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UniStar
NUCLEAR ENERGY

10 CFR 50.4
10 CFR 52.79

March 30, 2011

UN#11-119

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: UniStar Nuclear Energy, NRC Docket No. 52-016
Response to Request for Additional Information for the
Calvert Cliffs Nuclear Power Plant, Unit 3,
RAI No. 276, Stability of Subsurface Materials and Foundations

References:
1) Surinder Arora (NRC) to Robert Poche (UniStar Nuclear Energy), "FINAL RAI 276 RGS2 5267" email dated December 7, 2010

2) UniStar Nuclear Energy Letter UN#11-092, from Greg Gibson to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 276, Stability of Subsurface Materials and Foundations, dated February 23, 2011

The purpose of this letter is to respond to the request for additional information (RAI) identified in the NRC e-mail correspondence to UniStar Nuclear Energy, dated December 7, 2010 (Reference 1). This RAI addresses Stability of Subsurface Materials and Foundations, as discussed in Section 2.5.4 of the Final Safety Analysis Report (FSAR), as submitted in Part 2 of the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 Combined License Application (COLA), Revision 7.

Reference 2 provided a March 31, 2011 schedule for the response to RAI 276, Question 02.05.04-29.

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NRO

AREVA has communicated with UNE on a preliminary basis that they intend to respond to U.S. EPR RAI 376, Question 03.08.05-25, by revising existing U.S. EPR FSAR Tier 2, COL Item 2.5-10. The revised COL Item will require the COL applicant to determine the uniformity of soil layers underlying the foundation of Seismic Category I structures.

At such time that COL Item 2.5-10 is incorporated and reflected in the U.S. EPR FSAR, applicable parts of the CCNPP Unit 3 COLA will be updated to include this requirement.

The Enclosure provides our response to RAI 276, Question 02.05.04-29, and includes revised COLA content. A Licensing Basis Document Change Request has been initiated to incorporate these changes into a future revision of the COLA.

Our response does not include any new regulatory commitments. This letter does not contain any sensitive or proprietary information.

If there are any questions regarding this transmittal, please contact me at (410) 470-4205, or Mr. Wayne A. Massie at (410) 470-5503.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on March 30, 2011

Greg Gibson

Enclosure: Response to NRC Request for Additional Information, RAI 276 Question 02.05.04-29, Stability of Subsurface Materials and Foundations, Calvert Cliffs Nuclear Power Plant, Unit 3

cc: Surinder Arora, NRC Project Manager, U.S. EPR Projects Branch
Laura Quinn, NRC Environmental Project Manager, U.S. EPR COL Application
Getachew Tesfaye, NRC Project Manager, U.S. EPR DC Application (w/o enclosure)
Charles Casto, Deputy Regional Administrator, NRC Region II (w/o enclosure)
Silas Kennedy, U.S. NRC Resident Inspector, CCNPP, Units 1 and 2
U.S. NRC Region I Office

GTG/SJS/mdf

Enclosure

Response to NRC Request for Additional Information

RAI 276 Question 02.05.04-29,
Stability of Subsurface Materials and Foundations

Calvert Cliffs Nuclear Power Plant Unit 3

RAI 276

Question 02.05.04-29

COL Information Item 2.5-11 was added to the U.S. EPR Standard Design Certification FSAR in response to RAI 376 (eRAI 4377), Question 03.08.05-25. This COL Information Item states that "A COL applicant that references the U.S. EPR design certification will investigate and determine the horizontal variation in the seismic shear wave velocities for Seismic Category I structures. Horizontal variation in the seismic shear wave velocities should be no more than +/- 20 percent of the average velocity in any layer under a Seismic Category I structure to be considered laterally uniform."

Provide information that addresses this COL Information Item, including details on how shear wave velocities vary laterally beneath each Category I structure, and supporting data for the staff to be able to independently evaluate the conclusions.

Response

AREVA has communicated to UniStar Nuclear Energy (UNE) on a preliminary basis that they intend to respond to U.S. EPR RAI 376, Question 03.08.05-25, by deleting COL Item 2.5-11 and revising COL Item 2.5-10, thereby requiring: "A COL applicant that references the U.S. EPR design certification will investigate and determine the uniformity of soil layer(s) underlying the foundation basemats of Seismic Category I structures. Horizontal variation in the seismic shear wave velocities should be no more than ±10 percent of the average velocity in any layer under a Seismic Category I structure to be considered laterally uniform. Otherwise, the classification of uniformity or non-uniformity will be established by a geotechnical engineer."

The horizontal variation in shear wave velocities beneath Category I structures was assessed using the results of five geophysical surveys conducted within the Powerblock area. The locations of the geophysical survey borings (B-301, B-304, B-307, B-318, and B-323) are shown in Figure 1. The variation in seismic shear wave velocities exceeds 10 percent. As identified in the COL item, the classification of uniformity or non-uniformity will be established by a geotechnical engineer. The determination of uniformity for the CCNPP Unit 3 Site follows:

The variability of the geotechnical properties of a given soil formation mainly originates from the following sources: (1) spatial soil variability, (2) the epistemic uncertainty that exists due to the impossibility of sampling and testing each and every point in the subsurface, (3) measurement variability, and (4) transformation variability (Phoon and Kulhawy 1999). The spatial soil variability indicates the inherent soil variability. The measurement variability involves any uncertainty/scatter in the results due to measurement errors associated with the testing methodology and disturbance during soil penetration or sample extraction. The transformation variability refers to the uncertainty due to the correlations used to convert the measured parameter to the parameter used in the geotechnical analysis.

The analysis presented throughout this response aims to address the spatial soil variability in terms of shear wave velocity. Statistical computations do not attempt to reduce the variability in the results to account for the variability associated with the transformation or measurement uncertainties. Therefore, the variability in the shear wave velocity that is shown in the following plots is larger than what exists in reality.

The stratigraphy for the Powerblock at Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 consists of five major engineering layers: (1) Stratum I: Terrace Sand, (2) Stratum IIa: Chesapeake Clay/Silt, (3) Stratum IIb: Chesapeake Cemented Sand, (4) Stratum IIc: Chesapeake Clay/Silt, and (5) Stratum III: Nanjemoy Sand. Stratum IIb is divided into three sub-layers (IIb-1, IIb-2 and IIb-3). Excavations for the foundation of the Category I structures will result in the removal of Stratums I and IIa in their entirety, and will extend to the top of Stratum IIb. Thus, Stratum I and IIa are not considered in this assessment. Furthermore, these strata will be replaced with uniform engineering fill.

Shear wave velocity measurements were not conducted at exactly the same elevation. A tolerance of ± 1 ft was allowed for the reference elevation line to compare data points. Figures 2 through 6 present the shear wave velocity distribution comparison plots for each of the geophysical borings within the Powerblock Area for Stratums IIb and IIc as a function of elevation. The plots clearly indicate the existence of geologic uniformity. There is, however, some variability in shear wave velocity between El. 40 ft and El. -20 ft, which corresponds to Stratum IIb: Chesapeake Cemented Sand layer. Additionally, the shear wave velocity variation in Stratum IIb is mostly limited to the narrow zone between El. 25 ft and El. 10 ft.

Two borings (B-301 and B-401) within the CCNPP Unit 3 Site penetrated Stratum III: Nanjemoy Sand. Boring B-301 is located within the footprint of the Nuclear Island, and B-401 is located approximately 977 ft South of B-301 within the Construction Laydown Area (CLA). Both borings were compared to determine the lateral variability in shear wave velocity of Stratum III (See Figure 7). The coefficient of variation (COV) of shear wave velocity measurements within each engineering layer (Stratums IIb through III) is presented in Figures 8 and 9. The horizontal variation in shear wave velocity exceeds 10 percent for Stratum IIb. It is important to note that only measurements from borings B-301, B-304, and B-307 are within the area covered by the Nuclear Island Common Basemat. Variation within this area is lower than the one shown in Figure 8.

The variable shear wave velocity in Stratum IIb is attributed to the variable and thinner thicknesses of its sublayers (cemented versus non-cemented zones). This condition increases the uncertainty levels related to transformation and measurement. In addition, shear wave velocities are measured with the PS-Suspension techniques and scatter in the results is typical of the test, especially at formation interfaces. Such scatter increases the observed variability but does not reflect the true spatial variability.

The shear wave velocity plots shown in Figures 2 through 7 clearly indicate the presence of uniform subsurface conditions. For engineering analyses purposes, specifically settlement, foundation stability, and site response analysis, the shear wave velocity profiles are equivalent and the substrata can be considered uniform. In addition, the contribution of Stratum IIb to the overall engineering behavior at the site is not nearly as significant as that of Stratums IIc and III. Within the Powerblock, only 16 percent of the total settlement at the center of NI is associated with Stratum IIb (6 percent in IIb-1, 8 percent in IIb-2 and 2 percent in IIb-3), whereas 84 percent of the total settlement is associated with consolidation of the Stratum IIc (36 percent) and Stratum III (48 percent). The site response analyses incorporate random variability consistent with Approach 2A of NUREG/CR-6728 (NRC, 2001) and NUREG/CR-6769 (NRC, 2002). This methodology adequately covers the observed variability.

Based on the evaluation of the shear wave velocity as described above, the subsurface conditions at the CCNPP3 are characterized as geotechnically uniform.

Figure 1
Locations of Geophysical Survey Borings within the Powerblock Area

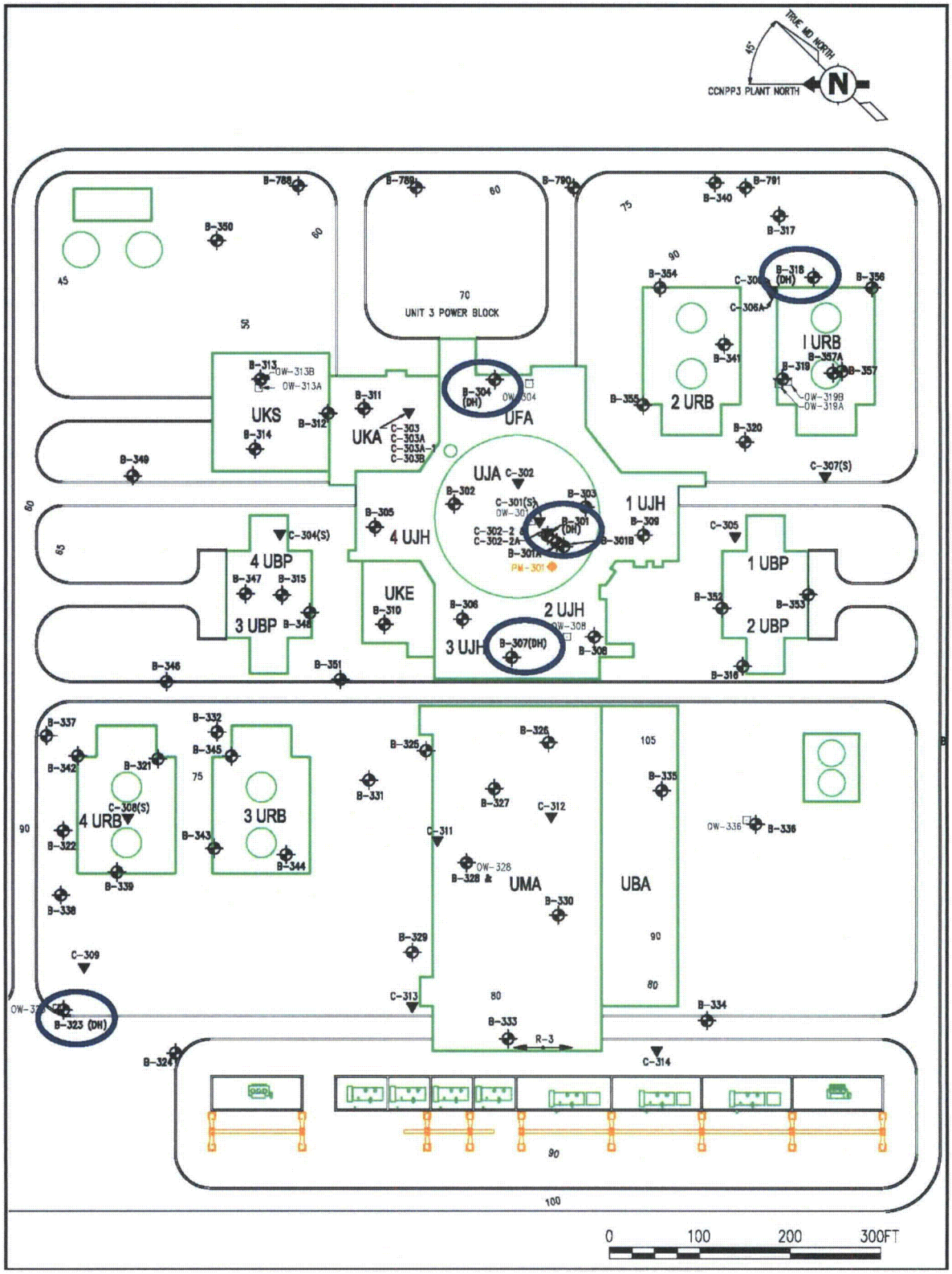


Figure 2
Comparison of Plots of Shear Wave Velocity Beneath Structural Fill for B-301

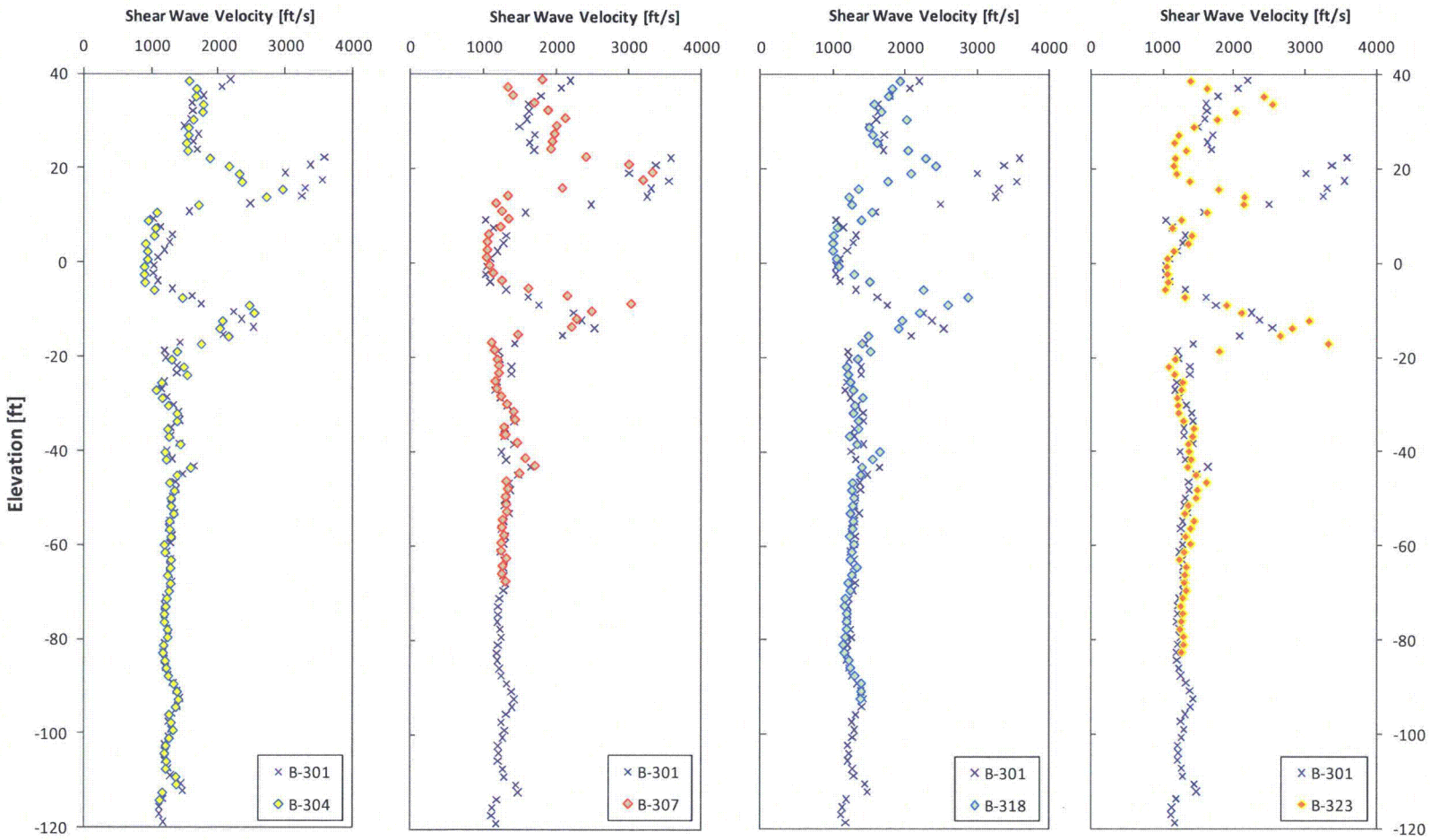


Figure 3
Comparison of Plots of Shear Wave Velocity Beneath Structural Fill for B-304

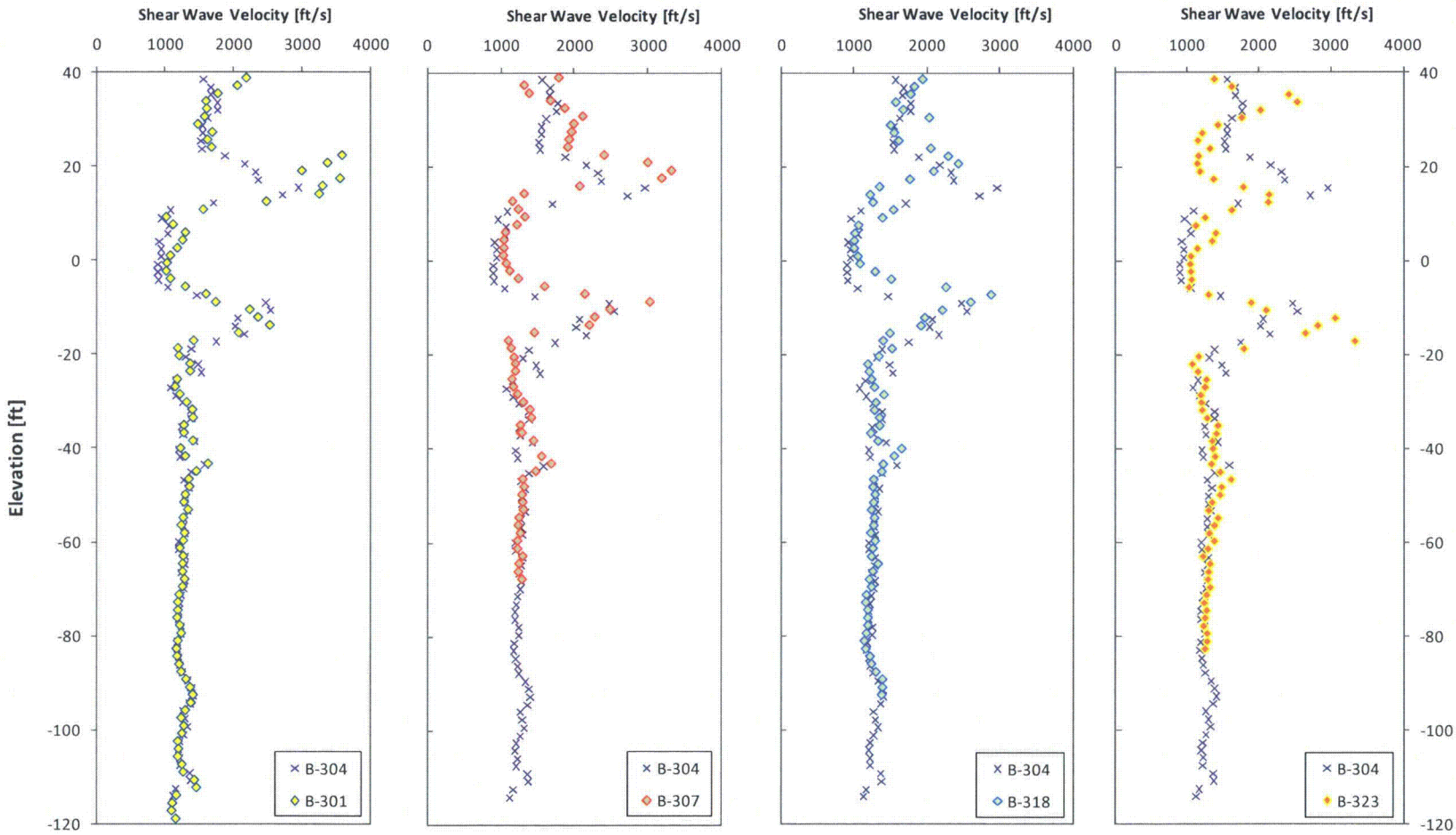


Figure 4
Comparison of Plots of Shear Wave Velocity Beneath Structural Fill for B-307

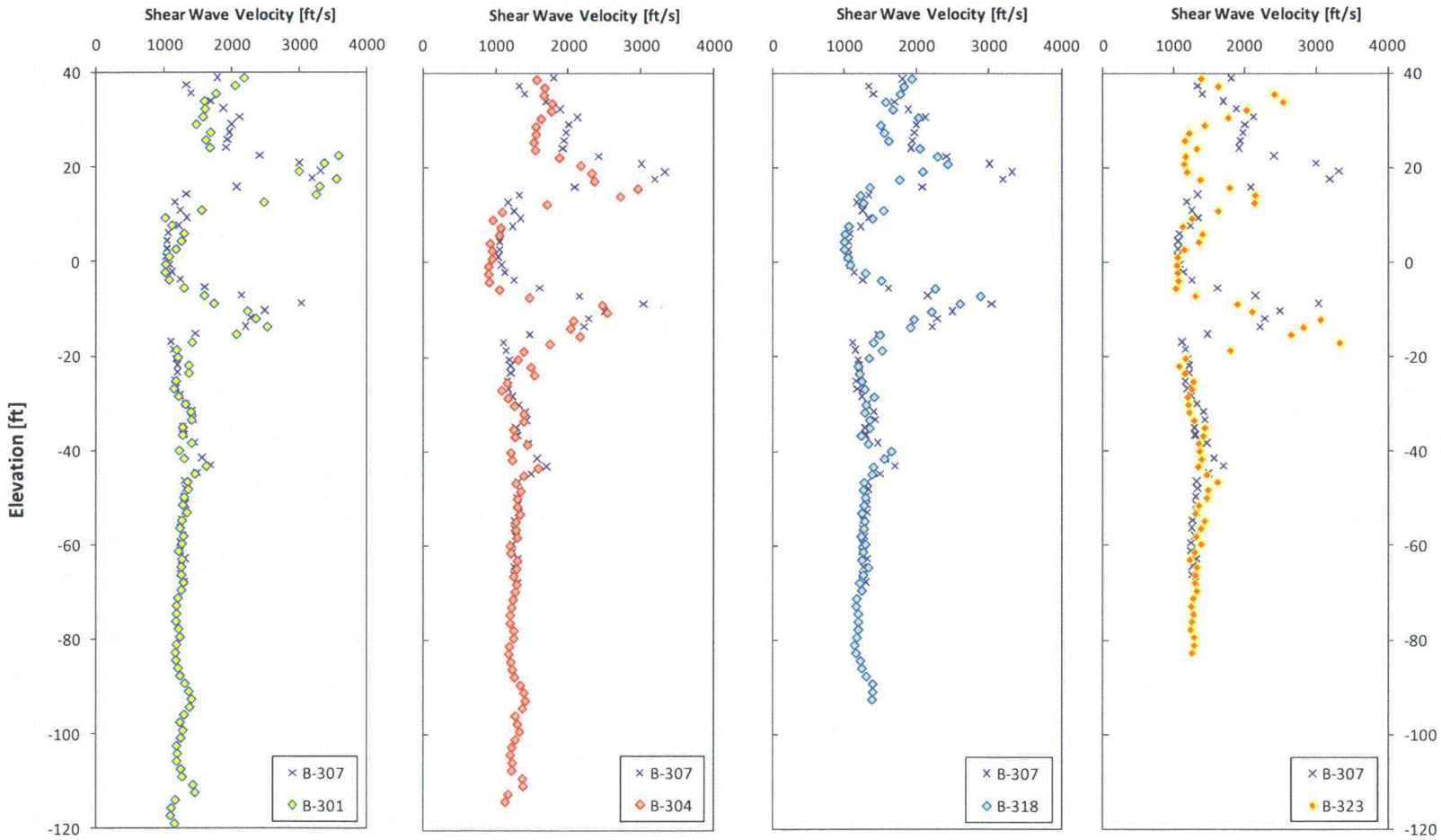


Figure 5
Comparison of Plots of Shear Wave Velocity Beneath Structural Fill for B-318

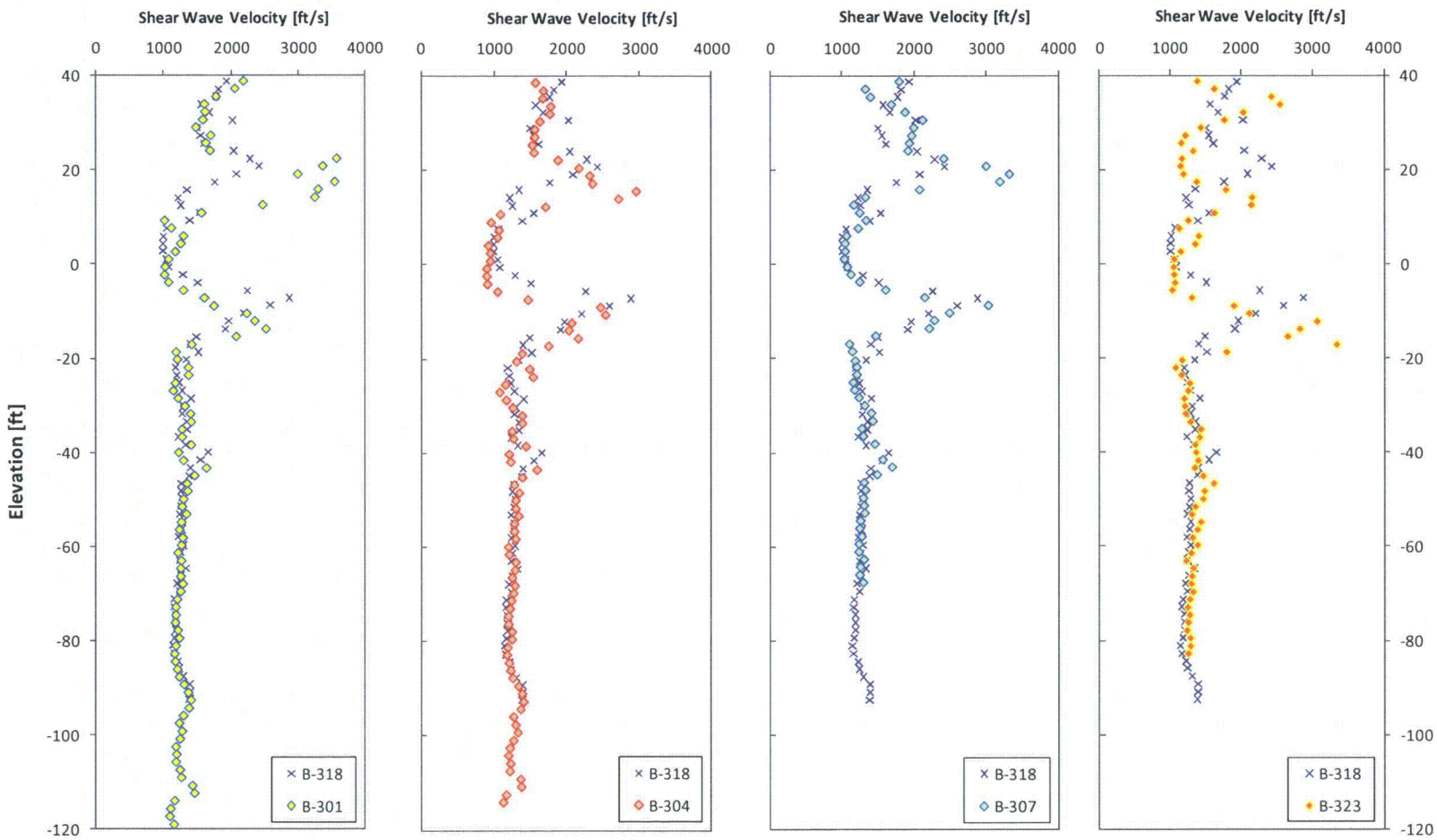


Figure 6
Comparison of Plots of Shear Wave Velocity Beneath Structural Fill for B-323

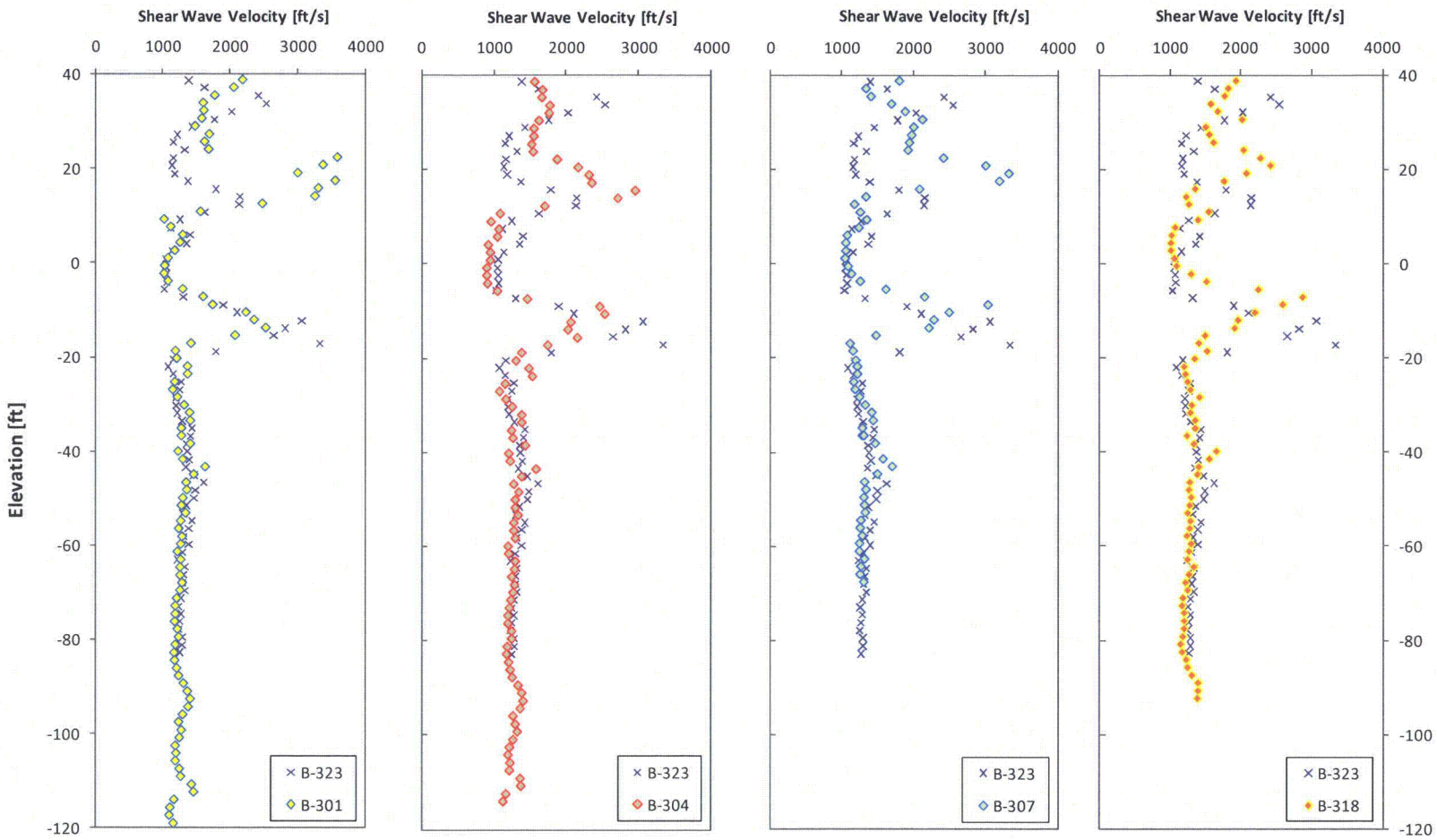


Figure 7
Comparison Plots of Shear Wave Velocity for Stratum III: Nanjemoy Sand

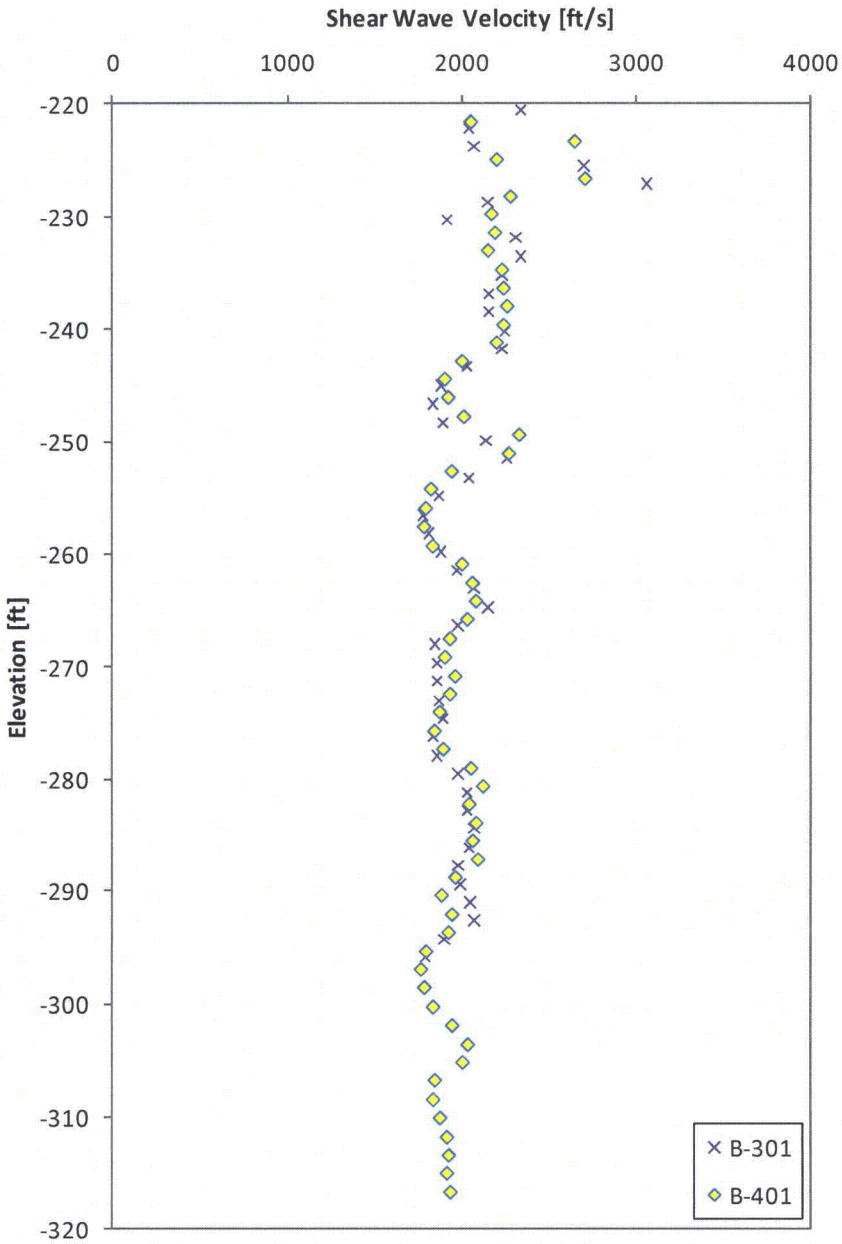


Figure 8
Coefficient of Variation (COV) of Shear Wave Velocity Measurements for Stratums IIB and IIC

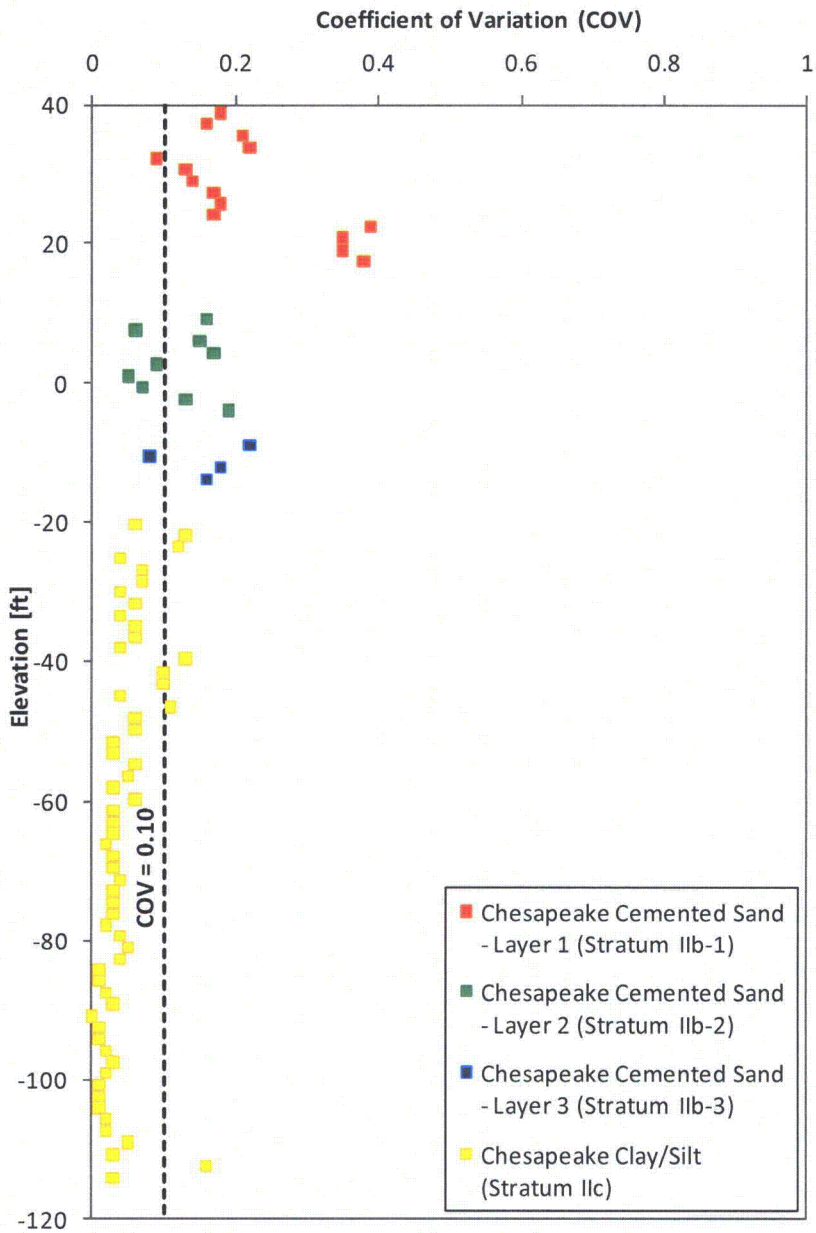
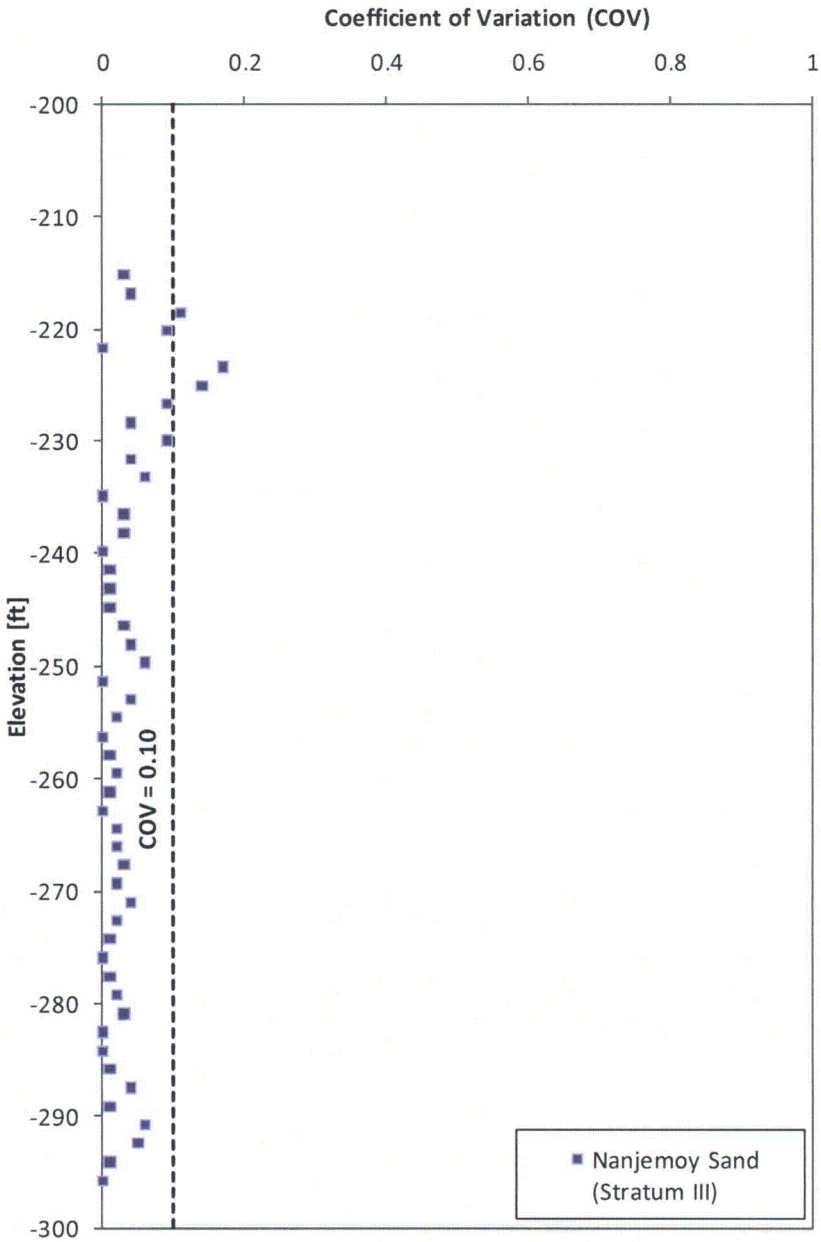


Figure 9
Coefficient of Variation (COV) of Shear Wave Velocity Measurements for Stratum III



COLA Impact

FSAR Section 1.8, Table 1.8-2 will be updated in a future revision to reflect the revision of COL Item 2.5-10, once the revised COL Item is reflected in the U.S. EPR FSAR.

FSAR Section 2.5.4.2.2.2 CCNPP Unit 3 Field Investigation (Suspension P-S Velocity Logging Survey), will be updated in a future revision of the COLA as shown below.

2.5.4.2.2.2 CCNPP Unit 3 Field Investigation

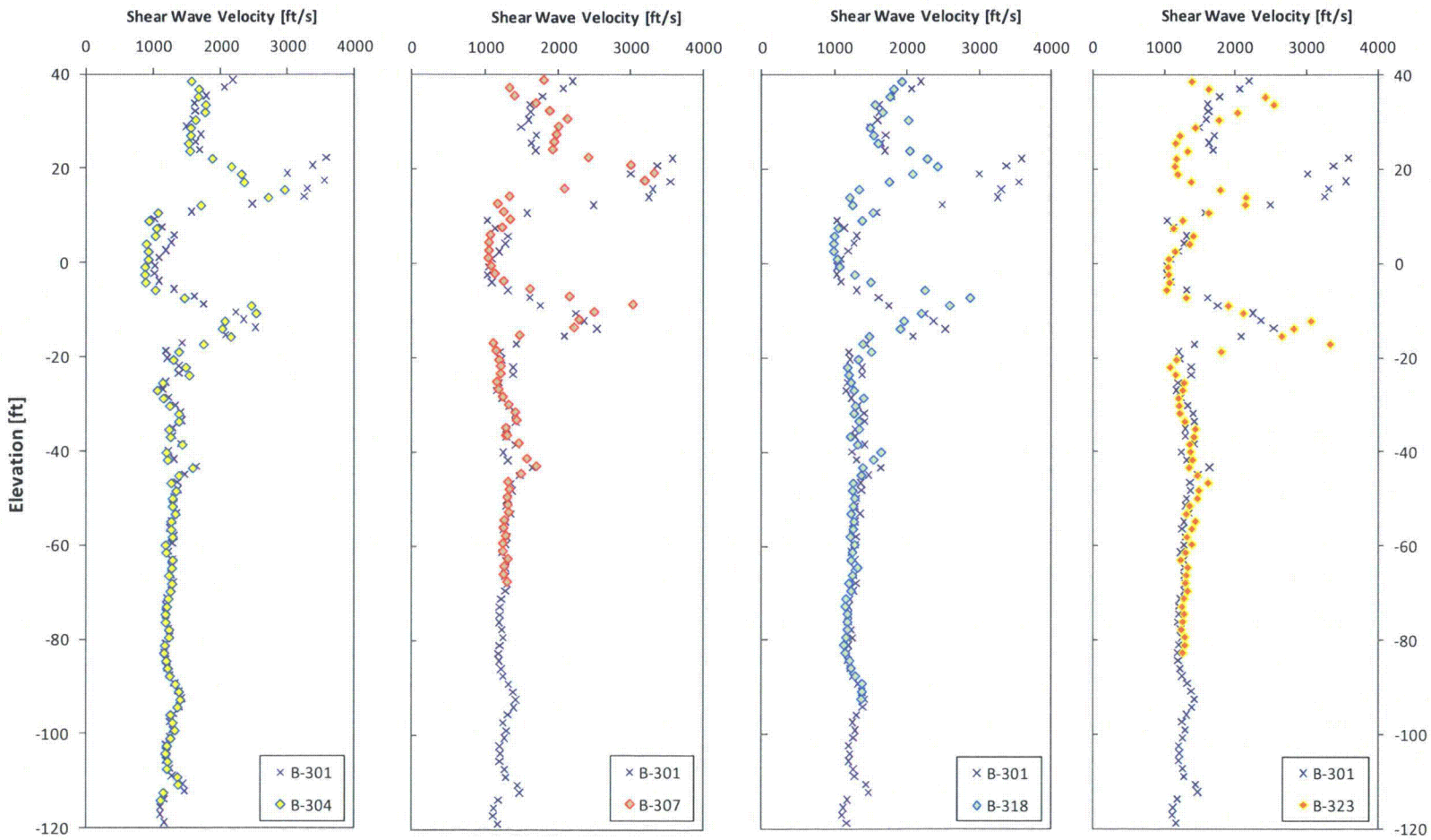
. . .

Suspension P-S Velocity Logging Survey

Borehole geophysical logging was performed in a total of 13 boreholes. The geophysical survey consisted of natural gamma, long- and short-normal resistivity, spontaneous potential, three-arm caliper, direction survey, and suspension P-S velocity logging. Geotechnical engineers or geologists provided full-time field inspection of borehole geophysical logging activities. Detailed results are provided in COLA Part 11J.

Suspension P-S velocity logging was performed in borings B-301, B-304, B-307, B-318, B-323, B-401, B-404, B-407, B-418, B-423, B-773, B-786, and B-821. The measurement at B-786 was performed directly underneath the UHS-MWIS in the Intake Area during the Phase II investigation. The boreholes were uncased and filled with drilling fluid. Boreholes B-301 and B-401 were approximately 400 ft deep each, while the remaining boreholes were approximately 200 ft deep each. The OYO/Robertson Model 3403 unit and the OYO Model 170 suspension logging recorder and probe were used to obtain the measurements. Details of the equipment are described in Ohya (Ohya, 1986). The velocity measurement techniques used for the project are described in Electric Power Research Institute (EPRI) Report TR-102293, Guidelines for Determining Design Basis Ground Motions, (EPRI, 1993). The results are provided as tables and graphs in COLA Part 11J. Figure 2.5-117 and Figure 2.5-118 present the results of the P-S logging surveys. <u>The values in the figures are presented regardless of location and elevation, and therefore the variability in the plots is only apparent. Variability between measurements in the Powerblock area is best shown by Figure 2.5-241, once the offset in elevations is accounted for and the measurements of distant borings excluded. The measurements from Boring B-301 are compared with the other measurements in the Powerblock Area. Only B-301, B-304, and B-307 are within the area covered by the Nuclear Island Common Basemat. The shear wave velocity measurements clearly indicate the presence of uniform subsurface conditions. According to these measurements, engineering analyses such as settlement, foundation stability, and site response analysis, can be performed with the use of uniform soil conditions represented by horizontal strata.</u> Figure 2.5-119 provides the test result of the PS log performed in the Intake Area. Overall, the result is consistent with the measurements in the Powerblock Area. Section 2.5.4.2.5.8 and 2.5.4.4 provide the analysis of the P-S data along with the development of the best estimate soil profiles for the Unit 3 Area and the Intake Area.

Figure 2.5-241
Comparison of Plots of Shear Wave Velocity Beneath Structural Fill for B-301



FSAR Section 2.5.4.10.3 will be updated in a future revision of the COLA as shown below. (Changes to the COL Item will be updated in a future revision of the COLA, once the revised COL Item is reflected in the U.S. EPR FSAR.)

2.5.4.10.3 Uniformity and Variability of Foundation Support Media

The U.S. EPR FSAR includes the following COL Item in Section 2.5.4.10.3:

> A COL applicant that references the U.S. EPR design certification will investigate and determine the uniformity of the underlying layers of site specific soil conditions beneath the foundation basemats. The classification of uniformity or non-uniformity will be established by a geotechnical engineer.

This COL Item is addressed as follows:

{Three criteria are identified in the U.S. EPR FSAR for establishing uniformity in foundation support media, namely, 1) presence of soil and rock, 2) dip angle of soil layers, and 3) shear wave velocity. Each is addressed below:

Foundations of all Seismic Category I structures at the CCNPP Unit 3 site are supported on compacted structural fill which is in turn supported on natural soils. Bedrock at the site is very deep, at about 2,500 ft below ground surface. Given the considerable depth to bedrock, non-uniform foundation conditions resulting from combined soil-rock support are not applicable to foundations at the CCNPP Unit 3 site.

Detailed subsurface information is presented in Section 2.5.4. Stratigraphic profiles indicate that the stratigraphic lines delineating various soil units have gentle slopes, mostly sloping about 1 to 2 degrees. This is consistent with the regional dip of 1 to 2 degrees in Coastal Plain deposits (refer to Section 2.5.1 for more details). However, at isolated CCNPP Unit 3 locations, stratigraphic units dip steeper, up to about 10 degrees which may be due to inherent assumptions in developing the stratigraphic lines or paleochannels and/or irregular erosional surfaces. Regardless, these steeper angles are less than the dip angle of 20 degrees from the horizontal identified in the U.S. EPR FSAR as the criterion for determining levelness of layers. On this basis, the soil layers at the CCNPP Unit 3 site are considered horizontal. ~~However, the settlement analysis accounts for the variability in the soil media with the implementation of a FEM model as discussed in Section 2.5.4.10.4.~~

Classification of uniformity (or non-uniformity) in foundation support media resides with the geotechnical engineer, per the U.S. EPR FSAR. Shear wave velocity (Vs) measurements are used for this determination because they are a) in-situ measurements reflecting the natural ground conditions and b) important input to the safety evaluation of structures such as in soil-structure interaction and seismic analyses. ~~The Vs values were evaluated to a depth of 344 ft below the Nuclear Island (NI) foundation basemat, corresponding to El. -300 ft. The 344 ft value was selected based on the three U.S. EPR FSAR criteria of: 1) 1.5 times an equivalent radius of foundation basemat, 2) 1.0 times the maximum foundation basemat dimension, or 3) no less than 200 ft below the bottom of the foundation basemat; with criterion (2) selected as the governing condition for the CCNPP Unit 3 NI basemat for its greater dimension. Minor appendages and protrusions in the irregularly shaped U.S. EPR NI foundation were~~

~~ignored in selecting the 344 ft value. The variations in shear wave velocity have been properly accounted for in the dynamic analysis by means of a best estimate soil profile.~~ The shear wave velocity measurements clearly indicate the presence of uniform subsurface conditions. For engineering analyses purposes, specifically settlement, foundation stability, and site response analysis, the shear wave velocity profiles are equivalent and the substrata can be considered uniform. This conclusion is supported by the information and analysis provided in Section 2.5.4.2.2.2.

Based upon the above, CCNPP Unit 3 is considered a Uniform Site.