Client: Duquesne Light/PLG, Inc. Calculation No. 93C1783-07

Title: Seismic Fragility (SPRA) Analysis, Beaver Valley Unit #1 Diesel Generator, EE-EG-1, 2

Project: BEAVER VALLEY FRAGILITY ANALYSIS FOR INDIVIDUAL PLANT EXAMINATIONS FOR EXTERNAL EVENTS

Method:

Acceptance Criteria:

Remarks:

REVISIONS

No.	Description	By	Date	Chk.	Date	App.	Date
0	Initial Issue	YZ	1-31-94	PRW	1-31-94	PRW	1-31-94

S&A Stevenson and Associates

CALCULATION COVER SHEET

FIGURE 1.3

CONTRACT NO. 93C1783

Diesel Generator EE-EG-1, 2

1. Basic Information Summaries (Ref. 1)

The diesel generator was qualified successfully by the vibration tests for the same diesel generator of the Pasny nuclear power plant. When including the stiffening effects of piping the diesel generator had a fundamental frequency over 30 Hz. The input test seismic level was 0.3g in the horizontal direction and 0.2g in the vertical direction. The most critical component of the diesel generator was found to be the expansion tank with a factor of safety equal to 10.97. The stress state was primarily bending plus shear.

2. Determination of Median Capacity, Am

Due to governing seismic loading the effect of the normal stress is small, then the strength factor, F_s, is determined as

$$F_s = \frac{\sigma_y/\sigma_d - \sigma_n/\sigma_d}{\sigma_t/\sigma_d - \sigma_n/\sigma_d} \simeq \frac{\sigma_y}{\sigma_t} = \frac{1.0}{0.9}(10.97) = 12.2$$

in which 0.9 is the factor for allowable stress using the minimum yield stress.

Ref. 2 presented a ductility value from 2.5 to 10 for steel loaded primarily in bending. 6.25 may be assumed to be the median value, 1.875 may be a logarithmic standard deviation. Therefore the median ductility factor, F_u, can be calculated

$$F_u = \sqrt{2 \times 6.25 - 1} = 3.39$$

At the fundamental frequency of 30Hz, the horizontal UHS floor spectrum at EL. 735' of the diesel generator building is read as 0.18g. The corresponding ZPGA value for the UHS spectrum is 0.15g. The median value for the yield stress of carbon steel is 1.2 times the minimum one used to calculate the capacity of the expansion tank. Therefore, the median capacity Am is computed as

$$A_m = \frac{0.3g}{0.18g} \times 12.2 \times 3.39 \times 1.2 \times 0.15g = 12.4g$$

3. Logarithmic Standard Deviation Values of Variables

The logarithmic standard deviation of randomness and uncertainty is primarily due to earthquake component combination, damping, and the test measurement of the table acceleration. In addition, the ductility

should be treated as a variable since it has been considered for the median capacity.

Variable	β_r	β_u
Earthquake Component Combination	0.4	0.2
Damping	0.0	0.15
Test Measurement	0.0	0.15
Ductility	0.05	0.20
Combined	0.40	0.35

4 Seismic Fragility (Ref. 3)

The SPRA fragility, $HCLPF_{50}$, may be computed as

$$HCLPF_{50} = A_m \, Exp\,[-1.65(\beta_r + \beta_u)]$$
$$= 12.4g \, Exp[-1.65(0.4 + 0.35)]$$
$$= 3.6g$$

The SMA fragility, $HCLPF_{84}$, may be computed as

$$HCLPF_{84} = HCLPF_{50} \cdot Exp\,[\beta_{rs}]$$
$$= 3.6g \times 1.2$$
$$= 4.3g$$

Reference:

1. "Seismic Report — Diesel Generators," DWG No 8700-1.30-39A, J.O. No. 11700 — O.F.E. No. 8700 — C.O. No. 3468

2. Newmark, N. W., "Inelastic Design of Nuclear Reactor

Structures and Its Implications on Design of Critical Equipment," SMiRT 4, K4/1, 1977

3. Reed, J. W. and Kennedy, R. P., "Methodology for Developing Seismic Fragilities," (Draft) EPRI NP-XXXX, RP2722-23, August 1993

ATTACHMENT G

Fragility Calculation for BVPS-1 Emergency Diesel Generator Building