

# **NUCLEAR REGULATORY COMMISSION**

**Docket No. 50-483**

**Union Electric Company**

**Callaway Plant, Unit No. 1**

**Exemptions**

## **I. Background**

Union Electric Company, doing business as (dba) as Ameren Missouri (the licensee), is the holder of Renewed Facility Operating License No. NPF-30, which authorizes operation of the Callaway Plant, Unit No. 1 (Callaway). The license provides, among other things, that the facility is subject to all rules, regulations, and orders of the U.S. Nuclear Regulatory Commission (NRC) now or hereafter in effect. The facility consists of a pressurized-water reactor (PWR) located in Callaway County, Missouri.

In 1996, the NRC identified Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR Sump Performance," associated with the effects of debris accumulation on PWR sump performance during design-basis accidents. As part of the actions to resolve GSI-191, the NRC issued Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," dated September 13, 2004 (ML042360586), to holders of operating licenses for PWRs. In GL 2004-02, the NRC staff requested that licensees perform an evaluation of their emergency core cooling systems (ECCS) and containment spray system (CSS) recirculation functions considering the potential for debris-laden coolant to be circulated by the ECCS and the CSS after a loss-of-coolant accident (LOCA) or high energy line break inside containment and, if appropriate, take additional actions to ensure system function. GL 2004-02 required that licensees provide a written response to the NRC, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR)

Section 50.54(f), describing the results of their evaluation and any modifications made, or planned, to ensure the ECCS and CSS remain functional.

## **II. Request/Action**

By application dated March 31, 2021, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21090A184), as supplemented by letters dated May 27, 2021, July 22, 2021, August 23, 2021, October 7, 2021, January 27, 2022, March 8, 2022, May 26, 2022, and September 8, 2022 (ML21147A222, ML21203A192, ML21237A135, ML21280A378, ML22027A804, ML22068A027, ML22146A337, and ML22251A343, respectively), the licensee, pursuant to 10 CFR 50.12, "Specific exemptions," requested exemptions from certain requirements of 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," and 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 35, "Emergency core cooling"; GDC 38, "Containment heat removal"; and GDC 41, "Containment atmosphere cleanup," to allow use of a risk-informed methodology instead of the traditional deterministic methodology, to resolve the concerns associated with GSI-191, and respond to GL 2004-02 for Callaway.

Specifically, the licensee requested exemptions from 10 CFR 50.46(a)(1)(i), which, in part, requires the ECCS cooling performance to be calculated in accordance with an acceptable evaluation model as described in 10 CFR 50.46(a)(1), and for postulated LOCAs of different sizes, locations and other properties sufficient to provide assurance that the most severe LOCAs are evaluated. The NRC staff interprets the Section 50.46(a)(1) requirement to calculate ECCS performance for "other properties" as requiring licensees to consider the impacts of debris generation and transport in containment. The most significant form of debris in nuclear power reactor containments is piping and component insulation that can become debris during LOCAs, transport and

accumulate in the sumps, and clog the sumps strainers, thus creating resistance to coolant flow. Fibrous debris from this insulation can also enter the reactor core and directly impede heat transfer from the fuel to the coolant.

The approval of a risk-informed methodology would require exemptions from 10 CFR 50.46(a)(1)(i) and GDCs 35, 38, and 41 because the NRC has interpreted these regulations as requiring a deterministic approach and bounding calculation to show compliance with ECCS and CSS performance criteria in 10 CFR 50.46(b) and GDCs 35, 38, and 41. Issuance of exemptions is an appropriate means to grant relief from the use of a deterministic approach to show compliance with these requirements.

The licensee's 10 CFR 50.46 deterministic analysis considered the debris in containment and demonstrated that the debris loading could prevent acceptable ECCS and CSS operation and core cooling for certain pipe ruptures. Based on its analysis, the licensee concluded that the amount of debris in the Callaway containment would need to be reduced to demonstrate compliance with 10 CFR 50.46 criteria using a deterministic analysis for certain large-break LOCA sizes because, for those breaks, the plant-specific testing threshold for generation and transport of debris was exceeded.

Additionally, the licensee's deterministic in-vessel analysis was limited to breaks that could generate and transport to the strainers fibrous debris amounts in excess of the plant-specific tested debris limit for the strainers. This value was chosen because it also represents the deterministic limit for strainer failure for pipe breaks. Therefore, any break that generates and transports more than the amount of fibrous debris bounded by plant testing is already assumed to cause strainer failure and increase core damage frequency. Because these large breaks are already assumed to contribute to plant risk because of strainer failure, there is no need to evaluate them for risk contribution due to in-vessel failure. Other debris types were bounded by the strainer evaluation and are not

critical to the in-vessel analysis. Therefore, all cases where core damage might occur due to debris arriving at the core are already covered by scenarios that cause strainer failure and do not need to be counted as additional increases in risk.

The licensee requested exemptions from the requirement to use a deterministic analysis for specific scenarios of LOCA breaks producing and transporting debris in excess of the plant-specific tested debris limits. Since it determined that the probability of consequences from debris effects is very low, the licensee requested exemptions to allow the use of a risk-informed analysis to show adequate assurance of ECCS and CSS functionality, in accordance with the criteria in Regulatory Guide (RG) 1.174, Revision 3, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," dated January 2018 (ML17317A256). RG 1.174 was developed in consideration of the Commission's Policy Statements on safety goals<sup>1</sup> and the use of probabilistic risk assessment methods in nuclear regulatory activities.<sup>2</sup> Therefore, RG 1.174 provides an acceptable method for licensees and NRC staff to use in assessing the impact of licensing basis changes when the licensee chooses to use risk information.

The requirements in GDC 35 require, in part, that the ECCS safety system functions adequately to transfer heat from the reactor core following a LOCA and in the presence of a worst single failure, at a rate such that (a) fuel and clad damage that could interfere with continued effective core cooling is prevented and (b) clad metal-water reactor is limited to negligible amounts. The licensee stated in its application dated

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<sup>1</sup> Commission's Safety Goal Policy Statement, "Safety Goals for the Operations of Nuclear Power Plants; Policy Statement," published in the *Federal Register* on August 4, 1986 (51 FR 28044), as corrected, and republished, on August 21, 1986 (51 FR 30028).

<sup>2</sup> Use of Probabilistic Risk Assessment Methods in Nuclear Activities; Final Policy Statement," August 16, 1995 (60 FR 42622).

March 31, 2021, that the function of the ECCS emergency sump is assumed to fail for scenarios where debris exceeds the amount determined in acceptable plant-specific testing. Failure of the sump and strainers results in loss of cooling to the core. The licensee requested exemptions from the requirements of GDC 35, which requires the use of a deterministic approach, for those LOCA breaks that exceed the plant-specific testing debris threshold. The licensee requested exemptions from the deterministic requirements of GDC 35, to allow the use of a risk-informed analysis, in accordance with the criteria in RG 1.174, to show that the risk from debris effects is very low.

The requirements in GDC 38 require containment heat removal, rapid reduction of containment pressure and temperature, and maintenance of pressure and temperature at an acceptably low level following a LOCA, and in the presence of a single failure, to preserve containment function. The licensee proposed that exemptions be granted from the requirements in GDC 38 that specify the use of a deterministic approach. The request applies only to those LOCA breaks that exceed the plant-specific testing debris threshold. Current Callaway design basis calculations are based on the containment cooling system (containment fan coolers) functioning in conjunction with the CSS and ECCS, both of which can be affected by debris. Using deterministic assumptions, the licensee's analysis and testing does not assure that the emergency sump strainers will be available to support the CSS and ECCS function considering the effects of debris produced by those breaks that can generate and transport debris amounts greater than the plant-specific testing threshold. The licensee requested exemptions from the deterministic requirements of GDC 38 to allow the use of a risk-informed analysis, in accordance with the criteria in RG 1.174, to show that the risk from debris effects is very low.

The requirements in GDC 41, require, in part, containment atmosphere cleanup to control substances that may be released into the reactor containment, to reduce the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents, assuming a single failure. The licensee stated that using deterministic assumptions, its analysis and testing cannot demonstrate that the emergency sump strainers will be available to support the CSS function considering the effects of debris produced and transported by breaks not bounded by acceptable plant-specific testing. The licensee requested exemptions from the deterministic requirements of GDC 41 to allow the use of a risk-informed analysis, in accordance with the criteria in RG 1.174, to show that the risk from debris effects is very low.

### **III. Discussion**

Pursuant to 10 CFR 50.12, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50, when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present. Under 10 CFR 50.12(a)(2)(ii), special circumstances are present when “[a]pplication of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule.”

The licensee proposed to use a risk-informed methodology instead of a deterministic approach to account for the effects of debris in containment for portions of the LOCA analysis applicable to breaks that exceed the Callaway plant-specific debris testing threshold. The licensee’s methodology, termed Risk over Deterministic, or

RoverD, divides the loss of core cooling design-basis analysis into two portions: the “deterministic analysis” and the “risk-informed analysis.” The risk-informed analysis is used by the licensee for breaks that generate and transport debris exceeding the plant-specific testing threshold. These breaks result in fibrous debris estimated to arrive in the ECCS sump post-LOCA in amounts that are equal to or greater than the amount of fiber used in acceptable strainer testing. The acceptable limit was determined using testing methods intended to determine the maximum ECCS strainer head loss for the tested condition.

Also, the licensee evaluated the in-core aspects of fibrous debris to prevent adequate fuel cooling. The licensee found that for in-vessel effects, all breaks that generate and transport fibrous debris amounts less than the strainer acceptance criterion can be evaluated deterministically and shown to have acceptable outcomes. Therefore, the in-vessel effects do not contribute to changes in core damage frequency. For ECCS and CSS analyses other than the postulated large-break LOCAs that generate less than the strainer acceptance limit, the licensee applied a deterministic methodology. If the exemptions were granted for these postulated breaks, the requirement to use a deterministic methodology for all other postulated LOCA breaks would continue to apply.

**A. The Exemptions are Authorized by Law**

The exemptions would allow the use of a risk-informed methodology to show compliance with 10 CFR 50.46(a)(1)(i), and GDCs 35, 38, and 41 of Appendix A to 10 CFR Part 50, when considering debris in containment generated and transported by those breaks that exceed the plant-specific testing threshold. These regulations were promulgated under and are consistent with the Commission’s authority under

Section 161 of the Atomic Energy Act of 1954, as amended. Because the application of a risk-informed methodology to show compliance with 10 CFR 50.46, and GDC 35, 38, and 41 of Appendix A to 10 CFR Part 50, would not violate the Atomic Energy Act of 1954, as amended, or the Commission's regulations, the exemptions are authorized by law provided all requisite findings are made.

**B. The Exemptions Present no Undue Risk to Public Health and Safety**

The provisions of 10 CFR 50.46 and GDCs 35, 38, and 41 of Appendix A to 10 CFR Part 50 establish criteria for the emergency core cooling, containment cooling, and containment atmosphere cleanup system performance. As part of the amendment request, the licensee submitted exemption requests to change its design-basis analysis specified in the Updated Final Safety Analysis Report (UFSAR) to allow use of risk-informed and deterministic methodologies to specifically account for the impacts of debris in containment. The licensee justified its use of the risk-informed approach by stating that the proposed risk-informed approach meets the key principles in RG 1.174, Revision 3, in that it is consistent with defense-in-depth philosophy, maintains sufficient safety margins, results in a small increase in risk, and is monitored by the licensee using performance measurement strategies.

Additionally, the licensee stated that the proposed exemptions, to allow use of the risk-informed method, are consistent with Key Principle 1 in RG 1.174 that requires a proposed change to the licensing basis (or amendment) to meet current regulations unless the change is explicitly related to requested exemptions. The probabilistic risk analysis results provided by the licensee and evaluated by the NRC staff in its safety evaluation, showed that the increase in risk associated with debris generation and transport on ECCS and CSS function following postulated LOCAs is very small, in accordance with the criteria in RG 1.174.



The NRC staff concluded that the risk is consistent with the guidance in RG 1.174 and with the Commission policy statements on safety goals and the use of probabilistic risk assessment methods in nuclear regulatory activities; therefore, the requested exemptions present no undue risk to public health and safety.

**C. The Exemptions are Consistent with the Common Defense and Security**

The requested exemptions would allow the licensee to use a risk-informed methodology to resolve a generic safety concern for PWRs associated with potential clogging of the ECCS and CSS strainers during certain design-basis events. The change is adequately controlled by safety acceptance criteria and technical specification requirements and is not related to security issues. Because the common defense and security is not impacted by the exemptions, the exemptions are consistent with the common defense and security.

**D. Special Circumstances**

Under the regulations in 10 CFR 50.12, the Commission may grant exemptions from the requirements of 10 CFR Part 50 provided certain findings are made; namely, that special circumstances are present, the exemptions present no undue risk to public health and safety, the exemptions are consistent with the common defense and security, and the exemptions are authorized by law. The exemptions would allow the use of a risk-informed methodology to show compliance with 10 CFR 50.46(a)(1)(i), and GDCs 35, 38, and 41 of Appendix A to 10 CFR Part 50, specifically for the analyses of debris in containment impacting emergency cooling function during postulated large-break LOCAs that exceed the plant-specific testing threshold.

The licensee requested exemptions citing the special circumstances criteria of 10 CFR 50.12(a)(2)(ii), because compliance in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying

purpose of the rule. The licensee cited these special circumstances for all of the requested exemptions.

The licensee stated that an objective of each of the regulations for which exemptions are proposed is to maintain low risk to the public health and safety through the adequate functioning of the ECCS and CSS safety systems. These systems must be supported by adequate functioning of the containment sumps. The regulations in 10 CFR 50.46(a)(1)(i) and GDCs 35, 38, and 41 of Appendix A to 10 CFR Part 50 are met when the licensee can demonstrate, using a bounding calculation or other deterministic method that the ECCS and CSS are capable of functioning during design basis events. The licensee stated that its risk-informed analysis to show adequate functioning of ECCS and CSS, considering the impacts of debris during certain LOCA events, demonstrates that the ECCS and CSS systems will operate with a high degree of reliability. The licensee stated that special circumstances exist because the underlying intent of the regulations, to ensure adequate protection of public health and safety is met when applying a risk-informed approach to address GSI-191 and responding to GL 2004-02. Further, it states that the risk-informed approach is consistent with RG 1.174 and supports operation of those functions with a high degree of reliability. Thus, the licensee concludes that the underlying intent of each regulation is met, and the special circumstances described in 10 CFR 50.12(a)(2)(ii) apply to each of the exemptions proposed by the licensee.

The NRC staff evaluated the licensee's application, as supplemented and discussed the details of its evaluation of the risk-informed approach in an NRC safety evaluation available under ADAMS Accession No. ML22220A132. Although 10 CFR 50.46(a)(1) requires a deterministic approach, the GDCs do not specify that a risk-informed methodology may not be used to show compliance; however, because the

NRC has interpreted each of these regulations as requiring a deterministic approach, exemptions are an appropriate means to grant the licensee relief to use an alternative approach. The underlying purpose of each regulation is to protect public health and safety in the event of a LOCA by establishing criteria for emergency core cooling, containment cooling and containment atmosphere cleanup system performance. In its safety evaluation, the NRC staff concluded, in part, that the licensee adequately demonstrated that the change in risk attributable to debris that exceed the plant specific threshold is very small and meets the risk acceptance guidelines in RG 1.174. The NRC staff also concluded that the analysis is consistent with defense-in-depth philosophy, maintains sufficient safety margins, results in a small increase in risk, and is monitored by the licensee using performance measurement strategies. Therefore, the licensee's use of the risk-informed analysis meets the underlying requirements of 10 CFR 50.46 and GDCs 35, 38, and 41 of Appendix A to 10 CFR Part 50, to ensure that a licensee demonstrates that the ECCS and CSS will provide adequate cooling for the reactor core and containment and provide containment atmosphere cleanup during design-basis accidents considering the impacts of debris, since it meets the guidelines in RG 1.174.

Based on the above, the NRC staff concludes that special circumstances under 10 CFR 50.12(a)(2)(ii) exist because compliance with the deterministic requirements of 10 CFR 50.46(a)(1)(i), and GDCs 35, 38, and 41 of Appendix A to 10 CFR Part 50 is not necessary to achieve the underlying purpose of each rule.

**E. Supplemental Information**

For more technical details, refer to the SE associated with these exemptions under ADAMS Accession No. ML22220A130 (enclosure 2).

## **F. Environmental Considerations**

Pursuant to 10 CFR 51.21, “Criteria for and identification of licensing and regulatory actions requiring environmental assessments,” the NRC has prepared an environmental assessment (EA) and finding of no significant impact (FONSI) summarizing the findings of its review of the environmental impacts of the proposed action under the National Environmental Policy Act (NEPA). The NRC staff determined that special circumstances under 10 CFR 51.21 exist to warrant preparation of an EA and FONSI because Callaway is proposing a risk-informed approach to resolve GSI-191 as recognized in Staff Requirement Memorandum SECY-12-0093, “Closure Options for Generic Safety Issue–191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance,” dated December 14, 2012 (ML12349A378). Because this action uses risk information to justify exemptions from deterministic regulations, the NRC staff considered preparations of an EA and FONSI to be a prudent course of action that would further the purposes of NEPA. Based on its review, the NRC concluded that an environmental impact statement is not required and that the proposed action will have no significant impact on the environment.

The NRC published a final EA and FONSI on the proposed action in the *Federal Register* on August 29, 2022 (87 FR 52816).

## **IV. Conclusions**

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12, exemptions are authorized by law, will not present an undue risk to the public health and safety, are consistent with the common defense and security, and special circumstances are present pursuant to 10 CFR 50.12(a)(2)(ii). Therefore, the NRC hereby grants Union Electric Company, dba Ameren Missouri, one-time exemptions from 10 CFR 50.46(a)(1),

and 10 CFR Part 50, Appendix A, GDCs 35, 38, and 41 to allow the use of a risk-informed methodology in lieu of a deterministic methodology to show conformance with the ECCS and CSS performance criteria accounting for debris in containment for those breaks that exceed the plant-specific Callaway testing threshold.

Dated at Rockville, Maryland, this 21<sup>st</sup> day of October 2022.

For the Nuclear Regulatory Commission.

Gregory F. Suber, Deputy Director,  
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