UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

October 26, 2012

LICENSEE: Entergy Nuclear Operations, Inc.

FACILITY: Palisades Nuclear Plant

SUBJECT: SUMMARY OF THE OCTOBER 12, 2012, AND OCTOBER 18, 2012, MEETINGS REGARDING PALISADES NUCLEAR PLANT CONTROL ROD DRIVE MECHANISM (CRDM) 24 AND CRDM 25

On October 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) held a Conference Call Meeting with members of the Palisades management team at the NRC's request. Discussions were related to the root cause evaluation that was performed on the CRDM 24 housing failure, crack growth rate analysis and future CRDM inspections, and testing performed on the CRDM 25 housing.

Root cause evaluation: The licensee stated that the metallurgical failure analysis conducted by an independent laboratory (Babcox and Wilcox (B&W)) was nearing completion. Two aspects of the investigation, micro-hardness measurements, and residual stress measurements near Weld No. 5 were not yet complete. All available data to date indicated that the observed cracking was transgranular stress corrosion cracking (TGSCC) which was probably the result of stress and an environment which contained elevated temperatures, chlorides, and oxygen. The failure analysis identified several issues, which, in combination, may be significant to the observed cracking. These were:

1. The witness mark appears to be non-concentric with the CRDM housing tube;

2. Weld No. 5 appears concentric with the witness mark and therefore, non-concentric with the tube;

3. The observed cracks are located in two areas. These areas are approximately 120 degrees from each other;

4. A rub mark is present on Weld No. 5. This rub mark is approximately 120 degrees from each area of cracking. The presence of the rub mark may indicate contact between the CRDM and the CRDM housing at Weld No. 5.

5. In 2001, when the CRDM 24 housing was originally installed, it was necessary to drill out (make oversize) two bolt holes in the flange connecting the CRDM housing to the flange due to misalignment between the holes in the CRDM housing flange and the head flange.

When combined, these observations may demonstrate causes and/or effects which could create stresses in Weld No. 5 which would result in the observed cracking.

The licensee indicated that these observations in conjunction with the residual stress measurements from B&W will be forwarded to Lucius Pitkin Incorporated (LPI) for further analysis. This analysis is expected to take 1-2 weeks.

The lack of concentricity of the witness mark and the tube appears to be possibly significant in the failure analysis and because it appears to be a manufacturing defect, the NRC and the licensee discussed whether this situation was unique to the CRDM 24 housing. The licensee indicated that its records did not indicate the presence of any similar manufacturing defects or the need to enlarge bolt holes to achieve alignment in any CRDM housings. The NRC asked whether CRDM housings in storage on site exhibited any eccentricity between the witness mark and the CRDM housing tube. The licensee reported that there was no obvious eccentricity between the tube and witness mark on these housings but that precise measurements had not yet been made. The NRC requested to be informed of these measurements once they are completed.

The licensee noted that the CRDM 24 housing still appeared unique, as it was the only CRDM housing with the flange fit up issue. The licensee stated that, to date, the root cause analysis points to the potential that the observed failures are related to a manufacturing defect and that nothing in the root cause analysis, to date, indicates that the conditions present in the CRDM 24 housing, which may have contributed to the crack, are present in other CRDM housings. The NRC asked the licensee to include the eccentricity of the witness mark and the CRDM housing tube in the extent of condition review, including inspections during the next refueling outage.

Crack growth rate analysis and future CRDM inspections: The licensee stated that, based on their analysis method, the conservative timeline for the CRDM inspections remained at the originally evaluated 40-50 month period, which was the timeline for an undetected crack to propagate. Additional laboratory testing from other facilities did not help them gain any additional insights related to crack growth analysis. The licensee concluded the rings are showing the introduction of new Oxygen over each refueling cycle (with the reactor vessel head removed). The NRC suggested that there were three potential mechanisms for crack growth:

1. The reactor head is removed during refueling outages which causes new oxygen to enter the CRDM housing which results in accelerating the crack growth by TGSCC. The crack propagates and then stops as Oxygen is depleted.

2. Crack growth is continuous when the reactor vessel is under pressure. The inner most areas of the “beach” marks should have the highest thickness of oxygen. The crack will only propagate when oxygen is present. It should take anywhere from one week to three weeks before the oxygenated water leaks out through the CRDM seals. For this mechanism, crack growth is very rapid. Through wall crack growth may be more dependent on the number of times oxygen is introduced into the system than the amount of times the system is operated.

3. Each “beach” mark develops when the primary coolant system temperature/pressure is reduced and does not rely on massive oxygen infusions as are provided by head removal during refueling outages. Given the timing of heat up/cool down cycles in this case, through wall crack growth may have occurred in approximately 2 years.

The NRC mentioned that measuring the optical density around the “beach” marks could provide further insights into the crack growth analysis and that a darker film would indicate the presence of a thicker oxide layer. For all the proposed crack growth mechanisms the actual beach marks will be dark. Also for all the proposed crack growth mechanisms, the area closest to the crack origin will be darkest (have the thickest oxide film) and the area farthest from the origin will be lightest (have the thinnest film). Discounting the color of the actual beach marks, crack growth mechanisms 1 and 2 should produce oxide films in which the oxide film within each growth area has a uniform thickness (uniform optical density) and the oxide thickness and optical density between growth areas varies in a stepwise manner (thickest/darkest in the inner most band, thinnest, lightest in the outermost band). This pattern is expected because oxygen is introduced once each refueling cycle. Also discounting the color of the actual beach marks, crack growth mechanism 3 should produce an oxide film which varies, more or less, uniformly from thickest (darkest) at the origin to thinnest (lightest) away from the origin. No steps in optical density should be expected between growth areas. This pattern is expected because the crack is being exposed to low levels of oxygen throughout its growth. An initial look at some photographs of some cracks from the CRDM 24 housing showed that optical density change does not stair step; this implies that refueling outages may not necessarily be the source of beach marks. The licensee noted the need to be careful while using photographs to perform analysis since lighting, image quality and pixel mapping would need to be considered. The NRC agreed that these issues would affect optical density measurements. The NRC concluded the crack propagation rate issue was still not closed, and noted the importance of follow-on inspections of other CRDMs.

The NRC asked the licensee if they were planning on inspecting any CRDMs during the next refueling outage. The licensee stated that they were planning on conducting inspections during the next refueling outage. The licensee indicated that the exact nature and scope of these exams were still under development and would be provided to the NRC by the end of October 2012. The licensee also indicated that additional examinations would be conducted in subsequent refueling outages. The licensee indicated that they were communicating with Fort Calhoun, which has experienced a similar CRDM failure in the past. The NRC also mentioned it would be interested in the site’s view on potential generic implications to other plants with regards to areas near welds, TGSCC and CRDM designs. The licensee stated that they aware of the potential generic implications to other plants and they were working with industry groups to ensure the information is captured and being evaluated.

Testing performed on the CRDM 25 housing: As a result of the leak observed on the CRDM 24 housing, the licensee conducted ultrasonic examinations of the Weld No. 5 area of 8 additional CRDM housings. As a result of these examinations, the licensee reported that there were no defects in the additional housings examined. The NRC obtained the data from these examinations and provided this information to its contractor, Pacific Northwest National Laboratory (PNNL). During its review of the UT examinations conducted by the licensee on August 20 and August 26, 2012, PNNL detected a possible crack emanating from the internal diameter on the CRDM 25 housing. PNNL identified several indications on the extent of condition examination performed by the licensee that were not reported as flaws or cracks. Some indications were apparently in between the external and internal diameter, while others

were external, and one axial indication was located on CRDM 25 housing emanating from the inner diameter with unknown depth. The latter was the one of concern, because it could be similar to cracks caused by TGSCC. PNNL stated that the UT displayed a fairly bright indication on one particular scan. They mentioned that this indication was displayed in several scans, but not all. It was displayed on the scan that was performed on August 20, 2012, at the 300mm and 350mm mark and in other places in the scan performed on August 26, 2012. PNNL was not sure if the scan was started at the same location on both days. PNNL could not confirm if the indication was surface connected on the internal diameter or connected to the crack on the CRDM, but they could not reject the data as not being a flaw based on the information available to them. The licensee said that their results only showed one indication which was analyzed to be sub-surface and not connected to the inner diameter. The licensee stated that they would review the information, and then discuss the results of this scan with the technical experts from PNNL, NRC, and Westinghouse. Although the NRC agreed that there was no immediate safety concern related to the CRDM 25 housing indication, prompt action by the licensee to determine the results of the UT scan is important. The NRC stated that after the technical experts discussed the issue, another call at the management level would be held to discuss the results.

The call lasted about an hour. Enclosure 1 is a list of attendees for the meeting.

On October 18, 2012, the NRC held a Conference Call Meeting with members of the Palisades management team at the NRC's request. The discussion was related to the possible indication emanating from the internal diameter (ID) of the CRDM 25 housing that was detected by PNNL and discussed with the licensee on October 12, 2012.

The NRC provided a synopsis of previous calls with technical experts from the licensee and the NRC. The NRC stated the licensee's contractor noted indications on the CRDM 25 housing and, based on engineering judgment and their expertise with their equipment, classified these indications as non-relevant. The NRC also stated that its contractor, PNNL, could not draw the same conclusion.

Following the recap of previous calls, the NRC stated that, while it had no immediate safety concern regarding the CRDM 25 housing, additional information was required to promptly resolve the difference in opinion between the licensee's contractor and PNNL concerning the significance of the observed indications. The NRC expressed a strong interest that the licensee perform a test or other assessment on a similar specimen, which could be observed by the NRC, using identical equipment and procedures, to demonstrate that a non relevant indication, such as a surface scratch, as proposed by the licensee, would be detectable and have an appearance in the test data similar to that observed in the CRDM 25 housing data. The licensee stated that they would provide information on their approach to address the NRC's concern on Tuesday, October 23, 2012.

The call lasted approximately 15 minutes. Enclosure 2 is a list of the attendees for the meeting.

Enclosure 3 is a simplified drawing of the CRDM housing.

Sincerely,

/RA/

John B. Giessner, Chief
Branch 4
Division of Reactor Projects

Docket No.: 50-255
License No.: DPR-20

Enclosures:
1. List of Meeting Attendees for the October 12, 2012, Conference Meeting
2. List of Meeting Attendees for the October 18, 2012, Conference Meeting
3. Simplified Drawing of the CRDM Housing

cc w/encl: Distribution via List Serv

Enclosure 1

LIST OF MEETING ATTENDEES FOR THE OCTOBER 12, 2012 CONFERENCE MEETING

NRC Attendees

John Giessner, Chief, Division of Reactor Projects, Branch 4
Istvan Frankl, Chief, Nuclear Reactor Regulation, Plant Licensing Branch III-1
April Scarbeary, Palisades Resident Inspector
Elba Sanchez Santiago, Reactor Engineer, Division of Reactor Safety, Engineering Branch 1
Atif Shaikh, Reactor Engineer, Division of Reactor Safety, Engineering Branch 1
David Alley, Senior Materials Engineer, Nuclear Reactor Regulation, Piping and NDE Branch
Thomas Wengert, Project Manager, Nuclear Reactor Regulation, Plant Licensing Branch III-1
Swetha Shah, Reactor Engineer, Division of Reactor Projects, Branch 4
Diana Betancourt, Reactor Engineer, Division of Reactor Projects, Branch 4
James Neurauter, Senior Reactor Inspector, Division of Reactor Safety, Branch 1

Licensee Attendees

Barry Davis, Entergy Nuclear General Manager Engineering
Charles Arnone, Palisades Nuclear Safety Assurance Director
Jack Milliken, Engineering Supervisor
Paul Deniston, Engineer
Paul Deeds, Engineer
Ben Williams, Engineer
Terry Davis, Licensing Manager
John (Jack) P. Lareau, Chief Engineer, Wesdyne
James Hyres, Babcock & Wilcox

Enclosure 2

LIST OF MEETING ATTENDEES FOR THE OCTOBER 18, 2012
CONFERENCE MEETING

NRC Attendees

John Giessner, Chief, Division of Reactor Projects, Branch 4
Timothy Lupold, Chief, Nuclear Reactor Regulation, Piping and NDE Branch
Thomas Taylor, Palisades Senior Resident Inspector
Elba Sanchez Santiago, Reactor Engineer, Division of Reactor Safety, Engineering Branch 1
Atif Shaikh, Reactor Engineer, Division of Reactor Safety, Engineering Branch 1
David Alley, Senior Materials Engineer, Nuclear Reactor Regulation, Piping and NDE Branch
Thomas Wengert, Project Manager, Nuclear Reactor Regulation, Plant Licensing Branch III-1
Diana Betancourt, Reactor Engineer, Division of Reactor Projects, Branch 4

Licensee Attendees

Barry Davis, Entergy Nuclear General Manager Engineering
Charles Arnone, Palisades Nuclear Safety Assurance Director
Jim Miksa, Engineering Manager
Otto Gustafson, Licensing Manager
Jack Milliken, Engineering Supervisor
Dave Mannai, Sr. Manager, Nuclear Safety and Licensing
John Dills, Operations Manager (Acting GMPO)
Terry Davis, Licensing
John P. Lareau, Chief Engineer, Wesdyne
Dick Smith, Structural Integrity

The call lasted approximately 15 minutes. Enclosure 2 is a list of the attendees for the meeting.

Enclosure 3 is a simplified drawing of the CRDM housing.

Sincerely,

/RA/

John B. Giessner, Chief
Branch 4
Division of Reactor Projects

Docket No.: 50-255
License No.: DPR-20

Enclosures:
1. List of Meeting Attendees for the October 12, 2012, Conference Meeting
2. List of Meeting Attendees for the October 18, 2012, Conference Meeting
3. Simplified Drawing of the CRDM Housing

cc w/encl: Distribution via List Serv

DOCUMENT NAME: Palisades meeting summary - 2012 October 12th and October 18th
☒ Publicly Available ☐ Non-Publicly Available ☐ Sensitive ☒ Non-Sensitive
To receive a copy of this document, indicate in the concurrence box "C" = Copy without attach/encl "E" = Copy with attach/encl "N" = No copy

OFFICE	RIII		RIII					
NAME	SShah:dtp/rj		JGiessner					
DATE	10/26/12		10/26/12					

OFFICIAL RECORD COPY

Letter to Entergy Nuclear Operations, Inc. from J. Giessner dated 10/26/2012

SUBJECT: SUMMARY OF THE OCTOBER 12, 2012, AND OCTOBER 18, 2012, MEETINGS REGARDING PALISADES NUCLEAR PLANT CONTROL ROD DRIVE MECHANISM (CRDM) 24 AND CRDM 25

DISTRIBUTION:
Cayetano Santos
RidsNrrPMPalisades Resource
RidsNrrDorlLpl3-1 Resource
RidsNrrDirsIrib Resource
Chuck Casto
Cynthia Pederson
Steven Orth
Jared Heck
Allan Barker
Christine Lipa
Carole Ariano
Linda Linn
DRPIII
DRSIII
Patricia Buckley
Tammy Tomczak
ROPassessment.Resource@nrc.gov

Palisades Rack and Pinion CRDM