

**Response to**

**Request for Additional Information No. 37, Revision 0**

**8/07/2008**

**U. S. EPR Standard Design Certification**

**AREVA NP Inc.**

**Docket No. 52-020**

**SRP Section: 02.03.01 - Regional Climatology**

**SRP Section: 02.03.04 - Short Term Atmospheric Dispersion Estimates for  
Accident Releases**

**SRP Section: 02.03.05 - Long-Term Atmospheric Dispersion Estimates for  
Routine Releases**

**Application Section: FSAR Ch. 2**

**RSAC Branch**

**Question 02.03.01-10:**

The response to RAI 02.03.01-7 noted that inherent to the definition of zero percent exceedance temperature is to exclude peaks of less than two hours in duration. In spite of the two hour criterion, the staff still believes that the proposed zero percent maximum non-coincident wet bulb temperature of 81°F is under-conservative. As shown in attachment 1, compared to maximum observed wet bulb temperatures from ASHRAE, the U.S. EPR proposed site parameter is exceeded throughout the majority of the U.S., 67 percent of the time, especially in the Southeast U.S., where the proposed site parameter is exceeded 96 percent of the time. The NRC staff is not inclined to approve a plant design that cannot be sited at a reasonable number of potential COL sites without requiring COL applicants to request a departure from the design as part of their COL application. Please revise the zero percent maximum non-coincident wet bulb temperature or provide additional justification how this value is representative of a reasonable number of sites.

**Response to Question 02.03.01-10:**

A response to this question will be provided by November 17, 2008.

**Question 02.03.01-11:**

The response to RAI 02.03.01-8 is inadequate since it only discusses the zero percent exceedance maximum wet bulb temperature of 81° F. Please provide a technical basis for the site parameter values listed in FSAR Table 2.1-3 and FSAR Table 2.1-4. Also, please justify that these site parameter values are representative of a number of potential COL sites.

**Response to Question 02.03.01-11:**

A response to this question will be provided by November 17, 2008.

**Question 02.03.04-5:**

The staff intends for the control room accident  $\chi/Q$  values to be presented in the site parameter table, FSAR Table 2.1-1. Standard Review Plan 2.3.4 specifically states that a DC applicant should include EAB, LPZ, and control room atmospheric dispersion factors for the appropriate time periods in the list of site parameters. Note, Standard Review Plant 2.0 states that the examples of site characteristics and site-related design parameters provided are not necessarily a complete list. Please revise FSAR Table 2.1-1 accordingly.

**Response to Question 02.03.04-5:**

The control room accident  $\chi/Q$  values will be relocated from U.S EPR FSAR Tier 2, Tables 2.3-1 and 2.3-2 to U.S. EPR FSAR Tier 2, Table 2.1-1. U.S. EPR FSAR Sections 1.8, 2.3.4, 15.0.3.3.3, and 15.0.3.11.2 will also be revised to reflect this change. U.S EPR FSAR Tier 2, Table 2.3-3 will be renumbered as Table 2.3-1.

**FSAR Impact:**

U.S. EPR FSAR Tier 2, Table 1.8-2, Table 2.1-1, Table 2.3-1, Section 2.3.4, Section 15.0.3.3.3, and Section 15.0.3.11.2 will be revised as described in the response and indicated on the enclosed markup. U.S. EPR FSAR Tier 2, Tables 2.3-1 and 2.3-2 will be deleted and their material relocated to Table 2.1-1.

**Question 02.03.04-6:**

Per Regulatory Guide 1.206 and Standard Review Plan 2.3.4, please provide a site plan showing plant north and indicating locations of all potential accident release pathways and control room intake and unfiltered in-leakage pathways.

**Response to Question 02.03.04-6:**

U.S. EPR FSAR Tier 2, Figure 2.3-1, "U.S. EPR Release Points and Control Room Air Intakes," provides the source term release locations on the Nuclear Island and the control room intakes for normal and accident ventilation. The unfiltered in-leakage is attributed to ingress and egress from the control room envelope. Plant north is pointing vertically towards the top of the page in this figure consistent with the plant north shown in U.S. EPR FSAR Tier 2, Figure 1.2-3, "Plant Configuration."

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

**Question 02.03.05-5:**

- a. The response to RAI 02.03.05-1 stated that the annual average  $\chi/Q$  value of  $4.973E-6$   $\text{sec}/\text{m}^3$  was determined using meteorological data from the Calvert Cliffs Nuclear Power Plant site; whereas the response to RAI 02.03.05-3 stated that the  $\chi/Q$  values were based on information in the EPRI ALWR URD and available early site permits. Please clarify this apparent contradiction. If the  $\chi/Q$  values in FSAR Section 2.3.5 were based on previous early site permit (ESP) applications, please explain how ground-level release  $\chi/Q$  values from the ESP applications were used to determine the mixed-mode release  $\chi/Q$  values for the U.S. EPR.
- b. Please explain how the proposed  $\chi/Q$  values presented in FSAR Section 2.3.5 could be considered representative of a reasonable number of potential sites.

**Response to Question 02.03.05-5:**

- a. The annual average  $\chi/Q$  was not obtained from the ALWR URD or ESP applications. The response to RAI 02.03.05-1 described the calculation of the annual average  $\chi/Q$ . The value of  $4.973E-6$   $\text{sec}/\text{m}^3$  was determined with the Calvert Cliffs Nuclear Power Plant (CCNPP) data described in the response.

The response to RAI 02.03.05-3 should have stated the EPRI ALWR URD and ESP data were sources of information considered in establishing the U.S. EPR annual average  $\chi/Q$ .

- b. The  $\chi/Q$  values in U.S. EPR FSAR Tier 2, Section 2.3.5 were based on a comparison of accident atmospheric dispersion factors for the Exclusion Area Boundary (EAB), Low Population Zone (LPZ), and the Control Room (CR) from thirty-two operating nuclear power plants. The  $\chi/Q$  values from existing nuclear power plants were obtained primarily from alternative source term submittals to the NRC and then compared to the U.S. EPR  $\chi/Q$  values. These values were collectively plotted on graphs and the U.S. EPR  $\chi/Q$  values were found to be representative.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

# U.S. EPR Final Safety Analysis Report Markups

**Table 1.8-2—U.S. EPR Combined License Information Items  
Sheet 4 of 41**

Item No.	Description	Section	Action Required by COL Applicant	Action Required by COL Holder
2.3-1	If a COL applicant that references the U.S. EPR design certification identifies site-specific meteorology values outside the range of the design parameters in Table 2-1, then the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of the Combined License application.	2.3	Y	
2.3-2	A COL applicant that references the U.S. EPR design certification will provide site-specific characteristics for regional climatology.	2.3.1	Y	
2.3-3	A COL applicant that references the U.S. EPR design certification will provide site-specific characteristics for local meteorology.	2.3.2	Y	
2.3-4	A COL applicant that references the U.S. EPR design certification will provide the site-specific, onsite meteorological measurement program.	2.3.3	Y	
2.3-5	A COL applicant that references the U.S. EPR design certification will provide a description of the atmospheric dispersion modeling used in evaluating potential design basis events to calculate concentrations of hazardous materials (e.g., flammable or toxic clouds) outside building structures resulting from the onsite and/or offsite airborne releases of such materials.	2.3.4	Y	
2.3-6	<div data-bbox="22 1367 232 1409" style="border: 1px solid red; padding: 2px;">02.03.04-5</div> <div data-bbox="293 1457 915 1560" style="border: 1px solid red; padding: 2px;"> <del>specified in Table 2-1 at the EAB, and LPZ and the control room by Table 2.3-1 at the control room.</del> </div> <p>For site-specific <math>X_{\gamma}/Q</math> values that exceed the bounding <math>X_{\gamma}/Q</math> values, a COL applicant that references the U.S. EPR design certification will demonstrate that the radiological consequences associated with the controlling design basis accident continue to meet the dose reference values given in 10 CFR 50.34 and the control room operator dose limits given in GDC 19 using site-specific <math>X_{\gamma}/Q</math> values.</p>	2.3.4	Y	

02.03.04-5

Table 2.1-1—U.S. EPR Site Design Envelope  
Sheet 1 of 7

<b>U.S. EPR Site Design Envelope</b>	
<b>Precipitation (Refer to Section 2.4)</b>	
Rainfall	≤19.4 in/hr
Snow (design: extreme live load, including 48-hour probable maximum winter precipitation)	≤100 psf
<b>Seismology (Refer to Sections 2.5 &amp; 3.7)</b>	
Horizontal SSE Acceleration	0.3g Peak (CSDRS shapes – See Section 3.7.)
Vertical SSE Acceleration	0.3g Peak (CSDRS shapes – See Section 3.7.)
Fault Displacement Potential	No fault displacement is considered for safety-related SSCs in U.S. EPR design certification.
<b>Soil (Refer to Section 2.5)</b>	
Minimum Bearing Capacity (Static)	22 ksf in localized areas at the bottom of the Nuclear Island basemat and 15 ksf on average across the total area of the bottom of the Nuclear Island basemat.
Minimum Shear Wave Velocity (Low strain best estimate average value at bottom of basemat)	1000 fps
Liquefaction	None
Maximum Differential Settlement (across the basemat)	1/2 inch in 50 feet in any direction

02.03.04-5

Table 2.1-1—U.S. EPR Site Design Envelope

Sheet 2 of 7

<b>U.S. EPR Site Design Envelope</b>	
Slope Failure Potential	No slope failure potential is considered in the design of safety-related SSC for U.S. EPR design certification.
Maximum Ground Water	3.3 ft below grade
<b>Inventory of Radionuclides Which Could Potentially Seep Into the Groundwater</b>	
See Table 2.1-2—Bounding Values for Component Radionuclide Inventory	
<b>Flood Level (Refer to Section 2.4)</b>	
Maximum Flood (or Tsunami)	1 ft below grade
<b>Wind (Refer to Section 3.3)</b>	
Maximum Speed (Other than Tornado)	145 mph (Based on 3-second gust at 33 ft above ground level and factored for 50-yr mean recurrence interval.)
Importance Factor	1.15 (Safety-related structures for 100-year mean recurrence interval.)

02.03.04-5

Table 2.1-1—U.S. EPR Site Design Envelope

Sheet 3 of 7

<b>U.S. EPR Site Design Envelope</b>	
<b>Tornado (Refer to Sections 3.3 and 3.5)</b>	
Maximum Pressure and Rate of Drop	1.2 psi at 0.5 psi/s
Maximum Rotational Speed	184 mph
Maximum Translational Speed	46 mph
Maximum Wind Speed	230 mph
Radius of Maximum Rotational Speed	150 ft
Missile Spectra	6 in Schedule 40 pipe, 6.625 in diameter x 15 ft long, 287 lb, 34.5 in <sup>2</sup> impact area, impact velocity of 135 fps horizontal and 90 fps vertical.
	Automobile, 16.4 ft x 6.6 ft x 4.3 ft, 4000 lb, 4086.7 in <sup>2</sup> impact area, impact velocity of 135 fps horizontal and 90 fps vertical. (Automobile missile is considered at elevations up to 30.0 ft above grade elevation.)
	Solid steel sphere, 1 in diameter, 0.147 lb, 0.79 in <sup>2</sup> impact area, impact velocity of 26 fps horizontal and 17 fps vertical.

02.03.04-5

Table 2.1-1—U.S. EPR Site Design Envelope

Sheet 4 of 7

U.S. EPR Site Design Envelope			
Temperature (Refer to Section 2.3)			
Air	0% Exceedance Values	Maximum	115°F Dry Bulb / 80°F Wet Bulb (coincident) 81°F Wet Bulb (non-coincident) <u>UHS Design Only</u>
		Minimum	-40°F
	1% Exceedance Values	Maximum	100°F dry bulb/77°F coincident wet bulb 80°F wet bulb (noncoincident) <u>UHS Design Only</u>
		Minimum	-10°F
UHS Meteorological Conditions			
Conditions resulting in Maximum Evaporation and Drift Loss of Water from the UHS (Section 2.3.1)		As presented in Table 2.1-3—Design Values for Maximum Evaporation and Drift Loss of Water from the UHS	
Conditions resulting in Minimum Water Cooling in the UHS (Section 2.3.1)		As presented in Table 2.1-4—Design Values for Minimum Water Cooling in the UHS	
Potential for Water Freezing in the UHS Water Storage Facility (Sections 2.4.7 and 9.2.5)		As presented in Sections 2.4.7 and 9.2.5	

02.03.04-5

Table 2.1-1—U.S. EPR Site Design Envelope

Sheet 5 of 7

<b>U.S. EPR Site Design Envelope</b>	
<b>UHS Design Parameters (Section 9.2.5)</b>	
Maximum UHS Evaporative Water Loss	571 gpm
Maximum Drift Water Loss	≤0.005%
Design Cold (outlet) Water Temperature	≤95°F (max ESWS supply design limit)
<b>Atmospheric Dispersion Factors (<math>\chi/Q</math>) (Refer to Section 2.3)</b>	
Maximum Annual Average (0.5 mile - limiting sector)	≤4.973E-06 s/m <sup>3</sup>
<b>Accident</b>	
0-2 hr (EAB, 0.5 miles)	≤1E-03 s/m <sup>3</sup>
0-2 hr (LPZ, 1.5 miles)	≤1.75E-04 s/m <sup>3</sup>
2-8 hr (LPZ, 1.5 miles)	≤1.35E-04 s/m <sup>3</sup>
8-24 hr (LPZ, 1.5 miles)	≤1.00E-04 s/m <sup>3</sup>
1-4 day (LPZ, 1.5 miles)	≤5.40E-05 s/m <sup>3</sup>
4-30 day (LPZ, 1.5 miles)	≤2.20E-05 s/m <sup>3</sup>



Table 2.1-1—U.S. EPR Site Design Envelope  
Sheet 6 of 7

U.S. EPR Site Design Envelope									
<u>Main Control Room/Technical Support Center Intake Atmospheric Dispersion Factors</u>									
<u>for Onsite Accident Dose Analysis (<math>\gamma/Q</math>)</u>									
<u>Time Period</u>	<u>Vent Stack Base</u>	<u>Releases via Safe-guard Building Canopy #1</u>	<u>Releases via Safe-guard Building Canopy #2</u>	<u>Equip-ment Hatch Releases via Material Lock</u>	<u>Depress-urization Shaft Releases</u>	<u>Main Steam Relief Train Silencer #1</u>	<u>Main Steam Relief Train Silencer #2</u>	<u>Main Steam Relief Train Silencer #3</u>	<u>Main Steam Relief Train Silencer #4</u>
<u>0–2 hours (<math>s/m^3</math>)</u>	<u>1.93E-03</u>	<u>6.52E-03</u>	<u>1.66E-03</u>	<u>1.01E-03</u>	<u>4.45E-03</u>	<u>1.57E-03</u>	<u>1.99E-03</u>	<u>4.30E-03</u>	<u>3.28E-03</u>
<u>2–8 hours (<math>s/m^3</math>)</u>	<u>1.73E-03</u>	<u>5.68E-03</u>	<u>1.47E-03</u>	<u>8.97E-04</u>	<u>3.95E-03</u>	<u>1.36E-03</u>	<u>1.63E-03</u>	<u>3.71E-03</u>	<u>2.83E-03</u>
<u>8–24 hours (<math>s/m^3</math>)</u>	<u>6.74E-04</u>	<u>2.34E-03</u>	<u>6.28E-04</u>	<u>3.53E-04</u>	<u>1.70E-03</u>	<u>5.44E-04</u>	<u>6.47E-04</u>	<u>1.46E-03</u>	<u>1.12E-03</u>
<u>1–4 days (<math>s/m^3</math>)</u>	<u>5.12E-04</u>	<u>1.63E-03</u>	<u>4.19E-04</u>	<u>2.66E-04</u>	<u>1.11E-03</u>	<u>4.11E-04</u>	<u>4.93E-04</u>	<u>1.12E-03</u>	<u>8.57E-04</u>
<u>4–30 days (<math>s/m^3</math>)</u>	<u>4.72E-04</u>	<u>1.50E-03</u>	<u>3.81E-04</u>	<u>2.46E-04</u>	<u>1.00E-03</u>	<u>3.78E-04</u>	<u>4.52E-04</u>	<u>1.03E-03</u>	<u>7.86E-04</u>



Table 2.1-1—U.S. EPR Site Design Envelope  
Sheet 7 of 7

U.S. EPR Site Design Envelope									
<u>Main Control Room/Technical Support Center Unfiltered Inleakage Atmospheric Dispersion Factors</u>									
<u>for Onsite Accident Dose Analysis (<math>\gamma/Q</math>)</u>									
<u>Time Period</u>	<u>Vent Stack Base</u>	<u>Releases via Safe-guard Building Canopy #1</u>	<u>Releases via Safe-guard Building Canopy #2</u>	<u>Equip-ment Hatch Releases via Material Lock</u>	<u>Depress-urization Shaft Releases</u>	<u>Main Steam Relief Train Silencer #1</u>	<u>Main Steam Relief Train Silencer #2</u>	<u>Main Steam Relief Train Silencer #3</u>	<u>Main Steam Relief Train Silencer #4</u>
<u>0–2 hours (s/m<sup>3</sup>)</u>	<u>4.30E-03</u>	<u>1.67E-02</u>	<u>3.03E-03</u>	<u>1.65E-03</u>	<u>7.52E-03</u>	<u>1.93E-03</u>	<u>2.43E-03</u>	<u>1.76E-02</u>	<u>8.65E-03</u>
<u>2–8 hours (s/m<sup>3</sup>)</u>	<u>3.71E-03</u>	<u>1.47E-02</u>	<u>2.68E-03</u>	<u>1.47E-03</u>	<u>6.67E-03</u>	<u>1.66E-03</u>	<u>2.12E-03</u>	<u>1.48E-02</u>	<u>7.21E-03</u>
<u>8–24 hours (s/m<sup>3</sup>)</u>	<u>1.46E-03</u>	<u>5.96E-03</u>	<u>1.15E-03</u>	<u>5.74E-04</u>	<u>2.88E-03</u>	<u>6.69E-04</u>	<u>8.28E-04</u>	<u>5.88E-03</u>	<u>2.96E-03</u>
<u>1–4 days (s/m<sup>3</sup>)</u>	<u>1.12E-03</u>	<u>4.28E-03</u>	<u>7.59E-04</u>	<u>4.37E-04</u>	<u>1.89E-03</u>	<u>5.02E-04</u>	<u>6.38E-04</u>	<u>4.55E-03</u>	<u>2.22E-03</u>
<u>4–30 days (s/m<sup>3</sup>)</u>	<u>1.03E-03</u>	<u>3.89E-03</u>	<u>6.89E-04</u>	<u>4.00E-04</u>	<u>1.71E-03</u>	<u>4.65E-04</u>	<u>5.85E-04</u>	<u>4.16E-03</u>	<u>2.06E-03</u>

**Notes:**

**2.3.4 Short-Term Atmospheric Dispersion Estimates for Accident Releases**

Atmospheric dispersion factors ( $\chi/Q$  values) considered to be representative of potential future nuclear plant sites in the U.S. were used to calculate the consequences from postulated accidental releases of radioactive and hazardous materials.

$\chi/Q$  values for ground-level releases were calculated at the exclusion area boundary (EAB) and at the low population zone (LPZ) for appropriate time periods up to 30 days after an accident. The accident  $\chi/Q$  values were either extracted from Reference 1 or were calculated following the methodology in NRC RG 1.145. The ground-level  $\chi/Q$  values used for short-term atmospheric dispersion dose analyses at the EAB and LPZ receptor locations are provided in Table 2.1-1.

02.03.04-5

In addition to the offsite accident consequences evaluated at the EAB and LPZ, onsite accident dose consequences at the Main Control Room (MCR) and Technical Support Center (TSC) were evaluated. MCR and TSC  $\chi/Q$  values, provided in [Table 2.3-1](#) [Table 2.1-1](#) for the main air supply and [Table 2.3-2](#) for the unfiltered inleakage, are used for these analyses from potential post-accident release points. These multiple potential release points affecting the MCR and the TSC include:

- The vent stack.
- Main steam relief train (MSRT) releases for steam generator overpressure protection.
- Safeguard Building roofs via the Safeguard Building canopies.
- An open equipment hatch.
- Safeguard Building depressurization shaft.

02.03.04-5

The information in these tables conforms to the guidance in RG 1.23, RG 1.145, and RG 1.194. Conformance with RG 1.78 is addressed in Sections 2.2, 6.4, 9.4, and 9.5.

[The input variables used in calculating the accident  \$\chi/Q\$  values are shown in \[Table 2.3-1\]\(#\).](#)

Figure 2.3-1—U.S. EPR Release Points and Control Room Air Intakes provides the relative locations of the release points and the control room air intakes. Section 15.0.3 addresses the dose calculation methodology for accident analyses.

02.03.04-5

A COL applicant that references the U.S. EPR design certification will confirm that site-specific  $\chi/Q$  values, based on site-specific meteorological data, are bounded by those specified in Table 2.1-1 at the EAB, and LPZ, and [by Table 2.3-1](#) at the control room.

**Table 2.3-1—Input Parameters for Control Room  $\gamma/Q$  Values  
Sheet 1 of 2**

<u>Parameter</u>	<u>Value(s)</u>
<u>Temperature sensor separation</u>	<u>168 ft (51.21 m)</u> <u>164 ft (50 m)</u>
<u>Wind instrument heights</u>	<u>30 ft, 100 ft, and 200 ft</u> <u>33 and 197 ft (10 m and 60 m)</u>
<u>Annual average mixing layer height</u>	<u>2953 ft (900 m) (Conservative, low value</u> <u>applicable to both sites)</u>
<u>Meteorological channel units of measure</u>	<u>Wind speed, miles per hour</u> <u>Wind direction, degrees from true north</u> <u>delta-temperature, degrees fahrenheit per sensor</u> <u>separation in ft</u>
<u>Minimum wind speed value for ARCON96</u>	<u>0.5 m/s as listed in RG 1.194</u>
<u>Surface roughness for ARCON96</u>	<u>0.2</u>
<u>Sector averaging constant for ARCON96</u>	<u>4.3</u>
<u>Wind direction window for ARCON96</u>	<u>90 degrees</u>
<u>Control room air intake location employed in</u> <u>analysis</u>	<u>Intake closest to stack</u>
<u>Control room air intake elevation</u>	<u>32.1 m (mid-point of intake) in units required by</u> <u>ARCON96</u>
<u>Control room intake horizontal distance to stack</u> <u>base</u>	<u>69.0 m in units required by ARCON96</u>
<u>Control room air intake horizontal distance to</u> <u>MSRT via Silencer (referred to as the Silencer</u> <u>release point in the present application):</u> <u>SG-4 Silencer to MCR Division 3 air intake</u> <u>SG-3 Silencer to MCR Division 3 air intake</u> <u>SG-1 Silencer to MCR Division 3 air intake</u> <u>SG-2 Silencer to MCR Division 3 air intake</u>	<u>53.0 m</u> <u>46.0 m</u> <u>78.0 m</u> <u>71.0 meters in units required by ARCON96</u>
<u>Control room air intake horizontal distances to</u> <u>Canopy exhausts (referred to as the Canopy</u> <u>release point in the present application)</u> <u>1) Near depressurization shaft (SB Division 4)</u> <u>2) Southeast side of SB Division 4</u>	<u>30.1 m</u> <u>65.3 m in units required by ARCON96</u>
<u>Control room air intake horizontal distance to</u> <u>material lock (for the equipment hatch release)</u>	<u>97.5 m in units required by ARCON96</u>

**Table 2.3-1—Input Parameters for Control Room  $\gamma/Q$  Values**  
Sheet 2 of 2

<u>Control room air intake horizontal distance to the depressurization shaft of SB Division 4 (referred to as the depressurization shaft release point in the present application)</u>	<u>31.4 m in units required by ARCON96</u>
<u>Release heights used in ARCON96</u>	<u>Silencer - 33.9 m</u>  <u>Stack - 32.1 m</u>  <u>Canopy Pt. 1 - 15.5 m</u> <u>Canopy Pt. 2 - 11.5 m elevation</u> <u>Material lock (equipment hatch release) - 32.1 m</u>  <u>Depressurization shaft - 7 m in units required by ARCON96</u>

- MSLB outside of the Reactor Building.
- RCP locked rotor.
- Rod ejection.
- Fuel handling accident.
- LOCA.

The Reactor Building includes the Inner Containment Building, the Outer Shield Building and includes the annulus space. The radiological consequences evaluation for each DBA includes the radiological habitability of the MCR and the technical support center (TSC), which is within the MCR envelope. The post-LOCA Reactor Building water chemistry analysis has been performed and demonstrates that the in-containment refueling water storage tank (IRWST) solution pH remains above 7.0 for the duration of the accident in accordance with RG 1.183, Appendix A, Item 2.

**15.0.3.3 Analytical Assumptions**

The analytical assumptions that are common to the DBA evaluations are presented in this section.

**15.0.3.3.1 Non-Safety-Related Systems Credited in the Analyses and Operator Action**

The DBA radiological evaluations credit safety-related structures, systems, or components (SSC) to mitigate the radiological consequences of a DBA. However, non-safety-related SSC are assumed operational if the assumption results in a more limiting radiological consequence. Additionally, certain non-safety-related backup PSs and components are credited in the design basis analyses as described in Section 15.0.0.3.6. Operator actions from the MCR are assumed to take place 30 minutes or later from the start of accident.

**15.0.3.3.2 Loss of Offsite Power Assumptions**

LOOP coincident with the event or with an RT (if more restrictive) is assumed for the DBA radiological evaluations. In line with current regulatory requirements for new applications, a LOOP is not considered a single, active failure, but an addition to a single, active failure.

**15.0.3.3.3 Atmospheric Dispersion Factors**

02.03.04-5

The short-term atmospheric dispersion factors applied to the radiological evaluations are presented in Table 2.1-1—U.S. EPR Site Design Envelope for the exclusion area boundary (EAB) and low population zone (LPZ). The MCR/TSC atmospheric dispersion factors are presented in ~~Table 2.3-1—Main Control Room/Technical Support Center Intake Atmospheric Dispersion Factors for Onsite Accident Dose~~

~~Analysis ( $\chi/Q$ ) Table 2.1-1, and Table 2.3-2—Main Control Room/Technical Support Center Unfiltered Inleakage Atmospheric Dispersion Factors for Onsite Accident Dose Analyses.~~

The MCR/TSC analytical model for the radiological habitability evaluations includes a primary intake flow from one location, with and without filtration, and a secondary unfiltered intake flow from a different location. The single intake simplification requires time-dependent effective atmospheric dispersion factors and associated MCR intake filter bypass fractions. The MCR/TSC effective  $\chi/Q$  values are determined following the guidance in RG 1.194, Section 3.3.2.1, and are scenario dependent. The radiological event descriptions in this chapter include these effective  $\chi/Q$  factors and bypass fractions.

#### 15.0.3.3.4 Core Radionuclide Inventory Assumptions

The design basis core radionuclide inventory is calculated using the ORIGEN-2.1 software (Reference 9) along with extended burnup libraries from ORIGEN-2 high burnup reactor models (Reference 10). The U.S. EPR-specific parameters listed in Table 15.0-13—Parameters Used to Calculate Design Basis Core Radionuclide Inventory are used to determine the DBA core radionuclide inventory. The bounding radionuclide inventory is derived from a parametric evaluation with fuel enrichments ranging from 2–5 wt% in uranium U-235 and burnup steps ranging between approximately 5 and 62 GWD/MTU. Each parametric case assumed continuous reactor operation at full power without any refueling outage. The maximum activity for each radionuclide from the parametric cases is selected to provide a bounding core radionuclide inventory for the listed fuel-enrichment and burnup ranges. The resulting core inventory is shown in Table 15.0-14—Design Basis Core Radionuclide Inventory.

The core inventory in Table 15.0-14 also provides the source for computation of the RCS radionuclide concentrations. The RCS iodine and noble gas concentrations are assumed to initially be at the maximum equilibrium TS limits for continued operation, while the alkalis are assumed to be at the design basis values corresponding to a 0.25 percent failed fuel fraction. Table 15.0-15 provides the RCS initial concentrations. Corresponding secondary side radionuclide concentrations are provided in Table 15.0-16—U.S. EPR Secondary Coolant Bounding Concentrations.

#### 15.0.3.3.5 Iodine Appearance Rates

The iodine appearance rates are used in DBA analyses that require the assumption of an accident-induced concurrent iodine spike, such as a SGTR and a MSLB. These appearance rates are shown in Table 15.0-17—Iodine Appearance Rates into RCS from Defective Fuel and are based on an RCS purification flow rate of 120,000 lbm/hr. The flow rate used is 60 percent higher than the nominal value of 75,000 lbm/hr used in

Releases to the atmosphere are as follows:

- During the 305-second drawdown time of the Safeguard Building and Fuel Building (by the KLC), 100 percent of the airborne source term from the ESF component leakage was assumed to be exhausted directly, without holdup, to the environment at a location adjacent to the SG 3 silencer (closest point to the MCR intakes), unfiltered.
- Following the end of drawdown, the ESF component leakage release is directly to the atmosphere via the main stack, a ground-level release, and is filtered by the KLC, with 99 percent filtration efficiency for all species.

The receptors of interest are at the EAB, LPZ and MCR. Atmospheric dispersion factors for the EAB and LPZ are shown in Table 2.3-1. Time-shifting of the atmospheric dispersion factors was applied to all receptors of interest so that the most adverse release of radioactive material to the environment occurs coincident with the period of most adverse atmospheric dispersion (in line with RG 1.183, Section 4.1.5, and RG 1.194, Section 2). The MCR filtered and unfiltered atmospheric dispersion factors are listed in [Table 2.1-1](#), [Table 2.3-1](#) and [Table 2.3-2](#), respectively.

02.03.04-5

Table 15.0-51—MCR Composite  $\chi/Q$  and Filter-Bypass Fractions LOCA Releases at the Main Stack Base<sup>1</sup> provides the MCR composite atmospheric dispersion factors and filter-bypass fractions for the LOCA. These are the  $\chi/Q$  values and filter-bypass fractions that are appropriate if both the MCR supply air and unfiltered inleakage were modeled using a single junction from the environment into the MCR.

The MCR envelope ventilation model is described in Section 15.0.3.4.1. The MCR envelope is substantially shielded by the concrete structures of the Containment Building and Shield Building (including annulus). Thus, the only external shine dose explicitly calculated for the MCR is that associated with filter shine from the SAB charcoal filter. The charcoal filter is modeled as a point source located on elevation 69 feet of the MCR envelop (the HVAC space), approximately ten feet above the receptor point in the MCR proper (on elevation 53 feet), which is shielded by the approximately 20-inch (50 cm) intervening concrete floor. The HVAC space is within the MCR envelope and accounts for one third of the 200,000 ft<sup>3</sup> volume of the MCR envelope. Direct shine from airborne radioactivity within the HVAC space to the MCR proper was neglected in view of the shielding provided by the 20-inch concrete floor.

### 15.0.3.11.3 Results

The U.S. EPR LOCA doses are summarized in Table 15.0-53—Radiological Consequences of U.S. EPR Design Basis Accidents (rem TEDE). The worst-case receptor is in the MCR, where the overall TEDE dose corresponds to approximately 80 percent of the limit. The MCR filter shine dose is relatively small, resulting in less than 0.1 rem, accounting for occupancy factor.