

Client: Duquesne Light/PLG, Inc. Calculation No. 93C1783-40

Title: SEISMIC FRAGILITY (SPRA) ANALYSIS, BEAVER VALLEY UNIT #1
DIESEL GENERATOR BUILDING

Project: BEAVER VALLEY SEISMIC 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	YE	1-31-94	PRW	1-31-94	PRW	1-31-94



CALCULATION
COVER
SHEET

FIGURE 1.3

CONTRACT NO.
93C1783



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CLIENT PLG Inc. IEEE JOB No. 9301283 SHEET 1 OF 2

SUBJECT Seismic Fragility (SPRA)
Analysis, Beaver Valley Unit #1

Diesel Generator Building

REVISIONS	
0	FE 1-31-94
	PRW 1-31-94

Diesel Generator Building

From Reference 1 some basic information may be summarized as following:

The building was designed using ACI 318-1963. The horizontal DBE ZPGA was equal to $0.125g$ @ 7% damping. The input spectrum value for the equivalent static analysis was $0.279g$ at EL. 735'-6", $0.34g$ at EL. 757'-3", and $0.37g$ at 766'-3". The critical part was the shear wall bottom dominated by flexure. The base of the building was at EL. 735'-6". The vertical excitation was $2/3$ times horizontal one.

A reference earthquake scale factor and an inelastic energy absorption factor for typical shear walls may be assumed to 3.0 and 2.0 separately using Reference 2. Then the median capacity A_m may be computed as

$$A_m = \frac{0.279g}{0.36g} \times 3.0 \times 2.0 \times 0.15g = 0.70g$$

In which, $0.36g$ is the horizontal UHS spectrum value at EL. 735' of the diesel generator building at typical fundamental frequency of about 4 Hz.

The logarithmic standard deviation of randomness and



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CLIENT	PLG, Inc., IPSEE	JOB No.	93C1785	SHEET	2	OF	2
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	Diesel Generator Building						
REVISIONS	0	YB	1-31-94				
		PRW	1-31-94				

uncertainty may be assumed to be 0.25 for β_r and 0.35 for β_u , respectively using Refs. 2, 3, and 4. Then the SPRA fragility, $HCLPF_{50}$, is computed as

$$\begin{aligned} HCLPF_{50} &= A_m \text{Exp}[-1.65(\beta_r + \beta_u)] \\ &= 0.70 \text{Exp}[-1.65(0.25 + 0.35)] \\ &= 0.26g \end{aligned}$$

The SMA fragility, $HCLPF_{84}$, is computed as (Ref. 2)

$$\begin{aligned} HCLPF_{84} &= HCLPF_{50} \cdot \text{Exp}[0.20] \\ &= 0.26 \text{Exp}[0.20] = 0.32g \end{aligned}$$

Reference:

1. "Diesel Generator Building Calculation," by Stone & Webster, Job Brook No. 5C-AB, Sept. 1970
2. Reed, J.W. and Kennedy, R.P., "Methodology for Developing Seismic Fragilities," (Draft) EPRI, NP-XXXX, RP2722-23, Aug. 1993
3. "An Approach to the Quantification of Seismic Margins in Nuclear Power Plants," NUREG/CR-4334, Aug. 1985
4. "Handbook of Nuclear Power plant Seismic Fragilities, Seismic Safety Margins Research Program," NUREG/CR-3558, June 1985

ATTACHMENT H

**Detailed Description of the Top 5
Seismic Core Damage Sequences**

Detailed Description of the Top 5 Seismic Core Damage Sequences						
Seismic CDF Sequence	Frequency per year (Percent of Seismic Total)	Earthquake Acceleration Level (g)	Seismic Failures	Guaranteed Failures	Independent Non-seismic Failures	Operator Action Failures/Timing
1	5.3935E-07 (10.13%)	SEIS4 (0.5 - 1.0)	<ul style="list-style-type: none"> • ZC4 - Offsite Grid • ZD4 - Normal AC/DC Power • ZE4 - Emergency AC Power • ZB4 - ERF Diesel Generator Power 	<ul style="list-style-type: none"> • OGF - Offsite Grid • D5F - 125V DC Battery 2-5 Supply • D6F - 125V DC Battery 2-6 Supply • AOF - Emergency AC Orange Train • BPF - Emergency AC Purple Train • XTF - Station AC Power Cross Tie • OSF - Operator Initiates Safety Injection • WAF - Service/Standby SW Train-A Pumps & Flow Path • WBF - Service/Standby SW Train-B Pumps & Flow Path • BKF - ERF (Black) Diesel Generator Power • CSF - Turbine Plant Component Cooling Water • IAF - Station Instrument Air Supply • CCF - Primary Component Cooling Water System • ICF - Containment Instrument Air System • TBF - RCP Thermal Barrier Cooling • AFF - Auxiliary Feedwater • PRF - Pressurizer Relief and Reclosure • OFF - Manual Actions to Reestablish MFW • OBF - Bleed & Feed Cooling • HiHF - High Head Safety Injection Pumps • LHF - Low Head Safety Injection Pumps • NRF - Recirculation from sump not required • NMF - No melt condition from injection phase • QSF - Quench Spray Pumps • SMF - Containment Sump Water Level, Plugging • CIF - Containment Isolation • REF - Electric power recovery prior to core uncover 	N/A	N/A
2	3.6910E-07 (6.93%)	SEIS4 (0.5 - 1.0)	<ul style="list-style-type: none"> • ZC4 - Offsite Grid • ZD4 - Normal AC/DC Power • ZB4 - ERF Diesel Generator Power 	<ul style="list-style-type: none"> • OGF - Offsite Grid • D5F - 125V DC Battery 2-5 Supply • D6F - 125V DC Battery 2-6 Supply • OSF - Operator Initiates Safety Injection • WAF - Service/Standby SW Train-A Pumps & Flow Path • WBF - Service/Standby SW Train-B Pumps & 	N/A	N/A

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				<ul style="list-style-type: none"> Flow Path • BKF - ERF (Black) Diesel Generator Power • CSF - Turbine Plant Component Cooling Water • IAF - Station Instrument Air Supply • CCF - Primary Component Cooling Water System • ICF - Containment Instrument Air System • TBF - RCP Thermal Barrier Cooling • AFF - Auxiliary Feedwater • PRF - Pressurizer Relief and Reclosure • OFF - Manual Actions to Reestablish MFW • OBF - Bleed & Feed Cooling • HHF - High Head Safety Injection Pumps • LHF - Low Head Safety Injection Pumps • NRF - Recirculation from sump not required • NMF - No melt condition from injection phase • QSF - Quench Spray Pumps • SMF - Containment Sump Water Level, Plugging • CIF - Containment Isolation • REF - Electric power recovery prior to core uncover 		
3	2.8510E-07 (5.35%)	SEIS3 (0.35 - 0.5)	<ul style="list-style-type: none"> • ZC3 - Offsite Grid • ZE3 - Emergency AC Power • ZB3 - ERF Diesel Generator Power 	<ul style="list-style-type: none"> • OGF - Offsite Grid • AOF - Emergency AC Orange Train • BPF - Emergency AC Purple Train • XTF - Station AC Power Cross Tie • WAF - Service/Standby SW Train-A Pumps & Flow Path • WBF - Service/Standby SW Train-B Pumps & Flow Path • BKF - ERF (Black) Diesel Generator Power • CSF - Turbine Plant Component Cooling Water • IAF - Station Instrument Air Supply • CCF - Primary Component Cooling Water System • ICF - Containment Instrument Air System • TBF - RCP Thermal Barrier Cooling • HHF - High Head Safety Injection Pumps • SEF - RCP Seal Injection • LHF - Low Head Safety Injection Pumps • ODF - Depressurization of RCS for RHR Entry 	N/A	N/A

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				<ul style="list-style-type: none"> • NRF - Recirculation from sump not required • NMF - No melt condition from injection phase • QSF - Quench Spray Pumps • SMF - Containment Sump Water Level, Plugging • REF - Electric power recovery prior to core uncover 		
4	2.1881E-07 (4.11%)	SEIS3 (0.35 - 0.5)	<ul style="list-style-type: none"> • ZC3 - Offsite Grid • ZD3 - Normal AC/DC Power • ZE3 - Emergency AC Power • ZB3 - ERF Diesel Generator Power 	<ul style="list-style-type: none"> • OGF - Offsite Grid • D5F - 125V DC Battery 2-5 Supply • D6F - 125V DC Battery 2-6 Supply • AOF - Emergency AC Orange Train • BPF - Emergency AC Purple Train • XTF - Station AC Power Cross Tie • WAF - Service/Standby SW Train-A Pumps & Flow Path • WBF - Service/Standby SW Train-B Pumps & Flow Path • BKF - ERF (Black) Diesel Generator Power • CSF - Turbine Plant Component Cooling Water • IAF - Station Instrument Air Supply • CCF - Primary Component Cooling Water System • ICF - Containment Instrument Air System • TBF - RCP Thermal Barrier Cooling • HHF - High Head Safety Injection Pumps • SEF - RCP Seal Injection • LHF - Low Head Safety Injection Pumps • ODF - Depressurization of RCS for RHR Entry • NRF - Recirculation from sump not required • NMF - No melt condition from injection phase • QSF - Quench Spray Pumps • SMF - Containment Sump Water Level, Plugging • REF - Electric power recovery prior to core uncover 	N/A	N/A
5	2.0439E-07 (3.84%)	SEIS4 (0.5 - 1.0)	<ul style="list-style-type: none"> • ZC4 - Offsite Grid • ZE4 - Emergency AC Power • ZB4 - ERF Diesel Generator Power 	<ul style="list-style-type: none"> • OGF - Offsite Grid • AOF - Emergency AC Orange Train • BPF - Emergency AC Purple Train • XTF - Station AC Power Cross Tie • OSF - Operator Initiates Safety Injection 	N/A	N/A

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