From:	Mahesh Chawla
Sent:	Friday, October 14, 2022 12:09 PM
To:	Elwood, Thomas B
Cc:	Jennifer Dixon-Herrity; Barbara Hayes; Kevin Quinlan; John Parillo; Kevin Hsueh; Chakrapani Basavaraju; Stewart Bailey; Derek Scully; Brian Wittick; Jack Zhao; Michael Waters; Jason Huang; Jesse Seymour; Brian Green (He/Him); Jorge Cintron-Rivera; Matthew Hamm; Matthew McConnell; Jason Paige; Vic Cusumano; Mike Mazaika; Steve Jones
Subject:	Final - Request for Additional Information - Callaway Plant, Unit 1 - License Amendment Request for Adoption of Alternate Source Term and Revision of Technical Specifications - EPID L-2021-LLA-0177
Attachments:	Callaway - Final_Second_RAI Related to ARCON96-NAI Onsite Dispersion Analysis for LAR to Implement AST.docx

Dear Mr. Elwood,

By letter dated September 28, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21272A167), supplemented by letters dated December 1, 2021 (ML21335A451), and July 5, 2022 (ML22186A103), Union Electric Company, dba Ameren Missouri (the licensee) 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 alternate source term (AST) dose analysis methodology into the Callaway licensing basis. In order to complete our review of the onsite dispersion modeling analysis and related accident dose calculations in the application, the NRC staff is requesting additional information (RAI), attached herewith.

The NRC staff conducted a clarification call with you and your representatives on October 4, 2022, to discuss the draft RAI sent to you on September 20, 2022. During this call, you confirmed our observation that incorrect default input values were used in your ARCON96-NAI dispersion modeling calculations. You agreed to re-run all the ARCON96-NAI model runs using the correct default input value~~s~~ for the 720-hour (i.e., 4- to 30-day) averaging period to reconcile any differences between the NRC confirmatory results and your calculations, to revise any affected dose calculations, to update any affected tables and/or figures in your application submittal, and to verify if the incorrect default value~~s~~ for that averaging period were inherent to the ARCON96-NAI code itself or simply an error in preparing the model input files.

You estimated and agreed to provide these results in a supplement on the docket within 60 days upon receipt of this email. The NRC estimates that its review will take another 90 days to evaluate the data and complete this project. However, it is contingent upon no additional dispersion modeling-related changes by you, or any other issues or concerns being raised by the NRC staff. Upon completion of their evaluation, the NRC staff will be able to provide a more accurate assessment with regards to any additional time or hours needed to complete the project. Thanks

Sincerely,

Mahesh Chawla, Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
ph: 301-415-8371
Docket No. 50-483

	DORL/LPL4/PM	DORL/LPL4/BC
	MChawla	JDixon-Herrity
	10/14/22	10/14/22

Hearing Identifier: NRR_DRMA
Email Number: 1808

Mail Envelope Properties (SA1PR09MB84155789AA0BD9B43EA49CA2F1249)

Subject: Final - Request for Additional Information - Callaway Plant, Unit 1 - License Amendment Request for Adoption of Alternate Source Term and Revision of Technical Specifications - EPID L-2021-LLA-0177
Sent Date: 10/14/2022 12:08:57 PM
Received Date: 10/14/2022 12:08:58 PM
From: Mahesh Chawla

Created By: Mahesh.Chawla@nrc.gov

Recipients:
"Jennifer Dixon-Herrity" <Jennifer.Dixon-Herrity@nrc.gov>
Tracking Status: None
"Barbara Hayes" <Barbara.Hayes@nrc.gov>
Tracking Status: None
"Kevin Quinlan" <Kevin.Quinlan@nrc.gov>
Tracking Status: None
"John Parillo" <John.Parillo@nrc.gov>
Tracking Status: None
"Kevin Hsueh" <Kevin.Hsueh@nrc.gov>
Tracking Status: None
"Chakrapani Basavaraju" <Chakrapani.Basavaraju@nrc.gov>
Tracking Status: None
"Stewart Bailey" <Stewart.Bailey@nrc.gov>
Tracking Status: None
"Derek Scully" <Derek.Scully@nrc.gov>
Tracking Status: None
"Brian Wittick" <Brian.Wittick@nrc.gov>
Tracking Status: None
"Jack Zhao" <Jack.Zhao@nrc.gov>
Tracking Status: None
"Michael Waters" <Michael.Waters@nrc.gov>
Tracking Status: None
"Jason Huang" <Jason.Huang@nrc.gov>
Tracking Status: None
"Jesse Seymour" <Jesse.Seymour@nrc.gov>
Tracking Status: None
"Brian Green (He/Him)" <Brian.Green@nrc.gov>
Tracking Status: None
"Jorge Cintron-Rivera" <Jorge.Cintron-Rivera@nrc.gov>
Tracking Status: None
"Matthew Hamm" <Matthew.Hamm@nrc.gov>
Tracking Status: None
"Matthew McConnell" <Matthew.McConnell@nrc.gov>
Tracking Status: None
"Jason Paige" <Jason.Paige@nrc.gov>
Tracking Status: None
"Vic Cusumano" <Victor.Cusumano@nrc.gov>
Tracking Status: None
"Mike Mazaika" <Michael.Mazaika@nrc.gov>

Tracking Status: None
"Steve Jones" <Steve.Jones@nrc.gov>
Tracking Status: None
"Elwood, Thomas B" <TElwood@ameren.com>
Tracking Status: None

Post Office: SA1PR09MB8415.namprd09.prod.outlook.com

Files	**Size**	**Date & Time**
MESSAGE	2744	10/14/2022 12:08:58 PM
Callaway - Final_Second_RAI Related to ARCON96-NAI Onsite Dispersion Analysis for LAR to Implement AST.docx	43123	

Options
Priority: Normal
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:

LAR to Implement Alternative Source Term for Callaway Unit 1
Request for Additional Information Related to Onsite Dispersion Modeling Analysis

By letter dated September 28, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21272A167), Union Electric Company, dba Ameren Missouri (the licensee) submitted a license amendment request (LAR) for Callaway Plant, Unit No. 1 (Callaway). 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.

In order to accept the application, the NRC staff determined that supplemental information was needed from the licensee. The request for supplemental information was initially sent by email to the licensee on November 4, 2021 (ML21308A069), followed by a clarification call. The request was formally sent on November 30, 2021 (ML21319A006). The supplemental information was submitted by the licensee on December 1, 2021 (ML21335A452).

The supplemental submittal included, in part, responses to requests for data and information pertaining to the offsite and onsite atmospheric dispersion modeling analyses. During its safety review, the NRC staff determined that additional information and clarifications to some of this supplemental submittal was still needed. Requests for additional information (RAIs) were drafted and initially sent by email to the licensee on May 16, 2022 (ML22137A029), followed by a clarification call. The final RAIs were formally sent by email on June 2, 2022 (ML22154A012). The licensee provided its responses on July 5, 2022 (ML22186A104).

In order to complete its safety review of the atmospheric dispersion modeling analyses, the NRC staff has further determined the need to resolve a potential software issue with respect to the onsite dispersion modeling (i.e., with the ARCON96-NAI model). This potential issue may only affect a portion of that model's results.

REGULATORY BASIS

The regulatory basis related to onsite atmospheric dispersion modeling analysis was already established in the previous requests for additional information (ML22154A012) and is not repeated here. For reference, though, the guidance pertaining to onsite dispersion analyses is:

- Regulatory Guide (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.

BACKGROUND INFORMATION - ONSITE DISPERSION MODELING ANALYSIS

The licensee's onsite dispersion modeling analysis was based on the ARCON96-NAI code. This model was used to estimate atmospheric dispersion factors (X/Qs) at the normal and emergency air intakes (and at the midpoint between the two emergency intakes) of the control building, at the air intake (or nearest point on) the technical support center (TSC), and at various analysis points along the path of ingress and egress to the control building.

As stated in the previous RAIs, ARCON96-NAI appears to be essentially the same as the NRC-approved ARCON96 dispersion model. ARCON96 implements RG 1.194 and the user's guidance in NUREG/CR-6331. Enclosure 14 to the December 1, 2021, supplemental submittal discusses the differences between ARCON96-NAI and ARCON96.

In its supplemental submittal, the licensee provided 78 ARCON96-NAI input and output files (Enclosures 9, 10, and 11). These model runs are intended to estimate X/Q values at the receptors above due to potential accident releases from the various sources identified in the tables and figures of Enclosure 1 of that submittal. Clarifications to the release points and onsite receptor locations were provided by the licensee in Attachment 1 of its July 5, 2022, responses to the RAI questions of June 2, 2022. At that time, the licensee also withdrew 13 of the originally submitted 78 ARCON96-NAI model runs as extraneous to the LAR submittal. The NRC staff's review focused on the remaining 65 model runs.

Enclosures 9, 10, and 11 of the supplemental submittal also included 32 ARCON96-NAI model runs intended to evaluate various accident release scenarios from the reactor (containment) building vent and the refueling water storage tank (RWST) vent. The licensee's July 5, 2022, RAI responses included additional information to better understand the sketch of ingress/egress pathways and analysis (receptor) points that were originally part of Enclosure 1 of the supplemental submittal. None of these 32 model runs were withdrawn.

The NRC staff used the ARCON2 dispersion model for its confirmatory checks of the ARCON96-NAI model runs. ARCON2 is available from the agency's Radiation Protection Computer Code Analysis and Maintenance Program (RAMP) website. This model is essentially the same as the ARCON96 code except that a more user-friendly graphical user interface has been incorporated. In addition to implementing the provisions of RG 1.194 an option to utilize RASCAL dispersion algorithms is also provided. However, for this LAR review, the RG 1.194 and NUREG/CR-6331 provisions were followed. The same ARCON96-formatted meteorological data files provided by the licensee were used for the confirmatory model runs.

A number of potentially questionable results were identified based on these confirmatory checks. The controlling X/Q values for a given accident scenario are input to dose calculations and are directly proportional to the resulting dose. Different X/Qs for all averaging times are not unusual when doing confirmatory checks (e.g., due to round-off, etc.). Results were considered to be acceptable if the ARCON2 X/Q estimates differed from the ARCON96-NAI X/Qs by less than 5 percent. However, ARCON2 X/Q values higher than ARCON96-NAI values by more than 10 percent or by greater than 5 percent but less than 10 percent were identified. All overpredictions occurred for only the longest accident averaging period (i.e., 4 to 30 days or from 96 and 720 hours). X/Q values for all shorter averaging intervals were essentially the same between the two models.

ARCON2 X/Qs for several (8) accident source-receptor configurations more than 10 percent higher than ARCON96-NAI X/Qs include:

- RWST vent to all Control Bldg. Emerg. Intakes (i.e., >20 percent higher than clwA96_04, 05, and 06 results, no building wake);
- Fuel Handling Bldg. (FHB) to all Control Bldg. Emerg. Intakes (i.e., >18 percent higher than clwA96_07, 08, and 09 results, no building wake);

- Containment Bldg. vent to Control Bldg. Normal Intake (i.e., >13 percent higher than clwA96_32 results, with building wake); and
- Maint. Hatch to Control Bldg. Normal Intake (i.e., >15 percent higher than clwA96_56 results, no building wake).

ARCON2 X/Qs for various (16) accident source-receptor configurations more than 5 percent but less than 10 percent higher than ARCON96-NAI X/Qs also include:

- FHB to Control Bldg. Normal Intake (i.e., >7 percent higher than clwA96_10 results, no building wake);
- Maint. Hatch to all Control Bldg. Emerg. Intakes (i.e., >9 percent higher than clwA96_23, 24, and 25 results, no building wake);
- Containment Bldg. (Diffuse) to Midpoint Between Control Bldg. Emerg. Intakes A and B (i.e., >6 percent higher than clwA96_34 results, with building wake);
- RWST vent to Control Bldg. Normal Intake (i.e., >6 percent higher than clwA96_39 results, no building wake);
- FHB to TSC Intake (i.e., >6 percent higher than clwA96_42 results, no building wake);
- Main Steam Line to TSC Intake (i.e., >8 percent higher than clwA96_51 results, no building wake);
- Feedwater Line to TSC Intake (i.e., >9 percent higher than clwA96_54 results, no building wake);
- Maint. Hatch to TSC Intake (i.e., >6 percent higher than clwA96_57 results, no building wake);
- Steam Air Jet Ejector Line to TSC Intake (i.e., >5 percent higher than clwA96_60 results, no building wake);
- Condenser to TSC Intake (i.e., >8 percent higher than clwA96_63 results, no building wake);
- Turbine Driven Aux Feedwater Pump to TSC Intake (i.e., >5 percent higher than clwA96_69 results, no building wake);
- Containment Bldg. (Diffuse) to TSC Intake (i.e., >8 percent higher than clwA96_71 results, no building wake);
- Emerg. Hatch to Control Bldg. Normal Intake (i.e., >7 percent higher than clwA96_76 results, no building wake);
- Emerg. Hatch to TSC Intake (i.e., >6 percent higher than clwA96_77 results, no building wake).

Further, there are eight analysis points along the pathways leading to and around the Control Building for evaluating dispersion associated with ingress and egress and used as input, as needed, for dose calculations (i.e., Points 1 thru 7 and an additional analysis point between Points 4 and 5). Each analysis point included model runs assuming two receptor heights – at 0 m (ground-level) and 2 m (nominal breathing height). Two potential accident release scenarios were modeled (i.e., from the Containment Building vent and from the RWST vent). In all cases, credit for additional plume dispersion due to building wake effects was conservatively <u>not</u> considered (i.e., this resulted in relatively higher X/Qs and, therefore, doses).

As above, ARCON2 X/Q estimates differing from the ARCON96-NAI values by less than 5 percent were considered to be acceptable. However, ARCON2 X/Qs higher than ARCON96-NAI values ranging from more than 10 percent to about 20 percent were identified. Also as

before, all overpredictions occurred for only the longest accident averaging period (i.e., 4 to 30 days or from 96 and 720 hours) with X/Q values for all shorter averaging intervals essentially the same between the two models. Further, it is noted that these overpredictions occurred for downwind distances less than about 200 m for potential releases from the Containment Building vent and for distances less than about 240 m for potential releases from the RWST vent. Analysis points farther away had ARCON2 overpredictions of less than 5 percent.

The ARCON2 overpredictions of note (a total of 12) compared to ARCON96-NAI results at certain ingress/egress points include:

- RWST vent to Point 5 at 238.4 m downwind (i.e., >14 percent higher than rwst_mp5 and rwst_mp5_0height results, no building wake);
- RWST vent to Point 6 at 148.0 m downwind (i.e., >19 percent higher than rwst_mp6 and rwst_mp6_0height results, no building wake);
- RWST vent to Point 7 at 137.8 m downwind (i.e., >18 percent higher than rwst_mp7 and rwst_mp7_0height results, no building wake).

- Containment Bldg. vent to Point 5 at 197.4 m downwind (i.e., >11 percent higher than vent_mp5 and vent_mp5_0height results, no building wake);
- Containment Bldg. vent to Point 6 at 119.5 m downwind (i.e., > about 12 percent higher than vent_mp6 and vent_mp6_0height results, no building wake);
- Containment Bldg. vent to Point 7 at 98.2 m downwind (i.e., >12 percent higher than vent_mp7 and vent_mp7_0height results, no building wake).

The NRC staff noted a difference in what may be a relevant portion of the output files and discrepancies produced between the ARCON2 and ARCON96-NAI models. Selected from the entire set of paired model runs, a portion of the respective output files that correspond to the highest ARCON2 overprediction (i.e., 22.37 percent) is reproduced below. Notice that in this example the total counts of hours in the two rows labeled “In Range” and “Total X/Qs” are numerically the same for all averaging periods, regardless of the model used, except for the 720-hour interval (i.e., the averaging period in question). For that time period, the counts differ between the two codes (i.e., 34417 for the ARCON2 run and 20411 for the ARCON96-NAI run).

Notice too that while the data counts for these two rows are identical in the ARCON2 and ARCON96-NAI outputs, except as noted, the total counts per averaging interval in the row labeled “In Range” generally vary from model run to model run. This is assumed to simply be a function of differing source-receptor orientations. Nevertheless, spot checks of other model run pairs indicate agreement in the counts for all averaging intervals other than 720 hours between the outputs from the two codes.

The spot checks also show that the counts in the row labeled “Total X/Qs” do not vary between the two models (again, except for the 720-hour averaging interval) regardless of the model run. This appears to simply be a function of the number of hours of valid meteorological input data. The licensee stated under Section 3.1.1 in Enclosure 1 of its December 1, 2021, supplemental submittal that “the ARCON96 analyses (Section 3.1.3) reported a total number of 35,064 hours of data processed with only 79 hours of missing data” and that “the recovery rate for all four years [i.e., 2013 to 2016] is 99.8%.”

As a result, the data count for the 720-hour interval as indicated above for the ARCON96-NAI model run (which is the same for all of the licensee's model runs) and the X/Q discrepancies between the two models are suspect without further clarification and/or justification for their use.

Data extracted from the ARCON2 confirmatory model run designated as clwA96_04chk:

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	7101.	8494.	10470.	13228.	15391.	20210.	32244.	34568.	34741.	34417.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	27884.	26462.	24430.	21560.	19431.	14527.	2596.	323.	0.	0.
TOTAL X/Qs	34985.	34956.	34900.	34788.	34822.	34737.	34840.	34891.	34741.	34417.
% NON ZERO	20.30	24.30	30.00	38.02	44.20	58.18	92.55	99.07	100.00	100.00

Data extracted from the ARCON96-NAI model run designated as clwA96_04:

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	7101.	8494.	10470.	13228.	15391.	20210.	32244.	34568.	34741.	20411.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	27884.	26462.	24430.	21560.	19431.	14527.	2596.	323.	0.	0.
TOTAL X/Qs	34985.	34956.	34900.	34788.	34822.	34737.	34840.	34891.	34741.	20411.
% NON ZERO	20.30	24.30	30.00	38.02	44.20	58.18	92.55	99.07	100.00	100.00

Please address the following:

RAI-1a

Given the preceding observations from the Staff's safety review, please confirm the validity of the ARCON96-NAI calculations of the 4- to 30-day (96- to 720-hour) averaging interval X/Qs.

RAI-1b

If that portion of the ARCON96-NAI dispersion model is inaccurate, revise the code and any affected documentation accordingly.

RAI-1c

Also, if that portion of the ARCON96-NAI dispersion model is inaccurate, either:

- revise all of the model runs and any affected tables and/or figures in Enclosure 1 of the December 1, 2021, supplemental submittal, evaluate whether any of the conclusions drawn from the previous modeling results change (as reflected in Table 3-29 of Enclosure 1) and update as necessary, and revise all affected dose calculations; or

- document and provide other adequate justification for the retention of the previous ARCON96-NAI modeling results and related dose calculations and/or revisions to that modeling and those dose calculations.