VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

May 14, 2013

U. S. Nuclear Regulatory Commission
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VIRGINIA ELECTRIC AND POWER COMPANY
SURRY 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

By letters dated February 29, 2008 (ML080650562), February 27, 2009 (ML090641018), December 17, 2009 (ML093521426), and April 13, 2010 (ML101040082), Virginia Electric and Power Company (Dominion) submitted detailed information concerning corrective actions taken in response to NRC Generic Letter (GL) 2004-02 for Surry Power Station Units 1 and 2 (SPS 1 and 2) to address the containment sump strainer issues identified in GSI-191. The remaining open item for resolution is downstream in-vessel effects.

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on Pressurized-Water Reactor Sump Performance*, dated July 9, 2012 (ML121310648), the NRC staff effectively superseded the NEI approach by presenting three options to the Commission as viable paths for licensees to resolve GSI-191 and recommended that the Commission allow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 for SPS 1 and 2 and also describes the GSI-191 closure option, resolution plan and implementation schedule for resolving downstream in-vessel effects. Attachment 2 provides a summary of the corrective actions and analyses that have been implemented at SPS, 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

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actions discussed herein have been completed. Attachment 3 provides the regulatory commitment included in this submittal.

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

Commitment 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 Commitment

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 14TH day of MAY, 2013.

My Commission Expires: MAY 31, 2014.

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Notary Public
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My Commission Expires May 31, 2014

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Attachment 1

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

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

Generic Safety Issue-191 (GSI-191) In-vessel Effects Resolution Plan
Surry Power Station Units 1 and 2 (SPS 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 SPS 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 SPS 1 and 2 is provided in Attachment 2.

Characterization of Current Containment Fiber Status

From the debris generation and transport analyses performed for SPS 1 and 2, Dominion has determined the types and quantities of fibrous debris that could be transported to the strainers, as documented by letter dated February 29, 2008 (ML080650562). The fibrous debris sources considered in these analyses include asbestos, Thermal Wrap, TempMat, fiberglass, PAROC/mineral wool, Thermal Insulating Wool, and latent fiber. The total fibrous debris quantity from these sources that could potentially reach the sump strainer was conservatively calculated to be approximately 1,169 pounds-mass (lbm).

Reduced scale testing for SPS 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. Three 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-micrometer (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 SPS 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 millimeters (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 99.91% 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 99.91% filtration, approximately 1.05 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 approximately 3.1 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 address GL 2004-02 for SPS 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 (ML080650562), February 27, 2009 (ML090641018), and December 17, 2009 (ML093521426). 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 SPS 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 Commitment

Dominion currently has one outstanding commitment regarding the resolution of GSI-191 for SPS 1 and 2. Specifically, in letter dated February 27, 2009 (ML090641018), Dominion committed to 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 WCAP-16793-NP, Revision 2, and the associated NRC Safety Evaluation Report (SER). The NRC SER for WCAP-16793, Rev. 2, was issued April 8, 2013. However, based on the information contained within this document regarding the intended direction to be taken to resolve GSI-191 in-vessel downstream effects, this statement is no longer applicable. A new commitment as a result of this closure effort is listed in Attachment 3 and subsumes the commitment identified above.

Resolution Schedule

Dominion currently anticipates that it will achieve resolution of GSI-191 and closure of GL 2004-02 for SPS 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 - 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.

Summary of Actions Completed to Address GL 2004-02

A summary of the corrective actions that Dominion has completed for SPS 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 SPS 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 SPS 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 RWST. For both SPS 1 and 2, the EOPs direct that the transfer to Hot Leg Recirculation be completed by nine 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 nine hours, SPS 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, SPS 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 SPS-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 SPS 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 SPS strainer head loss basis assumes no chemical influence until after four hours, which is conservative compared to the expected timing of impacts from chemical effects. The chemical effects program was summarized in Dominion letter dated February 27, 2009 (ML090641018).

Because chemical precipitates form over the long-term and would not be considered to be of sufficient concentration within the strainer bypass content to result in significant in-vessel deposition within nine hours of the onset of the LOCA, the current transfer to Hot Leg Recirculation directed by the SPS 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. SPS-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, SPS 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 40% 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 SPS 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. One of these trees is related to the Core Cooling safety function (F-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, SPS 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.

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

Although these 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 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 SPS 1 and 2.

Conclusion

Dominion expects the GSI-191 resolution path for SPS 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)
Surry Power Station Units 1 and 2

Implemented Corrective Actions to Address GL 2004-02
Surry Power Station Units 1 and 2 (SPS 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 SPS 1 and 2 is provided below.

Modifications to Improve Plant Performance

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

1. New containment sump strainers (with corrugated, perforated stainless steel fins) were installed in the containment sump for SPS 1 and 2. The total surface area of the Unit 1 Recirculation Spray (RS) strainer is approximately 5750 ft^2, and the total surface area of the Low Head Safety Injection (LHSI) strainer is approximately 2200 ft^2. The total surface area of the Unit 2 RS strainer is approximately 5800 ft^2, and the total surface area of the Unit 2 LHSI strainer is approximately 2250 ft^2. These strainers replaced the previous screens, which had a surface area of approximately 158 ft^2.
2. Microtherm insulation installed within the break zone of influence (ZOI) was removed from the SPS 1 containment.
3. A drain was installed in the Primary Shield Wall of the Incore Sump Room to reduce the water holdup volume and increase the total volume of water available for strainer submergence and recirculation.
4. Engineered Safeguards Features (ESF) circuitry was added to start the RS pumps on a Hi-Hi Containment Pressure Consequence Limiting Safeguards (CLS) signal coincident with a Refueling Water Storage Tank (RWST) Level Low signal. The Inside RS (IRS) pumps receive an immediate start signal once the coincidence logic is satisfied. The Outside RS (ORS) pumps start following a timer delay of 120-seconds once the coincident logic is satisfied. These changes ensure sufficient water is available to meet the RS strainer submergence and the RS pumps net positive suction head (NPSH) requirements.
5. Insulation inside the containment that could contribute to spray or submergence generated debris that was determined to be damaged, degraded or covered with an unqualified coating system was removed or jacketed with a jacketing system qualified for a design basis accident (DBA).

6. The containment sump level transmitters were modified to protect them from clogging due to debris. Specifically:

   - Level transmitters located within the sump have been modified by drilling holes through stilling wells at various locations 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.

7. Air ejectors were re-installed on the SPS 1 and 2 LHSI pump cans.

<u>Additional Corrective Actions Taken to Address GSI-191</u>

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 ECCS strainer

2. Completed analysis of water hold-up in containment to identify locations where water will be blocked from reaching the RS and LHSI strainers.

3. Revised the SPS 1 and 2 Technical Specifications (TS) to change the method for starting the inside and outside recirculation spray (RS) pumps in response to a design basis accident. The RS pump start, which was based on a time delay following a Consequence Limiting Safeguards (CLS) High High containment pressure setpoint, was revised to start on a coincident CLS High High pressure and RWST low level.

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

5. Revised the SPS 1 and 2 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.

6. 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 provides margin in LOCA peak containment pressure and other accident analysis results.

7. Revised the SPS 1 and 2 LOCA Alternate Source Term analysis to include the effects from changing the RS pump start methodology and from the other modifications associated with the GSI-191 project.

8. Revised and/or created procedures and programs to ensure that future changes to the plant are evaluated for their effects on the ability of the new containment strainers to perform their design function.

9. Trained operators on the operation of the RS and LHSI systems with respect to the new containment strainers.

10. Completed a Finite Element Analysis (FEA) demonstrating the acceptability of the 18-inch band spacing on the Surry insulation jacketing.

Margins and Conservatisms

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

1. Testing and analyses for strainer head loss and vortexing were performed with the following conservatisms:

   - A reduced-scale test tank was used to determine debris strainer design size and fin pitch by measuring debris head loss. The small diameter of the tank and the constant stirring ensured that a minimal amount of the debris settled on the floor of the tank thus maximizing the amount of debris and subsequent head loss across the test fins. Settling of small debris in containment is expected to be significant especially in areas remote from the strainer.

   - The maximum head loss is dependent on formation of a thin-bed on the strainer surface. Formation of a thin-bed is dependent on a small quantity of fiber mixing with the particulate on the strainer. Additional fiber beyond the minimum quantity required for the thin-bed tends to produce lower head losses. Thin-bed formation conservatively used the minimum quantity of fiber necessary to form a thin-bed in combination with the maximum large break (LB) LOCA particulate load. This conservative combination is very unlikely to occur at the strainer for either a small break LOCA or a LBLOCA.

- Vortexing analysis and testing showed no vortexing with a strainer that has zero submergence (water level at the top of the strainer). The submergence at the beginning of recirculation is at least three inches for the RS strainer and eight inches for the LHSI strainers. Submergence increases as RWST water continues to be sprayed into containment.

- Maximum head loss is calculated at the minimum containment sump water level. The minimum water level only occurs at the beginning of recirculation and water level increases as additional RWST water is sprayed into containment. The maximum head loss will not be established until a significant period of time after RS pump start and, based on head loss testing, will not occur until well after the approximately 2 hours required for all of the RWST water to be pumped into containment.

- Head loss testing involved adding all of the particulate to the test tank prior to the addition of any fiber, and then adding fiber in increments to gradually build a thin-bed on the strainer. An actual break is much more likely to mix all of the available fiber and particulate together in the sump pool so that they arrive at the screen together. Consequently they are unlikely to form a thin bed since there is likely to be more fiber in the mix than is necessary for thin bed formation. This will lead to lower head losses.

2. Test evaluations demonstrate that a fully formed thin-bed of debris requires 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 available for chemical effects head loss. However, as a conservative measure, chemical effects testing began with an established debris thin bed on the strainer fins and was conducted for the 30-day mission time.

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

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

5. 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.

6. 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.

7. 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.

8. 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.

9. 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. The downstream wear analysis used the LBLOCA 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 zone of influence (ZOI). This unqualified coating is assumed to dislodge due to exposure to the containment environment. However, such dislodgement is likely only after many hours and days, 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 bottom of the RS strainer is located approximately six inches above the containment floor and the bottom of the LHSI strainer is located approximately 19 inches above the containment floor.

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

10. Chemical effects testing results were conservative based upon the following conditions:

- Aluminum corrosion amounts were calculated at high pH (pH 9), where aluminum corrosion and release rates are high. Testing was performed at neutral pH (pH 7), where aluminum solubility is low to encourage aluminum compound precipitation. Sump water pH is expected to be approximately pH 8 in the long-term.

- The minimum sump water volume at specified post-LOCA times was 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 which 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 [Generic Safety Issue]-191."

11. NPSH margins were determined with the following conservatisms:

- The calculation of NPSH available used the NRC-approved methodology in Topical Report DOM-NAF-3, Rev. 0.0-P-A, "GOTHIC Methodology for Analyzing the Response to Postulated Pipe Ruptures Inside Containment," September 2006. The methodology includes assumptions that minimize the contribution of containment accident pressure to the calculated NPSH margin and maximize the sump water temperature (and, thus, the vapor pressure of the pumped fluid).

- The NPSH analysis includes conservatisms that ensure a minimum containment water level is used. Conservative assumptions are made for water hold-up in spray system piping, water trapped from transport to the containment sump in volumes (e.g., the refueling canal and reactor cavity), condensation films on heat structures, films on platforms and equipment that form after spray is initiated, other losses, and spray water droplets in the atmosphere. The following conservatisms are also applied to the available water sources:
  - No contribution from the chemical addition tank;
  - Initial RWST volume of 384,000 gallons (versus TS minimum of 387,100 gallons);
  - The containment sump is empty at the start of the LOCA (normal operation maintains approximately 500 gallons in the pit); and
  - +2.5% RWST wide range level uncertainty (9738 gallons) is applied in determining the initiation of RS and LHSI recirculation (the minimum NPSH available for the LHSI pump occurs right after recirculation mode transfer to the sump).

- Analyses were performed to identify the limiting set of conditions (break location, plant operating conditions, equipment performance, single failure) that produces the minimum NPSH available for each pump (LHSI, IRS, and ORS). This deterministic approach ensures that all variables are biased in their most adverse direction. For scenarios other than the most limiting case identified for each pump, additional NPSH margin exists.

- For evaluation of short-term pump NPSH margins, the maximum debris bed head loss from the test program was compared to the minimum NPSH available that occurs during a transient time when a debris bed is just beginning to form on the strainer fins. Testing performed by Atomic Energy of Canada, Limited (AECL) has shown that several hours to days are required to reach the maximum debris bed head loss that was used in the short-term NPSH margin evaluation.

- There is conservatism in the methodology used for scaling strainer debris bed head loss 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 for scaling to higher temperatures is conservative.

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 SPS aluminum inventories and were found to predict a greater 30-day release of aluminum.

Attachment 3

Regulatory Commitment

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

Regulatory Commitment

The following table identifies the action 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 this commitment to Gary Miller at (804) 273-2771.

No.	Commitment	Expected Completion Date
1	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 that plan to the NRC.	Within 60 days of the PWROG establishing new in-vessel acceptance criteria