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Dominion

December 14, 2011

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

Serial No. NA3-11-033RA
Docket No. 52-017
COL/JBL

DOMINION VIRGINIA POWER
NORTH ANNA UNIT 3 COMBINED LICENSE APPLICATION
ESRP 7.3: RESPONSE TO ER RAI LETTER DATED MAY 23, 2011

On May 23, 2011, the NRC requested additional information to support the review of certain portions of the North Anna Unit 3 Combined License Application (COLA) Environmental Report. Complete responses to seven of the nine Request for Additional Information (RAI) questions were provided previously by Dominion letter NA3-11-033R dated August 10, 2011. The response to one of remaining two questions is provided in the Enclosure:

- RAI ACC-04 Postulated Accidents US-APWR SAMDA Cost Analysis

Please contact Tony Banks at (804) 273-2170 (tony.banks@dom.com) if you have questions.

Very truly yours,

Eugene S. Grecheck

Enclosure:

1. Response to ER RAI Letter Dated May 23, 2011, RAI ACC-04 Postulated Accidents

Commitments made by this letter:

1. None

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NRO

COMMONWEALTH OF VIRGINIA

COUNTY OF HENRICO

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Eugene S. Grecheck, who is Vice President-Nuclear Development of Virginia Electric and Power Company (Dominion Virginia Power). He has affirmed before me that he is duly authorized to execute and file the foregoing document on behalf of the Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 14th day of December, 2011
My registration number is 7173057 and my
Commission expires: August 31, 2012

Notary Public

WANDA K. MARSHALL
Notary Public
Commonwealth of Virginia
7173057
My Commission Expires Aug 31, 2012

cc: U. S. Nuclear Regulatory Commission, Region II
C. P. Patel, NRC
T. S. Dozier, NRC
G. J. Kolcum, NRC

ENCLOSURE

Response to NRC RAI Letter Dated May 23, 2011

RAI ACC-04

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI No.: ACC-04 (RAI Letter dated May 23, 2011)

ESRP SECTION: 7.3 – SEVERE ACCIDENT MITIGATION ALTERNATIVES

DATE OF RAI ISSUE: 05/23/2011

QUESTION NO.: ACC-04

The costs for SAMDA analysis should be adjusted to a common time frame for an appropriate cost comparison. Similarly, the cost of replacement power should be adjusted for the difference in capacity factor between the 60 to 65% capacity factor assumed in NUREG-BR-0184 and the anticipated capacity factor for the US-APWR. Therefore, the staff requests the following information:

> Provide a revised SAMDA analysis for a US APWR at the NAPS site. Adjust all costs to a common time frame to account for inflation using appropriate deflators and ensure that the replacement power costs appropriately accounts for the expected capacity factor for the US APWR. Provide the details of the SAMDA analysis, identifying all assumptions and input parameters.

Supporting Information

Both the ER submitted by MHI for the US-APWR design certification and Section 7.3 of the NAPS ER review include SAMDA analyses. Neither of the analyses appears to adjust costs to a common time frame for use in determining whether there are potentially cost-beneficial SAMDAs. Similarly, although both analyses adjust the cost of replacement power for the difference between the 910 MWe assumed in NUREG/BR-0184 and 1610 MWe for the US-APWR, neither analysis appears to adjust the cost of replacement power for the difference in capacity factor between the 60 to 65% capacity factor assumed in NUREG-BR-0184 and a more realistic capacity factor for the US-APWR (90 to 95%).

Dominion Response

The SAMA analyses in the US-APWR ER and the NAPS ER consider long-term replacement power costs using the formula from Section 5.7.6.2 of NUREG/BR-0184. This section of NUREG/BR-0184 does not indicate that the long-term formula assumes a 60-65% capacity factor. Section 5.7.7.1 provides a different formula for calculating short-term replacement power costs based on an assumed 60-65% capacity factor. This short-term formula is not used in SAMA analyses. Rather, the short-term formula is used in regulatory analysis to determine the cost of proposed regulatory requirements or backfits that would require modifications taking a plant out of service, and the assumed 60-65% capacity factor is conservative for this purpose. While Dominion has not validated the NRC's concern with the replacement power formula used in the SAMA analyses, Dominion has nevertheless included an adjustment to demonstrate that the results of the SAMA analyses would not be affected.

A new SAMDA analysis was performed for the US-APWR at the NAPS site to update several input assumptions, adjusted to a common time frame to account for inflation. For this analysis, the base risk is taken to be the sum of the six at-power release category (RC) frequency values and the two low-power and shutdown (LPSD) release category frequency values from Section 19.1 of the Design Control Document (DCD) for the US-APWR, Revision 2. (A sensitivity analysis was performed applicable to DCD, Revision 3, and results did not warrant changes in the NA3 S-COLA ER.)

For each at-power and LPSD RC, representative releases were determined and representative sequences from each RC analyzed to develop timing and release characteristic information for representative fission product groups. This information was then used to approximate the radiological release plumes used in the Level 3 analysis. Offsite consequences were calculated from a Level 3 Probabilistic Risk Assessment (PRA) analysis and updated meteorological data and site characteristic data. The meteorological data used represented the year 2008. Because the SECPOP2010 computer code is not yet available, site population data was updated using the SECPOP2000 computer code data that was extrapolated to 2010 census data using county-by-county information. This 2010 estimation was then extrapolated to the year 2030. Regional economic data was updated to 2007 values with data obtained from the U.S. Census Bureau and the U.S. Department of Agriculture 2007 Census of Agriculture for the 31 counties that are all, or in part, within 50 miles of the North Anna site. For each RC, the US-APWR Level 3 PRA provides values for the conditional offsite dose and conditional offsite property damage that would result given that a fission product release occurred with the associated plume characteristics and source term. The total expected dose consequence is obtained by multiplying the conditional offsite dose by the expected frequency for each RC, then summing the expected doses for all RCs. The conditional dose and expected dose for each RC along with the total expected dose are shown in Tables 1 through 4.

Similarly, the total expected property damage is obtained by multiplying the conditional property damage value by the frequency for each RC, then summing the expected property damage values for all RCs. The conditional property costs and expected property costs for each RC along with the total expected property costs are shown in Tables 5 through 8.

Unmitigated Risk Monetary Value

The unmitigated risk monetary value is calculated using the methodology given in NUREG/BR-0184 for the performance of cost-benefit analyses using the same methodology presented in the Unit 3 S-COLA Environmental Report (ER), Revision 3, Section 7.3.1. The value of unmitigated risk can be used to represent averted costs that could be achieved if all risk was eliminated for at-power events. Using the values for core damage frequency (CDF), offsite exposure, and offsite economic consequences presented in Tables 1 through 8, the maximum averted cost benefit was calculated to be $824,744.

This value can be viewed as the maximum risk benefit attainable if all core damage scenarios from internal events are eliminated over the 60-year license period (assuming a 40-year initial operating license and one 20-year license renewal) and any enhancements that cost more than this amount would not show a positive benefit if implemented.

Calculation of this value used several changes from the analyses originally presented in the ER, Revision 3, Section 7.3.1. First, as described above, offsite exposure and economic consequences were calculated using data that accounted for more recent site-specific data. Second, meteorological data updated for 2008 was used to evaluate offsite consequences. Development of the meteorological data is detailed in the response to RAI Question MET-02. Finally, the calculation of replacement power costs was revised to update two inputs. First, the equation for replacement power costs presented in NUREG/BR-0184was adjusted to account for the current value of money. Second, the equation for replacement power costs was adjusted to show that the capacity factor assumption suggested in RAI Question ACC-04 would not affect the outcome of the analyses. The two updates for replacement power costs were addressed as described below.

To address the difference between 1993 dollars and 2010 dollars, the replacement power costs were adjusted to a common time frame by applying a ratio of the national average Bureau of Labor Statistics Producer Price Index for Electric Power from the years 1993 and 2010. The Producer Price Index for Electric Power for 2010 is 184.4, and the Producer Price Index for Electric Power for 1993 is 128.6. The 2010 dollars scaling factor is calculated as 184.4/128.6, which equals 1.43.

To address the potential difference between average capacity factors of 60% to 65% assumed in RAI Question ACC-04 and the average capacity factor expected for new plants, which is approximately 95%, a simple multiplier was derived by dividing 95% by 60% to get a value of 1.58. The value of replacement power costs calculated using the equation given in Section 5.7.7.1 of NUREG/BR-0184 was increased by multiplying by each of the two factors given above to estimate the costs for Unit 3.

Evaluation of SAMDAs

The list of SAMDAs considered for the US-APWR reactor are listed in Table 12 of MUAP-DC021, Revision 2 (Reference). Of the SAMDAs considered, the least costly is number 10 (addition of a redundant containment spray system) which has a total cost estimated at $870,000. Since this cost is greater than the maximum averted cost benefit calculated above, it is concluded that none of the SAMDAs would show a benefit if implemented at a 7% discount rate.

Three-Percent Discount Rate Sensitivity Analysis

The parameters that influence the cost-benefit analyses of the SAMDA evaluations were examined to determine if a change in value for one of the parameters would change the conclusions of the evaluation. Equations for four types of averted costs described in NUREG/BR-0184 each contain a term for the real discount rate, which would have a direct impact on the calculated averted costs.

NUREG/BR-0184 recommends using a 7% discount rate for cost-benefit analyses and suggests that a 3% discount rate should be used for sensitivity analyses on the maximum benefit and the unscreened SAMDAs to indicate the sensitivity of the results to the choice of discount rate. The results of this sensitivity case are discussed below and were quantified using the same methodology presented in ER, Revision 3, but used the same changes to offsite consequences, meteorological data, and replacement power costs summarized above. The results of this sensitivity analysis show that the maximum averted cost benefit using a 3% discount rate is $1,126,633.

This maximum averted cost benefit of $1,126,633 is greater than the Cost of Enhancement (COE) for two SAMDAs (#4 and #10) listed in Table 12 of MUAP-DC021, Revision 2. Therefore, the benefits for these two SAMDAs were evaluated in more detail to determine if they would show a positive benefit if implemented at a 3% discount rate. These evaluations are summarized below.

SAMDA Benefit Evaluation - Three-Percent Discount Rate Sensitivity Analysis

The two SAMDAs that were estimated to have implementation costs less than the maximum averted cost benefit using a 3% discount rate were evaluated in more detail to determine the potential benefits that could be achieved if implemented. [In evaluating benefits, the specific impact on risk for each of the RCs in each of the accident categories was obtained from MNES/MHI.]

SAMDA #4 – Provide an Additional High Pressure Injection Pump with Independent Diesel

The goal of this SAMDA is to provide a diverse means of high pressure injection that can be used when AC power is not available. This SAMDA would provide an additional pump powered by an independent diesel generator.

The at-power RC frequency values for SAMDA #4 are shown in Table 9. The CDF values for low-power and shutdown (LPSD) plant operating states are shown in Table 10.

The frequency of each at-power and LPSD RC is multiplied by the conditional dose from Tables 1 through 4 that is associated with each RC to obtain the expected dose for each RC.

Similarly, the frequency of each RC above is multiplied by the conditional property damage value from Tables 5 through 8 that is associated with each RC to obtain the expected property damage value for each RC.

The total averted cost for SAMDA #4 is $342,261. Since this potential benefit is much less than the implementation costs of $1,000,000 shown in Table 12 of MUAP-DC021 Revision 2, it is determined that implementation of this SAMDA would not show a net positive benefit.

SAMDA #10 – Install a Redundant Containment Spray System

This SAMDA would provide a redundant containment spray system.

The at-power RC frequency values for SAMDA #10 are shown in Table 11. The CDF values for LPSD plant operating states are shown in Table 12.

The frequency of each at-power and LPSD RC is multiplied by the conditional dose from Tables 1 through 4 that is associated with each RC to obtain the expected dose for each RC.

Similarly, the frequency of each RC above is multiplied by the conditional property damage value from Tables 5 through 8 that is associated with each RC to obtain the expected property damage value for each RC.

The total averted cost for SAMDA #10 is $212,923. Since this potential benefit is much less than the implementation costs of $870,000 shown in Table 12 of MUAP-DC021, Revision 2, it is determined that implementation of this SAMDA would not show a net positive benefit.

Conclusion

In summary, a revised SAMDA analysis was performed for a US-APWR at the NAPS site, adjusted to a common time frame to account for inflation. The revised analysis used more recent site-specific population and economic data as well as 2008 meteorological data. Development of this data was provided in Dominion's responses to RAI Questions MET-02 and ACC-02 (ML11224A116). In addition, replacement power costs were adjusted from 1993 dollars to 2010 dollars and by a further factor to address capacity factor concerns. The results of these analyses show that the maximum risk benefit attainable from eliminating all risk would be less than the implementation costs of the least-costly SAMDA. Using a 3% discount rate for a sensitivity analysis showed that the maximum averted cost benefit would be less than the implementation costs for all but two of the SAMDAs evaluated. For these two SAMDAs, specific benefits were evaluated and showed benefits much less than the implementation costs. Additionally, evaluation of administrative SAMAs would not be appropriate until the plant design is finalized, and plant processes and procedures are developed. At that time, appropriate administrative controls on plant operations would be incorporated into the plant's management systems. It is concluded, therefore, that no additional changes would show a net positive value.

Reference

Mitsubishi Heavy Industries, Ltd., "Applicant's Environmental Report – Standard Design Certification," MUAP–DC021, Revision 2, October 2009 (ML093130259)

Proposed COLA Revision

None

Table 1
Base Case - Offsite Exposure By Release Category - Internal Events

RC	Description	RC Frequency (per year)	Conditional Person-Sv Offsite	Conditional Person-REM Offsite	Expected Person-REM/yr Offsite
1	Containment Bypass	1.2E-08	8.68E+04	8.68E+06	1.04E-01
2	Containment Isolation Failure	3.4E-09	6.49E+04	6.49E+06	2.21E-02
3	Containment Failure Before Core Damage	2.4E-08	1.45E+05	1.45E+07	3.48E-01
4	Early Containment Failure	1.2E-08	4.73E+04	4.73E+06	5.68E-02
5	Late Containment Failure	4.7E-08	3.50E+04	3.50E+06	1.65E-01
6	Intact Containment	9.3E-07	1.04E+01	1.04E+03	9.67E-04
	Total	**1.0E-06**			**6.96E-01**

Table 2
Base Case - Offsite Exposure By Release Category - Internal Flooding Events

RC	Description	RC Frequency (per year)	Conditional Person-Sv Offsite	Conditional Person-REM Offsite	Expected Person-REM/yr Offsite
1	Containment Bypass	1.0E-08	7.83E+03	7.83E+05	7.83E-03
2	Containment Isolation Failure	3.3E-09	1.32E+04	1.32E+06	4.36E-03
3	Containment Failure Before Core Damage	2.0E-07	1.07E+05	1.07E+07	2.14E+00
4	Early Containment Failure	2.7E-08	7.08E+04	7.08E+06	1.91E-01
5	Late Containment Failure	4.0E-08	5.69E+03	5.69E+05	2.28E-02
6	Intact Containment	1.1E-06	1.49E+01	1.49E+03	1.64E-03
	Total	**1.4E-06**			**2.37E+00**

Table 3
Base Case - Offsite Exposure By Release Category - Fire Events

RC	Description	RC Frequency (per year)	Conditional Person-Sv Offsite	Conditional Person-REM Offsite	Expected Person-REM/yr Offsite
1	Containment Bypass	4.0E-08	7.83E+03	7.83E+05	3.13E-02
2	Containment Isolation Failure	1.0E-08	6.48E+04	6.48E+06	6.48E-02
3	Containment Failure Before Core Damage	5.0E-08	1.45E+05	1.45E+07	7.25E-01
4	Early Containment Failure	5.7E-08	7.08E+04	7.08E+06	4.04E-01
5	Late Containment Failure	6.9E-08	3.49E+04	3.49E+06	2.41E-01
6	Intact Containment	1.6E-06	1.49E+01	1.49E+03	2.38E-03
	Total	**1.8E-06**			**1.47E+00**

Table 4
Base Case - Offsite Exposure By Release Category - LPSD Events

Plant Operating State	CDF (per year)	Conditional Person-Sv Offsite	Conditional Person-REM Offsite	Expected Person-REM/yr Offsite
RCS Filled	5.6E-08	1.21E+03	1.21E+05	6.78E-03
Mid-Loop Operation	1.7E-07	4.63E+04	4.63E+06	7.87E-01
Total	**2.2E-07**			**7.94E-01**

Table 5
Base Case - Offsite Property Damage Costs By Release Category - Internal Events

RC	Description	RC Frequency (per year)	Conditional Property Costs ($)	Expected Property Costs ($/year)
1	Containment Bypass	1.2E-08	2.63E+10	3.16E+02
2	Containment Isolation Failure	3.4E-09	1.41E+10	4.79E+01
3	Containment Failure Before Core Damage	2.4E-08	4.24E+10	1.02E+03
4	Early Containment Failure	1.2E-08	1.25E+10	1.50E+02
5	Late Containment Failure	4.7E-08	5.24E+09	2.46E+02
6	Intact Containment	9.3E-07	1.03E+04	9.58E-03
	Total	**1.0E-06**		**1,780**

Table 6
Base Case - Offsite Property Damage Costs By Release Category - Internal Flooding Events

RC	Description	RC Frequency (per year)	Conditional Property Costs ($)	Expected Property Costs ($/year)
1	Containment Bypass	1.0E-08	7.04E+08	7.04E+00
2	Containment Isolation Failure	3.3E-09	2.92E+09	9.64E+00
3	Containment Failure Before Core Damage	2.0E-07	3.34E+10	6.68E+03
4	Early Containment Failure	2.7E-08	1.07E+10	2.89E+02
5	Late Containment Failure	4.0E-08	2.47E+08	9.88E+00
6	Intact Containment	1.1E-06	1.57E+04	1.73E-02
	Total	**1.4E-06**		**7,000**

Table 7
Base Case - Offsite Property Damage Costs By Release Category - Fire Events

RC	Description	RC Frequency (per year)	Conditional Property Costs ($)	Expected Property Costs ($/year)
1	Containment Bypass	4.0E-08	7.04E+08	2.82E+01
2	Containment Isolation Failure	1.0E-08	1.41E+10	1.41E+02
3	Containment Failure Before Core Damage	5.0E-08	4.24E+10	2.12E+03
4	Early Containment Failure	5.7E-08	1.07E+10	6.10E+02
5	Late Containment Failure	6.9E-08	5.25E+09	3.62E+02
6	Intact Containment	1.6E-06	1.57E+04	2.51E-02
	Total	**1.8E-06**		**3260**

Table 8
Base Case - Offsite Property Damage Costs By Release Category - LPSD Events

Plant Operating State	CDF (per year)	Conditional Property Costs ($)	Expected Property Costs ($/year)
RCS Filled	5.6E-08	3.07E+07	1.72
Mid-Loop Operation	1.7E-07	1.20E+10	2.04E+03
Total	**2.2E-07**		**2040**

Table 9
SAMDA #4 - Release Category Summary for At-Power Events

RC	Description	RC Frequency (per year)		
		Internal	Flood	Fire
1	Containment Bypass – Containment bypass which includes both core damage after SGTR and thermal induced SGTR after core damage	1.2E-08	1.0E-08	4.0E-08
2	Containment Isolation Failure	3.3E-09	3.3E-09	9.2E-09
3	Containment Failure Before Core Damage – This category is for an overpressure failure before core damage due to loss of heat removal.	2.5E-08	2.0E-07	3.6E-08
4	Early Containment Failure – This is containment failure condition due to dynamic loads which includes hydrogen combustion before or just after reactor vessel failure, in-vessel or ex-vessel steam explosion, rocket-mode RV failure and containment direct heating.	5.9E-09	2.7E-08	5.1E-08
5	Late Containment Failure – This failure of the containment includes overpressure failure after core damage, hydrogen combustion failure after core damage, hydrogen combustion long after reactor vessel failure and basemat melt-through.	1.5E-08	4.0E-08	1.3E-08
6	Intact Containment – This condition assumes an intact containment throughout the sequence and fission products are released at the design leak rate.	3.2E-07	1.1E-06	3.2E-07
	Total	**3.8E-07**	**1.4E-06**	**4.7E-07**

Table 10
SAMDA #4 - Release Category Summary for LPSD

Plant Operating State	CDF (per year)
RCS Filled	4.4E-08
Mid-Loop Operation	4.9E-08
Total	**9.3E-08**

Table 11
SAMDA #10 - Release Category Summary for At-Power Events

RC	Description	RC Frequency (per year)		
		Internal	Flood	Fire
1	Containment Bypass – Containment bypass which includes both core damage after SGTR and thermal induced SGTR after core damage	1.2E-08	1.0E-08	4.0E-08
2	Containment Isolation Failure	3.4E-09	3.3E-09	1.0E-08
3	Containment Failure before Core Damage – This category is for an overpressure failure before core damage due to loss of heat removal.	2.4E-08	8.0E-08	4.5E-08
4	Early containment failure – This is containment failure condition due to dynamic loads which includes hydrogen combustion before or just after reactor vessel failure, in-vessel or ex-vessel steam explosion, rocket-mode RV failure and containment direct heating.	1.2E-08	2.7E-08	5.7E-08
5	Late Containment Failure – This failure of the containment includes overpressure failure after core damage, hydrogen combustion failure after core damage, hydrogen combustion long after reactor vessel failure and basemat melt-through.	4.7E-08	4.0E-08	6.9E-08
6	Intact Containment – This condition assumes an intact containment throughout the sequence and fission products are released at the design leak rate.	9.3E-07	1.1E-06	1.6E-06
	Total	**1.0E-06**	**1.2E-06**	**1.8E-06**

Table 12
SAMDA #10 - Release Category Summary for LPSD

Plant Operating State	CDF (per year)
RCS Filled	5.6E-08
Mid-Loop Operation	1.7E-07
Total	**2.2E-07**