VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

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U. S. Nuclear Regulatory Commission
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VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
NRC GENERIC LETTER 2004-02, POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS
GENERIC SAFETY ISSUE (GSI)-191 CLOSURE OPTION AND TEMPMAT INSULATION REMEDIATION

By letters dated February 29, 2008 (ML080650563) and February 27, 2009 (ML090641038), Virginia Electric and Power Company (Dominion) submitted detailed information concerning corrective actions taken in response to NRC Generic Letter (GL) 2004-02 for North Anna Power Station Units 1 and 2 (NAPS 1 and 2) to resolve the containment sump issues identified in GSI-191. In a letter dated May 29, 2009 (ML091350073), the NRC stated that, based on the information Dominion had provided in its submittals, they did not have additional questions regarding the performance of the NAPS 1 and 2 containment sump strainers. However, in the February 27, 2009 letter noted above, Dominion committed to address the resolution of downstream in-vessel effects for NAPS 1 and 2 following the issuance of revised WCAP-16793-NP and the associated NRC Safety Evaluation Report (SER).

By letter dated May 4, 2012 (ML12142A316), the Nuclear Energy Institute (NEI) submitted a letter to the NRC recommending actions for resolving the remaining GSI-191 containment sump issues that a licensee would select based on the amount of fiber remaining in containment. The letter also stated that licensees would submit a plant specific path and schedule for resolution of GSI-191. In SECY-12-0093, *Closure Options for Generic Safety Issue -191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance*, dated July 9, 2012 (ML121310648), the NRC staff effectively superseded the NEI approach by presenting three options to the Commission as viable paths for licensees to resolve GSI-191 and recommended that the Commission allow licensees the flexibility of choosing any of the options presented subject to the conditions and schedules discussed therein. The Commission approved the staff's recommendation in the associated Staff Requirements Memorandum dated December 14, 2012 (ML12349A378).

Attachment 1 provides information regarding the current status of Dominion's efforts to address GL 2004-02 and also describes the GSI-191 closure option, resolution plan and implementation schedule for resolving downstream in-vessel effects for NAPS 1 and 2. Attachment 2 provides a summary of the corrective actions and analyses that have

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been implemented at NAPS, including inherent margins and conservatisms, to address GSI-191 containment sump performance issues and to also provide reasonable assurance that the health and safety of the public will be maintained until the identified actions discussed herein have been completed. Attachment 3 provides a list of the regulatory commitments included in this submittal.

Separately, by letter dated April 27, 2011 (ML111180686), Dominion informed the NRC that a quantity of TempMat insulation, which was previously believed to have been removed from the zones of influence (ZOI) associated with containment sump recirculation, had not been removed from containment. This TempMat insulation is located in piping penetrations in the reactor vessel primary shield wall of both containments. The additional insulation was evaluated for impact on the debris generation and transport calculations, as well as the operability of the Recirculation Spray and Low Head Safety Injection Systems and the containment sump. It was determined that continued operation was acceptable based on the margins and conservative assumptions included in the debris generation and transport calculations. To remediate the additional TempMat insulation, plant modifications are being planned and scheduled to replace a portion of the fibrous insulation in containment with reflective metal insulation (RMI). The schedule for completion of the planned modifications is in accordance with the resolution period specified in SECY 12-0093 and is discussed in the Resolution Schedule provided in Attachment 1.

Should you have any questions or require additional information, please contact Mr. Gary D. Miller at (804) 273-2771.

Respectfully,

Eugene S. Grecheck
Vice President – Nuclear Engineering and Development

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mr. Eugene S. Grecheck, who is Vice President – Nuclear Engineering and Development, of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 15th day of May, 2013.

My Commission Expires: May 31, 2014.

Notary Public

VICKI L. HULL
Notary Public
Commonwealth of Virginia
140542
My Commission Expires May 31, 2014

Commitments contained in this letter: See Attachment 3.

Attachments:
1. Generic Safety Issue-191 (GSI-191) In-vessel Effects Resolution Plan
2. Implemented Corrective Actions to Address GL 2004-02
3. Regulatory Commitments

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Attachment 1

Generic Safety Issue-191 (GSI-191) In-vessel Effects Resolution Plan

Virginia Electric and Power Company
(Dominion)
North Anna Power Station Units 1 and 2

Generic Safety Issue-191 (GSI-191) In-vessel Effects Resolution Plan North Anna Power Station Units 1 and 2 (NAPS 1 and 2)

Introduction

SECY-12-0093, *Closure Options for Generic Safety Issue -191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance*, dated July 9, 2012, presented three options for the resolution of GSI-191. The three options are as follows:

- Option 1 Compliance with 10 CFR 50.46 based on approved models,
- Option 2 Mitigative measures and alternate methods approach (which includes deterministic and risk-informed alternatives), and
- Option 3 Different regulatory treatment for suction strainer and in-vessel effects.

Dominion has selected Option 2 (deterministic) for final resolution of GSI-191 for NAPS 1 and 2 and intends to pursue refinements to evaluation methods and acceptance criteria associated with downstream in-vessel effects. To support the use of this path, and continued operation for the period required to complete the necessary analysis and testing, Dominion has evaluated the design and procedural capabilities that provide defense-in-depth for identifying and mitigating potential in-vessel blockage. A description of these measures is provided later in this document. A summary of the corrective actions, and associated margins and conservatisms, previously implemented to resolve GSI-191 containment sump issues for NAPS 1 and 2 is provided in Attachment 2.

Characterization of Current Containment Fiber Status

From the debris generation and transport analyses performed for NAPS 1 and 2, Dominion has conservatively determined the types and quantities of fibrous debris that could be transported to the strainers, as discussed in Dominion letters dated February 29, 2008 (ML080650563) and April 27, 2011 (ML111180686) and NRC letter dated August 4, 2008 (ML072740400). The fibrous debris sources considered in these analyses include Thermal Wrap, TempMat, Paroc/mineral wool, fiberglass and latent fiber. The total fibrous debris quantity from these sources that could potentially reach the sump strainer was conservatively calculated to be 2289 pounds-mass (lbm).

Reduced scale testing for NAPS 1 and 2 was previously performed and included fiber bypass testing that determined the amount of fiber bypass that would occur for the replacement strainer. Bypass testing was conducted with the full fibrous debris load with no added particulate or reflective metal insulation (RMI). The test debris was not thermally aged prior to the test, and tap water was used during the test. Two tests were performed for each strainer [i.e., the Recirculation Spray (RS) and Low Head Safety

Injection (LHSI) strainers.] The duration of each test was at least ten (10) tank turnovers. Multiple grab samples were collected from the pump return line downstream of the strainer for each test. Each sample was filtered using a membrane filter with 0.1 and/or 0.8-micrometers (μm) pore size, and the dried filter paper was weighed to determine the quantity of bypass fiber. The amount of fiber that passed through the strainer was extremely low; consequently, Scanning Electron Microscopy (SEM) and/or Energy Dispersive X-ray analysis were performed on one sample from each of the first five turnovers (at one half turnover) to determine the quantity and characteristics of the fibrous debris that passed through the NAPS strainer. Tests were conducted for both two-train and one-train flow rates.

Analysis of the fiber bypass test results showed that:

- Fiber bypass concentrations exhibited a near exponential decreasing trend with time for the RS and LHSI strainers.
- The vast majority (~90%) of the fibers that bypassed the strainer were less than 1 mm in length. (The strainer hole size is 1/16 inch or 1.6 millimeter (mm).)
- There is no consistent trend as to whether one-train or two-train flow rates result in greater fiber bypass concentrations.

From the fiber bypass testing, it was determined that 99.9% of the fiber would be filtered out by the strainer on the first pass. In addition, since the sump strainer is a stacked strainer design, i.e., the LHSI strainer portion is located on top of the RS strainer portion, the quantity of debris transported to the LHSI strainer will be a fraction of the total debris inventory, as the RS strainer will become loaded with debris first and will still be operating when the LHSI pumps switchover to recirculation mode. Based on the strainer bypass testing performed and assuming 99.9% filtration, approximately 2.29 lbm of fibrous debris will bypass the sump strainer. Attributing 100% of the fiber bypass to the LHSI strainer (and none to the RS strainer), the total quantity of fiber calculated to bypass the strainer and potentially reach the reactor fuel is 6.6 grams/fuel assembly (g/FA).

Although the calculated value appears to meet the limits specified in WCAP-16793, Revision 2, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid," dated October 2011, the fiber bypass test procedure that was used was not consistent with the current NEI test protocol. As a result, Dominion is participating in the Pressurized Water Reactor Owners' Group (PWROG) comprehensive program to develop new acceptance criteria for in-vessel debris. The above determined value of in-vessel fiber provides support for the extension of time required to completely address GL 2004-02 for NAPS 1 and 2. At the time the PWROG establishes new in-vessel acceptance criteria, Dominion will develop a plan for demonstrating compliance with the PWROG program limits and communicate the plan to the NRC within 60 days of the PWROG establishing new in-vessel acceptance criteria.

Characterization of Strainer Head Loss Status

Dominion previously provided the results of strainer head loss testing, including the impact of chemical effects, in letters dated February 29, 2008 (ML080650563) and February 27, 2009 (ML090641038). The testing results demonstrated acceptable allowable strainer head loss.

Characterization of In-vessel Effects

As noted above, Dominion intends to follow the resolution strategy proposed by the PWROG for establishing in-vessel acceptance criteria for the type of plant design that exists at NAPS 1 and 2. The PWROG comprehensive GSI-191 program is designed to develop acceptance criteria to support resolution under Option 2 (deterministic) as described in SECY-12-0093. The PWROG program includes loss of coolant accident (LOCA) analyses and corroborative testing that will develop acceptance criteria that may provide less restrictive in-vessel debris limits than WCAP-16793, Revision 2, or preclude the need for specific in-vessel debris limits altogether.

Licensing Basis Commitments

Dominion currently has two outstanding commitments regarding the resolution of GSI-191 for NAPS 1 and 2. The commitments are as follows:

1. Determine the corrective actions for resolution of potential chemical and downstream effects on the reactor core and flowpaths and provide the corrective actions to the NRC within 90 days following the issuance of revised WCAP-16793-NP and the associated NRC Safety Evaluation Report (SER). [Reference Dominion letter dated February 27, 2009 (ML090641038).]

2. Dominion will take appropriate additional corrective actions (e.g., recalculate debris generation totals, fibrous insulation removal, jacketing, additional testing, etc.) as may be applicable [to remediate the subsequently identified TempMat insulation in containment ZOIs.] If the corrective actions require additional plant modifications or testing, Dominion will provide the NRC with a schedule for the subsequent actions required to ensure the NAPS 1 and 2 containment sump systems conform to design requirements. This schedule will be provided within six months of completion of the industry activities and NRC concurrence of the test and analyses results. [Reference Dominion letter dated April 27, 2011 (ML111180686).]

However, based on the information contained within this document, the previously established commitments are considered closed based on the intended direction to be taken to resolve GSI-191 in-vessel downstream effects and to remediate the identified TempMat as described herein. New commitments as a result of this closure effort are listed in Attachment 3 and subsume the two commitments listed above.

Resolution Schedule

Dominion currently anticipates that it will achieve resolution of GSI-191 and closure of GL 2004-02 for NAPS 1 and 2 per the following schedule:

- In-vessel Testing/Analysis – Dominion is participating in the PWROG program for establishing revised and bounding in-vessel debris limits. As noted above, Dominion will develop a plan for demonstrating compliance with the PWROG program limits and communicate that plan to the NRC within 60 days of the PWROG establishing new in-vessel acceptance criteria.

- Plant Modifications

  - Removal of Fibrous Insulation – As noted above, sufficient fibrous insulation will be removed and replaced in the Units 1 and 2 containments with RMI to remediate the subsequently identified TempMat insulation in containment ZOIs. Insulation walkdowns and measurements (scans) were performed during the recently completed NAPS 2 spring refueling outage (RFO) and are currently scheduled to be performed during the 2013 NAPS 1 fall RFO. Insulation removal/replacement modifications will be completed for NAPS 1 and 2 during the 2016 fall and spring RFOs, respectively. These completion dates are within the SECY 12-0093 proposed resolution period for Option 2 (deterministic) plants of three RFOs after January 1, 2013.

  - The need for additional plant modifications is not anticipated at this time. However, the revised in-vessel acceptance criteria being developed by the PWROG could potentially indicate that additional insulation removal/remediation or testing is required. Should that occur, Dominion will notify the NRC as part of its plan for demonstrating compliance with the PWROG program limits as noted above.

- Licensing Basis Update - Dominion will update the current licensing basis (UFSAR in accordance with 10 CFR 50.71(e), etc.) following NRC acceptance of the updated supplemental response for NAPS 1 and 2 and completion of the identified insulation remediation modifications in containment per plant modification procedures and processes.

Summary of Actions Completed to Address GL 2004-02

A summary of the actions that Dominion has completed for NAPS 1 and 2 to resolve GSI-191 and address GL 2004-02 is provided in Attachment 2.

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

A summary of the margins and conservatisms associated with the resolution actions taken to date to resolve GSI-191 is provided in Attachment 2. These margins and conservatisms provide support for the extension of time required to address GL 2004-02 for NAPS 1 and 2.

Summary of Defense-In-Depth Measures

The following discussion describes the plant specific design features and procedural capabilities that exist for detecting and mitigating a fuel blockage condition that could potentially occur due to in-vessel debris:

Description of Post-LOCA Emergency Core Cooling System (ECCS) Operation and Effect on In-Vessel Debris

The NAPS 1 and 2 Emergency Operating Procedures (EOPs) provide direction for the transfer of the ECCS operating mode from Cold Leg Injection to Cold Leg Recirculation (ES-1.3) and subsequently from Cold Leg Recirculation to Hot Leg Recirculation (ES-1.4). By design these modes of ECCS operation ensure sufficient core cooling for the duration of the design basis LOCA. The transfer to Cold Leg Recirculation aligns the ECCS for suction from the containment sump following sufficient depletion of the Refueling Water Storage Tank (RWST). For both NAPS 1 and 2, the EOPs direct that the transfer to Hot Leg Recirculation be completed by 5 hours from the onset of the LOCA. During Hot Leg Recirculation, the discharge of all ECCS pumps is aligned to the Hot Leg injection points. Although the purpose of this ECCS flow redirection is primarily to flush the reactor vessel and prevent boron precipitation on the surfaces of the fuel rod cladding and reactor vessel internals, the flow reversal can also serve to disrupt a debris bed that may have formed in the lower core region during Cold Leg Recirculation.

Per WCAP-16793, Revision 2, fuel assembly tests have shown that the limiting conditions for fuel blockage require the combination of fibrous debris, particulates, and chemical precipitates. Significantly higher fiber debris loads can be accommodated without flow reductions with the absence of chemical precipitates. Before the transfer to hot leg recirculation at five hours, NAPS does not expect chemical precipitates to form and affect core cooling, based on the following evaluation.

As part of the design evaluation for containment sump strainer performance, NAPS performed calculations for post-LOCA containment sump chemical effects, which was limited to aluminum oxyhydroxide formation. The total aluminum mass released to the sump water was calculated using an aluminum release rate equation with NAPS-specific aluminum inventory based on exposure category, sump and spray water pH, and sump and spray water temperatures for specific time intervals following a LOCA. The precipitation behavior of aluminum oxyhydroxide under representative post-LOCA sump water conditions was evaluated in bench-top testing. The NAPS chemical effects analysis and testing program demonstrated that chemical effects would not begin to influence the strainer debris head loss for several hours or days. As such, the NAPS strainer head loss basis assumes no chemical influence until after six hours. This conclusion was previously reviewed by the NRC (see audit report dated February 10, 2009 (ML090410626)) and summarized in Dominion letter dated February 27, 2009 (ML090641038).

Because chemical precipitates form over the long-term (more than six hours) and would not be considered to be of sufficient concentration within the strainer bypass content to result in significant in-vessel deposition within five hours of the onset of the LOCA, the current transfer to Hot Leg Recirculation directed by the NAPS 1 and 2 EOPs is considered to be a major mitigating measure for debris bed formation and a means of preventing potential flow degradation below decay heat removal levels. Once the reactor vessel is flushed with ECCS from the hot side, a significant amount of in-vessel fiber and particulates would be returned to the containment pool for subsequent filtration by the sump strainer. NAPS-specific strainer bypass testing has shown very high fiber filtration once a thin debris bed forms on the sump strainer.

For resolution of GSI-191, NAPS 1 and 2 each installed two containment sump strainers with corrugated, perforated stainless steel fins. There are separate strainers for the RS system and the LHSI system during sump recirculation mode. In post-LOCA long-term operation with maximum ECCS pump operation, the flow to the LHSI strainer is less than 50% of the total (LHSI + RS) strainer flow. Thus, a significant amount of fibrous debris is drawn to the RS strainer and away from the LHSI strainer that supplies the ECCS. This element of the GSI-191 strainer design would tend to delay fibrous debris introduction to the ECCS and provides additional defense-in-depth.

Review of EOPs for Lower Core Blockage

As described above, the NAPS 1 and 2 EOPs direct the ECCS modes of operation in the designed sequence to mitigate the potential for in-vessel lower core region flow blockage. In addition, the EOPs also direct routine monitoring of the Critical Safety Functions during accident conditions. This is facilitated by monitoring the Critical Safety Function Status Trees (F-0). One of these trees is related to the Core Cooling safety function (F-0, Attachment 2). The status of the Core Cooling safety function is assessed using the tree logic, based on the monitoring of RCS Subcooling, Core Exit Temperature, and Reactor Vessel Level. Should lower core debris blockage occur in a manner that significantly degrades flow to the Reactor Core, it is expected that Core Exit Temperature will exhibit an increasing trend. Uncorrected, this temperature trend would lead to a diagnosis of an Inadequate Core Cooling condition by the tree logic. In accordance with the Critical Safety Function Tree rules of usage, diagnosis of such a condition would require immediate entry into the Functional Restoration procedure for Response to Inadequate Core Cooling (FR-C.1). Based on expected indications of associated Core Cooling parameters and ECCS flow, FR-C.1 would direct interim cooling strategies that involve depressurization of intact Steam Generators and starting of Reactor Coolant Pumps (RCPs), one at a time, regardless of the status of RCP support conditions. It is anticipated that in the course of these conditions and interim cooling strategies, Technical Support Center (TSC) personnel would assist in the evaluation of the situation and recommend realignment of the ECCS to Hot Leg Recirculation.

Using recent generic guidance from the PWROG, NAPS intends to improve the EOP defense-in-depth measures for early diagnosis and response to potential lower core region flow blockage. This enhancement will involve a modification to EOP ES-1.3, "Transfer to Cold Leg Recirculation", that will initiate early actions to monitor and evaluate the trends of parameters indicative of lower core region blockage following the completion of the sump recirculation alignment. It is expected that monitoring would be initially performed by Control Room Operators, with longer-term trending and evaluation support provided by the TSC. Should parameter trends support a diagnosis of significant flow blockage in the lower core region prior to the normal designated time for Transfer to Hot Leg Recirculation, guidance will be provided to evaluate performing the transfer earlier as a mitigating measure to disturb the blocking debris bed and maintain adequate core cooling. In this manner, a more timely diagnosis and proactive response would be possible without over-reliance on the Core Cooling Critical Safety Function Tree assessment.

NAPS 1 and 2 plans to implement the described change to EOP ES-1.3, "Transfer to Cold Leg Recirculation" and complete required training before September 30, 2013.

Although these defense-in-depth measures are not expected to be required based on the very low probability of an event that would result in significant quantities of debris being transported to the reactor vessel that would inhibit the necessary cooling of the fuel, they do 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 NAPS 1 and 2.

Conclusion

Dominion expects the GSI-191 resolution path for NAPS 1 and 2 to be acceptable based on the information provided in this submittal. The execution of the actions identified in this document will result in successful resolution of GSI-191 and closure of GL 2004-02. Given the significantly increased size and advanced design of the installed strainers, the extensive corrective actions already taken, the design margins and conservatisms inherent in the analyses performed, the defense-in-depth measures in place and planned enhancements, and the low probability of challenging pipe breaks, there is reasonable assurance that the health and safety of the public will be maintained until the identified actions have been completed.

Attachment 2

Implemented Corrective Actions to Address GL 2004-02

Virginia Electric and Power Company
(Dominion)
North Anna Power Station Units 1 and 2

Implemented Corrective Actions to Address GL 2004-02
North Anna Power Station Units 1 and 2 (NAPS 1 and 2)

Corrective Actions

A summary of the corrective actions that Dominion has completed to resolve NRC Generic Safety Issue (GSI)-191, "*Assessment of Debris Accumulation on PWR Sump Performance,*" for NAPS 1 and 2 is provided below.

Modifications to Improve Plant Performance

Numerous plant modifications have been completed for NAPS 1 and 2 in support of GSI-191 resolution including the following:

1. Two new containment sump strainers (with corrugated, perforated stainless steel fins) were installed with a total surface area of approximately 4000 ft^2 for the Recirculation Spray (RS) pumps in each unit, approximately 2000 ft^2 for the Unit 1 Low Head Safety Injection (LHSI) pumps and approximately 1900 ft^2 for the Unit 2 LHSI pumps. These strainers replaced the previous containment sump screens, which had a surface area of approximately 168 ft^2.
2. Calcium-Silicate (Cal-Sil) insulation located within the steam generator (SG) cubicles and pressurizer room was removed and replaced with Paroc and TempMat insulation in both Units 1 and 2.
3. Microtherm insulation installed within the break zone of influence (ZOI) was removed from the NAPS Units 1 and 2 containments.
4. A drain was installed in the Primary Shield Wall to the Incore Sump Room (ISR) in NAPS Units 1 and 2 to reduce the water holdup volume and to increase the total volume of water available for strainer submergence and recirculation.
5. Engineered Safety Features (ESF) circuitry was modified to start the RS pumps on a Containment Depressurization Actuation (CDA) signal coincident with a Refueling Water Storage Tank (RWST) Level-Low signal. The Outside RS (ORS) pumps start immediately once the coincidence logic is satisfied. The Inside RS (IRS) pumps start following a time delay of 120-seconds once the coincidence logic is satisfied. These changes ensure sufficient water is available to meet the RS strainer submergence and RS pump net positive suction head (NPSH) requirements.
6. The RWST level instrumentation was modified to change the safety injection Recirculation Mode Transfer (RMT) setpoint from 19.4% to 16.0% RWST wide range level. This allows more energy to be removed from the containment and lowers the sump temperature prior to the LHSI pump suction switching from the RWST to the containment sump. This change also provides a higher water level in the containment sump prior to the LHSI pump suction switching to the containment sump. The combination of lower sump temperature and higher water level

provides increased net positive suction head (NPSH) available to the LHSI pumps and ensures the required volume of water to maintain the strainers submerged.

7. The containment sump level transmitters were modified to protect them from clogging due to debris.
   - Level transmitters located within the sump have been modified by drilling holes through stilling wells at various places to prevent the element from clogging.
   - Level transmitters located above the containment floor have been provided with debris shields to protect them from containment spray generated debris.

Additional Corrective Actions Taken to Address GSI-191

In addition to the modifications listed above, the following actions have been completed in support of GSI-191 resolution:

1. Completed debris generation and debris transport analyses. These analyses contain:
   - Break selection criteria
   - Calculation of amount and type of debris generated for limiting breaks
   - Breakdown of debris sizes
   - Physical debris characteristics (i.e. density, fiber size, particulate size)
   - Calculation of amounts of each debris postulated to reach the LHSI strainer

2. Performed a downstream effects analysis for clogging/wear of components in ECCS and RS flow streams downstream of LHSI and RS strainers.

3. Completed analysis of water hold-up in containment to identify locations where water will be blocked from reaching the ECCS strainer.

4. Revised the NAPS 1 and 2 Technical Specifications (TS) to increase the containment air partial pressure limits to provide analytical margin, including NPSH margin, for the RS and LHSI pumps. The TS were also revised to provide new containment sump inspection requirements associated with the new strainers.

5. Replaced the LOCTIC containment analysis methodology for analyzing the response to postulated pipe ruptures inside containment, including a loss of coolant accident (LOCA) and a main steam line break (MSLB), with the NRC-approved GOTHIC evaluation methodology discussed in Dominion Topical Report DOM-NAF-3-0.0-P-A. The change to the GOTHIC code provided margin in LOCA peak containment pressure and other accident analysis results.

6. Revised the LOCA Alternate Source Term (AST) analysis to include the effects from changing the RS pump start methodology and other changes.

7. Revised and/or created procedures and programs to ensure that future changes to the plant do not adversely affect the ability of the new containment strainers to perform their design function.

8. Trained operators on the operation of the RS and LHSI Systems with respect to the new containment sump strainers.

Margins and Conservatisms

To ensure the modifications implemented and the analyses performed effectively addressed uncertainties with sufficient margin, the following conservatisms were incorporated:

1. Test evaluations demonstrate that a fully formed thin-bed of debris takes significant time (hours) to form and that formation of a thin-bed is dependent upon disturbing settled debris throughout the test tank. Consequently, a worst-case thin-bed of debris would be difficult to form and would not be expected to form until several hours after sump recirculation is initiated. Significant debris settling and sump water subcooling occurs during the formation of a debris-bed so additional NPSH margin is present for chemical effects head loss. However, as a conservative measure, chemical effects testing began with an established debris thin-bed on the strainer fin and was conducted for the 30-day mission time.

2. The debris load in head loss testing was taken from the debris transport calculation, which conservatively credits no particulate settling.

3. Debris introduction procedures in chemical effects testing ensured minimum near-field settling and resulted in conservatively high debris bed head losses.

4. Debris introduction was accomplished in a carefully controlled manner to result in the highest possible head loss. Particulate was introduced initially, which was followed by discrete fiber additions after the particulate debris had fully circulated.

5. Only fines of fibrous debris were used in head loss testing as if all the fibrous debris erosion, which is expected to take a considerable amount of time, occurred at recirculation start.

6. Debris bed formation during testing included agitating (or "stirring") the settled debris to ensure maximum debris on the strainer. However, any turbulence in post-LOCA containment sump water is expected to be localized to limited areas of the strainers. Consequently, much of the sump water will be quiescent, which would promote debris settling.

7. Particulate settling in head loss testing was conservatively minimized through use of a lower density walnut shell particulate as a surrogate for the higher density epoxy coating particulate that may be present in post-LOCA sump water.

8. Downstream effects analyses (components) were completed consistent with WCAP-16406-P, Rev. 1, "Evaluation of Downstream Sump Debris Effects in Support of GSI [Generic Safety Issue]-191," to identify any wear, blockage or vibration concerns with components and systems due to debris-laden fluids. Significant conservatisms are inherent in these analyses, which provide reasonable assurance that downstream component clogging will not occur, and downstream component wear will not significantly affect component or system performance. Downstream wear analysis used the Large Break LOCA particulate load to determine abrasive and erosive wear. This is a conservative particulate loading, in view of the following:

   - Much of the particulate included in the analysis is unqualified coating that is outside the break ZOI. This unqualified coating is assumed to dislodge due to exposure to the containment environment. However, such dislodgement is likely only after many hours, if at all.

   - The low velocity of the sump water column and the significant number of surfaces throughout containment promote significant settling of particulate in containment. Settled coating will not be drawn through the sump strainer since the RS strainer is located approximately six inches above the containment floor and the LHSI strainer is approximately nineteen inches above the containment floor.

   - The analysis assumes 100% strainer bypass of particulate conservatively maximizing the effects of downstream wear.

9. Chemical effects testing results were conservative based upon several conditions:

   - Aluminum corrosion amounts were calculated at high pH, where aluminum corrosion and release rates are high. Testing was performed at neutral pH, where aluminum solubility is low to encourage aluminum compound precipitation. Sump water pH is expected to be approximately 8 in the long-term.

   - The minimum sump water volume at specified times post-LOCA were used to maximize the calculated sump aluminum concentrations.

   - The analysis of aluminum load conservatively does not account for the possible inhibitory effect of silicate or other species on aluminum corrosion.

- The rate of corrosion is maximized by the analysis that does not assume development of passive films, i.e., no aluminum oxides remain adhered to aluminum surfaces. The formation of passive films could be credited to decrease the corrosion and release rates at long exposure times. Consequently, it is conservative to assume that all aluminum released by corrosion enters the solution.

- All aluminum released into the solution is conservatively assumed to transport to the debris-bed instead of plating out on the multiple surfaces throughout containment. During bench-top testing, aluminum plated out on glass beakers and, during reduced-scale testing, aluminum plated out on fiber. It is reasonable to expect that a portion of the aluminum ions released into solution will plate out on some of the multiple surfaces in containment prior to arriving at the debris-bed on the strainer.

- Chemical effects test evaluations conservatively neglect the effect of the presence of oxygen in the sump water. The corrosion rate of aluminum in aerated pH 10 alkaline water can be a factor of two lower than that measured in nitrogen-deaerated water. This data is in NUREG/CR-6873, "Corrosion Rate Measurements and Chemical Speciation of Corrosion Products Using Thermodynamic Modeling of Debris Components to Support GSI-191."

10. NPSH margins were determined with the following conservatisms:

    - No credit was taken for additional NPSH margin in the short-term due to subcooling of the sump water combined with the several hours required to form the limiting thin-bed of debris. Our analyses conservatively assume transport to the strainer following the break occurs much sooner.

    - There is conservatism in scaling from test temperatures to higher specified sump temperatures. The debris bed will expand slightly when head loss is lower, i.e., at the higher sump temperature, the bed would be expected to be slightly more porous than at the lower test temperature. The assumption of a purely linear relationship between head loss and viscosity when scaling to higher temperatures is, therefore, conservative.

    - The NPSH calculations were guided by the observation that the minimum margin would likely occur for the combination of parameters that would minimize the containment pressure and maximize the sump water temperature (and, hence the vapor pressure of this fluid), thereby conservatively minimizing the contribution of containment accident pressure to the calculated NPSH margin.

11. Chemical effects testing and analyses have been completed for the LHSI and RS strainers. Atomic Energy of Canada, Limited (AECL) has performed various hydraulic tests that simulated the actual debris loading and chemical conditions specific to NAPS 1 and 2 based on debris generation, debris transport, and chemical effects evaluations. Fibrous and particulate debris and chemicals were added to a test rig to simulate the plant-specific chemical environment present in the water of the containment sump following a design basis accident (DBA). Each test was operated for more than 30 days after the formation of the debris bed and initial chemical addition at specified temperatures and flow rates to assess chemical precipitate formation and head loss change. These tests verified that adequate NPSH is available to support the operation of the LHSI and RS pumps during the post-LOCA recirculation mode.

12. Aluminum release analysis was conducted using the release rate equation developed by AECL, which can be more conservative under certain conditions than the release rate equation specified by Equation 6-2 of WCAP-16530-NP. The results of the application of the AECL release rate model were compared to the WCAP-16530-NP model results using NAPS aluminum inventories and were found to predict a greater 30-day release of aluminum.

Attachment 3

Regulatory Commitments

**Virginia Electric and Power Company
(Dominion)
North Anna Power Station Units 1 and 2**

Regulatory Commitments

The following table identifies the actions committed to in this letter. Statements in this submittal with the exception of those in the table below are provided for informational purposes and are not considered commitments. Please direct any questions regarding these commitments to Gary Miller at (804) 273-2771.

No.	Commitment	Expected Completion Date
1	Once the PWROG establishes new in-vessel acceptance criteria, Dominion will develop a plan for demonstrating compliance with the PWROG program limits and communicate that plan to the NRC.	Within 60 days of the PWROG establishing new in-vessel acceptance criteria
2	Sufficient fibrous insulation will be removed from the NAPS 1 and 2 containments and replaced with Reflective Metal Insulation to remediate the subsequently identified TempMat insulation.	Fall 2016 and spring 2016 refueling outages for NAPS 1 and 2, respectively
3	Dominion will update the current licensing basis (UFSAR, etc.) for NAPS 1 and 2 following completion of insulation removal/replacement modifications in containment per plant modification procedures and processes (10 CFR 50.71(e)).	Following NRC acceptance of supplemental response and in accordance with 10 CFR 50.71(e)