm Flow Rate for Special and Additional Receptors," 2.3-126, "Normal Effluent Annual Average, Gamma χ/Q Values for Mixed Mode Release Using 242,458 cfm Flow Rate for Special and Additional Receptors," 2.3-129, "Normal Effluent Annual Average, D/Q Values for Mixed Mode Release Using 242,458 cfm Flow Rate for Special and Additional Receptors," and 2.3-130. Therefore, the staff considers RAI 1, Question 02.03.05-1 resolved.

The staff has confirmed the COL applicant's receptor locations based on the results of a land use survey conducted around CCNPP during the operating period from January 1, 2006 through December 31, 2006 (Docket Nos. 50-317/50-318/72-8).

The staff finds that the COL applicant provided a detailed description of atmospheric release points, the locations of potential receptors, terrain heights and other data as described in the fourth and fifth acceptance criteria of NUREG-0800, Section 2.3.5.

2.3.5.4.2.3 *Meteorological Input Data*

As discussed in COL FSAR Section 2.3.5.2, meteorological data input to the AEOLUS-3 dispersion model consists of onsite measurements from the existing CCNPP Units 1 and 2 operational phase monitoring program (i.e., the CCNPP Unit 3 preoperational phase) and offsite mixing height data (based on regional observations). The COL applicant states that the guidance in RG 1.23 (Revision 1) was followed "in the determination of appropriate onsite meteorological data."

The COL applicant stated that a 7-year POR of onsite data (from 2000 through 2006) was used for the dispersion analysis and that the meteorological data summaries input to AEOLUS-3 were provided in COL FSAR Section 2.3.2. In addition, the COL applicant states that, in COL FSAR Section 2.3.2, JFDs were determined using two sets of onsite meteorological data for the periods "2001-2005" and "2001-2006"; the latter including a more recent year of data. Finally, the COL applicant states that the differences in annual average atmospheric dispersion factor values (i.e., χ/Qs) range from -3.4 percent to 6.8 percent over downwind distances from 0.8 km (0.5 mi) to 80 km (50 mi) when the 2006 meteorological data were included, concluding that the impact of the difference in data sets is not significant.

In RAI 1, Question 02.03.05-2, the staff requested that the COL applicant resolve discrepancies in the COL applicant's description of the meteorological data that were used to develop data summaries in COL FSAR Sections 2.3.2, 2.3.4, and 2.3.5. Specifically, COL FSAR Sections 2.3.4 and 2.3.5 stated that 2000-2006 (i.e., 7 year) meteorological data summaries used as input for AEOLUS-3 were provided in COL FSAR Section 2.3.2. However, the data in COL FSAR Section 2.3.2 is for the period 2000-2005 (i.e., 6 years). In an October 30, 2008, response to RAI 1, Question 02.03.05-2, the COL applicant committed to update COL FSAR Section 2.3.2 to add the 2000-2006 joint frequency distribution tables. The 2000-2006 annual joint frequency distribution tables for both the 10 m and 60 m elevation are provided in COL FSAR, Tables 2.3-134, "CCNPP 33' (10-m) 2000-2006 Annual Joint Frequency Distribution Table," and 2.3-135, "CCNPP 197' (60-m) 2000-2006 Annual Joint Frequency Distribution Table," respectively. The staff found the COL applicant's response acceptable. Therefore, the staff considers RAI 1, Question 02.03.05-2 resolved.

With regards to the annual average height of the inversion layer, or the maximum allowable plume centerline height, COL FSAR Section 2.3.5.2 specifies a value of 748 m (2,454 ft) based on mixing height data from the NCDC. The staff independently verified the mixing height estimate using Holzworth (1972), which lists a mean annual morning value of 600 m (1,969 ft) and a mean annual afternoon value of 1,400 m (4,593 ft), and finds the COL applicant's data to be acceptable.

The staff finds that the COL applicant provided a detailed description of meteorological data summaries used as input for dispersion modeling, as described in the third acceptance criteria of NUREG-0800, Section 2.3.5.

2.3.5.4.3 Site-Specific Evaluation of Maximum Annual Average χ/Q

COL FSAR Section 2.3.5.3 presented a follow-up discussion to the maximum annual average χ/Q value identified in COL FSAR Section 2.3.5.2. COL FSAR Section 2.3.5.3 states that, based on information about distances to nearest gaseous dose receptors in CCNPP Unit 3, Environmental Report, Table 5.4-6, the maximum annual average χ/Q occurred on the EAB, in

the northeast sector, at a distance of 0.8 km (0.5 mi) downwind centered on the Reactor Building. The discussion also indicated that the Site Area Boundary in this sector was located 0.45 km (0.28 mi) downwind at the shoreline of the Chesapeake Bay and that the EAB in this sector was located 0.35 km (0.22 mi) farther offshore in the Chesapeake Bay.

The COL applicant stated that the maximum site-specific annual average χ/Q and D/Q values at the EAB are 5.039E-06 s/m^3 and 3.79E-8 1/m^2, respectively. The EAB χ/Q value is a departure from the site parameter value of 4.973E-6 s/m^3. The difference between the site characteristic and the site parameter is very small (i.e., about one percent). In Part 7 of the CCNPP Unit 3 COLA, the COL applicant determined that the dose limits of 10 CFR 50, Appendix I for the maximally exposed individual are not exceeded. The staff's evaluation of the COL applicant's compliance with offsite dose limits is provided in Section 11 of this report. The staff also notes that the maximum site-specific annual average χ/Q value at the EAB is not a Tier 1 parameter and, therefore, no exemption is required.

The COL applicant also stated, referencing COL FSAR Table 2.3-118, that the annual average χ/Q values at 0.8 km (0.5 mi) in all other sectors were bounded by the maximum annual average χ/Q value (i.e., 4.973E-6 seconds per cubic meter) in U.S. EPR FSAR Tier 2, Table 2.1-1.

COL FSAR Section 2.3.5.3 also presented the COL applicant's justification for the acceptability of exceeding the site parameter χ/Q value in U.S. EPR FSAR Tier 2, Table 2.1-1 on the basis that:

- There are no persons currently living within the EAB or on its boundary in the northeast sector and the probability of anyone living on a watercraft at the EAB in that sector, 0.35 km (0.22 mi) offshore, for an extended period of time is extremely low.
- CCNPP Unit 3 will have control over persons living within the EAB and site boundary.
- The maximum annual average χ/Q values in all other sectors are within the limiting χ/Q value.

The COL applicant concluded that the dose limits in 10 CFR Part 50, Appendix I for the maximally exposed individual will not be exceeded.

The staff independently evaluated the COL applicant's values using 7 years of onsite meteorological data (2000-2006) and other assumptions as stated by the COL applicant. The staff finds that the COL applicant's values in the near-field (less than about 8 km (5 mi) were higher (more conservative) and that the staff's values beyond about 8 km (5 mi) were slightly higher. On the basis of the staff calculating comparable χ/Q values in its independent evaluation, the staff finds the COL applicant's site-specific maximum annual average χ/Q values to be acceptable.

2.3.5.4.4 Anticipated Influence of Chesapeake Bay on Atmospheric Dispersion

Short-term Atmospheric Dispersion – Offshore Wind

In COL FSAR Section 2.3.5.4, the COL applicant summarizes the results of a study (Slade, 1962) conducted in the Chesapeake Bay area. Slade observed atmospheric dispersion

over water, as compared to that over land, during conditions of offshore flow. Slade concluded that dispersion is generally poorer over water than over land due to reduced wind fluctuations over the comparatively cooler and smoother water surface. Slade also noted that, although his study included numerous simplifications, diffusion over small inland water bodies is likely to be different enough from that over the adjoining land to indicate that this difference should be considered in evaluating the effects of shoreline and over water pollution sources.

After summarizing Slade's study, the COL applicant stated its conclusion that effluent plumes originating at CCNPP Unit 3 and moving out over the Chesapeake Bay will experience less efficient atmospheric dispersion than plumes that stay over land, although important dispersion would still occur before a plume reached receptors at the closest point in eastern Maryland, across the Chesapeake Bay, at a distance of about 11 km (7 mi). The COL applicant also stated that the dispersion modeling accounted for potential recirculation of normal effluent releases, and concluded that the modeling results for CCNPP Unit 3 were therefore acceptable.

The staff evaluated Slade, and observed that this study includes measurements of horizontal wind fluctuations (a measure of atmospheric stability) of westerly winds during both day and night, at different surface water temperatures, across a 7-mi wide section of the Chesapeake Bay. The data shows that the atmospheric stability was generally neutral (Class "D") at the upwind location over land, and became more stable during passage over water, resulting in an equivalent Class "E" stability on the opposite shore. Wind speeds on the opposite shore were from 16 percent to 101 percent higher than wind speeds measured at the upwind location.

Based on Slade's results, staff used CCNPP Unit 3 site-specific meteorological data to simulate the stabilizing effect of overwater wind trajectories on atmospheric dispersion estimates for the EAB and outer boundary of the LPZ. The staff adjusted the CCNPP Unit 3 joint frequency distribution by increasing all hourly observations of winds blowing offshore by one stability class (i.e., All Class A changed to Class B, all B to C, etc.), including combining all Class F and G Class observations into Class G. This simple approach simulates the results observed by Slade (1962), in which off shore wind became more stable by approximately one stability class. The staff made no adjustments to observed wind speeds, even though Slade observed higher overwater wind speeds in his study. This is a conservative assumption, because higher wind speeds increase dispersion of pollutants. Using these assumptions, the staff calculated using PAVAN a bounding 0 – 2-hour χ/Q value for the outer boundary of the LPZ in the NE sector about 30 percent higher than the value using the original, non-adjusted joint frequency distribution. However, this value was still below the site characteristic value calculated by the COL applicant (2.15×10^{-4} s m^{-3}) using AEOLUS-3. Therefore, the staff finds the COL applicant's value is conservative, and is therefore acceptable.

The staff evaluation of the departure and exemption from the site parameter for the 0 − 2-hour LPZ χ/Q value is provided in Section 2.3.4.4.2 of this report.

Long-term Atmospheric Dispersion – Offshore Wind

The staff also evaluated the effect that overwater wind trajectories could have on long-term χ/Q values calculated for Maryland's Eastern Shore and beyond. As was the case for short-term χ/Q values described above, the staff believes that the downwind atmospheric stability class could be one class more stable than measured onsite as a result of an overwater trajectory. However, staff finds that several factors will reduce the magnitude of this effect on

long-term χ/Q values, as compared to short-term values at the EAB and outer boundary of the LPZ.

The staff finds that the following factors will offset the stabilizing effect of colder, smoother water surface of the Chesapeake Bay on plume dispersion:

- In the sector average atmospheric dispersion model used in XOQDOQ, atmospheric stability effects the downwind ground-level concentration only insofar as it changes the vertical dispersion coefficient (σ_z). Thus, the expected impact of higher atmospheric stability resulting from overwater trajectories is less than that for short-term χ/Q values, which depend on both horizontal and vertical dispersion coefficients (σ_y and σ_z).

- Annual average χ/Q estimates include diurnal and seasonal periods of time in which Chesapeake Bay surface temperatures exceed nearby ground surface temperatures. The resulting higher advective air turbulence over water would actually increase, rather than decrease.

- In the sector-average model implemented in XOQDOQ, downwind concentrations during unstable conditions (A, B, or C) beyond a certain distance (when the vertical dispersion coefficient exceeds 1,000 m) are no longer dependent on stability class, but vary only with the width of the sector. Therefore, a significant contribution to the annual average χ/Q values is not stability class dependent, and, thus, would not be affected by overwater trajectories.

Based on the factors described above, the staff finds that the overall effect of the Chesapeake Bay on long-term atmospheric dispersion is small. Therefore, the staff finds that the COL applicant's long-term atmospheric dispersion estimates are realistically conservative, and are therefore acceptable.

Short-term Atmospheric Dispersion - Onshore Wind

In the case of ground-level sources near the shoreline, the downwind dispersion of an onshore flow will be characteristic of overland dispersion (Van der Hoven, 1967). The COL applicant assumed that all short-term releases occur at ground level. Therefore, there is no effect of the Chesapeake Bay on dispersion downwind for onshore wind conditions.

Long-term Atmospheric Dispersion – Onshore Wind

In the case of onshore winds, and a ground-level release, downwind dispersion of an onshore flow will be characteristic of overland dispersion, as described above for short-term dispersion during onshore winds (Van der Hoven, 1967). In the case of highly stable onshore winds (i.e., Class F and G), and an elevated release, the potential exists for fumigation as the plume impacts a mixed, turbulent layer (thermal internal boundary layer (TIBL)) at some distance inland. The effect of potential fumigation conditions resulting from fumigation of elevated plumes moving inland is not explicitly accounted for in XOQDOQ. However, the staff notes that, during 2000 to 2007, highly stable onshore flow occurred less than two percent of the time. As a result, these conditions do not occur frequently enough to substantially alter annual average dispersion conditions downwind. Also, as noted by the COL applicant, a recirculation correction factor is applied 100 percent of the time in all downwind sectors. This factor increases annual average ground level concentrations by a factor of four out to a distance of 1 km (0.62 mi) from the release point, and decreases logarithmically to a value of 1 at 16 km (10 mi) downwind.

Even though the recirculation factor was developed to account for unrelated effects that increase downwind concentration (i.e., recirculation and atmospheric stagnation), the staff believes that the factor, in this case, would also account for infrequent fumigation conditions.

2.3.5.5 *Post Combined License Activities*

There are no post-COL activities related to this section.

2.3.5.6 *Conclusions*

The staff reviewed the application and checked the referenced U.S. EPR FSAR. The staff's review confirmed that, with the exception of an open item associated with that portion of RAI 250, Question 02.03.01-34 which pertains to the fact that the applicant has not fully addressed COL Information Item No. 2.3-1 by describing the exemption and departure from the maximum annual average χ/Q site parameter value, the COL applicant addressed the required information relating to long-term atmospheric dispersion estimates for routine releases, and there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to long-term atmospheric dispersion estimates for routine releases incorporated by reference in the COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete. The staff will update Section 2.3.5 of this report to reflect the final disposition of the design certification application.

Based on the meteorological data provided by the COL applicant and an atmospheric dispersion model that is appropriate for the characteristics of the site and release points, the staff concludes that representative atmospheric dispersion and deposition factors have been calculated for 16 radical sectors from the site boundary to a distance of 80 km (50 mi), as well as for specific locations of potential receptors of interest. The characterization of atmospheric dispersion and deposition conditions are acceptable to meet the relevant requirements of 10 CFR 100.21(c)(1) and are appropriate for the evaluation to demonstrate compliance with the numerical guides for doses contained in 10 CFR Part 20, Subpart D, 10 CFR 50.34a, and to 10 CFR Part 50, Appendix I.