



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
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September 1, 2023

MEMORANDUM TO: Brian W. Smith, Director  
Division of New and Renewed Licenses  
Office of Nuclear Reactor Regulation

FROM: David Rudland, Senior Technical Advisor **/RA/**  
Division of New and Renewed Licenses  
Office of Nuclear Reactor Regulation

SUBJECT: RISK-INFORMED ASSESSMENT OF FRENCH STRESS  
CORROSION CRACKING OPERATIONAL EXPERIENCE  
RELATIVE TO US FLEET

In accordance with the Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-504, Revision 5, "Integrated Risk-Informed Decision-Making Process for Emergent Issues," dated March 4, 2020, the staff of the U.S. Nuclear Regulatory Commission (NRC) has performed a risk-informed evaluation of the potential safety significance of the recent French stress corrosion cracking (SCC) operational experience to the US fleet.

During a typical inservice inspection on October 21, 2021, at Civaux Unit 1 (a 4-loop, 1450 MW pressurized water reactor (PWR)) in France, Électricité de France (EDF) found circumferential cracking at several locations near an elbow in the Emergency Core Cooling System (ECCS). The maximum depth of the cracking was 5.6 mm and, in one case, extended completely around the inside circumference of the pipe. Similar cracking was also found at Civaux Unit 2 and Chooz Unit 2. On November 13, 2021, EDF reported that cracking less severe than the other cases was found in EDF's Penly Unit 1 (a 4-loop 1300 MW PWR) during a routine inspection in the safety injection system (SIS) piping near the cold leg. The locations of the flaws were in a non-isolable section of the piping system that is susceptible to thermal fatigue. In most cases, the cracks were long, but very shallow. Through destructive examinations, EDF determined that the root cause of the cracking was intergranular stress corrosion cracking (IGSCC) caused by thermal stratification and welding residual stresses. Upon expansion of the inspection scope, EDF identified over 100 indications in the piping system lines with higher thermal stratification loads. In addition to the shallow flaws, EDF also found an 85 percent deep, 152 mm (6-inch) long circumferential crack in a non-isolable location in the SIS piping of Penly Unit 1 near the hot leg without the thermal stratification loads found in the other locations.

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In response, the Electric Power Research Institute (EPRI) and the Pressurized Water Reactor Owners Group (PWROG) created a focus group to study these issues, understand their applicability to the US fleet, and make any needed recommendations. The focus group had two goals: (1) assess the potential safety impacts of the EDF operating experience (OE) on the US industry and (2) assess applicability of EDF OE to the US industry. At this point, EPRI has completed its safety assessment and concluded that past inspections of similar SIS locations in the US revealed no indications of SCC and that the issue does not represent a significant safety concern for PWROG members based on an assessment of the likelihood and consequences of such flaws. However, EPRI recommends an IGSCC-specific volumetric inspection procedure (characterized as NEI 03-08<sup>1</sup> “needed”) to address this OE. EPRI’s applicability assessment is still ongoing and is expected to be completed by April 2024.

The enclosure to this memorandum summarizes the NRC staff’s analysis of the safety implications of the French OE relative to the US fleet. The analysis used the Extremely Low Probability of Rupture (xLPR) probabilistic fracture mechanics code to estimate initiating event frequencies caused by SCC, and then use those as inputs in a probabilistic risk assessment. Due to the limited OE from the US fleet, and after conducting a qualitative BeRiskSMART analysis, the staff decided to analyze this problem with a simplified LIC-504 process considering the following two options:

1. Revise inspection requirements for susceptible piping locations consistent with the French OE.
2. Take no direct action but continue to monitor industry actions.

The results of the NRC staff’s analyses indicate that the change in risk for both options is very low and acceptable. Under Option 2, industry implementation of the NEI 03-08 “needed” recommendation to modify the inspection approach at locations where the French OE occurred will maintain safety margins and performance monitoring, thus allowing reasonable assurance of the continued structural integrity of the piping. Therefore, the NRC staff recommends Option 2 since it provides reasonable assurance of safety in an efficient and economical manner.

In addition to continuing to monitor industry actions (e.g., review the PWROG applicability assessment when published and verify implementation of the NEI 03-08 “needed” recommendations), the NRC staff will also hold a public meeting to discuss the NRC staff’s and the industry’s safety analysis results. Additionally, if any OE like that in the French fleet occurs, the NRC staff will ensure that appropriate inspection scope expansion occurs to characterize the emerging degradation, which may include reconsideration of Option 1.

Enclosures:

Risk-informed Assessment of French Stress Corrosion Cracking Operational Experience to the US Fleet  
Management Decision

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<sup>1</sup> NEI 03-08 Rev. 04, “Guideline for the Management of Materials Issues,” Nuclear Energy Institute, October 2020

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 CRACKING OPERATIONAL EXPERIENCE TO THE US FLEET.  
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