Ameren Missouri Response to NRC RAIs

9 pages

Ameren Missouri Response to NRC RAIs

On March 31, 2021, Union Electric Company, dba Ameren Missouri, submitted a license amendment request (LAR), in combination with a request for regulatory exemptions, for adopting a risk-informed approach for resolving GSI-191 and responding to Generic Letter (GL) 2004-02, for Callaway Plant. In support of the initial submittal, a number of supplements have been submitted, as identified in the cover letter of this submittal. 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 two individual requests, RAI No. 1 (with two parts) and RAI No. 2, was electronically transmitted on April 5, 2022.

RAI No. 1 (RAI-1):

Regulatory Requirement: Section 51.30(a) of Title 10 of the Code of Federal Regulations requires, in part, that an environmental assessment include a brief discussion of the environmental impacts of the proposed action and alternatives, as appropriate.

Background: In reviewing Ameren Missouri's Callaway, Unit 1, Fourth (Post-Audit) Supplement to Request for License Amendment and Regulatory Exemptions for Risk-Informed Approach to Address GSI-191 and Respond to GL 2004-02, dated January 27, 2022 (ADAMS Accession No. ML22027A804), NRC staff has determined that environmental impacts (specifically, additional worker dose and radiologically contaminated waste) could occur in association with the No Action Alternative (i.e., complete compliance with the existing provisions in 10 CFR 50.46(a)(1) and the relevant General Design Criteria), should the subject exemptions and associated license amendment request not be granted. NRC requires this dose and waste information to inform its environmental review.

Request:

a) Enclosure 1 of Ameren Missouri's Fourth Supplement, i.e., Request for Exemptions for Callaway Risk-Informed Approach to Resolution for Generic Letter 2004-02, states that the minimum dose associated with replacement of insulation in containment is "estimated to be greater than 50 person-rem." In order to support the staff's evaluation of potential worker dose impacts, NRC requests that Ameren Missouri provide a more definitive value or upper range for this estimate.

b) Enclosure 1 also states that compliance with 10 CFR 50.46(a)(1) and the relevant General Design Criteria would entail removal and disposal of significant amounts of insulation. In order to support the staff's evaluation of potential waste management impacts, NRC requests that Ameren Missouri provide the estimated volume (cubic feet) of radiologically contaminated waste that would be generated from the replacement of the existing insulation addressed in Enclosure 1.

Ameren Response:

a) Ameren planning documents prepared in 2010 (per References RAI-1.1 and RAI-1.2 on page 4 of this enclosure) estimate a total worker dose of between 350 and 400 person-Rem for complete fiber removal and replacement with reflective metallic insulation. A present-day

estimate would likely be higher because of the intervening 12 years of continuous plant operation. At the time the dose estimate was performed, it was considered to be "… in line with other utilities impacted by this same issue." The Callaway dose estimate is based on extrapolation of the dose incurred to install reflective metal insulation (RMI) on the new steam generators installed in Refuel 14, but detailed ALARA work plans for every affected area may yield a higher total dose assessment. See the description of insulated pipes given in Response RAI-1b (as follows).

b) Figures RAI-1.1 and RAI-1.2 (on the following pages) illustrate the low-density fiber glass (LDFG) insulation present in the Callaway containment building. Gold-colored jackets denote Nukon™ insulation, and tan-colored jackets denote ThermalWrap™ insulation (mostly applied to top segments of the Main Steam and Feedwater lines). These images are produced from the CAD model used/described in Enclosure 1 to the March 31, 2021 LAR (identified above and as Ref. RAI-1.3 on page 4) to address the "RoverD" risk attributed to fiber insulation. The figures illustrate that fiber insulation is present in every region of containment, including locations difficult to access that would prolong worker exposure and high-dose areas such as the Regenerative Heat Exchanger and the Letdown Valve Cubicles that are presently managed as locked high-radiation areas.

There are 5023.5 ft^3 of Nukon™ and 436.1 ft^3 of ThermalWrap™ in containment, giving a total LDFG inventory of approximately 5460 ft^3. Assuming a manufactured density of 2.4 lbm/ft^3, this volume corresponds to a total potential debris mass of 13,103 lbm, or 6.6 tons. Most of the removed insulation would be disposed of as low-level radioactive waste with varying degrees of radiation contamination and associated hazards.

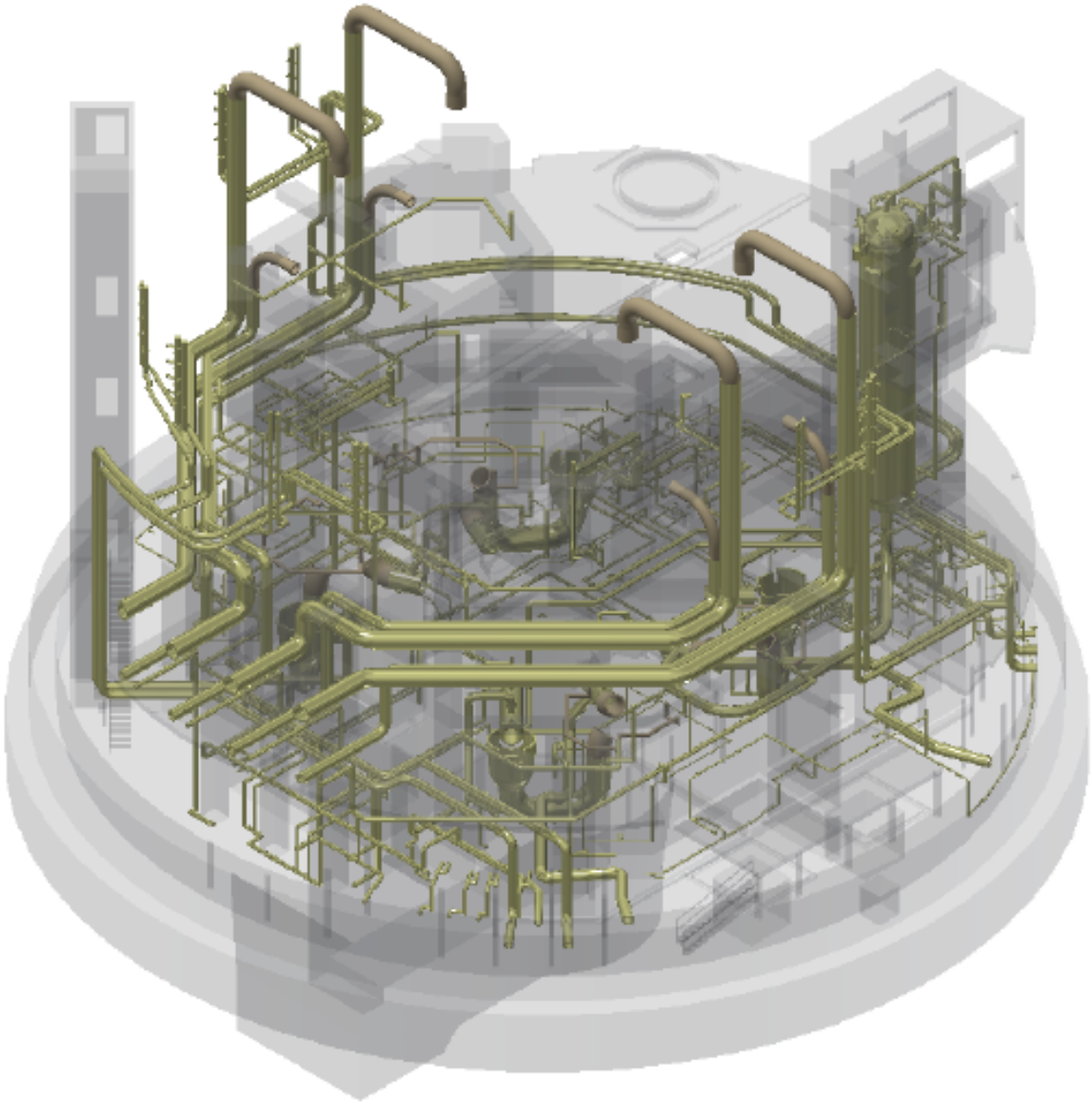

Figure RAI-1.1. First view of Callaway fiber insulation (Nukon™ in gold, ThermalWrap™ in tan).

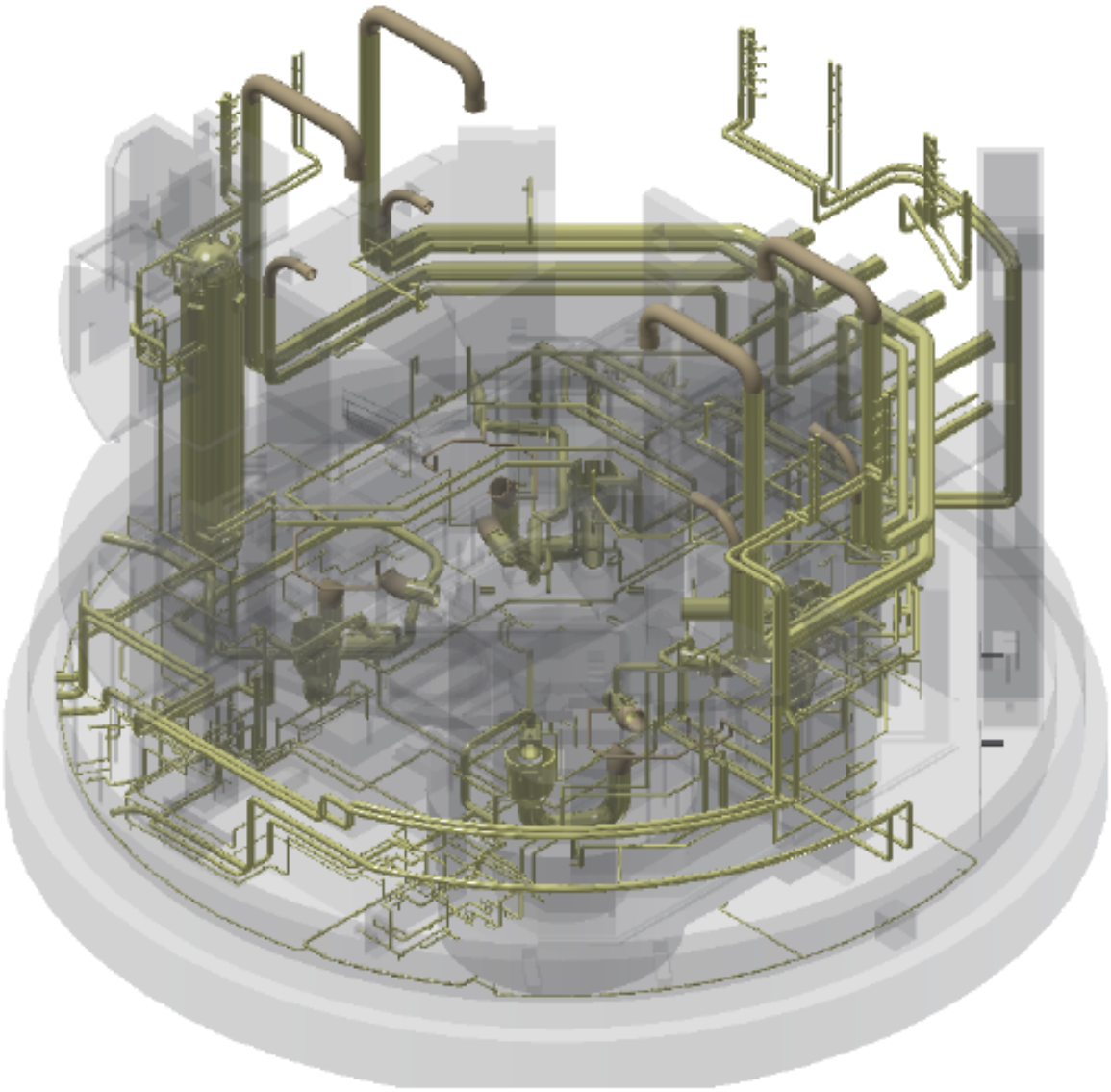

Figure RAI-1.2. Second view of Callaway fiber insulation (Nukon™ in gold, ThermalWrap™ in tan).

RAI-1 References:

1. RFR 201006483, "GL 2004-02 Containment Debris Reduction"
2. Design Scoping Study IWA EDP-ZZ-04015 (Internal Draft)
3. Enclosure 1 to ULNRC-06526, "Request for License Amendment and Regulatory Exemptions for a Risk-Informed Approach to Address GSI-191 and Respond to GL 2004-02 (LDCN 19-0014)," dated March 31, 2021 (ADAMS Accession No. ML21090A184)

RAI No. 2 (RAI-2):

Regulatory Requirement: 10 CFR 40.46 requires that plants maintain the ability to provide long-term core cooling following any initial LOCA response. To ensure that this cooling is available, licensees demonstrate that flashing will not occur at the ECCS strainer so that flow to the ECCS pumps is not interrupted.

Background: In Enclosure 3 of the submittal dated March 31, 2021, the licensee provided the methodology used to demonstrate that flashing would not occur. The NRC discussed this information with the licensee during an audit conducted virtually from August 10 to August 12, 2021 (ADAMS Accession No. ML21238A138), and the licensee submitted additional information regarding the flashing analysis in a submittal dated January 27, 2022 (ADAMS Accession No. MLML22027A804). In this submittal, the licensee stated that approximately 10 percent of the available pressure in containment is required to prevent flashing at the strainer for the large break loss of coolant accident (LBLOCA). The NRC staff agrees that the need to credit only 10 percent of the available pressure, based on a design basis calculation, demonstrates that there is large margin to flashing. However, the long-term cooling period spans a period during which the pool temperature and containment pressure change significantly. The NRC staff could not determine how the 10 percent value was derived.

Request: Clarify whether the 10 percent value is based on the time at which the minimum margin to flashing occurs and that it is based on the pressure predictions for the LBLOCA, not the main steam line break. If it is not based on the time of minimum margin, provide the margin to flashing based on the time at which the margin to flashing is at its minimum.

Ameren Response:

Overpressure credit is based on containment pressure predictions for LBLOCA, not for a main steam line break. Estimates of overpressure credit required to suppress flashing do consider time-dependent containment pressure while pool temperature exceeds 212°F, including the time at which the margin to flashing is at its minimum, as illustrated in the following discussion. The discussion also clarifies: 1) the percentage of available containment pressure associated with the baseline overpressure credit of 1.7 psi, and 2) the overpressure credit associated with 10% of available containment pressure.

Figure RAI-2.1 (next page) displays containment pressure available for a LBLOCA with minimum and maximum safeguards configurations from the time of ECCS switchover until the time when sump temperature reduces below 212 °F. Containment pressure available equals calculated absolute containment pressure reduced by saturation pressure and reduced by an additional 1.8 psi. Saturation pressure is required to maintain the fluid as a liquid, and thus, it is not available for containment overpressure credit. The further reduction of 1.8 psi is determined by reducing the calculated containment pressure of the design basis analysis from a Technical Specification maximum of 1.5 psig [References RAI-2.1 and RAI-2.2 on page 9] to the Technical Specification minimum of -0.3 psig [Ref. RAI-2.1]. In the minimum safeguards configuration, available containment pressure reaches a minimum at approximately 50 min.

Ref RAI-2.4 states that 1.7 psi of overpressure credit is needed to suppress flashing at the top of the strainer for LBLOCA under the conservative assumption of maximum constant pump flow.

Figure RAI-2.1 illustrates that during most of the minimum safeguards LBLOCA history, 1.7 psi of overpressure credit is approximately 15% of containment pressure available (1.7psi/11psi ≈ 15%). For approximately 30 minutes, 1.7 psi is more than 15% of the available containment pressure and reaches a maximum credit of approximately 22% at the minimum-safeguards-LBLOCA minimum available containment pressure (1.7psi/7.7psi ≈ 22%). When consideration is given to pump flow timing, required overpressure is reduced to approximately 10%, or less, of available containment pressure for the duration of the accident scenario (presented below).

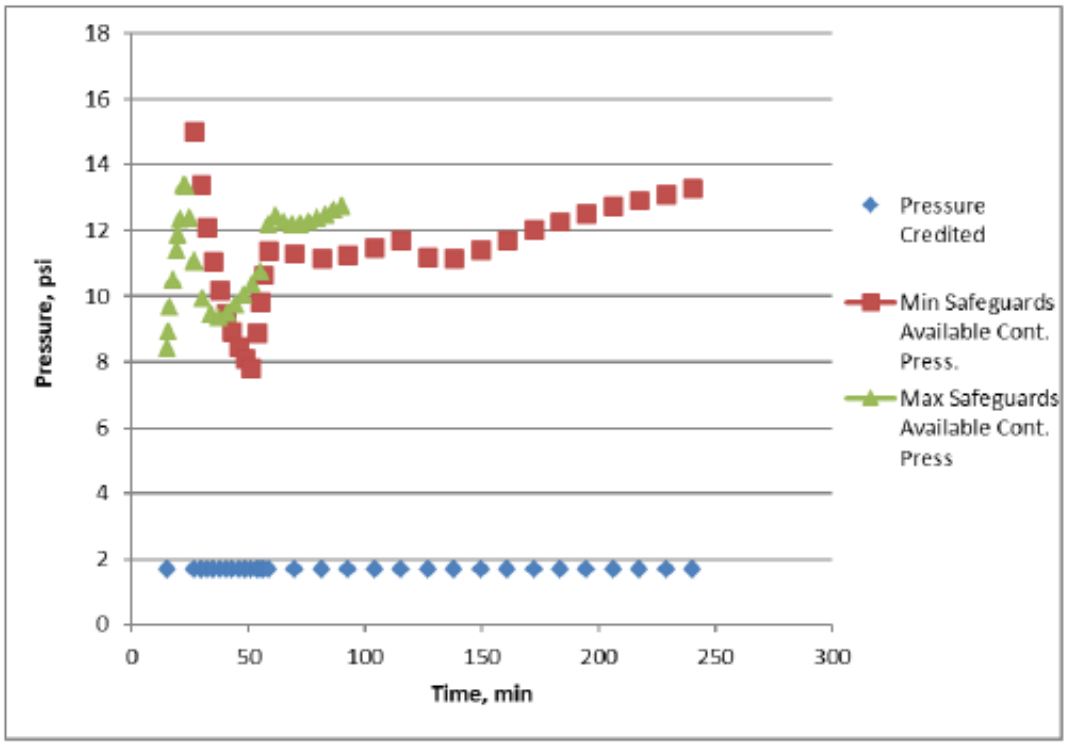

Figure RAI-2.1. Containment-pressure-available history for LBLOCA.

Conservative pump-flow timing assumptions are presented in the last column of Table RAI-2.1 (next page), which consolidates calculation assumptions from Ref. RAI-2.4 and compares actual plant conditions to values implemented in the 1.7-psi baseline analysis.

(Cont.)

Table RAI-2.1. LBLOCA conservative timing assumptions applied for flashing analysis.

Variable	Prior to Containment Spray Switchover	After Containment Spray Switchover	Implemented in 1.7-psi baseline analysis
Static Pressure	0.2 psi	0.4 psi	0.2 psi
Clean Screen Pressure Loss	0.1 psi at 4,800 gpm & 212 °F	0.2 psi at 8,750 gpm & 212 °F	0.3 psi at 8,750 gpm & 140 °F
Debris Bed Pressure Loss	0.4 psi at 4,800 gpm & 119 °F**	1.1 psi at 8,750 gpm & 120 °F**	1.5 psi at 10,000* gpm & 120 °F
*10,000 gpm was the modeled test flow rate for the debris bed head loss test to add additional conservatism. The maximum strainer plant flow rate is 8,750 gpm. The conservative debris bed head loss of 1.5 psi was implemented for all analyses. **These conditions were examined during flow sweeps of the strainer head loss test [Ref. RAI-2.3].			

Accounting for the more detailed static pressure and strainer pressure losses shown in Table RAI-2.1 above results in an overpressure credit needed to suppress flashing of 0.4 psi prior to containment spray (CS) switchover and 1.0 psi after CS switchover (reduced from the stated 1.7-psi baseline credit). These values for required overpressure credit remain conservatively high because debris-induced pressure drop measured at cooler laboratory test temperature was not adjusted (reduced) to account for actual higher pool temperatures existing at the time of minimum available overpressure.

Figures RAI-2.2 and RAI-2.3 (next page) display the containment-pressure-available transient for minimum and maximum safeguards configurations, respectively, including the design basis accident sump switch over time of 51 min and 20 min, for minimum and maximum safeguards configurations, respectively. Application of the refined inputs that account for event timing results in an overpressure credit of approximately 10% (or less) of the available containment pressure for the entire duration of the LBLOCA. For the more limiting minimum safeguards configuration illustrated in Fig RAI-2.2, the required credit is approximately 0.4psi/7.7psi≈5% prior to CS switchover and 1psi/11psi≈9% following CS switchover.

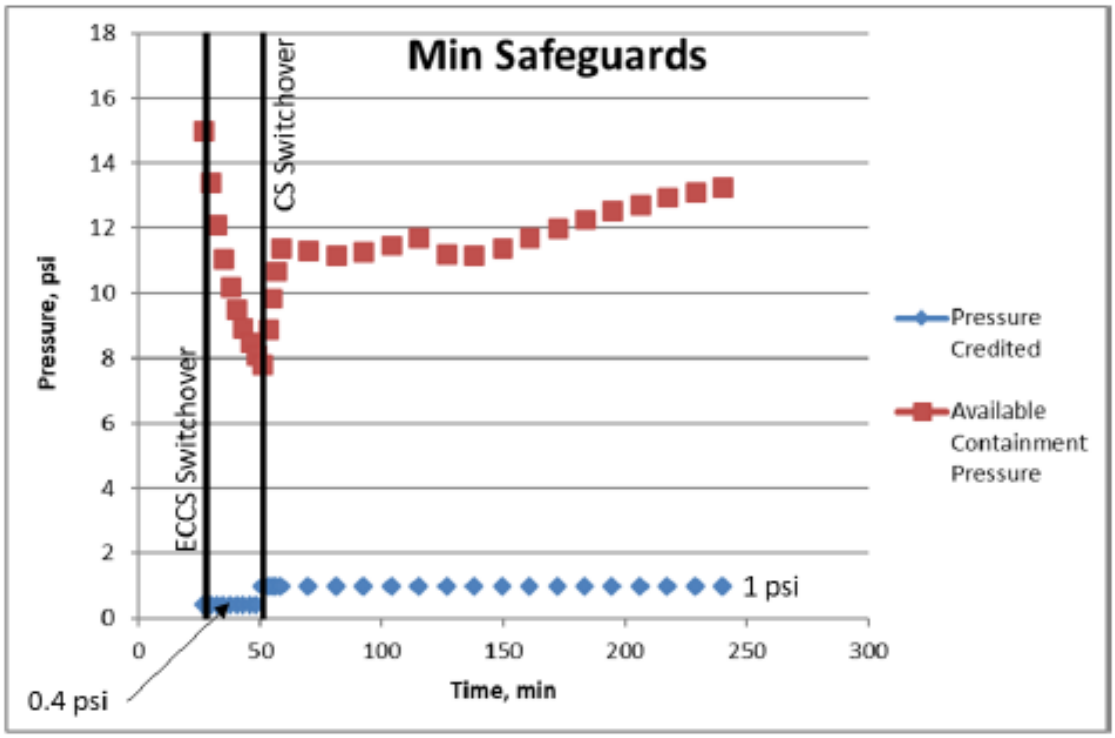

Figure RAI-2.2. Refined examination of LBLOCA containment-pressure-available history under Minimum Safeguards configuration.

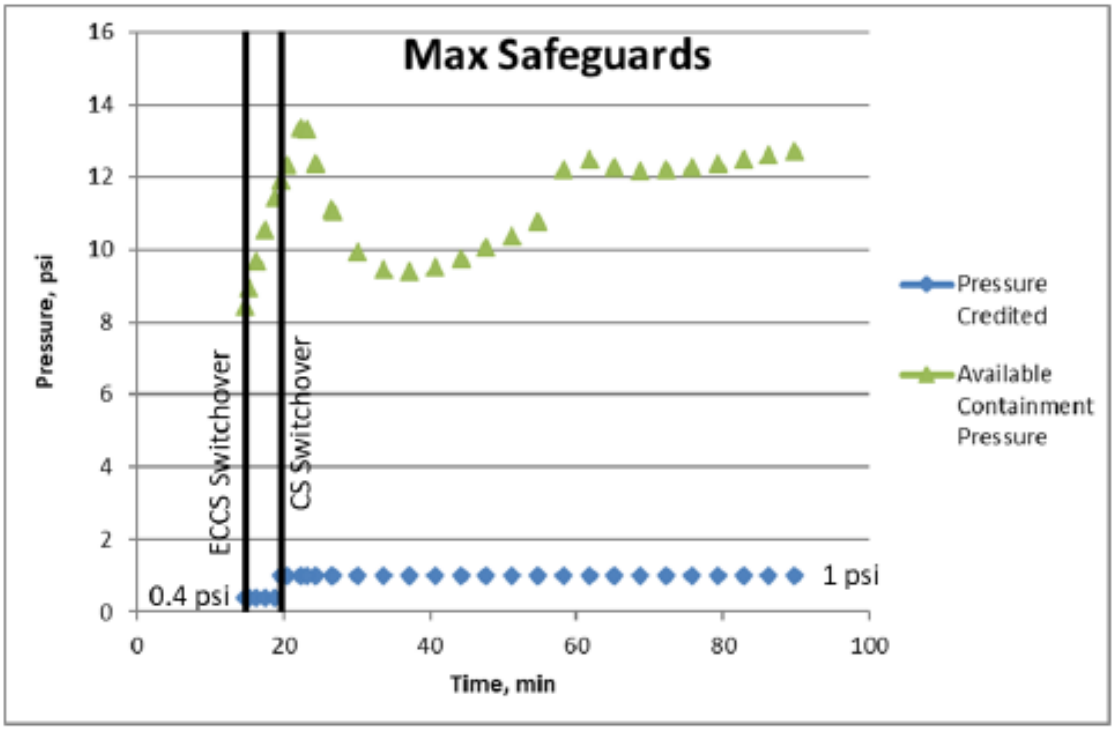

Figure RAI-2.3. Refined examination of LBLOCA containment-pressure-available history under Maximum Safeguards configuration.

RAI-2 References:

1. Technical Specification 3.6.4, “Containment Pressure,” Amendment No. 202
2. Calculation ZZ-525, Revision 001, Addendum 5, “Containment Temperature-Pressure Sensitivities During Main Steam Line Break and Large Break Loss of Coolant Accident for Containment Cooler Energy Removal Capability (CAR #201208648),” October 8, 2013
3. 1162CECGSI-R2-00, “Callaway Energy Center Head Loss Technical Report – Revision 00,” March 20, 2017
4. ALION-CAL-CEC-9345-004, “Strainer Head-Loss Analysis Report,” Revision 1, July 6, 2018