Attachment 2

Dominion Calculation PA-0243

Attachment 2 provides Dominion Calculation, PA-0243 and its addenda.

- PA-0243, Revision 0, "Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems," dated February 24, 2008.
- PA-0243, Revision 0, Addendum A, "Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems," dated June 1, 2011.
- PA-0243, Revision 0, Addendum B, "Impact on the ISFSI dose rates due to gaps between HSM-H modules," dated October 9, 2012.
- PA-0243, Revision 0, Addendum C, "Impact on the ISFSI dose rates of placing a TN-32 HBU Demonstration Cask on Pad 1," dated June 30, 2015.

Signatories of these calculations have been redacted from the calculations.

Attachment 2 of PA-0243, Revision 0, Addendum C has been redacted due to AREVA-TN proprietary information. This redacted attachment is Section 4.0 of the Design and Licensing Basis Document (DLBD), E-42038. This redacted information was previously provided to the NRC in Attachment 4 of the License Amendment Request (LAR), Dominion Letter, S/N 15-369 on August 24, 2015.

North Anna Power Station ISFSI

Virginia Electric and Power Company

Dominion™

Calculation Cover Sheet

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1.Type CALC	2. Sub	3. Station	4. Unit	5. Status	6. System Code(s)
	NFL	59	00	AC	N/A

7. Calculation Number	8. Rev.	9. Addendum
PA-0243	0	N/A

10. QA Cat ☐ SR ☒ NSQ ☐ NS

11. Critical Calculation ☐ Yes ☒ No

12. Calculation Title (Subject):
Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems

13. Key Words:
ISFSI, Dose, Rates

14. DMIS Cross Reference: Yes ☒ No ☐
(If "Yes" list cross references in the Calculation Reference section using the appropriate DMIS code, doc type, and sub)

15. Initiating Document:
N/A

16. Originator:	17. Discipline:
C. A. Ford	Nuclear Analysis and Fuel

18. Firm Name:	19. Vendor Code:
Dominion Resources Services	N/A

20. EDS Mark Number References:

Station	Unit	System	Prefix	Sequence	Component Code	Suffix
N/A	N/A	N/A	N/A	N/A	N/A	N/A

21. Purpose:
The objective of this calculation is to determine on-site and off-site annual radiation doses resulting from the normal operation of the North Anna ISFSI after installation of the NUHOMS dry fuel storage system.

22. Conclusion:
Dose rates were calculated for the ISFSI perimeter fence and the site boundary. The maximum perimeter fence dose rate (averaged over a length of fenceline) was calculated to be 1.1 mRem/hr. The site boundary dose rate was 4.2E-4 mRem/hr. This results in an annual dose at the site boundary of 3.7 mRem assuming a 100% occupancy or 0.9 mRem assuming a 40 hr/week occupancy. The site boundary dose rates and annual doses can be used as conservative estimates for the nearest permanent resident and nearest real individual.

23. Affected Calculation(s): None

24a. Prepared By:	24b. [redacted]	24c. Date 2-24-08
[redacted]		
25a. Reviewed By:	25b. [redacted]	25c. Date 2-25-08
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(June 2005)

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Attachments

A. Calculation Review Checklist (1 page)

B. Activity Checklist

1.0 OBJECTIVE

The objective of this calculation is to determine limiting on-site and off-site radiation dose rates resulting from the normal operation of the North Anna ISFSI after installation of the NUHOMS dry fuel storage system.

2.0 BACKGROUND

The North Anna ISFSI is used to store used nuclear fuel in dry storage containers on concrete pads. Calculation PA-0181, Revision 0 and PA-0181, Revision 0 Addendum A calculated the on-site and off-site radiation dose rates from three storage pads containing 84 TN-32 dry storage casks loaded with design basis fuel.

After loading one of three ISFSI pads with vertical, cylindrical TN-32 storage casks, Dominion now plans to load the second ISFSI pad with twelve NUHOMS horizontal storage modules (HSMs). Each concrete HSM will be used to store 32 used fuel assemblies in a thin-walled steel canister. This change in storage system to be used on the second pad results in the need to recalculate the design basis radiation dose rates at the ISFSI fence, the North Anna site boundary, and the locations of the limiting Real Individuals.

3.0 REFERENCES

1 PA – CALC – NFL, PA-0181, Revision 0

2 PA – CALC – NFL, PA-0181, Revision 0, Addendum A

3 N/A

4 PA – CALC – NFL, PA-0235, Revision 0

5 RF – DRAWING – 000, Drawing 11715-FY-9A, Rev. 1

6 RF – DRAWING – 000, Drawing N-05004-0-1FY9A1, Rev. 5

7 RF – North Anna ISFSI FSAR, Section 4.2.1

8 RF – DRAWING – 000, Drawing N-05004-0-1FC49A1, Rev. 4

9 PA – CALC – NFL, PA-0164, Revision 1, Addendum A

*10 PA – NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel, Safety Analysis Report, Revision 4

*11 PA – ORNL/TM-2005/39, Version 5.1, "Standard Composition Library," November 2006.

*12 RF – LA-CP-05-0369, MCNPX User's Manual, Version 2.5.0, April 2005.

13 PA – CODE, MCNP5 Version 1 Mod 0

* References indicated with an asterisk (*) are to be entered into DMIS under the "Nos" of the Contents section.

4.0 METHOD OF ANALYSIS

The North Anna dose rates were calculated with methods documented in PA-0235, Revision 0. The following paragraphs document changes to the method of analysis necessary to model the North Anna ISFSI.

The surface currents for the TN-32 casks were previously calculated in PA-0235, Revision 0. Those results will be used as the TN-32 surface sources in this calculation. Surface radiation currents for the NUHOMS modules were derived from data in the NUHOMS FSAR in a manner identical to the method used in PA-0235, Revision 0.

The outer surface currents associated with the TN-32 casks and HSMs will be used together as the radiation source in a model of the North Anna ISFSI with two separate storage pads. The two-pad model will be used to calculate the required dose rates. While the ISFSI has been sized for a total of three pads, the design of the third pad and the storage systems to be used on that pad have not yet been determined and will not be modeled in this calculation.

The physical model (surfaces, cells, and materials) and the radiation source (representing the fuel and insert components) of the TN-32 cask will be taken directly from PA-0235, Revision 0. The physical model of the HSM will also be taken directly from PA-0235, Revision 0. The layout of the ISFSI will be based on the layout described in PA-0181, Revision 0, modified to reflect the new ISFSI pad arrangement.

The current licensing basis for the North Anna site-specific ISFSI includes the calculation of the annual exposure of the Nearest Permanent Resident (NPR). The NPR is defined as the closest location of a full-time resident and is assumed to be continuously occupied. The second pad at the North Anna ISFSI will be used under a general license, which requires that dose evaluations be performed for Real Individuals located at or beyond the controlled area.

5.0 DESIGN INPUTS

Regulatory Limits

- 10 CFR 72.104 limits the annual dose equivalent to any real individual who is located beyond the controlled area of a site-specific ISFSI to no greater than 25 mrem to the whole body as a result of exposure to all aspects of the uranium fuel cycle.

- 10 CFR 72.212(b)(2) requires that the general ISFSI licensee maintain written real individual dose evaluations which establish that the 10 CFR 72.104 requirements are met (i.e. a 25 mrem/year exposure limit).

- 10 CFR 20.1301(a)(1) limits the total effective dose equivalent to individual members of the public to 100 mrem/year.

- 10 CFR 20.1301(a)(2) limits the dose in any unrestricted area from external sources to 2 mrem in any one hour.

Other

The MCNPX model for the TN-32 cask and the NUHOMS HSM array was taken from the approved model documented in PA-0235 Rev 0.

The nearest site boundary is 2500 feet (76,200 cm) from the ISFSI (PA-0181, Rev. 0, page 19).

The following dimensions were used to model the North Anna ISFSI:

Dimension	Reference	Value (feet)
Pad 1 width	Drawing 11715-FY-9A, Rev. 1	32
Pad 1 length (excluding ramps)	Drawing 11715-FY-9A, Rev. 1	224
Pad 1 centerline to Pad 2 centerline	Drawing N-05004-0-1FY9A1, Rev. 5	202.5
Pad 2 width (including ramps)	Drawing N-05004-0-1FY9A1, Rev. 5	125
Pad 2 length	Drawing N-05004-0-1FY9A1, Rev. 5	205
Pad 2 ramp (each side)	Drawing N-05004-0-1FY9A1, Rev. 5	20
Distance from west side fence to the centerline of Pad 1	PA-0181, Rev. 0	350
Distance from east side fence to the centerline of Pad 1	PA-0181, Rev. 0	400
Distance from north fence to north end of Pad 1	PA-0181, Rev. 0	233
Distance from south fence to south end of Pad 1	PA-0181, Rev. 0	203
Centerline of north berm to north fence	PA-0181, Rev. 0	28 (approx.)
Centerline of east berm to east fence	PA-0181, Rev. 0	28 (approx.)
Distance from pad 1 North/South centerline to pad 2 North/South centerline	Drawing N-05004-0-1FY9A1, Rev. 5	0
Pad 1 thickness	North Anna ISFSI SAR, Section 4.2.1	2
Pad 2 thickness	Drawing N-05004-0-1FC49A1, Rev. 4	3

The material compositions and densities used in the MCNPX calculations were taken from a number of sources. The material properties used in modeling the TN-32 storage cask were identical to those used in PA-0164, Rev. 1, Addendum A, with the exception of the composition of carbon steel (discussed later). The material properties used to model the NUHOMS HD were taken from the NUHOMS HD SAR. For photon cases, the composition of carbon steel is identical to that given in the NUHOMS HD SAR. For neutron transport cases, the elemental iron in the carbon steel composition was separated into an isotopic composition using the following isotopic mass percentages taken from the SCALE 5 manual (Reference 11).

Iron Isotope	Weight Percent
26054	5.699
26056	91.870
26057	2.141
26058	0.290

The radial and axial surface currents (both photon and neutron) used as surface sources for the TN32 dry storage casks are documented in Sections 7.2 and 7.3 of PA-0235, Rev. 0. HSM surface current spectra (photon and neutron) were taken from the NUHOMS HD SAR, Table 10-3. The total surface currents (photon and neutron) will be calculated from data in the NUHOMS HD SAR, Table 10-4.

6.0 ASSUMPTIONS

The following table lists the assumptions used in creating the MCNPX models. A value of 3 miles is reasonable for Assumption No. 2 because this distance represents a very large number of mean free paths for both photons and neutrons. This prevents histories from escaping the problem geometry and adequately models the backscatter from the air. Assumptions 5 and 6 are reasonable for a tally representing the ISFSI boundary fence because the height is similar to the height of a person and the thickness is large enough to generate reasonably stable results but not so large that the flux will vary across the thickness.

Assumption No.	Description	Value
1	Elevation of top of soil surface	0 ft
2	Radius of problem geometry	3 miles
3	X location of Pad 1 Southwest corner	0 cm
4	Y location of Pad 1 Southwest corner	0 cm
5	Thickness of cell used to model fencing	30 cm
5	Height of ISFSI perimeter fence	6 feet
6	No DSC is included in each HSM	N/A
7	With the exception of the earthen berms, the geography around the ISFSI is flat and level with no trees, buildings, or other objects between the ISFSI and the locations where doses are calculated	N/A
8	Dry air	N/A
9	The radiation sources in the fuel stored at the ISFSI do not decay with time once the fuel is at the ISFSI.	N/A
10	Pad 1 is filled with a total of 28 TN-32 casks and Pad 2 holds only 12 HSMs	N/A

7.0 CALCULATION

7.1 Validation of MCNPX

MCNPX is not a production code as defined by Dominion's software quality assurance program. Therefore, MCNPX must be validated to ensure that it is operating correctly and produces results that are consistent with MCNP5 version 1.14. MCNP5 version 1.14 has been qualified under Dominion's software quality assurance program. Within Dominion's program MCNP5 version 1.14 is also referred to as MCNP5 Version 1, Mod. 0.

MCNPX was validated by rerunning a TN-32 model previously used in calculation PA-0164, Revision 1, Addendum A. The TN-32 model was documented in that calculation as input file "radial2.job". That input file underwent only slight modifications to be used as a validation case. The title card at the beginning of the file was modified to reflect which program was being run (MCNP5 or MCNPX). An nps card was added to ensure that each execution ran a constant number of histories. Finally, an additional tally was added to the MCNPX execution to validate MCNPX's internal flux-to-dose conversion factors.

Two cases were run. The first case MCNP1, was executed with MCNP5 version 1.14. The second case MCNPX1 was executed with MCNPX. The following table shows the results of the current and flux tallies.

Case	Tally 1 (Radial Surface Current)	Tally 2 (Radial Dose Rate)	Tally 12 (Radial Dose Rate Using MCNPX Conversion Factors)
MCNP1	3.0880E+10	1.3315E+02	N/A
MCNPX1	3.0880E+10	1.3315E+02	1.3317E+02

The table shows that MCNP version 1.14 and MCNPX produce nearly identical results (to within the printed precision) for both surface currents and dose rates. This agreement reflects the common ancestry of the two programs. The table also demonstrates that the flux-to-dose conversion factors built into MCNPX produce dose rates that are consistent with manually-entered conversion factors.

7.2 HSM Surface Currents

The HSM surface current spectra (neutron and photon) were taken from NUHOMS HD SAR, Table 10-3. The total surface currents (neutron and gamma) were based on data from

NUHOMS HD SAR, Table 10-4. Data from Table 10-4 of the SAR was used to calculate an average surface current per cm^2. This value was then used along with the surface areas of the HSM arrays in the MCNPX models to calculate surface currents appropriate for use in this calculation. This approach properly accounted for the difference in the number of modules modeled here and in the SAR, as well as accounting for the larger area on the side of the array that was used as a source in this calculation. The following tables document the current spectra as well as the generation of the integral current source magnitudes used in the MCNPX models.

HSM-H Neutron Surface Current Spectrum

Group Number	Energy Group Boundary (MeV)	Neutron Current (n/cm^2-sec per mrem/hr)
	0.00E-00	----
1	1.00E-02	9.020E+01
2	1.00E-01	6.223E+00
3	2.50E-01	8.086E-01
4	5.00E-01	4.259E-01
5	1.00E+00	3.670E-01
6	1.50E+00	1.395E-01
7	2.00E+00	8.978E-02
8	4.00E+00	1.494E-01
9	6.00E+00	1.957E-02
10	1.00E+01	3.705E-03
11	1.50E+01	8.269E-04
12	2.00E+01	8.842E-04

HSM-H Gamma Surface Current Spectrum

Group Number	Energy Group Boundary (MeV)	Photon Current (γ/cm²-sec per mrem/hr)
	0.00E-00	----
1	5.00E-02	1.292E+01
2	1.00E-01	6.230E+02
3	2.00E-01	4.150E+02
4	3.00E-01	1.153E+02
5	4.00E-01	4.583E+01
6	6.00E-01	2.590E+01
7	8.00E-01	8.355E+00
8	1.00E+00	5.260E+00
9	1.33E+00	6.297E+00
10	1.66E+00	4.304E+00
11	2.00E+00	7.358E-01
12	2.50E+00	9.946E-01

HSM-H SAR Surface Activities

Surface	Area (cm²)	Neutron Activity (n/sec)	Neutron Current (n/sec/cm²)	Photon Activity (γ/sec)	Photon Current (γ/sec/cm²)
Roof	3.942E+06	7.490E+08	1.900E+02	6.936E+10	1.760E+04
Front	1.765E+06	8.598E+07	4.871E+01	4.523E+10	2.563E+04
Side	7.104E+05	1.294E+07	1.822E+01	3.430E+08	4.828E+02

HSM-H Model Surface Sources

Surface	Area (cm2)	Neutron Current (n/sec/cm2)	Neutron Source (n/sec)	Photon Current (γ/sec/cm2)	Photon Source (γ/sec)
Roof	2.245E+06	1.900E+02	4.265E+08	1.760E+04	3.951E+10
Front 1	1.078E+06	4.871E+01	5.249E+07	2.563E+04	2.762E+10
Front 2	1.078E+06	4.871E+01	5.249E+07	2.563E+04	2.762E+10
Side 1	7.741E+05	1.822E+01	1.410E+07	4.828E+02	3.737E+08
Side 2	7.741E+05	1.822E+01	1.410E+07	4.828E+02	3.737E+08
Total	5.948E+06	N/A	5.597E+08	N/A	9.550E+10

7.3 Total MCNP Source Term Issues

The gamma and neutron source terms for the TN32 casks were taken from PA-0235, Rev. 0. The neutron source terms for a single TN32 cask, in neutrons/sec, were 2.722E+8 (radial), 1.284E+7 (axial), and 2.850E+8 (total, within round off). The gamma source terms for a single TN32 cask, in photons/sec, were 3.106E+10 (radial), 1.081E+9 (axial), and 3.215E+10 (total, within round off). When combined with the NUHOMS source terms from Section 7.2, the total source terms for pads 1 and 2 were 9.956E+11 photons/sec and 8.541E+9 neutrons/sec. However, the photon dose rate cases were run with a total photon source term of 1.896E+12 photons/sec, or 90.4% larger than should have been used. As the error is conservative, no change was made to the results. This issue affects all of the photon results reported in this calculation.

The photon and neutron surface source terms for the top and end surfaces of the HSM array should have been uniformly distributed over the respective surfaces. However, the source distributions (see the si22 card) were actually specified to range from 6664.88 cm to 7299.8 cm, corresponding to only the eastern half of the back-to-back HSM array. While this did not affect the total source terms for the HSM array, it did result in localizing the source term more that was justified by the model. This error will have an insignificant effect on the site boundary dose rate calculations (previous models have used an even less specific single TN32 cask to represent the source distribution for a collection of casks). This error will have a larger impact on the ISFSI fence dose rates, but the results will still be conservative (concentrating the source in one area will increase the peak dose rates associated with that source). The source terms associated with the array of TN32 casks are larger than those of the HSM array and will control the peak dose rates at the ISFSI fence. Given the distance from the HSM array to the north and south fences, the error will have an insignificant effect on the average dose rates at the fences.

7.4 ISFSI Fence Dose Rates

The neutron and photon dose rates at the ISFSI perimeter fences were calculated using an ISFSI model constructed using the dimensions given in Section 5. Two pads were modeled – one pad holding 28 TN-32 casks and one pad holding 12 HSMs. The pads were modeled as concrete and the ground was modeled as a flat expanse of soil. The outer boundary of the problem was a sphere with a radius of 3 miles. This sphere defined the outer boundary of both air and soil. The TN-32 casks were modeled using the geometry from calculation PA-0235. A single HSM was constructed using the model from calculation PA-0235. The single HSM was

then replicated using an array structure to create the HSM array. DSCs were not included in this model, simplifying the geometry and reducing the shielding slightly (a conservative approach). Surface sources were placed on the outer surfaces of the HSMs and TN-32 casks, using the neutron and photon surface sources calculated in sections 7.2 and 7.3. The ISFSI fences were modeled as regions (cells) of air 6 feet tall and 30 cm deep. Soil berms were included on the north and east sides of the ISFSI, between the storage systems and the fences. Dose rates were tallied in the ISFSI fence cells by segmenting the cells into 10 equal segments along the length of each side of the ISFSI. This facilitated calculating both average and peak dose rates.

The photon dose rates were calculated using the input file isfsi5, generating the output file isfsi5o. The neutron dose rates were calculated using the input file nsfsi2 and nsfsi5. Tallies 4 and 34 from nsfsi2 generated dose rates for the north and west fences. Tallies 14 and 24 from nsfsi5 generated dose rates for the south and east fences. The output is stored in files nsfsi2o and nsfsi5o. Mesh based weight-windows were used to improve the quality of the tally results.

The following tables show the calculated ISFSI perimeter fence dose rates. Note that the peak total dose rate does not always equal the sum of the peak photon and neutron dose rates because the peak photon and neutron dose rates may occur at different locations. The standard deviations for the total dose rates were calculated by taking the square root of the sum of the variances of the photon and neutron dose rates.

ISFSI North Perimeter Fence Dose Rates

Source Type	Average Dose Rate (mrem/hr)	Standard Deviation (%)	Peak Dose Rate (mrem/hr)	Standard Deviation (%)
Photon	0.144	1.50	0.171	4.04
Neutron	0.087	1.74	0.110	4.52
Total	0.231	1.14	0.275	2.98

ISFSI South Perimeter Fence Dose Rates

Source Type	Average Dose Rate (mrem/hr)	Standard Deviation (%)	Peak Dose Rate (mrem/hr)	Standard Deviation (%)
Photon	0.883	1.19	1.107	3.30
Neutron	0.226	1.33	0.311	3.89
Total	1.109	0.99	1.407	2.78

ISFSI East Perimeter Fence Dose Rates

Source Type	Average Dose Rate (mrem/hr)	Standard Deviation (%)	Peak Dose Rate (mrem/hr)	Standard Deviation (%)
Photon	0.241	1.22	0.296	4.69
Neutron	0.101	2.14	0.135	6.24
Total	0.342	1.06	0.411	2.93

ISFSI West Perimeter Fence Dose Rates

Source Type	Average Dose Rate (mrem/hr)	Standard Deviation (%)	Peak Dose Rate (mrem/hr)	Standard Deviation (%)
Photon	0.820	1.20	1.041	3.39
Neutron	0.183	1.10	0.232	2.81
Total	1.003	1.00	1.257	2.85

Two additional cases were run to determine bounding dose rates above the north berm. These dose rates are of use if a TLD is placed on a fence in such a manner that there is a line of sight between the TLD and the storage systems. The dose rates were calculated at a point located 3 feet above the top of the north berm and located on the major axis of Pad 1. The location was chosen because the axis of Pad 1 (the pad with the largest number of storage containers and

the pad with the storage containers closest to the berm) will be the approximate location of the highest dose rate at the top of the berm. The calculated dose rates were:

Source Type	Dose Rate (mrem/hr)	Standard Deviation (%)
Photon	0.701	0.45
Neutron	0.233	1.32
Total	0.934	0.47

As expected, these dose rates are higher than the fence dose rates because the fence dose rates include the shielding effect of the berm. However, these dose rates are lower than the peak dose rates calculated for the south fence. Hence, the dose rate results for the south fence can be used for the north fence since portions of the north fence are not shielded by the north berm.

7.5 Site Boundary Dose Rates

The dose rates at the site boundary were calculated with a model similar to the ISFSI perimeter fence model. The significant changes were:

- The dose rates were tallied using a point detector located 3 feet above the surface of the soil and a spherical volume tally with a radius of 3 feet located 3 feet above the surface of the soil.
- The air and soil were divided into multiple bodies (cells) using concentric spheres centered on the dose rate tallies. These multiple bodies permitted the use of cell-based weight windows to optimize the calculation.

Given that the dose rates vary as a function of azimuthal angle around the ISFSI, the site boundary dose point was located 762 meters west of pad 1. This location was chosen to maximize the calculated dose rates because of the following factors:

- The TN-32 casks, which have the highest source terms, are located on the west pad (pad 1),
- The dose rates to the west of the ISFSI should decrease more slowly with distance than would be the case in other directions because the array of casks on pad 1 simulate an unshielded line source.

The photon dose rates were calculated using the input file siteg2, generating the output file siteg2o. The neutron dose rates were calculated using the input file siten3, generating the output file siten3o. The following table lists the calculated site boundary dose rates.

Site Boundary Dose Rates and Annual Exposures From the ISFSI

Source Type	Average Dose Rate (mrem/hr)	Standard Deviation (%)	Annual Dose Assuming 100% Occupancy (mrem)	Annual Dose Assuming 40 Hr/Week Occupancy (mrem)
Photon	3.6524E-04	1.10	3.2	0.8
Neutron	5.4744E-05	2.65	0.5	0.1
Total	4.1998E-04	1.02	3.7	0.9

8.0 CONCLUSIONS AND SUMMARY

Dose rates at ISFSI perimeter fence and the site boundary resulting from the ISFSI were calculated. These dose rates included contributions from one pad of TN-32 casks as well as an array of NUHOMS HD modules. The calculated dose rates are shown in the tables included in sections 7.4 and 7.5 of this calculation. The dose rates calculated for the site boundary are suitable for use in determining the annual personnel exposures for the Nearest Permanent Resident and the Nearest Real Individual. These results may not reflect small localized variations in dose rates at the ISFSI perimeter fence.

The PRC and CDS were reviewed and there were no identified impacts, therefore, neither is attached. Any use(s) of the calculations contained herein shall be further evaluated and screened at the time of their use.

9.0 List of Computer Files

File Name	File Date/Time	Description
mcnp1	02/26/2007 12:21	MCNP Validation Case
mcnp1o	02/26/2007 12:47	
mcnpx1	02/26/2007 12:21	MCNPX Validation Case
mcnpx1o	02/26/2007 12:43	
siteg2	03/11/2007 22:05	γ Dose Rate Calculation For The Site Boundary (Tally 5)
siteg2o	03/11/2007 22:41	
siten3	03/13/2007 09:35	Neutron Dose Rate Calculation For The Site Boundary (Tally 5)
siten3o	03/13/2007 10:02	
isfsi5	03/01/2007 08:33	γ Dose Rate Calculations At The ISFSI Outer Fences (Tallies 4, 14, 24, and 34)
isfsi5o	03/01/2007 09:23	
isfsi4e	03/01/2007 00:45	
nsfsi2	03/01/2007 10:17	Neutron Dose Rate Calculations At The North and West ISFSI Outer Fences (Tallies 4 and 34)
nsfsi2o	03/01/2007 13:38	
nsfsi1e	03/01/2007 10:16	
nsfsi5	03/01/2007 15:37	Neutron Dose Rate Calculations At The South and East ISFSI Outer Fences (Tallies 14 and 24)
nsfsi5o	03/01/2007 16:11	
nsfsi3e	03/01/2007 14:26	
point2	03/01/2007 16:04	γ Dose Rate Calculation At The North ISFSI Outer Fence (Above the Berm)
point1e	03/01/2007 16:00	
point2o	03/01/2007 16:42	
npoint1	03/01/2007 16:17	Neutron Dose Rate Calculation At The North ISFSI Outer Fence (Above the Berm)
ne	03/01/2007 14:26	
npoint1o	03/01/2007 16:29	

Note: The time stamps shown in the table above may differ by one or more integer hours from the timestamps displayed by directory listings of the CDROM associated with this calculation. This is a known phenomena associated with variations in the way daylight savings time and time zone changes and handled by various server, workstation, and file server operating systems.

10.0 Reviewer's Comments

Comment	Resolution
The comment card associated with MCNPX cell number 417 on page 54 of the calculation should read "lower right vent liner (upper)".	While this error does not affect the calculated dose rates, it is present in all of the MCNPX input decks which include models of NUHOMS HD storage systems as well as the MCNPX models included in Appendices 2 and 3.
The openings in the vent cover (see MCNPX cells 425 and 427) should be 12' 10" wide. The openings in the right and left roof vent risers (see MCNPX cells 428 and 429) should be 12' 8" wide. All were modeled as 12' 4" wide.	The impact of the error is minimal for the following reasons: (1) the radiation source terms in the NUHOMS models are located on the outer surface of the modules pointing away from the modules. Hence the outgoing radiation does not pass through the openings that are in error, (2) the radiation source terms associated with the TN32 casks are not located such that a significant amount of direct or scattered radiation would pass through the openings that are in error (i.e. they are not positioned along the long axis of the HSM array).
The width of the square outer steel portion of the HSM door was modeled as 8' 1.5" square rather than the correct value of 7' 7.25" square.	The impact of the error is minimal for the reasons listed earlier for the openings in the vent cover and roof vent risers.
Pad 1 was modeled as 3 ft thick rather than 2 ft thick as indicated in Section 5, Design Inputs	The impact of the error is minimal because little of the radiation contributing to the calculated dose rates penetrates more than 2 ft into the concrete pad and then penetrates another 2 ft through concrete to return to the air. Most of the radiation contributing to the calculated dose rates is either direct shine from the storage systems or radiation scattered in the air above the ISFSI.

CALCULATION REVIEW CHECKLIST **ATTACHMENT A**

Calculation No. PA-0243	Rev. 0	Addendum N/A	Page 1 of 1

NOTE: If "Yes" is not answered, an explanation shall be provided below.
Reference may be made to explanations contained in the calculation or addendum.

Questions:	Yes	N/A
1. Have the sources of design inputs been correctly selected and referenced in the calculation?	☒	☐
2. Are the sources of design inputs up-to-date and retrievable/attached to the calculation?	☒	☐
3. Where appropriate, have the other disciplines reviewed or provided the design inputs for which they are responsible?	☒	☐
4. Have design inputs been confirmed by analysis, test, measurement, field walkdown, or other pertinent means as appropriate for the configuration analyzed?	☒	☐
5. Are assumptions adequately described and bounded by the Station Design Basis?	☒	☐
6. Have the bases for engineering judgments been adequately and clearly presented?	☒	☐
7. Were appropriate calculation/analytic methods used and are outputs reasonable when compared to inputs?	☒	☐
8. Are computations technically accurate?	☒	☐
9. Has the calculation made appropriate allowances for instrument errors and calibration equipment errors? (Reference STD-EEN-0304)	☐	☒
10. Have those computer codes used in the analysis been referenced in the calculation?	☒	☐
11. Have all exceptions to station design basis criteria and regulatory requirements been identified and justified in accordance with NQA-1-1994.	☒	☐
12. The design authority/original preparer for this calculation has been informed of its revision or addendum, if required.	☐	☒

Comments: (Attach additional pages if needed)
No allowance for instrument errors were included because the calculated dose rates are conservative and intended to bound all field measurements.

Prepared By (Print Name)	Signatu[redacted]	Date 2-24-08
Reviewed By (Print Name) [redacted]	Sig[redacted]	Date 2-25-08

(June 05)

VPAP-3001 – Attachment 2

1. Identification of Governing Document	2. Applicable Station	3. Applicable Unit
PA-0243, Rev. 0	[x] North Anna Power Station [ ] Surry Power Station	[ ] Unit 1 [ ] Unit 2 [x] ISFSI

4. Brief Description of the Entire Activity

PA-0243, Rev. 0 calculates limiting on-site and off-site radiation dose rates that will result from the normal operation of the North Anna ISFSI after loading fuel in all of the NUHOMS dry fuel storage systems currently installed.

5. Is the activity bounded by another change that has already been determined to require NRC approval? [ ] Yes [x] No	If YES, identify the source document: **(Skip to Block 8)**
6. Is the activity based on a source document that has already been reviewed in accordance with VPAP-3001 or DNAP-3004? [ ] Yes [x] No	If YES, identify the source document or attach a copy of the completed review. **(Skip to Block 8)**

7. General Screen (Definitions are provided in VPAP-3001)
NOTE: UFSAR and ISFSI SAR are to be used interchangeably when completing this Checklist

A. Does this activity require a change to the Operating License, Technical Specifications (station or ISFSI), Technical Specification Bases, ISFSI License, or the Technical Requirements Manual?	[ ] Yes [x] No
B. Does this activity alter (temporarily or permanently) the **design** of a Structure, System, or Component (SSC) described in the UFSAR?	[ ] Yes [x] No
C. Does this activity alter (temporarily or permanently) the **function, ability to function, or method of performing a function** of an SSC described in the UFSAR?	[ ] Yes [x] No
D. Does this activity alter a **numeric** value associated with design or performance requirements that has **not** been previously reviewed in accordance with VPAP-3001 or DNAP-3004?	[ ] Yes [x] No
E. Does this activity modify how SSCs are **operated** or **controlled as** described, outlined, or summarized in the UFSAR?	[ ] Yes [x] No
F. Does this activity perform a **test or experiment** that is **not** described in the UFSAR?	[ ] Yes [x] No
G. Does this activity involve a change in a **calculational method** that supports the function of an SSC described in the UFSAR?	[ ] Yes [x] No
H. Does this activity involve a temporary modification, as defined in VPAP-1403?	[ ] Yes [x] No
I. Does this activity involve a change, test, or experiment that may affect the **environment**?	[ ] Yes [x] No

Note: If any response to Question 7 is "Yes," a Safety Review (IAW VPAP 3001) and Regulatory Screen (IAW DNAP 3004) must be performed and no response to Question 8 or 9 is required. If all responses are "No," then answer Questions 8 and 9.

8. Maintaining the UFSAR

Does this activity require revising the UFSAR or ISFSI SAR? [ ] Yes [x] No	If "YES," Initiate a Change Request in accordance with VPAP-2803 and obtain the signature of a qualified Regulatory Evaluator as a reviewer

9. Results and References

9a. [x] Based on the results of the completed Activity Checklist, the activity has no impact on the design, function, ability to function, method of performing the function, or control or operation of a SSC described in the UFSAR (i.e., the change activity is safe) and the activity can be implemented without prior regulatory approval.

List documents used to perform the General Screen.
North Anna ISFSI Safety Analysis Report
North Anna Updated Final Safety Analysis Report

9b. Conclusion
Provide additional discussion to support the conclusion.
PA-0243, Rev. 0 calculates bounding on-site and off-site radiation dose rates that will result from storing fuel in the NUHOMS HD dry fuel storage system at the North Anna ISFSI. These values, when combined with other data, may be used to determine if fuel may be stored in the NUHOMS HD dry fuel storage system. That evaluation will be performed and approved prior to loading fuel in the NUHOMS system. Therefore, this calculation does not require a change to the Technical Specifications. No UFSAR changes are required in support of this calculation. No tests are performed, the environmental plan is not affected, and no temporary modifications are made.

10. Preparer Name (Print) [redacted]	11. Title Engineer III	
12. Preparer Signature [redacted]		13. Date 2-24-08
14. Reviewer Name (Only Required if Preparer is not AC Qualified) or IAW Block 8	15. Title	
16. Reviewer Signature		17. Date

Key: UFSAR-Updated Final Safety Analysis Report which includes the plant specific UFSAR and the ISFSI FSAR; AC-Activity Checklist; IAW-In Accordance With

Form No. 730914 (Dec 2006)

Dominion

Calculation Cover Sheet

CM-AA-CLC-301 Attachment 1 Page 1 of 7

Calculation Number: PA-0243	Revision: 0	Addendum: A	Decommissioning? ☐ Yes ☒ No

Calculation Quality Class: ☐ Safety Related ☒ NSQ ☐ Non-Safety Related

Installation Verification Required? ☐ Yes ☐ No ☒ N/A (Virginia Plants)

IV information:

Printed Name: Signature: _____ Date:

Subject (Calculation Title):
Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems

Addendum Title (if applicable):

Station(s) and Unit(s): North Anna Units 1 and 2	Affected System(s), Structure(s), or Component(s):

Purpose:
The objective of this addendum is to determine on-site and off-site annual radiation doses resulting from the normal operation of the North Anna ISFSI after installation of the NUHOMS dry fuel storage system and loading 26 HSMs onto pad #2. A sensitivity study will also be performed to determine the dose rate with 40 HSMs loaded onto pad #2.

Originator (Qual. Required): Printed Name		Signature:	Date:
[redacted]		[redacted]	05-31-2011
Reviewer (Qual. Required): Printed Name [redacted]	Type of Review: Independent	Signature: [redacted]	Date: 5-31-2011
Approver: Printed Name [redacted]		Signature: [redacted]	Date: 6/1/11

(1) At the discretion of the originator, a facsimile of this cover sheet that does not contain the "CM-AA-CLC-301"or "Attachment 1" headers may be used. Facsimiles must contain all of the elements of the cover sheet in the current revision of CM-AA-CLC-301. (2) Add lines for additional originators or reviewers as necessary. Note if reviews are "Independent", "Peer", "Subject Matter Expert", "Supervisor", or "Owner's".

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3. Method of Analysis 3
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5. Assumptions 5
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7. Acceptance Criteria 6
8. Conclusion 6
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Attachments

A. Calculation Review Checklist (1 page)

1. Objective

The objective of this calc is to determine limiting on-site and off-site radiation dose rates resulting from the normal operation of the North Anna ISFSI after installation of more Horizontal Storage Modules (HSMs) in the NUHOMS dry fuel storage system.

2. Background

PA-0243 (Reference 1) addressed the installation of 12 HSMs in the NUHOMS dry fuel storage system, and included the recalculation of the design basis radiation dose rates at the ISFSI perimeter fence and the nearest North Anna site boundary. These calculations included the radiation dose rates from one existing ISFSI pad containing 28 cylindrical TN-32 storage casks on pad 1 as well as 12 HSMs on pad 2. The surface currents used in PA-0243 for the TN-32 casks were previously calculated in PA-0235 Rev. 0 (Reference 3).

3. Method of Analysis

In PA-0243 Rev. 0, 12 HSMs were modeled and the corresponding dose rates from these modules were calculated. This addendum will analyze a scenario where 14 HSMs will be added to pad 2, for a total of 26 HSMs. For sensitivity, a scenario involving the addition of 28 HSMs to pad 2, for a total of 40 HSMs, will be evaluated to determine dose rates.

The results from PA-0243 Rev. 0 for 12 HSMs and 28 TN-32 casks will be used to conservatively estimate the dose rates for both 26 HSMs and 40 HSMs being loaded on the ISFSI pad.

The impact of adding HSMs upon the PA-0243 fence line peak dose rates was examined relative to the 10 CFR 20.1301(a)(1) limit of 2mrem/hr for unrestricted areas. An average dose rate for the fence line was calculated for the entire loading of pads 1 and 2 combined. The dose rate for the south fence was used because it demonstrates the most limiting case by having the highest dose rate, as seen in Table 1 below (Reference 1, page 14). The peak dose rate was the most conservative dose rate to use in this evaluation because the dose at the south fence line is mostly controlled by the TN-32 casks. The addition of HSMs on pad 2 will not provide a significant dose increase to the south fence due to self-shielding from the HSMs already in place, and the HSMs will be loaded north of the existing HSMs. The surface currents of the HSMs tend to be predominantly perpendicular to the faces of the HSMs, so neither the south fence line dose nor the peak dose rate will be affected significantly by the additional HSMs added on pad 2.

The average dose rate was determined by dividing the peak dose rate at the south fence by the total number of TN-32 casks and HSMs on pads 1 and 2. This value was then multiplied by the total number of units on pads 1 and 2 after loading 14 additional HSMs on pad 2, and again after the addition of 26 HSMs on pad 2.

Using the dose rates from the TN-32 casks and the existing HSMs, an average dose rate per storage unit is calculated. This value will then be used to determine the dose rates at the site boundary for the additional HSMs that are added. This approach is reasonable for calculating the increase in dose rate at the nearest site boundary since the nearest site boundary is 2500 feet west of pad 1 (Reference 1) and pads 1 and 2 are dimensionally small enough (about 200 feet long and 200 feet apart) that they can reasonably be treated as a point source. Because pad 2 is east of pad 1 and the nearest site boundary is west of pad 1, any HSMs added to pad 2 would be further from the site boundary than the equivalent average cask/HSM based on PA-0243. Thus applying the average dose rate per cask/HSM to new HSMs on pad 2 produces conservative increases in dose rates at the site boundary.

4. Design Inputs

Regulatory Limits:

10 CFR 72.104 limits the annual dose equivalent to any real individual who is located beyond the controlled area of a site-specific ISFSI to no greater than 25 mrem to the whole body as a result of exposure to all aspects of the uranium fuel cycle.

10 CFR 72.212(b)(2) requires that the general ISFSI licensee maintain written real individual dose evaluations which establish that the 10 CFR 72.104 requirements are met (i.e. a 25 mrem/year exposure limit).

10 CFR 20.1301(a)(1) limits the total effective dose equivalent to individual members of the public to 100 mrem/year.

10 CFR 20.1301(a)(2) limits the dose in any unrestricted area from external sources to 2 mrem in any one hour.

Table 1: ISFSI South Perimeter Fence Dose Rates (Page 14 of Reference 1)

Source Type	**Average Dose Rate (mrem/hr)**	**Peak Dose Rate (mrem/hr)**
Photon	0.883	1.107
Neutron	0.226	0.311
Total	1.109	1.407

Table 2: Site Boundary Dose Rates and Annual Exposures From the ISFSI
(Page 16 of Reference 1)

Source Type	Average Dose Rate (mrem/hr)	Annual Dose Assuming 100% Occupancy (mrem)	Annual Dose Assuming 40 Hr/Week Occupancy (mrem)
Photon	3.6524E-04	3.2	0.8
Neutron	5.4744E-05	0.5	0.1
Total	4.1998E-04	3.7	0.9

5. Assumptions

The same assumptions used in PA-0243 (Reference 1) are used in this addendum.

6. Calculations

6.1 Fence Line Dose Rate

The highest dose rates from the original 40 units are taken from the south perimeter fence around the ISFSI, and are shown above in Table 1.

The peak dose rate is the most limiting value, and is divided by the total number of storage units to yield a dose rate per storage unit.

$$\frac{\text{Peak Dose Rate}}{\text{\# storage units}} = \frac{1.407 \text{ mrem/hr}}{40 \text{ units}} = 0.03518 \text{ mrem/hr per unit}$$

For a total of 26 HSMs and 28 TN-32s, the dose rate is:

0.03518 mrem/hr per unit * 54 units = 1.899 mrem/hr

Performing a sensitivity case for a total of 40 HSMs, the dose rate is:

0.03518 mrem/hr per unit * 68 units = 2.392 mrem/hr

6.2 Site Boundary Dose Rate

The site boundary dose rates and exposures are listed above in Table 2 for the original 40 units.

$$\frac{\text{Dose Rate}}{\text{\# storage units}} = \frac{4.199\text{E-}04 \text{ mrem/hr}}{40 \text{ units}} = 1.049\text{E-}05 \text{ mrem/hr per unit}$$

For a total of 26 HSMs and 28 TN-32s, the dose rate is:

1.049E-05 mrem/hr per unit * 54 units = 5.670E-04 mrem/hr

For 100% occupancy, the dose rate is: 5.670E-04 mrem/hr * 8760hr/yr = 4.967 mrem/yr.

Assuming an occupancy of 40 hours per week, the dose rate is: 5.670E-04 mrem/hr * 40 hrs/wk * 52 wk/yr = 1.179 mrem/yr.

Performing a sensitivity case for a total of 40 HSMs, the dose rate is:

1.049E-05 mrem/hr per unit * 68 units = 7.140E-04 mrem/hr

For 100% occupancy, the dose rate is: 7.140E-04 mrem/hr * 8760hr/yr = 6.254 mrem/yr.

Assuming an occupancy of 40 hours per week, the dose rate is: 7.140E-04 mrem/hr * 40 hrs/wk * 52 wk/yr = 1.485 mrem/yr.

The results (rounded up) are shown below in Table 3:

Table 3: Calculated Dose rates

	40 total units	**54 total units**	**68 total units**
Fence Dose Rate (mrem/hr)	1.407	1.899	2.392
Site Boundary Dose Rate (mrem/hr)	4.2E-04	5.7E-04	7.2E-04
100% Occupancy (mrem/yr)	3.7	5.0	6.3
40 hrs/wk Occupancy (mrem/yr)	0.9	1.2	1.5

7. Acceptance Criteria

10 CFR 72.104 limits the annual dose equivalent to any real individual who is located beyond the controlled area of a site-specific ISFSI to no greater than 25 mrem to the whole body as a result of exposure to all aspects of the uranium fuel cycle.

10 CFR 72.212(b)(2) requires that the general ISFSI licensee maintain written real individual dose evaluations which establish that the 10 CFR 72.104 requirements are met (i.e. a 25 mrem/year exposure limit).

10 CFR 20.1301(a)(1) limits the total effective dose equivalent to individual members of the public to 100 mrem/year.

10 CFR 20.1301(a)(2) limits the dose in any unrestricted area from external sources to 2 mrem in any one hour.

8. Conclusion

The dose rates at the nearest site boundary to the ISFSI were calculated. These dose rates included contributions from 28 TN-32 casks on pad 1 as well as either 26 or 40 HUHOMS horizontal storage modules on pad 2. The calculated dose rates are shown in Table 3 above. The dose rates calculated for the site boundary are suitable for use in determining the personnel exposures for the Nearest Permanent Resident and the Nearest Real Individual.

Using the methodology contained within this document, adding 14 additional HSMs to pad 2 will not increase the fence line dose over the limit of 2mrem/hr. This analysis shows that when 26 HSMs are added to pad 2, the dose rate increases above the limit to almost 2.4 mrem/hr. However, this value is extremely conservative. The source terms that are used for the calculation of the dose rates are the design basis values and are much larger than what is actually present. Additionally, the average value that is calculated is very conservative due to the TN-32 source terms being much higher than the source terms from the HSMs. The average value is skewed closer to the values of the TN-32s, and provides a very conservative calculation. Also, the HSMs that are currently located on the south side of pad 1 provide shielding for the new HSMs that will be loaded to the north, which further reduces the contribution of the new HSMs to the dose rate. Also, the peak dose rate is used to find the average dose rate per unit. This is primarily controlled by the TN-32s because of their much higher source term, and they are essentially unaffected by the addition of HSMs to pad 2.

As stated previously, the dose rate at the fence is limited by 10 CFR 20.1301(a)(1) restrictions which specify that the dose rate at the fence line cannot be measured to be higher than 2 milliRem per hour since it is considered an unrestricted area. If the measured dose rates at the side of the fence line ever exceeded 2 milliRem per hour, then additional shielding could be placed between the pads and the fence line.

The layout of the ISFSI is documented in drawing number 11715-FY-9A1 Rev. 0 (Reference 2).

9. References

1. PA-CALC-NFL, PA-0243, Revision 0, "Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems."
2. Drawing 11715-FY-9A1 Rev. 0
3. PA-CALC-NFL, PA-0235, Rev. 0, "Dose Rate Evaluation of the Surry ISFSI Based on TN-32 and NUHOMS HD Storage Systems," June 2007.

Dominion

Calculation Cover Sheet

CM-AA-CLC-301 ATTACHMENT 2 Page 1 of 1

Calculation Number:	Revision:	Addendum:	Attachment:
PA-0243	0	A	2

NOTE: If "Yes" is not answered, an explanation may be provided below.
Reference may be made to explanations contained in the calculation or addendum.

Questions:	Yes	N/A
1. Have the sources of design inputs been correctly selected and referenced in the calculation?	☒	☐
2. Are the sources of design inputs up-to-date and retrievable/attached to the calculation?	☒	☐
3. Where appropriate, have the other disciplines reviewed or provided the design inputs for which they are responsible?	☒	☐
4. Have design inputs been confirmed by analysis, test, measurement, field walkdown, or other pertinent means as appropriate for the configuration analyzed?	☒	☐
5. Have the bases for assumptions been adequately and clearly presented and are they bounded by the Station Design Basis?	☒	☐
6. Were appropriate calculation/analytic methods used and are outputs reasonable when compared to inputs?	☒	☐
7. Are computations technically accurate?	☒	☐
8. Has the calculation made appropriate allowances for instrument errors and calibration equipment errors?	☐	☒
9. Have those computer codes used in the analysis been referenced in the calculation?	☐	☒
10. Have all exceptions to station design basis criteria and regulatory requirements been identified and justified in accordance with NQA-1-1994?	☒	☐
11. Has the design authority/original preparer for this calculation been informed of its revision or addendum, if required?	☒	☐
12. If preparing an addendum or revision, has a Cumulative Effects review been performed to ensure that cumulative effects are considered in the results and conclusions?	☒	☐

Comments: (Attach additional pages if needed)

8. No instruments or equipment were used in this calculation.
9. No computer codes were used in this calculation

Prepared By (Print Name)	Signature	Date
[redacted]	[redacted]	5-31-2011
Reviewed By (Print Name)	**Signature**	**Date**
[redacted]	[redacted]	5-31-2011

Calculation Cover Sheet

Dominion

CM-AA-CLC-301 ATTACHMENT 2 Page 1 of 1

Note: This form is only applicable to **Revision 6** of this procedure.
Complete the fields with text or an **X** as required.

Calculation Number:	Revision:	Addendum:	Sub type:	Decommissioning Record?
[PA-0243]	[0]	[B]	CAF 10-16-12 ~~[000]~~ NFL	☐Yes ☒No

Vendor (If not Dominion):	Calculation Preparation Risk:
N/A	☒Low ☐Medium ☐High
Vendor Proprietary: ☒Yes ☐No	Pre-Job Brief Completed: ☐Yes ☐No ☒NA

Calculation Quality Class: ☐Safety Related ☒NSQ ☐Non-Safety Related

Subject (Calculation Title):
Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems

Addendum Title: Impact on the ISFSI dose rates due to gaps between HSM-H modules

Station(s) and Unit(s): NA ☒1 ☒2 ☐3 SU ☐1 ☐2 KW ☐ MP ☐1 ☐2 ☐3 ☐CO (Note: If both SU and NA then only check CO)	Affected System(s), Structure(s), or Component(s): N/A

Purpose (Executive Summary):
The objective of this addendum is to update the on-site and off-site design basis radiation dose rates and annual doses from the normal operation of the North Anna ISFSI. The update will include dose contributions from gaps between HSM-H modules.

Originator (Qual. Required): Printed Name (1) (3)		Signature: (1) (3)	Date: (1) (3)
[redacted]		[redacted]	10-8-12
Reviewer (Qual. Required): Printed Name (1) [redacted]	Type of Review: (2) Independent	Signature: [redacted]	Date: 10-9-12
Approver: Printed Name [redacted]		Signature: [redacted]	Date: 10/9/12

Note: Physical or electronic signatures are acceptable.

Note: At the discretion of the originator, a facsimile of this cover sheet that does not contain the "CM-AA-CLC-301"or "Attachment 1" headers may be used. Facsimiles must contain all of the elements of the cover sheet in the current revision of CM-AA-CLC-301. (1) Add lines for additional originators or reviewers as necessary. (2) Note if reviews are "Independent," "Peer", "Subject Matter Expert", "Supervisor", or "Owner's". (3) Enter N/A for Owner's Review of Vendor Calculation.

Calculation # PA-0243_ Rev. ___0__ Add. __B___

Instructions: To update the Table of Contents page numbers, click within the Table of Contents to select the table, then select "**Print Preview,**" (Click the **Office Button** at the upper left of the computer screen; then select "**Print,**" and then "**Print Preview**") close "**Print Preview.**" The page numbers should update.

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Calculation # PA-0243_____ Rev. _0____ Add. ___B___

1. Record of Revision and Addenda

Initial Issue – Calculated the dose rate at the ISFSI fence and the off-site annual dose from normal operations.

Addendum A – Calculated similar dose rates and annual doses for fully loaded ISFSI pads.

Addendum B – Added the impact of gaps between HSMs caused by earthquake motion.

2. Cumulative Effects Review (Required for Revisions and Addenda)

All of the documents listed in the Record of Revision and Addenda have been reviewed. The purpose of the original calculation and Addendum A continue to be satisfied and the conclusion of this addendum reflects the cumulative effects of the changes.

3. References

1) Calculation PA-0243, Revision 0 through Addendum A, "Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems".

2) ETE-NAF-2011-0170, Rev. 1, "North Anna ISFSI NUHOMS Horizontal Storage Modules (HSM) Concrete Gap Inspections."

3) Transnuclear Calculation 10494-184, "Impact on the HSM-H dose rates due to gaps between HSM-H modules-NUHOMS-32HD".

4. Computer Codes Used

None

5. Identification of Computer Inputs and Outputs

None

6. *Purpose*

See the title page.

7. *Background (OPTIONAL)*

N/A

8. *Design Inputs*

Design Input	Value	Reference
Peak fence dose rate	2.392 mrem/hr	Reference 1
Site boundary dose rate	7.2E-04 mrem/hr	Reference 1
Site boundary annual dose assuming 100% occupancy	6.3 mrem/yr	Reference 1
Site boundary annual dose assuming 40 hrs/wk occupancy	1.5 mrem/yr	Reference 1
Dose rate increase (multiplier) at the surface of an HSM resulting from a 1.5" gap between HSM-H modules	< 1.35	Reference 3
Dose rate increase (multiplier) at 200 meters resulting from 1.5" gaps between each HSM in a 2X10 array of HSMs	1.35	Reference 3
Number of gaps ≥0.75" between HSMs on NAPS ISFSI Pad 2	4	Reference 2, Attachment 2
Site Boundary dose rate contribution per HSM	1.049E-5 mrem/hr	Reference 1

9. Assumptions

It is assumed that the gaps between HSMs occur at a point where the ISFSI fence is not shielded by an earthen berm. This is a conservative assumption.

It is assumed that the gaps between HSMs occur at locations where line-of-site direct-shine contributions to off-site dose rates are not reduced due to shielding by earthen berms or other storage systems within the ISFSI.

10. Methodology

The dose rate increase at the ISFSI fence will be calculated based on the multiplier of 1.35, representing the dose rate increase at the surface of the HSM (due to gaps $\geq$0.75" and $\leq$1.5" between the HSMs). This would hold true for a full array with gaps between HSMs and is conservative when only a few (in this case 4) gaps exist. This methodology is based on the concept of point-kernel shielding and superposition of sources.

The annual dose increase at the site boundary will be determined by multiplying the number of gaps by the dose rate per HSM and then multiplying by 1.35. This is conservative because it uses the 200 meter multiplier at longer distances. This is based on point kernel shielding modeling.

11. Calculations

Using a multiplier of 1.35, the peak ISFSI fence dose rate becomes 3.3 mrem/hr. This is a conservative, bounding design basis value. Actual dose rates based on nominal fuel loadings and subsequent radioactive decay are expected to be lower. If measured dose rates are considered too large, temporary shielding or moving the ISFSI fence should be considered (these are consistent with past operations at Dominion ISFSIs).

Using a multiplier of 1.35, the contribution to the dose rate at the site boundary from four HSM module gaps is calculated to be (1.049E-5 mrem/hr)(4)(1.35 – 1) = 1.469E-5 mrem/hr. Assuming 365.25 days per year, the contribution to the annual dose assuming 100% occupancy is 0.13 mrem, for a total annual dose at the site boundary of 6.5 mrem (assuming 100% occupancy). For the 40hr/week occupancy case, the increase in total annual dose is 0.13 mrem x 40 / (7x24) = 0.03 mrem, for a total dose at the site boundary of 1.6 mrem (assuming 40 hr/wk occupancy).

12. Acceptance Criteria (OPTIONAL)

N/A

13. Results and/or Conclusions

Peak ISFSI fence dose rate	3.3 mrem/hr
Site boundary annual dose assuming 100% occupancy	6.5 mrem/yr
Site boundary annual dose assuming 40 hrs/wk occupancy	1.6 mrem/yr

14. Precautions and Limitations

None

15. Recommendations (OPTIONAL)

N/A

16. Calculation Review Checklist

See Attachment 1.

17. List of Attachments

Attachment 1 – Calculation Review Checklist

Dominion

Calculation Review Checklist

Calculation # PA-0243_ Rev. ___0_ Add. _B___ Attachment 1

NOTE: If "Yes" is not answered, an explanation may be provided below. Reference may be made to explanations contained in the calculation or addendum.

Questions:	Yes	N/A
1. Have the sources of design inputs been correctly selected and referenced in the calculation?	[X]	[ ]
2. Are the sources of design inputs up-to-date and retrievable/attached to the calculation?	[X]	[ ]
3. Where appropriate, have the other disciplines reviewed or provided the design inputs for which they are responsible?	[ ]	[X]
4. Have design inputs been confirmed by analysis, test, measurement, field walkdown, or other pertinent means as appropriate for the configuration analyzed?	[ ]	[X]
5. Have the bases for assumptions been adequately and clearly presented and are they bounded by the Station Design Basis?	[X]	[ ]
6. Were appropriate calculation/analytic methods used and are outputs reasonable when compared to inputs?	[X]	[ ]
7. Are computations technically accurate?	[X]	[ ]
8. Has the calculation made appropriate allowances for instrument errors and calibration equipment errors?	[ ]	[X]
9. Have those computer codes used in the analysis been referenced in the calculation?	[ ]	[X]
10. Have all exceptions to station design basis criteria and regulatory requirements been identified and justified in accordance with NQA-1-1994?	[ ]	[X]
11. Has the design authority/original preparer for this calculation been informed of its revision or addendum, if required?	[X]	[ ]

Comments: (Attach additional pages if needed)

None

Signature: [redacted] Date: 10-8-12
(Preparer)

Signature: [redacted] Date: 10-9-12
(Reviewer)

Note: Physical or electronic signatures are acceptable.

INDEX DOCUMENT INFORMATION FORM

CALC-PA-243, Rev. 0, Add. B, "Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems, " by [redacted] dated SEP 20 2012.

INDEX DOCUMENT INFORMATION
Index Document ID: 243-0-B
Index Entry Preparer(s): [redacted]
Index Entry Reviewers: None

Document Title: Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems
Document Author: [redacted]
Document Date: 09/20/2012
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Responsible Group: NAF-RAD - Radiological Engineering Group
Applicable Sites: North Anna Unit 1,North Anna Unit 2
Project ID(s): ISFSI-North Anna
Vendor Deliverable?: No
Owner Review Performed?: No
Owner Review Comments:

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Records Management Document SubType: NFL
Applicable Sites: North Anna Unit 1,North Anna Unit 2
User Specified Instructions:
Additional Records Management Information: NOTE TO DOCUMENT PREPARER CONCERNING CALC STATUS CHANGE FORMS: A Calculation Status Change Form should be submitted (via INDEX) to, and processed by, Nuclear Document Management as a Supporting Document with Supporting DocType=RCN. The Document Number on the Calculation Status Change Form (and in INDEX) should be set to be equal to the Document Type (CALC), Document Number/ID (e.g., ME-1234), and Revision Number of the Calculation for which the Status is being changed. The basis for the Calculation Status Change must be documented on the Calculation Status Change Form, and the Preparer and Approver (Supervisor) must sign (or electronically authenticate) the form.
Site Specific Records Management Instructions: NOTE TO DOCUMENT PREPARER: Processing of Calculations is governed by both Procedure RM-AA-101 and site-specific requirements described in GARD CM-AA-CLC-301-1001, Attachment 4, Section 5.0. Per GARD CM-AA-CLC-301-1001, Calculations are subjected to engineering review by the KPS DBD Process Owner prior to processing of the document by Kewaunee Nuclear Document Management. Calculation preparers must include a completed DBD Load Form GNP-05.27.07-1 per Procedure GNP-05.27.07 as part of the Calculation. When the INDEX entry is Sent to Recipients, the Calculation and its data are automatically submitted to the KPS DocEm location, which is monitored by the KPS DBD Process Owner. The DBD Process Owner will incorporate the data in the DBD Load Form (GNP-05.27.07-1) per Procedure GNP-05.27.07 into the Design Basis Database.NOTE TO DOCUMENT PREPARER: Processing of Calculations is governed by both Procedure RM-AA-101 and site-specific requirements described in GARD CM-AA-CLC-301-1001, Attachment 5, Section 6.0. Per GARD CM-AA-CLC-301-1001, Calculations are subjected to engineering review by the MPS Passport Process Owner prior to processing of the document by Millstone Nuclear Document Management. Calculation preparers must include a completed Passport Database Input Form as part of the Calculation. When the INDEX entry is Sent to Recipients, the Calculation and its data are automatically submitted to the MPS DocEm location, which is monitored by the MPS Passport Process Owner. The Passport Process Owner will incorporate the data into the controlled Documents module of Passport prior to processing the Calculation into Documentum.

RELATED REFERENCES

INDEX DOCUMENT INFORMATION FORM - Files

FILES USED TO CREATE FINAL DOCUMENT PACKAGE

1. CM-AA-CLC-301 Rev 6 Att 2 - Cover Sheet (731189 (Mar 2012)).doc (9/20/2012 9:38:37 AM)
2. CM-AA-CLC-301 Rev 6 Att 3 - Calculation Worksheet (729292 (Mar 2012)).doc (10/8/2012 4:50:07 PM)
3. CM-AA-CLC-301 Rev 6 Att 4 (731190(MAR 2012)).doc (10/8/2012 4:54:32 PM)

COMPUTER I/O FILES

None

INDEX DOCUMENT INFORMATION FORM - Correspondence

ASSOCIATED CORRESPONDENCE

SENT DATE:

Recipients: None

CC Recipients:

LETTER TEXT

INDEX DOCUMENT INFORMATION FORM - Approvals

CALC-PA-243, Rev. 0, Add. B, "Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems, " by [redacted], dated SEP 20 2012.

APPROVER	PURPOSE OF ELECTRONIC AUTHENTICATION	DATE APPROVED
()	Calculation Preparer	
()	Calculation Reviewer	
()	Calculation Approver	
()	Approval - Passport Process Owner Approval (MPS Only)	

Calculation Cover Sheet

CM-AA-CLC-301 ATTACHMENT 3 Page 1 of 1

Complete the fields with text or an **X** as required.

Page 1 of 11

Calculation Number: PA-0243	Revision: 0	Addendum: C	Sub type: NFL	Decommissioning Record? ☐ Yes ☒ No
Vendor (If not Dominion): N/A		Calculation Preparation Risk: ☒ Low ☐ Medium ☐ High		
Vendor Proprietary: ☒ Yes ☐ No				
Calculation Quality Class: ☐ Safety Related ☒ NSQ ☐ Non-Safety Related				
Subject (Calculation Title): Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems				
Addendum Title: Impact on the ISFSI dose rates of placing a TN-32B HBU Demonstration Cask on Pad 1				
Station(s) and Unit(s): NA ☐ 1 ☐ 2 ☐ 3 ☒ ISFSI KW ☐ ☐ ISFSI SU ☐ 1 ☐ 2 ☐ ISFSI MP ☐ 1 ☐ 2 ☐ 3 ☐ ISFSI				
Affected System(s), Structure(s), or Component(s): N/A				

Purpose (Executive Summary):

The objective of this addendum is to evaluate the impact on the ISFSI dose rates of placing one TN-32B HBU demonstration cask on the ISFSI Pad 1 in location 01-28, which is the northeast corner of Pad 1. The HBU demonstration cask will be loaded with 32 North Anna high burnup fuel assemblies. This calculation demonstrates that the ISFSI fence dose rates increase by up to 0.077 mrem/hr and the site boundary annual dose does not increase.

****** Contains AREVA-TN Proprietary Information ******

Originator (Qual. Required): Printed Name [1][3]		Signature: [1][3]	Date: [1][3]
[redacted]		[redacted]	6-29-15
Reviewer (Qual. Required): Printed Name [1]	Type of Review: [2] Independent	Signature:	Date:
[redacted]		[redacted]	6-29-15
Approver: Printed Name		Signature:	Date:
[redacted]		[redacted]	6/30/15

Note: Physical or electronic signatures are acceptable.

Note: (1) Add lines for additional originators or reviewers as necessary. (2) Note if reviews are "Independent," "Peer", "Subject Matter Expert", "Supervisor", or "Owner's". (3) Enter N/A for Owner's Review of Vendor Calculation.

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Record of Revisions and Addenda

Initial Release: Determined the on-site and off-site annual radiation doses resulting from the normal operation of the North Anna ISFSI after installation of 12 NUHOMS dry fuel storage system modules in addition to one pad full of TN-32 dry fuel storage casks.

Addendum A: Determined the on-site and off-site annual radiation does resulting from the normal operation of the North Anna ISFSI after installing a total of 40 NUHOMS dry fuel storage system modules in addition to 28 TN-32 dry fuel storage casks.

Addendum B: Determined the on-site and off-site dose contributions from gaps between the NUHOMS storage modules.

Cumulative Effects Review (Required for Revisions and Addenda)

The original purpose of PA-0243 Rev. 0 was to calculate ISFSI fence dose rates and off-site annual doses associated with the normal operation of the North Anna ISFSI. This addendum updated the results of that calculation, including the results of Addenda A and B, to include the effects of the TN-32B HBU cask. Therefore, the original purpose of this calculation is satisfied. All changes associated with Addenda A and B are included in the results generated here.

References

1) Calculation PA-0243 Rev. 0 through Addendum B, "Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems," October 2012.
2) Calculation PA-181 Rev. 0 through Addendum B, "North Anna ISFSI Cask Surface, Perimeter Fence, Site Boundary, and Nearest Permanent Resident Dose Rates Based on the TN-32 Dry Storage Cask," May 2003.

Computer Codes Used

None

Identification of Computer Inputs and Outputs

None

Purpose (Optional)

See the cover page.

Background (Optional)

N/A

Design Inputs

The calculation is performed in six phases, each with separate requirements for design inputs and assumptions. Thus, the design inputs are divided into six phases to simplify identification of data used in each of the six phases of the calculation. These design inputs, out of context, may not present a clear picture of the analysis. To achieve an understanding of why these design inputs were chosen, the reader is directed to the "Methodology" section of this calculation.

Table 4 of PA-0181, Addendum A, provides the neutron dose from a single TN-32 cask as a function of distance from the cask. That data is reproduced here:

Table 1 – Neutron Dose Rate from a Single TN-32 Cask

distance (meters)	mRem/hr
50	9.82E-03
460	2.59E-05
1500	4.42E-09
2460	7.35E-12

Table 5 of PA-0181, Addendum A, provides the gamma dose from a single TN-32 cask as a function of distance from the cask. That data is reproduced here:

Table 2 – Gamma Dose Rate from a Single TN-32 Cask

distance (meters)	mRem/hr
2.00	3.34E+01
3.05	1.42E+01
6.10	3.38E+00
9.14	1.43E+00
12.20	8.34E-01
15.20	5.20E-01
30.50	1.21E-01
50.00	4.38E-02
61.00	2.87E-02
91.40	1.16E-02
122.00	5.91E-03
152.00	3.48E-03
305.00	5.52E-04
460.00	1.40E-04
610.00	4.45E-05
914.00	5.06E-06
1220.00	6.68E-07
1520.00	7.32E-08

Tables 4.5-1 and 4.5-2 of the TN-32B HBU Demonstration Cask Design License Basis Document (included in Attachment 2 of this calculation) provided the total dose rate and the skyshine dose rate as a function of distance from a TN-32B HBU cask. That data is reproduced here:

Table 3 – Total and Skyshine Dose Rate from a Single TN-32B HBU Cask

distance (meters)	Total Dose Rate (mrem/hr)	Skyshine Dose Rate (mrem/hr)
2	2.40E+01	1.60E+00
5	9.27E+00	1.49E+00
10	2.92E+00	3.28E-01
20	8.10E-01	1.05E-01

50	1.31E-01	3.31E-02
100	2.78E-02	1.04E-02
150	9.24E-03	3.38E-03
200	3.99E-03	2.13E-03
300	9.69E-04	5.75E-04
400	3.03E-04	1.91E-04
500	1.07E-04	7.06E-05

Consistent with PA-0243, Rev. 0 (page 6) and PA-0181, Rev. 0 (page 19), the nearest site boundary is at 2500 feet (**762 meters**).

The distance from the west-side ISFSI fence to the centerline of Pad 1 is 350 feet (**107 meters**). The distance from the east-side ISFSI fence to the centerline of Pad 1 is 400 feet (**122 meters**). The distance from the north fence to the north end of Pad 1 is 233 feet (**71 meters**). The distance from the south fence to the south end of Pad 1 is 203 feet (**62 meters**), and the length Pad 1 is 224 feet (**68 meters**).These values are taken from PA-0243, Rev. 0, page 6.

PA-0243, Rev. 0 Addendum B concluded that the peak ISFSI fence dose rate was **3.3 mrem/hr**, the site boundary annual dose assuming 100% occupancy was **6.5 mrem/yr**, and the site boundary annual dose assuming 40 hrs/week occupancy was **1.6 mrem/yr**.

Assumptions

Shielding of the TN-32B HBU cask by the other casks and storage systems that are part of the ISFSI is not modeled. This is conservative in this analysis because it will increase the resulting calculated dose rates.

Interpolations of dose rates vs. distance are performed by linear interpolation of the $\log_{10}$ of the dose rate. This is performed to smooth the shape versus distance and is acceptable because 1) at large distances the rate-of-change in dose rate is exponential and 2) at shorter distances, where the dose rates can change as a function of the square of the distance, the $\log_{10}$ of the dose rate is a smoother function of distance and more amenable to linear interpolation. Any extrapolations to shorter distances will use linear extrapolation of the $\log_{10}$ of the dose rate. This will under-predict the dose rate at short distances because the dose rate in air at short distances will likely change as a function of $1/x^2$ (when a cask can be approximated by a point source) or $1/x$ (when a cask can be approximated by a line source). Both $1/x^2$ and $1/x$ functions will vary more rapidly than an exponential function at short distances. However, under-predicting the dose rates from the current ISFSI will result in over-predicting any incremental dose rate increase caused by replacing a standard TN-32 cask with a HBU cask. Thus, this is a conservative methodology when calculating the incremental impact of using a HBU cask in the ISFSI.

Methodology

The original analyses in PA-0243 Rev. 0 through Addendum B modeled the ISFSI Pad 1 with all storage locations occupied by standard TN-32 casks. Thus the impact of storing one TN-32B HBU cask in place of one TN-32 cask can be evaluated by determining the net difference (increase or decrease) in the dose rate versus distance between the two cask designs. Given the distance to the ISFSI fence and off-site locations, the incremental impact on dose rates at those locations can then be determined.

Earthen berms are located on the north and east sides of the ISFSI. Changes in the doses at off-site locations are modeled assuming no shielding from the berms by using the incremental change in the total dose rate versus distance. Doses at the south and west ISFSI fence lines are evaluated in a similar manner.

Calculations

The neutron and gamma dose rates from the TN-32 cask were combined to determine the total dose rate versus distance from a TN-32 cask. Since the distance scales used in Tables 1 and 2 are not identical, the neutron dose rates from Table 1 were interpolated and extrapolated to calculate neutron dose rates at the distances in Table 2. The resulting values are as follows:

Table 4 – Updated Gamma, Neutron, and Total dose rates from a TN-32 Cask

distance (meters)	Gamma dose rate (mrem/hr)	Neutron dose Rate (mrem/hr)	Total dose rate (mrem/hr)
50.00	4.38E-02	9.82E-03	5.36E-02
61.00	2.87E-02	8.37E-03	3.71E-02
91.40	1.16E-02	5.39E-03	1.70E-02
122.00	5.91E-03	3.46E-03	9.37E-03
152.00	3.48E-03	2.24E-03	5.72E-03
305.00	5.52E-04	2.44E-04	7.96E-04
460.00	1.40E-04	2.59E-05	1.66E-04
610.00	4.45E-05	7.41E-06	5.19E-05
914.00	5.06E-06	5.87E-07	5.65E-06
1220.00	6.68E-07	4.57E-08	7.14E-07
1520.00	7.32E-08	3.87E-09	7.71E-08

The total dose rates in Table 4 were then interpolated to produce values at the distances given in Table 3. The results, along with the dose rates from Table 3, are as follows:

Table 5 – Total Dose Rates from the TN-32B and TN-32 Casks

Distance (meters)	Total TN-32B HBU Dose Rate (mrem/hr)	Total TN-32 Dose Rate (mrem/hr)
50	0.131	0.054
100	0.0278	0.0144
150	9.24E-03	5.91E-03
200	3.99E-03	3.08E-03
300	9.69E-04	8.49E-04
400	3.03E-04	3.04E-04
500	1.07E-04	1.22E-04

The dose rates from the TN-32B HBU cask are higher at intermediate distances ranging from 50 meters to 300 meters, with the differences generally decreasing with distance. At longer distances the original TN-32 dose rates are higher. Thus the dose rates from Pad 1 filled with the original TN-32 casks will be bounding at the site boundary (762 meters), even when spacing of the TN-32 and TN-32B casks are accounted for. **No changes will be made to the annual dose at the site boundary.**

The closest point on each side of the ISFSI fence to the TN-32B HBU cask range approximately (i.e. not including cask spacing issues) from 71 meters (north fence) to 130 meters (south fence). The increase in dose rates from the TN-32B HBU cask relative to the standard TN-32 cask can be conservatively estimated by using the data from Table 5 at 50 meters. This data shows an increase in total dose rate of **0.077 mrem/hr**. Where an earthen berm protects the fence, the dose rate should increase by no more than the skyshine dose rate from the TN-32B HBU cask at 50 meters, or **0.033 mrem/hr**. The peak calculated ISFSI fence dose rate increases from the value calculated in PA-0243 Rev. 0 Addendum B to 3.3 mrem/hr+0.077 mrem/hr = **3.4 mrem/hr**.

Acceptance Criteria (Optional)

N/A

Results and/or Conclusions

The resulting conservative dose rates and annual doses for the ISFSI (including 27 TN-32 casks, one TN-32B HBU cask, and 40 NUHOMS modules) are:

Peak ISFSI fence dose rate	3.4 mrem/hr
Site Boundary annual dose assuming 100% occupancy	6.5 mrem/yr
Site boundary annual dose assuming 40 hrs/wk occupancy	1.6 mrem/yr

Precautions and Limitations

None

Recommendations (Optional)

None

Calculation Review Checklist

The Calculation Review Checklist is included in Attachment 1.

List of Attachments

Attachment 1 – Calculation Review Checklist (1 page)

Attachment 2 – Selected Pages of the TN-32B HBU Demonstration Cask Design License Basis Document (13 pages)

Calculation Review Checklist

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CM-AA-CLC-301 ATTACHMENT 5 Page 1 of 1

Attachment 1

Calculation # _PA-0243_____ Rev. ___0___ Add. __C____

NOTE: If "Yes" is not answered, an explanation may be provided below. Reference may be made to explanations contained in the calculation or addendum.

Questions:		Yes	N/A
1.	Have the sources of design inputs been correctly selected and referenced in the calculation?	[X]	[ ]
2.	Are the sources of design inputs up-to-date and retrievable/attached to the calculation?	[X]	[ ]
3.	Where appropriate, have the other disciplines reviewed or provided the design inputs for which they are responsible?	[X]	[ ]
4.	Have design inputs been confirmed by analysis, test, measurement, field walkdown, or other pertinent means as appropriate for the configuration analyzed?	[X]	[ ]
5.	Have the bases for assumptions been adequately and clearly presented and are they bounded by the Station Design Basis?	[X]	[ ]
6.	Were appropriate calculation/analytic methods used and are outputs reasonable when compared to inputs?	[X]	[ ]
7.	Are computations technically accurate?	[X]	[ ]
8.	Has the calculation made appropriate allowances for instrument errors and calibration equipment errors?	[X]	[ ]
9.	Have those computer codes used in the analysis been referenced in the calculation?	[X]	[ ]
10.	Have all exceptions to station design basis criteria and regulatory requirements been identified and justified in accordance with NQA-1-1994?	[X]	[ ]
11.	Has the design authority/original preparer for this calculation been informed of its revision or addendum, if required?	[X]	[ ]
12.	Was the pre-job brief completed without any identified HU error precursors/compensating actions? (If HU error precursors/compensating actions were identified, then mark N/A and provide explanation/summary below or attach pre-job brief form to calculation.)	[X]	[ ]

Comments: (Attach additional pages if needed)
N/A

Signature: [redacted] Date: 6-4-15
(Preparer)

Signature: [redacted] Date: 6/9/15
(Reviewer)

Signature: [redacted] Date: _____
(Owner's Review, if applicable)

Note: Physical or electronic signatures are acceptable.

PA-0243, Rev. 0, Add. C, Attachment 2 has been redacted due to AREVA-TN proprietary information.

This redacted attachment is Section 4.0 of the Design and Licensing Basis Document, E-42038. This redacted information was previously provided to the NRC in Attachment 4 of the LAR, Dominion Letter, S/N 15-369 on August 24, 2015.

PA-0243, Rev. 0, Add. C, Attachment 2 has been redacted due to AREVA-TN proprietary information.

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INDEX DOCUMENT INFORMATION FORM

"Dose Rate Evaluation of the North Anna ISFSI Based on TN-32 and NUHOMS HD Storage Systems," CALC-PA-243, Rev. 0, Add. C, by [redacted], dated JUN 30 2015.

INDEX DOCUMENT INFORMATION
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Additional Records Management Information: NOTE TO DOCUMENT PREPARER CONCERNING CALC STATUS CHANGE FORMS: A Calculation Status Change Form should be submitted (via INDEX) to, and processed by, Nuclear Document Management as a Supporting Document with Supporting DocType=RCN. The Document Number on the Calculation Status Change Form (and in INDEX) should be set to be equal to the Document Type (CALC), Document Number/ID (e.g., ME-1234), and Revision Number of the Calculation for which the Status is being changed. The basis for the Calculation Status Change must be documented on the Calculation Status Change Form, and the Preparer and Approver (Supervisor) must sign (or electronically authenticate) the form.
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RELATED REFERENCES

INDEX DOCUMENT INFORMATION FORM - Files

FILES USED TO CREATE FINAL DOCUMENT PACKAGE

1. PA-0243 Add C long version.docx (6/29/2015 11:10:12 AM)
2. NA-PROCNA-ADM-CM-AA-CLC-301 (731189(SEP 2014) ATT 3-EFORM-doc).doc (6/29/2015 11:23:34 AM)
3. NA-PROCNA-ADM-CM-AA-CLC-301 (731190(SEP 2014) ATT 5-EFORM-doc).doc (5/22/2015 3:56:04 PM)

COMPUTER I/O FILES

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INDEX DOCUMENT INFORMATION FORM - Correspondence

ASSOCIATED CORRESPONDENCE

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Recipients: [redacted]

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