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Notice of 10 CFR 21 Defect

Subject:

Notification of 10 CFR 21 Defect

Name and Address of Individual Informing the Commission:

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Framatome Inc.
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Title:

The affected component is the thermal sleeve in the control rod drive mechanism (CRDM) penetration tube in the replacement Reactor Vessel Closure Head (RVCH) provided to the Callaway plant in 2014.

The CRDM thermal sleeve is not listed as a basic component in Table 3 of the Callaway Final Safety Analysis Report [1], but the thermal sleeve can fail in a way that could potentially affect the safety related function of other components.

Identification of Basic Activity:

Simultaneous failure of multiple thermal sleeves could potentially create a substantial safety hazard if multiple control rods fail to fully insert.

Basic Activity Supplied By:

Framatome Inc.

Nature of Defect:

The reportable defect is the unanticipated wear rate of the CRDM thermal sleeve flanges supplied to Callaway as part of the replacement RVCH that was installed during RF20 in the fall of 2014.

In the summer of 2022 in response to industry events related to thermal sleeve flange wear, Framatome provided an assessment to Callaway which

recommended measurement of thermal sleeve descent sometime between 15 and 20 Effective Full Power Years of operation (EFPY).

During Callaway refueling outage RF27 in the spring of 2025, the thermal sleeve at location H08 was found resting on the upper internals. A ring shaped remnant of the thermal sleeve flange had become separated and was present in the CRDM adapter. At the start of RF27 the replacement thermal sleeves had experienced approximately 8.6 EFPY.

Measurements were performed on the remaining CRDM thermal sleeves to determine the amount of thermal sleeve descent from the nominal design configuration. Descent distances ranged from 0.03” to 1.7”, with four thermal sleeves having descent of 0.9” or more.

The failure of a thermal sleeve resulting in a detached flange segment can impact the performance of the corresponding CRDM with the potential to impede or prevent control rod insertion. This issue was first reported under 10 CFR 21 by Westinghouse in Reference [2]. A summary of the NRC evaluation of this issue is provided in Reference [3].

Since the identification of the thermal sleeve flange wear issue by Électricité de France (EdF) in 2018, [4] **Error! Reference source not found.** Framatome is unaware of any instances of a control rod failing to insert due to CRDM thermal sleeve events, even at plants which have experienced multiple locations with complete thermal sleeve flange separation. [5]

Framatome is conservatively making this notification because the undetected simultaneous failure of multiple thermal sleeves could potentially create a safety hazard if multiple control rods fail to fully insert.

Defect Determination Date:

This issue was determined to be a 10 CFR 21 deviation on May 2, 2025. The issue was determined to be a 10 CFR 21 defect on June 10, 2025.

Location and Discussion of Basic Components:

The flange wear rate of the thermal sleeves at Callaway is significantly higher than expected compared to industry experience both domestically and internationally. The Pressurized Water Reactor Owners Group (PWROG) has recently issued a report [6] that reviews actual thermal sleeve wear data from multiple plants and discusses some parameters that seem to contribute to increased thermal sleeve wear. In particular, the Callaway plant is a 4-loop Westinghouse-designed, Tcold plant and has the “inverted top hat" internals configuration. For the data set considered in the PWROG report, the majority of

thermal sleeves requiring repair or replacement were in plants with the inverted top hat internals configuration.

Several other factors unique to Callaway which may have contributed to the accelerated wear rate are the thermal sleeve design (modified centering tabs) and the thermal sleeve material (304L stainless steel vs 304 stainless steel).

Although the causal analysis in still in process, Framatome has reviewed the other replacement RVCHs supplied by Framatome to the US fleet and have not identified any other plants which contain an equivalent combination of conditions that would indicate the potential for accelerated thermal sleeve flange wear.

Based on this review, the population of Framatome supplied thermal sleeves considered to have the potential for accelerated wear is limited to the thermal sleeves installed at the Callaway plant.

Corrective Actions to Date:

Using the measurements taken during RF27 and the operating history of the Callaway plant since installation of the replacement RVCH, a projected thermal sleeve wear rate specific to Callaway was calculated. This wear rate is greater than the industry standards described in References [2] and [3] for PWRs in the US.

Based on this projected wear rate and a Callaway specific thermal sleeve lowering acceptance criteria, four additional thermal sleeves were identified that could potentially separate during the next operating cycle. These four thermal sleeves and the thermal sleeve at location H08 were replaced with an alternate thermal sleeves supplied by another vendor. Framatome has not performed any evaluations of these alternate thermal sleeves.

Framatome is currently performing additional causal analysis on the failed thermal sleeve at Callaway. The results of this analysis will include recommended inspection guidance and suggestions for thermal sleeve remediation for Callaway for the remaining thermal sleeves originally provided with the replacement RVCH. This evaluation is anticipated to be complete on or before Q4 2025.

Advice Related to the Defect:

For the other US plants with Framatome supplied replacement RVCHs with thermal sleeves, Framatome will provide a notification to continue using the current and future inspection guidance published by industry bodies (PWROG / EPRI).

These notifications will be updated as necessary pending completion of the causal analysis on the Callaway thermal sleeves.

References:

[1] Callaway Unit 1 - Revision OL-25 to Final Safety Analysis Report, Chapter 3, Design of Structures, Components, Equipment and Systems (1087 page(s), 6/22/2021), ADAMS ML21193A186

[2] Letter, James A. Greshem (Westinghouse) to NRC, “Notification of the Potential Existence of Defects Pursuant to 10 CFR Part 21”, LTR-NRC-18-34, May 23, 2018.

[3] Memorandum, David L. Rudland (Senior Level Advisor NRC) to George A. Wilson (Director, Division of Material and License Renewal NRC), “Technical Assessment of Potential Control Rod Drive Mechanism Thermal Sleeve Failure,” September 27, 2018.

[4] NRC Information Notice 2018-10: “Thermal Sleeve Flange Wear Leads to Stuck Control Rod at Foreign Nuclear Plant.”

[5] INPO Event #518051: “Control Rod Thermal Sleeve Discovered Detached During Refueling Preparations.”

[6] PWROG-25006-NP, Revision 0, “Thermal Sleeve Flange Wear Rate Study Task 3 Exploratory Data Analysis.”