Exelon Generation
200 Exelon Way
Kennett Square, PA 19348

www.exeloncorp.com

10 CFR 50.90

JAF-19-0029

March 30, 2020

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

James A. FitzPatrick Nuclear Power Plant
Renewed Facility Operating License No. DPR-59
NRC Docket No. 50-333

Subject: Response to Request for Additional Information Associated with the License Amendment Request for Application of the Alternative Source Term for Calculating Loss-of-Coolant Accident Dose Consequences

References:

1. Letter from D. Gudger (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "License Amendment Request for Application of the Alternative Source Term for Calculating Loss-of-Coolant Accident Dose Consequences," dated August 8, 2019

2. Letter from D. Gudger (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "Supplemental Information Associated with the License Amendment Request for Application of the Alternative Source Term for Calculating Loss-of-Coolant Accident Dose Consequences," dated August 27, 2019

3. Email from S. Lee (U.S. Nuclear Regulatory Commission) to T. Loomis (Exelon Generation Company, LLC), "FitzPatrick request for additional information: License Amendment Request for Application of the Alternative Source Term for Calculating Loss-of-Coolant Accident Dose Consequences (EPID: L-2019-LLA-0171 and L-2019-LLE-0020)," dated December 19, 2019

4. Letter from D. Gudger (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information Associated with the License Amendment Request for Application of the Alternative Source Term for Calculating Loss-of-Coolant Accident Dose Consequences," dated January 16, 2020

5. Email from S. Lee (U.S. Nuclear Regulatory Commission) to T. Loomis (Exelon Generation Company, LLC), "FitzPatrick request for additional information: License Amendment Request for Application of the Alternative Source Term for Calculating Loss-of-Coolant Accident Dose Consequences (EPID: L-2019-LLA-0171 and L-2019-LLE-0020)," dated February 3, 2020

In the Reference 1 letter, Exelon Generation Company, LLC (EGC) requested approval for adopting the Alternative Source Term (AST), in accordance with 10 CFR 50.67, for use in calculating the Loss-of-Coolant Accident (LOCA) dose consequences at the James A. FitzPatrick Nuclear Power Plant (JAFNPP).

In the Reference 5 email, the U.S. Nuclear Regulatory Commission requested additional information. Attachment 1 is the EGC response.

In the Reference 1 submittal, EGC submitted a revision to TS Section 3.1.7, "Standby Liquid Control (SLC) System." The proposed change revised Condition C of Technical Specification (TS) 3.1.7 to add a Required Action for Mode 3. The previous markups inadvertently did not provide a Mode 3 Completion Time. The Actions have been modified to require the reactor to be in Mode 3 within 12 hours, and Mode 4 within 36 hours. This change implements AST assumptions regarding the use of the SLC System to buffer the suppression pool following a LOCA involving significant fission product release. The required actions for Condition C are being revised to add an additional requirement to be in MODE 4 if the TS LCO applicability cannot be met. This wording is similar to other BWR/4 Technical Specifications as approved in the Safety Evaluation Report dated September 11, 2006 (ML062070290) for the Dresden Nuclear Power Plant, Units 1 and 2, and Quad Cities Nuclear Power Plant, Units 1 and 2 for the adoption of Alternative Source Term Methodology. Accordingly, Attachment 2 contains a revised page 3.1.7-1.

EGC has reviewed the information supporting a finding of no significant hazards consideration, and the environmental consideration, that were previously provided to the NRC in the Reference 1 letter. The supplemental information provided in this response does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration under the standards set forth in 10 CFR 50.92. In addition, EGC has concluded that the information provided in this supplemental response does not affect the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed amendment.

There are no regulatory commitments contained in this submittal. Should you have any questions concerning this submittal, please contact Tom Loomis at (610) 765-5510.

I declare under penalty of perjury that the foregoing is true and correct. This statement was executed on the 30th day of March 2020.

Respectfully,

David T. Gudger

David T. Gudger
Sr. Manager - Licensing
Exelon Generation Company, LLC

Attachments: 1) Response to Request for Additional Information
2) Revised Technical Specification Page 3.1.7-1

cc: USNRC Region I, Regional Administrator
USNRC Senior Resident Inspector, JAFNPP
USNRC Senior Project Manager, JAFNPP
A. L. Peterson, NYSERDA

ATTACHMENT 1

Response to Request for Additional Information

ARCB-RAI-1A:

Please provide additional information describing how the design characteristics of the containment spray systems regarding the ability to provide a reduction in airborne activity in accordance with SRP 6.5.2, as discussed in Calculation No. JAF-CALC-19-00005 Rev. 0, will be incorporated into the JAFNPP UFSAR.

Response:

The JAFNPP UFSAR will be updated in accordance with 10 CFR 50.71(e) as part of implementation of the approved amendment. A summary of the proposed changes is provided below.

- Sections 1.6.2.12, 4.8.4, 4.8.5, and 4.8.6.2 will be updated to include a discussion of how containment spray aids in removal of airborne fission products.
- Section 4.8.6.2 will be revised to summarize the design characteristics of the containment spray system that impact its ability to provide a reduction in airborne activity. The revision to Section 4.8.6.2 will include a discussion of how the requirements of ANS/ANSI 56.5 are met as it relates to calculation of airborne fission product removal following a LOCA such as geometry, physical features, flow characteristics, and mixing considerations as described in Standard Review Plan Section 6.5.2.

ARCB-RAI-1B:

Please provide additional information providing a justification for the use of the fall height of 31 feet in the determination of the particulate removal coefficient, which apparently does not consider obstructions present in the drywell that would significantly limit the effective fall height.

Response:

Revision 0 of JAF-CALC-19-00005 used a spray removal coefficient of 30.0 hr^{-1} for times when the decontamination factor (DF) ≤ 50. This value was based in part on a spray fall height calculated as the difference between the lower spray header elevation (287' – 6") and the bottom of drywell elevation (256' – 6"). The calculated value of 30.0 hr^{-1} was then reduced to 3 hr^{-1} when a DF of 50 was reached. A reduction in the spray removal coefficient to account for possible obstructions to the spray coverage was not included.

Nine Mile Point Unit 1 and Oyster Creek used a methodology which made specific reductions in the spray removal coefficient calculation based on obstructions in the drywell or blocked nozzles that may impede flow. The spray removal coefficient analysis performed for Nine Mile Point Unit 1 (Reference 1) used an average spray header elevation and the full design flow rate along with a 33.3% reduction in the fall height to account for obstructions in the drywell and a 33.3% reduction in the flow rate to account for potentially blocked nozzles. The 33.3% reduction in fall height to account for obstructions was based on 3D modeling of the drywell performed for Oyster Creek (Reference 2) and the 33.3% reduction in flow rate is based on MAAP analysis performed for Oyster Creek that showed that the design flow rate was lower than the actual flow rate that would be present. Nine Mile Point Unit 1 used the same Oyster Creek assumption because it is expected that the obstructions would be similar for BWR Mark I containments. The

Oyster Creek methodology also considers obstructions due to grating; the corresponding Fitzpatrick drywell gratings are at elevations 290'-4" and 269'-10 ¼". The Fitzpatrick spray design meets the NUREG/CR-5966 requirements as related to considering obstructions in the drywell.

Using the same methodology for Fitzpatrick as in Nine Mile Point Unit 1 and Oyster Creek, the spray removal coefficient is calculated as follows:

F = volume flow rate of the spray pump = 5,600 gal/min

$F = 5{,}600 \text{ gal/min} \times 0.13368 \text{ ft}^3\text{/gal} \times 0.028317 \text{ m}^3\text{/ft}^3 \times 60 \text{ min/hr} = 1271.9 \text{ m}^3\text{/hr}$

V = Drywell net free volume = 1.50E+05 ft^3

$V = 1.50\text{E+05 ft}^3 \times 0.028317 \text{ m}^3\text{/ft}^3 = 4.247\text{E+03 m}^3$

Elevation of Upper DW Spray Header = 311' – 3"

Elevation of Lower DW Spray Header = 287' – 6"

Elevation of Bottom of Drywell Floor = 256' – 6"

Average Fall Height h = ((287' – 6" - 256' – 6")+(311' – 3" - 256' – 6"))/2 = 42.875' × 0.3048 m/ft = 13.07 m

The particulate aerosol spray removal coefficient equation with reductions in the spray flow and fall height by 1/3 each is:

For DF ≤ 50:

$\lambda_p = ((3 \times 13.07 \text{ m} \times 1271.9 \text{ m}^3\text{/hr}) \times (10 \text{ m}^{-1}) / (2 \times 4.247\text{E+03 m}^3)) *0.67*0.67$

$\lambda_p = 26.36 \text{ hr}^{-1}$

For DF > 50, E/D is 1.0 m^{-1} instead of 10 m^{-1}. The removal coefficient is therefore 1/10 of the above value

$\lambda_p = 2.636 \text{ hr}^{-1}$

JAF-CALC-19-00005, Revision 1, gives the revised offsite and onsite doses using the revised RADTRAD spray removal coefficient input of 26.36 hr^{-1} for DF ≤ 50 and 2.636 hr^{-1} thereafter for the remaining duration of spray operation. The results from this calculation are given below. As seen, the doses remain below the regulatory limit.

JAF Post-LOCA EAB, LPZ, & CR Doses - MSIV Leak rate of 270 scfh

Post-LOCA Release Pathway /	Post-LOCA TEDE Dose (Rem) Receptor Location		
	Control Room	**EAB**	**LPZ**
Containment Leakage	1.06	0.51 (occurs @ 3.2 hr)	0.30
ESF Leakage	9.68E-02	9.51E-02 (occurs @ 9.8 hr)	3.49E-02
MSIV Leakage	3.44	0.22 (occurs @ 8.4 hr)	0.27
Containment Shine	9.56E-03	N/A	N/A
External Cloud	0.065	N/A	N/A
CR Filter Shine	Negligible	N/A	N/A
Total Dose	**4.67**	**0.83**	**0.60**
Allowable TEDE Limit	**5**	**25**	**25**

References:

1. H21C092, Rev. 1, Unit 1 LOCA with LOOP, AST Methodology

2. Letter from P. Cowan (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "License Amendment Request No. 315 - Application of Alternative Source Term," dated March 28, 2005 (ML050940234)

ARCB-RAI-1C

Please provide additional information providing a justification for assuming the full spray flow rate of 5,600 gallons per minute in the determination of the particulate removal coefficient, which apparently does not consider obstructions present in the in the drywell that would significantly limit the ability of the spray to remove airborne radioactivity in the drywell atmosphere.

Response:

UFSAR Section 5.2.4.4 gives the total containment spray flow rate as 11,500 gpm corresponding to 2 pumps in operation. UFSAR Table 14.6-1 lists a containment spray flow rate of 7,700 gpm for one pump operation. UFSAR Section 14.6.1.3.3, Primary Containment Response, documents changes made to the containment spray portion of the RHR system in 1984. The September 1984 change to this system resulted in the removal of four nozzle location assemblies which, in turn, resulted in a slight reduction of spray flow. The current LOCA dose calculation uses a design flow rate of 5,600 gpm which is a conservatively low flow rate for one train of RHR in the containment spray mode as compared to the capabilities of the pumps. This flow rate is also above the minimum drywell spray flow necessary for an effective spray pattern as defined in the emergency operating procedures (5240 gpm for RHR Subsystem A and 4420 gpm for RHR Subsystem B). The conservative flow rate of 5600 gpm is reduced by 1/3 to 3752 gpm which accounts for flow obstructions in Revision 1 of calculation JAF-CALC-19-00005. Using 3752 gpm to calculate the spray removal coefficient is conservative as compared to using the flow values referenced in the emergency operating procedures.

ARCB-RAI-2:

Please provide additional information describing how the gravitational settling credited in the main steam lines considers the changing aerosol characteristics (i.e., aerosol size and density distributions) due to the preferential removal of larger aerosols because of the credit assigned to containment sprays.

Response:

The LOCA AST dose analysis assumes the drywell is the source of MSIV leakage in accordance with the NRC Regulatory Position 6.1 of Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants;" therefore, it is appropriate to consider radionuclide removal mechanisms in the drywell before release via the MSIV leakage pathway. A sensitivity analysis was performed to evaluate the impact of sprays on the aerosol settling velocity and to identify other inputs with well-defined uncertainty or conservatism that could be used to offset the uncertainty associated with the current aerosol deposition model. This sensitivity analysis concludes that conservatisms are sufficient to offset the uncertainty introduced by the drywell spray effects on the aerosol deposition model.

In order to address the reduced aerosol removal rates due to drywell spray, sensitivity cases on various conservatisms were evaluated. Some of the inherent conservatisms in the AST LOCA model are listed below. This list is not a complete list of every conservatism that may be present. However, these conservatisms are ones that are reasonable to define and model deterministically:

- Credit full drywell spray lambdas (not included in this study)
- Credit for plateout and deposition in drywell (not included in this study)
- Inclusion of all four main steam lines for holdup and deposition
- More realistic control room operator breathing rate
- Aerosol impaction on the first closed MSIV
- Condenser holdup and deposition

There are other significant conservatisms associated with the AST LOCA model. For example, control room atmospheric dispersion factors have readily defined uncertainty distributions and if incorporated would demonstrate there is a substantial amount of margin in the associated input parameters. For simplicity, the distribution of potential values for such input parameters were not evaluated in the sensitivity study.

Nodalization Changes

The sensitivity analysis modified the nodalization of the main steam line to overcome limitations of the RADTRAD code. The JAF-CALC-19-00005 nodalization was modified to separately model each of the four main steam lines as shown in Figure RAI-2b. As a result, each sensitivity case includes four RADTRAD models, one for each line with three well-mixed nodes per line.

Impact of Spray on Aerosol Settling Velocity

A simplified model was developed using first principles as identified in NUREG/CR-5966, "A Simplified Model of Aerosol Removal by Containment Sprays." Specifically, the ordinary differential equation shown on page 1 of NUREG/CR-5966 was solved to provide an analytical solution of the suspended aerosol mass in the drywell. The spray removal rate in this simplified model is the same as that identified in JAF-CALC-19-00005 Section 2.1.3 and RG 1.183, Appendix A, Section 3.3. Since sprays will remove aerosols at different rates depending on their particle size, the spray removal rate is adjusted by collection efficiency variation as provided in Figure 19 of NUREG/CR-5966. The suspended aerosol mass was solved from the beginning of the accident through the termination of the sprays at 4 hours for 20 distinct particle size groups. The mass of particles in each group is defined by the probability distribution associated with the source distribution.

The size distribution of the particles released from the fuel was assumed to be log-normal with a 2 micron Aerodynamic Mass Median Diameter (AMMD) (0.473 micron geometric mean diameter) and Geometric Standard Deviation (GSD) of 2. The aerosol mass was calculated for each group independently with no consideration of particles interacting with one another; therefore, agglomeration is not accounted for, and this conservatism will artificially and permanently lower the average particle size as large particles are removed and not replaced. The result is a much smaller gravitational settling and spray removal rate. Table RAI-2a summarizes the results of the 20-group particle size distribution in the drywell. Figure RAI-2a visually illustrates the time-dependent nature of the aerosol particle size distribution. As shown in Figure RAI-2a, the effect of the drywell spray in reducing the size of the particles is accounted for in the model.

These particle size and settling velocity distributions were then used to recalculate the aerosol removal rate using the equation provided in Appendix A of AEB-98-03 (ADAMS Accession No. ML011230531), consistent with Section 7.5.1 of JAF-CALC-19-00005. The resulting aerosol removal factors are summarized in Table RAI-2d. The aerosol removal factors including spray combined with the nodalization adjustments described in the previous section are represented by the "Base Sensitivity Case" row in Table RAI-2e.

Breathing Rate Sensitivity

JAF-CALC-19-00005 uses a constant control room operator breathing rate consistent with the value given in RG 1.183. However, a review of breathing rate data in Table 6-17 of EPA/600/R-09/052F, "Exposure Factors Handbook: 2011 Edition" indicates that the RG 1.183 value is conservative. To evaluate the sensitivity of the dose result to the assumed breathing rate, the rate is adjusted. For the first 2 hours, the CLB breathing rate assumption from RG 1.183 was retained for conservatism. However, after 2 hours the breathing rate was reduced using the 95th percentile data for light intensity work typical of control room operator activity from the EPA handbook (3.28E-4 m^3/sec from 2 to 12 hours and 3.06E-4 m^3/sec from 12 hours to 30 days).

Aerosol MSIV Impaction Sensitivity

The Nine Mile Point Unit 1 AST LOCA licensing basis described in H21C092 (ADAMS Accession No. ML070110240) credits the phenomenon of impaction at the first closed MSIV. In this scenario, some of the travelling aerosol particles will be deposited on the MSIV valve sealing surface as the aerosols entrained with the carrier gas pass through the closed MSIV. Nine Mile Point Unit 1 conservatively determined this impaction results in a Decontamination Factor (DF) of 2, which is modeled as a 50% filter in the transfer pathway through the first closed MSIV. This reduction is only accounted for once in each main steam line. This approach was previously approved for Nine Mile Point Unit 1 (ADAMS Accession No. ML081230439) and is reasonable given that the aerosol settling rates calculated in this sensitivity analysis are conservatively low and are even lower than those used in the Nine Mile Point Unit 1 analysis.

Condenser Holdup and Deposition Sensitivity

A further conservatism that is not currently modeled in JAF-CALC-19-00005 is the holdup and aerosol deposition provided by the condenser. Depending on the event scenario, multiple pathways could exist to route activity to the condenser including the drain lines and the turbine itself.

In this sensitivity, the leakage is assumed to travel to the condenser through the drain lines from the main steam line piping between the MSIVs. This conservatively neglects any holdup and deposition in the outboard main steam line piping. Modelling the release to the condenser from the piping between the MSIV is consistent with other plants in the Exelon fleet (e.g. LaSalle and Limerick). Operating experience associated with the North Anna earthquake and post-Fukushima evaluations have shown that components and piping systems typically used in this release path are sufficiently rugged to ensure they are capable of performing some level of radioactivity removal during and following a safe shutdown earthquake (SSE). Thus, it is reasonable to assume that the condenser pathway could be made available for mitigating the consequences of MSIV leakage.

The data used to calculate the steam line and condenser aerosol removal rates are provided in Tables RAI-2b and 2c and are consistent with JAF-CALC-19-00005.

Inboard Holdup Volume on the Ruptured Steam Line

The JAF-CALC-19-00005 analysis credits the inboard main steam line volume as part of the first well-mixed node for the steam line with the MSIV failed open. As shown in Table RAI-2b the base sensitivity case neglects the inboard main steam line volume to accommodate the effect of a steam line rupture. A sensitivity case is included that evaluates the effect of crediting a portion of the inboard pipe volume. In this case, the volume of the inboard main steam line was varied until the dose results were within the regulatory limits.

Individual Sensitivity Cases and Results

A total of eight sensitivity cases were performed by varying the base case. The base case is essentially the JAF-CALC-19-00005 Revision 1 model including the nodalization adjustments and the revised aerosol removal factors described above. As Table RAI-2e indicates, these eight sensitivity cases are various combinations of the four sensitivities described above (breathing rate, MSIV impaction, inboard volume of ruptured steam line, and condenser holdup/deposition). The sensitivity case results are summarized in Table RAI-2e.

As expected, the base case indicates the conservative modelling of the drywell spray impact on the aerosol removal in the main steam lines without adjusting any other inherent conservatisms in the RADTRAD inputs results in increased doses.

The increase in dose is due to the conservative modeling approach taken to incorporate the effects of the drywell sprays. In order to analyze the effect of drywell sprays, simplifications of the aerosol physics were made. As a result, the calculated lambdas are very low compared to values typically seen with high fidelity codes. For example, as discussed briefly before, the Nine Mile Point Unit 1 AST licensing basis calculation (ADAMS Accession No. ML070110240) employed a higher fidelity approach and, in general, calculated higher steam line lambdas. As a result, the overall decontamination factor for aerosols in this sensitivity analysis is conservatively lower than what could typically be afforded by a higher fidelity approach. Given this larger conservatism it is not unusual or unexpected that the calculated doses increased substantially, even over the 10 CFR 50.67 limits. This under estimation of the aerosol settling also justifies the usage of the aerosol impaction, which is consistent with the Nine Mile Point Unit 1 approval.

One case, S8, shows that the control room dose can meet the 5 rem TEDE limit if 50 ft^3 or approximately 17% of the ruptured inboard pipe volume is included in the model for holdup. Given that a pipe break could occur at many locations in the inboard pipe volume, this small amount of volume credited is still conservative and reasonable.

As described above, there are other inherent conservatisms included in the dose consequence assessment, such as those associated with the atmospheric dispersion factors and source term, that are not included in the evaluated sensitivity cases. Taking these additional inherent conservatisms into account would further offset the impact of the revised aerosol removal factors. The availability of these margins provides reasonable assurance that the applicable dose limits would not be exceeded.

The sensitivity results demonstrate that the condenser is very effective at substantially reducing the dose consequences. Even if this capability is limited to a small fraction of the reduction shown in the sensitivity analyses in Table RAI-2e, the condenser credit has the capability to ensure post-LOCA releases remain well within the 10 CFR 50.67 limits

In conclusion, the sensitivity analysis results confirm adequate margin is present in the JAF-CALC-19-00005 calculated dose when using existing AEB-98-03 aerosol deposition with 20 group settling velocity distribution including drywell spray.

Table RAI-2a: Drywell Particle Size Distributions					
Group	D_a (micron)	Settling Velocity (m/s)	Cumulative Probability		
			No Spray	With Spray	
			Release	During Release	After Release
1	0.091	2.33E-07	0.0001	0.00024	0.00028
2	0.106	3.14E-07	0.003	0.00724	0.00832
3	0.326	3.00E-06	0.01	0.02392	0.02727
4	0.409	4.71E-06	0.03	0.07106	0.08035
5	0.552	8.61E-06	0.05	0.11759	0.13218
6	0.642	1.16E-05	0.08	0.18672	0.20851
7	0.750	1.59E-05	0.1	0.23221	0.25820
8	0.850	2.04E-05	0.15	0.34515	0.38079
9	0.984	2.73E-05	0.2	0.45667	0.50052
10	1.140	3.67E-05	0.25	0.56703	0.61794
11	1.268	4.53E-05	0.3	0.67557	0.73177
12	1.410	5.61E-05	0.35	0.78279	0.84298
13	1.552	6.79E-05	0.4	0.88698	0.94839
14	1.683	7.99E-05	0.45	0.95703	0.99737
15	1.840	9.55E-05	0.5	0.97634	1.00000
16	1.997	1.13E-04	0.6	0.98450	1.00000
17	2.371	1.59E-04	0.7	0.98838	1.00000
18	2.897	2.37E-04	0.8	0.99225	1.00000
19	3.600	3.66E-04	0.9	0.99613	1.00000
20	4.859	6.66E-04	1	1.00000	1.00000

Figure RAI-2a

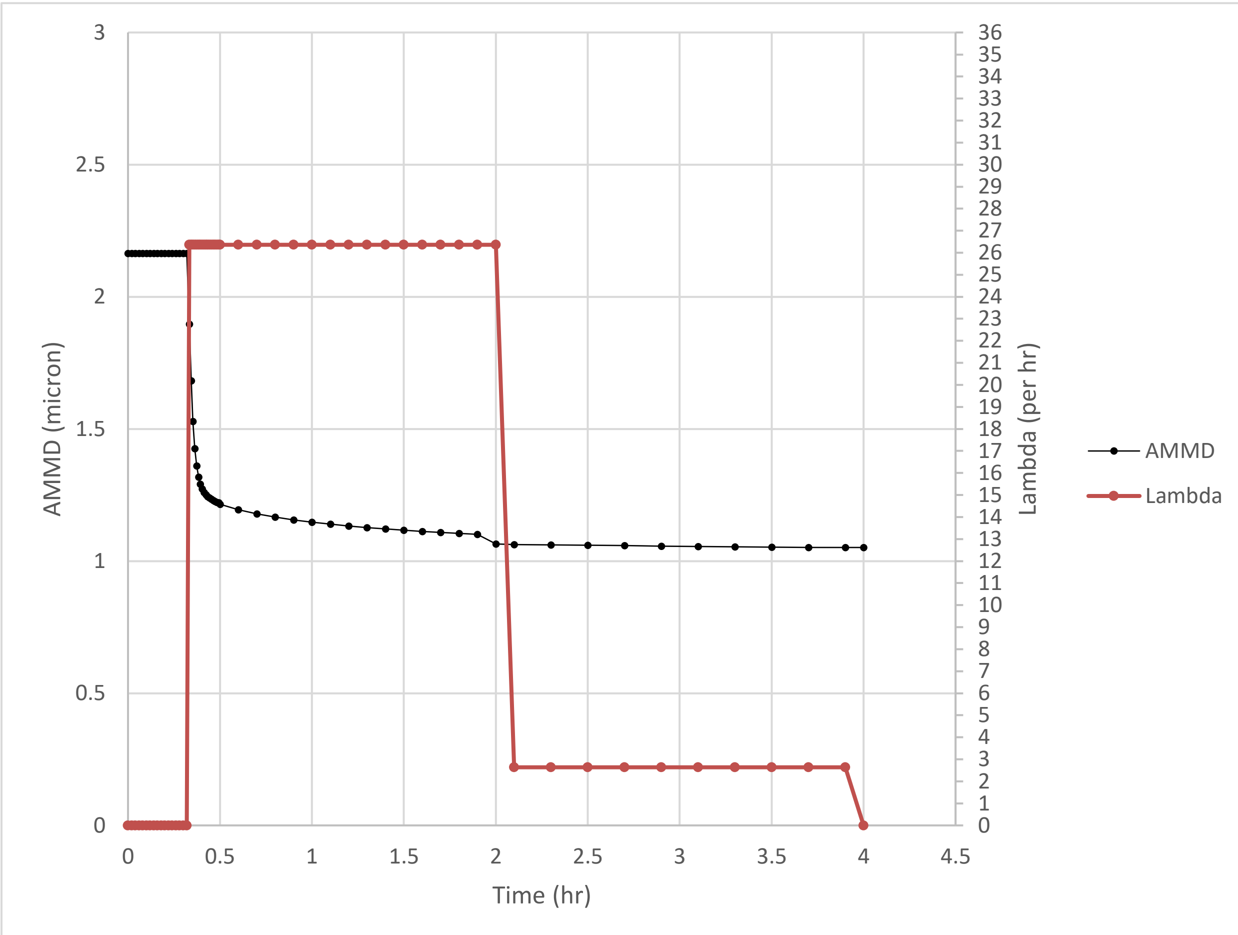
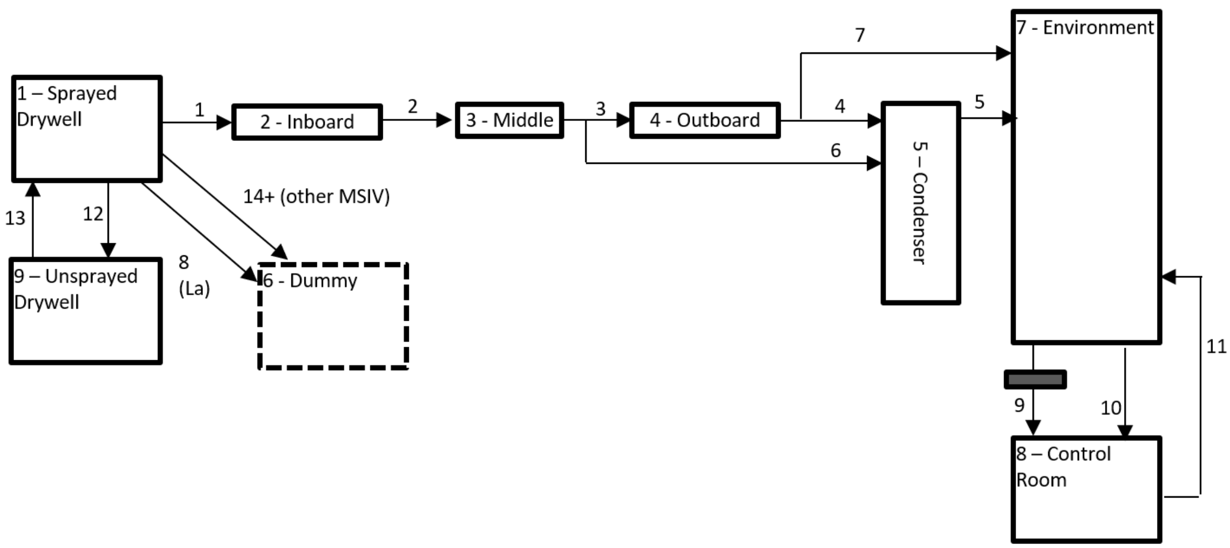


Figure RAI-2b: Modified Nodalization for a Single Steam Line



Note: Unsprayed compartment 9 and pathways 4, 12, and 13 are not used in the sensitivity analysis.

Table RAI-2b: Steam Line and Condenser Geometry Data

Steam Line "A"			
Parameter	Inboard	Between	Outboard
A (ft^2)	n/a	103.50	770.40
V (ft^3)	n/a	45.97	508.00
Steam Line "B"			
Parameter	Inboard	Between	Outboard
A (ft^2)	159.72	91.22	770.40
V (ft^3)	257.77	40.52	508.00
Steam Line "C"			
Parameter	Inboard	Between	Outboard
A (ft^2)	159.72	91.22	770.40
V (ft^3)	257.77	40.52	508.00
Steam Line "D"			
Parameter	Inboard	Between	Outboard
A (ft^2)	243.60	103.50	770.40
V (ft^3)	300.92	45.97	508.00

Parameter	Condenser
A (ft^2)	2715.6
V (ft^3)	59417

Table RAI-2c: Steam Line Leak Rate Data

Inboard Flow Rate Q (cfh)				
	Steam Lines			
Time Period	"A"	"B"	"C"	"D"
0 to spray initiation	n/a	1.65E+01	1.65E+01	1.65E+01
spray initiation to 2 hr	n/a	1.65E+01	1.65E+01	1.65E+01
2 hr to 24 hr	n/a	9.56E+00	9.56E+00	9.56E+00
24 hr+	n/a	4.78E+00	4.78E+00	4.78E+00

Between Flow Rate Q (cfh)				
	Steam Lines			
Time Period	"A"	"B"	"C"	"D"
0 to spray initiation	4.95E+01	1.65E+01	1.65E+01	1.65E+01
spray initiation to 2 hr	4.95E+01	1.65E+01	1.65E+01	1.65E+01
2 hr to 24 hr	2.87E+01	9.56E+00	9.56E+00	9.56E+00
24 hr+	1.43E+01	4.78E+00	4.78E+00	4.78E+00

Outboard Flow Rate Q (cfh)				
	Steam Lines			
Time Period	"A"	"B"	"C"	"D"
0 to spray initiation	1.35E+02	4.50E+01	4.50E+01	4.50E+01
spray initiation to 2 hr	1.35E+02	4.50E+01	4.50E+01	4.50E+01
2 hr to 24 hr	7.82E+01	2.61E+01	2.61E+01	2.61E+01
24 hr+	3.91E+01	1.30E+01	1.30E+01	1.30E+01

Table RAI-2d: Steam Line and Condenser Aerosol Removal Factors

Inboard Aerosol Deposition λ_s (hr^{-1})				
	Steam Lines			
Time Period	"A"	"B"	"C"	"D"
0 to spray initiation	n/a	0.402	0.402	0.485
spray initiation to 2 hr	n/a	0.187	0.187	0.229
2 hr to 24 hr	n/a	0.158	0.158	0.195
24 hr+	n/a	0.144	0.144	0.177

Between Aerosol Deposition λ_s (hr^{-1})				
	Steam Lines			
Time Period	"A"	"B"	"C"	"D"
0 to spray initiation	2.063	0.598	0.598	0.528
spray initiation to 2 hr	0.853	0.443	0.443	0.400
2 hr to 24 hr	0.718	0.342	0.342	0.307
24 hr+	0.650	0.255	0.255	0.224

Outboard Aerosol Deposition λ_s (hr^{-1})				
	Steam Lines			
Time Period	"A"	"B"	"C"	"D"
0 to spray initiation	0.572	0.176	0.176	0.155
spray initiation to 2 hr	0.385	0.161	0.161	0.144
2 hr to 24 hr	0.305	0.109	0.109	0.095
24 hr+	0.237	0.060	0.060	0.049

Table 2d – Continued

Time Period	Condenser λ_s (hr^{-1})
0 to spray initiation	0.0160
spray initiation to 2 hr	0.0102
2 hr to 24 hr	0.00807
24 hr+	0.00629

RAI-2e: Sensitivity Study Results

Case		Condenser Credit	Breathing Rate	MSIV Impaction	Dose (rem TEDE)		
Id	Description				Control Room	EAB	LPZ
N/A	JAF-CALC-19-00005				4.67	0.83	0.60
S0	Base Sensitivity Case				7.35	0.96	0.65
S1	Sensitivity 1		X		6.93	0.97	0.65
S2	Sensitivity 2			X	5.96	0.92	0.63
S7	Sensitivity 7		X	X	5.61	0.93	0.63
S8	Sensitivity 8*		X	X	4.99	0.85	0.59
S3	Sensitivity 3	X			1.35	0.61	0.34
S4	Sensitivity 4	X	X		1.32	0.61	0.34
S5	Sensitivity 5	X		X	1.35	0.61	0.34
S6	Sensitivity 6	X	X	X	1.32	0.61	0.34

*Includes 50 ft^3 modelled in the inboard steam line “A” node

ARCB-RAI-3:

Please provide additional information to justify that assuming a recirculation line rupture instead of a main steam line rupture is consistent with the guidance from RG 1.183 that assumptions should be selected with the objective of maximizing the postulated radiological consequences.

Response:

The main steam line (MSL) model in the AST LOCA analysis conservatively only models MSLs "B" and "C" which are symmetrical and shorter than lines "A" and "D". To address this RAI, all four MSLs were modeled to quantify the impact of assuming a MSL break on offsite and onsite doses. Due to the RADTRAD code limit of the number of control volumes to ten each MSLs "A", "B", and "D" were modelled in separate RADTRAD runs. MSL "C" was not modeled separately because it is a mirror image of MSL "B". It was assumed that MSL "A" has a line break inside containment and a failed inboard MSIV. As a result, there was no credit taken for aerosol iodine deposition or elemental iodine plateout in the line segment from the RPV nozzle to the inboard MSIV for this main steam line. MSL "A" is also assumed to have a flow of 135 scfh and the remaining main stem lines were modeled with equal flows of 45 scfh. The sensitivity evaluation performed to model a MSL break also incorporated the changes in drywell spray removal discussed in the responses to RAI-1B and -1C, above. With these model changes the resulting offsite and onsite doses for the main steam line contributor to the total dose are shown below. These results demonstrate that the current dose consequences based on modeling two steam lines and a recirculation line break are conservative for the most limiting case of post-LOCA TEDE to the control room (CR). The EAB dose for the MSLB case is slightly higher than the base case but the dose is still well within the regulatory limits.

JAF Post-LOCA - Total MSIV Leak rate of 270 scfh

Post-LOCA Release Pathway	Post-LOCA TEDE Dose (Rem) EAB	Post-LOCA TEDE Dose (Rem) LPZ	Post-LOCA TEDE Dose (Rem) CR
MSIV Leakage (Base Case)	**0.22**	**0.27**	**3.44**
MSL Break Sensitivity			
MSIV A (MSLB)	0.273	0.233	2.544
MSIV B Leakage	0.006	0.014	0.272
MSIV C Leakage	0.006	0.014	0.272
MSIV D Leakage	0.005	0.013	0.256
Total	**0.29**	**0.27**	**3.34**

A separate sensitivity was performed based on the same methodology as described above except the MSLB is assumed to be in MSL B rather than MSL A. The EAB and LPZ doses for this case are slightly higher than the base case but the doses are still well within the regulatory limits. The results of this case are as follows:

MSL Break Sensitivity			
MSIV A Leakage	0.005	0.013	0.256
MSIV B (MSLB)	0.283	0.238	2.587
MSIV C Leakage	0.006	0.014	0.272
MSIV D Leakage	0.005	0.013	0.256
Total	**0.30**	**0.28**	**3.37**

ATTACHMENT 2

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3.1 REACTIVITY CONTROL SYSTEMS

3.1.7 Standby Liquid Control (SLC) System

LCO 3.1.7 Two SLC subsystems shall be OPERABLE.

APPLICABILITY: ~~MODES 1 and 2~~. MODES 1, 2, and 3

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One SLC subsystem inoperable.	A.1 Restore SLC subsystem to OPERABLE status.	7 days
B. Two SLC subsystems inoperable.	B.1 Restore one SLC subsystem to OPERABLE status.	8 hours
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 3. AND C.2 Be in MODE 4.	12 hours 36 hours