RAS5481 72-22-ISFSI-APPLICANT EXHIBIT 231 - Rec'd 6/18/02

MAR 2 6 2002

STONE & WEBSTER, INC.
CALCULATION SHEET

PREP'D BY P.T. Rudeen Reviewed & Checked by Thomas Y. Chang

A 5010.65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO. 05996.02	DIVISION & GROUP G(B)	CALCULATION NO.	OPTIONAL TASK CODE	PAGE ___

DETERMINE RADIATION DAMPING APPLICABLE FOR PADS IN THE VERTICAL DIRECTION

$c_{critical} = 2\sqrt{km}$ (p.5 Newmark & Rosenblueth, 1971)

For vertical motion, p. B-2 (Holtec, 2001) indicates

$k_{v_{LOWER\ BOUND}} = 1.204 \times 10^7 \ \frac{lbf}{in.}$

$m = \Sigma 8 \times mass_{mpc+cask}$ (p C-3) $+ mass_{pad}$ (p B-4) $+ M_{v\,soil}$

$= 7,381 + 2,343 + 5,785 \ \frac{lbf\text{-}sec^2}{in.}$

$8 \times \frac{3.565 \times 10^5 \ lbf}{386.4 \ in./sec^2} = 7,381 \ \frac{lbf\text{-}sec^2}{in.}$ (p C-1)

$\therefore \ m = 15,509 \ \frac{lbf\text{-}sec^2}{in.}$

$c_{crit} = 2\sqrt{1.204 \times 10^7 \ \frac{lbf}{in.} \times 15,509 \ \frac{lbf\text{-}sec^2}{in.}} = 8.642 \times 10^5 \ \frac{lbf\text{-}sec}{in.}$

$D_v = \frac{c_{v_{LB}}}{c_{crit}} = \frac{4.473 \times 10^5 \ \frac{lbf\text{-}sec}{in.}}{8.642 \times 10^5 \ \frac{lbf\text{-}sec}{in.}} = 0.52$ (p B-3)

231

Template - Secy-028 Secy-02

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OFFICE OF THE SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

NUCLEAR REGULATORY COMMISSION

Docket No. 72-22 Official Exh. No. -PFS 231

In the matter of PFS, LLC

Staff ✓ IDENTIFIED ✓

Applicant RECEIVED ✓

Intervenor REJECTED

Cont'g Off'r DATE 6/18/02

Contractor Witness Trudeau

Other G. Gern

Reporter

MAR 2 6 2002
Prep'd by R.F. Dundas

STONE & WEBSTER, INC.
CALCULATION SHEET
Reviewed & Chkd by Thanes Y. Chang

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DETERMINE RADIATION DAMPING APPLICABLE FOR PADS IN THE VERTICAL DIRECTION

$$c_{critical} = 2\sqrt{km} \quad \text{(p.5 Newmark \& Rosenblueth, 1971)}$$

For vertical motion, p. B-12 (Holtec, 2001) indicates

$$k_{v_{BEST\ ESTIMATE}} = 2.37 \times 10^7 \ \frac{lbf}{in.}$$

$$m = \Sigma 8 \times mass_{mpc + cask} + mass_{pad}^{p\,C-3} + M_{v\,soil}^{p\,B-15}$$

$$= 7,381 + 2,343 + 5,798 \ \frac{lbf\text{-}sec^2}{in.}$$

$$8 \times \frac{3.565 \times 10^5 \ lbf}{386.4 \ in./sec^2} = 7,381 \ \frac{lbf\text{-}sec^2}{in.} \quad \text{(p C-1)}$$

$$\therefore \ m = 15,522 \ \frac{lbf\text{-}sec^2}{in.}$$

$$c_{crit} = 2\sqrt{2.37 \times 10^7 \ \frac{lbf}{in.} \times 15,522 \ \frac{lbf\text{-}sec^2}{in.}} = 12.13 \times 10^5 \ \frac{lbf\text{-}sec}{in.}$$

$$D_v = \frac{c_{v_{BE}}}{c_{crit}} = \frac{6.052 \times 10^5 \ \frac{lbf\text{-}sec}{in.}}{12.13 \times 10^5 \ \frac{lbf\text{-}sec}{in.}} = 0.50 \quad \text{(p B-14)}$$

STONE & WEBSTER, INC.
CALCULATION SHEET

Prep'd MAR 26 2002 by P. Trudeau Rev'd & Checked by Thomas Y. Chang

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DETERMINE RADIATION DAMPING APPLICABLE FOR PADS IN THE VERTICAL DIRECTION

$c_{critical} = 2\sqrt{km}$ (p.5 Newmark & Rosenblueth, 1971)

For vertical motion, p. B-7 (Holtec, 2001) indicates

$k_{v_{UPPER\ BOUND}} = 5.405 \times 10^7 \ \frac{lbf}{in.}$

$m = \Sigma 8 \times mass_{mpc + cask} + mass_{pad} + M_{v_{soil}}$ (pC-3, pB-10)

$= 7{,}381 + 2{,}343 + 5{,}823 \ \frac{lbf\text{-}sec^2}{in.}$

(pC-1) $8 \times \frac{3.565 \times 10^5 \ lbf}{386.4 \ in./sec^2} = 7{,}381 \ \frac{lbf\text{-}sec^2}{in.}$

$\therefore \ m = 15{,}547 \ \frac{lbf\text{-}sec^2}{in.}$

$c_{crit} = 2\sqrt{5.405 \times 10^7 \ \frac{lbf}{in.} \times 15{,}547 \ \frac{lbf\text{-}sec^2}{in.}} = 18.33 \times 10^5 \ \frac{lbf\text{-}sec}{in.}$

$D_v = \frac{c_{v_{UB}}}{c_{crit}} = \frac{8.794 \times 10^5 \ \frac{lbf\text{-}sec}{in.}}{18.33 \times 10^5 \ \frac{lbf\text{-}sec}{in.}} = 0.48$ (pB-9)

PREP'D BY PJ. Dudeck
MAR 27 2002

STONE & WEBSTER, INC.
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CALCULATE NATURAL FREQUENCY OF PAD FOR VERTICAL VIBRATION

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k_z}{m}}$$ EQ 5.25 DAS (1993)

FOR BEST-ESTIMATE SOIL PROPERTIES

$k_z = k_v$ ON p B-12 OF HOLTEC (2001) $= 2.37 \times 10^7 \frac{lbf}{in.}$

$m = \Sigma$ masses = 8 CASKS + MPCs + 1 PAD + VIRTUAL SOIL BLOCK

$$m = 15{,}552 \frac{lbf\text{-}sec^2}{in.} = \frac{8 \times 3.565 \times 10^5 \text{ lbf}}{386.4 \frac{in./sec^2}{g}} + 2{,}343 + 5{,}798$$

(3.565 × 10^5 lbf: p C-1; 2,343: p C-3; 5,798: p B-15)

$$\Rightarrow f_n = \frac{1}{2\pi}\sqrt{\frac{2.37 \times 10^7 \text{ lbf/in.}}{15{,}552 \frac{lbf\text{-}sec^2}{in.}}} = 6.213 \text{ Hz} \Rightarrow T_n = 0.161 \text{ sec}$$

FOR LOWER-BOUND SOIL PROPERTIES:

$$f_n = \frac{1}{2\pi}\sqrt{\frac{1.204 \times 10^7 \frac{lbf/in.}{lbf\text{-}sec^2/in.}}{15{,}509}} = 4.43 \text{ Hz} \Rightarrow T_n = 0.23 \text{ sec}$$

FOR UPPER-BOUND SOIL PROPERTIES

$$f_n = \frac{1}{2\pi}\sqrt{\frac{5.405 \times 10^7 \text{ lbf/in.}}{15{,}547 \frac{lbf\text{-}sec^2}{in.}}} = 9.38 \text{ Hz} \Rightarrow T_n = 0.11 \text{ sec's}$$