DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Structural Assessments	Date 9/21/94
Project Title/Work Order		EDT No. 607241
Seismic Qual. of SC 1 Incinerator Glovebox in Building 232Z		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
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L. E. Ebbeson	T5-04	X			
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DEC 30 1994

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT

607241

2. To: (Receiving Organization) G. A. Glover (PFP Engineering) 15510		3. From: (Originating Organization) Structural Assessments 8D440		4. Related EDT No.: N/A	
5. Proj./Prog./Dept./Div.: PFP Start Up/ 232Z		6. Cog. Engr.: E. C. Ocoma		7. Purchase Order No.: N/A	
8. Originator Remarks: Release drawings for installation				9. Equip./Component No.: Incinerator Glovebox	
				10. System/Bldg./Facility: 232Z/PFP	
11. Receiver Remarks:				12. Major Assm. Dwg. No.: N/A	
				13. Permit/Permit Application No.: N/A	
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(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-CP-SA-027		0	Seismic Analysis of SC 1 Glovebox in 232Z Building	SQ	2	1	

16. KEY					
Approval Designator (F)		Reason for Transmittal (G)		Disposition (H) & (I)	
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(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)								(G)	(H)
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
1	1	Cog.Eng. EC Ocoma	<i>E.C. Ocoma</i>	9/23/94	H5-55	PFP Eng. RJ Thomas	<i>R.J. Thomas</i>	9/23/94	H4-20	1	1
1	1	Cog. Mgr. TJ Conrads	<i>T.J. Conrads</i>	9/23/94	H5-55	PFP Eng. LH Rodgers	<i>L.H. Rodgers</i>	9/23/94	H4-54	1	1
1	1	QA AK Sharma	<i>A.K. Sharma</i>	9/27/94	H5-60	PFP Eng. RA Russell	<i>R.A. Russell</i>	9/30/94	H4-20	1	1
1	1	Safety SE Nunn	<i>S.E. Nunn</i>	12/5/94	T4-18						
		Env									
1	1	Oper. LE Ebbeson	<i>L.E. Ebbeson</i>	12/1/94	H5-04						
1	1	PFP Eng. GA Glover	<i>G.A. Glover</i>	12/1/94	H4-20						

18. E. C. Ocoma Signature of EDT Originator Date 9/23/94		19. G. A. Glover Authorized Representative for Receiving Organization Date 12/5/94		20. T. J. Conrads Cognizant Manager Date 12/7/94		21. DOE APPROVAL (if required) Ctrl. No. N/A ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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RELEASE AUTHORIZATION

Document Number: WHC-SD-CP-SA-027, REV. 0

Document Title: Seismic Analysis of Ser-1 Glovebox in 232Z Building

Release Date: 12/29/94

This document was reviewed following the
procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Niki Solis

12/29/94

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SUPPORTING DOCUMENT

1. Total Pages 35 41

2. Title

Seismic Analysis of Safety Class 1 Incinerator
Glovebox in Building 232Z

3. Number

WHC-SD-CP-SA-027

4. Rev No.

0

5. Key Words

seismic
safety class 1
glovebox, incinerator
USQ, PFP, 232Z

6. Author

Name: E. C. Ocoma

Signature

Organization/Charge Code 8D440/E23303

7. Abstract

This report documents the seismic evaluation for the existing safety class 1 incinerator glovebox in 232Z Building. The glovebox is no longer in use and most of the internal mechanical equipment have been removed. However, the insulation firebricks are still in the glovebox for proper disposal.

8. RELEASE STAMP

OFFICIAL RELEASE
DATE DEC 30 1994
35 Station 21

DESIGN VERIFICATION METHOD

The need for design verification has been reviewed with the method selected as indicated below:

<u> x </u>	Independent Review
<u> </u>	Alternate Calculations
<u> </u>	Qualification Testing
<u> </u>	Formal Design Review

T. J. Conrads
Cognizant/Project/Design Manager

SD #WHC-SD-CP-SA-027, REV. 0

ECN # N/A

DWG(S) # N/A

TYPICAL CHECKLIST FOR INDEPENDENT REVIEW

Document Reviewed WHC-SD-CP-SA-027, REV. 0

Author M.A. ISLAM

Yes No N/A

☒	☐	☐	Problem completely defined.
☒	☐	☐	Necessary assumptions explicitly stated and supported.
☐	☐	☒	Computer codes and data files documented.
☒	☐	☐	Data used in calculations explicitly stated in document.
☒	☐	☐	Data checked for consistency with original source information as applicable.
☒	☐	☐	Mathematical derivations checked including dimensional consistency of results.
☐	☐	☒	Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐	Hand calculations checked for errors.
☐	☐	☒	Code run streams correct and consistent with analysis documentation.
☐	☐	☒	Code output consistent with input and with results reported in analysis documentation.
☒	☐	☐	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
☒	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	Results and conclusions address all points required in the problem statement.

MANDATORY

Software QA Log Number N/A

E.C. O'Connell
Reviewer

9/23/94
Date

SEISMIC ANALYSIS OF SAFETY CLASS 1
INCINERATOR GLOVEBOX IN BUILDING 232-Z
200 W AREA

September 1994

Prepared by:

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Structural Assessments

9-21-94

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9-21-94

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9-21-94

WESTINGHOUSE HANFORD COMPANY
Hanford Operations and Engineering Contractor
for the
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Field Office, Richland, Washington

ANALYTICAL CALCULATIONS

REV 0

Page 2 of

Subject Glovebox Analysis, 232-Z Building
Originator M. A. Islam Date 9/19/94
Checker E. C. Ocoma Date 9/20/94, 12/1/94

Scope

This report documents the evaluation to determine the seismic adequacy of the existing support for the incinerator glovebox located in Building 232-Z to withstand seismic loads (DBE). Based on previous seismic evaluation of existing gloveboxes at the PFP Complex and from the results of the field verification walkdown, the evaluation will proceed by using the ground response spectra for .12g PGA (half the return period for safety class 1 criteria) shown in Figure 5 of Reference 1. If with the reduced loads, the existing support is found to be inadequate, a fix or seismic upgrade will be designed using the .2g PGA spectra. In both cases, 5 % damping will be used.

Criteria & References

1. Seismic accelerations per SDC-4.1, Rev.12
2. Allowable anchor capacities per SDC-4.2, Rev. 0 (for new bolts) and Guideline WHC-SD-GN-DGS-30006, Rev. 1 (for existing anchor bolts).
3. UCRL-15910
4. ANSI/AISC N690
5. Rigid Frame Analysis by Kleinlogel
6. Elementary Structural Analysis by Wilbur & Norris.

Drawings: H-2-24680 Rev. 2 ; H-2-31349 Rev. 0 ; H-2-31340 Rev. 2
H-2-25566 Rev. 1 ; H-2-25883 Rev. 5 ; H-2-824488 Rev. 1

Assumptions

1. Glovebox is rigid and the support frame posts are pinned at base.
2. The empty space inside glovebox is filled with bricks, the density of which is assumed to be 50 pounds per cu. ft. Actual density (average) was calculated and found to be 43 pcf. See page 22 and Attachment A.

Conclusions

The existing support frame for the incinerator glovebox is not adequate to withstand DBE loads that are based on .12g PGA. The calculated combined anchor bolt pullout load is 8430 lbs. The allowable capacity of the existing anchor bolts in tension is 1785 lbs. which is based on the ultimate capacity with a factor of safety of 4 and 3000 psi concrete compressive strength. Therefore the failure of the existing anchor bolts during the seismic event will cause the glovebox to topple. However, a support frame with kick braces around the glovebox is recommended and designed in this report to prevent the glovebox from toppling. The recommended 'fix' is designed to withstand the .2g DBE loads for safety class 1 equipment. The fix has been installed as shown on drawing H-2-824488, sheets 1 & 2, Rev. 1 and the as-built configuration is depicted in this analysis.

ANALYTICAL CALCULATIONS

REV 0

Page 3 of

Subject Glove box Analysis, 232-Z Bldg.

Originator M. A. ISLAM

Date 9/1/94

Checker E.C. O'Connor

Date 9/20/94

PLAN

ELEVATION

Subject Glovebox Analysis 232-Z Bldg.

Originator M.A. ISLAM

Date 9/1/92

Checker F. C. O'Connell

Date 9/20/90

Calculation of Weight (Approximate)

Central Glove box (Dwg. H-2-24680)

1.

Elev.	{	$\frac{3}{8}" \text{ } \phi @ \text{ Wall} = 2 \times 96 \times 68 \times \frac{1}{144} \times 4.5^{\#F}$	=	408 #
		" " = $2 \times 92 \times 38 \times "$	=	219
Sec.	{	$6" \text{ I beam} = 2(96 + 35) \times \frac{1}{12} \times 17.25^{\#}$	=	377
B-B	{	$\frac{3}{8}" \text{ bent } \phi = 12 \times 96 \times \frac{1}{144} \times 4.5$	=	36
		$\frac{3}{8}" \phi @ \text{ Top \& bottom of I beam} = 2 \times 96 \times 35 \times "$	=	210
Sec.	{	$L2 \times 2 \times \frac{1}{4} @ \text{ Top} = 2 \times 96 \times \frac{1}{12} \times 3.19^{\#I}$	=	51
C-C	{	$L3 \times 2 \times \frac{1}{4} " = 2 \times 3 \times 96 \times \frac{1}{12} \times 4.1$	=	197
		Glove box top $\frac{3}{8}" \phi = 96 \times 35 \times \frac{1}{144} \times 4.5$	=	105
				<u>1,603 #</u>
		<u>support frame</u>	10% Misc.	<u>160</u>
				<u>1763 #</u>
Elev.		Posts $L3 \times 3 \times 5/16 = 4 \times 57/12 \times 6.1^{\#I}$	=	116

Misc. 10% (stiffener, stud, nut etc.) $\approx \frac{12}{128} \#$

2. Glove box inside

Dwg. H-2-25883 sh. 1

Dwg. H-2-25883 sh. 1

Top Combustion chamber = $\pi \times 5.125 \times .375 \times \frac{1}{144} \times 9' = .377 \text{ CF}$

Lower " " = $\pi \times 8.25 \times \frac{1}{2} \times .375 \times \frac{1}{144} \times 11.5' = .39$

" " " = $10'' \times 11.5' \times \frac{3}{8} \times \frac{1}{144} = .3$

Sec. T Section $2\frac{5}{8}'' \text{ O.D.} \times \frac{3}{8} = \pi \times 2.25 \times .375 \times \frac{3}{12 \times 144} \times 4 = .018$

G-G " $\frac{1}{2}'' \text{ Ave. th.} = \pi \times 4.5 \times .5 \times \frac{4}{12 \times 144} \times 4 = .065$

$\Sigma = 1.15 \text{ CF}$

BD-6400-060.1 (07)

ANALYTICAL CALCULATIONS

REV 0

Page 5 of Subject Glove box Analysis, 232-Z Bldg.Originator M.A. ISLAMDate 9/1/94Checker E.C. OdomsDate 9/20/90Dwg. H-2-25883 sh. 1 Contd.

$$\Sigma = 1.15 \text{ CF}$$

$$\text{Sec. } \left. \begin{array}{l} \text{'T' section, } 3\frac{3}{8}'' \text{ o.d.} \times \frac{3}{8}'' = \pi \times 3 \times .375 \times \frac{3}{12 \times 144} \times 4 = .025 \text{ CF} \\ \text{H.H. } \left. \begin{array}{l} \text{'' } \text{'' } \frac{1}{2}'' \text{ Ave. th.} = \pi \times 4.5 \times .5 \times \frac{4}{12 \times 144} \times 4 = .065 \end{array} \right\}$$

$$\Sigma = \frac{1.24}{.12} \text{ CF}$$

$$1.36 \text{ CF}$$

Add 10% Misc.

H-2-25883 sh. 4

$$\text{Flue } 2\frac{5}{8}'' \phi \text{ tube} = \pi \times 2.25 \times .375 \times 1.5 \times 4 \times \frac{1}{144} = .11$$

$$\text{'' Flange } 1\frac{1}{2}'' \text{ th.} = 1.25 \times 2 \times 1.125 \times \frac{1}{144} \times 16 = .31$$

$$\text{Cover } \phi 13\frac{1}{2}'' = \frac{\pi}{4} \times 13.5 \times .1875 \times \frac{1}{144} \times \frac{1}{12} \times 2 = .03$$

$$\text{Hanger Assembly} \approx .1$$

Misc. 10%

$$\Sigma .55$$

$$\Sigma = \frac{.05}{.16} \text{ CF}$$

H-2-25566, sh. 1 & 4

Ash Discharge End Insulation Assy.

$$\text{Belt End, Cover shield} \approx .25 \text{ CF}$$

$$\text{Total metal Vol.} = 1.36 + .6 + .25 = 2.21 \text{ CF}$$

$$\text{Total Inside (Glove box) vol.} = 8 \times 2.92 \times 5.67$$

$$= 132.5 \text{ CF}$$

\(\therefore\) Vol. of Insulation (Brick by Johnsmanville Co.,
Marinite, Min-K-2000)

$$= 132.5 - 2.21 = 130.29 \text{ CF}$$

$$\text{Density of brick} \approx 50 \text{ \# / CF (see Page 2)}$$

$$\therefore \text{Weight of Metal} = 2.21 \times 490 = \underline{1083} \text{ \#}$$

$$3. \therefore \text{Brick} = 130.29 \times 50 = \underline{6515} \text{ \#}$$

ANALYTICAL CALCULATIONS

REV 0
Page 6 of

Subject Glovebox Analysis, 232-Z Bldg.
 Originator M. A. ISLAM Date 9/1/94
 Checker E. C. O'Connell Date 9/20/94

Approximate Wt. of Following Items

4. Ash Discharge End (H-2-31339) $\approx 250^{\#}$
 5. Heating Element Plug Assy (H-2-26147) $\approx 250^{\#}$
 6. Ash Discharge End Insulation (H-2-25566) $\approx 100^{\#}$
 7. Blower Assembly $\approx 250^{\#}$

$$\sum W_A \text{ (1 thru 7)} = 1763 + 128 + 1083 + 6515 \\ + 250 + 250 + 100 + 250 \\ \sum W = 10339 \approx 10,500^{\#}$$

Approx. Wt. of (B)

$$\text{Prorate from (A), Volume B} = 48 \times 35 \times \overbrace{(68+57-30)}^{95} \\ = 159600 \text{ in}^3$$

$$\text{Volume A} = 96 \times 35 \times 68 = 228,480 \text{ in}^3$$

$$\therefore W_B = (1763 + 128) \times \frac{159600}{228480} = 1321^{\#}$$

Per Field Engineering, there is none inside (B), however, add 10% (Conser)

$$\therefore W_B = 1321 + 132 \approx 1,500^{\#}$$

Approx. Wt. of (C)

$$\text{Similarly, Volume (C)} = [30 \times 95 + 18 \times 95 + (54-18)(75-30)] \times 35 \\ = 216300 \text{ in}^3$$

$$W_C = [(1763 + 128) \times \frac{216300}{228480}] \times 1.10 \approx 2,000^{\#}$$

ANALYTICAL CALCULATIONS

REV 0

Page 7 of

Subject Glovebox Analysis, 232-Z Bldg.Originator M. A. ISLAMDate 9/1/94Checker E. C. JonesDate 9/20/90Approximate Location of C.G.

c.g. of (A) _{Blower}

$$c.g. = \frac{128 \times 28.5 + 250 \times 57 \times \frac{2}{3} + (10500 - 128 - 250) \times (57 + 34)}{10500}$$

$$= 89"$$

c.g. of (B) _{Support}

$$= (30 + 95/2) = 77.5"$$

c.g. of (C)

$$= 30 + \frac{30 \times 75^2/2 + 18 \times (96 - 30)^2/2 + (54 - 18) \times (75 - 30)^2/2}{(30 \times 95) + \{18 \times (96 - 30)\} + \{54 \times (75 - 30)\}} = 67.3"$$

c.g. of (A), (B), (C)

$$C.G. = \frac{10500 \times 89 + 1500 \times 77.5 + 2000 \times 67.3}{14000}$$

$$= 84.7"$$

ANALYTICAL CALCULATIONS

REV 0

Page 8 of

Subject Glovebox Analysis. 232-Z Bldg.Originator M.A. ISLAMDate 9/2/94Checker E.C. OermeDate 9/20/94Stiffness of Glovebox A

Existing Condition:

$$L = 57 - 24/2 = 45"$$

$$I \text{ of } L3 \times 3 \times 5/16 = 1.51 \text{ in}^4$$

$$I \text{ of } 1\frac{1}{2}" \phi \text{ CS ROD} = .119 \text{ in}^4$$

∴ For stiffness calculation, use $I = .119 \text{ in}^4$

stiffness along horiz. direction, K_A

$$K_A = \frac{12EI}{L^3} \times 2^{\text{#s of frame}} = \frac{12 \times 29 \times 10^6 \times .119}{45^3} \times 2$$

$$= 9089 \text{ \#/in}$$

$$\text{Frequency, } f = 3.13 \sqrt{\frac{K}{W_A}} = 3.13 \sqrt{\frac{9089}{10500}}$$

$$= 2.9 \text{ Hz} \Rightarrow \text{Flexible}$$

∴ Use Peak acceleration

Per SDC-4.1, Rev 12

Because the glovebox has remaining useful life less than 20 years and hazard exceedance probabilities twice the recommended value, use SDC-4.1, Rev 12, Fig. 5 response at 5% damping.

$$\text{ZPA } g = .12 g$$

$$\text{@ 5\% damp. Peak } g_h = .27 g \quad ; \quad g_v = \frac{2}{3} \times .27 = .18 g$$

With the above accelerations, if support is found inadequate, 'Fix' will be provided based on acceleration per Fig. 3 response, ZPA $g = .20 g$.

ANALYTICAL CALCULATIONS

REV 0
Page 9 ofSubject Glove box Analysis, 232-Z Bldg.Originator M. A. ISLAMDate 9/2/94Checker E.C. OsawaDate 9/20/94Loads on Anchor bolt (Refer to WHC-SD-GN-DGS-30006, Rev 1)

$$\begin{aligned} \text{C.G.} &= \frac{4 \times 20 + 4 \times (46 + 94/2) + 4(46 + 94 + 36 + 48/2)}{12} \\ &= 104.3 \text{ " (not used)} \end{aligned}$$

Seismic Forces

$$\text{Transverse, } F_T = 14000 \times .27 \times \frac{1}{6} = 630 \text{ \#/Frame}$$

$$\text{Longitudinal, } F_L = 14000 \times .27 \times \frac{1}{2} = 1890 \text{ \#/Frame}$$

$$\text{Vertical, } F_v = 14000 \times .18 = 2520 \text{ \#}$$

Note: The posts, close to the base plate for the extended parts (B & C) of the main glove box, A, have unique design so that the parts B & C can slide while the base plates are anchored. The anchors for B & C may not resist pullout due to longitudinal load, F_L . Therefore, anchors for A may have to support additional pullout.

ANALYTICAL CALCULATIONS

REV 0

Page 10 of

Subject Glove box Analysis, 2322 Bldg.Originator M. A. ISLAMDate 9/6/94Checker E.C. O'ConnorDate 9/20/94Loads on AnchorsTransverse

$$\text{Tension} = \frac{630 \times 84.7}{35} = 1525 \text{ \#}$$

$$\text{shear} = 630/2 = 315 \text{ \#}$$

Longitudinal

$$\text{Tension} = \frac{1890 \times 84.7}{94} = 1703 \text{ \#}$$

$$\text{shear} = 1890/2 = 945 \text{ \# (use only 2 anchors)}$$

Vertical

$$\text{Tension} = 2520/12 = 210 \text{ \#}$$

$$\text{Compression} = 14000/12 = 1167 \text{ \#}$$

Load Combination

Per Design Guide, WHC-SD-GN-DGS-30006, Rev 1
and UBC 1988

$$\text{Net Tension, } T = 1703 + .4 \times 1525 + .4 \times 210 - .85 \times 1167 \\ = 1405 \text{ \#}$$

$$\text{Net shear, } V = \sqrt{315^2 + 945^2} = 996 \text{ \#}$$

Dwg. H-2-31349 indicates that the anchor is 5/8" ϕ expansion anchor. In lieu of its brand name and emb. depth, it is difficult to determine the allowable values. Therefore, use the above Des. Guide's tabulated values which are conservative

ANALYTICAL CALCULATIONS

REV 0

Page 71 of _____

Subject Glovebox Analysis, 232-Z Bldg.Originator M.A ISLAMDate 9/6/94Checker E.C O'ConnorDate 9/20/94

Per Des. Guide WHC-SD-GN-DGS-30006, Rev 1,
Table 4.3, Page 4-31

For $5/8" \phi \times 2 3/4" \text{ Emb.}$ and $f_c' = 3000 \text{ Psi}$

$$T_{all} = 2380 \times \frac{3000}{4000} = 1785 \#$$

$$V_{all} = 2840 \times \left[\frac{3000}{10000} + .65 \right] = 2698 \#$$

Add Prying action to anchor

$$\therefore T_p = \frac{T(l+x)}{x} = 1405 \times \left(\frac{4+1}{1} \right) = 7025 > T_{all} = 1785 \#$$

(N.G.)

Even without Prying action, the interaction,

$$I = \frac{T}{T_{all}} + \frac{V}{V_{all}} = \frac{1405}{1785} + \frac{996}{2698} = 1.16 > 1$$

(N.G.)

Bending

$$M = 1231 \times 4 = 4924 \# \text{ in}$$

$$S = bd^2/6 = 3 \times 3.75^2/6 = 1.07$$

$$\sigma_b = \frac{4924}{1.07} = 70343 \text{ Psi} > 1.6 \times 33000 \times 1.16 = 31,680 \text{ Psi}$$

(N.G.)

Therefore, the As-built support is inadequate to withstand seismic load. Provide a frame around the box to resist the seismic load only.

ANALYTICAL CALCULATIONS

REV 0
Page 12 of 12

Subject Glovebox Analysis, 232-Z Bldg.

Originator M. A. ISLAM

Date 9/6/94

Checker E. C. J. J. J.

Date 9/20/94, 12/1/94

PLAN

Subject Glovebox Analysis, 232-Z Bldg.

Originator M. A. ISLAM

Date 9/6/94

Checker E. C. O'Connell

Date 9/20/90 12/1/95

Subject Glovebox Analysis, 232-Z Bldg.

Originator M. A. ISLAM

Date 9/6/94

Checker E.C. O'Connor

Date 9/20/95

'Fix' Analysis Model

Transverse direction

** Use $P_T = 1.0 \text{ W}$ (conservative)

Transverse force per frame, P_T

$$P_T = 14000 \times .43 \times \frac{1}{2} = 3,010 \text{ \#}$$

Tension @ A or Comp. @ C

$$= \frac{P_T (94)}{60} = 4716$$

Shear @ A = 0

← Shear @ C = 3,010 #

- * Hinged ends will not make any difference. No bending

Refer
Kleinlogel
"Rigid"
Frame
Formulas

Case
* 31/6
*

ANALYTICAL CALCULATIONS

REV 0

Page 15 of

Subject Glovebox Analysis, 232-Z Bldg.Originator M.A. ISLAMDate 9/7/94Checker E.C. OdomDate 9/20/94Longitudinal Direction

$$P_L = 14000 \times .43 \times \frac{1}{2} = 3010 \text{ \#}$$

Refer to Wilbur & Norris's
"Elementary Structural Analysis"
Page 296

$$\text{Tension @ A, } T = \frac{P_L (94)}{96} = \frac{3010 \times 94}{96} = 2947 \text{ \#}$$

$$\text{Shear @ A, } V = \frac{P_L}{2} = 1505 \text{ \#}$$

Vertical direction is resisted by the existing anchorage (compression)

Load Combination

Because transverse direction produces critical tension, consider trans. direction primary.

$$\therefore \text{Net tension, } T = 4716 + .4 \times 2947 = 5895 \text{ \#}$$

$$\text{Net Shear, } V = 1.05 \times 1505 = 1580 \text{ \#}$$

— Accidental torsion

Use a 4-bolt base plate at each Post and diagonal bases

$$\text{Tension @ Each bolt, } T = \frac{5895}{4} = 1474 \text{ \#}$$

$$\text{Shear @ " " , } V = \frac{1580}{4} = 395 \text{ \#}$$

ANALYTICAL CALCULATIONS

REV 0

Page 16 of

Subject Glovebox Analysis, 232-Z Bldg.Originator M.A. ISLAMDate 9/7/94Checker E.C. OdomsDate 9/20/94

Because HKB are new, use allowable loads per SDC-4.2

For $5/8" \phi$ HKB $\times$ $23/4"$ Emb. & $f_c' = 3000$ Psi
(Table 11)

$$T_{all.} = 1750 \# ; V_{all.} = 2530 \#$$

$$\therefore \text{Interaction, } I = \frac{T}{T_{all.}} + \frac{V}{V_{all.}} = \frac{1474}{1750} + \frac{395}{2530}$$

$$I = .99 < 1.0 \quad \text{OK. Margin of Safety, } *$$

$$M.S. = \frac{1}{.99} - 1 = .002$$

 ϕ Bending

$$M = T(1) = 972.5 \times 2 \times 1 = 1945 \text{ #-in}$$

$$S = \frac{b t^2}{6} = \frac{9 \times 5^2}{6} = .375 \text{ in}^3$$

$$\sigma_b = \frac{1945}{.375} = 5187 \text{ Psi} < .75 \times 36000 \text{ Psi OK}$$

(* M.S. would increase if actual load = .9W per
bolts # in Page 14 was
used. $\therefore$ Result is cons.)

Weld betn. W6 or L4x4 and base ϕ

consider weld with L4x4 (conservative)

$$A_w \approx 4 + 4 = 8"$$

Forces in weld, f_w

$$f_w = \left[\left(\frac{3890}{8} \right)^2 + \left(\frac{2128}{8} \right)^2 \right]^{1/2}$$

$$= 554 \text{ #/in} \Rightarrow \text{very low}$$

$$\text{Allow. } F_w = .4 \times 36000 \times .1875 \times 1.4 = 3780 \text{ #/in} >> 139 \text{ #/in}$$

- increase due to DBE (ANSI A690)

OK

ANALYTICAL CALCULATIONS

REV 0
Page 17 ofSubject Glovebox Analysis, 232-Z Bldg.Originator M. A. ISLAMDate 9/8/94Checker E C O'ConnellDate 9/20/94; 12/1/94Stresses in Frame

Brace $L4 \times 4 \times 3/8$ is subjected to axial compression (No bending).

$$\text{Axial load} = [4710^2 + 3010^2]^{\frac{1}{2}} = 5595 \text{ \#}$$

(from page 14)

$$\text{For } L4 \times 4 \times 3/8, L = [94^2 + 60^2]^{\frac{1}{2}} = 111.5"$$

$$A = 2.86 \text{ in}^2$$

$$r = .788 \text{ in}$$

Use $K = 1.2$ (One end fixed, other end rotation fixed only)

$$\therefore \frac{KL}{r} = \frac{1.2 \times 111.5}{.788} = 170 < 200 \text{ OK}$$

Allow. Compressive stress, σ_c for $\frac{KL}{r} = 170$ per AISC 8th Ed.

$$\sigma_c = 5170 \text{ Psi}$$

$$\text{Actual stress, } \sigma = \frac{5595}{2.86} = 1956 \text{ Psi} < 5170 \text{ Psi OK}$$

$$M.S. = \frac{5170}{1956} - 1 = 1.64$$

$\therefore L4 \times 4 \times 3/8$ is adequate

Base Φ with brace, $L4 \times 4$

These base Φ s are subjected to compression and shear loads only. Worst base Φ at North-west. This Φ is subjected to additional shear due to torsion.

$$V \text{ (from page 14)} = 3010 \text{ \#; ignore compression}$$

$$\text{Torsion} = 3010 \times 10.75 = 32,358 \text{ \# in}$$

$$\text{Polar moment of Inertia, } J = 2(3.75^2 \times 2 \times 2) = 112.5 \text{ bolt-in}^2$$

$$\text{shear/bolt} = \frac{32358 \times 3.75}{112.5} = 1079 \text{ \# each way}$$

$$\therefore \text{Resultant shear/bolt} = \sqrt{\left(\frac{3010}{4} + 1079\right)^2 + 1079^2} = 2125 \text{ \#}$$

$$\text{Interaction, } I = \frac{2125}{2530} = .84 < 1 \text{ OK}$$

ANALYTICAL CALCULATIONS

REV 0

Page 18 of

Subject Glovebox Analysis, 232-Z Bldg.Originator M.A. ISLAMDate 9/8/94Checker E.C. O'ConnorDate 9/20/94Frame along Long. direction

$$T = 5895^{\#} \text{ (Page 15)}$$

$$V = 1580^{\#} \text{ (No shear develops from transverse direc.)}$$

$$M = 1580 \times 94 = 148,520^{\#}\text{-in}$$

Slenderness Ratio

$$K = 2 \text{ (one end pinned, other end rotation fixed)}$$

$$\text{For } W6 \times 16, A = 4.74 \text{ in}^2; S_{\text{major}} = 10.2 \text{ in}^3; r_{\text{min}} = 1.966$$

$$\frac{KL}{r_{\text{min}}} = \frac{2 \times 94}{1.966} = 195 < 200 \text{ OK}$$

$$\text{Allow. Comp. stress @ } \frac{KL}{r} = 195, F_a = 3970 \text{ Psi}$$

Per AISC/ANSI N690, allowable stresses can be increased by 60% for bending/tension and 40% for shear when stresses are associated with DBE loads.

$$\therefore F_a = 3970 \times 1.6 = 6352 \text{ Psi for A36 steel, } F_y = 36000 \text{ Psi}$$

$$\text{Bending Allow.}, F_b = .6 F_y (1.6) = 34560 \text{ Psi}$$

$$\sigma_a = \frac{5895}{4.74} = 1,244 \text{ Psi}; \quad \sigma_b = \frac{148,520}{10.2} = 14,561 \text{ Psi}$$

$$\text{Interaction, } I = \frac{1,244}{6352} + \frac{14,561}{34560} = .62 < 1.0 \text{ OK}$$

$$M.S. = \frac{1}{.62} - 1 = .61$$

ANALYTICAL CALCULATIONS

REV 0

Page 19 of

Subject Glovebox Analysis, 232-Z Bldg.Originator M.A. ISLAMDate 9/8/94Checker E.C. OdomDate 9/20/94Weld betn. W6 & W6

$$A_w = \overset{\text{flange}}{2 \times 4} + \overset{\text{flange}}{2 \times 3} + \overset{\text{web}}{2 \times 5} = 24 \text{ in}$$

$$S_w = 4 \times 6 + 3 \times 5 + 5^2/2 = 51.5 \text{ in}^2$$

$$\text{Axial Force} = 1580 \#; \text{ shear} = 5895 \#$$

$$M = 148,520 \# \cdot \text{in}$$

$$f_w = \left[\left(\frac{1580}{24} + \frac{148,520}{51.5} \right)^2 + \left(\frac{5895}{24} \right)^2 \right]^{1/2} = 2960 \#/\text{in}$$

For $3/16$ " Fillet Weld, $F_w = 3780 \#/\text{in} > 2960 \#/\text{in}$ OK

$$M.S. = \frac{3780}{2960} - 1 = .27$$

Therefore, W6x16 are adequate

Frame around Glovebox End U-FRAME

$$P_L = \frac{P_D}{2} = \frac{3010}{2} = 1505 \#/\text{end/connection}$$

ANALYTICAL CALCULATIONS

REV. 0
Page 20 ofSubject Glovebox Analysis, 232-Z Bldg.Originator M.A. ISLAMDate 9/8/94Checker E.C. OsmaDate 9/20/94, 12/1/94Member BC ($L3 \times 3 \times 3/8$, $S = .833 \text{ in}^3$)

$$\text{Max. } M = 1505 \times 15 = 22,575 \text{ #-in}$$

$$\sigma_b = \frac{22,575}{.833} = 27,101 \text{ Psi}$$

$$\begin{aligned} \sigma_b (\text{allow.}) &= .6 \times F_y \times 1.6 = .6 \times 36000 \times 1.6 \\ &= 34560 \text{ Psi} > 27,101 \text{ Psi OK.} \end{aligned}$$

$$M.S. = \frac{34560}{27101} - 1 = .28$$

Weld Connection

$$\text{Max. Load} = 3010 \text{ #}$$

$$\begin{aligned} A_w &= 2 \times 3 = 6 \text{ in} \\ F_w (\text{for } 3/16" \text{ Fillet}) &= 3780 \text{ #/in} \\ f_w &= \frac{3010}{6} = 502 \text{ #/in} < 3780 \text{ #/in OK} \end{aligned}$$

2 Bolts betn. W6 & $\phi 3/8$ are not stressed. This supports the $\phi 3/8$ for dead wt. only.

Member AB ($L3 \times 3 \times 3/8$) is OK by comparison.

Weld betn. $L3 \times 3$ & W6

$$\begin{aligned} A_w &= 6 \times 2 = 12 \text{ in} \\ f_w &= \frac{1505}{12} = 125 \text{ #/in} \Rightarrow \text{Very low} \\ 3/16" \text{ Fillet Weld will be adequate} \end{aligned}$$

Note: Welds analyzed are conservative than actually built.

ANALYTICAL CALCULATIONS

REV 0

Page 27 of

Subject Glove box Analysis, 232-Z BldgOriginator M.A. ISLAMDate 9/16/94Checker E.C. OermaDate 9/20/94Existing Base

Because the frame around glovebox was not set at the c.g. of glovebox, this will produce some shear load at the base of the existing support frame.

It has been determined in page 12 of this calculation that 10% of total load goes to the base.

∴ Force @ transverse or longitudinal direction,

$$F_t = F_l = (1W) \times g = .1 \times 14000 \times .43 = 602^\#$$

∴ Resultant shear, V per anchor = $\sqrt{\left(\frac{602}{4}\right)^2 + \left(\frac{602}{4}\right)^2}$
(use 4 anchors with glovebox only - conservative)

$$V = 213^\# < 2698^\# \text{ (Page 11)} \quad \text{OK}$$

Hood Leveling Foot Assembly

$1\frac{1}{4}" \phi$ threaded bar, $A = .89 \text{ in}^2$ (root), $S = \frac{\pi d^3}{32} = .192 \text{ in}^3$

By comparison the shear is adequate. check bending.

$$M = 6 \times 213 = 1278^\# \cdot \text{in}$$

$$S = \frac{14000 \text{ SW}}{12 \text{ \#s of posts}} \times \frac{1}{.89} + \frac{1278}{.192} = 7967 \text{ Psi}$$

$$< .75 \times 1.6 > \cdot 9 F_y = .9 \times 33000$$

OK

Leveling Foot assembly is adequate.

ANALYTICAL CALCULATIONS

REV 0

Page 22 of

Subject Glovebox Analysis, 232-ZOriginator M. A. ISLAMDate 9/16/74Checker E. C. OdomDate 9/16/74Density of Insulating BrickFirebrick

$$\text{Density: } 36 \text{ Pcf} \quad \text{Pieces}$$

$$\text{Volume} = 2.5 \times 4.5 \times 9 \times \frac{1}{12 \times 12} \times 125 = 7.3 \text{ CF}$$

Min-K-2000

$$\text{Density: } 20 \text{ Pcf}$$

$$\text{Volume} = 3 \times 18 \times 36 \times \frac{1}{12 \times 12} \times 5^{\text{sheets}} = 5.625 \text{ CF}$$

Super-X (2" & 3")

$$\text{Density: } 24 \text{ Pcf}$$

$$\text{Volume} = (2 + 3) \times \frac{1}{12} \times 100^{\text{SF}} = 41.7 \text{ CF}$$

Marinite

$$\text{Density: } 26 \text{ Pcf}$$

$$\text{Volume} = \frac{2}{12} \times 4 \times 8 = 5.3 \text{ CF}$$

Insulating block

$$\text{Density: } 15 \text{ Pcf ; Volume} = 45 \text{ CF}$$

Castable

$$\text{Density: } 90 \text{ Pcf ; Volume} = 50 \text{ CF}$$

Cerafelt

$$\text{Density: } 10 \text{ Pcf \& 24 Pcf}$$

$$\text{Volume 1} = \frac{5}{12} \times 4 \times 8 = 1.3 \text{ CF}$$

$$\text{Volume 2} = (\frac{1}{8} + \frac{1}{4}) \times \frac{1}{12} \times 4 \times 8 = 1 \text{ "}$$

Average density

$$\frac{36 \times 7.3 + 20 \times 5.625 + 24 \times 41.7 + 26 \times 5.3 + 15 \times 45 + 90 \times 50 + 10 \times 1.3 + 24 \times 1}{7.3 + 5.625 + 41.7 + 5.3 + 45 + 50 + 1.3 + 1}$$

$$\approx 43 \text{ PCF} < \text{Assumed density} = 50 \text{ Pcf}$$

Therefore, analysis is conservative.

WHC-SD-CP-SA-027

REV 0 PAGE A-1

ATTACHMENT A

Insulating Materials Density Information

FUSION UNIT

Fax Transmittal Memo 7872

To **E. OCOM**

Company

Location

Fax #

Comments

No. of Pages

Today's Date

Time

From

Company

Location

Fax #

Original
Disposition:☐ Destroy☐ Return☐ Call for pickupFrom **Lon Rodgers**

Dept. Charge

Telephone #

Insulation data for incinerator

WHC-SD-CP-SA-027

REV 0 PAGE A-2

March 7, 1963

W.O. 1866

INSULATING MATERIAL REQUIRED
INCINERATOR REPAIR 232-2 BUILDING

The following material is required to replace the insulation in the incinerator. This material will be listed and specified in detail on the following drawings:

- H-2-24718 - Sections and Details, Insulation Replacement
H-2-24719 - Elevations and Details, Insulation Replacement
H-2-24720 - Plans and B.M. Insulation Replacement

<u>Item</u>	<u>Qty.</u>	<u>Description</u>
450.00 1.	123 pcs.	Firebrick, insulating
2.	1 sheet	Min-X #1301 - 3 in. thick, by 18 in. by 36 in.
900.00 3.	5 sheets	Min-X #2000 - 3 in. thick, by 18 in. by 36 in.
63.00 4.	100 sq ft	Super X - 2 in. thick
100.00 4A.	100 sq ft	Super X - 3 in. thick
100.00 5.	1 sheet	Marinite - 2 in. thick, by 4 ft. by 8 ft.
x6.	45 ft. cu	Block, insulating, 2-1/2 in. thick
7.	50 cu. ft.	Castable
360.00 { 8.	1 sheet	Cerafelt - 1/2 in thick, 10 pcf., 4 ft by 8 ft
9.	1 sheet	Cerafelt - 24 pcf. 1/8 in. thick, 4 ft by 8 ft
10.	1 sheet	Cerafelt - 24 pcf. 1/4 in. thick, 4 ft by 8 ft

note: The above quantities include various additional quantities for wastes, cutting, etc. The amounts are believed adequate for estimating purposes and for preliminary quotation.

H J Bellarts

POWER AND MECHANICAL DESIGN
DESIGN ENGINEERING SECTION

HJ Bellarts:dtj
761 Bldg., 700 Area

Attachments

WHC-SD-CP-SA-027

REV 0 PAGE A-3

Item 1 - Firebrick

ASTM C 134

36 PCF

- Material specified this way shall be Johns-Manville Co. Insulating Firebrick designated JN 23 or approved equal.

This material shall have the following characteristics:

1. It shall withstand continuous exposure to 2300°F temperature without damage.
2. The cold crushing strength shall exceed 200 psi.
3. The transverse strength shall exceed 135 psi.
4. Thermal conductivity shall not exceed 1.25 at 1000°F nor 1.4 at 1500°F mean temperature measured as BTU/Hr/Sq/Ft./In./°F.
5. The brick shall have a nominal size of 2-1/2 by 9 by 4-1/2 inches.
6. It shall be composed largely of refractory clays.

Item 2 - Min-K

- Material specified this way shall be Johns-Manville Co. Min-K #1301 or an approved equal.

This material shall have the following characteristics:

1. It shall be provided in a soft board form, (or a stiff batt) in sizes and thickness specified.
2. Thermal conductivity shall not exceed .30 at 1000°F nor .27 at 500°F mean temperature measured as BTU/Sq. Ft./Hr./In./°F.
3. It shall withstand continuous exposure to a temperature of 1300°F without damage.
4. Nominal density shall approximate 21 pcf.

Item 3 - Min-K 2000

- Material specified this way shall be Johns-Manville Co. Min-K #2000 or an approved equal.

This material shall have the following characteristics:

1. It shall be provided in a soft board form (or a stiff batt) in sizes and thickness specified.
2. It shall withstand continuous exposure to a temperature of 2000°F without damage.
3. Thermal conductivity shall not exceed .27 at 1000°F nor .24 at 500°F mean temperature expressed as BTU/Sq. Ft./In./Hr./°F.
4. Nominal density shall approximate, 20 PCF.

WHC-SD-CP-SA-027

REV 0 PAGE A-4

Item 4 - Super X

- Material specified this way shall be Johns-Manville Co. Super X or approved equal.

This material shall have the following characteristics:

1. It shall withstand continuous exposure to a temperature of 1900°F without damage.
2. Nominal density shall approximate 24 pcf.
3. Compressive strength shall be adequate to resist a deformation of more than 1/8 inch when loaded to 85 psi.
4. Thermal conductivity shall not exceed .85 at 1000°F nor .75 at 500°F mean temperature, in BTU/Sq Ft/In/Hr.
5. It shall comply with Specification MIL-1-2819 Class C.
6. Material shall be supplied in sizes and packages according to the manufacturers standard and in sizes and thickness as specified.

Item 5 - Marinite

- Material specified this way shall be Johns-Manville Co. Molten Metal Marinite number 36 or an approved equal.

This material shall have the following characteristics:

1. This material shall be supplied as a stiff and hard board in the thickness specified. It shall not be assembled from (or laminated) from thinner sheets.
2. It shall withstand continuous exposure to a temperature of 1300°F without destruction.
3. Transverse strength, measured as Modulus of Rupture (ASTM C-268) shall be not less than 1000 psi.
4. Thermal conductivity shall not exceed .85 at 500°F nor .88 at 1000°F mean temperature, in BTU/Hr/Sq Ft/In/Oy.
5. It shall be available in sheet form not less than 24-inches wide, nor less than 36 inches long.
6. Density shall approximate 26 pcf.
7. It shall be composed largely of asbestos fiber and silica.

WHC-SD-CP-SA-027

REV 0 PAGE A-5

Item 6 - Block

- Material specified this way shall be an insulating block such as "Insulating Block" as made by the A.P. Green Co., or the "H.T. Bamroc" made by the Johns-Manville Co., or an approved equal.

This material shall have the following characteristics:

1. It shall be composed largely of mineral wool.
2. It shall withstand continuous exposure to a temperature of 1700°F without destruction.
3. It shall be available in block or stiff batt form.
4. Thermal conductivity shall not exceed .53 at 500°F mean temperature in BTU/In/Sq Ft/Hr/°F.
5. Compressive strength shall be adequate to resist a deformation greater than 1/8 inch when loaded to 2000 pcf.
6. Density shall approximate 15 pcf.

Item 7 - Castable

- Material specified this way shall be A.P. Green Company "Kastolite" or an approved equal.

This material shall have the following characteristics:

1. It shall be provided in granular form, bagged, so that by the addition of water it may be cast into any shape for which a mold may be provided. When mixed according to the manufacturer's directions it shall flow (pour) into the mold as a slurry.
2. Setting time shall not exceed 16 hours. It shall be removable from the mold within that time.
3. After casting and curing it shall have the following characteristics:
 - a. It shall weigh not over 90 pcf.
 - b. Modulus of rupture (ASTM C-268) shall not be lower than 150 psi at any operating temperature.
 - c. It shall withstand continuous exposure to a temperature of 2400°F without damage.
 - d. Thermal conductivity shall not exceed 2.65 at a mean temperature of 1600°F expressed in BTU/In/Sq Ft/Hr/°F.
 - e. Cold crushing strength shall exceed 400 psi at all operating temperatures.

Item 8 - "Cerafelt"

- This material shall be "Cerafelt" as made by Johns-Manville Co. or an approved equal.

This material shall have the following characteristics:

1. It shall withstand continuous exposure to a temperature of 2000°F without destruction.

look
A P Green Castables
50 lb bag

1/2" 3/29. P -

Item 8 - (Continued)

2. It shall be available as a batt or soft board form.
3. It shall not be abrasive or harsh to handle.
4. It shall be moderately flexible (not brittle) and shall permit a small amount of bending in the higher density materials. The material shall yield to the irregularities of adjacent surfaces when used as a spacer or filler material.
5. It shall be available in a nominal density of 10 pcf which shall have a thermal conductivity not to exceed .45 at 500°F, not .3 at 1500°F mean temperature in BTU/In/Sq Ft/Hr/°F.
6. It shall be available in a nominal density of 24 pcf which shall have a thermal conductivity in a nominal density of 24 pcf which shall have a thermal conductivity not to exceed .39 at 500°F nor .90 at 1500°F mean temperature in BTU/Sq Ft/In/Hr/°F.
7. Material shall be supplied in sizes and packages according to the manufacturer's standard practice and in the sizes and thickness as specified.