Dominion Energy Kewaunee, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060

July 28, 2009

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Serial No.: 09-436
LR/DEA R3
Docket No.: 50-305
License No.: DPR-43

**DOMINION ENERGY KEWAUNEE, INC.**
**KEWAUNEE POWER STATION**
**RESPONSE TO FOLLOW-UP QUESTION REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES (SAMA)**

By letter dated June 1, 2009 (reference 1), Dominion Energy Kewaunee (DEK) submitted responses to follow-up questions regarding the Severe Accident Mitigation Alternatives for Kewaunee Power Station (KPS). These questions were related to DEK's license renewal application for KPS (reference 2). As documented by letter dated July 8, 2009 (reference 3), a teleconference between the NRC and DEK was conducted on June 30, 2009, to discuss an additional NRC question regarding mitigating the consequences of a steam generator tube rupture (SGTR) through the use of a "gagging device" to close a stuck-open steam generator (SG) safety valve.

As a result of the teleconference, DEK agreed to supplement the June 1, 2009 response regarding mitigation of the consequences of a steam generator tube rupture through the use of a "gagging device" to close a stuck open SG safety valve. The attachment to this letter provides this supplemental response.

Should you have any questions regarding this submittal, please contact Mr. Paul C. Aitken at (804) 273-2818.

Very truly yours,

J. Alan Price
Vice President – Nuclear Engineering

GINGER L. ALLIGOOD
Notary Public
Commonwealth of Virginia
310847
My Commission Expires Apr 30, 2013

COMMONWEALTH OF VIRGINIA )
)
COUNTY OF HENRICO )

The foregoing document was acknowledged before me, in and for the County and State aforesaid, today by J. Alan Price, who is Vice President – Nuclear Engineering of Dominion Energy Kewaunee, 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 28th day of July, 2009.

My Commission Expires: 4/30/13

Notary Public

References:

1. Letter from Leslie N. Hartz (DEK) to Document Control Desk (NRC), "Response to Follow-up Questions Regarding Severe Accident Mitigation Alternatives for Kewaunee Power Station," dated June 1, 2009. [ADAMS Accession No. ML091600037].
2. Letter from David A. Christian (DEK) to Document Control Desk (NRC), "Kewaunee Power Station Application for Renewed Operating License," dated August 12, 2008. [ADAMS Accession No. ML082341020]
3. Letter from Sarah Lopas (NRC) to Dominion Energy Kewaunee, Inc., "Summary of Conference Call with Dominion Energy Kewaunee, Inc., to Discuss Response to Follow-up Question Regarding Severe Accident Mitigation Alternatives Request for Additional Information for Kewaunee Power Station (TAC No. MD9409)," dated July 8, 2009. [ADAMS Accession No. ML091820565].

Attachment:

1. Response to Follow-up Question Regarding Severe Accident Mitigation Alternatives (SAMA)

Commitments made in this letter: None.

cc:

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# ATTACHMENT 1

# RESPONSE TO FOLLOW-UP QUESTION REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES (SAMA)

KEWAUNEE POWER STATION
DOMINION ENERGY KEWAUNEE, INC.

## Background

By letter dated January 8, 2009, the NRC requested additional information regarding the license renewal application (LRA) for Kewaunee Power Station (KPS). Dominion Energy Kewaunee (DEK) submitted responses to these requests for additional information (RAIs) regarding the Severe Accident Mitigation Alternatives (SAMA) for KPS by letter dated March 9, 2009. As documented by letter dated April 22, 2009, a teleconference between the NRC and DEK was conducted on April 15, 2009, to discuss follow-up questions concerning the SAMA RAI responses provided by letter dated March 9, 2009. DEK submitted the responses to the follow-up questions by letter dated June 1, 2009.

On June 30, 2009, another teleconference was held between the NRC and DEK to discuss one additional question regarding the response provided in the June 1, 2009 letter for a SAMA. This additional question pertained to the installation and use of a gagging device to close a stuck-open steam generator safety valve (thus limiting a potential post-accident radiological release to the environment).

## Introduction

A steam generator safety valve gagging device could provide a potential benefit for PRA accident sequences for which initial RCS cooldown performed in accordance with emergency operating procedures (EOPs) is assumed not successful or when the faulted steam generator is assumed not isolated because a safety valve (SV) is stuck open during the initial phase of the accident. As indicated in the June 1, 2009 letter, the risk impact of a random SV opening during the initial phase of an accident was evaluated and the results showed only a negligible effect.

In the KPS PRA, induced steam generator tube rupture (SGTR) events (i.e., ruptures that occur after core damage) account for about 80 percent of SGTR-related Large Early Release Frequency (LERF). However, use of a SV gagging device to limit releases after an induced SG tube rupture would not be of practical benefit because radiation doses would likely be too high to allow operators safe access to the area.

The circumstances under which SV gagging could provide a benefit for KPS, and quantification of the cost/benefit, are detailed below.

## Valve Gagging Evaluation

If initial cooldown in accordance with the EOPs is not successful, the SGTR model used for the SAMA PRA analysis assumes that reactor coolant system (RCS) leakage through the ruptured steam generator (SG) tube causes an increase in level and pressure on the secondary side of the ruptured SG. The increase in SG level and pressure quickly causes an SV to open and pass liquid. For these sequences, the SAMA PRA analysis assumes that the opened SV fails to close (i.e., remains stuck-open).

If a SG tube ruptures, high pressure on the primary side of the SG tube (RCS side) causes flow to occur through the rupture and into the secondary side of the SG. This results in an increase in the pressure and level on the secondary side of the affected SG. Consequently, RCS temperature and pressure must be lowered before a gagging device could be used. Although a stuck-open SV would initially cause RCS temperature and pressure to decrease, closing the stuck-open SV with a gagging device would only stop RCS heat removal until RCS temperature rises, at a minimum, to the SG power operated relief valve (PORV) setpoint of 550 °F (corresponding to 1050 psig setpoint), unless additional actions are taken to lower and control RCS temperature and pressure.

If actions to lower and control RCS temperature are not taken, an increase in pressure and level in the ruptured SG occurs following gagging a stuck-open SV.

If a SG with a ruptured tube fails to isolate, the EOPs direct operators to cooldown and depressurize the RCS to cold shutdown conditions and establish RHR decay heat removal. Depressurizing the RCS and establishing RHR decay heat removal minimizes leakage from the RCS through the ruptured SG tube and into the environment through the stuck-open SV. Removal of decay heat using one or both SGs requires some pressure in the RCS to induce flow through the SG tubes and ensure heat transfer to the SG. With the RCS pressurized and a stuck-open SG SV, a continuous loss of coolant to the environment would occur.

The initial actions directed by the EOPs could result in a reduction of RCS temperature and pressure below the SG SV setpoint. In this case, a gagging device could be used to eliminate the need to promptly cool the RCS to cold shutdown. Gagging closed a stuck-open SV in conjunction with cooling and depressurizing the RCS below the SG SV setpoints would allow decay heat removal using the intact SG while preventing release of reactor coolant to the environment from the ruptured SG. When RCS temperature is less than 350 °F, decay heat removal using the intact SG would be redundant to closed loop cooling using the residual heat removal (RHR) system.

After a postulated SG tube rupture event, some cooling and depressurization of the RCS must be accomplished to allow installation and use of a gagging device on a stuck-open SG SV. However, given that operators would initiate cooldown as directed by the EOPs, it is expected that they would proceed to cold shutdown and initiate RHR heat removal as expeditiously as possible, regardless of whether a SG SV gagging device was installed. Based on the available Refueling Water Storage Tank (RWST) inventory, the analyses performed to support the SAMA PRA model for KPS shows that 14 hours are available to cooldown and establish RHR closed loop cooling. Consequently, installation and use of a SG SV gagging device would need to be accomplished within the same 14-hour time period as the cooldown directed by the EOPs.

The KPS SGTR PRA model event tree considers the availability of safety injection before considering the ability of secondary cooling or actions to depressurize the RCS and stop the primary to secondary side coolant loss. Success of safety injection for SGTR sequences evaluates equipment conservatively assuming a 24-hour mission time even though safety injection may only be needed for a few hours. Use of the 24-hour mission time bounds all potential uses of the safety injection system and simplifies fault tree modeling. Sequences involving any failure of the safety injection system within the 24-hour mission time are defined as LERF sequences.

Assuming successful initiation of safety injection, the KPS SGTR PRA model event tree next evaluates the availability of auxiliary feedwater (AFW) or main feedwater (MFW) to provide makeup water to the SG for 24-hours. The availability of these systems to provide secondary side heat removal is assessed before evaluating the ability to stop RCS leakage from the ruptured SG. Successful secondary side heat removal requires that AFW or MFW be available to the SG that is used for cooldown for a mission time of 24 hours. Sequences that involve any failure of AFW and MFW in the 24-hour mission time are defined as LERF sequences.

If safety injection and either AFW or MFW are successful, then operator action to depressurize the RCS and stop RCS leakage from the ruptured SG are evaluated. Successful cooldown in accordance with the EOPs is assumed to prevent lifting any SG SV and, therefore, precludes the need for a SV gagging device.

As discussed above, the KPS SGTR PRA model assumes that a failure to cooldown the RCS in accordance with EOPs results in overfilling the SG, lifting a SG SV, and a failure of the open SV to close (i.e., SV remains stuck-open). For these scenarios, installation and use of a gagging device would close the stuck-open SV and allow decay heat removal using either RHR closed loop cooling or cooling using the intact SG.

The KPS SAMA PRA model fault tree used to model a failure to cooldown the RCS after a SGTR event in accordance with the EOPs includes four basic fault tree failure branches.

1. Failure of operator to perform actions needed to recognize the event and then successfully complete actions needed to cooldown and depressurize the RCS and establish RHR closed loop cooling,
2. Failure of the steam valves (e.g., main condenser steam dump valves, atmospheric steam dump valves, and SG PORVs) needed for a forced cooldown using either steam generator,
3. Failure of the hardware needed to depressurize the RCS, and;
4. Failure of operator to establish RHR closed loop cooling.

To model use of a gagging device to close a stuck-open SV, the KPS SAMA PRA model fault tree failure branch that represents RHR closed loop cooling failures was deleted from the fault tree used for cooldown failures. Since the AFW and MFW systems are assumed to be available, as discussed above, eliminating the RHR closed loop cooling fault tree effectively creates a model which indicates that use of a gagging device ensures that decay heat removal will be successful. Therefore, no release to the environment will occur since decay heat removal is successful.

Utilizing this modeling results in a Source Term Category (STC) Frequency of 8.060E-5 with the following contributions from each STC:

| | |
|---|---|
| STC 1. | 1.499E-6 |
| STC 2. | 0.000E+0 |
| STC 3. | 0.000E+0 |
| STC 4. | 4.057E-5 |
| STC 5. | 1.971E-7 |
| STC 6. | 5.082E-9 |
| STC 7. | 2.731E-8 |
| STC 8. | 2.563E-5 |
| STC 9. | 0.000E+0 |
| STC 10. | 0.000E+0 |
| STC 11. | 1.217E-7 |
| STC 12. | 1.546E-7 |
| STC 13. | 9.266E-6 |
| STC 14. | 3.122E-6 |

The frequency of each STC above was multiplied by the associated conditional dose value from LRA Appendix E, Attachment F, Table F-15, to obtain the expected dose value for each STC. These expected dose values were then summed to obtain the total expected dose value of 29.86 person-REM per year that would result after implementation of the SAMA.

Similarly, the frequency of each STC above was multiplied by the associated conditional property damage value from LRA Appendix E, Attachment F, Table F-16, to obtain the expected property damage value for each STC. These expected property damage values were then summed to obtain the total expected damage value of $49,010 per year that would result after implementation of the SAMA.

The benefit of implementing this SAMA was then calculated as shown in LRA Appendix E, Attachment F, Section F.4, and the results are shown below along with the total averted costs.

**Results of Benefit Analysis**
**Implement SAMA to Use SG SV Gagging Device During SGTR Event**

| | |
|---|---|
| CDF After Enhancements | 8.060E-5 |
| Total Expected Offsite Property Damage $/year Offsite ($F_AP_{DA}$) | 49,010 |
| Total Expected Person-REM/year Offsite ($F_AD_{PA}$) | 29.86 |
| Averted Public Exposure (APE) | $7,057 |
| Averted Offsite Property Damage Costs (AOC) | $7,417 |
| Averted Immediate Occupational Exposure Costs ($W_{IO}$) | $21 |
| Averted Long-Term Occupational Exposure Costs ($W_{LTO}$) | $90 |
| Total Averted Occupational Exposure Costs (AOE) | $111 |
| Averted Cleanup and Decontamination Costs ($U_{CD}$) | $3,376 |
| Averted Replacement Power Costs ($U_{RP}$) | $1,402 |
| Averted Onsite Costs (AOSC) | $4,778 |
| Total Averted Costs (APE + AOC + AOE +AOSC) | $19,363 |
| Significant Costs Not Considered? (Yes/No) | Yes |
| Cost of Enhancement (COE) | $50,000 |
| NPV of benefit | (-)30,637 |

The present value of total averted costs for implementing this SAMA is $19,363. Since this SAMA only affects SGTR sequences, the benefit is not doubled.

In order to implement the new SAMA, changes to the EOPs would be required. As assumed in the SAMA analysis, the changes to the EOPs alone would cost a minimum of $50,000.

Additional costs not included would encompass the equipment needed to be staged in order to install the device, thermal-hydraulic analyses needed to support the procedure changes to use the device, and operator training to ensure correct usage of the equipment. However, since the cost of the procedure change alone is significantly greater than the potential benefit, more detailed costs estimates have not been performed.

As quantified above, the total averted costs of this SAMA are \$19,363. Implementation of this alternative would cost greater than \$50,000. Therefore, the present worth can be calculated as:

NPV ≤ \$19,363 – \$50,000.
NPV ≤ -\$30,637

Consequently, since the calculated present worth is negative, implementation of this SAMA would not be cost beneficial.