Attachment to
ULNRC-06754
July 5, 2022

Ameren Missouri Response to NRC RAIs

24 pages

Ameren Missouri Response to NRC RAIs

On September 28, 2021 Union Electric Company, dba Ameren Missouri, submitted a license amendment request (LAR) for Callaway Plant, Unit No. 1 (Callaway) to the U.S. Nuclear Regulatory Commission (NRC). Pursuant to Title 10 of *Code of Federal Regulations* (10 CFR) Section 50.90, "Application for amendment of license, construction permit, or early site permit," and 10 CFR 50.67, "Accident Source Term," the licensee requested, in part, to incorporate the alternative source term (AST) dose analysis methodology into the Callaway licensing basis. As the U.S. Nuclear Regulatory Commission (NRC) staff is continuing to review the application, it recently determined that additional information is required in order to complete the review of the subject LAR. The NRC staff's request for additional information (RAI), consisting of four individual requests, RAI No. 1 (with four parts), RAI No. 2 (with three parts), RAI No. 3, and RAI No. 4 (with three parts), was electronically transmitted on June 2, 2022.

RAI No. 1 (RAI-1):

Regulatory Requirement: The regulation at 10 CFR 50.67(b)(1) states that "[t]he application shall contain an evaluation of the consequences of applicable design-basis accidents previously analyzed in the safety analysis report." In turn, the regulation at 10 CFR 50.67(b)(2) requires that "the applicant's analysis demonstrates with reasonable assurance" that the dose limits at any point on the exclusion area boundary (EAB) and the outer boundary of the low population zone (LPZ), and at the control room, are met. Those dose analyses require, as direct inputs, dispersion parameters, which are based on using appropriate dispersion models that rely, in part, on the input of representative Meteorological data. The analyses above pertain to offsite impacts.

In addition, General Design Criterion 19, "Control room," in Appendix A to 10 CFR Part 50 applies, in part, to the analysis of onsite impacts at the control room and access to it during radiological accident conditions. Further, radiological protection equivalent to that at the control room is called for at the technical support center (TSC) by: NUREG-0696, "Functional Criteria for Emergency Response Facilities, Final Report," dated February 1981 (ML051390358) and by Supplement 1 to NUREG-0737, "Clarification of TMI [Three Mile Island] Action Plan Requirements," Supplement No. 1, dated January 1983 and reprinted February 1989 (ML102560009), Section 8.2.1. Item (f).

Guidance on implementing the overall AST methodology is given in:

- Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," Revision 0, July 2000 (ML003716792).

Guidance on modeling offsite dispersion parameters is given by:

- RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Revision 1 (November 1982), Reissued February 1983 (ML003740205).

- NUREG/CR-2858, "PAVAN – An Atmospheric-Dispersion Program for Evaluating Design-Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations, November 1982 (ML12045A149).

- NUREG/CR-2260, "Technical Basis for Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," October 1981 (ML12045A197).

Guidance on modeling onsite dispersion modeling parameters is given by:

- RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," Revision 0, June 2003 (ML031530505).

- NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes," Revision 1, May 1997 (ML17213A190).

Guidance on meteorological monitoring is given by:

RG 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants," Revision 1, March 2007 (ML070350028).

Background: The Licensee's offsite dispersion modeling analysis was based on the PAVAN-NAI code and used to estimate atmospheric dispersion factors (X/Qs) at the EAB and outer boundary of the LPZ. PAVAN-NAI appears to be essentially the same as the NRC-approved PAVAN dispersion model. PAVAN implements RG 1.145, the associated user's guidance in NUREG/CR-2858, and the technical basis document for the regulatory guide in NUREG-CR-2260. Enclosure 14 to the December 1, 2021, supplemental submittal discusses the differences between PAVAN-NAI and PAVAN. Slight differences between the input to and output of the two codes were determined and had to be accounted for in the NRC staff's initial review.

The Licensee chose to input Met data to PAVAN-NAI in the form of joint frequency distributions (JFDs) of wind speed, wind direction, and atmospheric stability. This is consistent with the NRC's PAVAN model. According to Enclosure 14, the other approach available in PAVAN-NAI is to input hourly Met data in the ARCON96 format, a provision not available in the PAVAN model. The period of record (POR) of onsite Met data covers four years from 2013 to 2016. Enclosure 1 of the December 1, 2021, supplemental submittal indicates that hourly atmospheric stability values were determined consistent with RG 1.23 and that wind speed and direction values were determined by scalar (as opposed to vector) averaging.

The Licensee provided PAVAN-NAI input and output files that correspond to Enclosures 12 and 13, respectively, of the supplemental submittal. These files were in response to Question 21c from a June 14, 2018, pre-application meeting with the Licensee (ML18215A375). This question was reiterated during a second pre-application meeting on March 15, 2021 (ML21103A003).

The model runs evaluated accident releases from a variety of potential sources located close to the containment structure. The runs designated as "RB" and "RWST" model releases from the reactor building and refueling water storage tank, respectively. Distances to the EAB and LPZ are consistent with the distances from the midpoint between the Unit 1 reactor building and the cancelled Unit 2 reactor building to each offsite boundary as given in the UFSAR (i.e., 1,200 meters (m) and 4,023 m, respectively). PAVAN-NAI was configured to account for and to exclude enhanced building wake effects on plume dispersion, as available in the PAVAN model.

From these model runs, only the bounding X/Q values for the EAB and LPZ, as summarized in Table 3-23 (see Enclosure 1 of the supplemental submittal) and that account for building wake effects, appear to be directly input to the offsite dose analyses. Further, for the RB and RWST model runs, the respective 0- to 2-hour X/Qs in Table 3-23 are assigned to all averaging periods for the EAB distance.

Additional PAVAN-NAI input and output files were also provided in Enclosures 12 and 13. These files appear to be source- and distance-specific. Only one receptor distance is evaluated in these model runs, and the same distance is assigned, in a given model run, to all 16 direction sectors. The distances entered for these other runs presumably represent the distances to the EAB from a potential release point other than the RB or RWST and appear to correspond to sources modeled by the Licensee using the ARCON96-NAI code.

Request:

a) An input error was identified in each of the RB, RWST, and additional PAVAN-NAI model runs. Tables 3-8 through 3-14 (see Enclosure 1 of the supplemental submittal) list the frequencies of calm wind conditions for stability classes A thru G in term of hours with wind speeds less than or equal to 0.5 meters per second (m/sec). They are: 0, 0, 0, 15, 85, 136, and 198, respectively. PAVAN-NAI appears to follow the format for Card Type 8 of the PAVAN code. Card Type 8 calls for these input entries to be right-justified every five (5) columns. Upon review, the first three entries for stability classes A, B, and C were determined to be 0, 0, 0, consistent with that format. Likewise, the last two entries for stability classes F and G were determined to be formatted correctly as 136 and 198, respectively.

However, the entry for stability class D (i.e., 15) was determined to be misaligned. The "1" digit was right-justified in the fourth input field but the "5" digit was placed in the first column of the fifth input field, followed by two blank spaces, and then the properly placed entry for stability class E (i.e., 85) right-justified in the fifth input field. The effect of this error was further complicated by what is believed to be differences between the compiler used for PAVAN-NAI and that for the NRC-approved PAVAN code. That is, "read" statements for the former appear to account for all entries within a given field even if the entries are not continuous. The value assigned by PAVAN-NAI to the fifth input field was "585". This was verified by inspecting each of the PAVAN-NAI output files which echoed the input for Card Type 8 as "0, 0, 0, 1, 585, 136, 198". The PAVAN echo in the output and X/Q values were different.

After recognizing and addressing the apparent difference in "read' statements, the NRC staff was able to reproduce the Licensee's X/Q results using the incorrect calm frequencies as input. The effect of this error on the offsite X/Qs was not immediately known because the discrepancies were associated with stability classes D and E. Nevertheless, the increase for stability class E was almost seven-fold. As a result, the influence on the X/Q frequency distribution was investigated because dose calculations could be directly affected. The NRC staff then re-ran the RB, RWST, and additional offsite model runs using the calm frequencies from Tables 3-8 thru 3-14 as input (i.e., 0, 0, 0, 15, 85, 136,198). The corrected results show that the offsite X/Qs at the EAB and LPZ in the LAR submittal are slight overestimates by about 3.5 percent or less depending on the release scenario, the receptor, and averaging time.

Therefore, the Licensee should either: (a) decide to let the PAVAN-NAI modeling results and related dose calculations stand unchanged from the September 28, 2021, LAR submittal, but formally acknowledge this error since the PAVAN-NAI input and output files were provided on the docket as supplemental information pursuant to the LAR's acceptance, or (b) revise the PAVAN-NAI offsite dispersion modeling, and any affected dose calculations, related text, tables, and figures.

b) Correct the labeling in Tables 3-9 through 3-14 of Enclosure 1 to the December 1, 2021, supplemental submittal. In the upper left-hand portion of these table bodies, the labels incorrectly read "Atmospheric Stability: Class A" for all seven stability classes (A to G). This discrepancy only affects the labeling, not the individual table contents or the table titles. The labels should be corrected to match stability classes B through G in the corresponding tables.

c) Clearly explain the purpose and use of the PAVAN-NAI model input and output files (i.e., other than for the RB and RWST model runs) provided in Enclosures 12 and 13, respectively, of the supplemental submittal. This includes verifying: (a) what the distances entered in the input files are relative to (e.g., the EAB), (b) what potential source each run corresponds to, and (c) their relationship, if any, to the model runs using ARCON96-NAI.

d) To avoid confusion, and if the PAVAN-NAI modeling analysis is re-run based on RAI-1a, the NRC staff recommends that the second entry for Card Type 3 of the model input be changed from "Delta-T from 10-60m" to read "Delta-T from 60-10m". This would be consistent with how the vertical temperature difference (Delta T) is calculated for determining the hourly stability class. The NRC staff verified, in this case, that the hourly Delta-T values reported in Enclosure 7 of the supplemental submittal and as used in the offsite and onsite dispersion modeling analyses, was determined correctly (i.e., based on the difference between the temperatures at the upper (60 m) minus the lower (10 m) measurement heights).

Ameren Response:

a) RAI-1a correctly identified an input format error in the alignment of the stability class D entry on Card Type 8 of the Reactor Building (RB) and Refueling Water Storage Tank (RWST) PAVAN-NAI models of Enclosure 12. The misalignment of the stability class D entry in the fourth input field resulted in a defined number of 1 calm hour for stability class D and 585 calm hours for stability class E rather than the intended values of 15 and 85, respectively. Underprediction of the stability class D calm hours and overprediction of the stability class E calm hours was confirmed to have produced a set of conservatively high atmospheric dispersion factors (X/Qs). The extent of this X/Q conservatism ranges from 0.3% to as much as 8.3% larger than would have been calculated with the intended values. As this error conservatively overpredicts the X/Q values and subsequently increases the doses at the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ), the PAVAN-NAI models and Alternate Source Term (AST) dose analyses supporting the License Amendment Request (LAR) will not be revised at this time.

b) The typographical error in the stability class labeling of Tables 3-9 through 3-14 of Enclosure 1 has been corrected to reflect the appropriate stability class in the first cell of each table. The updated tables are provided below (as pages 6 through 11 of this enclosure)

Table 3-9 Joint Frequency Distribution (in number of total hours) for Stability Class B

Atmospheric Stability: Class B
Period of Record: January 1, 2013 to December 31, 2016
(based on lower wind speed instrument)

Maximum Wind Speed (m/s)	Wind Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0.22																	0
0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.25	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
1.50	2	1	1	0	0	0	0	1	0	0	0	1	0	0	0	0	6
2.00	2	1	2	2	1	1	2	4	4	2	1	1	1	0	1	0	25
3.00	10	13	16	11	4	13	36	49	46	26	26	18	19	16	17	10	330
4.00	21	15	21	16	9	11	39	51	32	51	45	18	25	37	42	47	480
5.00	17	7	5	10	8	7	14	24	28	44	26	17	25	22	32	39	325
6.00	15	8	2	2	0	2	2	12	37	22	16	3	9	15	9	11	165
8.00	1	4	0	1	1	0	1	8	13	11	10	6	5	5	5	13	84
10.00	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	6
26.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	68	49	47	42	23	35	94	149	165	156	125	64	84	95	106	120	1422

Table 3-10 Joint Frequency Distribution (in number of total hours) for Stability Class C

Atmospheric Stability: Class C
Period of Record: January 1, 2013 to December 31, 2016
(based on lower wind speed instrument)

Maximum Wind Speed (m/s)	Wind Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0.22																	0
0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.75	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
1.00	1	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	5
1.25	0	1	0	0	0	0	0	1	1	0	2	0	0	0	0	0	5
1.50	0	2	0	1	1	1	5	3	6	1	2	1	2	0	3	1	29
2.00	6	4	9	7	8	5	7	26	12	16	11	9	15	19	9	2	165
3.00	30	30	35	29	23	26	99	96	76	76	42	29	39	46	36	36	748
4.00	25	37	17	23	16	21	66	75	71	57	45	26	34	41	46	41	641
5.00	34	16	8	11	7	17	19	28	34	52	32	13	17	20	19	40	367
6.00	17	11	2	2	2	6	3	12	32	26	14	10	12	18	16	26	209
8.00	5	0	0	1	1	0	0	9	29	12	3	5	5	10	11	6	97
10.00	0	0	0	0	0	0	0	1	2	5	0	0	0	0	0	0	8
26.00	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Total	118	101	72	74	58	76	199	251	264	245	152	94	126	154	140	152	2276

Table 3-11 Joint Frequency Distribution (in number of total hours) for Stability Class D

Atmospheric Stability: Class D
Period of Record: January 1, 2013 to December 31, 2016
(based on lower wind speed instrument)

Maximum Wind Speed (m/s)	Wind Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0.22																	4
0.50	0	1	0	0	1	2	1	0	2	0	0	0	0	3	0	1	11
0.75	3	4	4	5	2	3	1	0	3	2	3	3	2	7	3	3	48
1.00	19	6	8	13	8	8	20	11	15	11	11	15	12	8	15	4	184
1.25	11	9	18	6	7	12	20	13	7	8	12	8	7	12	13	8	171
1.50	26	33	36	42	43	50	68	40	41	23	32	20	34	40	40	29	597
2.00	73	87	61	81	70	105	170	146	86	60	72	48	104	108	92	81	1444
3.00	203	212	208	213	209	282	471	344	220	163	171	118	172	255	285	277	3803
4.00	291	201	155	135	139	175	254	249	220	196	159	86	128	234	236	338	3196
5.00	283	138	74	49	60	94	73	139	187	137	106	63	123	174	195	203	2098
6.00	156	55	24	17	19	16	11	62	133	73	59	33	88	106	116	127	1095
8.00	66	20	22	9	4	4	1	31	183	48	35	29	71	61	49	79	712
10.00	5	0	7	0	0	0	0	0	16	4	3	4	7	1	1	9	57
26.00	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	1	5
Total	1136	766	617	570	562	751	1090	1035	1113	725	664	429	749	1009	1045	1160	13421

Table 3-12 Joint Frequency Distribution (in number of total hours) for Stability Class E

Atmospheric Stability: Class E
Period of Record: January 1, 2013 to December 31, 2016
(based on lower wind speed instrument)

Maximum Wind Speed (m/s)	Wind Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0.22																	26
0.50	3	3	3	2	9	4	10	4	2	3	0	2	4	5	2	3	59
0.75	6	2	8	6	9	8	10	6	8	9	6	7	8	12	12	7	124
1.00	23	22	17	20	25	22	39	33	22	18	22	17	26	36	31	13	386
1.25	12	15	16	15	12	18	43	18	19	11	17	26	17	37	33	21	330
1.50	28	45	40	41	39	59	149	53	33	22	35	42	41	61	48	42	778
2.00	92	68	80	81	94	127	327	180	77	57	70	79	61	94	125	87	1699
3.00	158	125	118	93	132	167	464	632	308	215	186	132	182	168	182	208	3470
4.00	72	34	24	27	47	65	136	330	411	229	151	85	151	71	68	94	1995
5.00	11	6	7	3	8	14	26	133	247	103	47	32	52	33	19	22	763
6.00	1	1	3	0	0	7	5	52	143	47	12	4	19	9	9	7	319
8.00	1	0	3	0	0	0	2	23	65	16	3	5	4	0	1	1	124
10.00	0	0	0	0	0	0	0	2	1	0	0	2	1	0	1	1	8
26.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	407	321	319	288	375	491	1211	1466	1336	730	549	433	566	526	531	506	10055

Table 3-13 Joint Frequency Distribution (in number of total hours) for Stability Class F

Atmospheric Stability: Class F
Period of Record: January 1, 2013 to December 31, 2016
(based on lower wind speed instrument)

Maximum Wind Speed (m/s)	Wind Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0.22																	40
0.50	10	4	3	6	9	12	12	7	5	2	3	3	7	3	6	4	96
0.75	7	6	9	13	10	16	23	16	15	7	7	4	14	7	6	9	169
1.00	22	27	31	23	29	37	68	37	22	12	17	22	26	38	26	29	466
1.25	24	17	22	22	24	24	72	35	14	13	16	18	13	23	22	4	363
1.50	24	31	48	48	39	53	140	89	34	39	28	28	19	61	66	21	768
2.00	58	39	37	40	28	46	147	229	93	66	74	30	34	65	86	49	1121
3.00	33	25	19	18	12	15	93	550	236	118	121	38	35	44	38	81	1476
4.00	2	1	0	0	1	0	1	96	123	63	28	6	6	0	0	5	332
5.00	0	0	0	0	0	0	2	2	15	6	0	2	1	0	0	0	28
6.00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
8.00	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
10.00	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
26.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	180	150	169	170	152	203	558	1063	558	326	294	151	155	241	250	202	4822

Table 3-14 Joint Frequency Distribution (in number of total hours) for Stability Class G

Atmospheric Stability: Class G
Period of Record: January 1, 2013 to December 31, 2016
(based on lower wind speed instrument)

Maximum Wind Speed (m/s)	Wind Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0.22																	66
0.50	7	16	12	6	8	5	15	14	13	4	4	2	8	6	5	7	132
0.75	11	15	9	11	10	13	20	18	19	10	7	9	6	5	4	10	177
1.00	34	32	31	18	16	15	41	60	29	10	18	12	11	23	29	15	394
1.25	14	19	15	9	5	7	12	37	15	7	6	6	5	19	22	12	210
1.50	25	25	34	9	7	8	27	60	26	20	11	9	7	24	29	30	351
2.00	26	23	15	6	2	2	19	79	37	17	13	4	6	14	27	29	319
3.00	5	3	1	0	0	0	6	117	32	13	7	1	2	3	18	10	218
4.00	0	0	0	0	1	0	0	28	9	2	2	0	0	0	0	0	42
5.00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.00	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
10.00	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
26.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	122	133	117	59	49	50	140	415	181	83	68	43	45	94	134	113	1846

c) The PAVAN-NAI input and output files of Enclosures 12 and 13 were used only for the purpose of calculating the atmospheric dispersion factors (X/Qs) for the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) for releases from the Reactor Building (RB) and Refueling Water Storage Tank (RWST).

The PAVAN-NAI input files intended to be submitted in Enclosure 12 are as follows:

- clwAST_PAVAN_RB.inp
- clwAST_PAVAN_RWST.inp

Likewise, the PAVAN-NAI output files intended to be submitted in Enclosure 13 are as follows:

- clwAST_PAVAN_RB.out
- clwAST_PAVAN_RWST.out

Any other PAVAN-NAI files were not intended to be transmitted and as such should not be considered as a part of the License Amendment Request or the December 1, 2021 supplemental submittal.

d) Callaway acknowledges the NRC staff recommendation to update the second entry of Card Type 3 of the PAVAN-NAI model input to be consistent with the implemented calculation of vertical temperature difference between the upper and lower measurement heights. Due to formal acknowledgement of the input read error identified in RAI-1a, the PAVAN-NAI input files were not revised at this time.

<u>RAI No. 2 (RAI-2):</u>

Regulatory Requirement: see Regulatory Requirements for RAI No. 1

Background: The Licensee's onsite dispersion modeling analysis was based on the ARCON96-NAI code. This model was used to estimate X/Qs at the normal and emergency air intakes of the control building, at various points along the path of ingress and egress to the control building, and at the air intake to the TSC. As with PAVAN-NAI, ARCON96-NAI appears to be essentially the same as the NRC-approved ARCON96 dispersion model. ARCON96 implements RG 1.194 and the associated user's guidance in NUREG/CR-6331. Enclosure 14 to the December 1, 2021, supplemental submittal discusses the differences between ARCON96-NAI and ARCON96. Only slight differences between the input to and output of the two codes were observed during the NRC staff's initial review. The staff notes that model appears to have been run at different times during 2017 with the input / output files differing slightly after about July of that year although the same version number of the code (i.e., 1.1) is designated for all runs.

According to Enclosure 14, Met data were input to ARCON96-NAI in the prescribed ARCON96 format. The 2013 to 2016 POR of onsite Met data is the same as that used for the PAVAN-NAI modeling analysis. However, the staff notes that the wind speed units of measure as input to ARCON96-NAI is in miles per hour (mph) whereas the hourly data reported in Enclosure 7 to the supplemental submittal is in units of m/sec consistent with Appendix A of RG 1.23.

The Licensee provided ARCON96-NAI input and output files in Enclosures 9, 10, and 11 of the supplemental submittal in response to Question 22c from the previously referenced June 14, 2018, and March 15, 2021, pre-application meetings with the Licensee. These enclosures included 78 model runs (one input and two output files per run) to evaluate potential accident releases from sources generally designated by Items 3 through 14 and Item 16 as shown on Figure 3.1 of Enclosure 1 to the December 1, 2021, supplemental submittal. Modeled receptor locations were also generally identified on Figure 3.1 as Item 1 (consisting of emergency air intakes A and B and the midpoint between those two intakes), Item 2 (the normal air intake for the control room), and Item 15 (the air intake for the TSC).

In response to Question 19 from the previously referenced June 14, 2018, and March 15, 2021, pre-application meetings with the Licensee, Table 3-25 of Enclosure 1 lists, in part, various characteristics of the release/receptor pairs input to the ARCON96-NAI model runs. These inputs identify the respective release and receptor points, the horizontal distance between these points, the release and intake heights (in meters) above plant grade, and the direction looking at a given source from a given receptor in degrees relative to True North.

Enclosures 9, 10, and 11 also included 32 ARCON96-NAI model runs (again, one input and two output files per run) to evaluate various accident release scenarios from the reactor building vent and the RWST vent as potential sources. The control room operator access path was sketched on Figure 3.2 of Enclosure 1. Receptor locations are presumably at the turning points along this sketched path.

Figure 3.1 of Enclosure 1 indicates the offset between Plant North and True North (i.e., the former is oriented about 133.56 degrees counterclockwise of the latter). Neither Figure 3.1 nor Figure 3.2 of Enclosure 1 indicates a distance scale as called for by Question 17a from the previously referenced pre-application meetings with the Licensee.

Request:

a) The NRC staff tried to verify many of the distances between the numerous potential source and receptor pairs as well as the receptor-to-source directions of these pairs relative to True North using Table 3-25 and Figure 3.1 of Enclosure 1 to the supplementary submittal and other readily available information. In doing so, the staff exercised reasonable flexibility, given this information, by considering distances to be verified if they were within about ± 5 meters and about ± 5 degrees relative to True North of the values listed in Table 3-25.

The items listed in Figure 3.1 use phrases such as “nearest point to receptor”, “closest [source name]”, and “closest [source name] nearest point to receptor”. However, when evaluating a number of the same sources but impacting a different receptor, the distance and/or receptor-to-source direction would only meet the above acceptance criteria if the source and/or receptor were located in different positions (e.g., at some point on the item label itself, at the tip of the arrow associated with an item label, at some point on the edge of the building housing a potential source or receptor, or at some point within the perimeter of the building itself).

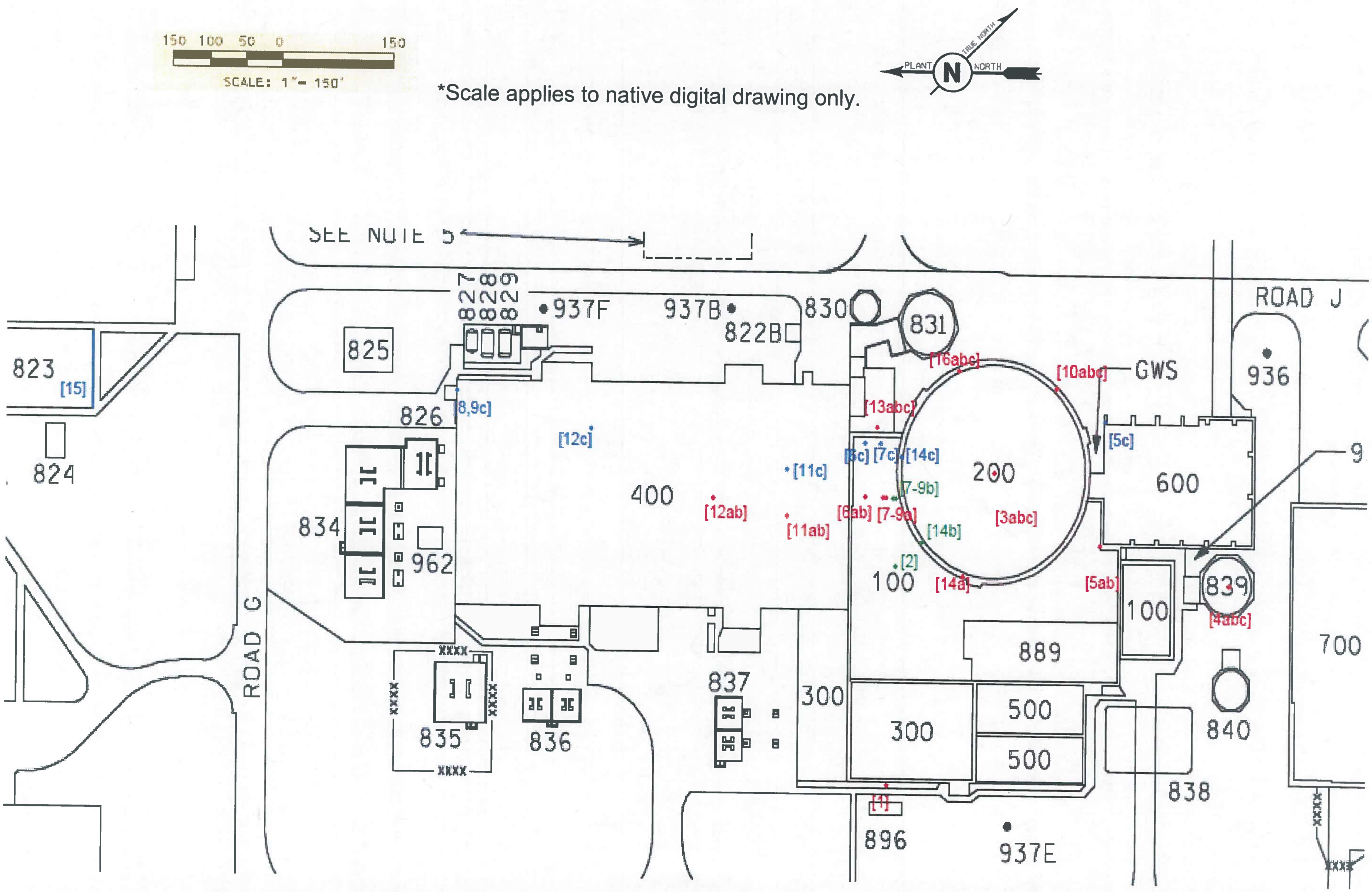
As a result, this portion of the ARCON96-NAI dispersion modeling review was not completed. Because these characteristics are direct inputs to the run files, Figure 3.1 in Enclosure 1 of the supplemental submittal should be clarified: (a) to include a distance scale, and (b) show specific source and receptor locations that correspond to the various model runs. Due to the number of model-runs, more than one figure may be necessary to clearly illustrate all of these relationships. Any other figures, tables, and text affected by these clarifications should be revised as well.

b) Figure 3.2 in Enclosure 1 of the supplemental submittal should be: (a) clarified to include a distance scale, (b) ensure that its orientation, as reproduced in that submittal, is relative to Plant North, (c) identify the potential release points for the reactor building vent and RWST vent, and (d) indicate the receptor locations evaluated in the corresponding model runs (e.g., presumably at the turning points along the sketched path in Figure 3.2). As above, any other figures, tables, and text affected by these clarifications should be revised as well.

c) Clearly explain the purpose and use of the thirteen (13) ARCON96-NAI model runs provided in Enclosures 9, 10, and 11 of the supplemental submittal with receptor distances ranging between 1322.7 m and 1471.7 m. This includes verifying: (a) what the distances entered in the input files are relative to (e.g., the EAB), (b) what directions relative to True North the respective distances correspond to understanding that the distances selected may not necessarily be associated with the directions having the most restrictive dispersion conditions (i.e., the highest X/Qs), (c) what potential source each run corresponds to (only a few appear to be missing), and (d) their relationship, if any, to the offsite model runs using PAVAN-NAI.

Ameren Response:

a) Excerpts of the plant area layout with the attached digital markup, drawing 8600-X-88100 are included below and the measured distances and angles between release and receptor locations. The drawing scale, highlighted in yellow, was used to determine all distances associated with the release/receptor pairings of the PAVAN and ARCON model runs. The release and receptor locations are indicated with color-coded alphanumeric values. Release points are given a strictly numerical value, while receptor locations are assigned one or more letters between ‘a’ and ‘c’ indicating the associated release point(s). Red alphanumeric values are applicable to the emergency Control Room intake receptor at minimum. Green alphanumeric values are applicable to the normal Control Room intake receptor only. Blue alphanumeric values are applicable to the Technical Support Center (TSC) receptor only.



*Scale applies to native digital drawing only.

Red: applicable to emergency control room intake receptor, noted with a (or multiple receptors)

Green: applicable to normal control room intake receptor only, noted with b

Blue: applicable to technical support center receptor only, noted with c

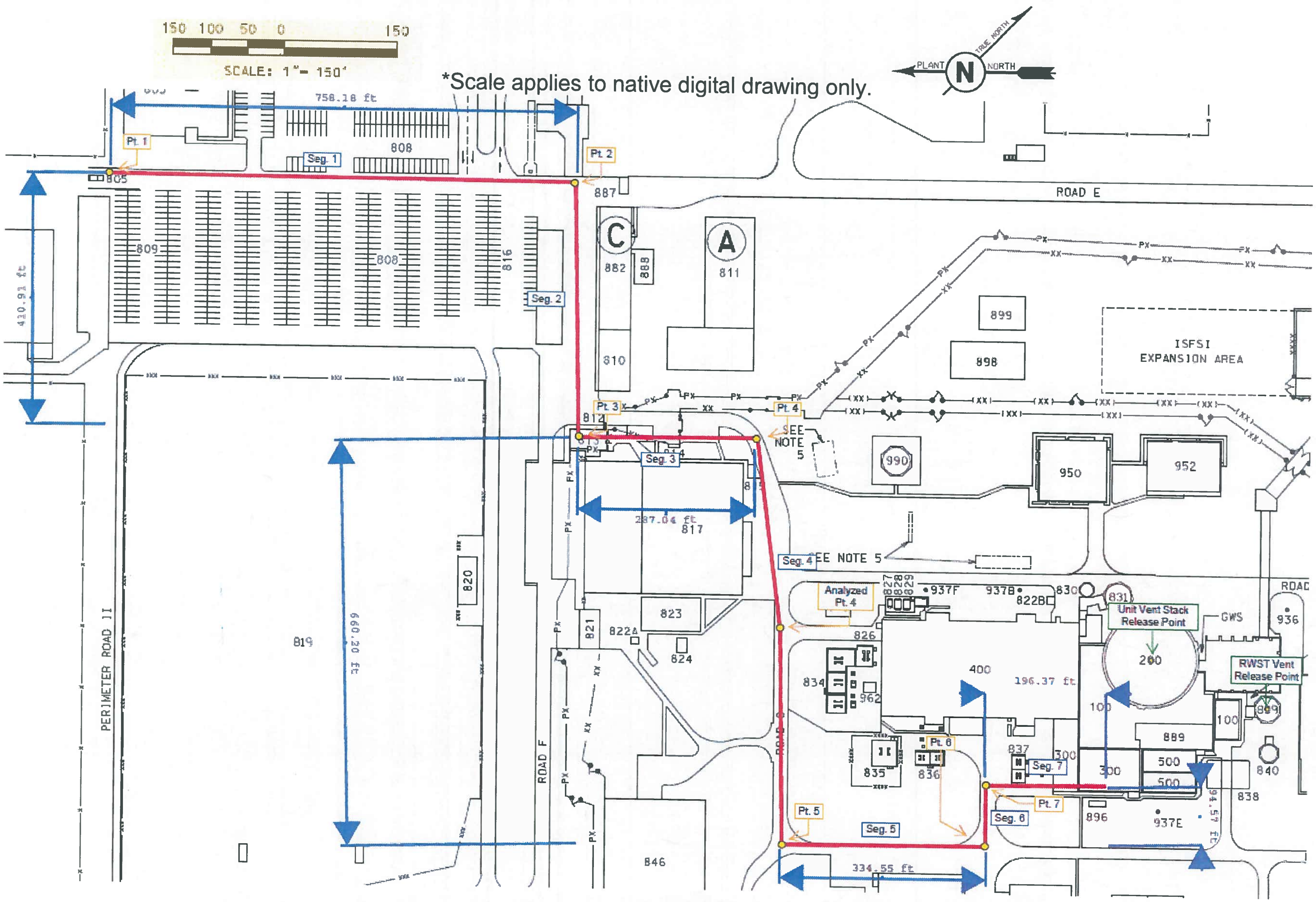
[1] Emergency control room intake
[2] Normal control room intake
[3] Unit vent stack
[4] RWST vent
[5] Fuel handling building (nearest point to receptor)
[6] Closest ADV
[7] Closest MSSV
[8] Closest Main Steam Line (nearest point to receptor)
[9] Closest Feedwater Line (nearest point to receptor)
[10] Containment Maintenance Hatch
[11] Steam Jet Air Ejector (nearest point to receptor)
[12] Condenser (nearest point to receptor)
[13] Turbine Driven AFW Exhaust Vents
[14] Reactor Building Wall (nearest point to receptor)
[15] Technical Support Center
[16] Emergency Personnel Access Hatch

Release Point	Distance to [1], ft	Distance to [2], ft	Distance to [15], ft
[3] Unit Stack Vent	233.23	104.56	731.59
[4] RWST Vent	309.47	271.24	927.12
[5] FHB (nearest point)	242.78	171.30	820.71
[6] Closest ADV Vent	199.18	52.24	627.71
[7] Closest MSSV Vent	198.50	47.50	640.29
[8] Closest point of the Main Steam Line	198.50	47.50	296.96
[9] Closest point of the Feedwater Line	198.50	47.50	296.96
[10] Containment Maintenance Hatch	305.02	177.43	776.28
[11] Steam Jet Air Ejector	204.71	94.71	563.03
[12] Nearest Point of the Condenser	241.78	153.15	404.60
[13] Turbine Driven AFW Exhaust Vents	247.98	97.81	635.46
[14] Nearest Point of Reactor Building Wall	156.13	30.54	657.57
[16] Emergency Personnel Access Hatch	290.45	143.61	702.52

b) Excerpts of the plant area layout, drawing 8600-X-88100 are included below. The drawing scale, highlighted in yellow, and compass were used to determine all distances and angles associated with the release/receptor pairings of the ARCON96 model runs. The path taken by the operator during CR ingress/egress is depicted with a red line from the parking lot to the Control Building. Turning points in the operator's path (labeled with yellow boxes) were used to divide the trip into seven segments (labeled with blue boxes). The length of each segment was scaled from the drawing. The determined measurement of each segment is indicated with two straight blue lines, a set of blue arrows to indicate the direction of the measurement and the length in black text. The measured length of each segment was conservatively rounded up to the next nearest foot. In general, these distances closely matched the result from the root-mean-square of the plant N-S and plant E-W distances; however, to ensure conservatism, the horizontal distance was reduced by 5% for use in ARCON96. The location of analyzed Point 4 is actually at the closest point to containment along Segment 4 for conservatism, as indicated. This point is referred to as Access Point 4 in the License Amendment Request for simplicity.

Segment 1 of the defined path was excluded from the transit dose calculation as operators are expected to park as close to the site entry near Point 3 as possible; however, the segment was included for informational purposes. Segment 2 was retained in full length as a conservative adder to the access dose over and above the projected path operators are expected to take.

The release locations are indicated by green text boxes at the Unit Vent Stack and RWST Vent. A designated release location of the plant stack is applied for the expected diffuse containment leakage with respect to operators in transit at ground level. This release location is conservative as it predicts a higher concentration of radioactive isotopes along the operator path than a diffuse containment leakage model.


150 100 50 0 150
SCALE: 1" = 150'
*Scale applies to native digital drawing only.
PLANT
NORTH
TRUE NORTH
N
758.18 ft
430.93 ft
660.20 ft
287.04 ft
196.37 ft
334.55 ft
94.57 ft
Pt. 1
Pt. 2
Pt. 3
Pt. 4
Pt. 5
Pt. 6
Pt. 7
Seg. 1
Seg. 2
Seg. 3
Seg. 4
Seg. 5
Seg. 6
Seg. 7
Analyzed Pt. 4
Unit Vent Stack Release Point
RWST Vent Release Point
ROAD E
ROAD F
PERIMETER ROAD II
ISFSI EXPANSION AREA
SEE NOTE 5
GWS
805
808
809
816
887
882
888
811
810
812
817
820
819
821
822A
823
824
846
899
898
990
950
952
826
834
835
836
837
400
962
937F
937B
822B
830
831
200
100
300
500
889
936
840
838
896
937E

c) The ARCON96 files intended to be submitted in Enclosures 9, 10, and 11 of the supplemental submitted are as follows.

Input Files (Enclosure 9)	Output Logs (Enclosure 10)	Output CFDs (Enclosure 11)
clwA96_01.RSF	clwA96_01.log	clwA96_01.CFD
clwA96_02.RSF	clwA96_02.log	clwA96_02.CFD
clwA96_03.RSF	clwA96_03.log	clwA96_03.CFD
clwA96_04.RSF	clwA96_04.log	clwA96_04.CFD
clwA96_05.RSF	clwA96_05.log	clwA96_05.CFD
clwA96_06.RSF	clwA96_06.log	clwA96_06.CFD
clwA96_07.RSF	clwA96_07.log	clwA96_07.CFD
clwA96_08.RSF	clwA96_08.log	clwA96_08.CFD
clwA96_09.RSF	clwA96_09.log	clwA96_09.CFD
clwA96_10.RSF	clwA96_10.log	clwA96_10.CFD
clwA96_11.RSF	clwA96_11.log	clwA96_11.CFD
clwA96_12.RSF	clwA96_12.log	clwA96_12.CFD
clwA96_13.RSF	clwA96_13.log	clwA96_13.CFD
clwA96_14.RSF	clwA96_14.log	clwA96_14.CFD
clwA96_15.RSF	clwA96_15.log	clwA96_15.CFD
clwA96_16.RSF	clwA96_16.log	clwA96_16.CFD
clwA96_17.RSF	clwA96_17.log	clwA96_17.CFD
clwA96_18.RSF	clwA96_18.log	clwA96_18.CFD
clwA96_19.RSF	clwA96_19.log	clwA96_19.CFD
clwA96_20.RSF	clwA96_20.log	clwA96_20.CFD
clwA96_21.RSF	clwA96_21.log	clwA96_21.CFD
clwA96_22.RSF	clwA96_22.log	clwA96_22.CFD
clwA96_23.RSF	clwA96_23.log	clwA96_23.CFD
clwA96_24.RSF	clwA96_24.log	clwA96_24.CFD
clwA96_25.RSF	clwA96_25.log	clwA96_25.CFD
clwA96_26.RSF	clwA96_26.log	clwA96_26.CFD
clwA96_27.RSF	clwA96_27.log	clwA96_27.CFD
clwA96_28.RSF	clwA96_28.log	clwA96_28.CFD
clwA96_29.RSF	clwA96_29.log	clwA96_29.CFD
clwA96_30.RSF	clwA96_30.log	clwA96_30.CFD
clwA96_31.RSF	clwA96_31.log	clwA96_31.CFD
clwA96_32.RSF	clwA96_32.log	clwA96_32.CFD
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clwA96_37.RSF	clwA96_37.log	clwA96_37.CFD
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clwA96_40.RSF	clwA96_40.log	clwA96_40.CFD
clwA96_42.RSF	clwA96_42.log	clwA96_42.CFD
clwA96_44.RSF	clwA96_44.log	clwA96_44.CFD
clwA96_45.RSF	clwA96_45.log	clwA96_45.CFD
clwA96_47.RSF	clwA96_47.log	clwA96_47.CFD

Input Files (Enclosure 9)	Output Logs (Enclosure 10)	Output CFDs (Enclosure 11)
clwA96_48.RSF	clwA96_48.log	clwA96_48.CFD
clwA96_50.RSF	clwA96_50.log	clwA96_50.CFD
clwA96_51.RSF	clwA96_51.log	clwA96_51.CFD
clwA96_53.RSF	clwA96_53.log	clwA96_53.CFD
clwA96_54.RSF	clwA96_54.log	clwA96_54.CFD
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clwA96_59.RSF	clwA96_59.log	clwA96_59.CFD
clwA96_60.RSF	clwA96_60.log	clwA96_60.CFD
clwA96_62.RSF	clwA96_62.log	clwA96_62.CFD
clwA96_63.RSF	clwA96_63.log	clwA96_63.CFD
clwA96_65.RSF	clwA96_65.log	clwA96_65.CFD
clwA96_66.RSF	clwA96_66.log	clwA96_66.CFD
clwA96_67.RSF	clwA96_67.log	clwA96_67.CFD
clwA96_68.RSF	clwA96_68.log	clwA96_68.CFD
clwA96_69.RSF	clwA96_69.log	clwA96_69.CFD
clwA96_71.RSF	clwA96_71.log	clwA96_71.CFD
clwA96_73.RSF	clwA96_73.log	clwA96_73.CFD
clwA96_74.RSF	clwA96_74.log	clwA96_74.CFD
clwA96_75.RSF	clwA96_75.log	clwA96_75.CFD
clwA96_76.RSF	clwA96_76.log	clwA96_76.CFD
clwA96_77.RSF	clwA96_77.log	clwA96_77.CFD
rwst_mp1.RSF	rwst_mp1.log	rwst_mp1.CFD
rwst_mp2.RSF	rwst_mp2.log	rwst_mp2.CFD
rwst_mp3.RSF	rwst_mp3.log	rwst_mp3.CFD
rwst_mp4.RSF	rwst_mp4.log	rwst_mp4.CFD
rwst_mp4p5.RSF	rwst_mp4p5.log	rwst_mp4p5.CFD
rwst_mp5.RSF	rwst_mp5.log	rwst_mp5.CFD
rwst_mp6.RSF	rwst_mp6.log	rwst_mp6.CFD
rwst_mp7.RSF	rwst_mp7.log	rwst_mp7.CFD
vent_mp1.RSF	vent_mp1.log	vent_mp1.CFD
vent_mp1_0height.RSF	vent_mp1_0height.log	vent_mp1_0height.CFD
vent_mp2.RSF	vent_mp2.log	vent_mp2.CFD
vent_mp2_0height.RSF	vent_mp2_0height.log	vent_mp2_0height.CFD
vent_mp3.RSF	vent_mp3.log	vent_mp3.CFD
vent_mp3_0height.RSF	vent_mp3_0height.log	vent_mp3_0height.CFD
vent_mp4.RSF	vent_mp4.log	vent_mp4.CFD
vent_mp4_0height.RSF	vent_mp4_0height.log	vent_mp4_0height.CFD
vent_mp4p5.RSF	vent_mp4p5.log	vent_mp4p5.CFD
vent_mp4p5_0height.RSF	vent_mp4p5_0height.log	vent_mp4p5_0height.CFD
vent_mp5.RSF	vent_mp5.log	vent_mp5.CFD
vent_mp5_0height.RSF	vent_mp5_0height.log	vent_mp5_0height.CFD
vent_mp6.RSF	vent_mp6.log	vent_mp6.CFD
vent_mp6_0height.RSF	vent_mp6_0height.log	vent_mp6_0height.CFD
vent_mp7.RSF	vent_mp7.log	vent_mp7.CFD
vent_mp7_0height.RSF	vent_mp7_0height.log	vent_mp7_0height.CFD

Any other ARCON96 input, output log, or output CFD files were not intended to be transmitted and as such should not be considered as part of the License Amendment Request or the December 1, 2021 supplemental submittal. None of the above referenced ARCON96 cases meet the criteria identified in RAI-2c.

RAI No. 3 (RAI HFE-1):

Regulatory Requirement: 10 CFR Part 50.67(b) states, in part, that "[a] licensee who seeks to revise its current accident source term in design basis radiological consequence analyses shall apply for a license amendment under § 50.90. The application shall contain an evaluation of the consequences of applicable design basis accidents previously analyzed in the safety analysis report."

NUREG-0800, Section 15.0.1, "Radiological Consequence Analyses Using Alternative Source Terms," Rev. 0, assigns responsibility to the Operator Licensing and Human Factors Branch for the review issues related to emergency operating procedures and human factors engineering design. This section also states, in part, that an acceptable implementation of an alternative source term should demonstrate compliance with plant-specific licensing commitments made in response to the NUREG-0737, "Clarification of TMI Action Plan Requirements." Specific provisions of interest within the context of this review plan section include III.D.3.4, Control Room Habitability, as it relates to maintaining the control room in a safe, habitable condition under accident conditions by providing adequate protection against radiation and toxic gases.

Background: In the license amendment request (LAR), Callaway does not appear to address the area of emergency operating procedures. In order to determine whether human factors considerations have been adequately accounted for, the NRC staff require a description of whether modifications to emergency operating procedures will occur as part of the LAR (for example: the incorporation of new or modified operator actions for maintaining control room habitability under accident conditions).

Request: Please describe whether Callaway will be modifying any emergency operating procedures as part of the LAR, and if so, describe the procedural changes, any changes in the time constraints associated with the performance of procedurally driven actions, and any operator training associated with those changes. If applicable, be sure to include a discussion of how the considerations like those in NUREG-0737 described above are addressed.

Ameren Response: Fuel Handling Accident in the reactor containment building

Table 3-58 of ULNRC-06636 Enclosure 1 documents credit for operator action to initiate the Emergency Exhaust system within 10-minutes of accident initiation. Manual actuation of the Emergency Exhaust system is performed from the Control Room as directed by the current fuel handling accident response procedure, OTO-KE-00001. This action was previously implemented in the procedure although it has not been previously credited in Callaway's radiological dose analysis of the Fuel Handling Accident. The 10-minute requirement for completion of the action will be added to Callaway's Significant Operator Response Timing program as a Time Critical Action (TCA) upon implementation of the AST License Amendment. Inclusion as a TCA ensures that the action and action timing are trained on by the operators and periodically validated.

All other operator actions credited to mitigate a radiological dose event are consistent with the Analyses of Record for Callaway. No other changes to operator actions, timing requirements, or emergency operating procedures are required as part of AST implementation.

RAI No. 4 (EMIB-RAI-1):

Regulatory Requirement: RG 1.183, Re-Analysis Guidance section identifies that the ability of the damper to close against increased containment pressure may need to be evaluated or the ability of ductwork downstream of the dampers to withstand increased stresses.

Background: In Enclosure 1, Section 2.2.2 of the LAR, the licensee addresses Control Room Emergency Ventilation System (CREVS) Design and Operation. However, the following information was not discussed, and the licensee is requested to provide details.

Request: The licensee is requested to provide the following details:

a) Discuss whether the adoption of the Alternative Source Term (AST) affects any of the safety related piping.

b) Discuss whether any safety related Heating Ventilation and Air Conditioning (HVAC) system is credited in the AST adoption.

c) Discuss the seismic qualification of the control room safety related HVAC including ductwork, air handlers, damper systems, chillers, and supports.

Ameren Response:

a) Callaway's adoption of the Alternative Source Term (AST) relies on the seismic qualification of the safety related piping connecting the containment recirculation sump to the Refueling Water Storage Tank (RWST) for consideration of RWST back-leakage in the event of a Loss of Coolant Accident (LOCA). In accordance with NRC Information Notice 2012-01, "Seismic Considerations – Principally Issues Involving Tanks," all flow paths above and below the normal water level of the RWST are:

- Designed, installed, maintained, and qualified to seismic Category I criteria in accordance with the ASME B&PV Code Section III Class 2 and
- Isolated from non-seismic category I piping by redundant automatic isolation valves which close on a safety injection signal and fail closed on loss of power, or
- Isolated from non-seismic category I piping by a locked closed isolation valve.

Therefore, reliance on this safety-related piping and isolation capability for AST adoption is acceptable based on the design.

b) As part of adopting the AST at Callaway Energy Center, credit is taken for certain safety-related Heating Ventilation and Air Conditioning (HVAC) systems in two of the radiological dose analyses, in accordance with the guidance of Regulatory Guide 1.183.

During a Loss of Coolant Accident (LOCA), the Auxiliary Building (AB) emergency exhaust filtration is credited for the ECCS leakage case during recirculation. Additionally, modeling for isolation of the Containment mini-purge system is built on the assumption of prompt isolation at 11 seconds, which includes the valve stroke times, generation of safety injection signal, and signal delay time. While the mini-purge flow leaving containment is filtered, this filtration is not included in the Engineered Safety Feature portion of the system and so was not credited in the AST dose analysis.

During a Fuel Handling Accident (FHA) in the Fuel Handling Building (FHB), Emergency Exhaust from the FHB is credited without filtration. Technical Specification Table 3.3.7-1 shows that the radiation monitors at the control room air intakes are not required to be operable during movement of irradiated fuel assemblies in the fuel building. Instead, Technical Specification 3.3.7 and 3.3.8 show that High Gaseous Fuel Building Exhaust Radiation channels GG-RE-27 and GG-RE-28 actuate both the Emergency Exhaust System (EES) and control room isolation.

Although Regulatory Guide 1.183 does not provide guidance with regard to the Technical Support Center (TSC) HVAC, safety-grade filtration of outside makeup air and recirculated air is credited during emergency mode operation in the AST dose analyses. As documented in Item 3 of the Conformance with RIS 2006-04 Table, Attachment D of Enclosure 1 of the LAR, for events where safety related HVAC is not credited:

> "Actuation of emergency control room HVAC mode is not credited for certain accidents. Therefore, events which do not result in a safety injection signal or do not reach a radiation monitor setpoint are assumed to stay in normal control room HVAC mode. The normal ventilation system does not credit filtration and has greater flow rate than the ESF ventilation. Therefore, the resulting doses to personnel within the control room will be greater if it is assumed that the ESF ventilation system is not actuated at the event initiation due to a loss of offsite power. Acceptable control room doses have been calculated with a maximum unfiltered inleakage of 6000 cfm to the control building, 60 cfm to the control room, and 300 cfm to the equipment room."

c) The Control Room Emergency Ventilation System (CREVS) is comprised of the following components, in addition to the supporting piping, electrical supply, instrumentation, ductwork and dampers. Each of these components is designed to seismic Category I criteria (Reg Guide 1.29) and qualified either by test, analysis, or a combination thereof. All the power supplies and control functions necessary for safe functioning of the control room air-conditioning system are Class IE and designed, installed and qualified to Seismic Category I criteria.

__**Control Room Filter Adsorber Units (FGK01A/B)**__: The items procured under specification M-621 were qualified by analysis and test. Specifically, the filter adsorber units themselves were qualified by finite element analysis with discrete components qualified by test in accordance with IEEE 344-1975.

(Ref. Specification M-621)

__**Control Room Pressurization Filter Adsorber Units (FGK02A/B)**__: Like FGK01A/B, the items procured under specification M-621 were qualified by analysis and test. Specifically, the filter adsorber units themselves were qualified by finite element analysis with discrete components qualified by test in accordance with IEEE 344-1975.

(Ref. Specification M-621)

__**Control Room Air Conditioning (A/C) Units (SGK04A/B)**__: These units were qualified by test in accordance with IEEE 344-1975.

(Ref. Specification M-622.1)

__**Control Room Filtration Fans (CGK03A/B)**__: These units were qualified by analysis, test and combinations. Specifically, the fans were qualified by analysis in accordance with IEEE 344-1975, and the motors were qualified separately by analysis/test in accordance with IEEE 323-1974/IEEE 344-1975.

(Ref. Specification M-622.1, E-013)

__**Control Room Pressurization Fans (CGK04A/B)**__: Like the Control Room Filtration Fans, these units were qualified by analysis, test and combinations. Specifically, the fans were qualified by analysis in accordance with IEEE 344-1975, and the motors were qualified separately by analysis/test in accordance with IEEE 323-1974/IEEE 344-1975.

(Ref. Specification M-622.1, E-013)

Isolation Dampers are categorized as safety related seismic Category I components and qualified in accordance with IEEE 344-1975 by a combination of test and analysis.

(Ref. Specification M-627A/B)

Aside from these components, pressure piping servicing these equipment items was designed, analyzed, and installed in accordance with the ASME B&PV Code, Section III, Subsection 3, including the pipe supports. Also, ductwork was designed, analyzed and installed as safety related, seismic Category I items and supported based on ASME/ANSI standards for HVAC systems following the guidance of USNRC Regulatory Guide 1.52.