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

February 19, 2015

EA-14-237

Mr. Thomas A. Vehec
Vice President
NextEra Energy Duane Arnold, LLC
3277 DAEC Road
Palo, IA 52324-9785

SUBJECT: DUANE ARNOLD ENERGY CENTER – REACTIVE INSPECTION REPORT 05000331/2014011 AND PRELIMINARY WHITE FINDING

Dear Mr. Vehec:

On October 20, 2014, the U.S. Nuclear Regulatory Commission (NRC) completed its initial assessment of the torus coating delamination, which you discovered on October 9, 2014, at Duane Arnold Energy Center (DAEC). Based on this initial assessment, the NRC sent a Special Inspection Team (SIT) to your site on October 21, 2014.

On January 8, 2015, the team presented the results of this inspection during an exit meeting with you and other members of your staff. The results of this inspection are documented in the enclosed report. The basis for initiating the special inspection and the focus areas for review are detailed in the Special Inspection Charter (Attachment 4 of the Enclosure).

The enclosed report discusses a finding that has preliminarily been determined to be a White finding with low-to-moderate safety significance that may require additional inspections, regulatory actions, and oversight. As described in report Section 4OA5.1.d(1), inadequate quality controls during the application of torus coating resulted in unqualified torus coating in excess of emergency core cooling system (ECCS) suction strainer design debris loading margin. This finding does not present an immediate safety concern because the unqualified torus coating in excess of the design margin was removed during an outage before the reactor resumed operation. The finding was assessed based on the best available information, using the NRC's significance determination process (SDP). The result of the detailed risk evaluation was a change in core damage frequency estimate between 1E-5/yr and 1E-6/yr which was a finding of low-to-moderate safety significance (White). The basis for the NRC's preliminary significance determination is described in the enclosed report. The NRC will inform you in writing when the final significance has been determined.

The finding is also an apparent violation (AV) of NRC requirements and is being considered for escalated enforcement in accordance with the NRC Enforcement Policy, which appears on the NRC's website at http://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html.

We intend to complete and issue our final safety significance determination in accordance with NRC Inspection Manual Chapter (IMC) 0609, "Significance Determination Process," within 90 days from the date of this letter. The NRC's SDP is designed to encourage an open dialogue between your staff and the NRC; however, the dialogue should not affect the timeliness of our final determination.

Before the NRC makes a final decision on this matter, you may choose to: (1) attend a Regulatory Conference, where you can present to the NRC your point of view on the facts and assumptions used to arrive at the finding and assess its significance, or (2) submit your position on the finding to the NRC in writing. If you request a Regulatory Conference, it should be held within 30 days of your receipt of this letter. We encourage you to submit supporting documentation at least 10 days prior to the conference in an effort to make the conference more efficient and effective. The focus of the Regulatory Conference is to discuss the significance of the finding and not necessarily the root causes or corrective actions associated with the finding. If you choose to attend a Regulatory Conference, it will be open for public observation. The NRC will issue a public meeting notice and press release to announce the conference. If you decide to submit only a written response, it should be sent to the NRC within 30 days of your receipt of this letter. If you choose not to request a Regulatory Conference or to submit a written response, you relinquish your right to appeal the final significance determination, in that by not doing either, you fail to meet the appeal requirements stated in the Prerequisite and Limitation sections of Attachment 2 of NRC IMC 0609.

Please contact Christine Lipa at (630) 829-9703, and in writing, within 10 days from the issue date of this letter to notify the NRC of your intentions. If we have not heard from you within 10 days, we will continue with our significance determination and enforcement decision.

Because the NRC has not made a final determination in this matter, no Notice of Violation is being issued for this inspection finding at this time. In addition, please be advised that the number of violations and the characterization of the apparent violation may change based on further NRC review.

The enclosed report also documents one finding of very low safety significance (Green). This finding involved a violation of NRC requirements. The NRC is treating this violation as a Non-Cited Violation (NCV) consistent with Section 2.3.2.a of the Enforcement Policy.

If you contest the subject or severity of the NCV, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, with a copy to the Regional Administrator, U.S. Nuclear Regulatory Commission, Region III; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; and the Resident Inspector at the Duane Arnold Energy Center.

If you disagree with a cross-cutting aspect assignment in this report, you should provide a response within 30 days of the date of this inspection report, with the basis for your disagreement, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001; with copies to the Regional Administrator, Region III; and the NRC Resident Inspector at the Duane Arnold Energy Center.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records System (PARS) component of NRC's Agencywide Document Management System (ADAMS). ADAMS is accessible from the NRC Website at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Kenneth G. O'Brien, Director
Division of Reactor Safety

Docket No. 50-331
License No. DPR-49

Enclosure:
Inspection Report 05000331/2014011
w/Attachments:

1. Supplemental Information
2. List of Documents Reviewed
3. List of Acronyms Used
4. Special Inspection Charter
5. Event Timeline

cc w/encl: Distribution via LISTSERV®

U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No.:	50-331
License No.:	DRP-49
Report No.:	05000331/2014011
Licensee:	NextEra Energy Duane Arnold, LLC
Facility:	Duane Arnold Energy Center
Location:	Palo, IA
Dates:	October 21, 2014, through January 8, 2015
Inspectors:	N. Féliz Adorno, Senior Reactor Inspector (Lead) M. Jones, Reactor Inspector J. Mancuso, Reactor Inspector C. Zoia, Operations Engineer
Technical Experts:	M. Yoder, Senior Chemical Engineer S. Smith, Reactor Systems Engineer
Approved by:	K. O'Brien, Director Division of Reactor Safety

SUMMARY OF FINDINGS

05000331/2014011; 10/21/2014 – 1/8/2015; Duane Arnold Energy Center; Special Inspection.

This report covers a 12-week period of inspection by four regional inspectors and two staff members of the Office of Nuclear Reactor Regulation (NRR). Based on the results of this inspection, one U.S. Nuclear Regulatory Commission (NRC)-identified finding of very-low safety significance (Green) and one self-revealed finding were identified. The self-revealed finding was considered an apparent violation of NRC regulations. The significance of most findings is indicated by their color (i.e., greater than Green, or Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process." Cross-cutting aspects were determined using IMC 0310, "Aspects within the Cross Cutting Areas." Findings for which the SDP does not apply may be Green or be assigned a severity level after NRC management review. All violations of NRC requirements are dispositioned in accordance with the NRC's Enforcement Policy dated July 9, 2013. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 5, dated February 2014.

A. NRC-Identified and Self-Revealed Findings

Cornerstone: Mitigating System

- To Be Determined (TBD) – Preliminary White. An apparent violation of 10 *Code of Federal Regulations* (CFR) Part 50, Appendix B, Criterion IX, "Control of Special Processes," was self-revealed for the failure to install the torus coating under suitable controlled conditions. Specifically, inadequate quality controls during the application of the torus coating resulted in unqualified torus coating in excess of the debris loading design margin of the emergency core cooling system (ECCS) suction strainers. This finding was entered into the licensee's Corrective Action Program (CAP) to evaluate and resolve, including removal of the unqualified torus coating in excess of design margin.

  The performance deficiency was determined to be more than minor because it was associated with the Mitigating System Cornerstone attribute of design control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The finding has been preliminarily determined to be White, a finding of low-to-moderate safety significance, because it affected the function of the low-pressure ECCSs. The team determined that this finding had a cross-cutting aspect in the area of Human Performance because licensee senior managers did not ensure supervisory and management oversight of work activities, including contractors and supplemental personnel. [H.2] (Section 4OA5.1.d(1))

- Green. The team identified a finding having very-low safety significance and a Non-Cited Violation of 10 CFR Part 50, Appendix B, Criterion III, "Design Control," for the licensee's failure to account for all unqualified coating debris available for transport to the ECCS strainers. Specifically, the licensee relied on assumptions that were inconsistent with their licensing basis, resulting in a non-conservative unqualified coating debris loading value which was used in the strainer hydraulic calculations. This finding was entered into the licensee's CAP to evaluate and resolve, including correction of the affected calculations.

The performance deficiency was determined to be more than minor because it was associated with the Mitigating System Cornerstone attribute of design control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The finding screened as very-low safety significance (Green) because it did not result in the loss of operability or functionality. Specifically, the licensee removed conservatisms from the calculations, added the additional unqualified coating debris loading, and reasonably determined the system remained operable. The unqualified torus coating debris associated with the apparent violation did not affect this finding. The team did not identify a cross-cutting aspect associated with this finding because it was not indicative of current licensee performance due to the age of the performance deficiency. (Section 4OA5.1.d(2))

B. **Licensee-Identified Violations**

No violations were identified.

REPORT DETAILS

4OA5 Other Activities

.1 Special Inspection (IP 93812)

a. Event Summary

The torus is a steel pressure vessel which contains approximately 60,000 cubic feet of water. It serves as the initial heat sink for any postulated transient or accident condition in which the normal heat sinks (i.e., main condenser or shutdown cooling system) are unavailable. It also serves as a source of water for the emergency core cooling systems (ECCS) which are relied upon to mitigate the consequences of postulated accidents.

During Refueling Outage 23 (RFO23), which occurred during the fall of 2012, the licensee installed a new coating in the immersed portion of the torus as part of a license renewal commitment to protect the internal torus metal shell and supports from corrosion. During the installation process, the licensee had difficulty with the application of the coating and subsequently identified certain areas that did not achieve the specified coating thickness. As a result, the licensee applied a second coat layer on these areas.

On October 9, 2014, during Refueling Outage 24 (RFO24), the licensee discovered coating delamination in Bays 1, 12, and 15 of the torus. Subsequent activities identified additional delaminated and/or non-bonded coating material in all but one of the bays. Because the failure of this coating could lead to the malfunction of safety-related systems such as the ECCS, the licensee initiated their Failure Investigation Process in accordance with site procedures to identify the apparent cause, determine the extent of condition, implement repairs, and address operability concerns regarding the torus delamination issue.

b. Inspection Scope

A Special Inspection was initiated following the U.S. Nuclear Regulatory Commission (NRC) review of the deterministic and conditional risk criteria specified in Management Directive 8.3, "NRC Incident Investigation Program." The inspection was conducted in accordance with NRC Inspection Procedure (IP) 93812, "Special Inspection." The Special Inspection Team (SIT) Charter, dated October 20, 2014, is included as Attachment 4. The team reviewed technical and design documents, coating application maps, procedures, work orders, corrective action documents, operator logs, vendor documents, and training documents. In addition, the team interviewed station personnel and performed walkdowns of the torus.

A list of specific documents reviewed is provided in Attachment 2.

c. Inspection Documentation

As detailed in the Special Inspection Charter (Attachment 4), the following items were reviewed and associated results obtained.

(1) Establish a historical sequence of events related to the installation of torus coating during the last refueling outage (RFO23). This would include dates and times for

the installation of the initial coat, measurement for acceptance, application of second coat, measurement of acceptance, and post application or adhesion testing. This would also include dates for startup, period when torus cooling was in service such as during high-pressure coolant injection (HPCI) or reactor core injection cooling (RCIC) testing, shutdowns, the time of discovery, and subsequent actions taken by the licensee to address this issue. Identify the time-line for the event and include plant conditions.

The detailed sequence of events is provided in Attachment 5. While the scope of the SIT Charter included the times that torus cooling was in service, this information was not included in this inspection report because the team, in consultation of Regional Management, determined that this information did not have an impact on the delamination process.

In summary, on March 9, 2010, the licensee committed to replace the torus interior coating below the water line prior to startup from the first refueling outage during the period of extended operation (ADAMS Accession No. ML100700248). This commitment was made in response to NRC requests for additional information during the license renewal review.

In November 2012, during RFO 23, the torus coating was replaced with Carboguard 6250N while the unit was in Mode 5. The daily inspection records showed ambient conditions in the torus were maintained at between 71 degrees Fahrenheit and 80 degrees Fahrenheit, and between 8 percent and 21 percent relative humidity for the duration of the project. Although the coating was intended to be applied as a single layer, the licensee identified certain areas that did not achieve the specified coating thickness, and decided to apply a recoat layer on these areas.

On October 9, 2014, during RFO24, the licensee entered the torus while the unit was in Mode 5 with the fuel pool gates removed and discovered coating delamination. The licensee then initiated their failure investigation process and notified the NRC resident inspectors about the discovery. As part of the immediate actions, the licensee removed the majority of the non-bonded coating layer, performed adhesion tests to confirm remaining material was adhered, and evaluated the acceptability of the as-left condition prior to restart.

(2) Review the circumstances surrounding the delamination of coating, including the locations of the delamination and the relationship to potential perturbations during accident conditions, the most likely cause of the delamination; the length of time the torus may have been in an unrecognized condition; and any potential for operators to recognize degraded torus suction strainer conditions, including any actions they may take to mitigate the consequences.

Coating delamination was found in Bays 1-3, 5-11, 15, and 16, as documented in AR01997546 and AR01999648. In addition, work order (WO) 4027893 documented additional non-bonded material removed using hydraulic pressure (i.e., pressure wash) from all of the bays with the exception of Bay 13. All of the non-bonded coating locations would have been perturbed by the turbulent environment created during a design basis accident (DBA) by the high-energy injection to the torus via components such as downcomer pipes and quenchers which are distributed among the bays. The delaminated and non-bonded coating material was from the top coat layer applied on those areas requiring a recoat layer to achieve the specified thickness. Thus, this condition, which went undetected for the entire operating cycle between RFO23 and RFO24, did not result in exposed bare metal. Consequently, this issue did not adversely affect the associated license renewal commitment.

However, since the intended torus coating was qualified for DBA environments as a single coat, top layers that were not chemically bonded to the base coat were unqualified and likely to detach during a DBA and clog the ECCS and RCIC strainers. Strainer clogging represents a safety concern because it adversely affects the ECCS capability to mitigate accident consequences. The ECCS strainers were located at Bays 8, 10, 14, and 16, while the RCIC strainer was located at Bay 11.

Strainer clogging has been the subject of multiple NRC generic communications. For instance, on February 18, 1994, the NRC issued Supplement 1 to Bulletin 93-02, "Debris Plugging of Emergency Core Cooling Suction Strainers," which required interim actions to enhance the capability to prevent or mitigate the loss of ECCS due to strainer clogging following a loss of coolant accident (LOCA.) As a result, the licensee committed to create a procedure to mitigate this condition in letter NG-94-3979 to the NRC titled "Commitment 940362 Closure," dated October 25, 1994. Specifically, Commitment 940362 resulted in the development of procedure SEP 305, "ECCS Suction Strainer Blockage," to, in part, detect potential suction strainer blockage, provide instructions to backflush the residual heat removal (RHR) strainers using diverse configurations if required and directed by the operations shift supervisor, and require the use of alternate injection systems permitted by emergency operating procedures (EOPs). The strainer blockage indicators included in EOPs were low system flowrate or discharge pressure, decreased or erratic suction pressure and/or motor current, and erratic discharge pressure for a given flow. The alternate injection systems permitted by EOPs to maintain reactor pressure vessel (RPV) water level were condensate, feedwater, and control rod drive. However, the team found these mitigating actions questionable during a large LOCA. Specifically, the alternate injection systems would likely isolate during a large LOCA, or lack sufficient capacity to mitigate a large LOCA. In addition, the strainer backwash would not remove the debris from the torus potentially leading to strainer re-clogging.

The most likely cause for the coating delamination was inadequate coating application resulting in lack of recoat chemical bonding to the base coat. Specifically, the coating was designed and intended to be applied as a single coat system. However, inadequate quality controls led to the application of coating in two layers, and the second layer (i.e., the recoat) did not chemically bond to the base coat. The details and enforcement of this issue are discussed in Section 4OA5.1.d(1)of this report.

(3) <u>Review operating experience related to coatings to determine whether the licensee addressed this experience in accordance with their Corrective Action Program (CAP.) This would include industry experience, NRC generic communication, and 10 *Code of Federal Regulations* (CFR) Part 21 reports.</u>

The team reviewed operating experience information related to coatings including NRC Information Notices, 10 CFR Part 21 reports, and industry experience. The team determined the licensee addressed this experience in accordance with their CAP.

(4) Determine if the licensee is performing an adequate root cause for the torus coating delamination. As available, evaluate the scope, schedule, staffing and available results of the licensee's root cause investigation.

The licensee initiated root cause evaluation (RCE) 1999648-01 on October 27, 2014, to determine failure mechanism and causes for the torus coating delamination. The RCE was completed on December 11, 2014. The licensee's RCE determined the root causes were less-than-adequate coating application specification and work instructions; and less-than-adequate vendor guidance for curing schedule. In addition, it determined the contributing causes were less-than-adequate project oversight; and less-than-adequate contingency planning for areas of low-coating thickness.

The inspection team determined that the scope, as described in the root cause charter, was of sufficient depth and breadth. In addition, it was staffed with personnel knowledgeable on root cause investigation and coatings. The team did not identify major concerns associated with the licensee's RCE.

(5) Review procedures used during the installation of the coating including those used for measurement and application of a second coat. Review vendor and/or manufacturer literature to assess any procedural or testing inadequacies which may have contributed to the delamination process. Determine whether the coating material was obtained through a qualified vendor and whether the work was accomplished by trained individuals.

The licensee relied on multiple contractors to develop procedures, create training qualifications, apply the coating, inspect the coating application, and provide oversight of the torus coating project. These contractors, including the coating vendor, maintained a Quality Assurance (QA) Program under 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

The application of the base coat was accomplished by trained individuals using vendor procedures WSS-305100-WI-001, "Work Instructions for Surface Preparation and Coating Application," and WSS-305100-PCP-003, "Specification for Coating Application and Repair Duane Arnold Energy Center (DAEC) Torus Recoat Project." The vendor procedures were based on DAEC specification BECH-MRS-A148, "Torus Coating Installation Specification," and Carboguard 6250N Product Data Sheets. The licensee reviewed and accepted this procedure using procedures DAEC-TS-PEG-07, "DAEC Review of Supplier Documentation," and AD-AA-100-1004, "Preparation, Revision, Review/Approval of Procedures." However, the team noted these procedures did not incorporate the coating wet film thickness measurement requirements stated in DAEC specification BECH-MRS-A150, "Third Party Protective Coatings Inspection Specification," and vendor specifications stated in Carboline PA-3. As a result, significant coating areas did not meet the specified thickness and necessitated the application of a second coating layer (i.e., recoat layer) to achieve the target thickness. However, since the licensee intended the coating to be applied in a single application, they did not have a procedure for the recoat application. The details and enforcement of these issues are discussed in Section 4OA5.1.d(1) of this report.

In addition, the coating vendor specification "Carboguard 6250N Product Data," dated March 2011, included potentially incorrect recoat cure time information. Specifically, in a subsequent letter to the licensee titled "Carboguard 6250N Recoat Window," dated October 22, 2014, the vendor indicated testing was performed on a non-nuclear version of this product and was not performed under various controlled environmental conditions. In addition, the vendor letter stated "The exact times that the work [test] was performed on each day was not noted and he [technical field representative] could not state that a 2-day recoat was equivalent to a full 48 hours or closer to 40 hours." In addition, in a letter to the licensee titled "Carboguard 6250N," dated October 20, 2014, the vendor explained the airless spray equipment used during the coat application may have added heat to the coating and this heat may have shortened the recoat cure time.

(6) Assess the potential for generic implications, that is, possibility of a product defect, inadequate or non-existent vendor guidance.

The team communicated the insights and conclusions from this inspection to members of the Operating Experience Branch of Office of Nuclear Reactor Regulations (NRR). The NRR staff will review this information for potential generic implications.

(7) Determine if the licensee performed an adequate extent-of-condition evaluation to assess if the contributing causes to the delamination have the potential to affect other safety-related structures, systems or components. This would include other surfaces where a similar technique or product was used.

The licensee performed an extent-of-condition evaluation during apparent cause evaluation (ACE) 1999648-04 and RCE 1999648-01. The extent-of-condition evaluation concluded Carboguard 6250N was not applied with more than one layer in any other structure, system, or component. In addition, it did not identify other structures, systems, or components where a second layer was applied to the first layer and did not utilize manufacturer recommendations for cleaning and sanding prior to application of a second layer. The team did not have further questions or concerns.

(8) Assess the adequacy of the licensee's immediate corrective actions, including testing, to the affected areas or the engineering evaluations used to justify acceptance without repair. Review such justification to ensure the licensee addressed the adequacy of adhesion under accident conditions. Observe repairs or testing when possible.

The licensee initiated AR 01997546 on October 9, 2014, upon discovery of the torus coating delamination while in MODE 5 with the spent fuel pool gates removed. On October 16, 2014, the licensee discovered additional areas of delamination and initiated AR 01999648. These corrective action documents were initially screened as severity level 2, which was associated with conditions adverse to quality. As a result, the licensee invoked their failure investigation process, placed a hold on going to MODE 4, and chartered a team to identify the apparent cause, determine the extent-of-condition, implement repairs, and address operability concerns regarding the torus delamination issue. On October 22, 2014, the licensee re-screened AR 01999648 and AR 01997546 as severity level 1. This classification was associated with significant conditions adverse to quality. As a result, the licensee performed a RCE to, in part, further investigate the technical cause of the coating delamination. Section 4OA5.1.c(4) of this report briefly discusses the details of this RCE.

While the licensee's investigation was ongoing, the licensee needed to assess their capability to support continued actions associated with startup. Specifically, on October 22, 2014, the licensee completed a prompt operability determination (POD) under Assignment 8 of AR 01997546 to justify installing the spent fuel pool gates. Specifically, Technical Specifications (TS) 3.5.2 required two low-pressure ECCS subsystems to be operable in MODEs 4 and 5, except with the spent fuel storage pool gates removed and water level greater than or equal to 21 feet and 1 inch over the top of the RPV flange in MODE 5 only. This POD concluded these systems were operable because in these MODEs the RPV is depressurized and, thus, in a low-energy condition resulting in minimal turbulence into the torus due to a LOCA. Flow conditions in this event would be similar to RHR operation in its torus cooling mode and surveillances of its ECCS mode during normal operations. During the RFO24 torus underwater inspection, only a few small pieces of coating debris were identified in the RHR suction strainers.

On November 2, 2014, the licensee completed ACE 1999648-04. It concluded the recoat cure time specified by the coating vendor was the apparent cause because it was not qualified in a controlled environment and may have been incorrect. In addition, the ACE performed an extent of condition as described in Section 4OA5.1.c(7) of this report.

The licensee implemented repairs under WO 40278293 to manually remove delaminated coating with scrapers. The team walked down the torus and observed divers manually removing delaminated coating. The licensee originally planned to confirm the remaining material was properly adhered to the substrate using hydrologic treatment (i.e., pressure washing) and visually inspecting the bays. However, the team determined these methods were inadequate to confirm the remaining coating was DBA qualified. As a result, the licensee performed coating visual examinations and adhesion testing. Visual examinations were performed in accordance with American Standard for Testing of Materials (ASTM) D5163, "Guide for Establishing Procedures to Monitor the Performance of Service Level I Coating Systems in an Operating Nuclear Power Plant," and the licensee used adhesion testing acceptance criteria provided in ASTM D5144, "Standard Guide for Use of Protective Coating Standards in Nuclear Power Plants." Both ASTM standards were endorsed by NRC Regulatory Guide (RG) 1.54, "Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants," Revision 1. The adhesion testing samples included eight base coating samples without recoat layer applied, four samples of intact recoat layer on base coat, four samples of base coating where the recoat layer was removed, and two samples of delaminated coating still in place. Four of these samples experienced glue failures below the acceptance criteria and, thus, did not provide valid results.

The samples of delaminated coating still in place failed well below the acceptance criteria adding confidence to the test setup. The remaining samples met the acceptance criteria with one exception related to intact recoat layer on base coat.

The licensee followed this test with pressure washing of the bays with 5,000 pounds per square inch (psi) at a distance of 4-8 inches to locate and remove the recoat layers that did not achieve chemical bonding with the base coat. Additional adhesion testing and visual inspection were performed. The adhesion test included 16 samples of intact recoat layer on base coating of which two samples did not meet the acceptance criteria. As a result, the licensee performed another round of pressure washing with 5,000 psi at a distance of 1 inch directed specifically on the recoat layer. Afterwards, the licensee performed a final round of visual examinations and adhesion testing. The adhesion test included 12 samples of intact recoat layer on base coating, four samples of base coat without recoat layer applied, and two samples of base coating where the recoat layer was removed. The base coating samples were included in response to team questions regarding potential adverse effects of the aggressive pressure washing to the base coating. All of the samples met the acceptance criteria with the exception of one sample that experienced glue failure resulting in an invalid test data point.

Mechanical scraping removed 1,648.5 square feet of delaminated coating from the total coated surface area of approximately 13,000 square feet. The two rounds of pressure washing removed an additional 3,665 square feet of coating for a total of 5,313.5 square feet. This total was estimated to be 80-95 percent of the applied recoat layer.

After these repair activities were completed, the licensee performed dry film thickness measurements and found approximately 244 square feet of coating areas with thicknesses below the DBA qualification requirements of 18.8 mils established by CAL-A11-001, “Carboguard 6250N Service Level 1 Coating Qualification for Suppression Pool.” These areas represented approximately 23 pounds of unqualified coating with a 15 mils thickness. As a result, on November 4, 2014, the licensee performed a POD under Assignment 1 of AR01997546 and determined ECCS and RCIC would be operable when transitioning to MODEs 3, 2, and 1. Specifically, the POD concluded the amount of unqualified torus coating was bounded by 46 pounds of margin available in design basis calculations of unspecified thickness.

The team reviewed the POD and associated calculations, and noted this margin was incorrectly derived by CAL-A06-001, “Primary Containment – Unqualified Coatings Logs.” Specifically, the calculation relied on assumptions that were inconsistent with the licensing basis established when responding to NRC Bulletin 96-03, “Potential Plugging of ECCS Suction Strainers by Debris in Boiling Water Reactors.” When these assumptions were corrected, the unqualified coating debris acceptance criterion was exceeded even without accounting for the additional 23 pounds of unqualified torus coating. The licensee captured this concern in the CAP as AR02005308 to correct the calculation, perform a new POD, and prohibit transitioning to MODEs 3, 2, and 1 until the new POD was approved. The details and enforcement of this issue are discussed in Section 4OA5.1.d(2) of this report.

On November 15, 2014, the licensee completed the new POD under Assignment 1 of AR02005308 and revised calculations CAL-A06-001, CAL-M98-002, "Post LOCA Debris Generation for ECCS Strainers," and CAL-97-007, "NPSH (net positive suction head) for Core Spray and RHR Pumps." The calculation revisions reduced the margin available for other types of debris sources based on operational history and relocated that margin for the additional unqualified coating loading.

(9) Assess the planned long term corrective actions to prevent recurrence and whether these actions are consistent with the current licensing bases.

The planned long term corrective actions to prevent recurrence were:

- Revise specification BECH-MRS-A148 to require the coating application contractor to measure the wet film thickness during coating application. In addition, the licensee planned to revise other similar specifications for coating applications inside and outside primary containment.
- Revise specification BECH-MRS-A148 as necessary to prohibit use of Carboguard 6250N with multiple layers until the vendor provides a properly qualified recoat window specification.

In addition, the licensee planned the following corrective actions to address the contributing causes:

- Perform a quick hit self-assessment of past major projects completed during RFO23 and RFO24 to identify common themes that led to project delays and workmanship issues associated with less than adequate oversight and contingency planning.
- Assess the training needs for contract coordinators and project managers on the lessons learned from the quick hit self-assessment and the requirements for developing contingency plans and field activity monitoring. Provide training to contract coordinators and project managers based on this assessment.

The team determined these corrective actions addressed the identified root and contributing causes, and were consistent with their current licensing basis.

(10) Identify lessons learned from the Special Inspection and, as appropriate, prepare a feedback form on recommendations for improving reactor oversight process (ROP) baseline inspection procedures.

The team will evaluate and make recommendations in accordance with applicable NRC Management Directives and other NRC procedures.

d. Findings

(1) Failure to Install Torus Coating in Accordance with Established Processes

Introduction: An Apparent Violation (AV) of 10 CFR Part 50, Appendix B, Criterion IX, "Control of Special Processes," was self-revealed for the failure to install torus coating under suitable controlled conditions in November 2012. Specifically, inadequate quality controls during the application of the torus coating resulted in unqualified torus coating in excess of ECCS suction strainer debris loading design margin.

Description: On October 9, 2014, during a planned refueling outage, the licensee entered the torus while the unit was in MODE 5 and discovered coating delamination as documented in AR01997546 and AR01999648. The circumstances surrounding the coating delamination are discussed in detail in Section 4OA5.1.c(2) of this report.

The licensee had performed a design review of the torus coating application under Engineering Change (EC) 274627, "Primary Containment Coating." This EC assumed the coating would be applied as a single coat system, and identified specifications BECH-MRS-A150 and BECH-MRS-A148 as primary design documents. Specification BECH-MRS-A150 defined the requirements for third party inspections of protective coatings. Step 8.2.1 of this specification required the preparation of an inspection procedure for all quality control testing to be performed that included, in part: when, where, and how many measurements to take; list of hold/witness points; pass/fail criteria for all measurements; and what inspection tools to use. Step 8.2.5 required recording wet film thickness measurements. Step 8.5.21 required observing and recording wet film thickness during the coating application. Step 8.6.1 required to establish hold and inspection points during the application of the coating to obtain wet film thickness measurements. These requirements were consistent with coating vendor specification Carboline PA-3, which stated "Application technique and coverage rate shall be checked during the coating application." It also stated "A rough estimate of coverage shall be made with a wet film gauge used immediately after application of coating." Specification BECH-MRS-A148 did not include requirements associated with wet film thickness measurements.

The coating application was accomplished during RFO23 using vendor work instruction WSS-305100-WI-001 and vendor specification WSS-305100-PCP-003, which specified a target wet film thickness of 43- 48 mils. However, these work documents did not incorporate the wet film thickness requirements stated in specification BECH-MRS-A150 and vendor specifications stated in Carboline PA-3. In addition, ACE 1821308-04 found that, although contractor supervision discussed the expectation to measure wet film thickness in several meetings prior to the coating application, the applicators did not consistently measure wet film thickness due to field challenges including time pressure and lack of rags to clean wet film thickness gauges. Interviews conducted for this ACE also found the applicators believed continuous measurement was not needed because the applicators thought they knew how many passes were needed to obtain the target thickness. In addition, the ACE found DAEC contract coordinators did not adequately implement their Field Activity Monitoring Plan, which included observing wet film thickness measurement documentation. As a result, significant coating areas did not meet the specified thickness and, because this discovery was not timely identified during the coating application, the licensee had to apply a second coating layer (i.e., recoat layer) to achieve the target thickness.

Because EC 274627 assumed the coating would be applied as a single coat system and did not include contingency plans for large base coating areas of low-film thickness, the licensee relied on a review of Carboguard 6250N Product Data Sheet and conversations with the coating vendor. Based on this review, the licensee determined the recoat needed to be applied within a temperature-based time window which started when the base coat was applied. For the applicable temperature of 75 degrees Fahrenheit, the specified minimum and maximum recoat target time was 12 hours and 2 days, respectively. The maximum recoat time assumed 50 percent relative humidity and 20 mils coating film thickness. However, the licensee did not evaluate if these assumptions were met and, as a result, failed to recognize elevated surface temperatures, thinner film thickness, and low humidity existed, which adversely affected maximum recoat cure time. The recoat target time window was also likely affected by potentially incorrect recoat cure times included in coating vendor specification Carboguard 6250N Product Data Sheet and the heat added to the coating from the spray pumps. The observations associated to the vendor specifications are discussed in more detail in Section 4OA5.1.c(5) of this report.

In addition, since the licensee originally intended to apply the coating in a single application, they did not develop an implementing procedure for the application of the recoat layer. Specifically, work instruction WSS-305100-WI-001 did not incorporate the guidance for repair activities, such as spraying large areas that did not achieve the specified coating thickness, included in vendor coating specification WSS-305100-PCP-003. This guidance included cleaning and abrading base coat surfaces requiring a recoat layer if cure time was greater than 24 hours. In addition, the work instruction did not include guidance to track base coat and recoat actual application times to ensure recoat application occurred within the specified recoat cure time window to achieve chemical bonding. As a result, the licensee did not adequately manage and implement the recoat layer application.

The amount of failed torus coating significantly increased the debris loading for the ECCS suction strainers resulting in higher head loss and, thus, reduced NPSH available. Section 1.8.30 of the Updated Final Safety Analysis Report (UFSAR,) "RG 1.54, 'Quality Assurance Requirements for Protective Coatings Applied To Water-Cooled Nuclear Power Plants,'" stated "The application of a special protective coating shall be controlled as a special process when the failure (i.e., peeling or spalling) of the coating to adhere to the substrate can cause the malfunction of a safety-related, important to safety, or selected other structure, system or component." UFSAR Section 1.8.1, "Safety Guide 1 (RG 1.1), NPSH for Emergency Core Cooling and Containment Heat Removal System Pumps," stated "The entire spectrum of possible operating modes of the ECCS has been examined for adequacy with regard to NPSH at the RHR, core spray, and HPCI pumps." It also stated "Under no circumstance would there be insufficient NPSH at any of the pumps at any time." Section 1.8.30 of the UFSAR also stated "Special process coatings shall be applied by qualified personnel using qualified materials and equipment, and approved procedures." Section 6.1.2 of the UFSAR, "Organic Materials," stated "Coating qualified for use inside primary containment (i.e., safety-related, Service Level I) are qualified and controlled under the DAEC Protective Coatings Program." It also stated "In the case of Service Level I coatings system laboratory testing, irradiation and DBA testing are included in the qualification process." Therefore, the team concluded the licensee failed to install the coating in accordance with the processes described in the UFSAR and established programs.

The immediate and long-term corrective actions performed under AR01997546 and AR01999648 are discussed in detail in Section 4OA5.1.c(8) and 4OA5.1.c(9) of this report, respectively.

Analysis: The team determined the failure to install torus coating under suitable controlled conditions was contrary to 10 CFR Part 50, Appendix B, Criterion IX, "Control of Special Processes," and was a performance deficiency. The performance deficiency was determined to be more than minor because it was associated with the Mitigating System Cornerstone attribute of design control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Specifically, the capability of ECCS to provide their mitigating function was not ensured because the amount of non-bonded coating exceeded the ECCS suction strainer debris loading margin established by design evaluations.

The team performed a significance screening of this finding using the guidance provided in IMC 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings." The team determined the finding required a detailed risk evaluation in accordance with Exhibit 2, "Mitigating Systems Screening Questions," of IMC 0609, Appendix A, "The Significance Determination Process for Findings At-Power." Specifically, the team concluded the licensee had not demonstrated reasonable assurance that the ECCS pumps would have remained functional based on the information provided by the licensee as of February 4, 2015, including information contained in licensee's letter to the NRC titled "NRC Special Inspection of the Duane Arnold Energy Center Torus Coating Delamination," dated February 4, 2015 (ADAMS Accession No. ML15040A610). This conclusion is based on multiple areas of uncertainty that in aggregate degrade a condition that already resulted in small predicted margins. For example,

- The event resulted in a significant increase in the debris loading of the ECCS suction strainers.

- The original analysis assumed the debris mass was generated in the drywell and transported to the torus and strainers. The as-found conditions resulted in additional debris generated in the torus, being delivered to the strainers before the drywell-generated debris would be transported to the strainers. This scenario would result in strainer surface area being directly blocked off by the transported chips prior to any other debris arriving at the strainer surface. The net effect would be that the fibrous and other debris arriving later would have a reduced surface area to build a bed on. Additionally, the flow area of the strainer would be reduced, increasing velocity through the open area of the strainer. This would increase head loss and could exceed the relatively small margins predicted by the empirical correlations used by the licensee past operability review (POR). These empirical correlations assumed all the fibrous and coating debris are generated at and transported from the drywell.

- The performance deficiency resulted in small margins for RHR and core spray (CS) during runout conditions. Section 6.3.2.2.8 of the UFSAR, "Evaluation of RHR (LPCI) Pump Runout Conditions," and Section 15.2.1, "Loss of Coolant Accidents," discuss runout conditions during the first ten minutes of a LOCA and assume no operator actions. Section 6.3.1, "Design Bases and Summary Description," states "Automatic actuation is provided such that no operator action is required until ten minutes after an accident, to allow for operator assessment and decision…"

- There is uncertainty as to what the coating debris size characteristics would be under LOCA conditions because degraded (i.e., no longer qualified) Carboguard 6250N characteristics have not been studied under LOCA conditions. If the coatings failed as particulate it is highly likely that the strainers would fail on NPSH. This assertion is based on the NRR staff's observations of the empirical correlation's response to fine particulate in the form of sludge. If the failed coatings remain in chip form as the licensee asserts, then the scenario described by the second bullet above becomes applicable.

In addition, the POR evaluated the potential impact of the unqualified torus coating to the use of RHR in the suppression pool cooling mode combined with safety relief valve operation. It concluded suppression pool cooling remained operable. However, the team noted the evaluation relied on information that did not appear to be applicable for this condition. For example, it relied on a study designed to simulate a pressurized water reactor environment with uniform flow while the torus environment would be thermo-hydraulically more violent with turbulent flow and on a study that established transport metrics for chips much smaller than the majority of the chips found in the torus.

The Senior Reactor Analysts (SRAs) performed a detailed risk evaluation in accordance with IMC 0609 Appendix A, "The Significance Determination Process for Findings At-Power." The SRAs used the Duane Arnold Standardized Plant Analysis Risk (SPAR) Model, version 8.26, and the Systems Analysis Program for Hands-on Integrated Reliability Evaluations (SAPHIRE), version 8.1.2.0, to perform the evaluation. The Duane Arnold SPAR model contains both internal events and external events. Specifically, the external events considered in the model include fire and seismic events. The exposure period used in the evaluation was one year.

The additional 5,313.5 square feet of potential debris in the torus due to the performance deficiency was assumed to plug the suction strainers resulting in a loss of NPSH and failure of the low-pressure ECCS pumps in response to medium and large LOCA initiating events. This assumption was modeled by setting a basic event in the risk model representing common cause plugging of all four strainers for low pressure ECCS to "True" which results in the failure of the low pressure ECCS pumps. The HPCI and RCIC systems were not significantly affected by the performance deficiency because their normal suction source is initially the condensate storage tank. The dominant core damage sequence was a large LOCA event followed by failure of low-pressure injection and low-pressure core spray due to the performance deficiency. The total failures of low pressure injection and low pressure core spray systems represented an upper bound. The delta core damage frequency (CDF) calculated was 1.0E-5/yr.

The SRAs performed several lower bounding sensitivity evaluations given the overall complexity and uncertainty in evaluating strainer and ECCS pump performance considering the additional amount of debris in the torus due to the inspection finding. For the medium and large break LOCA scenarios, an evaluation was performed by setting the common cause failure probability for low-pressure ECCS strainer plugging to a failure probability of 0.1. This failure probability was selected to show the risk significance of the finding if common cause strainer plugging due to the performance deficiency was considered to be a high-likelihood but not certain failure. Currently, no data is available to estimate strainer plugging probabilities as a result of a performance deficiency involving inadequate torus coating applications. Using a 0.1 failure probability, the delta CDF calculated was 1.0E-6/yr. The preliminary conclusion of the detailed risk evaluation, considering the best estimate case with the strainers assumed to plug and the sensitivity case using a 0.1 failure probability, was a finding of low-to-moderate safety significance (White).

The SRAs also considered the potential risk contribution from non-LOCA scenarios, including fire scenarios and other external events contained in the SPAR model, in several sensitivity evaluations. The results of these evaluations varied from very-low safety significance to high safety significance, depending on the assumptions regarding how many strainers were impacted and the probability of strainer plugging. For initiating events other than medium and large LOCAs, such as a fire-induced loss of offsite power (LOOP) events, the use of the RHR system in the suppression pool cooling mode combined with safety relief valve operation could also impact strainer performance and pump operation due to the additional debris in the torus. However, the potential impact was considered to be less in these scenarios since there will be no debris generated from the drywell, the energy deposited in the torus is less than a LOCA event, and the environment is judged to be significantly less challenging to the non-bonded coating material portion that was removed with hydraulic pressure. As a result of a qualitative assessment that the potential impact is considered to be less for these scenarios, the preliminary NRC significance determination is based primarily on the consideration of only LOCA scenarios. The NRC will continue to consider both LOCA and non-LOCA scenarios when completing the final SDP evaluation of the finding.

The SRAs used IMC 0609, Appendix H, “Containment Integrity Significance Determination Process,” to evaluate the potential risk contribution from large early release frequency (LERF). Duane Arnold is a General Electric (GE) boiling water reactor (BWR) plant with a Mark I containment. Using Table 5.1 from Appendix H, the SRAs determined that the finding was not risk significant for LERF because the dominant core damage sequences did not involve anticipated transient without scram, station blackout, or sequences involving core melt at high reactor coolant system pressure.

The licensee performed a draft risk evaluation and concluded that the finding was of very-low safety significance (Green). The draft evaluation increased strainer plugging probabilities based on engineering judgment. The SRAs considered the information provided and concluded that the increased plugging probabilities used in the licensee’s analysis represented strainers that remained very reliable which was inconsistent with the NRC’s preliminary conclusions on the impact of the additional debris on strainer performance. Additionally, the SRAs noted that the licensee’s evaluation did not appear to fully address common cause plugging of the low-pressure ECCS system strainers during LOCA conditions.

The licensee also stated that operators would take action within the first ten minutes of a LOCA event in response to annunciators that would indicate loss of NPSH for operating low pressure ECCS pumps. It was unclear if the actions to reduce flow after receiving alarms, such as on pump motor overload, would be successful in maintaining injection flow and restoring adequate NPSH simultaneously. The SRAs reviewed the proposed actions to determine if they would change the preliminary SDP result if successful, but concluded that the actions would not be reliable and would not change the preliminary result.

The team determined that this finding had a cross-cutting aspect in the area of Human Performance because senior managers did not ensure supervisory and management oversight of work activities, including contractors and supplemental personnel. Specifically, contractor oversight failed to ensure the wet film thickness inspection requirements of specification BECH-MRS-A150 were incorporated in procedures and did not ensure the project implementation plan included contingency plans for large base coating areas of low film thickness. In addition, leaders were not seen in the work areas of the plant observing, coaching, and reinforcing standards and expectations. Specifically, DAEC contract coordinators did not implement their monitoring plan which included verifying wet film thickness measurements were taken. [H.2]

Enforcement: Title 10 CFR Part 50, Appendix B, Criterion IX, "Control of Special Processes," required measures to be established to assure that special processes, including welding, heat treating, and non-destructive testing, are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.

Section 1.8.30 of the UFSAR, "RG 1.54, 'Quality Assurance Requirements for Protective Coatings Applied To Water-Cooled Nuclear Power Plants,' stated, in part, "The application of a special protective coating shall be controlled as a special process when the failure (i.e., peeling or spalling) of the coating to adhere to the substrate can cause the malfunction of a safety-related, important to safety, or selected other structure, system or component." This section also stated "Special process coatings shall be applied by qualified personnel using qualified materials and equipment, and approved procedures." Section 6.1.2 of the UFSAR, "Organic Materials," stated, in part, that "Coating qualified for use inside primary containment (i.e., safety related, Service Level I) are qualified and controlled under the DAEC Protective Coatings Program." It also stated "In the case of Service Level I coatings system laboratory testing, irradiation and DBA testing are included in the qualification process."

From November 5-10, 2012, the licensee apparently failed to establish measures to assure that special processes were controlled and accomplished using qualified procedures in accordance with applicable standards and criteria. Specifically, the licensee did not control the application of the torus coating, a special process, because the requirements associated, in part, with wet film thickness measurements and conditions for recoat application that were contained in design specifications and vendor documentation were not included in procedures, and thus were not met.

The licensee's immediate corrective actions included removal of the non-bonded coating and evaluating the acceptability of the unqualified coating areas that remained in the torus as described in Section 4OA5.1.c(8).

Because the final significance of this finding has not been determined, it is being treated as an AV pending a final significance determination (AV 05000331/2014011-01; Failure to Install Torus Coating in Accordance with Established Processes).

(2) Inadequate Coating Strainer Debris Loading Calculation

Introduction: A finding of very-low safety significance (Green) and associated Non-Cited Violation (NCV) of 10 CFR Part 50, Appendix B, Criterion III, "Design Control," was identified by the team for the failure to account for all unqualified coating debris available for transport to the ECCS strainers. Specifically, the licensee relied on assumptions that were inconsistent with their licensing basis resulting in a non-conservative unqualified coating debris loading value which was used in ECCS strainer hydraulic calculations.

Description: Following the repair activities for torus coating delamination described in Section 4OA5.1.c(8) of this report, the licensee performed dry film thickness measurements of the torus coating that remained in place and identified approximately 244 square feet of coating areas with thicknesses less than 18.8 mils. These coating areas were considered unqualified because the torus coating DBA qualification, as documented in CAL-A11-001, was established based on a minimum thickness of 18.8 mils. The approximately 244 square feet of coating were equivalent to approximately 23 pounds of unqualified coating with a 15 mils thickness.

In MODEs 1, 2, and 3, TS 3.5.1, “ECCS – Operating,” becomes applicable and requires “Each ECCS injection/spray subsystem and the automatic depressurization system (ADS) function of four safety/relief valves shall be operable.” Therefore, to justify transitioning to these MODEs, the licensee performed a POD under Assignment 1 of AR01997546 on November 4, 2014, to evaluate the additional unqualified coating for potential impact to the operability of the ECCS suction strainers. The POD determined ECCS and RCIC would be operable because the amount of unqualified torus coating was bounded by 46 pounds with an unspecified thickness of margin available in design basis calculation CAL-A06-001.

However, the team identified that the licensee derived this margin using calculation CAL-A06-001 assumptions which were inconsistent with the design basis established when responding to NRC Bulletin 96-03. As a result, the calculated ECCS strainer unqualified coating debris loading value was non-conservative. Specifically, licensee letter NG-97-1909 titled “Response to NRC Bulleting 96-03,” dated November 20, 1997, stated “The quantities for drywell dust, dirt, rust from unpainted surfaces, paint, coating and transportable foreign materials will follow the Utility Resolution Guide (URG) recommendations as supplemented by plant specific data.” The URG is NEDO-32686, “URG for ECCS Suction Strainer Blockage.” Further, this design basis was incorporated in UFSAR Section 6.2.1.6.2.5, “Containment Debris Generation Post LOCA,” which stated “The DAEC used the guidance of NEDO-32686 to evaluate the quantity of debris that would be present on the ECCS strainers following a large break LOCA.” This guidance incorporated the analyses of report titled “Performance of Containment Coatings during a Loss of Coolant Accident,” dated November 10, 1994. This report stated “All coatings in the near proximity of a line break will fail regardless of their qualification status.” In contrast, calculation CAL-A06-001 assumed only 50 percent of unqualified drywell coating inside the zone of influence (ZOI) will fail and be available for transport to the strainers during a LOCA.

In addition, the licensee had not removed unqualified drywell coating outside the ZOI but CAL-A06-001 implicitly assumed they would not failed during a DBA and, thus, would not transport to the ECCS suction strainers. With respect to plant specific analysis related to unqualified coating, NEDO-32686 stated “The URG does not provide any specific guidance other than a licensee should determine the quantity of such debris that can be available to transport to the suppression pool.” It also stated “As an alternative, the URG notes that licensees may remove the unqualified or indeterminate coatings, or attempt to qualify them through in situ qualification.” However, the licensee had not performed a site specific evaluation or in situ qualification to support the implicit assumption that unqualified drywell coating outside the ZOI would not fail and transport to the strainers during a DBA.

When these assumptions were corrected, the unqualified drywell coating was approximately 76 pounds with a 3 mils thickness in excess of the acceptance criteria even without accounting for the additional 23 pounds of unqualified torus coating with a

15 mils thickness. Thus, calculation CAL-A06-001 and the recent POD were incorrect. The licensee captured this concern in the CAP as AR02005308. As a result, the licensee corrected the calculation, performed a new POD, and prohibited transitioning to MODEs 3, 2, and 1 until the new POD was approved. The licensee also revised other ECCS hydraulic calculations and regained sufficient margin to justify ECCS operability.

Analysis: The team determined the failure to account for all unqualified coating debris available for transport to the ECCS strainers was contrary to 10 CFR Part 50, Appendix B, Criterion III, "Design Control," and was a performance deficiency. The performance deficiency was determined to be more than minor because it was associated with the Mitigating System Cornerstone attribute of design control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Specifically, the design basis calculations did not ensure the ECCS capability to provide their mitigating function because the calculations failed to account for all unqualified coating debris that could clog the ECCS suction strainers during a DBA.

The team determined that the finding could be evaluated using the SDP in accordance with IMC 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings." Because the finding impacted the Mitigating Systems cornerstone, the team screened the finding through IMC 0609 Appendix A, "The Significance Determination Process for Findings At-Power," using Exhibit 2, "Mitigating Systems Screening Questions." The finding screened as very-low safety significance (Green) because it did not result in the loss of operability or functionality. Specifically, the licensee removed conservatisms from the calculations, added the additional unqualified coating debris loading, and reasonably determined the system remained operable. Even though the inadequate calculation was in effect during the period the torus contained unqualified coating as discussed in Section 4OA5.1.d(2), the risk impact of this finding to that period was incorporated into the apparent violation discussed in that section.

The team did not identify a cross-cutting aspect associated with this finding because it was not indicative of current licensee performance due to the age of the performance deficiency. Specifically, the error was introduced in the affected calculation more than three years ago.

Enforcement: Title 10 CFR Part 50, Appendix B, Criterion III, "Design Control," required, in part, that measures shall be established to assure that applicable regulatory requirements and the design basis are correctly translated into specifications, drawings, procedures, and instructions. Section 6.2.1.6.2.5 of UFSAR discussed the design basis for containment debris generation and stated "The DAEC used the guidance of NEDO-32686 to evaluate the quantity of debris that would be present on the ECCS strainers following a large break LOCA." This guidance incorporated the analyses of report titled "Performance of Containment Coatings during a Loss of Coolant Accident," dated November 10, 1994. This report stated "All coatings in the near proximity of a line break will fail regardless of their qualification status." With respect to plant specific analysis related to unqualified coating, NEDO-32686 stated "The URG does not provide any specific guidance other than a licensee should determine the quantity of such debris that can be available to transport to the suppression pool." In addition, it stated "As an alternative, the URG notes that licensees may remove the unqualified or indeterminate coatings, or attempt to qualify them through in situ qualification."

Contrary to the above, as of November 6, 2014, the licensee failed to assure that applicable regulatory requirements and the design basis were correctly translated into specifications, drawings, procedures, and instructions. Specifically, the design basis for containment debris generation was not correctly translated into calculation CAL-A06-001 as evidenced by the following examples:

- The calculation assumed only 50 percent of unqualified coating inside the ZOI will fail and be available for transport to the strainers during a LOCA when the design basis assumed all coatings in the ZOI fails regardless of their qualification status.

- The calculation implicitly assumed unqualified coatings outside the ZOI will not fail during a LOCA without a plant specific analysis or in situ qualification.

Even though the inadequate calculation was in effect during the period the torus contained unqualified coating as discussed in Section 4OA5.1.d(2), the risk impact of this finding to that period was incorporated into the apparent violation discussed in that section.

The licensee's corrective actions included correcting the calculation, performing a new POD, and prohibiting transitioning to MODEs 3, 2, and 1 until the new POD was approved.

Because this violation was of very low safety significance and was entered into the licensee's CAP as AR02005308, this violation is being treated as a NCV, consistent with Section 2.3.2 of the NRC Enforcement Policy (NCV 05000331/2014011-02; Inadequate Coating Strainer Debris Loading Calculation).

4OA6 Management Meetings

1. Exit Meeting Summary

On January 8, 2015, the team presented the inspection results to Mr. T. Vehec and other members of the licensee staff. On February 13, 2015, the team had follow-up discussions with Mr. T. Vehec and other members of the licensee staff regarding the preliminary characterization of the apparent violation. The licensee acknowledged the issues presented. The inspectors confirmed that none of the potential report input discussed was considered proprietary.

ATTACHMENTS:

1. Supplemental Information
2. List of Documents Reviewed
3. List of Acronyms Used
4. Special Inspection Charter
5. Event Timeline

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee

T. Vehec, Site Vice President
K. Kleinheinz, Engineering Director
J. Maham, Nuclear Oversight Manager
R. Wheaton, Operations Director
C. Moser, Training Supervisor
L. Swenzinski, Licensing Engineer
R. Murrell, Licensing Engineer

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C. Lipa, Division of Reactor Safety, Engineering Branch 2, Chief
A. Stone, Division of Reactor Projects, Technical Support Team Leader
L. Kozak, Division of Reactor Projects, Senior Reactor Analyst
N. Féliz Adorno, Division of Reactor Safety, Senior Reactor Inspector

LIST OF ITEMS OPENED, CLOSED AND DISCUSSED

Opened

05000331/2014011-01	AV	Failure to Install Torus Coating in Accordance with Established Processes (Section 4OA5.1.d(1))
05000331/2014011-02	NCV	Inadequate Coating Strainer Debris Loading Calculation (Section 4OA5.1.d(2))

Closed

05000331/2014011-02	NCV	Inadequate Coating Strainer Debris Loading Calculation (Section 4OA5.1.d(2))

LIST OF DOCUMENTS REVIEWED

The following is a partial list of documents reviewed during the inspection. Inclusion on this list does not imply that the NRC inspector reviewed the documents in their entirety, but rather that selected sections or portions of the documents were evaluated as part of the overall inspection effort. Inclusion of a document on this list does not imply NRC acceptance of the document or any part of it, unless this is stated in the body of the inspection report.

CALCULATIONS

Number	Description or Title	Revision
CAL-A06-001	Primary Containment – Unqualified Coatings Log	5
CAL-A06-001	Primary Containment – Unqualified Coatings Log	6
CAL-M98-002	Post LOCA Debris Generation for ECCS Strainers	2
CAL-M98-002	Post LOCA Debris Generation for ECCS Strainers	3
CAL-M97-007	NPSH for Core Spray and RHR Pumps	4
CAL-M97-007	NPSH for RHR and CS Pumps	3
CAL-A11-001	Carboguard 6250n Service Level I Coating Qualification for the Suppression Chamber	0
CAL-M97-008	HPCI NPSH Calculation	3
CAL-M97-009	RCIC NPSH Calculation	3

CORRECTIVE ACTION DOCUMENTS GENERATED DUE TO THE INSPECTION

Number	Description or Title	Date
AR02003738	Commitment Change for Service Level 1 Coating Qualification	10/31/14
AR02005308	POD01997546 Torus Secondary Coating Layer Delamination	11/6/14
AR02005389	Reference Number Error in POD 1997546-01	11/7/14
AR02014069	Revised Debris Assumptions for Torus Coating POR	12/18/14

CORRECTIVE ACTION DOCUMENTS REVIEWED DURING THE INSPECTION

Number	Description or Title	Date
AR01997546	Coating Delamination Found in Bay 1 of the Torus	10/9/14
AR01999648	Additional Coating Delamination Found in Torus	10/16/14
AR01806408	CR Re: Lack of Temperature Monitors in Coating Shipment	10/21/14
AR00349116	OE 006559 OE20671 – Peeling Paint Found on Reactor	6/30/05
AR00293541	IN97-13: Deficient Conditions Associated with Protective Coatings	4/24/97
AR00326994	CAQ – Torus Underwater Coating Does Not Meet ANSI N101	3/4/08
AR01822751	Torus Heatup Plan Slower than Anticipated	11/12/12
AR01823554	Concern With Torus Heatup	11/14/12

CORRECTIVE ACTION DOCUMENTS REVIEWED DURING THE INSPECTION

AR 01855940	PCPP 2.1 – Long Term Strategy for Primary Containment Suppression Chamber (Torus)	6/13/13
AR00670520	CDBI Water Hammer Calculation Temperature Assumption	9/12/07
AR01806408	Carboguard 6250N and 2012N Shipped Without Temp. Monitoring	9/24/12
AR01815084	Downcomer Coating Requirement	10/10/12
AR01818244	Impact on Plant Equipment During Coating Cure Time in Torus	10/30/12
AR01819397	Three Williams Personnel Exceeded 72/7	11/2/12
AR01821308	Torus Coating Rework	11/13/12
AR01846294	CAL-M98-002 and PCPP 2.1 Need Updated Following Torus Recoat	2/7/13
AR02005308	Torus Secondary Coating Layer Delaminations	11/15/14
AR01431174	P2R19 Torus Unqualified Coatings, Assignment 2 (ACE)	10/24/12
WSS-2012-305100-001	Deficient Coating that Requires Rework	11/16/12
WSS-2012-305100-002	Interior of Seven Pipes Not Prepared and Coated During RFO23	11/18/12
AR01816385	PSV 4402 Opening Results in Water Transfer to Torus	10/24/12

MISCELLANEOUS

Number	**Description or Title**	**Date or Revision**
QF-0136	Inspector Qualification – ITLS	3
OBD000304	CAQ – Torus Underwater Coating Does Not Meet ANSI N101.2 requirements	4/24/08
S107	Paint Mixing Log	11/10/12
WSS-305100-PCP-001	Qualification Training of Project Personnel	5
BECH-MRS-A150	Third Party Protective Coatings Inspection Specification	A
BECH-MRS-148	Torus Coating Installation Specification	1
S107	Paint Mixing Log	11/10/12
	Coating Material Receipt Inspections	10/20/12
	Shift Turnover Logs	RFO23
	Carboguard 6250 N Product Data Sheet	6/2012
	Carboline letter to G. Dolderer Re: Carboguard 6250 N	10/20/14
	Carboline letter to G. Dolderer Re: Carboguard 6250 N Adhesion Strength	10/21/14
	Carboline letter to G. Dolderer Re: Retain Evaluation	10/22/14
	Carboline letter to G. Dolderer Re: Carboguard 6250 N Recoat Window	10/22/14
	Carboline letter to G. Dolderer Re: Carboguard 6250 N – Amine Blush Removal	1/26/12

MISCELLANEOUS

Number	Description or Title	Date or Revision
	Certificate of Conformance: Torus Recoat Project	12/5/12
	Carboline Letter to G. Dolderer Re: Carboguard 6250N – Spray tip nozzle	11/19/14
	MSDS: Carboguard 6250 N	10/5/11
	Product Data Sheet: Plasite 4550 S	10/2009
	Nuclear Projects Team Room Turnover sheets	11/6-9/12
	Nuclear Projects Team Room Turnover sheets	11/9-12/12
50007, 95.03	EOP Support ILT Lesson Plan	14
50023 2013A	NSPEO Continuing Training	0
203000-03	JPM: Respond to ECCS Suction Strainer Blockage	3
RH05	Simulator Malfunction: RHR Suction Blockage	3
149.0	Residual Heat Removal System Initial Systems Lesson	0
002N2591	DAEC ECCS Strainer Evaluation Letter Report	2
002N2591	DAEC ECCS Strainer Evaluation Letter Report	3
002N2591	DAEC ECCS Strainer Evaluation Letter Report	4
PCPP 1.1	Protective Coating Program Plan for DAEC	3
WCD 40278293	FAR #8 Underwater Torus Adhesion Testing Phase 2	0

MODIFICATIONS

Number	Description or Title	Date or Revision
EC 274627	Primary Containment Coating	2

PROCEDURES

Number	Description or Title	Revision
WSS-305100-PCP-003	Specifications for Coating Application and Repair	3
WSS-305100-WI-001	Work Instructions for Surface Preparation and Coating Application	3
OI-149	Residual Heat Removal System	145
PCP-001	Qualification and Training of Project Personnel	5
PCPP 1.1	Protective Coating Program Plan	3
PI-AA-100	Condition Assessment and Response	7
WSS-305001-F-001	Paint Mixing Log	0
WSS-305001-F-002	Qualification of Personnel Performing Coating Work	3
WSS-305001-F-004	Process Control Traveler	3
WSS-305001-F-DIR-1	Daily Coating Inspection Record	1
WSS-305100-PCP-003	Specifications for Coating Application and Repair	3
WSS-305100-PCP-005	Work Controls	0

PROCEDURES

Number	Description or Title	Revision
WSS-305100-PCP-007	Control of Purchased Coating Material, Equipment, and Services	1
WSS-305100-PCP-008	Identification and Control of Materials	1
WSS-305100-PQP	Project Quality Plan	2
SEP 305	ECCS Suction Strainer Blockage	3
OI-149	Residual Heat Removal System	145
AOP 301.1	Station Blackout	55
OI-150	Reactor Core Isolation Cooling System	77
OI-151	Core Spray System	74
OI-152	High Pressure Coolant Injection System	110
OP-AA-106	Severe Accident Management Program	2
OP-AA-107	Extensive Damage Management Program	4
EOP-1	RPV Control	18
EOP-2	Primary Containment Control	18
EOP-3	Secondary Containment Control	20

DRAWINGS

Number	Description or Title	Date or Revision
	DAEC Torus Bay Coating Maps (Bay 1 – 15)	10/2012
BECH-M043	Suppression Chamber Plan, Sections and Penetrations	26
ISO-GBC-006-01	Isometric – Reactor Building Main Steam (Inside Drywell)	7
S12-0041-001	WSS LLC General Arrangement Ventilation System	A
ISO-HBB-023-01	RHR Pumps – Shut-down & Suction (NW)	3
ISO-HBB-023-02	RHR Pump Suction (NW)	4
ISO-HBB-023-03	RHR Pump Suction 1P229B&D (NW)	3
ISO-HBB-023-04	RHR Pumps - Shut-down	2
ISO-HBB-024-01	RHR Pump Suction (SE)	0
ISO-HBB-024-02	RHR Pump Suction (SE)	3
ISO-HBB-024-03	RHR Pump Suction (SE)	1
ISO-HBB-024-04	RHR Pumps - Shut-down	1
ISO-HB-001-01	Core Spray Pump Suction (NW)	0
ISO-HB-001-02	Core Spray Pump Suction (SE)	0
BECH-M120	Core Spray System P&ID	68
BECH-M121	Core Spray System P&ID	40
BECH-M113	RHR System P&ID	75
BECH-M115	RHR System P&ID	60
BECH-M118	RHR System P&ID	85

WORK DOCUMENTS

Number	Description or Title	Date or Revision
WO40278293	SUS59.00: Underwater Torus Inspection	0
WSS-305100-F-DIR-1D	Environmental Conditions Record	10/20/12 to 11/17/12

LIST OF ACRONYMS USED

ADAMS	Agencywide Document Access and Management System
ADS	Automatic Depressurization System
ASTM	American Standard for Testing of Materials
AV	Apparent Violation
BWR	Boiling Water Reactor
CDF	Core Damage Frequency
CFR	*Code of Federal Regulations*
CS	Core Spray
DAEC	Duane Arnold Energy Center
DBA	Design Basis Accident
DRP	Division of Reactor Projects
DRS	Division of Reactor Safety
EC	Engineering Change
ECCS	Emergency Core Cooling System
EOP	Emergency Operating Procedure
GE	General Electric
HPCI	High Pressure Coolant Injection
IMC	Inspection Manual Chapter
IP	Inspection Procedure
LERF	Large Early Release Frequency
LOCA	Loos of Coolant Accident
LOOP	Loss of Offsite Power
NCV	Non-Cited Violation
NPSH	Net Positive Suction Head
NRC	U.S. Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulations
PARS	Publicly Available Records System
POD	Prompt Operability Determination
POR	Past Operability Review
PSI	Pounds Per Square Inch
QA	Quality Assurance
RCE	Root Cause Evaluation
RCIC	Reactor Core Injection Cooling
RFO	Refueling Outage
RG	NRC Regulatory Guide
RHR	Residual Heat Removal
RPV	Reactor Pressure Vessel
SAPHIRE	Systems Analysis Program for Hands-on Integrated Reliability Evaluations
SDP	Significance Determination Process
SIT	Special Inspection Team
SPAR	Standard Plant Analysis Risk
SRA	Senior Reactor Analyst
TBD	To-Be-Determined
TS	Technical Specification
UFSAR	Updated Final Safety Analysis Report
URG	Utility Resolution Guide
WO	Work Order
ZOI	Zone of Influence

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

October 20, 2014

MEMORANDUM TO: Nestor Feliz-Adorno, Senior Inspector
Duane Arnold Energy Center, Region III

FROM: Kenneth O'Brien, Director ***/RA Mohammed Shuaibi Acting for/***
Division of Reactor Safety

SUBJECT: SPECIAL INSPECTION CHARTER FOR DUANE ARNOLD ENERGY CENTER TORUS COATING DELAMINATION

On October 9, 2014, during Refueling Outage 24 (RFO24), the licensee identified coating delamination in Bays 1, 2, 7, 10 and 11 of the Torus. At this time, the delamination has not resulted in a loss of coating to the base metal; therefore, it appears a layer of coating has been removed.

During the previous outage in October 2012, the licensee installed a new coating in the immersed portion of the torus as part of a license renewal commitment. During the installation process, the licensee had difficulty with the application of the coating and subsequently identified certain areas that did not achieve the desired coating thickness. In order to achieve the required thickness, the licensee applied a second coat on these areas. At this time, the full extent of condition is unknown and the cause of the delamination has not been determined. The delamination concern may also have generic implications. At the present time, the unit is shutdown in Mode 5.

The sequence of events and the cause of the problem are being investigated by the licensee. Based on the deterministic criteria provided in Management Directive (MD) 8.3, "NRC Incident Investigation Program," the incident met MD 8.3 Criterion e, "Involved possible adverse generic implications and potentially met Criterion d, "Led to the loss of a safety function or multiple failures in systems used to mitigate an actual event." A Region III Senior Reactor Analyst completed a modified Duane Arnold SPAR model event assessment to provide risk insights for the potential of significant torus coating degradation resulting in ECCS strainer blockage. The assessment resulted in a preliminary Incremental Conditional Core Damage Probability (ICCDP) value of approximately 1E-6 to 1E-5 assuming the strainers for RHR and LPCS were plugged in response to only LOCA events. The ICCDP is approximately 6.4E-4 if the strainers for RHR and LPCS are plugged with debris in response to both LOCA events and non-LOCA events, which is worst case bounding condition.

Enclosure:
DAEC Special Inspection Charter

CONTACT: Ann Marie Stone
630-829-9729

Accordingly, based on the deterministic and risk criteria in MD 8.3, and as provided in Regional Procedure 8.31, "Special Inspections at Licensed Facility," a special inspection team will commence an inspection on October 21, 2014. The special inspection team will be led by you and will include Michael Jones, Charles Zoia, and Joseph Mancuso from the Region III office and Matthew Yoder from the Division of Engineering, Steam Generator Tube Integrity and Chemical Engineering Branch in NRR.

The special inspection will determine the sequence of events and will evaluate the facts, circumstances, and the licensee's actions surrounding the torus coating delamination issue. The specific charter for the Team is enclosed.

Enclosure:
DAEC Special Inspection Charter

cc w/encl: Cynthia Pederson, Regional Administrator, RIII
Darrell Roberts, Deputy Regional Administrator, RIII
Regional Government Liaison Officer, RIII
Anne Boland, Director, DRP, RIII
John Giessner, Deputy Director, DRP, RIII
Kenneth O'Brien, Director, DRS, RIII
Mohammed Shuaibi, Deputy Director, DRS, RIII
Michael Jones, DRS, RIII
Joseph Mancuso, DRP, RIII
Charles Zoia, DRS, RIII
Matthew Yoder, NRR
Michael Johnson, DEDO
John Jandovitz, OEDO Coordinator
Hio Nieh, Director, DRP, RI
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Jeff Clark, Deputy Director, DRS, RIV
NRR_Reactive_Inspection Resource@nrc.gov
RidsNrrPMDuaneArnold Resource

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DOCUMENT NAME: DAEC Tonus Coating Delamination SITE Charter
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OFFICE	RIII - DRS		RIII - DRP		RIII - DRP		RIII - DRS	
NAME	AMStone		CLipa		JGiessner for ABoland		MShuaibi for KO'Brien	
DATE	10/20/14		10/20/14		10/20/14		10/20/14	

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DUANE ARNOLD ENERGY CENTER SPECIAL INSPECTION CHARTER

This special inspection team is chartered to assess the circumstances surrounding the torus coating delamination identified during the refueling outage on October 9, 2014. The decision to charter this special inspection team is due to the potential common mode failure of emergency core cooling systems, caused by the strainer blockage from the loose torus coating. The Special Inspection will be conducted in accordance with Inspection Procedure 93812, "Special Inspection," and will include, but not be limited to, the items listed below. This charter may be revised based on the results and findings of the inspection and the results will be documented in NRC Inspection Report 05000331/2014011.

1. Establish a historical sequence of events related to the installation of torus coating during the last refueling outage (RFO23). This would include dates and times for the installation of the initial coat, measurement for acceptance, application of second coat, measurement of acceptance, and post application or adhesion testing. This would also include dates for startup, period when torus cooling was in service such as during HPCI or RCIC testing, shutdowns, the time of discovery, and subsequent actions taken by the licensee to address this issue. Identify the time-line for the event and include plant conditions.

2. Review the circumstances surrounding the delamination of coating, including the locations of the delamination and the relationship to potential perturbations during accident conditions, the most likely cause of the delamination; the length of time the torus may have been in an unrecognized condition; and any potential for operators to recognize degraded torus suction strainer conditions, including any actions they may take to mitigate the consequences.

3. Review operating experience related to coatings to determine whether the licensee addressed this experience in accordance with their corrective action program. This would include industry experience, NRC generic communication, and 10 CFR Part 21 reports.

4. Determine if the licensee is performing an adequate root cause for the torus coating delamination. As available, evaluate the scope, schedule, staffing and available results of the licensee's root cause investigation.

5. Review procedures used during the installation of the coating including those used for measurement and application of a second coat. Review vendor and/or manufacturer literature to assess any procedural or testing inadequacies which may have contributed to the delamination process. Determine whether the coating material was obtained through a qualified vendor and whether the work was accomplished by trained individuals.

6. Assess the potential for generic implications, that is, possibility of a product defect, inadequate or non-existent vendor guidance.

7. Determine if the licensee performed an adequate extent-of-condition evaluation to assess if the contributing causes to the delamination have the potential to affect other safety-related structures, systems or components. This would include other surfaces where a similar technique or product was used.

8. Assess the adequacy of the licensee's immediate corrective actions, including testing, to the affected areas or the engineering evaluations used to justify acceptance without repair. Review such justification to ensure the licensee addressed the adequacy of adhesion under accident conditions. Observe repairs or testing when possible.

9. Assess the planned long term corrective actions to prevent recurrence and whether these actions are consistent with the current licensing bases.

10. Identify lessons learned from the Special Inspection and, as appropriate, prepare a feedback form on recommendations for improving reactor oversight process (ROP) baseline inspection procedures.

Charter Approval

/RA/	A.M. Stone, Chief, Engineering Branch 2, DRS
/RA/	C. Lipa, Chief, Branch 1, DRP
/RA John Giessner Acting for/	A. Boland, Director, Division of Reactor Projects
/RA Mohammed Shuaibi Acting for/	K. O'Brien, Director, Division of Reactor Safety

Event Timeline

Duane Arnold Energy Center Torus Coating Delamination Timeline

DATE	TIME	EVENT	SOURCE
11/05/12	17:30	• Third party review of coating readiness complete	Shift turnover logs for night to day shift
11/05/12	22:30 (approx.)	• Striping begins in Bays 13 and 14. ("Striping" is brush/roller work for surfaces which were sharp and/or hard to cover with the sprayer.) • Stripe coating also began for Bays 11, 12, 15, and 16.	Shift turnover logs for night to day shift
11/06/12	01:00	• Stripe coating completed in Bays 11, 12, 13, 14, 15, and 16.	Shift turnover logs for night to day shift
11/06/12	02:00	• Torus coating application begins in Bays 13 and 14. Wet film thickness measurements are noted as taken in inspection reports.	Shift turnover logs for night to day shift and "Daily Inspection Records for Surface Preparation & Coating" for night shift
11/06/12	04:00 (approx.)	• Torus coating application for Bays 12 and 15 took place during this shift. Wet film thickness are noted as being taken in inspection reports. (A specific start time was not recorded. This time was approximated based on other activities occurring earlier in the shift.)	Shift turnover logs for night to day shift and "Daily Inspection Records for Surface Preparation & Coating" for night shift
11/06/12	06:00	• Torus coating application completed in Bays 12 and 15.	Shift turnover logs for night to day shift and "Daily Inspection Records for Surface Preparation & Coating" for night shift
11/06/12	06:00 (worst case)	• Bays 13 and 14 were completed during the night shift. (A specific start time was not recorded.)	Shift turnover logs for night to day shift and "Daily Inspection Records for Surface Preparation & Coating" for night shift
11/06/12	09:30	• Torus coating application begins in Bays 11 and 16. • Striping begins in Bays 1, 2, 3, 10, 9, and 8.	Shift turnover logs for day to night shift and "Daily Inspection Records for Surface Preparation & Coating" for day shift

DATE	TIME	EVENT	SOURCE
11/06/12	17:00	• Torus coating application completed in Bays 1 and 10.	Shift turnover logs for day to night shift and "Daily Inspection Records for Surface Preparation & Coating" for day shift
11/06/12	17:00 (worst case)	• Torus coating application for Bays 16 and 11 was completed on this shift. (A specific start time was not recorded.) • Striping was completed in Bays 2, 3, 9, 1, and 10 on this shift. (A specific start time was not recorded.)	Shift turnover logs for day to night shift and "Daily Inspection Records for Surface Preparation & Coating" for day shift
11/06/12	18:00 (approx.)	• Torus coating application began in Bays 2, 3, 4, 8, and 9 on this shift. Inspection reports documented wet film thickness tests for Bays 3, 8, and 5. (A specific start time was not recorded.) • Striping rework began in Bays 4, 7, and 8. (A specific start time was not recorded.)	Shift turnover logs for night to day shift and "Daily Inspection Records for Surface Preparation & Coating" for night shift
11/07/12	06:00 (worst case)	• Torus coating application completed for Bays 2, 3, 4, 8, and 9 during this shift. (A specific start time was not recorded.) • Striping rework completed in torus Bays 4, 7, and 8 during this shift. (A specific start time was not recorded.)	Shift turnover logs for night to day shift and "Daily Inspection Records for Surface Preparation & Coating" for night shift
11/07/12	11:00 (worst case)	• Torus coating application was completed in Bays 5, 7, and 6 during this shift. (A specific start time was not recorded.)	Shift turnover logs for day to night shift and "Daily Inspection Records for Surface Preparation & Coating" for day shift
11/07/12	16:00	• Coating thickness acceptability reported as in progress.	Shift turnover logs for day to night shift
11/08/12	06:00 (worst case)	• Torus recoating completed in Bays 10, 11, 12, 13, 14, and 15 on this shift. (A specific start time was not recorded.). • Dry film thickness acceptability measurements completed in Bays 10, 11, 12, 13, 14, and 15. (A specific start time was not recorded.). • Recoat application in Bay 16 was in progress at the close of the shift.	Shift turnover logs for night to day shift and "Daily Inspection Records for Surface Preparation & Coating" for night shift

DATE	TIME	EVENT	SOURCE
11/08/12	16:00 (worst case)	• Torus recoating completed in Bays 16and 1 through 9 on this shift. (A specific start time was not recorded.) • Dry film thickness acceptability measurements completed in Bays 16 and 1 through 9. (A specific start time was not recorded.)	Shift turnover logs for day to night shift and "Daily Inspection Records for Surface Preparation & Coating" for day shift
11/08/12	Not available	• Licensee captured the discovery of significant areas of torus coating requiring additional application to obtain the required thickness in the Corrective Action Program.	AR 01821308
11/10/12	23:55	• Final coating touch ups completed	Shift turnover logs
11/10/12	Not available	• Completion of all dry film thickness measurements for acceptability.	"Daily Inspection Records for Surface Preparation & Coating"
11/12/12	Not available	• The licensee identified the torus heat up rate was lower than planned resulting in longer coating cure time.	AR 01822751
11/14/12	Not available	• The licensee identified that while the coating cure time was based on the coolest portions of the torus shell, the thermocouples were not in the coolest locations.	AR 01823554
11/27/12	Not available	• Turbine brought online during startup after completion of turbine overspeed trip testing.	Licensee interview
12/01/12	Not available	• Operators took the generator offline and returned the reactor to Mode 4 after discovering a hard ground on the rotor.	Licensee interview
12/07/12	Not available	• Turbine brought online again.	Licensee interview
12/12/12	Not available	• Reactor reaches full power	Resident Inspector Office
12/19/12	Not available	• Completed an ACE related to the incorrect application of the base coat.	AR 01821308
10/04/14	Not available	• Unit taken offline to begin RFO24	Licensee interview

DATE	TIME	EVENT	SOURCE
10/09/14	Not available	• During initial walk around of the torus interior the licensee identified an area of delamination at the water line in Bay 1. Additionally, sagging was identified on several downcomers and several pieces of delaminated coating were visible in Bays 12 and 15.	AR 1997546
10/16/14	Not available	• The licensee completed walkdowns and underwater inspections identifying additional areas of delamination in Bays 1, 2, 3, 5, 6, 7, 9, and 10. • Licensee invoked their failure investigation process and chartered a team to identify the apparent cause, determine the extent of condition, implement repairs, and address operability concerns regarding the torus delamination issue. • Licensee places a MODE restriction to not enter MODEs 1, 2, or 3 until operability concerns related to the delamination are resolved.	AR 1999648
10/18/14	Not available	• Licensee began implementing various corrective actions to address coating delamination issues	Torus Failure Investigation Process schedule
10/27/14	Not available	• Licensee chartered a root cause evaluation	Root cause charter

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records System (PARS) component of NRC's Agencywide Document Management System (ADAMS). ADAMS is accessible from the NRC Website at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Kenneth G. O'Brien, Director
Division of Reactor Safety

Docket No. 50-331
License No. DPR-49

Enclosure:
Inspection Report 05000331/2014011
w/Attachments:
1. Supplemental Information
2. List of Documents Reviewed
3. List of Acronyms Used
4. Special Inspection Charter
5. Event Timeline

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