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October 27, 1984

Director, Office of Nuclear Reactor Regulation
Attention: Mr. J. A. Zwolinski, Chief
Operating Reactors Branch No. 5
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

Subject: Docket No. 50-206
Seismic Evaluation of Vent Stack
San Onofre Nuclear Generating Station
Unit 1

By letter dated August 29, 1984 SCE submitted the results of the seismic evaluation of the San Onofre Unit 1 vent stack. At a meeting on September 6, 1984, the NRC Staff requested additional information regarding this evaluation. The requested information is provided as an enclosure to this letter.

If you have any questions on this information, please call me.

Very truly yours,

M. O. Medford

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RESPONSE TO NRC QUESTIONS
VENT STACK SEISMIC EVALUATION
SAN ONOFRE NUCLEAR GENERATING STATION
UNIT NO. 1

Question

What effect on the foundation analysis would soil-structure interaction and the new response spectra (.67g Housner Response Spectra obtain from Section 9.2 of SONGS 1 FSA increased 10% in the period range 0.07 second to 0.25 second for the horizontal spectra and 0.05 second to 0.15 second for the vertical spectra) have on the factors of safety against sliding and overturning?

Response

The analysis was originally conducted on the stack foundation system assuming that any soil-structure interaction would deamplify the motion. As a result, the soil-structure interaction was not considered. The analysis assumed the stack to be rigidly anchored to the foundation with the free field motion as the input. To evaluate the foundation for sliding and overturning it was excited statically to 2/3g horizontally and 4/9g vertically. The three orthogonal components of this loading were combined using 100% of the effects due to the response in one direction and 40% of the effects corresponding to the two directions of motion orthogonal to the principle motion considered. It was assumed conservatively that the passive pressure resistance to sliding of the surrounding Category D backfill was not effective. As a further conservative check, the stack foundation has been reanalyzed using the new response spectra assuming the foundation as a rigid body connected to an elastic half-space, modeled as springs with 20% dampening. The results of this reanalysis are shown below:

Stability Item	Original Analysis Safety Factor	Reanalysis Safety Factor	Allowable Safety Factor
Sliding	1.27	1.13	1.10
Overturning	1.54	1.41	1.10

The above values have been included in Table 1, revised 10/2/84, of the subject evaluation.

Question — What effect does the stack shell shear center eccentricity have at the duct openings at elevations 31'-0 and 38'-0?

Response — The original stack shell analysis evaluated shear stresses at the base section and at the reduced section at elevation 70'-0. Further analysis at the duct openings at Elevation 31'-0 and 38'-0 which include the torsional effects of the shear center eccentricity shows a maximum stack shell shear stress of 801 psi at Elevation 38'-0 and 585 psi at Elevation 31'-0. As a conservative simplification the analysis did not include the structural contributions of the stiffened areas around the openings or the stack shell section between the duct openings at Elevation 38'-0. The allowable shear stress is 23,040 psi. The maximum shear stress at elevation 38'-0 has been included in the attached Table 1, revised 10/2/84, of the subject evaluation.

Question — What was the reference used to develop the stack shell allowable buckling stress? Show the calculation used to obtain the allowable stress.

Response — The formula for the allowable buckling stress, as shown in the attached calculation, was obtained from Formulas For Stress and Strain by R. J. Roark, 4th Edition, McGraw-Hall, 1965, p. 274. Note that the 1.6 stress increase was not incorporated for the extreme environmental loading condition (DBE). See the attached Table 1, revised 10/2/84, of the subject evaluation for the revised allowable stress.

Question — How were the allowable stress values obtained as shown in Table 1 of the subject evaluation?

Response — The allowable stresses as shown in the attached Table 1, revised 10/2/84, are in accordance with the acceptance criteria shown in Table 3.8.2 of "Balance of Plant Structures Seismic Reevaluation Criteria." The allowable stress values for structural steel, excluding allowable buckling stress, are in accordance with the AISC Manual of Steel Construction, eighth edition, Part 1 and include the 1.6 stress increase for extreme environmental loading condition (DBE). The allowable shear stress for concrete is based on the ultimate shear strength as defined in ACI Standard 349-76. The attached calculation presents the methods used to develop these values.

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TABLE 1. VENT STACK SEISMIC EVALUATION SUMMARY

(Revised 10/2/84)

Structural Element Loading	Calculated Value	Allowable Value
Stack Shell at Base		
Compression, (Buckling)	4,840 psi	11,039 psi
Tensile	4,320 psi	34,600 psi
Shear	249 psi	23,040 psi
Stack Shell at Mid-Height		
Compression, (Buckling)	7,080 psi	11,039 psi
Tensile	6,580 psi	34,600 psi
Shear	450 psi	23,040 psi
Shear Stress at Duct Openings at EL.38'-0	801 psi	23,040 psi
Anchor Bolts		
Tensile	8,662 psi	66,000 psi
Concrete Pullout Shear	17 psi	201 psi
Bending on Embed. Plate	2,176 psi	43,200 psi
Stack Base		
Weld Stress	1,132 psi	33,600 psi
Bending Stress	19,400 psi	43,200 psi
Foundation Sliding F.S.	1.13*	1.1
Overturing F.S.	1.41*	1.1
Foundation Bearing Pressure	12,600 psf	25,000 psf

*Per revised analysis based upon soil structure interaction and the new response spectra (.67g Housner Response spectra obtained from Section 9.2 of SONGS 1 FSA increased 10% in the period range 0.07 second to 0.25 second for the horizontal spectra and 0.05 second to 0.15 second for the vertical spectra).

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ENGINEERING DEPARTMENT
CALCULATION SHEET

SUBJECT: VENT STACK SEISMIC EVALUATION DESIGN CALCULATION NO. DC 1663

J.O. NO. 8857 MADE BY Jim Kennedy DATE 9/10/84 CHK. BY M.P. Ahuja DATE 10-11-84

(23) EVALUATION OF ALLOWABLE STRESSES

STACK SHELL TENSION

$F_t = .6F_y(1.6) = (.6)(36{,}000\text{PSI})(1.6)$

$= 34{,}600$ PSI

STACK SHELL SHEAR

$F_v = .4F_y(1.6) = (.4)(36{,}000\text{PSI})(1.6)$

$= 23{,}040$ PSI

ANCHOR BOLT TENSION

$F_t = .33F_u(1.6)$

ANCHOR BOLTS = ASTM A193, $F_u = 125{,}000$ PSI

$F_t = (.33)(125{,}000)(1.6) = 66{,}000$ PSI

BENDING IN ANCHOR BOLT EMBED PLATE & STACK BASE

$F_b = .75F_y(1.6) = (.75)(36{,}000\text{PSI})(1.6)$

$= 43{,}200$ PSI

DWG. NO.

ENGINEERING DEPARTMENT
CALCULATION SHEET

SUBJECT: VENT STACK SEISMIC EVALUATION DESIGN CALCULATION NO. DC 1663 –

J.O. NO. 8857 MADE BY Jim Kennedy DATE 9/10/84 CHK. BY M.P. Adams DATE 10-11-84

EVALUATION OF ALLOWABLE STRESSES

WELD STRESS IN STACK BASE

$$F_v = .3(70{,}000\ PSI)(1.6)$$

$$= 33{,}600\ PSI$$

CONCRETE/ANCHOR BOLT Pullout SHEAR

$$V = (.85)(4)\sqrt{3500\ PSI}$$

$$= 201\ PSI$$

DWG. NO.

ENGINEERING DEPARTMENT
CALCULATION SHEET

SUBJECT: VENT STACK SEISMIC EVALUATION DESIGN CALCULATION NO. DC 1603 -

J.O. NO. 8857 MADE BY Jim Kennedy DATE 9/10/84 CHK. BY M. P. Ahuja DATE 10-11-84

(24) SHELL BUCKLING ALLOWABLE STRESS

REFERENCE: "FORMULAS FOR STRESS AND STRAIN" BY ROARK, 4Ed. MCGRAW-HILL P. 274

$$\text{(Allowable)} \qquad \frac{Q}{A} = XY$$

where $Y = 1$ for $L/r \leqq 60$

$$Y = \frac{21{,}600}{18{,}000 + (L/r)^2} \text{ for } \frac{L}{r} > 60$$

$$X = \left[1{,}000{,}000\frac{t}{R}\right]\left[2 - \frac{2}{3}\left(100\frac{t}{R}\right)\right] \text{ for } \frac{t}{R} \leqq 0.015$$

$X = 15{,}000$ for $t/R \leqq 0.015$

Min $t = \frac{1}{4}$ in.

Q = ALLOWABLE LOAD , A = SHELL SECTION AREA

R = RADIUS , r = .707 R t = .375 $\frac{t}{R}$ = .0099

AVG. R = 37.69 r = 26.65 $\frac{KL}{r} = \frac{(2)1199}{26.65} = 89.99$

$$Y = \frac{21{,}600}{18{,}000 + (89.99)^2} = .83$$

$$X = [1{,}000{,}000\,(.0099)][2 - 2/3\,(100\,(.0099)] = 13{,}300 \text{ PSI}$$

$$Q = 13{,}300\,(.83) = 11{,}039 \text{ PSI}$$

MAX. COMPRESSIVE STRESS = 7.08 KSI < 11.04 KSI

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DWG. NO.