



May 21, 2008

U.S. Nuclear Regulatory Commission  
Attention: Document Control Desk  
One White Flint North  
11555 Rockville Pike  
Rockville, MD 20852-2738

Serial No. 08-0275  
NL&OS/GDM R4  
Docket Nos. 50-305  
50-336/423  
50-338/339  
50-280/281  
License Nos. DPR-43  
DPR-65/NPF-49  
NPF-4/7  
DPR-32/37

**DOMINION ENERGY KEWAUNEE, INC.**  
**DOMINION NUCLEAR CONNECTICUT, INC.**  
**VIRGINIA ELECTRIC AND POWER COMPANY**  
**KEWAUNEE POWER STATION**  
**MILLSTONE POWER STATION UNITS 2 AND 3**  
**NORTH ANNA AND SURRY POWER STATION UNITS 1 AND 2**  
**NRC GENERIC LETTER (GL) 2004-02, POTENTIAL IMPACT OF DEBRIS**  
**BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS**  
**ACCIDENTS AT PRESSURIZED-WATER REACTORS**  
**REQUEST FOR EXTENSION OF COMPLETION DATES FOR CORRECTIVE ACTIONS**

In a letter dated September 1, 2005 (Serial No. 05-212), Dominion Energy Kewaunee, Inc. (DEK), Dominion Nuclear Connecticut, Inc. (DNC) and Virginia Electric and Power Company (Dominion) submitted a response to NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors." In that letter, Dominion committed to completing corrective actions required by GL 2004-02 to resolve NRC Generic Safety Issue (GSI) 191, "Assessment of Debris Accumulation on PWR Sump Performance," by December 31, 2007 for Kewaunee Power Station (Kewaunee), Millstone Power Station Units 2 and 3 (Millstone Units 2 and 3), North Anna Power Station Units 1 and 2 (North Anna Units 1 and 2), and Surry Power Station Units 1 and 2 (Surry Units 1 and 2). In a subsequent letter dated January 11, 2007 (Serial No. 06-481), Dominion submitted an extension request for Surry Unit 2 to permit the completion of the installation of the recirculation spray pump strainer system during the spring 2008 refueling outage (RFO). The NRC approved the Surry Unit 2 extension request in their letter dated March 8, 2007.

In a subsequent letter dated November 15, 2007 (Serial No. 07-0660), DEK, DNC and Dominion submitted extension requests for Kewaunee, Millstone Units 2 and 3, North Anna Units 1 and 2 and Surry Units 1 and 2 primarily for the completion of downstream effects evaluations and chemical effects testing and evaluation. Justification was provided for the individual plant extensions in accordance with the "Criteria for Evaluating Delay of Hardware Changes," as described in SECY-06-0078 dated March 31, 2006. The requested extension dates were June 30, 2008 for Kewaunee and November 30, 2008 for Millstone, North Anna and Surry. Due to the importance of prompt closure of GL 2004-02, the NRC granted Dominion an extension to May 31, 2008 for each plant to complete the outstanding corrective actions identified in the extension requests. However, the staff also stated that should Dominion be unable to complete the GL 2004-02 corrective actions by May 31, 2008, additional justification must be provided to the NRC for any requested extension beyond May 31, 2008.

Considerable effort and resources have been expended to complete the outstanding corrective actions for each station by the approved extension date, and significant progress has been made towards the resolution of the remaining GSI-191 issues. DNC and Dominion have had extensive interaction with the NRC over the past several months regarding the testing protocols used for the chemical effects testing for the Millstone, North Anna and Surry units, including NRC observation of reduced scale testing activities at the vendor testing facility. However, it has become evident that all of the remaining corrective actions cannot be completed by May 31, 2008. The remaining corrective actions are identified in the following table:

<b>Plant</b>	<b>Remaining Corrective Actions that Require an Extension</b>
Kewaunee	<ul style="list-style-type: none"> <li>• Complete post-LOCA containment sump pool computational fluid dynamics (CFD) analysis</li> <li>• Complete strainer performance testing and documentation update that confirms Kewaunee's low fiber quantity and containment sump pool transport characteristics do not result in a thin or thick bed of debris on the sump strainer</li> <li>• Following completion of the CFD analysis and strainer performance testing and documentation, update the Kewaunee Updated Safety Analysis Report (USAR)</li> </ul>

<b>Plant</b>	<b>Remaining Corrective Actions that Require an Extension</b>
Millstone Units 2 and 3	<ul style="list-style-type: none"> <li>• Issuance and internal review of chemical evaluation and benchtop testing reports</li> <li>• Completion of Emergency Core Cooling System (ECCS) downstream component wear, system performance, and pump seal evaluations</li> <li>• Completion of chemical effects reduced scale testing, evaluation, and test report preparation and review</li> <li>• Determine whether any additional actions are required based on the results of the chemical effects testing and evaluations</li> <li>• Update design and licensing basis documents (e.g., UFSAR) to reflect the plant changes implemented to resolve GSI-191 issues</li> </ul>
North Anna Units 1 and 2  Surry Units 1 and 2	<ul style="list-style-type: none"> <li>• Complete internal review and issue of final analyses and evaluation reports of bench-top testing, downstream component wear and system performance, and debris generation and transport</li> <li>• Complete chemical effects reduced scale testing, evaluation, and test report preparation and review</li> <li>• Determine whether any additional actions are required based on the results of the chemical effects testing and evaluations</li> <li>• Update design and licensing basis documents (e.g., UFSAR) to reflect plant changes implemented to resolve GSI-191 issues</li> </ul>

Attachments 1 through 4 provide the bases for the proposed extensions of the GL 2004-02 corrective action completion dates for Kewaunee, Millstone Units 2 and 3, North Anna Units 1 and 2, and Surry Units 1 and 2, respectively. The extension basis for each plant provides adequate assurance that safe, continued operation will be maintained during the requested extension period. Kewaunee, Millstone Units 2 and 3,

North Anna Units 1 and 2, and Surry Units 1 and 2 currently meet, and will continue to meet their current plant licensing bases regarding the function and operability of the containment sump during the period of the requested extensions.

As a result of the remaining required activities noted above and discussed in the attachments, an extension to September 30, 2008 is requested for Kewaunee, Millstone Units 2 and 3, North Anna Units 1 and 2, and Surry Units 1 and 2 to complete the GL 2004-02 corrective actions.

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

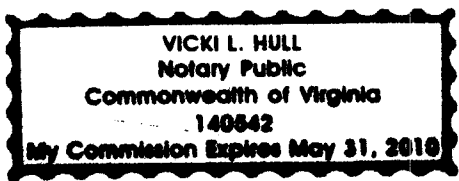
Sincerely,

Gerald T. Bischof  
Vice President – Nuclear Engineering

COMMONWEALTH OF VIRGINIA    )  
  )  
COUNTY OF HENRICO            )

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Gerald T. Bischof, who is Vice President – Nuclear Engineering of Dominion Energy Kewaunee, Inc., Dominion Nuclear Connecticut, Inc. and 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 those companies, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 21<sup>ST</sup> day of May, 2008.  
My Commission Expires: May 31, 2010.



Vicki L. Hull  
Notary Public

Attachments:

1. Request for an Extension of the Completion Date for Corrective Actions, Kewaunee Power Station
2. Request for an Extension of the Completion Date for Corrective Actions, Millstone Power Station Units 2 and 3
3. Request for an Extension of the Completion Date for Corrective Actions, North Anna Power Station Units 1 and 2
4. Request for an Extension of the Completion Date for Corrective Actions, Surry Power Station Units 1 and 2

Commitments made in this correspondence:

This letter contains no new commitments. Completion dates are changed for regulatory commitments previously associated with GL 2004-02.

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NRC Senior Resident Inspector  
Kewaunee Power Station

NRC Senior Resident Inspector  
Millstone Power Station

NRC Senior Resident Inspector  
North Anna Power Station

NRC Senior Resident Inspector  
Surry Power Station

cc: (continued)

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**ATTACHMENT 1**

**NRC GENERIC LETTER 2004-02 POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON  
EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT  
PRESSURIZED-WATER REACTORS**

**REQUEST FOR AN EXTENSION OF THE COMPLETION DATE  
FOR CORRECTIVE ACTIONS**

**DOMINION ENERGY KEWAUNEE, INC.  
(DEK)  
KEWAUNEE POWER STATION**

## **Request for an Extension of the Completion Date for Corrective Actions** **Kewaunee Power Station**

### **1.0 Background**

During the ensuing work to complete the Generic Letter (GL) 2004-02 corrective actions, it became apparent that certain activities required to address the containment sump recirculation issues could not be completed by December 31, 2007. For Kewaunee, these activities included downstream effects evaluations for component wear and system performance and for nuclear fuel and the reactor vessel, as well as completing strainer performance documentation in support of chemical effects resolution. Consequently, in a letter dated November 15, 2007 (Serial No. 07-0660), Dominion Energy Kewaunee, Inc. (DEK) requested an extension to June 30, 2008 to complete the outstanding corrective actions. In a letter dated December 13, 2007, the NRC took exception to DEK's extension request. While the NRC confirmed that adequate mitigation measures had been put in place to reduce plant risk for the requested six-month extension, the staff noted that given the importance of reaching prompt closure of GL 2004-02, the NRC expected Kewaunee to complete corrective actions by May 31, 2008. The staff also stated that should DEK be unable to complete the Kewaunee GL 2004-02 corrective actions by May 31, 2008, additional justification must be provided to the NRC for any requested extension beyond that date.

### **1.1 Current Status of Activities**

DEK has made significant progress regarding the completion of downstream effects evaluations and chemical effects resolution for Kewaunee.

#### **Downstream Effects**

As stated in DEK's GL 2004-02 supplemental response to the staff dated February 29, 2008 (Serial No. 08-0017), Kewaunee performed a series of downstream effects evaluations to identify clearances, potential for system blockage and component wear in the Safety Injection (SI), Residual Heat Removal (RHR) and Internal Containment Spray (ICS) systems. In September 2007, WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of Resolution of GSI-191," was revised to provide improved guidance for performing downstream effects evaluations for component wear. Consequently, DEK has completed a revision to Kewaunee's downstream effects evaluations for the SI, RHR and ICS systems. The revised evaluations did not identify the need for any physical changes to plant equipment.

An additional downstream effects evaluation has been prepared using WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculation Fluid, Revision 0." The new evaluation confirms the quantity of chemical precipitants postulated to plate-out on the fuel cladding after a Loss of Coolant Accident (LOCA) will not pose an adverse impact on



the ability of the coolant to remove decay heat from the core. The evaluation was completed on May 15, 2008.

As stated in DEK's letters to the staff dated November 15, 2007, and February 29, 2008, Kewaunee also contracted with Westinghouse to perform a downstream effects evaluation for the reactor internals and nuclear fuel. The evaluation confirmed the clearances in Kewaunee's reactor internals far exceed the size of debris that could bypass the strainer; therefore, flow blockage in the reactor internals due to bypassed debris will not occur. The evaluation also confirmed that the quantity of fiber that could bypass the strainer would not form a thin bed of fiber on the top support grid of the core.

Kewaunee's downstream effects evaluations are now complete.

### Chemical Effects

Kewaunee is in the process of completing a computational fluid dynamics (CFD) analysis of the post-LOCA sump pool during recirculation. This activity is in support of preparation of the updated strainer performance documentation for resolution of chemical effects. Preliminary results from the CFD analysis recently identified that flow rates over one of Kewaunee's three debris interceptors is in excess of the flow rates used during debris interceptor testing. Therefore, an additional flume test will be performed using the new analyzed sump pool flow to reconfirm that transport of debris to the strainer remains sufficiently low and results in clean strainer surfaces. Clean strainer surfaces will prevent increased strainer head loss due to chemical precipitants in the recirculation fluid and will resolve the issue of chemical effects. DEK is requesting a schedule extension to complete an additional strainer/debris interceptor flume test and to update the strainer performance and licensing basis documentation to complete resolution of the chemical effects issue.

The CFD analysis is in progress and will be complete by June 15, 2008. Preliminary planning for the next strainer/debris interceptor test is in progress at this time. Following completion of the CFD analysis, the strainer/debris interceptor Test Plan will be finalized and testing will be performed.

An extension is requested to September 30, 2008 to complete an additional strainer/debris interceptor flume test and to update Kewaunee's strainer performance documentation and licensing basis. These final corrective actions will complete resolution of chemical effects and GL 2004-02 activities.

Required physical changes to the plant have been completed and are addressed in DEK's letter to the staff dated February 29, 2008.

In the following discussion, DEK has addressed the "Criteria for Evaluating Delay of Hardware Changes," as described in SECY-06-0078 dated March 31, 2006, as the foundation for this extension request. An extension is requested to September 30, 2008

to complete the final strainer performance testing and documentation for resolution of chemical effects. The proposed extension for Kewaunee does not alter the original conclusions summarized in GL 2004-02 in which the staff determined that it is acceptable for PWR licensees to operate until the corrective actions are completed because of sufficiently low plant risk.

## **2.0 Justification for the Proposed Extension**

The NRC provided a justification for continued operation (JCO) in the "Summary of July 26-27, 2001 Meeting with Nuclear Energy Institute and Industry on ECCS Strainer Blockage in PWRs," dated August 14, 2001, that supports continued operation through December 31, 2007. Elements of the JCO that continue to be applicable to Kewaunee include the following items:

- The Kewaunee containment is compartmentalized making transport of debris to the sump difficult.
- The probability of the initiating event is extremely low (large and intermediate break LOCA and small break LOCA requiring recirculation).
- Leak-Before-Break (LBB) qualified piping is of sufficient toughness that it will most likely leak (even under safe shutdown conditions) rather than rupture.
- Kewaunee is not susceptible to primary water stress corrosion cracking associated with pressurizer Alloy 600/82/182 dissimilar metal welds since the Kewaunee pressurizer does not contain these types of welds.
- The time to switch over to recirculation from the sump after accident initiation allows for debris settling.
- No credit is taken for containment overpressure in the net positive suction head (NPSH) analyses for the RHR system in the recirculation mode.
- The replacement Emergency Core Cooling System (ECCS) strainer installed in October 2006 was designed to include margin for particulate, fibrous and chemical debris.
- 5.8 feet of net positive suction head (NPSH) margin is available for the RHR pumps when operating in the containment sump recirculation mode with the new ECCS recirculation strainer arrangement and the maximum allowed strainer head loss (10 feet). Strainer performance testing and calculations using NUREG/CR-6224 show greater margin is available.

### **3.0 Reason for the Proposed Extension**

#### **3.1 Chemical Effects Resolution**

DEK's letter to the staff dated February 29, 2008, summarizes Kewaunee's chemical effects resolution activities. Significant effort has been expended in resolving this issue. Chemical precipitation analyses are complete, as indicated in the February 29, 2008 letter. Strainer flume testing has been performed, including debris transport flume tests with the strainer debris interceptors modeled in the flume. Additional strainer/debris interceptor test planning is in progress using the results of a recent CFD analysis. The additional test is expected to verify the quantity of debris that can transport to the strainer is insufficient to form a thin or thick bed of debris on the strainer.

Kewaunee has a low fibrous debris load due to the large majority of reflective metal insulation on piping and equipment in the Reactor Coolant System (RCS) and ECCS, and close proximity systems. A CFD analysis is being performed to support a refined GSI-191 debris transport evaluation. Following completion of the CFD analysis, an additional strainer/debris interceptor test will be performed and the strainer performance documentation and licensing basis will be updated. The final flume testing and documentation updates will complete resolution of the outstanding chemical effects issue.

Delays in completing this activity can be attributed to a delay in obtaining a vendor-supplied CFD analysis. The recent CFD preliminary results revealed higher flow rates over one of three debris interceptors. The flow rate over the south debris interceptor exceeds the flow rates used in debris transport flume tests conducted in 2007. Consequently, the debris transport flume tests performed in 2007 are not bounded by the results of the new CFD analysis. Therefore, an additional flume test will be performed at the flow rates identified by the CFD to confirm the quantity of debris expected to transport to the strainer and the resultant impact on the strainer head loss. Kewaunee has been an active participant in the Performance Contracting, Incorporated (PCI) Sure Flow Strainer Users Group (SFSUG) and the SFSUG large scale flume testing effort. Therefore, Kewaunee is prepared to begin testing as soon as the SFSUG test flume is available. The current SFSUG test schedule for the large scale test flume indicates Kewaunee's testing can commence approximately July 7, 2008.

The vendors supporting Kewaunee's GSI-191 resolution are supporting multiple pressurized water reactor (PWR) units with GSI-191 resolution concurrently. Kewaunee staff has made significant effort to provide timely inputs and timely reviews for vendor-supplied documents to expedite this work as much as possible. The importance of completing these activities in a timely fashion is well understood by DEK and the vendor staff involved in completing Kewaunee's GSI-191 resolution. The majority of the GSI-191 resolution activities for Kewaunee have been completed. The final resolution is nearing completion and will be completed by September 30, 2008.

### 3.2 Extension Request

DEK is requesting an extension until September 30, 2008 for completion of the following activities:

1. Complete the post-LOCA containment sump pool CFD analysis.
2. Complete strainer performance testing and documentation that confirms Kewaunee's low fiber quantity and containment sump pool transport characteristics do not result in a thin or thick bed of debris on the sump strainer. Consequently, clean strainer surfaces are expected to remain and there will be no increased strainer head loss due to chemical precipitants in the sump pool.
3. Following completion of the CFD analysis and strainer performance testing and documentation, the Kewaunee Updated Safety Analysis Report (USAR) will be updated.

### 4.0 Compliance with SECY-06-0078 Criteria

SECY-06-0078 specifies two criteria for short duration GL 2004-02 extensions, limited to several months, and a third criterion for extensions beyond several months. These three criteria and the associated responses for Kewaunee are provided in detail below.

#### 4.1 SECY-06-0078 Criterion No. 1:

*The licensee has a plant-specific technical/experimental plan with milestones and schedule to address outstanding technical issues with enough margin to account for uncertainties.*

#### DEK Response

#### KEWAUNEE PLANT-SPECIFIC TECHNICAL/EXPERIMENTAL PLAN

In accordance with Kewaunee's Plant-Specific Plan, outlined in DEK's extension request letter dated November 15, 2007, DEK's GL 2004-02 supplemental response dated February 29, 2008, and information presented in this letter, the following tasks have been completed:

- Debris analyses
  - Debris generation analyses
  - Chemical precipitant analyses

- Downstream effects analyses
  - Nuclear fuel and reactor vessel downstream effects evaluations.
  - Debris blockage, component wear and system performance downstream effects analyses for components in the SI, RHR and ICS systems.
- Strainer head loss, vortex evaluations, initial strainer/debris interceptor debris transport and strainer head loss flume testing, and a preliminary CFD analysis.
- Replacement strainer design and installation.

To complete this effort and adopt the licensing basis required for long-term core cooling required for resolution of GSI-191 at Kewaunee, the following milestones are to be met:

June 15, 2008	Complete the post-LOCA containment sump pool CFD analysis.
September 30, 2008	Complete strainer performance testing and documentation, and prepare and approve an update to the Kewaunee USAR.

Based on the above discussion, Kewaunee meets the requirements of SECY-06-0078 Criterion 1.

#### **4.2 SECY-06-0078 Criterion No. 2:**

*The licensee identifies mitigative measures to be put in place prior to December 31, 2007, and adequately describes how these mitigative measures will minimize the risk of degraded ECCS [emergency core cooling system] functions during the extension period.*

#### DEK Response

To date, the following mitigative measures have been implemented to minimize the risk of degraded ECCS functions during the requested extension period. Although SECY-06-0078 Criterion No. 2 specifically mentions a completion date of December 31, 2007, DEK was previously granted an extension until May 31, 2008 to complete GL 2004-02 corrective actions (reference NRC letter dated December 13, 2007). The following mitigative measures pertain to the current request for extension to September 30, 2008:

##### **4.2.1 Mitigative Measures**

DEK is fully committed to resolving the issues associated with GSI-191 and is continuing efforts to complete the corrective actions as discussed in our February 29, 2008 supplemental response to GL 2004-02. Required physical modifications have been completed.

## 1. Physical Modifications

As discussed in greater detail in DEK's February 29, 2008 letter to the staff, physical modifications included installation of a new, passive, safety-related Sure-Flow strainer designed by Performance Contracting, Incorporated (PCI). The modification included installing debris interceptors around the strainer to prevent debris traveling along the sump floor from reaching the strainer's perforated material. The modification also included a change to the narrow range sump level instrument float columns to prevent entry of debris exceeding the strainer perforation size into the recirculation sump.

Downstream effects evaluations for the reactor vessel and nuclear fuel and SI, RHR and ICS systems are complete. No additional modifications are required.

## 2. Containment Cleanliness

DEK has procedures in place to ensure containment cleanliness and to quantify potential debris sources. The procedures are described in DEK's letters to the staff dated November 15, 2007 and February 29, 2008.

## 3. Procedural Guidance, Training, and Actions

Operators are trained and have guidance for monitoring ECCS pump parameters including loss of NPSH as indicated by erratic pump current or discharge flow.

## 4. Information Notice 2005-26

On September 16, 2005, the NRC issued Information Notice (IN) 2005-26, "Results of Chemical Effects Head Loss Tests in a Simulated PWR Sump Pool Environment." IN 2005-26 applies to plants with calcium silicate insulation and trisodium phosphate as a buffer. Kewaunee does not use trisodium phosphate as its buffer. Therefore, no response to IN 2005-26 was required for Kewaunee.

## 5. Risk Evaluation

With the installation of the new containment recirculation sump strainer, revised programmatic controls, and evaluations performed to date, Kewaunee has significantly reduced the vulnerability to debris blockage in the recirculation system when mitigating a LOCA.

DEK's extension request for Kewaunee dated November 15, 2007 provided a risk evaluation for a six-month extension. The risk evaluation is repeated in the following paragraphs and adjusted for the additional extension to September 30, 2008 to complete the remaining GSI-191 resolution activities.

With the installation of the advanced sump strainer design, debris interceptors, and other associated changes and evaluations, there has been a significant reduction in the vulnerability to debris blockage and component wear in the recirculation system when mitigating a LOCA. For the remaining outstanding issue related to chemical effects, the vulnerability is limited to large break LOCAs only. For small and intermediate break LOCAs, it is expected that there will be a significant reduction in debris generation, as much as one to two orders of magnitude. With this type of reduction in the fibrous and particulate sources, core cooling will be assured for small and intermediate break LOCAs. Since the advanced strainer design is sized for a conservative estimate of the fibrous debris loading from a large break LOCA, it is expected that for fibrous debris loadings that are an order of magnitude or more lower, there will also be open screen area such that any chemical precipitants that are generated will not prevent flow through the strainer and adequate NPSH will be maintained. The quantitative risk evaluation addresses potential vulnerability for large break LOCAs only. The probability of this initiating event is low (5.0E-6/yr).

The increase in Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) is determined from the initiating event frequency for a large break LOCA. Integrating the initiating event frequency over the period of the proposed nine month extension (i.e., from December 31, 2007 to September 30, 2008) calculates the Core Damage Probability (CDP) and the Large, Early Release Probability (LERP). As noted above, the initiating event frequency for a LBLOCA is equal to 5.0E-6/yr. Therefore, for a nine month extension to complete GL 2004-02 corrective actions, the CDP is calculated as follows:

$$\text{CDP} = (5.0\text{E-}6/\text{yr}) * (0.75 \text{ years})$$

$$\text{CDP} = 3.75\text{E-}6$$

The LERP is then equal to 3.75E-7. This value is determined by using the 0.1 factor for containment performance that is typically assumed for qualitative large, early release estimates.

No credit is taken for recovery actions, which Kewaunee would normally utilize, to ensure conservative results. The base CDF and base LERF values for Kewaunee are shown below along with the CDP and LERP values that were calculated for the proposed nine month extension.

<b>Base CDF</b>	<b>CDP for 9 month extension</b>	<b>Base LERF</b>	<b>LERP for 9 month extension</b>
7.60E-5/yr	3.75E-6	9.80E-6/yr	3.75E-7

Regulatory Guide (RG) 1.174 states that, when calculated changes in risk are in the range of 1E-6/yr to 1E-5/yr, a permanent change is "small" if the total CDF is less than 1E-4/yr. For LERF, a "small" change is a calculated risk increase in the range of 1E-7/yr to 1E-6/yr if the total LERF is less than 1E-5/yr. This RG sets criteria for

permanent plant changes with associated risk increases. In this case, it may be conservatively used to evaluate the risk impact of the nine month extension to complete the GL 2004-02 corrective actions. The assumption that the sump is 100% unavailable is additionally conservative. Therefore, based on RG 1.174, the proposed additional extension to September 30, 2008 to complete the GL 2004-02 corrective actions for Kewaunee is acceptable.

#### 6. Safety Features and Margins in Current Configuration/Design Basis

There are design features that facilitate mitigation of this issue. Kewaunee has previously received NRC approval to invoke the leak-before-break methodology to eliminate the dynamic effects (pipe whip and jet impingement) of a postulated rupture of the RCS piping (hot leg, cold leg, crossover piping, pressurizer surge piping and piping connected to the RCS) from the design basis of the plant. The approval was based on the conclusion that the probability is low that a pipe failure occurs before noticeable leakage could be detected and the plant can be brought to a safe shutdown condition. While leak-before-break is not being used to establish the design basis debris load on the ECCS recirculation strainer, it does provide further basis for safe continued operation until the completion of the GL 2004-02 corrective actions.

Based on the above discussion, Kewaunee meets the requirements of SECY-06-0078 Criterion 2.

#### 4.3 **SECY-06-0078 Criterion 3:**

*For proposed extensions beyond several months, a licensee's request will more likely be accepted if the proposed mitigative measures include temporary physical improvements to the ECCS sump or materials inside containment to better ensure a high level of ECCS performance.*

#### DEK Response

As noted in Section 4.2.1 above, DEK has completed the required physical modifications to the plant for resolution of GSI-191 at Kewaunee. The modifications included installation of a new, passive, safety-related Sure-Flow strainer designed by PCI. The modification also included installation of debris interceptors around the strainer to prevent debris traveling along the sump floor from reaching the strainer's perforated material. A modification was also made to the narrow range sump level instrument float columns to prevent entry of debris into the sump that would exceed the strainer perforation size.

Based on the above discussion, Kewaunee meets the requirements of SECY-06-0078 Criterion 3.



## 5.0 Conclusion

An extension of the Kewaunee completion date from May 31, 2008 to September 30, 2008 to complete the remaining corrective action required by GL 2004-02 is acceptable because:

- The initiating event and large, early release probabilities for Kewaunee associated with the nine month extension (from December 31, 2007) are  $3.75E-6$  and negligible, respectively. This risk impact is characterized as "small" per NRC Regulatory Guide 1.174.
- DEK has completed considerable physical and analytical activities to provide a high level of ECCS performance including replacing the ECCS recirculation strainer.
- DEK has implemented mitigative measures to minimize the risk of degraded ECCS functions during the extension period.
- DEK has a plant-specific plan with milestones and schedules to address the outstanding technical issues with sufficient conservatism to address uncertainties.

Therefore, per the criteria included in SECY-06-0078, DEK has established that the risk of degraded ECCS functions for Kewaunee is not considered to be significant.

**ATTACHMENT 2**

**NRC GENERIC LETTER 2004-02 POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON  
EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT  
PRESSURIZED-WATER REACTORS**

**REQUEST FOR AN EXTENSION OF THE COMPLETION DATE  
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**DOMINION NUCLEAR CONNECTICUT, INC.  
(DNC)  
MILLSTONE POWER STATION UNITS 2 AND 3**

**Request for an Extension of the Completion Date for Corrective Actions**  
**Millstone Power Station Units 2 and 3**

**1.0 Background**

Corrective actions that address containment sump performance and compliance with the regulatory considerations of NRC Generic Letter (GL) 2004-02 for Millstone Power Station Units 2 and 3 were initially scheduled to be complete by December 31, 2007. During the efforts to complete the corrective actions, it became apparent that some actions could not be completed by December 31, 2007. These actions include downstream effects evaluations for component wear and system performance and for nuclear fuel and the reactor vessel, as well as chemical effects testing and evaluation. Consequently, in a letter dated November 15, 2007 (Serial No. 07-0660), Dominion Nuclear Connecticut, Inc. (DNC) requested an extension to November 30, 2008 to complete the outstanding corrective actions. However, in a letter dated December 13, 2007, the NRC took exception to DNC's extension request. While the NRC confirmed that adequate mitigation measures had been put in place to reduce risk for the requested eleven month extension, the staff also noted that DNC's requested extension date was not reasonable based on the case provided. Due to the importance of prompt closure of GL 2004-02, the NRC granted DNC an extension to May 31, 2008 to complete the outstanding corrective actions for Millstone Units 2 and 3. However, the staff also stated that should DNC be unable to complete the Millstone GL 2004-02 corrective actions by May 31, 2008, additional justification must be provided to the NRC for any requested extension beyond that date.

As discussed in greater detail below, DNC has made significant progress regarding the completion of downstream effects evaluations and chemical effects testing and evaluation.

- **Downstream Effects** - Downstream effects evaluations are required to determine:
  - 1) the effect of debris laden water on the reactor vessel and fuel assemblies, and
  - 2) component wear due to the effects of debris and the resultant effect, if any, on system performance due to potentially degraded components. Component wear evaluations and an evaluation of the ability of the Emergency Core Cooling System (ECCS) pump seals to withstand pumping debris laden water without excessive leakage and hydraulic impact on the pumps are in progress.
  
- **Chemical Effects** - Benchtop testing has been completed to determine the solubility/precipitate behavior of the chemicals expected to exist in the containment sump as a result of a loss of coolant accident (LOCA). In addition, a conservative reduced scale test is in progress (see item 3.3 below). DNC and the NRC have conducted status update conference calls associated with chemical effects testing progress, and the staff has reviewed and commented on the testing protocols for benchtop, single loop and multi-loop testing prepared by Atomic Energy of Canada, Limited (AECL, the chemical effects testing vendor). Furthermore, the staff has

witnessed certain multi-loop testing activities at AECL's Chalk River Test Facility.

Even though considerable progress has been made to address the remaining GL 2004-02 corrective actions for Millstone Units 2 and 3, certain chemical effects testing activities cannot be completed by May 31, 2008. Specifically, completion of ongoing reduced scale multi-loop testing using Millstone plant-specific chemical conditions is required to determine containment sump strainer head loss. Review of test results and finalization of test documentation will be completed following testing. Therefore, DNC is requesting a schedule extension for Millstone Units 2 and 3 to complete the remaining chemical effects testing, test reports, and licensing basis updates, as well as to determine whether any additional actions may be required based on the results of the testing.

The information in the balance of this attachment provides a request and basis for extending this corrective actions schedule to September 30, 2008. Specifically, DNC has addressed the "Criteria for Evaluating Delay of Hardware Changes," as described in SECY-06-0078 dated March 31, 2006. This discussion supports DNC's request for an extension of the corrective actions completion date to ensure that the necessary testing and test reports have been completed and the supporting calculations have been reviewed and validated to facilitate resolution of the Generic Safety Issue (GSI)-191. An extension to September 30, 2008 is requested to allow completion of the remaining required actions discussed below and to update the licensing basis documents. The proposed extension for Millstone Units 2 and 3 does not alter the original conclusions summarized in GL 2004-02 in which the staff determined that it is acceptable for PWR licensees to operate until the corrective actions are completed because of sufficiently low plant risk.

## **2.0 Justification for the Proposed Extension**

The NRC provided a justification for continued operation (JCO) in the "Summary of July 26-27, 2001 Meeting with Nuclear Energy Institute and Industry on ECCS Strainer Blockage in PWRs" dated August 14, 2001, that supports continued operation through December 31, 2007. Elements of the JCO that continue to be applicable to Millstone Units 2 and 3 include the following:

- Both Millstone Units 2 and 3 containments are compartmentalized, thus slowing transport of debris to the sump.
- The probability of the initiating event (i.e., large break LOCA) is extremely low.
- Leak-Before-Break (LBB) qualified piping is of sufficient toughness that it will most likely leak (even under safe shutdown conditions) rather than rupture.
- The time for switchover to recirculation from the sump after accident initiation allows for debris settling.

### **3.0 Current Status and Reason for the Proposed Extension**

#### **3.1 Downstream Effects – Nuclear Fuel and Reactor Vessel**

WCAP-16793-NP Rev. 0, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculation Fluid," provides the criteria for performing downstream effects evaluations regarding core effects. This evaluation has been completed and concluded that:

- Adequate flow to remove decay heat will continue to reach the core even with debris from the sump reaching the Reactor Coolant System (RCS) and core,
- Decay heat will continue to be removed even with debris collection at the fuel assembly spacer grids,
- Fibrous debris, should it enter the core region, will not tightly adhere to the surface of fuel cladding,
- Simulating large debris loadings of fiberglass and calcium silicate, decay heat will be removed, and acceptable fuel clad temperatures will be maintained, and
- As blockage of the core will not occur, the calculations that demonstrate appropriate boric acid dilution to preclude boric acid precipitation remain valid.

Unit-specific calculations were performed to determine the expected deposition of chemicals on the fuel and demonstrated that the WCAP evaluations and conclusions are directly applicable to Millstone Units 2 and 3. Consequently, there is reasonable assurance that long-term core cooling for Millstone Units 2 and 3 will be established and maintained post-LOCA even when considering the presence of debris in the RCS and core.

Refer to Millstone's Supplemental Response to the NRC, dated February 29, 2008 (Serial No. 07-0797, ADAMS ML080650561), Attachments 1 and 2 (Sections 3N), for a more detailed technical discussion of the evaluation. This effort is complete. No extension is required for this effort.

#### **3.2 Downstream Effects – Component Wear and System Performance**

WCAP-16406-P Rev. 1, "Evaluation of Downstream Sump Debris Effects in Support of Resolution of GSI-191," provides revised guidance for the performance of downstream effects evaluations for component wear and resulting system performance with potentially degraded components. The resultant revised downstream component wear effects evaluations are in progress for Millstone Units 2 and 3. These evaluations are expected to be complete and reviewed by July 31, 2008. System performance evaluations using the information from the wear evaluations are expected to be completed by August 15, 2008.

### **3.3 Strainer Debris and Chemical Testing**

Completion of chemical effects testing and evaluation is required to confirm that the replacement strainers installed at Millstone Units 2 and 3 are adequate to maintain NPSH margin for the ECCS pumps during long-term core cooling and to confirm that no further physical modifications are required.

A chemical effects evaluation is currently being performed for Millstone Units 2 and 3 by AECL to determine the potential for chemical precipitate formation. Published industry data were collected, consolidated, and depicted as a series of temperature dependent curves plotted on a pH/precipitate concentration graph. Benchtop testing was performed to confirm the validity of the curves, thus providing an accurate indication of when precipitate formation would be expected to occur. Benchtop testing is complete, and upon receipt of the test report from AECL, DNC will begin its internal review.

Multi-loop testing will provide a means of performing numerous (i.e., six) reduced scale tests simultaneously for the Dominion units. Millstone Units 2 and 3 strainers will be tested with Millstone plant specific fibrous and particulate debris loads and chemical conditions that would be expected to be in the containment sump following a LOCA. Each test will be performed for 30-days following the formation of a thin-bed of debris at a specified temperature and flow rate to reproduce the possibility of precipitate formation and its resulting impact on head loss. Testing is currently scheduled to be completed by July 31, 2008, with the Strainer Test Report issued by August 31, 2008.

### **3.4 Extension Request**

DNC is requesting an extension until September 30, 2008 for completion of the following activities:

- Issuance and internal review of chemical evaluation and benchtop testing reports,
- Completion of ECCS downstream component wear, system performance, and pump seal evaluations,
- Completion of chemical effects reduced scale testing, evaluation, and test report preparation and review,
- Determination of whether any additional actions are required based on the results of the chemical effects testing and evaluations, and
- Update of design and licensing basis documents to reflect the plant changes implemented to resolve GSI-191 issues.

#### **4.0 Compliance with SECY-06-0078 Criteria**

SECY-06-0078 specifies two criteria for short duration GL 2004-02 extensions limited to several months and a third criterion for extensions beyond several months. These three criteria and the associated responses for Millstone Units 2 and 3 are provided in detail below.

##### **4.1 SECY-06-0078 Criterion No. 1:**

*The licensee has a plant-specific technical/experimental plan with milestones and schedule to address outstanding technical issues with enough margin to account for uncertainties.*

##### DNC Response

##### MILLSTONE PLANT SPECIFIC TECHNICAL/EXPERIMENTAL PLAN

In accordance with Millstone's Plant Specific Plan, outlined in DNC's extension request letter dated November 15, 2007 (ADAMS ML073190553), DNC's GL 2004-02 supplemental response dated February 29, 2008, and the information contained in this letter, the following tasks have been completed:

- Debris analyses
  - Debris generation analyses in accordance with WCAP-16568-P, Rev 0 (Zone of Influence determination)
  - Debris transport analyses
- Downstream effects analyses
  - Fuel and vessel downstream effects analyses in accordance with WCAP-16793-NP, Rev. 0
- Strainer head loss and vortex testing for expected debris load (excluding chemical precipitants).
- Benchtop testing (including consideration of WCAP-16530-NP results) to determine likely precipitate formation and bounding quantities of precipitants to use in reduced scale testing.
- Replacement strainer design and installation for both Millstone Units 2 and 3.

Downstream effects evaluations and reduced scale chemical testing and results evaluation of the impact of potential chemical precipitants on strainer head loss are currently underway and are scheduled to be completed by August 31, 2008. To complete this effort and to adopt the licensing basis required for long-term core cooling required for resolution of GSI-191 at Millstone Units 2 and 3, the following milestones have been established:

<b>GL 2004-02 CORRECTIVE ACTION MILESTONES</b>	
<b>Activity</b>	<b>Milestone Date</b>
Downstream wear calculations	
<ul style="list-style-type: none"> <li>• DNC review and comment</li> </ul>	June 18, 2008
<ul style="list-style-type: none"> <li>• Issue final calculation</li> </ul>	July 18, 2008
Pump seal wear evaluations	July 31, 2008
System performance evaluations	August 15, 2008
Strainer chemical effects reduced scale testing and evaluation	
<ul style="list-style-type: none"> <li>• Complete strainer testing</li> </ul>	July 31, 2008
<ul style="list-style-type: none"> <li>• AECL issue Test Report</li> </ul>	August 31, 2008
<ul style="list-style-type: none"> <li>• DNC review and comment</li> </ul>	September 15, 2008
<ul style="list-style-type: none"> <li>• AECL issue Final Strainer Test Report</li> </ul>	September 30, 2008
Revision to Design Change Record (DCR)	September 15, 2008
Determination of whether any hardware and/or procedural modifications are needed as a result of the completion of the chemical precipitate head loss testing	September 30, 2008

Based on the above discussion, Millstone Units 2 and 3 meet the requirements of SECY-06-0078 Criterion 1.

**4.2 SECY-06-0078 Criterion No. 2:**

*The licensee identifies mitigative measures to be put in place prior to December 31, 2007, and adequately describes how these mitigative measures will minimize the risk of degraded ECCS [emergency core cooling system] functions during the extension period.*



## DNC Response

To date, the following mitigative measures have been implemented to minimize the risk of degraded ECCS system functions during the requested extension period. Although the SECY-06-0078 Criterion No. 2 specifically mentions a completion date of December 31, 2007, DNC has been granted an extension until May 31, 2008 (NRC letter dated December 13, 2007, ADAMS ML073450594), and all of the following mitigative measures pertain to the current request for extension to September 30, 2008:

### **4.2.1 Mitigative Measures**

DNC is fully committed to resolving the issues associated with GSI-191 and is continuing efforts to complete the corrective actions as detailed in the February 29, 2008 supplemental response to GL 2004-02. DNC has implemented the physical modifications identified below at Millstone Units 2 and 3. Refer to the Millstone Units 2 and 3 GL 2004-02 supplemental response dated February 29, 2008 for greater detail on the information provided below.

#### 1. Physical Modifications

As discussed in greater detail in Section 4.3 below, DNC completed the installation of the replacement strainer systems in Units 2 and 3.

DNC has removed calcium silicate insulation from Unit 2 loop rooms as required to eliminate the presence of calcium silicate from any potentially limiting break zone of influence. Unit 3 does not have any calcium silicate insulation.

DNC has delayed the start of the Unit 3 Recirculation Spray (RSS) pumps to ensure sufficient water is available to completely submerge the ECCS strainer prior to RSS pump start.

#### 2. Containment Cleanliness

DNC has procedures in place to ensure containment cleanliness as documented in the response to NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors."

#### 3. Procedural Guidance, Training, and Actions

Operators are trained and have guidance for continuously monitoring ECCS pump parameters including loss of NPSH as indicated by erratic pump current or discharge flow.

4. Information Notice 2005-26

On September 16, 2005, the NRC issued Information Notice (IN) 2005-26, "Results of Chemical Effects Head Loss Tests in a Simulated PWR Sump Pool Environment." IN 2005-26 applies to plants with calcium silicate insulation and trisodium phosphate as a buffer. Millstone Unit 2 has this combination in its containment. Removal of calcium silicate from the loop rooms at Millstone Unit 2 was done as part of the response to this NRC concern. Since Millstone 3 does not have any calcium silicate insulation in its containment, this IN does not apply.

5. Risk Evaluation

With the installation of the new containment sump strainers and other associated changes and evaluations, there has been a significant reduction in the vulnerability to debris blockage and component wear in the recirculation system when mitigating a LOCA. For the remaining outstanding issue of chemical effects, the vulnerability is limited to large break LOCAs only. For small and intermediate break LOCAs, it is expected that there will be a significant reduction in debris generation, as much as one to two orders of magnitude. With this type of reduction in the fibrous and particulate sources, core cooling will be assured for small and intermediate break LOCAs. Since the new strainer was designed to handle a conservatively estimated quantity of the fibrous and particulate debris loading from a large break LOCA, it is expected that for particulate debris loadings that are an order of magnitude or more lower, there will be insufficient particulate to form a thin-bed on the replacement strainers, and there will potentially be open strainer area. Thus, it is likely that any chemical precipitates that are generated will not create a head loss larger than the tested thin-bed head loss, for which the strainer was designed, and adequate NPSH will be maintained. Furthermore, with an order of magnitude or more reduction in the particulate debris, the particulate debris concentration should be low enough such that wear of downstream components would be limited to the point that there is reasonable assurance that the ECCS pumps and downstream components would continue to provide adequate core cooling. Thus, the quantitative risk evaluation addresses potential vulnerability for large break LOCAs only. The probability of this initiating event is low ( $5.0E-6$  for one year or  $3.75E-6$  for nine months) and the probability of a large, early release is negligible.

DNC's previous extension request dated November 15, 2007 provided a risk evaluation for an eleven month extension. The NRC replied in their response letter dated December 13, 2007, with a summary paragraph associated with the risk evaluation:

"Dominion provided a risk evaluation for Millstone 2 and Millstone 3, which compared the increase in Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) from a large-break LOCA to total plant CDF and LERF risk values and showed that these values could be categorized as

“small” in accordance with the criteria stated in Regulatory Guide 1.174, ‘An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis.’”

DNC’s current request for extension is for nine months, which is enveloped by the eleven month risk assessment referenced above.

#### 6. Safety Features and Margins in Current Configuration/Design Basis

DNC has NRC approval to invoke the leak-before-break (LBB) methodology to eliminate the dynamic effects (pipe whip and jet impingement) of postulated primary coolant piping ruptures from the design basis of the plant.

For Millstone Unit 2, the licensing basis includes approved LBB analysis for the hot legs, cold legs, and crossover legs of the Reactor Coolant System (RCS), the pressurizer surge line, and portions of the Safety Injection (SI) and Shutdown Cooling lines, which are not isolable from the RCS piping.

For Millstone Unit 3, the plant licensing basis includes approved partial LBB analysis for the hot legs, cold legs, and crossover legs of the RCS.

The approval was based on the conclusion that the probability of a pipe failure before noticeable leakage could be detected and the plant brought to a safe shutdown condition is small. While leak-before-break is not being used to establish the design basis debris load on the sump strainers, it does provide additional basis for safe continued operation until the completion of the GL 2004-02 corrective actions.

#### 7. Chemical Evaluations and Benchtop testing

DNC’s chemical evaluations have concluded that Millstone’s chemicals are expected to remain in solution with the exception of the potential formation of calcium phosphate. Benchtop testing has been completed, providing empirical chemistry data which are specific to the Millstone power station. This data establishes what conditions are required for the expected containment sump chemical mix to either remain in solution or precipitate out. Potential calcium sources include fiberglass insulation and bare concrete. Calcium has been observed to leach from these sources during benchtop testing.

Based on the above discussion, Millstone Units 2 and 3 meet the requirements of SECY-06-0078 Criterion 2.

#### **4.3 SECY-06-0078 Criterion 3:**

*For proposed extensions beyond several months, a licensee’s request will more likely be accepted if the proposed mitigative measures include temporary physical*

*improvements to the ECCS sump or materials inside containment to better ensure a high level of ECCS performance.*

### DNC Response

As noted above, DNC has implemented the following permanent physical improvements to the containment sumps to better ensure a high level of ECCS and Recirculation System (RS) sump performance.

- **Strainer Installation**

DNC completed the installation of replacement strainer systems for both units. The total surface area of the new Millstone Unit 2 strainer is approximately 6000 ft<sup>2</sup> and the total surface area of the new Millstone Unit 3 strainer is approximately 5000 ft<sup>2</sup>.

- **RSS Pump Start Time Change**

DNC has delayed the start of the Unit 3 recirculation spray (RSS) pumps to ensure sufficient water is available to completely submerge the ECCS strainer prior to RSS pump start.

- **Insulation Replacement/Removal at Millstone Unit 2**

DNC has removed calcium silicate insulation from Millstone Unit 2 loop rooms as required to eliminate the presence of calcium silicate from any potentially limiting break zone of influence.

Based on the above discussion, Millstone Units 2 and 3 meet the requirements of SECY-06-0078 Criterion 3.

## **5.0 Conclusion**

An extension of the Millstone Units 2 and 3 completion dates from May 31, 2008 to September 30, 2008 to complete the corrective actions required by GL 2004-02 is acceptable because:

- The initiating event and large, early release probabilities for Millstone Units 2 and 3 associated with a nine month extension (from December 31, 2007) are 3.75E-6 and negligible, respectively. This risk impact is characterized as "small" per NRC Regulatory Guide 1.174.
- DNC has completed considerable work to further promote a high level of ECCS pump performance including replacement strainer installation at both Millstone Units 2 and 3.

- DNC has implemented mitigative measures to minimize the risk of degraded ECCS functions during the extension period.
- DNC has completed chemical evaluations and benchtop tests, and performed downstream evaluations for the core and fuel in accordance with the applicable WCAP requirements that provide reasonable assurance that sufficient core cooling will be maintained:
- DNC has a plant-specific plan with milestones and schedules to address the outstanding technical issues with sufficient conservatism to address uncertainties.

Therefore, per the criteria included in SECY-06-0078, DNC has established that the risk of degraded ECCS functions for Millstone Units 2 and 3 is not considered to be significant.

**ATTACHMENT 3**

**NRC GENERIC LETTER 2004-02 POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON  
EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT  
PRESSURIZED-WATER REACTORS**

**REQUEST FOR AN EXTENSION OF THE COMPLETION DATE  
FOR CORRECTIVE ACTIONS**

**VIRGINIA ELECTRIC AND POWER COMPANY  
(DOMINION)  
NORTH ANNA POWER STATION UNITS 1 AND 2**

**Request for an Extension of the Completion Date for Corrective Actions**  
**North Anna Power Station Units 1 and 2**

**1.0 Background**

During the ensuing work to complete the GL 2004-02 corrective actions, it became apparent that certain activities required to address the containment sump issues could not be completed by December 31, 2007. These activities included downstream effects evaluations for component wear and system performance and for nuclear fuel and the reactor vessel, as well as chemical effects testing and evaluation. Consequently, in a letter dated November 15, 2007 (Serial No. 07-0660), Dominion requested an extension to November 30, 2008 to complete the outstanding corrective actions. However, in a letter dated December 13, 2007, the NRC took exception to Dominion's extension request. While the NRC confirmed that adequate mitigation measures had been put in place to reduce plant risk for the requested eleven month extension, the staff also noted that Dominion's requested extension date was not reasonable based on the case provided. Due to the importance of prompt closure of GL 2004-02, the NRC granted Dominion an extension to May 31, 2008 to complete the outstanding corrective actions for North Anna Units 1 and 2. However, the staff also stated that should Dominion be unable to complete the North Anna GL 2004-02 corrective actions by May 31, 2008, additional justification must be provided to the NRC for any requested extension beyond that date.

As discussed in greater detail below, Dominion has made significant progress regarding the completion of downstream effects evaluations and chemical effects testing and evaluation.

- Downstream Effects - Downstream effects evaluations have been performed to determine: 1) the effect of debris laden water on the reactor vessel and fuel assemblies, and 2) component wear due to the effects of debris and the resultant effect, if any, on system performance due to potentially degraded components. Details of the evaluation results are provided in Sections 3.1 and 3.2 below. An extension is required to complete Dominion staff review of the downstream component wear and systems performance evaluations and to finalize the associated documentation.
- Chemical Effects – Bench-top testing has been completed to determine the solubility/precipitate behavior of the chemicals expected to exist in the containment sump as a result of a loss of coolant accident (LOCA). The results of the bench-top tests are currently in Dominion staff review. In addition, a conservative reduced scale single loop test has been performed to demonstrate that the North Anna Units 1 and 2 Recirculation Spray (RS) and Low Head Safety Injection (LHSI) pumps will have an acceptable strainer face head loss during long term cooling following a LOCA. Moreover, Dominion and the NRC have conducted status update conference calls associated with chemical effects testing progress, and the staff has reviewed

and commented on the testing protocols for bench-top, single loop and multi-loop testing prepared by Atomic Energy of Canada, Limited (AECL, the chemical effects testing vendor). Furthermore, the staff has witnessed certain multi-loop testing activities at AECL's Chalk River Test Facility.

Even though considerable progress has been made to address the remaining GL 2004-02 corrective actions for North Anna Units 1 and 2, certain chemical effects testing activities cannot be completed by May 31, 2008. Specifically, completion of ongoing reduced scale multi-loop testing and evaluation, using North Anna plant-specific chemical conditions, is required to provide confidence in their application to containment sump strainer performance. Subsequent review of test results and finalization of test documentation are also required to be completed once testing has been completed. Therefore, Dominion is requesting a schedule extension for North Anna Units 1 and 2 to complete the remaining chemical effects testing, technical evaluations and reviews, and licensing basis updates, as well as to determine whether any additional actions may be required based on the results of the testing and technical evaluations.

The information provided below includes the basis for the extension request. Specifically, Dominion has addressed the "Criteria for Evaluating Delay of Hardware Changes," as described in SECY-06-0078 dated March 31, 2006. This discussion supports Dominion's request for an extension of the corrective actions completion date to ensure that the necessary testing and technical evaluations have been completed and the supporting calculations and technical reports have been reviewed and validated to facilitate resolution of GSI-191 issues. An extension is requested until September 30, 2008 to complete the remaining required actions and to update the associated licensing basis documents. The proposed extension for North Anna Units 1 and 2 does not alter the original conclusions summarized in GL 2004-02 in which the staff determined that it is acceptable for PWR licensees to operate until the corrective actions are completed because of sufficiently low plant risk.

## **2.0 Justification for the Proposed Extension**

The NRC provided a justification for continued operation (JCO) in the "Summary of July 26-27, 2001 Meeting with Nuclear Energy Institute and Industry on ECCS Strainer Blockage in PWRs," dated August 14, 2001, that supports continued operation through December 31, 2007. Elements of the JCO that continue to be applicable to North Anna Units 1 and 2 include:

- Both North Anna Units 1 and 2 containments are compartmentalized, thus slowing transport of debris to the sump.
- The probability of the initiating event (i.e., large break LOCA) is extremely low.



- Leak-Before-Break (LBB) qualified piping is of sufficient toughness that it will most likely leak (even under safe shutdown conditions) rather than rupture.
- The time for switchover to recirculation from the sump after accident initiation allows for debris settling.

### **3.0 Current Status and Reason for the Proposed Extension**

#### **3.1 Downstream Effects – Nuclear Fuel and Reactor Vessel**

WCAP-16793-NP Rev. 0, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculation Fluid," provides the criteria for performing downstream effects evaluations regarding core effects. This evaluation has been completed and concluded that:

- Adequate flow to remove decay heat will continue to reach the core even with debris from the sump reaching the Reactor Coolant System (RCS) and core,
- Decay heat will continue to be removed even with debris collection at the fuel assembly spacer grids,
- Fibrous debris, should it enter the core region, will not tightly adhere to the surface of fuel cladding,
- Simulating large debris loadings of fiberglass and calcium silicate, decay heat will be removed, and acceptable fuel clad temperatures will be maintained, and
- As blockage of the core will not occur, the current accepted licensing calculations that demonstrate appropriate boric acid dilution to preclude boric acid precipitation remain valid.

The plant-specific evaluation also demonstrated that the WCAP-16793-NP Rev. 0 conclusions are directly applicable to North Anna Units 1 and 2. Consequently, there is reasonable assurance that for North Anna Units 1 and 2, long-term core cooling will be established and maintained post-LOCA even when considering the presence of debris in the RCS and core. Refer to North Anna's Supplemental Response to the NRC, dated February 29, 2008 (Serial Number 08-0019) paragraph 3n, for a more detailed technical discussion of the evaluation. This effort is complete. No extension is required for this effort.

#### **3.2 Downstream Effects – Component Wear and System Performance**

WCAP-16406-P Rev. 1, "Evaluation of Downstream Sump Debris Effects in Support of Resolution of GSI-191," provides revised guidance for the performance of downstream effects evaluations for component wear and resulting system performance with potentially degraded components. Revised downstream component wear effects and system performance evaluations have been completed for North Anna Units 1 and 2 by

Sargent and Lundy and were performed in accordance with the WCAP-16406-P Rev. 1 guidelines. Dominion is currently reviewing the evaluations and is scheduled to complete the review by June 18, 2008. The evaluation findings are preliminary at this time and are summarized as follows:

### **3.2.1 Component Wear**

Wear analysis and wear effects on component performance have been performed for the following components:

- High Head Safety Injection (HHSI) pumps (Charging Pumps),
- Low Head Safety Injection (LHSI) pumps,
- Inside Recirculation Spray (IRS) pumps,
- Outside Recirculation Spray (ORS) pumps,
- manually throttled valves,
- motor operated valves,
- orifices,
- heat exchangers, and
- piping.

The results of the component wear evaluation demonstrate that non-pump components are acceptable for wear and blockage in accordance with WCAP-16406-P methodologies, and ORS, IRS, and SI pumps meet the acceptance criteria for performance and vibration starting from their design clearances, which are monitored and maintained by Dominion's inservice testing and corrective maintenance programs.

### **3.2.2 System Performance**

The downstream effects evaluation performed for system performance concluded the Emergency Core Cooling System (ECCS) and RS pumps for North Anna Units 1 and 2 are capable of supplying flow in excess of the minimum system requirements. It has been determined that both systems are capable of meeting the minimum flow requirements under debris laden conditions for a period of 30 days following a LOCA. In addition, a system vibration evaluation has determined that the RS, LHSI and HHSI piping does not exceed vibration acceptance criteria. Mechanical seals in the ECCS and RS system will perform as designed, and debris in the recirculated sump fluid will not adversely affect the seals.

The RS, LHSI, and two of the six HHSI pumps are acceptable for vibration, as their maximum flow rates are within analyzed runout limits. Four of the six HHSI pumps are still under evaluation.

### **3.3 Strainer Debris and Chemical Effects Testing**

Completion of chemical effects testing and evaluation is required to confirm that the replacement strainers installed at North Anna Units 1 and 2 are adequate to maintain NPSH margin for the ECCS pumps during long-term core cooling and to confirm that no further physical modifications are required.

A chemical effects evaluation is currently being performed for North Anna Units 1 and 2 by AECL to determine the potential for chemical precipitate formation. Published industry data were collected, consolidated, and depicted as a series of temperature dependent curves plotted on a pH/precipitate concentration graph. Bench-top testing was performed to confirm the validity of the curves, thus providing an accurate indication of when precipitate formation would be expected to occur. Bench-top testing is complete, and the results are currently undergoing internal Dominion review. To verify the results of the bench-top testing and evaluations, reduced scale testing using plant-specific chemical concentrations was performed. Single-loop reduced scale testing was performed with a simulation of expected Surry chemistry conditions and debris load, as the Surry conditions were determined to be bounding for North Anna Units 1 and 2. The test results indicate that North Anna Units 1 and 2 will sustain an acceptable strainer face head loss due to a thin bed formation from latent debris and chemical effects.

Multi-loop testing is also being employed to provide a means of performing numerous (i.e., six) reduced scale tests simultaneously. North Anna Units 1 and 2 RS and LHSI strainers will be simulated with the North Anna plant specific fibrous and particulate debris loads and chemical conditions that would be expected to be in the containment sump following a LOCA. Each test will be performed for 30 days following the formation of a thin debris bed at a specified temperature and flow rate to reproduce the possibility of precipitate formation and its resulting impact on head loss. Testing is currently scheduled to be completed by July 7, 2008, and the final Strainer Test Report and the final Chemical Strainer Hydraulic Calculation are scheduled to be issued by August 29, 2008 and September 12, 2008.

### **3.4 Extension Request**

Dominion is requesting an extension until September 30, 2008 for completion of the following activities:

- Internal review and issue of final analyses and evaluation reports of bench-top testing, downstream component wear and systems performance, and debris generation and transport,
- Chemical effects reduced scale testing, evaluation, and test report preparation and review,

- Determination of any additional actions that may be required based on the results of the chemical effects testing and evaluations, and
- Update of design and licensing basis documents (e.g., UFSAR, plant procedures, etc.) to reflect plant changes implemented to resolve GSI-191 issues.

#### **4.0 Compliance with SECY-06-0078 Criteria**

SECY-06-0078 specifies two criteria for short duration GL 2004-02 extensions limited to several months and a third criterion for extensions beyond several months. These three criteria and the associated responses for North Anna Units 1 and 2 are provided in detail below.

#### **4.1 SECY-06-0078 Criterion No. 1:**

*The licensee has a plant-specific technical/experimental plan with milestones and schedule to address outstanding technical issues with enough margin to account for uncertainties.*

#### Dominion Response

#### NORTH ANNA PLANT SPECIFIC TECHNICAL/EXPERIMENTAL PLAN

In accordance with North Anna's Plant Specific Plan, outlined in Dominion's extension request dated November 15, 2007, the GL 2004-02 supplemental response dated February 29, 2008 and the information discussed above, the following tasks have been completed (with outstanding reviews noted where applicable):

- Debris analyses (currently in Dominion review)
  - Debris generation analyses in accordance with WCAP-16568-P Rev 0 (Zone of Influence determination)
  - Debris transport analysis
- Downstream effects analyses
  - Fuel and vessel downstream effects analyses in accordance with WCAP-16793-NP Rev. 0
  - Debris blockage, component wear and system performance downstream effects analyses in accordance with WCAP-16406-P Rev. 1 (currently in Dominion review)
- Strainer head loss and vortex testing for expected debris load (excluding chemical precipitants)
- Bench-top testing (including consideration of WCAP-16530-NP results) to determine likely precipitate formation and bounding quantities of precipitants to use in reduced scale testing (currently in Dominion review)
- Replacement strainer design and installation for both North Anna Units 1 and 2

Reduced scale chemical testing and results evaluation of the impact of potential chemical precipitants on strainer head loss are currently underway and are scheduled to be completed by September 12, 2008. To complete this effort and adopt the licensing basis required for long-term core cooling required for resolution of GSI-191 at North Anna Units 1 and 2, the following milestones have been established:

<b>GL 2004-02 CORRECTIVE ACTION MILESTONES</b>	
<b>Activity</b>	<b>Milestone Date</b>
Downstream wear calculations, bench-top testing, downstream wear effects on components, and system performance, and debris generation and transport	
<ul style="list-style-type: none"> <li>• Dominion review and comment</li> </ul>	June 18, 2008
<ul style="list-style-type: none"> <li>• Issue final calculations/evaluations</li> </ul>	July 18, 2008
Pump Seal Wear Evaluations	July 31, 2008
System Performance Evaluations	July 31, 2008
Strainer chemical effects reduced scale testing and evaluation	
<ul style="list-style-type: none"> <li>• Complete strainer chemical effects testing</li> </ul>	July 7, 2008
<ul style="list-style-type: none"> <li>• AECL issue Test Report</li> </ul>	July 31, 2008
<ul style="list-style-type: none"> <li>• Dominion review and comment</li> </ul>	August 15, 2008
<ul style="list-style-type: none"> <li>• AECL issue Final Strainer Test Report</li> </ul>	August 29, 2008
Determination of whether any hardware and/or procedural modifications are needed as a result of the completion of the chemical precipitate head loss testing	Sept. 15, 2008

Field Change to design change package (DCP) to implement chemical design documents	
<ul style="list-style-type: none"> <li>Issue Field Change to strainer installation DCP for acceptance of chemical strainer testing</li> </ul>	Sept. 19, 2008
<ul style="list-style-type: none"> <li>Facility Safety Review Committee approval of design and licensing basis changes</li> </ul>	Sept. 30, 2008

Based on the above discussion, North Anna Units 1 and 2 meet the requirements of SECY-06-0078 Criterion 1.

#### **4.2 SECY-06-0078 Criterion No. 2:**

*The licensee identifies mitigative measures to be put in place prior to December 31, 2007, and adequately describes how these mitigative measures will minimize the risk of degraded ECCS [emergency core cooling system] functions during the extension period.*

#### Dominion Response

To date, the following mitigative measures have been implemented to minimize the risk of degraded ECCS and RS system functions during the requested extension period. Although SECY-06-0078 Criterion No. 2 specifically mentions a completion date of December 31, 2007, Dominion was previously granted an extension until May 31, 2008 to complete GL 2004-02 corrective actions (reference NRC letter dated December 13, 2007). The following mitigative measures pertain to the current request for extension to September 30, 2008:

#### **4.2.1 Mitigative Measures**

Dominion is fully committed to resolving the issues associated with GSI-191 and is continuing efforts to complete the corrective actions as detailed in the February 29, 2008 supplemental response to GL 2004-02. Dominion has implemented the physical modifications identified below at North Anna Units 1 and 2. Refer to the North Anna Units 1 and 2 supplemental response for greater detail on the information provided below.

## 1. Physical Modifications

As discussed in greater detail in Dominion's February 29, 2008 supplemental response to GL 2004-02, physical modifications include the installation of replacement strainers in Units 1 and 2.

Calcium-Silicate (Cal-Sil) and Microtherm insulation was either removed or replaced in Units 1 and 2 containments as required to reduce the calculated quantities of particulates and fiber that could reach the containment sumps and achieve the specified strainer head loss and to help reduce component wear.

Dominion has modified the North Anna Units 1 and 2 Refueling Water Storage Tanks (RWSTs) level instrumentation and the SI automatic Recirculation Mode Transfer (RMT) setpoint to ensure sufficient water is available to meet RS and LHSI strainer submergence requirements.

A 12-inch hole was core bored in the primary shield wall plug for both North Anna Units 1 and 2 to allow reactor cavity water to drain from the in-core sump (ICS) room into the containment sump. This facilitates transfer of additional water to the containment sump to ensure full submergence of the new containment sump strainers.

## 2. Containment Cleanliness

Dominion has procedures in place to ensure containment cleanliness as documented in the response to NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors."

## 3. Procedural Guidance, Training, and Actions

Operators are trained and have guidance for monitoring ECCS pump parameters including loss of NPSH as indicated by erratic pump current or discharge flow.

## 4. Information Notice 2005-26

On September 16, 2005, the NRC issued Information Notice (IN) 2005-26, "Results of Chemical Effects Head Loss Tests in a Simulated PWR Sump Pool Environment." IN 2005-26 applies to plants with calcium silicate insulation and trisodium phosphate as a buffer. Neither North Anna Unit was listed in this document as units having the above-described combination in its containment; therefore, no response to IN 2005-26 was required for North Anna Unit 1 or 2.

## 5. Risk Evaluation

With the installation of the new containment sump strainers and other associated changes and evaluations, there has been a significant reduction in the vulnerability to debris blockage and component wear in the recirculation system when mitigating a LOCA. For the remaining outstanding issue of chemical effects, the vulnerability is limited to large break LOCAs only. For small and intermediate break LOCAs, it is expected that there will be a significant reduction in debris generation, as much as one to two orders of magnitude. With this type of reduction in the fibrous and particulate sources, core cooling will be assured for small and intermediate break LOCAs. Since the new strainer was designed to handle a conservatively estimated quantity of the fibrous and particulate debris loading from a large break LOCA, it is expected that for particulate debris loadings that are an order of magnitude or more lower, there will be insufficient particulate to form a thin-bed on the replacement strainers, and there will potentially be open strainer area. Thus, it is likely that any chemical precipitates that are generated will not create a head loss larger than the tested thin-bed head loss, for which the strainer was designed, and adequate NPSH will be maintained. Furthermore, with an order of magnitude or more reduction in the particulate debris, the particulate debris concentration should be low enough such that wear of downstream components would be limited to the point that there is reasonable assurance that the ECCS pumps and downstream components would continue to provide adequate core cooling. Thus, the quantitative risk evaluation addresses potential vulnerability for large break LOCAs only. The probability of this initiating event is low ( $5.0E-6$  for one year or  $3.75E-6$  for nine months) and the probability of a large, early release is negligible.

Dominion's previous extension request dated November 15, 2007, provided a risk evaluation for an eleven month extension. The NRC replied in their response letter dated December 13, 2007, with a summary paragraph associated with the risk evaluation:

"Dominion provided a risk evaluation for North Anna 1 and North Anna 2, which compared the increase in Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) from a large-break LOCA to total plant CDF and LERF risk values and showed that these values could be categorized as "small" in accordance with the criteria stated in Regulatory Guide 1.174, 'An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis.'"

Dominion's current request for extension is for nine months, which is enveloped by the eleven month risk assessment referenced above.



## 6. Safety Features and Margins in Current Configuration/Design Basis

Dominion has NRC approval to invoke the leak-before-break (LBB) methodology to eliminate the dynamic effects (pipe whip and jet impingement) of postulated primary coolant piping ruptures from the design basis of the plant.

For North Anna Units 1 and 2, the licensing basis includes approved LBB analysis for the RCS primary loop piping.

The approval was based on the conclusion that the probability of a pipe failure before noticeable leakage could be detected and the plant brought to a safe shutdown condition is small. While leak-before-break is not being used to establish the design basis debris load on the sump strainers, it does provide additional basis for safe continued operation until the completion of the GL 2004-02 corrective actions.

## 7. Bench-top Testing & Chemical Evaluations

Bench-top testing has been completed, which provides empirical chemistry data that are specific to North Anna. This data (currently in Dominion review) establishes what conditions are required for North Anna's expected containment sump chemical mix to either remain in solution or form precipitates. Dominion's subsequent chemical evaluations, based on these bench-top results, have concluded that North Anna's chemicals are expected to remain in solution, supporting the position that chemical effects are not expected to increase the sump strainer face head loss.

Based on the above discussion, North Anna Units 1 and 2 meet the requirements of SECY-06-0078 Criterion 2.

### **4.3 SECY-06-0078 Criterion 3:**

*For proposed extensions beyond several months, a licensee's request will more likely be accepted if the proposed mitigative measures include temporary physical improvements to the ECCS sump or materials inside containment to better ensure a high level of ECCS performance.*

#### Dominion Response

As noted above, Dominion has implemented the following permanent physical improvements to the containment sump to better ensure a high level of ECCS and RS sump performance.

- **Strainer Installation**

Dominion completed the installation of replacement strainer systems for both units. The total surface area of the new RS strainer systems are approximately 4400 ft<sup>2</sup> (each unit), and the total surface area of the LHSI strainer is approximately 2000 ft<sup>2</sup>

for Unit 1, and 1900 ft<sup>2</sup> for Unit 2. This replaces the previous screens which had a surface area of approximately 168 ft<sup>2</sup> for each strainer.

- RS Pump Start Time Change

The RWST instrumentation was modified at both North Anna units to change the start signals for the RS pumps. This change will ensure sufficient water is available to meet strainer submergence requirements. A 120-second time delay was added for the start of the IRS pumps, reducing the load impact on the Emergency Diesel Generators and allowing sufficient time for the ORS pumps to fill their piping and attain stable operation prior to the start of the IRS pumps.

- LHSI Pump Recirculation Mode Transfer Change

The RWST instrumentation has been modified for both units to change the Safety Injection RMT setpoint to allow more energy to be removed from the containment to lower the sump water temperature prior to swapping the LHSI pump suction from the RWST to the containment sump. This change also provides a higher water level in the containment prior to LHSI suction swap to the containment sump. The combination of lower temperature and higher water level provides more NPSH to the LHSI pumps and provides the required volume of water to maintain strainer submergence.

- Insulation Replacement/Removal at NAPS

Evaluations were performed for North Anna Units 1 and 2 to identify lines within the containments that required insulation removal/replacement to minimize the Zone of Influence (ZOI) generated particulate during a critical pipe break. Cal-Sil and Microtherm insulation within the ZOI of postulated LOCA pipe breaks was removed / replaced during the North Anna Units 1 and 2 2007 Refueling Outages (RFOs). Removal of Cal-Sil and Microtherm insulation was required to achieve the specified strainer head loss and to help reduce component wear.

- Incore Sump Room Drain

An ICS room drain was installed in the primary shield wall plug for both units during the 2007 RFOs. This modification allows water held up in the reactor cavity to drain to the containment sump from the ICS room facilitating full submergence of the new containment sump strainers.

Based on the above discussion, North Anna Units 1 and 2 meet the requirements of SECY-06-0078 Criterion 3.

## 5.0 Conclusion

An extension of the North Anna Units 1 and 2 completion dates from May 31, 2008 to September 30, 2008 to complete the corrective actions required by GL 2004-02 is acceptable because:

- The initiating event and large early release probabilities for North Anna Units 1 and 2 associated with a nine month extension (from December 31, 2007) are  $3.75E-6$  and negligible, respectively. This risk impact is characterized as "small" per NRC Regulatory Guide 1.174.
- Dominion has completed considerable work to further promote a high level of ECCS and RS pump performance including replacement strainer installation at both North Anna Units 1 and 2.
- Dominion has implemented mitigative measures to minimize the risk of degraded ECCS and RS system functions during the extension period.
- Dominion has completed numerous chemical bench-top tests, performed a conservative reduced scale test, and performed downstream and chemical effects evaluations in accordance with the applicable WCAP requirements that provide reasonable assurance that:
  - NPSH margin will be maintained in the event of a LOCA,
  - Downstream wear effects are acceptable, and
  - Sufficient core cooling will be maintained.
- Dominion has a plant-specific plan with milestones and schedules to address the outstanding technical issues with sufficient conservatism to address uncertainties.

Therefore, per the criteria included in SECY-06-0078, Dominion has established that the risk of degraded ECCS and RS functions for North Anna Units 1 and 2 is not considered significant.

**ATTACHMENT 4**

**NRC GENERIC LETTER 2004-02 POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON  
EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT  
PRESSURIZED-WATER REACTORS**

**REQUEST FOR AN EXTENSION OF THE COMPLETION DATE  
FOR CORRECTIVE ACTIONS**

**VIRGINIA ELECTRIC AND POWER COMPANY  
(DOMINION)  
SURRY POWER STATION UNITS 1 AND 2**

## **Request for an Extension of the Completion Date for Corrective Actions** **Surry Power Station Units 1 and 2**

### **1.0 Background**

During the ensuing work to complete the GL 2004-02 corrective actions, it became apparent that certain activities required to address the containment sump issues could not be completed by December 31, 2007. These activities included downstream effects evaluations for component wear and system performance and for nuclear fuel and the reactor vessel, as well as chemical effects testing and evaluation. Consequently, in a letter dated November 15, 2007 (Serial No. 07-0660), Dominion requested an extension to November 30, 2008 to complete the outstanding corrective actions. However, in a letter dated December 13, 2007, the NRC took exception to Dominion's extension request. While the NRC confirmed that adequate mitigation measures had been put in place to reduce risk for the requested eleven month extension, the staff also noted that Dominion's requested extension date was not reasonable based on the case provided. Due to the importance of prompt closure of GL 2004-02, the NRC granted Dominion an extension to May 31, 2008 to complete the outstanding corrective actions for Surry Units 1 and 2. However, the staff also stated that should Dominion be unable to complete the Surry GL 2004-02 corrective actions by May 31, 2008, additional justification must be provided to the NRC for any requested extension beyond that date.

As discussed in greater detail below, Dominion has made significant progress regarding the completion of downstream effects evaluations and chemical effects testing and evaluation.

- **Downstream Effects** - Downstream effects evaluations have been performed to determine: 1) the effect of debris laden water on the reactor vessel and fuel assemblies, and 2) component wear due to the effects of debris and the resultant effect, if any, on system performance due to potentially degraded components. Details of the evaluation results are provided in Sections 3.1 and 3.2 below. An extension is required to complete Dominion staff review of the downstream component wear and systems performance evaluations and to finalize the associated documentation.
- **Chemical Effects** – Bench-top testing has been completed to determine the solubility/precipitate behavior of the chemicals expected to exist in the containment sump as a result of a loss of coolant accident (LOCA). The results of the bench-top tests are currently in Dominion staff review. In addition, a Surry specific reduced scale single loop test was performed (See item 3.3 below) to demonstrate that the Surry Units 1 and 2 Recirculation Spray (RS) and Low Head Safety Injection (LHSI) pumps will have an acceptable strainer face head loss during long term cooling following a LOCA. Moreover, Dominion and the NRC have conducted status update conference calls associated with chemical effects testing progress, and the staff has reviewed and commented on the testing protocols for bench-top, single loop and

multi-loop testing prepared by Atomic Energy of Canada, Limited (AECL, the chemical effects testing vendor). Furthermore, the staff has witnessed certain multi-loop testing activities at AECL's Chalk River Test Facility.

Even though considerable progress has been made to address the remaining GL 2004-02 corrective actions for Surry Units 1 and 2, certain chemical effects testing activities cannot be completed by May 31, 2008. Specifically, completion of ongoing reduced scale multi-loop testing and evaluation, using Surry plant-specific chemical conditions, is required to provide confidence in their application to containment sump strainer performance. Subsequent review of test results and finalization of test documentation are also required to be completed once testing has been completed. Therefore, Dominion is requesting a schedule extension for Surry Units 1 and 2 to complete the remaining chemical effects testing, technical evaluations and reviews, and licensing basis updates, as well as to determine whether any additional actions may be required based on the results of the testing and technical evaluations.

The information provided below includes the basis for the extension request. Specifically, Dominion has addressed the "Criteria for Evaluating Delay of Hardware Changes," as described in SECY-06-0078 dated March 31, 2006. This discussion supports Dominion's request for an extension of the corrective actions completion date to ensure that the necessary testing and technical evaluations have been completed and the supporting calculations and technical reports have been reviewed and validated to facilitate resolution of GSI-191 issues. An extension is requested until September 30, 2008 to complete the remaining required actions discussed below and to update the licensing basis documents. The proposed extension for Surry Units 1 and 2 does not alter the original conclusions summarized in GL 2004-02 in which the staff determined that it is acceptable for pressurized water reactor (PWR) licensees to operate until the corrective actions are completed because of sufficiently low plant risk.

## **2.0 Justification for the Proposed Extension**

The NRC provided a justification for continued operation (JCO) in the "Summary of July 26-27, 2001 Meeting with Nuclear Energy Institute and Industry on ECCS Strainer Blockage in PWRs," dated August 14, 2001, that supports continued operation through December 31, 2007. Elements of the JCO that continue to be applicable to Surry Units 1 and 2 include:

- Both Surry Units 1 and 2 containments are compartmentalized, thus slowing transport of debris to the sump.
- The probability of the initiating event (i.e., large break LOCA) is extremely low.
- Leak-Before-Break (LBB) qualified piping is of sufficient toughness that it will most likely leak (even under safe shutdown conditions) rather than rupture.

- Surry is not susceptible to primary water stress corrosion cracking associated with pressurizer Alloy 600/82/182 dissimilar metal welds since the Surry pressurizer does not contain these types of welds.
- The time for switchover to recirculation from the sump after accident initiation allows for debris settling.

### **3.0 Current Status and Reason for the Proposed Extension**

#### **3.1 Downstream Effects – Nuclear Fuel and Reactor Vessel**

WCAP-16793-NP Rev. 0, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculation Fluid," provides the criteria for performing downstream effects evaluations regarding core effects. This evaluation has been completed and concluded that:

- Adequate flow to remove decay heat will continue to reach the core even with debris from the sump reaching the Reactor Coolant System (RCS) and core,
- Decay heat will continue to be removed even with debris collection at the fuel assembly spacer grids,
- Fibrous debris, should it enter the core region, will not tightly adhere to the surface of fuel cladding,
- Simulating large debris loadings of fiberglass and calcium silicate, decay heat will be removed, and acceptable fuel clad temperatures will be maintained, and
- As blockage of the core will not occur, the current accepted licensing calculations that demonstrate appropriate boric acid dilution to preclude boric acid precipitation remain valid.

The plant-specific evaluation also demonstrates that the WCAP-16793-NP Rev. 0 conclusions are directly applicable to Surry Units 1 and 2. Consequently, there is reasonable assurance that for Surry Units 1 and 2, long-term core cooling will be established and maintained post-LOCA even when considering the presence of debris in the RCS and core.

Please refer to Surry's GL 2004-02 Supplemental Response to the NRC, dated February 29, 2008 (Serial Number 08-0018), paragraph 3n, for a more detailed technical discussion of the evaluation. This effort is complete. No extension is required for this effort.

#### **3.2 Downstream Effects – Component Wear and System Performance**

WCAP-16406-P Rev. 1, "Evaluation of Downstream Sump Debris Effects in Support of Resolution of GSI-191," provides revised guidance for the performance of downstream

effects evaluations for component wear and resulting system performance with potentially degraded components. Revised downstream component wear effects and system performance evaluations have been completed for Surry Units 1 and 2 by Sargent and Lundy and were performed in accordance with the WCAP-16406-P Rev. 1 guidelines. Dominion is currently reviewing the evaluations and is scheduled to complete the review by June 18, 2008. Although the evaluation findings are preliminary at this time, they appear to be generally favorable and are summarized as follows:

### **3.2.1 Component Wear**

Wear analysis and wear effects on component performance have been performed for the following components:

- High Head Safety Injection (HHSI) pumps (Charging Pumps),
- Outside Recirculation Spray (ORS) pumps,
- Inside Recirculation Spray (IRS) pumps,
- Low Head Safety Injection (LHSI) pumps,
- manually throttled valves,
- motor operated valves,
- orifices,
- cavitating venturis,
- recirculation spray nozzles,
- heat exchangers, and
- piping.

The results of the component wear evaluation demonstrate that non-pump components are acceptable for wear and blockage in accordance with WCAP-16406-P methodologies. In addition, the ORS, IRS, and LHSI pumps meet the acceptance criteria for performance and vibration starting from their design clearances, which are monitored and maintained by Dominion's inservice testing and corrective maintenance programs. However, the HHSI pumps do not meet the current general acceptance criteria for vibration. A rotor dynamic analysis is being performed to ascertain acceptance criteria specific to this pump type, and the acceptability of the HHSI pumps is currently being re-evaluated.

### **3.2.2 System Performance**

The downstream effects evaluation performed for system performance concluded the Emergency Core Cooling System (ECCS) and RS pumps for Surry Units 1 and 2 are capable of supplying flow in excess of the minimum system requirements. Under



maximum flow, the RS and LHSI pumps will not reach run out condition under debris laden conditions for 30 days following a LOCA. The LHSI pumps may experience flow rates that could slightly exceed the maximum safety analysis flow rate; however, these flow rates were analyzed and determined to be acceptable, as adequate margin remained for net positive suction head (NPSH). Also, a system vibration evaluation has determined that the LHSI and RS piping do not exceed vibration acceptance criteria. Mechanical seals in the ECCS and RS system will perform as designed, and debris in the recirculated sump fluid will not adversely affect the seals.

The RS, LHSI, and one of the six HHSI pumps are acceptable for vibration, as their maximum flow rates are within analyzed runout limits. The five remaining HHSI pumps are still under evaluation.

### **3.3 Strainer Debris and Chemical Effects Testing**

Completion of chemical effects testing and evaluation is required to confirm that the replacement strainers installed at Surry Units 1 and 2 are adequate to maintain NPSH margin for the ECCS pumps during long-term core cooling and to confirm that no further physical modifications are required.

A chemical effects evaluation is currently being performed for Surry Units 1 and 2 by AECL to determine the potential for chemical precipitate formation. Published industry data were collected, consolidated, and depicted as a series of temperature dependent curves plotted on a pH/precipitate concentration graph. Bench-top testing was performed to confirm the validity of the curves, thus providing an accurate indication of when precipitate formation would be expected to occur. Bench-top testing is complete, and the results are currently undergoing internal Dominion review. To verify the results of the bench-top testing and evaluations, reduced scale testing using plant-specific chemical concentrations was performed. Single-loop reduced scale testing was performed with a simulation of expected Surry chemistry conditions and debris load. The testing results indicate that Surry Units 1 and 2 will sustain an acceptable strainer face head loss due to a thin bed formation from latent debris and chemical effects.

Multi-loop testing is also being employed to provide a means of performing numerous (i.e., six) reduced scale tests simultaneously. Surry Units 1 and 2 RS and LHSI strainers will be simulated with the Surry plant specific fibrous and particulate debris loads and chemical conditions that would be expected to be in the containment sump following a LOCA. Each test will be performed for 30 days following the formation of a thin debris bed at a specified temperature and flow rate to reproduce the possibility of precipitate formation and its resulting impact on head loss. Testing is currently scheduled to be completed by July 7, 2008, and the final Strainer Test Report and the final Chemical Strainer Hydraulic Calculation are scheduled to be issued by August 29, 2008 and September 12, 2008, respectively.

### **3.4 Extension Request**

Dominion is requesting an extension until September 30, 2008 for completion of the following activities:

- Internal review and issue of final analyses and evaluation reports of bench-top testing, downstream component wear and systems performance, and debris generation and transport,
- Chemical effects reduced scale testing, evaluation, and test report preparation and review,
- Determination of any additional actions that may be required based on the results of the chemical effects testing and evaluations, and
- Update of design and licensing basis documents (e.g., UFSAR, Tech Specs, plant procedures, etc.) to reflect the plant changes implemented to resolve GSI-191 issues.

### **4.0 Compliance with SECY-06-0078 Criteria**

SECY-06-0078 specifies two criteria for short duration GL 2004-02 extensions, limited to several months and a third criterion for extensions beyond several months. These three criteria and the associated responses for Surry Units 1 and 2 are provided in detail below.

#### **4.1 SECY-06-0078 Criterion No. 1:**

*The licensee has a plant-specific technical/experimental plan with milestones and schedule to address outstanding technical issues with enough margin to account for uncertainties.*

#### Dominion Response

#### SURRY PLANT SPECIFIC TECHNICAL/EXPERIMENTAL PLAN

In accordance with Surry's Plant Specific Plan, outlined in Dominion's Extension Request letter dated November 15, 2007 (Serial No. 07-0660), the following tasks have been completed (with outstanding reviews noted where applicable):

- Debris analyses (currently in Dominion review)
  - Debris generation analyses in accordance with WCAP-16568-P Rev. 0 (Zone of Influence determination)
  - Debris transport analysis

- Downstream effects analyses
  - Fuel and vessel downstream effects analyses in accordance with WCAP-16793-NP Rev. 0.
  - Debris blockage, component wear and system performance downstream effects analyses in accordance with WCAP-16406-P Rev. 1 (currently in Dominion review)
- Strainer head loss and vortex testing for expected debris load (excluding chemical precipitants)
- Bench-top testing (including consideration of WCAP-16530-NP results) to determine likely precipitate formation and bounding quantities of precipitants to use in reduced scale testing (currently in Dominion review)
- Replacement strainer design for both Surry Units 1 and 2, with completed installation for Unit 1, and Unit 2 installation being completed during the ongoing spring 2008 refueling outage

Reduced scale chemical testing and results evaluation of the impact of potential chemical precipitants on strainer head loss are currently underway and are scheduled to be completed by September 12, 2008. To complete this effort and adopt the licensing basis required for long-term core cooling required for resolution of GSI-191 at Surry Units 1 and 2, the following milestones have been established:

<b>GL 2004-02 CORRECTIVE ACTION MILESTONES</b>	
<b>Activity</b>	<b>Milestone Date</b>
Downstream wear calculations, bench-top testing, downstream wear effects on components, and system performance, and debris generation and transport	
<ul style="list-style-type: none"> <li>• Dominion review and comment</li> </ul>	June 18, 2008
<ul style="list-style-type: none"> <li>• Issue final calculations/evaluations</li> </ul>	July 18, 2008
Pump Seal Wear Evaluations	July 31, 2008
System Performance Evaluations	July 31, 2008
Strainer chemical effects reduced scale testing and evaluation	
<ul style="list-style-type: none"> <li>• Complete strainer chemical effects testing</li> </ul>	July 7, 2008

<ul style="list-style-type: none"> <li>• AECL issue Test Report</li> </ul>	July 31, 2008
<ul style="list-style-type: none"> <li>• Dominion review and comment</li> </ul>	August 15, 2008
<ul style="list-style-type: none"> <li>• AECL issue Final Strainer Test Report</li> </ul>	August 29, 2008
Determination of whether any hardware and/or procedural modifications are needed as a result of the completion of the chemical precipitate head loss testing	Sept. 15, 2008
Field Change to design change package (DCP) to implement chemical design documents	
<ul style="list-style-type: none"> <li>• Issue Field Change to strainer installation DCP for acceptance of chemical strainer testing</li> </ul>	Sept. 19, 2008
<ul style="list-style-type: none"> <li>• Facility Safety Review Committee approval of design and licensing basis changes</li> </ul>	Sept. 30, 2008
License amendment request (LAR) to delete RS subsystems minimum recirculation flow value from the Surry Technical Specifications Section 5.2.C	
<ul style="list-style-type: none"> <li>• NRC approve LAR submitted April 2, 2008 (Serial No. 08-0168) to delete RS flow design value that is being revised to provide additional pump margin</li> </ul>	Sept. 30, 2008

Based on the above discussion, Surry Units 1 and 2 meet the requirements of SECY-06-0078 Criterion 1.

#### 4.2 SECY-06-0078 Criterion No. 2:

*The licensee identifies mitigative measures to be put in place prior to December 31, 2007, and adequately describes how these mitigative measures will minimize the risk of degraded ECCS [emergency core cooling system] functions during the extension period.*

## Dominion Response

To date, the following mitigative measures have been implemented to minimize the risk of degraded ECCS and RS system functions during the requested extension period. Although SECY-06-0078 Criterion No. 2 specifically mentions a completion date of December 31, 2007, Dominion was previously granted an extension until May 31, 2008 to complete GL 2004-02 corrective actions (reference NRC letter dated December 13, 2007). The following mitigative measures pertain to the current request for extension to September 30, 2008:

### **4.2.1 Mitigative Measures**

Dominion is fully committed to resolving the issues associated with GSI-191 and is continuing efforts to complete the corrective actions as detailed in the February 29, 2008 supplemental response to GL 2004-02. Dominion has implemented the physical modifications identified below at Surry Units 1 and 2. Refer to the Surry Units 1 and 2 supplemental response for greater detail on the information provided below.

#### 1. Physical Modifications

As discussed in the February 29, 2008 supplemental response to GL 2004-02, Dominion completed the installation of replacement strainer systems in Unit 1 and is currently completing the Unit 2 strainer installation during the ongoing spring 2008 refueling outage.

Dominion has repaired, jacketed, or removed damaged or unqualified insulation and insulation jacketing in Surry Unit 1 containment, and is currently performing the same modifications in the Surry Unit 2 containment during the ongoing refueling outage, as required to reduce the calculated quantities of fiber that could reach the containment sumps and achieve the specified strainer head loss and help reduce component wear.

Dominion has modified the Surry Units 1 and 2 Refueling Water Storage Tanks (RWSTs) level instrumentation to ensure sufficient water is available to meet RS and LHSI strainer submergence requirements.

A 12-inch hole was core bored in the primary shield wall plug for both Surry Units 1 and 2 to allow reactor cavity water to drain from the in-core sump (ICS) room into the containment sump. This facilitates transfer of additional water to the containment sump to ensure full submergence of the new containment sump strainers.

2. Containment Cleanliness

Dominion has procedures in place to ensure containment cleanliness as documented in the response to NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors."

3. Procedural Guidance, Training, and Actions

Operators are trained and have guidance for monitoring ECCS pump parameters including loss of NPSH as indicated by erratic pump current or discharge flow.

4. Information Notice 2005-26

On September 16, 2005, the NRC issued Information Notice (IN) 2005-26, "Results of Chemical Effects Head Loss Tests in a Simulated PWR Sump Pool Environment." IN 2005-26 applies to plants with calcium silicate insulation and trisodium phosphate as a buffer. Neither Surry unit was listed in this document as units having the above-described combination in its containment; therefore, no response to IN 2005-26 was required for Surry Unit 1 or 2.

5. Risk Evaluation

With the installation of the new containment sump strainers and other associated changes and evaluations, there has been a significant reduction in the vulnerability to debris blockage and component wear in the recirculation system when mitigating a LOCA. For the remaining outstanding issue of chemical effects, the vulnerability is limited to large break LOCAs only. For small and intermediate break LOCAs, it is expected that there will be a significant reduction in debris generation, as much as one to two orders of magnitude. With this type of reduction in the fibrous and particulate sources, core cooling will be assured for small and intermediate break LOCAs. Since the new strainers were designed to handle a conservatively estimated quantity of the fibrous and particulate debris loading from a large break LOCA, it is expected that for particulate debris loadings that are an order of magnitude or more lower, there will be insufficient particulate to form a thin-bed on the replacement strainers, and there will potentially be open strainer area. Thus, it is likely that any chemical precipitates that are generated will not create a head loss larger than the tested thin-bed head loss, for which the strainer was designed, and adequate NPSH will be maintained. Furthermore, with an order of magnitude or more reduction in the particulate debris, the particulate debris concentration should be low enough such that wear of downstream components would be limited to the point that there is reasonable assurance that the ECCS pumps and downstream components would continue to provide adequate core cooling. Thus, the quantitative risk evaluation addresses potential vulnerability for large break LOCAs only. The probability of this initiating event is low ( $5.0E-6$  for one year or  $3.75E-6$  for nine months) and the probability of a large, early release is negligible.

Dominion's previous extension request dated November 15, 2007, provided a risk evaluation for an eleven month extension. The NRC replied in their response letter dated December 13, 2007, with a summary paragraph associated with the risk evaluation:

"Dominion provided a risk evaluation for Surry 1 and Surry 2, which compared the increase in Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) from a large-break LOCA to total plant CDF and LERF risk values and showed that these values could be categorized as "small" in accordance with the criteria stated in Regulatory Guide 1.174, 'An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis.'"

Dominion's current request for extension is for nine months, which is enveloped by the eleven month risk assessment referenced above.

#### 6. Safety Features and Margins in Current Configuration/Design Basis

Dominion has NRC approval to invoke the leak-before-break (LBB) methodology to eliminate the dynamic effects (pipe whip and jet impingement) of postulated primary coolant piping ruptures from the design basis of the plant.

For Surry Units 1 and 2, the licensing basis includes approved LBB analysis for the RCS primary loop, the pressurizer surge line, and portions of the Feedwater and Main Steam lines.

The approval was based on the conclusion that the probability of a pipe failure before noticeable leakage could be detected and the plant brought to a safe shutdown condition is small. While leak-before-break is not being used to establish the design basis debris load on the sump strainers, it does provide additional basis for safe continued operation until the completion of the GL 2004-02 corrective actions.

#### 7. Bench-Top Testing & Chemical Evaluations

Bench-top testing has been completed, which provides empirical chemistry data that are specific to Surry. This data (currently in Dominion review) establishes what conditions are required for Surry's expected containment sump chemical mix to either remain in solution or form precipitates. Dominion's subsequent chemical evaluations, based on these bench-top results, have concluded that Surry's chemicals are expected to remain in solution, thus supporting the position that chemical effects are not expected to increase the sump strainer face head loss.

Based on the above discussion, Surry Units 1 and 2 meet the requirements of SECY-06-0078 Criterion 2.

#### 4.3 SECY-06-0078 Criterion 3:

*For proposed extensions beyond several months, a licensee's request will more likely be accepted if the proposed mitigative measures include temporary physical improvements to the ECCS sump or materials inside containment to better ensure a high level of ECCS performance.*

##### Dominion Response

As noted above, Dominion has implemented or is currently implementing, the following permanent physical improvements to the containment sump to better ensure a high level of ECCS and RS sump performance.

- Strainer Installation

Dominion completed the installation of replacement strainer systems for Unit 1, and will complete Unit 2 during the current spring 2008 refueling outage. The total surface area of the new RS strainer systems is approximately 6220 ft<sup>2</sup> for Unit 1 and 6258 ft<sup>2</sup> for Unit 2, and the total surface area of the LHSI strainer is approximately 2180 ft<sup>2</sup> for Unit 1 and 2230 ft<sup>2</sup> for Unit 2. This replaces the previous screens, which had a total surface area of approximately 158 ft<sup>2</sup> for each strainer.

- RS Pump Start Time Change

The RWST instrumentation was modified on both Surry units to change the start signals for the RS pumps. This change will ensure sufficient water is available to meet strainer submergence requirements. A 120-second time delay was added for the start of the ORS pumps, minimizing the impact on the Emergency Diesel Generators, and allowing sufficient time for the IRS pumps to fill its piping and attain stable operation prior to the start of the ORS pumps.

- Insulation Removal or Jacketing/Repair at Surry

Containment insulation that was damaged or had unqualified jacketing was repaired, removed, or jacketed with a qualified jacketing system in Surry Unit 1, and the same modifications are currently being implemented in Surry Unit 2. This will further minimize the amount of spray and submergence generated debris at Surry.

- Incore Sump (ICS) Room Drain

An ICS room drain was installed in the primary shield wall plug on Surry Unit 2 during the fall 2006 RFO and on Unit 1 during the fall 2007 RFO. This modification allows water held up in the reactor cavity to drain to the containment sump from the ICS room, facilitating full submergence of the new containment sump strainers.



Based on the above discussion, Surry Units 1 and 2 meet the requirements of SECY-06-0078 Criterion 3.

## 5.0 Conclusion

An extension of the Surry Units 1 and 2 completion dates from May 31, 2008 to September 30, 2008 to complete the corrective actions required by GL 2004-02 is acceptable because:

- The initiating event and large, early release probabilities for Surry Units 1 and 2 associated with the nine month extension (from December 31, 2007) are 3.75E-6 and negligible, respectively. This risk impact is characterized as "small" per NRC Regulatory Guide 1.174.
- Dominion has completed considerable work to further promote a high level of ECCS and RS pump performance including replacement strainer installation on Surry Unit 1. Unit 2 strainer installation is being completed during the ongoing spring 2008 refueling outage.
- Dominion has implemented mitigative measures to minimize the risk of degraded ECCS and RS functions during the extension period.
- Dominion has completed numerous chemical bench-top tests, performed a Surry plant specific reduced scale test, and performed downstream and chemical effects evaluations in accordance with the applicable WCAP requirements that provide reasonable assurance that:
  - NPSH margin will be maintained in the event of a LOCA,
  - Downstream wear effects are acceptable, and
  - Sufficient core cooling will be maintained.
- Dominion has a plant-specific plan with milestones and schedules to address the outstanding technical issues with sufficient conservatism to address uncertainties.

Therefore, per the criteria included in SECY-06-0078, Dominion has established that the risk of degraded ECCS and RS functions for both Surry Units 1 and 2 is not considered significant.