PORTLAND GENERAL ELECTRIC COMPANY
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PORTLAND, OREGON 97204

CHARLES GOODWIN, JR.

October 13, 1978

Trojan Nuclear Plant
Docket 50-344
License NPF-1

Director of Nuclear Reactor Regulations
ATTN: Mr. A. Schwencer, Chief
Operating Reactors Branch #1
Division of Operating Reactors
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Attached are responses to the NRC Staff questions of October 11 through 13, 1978, based on information provided by Bechtel in confirmation of telephone conversations between Portland General Electric Company, Bechtel and the NRC Staff.

This letter and attachments are being served on the Atomic Safety and Licensing Board and all parties to the Control Building Hearings.

Sincerely,

C. Goodwin, Jr.

C. Goodwin, Jr.
Assistant Vice President
Thermal Plant Operation and Maintenance

CG/LWE/crw/jwTIA29

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ANSWER TO ADDITIONAL REQUEST
FOR CLARIFICATION TO SUBMITTALS ENTITLED

TROJAN CONTROL BUILDING
SUPPLEMENTAL STRUCTURAL EVALUATION
SEPTEMBER 19, 1978

and

RESPONSE TO QUESTIONS FROM THE
NUCLEAR REGULATORY COMMISSION
DATED AUGUST 30, 1978
September 20, 1978

ADDITIONAL REQUEST # 1

"Explain the effect of vertical earthquake motion on the shear capacity of the major shear walls. Include the load-carrying effects of the structural steel framing.

CLARIFICATION # 1

The last two columns of the attached tables 1(a) and 1(b) demonstrate that the effect of vertical earthquake motion on the shear capacity of the major shear walls does not significantly reduce their capacities. The effect of the vertical earthquake on the shear capacity of the major shear walls is taken into account through a reduction in the dead load. Considering the vertical stiffness of the Control Building, the average vertical acceleration would be approximately 0.2g, which in effect reduces the dead load by 20%. To provide further conservatism in the assessment of shear capacities when considering vertical earthquake motion, the dead load used to determine the capacities shown in the column "Alternate Capacities" includes only 80% of direct load considering the weight of the walls and one-half of the equipment weight, but no contribution from the slabs. The weight of the slabs was conservatively assumed to be completely carried by the steel frame. Even with the 20% reduction in the dead load and reducing the dead load to only the direct dead load, the capacities have not been significantly reduced from the more realistic capacities given in Tables 4-1 and 4-2 of the "Supplemental Structural Evaluation" dated September 1978. Information on the dead load contribution is given in Table 1(c). As can be seen by comparing these values with those in Tables 5-1 through 5-4, 7-7, and 7-8, the capacities are greater than the loads for the walls listed in Table 1(c) excluding all dead load contributions.

Table 1(a) Force-Capacity Comparison, N-S And E-W Motion Elevation 45'-61', Fixed Base, SSE = 0.25g, β = 5% (Refer To Tables 5-1 Through 5-4 Of The "Trojan Control Building Supplemental Structural Evaluation, September 1978")

	WALL NUMBER	SHEAR FORCE (KIPS)	CAPACITY (KIPS)	CAPACITY / LOAD	ALTERNATE CAPACITY (KIPS)**	ALTERNATE CAPACITY / LOAD
N-S WALLS N-S MOTION	1	4110	5390	1.31	4980	1.21
	2	780	470	.60*	470	.60*
	3	560	490	.88*	490	.88*
	4	2240	3810	1.70	3080	1.38
	5	3050	5970	1.96	5350	1.75
	6	340	110	.32*	110	.32*
	7	540	420	.78*	420	.78*
	8	290	60	.21*	60	.21*
		∑ = 11910	∑ = 16720	1.40	∑ = 14960	1.26
E-W WALLS E-W MOTION	9	1700	4730	2.78	4220	2.48
	10	1680	5560	3.31	5050	3.01
	11	510	240	.47*	240	.47*
	12	320	420	1.31	420	1.31
	13	4620	9350	2.02	8600	1.86
	14	450	170	.38*	170	.38*
	15	870	760	.87*	760	.87*
		∑ = 10150	∑ = 21230	2.09	∑ = 19470	1.92

*Ratios less than 1.0 indicate the load is fictitious since the load cannot exceed the capacity.

**Alternate capacity evaluation is made only for walls governed by the basic criteria.

Table 1(b) Force-Capacity Comparison, N-S And E-W Motion Elevation 61'-77', Fixed Base, SSE = 0.25g, β = 5% (Refer To Tables 5-1 Through 5-4 Of The "Trojan Control Building Supplemental Structural Evaluation, September 1978")

	WALL NUMBER	SHEAR FORCE (KIPS)	CAPACITY (KIPS)	CAPACITY / LOAD	ALTERNATE CAPACITY (KIPS)**	ALTERNATE CAPACITY / LOAD
N-S WALLS N-S MOTION	1	3910	5100	1.30	5100	1.30
	2	560	190	.34*	190	.34*
	3	3140	4520	1.44	4170	1.33
	4	1910	2240	1.17	2240	1.17
	5	470	650	1.38	650	1.38
	6	600	750	1.25	750	1.25
		∑ = 10590	∑ 13450	1.27	∑ = 13100	1.24
E-W WALLS E-W MOTION	7	1670	4440	2.66	4440	2.66
	8	3560	9340	2.62	8770	2.46
	9	790	2820	3.57	2320	2.94
	10	350	1380	3.94	1380	3.94
	11	950	2390	2.52	2390	2.52
	12	1310	2390	1.82	2390	1.82
		∑ = 8630	∑ = 22760	2.64	∑ = 21690	2.51

*Ratios less than 1.0 indicate the load is fictitious since the load cannot exceed the capacity.

**Alternate capacity evaluation is made only for walls governed by the basic criteria.

Table 1(c) Alternate Capacity Calculation

		WALL	W_1	$W_2 = 0.8W_1$	V_1	$0.25W_2$	ALTERNATE V_{TOTAL}
El. 45'-61'	N-S	1	1227	982	4773	245	4978
		4	2081.1	1665	2672	416	3088
		5	927	742	5165	185	5350
	E-W	9	1774	1419	3868	355	4223
		10	841	673	4881	168	5049
		13	2968	2374	8010	594	8604
El. 61'-77'	N-S	3	1530	1224	3864	306	4170
	E-W	8	1966	1573	8381	393	8774
		9	565	452	2207	113	2320

Where: W_1 = direct dead load

$V_1 = 0.75V_{Schneider}$

$V_{total} = V_1 + 0.25W_2$

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ADDITIONAL REQUEST # 2

"As additional information to Clarification No. 22, provide the ratio of the dowel capacity to the reported shear wall capacity for the lower two stories of the western portion of the complex."

CLARIFICATION # 2

The dowel capacities corresponding to each wall for the lower two stories of the western portion of the complex are summarized in tables 2(a) and 2(b) attached.

Table 2(a) Dowel Capacity Comparison
(Elevation 45'-61')

	WALL	CAPACITY (KIPS) $V_{REPORTED}$	CAPACITY (KIPS) V_{DOWEL}	$\frac{V_{DOWEL}}{V_{REPORTED}}$
N-S DIRECTION	1	5390	3390	0.63
	2	470	1220	2.60
	3	490	1480	3.02
	4	3810	4070	1.07
	5	5970	6260	1.05
	6	110	220	2.00
	7	420	420	1.00
	8	60	165	2.75
		16720	17225	
E-W DIRECTION	9	4730	8880	1.88
	10	5560	3130	0.57
	11	240	510	2.13
	12	420	670	1.60
	13	9370	8065	0.86
	14	170	270	1.59
	15	760	782	1.03
		21230	22307	

Table 2(b) Dowel Capacity Comparison
(Elevation 61'-77')

	WALL	CAPACITY (KIPS)		$\frac{V_{DOWEL}}{V_{REPORTED}}$
		$V_{REPORTED}$	V_{DOWEL}	
N-S DIRECTION	1	5100	3830	0.75
	2	190	1020	5.37
	3	4520	4790	1.06
	4	2240	2010	0.90
	5	650	960	1.48
	6	750	1020	1.36
		13450	13630	
E-W DIRECTION	7	4440	8070	1.82
	8	9340	9310	0.997
	9	2820	4920	1.74
	10	1380	1885	1.36
	11	2390	8021	3.36
	12	2390	2075	0.87
		22760	34281	

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ADDITIONAL REQUEST #3

"Provide further information to the information included in Clarification No. 12 on the effects of ductility ratio and frequency shift on the Control Building floor response spectra based on the information presented in Appendix D. Consider these effects on the safety-related equipment, cable trays, and Class 1 piping systems in the Control Building."

CLARIFICATION # 3

In order to arrive at an extreme upper bound estimate of the ductility ratio and possible frequency shift due to the Control Building inelastic behavior, the information presented in Appendix D for estimating an upper bound displacement of the most highly stressed wall (wall 1) is used. Based on the shear stress-strain curve for the composite wall shown in Figure D-1, an idealized elasto-(perfectly)-plastic shear stress-strain curve is developed. This curve has as its "yielding" stress a value of 150 psi, which is a conservative value derived from the concrete "cracking" shear stress (280 psi) in the PCA tests, and the block "cracking" shear stress (100 psi) in the Berkeley tests, as shown in Figure D-1. The elastic modulus of this idealized elasto-plastic curve is the lower bound shear modulus of 0.45×10^6 psi as reported in Appendix D. Based on this idealized elasto-plastic shear stress-strain curve, the "yield" displacement and the total elasto-plastic displacement on the top of wall 1 in the N-S direction subjected to the SSE load can be calculated using the response energy conservation technique as follows:

El. 93'-117': H = 288", v = 60 psi

$$\delta_1 = \frac{60}{0.45\times10^6}(288) = 0.04"$$

El. 77'-93': H = 192", v = 115 psi

$$\delta_2 = \frac{115}{0.45\times10^6}(192) = 0.049"$$

El. 61'-77': H = 192", v = 135 psi

$$\delta_3 = \frac{135}{0.45\times10^6}(192) = 0.058"$$

El. 45'-61': H = 192", v = 215 psi

$$\delta_4^y = \frac{150}{0.45\times10^6}(192) = 0.064"$$

$$\delta_4^{ep} = [\frac{215}{0.45\times10^6} + \frac{(215-150)^2}{0.45\times10^6}(\frac{1}{2})(\frac{1}{150})](192) = 0.098"$$

Total elasto-plastic displacement:

$$\delta^{ep} = \delta_1+\delta_2+\delta_3+\delta_4{}^{ep} = 0.04+0.049+0.058+0.098 = 0.245"$$

Total "yielding" displacement:

$$\delta^y = \delta_1+\delta_2+\delta_3+\delta_4^y = 0.04+0.049+0.058+0.064 = 0.211"$$

Thus, the ductility ratio μ fo ie N-S direction is given by:

$$\mu = \frac{\delta^{ep}}{\delta^y} = \frac{0.245}{0.211} = 1.16$$

If, instead of 150 psi, the idealized elasto-plastic curve assumes the extreme lower bound block cracking shear stress of 100 psi as its yielding stress, then the calculations for ductility ratio become as follows:

El. 93'-117': H = 288", v = 60 psi

$$\delta_1 = \frac{60}{0.45\times10^6}(288) = 0.04"$$

El. 77'-93': H = 192", v = 115 psi

$$\delta_2^y = \frac{115}{0.45\times10^6}(192) = 0.043"$$

$$\delta_2^{ep} = [\frac{115}{0.45\times10^6} + \frac{(115-100)^2}{0.45\times10^6}(\frac{1}{2})(\frac{1}{100})](192) = 0.049"$$

El. 61'-77': H = 192", v = 135 psi

$$\delta_3^y = \frac{100}{0.45\times10^6}(192) = 0.043"$$

$$\delta_3^{ep} = [\frac{135}{0.45\times10^6} + \frac{(135-100)^2}{0.45\times10^6}(\frac{1}{2})(\frac{1}{100})](192) = 0.06"$$

El. 45'-61': H = 192", v = 215 psi

$$\delta_4^y = \frac{100}{0.45\times10^6}(192) = 0.043"$$

$$\delta_4^{ep} = [\frac{215}{0.45\times10^6} + \frac{(215-100)^2}{0.45\times10^6}(\frac{1}{2})(\frac{1}{100})](192) = 0.12"$$

Total elasto-plastic displacement:

$$\delta^{ep} = \delta_1+\delta_2^{ep}+\delta_3^{ep}+\delta_4^{ep} = 0.04+0.049+0.06+0.12 = 0.269"$$

Total "yielding" displacement:

$$\delta^y = \delta_1+\delta_2^y+\delta_3^y+\delta_4^y = 0.04+0.043(3) = 0.169"$$

Thus, the ductility ratio for the N-S direction in this case is:

$$\mu = \frac{\delta^{ep}}{\delta^y} = \frac{0.269}{0.169} = 1.59$$

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CLARIFICATION # 3, continued

Using an uncracked elastic shear modulus of 1.59×10^6 psi and the effective wall thickness, the fundamental N-S mode frequency determined from the STARDYNE analysis is 6.8 cps. To correspond to the effective thickness used in the STARDYNE analysis, the lower bound shear modulus for wall 1 of 0.45×10^6 psi becomes 0.6×10^6 psi after adjustment by the gross-to-effective thickness ratio of 4/3. If the 0.6×10^6 psi shear modulus is assumed to apply throughout the entire structural complex and this value is used in the STARDYNE analysis, the STARDYNE fundamental N-S frequency of 6.8 cps would be reduced by a factor of $(0.6/1.59)^{1/2} = 0.61$, giving a frequency of 4.2 cps.

Assuming that the extreme lower bound ductility ratio for the most highly stressed wall 1, $\mu = 1.59$, applies to the entire structural complex, the frequency of 4.2 cps would further be reduced by a factor of $1/(\mu)^{1/2} = 1/(1.59)^{1/2} = 0.79$, giving a frequency of 3.3 cps. This is the extreme lower frequency to which the STARDYNE fundamental N-S frequency would shift as a result of the inelastic behavior of the Control Building.

Corresponding to the extreme lower bound frequency of 3.3 cps, the Control Building N-S pseudo-elastic floor response spectra would have a widened floor spectral peak covering the frequency range of 3.0 to 3.6 cps, and a spectral peak amplitude of $1/(2\mu - 1)^{1/2} = 0.68$ of the corresponding STARDYNE elastic floor spectral peak amplitude. The original Control Building N-S floor response spectra have a widened peak covering the frequency range of 4.2 to 6.0 cps. Thus, the extreme lower bound pseudo-elastic floor spectral peak frequency band extends below the original floor spectral peak frequency band by 1.2 cps.

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CLARIFICATION # 3, continued

The above information does not change the response previously offered in Question 3(b) or in Clarification No. 18 with respect to the effect on equipment, components, piping, and cable trays (including supports).

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ADDITIONAL REQUEST # 4

"Discuss the influence of the vertical earthquake on the coefficients of friction calculated in Clarification No. 22."

CLARIFICATION # 4

When the influence of the vertical earthquake is considered, the coefficient of friction that is needed to resist the load, as explained in Clarification No. 22, at el 45'-61' changes from 0.6 to 0.73. At el 61'-77', the previous coefficient of 0.17 should be corrected to 0.06. With the influence of the vertical earthquake incorporated, the latter coefficient becomes 0.08.

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ADDITIONAL REQUEST #5

Please provide additional data on results of the recent Berkeley tests performed on the six squat wall specimens.

CLARIFICATION #5

Test data for the six squat wall specimens recently tested at Berkeley are summarized as follows:

Specimen	ρ_h (%)	ρ_v (%)	v_u Test (psi)	σ_n Test (psi)	(Calculated) v_u (psi)
HCBL-12-1	0	0.28	328	184	264*
HCBL-12-2	0.05	0.28	347	199	268*
HCBL-12-3	0.10	0.28	412	237	277*
HCBL-12-4	0.15	0.28	358	218	273
HCBL-12-5	0.20	0.28	374	215	272
HCBL-12-6	0.28	0.28	429	234	277

$$v_u = 0.75\ (348 - 113\frac{H}{W}) + \frac{\sigma_n}{4}$$

NOTE: For all specimens, H/W = 0.5, H = 40", W = 80" and t = 7-5/8"

*Since ρ_h <0.0013 the basic criteria does not apply (150 psi limit applicable).

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket 50-344
PORTLAND GENERAL ELECTRIC COMPANY,	)	
et al	)	(Control Building Proceeding)
	)	
(Trojan Nuclear Plant)	)	

CERTIFICATE OF SERVICE

I hereby certify that on October 13, 1978, Licensee's letter to Director of Nuclear Reactor Regulation, transmitting clarifications in response to the Nuclear Regulatory Commission Staff questions of October 11 through 13, 1978, has been served upon the persons listed below by delivery to a messenger for service or by depositing copies thereof in the United States mail with proper postage affixed for first class mail.

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Dated: October 13, 1978