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AUTH.NAME AUTHOR AFFILIATION
CURTIS,N.W. Pennsylvania Power & Light Co.
RECIP.NAME RECIPIENT AFFILIATION
SCHWENCER,A. Licensing Branch 2

SUBJECT: Forwards response to SER Outstanding Issue 26,consisting of write-up to be included in Subsection 9.6.3 of Revision 6 to design assessment rept.

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NORMAN W. CURTIS
Vice President-Engineering & Construction-Nuclear
770-5381

June 10, 1981

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washigngton, D.C. 20555

Docket Nos. 50-387
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U.S. NUCLEAR REGULATORY COMMISSION

SUSQUEHANNA STEAM ELECTRIC STATION
SER OUTSTANDING ISSUE # 26
ER100450 FILE 841-2
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Dear Mr. Schwencer:

Attached is our response to SER outstanding Issue #26. This letter completes our action on SER Outstanding Issue #26.

Very truly yours,

N.W. Curtis
Vice President-Engineering and Construction-Nuclear

cc: R.M. Stark

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The following write-up will be included in Subsection 9.6.3 of Revision 6 to the SSES Deign Assessment Report.

9.6.3 Statistical Evaluation of the GKM II-M Resultant Bracing Force Data

9.6.3.1 Introduction

DAR Subsection 9.6.2 compares the maximum calculated resultant bracing force at GKM II-M, using the Mark II single vent lateral load, with the maximum measured resultant bracing force at GKM II-M. This comparison reveals that the theoretical value bounds the measured value and indicates the conservatism of the Mark II single vent lateral load. However, the NRC performed a re-evaluation of the Mark II load based on a statistical analysis of the original 4T bracing force data. They now conclude that the Mark II impulse should be extrapolated to 65 Kips while preserving the 3 msec impulse duration. This corresponds to a lateral load which will be exceeded once in 10^5 bracing force events or once in ten LOCAs, if one assumes 100 chugs at 100 vents.

To provide additional confirmation of the conservatism of using an extrapolated Mark II lateral load at 10^{-5} exceedance probability, a statistical analysis of the GKM II-M bracing force data has been performed. This gave a relation for determining the resultant bracing force as a function of the exceedance probability. From this relation, the GKM II-M resultant bracing force required for a 10^{-5} exceedance probability was then determined. The extrapolated Mark II lateral load which predicts this bracing force at GKM II-M was then determined. The following subsections document this effort.

9.6.3.2 Derivation of a Probability Density Function from the Measured Resultant Bracing Forces from the 1/6 MSL Tests

The mean and maximum resultant bracing force values for the 1/6 MSL tests envelop the mean and maximum valves for the full and 1/3 MSL tests. Thus, to maximize the statistically determined resultant bracing force, the present statistical analysis is restricted to only the 1/6 MSL bracing force data base.

9.6.3.2.1 General Considerations

To derive an expression for the probability density function, we assume the function follows an exponential decay. Thus, the following probability density function is selected for the 1/6 MSL resultant bracing force data:

$$f(u) = u \cdot e^{-u} \qquad (1)$$

where:
- $u = C \cdot x$
- $C =$ constant to be determined
- $x =$ resultant bracing force, kN

Integrating Eq. (1) and evaluating the interval yields:

$$\int_0^{\infty} f(u)\,du = \int_0^{\infty} u \cdot e^{-u} du = e^{-u}(-u-1) \Big|_0^{\infty} = 1$$

Thus, this function satisfies the basic condition imposed on the probability density function; namely, that the total probability = 1.

To determine the constant, C, the mean value of the distribution, $\bar{u}$, is defined as the first-order moment of the probability density function described by Eq. (1). Thus

$$\bar{u} = \int_0^{\infty} u^2 \cdot e^{-u} \cdot du = e^{-u}(-u^2-2u-2) \Big|_0^{\infty} = 2$$

This is used to determine the constant, C, as:

$$C = \frac{2}{\bar{x}}$$

and u from Eq. (1) as:

$$u = \frac{2}{\bar{x}} \cdot x \qquad (2)$$

where: $\bar{x}$ is the mean value of the 1/6 MSL resultant bracing force data.

The exceedance probability based on the probability density function of Eq. (1) is:

$$F'(u) = \int_0^{\infty} f(u)\,du = (1+u)e^{-u} \qquad (3)$$

The probability that the resultant lies in the internal $a \leq x \leq b$ is:

$$F(a \leq u \leq b) = (a+1)e^{-a} - (b+1)e^{-b} \qquad (4)$$

9.6.3.2.2 Application to the 1/6 MSL Tests

The range of mass fluxes to be used in evaluating the resulting bracing forces from Tests 13 to 18 is:

$$11 \leq \frac{\dot{m}}{A} \leq 33 \quad (kg/m^2 s)$$

Tests 19 and 20 were omitted since they are bounded by the remaining 1/6 MSL tests.

Table 1 shows the frequency distribution for Tests 13 to 18. The numbers in parenthesis designate the frequencies per test.

TABLE 1

Bracing forces kN	Number of Events
0 - 10	36 (6)
10 - 20	212 (35.3)
20 - 30	237 (39.5)
30 - 40	110 (18.3)
40 - 50	52 (8.6)
50 - 60	25 (4.16)
60 - 70	6 (1)
70 - 80	1 (1/6)
80 - 90	1 (1/6)

Listed in Table 1 are a total of 680 events, or 111.3 events per test.

The mean value of the frequency distribution is:

$$\bar{x} = 25.6 \text{ kN}$$

Thus, Eq. (2) becomes

$$u = \frac{2 \cdot x}{25.6} = 0.078 \cdot x \qquad (5)$$

Now Eq. (4) and (5) can be used to determine the interval propability. A comparison of the theoretically determined interval probability (Eq. 4 and Eq. 5) with the relative frequencies obtained from Table 1 (test data) is shown in Table 2.

TABLE 2

Bracing Forces kN	Relative Frequency	Interval Probability
0 - 10	0.053	0.184
10 - 20	0.31	0.2784
20 - 30	0.35	0.216
30 - 40	0.16	0.14
40 - 50	0.026	0.0826
50 - 60	0.037	0.0465
60 - 70	8.8×10^{-3}	0.025
70 - 80	1.5×10^{-3}	0.013
80 - 90	1.5×10^{-3}	6.8×10^{-3}

Figure 1 compares the theoretical with the measured relative frequencies. Thus, the function $f(u) = ue^{-u}$ provides a conservative distribution.

From Eq. (3) the exceedance probability is:

$$F'(u) = (1 + u)\, e^{-u} \tag{6}$$

with $u = 0.078 \cdot x$

Thus, the bracing force x which is exceeded with a probability F' can be determined.

From equation (6) with an exceedance probability of 10^{-5} the resultant bracing force x is:

182 kN = 40.9 Kips

9.6.3.3 Determination of Extrapolated Mark II Impulse

To determine the Mark II impulse required to produce a bracing force of 182 kN at GKM II-M, we assume that the bracing force is linearly proportional to the impulse. This yields the following relation:

$$\frac{I_m}{F_m} = \frac{I_1}{F_1} \tag{7}$$

where: I_m = impulse of present Mark II single vent lateral load definition.

F_m = bracing force at GKM II-M produced by I_m

I_1 = impulse required to produce bracing force at GKM II-M corresponding to a 10^{-5} exceedance probability

F_1 = statistical determined bracing force at GKM II-M for a 10^{-5} exceedance probability.

DAR Subsection 9.6.2.1.6 calculates a maximum bracing force of 22.8 Kips with the Mark II lateral load of 30,000 lbs. and 3 msec impulse duration. Thus, F_m = 22.8 Kips and the Mark II impulse, I_m, is the area under the half sine wave impulse curve calculated with the following relation:

$$I_m = 2 \cdot F \cdot t_D / \pi \qquad (8)$$

where: F = amplitude of Mark II impulse

t_D = time duration of Mark II impulse.

Substituting F = 30,000 lbs. and t_D = 3 msec gives:

$$I_m = (2)(30{,}000)(.003)/\pi$$

$$I_m = 57.3 \text{ \#-sec}$$

Substituting F_1 = 182 kN = 40.9 Kips, I_m = 57.3 #-sec and F_m = 22.8 Kips into Eq. (7) gives:

$$\frac{57.3}{22.8} = \frac{I_1}{40.9}$$

$$I_1 = 102.8 \text{ \#-sec}$$

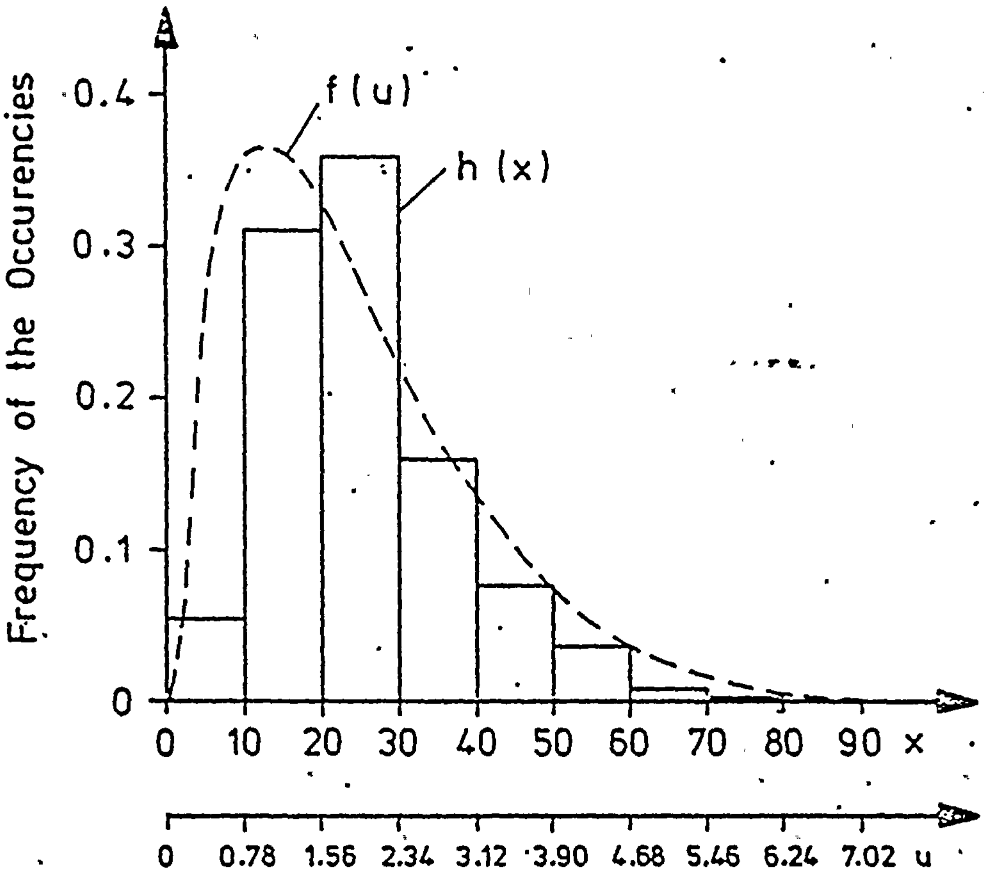
To determine the extrapolated Mark II force required to give an impulse of 102.8 #-sec, we assume the impulse duration of 3 msec remains the same and solve for F in Eq. (8). Thus, for I_1 = 102.8 #-sec

$$F = \frac{(102.8)(\pi)}{(2)(.003)}$$

$$F = 54.8 \text{ Kips}$$

Thus an extrapolated Mark II impulse of 54 Kips with a 3 msec duration produces a bracing force in GKM II-M corresponding to an exceedance probability of 10^{-5}.

However, for SSES, an extrapolated Mark II impulse of 65 Kips at 3 msec time duration, as required by the NRC, will be used for a single vent lateral load definition.



GKM II M

Frequency Distribution of the Bracing Forces for 1/6 MSL-Breaks

Tests 13 through 18

Fig. ~~A.4.4~~ 1