From: <Joseph_Hegner@dom.com>
To: <bxs2@nrc.gov>
Date: Mon, Jul 25, 2005 9:32 AM
Subject: Dominion Letter with Seismic Information/Rev 5 North Anna ESP Application

Belkys,

Attached is the Dominion letter that provides additional (or corrected) seismic information. It also transmits Rev. 5 of the North Anna ESP Application.

Joe H.

(See attached file: 072505 Dominion Letter.pdf)

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Subject: Dominion Letter with Seismic Information/Rev 5 North Anna ESP Application
Creation Date: Mon, Jul 25, 2005 9:31 AM
From: <Joseph_Hegner@dom.com>

Created By: Joseph_Hegner@dom.com

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Dominion Nuclear North Anna, LLC
5000 Dominion Boulevard, Glen Allen, VA 23060

Dominion®

July 25, 2005

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

Serial No. 05-457
ESP/JDH
Docket No. 52-008

DOMINION NUCLEAR NORTH ANNA, LLC
NORTH ANNA EARLY SITE PERMIT APPLICATION
FINAL SAFETY EVALUATION REPORT REVIEW ITEMS AND REVISION 5 TO THE NORTH ANNA ESP APPLICATION

On June 16, 2005, the NRC issued its Final Safety Evaluation Report (FSER) for the North Anna Early Site Permit Application. As part of our review of the FSER, we identified several corrections that must be made to documents Dominion previously submitted to the NRC. Enclosure 1 to this letter describes those corrections.

The North Anna ESP Application has been updated to reflect the corrections. A summary of the changes in Revision 5 of the ESP Application is provided in Enclosure 2. A CD containing Revision 5 of the ESP Application is provided as Enclosure 3.

If you have any questions or require additional information, please contact Mr. Joseph Hegner at 804-273-2770.

Very truly yours,

Eugene S. Grecheck
Vice President-Nuclear Support Services

Enclosures:

1. Final Safety Evaluation Report Review Items
2. Description of Changes in Revision 5
3. One CD-ROM labeled "North Anna Early Site Permit Application, Docket No. 52-008, September 2003; Revision 5, July 2005, NRC ADAMS Edition," containing the following files:

- North Anna ESP Application R5 (1 of 8).pdf; 9355 KB; publicly available
- North Anna ESP Application R5 (2 of 8).pdf; 28,064,970 bytes, publicly available
- North Anna ESP Application R5 (3 of 8).pdf; 49,772,302 bytes, publicly available
- North Anna ESP Application R5 (4 of 8).pdf; 47,578,761 bytes, publicly available
- North Anna ESP Application R5 (5 of 8).pdf; 43,787,240 bytes, publicly available
- North Anna ESP Application R5 (6 of 8).pdf; 34,327,107 bytes, publicly available
- North Anna ESP Application R5 (7 of 8).pdf; 51,600,526 bytes, publicly available
- North Anna ESP Application R5 (8 of 8).pdf; 32,215,787 bytes, publicly available

Commitments made in this letter: None

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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 Support Services, of Dominion Nuclear North Anna, LLC. He has affirmed before me that he is duly authorized to execute and file the foregoing document on behalf of Dominion Nuclear North Anna, LLC, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 25TH day of July, 2005

My Commission expires: May 31, 2006

Vicki L. Hull
Notary Public

(SEAL)

Enclosure 1

Final Safety Evaluation Report Review Items

Correction of Coordinates for ESP Site Footprint

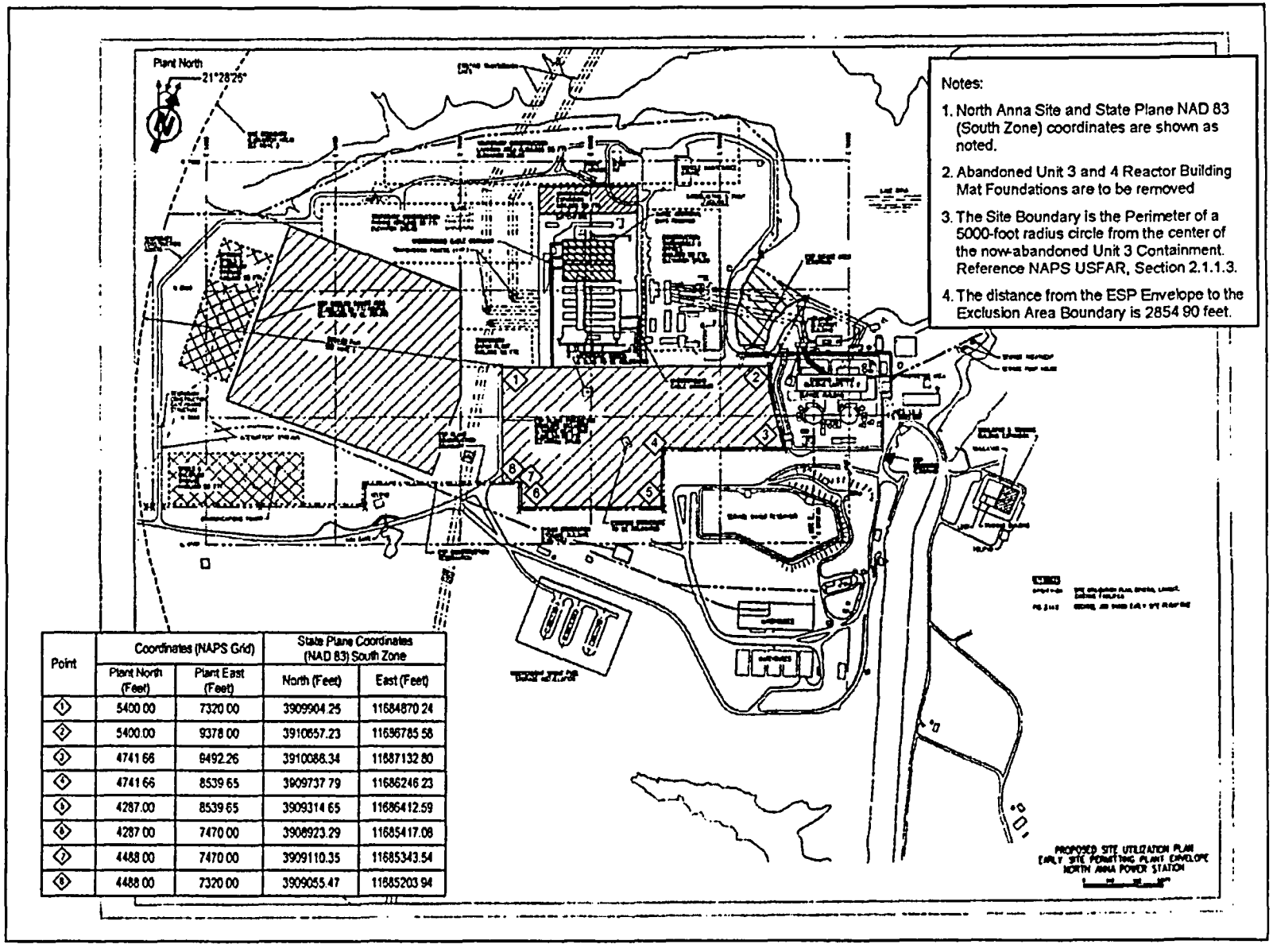
Coordinates for the ESP site footprint were submitted to the NRC in response to Draft Safety Evaluation Report (DSER) Open Item 2.4-1 (Dominion Letter 05-785B dated March 3, 2005).

As discussed in a July 5, 2005 conference call with NRC Staff, upon further review, it has been determined that the coordinates identified in Figure 1 of the DSER Open Item 2.4-1 response contained errors.

A corrected version of Figure 1 is provided on the next page.

Application Revision

None. Figure 1 on the next page is not included in the North Anna ESP Application.



Point	Coordinates (NAPS Grid)		State Plane Coordinates (NAD 83) South Zone	
	Plant North (Feet)	Plant East (Feet)	North (Feet)	East (Feet)
1	5400 00	7320 00	3909904 25	11684870 24
2	5400.00	9378 00	3910657.23	11696785 58
3	4741 66	8492.26	3910088.34	11687132 80
4	4741 66	8539 65	3909737 79	11686246 23
5	4287.00	8539 65	3909314 65	11686412.59
6	4287 00	7470 00	3908923.29	11685417.08
7	4488 00	7470 00	3909110.35	11685343.54
8	4488 00	7320 00	3909055.47	11685203 94

Incorrect Version of SSAR Figure 2.5-55A

In Dominion's response to DSER Open Item 2.5-2 (Dominion Letter 05-194 dated March 30, 2005), a new SSAR figure, Figure 2.5-55A, was included titled:

Figure 2.5-55A	Selected Horizontal and Vertical OBE and SSE Spectra for the Hypothetical Rock Outcrop Control Point at the Top of Zone III-IV Material (Representative Elevation 250 ft, 3300 ft/sec Shear Wave Velocity)

Revision 4 of the North Anna ESP Application included an incorrect version of SSAR Figure 2.5-55A. (A duplicate copy of SSAR Figure 2.5-55 was inadvertently included as SSAR Figure 2.5-55A.)

The correct version of SSAR Figure 2.5-55A has been incorporated in Revision 5 of the ESP Application.

Application Revision

In Revision 5 of the ESP Application, SSAR Figure 2.5-55A has been replaced with the correct version shown on the next page.

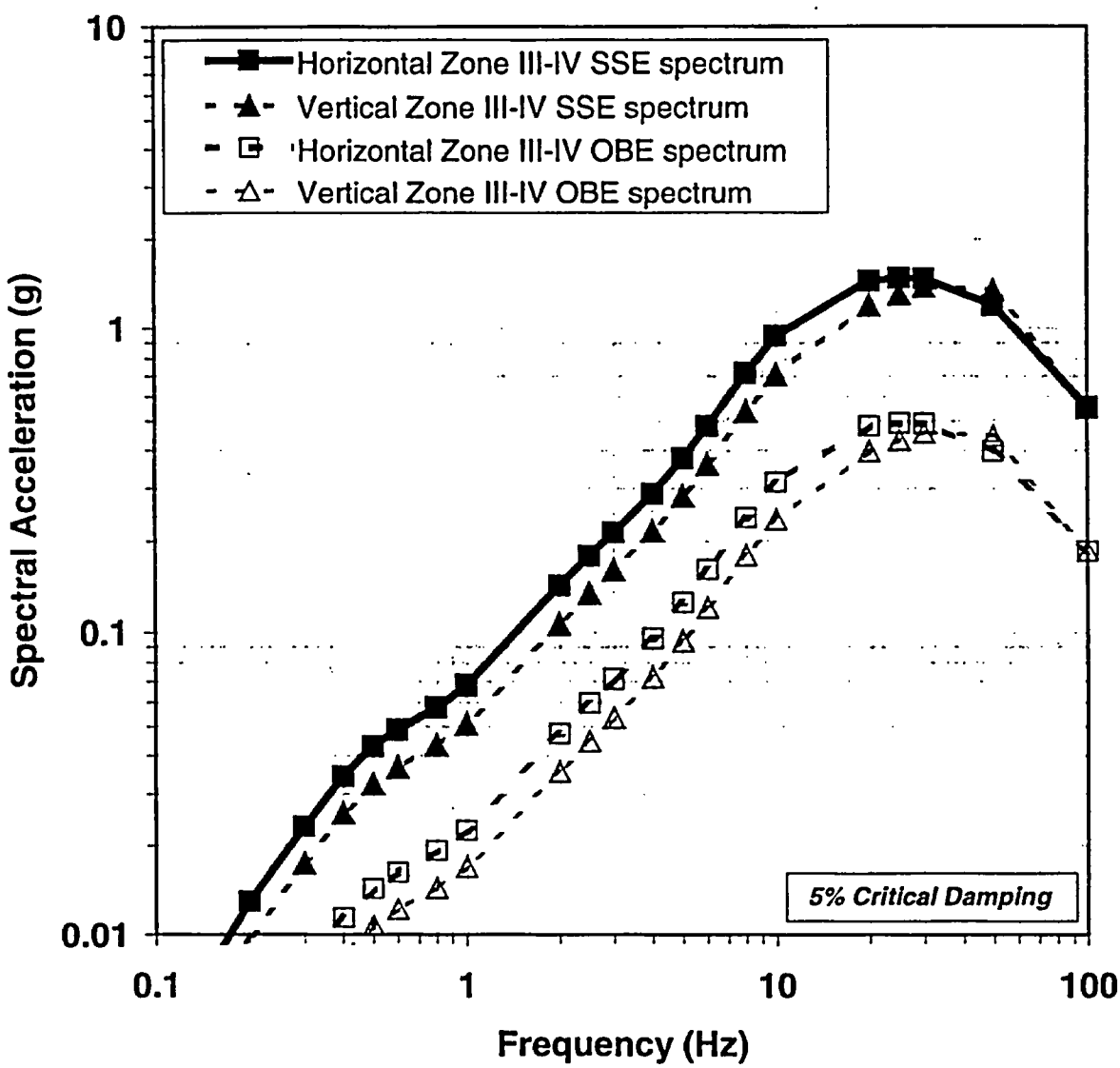


Figure 2.5-55A **Selected Horizontal and Vertical OBE and SSE Spectra for the Hypothetical Rock Outcrop Control Point at the Top of Zone III-IV Material (Representative Elevation 250 ft, 3300 ft/sec Shear Wave Velocity)**

Confirmatory Analysis of V/H Ratios for Zone III-IV Hypothetical Rock Outcrop Control Point SSE Spectrum

In Revision 4 of the North Anna ESP Site Safety Analysis Report (SSAR), the site horizontal and vertical safe shutdown earthquake (SSE) spectra were estimated at a control point at the top of a hypothetical outcrop of Zone III-IV material having a best estimate shear wave velocity of 3,300 ft/sec. The vertical SSE was determined using V/H ratios from NUREG/CR-6728 (Reference 171 of SSAR Section 2.5) that are listed in SSAR Table 2.5-27A. These V/H ratios are identical to those used for hard rock conditions (see SSAR Table 2.5-27).

As discussed in a July 14, 2005 conference call with NRC Staff, upon further evaluation, it has been determined that the NUREG/CR-6728 V/H ratios apply explicitly to hard rock conditions with a shear wave velocity of 9,200 ft/sec. The NUREG/CR-6728 V/H ratios are not explicitly appropriate for the site-specific shear wave velocity profile and controlling earthquake magnitude and distance for the North Anna ESP site.

A site-specific analysis has been performed to investigate the appropriateness of the V/H ratios listed in SSAR Table 2.5-27A for the characteristics of the North Anna ESP site. A description of the site-specific analysis is provided in the following section.

Site-Specific Analysis of V/H Ratios

1. Description of Site-Specific Analysis

A site-specific vertical to horizontal (V/H) spectral ratios analysis has been performed following a methodology similar to that used in NUREG/CR-6728 (Reference 171 of SSAR Section 2.5), which is the source of the V/H spectral ratios in SSAR Table 2.5-27A. For the analysis, site-specific shear and compressional wave (S- and P-wave) profile data were used along with the high frequency deaggregation results from the probabilistic seismic hazards analysis (PSHA). The stochastic point source ground motion model was used with an implementation of random vibration theory to generate the horizontal and vertical ground motions and subsequent V/H spectral ratios.

To maintain a consistency between the S- and P-wave profiles, the P-wave profile was developed from a model of Poisson's ratio with depth rather than the P-wave velocity data for the site. This application of the Poisson's ratio model to the previously developed S-wave profile maintains the consistency between the S- and P-wave profiles developed for the site. The Poisson's ratio values were derived from the site S- and P-wave data. Based on the distribution of observed Poisson's ratio data, two models were developed which, when applied to the single S-wave profile, resulted in

two P-wave profiles for the analysis. The first model was based on the older subsurface data from the Units 1 and 2 investigation, using the profiles from borings B-20 and B-104, and Well #1. The more recent ESP investigation data from boring B-802 were used to develop the second model. Preferred relative weights of 0.25 and 0.75 were used in the analysis for the P-wave Models 1 and 2, respectively; these weights were assigned based on the quality of the recently recorded ESP site investigation data compared to the older North Anna site data. The two Poisson's ratio models used in the analysis are shown in Figure 1 along with the site-specific data. The corresponding two P-wave velocity profiles are listed in Table 1 along with the S-wave and two Poisson's ratio models.

Four pairs of magnitude and distance values (weighted average magnitudes for given distance bins of the high-frequency PSHA deaggregation, shown in SSAR Figure 2.5-50) were used in the analysis. These same magnitude and distance pairs were used for both the horizontal and vertical ground motions. Associated deaggregation weights for these paired values, below, were used to combine the results.

Magnitude (M)	Distance (km)[1]	Weight[2]
5.1	7.5	0.34
5.3	22.5	0.33
5.7	37.5	0.25
6.1	75.0	0.08

[1] value used for the given distance bin
[2] contribution of the hazard for the given distance bin

Horizontal and vertical ground motions spectra, based on the magnitude-distance values and corresponding profiles listed in Table 1, were computed using a stochastic point source model and an implementation of random vibration theory. For each case, a total of 100 realizations were performed to provide a stable statistical estimate of the ground motions and corresponding V/H spectral ratios. Ground motions were computed based on a linear response at low strain material damping levels of 0.5, 1.0, 2.0, and 5.0%. The 2.0% damping level was chosen as the base case level and the additional three damping levels were used for a sensitivity analysis of the site-specific V/H ratios.

Statistical 16th, 50th, mean, and 84th percentile V/H spectral ratio values as a function of frequency were developed based on the relative weighting between the two P-wave profiles and four magnitude-distance cases from the high-frequency deaggregation results. These results were computed for the four damping levels.

2. Results

The statistical results of the V/H spectral ratios for the 0.5% damping level are shown in Figure 2. For comparison purposes, the V/H ratio for the 0.2g<PGA<0.5g bin from NUREG/CR-6728, which was used in SSAR Table 2.5-27A, is shown in Figure 2.

Similar plots for the additional damping levels of 1.0, 2.0, and 5.0% are shown in Figures 3, 4, and 5. The results for the base case damping level of 2.0% are tabulated in Table 2 for the 21 frequencies used in SSAR Table 2.5-27A.

3. Summary and Conclusions

A site-specific analysis of vertical to horizontal (V/H) spectral ratios for the North Anna ESP site was performed. Two P-wave profiles were developed which are consistent with the base case S-wave profile used in the PSHA. The results from these two models were assigned relative weights of 0.25 and 0.75 for P-wave Model 1 and 2, respectively. The higher weight of 0.75 was based on P-wave Model 2 being developed from the more recently recorded ESP site investigation data. Horizontal and vertical ground motion spectra were computed for four magnitude and distance values based on the 5-10 Hz PSHA deaggregation. The associated weights from the PSHA deaggregation for these four magnitude-distance values were combined with the assigned weights for the two P-wave models. The base case was run for a damping level of 2.0%. In addition, damping levels of 0.5, 1.0, and 5.0% were analyzed. These other damping values did not produce significantly different results (i.e., comparison of the results presented in Figures 2 through 5).

The 16th, 50th, and 84th percentiles and mean V/H ratios are shown in Figure 4 for the 2.0% damping case and listed in Table 2. For comparison, the V/H ratios from NUREG/CR-6728 for the 0.2g<PGA<0.5g case, which was used for SSAR Table 2.5-27A, are also shown in Figure 4 and listed in Table 2. On average, the mean V/H ratios from the site-specific analysis are approximately 30% lower (ranging from 18-35% lower) over the complete frequency range of 100 Hz to 0.1 Hz than the V/H ratios used in SSAR Table 2.5-27A. At the 84th percentile, the site-specific V/H ratio values are on average 8% lower (ranging from 19% lower to 5% higher) over the entire frequency range than the SSAR Table 2.5-27A V/H ratio values.

The comparison results provide justification that the V/H ratios given in NUREG/CR-6728 and used in SSAR Table 2.5-27A are appropriate for the North Anna ESP site. To maintain a hazard-consistent level in scaling the horizontal ground motions, the fractile level needed for the V/H ratio is between the 50th and 84th percentile. The exact percentile level would depend on frequency, site, design considerations, and judgment.

The site-specific analysis included the deaggregation information from the high frequency (i.e., 5-10 Hz) controlling earthquake only. If a more detailed analysis were performed, the deaggregation events from the low-frequency (i.e., 1-2.5 Hz) deaggregation would be included. In addition, the 5-10 Hz deaggregation events for distances greater than 75 km were included in the 75 km case. The above factors, if implemented, would result in smaller V/H ratios within the low-frequency range than those currently shown in Figure 4.

Table 1. S-wave profile, Poisson's ratio models, and corresponding P-wave profiles.

Thickness (m)	Base Case Vs (m/sec)	Model 1 Poisson's Ratio	Model 2 Poisson's Ratio	Model 1 P wave (m/sec)	Model 2 P wave (m/sec)
2.286	1102	0.3340	0.4267	2207.4	3082.2
2.286	1199	0.3326	0.4253	2394.3	3326.5
2.286	1295	0.3313	0.4240	2578.1	3564.5
2.286	1391	0.3299	0.4226	2760.9	3799.2
2.286	1488	0.3285	0.4212	2944.6	4033.4
2.286	1584	0.3272	0.4199	3125.3	4261.8
2.286	1680	0.3258	0.4161	3305.0	4431.2
2.286	1777	0.3244	0.4062	3485.6	4471.7
2.286	1873	0.3230	0.3964	3663.4	4521.1
2.286	1969	0.3217	0.3866	3840.2	4579.0
2.286	2066	0.3203	0.3767	4018.0	4645.8
2.286	2162	0.3189	0.3669	4193.0	4715.5
2.286	2258	0.3176	0.3571	4367.1	4789.2
2.286	2355	0.3162	0.3473	4542.2	4868.4
2.286	2451	0.3108	0.3341	4678.2	4911.0
2.286	2547	0.2930	0.3097	4707.1	4850.8
2.286	2644	0.2752	0.2852	4747.4	4823.4
2.286	2740	0.2573	0.2608	4793.4	4816.5
2.286	2830	0.2500	0.2500	4901.7	4901.7

Table 2. V/H Spectral Ratios[1]					
Frequency (Hz)	16th Percentile	50th Percentile	Mean	84th Percentile	SSAR Table 2.5-27A
.1000	.4066	.5161	.5315	.6552	0.75
.2000	.4164	.5129	.5245	.6317	0.75
.3000	.4081	.5005	.5113	.6138	0.75
.4000	.3936	.4906	.5030	.6114	0.75
.5000	.3881	.4965	.5125	.6350	0.75
.6000	.3926	.5170	.5381	.6808	0.75
.8000	.4162	.5654	.5935	.7682	0.75
1.0000	.4325	.5848	.6119	.7907	0.75
2.0000	.3850	.5281	.5533	.7246	0.75
2.5000	.3787	.5300	.5583	.7418	0.75
3.0000	.3772	.5268	.5545	.7359	0.75
4.0000	.3838	.5013	.5192	.6547	0.75
5.0000	.3808	.4887	.5045	.6273	0.75
6.0000	.3748	.4912	.5094	.6439	0.75
8.0000	.3346	.4712	.4969	.6635	0.75
10.0000	.3046	.4569	.4913	.6855	0.75
20.0000	.3393	.5263	.5726	.8162	0.83
25.0000	.3593	.5475	.5919	.8343	0.88
30.0000	.3777	.5727	.6185	.8682	0.94
50.0000	.4176	.6693	.7380	1.0725	1.12
100.0000	.4276	.6329	.6788	.9366	1.00

[1]V/H spectral ratios for the 16th, 50th, and 84th percentiles, and mean from the site specific analysis and the V/H ratio values used in SSAR Table 2.5-27A at the 21 frequency points used in SSAR Table 2.5-27A. The site-specific results are based on the relative weights from the PSHA deaggregation and a weighting of 0.25 for P-wave Model 1 and 0.75 for P-wave Model 2.

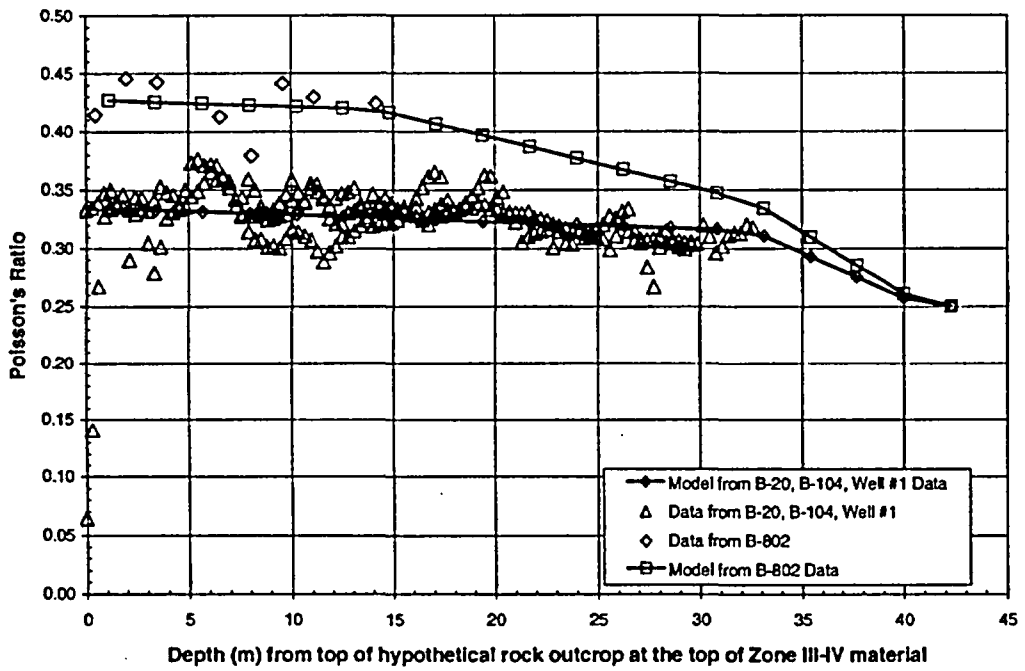


Figure 1. Poisson's ratio data and fitting models, used to develop P-wave velocity models.

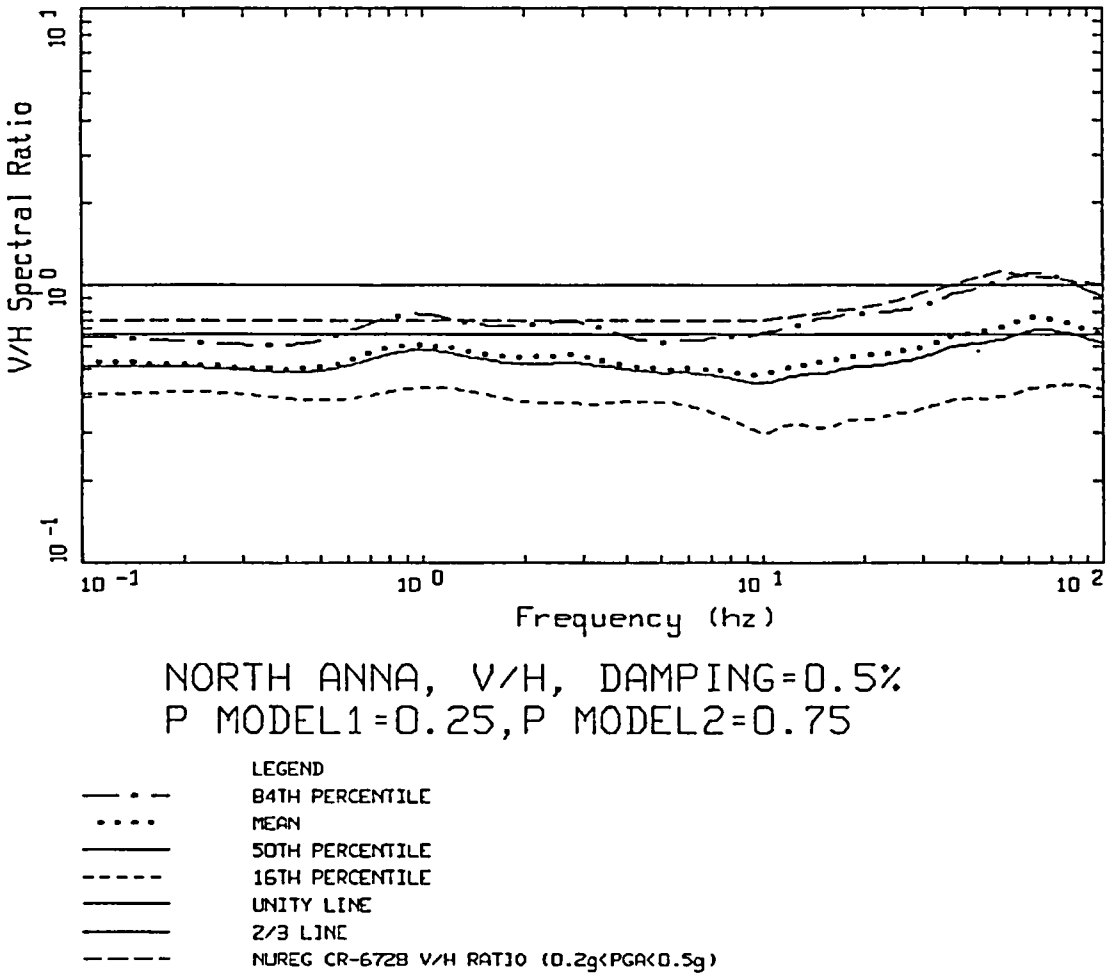
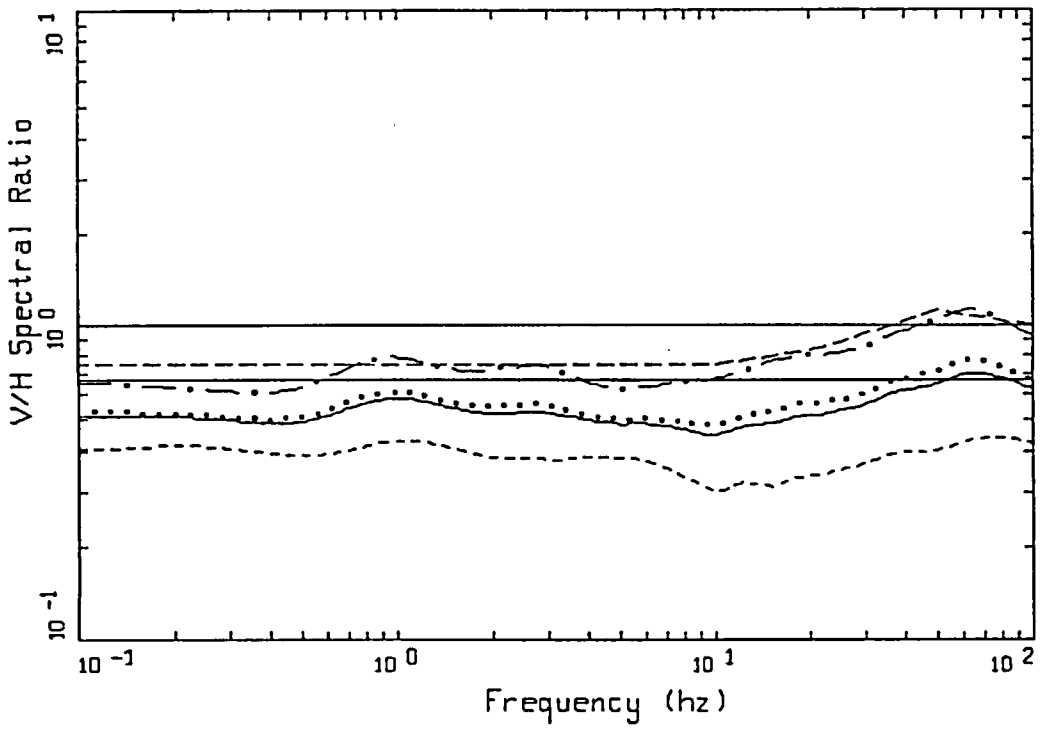


Figure 2. **V/H spectral ratios for the base damping level of 0.5% with a combined weighting of 0.25 and 0.75 for the P-wave Model 1 and 2, respectively. Median, mean, and plus and minus one-sigma (84th and 16th percentile) curves are shown. The NUREG/CR-6728 V/H ratio used in SSAR Table 2.5-27A is shown as a long dashed line for comparison.**



NORTH ANNA, V/H, DAMPING=1.0%
P MODEL1=0.25,P MODEL2=0.75

LEGEND
84TH PERCENTILE
MEAN
50TH PERCENTILE
16TH PERCENTILE
UNITY LINE
2/3 LINE
NUREG CR-6728 V/H RATIO (0.2g<PGA<0.5g)

Figure 3. **V/H spectral ratios for the base damping level of 1.0% with a combined weighting of 0.25 and 0.75 for the P-wave Model 1 and 2, respectively. Median, mean, and plus and minus one-sigma (84th and 16th percentile) curves are shown. The NUREG/CR-6728 V/H ratio used in SSAR Table 2.5-27A is shown as a long dashed line for comparison.**

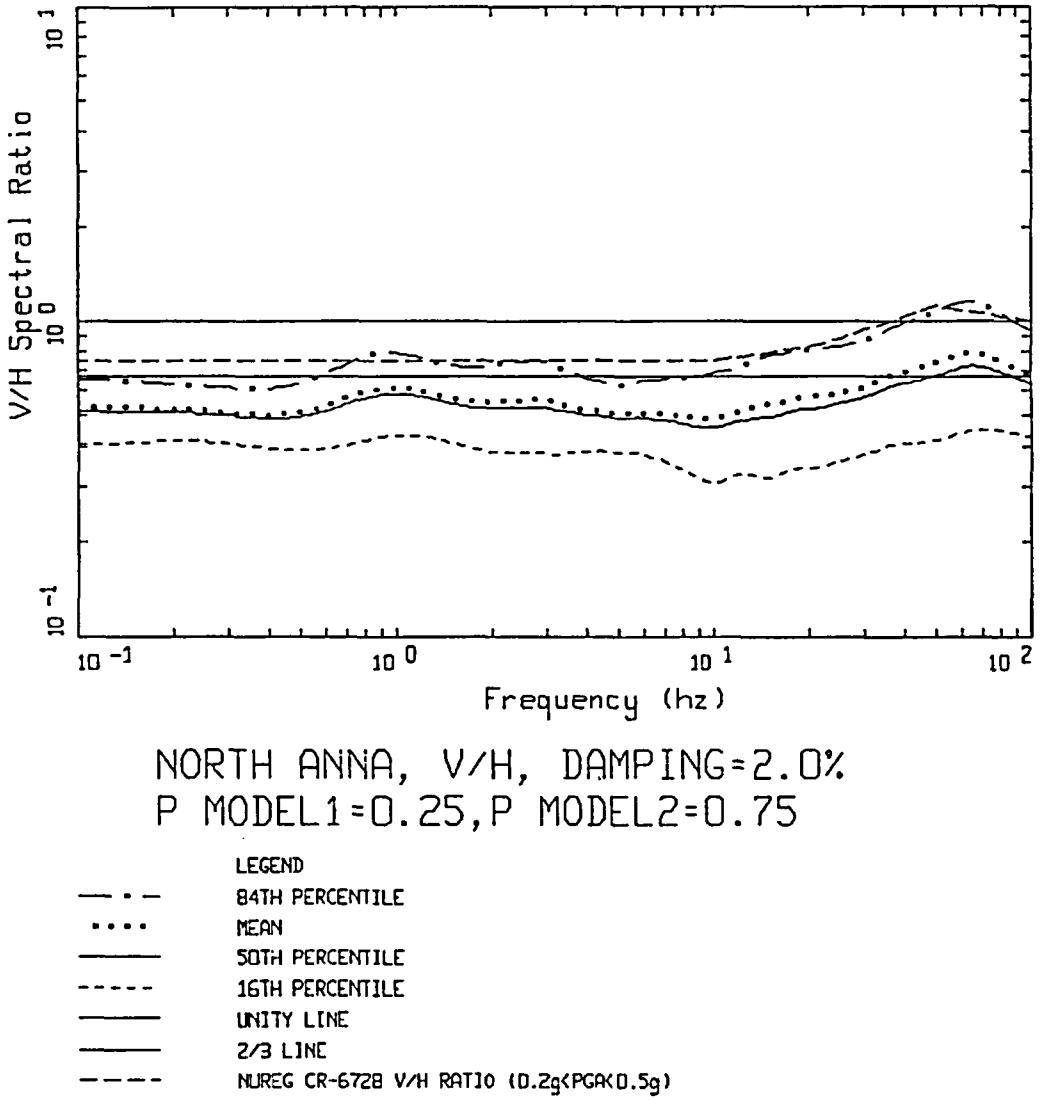


Figure 4. **V/H spectral ratios for the base damping level of 2.0% with a combined weighting of 0.25 and 0.75 for the P-wave Model 1 and 2, respectively. Median, mean, and plus and minus one-sigma (84th and 16th percentile) curves are shown. The NUREG/CR-6728 V/H ratio used in SSAR Table 2.5-27A is shown as a long dashed line for comparison.**

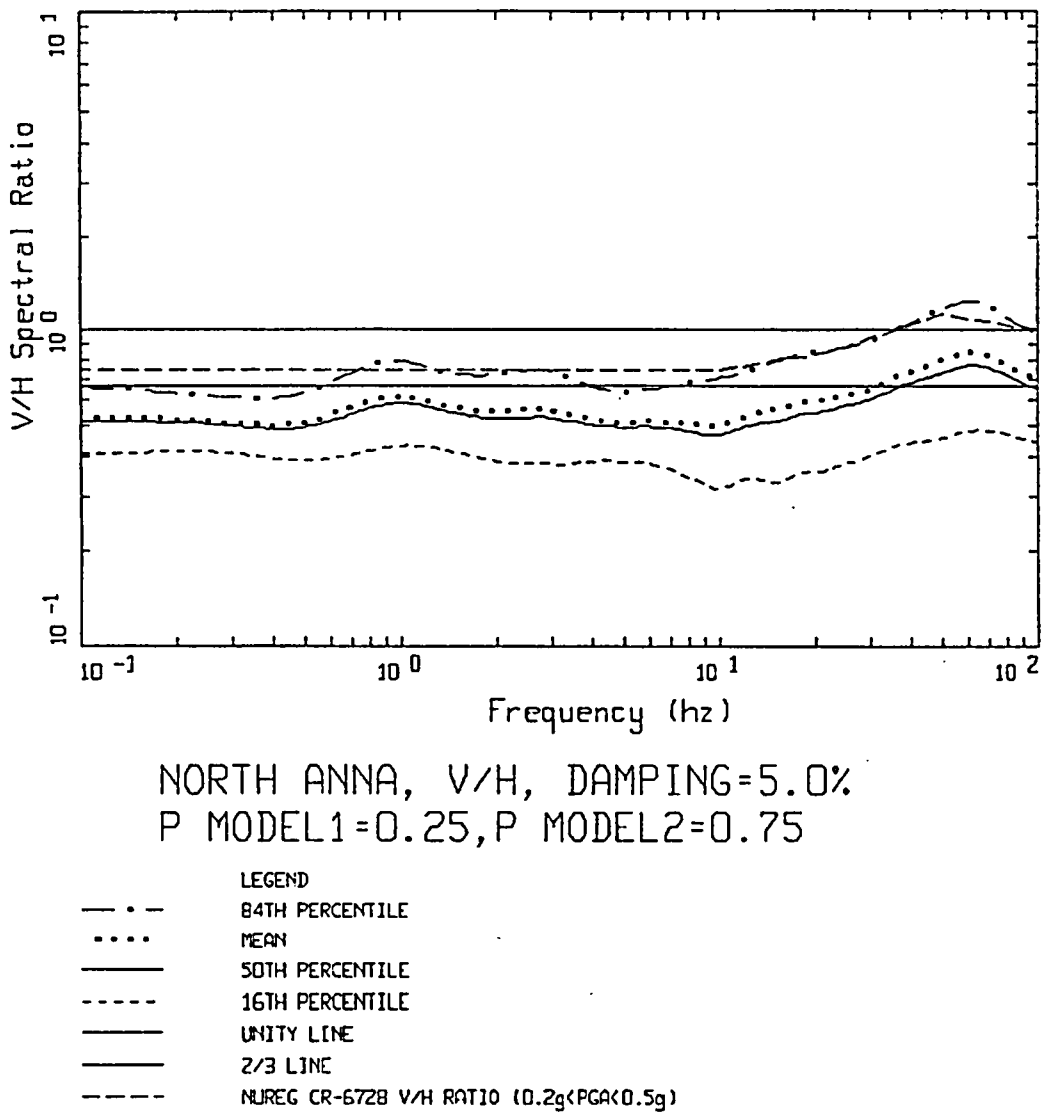


Figure 5. **V/H spectral ratios for the base damping level of 5.0% with a combined weighting of 0.25 and 0.75 for the P-wave Model 1 and 2, respectively. Median, mean, and plus and minus one-sigma (84th and 16th percentile) curves are shown. The NUREG/CR-6728 V/H ratio used in SSAR Table 2.5-27A is shown as a long dashed line for comparison.**

Application Revision

In Revision 5 of the ESP Application, SSAR Section 2.5.2.6.7.d has been revised to read as follows:

d. Development of Vertical SSE Spectra

Hard Rock SSE Spectrum

The applicable V/H ratios used to develop the selected vertical hard rock SSE spectrum (5 percent of critical damping) are listed in Table 2.5-27. The vertical SSE spectrum is calculated by multiplying the selected horizontal SSE spectral amplitude at each frequency by the applicable V/H ratio for that frequency. The selected horizontal and vertical spectra are plotted in Figure 2.5-48 for the hard rock SSE.

Zone III-IV Hypothetical Rock Outcrop Control Point SSE Spectrum

The horizontal SSE spectral accelerations, V/H ratios, and vertical SSE spectral accelerations for the Zone III-IV hypothetical rock outcrop control point are listed in Table 2.5-27A. The vertical SSE spectrum is calculated by multiplying the selected horizontal SSE spectral amplitude at each frequency by the applicable V/H ratio for that frequency. The selected horizontal and vertical spectra are plotted in Figure 2.5-48A.

To confirm the appropriateness of the V/H ratios listed in Table 2.5-27A, a site-specific analysis was performed. For the site-specific analysis, the stochastic point source model was used with an implementation of random vibration theory to model both horizontal and vertical spectra. The vertical ground motion was extended to consider P-SV waves. This approach has been used to develop the recommended V/H ratios in Reference 171 and has been shown to predict general trends in V/H ratios for earthquakes recorded in the Western United States. The model has been validated against empirical V/H ratio data from the 1989 Loma Prieta earthquake for rock site conditions.

Two site-specific P-wave profiles were developed that are consistent with the base shear wave profile used in the site analysis. These two P-wave profiles were developed by applying two Poisson's ratio models as a function of depth to the base shear wave profile. These two Poisson's ratio models are based on measured shear and compression wave data for the North Anna site, with the more recent data from the ESP investigation being assigned a larger weight of 0.75 and the older data from the investigation for Units 1 and 2 having a weight of 0.25 in the analysis. Both the horizontal and vertical ground motions were

computed assuming a linear response. Four magnitude-distance values and associated weights based on the 5-10 Hz PSHA deaggregation were used in the analysis to develop the horizontal and vertical ground motions. Relative weights for each of the four cases were used in combining the spectral ratios. A constant damping level of 2.0% was used. For each case, a total of 100 realizations were performed for both the horizontal and vertical ground motions. Statistics were computed for the suite of V/H spectral ratios. Additional damping levels of 0.5%, 1.0, and 5.0% were computed in a sensitivity study.

The results of the site-specific analysis confirm the appropriateness of the V/H ratios listed in Table 2.5-27A. Compared with the Table 2.5-27A values, the mean V/H ratios from the site-specific analysis are, on average, approximately 30% lower (ranging from 18-35% lower) over the complete frequency range of 100 Hz to 0.1 Hz. At the 84th percentile, the site-specific V/H ratio values are on average 8% lower (ranging from 19% lower to 5% higher) over the entire frequency range than the Table 2.5-27A V/H ratio values.

The comparison results provide justification that the V/H ratios given in Reference 171 and used in Table 2.5-27A are appropriate for the North Anna ESP site. To maintain a hazard-consistent level in scaling the horizontal ground motions, the fractile level needed for the V/H ratio is between the 50th and 84th percentile. The exact percentile level would depend on frequency, site, design considerations, and judgment.

Enclosure 2

Description of Changes in Revision 5
North Anna Early Site Permit Application

North Anna Early Site Permit Application Description of Changes in Revision 5	
Affected Section, Table, or Figure	**Reason for Change**
Part 2 Chapter 2	
• Section 2.5.2.6.7.d	Confirmatory analysis for V/H ratios; Reference Dominion's 7/25/05 Letter; Serial No. 05-457.
• Figure 2.5-55A	Replaced incorrect figure; Reference Dominion's 7/25/05 Letter; Serial No. 05-457.