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Dominion®

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

Serial No. NA3-11-048RA
Docket No. 52-017
COL/RGM

DOMINION VIRGINIA POWER
NORTH ANNA UNIT 3 COMBINED LICENSE APPLICATION
SRP 03.07.01: RESPONSE TO RAI LETTER 81

On August 15, 2011, the NRC requested additional information to support the review of certain portions of the North Anna Unit 3 Combined License Application (COLA), which consisted of two questions. The response to Request for Additional Information (RAI) 5942 Question 03.07.01-5 was provided in Dominion letter NA3-11-048R dated February 8, 2012 (ML12047A293).

Upon further review, it was determined that supplemental information regarding this RAI would be beneficial to the NRC in their review.

Please contact Regina Borsh at (804) 273-2247 (regina.borsh@dom.com) if you have questions.

Very truly yours,

Eugene S. Grecheck

DD89
NRD

Enclosure:

1. Response to NRC RAI Letter 81, RAI 5942 Question 03.07.01-5 Supplemental Information

Commitments made by this letter:

None.

COMMONWEALTH OF VIRGINIA

COUNTY OF HENRICO

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

Acknowledged before me this 31st day of May, 2012
My registration number is 7173057 and my
Commission expires: August 31, 2012

Wanda K. Marshall

Notary Public

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

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

ENCLOSURE 1

Supplemental Response to NRC RAI Letter 81

RAI 5942 Question 03.07.01-5

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5942 (RAI Letter 81)

SRP SECTION: 03.07.01 – Seismic Design Parameters

QUESTIONS for Geosciences and Geotechnical Engineering Branch 2 (RGS2)

DATE OF RAI ISSUE: 8/15/2011

Supplemental Response to RAI QUESTION NO.: 03.07.01-5

Dominion has determined that a supplement to the response to RAI Question 03.07.01-5 would further clarify the approach used to develop shear wave velocity (V_S) profiles for North Anna Unit 3 seismic Category I structures. This supplement addresses the following topics:

1. Weighting factors applied to each boring and the justification for their use
2. Assigning V_S values to average rock/soil zones (Method 2 in the response to RAI 03.07.01-5)
3. Averaging of V_S values across rock/soil zone boundaries
4. Variation between the minimum and maximum V_S bounds in FSAR Figure 3OO-202

Dominion Supplemental Response

1. Weighting Factors

As described in the initial response to RAI 03.07.01-5, there are five suspension P-S velocity logging boreholes (B-901, B-907, B-909, M-10, and M-30) used in the development of V_S profiles for the seismic analysis of Unit 3 seismic Category I structures in the FSAR. The individual V_S profiles for the West PS/B and PSFSV, the UHSRS A & B, and the UHSRS C were each derived using V_S data from a single V_S boring (B-909, M-30, and B-907, respectively). Therefore, weighting was not applicable for these structures because only data from one V_S boring were used for each of these structures. These V_S profiles are shown on FSAR Figures 2.5-241 b, c and d, respectively.

For UHSRS D, V_S data from borings M-10 and B-907 were combined and used as input to the V_S profile shown on FSAR Figure 2.5-241e. The V_S data from each boring were given equal weighting because these two borings are equidistant from the structure. Also, as described in

the initial response to RAI 03.07.01-5, the subsurface zones defined by V_S boring B-907 data are representative of the actual subsurface zones under the plant southeast portion of the structure, while the subsurface zones defined by boring M-10 data are representative of the actual zones under the plant northwest portion of the structure. Thus, equal weighting is applicable.

Derivation of the V_S profiles for the UHSRS Pipe Chase, East ESWPT and West ESWPT involved the averaging of data from either two or three V_S borings. In each case, applicable V_S borings were identified based on proximity to the structure, i.e., the nearest V_S borings were chosen as applicable; however, the average rock zone thicknesses beneath the structure were generally not similar to the zone thicknesses in these V_S borings. Thus, there was no reason to give preferred weighting to the data from any one V_S boring, and so equal weighting was given in all cases. These V_S profiles are shown on FSAR Figures 2.5-241 f, g and h.

2. Assigning V_S Values to Average Rock/Soil Zones Using Method 2

The following discussion provides additional details on the process used to assign lower bound (minimum), upper bound (maximum), and best estimate (average) values of V_S to rock/soil zones under structures where the nearest V_S boring locations and the structure location are not similar. The initial response to RAI 03.07.01-5 identified this process as Method 2.

There are several seismic Category I structures that do not have V_S borings within their footprints. In some cases, there are V_S borings that are very close to the structures. For example, for the UHSRS, there are V_S borings at either end of the row of UHSRS structures; and for the West PS/B, V_S boring B-909 is just to the plant north of the structure. Other structures do not have V_S borings as close. For example, for the East ESWPT, there are several borings under the footprint or close to the structure (rock/soil borings), but none of these are V_S borings. V_S boring M-30 is to the plant northeast of the structure, while V_S borings B-901 and B-907 are to the plant west, and all three are at some distance from the structure. The rock/soil borings beneath and close to the East ESWPT allow an estimate to be made of the average thickness of the rock/soil subsurface zones beneath the structure and also allow an estimate to be made of the thickness of concrete fill needed to replace the unsuitable soil above the Zone III rock on which the tunnel will be placed. These borings capture the variations in thickness of each rock/soil zone directly beneath the structure. Method 2 was then used to assign lower and upper bound and best estimate (average) values of V_S to these rock/soil zones.

For the concrete fill beneath the East ESWPT, the best estimate value of V_S is 7,000 ft/sec (see FSAR Table 2.5-212), with lower and upper bounds of 6,000 ft/sec and 8,000 ft/sec, respectively (see FSAR Section 2.5.4.7.1). These values are represented on the V_S profile for the East ESWPT on FSAR Figure 2.5-241g. A similar generic approach could have been adopted to obtain a generic value for the average, and lower and upper bound V_S values for the rock/soil zones beneath the concrete fill, since, as noted in the initial response to RAI 02.05.02-3, the rock/soil zones at the North Anna site have defined V_S ranges, as tabulated below. That is, each rock/soil zone could have been assigned only one generic average value, one lower bound (minimum) and one upper bound (maximum) V_S value for their entire thickness.

Material	Vs, ft/sec
Zone III	2,000-4,000
Zone III-IV	4,000-8,000
Zone IV	>8,000

The average of the Zones III and III-IV values from this table are 3,000 ft/sec and 6,000 ft/sec, respectively. For Zone IV, the average value is 9,000 ft/sec as depicted on FSAR Table 2.5-212. This value is representative of about the top 30 ft of Zone IV. The average V_S value increases to approximately 10,000 ft/sec below the top 30 ft (approximated from FSAR Figure 2.5-237). The attached figure (Figure 3.7.1-5-1) shows these generic average values superimposed for each rock zone on FSAR Figure 2.5-241g. There is generally good agreement with the existing average values on FSAR Figure 2.5-241g obtained from Method 2, which is described in more detail later.

If this generic approach had been applied, an appropriate coefficient of variation (COV) would have been applied to obtain lower and upper bounds for each of the generic average values. The COV for the weathered rock (Zone III and Zone III-IV) would be significantly greater than for the Zone IV fresh rock since weathering is the main source of variability in the rock. Lower and upper bounds using a COV value of 0.5 for Zones III and III-IV and a COV of 0.1 for Zone IV are superimposed as dashed red lines on the attached Figure 3.7.1-5-1 and show reasonable agreement with the Method 2 lower and upper bounds. For comparison, assuming the lower and upper bounds for the concrete fill reflect one standard deviation from the mean, the COV for the concrete fill is about 0.14. All of these COV values are considered reasonable for the materials they represent.

Although the method described above provides a reasonable V_S profile for the East ESWPT, it does not directly include any of the V_S values measured in the three V_S borings closest to the structure nor does it account for the general increase in V_S as depth increases. Method 2, described below, averages the V_S values from these V_S borings and estimates lower and upper bounds based on the variation of the measured values. As shown in Figure 3.7.1-5-1, the results are generally similar to those obtained using the generic values derived for each zone, but show local variation within each zone, thus providing the most appropriate estimate of the V_S profile since the V_S variations within each zone will be accounted for in the SHAKE analysis.

As described in the initial response to RAI 03.07.01-5, there are structures where the subsurface characteristics (zone thicknesses and top of zone elevations) at the nearest V_S boring locations and the structure location are not similar, for example the East ESWPT. Using the East ESWPT as the example for how Method 2 was applied, the following describes the detailed evaluation of applicable V_S boring data and rock/soil boring data to correlate the V_S data and derive the V_S profile for this structure. For the following description of Method 2, refer to Figure 3.7.1-5-2.

The first step of Method 2 ("Step 1") is to develop the "Average Rock/Soil Thickness Profile" which is a subsurface profile that represents the subsurface characteristics beneath a structure, where the zone thicknesses and top of zone elevations are developed from the extensive set of rock/soil boring data (boring logs and rock quality data (RQD)) obtained from borings underlying or near the structure that are tabulated in FSAR Table 2.5-208. For the East ESWPT, the three rock/soil borings directly beneath the structure (B-934, M-16, and M-19) and the five rock/soil borings that are within 100 ft of the structure (B-926, B-927, B-933, B-948, and M-12) were used

to develop this profile. The elevation of the East ESWPT foundation bottom is 259 ft as provided in FSAR Table 2.5-213 (elevations in this response are NAVD88 values).

The top layer of the East ESWPT "Average Rock/Soil Thickness Profile" is the first zone of material beneath the East ESWPT foundation bottom. This material is the concrete that is used to replace the unsuitable Zone IIA and IIB material, as was described in the initial response to RAI 03.07.01-5. The average thickness of this concrete is the average thickness of the Zone IIA and IIB that is estimated to be below the East ESWPT foundation bottom. The average concrete thickness is the average of each rock/soil boring elevation difference between the bottom of foundation (259 ft) and the top of Zone III elevation as determined in each rock/soil boring (see FSAR Table 2.5-208). In cases where the top of Zone III elevation was absent, the top of Zone III-IV elevation was used. Using this process, the average concrete thickness for the East ESWPT was determined to be 13.8 ft which is shown in FSAR Figure 2.5-241g as the difference between elevations for the boundaries for the concrete fill material.

Zone III is the zone beneath the concrete fill in the East ESWPT "Average Rock/Soil Thickness Profile." The average thickness of Zone III used in this profile is the average thickness of Zone III that exists below the foundation bottom elevation, not the entire zone thickness obtained from the borings. This is the reason why the Zone III thicknesses of the borings used for the East ESWPT from FSAR Table 2.5-208 cannot be used directly to determine the average Zone III thicknesses beneath this structure. Table 2.5-208 thicknesses are the actual full height zone thicknesses for each boring and these do not account for foundation bottom elevations. For this average rock/soil profile, the average thickness of Zone III below the foundation bottom is the average of each rock/soil boring elevation difference between the top of Zone III elevation and the top of Zone III-IV elevation. However, in the cases where the top of Zone III elevation is above the foundation bottom of the East ESWPT, the foundation bottom elevation is used as the top of Zone III elevation. The average thickness of Zone III below the East ESWPT foundation bottom elevation is 6.1 ft which is shown in FSAR Figure 2.5-241g as the difference between elevations for the boundaries for Zone III.

A similar process was used to determine the average thickness of the Zone III-IV material beneath the foundation bottom elevation. The average thickness of Zone III-IV below the foundation bottom is the average of each rock/soil boring elevation difference between the top of Zone III-IV elevation and the top of Zone IV elevation. However, in the cases where the top of Zone III-IV elevation is above the foundation bottom of the East ESWPT, the foundation bottom elevation is used as the top of Zone III-IV elevation. Using this process, the average thickness of Zone III-IV below the East ESWPT foundation bottom was determined to be 18.5 ft which is shown in FSAR Figure 2.5-241g as the difference between elevations for the boundaries for Zone III-IV.

Once the zone thicknesses have been determined, the top of zone elevations can be computed. The top of Zone III elevation of this profile is the bottom of foundation elevation minus the average concrete thickness. The top of Zone III-IV elevation is the top of Zone III elevation minus the average Zone III thickness. The top of Zone IV elevation is the top of Zone III-IV elevation minus the average Zone III-IV thickness. For the East ESWPT average rock/soil profile, the top of Zone III elevation is 245.2 ft (259 ft minus 13.8 ft), the top of Zone III-IV elevation is 239.1 ft (245.2 ft minus the thickness of Zone III, 6.1 ft), and the top of Zone IV elevation is 220.6 ft (239.1 ft minus the thickness of Zone III-IV, 18.5 ft). FSAR Figure 2.5-241g shows these elevations for the East ESWPT. FSAR Figures 2.5-241f, 2.5-241g, and 2.5-241h show the elevations for the "Average Rock/Soil Thickness Profile" for each of the structures that used Method 2.

The next step of Method 2 ("Step 2") is to develop the "Combined V_S Profile," which is a subsurface profile that represents the subsurface characteristics of the applicable V_S borings combined, where the zone thicknesses have been primarily determined from V_S data collected from each of the applicable borings. As described in the initial response to RAI 03.07.01-5, applicable V_S borings were identified based on proximity to the structure, i.e., the nearest V_S borings were chosen as applicable. For the East ESWPT, the applicable borings are B-901, B-907, and M-30. The V_S boring data from these borings are shown in FSAR Figure 2.5-237 and are tabulated in FSAR Appendix 2.5.4AA, Volume 3 and FSAR Appendix 2.5.4CC. The V_S measurement values from each of the applicable V_S borings were combined on a zone by zone basis (Zone III values were combined, Zone III-IV values were combined, and Zone IV values were combined) by averaging this V_S data on a depth interval basis. This can be seen from Figure 3.7.1-5-2 (in the profile labeled as "Combined V_S Profile"), where as part of the combined V_S profile (Zone III-IV is used as an example), Zone III-IV has been divided into an equal number (and equal thickness) of "depth intervals" (listed as "1st", "2nd", and "3rd" Depth Intervals).

Each of these depth intervals is represented by an average Vs value (AVGx), a minimum Vs value (MINx), and a maximum V_S value (MAXx). As described in the initial response to RAI 03.07.01-5, a V_S measurement value was obtained for each of the three (for the East ESWPT case) applicable V_S borings at each 1.64-ft increment (as depicted in FSAR Figure 2.5-237). These three values were averaged, thus resulting in one average V_S value for each 1.64-ft increment within a depth interval. Each depth interval was chosen as 10-ft thick, thus resulting in six (6) of these 1.64-ft increments and thus six (6) average values (10 divided by 1.64 is 6). There are thus 6 average V_S values per depth interval. These six average values were then averaged together to create one overall average V_S value for each depth interval, which is shown in Figure 3.7.1-5-2 as "AVGx." The minimum of these 6 average values of each depth interval is "MINx" and the maximum of these 6 average values is "MAXx" with "x" representing an individual depth interval. This step was repeated for each Zone, thus forming the single "Combined V_S Profile."

The final step of Method 2 is to develop the "Derived V_S Profile," for a structure. As shown in Figure 3.7.1-5-2, each zone of the "Average Rock/Soil Thickness Profile," (keeping with the Zone III-IV as the example) was divided into the same number of depth intervals of equal thickness as was defined for the Combined V_S Profile above (however, not necessarily of the same thickness as the depth interval of the Combined V_S Profile – they might be smaller or larger in thickness, in this case smaller). The V_S values (AVGx, MINx, and MAXx) from each depth interval of the Combined V_S Profile were then applied to the corresponding subsurface profile depth intervals of the Average Rock/Soil Thickness Profile. This process, once it has been performed for the other zones, creates the "Derived V_S Profile" which is used as input to the foundation input response spectra (FIRS) calculation for a structure. This process resulted in a derived V_S profile for a structure that is representative of both measured V_S values nearest the structure and the average zone thicknesses beneath the structure. Method 2 was utilized for the UHSRS Pipe Chase and the ESWPTs.

3. Averaging of V_S Values across Rock/Soil Zone Boundaries

As explained in Clarification 2, and illustrated in attached Figure 3.7.1-5-2, the depth intervals used for averaging the V_S values were chosen within each zone. In the calculation process, each zone was considered separately. As shown in Figure 3.7.1-5-2, three depth intervals were chosen for Zone III-IV and the average, maximum and minimum V_S values for each depth

interval were computed using the Zone III-IV V_S values within the depth interval. A similar process was used to compute the V_S values for the two depth intervals in Zone III above, and for the 15 depth intervals for Zone IV below. The process does not allow averaging of V_S values across the interface between zones.

There is one case where the depth interval crosses the interface between zones. This is the depth interval between Zone III-IV and Zone IV for UHSRS D (FSAR Figure 2.5-241e), between about El. 177 ft and El. 167 ft. This is the only profile that used two V_S borings and did not employ the Method 2 approach. All other profiles that did not employ Method 2 used only a single V_S boring. Method 2 was not used for developing the UHSRS D V_S profile because the average soil/rock profile beneath the structure was relatively similar to the average zone thickness profile from V_S borings B-907 and M-10. In B-907, V_S from about El. 177 ft to El. 167 ft was consistently above 9,000 ft/sec, i.e., clearly Zone IV, while the average V_S in M-10 from about El. 177 ft to El. 167 ft was closer to 7,500 ft/sec, i.e., the top end of Zone III-IV. The average V_S from B-907 and M-10 in this depth interval was about 8,600 ft/sec, i.e., Zone IV, and the interface between the zones could have been placed at the top of the depth interval, at El. 177 ft. The interface was placed in the middle of the depth interval to reflect the different zones of the two V_S borings in this interval. The actual placement of the interface does not affect the response analysis.

4. Variation between Minimum and Maximum V_S Bounds in FSAR Figure 3OO-202

The relatively large variation shown in FSAR Figure 3OO-202 between the minimum and maximum V_S bounds for the simulated profiles are further discussed here. As described in FSAR Section 3OO.1.1, Figure 3OO-202 provides the V_S variation of the 60 simulated (randomized) soil profiles corresponding to the R/B complex. Within each layer, the shear wave velocities are randomized following a log-normal distribution with log-mean shear wave velocities and log-standard deviations determined as described below. The maximum and minimum bounds of twice the log-standard deviation on each side of the log-mean are imposed to prevent unrealistic V_S realizations. The large range of variation observed for the rock shear-wave velocities reflect the large variations in the borehole V_S data observed in FSAR Figure 2.5-240. Note that Figure 3OO-202 provides intermediate results prior to the consideration of layer thickness variations. The final set of shear wave velocities including layer thickness variations are provided in FSAR Figure 3OO-203. The final best estimate profiles for R/B Complex is presented in FSAR Figure 3OO-201 and described in FSAR Section 3OO.1.1. This profile is used as the median (or log-mean) for the soil profile simulation.

The log-standard deviations for V_S for in-situ rock strata below El. 250 ft are obtained from the following two alternative estimates. In the first alternative, log-standard deviations are directly calculated from the V_S measurements from V_S borings B-901, B-907, and B-909. In the second alternative, they are estimated from the two design profiles (Profiles 1 and 2 in FSAR Figure 2.5-241a) by assuming that Profile 1 and Profile 2 are each one standard deviation from their log-mean. Based on the results calculated from both approaches, the log-standard deviation for rock above the assumed bedrock (El. 135 ft) ranges from 0.08 to 0.4 and are adopted at different strata. The calculated and used values of the log-standard deviation in the simulation are presented in Figure 3.7.1-5-3 below. A sensitivity study which examined the sensitivity of the calculated FIRS to a lower log-standard deviation (0.2 instead of 0.3 and 0.4 above El. 184 ft) for rock V_S was performed and it was confirmed that any change in FIRS values due to less variation in the rock V_S are 5% or less. Therefore, the FIRS values are not sensitive to the adopted log-standard deviations for the V_S, and the adopted values are considered adequate.

Proposed COLA Revision
None

Figure 3.7.1-5-1: Generic Vs Values Superimposed on FSAR Figure 2.5-241g

NAPS COL 2.5(1)

Figure 2.5-241g Shear Wave Velocity Profile beneath the East ESW Pipe Tunnel Foundation

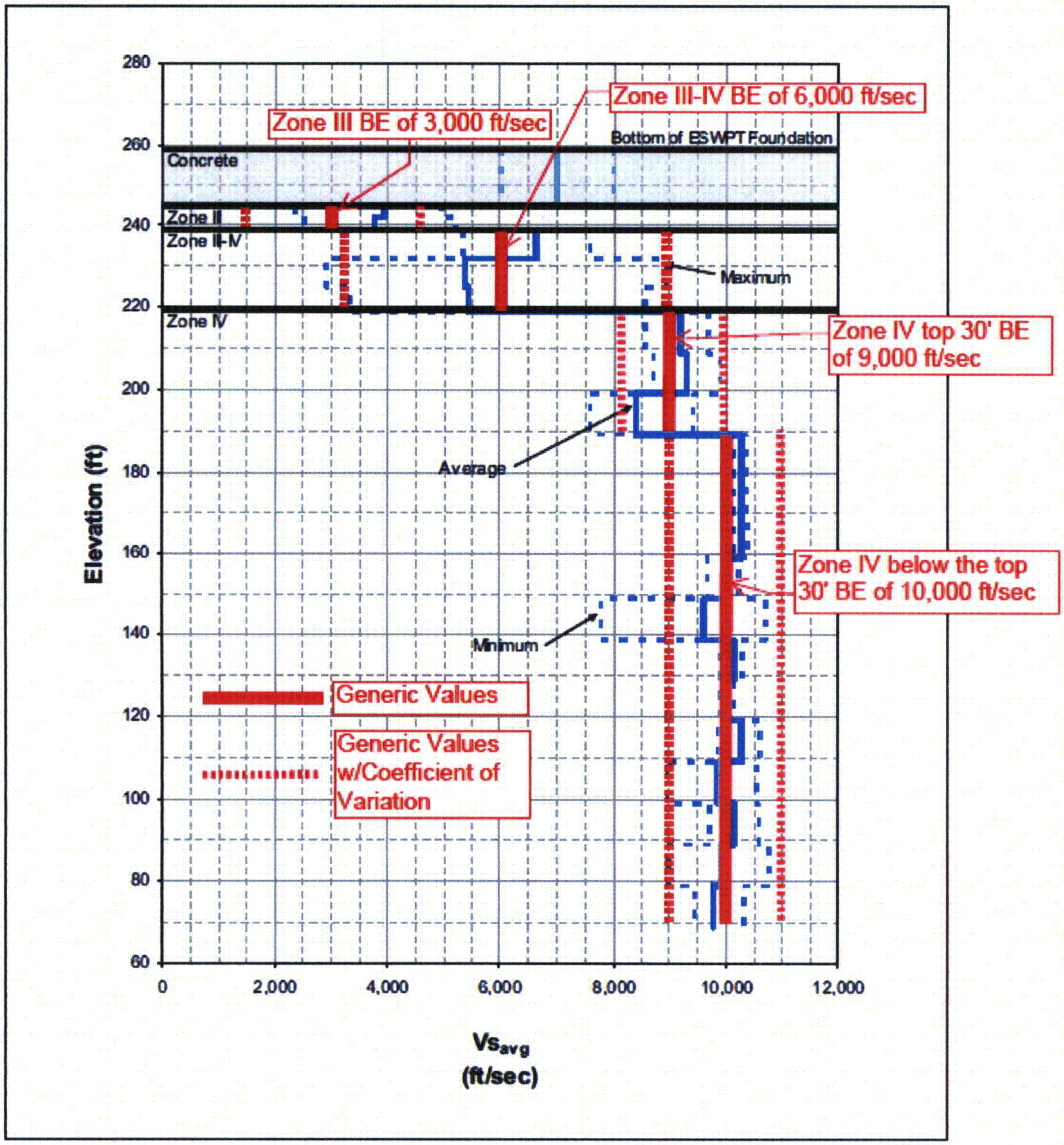

Figure 3.7.1-5-2: Method 2 Used to Develop FSAR Figure 2.5-241g

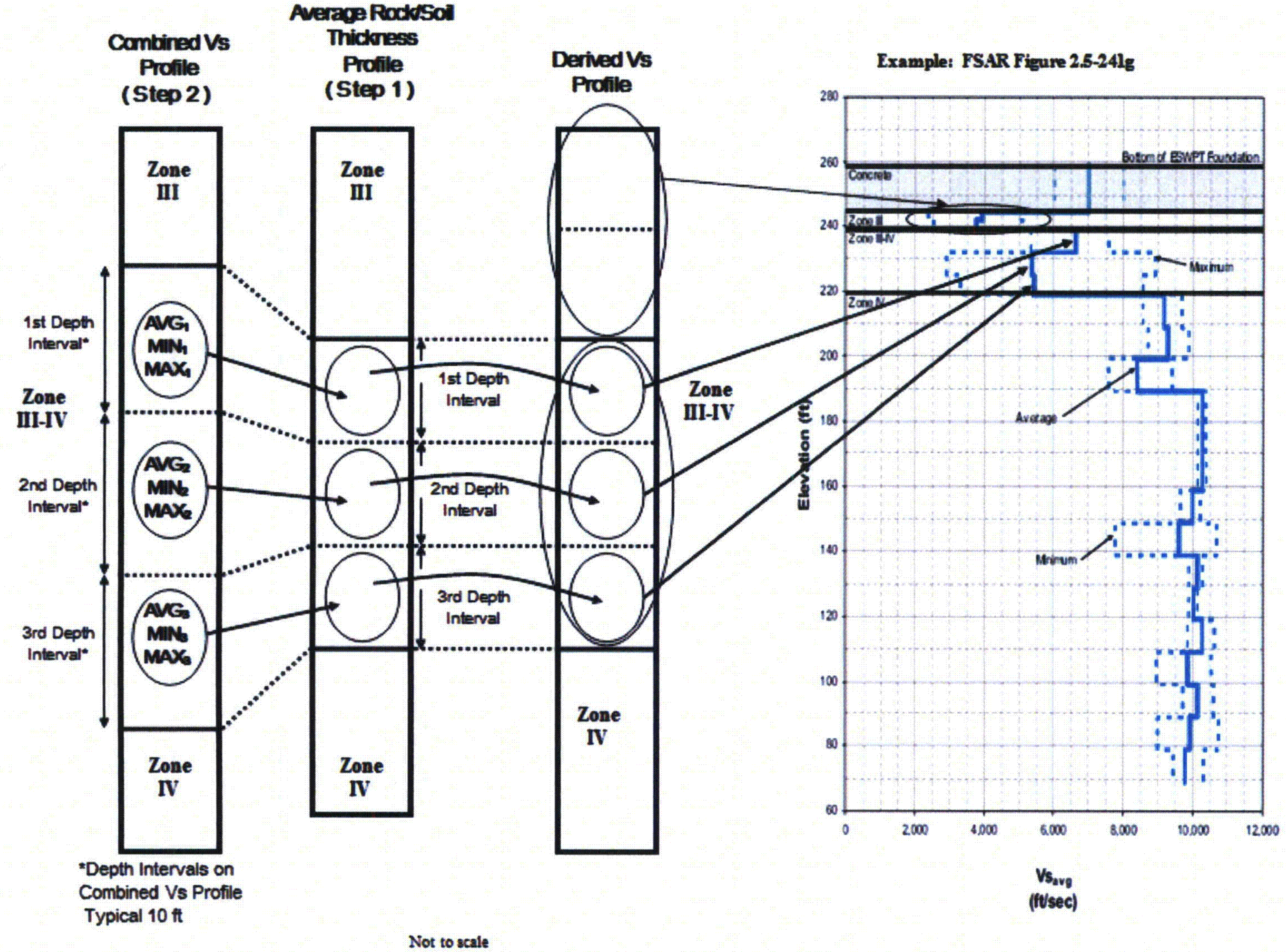

Figure 3.7.1-5-3: Log-SD for In-Situ Shear Wave Velocity Profile