Callaway2COLPEm Resource

From: Harvey, Brad
Sent: Wednesday, March 18, 2009 11:54 AM
To: Mazaika, Michael; Hart, Michelle
Cc: Galletta, Thomas; Quinlan, Kevin; Brown, Leta; Lee, Jay; Tammara, Seshagiri; Charles Cox; CCNPP3COL Resource; Callaway2COL Resource; BellBendCOL Resource; NMP3SCOL Resource
Subject: RE: U.S. EPR - Applicability of X/Q Site Parameters in DC FSAR Table 2.3-2
Attachments: RAI 37 Response US EPR DC.PDF

I am currently the responsible meteorological reviewer for the US EPR, having taken over that responsibility from Joe Hoch when he left the agency last fall.

Attached please find the AVERA's response to RAI 02.03.04-5 (starting on page 4 of 21) where the applicant has committed to delete U.S. EPR FSAR Tier 2, Tables 2.3-1 and 2.3-2, and relocate their material to Table 2.1-1. Another words, both the CR intake and unfiltered inleakage X/Q values will become site parameter values in an upcoming revision to the US EPR FSAR. When that occurs, all the COL applicants referencing the US EPR will need to revise their COL applications to demonstrate that their control room X/Q site characteristic values are bounded by the corresponding EPR site parameters.

Note that US EPR Table 2.3-3 table was also added to describe some of the ARCON96 input parameters.

Hope this helps. Please let me know if you have any questions.

Brad
415-4118

From: Michael Mazaika
Sent: Wednesday, March 18, 2009 10:44 AM
To: Michelle Hart; Brad Harvey
Cc: Thomas Galletta; Kevin Quinlan; Leta Brown; Jay Lee; Seshagiri Tammara; Charles Cox; CCNPP3COL Resource; Callaway2COL Resource; BellBendCOL Resource; NMP3SCOL Resource
Subject: RE: U.S. EPR - Applicability of X/Q Site Parameters in DC FSAR Table 2.3-2

Michelle:

Thank you Michelle. You confirmed what I thought was the case. I'm interpreting that to mean, then, that staff should expect to see site-specific X/Qs modeled for receptor points where unfiltered, inleakage is expected to occur (as shown in Figure 2.3-1 of the DCD FSAR) or at least a clear demonstration by some other means that the corresponding site parameters in DCD Tier 2, Table 2.3-2 are being bounded. As I noted in my earlier e-mail, I don't agree with UniStar's response to Joe Hoch's RAI question and believe, further, that the ARCON96 modeling itself is deficient. I would plan to include the disconnect in the DCD and COLAs regarding Table 2.3-2 as one of several related new RAI questions.

I'll also take a look at DCD FSAR 15.0.3, and perhaps you, Brad and I should get together to discuss, how UniStar/Areva did the ARCON96 modeling in order to frame the RAI questions properly. In general, it looks to me that they estimated X/Qs by assuming <u>all</u> potential release points were directly upwind of the modeled receptor location without using the actual source-receptor orientation (i.e., not taking credit for variations in the hourly meteorology) but rather assuming a generic orientation 180-degrees out of phase with the same sector that produced the highest X/Qs for the stack release-control room air intake calculation.

I presume the applicant considers that to be a conservative approach (and it may very well turn out to be so) and I suppose the margin based on the X/Qs in the application are acceptable (pending the likely need to revise the modeling). **<u>Having taken a brief look at Reg Guide 1.194 last night, can you tell me</u>**:

- whether both intakes operate simultaneously or one can be isolated - looks as if they are both within the same 90-degree window, so modeling a single intake location (presumably the closest to each source which does not appear to be the case) would be one conservatism?, and

  - if simultaneous, then how does a modeled X/Q for a single receptor point get apportioned to each intake system?,

- whether both unfiltered, inleakage locations are assumed to contribute to the determination of the effective Control Room X/Q?, and

  - if both, then how does a (not yet) modeled X/Q for a single receptor point get apportioned to determine the contribution to the effective Control Room X/Q?

It seems to me that there are numerous scenarios that we could ask to be modeled here depending on the answers to the above. I'm trying to get a handle on whether or not it is advisable (or even necessary) to pursue that in RAI questions. I'm OK with that (and that seems to be the approach reflected in the four U.S. EPR COLAs - but I'm trying to get my head around the physical side of the issue as well as correcting what I believe are errors in those ARCON96 modeling analyses before cutting RAI questions.

Please annotate with your thoughts.

Thanks again,

Mike

From: Michelle Hart
Sent: Wednesday, March 18, 2009 9:32 AM
To: Michael Mazaika; Brad Harvey; Jay Lee; Seshagiri Tammara
Cc: Charles Cox; CCNPP3COL Resource; Callaway2COL Resource; BellBendCOL Resource; NMP3SCOL Resource
Subject: RE: U.S. EPR - Applicability of X/Q Site Parameters in DC FSAR Table 2.3-2

Mike,

The values given in DCD FSAR Table 2.3-2 for the control room unfiltered inleakage are used as input to the DCD FSAR DBA calculations (and by incorporation, the COL calculations), just like the values in DCD FSAR Table 2.3-1 are. Therefore, they should also be considered site parameters.

Areva uses both sets of control room X/Qs (intake and unfiltered inleakage) to calculate a control room effective X/Q that is used in the DBA analyses in DCD FSAR Chapter 15.0.3. They do that to address a limitation in the computer code used to calculate the doses.

A related issue was something that Joe Hoch had previously noted. He asked an RAI in the RCOL Calvert Cliffs why the control room X/Q values for unfiltered inleakage were not included or addressed - you can look at the question in the eRAI workflow as RAI 194, question 544. The applicant's response was sent on October 30, 2008, and did not address the COL information item. I don't think Joe brought up the COL information item itself. I'm not sure how the COL information item is being handled in the DC. It's something we should follow up on in the DC (and the COLs, which should follow the DC) if it's not already being addressed.

Michelle

From: Michael Mazaika
Sent: Tuesday, March 17, 2009 6:40 PM
To: Brad Harvey; Michelle Hart; Jay Lee; Seshagiri Tammara

Cc: Charles Cox; CCNPP3COL Resource; Callaway2COL Resource; BellBendCOL Resource; NMP3SCOL Resource
Subject: U.S. EPR - Applicability of X/Q Site Parameters in DC FSAR Table 2.3-2

Folks:

Need your help in determining if this is a disconnect in the U.S. EPR Design Certification (DC) FSAR. There is a COL Information Item (No. 2.3-6) in Table 1.8-2 of Section 1.8, Tier 2, Chapter 1 of the DC FSAR. The parallel table in the Bell Bend COL FSAR is also identified as Table 1.8-2 and includes the same COL Item; both read as follows (my underline and bold text):

> A COL applicant that references the U.S. EPR design certification will confirm that site specific X/Q values, based on site-specific meteorological data, are bounded by those specified in Table 2-1 at the EAB and LPZ **<u>and by Table 2.3-1 at the control room</u>**. For site-specific X/Q values that exceed the bounding X/Q values, a COL applicant that references the U.S. EPR design certification will demonstrate that the radiological consequences associated with the controlling design basis accident continue to meet the dose reference values given in 10 CFR 50.34 and the control room operator dose limits given in GDC 19 using site-specific X/Q values.

Tier 2, Table 2.3-1 of the DC FSAR is titled "Main Control Room / Technical Support Center Intake Atmospheric Dispersion Factors for Onsite Accident Dose Analysis (X/Q)". However, there is a companion table, Tier 2, Table 2.3-2 titled ""Main Control Room / Technical Support Center Unfiltered Inleakage Atmospheric Dispersion Factors for Onsite Accident Dose Analysis (X/Q)" that is not mentioned among the COL Infomration Items.

- Do the X/Q values in Table 2.3-2 represent site parameters for which corresponding site characteristic X/Q values need to be determined (using ARCON96) along with a demonstration that they are bounded by the respective site parameter X/Qs in Table 2.3-2?

- If so, then is this a discrepancy in the DC FSAR that needs to be addressed (or has already been)?

- If not, then why not and why is this table in the DC FSAR?

If this is a discrepancy (i.e., Table 2.3.-2 should be included in COL Information Item 2.3-6), then it likely has ripple effects in the DC FSAR, and definitely would carry over into Table 1.8-2 of the COL FSAR, as well as the text in COL FSAR Section 2.3.4 where COL items pertaining to the short-term accident analyses, including this one, are reiterated at the beginning of the section (although this item is parsed into two paragraphs). The same text appears in COL FSAR Section 2.3.4 of all four current U.S. EPR COL applications.

I note that the X/Qs in Table 2.3-2 are all higher than the values in Table 2.3-1 for the respective post-accident time periods and nine potential release points. I also note that in the ARCON96 modeling discussion in FSAR Section 2.3.4.2.3 of all four U.S. EPR COLAs, DC FSAR Table 2.3-2 is acknowledged as providing "Short-term atmospheric dispersion X/Q estimates for unfiltered inleakage into the control room". On the other hand:

- only one of the four applications (i.e., for Callaway Unit 2) makes a statement as to whether the unfiltered. inleakage X/Qs are bounded by the site parameters in Table 2.3-2,

    - a statement to that effect is included in UniStar's October 30, 2008 response to RAI No. 02.03.04-2 on the basis that the meteorological data used to model the control room air intake X/Qs is the same and those X/Qs were bounded by the site parameters in table 2.3-1 of the U.S. EPR FSAR (that's all based on the presumption that that modeling was done correctly - from what I've seen and understand so far, I tend to disagree; the analysis explanation is convoluted at best, some release points are closer to the other control room air intake than the one modeled, receptor distances to unfiltered, inleakage intakes are much closer to the release points than the one modeled, and site-specific source-receptor orientations were not modeled except for the (vent) stack),

- none of the four applications presents unfiltered, inleakage X/Q modeling results that correspond to the site parameters in Table 2.3-2, and

- only one of the four applications (again, for Callaway) contains some discussion of ARCON96 modeling assumptions related to the unfiltered, inleakage receptors (and as above, I don't particularly agree with some of those assumptions).

The main purpose of this e-mail is to determine whether the X/Q values in DC FSAR Tier 2, Table 2.3-2 represent site parameters that need to be acknowledged as such and addressed in the short-term, accident modeling analyses and write-ups. I will address issues related to how the ARCON96 modeling was done in a separate that we can discuss before I cut any RAI questions on that subject.

Please annotate this e-mail with your thoughts.

Thanks,

Mike

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Hearing Identifier: CallawayPlant_Unit2_COL_Public
Email Number: 100

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Sent Date: 3/18/2009 11:53:34 AM
Received Date: 3/18/2009 11:53:37 AM
From: Harvey, Brad

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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 81ºF 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 81º 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 χ/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 χ/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 χ/Q value of 4.973E-6 sec/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 χ/Q values were based on information in the EPRI ALWR URD and available early site permits. Please clarify this apparent contradiction. If the χ/Q values in FSAR Section 2.3.5 where based on previous early site permit (ESP) applications, please explain how ground-level release χ/Q values from the ESP applications were used to determined the mixed-mode release χ/Q values for the U.S. EPR.

b. Please explain how the proposed χ/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 χ/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 χ/Q. The value of 4.973E-6 sec/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 χ/Q.

b. The χ/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 χ/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 χ/Q values. These values were collectively plotted on graphs and the U.S. EPR χ/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	A COL applicant that references the U.S. EPR design certification will confirm that site-specific χ/Q values, based on site-specific meteorological data, are bounded by those specified in Table 2-1 at the EAB, ~~and~~ LPZ and the control room ~~by Table 2.3-1 at the control room~~. For site-specific ~~X~~χ/Q values that exceed the bounding ~~X~~χ/Q values, a COL applicant that references the U.S. EPR design certification will demonstrate that the radiological consequences associated with the controlling design basis accident continue to meet the dose reference values given in 10 CFR 50.34 and the control room operator dose limits given in GDC 19 using site-specific ~~X~~χ/Q values.	2.3.4	Y	

02.03.04-5

02.03.04-5

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

U.S. EPR Site Design Envelope	
Precipitation (Refer to Section 2.4)	
Rainfall	≤19.4 in/hr
Snow (design: extreme live load, including 48-hour probable maximum winter precipitation)	≤100 psf
Seismology (Refer to Sections 2.5 & 3.7)	
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.
Soil (Refer to Section 2.5)	
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 Differental 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

U.S. EPR Site Design Envelope	
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
Inventory of Radionuclides Which Could Potentially Seep Into the Groundwater	
See Table 2.1-2—Bounding Values for Component Radionuclide Inventory	
Flood Level (Refer to Section 2.4)	
Maximum Flood (or Tsunami)	1 ft below grade
Wind (Refer to Section 3.3)	
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.)

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Table 2.1-1—U.S. EPR Site Design Envelope
Sheet 3 of 7

U.S. EPR Site Design Envelope	
Tornado (Refer to Sections 3.3 and 3.5)	
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^2 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^2 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^2 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) UHS Design Only
		Minimum	-40°F
	1% Exceedance Values	Maximum	100°F dry bulb/77°F coincident wet bulb 80°F wet bulb (noncoincident) UHS Design Only
		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

U.S. EPR Site Design Envelope	
UHS Design Parameters (Section 9.2.5)	
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)
Atmospheric Dispersion Factors (χ/Q) (Refer to Section 2.3)	
Maximum Annual Average (0.5 mile - limiting sector)	≤4.973E-06 s/m^3
Accident	
0-2 hr (EAB, 0.5 miles)	≤1E-03 s/m^3
0-2 hr (LPZ, 1.5 miles)	≤1.75E-04 s/m^3
2-8 hr (LPZ, 1.5 miles)	≤1.35E-04 s/m^3
8-24 hr (LPZ, 1.5 miles)	≤1.00E-04 s/m^3
1-4 day (LPZ, 1.5 miles)	≤5.40E-05 s/m^3
4-30 day (LPZ, 1.5 miles)	≤2.20E-05 s/m^3

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

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

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

U.S. EPR Site Design Envelope

Main Control Room/Technical Support Center Unfiltered Inleakage Atmospheric Dispersion Factors - for Onsite Accident Dose Analysis (χ/Q)

Time Period	Vent Stack Base	Releases via Safe-guard Building Canopy #1	Releases via Safe-guard Building Canopy #2	Equip-ment Hatch Releases via Material Lock	Depress-urization Shaft Releases	Main Steam Relief Train Silencer #1	Main Steam Relief Train Silencer #2	Main Steam Relief Train Silencer #3	Main Steam Relief Train Silencer #4
0–2 hours (s/m^3)	4.30E-03	1.67E-02	3.03E-03	1.65E-03	7.52E-03	1.93E-03	2.43E-03	1.76E-02	8.65E-03
2–8 hours (s/m^3)	3.71E-03	1.47E-02	2.68E-03	1.47E-03	6.67E-03	1.66E-03	2.12E-03	1.48E-02	7.21E-03
8–24 hours (s/m^3)	1.46E-03	5.96E-03	1.15E-03	5.74E-04	2.88E-03	6.69E-04	8.28E-04	5.88E-03	2.96E-03
1–4 days (s/m^3)	1.12E-03	4.28E-03	7.59E-04	4.37E-04	1.89E-03	5.02E-04	6.38E-04	4.55E-03	2.22E-03
4–30 days (s/m^3)	1.03E-03	3.89E-03	6.89E-04	4.00E-04	1.71E-03	4.65E-04	5.85E-04	4.16E-03	2.06E-03

Notes:

2.3.4 Short-Term Atmospheric Dispersion Estimates for Accident Releases

Atmospheric dispersion factors (χ/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.

χ/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 χ/Q values were either extracted from Reference 1 or were calculated following the methodology in NRC RG 1.145. The ground-level χ/Q values used for short-term atmospheric dispersion dose analyses at the EAB and LPZ receptor locations are provided in Table 2.1-1.

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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 χ/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.

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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 χ/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.

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

Table 2.3-1—Input Parameters for Control Room χ/Q Values
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Parameter	Value(s)
Temperature sensor separation	168 ft (51.21 m) 164 ft (50 m)
Wind instrument heights	30 ft, 100 ft, and 200 ft 33 and 197 ft (10 m and 60 m
Annual average mixing layer height	2953 ft (900 m) (Conservative, low value applicable to both sites)
Meterological channel units of measure	Wind speed, miles per hour Wind direction, degrees from true north delta-temperature, degrees fahrenheit per sensor separation in ft
Minimum wind speed value for ARCON96	0.5 m/s as listed in RG 1.194
Surface roughness for ARCON96	0.2
Sector averaging constant for ARCON96	4.3
Wind direction window for ARCON96	90 degrees
Control room air intake location employed in analysis	Intake closest to stack
Control room air intake elevation	32.1 m (mid-point of intake) in units required by ARCON96
Control room intake horizontal distance to stack base	69.0 m in units requred by ARCON96
Control room air intake horizontal distance to MSRT via Silencer (referred to as the Silencer release point in the present application): SG-4 Silencer to MCR Division 3 air intake SG-3 Silencer to MCR Division 3 air intake SG-1 Silencer to MCR Division 3 air intake SG-2 Silencer to MCR Division 3 air intake	 53.0 m 46.0 m 78.0 m 71.0 meters in units required by ARCON96
Control room air intake horizontal distances to Canopy exhausts (referred to as the Canopy release point in the present application) 1) Near depressurization shaft (SB Division 4) 2) Southeast side of SB Division 4	 30.1 m 65.3 m in units required by ARCON96
Control room air intake horizontal distance to material lock (for the equipment hatch release)	97.5 m in units required by ARCON96

Table 2.3-1—Input Parameters for Control Room χ/Q Values
Sheet 2 of 2

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)	31.4 m in units required by ARCON96
Release heights used in ARCON96	Silencer - 33.9 m Stack - 32.1 m Canopy Pt. 1 - 15.5 m Canopy Pt. 2 - 11.5 m elevation Material lock (equipment hatch release) - 32.1 m Depressurization shaft - 7 m in units required by ARCON96

Next File

- 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

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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 (χ/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 χ/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 χ/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.

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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~~. Table 15.0-51—MCR Composite χ/Q and Filter-Bypass Fractions LOCA Releases at the Main Stack Base[1] provides the MCR composite atmospheric dispersion factors and filter-bypass fractions for the LOCA. These are the χ/Q values and filter-bypass fractions that are be 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^3 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.