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Dominion®

January 15, 2014

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

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|---|---|
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| NSSL/MLC | R0 |
| Docket No. | 50-423 |
| License No. | NPF-49 |

**DOMINION NUCLEAR CONNECTICUT, INC.**
**MILLSTONE POWER STATION UNIT 3**
**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUEST FOR CHANGES TO TECHNICAL SPECIFICATION 3/4.7.5, "ULTIMATE HEAT SINK"**

By letter dated May 3, 2013, Dominion Nuclear Connecticut, Inc. (DNC) submitted a license amendment request (LAR) for Millstone Power Station Unit 3 (MPS3). The proposed amendment would modify Technical Specification (TS) 3/4.7.5, "Ultimate Heat Sink," to increase the current ultimate heat sink (UHS) water temperature limit from 75°F to 80°F and change the TS Action to state, "With the ultimate heat sink water temperature greater than 80°F, be in HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours."

In a letter dated June 26, 2013, the Nuclear Regulatory Commission (NRC) provided DNC an opportunity to supplement the LAR identified above. Supplemental information was provided to the NRC in a letter dated July 2, 2013. In an e-mail dated September 5, 2013, the NRC transmitted a request for additional information (RAI) related to the LAR. DNC responded to the RAI in a letter dated October 2, 2013. In a letter dated December 19, 2013, the NRC transmitted a second RAI. Attachment 1 to this letter contains DNC's response to the second RAI.

If you have any questions or require additional information, please contact Wanda Craft at (804) 273-4687.

Sincerely,

Mark D. Sartain
Vice President – Nuclear Engineering and Development

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

COMMONWEALTH OF VIRGINIA )
)
COUNTY OF HENRICO )

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mark D. Sartain, who is Vice President - Nuclear Engineering and Development of Dominion Nuclear Connecticut, Inc. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 15TH day of January, 2014.

My Commission Expires: May 31, 2014.

Vicki L. Hull
Notary Public

ADD1
NRR

Commitments made in this letter: None

Attachment:

1. Response to Request for Additional Information Regarding License Amendment Request for Changes to Technical Specifications 3/4.7.5, "Ultimate Heat Sink"

cc: U.S. Nuclear Regulatory Commission
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# Attachment 1

## Response to Request for Additional Information Regarding License Amendment Request for Changes to Technical Specifications 3/4.7.5, "Ultimate Heat Sink"

**Dominion Nuclear Connecticut, Inc.**
**Millstone Power Station Unit 3**

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**DNC introduction to responses**

A number of the RAIs were concerned with apparent discrepancies between vendor supplied data and results of MPS3 calculations. Heat exchanger vendor data is based on a given set of conditions, typically taken from the purchase order specifications. When scenario-specific conditions are different than the design inputs used by the vendor, then, different heat transfer rates, different flow rates, different outlet temperatures, etc. are likely to result between component design point and scenario-specific calculations. The conditions specified by the vendor, which may vary, include the fluids involved (typically fresh water or seawater, which have different thermal properties), flow rates, the inlet temperatures of each fluid, the outlet temperatures of each fluid, the heat transfer rate, and the fouling factors. If one or more of these conditions differ, calculated values are affected. Some conditions, such as tube number and dimensions and tube material, do not change. The responses to the individual RAIs highlight the most relevant differences between the conditions assumed by the vendor and the conditions expected in the field for the various analyzed events.

**RAI-1**

*Vendor data sheet [Figure 6 of Millstone Power Station, Unit 3 (MPS3) letter dated July 2, 2013] for recirculation spray heat exchangers (3RSS*E1A, E1B, E1C, E1D) specifies approximate service water flow of 6500 GPM at 75°F for a heat load of 184,534,533 BTU/Hr. But Table 5.2 of MPS3 letter dated May 3, 2013 lists a minimum flow of 5400 GPM at 80°F.*

a.) *Explain why the licensee's minimum required flow is significantly less than the vendor sheet specified flow for the same heat removal duty.*

*b.) Explain why the flow rates specified in Table 5.2 for the recirculation spray heat exchangers (3RSS*E1A, E1B, E1C, E1D) are identical for both the 75°F and 80°F analyses of record.*

**DNC Response**

a) The heat removal capability is a function of several parameters, such as flow rate and fluid temperature. The MPS3 containment analysis was performed using a fixed heat removal rate which determined the resulting sump temperature over time. From the containment analysis, the resulting calculated peak sump temperature (corresponding to the peak heat removal rate) is 220.6°F. The sump temperature specified on the vendor data sheet is 201.5°F. Since the analyzed peak sump temperature is higher than the vendor specified sump temperature, the service water flow rate can be lower than the vendor specified flow rate and produce the same heat removal capability.

b) The flow rates specified in Table 5.2 for the RSS heat exchangers are identical for both the 75°F and 80°F analyses of record since a service water temperature of 80°F was used for the RSS heat exchangers for both analyses. Therefore, there was no change to the minimum required flow.

**RAI-2**

*Table 5.2 of the MPS3 letter dated May 3, 2013 lists calculated minimum available flow for all the safety related heat exchangers cooled by Service Water (SW). In order to provide validity to the proposed increase in SW temperature to 80°F, calculated flow rates from the SW model should match actual flow rates as determined by measurement in the field.*

*a.) Describe the accuracy of calculated SW flow values provided in Table 5.2 as compared to field measured testing of flow rates and provide justification that the calculated flow rates are valid.*

*b.) Provide assurance that calculated flow rates are accurate for the various SW lineups including the "DBA COINCIDENT WITH LOSS OF OFFSITE POWER" and "LOSS OF POWER WITH TRAIN FAILURE" lineups as specified in Table 9.2-2 of the Final Safety Analysis Report (FSAR) by comparing calculated values to measured values in the field.*

**DNC Response**

a) To assess the accuracy of the flow model, model runs were performed to match system alignments for which measured flow test data was available. The model was adjusted to make the calculated flow results more closely match the measured data. Adjustments were made to each of the test cases to obtain the minimum flow value (including instrument uncertainty). This ensured the calculated flow result was biased to the lowest possible value with a minimum predicted flow for each service water cooled component. For each cooled component, the minimum flow error between the measured flow and the calculated flow is effectively zero (the measured flow is higher than the calculated flow for each of the components in each of the test cases). The maximum flow differential between the measured flow and the calculated flow varies from 3-20%. As confirmed, the calculated flows from the model are lower than the actual delivered flows, and thus are conservative and valid for demonstrating that the required flows are obtained. It is noted that the measured values were obtained during flow testing performed in 1995. Modifications to the system since then have been very minor and are considered to have an insignificant effect on the system flow balance.

b) Calculated flows are listed in Table 1 below for the design basis accident (DBA) Coincident with Loss of Power and Loss of Power with Train Failure cases from FSAR Table 9.2-2. Flows for each of these cases have not been measured, however, based on model benchmarking described in part a) above, the calculated flows exceed the required flows for the analyzed service water lineups.

**RAI-3**

*MPS3 letter dated May 3, 2013, paragraphs 5.3.2.4 and 5.3.2.5, for the Residual Heat Removal Pump Ventilation Units and the Containment Recirculation Pump Cubicle Ventilation Units, respectively, and Table 5.2 list identical required minimum flow rates for 75°F and 80°F SW temperatures. The stated reason is the limit was based on "downstream piping analysis temperature limitation. Re-evaluation of the piping system at an increased outlet temperature has increased this limitation such that the required flow is unchanged from the 75°F Analysis of Record."*

*Explain the downstream temperature limitation and how this limitation was increased for the 80°F analysis.*

**DNC Response**

When service water flow is maintained at a constant rate for the subject ventilation units, the discharge temperature increases for a commensurate increase in service water inlet temperature. In the subject cases (i.e., for 3HVQ*ACUS1A/B and 3HVQ*ACUS2A/B), the pipe stress and support analyses were based on a discharge service water temperature of 110°F for a corresponding service water inlet temperature of 75°F. The pipe stress and pipe support analyses were re-evaluated and were determined to be acceptable for a discharge service water temperature of 115°F for a corresponding service water inlet temperature of 80°F. Adequate heat removal was maintained for the flow and temperature condition (i.e., service water inlet temperature of 80°F) specified in the May 3, 2013 MPS3 letter.

**RAI-4**

*Tables in the MPS3 letter dated July 2, 2013, for ESF Air Conditioning Unit Heat Exchangers 3HVQ*ACUS1A, 1B, 2A and 2B list Figure 4 as the vendor data sheet. The vendor data sheet shows a SW flow rate of approximately 65 GPM at 80°F for a heat load of 510,000 BTU/hr. The tables in the July 2 letter list design heat loads of 360,600 BTU/hr and 396,400 BTU/hr with required minimum SW flow rates of 25 GPM and 33.2 GPM respectively, for these heat exchangers. Using a linear heat transfer relationship on the water side of the heat exchangers, the listed flow rates of 25 GPM and 33.2 GPM are much lower than flow rates needed for transfer of 360,600 BTU/hr and 396,400 BTU/hr, since 65 GPM at 80°F is needed to absorb 510,00 BTU/hr.*

*Please explain the seeming inconsistency.*

**DNC Response**

The above statement is true, if the differential temperature ($\Delta T$) across the heat exchanger is not allowed to change. However, since the rate of heat transfer for the subject Air Conditioning Unit (ACU) heat exchangers is proportional to the service water flow rate and the $\Delta T$ of the service water, and the $\Delta T$ across the heat exchanger has been allowed to increase, the results provided are considered to be reasonable. Please see the simplified derivation provided below in support of this response:

The data sheet value of 510,000 Btu/hr is based on a fresh water flow rate of 65 gpm and a $\Delta T$ of 15.7°F (95.7-80°F). Equivalent values based on the properties of salt water were determined to be 63.6 gpm and 16.37°F $\Delta T$.

The ACUS1 units were analyzed based on an 80°F service water flow rate of 24.97 gpm at a service water $\Delta T$ of 29.5°F. The resultant rate of heat transfer can be estimated as follows:

(24.97 gpm * 29.5°F)/(63.6 gpm * 16.37°F) = 0.7075 * 510,000 ≈ 360,600 Btu/hr.

The ACUS2 units were analyzed based on an 80°F service water flow rate of 33.15 gpm at a service water $\Delta T$ of 24.42 °F. The resultant rate of heat transfer can be estimated as follows:

(33.15 gpm * 24.42°F)/(63.6 gpm * 16.37°F) = 0.7775 * 510,000 ≈ 396,400 Btu/hr.

These results are consistent with the values previously provided in the July 2, 2013 submittal.

**RAI-5**

*Vendor data sheet (Figures 2(a) and 2(b) of MPS3 letter dated July 2, 2013) for the emergency diesel generator heat exchangers (3EGS*E1A, E1B, E2A, E2B) specify SW* *flow of 1900 GPM at 80°F. But Table 5.2 of MPS letter dated May 3, 2013 lists a minimum flow of 1444 GPM at 80°F.*

*Explain and justify why the licensee's minimum required SW flow is significantly less than the vendor sheet specified flow for similar heat load removal duty.*

**DNC Response**

The vendor used a fouling factor of 0.0015 hr-ft2-°F/Btu. Heat exchanger thermal performance testing demonstrated that a more appropriate fouling factor is 0.000959 hr-ft2-°F/Btu. When using a more accurate (lower) fouling factor, the required service water flow rate is lower.

**RAI-6**

*Paragraph 5.3.2.8 titled "EDG Heat Exchangers (3EGS*E1A/B and 3EGS*E2A/B)," states that the analysis of record was performed using an overly conservative heat load assumption and that when the calculation was revised for an Ultimate Heat Sink (UHS) temperature of 80°F using the design basis heat load, the minimum required flow rate did not change from the calculation performed at 75°F.*

*Describe the aforementioned overly conservative heat load assumption and justify the assumption(s) used in its place.*

**DNC Response**

The "overly conservative heat load assumption" referred to in Paragraph 5.3.2.8 is the fouling factor of 0.0015 hr-ft2-°F/Btu used by the vendor and discussed in RAI-5 above. Heat exchanger thermal performance testing demonstrated that a more appropriate fouling factor is 0.000959 hr-ft2-°F/Btu. When using a more accurate (lower) fouling factor, the required service water flow rate is lower.

**RAI-7**

*The list of regulatory commitments in Attachment 4 of the May 3, 2013 letter list calculations/analysis [Commitment numbers 4, 7, 8, 9, 10, 11, and 13] that the licensee plans to complete upon implementation of the NRC approved License Amendment Request (LAR).*

*The NRC cannot approve an LAR unless all pertinent safety related calculations/analysis are complete in accordance with the licensee's approved quality assurance program that meets the requirements of 10 CFR 50 Appendix B.*

*The licensee is requested to complete all calculations/analysis associated with the commitments listed above and report the status of completion of those items and any effect of the completed calculations/analysis on the LAR to the NRC before NRC staff approval of the LAR.*

**DNC Response**

The calculations required to prove the viability of the existing equipment to perform adequately with 80°F service water temperature were completed prior to the May 3, 2013 submittal. Remaining work was updating documentation associated with administrative changes only, which has been completed since the May 3, 2013 submittal.

**RAI-8**

*The vendor data sheet for the Reactor Plant Closed Cooling Water (RPCCW) heat exchangers (Figure 1 of the July 2, 2013 letter) show that the heat exchanger's capability is 76 E+6 BTU/hr with a SW flow rate of 4,000,000 lb/hr (8000GPM) at 75°F. This does not apparently correlate with the information provided in Enclosure 2 page 1 of the July 2, 2013 letter which shows a design heat load of 117.8 E+6 Btu/hr. Neither data sheet correlate with the heat transfer requirements listed in Table 9.2-2 of the FSAR.*

*The licensee is requested to explain the seeming lack of agreement in the above listed documents and justify the proposed UHS/SW temperature limit of 80°F for the RPCCW heat exchangers.*

**DNC Response**

RPCCW heat removal capability depends on the system alignment under consideration. The most limiting alignment is safety grade cold shutdown (SGCS). Heat removal capability is a function of RPCCW temperature limitations, time to cold shutdown requirements, flow rates on both the shell side and tube side, and time (due to decreasing decay heat). For the limiting SGCS alignment, RPCCW and Residual Heat Removal systems are analyzed together in discrete time steps. The parameters of interest, including heat removal rate, are interdependent and are solved iteratively. The analysis uses a fixed heat exchanger proportionality constant (UA) and a fixed service water flow rate. The peak heat transfer rate occurs when the RPCCW inlet temperature to the heat exchanger is 142.4°F. The vendor data sheet documents performance at a single discrete set of conditions, among which is the RPCCW inlet temperature to the heat exchanger of 113.8°F. The higher RPCCW temperature in the MPS3 analysis drives a greater heat removal capability than shown on the vendor data sheet. Please also see Attachment 1 to the July 2, 2013 submittal for a discussion of this issue.

The FSAR will be updated upon implementation of the License Amendment.

**RAI-9**

*Table 5.2 of the MPS3 letter dated May 3, 2013 lists similar minimum SW flow requirements at 75°F and 80°F for the control building air conditioning water chillers (3HVK*CHL1A/B) with no justification given for why the required flow has not increased for 80°F.*

*Provide justification as to why the required SW flow at 80°F has not increased when compared to the required flow for 75°F.*

**DNC Response**

The service water flow at 80°F is not increased because the air conditioner condenser pressure is allowed to rise. The normal operating range limit (maximum allowable condensing pressure) of the Control Building Air Conditioning Water Chillers is 161 psig (175.7 psia) and the refrigerant is R-12. The condensing temperature of 3HVK*CHL1A/B is 107.60°F, corresponding to a saturation pressure of 146.1 psia. Because the maximum allowable condensing pressure is greater than the saturation pressure, the Control Building Air Conditioning Water Chillers, 3HVK*CHL1A/B, will continue to perform as required. The Control Building air conditioning water temperatures will be unaffected.

**Table 1: Calculated Flows for Service Water Lineups in FSAR Table 9.2-2**

| Component | Normal Operation Conditions (flow in gpm) | Normal Unit Cooldown Conditions(1) (flow in gpm) | DBA Coincident with Loss of Power | | Loss of Power with Train Failure | |
|---|---|---|---|---|---|---|
| | | | Minimum ESF (flow in gpm) | Normal ESF (flow in gpm) | Hot Standby and Cooldown to RHS Entry Conditions (flow in gpm) | Cooldown to Cold Shutdown Conditions (flow in gpm) |
| **Reactor plant component cooling water heat exchangers (total 3)** | 3CCP*E1A: 7990<br>3CCP*E1B: 7753<br>3CCP*E1C: not calculated | 3CCP*E1A: 7623<br>3CCP*E1B: 7646<br>3CCP*E1C: 7411 | Heat exchangers isolated | Heat exchangers isolated | 3CCP*E1A: 7623<br>3CCP*E1B: 7646<br>3CCP*E1C: 7411 | 3CCP*E1A: 7623<br>3CCP*E1B: 7646<br>3CCP*E1C: 7411 |
| **Turbine plant component cooling water heat exchangers (total 3)** | 3CCS-E1A: 4937<br>3CCS-E1B: 4924<br>3CCS-E1C: 4932 | Heat exchangers isolated | Heat exchangers isolated | Heat exchangers isolated | Heat exchangers isolated | Heat exchangers isolated |
| **Containment recirculation coolers (total 4)** | Heat exchangers isolated | Heat exchangers isolated | 3RSS*E1A: 5493<br>3RSS*E1C: 5479 | 3RSS*E1A: 5493<br>3RSS*E1B: 5753<br>3RSS*E1C: 5479<br>3RSS*E1D: 5641 | Heat exchangers isolated | Heat exchangers isolated |
| **Control building air-conditioning water chillers (total 2)** | 3HVK*CHL1A: 444<br>3HVK*CHL1B: 452 | 3HVK*CHL1A: 418<br>3HVK*CHL1B: 438 | 3HVK*CHL1A: 366 | 3HVK*CHL1A: 366<br>3HVK*CHL1B: 386 | 3HVK*CHL1A: 413<br>3HVK*CHL1B: 436 | 3HVK*CHL1A: 413<br>3HVK*CHL1B: 436 |
| **Containment recirculation pump ventilation units (total 2)** | Heat exchangers isolated | Heat exchangers isolated | 3HVQ*ACUS2A: 41 | 3HVQ*ACUS2A: 41<br>3HVQ*ACUS2B: 44 | Heat exchangers isolated | Heat exchangers isolated |
| **Residual heat removal pump ventilation units (total 2)** | Heat exchangers isolated | 3HVQ*ACUS1A: 60<br>3HVQ*ACUS1B: 52 | 3HVQ*ACUS1A: 34 | 3HVQ*ACUS1A: 34<br>3HVQ*ACUS1B: 31 | Heat exchangers isolated | 3HVQ*ACUS1A: 60<br>3HVQ*ACUS1B: 52 |
| **Charging pump coolers (total 2)** | 3CCE*E1A: 51<br>3CCE*E1B: 55 | 3CCE*E1A: 50<br>3CCE*E1B: 56 | 3CCE*E1A: 62 | 3CCE*E1A: 62<br>3CCE*E1B: 67 | 3CCE*E1A: 49<br>3CCE*E1B: 55 | 3CCE*E1A: 49<br>3CCE*E1B: 55 |
| **Safety injection pump coolers (total 2)** | 3CCI*E1A: 50<br>3CCI*E1B: 58 | 3CCI*E1A: 47<br>3CCI*E1B: 57 | 3CCI*E1A: 26 | 3CCI*E1A: 26<br>3CCI*E1B: 34 | 3CCI*E1A: 46<br>3CCI*E1B: 57 | 3CCI*E1A: 46<br>3CCI*E1B: 57 |
| **EDG engine coolers (total 2)** | Heat exchangers isolated | 3EGS*E1A/E2A: 2092<br>3EGS*E1B/E2B: 2125 | 3EGS*E1A/E2A: 1851 | 3EGS*E1A/E2A: 1851<br>3EGS*E1B/E2B: 1880 | 3EGS*E1A/E2A: 2081<br>3EGS*E1B/E2B: 2117 | 3EGS*E1A/E2A: 2081<br>3EGS*E1B/E2B: 2117 |
| **Motor control center and rod control area ACUs (total 2)** | Service water not required<br>3HVR*ACU1A: 87<br>3HVR*ACU1B: 88 | 3HVR*ACU1A: 165<br>3HVR*ACU1B: 162 | 3HVR*ACU1A: 159 | 3HVR*ACU1A: 159<br>3HVR*ACU1B: 156 | 3HVR*ACU1A: 153<br>3HVR*ACU1B: 148 | 3HVR*ACU1A: 153<br>3HVR*ACU1B: 148 |
| **Post-accident liquid sample cooler (total 1)** | Heat exchanger isolated | Heat exchanger isolated | 3SSP-SCL3: 8 | 3SSP-SCL3: 8 | Heat exchanger isolated | Heat exchanger isolated |

(1) SGCS case is modeled instead of a normal cooldown. This case bounds the normal cooldown case.