PSNH PUBLIC SERVICE
Company of New Hampshire

SEABROOK STATION
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SBN- 294
T.F. B 7.1.2

United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Frank J. Miraglia, Chief
Licensing Branch No. 3
Division of Licensing

References:
(a) Construction Permit CPPR-135 and CPPR-136, Docket Nos. 50-443 and 50-444
(b) PSNH Letter, dated April 8, 1982, "Meeting Notes; Structural Engineering Branch Design Audit," J. DeVincentis to F. J. Miraglia

Subject: Submittal of Followup Documentation; Structural Engineering Branch Design Audit

Dear Sir:

We have enclosed followup documentation from the Structural Engineering Branch Design Audit which was conducted at the offices of United Engineers on March 29, 1982, through April 2, 1982.

The following "Action Items" specified in Reference (b) are included with this submittal.

- Action Item # 9, dated 4/1/82
- Action Item #11, dated 4/1/82
- Action Item # 2, dated 4/1/82

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

Allen J. Legendre Jr.

J. DeVincentis
for: Project Manager

B001

Enclosures

Action Item #9, dated 4/1/82

220.17 (3.7(B).2.4)

In this section, you have stated that embedment effects are neglected in the soil-structure interaction analysis for Category I manholes. Discuss the implications and conservatism of this assumption. Also, discuss the values of the soil parameters used in your analysis. Specifically, address the variation of parameters and how the radiation damping effects were accounted for. Indicate and discuss whether or not the seismic input motion at the base of the soil-spring was different from the one described in Section 3.7.1.

RESPONSE: The analysis objective was to arrive at a maximum seismic loading for the design of manholes.

The effect of embedment is to increase the soil spring stiffness thus increasing the natural frequency of the system resulting in reduced seismic design value. Hence, it was conservatively assumed to neglect embedment effect. The input design ground response spectra which were used for the analysis indicated that the increase in frequency would result in decrease in response.

To reduce amplification properties of the soil between the ground surface and the rock, the backfill material is controlled by controlling the placement requirement and material characteristics. The soil property given in the FSAR Subsection 3.7(B).1.4 is used for determining soil stiffness. The variations in soil parameters were not considered for the analysis. The lowest shear wave velocity was used to obtain lowest structural frequency which would give higher structural responses as stated above.

The above conservative assumption combined with lower system damping values of 7 percent for SSE and 4 percent for OBE causes seismic load in excess of the actual value.

The design ground response spectra discussed in Subsection 3.7(B).1.1 were used as input for the analysis.

Response to RAI 220.25 provides justification of considering mean peak particle velocity at the ground surface.

The soil amplification and soil structure interaction effects were considered in the analysis of manholes in accordance with the procedure outlined by Whitman in his paper referenced in FSAR Section 3.7(B).2.4.

The design of manholes is governed by dynamic soil pressure; the inertia loads had a minimum effect on the design.

Action Item # 11, dated 4/1/82

220.25 (3.7(B).3.12)

In general, the staff finds the procedure indicated in this section acceptable for the buried systems sufficiently flexible relative to the surrounding and underlying soil. However, provide a discussion on the types of waves and angles of incidences considered 'n your analysis for the staff's review. Also, discuss the amplification of input motion duc to the backfill over the bedrock.

RESPONSE: For pipes and ductbanks, seismic stresses may be analyzed using the methods described in Iqbal and Goodling (1973). The maximum stresses may be computed by considering the combined effects of Rayleigh (R) and shear (S) waves. The design earthquake is an Intensity VIII event occurring at or very near the site. Close to the epicenter of an earthquake, the Rayleigh waves carry only a small fraction of the earthquake energy (Newmark and Rosenbleuth, 1971). The peak velocity and acceleration are conservatively assumed to be due to a 25 percent contribution of Rayleigh waves and 75 percent of shear waves. It is further assumed that the Rayleigh and shear waves propagate in the same direction relative to the orientation of the pipe. A contribution of the compression (P) wave was not considered since the P wave would arrive at a different time than the R and S waves.

For a straight pipe, the combined axial stress from the Rayleigh and shear wave with an energy distribution of 25-75 percent as described above, is:

$$a = (EV_m/C_s)\ (0.25 \cos^2 \ = 0.75 \sin \ \cos \ )$$

where a = Axial stress in the pipe

E = Modulus of pipe

$V_m$ = Maximum particle velocity

$C_s$ = Shear and Rayleigh wave propagation velocity (actually the shear and Rayleigh wave velocities are slightly different)

= Angle of incidence of shear and Rayleigh waves

For the assumed energy distribution, the maximum axial stress occurs at an angle, $0 = 36^o$, resulting in an axial stress

$$_a = 0.52\ EV_m/C_s$$

Bending stresses, $_b$, were not included in the combined analyses since they were less than 1.5 percent of the axial stress.

From the above equation it is seen that the axial stresses in buried conduits and ducts due to seismic events is governed by the maximum particle velocity. The maximum particle velocity, $v_m$, for an Intensity VIII event at the site may be obtained from data published by Trifunac and Brady (1975).

Trifunac and Brady performed a statistical analysis of 187 earthquake accelerograms and developed correlations of earthquake intensity with peak particle velocity, acceleration and displacement. Comparison of data in Table 3 and 5 of Trifunac and Brady shows that the average values of $V_m$ for all site classifications (soft ground, hard and intermediate) corresponds very closely with the average value for intermediate sites. At Seabrook, the site conditions for the buried pipes and ducts are most closely represented as intermediate or hard, using the criteria of Trifunac and Brady, because the compacted fill in the zone of safety-related pipes and ducts has a maximum thickness of 28.5 ft. Thus, it is appropriate to use the mean peak particle velocity for all site classifications as the particle velocity at the ground surface at Seabrook. Using Eq. 2 in Trifunac and Brady, which gives a best fit straight line for the mean peak particle velocities for all intensities, one obtains for Intensity VIII a value of $V_m$ = 23.5 cm/sec. To be reasonably conservative, one standard deviation of the velocity (from Table 3) should be added to this value. Thus, the appropriate design value of $V_m$ at the ground surface is found to be (23.5 + 9.7) = 33.2 cm/sec, or 13.0 in/sec.

The velocity at hard sites, i.e., bedrock, for Intensity V and higher earthquakes, is on average about 80% of the velocity at intermediate sites based on the data provided by Trifunac and Brady. Therefore, at bedrock the mean peak particle velocity, plus one standard deviation, would be about 0.8 x 13 in/sec or 10.5 in/sec.

Based on the above information, we conclude that the following peak particle velocities are appropriate for computing stress in pipes and ducts buried at various depths in the compacted fill.

| | |
|---|---|
| Upper third of fill | 13 in/sec |
| Middle third of fill | 12 in/sec |
| Lower third of fill | 11 in/sec |

The above discussion shows that the Rayleigh waves have no significant effect on the design of the buried structures. The structures on the Seabrook project are buried at different heights from the surface, and their design considers the effects of shear wave alone and particle velocity of 1/2 in/sec.

Action Item #2 dated 4/1/82

Justify why wave other than shear wave is not considered in calculating soil strain.

RESPONSE: See responses to RAIs 220.17 and 220.25.