LOFT TECHNICAL REPORT LTR 1310-18
RE & C REPORT NUMBER RE-A-77-076
SEPTEMBER 1, 1977

MASTER

PSMG SWITCHGEAR SEISMIC ANALYSIS

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IDAHO OPERATIONS OFFICE UNDER CONTRACT EY-76-C-07-1570

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RESEARCH, ENGINEERING AND CONSTRUCTION REPORT ENGINEERING ANALYSIS DIVISION

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PSMG SWITCHGEAR SEISMIC ANALYSIS

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**LOFT TECHNICAL REPORT
LOFT PROGRAM**

FORM EG&G-229
(Rev. 12-78)

TITLE PSMG SWITCHGEAR SEISMIC ANALYSIS		REPORT NO. LTR 1310-18
		RE-A-77-076
AUTHOR C. J. Kuehster		GWA NO.
PERFORMING ORGANIZATION Applied Mechanics Branch		DATE Published by CDCS Jan. 18, 1978
LOFT APPROVAL <i>[Signature]</i>		September 1, 1977

ABSTRACT

PSMG switchgear boxes were analyzed for sliding and overturning during a seismic event. Boxes are located in TAN-650, Room B-239, with the PSMG generators. Both boxes are sufficiently anchored to the floor.

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1.0 INTRODUCTION

PSMG generator switchgear boxes^[1] are located in the basement of Bldg. TAN-650. The two units each consist of four cabinets with a total weight of 4680 lbs. Analysis for seismic conditions verifies that the boxes will not slide or tip during a seismic event.

2.0 CONDITIONS OF ANALYSIS

Seismic accelerations for LOFT analyses are developed in Reference (2). These result in loads of less than 1g for 4% damping. The switching gear boxes are considered to be able to withstand a 1g load (shipping and installation requirement). Only the rigid body modes of sliding and rotation are examined. Activating forces are calculated according to RDT-F9-2T in Appendix A.

The arrangements for the switchgear boxes are shown in Figure's 1 and 2. Connections of the gear to the floor are shown in Figure 3.

2.1 Sliding Displacement

The unit is assumed to undergo maximum horizontal acceleration concurrently with maximum vertical acceleration in opposition to gravity. The coefficient of friction between the floor and the unit is assumed to be zero.

2.2 Overturning

The loading condition is the same as for the sliding mode calculations appearing in Appendix C. Both units have sufficient restraint.

3.0 RESULTS

Stress results for sliding shear stress and axial overturning stress are combined using stress intensity where shear stress intensity is twice the maximum shear stress. The resulting stress intensity is compared to the

PSMG POWER SWITCH GEAR
GENERATOR A

PLAN VIEW

WEIGHT $\approx$ 4860#

SECTION A-A

FIGURE 1

PSMG POWER SWITCH GEAR
GENERATOR B

FIGURE 2

FIGURE 3

AISC allowable stress level of either Section 1.5.3 or Section 1.6.3, dependent on the governing connection.

Comparison is made in Table I:

	<u>Shear Stress</u>	<u>Axial Stress</u>	<u>Stress Intensity</u>	<u>Weld Allowable</u>	<u>Bolt Allowable</u>
Rear	3,260	7,300	9,790	14,400	20,000
Front	3,260	8,630	10,820	14,400	20,000

The stresses are the same for both units.

4.0 RECOMMENDATIONS

The connections are satisfactory for the specified loading conditions.

5.0 REFERENCES

1. Identification of PSMG Switch Gear Boxes; Contract #AT(10-1)-1375, Customer Order #S-7250, G. E. Requisition #438-50636, Drawings 207483 and 207484 (included at end of Appendices).
2. V. W. Gorman and R. C. Guenzler, "LOFT SSE Definition and Seismic Analysis Methods", LOFT Technical Report LTR 10-19, October 8, 1974.
3. American Institute of Steel Construction, "Steel Construction Manual", Seventh Edition, 1971.
4. N. B. Smith, "Vital Power Switch Gear Seismic Analysis", EG&G Technical Report RE-E-77-127, February 11, 1977.

APPENDIX A
LOAD CALCULATIONS

CONDITIONS OF ANALYSIS:

PEAK RESPONSE SPECTRUM ACCELERATION FOR LOFT SITE
IS $19.5 \text{ FT}^2/\text{SEC}^2$

MAXIMUM VERTICAL GROUND ACCELERATION IS $2/3$ 'S HORIZONTAL
ACCELERATION ACTING UP & DOWN. DOWN WOULD TEND TO PREVENT
BOX MOTION I.E. INCREASE FRICTION & RESTORE MOMENT & WILL NOT
BE CONSIDERED

LEVELS OF LOFT FACILITIES BELOW GROUND ARE CONSIDERED
TO RESPOND AS GROUND MOTION, THEREFORE;

$$A = 1.5 \times A_s$$

WHERE

A = RESULTING ACCELERATION

A_s = PEAK GROUND MOTION ACCELERATION
FROM RESPONSE SPECTRUM

$$\begin{aligned} A_H &= (1.5) \times 19.5 \text{ FT}^2/\text{SEC}^2 \\ &= 29.25 \text{ FT}^2/\text{SEC}^2 \\ &= .91 \text{ G} \end{aligned}$$

$$\begin{aligned} A_V &= 2/3 A_H \\ &= 0.61 \text{ G} \end{aligned}$$

REFERENCE: DIVISION OF REACTOR RESEARCH AND DEVELOPMENT UNITED
STATES ATOMIC ENERGY COMMISSION, RDT STANDARD F9-2T, JANUARY 1974

NOTE: THIS REFERENCE ALSO DEALS WITH 4% OF

CRITICAL DAMPING FOUND ON PAGE 1 UNDER

CONDITIONS OF ANALYSIS.

APPENDIX B AND APPENDIX C

SLIDING AND OVERTURNING

(COMBINED)

APPENDIX B

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SLIDING

EACH SWITCHBOX IS ANALYSED AS ONE UNIT. ASSUMING THAT CONNECTIONS BETWEEN THE FOUR CABINETS OF EACH UNIT RELATE THEM AS ONE. THE WEIGHT OF EACH UNIT IS 4860#

HORIZONTAL FORCE WOULD CAUSE SLIDING:

$$F_H = .91 \times 4860 = 4423$$

FRICTION BETWEEN SWITCH BOX AND FLOOR IS ASSUMED TO BE ZERO. THE BOX IS ATTACHED TO A CHANNEL WHICH IN TURN IS BOLTED TO THE FLOOR.

SHEAR AREA OF BOLTS₁ TO FLOOR

$$A = .226 \times 6 \\ = 1.36 \text{ IN}^2$$

AISC MANUAL
4-125

SHEAR STRESS

$$\sigma = 4423 / 1.36 \\ = 3260 \text{ PSI}$$

SHEAR AREA OF BOLTS₂ + WELD

$$A = 7 \times 1/4 \times 3/8 \times \pi + .707 \times 1/4 \times 11 1/2 \times 1 \\ = 2.80 \text{ IN}^2$$

SHEAR STRESS

$$\sigma = 4423 / 2.80 \\ = 1570 \text{ PSI}$$

USE THE MORE CRITICAL VALUE OF 3260 PSI

APPENDIX C

OVERTURNING

OVERTURNING MOMENT FOR UNIT IS

$$M_T = A_H \times W \times H$$

A_H = HORIZONTAL ACCELERATION

W = BOX WEIGHT

H = HEIGHT TO THE CENTER OF GRAVITY

MINIMUM RESTORING MOMENT IS:

$$M_R = (1 - A_v)(\text{WEIGHT})(\text{WIDTH}/2)$$

A_U = MAXIMUM VERTICAL ACCELERATION
 T_W = MINIMUM BOX WIDTH OR DEPTH

GENERATOR A

$$\begin{aligned} M_T &= .91 \times 4860 \times 48 \\ &= 212,285 \text{ IN-IB} \\ M_R &= (1-.061)(4860)(21) \\ &= 3980 \text{ IN-IB} \end{aligned}$$

PART I, BOLTS TO FLOOR. UNBALANCED FORCE IS DEVELOPED BY STRESS IN THE BOLTS. ONE HALF OF ANCHOR AVAILABLE TO PREVENT OVERTURNING

$$\begin{aligned} \sigma &= \frac{(M_T - M_R)2}{T_W A} \\ &= \frac{(212,290 - 3980)2}{42 \times 1.36} \\ &= 7300 \text{ PSI} \end{aligned}$$

PART II (BOLTS & WELD) EACH SIDE IS ANALYSED SEPERATELY DUE TO DIFFERENT CONNECTIONS

$$\text{REAR } \sigma = \frac{(212,290 - 3980)2}{42 \times \left[(3 \times \frac{1}{4} \times \frac{3}{8} \times \pi) + (.107 \times \frac{1}{4} \times 7 \frac{1}{2} \times 1) \right]} = 7300 \text{ PSI}$$

$$\text{FRONT } \sigma = \frac{(212,290 - 3980)2}{42 \times \left[(4 \times \frac{1}{4} \times \frac{3}{8} \times \pi) + (.107 \times \frac{1}{4} \times 4 \times 1) \right]} = 8630 \text{ PSI}$$

GENERATOR B HAS SAME WEIGHT & CONNECTIONS THEREFORE SAME STRESSES

*

	SHEAR STRESS	AXIAL STRESS	STRESS INTENSITY	WELD ALLOWABLE	BOLT ALLOWABLE
REAR	3260	7300	9788	14,400	20
FRONT	3260	8630	10816	14,400	20

BOTH SIDES ARE COMPATIBLE

* ALLOWABLE FILLET WELD STRESS $.3\sigma_u$ OR $.4\sigma_y$
 ASSUMED $36 \text{ KSI} = \sigma_y$ $.4\sigma_y = 14.4 \text{ KSI} \leftarrow \text{USE}$
 $70 \text{ KSI} = \sigma_u$ $.3\sigma_u = 21 \text{ KSI}$

ALLOWABLE BOLT MINIMUM FOR A307

$$F_t = 28 - 1.6F_u \leq 20 \quad F_t = 28 - 1.6(3.26) = 22.78 > 20 \therefore \text{USE } 20$$

AISC
TABLE
1.5.3
1.6.3