

MAR 26 2002

PREP'D BY P. Prudeen

STONE & WEBSTER, INC.
CALCULATION SHEET

Reviewed & Checked by Thomas V. Chang

A 5010.85

CALCULATION IDENTIFICATION NUMBER				PAGE ____
J.O. OR W.O. NO. 05996.02	DIVISION & GROUP G(8)	CALCULATION NO.	OPTIONAL TASK CODE	

DETERMINE RADIATION DAMPING APPLICABLE FOR
PADS IN THE VERTICAL DIRECTION

$$C_{critical} = 2 \sqrt{k_m} \quad (\text{p. 5 Newmark \& Rosenbluth, 1971})$$

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

$$k_v = 1.204 \times 10^7 \frac{\text{lb}}{\text{in.}} \quad \text{LOWER BOUND}$$

$$m = \sum \text{mass}_{\text{mpc} + \text{cask}} + \text{mass pad} + M_{\text{soil}}$$

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

$$8 \times \frac{3.565 \times 10^5 \text{ lb}}{386.4 \frac{\text{m}}{\text{sec}^2}} = 7,381 \frac{\text{lb-sec}^2}{\text{in.}} \quad \text{p.c-1}$$

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

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

$$D_v = \frac{C_{vLB}}{C_{crit}} = \frac{4.473 \times 10^5 \frac{\text{lb-sec}}{\text{in.}}}{8.642 \times 10^5 \frac{\text{lb-sec}}{\text{in.}}} = \underline{\underline{0.52}} \quad \text{p.B-3}$$

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RULEMAKINGS AND
ADJUDICATIONS STAFF

NUCLEAR REGULATORY COMMISSION
~~98-985~~ 231
Official Exh. No. _____

Docket No. 72-22 PFSTW IDENTIFIED RECEIVED REJECTED

In the matter of _____

Staff _____

Applicant _____

Intervenor _____

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

Contractor _____ Witness _____

Other C. G. H. S. R.

Reporter _____

MAR 26 2002

Prep'd by R. Dundean

STONE & WEBSTER, INC.
CALCULATION SHEET
Reviewed & chd by Thomas Y. Chang

A 5010.05

CALCULATION IDENTIFICATION NUMBER

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DETERMINE RADIATION DAMPING APPLICABLE FOR PADS IN THE VERTICAL DIRECTION

$$C_{critical} = 2 \sqrt{k m} \quad (\text{p. 5 Newmark \& Rosenbluth, 1971})$$

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

$$k_v = 2.37 \times 10^7 \frac{\text{lb}}{\text{in.}} \quad \text{BEST ESTIMATE}$$

$$m = \Sigma \text{mass}_{\text{mpc} + \text{cask}} + \text{mass pad} + M_{v \text{ soil}}$$

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

$$\uparrow \quad \text{p. C-1} \quad 8 \times \frac{3.565 \times 10^5 \text{ lb}}{386.4 \frac{\text{m}}{\text{sec}^2}} = 7,381 \frac{\text{lb-sec}^2}{\text{in.}}$$

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

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

$$D_v = \frac{C_{vBE}}{C_{crit}} = \frac{6.052 \times 10^5 \frac{\text{lb-sec}}{\text{in.}}}{12.13 \times 10^5 \frac{\text{lb-sec}}{\text{in.}}} = \underline{\underline{0.50}} \quad \leftarrow \text{p. B-14}$$

Prep'd MAR 26 2002 by R. Stauden

Revised & Checked by Thomas Y. Chang

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DETERMINE RADIATION DAMPING APPLICABLE FOR
PADS IN THE VERTICAL DIRECTION

$$C_{critical} = 2 \sqrt{k_m} \quad (\text{p. 5 Newmark \& Rosenbluth, 1971})$$

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

$$k_v = 5.405 \times 10^7 \text{ UPPER BAND}$$

$$\frac{\text{lbft}}{\text{in.}}$$

$$m = \Sigma \text{mass}_{\text{mpc} + \text{cask}} + \text{mass pad} + M_{\text{v soil}}$$

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

$$\begin{matrix} \nearrow \\ \text{pc-1} \\ 8 \times \frac{3.565 \times 10^5 \text{ lbft}}{386.4 \frac{\text{m/sec}^2}} \end{matrix} = 7,381 \frac{\text{lbft-sec}^2}{\text{in.}}$$

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

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

$$D_v = \frac{C_{VUB}}{C_{crit}} = \frac{8.794 \times 10^5 \frac{\text{lbft-sec}}{\text{in.}} \leftarrow \text{p. B-9}}{18.33 \times 10^5 \frac{\text{lbft-sec}}{\text{in.}}} = \underline{\underline{0.48}}$$

PREP'D BY P. J. Duda
 MAR 27 2002

STONE & WEBSTER, INC.
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05996.02	GLB)			

CALCULATE NATURAL FREQUENCY OF PAD FOR VERTICAL VIBRATION

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

FOR BEST-ESTIMATE SOIL PROPERTIES

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

$$m = \Sigma \text{ masses} = \text{8 CASKS} + \text{PAD} + \text{VIRTUAL SOIL BLOCK}$$

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

$$\Rightarrow f_n = \frac{1}{2\pi} \sqrt{\frac{2.37 \times 10^7 \text{ lb/in.}}{15,552 \frac{\text{lb} \cdot \text{sec}^2}{\text{in.}}}} = 6.213 \text{ Hz} \Rightarrow T_n = 0.16 \text{ sec}$$

FOR LOWER-BOUND SOIL PROPERTIES:

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

FOR UPPER-BOUND SOIL PROPERTIES

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