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a joint venture of
Constellation Energy EDF

CALVERT CLIFFS
NUCLEAR POWER PLANT

May 16, 2013

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 and 2; Docket Nos. 50-317 and 50-318
Calvert Cliffs GSI-191 Resolution Plan

REFERENCES:

(a) Nuclear Regulatory Commission SECY-12-0093, dated July 9, 2012, Closure Options for Generic Safety Issue-191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance

(b) Nuclear Regulatory Commission Staff Requirements, dated December 14, 2012, SECY-12-0093, Closure Options for Generic Safety Issue-191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance

In Reference (a), the Nuclear Regulatory Commission required each pressurized water reactor plant to submit its chosen Generic Safety Issue-191 resolution option and associated implementation schedule. Attachment (1) contains Calvert Cliffs submittal of the required information. The implementation schedule is in alignment with the guiding statements contained in Reference (b).

This letter contains regulatory commitments as listed in Attachment (2).

Should you have questions regarding this matter, please contact Mr. Douglas E. Lauver at (410) 495-5219.

A116
NRR

I declare under penalty of perjury that the foregoing is true and correct. Executed on May 16, 2013.

Very truly yours,

GHG/KLG/bjd

Attachments: (1) Calvert Cliffs GSI-191 Resolution Response
(2) List of Regulatory Commitments

cc: N. S. Morgan, NRC
W. M. Dean, NRC
Resident Inspector, NRC
S. Gray, DNR

ATTACHMENT (1)

CALVERT CLIFFS GSI-191 RESOLUTION RESPONSE

Calvert Cliffs Nuclear Power Plant, LLC
May 16, 2013

Introduction

Generic Safety Issue-191 (GSI-191), "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance" remains a long-standing open issue. Generic Safety Issue-191 concluded that debris could clog the containment sump strainers in pressurized water reactors, leading to the loss of net positive suction head for the Safety Injection System and Containment Spray System pumps. The Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02, (Reference 1), requesting that licensees address the issues raised by GSI-191. Generic Letter 2004-02 was focused on demonstrating compliance with 10 CFR 50.46.

In accordance with the May 4, 2012 Nuclear Energy Institute (NEI) letter to the NRC (Reference 2), each licensee will submit a resolution option and associated implementation schedule to the NRC. On July 9, 2012 the NRC staff issued SECY-12-0093 (Reference 3), presenting three options to the Commission all of which are considered to be viable paths for resolving GSI-191. These options are: Option 1-Deterministic approach with approved models for both strainer and in-vessel effects resolution, Option 2-Deterministic approach with refined models or risk-informed approach for both strainer and in-vessel effects resolution, and Option 3-Deterministic approach with approved models for strainer resolution and risk-informed approach for in-vessel effects resolution. The NRCs SECY-12-0093 considered and expanded upon the options provided in the May 4, 2012 NEI letter. The options identified in the SECY provide approaches that can be used to address plants with minimal fibrous insulation, low to medium fibrous insulation, and substantial amounts of fibrous insulation.

Calvert Cliffs Nuclear Power Plant, LLC (Calvert Cliffs) has selected the deterministic approach of Option 2, with refined chemical effects testing and the risk-informed resolution approach, as identified in SECY-12-0093, for Calvert Cliffs Units 1 and 2. Calvert Cliffs has determined that performing refined chemical effects testing may demonstrate the reduced potential for recirculation sump strainer blockage and in-vessel blockage sufficiently to resolve GSI-191 through a deterministic approach. In parallel Calvert Cliffs will also pursue the risk-informed approach partnering with the South Texas Project to provide either defense in depth or as an alternate solution if the refined chemical effects testing fails to resolve GSI-191 through a deterministic approach. The refined chemical effects testing performed in pursuit of the deterministic resolution will complement the risk-informed approach.

To support both of these paths, for the period required to complete the necessary analysis and testing, Calvert Cliffs has completed limited insulation replacement and limited supplemental design for further insulation replacement if needed to resolve GSI-191 issues. A description of these mitigating measures are included in this document. Additionally, summaries of the existing margins and conservatisms that exist for Calvert Cliffs, as well as the defense-in-depth measures at Calvert Cliffs are tabulated in this document. In the event that the refined chemical effects testing and the risk-informed approach are both determined to not to be viable for Calvert Cliffs, a resolution path using a fully deterministic approach (Option 1) will be followed to resolve GSI-191 and close GL 2004-02.

The following provides the key components for the chosen resolution path option for Calvert Cliffs.

Characterization of In-Vessel Effects

Calvert Cliffs intends to establish plant-specific in-vessel debris limits for Calvert Cliffs Units 1 and 2. This will be performed in concert with the Pressurized Water Reactor Owners' Group Comprehensive Analysis and Test Program for GSI-191 closure and testing performed in concert with the South Texas Project risk-informed GSI-191 resolution project.

Licensing Basis Commitments

Calvert Cliffs does not currently have open commitments within Calvert Cliffs Units 1 and 2 commitment management system to provide additional updates or information to the NRC regarding GL 2004-02. Commitments stated in this letter are listed in Attachment (2).

Resolution Schedule

Calvert Cliffs will achieve closure of GSI-191 and address GL 2004-02 on the following schedule. This schedule is developed to be consistent with the guiding statements contained in Reference 4.

- Calvert Cliffs will complete any necessary insulation replacements or remediation, or other identified plant changes no later than the 2018 refueling outage at Calvert Cliffs Unit 1 and no later than the 2019 refueling outage at Calvert Cliffs Unit 2. These completion dates are predicated on the successful completion of our Option 2 approach and the Pressurized Water Reactor Owners Group successful resolution of the in-vessel effects issue.
- Calvert Cliffs will establish plant-specific in-vessel debris limits for Calvert Cliffs Units 1 and 2. This task will be performed in concert with the Pressurized Water Reactor Owners Group Comprehensive Analysis and Test Program for GSI-191 closure. The plant-specific in-vessel debris limits will be submitted after NRCs evaluation of the Pressurized Water Reactor Owners Group testing to resolve in-vessel effects is issued.
- If either of Calvert Cliff's Option 2 resolution methods (the deterministic approach, with refined chemical effects testing, or the risk-informed approach) is successful for resolving the GSI-191 issue, then Calvert Cliffs will submit a final updated supplemental response to support closure of GL 2004-02 for Calvert Cliffs Units 1 and 2 by December 31, 2019.
- If neither of Calvert Cliff's Option 2 resolution methods (the deterministic approach, with refined chemical effects testing, and the risk-informed approach) is successful for resolving the GSI-191 issue, then Calvert Cliffs will submit a new resolution plan and schedule. This plan will be submitted after the NRCs evaluation of the Pressurized Water Reactors Owners Group testing to resolve in vessel effects is issued.

Summary of Actions Completed for GL 2004-02

In response to GL 2004-02, Calvert Cliffs has completed the following actions for Calvert Cliffs Units 1 and 2:

- Performed comprehensive debris generation and debris transport analyses in accordance with approved methods presented in NEI 04-07.
- Performed walk downs to sample and characterize latent debris, including other debris sources, e.g., labels, etc.
- Performed as-built verification walk downs of insulation in Calvert Cliffs Units 1 and 2 Containments.
- Replaced a simple geometry strainer that had a filtering surface area of approximately 150 ft^2, and had a gross mesh, with a complex geometry strainer having a filtering surface area of approximately 6060 ft^2 and a finer mesh.
- Replaced trisodium phosphate containment buffering agent with sodium tetraborate.
- Performed ex-vessel downstream effects analysis in accordance with approved methods presented in WCAP-16406-P (Reference 5).

- Performed net positive suction head and debris bed deaeration analyses.
- Performed a series of variable temperature vertical loop head loss tests to investigate chemical effects head loss effects. No head loss effects were observed with the dissolved aluminum concentrations predicted for Calvert Cliffs Units 1 and 2 down to temperatures of 70°F.
- Enlarged the reactor refueling cavity drains to reduce post-loss-of-coolant accident water holdup and increase strainer submergence.
- Installed blow-out panels in the reactor cavities ventilation ducting to allow early failure of the ventilation duct should it fill with water. This will reduce post-loss-of-coolant accident water holdup and increase strainer submergence.
- Removed the telescoping aluminum ladder from the Polar Crane in Containment to reduce the aluminum content in Containment.
- Installing temperature instrumentation in the emergency recirculation sump suction header to ensure Operations has a means of assessing containment sump pool temperature. This modification was largely completed during Calvert Cliffs Unit 1 2012 refueling outage and is scheduled to be completed during the 2014 refueling outage. This modification also began during Calvert Cliffs Unit 2 2013 refueling outage and is scheduled to be completed during the 2015 refueling outage.

Summary of Margins and Conservatisms for Completed Actions for GL 2004-02

The following provides a summary description of the margins and conservatisms associated with the resolution actions taken to date. These margins and conservatisms provide support for the extension of time required to address GL 2004-02 for Calvert Cliffs Units 1 and 2.

- The Calvert Cliffs debris generation analysis was performed in accordance with NEI 04-07 (Reference 6) that includes multiple levels of conservatism:
  - The limiting break is controlled by a unique combination of break size and location that make it highly improbable. The likelihood of a large rupture in pressurized water reactor coolant piping is less than $1x10^{-5}$ per year. Estimates for the frequency of a full double-ended rupture of the main coolant piping are on the order of $1x10^{-8}$ per year. Smaller piping ruptures, while still unlikely, provide a better measure of expected behavior.
  - Break opening time and full offset displacement are instantaneous. The non-physical assumption of an instantaneous opening of a fully offset double-ended rupture leads to a significant overestimation of the debris generation potential for a postulated break. Even conservative estimates of minimum break opening times for large bore piping preclude formation of damaging pressure waves. The wide recognition that a large Reactor Coolant System pipe is more likely to leak and be detected by the plant's leakage monitoring systems long before cracks grow to unstable sizes is referred to as leak before break and is an accepted part of regulatory compliance with General Design Criterion 4.
  - Full destruction of materials within a conservatively determined spherical zone of influence based upon a conservative extrapolation of limited test data performed under non prototypic conditions, with limiting configurations. The sparse database on insulation destruction testing has forced the use of bounding results. For example: results based on aluminum jacketed insulation are applied to stainless steel jacketed insulation; all insulation is presumed to have a worst case seam orientation relative to the break. The zone of influence for insulation materials is expected to be significantly smaller than that predicted by the NRC guidance due to real factors such as the absence of a damaging pressure wave, greater structural integrity than tested materials, non limiting seam orientations, etc.

- The Calvert Cliffs debris transport analysis was performed in accordance with NEI 04-07, that includes multiple levels of conservatism:
  - All fine debris is assumed to wash down to the sump pool elevation with no holdup on structures. Although fine debris would be easily carried by draining spray flow, a significant quantity of fines would likely be retained on walls and structures above the containment pool due to incomplete spray coverage and hold up on structures. Even in areas that are directly impacted by sprays, some amount of fines would agglomerate together and settle prior to reaching the strainer.
  - All fine debris is assumed to transport to the surface of the strainer. Flows that are sufficient to cause any movement of individual pieces of small and large debris are assumed to transport the debris to the strainer. Debris present or generated at the beginning of the event will generally be pushed by break and spray flows into quiescent regions and will reside as debris piles. At the start of recirculation, it would take substantially higher flow rate than what would actually occur, to cause movement of these piles of debris. Even if these piles of debris were to move, there are numerous obstacles (supports, equipment, curbs, etc.) that would prevent debris from reaching the strainers.
  - Approved guidance calls for uniform debris transport to and deposition on the strainer surfaces. Testing shows that debris transport to the surface of complex strainers will not be uniform, unless it is artificially induced in the testing. Some settling and uneven debris distribution is prototypical, which results in lowered head loss across the strainers.

- The Calvert Cliffs strainer head loss testing was performed in accordance with the NRC March 2008 guidance (Reference 7) that includes multiple levels of conservatism:
  - During head loss testing, only fiber fines were used to conservatively bound head loss as it was observed that small pieces of fiber reduced debris bed head loss. Actually, should large quantities of debris be generated and transported to the strainer, it would be a mixture of fiber fines, small pieces, and large pieces.
  - During head loss testing, fiber fines produced by erosion are assumed to arrive at the strainer at time $t = 0$, instead of hours or days later when flow margin is greater. Fiber fines created by erosion will arrive at the strainer over a period of hours or even days. A significant portion of these fines will arrive after flow margin has increased to the point where additional strainer head loss can be readily accommodated.
  - During head loss testing, a full 30 day chemical precipitate load is assumed to arrive at the strainer at the earliest possible time with no credit for settling or nucleation on containment surfaces. The quantity of precipitate arriving at the strainer is expected to be significantly lower than tested amounts. In addition the precipitate is expected to arrive or form in the debris bed gradually and the resultant head loss would be compensated by increased head loss margins.
  - During head loss testing, all fiber and particulate debris is collected on the strainer prior to addition of chemical precipitates. The chemical precipitate coating on the debris bed observed in head loss testing is not prototypical. In reality it would be less uniform than that achieved during testing since some fiber and particulate debris would arrive along with the precipitates, or the precipitates would form in the debris bed, producing a less uniform deposit. A less uniform deposition of precipitates would yield a lower strainer head loss.
  - During head loss testing, repeated attempts are made to get debris that has settled in the immediate vicinity of the strainer back onto the strainer. The conservatism of debris transport calculations is clearly demonstrated in testing where non prototypic agitation must be employed to prevent natural settling of debris. Much of the debris that is predicted to transport to the

strainer will settle in the immediate vicinity of the strainer and not become part of the strainer debris bed.

- During testing, metallic insulation debris is excluded from the tested debris bed in order to conservatively bound head loss. Some of the smaller metallic insulation debris will transport to the strainer and disrupt formation of a uniform fiber/particulate debris bed. This will result in lower strainer head loss.
- Metallic insulation debris that is predicted to enter the sump pool but not reach the strainer is excluded from testing to prevent capture of finer debris before it reaches the strainer. Any debris that enters the sump pool but does not transport to the strainer would capture some of the fine debris before it reaches the strainer.

- The Calvert Cliffs chemical effects analysis was performed in accordance with WCAP-16530 (Reference 8) that includes multiple levels of conservatism:
  - WCAP-16530 relies largely upon short-term release rates (hours) for the determination of long-term releases (30 days). Long-term release rates of constituent materials are expected to be significantly lower than that predicted by design basis models due to surface passivation and formation of surface films.
  - One hundred percent of chemical species of interest are assumed to precipitate. When solubility limits are taken into account, the predicted precipitation is reduced by one to two orders of magnitude. In addition, precipitates will form during periods when flow net positive suction head margins are greater.
  - The current models call for chemical precipitate formation in a form readily transported to the sump screen. A significant portion of precipitate formation will occur on large surface areas in Containment, and in settled debris, all of which are remote from the strainer, and will not then be readily transported to the strainer.
  - The approved testing methodology results in the chemical precipitates being pre-formed and overlaid upon the strainer debris bed as a whole, after debris and particulates are placed into the test. This is conservative. However, some chemical precipitates will typically form in the debris bed itself on the fiber surfaces, instead of laying over the exterior top surface of the strainer debris bed as a whole. This will result in lower strainer head loss.
- For in-vessel effects, the flow rate through the Calvert Cliffs core can range from less than 2.3 gpm per fuel assembly to 6.8 gpm per fuel assembly, which is significantly lower than the ~44.7 gpm per fuel assembly used for fuel assembly blockage testing as described in WCAP-16793-NP (Reference 9). This provides for a significant margin above the bounding 15g/fuel assembly established in the WCAP.

Summary of Defense-In-Depth Measures

The following describes the plant specific design features and procedural capabilities that exist for detecting and mitigating a strainer blockage or fuel blockage condition. These measures are not expected to be required based on the very low probability of an event that would challenge either the capability of the strainer to provide the necessary flow to the Safety Injection System and the Containment Spray System, or result in significant quantities of debris being transported to the reactor vessel that would inhibit the necessary cooling of the fuel. They provide additional assurance that the health and safety of the public would be maintained. These measures provide support for the extension of time required to completely address GL 2004-02 for Calvert Cliffs Units 1 and 2.

- Prevention of Inadequate Recirculation Strainer Flow
  - Calvert Cliffs Units 1 and 2 have within their Emergency Operating Procedure (EOP) framework, specific steps for monitoring for indications of sump strainer blockage and actions to be taken if this condition occurs. These actions are described in the Calvert Cliffs response to NRC Bulletin 2003-01 (Reference 10) and the subsequent responses to the NRC requests for additional information (References 11 and 12). The actions taken in response to NRC Bulletin 2003-01 (Reference 13) are still in effect at Calvert Cliffs Units 1 and 2.
  - The chemical precipitates of concern to head loss at Calvert Cliffs are aluminum-based precipitates. It is widely recognized that aluminum precipitates, for the aluminum precipitates postulated for the sump pool at Calvert Cliffs, remain in solution at elevated temperatures and do not precipitate until the pool temperature reaches temperatures below 140°F when net positive suction head margin is greater. Calvert Cliffs is installing temperature indication instrumentation in the emergency recirculation sump suction header to ensure Operations has a means of assessing containment sump pool temperature.
  - Reducing Flow Through the Strainer – Calvert Cliffs is revising the EOPs to allow reduction of strainer flow rate two one high pressure safety injection pump and one containment spray pump prior to the onset of the chemical precipitates (140°F). By reducing flow rate to the strainer prior to the onset of chemical precipitates, the impact of these precipitates on strainer head loss will be reduced.

- Mitigation of Inadequate Recirculation Strainer Flow
  - Refueling Water Tank Refill and Realignment for Injection Flow – The Calvert Cliffs EOPs provide guidance for refilling the refueling water tank and realigning the safety injection system for injection flow.

- Prevention of Inadequate Reactor Core Flow
  - Inadequate core cooling due to debris blocking the core or boric acid precipitation would be indicated by an increase in core exit thermocouple temperature. Emergency Operating Procedure-5 provides operator guidance for commencing core flush and maintaining reactor coolant subcooling.
  - The chemical precipitates of concern to head loss at Calvert Cliffs are aluminum-based precipitates. It is widely recognized that aluminum precipitates, for the aluminum precipitates postulated for the sump pool at Calvert Cliffs, remain in solution at elevated temperatures and do not precipitate until the pool temperature reaches temperatures below 140°F when net positive suction head margin is greater. Calvert Cliffs is installing temperature indication instrumentation in the emergency recirculation sump suction header to ensure Operations has a means of assessing containment sump pool temperature.

Conclusion

The above summary of Calvert Cliffs GSI-191 resolution plan meets the requirement for a docketed submittal as required by SECY 12-0093. The execution of the actions identified in this document will result in successful resolution of GSI-191 and closure of GL 2004-02.

References

1. Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized Water Reactors, September 13, 2004

2. Letter from Mr. J. C. Butler (NEI) to Mr. W. H. Ruland (NRC), dated May 4, 2012, GSI-191 – Current Status and Recommended Actions for Closure
3. SECY-12-0093, Closure Options for Generic Safety Issue – 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance, July 9, 2012
4. NRC Memorandum from A. L. Vietti-Cook to R. W. Borchardt, dated December 14, 2012, Staff Requirements – SECY-12-0093 – Closure Options for Generic Safety Issue-191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance
5. Westinghouse Owners Group WCAP-16406-P, Evaluation of Downstream Sump Debris Effects in Support of GSI-191, Revision 1, August 2007
6. Nuclear Energy Institute, NEI-04-07, Pressurized Water Reactor Sump Performance Evaluation Methodology, Revision 0, December 2004
7. NRC Staff Review Guidance Regarding Generic Letter 2004-02, Closure in the Area of Strainer Head Loss and Vortexing, March 2008
8. Westinghouse Owners Group WCAP-16530-NP-A, Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191, March 2008
9. Westinghouse Owners Group WCAP-16793-NP, Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid, Revision 2, October 2011
10. Letter from K. J. Nietmann (CCNPP) to Document Control Desk (NRC), dated August 8, 2003, Response to NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors"
11. Letter from G. Vanderheyden (CCNPP) to Document Control Desk (NRC), dated November 8, 2004, Response to Request for Additional Information Regarding NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors"
12. Letter from B. S. Montgomery (CCNPP) to Document Control Desk (NRC), dated August 4, 2005, Response to Request for Additional Information Regarding NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors"
13. NRC Bulletin 2003-01, Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors, June 9, 2003

ATTACHMENT (2)

LIST OF REGULATORY COMMITMENTS

ATTACHMENT (2)

LIST OF REGULATORY COMMITMENTS

The table below lists the actions committed to in this letter. Any other statements in this letter are provided for information purposes and are not considered to be regulatory commitments.

Regulatory Commitment	Date
Calvert Cliffs will complete any necessary insulation replacements or remediation, or other identified plant changes no later than the 2018 refueling outage for Calvert Cliffs Unit 1. This completion date is predicated on the successful completion of our Option 2 approach and the Pressurized Water Reactor Owners Group successful resolution of the in-vessel effects issue.	5/1/2018 (Unit 1)
Calvert Cliffs will complete any necessary insulation replacements or remediation, or other identified plant changes no later than the 2019 refueling outage for Calvert Cliffs Unit 2. This completion date is predicated on the successful completion of our Option 2 approach and the Pressurized Water Reactor Owners Group successful resolution of the in-vessel effects issue.	5/1/2019 (Unit 2)
Calvert Cliffs will establish plant-specific in-vessel debris limits for Calvert Cliffs Units 1 and 2. This task will be performed in concert with the Pressurized Water Reactor Owners Group Comprehensive Analysis and Test Program for GSI-191 closure. The plant-specific in-vessel debris limits will be submitted after NRCs evaluation of the Pressurized Water Reactor Owners Group testing to resolve in-vessel effects is issued.	2/15/2016
If either of Calvert Cliff's Option 2 resolution methods (the deterministic approach, with refined chemical effects testing, or the risk-informed approach) is successful for resolving the GSI-191 issue, then Calvert Cliffs will submit a final updated supplemental response to support closure of GL 2004-02 for Calvert Cliffs Units 1 and 2 by December 31, 2019.	12/31/2019
If neither of Calvert Cliff's Option 2 resolution methods (the deterministic approach, with refined chemical effects testing, and the risk-informed approach) is successful for resolving the GSI-191 issue, then Calvert Cliffs will submit a new resolution plan and schedule after the NRCs evaluation of the Pressurized Water Reactors Owners Group testing to resolve in vessel effects is issued.	2/15/2016