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UniStar
NUCLEAR ENERGY

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April 14, 2010

UN#10-104

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: UniStar Nuclear Energy, NRC Docket No. 52-016
Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3,
RAI No.151 and RAI No. 152, Regional Climatology

References:
1) Surinder Arora (NRC) to Robert Poche (UniStar Nuclear Energy), "Final RAI No. 151 RSAC 2719" email dated September 17, 2009

2) Surinder Arora (NRC) to Robert Poche (UniStar Nuclear Energy), "Final RAI No. 152 RSAC 2797" email dated September 17, 2009

3) UniStar Nuclear Energy Letter UN#10-044, from Greg Gibson to Document Control Desk, U.S. NRC, RAI No. 151 and RAI No. 152, Regional Climatology, dated March 29, 2010

The purpose of this letter is to respond to the requests for additional information (RAIs) identified in the NRC e-mail correspondence to UniStar Nuclear Energy, dated September 17, 2009 (References 1 and 2). These RAIs address Regional Climatology, as discussed in Section 2.3.1 of the Final Safety Analysis Report (FSAR), as submitted in Part 2 of the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 Combined License Application (COLA), Revision 6.

Reference 3 provided an April 16, 2010 schedule for the response date for RAI No. 151 Questions 02.03.01-23 through 02.03.01-25 and 02.03.01-27, and RAI No. 152 Questions 02.03.01-28 through 02.03.01-32. Enclosure 1 provides the responses to RAI No. 151

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Questions 02.03.01-23 through 02.03.01-25 and 02.03.01-27. Enclosure 2 provides the responses to RAI No. 152 Questions 02.03.01-28 through 02.03.01-32.

The responses contain revised COLA content. A Licensing Basis Document Change Request has been initiated to incorporate these changes into a future revision of the COLA.

Our responses do not include any new regulatory commitments. This letter does not contain any sensitive or proprietary information.

If there are any questions regarding this transmittal, please contact me at (410) 470-4205, or Mr. Wayne A. Massie at (410) 470-5503.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on April 14, 2010

Greg Gibson

Enclosures:

1) Response to NRC Request for Additional Information, RAI No. 151, Regional Climatology, Questions 02.03.01-23 through 02.03.01-25 and 02.03.01-27, Calvert Cliffs Nuclear Power Plant, Unit 3
2) Response to NRC Request for Additional Information, RAI No. 152, Regional Climatology, Questions 02.03.01-28 through 02.03.01-32, Calvert Cliffs Nuclear Power Plant, Unit 3

cc: Surinder Arora, NRC Project Manager, U.S. EPR Projects Branch
Laura Quinn, NRC Environmental Project Manager, U.S. EPR COL Application
Getachew Tesfaye, NRC Project Manager, U.S. EPR DC Application (w/o enclosure)
Loren Plisco, Deputy Regional Administrator, NRC Region II (w/o enclosure)
Silas Kennedy, U.S. NRC Resident Inspector, CCNPP, Units 1 and 2
U.S. NRC Region I Office

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Enclosure 1

Response to NRC Request for Additional Information, RAI No. 151, Regional Climatology, Questions 02.03.01-23 through 02.03.01-25 and 02.03.01-27, Calvert Cliffs Nuclear Power Plant, Unit 3

RAI No 151

Question 02.03.01-23

The Staff considered the response to RAI Question No. 02.03.01-8 for the COL FSAR, submitted on October 30, 2008 (ML083100776), regarding the wet- and dry-bulb temperature data for determining maximum evaporation of water from the Ultimate Heat Sink (UHS). The Staff is concerned that this discussion is incomplete in terms of:

- how the meteorological input data were processed; and
- what criteria were used to conclude that the site characteristic values are enveloped by the corresponding U.S. EPR site parameter value(s).

The Applicant should address the following technical issues to fully resolve the Staff's concerns and to enable a better understanding of the analysis:

(a) Confirm whether the hourly data set for Patuxent River Naval Air Station (NAS) (1978-2007) included direct entries of wet-bulb temperature, or if the wet-bulb was calculated for each hour. If the latter, revise COL FSAR Section 2.3.1.2.2.13 to explain the calculation of the wet-bulb values using other concurrent observations.

(b) Confirm whether the data taken nominally on the hour were used exclusively, or if all observations were considered. If the latter, revise COL FSAR Section 2.3.1.2.2.13 to summarize how data from the more random synoptic or special observation times were integrated into the overall 30-year hourly data set.

(c) Identify any significant data gaps in the 30-year period of record considered and, if any, revise COL FSAR Section 2.3.1.2.2.13 to address the potential effects on determining the controlling 72-hour period of wet- and dry-bulb temperatures.

(d) The 72 consecutive hours of concurrent site parameter data presented in U.S. EPR FSAR Tier 2 Table 2.1-3 and the site characteristic wet- and dry-bulb temperature data presented in the proposed revision(s) to COL FSAR Table 2.0-3 and/or Section 2.3.1.2.2.13 are identical. This implies that the data from the Patuxent River NAS represent the U.S. EPR design values for maximum evaporation of water from the UHS as presented in U.S. EPR FSAR Tier 2 Table 2.1-3. Confirm that this is the case and, if so, revise (annotate) COL FSAR Table 2.0-3 and Section 2.3.1.2.2.13 accordingly. Specify the starting date and time of the controlling 72-hour period of site characteristic values.

(e) The Staff cannot conclude that the comparison table alone, as presented in the October 30, 2008 RAI response, adequately demonstrates that the U.S. EPR design values for maximum evaporation of water from the UHS envelope the CCNPP3 site characteristics. Summarize in COL FSAR Table 2.0-3 and/or Section 2.3.1.2.2.13 how such a conclusion can be drawn from looking at 72 pairs of sequential hourly wet- and dry-bulb temperature values, for example:

  - by demonstrating that the hourly wet-bulb depressions based on the site characteristic, concurrent wet- and dry-bulb temperature pairs are generally less than the hourly wet-bulb depressions for the corresponding 72-hour controlling period of site parameter wet- and dry-bulb temperature pairs, and/or

- based on a comparison between the evaporative loss estimated using the controlling 72-hour period of site characteristic wet- and dry-bulb temperature pairs and the design-basis maximum evaporative loss listed in U.S. EPR FSAR Tables 2.1-1 and 9.2.5-2).

Response

(a) As discussed in the response to RAI Question 02.03.01-8[1], the UHS evaluation was based on the 1976-2006 meteorological data from the Patuxent River Naval Air Station (NAS) (i.e., not 1978-2007). The hourly meteorological data for the NAS did not include wet bulb temperature values. Wet bulb temperature values were determined using the dry bulb temperatures, dew point temperatures, and atmospheric pressure values.

(b) Some of the NAS data observations included multiple data values for a given hour (e.g., values reported at 1507, 1522, and 1552). The computer program used a rolling average to establish the 72-hour period of dry bulb and wet bulb temperatures, and the evaporation potential. Any missing hourly data was filled in using the last temperature reading (e.g., if the temperature data was missing at 1200h, the data at 1100h was used). The computer program skipped any non-hourly data (e.g., data at 1430 hours).

(c) To address gaps in the data, the maximum number of missing hours allowed in any 72-hour running average was four. The rolling average data set was not used if the maximum number of missing hours over the 72-hour period exceeded four. If the number of missing hours exceeded four, then the next rolling average data set was selected with single increments in the hourly data and the same process was applied.

The criteria used to conclude that the site specific characteristic values are enveloped by the corresponding U.S. EPR site parameter value(s) are described in CCNPP Unit 3 FSAR Section 2.3.1.2.2.13, Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink. A comparison of the 72-hour wet bulb and dry bulb temperatures for maximum evaporation is addressed in that section. The acceptability of the 0% exceedance non-coincident wet bulb temperature design value is described in CCNPP Unit 3 FSAR Section 9.2.1, Essential Service Water System.

The 30 year meteorological data was examined to identify any significant gap in the hourly data. It was concluded that for the 30 years of data, less than 7% of the hourly data was missing. The data was also analyzed to identify missing information for the critical period from June to September when the parameters defining the UHS design are expected to be limiting. For this period, the total number of days with 10 hours or more of data missing in a day is less than 2%. A sensitivity analysis was performed with maximum allowable number of missing data of 10, 20 and 30 over a 72-hour rolling average period to establish the maximum evaporation. The results of this sensitivity analysis are identical to those determined using a maximum allowable four missing data points. Based on the results of these analyses, it is concluded that gaps in the weather data will not adversely impact the evaluated controlling 72-hour temperature data.

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[1] UniStar Nuclear Energy Letter UN#08-055, from Greg Gibson to Document Control Desk, U.S. NRC, Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 - Meteorology, dated October 30, 2008

(d) The U.S. EPR FSAR Tier 2 Table 2.1-3 used the CCNPP Unit 3 site characteristic wet bulb and dry bulb temperature data as the U.S. EPR controlling design values for maximum evaporation of water from the UHS. This will be clarified in CCNPP Unit 3 FSAR Section 2.3.1.2.2.13. CCNPP Unit 3 FSAR Section 2.0, Site Characteristics, has already been updated to reflect that the design values for maximum evaporation and drift loss of water from the UHS is incorporated from the U.S. EPR DCD by reference with no departures or supplements. The starting date and time of the 72-hour controlling period are 7/20/1987 hour 1.

(e) The same 72 pairs of sequential hourly wet bulb and dry bulb temperature values are used to determine the maximum evaporation of water from the UHS for the U.S. EPR DCD and CCNPP Unit 3. Therefore, the evaporative losses are the same and as such, the U.S. EPR design values envelop the CCNPP Unit 3 site characteristics.

COLA Impact

FSAR Section 2.3.1.2.2.13, Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink, will be revised as follows:

In accordance with Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants," (NRC, 1976), the meteorological conditions resulting in maximum evaporation and drift loss should be the worst 30-day average combination of controlling parameters (wet bulb and dry bulb temperatures). The design of the UHS, as stated in the U.S. EPR FSAR Section 2.3.1.2, is based on meteorological conditions that exist for 72 hours, consistent with the sizing of the UHS cooling tower basin. For CCNPP Unit 3, the worst meteorological conditions resulting in maximum evaporation and drift loss of water for the UHS over a 72 hour period are shown in Table 2.0-3. The U.S. EPR and CCNPP Unit 3 use the same 72-hour period of temperature data to determine maximum evaporation of water from the UHS.

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The U.S. EPR FSAR also states that the design of the UHS is based on a consideration of air temperature data listed in U.S. EPR FSAR Table 2.1-1. Site-specific values for these parameters were determined using 30 years (1978-2007) of meteorological data from Patuxent River Naval Air Station (NAS), Maryland, a nearby representative site (NCDC, 2008). The 0% exceedance maximum dry bulb and coincident wet bulb temperature values are 102°F (39°C) and 80°F (27°C), respectively. The 0% exceedance non-coincident maximum wet bulb temperature value is 85°F (29° C). ~~The highest monthly (July) 1% design values are 80°F (27°C) and 89.5°F (31.9°C) for the wet and mean coincident dry bulb temperatures, respectively.~~ The hourly data set for the NAS did not include wet bulb temperature values. Wet bulb temperature values were determined using the provided temperature, dew point temperature, and atmospheric pressure hourly values. Hourly observations that had valid values for ambient temperature, dew point temperature, and atmospheric pressure were used in the analysis. The U.S. EPR FSAR design values listed in Table 2.1-1 bound the calculated values for CCNPP Unit 3 listed above except for the 0% exceedance non-coincident wet bulb temperature value. This comparison is shown in Table 2.0-1. The acceptability of the 0% exceedance non-coincident wet bulb temperature design value is described in FSAR Section 9.2.1.1.

Since a closed loop hybrid cooling tower will act as the normal heat sink for CCNPP Unit 3, another meteorological condition to consider is the maximum one-hour dry bulb temperatures. The maximum one-hour dry bulb temperature determined for Baltimore, Maryland, in Local Climatological Data, 2002 Annual Summary with Comparative Data, (NOAA, 2002a) is 105°F (40.6°C). This value was determined over a 52-year period of record (1951-2002). The maximum one-hour dry bulb temperature determined for Patuxent River NAS, Maryland, is 103°F (39.4°C) over the period 1978 through 2007.

The meteorological conditions resulting in minimum cooling due to evaporation of water are presented in Table 2.0-4.

The site wet bulb temperature was calculated using site dry bulb temperature, dew point temperature and station atmospheric pressure. The evaporation potential was determined as the difference between the moisture content of saturated air at the dry bulb temperature minus the actual moisture content of the air. The computer program used a rolling average to establish the 72-hour period of dry bulb and wet bulb temperatures, and the evaporation potential. Any missing hourly data was filled in using the last temperature reading (e.g., if the temperature data was missing at 1200h, the data at 1100h was used). The computer program skipped any non-hourly data (e.g., data at 1430 hours), and the maximum number of missing hours allowed in any 72-hour running average was four. The rolling average data set was not used if the maximum number of missing hours over the 72-hour period exceeded four.

Question 02.03.01-24

The Staff considered the response to RAI Question No. 02.03.01-8 for the COL FSAR, submitted on October 30, 2008 (ML083100776), regarding the wet- and dry-bulb temperature data for determining minimum water cooling in the Ultimate Heat Sink (UHS). As with the wet- and dry-bulb temperature data for determining maximum evaporation of water from the UHS cooling basins, the Staff is concerned that this discussion is also incomplete in terms of:

- what criteria were used to conclude that the site characteristic values are enveloped by the corresponding U.S. EPR site parameter value(s).

Issues related to the processing of the hourly meteorological data have been raised in a previous question regarding maximum evaporative water loss from the UHS except that a controlling period of 24 consecutive hours is applicable to the determination of minimum water cooling rather than the 72-hour period related to determining maximum evaporative water loss.

Therefore, the Applicant should address the following technical issues to fully resolve the Staff's concerns:

(a) The 24 consecutive hours of concurrent site parameter data presented in U.S. EPR FSAR Tier 2 Table 2.1-4 and the site characteristic wet- and dry-bulb temperature data presented in the proposed revision(s) to COL FSAR Table 2.0-4 and/or Section 2.3.1.2.2.13 are identical. This implies that the data from the Patuxent River Naval Air Station represent the U.S. EPR design values for minimum water cooling in the UHS as presented in U.S. EPR FSAR Tier 2 Table 2.1-4. Confirm that this is the case and, if so, revise (annotate) COL FSAR Table 2.0-4 and Section 2.3.1.2.2.13 accordingly. Specify the starting date and time of the controlling 24-hour period of site characteristic values.

(b) The Staff cannot conclude that the comparison table alone, as presented in the October 30, 2008 RAI response, adequately demonstrates that the U.S. EPR design values for minimum water cooling in the UHS envelope the CCNPP3 site characteristics. Summarize in COL FSAR Table 2.0-4 and/or Section 2.3.1.2.2.13 how such a conclusion can be drawn from looking at 24 pairs of sequential hourly wet- and dry-bulb temperature values, for example:

  - by demonstrating that the hourly wet-bulb depressions based on the site characteristic concurrent wet- and dry-bulb temperature pairs are generally larger than the hourly wet-bulb depressions for the corresponding 24-hour controlling period of site parameter wet- and dry-bulb temperature pairs, and/or
  - based on a comparison between the cold (outlet) water temperature estimated using the 24-hour period of site characteristic wet- and dry-bulb temperature pairs and the corresponding cold (outlet) water temperature listed in U.S. EPR FSAR Tables 2.1-1 and 9.2.5-2).

Response

FSAR Table 2.0-4, Design Values for Minimum Water Cooling in the UHS, is incorporated from the U.S. EPR FSAR by reference. CCNPP Unit 3 FSAR Section 2.3.1.2.2.13, Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink, will be revised to indicate that the same 24 hours of temperature data were used.

Since the same 24 hours of temperature values are used to determine the minimum water cooling in the UHS for the U.S. EPR FSAR and CCNPP Unit 3, the minimum water cooling is the same and as such, the U.S. EPR design values envelope the CCNPP Unit 3 site characteristics. The starting date and time of the controlling 24-hour period is 7/15/1995 hour 9.

COLA Impact

FSAR Section 2.3.1.2.2.13, Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink, will be revised as follows:

> The table below provides a comparison of the Table 2.1-4 values in the U.S. EPR FSAR and the CCNPP site-specific values used for minimum cooling from the UHS. Since the same 24 hours of temperature values are used to determine the minimum water cooling in the UHS for the U.S. EPR FSAR and CCNPP Unit 3, the minimum water cooling is the same and as such, the U.S. EPR design values envelop the CCNPP Unit 3 site characteristics.

Question 02.03.01-25

The Staff considered the response to RAI Question No. 02.03.01-8 for the COL FSAR, submitted on October 30, 2008 (ML083100776), in particular revised Paragraph 9 in COL FSAR Section 2.3.1.2.2.13. Among other things, revised Paragraph 9:

- cross-references air temperature data listed in U.S. EPR FSAR Table 2.1-1;
- introduces 0% exceedance maximum dry-bulb and coincident wet-bulb temperatures, the 0% exceedance non-coincident wet-bulb temperature; and revised 1% exceedance wet- and mean coincident dry-bulb temperatures; and
- makes statements as to whether these site characteristic values are bounded by the temperature-related site parameters listed in U.S. EPR Table 2.1-1.

The Staff has concerns over the inclusion of what appears to be information and data without a discussion that establishes its relevance to the Ultimate Heat Sink (UHS) design or how the acceptability of these site-specific characteristics is to be evaluated. Therefore, in order to fully resolve the Staff's concerns, the Applicant should address the following technical issues and revise related sections in the COL FSAR accordingly:

(a) The text, as proposed to be revised, identifies 0% exceedance maximum dry-bulb and coincident wet-bulb temperature site characteristic values of 102 °F and 80 °F, respectively, based on 30 years of meteorological data (1978-2007) from the Patuxent River Naval Air Station (NAS). Explain the following:

- the relevance of these specific site characteristic values to the UHS design; and
- their relationship, if any, to the 72-hour controlling period for estimating maximum evaporation from the UHS cooling towers.

(b) The text, as proposed to be revised, identifies a 0% exceedance maximum non-coincident wet-bulb temperature site characteristic value of 85 °F based on the same 30-year data set from the Patuxent River NAS. The Staff notes that COL FSAR Section 9.2.1.1 lists 0% exceedance maximum wet-bulb and coincident dry-bulb site characteristic values of 85 °F and 99 °F, respectively. The Staff also notes that: the site characteristic non-coincident wet-bulb temperature component (85 °F) exceeds the corresponding 0% exceedance non-coincident site parameter value (81 °F) in U.S. EPR Table 2.1-1; that the proposed revisions to Paragraph 9 acknowledge this exceedance; and that this 85 °F site characteristic value exceeds most of the wet-bulb temperatures in U.S. EPR Table 2.1-4. Explain the following:

- the relevance of the 0% exceedance non-coincident maximum wet bulb temperature site characteristic value to the UHS design; and
- the relationship, if any, to the 24-hour controlling period for estimating minimum water cooling in the UHS.

(c) Based on a referenced discussion in COL FSAR Section 9.2.1.1, the 0% exceedance criterion for the maximum non-coincident wet-bulb temperature means "that the wet bulb temperature does not exceed the 0% exceedance value for more than two consecutive data occurrences", with the data recorded hourly. This ambient design temperature data filtering criterion appears to be fundamentally different from the criterion expressed parenthetically 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) for 0% exceedance values – that is, an "historical limit excluding peaks < 2 hours". The former criterion appears to incorporate peaks in the wet-bulb temperature data that persist for less than or equal to 2 hours in defining the 0% exceedance maximum non-coincident wet-bulb temperature site characteristic / site parameter value. The latter criterion appears to exclude peaks in the wet-bulb temperature data that persist for only one hour in defining the 0% exceedance maximum non-coincident wet-bulb temperature value.

Address the following:

- Reconcile the apparent difference between the descriptions of the ambient design temperature data filtering criteria in the COL FSAR and the referenced URD not only for the 0% exceedance non-coincident wet-bulb temperature but for the 0% exceedance dry-bulb and coincident wet-bulb temperatures, and the 0% exceedance minimum dry-bulb temperature as well. Provide supplemental information to clarify related sections and tables in the COL FSAR accordingly.
- Provide examples that illustrate the 0% exceedance value selection process.

(d) The text, as proposed to be revised, identifies the highest monthly (July) 1% design wet- and mean coincident dry-bulb temperatures of 80 °F and 89.5 °F, respectively. These site characteristic values are fundamentally different from the 1% exceedance maximum temperature (site parameter) values of 100 °F (dry-bulb) and 77 °F (coincident wet-bulb) in U.S. EPR FSAR Table 2.1-1 in several respects. Address the following technical issues and provide supplemental information to clarify related sections and tables in the COL FSAR accordingly:

- Explain the relevance of these site characteristic values to the UHS design and their relationship to the 72-hour controlling period for estimating maximum evaporation from and the 24-hour controlling period for estimating minimum water cooling in the UHS.
- Identify the applicable site parameter values and discuss the basis for determining whether or not the site parameter values envelope the corresponding site characteristic values.
- Discuss how the site characteristic wet-bulb and mean coincident dry-bulb temperatures and the 1% exceedance maximum dry-bulb and coincident wet-bulb U.S. EPR site parameter values were determined.
- Explain why the coincident wet-bulb site parameter value is specified as a coincident temperature, and not as a mean coincident temperature.
- The site characteristic 1% exceedance wet- and mean coincident dry-bulb temperature values appear to be associated with a highest month (July). This brings into question whether the site parameters in U.S. EPR FSAR Table 2.1-1 and/or the corresponding site characteristic values represent percent exceedances on a monthly, seasonal, or annual basis. Clarify what the various percent exceedance design temperature site parameter values represent and confirm that the respective site characteristic values have been developed on the same basis.

(e) If all or part of revised Paragraph 9 is retained, then pursuant to the guidance in Reg. Guide 1.206, Section C.I.2.3.1.2, Paragraph 2, identify the specific systems or components that utilize the 0% exceedance maximum dry- and coincident wet-bulb, the 0% exceedance maximum non-coincident wet-bulb, and the highest monthly 1% design wet- and mean coincident dry-bulb temperature values for design purposes. Provide cross-references to the specific COL and/or U.S. EPR FSAR sections where these conditions are used.

(f) If all or part of revised Paragraph 9 is deleted, then explain the rationale for doing so.

Response

(a) The period of record used in the evaluation of UHS design is 30 year data from 1976-2006. The 0% exceedance maximum dry bulb and coincident wet bulb temperature site characteristic values of 102°F and 80°F respectively, were part of the data set considered during the design of UHS. However, the maximum evaporation for the 72-hour controlling period established in U.S. EPR FSAR Table 2.1-3, Design Values for Maximum Evaporation and Drift Loss of Water from the UHS, does not contain this data point. Hence, there is no significance of this data point relative to the 72-hour controlling period for estimating the maximum evaporation from UHS cooling towers.

(b) 1. The 0% exceedance non-coincident maximum wet bulb temperature of 85°F is the controlling factor for establishing the tower basin water temperature because of the more limited ability of the ambient air to absorb heat energy in moving through the tower.

2. As described in U.S. EPR FSAR Table 2.1-4, Design Values for Minimum Water Cooling in the UHS, which provides a 24 hour profile of the worst case meteorological conditions for the UHS cooling tower, the 85°F wet bulb temperature is included as one of the observed data points. This profile was applied to the cooling tower along with the DBA heat load to simulate the worst case cooling tower performance, to establish the required cooling capacity. The resulting cold water temperature (i.e. CCW heat exchanger ESW inlet water temperature) is less than the maximum acceptable temperature of 95°F. Therefore, the performance of the cooling tower for the worst case ambient condition (per U.S. EPR FSAR Table 2.1-1, U.S. EPR Site Design Envelope) at CCNPP Unit 3 is acceptable.

(c) The quote from the EPRI URD "historical limit excluding peaks < 2 hours" means that the results are not invalidated if a single hourly value is higher than the 0% maximum or lower than the 0% minimum. This corresponds with the usage and definition provided in CCNPP Unit 3 FSAR Section 9.2.1, Essential Service Water System. Alternatively, the definition of the 0% exceedance temperature value is "The definition of the maximum/minimum zero percent exceedance temperature values is the highest/lowest value that can occur for consecutive hours (two or more) and can only be exceeded one hour at a time (i.e., no consecutive hourly temperature values can exceed it)."

Example of 0% exceedance value selection: Obtain 30 years (or more) of data from a nearby site. Analyze the data to find maximum (or minimum) 2-hour average temperature value. For the CCNPP Unit 3 analysis, output values that met certain criteria were chosen (e.g., wet bulb temperature values greater than 80°F as well as the 2-hour average temperature value) to allow the analyst to see the periods of time when conditions were most extreme and to easily check the 2-hour average value.

(d) These values (July 1% exceedance temperature) were not used in the UHS design and will be removed from CCNPP Unit 3 FSAR Section 2.3.1.2.2.13, Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink.

(e) The following information is provided to identify specific systems or components that utilize the 0% and 1% exceedance temperature values for design purposes. Note that the systems or components are designed to the more stringent U.S. EPR FSAR values rather than the site specific CCNPP Unit 3 values.

The Heating, Ventilation and Air Conditioning (HVAC) systems that are safety-related and are designed to 0% exceedance temperature values (115°F dry bulb temperature and coincident 80°F wet bulb temperature; -40°F dry bulb temperature) are:

- Containment Building Ventilation System (Section 9.4.7)
- Annulus Building Ventilation System (Section 9.4.7)
- Safeguard Building Controlled-Area Ventilation System (Section 9.4.5)
- Main Control Room AC System (Section 9.4.1)
- Electrical Division of Safeguard Building Ventilation Systems (Section 9.4.6)
- Emergency Power Generating Building Ventilation System (Section 9.4.9)
- Fuel Building Ventilation System (Section 9.4.2)
- Essential Service Water Ventilation System (Section 9.4.11)

The HVAC Systems that are non-safety-related and are designed to 1% exceedance temperature values (100°F dry bulb temperature and coincident 77°F wet bulb temperature; -10°F dry bulb temperature) are:

- Nuclear Auxiliary Building Ventilation System (Section 9.4.3)
- RAD Waste Building Ventilation System (Section 9.4.8)
- Smoke Confinement System (Section 9.4.13)
- MS & FW Valve Compartment Ventilation System (Section 9.4.12)
- Access Building Ventilation System (Section 9.4.14)
- Switchgear & SBO Building (Section 9.4.10)
- Turbine Building Ventilation System (Section 9.4.4)

Since these systems deal with HVAC design as opposed to UHS design, this information will be added to CCNPP Unit 3 FSAR Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning.

The HVAC systems that are safety-related, and are designed to site specific 0% exceedance temperature values (102ºF dry bulb temperature coincident 80ºF wet bulb temperature; -0ºF dry bulb temperature) are:

- UHS Makeup Water and Electrical Distribution Ventilation System (Section 9.4.15)

The HVAC system that is non-safety-related, augmented quality and are designed to 0% exceedance temperature values (115°F dry bulb temperature and coincident 80°F wet bulb temperature; -40°F dry bulb temperature) is:

- Fire Protection Building Ventilation System (Section 9.4.16)

The HVAC systems that are non-safety-related and are designed to site specific 1% Monthly (July or December) exceedance temperature values (93°F dry bulb temperature and coincident 76.8°F wet bulb temperature; 14°F dry bulb temperature) are:

- Circulating Water Pump Building Ventilation System
- Circulating Water Makeup Intake Structure Ventilation
- Waste Water Treatment Building Ventilation System
- Water Treatment Building Ventilation System
- Security Access Ventilation System
- Workshop & Warehouse Ventilation System

Additional information on air conditioning, heating, cooling and ventilation systems are provided in U.S. EPR FSAR and COLA FSAR Section 9.4, Air Conditioning, Heating, Cooling and Ventilation Systems. Some of the non-safety HVAC systems listed above are not described in the FSAR (e.g. Workshop & Warehouse).

(f) The fifth sentence in paragraph nine will be deleted since the July 1% exceedance temperature values were not used in the UHS design.

COLA Impact

FSAR Section 2.3.1.2.2.13, Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink, will be revised as follows:

The U.S. EPR FSAR also states that the design of the UHS is based on a consideration of air temperature data listed in U.S. EPR FSAR Table 2.1-1. Site-specific values for these parameters were determined using 30 years (1978-2007) of meteorological data from Patuxent River Naval Air Station (NAS), Maryland, a nearby representative site (NCDC, 2008). The 0% exceedance maximum dry bulb and coincident wet bulb temperature values are 102°F (39°C) and 80°F (27°C), respectively. The 0% exceedance non-coincident maximum wet bulb temperature value is 85°F (29°C). ~~The highest monthly (July) 1% design values are 80°F (27°C) and 89.5°F (31.9°C) for the wet and mean coincident dry bulb temperatures, respectively.~~ The hourly data set for the NAS did not include wet bulb temperature values. Wet bulb temperature values were determined using the provided temperature, dew point temperature, and atmospheric pressure hourly values. Hourly observations that had valid values for ambient temperature, dew point temperature, and atmospheric pressure were used in the analysis. The U.S. EPR FSAR design values listed in Table 2.1-1 bound the calculated values for CCNPP Unit 3 listed above except for the 0% exceedance non-coincident wet bulb temperature value. This comparison is shown in FSAR Table 2.0-1. The acceptability of the 0% exceedance non-coincident wet bulb temperature design value is described in FSAR Section 9.2.1.1.

FSAR Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning, will be revised as shown in the response to Question 02.03.01-30 (see Enclosure 2 of this submittal).

Question 02.03.01-27

(a) Standard Review Plan (SRP) Section 2.3.1, Section II (Acceptance Criteria), SRP Acceptance Criterion (2) 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".

Revise 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 FSAR sections that utilize this information.

Response

Historical data and current literature on postulated long-term environmental changes were reviewed to provide assurance that the methods used to predict weather extremes are appropriate and reasonable. Reports issued by the International Panel on Climate Change (IPCC, 2007) and the U.S. Global Change Research Program (GCRP, 2009) indicate that global average air temperatures are increasing. However, there is insufficient evidence to determine whether trends exist in small-scale phenomena such as tornadoes, hail, lightning, and dust storms (IPCC, 2007), and there is no clear trend in the annual number of tropical storms (IPCC, 2007). Regionally, the Maryland Commission on Climate Change (MCCC, 2008) reports that climate change could result in the following impacts in Maryland:

- Temperature is projected to increase throughout the century. The annual average temperature is projected to increase by about 3°F by mid century. The amount of warming later in the century is dependent on the mitigation of greenhouse gas emissions.
- Precipitation is projected to increase during the winter, but become more episodic. Projections of precipitation are much less certain than for temperature. There has been no statistically significant trend in recent years, but modest increases are more likely in the winter and spring.
- Rains and winds from hurricanes are likely to increase, but their frequency and whether storm tracks will impact the state cannot be predicted.

The above described climate change projections are uncertain. Although broad trends that may result as a consequence of climate change are identified, such projections are so general that an assessment of the potential impact on design site characteristics is inherently limited. However, these potential climate-related changes were considered and addressed as follows:

- For average temperatures, the amount of warming later in the century is dependent on factors such as the mitigation of greenhouse gas emissions and cannot be accurately predicted. CCNPP FSAR Section 2.3.1, Regional Climatology, states that on average, temperatures of 90°F or higher occur 15 to 25 days per year along the shores of the Chesapeake Bay. CCNPP FSAR Section 2.3.2.1.2, Temperature and Humidity, states that the maximum hourly temperature at the CCNPP site between January 2000 and December 2005 was 96.3°F. Thus, even a projected average temperature increase of 3°F would be within the dry bulb temperature design parameter for the U.S. EPR.

For extreme temperatures, the response to RAI 152 Question 02.03.01-30 (Enclosure 2) states that the 100-year return period temperature value was calculated based on the ASHRAE method using 30 years of data from 1978-2007. This method yielded a value of 104.8°F. The response to Question 02.03.01-30 also states that the highest recorded temperature was 106°F at Cambridge Water Treatment, Maryland, on 7/21/1930, and at Owings Ferry Landing, Maryland, on 8/6/1918. While these two temperatures were not taken at the site, the locations are within 25 miles of the site. Given that the calculated value is comparable to the highest recorded value in the previous 75-90 years, the method used to calculate the 100-year return period extreme temperature is appropriate and reasonable. The calculated extreme temperature is within the dry bulb temperature design parameter for the U.S. EPR.

- The maximum rainfall rate is generally associated with tropical storms, whose frequency and storm tracks cannot be predicted. However, for the site region (Solomons, MD), the National Weather Service calculated a 100-year annual recurrence interval for rainfall of 3.28 in/hr (NOAA, 2006). This value is considerably less than the U.S. EPR design parameter of 19.4 in/hr.
- Winter snow volumes are projected to decrease while winter precipitation amounts are projected to increase. Thus, there is likely no impact on the roof loads due to snow.
- There are no specific projections regarding wind speed. Thus, there is no basis to assess the possible impact on the ASCE 7-05 Basic Wind Speed (3-second gust) (ASCE, 2006).
- There is insufficient evidence to determine whether trends exist in small-scale phenomena such as tornadoes. Thus, there is no basis to assess the possible impact on the tornado maximum wind speed.

References

ASCE, 2006. Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7-05, American Society of Civil Engineers, 2006.

IPCC, 2007. Climate Change 2007: Synthesis Report, An Assessment of the Intergovernmental Panel on Climate Change, 2007.

GCRP, 2009. Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.

MCCC, 2008. Comprehensive Assessment of Climate Change Impacts, Chapter Two, Report to the Maryland Commission on Climate Change, scientific and Technical Working Group, July 2008.

NOAA, 2006. Precipitation-Frequency Atlas of the United States NOAA Atlas 14, Solomons Island, Maryland (18-8405), Volume 2, Version 3.0, NOAA, National Weather Service, Silver Spring, Maryland.

COLA Impact

The following text will be added as a new subsection in the CCNPP Unit 3 FSAR:

2.3.1.2.2.17 Possible Climate Change and Potential Impact on Related Site Characteristics

Historical data and current literature on postulated long-term environmental changes were reviewed to provide assurance that the methods used to predict weather extremes are appropriate and reasonable. Reports issued by the International Panel on Climate Change (IPCC, 2007) and the U.S. Global Change Research Program (GCRP, 2009) indicate that global average air temperatures are increasing. However, there is insufficient evidence to determine whether trends exist in small-scale phenomena such as tornadoes, hail, lightning, and dust storms (IPCC, 2007), and there is no clear trend in the annual number of tropical storms (IPCC, 2007). Regionally, the Maryland Commission on Climate Change (MCCC, 2008) reports that climate change could result in the following impacts in Maryland:

- Temperature is projected to increase throughout the century. The annual average temperature is projected to increase by about 3°F by mid century. The amount of warming later in the century is dependent on the mitigation of greenhouse gas emissions.
- Precipitation is projected to increase during the winter, but become more episodic. Projections of precipitation are much less certain than for temperature. There has been no statistically significant trend in recent years, but modest increases are more likely in the winter and spring.
- Rains and winds from hurricanes are likely to increase, but their frequency and whether storm tracks will impact the state cannot be predicted.

The above described climate change projections are uncertain. Although broad trends that may result as a consequence of climate change are identified, such projections are so general that an assessment of the potential impact on design site characteristics is inherently limited. However, these potential climate-related changes were considered and addressed as follows:

- For average temperatures, the amount of warming later in the century is dependent on factors such as the mitigation of greenhouse gas emissions and cannot be accurately predicted. CCNPP FSAR Section 2.3.1, Regional Climatology, states that on average, temperatures of 90°F or higher occur 15 to 25 days per year along the shores of the Chesapeake Bay. CCNPP FSAR Section 2.3.2.1.2, Temperature and Humidity, states that the maximum hourly temperature at the CCNPP site between January 2000 and December 2005 was 96.3°F. Thus, even a projected average temperature increase of 3°F would be within the dry bulb temperature design parameter for the U.S. EPR.

  For extreme temperatures, the response to RAI 152 Question 02.03.01-30 (Enclosure 2) states that the 100-year return period temperature value was calculated based on the ASHRAE method using 30 years of data from 1978-2007. This method yielded a value of 104.8°F. The response to Question 02.03.01-30 also states that the highest recorded temperature was 106°F at Cambridge Water Treatment, Maryland, on 7/21/1930, and at Owings Ferry Landing, Maryland, on 8/6/1918. While these two temperatures were not taken at the site, the locations are within 25 miles of the site. Given that the calculated value is comparable to the highest recorded value in the previous 75-90 years, the method used to calculate the 100-year return period extreme temperature is appropriate and reasonable. The calculated extreme temperature is within the dry bulb temperature design parameter for the U.S. EPR.

- The maximum rainfall rate is generally associated with tropical storms, whose frequency and storm tracks cannot be predicted. However, for the site region (Solomons, MD), the National Weather Service calculated a 100-year annual recurrence interval for rainfall of 3.28 in/hr (NOAA, 2006). This value is considerably less than the U.S. EPR design parameter of 19.4 in/hr.
- Winter snow volumes are projected to decrease while winter precipitation amounts are projected to increase. Thus, there is likely no impact on the roof loads due to snow.
- There are no specific projections regarding wind speed. Thus, there is no basis to assess the possible impact on the ASCE 7-05 Basic Wind Speed (3-second gust) (ASCE, 2006).
- There is insufficient evidence to determine whether trends exist in small-scale phenomena such as tornadoes. Thus, there is no basis to assess the possible impact on the tornado maximum wind speed.

The following references will be added to FSAR Section 2.3.1.2.3, References:

IPCC, 2007. Climate Change 2007: Synthesis Report, An Assessment of the Intergovernmental Panel on Climate Change, 2007.

GCRP, 2009. Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.

MCCC, 2008. Comprehensive Assessment of Climate Change Impacts, Chapter Two, Report to the Maryland Commission on Climate Change, Scientific and Technical Working Group, July 2008.

NOAA, 2006. National Oceanic and Atmospheric Administration Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 2 Version 3.0: Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, Revised 2006.

Enclosure 2

Response to NRC Request for Additional Information, RAI No. 152, Regional Climatology, Questions 02.03.01-28 through 02.03.01-32, Calvert Cliffs Nuclear Power Plant, Unit 3

RAI No 152

Question 02.03.01-28

The Staff agrees with the response to RAI Question No. 02.03.01-12 for the COL FSAR, submitted on October 30, 2008 (ML083100776), regarding the proposed deletion of the 2% exceedance dry- and wet-bulb temperatures from the discussion in COL FSAR Section 2.3.1.2.2.16 and COL FSAR Tables 2.3-10, 2.3-11, 2.3-13, 2.3-14, and 2.3-15.

However, the Staff has a general concern over the inclusion of what appears to be information and data without a discussion that establishes its relevance to the design of the heating, ventilation, and air conditioning systems for safety-related and/or other structures, systems, and components at the CCNPP3 site.

Therefore, in order to fully resolve the Staff's concern, the Applicant should explain the relevance of the extreme annual design wind speed, extreme annual maximum and/or minimum wet- and dry-bulb temperature data, and 10-, 20- and 50-year return interval extreme maximum and minimum dry-bulb temperatures presented in Table 2.3-12. If retained, revise Section 2.3.1.2.2.16 accordingly: otherwise, delete Table 2.3-12 as well.

Response

FSAR Table 2.3-12 was deleted in Revision 5 of the CCNPP Unit 3 COLA.

COLA Impact

There are no additional impacts to the COLA.

Question 02.03.01-29

The Staff considered the response to RAI Question No. 02.03.01-12 for the COL FSAR, submitted on October 30, 2008 (ML083100776), in particular revised Paragraph 2. Among other things, revised Paragraph 2:

- presents revised 1% exceedance maximum dry-bulb and coincident wet-bulb temperatures and a revised 1% exceedance minimum dry-bulb temperature for the hottest and coldest months, respectively;
- presents 0% exceedance maximum dry-bulb and coincident wet-bulb temperatures; and
- makes a statement that the design values in U.S. EPR FSAR Table 2.1-1 bound these calculated values for the Calvert Cliffs Unit 3 site.

Nevertheless, the Staff cannot tell what the maximum and minimum dry- and/or wet-bulb temperature design (site parameter) values in the U.S. EPR FSAR (including Table 2.1-1) represent statistically, or whether the corresponding site characteristic values were developed on the same basis. As a result, the Staff cannot conclude if the temperature-related site parameters in the U.S. EPR envelope the CCNPP3 site characteristics. Therefore, to fully resolve these concerns, the Applicant should address the following technical issues:

(a) The 1% exceedance maximum dry-bulb and coincident wet-bulb site characteristic temperatures are said to be associated with the hottest month (July). This brings into question whether the design values (site parameters) in U.S. EPR FSAR Table 2.1-1 represent percent exceedances on a monthly, seasonal, or annual basis. Provide supplemental information to clarify COL FSAR Section 2.3.1.2.2.16 and COL FSAR Table 2.0-1 as to whether the U.S. EPR maximum 1% exceedance (design) values represent monthly, seasonal, or annual exceedances. Confirm that these site parameters and the corresponding site characteristic values have been developed on the same basis.

(b) The 1% exceedance minimum dry-bulb site characteristic temperature is said to be associated with the coldest month (i.e., December).

- Resolve the discrepancy between the "coldest month" as specified in revised Paragraph 2 and as defined and indicated (i.e., January) in the 2005 ASHRAE Handbook summary for the Patuxent River Naval Air Station, in the National Climatic Data Center's Climatography of the United States (No. 81) for that station, and in COL FSAR Tables 2.3-56 and 2.3-64 based on onsite and offsite meteorological data. If necessary, recalculate the 1% exceedance minimum dry-bulb temperature and revise COL FSAR Section 2.3.1.2.2.16 accordingly.
- As above, this brings into question whether the design value (site parameter) in U.S. EPR FSAR Table 2.1-1 represents a percent exceedance on a monthly, seasonal, or annual basis. Provide supplemental information to clarify COL FSAR Section 2.3.1.2.2.16 and COL FSAR Table 2.0-1 as to whether the U.S. EPR minimum 1% exceedance (design) value represents a monthly, seasonal, or annual exceedance. Confirm that this site parameter and the corresponding site characteristic values have been developed on the same basis.

(c) COL FSAR Table 2.0-1 is intended to compare design (site parameter) values against site characteristic values. Table 2.0-1 identifies the temperature-related site parameter values from U.S. EPR FSAR Table 2.1-1, but does not provide corresponding site characteristic values except for a questionable 0% exceedance minimum dry-bulb temperature (i.e., 31.8 °F).

- The same issues identified in (b) above for the 1% exceedance minimum dry-bulb temperature apply to the reported 0% exceedance minimum dry-bulb temperature. If necessary, recalculate the 0% exceedance minimum dry-bulb temperature and revise COL FSAR Section 2.3.1.2.2.16 accordingly.
- If applicable to the design of safety-related and other heating, ventilation, and air conditioning (HVAC) systems, specify in COL FSAR Section 2.3.1.2.2.16, as applicable, the 0% and 1% exceedance non-coincident site characteristic wet-bulb temperatures and the 0% exceedance site characteristic minimum dry-bulb temperature.
- Update COL FSAR Table 2.0-1 with the 0% and 1% exceedance dry- and/or wet-bulb site characteristic temperatures.
- If any of the 0% or 1% exceedance dry- and/or wet-bulb temperatures are also related to the design of the Ultimate Heat Sink (UHS), ensure consistency with the values presented in revised COL FSAR Section 2.3.1.2.2.13.
- Explain the criteria used to conclude that the various design (site parameter) values, as individual dry- or wet-bulb temperatures or as dry- and wet-bulb temperature pairs, bound the corresponding site characteristic values. For example, is a site characteristic dry- or wet-bulb temperature expected to be higher or lower than the corresponding design (site parameter); for a site characteristic dry- and wet-bulb temperature pair, do both the dry- and wet-bulb site characteristic values need to be bounded by the corresponding U.S. EPR site parameter values, is one parameter more applicable to the design of a given system, or is the site characteristic wet-bulb depression expected to be greater or less than the corresponding design wet-bulb depression?

(d) Consistent with the guidance in Reg. Guide 1.206, Section C.I 2.3.1.2, Paragraph 2 (Sentence 2), provide cross-references from COL FSAR Section 2.3.1.2.2.16 to the specific COL and/or U.S. EPR FSAR sections where these temperature conditions are used.

Response

(a) The U.S. EPR maximum and minimum 1% exceedance (design) values were taken from the EPRI Advanced Light Water Reactor Utility Requirements Document (URD). A source document for the EPRI URD indicates that the 1% exceedance design values represent seasonal exceedances.

When the technical information for the CCNPP Unit 3 COLA was developed, the basis for the EPRI 1% exceedance temperature values was not known. It was therefore decided that the basis for the CCNPP Unit 3 1% exceedance temperature values would be monthly, so as to bound the other possibilities (seasonal and annual). Since then, it has been determined that the EPRI 1% temperature values are on a seasonal basis. The site specific 1% exceedance temperature values on a seasonal basis have been determined and FSAR Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning, will be updated to include these values.

(b) The coldest month was incorrectly stated to be December in revised Paragraph 2 presented in the response to RAI Question No. 02.03.01-12[2]. The correct month is January, as defined and indicated (i.e., January) in the 2005 ASHRAE Handbook summary for the Patuxent River Naval Air Station.

As stated in the response to part (a), the U.S. EPR maximum and minimum 1% exceedance (design) values were taken from the EPRI Advanced Light Water Reactor Utility Requirements Document. A source document for the EPRI URD indicates that the 1% exceedance design values represent seasonal exceedances.

When the technical information for the CCNPP Unit 3 COLA was developed, the basis for the EPRI 1% exceedance temperature values was not known. It was therefore decided that the basis for the CCNPP Unit 3 1% exceedance temperature values would be monthly, so as to bound the other possibilities (seasonal and annual). Since then, it has been determined that the EPRI 1% temperature values are on a seasonal basis. FSAR Section 2.3.1.2.2.13, Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink, will be revised as discussed in the response to RAI Question 02.01.01-21[3]. The site-specific 1% exceedance temperature values on a seasonal basis have been determined and FSAR Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning, and Table 2.0-1, U.S. EPR Site Design Envelope Comparison, will be updated to include these values.

(c) The U.S. EPR maximum and minimum 0% exceedance (design) values were taken from the EPRI Advanced Light Water Reactor Utility Requirements Document and represent annual exceedances.

The site-specific 0% exceedance values represent annual exceedances.

Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning, in Revision 6 of the COLA FSAR presents the 0% and 1% exceedance temperature values and a list of specific systems that utilize the 0% and 1% exceedance temperature values for design purposes. This section will be revised to replace the monthly-basis 1% exceedance temperature values with the seasonal-basis 1% exceedance temperature values.

COL FSAR Table 2.0-1, U.S. EPR Site Design Envelope Comparison of the COLA FSAR provides U.S. EPR FSAR Design Parameter Values and CCNPP Unit 3 Site Characteristic Values. The incorrect value of 31.8°F for the 0% exceedance minimum dry bulb temperature has been corrected to 0°F. This table will be revised to replace the monthly-basis 1% exceedance temperature values with the seasonal-basis 1% exceedance temperature values.

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[2] UniStar Nuclear Energy Letter UN#08-055, from Greg Gibson to Document Control Desk, U.S. NRC, Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 - Meteorology, dated October 30, 2008

[3] UniStar Nuclear Energy Letter UN#09-439, from Greg Gibson to Document Control Desk, RAI No. 151, Regional Climatology, dated October 19, 2009

COL FSAR Section 2.3.1.2.2.13 presents the maximum and minimum 0% exceedance temperature values. These values are consistent with those presented in COL FSAR Section 2.3.1.2.2.16.

To be considered bounding, the site maximum values should be less than the U.S. EPR maximum values and the site minimum values should be greater than the U.S. EPR minimum values. In CCNPP Unit 3 FSAR Table 2.0-1, the only site value that is not bounded by the corresponding U.S. EPR value is the 0% exceedance non-coincident wet bulb temperature. The 0% exceedance non-coincident wet bulb temperature value was used in the design of the UHS and its acceptability is described in CCNPP Unit 3 FSAR Section 9.2.1, Essential Service Water System.

(d) Cross-references from COL FSAR Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning, to the specific COL and/or U.S. EPR FSAR sections where these temperature conditions are used, are provided in the response to Question 02.03.01-30 (this enclosure).

COLA Impact

FSAR Table 2.0-1, U.S. EPR Site Design Envelope Comparison, will be revised as follows:

Table 2.0-1—{U.S. EPR Site Design Envelope Comparison}
(Page 3 of 5)

U.S. EPR FSAR Design Parameter Value/~~Characteristic~~				**CCNPP Unit 3 ~~Design Parameter~~ ~~Value/~~Site Characteristic Value**
Temperature				
Air	0% Exceedance Values	Maximum	115°F Dry Bulb / 80°F Wet Bulb (coincident)	102°F Dry Bulb /80°F Wet Bulb (coincident) (See Section ~~9.2.1~~2.3.1)
			81°F Wet Bulb (non-coincident) for UHS Design only	85°F Wet Bulb (non-coincident) for UHS Design only (See Section 9.2.1)
		Minimum	-40°F	0°F (See Section 2.3.1)
	1% Exceedance Values	Maximum	100°F Dry Bulb / 77°F Wet Bulb (coincident)	~~95°F / 77.5°F~~93°F dry bulb / 76.8°F wet bulb (coincident)
			80°F Wet Bulb (non-coincident) ~~for UHS Design only~~	80°F wet bulb (non-coincident)
		Minimum	-10°F	~~32.3°F~~14°F

FSAR Section 2.3.1.2.2.13, Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink, was revised to correct the reference to the coldest month in the response provided to RAI Question 02.03.01-21[4].

FSAR Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning, will be revised as shown in the response to Question 02.03.01-30 (this enclosure).

[4] UniStar Nuclear Energy Letter UN#09-439, from Greg Gibson to Document Control Desk, RAI No. 151, Regional Climatology, dated October 19, 2009

Question 02.03.01-30

The Staff considered the response to RAI Question No. 02.03.01-12 for the COL FSAR, submitted on October 30, 2008 (ML083100776), regarding the assumption that the "use of a 30 year data set is considered to represent a sufficient period of data to capture cyclical extremes based on established NRC guidance". The Staff disagrees with this premise, as applied to the design of heating, ventilation, and air conditioning (HVAC) systems that support safety-related structures, systems, and components at the CCNPP3 site, for several reasons:

- Reference to NUREG-0800, SRP Section 2.3.1, SRP Acceptance Criterion (5) and to Reg. Guide 1.27 (Ultimate Heat Sink for Nuclear Power Plants), Regulatory Position (C.1.b) applies to the design of the Ultimate Heat Sink whereas the information in COL FSAR Section 2.3.1.2.2.16 addresses site parameters and site characteristics related to the design of HVAC systems.
- The regulation at 10 CFR 52.79(a)(1)(iii) requires, in part, a COL application to include information on the 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, with sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated.

  Temperatures based on a 100-year return period are considered by the Staff to provide this "sufficient margin" to account for situations where the historical data used to characterize a site may not adequately capture cyclical climatic events. The 100-year return period is consistent with the recurrence intervals to be considered in the evaluation of site characteristic extreme wind conditions and snow loads on safety-related structures (which are also addressed under SRP Section 2.3.1). Furthermore, if a representative historical temperature observation in the site area exceeds the estimated 100-year return period value, then the historically reported value represents the applicable site characteristic.

Given the basis in regulation and regulatory guidance for considering 100-year return period climate-related site characteristics, in order to fully resolve this concern the Applicant should address the following technical issues and update COL FSAR Section 2.3.1.2.2.16 (Paragraph 3) and Table 2.0-1 accordingly:

(a) Based on the same 30-year period of record for the Patuxent River NAS used to calculate the 0% and 1% exceedance dry- and/or wet-bulb temperatures reported in revised Section 2.3.1.2.2.16, estimate the following 100-year return period site characteristic values - the maximum and minimum dry-bulb temperatures, the non-coincident maximum wet-bulb temperature, and the maximum wet-bulb temperature coincident with the 100-year return period maximum dry-bulb temperature.

(b) Explain how the maximum wet-bulb temperature coincident with the 100-year return period maximum dry-bulb temperature is determined.

Response

(a) 100-year Return Values

Table 2.3.1-30a (below) presents the 100-year return period calculated values - the maximum and minimum dry bulb temperatures, and the non-coincident maximum wet bulb temperature. Instead of the maximum wet bulb temperature coincident with the 100-year return period maximum dry bulb temperature, Table 2.3.1-30a presents the coincident mean wet bulb temperature. This was necessary due to the derivation of the 100-year return period, as described in Response (b) of this question (below). The results are based on the ASHRAE method (ASHRAE 2005) and the same 30-year period of record (1978-2007) for the Patuxent River NAS used to calculate the 0% and 1% exceedance dry- and/or wet bulb temperatures reported in revised CCNPP FSAR Section 2.3.1.2.2.16.

Table 2.3.1-30a: 100-Year Return Period Temperature Values Determined Using 30 Years of Patuxent River NAS, Maryland, Meteorological Data

100-Year Return Period Calculated Temperature Values (°F)	
Maximum Dry Bulb Temperature	104.8*
Minimum Dry-Bulb Temperature	-5.0*
Non-Coincident Maximum Wet Bulb Temperature	86.6
Coincident (Mean) Wet Bulb Temperature	80.8

* Note the extreme annual site characteristic values based on actual historical temperature observation for maximum dry bulb and minimum dry bulb temperature are 106°F and -14°F, respectively, as explained in this RAI response.

These 100-year return values, except for the mean coincident wet bulb temperature, were determined using the maximum two-hour average dry bulb and non-coincident wet bulb temperature values for each year of the 30-year data period. Two-hour average temperature values are used because the U.S. EPR FSAR 0% exceedance design temperature values are based on two-hour average temperature values. These two sets of thirty temperature values were then averaged and the standard deviation determined. The values of the averages and standard deviations were input to the following equation from the ASHRAE method (ASHRAE 2005):

$$Tn = M + I * F * s$$

where Tn is the n-year return period value of extreme dry bulb temperature, M is the mean of the annual extreme maximum or minimum dry bulb temperatures, s is the standard deviation of the annual extreme maximum or minimum dry bulb, I is 1 if maximum dry bulb temperatures are being considered or -1 if minimum dry bulb temperatures are being considered, and F is given by:

$$F = -\sqrt{6}/\pi(0.5772 + \ln(\ln(100/99)))$$

Due to the derivation of the coincident mean wet bulb temperature, the 100-year return period maximum dry bulb temperature was calculated differently as explained in Response (b).

Extreme Annual Site Value

A review was also conducted of historical maximum and minimum temperature values recorded at stations within 25 miles of the CCNPP site and obtained from the Southeast Regional Climate Center (SERCC, 2009). Two of the recorded maximum temperature values are greater than the calculated 100-year return period maximum temperature of 104.8°F (40.4°C). The highest recorded maximum temperature value was 106°F at Cambridge Water Treatment, Maryland, on 7/21/1930, and at Owings Ferry Landing, Maryland, on 8/6/1918. Five sites, Blackwater Refuge, Maryland, Owings Ferry Landing, Maryland, Mechanicsville 5NE, Maryland, Prince Frederick 1 N, Maryland, and Cambridge Water Treatment Plant, Maryland, recorded minimum temperatures that are less than the calculated 100-year return period minimum temperature of -5.0°F (-20.6°C). The lowest of these minimum temperature values, -14°F (-25.6°C), was recorded at Blackwater Refuge, Maryland, on 1/11/1942. Therefore, the highest recorded maximum temperature value of 106°F (41.1°C) is determined to be the extreme annual site characteristic maximum dry bulb temperature value, and the lowest recorded minimum temperature value of -14°F (-25.6°C) is determined to be the extreme annual site characteristic minimum dry bulb temperature value.

(b) The 100-year return period maximum dry bulb temperature is a calculated value. As a result, there is no wet bulb temperature measurement that is coincident with it, as there would be if it was a measured value. Consequently, a relationship between dry bulb and wet bulb temperature was determined using the 30 years of hourly meteorological data recorded at Patuxent River Naval Air Station (NAS), Maryland, and a joint frequency table of one-degree-wide bins. The coincident wet bulb temperature was determined for each given dry bulb temperature value by calculating the average of the values within each bin, i.e., a coincident mean wet bulb temperature. A plot was then made of dry bulb versus coincident mean wet bulb temperature. A third-order polynomial line fit was made to the data using an unweighted least squares method. Other fits were tried but the third-order polynomial was chosen based on the best fit and visual inspection of the tails. The equation of the third-order polynomial line fit was used to determine the 100-year return period coincident mean wet bulb temperature value by inputting the value of the 100-year return period maximum dry bulb temperature value, as shown in Response (a).

Conclusions for Question 02.03.01-30 based on Parts a) and b)

As discussed herein and as described in NUREG-0800 Section 2.3.1, Regional Climatology, the calculated 100-year return values for maximum dry bulb temperature and coincident wet bulb temperature, for maximum wet bulb temperature (non-coincident) and for minimum dry bulb temperature are provided. The extreme annual values were also determined. In the case of the maximum recorded temperature and minimum recorded temperature, the observed extreme annual values were higher and lower, respectively, than the calculated 100-year values. These values were considered in determining the appropriate design heat loads (i.e. design conditions) of plant HVAC systems.

The 1% and 0% exceedance values presented in U.S. EPR FSAR Table 2.1-1, U.S. EPR Site Design Envelope, were found to be appropriate design values for HVAC systems. These design parameter values bound the 1% and 0% exceedance site characteristic values for CCNPP Unit 3 as demonstrated by CCNPP Unit 3 FSAR Table 2.0-1, U.S. EPR

Site Design Envelope Comparison. The preceding statements are based on the following information:

- Design Conditions

  Per ASHRAE, 2005 Handbook and Fundamentals (ASHRAE, 2005) – Chapter 28 Climatic Design Information, climatic design information is used for design sizing. This chapter of ASHRAE, 2005 further states that that "warm-season temperature and humidity conditions are based on annual percentiles of 0.4, 1.0, and 2.0. Cold-season conditions are based on annual percentiles of 99.6 and 99.0. The use of annual percentiles to define design conditions ensures that they represent the same probability of occurrence in any climate, regardless of the seasonal distribution of extreme temperature and humidity."

  Therefore, the use of the 0% and 1% exceedance values as design conditions for HVAC is determined to be appropriate. For the U.S. EPR FSAR, HVAC systems that are safety-related are designed to 0% exceedance temperature values (115°F dry bulb temperature and coincident 80°F wet bulb temperature; -40°F dry bulb temperature). The HVAC Systems that are non-safety-related are designed to 1% exceedance temperature values (100°F dry bulb temperature and coincident 77°F wet bulb temperature; -10°F).

- Extreme Annual Conditions

  Per ASHRAE, 2005 Handbook and Fundamentals (ASHRAE, 2005) – Chapter 28 Climatic Design Information, the extreme annual temperature conditions represent the most extreme temperatures observed over the entire period of record.

  In the case of CCNPP Unit 3, the highest recorded maximum temperature value of 106°F (41.1°C) is determined to be the extreme annual site characteristic maximum dry bulb temperature value, and the lowest recorded minimum temperature value of -14°F (-25.6°C) is determined to be the extreme annual site characteristic minimum dry bulb temperature value. These extreme annual values do not have persistence data associated with their determination. They are simply the extreme temperatures observed within 25 miles of the CCNPP Unit 3 site. As described in U.S. EPR FSAR, the design of safety-related HVAC systems is based on 2-hour average temperatures. Therefore, the 0% and 1% exceedance values are determined to be appropriate design values for HVAC, as opposed to extreme temperature values representing one-time, short duration extreme temperature observations.

- Return Period of Extreme Temperatures

  A return period (or recurrence interval) is defined as the reciprocal of the annual probability of occurrence. For instance, the 100-year return period maximum dry bulb temperature has a 1% (i.e., 1/100) probability of occurring or being exceeded each year. Per ASHRAE, 2005 Handbook and Fundamentals (ASHRAE, 2005) – Chapter 28 Climatic Design Information, "This statistic does not indicate how often the condition will occur in terms of the number of hours each year (as in the design conditions based on percentiles) but describes the probability of the condition occurring at all in any year." ASHRAE also states that, "Calculation of the n-year return period is based on assumptions that annual maxima and minima are distributed according to the Gumbel (Type 1 Extreme Value) distribution and are fitted with the method of moments (Lowery and Nash 1970). The uncertainty or standard error using this method increases with standard deviation, value of return period, and decreasing length of the period of record. It can be significant."

- The 100-year return maximum and minimum dry bulb temperature values were calculated to be less than the 0% exceedances values. The 100-year return temperature for the coincident mean wet bulb temperature (associated with the 100-year return period maximum dry bulb temperature of 104.8°F) was calculated to be 80.8°F. Based on the definitions above, as well as the method descried for calculating the 100-year return temperatures, the following is relevant to the interpretation of this value:
- The 100-year return values are calculated values based on data extrapolated based on binning of observed data and the use of a best-fit regression curve. As described in ASHRAE, 2005, there is uncertainty associated with the assumptions and methods used to calculate the 100-year return values, and this uncertainty can be significant. Because the 0% and 1% values are based on actual empirical data, they are not subject to the error associated with the calculation of the 100-year return values.
- As described in ASHRAE, 2005, the method for calculating the 100-year return value does not indicate how often or how long the value will occur. The 100-year return temperature simply provides a temperature which has a 1% chance of being exceeded in a given year. The design of the HVAC systems described in the U.S. EPR FSAR is based on 0% and 1% exceedance temperature values. It is appropriate to use the 0% and 1% exceedance values for design since the 100-year return values do not provide information related to the persistence of a given temperature condition, only the chance that it will be exceeded any time in a given year.
- Because the 100-year return period maximum dry bulb temperature is a calculated value, there is no wet bulb temperature measurement that is coincident with it, as there would be if it was a measured value. This dictates that the coincident mean wet bulb temperature is based on another extrapolated relationship introducing additional sources of uncertainty into the value.

  In the case of the 80.8°F value calculated for the 100-year return coincident mean wet bulb temperature calculated for CCNPP Unit 3, this value corresponds well with the design value of 80.0°F. The two values are within 1% of each other. Given the uncertainties associated with the calculation of 100-year return period temperatures, in general, and the 100-year return coincident mean wet bulb temperature, in particular, the values give high confidence in the appropriateness of the design value. The agreement between these two values also gives confidence that the historical data used to characterize the CCNPP Unit 3 site is adequate to capture cyclical climactic events. The 100-year return maximum dry bulb temperature (104.8°F) is less that the 115°F, 0% exceedance design maximum condition.

COLA Impact

FSAR Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning, will be replaced with the following:

U.S. EPR FSAR Section 2.3.1.1 indicates that the U.S. EPR design is based on the 0% and 1% exceedance dry bulb and coincident wet bulb temperatures listed in U.S. EPR FSAR Table 2.1-1. Site-specific values for these parameters were determined using 30 years of meteorological data from Patuxent River Naval Air Station (NAS), Maryland, a nearby representative site (NCDC, 2008).

The 1% exceedance maximum dry bulb and coincident wet bulb temperature values are 93°F (33.9°C) and 76.8°F (24.9°C) on a seasonal basis. The 1% exceedance minimum dry bulb temperature value is 14°F (-10°C) on a seasonal basis. The 0% exceedance maximum dry bulb and coincident wet bulb temperature values are 102°F (39°C) and 80°F (27°C), respectively. As demonstrated by Table 2.0-1, the U.S. EPR FSAR design values bound the 0% and 1% exceedance values for CCNPP Unit 3 listed above.

The calculated 100-year return period values of maximum and minimum dry bulb temperature are 104.8°F (40.4°C) and -5.0°F (-20.6°C), respectively. The calculated 100-year return period value of mean wet bulb temperature "coincident" with the 100-year return period value of maximum dry bulb temperature is 80.8°F (27.1°C). The 100-year return period value of maximum wet bulb temperature (non-coincident) is 86.6°F (30.3°C). These values, except for the mean wet bulb temperature "coincident" with the 100-year return period maximum dry bulb value, were determined using the ASHRAE, 2005 methodology and the maximum two-hour average dry bulb and non-coincident wet bulb temperature values for each year of the same 30-year meteorological data set used to determine the 0% and 1% exceedance temperature values.

Because the 100-year return period maximum dry bulb temperature is a calculated value, there is no wet bulb temperature measurement that is coincident with it, as there would be if it was a measured value. Therefore, a relationship between dry bulb and wet bulb temperature was determined and this value was calculated using the ASHRAE methodology and 30 years of hourly meteorological data recorded at Patuxent River Naval Air Station (NAS), Maryland.

A review was also conducted of historical maximum and minimum temperature values recorded at stations within 25 miles of the CCNPP site and obtained from the Southeast Regional Climate Center (SERCC, 2009). The highest recorded maximum temperature value was 106°F at Cambridge Water Treatment, Maryland, on 7/21/1930, and at Owings Ferry Landing, Maryland, on 8/6/1918. The lowest minimum temperature value, -14°F (-25.6°C), was recorded at Blackwater Refuge, Maryland, on 1/11/1942. Therefore, the highest recorded maximum temperature value of 106°F (41.1°C) is the extreme maximum annual site temperature. The lowest recorded minimum temperature value of -14°F (-25.6°C) is the extreme minimum annual site temperature.

The design parameters of the U.S. EPR FSAR HVAC systems are appropriate design parameters and bound the CCNPP Unit 3 design parameters based on the following:

- "The use of annual percentiles to define design conditions [for HVAC systems] ensures that they represent the same probability of occurrence in any climate, regardless of the seasonal distribution of extreme temperature and humidity." (ASHRAE, 2005). Therefore, it is appropriate to use the 0% and 1% exceedance values for HVAC design parameters as specified in the U.S. EPR FSAR.

- Because extreme annual temperature values provide the highest or lowest temperature observed without information on the associated duration of the temperature excursion, it is not appropriate to use these values for design conditions. The U.S. EPR FSAR HVAC design is based on 0% and 1% exceedance temperatures.
- The CCNPP Unit 3 100-year return period value of coincident mean wet bulb temperature corresponds well with the design value (within 1%) providing high assurance of the appropriateness of the 0% exceedance values. It is not used as a design characteristic because a) 100-year return values are extrapolated, calculated values subject to uncertainty, b) the 100-year return values provide a temperature that has a 1% chance of being exceeded in a given year, but do not provide data on how long that temperature persists, and c) there is not actually a coincident data set, instead coincident mean wet bulb temperature is further extrapolated based on a best fit regression.

The HVAC systems that are safety-related and are designed to 0% exceedance temperature values (115°F dry bulb temperature and coincident 80°F wet bulb temperature; -40°F dry bulb temperature) are:

- Containment Building Ventilation System (Section 9.4.7)
- Annulus Building Ventilation System (Section 9.4.7)
- Safeguard Building Controlled-Area Ventilation System (Section 9.4.5)
- Main Control Room AC System (Section 9.4.1)
- Electrical Division of Safeguard Building Ventilation Systems (Section 9.4.6)
- Emergency Power Generating Building Ventilation System (Section 9.4.9)
- Fuel Building Ventilation System (Section 9.4.2)
- Essential Service Water Ventilation System (Section 9.4.11)

The HVAC systems that are non-safety-related and are designed to 1% exceedance temperature values (100°F dry bulb temperature and coincident 77°F wet bulb temperature; -10°F dry bulb temperature) are:

- Nuclear Auxiliary Building Ventilation System (Section 9.4.3)
- RAD Waste Building Ventilation System (Section 9.4.8)
- Smoke Confinement System (Section 9.4.13)
- MS & FW Valve Compartment Ventilation System (Section 9.4.12)
- Access Building Ventilation System (Section 9.4.14)
- Switchgear & SBO Building (Section 9.4.10)
- Turbine Building Ventilation System (Section 9.4.4)

The HVAC systems that are safety-related, and are designed to site specific 0% exceedance temperature values (102°F dry bulb temperature coincident 80°F wet bulb temperature; 0°F dry bulb temperature) are:

- UHS Makeup Water and Electrical Distribution Ventilation System (Section 9.4.15)

The HVAC system that are non-safety-related, augmented quality and are designed to 0% exceedance temperature values (115°F dry bulb temperature and coincident 80°F wet bulb temperature; -40°F dry bulb temperature) are:

- Fire Protection Building Ventilation System (Section 9.4.16)

The HVAC systems that are non-safety-related and are designed to site specific 1% Monthly (July or December) exceedance temperature values (93°F dry bulb temperature and coincident 76.8°F wet bulb temperature; 14°F dry bulb temperature) are:

- Circulating Water Pump Building Ventilation System
- Circulating Water Makeup Intake Structure Ventilation
- Waste Water Treatment Building Ventilation System
- Water Treatment Building Ventilation System
- Security Access Ventilation System
- Workshop & Warehouse Ventilation System

Additional information on air conditioning, heating, cooling and ventilation systems are provided in Section 9.4.

Question 02.03.01-31

The Staff considered the response to RAI Question No. 02.03.01-12 for the COL FSAR, submitted on October 30, 2008 (ML083100776), in particular revised Paragraphs 3 and 4. Among other things, revised Paragraph 4, states that:

- "reliable, sequential hourly meteorological data does not exist for the duration of 100 years"; and
- the "use of extrapolated maximum/minimum 100 year return period temperature values would be overly conservative and exceed any recorded values in the available 30-year Pax River NAS data set".

In Paragraph 4, regarding the statement that extrapolated maximum/minimum 100-year return period values would be overly conservative, the basis in regulation and regulatory guidance for the applicability of such 100-year return period site characteristic temperatures is explained in the previous question.

Therefore, in order to fully resolve the Staff's concerns regarding revised Paragraphs 3 and 4, the Applicant should address the following technical issues by updating COL FSAR Section 2.3.1.2.2.16 accordingly:

(a) Explain the relevance of the parenthetical statement "(in this case the 50-year values of 103.4 °F and -5.9 °F)", in revised Paragraph 3, to the equation used to estimate 100-year return period site characteristic temperature values. If not relevant, then delete the parenthetical statement.

(b) In revised Paragraph 4, the statement that "[r]eliable, sequential hourly meteorological data does not exist for the duration of 100 years" is not in proper context. The Staff does not disagree with the statement per se. However, the equation for determining n-year return period temperature values is not constrained to operate on sequential hourly data; rather it takes into consideration the set of extreme annual maximum or minimum temperatures for each year in the period of record being evaluated. Therefore, the use of hourly data should, in general, only be relevant to estimating the 100-year return period wet-bulb temperature (non-coincident) and the wet-bulb temperature that is coincident with the 100-year return period maximum dry-bulb temperature.

(c) In revised Paragraph 4, the statement that "100 year return period temperature values would...exceed any recorded values in the available 30-year Pax River NAS data set" appears to be inaccurate. The calculated 100-year return period maximum and minimum dry-bulb temperatures in revised Paragraph 3 of COL FSAR Section 2.3.1.2.2.16 (i.e., 104.6 °F and -9.1 °F, respectively), based on 20 years of data from the Patuxent River Naval Air Station (NAS), have been exceeded by temperature records set at other nearby cooperative observing stations.

Based on an independent review of the National Climatic Data Center (NCDC) TD3200/3210 (Surface Summary of the Day) data files and information available on-line from the Southeast Regional Climate Center (SERCC) for the State of Maryland at http://www.sercc.com/climateinfo/historical/historical.html, the Staff identified an historic maximum dry-bulb temperature of 106 °F recorded on July 21, 1930 at the Cambridge Water Treatment Plant (about 22 miles from the Calvert Cliffs site). An historic minimum dry-bulb temperature of -14 °F was recorded on January 11, 1942 at the Blackwater Refuge observing station (about 17 miles from the Calvert Cliffs site).

In determining whether an extreme maximum or minimum dry-bulb temperature may be reasonably expected to occur at the Calvert Cliffs site, the Staff cautions that the observations considered should not be limited to those recorded only in Calvert County. Reg. Guide 1.206, Section C.I.2.3.2.1, Paragraph 1 and NUREG-0800, SRP Section 2.3.1, Section I (Areas of Review), Item 1, call for these conditions to be addressed for the site region which nominally includes the area within 50 miles of the site. The Staff also cautions that proximity of an observing station to a large water body does not always result in extreme minimum temperatures higher than, or conversely, extreme maximum temperatures lower than those recorded at other nearby stations located farther inland.

Nevertheless, the Staff recognizes the varying topography within 50 miles of the site and that the area covered within this radius may be too large, in this case, for identifying representative dry-bulb temperature extremes given the site's location adjacent to the Chesapeake Bay. The Staff also acknowledges that the number of observing stations with representative concurrent dry- and wet-bulb temperature data may be limited. Therefore, the Applicant should:

- expand the area used to characterize the occurrence of extreme temperature events beyond Calvert County, MD (e.g., within about 25 miles of the Calvert Cliffs site);
- 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 dry- and/or wet-bulb temperatures or any historical maximum or minimum dry-bulb site characteristic temperatures that exceed the 0% exceedance maximum dry-bulb and coincident wet-bulb temperature pair, the 0% exceedance non-coincident wet-bulb temperature, and/or the 0% exceedance minimum dry-bulb temperature site characteristic values and update COL FSAR Section 2.3.1.2.2.16 (Paragraph 3 and 4) and Table 2.0-1 accordingly.

Response

(a) The parenthetical statement was not relevant and will be deleted from FSAR Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning.

(b) The Staff's statement that the equation for determining n-year return period temperature values 'is not constrained to operate on sequential hourly data' is acknowledged. The sentence will be removed from FSAR Section 2.3.1.2.2.16.

(c) Data from the Patuxent River Naval Air Station, Maryland, were used to determine the 0% exceedance, 1% exceedance, and 100-year return period temperature values for CCNPP Unit 3. This site is located in Saint Mary's County, not Calvert County. This site was selected because both it and CCNPP are located in climate division MD-03, Lower Southern, as designated by the U.S. National Climatic Data Center. A climate division represents a region within a state that is as climatically homogeneous as possible. Since both sites are in the same climate division, both are located on the shoreline of Chesapeake Bay, and the sites are located within 11 miles of each other, it is deemed acceptable to use temperature statistics from Patuxent River Naval Air Station to represent the CCNPP site.

As the Staff surmised, the number of observing stations with representative concurrent dry- and wet bulb temperature data is limited. Surrounding stations tend to be cooperative stations, not first-order National Weather Service stations. The primary intent of cooperative stations is the recording of 24-hour precipitation amounts, although some stations also record maximum and minimum temperatures. Therefore, cooperative stations such as Cambridge Water Treatment Plant and Blackwater Refuge do not measure wet bulb temperature, nor do they measure the atmospheric parameters necessary to calculate wet bulb temperature. As such, design wet bulb temperature values cannot be determined using data from cooperative stations.

Table 2.3.1-31a (below) presents historical maximum and minimum temperature values recorded at stations within 25 miles of the CCNPP site and obtained from the Southeast Regional Climate Center (SERCC, 2009). Two of the maximum temperature values in Table 2.3.1-31a are greater than the 100-year return period maximum temperature of 104.8°F (40.4°C). Five sites, Blackwater Refuge, Maryland, Owings Ferry Landing, Maryland, Mechanicsville 5NE, Maryland, Prince Frederick 1 N, Maryland, and Cambridge Water Treatment Plant, Maryland, recorded minimum temperatures that are less than the 100-year return period minimum temperature of -5.0°F (-20.6°C). Therefore, the highest recorded maximum temperature value of 106°F (41.1°C) will be used as the extreme maximum annual site temperature, and the lowest recorded minimum temperature value of -14°F (-25.6°C) will be used as the extreme minimum annual site temperature.

Table 2.3.1-31a Historical Maximum And Minimum Temperature Values Recorded At Stations Within 25 Miles Of The CCNPP Unit 3 Site

Station	Max Temp	Date	Min Temp	Date
Blackwater Refuge, MD	102	6/30/1959	-14	1/11/1942
Cambridge Water Treatment Plant, MD	106	7/21/1930	-6	2/9/1934
Mechanicsville 5 NE, MD	103	7/16/1980	-9	2/5/1996
Owings Ferry Landing, MD	106	8/6/1918	-13	1/28/1935
Prince Frederick 1 N, MD	103	7/31/1954	-7	1/14/1912
Solomons, MD	104	8/7/1918	-5	2/10/1899

The definition of the maximum/minimum zero percent exceedance temperature values is the highest/lowest value that occurs for consecutive hours (two or more) and can only be exceeded one hour at a time (i.e., no consecutive hourly temperature values can exceed it). By definition, the 0% exceedance temperature values can be exceeded by non-consecutive hourly temperature values.

The HVAC systems that are safety-related are designed to the U.S. EPR FSAR 0% exceedance temperature values (115°F dry bulb temperature and coincident 80°F wet bulb temperature; -40°F dry bulb temperature) rather than the site specific CCNPP Unit 3 values. The HVAC systems that are non-safety-related are designed to the U.S. EPR FSAR 1% exceedance temperature values (100°F dry bulb temperature and coincident 77°F wet bulb temperature; -10°F dry bulb temperature) rather than the site specific CCNPP Unit 3 values. The response to RAI Question 02.03.01-30 (this enclosure) describes why the design parameters of the U.S. EPR FSAR HVAC systems are appropriate and bound the CCNPP Unit 3 design parameters.

Reference:

SERCC, 2009. Southeast Regional Climate Center, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3220, Website: http://www.sercc.com/ and http://www.sercc.com/climateinfo/historical/historical_md.html,
Date accessed: October 11, 2009.

COLA Impact

FSAR Section 2.3.1.2.2.16, Temperature and Humidity for Heating, Ventilation and Air Conditioning, will be revised as shown in the response to Question 02.03.01-30 (this enclosure).

Question 02.03.01-32

The Staff evaluated the responses to RAI Question No. 02.03.01-13 for the COL FSAR, submitted on October 30, 2008 (ML083100776). RAI Question No. 02.03.01-13 raises a number of issues related to the determination, reporting, and applicability of site characteristic and design (site parameter) dry- and wet-bulb temperatures, including:

- the bases for the 0% and 1% exceedance site characteristic dry- and/or wet-bulb temperatures in COL FSAR Table 2.0-1;
- the basis for the maximum 0% exceedance U.S. EPR site parameter dry-bulb and coincident wet-bulb temperatures;
- the rationale for considering the 0% exceedance dry- and wet-bulb temperatures, based on 30-years of data, to be sufficient compared to the more conservative 100-year return period temperatures;
- the absence of 1% exceedance site characteristic dry-and wet-bulb temperatures from COL FSAR Table 2.0-1; and
- the identification of structures, systems, and components, and reference to corresponding FSAR section(s), that rely on the 1% exceedance temperature information.

In some cases, similar technical issues have already been raised as a result of the Staff's evaluation of the responses to RAI Question Nos. 02.03.01-8 and No. 02.03.01-12. In order to fully resolve the Staff's concerns, the Applicant should address the following issues and provide additional clarification (as required) as indicated below or as referenced to these other related RAI questions:

(a) The acceptability of the responses to sub-questions (1a) and (1b) under RAI Question No. 02.03.01-13 are dependent on the resolution of the follow-up questions based on the Staff's evaluation of the responses to RAI Question No. 02.03.01-8 and/or No. 02.03.01-12. See the evaluation of the responses to those RAI questions for the technical issues to be resolved.

(b) Paragraph 1 of the response to sub-question (2) cross-references the response to RAI Question No. 02.03.01-12 regarding "the appropriateness of the use of the recorded 30-year data set versus the use of an extrapolated 100-year return period temperature". The Staff disagrees with that part of the response to RAI Question No. 02.03.01-12. See the evaluations of the response to RAI Question No. 02.03.01-12 for the basis in regulation and regulatory guidance for the applicability of such 100-year return period site characteristic temperatures and for the follow-up technical issues to be resolved.

(c) Paragraph 2 of the response to sub-question (2) concludes that Colonial Beach, VA is not representative of the CCNPP site (with respect to an historic observed maximum temperature value of 109 °F at that station). The Staff accepts the statement that Colonial Beach is not representative of the CCNPP site, at least with respect to recorded extreme maximum temperatures.

(d) Paragraph 1 of the response to sub-question (3a) states that "Table 2.0-1 has been revised in response to RAI 2.3.1-8 to include the site-specific calculated temperature values".

However, the Staff notes that Table 2.0-1 as presented in Revision 4 of the COL Application for Calvert Cliffs Unit 3 (ML090860073), does not include any such revisions.

(e) Regarding the paragraph that precedes the response to sub-question (3b) and that discusses how the 0% exceedance dry- and coincident wet-bulb temperatures and the maximum wet-bulb temperature observed at Patuxent River Naval Air Station were used in the design of the Ultimate Heat Sink cooling tower, see the evaluations of the response to RAI Question No. 02.03.01-8 for the technical issues to be resolved.

(f) Regarding the response to sub-question (3b), consistent with the guidance in Reg. Guide 1.206, Section C.I.2.3.1.2, Paragraph 2 (Sent. 2), provide cross-references from COL FSAR Section 2.3.1.2.2.16 to the specific COL and/or U.S. EPR FSAR sections where the identified structures, systems, and components are designed to the 1% exceedance temperature information.

(g) Additional confusion with the contents in COL FSAR Table 2.0-1 appears to be due to the use of similar terminology. The column labels in COL FSAR Table 2.0-1 read as follows: "U.S. EPR FSAR Design Parameter Value/Characteristic" and "CCNPP Unit 3 Design Parameter Value/Characteristic". To help minimize further confusion, revise the second column label to read "CCNPP Unit 3 Site Characteristic Value".

Response

(a) RAI Question numbers 02.03.01-22 through 02.03.01-25 are follow-up questions to the response to RAI Question 02.03.01-8, which was associated with these issues. The following was provided in response to RAI Question 02.03.01-22: 1% exceedance temperature values are not used in the design of the UHS – they were removed from FSAR Section 2.3.1.2.2.13, Conditions for Maximum Evaporation and Potential Water Freezing in the Ultimate Heat Sink. Also, a clarification was provided that the design values used for UHS were in FSAR Section 9.2.1.1 instead of U.S. EPR FSAR Section 2.3.1.1 and 'UHS Design Only' was removed from FSAR Table 2.0-1 for the 1% values.

(b) The response to RAI Question 02.03.01-30 (this enclosure) indicates that the HVAC systems that are safety-related are designed to the U.S. EPR FSAR 0% exceedance temperature values (115°F dry bulb temperature and coincident 80°F wet bulb temperature; -40°F dry bulb temperature) rather than the site specific CCNPP Unit 3 values. FSAR Section 2.3.1.2.2.16 was modified in the response to RAI Question 02.03.01-30 to include information on the most severe of the meteorological characteristics that have been historically reported for the site and surrounding area. This information along with the 100-year return period values were considered in determining the appropriate design heat loads (i.e. design conditions) of plant HVAC systems.

(c) No response necessary.

(d) FSAR Table 2.0-1, U.S. EPR Site Design Envelope Comparison, was revised in response to RAI Question 02.03.01-8[5] to include the site-specific calculated temperature values. Table 2.0-1 will be revised to replace the site-specific monthly-basis 1% exceedance

[5] UniStar Nuclear Energy Letter UN#08-055, from Greg Gibson to Document Control Desk, U.S. NRC, Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 - Meteorology, dated October 30, 2008

temperature values with the seasonal-basis 1% exceedance temperature values as stated in the response to RAI Question 02.03.01-29 (this enclosure).

(e) The responses to RAI Questions 02.03.01-23[6], 02.03.01-24[6], and 02.03.01-25 (this enclosure) resolve the technical issues identified in this paragraph.

(f) A response to this question is provided in response to RAI Question 02.03.01-30 (this enclosure).

(g) The column labels in FSAR Table 2.0-1 read as follows: "U.S. EPR FSAR Design Parameter Value/Characteristic" and "CCNPP Unit 3 Design Parameter Value/Characteristic". To help minimize further confusion, the first column will be revised to "U.S. EPR FSAR Design Parameter Value" and the second column label will be revised to read "CCNPP Unit 3 Site Characteristic Value".

COLA Impact

FSAR Table 2.0-1, U.S. EPR Site Design Envelope comparison, will be revised as shown in the response to RAI Question 02.03.01-29 (this enclosure).

[6] UniStar Nuclear Energy Letter UN#09-439, from Greg Gibson to Document Control Desk, RAI No. 151, Regional Climatology, dated October 19, 2009