VIRGINIA ELECTRIC AND POWER COMPANY
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April 27, 2011

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
UPDATED SUPPLEMENTAL RESPONSE TO NRC GENERIC LETTER 2004-02 "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS"

By letters dated February 29, 2008 (ADAMS ML080650563) and February 27, 2009 (ADAMS 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. Those letters fully detailed the corrective actions that had been performed to address the issues identified in GL 2004-02 including: 1) downstream effects evaluations for Emergency Core Cooling System (ECCS) and Recirculation Spray (RS) System pump seal performance and component wear, and 2) chemical effects testing and evaluation. In a letter dated May 29, 2009 (ADAMS 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 North Anna Units 1 and 2 ECCS strainers.

However, Dominion has since identified three discrepancies regarding the information provided in the supplemental responses noted above as a result of detailed inspections, and drawing and design document reviews. First, in Dominion's February 29, 2008 supplemental response, it was stated that Microtherm insulation had been removed from the Unit 2 containment and that no Microtherm insulation was installed in the Unit 1 containment. However, additional quantities of Microtherm insulation were subsequently identified in the zones of influence (ZOI), associated with containment sump recirculation, in both the Units 1 and 2 containments. Second, it was stated that Calcium-Silicate (Cal-Sil) insulation within the steam generator cubicles and pressurizer room had been replaced with fibrous insulation or removed in both containments. However, additional Cal-Sil insulation was identified in the same areas that it had been reported to have been completely removed. Third, additional quantities of Tempmat insulation have been identified in piping penetrations in the reactor vessel primary shield wall of both containments that were not accounted for in the 2008 submittal.

The Microtherm and Cal-Sil insulation mentioned above was remediated during the fall 2010 outages. Dominion has also completed a formal review of the latest plant design documents to identify other design or testing information/data or a plant configuration pertaining to insulation that may have changed since the February 29, 2008 and February 27, 2009 submittals.

The debris and chemical effects testing and analyses performed as part of the station's GSI-191 analysis did not include Microtherm or Cal-Sil insulation types, and the new total debris loading of fibrous insulation exceeds the tested debris loading. Therefore, the purpose of this letter is to: 1) formally notify the NRC on the docket of the identification of additional quantities of insulation in the North Anna containments, 2) document how these insulation materials have been/will be dispositioned to maintain compliance with the plant GL 2004-02 design and licensing bases, and 3) discuss the additional differences identified during the design documentation review, and if these discrepancies/differences impact the sump's ability to perform its intended safety function.

Particulate Insulation

Dominion had previously stated that: 1) Microtherm insulation had been removed/replaced from the North Anna Unit 2 containment, 2) based on previous walkdowns and review of the piping and component drawings for inside containment, no Microtherm insulation was installed in the Unit 1 containment, and 3) Cal-Sil had been removed/replaced in both containments in those areas within the ZOIs for break locations that could produce a thin bed and require containment sump recirculation. However, during the review of an old design change package (DCP) unrelated to GL 2004-02, engineering personnel noted that a Unit 1 vendor drawing included in the DCP identified the insulation installed on the reactor vessel nozzles as Microtherm insulation. Consequently, a review of the original GL 2004-02 walkdown reports, material specifications, applicable design changes, and plant drawings was initiated for both units to determine if Microtherm could be installed anywhere else in containment. Additional insulation drawings were obtained from the insulation vendor that were not in the Dominion controlled drawing system. These drawing reviews and interviews of cognizant plant personnel were conducted to determine the type of insulation installed. The document/drawing reviews and interviews identified potential locations where Microtherm might have been installed. Detailed inspections were performed in Unit 1, which was in a refueling outage at the time, to determine if Microtherm was actually installed in the Unit 1 containment. The inspections included those areas that were not walked down during original GL 2004-02 walkdowns due to localized high radiation areas and focused on piping configurations that provided limited space for insulation (e.g., penetrations, pipe supports, pump bowls, elbows, etc.) These inspections confirmed that Microtherm was installed in certain locations in the Unit 1 containment contrary to previous conclusions. Consequently, Unit 2 was shut down to perform similar inspections, which also confirmed the existence of Microtherm insulation in the Unit 2 containment.

During the Unit 1 and 2 inspections, Cal-Sil was also identified within the ZOIs for break locations that would require containment sump recirculation and could generate enough fiber debris to form a thin bed. It was concluded that the associated design changes to remove Cal-Sil and Microtherm had not been properly implemented and some of the Cal-Sil and Microtherm that had been previously identified for removal had been erroneously left in place. Other quantities of Cal-Sil, although not in a limiting break ZOI, also meet the criteria for insulation removal by the design change packages, but erroneously had not been identified as in scope. In the subsequent fall 2010 reassessment and remediation effort, the search for Cal-Sil was expanded to include ZOIs for break locations that require containment sump recirculation but did not generate enough fiber to result in a thin bed being established.

Prior to returning the Units to service, detailed inspections, both within and outside of the ZOIs, were completed to determine the extent of condition. Microtherm and Cal-Sil insulation were removed from the ZOIs. The remaining Microtherm or Cal-Sil insulation within the containments is not located within a ZOI of a break location that would require containment sump recirculation. Additionally, the remaining Microtherm or Cal-Sil is adequately protected or located in areas to preclude transport to the strainer due to containment spray or submergence. The inspections and remediation of the Microtherm insulation in the North Anna containment were the subject of an NRC special inspection that is documented in Inspection Report Nos. 05000338/2010006 and 05000339/2010006 dated December 10, 2010.

Fibrous Insulation

During the process of reviewing plant documentation during the February 2008 timeframe, Dominion identified additional fibrous insulation, specifically Tempmat, installed in the reactor vessel nozzle areas that was identified as having not been included in the debris loading totals presented in our February 29, 2008 or February 27, 2009 letters. The additional insulation was evaluated for impact on the debris generation and transport calculations, as well as the operability of the RS and Low Head Safety Injection (LHSI) systems and the containment sump, and it was determined that continued operation was acceptable based on the margins and conservative assumptions included in the debris generation and transport calculations. Subsequently, when WCAP-16710-P and WCAP-16720-P were published, Dominion used the associated revised ZOIs to re-evaluate the total debris generated based on the revised fibrous insulation inventory following a design basis accident. Using the WCAPs' test results, which reduced the ZOIs, the total debris generated was bounded by the strainer testing performed by our vendor. Subsequent to this re-evaluation of the debris generation calculation, the NRC questioned the testing methodology contained in the WCAPs for determining ZOIs, which required reinstatement of the earlier operability assessment for the additional fibrous material. During the fall 2010 inspections to locate any Microtherm and Cal-Sil, the insulation material types in each of the limiting break locations (RCS loop rooms and pressurizer cubicle) were also verified and reconciled within the debris generation calculation. After the Microtherm and Cal-Sil insulation was removed from the Unit 1 and Unit 2 ZOIs, an assessment of the current fibrous insulation inventories in the Unit 1 and Unit 2 containments was completed to provide assurance that the current inventories, detailed in Tables 1 and 2 below, had been properly accounted for. This assessment confirmed that while the fibrous debris generated insulation inventories in the Unit 1 and Unit 2 containments presently exceed the tested fibrous insulation inventories assumed for Test Rigs 33 and 89, the containment sump system will continue to perform its intended safety function.

Consistent with the NRC Staff Requirements Memorandum SECY-10-0113, *Closure Options for Generic Safety Issue – 191, Assessment of Debris Accumulation on Pressurized Water Reactor Sump Performance*, dated August 26, 2010, Dominion intends to defer further plant modifications or additional strainer head loss testing until the ongoing

PWROG ZOI testing activities have been completed. Once the testing and analyses have been completed, which is currently scheduled to be completed by December 31, 2011, Dominion will take appropriate additional corrective actions (e.g., recalculate debris generation totals, fibrous insulation removal, jacketing, additional testing, etc.) as may be applicable. 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 North Anna Units 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.

The following tables provide the current insulation debris types and quantities that may be generated for the limiting break locations in the Unit 1 and Unit 2 containments.

Table 1 – Unit 1 Bounding LOCA-Generation Insulation Debris Quantities*

DEBRIS TYPE	BREAK BK1	BREAK BK2	BREAK BK3	BREAK BK4
ZOI Generated				
Metallic (ft^2)				
Transco RMI	710.2	667.6	751.6	354.6
Fibrous (ft^3)				
Thermal-Wrap	692.3	693.3	697.5	0
Tempmat	82.2	91.4	88.7	30.0
Paroc / Mineral Wool	2.9	10.3	10.6	13.1
Fiberglass	110.4	104.6	90.0	211.8
Containment Spray or Submergence Generated				
Fibrous (ft^3)				
Fiberglass	3.2	3.2	3.2	3.2
Thermal-Wrap	0	0.9	0.9	0.9
Tempmat	0.07	0.02	0.05	0.07
Total Fibrous Debris				
Fibrous (ft^3)	891.1	903.7	891.0	259.1

* 5% Margin (uncertainty) was conservatively included in the ZOI generated debris quantities. 20% Margin (uncertainty) was conservatively included in the spray/submergence generated quantities. Coatings and foreign materials are not included in the table.

Table 2 – Unit 2 Bounding LOCA-Generation Insulation Debris Quantities*

DEBRIS TYPE	BREAK BK5	BREAK BK6	BREAK BK7	BREAK BK8
ZOI Generated				
Metallic (ft^2)				
Transco RMI	719.8	719.8	719.8	533.5
Fibrous (ft^3)				
Thermal-Wrap	686.3	687.9	686.0	0
Tempmat	80.3	66.2	81.3	9.6
Paroc / Mineral Wool	2.9	12.8	16.0	5.0
Fiberglass	80.5	57.6	74.6	175.0
Containment Spray or Submergence Generated				
Fibrous (ft^3)				
Fiberglass	3.9	3.9	3.9	1.5
Cellular Foam Glass	0.8	0.8	0.8	0.8
Tempmat	2.5	1.8	1.2	2.1
Total Fibrous Debris				
Fibrous (ft^3)	857.2	831.0	863.8	194.0
* 5% Margin (uncertainty) was conservatively included in the ZOI debris quantities and the spray/submergence generated quantities. Coatings and foreign materials are not included in the table.				

<u>Sump Strainer Size</u>

After the strainer testing was completed and the final test configuration and test data were being re-evaluated by the vendor, it was identified that the strainer surface areas were calculated incorrectly. AECL originally calculated the corrugated RS and LHSI strainers' surface areas using a simplified formula whereby the strainer surface area equals the projected area multiplied by a factor of 1.8. For the large LHSI strainer fins, the formula provides a reasonably accurate result. However, for the substantially smaller RS fins, the formula will non-conservatively over-predict the available surface area since the un-corrugated upper and lower parts of the fin represent a larger fraction of the total screen area.

The recalculated surface area of the LHSI is relatively unaffected, although the corrected size decreased by 38 ft^2 for Unit 1 and 35 ft^2 for Unit 2. However, the Rig 33 test results remain conservative for the LHSI strainers due to original test conditions overestimating the debris (lower scaling factors) and velocity of the sump fluid at the strainer. The RS strainer area was originally calculated at approximately 4400 ft^2. The corrected value is approximately 4000 ft^2. The Rig 33 thin bed and encapsulation tests for the RS strainers were impacted negatively by the decrease in surface area since the original test conditions slightly underestimate the debris (higher scaling factors) and velocity of the sump fluid at the strainer. However, this impact is not considered significant.

With regard to the Rig 89 chemical effects strainer test results, these reductions in surface areas for the strainers have an overall conservative impact on head loss test results due to the original test conditions overestimating the debris loading (lower scaling factors) and velocity of the sump fluid at the strainer. The following is a discussion of the test/results and parameters affected by the corrected (reduced) surface area of the strainer:

- **RIG 33**

Using a detailed fin geometric model, AECL re-calculated the actual surface areas for both the test module and the installed modules. The following table presents the differences in the test modules:

Table 3 – Changes in Rig 33 Test Modules' Surface Areas

FIN DIMENSIONS L x H (inches)	MODULE TYPE	ASSUMED FIN AREA (ft^2)	ASSUMED TEST SECT. AREA (ft^2)	CORRECTED FIN AREA (ft^2)	CORRECTED TEST SECTION AREA (ft^2)
30 x 15	RS	11.3	22.5	10.47	20.94
30 x 20	LHSI	15	30	14.93	29.87

Note: Assumed fin and test section areas used the original simplified formula.

For the installed strainers, the table below provides the corrected total installed surface areas, the effective areas, testing scaling factors, and the actual modeled surface areas. The testing scaling factors are used to scale plant debris load and plant flow rate to the test debris load and test flow rate.

Table 4 – Differences between Effective & Rig 33 Modeled Areas

STRAINER	CORRECTED TOTAL INSTALLED SURFACE AREA[1] (ft^2)	EFFECTIVE SURFACE AREA[2] (ft^2)	TEST SCALING FACTOR[3]	ACTUAL TEST MODULE AREA (ft^2)	MODELED SURFACE AREA[4] (ft^2)	DIFFERENCE BETWEEN EFFECTIVE & MODELED AREA[5] (%)
RS Unit 1	3978	3828	187.1	20.94	3918	-2.3
LHSI Unit 1	2008	1858	54.3	29.87	1622	+14.5
RS Unit 2	3988	3838	187.1	20.94	3918	-2.0
LHSI Unit 2	1855	1705	54.3	29.87	1622	+5.1

Notes:

1) Calculated strainer surface area according to its geometrical model.
2) Effective surface area equals the Corrected Total Installed Surface Area minus the required sacrificial area of 150 ft^2.
3) Test Scaling Factor used for original Rig 33 tests.
4) Modeled Surface Area = Test Scaling Factor x Actual Test Module Area. The uncorrected RS Modeled Surface Area used for testing is 4210 ft^2 (22.5 ft^2 x 187.1) and the LHSI Modeled Surface Area used for testing is 1630 ft^2 (30 ft^2 x 54.3).
5) Difference between Effective & Modeled Area = (Effective Surface Area – Modeled Surface Area)/Modeled Surface Area.

Since the modeled surface areas for the LHSI strainers are less than the corrected effective surface areas of the installed strainers, the existing head loss test results from Rig 33 remain conservative (i.e., more debris per square foot in test than in plant and scaled velocity is higher than actual plant velocity). Since the modeled surface areas for the RS strainers are greater than the effective surface areas of the installed strainers, the existing head loss test results from Rig 33 are non-conservative. However, AECL estimated that the approximate 2% discrepancy in RS strainer area results in about 0.1 ft of extra head loss, which is not considered significant based on the margin between the allowable head loss of 5.0 feet and the previously determined total strainer head loss of 2.2 feet.

- **RIG 89**

As in the case of Rig 33, the correction factor for the strainer area determination applies to the actual fin surface areas and the fin area of the test module. Table 5 below presents the differences in the test modules.

Table 5 – Changes in Rig 89 Test Modules' Surface Areas

FIN DIMENSIONS L x H (inches)	MODULE TYPE	ASSUMED FIN AREA (ft^2)	ASSUMED TEST SECTION AREA (ft^2)	CORRECTED FIN AREA (ft^2)	CORRECTED TEST SECTION AREA (ft^2)
30 x 15	RS	11.3	5.74	10.47	5.08
30 x 20	LHSI	15	5.74	14.93	5.08

NOTE: Assumed fin and test section areas used the original simplified formula.

Table 6 below provides the corrected total installed surface areas, the effective areas, testing scaling factors, and the actual modeled surface areas. The testing scaling factors are used to scale plant debris load and plant flow rate to the test debris load and test flow rate.

Table 6 – Differences between Effective & Rig 89 Modeled Areas

STRAINER	CORRECTED TOTAL INSTALLED SURFACE AREA[1] (ft^2)	EFFECTIVE SURFACE AREA[2] (ft^2)	TESTING SCALING FACTOR[3]	ACTUAL TEST MODULE AREA (ft^2)	MODELED SURFACE AREA[4] (ft^2)	DIFFERENCE BETWEEN EFFECTIVE & MODELED AREA[5] (%)
RS Unit 1	3978	3828	733.4	5.08	3726	+2.7
LHSI Unit 1	2008	1858	284.0	5.08	1443	+28.8
RS Unit 2	3988	3838	733.4	5.08	3726	+3.0
LHSI Unit 2	1855	1705	284.0	5.08	1443	+18.2

Notes:

1) Calculated strainer surface area according to its geometrical model.
2) Effective surface area equals the Corrected Total Installed Surface Area minus the required sacrificial area of 150 ft^2.
3) Testing Scaling Factor was used for original Rig 89 tests.
4) Modeled Surface Area = Testing Scaling Factor x Actual Test Module Area. The uncorrected RS Modeled Surface Area used for testing is 4210 ft^2 (5.74 ft^2 x 733.4) and the LHSI Modeled Surface Area used for testing is 1630 ft^2 (5.74 ft^2 x 284.0).
5) Difference between Effective & Modeled Area = (Effective Surface Area – Modeled Surface Area)/Modeled Surface Area.

A review of Table 6 indicates that the modeled surface areas for the RS and LHSI strainers are less than the effective surface areas. Consequently, the existing head loss test results from Rig 89 are conservative.

The overall effect of the reduced strainer and test fin areas is that additional margin has been created for the strainer aluminum loading for both the RS and LHSI strainers.

Should you have any questions or require additional information, please contact Mr. Thomas Shaub at (804) 273-2763.

Sincerely,

J. Alan Price
Vice President – Nuclear Engineering

Commitment:

1. Dominion will take appropriate additional corrective actions (e.g., recalculate debris generation totals, fibrous insulation removal, jacketing, additional testing, etc.) as may be applicable. 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 North Anna Units 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.

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mr. J. Alan Price, who is Vice President – Nuclear Engineering, 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 27th day of April, 2011.

My Commission Expires: 4/30/13.

Ginger L. Melton
Notary Public

I was commissioned a notary public as Ginger L. Alligood.

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My Commission Expires Apr 30, 2013

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