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SD 70-205

STRUCTURAL ANALYSIS
SKYLAB SPACECRAFT
ADDENDUM A (RESCUE VEHICLE)

APRIL 1973

H. M. Clancy

H. M. CLANCY, SUPERVISOR
STRUCTURES AND MATERIALS

(NASA-CR-150928) STRUCTURAL ANALYSIS SKYLAB SPACECRAFT. ADDENDUM A: RESCUE VEHICLE (Rockwell International Corp.) 400 p
N76-78068
Unclas
00/98 02460

Space Division
Rockwell International

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SD 70-205

STRUCTURAL ANALYSIS
SKYLAB SPACECRAFT
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Space Division
Rockwell International

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CONTENTS

SECTION I.1

FOREWORD

(4)

FOREWORD

The rescue vehicle is designed to provide the capability of having two astronauts rescue three additional astronauts in earth orbit. Basic Skylab configured Command and Service Modules are modified to provide this capability.

Modifications include two rescue couches with restraint harness assemblies, additional crew oxygen supplies, a urine chiller adapter frame (and ballast), ballast for the center crew couch, a stowage pallet and additional stowage capability, a modified drogue, and a modified SLA. The two rescue couches are to be utilized in conjunction with the center crew couch to effect the rescue. Utilization of the ballast on the center crew couch is to obtain the design stroking of the couch in an abort condition during launch. The urine chiller adapter frame facilitates the stowage of the urine chiller transferred from the rescued vehicle. The stowage pallet provides the capability of returning items of potential importance from the vehicle being rescued. Undocking of the Command Module from the Multiple Docking Adapter is facilitated by the Modified Drogue.

Modification of SLA's 23, 24, and 25, the SLA's to be utilized on the 2nd, 3rd, and 4th Skylab vehicles, consisted of the addition of a SLA panel retention system. The panel retention system, previously installed on all SLA's through SLA 15, was discontinued after one of the panels "snapped back" upon deployment. The same hardware is being used but the SLA 23, 24, and 25 panels are weaker than those for which the retention system was designed.

SLA 23 is the first SLA to fly with the in-line changed LEM support structure for the jettison of LEM A modification installation (8V24-321504), utilized on SLA's 11 through 21, was analyzed in section VI 2.5 of report SD 67-1103. The in-line change and the modification installation are very similar

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Tests on the rescue couch assembly, urine chiller adapter frame, Command Module forward tunnel apex, and center crew couch ballast tie down straps were conducted in accordance with TR's 611016, 611017, 691008, 691020, and 611025. The following table indicates the structures tested and the applicable test report numbers

STRUCTURE	DOCUMENT NUMBER	TEST
Rescue Couch	LR 9601-3301	Rescue Couch Adapter Frame Static Limit Load Test
	IL 191-06-72-076	Evaluation of Rescue Couch Adapter Frames Static Limit Load Test
	SD 73-CS-0003	Structural and Functional Testing of the Rescue Couch
Urine Chiller Adapter Frame	SD 73-CS-0003	Structural and Functional Testing of the Rescue Couch
Forward Tunnel Apex	SD 72-CS-0071	Skylab Apex Tunnel Bending Capacity
Ballast Straps	LR96434035	Tensile Test of P B I Tie-Down System

Launch trajectory and thermal environment for the rescue vehicle are identical to that of the basic Skylab configuration. A comparison of the Skylab parameters with those of CCA 1520 was conducted in the SD 70-205 report. For further information regarding the above mentioned comparisons, refer to report SD 70-205.

The following pages contain pictures depicting the modifications involved in the conversion of the basic Skylab vehicle into the rescue vehicle configuration.

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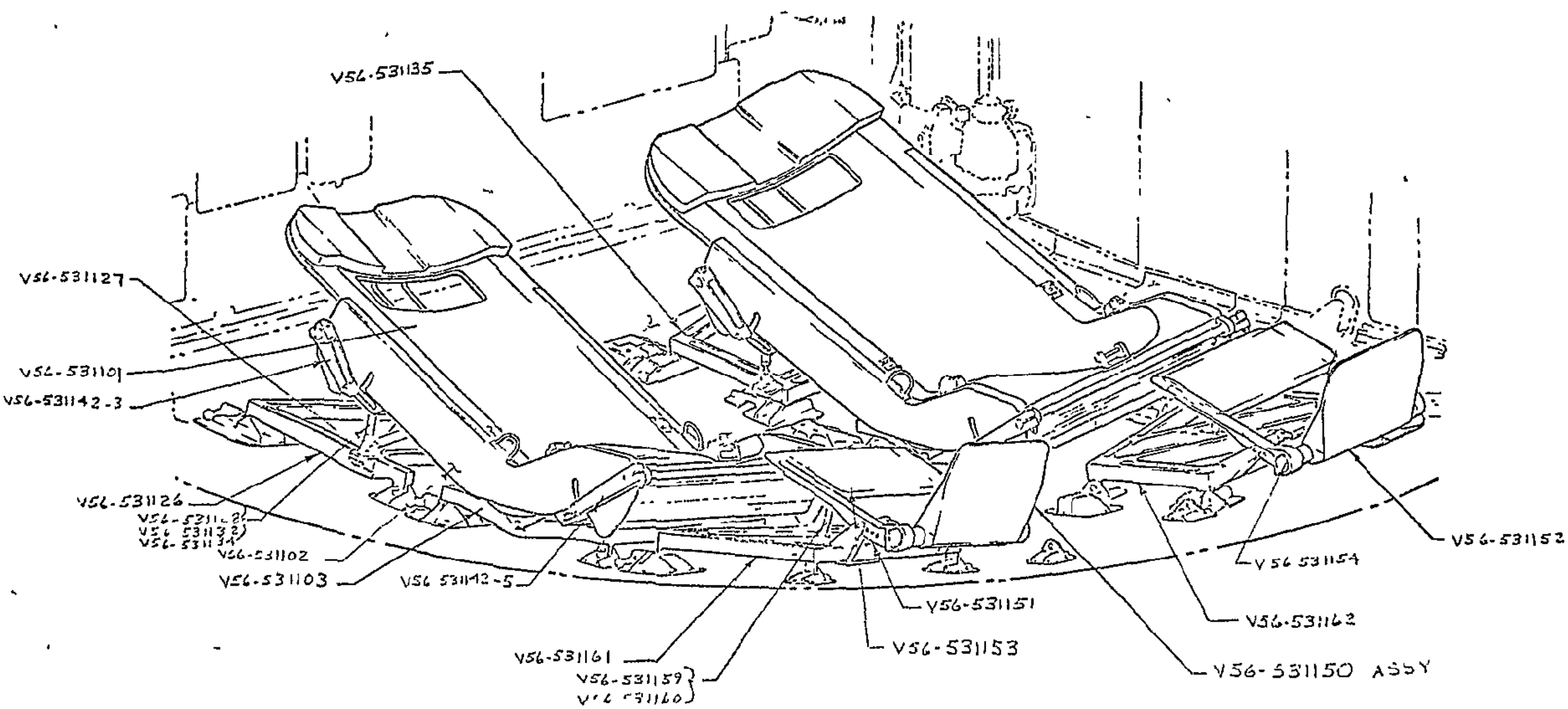
PAGE NO 2 1 3 OF
REPORT NO SD 70-205
MODEL NO SKYLAB

FOREWORD

RESCUE COUCHES

5



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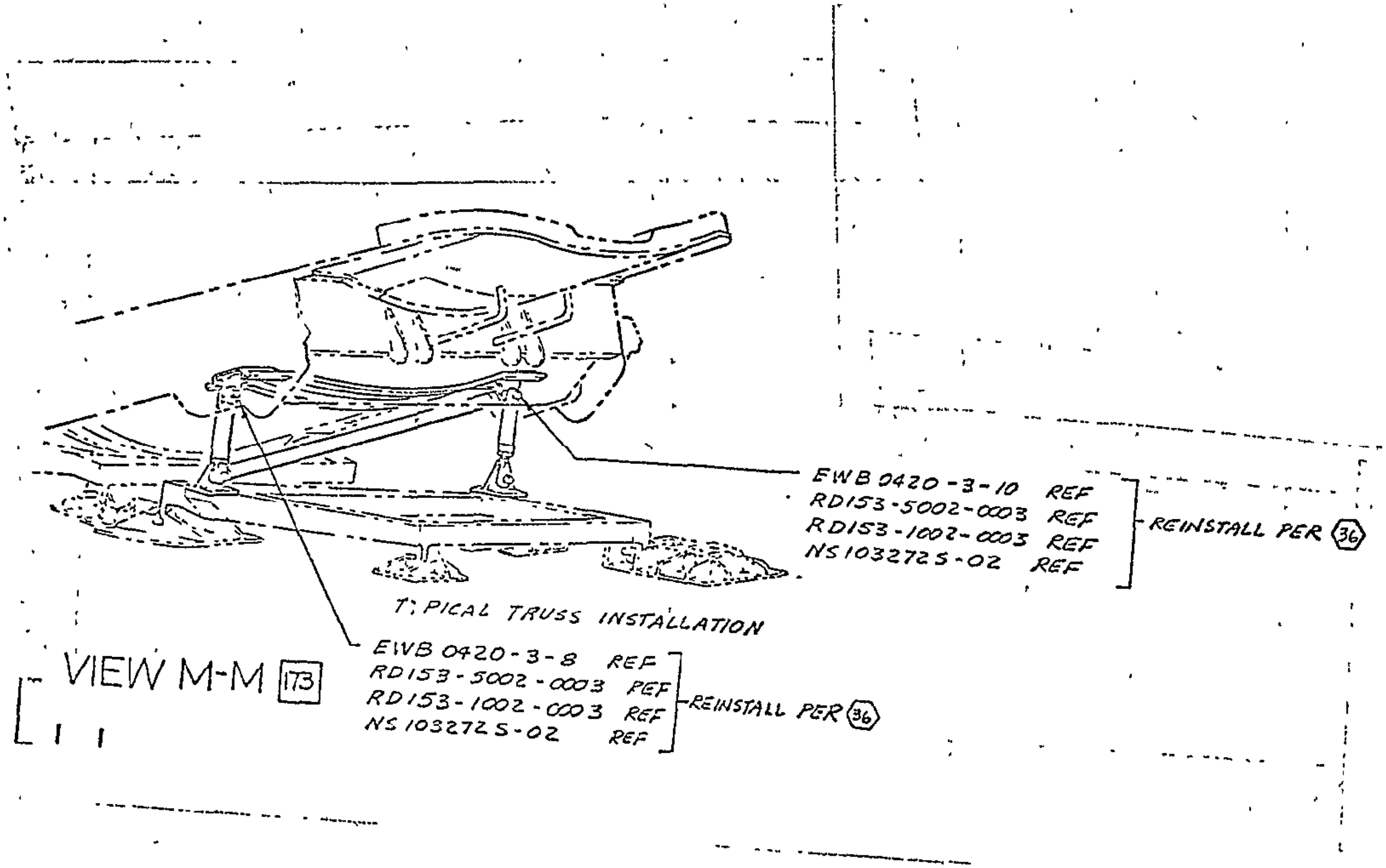
PAGE NO I.1.4 OF
REPORT NO SD 70-205
MODEL NO. SKYLAB

FOREWORD
RESCUE COUCHES



VIEW M-M 173

FORM M131-A REV 11-67

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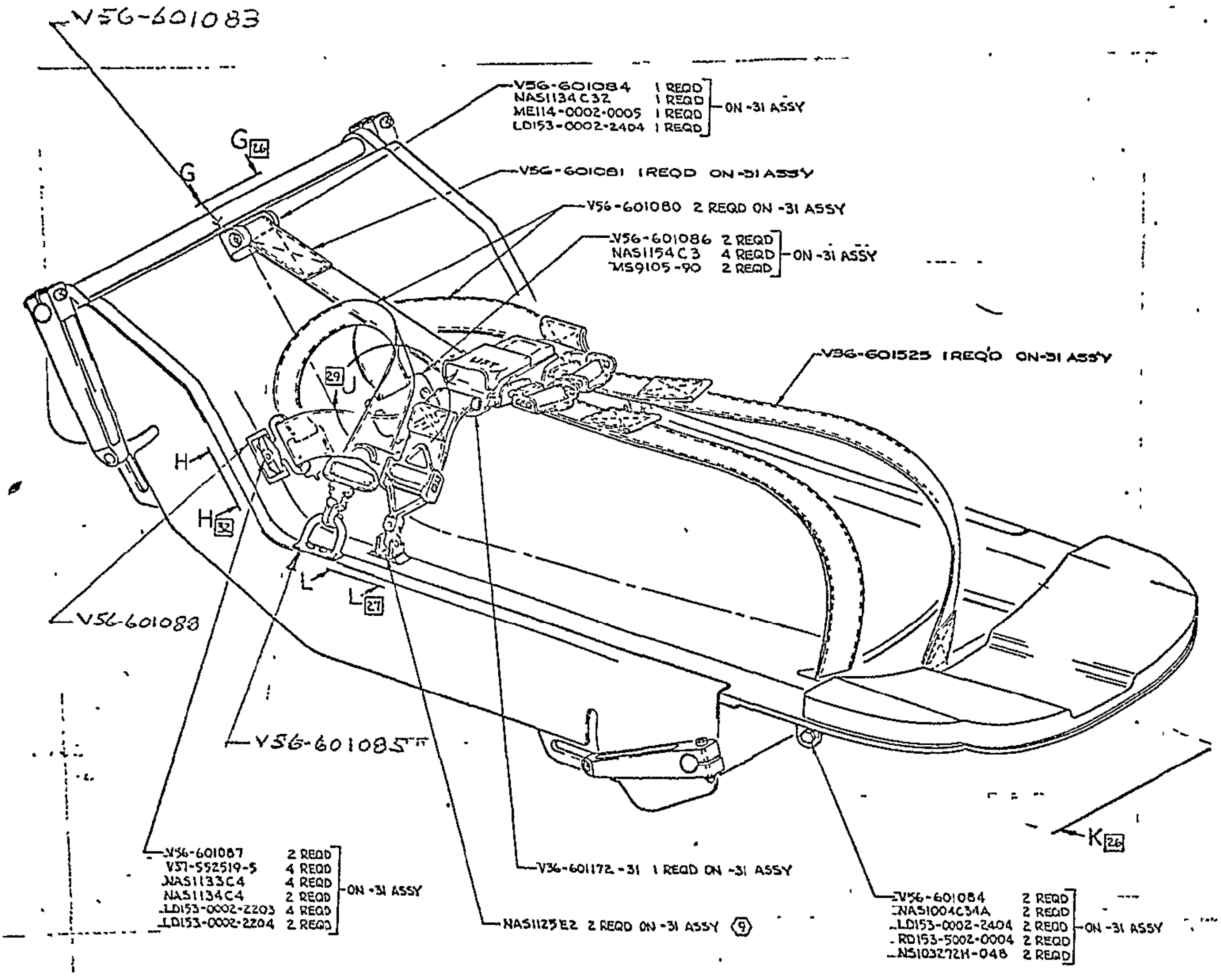
PAGE NO I-1.5 OF
REPORT NO SD 70-205
MODEL NO. SKYLAB

FOREWORD

RESCUE COUCH HARNESS ASSEMBLY



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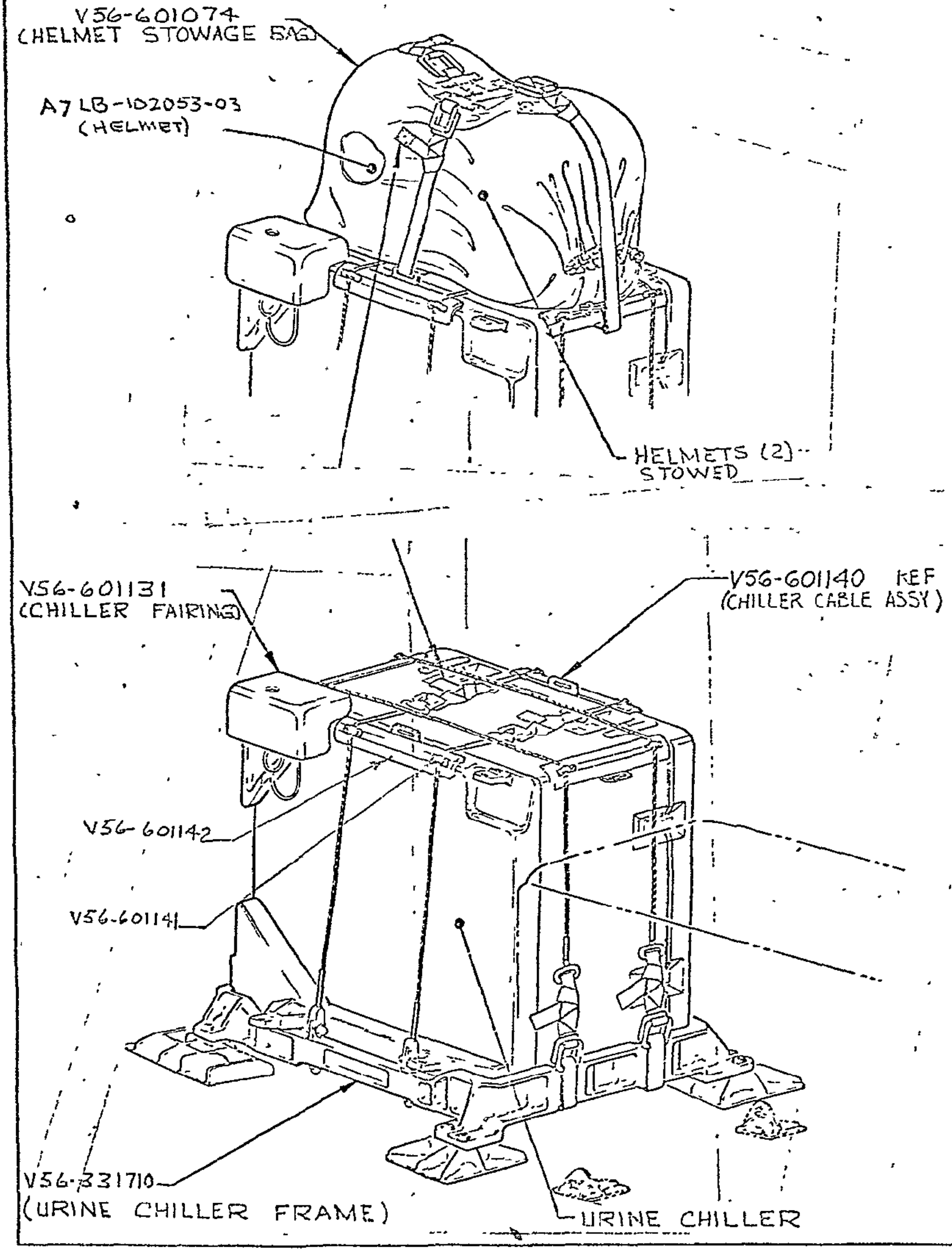
RESCUE MISSION
GENERAL

PAGE NO I.1.6 OF
REPORT NO SD 70-205
MODEL NO SKYLAB

FOREWORD



FORM M82 A REV 11-67

PREPARED BY G F	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 17 OF
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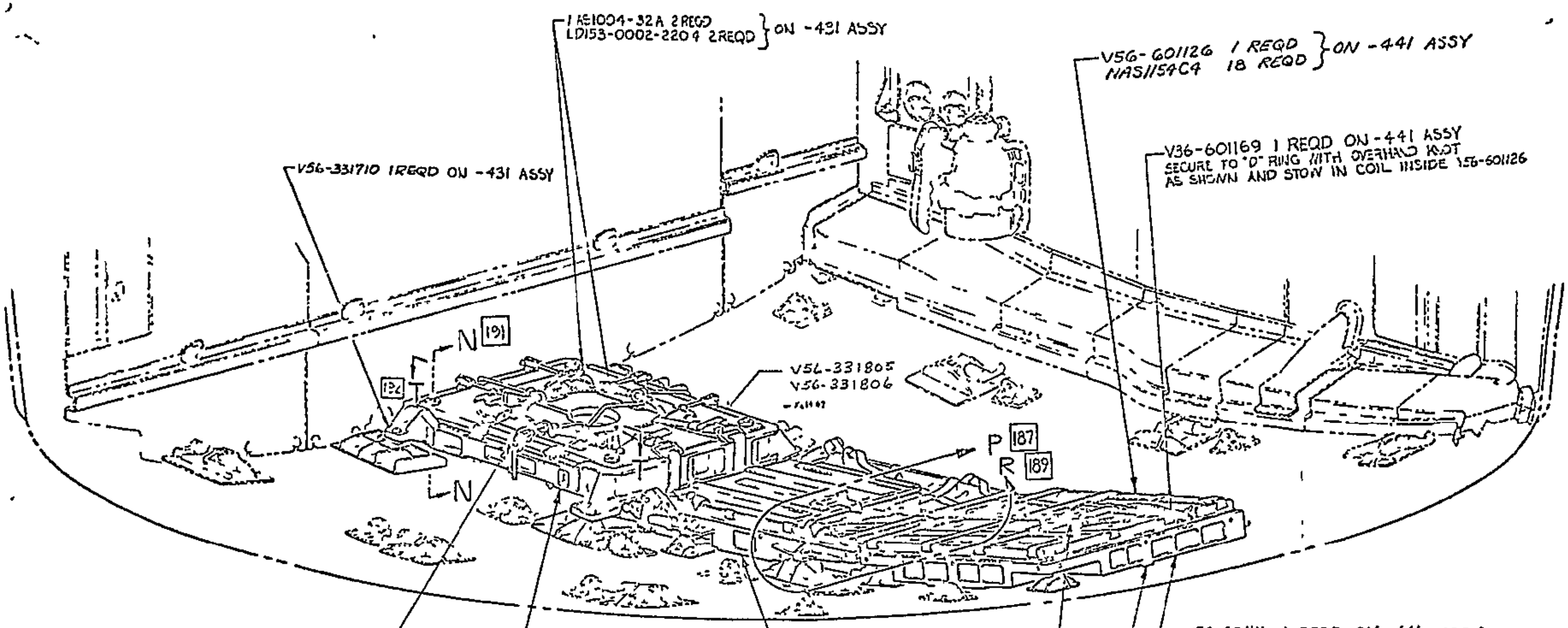
DATE 3/1/73	GENERAL	MODEL NO SKYLAB

FOREWORD

STOWAGE PALLET



1 AE1004-32A 2 REQD
LD153-0002-2204 2 REQD } ON -431 ASSY

V56-601126 1 REQD
NAS1154C4 18 REQD } ON -441 ASSY

V36-601169 1 REQD ON -441 ASSY
SECURE TO "D" RING WITH OVERHAND KNOT
AS SHOWN AND STOW IN COIL INSIDE V56-601126

V56-331710 1 REQD ON -431 ASSY

V56-331805
V56-331806

V56-601111 1 REQD ON -441 ASSY

(-431) 1 REQD

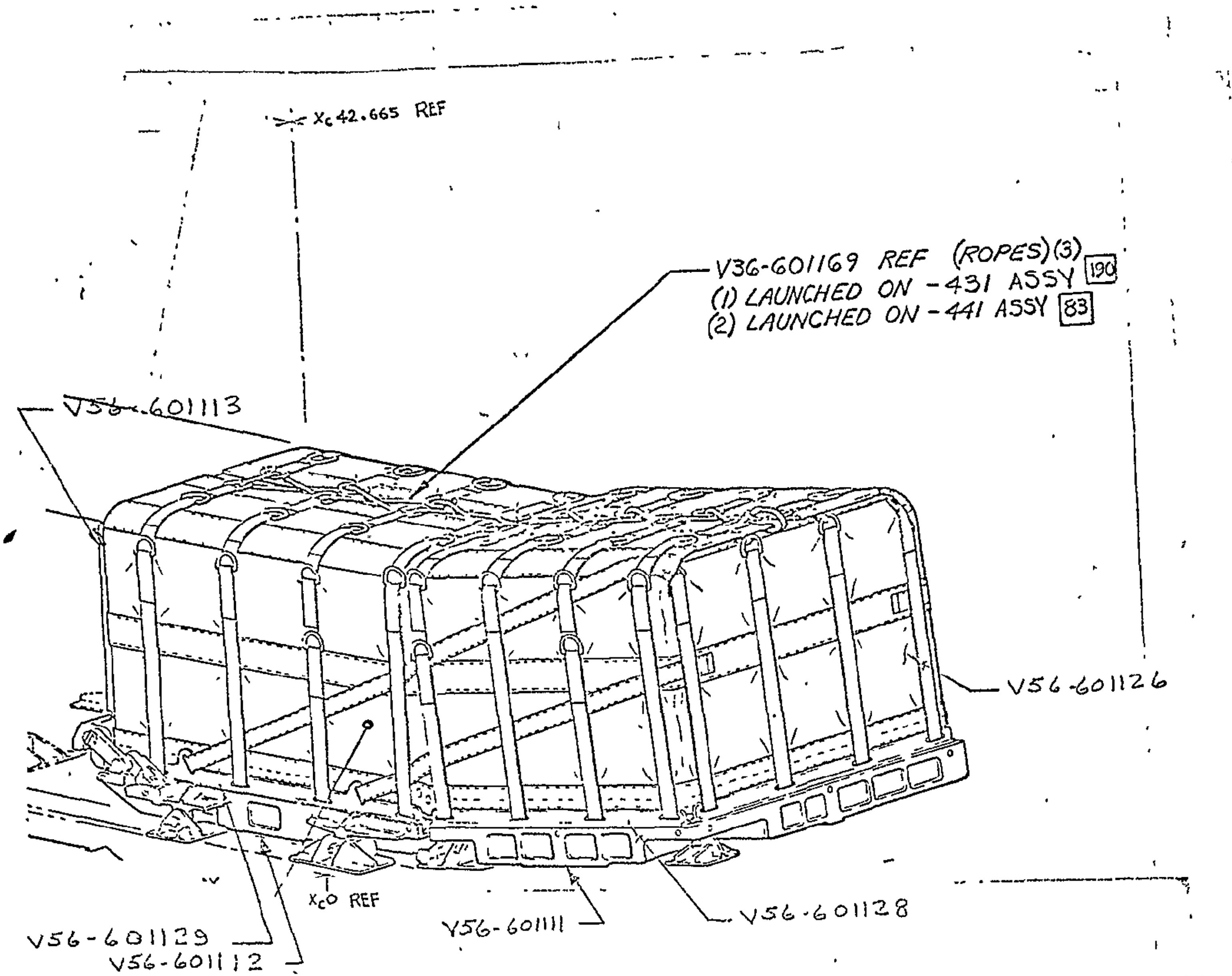
(441) 1 REQD

V56-601110 1 REQD
ON -441 ASSY

V36-601169 1 REQD ON -431 ASSY
USE TO SECURE CABLE IN COIL
TO BALLAST AS SHOWN. TIE
OFF WITH DOUBLE OVERHAND
KNOT.

V36-601169 1 REQD ON -441 ASSY
LACE THRU RINGS ON V56-601126 AS
SHOWN & TIE OFF WITH DOUBLE OVER-
HAND KNOT

FORM M22-A REV 11-67



FOREWORD
STOWAGE PALLET

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PAGE NO. I.18 OF
REPORT NO SD 70-205
MODEL NO SKYLAB

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NORTH AMERICAN ROCKWELL CORPORATION

RESCUE MISSION

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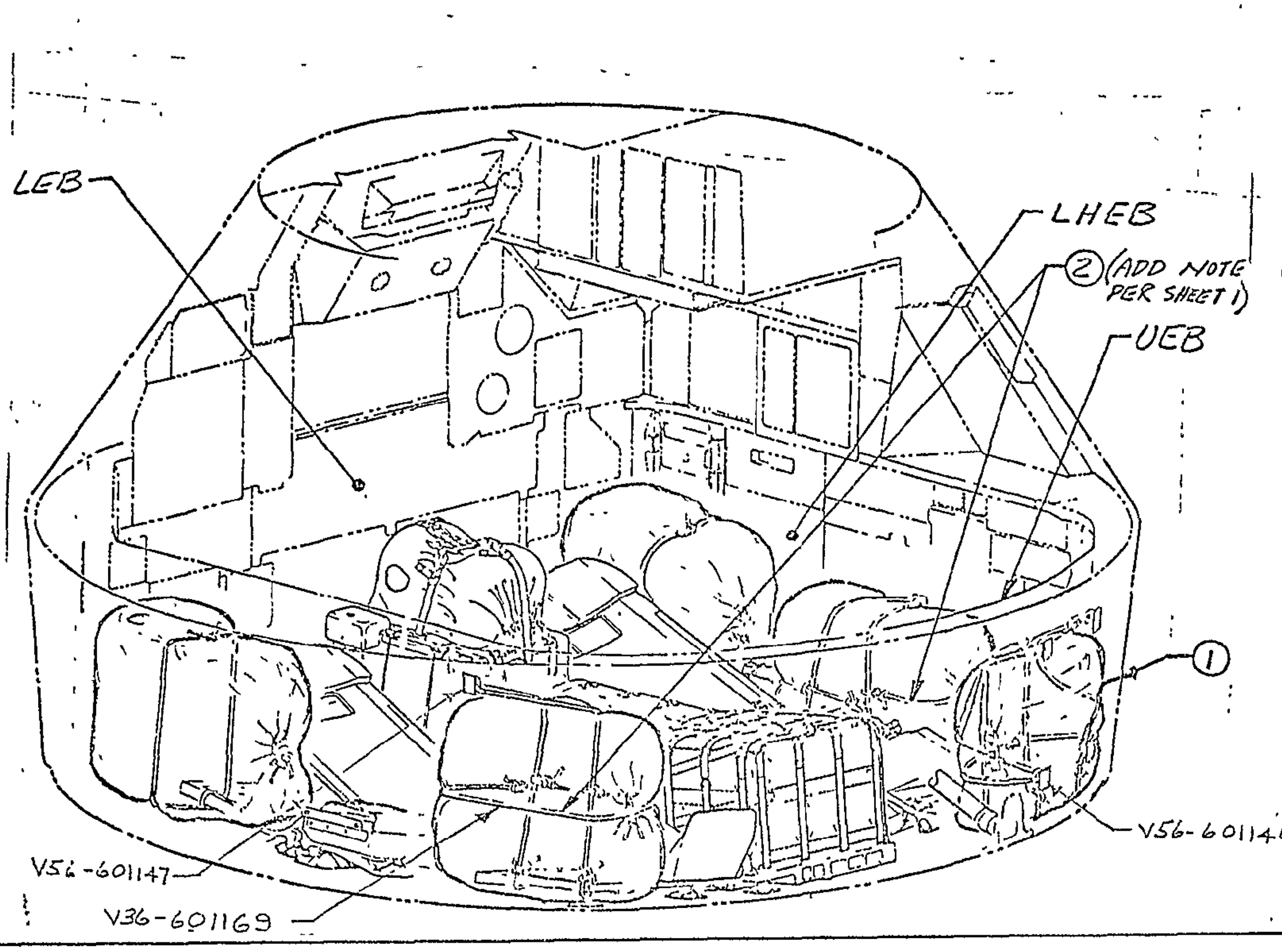
PAGE NO. I.1.9J OF
REPORT NO SD 70-205
MODEL NO. SKYLAB

FOREWORD PGA STOWAGE



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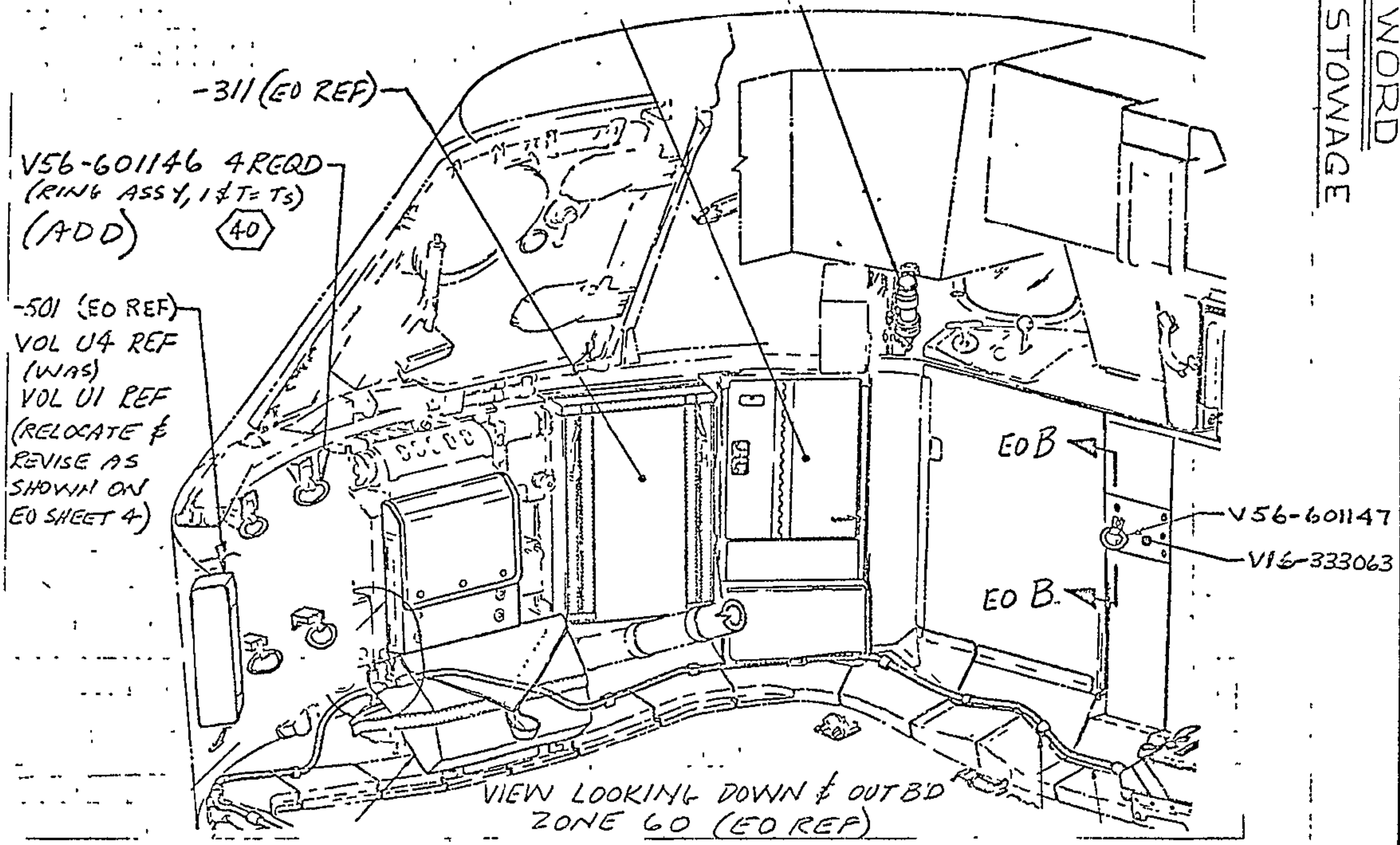
PAGE NO. I.1.10. OF
REPORT NO. SD 70-205
MODEL NO. SKYLAB

FOREWORD

PGA STOWAGE



VIEW LOOKING DOWN & OUTBD
ZONE 60 (EO REF)

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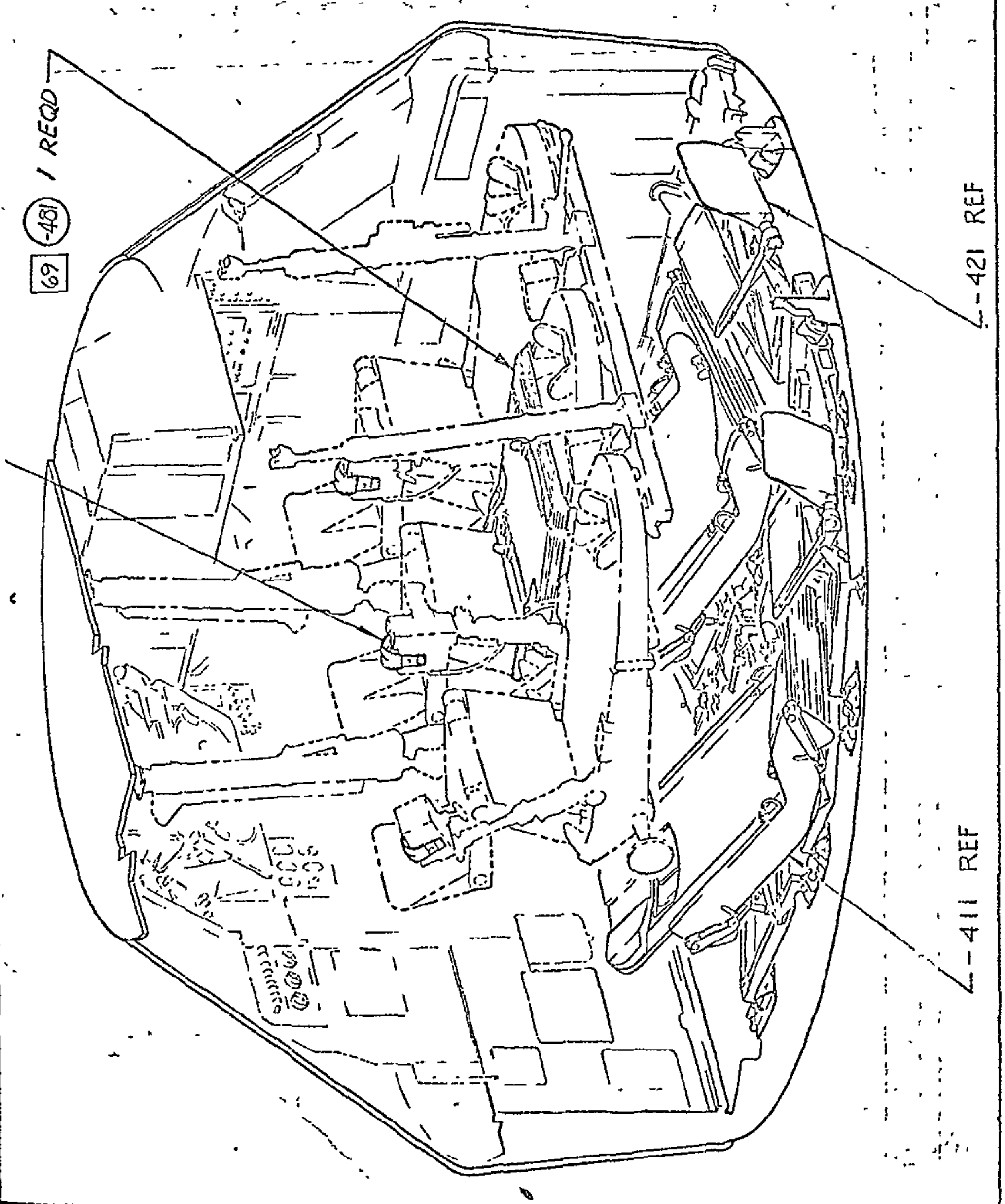
DATE: 3/19/73	GENERAL	MODEL NO. SKYLAB

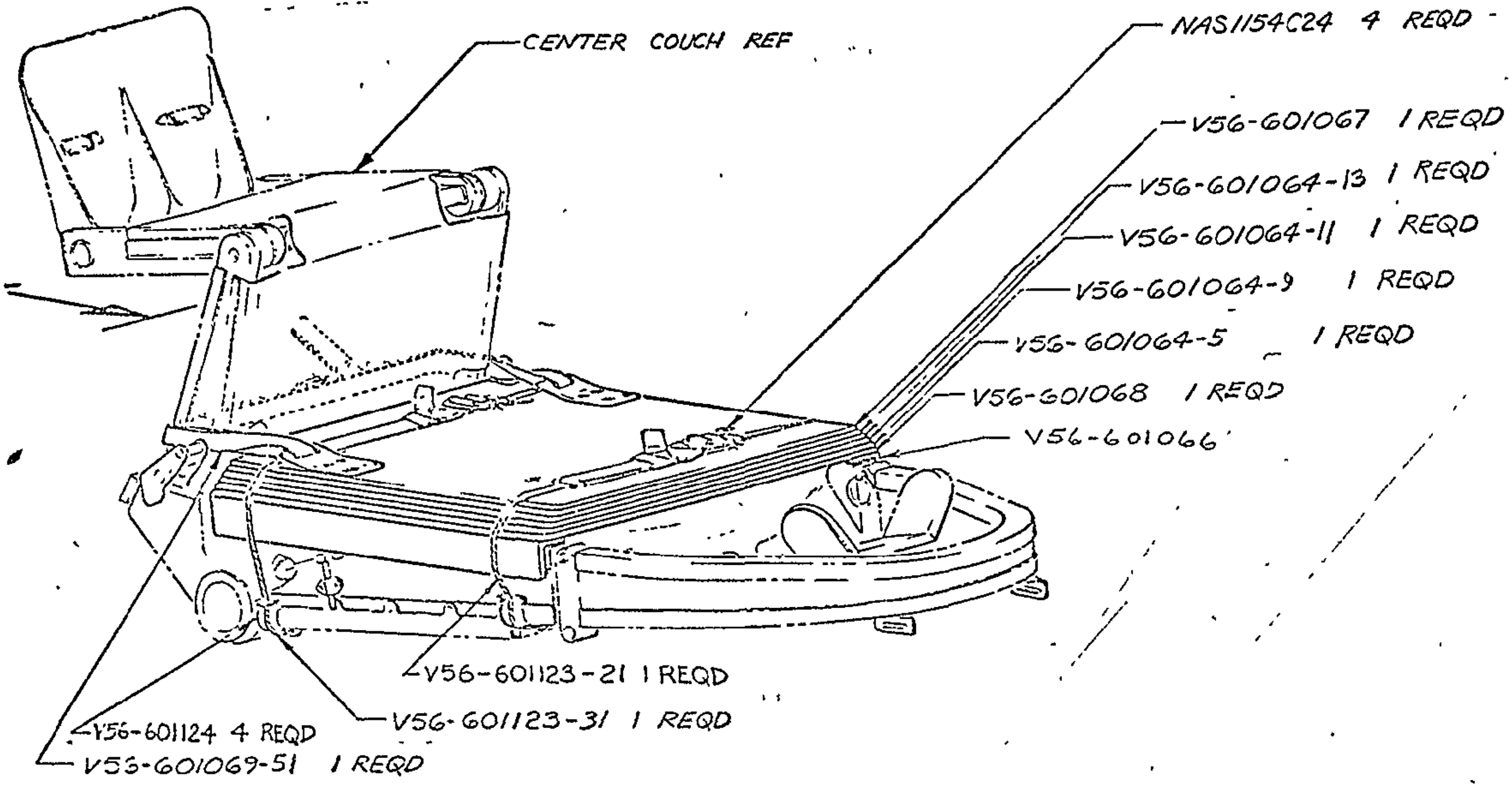
FOREWORD

CREW COUCH BALLAST



FOREWORD

CREW COUCH BALLAST



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RESCUE MISSION

GENERAL

PAGE NO II.1.12- OF
REPORT NO SD 70-205
MODEL NO. SKYLAB

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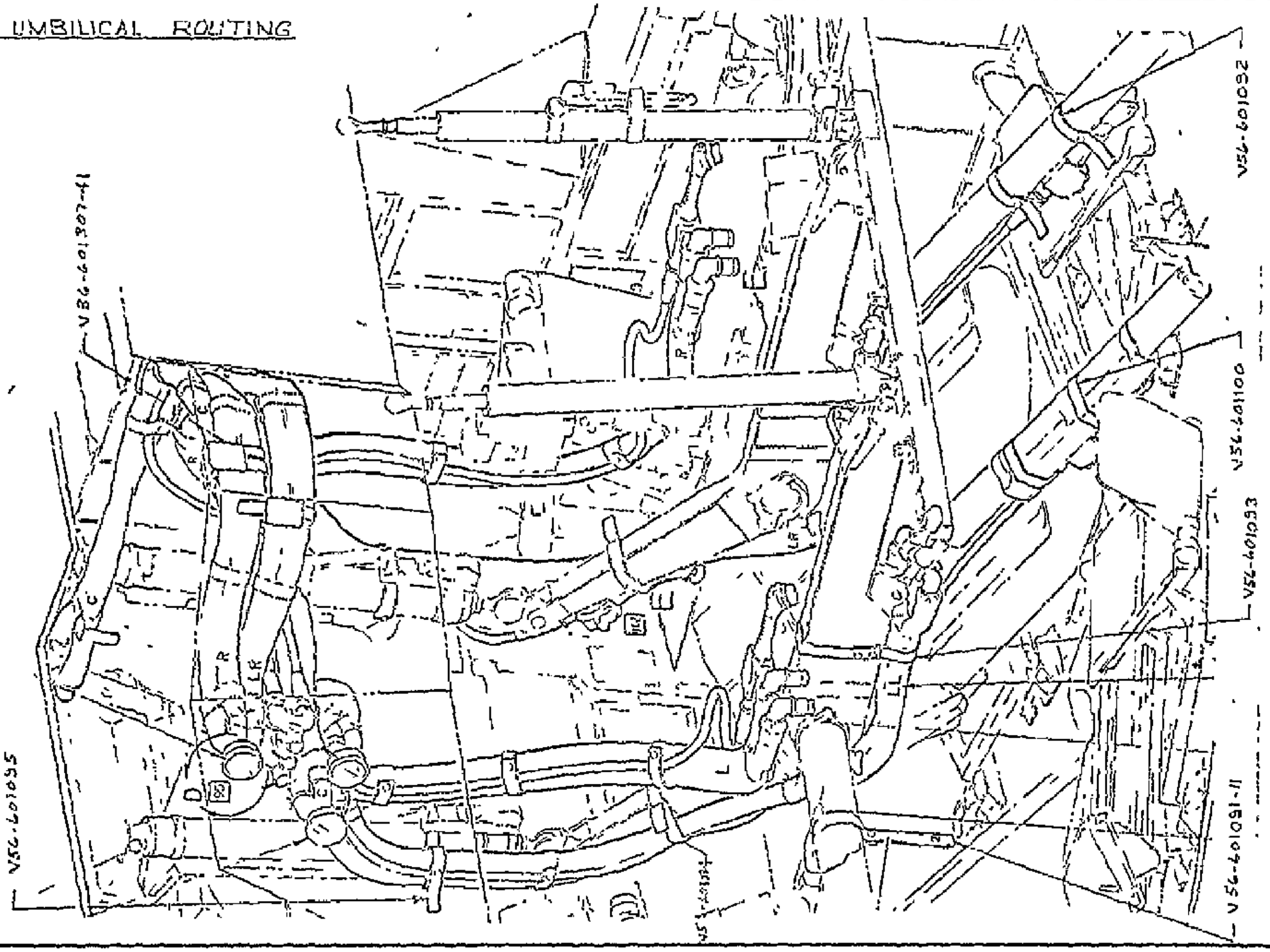
DATE 3/1/73	GENERAL	MODEL NO SKYLAB

FOREWORD

O₂ & CCU UMBILICAL ROUTING



SECTION I.2

LOADS, LAUNCH VEHICLE

LOADS, LAUNCH VEHICLE

Launch vehicle loading for the rescue mission is identical to the loading of the basic Skylab vehicle. A comparison of the basic Skylab vehicle launch loads to CCA 1520 loads was conducted in the SD 70-205 report A restatement of this comparison will not be provided If further information is required, reference to report SD 70-205 is recommended.

SECTION I.3

CRITICAL MARGIN OF SAFETY EVALUATION

CRITICAL MARGINS OF SAFETY EVALUATION

Margins of safety found in the analysis sections of the report, sections II.3 and II.4, are presented in the following tables if they are 0.25 or less. These minimum margins of safety are tabulated alpha numerically

Four negative margins of safety were found in the analysis. Two of the margins were for shear of the aft bulkhead core by bond-on stowage locker brackets. The remaining two margins were for compression yield of parts of the rescue couch back pan support truss.

Water drop testing of a rescue vehicle configured Command Module was conducted in accordance with TR 691008. Results of the test, as presented in report SD 73-CS-0003, verify the structural capability of the four parts in question to sustain water impact loads. Based upon these results, no further analysis is required at this time.

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PAGE NO 132 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

CRITICAL MARGINS OF SAFETY EVALUATION

DRAWING NUMBER	PART NAME	LOAD CONDITION	FAILURE MODE	MARGIN OF SAFETY
F04-100002	BOLT	MAX $q\alpha$	TENSION	.20
V36-317053	CORE	BOEING CRIT	COMPRESSION	07
V36-331205	COVER	WATER IMPACT	CRIPPLING	.14
V36-441361	COVER	WATER IMPACT	BENDING	.11
V56-317537	CORE	BOEING CRIT	CORE SHEAR	00
V56-317538	CORE	" "	" "	-.01
V56-317561	CORE	" "	" "	.09
V56-317564	CORE	" "	" "	-.07
V56-331763	RING	STRAP LOAD	BENDING	.01
V56-331764	RING CLIP	" "	BENDING	.15
V56-531101	BUSHING	BOEING CRIT	BENDING	.00
V56-531102	RIB	ARM-6	BENDING	.12
V56-531102	SUPPORT		BENDING	.24
V56-531104	LUG		BENDING	.00
V56-531111	BACK PAN		TENSION	.21
V56-531111	BACK PAN		PLATE BUCKLING	01
V56-531113	FRAME		BUCKLING	.16
V56-531120	RAIL		BENDING	.22
V56-531124	FRAME		BENDING	.09
V56-531125	BEARING		BEARING	.24
V56-531125	FITTING		BENDING	.06
V56-531126	FRAME		BENDING	15
V56-531126	FRAME		BENDING	.13
V56-531126	LUG		BENDING	.06
V56-531126	LUG		BENDING	.02
V56-531127	FITTING		TENSION	.06
V56-531127	FITTING		BENDING	.10
V56-531128	SUPPORT TRUSS		COMPRESSION	-.29
V56-531131	CLEVIS		SHEAR BEARING	.16
V56-531134	SUPPORT TRUSS		COMPRESSION	-.27
V56-531135	ADAPTER FRAME		BENDING	03
V56-531135	ADAPTER FRAME		BENDING	01
V56-531125	ADAPTER FRAME		BENDING	02
V56-531[illegible]2	STABILIZER ARM	ARM-6	BENDING	.18
V56-531158	CLIP	BOEING CRIT	BENDING	.20
V56-531171	LOCK PIN	BOEING CRIT.	SHEAR	.00
V56-531174	SUPPORT	PERSONNEL	BENDING	.14
V56 575666	PIN	PERSONNEL	SHEAR	.08
V56-601069	STRAP	BOEING CRIT.	TENSION	.13
V56-601069	STRAP	WATER IMPACT	TENSION	.08

18

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REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

CRITICAL MARGINS OF SAFETY EVALUATION

DRAWING NUMBER	PART NAME	LOAD CONDITION	FAILURE MODE	MARGIN OF SAFETY
V56-601076	RETAINER	BOEING CRIT	TENSION	.11
V56-601083	SCREW	ARM-6	SHEAR + TENS	.23
V56-601084	BUSHING	ARM-6	BENDING	.24
V56-601087	UNIVERSAL	ARM-6	SHEAR OUT	.17
V56-601087	UNIVERSAL	ARM-6	BEARING	.22
V56-601087	BOLT AND BUSHING	ARM-6	BENDING	.05
V56-601087	BOLT AND BUSHING	ARM-6	BENDING	.00
V56-601089	FITTING	ARM-6	SHEAR-OUT	.03
V56-601093	STRAP SNAP	RE-ENTRY	SHEAR	.00
V56-601094	STRAP SNAP	RE-ENTRY	SHEAR	.21
V56-601101	SNAP	BOEING CRIT	SHEAR	.10
V56-601111	FRAME FITTING	BOEING CRIT	BENDING	.19
V56-601111	FRAME FITTING	BOEING CRIT.	BENDING	.03
V56-601112	FRAME	BOEING CRIT	SHEAR	.12
V56-601114	HINGE PIN	BOEING CRIT	SHEAR + BEND.	.00
V56-601115	PALLETTE	BOEING CRIT	BENDING	.01
V56-601116	HINGE BRACKET	BOEING CRIT	BENDING	.23
V56-601126	"D" RING	BOEING CRIT	BENDING	.17
V24-880009	CHANNELS	SEPARATION	COMPRESSION	.10
V54-575667	SHAFT	PERSONNEL	BEND + TORSION	.20

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PAGE NO I.4.0 OF
REPORT NO SD 70-205
MODEL NO Skylab

SECTION I.4

DRAWING NUMBER LIST

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RESCUE MISSION
GENERAL

PAGE NO I.4.1 OF
REPORT NO SD 70-205
MODEL NO Skylab

DRAWING NUMBER LIST

The following tables present a concise listing of the numbers of the drawings whose analysis is contained within this report. The tables are organized into a Command Module section and a SLA section. Each drawing number is coded to indicate whether or not the drawing is of a structural or non-structural part.

DRAWING NUMBER LIST

COMMAND MODULE

	0	1	2	3	4	5	6	7	8	9
F04-10000X			●							
2X	▲									
V36-31705X				●						
33120X						●				
57X			●							
44136X		●								
60117X			▲							
29X									▲	▲
52X						●	●	●	●	
61181X									▲	
78802X	●									
V37-55251X										●
V56-00025X	●									
31753X								●		
5X									●	
6X		●			●					
33171X	●		●							
6X				●	●					
80X						●	●			
42010X				▲	▲	▲				
53110X	●	●	●	●	●	●	●			
1X		●	●	●	▲					
2X	●			●	●	●	●	●	●	●
3X	●	●	●	●	●	●				
4X			●		●					
5X	●	●	●	●	●	●		●	●	●
6X	●	●	●							●
7X	●	●	●	●	●					

● STRUCTURAL

▲ NON STRUCTURAL (No ANALYSIS REQUIRED)

DRAWING NUMBER LIST

COMMAND MODULE

	0	1	2	3	4	5	6	7	8	9
V56-57520X							●			
66X					●	●	●	●		
7X	●									
60051X	▲	▲		▲	▲					
60101X				▲						
6X	●				●	●	●	●	●	●
7X					●	●	●		●	●
8X	●	●	●	●	●	●	●	●	●	
9X	●	●	●	●	●	●	●	●	●	●
10X	●	●	●	▲	▲	▲	●	●	●	●
1X	●	●	●	●	●	●	●	●	●	●
2X	▲	●	●	●	●		●	▲	●	●
3X	●	▲	▲	▲	●				●	●
4X	●	▲	●				●	●		▲
5X	▲									
V56-78680X		▲	▲							
88000X					●	●	●	●	▲	

● STRUCTURAL

▲ NON STRUCTURAL (No ANALYSIS REQUIRED)

DRAWING NUMBER LIST

SLA

	0	1	2	3	4	5	6	7	8	9
V24-00800X					▲					
32802X		●	●	●						
4X		●								
6X										●
10X								●		
1X		●		▲						
21X				●					●	
2X	●							●	●	●
3X		●	●	●	●				●	
4X				●						
5X						●				
38X										●
59000X			●							
88000X									●	●
1X	●				●					
8V24-32000X				●						
1X	●	▲				●				
10X								●	●	
1X						▲				
2X	▲			▲						●
3X	●									
32100X			●	●						
10X					●					
32300X			●							
8V58-00800X			●							

● STRUCTURAL

▲ NON-STRUCTURAL (NO ANALYSIS REQUIRED)

DRAWING NUMBER LIST

THE PARTS LISTED BELOW HAVE BEEN UTILIZED ON PREVIOUS MISSIONS AND WERE ANALYZED IN OTHER REPORTS [SD67-1103 AND ADDENDUMS, AND SD70-205]. NO FURTHER ANALYSES WILL BE PERFORMED

V37-552519-5	SPACER
V36-601525	HARNESS ASSY
V36-601526	BUCKLE ASSY
V36-601527	HANDLE
V36-601528	PIN

22

SECTION I.5

REFERENCES

REFERENCES

Contractual Documents

A1 SID 64-1344 CSM Technical Specification, Block II, NAS 9-150.

A2 SID 64-1345 CSM Master End Item Specification, Block II, NAS 9-150.

REFERENCES

Contractor Documents

B1 SID 64-60, Structural Analysis Report - Apollo Spacecraft.

B2 AVSSD-0035-67-CR, (AVCO Thermo Structural Anal) Vol's I, II, II, IV, V, and VI.

B3 RAD-SR-65-153, (AVCO Thermo Structural Anal) Addendum II.

B4 SD 67-1101, Structural Analysis - Preliminary Apollo Block II Spacecraft.

B5 SD 67-1104, External Loads and Criteria Apollo Block II Spacecraft.

B6 SD 67-1105, Internal Loads Apollo Block II Spacecraft.

B7 SD 67-1106, Vibro Acoustic Loads Apollo Block II Spacecraft.

B8 SD 67-1107, Thermal Data Apollo Block II Spacecraft.

B9 SD 67-1103-1, Structural Analysis Apollo Block II Spacecraft.

B10 SD 69-449, Structural Analysis - "J" Mission Spacecraft

B11 SD69-450, External Loads and Criteria - "J" Missions Spacecraft

B12 SD69-451, Structural Models and Internal Loads - "J" Missions Spacecraft

B13 SD69-452, Sub-system Vibration Design Loads - "J" Missions Spacecraft

B14 SD69-453, Vehicle Transient Dynamic Loads - "J" Missions Spacecraft

B15 SD69-454, Thermal Data - "J" Missions Spacecraft.

REFERENCES

B16 Purposely left blank

B17 SD70-206 External Loads and Criteria - Skylab Spacecraft.

B18 SD70-207 Structural Models and Internal Loads - Skylab Spacecraft.

B19 SD70-208 Sub-system Vibration Design Loads - Skylab Spacecraft

B20 SD70-209 Vehicle Transient Dynamic Loads - Skylab Spacecraft

B21 SD69-644A Apollo Applications Program - CSM Thermal Environment Verification Requirements.

REFERENCES

Government Documents

C1 Mil Handbook 5A, Metallic Materials and Elements for Aerospace Vehicle Structure.

C2 Mil Handbook 17, Plastics for Flight Vehicles.

C3 Mil Handbook 23, Composite Construction for Flight Vehicles.

C4 NACA TN 3544, Comparison between Theoretical and Experimental Stresses in Circular Semi-Monocoque Cylinders with Rectangular Cutouts.

C5 NACA TN 929, Analysis of Circular Shell - Supported Frames.

C6 NACA TN 2661, A Summary of Diagonal Tension.

C7 WADC TDR 56-645, Properties of Glasses at Elevated Temperatures.

C8 National Bureau of Standards Handbook No. 28, Screw-Thread Standards for Federal Services, 1957.

C9 Mil Spec QQ-W-423, Wire, Steel, Corrosion-Resisting.

C10 Mil STD 29A (1962), Springs, Mechanical, Drawing Requirements.

C11 AMS 5673, Steel Wire Corrosion Resistant 17Cr-7Ni-1Al Precipitation Hardening-Spring Temper.

C12 Mil-S-6721, Steel, Corrosion and Heat Resistant (Chemical Stabilized) Plate, Sheet, and Strip.

C13 Not Used

C14 WADD-TR-60-517, Thermo-Structural Analysis Manual, August 1962.

C15 MSFC-252, NASA Astronautic Structures Manual.

C16 Mil-C-5040C, Cord Nylon.

24

REFERENCES

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D28 MC 464-0015, Apollo Spacecraft, Fuel Cell, Electrical Powerplant.

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27

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SECTION II

STRUCTURAL ANALYSIS

32

SECTION II 1

INTRODUCTION

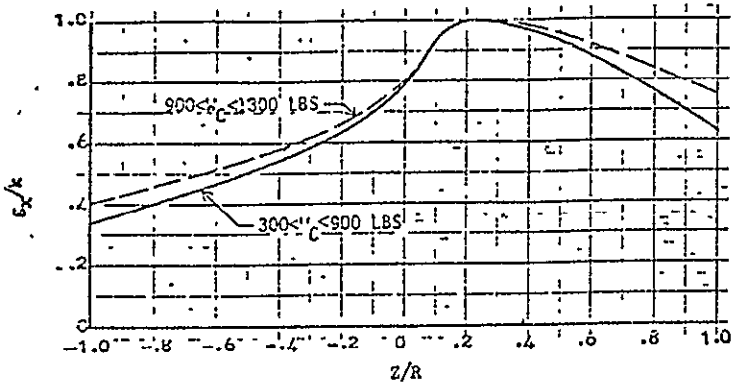
INTRODUCTION

Structural internal loads on the Skylab rescue hardware are developed in section II.2. Analyses of the detailed parts are filed alpha-numerically in sections II.3 and II.4 for the Command Module and SLA, respectively.

Acceleration criteria utilized for equipment stored on the aft bulkhead of the Command Module was taken from MCR A12168 which established the use of the "Boeing Criteria" as presented in Boeing STAM 70-1, Load Criteria for Structural Evaluation of Command Module Aft Bulkhead Stowage, April 22, 1970. An excerpt from this MCR is presented on the following page. Unless otherwise stated, the acceleration factors from SD 67-1106-2A, page 11-4, are utilized for all structure not mounted on the Command Module aft bulkhead. These acceleration factors are tabulated on page II.1.2.

The table on page II.1 3 lists the major structural assemblies examined within this analysis and their top drawing numbers.

INTRODUCTION



g_x = Positive longitudinal acceleration

g_{x-} = Negative longitudinal acceleration

$$k = g_{x_{MAX}}\left[1 - \frac{Y^2}{2.5(R^2 + Z^2)}\right] \quad \text{for 300 lbs} < W_C < \text{900 lbs}$$

$$k = g_{x_{MAX}}\left[1 - \frac{Y^2}{14.3(R^2 + Z^2)}\right] \quad \text{for 900 lbs} < W_C < \text{1300 lbs}$$

$$g_{x_{MAX}} = 149f$$

$$f = \left(\frac{206}{206 + W_C}\right)^{\frac{1}{2}}$$

W_C = Weight of all components attached to bulkhead

R = 56 5 inches

$$g_{x-} = \frac{2}{3}\left(\frac{Z}{R} + 1\right)\frac{k}{g_{xMAX}}\,g_x \quad \text{for } -1.0 < \frac{Z}{R} < +.5$$

$$g_{x-} = 2\left(1 - \frac{Z}{R}\right)\frac{k}{g_{x_{MAX}}}\,g_x \quad \text{for } +.5 < \frac{Z}{R} < +1.0$$

and,

$$g_x \text{ not less than } \begin{cases} 45 \text{ for } +Z \\ 24 \text{ for } -Z \end{cases}$$

g_{x-} not less than 7

$g_y = \pm 0.125\ g_x$, $g_z = \pm 0.25\ g_x$

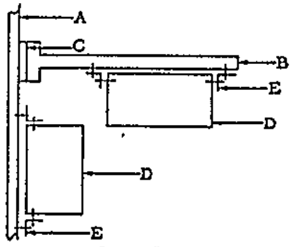
All combinations of positive and negative accelerations shall be considered. An ultimate factor of safety of 1.0 shall be used with these criteria.

FIGURE 91A. LOAD CRITERIA FOR STRUCTURAL EVALUATION OF COMMAND MODULE AFT BULKHEAD STOWAGE

INTRODUCTION

Table 11-1. Command Module Structural Load Criteria for Water Landings

	Design Loads (Ultimate) in Command Module Axes		
	X	Y	Z
Components, operating during or after impact (Notes D and E)	±78 g	±30 g	±35 g
Components, nonoperating during or after impact (Notes D and E)	±35 g	±15 g	±25 g
Secondary structure, all except aft equipment compartment	+35 -5 g	±15 g	-25 g +5 g
Aft equipment compartment (Notes B and C)	+45 -5 g	±15 g	-25 g +5 g
Inner structure, such as pressure hull, all except aft sidewall	+35 -5 g	±15 g	-25 g +5 g
Aft sidewall (Note A)	+45 -5 g	±15 g	-25 g +5 g



Notes

- A - Primary structure such as pressure hull
- B - Secondary structure such as equipment bays and bracketry
- C - Attachments such as bonding, between large subassemblies (equipment bays) and A
- D - Individual components
- E - Fasteners attaching D to A or B

INTRODUCTION

STRUCTURE	DRAWING NUMBER
Rescue Couch	V56-880004
Rescue Couch Restraint System	V56-531100
Urine Chiller Adapter Frame	V56-331710
Urine Chiller Adapt. Frame Restraint	V56-601140
Stowage Pallet	V56-601110
Stowage Pallet Container	V56-601126
PCA Stowage	V56-601146
Rescue Drogue	V56-575206
Ballast, Crew Couch	V56-601068
Restraint, Crew Couch Ballast	V56-601069
Aft Bulkhead Fittings	V56-317558
SLA	V24-880014

SECTION II 2

STRUCTURAL LOADS, INTERNAL

SECTION II.2.1

RESCUE COUCH

RESCUE COUCH

Two rescue couches, mounted on the aft bulkhead, are used in conjunction with the center crew couch to provide the capability of effecting a rescue. The rescue couches consist of a back pan assembly, leg support assembly, back pan support frames, leg support assembly frame, and strap restraint system.

The support frames are located in the A1, A3, A4, A6, A7, and A9 locker locations. Locker fittings are utilized to secure the frames to the aft bulkhead. Back pan support frames are in the A4, A7, and A6, A9 locker locations. Leg support assembly frames are in the A1 and A3 locker positions.

Loads on the rescue couch back pan were developed through the use of two ASKA computer programs. One program was based on a model of the complete couch back pan. The second utilized a model of half of the back pan. Due to the sizes of the programs' outputs, they will not be included in this report. The structural models are included. The program output is available within the Apollo stress group if required.

Loads development of the back pan support frames and the strap restraint system are presented in this section. The loads for the leg support system, including the support frame, are developed within the II.3 analysis section on the pertinent drawings.

Load factors applicable to the leg support system are developed using "Boeing" criteria. The load factors used for the back pan frame adapter loading are "Boeing" criteria acceleration factors.

PREPARED BY: G.F.
CHECKED BY: R.G.R.
DATE: 4-18-73

SPACE DIVISION
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COMMAND MODULE

PAGE NO II.2.1.2 OF
REPORT NO SD 70-205
MODEL NO Skylab

Acceleration factors for the man-back pan loading are taken essentially from ARM-6. Some modifications were made, however, as shown on the chart on page II.2.1.4.

A computer program was used in the analysis of the adapter frame in the A4 locker location. Its inputs are presented in this section.

Portions of the computer output from the rescue couch back pan programs and the A-4 adapter frame program are presented in the analysis section of this report, section II.3. The data are presented as part of the analysis of appropriate structural parts.

PREPARED BY: HO
CHECKED BY: GD
DATE: 10-1-71

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RESCUE MISSION

COMMAND MODULE

PAGE NO II.2.1.3 OF
REPORT NO SD 70-205
MODEL NO SKYLA.
DWG NO.

REF

WT GROUP

RESCUE COUCH

MAN WEIGHTS

NINTY PERCENTILE MAN

TOTAL WT = 251 LBS.

BODY PART	WT	
FH (HEAD)	17.2	215.3# (BACK PAN)
FC (CHEST)	112.4	
FA (ABDOMIN)	11.6	
FB (BUTTOCKS)	23.1	
FT (THIGHS)	54.0	
FL (LEGS)	24.1	32.6 (LEG SUPPORT)
FF (FEET)	8.5	

PREPARED BY
CHECKED BY: G.F
DATE 7-20-72
REF

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO II.2.1.4 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG. NO.

RESCUE COUCH
LOAD FACTORS

	* CREW SYSTEM		** RESCUE COUCH DESIGN ULT.	*** PREDICTED
	NOMINAL LIMIT	EMERGENCY LIMIT		
EYE BALLS IN	20	40	40	16.2
" OUT	20	30	30	--
" UP	15	20	22.5	--
" DOWN	15	25	22.5	6.2
" LEFT & RIGHT	10	20	12.75	--

REFERENCES

* ARM-6 : VALUES ARE COMBINED WITHIN MODIFIED SPHERE

** VERBAL AGREEMENT WITH G. SANDAICS
VALUES ARE COMBINED WITHIN AN ELLIPTIC WEDGE

*** I.L. 191-406-72-036
WEST TO LUSK

PREPARED BY:
CHECKED BY: G F
DATE 11-3-71
REF

SPACE DIVISION
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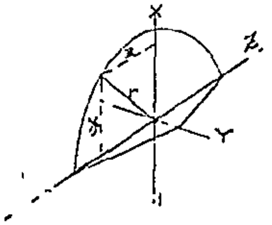
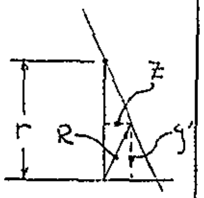
RESCUE MISSION
COMMAND MODULE

PAGE NO II 2 1.5 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

RESCUE COUCH

ACCELERATION FACTOR ENVELOPE





(+)

EBI, EBD, & EBL

$z = (-3.1605X^2 + 1600)^{\frac{1}{2}}$

$r^2 = z^2 + y^2$

$= -3.1605X^2 + 1600 + y^2$

$r = (-2.1605X^2 + 1600)^{\frac{1}{2}}$

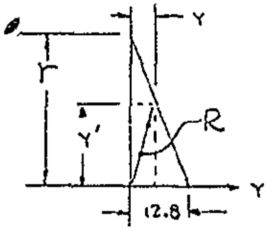
(−)

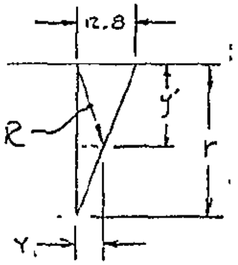
EDO, EBD, EBL

$z = (-1.7778X^2 + 900)^{\frac{1}{2}}$

$r = (-.7778X^2 + 900)^{\frac{1}{2}}$

38





$Y' = mY + b$

$= -\frac{r}{12.8}Y + r$

$Y' = r\left(-\frac{Y}{12.8} + 1\right)$

$y' = mY + b$

$= \frac{r}{12.8}Y - r$

$y' = r\left(\frac{Y}{12.8} - 1\right)$

PREPARED BY:
CHECKED BY: G F
DATE: 12 NOV 71
REF

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

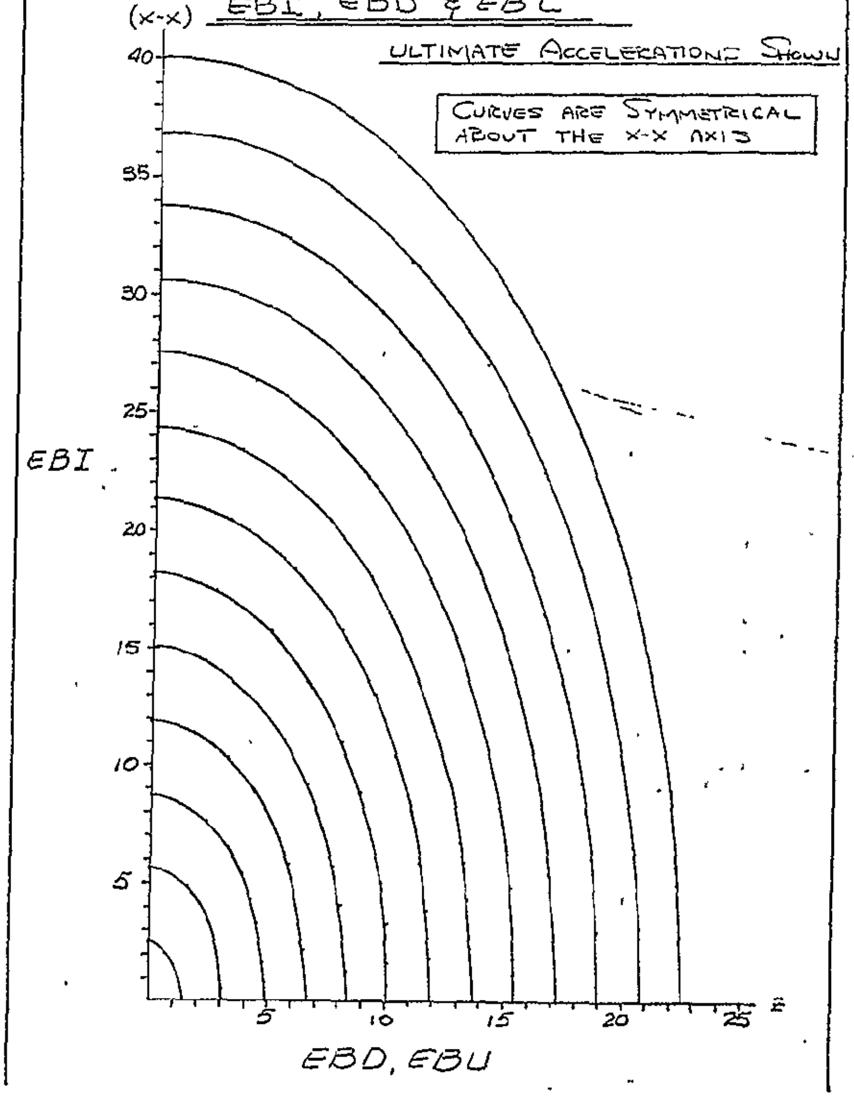
PAGE NO II 2 1.5 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

RESCUE COUCH

EBI, EBD & EBL

ULTIMATE ACCELERATIONS SHOWN

CURVES ARE SYMMETRICAL ABOUT THE X-X AXIS

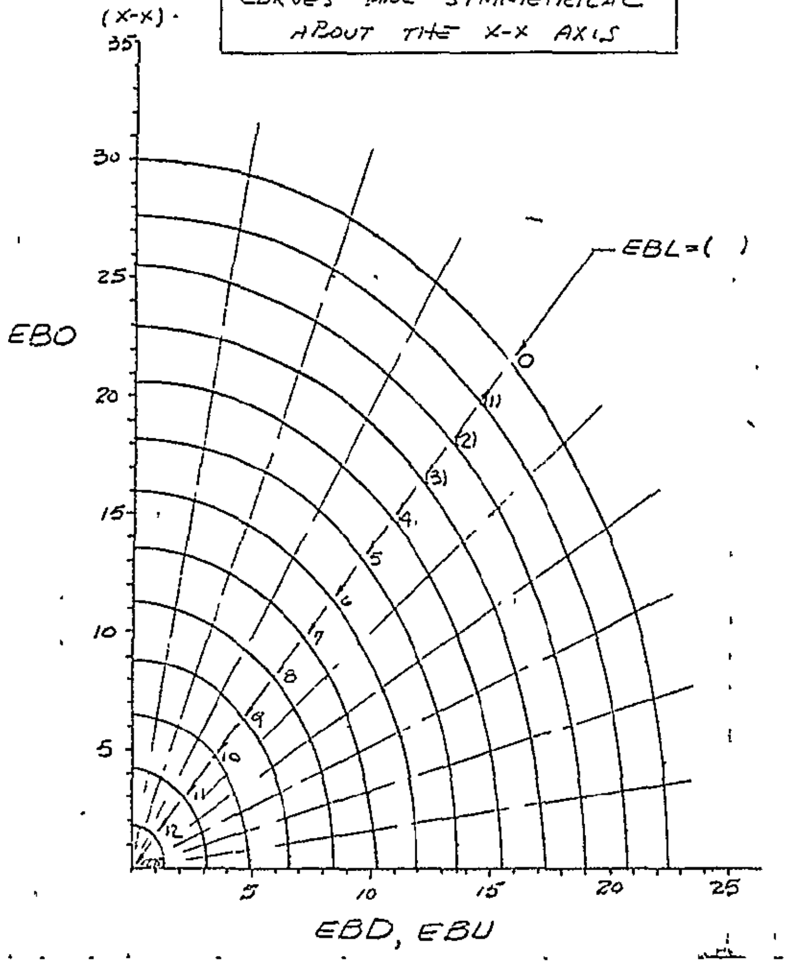


RESCUE COUCH

EBO, EBD & EBL

ULTIMATE ACCELERATIONS SHOWN

CURVES ARE SYMMETRICAL ABOUT THE X-X AXIS



RESCUE COUCH

FOOT RESTRAINT LOADS

BOEING CRITERIA

TWO CASES

CASE I $W_c = 900\text{ lb.}$

$Z = -32$
$Y = \pm 22$ $\Big\}$ $Z/R = \frac{-32}{56.5} = -.566$

CASE II $W_c = 1300\text{ lb.}$

$Z = -32$
$Y = \pm 22$ $\Big\}$ $Z/R = \frac{-32}{56.5} = -.566$

$$f_1 = \left(\frac{206}{206 + W_c}\right)^{1/2} = .432$$

$$f_2 = \left(\frac{206}{206 + W_c}\right)^{1/2} = .370$$

$$gx_{MAX_1} = f_1\, 149 = 64.37$$

$$gx_{MAX_2} = f_2\, 149 = 55.13$$

$$K_1 = g_{x_{MAX_1}}\Big[1 - \overset{.99197}{\frac{Y^2}{14.3(R^2+Z^2)}}\Big] = 63.85$$

$$K_2 = g_{x_{MAX_2}}\Big[1 - \frac{Y^2}{14.3(R^2+Z^2)}\Big] = 54.69$$

FROM CURVE

$gx/k = .53$

PREPARED BY: GAD
CHECKED BY: G.F
DATE: NOV.30,71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 2.1.9 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

FOOT RESTRAINT LOADS

BOEING CRITERIA

$$g_{x_1} = .53\left(63.85\right) = 33.84$$

$$g_{x_2} = .53\left(54.69\right) = 28.98$$

$$g_{x-1} = \frac{2}{3}\left(-.566+1\right)\frac{63.85}{64.37}\,33.84 = 9.71$$

$$g_{x-2} = \frac{2}{3}\left(-.566+1\right)\frac{54.69}{55.13}\,28.98 = 8.32$$

$$g_{Y_1} = \pm.125\left(33.84\right) = \pm 4.23$$

$$g_{Y_2} = \pm.125\left(28.98\right) = \pm 3.62$$

$$g_{Z_1} = \pm.25\left(33.84\right) = \pm 8.46$$

$$g_{Z_2} = \pm.25\left(28.98\right) = \pm 7.24$$

LOADS SUMMARY –

CASE	W_C	g_{x-}	g_x	g_Y	g_Z
I	900	33.84	9.71	±4.23	±8.46
II	1300	28.98	8.32	±3.62	±7.24

PREPARED BY: HG
CHECKED BY: G.F
DATE: 11-8-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
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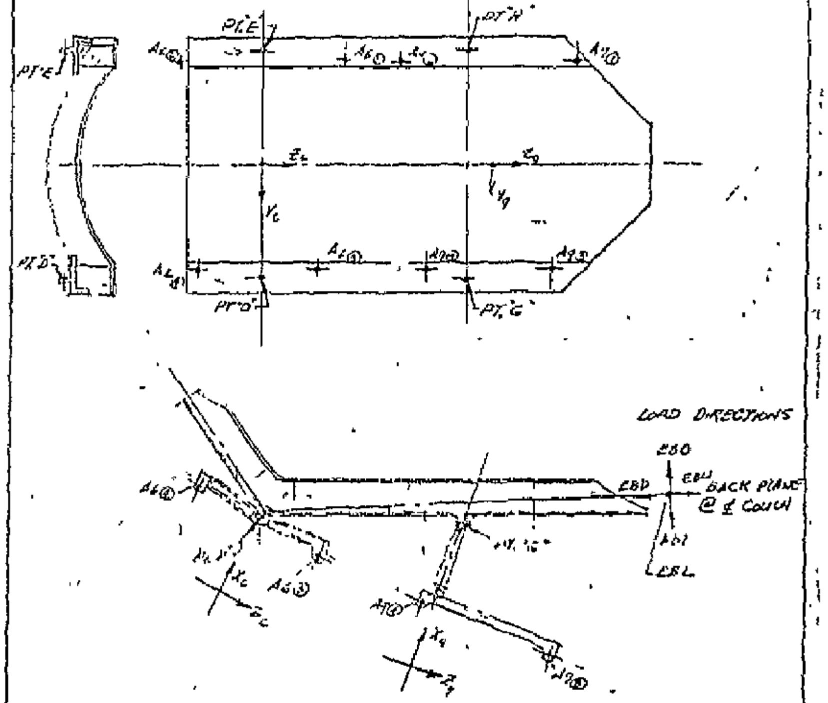
COMMAND MODULE

PAGE NO II.2 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO.

REF

RESCUE COUCH

BACK PAN



PREPARED BY: H.O.
CHECKED BY: G.F.
DATE: 10-28-71

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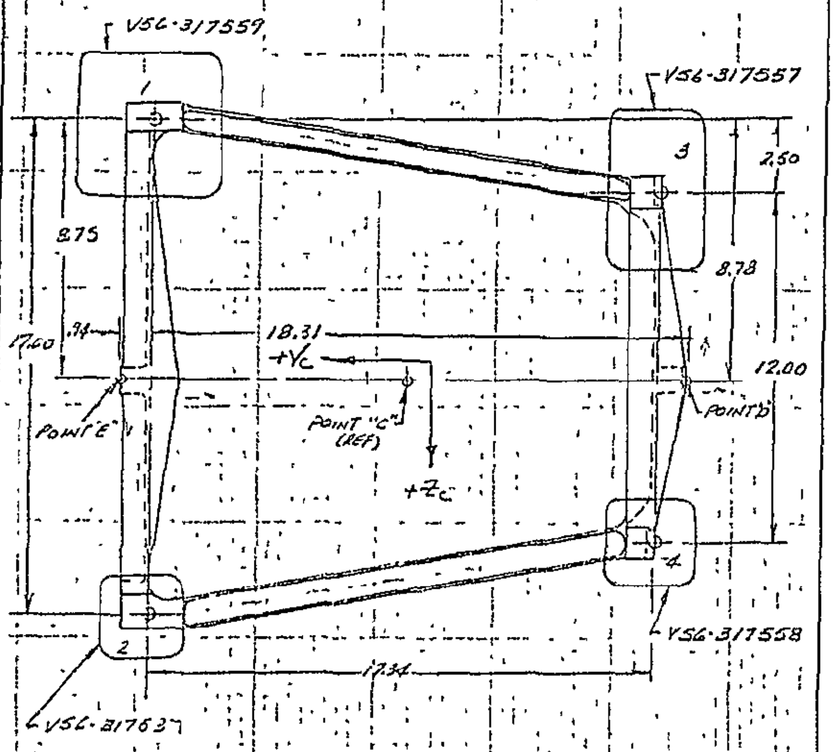
COMMAND MODULE

REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

RESCUE COUCH

BACK REST SUPPORT FRAME
BOND-ONS – A-4 COMPLEX



FITTING NO. 1 X, Y & Z LOADING
" " 2 X "
" " 3 X & Z "
" " 4 X "

PREPARED BY: H.O.
CHECKED BY: G.F.
DATE: 10-28-71

SPACE DIVISION
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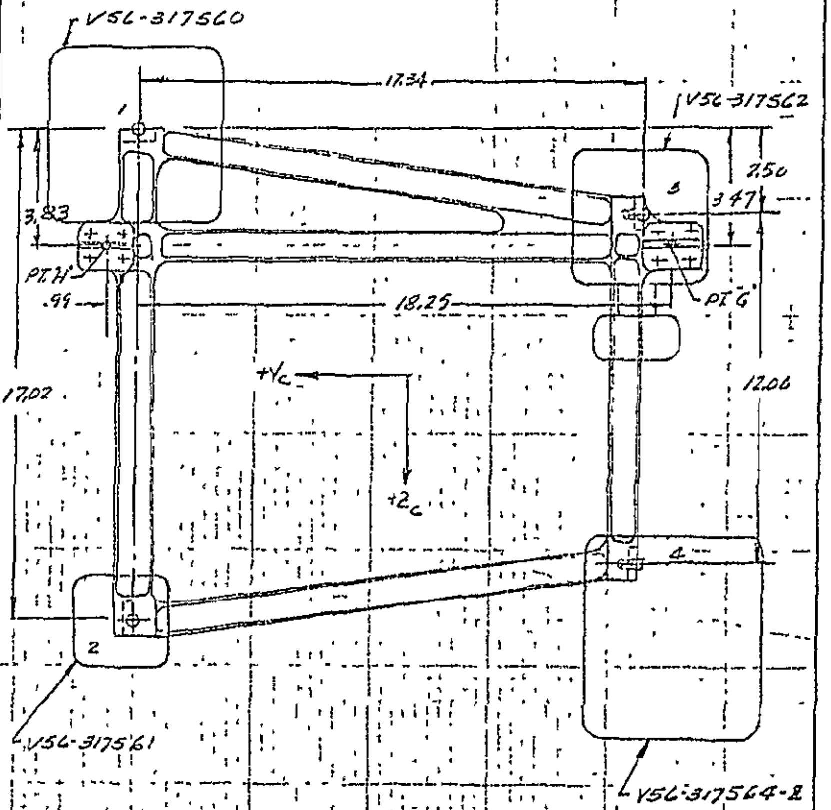
RESCUE MISSION
COMMAND MODULE

REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

RESCUE COUCH

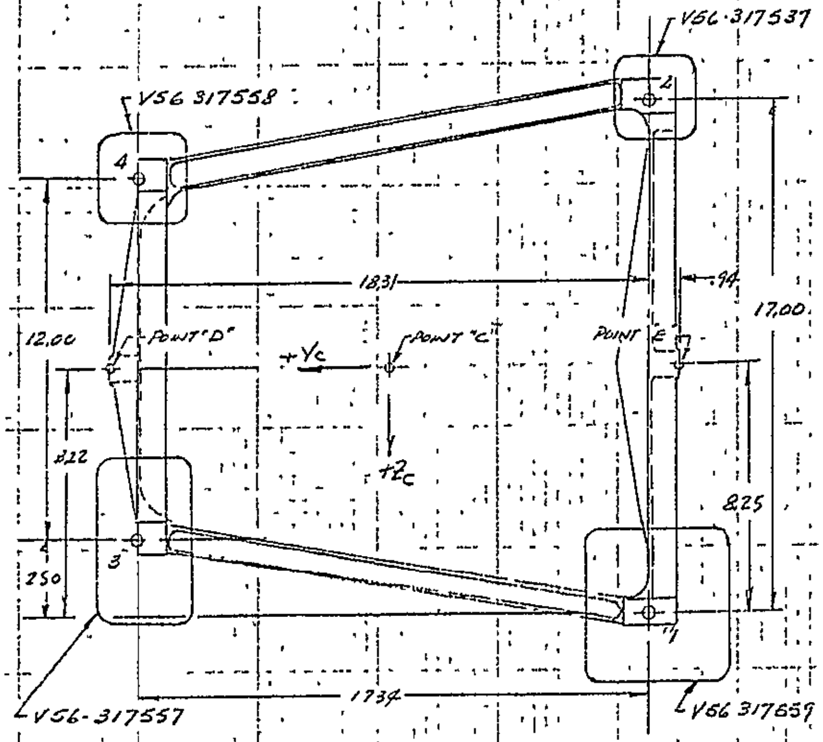
BACK REST SUPPORT FRAME
BOND-ONS – A 7 COMPLEX



FITTING NO. 1 X, Y & Z LOADING
" " 2 X ONLY "
" " 3 X & Z "
" " 4 X ONLY "

RESCUE COUCH

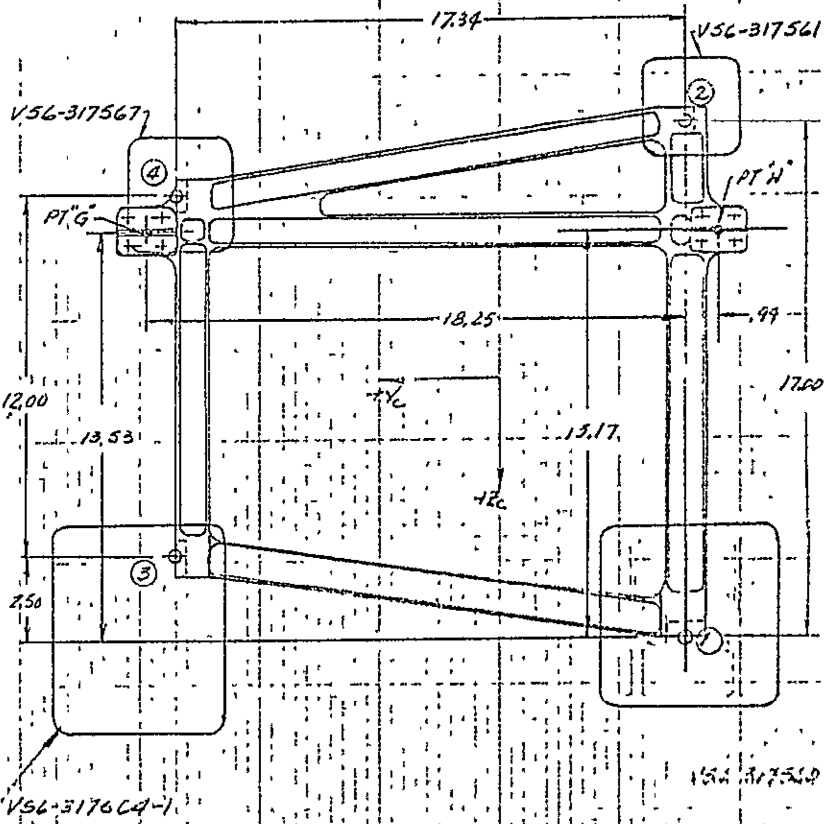
BACK REST SUPPORT FRAME
BOND-ONS ~ A-6 COMPLEX



FITTING NO. 1 ~ X, Y & Z LOADING
" " 2 ~ X "
" " 3 ~ X & Z "
" " 4 ~ " "

RESCUE COUCH

SUPPORT STRUCTURE - RESCUE COUCH (LEFT)
BOND-ONS - A-9 COMPLEX



FITTING NO. 1 ~ X, Y & Z LOADING
" 2 ~ X ONLY

PREPARED BY: L.O.
CHECKED BY: G.F.
DATE: 11-5-71

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COMMAND MODULE

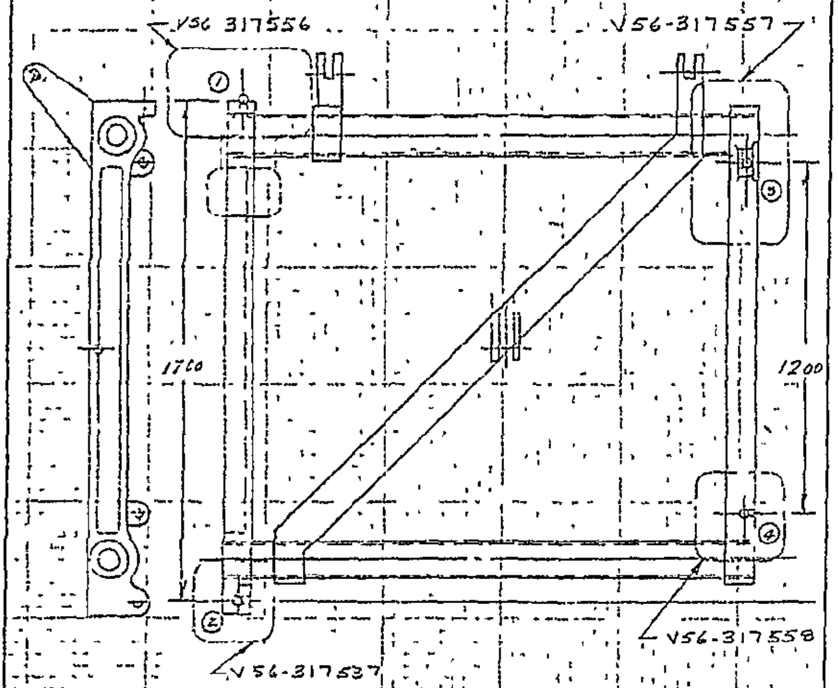
II 2.1.15
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

RESCUE COUCH

LEG & FOOT SUPPORT STRUCTURE - RESCUE COUCH

A-1 COMPLEX



PREPARED BY: L.O.
CHECKED BY: GLD
DATE: 11-2-71

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COMMAND MODULE

II 2.1.16
PAGE NO. OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

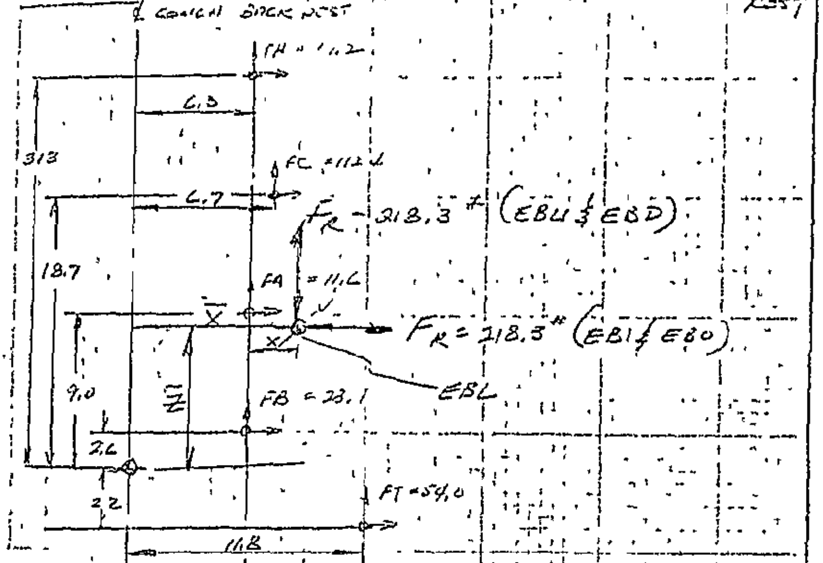
REF

RESCUE COUCH

CG OF 90 PERCENTILE MAN SUPPORTED BY BACK REST

ASSUME - FH, FC, FA, FB & FT SUPPORTED BY BKR REST

II 2.1.3



$$X' = \frac{.4FC + 55FT}{F_R} = \frac{.4(112.4) + 55\times54}{218.3} = 1.56$$

$$\overline{X} = 6.3 + X' = 6.3 + 1.56 = 7.86''$$

$$\overline{Z} = \frac{31.3\times17.2 + 187\times112.4 + 9.0\times11.6 + 2.6\times23.1 - 2.2\times54.0}{218.3}$$

$$= 12.30$$

PREPARED BY: G.C.
CHECKED BY: GD
DATE: 1 - 2 - 71

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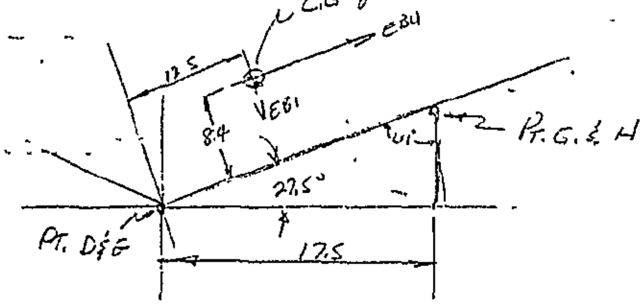
COMMAND MODULE

II 2 1 11
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

C.G LOCATION OF 90 PERCENTILE MAN



PREPARED BY: G.O
CHECKED BY: CLD
DATE: 11 16 71

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COMMAND MODULE

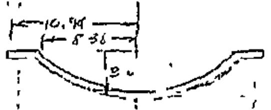
II 2 1 12
PAGE NO OF
REPORT NO SD 70-20
MODEL NO SKYLAB
DWG NO V52-531111

REF

RESCUE COUCH

BACK PAN WEIGHT AND C G LOCATION

MATERIAL - AL. t = .38



FLAT WIDTH = 23.2"

LENGTH - 38"

AREA - 23.2 x 38 - 882 sq in

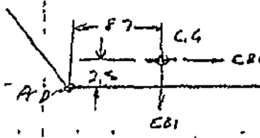
HEAD - 146 sq in

VOL. = 1028 x .38 = 390 cu in

WT. = 390 x .10 = 39#

MISC : = 1#

WT. = 40#

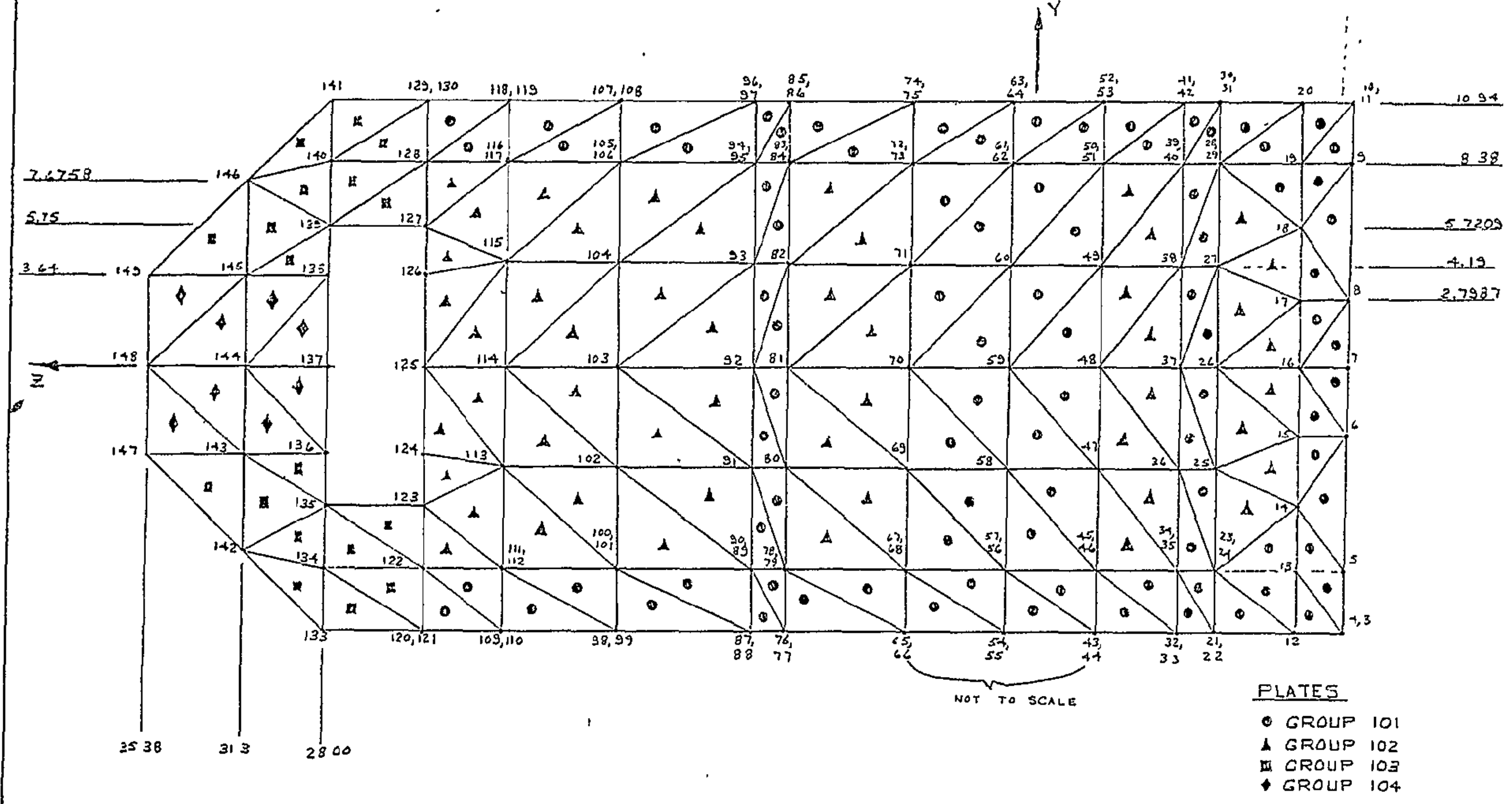


RESCUE COUCH
BACK PAN ASKA COMPUTER MODEL

PREPARED BY: G F.
CHECKED BY RGR
DATE: 3/26/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

II-119
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB



45

73

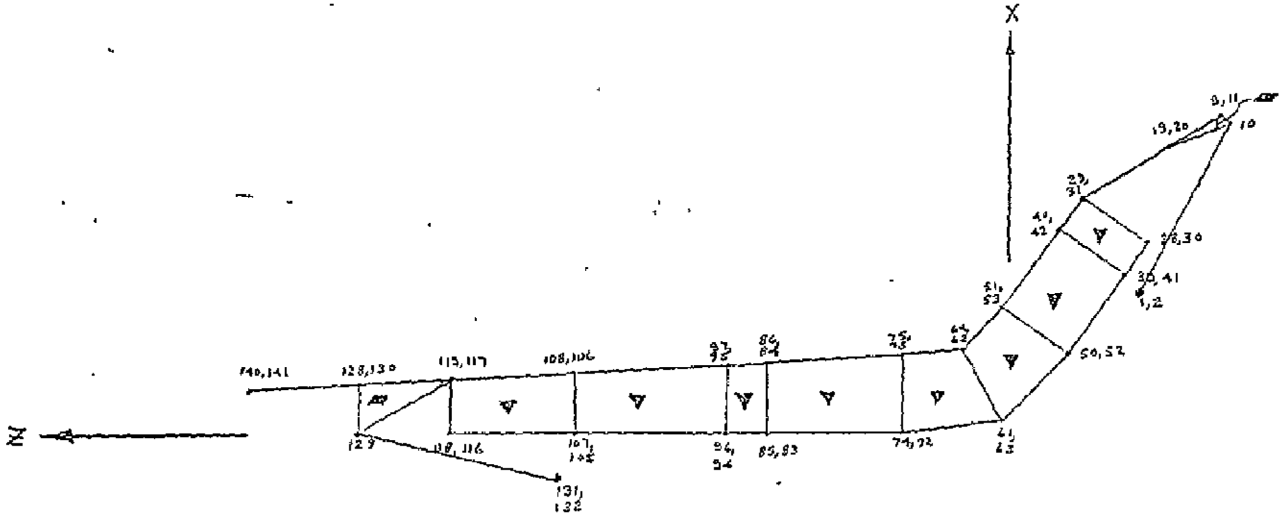
PREPARED BY G.F.
CHECKED BY: RGR
DATE: 3/27/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB

RESCUE COUCH

BACK PAN ASKA COMPUTER MODEL



PLATES
▱ GROUP 106
▽ GROUP 107

FORM 2955-E REV. 2-66

PREPARED BY: G.E.
CHECKED BY: RGR
DATE: 3/27/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

BACK PAN ASKA COMPUTER MODEL

PLATE NUMBERS

GROUP	NODE NUMBERS	GROUP	NODE NUMBERS
101	13 - 12 - 4.	101	59 - 58 - 47.
	4 - 5 - 13		47 - 48 - 59
	14 - 13 - 5		48 - 49 - 59
	5 - 6 - 14		60 - 59 - 49
	15 - 14 - 6		49 - 51 - 60
	16 - 15 - 6		62 - 60 - 51
	6 - 7 - 16		51 - 53 - 62
	7 - 8 - 16		64 - 62 - 53
	17 - 16 - 18		68 - 66 - 55
	18 - 17 - 8		55 - 57 - 68
	8 - 9 - 19		69 - 68 - 57
	19 - 13 - 9		57 - 58 - 69
	9 - 11 - 19		70 - 69 - 58
	20 - 19 - 11		58 - 59 - 70
	24 - 22 - 11		59 - 60 - 70
	12 - 13 - 24		71 - 70 - 60
	13 - 14 - 24		60 - 62 - 71
	18 - 19 - 29		73 - 71 - 62
	19 - 20 - 29		62 - 64 - 73
	31 - 29 - 20		75 - 73 - 64
	35 - 33 - 22		79 - 77 - 66
	22 - 24 - 35		66 - 68 - 79
	36 - 35 - 24		73 - 75 - 84
	24 - 25 - 36		86 - 84 - 75
	37 - 36 - 25		90 - 88 - 77
	25 - 26 - 37		77 - 79 - 90
	26 - 27 - 37		91 - 90 - 79
	35 - 37 - 27		79 - 80 - 91
	27 - 29 - 33		92 - 91 - 80
	49 - 38 - 29		80 - 81 - 92
	29 - 31 - 40		81 - 82 - 92
	42 - 40 - 31		93 - 92 - 82
	46 - 44 - 33		82 - 84 - 93
	33 - 35 - 46		95 - 93 - 84
	40 - 42 - 51		84 - 86 - 95
	53 - 51 - 42		97 - 95 - 86
	57 - 55 - 44		101 - 99 - 88
	44 - 46 - 57		88 - 90 - 101
	59 - 57 - 46		95 - 97 - 106
101	46 - 47 - 59	101	108 - 106 - 97

PREPARED BY: G.E.
CHECKED BY: RGR
DATE: 3/27/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

BACK PAN ASLA COMPUTER MODEL

PLATE NUMBERS (CONT.)

GROUP	NODE NUMBERS	GROUP	NODE NUMBERS
101	112 - 110 - 99	102	113 - 112 - 101.
	99 - 101 - 112		101 - 102 - 113
	106 - 108 - 117		114 - 113 - 102
	119 - 117 - 108		102 - 103 - 114
	122 - 121 - 110		103 - 104 114
	110 - 112 - 122		115 - 114 - 104
	117 - 119 - 128		104 - 106 - 115
101	130 - 128 - 119		117 - 115 - 106
102	25 - 24 - 14		123 - 122 - 112
	14 - 15 - 25		112 - 113 - 123
	26 - 25 - 15		124 - 123 - 113
	15 - 16 - 26		125 - 124 - 113
	16 - 17 - 26		113 - 114 - 125
	27 - 26 - 17		114 - 115 - 125
	17 - 18 - 27		126 - 125 - 115
	29 - 27 - 18		127 - 126 - 115
	47 - 46 - 35		115 - 117 - 127
	35 - 36 - 47	102	128 - 127 - 117
	48 - 47 - 36	103	134 - 133 - 121
	36 - 37 - 48		121 - 122 - 134
	37 - 38 - 48		135 - 134 - 122
	49 - 48 - 38		122 - 123 - 135
	38 - 40 - 49		127 - 128 - 139
	51 - 49 - 40		140 - 139 - 128
	80 - 79 - 65		128 - 130 - 140
	68 - 67 - 80		141 - 140 - 130
	81 - 80 - 69		133 - 134 - 142
	69 - 70 - 81		134 - 135 - 142
	70 - 71 - 81		143 - 142 - 135
	82 - 81 - 71		135 - 136 - 143
	71 - 73 - 82		138 - 137 145
	84 - 82 - 73		146 - 145 - 139
	102 - 101 - 90		139 - 140 - 146
	90 - 91 - 102		140 - 141 - 146
	103 - 102 - 91		142 - 143 - 147
	91 - 92 - 103	103	145 - 146 - 149
	92 - 93 - 103	104	144 - 143 - 136
	104 - 103 - 93		136 - 137 - 144
	93 - 95 - 104		137 - 138 - 144
102	106 - 104 - 95	104	145 - 144 - 133

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 3/21/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 21 23 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

BACK PAN ASKA COMPUTER MODEL

PLATE NUMBERS (CONT.)

GROUP	NODE NUMBERS	GROUP	NODE NUMBERS
104	146-147-143.	107	74-85-86-75
↓	143-144-148	↓	85-96-97-86
	144-145-148		96-107-108-97
104	149-143-145	107	107-118-119-108
106	12-4-3	108	21-22-24-23
↓	4-5-3	↓	32-33-35-34
	20-11-10		43-44-46-45
	9-11-10		54-55-57-56
	121-110-120		65-66-68-67
	121-122-120		76-77-79-78
	130-113-129		87-88-90-89
106	128-130-129		98-99-101 100
107	21-22-33-22		109-110-112-111
↓	32-43-44-33		28-29-31-30
	43-54-55-44		39-40-42-41
	54-65-66-55		50-51-53-52
	65-76-77-66		61-62-64-63
	76-87-88-77		72-73-75-74
	87-98-99-88		83-84-86-85
	98-109-110-99		94-95-97-96
	23-34-35-24		105-106-108-107
	34-45-46-35	108	116-117-119-118
	45-56-57-46		
	56-67-68-57		
	67-78-79-68		
	78-89-90-79		
	89-100-101-90		
	100-111-112-101		
	28-39-40-29		
	39-50-51-40		
	50-61-62-51		
	61-72 73-62		
	72-83-84-72		
	83-94-95-84		
	94-105-106-95		
	105-116-117-106		
	30-41-42-31		
	41-52-53-42		
	52-63-64-53		
107	63-74-75-64		

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 21 24 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

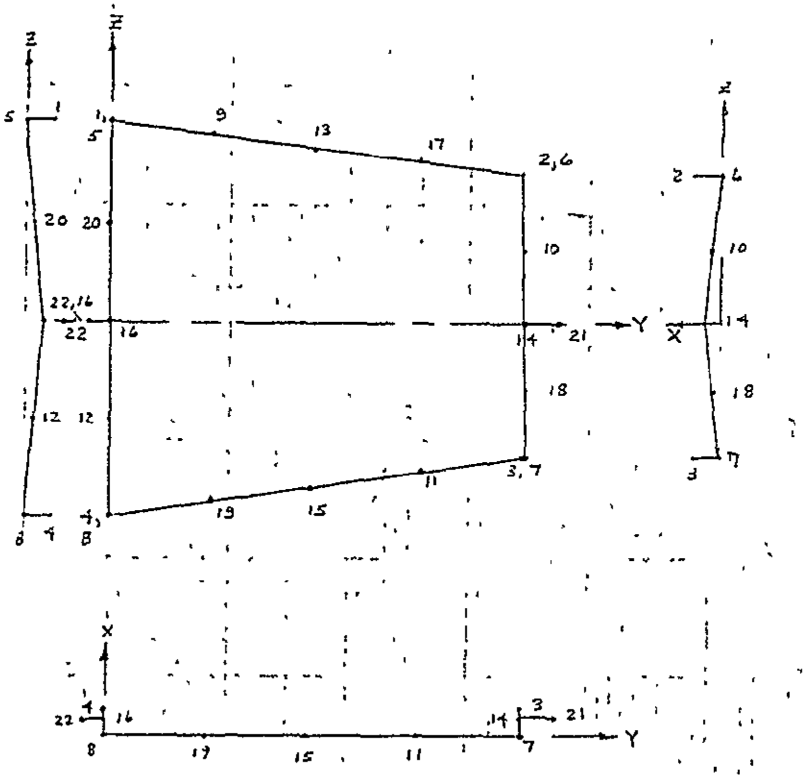
BACK PAN ASKA COMPUTER MODEL

BAR NUMBERS

GROUP	NODES	GROUP	NODES
105	4-5	109	1-3
↓	5-6	↓	2-10
	6-7		3-10
	7-8		120-129
	8-9		120-131
	9-11	109	129-132
	101-102	110	12-22
	102-103	↓	20-31
	103-104		33-44
	104-106	110	42-53
	121-122		
	122-123		
	123-124		
	124-125		
	125-126		
	126-127		
	127-128		
	128-130		
	16-26		
	37-48		
	70-81		
	92-103		
	103-114		
105	114-125		

RESCUE COUCH

BACK PAN SUPPORT FRAME, A4, COMPUTER MODEL



RESCUE COUCH

BACK PAN SUPPORT FRAME, A4, COMPUTER MODEL

NODE COORDINATES

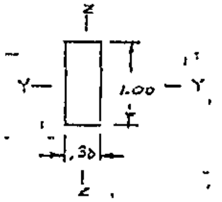
NODE NUMBER	X	Y	Z
1	1.12	0 0	8.50
2	1 12	17.13	6.30
3	1.12	17 13	-5 70
4	1 12	0.0	-8.20
5	0.0	0.0	8.50
6	0.0	17.30	6.30
7	0 0	17 30	- 5.70
8	0 0	0.0	-8.20
9	0.0	4.32	7 95
10	.413	17 30	3.15
11	0.0	12.97	-6.32
12	.415	0 0	-4 10
13	0 0	8 56	7.40
14	.83	17.30	0.0
15	0 0	8.56	-6 95
16	.83	0.0	0.0
17	0.0	12 97	6 85
18	.415	17.30	-2 55
19	0 0	4.32	-7 58
20	.415	0.0	4 25
21	.83	18 671	0.0
22	.83	-.971	0.0

PREPARED BY: W FG	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	II 2 1 27 PAGE NO OF
CHECKED BY: G. F	RESCUE MISSION	REPORT NO SD 70-205
DATE: 3/27/73	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO

RESCUE COUCH

BACK PAN SUPPORT FRAME, A4, COMPUTER MODEL SECTION PROPERTIES

(TYPE I)



$I_Y = \frac{1}{12}(.38)(1)^3$

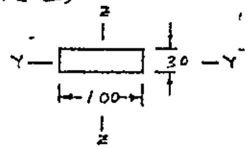
$\doteq .0317 \text{ IN}^4$

$I_Z = \frac{1}{12}(1.0)(.38)^3$

$\doteq .00457 \text{ IN}^4$

$A = .38 \text{ IN}^2$

(TYPE II)



$I_Y = \frac{1}{12}(1.0)(30)^3$

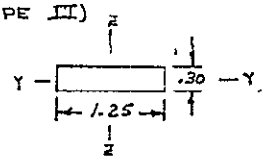
$= 00225 \text{ IN}^4$

$I_Z = \frac{1}{12}(30)(1 0)^3$

$= 025 \text{ IN}^4$

$A = .30 \text{ IN}^2$

(TYPE III)



$I_Y = \frac{1}{12}(1 25)(30)^3$

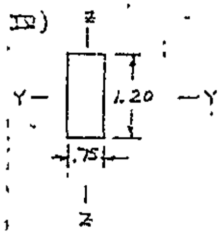
$= .00251 \text{ IN}^4$

$I_Z = \frac{1}{12}(30)(1.25)^3$

$= .0487 \text{ IN}^4$

$A = .375 \text{ IN}^2$

(TYPE IV)



$I_Y = \frac{1}{12}(75)(1 20)^3$

$= .108 \text{ IN}^4$

$I_Z = \frac{1}{12}(1.20)(75)^3$

$= .042 \text{ IN}^4$

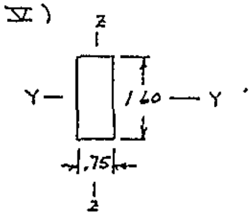
$A = .90 \text{ IN}^2$

PREPARED BY: WFG	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	II - 128 PAGE NO OF
CHECKED BY: G.F	RESCUE MISSION	REPORT NO SD 70-205
DATE: 3/28/73	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO

RESCUE COUCH

BACK PAN SUPPORT FRAME, A4, COMPUTER MODEL SECTION PROPERTIES (CONT.)

(TYPE V)



$I_Y = \frac{1}{12}(.75)(1.60)^3$

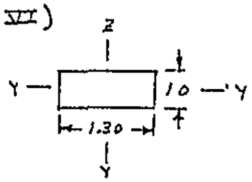
$= .262 \text{ IN}^4$

$I_Z = \frac{1}{12}(1.60)(.75)^3$

$= .0586 \text{ IN}^4$

$A = 1.20 \text{ IN}^2$

(TYPE VI)



$I_Y = \frac{1}{12}(1 30)(1 0)^3$

$= .108 \text{ IN}^4$

$I_Z = \frac{1}{12}(1 0)(1.30)^3$

$= .183 \text{ IN}^4$

$A = 1.30 \text{ IN}^2$

RESCUE COUCH

BACK PAN SUPPORT FRAME, A4, COMPUTER MODEL

BEAMS

BEAM NUMBER	BEAM TYPE	BEAM NODES
1	II	1 - 5
2	I	5 - 9
3	↓	9 - 13
4		13 - 17
5		17 - 6
6		6 - 10
7		10 - 14
8		14 - 18
9		18 - 7
10		7 - 11
11		11 - 15
12		15 - 19
13		19 - 8
14		8 - 12
15		12 - 16
16		16 - 20
17	I	20 - 5
18	III	2 - 6
19	IV	3 - 7
20	IV	4 - 8
21	V	14 - 21
22	VI	16 - 22

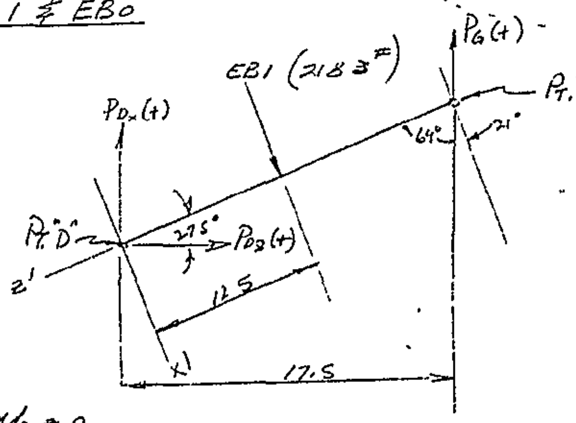
RESCUE COUCH

BACK PAN ADAPTER FRAME LOADS

LOADS (1 g. 90% MAN)

EB1 & EB0

II.2.1.3



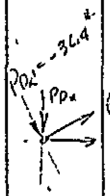
$\Sigma M_O = 0$

$17.5\,P_G + \frac{218.3}{2} \times 12.5 = 0$

$P_H = P_G = -\frac{218.3 \times 12.5}{2 \times 17.5} = \underline{\underline{-78.0}}^{\#}$

$\Sigma F_{X'} = 0$

$P_{Dx'} = \frac{218.3}{2} - P_G \cos 21° = 109.2 - 78 \times .934 = -36.4^{\#}$



$\Sigma F_{Z'} = 0 \quad P_{Dz'} = P_G \sin 21° = 78 \times .358 = 27.9^{\#}$

P_{Dz} $\quad P_{Dx} = -P_{Dx'} \cos 27.5° + P_{Dz'} \sin 27.5$

$P_{Dx} = P_{Ex} \quad = -36.4 \times .886 + 27.9 \times .462 = \underline{\underline{-19.4}}^{\#}$

$P_{Ez} = P_{Dz} = P_{Dx'} \sin 27.5° + P_{Dz'} \cos 27.5°$

$= 36.4 \times .462 + 27.9 \times .886 = \underline{\underline{41.5}}^{\#}$

(EB0 - OPPOSITE SIGN)

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 2 / 31 OF

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO

REF

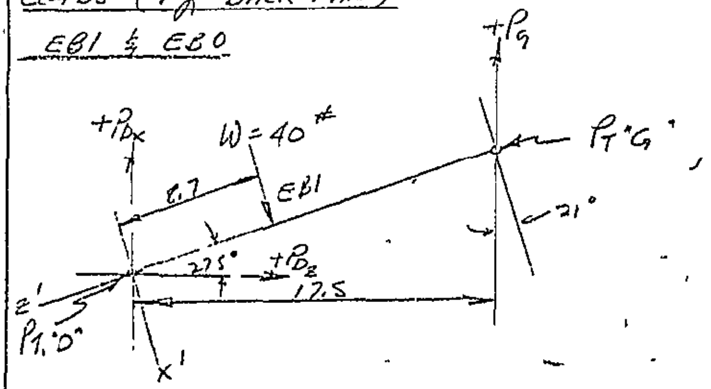
RESCUE COUCH

BACK PAN ADAPTER FRAME LOADS

LOADS (1g BACK PAN)

EB1 & EB0

II.2.1.18



$\Sigma M_D = 0$

$P_H = P_G = -\frac{40}{2} \times \frac{8.7}{17.5} = \underline{-10^{\#}}$

$\Sigma F_{X'} = 0$

$P_{DX'} = \frac{W}{2} - (P_G \cos 21^\circ) = -\frac{40}{2} + 10 \times .934 = -10.7^{\#}$

$\Sigma F_{Z'} = 0$

$P_{DZ'} = -P_G \sin 21^\circ = 10 \times .358 = 3.6^{\#}$

$P_{DX} = P_{DX'} \cos 27.5^\circ + P_{DZ'} \sin 27.5^\circ$

$P_{EX} = P_{DX} = -10.7 \times .886 + (3.6 \times .462) = \underline{-7.9^{\#}}$

$P_{DZ} = P_{DX'} \sin 27.5^\circ + P_{DZ'} \cos 27.5^\circ$

$P_{EZ} = P_{DZ} = \underline{8.1^{\#}}$

52

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 2 / 32 OF

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO

REF

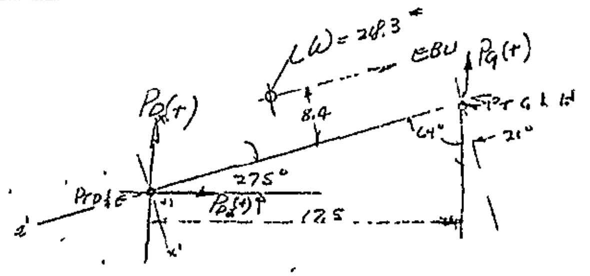
RESCUE COUCH

BACK PAN ADAPTER FRAME LOADS

LOADS (1g 90% MAN)

EB4 & EBD

II.2.1.3



$\Sigma M_D = 0$

$17.5\ P_G(2) = -8.4(218.3)$

$P_H = P_G = \underline{-52.4^{\#}}$

$\Sigma F_{X'} = 0$

$P_{DX'} = P_{EX'} = P_G \cos 21^\circ = 52.4 \times .934 = 49.0^{\#}$

$\Sigma F_{Z'} = 0$

$P_{DZ'} = P_{EZ'} = \frac{218.3}{2} + P_G \sin 21^\circ =$

$= \frac{218.3}{2} - 52.4 \times .358 = 90.35^{\#}$

$P_{EX} = P_{DX} = P_{DX'} \cos 27.5^\circ + P_{DZ'} \sin 27.5^\circ$

$= 49 \times .886 + \overset{90.35}{\cancel{12.8}} \times .462 = 86.6^{\#}$

$P_{EZ} = P_{DZ} = P_{DZ'} \cos 27.5^\circ - P_{DX'} \sin 27.5^\circ$

$= \underset{90.35}{\cancel{12.8}} \times .886 - 49 \times .462 = 57.4^{\#}$

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 2.1.33 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

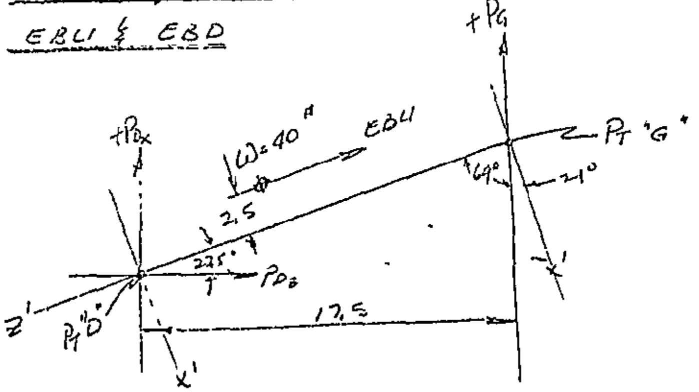
RESCUE COUCH

BACK PAN FRAME ADAPTER LOADS

LOADS (1 G BACK PAN)

EBU & EBD

II.2.1.18



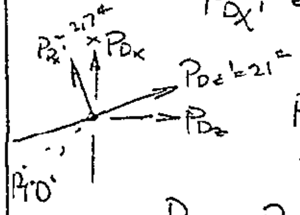
$\Sigma M_D = 0$

$P_H = P_G = -\frac{40}{2}\frac{\times 2.5}{17.5} = \underline{\underline{-2.9}}^{\#}$

$\Sigma F_{Z'} = 0 \quad P_{DZ'} = \frac{W}{2} + P_G \sin 21°$

$P_{DZ'} = \frac{40}{2} - 2.9(.358) = 19^{\#}$

$\Sigma F_{X'} = 0 \quad P_{DX'} = P_G \cos 21° = 2.9(.934) = 2.7^{\#}$



$P_{DX} = P_{DX'} \cos 22.5° + P_{DZ'} \sin 27.5°$

$= 2.7(.886) + 19(.462) = 11.2^{\#}$

$P_{DZ} = P_{DZ'} \cos 27.5° - P_{DX'} \sin 27.5°$

$= 19(.886) - 2.7(.462) = 15.6^{\#}$

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 2.1.34 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

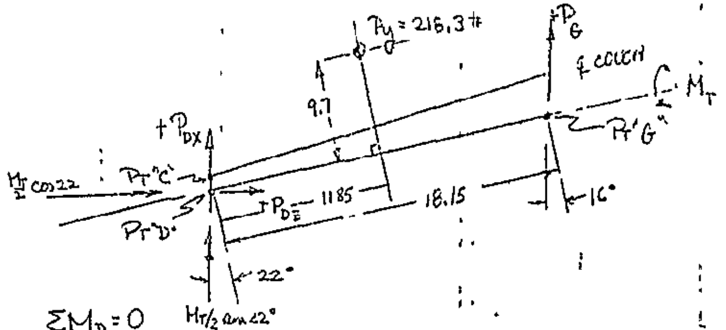
RESCUE COUCH

BACK PAN FRAME ADAPTER LOADS

EYE BALLS LEFT

90% MAN UNIT LOAD

II.2.1.3



$\Sigma M_D = 0$

$R_{GY} = \frac{11.85}{18.15} P_y = .65 P_y = \underline{141.9}$

$\Sigma F_y = 0$

$R_{EY} + R_{DY} = P_y - R_{GY} = P_y - .65 P_y = .35 P_y = 76.4$

$R_{DY} = \frac{76.4}{2} = \underline{\underline{38.2}}^{\#}$

ASSUME M_T REACTED EQUALLY AT POINT D & G AND POINT G & H AS COUPLE LOADS.

$P_{GX} = -P_{HX} = \frac{M_T}{2}\frac{\cos 16°}{19.24} = -\frac{9.7(218.3)}{2}\frac{.96}{(19.24)} = \underline{-52.8}$

$P_{DX} = -P_{EX} = \frac{M_T}{2}\frac{\cos 22°}{19.25} = \underline{-50.6}$

$P_{EZ} = -P_{DZ} = -\frac{M_T}{2}\frac{\sin 22°}{(19.25)} + \frac{M_T \sin 16°}{2(19.24)} = \underline{-35.8}$

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RESCUE MISSION
COMMAND MODULE

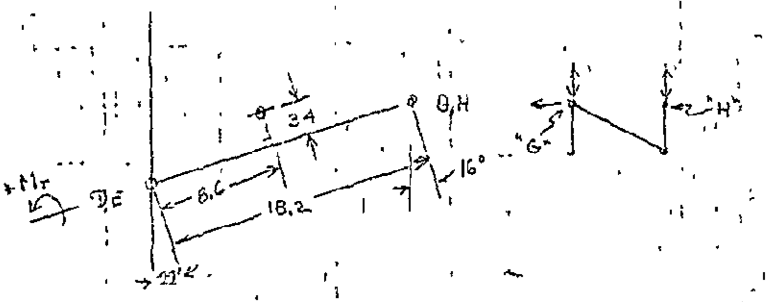
PAGE NO II 2.1.35 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

BACK PAN FRAME ADAPTER LOADS

EBL (1g BACK PAN)



I 2.1.18

$\Sigma M_{DE} = 0$

$$P_{GV} = \frac{40(6.6)}{16.2} = \underline{\underline{18.9\#}}$$

$\Sigma F_y = 0$

$$P_{DY} = P_{EY} = \frac{W - P_{GY}}{2} = \underline{+10.6\#}$$

$M_T = W(3.4) = -136$ IN#

(ASSUME ½ MOMENT REACTED AT EACH END)

$$P'_D = -P'_E = \frac{-M_T}{2(19.25)} = -3.5$$

$$P_{DX} = -P_{EX} = -3.5 \cos 22° = \underline{\underline{-3.2\#}}$$

$$P_{EZ} = -P_{DZ} = 3.5 \sin 22° + \frac{M_T}{2}\frac{\sin 16°}{(19.24)} = \underline{\underline{-2.3\#}}$$

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RESCUE MISSION
COMMAND MODULE

PAGE NO I 2.1.36 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

BACK PAN ADAPTER FRAME LOADS

EYE BALLS LEFT

BACK PAN UNIT LOAD

$$P_G = -P_H = -\frac{M_T}{2}\frac{\cos 16°}{(19.24)} = \underline{-3.4\#}$$

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 2 1 27 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO.

REF

RESCUE COUCH

BACK PAN ADAPTER FRAME LOADS

UNIT LOAD SUMMARY

LOADS DUE TO BACK PAN. 1 g WT OF 40 #

LOAD COND	P_{Dx}	P_{Dy}	P_{Dz}	P_{Ex}	P_{Ey}	P_{Ez}	P_{Gx}	P_{Gy}	P_{Hx}
EBI	-7.9	—	+3.1 #	-7.9 #	—	+3.1 #	-10.0 #	—	-10.0 #
EBC	7.9	—	-3.1	7.9	—	-3.1	10.0	—	10.0
EBU	11.2	—	+15.6	11.2	—	15.6	-2.9	—	-2.9
EBD	-11.2	—	-15.6	-11.2	—	-15.6	2.9	—	2.9
EBL	+3.2	10.6	+2.3	+3.2	10.6	-2.3	-5.4	18.9	+3.4

LOADS DUE TO 90 PERCENTILE MAN ON BACK REST (W=218.3 #)

LOAD COND	P_{Dx}	P_{Dy}	P_{Dz}	P_{Ex}	P_{Ey}	P_{Ez}	P_G	P_{Gy}	P_H
EBI	-19.4	—	+41.5	-19.4	—	+41.5	-78.0	—	-78.0
EBC	19.4	—	-41.5	19.4	—	-41.5	78.0	—	78.0
EBU	86.6	—	57.4	86.6	—	57.4	-52.4	—	-52.4
EBD	-86.6	—	-57.4	-86.6	—	-57.4	+52.4	—	+52.4
EBL	-50.6	+38.2	+35.8	+50.6	+38.2	-35.8	-52.8	141.9	+52.8

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DATE: 11-2-71

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RESCUE MISSION
COMMAND MODULE

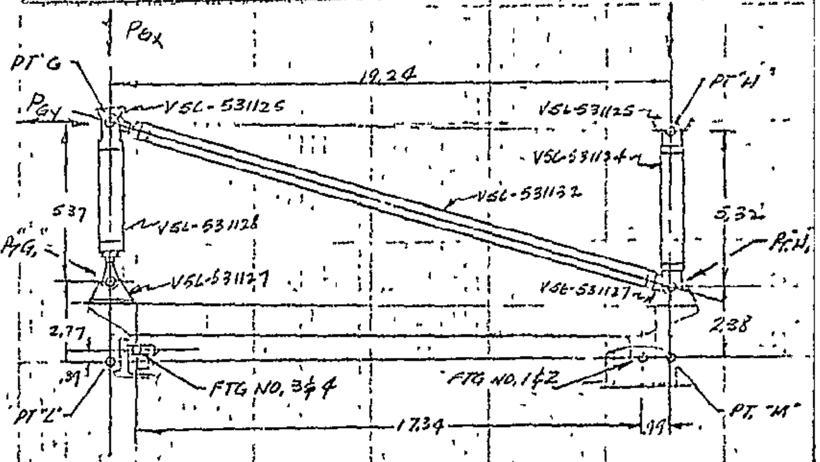
PAGE NO. II.2.1 35 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG. NO

REF

RESCUE COUCH

SUPPORT STRUCT.-RESCUE COUCH (A-9)

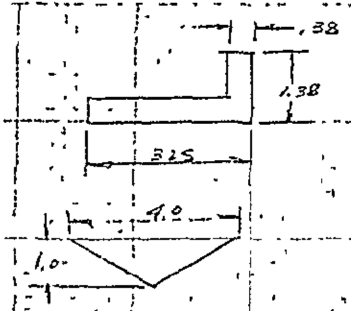
TRUSS SUPPORT - BACK REST



RESCUE COUCH

BACK PAN ADAPTER FRAME LOADS

BACK PAN SUPPORT STRUCTURE LOADS



$A = 3.25 \times .38 + 1 \times .38 = 1.615 \,\square''$

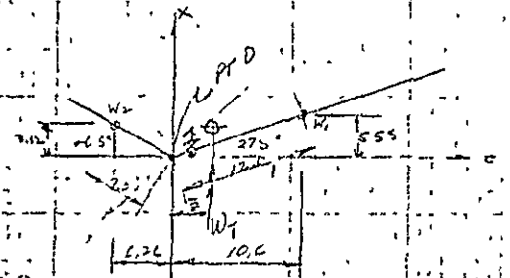
LENGTH ~ 38"/SIDE

$VOL = 1.615 \times 38 \times 2 = 123$ cu in

LUG. $A = 2\,\square''/SIDE$

$VOL = 2 \times .38 \times 2 = 1.5$ cu in

TOTAL WEIGHT $= (123 + 1.5)\,.10 = 12.5\#$



$W_1 = 1.615 \times 24 \times 2 \times .10 = 7.75\#$

$W_2 = 4.5\#$

$\Sigma M_D = 0$

$$\bar{Z} = \frac{W_1 \times 10.6 - W_2 \times 6.26}{W_T} = \frac{7.75 \times 10.6 - 4.5 \times 6.26}{12.5} = 4.32$$

$$\bar{X} = \frac{W_1 \times 5.55 + W_2 \times 7.12}{W_T} = \frac{7.75 \times 5.55 + 4.5 \times 7.12}{12.5} = 4.56$$

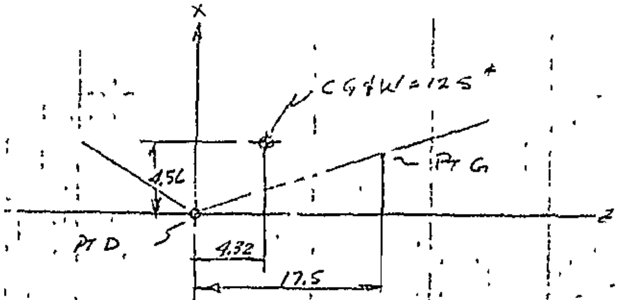
56

RESCUE COUCH

BACK PAN ADAPTER FRAME LOADS

BACK PAN SUPPORT STRUCTURE LOADS

II.2.1.39



$\Sigma M_D = 0$ $\underline{\ddot{X} = -1g}$

$$P_G = \frac{4.32\,W}{2 \times 17.5} = \frac{-4.32 \times 12.5}{2 \times 17.5} = -1.54\#$$

$P_G = P_N$

$$P_{D_X} = P_{E_X} = \frac{-12.5 + 2(1.54)}{2} = -4.71\#$$

$\underline{\ddot{Z} = 1g}$

$\Sigma M_D = 0$

$$P_G = \frac{-4.56\,W}{2 \times 17.5} = \frac{-4.56 \times 12.5}{2 \times 17.5} = -1.62\#$$

$P_G = P_H = -1.62\#$

$P_{D_X} = P_{E_X} = -P_G = 1.62\#$

$P_{D_Z} = P_{E_Z} = \frac{W}{2} = 6.25\#$

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RESCUE MISSION
COMMAND MODULE

PAGE NO II 2.1.41 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

RESCUE COUCH
BACK PAN ADAPTER FRAME LOADS

BACK PAN SUPPORT STRUCTURE LOADS

$\ddot{Y}_1 = 1g$

$\Sigma M_{z_{E0}} = 0$

$$P_{Gy} = \frac{4.32\,W}{17.5} = 3.08^{\#}$$

$$P_{Dy} = P_{Ey} = \frac{12.5 - 3.08}{2} = 4.71^{\#}$$

$$M_z = W \times 4.56 = 12.5 \times 4.56 = 57^{''\#}$$

Assume M_z reacted by P @ D & E

$$P_{Dx} = -P_{Ex} = \frac{57}{19.24} = 2.96^{\#}$$

$$P_{H} = -P_{G} = \frac{P_{Gy} \times 5.37}{19.24} = \frac{3.08 \times 5.37}{19.24} = .86^{\#}$$

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DATE: JAN 24 73

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COMMAND MODULE

PAGE NO II 2.1.42 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH
BACK PAN ADAPTER FRAME LOADS

AS ADAPTER FRAME SUPPORT TRUSS LOADS

REF	MAIN SET of LOADS (MAN + BACK PAN)	POINT "G" P_{GX}	POINT "G" P_{GY}	POINT "H" P_{HX}
II.2.1.37				
II.2.1.4	EBI (1g)	-88		-88
	LIMIT (26.7g)	-2350		-2350
	ULTIMATE (40g)	-3520		-3520
	EBL (1g)	-56.2	+160.8	+56.2
	LIMIT (8.5g)	-478	+1367	+478
	ULT (12.75g)	-717	+2050	+717
	EBU (1g)	-55.3		-55.3
	LIMIT (15g)	-830		-830
	ULT. (22.5g)	-1244		-1244
BOEING CRITERIA II.2.1.40	SUPPORT STRUCTURE			
	N_x (1g)	-1.54		-1.54
	LIM N_x (65g)	-100		-100
	N_z (1g)	-1.62		-1.62
	LIM N_z (15g)	-24		-24
	N_y (1g)	0	-3.08	0
	LIM N_y (8g)	0	-24	0

REF

RESCUE COUCH

AS ADAPTER FRAME SUPPORT TRUSS LOADS

MAIN SET LOADS (CONT)	POINT "G"		POINT "H"
	P_{GX}	P_{GY}	
EBO (1g)	88	–	88
LIMIT (20g)	1760		1760
ULT (30g)	2640		2640
EBD (1g)	55.3	–	55.3
LIMIT (15g)	830		830
ULT (22.5g)	1244		1244

REF

RESCUE COUCH

AS ADAPTER FRAME SUPPORT TRUSS LOADS

MAXIMUM VERTICAL LOADS

DESIRE MAXIMUM LOADS ON POINTS "G" AND "H" of THE SHOULDER ADAPTER FRAME.

FROM THE ACCELERATION ENVELOPE HAVE THE FOLLOWING FOR EBU AND EBI AND EBL

II.2.1.5 $$X = \left[-31605(z)^2 + 1600\right]^{\frac{1}{2}}$$

TRY $z = 5$
$X = 39$

II.2.1.42 $$P_{GX} = \frac{39}{40}(3520) + \frac{5}{22.5}(1244)$$

$$= 3430 + 276 = 3706$$

TRY $z = 10$
$X = 358$

$$P_{GX}' = \frac{35.8}{40}(3520) + \frac{10}{22.5}(1244) = 3705$$

TRY $z = 7.5$
$X = 37.7$

$$P_{GX}' = \frac{37.7}{40}(3520) + \frac{7.5}{22.5}(1244) = 3735$$

ASSUMEING THIS TO BE THE MAXIMUM

PREPARED BY: ITO
CHECKED BY: G F
DATE: JAN 31 1973

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 2 1 45 OF
REPORT NO SD 70 - 205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

A9 ADAPTER FRAME SUPPORT TRUSS LOADS

MAXIMUM VERTICAL LOADS

WANT NOW TO ADD THE LOAD DUE TO THE SUPPORT STRUCTURE

2.1.42 $P_{GX_2} \cong 100\ (1.5) = 150\ \text{lb}$

THUS FOR THE MAXIMUM COMPRESSION CASE

$$P_H = P_G = P_{GX_1} + P_{GX_2} = -(3735 + 150) = -3885\ \text{lb.}\ (\text{ULT})$$

∴ MAXIMUM COMPRESSION LOAD = −3885
ON THE TWO SHOULDER ADAPTER FRAMES.

DESIRE NOW THE MAXIMUM TENSION LOAD ON THESE SAME TWO POINTS

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CHECKED BY: G F
DATE: 3/21/73

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RESCUE MISSION
COMMAND MODULE

PAGE NO II 2 1 46 OF
REPORT NO SD 70 - 205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

A9 ADAPTER FRAME SUPPORT TRUSS LOADS

MAXIMUM VERTICAL LOADS

MAXIMUM TENSION LOADS ON POINTS "G" AND "H" OF THE SHOULDER ADAPTER FRAME.

THE ACCELERATION ENVELOPE BELOW IS USED FOR EBO = 30g AND EBD = 22 5g AND EBL = 0

$$\frac{X^2}{(30)^2} + \frac{Z^2}{(22.5)^2} = 1$$

II.2.1.5

$$X = \left[900 - 1.7778Z^2\right]^{\frac{1}{2}}$$

II.2.1.43 TRY $Z = 5$

$X = 29\ 25$ $\quad P_{G_X} = \frac{29\ 25}{30}\left[2640\right] + \frac{5}{22.5}\left[1244\right]$

$= 2850$ LBS (ULT)

TRY $Z = 10$

$X = 26.87$ $\quad P_{GX} = \frac{26\ 87}{30}\left[2640\right] + \frac{10}{22.5}\left[1244\right]$

$= 2918$ LBS (ULT)

TRY $Z = 15$

$X = 22\ 36$ $\quad P_{GX} = \frac{22.87}{30}\left[2640\right] + \frac{15}{22\ 5}\left[1244\right]$

$= 2797$ LBS (ULT)

TRY $Z = 11$

$X = 26.17$ $\quad P_{GX} = \frac{26\ 17}{30}\left[2640\right] + \frac{11}{22.5}\left[1244\right]$

$= 2911$ LBS. (ULT)

TRY $Z = 9$

$X = 27.50$ $\quad P_{G_X} = \frac{27\ 50}{30}\left[2640\right] + \frac{9}{22\ 5}\left[1244\right]$

$= 2917$ LBS (ULT)

∴ $P_{GX_{MAX}} = 2918$ LBS (ULT)

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DATE: 3/2/72

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COMMAND MODULE

II 2.1.47
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

A9 ADAPTER FRAME SUPPORT TRUSS LOADS MAXIMUM VERTICAL LOADS

ADDING THE LOAD DUE TO THE SUPPORT STRUCTURE FOR THE MAXIMUM TENSION LOAD

II 2.1.42

$P_{G_{X_2}} = 100(1.5)$
$= 150$ LBS (ULT)

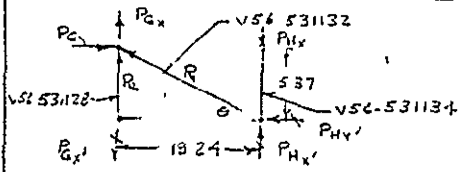
FOR THE MAXIMUM TENSION LOAD CASE:

$P_H = P_G = P_{G_X} + P_{G_{X_2}} = 2918 + 150$
$= 3068$ LBS (ULT)

MAXIMUM LATERAL LOAD (EB R)

60

II 2.1.42



$\theta = TAN^{-1} \frac{5.37}{19.24}$
$\theta = 15.6°$

$P_{G_Y} = 2050 + 24(1.5)$
$= 2086$ LBS (ULT)

$P_{H_Y} = -P_{G_X} = -717 + (-8)(1.5)$
$= -729$ LBS (ULT)

$R_1 = \frac{P_{G_Y}}{\cos 15.6°}$
$= \frac{2056}{\cos 15.6°}$
$R_1 = -2166$ LBS. (COMP)

$P_{H_Y'} = 2086$ LBS
$P_{G_X'} = R_2 = 1311$ LBS (TEN)
$P_{H_X} = -P_{G_X} = 1311$ LBS (COMP)

$R_2 = +729 + 2166 \sin 15.6°$
$= +729 + 582$
$R_2 = 1311$ LB. (TEN)

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RESCUE MISSION
COMMAND MODULE

II 2.1.46
PAGE NO. OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

A4, A6 ADAPTER FRAME SUPPORT LOADS

LOADS AT POINTS D AND E (lb)

II 2.1.37

MAIN LOADS (MAN + BACK PAN)	POINT D			POINT E		
	P_{DX}	P_{DY}	P_{DZ}	P_{EX}	P_{EY}	P_{EZ}
EBI (1g)	-19.4	—	+41.5	-19.4	—	+41.5
LIMIT (26.7g)	-518	—	1108	-518	—	1108
ULT (40g)	-776	—	1660	-776	—	1660
EBL (1g)	-50.6	+38.2	+35.8	+50.6	+38.2	-35.8
LIMIT (8.5g)	-430	+325	+304	+430	+325	-304
ULT (12.75g)	-645	+487	+454	+645	+487	-454
EBU (1g)	102.6	—	90.8	102.6	—	90.8
LIMIT (15g)	1539	—	1362	1539	—	1362
ULT (22.5g)	2309	—	2043	2309	—	2043
SUPPORT STRUCTURE						
EBI (1g)	-7.9	—	8.1	-7.9	—	+8.1
LIMIT (65g)	-514	—	527	-514	—	527
ULT (97.5g)	-770	—	790	-770	—	790
EBL (1g)	-3.2	+10.6	+2.3	+3.2	+10.6	-2.3
LIMIT (8g)	-25.6	+84.8	+18.4	+25.6	+84.8	-18.4
ULT (12g)	-38.4	+127.2	+27.6	+38.4	+127.2	-27.6
EBU (1g)	12.1	—	17.4	12.1	—	17.4
LIMIT (15g)	181.5	—	261	181.5	—	261
ULT (22.5g)	272	—	391	272	—	391

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COMMAND MODULE

REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

A4, A6 ADAPTER FRAME SUPPORT LOADS

FOR EXTERNAL LOADS AT POINTS G AND H SEE ANALYSIS of SUPPORT TRUSS

FOR POINTS D AND E TO OBTAIN THE MAXIMUM LOADS HAVE THE FOLLOWING AS WITH THE LOADS TO THE SUPPORT TRUSS,

EBI + EBD + EBL CASE I

FOR PORTION DUE TO MAN + RACK PAN

II.2.1 5
II.2.1.48

$$P_{Dx} = \frac{\ddot{X}}{40}(776) + \frac{\ddot{Z}}{22.5}(2309)$$

FROM LOADING ENVELOPE

$$\ddot{X} = \left(-3\,1605(\ddot{Z})^2 + 1600\right)^{\frac{1}{2}} \qquad ①$$

WANT TO APPROXIMATE THIS CURVE BY A POLYNOMIAL FOR CONVENIENCE, USE A SECOND ORDER POLY.

$$\ddot{Z} = A\ddot{X}^2 + B\ddot{X} + C \qquad ②$$

∴ HAVE THREE UNKNOWNS TO SATISFY,

FROM EQUATION ① CAN OBTAIN 3 POINTS TO SATISFY ②;

$\ddot{X}$	$\ddot{Z}$
0	22.5
40	0
14	21.1

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COMMAND MODULE

REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

RESCUE COUCH

A4, A6 ADAPTER FRAME SUPPORT LOADS

THUS,

$$C = 22.5$$

$$0 = A(40)^2 + B(40) + 22.5 \qquad ③$$

$$21 = A(14)^2 + B(14) + 22.5 \qquad ④$$

$$0 = 1600A + 40B + 22.5$$

$$21 = 196A + 14B + 22.5$$

$$-22.5 = 1600A + 40B$$

$$-1.5 = 196A + 14B$$

$$A = \frac{\begin{vmatrix} -22.5 & 40 \\ -1.5 & 14 \end{vmatrix}}{\begin{vmatrix} 1600 & 40 \\ 196 & 14 \end{vmatrix}} = \frac{-255}{14560} = -.0175$$

$$B = \frac{\begin{vmatrix} 1600 & -22.5 \\ 196 & -1.5 \end{vmatrix}}{} = \frac{2010}{14560} = .1380$$

$$\therefore \ddot{Z} \approx -.0175\ddot{X}^2 + .1380\ddot{X} + 22.5$$

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RESCUE MISSION
COMMAND MODULE

PAGE NO II 2 1 51 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCLE COUCH

A4, A6 ADAPTER FRAME SUPPORT. LOADS

$$P_{DX} = \frac{\ddot{X}}{40}(776) + \frac{\ddot{Z}}{22.5}(2309)$$

$$P_{DX} = 19.4\ddot{X} + 1025\left(-.0175\ddot{X}^2 + .1380\ddot{X} + 22\ 5\right)$$

$$P_{DX} = 19.4\ddot{X} - 1.795\ddot{X}^2 + 14.15\ddot{X} + 2310$$

$$P_{DX} = -1.795\ddot{X}^2 + 33.55\ddot{X} + 2310$$

TO FIND $P_{DX_{MAX}}$

$$\frac{dP_{DX}}{d\ddot{X}} = 0 = -3.59\ddot{X} + 33.55$$

$$\ddot{X} = \frac{33.55}{3.59} = \underline{9.34}$$

CORRESPONDING $\ddot{Z}$ ACCORDING TO ORIGINAL EQN.

$$(9.34)^2 = -3.16(\ddot{Z})^2 + 1600$$

$$\ddot{Z}^2 = \frac{87.2 - 1600}{-3.16} = \frac{1512.8}{3.16} = 479$$

$$\ddot{Z} = \underline{21.8\ g}$$

THUS

$$P_{DX} = \frac{9.34}{40}(776) + \frac{21.8}{22.5}(2309) =$$

$$P_{DX} = 181 + 2240 = 2421 \text{ lb. (ULT)}$$

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COMMAND MODULE

PAGE NO II 2 1.52 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

A4, A6 ADAPTER FRAME SUPPORT LOADS

CORRESPONDING

$$P_{DZ} = \frac{21.8}{22.5}(2043) - \frac{9.34}{40}(1660) = 1597 \text{ lb.}$$

ADDING IN THE PORTION DUE TO THE SUPPORT STRUCTURE USING THE SAME RATIO OF LOADING

$$\ddot{X} = \frac{9.34}{40}(97.5) = 22.8\ g$$

$$\ddot{Z} = 21.8\ g$$

THUS FOR SUPPORT STRUCTURE

$$P_{DX} = \frac{22.8}{97.5}(770) + \frac{21.8}{22.5}(272)$$

$$P_{DX} = 180 + 263 = 443 \text{ lb. (ULT)}$$

$$P_{DZ} = \frac{22.8}{97.5}(790) + \frac{21.8}{22.5}(391)$$

$$P_{DZ} = -185. + 379 = 194 \text{ lb (ULT)}$$

THUS FOR MAX P_{DX} HAVE FOLLOWING LOADS

$$\text{CASE I} \begin{cases} P_{DX} = 2421 + 443. = \underline{2864 \text{ lb. (ULT)}} \\ P_{DZ} = 1597 + 194 = \underline{1791 \text{ lb (ULT)}} \end{cases}$$

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RESCUE MISSION
COMMAND MODULE

PAGE NO II.2.153 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

RESCUE COUCH

A4, A6 ADAPTER FRAME SUPPORT LOADS

CASE II –

II.2.1 43 FOR THE MAXIMUM P_{DY} USE THE EBL LOAD

$$P_{DX} = \cdot 645 + 38.4 = 683.4 \text{ lb.}$$

$$\therefore P_{DY} = +487 + 117 = -604 \text{ lb.}$$

$$P_{DZ} \cdot +454 + 27.6 = +481.6 \text{ lb}$$

CASE III – MAXIMUM P_{DZ} (EBI + EBU + EBL)

II.2.1.5
II 2 1.45

$$P_{DZ} = \frac{\ddot{X}}{40}(1660) + \frac{\ddot{Z}}{22.5}(2043)$$

$$\ddot{Z} = -.0175\ddot{X}^2 + .1380\ddot{X} + 22.5$$

$$P_{DZ} = 41.5\ddot{X} + 91(-.0175\ddot{X}^2 + .1380\ddot{X} + 22.5)$$

$$P_{DZ} = -1.592\ddot{X}^2 + 54.05\ddot{X} + 2050$$

$$\frac{dP_{DZ}}{d\ddot{X}} = -3.184\ddot{X} + 54.05 = 0$$

$$\ddot{X} = \frac{54.05}{3.184} = 17.0g$$

$$\ddot{Z} = 20.4g$$

THUS

$$P_{DZ} = -460 + 919 + 2050 = 2509$$

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COMMAND MODULE

PAGE NO. II.2.1.54 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-521102

REF

RESCUE COUCH

A4, A6 ADAPTER FRAME SUPPORT LOADS

$$P_{DX} = \frac{\ddot{X}}{40}(-776) + \frac{\ddot{Z}}{22.5}(2309)$$

$$P_{DX} = \frac{17}{40}(-776) + \frac{20.4}{22.5}(2309) = 1760 \text{ lb (ULT)}$$

FOR CORRESPONDING SUPPORT STRUCTURE

$$P_{DX} = \frac{17}{40}(-770) + \frac{20.4}{22.5}(272)$$

$$P_{DX} = -327 + 247 = -80 \text{ lb.}$$

$$P_{DZ} = \frac{17}{40}(790) + \frac{20.4}{22.5}(391)$$

$$P_{DZ} \cdot 336 + 354 = 690 \text{ lb.}$$

THUS

$$\text{CASE III} \begin{cases} P_{DX} = 1760 - 86 = 1680 \text{ lb.} \\ P_{DZ} = 2509 + 690 = 3199 \text{ lb.} \end{cases}$$

PREPARED BY: G.E.
CHECKED BY: RGR
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COMMAND MODULE

II 2 1 55
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH
STRAP LOADS

SUMMARY OF LOADS

II.2.1.

1g LOADS*

LOAD / STRAP	EBI 1g (LBS)	EBO 1g (LBS)	EBU 1g (LBS)	EBD 1g (LBS)	EBL 1g (LBS)
SHOULDER	——	94 5	170	59 9	47.8
WAIST	41.4	228	86 2	359.2	76.2
THIGH	——	——	——	31.8	——
HEEL CLIP	——	32 3	——	——	——

ULTIMATE LOADS

LOAD / STRAP	EBI 40g (LBS)	EBO 30g (LBS)	EBU 22 5g (LBS)	EBD 22.5g (LBS)	EBL 12.75g (LBS)
SHOULDER	——	2835	2525	1350	610
**WAIST	1656	6840	1940	8060	971
THIGH	——	——	——	715	——
HEEL CLIP	——	969	——	——	——

* THE DEVELOPMENT OF THE LOADS IN THIS TABLE IS PRESENTED ON THE FOLLOWING PAGES.

** WAIST AND LAP STRAPS ARE ASSUMED TO REACT THESE LOADS EQUALLY

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COMMAND MODULE

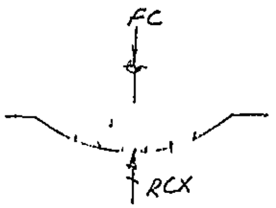
II 2 1 56
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH
STRAP LOADS

EYEBALLS IN (1g , 90 PERCENTILE MAN)

UNIT FC



$\Sigma F = 0$

$F_C = RCH$

UNIT FA

$\Sigma F = 0$

$FA = RAH$

UNIT FB

$\Sigma F = 0$

$FB = RBH$

UNIT F_H

$\Sigma F = 0$

$R_{HX} = F_H$

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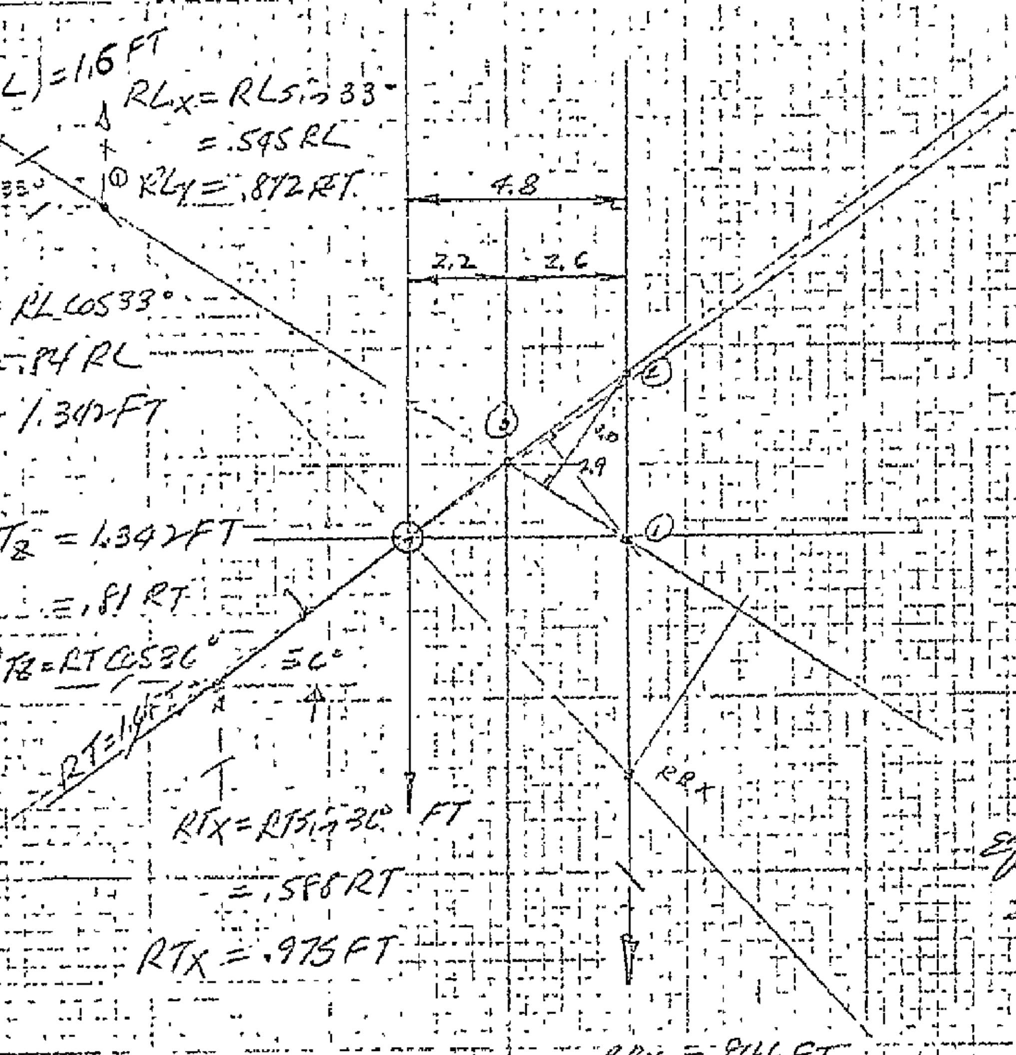
REPORT NO SD 70-207

MODEL NO. SKYLAB

DWG. NO.

RESCUE COUCH
STRAP LOADS
EYEBALLS IN (1g)



LEG (RL) = 1.6 FT

$RL_x = RL \sin 33°$
$= .545 RL$

$RL_y = .872 RT$

$RL_z = RL \cos 33°$
$= .84 RL$

$RL_z = 1.342 FT$

$RT_z = 1.342 FT$
$= .81 RT$

$RT_z = RT \cos 36°$

$RT = 1.66 FT$

$RTx = RT \sin 36°$ FT
$= .588 RT$

$RTx = .975 FT$

$RBX = .846 FT$

$\Sigma M_{①} = 0$ (+)

$3.0 RT - 4.8 FT = 0$

$RT = \frac{4.8 FT}{2.9} = 1.66 FT$

$\Sigma M_{②} = 0$ (+)

$3.2 RL - 4.8 FT = 0$

$RL = \frac{4.8 FT}{3.0} = 1.6 FT$

$\Sigma M_{③} = 0$ (+)

$2.6 RBX - 2.2 FT = 0$

$RBX = \frac{2.2 FT}{2.6} = .846 FT$

Equilibrium Check

$\Sigma F_x = 0$

$RT_x + RL_x - FT - RBX = 0$

$.975 FT + .872 FT - FT - .846 FT = 0$

$\Sigma F_z = 0$

$RT_z - RL_z = 0$

[illegible]

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RESCUE MISSION
COMMAND MODULE

II 2 1.56 PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

RESCUE COUCH
STRAP LOADS

EYEBALLS IN (1g)

SUMMARY OF LOADS - BACK REST

UNIT LOAD SUMMARY

	FH	FC	FA	FB	FT
RHX	FH	—	—	—	—
RCX	—	FC	—	—	—
RAX	—	—	FA	—	—
RBX	—	—	—	FB	-.846FT
RT	—	—	—	—	1.66FT
RL	—	—	—	—	1.6FT

II.2.1.57

1g WT. 90 PERCENTILE MAN (TOTAL WT. = 251#)

II.2.1.3 $FH = 17.2^{\#}$ (HEAD)

$FC = 112.4$ (CHEST)

$FA = 11.6$ (ABDOMEN)

$FB = 23.1$ (BUTTOCKS)

$FT = 54.0$ (THIGHS)

1g LOAD ON BACK REST

$RHX = FH = 17.2^{\#}$

$RCX = FC = 112.4^{\#}$

$RAX = FA = 11.6^{\#}$

$RBX = FB - .846FT = 23.1 - .846(54) = 23.1 - 45.7 = -22.6^{\#}$ *

$RT = 1.66FT = 1.66(54) = 89.6^{\#}$

$RL = 1.6FT = 1.6(54) = 86.4^{\#}$

166

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COMMAND MODULE

II 2 1 5[illegible] PAGE NO OF
REPORT NO SD 70-[illegible]
MODEL NO SKYLAB
DWG NO.

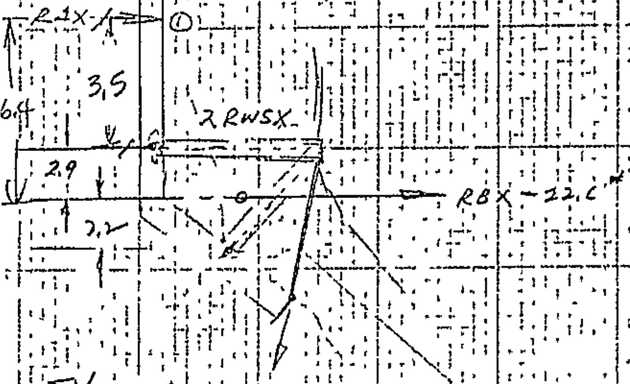
REF

RESCUE COUCH
STRAP LOADS

EYEBALLS IN (1g)

REDISTRIBUTION OF TENSION LOAD AT RBX (22.6#) TO WAIST STRAP & RAX

II.2.1 58



$\Sigma M_{①} = 0$

$3.5\,RWS(2) - 6.4\,RBX = 0$

$RWS = \frac{6.4\,RBX}{7} = .914\,RBX = 20.66^{\#}$

$\Sigma F_X = 0$

$RBX - 2RWS + RAX = 0$

$RAX = 2RWS - RBX = 41.32 - 22.6 = 18.72^{\#}$

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COMMAND MODULE

PAGE NO II.2 1.60 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

STRAP LOADS

EYEBALLS IN LOAD SUMMARY

1g LOAD ON BACK REST (RBX - TENSION LOAD REDIST.)

RHX = 17.2 #

RCX = 112.4 #

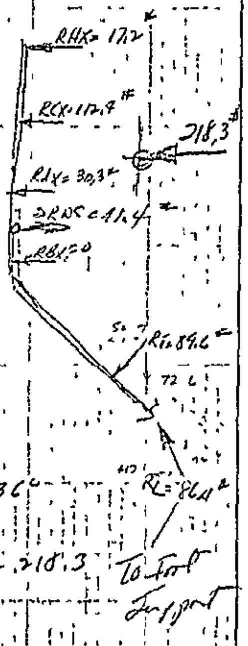
RAX = 11.6 + 18.7 = 30.3 #

RBX = 0

RT = 89.6 #

* RL = 86.4 # (This load reacted by Foot Support Struct)

RWS X 4/R = 20.7 #



$\Sigma F_x = 218.3$

RHX + RCX + RAX − 2RWS + RT Sin 36° + RL Sin 33° = 218.3

17.2 + 112.4 + 30.3 − 41.4 + 52.7 + 42.1 = 218.3

218.3 = 218.3

$\Sigma F_z = 0$

RT cos 36° = RL cos 33°

72.6 = 72.6

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COMMAND MODULE

PAGE NO II 2 1.61 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO -

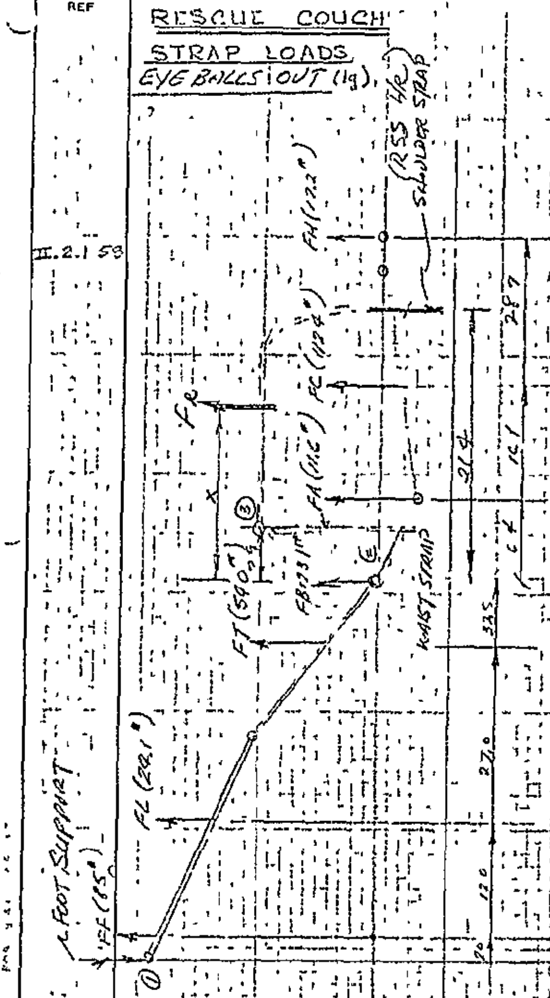
REF

II.2.1 58

RESCUE COUCH

STRAP LOADS

EYE BALLS OUT (1g)



LOAD DISTRIBUTION (Assume FF, FL & FT DISTRIBUTED TO FB & FOOT SUPPORT)

$\Sigma M_{①} = 0$

33.5 FB' = 2×FF + 12×FL + 27×FT

$FB' = \frac{2 \times 8.5 + 12 \times 22.1 + 27 \times 59.}{33.5} = 59.3$ #

$\Sigma F_x = 0$

$R_{FR} = 56.6 - 53.3 = 3.3$ #

FR = FH + FC + FA + FB + FB'

= 218.6 #

$\Sigma M_{②} = 0$

FR × X = 6.4 FA + 16.1 FC + 28.7 FH

$X = \frac{6.4 \times 11.6 + 16.1 \times 112.4 + 28.7 \times 17.2}{218.6}$

X = 10.9

RESCUE COUCH

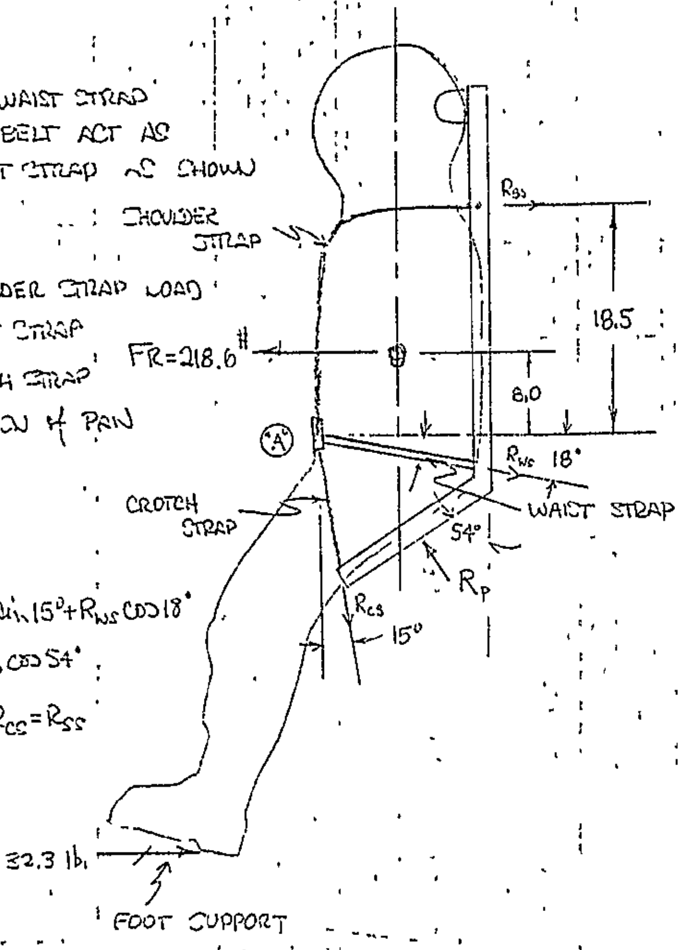
STRAP LOADS

EYEBALLS OUT (1g FOR 90 PERCENTILE MAN)

ASSUME WAIST STRAP
AND LAP BELT ACT AS
ONE WAIST STRAP AS SHOWN
BELOW

R_{SS} = SHOULDER STRAP LOAD
R_{WS} = WAIST STRAP
R_{CS} = CROTCH STRAP
R_P = REACTION of PAN

II.2 1 53



$\Sigma F_x = 0$

$218.6 = R_{CS}\sin 15^\circ + R_{WS}\cos 18^\circ$
$+ R_{SS} - R_P \cos 54^\circ$

ASSUME, $R_{CS} = R_{SS}$

RESCUE COUCH

STRAP LOADS

EYEBALLS OUT (1g FOR .90 PERCENTILE MAN)

$218.6 = 1.259 R_{SS} + R_{WS}\cos 18^\circ - R_P \cos 54^\circ$ ..①

$\Sigma M_A = 0$

ASSUME CONTRIBUTION DUE TO R_p IS NEGLIGIBLE

$8.0(218.6) = R_{SS}\, 18.5$

$R_{CS} = R_{SS} = \underline{\underline{94.5\text{ lb.}}}$ ◄——

$\Sigma F_z = 0$

$R_{CS}\cos 15^\circ - R_p \sin 54^\circ + R_{WS}\sin 18^\circ = 0$

$94.5(.966) - .81 R_p + .309 R_{WS} = 0$

$.81 R_p - .309 R_{WS} = .91.4$ ..②

FROM ①

$-.588 R_p + .952 R_{WS} \doteq 218.6 - 119 = 99.6$

$$R_P = \frac{\begin{vmatrix} 91.4 & -.309 \\ 99.6 & .952 \end{vmatrix}}{\begin{vmatrix} .81 & -.309 \\ -.588 & .952 \end{vmatrix}} = \frac{117.8}{.589} = 199.8\text{ lb.}$$

$R_{WS} = \underline{\underline{228\text{ lb}}}$ ◄——

69

PREPARED BY: HTO
CHECKED BY: CLD
DATE 2/21/73
REF

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

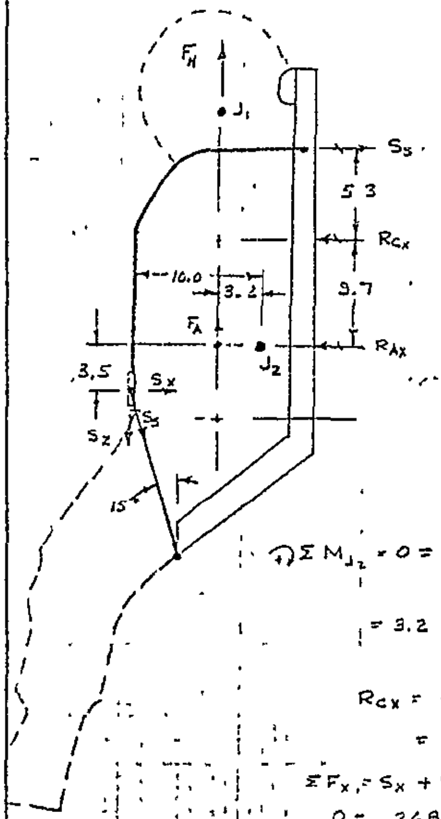
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

RESCUE COUCH

STRAP LOADS

EYEBALLS UP (UNIT F_H AND * F_A)

SHOULDER STRAPS REACT THE BODY UP LOADS



$$\Sigma F_Z - 0 = F_H - S_Z$$
$$S_Z = F_H$$
$$S_S = \frac{S_Z}{\cos 15°} = \frac{F_H}{\cos 15°}$$
$$S_S = 1\,036\ F_H$$
$$S_X = (1\,036\,F_H)\sin 15°$$
$$S_X = .268\ F_H$$

$$\circlearrowleft \Sigma M_{J_2} = 0 = 3\ 2\ F_H + 15 S_S - 3\ 5\ S_X - 10 S_Z - 9.7 R_{CX}$$
$$= 3.2\ F_H + 15(1\,036\,F_H) - 3.5(.268\,F_H) - 10\ F_H - 9\ 7\ R_{CX}$$
$$R_{CX} = \frac{7.782\ F_H}{9\ 7}$$
$$= .80\ F_H$$

$$\Sigma F_X = S_X + S_S - R_{CX} - R_{AX} = 0$$
$$0 = .268\ F_H + 1\,036\ F_H - .80\ F_H - R_{AX}$$
$$R_{AX} = .50\ F_H$$

* REACTIONS FOR F_A ARE THE SAME AS FOR F_H

118

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DATE: 2/21/73
REF

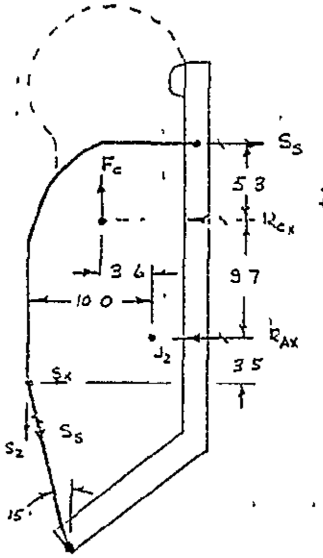
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

RESCUE COUCH

STRAP LOADS

EYEBALLS UP (UNIT F_c)



$$\Sigma F_Z = F_c - S_Z$$
$$S_Z = F_c$$
$$S_S = \frac{S_Z}{\cos 15°} = \frac{F_c}{\cos 15°}$$
$$S_S = 1\,036\ F_c$$
$$S_X = (1\,036\ F_c)\sin 15°$$
$$S_X = .268\ F_c$$

$$\circlearrowleft \Sigma M_{J_1} = 3\ 6\ F_c + 15 S_S - 9\ 7\ R_{CX} - 3\ 5 S_X - 10 S_Z = 0$$
$$9\ 7 R_{CX} = 3\ 6\ F_c + 15(1\,036 F_c) - 3\ 5(.268 F_c) - 10 F_c$$
$$R_{CX} = \frac{8\,182}{9.7} F_c$$
$$R_{CX} = .85\ F_c$$

$$\Sigma F_X = S_S + S_X - R_{CX} - R_{AX} = 0$$
$$R_{AX} = 1\,036\ F_c + .263\ F_c - .85\ F_c$$
$$R_{AX} = .45\ F_c$$

119

PREPARED BY: HT?
CHECKED BY: G L D
DATE: 7/21/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

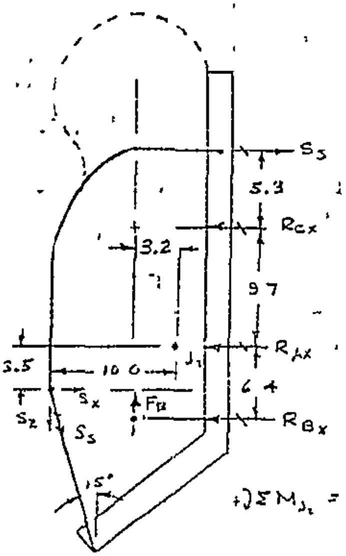
II 2 1.66
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAD
DWG NO

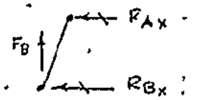
REF

RESCUE COUCH

STRAP LOADS

EYEBALLS UP (UNIT F_B)





$+\circlearrowright \Sigma M_{R_{SX}} = 0 = 3.2\,F_B + 6.4\,R_{BX}$

$R_{BX} = -.50\,F_B$

$\Sigma F_Z = F_B - S_Z = 0$

$S_Z = F_B$

$S_S = \frac{S_Z}{\cos 15°} = \frac{F_B}{\cos 15°}$

$S_S = 1.036\,F_B$

$S_X = (1.036\,F_B) \sin 15°$

$S_X = .268\,F_B$

$+\circlearrowright \Sigma M_{J_1} = 0 = 3.2\,F_B + 6.4\,R_{BX} + 15\,S_S - 9.7\,R_{CX}$
$- 3.5\,S_X - 10\,S_Z$

$9\,7\,R_{CX} = 3.2\,F_B + 6.4(-.50\,F_B) + 15\,(1.036\,F_B)$
$-3\,3(.268\,F_B) - 10\,F_B$

$R_{CX} = \frac{4\,582}{9.7}\,F_B$

$R_{CX} = .47\,F_B$

$\Sigma F_X = S_S - R_{CX} - R_{AX} + S_X - R_{BX} = 0$

$R_{AX} = 1036\,F_B - .47\,F_B + 268\,F_B - (-.50\,F_B)$

$R_{AX} = 1.334\,F_B$

PREPARED BY: HD
CHECKED BY: Carl
DATE: 10-13-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

I.2.1.67
PAGE NO OF
REPORT NO SD 70-
MODEL NO SKYLAB
DWG NO

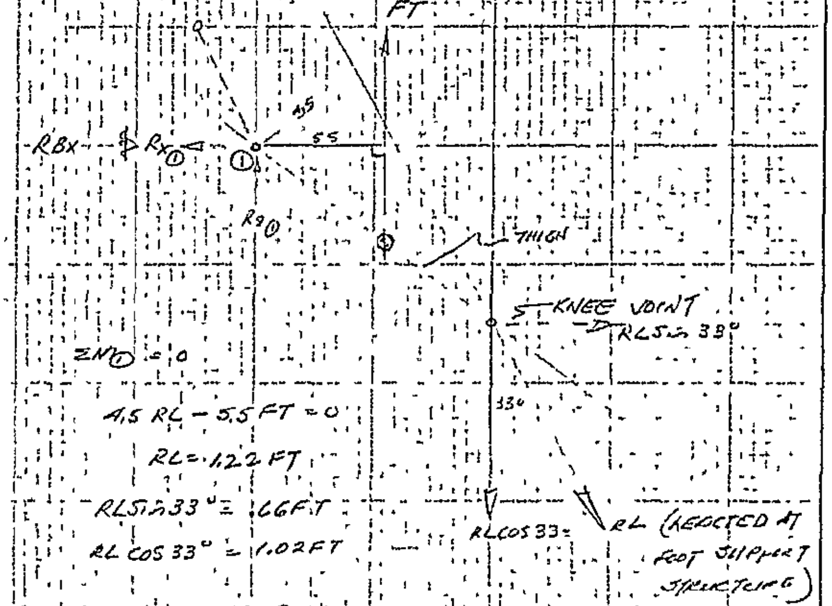
REF

RESCUE COUCH

STRAP LOADS

EYEBALLS UP (1g, 90 PERCENTILE MAN)

UNIT FT



$\Sigma M_① = 0$

$4.5\,RL - 5.5\,FT = 0$

$RL = 1.22\,FT$

$RL \sin 33° = .66\,FT$

$RL \cos 33° = 1.02\,FT$

THIGH MEMBER

$\Sigma F_X = 0$

$RL \sin 33° - R_{X①} = 0$

$R_{X①} = .66\,FT$

$\Sigma F_Z = 0$

$FT - RL \cos 33° + R_{Z①} = 0$

$R_{Z①} = -FT + 1.02\,FT = .02\,FT = .02(54) = 1^{\#}$

PREPARED BY: HTO
CHECKED BY: 2+D
DATE: 2/22/72

SPACE DIVISION
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COMMAND MODULE

PAGE NO II 2.1.68 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

STRAP LOADS (1g)

EYEBALLS UP UNIT LOAD SUMMARY

II 2.1.64 THRU II.2.1.67

REACT \ LOAD	FH	FC	FA	FB	FT
R_{HX}	—	—	—	—	—
R_{CX}	$80 F_H$	$.85 F_C$	$.80 F_A$	$.47 F_B$	—
R_{AX}	$.50 F_H$	$.45 F_C$	$.50 F_A$	$1\ 334 F_B$	—
R_{BX}	—	—	—	$-.50 F_B$	$-.66 F_T$
$2 R_{SSU}$	$1\ 036 F_H$	$1\ 036 F_C$	$1.036 F_A$	$1.036 F_B$	—
R_{SSL}	$1\ 036 F_H$	$1\ 036 F_C$	$1\ 036 F_A$	$1\ 036 F_b$	—
R_L	—	—	—	—	$1.22 F_T$

EYEBALLS UP 1g LOADS FOR 90 PERCENTILE MAN

II 2.1 3

$F_H = 17.2$ LBS (HEAD) $F_B = 23.1$ LBS (BUTTOCKS)

$F_C = 112\ 4$ LBS (CHEST) $F_T = 54.0$ LBS (THIGHS)

$F_A = 11.6$ LBS. (ABDOMEN)

R_{HX}	0.0	
R_{CX}	129 5	
R_{AX}	95 8	134.8
* R_{BX}	-47.15	
$2R_{SSU}$	170.0	
R_{SSL}	170 0	

* R_{BX} TENSION LOAD
MUST BE REDISTRIBUTED
TO R_{AX} AND R_{WSX}

$$R_{AX} = \frac{(47.15)(29)}{3.5} = 39.0 \text{ LBS.}$$

$$2 R_{WSX} = 47.15 + 39.0 = 86.15 \text{ LBS.}$$

PREPARED BY: HTO
CHECKED BY: CLW
DATE: 2/22/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

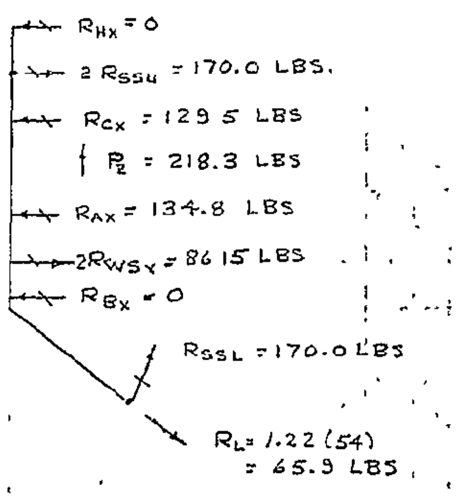
PAGE NO II 2 1 69 OF
REPORT NO SD 70-20
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH

STRAP LOADS

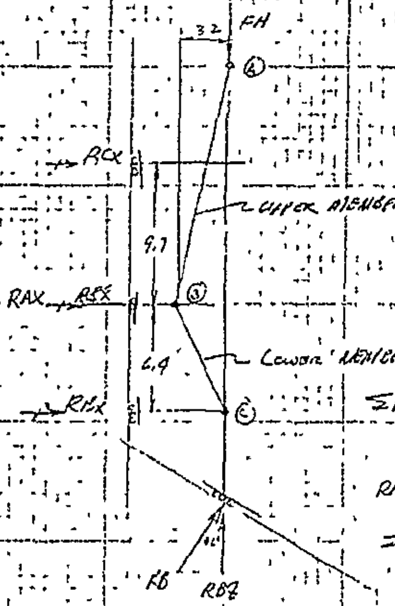
EYEBALLS UP LOAD SUMMARY (1g, 90 % MAN)



PREPARED BY: LD	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	II 2.1.70 PAGE NO OF
CHECKED BY: GLD	RESCUE MISSION	REPORT NO SD 70-205
DATE: 10-7-71	COMMAND MODULE	MODEL NO SKYLAB
REF.		DWG NO.

RESCUE COUCH
STRAP LOADS

EYEBALLS DOWN (UNIT F_H)



UPPER MEMBER

$\Sigma M_B \overset{+}{=} 0$

$FH \times 3.2 + 9.7\ RCX = 0$

$RCX = -\frac{3.2\ FH}{9.7} = -.330\ FH$

$\Sigma F \overset{+}{\rightarrow} = 0$

RAX ~~RSX~~ $= .330\ FH$

LOWER MEMBER

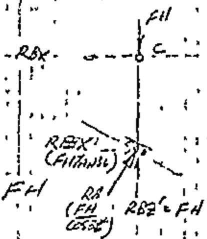
$\Sigma M_C \overset{+}{=} 0$

$RSX(6.4) - FH(3.2) = 0$

RAX ~~RSX~~ $= \frac{3.2\ FH}{6.4} = .50\ FH$

$\Sigma F \overset{+}{\rightarrow} = 0$

$RBX = -.50\ FH$



PT. C

LOAD - FH ↓

$RBZ = FH$

$RB' = \frac{FH}{\cos 36°} = 1.235\ FH$

$RBX' = FH \tan 36° = .729\ FH$

$RBX = RBX' = .729\ FH$

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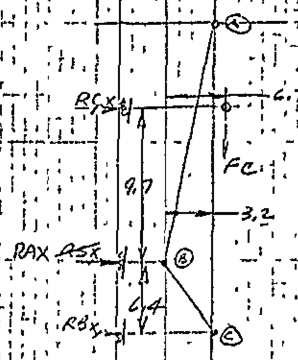
CHECKED BY: GLD	RESCUE MISSION	REPORT NO SD 70-205
DATE: 10-7-71	COMMAND MODULE	MODEL NO SKYLAB
REF.		DWG NO.

RESCUE COUCH
STRAP LOADS

EYEBALLS DOWN (UNIT F_C)



UPPER MEMBER

$\Sigma M_B \overset{+}{=} 0$

$FC(6.7) + RCX(9.7) = 0$

$RCX = -\frac{6.7}{9.7} FC = -.69\ FC$

$\Sigma F \overset{+}{\rightarrow} = 0$

RAX ~~RSX~~ $- .69\ FC = 0$

RAX ~~RSX~~ $= .69\ FC$

LOWER MEMBER

$\Sigma M_C \overset{+}{=} 0$

$RSX(6.4) - FC(3.2) = 0$

RAX ~~RSX~~ $= \frac{3.2}{6.4} FC = .50\ FC$

$\Sigma F \rightarrow = 0$

$.50\ FC + RBX = 0$

$RBX = -.50\ FC$

REACTION AT SEAT PAN
SAME AS FH LOADING

$RB = 1.235\ FC$

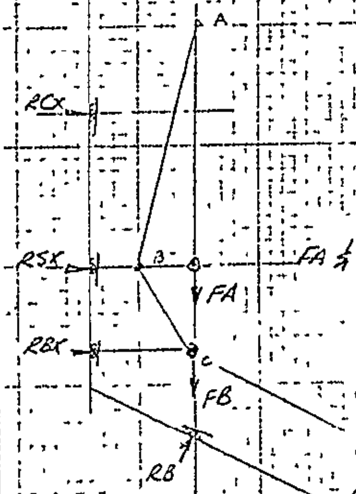
$RBX = -.729\ FC$

REF

RESCUE COUCH

STRAP LOADS

EYEBALLS DOWN (UNIT F_A AND F_B)



FA & FB IS TRANSFERRED DIRECTLY TO PT. C

∴ REACTION AT SEAT PAN SAME AS FH LOADING

UNIT FA

RB = 1.235 FA

RBX = -.729 FA

UNIT FB

RB = 1.235 FB

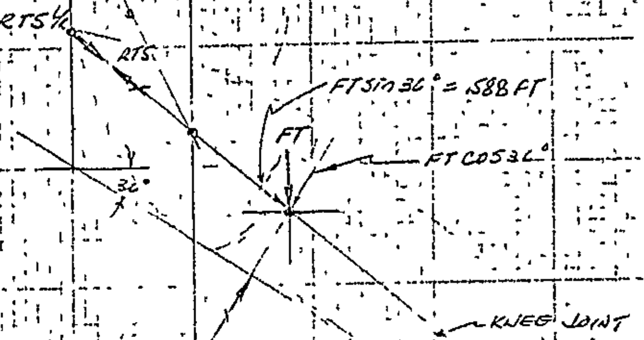
RBX = -.729 FB

REF

RESCUE COUCH

STRAP LOADS

EYEBALLS DOWN (UNIT F_T)



θ = 36°

SIN θ = .588

COS θ = .81

RT = FT COS 36° = .81 FT

ASSUME: FT SIN 36° IS REACTED BY THIGH STRAPS
NO LOADS REACTED AT KNEE JOINT

2 RTS = FT SIN 36° = .588 FT

PREPARED BY: HTO
CHECKED BY: G.F.
DATE: 2/7/71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
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COMMAND MODULE

PAGE NO. II 2.1.74 OF
REPORT NO SD 70-205
MODEL NO SKYLAC
DWG NO

REF

RESCUE COUCH

STRAP LOADS

EYEBALLS DOWN UNIT LOAD SUMMARY

II.2.1.72 THRU II 2 1.73

LOAD / REACT	F_H	F_C	F_A	F_B	F_T
R_{HX}	—	—	—	—	—
R_{CX}	$-.33 F_H$	$-.69 F_C$	—	—	—
R_{AX}	$.83 F_H$	$1\ 19 F_C$	—	—	—
R_{BX}	$-1\ 23 F_H$	$-1.29 F_C$	$-.73 F_A$	$-.73 F_B$	—
R_B	$1.24 F_H$	$1\ 24 F_C$	$1\ 24 F_A$	$1.24 F_B$	—
R_T	—	—	—	—	$.81 F_T$
$2 R_{TS}$	—	—	—	—	$.586 F_T$

EYEBALLS UP 1g LOADS FOR 50 PERCENTILE MAN

II.2.1.3

$F_H = 17.2$ LBS (HEAD)
$F_C = 112.4$ LBS (CHEST)
$F_A = 11.6$ LBS (ABDOMEN)
$F_B = 23\ 1$ LBS (BUTTOCKS)
$F_T = 54.0$ LBS. (THIGHS)

$R_{HX} = 0$
* $R_{CX} = -83.2$ LBS
$R_{AX} = 148$ LBS
* $R_{BX} = -191.7$ LBS
$R_B = 203.7$ LBS
$R_T = 43.7$ LBS
$R_{TS} = 31\ 8$ LBS.

* THESE TWO TENSION LOADS MUST BE REDISTRIBUTED. REFER TO THE FOLLOWING PAGES.

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 2/22/73

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COMMAND MODULE

PAGE NO II 2 1 75 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

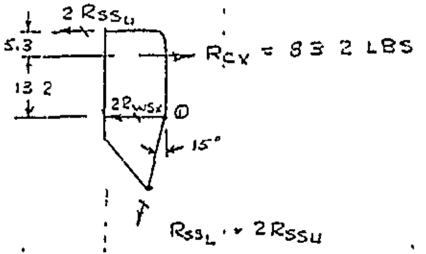
RESCUE COUCH

STRAP LOADS

EYEBALLS DOWN

REDISTRIBUTE THE R_{CX} TENSION LOAD TO THE SHOULDER AND WAIST STRAPS

II.2.1 74



$$\Sigma M_{①} = 0 = 13\ 2\ R_{CX} - 18\ 5\ (2 R_{SSU})$$

$$2 R_{SSU} = .72\ R_{CX}$$

$$= \underline{59\ 9\ \text{LBS.}}$$

$$\Sigma F_X = 0 = R_{CX} - 2 R_{SSU} - 2 R_{SSU} \sin 15° - 2 R_{WSX}$$

$$2 R_{WSX} = R_{CX} - .72\ R_{CX} - .1865\ R_{CX}$$

$$= .094\ R_{CX}$$

$$2 R_{WSX} = \underline{7.82\ \text{LBS.}}$$

REF.

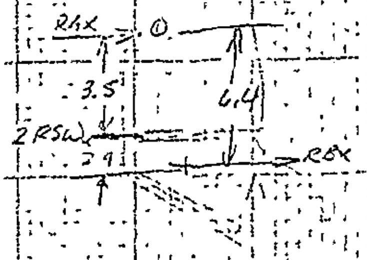
RESCUE COUCH

STRAP LOADS

EYEBALLS DOWN

REDISTRIBUTION OF RBX (TENSION LOAD) TO RWS & RAX

II.21.74



$\Sigma M_{RAX} = 0$

$$(2RSW_x) = \frac{RBx\,6.4}{3.5}$$

$$RSW_x = .914RBx = .914(191.7) = 175.2\#$$

$\Sigma F_R = 0$

$$RBX - 2RSW + RAX = 0$$

$$RAX = 2(175.2) - 191.7 = 158.7\#$$

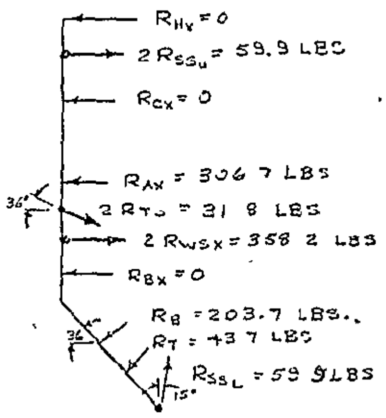
REF

RESCUE COUCH

STRAP LOADS

EYEBALLS DOWN LOAD SUMMARY (1g ; 90% MAN)

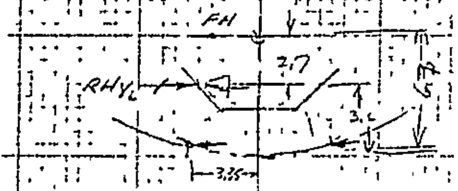
II 2 1.74
THRU
II 2 1.76



REF.

RESCUE COUCH
STRAP LOADS

EYEBALLS LEFT (UNIT FH)

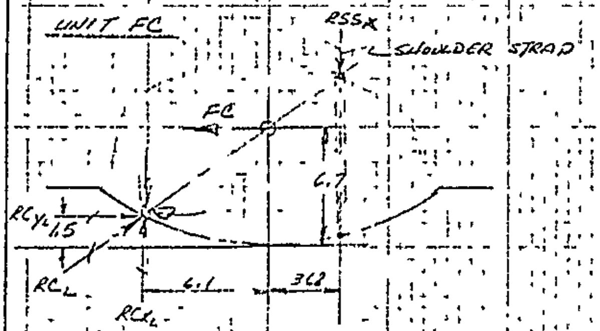


ASSUME HEAD REST REACT LATERAL LOAD ONLY.
UNBALANCED MOMENT REACTED AT CHEST $(M = 2.7 \cdot FH)$

$\Sigma F_Y = 0$

$RHY = FH$

UNIT FC



$\Sigma F_Y = 0$

$RCY_L = FC$

$\Sigma M_{RC_L} = 0$

$9.78 \, RSS_X = 5.2 FC \qquad RSS_X = \frac{5.2 FC}{9.78} = .53 FC$

REF

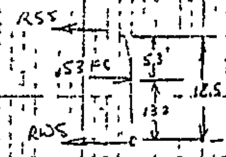
RESCUE COUCH
STRAP LOADS

EYEBALLS LEFT

UNIT FC

$\Sigma F_X = 0$

$RCX_L = RSS_X = .53 FC$



$RSS = \frac{.53 FC \times 13.2}{18.5} = .38 FC$

$RDS = .53 FC - .38 FC = .15 FC$

MOMENT DUE TO FH AT FC

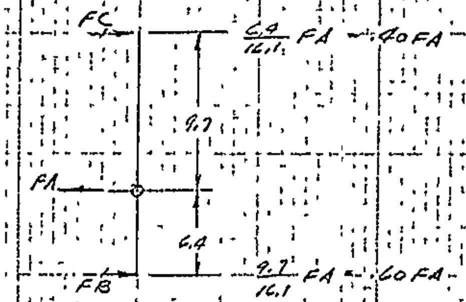
$M = 2.7 FH$

$RSS_X = \frac{2.7 FH}{9.78} = .276 FH \qquad RSS = \frac{.276 FH \times 13.2}{18.5} = .197 FH$

$RCX_L = RSS_X = .276 FH \qquad RDS = .276 FH - .197 FH = .079 FH$

UNIT FA

ASSUMPTION - NO LATERAL LOAD CAPABILITY AT FA
FA IS REACTED AT FC & FB.



$\frac{6.4}{16.1} FA = .40 FA$

$\frac{9.7}{16.1} FA = .60 FA$

PREPARED BY: LJO
CHECKED BY: C.F.
DATE: 10-19-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
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COMMAND MODULE

PAGE NO II 2.180 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

RESCUE COUCH
STRAP LOADS

EYEBALLS LEFT
UNIT FA

.40 FA AT FC (REF. UNIT FC CASE)

$\Sigma F_y = 0$

$RC_{YL} = .40\ FA$

$\Sigma M_{RCL} = 0$

$9.78\ RSS_R = 5.2(.40 FA)$ $RSS = \frac{.21 FA \times 13.2}{18.5} = .15FA$

$RSS_X = \frac{2.1 FA}{9.78} = .21FA$ $RWS = .21FA - .15FA = .06FA$

$\Sigma F_x = 0$

$RCX_L = RSS_X = .21\ FA$

.60 FA AT FB (REF. UNIT FB CASE)

$\Sigma F_y = 0$

$RBY_L = .60 FA$

$\Sigma M_{RBY} = 0$

$RWS_X = .40(.60FA) = .24FA$

$\Sigma F_x = 0$

$RBX_L = .48\ FA$

PREPARED BY: LJO
CHECKED BY: C.F.
DATE: 10-19-71

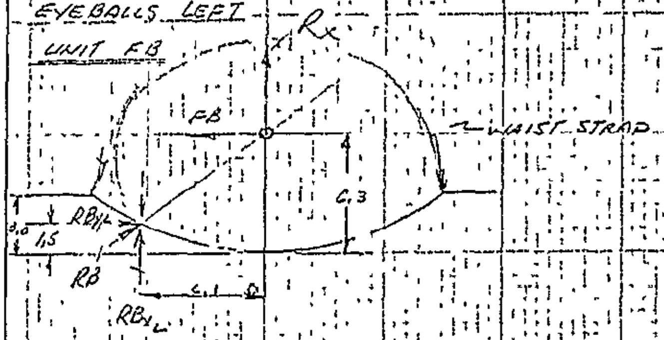
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. II 2.181 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

RESCUE COUCH
STRAP LOADS

EYEBALLS LEFT
UNIT FB



$\Sigma F_y = 0$

$RB_{YL} = FB$

$\Sigma M_{RB} = 0$

$6.1 RX = 4.8 FB$

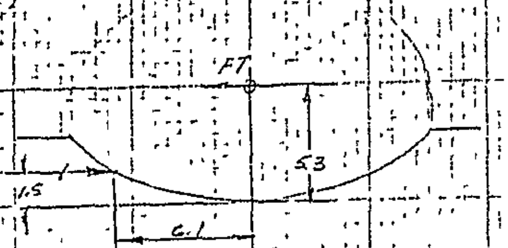
$RX = \frac{4.8}{6.1} FB = .79FB$

$\Sigma F_x = 0$ $2\ RWS_{XY_R} = Rx = .79\ FB$

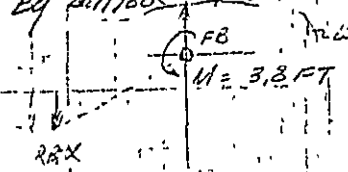
$RBX_L = RX = .79FB$

RESCUE COUCH
STRAP LOADS

EYE BALLS LEFT
UNIT FT



ASSUME $RTY_L = FT$ & UNBALANCED MOMENT REACTED BY BUTTOCK & WAIST STRAP



$$\Sigma M_{RT} = 0$$

$$2\ RWS = \frac{3.8FT}{6.1} = .62FT$$

$$\Sigma F_Z = 0$$

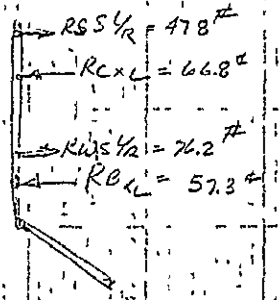
$$RB_{XL} = RWS_{2} = .62FT$$

RESCUE COUCH
STRAP LOADS

EYEBALLS LEFT LOAD SUMMARY (1g, 90% MAN)

REF: II 2.1.79 THRU II 2.1.82; II.2.1.3

	FH	FC	FA	FB	FT	1g Unit Load
RHY_L	FH	—	—	—	—	17.2#
RCY_L	—	FC	.40FA	—	—	117"
RCX_L	.28FH	.53FC	.21FA	—	—	66.8
RBY_L			.60FA	FB		30.1
RBX_L			.48FA	.79FB	.62FT	57.3
RTY_L					FT	54
RSS ½R	.20FH	.38FC	.18FA			47.8
RWS ½R	.08FH	.15FC	.66FA .48FA	.79FB	.62FT	76.2



SECTION II.2.2

URINE CHILLER ADAPTER FRAME

URINE CHILLER ADAPTER FRAME

The urine chiller adapter frame on the Skylab rescue vehicle provides the capability to return the M071/73 urine chiller of the rescued vehicle. The adapter frame is located in the Command Module's A8 stowage locker location and utilizes the A8 fittings on the aft bulkhead. For launch purposes, 200 pounds of steel ballast are secured to the adapter frame.

The M071/73 urine chiller is restrained by four steel cable-beta webbing strap assemblies The ballast is composed of four steel plates bolted together to the adapter frame by four bolts.

Two helmets in a double helmet bag are secured to the top of the urine chiller by beta webbing straps that are part of the helmet bag.

"Boeing criteria" acceleration factors are utilized with the urine chiller while abort landing acceleration factors are used for the ballast. The maximum I.C.D. weight of 158 pounds is used in the analysis for conservatism

PREPARED BY
CHECKED BY G F
DATE 20 MARCH 70

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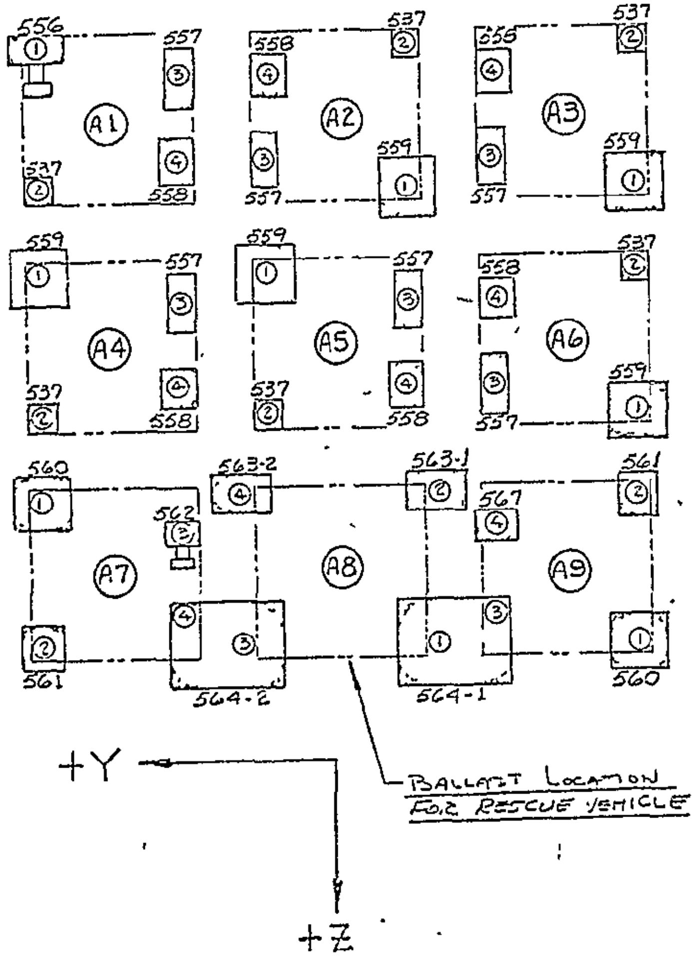
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II 224 OF
REPORT NO. SD 70-205
MODEL NO SKYLAB

URINE CHILLER ADAPTER FRAME

SKYLAB AFT BULKHEAD FITTINGS
THREE DIGIT NUMBERS SHOWN ARE PREFIXED
BY V56-317 XXX



PREPARED BY: G.F.
CHECKED BY: F.O.R.
DATE: 2/5/73

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PAGE NO II 223 OF
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MODEL NO SKYLAB
DWG NO

REF

URINE CHILLER ADAPTER FRAME

S.L RESCUE MISSION

	I C D.	MAY PROBABLE	CURRENT CALCULATION
URINE CHILLER (INCLUDE URINE)	*158	122	116
HELMETS @ 2 7 LBS EACH		5 4	5.4
DOUBLE BAG @ 2.6 LBS		2 6	2 6
TOTAL WT	158	130.0	124.0

CURRENT MAX CALCULATED = 2130 LBS @ 158 LBS

POSSIBLE USEABLE LOAD = 1750 LBS @ 130 LBS

" " " = 1670 LBS @ 124 LBS

SINCE THE I C.D WEIGHT IS THE HIGHEST OF THE THREE, IT IS USED IN THE FOLLOWING LOADS DEVELOPMENT.

*158 LBS FROM MCR 13514

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II 2.2.4
PAGE NO OF
REPORT NO. SD 70-205
MODEL NO SKYLAB
DRWG NO

REF

URINE CHILLER ADAPTER FRAME

ACCELERATION CRITERIA
FOR URINE CHILLER AS STOWED
IN RESCUE VEHICLE

BOEING CRITERIA

ASSUME C.G. AT $Y=0$, $Z=20.65$ & $W_c = 750$ #

$R = 56.5$ IN

$Z/R = .365$

$$f = \left(\frac{206}{206+900}\right)^{\frac{1}{2}} = .432$$

$$g_{x\,MAX} = 149 f = 64.4$$

$$K = g_{x\,MAX}\left[1 - \frac{Y^2}{143(R^2+Z^2)}\right]$$

MCRA 12768

SINCE $Y=0$ $\frac{K}{g_{x\,MAX}} = 1$

$K = 64.4$

FROM CURVE $\frac{g_x}{K} \approx 1.0$

$g_x = 64.4$

$$g_{x-} = \frac{2}{3}\left(\frac{Z}{R}+1\right)\frac{K}{g_{x\,MAX}}\,g_x$$

$$= 58.5$$

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II 2.2.5
PAGE NO OF
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MODEL NO SKYLAB
DRWG NO

REF

URINE CHILLER ADAPTER FRAME

$g_Y = \pm .125\, g_x = 8.05$

$g_Z = \pm .25\, g_x = 16.1$

URINE CHILLER MAX. WGT. = 158 #
ADAPTER FRAME WGT 18.5 #
TOTAL 176.5 #

$P_x = 176.5 \times 64.4 = 11{,}400$ #

$P_{x-} = 176.5 \times (-58.5) = 10{,}350$ #

$P_Y = \pm 176.5 \times 8 = 1415$ #

$P_Z = \pm 176.5 \times 16.1 = 2830$ #

COMBINE X, Y & Z LOADS OR
USE SINGULAR VECTOR WHICHEVER IS CRIT.

FACTOR OF SAFETY = 1.0

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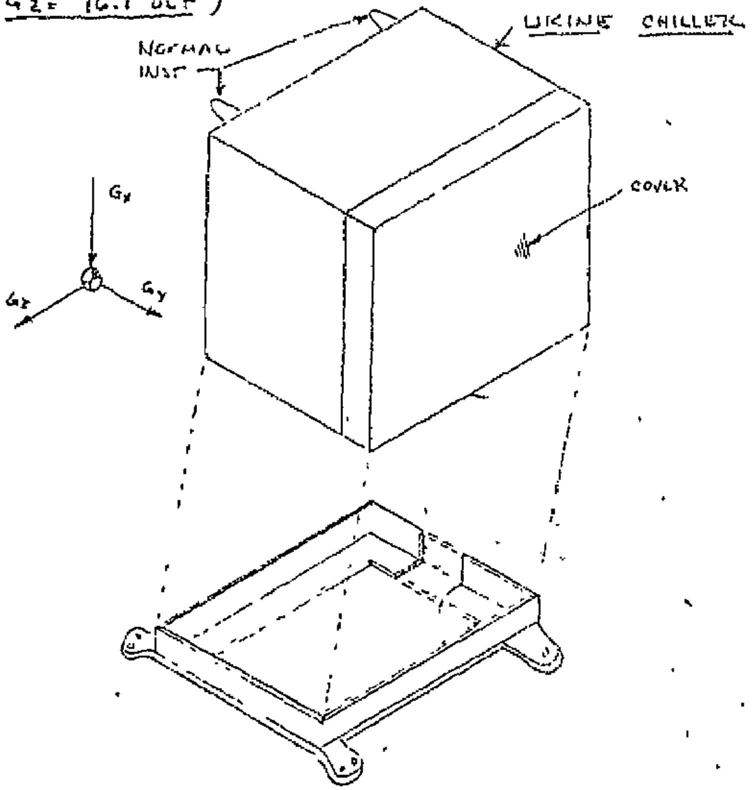
DATE: 1/31/72	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO

URINE CHILLER ADAPTER FRAME

$G_x = 6.4$ ULT
$G_y = 8.0$ ULT
$G_z = 16.1$ ULT

TO BE COMBINED $G_x + G_y + G_z$



NOTE: SUPPORT FRAME WILL TAKE LOADS ALONG CORNER OF ANGLE CROSSSECTION.

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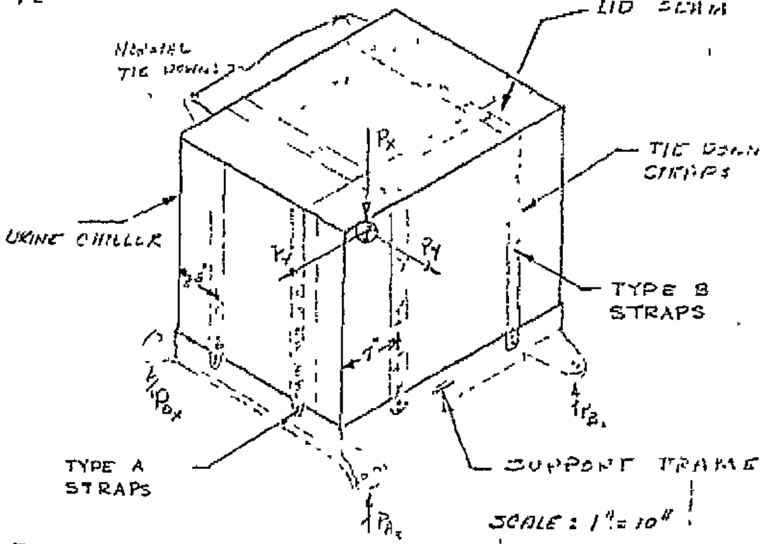
DATE: 1/31/72	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO

URINE CHILLER ADAPTER FRAME

ESTIMATED WEIGHT - URINE CHILLER = 158 #

$P_x = 11{,}400$ # ULT $(-P_x = -10{,}350$ # ULT$)$
$P_y = \pm 1415$ # ULT
$P_z = \pm 2830$ # ULT

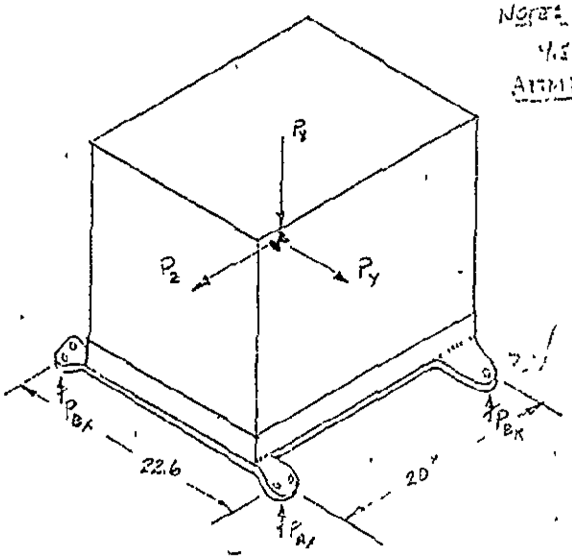


$P_{A_y} = 3822$ # ULT
$P_{B_y} = 2472$ # ULT
$P_{C_y} = 1878$ # ULT
$P_{D_y} = 3228$ # ULT

URINE CHILLER ADAPTER FRAME

SUPPORT POINT LOADS

NOTE: C.G. IS 9.5" ABOVE ATTMT PLANE



$$P_{Ax} = \frac{P_z(9.5)}{2(20)} + \frac{P_y(9.5)}{2(22.6)} + \frac{P_x}{4} = 675 + 297 + 2850$$

$$= 3222^{\#}$$

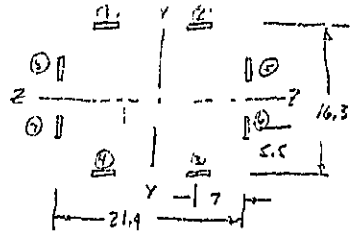
$$P_{Bx} = -675 + 297 + 2850 = 2472^{\#}$$

$$P_{Cx} = -675 - 297 + 2850 = 1878^{\#}$$

$$P_{Dx} = 675 - 297 + 2850 = 3228^{\#}$$

URINE CHILLER ADAPTER FRAME

MAX STRAP LOADINGS ($N_x = 9200^{\#}$) (PLUS [illegible]



SPAN (1-2) = 21.4-14 = 7.4

SPAN (5-6) = 16.3-11 = 5.3

$$P/A = \frac{10350}{8} = 1295^{\#}$$

ASSUME (a) STRAPS (2-3) + (1-4) TAKE M_y
(b) STRAPS (5-8) + (6-7) TAKE M_z

1265

$P/_{STRAP\,(2-3)} = \frac{2850(9.5)}{2(7.4)} = 1790^{\#}$ $P/A = 1295$, TOTAL $3085^{\#}$

$P/_{STRAP\,(1-4)} = -1790^{\#}$ " TOTAL $-495^{\#}$

$P/_{STRAP\,(5-8)} = \frac{(1415)(9.5)}{2(5.3)} = 1270$ " TOTAL $2565^{\#}$

$P/_{STRAP\,(6-7)} = -1270$ " TOTAL $25^{\#}$

(STRAP (1-4) COULD GO SLACK)

NOTE: NO APPRECIABLE PRELOAD CAN BE INTRODUCED INTO THE STRAPS DUE TO INSTALLATION IN A SPACE ENVIRONMENT.

STRAP MATERIAL HAS AN ELONGATION QUALITY OF 20.7% TO ULTIMATE, ENABLING THE CHILLER TO LIFT OFF FROM THE FRAME.

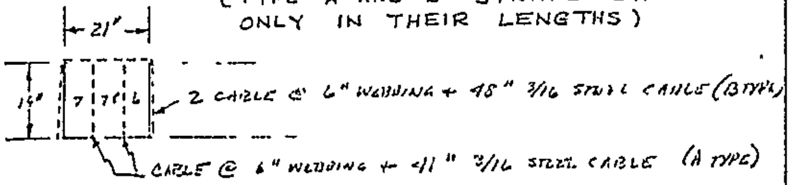
REF

URINE CHILLER ADAPTER FRAME

RE-EVALUATION OF LOADS BASED UPON THE USE OF STEEL CABLE OVER MOST OF THE LENGTH OF THE TIE-DOWN STRAPS.

USING THE Z & X LOAD COMPONENTS (AS ORIGINALLY COMPUTED)

(TYPE A AND B STRAPS DIFFER ONLY IN THEIR LENGTHS)



A TYPE MAX LOAD = 3085#

DEFLECTION PROPERTIES

- STRAP – LINEAR TO 25% e @ 3300#
- CABLE – PER ANC-5, CRES CABLE.

$\delta = (6")(\frac{3085}{3300})(.25) + (41")(.012\%)$

$= 1.40" + .49" = 1.89"$ TOTAL STRAIN

(PACKAGE RISE = $\frac{1}{2}\delta$ = .945" @ STRAP)

PACKAGE CORNER RISE = $\frac{20.5}{14.5}(.945)$ = 1.34 IN

B TYPE MAX LOAD = 1295# (SAME DEFLECTION PROPS)

$\delta = (6")(\frac{1295}{3300}).25 + (48")(.0122) =$

$= .59 + .29 = .88$ IN

PACKAGE CORNER RISE = .88 IN ASSUMING ALL STRAIN TO ONE SIDE.

∴ CORNER RISE ON A TYPE NOT EQUAL TO RISE ON B TYPE. REDUCE LOAD ON A TYPE, INCREASE ON B TYPE.

REF

URINE CHILLER ADAPTER FRAME

ASSUME ½ OVERTURNING MOMENT TAKEN AS SHOWN IN ORIGINAL CALCULATIONS – REF PAGE II.2.2.8 , THIS ANALYSIS.

$P_{STRAP\,(2)(C)} = 1295 + \frac{1790}{2} = 1295 + 895 = 2190\#$ 1905

ASSUME BALANCE TAKEN BY B TYPE CABLES:

$\Sigma M_{CORNER} = 0$

LATERAL LOAD = $\frac{1}{2}(2830) = 1415\#$ 250 – 2 LOAD

Δ CABLE LOAD = $\frac{(1415)(9.5)}{(2)(21)} = 320\#$

B TYPE CABLE LOAD = 1295 + 320 = 1625# 1437

A TYPE $\delta = (6)(\frac{2190}{3300})(.25) + (41")(.0095)$

$= .995 + .39 = 1.385$ IN

PACKAGE RISE = $(\frac{1.385}{2})(\frac{20.5}{14.5}) = .975$ IN

B TYPE $\delta = (6")(\frac{1625}{3300})(.25) + (48)(.0075)$

$= .74 + .36 = 1.10$ IN PACKAGE RISE.

∴ MORE LOAD SHOULD GO TO A TYPE STRAP.
ASSUME 60% OF OVERTURNING MOMENT TO A TYPE.

$P_{A\,TYPE} = 1295 + (.6)(1790) \approx 1295 + 1070 = 2365\#$

$\delta = (6)(\frac{2365}{3300})(.25) + (41)(.0095)$
$= 1.07 + .39 = 1.46$ IN

CORNER RISE = $(\frac{1.46}{2})(\frac{20.5}{14.5}) = 1.03$ IN

PREPARED BY: WFG.
CHECKED BY: RGR
DATE: 4/12/72

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PAGE NO II 2 2.12 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

URINE CHILLER ADAPTER FRAME

$$\Delta P_{BTYPE} = \frac{(.4)(30851)(9.5)}{2(21)} = \underline{280}^{\#}$$

$$P_{BTYPE} = 1295 + 280 = \underline{1575}^{\#}$$

$$\delta_{BTYPE} = (6'')\left(\frac{1575}{3303}\right)(25) + (48)(.0073)$$

$$= .715 + .35 = \underline{1.065\,IN}$$

$$A_{TYPE} = B_{TYPE} \quad @ \approx 1.04\,IN \text{ CORNER RISE}$$

$\therefore$ MAXIMUM LOAD IN ANY STRIP = $\underline{2365}^{\#}$

PREPARED BY: RGR
CHECKED BY:
DATE: 16 Jan 73

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PAGE NO II 2.2.13 OF
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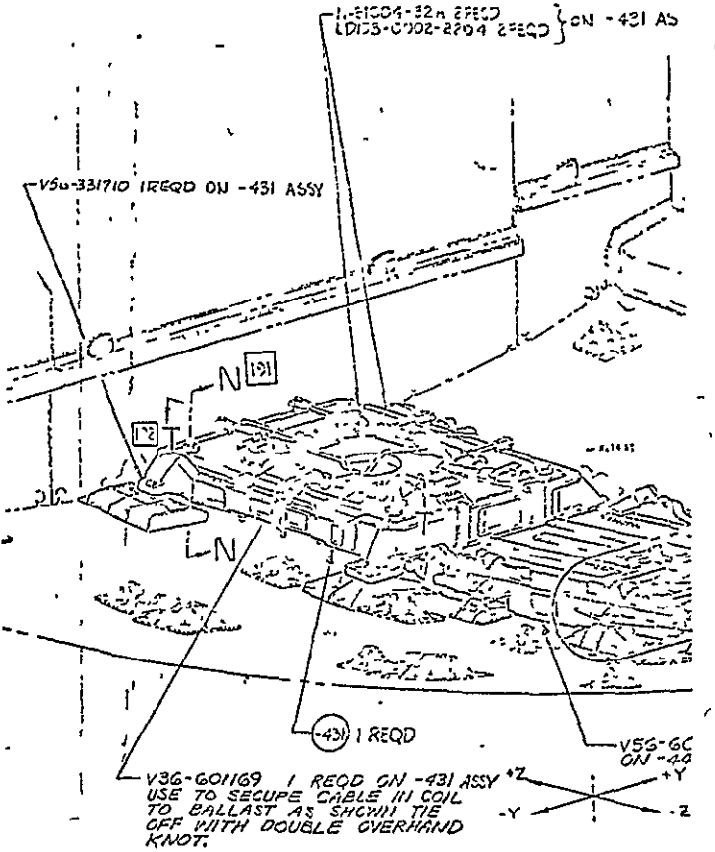
URINE CHILLER ADAPTER FRAME
BALLAST LOADING



V36-601169 1 REQD ON -431 ASSY
USE TO SECURE CABLE IN COIL TO BALLAST AS SHOWN TIE OFF WITH DOUBLE OVERHAND KNOT.

BALLAST PROVISIONS - URINE CHILLER FRAME
SEE FOLLOWING PAGE FOR DETAILED INSTALLATION

PREPARED BY: RGR
CHECKED BY: Corn
DATE: 16 JAN 73

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PAGE NO II 2 - 14 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
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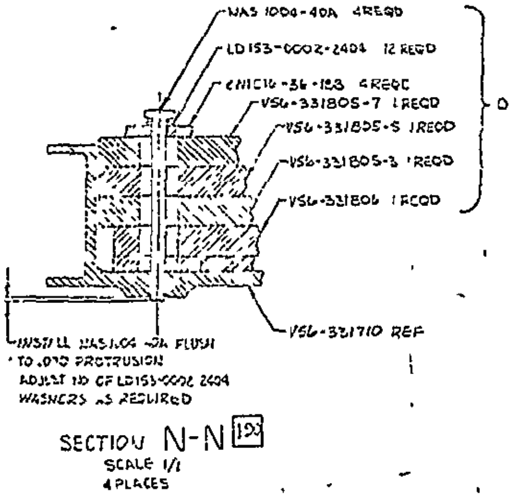
REF

URINE CHILLER ADAPTER FRAME

BALLAST LOADING



SECTION N-N 123
SCALE 1/1
4 PLACES

TYPICAL BALLAST INSTALLATION PROVISIONS.

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DATE: 4 JAN 73

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PAGE NO II 2 - 15 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

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URINE CHILLER ADAPTER FRAME

BALLAST LOADING

FOR RESCUE VEHICLE LAUNCH FOUR STEEL PLATES ARE BOLTED DOWN TO URINE CHILLER FRAME (V56-331710) FOR SPACECRAFT STABILITY. PLATES ARE BOLTED DOWN BY FOUR NAS 1004-40A BOLTS. CRITICAL CONDITION IS AN ABORT LANDING WITH "g_x" = 78.

PLATES

3 V56-331805

$$3(.65)(16.92)(21.50)(.3^{\#}/in^3) = 159^{\#}$$

1 V56-331806

$$(.65)(15.88)(20.99)(.3^{\#}/in^3) = 50^{\#}$$

ULTIMATE LOAD @ 78 g's (CALC'D)

$$P = 78(209)$$

$$P = 16{,}300^{\#}\ \underline{ULT}$$

WEIGHTS GROUP GIVES BALLAST LOAD AS

$$P = 200^{\#}$$

$$P_{APP} = 78(200) = 15{,}600^{\#}\ \underline{ULT}$$

"X" REACTIONS ONLY

$$R_{X_1} = \frac{15{,}600}{4} = 3{,}910^{\#}$$

PREPARED BY: RGR
CHECKED BY:
DATE. 17 JAN 73

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II.2.2.16
PAGE NO. 1 OF
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DWG. NO

REF.

URINE CHILLER ADAPTER FRAME

BALLAST LOADING

BALLAST PLATE INSTALLATION TOLERANCES

INTERNAL DIMENSIONS ADAPTER FRAME

V56-331712

$L_1 = 16.48''$
$L_2 = 21.56''$

EXTERNAL DIMENSIONS OF BALLAST PLATES

V56 331805

$L_1 = 16.36''$
$L_2 = 21.42''$

$$D_1 = 1/2(16.48 - 16.36)$$
$$D_1 = .06''$$
$$D_2 = 1/2(21.56 - 21.42)$$
$$D_2 = .07''$$

THESE TOLERANCES DO NOT PERMIT SHEAR AND/OR BENDING IN NAS 1004-40A BOLTS. THEREFOR ALL LATERAL LOAD IS DELIVERED TO WALLS OF V56-331712 FRAME ASSEMBLY.

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URINE CHILLER ADAPTER FRAME

FITTING LOADS COMPARISON

PREPARED BY: G.F.
CHECKED BY: RSR
DATE: 3/15/73
REF.

CASE	LOAD FACTR	R_{1X}	R_{1Y}	R_{1Z}	R_{2X}	R_{2Y}	R_{2Z}	R_{3X}	R_{3Y}	R_{3Z}	R_{4X}	R_{4Y}	R_{4Z}
A8 BOX	X = 20	1094			1162			1094			1162		
+SUIT	X = -78	-1486			-1564			-1486			-1564		
225.6 LBS	Y = 30	1424	1316		1493	1392		-1424	1974		-1493	2087	
30% X LOAD	Y = -30	-1424	-1974		-1493	-2087		1424	-1316		1493	-1392	
	Z = 78	-3740		5279	3740		3519	-3740		5279	3740		3519
	X=-39 Z=-675	2494		-3046	-4018		-4569	2494		-3046	-4018		-4569
*BALLAST	X = 20	1090			1090			1090			1090		
218 5 LBS	X = -78	-4270		—	-4270			-4270			-4270		
100% X LOAD	Y = ± 30		±1640			±1640			±1640			±1640	
	Z = 78			4270			4270			4270			4270
	X=-39 Z=-675	2140		3700	2140		3700	2140		3700	2140		3700
CHILLER	X=58 5	2580			2580			2580			2580		
158	X=-64.4	-2850			-2850			-2850			-2850		
+18.5	Y = 8.0	297	354		297	354		-297	354		-297	354	
176.5 LBS	Y = -8.0	-297	-354		-297	-354		297	-354		297	-354	
100% X LOAD	Z = 16.1	-675		710	675		710	-675		710	675		710
	Z = -16.1	675		-710	-675		-710	675		-710	-675		-710
	-X - Y + Z	-3822	-354	710	-2472	-354	710	-3228	-354	710	-1878	-354	710

* LOADS DUE TO AN OVERTURNING MOMENT ARE IGNORED DUE TO THE LOW C.G. OF THE BALLAST PLATES.

88

SECTION II.2.3

STOWAGE PALLET

STOWAGE PALLET

Stowage provisions on the rescue vehicle are provided by the stowage pallet, located on the Command Module aft bulkhead. The pallet is located between the rescue couches and utilizes the A2 and A5 stowage locker fittings.

The stowage pallet consists of the pallet frame and cloth container. The container is secured to the frame with beta webbing straps.

Acceleration factors effecting the pallet are derived from "Boeing criteria" as presented in MCR A12768. These factors are ultimate.

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NORTH AMERICAN ROCKWELL CORPORATION

RESCUE MISSION--

COMMAND M. [illegible]

STOWAGE PALLET

PREP'D BY: GD

CHECKED BY: [illegible]

DATE 10/19/1973

REF.

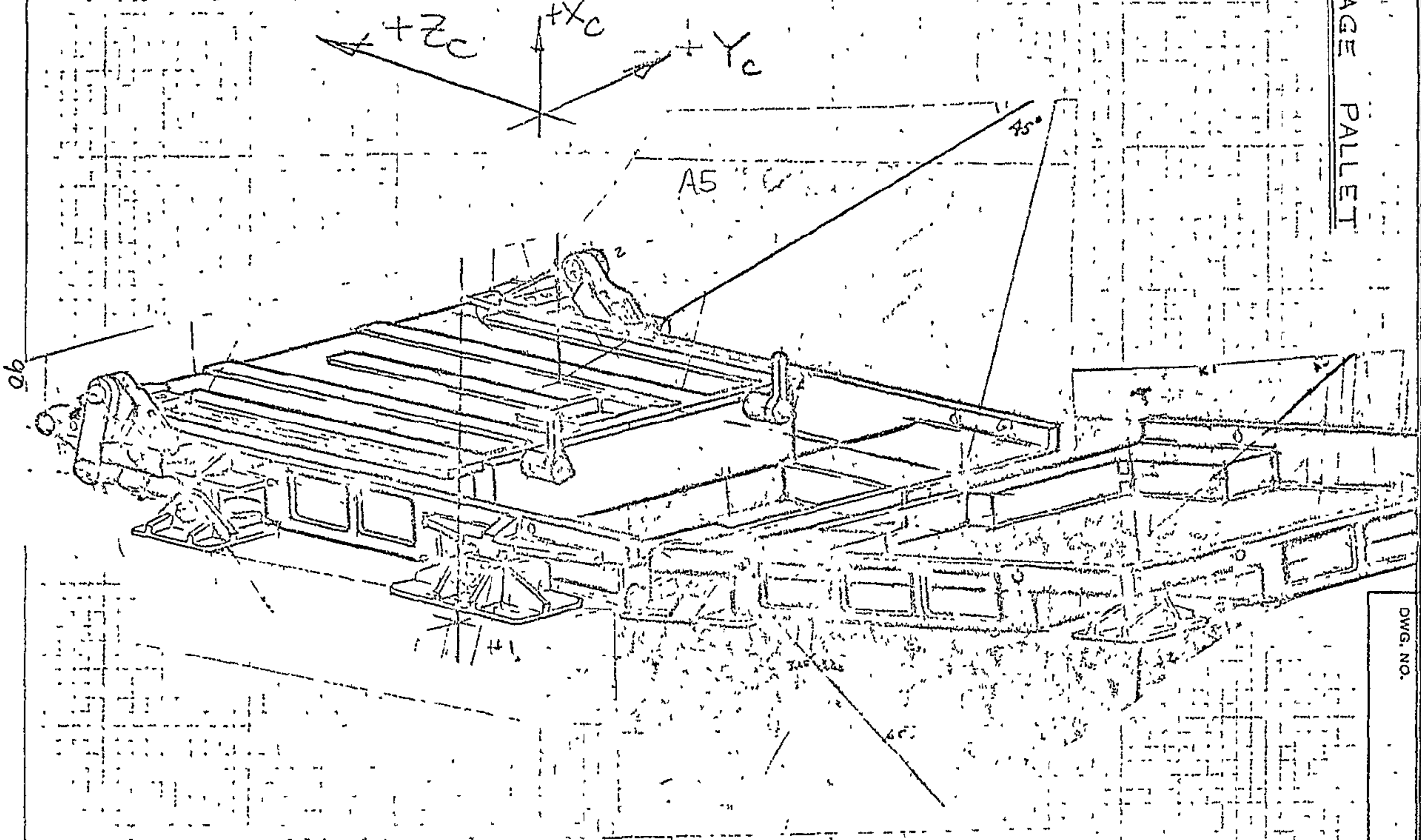
PAGE NO II.2.3.? - OF

REPORT NO. SD 70-205

MODEL NO. SKYLAB

DWG. NO.

SKETCH of STOWAGE PALETTES



PREPARED BY: GJD
CHECKED BY: WJ

DATE: MARCH 10 72

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II. 2 3 3
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

STOWAGE PALLET

10 lb

APPROXIMATE STOWAGE LOCATIONS

LOCATION	Y_c	Z_c
A5	0	-4.5
A2	0	-28.5

CALCULATION of LOADS BASED ON BOEING CRITERIA

LOCATION	Z/R	f^*	$g_{x_{MAX}}$	K	g/K^+	g_x	g_{x-}	g_y	g_z
A5	-.08	.432	64.3	64.3	.8	51.4	31.5	±6.42	±12.82
A2	-.50	.432	64.3	64.3	.55	35.4	11.8	±4.42	±8.84

MCR 30577

THE DESIGN STOWAGE CRITERIA = 35 lb/FT³

+ $100 < W_c < 1300$ lb CURVE
* BASED ON $W_c = 900$ lb

PREPARED BY: GJD
CHECKED BY: WJ

DATE: MARCH 12, 72

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II. 2 3 4
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

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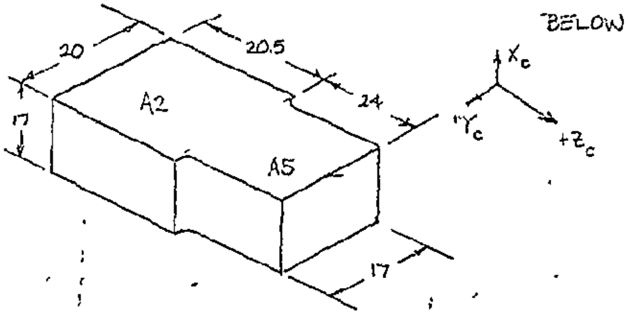
STOWAGE PALLET
EXTERNAL LOADS

THE APPROXIMATE ENVELOPE FOR THE BAG IS SHOWN BELOW.



APPROXIMATE VOLUMES FOR THE TWO STOWAGE LOCATIONS,

A2 VOLUME = 6970 IN³ = 4.03 FT³
A5 VOLUME = 6940 IN³ = 4.02 FT³

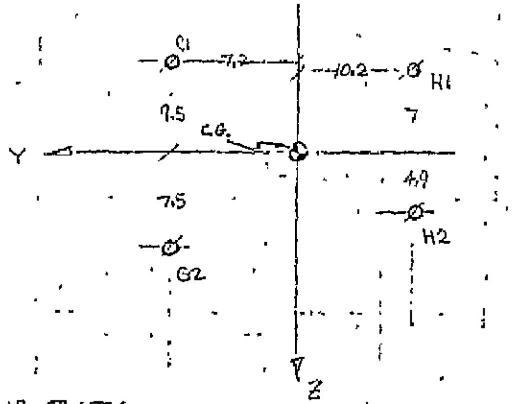
THE CORRESPONDING WEIGHTS BASED ON 35 lb/FT³,

A2 WEIGHT = 141 lb.
A5 WEIGHT = 141 lb

STOWAGE PALLET
LOADS ON FITTINGS

LOOKING NOW AT THE AFT BULKHEAD FITTINGS

A5 CONFIGURATION – LOOKING AFT



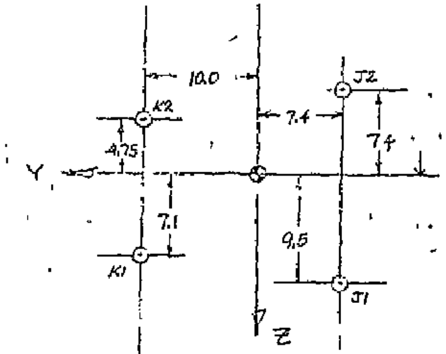
FITTING FIXITY –

FITTING	X	Y	Z
G1	FIX	FIX	FIX
G2	FIX	FREE	FREE
H1	FIX	FREE	FIX
H2	FIX	FREE	FREE

LETTING THE AREA OF THE FITTINGS BE "A".

STOWAGE PALLET
LOADS ON FITTINGS

A2 CONFIGURATION – LOOKING AFT



FITTING FIXITY –

FITTING	X	Y	Z
K1	FIX	FREE	FIX
K2	FIX	FREE	FREE
J1	FIX	FIX	FIX
J2	FIX	FREE	FREE

PREPARED BY: GLD
CHECKED BY:
DATE: MARCH 2072

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COMMAND MODULE

PAGE NO II 2 3 7 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO
REF

STOWAGE PALLET

EXTERNAL LOADS

REACTION of +X LOADS

A5 FITTINGS

$$P_{XG1} = \left(\frac{7.5}{17}\right)\frac{141(51.4)}{2} = 1599 \text{ lb}$$

$$P_{XG2} = \left(\frac{9.5}{17}\right)\frac{141(51.4)}{2} = 2025$$

$$P_{XH1} = \frac{4.9}{11.9}\ \frac{141(51.4)}{2} = 1492$$

$$P_{XH2} = \left(\frac{7}{11.9}\right)\frac{141(51.4)}{2} = 2132$$

A2 FITTINGS

$$P_{XK1} = \left(\frac{4.75}{11.85}\right)\frac{141(35.4)}{2} = 1000 \text{ lb.}$$

$$P_{XK2} = \left(\frac{7.1}{11.85}\right)\frac{141(35.4)}{2} = 1495$$

$$P_{XJ1} = \left(\frac{7.4}{16.9}\right)\frac{141(35.4)}{2} = 1093$$

$$P_{XJ2} = \left(\frac{9.5}{16.9}\right)\frac{141(35.4)}{2} = 1403$$

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RESCUE MISSION
COMMAND MODULE

PAGE NO II 2 3 8 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO
REF

STOWAGE PALLET

EXTERNAL LOADS

REACTION of +Y LOADS

A5 FITTINGS

$$P_y = 141(6.42) = 905$$

$$P_{yG1} = 905$$

$$M_z = 905(8.5) = 7690 \text{ IN-lb.}$$

$$P_{XG1} = \frac{7690}{17.4(2)} = 221 = P_{XG2}$$

$$P_{XH1} = P_{XH2} = -221$$

$$M_x = 905(9.5) = 8600 \text{ IN-lb.}$$

$$P_{ZH1} = -P_{ZG1} = \frac{8600}{17.4} = 495 \text{ lb.}$$

A2 FITTINGS

$$P_y = 141(4.42) = 623 \text{ lb.}$$

$$P_{yJ1} = 623 \text{ lb.}$$

$$M_z = 623(8.5) = 5300 \text{ IN-lb.}$$

$$P_{XK1} = \frac{5300}{17.4(2)} = 152 = P_{XK2} = 152$$

$$P_{XJ1} = P_{XJ2} = \frac{-5300}{17.4(2)} = -152$$

STOWAGE PALLET

EXTERNAL LOADS

REACTION of +Y LOADS (CONT.)

$$M_X = 623(9.5) = 5{,}920 \text{ IN-lb.}$$

$$-P_{ZK1} = -P_{ZJ1} = \frac{5920}{17.4} = 340 \text{ lb}$$

REACTION of +Z LOAD

ASSUME THAT 70% of THIS LOAD IS REACTED BY THE DOOR AND 30% IN THE A2 LOCATION USING FRICTION.

$$P_{Z_{TOTAL}} = 12.82(141) + 8.84(141) = 3055$$

$$P_{ZG1} = \frac{10.2}{17.4}(3055).70 = 1255 \text{ lb}$$

$$P_{ZH1} = \frac{7.2}{17.4}(3055).70 = 885 \text{ lb}$$

$$M_{y_{TOTAL}} = 3055(8.5) = 26{,}000 \text{ IN-lb.}$$

REACT 50% of M_y ON EACH SIDE of A5 CONFIGURATION.

$$P_{XG2} = \frac{26000}{2(17)}(.70) = 535 \text{ lb}$$

$$P_{XG1} = -\frac{26000}{34}(.70) = -535$$

$$P_{XH1} = -765$$

$$P_{XH2} = +765$$

STOWAGE PALLET

EXTERNAL LOADS

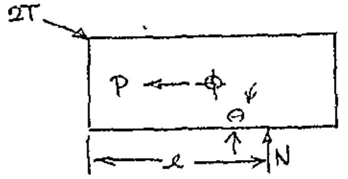
USING SAME METHOD AND 30% FOR A2 LOCATION,

$$P_{ZK1} = \frac{10}{17.4}(3055).3 = 527; \quad P_{XK2} = -P_{XK1} = \frac{26000}{2(11.85)}(.30) = 329 \text{ lb}$$

$$P_{ZJ1} = \frac{7.4}{17.4}(3055).3 = 390 \quad P_{XJ2} = -P_{XJ1} = \frac{26000}{2(16.9)}(.30) = 231 \text{ lb.}$$

REACTION of -Z LOAD

ASSUME THAT THE REACTION TO THE -Z ACCELERATION PRODUCES TENSION IN THE BAG AS SHOWN BELOW.



FREE BODY OF BAG CONTENTS

T = TENSION IN BAG, EACH SIDE

$$\theta \approx 28^\circ$$

$$P = 141(8.84) + 141(12.82) = 3058 \text{ lb.}$$

$$2T\cos\theta = P$$

$$T = \frac{3058}{2(\cos 28^\circ)} = 1730 \text{ lb.}$$

$$N = 2T\sin 28^\circ$$

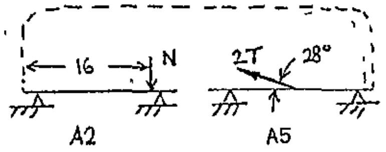
$$N = 3460(.47) = 1625 \text{ lb}$$

$$\ell = \frac{P(8.5)}{N} = \frac{3058(8.5)}{1625} \cong 16 \text{ IN.}$$

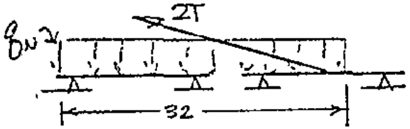
STOWAGE PALLET

EXTERNAL LOADS

REACTION of LOADS ON BASIC STRUCTURE,



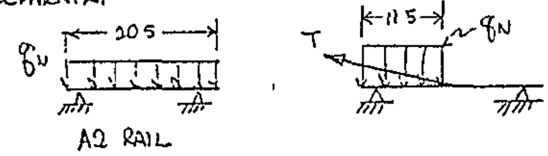
ASSUME THAT THE N LOAD IS DISTRIBUTED EVENLY TO EACH SIDE of N AS SHOWN ABOVE.



ON EACH SIDE HAVE

$$q_N = \frac{N}{2(32)} = \frac{1625}{64} = 25.4 \text{ lb/in}$$

∴ LOOKING AT EACH SIDE RAIL of A2 AND A5 SEPARATELY



STOWAGE PALLET

EXTERNAL LOADS

A5 FITTINGS

$$P_{XG1} = \frac{11.5(25.4)14.3}{17} - T\sin 28°\left(\frac{8}{17}\right) = -136.5 \text{ lb.}$$

$$P_{XG2} = \frac{11.5(25.4)2.7}{17} - T\sin 28°\left(\frac{9}{17}\right) = -383.6 \text{ lb.}$$

$$P_{XH1} = 11.5(25.4) - T\sin 28°\left(\frac{5.5}{11.9}\right) = -83.3 \text{ lb.}$$

$$P_{XH2} = -T\sin 28°\left(\frac{6.4}{11.9}\right) = -436.8 \text{ lb.}$$

$$P_{ZG1} = T\cos 28° = -1730(.883) = -1530 \text{ lb.}$$

$$P_{ZH1} = -1530 \text{ lb}$$

A2 FITTINGS

$$P_{XK2} = \frac{25.4(20.5)}{2} = 260.4 \text{ lb,}$$

$$P_{XK1} = \frac{25.4(20.5)}{2} = 260.4 \text{ lb.}$$

$$P_{XJ2} = \frac{25.4(20.5)}{2} = 260.4 \text{ lb}$$

$$P_{XJ1} = \frac{25.4(20.5)}{4} = 260.4 \text{ lb.}$$

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DATE: MAR 4 1972
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PAGE NO. II.2.5.13 OF
REPORT NO. SD 70-205
MODEL NO SKYLAB
DWG. NO.

STOWAGE PALLET

LOADS SUMMARY

FITTING	+X LOADING*			+Y LOADING			+Z LOADING			-Z LOADING		
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z
G1	1599	—	—	221	905	-495	-535	—	1255	-136.5	—	-1530
G2	2025	—	—	221	—	—	535	—	—	-383.6	—	—
H1	1492	—	—	-221	—	495	-765.	—	885.	-83.3	—	-1530
H2	2132	—	—	-221	—	—	765.	—	—	-436.8	—	—
J1	1093	—	—	-152	623	-340	-231	—	390	260.4	—	—
J2	1403	—	—	-152	—	—	231	—	—	260.4	—	—
K1	1000	—	—	152	—	340	-329	—	527	260.4	—	—
K2	1492	—	—	152	—	—	329	—	—	260.4	—	—

* FOR -X LOADINGS USE RATIO $\frac{31.5}{51.4}$ on A5 FITTINGS,
$\frac{11.8}{35.4}$ ON A2 FITTINGS

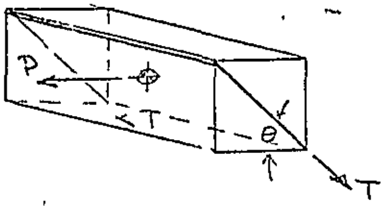
STOWAGE PALLET

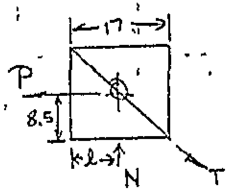
BAG

DUE TO THE FACT THAT THE BAG IS NOT A RIGID STRUCTURE THE METHOD OF REACTING Y AND Z LOADS MUST BE INVESTIGATED.

REACTION OF Y-Y LOADS

MUST REACT BOTH VOLUMES A2 AND A5





$P = 141(6.42) + 141(4.42) = 1527$

$2T\cos\theta = P = 1527$

ASSUME $\theta \approx 45°$

$T = \dfrac{1527}{2(.707)} = 1080$ lb.

$N = 2T\sin\theta = 1527$ lb.

$\ell = 8.5$ IN

SECTION II.2.4

PGA STOWAGE

G.P.	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	II.2.4 1
R G R		SD 70-205
4-15-72	COMMAND MODULE	Skylab

PGA STOWAGE

Provisions for the stowage of five PGA stowage containers are provided in the rescue vehicle Command Module for the return configuration. Two of the containers are launched in volume B1 and three are transferred from the Skylab.

The stowage containers are mounted on the aft bulkhead wireways. V36-601169 entry ropes secure the containers to the rescue couch frames. Three of the containers are also secured to ring assemblies. The two stowage containers not secured to ring assemblies are wedged between the heads of the rescue couches and the sidewalls.

Loading effects of the containers on the rescue couches and on the aft bulkhead wireway structure are developed in this section. The structural members involved in the loading development of this section are typical of the wireway structural members.

From a review draft of Apollo Command Module water impact tests dated July 16, 1969, the maximum G_{x-x} acceleration is approximately 40 g's. This load factor may be compared to those developed utilizing the Boeing criteria on page II.2.4.7

PREPARED BY: Pany	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	II 2.4 2 PAGE NO. OF
CHECKED BY: G.F		REPORT NO SD 70 - 205
DATE: 29 AUG 72	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO

REF

PGA STOWAGE

THE R.H WIRE WAYS CONTAIN THE LARGEST VOLUME OF WIRE AND HAVE THE WIDEST TRAYS WHICH MAKES THEM CRITICAL FOR DEFLECTION OF THE COVER INTO THE WIRE. THE MAXIMUM DEFLECTION IS ESTIMATED AT

$$Y_{MAX} = .0027\ P$$

II.2 4.5 $PRESS = 30\ psi$

II.2.4.10 $Y_{MAX} = \underline{0519\ IN}$

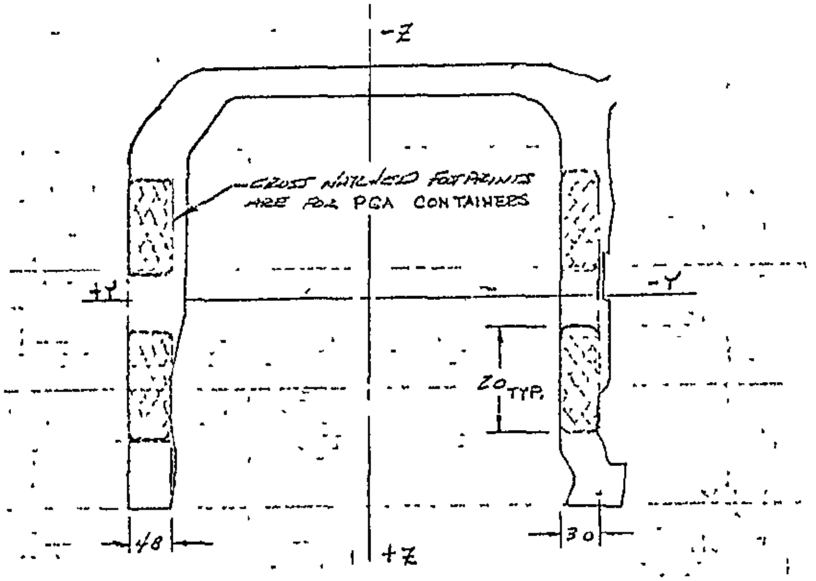
THE TRAYS ON THE R.H SIDE ARE FULL AND THE COVER RESTS ON THE WIRE STATICALLY. THEREFORE DURING A LANDING THE COVER WILL EXERT PRESSURE ON THE WIRES PROPORTIONAL TO THE SPRING RATE OF THE BUNDLES. THIS PIECE OF DATA CANNOT BE EVALUATED AT THIS TIME. HOWEVER SINCE THE BUNDLES ARE HEAVILY PADDED AS SHOWN ON PAGE 9 THIS CONDITION IS ASSUMED TO BE SATISFACTORY FOR THE FOLLOWING REASONS:

a) A PERSONEL INSPECTION OF THE WIRE BUNDLES IN S/C 113 REVEALED THE AFT BULKHEAD TRAYS TO CONTAIN A LOW DENSITY OF WIRES COMPARED TO CERTAIN AREAS IN THE LOWER EQUIPMENT BAY WHERE WIRE RUNS ARE CONTAINED IN MACHINED BRACKETS. DEFLECTIONS OF .060 OR MORE ARE EASILY OBTAINED WITH HAND PRESSURE ON THE WIRE RUNS IN THE AFT BULKHEAD TRAYS.

FIG 3 SECT III Pg 12 TEFLON, MECHANICAL DESIGN DATA BK PLASTICS DEPT., E I DU PONT DE NEMOURS & CO, INC WILMINGTON DEL 19898

b) THE TEFLON INSULATION WILL SUSTAIN 1000 PSI COMPRESSIVE STRESS ELASTICALLY WHICH APPEARS TO BE ENOUGH TO PREVENT DAMAGE FROM THE ABOVE COVER DEFLECTIONS.

WIREWAY CONFIGURATION & LOAD DISTRIBUTION



LOAD DISTRIBUTION

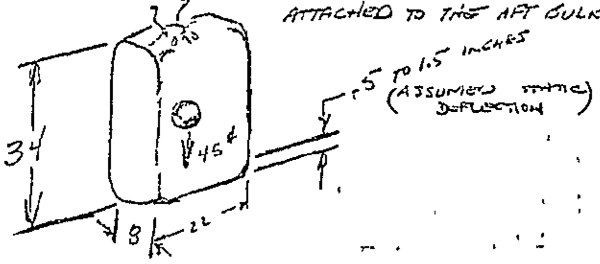
UNIT PRESSURE (+Y) R.H	$\frac{45}{4.8 \times 20} = .48 \text{ psi}$
UNIT PRESSURE (-Y) L. H.	$\frac{45}{3.0 \times 20} = .75 \text{ psi}$

MAXIMUM PRESSURE = .75 (40)
= 30 PSI (ULT)

PGA STOWAGE

DYNAMIC RESPONSE

THE PGA WHEN STOWED IN A V56-601010 FABRIC BAG IS AN 8 x 22 x 34 INCH PACKAGE THAT WEIGHS 45 # (i.e.) IT IS A RELATIVELY LARGE FLEXIBLE PACKAGE WITH A LOW NATURAL FREQUENCY. REALIZING THE FUTILITY OF COMPUTING AN ACCURATE NATURAL FREQUENCY THE FOLLOWING COMPUTATIONS ARE PRESENTED TO ESTABLISH THE ARGUMENT THAT THE BAG WILL NOT RESPOND TO WATER LANDING SHOCK LOADS THAT RIGID STRUCTURES EXPERIENCE WHICH ARE ATTACHED TO THE AFT BULKHEAD.



$$f_n = \frac{1}{2\pi}\sqrt{\frac{g}{\Delta_{\text{STATIC}}}}$$

$$\left.\begin{array}{l} f_n = 2.5 \\ f_n = 4.4 \end{array}\right\} \text{Hz, RANGE FOR ASSUMED STATIC DEF.}$$

$$f_d = 50 \text{ TO } 100 \text{ CPS}$$

FROM A VIBRATION ISOLATION CHART THIS COMBINATIO OF f_n AND f_d REPRESENTS APPROXIMATELY 99% ISOLATION ∴ THE BOEING CRITERIA IS NOT APPLICABLE TO THE PGA STOWAGE;

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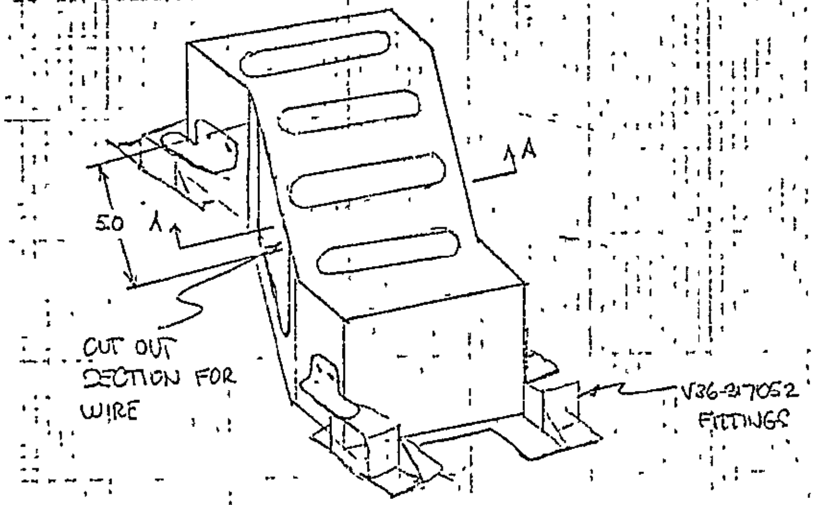
COMMAND MODULE

PAGE NO II.2.4.6 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

PGA STOWAGE

AFT BULKHEAD CABLE TRAY



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COMMAND MODULE

PAGE NO II.2.4.7 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

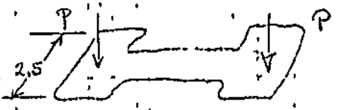
REF.

PGA STOWAGE

AFT BULKHEAD WIRE TRAYS

CAPABILITY of AFT BULKHEAD FITTINGS,

EXAMINE CAPABILITY of V36-317053 SMALLEST FITTINGS ON $-Y_C$ SIDE,



SD67-1103 IV 10.2. 5.38

$P_{ALLOW} = 237\ ^{lb}/_{IN} \times 2.5\ IN = 593\ lb.$

APPROXIMATE DISTANCE BETWEEN FITTINGS 9.0 IN.
THUS FOR ALLOWABLE of TRAY BASED ON FITTINGS,

$$p_{ALLOW} = \frac{2(593)}{9} = 132\ ^{lb}/_{IN}$$ ON TOP of FITTINGS

LOADS

LOADS ON WIRE TRAYS BASED ON BOEING CRITERIA

ASSUME $W_C = 900\ lb.$
$Y = 38\ IN.$
$Z = 0 \rightarrow 30\ IN.$

MAX LOADS OBTAINED AT $Z \approx 15\ IN$

$g_x = 62.4\,g$
$g_{x-} = 51\,g$
$g_y = 7.8\,g$
$g_z = 15.6\,g$

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RESCUE MISSION
COMMAND MODULE

PAGE NO II 2 4 8 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

PGA STOWAGE

LOADS ON BOND-ON FITTINGS

II.2 4.7 ALLOWABLE LINEAL LOAD = 132 #/IN

LIMIT TOP LOAD CONFIG. I = $\left[\frac{15}{20}\right](40) = 30$ #/IN

SD67-1103 II 13.2.6 .101

WIRE WGT. = 1.4 #/ft/IN^2
AREA L.H SIDE = 4.5 IN^2
WIRE WGT = $\frac{1.4 \times 4.5}{12} = .525$ #/IN

LIMIT WIRE LOAD = $.525 \times 62.4 = 32.8$ #/IN

TOTAL LOAD CONFIG. I = $30 + 32.8 = 123$ #/IN

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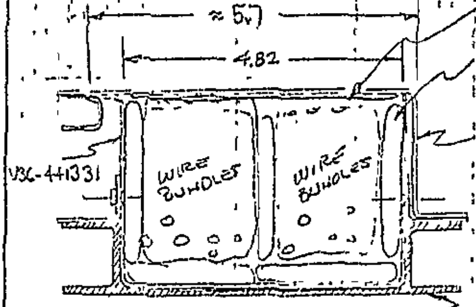
RESCUE MISSION
COMMAND MODULE

PAGE NO II.2 4 9 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

PGA STOWAGE

AFT BULKHEAD WIRE TRAY



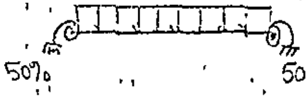
END VIEW

FITTING

SECTION A-A

CHECK DEFLECTION of TRAY TOP, ASSUME 50% FIXITY BEAM W/ UNIFORM LOAD

Ⓔ-4 TABLE III CASES 13 & 33



$y_{MAX} = \frac{3}{384}\frac{Wl^3}{EI}$

IN TERMS of PRESSURE LOADING (WIDTH c)

$c_1 = 2.50$ IN.

$W = p l c_1$

$y_{MAX} = \frac{3 p l^4 c_1}{384 EI}$

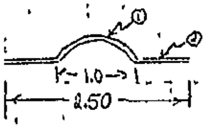
$l \approx 5.7$

$E = 10.4 \times 10^6$ psi

$\alpha = .925$ RAD

Ⓔ-4 TABLE I CASE 12

BEAM SECTION



$R = .6 \quad \alpha = 53° \quad t = .040$

$I_1 = (.6)^3 .040\left[\alpha + \sin\alpha\cos\alpha - \frac{2\sin^2\alpha}{\alpha}\right]$

$I_1 \approx .00023$ IN^4

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COMMAND MODULE

II 2.4.10
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

PGA STOWAGE

AFT BULKHEAD WIRE TRAY

(E-4)
TABLE I CASE 12

$$y_1 = R\left(\frac{\sin\alpha}{\alpha} - \cos\alpha\right) = .157$$

$$A_1 = 2\alpha R t = .044$$

$$I_2 = \frac{1.5(.040)^3}{12} = 8.0\times10^{-6}$$

$$A_2 = .040(1.50) = .06$$

$$y_2 = .020$$

$$\bar{y} = \frac{A_1 y_1 + A_2 y_2}{A_1 + A_2} = \frac{.0012 + .0069}{.104} = .078$$

$$I = 2.3\times10^{-4} + .08\times10^{-4} + (.044)(.157)^2 + (.06)(.02)^2 - (.104)(.078)^2$$
$$= 7.34\times10^{-4}$$

$$y_{MAX} = \frac{3p(5.7)^4 2.5}{384(10.4\times10^6)(7.34\times10^{-4})} = \underline{\underline{.0027\,p\ (IN.)}}$$

FOR STRESS IN TOP ASSUME SIMPLY SUPPORTED,

$$M = \frac{1}{8}Wl = \frac{plcl}{8} = \frac{pl^2c}{8}$$

$$\sigma_b = \frac{Mc}{I} \qquad c \cong .25$$

$$\sigma_b = \frac{p(5.7)^2 2.5(.25)}{(8)\,7.34\times10^{-4}} = \underline{\underline{3460\,p\ (psi)}}$$

II 2.4.5 $y_{max} = (.0027)[(.48)(40)]$
II 2.4.1 $= .0519$ IN.

$$\sigma_b = 3460[(.48)(40)]$$
$$= 66500 \text{ PSI}$$

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II 2.4.11
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

PGA STOWAGE

AFT BULKHEAD WIRE TRAY

CHECK FOR BUCKLING of BOX SIDE ABOVE FITTING,

$$P'_B = \frac{4\pi^2 EI}{l^2} = \frac{4(\pi^2)10.4\times10^6(2.0)(.040)^3}{12(1.0)^2} = \cancel{4379}\ \text{lb.}$$

USE $P' = .080(F_{cy}) = .080(38,000) = 3040$ lb.

TOTAL LOAD ON BOX

$$P_1 \cong \frac{(45)(40)}{20}(10) = 900 \text{ LBS}$$

LOAD AT LOCATION of P',

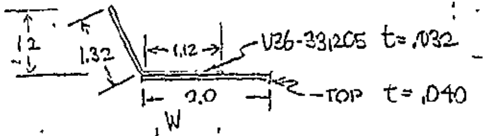
$$P_2 = \frac{P_1}{4} \cong 225 \text{ lb}$$

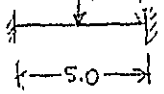
DETERMINE APPROXIMATE LOAD ON WIRE WAY COMING OUT of SIDE of TRAY, (REF. Pg. 1)

A_w = AREA of TOP SUPPORTED BY WIRE = $\frac{5.0(5.7)}{2} = 14.25$ in²

P_w = LOAD ON WIRE = $14.25\,p$ (lb.)

CHECK of CAPABILITY of V36-331205 ANGLE ON TOP of COVER OVER OPENING IN SIDE,





$$M_{MAX} = \frac{Wl}{8} = \frac{14.25\,p\,l}{8} = 8.90\,p\ \text{(in lb)}$$

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COMMAND MODULE

II 2.4.12
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

PGA STOWAGE

AFT BULKHEAD WIRE TRAY

ELEMENT	b	h	$\bar{y}_a$
1	.032	1.2	.64
2	1.088	.032	.056
3	2.0	.040	.020

$I = .0153$
$\bar{y} = .1836$
$A = .1532$

$$\sigma_b = \frac{Mc}{I} = \frac{8.90\,\rho\ 1.0564}{.0153} = 614\,\rho \quad (psi)$$

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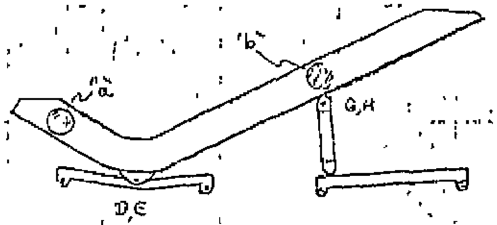
II 2.4.13
PAGE NO. OF
REPORT NO SD 70-2[illegible]
MODEL NO SKYLAB
DWG NO

REF.

PGA STOWAGE

INTRODUCTION

THE PURPOSE of THIS ANALYSIS IS TO DETERMINE THE IMPACT THAT THE STOWAGE of TWO PGA BAGS WILL HAVE ON THE RESCUE COUCH.



THE APPROXIMATE AREAS WHERE THE SUITS ARE EXPECTED TO CONTACT THE COUCH ARE SHOWN AS SHADED AREAS SHOWN ABOVE.

APPROXIMATE WEIGHT of PGA BAG,

II 2.4.5 $W_{PGA} = 45$ lb

II 2.4.7 $N_Y = 8\,g$ (BOEING CRITERIA)

PREPARED BY: GLD
CHECKED BY: G.F.
DATE: SEPT 15 '72

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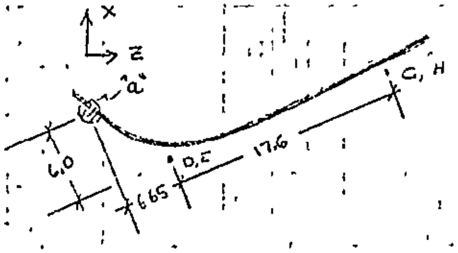
PAGE NO 2 2 4 14 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

PGA STOWAGE

ASSUME THAT PGA AT POSITION "a" IS REACTED AT SWAY BAR ATTACH POINT AT SUPPORT STRUCTURE.



REACT OVERTURNING MOMENT AT D,E,

$$P_{Dy}+P_{Ey}=\frac{P_a\,24.25}{17.6}=1.378\,P_a$$

ASSUME $P_{DY}=P_{EY}$

$$\therefore P_{DY}=P_{EY}=\frac{1.378P_a}{2}=.689\,P_a$$

ALSO

$$P_{GY}=\frac{6.65}{17.6}P_a=-.378\,P_a$$

OVERTURNING MOMENT,

$$M=P_a\,6.0$$

REACTING THIS AT D AND E NEGLECTING ANGLE,

$$P_{DX}=-P_{EX}=\frac{6.0\,P_a}{19}=.316\,P_a$$

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CHECKED BY: G.F.
DATE: SEPT 15 1972

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PAGE NO 2 2 4 15 OF
REPORT NO SD 70-20
MODEL NO SKYLAB
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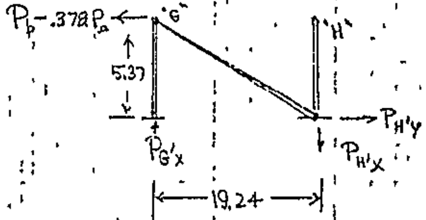
PGA STOWAGE

ASSUME THE LOAD DUE TO THE BAG AT "b" IS REACTED ENTIRELY BY THE SHOULDER TRUSS AND FRAME,



$$P_{H'y}=P_b+.274P_a$$

$$P_{H'x}=\frac{(P_b-.378P_a)\,5.37}{19.24}$$

$$P_{G'x}=-P_{H'x}$$

$$P_a=P_b=45\,(8g)=360\text{ lb.}$$

THUS, USING ACTUAL LOADS,

$P_{DY}=248$ lb.
$P_{EY}=248$ lb
$P_{DX}=114$ lb.
$P_{EX}=-114$ lb.

$P_{H'Y}=360-136=224$ LBS
$P_{H'X}=625$ lb.
$P_{G'X}=-62.5$ lb.

PGA STOWAGE

USING 8g INSTEAD of 12.75g ON COUCH LOADS OBTAIN THE FOLLOWING LOADS USING A SIMPLE RATIO,

$$P_{H'Y} = 2086\left(\frac{8}{12.75}\right) = 1310 \text{ lb.}$$

$$P_{H'X} = 1305\left(\frac{8}{12.75}\right) = 810 \text{ lb.}$$

$$P_{G'X} = -1305\left(\frac{8}{12.75}\right) = -810 \text{ lb.}$$

$$P_{DY} = [487+114]\,\frac{8}{12.75} = 378 \text{ lb,}$$

$$P_{EY} = 376$$

$$P_{DX} = (645+38.4)\,\frac{8}{12.75} = 429 \text{ lb.}$$

$$P_{EX} = -429 \text{ lb.}$$

NOW COMBINING THE PGA INDUCED LOADS WITH THE COUCH LOADS AT THE EXPECTED "g" LEVEL of 8g OBTAIN THE FOLLOWING,

$$P_{DX} = -P_{EX} = 429+114 = 543 \text{ lb.}$$

$$P_{DY} = P_{EY} = 378+248 = 626 \text{ lb.}$$

$$P_{G'X} = -P_{H'X} = 810+62.5 = 882.5 \text{ lb}$$

$$P_{H'Y} = 1310+224 = 1534 \text{ lb.}$$

PGA STOWAGE

TABLE COMPARING DESIGN LOADS TO BOEING CRITERIA LOADS PLUS PGA INDUCED LOADS.

	LOAD	DESIGN LOAD (12.75g)	EXPECTED LOAD PLUS PGA
	P_{DX}	683	543.
V56-531 103	P_{EX}	-683	-543
& V56-531 104	P_{DY}	601	626
	P_{EY}	601	626
V56-531 126	$P_{G'X}$	-1305	-882.5
	$P_{H'X}$	1305	882.5
	$P_{H'Y}$	2086	1534

THUS IT CAN BE SEEN THAT THE DESIGN LOADS WERE SUFFICIENTLY HIGH TO COVER THE ADDED LOADS INDUCED BY THE ADDITION of THE PGA BAGS EXCEPT FOR P_{DY} AND P_{EY}. THESE TWO LOADS ARE NOT SUFFICIENTLY HIGHER AS TO CAUSE ANY PROBLEMS.

PREPARED BY: G F.
CHECKED BY: R.G.R.
DATE: 4-18-73
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COMMAND MODULE
PAGE NO. II.2.5.0 OF
REPORT NO SD 70-205
MODEL NO Skylab

SECTION II.2.5

RESCUE DROGUE

PREPARED BY: [illegible]
CHECKED BY: G.F
DATE: 9 APRIL 73
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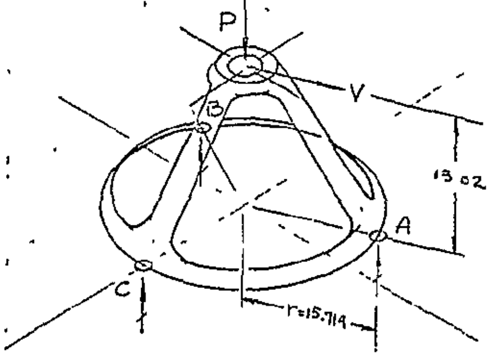
PAGE NO II.5.1 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575206
REF

RESCUE DROGUE

LOADS:

A DOCKING DROGUE HAS BEEN MODIFIED TO PROVIDE A FIXTURE FOR USE BY SKYLAB PERSONNEL TO JETTISON A DISABLED CSM FROM THE MDA. THIS FIXTURE (V56-575206) PROVIDES ACCESS TO THE PROBE PRELOAD MECHANISM AND DOCKING LATCHES REQUIRED FOR THE JETTISON OPERATIONAL SEQUENCE. THE FIXTURE MUST ALSO BE STRUCTURALLY CAPABLE OF REACTING THE FULL PROBE PRELOAD BREAKOUT FORCE.

THE FIXTURE WAS MADE BY CUTTING THE HONEYCOMB PANELS FROM A V28-575202 DROGUE ASSEMBLY LEAVING A TRIPOD STRUCTURE AS SHOWN IN THE SKETCH BELOW. THE STRUCTUAL ANALYSIS SHOWN IN SECTION II.3 USES A FACTOR OF SAFETY OF 1.5.



P = PRELOAD MECHANISM BREAKOUT FORCE = 6100# MAX.

REFERENCE: MA 0206-0292; DOCKING SUBSYSTEM, PROBE, ACCEPTANCE AND PRE-INSTALLATION SPECIFICATION

V = SHEAR COMPONENT DUE TO DROGUE/PROBE 1/2° MISALIGNMENT (ASSUMED) } = 6100 SIN 30' ≈ 53#

PROOF LOAD = 6710^{+50}_{-00} PER GENERAL NOTE (V56-575206)
= LIMIT LOAD + 10%

NOTE: TEST WAS CONDUCTED BY MANUFACTURING ON FLIGHT ARTICLE. THE ACTUAL TEST DATA IS PRESENTED IN [illegible] PAGE 8

SECTION II.2.6

BALLAST, CREW COUCH

BALLAST, CREW COUCH

Six steel plates are utilized on the center crew couch to obtain the design stroking of the couch during abort. The bottom plate is bolted to angles along two edges which are fastened to the torso support beams of the Weber couch. The remaining ballast plates are secured to the couch by means of a steel cable and beta webbing strap assembly system and four NAS 1154 screws which clamp all six of the plates together.

Loading of the Weber crew couch from the ballast, as developed in the following pages, is shown to be less than for man loading Additional analysis of the couch structure is, therefore, not required. Analysis of the ballast mounting hardware is, however, presented in section II.3 of this report.

The load factors utilized for the ballast plates were taken from. Apollo Command Module Water Impact Tests, Appendix B, water landing tests 5-9 with CM-099. Allowables for the steel cable and beta webbing strap assemblies were taken from the Skylab-Rescue — Development Verification Tensile Test of P.B.I. Tie-Down System, LR 9643-4035.

Maximum ballast weight utilized on the center couch is 246.6 lbs. This weight is representative of one astronaut entering the rescue vehicle from a disabled Skylab. The weight was taken from CSM/LM Spacecraft Operational Data Book, Volume III, Mass Properties Amendment 134, November 21, 1972.

PREPARED BY: RGR
CHECKED BY: GD
DATE: 6 MARCH 72

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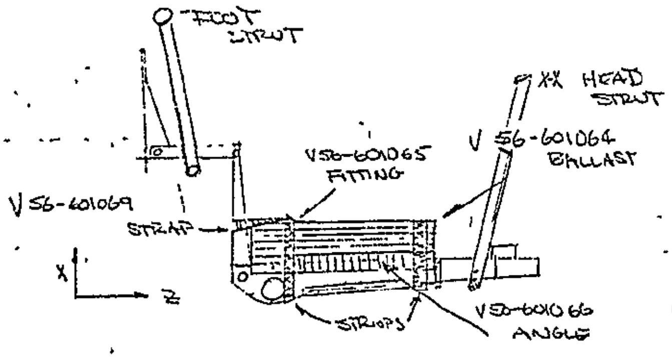
II.2 6.2
PAGE NO 1 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

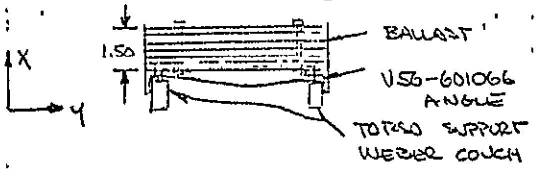
REF

108

BALLAST, CREW COUCH



WEBER CREW COUCH



SIX BALLAST PLATES OF QQ-S-766 CLASS 304

TOTAL DEAD WT = 246.6 LBS.

LOADS (ULTIMATE)

(-11.22)(1.5) ≈ 17 G EBI
17 G EBO
(13.3)(1.5) ≈ 20 G EBU, EBD
(1.45)(1.5) ≈ 2.18 G EBL, EBR

PREPARED BY: RGR
CHECKED BY: GD
DATE: 3-3-2

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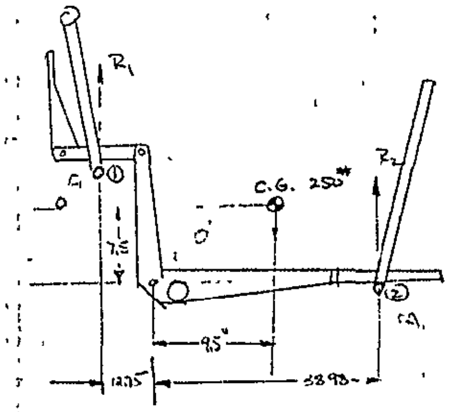
II 2 6.3
PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

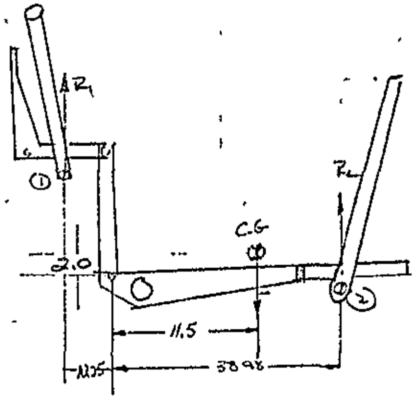
(B9)
II 12 1.
4.4

BALLAST, CREW COUCH

STRUT LOADS - MAN



STRUT LOADS - BALLAST



PREPARED BY: ZGR
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DATE: 3-6-2

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COMMAND MODULE

PAGE NO II.2.6.4 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

BALLAST, CREW COUCH

COMPARE X-X STRUT LOADS

ASSUME STRUTS IN X DIRECTION ONLY

MAN 30g LOAD

$$\Sigma M_1 = 0$$

$$(12.75+38.98)R_2 = (12.75+9.5)(250)(17)$$

$$R_2 = 1830^{\#}$$

$$R_1 = 250(17) - 1830$$

$$R_1 = 2420^{\#}$$

BALLAST

$$\Sigma M_1 = 0$$

$$(12.75+38.98)R_2 = (12.75+11.5)(246.6)(17)$$

$$R_2 = 1960^{\#}$$

$$R_1 = (246.6)(17) - R_2$$

$$R_1 = 2235^{\#}$$

THE X-X LOAD FOR THE HEAD STRUTS IS 130 LBS. GREATER FOR THE BALLAST LOADING THAN FOR THE MAN LOADING.

PREPARED BY: G.F.
CHECKED BY: R.G.R.
DATE: 4-18-73

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO II.2.7.0 OF
REPORT NO SD 70-205
MODEL NO Skylab

SECTION II 2.7

AFT BULKHEAD FITTINGS

AFT BULKHEAD FITTINGS

The aft bulkhead fittings used to secure the stowage lockers to the aft bulkhead for the basic Skylab mission are utilized on the rescue mission. For rescue, the fittings secure the rescue couch adapter frames, urine chiller frame, and stowage pallet to the aft bulkhead.

This section is concerned with the development of the maximum loads on each fitting. Reevaluation of those fittings whose rescue mission loading is greater than that due to basic Skylab configuration is performed in section II.3. In the cases involved, critical loading is shear of the aft bulkhead honeycomb core.

Material properties for the honeycomb core and calculation of the effective width of the honeycomb core face sheet applicable to the fittings are also included in this section. Shear distribution factors for the longitudinal and transverse directions are calculated.

136

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION

RESCUE MISSION

COMMAND MODULE

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CHECKED BY: RGR
DATE: 4/13/73

PAGE NO. II.2.7.2 OF
REPORT NO. SD 70-20
MODEL NO. SKYLAB
DWG. NO.

AFT BULKHEAD FITTINGS

LOADS SUMMARY

REF.
V56-531 162
II.2.3.13
V56-531 161
V56-531 104
V56-531 135
V56-531 126
II.2.2

LOCKER	FITTING NO. 1			FITTING NO. 2			FITTING NO. 3			FITTING NUMBER 4	
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y
A1	-573		229	-332			-645		278	-430	
A2	1093 -364 ∓152 -231 260.4	±623	∓340 390	1403 -468 ∓152 231 260.4			1000 -333 ±152 -329 260.4		±340 527	1492 -497 ±152 329 260.4	
A3	-4635		264.5	-463.5			-420		242.5	-631	
A4	-1375 375 -805	-1208	1747 -812 3128	-1425 389 -835			-1390 -363 -819		1835 812 3270	-1538 -401 -901	
A5	1599. -978 ±221 -535 -136.5	±905	∓495 1255 -1530	2025 -1240 ±221 535 -383.6			1492 -914 ∓221 -765 -83.3		±495 885 -1530	2132 -1308 ∓221 765 -436.8	
A6	-1375 375 -805	-1208	+1747 -812 3128	-1425 389 -835			-1390 -363 -819		+1835 812 3270	-1538 -401 -901	
A7	-3035 +2395 -1022	2086	-436	-850 +673 -289			-3560 +2815 +1201		+436	-325 +253 +110	

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PAGE NO. OF
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DWG. NO.

AFT BULKHEAD FITTINGS LOADS SUMMARY (CONT.)

LOCKER	FITTING NO. 1			FITTING NO. 2			FITTING NO. 3			FITTING NO. 4	
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y
A8	SEE PAGE II.2.2-17 FOR FITTING LOADS.										
A9	-873.9			-2961.8			-331.1			-3603.2	
	694			2355			263			2860	
	394.7	2086.0	-1561.5	1337.5			-145.8		1561.5	-1586.7	
	-394.7	-2086.0	1561.5	-1337.5			145.8		-1561.5	1586.7	

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RESCUE MISSION

COMMAND MODULE

AFT BULKHEAD FITTINGS

LOADS SUMMARY

PAGE NO. II.2.7.2 OF
REPORT NO. SD 70-20
MODEL NO. SKYLAB
DWG. NO.

REF.
II.2.2.2
V56-531 126
V56-531 135
V56-531 104
V56-531 161
II.2.3.13
V56-531 162

LOCKER	FITTING NO. 1			FITTING NO. 2			FITTING NO. 3			FITTING NUMBER 4	
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y
A1	-573		229	-332			-645		278	-430	
A2	1093 -364 ∓152 -231 260.4	±623	∓340 390	1403 -468 ∓152 231 260.4			1000 -333 ±152 -329 260.4		±340 527	1492 -497 ±152 329 260.4	
A3	-463.5		264.5	-463.5			-420		242.5	-631	
A4	-1375 375 -805	-1208	1747 -812 3128	-1425 389 -835			-1390 -363 -819		1835 812 3270	-1538 -401 -901	
A5	1599 -978 ±221 -535 -136.5	±905	∓495 1255 -1530	2025 -1240 ±221 535 -383.6			1492 -914 ∓221 -765 -83.3		±495 885 -1530	2132 -1308 ∓221 765 -436.8	
A6	-1375 375 805	-1208	+1747 -812 3128	-1425 389 -835			-1390 -363 -619		+1835 812 3270	-1538 -401 -901	
A7	-3035 +2395 -1022	2086	-436	-850 +673 -289			-3560 +2815 +1201		+436	-325 +253 +110	

AFT BULKHEAD FITTINGS

FITTING LOADS

II 2.2.2

FITTINGS	LOCKER LOADINGS
V56-317537	A1 (2) ; A2 (2) ; A3 (2) A4 (2) , A5 (2) ; A6 (2)
V56-317556	A1 (1)
V56-317557	A1 (3) , A2 (3) , A3 (3) A4 (3) ; A5 (3) ; A6 (3)
V56-317558	A1 (4) ; A2 (4) ; A3 (4) A4 (4) ; A5 (4) ; A6 (4)
V56-317559	A2 (1) ; A3 (1) , A4 (1) A5 (1) ; A6 (1)
V56-317560	A7 (1) ; A9 (1)
V56-317561	A7 (2) ; A9 (2)
V56-317562	A7 (3)
V56-317563	A8 (2) ; A8 (4)
V56-317564	A8 (1) AND A9 (3) ; A8 (3) AND A7 (4)

114

200

AFT BULKHEAD FITTINGS

MAXIMUM LOADS

	FITTING	P_X	P_Y	P_Z	LOAD CONDITION
 *	V56-317537	2781 -18446			+X +Y +Z -X -Y -Z
*	V56-317556	-573		229	-X + Z
* * * *	V56-317557	1813 -1900 -819 1629.7		-495 1330 3270 -2025	+X -Y -X +Y +Z EBI + EBD + EBL +X -Y -Z
 *	V56-317558	3118 -1965.8			+X -Y +Z -X +Y -Z
* * * *	V56-317559	1820 -1734 -805 -893.5	905 -905 905	-495 1750 3129 -2025	+X +Y -X -Y + Z EBI + EBU + EBL +X +Y -Z
* * *	V56-317560	2395 -3035 ±3947	 ±2086	 ∓1561.5	EBD + EBO + EBL EBU + EBI + EBL EBR OR EBL
*	V56-317561	2355 -29618			EBD + EBO + EBL EBU + EBI + EBL
* * *	V56-317562	2815 -3560 1201		 436	EBD + EBO + EBL EBU + EBI + EBL EBR
* *	V56-317563	3552 -3822	354 -354	710 -710	+X +Y +Z -X -Y -Z
*	V56-317564	(A8) (A9) -3822 -331.1 3752 263	-354 354	710	-X-Y+Z, EBU+EBI +EBL +X+Y-Z, EBD+EBO +EBL

* LOAD IS LESS THAN THE ONE UTILIZED IN SD70-205 FOR ANALYSIS OF FITTING

201

PREPARED BY: G.F.
CHECKED BY: RER
DATE: 4/4/73

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COMMAND MODULE

PAGE NO. II.2 7.7 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF.

AFT BULKHEAD FITTINGS

HONEYCOMB CORE PROPERTIES

5052-H39 M80170-027 3/16-0015P 1.5 IN THICK

DENSITY = 4.4 $\frac{LB}{FT^3}$

(D11)

31 10 00 .06 01 $F_{SU} = .78(305) = 238$ PSI 90% PROBABILITY (LONG)
$= .78(270) = 211$ PSI MINIMUM (LONG)

31 10 00 .09 01 $F_{SU} = \left(\frac{238}{211}\right)(134) = 151$ PSI

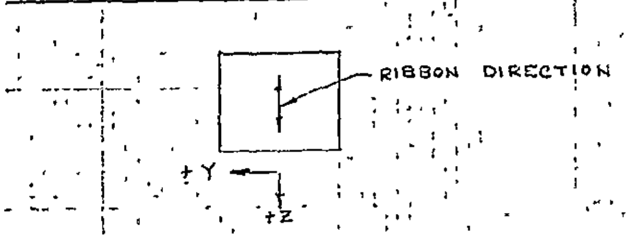
31 12 00 .05 01 $= .88(160) = 141$ PSI

31.12.00 .08.01 $F_c = 370$ PSI 90% PROBABILITY
$= 320$ PSI MINIMUM

$E_c = 120\,000$ PSI

$G_c = 42000$ PSI (LONG)
$G_c = 16000$ PSI (TRANS)

RIBBON DIRECTION

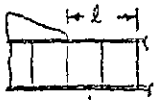


EFFECTIVE INCREASE IN FOUNDATION FROM SKIN BENDING

73MA1651 Pg 2

(C3)

2 210(b)



$M = \frac{w l^2}{2}$ $w = 370$ PSI

$F_b = \frac{6M}{bh^2} = 58000$ PSI $\left(\begin{matrix}2014\text{-}T6\\ t = .016 \text{ IN}\end{matrix}\right)$

$l = \left[\frac{(58000)(1.0)(.016)^2(2)}{6\,(270)}\right]^{\frac{1}{2}}$

$l = .116$ IN.

PREPARED BY: G.F.
CHECKED BY: RER
DATE: 4/4/73

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COMMAND MODULE

PAGE NO. 7 8 OF
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DWG NO

REF.

AFT BULKHEAD FITTINGS

SHEAR DISTRIBUTION FACTORS

73MA1651 Pg 3

q_1 = TRANSVERSE SHEAR
q_2 = LONGITUDINAL SHEAR

① $q_1 + q_2 = 1$

② $\frac{q_1}{G_{c_1}} - \frac{q_2}{G_{c_2}} = 0$

$$\frac{-\frac{q_1}{G_{c_1}} + \frac{q_2}{G_{c_1}} = -\frac{1}{G_{c_1}}}{\frac{q_2}{G_{c_1}} + \frac{q_2}{G_{c_2}} = \frac{1}{G_{c_1}}}$$

$q_2 = \frac{1/G_{c_1}}{\frac{1}{G_{c_1}} + \frac{1}{G_{c_2}}}$ $G_{c_1} = 16000$ PSI
$G_{c_2} = 42000$ PSI

$q_2 = \frac{\left(\frac{1}{16000}\right)}{\frac{1}{16000} + \frac{1}{42000}}$

$q_2 = .724$ LONGITUDINAL FACTOR

$q_1 = 1 - .724_0$
$q_1 = .276$ TRANSVERSE FACTOR

K FACTORS TO USE WITH SHEAR DISTRIBUTION

$K_{LONG} = 1.0$

$K_{TRANS} = \frac{1}{.724}(.276)$
$= .381$

SECTION II.2.8

SLA

SLA

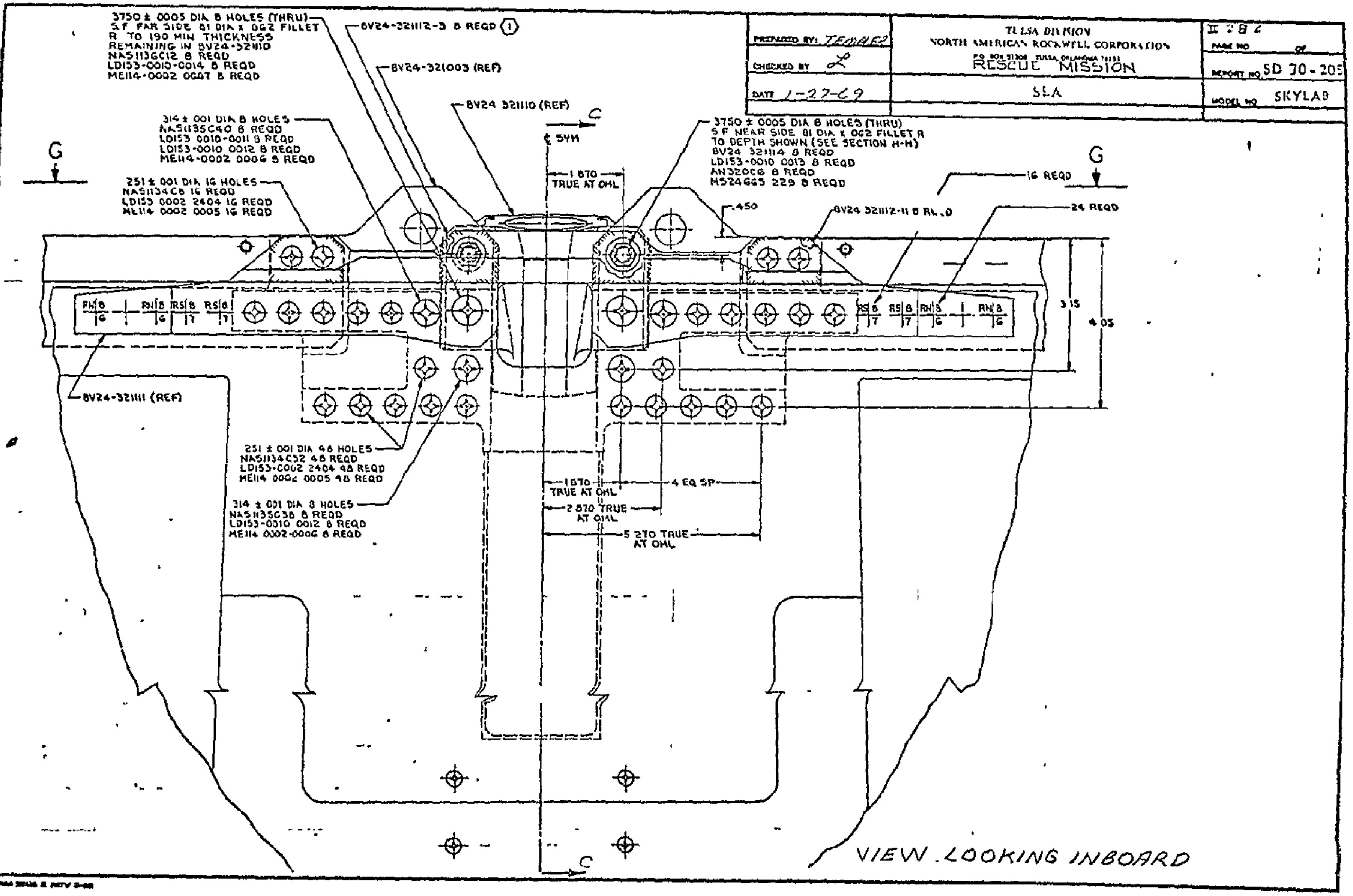
Analysis of the in-line change to the LEM structure is presented in this report because SLA 23 is the first SLA to be flown with this configuration. The loads used in the following development are based on A 32000 pound LEM supported in the SLA. For Skylab missions, a lightweight stabilizing structure is installed in the SLA. The analysis of the stabilizing structure is presented in report SID 64-60, Vol. VI, Section 10. The analysis is therefore very conservative for the Skylab missions.

The in-line installation is very similar to the modification installation. The inner frame and facesheet in the LEM attach area are cut out to accept a spring loaded cylinder which will eject the LEM/CSM during separation.

The support fitting (8V24-321110) transmits the vertical LEM load to the LEM support beam (8V24-321108) by bearing against the beam. The fitting acts as a splice for the inner frame (8V24-321109) for continuity in transmitting the hoop loads. The LEM loads are introduced into the SLA shell through the 8V24-328108 beam. Only the introduction of the LEM loads into the SLA shell shall be investigated since the other hardware is similar to the modification change analyzed in the SD 67-1103 report.

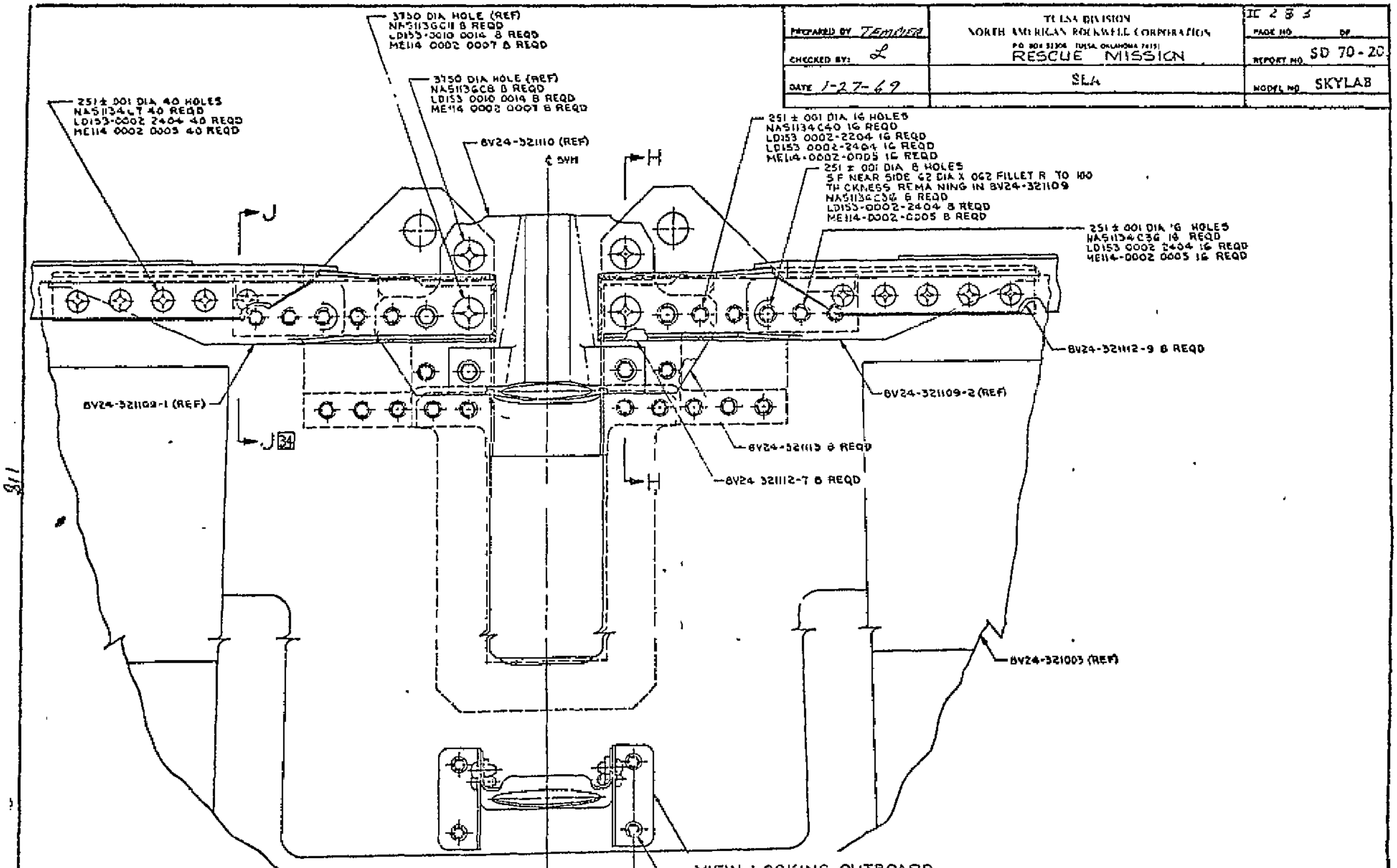
The structural integrity of the SLA panels will be examined using the loads from report SID 64-60, Volume VI, Sections 8 and 11. The factor of safety has been changed, however, from 1.5 to 1.4 as shown in SID 64-60, Vol. VI, page 6.C 1.1. The loads were changed accordingly. Modifications to the SLA panels must be capable of transmitting launch loads as well as attenuation and retention loads.

PREPARED BY: TEMNEZ	TULSA DIVISION NORTH AMERICAN ROCKWELL CORPORATION P.O. BOX 51308 TULSA, OKLAHOMA 74151	II 2 B 2 PAGE NO OF
CHECKED BY L	RESCUE MISSION	REPORT NO SD 70-205
DATE 1-27-69	SLA	MODEL NO SKYLAB



VIEW LOOKING INBOARD

PREPARED BY *Temmen*	TULSA DIVISION NORTH AMERICAN ROCKWELL CORPORATION P.O. BOX 51308 TULSA, OKLAHOMA 74151	*II 2 3 3* PAGE NO. OF
CHECKED BY: *L*	RESCUE MISSION	REPORT NO. SD 70-20
DATE *1-27-69*	SLA	MODEL NO. SKYLAB



VIEW LOOKING OUTBOARD

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CHECKED BY: L

DATE 1-27-67

TULSA DIVISION
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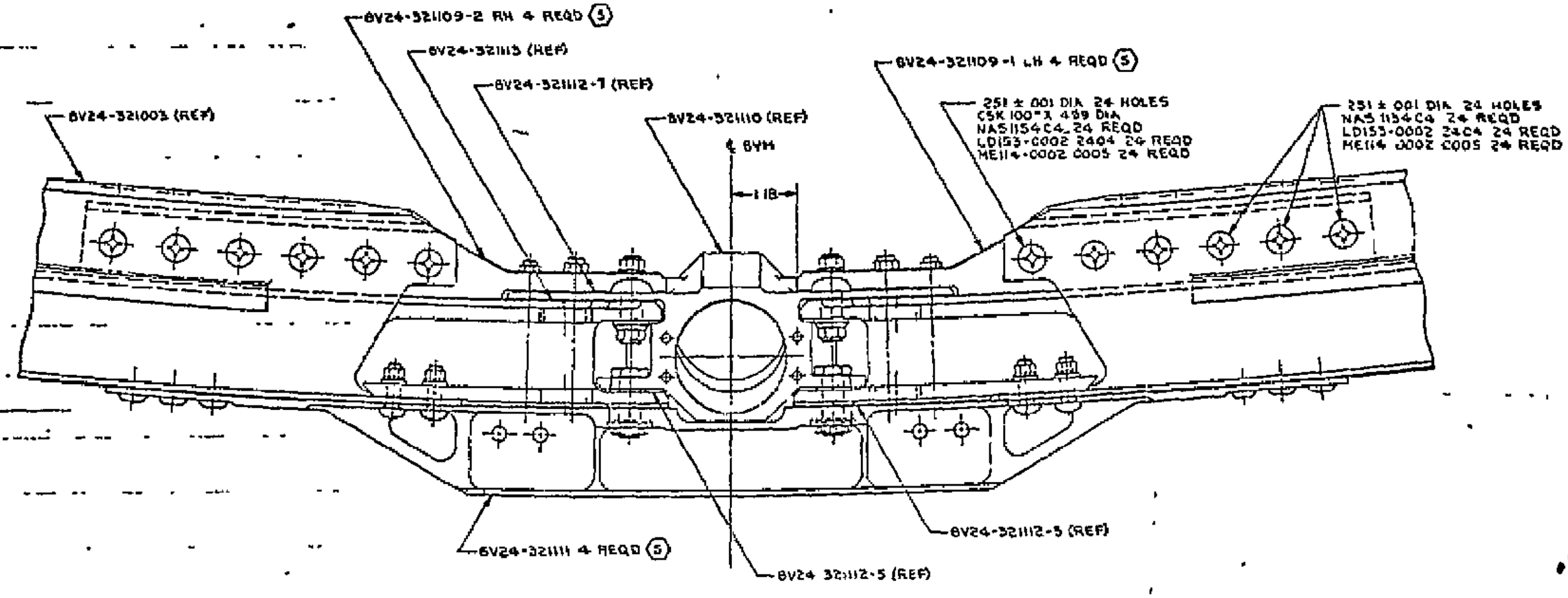
RESCUE MISSION

SLA

II 284
PAGE NO OF

REPORT NO. SD 70-205

MODEL NO SKYLAB

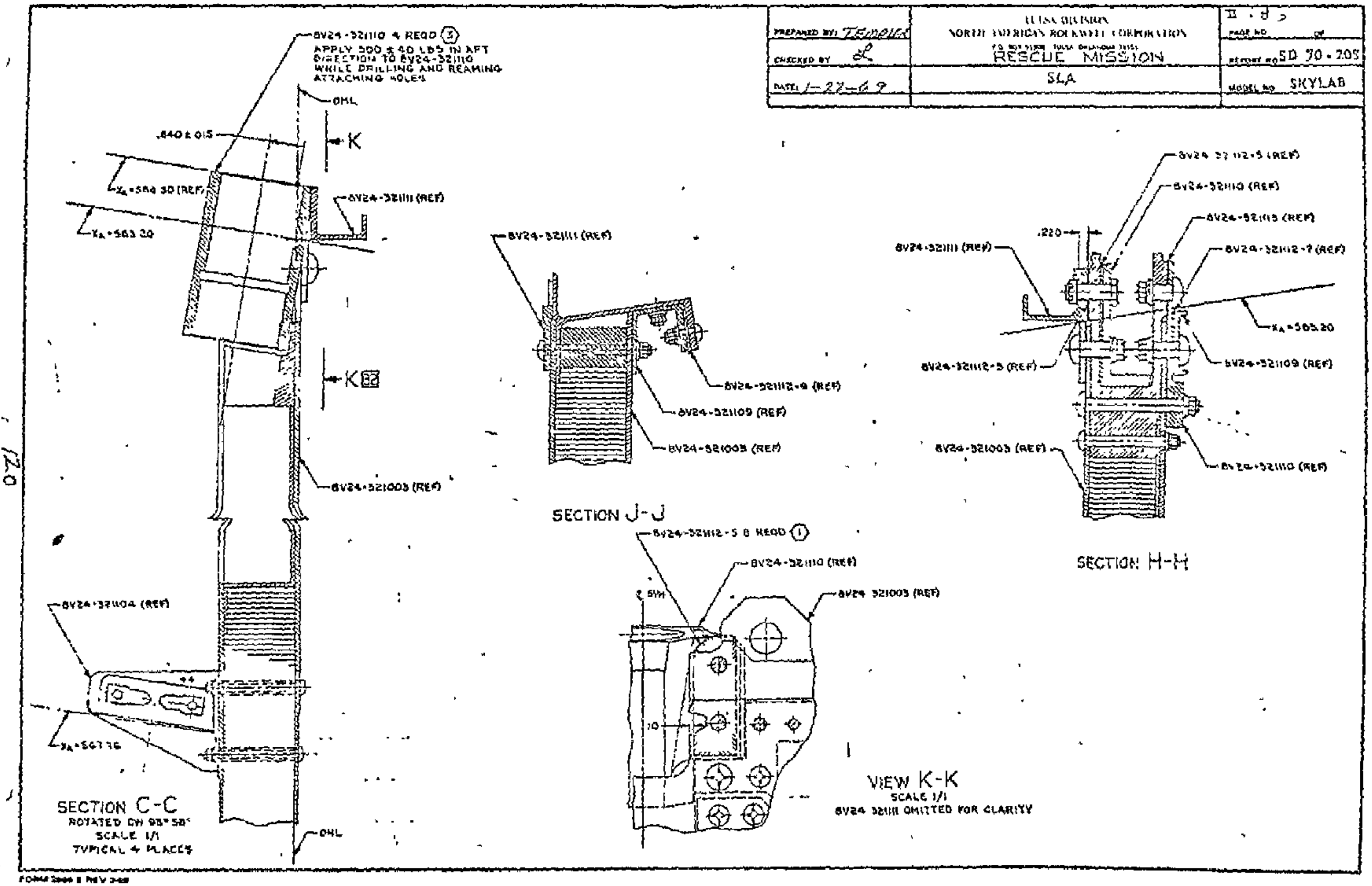


VIEW G-G

PREPARED BY: TEMPLE
CHECKED BY: L
DATE: 1-27-69

TULSA DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
P.O. BOX 51308 TULSA OKLAHOMA 74151
RESCUE MISSION
SLA

PAGE NO. II - 82 OF
REPORT NO. SD 70 - 205
MODEL NO. SKYLAB



PREPARED BY [illegible]
CHECKED BY
DATE 1-27-69

TULSA DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO

REF

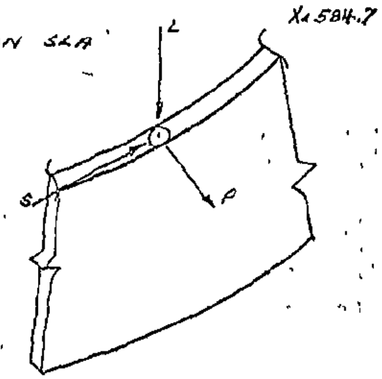
SLA
LOADS

MAX. LIMIT LOADS - ACTING ON LEM

Ⓑ⑨ VI.2.5.32

CONDITION & NO.	P(LBS)	S (LBS)	L (LBS)
END BOOST 22255	-5391	-749	-42307
MAX gα 21259	-7499	-1890	-17896
MAX gα 21262	1235	1967	-18158
SEPARATION 23259	, 719	, 93	-5816

SIGN CONVENTION ON SLA



ULT LOADS ACTING ON SLA

CONDITION & NO.	P(LBS)	S(LBS)	L(LBS)
END BOOST 22255	7540	1050	59200
MAXgα 21259	10500	2640	25000

PREPARED BY [illegible]
CHECKED BY
DATE 7 22-69

NORTH AMERICAN AVIATION, INC.
RESCUE MISSION
SLA

REF

SLA
LOADS

THE LOADS SHOWN ON THE PREVIOUS PAGE ARE THE CRITICAL SLA/LEM INTERFACE LOADS. FROM THESE, THE DESIGN LOADS SHOWN ON THE NEXT PAGE ARE DEVELOPED. THESE LOADS COME FROM THE BASELINE STRESS REPORT, PAGES VI 2 5.7 AND VI 2.5.9.

THE TOTAL LOAD ACTING ON THE FITTING (8V24 32110) IS A FUNCTION OF THE VERTICAL LEM LOAD, THE PRELOAD AND THE WEDGING LOAD ON THE BALL FROM THE SLA/LEM SIDE LOADS.

THE VERTICAL STRAP LOADS (R_1 & R_2) ARE EQUAL TO THE PRELOAD IN THE SYSTEM FOR THESE CONDITIONS.

PREPARED BY: TEMPLE
CHECKED BY: L
DATE: 1-29-69

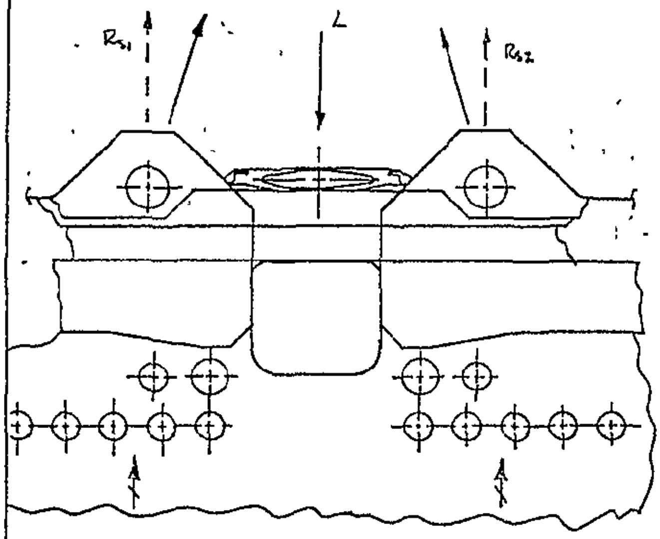
TULSA DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO II.2B8 OF
REPORT NO SD 70-205
MODEL NO SKYLAB

REF

DWG NO

SLA
LOADS



(83)
VI.2.5.7

COND NO	L ULT	R_{S1} ULT	R_{S2} ULT
22255	92860#	8075	8075
21257	64005#	8075	8075

TOTAL LOAD AT. ATTACH POINT IS VERTICAL LOAD FROM LM + PRELOAD IN CALIBRATED LINK + WEDGING DUE TO RADIAL AND TANGETIAL LM LOAD.

PREPARED BY: G.F.
CHECKED BY: R G.R.
DATE: 4-18-73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
GENERAL

PAGE NO II.3.0 OF
REPORT NO SD 70-205
MODEL NO Skylab

SECTION II.3

COMMAND MODULE

PREPARED BY: G.F
CHECKED BY: VGK
DATE: 3/1/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO F04-100002

REF.

FIELD SITE INSTALLATION - STOWABLE EQUIPMENT, CREW COMPARTMENT

THE ABOVE FIELD SITE INSTALLATION ANALYSIS CONTAINS A LISTING OF THE STRUCTURAL PARTS PRESENT ON THE DRAWING AND THEIR DISPOSITIONS. ANALYSIS OF MISCELLANEOUS FASTENERS IS ALSO INCLUDED.

PREPARED BY: MFS
CHECKED BY: G.F
DATE: 12/1/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO [illegible]

REF
N/R
F04-
100002

FIELD SITE INSTALLATION - STOWABLE EQUIPMENT, CREW COMPARTMENT

THIS DRAWING INCORPORATES THE MAJOR PORTION OF THE STOWED EQUIPMENT FOR RESCUE MISSION INCLUDING COUCHES. THE FOLLOWING IS A LISTING OF THE DRAWINGS AND WHERE THEIR ANALYSIS MAY BE FOUND:

* *("/" = NON-STRUCTURAL, "—" = PREVIOUSLY FLOWN, "O" = SKYLAB ANALYSIS SECTION, "@" = RESCUE ANALYSIS.)

F01-610347-21	CLORINE AMP	/
F01-610347-31	BUFFER AMP	/
V16-613205	SHIM	—
V36-321091-41	SPACER	—
V36-421649-21	WMS CABLE	/
V36-421851	PROBE CABLE	/
V36-471435-31	GND CABLE	/
V36-570025	SNAG LINE	—
V36-601015-401	TEMP STOW BAG	O
V36-601082	O₂ CLAMP	—
V36-601083-11	SCREEN CAP	⌿
V36-601113-11	CABLE STRAP	—
V36-601135-501	TOOL KIT	⌿
V36-601169	ROPE	⌿
V36-601170-31,-41	SNAP	—
V36-601171-11,-21	HOOK	—
V36-601197	CURTAIN	—
V36-601207	O₂ UMBIL	⌿
V36-601223	POUCH	—
V36-601229	CLAMP	—
V36-601230	CLIP	—
[illegible]	[illegible]	—
V36-601299	COVER	—
V36-601323	CONTROL STRAP	—
V36-601373	URINE HOSE	⌿
V36-601398	FECAL BAG ASSY	⌿
V36-601405	TOOL E	⌿

(CONTINUED)

PREPARED BY: IVFG
CHECKED BY: G.E.
DATE: 12/6/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO F04-100002

REF

FIELD SITE INSTALLATION - STOWABLE EQUIPMENT, CREW COMPARTMENT

DRAWING LIST (CONT)

V36 - 601520	U2 LOCKER	—
V36 - 601522	U1 LOCKER	—
V36 - 610307	NEEDLE	ƒ
V36 - 610320	CASING	—
V36 - 610323	LIOB	ƒ
V36 - 611813	FLX DUCT	—
V36 - 612547	FILTER	ƒ
V36 - 612555	COUPLING	—
V36 - 715107	CCU	—
V36 - 727013	CONTAINERS	—
V36 - 715011	CONTAINER	—
V36 - 727019	CONTAINER	—
V36 - 727313	B3 CUSHION	—
V36 - 737352	CONTAINER	—
V36 - 737802	CONTAINER	—
V36 - 727219	CONTAINER	—
V36 - 755020	UTILITY STRAP	—
V56 - 331710	CHILLER FRAME	0
V56 - 331805	BALLAST	0
V56 - 331806	BALLAST	0
V56 - 531100-11,-21	COUCH	0
V56 - 531105	ADAPTER	0
V56 - 531106	ADAPTER	0
V56 - 531150-11,-12	SUPPORT	0
V56 - 601027	FECAL BAG	/
V56 - 601064	BALLAST	0
V56 - 601067	PLATE	0
V56 - 601068	SUPPORT	0
V56 - 601123-21	STRAP	0
V56 - 601069	STRAP	0
V56 - 601074	HELMET BAG	0
V56 - 601075	HELMET BAG	0
V56 - 601073	STRAP	0
V56 - 601077	STRAP	0
V56 - 601075	STRAP	0
V56 - 601076	STRAP	0
V56 - 601077	STRAP	0
V56 - 601078	STRAP	0
V56 - 601079-101	LOCK	0

(CONTINUED)

PREPARED BY: IVFG.
CHECKED BY: G.F.
DATE: 12/13/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 4 OF
REPORT NO SD 70-20
MODEL NO SKYLAB
DWG NO F04-100002

REF

FIELD SITE INSTALLATION - STOWABLE EQUIP, CREW COMPARTMENT

DRAWING LIST (CONT.)

V56 - 601100	CCU STRAP	0
V56 - 601101	O_2 MASK BAG	0
V56 - 601102	STRAP	0
V56 - 601103	ADAPTER	0
V56 - 601105	COVER	0
V56 - 601110	PALLET	0
V56 - 601111	FRAME	0
V56 - 601126	PANEL	0
V56 - 601127	CLOSE OUT	0
V56 - 601131	FAIRING	0
V56 - 601234	O_2 MASK BAG	0
V56 - 612612	WMS Q DISC	0
V56 - 715100	CCU HEAD	0
V56 - 715101	CCU	0
V56 - 715102	CCU ADAPTER	0
V56 - 786507	MAG CONT.	O
V56 - 786509	CL CONTAINER	O
V56 - 786510	SEP CONT.	O
V56 - 786512	CPLG CONT.	O
V56 - 786513	HOSE CONT.	O
V56 - 786514	LCFH CONT.	O
V56 - 786515	CWG CONT.	O
V56 - 786578	WMS CONT.	O
V56 - 786531	FLTR CONT.	O
V56 - 786549	STRAP	O
V56 - 786551 (MTPL)	STRAP	O
V56 - 786552	CONTAINER	O
V56 - 786554	CONTAINER	O
V56 - 786577	STRAP	O
V56 - 786801	I.D. PLATE	/
V56 - 786802	I.D PLATE	/
V56 - 787556	STRAP	O
V56 - 601143	O_2 UMBILICAL	/
V56 - 601124	CLIP	0
V56 - 707035	C/B ACTUATION	/
V56 - 601091	STRAP	0
V56 - 601092	CCU STRAP	0

** PREVIOUSLY FLOWN STRUCTURE IS ANALYZED IN SD 67-1103 AND ADDENDUMS. SKYLAB ANALYSIS IS IN REPORT SD70-205.

PREPARED BY: RGR
CHECKED BY:
DATE: 17 JAN 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 5 OF 67
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO F04-100002

FIELD-SITE-INSTALLATION-STOWABLE EQUIP. CREW COMPARTMENT

URINE CHILLER ADAPTER FRAME BALLAST FASTENERS

WASHER

2W1C16-36-182 WASHER

CHECK LOAD PRODUCED BY TORQUE APPLIED BOLT STRESS OF 40,000 PSI

(THESE STANDARD PARTS ARE ANALYZED DUE TO THE CRITICAL LOADING CONDITIONS THEY EXPERIENCE IN THIS APPLICATION)

D8 1111-21

BOLT NAS 1004-40A

$D = .2470 - .2495$

USE $D = .250$

$A_{BOLT} = \frac{\pi D^2}{4} = .0491 \text{ IN}^2$

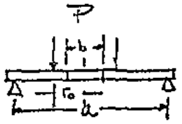
$P = 40{,}000(.0491)$

$P = 1{,}970^{\#}$

APPLY TO WASHER AS CONCENTRIC LOAD AS SHOWN

I 22.15

MAXIMUM LOAD = $3910^{\#}$ ULT.



E4 ROARK CASE 59 TABLE 10

MAXIMUM TENSILE STRESS

$$S_{max} = \frac{3W}{2\pi m t^2}\left[\frac{1}{2}(m-1)+(m+1)\log\frac{a}{r_0}-(m-1)\frac{r_0^2}{2a^2}\right]-\frac{6M(a^2+b^2)}{(a^2-b^2)t^2}$$

$m = 1/\nu$

$$M = \frac{W}{8\pi m}\left[(m-1)+2(m+1)\log\frac{a}{r_0}-(m-1)\frac{r_0^2}{a^2}\right]$$

$a = 1.125''$ $b = .250''$ $R_0 = .20''$

$W = 3910^{\#}$ $m = 3.03$ $t = .188$

$M = 826''^{\#}$

$S_{max} = 139727 - 154217$

$S_{max} = -14{,}490$ PSI

D8 5132-6

301 1/2 HARD $F_{TU} = 150$ KSI

M.S. = +9.65

PREPARED BY: RGR
CHECKED BY:
DATE: 17 JAN 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO F04-100002

FIELD-SITE-INSTALLATION-STOWABLE EQUIP. CREW COMPARTMENT

URINE CHILLER ADAPTER FRAME BALLAST FASTENERS

INSERT

MD 115-2002-0004 INSERT

D8 1156-21

$P_U = 5000^{\#}$ IN 356-T6 AL MIN QQ-A-601

$P_U = 7300^{\#}$ IN 2014-T6 AL MIN QQ-A-200/2

ADAPTER FRAME – QQ-A-250/4 2024-T351

ASSUME F_{SU} IS CRITICAL FOR COMPARISON OF QQ-A-200/2 TO QQ-A-250/4

$F_{SU} = 39$ KSI QQ-A-200/2

$F_{SU} = 37$ KSI QQ-A-200/4

RATIO

.949

INSERT P_U IN QQ-A-250/4

$P_U' = P_U \cdot .949$ QQA-200/2

$= 6{,}930^{\#}$

@ 78"9" ROUND

II 22.15

$P = 3910^{\#}$

$M.S. = \frac{6930}{3910} - 1 = .77$

BOLT

NAS 1004-40A

MIL-5A

ALLOW. TEN LOAD. = $4680^{\#}$

II 22.15

$P_{ULT.} = 3910^{\#}$

$M.S. = \frac{4680}{3910} - 1 = .20$

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 5/12/72

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V36-317053

REF
N/A
V36-317
004

BRACKET - SUPPORT, ELECTRICAL WIRING, INTERIOR, 6 SQ INCHES

THE ABOVE BRACKET HAS BEEN UTILIZED ON PREVIOUS FLIGHT VEHICLES. CORE COMPRESSION IS CHECKED HERE FOR LOADS DUE TO THE PGA STOWAGE CONTAINER ON THE SKYLAB RESCUE VEHICLE. THIS CORE LOADING IS TYPICAL FOR THE BRACKETS LOADED BY THE CONTAINERS

II.2.4 T

$P_{ALL} = 132 \frac{LB}{IN}$

$P_{ULT} = 123 \frac{LB}{IN}$

$M.S = \frac{132}{123} - 1 = \underline{.07}$

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 2/12/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-20
MODEL NO SKYLAB
DWG NO. V36-331205

REF
N/A
V36-331
001

COVE-RH EQUIP BAY, Z_c +4.00 TO Z_c -6.00, ASSY OF

THE ABOVE PART HAS FLOWN PREVIOUSLY. THE FOLLOWING ANALYSIS IS ONLY A CRIPPLING CHECK FOR LOADING DUE TO THE PGA CONTAINER ON THE RESCUE VEHICLE

II.2.4.12

$\sigma_b = 614\, p$

II.2.4.5 & II.2.4.4

$p = (.48)(40)$ (FOR RH. WIRE TRAY)

$= 19.2$ PSI

Ⓓ1 02.22.07.01

APPROXIMATE CRIPPLING ALLOW. ASSUMING 2024-T4 IS SIMILAR TO T3, T351

$\sigma_{cc} = 13500$ PSI

$\frac{b}{t} = \frac{1.2}{.032}$

$= 37.5$

$\sigma_b = 614(19.2)$

$= 11800$ PSI

$M.S. = \frac{13.5}{11.8} - 1 = \underline{.14}$

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 3/14/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V36-331572

REF.
N/A
V56-601147
V36-331525
V36-331531

CLIP, RING - TIE-DOWN, STOWAGE CONTAINER, AFT EQUIPMENT BAY, ASSY OF

THE ABOVE CLIP ASSEMBLY IS COMPOSED, OF THE DRAWINGS LISTED BELOW. REFER TO V56-331764 FOR ANALYSIS. THE -3 DOUBLER DOES NOT EXPERIENCE HIGH LOADING. NO ANALYSIS IS REQUIRED

V36-331572-3	DOUBLER
V56-331764	CLIP

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 3/13/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V36-441361

REF
N/A
V56-441081

COVER, CABLE TRAY, UPPER AFT BHD, R H EQUIP. BAY, ASSY OF

THE ABOVE COVER HAS FLOWN BEFORE. THE FOLLOWING ANALYSIS IS ONLY A BENDING CHECK FOR PGA CONTAINER LOADS ON THE SKYLAB RESCUE VEHICLE.

(C22)
TABLE 3230 (2a)

2024-T42

$F_{TU} = 57$ KSI

$F_{TY} = 34$ KSI

$F_b = 57 + 34\,(1.5-1)$
$= 74$ KSI

II 2410

$\sigma_b = 66{,}500$ PSI

$$M.S. = \frac{74}{66.5} - 1 = \underline{\underline{.11}}$$

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 4/13/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-000250

REF
N/A
END ITEM

GENERAL ASSY- DOCKING, MDA, COMPLETE

THE DRAWINGS LISTED BELOW ARE PRESENT ON THE ABOVE ASSEMBLY. REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS

** V56-420105	CONTROL UMBILICAL
** V56-601125	BLANKET
* V28-575202	DROGUE ASSY
** V56-420103-11	POWER UMBILICAL
V56-575664	RELEASE ASSY
** V56-600510	DUCT
** V56-420104-11	POWER UMBILICAL
V56-757206	DROGUE
V56-575670	RELEASE TOOL
** F04-100020	ABSORBER ELEMENT

* PREVIOUSLY FLOWN. NO FURTHER ANALYSIS REQUIRED.

** NON-STRUCTURAL PART. NO ANALYSIS REQUIRED.

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 4/4/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-317537

REF
N/A
V36-317
004

RESCUE VEHICLE

BRACKET- STOWAGE SUPPORT, ACEG J-2, AFT BULKHEAD

(REEXAMINATION OF THE BRKT FOR NEW LOAD)

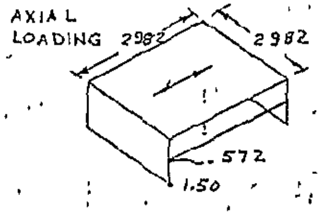
II 27 6
SD70-205

$P_x = 2781$ LBS (ULT)

$M_z = .049 P_x = .049(2781)$
$= 136.2$ IN-LBS

(USING EFFECTIVE WIDTH = .116 IN)

II 278 (CORE SHEAR)



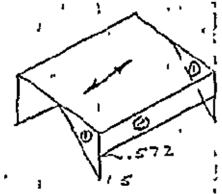
$K_T = 1.50 (.381)$
$= .572$

$A = 2[(1.50)(2.982)+(.572)(2.982)]$
$= 12.37$ IN²

$f_{s_1} = \frac{2781}{12.37}$

$f_{s_1} = 224$ PSI

BENDING SHEAR



ITEM	A	Y	AY
1	2.2365	.994	2.22
2	1.71	1.491	2.55
	3.946		4.77

COUPLE ARM $= \left[\frac{4.77}{3.946}\right] 2$

$= 2.42$ IN.

$f_{s_2} = \frac{136.2}{(2.42)(3.946)}$

$= 14.2$ PSI

$f_{s_{TOTAL}} = 224 + 14.2$

$= 238.2$ PSI (LONG)

II 2.77 (CORE SHEAR)

$M.S. = \frac{238}{238.2} - 1 = .00^+$

PREPARED BY: G. F.
CHECKED BY: RSR
DATE 4/4/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-317558

REF N/A

RESCUE VEHICLE

V36-317 004

BRACKET - STOWAGE SUPPORT DFHK-2, AFT BLKHD

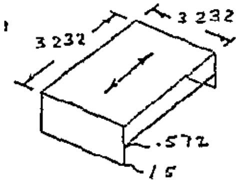
(RE-EXAMINATION OF BRACKET FOR HIGHER RESCUE LOADS; CORE SHEAR IS CRITICAL)

II.2.7.6 $P_X = 3118$ LBS (ULT)

SD70-205 $M_z = .036 (3118)$ (USING NOMINAL e)
$= 112$ IN-LBS

AXIAL SHEAR (USING .116 IN. EFFECTIVE FACE SHEET)

II.2.7.8

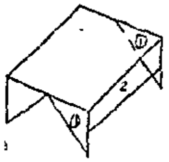


$K_T = 1.50 (.381)$
$= .572$ IN

$A = 2\left[(3.232)(1.50 + .572)\right]$
$= 13.4$ IN²

$f_{s_1} = \frac{3118}{13.4}$
$= 232$ PSI

BENDING SHEAR



ITEM	A	Y	AY
1	2 425	1.077	2 615
2	1 85	1 616	3 99
	4.275		6.605

COUPLE ARM $= \left[\frac{6.605}{4.275}\right] 2$
$= 3.09$ IN

$f_{s_2} = \frac{112}{(3.09)(4.275)}$
$= 8.5$ PSI

$f_{s_{TOTAL}} = 232 + 8.5$
$= 240.5$ PSI

II 2.7.7 M.S $= \frac{238}{240.5} - 1 = -.01$

PREPARED BY: G F
CHECKED BY: R-R
DATE: 4/5/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-317561

REF N/A
V36-317 004

BRACKET - STOWAGE SUPPORT A2, AFT BULKHEAD

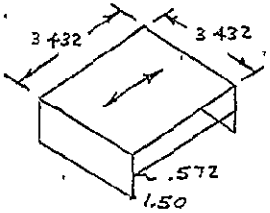
(RE-EXAMINATION OF BRACKET FOR HIGHER RESCUE LOADS, CORE SHEAR IS CRITICAL).

II 2.7.6 $P_X = -2961.6$ LBS. (ULT)

SD 70-205 $M_z = (2964.4)(.04)$
$= 118.5$ IN-LBS.

AXIAL SHEAR (USING .116 IN. EFFECTIVE FACE SHEET)

II.2.7.8

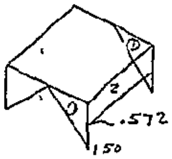


$K_T = 1.50 (.381)$
$= .572$ IN

$A_1 = 2\left[3.432 (1.50 + .572)\right]$
$= 14.22$ IN²

$f_{s_1} = \frac{2961.6}{14.22}$
$f_{s_1} = 208$ PSI

BENDING SHEAR



ITEM	A	Y	AY
1	2.574	1.144	2 945
2	1 96	1 716	3.365
	4.534		6.310

COUPLE ARM $= 2 \left(\frac{6.310}{4.534}\right)$
$= 2.785$ IN

$f_{s_2} = \frac{118.5}{(2.785)(4.534)}$
$= 9.4$ PSI

$f_{s_{TOT}} = 208 + 9.4$
$= 217.4$ PSI

II 2.7.7 M.S $= \frac{238}{2.74} - 1 = +.09$

PREPARED BY: G.F.
CHECKED BY: P.R.
DATE: 4/5/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-317564

REF

BRACKET - STOWAGE SUPPORT, L3, B1, L4, B2, AFT BULKHEAD

(RE-EXAMINATION OF BRKT FOR HIGHER RESCUE LOADS; CORE SHEAR IS CRITICAL)

(A 9)	(A 8)
$P_{x_1} = -331.1$ LBS (ULT)	$P_{x_2} = -3822$ LBS. (ULT)
	$P_{Y_2} = -354$ LBS (ULT)
	$P_{z_2} = 710$ LBS (ULT)

II.2.7.6

73MA1651 Pg 12

$M_Y = .31 P_{x_2} - 2.41 P_{x_1} - 1.0 P_{z_2}$

$= .31(-3822) - 2.41(-331.1) - 1.0(710)$

$= -1185 + 799 - 710$

$M_Y = -1096$ IN-LBS

$M_Z = -1.243 P_{x_2} + 1.35 P_{x_1} + 1.0 P_{Y_2}$

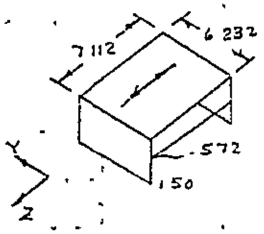
$= -1.243(-3822) + 1.35(-331.1) + 1.0(-354)$

$= 4760 - 446 - 354$

$M_Z = 3960$ IN-LBS

AXIAL SHEAR

II.2.7.8



$K_T = 1.50(.381)$

$= .572$ IN

$A = 2\left[(7.112)(.572) + (6.232)(1.50)\right]$

$= 26.926 \text{ IN}^2$

$f_{s_1} = \frac{3822 + 331.1}{26.926}$

$= 154.2$ PSI

PREPARED BY: G.F.
CHECKED BY: R.G.R.
DATE: 4/5/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

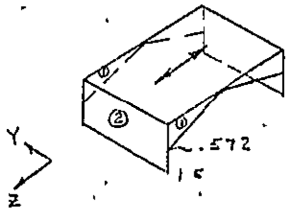
PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-317564

REF

BRACKET - STOWAGE SUPPORT, L3, B1, L4, B2, AFT BULKHEAD

BENDING SHEAR

M_Y



ITEM	A	Z	AZ
1	2.034	2.370	4.82
2	9.348	3.556	33.20
	11.382		38.02

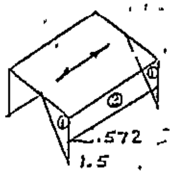
COUPLE ARM $= 2\left[\frac{38.02}{11.382}\right]$

$= 6.68$ IN

$f_{s_2} = \frac{1096}{(6.68)(11.382)}$

$= 14.4$ PSI

M_Z



ITEM	A	Y	AY
1	4.674	2.077	9.70
2	4.07	3.116	12.68
	8.744		22.38

COUPLE ARM $= 2\left[\frac{22.38}{8.744}\right]$

$= 5.12$ IN

$f_{s_3} = \frac{3960}{(5.12)(8.744)}$

$= 88.45$ PSI

$f_{s_{TOTAL}} = 154.2 + 14.4 + 88.45$

$= 257$ PSI

II.2.7.7

$\text{M.S.} = \frac{235}{257} - 1 = \underline{\underline{-.07}}$

PREPARED BY: C.F.
CHECKED BY: RGR
DATE: 2/5/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-331710

REF
N/A
F04.100
002

FRAME ASSEMBLY, ADAPTER - M071/73 CHILLER, AFT EQUIPMENT BAY

THE DRAWINGS LISTED BELOW ARE PRESENT ON THE ABOVE ASSEMBLY. REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS.

V56-331710-3,-5	PADS
V56-331712	FRAME
V56-601069-41	STRAP ASSY
V56-601140-11	CABLE ASSY
V56-601140-21	CABLE ASSY
V56-601140-31	CABLE ASSY
*V36-331558	SPACER

THE -3 AND -5 RUBBER PADS ARE NON STRUCTURAL AND NEED NOT BE ANALYZED

* NON-STRUCTURAL LAMINATED (PEELABLE) SPACER

PREPARED BY: RGR
CHECKED BY: G F
DATE: 25 JAN 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-331712

REF
N/A
V56
331710

FRAME ADAPTER - M071/73 CHILLER, AFT EQUIPMENT BAY, ASSY OF

RESCUE MISSION REQUIREMENTS INCLUDE PROVISIONS TO RETURN M071/73 URINE CHILLER IN CM LOCKER A8 LOCATION (MCR 31183). DESIGN RESPONSE IS THE V56-331712 ADAPTER FRAME CAPABILITY FOR THE ADAPTER FRAME INCLUDES BALLAST PROVISIONS FOR RESCUE MISSION LAUNCH, WITH URINE CHILLER RETURN. LAUNCH CRITERIA IS "78" g ABORT LANDING AND BOEING CRITERIA FOR CHILLER RETURN AS PER NORMAL LANDING.

MAT QQ-A-250/4 2024-T351

ⒸC22
TRS
3.2 3.0(b)

F_{tu} = 59,000 PSI
F_{ty} = 43,000 "
F_{cy} = 38,000 "
F_{su} = 35,000 "
F_{bru} = 114-117,000 PSI e/D = 1.5, 2.0
F_{bry} = 71-89,000 " " " "
E = 10.7×10^6 PSI
ν = .33

F_R = 59 + .5(43) K=1.5
F_R = 80.5 KSI

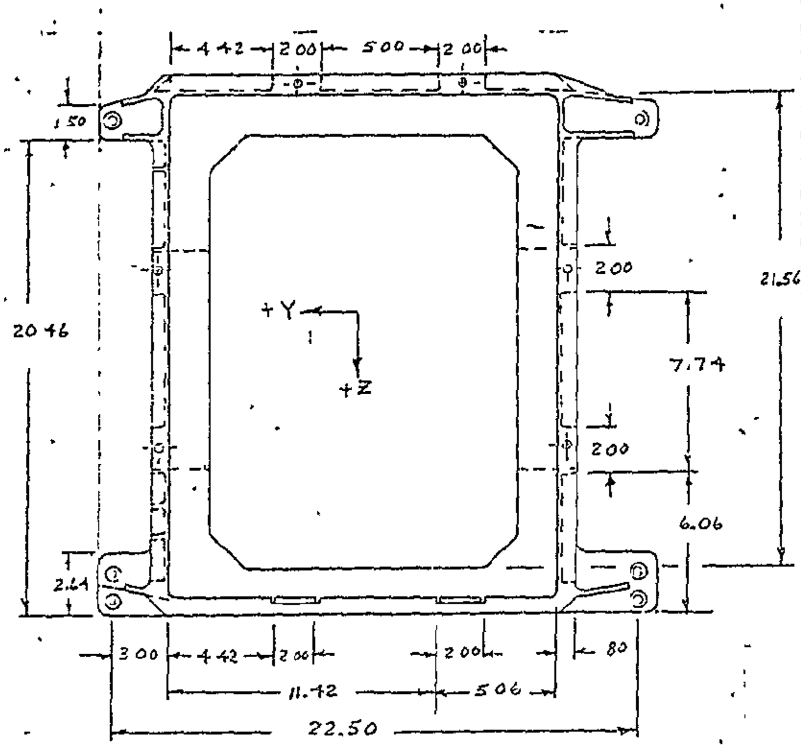
PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 2/11/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V26-331712

REF

FRAME, ADAPTER - M071/73 CHILLER, AFT EQUIP BAY, ASSY OF



PREPARED BY: NTG
CHECKED BY: RGR
DATE: 1/1/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

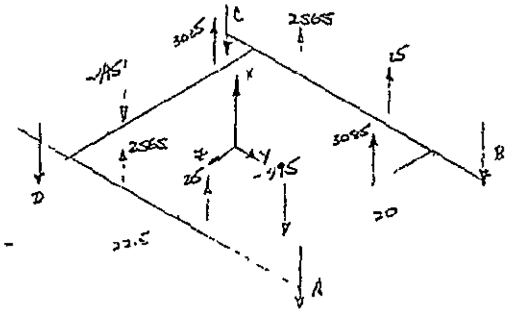
PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V26-331712

REF

FRAME - ADAPTER - M071/73 CHILLER, AFT EQUIPMENT BAY, ASSY OF

III.2.2.9 EQUIP BENDING
(TENSION IN STRAPS)

*NOTE: REVERSE LOADING IS CRITICAL FOR FRAME BENDING.



$$P_C = \frac{\overset{(37200)}{(2565)(14.5)} + \overset{(190)}{(25)(7.6)}}{22.5} + \frac{\overset{(42500)}{(3085)(13.3)} - \overset{2770}{(495)(5.6)}}{20}$$

$$= \frac{37390}{22.5} + \frac{39730}{20} = 1660 + 1985 = 3645^{\#} = P_B \text{ CRITICAL}^{*}$$

$$P_D = \frac{(2565)(14.5) + (25)(7.6)}{22.5} + \frac{\overset{20{,}000}{(3085)(6.5)} - \overset{6950}{(495)(14)}}{20}$$

$$= 1660 + \frac{13050}{20} = 1660 + 655 = \underline{2315}^{\#} = P_A \text{ CRITICAL}^{*}$$

$$P_B = \frac{2565(8) + (25)(15)}{22.5} + 1985$$

$$= \frac{20600 + 375}{22.5} + 1985 = 930 + 1985 = \underline{2915}^{\#} = P_C (\text{N.C.})^{*}$$

$$P_A = 930 + 655 = \underline{1585}^{\#} = P_D (\text{N.C.})^{*}$$

REF

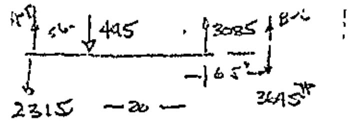
FRAME - ADAPTER - M071/73

CHILLER, AFT EQUIPMENT BAY, ASSY OF

FRAME BENDING (CON)

$\Sigma F_V = 3645 + 2315 + 2915 + 1585 = 10{,}460$ # ≅ 10350# APPLIED

BEAM H-B

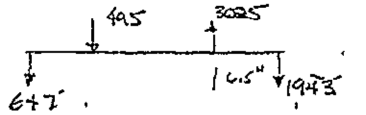


$\Sigma M_{AD} = \frac{2315(20) + 495(14.4) - 3085(6.5)}{20} = 1668$ LBS

$\Sigma F = 2315 + 495 + 3645 - 3085 - 1668 - BC = 0$

$BC = 1702$ LBS

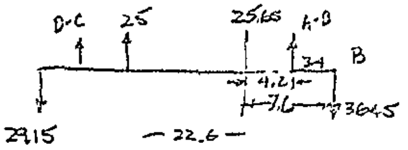
NET



$\Sigma F \approx 0$

$M_{AX} = 1943\,(6.5) = \underline{12{,}630 \text{ IN}^{\#}}$

BEAM B-C



$D\text{-}C = \frac{(2915)(19.2) - 25(11.6) - 2565(4.2) - (3.4)(3645)}{15.8}$

$D\text{-}C = 2058$ LBS

$AB = 2915 - 2058 - 25 - 2565 + 3645$

$= 1912$

$M_{max} = 3645(7.6) - 1912(4.2) = 27{,}800 - 8030$ (IN-#)

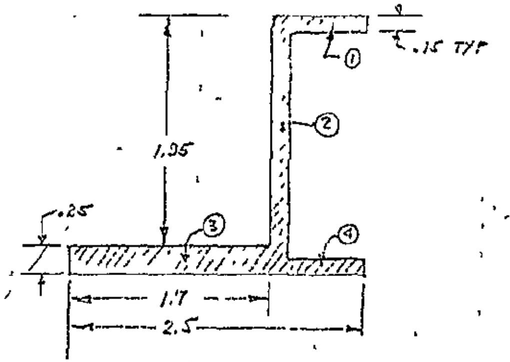
$M_{max} = 19{,}770$ IN #

133

REF

FRAME - ADAPTER - M071/73

CHILLER, AFT EQUIPMENT BAY, ASSY OF



ITEM	Y	A	AY	AY²	I₀
1	2.2	.12	.264	.580	
2	1.1	.33	.363	.400	.1325
3	.125	.42	.052	.006	
4	.07	.12	.008	.0	
		.99	.687	.986	.1325

$\bar{Y} = .695$ in

$I = .986 - (.99)(.695)^2 + .1325$

$= .986 - .478 + .1325$

$= \underline{.6405 \text{ in}^4}$

$f_b = \frac{Mc}{I} = \frac{(19{,}770)(2.2 - .695)}{.6405} = 46{,}450$ psi

P(1) $\sigma_B = 80{,}500$ psi M.S. = .73

$f_b = \frac{(19770)(.695)}{.6405} = 21{,}450$ psi

$\sigma_{cu} = 38{,}000$ psi M.S. = +.77

DII
32.22.67
.01

135

PREPARED BY: [illegible]
CHECKED BY: [illegible]
DATE: [illegible]

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO [illegible]1917

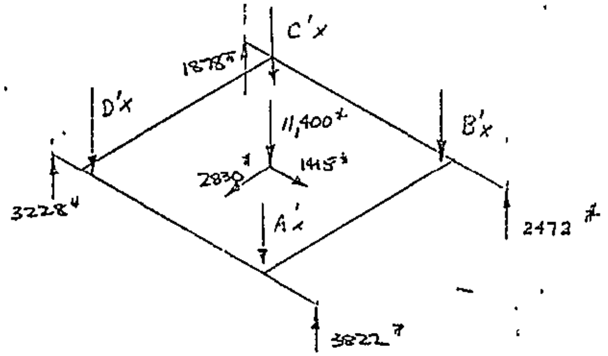
REF

FRAME - ADAPTER - M071/73

CHILLER AFT EQUIPMENT BAY, ASSY OF

CHECK AXIAL (X) LOAD, AFT DIRECTION:

II.2.27



$$A'_x = \frac{11{,}400^{\#}}{4} + \frac{(2830)(9.5)}{(20.5)(2)} + \frac{(1415)(9.5)}{(15.7)(2)}$$

$$= 2850 + 655 + 428 = \underline{3933}^{\#}$$

$$B'_x = 2850 - 655 + 428 = \underline{2623}^{\#}$$

$$C'_x = 2850 - 655 - 428 = \underline{1767}^{\#}$$

$$D'_x = 2850 + 655 - 428 = \underline{3077}^{\#}$$

$\Sigma F_y = 3933 + 2623 + 1767 + 3077 - 11{,}400 \approx 0$ CHECKS

134

PREPARED BY: RGR
CHECKED BY: G F
DATE: 23 JAN 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

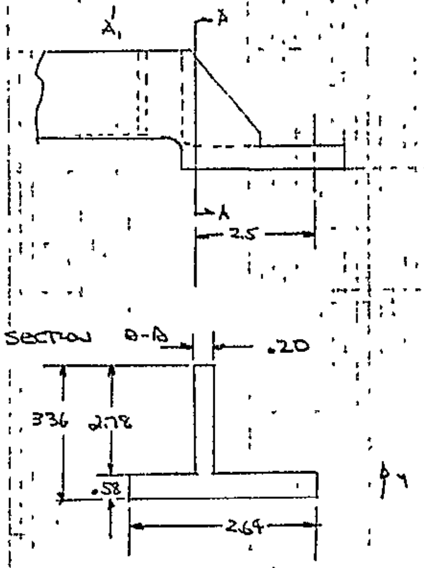
PAGE NO 7 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-337712

REF

FRAME, ADAPTER - M071/73 CHILLER, AFT EQUIP BAY, ASSY OF

FRAME BENDING A'

(TYPICAL ATTACHMENT LUG)



$A = 2.08 \text{ IN}^2$

$\bar{Y} = .66 \text{ IN}$

$I_{NA} = 1.19 \text{ IN}^4$

$C_c = 3.36 - .66 = 2.7$

PREPARED BY: R	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 8 OF 9
CHECKED BY: G.F.		REPORT NO SD 70-205
DATE: 23 [illegible] 73	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-331712

REF

FRAME ADAPTER - M071/73 CHILLER, AFT EQUIP BAY, ASSY OF

BENDING

II.2 2.6

CASE I CHILLER $P_{max} = 3822^{\#}$

$M_{max} = 3822(2.5) = 9550 \text{ IN}^{\#}$

$f_c = \frac{Mc}{I} = \frac{9550(2.7)}{1.19}$

$f_c = 21650 \text{ PSI}$

$F_{cy} = 38{,}000 \text{ PSI}$

$M.S._y = +.75$

CASE II $200^{\#}$ BALLAST $+ 18.5^{\#}$ FRAME

$P_{max} = 218.5(78)/4 = 4{,}270^{\#}$

$M_{max} = 4270(2.5) = 10{,}650 \text{ IN}^{\#}$

$f_c = \frac{10650(2.7)}{1.19}$

$f_c = 24{,}200 \text{ PSI}$

$F_{cy} = 38{,}000 \text{ PSI}$

$M.S._y = +.57$

PREPARED BY FB	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 1 OF 2
CHECKED BY G.E.		REPORT NO SD 70-205
DATE 9-2-70	COMMAND MODULE	SKYLAB MODEL NO
		DRWG NO V56-331753

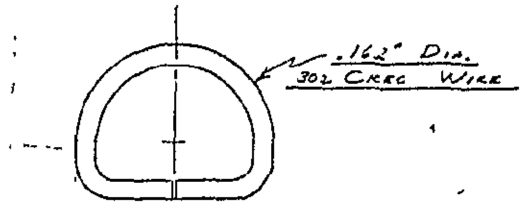
REF

N/A

V 56-601 147

V56-331 704 THRU V56 331 709

RING, TIE-DOWN-UTILITY LOCKER - AFT EQUIPMENT BAY



TIE-DOWN RING PROVIDES MEANS FOR SECURING BAGS ON TOPS OF LOCKERS. TIE-DOWN IS BY MEANS OF STRAPS OR CORDS. THE RING ALSO SECURES THE P.G.A. CONSTRAINTS DURING RESCUE MISSION RETURN LOADS.

IL 191-300 040-69-045

STRAP ALLOW. LOAD IS 600 LBS.

RING ASSY. WAS DESIGNED FOR THIS LOAD.

PREPARED BY FB
CHECKED BY G.F.
DATE 9-2-70

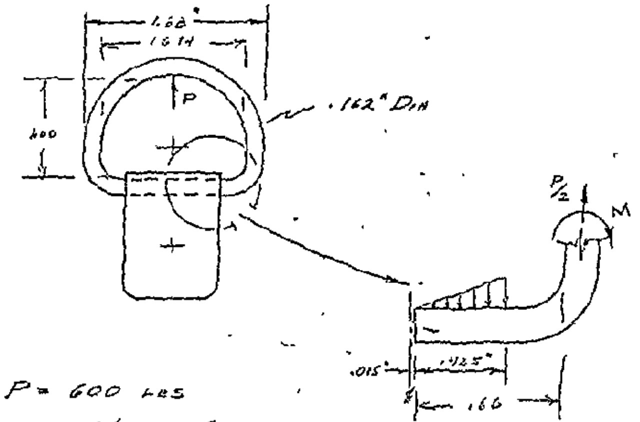
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 3
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DRWG. NO. V56-351763

REF

RING, TIE-DOWN - UTILITY LOCKER AFT EQUIP BAY

BENDING IN RING



$P = 600$ LBS

a = MOM. ARM

$$= \frac{1.28}{2} - \frac{2}{3}(.425) - .015 - \frac{.162}{2} = .461 \text{ IN.}$$

$$M = \frac{600}{2} \times .461 = 138 \text{ IN-LBS}$$

$$f_b = \frac{M\ D \times 64}{2 \times \pi D^4} = 10.2\ \frac{M}{D^3} = 10.2\ \frac{138}{.162^3{}_{1.925}}$$

$$= 331{,}000 \text{ PSI}$$

$$f_T = \frac{4P}{\pi D^2} = 1.275\ \frac{(600)}{2 \times .162^2} = 14{,}550 \text{ PSI}$$

$$f = 331{,}000 + 14{,}600 = 345{,}600 \text{ PSI}$$

PREPARED BY FB
CHECKED BY G.F.
DATE 9-2-70

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 3 OF 3
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DRWG. NO. V56-321763

REF

RING, TIE-DOWN - UTILITY LOCKER AFT EQUIP BAY

BENDING (CONT'D.)

$F_{TU} = T_{TY} = 205$ KSI

$F_{BM} = 205\ (1.7) = 349$ KSI

$$M.S.\ (\text{BENDING}) = \frac{349}{345.6} - 1 = \underline{.01}$$

PREPARED BY: F.B.	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO. 1 OF 5
CHECKED BY: G.F.	RESCUE MISSION	REPORT NO SD 70-205
DATE 9-2-70	COMMAND MODULE	MODEL NO SKYLAB
		DRWG NO V56-331764

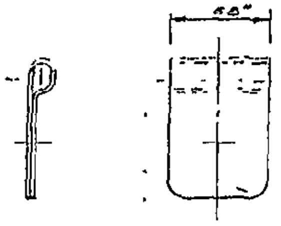
REF

N/A

V36-331 572

V56 331 704 THRU V56-331 709

CLIP, RING-TIE-DOWN, UTILITY LOCKER, AFT EQUIP BAY



MAT'L ~ 302 ANNEALED CRES. SHT.

IL 191-30 040-69-045

LOADS.

STRAP ALLOW. LOAD IS 600 LBS.

RING ASSY. WAS DESIGNED FOR THIS LOAD

MATERIAL PROP

(D11)

06.05 01 .01

		302 CRES KSI
	F_{TU}	75
	F_{TY}	20
	F_{CY}	35
	F_{SU}	48
e/D =2.0	F_{BU}	150
	F_{BRY}	50
	E	29.0
	G	11.5

PREPARED BY. F.B.	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO. 2 OF 5
CHECKED BY G.F.	RESCUE MISSION	REPORT NO SD 70-205
DATE 9-2-70	COMMAND MODULE	MODEL NO SKYLAB
		DRWG NO V56-351764

REF

CLIP, RING-TIE-DOWN, UTILITY LOCKER, AFT EQUIP BAY

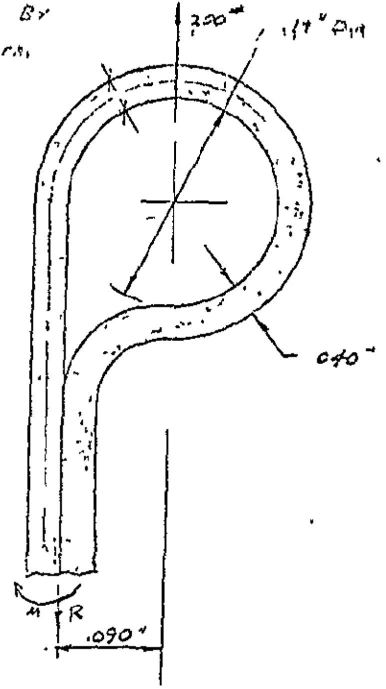
BENDING IN CLIP

MAX. APPLIED LD. IS 600#.

ASSUME CINCH DWN. LD. = 200# & ASSUME TOTAL LD. TAKEN BY (SMALLER) ARM.

$M = 200 \times .09$

$= 18$ IN-LBS.



$f_b = \frac{6 \times 18}{.88 \times .08^2}$

$= 19,200$ PSI

$F_{BU} = 75 + \frac{1}{2}(30)$

$= 90$ KSI

M.S (BENDING) $= \frac{90}{19.2} - 1 = \underline{\underline{3.68}}$

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RESCUE MISSION
COMMAND MODULE
PAGE NO. 3 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO V56-331764

CLIP, RING - TIE DOWN, UTILITY LOCKER, AFT EQUIP BAY

MAX APPLIED LD.

ANNEALED 302 CRES CAN STRAIGHTEN OUT FROM A FORMED SHAPE WITHOUT CRACKING.

Pg 2 P_M = MAX. APPLIED LD.
= 600 LBS.

$$f_T = \frac{600}{2 \times .88 \times .04} = 8520 \text{ PSI}$$

$$\text{M.S. (TENSION)} = \frac{75}{8.52} - 1 = \underline{+HIGH}$$

BEARING - CLIP HOLE

D_S = SPACER DIA. = .323 IN.

ASSUME LD. TAKEN ON ONE SIDE OF CLIP.

$$f_{br} = \frac{600}{.323 \times .04} = 46,400 \text{ PSI}$$

$$\text{M.S. (BEARING)} = \frac{150}{46.4} - 1 = \underline{2.23}$$

FORM 894-D REV 12 67

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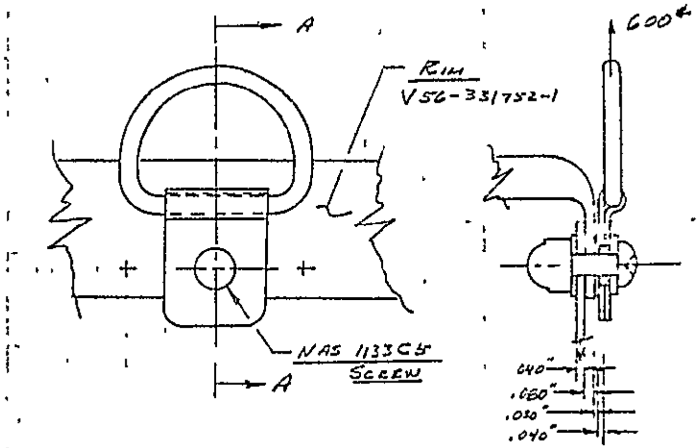
RESCUE MISSION
COMMAND MODULE
PAGE NO 4 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DRG NO V56-331764

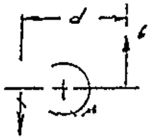
CLIP, RING - TIE-DOWN, UTILITY LOCKER, AFT EQUIP BAY

LOCKER RIM



SECTION A-A

$$d = \frac{.040}{2} + .080 + .030 + .040$$
$$= .170 \text{ IN.}$$



MODEL - BOLT LD'S

$$M = .170 \times 600 = 102 \text{ IN-LBS.}$$

W_F = EFF. FLANGE WIDTH
IN BENDING = 1.0 IN.

$$f_b = \frac{6 \times 102}{1.0 \times .08^2} = 95,700 \text{ PSI}$$

SD 70-205
V56-331752
Pg 5 F_{BU} (7075-T6 AL) = 110 KSI

$$\text{M.S. (BENDING)} = \frac{110}{95.7} - 1 = \underline{\underline{.15}}$$

FORM 894-D REV 12 67

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COMMAND MODULE

PAGE NO. 5 OF 5
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DRWG NO V56-331764

REF

CLIP, RING - TIE-DOWN, UTILITY LOCKER, AFT EQUIP BAY

D-RING ATTACH. FASTENER

ATTACH FASTENER IS A NAS 1133C5 SCREW.

Pg 4 d_A = FASTENER BENDING MOM. ARM

$= .040 + .030 + \frac{.080}{2} = .110$ IN.

$M = 600 \times .110 = 66$ IN-LBS.

D = FASTENER DIA.
= .188 IN.

$I = \frac{\pi(.188)^4}{64} = .0000613$ IN^4

$f_b = \frac{66 \times .188}{2 \times .0000613} = 101{,}000$ PSI

F_{BM} (A286 CRES)

$= F_{TU} + 0.7(F_{TY}) = 140 + 0.7(95) = 206$ KSI

M.S. (BENDING) $= \frac{206}{101} - 1 = \underline{1.04}$

FORM ... REV 12-67

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RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V36-331605
V56-331866

REF
M/D
+ 04-
100302

BALLAST, LAUNCH - M071/73 ADAPTER, AFT EQUIPMENT BAY, ASSY OF

BALLAST MUST SUPPORT ITS OWN INERTIA FOR 78g -

ASSUME 1" STRIP ALONG LONG DIMENSION:
(STEEL PLATE, .5" THICK @ .3 #/IN^3)
$w = .15$ #/IN × 78 G = 11.7 #/IN
$M = \frac{wl^2}{8} = \frac{(11.7)(21)^2}{8} = 646$ IN.#
$f_b = \frac{6M}{bt^2} = \frac{6(646)}{(.5)^2} = \underline{15{,}500 \text{ PSI}}$

$F_{ty} = 75000$ psi
304 S.S., COND A

M.S. = +HIGH

PREPARED BY: GLD

CHECKED BY:

DATE: DEC 18, 1972

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RESCUE MISSION

COMMAND MODULE

PAGE NO. 1 OF 4

REPORT NO. SD 70-205

MODEL NO. SKYLAB

DWG. NO V56-531100

REF.

11A
F04-
00002

COUCH ASSY - RESCUE

THIS DRAWING IS MERELY AN ASSEMBLY, SEE SPECIFIC PARTS FOR DETAILED ANALYSIS.

COMPONENTS of ASSEMBLY

	V56-531101	BACK PAN
	V56-531102	STRUCTURE
	V56-531103	ADAPTER
	V56-531104	ADAPTER
	V56-531142	ARM
	V56-531144	SHAFT
	V56-601080	STRAP ASSEMBLY
	V56-601081	STRAP ASSEMBLY
	V56-601084	BUSHING
	V56-601086	FITTING
	V56-601087	UNIVERSAL
*	V56-601104	CLOSE OUT
*	V36-601172	PAD
**	V36-601525	HARNESS
	V37-552519	SPACER

* NON STRUCTURAL. NO ANALYSIS REQUIRED.

** PREVIOUSLY FLOWN; NO NEW ANALYSIS REQD.

COUCH ASSY- RESCUE

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CHECKED BY: RGR
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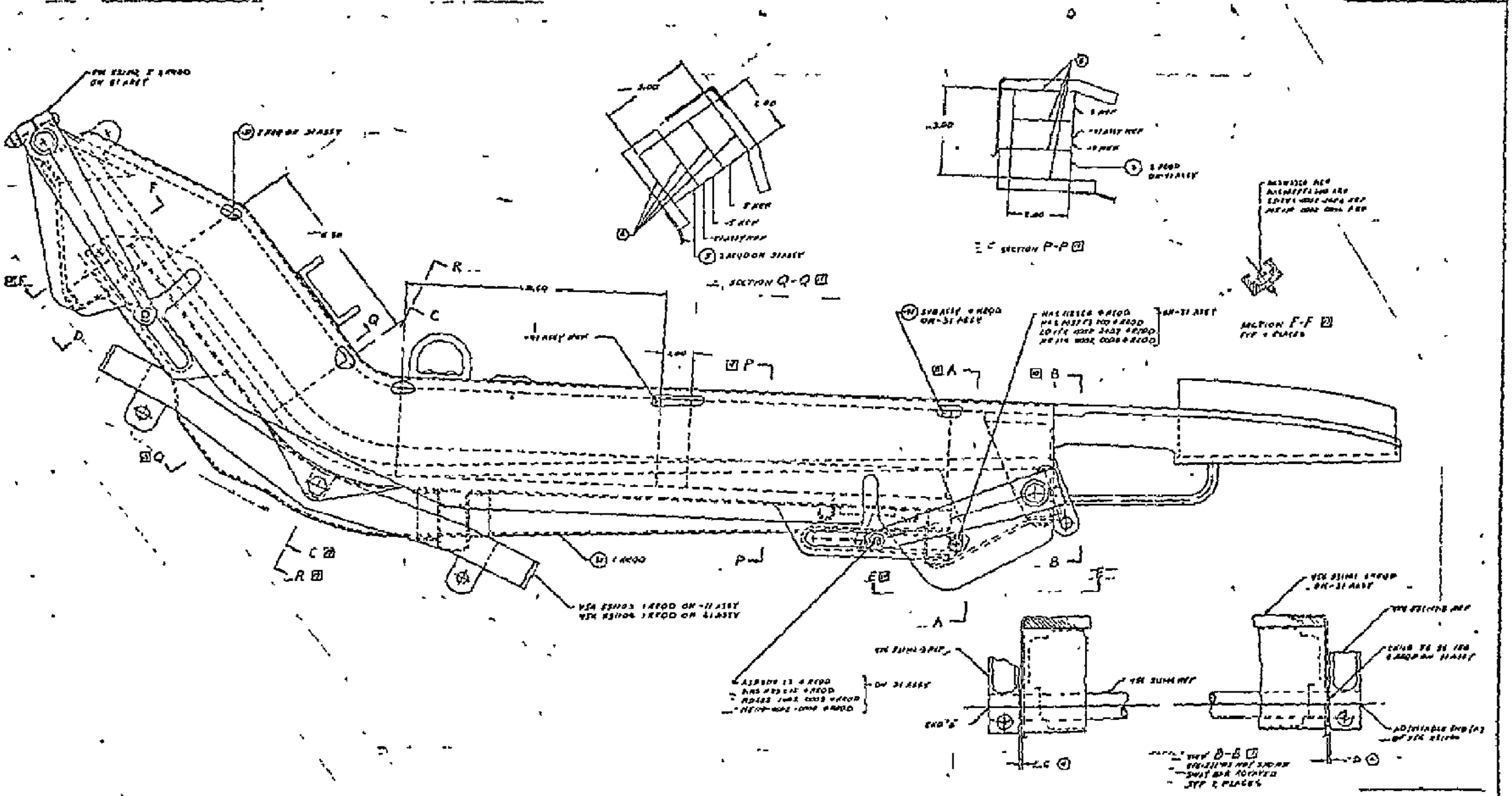
PAGE NO 2 OF [illegible]
REPORT NO SD 70-205
MODEL NO SKYLAB

V56-53110D



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RESCUE MISSION
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PAGE NO. 3 OF 4
REPORT NO. SD 70-205
MODEL NO SKYLAB
DWG. NO. V56-531100

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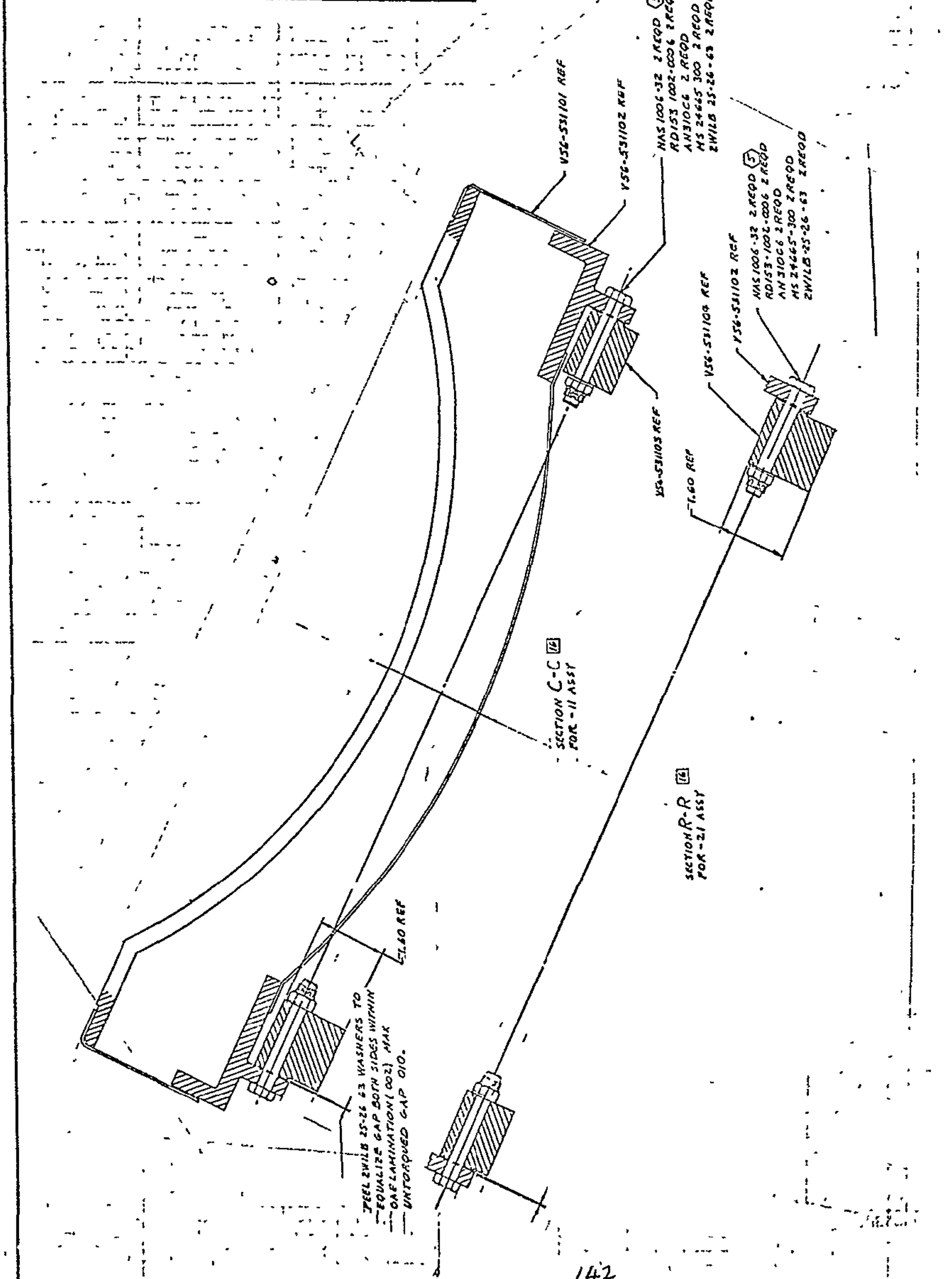
COUCH ASSY- RESCUE



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RESCUE MISSION
COMMAND MODULE

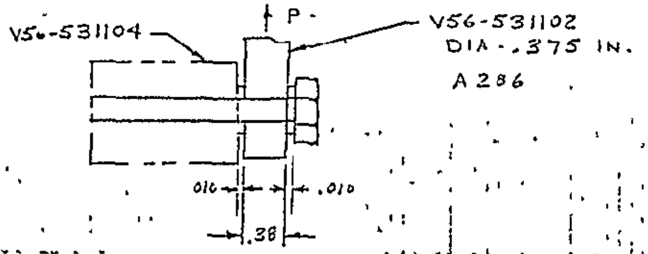
PAGE NO. 4 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531100

REF

COUCH ASSY - RESCUE

NAS 1006-32 BOLT BENDING

(D9) Pg 1111-21



I.2154

$P_x = 1680$ LBS (ULT)

$P_z = 3199$ LBS (ULT)

$$P = \left[(1680)^2 + (3199)^2\right]^{\frac{1}{2}}$$

$P = 3613$

$$M = (3613)\left(\frac{.38}{2} + .01\right)$$

$= 722.6$ IN-LBS.

$$I = \frac{\pi r^4}{4}$$

$$f_b = \frac{4M}{\pi r^3}$$

$$= \frac{4(722.6)}{\pi(.375)^3}$$

$= 17,500$ PSI

(C22) TABLE 2.10(b)

$F_{cy} = 95$ KSI

$$M.S. = \frac{95}{17.5} - 1 = \underline{4.42}$$

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RESCUE MISSION
COMMAND MODULE

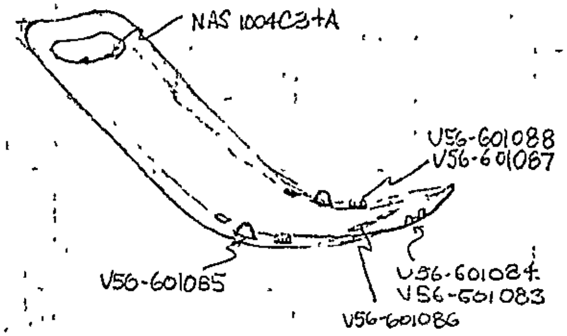
PAGE NO 1 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531101

REF

N/A V56 531100

BACKPAN ASSEMBLY - RESCUE COUCH

THE BACKPAN ASSEMBLY ATTACHES THE RESTRAINT STRAP ATTACHMENTS TO THE BACKPAN.



FASTENER LOADS FOR STRAP ATTACH POINTS:

	Pg	FITTING NO.	ULTIMATE TENSION	ULTIMATE SHEAR
-083	2	V56-601083	2975	1613.5
-085	2	V56-601085	89.5	44.8
-036	3	V56-601086	89.5	29.2
-083	3	V56-601088	2475	711

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SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531101

REF

RESCUE COUCH

BACKPAN ASSEMBLY

FASTENERS AND RESPECTIVE ALLOWABLES ASSOCIATED WITH EACH FITTING.

D11
A-10

FITTING	FASTENER USED	TENSION ALLOW.	SHEAR ALLOW.
083	NAS 1154C12	4690	4410
085	NAS 1133C4	2550	2525
086			
088	NAS 1154C3	4690	4410
SHLDR FRM. -	NAS1004C34	$M_{ALLW} = 207$ in lb.	4410

THUS CAN OBTAIN THE FOLLOWING MARGIN AT THE MOST CRITICAL JOINT,

$$R_S = \frac{1635}{4410} = .371$$

$$R_T = \frac{2975}{4690} = .635$$

FOR $R_S^3 + R_T^2 = 1$ INTERACTION,

C22
1.5.3.5.3

$$U = \frac{.371}{.51} = .728$$

$$MS = \frac{1}{.728} - 1 = \underline{\underline{.37}}$$

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RESCUE MISSION
COMMAND MODULE

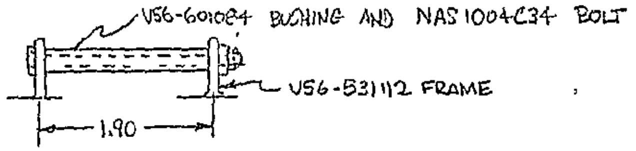
PAGE NO 3 OF
REPORT NO SD 70-2
MODEL NO SKYLAB
DWG NO V56-531101

REF

RESCUE COUCH

BACKPAN ASSEMBLY

SHOULDER ATTACH POINTS ;



-084 BUSHING

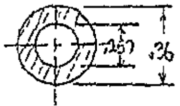
CRES BAR QQ-S-763 CLASS 304 COND. A

(D11)
06.05
.01.01

$F_{tu} = 75{,}000$

$F_{ty} = 30{,}000$

$E = 29.0 \times 10^6$



$I = .00061$

$C = .18$

$K = 1.55$

$F_b = 30{,}000(1.5) + .55(30{,}000) = 61{,}500$ psi

NAS 1004C34 BOLT

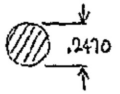
CRES A286 AMS5735, AMS5737 OR AMS5733

$F_{tu} = 140{,}000$ psi

$F_{ty} = 95{,}000$ psi

$E = 29.0 \times 10^6$

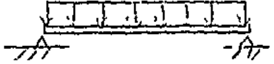
$F_b = 206{,}500$ psi



$I = .000183$

$C = .1235$

$K = 1.7$



$W = w\ell = 1910$ lb. (ULT)

(E4)
TABLE III
CASE C

$$\delta = \frac{5}{384} \frac{W\ell^3}{EI} \qquad M_{MAX} = \frac{W\ell}{8}$$

LET W_b = AMOUNT OF LOAD REACTED BY BUSHING

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SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531101

REF

RESCUE COUCH

BACKPAN ASSEMBLY

W_B = AMOUNT of LOAD TAKEN BY BOLT

δ_b = DEFL. of BUSHING

δ_B = DEFL. of BOLT

$$\delta_b = \delta_B$$

$$\frac{5}{384}\frac{W_b(1.9)^3}{E(.00061)} = \frac{5\ W_B\ (1.9)^3}{384\ E(.000183)}$$

$$W_b = \frac{.00061\ W_B}{.000183} = 3.33 W_B$$

$$W = W_b + W_B = 4.33 W_B$$

$w = \frac{2835}{2}$

W = 1418 LBS (ULT)

II 2155 EBO

146

$$W_B = \frac{1418}{4.33} = 328 \text{ lb}$$

$$W_b = 1090 \text{ lb.}$$

∴ MOMENT IN BUSHING

$$M_b = \frac{1090(1.9)}{8} = 258.5 \text{ IN-lb.}$$

$$\sigma_b = \frac{258.5(.18)}{.00061} = 76,500 \text{ psi}$$

IN BOLT

$$\sigma_B = \frac{328(1.9).1235}{8(.000183)} = 52,600 \text{ psi}$$

255

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RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531101

REF

RESCUE COUCH

BACKPAN ASSEMBLY

ASSUME NOW THAT THE BUSHING TAKES ENOUGH LOAD TO DEVELOP F_{tu} AT THE OUTER FIBER AND THEN GOES PLASTIC AND LOADS UP THE BOLT UNTIL THE REMAINDER of THE LOAD IS REACTED. THE ELONGATION of THE BUSHING MATERIAL IS 40% [(D11) Pg.06 05.010]

$$\sigma_b = \frac{W_b(1.9)(.18)}{8(.00061)} = 61,500 \text{ PSI}$$ (BUSHING PLASTIC BENDING STRESS AT ULTIMATE)

$$W_b = \frac{61,500(8)(.00061)}{1.9(.18)} = 880 \text{ lb.}$$ (LOAD TO CAUSE PLASTIC BENDING IN BUSHING)

THUS THE LOAD REMAINING TO BE REACTED BY THE BOLT

$$W_B = 1418 - 880 = 538$$

THUS

$$\sigma_B = \frac{1538(1.9).1235}{8(.000183)} = 86,400 \text{ psi}$$

$$\therefore \quad M.S._{BUSH} = \frac{61.5}{61.5} - 1 = \underline{0.0}$$

$$M.S._{BOLT} = \frac{206.5}{86.4} - 1 = \underline{1.39}$$

256

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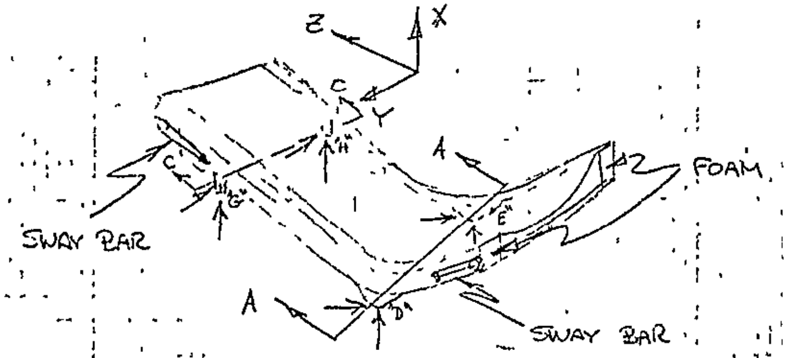
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531102

REF
N/A
V56
531100

STRUCTURE - SUPPORT, RESCUE COUCH, ASSY OF



THE MAIN RESCUE COUCH BACK PAN IS SEPARATED FROM THE PAN SUPPORT STRUCTURE BY TWO STRIPS OF SHOCK ABSORBING FOAM AND TWO SWAY BARS AT THE UPPER AND LOWER END OF THE COUCH... FOR THE X AND Y LOADS THE FOAM REACTS THE LOAD AND FOR THE Z LOADS THE SWAY BARS ARE UTILIZED AS A MEANS OF REACTING THE RESULTING OVER TURNING MOMENT.

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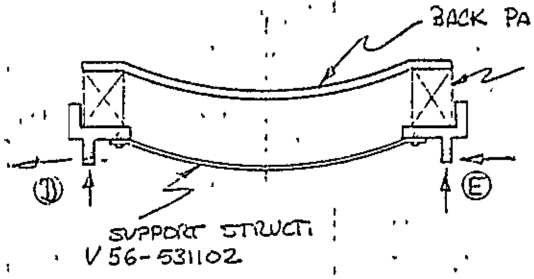
PAGE NO 2 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531102

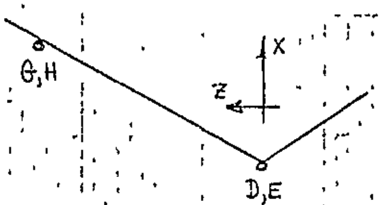
REF

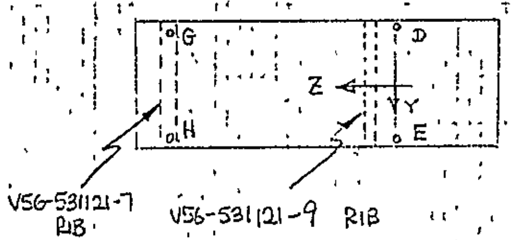
RESCUE COUCH SUPPORT STRUCTURE

SECTION A-A



COUCH DIAGRAM - SUPPORT POINTS



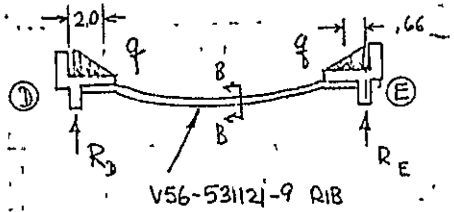


RESCUE COUCH

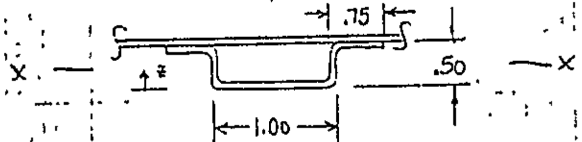
SUPPORT STRUCTURE

REACTION of EYE BALLS IN AND OUT LOADINGS -

ASSUME AT SECTION A-A HAVE THE FOLLOWING LOAD DISTRIBUTION AT THE FOAM INTERFACE,



SECTION B-B of RIB



ITEM	b	h	$\bar{z}$
1	1.0	.063	.0315
2	.063	.374	.250
3	.063	.374	.250
4	1.50	.063	.4685
5	2.5	.063	.5315

$A = .3621 \text{ IN}^2$

$\bar{z} = .3914 \text{ IN.}$

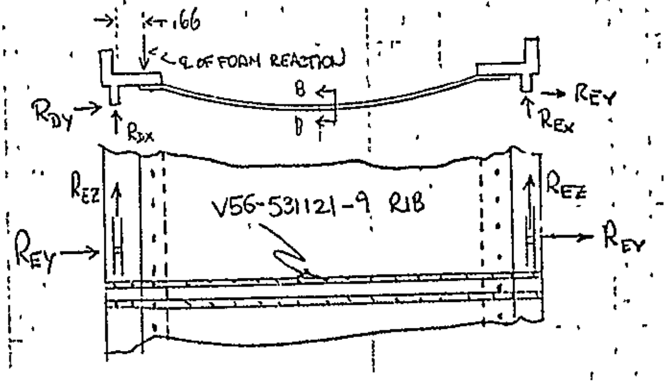
$I_{xx} = .0134 \text{ IN}^4$

SEE V56-531121

RESCUE COUCH

SUPPORT STRUCTURE

FOR THE LOADS AT POINTS D AND E HAVE THE FOLLOWING REACTIONS



USE SECTION B-B AS SHOWN ON PAGE 3 (-102) TO REACT MOMENT CAUSED BY R_{DX} WITH THE .66 ECCENTRICITY

II 2.1.52 $M_{MAX} = 2864(.66) = 1890 \text{ IN-lb.}$

MATERIAL : QQ-A-250/4 2024-T4

(C1) $F_{tu} = 62,000$

3.2.3.0(6) $\sigma_b = \dfrac{1890(.3914)}{.0134} = 55,200 \text{ psi}$

$MS = \dfrac{62}{55.2} - 1 = \underline{.12}$

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RESCUE MISSION
COMMAND MODULE

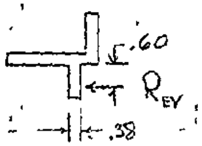
PAGE NO 5 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531102

REF

SEE V56-531120

RESCUE COUCH
SUPPORT STRUCTURE

REACTION IN Y DIRECTION CAN BE REACTED IN PAN AS A BEAM BUT MOMENT IS LESS THAN FOR X DIR. LOAD. HOWEVER Y REACTION CAUSES MOMENT IN OUTER FRAME LUG (SEE ALSO SWAY BAR SYSTEM)



II.2 1.53

$R_{EY_{MAX}} = 604 \text{ lb.}$

$M = 604(.60) = 362 \text{ IN-lb.}$

USING A ONE INCH STRIP OF LUG

$$\sigma_b = \frac{6(362)}{1.0(.38)^2} = 15000 \text{ psi}$$

$$MS = \frac{62}{15} - 1 = 3.14$$

BEARING IN LUG,

II.2.1.54 $P = 3179 + 1680 = 3615 \text{ lb. (ULT)}$

$$\sigma_{br} = \frac{3615}{.38(.25)} = 38,000 \text{ psi}$$

$F_{bru} = 118,000 \text{ PSI}$

$$M.S. = \frac{118000}{38000} - 1 = 2.10$$

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COMMAND MODULE

PAGE NO. 6 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531102

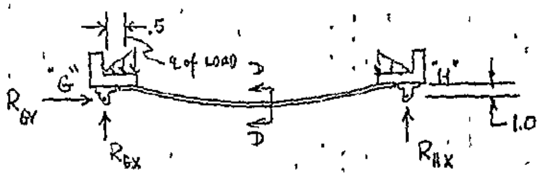
REF

SEE V56-531121

RESCUE COUCH
SUPPORT STRUCTURE

REACTIONS AT POINTS G AND H

SECTION C-C AT POINTS G AND H,

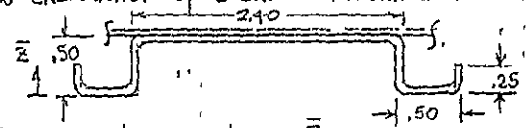


POINTS G AND H LOADS (ULTIMATE)

	CASE	R_{GX}	R_{GY}	R_{HX}
II.2.1.45	I	3885	0	3885
II 2.1.47	II	-3068	0	-3068
II.2 1.47	III	-729	2086	+729

SECTION D-D

IN CALCULATION OF SECTION PROPERTIES NEGLECT RADII,



SECTION	b	h	$\bar{z}$
1	.748	.063	.0315 ✓
2	.063	.25	.125 ✓
3	.063	.25	.125 ✓
4	.126	.50	.25 ✓
5	2.274	.063	.4685 ✓
6	2.5	.063	.525

$A = .4424 \text{ IN}^2$

$\bar{z} = .3888 \text{ IN.}$

$I = .0151 \text{ IN}^4$

SEE V56-531121

RESCUE COUCH

SUPPORT STRUCTURE

MAXIMUM MOMENT ON SECTION D-D

$M_{MAX} = 3885(.5) = 1942'$ IN·lb.

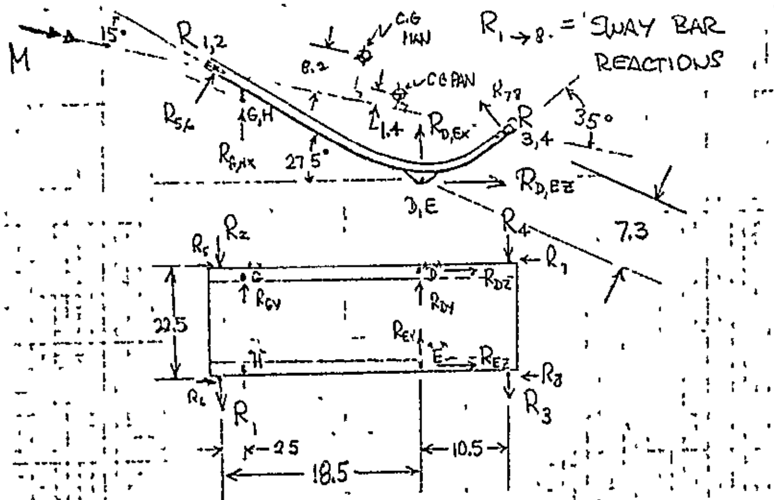
$\sigma_b = \frac{1942(.3888)}{.0151} = 50,000$ psi

MATERIAL: QQ-A-250/4 2024-T4

$F_{tu} = 62,000$

$M.S. = \frac{62}{50} - 1 = \underline{\underline{.24}}$

REACTION of EBL LOADS THROUGH SWAY BARS



$R_{1\to 8}$ = SWAY BAR REACTIONS

RESCUE COUCH

SUPPORT STRUCTURE

ASSUMING THAT FOAM TAKES NONE of THE EBL LOAD,

ΣM

$$(R_3+R_4)\,29.0 = (R_{EY}+R_{DY})\,18.5 + R_{GY}(2.5)$$

FOR EBL CASE II

II.2.1.53 $R_{DY} = R_{EY} = 604$ lb.

$R_{GY} = 2086$ LBS

$$R_3+R_4 = \frac{1208\,(18.5)+(2.5)(2086)}{29} = \frac{22350+5220}{29}$$

$R_3+R_4 = 950$ lb.

ASSUMING $\underline{R_3 = R_4 = 475 \text{ lb.}}$

$R_1+R_2 = 1208+2086-950 = 2344$

ASSUMING

$R_1 = R_2 = \underline{1172 \text{ lb.}}$

FOR REACTIONS ⊥ TO SWAY BAR ARMS DESIRE MOMENT ABOUT A LINE THROUGH THE TWO SWAY BAR ATTACH POINTS DUE TO THE LATERAL LOAD.

PREPARED BY: GLD	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO. 9 OF 11
CHECKED BY:		REPORT NO. SD 70-205
DATE: JAN 14 72	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531102

RESCUE COUCH

SUPPORT STRUCTURE

SEE V56-531120

I.2.1.3
I.2 1.18

$$M = 8.2(218.3)12.75 + 1.4(40)12.75$$

$$M = 22{,}650 + 713 = 23{,}563 \text{ IN-lb}$$

REACTING MOMENT BY SWAY BARS WITH 60% AT SHOLDER END AND 40% AT THIGH END,

$$R_5 = \frac{.60(23{,}563)}{22.5 \cos 15°} = \underline{650 \text{ lb. (ULT)}}$$

$$R_6 = \underline{-650 \text{ lb (ULT)}}$$

$$R_7 = \frac{.40(23{,}563)}{22.5 \cos 35°} = \underline{510 \text{ lb. (ULT)}}$$

$$R_8 = \underline{-510 \text{ lb. (ULT)}}$$

REACT THE LOADS AT THE THIGH END BY THE OUTER FRAME MEMBERS (RAILS),

BENDING MOMENT ON RAIL

$$M_b = R_7(8.0) = 510(8) = 4080 \text{ IN-lb.}$$

TORSION ON RAIL

$$T = R_3(7.3) = 477(7.3) = 3480 \text{ IN-lb.}$$

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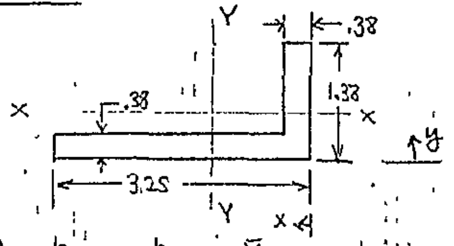
CHECKED BY:		REPORT NO SD 70-205
DATE: JAN 17 72	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531102

RESCUE COUCH

SUPPORT STRUCTURE

SEE V56-531120

RAIL SECTION



SECTION	b	h	$\bar{y}$
1	2.87	.38	.19
2	.38	1.38	.69

$A = 1.62 \text{ IN}^2$

$\bar{Y} = .35 \text{ IN.}$

$I_{xx} = .185 \text{ IN}^4$

SECTION	b	h	$\bar{x}$
1	1.0	.38	.19
2	.38	3.25	1.625

$A = 1.62$

$\bar{X} = 1.287$

$I_{yy} = 1.69$

FOR TORSION,

D88
1.31.01

$$J_2 = .26(1.0)(.38)^2 + .31(3.25)(.38)^2$$

$$J_2 = .0376 + .1455 = \underline{.1831}$$

$$J_1 = .25(1.0)(.38)^3 + .31(3.25)(.38)^3 =$$

$$J_1 = .01372 + .05528 = \underline{.069}$$

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DATE: JAN 17 72

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 11 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531102

REF

RESCUE COUCH

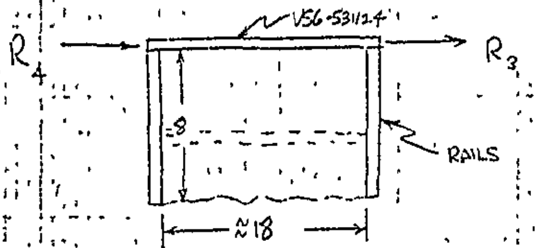
SUPPORT STRUCTURE

SEE V56-531120.

Pg 9

$$\sigma_S = \frac{T}{J_2} = \frac{3480}{.18311} = 19,000 \text{ psi}$$

$$\sigma_b = \frac{4080(1.03)}{.185} = 22,700 \text{ psi}$$

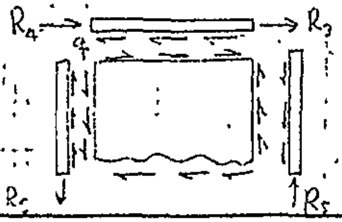


Pg 8

$$R_3 + R_4 = 950$$

$$q = \frac{955}{18.} = 53 \ \frac{lb}{IN}$$

IN SHEET t = .063



$$\sigma_s = \frac{53}{.063} = 840 \text{ psi}$$

$F_s = 6080$ (BUCK. FROM ROARK)

$P_F \leq 106 \frac{lb}{F.T}$ OK

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RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531104
V56-531103

REF
N/A
V56
531100

ADAPTOR FRAME A-4

ADAPTOR FRAME A-6

RESCUE COUCH, ASSY OF

DISCUSSION:

THE A-4 AND A-6 RESCUE COUCH ADAPTER FRAMES ARE IDENTICAL. THE A-4 FRAME IS MOUNTED SUCH THAT IT IS 180° TO THE A-6 FRAME ON THE $+Y_c$ SIDE OF THE $Z_c - Z_c$ AXIS. LOADING ON THE A-4 FRAME IS IDENTICAL TO THE LOADING ON THE A-6 FRAME AT IDENTICAL SECTIONS. SINCE LOADING IS THE SAME FOR BOTH FRAMES, ONLY THE A-4 FRAME WILL BE ANALYZED WITH THE UNDERSTANDING THAT THE RESULTS ARE APPLICABLE TO THE A-6 FRAME ALSO.

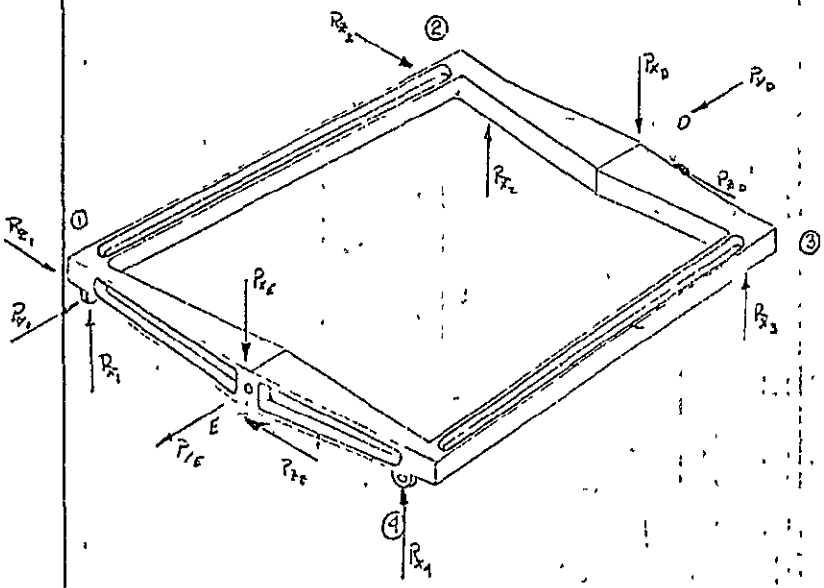
V56 531103

REF

N/A
V56
531100

ADAPTER FRAME - A-4 LOCATION.
RESCUE COUCH, ASSY OF.

LOADS AND REACTIONS



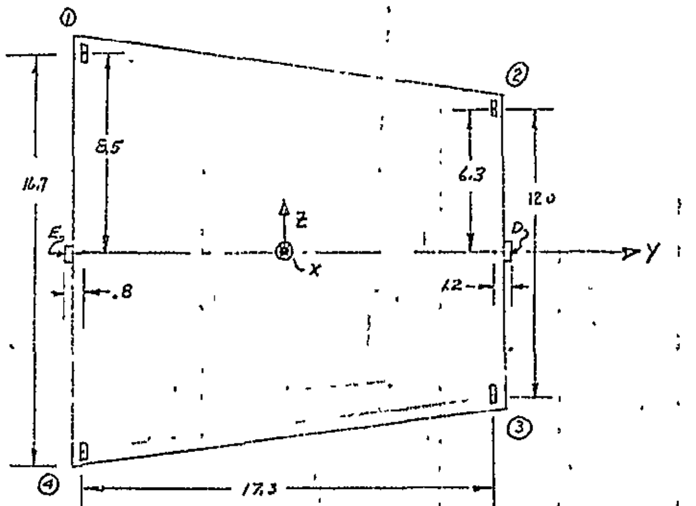
LOADS

II.2.1.52 CASE I
$P_{DX} = 2864$ # ULT $= P_{EX}$
$P_{DZ} = 1791$ # ULT $= P_{EZ}$
$P_{DY} = 0$ $= P_{EY}$

II.2.1.53 CASE II
$P_{DX} = 683.4$ # ULT $P_{EX} = -683.4$ # ULT
$P_{DY} = -604$ # ULT $P_{EY} = -604$ # ULT
$P_{DZ} = +481.6$ # ULT $P_{EZ} = -481\ 6$ # ULT

II.2.1.54 CASE III
$P_{DX} = 1620$ # ULT $= P_{EX}$
$P_{DZ} = 3199$ # ULT $= P_{EZ}$
$P_{DY} = 0$ $= P_{EY}$

REF



POSSIBLE REACTIONS

POINT ①	X, Z, Y
POINT ②	X, Z
POINT ③	X
POINT ④	X

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RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 10
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531104

REF

FRAME ATTMT LOADS

CASE I

"X" LOADS

$\Sigma M_{(2-3)} = 0 = (P_{1x} + P_{4x})(17.3) - P_{EX}(18.1) + P_{DX}(1.2)$

$(P_{1x} + P_{4x}) = \frac{(2864)(18.1) - (2864)(1.2)}{17.3} = 2800^{\#}$

$P_{1x} = \frac{8.2}{16.7}(2800) = 1375^{\#}$

$P_{4x} = 2800 - 1375 = 1425^{\#}$

$(P_{2x} + P_{3x}) = 5728 - 2800 = 2928^{\#}$

$P_{2x} = \frac{5.7}{12}(2928) = 1390^{\#}$

$P_{3x} = 2928 - 1390 = 1538^{\#}$

"Z" LOADS

$\Sigma M_{①} = 0 = P_{2z}(17.3) - P_{Dz}(18.5) + P_{Ez}(.8)$

$P_{2z} = \frac{(1791)(18.5) - (1791)(.8)}{17.3} = 1835^{\#}$

$P_{1z} = -1835 + (1791)(2) = -1747$

RECAP - CASE I

	P_x	P_y	P_z
P_1	1375	0	1747
P_2	1390	0	1835
P_3	1538	0	0
P_4	1425	0	0

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RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 15
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531104

REF

FRAME ATTMT LOADS (CON)

CASE II

"X" LOADS:

$\Sigma M_{(1-4)} = 0 = (P_2 + P_3)(17.3) - (+P_{Ex})(.8) - (P_{Dx})(18.5)$

$(P_2 + P_3) = \frac{(-683.4)(-.8) + (683.4)(18.5)}{17.3} = 764^{\#}$

$P_{2x} = \frac{5.7}{12}(764) = \underline{363^{\#}}$

$P_{3x} = 764 - 363 = \underline{401^{\#}}$

$P_{1x} + P_{4x} = -764^{\#}$

$P_{1x} = \frac{8.2}{16.7}(764) = \underline{-375^{\#}}$

$P_{4x} = -764 + 375 = \underline{-389^{\#}}$

"Y" LOADS

$P_{1y} = -1208$ (P_1 ONLY "Y" SUPPORT POINT)

"Z" LOADS

$\Sigma M_{①} = 0 = P_{2z}(17.3) + (P_y)(8.5) + P_{Ez}(.8) + P_{Dz}(18.5)$

$P_{2z} = \frac{-(-601)(8.5) - (481.6)(.8) + (+481.6)(18.5)}{17.3}$

$= \frac{5140 - 386 + 8900}{17.3} = \frac{13614}{17.3} = .812^{\#}$

$P_{1z} = -812^{\#}$

RECAP CASE II

	Px	Py	Pz
P_1	-375	-1208	-812
P_2	363	0	812
P_3	401	0	0
P_4	-389	0	0

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COMMAND MODULE

PAGE NO 6 OF 10
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V36-531104

FRAME ATTMT LOADS (CON)

CASE III

"X" LOADS:

$$\Sigma M_{(1-4)} = P_{Dx}(18.5) - P_{Ex}(.8) - (P_{x_2} + P_{x_3})(17.3) = 0$$

$$(P_{x_2} + P_{x_3}) = \frac{(1680)(18.5-.8)}{17.3} = 1720^{\#}$$

$$P_{x_2} = \frac{5.7}{12}(1720) = \underline{819}^{\#}$$

$$P_{x_3} = 1720 - 819 = \underline{901}^{\#}$$

$$(P_{1x} + P_{4x}) = 2(1680) - 1720 = 1640$$

$$P_{1x} = \frac{8.2}{16.7}(1640) = \underline{805}^{\#}$$

$$P_{4x} = 1640 - 805 = \underline{835}^{\#}$$

"Z" LOADS:

$$\Sigma M_{①} = 0 = -(3199)(18.5) + (3199)(.8) + P_{2z}(17.3)$$

$$P_{2z} = \frac{(3199)(17.7)}{17.3} = \underline{3270}^{\#}$$

$$P_{1z} = 2(3199) - 3270 = \underline{3128}^{\#}$$

RECAP CASE III

	P_x	P_y	P_z
P_1	905	0	3128
P_2	819	0	3270
P_3	901	0	0
P_4	835	0	0

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COMMAND MODULE

PAGE NO 7 OF 1?
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531104

ANALYSIS DISCUSSION

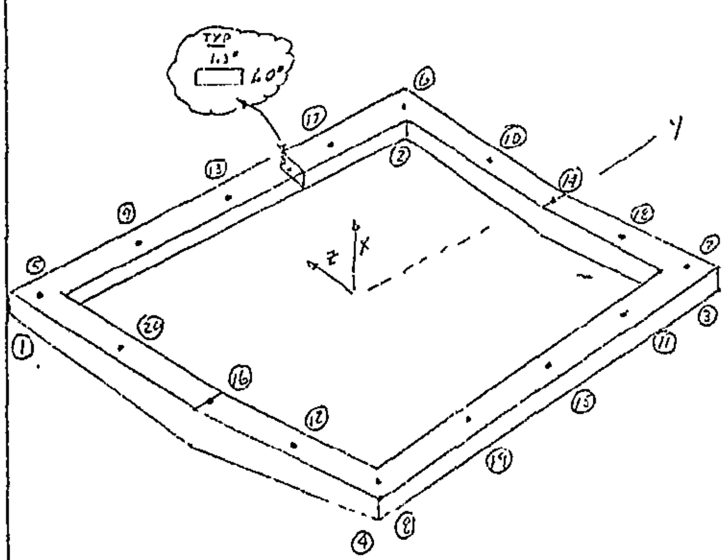
A COMPUTOR MODEL WAS COMPILED TO ANALYSE THE FRAME FOR:

1) MAXIMUM LATERAL DEFLECTION
2) MAXIMUM BENDING MOMENTS

INITIAL RESULTS INDICATED A HIGH DEGREE OF LATERAL (Y) FLEXIBILITY ALONG WITH HIGH BENDING MOMENTS IN CRITICAL AREAS OF THE FRAME.

BASED UPON THESE RESULTS, A REVISED CROSS SECTION SHAPE WAS DEVELOPED — 1" BY 1.3" — SOLID STEEL. WEIGHT IS NO BASIC OBJECT IN THIS DESIGN - STIFFNESS IS PRIMARY. THIS FINAL SHAPE PRODUCED CRITICAL DEFLECTIONS WITHIN THE DESIRED LEVEL.

SIGNIFICANT COMPUTER NODES



Ⓧ NODE NUMBERS
(NOTE NODE 1,2,3,4 AT FRM ATTMT TO BULKD.)

RESULTS: MAXIMUM MOMENT - CASE I
@ NODE 16 (COMPUTOR CASE 7)
ELEMENT 16

$M_y = 10,879$ IN#

ACTUAL CROSS SECTION 1.3 X 1.6

$$f_b = \frac{MC}{I} = \frac{10879(.8)}{\frac{1}{12}(1.3)(1.6)^3} = \underline{19650 \text{ psi}}$$

304 STAINLESS STEEL M.S. = MB

155

DEFLECTION OF NODE 4 + 3 IN "Y" DIRECTION
DUE TO WORST "Y" LOADING, CASE 2,
COMPUTOR CASE 8

NODE 3 $\underline{\Delta Y = .029 \text{ IN}}$ (.050 MAX DESIRED)

NOTE: THE "Y" DEFLECTION COULD CAUSE NODES 3 + 4 TO DISENGAGE FROM THEIR SUPPORT PINS SHOULD THEIR DEFLECTION EXCEED .050 IN.

276

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COMMAND MODULE

PAGE NO 10 OF 10
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531104

REF

AT LUG, MODEL POINT 6 NODE

LUG CROSS SECTION .92 X .3

$I = \frac{1}{12}(.3)(.92)^3 = .0197 \text{ IN}^4$

$M_{MAX} = 3702$ IN# CASE III (COMP CASE 9)

$f_b = \frac{MC}{I} = \frac{(3702)(.15)}{.0197} = \underline{28,200 \text{ psi}}$

D11 06.05.01.01

304 TYPE S.S.

$F_{ty} = 28000$ PSI

$\underline{M.S. = 0.0}$

At NODAL POINT 14

$M = 8570$ in# ACTUAL CROSSSECTION 1.56 X 1.24 DEEP

$f_b = \frac{(6)(8570)}{(1.56)(1.24)^2} = 21,570$ psi

D11 06.05.01.01

$F_{ty} = 28,000$ psi

$M.S. = \frac{28}{21.5} - 1 = \underline{.30}$

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RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531105

REF

NA V56-531001

A9 ADAPTER FRAME ASSEMBLY

THIS DRAWING IS MERELY AN ASSEMBLY, SEE SPECIFIC PARTS FOR DETAILED ANALYSIS.

COMPONENTS OF ASSEMBLY

V56-531126	FRAME
V56-531127	FITTING
V56-531128	TRUSS
V56-531132	TRUSS
V56-531134	TRUSS

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PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531106

REF
NA
156-
531001

A7 ADAPTER FRAME ASSEMBLY

THIS DRAWING IS MERELY AN ASSEMBLY, SEE SPECIFIC PARTS FOR DETAILED ANALYSIS.

COMPONENTS of ASSEMBLY

V56-531127	FITTING
V56-531128	TRUSS
V56-531132	TRUSS
V56-531134	TRUSS
V56-531135	FRAME

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COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO. V56-531101

REF
N/A
V56
531101

BACK PAN- RESCUE COUCH, ASSY OF

MATERIAL: ALUMINUM BAR MIL-A-22771 7075-T6

(C22)
TABLE
3.7.2 0(F..)

$F_{tu} = 66,000$

$F_{ty} = 56,000$

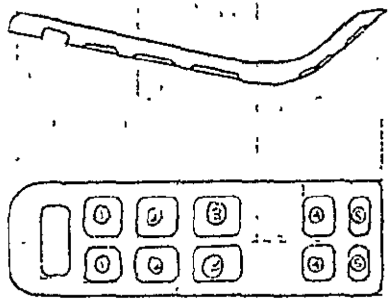
$F_{su} = 41,000$

$E = 10.3 \times 10^6$

$G = 3.9 \times 10^6$

$\mu = .33$

SKETCH of BACKPAN



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RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 10
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO VES-53111

REF

RESCUE COUCH

BACKPAN

WITH ASKA DATA WANT TO DETERMINE MAXIMUM STRESSES, IN THE BACK PAN. THE STRESSES FOR THE TRIB 3 ELEMENTS ARE GIVEN σ_x, σ_y AND τ_{xy} TO CONVERT THESE TO PRINCIPAL STRESSES USE,

$$\tau_{MAX} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

AND $$\sigma_{MAX} = \frac{\sigma_x + \sigma_y}{2} + \tau_{MAX}$$

THE MAXIMUM TENSION STRESS FOR THE BACKPAN ARE IN TRIB 3 ELEMENT 47 NODES 51, 53, 62

LIMIT STRESSES – CASE I, EB1

Pg 77
FULL
MODEL

$\sigma_{xx} = 23{,}340$ psi

$\sigma_{yy} = 30{,}510$ psi

$\sigma_{xy} = 8{,}615$ psi

CORRESPONDING PRINCIPAL STRESSES (LIMIT)

$\sigma_{N_{MAX}} = 36{,}256$ psi

$\sigma_{N_{MIN}} = 17{,}594$ psi

$\tau_{MAX} = 9{,}331$ psi

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RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531111

REF

RESCUE COUCH

BACKPAN

CORRESPONDING ULTIMATE PRINCIPAL STRESSES

$\sigma_{N_{MAX}} = 54{,}400$ psi

$\sigma_{N_{MIN.}} = 26{,}400$ psi

$\tau_{MAX.} = 14{,}000$ psi

$$MS. = \frac{66}{54.4} - 1 = +.21$$

FULL
MODEL
Pg 82

NOW FOR THE MAXIMUM COMPRESSION STRESS, LIMIT STRESSES – TRIB 3 ELEMENT 59 CASE 1

$\sigma_{xx} = -30{,}830$ psi

$\sigma_{yy} = -24{,}770$ psi

$\sigma_{xy} = -2000$ psi

CORRESPONDING PRINCIPAL STRESSES (LIMIT)

$\sigma_{N_{MAX}} = -31{,}430$ psi

$\sigma_{N_{MIN}} = -24{,}167$ psi

$\tau_{MAX} = 3631$ psi

RESCUE COUCH

BACKPAN

CORRESPONDING ULTIMATE PRINCIPAL STRESSES

$\sigma_{N_{MAX}} = -47{,}200$ psi

$\sigma_{N_{MIN}} = -36{,}200$ psi

$\tau_{MAX.} = 5450$ psi

FOR THE ALLOWABLE LOAD CHECK BUCKLING. THIS 3 ELEMENT IS IN THE OUTER BEAM AREA $t=.38$ AND BUCKLING IS NOT CRITICAL.

CHECKING NOW THE WEB ELEMENTS WITH $t=.10$ OBTAIN THE FOLLOWING MAXIMUM COMPRESSION CASES (GROUP 102)

ELEMENT 6 CASE 1 HALF MODEL (LIMIT LD.)

$\sigma_{xx} = -8259$ psi (LIMIT)

$\sigma_{yy} = -7839$

$\sigma_{xy} = -1214$

ELEMENT 8 CASE 3 HALF MODEL

$\sigma_{xx} = -5413$ psi (LIMIT)

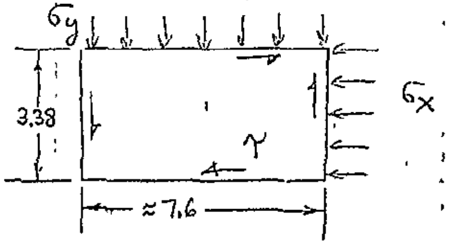
$\sigma_{yy} = -8713$

$\sigma_{XY} = -5213$

RESCUE COUCH

BACKPAN

BUCKLING ALLOWABLE FOR WEB W/ MAXIMUM LOAD. MAXIMUM LOAD OCCURS IN WEB ④ AS SHOW ON FIRST PAGE OF THIS ANALYSIS.



$$\frac{a}{b} = \frac{7.6}{3.38} = 2.25$$

$$\left.\begin{array}{l}\sigma_x = 8259 \text{ psi} \\ \sigma_y = 7839 \\ \tau = 1214 \text{ psi}\end{array}\right\} \text{CASE 1}$$

ROARK TABLE XVI CASE E.13

$$C = \frac{0.823}{1-\nu^2}\left(\frac{t}{b}\right)^2 = \frac{.823}{.91}\left(\frac{.10}{3.38}\right)^2 = .00079$$

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COMMAND MODULE

PAGE NO. 6 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531111

RESCUE COUCH

BACKPAN

CHECKING SAME PANEL FOR σ_x AND σ_y LOADS ONLY, AS A CHECK HAVE THE FOLLOWING METHOD

22 CLAMPED (NEGLECTING SHEAR)

60.05 $$\frac{K_x}{K_y} = \frac{8259}{7839} = 1.05$$

$$\therefore K_x = 3.9$$

$$K_y = 3.9$$

$$\therefore \frac{\sigma_{x_{CR}}}{\eta} = \frac{3.9\,\pi^2 E}{12(1-\mu^2)}\left[\frac{t}{b}\right]^2 = \frac{3.9\,\pi^2)\,10.3\times10^6}{12(1-.33^2)}\left[\frac{.1}{3.38}\right]^2$$

$$\frac{\sigma_{x_{CR}}}{\eta} = 32500 \text{ psi}$$

MARGIN BASED ON CASE ABOVE,

$$MS = \frac{32500}{8259(1.5)} - 1 = \underline{\underline{1.62}}$$

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TE: FEB 8 1972
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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 7 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531111

RESCUE COUCH

BACKPAN

CHECKING SECTION FOR LOADS CASE II,

$$\sigma_{xx} = -5413 \text{ psi (LIMIT)}$$

$$\sigma_{yy} = -8713$$

$$\sigma_{xy} = -5213$$

$$\frac{\sigma_x'}{\sigma_s'} = \frac{5413}{5213} = 1.04$$

$$\frac{\sigma_y}{\sigma_s} = \frac{8713}{5213} = 1.67$$

D88
6.60,22 $K_x = 1.0$ (FOR SIMPLY SUPPORTED PLATE, CONSERVATIVE)

$$t_{REQD} = \left[\frac{12(5413)1.5(.89)(3.38)^2}{1.0(\pi^2)\,10.3\times10^6}\right]^{\frac{1}{3}} = .0991 \text{ IN.}$$

$$MS = \left[\frac{.10}{.0991}\right]^2 - 1 = \underline{\underline{.01}}$$

ANOTHER CASE TO BE CHECKED IS MAX. SHEAR IN t=.10 AREAS

$$\left.\begin{aligned} \sigma_{xx} &= -229 \text{ psi (LIMIT)} \\ \sigma_{yy} &= -2774 \text{ psi} \\ \sigma_{xy} &= -9046 \text{ psi} \end{aligned}\right\} \text{ELEMENT 11 CASE 2 HALF MODEL}$$

PREPARED BY: GD
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SPACE DIVISION
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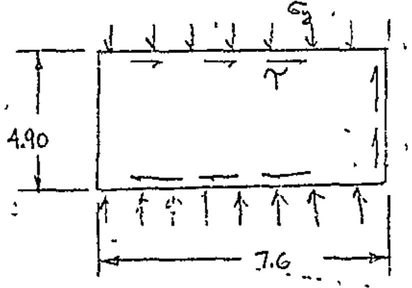
RESCUE MISSION
COMMAND MODULE

PAGE NO 8 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531111

RESCUE COUCH

BACKPAN

THIS STRESS OCCURS IN AREA ③ AS SHOWN ON THE FIRST PAGE. FOR THIS AREA HAVE THE FOLLOWING TYPE ELEMENT,



$$\frac{a}{b} = \frac{7.6}{4.9} = 1.55$$

NEGLECTING σ_x COMPONENT AND USING FIXED EDGES W/ $a/b = \infty$, CONSERVATIVE a/b RATIO

D88
6.60.10

$$\frac{K_s}{K_y} = \frac{9046}{2774} = 3.26$$

FROM GRAPH

$$K_y = 2.1$$

$$\frac{\sigma_{CR}}{n} = \frac{2.1\,\pi^2\,10.3\times10^6}{12(.89)}\left[\frac{.10}{4.90}\right]^2 = 8325 \text{ psi}$$

$$MS = \frac{8325}{1.5(2774)} - 1 = \underline{\underline{1.0}}$$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 9 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531111

RESCUE COUCH

BACKPAN

CHECK of $t = .125$ IN. ELEMENTS · ASKA GROUP 104

MAXIMUM LOAD:

GROUP 104 ELEMENT. 4 LOADING CASE 1 FULL MODEL

$\sigma_{xx} = 5663$ psi (LIMIT)
$\sigma_{yy} = 2297$ psi (LIMIT)
$\sigma_{xy} = 1897$ psi (LIMIT)

THE VALUES of THESE STRESSES ARE LESS THAN THOSE ALREADY EXAMINED.

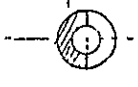
CHECK of FASTENER ATTACH POINTS ON BACKPAN.

V56-531174 · NECK RING SUPPORT ATTACH

V56-531
174
Pg.3

MOMENT AT ATTACH

$e \rightarrow| |\leftarrow$ $M_A = 109$ IN-lb. $e = .104$ IN.



O.D. = 5/16 = .312
I.D. = .190

SECTION AT ATTACH

$r_i = .095$
$r_o = .156$

ASSUMING A TENSION BEARING COUPLE THE AXIAL LOADS PRODUCED ARE,

$$P = \frac{109}{.104} = 1050 \text{ lb.}$$

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RESCUE MISSION
COMMAND MODULE
PAGE NO. 10 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531111
REF.

RESCLE COUCH

BACKPAN

DISTRIBUTING THIS LOAD UNIFORMLY OVER SHADED PORTION of AREA SHOWN ON PREVIOUS PAGE

$$\sigma_c = \frac{1050(2)}{\pi(.156^2 - .095^2)} = 43{,}800 \text{ psi}$$

SHEAR REACTED AT OUTER EDGE ONLY,

$$\tfrac{1}{2} \text{ CIRCUMFERENCE} = \frac{\pi(.312)}{2} = .49 \text{ IN.}$$

$$t = .25$$

$$\sigma_S = \frac{1050}{.25(.49)} = 8570 \text{ psi}$$

THE ATTACH POINTS FOR THE COUCH STRAPS ARE THROUGH THREADED INSERTS.

DS 1156-21

		FACT. SIZE
MD115-2002-0003	$P_{T_{ALLOW}} = 4000$ lb.	10-32 UNF
MD115-2002-0005	$P_{T_{ALLOW}} = 7300$ lb.	1/4-28 UNF

THE ALLOWABLE of A COMMON A286 FASTENER (NAS 1131-1138) SERIES

10-32 $P_{T_{ALLOW}} = 2800$ lb (ULT)

1/4-28 $P_{T_{ALLOW}} = 5100$ lb (ULT)

THUS THE PAN SIDE of THE ATTACH POINTS IS STRONGER THAN THE ATTACH FASTENERS.

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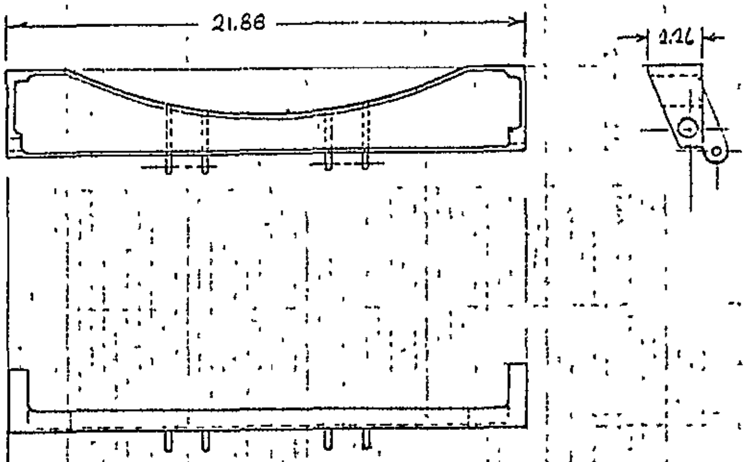
RESCUE MISSION
COMMAND MODULE
PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531112
REF

N/A V56 531101

FRAME - BACKPAN, RESCUE COUCH, ASSY OF



C22 3.7.2.0 (g)

MATERIAL: QQ-A-200/11 7075-T651 ALUMINUM BAR

$F_{tu} = 78{,}000$ psi

$F_{ty} = 70{,}000$

$F_{cy} = 70{,}000$

$F_{su} = 42{,}000$

$F_{bru} = 112{,}000$ $e/D = 1.5$

$E = 10.4 \times 10^6$ psi

PREPARED BY: G.D
CHECKED BY: DSR
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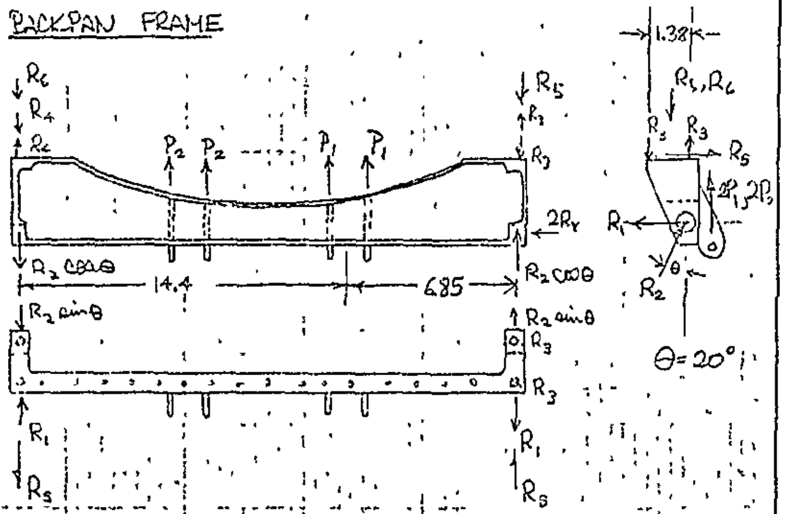
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO 2 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO. V56-531112
REF

RESCUE COUCH

BACKPAN FRAME



P LOADS DUE TO SHOULDER STRAPS (ULTIMATE)

I.2.1.55

CASE	P_1	P_2
EBO	23.6(30)=708	708
EBU	42.5(22.5)= 955	955
EBD	14.975(22.5) = 337.5	337.5
EBL1	24.2 (12.75)=309	—
EBL2	—	309

$(P_1 = P_2 = \frac{R_{SS}}{4})$

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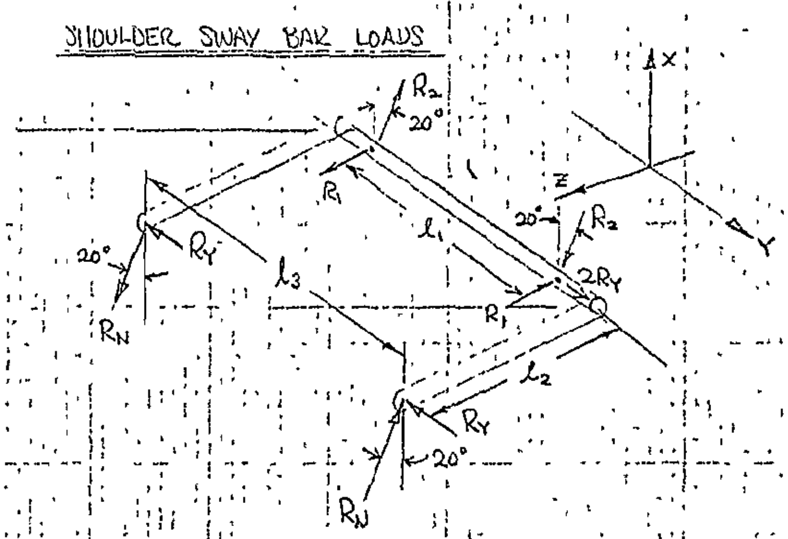
RESCUE MISSION
COMMAND MODULE
PAGE NO. 3 OF 8
REPORT NO. SD 70-205
MODEL NO SKYLAB
DWG NO V56-531112
REF

RESCUE COUCH

BACKPAN FRAME

SHOULDER SWAY BAR LOADS



USING DATA ABOVE,

$$R_1 = \frac{2R_Y l_2}{l_1}$$

$$R_2 = \frac{l_3 R_N}{l_1}$$

$l_1 = 21.32$
$l_3 = \approx 21.32$
$l_2 = 5.45$

FOR SHOLDER LOADS,

$R_N = 288.98$

$R_{Y_{NG_0}} = 563.35$

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RESCUE MISSION
COMMAND MODULE
PAGE NO. 4 OF 9
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG. NO V56-531112
REF.

RESCUE COUCH

BACKPAN FRAME

ASKA LOADS (PAN ANALYSIS)

SWAY BAR REACTIONS.

FULL COUCH MODEL Pg. 185

THIGH EBL+TEN. (LIMIT 8.5g)

1 $R_N = -86.86$ lb $R_y = -288.97$ lb.
2 $R_N = +86.86$ lb. $R_y = -261.58$ lb.
$R_{y_{AVG}} = -275.27$

$M_T = 585.8$ IN-lb (TORQUE AT BAR)

EBL (LIMIT)

1 $R_N = -73.68$ $R_y = -295.74$ lb
2 $R_N = 73.68$ $R_y = -297.36$ lb.
$R_{y_{AVG}} = -296.55$

$M_T = 496.97$ IN-lb.

SHOLDER EBL+TEN. (LIMIT)

131 $R_N = -288.98$ $R_y = -578.25$
132 $R_N = 288.98$ $R_y = -548.46$
$R_{y_{AVG}} = -563.35$

$M_T = 1511$ IN-lb

FULL COUCH PROGRAM Pg 190

EBL

131 $R_N = -245.09$ $R_y = -560.92$
132 $R_N = 245.09$ $R_y = -538.50$
$R_{y_{AVG}} = -549.71$

$M_T = 1282$ IN-lb.

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO 5 OF 9
REPORT NO. SD 70-205
MODEL NO SKYLAB
DWG NO V56-531112
REF

RESCUE COUCH

BACKPAN FRAME

CHECKING SHOLDER FRAME FOR GIVEN LOADS,

CASE I EBU

Pg. 2

$P_1 = P_2 = 955$ lb. (ULT)

$R_N = R_y = 0.$

Pg 4

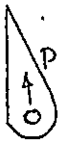
CASE II EBL+TEN. (ULT)

$R_N = -288.98(1.5) = -434$ lb.

$R_y = -563.35(1.5) = -845$ lb.

P_1 OR P_2 BUT NOT BOTH = 309 lb.

CHECK of LUG FOR P LOADS



$P_{MAX} = 955$

$t = .120$

$D_{HOLE} = .375$

$$\sigma_{br} = \frac{955}{.120(.375)} = 21{,}200 \text{ psi}$$

297

PREPARED BY: RD
CHECKED BY: HR
DATE: JAN 27 72

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RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-521112

REF.

RESCUE COUCH

BACKPAN FRAME

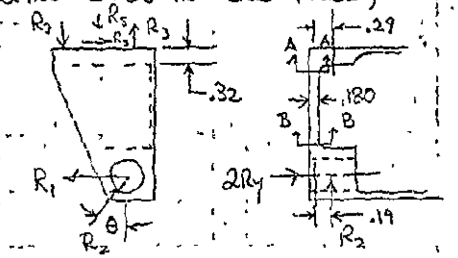
Pg 2

$$R_5 = \frac{2(309)\,14.4}{21.25} = 419$$

$$R_6 = \frac{2(309)\,6.85}{21.25} = 199$$

$$R_5 = R_1 - R_2 \sin 20° = 432 - 434 \sin 20° = 283.5$$

REACTING LOADS IN END PIECE,



$R_y = 845$

LETTING R_5 AND R_6 ACT OVER A 1.5 INCH STRIP AT SECTION A-A

$$\sigma_b = \frac{6(1157).29}{1.5(.32)^2} = 13,100 \text{ psi}$$

MECH. PTS. MAN. 1156-21

INSERT AT R_3 MD115-2002-0003

$P_{ALLOW} = 2750$ (IN LOW STRENGTH AL.)

$$MS = \frac{2750}{738} - 1 = \underline{2.72}$$

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RESCUE MISSION
COMMAND MODULE

PAGE NO. 7 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-521112

REF.

RESCUE COUCH

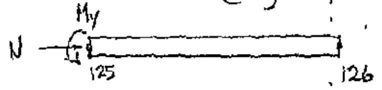
BACKPAN FRAME

CHECKING FRAME W/ ASKA

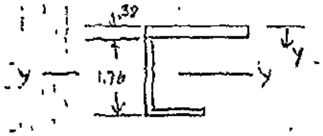
BECOS ELEMENT 6 LOADING CASE I (125,126),

$M_y = -9348$ IN-lb. (LIM)

$N = -2090$ lb. (LIM)



SECTION of BEAM



$A = .4330$

$\bar{y} = .4525$

$I_{yy} = .3798$

COMPRESSION ON TOP FLANGE,

$$\sigma_c = \frac{9348(1.5).4525}{.3798} + \frac{2090(1.5)}{.4330} = 23,946 \text{ psi}$$

TENSION AT LOWER FLANGE

$$\sigma_t = \frac{9348(1.688)(1.5)}{.3798} - \frac{2090(1.5)}{.4330} = \underline{55,079 \text{ psi}}$$

Pg. 1

$$MS = \frac{78}{55079} - 1 = \underline{.42}$$

PREPARED BY: GLD
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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 9 OF 9
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO. V56-531112

REF.

RESCUE COUCH
BACKPAN FRAME

CHECKING THE SHEAR AT THE BOLTS ALONG TOP of FRAME,

LOADING CASE I 3EQM 6 Pg. 97

$V = 484\,(1.5)\text{ lb (ULT)} = 725\text{ lb (ULT)}$

$Q = .38(2.25)(.2625) = .225$

$I = .3798$

$$\sigma_S = \frac{725(.225)}{.3798} = 430\ \frac{\text{lb}}{\text{IN}}\ \text{(ULT)}$$

$\text{FASTENER SPACING} = 1.5\ \frac{\text{IN}}{\text{FAST}}$

$\therefore\ P_S = 645\ \frac{\text{lb}}{\text{FAST}}$

D11 A-13 Ⓓ3 .123-24

NAS 1153CB (A286)

$F_{TU} = 140$ KSI

$F_{SU} = 91$ KSI

Ⓒ22 TABLE 8.1.5(A)

$P_{S_{ALL}} = 2513$ LBS

$$\text{M.S.} = \frac{2513}{645} - 1 = \underline{\underline{2.90}}$$

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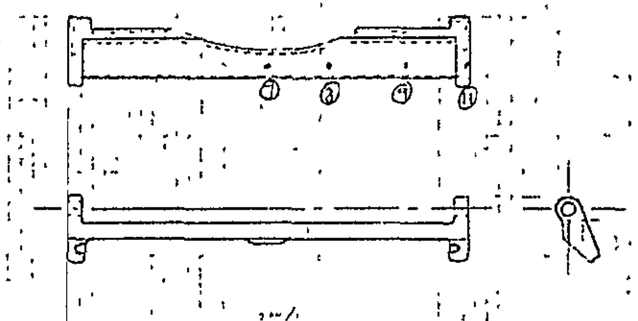
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531113

REF

FRAME - BACKPAN, RESCUE COUCH, ASSY OF

N/A V56 531101



MATERIAL: QQ-A-200/11 7075-T651, ALUMINUM BAR

Ⓒ22 3720 (g.)

$F_{tu} = 78{,}000$

$F_{ty} = 70{,}000$ $F_{cy} = 70$ KSI

$F_{su} = 42{,}000$

$F_{Bru} = 141{,}000$ psi

SWAY BAR REACTIONS,

FULL COUCH MODEL Pg 185

THIGH EBL + TENSION (LIMIT 8.5g)

1 $R_N = -86.86$ lb $R_y = -288.97$ lb.
2 $R_N = +86.86$ lb $R_y = -261.58$ lb $\Big\}\ R_{y_{AVG}} = -275.27$.

EBL (LIMIT)

1 $R_N = -73.68$ $R_y = -295.74$
2 $R_N = 73.68$ $R_y = -297.36$ $\Big\}\ R_{y_{AVG}} = -296.55$

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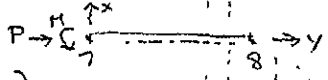
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO. 2 OF
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DWG NO V56-531113
REF.

RESCUE COUCH

BACKPAN FRAME

FROM ASKA RUN OBTAIN THE FOLLOWING

LOADING CASE 3

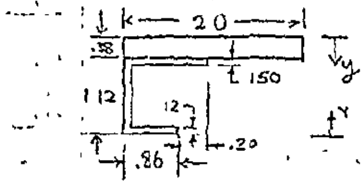


FULL COUCH MODEL Pg. 95

$M_{7X} = 6959$ IN-lb. (LIMIT)

$P_{7N} = -788$ lb. (LIMIT)

SECTION of BEAM AT NODE 7



$A = .223$

$\bar{y} = .5411$

$I = .1587$

AT BOTTOM FLANGE (COMPRESSION)

$$\sigma_c = \frac{6959(.9589)(1.5)}{.1587} + \frac{788(1.5)}{.223} = 68{,}372 \text{ psi}$$

CHECKING BUCKLING of OUTER FLANGE,

$$\frac{\sigma_{CR}}{\eta} = K \frac{\pi^2 E}{12(1-\mu^2)} \left[\frac{t}{b}\right]^2$$

$a \approx \infty$

$b = .86$

$t = .120$

$K = 1.28$ (CASE A)

D88 6.20.05

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RESCUE MISSION
COMMAND MODULE
PAGE NO. 3 OF
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DWG NO V56-521113
REF

RESCUE COUCH

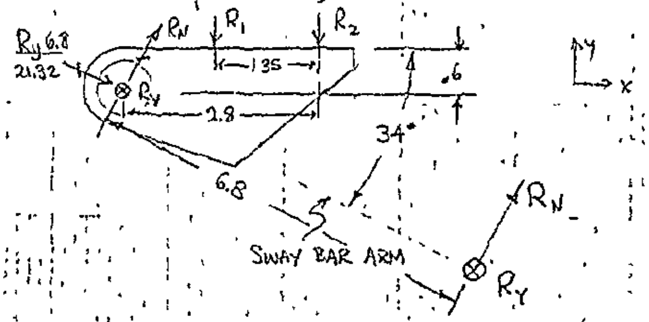
BACKPAN FRAME

$$\frac{\sigma_{CR}}{\eta} = \frac{1.28 \cdot \pi^2 (10.4 \times 10^6)}{12(.91)} \left(\frac{.12}{.86}\right)^2 = 228{,}000 \text{ psi}$$

$$M.S. = \frac{70}{60.05} - 1 = .16$$

CHECKING FASTENERS AT FRAME ATTACH POINTS DUE TO SWAY BAR LOADS,

END VIEW of FRAME,



Pg-1

$R_N = 86.86(1.5) = 130.5$ lb (ULT)

$R_y = (275.27)\,1.5 = 413.$ lb. (ULT)

REF

RESCUE COUCH

BACKPAN FRAME

$\Sigma F_y = 0$

$R_N \cos 34° - R_1 - R_2 - \frac{R_y 6.8}{21.32} \sin 34° = 0$

$108.3 - R_1 - R_2 - 73.66 = 0$

$R_1 + R_2 = +34.53$

$\Sigma M = 0$

$\frac{R_u 6.8}{21.32} \sin 34°(2.8) + \frac{R_y 6.8}{21.32} \cos 34°(.6) - R_N \cos 34°(2.8)$

$+ R_N \sin 34°(.6) + R_1(1.35) = 0$

$206.3 + 65.5 - 302.9 + 43.78 + 1.35 R_1 = 0$

$1.35 R_1 = -12.68$

$R_1 = -9.39$

$R_2 = 34.53 + 9.39 = 43.92$ lb.

∴ THUS MAXIMUM TENSION LOAD IN FASTENERS IS 43.92 lb (ULT)

Ⓓ9
1121-26
Ⓒ22
TABLE
515(b)

NAS 1133 C6 (A286)

$F_{TU} = 140$ KSI

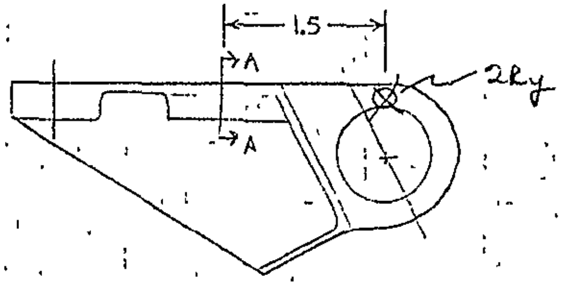
$P_{TU} = 11540$ LBS

$M.S = \frac{11540}{44} - 1 = \underline{+ HIGH}$

REF

RESCUE COUCH

BACKPAN FRAME



ASSUME SIDE THRUST REACTED ON ONE SIDE ONLY

CHECK AT LUG FOR SIDE LOAD.

SECTION A-A

$M = 2R_y(1.5) = 826(1.5) = 1240$ IN-lb.

$\sigma_b = \frac{6(1240)}{.32(.76)^2} = 40300$ psi

$M.S = \frac{70}{40.3} - 1 = \underline{.74}$

FULL
COUCH
MODEL
Pg 95
BAR 1
CASE 3

SHEAR AT FASTENERS,

$V_7 = 914(1.5) = 1370$ lb (ULT)

$V_{7N} = 788(1.5) = 1182$ LBS (ULT)

$P_S = [(1370)^2 + (1182)^2]^{\frac{1}{2}}$

$P_S = 1809$ LBS

PREPARED BY: G.D
CHECKED BY: TGE
DATE: FEB 1 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 6 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531113

REF

RESCUE COUCH

BACKPAN FRAME

(D5) 1123-24 (C22) TABLE 815(a)

NAS 1154C12 FASTENER

$P_{S_{ALLOW}} = 4470$ lb.

BEARING ALLOWABLE IN FRAME

$P_{BRU} = 141,000(.15)(.25) = 5290$ lb,

$M.S = \frac{4470}{1809} - 1 = \underline{1.47}$

PREPARED BY: GLD
CHECKED BY: KGR
DATE: AUG 1, 72

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RESCUE MISSION
COMMAND MODULE

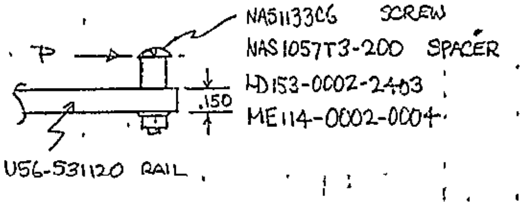
PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531120

REF

N/A V56 531102

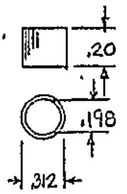
RAIL - SUPPORT STRUCTURE, RESCUE COUCH, ASSY OF

CALCULATION of ALLOWABLE of RETAINING BOLT IN V56-531120 RAIL. THE BOLT AND BUSHING ARE LOCATED IN THE SLOTS THAT CONTAIN THE BEARING FOR THE SWAY BAR ARMS.



D8 1121-26 D8 1522-22

NAS1133C6 SCREW A286 140,000 HT STEEL PER AMS5735
NAS1057T3-200 303 CRES (F_{bru} = 150,000 psi, ANNEALED)
-200 CALLOUT MUST BE 020 WHICH MEANS .20 LENGTH



P_{ALLOW} BASED ONLY ON BENDING of BOLT

$$F_b = \frac{P(.20)4}{\pi R^3} = \frac{P(.80)}{\pi(.0942)^3}$$

$$P_{ALLOW} = \frac{206,500\,\pi(.0942)^3}{(.80)} = \underline{\underline{678 \text{ lb.}}}$$

PREPARED BY: GD
CHECKED BY: RER
DATE: 6-6-21-72.

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V5--531120

REF

RESCUE COUCH

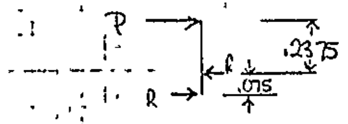
CALCULATION of ALLOWABLE BASED ON BEARING IN RAIL, MIN e/D IN RAIL,

$$e/D = .190/.190 = 1$$

MOMENT AT RAIL,

$$M_R = P(.20+.075) = .275P$$

REACT BY COUPLE IN RAIL



$$R = \frac{.2375P}{.075} = 3.16P$$

USING SHEAR TEAR-OUT AS MODE of FAILURE,

$$R_{TO} = 2\left(\frac{.190}{2}\right)\tau\left(\frac{.150}{2}\right) = (.190)\,39{,}000\left(\frac{.150}{2}\right) = 556 \text{ lb.}$$

THUS

$$P_{ALLOW_{TO}} = \frac{556}{3.16} = \underline{\underline{176 \text{ lb.}}}$$

PREPARED BY: GLD
CHECKED BY: RER
DATE: FEB 10 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531120

REF

RESCUE COUCH

SUPPORT STRUCTURE

LOADS TO THE V56-531120 FRAME FROM THE FOAM PER ASKA PROGRAM RUN

CASE I LOADS - HALF MODEL, LIMIT LOAD IN lbs.

HALF COUCH MODEL Pg 147 THRU Pg 149

NODE	P_x	P_y	P_z	M_x	M_Y	M_z
28	18.9	27	33.2	—	—	—
30	17.0	-1.7	30.2	—	—	—
39	63.0	8.8	93.3	—	—	—
41	56.3	-5.3	84.8	—	—	—
50	89.3	12.9	127.6	—	—	—
52	80.5	-6.0	116.6			
61	86.3	8.9	57.2			
63	77.6	-2.7	52.5			
72	112.6	10.3	40.9			
74	92.4	-1.6	39.0			
83	124.2	9.5	32.0			
85	104.8	-5.8	20.8			
94	171.5	11.4	37.7			
96	148.0	-8.0	37.3			
105	353.0	23.0	57.2			
107	323.9	-21.1	57.6			
116	186.3	13.5	18.8			
118	176.5	-13.2	19.6			

PREPARED BY: GLD
CHECKED BY:
DATE: FEB 11 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531120
REF

RESCUE COUCH
SUPPORT STRUCTURE

HALF COUCH MODEL Pg 152 THRU Pg 152

CASE II LOADS - HALF MODEL, LIMIT LOAD POUNDS

NODE	Px	Py	Pz
28	37.6	4.7	75.1
30	35.6	-3.8	72.0
39	97.3	14.5	177.8
41	90.1	-11.5	169.3
50	122.6	20.0	218.0
52	114.1	-13.0	208.1
61	62.6	7.4	69.5
63	54.6	-2.4	65.3
72	-49.5	-2.4	70.1
74	67.7	6.4	68.5
83	-47.2	-3.2	54.3
85	-62.3	4.6	53.9
94	-53.5	-3.5	60.6
96	-69.0	5.1	61.0
105	-77.7	-5.0	87.5
107	-93.0	7.0	88.5
116	-60.2	-2.3	36.9
118	-64.4	2.8	37.5

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CHECKED BY: DER
DATE: FEB 11 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 5 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531120
REF.

RESCUE COUCH
SUPPORT STRUCTURE

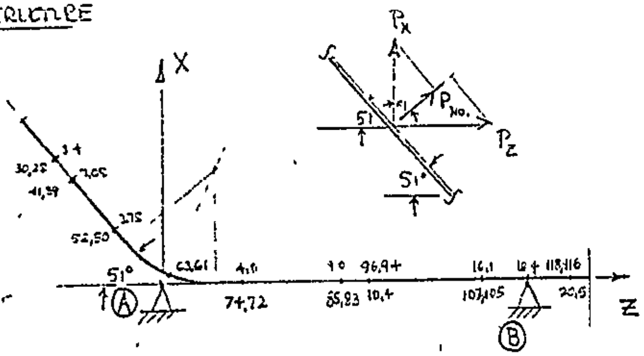
HALF COUCH MODEL Pg 153 THRU Pg 153

CASE III - HALF MODEL, LIMIT LOADS POUNDS

NODE	Px	Py	Pz
28	-31.8	-4.1	-57.6
30	-30.1	3.5	-54.8
39	-94.3	-12.3	-146.0
41	-87.9	10.2	-138.5
50	-112.2	-157	-170.7
52	-105.0	11.0	-162.7
61	-74.3	-7.3	-58.9
63	-69.0	3.4	-56.5
72	-16.1	-3.7	-44.7
74	-8.0	-2.7	-44.8
83	13.3	-.2	-33.6
85	18.7	-3.0	-33.6
94	28.1	.5	-37.3
96	34.0	-3.5	-37.5
105	71.9	4.1	-53.6
107	77.0	-6.3	-541
116	56.8	2.8	-23.1
118	57.9	-3.0	-23.4

RESCUE COUCH

SUPPORT STRUCTURE



FOR MAXIMUM MOMENT IN FRAME TO THE LEFT of THE X-AXIS AS SHOWN ABOVE,

$$M_A = (P_{30} + P_{28})\,8.05 + (P_{41} + P_{39})\,6.7 + (P_{52} + P_{50})\,3.35$$

FOR EACH of THE P FORCES LISTED ABOVE DESIRE COMPONENT ⊥ TO RAIL.

$$P_{NO.} = P_x \cos 51° + P_z \sin 51°$$

SEE THE FOLLOWING PAGE FOR THE LOADS ⊥ TO THE RAIL FOR THE CRITICAL LOADING CONDITION.

RESCUE COUCH

SUPPORT STRUCTURE

CASE I & II LDS. RESOLVED INTO ⊥ COMPONENTS (LIMIT LOAD IN POUNDS)

NODE	$P_\perp$ CASE I	$P_\perp$ CASE II
28	37.70	82.0
30	34.17	78.4
39	112.15	199.4
41	101.33	188.3
50	155.36	246.6
52	141.28	233.5
61	98.76	93.4
63	89.64	85.1
72	112.6	-49.5
74	92.4	67.7
83	124.2	-47.2
85	104.8	-62.3
94	171.5	-53.5
96	148.0	-69.0
105	353.9	-77.7
107	323.9	-93.0
116	186.3	-60.2
118	176.5	-64.4

THUS MAXIMUM M_A IS CASE II,

$$M_{A_{MAX}} = 1.5\left[(1291.2) + (2597.6) + (1608.3)\right] = 8245.7 \text{ IN-lb}$$

REF

RESCUE COUCH

SUPPORT STRUCTURES

Fig 17
V56-531122

I of SECTION $= .185\ IN^4$

C " " $= 1.38 - .35 = 1.03$ IN.

$$\sigma_b = \frac{8246(1.03)}{.185} = 45{,}900\ psi$$

FOR SECTION of RAIL FROM Ⓐ TO Ⓑ THE CRITICAL LOADING CONDITION IS CASE I.

REACTION AT ② USING ⊥ COMPONENTS,

$$\Sigma M_A = 0$$

$$(P_{30}+P_{23})8.4+(P_{41}+P_{39})7.05+(P_{52}+P_{50})3.75-(P_{74}+P_{72})4.0$$
$$-(P_{85}+P_{83})9.0-(P_{96}+P_{94})10.4-(P_{107}+P_{105})16.1-R_{BX}18.4$$
$$-(P_{118}+P_{116})20.5=0$$

$$R_{BX}=\frac{(P_{30}+P_{23})8.4+(P_{41}+P_{39})7.05+(P_{52}+P_{50})3.75-(P_{74}+P_{72})4.0}{18.4}$$
$$\frac{-(P_{85}+P_{83})9.0-(P_{96}+P_{94})10.4-(P_{107}+P_{105})16.1-(P_{118}+P_{116})20.5}{18.4}$$

THUS FOR CASE I,

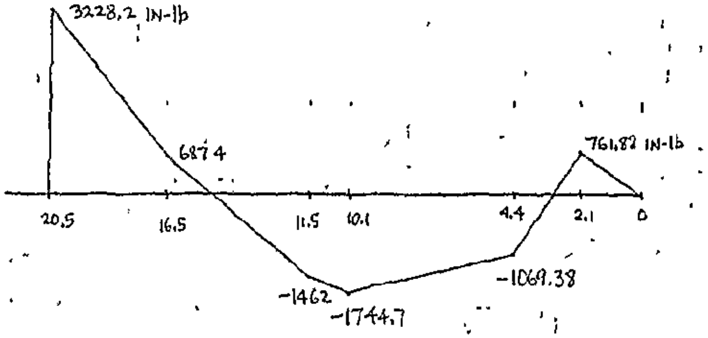
$$R_{BX} = -1159(1.5) = -1739\ lb.\ (ULT)$$

REF

RESCUE COUCH

SUPPORT STRUCTURE

STARTING AT NODES 118 AND 116 GOING ALONG Z-AXIS MOMENT ALONG RAIL, (LIMIT LOADS) OBTAIN THE FOLLOWING MOMENT DIAGRAM,



THUS THE MAXIMUM MOMENT OCCURS AT APPROXIMATELY THE SAME AREA THAT WAS CHECKED FOR CASE II LOADS PREVIOUSLY AND SINCE THE MOMENT IS LESS NO STRESS CALCULATION IS REQUIRED.

CRITICAL BENDING STRESS : $\sigma_b = 45{,}900$ psi

MATERIAL : QQ-A-250/4 2024-T351 AL PLATE

CR2
3.2.3.0
(b)

$F_{tu} = 56{,}000$ psi

$F_{ty} = 40{,}000$ psi

$F_{su} = 34{,}000$ psi

$F_{bru} = 104{,}000$

$$MS = \frac{56}{45.9} - 1 = \underline{.22}$$

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DATE: FEB 15 1972

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 10 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531120

REF

V56-531112 pg 4

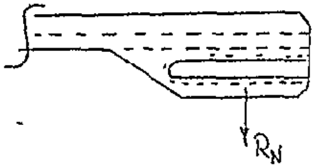
RESCUE COUCH

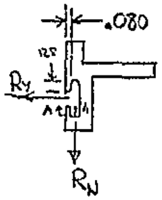
SUPPORT STRUCTURE

CHECK of SWAY BAR ATTACT SLOTS

$$R_{N_{MAX}} = 289.93(1.5) = 434 \text{ lb. (ULT)}$$

$$R_{Y_{MAX}} = 563.35(1.5) - 845 \text{ lb (ULT)}$$





REACTION of R_y AT SECTION A-A

HALF R_y TOP AND BOTTOM AND ASSUME BEARING LOAD IS REACTED .075 IN. FROM ROOT SECTION A-A;

$$\sigma_b = \frac{6M}{bt^2} = \frac{6(845)(.075)}{2(.5)(.08)^2} = \underline{59{,}500 \text{ psi}}$$

$$F_b = 56{,}000 + 20{,}000 = 76{,}000$$

$$MS = \frac{76}{59.5} - 1 = \underline{+.27}$$

CHECK of LOADS ON MD115-2002-0003 INSERTS ASSOCIATED W/ V56-531125

$$P = 1460/2 = 730 \text{ lb.}$$

OK

CL- [illegible] pg 5

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RESCUE MISSION
COMMAND MODULE

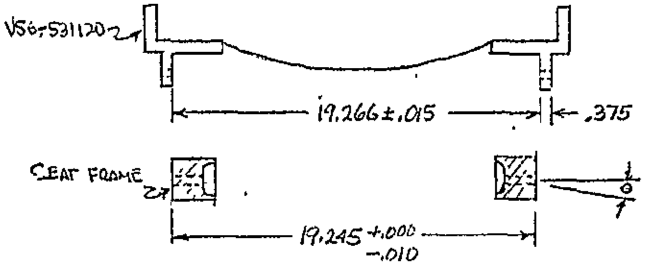
PAGE NO 11 OF 1‾
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531120

REF

RESCUE COUCH

SUPPORT STRUCTURE

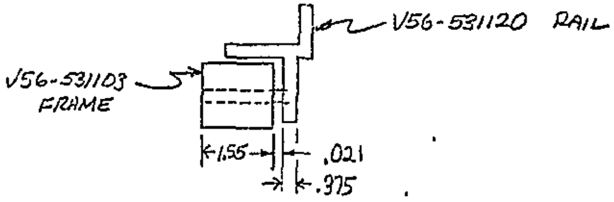
SUPPORT STRUCTURE AFT BULKHEAD FRAME - INTERFACE,



θ ROTATION of FRAME DUE TO ECCENTRICITY of RAIL ATTACHMENT,

$$\theta \cong .01 \text{ RADIANS} = .573 \text{ DEG.}$$

CHECKING FRAME RAIL INTERFACE,



MAXIMUM SHEAR AT BOLT = 3615 lb (ULT)

ASSUME THE FOLLOWING TYPE of REACTION TO THE LOAD IN THE V56-531120 RAIL

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CHECKED BY: RGR
ATE: MARCH 6 72
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SPACE DIVISION
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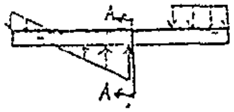
RESCUE MISSION
COMMAND MODULE

PAGE NO. 12 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531120

RESCUE COUCH

RAIL FRAME INTERFACE



$M_{MAX} = P(.1875+.021) = 754$ IN-lb (ULT) @ A-A.

FOR AN ALLOWABLE BENDING MODULUS USE K=1.7
AND 140,000 A286 ($F_{ty} = 95,000$)

$$F_b = 140,000 + .7(95,000) = 206,500 \text{ psi}$$

$$206,500 = \frac{754(4)}{\pi R^3}$$

$$R = \sqrt[3]{\frac{754(4)}{\pi(206,500)}} = .167 \text{ IN.}$$

D11
A10

COMBINE SHEAR AND BENDING W/ 3/8 FASTENER

$$R_S = \frac{3615}{9950} = .364$$

$$R_b = \frac{146}{206} = .709 \qquad \left(\sigma_b = \frac{754(.188)64}{\pi(.375)^4}\right)$$

$R_S^2 + R_b^2 = 1$ INTERACTION

$$MS = \frac{.47}{.364} - 1 = +.29 \longleftarrow$$

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ATE: MAR 17 1972
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SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO. 13 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531120

RESCUE COUCH

RAIL FRAME INTERFACE

SHEAR TEAR OUT IN RAIL AS A RESULT of 3/8 HOLE.

$F_{su} = 34,000$ psi

$$\sigma_S = \frac{3615}{(.50-.1875)2(.375)} = 15,424$$

$$MS = \frac{34}{15.4} - 1 = +1.20$$

PREPARED BY: G. F.
CHECKED BY: [illegible]
DATE: [illegible]

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COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V5[illegible]-531123

REF: N/A
V56-531102

FRAME- BACK PAN SUPPORT STRUCTURE, RESCUE COUCH, ASSY OF

THIS PART WAS INCLUDED IN THE ASKA RESCUE COUCH BACK PAN COMPUTER PROGRAM.

Pg I.2.1.19

(NODE 124-125) Pg.97 FULL COUCH MODEL
(EBI) $M_y = 9348$ IN-LBS (LIMIT)

$I = .3798\ \text{IN}^4$, $c = 1.3075$ IN } FROM PROGRAM

$$f_b = \frac{[(9348)(1.5)](1.3075)}{.3798}$$

$$= 48{,}272 \text{ PSI}$$

(C22) TABLE 3.2.3.0(g)

2024-T4 QQ-A-225/6
AL BAR

$F_{TU} = 62$ KSI
$F_{TY} = 40$ KSI

$$\text{M.S.} = \frac{62}{48.27} - 1 = \underline{+.29}$$

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RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56 531124

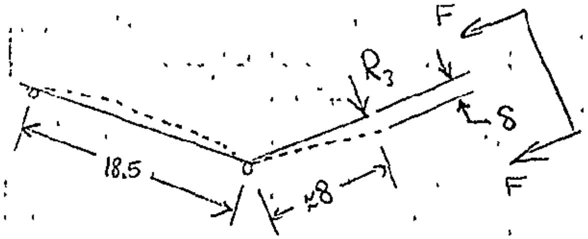
REF: N/A
V56 531102

FRAME-SEAT PAN SUPPORT STRUCT, RESCUE COUCH, ASSY OF

SEE V56-531120

THUS THE TORQUE CAN BE REACTED BY AN AXIAL AND SHEAR LOAD AT THE OUTER RAILS.

THE DEFLECTION AT THE ENDS OF THE V56-531120 RAILS WRT EACH OTHER WILL CAUSE LOADING ON THE V56-531124 FRAME.



(E4) TABLE III CASE 1+19

$$\delta = \frac{1}{3}\frac{R_3(8)^3}{EI} + \frac{8\,R_3(8)(18.5)}{3\,EI}$$

$E = 10.5 \times 10^6$
$I = .185$

V56 531102 Pg 8

$$\delta = \frac{171\,R_3}{EI} + \frac{395\,R_3}{EI} = \frac{566\,R_3}{EI}$$

$$\delta = 2.91 \times 10^{-4} R_3 = 2.91 \times 10^{-4}(477) = \underline{.1385 \text{ IN}}$$

PREPARED BY: GLD
CHECKED BY: RSK
DATE: JAN 18 72

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

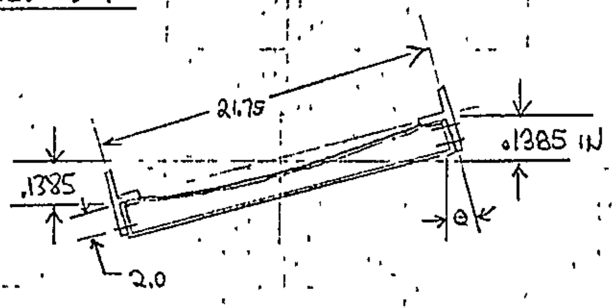
PAGE NO 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531124

REF.

RESCUE COUCH

SUPPORT STRUCTURE

VIEW F-F



$\theta = \sin^{-1}\frac{.1385}{10.88} = \sin^{-1}.01275 = .729$ DEG
$= .01272$ RAD

FOR TORSION,

$T = GJ_1\theta$ (A)

D85
1-30.01

θ = ANGLE of TWIST PER UNIT LENGTH (RAD/IN)

$G = 4.0\times10^6$

ASSUMING THE TORQUE IS REACTED BY THE RAILS WANT TO FIND TORQUE APPLIED TO GET θ ROTATION.

$T = GJ_1\theta = 4.0\times10^6(.069)\frac{.01272}{8} = 440$ IN-lb

THUS THE LOAD AT THE FASTENERS IS

$P = \frac{440}{2.0} = \underline{220 \text{ lb.}}$

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SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

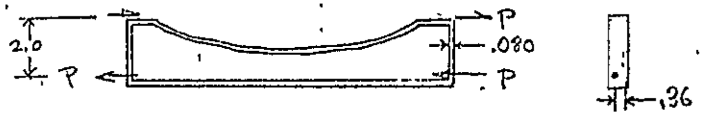
PAGE NO 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO 56-531124

REF

RESCUE COUCH

SUPPORT STRUCTURE

THIS LOAD P IS REACTED AT THE END PLATES of THE V56-531124 FRAME



BENDING STRESS CAUSED IN FRAME (UNIT STRIP)

$\sigma_b = \frac{6(220).36}{(.080)^2} = 74{,}300$ psi

C22
3.2 3.0
(g)

MATL. QQ-A-225/6 2024-T4

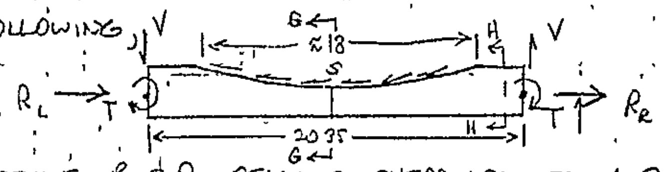
$F_{tu} = 61{,}000$

$F_{tu} = 40{,}000$

$F_b = 61{,}000 + 20{,}000 = 81{,}000$

$M.S. = \frac{81}{74.3} - 1 = \underline{+.09}$

NOW FOR ACTUAL LOADING ON FRAME HAVE THE FOLLOWING,



ASSUME R_L & R_R REACT AT SHEAR CENTER of S.

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CHECKED BY: RGR		REPORT NO SD 70-205
DATE: JAN 19,72	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531124

RESCUE COUCH

SUPPORT STRUCTURE

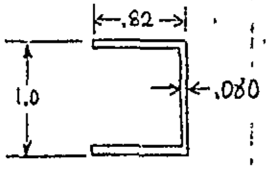
$T = 440$ IN-lb.

$$V = \frac{440}{20.35} = 21.6 \text{ lb.}$$

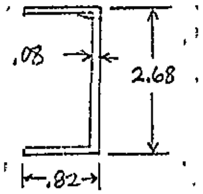
$S = 53 \frac{\text{lb}}{\text{IN}}$

$R_3 + R_4 = 955$

SECTION G-G



SECTION H-H



ITEM	b	h	$\bar{y}$
1	.82	.08	.04
2	.08	.84	.50
3	.82	.08	.92

$A = .198$
$\bar{y} = .487$
$I = .029$

ITEM	b	h	$\bar{y}$
1	.62	.080	.04
2	.08	2.52	1.34
3	.82	.08	2.64

$A = .333$
$\bar{y} = 1.34$
$I = .328$

MOMENT AT G-G = 0

MOMENT AT H-H

$M = 440$ IN-lb.

$$\sigma_b = \frac{440(1.34)}{.328} = 1800. \text{ psi}$$

M.S. = + HIGH

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CHECKED BY: RGR		REPORT NO SD 70-205
DATE: 11/30/71	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531125

N/A V56 531102

C29

TBB 32.30(a)

FITTING-COUCH ATTACH, HEAD END, RESCUE COUCH, ASSY OF

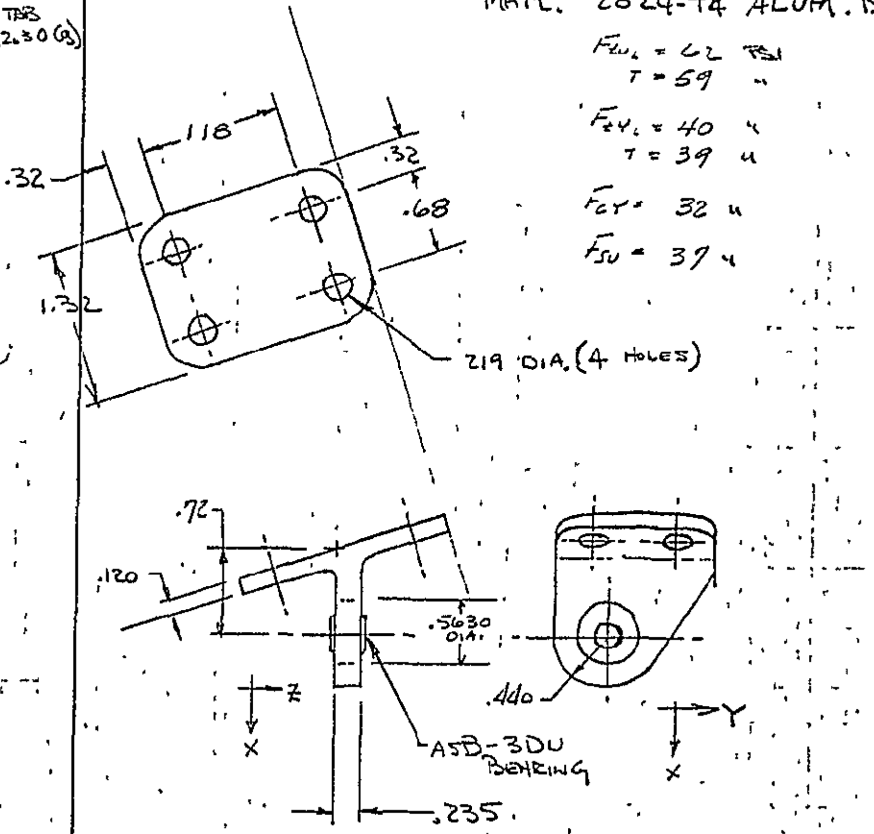
MATL. 2024-T4 ALUM. BAR

F_{tu} L = 62 KSI
T = 59 "

F_{ty} L = 40 "
T = 39 "

F_{cy} = 32 "

F_{su} = 37 "



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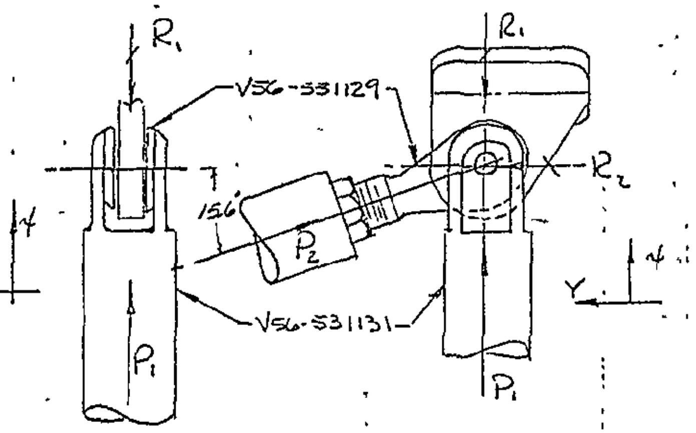
CHECKED BY: RGR	RESCUE MISSION	REPORT NO SD 70-205
DATE: 11-30-71	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531125

FITTING – COUCH ATTACH



DESIGN ULT. LOADS

	CONDITION:	P_1	P_2	R_1	R_2
II.2.1.45	1. EBI + EBU	3885	0	3885	0
II 2 1.47	2. EBO + EBD	-3068	0	-3068	0
	3. EBL = 12.75	729	-2166	729	-2086
II.2 1.47	4. EBR	-729	2166	-7.29.	2086

PREPARED BY:	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 3 OF 5
CHECKED BY: RGR	RESCUE MISSION	REPORT NO SD 70-205
DATE: 12-2-71	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531125

FITTING – COUCH ATTACH

CHECK BEARING (ASB-3DU)

FROM NEWHAMPSHIRE BALL BEARING INC.
PETERBOROUGH, N.H.

Pg 2 STATIC ALLOWABLE = 4840#
ULT. LOAD = 3885#

$$M.S. = \frac{4840}{3885} - 1 = .24$$

Pg 2 CHECK LUG SHEAR BEARING

MAXIMUM LOAD = 3068# ULT.

$w = .440 \times 2 = .880$
$D = .5630$

$\frac{w}{D} = 1.56$ $K_t = .98$

$a = .440$ $\frac{a}{D} = .78$ $K_{br} = .70$

$$A_{br} = .5630(.235) = .132$$

$$A_{ten} = (.880 - .5630)(.235) = .075$$

$$P'_u = K_{br} A_{br} F_{tu}$$

$$= .7(.132)(59000)$$

$$= 5460\#$$

$$P'_{tu} = K_t A_t F_{tu}$$

$$= .98(.075)(59000)$$

$$= 4350\#$$

$$M.S. = \frac{4350}{3068} - 1 = .42$$

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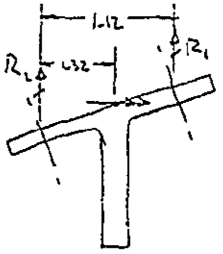
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

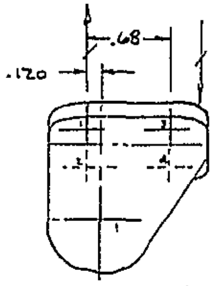
PAGE NO. 4 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531125

REF

FITTING – COUCH ATTACH

CHECK BASE OF FITTING





Pg.2 MAXIMUM TENSION CASE

$R_1+R_2 = 3068\left(\frac{.56}{.68}\right) = 2525$ #

$R_1 = 2525\left(\frac{.632}{1.12}\right) = 1425$ #

$R_2 = 1100$ #

Pg 2 MAXIMUM Y-Y LOAD

$R_1+R_2 = 2086\left(\frac{.72}{1}\right) = 1500$ #

Pg.2 MAXIMUM LOAD FOR RESULTANT VECTOR THAT FALLS THRU BOLTS 1 & 2

$R_1+R_2 = \frac{.729 \rightarrow 2086}{\cos 15°} = 2310$ #

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG. NO V56-531125

REF

FITTING ~ COUCH ATTACH

CHECK BASE OF FITTING CONT'D.

MOM @ THE .06 RAD. = 1100(.47) = 517. # ULT.

Pg.4 $f_b = \frac{6(517)}{.66(t)^2}$

$F_b = 59000 + \frac{39}{2} = 78,500$

$t = \sqrt{\frac{6 \times 517}{.66 \times 78500}} = .245$

USE .260

$M.S. = \frac{.260}{.245} - 1 = \underline{.06}$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-S31126

REF
N/A
V56
531105

ADAPTER FRAME- A9 LOCATION, RESCUE COUCH, ASSY OF

MATERIAL: 7075-T73 HAND FORGING

F_{tu} = 66,000 psi (L)
= 64,000 psi (LT)
= 61,000 psi (ST)

F_{ty} = 56,000 psi (L)
= 54,000 psi (LT)
= 52,000 psi (ST)

D11
02.71
.01.02

F_{cy} = 56,000 psi (L)
= 52,000 psi (LT)

F_{su} = 39,000 psi

F_{bru} = 119,000 psi (e/D = 2.0)

TBI

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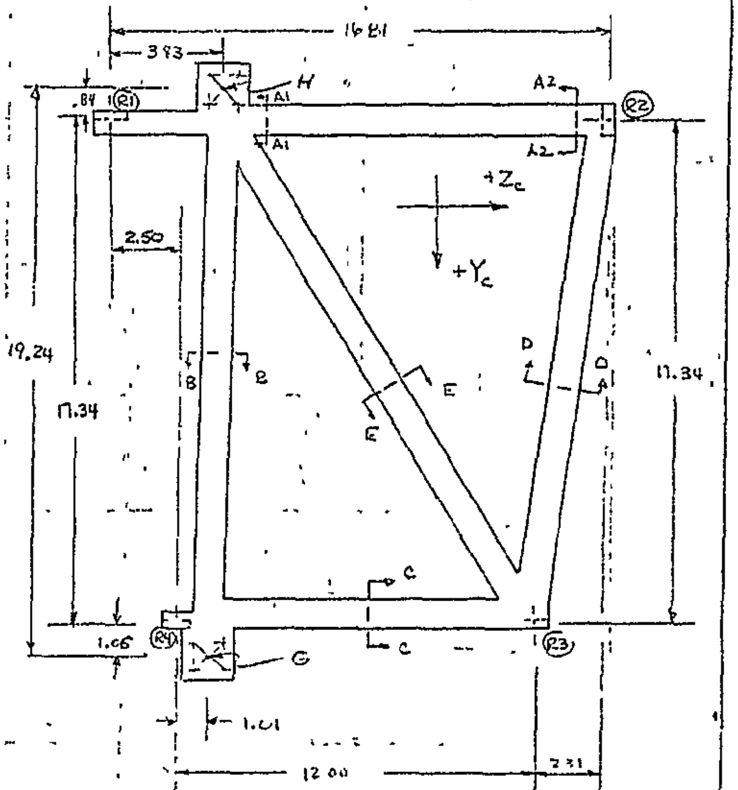
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-S31126

REF

RESCUE COUCH

A-9 ADAPTER FRAME



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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 3 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

LOADS (ULT.)

CASE #1 (EBU + EBI)

II 2.1.45 $P_{H_x} = -3885^{\#}$ (COMP)

$P_{Gx} = -3865^{\#}$ (COMP)

CASE #2 (EBD + EBO)

II.2.1.47 $P_{Hx} = +3068^{\#}$ (TENSION)

$P_{Gx} = +3068^{\#}$ (TENSION)

CASE # 3 (EBR)

II.2.1.47 $P_{HX} = +1311.^{\#}$ (TENS)

$P^{*}_{HY} = -2086^{\#}$

$P_{Gx} = -1311^{\#}$ (COMP)

CASE #4 (EBL)

$P_{Hx} = -1311^{\#}$ (COMP)

$P^{*}_{HY} = +2086^{\#}$

$P_{Gx} = +1311.^{\#}$ (TENS)

* APPLIED .74 ABOVE FLANGE

FORM 604-B REV 12-67

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 4 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

RESTRAINT :

R1 - X - DIRECTION
R2 - X, Y, Z - DIRECTIONS
R3 - X, Z - DIRECTIONS
R4 - X - DIRECTION

LOAD CASES 1 & 2

$\Sigma M = 0$ ABOUT R3 - R4

$17.34 R_{1x} + 17.34 R_{2x} = -(1134 + .84) P_{Hx} + 1.06 P_{Gx}$

$3.83 R_{1x} = (1621 - 3.83) R_{2x}$

$R_{1x} = -.80957 P_{Hx} + .04720 P_{Gx}$

$R_{2x} = -.23888 P_{Hx} + .01393' P_{Gx}$

$\Sigma M = 0$ ABOUT R1 - R2

$17.34 R_{4x} + 17\ 34 R_{3x} = -(17.34 + 1.06) P_{Gx} + .84 P_{Hx}$

$1.01 R_{4x} = (1200 - 1.01) R_{3x}$

$R_{3x} = -.08931 P_{Gx} + 00408 P_{Hx}$

$R_{4x} = -.97182 P_{Gx} + 04437 P_{Hx}$

FORM 604-B REV 12-67

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 5 OF 35
REPORT NO SD 70-205
MODEL NO. SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

LOAD CASES 3 & 4

$\Sigma M = 0$ ABOUT R3-R4

$$17.34(R_{1x} + R_{2x}) = -(1734 + 84)P_{Hx} + 1\,06\,P_{Gx}$$
$$- (.74 + 1\,625)P_{HY}$$

$$3\,83\,R_{1x} = (16.81 - 3.83)R_{2x}$$

$$R_{1x} = -.80957\,P_{Hx} + 04720\,P_{Gx} - .10531\,P_{HY}$$

$$R_{2x} = -.23888\,P_{Hx} + .01393\,P_{Gx} - .03108\,P_{HY}$$

$\Sigma M = 0$ ABOUT R1-R2

$$17.34(R_{3x} + R_{4x}) = -(17.34 + 1.66)P_{Gx} + .84\,P_{Hx}$$
$$+ (.74 + 1.625)P_{HY}$$

$$1.01\,R_{4x} = (12.00 - 1.01)R_{3x}$$

$$R_{3x} = -.08931\,P_{Gx} + .00408\,P_{Hx} + .01148\,P_{HY}$$

$$R_{4x} = -.97182\,P_{Gx} + .04437\,P_{Hx} + .12491\,P_{HY}$$

$$R_{2Y} = -P_{HY}$$

$$R_{2Z} = \frac{16\,81 - 3\,83}{17\,34}P_{HY} = .74856\,P_{HY}$$

$$R_{3Z} = -R_{2Z} = -.74856\,P_{HY}$$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 6 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

LOAD CASE #1

Pg. 3 $P_{Gx} = P_{Hx} = -3885\#$ (ULT)

$R_{1x} = 2961.8\#$

$R_{2x} = 873.9\#$

$R_{3x} = 331.1\#$

$R_{4x} = 3603.2\#$

LOAD CASE #2

Pg. 3 $P_{Gx} = P_{Hx} = 3086\#$ (ULT)

$R_{1x} = -2355\#$

$R_{2x} - -694\#$

$R_{3x} = -263\#$

$R_{4x} = -2860\#$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 7 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

LOAD CASE # 3

P_{HX} = +1311.# (ULT)
P_{HY} = +2086# (ULT)
P_{GX} = -1311 # (ULT)
R_{1X} = -1337.8 #
R_{2X} = - 374.7 #
R_{2Y} = -2086 0 #
R_{2Z} = +1561.5#
R_{3X} = +145.8 #
R_{3Z} = -1561.5#
R_{4X} = +1586 7#

LOAD CASE # 4

LOADS HAVE SAME MAGNITUDE BUT OPPOSITE SIGNS OF CASE 3

184

333

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 8 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

	LOAD CONDITION			
LOAD	1	2	3	4
P_{HX}	-3885	+3068	+1311	-1311
P_{HY}	0	0	+2086	-2086
P_{GX}	-3885	+3068	-1311	+1311.
R_{1X}	+2961.8	-2355.	-1337.8	+1337.8
R_{2X}	+813.9	-694.	-394.7	+394.7
R_{2Y}	0	0	-2086.0	+2086.0
R_{2Z}	0	0	+1561 5	-1561.5
R_{3X}	+331.1	-263	+145 8	-145 8
R_{3Z}	0	0	-1561.5	+1561 5
R_{4X}	+3603.2	-2860	+1586.7	-1586.7

TABLE OF ULTIMATE LOADS.

334

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DATE 12-9-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 9 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

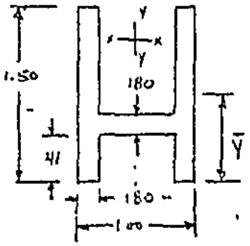
REF

RESCUE COUCH

A-9 ADAPTER FRAME

SECTION PROPERTIES

SECTION A1-A1



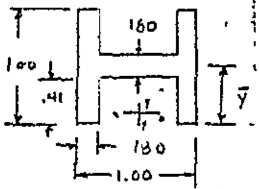
A = .6552

I_{xx} = .1075

$\bar{y}$ = .7060

I_{yy} = .0962

SECTION A2-A2



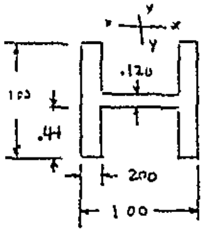
A = .4752

I_{xx} = .0303

$\bar{y}$ = .500

I_{yy} = .0654

SECTION B-B



A = .4720

I_{xx} = .0334

$\bar{y}$ = .500

I_{yy} = .0675

185

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

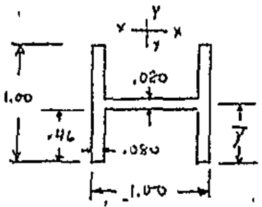
PAGE NO. 10 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

SECTION C-C



A = .2272

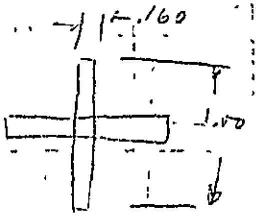
I_{xx} = .0134

$\bar{y}$ = .500 ✓

I_{yy} = .0379

SECTION D-D & ~~E-E~~ PROPERTIES ARE THE SAME AS FOR SECTION C-C

SECTION E-E



A = .2744

I = .01362

$\bar{y}$ = .50

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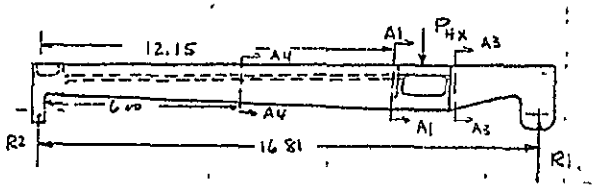
RESCUE MISSION
COMMAND MODULE

PAGE NO 11 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME



BENDING AT A1-A1

$R2)_{MAX}$ = 873.9 #

M_b = 12.15 R2 = 10,618 IN-LBS

$f_{b_t} = \frac{Mc}{I} = \frac{10,618 \times (1.50-.706)}{.1075}$

f_{b_t} = 78,425 psi

$F_b = F_{tu} + .5\,F_{ty}$ = 64,000 + .5 (52,000)

F_b = 90,000 psi

M.S. = $\frac{90,000}{78,425} - 1 = \underline{+0.15}$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 12 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

BENDING AT SECTION A1-A1

MAX. COMP.

Pg. 8 R2 = 694 LBS

M_b = .1215R2 = 8430 IN-LBS

$f_b = \frac{Mc}{I} = \frac{8439 \times (1.50-.706)}{.1075}$

f_b = 62,400 psi

M.S. = $\frac{90,000}{62400} - 1 = \underline{+0.44}$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 13 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO VS6-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

BENDING AT SECTION A3-A3

$R1)_{MAX} = 2961.8^{\#}$

$M_b = 2.95\,R1 = 8737.3$ IN-LBS

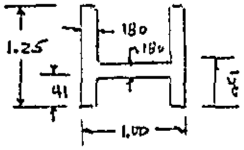
$b = .80 \quad h = 1.5$

$$f_b = \frac{6M}{bh^2} = \frac{6 \times 8737.3}{(.80)(1.5)^2} = 29,124 \text{ psi}$$

$$M.S. = \frac{90,000}{29,124} - 1 = \underline{+2.09}$$

BENDING AT SECTION A4-A4

$M_b = 6.0\,R2 = 5243.4$ IN-LBS



$\bar{y} = .5995$

$I = .06034$

$$f_b = \frac{Mc}{I} = \frac{5243.4 \times (1.25 - .5995)}{.06034}$$

$f_b = 56,527$ psi

$$M.S. = \frac{90,000}{56,527} - 1 = \underline{+0.59}$$

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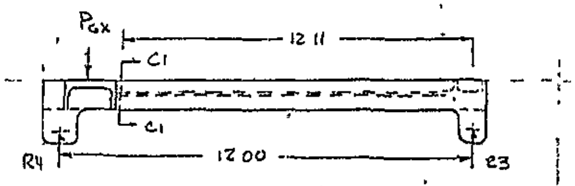
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 14 OF 35
REPORT NO SD 70-20
MODEL NO SKYLAB
DRAG NO VS6-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME



BENDING AT SECTION C1-C1

$R3)_{MAX} = 331.1^{\#}$

$M_b = 12.11\,R3 = 4009.6$ IN-LB

$$f_b = \frac{Mc}{I} = \frac{4009.6 \times 0.500}{.0134}$$

$f_b = 149,612$ psi

INCREASE THICKNESS $t = .150 \rightarrow I = .0252$

$$f_b = \frac{4009.6 \times .5}{.0252} = 79,600 \text{ psi}$$

$$M.S. = \frac{90,000}{79,600} - 1 = \underline{+0.13}$$

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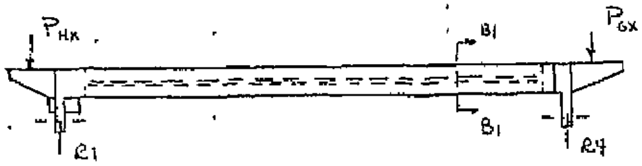
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 15 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO. V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME



BENDING AT B1-B1

CASE 1 : $M_b = 1.06\ P_{GX} = 4118.1$ IN LBS

$$f_b = \frac{Mc}{I} = \frac{4118.1 \times .5}{.0334}$$

$f_b = 61,650$ PSI

CASE 3 : $M_b = (.74 + .50)\ P_{HY} = 2586.64$ IN-LBS

$$f_b = \frac{MC}{I} = \frac{2586.64 \times .5}{.0334}$$

$f_b = 38,722$ psi

$$M.S. = \frac{90,000}{61,650} - 1 = \underline{+\ 0.46}$$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

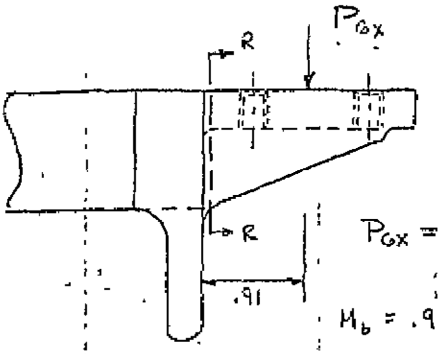
PAGE NO. 16 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO. V56-531126

REF

RESCUE COUCH

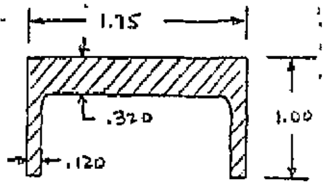
A-9 ADAPTER FRAME

BENDING OF LUG AT PT. G



$P_{GX} = 3885$#

$M_b = .91\ P_{GX} = 3535$ IN-LBS



SECTION R-R

$\bar{y}_1 = .2728$

$\bar{y}_2 = .7272$

$I = .04266$

$$f_b = \frac{Mc}{I} = \frac{3535 \times .7272}{.04266} = 60260\ \text{psi}$$

$F_{tu} = 64,000$ psi

$$M.S._o = \frac{64,000}{60,260} - 1 = \underline{+\ 0.06}$$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

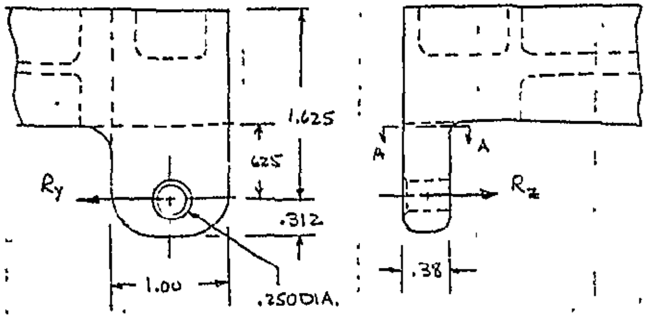
PAGE NO. 17 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

LUG AT R2



$R_y = 2086^{\#}$ $R_z = 1561.5^{\#}$

BENDING AT SECTION A-A

$$f_{b_1} = \frac{6M}{bh^2} = \frac{6\times(.625\times1561.5)}{1.00\times(.38)^2}$$

$f_{b_1} = 40,550$ psi

$$f_{b_2} = \frac{6M}{bh^2} = \frac{6\times(.625\times2086)}{(.38)\times(1.00)^2}$$

$f_{b_2} = 20,586$ psi

$f_{b_T} = f_{b_1} + f_{b_2} = 61,137$ psi

$F_b = 61,000 + 5(52,000) = 87,000$ (ST)

$$M.S. = \frac{57,000}{61,137} - 1 = +0.42$$

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CHECKED BY GLD
DATE 12-14-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 18 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

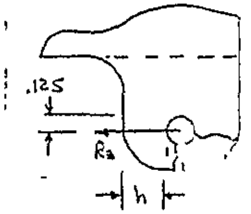
REF

RESCUE COUCH

A-9 ADAPTER FRAME

LUG AT R2

CHECK LUG AS A CANTILEVERED BEAM



$h = \frac{1.00-.25}{2} = .375$

$R_z = 2086$

$$f_b = \frac{6M}{bh^2} = \frac{6\times(.125\times2086)}{(.38)(.375)^2}$$

$f_b = 29,280$ psi

$F_b = 87,000$ psi

$$M.S. = \frac{87,000}{29,280} - 1 = +1.97$$

BEARING

$$f_{br} = \frac{2086}{(.25)(.38)} = 21,958 \text{ psi}$$

$F_{br_u} = 119,000$ psi

$$M.S. = \frac{119,000}{21,958} - 1 = +4.42$$

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DATE 12-14-71

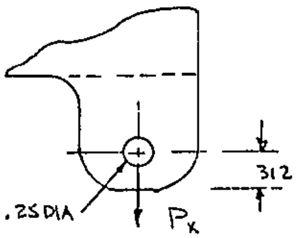
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 19 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-S31126

REF

RESCUE COUCH
A-9 ADAPTER FRAME
LUG AT R2

Pg 12



$P_x = 694$ #

SHEAR TEAR OUT

$P_{tu} = 2(.312-.125)(.38)(39,000)$

$P_{tu} = 5542$#

$M.S = \frac{5542}{694} - 1 = $ + HIGH

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DATE 12-14-71

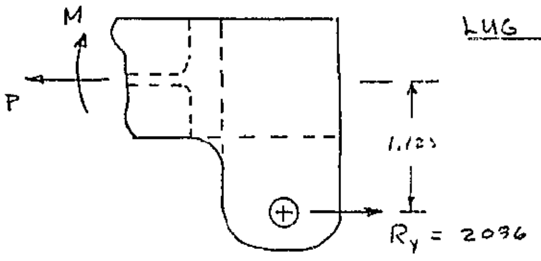
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 20 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-S31126

REF

RESCUE COUCH
A-9 ADAPTER FRAME

LUG R2



$P = 2086$

$M = 1.125 \times 2086 = 2345$, IN LBS

$f_t = P/A = \frac{2086}{.2272} = 9190$ psi

$f_b = \frac{Mc}{I} = \frac{2345 \times .5}{.0134} = 87,500$ psi

$F_b = 96,000$ psi

$F_{tu} = 64,000$ psi

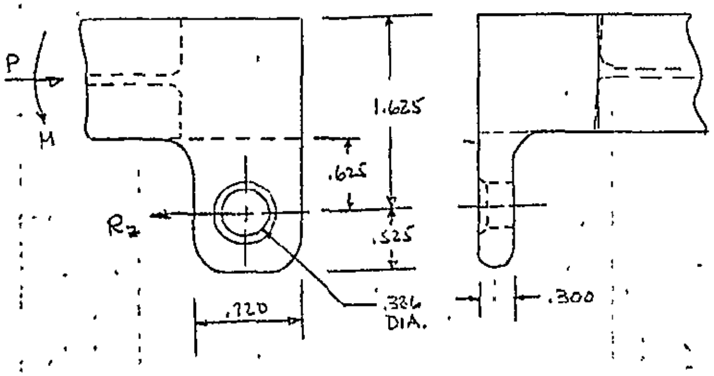
$MS = \frac{1}{\sqrt{\left(\frac{87500}{96,000}\right)^2 + \left(\frac{9190}{64,000}\right)^2}} - 1 = +0.02$

PREPARED BY DF	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO. 21 OF 35
CHECKED BY GLD	RESCUE MISSION	REPORT NO SD 70-205
DATE 12-14-71	COMMAND MODULE	MODEL NO SKYLAB
REF		DRAG NO Y56-531126

RESCUE COUCH

A-9 ADAPTER FRAME

LUG AT R3



$R_z = 1561.5$ #

TRANSVERSE LOADING LUG ANALYSIS

DS8 10.11.09

$A_1 = (.46 - \frac{.386}{2} \sin 45°)(.300) = .0971$

$A_2 = (.46 - .193)(.300) = .0801$

$A_3 = A_2 = .0801$

$A_4 = A_1 = .0971$

$$A_{AV} = \frac{6}{(3/A_1) + 1/A_2 + 1/A_3 + 1/A_4}$$

$A_{AV} = .0907$

PREPARED BY DF	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO. 22 OF 35
CHECKED BY GLD	RESCUE MISSION	REPORT NO SD 70-205
DATE 12-14-71	COMMAND MODULE	MODEL NO SKYLAB
REF		DRWG NO Y56-531126

RESCUE COUCH

A-9 ADAPTER FRAME

$A_{br} = Dt = (.386)(.300) = .1158$

$\frac{A_{AV}}{A_{br}} = \frac{.0907}{.1158} = .783$

DS8 10.11.10

$K_{tru} = .32$ (CURVE 10)

$P_{tru} = (K_{tru} F_{tux} A_{br}) = (.32)(61,000)(.1158)$

$P_{tru} = 2260.4$

$M.S. = \frac{2260.4}{1561.5} - 1 = +0.44$

TENSION LOAD ON LUG R3

$P_t = 263$ #

SHEAR TEAR OUT

$P_{t.o.} = 2(.525 - \frac{.386}{2})(39,000)(.300)$

$P_{t.o} = 7,768$ #

$M.S. = \frac{7768}{263} - 1 = +$ HIGH

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CHECKED BY GLD
DATE 12-14-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 23 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

BENDING DUE TO R_z AT LUG R3

$P = R_z = 1561.5$

$M = 1.125 R_z = 1756.7$ IN-LB

$f_t = \frac{P}{A} = \frac{1561.5}{.2272} = 6873$ psi

$f_b = \frac{Mc}{I} = \frac{1756.7 \times 0.5}{.0134} = 65{,}548$

$F_b = 90{,}000$ psi

$F_{tu} = 64{,}000$ psi

$$M.S. = \frac{1}{\sqrt{\left(\frac{65{,}548}{90{,}000}\right)^2 + \left(\frac{6873}{64{,}000}\right)^2}} - 1 = +0.35$$

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DATE 12-15-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

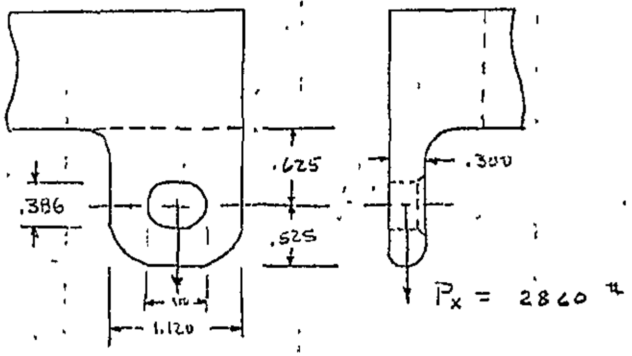
PAGE NO. 24 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

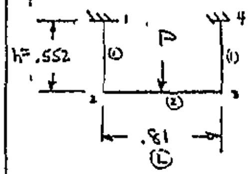
REF

RESCUE COUCH

A-9 ADAPTER FRAME

LUG AT R4





$I_1 = \frac{bh^3}{12} = \frac{(.3)(.31)^3}{12} = 7.448 \times 10^{-4}$

$I_2 = \frac{(.3)(.332)^3}{12} = 9.149 \times 10^{-4}$

$M_1, M_4 = \frac{PL}{8D}$ $\qquad D = 2 + \frac{I_2}{I_1}\left(\frac{h}{L}\right)$

$D = 2.8371$

$M_1 = 102.2$ IN-LBS

$M_2 = -2M_1 = 204.4$ IN-LBS

$M_P = {}^{0}\frac{PL}{4} - M_2 = 375.6$ IN-LBS

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DATE 12-15-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 25 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

STRESS IN MEMBER ①

$$f_b = \frac{6M_L}{bt^2} = \frac{6 \times 204\,4}{(.3)(\,31)^2} = 42{,}500 \text{ psi}$$

$$f_t = \frac{P}{A} = \frac{2860/2}{(.3)(.31)} = 15{,}400 \text{ psi}$$

$$M.S. = \frac{1}{\sqrt{\left(\frac{42{,}500}{87{,}000}\right)^2 + \left(\frac{15{,}400}{61{,}000}\right)^2}} - 1 = \underline{+0.82}$$

STRESS IN MEMBER ②

$$f_b = \frac{6M_P}{bt^2} = \frac{6 \times 375.6}{(.3)(.332)^2} = 68{,}100 \text{ psi}$$

$$M.S. = \frac{87{,}000}{68{,}100} - 1 = \underline{+0.28}$$

LUG AT R1

Pg. 8 LOAD. P_x = 2355 # (TEN)

LUG SAME AS AT R4 AND APPLIED LOAD IS LESS.

193

362

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DATE 12-14-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

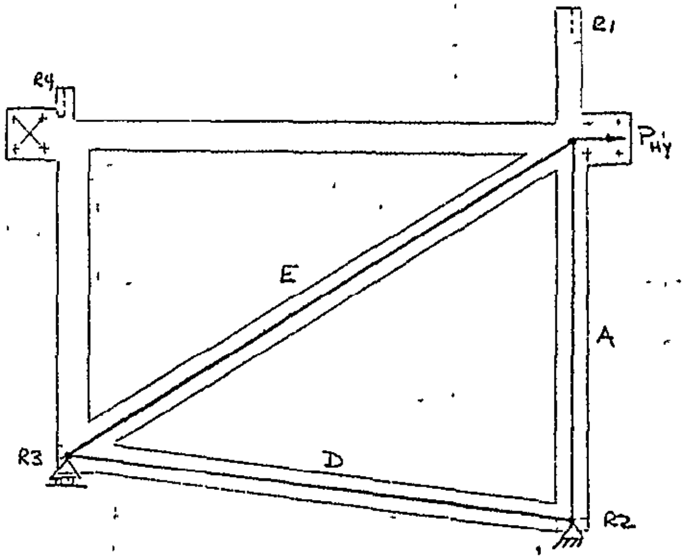
PAGE NO. 26 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF.

RESCUE COUCH

A-9 ADAPTER FRAME

LATERAL LOAD ON FRAME



LATERAL LOAD P_{HY} IS REACTED AT POINTS R2 & R3 ONLY. THE FRAME IS ASSUMED TO BE A PIN JOINTED TRUSS.

Pg 8 P_{HY} = 2086 #

363

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CHECKED BY GLD
DATE 12-15-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

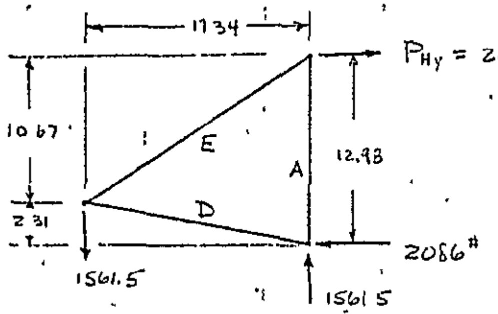
PAGE NO 27 OF 35
REPORT NO SD 70-205
MODEL NO. SKYLAB
DRWG NO V56-531126

REF

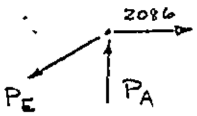
Pg. 8

RESCUE COUCH

A-9 ADAPTER FRAME



SOLVE FOR MEMBER FORCES

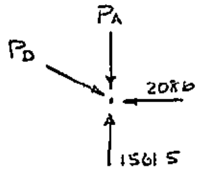


$$\frac{17.34}{\sqrt{17.34^2+10.67^2}} P_E = 2086$$

$$P_E = 2449.3^{\#} \quad \text{(TENSION)}$$

$$\frac{10.67}{\sqrt{10.67^2+17.34^2}} P_E = P_A$$

$$P_A = 1283.6^{\#} \quad \text{(COMP.)}$$



$$\frac{17.34}{\sqrt{2.31^2+17.34^2}} P_D = 2086$$

$$P_D = 2104.4^{\#} \quad \text{(COMP.)}$$

PREPARED BY DF
CHECKED BY GLD
DATE 12-15-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 28 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531126

REF

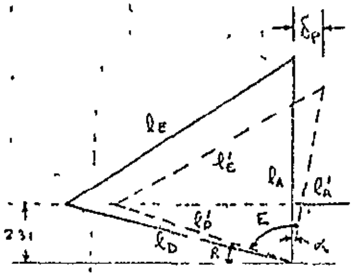
RESCUE COUCH

A-9 ADAPTER FRAME

MEMBER DEFLECTION

$$\delta_n = \frac{P_n L_n}{A_n E} \qquad E = 10^7 \text{ psi}$$

MEMBER	LOAD	AREA	L	δ
A	1283.6 (C)	.5652	12.98	-2.95×10^{-3}
D	2104.4 (C)	.2272	17.4932	-16.20×10^{-2}
E	2449.3 (T)	.2744	20.3599	$+16.94 \times 10^{-3}$



$$\alpha = R + E - 90°$$

$$\cos E = \frac{l_A'^2 + l_D'^2 - l_E'^2}{2 l_A' l_D'}$$

$$\sin R = \frac{2.31}{l_D'}$$

$$l_A' = 12.98 - 2.95 \times 10^{-3} = 12.97705$$

$$l_D' = 17.4932 - 16.20 \times 10^{-3} = 17.4770$$

$$l_E' = 20.3599 + 16.94 \times 10^{-3} = 20.37684$$

PREPARED BY DF	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 29 OF 35
CHECKED BY GLD	RESCUE MISSION	REPORT NO SD 70-205
DATE 12-15-71	COMMAND MODULE	MODEL NO SKYLAB
REF		DRWG NO V56-531126

RESCUE COUCH

A-9 ADAPTER FRAME

$\cos E = .129263$

$E = 82\ 572984°$

$\sin R = .132174$

$R = 7.595221°$

$\alpha = .168205°$

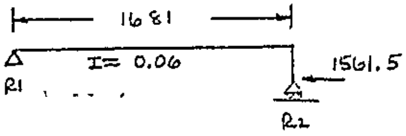
$l_A' = 12.97705$

$\delta_P = l_A' \sin\alpha = .0381''$

AT POINT R1

$\delta_{R_1} = 16.81 \sin\alpha = .0493''$

CALC. TRANSLATION OF POINT R1 DUE TO BENDING AT LUGS R2 & R3



$M = 1.125 \times 1561.5 = 1756.7$ IN-LBS

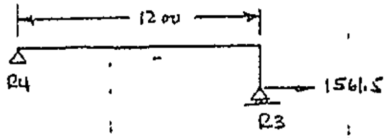
$\theta = \frac{1}{3}\frac{ML}{EI} = \frac{1}{3}\frac{1756.7 \times 16.81}{10^7 \times (.06)} = .0164$ rad.

$\delta_{R2})_z = 1.125\theta = .0184$ IN.

PREPARED BY DF	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 30 OF 35
CHECKED BY GLD	RESCUE MISSION	REPORT NO SD 70-205
DATE 12-15-71	COMMAND MODULE	MODEL NO SKYLAB
REF		DRWG NO V56-531126

RESCUE COUCH

A-9 ADAPTER FRAME



$I_{AVG} = \frac{.0252 + .0134}{2}$

$I_{AVG} = .0193$

$M = 1.125 \times 1561.5 = 1756.7$ IN-LB

$\theta = \frac{1}{3}\frac{ML}{EI} = \frac{1}{3}\frac{1756.7 \times 12.00}{10^7 (.0193)} = .0364$

$\delta_{R3})_z = 1.125\theta = .0410''$

FRAME ROTATION

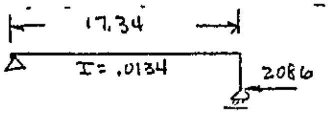
$\theta_F = \frac{\delta_{R2})_z + \delta_{R3})_z}{17.34} = \frac{.0184 + .0410}{17.34}$

$\theta_F = .003426$ RAD

TRANSLATION OF POINT R2

$\delta_{R2} = 16.81\,\theta_F = .0576$

WHOLE FRAME TRANSLATES DUE TO DEFLECTION AT LUG R2 IN Y-DIRECTION



$M = 2026 \times 1.125 = 2346.7$

$\delta = 1.125\theta = 1.125\ \frac{1}{3}\ \frac{2346.7 \times 17.34}{10^7 (.0134)}$

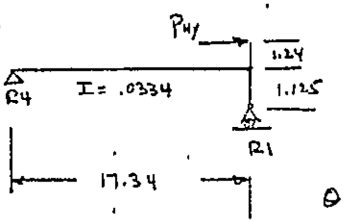
$\delta_{R2})_y = .1139$

REF

RESCUE COUCH

A-7 ADAPTER FRAME

SUPPORT PT R1 ROTATES DUE TO THE APPLICATION OF P_{HY} ABOVE FRAME CL



$M_b = 1.24\, P_{HY}$

$M = 2586.6$ IN-LBS

$\theta = \frac{1}{3}\frac{ML}{EI} = \frac{1}{3}\frac{2586.6 \times 17.34}{10^7 (.0334)}$

$\theta = .0448$

$\delta_{R1} = 1.125\,\theta = .0504$

TOTAL DEFLECTION AT R1

$\delta_{R1})_T = .0493 + .0576 + .1139 - .0504$

$\delta_{R1})_T = .1704''$ (ULT)

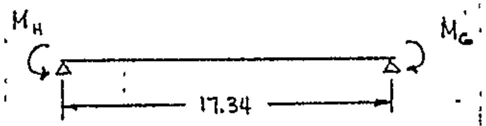
$= .1136''$ (LIMIT)

REF

RESCUE COUCH

A-9 ADAPTER FRAME

ROTATION OF BEAM B



$E = 10^7$

$I = .0334$

$L = 17.34$

Pg. 8

$M_H = .84 \times 3885 = 3263.4$

$M_G = 1.06 \times 3885 = 4118.1$

$\Theta_H = \frac{L}{EI}\left(\frac{M_H}{3} + \frac{M_G}{6}\right) =$

$\Theta_H = .0921$ rad.

$\Theta_G = \frac{L}{EI}\left(\frac{M_G}{3} + \frac{M_H}{6}\right) =$

$\Theta_G = .0995$ rad

$\Delta H = 1.125 \times .0921 = .104$

$\Delta G = 1.125 \times .0995 = .112$

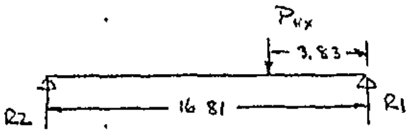
ΔTOTAL = .216" (LIMIT) (TOE IN) (TOTAL BETWEEN R1 + R4)

ΔTOTAL = $.216\,\frac{3112}{3885}$ = .173" (LIMIT) (TOE OUT)

RESCUE COUCH

A-9 ADAPTER FRAME

DEFLECTION OF BEAM A



$I \approx .10$

$\ell = 16.81 \quad a = 3.83 \quad b = 12.98$

$$y_P = \frac{Wba}{6EI\ell}\left[2\ell b - b^2 - b^2\right]$$

$$y_P = \frac{Wa^2b^2}{3EI\ell}$$

$$y_P)_{MAX} = \frac{(3885)(3.33)^2(12.98)^2}{3(10^7)(.10)(16.81)}$$

$y_P)_{MAX}$ = .1904 " (ULT LOAD)

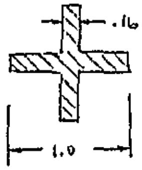
= .1269 " (LIMIT LOAD)

RESCUE COUCH

A-9 ADAPTER FRAME

BUCKLING OF FRAME MEMBERS

MEMBER 'E'



A = .2944

I = .01362

L = 20.36

$$P_{cr} = \frac{\pi^2 EI}{L^2} = \frac{\pi^2(10^7)(.01362)}{(20.36)^2}$$

P_{cr} = 32428 #

Fg. 27 P_E = 2449.3 #

$$M.S. = \frac{32428}{2449.3} - 1 = \underline{+0.32}$$

MEMBER 'D'

A = .2272 I = .0134 L = 17.493

$$P_{cr} = \frac{\pi^2(10^7)(.0134)}{(17.493)^2}$$

P_{cr} = 4321.9 #

Fg. 27 P_D = 2104.4 #

$$M.S. = \frac{4321.9}{2104.4} - 1 = \underline{+1.05}$$

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DATE: 12-16-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 35 OF 35
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO V56-531126

REF

RESCUE COUCH

A-9 ADAPTER FRAME

TORSIONAL BUCKLING - MEMBER E

E2
P225
-P228

$$\sigma_{cr} = \left(.456 + \frac{b^2}{l^2}\right)\frac{\pi^2}{6(1-\nu)}\,\frac{G\,t^2}{b^2}$$

$b = .5$ $\nu = .3$

$t = .160$ $G = 4\times10^6$

$l = 20\ 36$

$$\sigma_{cr} = \left(.456 + \left(\frac{.5}{2036}\right)^2\right)\frac{\pi^2}{6(1-.3)}\,\frac{4\times10^6\,(.16)^2}{(.5)^2}$$

$$\sigma_{cr} = 439{,}490 \text{ psi}$$

∴ TORSIONAL BUCKLING NOT CRITICAL

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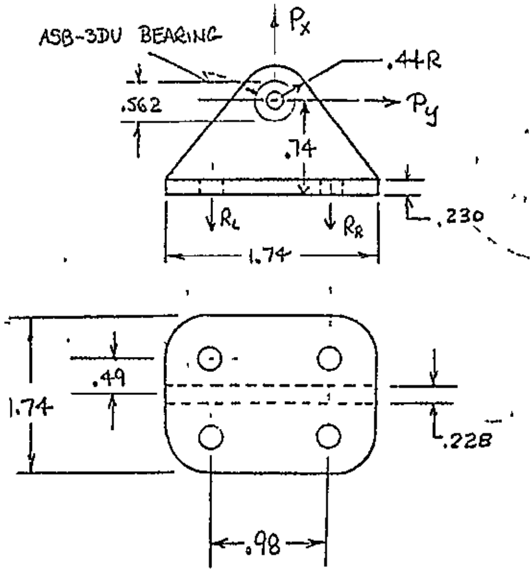
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531127

REF

N/A
V56
531105
531106

FITTING - BULKHEAD ADAPTER (A9, A7), RESCUE COUCH, ASSY OF



C22
3.2.3.0
(g)

MATERIAL: ALUMINUM BAR QQ-A-225/6 2024-T4

$F_{tu} = 57{,}000$

$F_{ty} = 38{,}000$

$F_{su} = 37{,}000$

$F_{bru} = 118{,}000$

$E = 10.5\times10^6$

$\mu = .33$

II 2.1.45

LOADS:

$P_x = -3885$ lb. MAX. COMP. (ULT)

$= 3068$ lb (ULT) MAX. TENSION

$P_y = \pm 2166$ lb. (ULT)

$R_T = 3068 + 2166 = 3758$ lb. (MAX.)

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DATE: DEC. 2, 71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531127

REF

BULKHEAD FITTING

CHECK of LUG,

$$\left.\begin{aligned} e &= .44 \\ D &= .562 \\ W &= .88 \\ t &= .228 \\ W-D &= .318 \end{aligned}\right\} \quad \begin{aligned} e/D &= .78 \\ W/D &= 1.57 \\ D/t &= 2.4 \\ A_{Br} &= Dt = .128 \\ A_t &= (.318)t = .0725 \end{aligned}$$

D88
1Q11.05

199

SHEAR BEARING,

$$P_{ALLOW} = K_{br}F_{bru}A_{br} = .28(118{,}000).123 = 4240 \text{ lb.}$$

TENSION CASE,

$$P_{ALLOW} = K_tF_{tu}A_t = .96(57{,}000).0725 = 3970 \text{ lb.}$$

USING $R_T = 3758$ (SUPERIMPOSE $P_{X_{MAX}}, P_{Y_{MAX}}$, VERY CONSERV.)

$$M.S. = \frac{3970}{3758} - 1 = +.06$$

CALCULATION of REACTIONS,

$$P_X = R_L + R_R$$

$$\Sigma M = 0$$

$$0 = P_X(.49) - P_y(.74) - R_R(.98)$$

$$R_R = \frac{.49P_X - .74P_y}{.98} = .5P_X - .755P_y$$

$$R_L = P_X - R_R = P_X - .5P_X + .755P_y = .5P_X + .755P_y$$

PREPARED BY: GLD
CHECKED BY: RGR
DATE: DEC 3, 1971

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531127

REF

BULKHEAD FITTING

THUS FOR MAXIMUM LOAD AT FASTENERS,

$$R_L = .755P_y = .755(2166) = 1634^{\#}$$

LOAD PER FASTENER

$$R_L/2 = 817 \text{ lb.}$$

BENDING IN BASE,

$$\sigma_b = \frac{6M}{bh^2} = \frac{6(817).3725}{.5(.23)^2} = 69{,}100 \text{ psi}$$

$$F_b = 57{,}000 + 19{,}000 = 76{,}000 \text{ psi}$$

$$M.S. = \frac{76}{69.1} - 1 = .10$$

PREPARED BY: HO
CHECKED BY: GLD
DATE: 10-28-71

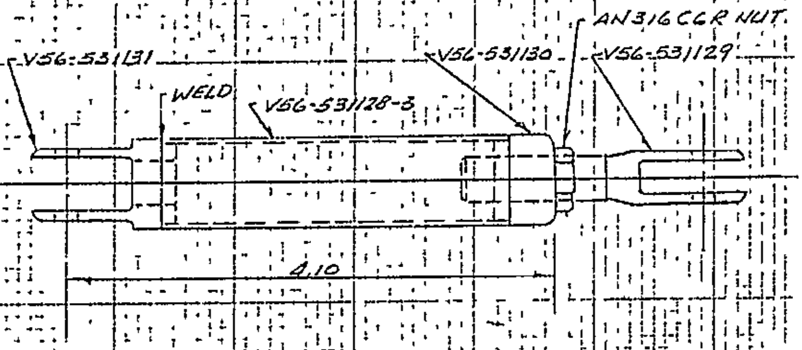
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531128
V56-531129

REF.

N/R V56 531100

SUPPORT TRUSS - RESCUE COUCH, ASSY OF



MATERIAL: ST. STL. TUBE MIL-T-8808 321
3/4 DIA x .035 WL

311 C6.05 -01.01

$F_{TU} = 75$ KSI
$F_{TY} = 30.$ KSI
$F_{CY} = 35$ KSI
$F_{SU} = 53$ KSI

AREA of TUBE $= \frac{\pi}{4}(D_o^2 - D_i^2) = \frac{\pi}{4}(.75^2 - .68^2) = .0785$ IN^2

$P_{TU} = F_{tu} A = 75000 \times .0785 = 5890$ #

WELD ALLOW. = 90% OF PARENT MAT'L.

$P_{TU} = .90 \times 5890 = 5300$ #

V56-531125 P. 2

MS $\frac{5300}{3068} - 1 = .73$

PREPARED BY: HO
CHECKED BY: GLD
DATE: 10-28-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

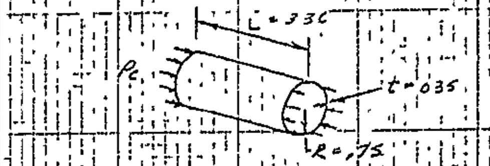
PAGE NO 2 OF -
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531128
V56-531129

REF

SUPPORT TRUSS RESCUE COUCH, ASSY OF.

D-2, p9.2201

CHECK FOR BUCKLING OF CYLINDER



BUCKLING STRESS

$\frac{\sigma_{cr}}{\eta} = C_c E \frac{t}{R}$ C_c from p.9.22.0 $c = .23$

$\frac{R}{t} = \frac{.75}{.035} = 21.4$

$Z = \frac{L^2}{Rt}\sqrt{1-\mu^2} = \frac{3.30^2}{.75 \times .035}\sqrt{1-.3^2} = \overset{410.3}{428}$

$\frac{\sigma_{cr}}{\eta} = .23 \times 29 \times 10^6 \times \frac{.035}{.75} = 311000$ psi

ELASTIC BUCKLING $\eta = 1$

$\sigma_{cr} = 311000$ psi

$P_{cr} = \sigma_{cr} A = 311000 \times .0785 = 24400$ #

CHECK W/ ROARK $S' = (.3)29 \times 10^6 \frac{.035}{.75} = 406 \times 10^5$

PREPARED BY: HD

CHECKED BY: GLD

DATE: 10-28-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF

REPORT NO SD 70-205

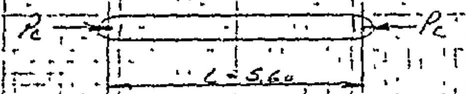
MODEL NO SKYLAB

DWG NO V56-531128
V56-531129

REF.

SUPPORT TRUSS - RESCUE COUCH, ASSY OF

CHECK FOR COLUMN BUCKLING



I of tube section $= \pi r t \left[r^2 + \frac{t^2}{4}\right] = \pi \times .36 \times .035 \left[.36^2 + \frac{.035^2}{4}\right]$

$I_t = .005 \text{ in}^4$

$P_{cr} = \frac{\pi^2 EI}{L^2} = \frac{\pi^2 \times 29 \times 10^6 \times .005}{5.60^2} = 45700 \#$

$P_{cr} = F_{cy} A$
$= (35000)(.0785)$
$P_{cr} = 2750$ LBS.

II 2.1.45 $P = -3885$ LBS. (COMP.)

$M.S. = \frac{2750}{3885} = -.29$

PREPARED BY: HD

CHECKED BY: GLD

DATE: 10-21-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 5

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-531129

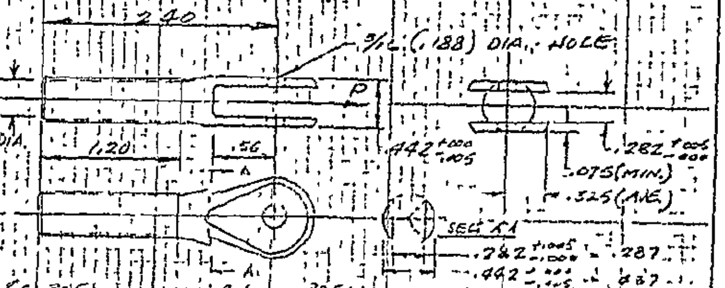
REF

CLEVIS SUPPORT TRUSS

MATERIAL,
ST. STL. BAR AMS 5737 A286

D11 07.01 .01.01 $F_{tu} = 140$ KSI $F_{ty} = 95$ $F_{cy} = 95$ $F_{su} = 91$

$F_{bru} = 266$ $(e/D = 2.0)$ $F_{bry} = 171$ $(e/D = 2.0)$



$e = .325$
$D = .188$
$t = .075$

$e/D = \frac{.325}{.188} = 1.73$

$W/D = \frac{.65}{.188} = 3.46$

$D/t = \frac{.188}{.075} = 2.51$

$A_{br} = Dt = .188 \times .075 = .0141$

$A_t = (W-D)t = (.65 - .188).075 = .0346$

AREA AT SECT. A-A

$A_2 = .1435 \times .165 = .0237$

$A = A_1 - A_2 = .0408 - .0237 = .0171$

$A_1 = \left(\frac{98}{360}\right)\left(\frac{\pi D^2}{4}\right) = \left(\frac{98}{360}\right)\left(\frac{\pi \, .437^2}{4}\right) = .0408$

PREPARED BY: LG
CHECKED BY: GLD
DATE: 10 22-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531129

CLEVIS - SUPPORT TRUSS

AXIAL LOAD (LUG)

ALLOWABLE SHEAR-BEARING ULTIMATE LOAD (P_{bru})

$P_{bru} = K_{br} F_{bru} A_{br}$ K_{br} from p 10.11.16 = .87

$P_{bru} = .87 \times 266 \times .0141 = 3260$ #/LUG

~~$P_{bru} = 2 \times 3260 = 6520$ #~~

ALLOWABLE TENSILE ULTIMATE LOAD (P_{tu})

$P_{tu} = K_t F_{tu} A_t$ K_t from p 10.11.18 = .91

$P_{tu} = .91 \times 140 \times .0346 = 4408$ #/LUG

$P_{tu} = 4408 \times 2 = 8816$ #

AXIAL LOAD AT SECTION A-A

$P_{tu} = 2 \times F_{tu} \times A = 2 \times 140 \times .0171 = 4788$ #

I.2.1.47 $M.S = \frac{4788}{3065} - 1 = \underline{.56}$

330

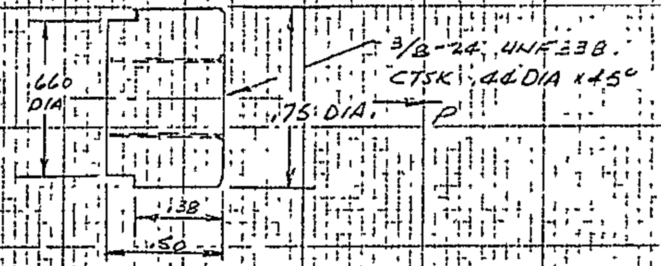
PREPARED BY: LG
CHECKED BY: GLD
DATE: 10-22-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531130

N/A
V56
531128
531132

PLUG - SUPPORT TRUSS



MATERIAL: ST. STL. BAR, QQ-S-763 CLASS 321

$F_{tu} = 75$ KSI
$F_{ty} = 30$
$F_{cy} = 35$
$F_{su} = 53$

CHECK THREAD IN SHEAR

LENGTH OF ENGAGEMENT $L_e = .32$

ASSUME EFFECTIVE $L_e' = .70 \times .32 = .224$

THREAD SHEAR AREA = $\pi \times D \times L_e = \pi \times .375 \times .224 = .264$

$P_s = F_{su} \times A_s = 53000 \times .264 = 14,000$ #

II 2.1.45 $M.S. = \frac{14000}{3885} - 1 = \underline{\underline{2.60}}$

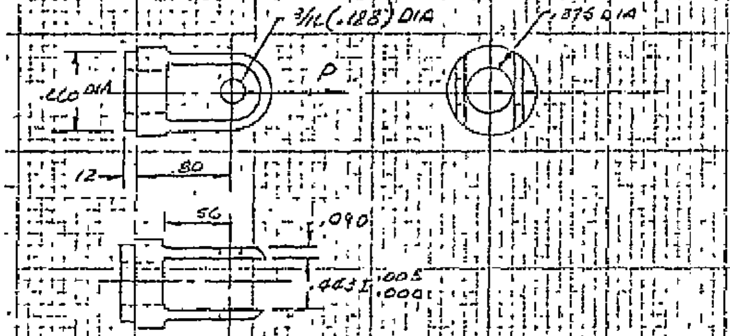
371

PREPARED BY: LJL	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 1 OF 7
CHECKED BY: GLD	RESCUE MISSION	REPORT NO SD 70-205
DATE: 10-22-71	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-531131

REF.

INFO
V56
531131

CLEVIS - SUPPORT TRUSS



MATERIAL: ST. STL. BAR QQ-S-763 CLASS 321

D11
06.04
03.03

F_{tu} = 75 KSI

F_{ty} = 30

F_{cy} = 35

F_{su} = 53

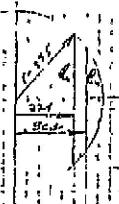
F_{bru} (e/D 2.0) = 150

F_{bry} (e/D 2.0) = 50

PREPARED BY: LJL	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 2 OF 7
CHECKED BY: GLD	RESCUE MISSION	REPORT NO SD 70-205
DATE: 10-22-71	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-531131

REF

CLEVIS: SUPPORT TRUSS



$\ell_1 = \sqrt{.375^2 - .224^2}$ = .30

$\ell_2 = \sqrt{.375^2 - .344^2}$ = .22

$\ell_{AVG} = \frac{\ell_1 + \ell_2}{2}$ = .26

D = .188 IN   W = .52

t = .090 IN.

$e/D = \frac{.26}{.188} = 1.38$ W/D = 2.76

$D/t = \frac{.188}{.090}$ = 2.085

A_{br} = Dt = .188 × .09 = .0169 IN^2

$A_t = (W - D)t = (.52 - .188).090$ = .0335 IN^2

CHECK FOR LUG AXIAL LOAD

ALLOWABLE SHEAR-BEARING ULTIMATE LOAD (P_{bru})

$P_{bru} = K_{br} F_{bru} A_{br}$ K_{br} from p. 10.11.R. = .67

P_{bru} = .70 × 150 × .0169 = 1780 #/LUG

P_{bru} = 2 × 1780 = 3560 #

M.S. = $\frac{3560}{3068}$ − 1 = .16

PREPARED BY: J.O.
CHECKED BY: GD
DATE: 10-22-71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531131

REF.

CLEVIS- SUPPORT TRUSS

ALLOWABLE TENSILE ULTIMATE LOAD (P_{TU})

$P_{TU} = K_f F_{TU} A_T$ K_f from p 10.11.18 = .93

P_{TU} = .93 × 75 × .0335 = 2340 #/LUG

P_{TU} = 2 × 2340 = 4680 #

$M.S. = \frac{4680}{3063} - 1 = .53$

PREPARED BY: GLD
CHECKED BY: RGR
DATE: DEC 1, 1971

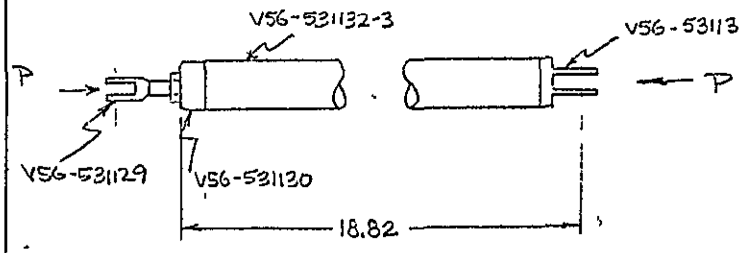
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF -
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531132

REF

TRUSS ASSEMBLY- SUPPORT, RESCUE COUCH

N/D V56 531106



II.2 1.47 P_{ULT} = 2166 lb.

MATERIAL: (V56-531132-3) STAINLESS TUBE MIL-T-8808 321
t = .035

F_{tu} = 75,000 psi
F_{ty} = 30,000
F_{su} = 53,000
E = 29×10^6 psi
μ = .28

$P_{cr} = F_{cy} A$
= 35000 (.0785).
P_{cr} = 2750 LBS.

CHECK FOR TUBE BUCKLING, REF. V56-531134

P_{ALLOW} = 31,900 lb.

CHECK FOR COLUMN BUCKLING,

$$P_{CR} = \frac{\pi^2 E I}{L^2} = \frac{\pi^2 (29 \times 10^6) .005}{20.32^2} = 3465 \text{ lb,}$$

USE P_{cr} = 2750 LBS

$MS = \frac{2750}{2166} - 1 = .27$

PREPARED BY:
CHECKED BY: RGR
DATE: 20 NOV 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531132

REF

TRUSS ASSEMBLY

NATURAL FREQUENCY

MATL. 321 CRES TUBE MIL-T-8808
3/4 DIA x .035 WL.

$E = 29 \times 10^6$
$w = .286$ #/IN.^{3}

$AREA = \frac{\pi}{4}(.75^2 - .68^2) = .0786$ IN^2

$w = .0225$ #/IN

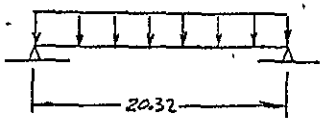
BEAM LENGTH = 20.32

$W = .457$ #

$I = \frac{\pi}{64}(.75^4 - .68^4) = 5.036 \times 10^{-3}$

$\Delta_{ST.} = \frac{5}{384}\frac{WL^3}{EI}$

$\Delta_{ST} = 3.419 \times 10^{-4}$



$$f_n = \frac{1}{2\pi}\sqrt{\frac{g}{\Delta_{ST}}}$$

$= 169$ Hz

PREPARED BY: GLD
CHECKED BY: RGR
DATE: DEC. 1, 1971

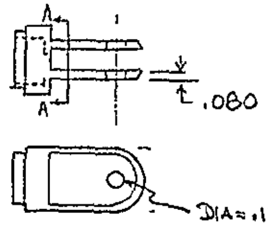
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531133

REF

N/A
V56
531134

CLEVIS - SUPPORT TRUSS, RESCUE COUCH

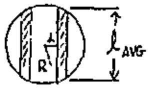


MATERIAL: QQ-S-763 CLASS 321 STAINLESS STL. BAR

$F_{tu} = 75{,}000$
$F_{ty} = 30{,}000$
$F_{su} = 53{,}000$
$F_{bru} = 150{,}000$
$E = 29 \times 10^6$

D11
06.05
.01.01

SECTION AA



$R = .375$
$d_1 = .141$
$d_2 = .221$

$l_{AVG} = \sqrt{.375^2 - .141^2} + \sqrt{.375^2 - .221^2}$

$l_{AVG} = .348 + .303 = .651$

$e = .325$
$D = .188$
$W = .651$
$t = .080$

$e/D = \frac{.325}{.188} = 1.73$
$W/D = \frac{.651}{.188} = 3.46$
$D/t = \frac{.188}{.08} = 2.35$

$A_{br} = Dt = .188(.08) = .015$
$A_t = (W-D)t = .463(.08) = .037$

PREPARED BY: GD
CHECKED BY: RER
DATE: DEC. 1, 1971

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531133

REF

SUPPORT TRUSS

CHECK of LUG,

$P_{BRU} = K_{BR} F_{BRU} A_{BR}$

$K_{BR} = .87$

$P_{BRU} = .87(150{,}000).015 = 1957$ lb/LUG

$P_{BRU_{TOT}} = 2(1957) = 3915$

II.2.1.47 $MS = \frac{3915}{3066} - 1 = +.28$

PREPARED BY: GLD
CHECKED BY:
DATE: NOV. 30, 1971

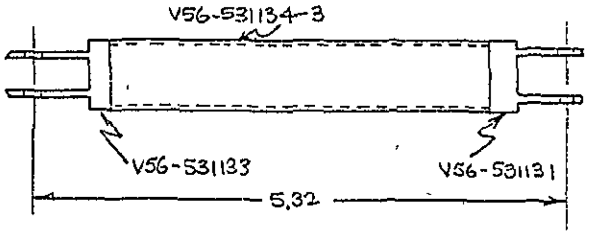
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531134

REF

N/A
V56
531105
531106

SUPPORT TRUSS - RESCUE COUCH, ASSY OF



DII
06.05
.01.01

MATERIAL: (-3) ST. STL. TUBE MIL-T-8808 321 $t = .035$
$O.D. = .75$

$F_{tu} = 75{,}000$ psi
$F_{ty} = 30{,}000$
$F_{cy} = 35{,}000$
$F_{su} = 53{,}000$
$E = 29 \times 10^6$ psi
$\mu = .28$

$P_{cr} = F_{cy} A$
$= (35000)(.079)$
$P_{cr} = 2765$ LBS

CHECKING TUBE FOR BUCKLING,

$$S' = .3 E \frac{t}{r} = .3(29 \times 10^6) \frac{.035}{.75} = 406{,}000 \text{ psi}$$

$$\frac{P}{A} = S'$$

$$P_{ALLOW} = S' \pi \left(\frac{.75^2}{4} - \frac{.68^2}{4} \right) = S'(.079) = 31{,}900 \text{ lb.}$$

CHECK FOR COLUMN BUCKLING,

V56-531
128

$I_t = .005$

$$P_{CR} = \frac{\pi^2 (29. \times 10^6).005}{5.32^2} = 50{,}600 \text{ lb.}$$

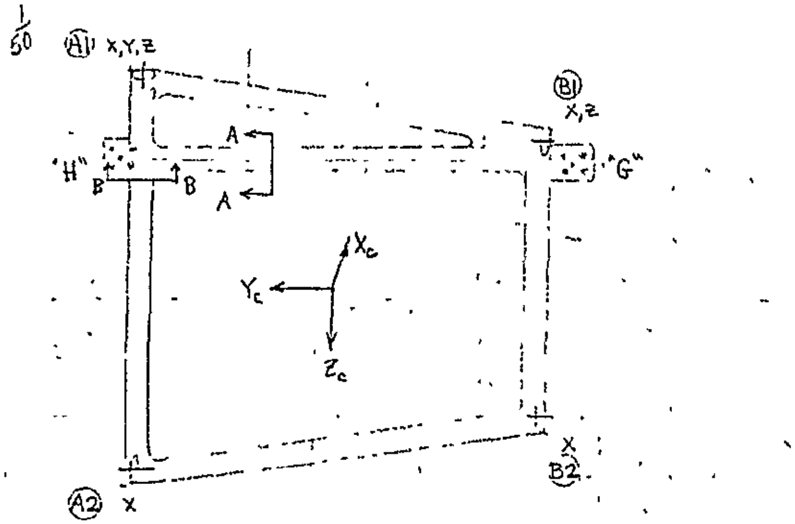
USE $P_{cr} = 2765$ LBS

$M.S = \frac{2765}{3885} - 1 = -.29$

REF

N/A
V56
531105
531106

ADAPTER FRAME - A7 LOCATION, RESCUE COUCH, ASSY OF



207

MATERIAL: MIL-A-22771, 7075-T73 HAND FORGED

C1
327.0(d)

$F_{tu} = 61,000$ psi

$F_{ty} = 52,000$; $F_{cy} = 52,000$

$F_{su} = 39,000$

$F_{bru} = 119,000$ $(e/D = 2.0)$

$E = 10.3 \times 10^6$ psi

$\mu = .33$

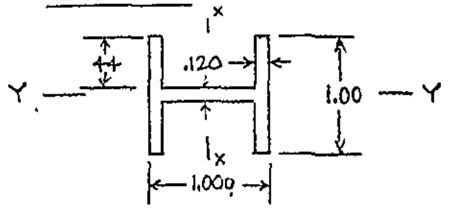
$G = 3.9 \times 10^6$ psi

REF

RESCUE COUCH

A7 ADAPTER FRAME

SECTION A-A



$A = .3312$ IN^2

$I_{XX} = .05114$ IN^4

$I_{YY} = .02011$ IN^4

$$I_{YY} = \frac{2(.12)(1.0)^3}{12} + \frac{.76(.120)^3}{12} = .0201 \text{ IN}^4$$

FOR PLASTIC BENDING,

$$K = \frac{2QC}{I}$$

$Q = 2(.5).12(.25) + .06(.03)(.86) = .03155$ IN^3

$C = .5$ IN

$I = .02011$ IN^4

$K = 1.568$

381

PREPARED BY: GLD	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 3 OF 17
CHECKED BY: RGR		REPORT NO SD 70-205
DATE DECEMBER 6 71	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531135

RESCUE COUCH

A7 ADAPTER FRAME

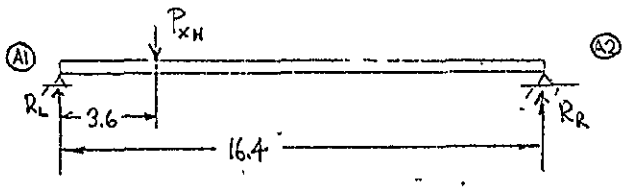
V56 531 126

LOADS (ULT, NEG X = COMPRESSION)

CASE	P_{XG}	P_{XH}	P_{YH}
I	-3885	-3885	—
II	3068	3068	- -
III	+1311	-1311	2086

REACTION of CASE I LOADS,

REACT P_{XH} WITH BEAM FROM THE A1 TO THE A2 FITTING,



$$R_R = \frac{P_{XH}(3.6)}{16.4} = .22\ P_{XH}$$

$$R_L = .78\ P_{XH}$$

MOMENT $M_{MAX} = .78\ P_{XH}(3.6) = 2.81\ P_{XH}$

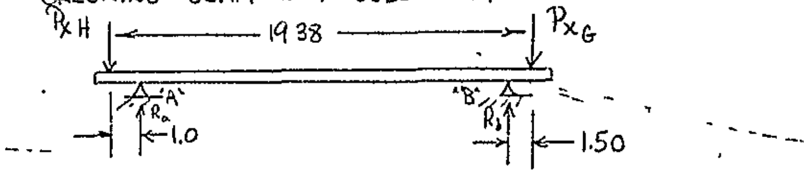
$$M_{MAX} = 2.81\ (3885) = \underbrace{10{,}900\ \text{IN-lb.}}$$

PREPARED BY: GLD	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 4 OF 17
CHECKED BY: RGR		REPORT NO SD 70-205
DATE: DEC 7, 71	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531135

RESCUE COUCH

A7 ADAPTER FRAME

CHECKING BEAM THAT GOES FROM "G" TO "H"

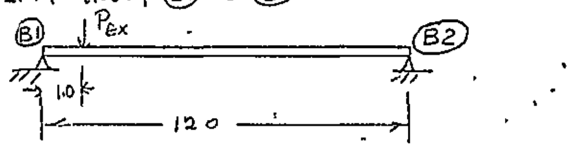


MAXIMUM MOMENT AT POINT B

$$M_B = P_{XG}(1.50) = 3885(1.50) = 5830\ \text{IN-lb}$$

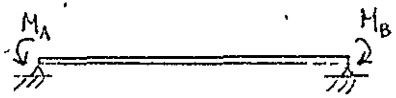
ASSUME HALF GOES TO EACH BEAM AT "G" TO "H" AND A1 FOR BENDING STRESS,

BEAM FROM Ⓑ1 TO Ⓑ2



$$M_{MAX} = \frac{11}{12}(3885)1.0 = 3560\ \text{IN-lb.}\ @\ P_{GX}.$$

TO DETERMINE ROTATION AT A AND B USE THE FOLLOWING SIMPLIFICATION,



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DATE: DEC 12 1971

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 5 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531135

RESCUE COUCH

A7 ADAPTER FRAME

SUPERIMPOSING TWO CASES of CASE 19 TABLE III IN ROARK

$$\theta_B = \frac{M_B l}{3EI} + \frac{M_A l}{3EI}$$

$M_B = 3885(1.50) = 5820$ IN-lb.

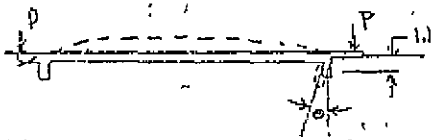
$M_A = 3885(1.0) = 3885$ IN-lb

LOOKING ONLY AT MEMBER FROM "G" TO "H" ASSUME 50% of M_B REACTED AND 55.7% of M_A IS REACTED IN THIS MEMBER (REF. PAGE 12)

$$\theta_B = \frac{5820(.5)l}{3EI} + \frac{.557(3885)l}{3EI}$$

$l = 16.88$; $E = 10.3 \times 10^6$; $I = .0201$

$\theta_B = .1379$ RAD.



DISTANCE DOWN TO PIN = 1.15 IN.

TOTAL DEFLECTION @ PIN

$$d = 1.15(.1379) = .1585 \text{ IN}$$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 6 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG. NO V56-531135

RESCUE COUCH

A7 ADAPTER FRAME

CHECK OF FRAME FOR CASE III LOADS

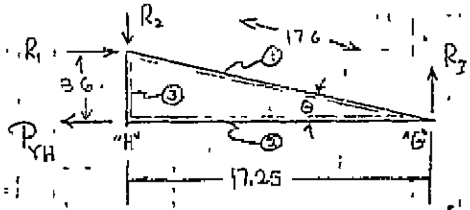
$P_{XG} = \pm 1311$ lb (ULT)

$P_{XH} = \mp 1311$ lb (ULT)

$P_{YH} = \pm 2086$ lb. (ULT)

FIRST DETERMINE LOADS IN FRAME, DUE TO P_{YH} LOAD.

DUE TO FITTING REACTION CAPABILITY HAVE FOLLOWING MODEL FOR THIS LOAD,



$P_{YH}(3.6) = R_3(1725)$

$R_3 = .209 P_{YH}$

$R_2 = .209 P_{YH}$

$R_1 = P_{YH}$

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COMMAND MODULE

PAGE NO 7 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531135

REF

Ref Pg 2

2-10

RESCUE COUCH

A7 ADAPTER FRAME

WITH LOADS SHOWN AND ASSUMING PINNED ENDS,

LOAD IN ①

$$P_1 = P_{yH}/\cos\theta = 1.02\,P_{yH} = 2130 \text{ lb.}$$

AND

$$P_2 = P_{yH} = 2086 \text{ lb.}$$

$$P_3 = 0$$

CHECKING MEMBERS FOR THESE LOADS AS COLUMNS

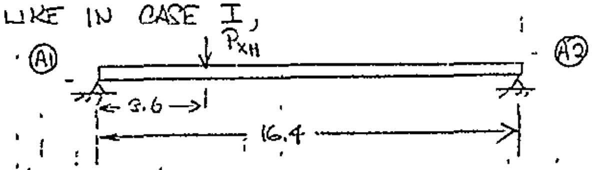
$$\sigma = \frac{1.02\,P_{yH}}{A} = \frac{1.02(2086)}{A} = \frac{2130}{.3312} = 6430 \text{ psi}$$

$$P' = \frac{\pi^2 EI}{L^2} = \frac{\pi^2(10.3\times10^6)(.02011)}{(17.6)^2} = 6600 \text{ lb.}$$

$$MS = \frac{6600}{2130} - 1 = \underline{2.10}$$

LOOK NOW AT BENDING IN BEAMS,

REACT TENSION COMPRESSION LOADS IN BEAMS LIKE IN CASE I,



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RESCUE MISSION
COMMAND MODULE

PAGE NO 8 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531135

REF

RESCUE COUCH

A7 ADAPTER FRAME

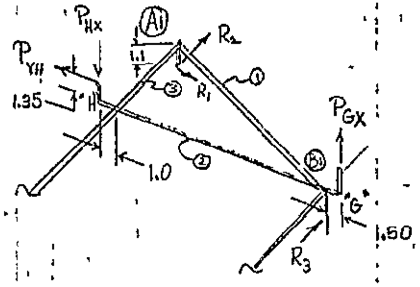
AS IN CASE I

$$M_{MAX} = 2.81\,P_{XH}$$

$$P_{XH} = 1311$$

$$M_{MAX} = 3685. \text{ in-lb.}$$

NOW CHECK BEAM FROM "G" TO "H" AND Ⓐ1 TO Ⓑ1,



$R_1 = R_{YH}$
$R_2 = .209\,P_{YH}$
$R_3 = .209\,P_{YH}$

MOMENT AT BEAM ②③ JUNCTION ONLY ..

$$M_{MAX_T} = 1.35 P_{Hy} + 1.0 P_{HX} = 1.35(2086) + 1311.$$
$$= 2820 + 1311 = 4131 \text{ in-lb}$$

MOMENT AT BEAM ①③ JUNCTION IN SAME DIRECTION

$$M_{MAX_{T2}} = 1.1(P_{Hy}) = 1.1(2086) = \underline{2300 \text{ in-lb.}}$$

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RESCUE MISSION
COMMAND MODULE

PAGE NO 9 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531135

REF.

D88
1.30.01

RESCUE COUCH

A7 ADAPTER FRAME

TORSIONAL STIFFNESS of MEMBER ③,

$$T = GJ_1\theta/L$$

$$\theta = \frac{TL}{GJ_1}$$ (TOTAL ROTATION DUE TO TORSION)

AND SHEAR STRESS

$$\tau_{MAX} = \frac{T}{J_2}$$

ANY MOMENT AT JUNCTION of MEMBERS ② AND ③ WILL DISTRIBUTED PARTLY TO MEMBER ① AND PARTLY TO ②. THE AMOUNT THAT IS DISTRIBUTED TO ① DEPENDS ON THE TORSIONAL STIFFNESS of MEMBER ③. CONSIDER THE FOLLOWING,

$M_{\textcircled{1}}$ = MOMENT DISTRIBUTED TO MEMBER ① AS TORSION IN ③

$M_{\textcircled{2}}$ = MOMENT REACTED BY MEMBER ②

$T_{\textcircled{3}}$ = TORSION IN ③

$\theta_{\textcircled{1}}$ = ROTATION of END of ① AT JUNCTION WITH ③

$\theta_{\textcircled{2}}$ = ROTATION of ② AT ③ JUNCTION

$\theta_{\textcircled{3}}$ = ANGLE of TWIST IN MEMBER ③

M_T = TOTAL MOMENT AT JUNCTION of ② & ③

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 10 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531125

REF

RESCUE COUCH

A7 ADAPTER FRAME

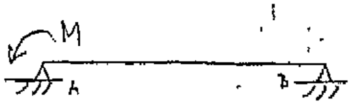
$$M_{\textcircled{1}} = T_{\textcircled{3}}$$

$$\theta_{\textcircled{1}} = \theta_{\textcircled{2}} - \theta_{\textcircled{3}}$$

$$M_T = M_{\textcircled{2}} + M_{\textcircled{1}}$$

FOR BOTH BEAMS ① AND ② ASSUME FOLLOWING MODEL,

REMARK
TABLE III
CASE 19



$$\theta_A = \frac{Ml}{3EI}$$

$$\theta_{\textcircled{1}} = \frac{M_{\textcircled{1}} l_{\textcircled{1}}}{3EI_{\textcircled{1}}}$$

$$\theta_{\textcircled{2}} = \frac{M_{\textcircled{2}} l_{\textcircled{2}}}{3EI_{\textcircled{2}}}$$

$$\theta_{\textcircled{3}} = \frac{T_{\textcircled{3}} l_{\textcircled{3}}}{GJ_{1\textcircled{3}}} = \frac{M_{\textcircled{1}} l_{\textcircled{3}}}{GJ_{1\textcircled{3}}}$$

$$\frac{M_{\textcircled{1}} l_{\textcircled{1}}}{3EI_{\textcircled{1}}} = \frac{M_{\textcircled{2}} l_{\textcircled{2}}}{3EI_{\textcircled{2}}} - \frac{M_{\textcircled{1}} l_{\textcircled{3}}}{GJ_{1\textcircled{3}}}$$

$$M_{\textcircled{2}} = \frac{3EI_{\textcircled{2}}}{l_{\textcircled{2}}}\left[\frac{M_{\textcircled{1}} l_{\textcircled{1}}}{3EI_{\textcircled{1}}} + \frac{M_{\textcircled{1}} l_{\textcircled{3}}}{GJ_{1\textcircled{3}}}\right]$$

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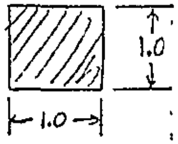
CHECKED BY: RGR		REPORT NO SD 70-205
DATE: DEC 10 1971	COMMAND MODULE	MODEL NO SKYLAB
REF.		DWG NO V56-531135

RESCIE COUCH

A7 ADAPTER FRAME

MAKING ③ SOLID SECTION;

ⒺⒶ TABLE IX CASE 3



$J_{1\textcircled{3}} = 0.1406\, a^4$

$J_{1\textcircled{3}} = .1406 \text{ IN}^4$

$l_{\textcircled{1}} = 17.6 \text{ IN.}$

$l_{\textcircled{2}} = 17.25 \text{ IN.}$

$l_{\textcircled{3}} = 3.6 \text{ IN.}$

$I_{\textcircled{1}} = I_{\textcircled{2}} = .02011 \text{ IN}^4$

THEN

$$M_{\textcircled{2}} = \frac{3(10.3).02011}{17.25}\left[\frac{17.6}{3(10.3)(.02011)} + \frac{3.6}{3.9(.1406)}\right] M_{\textcircled{1}}$$

$$\underline{M_{\textcircled{2}} = 1.26\, M_{\textcircled{1}}}$$

$M_{TOTAL} = M_{\textcircled{2}} + M_{\textcircled{1}} = 2.26\, M_{\textcircled{1}}$

$M_{\textcircled{1}} = .443\, M_T$

$M_{\textcircled{2}} = .557\, M_T$

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CHECKED BY: RGR		REPORT NO SD 70-205
DATE: DEC 13, 1971	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531135

RESCUE COUCH

A7 ADAPTER FRAME

NOW CHECK MEMBERS FOR THE MAXIMUM LOADS of CASES I, II OR III.

BEAM FROM Ⓐ① TO Ⓐ②

CASE I LOADS Pg. 3

$M_{MAX} = 10{,}900 \text{ IN-lb.}$

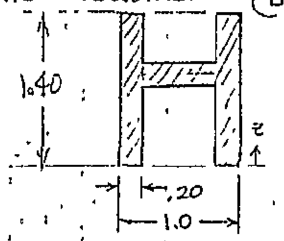
ASSUMING $k = 1.5$

$F_b = 61{,}000 + 26{,}000 = 87{,}000 \text{ psi}$

$\sigma_b = \frac{Mc}{I}$

$K_{REQD} = \frac{I}{c} = \frac{10{,}900}{87{,}000} = .126 \text{ IN}^3$

SECTION REQUIRED - (B-B)



	b	h	$\bar{z}$
1	.20	1.40	.70
2	.20	1.40	.70
3	.60	.20	.90

$I = .0958 \text{ IN}^4$

$c = .735 \text{ IN}$

$A = .68 \text{ IN}^2$

$\frac{I}{c} = .13 \text{ IN}^3$

$MS = \frac{87(.13)}{.99} - 1 = \underline{\underline{.03}}$

RESCUE COUCH

A7 ADAPTER FRAME

CHECKING CROSS MEMBERS ① OR ②;

CASE I,

CASE I LOADS

$M_{MAX} = .5(1.5)3885 = 2915$ (CASE I "G" END)

$\sigma_b = \dfrac{2915(.5)}{.02011} = 72500$ psi

CASE III,

$M_{MAX} = .557(M_{MAX_T}) + .443(M_{MAX_{T2}}) = 3320$ IN-lb.

CORRESPONDING AXIAL LOAD,

$P = 2086$

$P/A = \dfrac{2086}{.3312} = 6300$ psi

$\sigma = \sigma_b + \dfrac{P}{A} = \dfrac{3320(.5)}{.02011} + 6300 = 88,800$ psi

∴ WITH $K = 1.568$

$F_b = 61,000 + .568(52,000) = 90,600$

$MS = \dfrac{90.5}{88.8} - 1 = +.01$

CHECK of BEAM FROM (B1) TO (B2)

194

$M = 3560$ (CASE I)

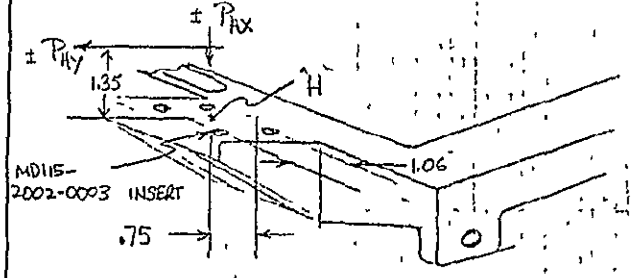
$\sigma = \dfrac{3560(.5)}{.02011} = 88,500$ psi

W/K = 1.568

$MS = \dfrac{90.5}{88.5} - 1 = .02$

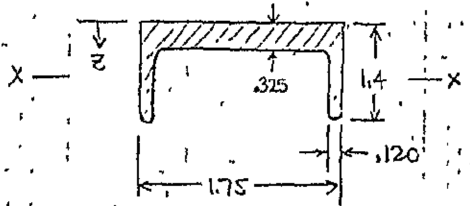
RESCUE COUCH

A7 ADAPTER FRAME



CHECK of LOADING PLATFORMS "G" AND "H"

SECTION AT FRAME



b	h	$\bar{z}$
1.75	.325	.1625
.120	1.075	.8625
.120	1.075	.8625

$A = .827$ IN²
$c = 1.019$ IN
$I_x = .117$ IN⁴

MOMENT AT FRAME –

$M = 2086(1.35) + 1311(.75) = 2820 + 985 = 3805$ psi

$\sigma_b = \dfrac{Mc}{I} = \dfrac{3805(1.019)}{.117} = 33,150$ psi

$F_b = F_{cy} = 52,000$ psi.

$MS = \dfrac{52}{33.15} - 1 = +.57$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
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COMMAND MODULE

PAGE NO 15 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531135

REF.

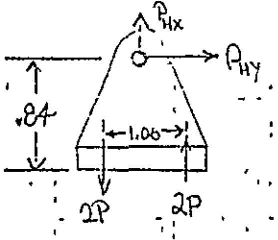
RESCUE COUCH

A7 ADAPTER FRAME

CHECK of MD115-2002-0003 INSERTS ON PLATFORM

D8

$P_{ALLOW} = 4000$ lb. (IN 2014-T6 ALUMINUM QQ-A-200/2)



$$P = \frac{P_{HX}}{4} + \frac{P_{HY}(.84)}{2(1.06)}$$

$$P = \frac{1311}{4} + \frac{2086(.84)}{2(1.06)} \quad \#10 \text{ Ok}$$

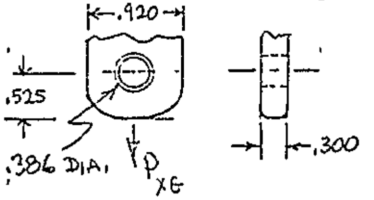
$$P = 328 + 828 = 1156 \text{ lb.}$$

$$MS = \frac{4000}{1156} - 1 = \underline{2.46}$$

CHECK of FRAME LUGS –

MAXIMUM LUG LOAD AT Ⓑ1 FITTING, TENSION CASE

$P_{XG} = 3068$ lb (ULT)



PIN DIA. = .375 IN

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 16 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531135

REF

RESCUE COUCH

A7 ADAPTER FRAME

E8
Pg 714

LUG TENSION ALLOWABLE,

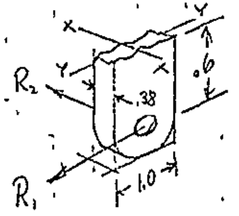
$$P_{ALLOW} = (.92-.386).30(61,000) = 9770 \text{ lb.}$$

SHEAR TEAR OUT ALLOWABLE,

$$P_{TO} = 2(.335)(.30)(39,000) = 7840 \text{ lb.}$$

$$MS = \frac{7840}{3068} - 1 = +\underline{1.56}$$

BENDING of LUG AT Ⓐ1



$R_1 = P_{YH} = 2086$ lb.
$R_2 = .209 P_{YH} = 437$ lb.

$$\sigma_b = \frac{R_1(.6)c}{I_X} + \frac{R_2(.6)c}{I_Y}$$

$$\sigma_b = \frac{2086(.6)6}{.38(1.0)^2} + \frac{.6(437)6}{1.0(.38)^2} = 19,750 + 10,900 = 30,650$$

W/K = 1.5

$$MS = \frac{87}{30.6} - 1 = +\underline{1.84}$$

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RESCUE MISSION
COMMAND MODULE

PAGE NO. 17 OF 17
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DWG NO V56-531135

REF.

RESCUE COUCH

A7 ADAPTER FRAME

CHECK AFT BULKHEAD FITTINGS

V56-317562

CORE COMPRESSION $P_c = 3885$ CASE I

$\frac{P}{A} = \frac{3885}{4.6(4.6)} = 184$ psi

$\sigma_{c_{ALLOW}} = 329$

$MS = \frac{329}{184} - 1 = +.78$

V56-317561

MAX LOAD COMPRESSION (CASE I)

$P_c = R_R = .22(3885) = 855$ lb

$P/A = \frac{855}{10} = 85.5$ psi

$MS = \frac{329}{85.5} - 1 = 2.84$

fig3

PREPARED BY RGR
CHECKED BY GF
DATE 1-19-2

SPACE DIVISION
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COMMAND MODULE

PAGE NO. 1 OF 10
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DWG NO V56-531142

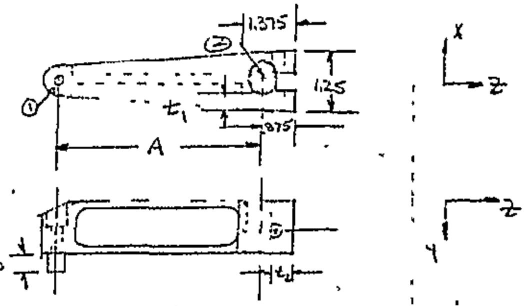
REF N/A

V56-531 100

ARM-STABILIZER, RESCUE COUCH

FOUR REQUIRED FOR EACH COUCH
TWO DASH NUMBERS PROVIDED
THE ARM AT THE COUCH HIGH POSITION BEING THE LONGEST.

DASH	A
-3	5450
-5	6.770



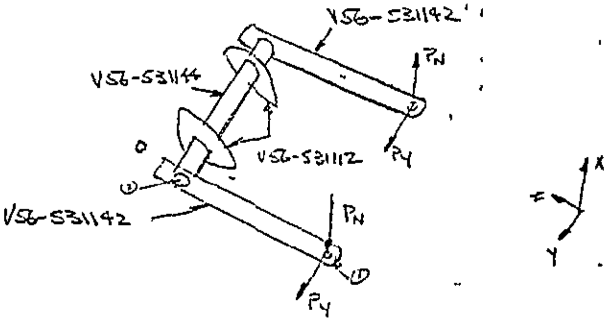
MATERIAL PROPERTIES
CRES BAR AMS 5737

D11 07.01 .01.01

$F_{TU} = 140$ KSI
$F_{TY} = 95$ "
$F_{SU} = 91$ "
$F_{BRU} = 210$ "

$F_B = F_{TU} + (K-1) F_{TY}$ $K = 1.5$ (Rock)
$F_B = 187$ KSI

COUCH STABILIZING SYSTEM



FORM 994-B REV 12 67

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COMMAND MODULE

PAGE NO 2 OF 10
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531142

REF
V56-531112
Pg3

LIMIT LOADS

HIGHEST LOADING AT THE SHOULDER STABLIZER POSITION

$R_N = \pm 288.98^{\#}$ $R_{Y_1} = -578.25$ $R_{Y_2} = -548.96$

ULTIMATE LOADS

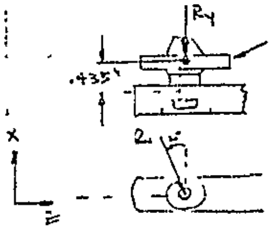
$R_N = 1.5(288.98)$ $R_{Y_1} = 1.5(578.25)$ $R_{Y_2} = 1.5(-548.46)$
$R_N = \pm 435^{\#}$ $R_{Y_1} = 866^{\#}$ $R_{Y_2} = 820^{\#}$

CRITICAL CASE

$R_N = 435^{\#}$ $R_Y = 866^{\#}$

LOAD INPUTS

LOADS ARE PICKED UP BY BEARING. V56-531146



$R_X = R_N \cos 20°$ (-)
$R_X = 408^{\#}$
$R_Z = R_N \sin 20°$ (-)
$R_Z = 145^{\#}$

FORM 594-B REV 12-67

PREPARED BY RGR
CHECKED BY GLD
DATE 1-21-2

SPACE DIVISION
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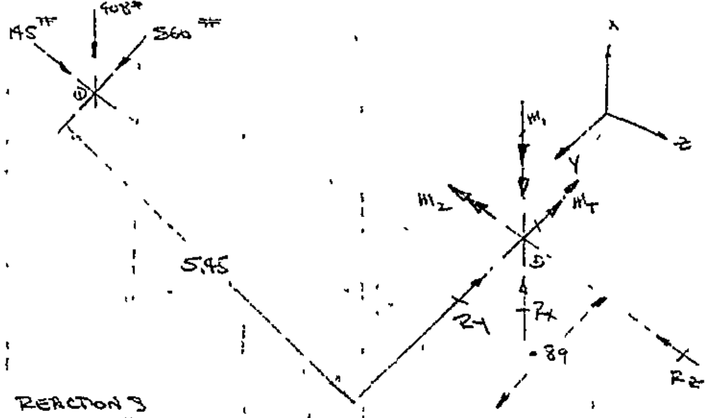
COMMAND MODULE

PAGE NO 3 OF 10
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531142

REF

FREE BODY REACTIONS



REACTIONS
$R_Z = 145^{\#}$
$R_Y = 866^{\#}$
$R_X = 408^{\#}$
$M_T = P_X(5.45)$ $M_T = 408(5.45) = 2220$ IN #
$M_1 = P_Z(.89) + P_Y(5.45)$ $M_1 = 145(.89) + 866(5.95) = 4850$ IN #
$M_2 = P_X(.89)$ $M_2 = 363$ IN #

INTERNAL REACTIONS

CHECK SHEAR AND SOCKET ACTION ON TOOTH SOCKET END ②

SHEAR - DUE TO TORQUE M_T

TORQUE ACTING OVER 1/2 SOCKET (MINOR DIA) CYLINDER

$$\tau = \frac{2T}{DA} = \frac{2(2220)}{.5(3.14)(.852)}$$

$\tau = 3{,}340$ PSI

$F_{SU} = 91$ KSI

- M.S. HIGH

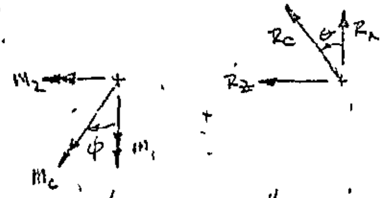
P (

FORM 594-B REV 12 67

PREPARED BY: R62	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 4 OF 10
CHECKED BY GLD	RESCUE MISSION	REPORT NO SD 70-205
DATE 1-21-2	COMMAND MODULE	MODEL NO SKYLAB
REF		DRWG NO V56-531192

SOCKET - CONT

COMBINE SOCKET REACTIONS (VECTOR)



$|M_c| = [M_2^2 + M_1^2]^{1/2} = [363^2 + 4850^2]^{1/2}$

$|M_c| = 4860$ IN #

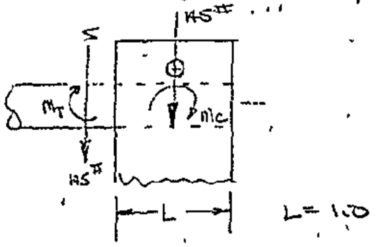
$|R_c| = [R_A^2 + R_Z^2]^{1/2} = [408^2 + 145^2]^{1/2}$

$|R_c| = 423$ #

NEGLECT RESULTANT ANGLES AND APPLY MOMENT + SHEAR IN SOCKET.

(NEGLECT INVOLUTED SERRATIONS)

STRUCT MEN 4-52-400 5-40-40-4



$M_{TOT} = M_c + 145(0.5)$

$M_{TOT} = 4932$ IN #

$S = 145$ #

FORM 1944-B REV 12-67

PREPARED BY R62	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 5 OF 10
CHECKED BY G.F.	RESCUE MISSION	REPORT NO SD 70-205
DATE 1-21-2	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-531192

SOCKET ACTION - CONT.

$\frac{SL}{M} = \frac{145(1)}{4932}$

$\frac{SL}{M} = .0295$

FROM FIG 5 $W_1 = W_2 = \frac{K_1 M}{L^2}$ $K_1 = 6$

$W_1 = \frac{6(4932)}{1}$

$W_1 = 29,600$ LBS/IN

SOCKET BEARING STRESS

$f_{br} = \frac{W}{D} = \frac{29,600}{.8416}$

$f_{br} = 35,200$ PSI

D4 6-40-40-1 E5 FIG D1 13

$F_{BR} = K_{BRU} F_{TU}$

$= .96(140)$

$F_{BR} = 135$ KSI

$e = .875$

$e/D = \frac{.875}{.8416} = 1.04$

$D/t = \frac{.8416}{1.0} = .8416$

BEARING M.S. $- \frac{135}{35.2} - 1 = \underline{+2.83}$

SOCKET WALL TENSION STRESS.

$f_t = \frac{W}{2t_1}$ $t_1 = 0.2$

$f_t = \frac{29,600}{2(.2)}$

$f_t = 74,000$ PSI

P1

$F_{TU} = 140$ KSI

$MOS = \frac{140}{74} - 1 = \underline{+.89}$

FORM 1944-B REV 12-67

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 6 OF 10
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531192

REF

SOCKET REACTIONS CONT

SOCKET SHEAR STRESS

$t_s = \frac{W}{2t_2}$ $t_2 = 0.45$

$= \frac{29,600}{2(.45)}$

$t_s = 32,900$ PSI

SHEAR M.S. = $\frac{91}{32.9} - 1 =$ M.S. = +1.72

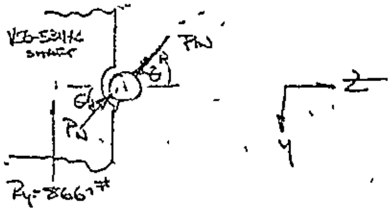
REACTIONS ON LOCKING BOLT (NAS 1133C20)

NAS 1133C - $F_T = 2,800^{\#}$

A286 - AMS 5735

SEE PAGE MAT. PROPERTIES

REACTION $R_y = 866^{\#}$ REACTED BY BOLT



R_y PUTS NORMAL LOAD (P_N) ON BOLT

θ - ASSUMED 30°

$P_N \sin 30° = R_y$

$P_N = \frac{R_y}{\sin} = \frac{866^{\#}}{.50}$

$P_N = 1730^{\#}$

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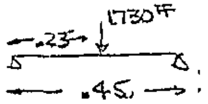
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 7 OF 10
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531192

REF

P.1

PIN REACTION END (2)



$M_{max} = .23 \left(\frac{1730}{2}\right)$

$M_{max} = 198$ IN#

$I = .0491(.25)^4 = .000214$

$\sigma = \frac{Mc}{I} = \frac{198(.128)}{.000214}$

$\sigma = 118,500$ PSI

$F_{tu} = 140$ KSI

M.S. = $\frac{140}{118.5} - 1 = +.18$

SHEAR

$P = 1730^{\#}$

$A_s = \pi r^2 = \frac{3.14(.25)^2}{4}$

$A_s = .0519$ IN^2

$\frac{P}{A_s} = \frac{1730}{.0519}$

$\frac{P}{A_s} = 33,400$ PSI

$F_{su} = 91$ KSI.

M.S. = +1.73

FORM 604-B REV 12-67

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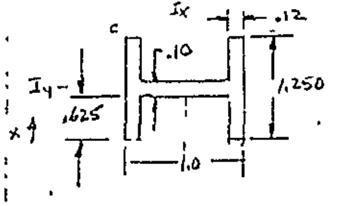
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO. 8 OF 10
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DRWG NO. V56-531192
REF

ARM BENDING

TRANSMISSION OF M_T



$A = .376 \text{ in}^2$
$\bar{X} = .625 \text{ in}$
$I_y = .0391$
$I_x = .0621$
$\bar{y} = 0.50 \text{ in}$

UPPER FIBERS IN BENDING

$$\sigma_x = \frac{M_x c}{I_x} = \frac{4850(.5)}{.0621}$$

$\sigma_x = 39,000$ PSI

$$\sigma_y = \frac{M_T c}{I} = \frac{2200(.625)}{.0391}$$

$\sigma_y = 35,485$

M_z IS TORQUE TREAT IN "DIFFERENTIAL" BENDING

$$P = \frac{M_z}{.88} = \frac{383}{.88} = 435^{\#}$$

$M_{max} = 435(4.95) = 2150$ IN #

$$\sigma = \frac{6M}{bt^2} = \frac{6(2150)}{(.12)(1.25)^2}$$

$\sigma = 68,800$ PSI

P.I.

TOTAL BENDING

$\sigma_T = 143,285$ PSI MAX

$F_B = 187$ KSI

$M.S. \frac{187}{143.3} - 1 = + .30$

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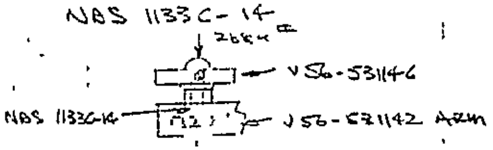
DATE: 1-24-2
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO. 9 OF 10
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DRWG NO. V56-531192
REF

PIN AT ①

NBS 1133C-14

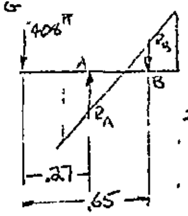


D = .19 IN.

TENSILE FORCE = 866#
$A = .0284$
$P/A = 866/.0284$
$P/A = 30,500$ PSI
$F_{tu} = 95$ KSI

$$MoS = \frac{95}{305} - 1 = +2.11$$

BENDING



R_A, R_B REACTIONS (ARM)

$\Sigma M_A = 0$

$R_B(.38) = 408(.27)$

$$R_B = \frac{408(.27)}{.38}$$

$R_B = 290^{\#}$

$\Sigma F = 0$

$408 + R_B = R_A$

$R_A = 698^{\#}$

$M_{max} = R_B(.38)$
$= 290(.38)$
$M_{max} = 110$ IN #
$I = .0491(D)^4$ D = 0.19
$I = .000064$

PREPARED BY Wee

CHECKED BY G.F

DATE 1-29-2

SPACE DIVISION
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RESCUE MISSION

COMMAND MODULE

PAGE NO 10 OF 10

REPORT NO SD 70-205

MODEL NO SKYLAB

DRAG NO V56-531142

REF

PIN BENDING -

$$\sigma = \frac{Mc}{I} = \frac{110(.095)}{.0000064} = 163000 \text{ PSI}$$

CIRCLE: $F_B = F_{TU} + (1.70-1)F_{TY}$

$= 140 + .70(95)$

$F_B = 2065 \text{ KSI}$

$\text{MoS.} \quad \frac{226.5}{163} - 1 = \underline{+.27}$

PREPARED BY RGR

CHECKED BY GLD

DATE 1-24-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION

COMMAND MODULE

PAGE NO 1 OF 5

REPORT NO SD70-205

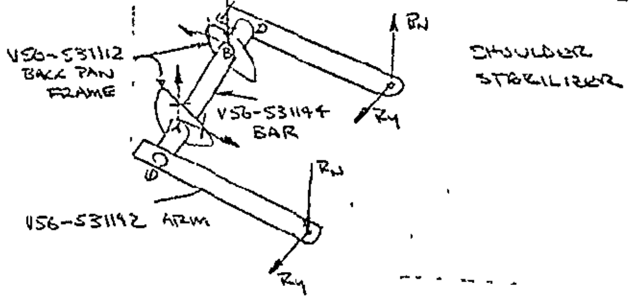
MODEL NO RESCUE

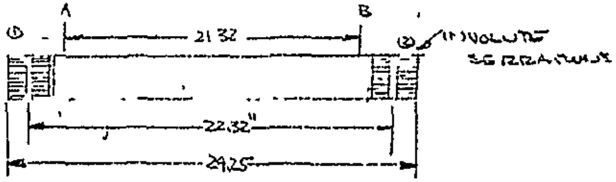
DRAG NO V56-531144

REF
NR
V56
531100

SHAFT - TORQUE, STABILIZER, RESCUE COUCH

SHAFT CONNECTS TWO V56-531142 ARMS IN STABILIZER SYSTEM





MATERIAL
CRES BAR AMS 5737

D11
07.01
.01.01

$F_{TU} = 140 \text{ KSI}$

$F_{TY} = 95 \text{ KSI}$

$F_{SU} = 91 \text{ KSI}$

$F_{BRU} = 210 \text{ KSI}$

$F_B = F_{TU} + (K-1)F_{TY} \quad K = 1.7 \text{ (SOLID CIRCLE)}$

$F_B = 140 + .7(95) = 206 \text{ KSI}$

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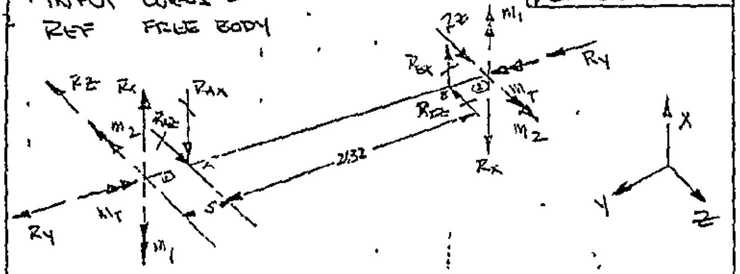
RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 5
REPORT NO. 5073 203
MODEL NO. RESCUE
DRAG NO V53-531144

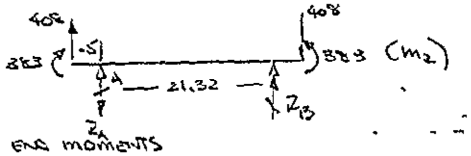
REF
V53-531147
P1,3

INPUT LOADS -
REF FREE BODY



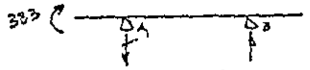
TWO REACTION POINTS
AT A - RAX, RAZ
AT B RBX, RBZ
LOADS
$R_X = \pm 408^{\#}$ $R_Y = -288.9^{\#}$ $R_Z = \pm 145^{\#}$
$M_T = \pm 2220$ IN # $M_1 = \pm 1700$ IN # $M_2 = \pm 383$ IN #

REACTIONS IN X-Y PLANE



NEGLECTING END MOMENTS
$\Sigma M_A = 0$ $.5(408) - 21.32(R_B) + 21.82(408) = 0$
$22.32(408) = 21.32 R_B$
$R_B = 426^{\#}$ AS SHOWN
$R_A = 426^{\#}$

END MOMENTS - SUPERIMPOSED



$R_B = \frac{M}{L} = \frac{383}{21.32}$
$R_B = 18^{\#}$
$R_A = 18^{\#}$

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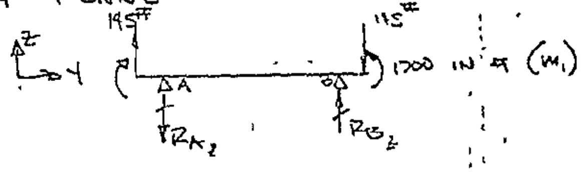
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE 3 OF 5
V53-531144

REF

REACTIONS CON'T
END MOMENT REACTIONS CANCEL EXCLUDING
TOTAL X-Y PLANE REACTIONS
$R_{B_X} = -R_{B_X} = 426^{\#}$

Z-Y PLANE



END MOMENT REACTIONS CANCEL
REACTIONS TO Z LOADS

$\Sigma M_A = 0$ $145(.5) - 21.32(R_B) - 145(21.82) = 0$
$R_B = \frac{145(22.32)}{21.32}$
$R_{B_Z} = 152^{\#}$ AS SHOWN
$R_{A_Z} = 152^{\#}$

INTERNAL REACTIONS

BENDING
VECTOR SUM OF MOMENTS
$|M_3| = [M_1^2 + M_2^2]^{1/2}$
VECTOR SUM OF SHEARS
$|P_3| = |P_X^2 + P_Z^2|^{1/2}$

NEGLECTING ANGULAR DIFFERENCES
MAXIMUM BENDING MOMENT

$M_3 + P_3(.5) = 1959$ IN #

FORM 604-B REV 12-67

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 5
REPORT NO SD70-205
MODEL NO RESCUE
DRWG NO V56-531144

REF

BENDING MINIMUM SECTION

$M = 1959$ IN #

$D = .812$

$I = .0491(.812)^4$

$I = .0213$

$C = D/2 = .406$

$\sigma = \frac{Mc}{I} = \frac{1959(.406)}{.0213}$

$\sigma = 37,261$ PSI $R_b = \frac{37,261}{206{,}000} = .181$

TORSIONAL STRESS

$T = 2220$ IN #

MAX SHEAR STRESS

ROARK TAB II 1   CIRCULAR SECTION

$S = \frac{2T}{\pi r^3}$ $r = D/2 = .812/2$

$r = .406$

$S = \frac{2(2220)}{3.14(.406)^3}$

$S = 21,118$ PSI

STRESS DUE TO SHEAR LOADS

ROARK ART 32

$S_{max} = \alpha \frac{V}{A}$ $V = 433$ #

$\alpha = \frac{4}{3}$

$S_{max} = \frac{4}{3} \frac{433}{\pi(.406)^2}$

$S_{max} = 1,114$ PSI

TOTAL SHEAR

$S_T = 21,118 + 1,114$

$S_T = 22,233$ PSI $R_s = \frac{22,233}{91,000} = .244$

FORM 994-B REV 12-67

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DATE 1-25-72

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RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 5
REPORT NO SD70-205
MODEL NO RESCUE
DRWG NO V56-531144

REF

COMBINED LOADING

$R_b^2 + R_s^2 = 1.0$

$MoS_u = \frac{1}{[R_b^2+R_s^2]^{1/2}} - 1$

$MoS_u = \underline{+2.29}$

FORM 994-B REV 12-67

PREPARED BY: G.F
CHECKED BY: RGR
DATE: 2/19/73

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RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531150

REF
N/A
FC4-100
002

LEG SUPPORT ASSY - RESCUE COUCH

THE ASSEMBLY ABOVE CONTAINS THE DRAWINGS LISTED BELOW. REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS. TWO PINS PRESENT ON THE ASSY ARE ANALYZED ON THE FOLLOWING PAGES.

V56-531151-1,-2	BEAM
V56-531152	PAN
V56-531153	PAN
V56-531154	PIN
V56-531155	PIN
V56-531157-1,-2	CLIP
V56-531158	CLIP
V56-531159	LINK
V56-531160	ROD END
V56-531161	FITTING
V56-531162	FITTING
V56-531169	PIN
V56-531170	HOUSING
V56-531171	HANDLE
V56-531172	BUSHING
V56-531173	SPACER

PREPARED BY: RGR
CHECKED BY: G F
DATE 2-14-2

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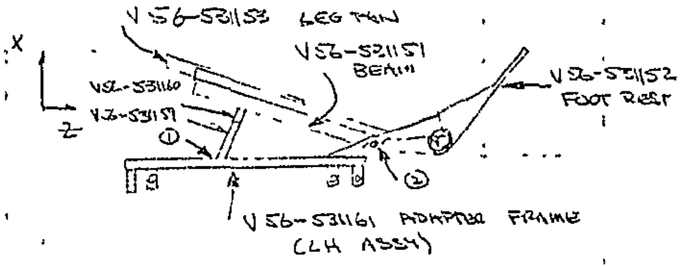
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531150

REF

LEG-SUPPORT, RESCUE COUCH, ASSY OF

- LEG SUPPORT ASSEMBLY



ASSEMBLY CONNECTORS

① NAS 1334A2C07 -

PIN, SAFETY + RETAINING (QUICK RELEASE).

DOUBLE SHEAR STRENGTH

$P_A = 9,200^{\#}$

D8

V56 531161 P.3

$P_{APPLIED} = 1120^{\#}$

$MoS = \frac{4200}{1120} - 1$

$MS = \underline{+ HIGH}$

② MS 171501

PIN, SPRING (ROLL)

AMS 5506 $F_{TU} = 100,000$ PSI

$F_{SU} \approx .55 F_{TU}$

$F_{SU} = 55,000$ PSI

SEE V56-531171 - P.2

PREPARED BY: RGR
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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531150

SHEAR UPDATE

$A_s = (.022)(\pi)D$

$= (.022)(3.14)(.094)$

$A_s = .0065\ IN^2$

$P = 150^{\#}$

$P/A = 150/.0065$

$P/A = 23{,}088$ PSI

$F_{SU} = 55{,}000$ PSI   MoS = $\underline{+1.38}$

PREPARED BY: Gillan
CHECKED BY: G.F.
DATE: 11/15/11

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RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531151

REF
N/A
V56-531
150

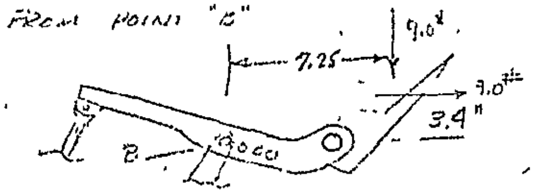
BEAM - RESCUE COUCH FOOT SUPPORT

III 2 1 9   / LOADS - USE 33.84 "G" N_x
4.23 "G" N_y
8.46 "G" N_z

/

III.2.1.3   WORST CASE - LONGEST OVERHANG OF BEAM FROM POINT "B"

2024-T4
QQ-A 225/6



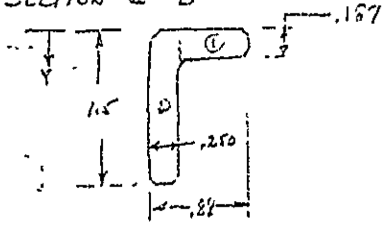
DUE TO $N_x + N_z + N_y$

MOMENT @ B $= \frac{(33.84)(9)}{2}(7.25) + \frac{(8.46)(9)}{2}(3.4) + (4.23)(9)\left(\frac{3.4}{3.25}\right)(7.25)$

$= \frac{2210}{} + \frac{259}{2} + 76.5$

$= \underbrace{1311.5\ in^{\#}}$

SECTION @ B



$A = (.167)(.62) + (1.5)(.250)$

$= .119 + .375 = .494\ IN^2$

$\bar{Y} = \Sigma \frac{A_i\bar{Y}_i}{A} = \frac{(.119)(.093) + (.375)(.75)}{.494} = \frac{.0111 + .281}{.494} = \frac{.292}{.494}$

$= \underline{.591\ IN}$

$C = 1.5 - .59 = .91\ IN$

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 4

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-531151

BEAM – RESCUE COUCH FOOT SUPPORT

$I_{NA} \cong \frac{1}{12}(.25)(1.5)^3 + (.281)(.16)^2 + (.0111)(.5)^2$

$= .0703 + .0072 + .00278$

$= .08028$

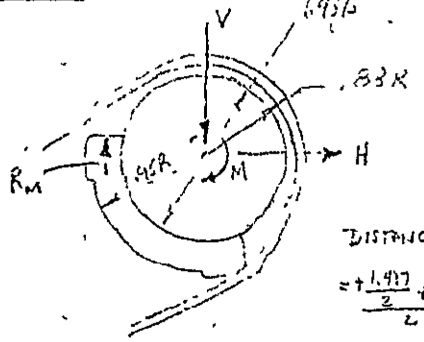
$f_b = \frac{MC}{I} = \frac{(1311.5)(.91)}{.08028} = \underline{14900 \text{ PSI}}$ (OUT I/A)

$\frac{L}{t} \cong \frac{.91}{.25} = 3.64$

ALLOWABLE ≅ f_{cy} = 32000 PSI – 2024 ROLLED BAR

M.S. = 1.22

LUG END



DISTANCE TO R_M

$= \frac{+\frac{1.437}{2} + .95}{2} = \frac{.718 + .95}{2}$

$= \frac{1.668}{2} = \underline{.834 \text{ IN}}$

PREPARED BY:

CHECKED BY: G F

DATE: 11/23/71

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 4

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-531151

BEAM – RESCUE COUCH FOOT SUPPORT

$V = (9)(33.84) = 305\,\#$

$H = (9)(8.46) = 56.2\,\#$

$M = \frac{(305)(1.6)}{2} + \frac{(56.2)(3.4)}{2} + (9)(4.23)\left(\frac{3.4}{8.35}\right)(1.6)$

$= \frac{488}{2} + \frac{191}{2} + 16.9$

$= 244 + 95.5 + 16.9 = \underline{\underline{356.4 \text{ IN}\#}}$ ON CRITICAL LUG.

$R_M = \frac{364.4\,\#\text{IN}}{.834\,\text{IN}} = \underline{437\,\#}$

$V_{TOTAL} = 305 + 437 = 742\,\#$

$H_{TOTAL} = 56.2\,\#$

TOTAL LOAD $= \sqrt{(742)^2 + (56.2)^2} = \underline{744\,\#}$

BEARING STRESS $\cong \frac{744}{(.5)(1.437)} = \underline{1036 \text{ PSI}}$

M.S. + HIGH

LEG PAN ATTACH (V56-531152)

LOAD $= \frac{\Sigma M_A}{5.5 \text{ IN}} = \frac{(362.5)(33.84) + (352.6)(8.46)}{5.5}$

$= \frac{12250 + 2980}{5.5} = \frac{15230}{5.5} = \underline{2770\,\#}$

TOTAL

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CHECKED BY: G. E.
DATE: 11/23/71
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO 1 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531151

REF.

BEAM - RESCUE COUCH FOOT SUPPORT

LEG PAN ATTACH (CON)

4 FASTENERS — 1385 # TOTAL

(C22) TABLE 6.1 5(a)

NAS 1133 C2 (A286)

P_{su} = 2580 LBS

$$MS\ \frac{2580}{348} - 1 = \underline{+HIGH}$$

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DATE 1-13-2
SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE
PAGE NO 1 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531152

REF
N/A
V56 531 150

Pg II.2 1.3

PAN - RESCUE COUCH FOOT SUPPORT

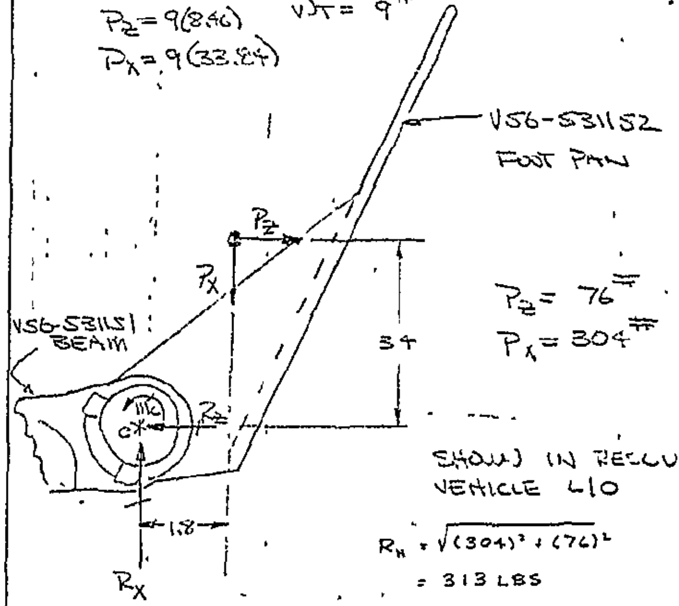
PROVIDE

MAX $N_x + N_z$ WT OF TWO BOOTS + TWO FEET

WT = 9#

$P_z = 9(8.46)$

$P_x = 9(33.84)$



$P_z = 76$#

$P_x = 304$#

SHOWN IN RESCUE VEHICLE 410

$R_H = \sqrt{(304)^2 + (76)^2}$

= 313 LBS

REACTIONS (SYSTEM)

$M_c = 304(1.8) + 76(3.4)$

$= 547 + 258$

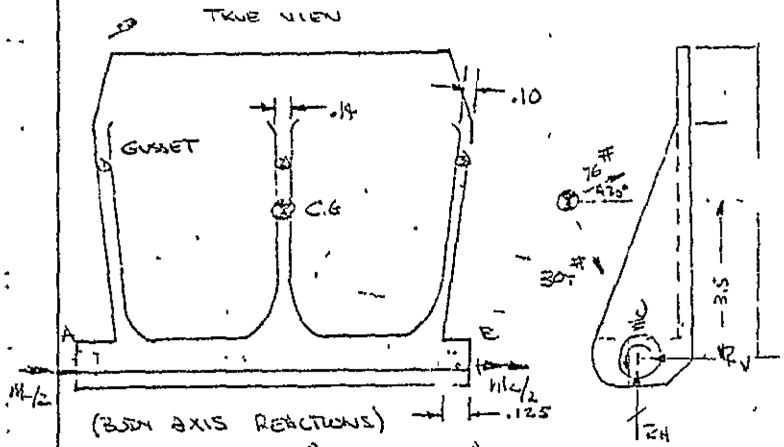
$M_c = 805$ IN # (TOTAL)

$R_x = P_x = 304$# (TOTAL)

$R_z = P_z = 76$# (TOTAL)

FORM 604-B REV 12-67

PREPARED BY RGR	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 2 OF 5
CHECKED BY GF	RESCUE MISSION	REPORT NO SD 70-205
DATE 1-13-2	COMMAND MODULE	MODEL NO SKYLAB
REF		DRWG NO V56-531152



(BEAM AXIS REACTIONS)

$R_V = 76\cos 30^0 + 304\sin 30^0$

$R_H = -76\sin 30^0 + 304\cos 30^0$

$R_V = 218^{\#}$

$R_H = 225^{\#}$

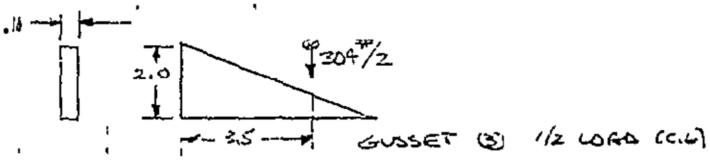
EACH FOOT CARRIES 1/2 LOAD INTO PAN AREA BETWEEN THE THREE NUMBERED GUSSETS

WORST POSSIBLE CASE WOULD BE TOTAL C.G. LOAD APPLIED NORMALLY TO PAN SURFACE THE LOAD IS CARRIED TO BEAM AB BY THE GUSSET MEMBERS

CHECK TWO FOOT POSITIONS—
1) NORMAL FOOT PLACEMENT
2) TIP LOAD

PREPARED BY RGR	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 3 OF 5
CHECKED BY: GF	RESCUE MISSION	REPORT NO SD 70-205
DATE 1-17-2	COMMAND MODULE	MODEL NO SKYLAB
REF		DRWG NO V56-531152

NORMAL FOOT PLACEMENT



BENDING

$M = 3.5(304/2) = 533^{\#}$

$C = 1.0$

$I = .0667$

$\sigma = \frac{Mc}{I} = \frac{1533(1)}{.0667}$

$\sigma = 77{,}991 - PSI$

M.S. = + HIGH

222
TABLE
3 7.20(F)

7075-T7352 AL

FTU - 66 KSI
FTY - 56 KSI
FSU - 39 KSI

$F_{BRU} = 96$ KSI, $e/d = 1.5$
$= 125$ KSI $e/D = 2.0$
$F_b = 66 + 56(1.5-1) = 94$ KSI

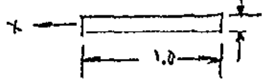
FOOT TIP LOAD
$304^{\#}$ OVER
9.62/2
4.81"

$LOAD = \frac{304}{4.81} = 63^{\#}/IN$

1/2 LOAD, CARRIED BY 1" BOTTOM PLATE IN BENDING

$M = 3.52(63) = 212$ IN #

SECTION



$I_x = 3.42\times10^{-4}$

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531152

REF

(D88)

1.31.01

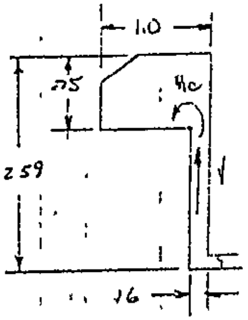
TRD CORD STRESS

$$\sigma = \frac{Mc}{I} = \frac{212(08)}{3.42\times10^{-4}}$$

$$\sigma = 49{,}591$$

$$M.S. = \frac{94}{49.6} - 1 = \underline{.90}$$

CORD TO PIVOT BEAM



$$M_c = T = J_2 \tau_{max} = 533 \text{ IN-LB}$$

$$\tau_{max} = \frac{533}{J_2}$$

$$J_2 = \alpha b t^2$$

$$J_2 = .1156$$

$$\tau_{max} = \frac{533}{.1156}$$

$$\tau_{max} = 4610 \text{ PSI}$$

$$P/A = \frac{152}{.415}$$

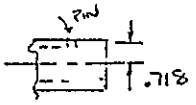
$$P/A = 366$$

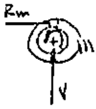
$$\tau_T = 4976 \text{ PSI}$$

$$F_{su} = 39 \text{ KSI}$$

$$M.S. = \frac{39}{4.976} - 1 = \underline{+HIGH}$$

BEARING AT PIN ATTACH POINTS
ATTACHMENT INCLUDES A LOCK PIN





$M_c = 402$ IN #
$V = 313$ LBS

FORM 804-D REV 12-67

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531152

REF

PIN - ATTACHMENT CONT -

$$R_M = \frac{Mc}{.718} = \frac{402}{.718}$$

$$R_M = 562\#$$

2 PINS - 281# PIN

BEARING

$D = .098 \quad t = .15$

$$\sigma = \frac{P}{Dt}$$

$$= \frac{281+156}{.098(.15)}$$

$$\sigma = 29800 \text{ PSI}$$

$$\sigma_{BR} = 96 \text{ KSI}$$

$$MOS = \frac{96}{29.8} - 1 = \underline{2.22}$$

LUG BENDING

$$P = 281 + 156$$
$$= 437 \text{ LBS}$$

$$M = (437)\left(\frac{1.25}{2}\right)$$
$$= 273 \text{ IN-LBS}$$

$$f_b = \frac{4 M r_o}{\pi(r_o^4 - r_i^4)}$$

$$= \frac{4(273)(.718)}{\pi[(.840)^4 - (.718)^4]}$$

$$= 1080 \text{ PSI}$$

$$MS = \underline{+HIGH}$$

FORM 804-D REV 12-67

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SPACE DIVISION
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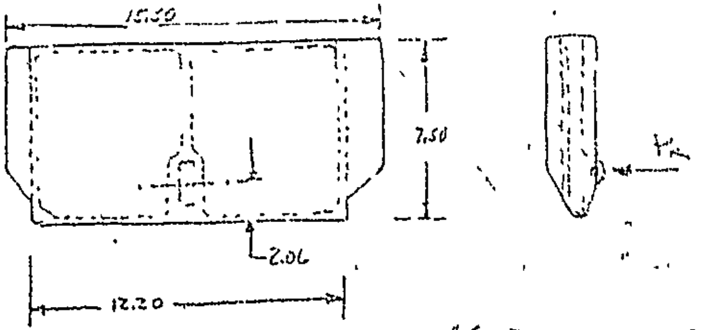
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531153

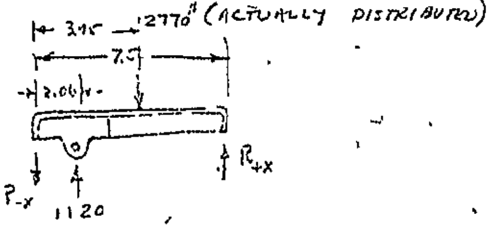
REF
N/A
V56-531
150

PAN - RESCUE COUCH LEG SUPPORT

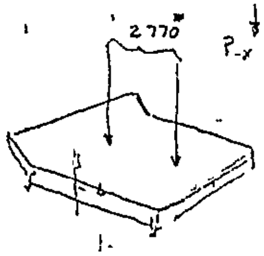


V56 531
151
Pg 3
V56-531
161
Pg 3

PR = 1120 # ULT



CENTR BEAM



TOTAL REACTION INTO TWO BEAMS V56-531151

229

(C22)
TABLE
323.0(h)

2024-T4
QQ-A-200/3

F_{TU} = 65 KSI
F_{TY} = 46 KSI
F_{CY} = 41 KSI

F_{SU} = 33 KSI

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RESCUE MISSION
COMMAND MODULE

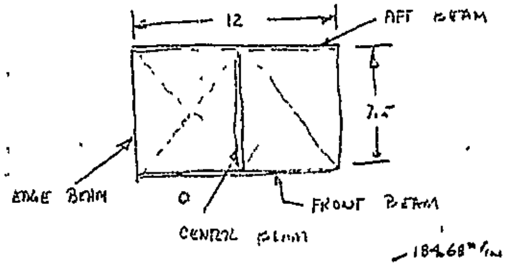
PAGE NO 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531153

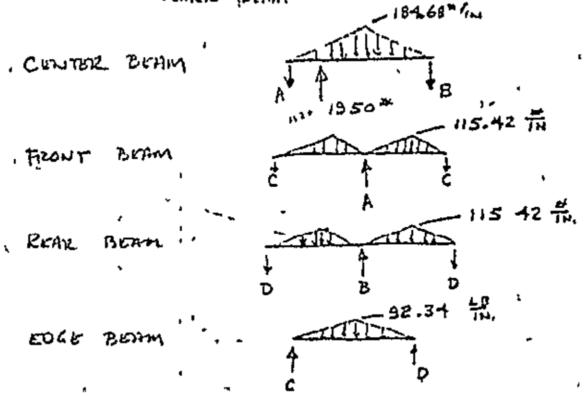
REF

PAN - RESCUE COUCH LEG SUPPORT

ASSUME AN EQUIVALENT PRESSURE OVER
12 X 7.5 IN AREA

$$p = \frac{2770}{(12)(7.5)} = \underline{30.78\ psi}$$





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RESCUE MISSION
COMMAND MODULE

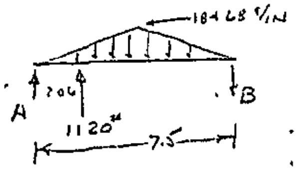
PAGE NO 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531153

REF

HEWLETT
PACKARD
PROGRAM

PAN - RESCUE COUCH LEG SUPPORT

CENTER BEAM



$\Sigma M_A = (1120)(2.06) - \left(\frac{184 68}{2}\right)(7.5)(3.75) - B(7.5) = 0$

$B = \frac{2310 - 2695}{7.5} = \frac{-285}{7.5} = -38\,\#$

$A = \left(\frac{184 68}{2}\right)(7.5) - 38 - 1120 = 692 - 38 - 1120$

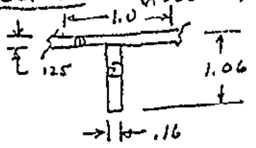
$= -466\ \#$

MOMENT IS MAX @ 1120 #/LOAD POINT -

$M = \overset{f}{(-466)(2.06)} + \overset{W_M}{\left(\frac{2.06}{3.75}\right)(184.68)}\overset{L}{\left(\frac{X}{3}\right)(2.06)}\overset{A}{\left(\frac{2.06}{4}\right)}$

$= -960. + 143.4 = -816\ 6\ \text{IN}\#$

CROSS SECTION (ASSUME)



$A = (1)(.125) + (.935)(.16)$
$= .125 + .150 = \underline{\underline{.275\ \text{IN}^2}}$

$\bar{y} = \frac{(.16)(.935)(.5925) + (1.0)(.125)(.0625)}{.275} = \frac{.0886 + .0078}{.275} = \frac{.0964}{.275}$

$= .350\ \text{IN}$

$K = 1.9$

$I_y = .0302\ \text{IN}^4$

$F_b = 65 + 46(1.9 - 1)$
$= 106.4\ \text{KSI}$

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SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531153

REF

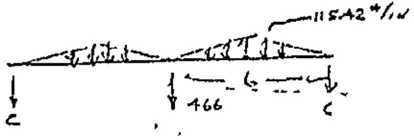
PAN - RESCUE COUCH LEG SUPPORT

$C = .71\ \text{IN}.$

$f_b = \frac{Mc}{I} = \frac{(816.6)(.71)}{.0302} = \underline{19200\ \text{PSI}}$

$\text{M.S} = \frac{106.4}{19.2} - 1 = \underline{4.55}$

FRONT BEAM

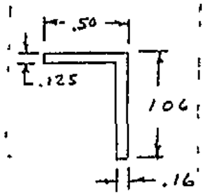


$2C = -466 - \frac{(115.42)(12)}{2} = -466 - 692.52 = -1158.52\ \#$

$C = -579.26\ \text{LBS}$

MOMENT IS MAX @ CENTER -

$\text{Max } M = (-579.26)(6) + \frac{(115.42)(6)(3)}{2} = -3475.56 + 1038.78 = -2436.\ \text{IN-LBS}$



$A = .2121\ \text{IN}^2$
$\bar{y} = .4363\ \text{IN}$
$I = .0234\ \text{IN}^4$

$f_b = \frac{(2436)(.6237)}{.0234}$
$= 64900\ \text{PSI}$

$F_b = 65 + 46(1.66 - 1)$
$= 95.4\ \text{KSI}$

$\text{M S} = \frac{95.4}{64.9} - 1 = \underline{\underline{.47}}$

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DATE: 11/29/71

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RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 3

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-531154

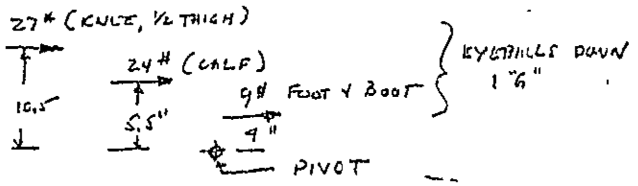
REF

N/A
V56-531
150

PIN - RESCUE COUCH FOOT SUPPORT PIVOT

MOMENTS ABOUT PIN ℄ DUE TO EYEBALLS DOWN + EYEBALLS IN WORST CASE:

II 2 1 3



II.21.9

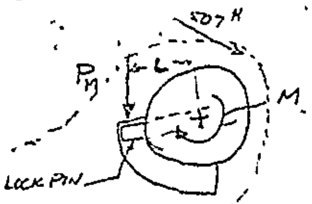
"G" LEVEL = 8.46 (EBD)

$M = [(27)(10.5)+(24)(5.5)+(9)(4)](8.46)$

$= [283 + 132 + 36](8.46) = (451)(8.46)$

$= 3820 \text{ IN}^{\#}$

$V = [27+24+9](8.46) = 507^{\#}$



LOCK PIN HEIGHT

$L = \frac{1.436}{2} + .12 = .83 \text{ IN}$

$P_M = \frac{3820}{.83} = \underline{\underline{4600}}^{\#}$

HINGE PIN LOAD ≅ 4600 + 507 = $\underline{\underline{5107}}^{\#}$ / TWO PINS

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DATE: 12/1/71

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RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 3

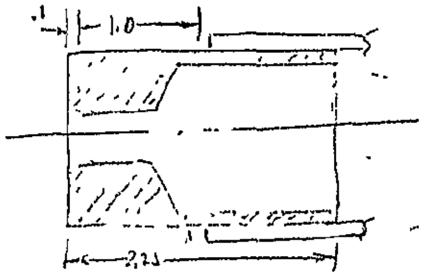
REPORT NO SD 70-205

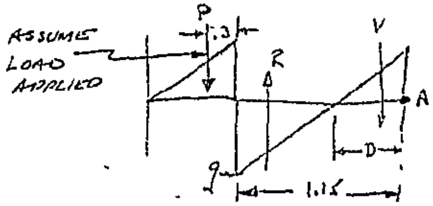
MODEL NO SKYLAB

DWG NO V56-531154

REF

PIN - RESCUE COUCH FOOT SUPPORT PIVOT





$P = R - V$

$\Sigma M_A = \frac{VD}{3} - \frac{R(230+D)}{3} + P(1.45)$

$R = \frac{q(1.15\,D)}{2}$

$\frac{Mc}{I} \pm \frac{P}{A} = \frac{P(.3+.57)(6)}{(1.15)^2} \pm \frac{P}{1.15} = [3.95 \pm .87]P = \underline{4.82P} \text{ or } \underline{3.08P}$

$D = \left(\frac{3.08}{7.90}\right)(1.15) = \underline{\underline{.45 \text{ IN}}}$

$V = \frac{(.45)(3.08)}{2}(P) = .695P$

$R = P + .695P$
$= 1.695\,P$

$q_{MAX} = \frac{1.695(2)P}{.7} = 4.81P = (4.85)(2550) = \underline{12370 \,^{\#}/\text{IN}}$

$f_t = \frac{12370}{1.436 - 1.188} = \frac{12370}{.248} = \underline{49,900 \text{ psi}}$

(IN SLEEVE AROUND PIN)

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CHECKED BY: G.E.
DATE 12/1/71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531154

REF

PIN - RESCUE COUCH FOOT SUPPORT PIVOT

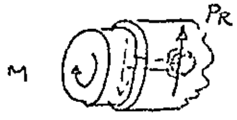
07 01 01 01 NR MTLS MANUAL

MATERIAL OF PIN- AMS 5737 A286

$F_{tu} = 140{,}000\,psi$

M.S. = 1.81

BEARING OF BOLT INTO PIN



$M - 3820\ IN^{\#}$

$P_R = \frac{3820}{2(.718)} = 2660^{\#}/\text{INTERFACE}$

$f_{br} = \frac{2660^{\#}}{(.187)(.124)} = 115000\ psi$ @ 3/16 DIAM PIN

07 01 01 01 NR MTLS MANUAL

$F_{br} = 266{,}000\,psi \quad E/D = 2$

M.S. = 1.31

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RESCUE MISSION
COMMAND MODULE

PAGE NO 1
REPORT NO. SD 70-205
MODEL NO SKYLAB

REF

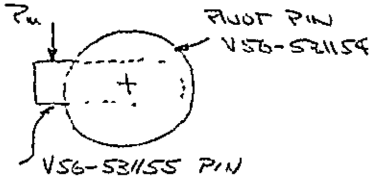
PIN-RESCUE COUCH FOOT SUPPORT LOCK V56-531155

N/A MAT. CRES BAR

V56-531155 AMS 5735 A286 .50 DIA X 1.50

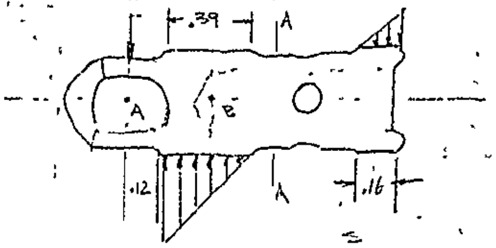
PIN SERVES AS A LOCK PIN IN THE PIVOT ASSY OF THE FOOT SUPPORT RESCUE COUCH

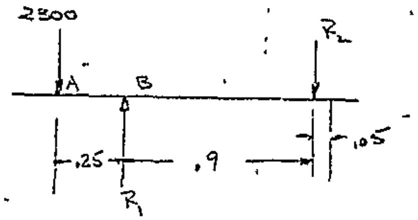
LOADS FROM ANALYSIS OF V56-531154



V56-531154 Pg. 1

$P_{in} = 4600^{\#}/2 = 2200^{\#}$





$\curvearrowright + \quad \Sigma M_B = 0 \quad 0 = -.25(2300) + .9R_2$

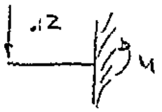
$R_2 = \frac{.25(2300)}{.9} \quad R_2 = .640^{\#}$

$\curvearrowright + \quad \Sigma M_A = 0 \quad -.25R_1 + 1.15R_2 = 0 \quad R_1 = 2940^{\#}$

PREPARED BY: RGR	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 2 OF 4
CHECKED BY G.F		REPORT NO. SD 70-205
DATE 12-10-71	COMMAND MODULE	MODEL NO SKYLAB

V56-531155

BENDING-PROTRUDING HEAD



$M = .12(2300) = 280$ IN #

$I = .0491 D^4 = .0491(.375)^4$

$I = 9.71\times10^{-4}$

$c = .375/2 = .1875$

$\sigma = \frac{Mc}{I}$

$= \frac{280(.1875)}{9.71\times10^{-4}}$

$\sigma = 5.4\times10^{4}$ PSI $F_{TU} = 140\times10^{5}$ $F_{TY} = 95\times10^{3}$ $F_{BU} = 206.5$ KSI

K = 1.7

$M.S. = \frac{206.5}{54} - 1 = \underline{2.82}$

SHEAR

$A = \pi\frac{D^2}{4} = \frac{3.14(.375)^2}{4}$

$A = 0.11 \text{ IN}^2$

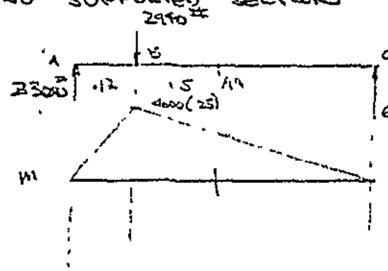
$P = 2300$#

$P/A = 2300/.11 = 2.09\times10^{4}$ PSI

$F_{SU} = 91\times10^{3}$

$M.S. = 91/21 - 1 \quad \underline{+3.34}$

BENDING SUPPORTED SECTION



$M_B = 640(.4)$

$M_B = 256$ IN#

FORM M182 R4 REV 11-67

PREPARED BY RGR	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 3 OF 4
CHECKED BY G.F		REPORT NO. SD 70-205
DATE 12-10-71	COMMAND MODULE	MODEL NO SKYLAB

V56-531155

BENDING @ A-A

$M = 256$ IN # $I = \frac{\pi}{64}[.375^4 - .257^4]$ $c = .1875$

$I = 7.59\times10^{-4}$

$\sigma = \frac{Mc}{I}$

$= \frac{256(.1875)}{7.59\times10^{-4}}$

$= 63300$ PSI

K = 1.48

$F_{BU} = F_{TU} + K F_{TY} = 185.6$ KSI $M.S. = \frac{185.6}{63.3} - 1 = +\underline{1.94}$

SHEAR - A-A

$A = \frac{\pi}{4}[.375^2 - .257^2]$

$A = 5.89\times10^{-2}$

$P = 640$

$P/A = 640/.0589$

$\tau = 10900$ $F_{SU} = 95$ KSI

$M.S. \quad \frac{91}{10.9} - 1 = \underline{+ \text{HIGH}}$

CHECK COMBINED BEND + SHEAR @ A-A

$f_b = 63.3\times10^{3}$ $F_{BU} = F_{TU} + KF_{TY} = 140 + 95(1.48-1)$

$= 185.6$ KSI

$f_s = 10.9\times10^{3}$

FOR FIG. 15.35. M-5A

$R_1 = \frac{f_b}{F_{BU}} = \frac{63.3}{185.6} = .345$ $R_2 = \frac{10.9}{91} = .12$

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RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 4
REPORT NO. SD 70-205
MODEL NO SKYLAB

V56-531155

$$R_1^2 + R_2^2 = 1$$

$$M.S = \frac{1}{\sqrt{R_1^2 + R_2^2}} - 1$$

$$M.S = \frac{1}{\left[.341^2 + .12^2\right]^{1/2}} - 1 = \underline{+1.77}$$

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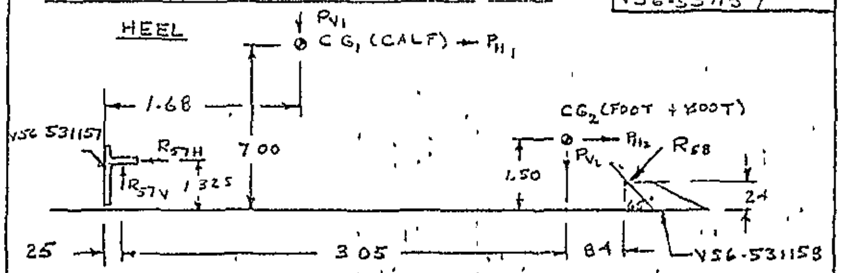
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531157

REF N/A

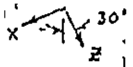
CLIP - RESCUE COUCH FOOT SUPPORT

V56-531150



II.2.1.3 WT FEET + BOOTS = 9.0 LBS

WT CALF (2) = 24 LBS.



II.2.1.9 $N_X = 33.84g$ $N_Z = 8.46g$

CALF LOADS

$P_{X_1} = (24)(\frac{1}{2})(33.84)$
$= 406$ LBS (ULT)

$P_{Z_1} = 12(8.46)$
$= 101.5$ LBS (ULT)

$P_{H_1} = -406 \cos 30° + 101.5 \sin 30°$
$= -352 + 50.75$
$= -301.25$ LBS

$P_{V_1} = 406 \sin 30° + 101.5 \cos 30°$
$= 203 + 87.9$
$= 290.9$ LBS.

FOOT AND BOOT LOADS

$P_{X_2} = 9(\frac{1}{2})(33.84)$
$= 152$ LBS (ULT)

$P_{Z_2} = (9.0)(\frac{1}{2})(8.46)$
$= 38.1$ LBS (ULT)

$P_{H_2} = -152 \cos 30° + 38.1 \sin 30°$
$= -112.6$ LBS (ULT)

$P_{V_2} = 152 \sin 30° + 38.1 \cos 30°$
$= 109$ LBS (ULT)

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531157

REF

CLIP-RESCUE COUCH FOOT SUPPORT HEEL

REACTIONS

$+\!\curvearrowright \Sigma M_{57} = 0 = (290.9)(1.43) + (-301.25)(5.675) + (112.6)(3.05) + (-109.)(.175) + R_{58}\left[\cos 65^\circ(3.89) + \sin 65^\circ(1.085)\right]$

$= 416 - 1709 + 343 - 19.08 + 2.628\,R_{58}$

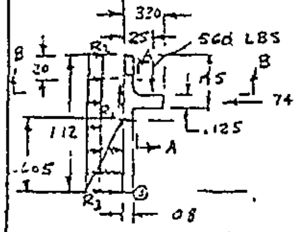
$R_{58} = 369 \text{ LBS.}$

$R_{57V} = 290.9 + 112.6 + 369 \cos 65^\circ$

$R_{57V} = \underline{559.5 \text{ LBS}}$

$-R_{57H} = -301.25 + 1109 + 369 \sin 65^\circ$

$= \underline{-744.68 \text{ LBS.}}$



$R_1 = \underline{560 \text{ LBS}}$

$\Sigma A = .08(1.12) + .125(.25)$
$= .1209 \text{ IN}^2$

$\Sigma A\bar{Y} = (.0896)(.56) + (.0313)(.7325)$
$= .0731 \text{ IN}^3$

$\bar{Y} = \dfrac{.0731}{.1209}$

$= .605 \text{ IN}$

$+\!\curvearrowright M_{c.g.} = .25(560) - (.1275)(745)$
$= 140. - 95$
$= 45 \text{ IN-LBS}$

① $\Sigma F_H = 745 = \frac{1}{2}(.605)R_3 + 1.12 R_2$

② $\Sigma M = 45. = \frac{1}{2}(.605 R_3)(.403) + (1.12) R_2 (.56)$

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531157

REF

CLIP-RESCUE COUCH FOOT SUPPORT HEEL

REACTIONS

$1.12 R_2 + .3025 R_3 = 745 \quad (\div 8.2)$

$\underline{.0504 R_2 + .1220 R_3 = 45 \quad (\div 3.3)}$

$.1366 R_2 + .0369 R_3 = 90.9$

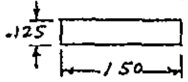
$\underline{.01527 R_2 + .0369 R_3 = 13.64}$

$.12133 R_2 = 77.26$

$R_2 = 636 \ \dfrac{LB}{IN}$

$R_3 = 108 \ \dfrac{LB}{IN}$

BENDING AT A-A



Ⓒ22 TABLE 3.7.2.0(g)

7075-T73511
$F_{TU} = 68$ KSI
$F_{TY} = 58$ KSI
$F_{CY} = 58$ KSI
$F_{SU} = 37$ KSI

$M_A = (.17)(560)$
$= 95.2 \text{ IN-LBS}$

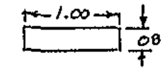
$f_b = \dfrac{6(95.2)}{(1.5)(.125)^2}$
$= 24,370 \text{ PSI}$

$\dfrac{P}{A} = \dfrac{745}{(1.50)(.125)}$
$= 3973. \text{ PSI}$

$f = 24370 + 3973$
$= 28348 \text{ PSI}$

$M.S. = \dfrac{58}{28.3} - 1 = \underline{1.04}$

BENDING AT B-B



$M_{B-B} = (634)(.325)(.1625) = 33.6 \text{ IN-LBS}$

$f_b = \dfrac{6(33.)}{(1)(.08)^2} = 31490 \text{ PSI}$

$M.S. = \dfrac{58}{31.5} - 1 = \underline{.84}$

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RESCUE MISSION
COMMAND MODULE
PAGE NO 4 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531157

REF

CLIP- RESCUE COUCH FOOT SUPPORT HEEL

FASTENERS

(C22) TABLE 8.1 5(a)

NAS 1131 (A286)

$P_s = \frac{R_1}{2} = 280$ LBS

$P_{su}' = 2513$ LBS

M.S = + HIGH

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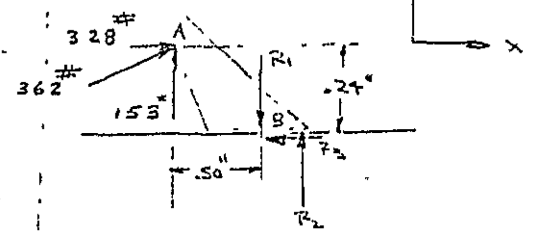
RESCUE MISSION
COMMAND MODULE
PAGE NO 1 OF
REPORT NO SD 70-205
MODEL NO SKYLAB

REF N/A V56-531150

CLIP-RESCUE COUCH FOOT SUPPORT INSTEP

V56-531158

REFER TO ANALYSIS V56-531157 PAGE 2 FOR INPUT LOADS



LOADING OF 93# IS SHOWN

ASSUMED REACTIONS R1, R2, R3 AS SHOWN

$+\Sigma M_b = 0$

$.50 R_1 - .70 R_2 + .24 R_3 = 0$

$\Sigma M_B = 0$

$.24(328) + .50(153) - .20 R_2 = 0$

$R_2 = \frac{78.8 + 76.5}{.20}$

$\underline{R_3 = 770\#}$

$\Sigma F_x = 0$ $\underline{R_3 = 328\#}$ $\Sigma F_z = 0$ $153 + R_2 = R_1$

$\underline{330 = R_1}$

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CHECKED BY: R.G.R.
DATE: 1/19/72

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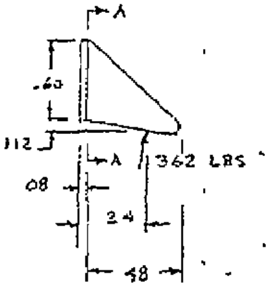
COMMAND MODULE

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531158

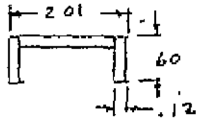
REF

CLIP-RESCUE COUCH FOOT SUPPORT

INSTEP



$M_{A-A} = .24\,(328) + (.412)(153)$
$= 78.6 + 63$
$= 141.6$ IN-LBS



SECT. A-A

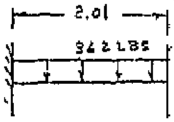
ASSUME EACH LEG TAKES ½ M.

$F_b = \frac{6\,(70.8)}{(.12)(.60)^2} + \frac{153}{(.072)}$
$F_b = 11970$ PSI

Ⓒ22
27.20(g)

7075-T73511
$F_{TU} = 68$ KSI
$F_{TY} = 58$ KSI
$F_{CY} = 58$ KSI
$F_{SU} = 37$ KSI

M.S. $= \frac{68}{11.97} - 1 = \underline{4.70}$



$M = \frac{1}{12}\,(362)(2.01)$
$= 60.6$ IN-LBS.

$f_b = \frac{6\,(60.6)}{(.48)(.125)^2}$
$= 48{,}400$ PSI

M.S. $= \frac{58}{48.4} - 1 = \underline{.20}$

Ⓒ22
31.5(c)
31.5(b)

NAS 1131 SCREWS (3)
$P_{su} = 2513$ LBS $\quad P_t = 2530$ LBS.
$\frac{R_3}{3} = 109$ LBS $\quad \frac{R_1}{3} = 310$ LBS
M.S. = $\underline{+HIGH}$

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DATE: 1/21/71

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RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531159

REF
NA
V56531
150
V56-531
161
Pg 3

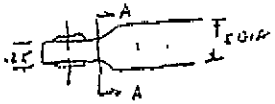
LINK - RESCUE COUCH LEG SUPPORT ASSY OF

LOADS IN LINK = 1120 LBS COMPRESSION (ULT)
IN 'Y' DIRECTION

SELF ALIGNING BEARING -
KSBG-4CR GOOD FOR 8400# YIELD
ON STEEL BALL (PER KAHR CATALOG)

M.S. $= \frac{8400}{1120} - 1 = \underline{+HIGH}$

MINIMUM AREA



$A = (.25)(.5) = .125\,\text{IN}^2$
$f_c = \frac{1950}{.125} = 15{,}600$ PSI $\quad \underline{\text{NOT CRITICAL}}$

COLUMN ON LINK ASSY - REF V56-531160

LENGTH = 5.4"

ASSUME AVERAGE CROSS SECTION AS THE ROOT DIAMETER OF -531160 PART

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RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531159

REF

LINK - RESCUE COUCH LEG
SUPPORT, ASSY OF (CONTINUED)

THREAD — 5/16-24 UNF

ROOT DIAM = .26 IN

ROOT $I = \frac{\pi D^4}{64} = \left(\frac{3.14}{64}\right)(.26)^4$

$= .000224 \text{ IN}^4$

$\rho = \sqrt{\frac{I}{A}} = \sqrt{\frac{\cancel{\pi} D^4 (4)}{64(\cancel{\pi} D^2)}} = \sqrt{\frac{D^2}{16}}$

$= \frac{D}{4} = \frac{.26}{4} = .065 \text{ IN}$

$L/\rho = \frac{5.4}{.065} = 83$

$\sigma_{cr} = \frac{\pi^2 E}{(L/\rho)^2} = \frac{(3.14)^2(30 \times 10^6)}{(83)^2}$

$= 42{,}900 \text{ PSI}$

$\text{AREA} = \frac{\pi D^2}{4} = \left(\frac{3.14}{4}\right)(.26)^2 = .053 \text{ IN}^2$

$f_c = \frac{1120}{.053} = 21150 \text{ PSI}$ $\quad MS = \frac{42.9}{21.15} - 1 = 1.03$

@ $\frac{1}{32}$ ECC $\quad f_b = \left(\frac{1120}{32}\right)\left(\frac{.13}{.000224}\right) = 20350 \text{ PSI}$

E22
TABLE
6.210(b)

$f_c = 41500 \text{ PSI}$ $\quad$ YIELD $M.S. \cong \frac{95}{41.5} - 1 = 1.29$

(BASED UPON 1/32 ECCENTRICITY SEE NAS2-400
PG 7-21-1

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531159

REF

LINK - RESCUE COUCH (CON)

$I_{\text{LARGER SECT}} = \frac{\pi D^4}{64}$ (V56-531160)

$= \frac{(3.14)(.5)^4}{64} = \frac{(3.14)(.0625)}{64}$

$= .00307 \text{ IN}^4$

NAS2-400
PAGE
2-52-1

$\frac{I_L}{I_S} = \frac{.00307}{.000224} = 13.7$ $\quad$ STEPPED COLUMN

$a/L = \frac{3.68}{5.4} = .681$

$B = 2.2$

$P_{cr} = \frac{(2.2)(30 \times 10^6)(.00307)}{(5.4)^2}$

$= 6950\#$ $\quad MS \ \frac{6950}{1120} - 1 = +\text{HIGH}$

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CHECKED BY: G F		REPORT NO SD 70-205
DATE: 11/23/71	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-531160

REF N/A

V56-531 150

ROD END - RESCUE COUCH

LEG SUPPORT, ASSY OF

REFERENCE V56-531159 FOR LOADS AND ANALYSIS. THE TWO PARTS ARE ASSEMBLED AS ONE LINK.

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DATE 1-13-2	COMMAND MODULE	MODEL NO SKYLAB

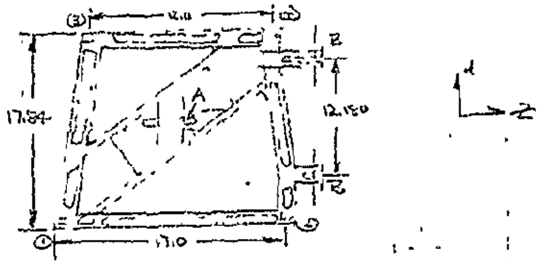
REF N/A

V56 531 150

FITTING - RESCUE COUCH LH SUPPORT ADAPTER

DWG NO V56-531161

FITTING ATTACHES TO A3 LOCKER MOUNTING BRACKETS SKYLAB RESCUE VEHICLE SUPPORTS LEG+FOOT PAN V56-531153,52



A3 ATTACH POINTS REACTIONS

	X	Y	Z
1	YES	YES	YES
2	YES		
3	YES		YES
4	YES		

ADAPTER INPUT

POINT A - STRUT ATTACHMENT (V56-531159)

POINTS B - FOOT, LEG PAN, BEAM ATTACHMENT (V56-531151)

MATERIAL PROPERTIES

HAND FORGED (BAR)

C22

3720(F2)

MB0170-065 7075 T-7352

FTU = 66 KSI

FTY = 56 "

FSU = 39 "

FBRU = 96 " e/D = 1.5

FBRY = 66+.5(56) = 84 "

FORM 604-B REV 12-67

PREPARED BY: R612
CHECKED BY: G F
DATE: 1-10-72

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

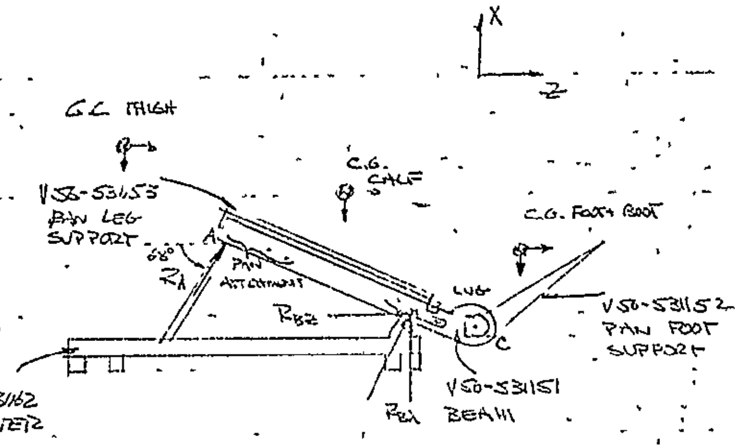
PAGE NO 2 OF 17
REPORT NO SD 70-705
MODEL NO SKYLAB
DWG NO V56-531161

REF

BEAM - RESCUE COUCH L.H SUPPORT ADAPTER

BEAM SUPPORTS LEG SUPPORT PAN (V56-531153)
AND THE SUPPORT PAN FOR THE FEET (V56-531152)
IT IS DESIGNED TO TRANSFER LOADING OF LOWER
LEG TO THE SUPPORT ADAPTER IN LOCKER SPACE A-1
V56-531162

LOADING



SUPPORT REACTIONS

R_A - ATTACH POINT ON V56-531153 PAN (1)

R_B - ATTACH POINTS ON V56-531151 BEAM (2)

C G LOADS

II 21.3 THIGH - 27# FOR 1/2 THIGH WT
CALF - 24# FOR CALF
FOOT - 9# FOR FEET + BOOTS

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SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

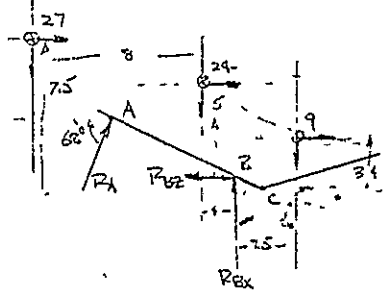
PAGE NO 3 OF
REPORT NO SD 70-705
MODEL NO SKYLAB
DWG NO V56-531161

REF

SYSTEM
REACTIONS $R_A + R_B$

DUE TO WORST CONDITION, $G_X + G_Z$

II.21.9 $G_X = -33.84$ } BOEING CRITERIA
$G_Z = 8.46$



$+\curvearrowleft \Sigma M_B = 0$

$$27(8.46)(7.5)-27(33.84)12+8R_A+24(8.46)5$$
$$-24(33.84)4+9(33.84)(6.5)+9(8.46)(3.4)=0$$

$$R_A = 1120^{\#}$$

$\Sigma F_Z = 0$

$$8.46\,(27+24+9) = R_{BZ} - R_A \cos 68^\circ$$
$$507 = R_{B\text{-}Z} - .375 R_A$$
$$R_{BZ} = +927^{\#}$$ TOTAL REACTION

$\Sigma F_X = 0$

$$R_A \sin 68^\circ + R_{BX} = (27+24+9)(33.84)$$
$$R_{BX} = 2030 - 1040 \quad (1)$$
$$R_{BX} = 990^{\#}$$ TOTAL REACTION

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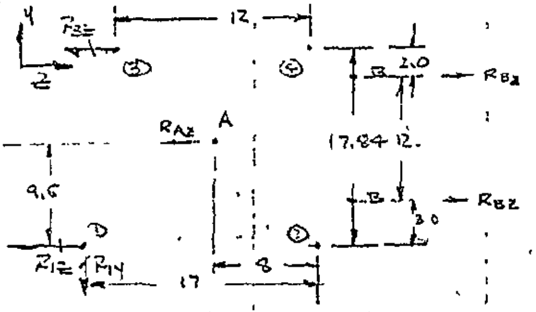
RESCUE MISSION
COMMAND MODULE

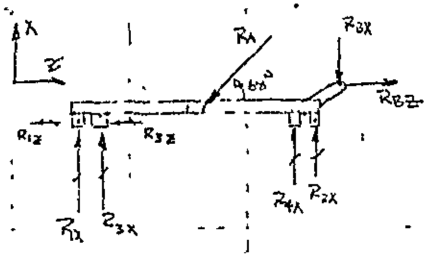
PAGE NO. 4 OF 18
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531161

REF

LOAD DISTRIBUTION

FITTING REACTIONS





$R_A = 1120^{\#}$
$R_{Ax} = 1040^{\#}$
$R_{Az} = 420^{\#}$

$R_{Bz} = 4635^{\#}$
$R_{Bx} = 495^{\#}$

FORM 984-D REV 12-67

PREPARED BY RGR
CHECKED BY G.F
DATE 1-18-2

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RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 18
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531161

REF

SUPPORT ADAPTER REACTION LOADS

MAX INPUT LOADS - $N_x + N_z$

Z LOADS

$\curvearrowright + \Sigma M_1 = 0 \quad -17.84(R_{3z}) + 3(R_{Bz}) + 15(R_{Bz}) - 9.5 R_{Az} = 0$

$17.84(R_{3z}) = -9.5(R_{Az}) + 18 R_{Bz}$

$R_{3z} = -\frac{9.5}{17.84}(420) + \frac{18}{17.84}(463.5)$

$R_{3z} = 242.5^{\#}$

$\Sigma F_z = 0$

$R_{1z} + R_{3z} + R_{Az} = 2R_{Bz}$

$R_{1z} = 2R_{Bz} - R_{Az} - R_{3z}$

$= 2(463.5) - 420 - 242.5$

$R_{1z} = 264.5$

X LOADS

$\curvearrowright + \Sigma M_{1-2} = 0$

$17.84(R_{3x}) + 17.84(R_{4x}) = 18 R_{Bx} + 9.5 R_{Ax}$

ASSUME 60% LOAD TO R_4

$R_{4x} = \frac{.60}{17.84}\left[18(495) + 9.5(1040)\right]$

$R_{4x} = 631^{\#}$

$1.5 R_{3x} = R_{4x}$

$R_{3x} = R_{4x}/1.5$

$R_{3x} = 420^{\#}$

FORM 984-D REV 12-67

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RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 13
REPORT NO SD 70-205
MODEL NO. SKYLAB
DRWG NO V56-531161

X LOADS CONT,

$\Sigma M_{3-4} = 0$

$17.84(R_{1x}) + 17.84(R_{2x}) = 8.34(R_{Ax}) + 16(R_{Bx})$

$R_{1x} + R_{2x} = \frac{1}{17.84}\left[8.34(1040) + 16(495)\right]$

ASSUME 50% LOAD TO R1X

$R_{1x} = .50 \frac{1}{17.84}\left[8.34(1040) + 16(495)\right]$

$\underline{R_{1x} = 463.5^{\#}}$

$\underline{R_{2x} = 463.5^{\#}}$

N_Y, N_Z LOADS NOT CRITICAL

SUMMARY OF LOADS

FITTING	X	Z	Y
1	463.5	264.5	
2	463.5		
3	420.	242.5	
4	631		

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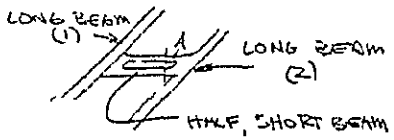
RESCUE MISSION
COMMAND MODULE

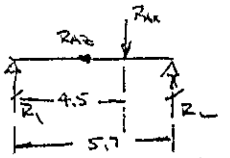
PAGE NO 7 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531161

INTERNAL REACTIONS

LOAD INPUT POINT A



TAKE 1/2 RA LOAD ON 1/2 SHORT BEAM
TREAT AS PINNED-PINNED



$R_{AX} = 1040/2 = 520^{\#}$

$R_{AZ} = 420/2 = 210^{\#}$

$R_2 = \frac{4.5(520)}{5.7}$

$R_2 = 410^{\#}$ ∴ $R_1 = 520 - 410$

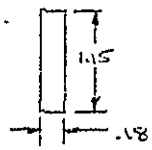
$R_1 = 110^{\#}$

$M_{MAX} = 1.2(R_2)$

$= 1.2(410)$

$M_{MAX} = 492$ IN #

SECTION AT A (HALF BEAM)



$A = .207$ IN^2

$\bar{X} = .57$ IN

$I = .0228$ IN^4

$C = 1.15 - \bar{X}$

$C = .57$

$P/A = \frac{210}{.207} = 1014$ PSI

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SPACE DIVISION
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- RESCUE MISSION -
COMMAND MODULE

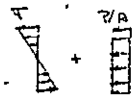
PAGE NO. 8 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531161

REF

BENDING

$$\sigma = \frac{Mc}{I} = \frac{492(.57)}{.0228}$$

$\sigma = 12300$ PSI



= MAX σ
12300 + 1014

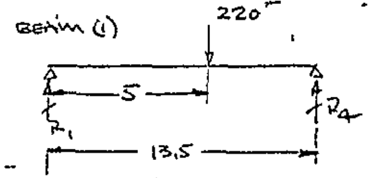
$\sigma = 13{,}314$ (TENSION)

$F_{TU} = 66$ KSI

$$MoS. = \frac{66}{13.31} - 1 = \underline{\underline{+3.95}}$$

LONG BEAM REACTIONS
TREAT AS PINNED-PINNED WITH INTERMEDIATE LOAD (FROM SHORT BEAMS)

LONG BEAM (1)



$$R_4 = \frac{5(220)}{13.5}$$

$R_4 = 121.8^{\#}$ 121.8

$R_1 = 220 - 121.8$

$R_1 = 98.2^{\#}$

MAX MOM = $R_1 X$

$M_{max} = 98.2(5)$
$= 491$ IN #

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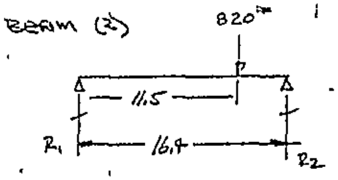
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 9 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAW NO V56-531161

REF

P. 7

LONG BEAM (2)



$$R_2 = \frac{820(11.5)}{16.4}$$

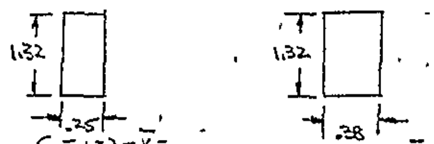
$R_2 = 575$ #

$R_1 = 820 - 575$

$R_1 = 245$ #

$M_{max} = 575(4.9)$
$M_{max} = 2820$ IN #

SECTION PROPERTIES



$C = 1.32 - \bar{X} =$	$C = 1.32 - \bar{X} =$
$A = .33$	$A = .502$
$\bar{X} = .66$	$\bar{X} = .66$
$I = .0479$	$I = .0728$

BENDING STRESS

$$\sigma_1 = \frac{491(.66)}{.0479}$$
$= 6760.$ PSI

$$\sigma_2 = \frac{2820(.66)}{.0728}$$
$= 18540$ PSI

$$MoS = \frac{.94}{18.54} - 1 = \underline{\underline{4.06}}$$

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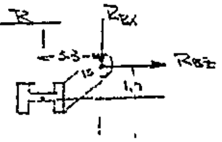
:RESCUE MISSION
COMMAND MODULE

PAGE NO 10 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531161

REF

INPUT REACTIONS B



SECTION BEAM 4-2

$R_{BX} = 495^{\#}$
$R_{BZ} = 463.5^{\#}$

TORQUE

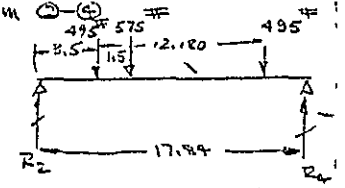
$T = 3.3(495) + 1.7(463.5)$

$T = 1630 + 786$

$T = 2416 \text{ IN } \#$

P1

BEAM ②-④



NEGLECT SIDE LOAD (R_{BZ})

575# LONG BEAM (2) LOAD A

$$R_4 = \frac{3.5(495) + 15.68(495) + 5(575)}{17.84}$$

$$R_4 = \frac{19.18(495) + 5(575)}{17.84}$$

$R_4 = 694^{\#}$

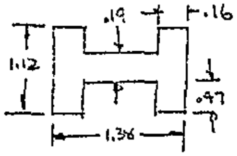
$R_2 = 871^{\#}$

Max Mom

$M_{max} = 871(5) - 495(1.5)$

$= 3623 \text{ IN } \#$

SECTION BEAM ②-④



K = 1.62

A = .5598
$\bar{X}$ = .5636
I = .0381"

$F_b = 66 + .62(56) = 100.7 \text{ KSI}$

FORM 604-B REV 12-67

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SPACE DIVISION
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RESCUE, MISSION
COMMAND MODULE

PAGE NO 11 OF 13
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531161

REF

BEAM - ②-④

BENDING -

$$\sigma = \frac{Mc}{I}$$

$$= \frac{3623(.56)}{.0381}$$

$\sigma = 53{,}300 \text{ PSI}$

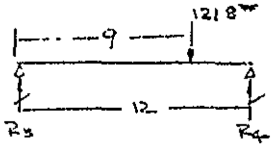
$$MS = \frac{100.7}{53.3} - 1 = +.89$$

BEAMS - (1)-(2) AND ③-④ PICK UP TORSION OR LOAD INPUTS B AS BEAM BENDING. HIGHEST VALUE FOR BEAM ③-④

BEAM - ③-④

BENDING MOMENT DUE TO LOAD FROM CROSS BEAM (1) AND LOAD POINT B BENDING

P. 8



$+ \; M = T = 2416 \text{ IN } \#$

$$R_4 = \frac{9(1218)}{12}$$

$R_4 = 914^{\#}$

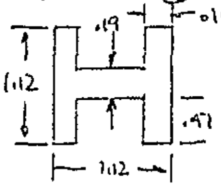
$R_3 = 304^{\#}$

$M_{max} = 30.4(9) = 273.6 \text{ IN } \#$

$M_T = 2416 + 273.6$

$M_T = 2689.6 \text{ IN } \#$

SECTION BEAM ③-④



K = 1.58

$F_b = 66 + .58(56)$
$= 98.45$

A .5598
$\bar{X}$ .5636
I .0381
C = .56

FORM 604-B REV 12-67

2444

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COMMAND MODULE

PAGE NO 12 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-53116/

REF

BENDING BEAM ③-④

$$\sigma = \frac{Mc}{I} = \frac{24876(.56)}{.0381}$$

σ = 38600 PSI

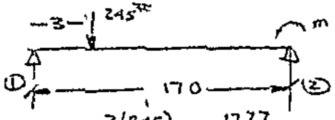
$$MoS \quad \frac{98.45}{39.6} - 1 = \underline{+\ 1.49}$$

BEAM ①-②

LOADED BY CROSS BEAM ①-④ AND TAKE TORQUE OF BEAM ②-③ AS BENDING.

$T = M = 1.7(463.5) + 2(495)$

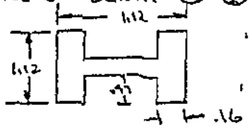
$M = 1777$ IN #



$$R_2 = \frac{3(245)}{17} - \frac{1777}{17.0}$$

$R_2 = -60.8$ LBS
$R_1 = 3495$ LBS
$M_{max} = 3495(3) = 1048$ IN #

SECTION BEAM ①-②



A .5104
$\bar{X}$ .5630
I .0379
C = .56

BENDING STRESS

$$\sigma = \frac{Mc}{I} = \frac{1048(.56)}{.0379}$$

σ = 15,480 PSI

$$MoS = \frac{98.45}{15.48} - 1 = \underline{+\ HIGH}$$

FORM 994-B REV 12-67

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

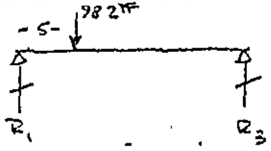
PAGE NO 13 OF 18
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO V56-531161

REF

P. 8

BEAM ①-②

BEAM IS LOADED BY CROSS BEAM ①

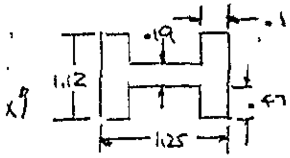


$$R_3 = \frac{5(98.2)}{17.88}$$

$R_3 = 27.5$ #
$R_1 = 70.7$ #
$M_{max} = 70.7(5) = 353.5$ IN #

SECTION BEAM ①-⑤

K = 1.6



A = .5351
$\bar{X}$ = .5633
I = .0380
C = .56

$F_b = 66 + .60(56)$
= 99.6 KSI

BENDING -

$$\sigma = \frac{Mc}{I} = \frac{353.5(.56)}{.0380}$$

σ = 5200 PSI

$$MoS = \frac{99.6}{5.2} - 1 = \underline{+\ HIGH}$$

FORM 994-B REV 12-67

246

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RESCUE MISSION
COMMAND MODULE

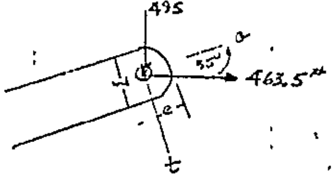
PAGE NO. 14 OF 18
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531161

REF

Ⓔ5
Pg D18

LOAD INPUT B

LUG REACTIONS –



$e = .44$ $D = .312$ $W = .88$ $t = 0.18$

$e/D = 1.41$ $W/D = 2.8$ $D/t = 1.7$ $A_{br} = Dt = .056$ $A_t = (W-D)t = .102$

<u>axial</u>

$P_{BRU} = K_{BR} F_{BRU} A_{br}$ $K_{BR} = .70$

$= .70(96)(.056)$

$P_{BRU} = 3760^{\#}$

$P_{ARP} = \frac{1}{2}[463.5 \cos 35° - 495 \sin 35°]$
$= 48$ LBS

$R_a = \frac{49}{3760} = .01276$

<u>TRANSVERSE</u>

$P_t = \frac{1}{2}[463.5 \sin 35° + 495 \cos 35°]$
$= 335$ LBS

$A_1 = A_4 = .18(.18) = .0324$

$A_2 = A_3 = .15(.18) = .0270$

$A_{av} = \frac{6}{3/A_1 + 1/A_2 + 1/A_3 + 1/A_4}$ $\frac{A_{av}}{A_{br}} = \frac{.0304}{.056}$

$= \frac{6}{4/A_1 + 2/A_2}$ $= .542$

$= \frac{6}{123+74}$

$A_{av} = .0304\ in^2$

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 15 OF 18
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531161

REF

<u>LUG AT B CUT</u>

$P_{TRU} = K_{TRU} F_{TU} A_{BR}$ $K_{TRU} = .32$

$= .32(66)(.056)$

$P_{TRU} = 1,180$

$P_T = 335^{\#}$

$R_T = \frac{335}{1180} = .284$

$M.S. = \frac{1}{(R_a^{1.6} + R_t^{1.6})^{.625}} - 1$

$= 3.52 - 1$

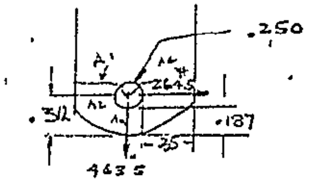
M.S = <u>2.52</u>

CRITICAL FITTING LUGS

LUG ① COMBINED LOAD

LUG ④ AXIAL LOAD

LUG ①



$e = .312$ $D = .250$ $W = 1.00$ $t = .40$

$e/D = 1.24$ $W/D = 4$ $D/t = .625$ $A_{br} = Dt = .10$
$A_t = (W-D)t = .3$

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RESCUE MISSION
COMMAND MODULE

PAGE NO. 16 OF 19
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DRWG NO V56-531161

REF

LUG ③ CONT

Axial Load

$P_{BRU} = K_{BR} F_{BRU} A_{BR}$ $K_{BR} = .55$
$F_{BRU} = 115$

$= .55(96)(.1)$

$P_{BRU} = 5280^{\#}$

$P_{APP} = 463.5^{\#}$

$R_a = \frac{463.5}{5280} = .0878$

TRANSVERSE

$A_1 = A_4 = (.4)(.4) = .16$

$A_2 = (.375)(.4) = .15$

$A_3 = (.187)(.4) = .0748$

$A_{AV} = \frac{6}{\frac{1}{A_1} + \frac{1}{A_2} + \frac{1}{A_3}} = \frac{6}{25 + 6.7 + 13.5}$

$A_{AV} = .133$

$\frac{A_{AV}}{A_{BR}} = \frac{.133}{.10} = 133$

$P_{TRU} = K_{TRU} F_{TU} A_{BR}$ $K_{TRU} = .28$

$= .28(66)(.1)$

$P_{TRU} = 1848^{\#}$

$R_T = \frac{264.5}{1848} = .143$

COMBINED

$MS_o = \frac{1}{(R_a^{1.6} + R_T^{1.6})^{.45}} - 1$

$= +4.53$

FORM 944-B REV 12-67

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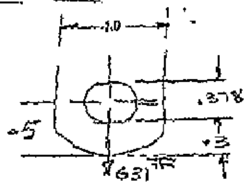
RESCUE MISSION
COMMAND MODULE

PAGE NO. 17 OF 19
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DRWG NO V56-531161

REF

LUG ④

Axial Only



$P_{BRU} = K_{BR} F_{BRU} A_{BR}$ $A_{BR} = DT = .378(.32)$
$K_{BR} = .65$

$= .65(96)(.121)$

$P_{BRU} = 7550^{\#}$

$MS_a = \frac{7550}{631} - 1 = +HIGH$

FORM 944-B REV 12-67

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 15 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531161

REF

FITTING-RESCUE COUCH L H SUPPORT ADAPTER

COMBINED BENDING AND TORSION BEAM 2-4

Pg 10

$M = 371(3.5)$
$= 3050$ IN-LBS

$T = 2416$ IN-LBS.

$$f_b = \frac{(3050)(.56)}{.0381}$$
$$= 44{,}900 \text{ PSI}$$

$$\tau = \frac{T t_1}{\Sigma b t^3}$$

$t_1 = .16$ IN.
$t_2 = .19$ IN
$b_1 = 1.12$
$b_2 = 1.06$

$$\Sigma b t^3 = 2(1.12)(.16)^3 + (1.06)(.19)^3$$
$$= .01648 \text{ IN}^4$$

$$\tau = \frac{(2416)(.16)}{.01648}$$
$$= 23460 \text{ PSI}$$

$$R_b = \frac{44.9}{100.7} = .445 \qquad R_{ST} = \frac{23.4}{39} = .6$$

$$M.S = \frac{1}{\sqrt{(.445)^2 + (.6)^2}} - 1 = +.34$$

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DATE: 1-5-72

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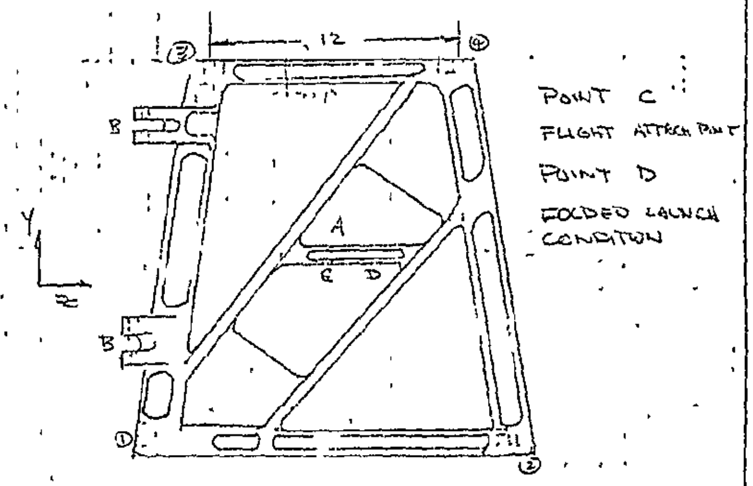
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531162

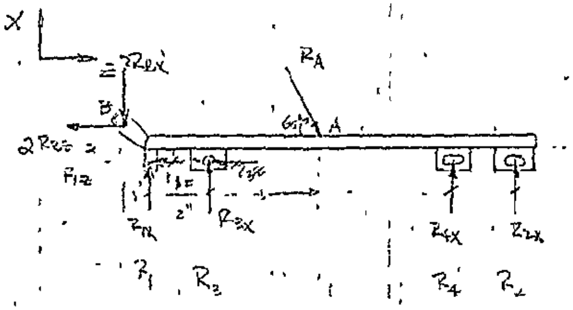
REF
N/A
V56-531150

FITTING-RESCUE SUPPORT ADAPTER ASSY OF

FITTING ATTACHES TO A1 LOCKER MOUNTINGS. SKYLAB RESCUE VEHICLE



FITTING REACTIONS



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RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531162

REF

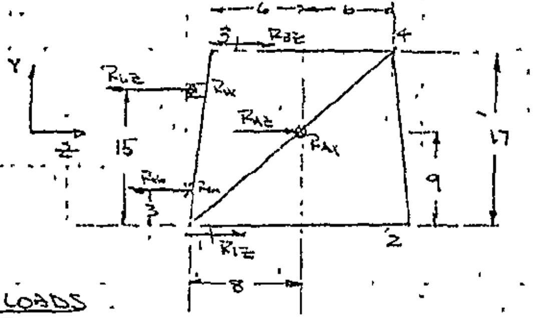
V56.531
161

LOADS ON FITTING

MAX LOAD $G_X = 33.84$ (BOEING) $+G_Z = 8.96$

$R_A = 1120^{\#}$
$R_{BZ} = 463.5^{\#}$
$R_{BX} = 495^{\#}$

$R_{AX} = R_A \sin 68^\circ = .927 R_A = 1040^{\#}$
$R_{AZ} = R_A \cos 68^\circ = .375 R_A = 420^{\#}$



RESULTING COMPONENTS

LUG # 1	X, Y, Z
2	X
3	X, Z
4	X

Z LOADS

$\overset{+}{\curvearrowleft} \Sigma M_3$

$+2R_{BZ} - 8R_{AZ} + 14R_{BZ} - 17R_{1Z} = 0$

$17R_{1Z} = 16R_{BZ} - 8R_{AZ}$

$R_{1Z} = \frac{16}{17}\left[R_{BZ} - .5R_{AZ}\right]$

$\underline{R_{1Z} = 229^{\#}}$

$\leftarrow \Sigma F_Z = 0$

$R_{1Z} + R_{3Z} + R_{AZ} = 2R_{BZ}$

$R_{3Z} = 2R_{BZ} - R_{1Z} - R_{AZ}$

$\underline{R_{3Z} = 278^{\#}}$

X LOADS

MOMENT ABOUT LINE 1-2

$\overset{+}{\curvearrowleft} -3R_{BX} - 15R_{BX} - 9R_{AX} + 17R_{3X} + 17R_{4X} = 0$

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CHECKED BY: G F
DATE: 1-6-72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531162

REF

X LOADS CONT

$+18R_{BX} + 9R_{AX} = 17R_{3X} + 17R_{4X}$

DISTRIBUTION BETWEEN R3 + R4

$\bar{Y}_3 = \frac{\Sigma YA}{\Sigma A}$ $\quad \bar{Y}_4 = \frac{\Sigma YA}{\Sigma A}$ $\quad$ A = CONST.

$\bar{y}_3 = \frac{A[2+14+10]}{3A}$

$\bar{y}_3 = 8.7$

$\bar{y}_4 = \frac{A[10+21+15]}{3A}$

$\bar{y}_4 = 15.3$

LOAD TO R_3

$\frac{8.7}{15.3} = .57$

DISTRIBUTE 60% LOAD TO R_3

$18/17 R_{BX} + 9/17 R_{AX} = R_{3X} + R_{4X}$

$18/17 R_{BX} + 9/17 R_{AX} = .6\left[18/17 R_{BX} + 9/17 R_{AX}\right] + R_{4X}$

$.4\left[18/17 R_{BX} + 9/17 R_{AX}\right] = R_{4X}$

$.4\left[1.06 R_{BX} + .53 R_{AX}\right] = R_{4X}$

$.4\left[1.06 (495) + .53 (1040)\right] = R_{4X}$

$\underline{430^{\#} = R_{4X}}$

$R_{3X} = 1.5 R_{4X}$

$\underline{R_{3X} = 645^{\#}}$

X LOADS CONT

LOAD TO R1-R2

DISTRIBUTE LOAD

$R_{1X} + R_{2X} = R_{AX} + 2R_{BX} - R_{3X} - R_{4X}$

$R_{1X} = .6\left[R_{AX} + 2R_{BX} - R_{3X} - R_{4X}\right]$

$= .6\left[1040 + 990 - 645 - 430\right]$

$= .6(955)$

$R_{1X} = 573^{\#}$

$R_{2X} = 382^{\#}$

INPUT LOADS TO TO IN PLANE ACCELERATIONS

Y LOADS

$R_{EX} = 28.2(G_Y)$ $G_Y = 4.23$

Z LOAD

$R_A = 44.7(G_Z)$ $G_Z = 8.46$

$R_{BX} = 20.75(G_Z)$

$R_{BZ} = -21.6(G_Z)$

CHECK REACTIONS TO Z LOAD

$R_A = 44.7(8.46) = 378^{\#}$

$R_{AX} = \cos 22^0 R_A = 350^{\#}$

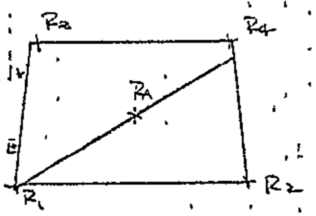
$R_{AZ} = \cos 68^0 R_A = 142^{\#}$

$R_{BX} = 20.75(8.46) = 176^{\#}$

$R_{BZ} = 21.6(8.46) = 183^{\#}$

+X IS MAXIMUM LOAD CONDITION –

SUMMARY MAXIMUM FITTING LOADS



	X	Y	Z
R1	573		229
R2	382		
R3	-645		278
R4	430		

MAXIMUM LOAD CONDITION $N_X + N_Z$

ALL LOADING LESS THAN FOR A1 BOX
∴ FITTINGS ARE SUFFICIENT

(C22)
3.7.2.0(F2)

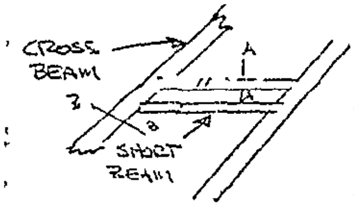
MATERIAL – MBO 170-065 7075 T7352

F_{TU} 66 KSI
F_{TY} 56 KSI
F_{SU} 39 KSI
F_{BRU} 96 KSI

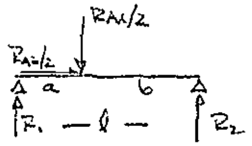
PREPARED BY. RGR	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 6 OF 19
CHECKED BY G.F	RESCUE MISSION	REPORT NO SD 70-205
DATE 1-12-2	COMMAND MODULE	MODEL NO SKYLAB
REF		DRWG NO V56-531162

INTERNAL REACTIONS

LOAD R_A



LOAD INPUT R_A (SHORT BEAM)



PINNED FOR MAX BENDING MOMENT

1/2 LOAD ON ONE SHORT BEAM

$R_{Ax}/2 = 1040/2 = 520^{\#}$

$R_{Az}/2 = 420/2 = 210^{\#}$ 21

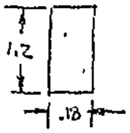
$R_1 = P\frac{b}{\ell} = \frac{520(4)}{5.3}$

$R_1 = 393^{\#}$ $R_2 = 127$ LBS

$\text{Max Mom} = \frac{Pab}{\ell} = \frac{520(1.3)(4)}{5.3}$

$M_{max} = 510$ IN #

SECTION A-A



$C = 0.6$

$I = 0.0259$ IN^4

$\sigma = \frac{Mc}{I} = \frac{510(.6)}{.0259}$

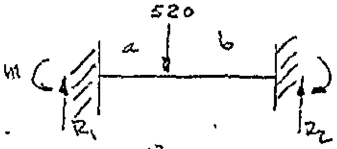
PREPARED BY. RGR	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 7 OF 19
CHECKED BY G.F	RESCUE MISSION	REPORT NO SD 70-205
DATE 1-12-2	COMMAND MODULE	MODEL NO SKYLAB
REF		DRWG NO V56-531162

$\sigma = 11800$ PSI NEGLECT P/A

COMPRESS YIELD MOS $- \ 56/11.8 - 1$

$M.S. = +3.75$

TREAT SHORT BEAM AS FIXED-FIXED FOR REACTIONS ON LONG BEAM



a - 1.3 IN
b - 4.0 IN

(E4) TABLE III CASE 32

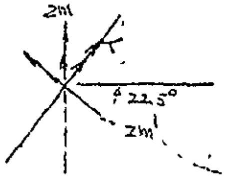
$R_1 = \frac{Pb^2}{\ell^3}(3a+b)$

$R_1 = 442^{\#}$

$M = W\frac{ab^2}{\ell^2}$

$M = 385$ IN #

RESOLUTION OF SHORT BEAM REACTIONS TO LONG BEAM AXIS



$M = 385$ IN #

$2M' = 2M \cos 22.5^\circ = 710$ IN #

$T = 2M \sin 22.5^\circ = 294.5$ IN #

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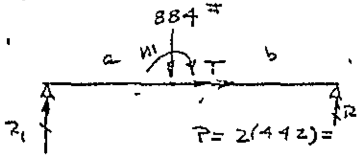
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 8 OF 19
REPORT NO SD 70-205
MODEL NO. SKYLAB
DRWG NO V56-531162

REF

LONG BEAM REACTIONS

a = 7.3 IN
b = 8.7 IN



$P = 2(442) = 884$ #

$R_1 = P\frac{b}{l} = \frac{884(8.1)}{16} - \frac{710}{16} = 435.6$ #

$R_2 = 448.6$ LBS

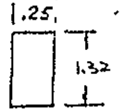
$M_{MAX\,M} = Ra = 435.6\,(7.3) = 3180$ IN #

TOTAL MOMENT AT LOAD POINT

3180 + 710. = 3890 IN #

SECTION B-B

CONSERVATIVE (NEGLECT CROSS WEB)



BENDING —

$\sigma = \frac{6M}{bh^2} = \frac{6(3890)}{.25(1.32)^2}$

$\sigma = 53400$ PSI

$F_B = F_{TU} + (K-1)F_{TY}$
$= 66 + (.5)\,56$

$F_B = 94$ KSI

$R_b = \frac{53.6}{94} = .569$

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SPACE DIVISION
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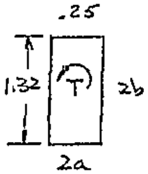
RESCUE MISSION
COMMAND MODULE

PAGE NO 9
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531162

REF

TORSION LONG BEAM SECTION B-B

(E4)
P. 199
4



MAX SHEAR STRESS

$S = \frac{T\left[3a + 1.8b\right]}{8a^2b^2}$

$S = \frac{294.5\left[3(.125) + 1.8(.66)\right]}{8(.125)^2(.66)^2}$

$S_{MAX} = 6710.$ PSI

$F_{SU} = 39$ KSI (NEGLECT PIN)

ULTIMATE SHEAR M.S. HIGH

$R_s = \frac{6.71}{39} = .172$

COMBINED LOADING

$R_b^2 + R_s^2 = 1$

$M.S = \frac{1}{\sqrt{.569^2 + .172^2}} - 1 = \underline{\underline{1.56}}$

PREPARED BY: RGR
CHECKED BY: G.F.
DATE: 1-17-2

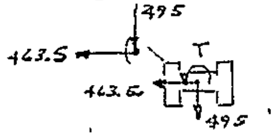
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 10 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO V56-531162

REF

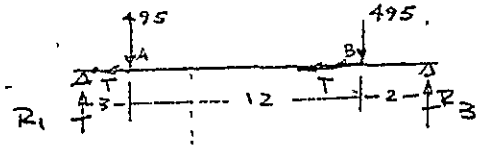
BEAM ① - ③ LOADING

SECTION F-F V56-531162



TORQUE $T = 463.5(2) + 495(3)$

$T = 2412$ IN #



NEGLECT SHEAR LOAD

$\Sigma M_{R_1} = 0$

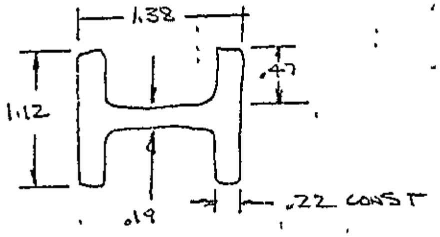
$495(3) + 495(15) - 17R_3 = 0$

$R_3 = 525^{\#}$

BENDING MOMENT AT B

$M = 525(2) = 1050$ IN #

BEAM ① - ③ SECTION



HEWLETT-PACKARD COMPUTER PROGRAM

$I = .052$

$\bar{X} = .55$

$C = 1.12 - \bar{X}$

$C = .57$

$K = 1.61$

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CHECKED BY: RGR
DATE: 1/22/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 11 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531162

REF

FITTING - RESCUE COUCH RH SUPPORT ADAPTER, ASSY OF

$f_b = \frac{(1050)(57)}{(052)}$

$= 11500$ PSI

$F_b = 66 + 56(1.61 - 1)$

$= 100.15$ KSI

$R_b = \frac{11.5}{100.15} = .115$

$\tau = \frac{T t_1}{\Sigma b t^3}$

$b_1 = 1.12$ IN,

$b_2 = .94$ IN

$t_1 = .22$ IN

$t_2 = .19$ IN

$\Sigma b t^3 = 2(1.12)(.22)^3 + (94)(.19)^3$

$= .0304 \text{ IN}^4$

$\tau = \frac{(2412)(22)}{0304}$

$= 17,450$ PSI

$R_s = \frac{1745}{39} = .447$

$M.S = \frac{1}{\sqrt{(447)^2 + (115)^2}} - 1 = \underline{1.17}$

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CHECKED BY G.F.
DATE 1-17-2

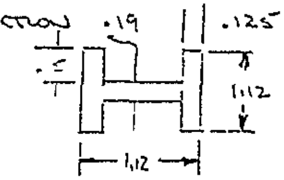
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 12 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531162

REF
V56-531162

BEAM ③-④

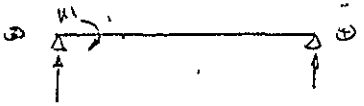
SECTION



$K = 2.00$

$F_b = 66 + 56(2-1)$
$= 122$ KSI

$\bar{X} = .604$
$I = .0303$
$c = 1.12 - \bar{X}$
$c = .516$



TORQUE FROM BEAM ①-③ IS BENDING (M) ON BEAM ③-④ (NEGLECT TORSION)

V56-531162
10

BENDING STRESS

$$\sigma = \frac{Mc}{I}$$

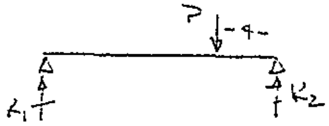
$$= \frac{2412(.604)}{.0303}$$

$$\sigma = 48\,000 \text{ PSI}$$

$$MS = \frac{122}{48} - 1 = \underline{1.54}$$

BEAM ①-② AND BEAM ②-④ ARE LOADED BY THE SHORTER CROSS BEAM ①-④

TREAT CROSS BEAM AS PINNED-PINNED



$\ell = 15$

P6

$P = 2(127)$
$= 254$ LBS

$R_2 = \frac{254(11)}{15} = 186\#$

$R_1 = 254 - 186 = 68\#$

FORM 994-B REV 12-67

PREPARED BY RCR
CHECKED BY G.E.
DATE 1-17-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

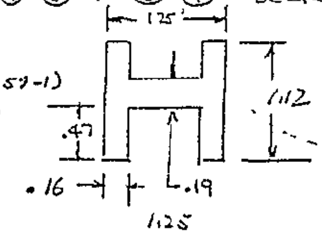
PAGE NO 13 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531162

REF

BEAM ①-② + ②-④ SECTION

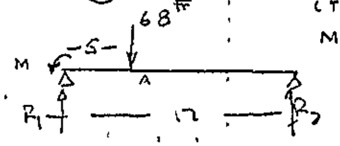
$K = 1.59$

$F_b = 66 + 56(1.59-1)$
$= 99.1$ KSI



$\bar{X} = .56$
$I = .038$
$C = 1.12 - \bar{X}$
$C =$

BEAM ①-②



(TORQUE FROM BEAM 1-3)
$M = 1.5(495) + 2(463.5)$
$= 1610$ IN-LBS

$\Sigma M_1 = 0 \quad R_2 = \frac{5(68)}{17} - \frac{1610}{17}$

$R_2 = -74.7$ LBS

$\Sigma M_A = 24.7(12)$
$= 897$ IN#

$m_{MAX} = M = 1610$ IN-LBS

BENDING STRESS

$$\sigma = \frac{Mc}{I}$$

$$= \frac{1610(.56)}{.038}$$

$$\sigma = 23{,}700 \text{ PSI}$$

$$MS = \frac{99.1}{23.7} - 1 = \underline{3.19}$$

FORM 994-B REV 12-67

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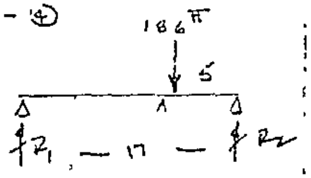
DATE 1-17-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 14 OF 17
REPORT NO SD 70-205
MODEL NO. SKYLAB
DRWG NO V56-531162

REF
P. 12

BEAM ②-④



$$R_1 = \frac{186(5)}{17}$$

$$\therefore R_1 = 54.7\,\#$$

$$M_A = 54.7(12)$$

$$= 656 \text{ IN \#}$$

BENDING STRESS

$$\sigma = \frac{Mc}{I} = \frac{656(.56)}{.038}$$

$$\sigma = 9{,}670 \text{ PSI}$$

$$\text{MoS} = \frac{99.1}{9.67} - 1 = +\text{HIGH}$$

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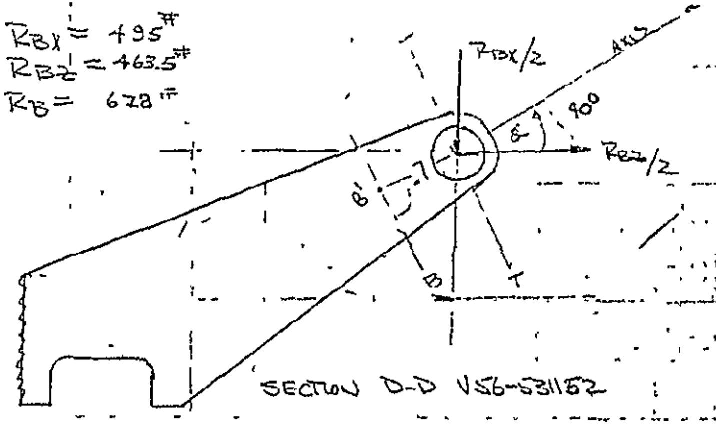
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 15 OF 17
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531162

REF

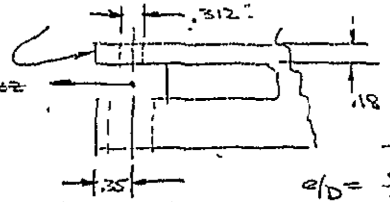
INTERNAL REACTIONS AT B

$R_{BX} = 495\,\#$
$R_{BZ} = 463.5\,\#$
$R_B = 678\,\#$



SECTION D-D V56-531162

TAKE 1/2 LOAD TO SMALLER PORTION OF ATTACHMENT

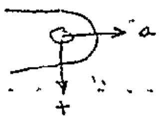


$$D/t = \frac{.312}{.18} = 1.75$$

$$e/D = \frac{.35}{.312} = 1.12$$

LUG LOADING

$R_{BZ}/2 = 232\,\#$ $R_{BX}/2 = 248\,\#$



$$P_a = 232 \cos 90^\circ - 248 \sin 90^\circ$$

$$P_a = 182\,\#$$

$$P_t = +232 \sin 90^\circ + 248 \cos 90^\circ$$

$$P_t = 369\,\#$$

PREPARED BY RGR
CHECKED BY G.E.
DATE 1-17-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION.
COMMAND MODULE

PAGE NO 16 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO V56-531162

REF

STRUCT MAN
10-11-05
-11-16

LUG REACTION.

BEARING - (AXIAL)

$P_{BRU} = K_{BR} F_{BRU} A_{BR}$ $\quad K_{BR} = .55$

$F_{BRU} = 96$ KSI $\quad A_{BR} = Dt = .312(.18)$

$P_{BRU} = .55(96)(.312)(.18)$

$P_{BRU} = 2960.$ $\quad MOS = \frac{2960}{18.2} - 1 = \underline{+HIGH}$

TENSILE

$P'_{TU} = K_t F_{TU} A_T$ $\quad A_T = (W-D)(t)$ $\quad W/D = \frac{.7}{.312}$

$= (.7-.312)(.18)$

$F_{TU} = 66$ KSI $\quad = .07$ $\quad W/D = 2.24$

$K_t = .87$

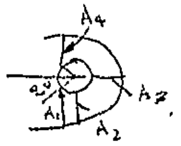
$P'_{TU} = .87(66)(.07)$

$P'_{TU} = 4.02$ KSI $\quad MOS = \frac{4.020}{18.2} - 1 = \underline{+HIGH}$

(TRANSVERSE)

$P_t = 369^{\#}$ (APPLIED)

LUG -



$A_1 = t(.15) = A_4 = .18(.15)$

$A_1 = A_4 = .027$ IN²

$A_2 = (.1)(.18) = A_3 = .018$ IN²

$$A_{AV} = \frac{6}{3/A_1 + 1/A_2 + 1/A_3 + 1/A_4} = \frac{6}{4/A_1 + 2/A_2}$$

$$= \frac{6}{4/.027 + 2/.018} = \frac{6}{148 + 111}$$

$A_{AV} = .023$ IN²

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 17 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DRW NO V56-531162

REF

LUG - TRANSVERSE LOAD UNIT

$A_{BR} = Dt = .312(.18) = .0566$ IN²

$A_{AV}/A_{BR} = \frac{.023}{.0566} = .406$

ULTIMATE LOAD

$P_{TRU} = K_{TRU} F_{TU} A_{BR}$ $\quad K_{TRU} = .28$

$= .28(66)(.0566)$

$P_{TRU} = 1,046^{\#}$

$M.S. = \frac{1046}{369} - 1 = \underline{1.84}$

COMBINED -

STRUCT MAN
10.11.12

$$M.S = \frac{1}{(R_a^{1.6} + R_t^{1.6})^{.625}} - 1$$

$R_a = 18.2/2960 = .00615$

$R_T = 369/1046 = .353$

$$M.S = \frac{1}{.353} - 1$$

$= 2.83 - 1$

$M.S = \underline{+1.83}$

CHECK CRITICAL SUPPORT LUG

CRITICAL LUG - AT R_3

P.5

$P_a = 645^{\#}$ $\quad P_t = 278^{\#}$

$e = .5$ $\quad D = .378$ $\quad t = .32$ $\quad w = 1.0$

$e/D = 1.32$ $\quad W/D = 2.6$ $\quad D/t = 1.18$ $\quad A_{BR} = Dt = .121$

$A_t = (w-D)t$

$A_T = .199$

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DATE 1-17-2

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COMMAND MODULE

PAGE NO. 18 of 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531162

REF

LUG 3 CONT.

BEARING ALLOWABLE (AXIAL)

$P_{BRU} = K_{br} F_{BRU} A_{br}$ $K_{br} = .65$

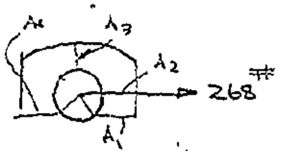
$P_{BRU} = .65(96)(.121)$

$P_{BRU} = 7550^{\#}$

$R = \frac{APPLIED}{ALLOW} = \frac{645}{7550}$

$R = .0855$

TRANSVERSE ALLOWABLE



$A_1 = A_4 = .35(.32) = .112$

$A_2 = A_3 = .3(.32) = .096$

$$A_{AV} = \frac{6}{3/A_1 + 1/A_2 + 1/A_3 + 1/A_4} = \frac{6}{4/A_1 + 2/A_2}$$

$$= \frac{6}{35.7 + 20.8} = .106$$

$$\frac{A_{AV}}{A_{br}}$$

$$= \frac{.106}{.121}$$

$= .877$

ULTIMATE LOAD -

$P_{TRU} = K_{TRU} F_{tu} A_{br}$ $K_{TRU} = .34$

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RESCUE MISSION -
COMMAND MODULE

PAGE NO. 19 OF 19
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-531162

REF

$P_{TRU} = K_{TRU} F_{tu} A_{br}$

$= .34(66)(.121)$

$P_{TRU} = 2700^{\#}$

$R_T = \frac{278}{2700} = .103$

COMBINED

$$M.S. = \frac{1}{(R_a^{1.6} + R_t^{1.6})} = 1$$

$= 6.86 - 1$

$MoS = \underline{\underline{+ HIGH}}$

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PAGE NO 1 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531169

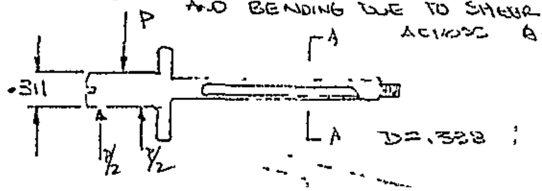
REF
N/A
V56-531 150

PIN- RESCUE COUCH LEG SUPPORT ADJUSTMENT

SEE ANALYSIS HOUSING - V56-531170

PIN UNDERGOES TWO LOADING CONDITIONS

1) SHEAR LOADING DUE TO LUG ATTACHMENT WITH BENDING DUE TO SHEAR TRANSFER
2) TENSILE LOADING - DUE TO SPRING-LOCK ACTION AND BENDING DUE TO SHEAR LOAD ACROSS A-A



MAT. BeCu BAR
QQ-C-530 COND. AT.

(C22)
7.2.5

$F_{TU} = 165$ KSI $F_{CY} = 120$ KSI
$F_{SU} = 87$ KSI $F_{BRU} = 160$ KSI $\frac{e}{D} = 1.5$
$F_{TY} = 120$ KSI $= 175$ KSI $\frac{e}{D} = 2.0$

1) SHEAR LOADING -

V56 531 162
Pg. 2

$$P = [(495)^2 + (463.5)^2]^{\frac{1}{2}}$$
$$P = 678\#$$
$$A = \pi r^2 = \frac{3.14}{4}(.311)^2$$
$$A = .076 \text{ in}^2$$
$$\frac{P}{2}/A = \frac{339}{.076}$$
$$\frac{P}{2}/A = 4460 \text{ PSI}$$
$$MoS = \frac{87}{4.46} - 1 = \underline{\underline{+\text{HIGH}}}$$

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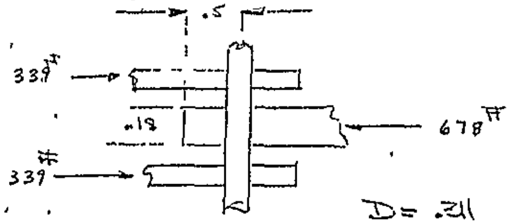
COMMAND MODULE

PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531169

REF

BENDING AT SHEAR LUG   LUG-PIN FAILURES



(D89)
PAGE
10 11.06

$D = .311$
$e = 0.5$
$t = .18$

$$r = [(e/D - 1/2)D/t]$$
$$r = [(\frac{.5}{.311} - .5)\frac{.311}{.18}]$$
$$r = 1.9$$

$P'_{BRU_2} = (K_{BR} F_{BRU} A_{BR})_2$ $A_{BR} = Dt = .311(.18)$
$A_{BR2} = .056 \text{ IN}^2$
$K_{BR} = .80$
$P'_{BRU_2} = [8(160)(.056)]_2$
$P'_{BRU_2} = 7170$ PSI

$P'_{TU_2} = [K_T F_{TU} A_T]_2$ $A_T = (W-D)t$ $\frac{W}{D} = \frac{.88}{.311}$
$= .94(165)(103)$ $= (.88-.311)(.18)$ $= 2.83$
$P'_{TU_2} = 16.0$ KSI $A_T = 0.103 \text{ in}^2$
$K_T = .94$

WITH $P_{BRU} = P'_U$
$$P_U/(A_{BR} F_{TU}) = 7.17/(.056)(165)$$
$$= .777 =$$
$Y = .38$

$K_b = .250(2t_1 + 4g + Yt_2)$ $t_2 = .18$
$t_1 = .18$
$g =$ NEGLECT

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RESCUE MISSION
COMMAND MODULE
PAGE NO 3 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V58-531167
REF

LUG-PIN CONT

$\gamma = .38$ TABLE 10.11.20

$K_b = .250\left[2(.18) + .38(.18)\right]$

$K_b = 0.107$

MAX BENDING MOMENT

$M = K_b P_{U1}$

$= .107(339)$

$M = 36.3$ IN #

MAX BENDING STRESS

$\sigma = \frac{Mc}{I}$ $C = 1/2 D = .155$

$I = \frac{\pi}{4} r^4$

$= 4.54 \times 10^{-4}$

$\sigma = \frac{36.3(.155)}{4.54 \times 10^{-4}}$

$\sigma = 1.24 \times 10^4$ PSI

$F_B = F_{TU} + .7 F_{TY}$

$= 165 + .7(120)$

$F_B = 249$ KSI

$MS_B = \frac{249}{124} - 1 = \underline{+HIGH}$

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RESCUE MISSION
COMMAND MODULE
PAGE NO 4 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531167
REF

BRM-6
VOL I

2) SPRING-LOCK ACTION

DESIGN "PULL" LOAD = 100#

PULT = 1.5(100) = 150#

SECTION A-A

$I = \frac{\pi(.169)^4}{4} - \frac{1}{12}(.127)(.338)^3$

$= .000232$ IN⁴

$A = \frac{\pi}{4}(.338)^2 - .25(.127)$

$A = .0815 - .0318$

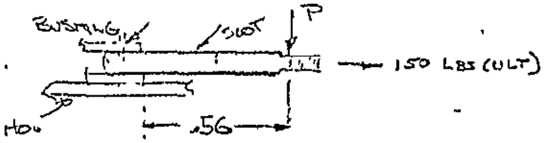
$A = .0497$ IN^2

$P/A = 2,587$ PSI

$F_{TU} = 165$ KSI MOS $= \underline{+HIGH}$

BENDING DUE TO SIDE LOAD

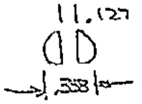
PIN AT MAXIMUM-POSITION (PULLED OUT)
AND SUBJECTED TO CANTILEVER LOAD —



FIND MAX P

$M = .56(P)$

SECTION



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COMMAND MODULE

PAGE NO 2 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531164

REF

ASSUME PERSONNEL LOAD OF 225 LBS (ULT)
IN LATERAL DIRECTION.

$M = 225(.56)$
$= 126$ IN-LBS

$$f_b = \frac{(126)(169)}{000232}$$
$= 91{,}700$ PSI

$f_t = 91700 + 2587$
$= 94287$ PSI

$$M.S. = \frac{165}{94.29} - 1 = \underline{.75}$$

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RESCUE MISSION
COMMAND MODULE

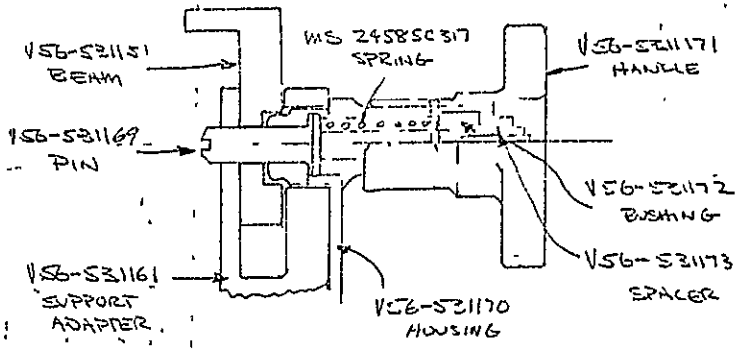
PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531170

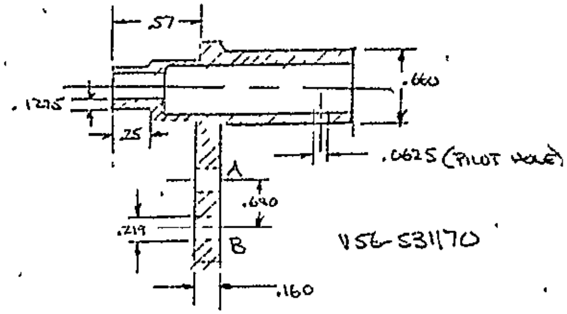
REF
N/A
V56-531150

HOUSING - RESCUE COUCH LEG SUPPORT ADJUST

SUPPORT ADJUSTMENT PERMITS RESCUE COUCH LEG PAN TO BE LENGTH ADJUSTED AND FITTED TO A_1, A_3 SUPPORT ADAPTERS (V56-531161, 62)

ASSEMBLY DRAWING





MATERIAL

CRES BAR

AMS 5737 A-286

$F_{TU} = 190$ KSI
$F_{TY} = 95.$ "
$F_{CY} = 91$ "
$F_{BRU} = 210$ "

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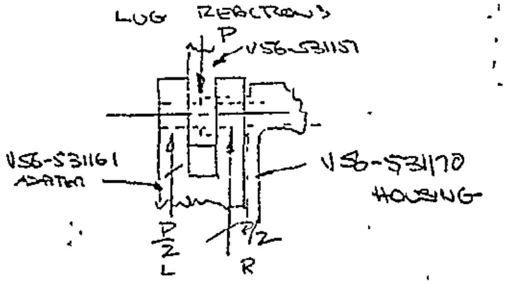
RESCUE MISSION
COMMAND MODULE

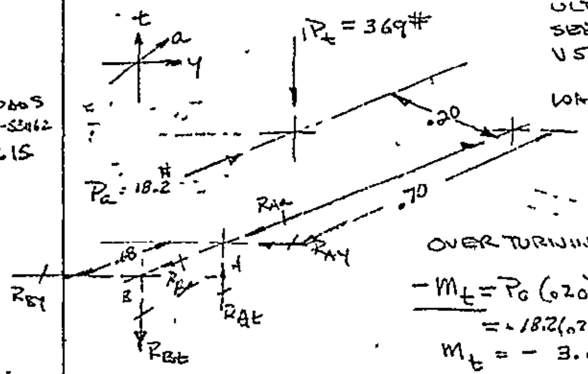
PAGE NO 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531170

LUG REACTION AT PIN-BEAM INTERFACE - CORRESPONDS TO POINT B OF ANALYSIS V56-531157 BEAM

LUG REACTIONS



LOADING FREE BODY



ULTIMATE LOADS SEE V56-531151

LOADS - a - AXIAL
t - TRANSVERSE

LOADS V56-53162 P.15

262

OVERTURNING MOMENT

$$\underline{-M_t} = P_a(.020)$$
$$= .18.2(.020)$$
$$M_t = -3.6 \text{ IN}\#$$

REACTED BY COUPLE IN y-a PLANE

$$R_{Ay} = -R_{By} = 3.6/.68$$
$$\underline{R_{Ay} = -R_{By} = 5.3^{\#}}$$

EQUILIBRIUM

$$\Sigma M_A = 0 \qquad P_t(.07) = R_{Bt}(.68)$$
$$\frac{369(.7)}{.068} = R_{Bt} = 380^{\#}$$
$$\underline{R_{At} = P_t + R_{Bt} = 749^{\#}}$$

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COMMAND MODULE

PAGE NO 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531170

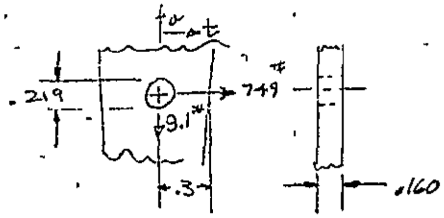
REACTIONS CONT

$$\Sigma F_a = 0 \qquad R_{Ba} + R_{Aa} = 18.2^{\#}$$
$$\underline{R_{Ba} = R_{Aa} = 18.2/2 = 9.1^{\#}}$$

INTERNAL REACTIONS

BEARING LOADS @ A, B

MAX LOAD AT A



$$e/D = .3/.219 = 1.37 \qquad D/t = \frac{.219}{.160} = 1.37$$

K = .63

TREAT AS SHEAR-BEARING

$$P_{BRU} = K_{BR} F_{BRU} A_{BR} \qquad A_{BR} = Dt = .219(.160)$$
$$A_{BR} = .0350 \text{ IN}^2$$
$$= .63(210)(.035)$$

ALLOW $P_{BRU} = 4{,}600^{\#}$

$P_{APPLIED}$

$$M.S. = \frac{P_{BRU}}{P_{APP}} - 1, \qquad \underline{M.S. = +HIGH}$$

LOADING AT LUG 3 LESS CRITICAL

D88
10-11-05

489

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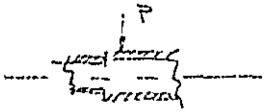
COMMAND MODULE

PAGE NO 4 OF A
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531170

REF

CHECK SHEAR LOAD IN BARREL



$P = \left[369^2 + 192\right]^{1/2}$

$P = 370^{\#}$

$A = \pi\left[r_o^2 - r_i^2\right] = 3.14\left[.281^2 - .241^2\right]$

$A = .066$

SHEAR

$\frac{P}{A} = \frac{370}{.066} = 5600 \text{ PSI}$

$F_{SU} = 91 \text{ KSI}$ M.S. = + HIGH

NO OTHER LOADING CRITICAL

NOTE PILOT HOLE IS FOR ASSEMBLY
TOTAL AXIAL LOAD (BARREL) DUE TO SPRING LOADED PIN IS 150# ULTIMATE
BEARING LOADING IS NOT SIGNIFICANT

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PAGE NO 1 OF 4
REPORT NO SD 70-2
MODEL NO SKYLAB
DWG NO V56-531171

REF
N/A
V56 531
150

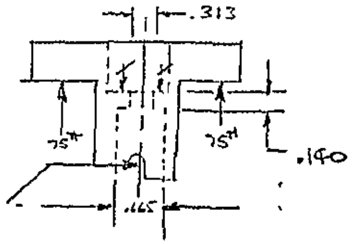
HANDLE - RESCUE COUCH LEG SUPPORT ADJUSTMENT

HANDLE HAS TWO POINTS OF LOAD CONCENTRATION DUE TO LOCKING ACTION

ULTIMATE DESIGN PULL FORCE = 150#

CONDITIONS

1) SHEAR DUE TO PULL LOAD
2) SHEAR LOADING AT PIN IN LOCK POSITION



MAT.

AL BAR

QQ-A-200/11 7075-T6

1¼ × 2½ × 2.00

$F_{TU} = 77 \text{ KSI}$

$F_{TY} = 66 \text{ KSI}$

$F_{SU} = 48 \text{ KSI}$

$F_{BRU} = 104 \text{ KSI}$

$F_{BRU} = 228 \text{ KSI}$ E/D = 2

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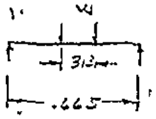
COMMAND MODULE

PAGE NO 2 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531171

REF.

HANDLE-RESCUE COUCH LEG SUPPORT ADJUSTMENT

1) PULL LOAD BENDING



$m = \frac{1}{\nu} = \frac{1}{.33} = 3.03$

$t = .14$ IN

$a = .3325$ IN

$r_0 = .1565$ IN

Ⓔ-4 TABLE X CASE 2

$$S = -\frac{3W}{2\pi m t^2}\left[\frac{1}{2}(m-1) + (m+1)\log\frac{a}{r_0} - (m-1)\frac{r_0^2}{2a^2}\right]$$

$$= -\frac{3(150)}{2\pi(3.03)(.14)^2}\left[\frac{1}{2}(2.03) + (4.03)\log\left(\frac{.3325}{.1565}\right) - (2.03)\left[\frac{(.1565)^2}{2(.3325)^2}\right]\right]$$

$S = -2543$ PSI

M.S = +HIGH

SHEAR

$A = \pi(.313)(.14)$

$= .138$ IN

$f_s = \frac{150}{.138}$

$= 1090$ PSI

M.S = +HIGH

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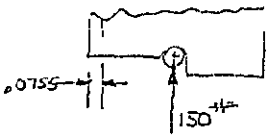
COMMAND MODULE

PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531171

REF

2) COND. (2)



$e/D > 2.$

$F_{BRU} = 228$ KSI

$P_{ALL} = F_{BRU}\,A_{BRG}$ $A_{BRG} = Dt = .120(.0755)$

$P_{ALL} = (228)(.120)(.0755)$

$P_{ALL} = 2065$ LBS

$P_{APP} = 150\#$ MOS. +HIGH

LOCK PIN SHEAR (MS 171501)

AMS 5506
CORROSION RESIST
STEEL

$P = \frac{150}{2} = 75$ LBS

$A = \frac{\pi}{4}\left[.103^2 - .096^2\right]$

$= .00109$ IN^2

$F_{TU} = 100$ KSI

ASSUME $F_{SU} = 70$ KSI

$f_s = \frac{75}{.00109} = 68800$ PSI

M.S. $= \frac{70}{68.8} - 1 = 0.0$

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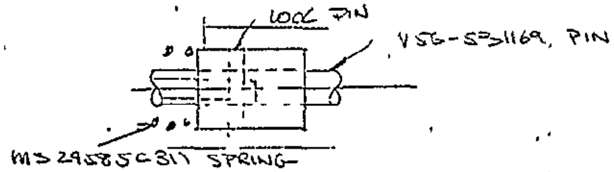
CHECKED BY: G F		REPORT NO SD 70-205
DATE: 1-31-2	COMMAND MODULE	MODEL NO SKYLAB
REF	BUSHING - RESCUE COUCH LEG SUPPORT ADJUST.	DWG NO V56-531172

N/A

V56-531150

PROVIDES END CONSTRAINT FOR SPRING (MS24585C317) IN SUPPORT ADJUSTMENT



NEGLECTING BEARING LOAD OF PIN (ASSUMED HIGH)
THERE IS ONLY ONE LOAD CONDITION AND THAT IS THE COMPRESSIVE LOAD DELIVERED BY THE SPRING IN THE LOCK POSITION

(C22) TABLE 6.2.1.0(b)

MAT. CRES BAR AMS 5737 A-286

$F_{tu} = 140$ KSI
$F_{ty} = 85$ "
$F_{su} = 91$ "
$F_{bru} = 210$ "
$F_{cy} = 95$ "

$P = 150^{\#}$ ULTIMATE

$A = \pi r^2 = \pi[.241^2 - .170^2]$
$A = .0917$
$\frac{P}{A} = \frac{150}{.0917} = 1635.$ PSI

M.S. = $\underline{+\text{HIGH}}$

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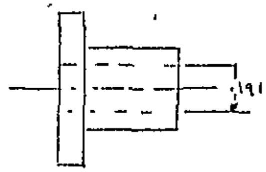
CHECKED BY: G F.		REPORT NO SD 70-205
DATE: 1-21-2	COMMAND MODULE	MODEL NO SKYLAB
REF	SPACER - RESCUE COUCH LEG SUPPORT ADJUST	DWG NO V56-531173

N/A

V56-531.150

SPACER FORMS BACKSTOP FOR SPRING LOADED BUSHING (V56-531172) IN THE SPRING LOCK ADJUSTMENT PERMITS HANDLE TO TURN FROM LOCK TO IN-PLACE ADJUSTMENT.

ONLY ONE LOAD CONDITION - COMPRESSION



(C22) TABLE 6.2.1.0(b)

MAT. CRES BAR, AMS-5737 A-286

$F_{cy} = 95$ KSI

MAX LOAD = $150^{\#}$ ULTIMATE

$A = \frac{\pi}{4}[.312^2 - .191^2]$
$A = .0478$ IN^2

$P/A = \frac{150}{.0478}$
$P/A = 3,140.$ PSI

MOS = $\underline{+\text{HIGH}}$

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COMMAND MODULE

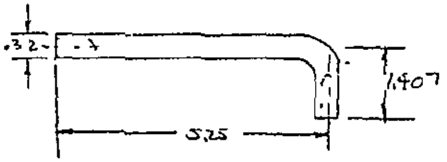
PAGE NO 1 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531174

REF
N/A

V56 531
101

SUPPORT- NECK RING, RESCUE COUCH

ATTACHES TO RESCUE COUCH AND SUPPORTS SUIT NECK RING



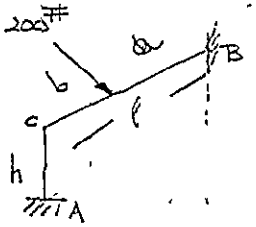
(D11)
6.5 1.1

MATERIAL

CRES BAR QQ-S-763 CLASS 321 (304-L)

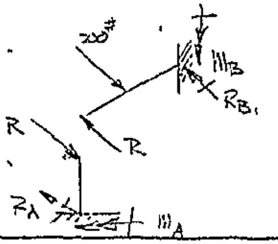
$F_{tu} = 75$ KSI
$F_{ty} = 30$ KSI
$F_{su} = 40$ KSI
$F_{cy} = 35$ KSI

CHECK FOR ULTIMATE PULL LOAD OF 200#



TREAT AS TWO CANTILEVERED BEAMS CONNECTED AT POINT "C".

FREE BODY



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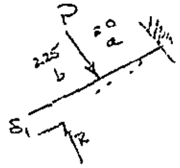
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531174

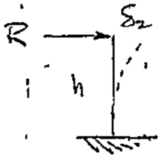
REF.

(E4)
TABLE III
CASES
1 & 2



$$\delta_1 = \delta_p - \delta_R = \frac{1}{6}\frac{P}{EI}\left[3(3)^2(5.25) - (3)^3\right] - \frac{1}{3}\frac{R(5.25)^3}{EI}$$

$$\delta_1 = \frac{P}{6EI}(115) - \frac{R}{3EI}(145)$$



$$\delta_2 = \frac{1}{3}\frac{Rh^3}{EI}$$

FOR CONTINUITY

$$\delta_1 = \delta_2$$

$$\frac{1}{3}\frac{Rh^3}{EI} = \frac{115P}{6EI} - \frac{145R}{3EI}$$

$$R\left[2h^3 + 2(145)\right] = 115P$$

$$R = \frac{115P}{2h^3 + 2(145)} \qquad P = 200^{\#}, h = 1.4 \text{ IN}$$

$$R = 78^{\#}$$

$$\therefore R_A = 78^{\#}$$

$$R_B = 200 - 78$$

$$R_B = 122^{\#}$$

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RESCUE MISSION
COMMAND MODULE
PAGE NO 3 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531174

MOMENTS

$M_B = -5.25(R) + 3(P)$

$M_B = -5.25(78) + 3(200)$

$= 600 - 410$

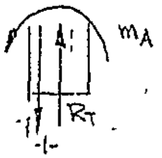
$M_B = 200$ IN# (REACTED AS T-C COUPLE)

$M_A = R(1.4) = 78(1.4)$

$M_A = -109$ IN # (REACTED AS T-C COUPLE)

RESOLVE MOMENTS TO T-C COUPLES

AT A



$\ell = \frac{2}{3}\left(\frac{.312}{2}\right) = \frac{.312}{3}$

$\ell = .104$ IN

$R_T = -R_C = \frac{M_A}{\ell}$

$R_T = R_C = \frac{109}{.104}$

$R_T = -R_C = 1040^{\#}$

AT B

$P = \frac{M}{\ell}$

$= \frac{200}{.104}$

$P = 1920^{\#}$

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RESCUE MISSION
COMMAND MODULE
PAGE NO 4 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-531174

BENDING AT HOLLOW SECTION OF PIN

$m = 200$ IN-LBS

$I = .0491(D_o^4 - D_i^4) = .0491(.312^4 - .159^4) = .00043$

$C = .156$ IN

$\sigma = \frac{mc}{I} = \frac{200(.156)}{.00043}$

$\sigma = 72600$ PSI

$F_B = F_{TU} + F_{TY}(K-1)$, $K = 1.25$

$F_B = 75 + .25(30)$

$F_B = 82.5$ KSI

MoS. $\frac{82.5}{72.6} - 1 = \underline{+.14}$

FASTENERS

NAS 1190C3 – $F_{TU} = 160{,}000$

SHEAR

$D = .169$ $A = \frac{\pi}{4}D^2$ $A = .0225$ IN²

$P = 122^{\#}$

$P/A = 122/.0225$

$P/A = 4970$ PSI

MoS. HIGH

TENSION AT B

$P = \underline{1920}$ LBS

C22 TABLE 3 1.5(b2)

$P_{ALL} = 2892$ LBS

$F_{TU} = 160{,}000$

$MoS = \frac{2892}{1920} - 1 = \underline{+.50}$

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REF

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RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V57-551114

SHEAR OF THREADED AREA

TOTAL AREA = $\pi D l$

$= 3.14(.169)(.56)$

$= 0.297 \text{ in}^2$

ASSUME 1/2 AREA ACTING

$A = .149 \text{ in}^2$

MAX LOAD = 1920 #.

$P/A = \frac{1920}{.149}$

$P/A = 72{,}915 \text{ PSI}$

$F_{SU} = 40 \text{ KSI}$

$MoS = \frac{40}{12.9} - 1 = \underline{+2.10}$

PREPARED BY: RGR
CHECKED BY: BB
DATE: 28 MARCH 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
DOCKING SYSTEM

PAGE NO 1 OF 8.
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575206

REF
N/A
V56-000250

DROGUE - DOCKING, LUNAR MODULE, ASSY OF

INTRODUCTION

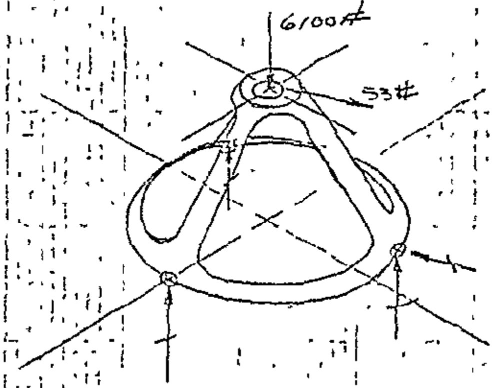
RESCUE DROGUE

DOCKING DROGUE HAS BEEN MODIFIED TO PERMIT SKYLAB PERSONNEL TO JETTISON A DISABLED CSM.

THE MODIFIED DROGUE IS ESSENTIALLY A TRIPOD, BEING SUPPORTED BY THREE V28-575218 STRINGERS AS SHOWN BELOW. THE STRINGER-LEGS ARE ASSUMED AS PIN-ENDED COLUMNS WITH AN ASSUMED LOAD ECCENTRICITY OF .33 IN.

THE MARGIN ON EULER COLUMN BUCKLING IS 1.61. THE MARGIN ON COMPRESSIVE BUCKLING STRESS IS .44. A FACTOR OF SAFETY OF 1.5 APPLIED THROUGHOUT

FOR LOADS (SEE PAGE II.2.5.1)



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CHECKED BY: G. E.
DATE: 4-10-73

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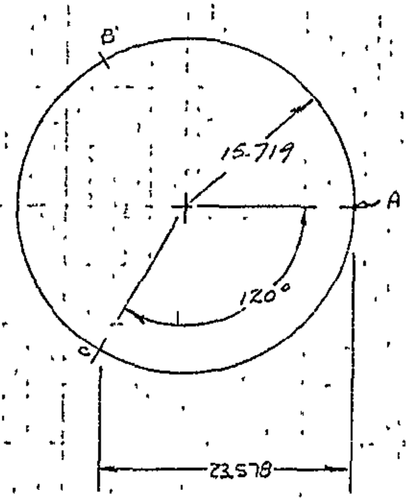
RESCUE MISSION
DOCKING SYSTEM

PAGE NO 2 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575206

REF.

RESCUE DROGUE

INTERNAL COLUMN LOAD



P = MAXIMUM AXIAL LOAD @ POINT $A = \frac{6100}{2} + \frac{53(13.02)}{23.578}$

$P = 2062$ # LIMIT

$P = 3094$ # ULT.

COLUMN LOAD ON LEG $A = \frac{3094}{\cos 42°45'} = 4213$ # ULT.

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CHECKED BY: RGR
DATE: 8 DEC 71

SPACE DIVISION
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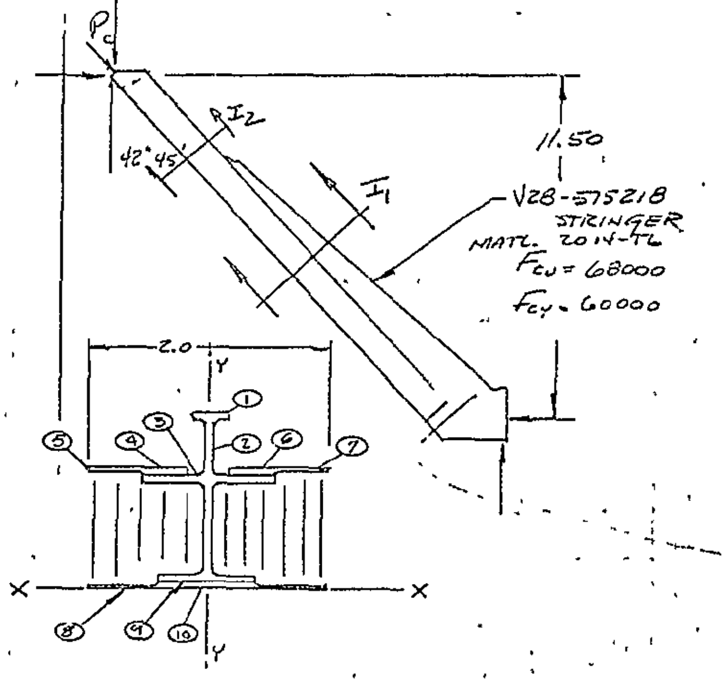
RESCUE MISSION
DOCKING SYSTEM

PAGE NO 3 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575206

REF

RESCUE DROGUE



ITEM	b	h	$\bar{X}$
1	.070	.40	0
2	1.600	.06	0
3	.060	1.12	0
4	.060	.404	.358
5	.022	.440	.880
6	.060	.404	-.358
7	.022	.440	-.880
8	.022	2.00	0
9	.060	.81	0
10	.038	.82	0

$A = .382$ IN^2

$\bar{X} = 0.0$

$I_{NA\ YY} = .0487$ IN^4

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CHECKED BY: RGR
DATE: 9 DEC 71

SPACE DIVISION
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RESCUE MISSION
DOCKING SYSTEM

PAGE NO 4 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO VS6-575206

REF

RESCUE DROGUE

SECTION PROPERTIES
SEE PG. 2
FOR PICTURE

ITEM	b	h	$\bar{y}$
1	.40	.07	1.63
2	.06	1.60	.86
3	1.12	.06	.92
4 & 6	.808	.06	.99
5 & 7	.880	.022	1.01
8	200	.022	.011
9	.81	.060	.090
10	.82	.038	.041

$A = .382 \ IN^2$

$\bar{y} = .689 \ IN$

$\bar{I}_{NA \atop x-x} = .1089 \ IN^4$

CHECK COLUMN FOR ECCENTRICITY IN THE Y-Y PLANE

$$\rho = \sqrt{\frac{I}{A}} = \left(\frac{.0487}{.382}\right)^{\frac{1}{2}} = .357$$

$$L \approx 18$$

$$\frac{L}{\rho} = \frac{18}{.357} = 50.5$$

E-4
PG. 252

$$f_c = \frac{P}{A}\left(1 + \frac{ec}{\rho^2} \sec\left[\frac{P}{4EA}\left(\frac{L}{\rho}\right)^2\right]^{\frac{1}{2}}\right)$$

$$= \frac{4213}{.382}\left(1 + \frac{.33 \times 689}{.357} \sec\left[\frac{2769}{4 \times 10^7 \times 382}(50.5)^2\right]^{\frac{1}{2}}\right.$$

$f_c = 20,061$ psi ULT. (THIS IS MAXIMUM STRESS PRODUCED BY AXIAL LOAD AND ECCENTRICITY)

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RESCUE MISSION
DOCKING SYSTEM

PAGE NO. 5 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO VS6-575206

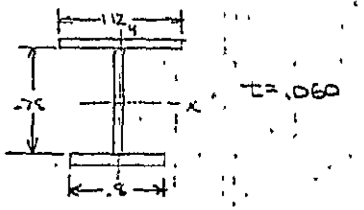
REF

RESCUE DROGUE

COLUMN ALLOWABLE

CHECK AS SINGLE STEPPED COLUMN

SECTION I_1



I_{yy}

	b	h	$\bar{x}$
1	.06	1.12	0
2	.78	.06	0
3	.06	.8	0

$A = .162$
$\bar{x} = 0$
$I_{yy} = 0.01$

I_{xx}

	b	h	$\bar{y}$
1	1.12	.06	.42
2	.06	.78	0
3	.8	.06	-.42

$A = .162$
$\bar{y} = .0498$
$I_{xx} = .0223$

DA
251-1

$I_1/I_2 = .0487/.01 = 4.87 \approx 5$

$a = 14 \quad L = 18$

$a/L = .77$

$\therefore B \approx 7$

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CHECKED BY [illegible]	RESCUE MISSION	[illegible] REPORT NO
DATE 29 [illegible]	DOCKING SYSTEM	MODEL NO [illegible]
REF.		DWG NO V56-515406

[illegible]

STEPPED COLUMN

$$P_{CR} = \frac{\beta EI}{L^2}$$

$$= \frac{7(10.5\cdot10^6)(4.87\times10^{-2})}{18^2}$$

$$P_{CR} = 11{,}047^{\#}$$

$$\sigma_{CR} = \frac{P}{A_{AREA}} = \frac{11{,}047}{.382}$$

$$\sigma_{CR} = 28{,}920\ PSI$$

P. 2

$$f_c = \frac{4212}{.382} = 11050\ psi\ ULT.$$

MARGIN FOR COLUMN BUCKLING STRESS $= \frac{28910}{11050} - 1 = \underline{1.61}$

MARGIN FOR COMPRESSIVE BUCKLING STRESS $= \frac{28920}{20061} - 1 = \underline{.44}$

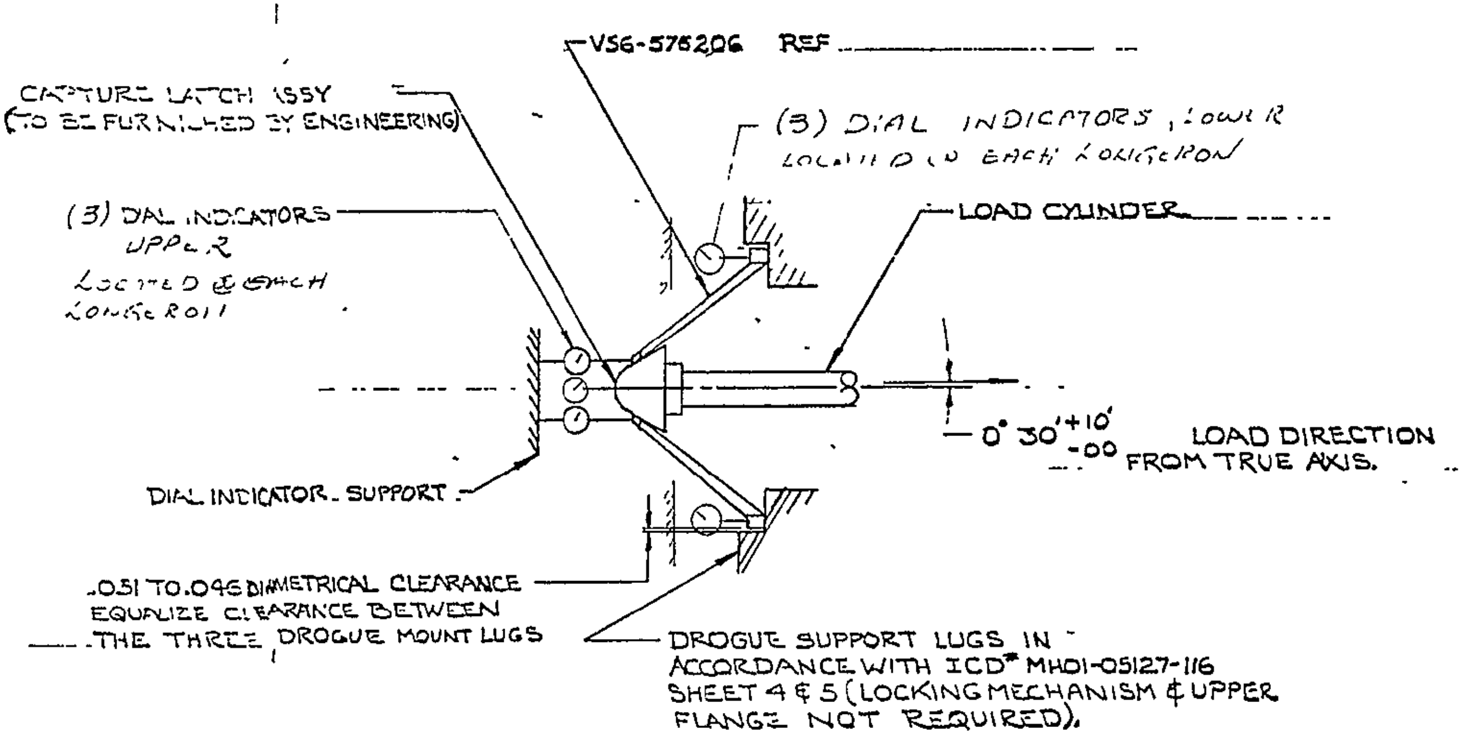
PREPARED BY: Bay
CHECKED BY: G F
DATE. 4-10-73
REF.

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE M.S.S. 3.1
DOCKING SYSTEM
RESCUE DROGUE

PAGE NO. 7 OF 8
REPORT NO SD 70-205
MODEL NO. SKY-13
DWG NO V56-575206

A STATIC PROOF TEST WAS CONDUCTED BY MANUFACTURING ACCORDING TO SKETCH SHOWN BELOW. THE TEST DATA IS PRESENTED ON THE FOLLOWING PAGES.

2T1



ACCEPTANCE TEST SKETCH

FORM M 113-N REV 12-67

PREPARED BY: RGR
CHECKED BY:
DATE 30 MARCH 73

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12214 LAKEWOOD BOULEVARD • DOWNEY, CALIFORNIA 90241

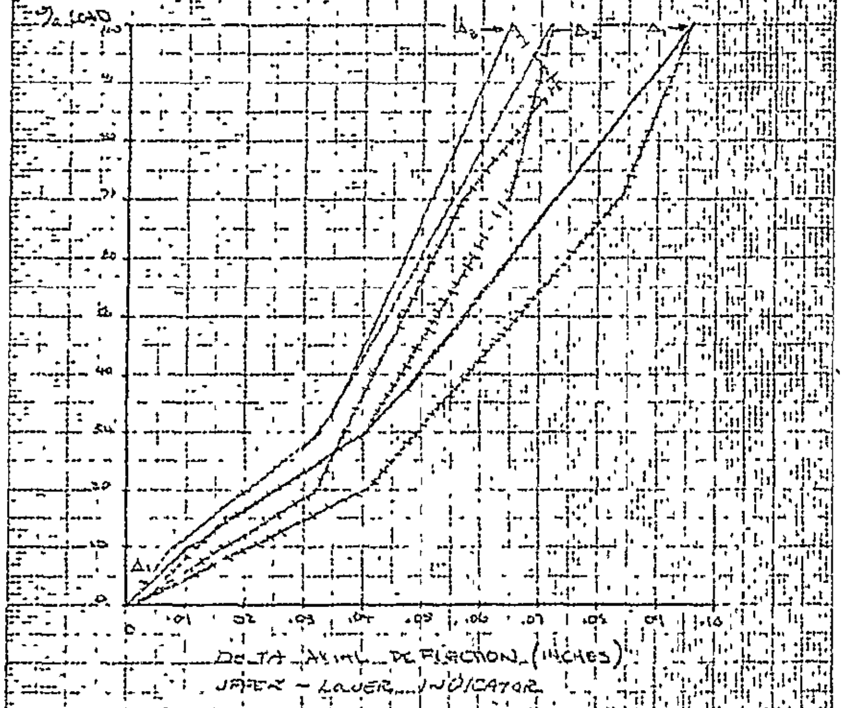
RESCUE MISSION

PAGE NO. 8 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB

RESCUE DROGUE
TEST DATA

TEST RUN 11/2/72

100% LOAD = 6710#
UP
DOWN



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CHECKED BY:
DATE: 6 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575664

REF
N/A
V56-000
250

RELEASE ASSEMBLY - MANUAL PROBE EXTENSION LATCH

PART OF THE MODIFICATION OF DOCKING-MECHANISM COMPATIBLE TO MODIFIED DROGUE (V56-575206). PROVIDES MANUAL CAPABILITY TO JETTISON A DISABLED CSM FROM MDA AXIAL PORT. ASSEMBLY IS MOUNTED TO EXTENSION LATCH, RELEASE MECHANISM (V36-575160) REPLACING ONE V36-575371 SOLENOID.

LOADS.

LOADS ARE PER HRM-6 P. 19-22 AND ARE

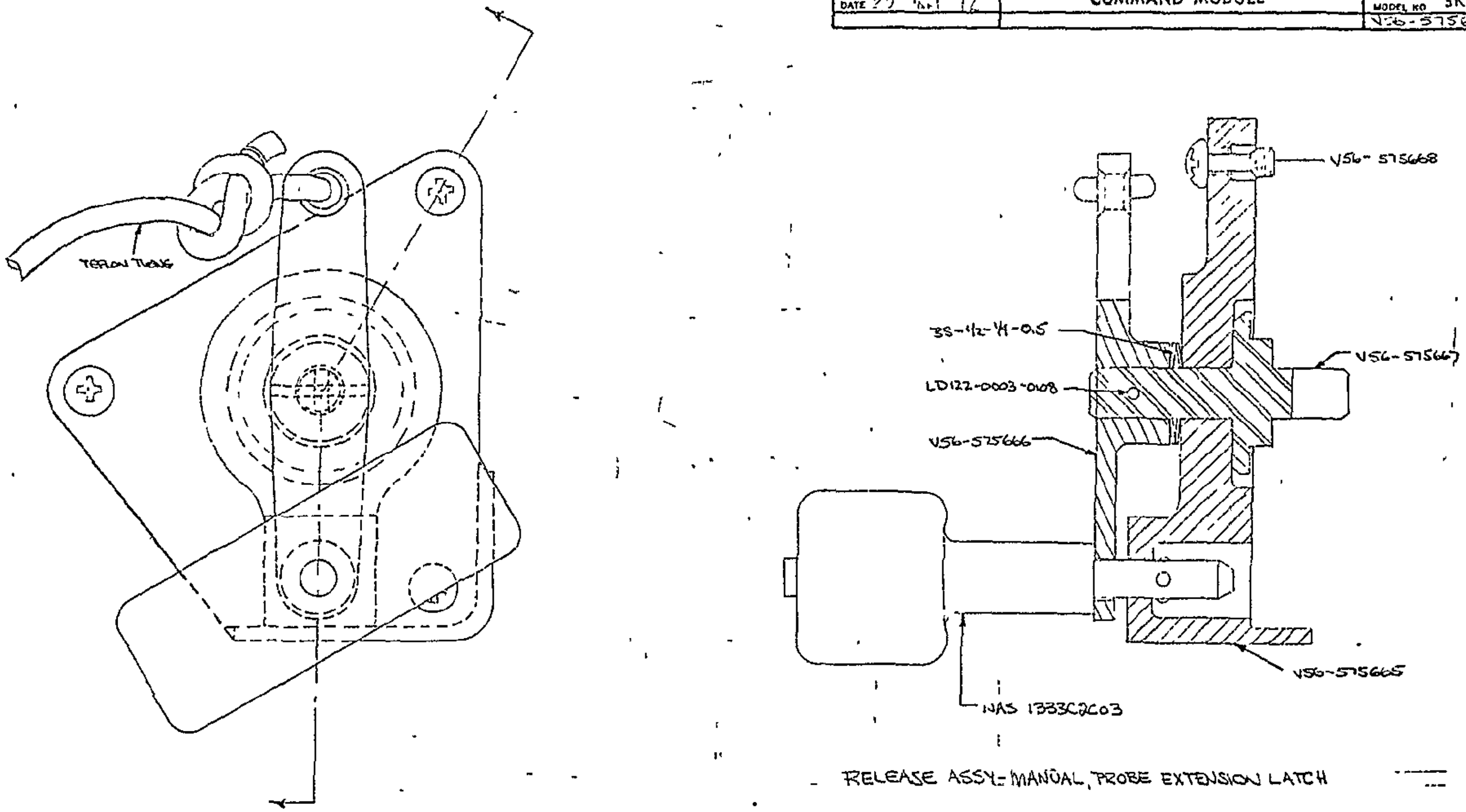
$50^{\#}$ PULL FORCE (LIMIT)

F.S. = 1.5

$P_{ULT} = 1.5(50) = 75^{\#}$ ULT.

@ ANGLE OF 20° FROM PLANE OF ROTATION.

PREPARED BY: JWL	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 2 OF 5
CHECKED BY: RGR		REPORT NO. SD 70-205
DATE 20 [illegible] '72	COMMAND MODULE	MODEL NO SKYLAB
		V56-575664

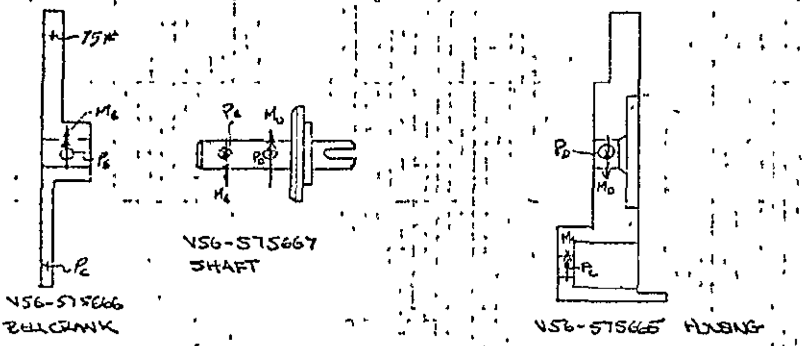


RELEASE ASSY-MANUAL, PROBE EXTENSION LATCH

REF

LOADS

CONDITION 1: LOAD ACTS IN PLANE OF ROTATION OF BELLCRANK. SHEAR PIN REMAINS ENGAGED



$P_C = 75(\frac{1}{.94})$
$= 80\#$ (ULT)
$P_B = 75+80$
$= 155\#$ (ULT)
$M_B = 75(.1875-.08)$
$+80(.1875-.045)$
$= 19.5$ IN-LB

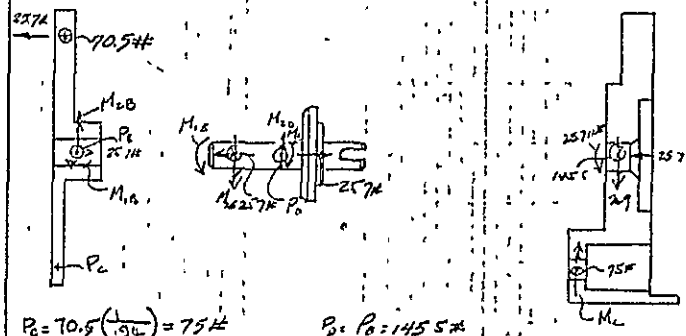
$P_D = P_B = 155\#$
$M_D = 19.5+155(.747-.1875-.159)$
$= 19.5+.4(155) = 81.5$ IN#

$P_C = 80\#$
$M_C = 80(.3-.045-.060)$
$= 15.6$ IN-LB.

REF

LOADS

CONDITION 2: LOAD ACTS 20° TO PLANE OF ROTATION OF BELLCRANK. SHEAR PIN REMAINS ENGAGED.



$P_C = 70.5(\frac{1}{.94}) = 75\#$
$M_{1B} = 25.7(1) = 25.7$ IN#
$M_{2B} = 70.5(.1075)+75(.1475) = 18.7$ IN#
$P_B = 70.5+75 = 145.5\#$

$P_D = P_B = 145.5\#$
$M_{1D} = M_{1B} = 25.7$ IN#
$M_{2D} = 18.7+145.5(.4) = 76.9$ IN#

$M_C = 75(.195) = 14.6\#$

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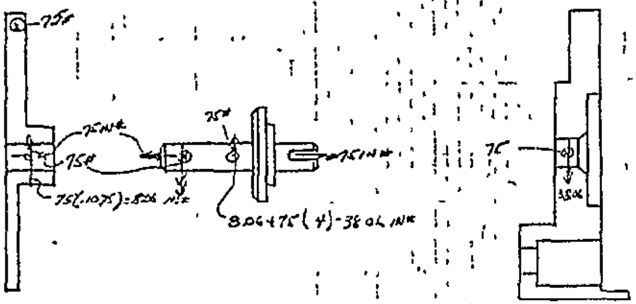
RESCUE MISSION
COMMAND MODULE

PAGE NO. 5 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575664

REF

LOADS.

CONDITION 3: MECHANISM JAMS WITHIN PROBE



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SPACE DIVISION
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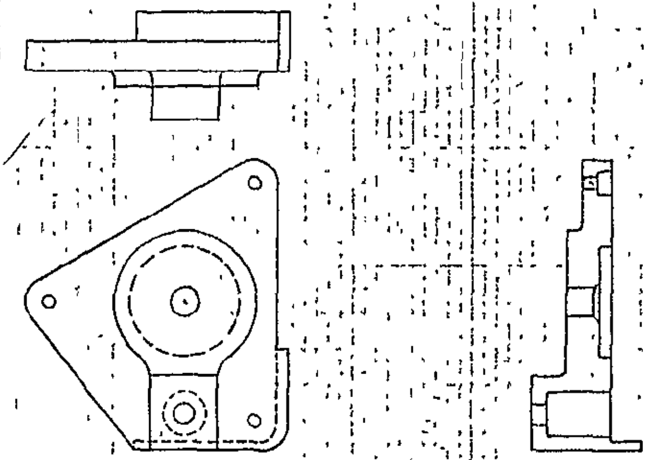
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG. NO. V56-575665

REF

N/A
V56
575664

HOUSING - PROBE EXTENSION LATCH, MANUAL RELEASE



MTL: 2014-T6511, QQ-A-225/4

C22
3.2.1.6(d)

$F_{tu} = 65000$

$F_{ty} = 55000$

$F_{cy} = 53000$

$F_{su} = 38000$

$F_{bru} = 98000$

124000

$F_{bry} = 77000$

88000

e = 8%

$E = 10.5 \times 10^6$

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DATE: 2 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575665

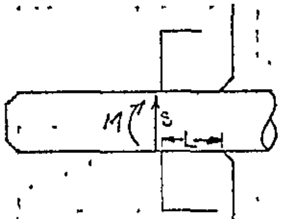
REF.

V56
575667
P.2
(D4)
6-40-40-4

HOUSING

CONDITION 1

BEAM-SOCKET EFFECTS - MAIN SHAFT



S = 155 #

M = 64 5 IN#

L = .223 IN

D = .2500

$t_1 = \frac{.938-.25}{2}$

$= .344$

$\frac{SL}{M} = 0.54$

$t_2 = t_1 = .344$

$K_1 = 8.2$ $\quad w_1 = \frac{K_1 M}{L^2} = \frac{(8.2)(64.5)}{(.223)^2} = 10,636$ #/IN

$K_2 = 7.1$ $\quad w_2 = \frac{K_2 M}{L^2} = \frac{(7.1)(64.5)}{(.223)^2} = 9209$ #/IN

$f_{br} = \frac{W}{D} = \frac{10636}{.25} = 42,600$ PSI $\qquad M.S. = \frac{124000}{42,600} - 1 = 191$

$f_t = \frac{W}{2t_1} = \frac{10636}{2(.344)} = 15,500$ PSI $\qquad MS = \frac{65000}{15,500} - 1 = 3\ 20$

$f_s = \frac{W}{2t_2} = \frac{10636}{2(.344)} = 15,500$ PSI $\qquad MS = \frac{38000}{15,500} - 1 = 1\ 45$

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DATE: 2 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 3 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575665

REF

V56
575664
P.2
(D4)
6-40-40-4

HOUSING

CONDITION 1

BEAM-SOCKET EFFECTS — LOCK PIN

S = 80 # $\quad$ M = 10.8 IN# $\quad$ L = .120 IN $\quad$ D = .1935

$t_1 = \frac{.63-.1935}{2}$

$= .218 = t_2$

$\frac{SL}{M} = \frac{(80)(.12)}{10.8} = .89$

$K_1 = 9.6$ $\quad w_1 = \frac{(9.6)(10.8)}{(.12)^2} = 7,200$ #/IN

$K_2 = 7.8$ $\quad w_2 = \frac{7.8(10.8)}{(.12)^2} = 5,850$ #/IN

$f_{br} = \frac{W}{D} = \frac{7200}{.1935} = 37,200$ PSI $\qquad M.S. = \frac{124000}{37200} - 1 = 2\ 34$

$f_t = \frac{W}{2t_1} = \frac{7200}{2(.218)} = 16,500$ PSI $\qquad MS = \frac{65000}{16,500} - 1 = 2\ 94$

$f_s = \frac{W}{2t_2} = \frac{7200}{2(.218)} = 16,500$ PSI $\qquad M.S. = \frac{38000}{16500} - 1 = 2\ 30$

PREPARED BY: JWL	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO. 4 OF 8
CHECKED BY: RGR		REPORT NO SD 70-205
DATE: 3 APRIL '73	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-575665

HOUSING

CONDITION 1

LOADS IN 3 TIE-DOWN SCREWS (V56-575668)

LOAD AND MOMENT AT C.G. OF BOLT PATTERN

$P = 75\#$

$T = 75\ IN\#$

$M_{OT} = 75(.667) = 50\ IN\#$

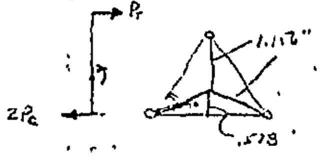
REACT P BY EQUAL SHEAR

$$P_{BOLT} = \frac{75}{3} = 25\#/BOLT$$

REACT T BY SHEAR IN BOLTS

$$T_T = \frac{75\ IN\#}{3\left(\frac{2.312}{2}\right)} = 21.6\#/BOLT$$

REACT M_{OT} BY TENSION COMP. COUPLE



$$P_T = \frac{Md}{\Sigma l^2} = \frac{(50)(1.156)}{(1.156)^2+2(.578)^2} = 28.8\#$$

$$P_C = \frac{(50)(.578)}{(1.156)^2+(.578)^2} = 14.4\#$$

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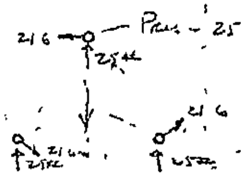
CHECKED BY: RGR		REPORT NO SD 70-205
DATE: 3 APRIL '73	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-575665

HOUSING

CONDITION 1

RESULTANT SHEAR IN BOLT



$P_{RES} = 25 + 21.6 = 33$

$D_{BOLT} = .083\ IN$

$$f_s = \frac{(28.8)(4)}{\pi(.083)^2} = 5350\ PSI$$

$$f_b = \frac{(33)(.1375)(32)}{\pi(.083)^3} = 110{,}300\ PSI$$

$F_s = 140{,}000$; $R_A = \frac{5350}{140{,}000} = .038$

$F_b = 206{,}500$; $R_B = \frac{110{,}300}{206{,}500} = .534$

$$M.S. = \frac{1}{.534+.038} - 1 = .75$$

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 3 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575665

REF

HOUSING

CONDITION 2

V56 575667 73 Ⓓ4 6-40-44-A

BEAM-SOCKET EFFECTS — MAIN SHAFT

FROM PAGE 11, $\frac{SL}{M} = 0.5$

$K_1 = 80 \qquad W_1 = \frac{K_1 M}{L^2} = \frac{(8)(66)}{(.223)^2} = 10617 \#/IN$

$K_2 = 70 \qquad W_2 = \frac{K_2 M}{L^2} = \frac{7(66)}{(.223)^2} = 9290 \#/IN$

THESE LOADS ARE LOWER THAN CONDITION 1, AND THUS LESS CRITICAL

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 3 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 7 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575665

REF.

HOUSING

CONDITION 2

LOADS IN TIE-DOWN SCREWS (V56-575668)

TRANSFER LOADS TO CG OF BOLT PATTERN

$P_S = 70.5 \#$

$P_T = 25.7 \#$

$T = 70.5 \text{ IN\#}$

$M_1 = (70.5)(.667) = 47 \text{ IN\#}$

$M_2 = (25.7)(1) = 25.7 \text{ IN\#}$

SHEAR IN BOLTS DUE TO P_S

$S = 70.5/3 = 23.5 \#/\text{BOLT}$

SHEAR DUE TO T

$S = \frac{T}{3(1.156)} = \frac{70.5}{3(1.156)} = 20.4 \#$

RESULTANT SHEAR = $23.5 + 20.4 = 31.11 \#$

TENSION IN BOLTS

$(P_{TB})_1 = \frac{25.7}{3} + \frac{(47)(1.156)}{(1.156)^2 + 2(.578)^2} = 35.67 \#$ MAX

$(P_{TB})_2 = \frac{25.7}{3} - \frac{(47)(.578)}{2.0045} + \frac{(25.7)}{(2.0023)} = 7.85 \#$

$(P_{TB})_3 = \frac{25.7}{3} - \frac{47(.578)}{2.0045} - \frac{25.7}{2.0023} = -17.83 \#$

REF

HOUSING

CONDITION 2

$$f_a = \frac{(35.67)(4)}{\pi(.083)^2} = 6{,}600 \text{ PSI}$$

$$f_b = \frac{(31.11)(.1875)(32)}{\pi(.083)^3} = 104{,}000 \text{ PSI}$$

$$R_A = \frac{6600}{140000} = .047$$

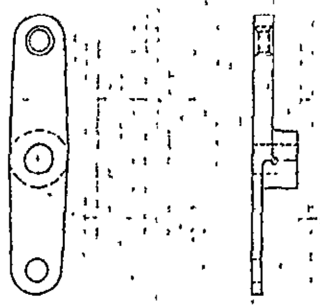
$$R_B = \frac{104{,}000}{206{,}500} = .503$$

$$M.S. = \frac{1}{.550} - 1 = .82$$

REF.

N/A
V56
575664

BELLCRANK - PROBE EXTENSION LATCH, MANUAL RELEASE



MATERIAL: QQ-A-225/4 2014-T6511

Ⓒ22
TABLE
3.2.1.0(d)

F_{tu} = 65000 PSI
F_{ty} = 55000 PSI
F_{cy} = 53000 PSI
F_{su} = 38000 PSI
F_{bru} = 98000 PSI (e/D = 1.5)
124000 PSI (e/D = 2.0)
F_{bry} = 77000 PSI (e/D = 1.5)
88000 PSI (e/D = 2.0)
e = 8 %
E = 10.5×10⁶ PSI

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 7 APRIL 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

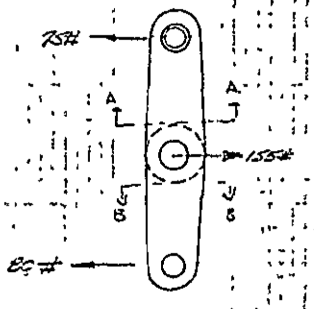
PAGE NO 2 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575666

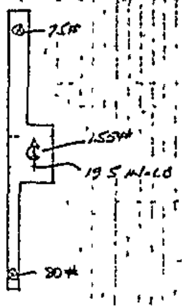
REF

V56
575664
P.2

BELLCRANK

CONDITION 1





BENDING ON A-A

$M = 75\# (1 - \frac{.5}{2}) = 56.2 IN\#$

$\sigma_b = \frac{6M}{bt^2} = \frac{6(56.2)}{(.16)(.475)^2} = 9,400\ PSI$

$F_{bu} = F_{tu} + (K-1)\frac{F_{ty}+F_{cy}}{2}$ $K = 1.5$

P.1

$F_{bu} = 65000 + (.5)(54000) = 92000\ PSI$

$M.S. = \frac{92000}{9400} - 1 = HIGH$

BENDING ON B-B

$M = 80\# (.94 - \frac{.5}{2}) = 55.2\ IN\#$

$\sigma_b = \frac{6M}{bt^2} = \frac{6(55.2)}{.09(.475)^2} = 16,500$

$M.S. = \frac{92000}{16500} - 1 = 4.59$

523

1280

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 7 APRIL 73

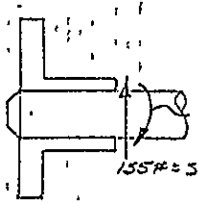
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575666

REF

BELLCRANK

BEAM SOCKET ANALYSIS (CONDITION II)



$M = 75(.375 - .05) + 80(.375 - .045) = 48.5\ IN\#$

$L = .375$

$\frac{M}{SL} = \frac{-48.5}{(155)(.375)} = -.835$

D4
TABLE II
6-40-40.5

$K_1 = -1.1$ $w_1 = \frac{K_1 S}{L} = \frac{(-1.1)(155)}{.375} = -455\ \#/IN$

$K_2 = -3.0$ $w_2 = \frac{K_2 S}{L} = \frac{(-3)(155)}{.375} = -1240\ \#/IN$

$K_a = .74$ $a = K_a L = (.75)(.375) = .281$

$f_{br} = \frac{W}{D} = \frac{1240}{.25} = 4960\ PSI$

$M.S. = HIGH$

D4
6-40-40-5

$f_t = \frac{W}{2t_1} = \frac{1240}{2(.125)} = 4960\ PSI$

$M.S. = HIGH$

$f_c = \frac{W}{2t_2} = \frac{1240}{2(.125)} = 4960\ PSI$

$M.S. = HIGH$

524

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 2 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

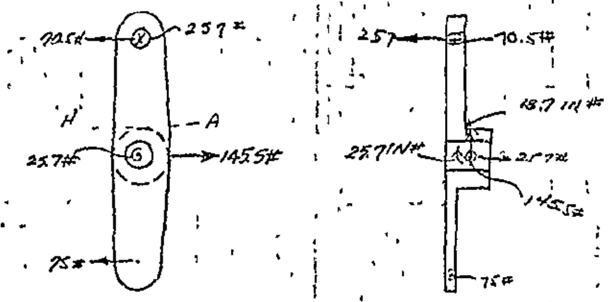
PAGE NO 4 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575666

REF

V56
575664
P.3

BELLCRANK

CONDITION 2



BENDING AT A-A

$M_1 = 70.5(.75)$ $\quad M_2 = 25.7(.75)$

$$\sigma = \frac{6M_1}{bt^2} + \frac{6M_2}{tb^2} = \frac{6(70.5)(.75)}{(.16)(.475)^2} + \frac{6(25.7)(.75)}{(.475)(.16)^2} = 18{,}300 \text{ PSI}$$

$$M.S. = \frac{92000}{} - 1 = +4.03$$

BEAM-SOCKET ANALYSIS

$M = \sqrt{25.7^2 + 485^2} = 54.9 \text{ IN\#}$

$S = 145.5 \qquad L = .375$

$$\frac{SL}{M} = \frac{(145.5)(.375)}{54.9} \approx 1$$

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 2 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575666

REF

(D4)
6-10-90-5

BELLCRANK

CONDITION 2
BEAM-SOCKET ANALYSIS

$K_1 = 0.4 \qquad w_1 = \frac{K_1 M}{L^2} = \frac{(.4)(54.9)}{(.375)^2} = 157 \text{ \#/IN}$

$K_2 = 0.8 \qquad w_2 = \frac{K_2 M}{L^2} = 2w_1 = 314 \text{ \#/IN}$

$K_m = 1.0 \qquad M_{max} = K_m M = (54.9)(1.0) = 54.9 \text{ IN\#}$

$f_{br} = \frac{w}{D} = \frac{314}{.25} = 1256 \text{ PSI}$

M.S. = HIGH

$f_t = \frac{w}{2t_1} = \frac{314}{2(.125)} = 1256 \text{ PSI}$

M.S. = HIGH

$f_s = \frac{w}{2t_2} = \frac{314}{2(.125)} = 1256 \text{ PSI}$

M.S. = HIGH

BEARING ON SHEAR PIN

$P_s = \frac{25.7}{2} = 12.85\#$ DOUBLE SHEAR

$$\sigma_{br} = \frac{12.85}{(3/64)(.125)} = \frac{64(12.85)}{.375} = 2200 \text{ PSI}$$

M S = HIGH

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 2 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575666

REF.

BELLCRANK

CONDITION 3

V56 575664 P04

THIS CONDITION IS LESS SEVERE THAN CONDITIONS 1 AND 2 EXCEPT FOR TRANSMISSION OF THE TORQUE THROUGH THE SHEAR PINS

$T = 75 \text{ IN\#}$

$P_c = 75/.375 = 200\#$ COUPLE LOAD

$$\sigma_{BR} = \frac{200}{(.060)(.125)} = 26{,}670 \text{ PSI}$$

$$M.S. = \frac{124000}{26{,}670} - 1 = +3.65$$

SHEAR ON PIN:

PIN IS LD 122-0003-0108

MTL QQ-W-423 COMP FS302, COND B

(D11) APP C C-2

$F_{su} = .6(255{,}000) = 153{,}000$

$A_s = \frac{\pi}{4}(.060)^2 = .0028 \text{ IN}^2$

$$P = \frac{3}{4} f_{su} A_s = \frac{3}{4}(153000)(.0028) = 325\#$$

$$P_s = \frac{75}{(.125)2} = 300\#$$

$$M.S. = \frac{325}{300} - 1 = +.08$$

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 3 APRIL '73

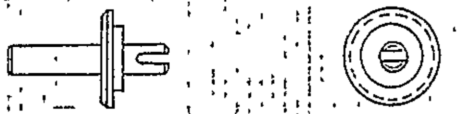
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575667

REF

N/A V56 575664

SHAFT - BELLCRANK, PROBE EXTENSION, LATCH, MANUAL RELEASE



MATERIAL: A286 CRES AMS 5737

(D11) 07.01.01.01

$F_{tu} = 140{,}000$ PSI

$F_{cy} = 95000$ PSI

$F_{cy} = 95000$ PSI

$F_{su} = 91000$ PSI

$F_{bru} = 210{,}000$ PSI (e/D=15)

266000 PSI (e/D=2.0)

$F_{bry} = 142000$ PSI (e/D=15)

171000 PSI (e/D=20)

e = 12%

$E = 29 \times 10^6$ PSI

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 2 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

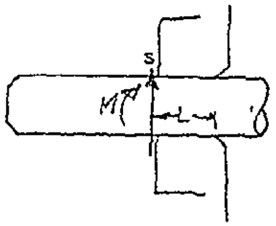
PAGE NO 2 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575667

REF

SHAFT

CONDITION 1

BEAM-SOCKET ANALYSIS



$S = 155\#$

$M = 19.5 + 155(.2895) = 64.5 \text{ IN}\#$

$L = .223$

$\frac{SL}{M} = \frac{(155)(.223)}{64.5} = .54$

D4

$K_m = 1.02$

$M_{max} = K_m M = (1.02)(64.5) = 66 \text{ IN}\#$

$f_b = \frac{32M}{\pi D^3} = \frac{32(66)}{\pi(.25)^3} = 43{,}100 \text{ PSI}$

$F_{bu} = 140{,}000 + .7(95000) = 206{,}500$

$M.S. = \frac{206{,}500}{43{,}100} - 1 = 3.79$

283

PREPARED BY: JWL
CHECKED BY: RGR
DATE: 3 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575667

REF

SHAFT

CONDITION 2

BEAM-SOCKET ANALYSIS

V56
575664
P.3

$S = 145.5\#$

$M = [18.7 + 145.5(.2895)] + 25.7 = 66 \text{ IN}\#$

$l = 223$

$\frac{SL}{M} = \frac{(145.5)(223)}{66} = .5$

D4

$K_m = 1.02 \qquad M = (1.02)(66) = 67.3 \text{ IN}\#$

$f_b = \frac{32(67.3)}{\pi(.25)^3} = 43{,}900 \text{ PSI}$

$f_t = \frac{25.7}{\frac{\pi}{4}(.25)^2} = 525 \text{ PSI}$

$R_b = \frac{43{,}900}{206{,}500} = .21$

$R_T = \frac{525}{140{,}000} = .01$

$M.S. = \frac{1}{R_b + R_T} - 1$

$M.S. = \frac{1}{.22} - 1 = \underline{3.54}$

530

SHAFT

CONDITION 3

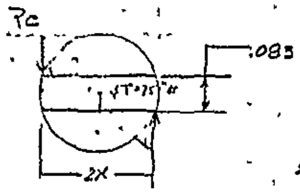
TORSION ON SHAFT

$T = 75$ IN#

$$\sigma = \frac{Tc}{J} = \frac{16T}{\pi D^3} = \frac{16(75)}{\pi(.25)^3} = 24,500$$

$$M.S. = \frac{91000}{24500} - 1 = 2.72$$

CHECK GROOVE (SCREWDRIVER SOCKET)



$R = .124$

$x = \sqrt{.124^2 - (.0415)^2}$

$x = .11685$

$2x = .2337$

$$P_c = \frac{T}{2x} = \frac{75}{.2337} = 321\#$$

ANALYSIS OF 1 LEG OF SHAFT

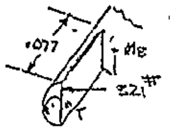
TRANSFER P_c TO CG. OF LEG

$P_c = 321\#$

$T = 75/2 = 37.5$ IN#

SHAFT

COMBINED TORSION AND BENDING



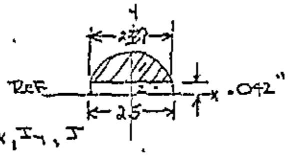
REACTION SURFACE IS LD_122 0002-0108 PIN WHICH PROVIDES LOCK TO TURN LATCH RELEASE MECHANISM V56-575160. THIS ANALYSIS ASSUMES V36-575160 MECHANISM JAMS DOWN STREAM FORCING PURE TORQUE ON SHAFT RESULTING IN TORSION AND BENDING AS SHOWN IN SCREWDRIVER END.

$P = 321\#$

$M_T = 321(.11685) = 37.5$ IN #

$M_B = 321(.077) = 24.7$ IN #

SECTION



WANT I_X, I_Y, J

SEMICIRCLE

$$A = \frac{\pi D^2}{8} = \frac{(3.14)(.25)^2}{8} = .02454 \text{ IN}^2$$

$$\bar{Y} = \frac{2D}{3\pi} = \frac{2(.25)}{3(3.14)} = .05305 \text{ IN}$$

PREPARED BY: RGR
CHECKED BY: G. F.
DATE: 18 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575667

REF.

SHAFT

SECTION PROPERTIES

SECT	A	Y	AY	AY²	I_o
1-2	.0245	.053	1.2785×10^{3}	6.88×10^{5}	2.679×10^{-5}
2	−.0105	.021	-2.205×10^{-4}	-4.63×10^{-6}	-1.543×10^{-6}
Σ =	1.4×10^{-2}		1.078×10^{-3}	6.417×10^{-5}	2.525×10^{-5}

$$\bar{Y} = \frac{\Sigma AY}{\Sigma A} = \frac{1.078 \times 10^{3}}{1.4 \times 10^{-2}}$$

$$\bar{Y} = 7.7 \times 10^{-2}$$

$$I_{xx NA} = \Sigma I_0 + \Sigma AY^2 - A\bar{Y}^2$$

$$= 2.525 \times 10^{5} + 6.417 \times 10^{-5} - (1.4 \times 10^{-2})(7.7 \times 10^{-2})^2$$

$$I_{NA} = 6.32 \times 10^{-6}$$

$$I_{yy NA} = I_{01-2} - I_{02}$$

$$= 9.57 \times 10^{-5} - 5.469 \times 10^{-5}$$

$$I_{yy NA} = 4.1 \times 10^{-5}$$

$$J = I_{xx} + I_{yy} = 6.32 \times 10^{-6} + 4.1 \times 10^{-5}$$

$$J = 4.732 \times 10^{-5}$$

COMBINED BENDING AND TORSION

TORSION

$$\tau = \frac{Tc}{J} \quad \text{(CIRCULAR SHAFT)}$$

$$= \frac{(37.5)(.125 - .077)}{4.732 \times 10^{-5}}$$

$$\tau = 3.804 \times 10^{4} \text{ PSI}$$

$$F_{su} = 91{,}000 \text{ PSI}$$

$$R_s = \frac{3\ 804}{9.100} = .4180$$

PREPARED BY: RGR
CHECKED BY: G. F.
DATE: 18 APRIL '73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 7 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575667

REF.

SHAFT

BENDING

$$\sigma_b = \frac{Mc}{I} = \frac{(247)(.077 - .042)}{6.32 \times 10^{-6}}$$

$$\sigma_b = 1.368 \times 10^{5} \text{ PSI}$$

$$K = 1.5$$

$$F_B = 140 + .5(95)$$

$$F_B = 187{,}500 \text{ PSI}$$

$$R_b = \frac{136{,}800}{187500} = .718$$

MARGIN

$$MoS_0 = \frac{1}{[R_b^2 + R_s^2]^{1/2}} - 1$$

$$= \frac{1}{.8308} - 1$$

$$= .2036$$

$$\underline{MoS = +.20}$$

PREPARED BY: G.F.	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 1 OF 3
CHECKED BY: RGR	RESCUE MISSION	REPORT NO SD 70-205
DATE: 4/20/73	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-575670

REF

N/A

V56-000250 RELEASE TOOL - DOCKING RING LATCH, ASSY OF

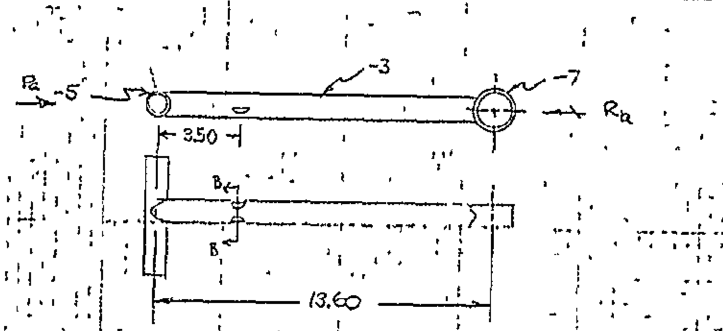
THE RELEASE TOOL IS DESIGNED TO
B9 PROVIDE A 37 LB FORCE (LIMIT) TO
4.0.14 ENGAGE THE DOCKING LATCHES. WHEN THE DOCKING LATCHES ARE ENGAGED, OR BOTTOMED OUT, A 225 LB. (ULT.) PERSONNEL FORCE MAY BE EXPERIENCED. THE RELEASE TOOL DELIVERS THE LOAD AXIALLY ALONG THE -3 TUBE

PREPARED BY: GLD	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 2 OF 3
CHECKED BY: G.F.	RESCUE MISSION	REPORT NO SD 70-205
DATE: JUNE 19 1972	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-575670

REF

DOCKING LATCH

RELEASE TOOL - DOCKING RING LATCH, ASSY OF



MATERIAL:

-3 CRES TUBE MIL-T-8809 (321) 3/4 OD, .065 WALL
-5 CRES TUBE MIL-T-8809 (321) 3/4 OD, .065 WALL
-7 CRES TUBE QQ-S-763 CLASS 321 COND. A

Pg 3 ALL

$F_{cy} = 35000$ PSI

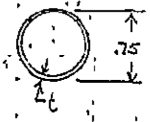
Ⓓ11 06.05 01.01 $F_{tu} = 75{,}000$ PSI

$F_{ty} = 30{,}000$ PSI

$F_{su} = 53{,}000$ PSI

Ⓑ9 440.14 $F_{bru} = 150{,}000$ PSI

$E = 29.0 \times 10^6$ PSI



$t = .065$

$$I = \frac{\pi}{4}\left[(.375)^4 - (.31)^4\right] = .00828\ IN^4$$

$$A = \pi\left[(.375)^2 - (.310)^2\right]$$
$$= .1399\ IN^2$$

PREPARED BY: GHD
CHECKED BY: G.E.
DATE: JUNE 19 1972

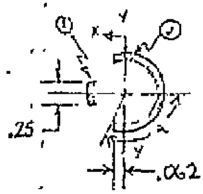
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-575670

REF.

RELEASE TOOL

SECTION B-B



$t = .065$

$\alpha = 1.775\ \text{RAD}$

$$I_1 = \frac{.25(.065)^3}{12} = 572 \times 10^{-6}$$

$$I_2 = (.375)^3 .065 \left[1.775 + \sin\alpha \cos\alpha - \frac{2 \sin^2\alpha}{\alpha} \right] = .0017$$

	I	$\bar{X}$	A
①	572×10^{-6}	.3425	.01625
②	.0017	−.2069	.0865
			.10275

$$\rho = \sqrt{\frac{.0058}{.10275}} = .2376\ \text{IN}$$

$$\bar{x}_T = \frac{.3425(.01625) - .2069(.0865)}{.01625 + .0865} = -.12\ \text{IN}$$

$$I = .0017 + (.4625)^2 .01625 + .0865(.0869)^2 = .0058\ \text{IN}^4$$

$$F_c = \frac{\pi^2 E}{(L/\rho)^2} = \frac{\pi^2 (29 \times 10^6)}{\left(\frac{13.60}{.2375}\right)^2} \quad \text{(COLUMN BUCKLING)}$$

$F_c = 87292$ PSI

USE, $F_c = F_{cY} = 35000$ PSI

$$f_c = \frac{225}{.10275} = 2190\ \text{PSI}$$

(COLUMN LOADING) M.S. = +HIGH

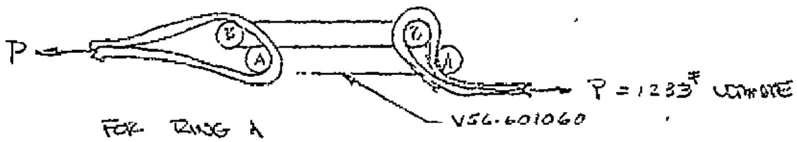
PREPARED BY: RER
CHECKED BY: G.F.
DATE: 12 APRIL 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601060

REF
N/A
V56-601067
V56-601069

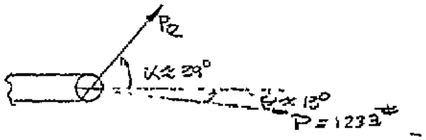
RING-LAUNCH-CENTER CREW COUCH RETAINER STRAP RESCUE VEHICLE



FOR RING A

$$P = \frac{2466}{2}$$

= 1233 LBS (ULT)

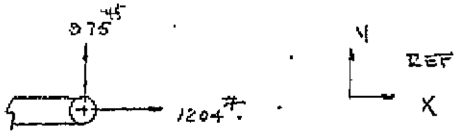


$$P_R = \frac{P \cos 13^\circ}{\cos 39^\circ}$$

$$P_R = 1233\left(\frac{.975}{.777}\right)$$

$P_R = 1550$# ULTIMATE

IN THE PLANE OF RING A



LOADS ARE STRAP INDUCED AND ARE UNIFORMLY DISTRIBUTED

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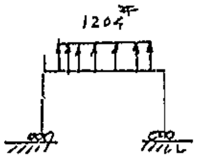
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

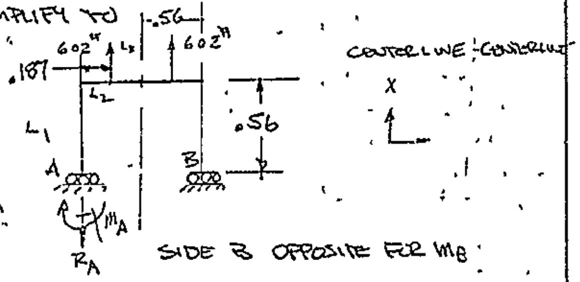
PAGE NO. 2 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601060

REF

FOR LOADING IN X DIRECTION



SIMPLIFY TO



SIDE B OPPOSITE FOR M_B

ROTATION AT A = 0

$\theta_A = 0$

DUE TO M_A

$$\theta_{M_A} = \frac{ML_1}{EI} = \frac{M_A(L_1+L_2+L_3)}{EI}$$

DUE TO P = 602#

$$\theta_P = \frac{1}{2}\frac{PL_3^2}{EI}$$

DUE TO R = 602#

$$\theta_R = \frac{1}{2}\frac{R(L_2+L_3)^2}{EI}$$

$\Sigma\theta = 0$

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DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601060

REF

$\theta_M + \theta_P = \theta_R$ EI = CONST

$$M_A(L_1+L_2+L_3) + \frac{1}{2}\frac{PL_3^2}{2} = \frac{1}{2}R(L_2+L_3)^2$$

$R = P$

$L_1 = .56$ $L_2 = .187$ $L_3 = .373$

$$1.12\, M_A = -\frac{1}{2}P(.373)^2 + \frac{1}{2}R(.56)^2$$

$M_A = 52.8$ IN #

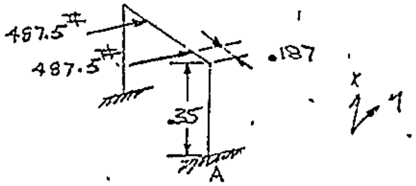
$M_{max} = M_A - R_A(.187)$

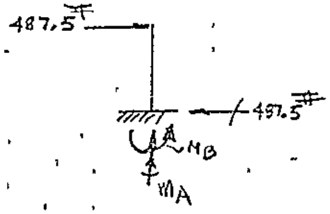
$= 52.8 - 112.6$

$M_{max} = -59.8$ IN #

LOADING IN Y DIRECTION

SIMPLIFIED LOADING





PREPARED BY L.	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO
CHECKED BY		REPORT NO SD 70-205
DATE 12 APRIL 72	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-601060

$\theta_D = 0$

$\theta_P = \frac{1}{2}\frac{Pl^2}{EI}$ $\quad l = .373$

$\theta_R = \frac{1}{2}\frac{Pl^2}{EI}$ $\quad l = .56$

$\theta_m = \frac{M_A L}{EI} = M_A(.35+.56)$

$\theta_m = 0.91 M_A$

$\theta_m + \theta_P = \theta_R$

$\theta_m = \theta_R - \theta_P$ $\quad EI = CONST$

$.91 M_A = \frac{1}{2}P[.56^2 - .373^2]$

$M_A = \frac{.5}{.91}(487.5)[.56^2 - .373^2]$

$M_A = 46.7$ IN #

$M_{max} = 46.7 - 487.5(.187)$

$= -4455$ IN #

$M_B = .35(487.5) = 170.51$ IN #

STRESS

BENDING

$\sigma_{xx} = \frac{Mc}{I}$; $I = \frac{\pi D^4}{64}$ $\quad D = .25$

$I = .00019$ IN^4

$\sigma_{xx} = \frac{(598)(.125)}{.00019}$

$\sigma_{xx} = 39,400$ PSI

SHEAR $\quad M = M_T = 4455$ IN #

$\tau = \frac{2M_T}{\pi r^3} = \frac{2(44.55)}{(3.14)(.125)^3} = 14540$ PSI

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CHECKED BY	
DATE 12 APRIL 72	COMMAND MODULE
REF	

BENDING

$\sigma_{yy} = \frac{M_B c}{I} = \frac{170.5(.125)}{.00019}$

$\sigma_{yy} = 112,600$ PSI

SHEAR (AREA)

$S = P/A = 487.5/\pi r^2$, $r = .125$

$S = \frac{487.5}{(3.14)(.125)^2}$

$S = 9910$ PSI

TENSION

$f_t = P/A$

$= 602/\pi(.125)^2$

$f_t = 12,250$ PSI

TOTAL SHEAR $= 14540 + 9910$

$= 24,450$ PSI

MAXIMUM SHEAR STRESS

$\tau_{MAX} = \left[\left(\frac{\sigma_{xx}-\sigma_{yy}}{2}\right)^2 + \tau^2\right]^{1/2}$

$\tau_{max} = 44,000$ PSI

$F_{SU} = 113$ KSI

MAXIMUM STRESS

$\sigma_{MAX} = \frac{\sigma_{xx}+\sigma_{yy}}{2} + \tau_{MAX}$

$\sigma_{MAX} = 120,000$ PSI

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CHECKED BY: G F
DATE: 12 FEB 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO VS6-601060

REF
Ⓓ11
7.2.1.1

INCONEL 718
MB 0170-041

$F_{SU} = 113$ KSI
$F_{TU} = 180$ KSI
$F_{TY} = 150$ KSI

MAXIMUM SHEAR

$f_s = 14{,}000$ PSI

$MS_o = \underline{+1.57}$

MAXIMUM PLANE STRESS

$f_t = 120{,}000 + 12\,250$

$= 132\,250$ PSI

$F_{TU} = 180$ KSI

$MS_o = \underline{+.35}$

PREPARED BY: RGR
CHECKED BY: HD
DATE: 7 MARCH 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO VS6-601067

REF
N/A
F04-100
002

BALLAST LAUNCH- CENTER CREW COUCH
RESCUE MISSION
SIX BALLAST PLATES = 220# DEAD WEIGHT

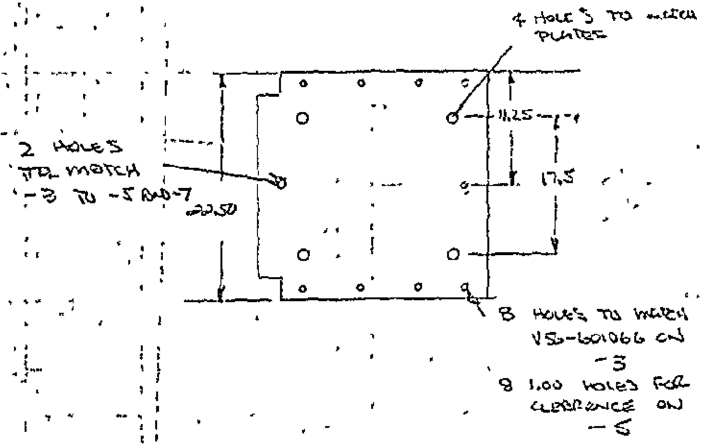
1 -7 TOP PLATE
1 -3 BOTTOM PLATE
4 -5 REMOVABLE BALLAST

D11
0605
.01.01

MATERIAL QQ S-766 CLASS 304 COND A

BASIC SIZE - .250 X 22.50 X 23.00

WT/PLATE ≈ $\rho V = .25(22.50)(23.0)(.286)$
$= 37$#



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DATE: 6 MARCH 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 3

REPORT NO SD 70-205

MODEL NO SKYLAB

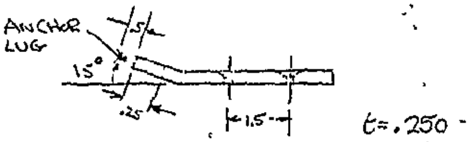
DWG NO V56-601065

REF

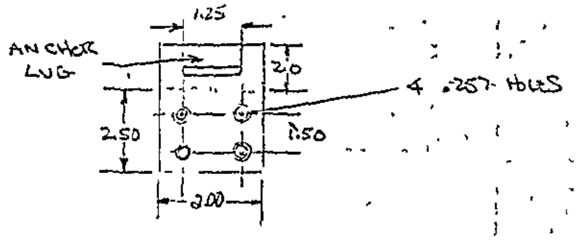
N/A
V56-601
067

FITTING, LAUNCH-BALLAST CENTER CREW COUCH

FITTING IS ATTACHED TO TOP BALLAST PLATE AND SERVES AS ANCHOR TO TIE DOWN STRAP FOR SUPPORT IN Z-Z DIRECTION



t = .250



MATERIAL

304 PLATE QQ-S-766, CLASS 304 COND A

D11-0605.01
.01

$F_{tu} = 75$ KSI

$F_{ty} = 30$ KSI

$F_{cy} = 35$ KSI

$F_{su} = 53$ KSI

$F_{bru} = 150$ KSI

$F_B = 75 + .5(30)$ K = 1.5

$F_B = 90$ KSI

PREPARED BY: RGR

CHECKED BY: GE

DATE: 6 MARCH 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 3

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-601065

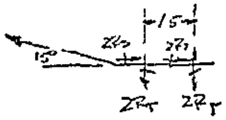
REF

FREEBODY

ULTIMATE

II.263

$\frac{P}{2(2)} = 1233^{\#}$



$P = 20(246.6)$

$P = 4932$ LBS (ULT)

$4R_S = 1233 \cos 15^{\circ}$

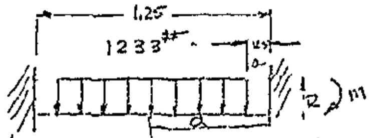
$R_S = 300^{\#}$

$2R_T = 1233 \sin 15^{\circ}(.25)/1.5$

$R_T = 38.6^{\#}$

BENDING OF STRAP ANCHOR LUG

E4
TABLE III
CASE 34



$R = \frac{1}{4}\frac{1233}{(1.25)^2}\left[12(.625)^2 - 8\frac{(.625)^3}{1.25} + \frac{2(1.25)(1)^2}{1.25} - \frac{(1)^3}{1.25} - (1)^3\right]$

$R = 617^{\#}$

$M = -\frac{1}{24}\frac{1233}{1.25}\left[24\frac{(.625)^3}{1.25} - 6\frac{(1.25)^2(1)}{1.25} + 3\frac{1}{1.25} - 4(1) - 24(.625)^2\right]$

$M = 152$ IN#

$M_{SPAN} = -M + Rd - \frac{w}{2}\frac{(x-a)^2}{c}$

$M_{SPAN} = 78$ IN#

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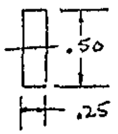
CHECKED BY: GLD
DATE: 7 MAR 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601065

REF.

BENDING OF ANCHOR BEAM



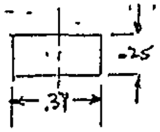
$\sigma = \frac{6m}{bt^2} = \frac{6(210)}{(.25)(.5)^2}$

$\sigma = ,7430$ PSI

$F_B = 90$ KSI $MoS_o = +$ HIGH

COMBINED BENDING + TENSION AT SUPPORT,

$\sigma = \frac{6m}{bt^2} = \frac{6(153)}{(.25)(.37)^2}$



$\sigma = 26,800$ PSI

$P/A = 617/(.25)(.37)$

$= 6670$ PSI

$\sigma + P/A = 32,970$ PSI

$F_B = 90$ KSI

$MoS_o = \frac{90}{89.3} - 1 = +2.66$

PLATE BEARING

$F_{BRU} = 150$ KSI

— MOS HIGH

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CHECKED BY: G.F
DATE: 3-3-2

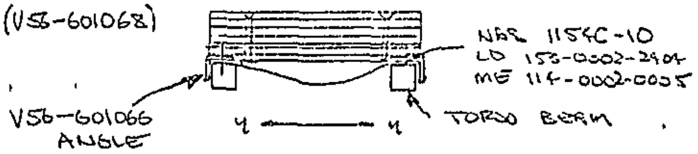
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

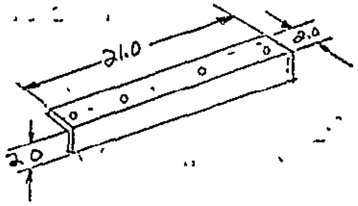
PAGE NO. 1 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601066

REF
N/A
V56
601068

ANGLE - BALLAST, CENTER COUCH, RESCUE VEHICLE

ANGLE ATTACHES TO EITHER SIDE (L,R) OF BALLAST BOTTOM PLATE (V56-601064-7) GIVING BALLAST A SEAT IN THE Y-Y DIRECTION ON THE TORSO SUPPORT BEAMS OF THE WEBER CREW COUCH. REMAING FIVE (5) PLATES ARE THEN ATTACHED TO THE RESULTING ASSEMBLY (V56-601068)





D11
06.05
.01.01

MATERIAL

QQ-S-763 COND A 304 BAR

$F_{TU} = 75$. KSI
$F_{TY} = 30$ KSI
$F_{CY} = 35$ KSI
$F_{SU} = 53$ KSI
$F_{BRU} = 150$ KSI $e/D = 2.0$

PREPARED BY: RGR

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DATE: 3-3-2

SPACE DIVISION
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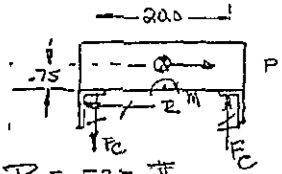
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601066

REF

ANGLE - BALLAST, CENTER COUCH, RESCUE VEHICLE

CHECK ANGLE FOR MAXIMUM LOADS — TIE-DOWN STRAPS TAKING NO 4-7 LOAD. REACT LOAD ON ONE SIDE.



II.2 6.2

$P = 2.18 (246\ 6)$
$= 537$ LBS (ULT)

$R = 537^{\#}$

OVER TURNING MOMENT

$M = 537 (.75 + .5 + \frac{1.25}{2})$

$M = .895$ IN#

REACTION TO OVERTURNING MOMENT

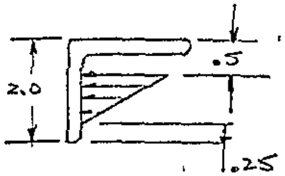
$F_c = \frac{M}{\ell} = \frac{.895}{20}$

$F_e = \pm 44.75^{\#}$

4 FASTENERS / SIDE

$F_c / \text{FAST.} = 44.75/4 = 11.18^{\#}$ (TENSION)

DISTRIBUTION OF R



$R = .537^{\#}$

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CHECKED BY: G F

DATE: 3-3-2

SPACE DIVISION
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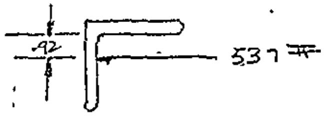
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601066

REF

ANGLE - BALLAST, CENTER COUCH, RESCUE VEHICLE

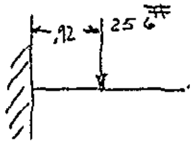
LOCATE AS CONCENTRATED LOAD AT 2/3 ℓ



DISTRIBUTED LOAD

$537^{\#}/21^{IN} = 25.6^{\#}/IN$

TREAT AS CANTILEVER



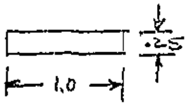
$M = Pa = 25.6 (.92)$

$M_{MAX} = 23 6$ IN #

BENDING STRESS

$\sigma = \frac{6M}{bt^2}$

SECTION (ONE INCH)



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SPACE DIVISION
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RESCUE MISSION
- COMMAND MODULE

PAGE NO 4 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601066

REF

ANGLE-BALLAST, CENTER COUCH, RESCUE VEHICLE

BENDING

$$\sigma = \frac{6M}{bt^2}$$

$$= \frac{6(23.6)}{(1.0)(.125)^2}$$

$$\sigma = 12{,}265 \text{ PSI}$$

$$F_B = F_{tu} + (K-1)F_{ty} \qquad K = 1.5$$

$$F_B = 75 + (.5)(30)$$

$$F_B = 90 \text{ (KSI)}$$

$$MoS_u = \frac{90}{2.265} - 1 = \underline{\underline{+\text{HIGH}}}$$

PREPARED BY: RGR
CHECKED BY: GLD
DATE: 7 MARCH 72

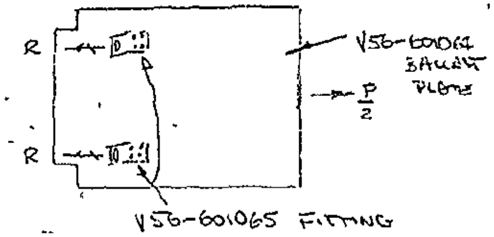
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601067

REF
N/A
F04-700
002

ASSEMBLY-LAUNCH BALLAST, CENTER CREW COUCH, UPPER PLATE

ASSEMBLY COMBINES TOP BALLAST PLATE V56-601064-7 WITH TWO V56-601065 FITTINGS TO PROVIDE ANCHOR POINTS FOR V56-601069- STRAP



NAS 1154C-10 2 REQD
LD 153-0002-2404 8 REQD
ME 114-0002-0005 8 REQD

II.2.6.2

$$P = 20(246.6)$$

$$= 4932 \text{ LBS (ULT)}$$

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PREPARED BY: R.C.R.
CHECKED BY: G.D.
DATE: 7 MARCH 72
PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601067

REF.

ASSEMBLY-LAUNCH BALLAST, CENTER CREW COUCH, UPPER PLATE

FASTENERS

4 NAS 1154-C10

SHEAR $\frac{P}{2} = 2466^{\#}$

$F_{su} = 84$ KSI

$D = .2485$

$A = \frac{\pi D^2}{4} = .0485 \text{ IN}^2$

$P_{all} = F_{su} A$

$= (84{,}000)(.0485)$

$P_{all} = 4{,}074^{\#}$

SHEAR $MOS_U = \frac{4{,}074}{616.5} - 1 = \underline{+HIGH}$

297

TENSION

$P_T = 5{,}100$

$P_{APP} = 38.6$ LBS.

D8

23-24

$MOS_U = \underline{+HIGH}$

56-601
065

PLATE BEARING —

V56
601065

$P = 616.5$ LBS

$F_{BRU} = 150$ KSI

$\sigma_B = P/Dt$

$= 616.5/(.25)(.25)$

$= 9880$ PSI

M.S. $\underline{+HIGH}$

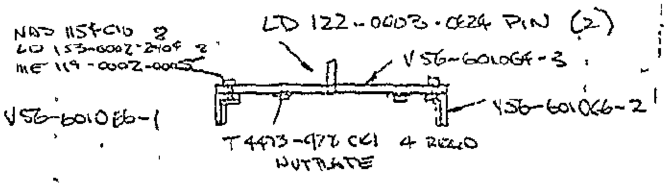
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PREPARED BY: R.C.R.
CHECKED BY: G.F.
DATE: 7 MARCH 72
PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601068

REF
N/A
F04-100
002

ASSEMBLY-LAUNCH BALLAST, CENTER CREW COUCH, BASE SUPPORT

ASSEMBLY COMBINES V56-601066-1,-2 ANGLES TO V56-601064-3 BALLAST PLATE. INCLUDED ARE PROVISIONS TO ATTACH REMAINING BALLAST PLATES.



LOADINGS -

SEE ANALYSIS V56-601066, (ANGLE)

V56-601
065

FASTENER SHEAR LOADING

$P = 1233$ LBS. ULTIMATE

REACTED BY ONE BANK OF FOUR NAS 1154C10 BOLTS.

$\text{LOAD}/\text{BOLT} = 1233/4 = 308^{\#}$ SHEAR

SHEAR ALLOWABLE $= 4{,}075^{\#}$

SHEAR $MOS_U = \frac{4075}{308} - 1$

SHEAR $MOS = \underline{+HIGH}$

TENSILE LOADING

$P = 11.18^{\#}$/FASTENER

$P_{all} = 5100^{\#}$ $\underline{MOS_U + HIGH}$

V56-601
066

PREPARED BY: G.F	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 1 OF 2
CHECKED BY: RGR		REPORT NO SD 70-205
DATE: 2/9/73	COMMAND MODULE	MODEL NO SKYLAB
REF.		DWG NO. V56-601069-11,

N/A STRAP-CENTER CREW COUCH BALLAST -31,-41,-5,

V56-601 123 RESTRAINT-ASSY OF

V56-331 710 THE DRAWINGS BELOW ARE PRESENT ON THE ABOVE ASSEMBLY. REFER TO

F04-100 002 INDIVIDUAL DRAWINGS FOR ANALYSIS

V56-601069-3 STRAP
-7
-9
-13
-15 STRAP
V56-601060 RING

LR 9643 4035 $P_{Ł_{ALL}}$ = 2665 LBS. P.B.I. WEBBING

#.2.2.11 P_{MAX} = 2365 LBS. (FROM URINE, CHILLER LOADING)

[-13 STRAP]

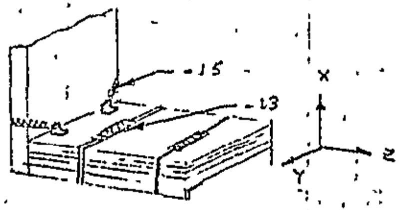
$M.S. = \frac{2665}{2365} - 1 = +.13$

PREPARED BY: G.F	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 2 OF 2
CHECKED BY: RGR		REPORT NO SD 70-205
DATE: 1/16/73	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-601069-11,-51

N/A STRAP-CENTER CREW COUCH, BALLAST

V56-601 123 RESTRAINT, RESCUE VEHICLE

TWO OF THE -13 STRAPS TIE DOWN THE BALLAST PLATES TO THE CENTER WEBER COUCH AS PART OF THE V56-601123 CABLE/STRAP ASSY. THE STRAPS ALLOW THE ASSY. TO BE CINCHED TIGHT.



APOLLO COMMAND MODULE WATER IMPACT TESTS APPENDIX E

WATER LANDING TESTS 5-7 WITH CM-099

P.B.I. WEBBING
1.00 X 24 00
$P_{Ł_{ALLOW}}$ = 2665 LBS

BALLAST WT. = 242 LBS
$N_x = (11.22)(1.5)$
$\approx 17g$

-13 STRAP

LR 9643 4035 $P_x = (246.4)(17) = 4195$ LBS (ULT)

$P_{Ł_{STRAP}} = \frac{4195}{2} = 2098$ LBS.

$M.S. = \frac{2665}{2098} - 1 = .27$

-15 STRAP

#262 THE STRAP IS DOUBLE THICKNESS ATTACHED AT TWO POINTS.

$P_3 = \frac{246.4(20)}{(2)}$

= 2466 LBS.

$M.S = \frac{2665}{2466} - 1 = .08$

PREPARED BY: G F
CHECKED BY: RnR
DATE: 2/5/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601074

REF
N/A
F04-100
.002

CONTAINER - TWO HELMET STOWAGE ASSY OF

BETA FABRIC, BAG AND STRAPS HOLD TWO HELMETS @ 2.70 LBS. EACH. THE STOWAGE CONTAINER IS STRAPED TO THE TOP OF THE URINE CHILLER. TOTAL LOADING IS SUCH THAT STRAP AND FABRIC LOADS ARE SMALL AND THE CONTAINER IS GOOD BY INSPECTION.

297

538

PREPARED BY: W.F.G.
CHECKED BY: G.E.
DATE: 1/26/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601075

REF
N/A
F04-100
002

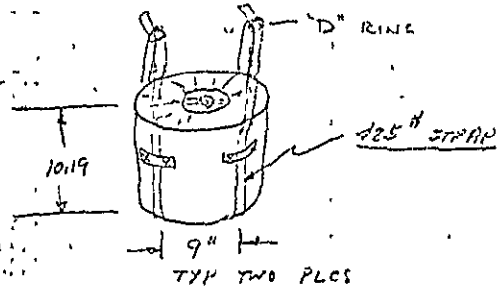
CONTAINER - HELMET STOWAGE, ASSY OF

DISCUSSION: THIS CONTAINER (BAG) SUPPORTS ONE HELMET @ 2.62#. THE BAG IS ATTACHED TO THE CREW COUCH LOWER LEG AND THE SEAT PAN.

THE "G" LOADING WOULD BE AS FOLLOWS:

$X = -30$ "G" ULT = 20.4#
$Y = 15$ G ULT = 40.2#
$Z = 22.5$ G ULT = 60.3#

SKETCH OF ASSEMBLY



ASSUME C.G. @ 5.09 IN

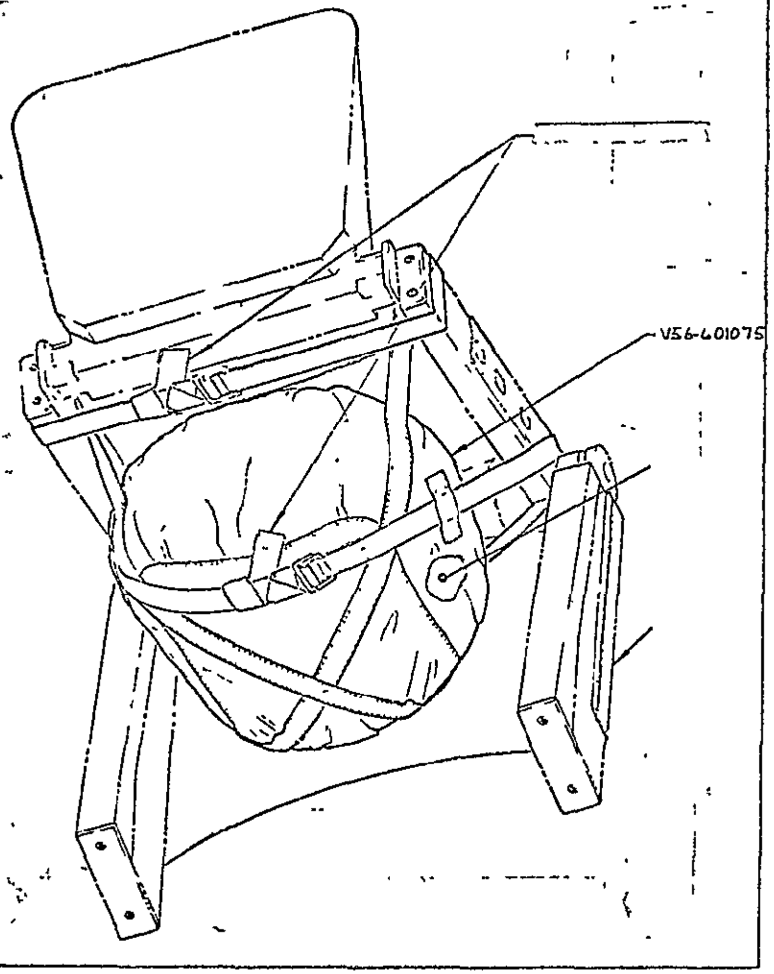
PREPARED BY: C.F.
CHECKED BY: RGR
DATE: 3/19/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB

CONTAINER-HELMET STOWAGE, ASSY OF

V56-601075

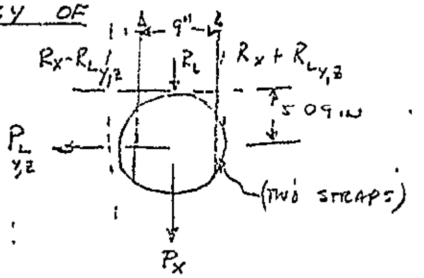


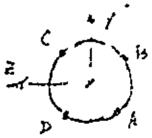
PREPARED BY: W.T.G.
CHECKED BY: G.F.
DATE: 1/26/72
REF.

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601075

CONTAINER - HELMET STOWAGE
ASSY OF





PER STRAP

$R_{L_z} = \frac{P_{L_z}(5.09)}{2(9.0)} = (60.3)(.282) = 17^{\#}$

$R_{L_y} = (40.2)(.282) = 11.4^{\#}$

$R_X = \frac{P_X}{4} = \frac{80.4}{4} = \frac{20.1^{\#}}{48.5^{\#}}$ MAX LOAD @ A.

@B, $R_{L_z} = 17^{\#}$, $R_{L_y} = -11.4^{\#}$, $R_X = 20.1$, $R_{T_B} = 25.7^{\#}$

@C, $R_{L_z} = -17^{\#}$, $R_{L_y} = -11.4$, $R_X = 20.1$ $R_{T_C} = -8.3^{\#}$ *

@D, $R_{L_z} = -17^{\#}$, $R_{L_y} = 11.4$, $R_X = 20.1$ $R_{T_D} = 14.5^{\#}$

* SOME PRELOAD WILL EXIST, ∴ STRAP WILL NOT GO SLACK!!

STRAP M.S. $= \frac{425}{48.5} - 1 =$ +HIGH.

PREPARED BY: WFG.
CHECKED BY: G.F.
DATE: 1/27/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601075

REF

CONTAINER - HELMET STOWAGE, ASSY OF

STITCHING APPEARS ADEQUATE TO SUPPORT CLOTH TO STRAP LOADS WHICH ARE SMALL, MOSTLY DUE TO HANDLING. THE STITCHING DOES NOT CONTRIBUTE TO THE PRIMARY LOAD SUPPORT.

PREPARED BY: RGR
CHECKED BY: G.F
DATE: 8 FEB 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO [illegible]
DWG NO V56-601076

REF

N/A
V56
601110

RETAINER-RING, RESCUE VEHICLE RETURN STORAGE PALLET

PART IS IDENTICLE TO V56-601089
SEE V56-601089 FOR PALL.

V56
601126
P3

$P_{ALL} = 614^{\#}$

$P_{APP} = 550^{\#}$

MoS + .11

PREPARED BY: W.F.G.
CHECKED BY: G.F.
DATE: 12/10/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

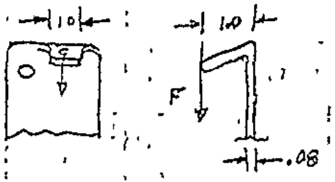
PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601078

REF
N/A
V56-601097

BRACKET - UMBILICAL TIE DOWN, LOWER MAIN DISPLAY CONSOLE BEAM, UPPER RIGHT

LOADS
V56-601097

STRAP LOAD = 28# LIMIT = 42# ULT



M = 42#(1.0) = 42 in#

$f_b = \frac{6M}{bt^2} = \frac{6(42)}{(1)(.08)^2} = \underline{39,400 \text{ psi}}$

D-92
02.22
.01.01

F_{tu} = 64000 psi
(2024 T351).

M.S. = .62

ALL FASTENER VALUES
(N/ASSEMBLY)
M.S. = +HIGH

PREPARED BY: W.F.G.
CHECKED BY: G.F.
DATE: 12/18/72

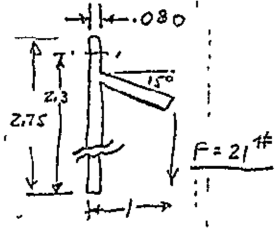
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

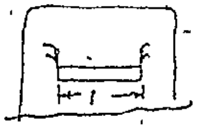
PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601079

REF.
N/A
V56-601096

BRACKET - UMBILICAL TIE DOWN, LOWER MAIN DISPLAY CONSOLE BEAM LOWER RIGHT

LOADS
V56-601096





M @ BASE OF TONGUE = (21)(1) = 21 in#

ASSUME ALL MOMENT TO ONE SIDE OF SUPPORT PLATE :

$f_b = \frac{6M}{bt^2} = \frac{(6)(21)}{(1)(.080)^2} = 19700$ psi

D-92
02.22.01
.01

2024-T351. F_{tu} = 64000 psi

$M.S = \frac{64}{194} - 1 = \underline{2.30}$

ATTMT TO WEB STRAP AND TO M.D.C.
OK BY INSPECTION.

PREPARED BY: RGR
CHECKED BY: G F.
DATE: 7 MARCH 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601080

REF
NA
V56
531100

STRAP - CREW RESTRAINT HARNESS RESCUE COUCH

THIGH RESTRAINT STRAP ASSEMBLY FOR RESTRAINT HARNESS OF RESCUE COUCH. ATTACHES TO V56-601086 FITTING* ON SEAT PAN THEN IS SNARED INTO V56-601085 RING.

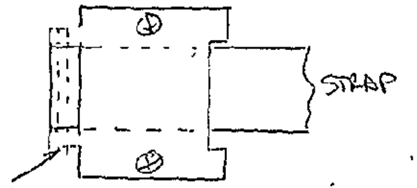
II.2 1.55

ULTIMATE STRAP LOAD = $\frac{715}{(2)2}$ = 179 LBS (EBD)

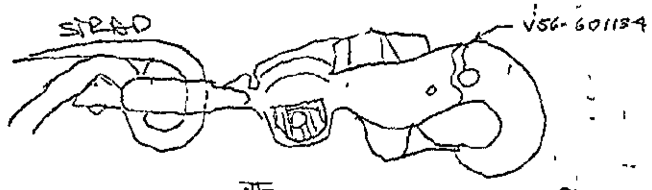
MAX ALLOWABLE STRAP LOAD = 8300#

$M.S._0 = \frac{8300}{179} - 1 = +$ HIGH.

* REVISION - ASSEMBLY DOES NOT INCLUDE ~~V56-601086 FITTING~~ V56-601086



PIN
LD 122-0003-6532 MATED IN SLOT
SEE V56-601086 FOR INTERFERENCE FIT.



ALLOWABLE = 2500#
M.S.$_0$ = + HIGH

FCS 22018
VAS VAS 22018

PREPARED BY: RGR
CHECKED BY: G F.
DATE: 7 MARCH 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601081

REF
N/A
V56
531100

STRAP - RETENTION, RESCUE COUCH

STRAP ATTACHES TO V56-601082 BUCKLE FITTING AND TO V56-601083 FITTING ON THE SEAT PAN OF RESCUE VEHICLE.

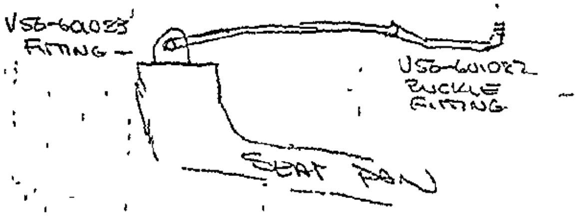
II 2155

MAXIMUM ULTIMATE LOAD = 5660#
STRAP ALLOWABLE = 8300#
PBI WEBBING PER STYLE 3-170

STRAP $M.S._0$

$= \frac{8300}{5660} - 1$

+.47



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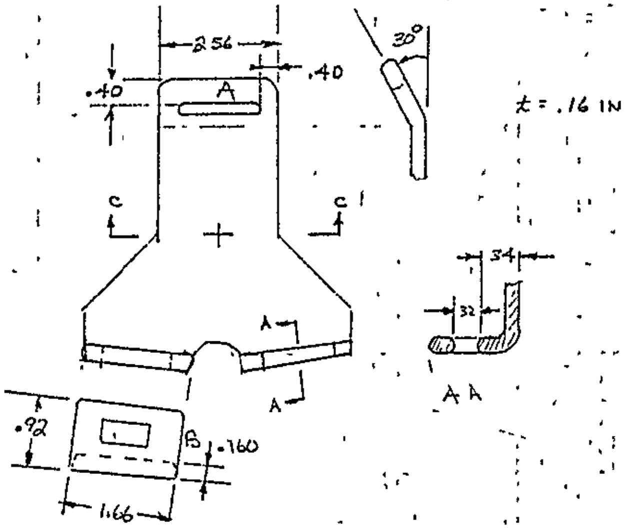
CHECKED BY: G.F	– RESCUE MISSION	REPORT NO SD 70-205
DATE: 2-16-2	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG. NO V56-601082

REF
N/A
V56-601
081

FITTING- BUCKLE, PLUS Z REST, RESCUE COUCH, ASSY OF



Ⓒ TABLE 4.2.10(b)

MATERIAL

A286 CRES BAR
AMS 5737
(ksi)
F_{tu} = 140
F_{ty} = 95
F_{su} = 91
F_{bru} = 210, 266

$F_B = F_{tu} + (1.5-1)F_{ty}$
F_B = 182.5 (ksi)

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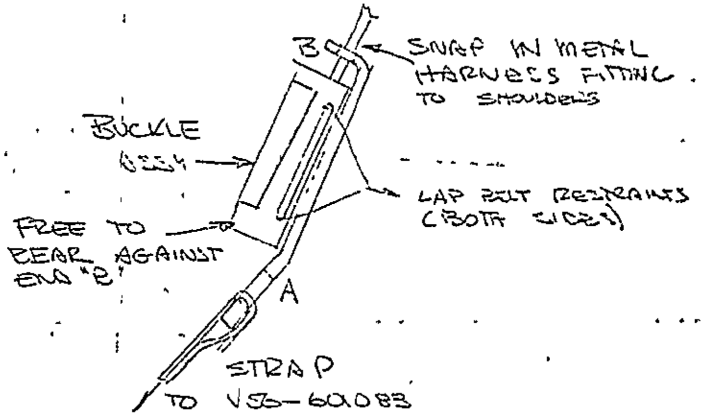
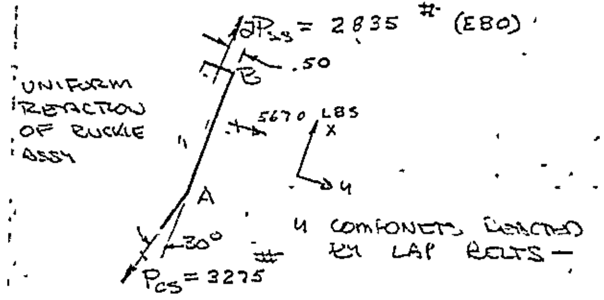
DATE: 2-16-2	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-601032

THIS PLATE IS THE BASE ON WHICH THE BUCKLE ASSEMBLY RESTS. THE SINGLE END HAS THE STRAP PERMANENTLY SEWN, THE STRAP EXTENDING TO BOTTOM OF COUCH AND ANCHORING ON V56-601083 FITTING THE UPPER HALF (TWO ENDED) PROVIDES GUIDEWAY FOR SHOULDER HARNESS LOCK ON



II.2.1.55 LOADING MAX EBU ULTIMATE



Y COMPONENTS REACTED BY LAP BELTS –

PREPARED BY: G.E.
CHECKED BY: [illegible]
DATE: 1/5/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

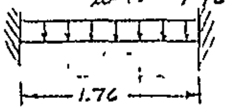
PAGE NO 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601082

REF

FITTING-BUCKLE, PLUS Z REST, RESCUE COUCH, ASSY OF

BENDING AT END A

$w = \frac{3275}{1.76} = 1810 \ \frac{LBS}{IN.}$



(E4)
TABLE III
CASE 33

$M_{max} = \frac{1}{12} W\ell$

$= \frac{1}{12} (3275)(1.76)$

$= 480 \text{ IN-LBS}$

$f_b = \frac{6M}{bt^2}$

$= \frac{6(480)}{(.16)(.40)^2}$

$= 112{,}300 \text{ PSI}$

$M.S. = \frac{182.5}{1123} - 1 = \underline{.62}$

BENDING AT C-C

$M_{c-c} = 2835 (.50)$

$= 1418 \text{ IN-LBS}$

$f_b = \frac{6(1418)}{(2.56)(.16)^2}$

$= 130{,}000 \text{ PSI}$

$M.S. = \frac{182.5}{130} - 1 = \underline{.40}$

303

569

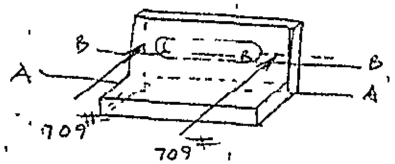
PREPARED BY: RGR
CHECKED BY: G.F
DATE: 2-25-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601082

REF

SIDE B



CONCENTRATED LOAD ACTING AS SHOWN

CHECK BENDING AT BB

$M = 709 (.04) = 28.35 \text{ IN\#}$

$\sigma = \frac{6M}{bt^2} = \frac{6(2835)}{(.44)(.16)^2}$

$\sigma = 15100 \text{ PSI}$

$MoS = \frac{182.5}{15.10} - 1 = + HIGH$

BENDING AT A-A

$M = 709 (.38)$

$M = 269 \text{ IN\#} \quad 430$

$\sigma = \frac{6M}{bt^2} = \frac{6(269)}{(.83)(.16)^2}$

$\sigma = 75{,}600 \text{ PSI}$

$MoS = \frac{182.5}{75.6} - 1 = \underline{+1.42}$

570

PREPARED BY: RGR
CHECKED BY: G.F
DATE: 2-3-72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

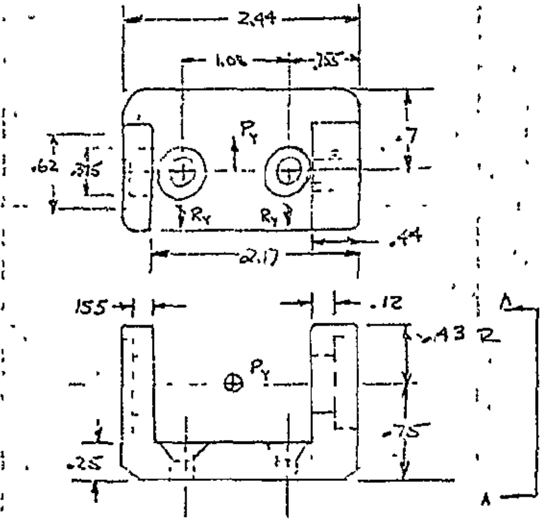
PAGE NO 1 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601083

REF N/A

V56-531 100

FITTING-SEAT PAN, PLUS Z REST, RESCUE COUCH

+Z CSM RESTRAINT FITTING ATTACHED TO SEAT PAN V56-531113.



MATERIAL

A286 AMS 5737

F_{TU} = 140 KSI
F_{TY} = 95 KSI
F_{CY} = 95 KSI
F_{SU} = 91 KSI
F_{BRU} = 210 e/D = 1.5, e/D = 2 - 266

PREPARED BY: G.F
CHECKED BY: RGR
DATE: 1/10/72

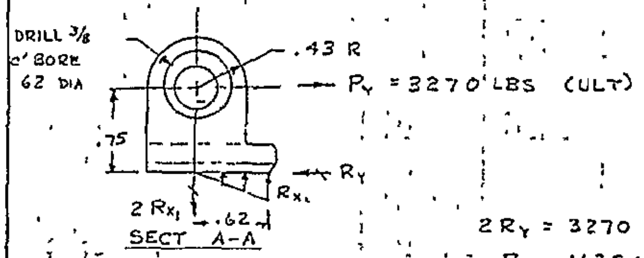
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601083

REF

FASTENERS

V56-601 082



$2 R_Y = 3270$

$R_Y = 1635$ LBS

$.75(3270) = \frac{2}{3}(.62) R_{X_2}$

$R_{X_2} = 5950$ LBS

R_{X_1} 2975 LBS

Ⓓ8 1123-4

NAS 1154 C12 SCREW (A286)

$P_t = 3950$ LBS

$P_S = 4470$

(C22) 1.5 3.5

$R_S^3 + R_t^2 = 1$

$R_S = \frac{1635}{4470} = .366$ $R_t = \frac{2975}{3950} = .753$ $U = \frac{.366}{.45} = .814$

M.S. $= \frac{1}{.814} - 1 = \underline{.23}$

(E5) D1.8

LUG TRANSVERSE LOADING

$A_{AV} = \frac{6}{\frac{3}{A_1} + \frac{1}{A_1} + \frac{1}{A_2} + \frac{1}{A_3}}$

$= .0202$ IN²

$A_1 = A_4 = (.211)(.12) = .0253$ IN²

$A_2 = A_3 = (.12)(.12) = .0144$ IN²

$A_{Br} = (.62)(.12) = .0744$ IN²

$\frac{A_{AV}}{A_{Br}} = .27$

$K_{tu} = .39$

$P_{tu} = (.39)(.0744)(140{,}000)$
$= 4060$ LBS.

M.S. $= \frac{4060}{1635} - 1 = \underline{1.48}$

PREPARED BY: G F
CHECKED BY: RGR
DATE: 1/10/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601083

REF.

LUG BENDING

M - 1635 (50)
= 818 IN-LBS

$$f_b = \frac{6(818)}{(.27)(.86)^2}$$

= 24500 PSI

$$M.S. = \frac{95}{24.5} - 1 = \underline{2.88}$$

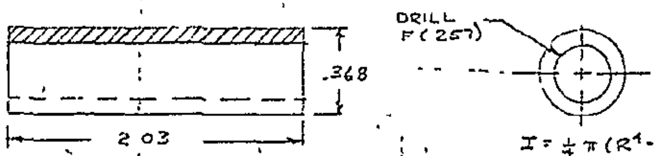
PREPARED BY: G F
CHECKED BY: RGR
DATE: 1/10/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO. V5-601084

REF.
N/A
V56-531
100

BUSHING - RESTRAINT STRAP, RESCUE COUCH



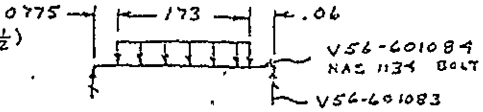
$I = \frac{1}{4}\pi(R^4 - R_o^4)$
$= .000753\ IN^4$
$A = .0545\ IN^2$

QQ-S-763 CLASS 304 COND A

F_{TU} = 75 KSI
$E = 29 \times 10^6$ KSI
F_{TY} -30 KSI
F_{SU} -53 KSI

REPORT
73CS0003
Ⓔ4
TABLE III
CASE 14

$W = (243)(78)(15)(\frac{1}{2})$
= 1420 LBS (ULT)



$$M_{MAX} = W\frac{d}{2}\left(a + \frac{cd}{2l}\right)$$

$$= 1420\left(\frac{9425}{1.8675}\right)\left[.0775 + \frac{(173)(9425)}{2(18675)}\right]$$

= 368 IN-LBS

a = .0775 IN
c = 1.73 IN
d = .9425 IN
l - 1.8675 IN

THE BENDING IS TAKEN BY THE BUSHING AND THE NAS 1134 (A286) BOLT.

$I_{BOLT} = \frac{\pi}{4}(125)^4 = .000192\ IN^4$

I_{TOTAL} = .000192 + 000753
= .000945 IN4

$$f_b = \frac{(368)(184)}{.000945}$$

= 71,500 KSI

$F_b = F_{TU} + F_{TY}(K-1)$

$K = \frac{2Q}{I/c}$

PREPARED BY: G. F.
CHECKED BY: RGR
DATE: 1/12/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYCAB
DWG NO V56-601084

REF.

BUSHING BENDING

$$a = \left\{\frac{\pi}{2}\left[(.184)^2-(.1285)^2\right]\right\}\left\{\frac{\pi\left[(.184)^2(.424)(.184)-(.1285)(.424)(.1285)\right]}{\pi\left[(.181)^2-(.1285)^2\right]}\right\}$$

$$= .002925$$

$$K = \frac{2(.002925)(.184)}{(.000753)}$$

$$= 1.43$$

(BUSHING) $F_b = 75 + 30(1.43-1)$

$= 87.9$ KSI

(BENDING) $M.S. = \frac{87.9}{71} - 1 = \underline{+.24}$

BOLT BENDING

$$F_b = \frac{(368)(.125)}{.000945}$$

$$= 48,600 \text{ PSI}$$

A 286
$F_{TU} = 140$ KSI
$F_{TY} = 95$ KSI
$F_{CY} = 95$ KSI

$MS = \frac{95}{48.6} - 1 = \underline{.95}$

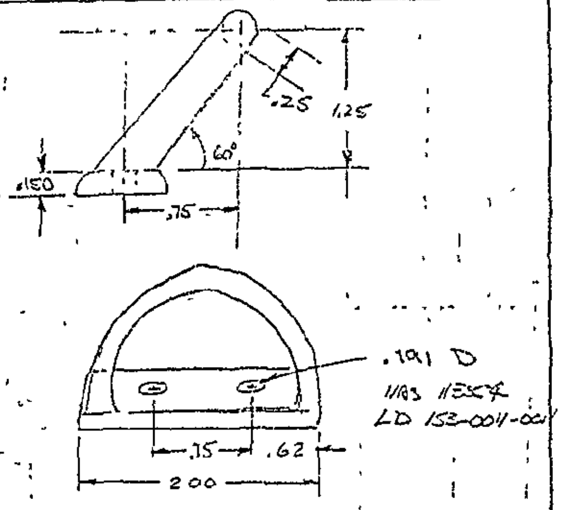
PREPARED BY: RGR
CHECKED BY: G F
DATE: 2-4-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYCAB
DWG NO V56-601085

REF
N/A
V56-531
100

RING-ATTACH, THIGH STRAP, RESCUE COUCH



LOADING CONDITION

II 21.55 ULTIMATE LOAD $= \frac{715}{(2)(2)} = 179$ LBS. (EED)

MATERIAL
A 286 AMS 5737
$F_{TU} = 140$ KSI
$F_{TY} = 95$ "
$F_{SU} = 91$ "
$F_{BRU} = 210$
$F_B = 140 + .5(95)$ $K = 1.5$
$F_B = 187.5$ KSI

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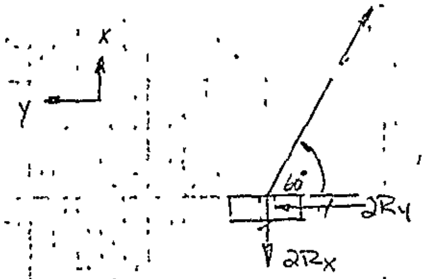
CHECKED BY: G.F.
DATE: 2-11-2
REF

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601085



$2R_x = P \sin 60°$

$R_x = \frac{179}{2} \sin 60° = 89.5$ LBS

$2R_y = P \cos 60°$

$R_y = .25\,P \qquad .25(179) = 44.8$ #

FASTENERS (TWO)

NAS 1133C4

$P_T = 2{,}800$ # ALLOW TENSION

$F_{SU} = 84$ KSI

SHEAR ALLOWABLE

$A = \pi r^2 = 3.14(.095)^2$

$A = .0284\ \text{IN}^2$

$P_S = F_{SU} A$

$P_S = 2{,}385$ # SHEAR ALLOWABLE

MARGINS

SHEAR $\quad$ M.S. $= \frac{2385}{448} - 1 =$ $\underline{\underline{+\ \text{HIGH}}}$

TENSION $\quad$ M.S. $= \frac{2800}{89.5} - 1 =$ $\underline{\underline{+\ \text{HIGH}}}$

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CHECKED BY: G.F.
DATE: 2-28-2
REF.

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
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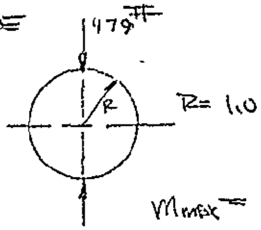
COMMAND MODULE

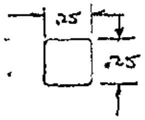
PAGE NO 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601085

FRAME MODULE



$M_{max} = .3183\,WR$

SECTION



$I = \frac{1}{12} bh^3$

$I = .000326\ \text{IN}^4$

BENDING

$\sigma = \frac{Mc}{I} = \frac{.3183(179)(1)(.125)}{.000326}$

$\sigma = 22{,}000$ (PSI)

$F_B = 82.5$ (KSI) QQ-S-763 CLASS 306

$F_B = 187.5$ (A 286)

MoS. $\overset{A\ 286}{\frac{187.5}{22}} - 1 =$ $\underline{\underline{+\ \text{HIGH}}}$

BENDING AT FRAME SUPPORTS

$M_{max} = .1817\,WR \quad @ \quad x = \pi/2$

$M_{max} = .1817(179)(1)$

$M_{max} = 32.6$ IN #

PREPARED BY: G.F
CHECKED BY: RGR
DATE: 1/11/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF [illegible]
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601095

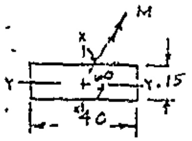
REF.

BENDING OF BASE PLATE AT BOLT HOLE

$$M = \left(\frac{179}{2}\right)\left[.62 - \frac{.25}{2}\right]$$

$$= 443 \text{ IN-LBS}$$

ASSUME THE BASE TO BE AS SHOWN



$$f_b = \frac{6M\cos 60°}{(.15)(.40)^2} + \frac{6M\sin 60°}{(.40)(.15)^2}$$

$$= \frac{6(443)\cos 60°}{(.15)(.40)^2} + \frac{6(443)\sin 60°}{(.40)(.15)^2}$$

$$= 5530 + 25500$$

$$= 3130.0 \text{ PSI}$$

$$\text{M.S.} = \frac{187.5}{31.30} - 1 = + \underline{\text{HIGH}}$$

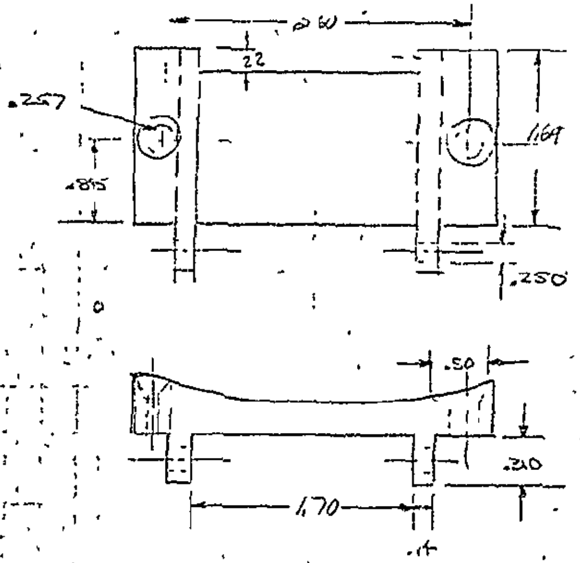
PREPARED BY: RGR
CHECKED BY: GF
DATE: 2-8-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF [illegible]
REPORT NO SD 70-205
MODEL NO [illegible]
DWG NO V56-601086

REF
N/A
V56
531100

FITTING - ATTACH, THIGH STRAP, RESCUE COUCH



MATERIAL

AL BAR MRO 170-065 7075-T7351

$F_{TU} = 64$ KSI
$F_{TY} = 52$ "
$F_{SU} = 40$ "
$F_{BRU} = 86$ " $F_{CY} = 53$ KSI
$F_B = 64 + .5(52)$
$F_B = 90$ KSI

PREPARED BY: RGR
CHECKED BY: [illegible]
DATE: 5 FEB 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

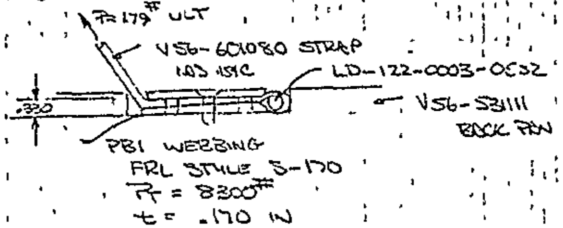
PAGE NO 2 OF 5
REPORT NO [illegible]-165
MODEL NO [illegible]
DWG NO V56-601086

REF.

V56-601-085

308-Q

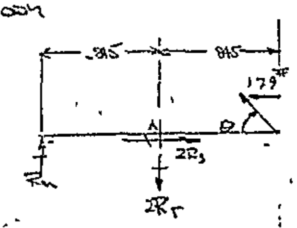
INSTALLATION



RESTRAINT STRAP IS ANCHORED BY LD-122-0003-0532 PIN WHICH TOGETHER WITH TWO THICKNESSES OF PBI WEBBING FORMS INTERFERENCE FIT WITH V56-601086 FITTING.

DIAMETER PIN + WEBBING = .1865 + 2(.17) = .5265"

FREE BODY



θ = 18° MAXIMUM

$\doteq$ $2R_S = 179$

$R_S = 89.5\#$ (PER NAS 1159)

$\Sigma M_b = 0$

$R_m = 179 \tan 18^\circ$

$\equiv$ $R_m = 58.4\#$

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CHECKED BY: [illegible]
DATE: 5 FEB 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 5
REPORT NO [illegible]
MODEL NO [illegible]
DWG NO V56-601086

REF

D8
1223-22

D11-
APPENDIX
C

DOWEL PIN

LD 122-0003-0532

L = 2.0"

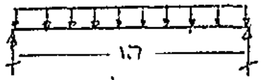
DIA = .1265"

MAT: CRES WIRE QQ-W-423 (302)

Ftu = 185 KSI (MIN)

PIN BENDING

W = 179# ULT



$M_{max} = \frac{1}{8} WL$

$= \frac{179(1.7)}{8}$

$= 38.1$ IN #

$I = \frac{\pi D^4}{64} = .0491 D^4$

$= (.0491)(.1265)^4$

$I = 5.95 \times 10^{-5}$

$f_b = \frac{Mc}{I}$ $c = .0932$

$f_b = \frac{(.0932)(38.1)}{5.95 \times 10^{-5}}$

$f_b = 59\,700$ PSI

$M.S. = \frac{185}{59.7} - 1 = \underline{2.10}$

582

PREPARED BY: RGR
CHECKED BY:
DATE: 5 FEB 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 4 OF 5
REPORT NO [illegible]
MODEL NO [illegible]
DWG NO V56-601056

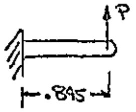
REF

DB
1123-24

CHECK FOR PULL-OUT OF NAS 1154

$P_{TU} = 5{,}100^{\#}$

MODEL PLATE SECTION TO NAS1154C



TAKE PLATE DIMENSIONS

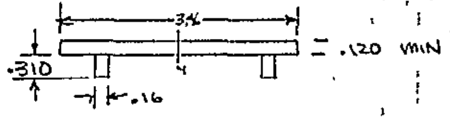
L=1.7" t=.120 (MINIMUM THICKNESS)

$$F_B = F_{TU} = \frac{Mc}{I} = \frac{P(.845)(.06)}{\frac{1}{12}(1.7)(.12)^3}$$

$$P_{ALL} = \frac{(64{,}000)(1.7)(.12)^3}{(.845)(.06)(12)}$$

$$P_{ALL} = 309^{\#}$$

REAL SECTION



$$I_{xx} = .00322, \quad \bar{Y} = .0899$$

$$P_{ALL}' = \frac{(64{,}000)(.00322)}{(.845)(.0899)}$$

$$P_{ALL}' = 2{,}718^{\#}$$

309

PREPARED BY: RGR
CHECKED BY:
DATE: 5 FEB 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 5 OF 5
REPORT NO [illegible]
MODEL NO [illegible]
DWG NO V56-601056

REF

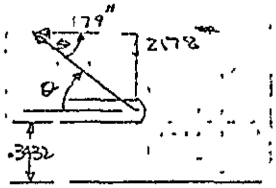
DEFLECTION OF PLATE

FOR $P = 2{,}178^{\#}$

$$\delta = \frac{1}{3}\frac{WL^3}{EI} = \frac{2178(.845)^3}{(3)(10.3\times10^6)(3.22\times10^{-3})}$$

$$\delta = .0132''$$

TOTAL $\delta = .0132 + .330 = .3432''$ GCP



FIND ANGLE θ FOR P= 2178

$2178 = 179 \tan\theta$

$\theta = 50.6°$

FIND PIN-WORKING DIAMETER FOR θ = 50.6°

$$\frac{.3432 - .5D}{.5D} = \sin 50.6° = .772$$

$.3432 = (.772)(.5)(D) + .5D$

$.3432 = .886D$

$.388'' = D$

NOT POSSIBLE

ACTUAL DIAM ≈ .5 PLUS

PREPARED BY: RGR
CHECKED BY: G F
DATE: 2-11-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION

RESCUE MISSION

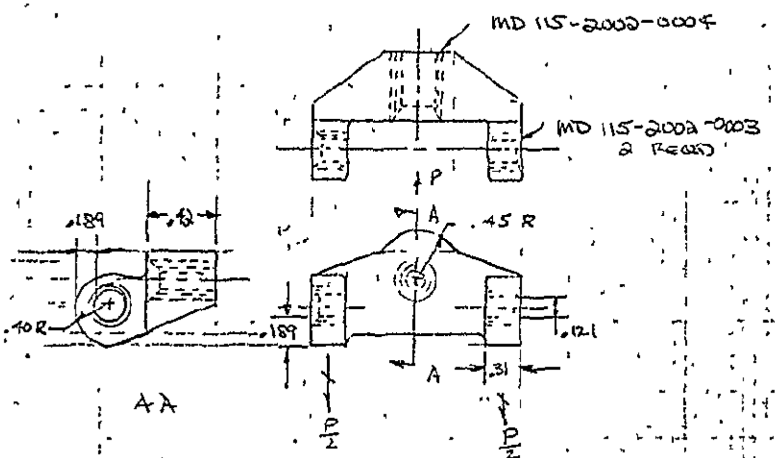
COMMAND MODULE

PAGE NO 1 OF 9
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601087

REF
N/A
V56
531100

UNIVERSAL - LAP BELT, RESCUE COUCH

FITTING ATTACHES LAP BELT TO V56-601082 ATTACH FITTING IN A MANNER THAT ALLOWS ROTATION



MATERIAL

AL BAR MB0 170-065.
7075-T7351

F_{tu} = 64 KSI
F_{ty} = 52 KSI
F_{su} = 40 KSI
F_{bru} = 86 e/D = 1.5
F_{bru} = 106 e/D = 2.0

PREPARED BY RGR
CHECKED BY G.F
DATE 2-11-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION

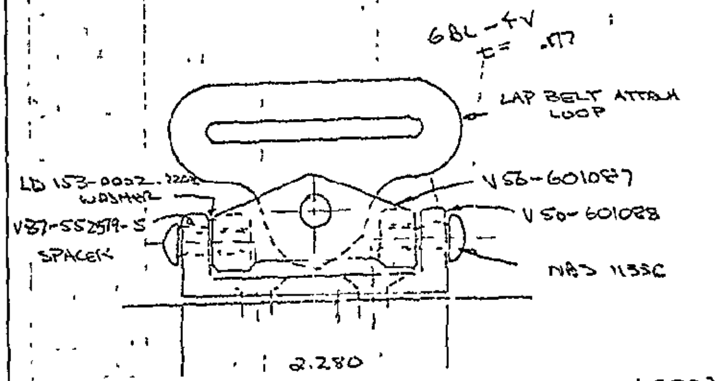
RESCUE MISSION

COMMAND MODULE

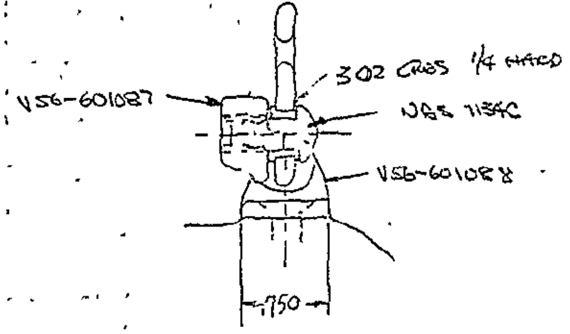
PAGE NO. 2 OF 9
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601087

REF

LAP BELT FITTING



II.2.1.55 P = $\frac{8060}{2(2)}$ = 2015 LBS (EBD)

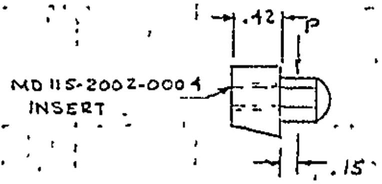


END VIEW

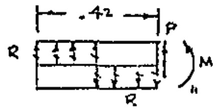
PREPARED BY: G.F	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO. 3 OF 9
CHECKED BY: RGR		REPORT NO SD 70-205
DATE: 1/11/73	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-601097

UNIVERSAL - LAP BELT, RESCUE COUCH

LUG A



D = .2785 IN



$t_2 = .45 - .1392$
$= .31$ IN

P = 2015 LBS.

M = 2015(.15)
= 302 IN-LBS

$$R = \frac{(.21 + .105)(2015) + 302}{.21}$$

= 4450 LBS

$$f_s = \frac{R}{2 t_2 d}$$

$$= \frac{4450}{2(.31)(.21)}$$

f_s = 34,200 PSI

(SHEAR OUT) $\quad M.S = \frac{40}{34.2} - 1 = +.17$

$$f_{Br} = \frac{4450}{(.2785)(.21)}$$

= 76,200 PSI

$\frac{e}{D} = \frac{.45}{.2785} = 1.67$

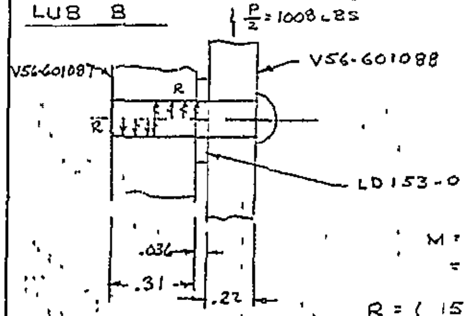
F_{BRU} = 92.8 KSI

(BEARING) $\quad M.S. = \frac{92.8}{76.2} - 1 = +.22$

PREPARED BY: G.F	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO. 4 OF 7
CHECKED BY: RGR		REPORT NO SD 70-205
DATE: 1/11/73	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V56-601097

UNIVERSAL - LAP BELT, RESCUE COUCH

LUG B



D = .2170 IN

M = 1008 (.11 +.036)
= 147 IN-LBS

$$R = \frac{(.155 + .0775)(1008) + 147}{.155}$$

= 2460 LBS

$$f_{BR} = \frac{2460}{(.2170)(.155)}$$

= 73,200 PSI

$\frac{e}{D} = \frac{.40}{.217} = 1.85$

F_{BRU} = 100 KSI

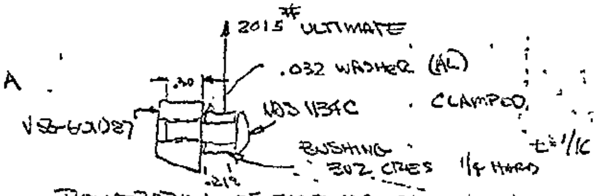
(BEARING) $\quad M.S. = \frac{100}{73.2} - 1 = .37$

$$f_s = \frac{2460}{2(.40 - .1085)(.155)}$$

= 27100 PSI

(SHEAR-OUT) $\quad M.S. = \frac{40}{27.1} - 1 = +.48$

AT A

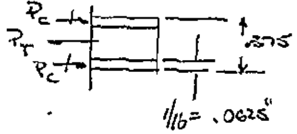


PENETRATION OF FASTENER SHOWN

ASSEMBLY IS INSTALLED IN "CLAMPED" POSITION
BUSHING + WASHER ARE CLAMPED TO FACE
OF -87 LUG

CHECK FOR BUSHING SEPARATION

NEGLECT WASHER



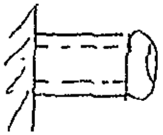
NAS 1134
$A_{ROOT} = .033 \text{ IN}^2$

$P_t = (40{,}000)(.033)$
$P_t = 1320$
$P_{C\,TOT} = 1320^{\#}$

COMPRESS STRESS ON BUSHING

$P = 1320^{\#}$
$A = \pi\left[r_o^2 - r_i^2\right]$
$A = 3.14\left[.187^2 - .125^2\right]$
$A = .061 \text{ in}^2$
$P/A = 1320/.061 = 21{,}600 \text{ PSI}$

TENSILE STRESS IN BUSHING DUE TO
BUSHING-BOLT BENDING



$D/t = \frac{.250}{.0625}$

$D/t = 4.0 \quad t/D = .25$

BARCO
AIRCRAFT
9.21
DD. 80, FD

$R = \frac{\text{ALLOWABLE MOMENT OF COMBINATION}}{\text{ALLOWABLE MOMENT OF BOLT}} = \frac{M_C}{M_B}$

I AT ROOT DIA
DIA = .2052 IN

$M_B = \frac{F_B I}{C} = \frac{(206.5\times10^3)(8.7\times10^{-5})}{(1.03\times10^{-1})}$

ALLOWABLE M_B = 175 IN # (ZERO M.S.)

PREPARED BY: RGR
CHECKED BY: G F
DATE: 14 MARCH 1972
REF

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 7 OF 9
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601087

$R = \frac{M_C}{M_B}$

FROM REF CURVE FOR D/t = 4

$M_C = RM_B$; $R = .1075$

$M_C = 1.075 M_B = 306$ IN#

APPLIED MOMENT

$l_{max} = \frac{1}{2}(.218) + .032$

$l_{max} = .141$ IN

$M_{APP} = .141 (2015)^{.115}$

$= 284$ IN#

COMBINATION OF PIN + BUSHING WILL TAKE LOADING

$MoS_o = \frac{306}{284} - 1$ $\quad MoS_o = +.08$

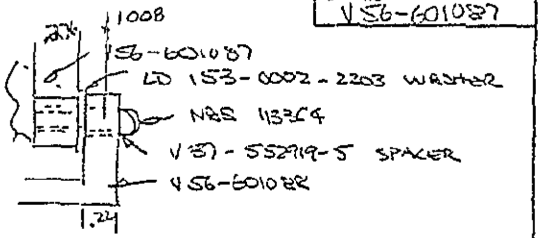
PREPARED BY: RGR
CHECKED BY: G F
DATE: 14 MARCH 72
REF

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 8 OF 9
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601087

LUG AT B

APPLIED IN CLAMPED CONDITION



TREAT V37-552919 SPACER & NAS 1133C4 BOLT AS BUSHING-BOLT COMBINATION

$t = .032$ (SPACER)

$D = .1885$ (SHANK) $D = .1506$ ROOT

$t/D = \frac{.032}{.1506} = .212$

$R = 1.7$

BOLT SHANK ALLOWABLE BENDING M_B

D AT ROOT

$D = .1506$ IN

$M_B = \frac{F_B I}{C} = \frac{206500(.000025)}{.0745}$

$M_B = 69.2$ IN# $\approx$ 136 IN#

COMBINATION ALLOWABLE

$M_C = RM_B = 1.7(69.2)$

$M_C = 118$ IN#

APPLIED MOMENT

$1008(.142) = 143$ IN#

PREPARED BY: G F
CHECKED BY: RGR
DATE: 1/12/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 9 OF 9
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601087

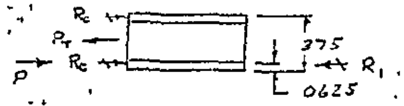
REF.

118 IN-LBS IS TAKEN BY THE BOLT-BUSHING COMBINATION WITH THE REMAINDER LOADING THE V37-552519-5 SPACER.

(BOLT-BUSHING BENDING) $M.S. = \frac{118}{118} - 1 = \underline{0.00}$

$M = 143 - 118 = 25$ IN-LBS

Pg. 6



$F_c = 21,600$ PSI

(E5) Pg A33

$P = \frac{M}{\frac{2r}{\pi}} = \frac{25\pi}{2(.075)}$ (BOLT)

$= 525$ LBS

Pg. 6

$f = \frac{525}{.030} = 17,500$ PSI

$\frac{A}{2} = .030$ IN^2

$F_{c_{TOT}} = 21600 + 17500$
$= 39100$ PSI.

(D11) ×05.0L01

302 CRES 1/4 HARD

$F_{CY} = 53$ KSI

$MS = \frac{53}{39.1} - 1 = \underline{.35}$

PREPARED BY: RGR
CHECKED BY: G.F.
DATE: 2-10-2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

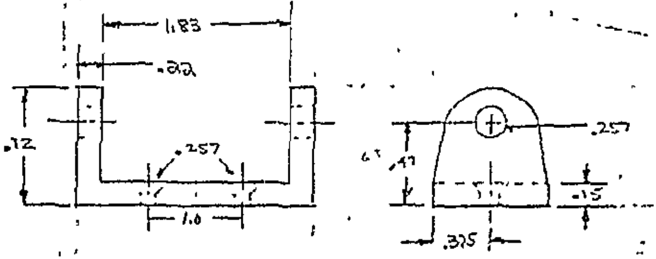
PAGE NO 1 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601088

REF

N/A
V56
531100

FITTING - ATTACH, LAP BELT, RESCUE COUCH

SEAT PAN Y-Y RESTRAINT STRAP ANCHOR. TWO PER COUCH



SEE V56-601087 FOR LAP BELT ATTACHMENT. THE FITTING IS LOADED SYMMETRICALLY WITH THE INPUT LOAD ALLOWED TO ROTATE RELATIVE TO THE FIXED ATTACH FITTING ASSUME MAXIMUM ANGULAR ROTATION IS 45° TOWARD BODY CENTER.

(C22) TABLE 6 2.1 0(b)

MAT.

A 286 BAR, (AMS-5737)
$F_{TU} = 140$ KSI
$F_{TY} = 95$
$F_{SU} = 91$
$F_{BRU} = 210, 266$

PREPARED BY: RGR
CHECKED BY: G.F.
DATE: 2-14-2
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO. 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG. NO. V56-601088
REF

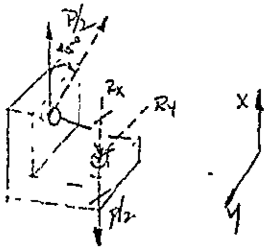
V56-601
087

LOADING

P/2

--- AT ANGLE

P = 2015 LBS (ULT)



FASTENER REACTIONS TO 45° LOAD

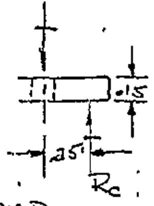
$R_y = (.5P)\cos 45^\circ$
$R_x = (.5P)\sin 45^\circ$

$R_y = .353P$ AS SHOWN
$R_x' = .353P$

OVERTURNING MOMENT DUE TO Y COMPONENT OF ANGULAR LOAD

$M = (.353P)(.62)$
$M = .219P$ IN #

REACT AS TENSION - COMPRESSION COUPLE BETWEEN FASTENER AND FITTING BODY



$R_c = \pm \frac{.219P}{.25}$

$R_c = I.876P$

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CHECKED BY: G.F.
DATE: 2-14-2
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601088
REF

V56-601
.087

TOTAL FASTENER REACTIONS (45° LOAD)

SHEAR = .353P   MAX ALL = P_s = 4,360#
= .353(2015)
= 711 LBS

$M.S. = \frac{4360}{711} - 1 = \underline{+HIGH}$

TENSION

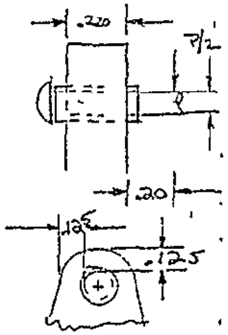
$P' = .353P + .876P$
$P' = 1.229P$
$P_{t\,all} = 5100\#$

$P' = 1.229(2015)$
= 2475 LBS

$M.S. = \frac{5100}{2475} - 1 = \underline{1.06}$

BEARING LOADS

FITTING HAS A SPACER (V37-558919-3) THROUGH THE .257 DIAMETER HOLE WHICH ALLOWS BOLT FITTING UNIVERSAL (V56-601087) TO ROTATE. THE ASSEMBLY IS



FOR SOCKET ANALYSIS,

$M = P/2(.20) = .10P$
$S = P/2 = .5P$

PREPARED BY: G.F.
CHECKED BY: RGR
DATE 1/15/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601088

REF
D4
6-40-40.5

FITTING - ATTACH, LAP BELT, RESCUE COUCH

$M = .10\ (2015$
$= 201.5$ IN-LBS

$S = .5(2015)$
$= 1008$ LBS

$\frac{SL}{M} = \frac{(1008)(22)}{186.2}$
$= 1.19$

$\frac{M}{SL} = .84$

$K_1 = 9.0 \quad K_2 = 7.0$

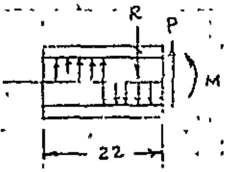
$W_{MAX} = \frac{(9.0)(1008)}{22}$
$= 41300$

$f_{Br} = \frac{W}{D} = \frac{41,300}{.257}$
$= 161,000$ PSI

$\frac{e}{D} = \frac{.30}{.257} = 1.17$

(SOCKET BEARING)

$MS = \frac{210}{161} - 1 = \underline{+.30}$



$R = \frac{1008(.165) + 201.5}{.11}$
$= 3,340$ LBS

$f_s = \frac{R}{2at}$

$a = .30 - .1285$
$= .1715$ IN

$= \frac{3340}{2(.1715)(.11)}$

(SHEAR OUT)

$f_s = 88,400$ PSI

$M.S. = \frac{91}{88.4} - 1 = \underline{+.03}$

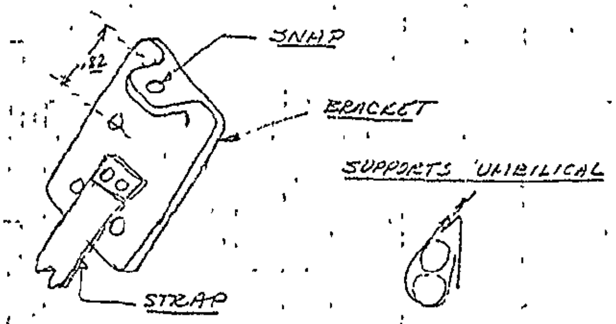
PREPARED BY: WFG
CHECKED BY: G.F.
DATE: 12/15/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601090

REF
N/A
V56-
601075

BRACKET - UMBILICAL TIE DOWN,
LOWER MAIN DISPLAY CONSOLE BEAM, LEFT



ASSUME 2 O_2 UMBILICALS @ 3/4#/FT each -
12" LONG -
$\therefore (24'')(\frac{3}{4}\ \#/FT)(\frac{1}{12}) = \underline{1.5\#}$

USE 10 "G" REENTRY -
$F = 15\#$ TOTAL

BUTTON SNAP IN SHEAR $\cong 20\#$
SNAP LOAD $= \frac{F}{2} \cong 7.5\#$

M.S. +HIGH.

MOMENT AT FIRST RIVET
$M = (7.5\#)(.82'') = 6.15$ IN#
$f_b = \frac{6M}{bt^2} = \frac{6(6.15)}{(1.44)(.090)^2} = \underline{2970\ PSI}$

M.S. +HIGH

PREPARED BY: WFG.
CHECKED BY: RSR
DATE: 12/15/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V36-601091

REF
N/A
F04-
100002

STRAP- RESTRAINT HARNESS STOWAGE,
RESCUE COUCH, ASSY OF

THIS STRAP IS USED FOR ZERO "G" STOWAGE OF THE RESTRAINT HARNESS, NOT IN USE, DURING REENTRY OR WATER LANDING.

OK by inspection

PREPARED BY: WFG.
CHECKED BY: G.F.
DATE: 12/15/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V36-601092

REF
N/A
F04-
100002

STRAP - RETENTION, RESCUE MISSION
CREWMAN'S COMMUNICATIONS CONTROL HEAD, R.H, ASSY OF

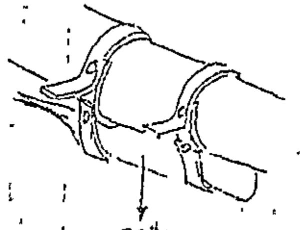
SUPPORTS 1 CCU HEAD @ 1#
1 CABLE @ 1#

TOTAL WEIGHT = 2#

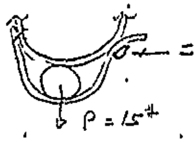
ENTRY "G" ≅ 10

F = 20# LIMIT = 30# ULT.

STRAP ASSEMBLY —



EACH STRAP



SNAP PRY STRENGTH ≅ 10#
SNAP SHEAR ≅ 20#

SNAP LOAD (PRY) = 7.5#

M.S. = .33

STRAP STRENGTH OK BY INSPECTION

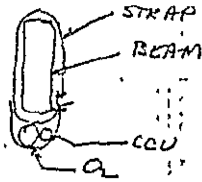
PREPARED BY: WFG.
CHECKED BY: G.E.
DATE: 12/18/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601093

REF.
N/A
F04-
100002

STRAP - UMBILICAL TIE DOWN, COUCH STABILIZER BEAM, UPPER, ASSY OF



10 G REENTRY

ASSUME FTTG + 1' (O_2) = .72 + .9 = 162#
2' (CCU) = 1.00#
TOTAL 2.62

F = 10 (2.62) = 26.2#

STRAP LOAD = 13.1# (1) = 19.65#

SNAP STRENGTH, SHEAR ≅ 20#

M.S. = 0

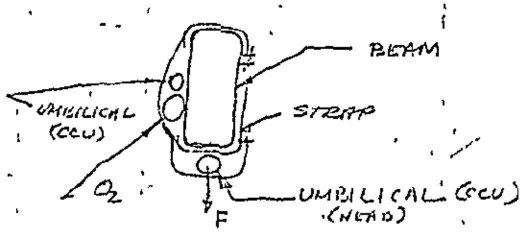
PREPARED BY: WFG
CHECKED BY: G.E.
DATE: 12/18/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

[illegible]
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601094
V56-601095

REF
N/A
F04-
100002

STRAP - UMBILICAL TIE DOWN, COUCH STABILIZER BEAM, LOWER, ASSY OF



LAUNCH + STOWED CONFIG.
LANDING (LESS CCU)

WORST CASE
½ CCU HEAD = .5#
2 FEET O_2 = 1.8#
2 FEET CCU = 1.0#
3.3#

HEAD STRAP F = .5# @ 10G = 7.5# ULT

M.S. = HIGH

MAIN STRAP $\frac{1.8}{2} + \frac{1.0}{2}$ = .9 + .5 = 1.4#

F = 14# L = 21# ULT

PLUS F_{UH} = 7.5#/2 = 3.75#

TOTAL STRAP LOAD = 24.75#

DOUBLE SNAP ≅ 20×1.5 = 30#

M.S. = .21

PREPARED BY: WFG.

CHECKED BY: G.F.

DATE: 12/18/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1

REPORT NO SD 70-205

MODEL NO SKYLAB

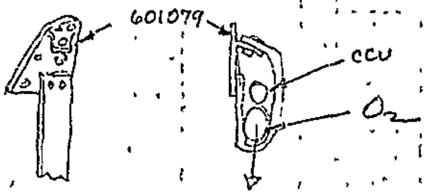
DWG NO V56-601096

REF N/A F04-100002

STRAP-UMBILICAL TIE DOWN, LOWER MAIN DISPLAY CONSOLE BEAM, LOWER RIGHT, ASSY OF

THIS ASSEMBLY INCORPORATES V56-601079 BRACKET

SEE BRACKET ANALYSIS FOR DETAILS.



$WT = 2'(O_2) = 1.8^{\#}$

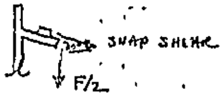
$2'(CCU) = \underline{1.0^{\#}}$

$2.8^{\#}$

$F = 10(2.8)(1.5) = 42^{\#}$ ULT.

SNAP SHEAR $= \frac{F}{2} \sin 30° = F/4$

$= 10.5^{\#}$



SHEAR STRENGTH $\cong 20^{\#}$

M.S. = 1.0

PREPARED BY: WFG

CHECKED BY: G.F.

DATE: 12/18/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1

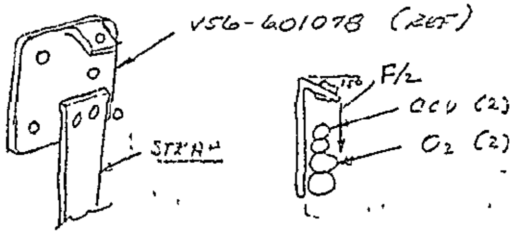
REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-601097

REF N/A F04-100002

STRAP-UMBILICAL TIE DOWN, LOWER MAIN DISPLAY CONSOLE BEAM, UPPER RIGHT, ASSY OF



$F = [2(2')(.9) + 2(2')(.5)](10G) = 56^{\#}$

$F/2 = 28^{\#}$ (LIMIT)

STRENGTH OF HARD MOUNTED STUD IS IN EXCESS OF $30^{\#}$ WHEN PULLED AROUND CORNER AS IN THIS CASE.

M.S. = ADEQUATE

PREPARED BY: WFG
CHECKED BY: C.F.
DATE: 12/15/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V52-601098

REF
N/A
F04-
100002

STRAP - UMBILICAL TIE DOWN,
LOWER MAIN DISPLAY CONSOLE BEAM,
LEFT, ASSY OF

REFER TO V56-601090 BRACKET FOR LOADS.

STRAP IS BATH WEBBING, 1.00" WIDE

$F_T \cong 400^{\#}$

$P_T = 7.5^{\#}$

M.S. = HIGH

PREPARED BY:
CHECKED BY: G F
DATE: 4-3-72

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601099

REF
N/A
F04
100002

SAFETY BLOCK - SEAT PAN LOCK,
ASSY OF

ASSUME $P = 100^{\#}$

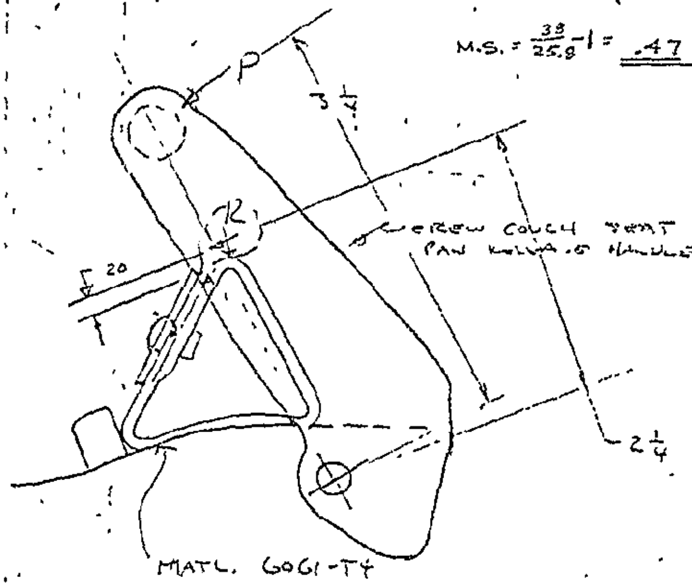
$R = \frac{3.25}{2.25}(100) = 145^{\#}$

SPLIT R & COMPUTE MOM. @ A

$MOM = \left(\frac{145}{2 \times .707}\right) .20 = 20.5^{\text{"}\#}$

$f_b = \frac{6M}{bh^2} = \frac{6 \times 20.5}{1.2(.063)^2} = 25800\,psi$

M.S. $= \frac{38}{25.8} - 1 = \underline{\underline{.47}}$



C22

3.6.1 α(b)

$F_{tu} = 26000\,psi$

$F_{bm30} = 38,500\,psi$

FORM 904-D REV 12-67

PREPARED BY: WFG.
CHECKED BY: GHS
DATE: 12/17/72

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO. V56-601100

REF
N/A
F04-100002

STRAP - RETENTION, RESCUE MISSION CCU CONTROL HEAD, L.H ASSY OF

CONFIGURATION AND LOADS SIMILAR TO V56-601092 Assy - SEE REFERENCED ANALYSIS FOR DETAILS.

OK. by REFERENCE.

PREPARED BY: RJD
CHECKED BY: WJA
DATE: JAN 10, 1973

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601101

REF
NA
F04-100002

BAG STOWAGE - RESCUE MISSION EMERGENCY OXYGEN MASK, ASSY OF

THIS STOWAGE BAG IS MOUNTED ON THE AFT BULKHEAD ON TOP OF THE AFT BULKHEAD WIREWAYS. THESE BAGS ARE TO BE ANALYZED USING BOEING CRITERIA. THE LOADS DERIVED FROM MCR12768 ARE A FUNCTION of AFT BULKHEAD COMPONENTS AND LOCATION of PART ON AFT BULKHEAD. THE LOCATION of THIS PARTICULAR STOWAGE IS APPROXIMATELY $Y_c = -34$ $Z_c = 9$. WITH THIS LOCATION OBTAIN THE FOLLOWING ACCELERATIONS FROM BOEING CRITERIA (ASSUMING COMPONENT WT. $W_c = 900$ lb)

$$f = \left(\frac{206}{206+900}\right)^{\frac{1}{2}} = .432$$

MCR 12768

$$g_{x_{MAX}} = 149 f = 64.4$$

$$k = g_{x_{MAX}}\left[1 - \frac{Y^2}{14.3(56.5^2+9^2)}\right] = 62.8$$

$$Z/R = \frac{9}{56.5} = .159 \;;\; g_x/k = .98 \;;\; g_x = 61.6g$$

$$g_{x_-} = \frac{2}{3}\left(\frac{Z}{R}+1\right)\frac{k}{g_{x_{MAX}}}\, g_x = 46.3g$$

$$g_y = \pm .125\, g_x = 7.7g$$

$$g_z = \pm .25\, g_x = 15.4g$$

PREPARED BY: G.D.
CHECKED BY: W.L.S.
DATE: JAN 3, 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601101

REF

BAG STOWAGE, OXYGEN MASK

THUS THE FOLLOWING ACCELERATIONS ARE OBTAINED FROM THE BOEING CRITERIA,

$g_x = 61.6g$

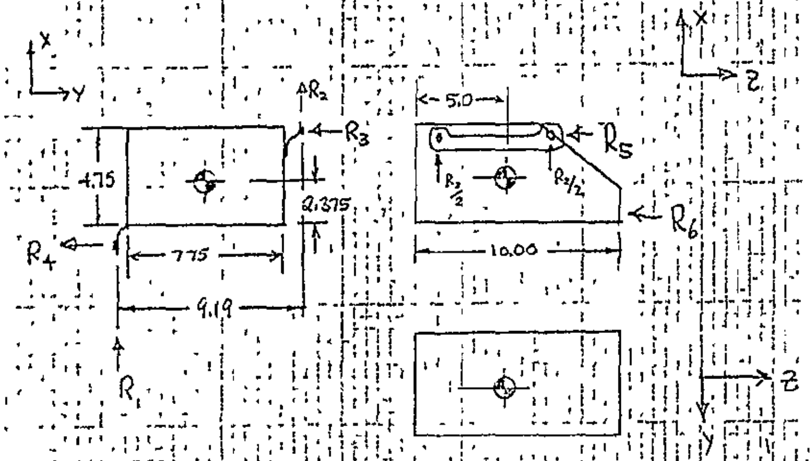
$g_{x_-} = 46.3\,g$

$g_y = \pm 7.7g$

$g_z = \pm 15.4g$

WT GROUP

WEIGHT of EMERGENCY MASK ASSY 3.11 lb (651-400-08)



PREPARED BY: G.D.
CHECKED BY: W.L.S.
DATE: JANUARY 4 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601101

REF

STOWAGE BAG FOR OXYGEN MASK

SINCE THE BAG RESTS ON A SOLID BACE THE +X ACCELERATION CASE NEED NOT BE EXAMINED.

CASE I LOADS $(-X = 46.3g)$

TOTAL UP LOAD (ASSUME 50% of ASSY. WT.)

$$P = \frac{46.3(3.11)}{2} = 72 \text{ lb.}$$

DISTRIBUTE THIS LOAD EVENLY TO SNAPS

$$R_1 = R_2 = \frac{72}{2} = 36 \text{ lb.}$$

SHEAR LOAD PER SNAP

$$P_s = \frac{R_1}{2} = 18 \text{ lb.}$$

ALLOWABLE W/ CLOTH BACKING 20 lb. FROM TEST 30 lb+ W/ METAL BACK.

$$MS = \frac{20}{18} - 1 = \underline{.10}$$

CASE II LOADS $(+Y = 7.7g)$

TOTAL LATERAL LOAD

$$P = \frac{7.7(3.11)}{2} = 12 \text{ lb}$$

$$R_3 = R_4 = 6 \text{ lb.}$$

TENSION LOAD PER SNAP, $P_t = 3$ lb.

APPROXIMATE PEEL ALLOWABLE BY TEST 10 lb.

$$MS = \frac{10}{3} - 1 = \underline{\underline{2.33}}$$

PREPARED BY: GD	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 4 OF 4
CHECKED BY: WJ	RESCUE MISSION	REPORT NO SD 70-205
DATE: JAN 15, 73	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-601101

REF

STOWAGE BAG, OXYGEN MASK

CASE III LOADS $(+Z = 15.4g)$

TOTAL LATERAL LOAD

$$P = \frac{15.4(3.11)}{2} = 24 \text{ lb.}$$

$$R_5 = R_6 = 12$$

SHEAR LOAD PER FASTNER

$$p_s = 6 \text{ lb}$$

COMBINING CASES I & III

$$p_s = 18 \nrightarrow 6 \doteq 19 \text{ lb.}$$

$$MS = \frac{30}{19} - 1 = \underline{.58}$$

DUE TO THE MAGNITUDE of THE LOADS THE REMAINDER of THE BAG NEED NOT BE ANALYZED.

PREPARED BY: WFG	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO 1 OF 1
CHECKED BY: BJD	RESCUE MISSION	REPORT NO SD 70-205
DATE: 12/19/72	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-601102

REF.
N/A
F04-
1000SF.

STRIP, RETENTION - RESCUE MISSION

EMERGENCY OXYGEN MASK, ASSY OF

RETAINS THE O_2 LINE (FLEXIBLE) AROUND THE AFT BULKHEAD. APPROXIMATELY 1½ FEET @ .75#/FT ACT ON EACH TIE -

$F \approx 1.0$#.

REENTRY "G"'S WILL NOT AFFECT THE INSTALLATION.

O.K. by INSPECTION.

PREPARED BY: W.F.G.
CHECKED BY: [illegible]
DATE: 12/20/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

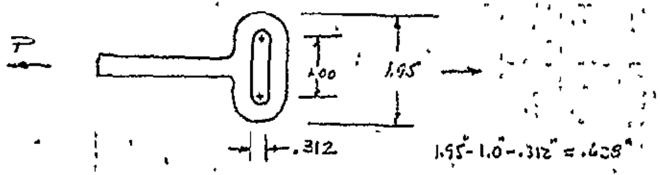
PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO VSC-601106

REF
N/A
VSC-601109

TERMINAL - SWAGED, 3/16 WIRE ROPE TO ONE INCH STRAP

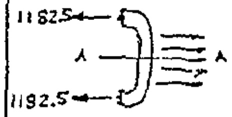
LOADS-
II 2.2,11

MAX TENSILE LOAD = 2365# (ULT)



$1.95'' - 1.0'' - .312'' = .638''$

ASSUME SIMPLE SUPPORT -



$M_{AA} = \frac{1182.5(1.95-.319)}{2} - 1182.5(.25)$

$= 1182.5[.815 - .25] = 668 \text{ in}^{\#}$

$f_b = \frac{6M}{bt^2} = \frac{(6)(668)}{(.359)(.319)^2} = \underline{110000 psi}$

D-92

A-286 CRES STEEL (AMS 5737)

$F_{tu} = 140000 psi$

$\underline{M.S = .27}$

NOTE: PART PROOF TESTED ON N/A TO 2220#

PREPARED BY: W.F.G.
CHECKED BY: [illegible]
DATE: 12/20/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO VSC-601107

REF
F04-
100002

EDGE PAD - 3/16 CABLE, ASSY OF

PAD DESIGNED TO PREVENT THE DOWN CABLES FROM LOCALLY PENETRATING THE RELATIVELY SOFT SHELL OF THE CHILLER. SHOULD MAXIMUM LOADINGS OCCUR ON WHILE LANDING, THE EDGE WILL BE DEFORMED BUT THE CONTAINER INTEGRITY WILL NOT BE JEOPARDISED.

PREPARED BY: G.D.
CHECKED BY: KJJ
DATE: 1 MAY 1972

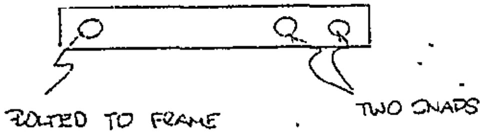
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601108

REF
N/A
V56
601110

RESCUE STOWAGE

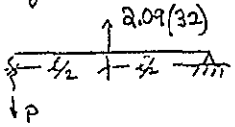
STRAP - DOOR RETENTION, RESCUE VEHICLE RETURN STOWAGE PALLET, ASSY OF



THE PURPOSE of THIS STRAP IS TO HOLD THE URINE CHILLER PROTECTIVE DOOR IN THE CLOSED POSITION DURING FLIGHT.

DOOR WT ≅ 13.9 × 15 × .1 (.1) = 209 lb.

$-\ddot{x} \cong 32g$



LOAD ON STRAP $P = \frac{2.09\,(32)}{2} = 33.5$ lb.

DUE TO THE MAGNITUDE of THIS LOAD NO ANALYSIS of THIS PART IS REQUIRED.

PREPARED BY: G F
CHECKED BY: RGP
DATE: 2/8/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601109-11,-21,-31,-41 & -51

REF
N/A
V56-601140
V56-601123

ASSEMBLY - SWAGED CABLE, M071/73 CHILLER HOLD DOWN

THE DRAWINGS LISTED BELOW ARE PRESENT ON THE ABOVE ASSEMBLY. REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS.

V56-601109-3	CABLE
-5	
-7	
-9	CABLE
V56-601106	TERMINAL

PREPARED BY: WFG.
CHECKED BY: [illegible]
DATE: 12/20/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601109

REF
N/A

V56-601140

V56-601123

ASSEMBLY - SWAGED CABLE, MO71/73

CHILLER HOLD DOWN

-3 OR -5 CABLE

REF: V56-601106 TERMINAL FOR ANALYSIS OF DETAIL PART.

II 2.2.11 LOAD IN ASSEMBLY = 2365# ULT

ASSEMBLY PROOF LOAD = 2220#.
(STANDARD SWAGE ASSEMBLY
PROOF LOAD FOR 3/16 ASSEMBLY)

MIL HBK -5 MIL-C-5424 3/16 CABLE (7X19)

$P_{ALLOW} = 3900\#$

$$M.S = \frac{3900}{2365} - 1 = \underline{.65}$$

PREPARED BY: WFG
CHECKED BY: [illegible]
DATE: 12/20/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601110

REF
N/A
F04-100002

FRAME ASSY - LOWER, RESCUE VEHICLE RETURN STOWAGE PALLET

REFER TO INDIVIDUAL DRAWINGS FOR DETAILS OF STRESS ANALYSIS:

	V56-601042-3	RING
	V56-601076	RETAINER
	V56-601108	STRAP
	V56-601112	FRAME
	V56-601113	FITTING
	V56-601114	PIN
	V56-601115	PANEL
	V56-601116-1,-2	BRACKET
	V56-601117	LINK
	V56-601118-1,-2	ARM
	V56-601119-1,-2	SPRING
*	V56-601120	SPACER
	V56-601121	BAR
	V56-601122	BOLT

* NON-STRUCTURAL PART. NO ANALYSIS REQUIRED

PREPARED BY: GLD.
CHECKED BY: WJS
DATE 3 MAY 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

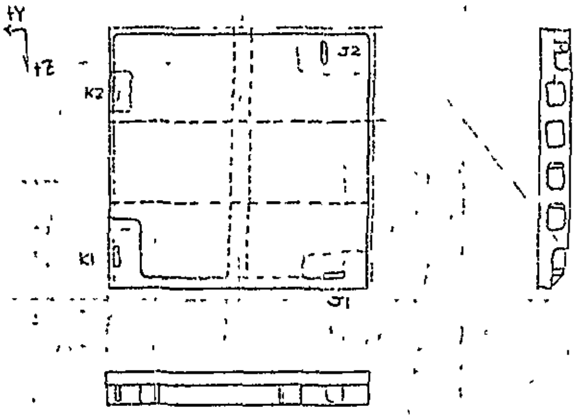
PAGE NO 1 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601111

REF

N/A
FOR
100002

RESCUE STOWAGE

FRAME - UPPER, RESCUE VEHICLE RETURN
STOWAGE PALLET, ASSY OF



MATERIAL: MB0170-065 AL PLATE 7075-T7351 t= 2.5

F_{tu} = 66,000

F_{ty} = 52,000

F_{su} = 38,000

F_{bru} = 131,000 e/D = 2.0

PREPARED BY: GLD
CHECKED BY: WJS
DATE 4 MAY 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601111

REF

RESCUE STOWAGE

UPPER FRAME

MAXIMUM FITTING LOADS (BOEING CRITERIA)

Rescue
Stowage
Loads
Summary
Pg.
II.23 13

J1 FITTING

P_x = 1093 + 152 + 231 = 1476

P_y = 623

P_z = 730

J2 FITTING

P_x = 1403 + 152 + 231 = 1786

P_y = 0

P_z = 0

K1 FITTING

P_x = 1000 + 152 + 329 = 1481.

P_y = 0.

P_z = 527 + 340 = 867

K2 FITTING

P_x = 1492 + 152 + 329 = 1973

P_y = 0

P_z = 0

PREPARED BY: GLD
CHECKED BY:
DATE: 5 MAY 1972
REF

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

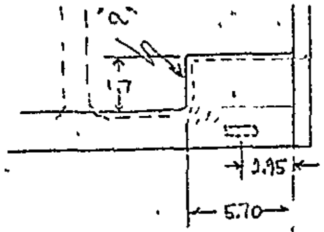
PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601111

RESCUE STOWAGE
UPPER FRAME

CHECK of J1 LUG

$M_z = .7(623) = 436$ IN-lb.

$M_y = .7(730) = 511$ IN-lb.



BEAMING P_x ACROSS SHADED AREA,

$$M_{MAX} = \frac{1476(2.95)(2.75)}{5.70} = 2100 \text{ IN-lb.}$$

ADDING M_z ABOVE

$$M_{z_{MAX}} = 2100 + 436 = 2536 \text{ IN-lb.}$$

$F_b = 92{,}000$

$$b = \frac{6(2536)}{92{,}000\,(.30)^2} = 1.83 \text{ IN. } W/\ t = .30$$

PREPARED BY: GLD
CHECKED BY:
DATE: 8 MAY 1972
REF.

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601111

RESCUE COUCH :
UPPER FRAME

REACTING M_y

$M_y = 511$

$$b = \frac{6(511)}{(.125)^2\,92{,}000} \cong 2.0 \text{ IN}$$

REACTING MOMENT IN .25 IN THICK PAN @ "a",

$M \cong .5(1476)\,1.5 = 1105$ IN-lb.

COUPLE

$$P = \frac{1105}{1.132} \cong 975 \text{ lb.}$$

SHEAR AREA

$A_s = 1.7(.5)(.25)$

$$\sigma_s \cong \frac{975}{1.7(.5).25} = 4590\text{psi}$$ OK

PREPARED BY: GLD
CHECKED BY: WJH
DATE: 3 MAY 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

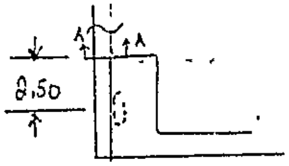
PAGE NO 5 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601111

REF

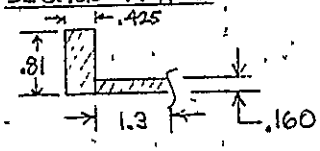
RESCUE STOWAGE

UPPER FRAME

CHECK of K1 FITTING,



SECTION A-A



$A = .55$
$\bar{x} = .28$
$I = .033$

$$M_{AA} - 867(1.25) + 1481(2\,50) = 4785$$

$$\sigma = \frac{4785(.53)}{.033} = 77{,}000 \text{ psi}$$

$$MS = \frac{92}{77} - 1 = \underline{.19}$$

K2 FITTING

$$M = \frac{P\ell}{8} = \frac{1973(2\,6)}{8} = 642 \text{ in-lb}$$

$$\sigma = \frac{6(642)}{.425(.81)^2} = 13{,}800 \text{ psi}$$

Ok

$$MS = \underline{+HIGH}$$

PREPARED BY: GLD
CHECKED BY: WJH
DATE: 9 MAY 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 8
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601111

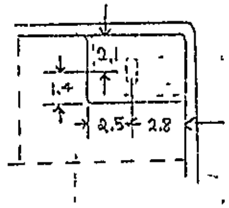
REF

RESCUE STOWAGE

UPPER FRAME

CHECK of J2 FITTING,

$R_x = 1786$ lb. (U-T)



ASSUME TWO BEAMS OF 2.0 IN WIDTH,

DEFLECTION of EACH BEAM @ LOAD ASSUMING SIMPLY SUPPORTED,

BEAM a

$$\delta_a = \frac{P_a(2.1)(1.4)}{6EI(3.5)}\left[2(3.5)(2.1) - (2.1)^2 - (2.1)^2\right]$$

$$\delta_a = \frac{.823 P_a}{EI}$$

BEAM b

$$\delta_b = \frac{P_b(2.5)(2.8)}{6EI(5.3)}\left[2(5.3)(2.8) - (2.8)^2 - (2.8)^2\right]$$

$$\delta_b = \frac{3.08 P_b}{EI}$$

$$\delta_a = \delta_b$$

$$.823 P_a = 3.08 P_b$$

$$P_a = 3.75 P_b$$

PREPARED BY: GLD

CHECKED BY:

DATE: 9 MAY 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION

COMMAND MODULE

PAGE NO 7 OF 8

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-601111

REF.

RESCUE STOWAGE
UPPER FRAME

$P_a + P_b = 1786$

$4.75 P_b = 1786$

$P_b = 376$ -lb.

$P_a = 1410$ lb.

$$M_{MAX} = \frac{1410(2.1)(1.4)}{3.5} = 1185 \text{ IN-lb.}$$

$$\sigma = \frac{6(1185)}{2(t)^2}$$

$$t = \sqrt{\frac{6(1185)}{2(92,000)}} = .196 \text{ IN}$$

ACTUAL t = .20 AT RELEASE $MS = \frac{92}{89} - 1 = \underline{\underline{.03}}$

CHECKING PAN,

TOTAL LOAD $P_x = 35.4(141) + 20.5(q_N)2$

$q_N = 25.4$ lb/IN. $P_x = 4990 + 1040 = 6030$ lb.

ASSUME UNIFORM LOADING ON SIMPLY SUPPORTED BEAM (MAIN TAPERED BEAM IN Y-Y DIRECTION)

E4 TABLE III CASE 13

$$M = \tfrac{1}{2} W\left(x - \frac{x^2}{l}\right)$$

$W = 6030$

$l = 20.4$

PREPARED BY: GLD

CHECKED BY:

DATE: 9 MAY 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION

COMMAND MODULE

PAGE NO 8 OF 8

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-601111

REF

RESCUE STOWAGE
UPPER FRAME

$F_b = 92,009$

$$\sigma = \frac{6M}{bt^2}$$

$t = .0311X + .375$

$$\sigma = \frac{6\left[3015\left(x - \frac{x^2}{20.4}\right)\right]}{7.3\left[.0311x + .375\right]^2}$$

WITH THE ABOVE FORMULA FOR STRESS OBTAIN MAXIMUM STRESS @ $x \cong 5.5$

$\sigma = 33,390$ psi

SINCE THE ALLOWABLE IS $F_b = 92,000$ CAN REDUCE THE b FROM 7.3

$$\frac{b_{REQD}}{33,390} = \frac{7.3}{92,000}$$

$b_{REQD} \cong 3.0$ FOR DESIGN PURPOSES

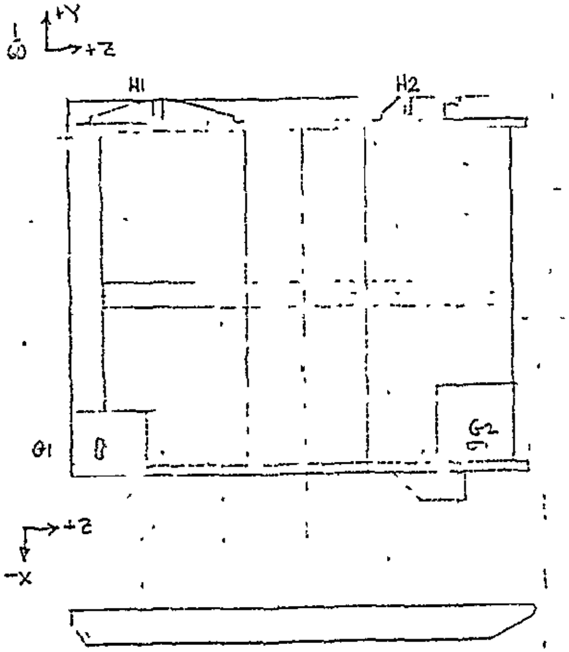
PREPARED BY: GLD
CHECKED BY: W.K.
DATE: APRIL 24 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601112

REF
N/A
V56
601110

FRAME - LOWER, RESCUE VEHICLE RETURN STOWAGE PALLET, ASSY OF



THE LOWER FRAME IS THE PAN THAT COVERS THE A5 SKYLAB STOWAGE LOCATION. IT PROVIDES THE HARD SUPPORT FOR THE STOWAGE WHICH IS CONTAINED BY A CLOTH BAG AND ATTACHED TO IT.

PREPARED BY: GLD
CHECKED BY: W.K.
DATE: 24 APRIL 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601112

REF

RESCUE STOWAGE LOWER FRAME - A5

MATERIAL: AL PLATE MB0170-065 7075-T7351 QQ A 250/12

D11
02.71.
01,02

$F_{tu} = 66{,}000$

$F_{ty} = 52{,}000$

$F_{su} = 38{,}000$

$F_{bru} = 131{,}000$ — $e/D = 2.0$

$E = 10.3 \times 10^6$

CASE I LOADS

II, 2.3.3

$-\ddot{X} = 51.4$

$WT = 141$ lb.

TOTAL LOAD IN -X DIRECTION, $P = .141(51.4) = 7250$ lb.

CASE II LOADS

$\ddot{Y} = 6.42\,g$

CASE III LOADS

$\ddot{Z} = 12.82\,g$

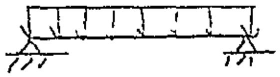
REFER TO PAGE 11 FOR FITTING LOADS THAT CORRESPOND TO THE CASES ABOVE.

RESCUE STOWAGE

LOWER FRAME

CASE I LOADS

CONSERVATIVLY REACT ENTIRE LOAD. WITH WIDE BEAM



$$M_{MAX} = \frac{wl}{8} = \frac{7250(17)}{8} = 15,400$$

$$\sigma = \frac{6(15400)}{6.2(.7)^2} = 30,400 \text{ psi}$$

BECAUSE BEAM IS TAPERED CHECK AT OTHER SECTIONS

$$M = \frac{1}{2}(7250)\left[x - \frac{x^2}{17}\right]$$

$$t = .0353x + .40$$

$$\sigma = \frac{6M}{bt^2} = \frac{6(3625)\left[x - \frac{x^2}{17}\right]}{\underset{4.3}{\cancel{6.2}}(.0353x + .40)^2} = \frac{\overset{5060}{\cancel{3508}}\left[x - \frac{x^2}{17}\right]}{(.0353x + .40)^2}$$

MAX STRESS OCCURS AT @ $x \cong 4.9$

$\sigma_{MAX} = 33,700$ psi

∴ CAN REDUCE SECTION

$$\sigma_{ALLOW} = 60,000 + .5(52,000) = 92,000$$

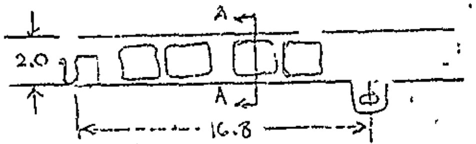
$$MS = \frac{92}{53.7} - 1 = \underline{.71}$$

RESCUE STOWAGE

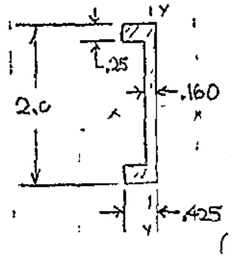
LOWER FRAME

.25 .425 .2125
1.5 .16 .08
.25 .425 .2125
.4525
.14222
.00569

CAPABILITY of SIDE BEAMS,



SECTION A-A



b	h	$\bar{z}$
.425	.25	.125
.160	1.50	1.0
.425	.25	1.575

A = .4525

$\bar{z} = 1.0$

I = .2088

$$Q = .16(.75).375 + .25(.425).875 = .138$$
$$= .045 + .093 = .138$$

$$F_b = 66,000 + \left[\overset{(1.32-1)}{\frac{2Qc}{I} - 1}\right]52,000 = 82,600 \text{ psi}$$

$$F_b = \frac{Mc}{I}$$

$$M_{ALLOW} = \frac{F_b I}{c} = \frac{82,600(.2088)}{1.0} = 17,250 \text{ in-lb.}$$

MOMENT IN MOST CRITICAL SIDE BEAM DUE TO REACTION of HALF of THE -X LOAD

$$M = \frac{Pl}{8} = \frac{7250(16.8)}{16} = 7,600 \text{ in-lb}$$

$$MS = \frac{17,150}{17,600} - 1 = \underline{1.27}$$

PREPARED BY: GLD
CHECKED BY: GF
DATE: 28 APRIL 72
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO. 5 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601112

REF

RESCUE STOWAGE

LOWER FRAME

CHECKING LATERAL STABILITY of FLANGE

(E8) 624

$M_{CR} = \frac{\pi\sqrt{(EI_y)GJ}}{L_e}$

$I_y = .00569$ IN⁴

$E = 10.7 \times 10^6$

$G = 3.9 \times 10^6$

$J = \frac{A^4}{4\pi^2 I_p} = .00495$

$I_p = I_x + I_y$

$L_e = \frac{168}{2} = 8.4$

$M_{CR} = 12,822$ IN-lb.

$MS = \frac{12,822}{7600} - 1 = .68$

PREPARED BY: GLD
CHECKED BY: WJH
DATE: 1 MAY 1972
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE
PAGE NO 6 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601112

REF

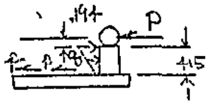
RESCUE STOWAGE

LOWER FRAME

CHECK of LUGS IN FRAME,

V56-601114 PIN LUG

V56-601 114 Pg 1



$P = 2580$ lb.

p = EQUIVALENT CONCENTRATED LOAD FOR q

$P(.415 + .194) = p(.415)\frac{2}{3}$

$p = \frac{.609(2580)}{.666(.415)} = 5700$ lb.

$\frac{1}{2} .415 q = 5700$

$q = \frac{2(5700)}{.415} = 27,500$ psi

SINCE THIS DISTRIBUTED FORCE GOES INTO THE LUG AND NOT TOWARDS THE OUTSIDE of THE LUG THE PART IS OKAY.

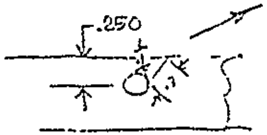
CHECK of LUG AT V56-601118 ARM ATTACH,

V56-601 118 Pg. 2

$R_1 = 3136.$

$\sigma_{BR} = \frac{3136}{5/16(.250)} = 40,000$ psi

SHEAR TEAR OUT,



$A_S = .1(.25) + .3(.25) \approx .10$

$\sigma_S = 31,360$ psi

$MS = \frac{38}{31,36} - 1 = .21$

PREPARED BY: GLD
CHECKED BY: WJA
DATE: 31 JAN 72
REF

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 7 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601117

RESCUE STOWAGE
LOWER FRAME

COMBINING LOADS +X, +Y, +Z

CHECK of G1 FITTING

.2 3.13 $P_x = 1599 + 221 + 535 = 2355$ lb.

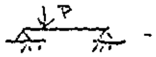
$P_y = 905$

$P_z = 495 + 1255 = 1750$ lb.

MOMENTS CAUSED BY LATERAL LOADS,

$M_y = 1750(.75) = 1310$ IN-lb.

$M_z = 905(.75) = 678$ IN-lb.

FOR MAXIMUM STRESS CAUSED BY M_z BENDING AND AXIAL LOAD, 

$$M = \frac{2355\ (1.6)(2.2)}{4.8} + 678 = 3188 \text{ IN-lb.}$$

$F_b = 92,000$ psi

$$t_{REQD} = \sqrt{\frac{6M}{bF_b}} = .274 \text{ IN.} \qquad (b=3.0)$$

THICKNESS CHANGED TO .28 IN.

$$\sigma = \frac{6(3188)}{3(.28)^2} = 81,500 \text{ psi}$$

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SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 8 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601112.

RESCUE STOWAGE
LOWER FRAME

REACT M_y AS CANTILEVER,

$$\sigma_b = \frac{6(1310)}{3(.25)^2} = 42,000 \text{ psi, psi}$$

σ AT NECKED DOWN SECTION AT RAIL

$M_z = 678$

$$\sigma = \frac{6(678)}{3.0(.16)^2} = 53,000$$

SHEAR AT THIS SECTION DUE TO P_x

$$\sigma_s = \frac{3.2}{4.8}\frac{(2355)}{.16(3.0)} = 3270 \text{ psi}$$

Pg. 7 (BENDING) $MS = \frac{92}{81.5} - 1 = \underline{.12}$

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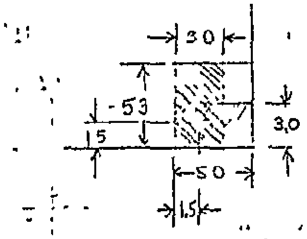
CHECKED BY:		REPORT NO SD 70-205
DATE: 4 MAY 1972	COMMAND MODULE	MODEL NO SKYLAB
REF.		DWG NO V36-601112

RESCUE STOWAGE

LOWER FRAME

CHECK OF G2 W/ COMBINED LOADS

II.2.3.13 $P_x = 2025 + 221 + 535 = 2781$ lb



ASSUME LOAD IS DISTRIBUTED BETWEEN TWO BEAMS AS SHOWN. BECAUSE OF SIMILAR GEOMETRY ASSUME EACH BEAM TAKES HALF THE LOAD.

ASSUMING SIMPLY SUPPORTS,

$$M_{MAX} = \frac{2781\,(1.5)\,3.8}{2\,(5.3)} = 1500 \text{ IN-lb}$$

$$\sigma_b = \frac{6(1500)}{3.0(.25)^2} = 48{,}000 \text{ psi}$$

$$MS = \frac{92}{48} - 1 = \underline{.91}$$

PREPARED BY: GLD	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 10 OF 11
CHECKED BY:		REPORT NO SD 70-205
DATE: 4 MAY 1972	COMMAND MODULE	MODEL NO SKYLAB
REF		DWG NO V36-601112

RESCUE STOWAGE

LOWER FRAME

CHECK OF H1 FITTING

II 2 3 13 $P_x = 1492 + 221 + 765 = 2478$ lb

$P_y = 0$

$P_z = 495 + 1530 = 2025$ lb

REACT P_x IN PAN

$M_z = 2478\,(1.8) = 4450$ IN-lb.

$$\sigma = \frac{6M}{bt^2} = \frac{6(4450)}{b(.25)^2}$$

$$b_{ALLOW} = \left(\frac{6\,(4450)}{92{,}000\,(.25)^2}\right) \doteq 4.65 \text{ IN. OK}$$

CHECK OF H2 FITTING

II.2.3.13 $P_x = 2132 + 221 + 765 = 3118$ lb.

$P_y = 0$

$P_z = 0$

$M_z = 3118\,(1.7) = 5300$ IN-lb.

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SPACE DIVISION
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RESCUE MISSION.
COMMAND MODULE

PAGE NO 11 OF 11
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V52-601112

RESCUE STOWAGE
LOWER FRAME

$$92000 = \frac{6(5300)}{b(.25)^2}$$

$$b_{REQD} = \frac{6(5300)}{92{,}000(.25)^2} = 5.52 \text{ IN.} \quad Ok$$

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N/A
V56
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III.2 3.10

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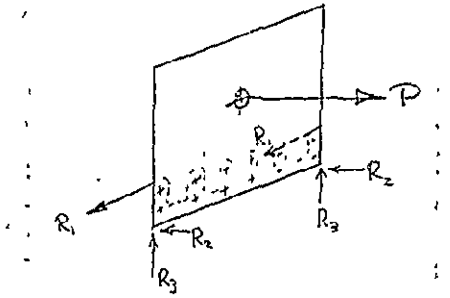
RESCUE MISSION
COMMAND MODULE

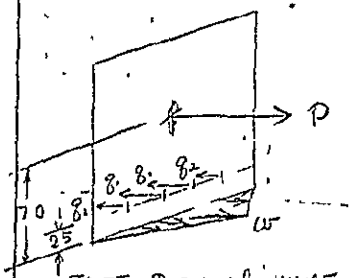
PAGE NO 1 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601113

FITTING - HINGE, RESCUE VEHICLE
RETURN STOWAGE PALLET, ASSY OF



$P = 3055(.7) = 2140$

FREE BODY of DOOR,



$P(7.0) = (2q_1 + 2q_2)\,2.5$

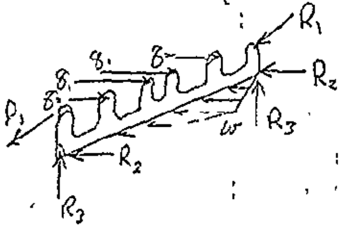
ASSUME $q_1 = \frac{1.45}{.6} q_2$

$q_1 = 2.42 q_2$

$q_2 = 878$ lb.

$q_1 = 2120$ lb

FREE BODY of HINGE FITTING,



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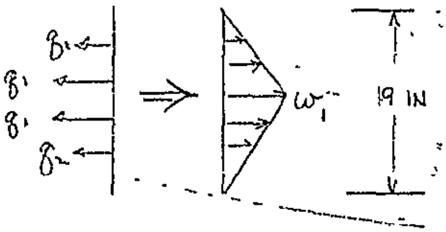
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601113

RESCUE STOWAGE
CHILLER DOOR

DETERMINATION of W LOADING,



$$2q_1+2q_2=\frac{1}{2}w_1 l$$

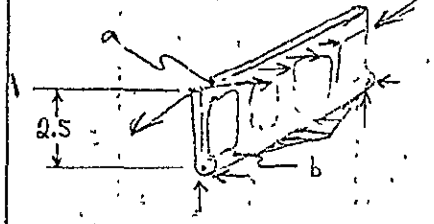
$$4240+1756=\frac{1}{2}w_1(19)$$

$$w_1=\frac{2(5996)}{19}=630\ \frac{lb}{IN}$$

FINAL W IS $w_1-\frac{2P}{l}$ (LOAD AT HINGE PIN LINE)

$$w=630-\frac{2(2140)}{19}=405\ \frac{lb}{IN}$$

ASSUME NOW THAT A BEAM IS INSTALLED THROUGH THE LINE of FASTENERS @ q_1, q_2 LINE,



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RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601113

RESCUE STOWAGE
CHILLER DOOR

FOR LOADS ON BEAM a MUST DETERMINE WHAT PART of LOAD GOES INTO BENDING IN a AND WHAT PART GOES INTO TORSION IN b.

E4 (Cont'd) TABLE III

FOR BEAM WITH TRIANGULAR LOADING

$$y_{max}=\frac{1}{60}\frac{Wl^3}{EI}$$

FOR BEAM b ROTATION AT CENTER of BEAM

$$y=r\,d\theta$$

$$r=2.5$$

$$y\cong 2.5\theta$$

$$T=GJ_1\theta$$

$$T=\frac{GJ_1 y}{2.5}$$

FOR CIRCLE $J_1=\frac{\pi r^4}{2}$

T EQUALS TORQUE EACH END of BEAM b

LET P_a BE AMOUNT of LOAD THAT GOES IN BEAM BENDING IN a BEAM AND P_b BE AMOUNT of LOAD THAT GOES IN TORSION TO BEAM b

$$P_a+P_b=2q_1+2q_2=9190\ lb.$$

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RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601113

RESCUE STOWAGE

CHILLER DOOR

$$T = \frac{G\pi r^4 y}{2(2.5)}$$

$$y = \frac{5T}{G\pi r^4}$$

AND FOR a

$$y = \frac{1}{60}\frac{Wl^3}{EI}$$

NOW

$$W = P_a$$

$$T = P_b 2.5$$

THUS,

$$y = \frac{5P_b(2.5)}{G\pi r^4}$$

$$y = \frac{P_a l^3}{60\,EI}$$

$l = 19$

$r = .375$

$$I = \frac{.5(.5)^3}{12} = .00521 \text{ IN}^4$$

ASSUME A286 $E = 29.1\times10^6$

$G = 10.4\times10^6$

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RESCUE MISSION
COMMAND MODULE

PAGE NO 5 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601113

RESCUE STOWAGE

$$\frac{P_a l^3}{60\,EI} = \frac{5P_b(2.5)}{G\pi r^4}$$

$$7.566\times10^{-4} P_a = 1.93\times10^{-5} P_b$$

$$39 P_a = P_b$$

39 X'S AS MUCH LOAD GOES INTO TORSION IN b AS GOES INTO BENDING IN a

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SPACE DIVISION
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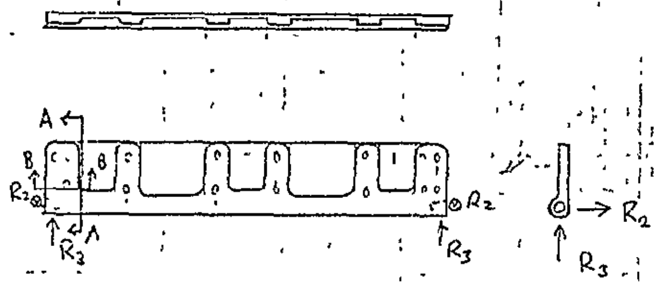
RESCUE MISSION
COMMAND MODULE

PAGE NO 6 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601113

REF

RESCUE STOWAGE HINGE FITTING

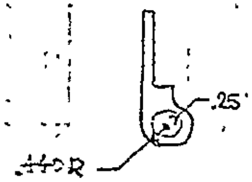


THIS HINGE FITTING SUPPORTS THE URINE CHILLER PROTECTION DOOR. SINCE THE TORQUE IS REACTED AT THE ENDS ASSUME THAT THE TORQUE DUE TO THE DOOR IS INTRODUCED UNIFORMLY ALONG THE FITTING. FOR THE MAXIMUM TORQUE TAKE HALF of TORQUE CAUSED BY THE DOOR AND REACT IT ACROSS SECTION A-A.

Pg. 1

$$T_{MAX} = \frac{7.0 \cdot (2140)}{2} = 7{,}500 \text{ IN-lb.}$$

SECTION A-A



D11 0701 01 p1

MATERIAL: AMS 5737 A286

$F_{tu} = 140{,}000$ psi
$F_{su} = 91{,}000$ psi
$F_{ty} = 95{,}000$ psi

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RESCUE MISSION
COMMAND MODULE

PAGE NO 7 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601113

REF

RESCUE STOWAGE HINGE FITTING

SHEAR STRESS IN BAR CAUSED BY TORSION;

$$\sigma_s = \frac{2Tr_i}{\pi(r_i^4 - r_o^4)} = \frac{2(7{,}500)(.44)}{\pi(.44^4 - .25^4)} = 71{,}500 \text{ psi}$$

$$MS = \frac{91}{71.5} - 1 = \underline{.27}$$

CHECK of END LUGS,

V56-601 115 Pg 6

$R_3 = 1725$
$R_2 = 1920$

LUG LOAD

$$P = R_2 \mathrel{+\!\!\!\!\rightarrow} R_3 = 2580 \text{ lb (ULT)}$$

$$\sigma_{BRU} = \frac{2580}{.50(.33)} = 15{,}650 \text{ psi}$$

TENSION FAILURE

$$\sigma_T = \frac{2580}{.25(.33)} = 31{,}300 \text{ psi}$$

BENDING AT SECTION B-B

$$\sigma_b = \frac{6(.866)3450(1.75)}{1.5(.5)^2} = 83{,}600 \text{ psi}$$

$$MS = \frac{140}{83.6} - 1 = \underline{.67}$$

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RESCUE MISSION
COMMAND MODULE

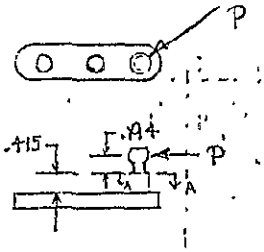
PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601114

REF.

N/A
V56
601110

RESCUE STOWAGE

PIN-HINGE, RESCUE VEHICLE RETURN STOWAGE PALLET



(C23)
TABLE
6.2.1.0(b)

MATERIAL : CRES BAR AMS 5737 A286

$F_{tu} = 140{,}000$ psi
$F_{ty} = 95{,}000$ psi
$F_{su} = 91{,}000$ psi

V56 601
115
Pg 6

$P = 1725 \mathbin{\vec{+}} 1920 = 2580$ lb.

MOMENT ON PIN

$M = 2580(.194) = 500$ IN-lb.

$F_b = 206{,}500$ psi

REQUIRED RADIUS AT SECTION A-A

$$R = \sqrt[3]{\frac{4M}{\pi(206{,}500)}} = .145 \text{ IN.}$$ (BENDING ONLY)

Shear + bending ($R_s^3 + R_t^2 = 1$) MS = 0.0

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RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601114

REF.

RESCUE STOWAGE

HINGE PIN

STRESS IN SOCKET (PLASTIC DISTRIBUTION)

$$\sigma_{br} = \frac{2580}{(.4052).415} + \frac{.4015(2580)}{(.2075)^2(.4052)} = 74{,}717 \text{ psi}$$

OK

THE STRESS ABOVE ALSO ASSUMES THAT NONE of THE MOMENT IS REACTED BY THE TAB of THE PIN.

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COMMAND MODULE

PAGE NO 1 OF 7

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-601115

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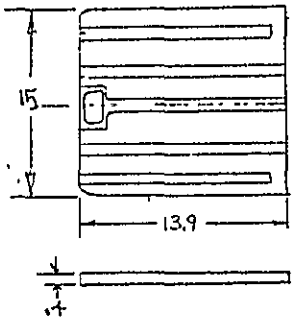
V56
601110

RESCUE STOWAGE

PANEL-END CLOSEOUT, RESCUE VEHICLE STOWAGE PALLET, ASSY OF

LOAD CAPABILITY of DOOR – THE DOOR ON THE A5 PALETTE THAT PROTECTS THE URINE CHILLER COULD BE SUBJECTED TO STEP LOADS IN THE STOWED POSITION.

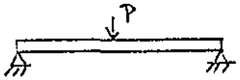


CASE I
$P = 200$ lb (ULT)
STEP LOAD ANYWHERE

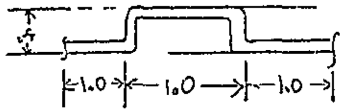
CASE II
$P = 2140$ lb (ULT)
STOWAGE CENTER

V56-601
113
Pg. 1

METHOD of SUPPORT



CAPABILITY of ONE of THE TYPICAL HAT SECTIONS



$t = .10$

	$\underline{b}$	$\underline{h}$	$\underline{\bar{z}}$
1	1.0	.10	.35
2	.10	.30	.15
3	.10	.30	.15
4	1.80	.10	.05

$A - .34$
$\bar{z} = .1559$
$I = .00647$

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COMMAND MODULE

PAGE NO 2 OF 7

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-601115

REF

RESCUE STOWAGE

A5 PALETTE

$$M = \frac{Pl}{4} = \frac{P\,139}{4} = 3.48P,$$

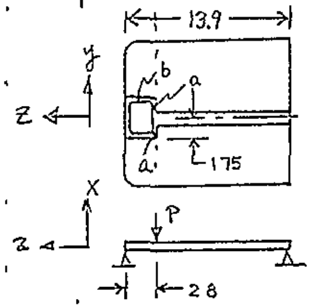
$$\sigma = \frac{Mc}{I} = \frac{3.48Pc}{I}$$

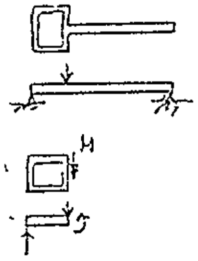
ASSUME σ ALLOWABLE = 70,000 psi

$$P_{ALLOW} = \frac{70{,}000\ I}{3.48\ c} = \frac{70{,}000(.00647)}{3.48\ (.2441)} = 532 \text{ lb.}$$

DESIGN CRITERIA = 200 lb. (ULT) OVER 10 SQ. IN.

TRANSFER of LOAD IN CENTER HAT AROUND HAND HOLE





ASSUME P = 200 lb. IS APPLIED AT INTERSECTION of HAT AND HAND HOLE

$$M_{y_{MAX}} = \frac{200(2.8)(11.1)}{13.9} = 447 \text{ in-lb.}$$

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SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601115

REF

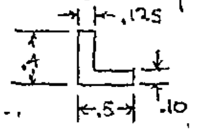
RESCUE STOWAGE

A5 PALETTE

ASSUME THE MOMENT IS REACTED BY TORSION IN THE TWO SECTIONS a. THUS THE TORSION T IN EACH LEG

$$T = \frac{447}{2} = 223.5 \text{ IN-lb.}$$

CROSS SECTION of a SECTIONS,



$$T = J_2 \tau_{MAX}$$

$$J_2 = \alpha_1 b_1 t^2 + \alpha_2 b_2 t_2^2$$

$$J_2 = .27(.4)(.125)^2 + .28(.375)(.1)^2 = .00274$$

$$\tau_{MAX} = \frac{223.5}{.00274} = 81{,}570 \text{ psi}$$

MUST INCREASE SECTION; TRY .25 IN WIDTH

$$J_2 \doteq .245(.4)(.25)^2 + .26(.25)(.1)^2$$

$$J_2 = .00612 + .00065 = .00672$$

$$\tau_{MAX} = \frac{223.5}{.00672} = 33{,}200$$

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COMMAND MODULE

PAGE NO 4 OF -
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601115

REF

RESCUE STOWAGE

A5 PALETTE

INCLUDING THE BENDING IN EACH LEG,

$$V = \frac{11.1(200)}{13.9(2)} \doteq 80 = \text{SHEAR TRANSFERED TO EACH LEG}$$

THUS THE BENDING IN EACH LEG

$$M_{MAX} = 80(1.75) = 140 \text{ IN-lb}$$

$$\sigma = \frac{6(140)}{.25(.4)^2} = 21{,}000 \text{ psi}$$

FOR INTERACTION USE,

E8 638

$$R_b^2 + R_s^2 = 1$$

MATERAL; MB0170-065, 7075-T7351

$F_{tu} = 67{,}000$
$F_{ty} = 56{,}000$
$F_{su} = 38{,}060$
$F_{bru} = 134{,}000$ $e/D = 2.0$
$E = 10.3 \times 10^6$

$$R_b = \frac{21}{67} = .314$$

$$R_s = \frac{33.2}{38} = .874$$

REF

RESCUE STOWAGE
A5 PALETTE

$$MS = \frac{1}{\sqrt{(314)^2 + (.874)^2}} - 1 = \frac{1}{.929} - 1 = \underline{.07}$$

IN b LEGS of HAND HOLD

$$M = \frac{M_{y_{MAX}}}{2} = 223.5 \text{ IN-lb.}$$

FOR TORSION ASSUME CONSERVATIVLY FIXED END MOMENT INPUT FROM a LEGS

$$T = \frac{200(3.5)}{8} = 87.5 \text{ IN-lb.}$$

IF USE SAME REVISED SECTION b = .25

$$\tau_{MAX} = \frac{87.5}{.00672} = 13,100 \text{ psi}$$

$$\sigma_b = \frac{6(223.5)}{.25(.4)^2} = 33,400 \text{ psi}$$

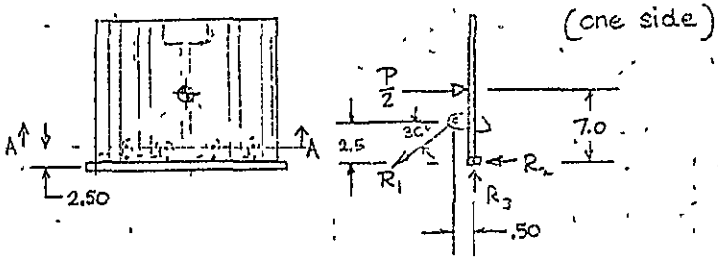
$$MS = \frac{1}{\sqrt{\left(\frac{33.4}{67}\right)^2 + \left(\frac{13.1}{38}\right)^2}} - 1 = \underline{.64}$$

REF

RESCUE STOWAGE
A5 PALETTE

CHECK of DOOR - FOR STOWAGE LOADS,

$P = 2140$ lb. (ULT)



$$R_1 \cos 30° \, 2.5 = P\left(\frac{7.0}{2}\right)$$

$$R_1 = \frac{7.0(2140)}{2(\cos 30°)2.5} = 3450 \text{ lb. (each side)}$$

$$R_2 = \frac{P}{2} - R_1 \cos 30° = 1070 - 3450(.266) = -1920. \text{ lb.}$$

$$R_3 = 3450 \sin 30° = 1725 \text{ lb.}$$

MAXIMUM MOMENT IN UNSUPPORTED SECTION of DOOR OCCURS AT BOLT LINE A-A.

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NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 7 OF 7
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601115

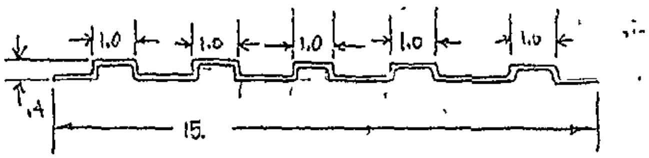
REF

RESCUE STOWAGE

A5 PALETTE

SECTION A-A

ALL t = .125

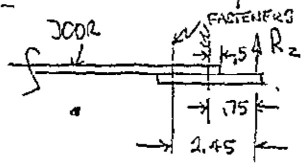


ITEM	b	h	$\bar{z}$	
1	10.0	.125	.0625	A = 2.219
2	1.25	.40	.20	$\bar{z}$ = .152
3	3.75	.125	.3375	I = .036

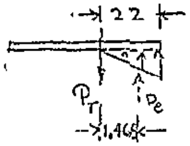
$$\sigma_b = \frac{Mc}{I} = \frac{2140(4.5).248}{.036} = 66{,}400$$

$$MS = \frac{67}{66.4} - 1 = \underline{.01}$$

LOAD AT FASTENERS,



ASSUME DISTRIBUTION BELOW,



$R_2 = 3042$

$$1.465\,P_T = (2.45 - 1.465)\,R_2$$

$$P_T = \frac{.985}{1.465} R_2 = 1290 \text{ lb. FOR. 4 FAST.}$$ C/R

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CHECKED BY: [illegible]
DATE: APRIL 7, 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO 36-601116

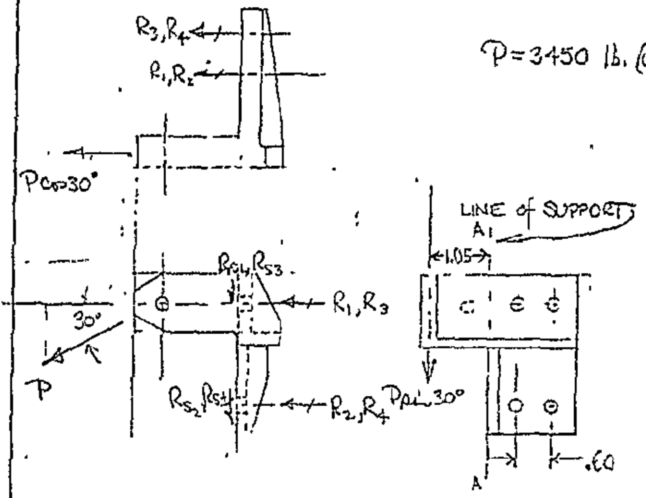
REF
N/A
V56
601110

V56-
601115
Pg. 6

RESCUE STOWAGE

BRACKET-HINGE, RESCUE VEHICLE RETURN STOWAGE PALLET, ASSY OF

$P = 3450$ lb. (ULT)



MATERIAL: A286

$F_{tu} = 140{,}000$

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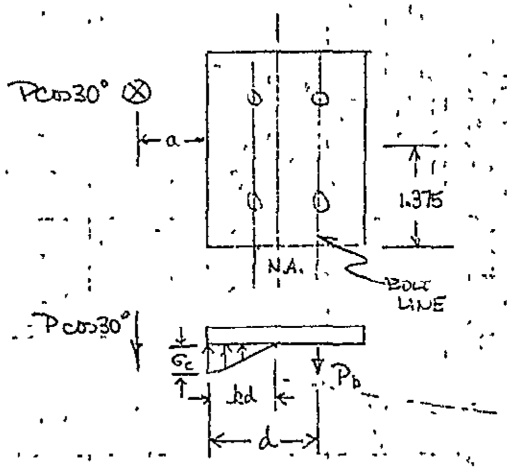
DATE: APRIL 1072 | COMMAND MODULE | MODEL NO SKYLAB
REF | | DWG NO V56-601116

RESCUE STOWAGE

HINGE BRACKET

TO REACT MOMENT ABOUT A-A CAUSED BY $P\cos 30°$ CONSIDER THE FOLLOWING ANALOGY of USING REINFORCED CONCRETE ANALYSIS.



P_b = LOAD IN BOLT

σ_c = BEARING STRESS

E8 Pg 317

E_c = E of ALUMINUM ≈ 10.5×10^6

E_s = E of STEEL = 29.0×10^6

$n = E_s / E_c - 2.76$

A_s = CROSS SECTION of BOLT = $\frac{\pi(.25)^2}{4} = .049$

$\rho = A_s / bd = \frac{.049}{(1.375)(1.1)} = .0324$

$b = 1.375$

$d = 1.10$

$a \approx .95$

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DATE: APRL-11-72 | COMMAND MODULE | MODEL NO SKYLAB
REF | | DWG NO V56-601116

RESCUE STOWAGE

HINGE BRACKET

$$k = \sqrt{2\rho n + (\rho n)^2} - \rho n = .3428$$

$$j = 1 - \frac{k}{3} = .8857$$

$$M = \frac{1}{2}\sigma_c k j b d^2$$

$$M = P(a + kd)$$

$$P(a + kd) = \frac{1}{2}\sigma_c k j b d^2$$

$$\sigma_c = \frac{2(P)(a + kd)}{k j b d^2}$$

ASSUME 70% of LOAD GOES TO THE UPPER SET of FASTENERS AND 30% GOES TO THE LOWER

THUS FOR UPPER PORTION, P = 3450 lb. (ULT)

$$\sigma_c = \frac{2(.70) P\cos 30° [.95 + .34(1.1)]}{.3428(.8857)\, 1.375(1.1)^2} = 10{,}950 \text{ psi}$$

$$\sigma_s = \frac{1}{2}\frac{(10{,}950)(.3428)}{.0324} = 58{,}000 \text{ psi}$$

THE AXIAL STRESS DUE TO THE COMPONENT MUST ALSO BE ADDED. THIS STRESS IS DEPENDENT ALSO ON REINFORCED CONCRETE TYPE of DESIGN.

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SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601116

REF

RESCUE STOWAGE
HINGE BRACKET

THIS AXIAL LOAD RELIEVES LOAD IN THE BOLT DUE TO THE MOMENT AND ADDS TO THE σ_c STRESS THUS

$$\sigma_c = 10{,}950 + \frac{3450(.866)}{1.5(1.375)} = 12{,}400 \text{ psi}$$

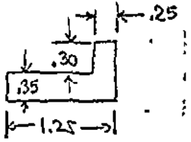
MS = +HIGH

CHECK of BASIC FITTING,

BENDING ACROSS SECTION A-A

$$M = P\cos 30°(1.05) = 3140 \text{ IN-lb.}$$

SECTION AA



b	h	$\bar{z}$
1.25	.35	.175
.25	.30	.5

A = .5125
$\bar{X}$ = .223
I = .0118

$$\sigma_b = \frac{3140(.427)}{.0118} = 113{,}500 \text{ psi}$$

$$MS = \frac{140}{113.5} - 1 = .23$$

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CHECKED BY: WGL
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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

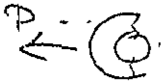
PAGE NO 5 OF 5
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601116

REF

RESCUE COUCH
HINGE BRACKET

IN ATTACH LUG

$$F_{br} = \frac{3450}{.5(.54)} + \frac{.42(3450)6}{.5(.54)^2} = 72{,}400 \text{ psi}$$



$$A = .50(.54) - .27 \text{ IN}^2$$

AXIAL STRESS IN LUG

$$\sigma = \frac{3450}{.27} = 12{,}800 \text{ psi}$$

M.S. = +HIGH

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CHECKED BY: WH
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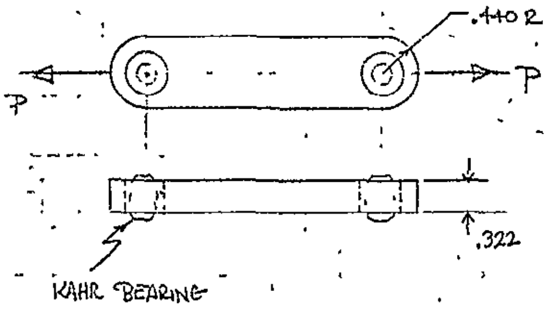
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601117

REF
N/A
V56
601110

RESCUE STOWAGE

LINK - PANEL, RESCUE VEHICLE RETURN STOWAGE PALLET



D18
5321-5

MATERIAL: AL BRONZE QQ-C-465 COMP 642

F_{tu} = 80,000

F_{ty} - 40,000

THIS IS THE LINK ON THE STOWAGE PALETTE THAT SUPPORTS THE URINE CHILLER PROTECTIVE DOOR.

V56-601
115
Pg. 6

P = 3450 lb (ULT)

LUG ANALYSIS

1

D = .50
e = .44
w = .88
t = .322

e/D = .88
W/D = 1.76
D/t = 1.55
A_{br} = Dt = .161
A_t = (W-D)t = .122

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DATE: APRIL 5 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601117

REF

RESCUE STOWAGE

PANEL LINK

SHEAR BEARING

D88
10.11.16

K_{br} = .36

P'_{br} = .36(106,000).161 = 6140 lb.

TENSION ULT.

CURVE F

K_t = .78

P'_{tu} = .78(66,000).122 = 6290 lb.

$MS = \frac{6140}{3450} - 1 = \underline{\underline{.78}}$

PREPARED BY: AD
CHECKED BY: WAJ
DATE: APRIL 5 72

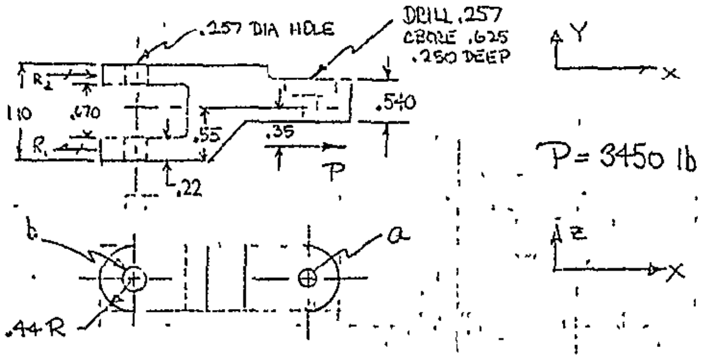
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601116

REF
N/A
V56
601110

RESCUE STOWAGE

ARM-ACTIVATING, RESCUE VEHICLE RETURN STOWAGE PALLET



$P = 3450$ lb (ULT)

V56-601115
Pg. 6

MATERIAL ; AMS 5737, A286

P11
07.01
.01.01

$F_{tu} = 140,000$

$F_{ty} = 95,000$

$F_{su} = 91,000$

$F_{bru} = 266,000$ $e/D = 2.0$

$E = 29 \times 10^6$

$\Sigma F_x = 0$

$P + R_2 - R_1 = 0$

$R_1 = P + R_2$

$\Sigma M = 0$

$P(.09) + R_2(.99) = 0$

$R_2 = -\frac{.09(P)}{.99} = -.091\,P$

PREPARED BY: GLD
CHECKED BY: WAJ
DATE: APRIL 6 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601118

REF

RESCUE STOWAGE

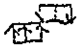
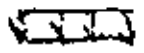
ACTUATING ARM

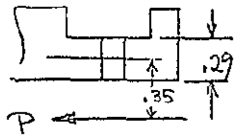
$P = 3450$

$R_2 = -314$ lb.

$R_1 = 3450 - 314 = 3136$ lb.

LUG "a" CHECK,

1. ASSUME MOMENT REACTED BY PLASTIC BENDING DISTRIBUTION ie 
2. AXIAL LOAD REACTED BY DISTRIBUTED AXIAL LOAD ie 



$P = 3450$

$M = .35P = 1210$ IN-lb.

∴ REACTING MOMENT BY COUPLE

$P_b = \frac{1210}{.145} = 8,350$ lb.

$q_b = \frac{8,350}{.145} = 57,600 \frac{lb}{IN}$

$\sigma_{br} = \frac{57,600}{.257} = 224,000$

AXIAL STRESS

$\sigma_{br} = \frac{3450}{.29(.257)} = 46,300$ psi

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601118

REF

RESCUE STOWAGE
ACTUATING ARM

BOLT BENDING

$$R_{REQD} = \sqrt[3]{\frac{1210(4)}{\pi\ 206{,}500}} = .195 \text{ IN}$$

LUG "D" CHECK

$R_1 = 3136$

$e = .44$

$D = .257$

$W = .88$

$t = .21$

$A_{br} = Dt = .0539$ $\quad e/D = 1.715 \quad D/t = 1.25$

$A_t = .623(.21) = .131 \quad W/D = 3.43$

$$P'_{bru} = K_{br} F_{bru} A_{br} = .58(266{,}000).0539 = 8300 \text{ lb.}$$

$$P'_{tu} = K_t F_{tu} A_t = .38(140{,}000).131 = 6960 \text{ lb.}$$

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CHECKED BY: G F
DATE: APRIL 6, 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 4 OF 4
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601118

REF.

RESCUE STOWAGE
ACTUATING ARM

SIZING LUG b W/ 5/16 FASTENER,

$e = .44$

$D = .312$

$W = .88$

$t = ?$

$W/D = 2.82$

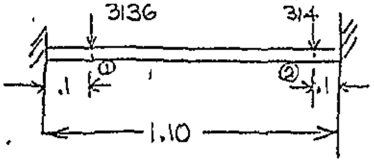
USE

$$P'_{tu} = K_t F_{tu} A_t = .5(140{,}000)(.88 - .312)\,t$$

$$3136 = 39{,}700\,t$$

$$t = \frac{3136}{39{,}700} = .08 \qquad \text{Ok}$$

ACTUAL BOLT BENDING, 5/16 BOLT



(E4) TABLE III CASE 32

$$R_L = \frac{3136(1.0)^2}{(1.1)^3}\left[3(.1)+1.0\right] + \frac{314(.1)^2}{(1.1)^3}\left[3(1.0)+.1\right] = 3047$$

$$M_{①} = -\frac{3136(.1)(1.0)^2}{(1.1)^2} - \frac{314(1.0)(.1)^2}{(1.1)^2} + R_L(.1)$$

$$M_{①} = 43.7 \text{ IN-lb}$$

$$M_L = \frac{3136(.1)(1.0)^2}{(1.1)^2} + \frac{314(1.0)(.1)^2}{(1.1)^2} = 262 \text{ IN-lb.}$$

$$\sigma = \frac{4(262)}{\pi(.15625)^3} = 87{,}500$$

MS = 140/[illegible] − 1 = .60

PREPARED BY: RLD
CHECKED BY: WFG.
DATE: 7 APRIL 72

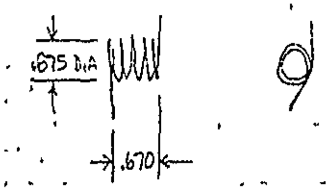
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601119

REF
N/A
V56
601110

RESCUE STOWAGE

SPRING - TORSION, RESCUE VEHICLE RETURN STOWAGE PALLET



WIRE DIA = .093 DIA
L = 12.50

D11
C3

MATERIAL: 17-7 PH CRES WIRE, MB0160-014 COND CH 900

$F_{tu} = 279,000$ psi

$E = 29 \times 10^6$ psi (ASSUMED)

$$\phi = \frac{ML}{EI}$$

$$I = \frac{\pi D^4}{64} = \frac{\pi(.093)^4}{64} = 3.67 \times 10^{-6}$$

$$M = \frac{\phi EI}{L} = \frac{\phi(29 \times 10^6)\,3.67 \times 10^{-6}}{12.50} = 8.514\,\phi$$

E4
16+

$$\left.\begin{aligned} R &= .391 \\ C &= .0465 \end{aligned}\right\} R/C = 8.41 \quad k_i = 1.1$$

$$\sigma = 1.1\,\frac{Mc}{I} = \frac{1.1(8.514)\phi\,.093}{2(3.67 \times 10^{-6})} = 118{,}600\,\phi \text{ psi}$$

$102^\circ \Rightarrow 211{,}000$ psi O.K. $\quad$ M.S. $= \frac{279}{211} - 1 = \underline{\underline{.32}}$

PREPARED BY: W.F.G.
CHECKED BY: G.F.
DATE: 1/26/73

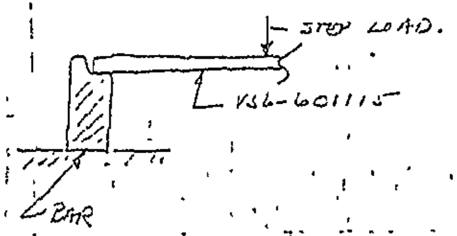
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601121

REF
N/A
V56
601110

BAR - SUPPORT, RESCUE VEHICLE RETURN STOWAGE PALLET, ASSY OF

NON FLYING PART - SUPPORTS V56-601115 PANEL FOR STEP LOADS DURING COUCH INSTALLATIONS. LOAD IS TAKEN BY BLOCK COMPRESSION - HIGH MARGIN OF SAFETY



PREPARED BY: GLD
CHECKED BY: WdH.
DATE 17 APRIL 72

SPACE DIVISION
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RESCUE MISSION
COMMAND MODULE

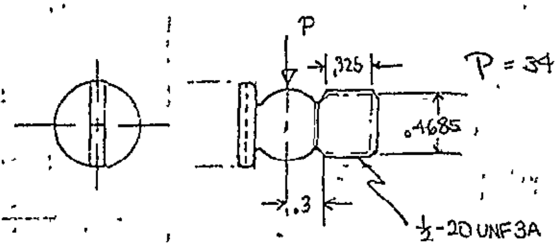
PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601122

REF
N/A
V56
601110

V56-601
115
Pg. 6

RESCUE STOWAGE

BOLT - RESCUE VEHICLE RETURN STOWAGE PALLET



$P = 3450 \text{ lb. (ULT)}$

MATERIAL: CRES BAR AMS 5737 A286

$F_{tu} = 140{,}000$

$F_{ty} = 95{,}000$

$F_{su} = 91{,}000$

$F_{bru} = 266{,}000 \quad e/D = 2.0$

$M = 3450\,(.3) = 1035 \text{ IN-lb.}$

$$\sigma = \frac{4\,(1035)}{\pi\,(.215)^3} = 139{,}000$$

$$MS = \frac{206}{139} - 1 = \underline{.48}$$

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CHECKED BY: WdH
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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO. V56-601122

REF

RESCUE STOWAGE

BOLT

COMPRESSION ON THREADS

$$\sigma_c = \frac{3450}{.325(.5)} + \frac{.4625(3450)}{.1625\,(.1625)(.5)} = 142{,}200 \text{ psi}$$

$$MS = \frac{266}{142} - 1 = \underline{.87}$$

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 1/2-/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601123
-11, -21, & -31

REF
N/A
V56-601 14P
F04-100 002

ASSY - CABLE/STRAP, MO 71/73 CHILLER HOLD DOWN.

THE DRAWINGS LISTED BELOW ARE ON THE ABOVE ASSEMBLY. REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS

V56-601069-11	STRAP ASSY
V56-601069-41	STRAP ASSY
V56-601109-21	CABLE ASSY
V56-601109-41	CABLE ASSY
V56-601109-51	CABLE ASSY

PREPARED BY
CHECKED BY GLW
DATE 5-16-72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

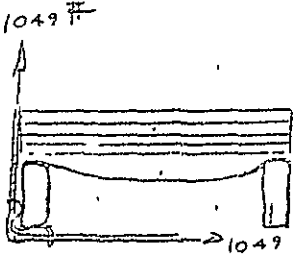
PAGE NO 1 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG V56-601124

REF
N/A
F04
100002
V56 601
069
Pg. 2

COUCH BALLAST
EDGE GUARD - 3/16 CABLE, ASSY OF

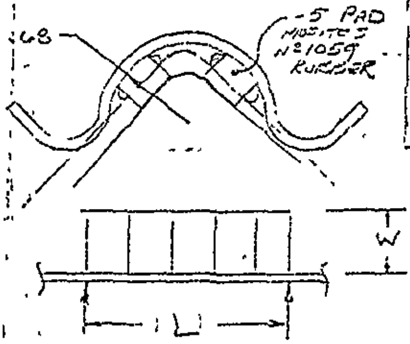
MATL. 304 STL SHT.
QQ-S-766
MIL-S-5059

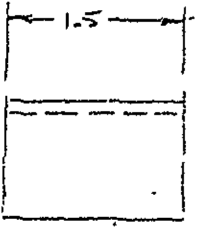
$P = \frac{2098}{2}$
$= 1049$ LBS



$F_{cu} =$
$F_{cy} =$

FROM ROGER OTTS
200 PSI 400 PSI
20% of 1" \ 40% of (275)





$L = (.68 + .03)\frac{90}{57.3} = 1.19$ IN

$w = \frac{1049 \times 1.41}{1.19} = 1242$ #/IN

FORM 604-D REV 12-67

PREPARED BY
CHECKED BY GLD
DATE 5/16/2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 2 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-601124

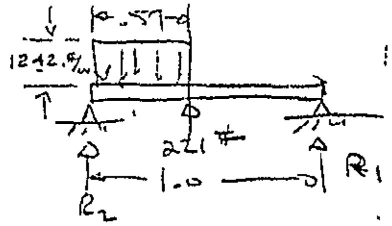
REF

COUCH BALLAST
EDGE GUARD

ASSUME GUARD BOTTOMS OUT
ON CORNER OF COUCH

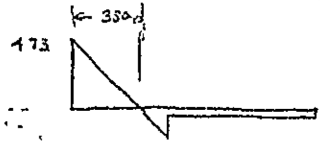
THE RUBBER WILL DEFLECT APPROX. 40%
& DEVELOPE 400 PSI

LOAD IN RUBBER = 400 (.37)(1.5) = 221 #



$$R_2 = \frac{1242\,(.59).795 - 221\,(.5)}{1.0}$$

$$= 473\ \#$$



$$\text{MAX. MOM} = 473\,(.380) - \frac{1242\,(.380)^2}{2}$$

$$= 179.5 - 89.5 = 90.\ \text{in-}\#$$

PREPARED BY
CHECKED BY GLD
DATE 5/16/2

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO V56-601124

REF

COUCH BALLAST
EDGE GUARD

$$f_b = \frac{6M}{bh^2}$$

$$= \frac{6\,(90)}{(1.50)(.10)^2}$$

$$= 36000\ \text{PSI}$$

$$\text{M.S} = \frac{70}{36} - 1 = \underline{.94}$$

PREPARED BY: GLD
CHECKED BY: [illegible]
DATE: 25 APRIL 72

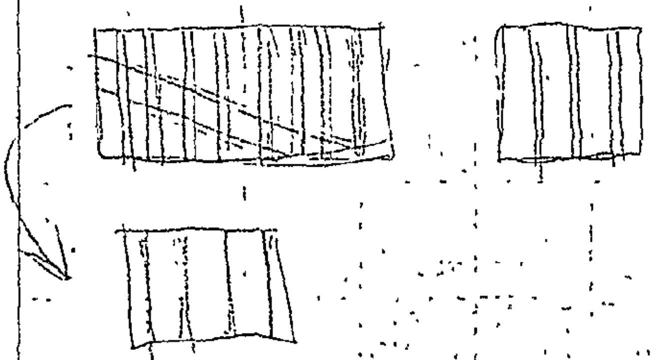
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601126

REF
N/A
F04
100002

RESCUE STOWAGE

CONTAINER - EXPERIMENT RETURN, RESCUE VEHICLE, ASSY OF



CASE I -X ACCELERATION

II.2.3.3 A5 STOWAGE LOCATION

$-\ddot{X} = 31.5$

A5 WT = 141 lb.

$P = 141(31.5) = 4440$ lb.

REACT THIS LOAD WITH 4 STRAPS

P_s = STRAP LOAD = $\frac{1110}{2} = 555$ lb.

II.2.3.10 CASE II -Z ACCELERATION

$P_s = \frac{1730}{2} = 865$ lb.

PBI WEBBING ;

FRL STYLE 2101 1650 #

PREPARED BY: GLD
CHECKED BY: [illegible]
DATE: 25 APRIL 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

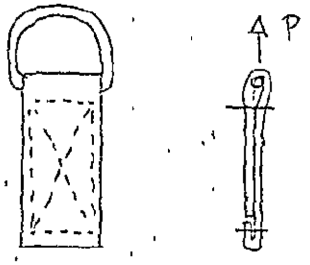
PAGE NO 2 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601126

REF

RESCUE STOWAGE

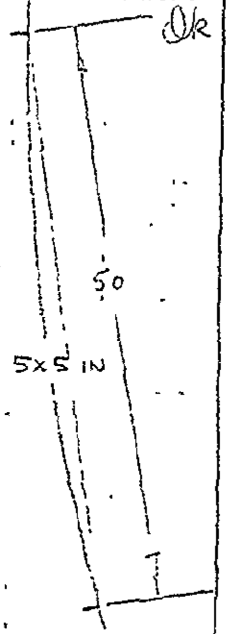
CONTAINER

"D" RING ATTACHMENT TO STRAPS



IN PRIOR APPLICATION 4 IN. of WW USED FOR 1.75 IN. PBI TO DEVELOP FULL STRENGTH FOR 1.0 IN WIDE USE $\frac{1.0}{1.75}(4) = 2.29$ IN FOR FULL STRENGTH; FOR 2.0 IN. of WW $\frac{2.0}{2.29}1650 = 1440$ lb. ALLOW.

OK



BASIC CLOTH PRESSURE LOADING ;

$p = \frac{141(31.5)}{17(24)} = 10.9$ psi

LARGEST UNSUPPORTED PIECE of CLOTH 5x5 IN

FOR DOUBLY CURVED MEMBRANE

$q = \frac{1}{2} p_r R$

SAY $q_{ALLOW} = 100$ lb/in

$100 = \frac{1}{2} p_r R$

$\frac{100(2)}{10.9} = R = 18.35$ IN.

PREPARED BY: GLD
CHECKED BY: G.F.
TE: 26 APRIL 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

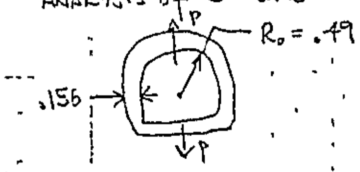
PAGE NO 3 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601126

REF.

RESCUE STOWAGE

CONTAINER

ANALYSIS of "D" RING V56-601042



E4
Pg 172
Case 1

$M_{MAX} = .3183\ PR$

$R = .49 + .078 = .568$

$M_{MAX} = .3183 (550) .568 = 100\ \text{IN-lb.}$

$\sigma = \frac{Mr(4)}{\pi r^4} = \frac{4M}{\pi r^3} = \frac{4(100)}{\pi (.078)^3} = 268\ \text{KSI}$

D18
5137-2

$\sigma_{ALLOW} = 220{,}000 + .7(.6) 220{,}000 = 312{,}400$

$MS = \frac{312.4}{268} - 1 = \underline{.17}$

355

PREPARED BY: GLD
CHECKED BY: G.F.
DATE: JAN 26, 73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601128

REF
N/A
V56
601126

RESCUE STOWAGE

BAR-ATTATCH, UPPER FRAME, EXPERIMENT RETURN CONTAINER, ASSY OF

BECAUSE of SIMILARITY of THIS PART AND THE LOWER ATTACH BAR (V56-601129) IN GEOMETRY AND LOADING REFER TO THE -129 BAR FOR DETAIL ANALYSIS.

PREPARED BY: GLD
CHECKED BY: G.F.
DATE: 24 APRIL 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601129

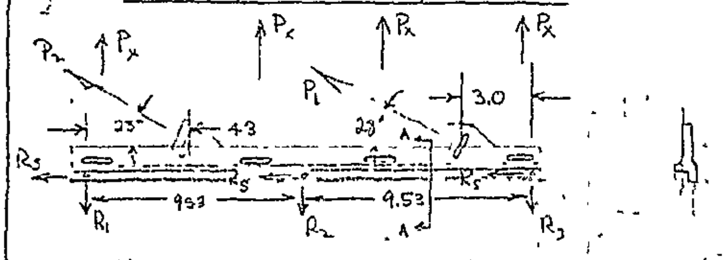
REF
N/A
V56
601126

(D11)
02 71 01 02

856

II,2.3.10

BAR-ATTACH, LOWER FRAME, EXPER. RETURN CONTAINER, ASSY OF



MATERIAL: AL BAR H20170-065 7075-T7351

$F_{tu} = 64,000$

$F_{ty} = 52,000$

$F_{su} = 40,000$

THIS ATTACH BAR ACCOMMODATES THE TIE DOWN STRAPS WHICH SECURES THE STOWAGE PACKAGE

CASE I LOADS

ASSUME THAT $P_1 = P_2 = T/2 = 1730/2 = 865$ lb.

$$R_S = \frac{1730 \cos 28°}{3} = 510 \text{ lb.}$$

$$R_3 \approx \frac{6.53}{9.53}(865)\sin 28° = 279 \text{ lb.}$$

$$R_2 \approx \frac{3.0}{9.53}(865)\sin 28° + \frac{4.3}{9.53} 865 \sin 28° = 311 \text{ lb.}$$

$$R_1 \approx \frac{5.23}{9.53} 865 \sin 28° = 223 \text{ lb.}$$

PREPARED BY: GLD
CHECKED BY: G.F.
DATE: 24 APRIL 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 3
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601129

REF

RESCUE STOWAGE

ATTACH BAR

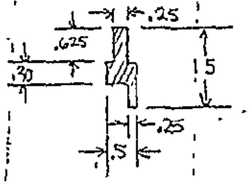
MAXIMUM LUG LOAD

$$P = R_S + R_2 = 510 + 311 = 597 \text{ lb.}$$

MAXIMUM BENDING

$$M_{MAX} \approx 1000 \text{ IN-lb.}$$

SECTION A-A



b	h	$\bar{z}$
.25	.625	1.1875
.50	.30	.75
.25	.575	.2875

A = .45
$\bar{Z} = .754$
I = .0708

$$\sigma = \frac{1000(.75)}{.0708} = 10,652 \text{ psi}$$

PREPARED BY: GLD

CHECKED BY: G F

DATE 24 APRIL 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 3 OF 3

REPORT NO SD 70-205

MODEL NO SKYLAB

DWG NO V56-601129

REF

RESCUE STOWAGE

ATTACH BAR

CASE II LOADS -X ACCELERATION

II.2.3.3 $P_X = \frac{31.5(141)}{2(4)} = 555$ lb.

APPROX BOLT LOADING (MAX)

$R_2 = 2P_X = 1110$ lb.

TO CHECK LUG SUPERIMPOSE R_2 ABOVE W/ LUG LOAD FROM -Z ACCEL.

MAX LUG LOAD $P = [(1110+311)^2 + (510)^2]^{\frac{1}{2}} = 1510$

SHEAR AREA $= .10(.25)2 = .050$ IN^2

WGT

$\sigma_S = \frac{1510}{.050} = 30200$ psi

$MS = \frac{40}{30.2} - 1 = \underline{.32}$

PREPARED BY: GLD

CHECKED BY: G.F

DATE MAY 3, 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1

REPORT NO SD 70-205

MODEL NO SKYLAB

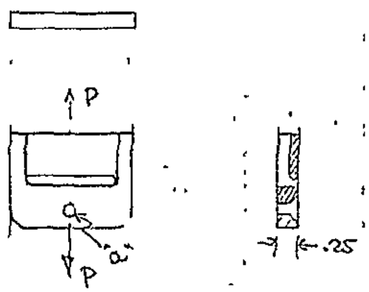
DWG NO V56-601130

REF

N/A
V56
601126

RESCUE STOWAGE

FITTING - ATTACH, LOWER FRAME, EXPERIMENT RETURN CONTAINER



MATERIAL: ALUMINUM PLATE MB0160-065 7075-T7351

$F_{tu} = 69,000$

$F_{ty} = 57,000$

$F_{su} = 39,000$

$F_{bru} = 137,000$ $(e/D = 2.0)$

SHEAR TEAR OUT AT HOLE "a",

$A_S \cong 2\left[.1715(.250) - \frac{1}{2}(.2)(.24) - \frac{1}{2}(.04)(.04)\right] = .036$ IN^2

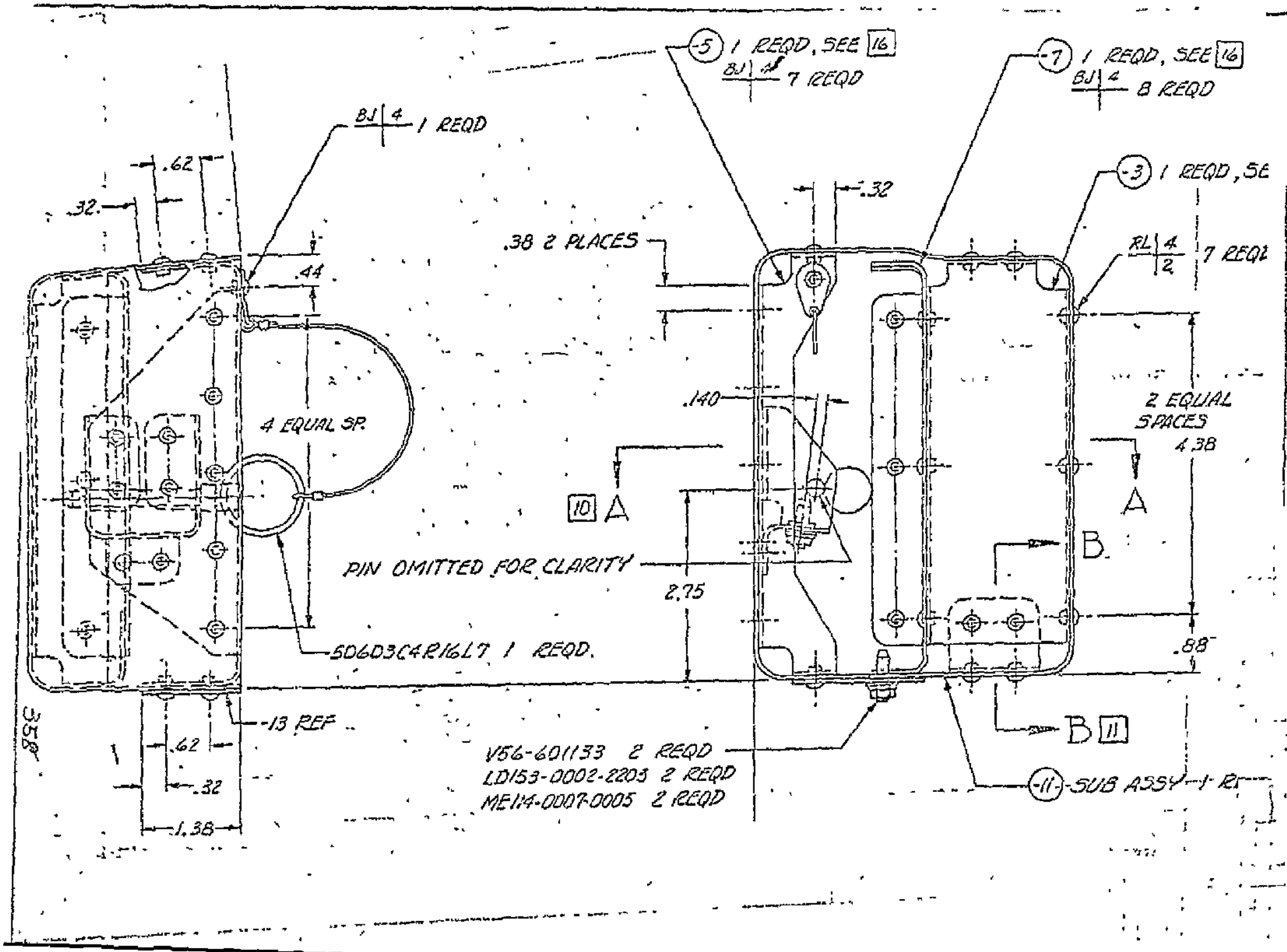
$\sigma_{S_{ALLOW}} = 39,000 = \frac{P}{.036}$

$P_{ALLOW} = .036(39,000) = 1409$ lb.

MAX P = 550

$MS = \frac{1409}{550} - 1 = \underline{1.71}$

631



SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION

RESCUE MISSION

COMMAND MODULE

FAIRING ASSY - RESCUE MISSION, URINE CHILLER PROTECTIVE

PREPARED BY: G.F.
CHECKED BY: RGR
DATE 4/12/73
REF. N/A F04-100 .002

PAGE NO. 1 OF 2
REPORT NO SD 70-20
MODEL NO. SKYLAB
DWG NO. V56-601131

PREPARED BY: WFG
CHECKED BY: G F
DATE 4/17/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601131

REF

FAIRING ASSY - RESCUE MISSION
URINE CHILLER PROTECTIVE

DISCUSSION:

THE URINE CHILLER TO BE RETURNED FROM A RESCUE MISSION IS INSTALLED IN A MANNER DIFFERENT FROM NORMAL FOR THE CHILLER. THUS THE FITTINGS NORMALLY USED FOR TIE-DOWN ARE EXPOSED AND PHYSICALLY ONE POINT IS IN RELATIVELY CLOSE PROXIMITY TO THE HELMET OF ONE OF THE RESCUED ASTRONAUTS. THIS FAIRING IS USED TO PREVENT THE HELMET FROM HITTING THE FITTING DURING WATER LANDING. THE POSSIBLE LOADS ARE UNKNOWN. THE PART IS CONSIDERED NON-STRUCTURAL.

359

PREPARED BY: GLD
CHECKED BY: G.F.
DATE: AUG 7, 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601134

REF
N/A
V56
601860

RESCUE VEHICLE

THIGH STRAP SNAP

THE SNAP IS MADE FROM A STANDARD MS22018 SNAP. THE CADMIUM PLATING IS REMOVED IN THE PROCESS OF BLENDING OUT CRACKS IN THE FINISH. EXCESS MATERIAL WAS REMOVED AT THE SNAP TIP TO ALLOW IT TO BE LOADED AS DESIGNED THESE MODIFICATIONS DO NOT EFFECT THE STRUCTURAL INTEGRATY OF THE SNAP IN THE AREAS THAT ARE LOADED. FURTHER ANALYSIS IS, THEREFORE, NOT REQUIRED.

MR 294
456

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 1/17/72

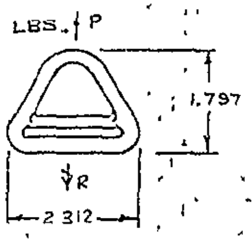
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE - MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601138

REF
N/A
V56-601 139

LINK - THIGH STRAP, CREW RESTRAINT,
RESCUE COUCH

MADE FROM A MS22020-1 LINK
PROOF LOADED TO 2500 LBS.



V56-601 139 P = 179 LBS (ULT)

M.S. = +HIGH

PREPARED BY: GLD
CHECKED BY: G.F.
DATE: JULY 28, 1972

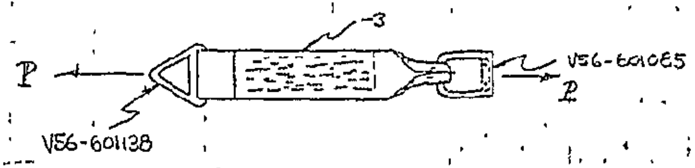
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601139

REF
N/A
V56-601 139

RECCUE COUCH

STRAP - THIGH, CREW RESTRAINT, RESCUE COUCH,
ASSY OF



MATERIAL: -3 STRAP PBI WEBBING FRL STYLE S169FX
1.75 IN WIDE P_{ALLOW} = 2180 (T. STRIECK)
1.0 IN WIDE PBI WEBBING, P_{ult} = 1650

THE STRAP IS PROOF LOADED TO 500 ± 50 lbs AND P_{ULT} = 930 lb
AT THE PROOF LOAD NO DETERIORATON SHALL BE PRESENT

THE V56-601138 LINK IS MADE FROM A MS22020 LINK.
THE MS LINK IS PROOF LOADED TO 2500 lb. Ok FOR
THE ABOVE APPLICATION.

II 2.1.55 $P = \frac{715}{(2)(2)} = 179$ LBS (ULT) (EBD)

$M.S. = \frac{2180}{179} - 1 =$ +HIGH

PREPARED BY: C.E.
CHECKED BY: RGR
DATE: 3/9/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601140-11,-21 & -31

REF
N/A
V56-331
710

CABLE - M071/73 CHILLER HOLD DOWN, ASSY OF

THE DRAWINGS LISTED BELOW ARE PRESENT ON THE ABOVE ASSEMBLY. REFER TO THE INDIVIDUAL DRAWINGS FOR ANALYSIS. NO FURTHER ANALYSIS IS REQUIRED SINCE THE -3 RUBBER PAD IS NON-STRUCTURAL.

* V56-601140-3	PAD
V56-601109-11	CABLE ASSY
V56-601109-31	CABLE ASSY
V56-601125-11	CABLE ASSY
* V56-601141	CLIP
V56-601142	PAD

* NON-STRUCTURAL PART. NO ANALYSIS REQUIRED

PREPARED BY: C.E.
CHECKED BY: RGR
DATE: 3/9/73

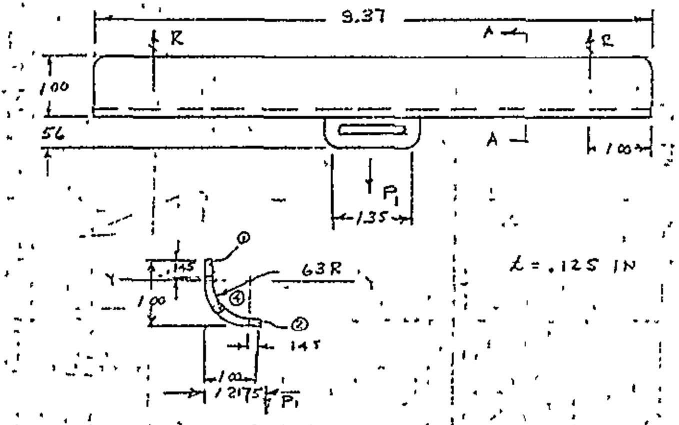
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601142

REF
N/A
V56-601
140

PAD - EDGE, M071/73 CHILLER HOLD DOWN

THE ABOVE PADS ACT AS THE ATTACH POINTS FOR THE TWO HELMETS AND HELMET BAG MOUNTED ON TOP OF THE URINE CHILLER. THE PADS TRANSFER THE LOAD TO THE STEEL CABLES THAT HOLD THE URINE CHILLER TO THE URINE CHILLER ADAPTER FRAME.



SECT A-A

$t = .125$ IN

II.2.2.2 2 HELMETS + BAG = 8.0 LBS. $N_x = 64.4\ g$

$P_1 = \frac{8}{4}(64.4)$

$P_1 = 128.8$ LBS (ULT)

PREPARED BY: C. E.
CHECKED BY: RGR
DATE: 2/?/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601142

REF

PAD-EDGE, M071/73 CHILLER HOLD DOWN

BENDING

$R = 64.4$ LBS

$M = 64.4(3.695)$
$= 237.5$ IN-LBS

	A	X	Ax	Ax²	I₀	I₀ + Ax²
1	.0181	-.0775	-.0014	1.084 x10⁻⁴	3.18 x10⁻⁵	14.02 x10⁻⁵
2	.0181	.6825	.01235	8.43 x10⁻³	2.36 x10⁻⁵	845.36 x10⁻⁵
3	.224	.32	.0716	.0229	.0179	.0397
4	-.156	.267	-.0416	-.0111	-.00865	-.01975
Σ	.1042		.04095			.02852

$$\bar{x} = \frac{.04095}{.1042} = .392 \text{ IN}$$

$$\bar{I} = .02852 - (.392)^2(.1042)$$
$$= .01257 \text{ IN}^4$$

$$f_b = \frac{(237.5)(.392)}{.01257}$$

$$f_b = 7400 \text{ PSI}$$

QQ-S-766
CLASS 304

M.S. = +HIGH

TORSION

$$T = (1.2175 + .392)\frac{(129.8)}{2}$$

$$T = 53.2 \text{ IN-LBS}$$

$$f_{ST} = \frac{3T}{b t^2} \qquad b = \frac{\pi(.63)2}{(4)} + 2(.145)$$

$$f_{ST} = \frac{3(53.2)}{(1.28)(.125)^2} \qquad = 1.28$$

$$= 7970 \text{ PSI}$$

M.S. = +HIGH

PREPARED BY: C.E.
CHECKED BY: RGR
DATE: 2/13/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

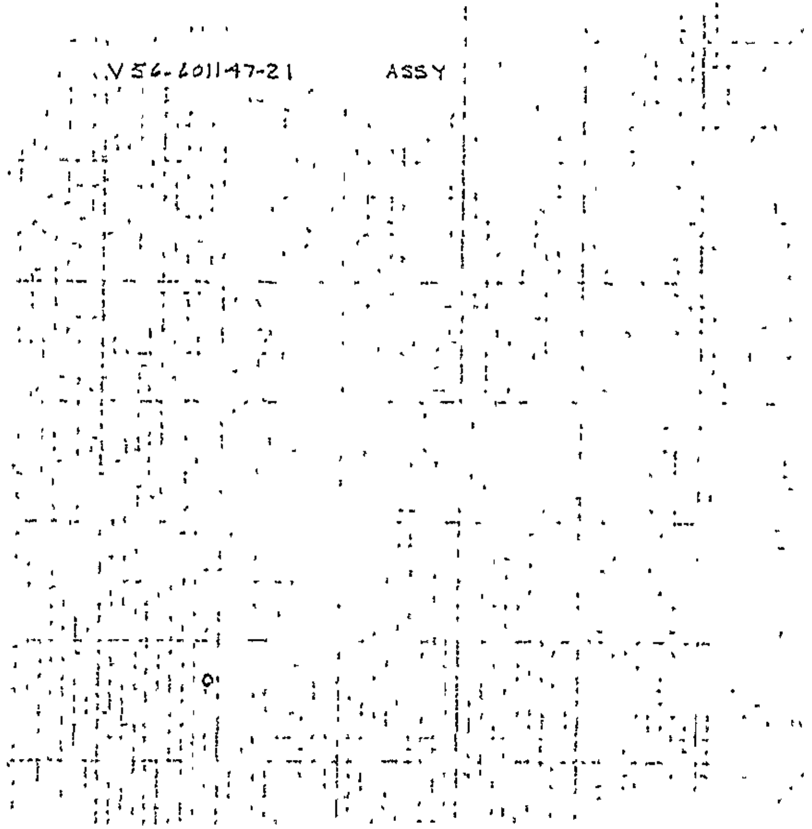
PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-601146

REF
N/A
F04-40-002

RING - TIE DOWN, PGA, ASSY

FOUR OF THE ABOVE ASSEMBLIES ARE UTILIZED ON THE SKYLAB RESCUE COMMAND MODULE TO RETAIN ONE PGA CONTAINER FOR RETURN. THE DRAWING BELOW MAKES UP THE ASSEMBLY. REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS.

V56-601147-21 ASSY



PREPARED BY: G.F.
CHECKED BY: RER
DATE: 3/13/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-651[illegible]17-11,-21

REF
N/A
V56 601
146
F04-100
002

RING-TIE DOWN, ASSY OF

THE ABOVE ASSEMBLY CONSISTS OF THE DRAWINGS LISTED BELOW. REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS.

V56-331763	RING
V36-331572	CLIP

THE -11 ASSEMBLY HAS A .323 DIA HOLE DRILLED IN LINE WITH V36-331572'S PILOT HOLE. FOUR OF THE -11 RING ASSEMBLIES ARE USED TO SECURE ONE PGA CONTAINER DURING RETURN OF THE SKYLAB RESCUE VEHICLE.

THE -21 ASSEMBLY HAS A .386 DIA HOLE DRILLED IN-LINE WITH V36-331572'S PILOT HOLE. TWO ASSEMBLIES, ONE PER CONTAINER, ARE USED TO HELP SECURE TWO PGA CONTAINERS DURING SKYLAB RESCUE VEHICLE RETURN.

PREPARED BY: GLD
CHECKED BY: [illegible]
DATE: DEC 19, 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-880004

REF
NA
V56-
880005

RESCUE VEHICLE COUCH KIT

THIS DRAWING SIMPLY LISTS THE DRAWINGS THAT MAKE UP THE KIT. FOR ANALYSIS SEE THE VARIOUS COMPONENTS LISTED BELOW.

COMPONENTS

V56-531100	COUCH ASSY
V56-531150	LEG SUPPORT ASSY
V56-531105	ADAPTER ASSY, LH
V56-531106	ADAPTER ASSY, RH

PREPARED BY: G.E.
CHECKED BY: RSZ
DATE: 4/12/73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-880005

REF N/A
ND ITEM

RESCUE VEHICLE (ACCUMULATION KIT)

THE DRAWINGS LISTED BELOW ARE PRESENT ON THE ABOVE KIT. REFER TO THE DETAIL DRAWINGS FOR ANALYSIS

V56-880004	RV COUCH
V56-880006	CM STOWAGE
V56-880007	RESTRAINT SYSTEM
V56-880009	CCU CABLE

PREPARED BY: GLD
CHECKED BY:
DATE: DEC 20, 72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-880006

REF N/A
V56 880005

RESCUE VEHICLE STOWAGE PROVISIONS INSTALLATION

THIS DRAWING SIMPLY LISTS THE COMPONENTS THAT MAKE UP THE R.V STOWAGE PROVISIONS. FOR ANALYSIS. SEE COMPONENTS LISTED BELOW.

COMPONENTS

** V36-784013 CONTAINER
** V36-785011
** V36-787019
** V36-787313
** V36-787352
** V36-787808
** V36-787819 CONTAINER
V36-788020 STRAP

* V56-786507 CONTAINER
* V56-786509
* V56-786510
* V56-786512
* V56-786513
* V56-786514
* V56-786515
* V56-786518
* V56-786531 CONTAINER
* V56-786549 STRAP
* V56-786551 STRAP
* V56-786554 CONTAINER

* V56-786597 STRAP
*** V56-786801 I.D. PLATE
*** V56-786802 I.D. PLATE
* V56-787556 STRAP

693

PREPARED BY: G.F.
CHECKED BY: RGR
DATE: 4/12/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-830006

REF

RESCUE VEHICLE STOWAGE PROVISIONS INSTALLATION

* ANALYSIS IS PRESENT IN SD70-205

** THE PARTS HAVE FLOWN PREVIOUSLY. NO FURTHER ANALYSIS IS INCLUDED IN THIS REPORT.

*** NON-STRUCTURAL PART. NO ANALYSIS REQD.

PREPARED BY: GLD
CHECKED BY: WKH
DATE: DEC 1972

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
COMMAND MODULE

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V56-880007

REF

NA.
V56-880005

RESCUE VEHICLE CREW EQUIPMENT KIT

THIS DRAWING LISTS THE PARTS THAT MAKE UP THE RV CREW EQUIPMENT KIT. FOR ANALYSIS SEE VARIOUS DETAILS BELOW.

COMPONENTS

* V36-601298	COVER
* V36-601299	COVER
* V36-611818	AIR DUCT
V56-331710	FRAME ASSEMBLY
V56-331805	BALLAST
V56-331806	BALLAST
V56-601064	BALLAST
V56-601067	PLATE ASSY
V56-601068	BASE ASSY
V56-601069	STRAP
V56-601074	CONTAINER
V56-601075	CONTAINER
V56-601091	STRAP ASSY
V56-601092	STRAP ASSY
V56-601093	↓
V56-601094	
V56-601095	
V56-601096	
V56-601097	
V56-601098	STRAP ASSY

PREPARED BY: GLD	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 2 OF 2
CHECKED BY:		REPORT NO SD 70-205
DATE: DEC 19 72	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-880007

REF

NA V56-880005

RESCUE VEHICLE CREW EQUIPMENT KIT

COMPONENTS (CONT)

V56-601099	BLOCK
V56-601100	STRAP ASSY
V56-601101	BAG ASSY
V56-601102	STRAP
V56-601103	ADAPTER ASSY
V56-601105	COVER
V56-601107	PAD
V56-601110	ASSY
V56-601111	FRAME
V56-601126	CONTAINER
V56-601127	CLOSEOUT
*V36-601169	ROPE ASSY
V56-601124	EDGE GUARD
V56-601131	FAIRING ASSY

* NON STRUCTURAL PARTS. NO ANALYSIS REQUIRED

PREPARED BY: GLD.	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO. 1 OF 1
CHECKED BY:		REPORT NO SD 70-205
DATE: DEC 19, 1972	COMMAND MODULE	MODEL NO SKYLAB
		DWG NO V56-880008

REF

NA V56-880008

RESCUE VEHICLE COMMUNICATIONS KIT

THIS DRAWING LISTS THE PARTS THAT MAKE UP THE RV COMMUNICATIONS KIT. FOR ANALYSIS SEE VARIOUS DETAILS BELOW.

COMPONENTS

* V56-715102	"T" ADAPTER
* V36-715100	CONTROL HD
* V36-715104	UMBILICAL
* V56-762035	HANDLE ASSY

* NON STRUCTURAL PARTS. NO ANALYSIS REQD.

PREPARED BY: G. F
CHECKED BY: R.C R.
DATE: 4-18-73

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION

SLA

II.4.0
PAGE NO OF
REPORT NO SD 70-205
MODEL NO Skylab

SECTION II.4

SLA

867

698

PREPARED BY: [illegible]
CHECKED BY: GF
DATE: 11/13/71

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION

SLA

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-128021

REF
N/A
8V24-321002

SPACER - PLMN, ADAPTER

NO CHANGES FROM PREVIOUSLY FLOWN SLA CONFIGURATIONS

699

PREPARED BY: WFG	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 1 OF 1
CHECKED BY: G.F		REPORT NO SD 70-205
DATE: 10/13/72	SLA	MODEL NO SKYLAB
		DWG NO V24-328012

REF.
N/A
V24-328
232

Door - Access

7.75 Diameter

Changed finish spec callout.

Non Structural CHANGE.

NO FURTHER ANALYSIS REQUIRED.

PREPARED BY: NFG	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO. 1 OF 1
CHECKED BY: G F		REPORT NO SD 70-205
DATE: 10/13/72	SLA	MODEL NO SKYLAB
		DWG NO. V24-328.223

REF
N/A
V24-328
231
V24-328
232
V24 328
234

Door - Access

11.75 Diameter

Changed finish spec callout -

Non Structural CHANGE

NO FURTHER ANALYSIS REQUIRED.

PREPARED BY: WFG.
CHECKED BY: G F
DATE: 10/17/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328041

REF
N/A
V24-328
359

COVER - FLY AWAY UMBILICAL ASSY OF

PREVIOUSLY FLOWN PART - NOT ON S/C 114. NO FURTHER ANALYSIS AVAILABLE.

PREPARED BY: WFG.
CHECKED BY: G F
DATE: 9/11/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328069

REF.
N/A
3V24-320
003

BLAST DEFLECTOR AND HARD POINT INSTALLATION - SLA

S/C 114 AND S/C 117 DIFFER ONLY IN THE DESIGN OF THE SEAL

V24-328068-3

AND THE SEQUENCE OF INSTALLATION OF CERTAIN INSERTS. SEE SEAL DRAWING FOR DETAILS OF DIFFERENCE.

PREPARED BY: W.F.G.
CHECKED BY: G.F.
DATE: 10/7/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO. V24-328101

REF
N/A
SV24-321
003

SKIN - OUTER, AFT SECTION

MINOR CHANGES IN SKIN TRIM AND CHEM-MILL PATTERN. NO STRUCTURAL EFFECT. NO FURTHER ANALYSIS REQUIRED.

PREPARED BY: W.F.G.
CHECKED BY: G.F.
DATE: 10/17/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328111

REF
N/A
SV24-321
003

SKIN - INNER, NO. 1,
AFT SECTION

MODIFIED TO CONFORM TO REQUIREMENTS OF NEW THRUSTER DESIGN. NO STRUCTURAL SIGNIFICANCE. NO FURTHER ANALYSIS REQUIRED.

PREPARED BY: WFG	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO. 1 OF 1
CHECKED BY: G.F	RESCUE MISSION	REPORT NO SD 70-205
DATE: 10/13/72	SLA	MODEL NO SKYLAB
		DWG NO V24-328212

REF.
N/A
V24-328
231

DOUBLER - INNER
LEM- ACCESS DOOR PANEL

NON STRUCTURAL CHANGE IN THICKNESS PATTERN (CHEM-MIL). NO FURTHER ANALYSIS REQUIRED.

PREPARED BY: WFG.	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION	PAGE NO. 1 OF 1
CHECKED BY: G.F	RESCUE MISSION	REPORT NO SD 70-205
DATE: 10/12/72	SLA	MODEL NO SKYLAB
		DWG NO V24-328216

REF
N/A
V24 328
232

DOOR - ACCESS SERVICE
MODULE, ASSY OF

THE -41 PART (N/A V24-328232) HAS BEEN PREVIOUSLY FLOWN ON "J" MISSION (N/A V24-328232)

N/C FURTHER ANALYSIS.

PREPARED BY: IVFG	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 1 OF 1
CHECKED BY: G.F.		REPORT NO SD 70-205
DATE: 10/12/72	SLA	MODEL NO SKYLAB
		DWG NO V24-325220

REF.

N/A

V24-325 231

DOOR - ENTRANCE, FWD SECTION ADAPTER, ASSY OF

CHANGE CONSISTS OF REMOVING -15 FILLER AND REPLACING WITH -19 FILLER TO BETTER FIT THE FACE SHEET.

NON STRUCTURAL CHANGE

NO FURTHER ANALYSIS REQUIRED.

PREPARED BY: WFG.	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO OF
CHECKED BY: G.F.		REPORT NO SD 70-205
DATE: 10/17/72	SLA	MODEL NO SKYLAB
		DWG NO V24-325227

REF.

N/A

V24-325 233

DOUBLER - OUTER, LARGE LEM ACCESS DOOR PANEL

CHANGED THE CHEM-MILL PATTERN, REDUCING THE AREA OF THIN MATERIAL. NO FURTHER STRESS ANALYSIS REQ'D.

PREPARED BY: WFG.
CHECKED BY: G.E.
DATE: 10/17/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-325128

REF
N/A
V24-329
233

DOUBLER - INNER, LARGE LEM
ACCESS DOOR PANEL

CHANGE IN CHEM-MILL PATTERN - INCREASED SIZE OF THICKER AREA. NO FURTHER ANALYSIS.

PREPARED BY: WFG.
CHECKED BY: G.E.
DATE: 10/17/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328229

REF
N/A
V24 329
233

DOOR - ENTRANCE, LARGE LEM
ACCESS, ASSY OF

MINOR STRUCTURAL CHANGE IN FACE SHEET THICKNESS OF INNER FACE SHEET (.016 TO .015). WITHIN TOLERANCE OF MTL.
NO FURTHER ANALYSIS REQUIRED.

PREPARED BY: WFG
CHECKED BY: G F
DATE: 9/12/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328231

REF.
N/A
V24-3-9
233

PANEL - QUARTER, NO 1
FWD SECTION ASSY OF

THE PRIMARY CHANGES FOR THIS PANEL ON S/C 117 VS S/C 114 IS THE HONEYCOMB CORE SPLICING AND SIZE OF SEGMENTS; NEW, WIDER SKIN SPLICES; INCREASED CORE DENSITY AROUND THE EDGES OF PANEL, AND THE ADDITION OF COVERS OVER CUTOUTS TO THIS DRAWING.

-141
-143
-149
-159
-185 (-187)
-189
-191
} 1/4-.001 } REPL -107 1/4-.001

NOTE -185 + -187 ARE 1/8-.002 IN SPLICE AREAS ONLY

-151
-153
-155
-157
} 1/8-.002 } INCREASED DENSITY AROUND PANEL.

-171	SPLICE	REPL	-39
-173	"	"	-43
-175	DBLR	"	-41
-177	SPLICE	"	-45
-179	"	"	-47
-181	"		-23
-183	"		-37

} NEW - NOS EQUAL TO OR BETTER THAN OLD PARTS.

PREPARED BY: WFG.
CHECKED BY: G F
DATE: 9/12/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328231

REF

THE FOLLOWING DOORS HAVE BEEN ADDED OR CHANGED:

V24-328023-11	DOOR	✓
V24-328213-3	DOUBLER, WAS BSC	✓
V24-328218-41	DOOR	✓
V24-328220-31	DOOR	✓
V24-328230-3	DOOR	✓
V24-328255-2	STIFFENER WAS BSC	✓

SEE INDIVIDUAL DRAWINGS FOR DETAILS OF CHANGES.

PREPARED BY: WFG.
CHECKED BY: GF
DATE: 10/12/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328232

REF.
N/A
V24-328
238

PANEL - QUARTER, No 2
FWD SECTION, ASSY OF

CHANGES TO THIS DRAWING ON S/C 117 RELATIVE TO S/C 114, CONSIST OF SMALLER SEGMENTS OF HONEYCOMB, MODIFIED SKIN SPLICES (WIDER) AND THE ADDITION OF COVERS OVER CUTOUTS.

-161
-163
-167
-169
-209
-211
-213
-199
} REPLACE -99

-171
-173
-175
-177
} REPLACE -103

-197
-195
-193
-191
} REPLACE -107

-185
-187
-189
} REPLACE -101

PREPARED BY: WFG.
CHECKED BY: G.F.
DATE: 10/12/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328232

REF

-159	DBLR	REPL	-67	NEW (-) NOS. EQUAL TO OR GREATER THAN OLD PARTS.
-207	SPLICE	"	-145	
-215	"	"	-27	
-217	"	"	-29	
-219	"	"	-35	
-221	"	"	-45	
-223	"	"	-49	
-227	"	"	-53	
-225	DBLR	"	-85	
-229	"	"	-59	

THE FOLLOWING PARTS HAVE BEEN ADDED OR CHANGED:

V24-328022-11	DOOR	✓
V24-328023-11	DOOR	✓
V24-328218-41	DOOR	✓
V24-328243-9	FRAME (WAS -5)	✓

REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS

PREPARED BY [illegible]
CHECKED BY [illegible]
DATE [illegible]

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO. [illegible] OF [illegible]
REPORT NO SD 70-235
MODEL NO. SKYLAB
DWG NO. V24-328233

REF
N/A
24-328
235

PANEL - QUARTER, NO. 3,
FWD SECTION, ASSY OF

THE PRIMARY CHANGES FOR THIS PANEL ON S/C 117 RELATIVE TO S/C 114 CONSIST OF REDUCING THE SIZE OF HONEYCOMB PANELS, MODIFICATION OF SKIN SPLICES (WIDER) AND THE ADDITIONS OF COVERS TO THIS DRAWING.

-111, -113, -117, -119, -135, -137, -139 } REPLACES -87 CORE

-121, -123, -125, -127 } REPLACES -29 CORE

-133, -141, -143, -145, -147 } REPLACES RESP { -27 SPLICE, -23 ", -25 ", -27 SPLICE, -77 DOUBLER

V24-328227-3 DOUBLER REPL -25C /
V24-328228-3 " REPL -25C /
V24-328229-31 DOOR ADDED /

SEE INDIVIDUAL PARTS FOR DETAILS OF CHANGES.

PREPARED BY [illegible]
CHECKED BY [illegible]
DATE [illegible]

SLA

REF
N/A
V24-328
256

PANEL - QUARTER, NO 4,
FWD SECTION ASSY OF

THE PRIMARY CHANGES FOR THIS PANEL ON S/C 117 RELATIVE TO S/C 114 CONSIST OF REDUCING THE SIZE OF HONEYCOMB PANELS, WIDER SKIN SPLICES, AND THE ADDITION OF COVERS TO THIS DRAWING.

-117, -119, -123, -125, -149, -151, -153 } CORE, REPL -89 CORE

-127, -129, -131, -133 } CORE, REPL -91 CORE

-115	DBLR	REPL	-43
-139	SPLICE	"	-29
-141	"	"	-23
-143	"	"	-25
-145	"	"	-27
-147	DBLR	"	-105

V24-328023-11 ADDED /
V24-328243-7 STIFFENER WAS -5 /

REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS

PREPARED BY: WFG.
CHECKED BY: G.F.
DATE: 9/11/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO. V24-328238

REF.
N/A
EV24 320 005

ADAPTER ASSY - FWD SECTION

THE FOLLOWING DRAWINGS CONSTITUTE THE CHANGES FROM S/C 114 TO S/C 117:

V24-328231-401 PANEL ✓
V24-328232-401 PANEL ✓
V24-328233-401 PANEL ✓
V24-328234-401 PANEL ✓

REFER TO INDIVIDUAL DRAWINGS FOR DETAILS OF CHANGES

PREPARED BY: W.F.G.
CHECKED BY: G.F.
DATE: 10/13/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 1
REPORT NO. SD 70-205
MODEL NO SKYLAB
DWG NO. V24-328243

REF
N/A
V24-328 232
V24-328 234

STIFFENER - HINGE ATTACH +Y & -Y AXIS

INCREASED WIDTH OF DOUBLER IN AREA OF HINGE ATTACH'T.

NO FURTHER ANALYSIS REQ'D.

PREPARED BY: WFG.
CHECKED BY: G F
DATE: 10/17/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

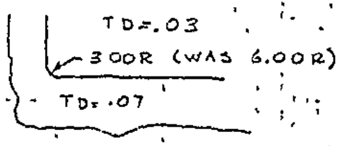
PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328255-3

REF
N/A
V24 328
231

STIFFENER - OUTER, LEM

ACCESS DOOR, -Z AXIS

CHANGED CHEM-MILL PATTERN.



CHANGE DOES NOT CRITICALLY EFFECT THE STRUCTURAL INTEGRITY OF THE V24-328231 PANEL ASSY. NO FURTHER ANALYSIS REQD.

PREPARED BY: WFG
CHECKED BY: CF
DATE: 9/11/72

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-328399

REF.
N/A
3V24 320
003

FLY-AWAY UMBILICAL INSTALLATION

S/C 117 DIFFERS FROM S/C 114 BY THE ADDITION OF
V24-328041 COVER

SEE THE DETAIL COVER ANALYSIS FOR DETAILS

PREPARED BY:
CHECKED BY: G.F
DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-590002

REF.

PANEL RETENTION SYSTEM

MECHANICAL INSTALLATION – SLA SEPARATION SYSTEM

THIS REVISION (P) INCORPORATES PARTS WHICH HAVE FLOWN PREVIOUSLY ON SLA'S 7-15.

NO NEW ANALYSIS REQUIRED.

PREPARED BY:
CHECKED BY: G.F
DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-390003

REF
N/A
V24-880
014

PANEL RETENTION SYSTEM

MOUNTING PROVISIONS – FWD SECTION

THIS DRAWING INCORPORATES MOUNTING PROVISIONS PREVIOUSLY INSTALLED ON SLA'S 7-15. THESE PROVISIONS FOR SLA'S 7-15 ARE SHOWN ON DRAWING V24-329003. THERE ARE NO NEW STRUCTURAL CHANGES.

NO NEW ANALYSIS IS NECESSARY.

PREPARED BY:
CHECKED BY: G F
DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-880009

REF
N/A
V24-880
014

PANEL RETENTION SYSTEM

MOUNTING PROVISIONS - AFT SECTION

THIS DRAWING INCORPORATES MOUNTING PROVISIONS PREVIOUSLY INSTALLED ON SLA'S 7-15, AS SHOWN ON DRAWING V24-728102. HOWEVER, THE BASIC PANEL ON WHICH THE HARDWARE IS MOUNTED HAS CHANGED, AND WILL BE ANALYZED BELOW:

THE SECTION OF PANEL CONSIDERED HEREIN IS BETWEEN X_A 585 AND X_A 540 AT θ = 45°, 135°, 225°, AND 315°.

IN THIS AREA, THE HONEYCOMB CORE IS FILLED WITH ADHESIVE TO INCREASE ITS SHEAR AND COMPRESSIVE ALLOWABLES.

ADDITIONALLY, AN .090 DOUBLER IS ADDED TO THE INNER FACE SHEET TO REPLACE THE V24-328168 SUPPORT ANGLE.

PREPARED BY:
CHECKED BY: G F
DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 2 OF 2
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-880007

REF

PANEL RETENTION SYSTEM

MOUNTING PROVISIONS - AFT SECTION

HONEYCOMB CORE FILL

THE CORE FILL MUST INCREASE THE STRENGTH OF THE CORE TO THE STRENGTH OF 1/8-.002 CORE, AND IT DOES AS SHOWN IN THE FOLLOWING TABLE.

D11
SEC. 31

	F_s'	F_c'
1/8-.002 CORE	450 PSI (AVG)	760 PSI
FILLED CORE *	940 PSI (AVG)	3200 PSI

* CORE FILLED WITH MB0120-037 PER MA0606-024
CORE DENSITY ~ 40 #/ft³

THE FILLED CORE IS MUCH STRONGER THAN THE 1/8-.002 CORE. NO ADDITIONAL ANALYSIS IS REQUIRED.

REPLACEMENT OF V24-328168 ANGLE WITH DOUBLER

FROM SID 64-60, VOLUME VI, PAGE VI 8.3.2.6

Ⓑ1
VOL VI
PAGE
VI. 8 3
2 6

$P = 3450$ #

$M = 30767$ IN#

LOAD REDUCTION = $\frac{1.4}{1.5}$ = .934

$P = .934(3450) = 3220$ #

$M = .934(30767) = 28716$ IN#

PREPARED BY: ℒ
CHECKED BY: G F
DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

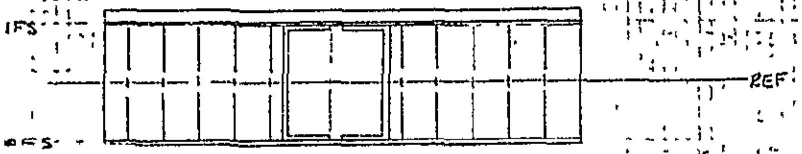
PAGE NO 3 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-880009

REF.

PANEL RETENTION SYSTEM

MOUNTING PROVISIONS - AFT SECTION

SECTION PROPERTIES



b	h	$\bar{y}$	DESCR
6.0	.090	-.910	INNER DOUBLER (V24-328194)
5.76	.015	-.8575	INNER FACE SHEET
1.696	.032	-.834	INNER CAP OF CHANNELS
.064	1.636	0	VERTICAL WEBS OF CHANNELS
1.696	.032	+.834	OUTER CAP OF CHANNELS
1.696	.028	.864	OUTER F/S
6.0	.040	.898	OUTER DOUBLER (V24-328195)

$A = 1.129$ IN² $\bar{y} = -.2721$ IN. $I = .7571$ IN⁴

$c_i = .6829$

$c_o = 1.1911$

$A_{INNER\ CAP} = 2(.090) + 1.76(.015+.032) = .180 + .083 = .263$ IN²

(B1) VOL VI PAGE VI 8326

$M = 30767\left(\frac{1.4}{1.5}\right) = 28716$ IN#

$P = 3450\left(\frac{1.4}{1.5}\right) = 3220$ #

PREPARED BY: ℒ
CHECKED BY: G F
DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 4 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-880009

REF

PANEL RETENTION SYSTEM

MOUNTING PROVISIONS - AFT SECTION

ASSUME MOMENT CARRIED BY TOTAL SECTION, AND AXIAL LOAD BY INNER CAP ONLY.

INNER CAP

$f_t = \frac{(28,716)(.623)}{.757} + \frac{3220}{.263} = 25,900 + 12,250$

$= 38,150$

(D11) PAGE 02.22.03.04

$F_{tu} = 56,500$ PSI (300°)

$M.S. = \frac{56,500}{38,150} - 1 = .48$

OUTER CAP

$f_c = \frac{(28,716)(1.1911)}{.757} = 45,200$ PSI

(D11) 02.22.03.05

$F_{cy} = 50,000$ PSI (300°F)

$M.S. = \frac{50,000}{45,200} - 1 = .10$

PREPARED BY:
CHECKED BY: C.F.
DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 5 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-880009

REF

PANEL RETENTION SYSTEM

CHECK BOND OF OUTER DOUBLER FOR FLIGHT LOADS.

OUTER DOUBLER IS BONDED WITH MB0120-053 PER MA0606-014. THE SKIN TEMPERATURE IS LIMITED TO 200°F BY THE ADDITION OF CORK.

FLIGHT LOADS

MAX $q\alpha$

$P_{585} = -209{,}300\#$ (ULT)

$M_{585} = 18{,}766{,}000$ IN# (ULT)

$R_{515} = 117''$

$$q_{515} = \frac{-209{,}300}{2\pi(117)} - \frac{18766000}{\pi(117)^2} = -721\ \#/\text{IN}$$

END BOOST

$P_{585} = -386{,}400\#$ (ULT)

$M_{585} = 5{,}670{,}000$ IN# (ULT)

$$q_{535} = \frac{-386{,}400}{2\pi(117)} - \frac{5{,}670{,}000}{\pi(117)^2} = -658\ \#/\text{IN}$$

PREPARED BY:
CHECKED BY: C.F.
DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 6 OF 6
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-880009

REF

PANEL RETENTION SYSTEM

ASSUME MAX $q\alpha$ DISTRIBUTED BY EQUAL STRAIN

$q_o = -721\left(\frac{.028}{.043}\right) = -470\ \#/\text{IN}$

$q_i = -721\left(\frac{.015}{.043}\right) = -251\ \#/\text{IN}$

ASSUME END BOOST REACTED ONLY IN O.F.S.

$q_o = -658\ \#/\text{IN}$

$\therefore$ END BOOST CRITICAL

BOND OVERLAP = 1.5" $f_{TEMP} = 0.5$ AT 200°F

$f_{su}' = 1200$ PSI $(.5) = 600$ PSI

$P_s' = (600\text{ PSI})(1.5''\text{ OVERLAP}) = 900\ \#/\text{IN}$ ALLOW.

$$M.S. = \frac{900}{658} - 1 = 0.37$$

NO FURTHER STRUCTURAL CHECKS ARE NECESSARY FOR THIS DRAWING. ALL OTHER CHANGES HAVE FLOWN PREVIOUSLY.

PREPARED BY: L
CHECKED BY: G F
DATE:

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
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SLA

PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO V24-880010

REF
N/A
V24-88
014

PANEL RETENTION SYSTEM

MOUNTING PROVISIONS-COMPLETE

THIS DRAWING INCORPORATES MOUNTING PROVISIONS PREVIOUSLY INSTALLED ON SLA'S 7-15. THESE PROVISIONS FOR SLA'S 7-15 ARE SHOWN ON DRAWINGS V24-328060 AND V24-328003. THERE ARE NO NEW STRUCTURAL CHANGES.

NO NEW ANALYSIS IS NECESSARY.

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DATE:

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SLA

PAGE NO 1 OF
REPORT NO SD 70-2
MODEL NO SKYLAB
DWG NO V24-880014

REF

PANEL RETENTION SYSTEM

THE FOLLOWING MOD KITS INSTALL THE PANEL RETENTION SYSTEM:

- V24-880014 — SUPPORT INSTALLATION
- V24-880006 — MOUNTING PROVISIONS-FWD SECTION
- V24-880008 — MOUNTING PROVISIONS-AFT SECTION
- V24-880010 — MOUNTING PROVISIONS-COMPLETE

IN ADDITION TO THE MOD KITS, THE FOLLOWING DRAWING IS REVISED:

V24-590002-MECHANICAL INSTALLATION-SLA SEPARATION, SYSTEM

REFER TO INDIVIDUAL DRAWINGS FOR ANALYSIS.

PREPARED BY: WFG	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION RESCUE MISSION	PAGE NO 1 OF 1
CHECKED BY: G F		REPORT NO SD 70-205
DATE: 4/11/72	SLA	MODEL NO SKYLAB
		DWG. NO 8V24-320003

REF
N/A
8V58-003
002

ADAPTER - STRUCTURE
COMPLETE, ASSY OF

THE FOLLOWINGS DRAWINGS SHOW THE COMPARISON BETWEEN S/C 114 AND S/C 117 SLA'S:

S/C 114 (V24-328003 - 811)		S/C 117 (8V24-320003)	
V24-328010-7	SPLICE	V24-328010-7	
V24-328113-25	SHIM	V24-328113-25	
V24-328209	SPACER	V24-328209	
8V24-320012	HARD PT INST	8V24-320012	
V24-328030-21	BRKT INST	V24-328030-21	
V24-328005-41	MOUNT INST	V24-328005-41	
	DIFFERENCES		
V24-328102-61	AQ. ASSY AFT	8V24-321002	✓
V24-328238-31	AQ. ASSY FWD	V24-328238-41	✓
8V24-320011	CORK INST	* V24-320011-21	✓
8V24-322002	ELECT INST	8V24-323022-11	✓
V24-328289-41	UMB INST	V24-328239-51	✓
8V24-320015-11	HINGE & CVR INST.	8V24-320015-21	✓
V24-328069-701	MOUNT INST	V24-328069-701	✓
8V24-320010	VENT HOLE INST	8V24-320010-11	✓

SEE INDIVIDUAL S/C 117 DRAWINGS FOR DETAILS OF DIFFERENCES.

* NON-STRUCTURAL PART. NO ANALYSIS REQD.

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CHECKED BY: G F		REPORT NO SD 70-205
DATE: 4/11/72	SLA	MODEL NO SKYLAB
		DWG NO 8V24-320010

REF
N/A
8V24-320
003

VENT HOLE INSTL - SLA

SMALL CHANGES IN VENT HOLE PATTERN - QUANTITY APPARENTLY DOES NOT CHANGE.

NO FURTHER ANALYSIS REQUIRED

PREPARED BY: WFG
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DATE: 9/11/72

SPACE DIVISION
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RESCUE MISSION
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PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO. SKYLAB
DWG NO 8V24-320015

REF.
N/A
8V24-32
003

Hinge and Cover Instl Panel Jettison, SLA

The following drawings indicate the differences between S/C 114 and S/C 116:

S/C 114		S/C 117	
8V24-320107-5,-6	Hinge	8V24-320107-7,-8	✓
8V24-320115-3	Shim	*8V24-320115-5	✓
8V24-320120-3	Shim	*8V24-320120-5	✓
8V24-320122-5	Shim	*8V24-320123-	✓
	DBLR	8V24-320129	✓
8V24-320130-3,-4	DBLR	8V24-320130-7	✓
8V24-320108	Cover	8V24-320108-31	✓

See individual drawings for details of changes

*NON-STRUCTURAL PART. NO ANALYSIS REQD.

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PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO 8V24-320107

REF
N/A
8V24-32
015

Hinge - Aft, Panel Jettison, SLA

-7 and -8 hinges used on Skylab.

Change consists of increasing width of cut for shim - no structural effect.

NO FURTHER ANALYSIS REQUIRED

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DATE: 10/16/72

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PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO 8V24-320108

REF
N/A
8V24-320
015

Cover - LEM Attach,
Panel Jettison, Assy of.

Non structural changes.

NO FURTHER ANALYSIS REQUIRED.

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CHECKED BY: G.F.
DATE: 10/16/7

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PAGE NO 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO 8V24-320127

REF.
N/A
8V24-320
015

Doubler - Support, Inbd,
Aft Hinge, Panel Jettison, SLA.

Removes cut on the which increases
the strength of the part.
NO FURTHER ANALYSIS REQUIRED

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DATE: 10/16/72
SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA
PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO 8V24-320130

REF.
N/A
8V24-320
015

DOUBLER - SUPPORT, INBOARD, FWD HINGE, PANEL JETTISON, SLA

INCREASED WIDTH OF MACHINE CUT ON DOUBLER TO PROVIDE FOR BETTER SHIM DESIGN ON NEXT ASSY.

NO FURTHER ANALYSIS REQUIRED

387

738

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SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA
PAGE NO. 1 OF 12
REPORT NO. SD 70-205
MODEL NO SKYLAB
DWG. NO. 8V24-321002

REF.
N/A
8V24 320
003

ADAPTER - AFT SECTION, SPACECRAFT, ASSY OF

THE FOLLOWING DRAWINGS CONSTITUTE THE CHANGES OR ADDITION TO S/C 117 RELATIVE TO S/C 114:

	V24-328021-9	SPACER	✓
*	V24-328112-7	SHIM	✓
	8V24-321003-11,-21,-31	QT. PANEL	✓
	8V24-321104	BRKT	✓
	8V24-321109-1,-2	CAP, INNER	✓
	8V24-321110	FITTING	✓
	8V24-321111	CAP - OUTER	✓
	8V24-321112-3,-5,-7,-9,-11	SHIM	✓
	8V24-321114	BOLT	✓

SEE INDIVIDUAL DRAWINGS FOR DETAILS OF CHANGES.

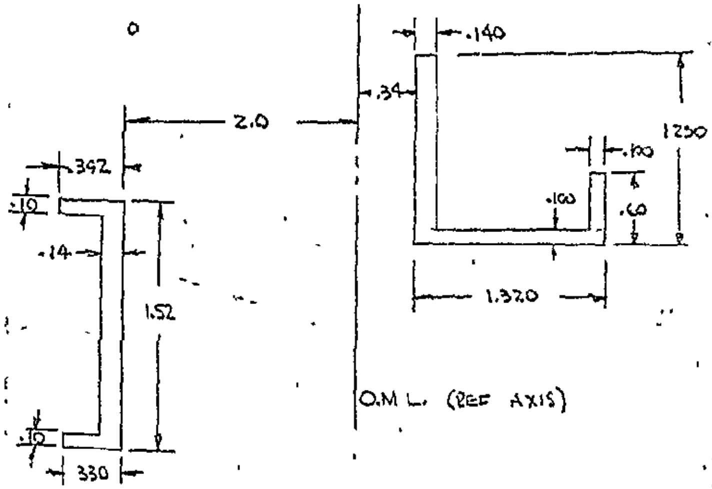
*NON-STRUCTURAL PART. NO ANALYSIS REQUIRED

739

INTRODUCTION

THE 8V24-321111 OUTER CAP AND THE 8V24-321109 INNER CAP PROVIDE CONTINUITY TO THE X_A= 585 FRAME AT THE LEM ATTACH LOCATIONS FOR THE IN-LINE CHANGE. (REF SKETCH PAGE II 2.76) THE BASIC CONFIGURATION AND LOAD PATHS ARE THE SAME AS THE MODIFICATION INSTALLATION (8V24-321504) THAT WAS ANALYZED IN SECTION VI.2.5 OF SD67-1103. THE BASIC CROSS-SECTIONS OF THE CAPS HAVE CHANGED SLIGHTLY AND THEY WILL BE ANALYZED IN THE FOLLOWING SECTION.

SECTION PROPERTIES



8V24-321109
AREA = 252 IN^2
$\bar{X}$ = 2.10 IN

8V24-321111
AREA = .343 IN^2
$\bar{X}$ = .81 IN

MATL: 6AL-4V TITANIUM STA

F_{tu} = 155000 psi

F_{ty} = 145000 psi

F_{cy} = 150000 psi

F_{bru} = 286000 psi

PREPARED BY GEP	NORTH AMERICAN AVIATION, INC. SPACE and INFORMATION SYSTEMS DIVISION	PAGE NO 4 OF 10
CHECKED BY: L	RESCUE MISSION	REPORT NO SD 70-205
DATE 10-8-69	SLA	MODEL NO SKYLAB
REF		DRWG NO 8V24-321002

LOADS

REF SD67-1103, VI.2.S.40 FOR CRITICAL LOAD CONDITIONS

+P IS TENSION

+M IS TENSION IN OUTBOARD CAP

LOAD IN OUTER CAP

$$P_o = \frac{P(.343)}{(343+.252)} + \frac{M}{(.81+2.10)}$$

$$= .576\,P + .344\,M$$

P = 9610 # LIMIT

M = 29636 IN# LIMIT

$\therefore P_o = 22022$ # ULT (TENSION)

P = -11793 # LIMIT

M = -26371 IN# LIMIT

$\therefore P_o = -22210$ # ULT (COMP)

PREPARED BY GEP	NORTH AMERICAN AVIATION INC SPACE and INFORMATION SYSTEMS DIVISION	PAGE NO 5 OF 10
CHECKED BY L	RESCUE MISSION	REPORT NO SD 70-205
DATE 10-8-69	SLA	MODEL NO SKYLAB
REF		DRWG NO 8V24-321002

LOADS

LOAD IN INNER CAP

$$P_i = \frac{(.252)P}{(343+.252)} - \frac{M}{(.81+2.10)}$$

$$= .424\,P - .344\,M$$

P = -9234 # LIMIT

M = -25092 IN# LIMIT

$\therefore P_i = 6603$ # ULT (TENSION)

P = 9610 # LIMIT

M = 29636 IN # LIMIT

$\therefore P_i = 8568$ # ULT (COMP)

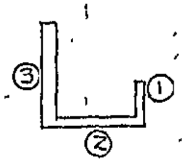
ANALYSIS

OUTER CAP

$$f_c = \frac{-22210}{.343} = -64750 \text{ psi}$$

D2
5 21(67)01

CRIPPLING ALLOWABLE



SECT	b	t	b/t	AREA	σ_{cc}	P_{cc}
1	.5	.1	5	.05	136000	6800
2	1.32	.1	13.2	.132	143000	18876
3	1.15	.14	8.2	.161	99000	15134
				.343		40810

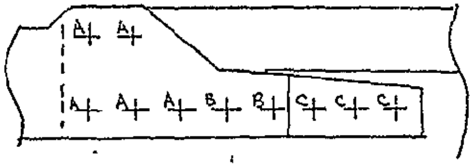
$$F_{cc} = \frac{40810}{.343} = 118980 \text{ psi}$$

$$M.S. = \frac{118980}{64750} - 1 = \underline{\underline{.84}}$$

ANALYSIS

OUTER CAP

TO ANALYSE THE FRAME SPLICE, CONSIDER ONLY THE FASTENERS BETWEEN THE 8V24-321111 CAP AND THE V24-328160 FRAME.



C1
8.1.2(a)
NAS 1400

A ~ NAS 1134C BOLT $F_{su} = 3682\#$

B ~ NAS 1399C RIVET $F_{su} = 2450\#$

C ~ NAS 1398C RIVET $F_{su} = 2330\#$

JOINT CAPABILITY

$$P = (5)(3682) + (2)(2450) + (3)(2330)$$
$$= 30300\#$$

$$M.S. = \frac{30300}{22210} - 1 = \underline{\underline{.36}}$$

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\- SLA

PAGE NO. 8 OF 10
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DRWG NO 8V24-321002

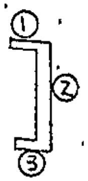
REF

ANALYSIS

INNER CAP

$$f_c = \frac{-8568}{.252} = -34000 \text{ psi}$$

CRIPPLING ALLOWABLE



SECT	b	t	b/t	σ_{cc}
1	.342	.1	3.4	143000
2	1.32	.14	9.4	143000
3	.330	.1	3.3	143000

$$\therefore F_{cc} = 143000 \text{ psi}$$

$$M.S. = \frac{143000}{34000} - 1 = \underline{\underline{3.21}}$$

FORM 604-D NEW 2-64

PREPARED BY GEP
CHECKED BY L
DATE 10-8-69

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PAGE NO. 9 OF 10
REPORT NO. SD 70-205
MODEL NO. SKYLAB
DRWG NO 8V24-321002

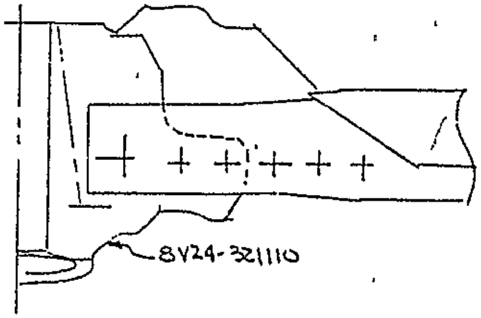
REF

ANALYSIS

INNER CAP

THIS CAP DOES NOT FORM A CONTINUOUS SPLICE ACROSS THE LEM ATTACH AREA. THE LOAD IS TRANSFERED THRU THE 8V24-321110 FITTING TO OBTAIN CONTINUITY.

THE MAXIMUM LOAD OF 8568# IS TRANSFERED FROM THE 8V24-321110 FITTING INTO THE 8V24-321109 CAP THRU 2 NAS 1134C AND 4 LHS13CC BOLTS.



C1 8 1.2 (a)

$$P = (2)(3682) + 8280 = 15644\#$$

$$M.S. = \frac{15644}{8568} - 1 = \underline{\underline{.83}}$$

FORM 604-D NEW 2-64

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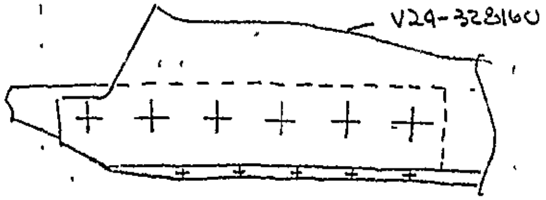
CHECKED BY: L	RESCUE MISSION	REPORT NO. SD 70-205
DATE: 10-8-69	SLA	MODEL NO. SKYLAB
		DRWG NO 8V24-321002

REF

ANALYSIS

INNER CAP

THE LOAD IS TRANSFERED FROM THE 8V24-321109 CAP INTO THE V24-328160 LEM FRAME THRU 6 NAS 1134C BOLTS IN .10 7075-T6 AND 5 NAS 1134C BOLTS IN .17 7075-T6.



C1

F_{bru} FOR 7075-T6 = 125000 psi

FASTENERS BEARING CRITICAL IN -10 7075-T6

$P_B = (125000)(.1)(.25) = 3125^{\#}$

$P_B = 3682^{\#}$

JOINT CAPABILITY

$= (6)(3125) + (5)(3682) = 37160^{\#}$

$$M.S. = \frac{37160}{8568} - 1 = \underline{3.34}$$

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CHECKED BY: G F	RESCUE MISSION	REPORT NO SD 70-205
DATE: 10/17/72	SLA	MODEL NO SKYLAB
		DWG. NO 8V24-321003

REF

N/A

8V24-321 002

PANEL - QUARTER, AFT SECTION, SLA, ASSY OF

THIS PANEL REPLACES V24-328103, USED ON S/C 114. THE FOLLOWING LISTING GIVES THE DRAWING DIFFERENCES –

S/C 116		S/C 114
V24-328022-11	DOOR	BSC
V24-328023-11	DOOR	BSC
V24-328107-5	SKIN	-3
V24-328111-3	SKIN	BSC
V24-328152-3	SKIN	BSC & -3
V24-328153-3	SKIN	BSC & -3
8V24-321105	FITTING	
8V24-321106	SPACER	
8V24-321107	FITTING	
8V24-321108	BEAM	

THE DASH NO DETAIL PARTS ARE COMPATIBLE BETWEEN S/C 114 AND S/C 117.

SEE DETAIL DRAWINGS FOR DEFINITION OF CHANGES.

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DATE 7-22-69

NORTH AMERICAN AVIATION, INC.
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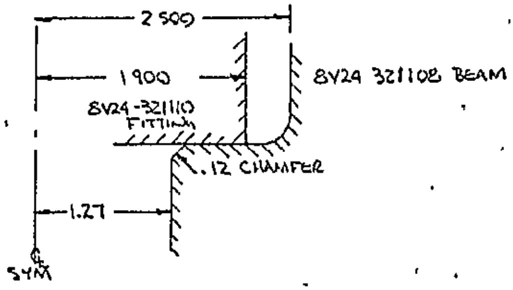
PAGE NO. 2 OF 12
REPORT NO SD 70-20
MODEL NO SKYLAB
DRWG NO 8V24-321003

REF

ANALYSIS

Pg II.28.9 END BOOST CONDITION 22255 IS THE CRITICAL CONDITION. THE 92860# LOAD IS TRANSFERRED FROM THE 8V24-321110 FITTING (6AL-4V TITANIUM) INTO THE 8V24-321108 BEAM (7075-T6511) THROUGH BEARING. THE BEARING CONTACT BETWEEN THESE PARTS IS INSURED BY LOADING THE 8V24-321110 FITTING TO 500 ± 40 lbs BEFORE DRILLING AND REAMING THE .3750 ± .0005 HOLES THAT ARE COMMON TO THE FITTING AND THE BEAM.



BEARING WIDTH = 1.900 - 1.27 - .12 = .51 IN
BEARING LENGTH = 1.18 - .21 = .97 IN (FROM DRAWINGS)

BEARING AREA = (.51)(.97) = .495 IN² / SIDE

II.289 $f_{bru} = \frac{92860}{(495)(2)} = 93800$ psi

MIL-HDBK-5 Pg 3.2.7.0(A) F_{bru} OF 7075-T6511 = 130000 psi

$M.S. = \frac{130000}{93800} - 1 =$ .39

750

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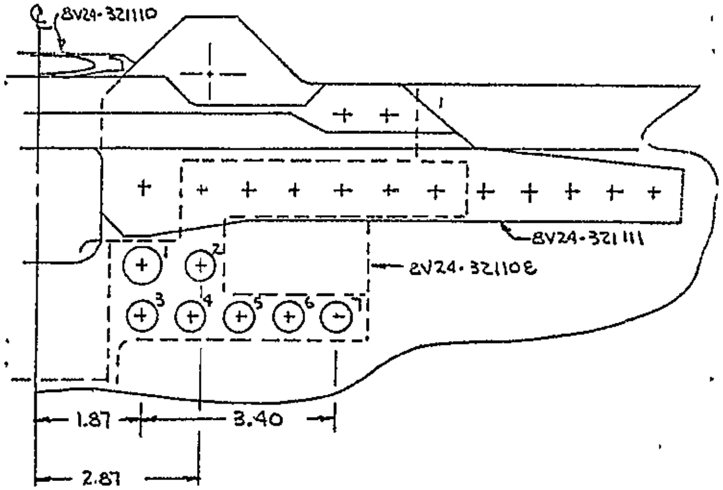
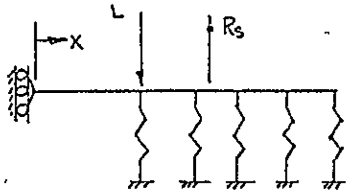
PAGE NO 3 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO 8V24-321003

REF

ANALYSIS

THE LOADS ARE TRANSFERRED FROM THE 8V24-321108 BEAM INTO THE AFT QUARTER PANEL STRUCTURE THROUGH THE FASTENERS. A MATHEMATICAL MODEL OF THE BEAM IS DEVELOPED AND USED WITH THE STIFFNESS MATRIX COMPUTER PROGRAM TO DETERMINE THE INTERACTION BETWEEN THE BEAM AND THE SHELL. THE SHELL IS REPRESENTED AS AN ELASTIC FOUNDATION.





SHELL SPRING CONSTANT

$K = \frac{Et}{L} = \frac{(10.3 \times 10^6)(.25)}{8}$

$= 322000$ #/in²/in

751

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CHECKED BY GF
DATE 7-25-69

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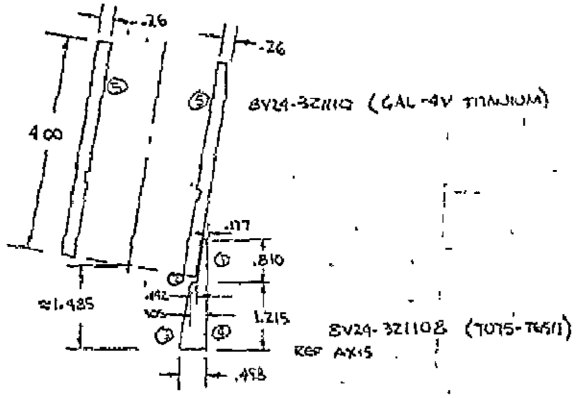
PAGE NO. 4 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO 8V24-321003

REF.

ANALYSIS

SECTION PROPERTIES AT X=0 (℄ OF LEM ATTACH)



TO DETERMINE THE SECTION PROPERTIES OF THIS SECTION, THE TITANIUM WILL BE CONVERTED TO AN EQUIVALENT ALUMINUM SECTION.

$$t_e = \frac{E_T}{E_A} t$$

MIL HDBK-5
5.4.4.1(b)
3.2.7.0(f)

$$E_T = 16 \times 10^6 \text{ psi}$$

$$E_A = 10.3 \times 10^6 \text{ psi}$$

$$t_e = \frac{16 \times 10^6}{10.3 \times 10^6}(.26) = .40$$

PREPARED BY. GFP
CHECKED BY ✓
DATE. 7-25-69

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SLA

PAGE NO 5 OF 12
REPORT NO SD 70-205
MODEL NO. SKYLAB
DRWG NO 8V24-321003

REF

ANALYSIS

SECTION PROPERTIES AT X=0

SECTION	AREA		Y	AY	AY^2	I_o
1	(.177)(.81) =	.1434	1.62	.2323	3763	0078
2	$\frac{1}{2}$(.163)(.81) =	.0660	1.485	0980	.1456	0026
3	$\frac{1}{2}$(1.215)(.193) =	.1172	.405	0475	0192	.0152
4	(1.215)(.305) =	.3706	.608	2253	1370	.0456
5	(4.00)(.80) =	3.2000	3.485	11 1520	38 8647	4.2666
Σ		3.8972		11.7551	39.5428	4 3378

$$\bar{Y} = \frac{\Sigma AY}{\Sigma A} = \frac{11.7551}{3.8972} = 3.0162 \text{ in}$$

$$I_{NA} = \Sigma I_o + \Sigma AY^2 - \bar{Y}\,\Sigma AY$$

$$= 4\,3378 + 39\,5428 - (3.0162)(11\,7551) = 8.4249 \text{ in}^4$$

PREPARED BY GFP
CHECKED BY L
DATE 7-25-69

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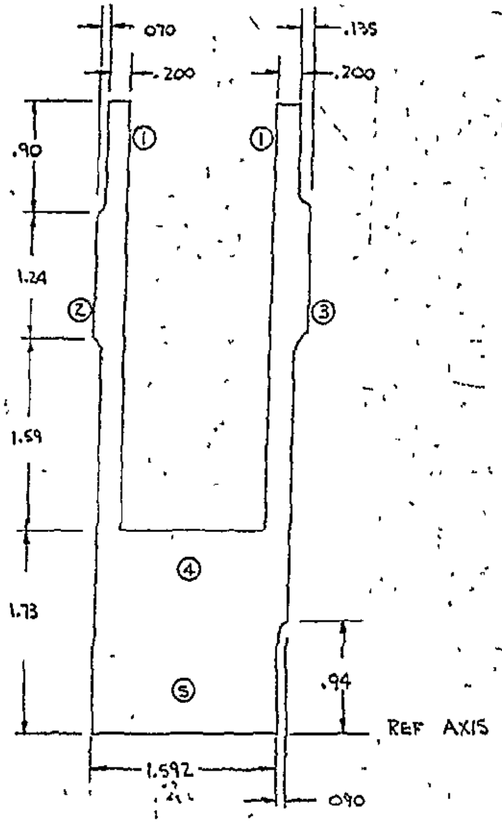
RESCUE MISSION
SLA

PAGE NO 6 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO 8V24-321003

REF

ANALYSIS

SECTION PROPERTIES AT X= 230"



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RESCUE MISSION
SLA

PAGE NO 7 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DRAG NO 8V24-321003

REF.

ANALYSIS

SECTION PROPERTIES AT X: 230

SECTION	AREA		Y	AY	AY^2	I_o
1	(3 73)(20)(2)=	1 4920	3 595	5 3637	19.2826	1 7298
2	(07)(1.24) =	0868	3 940	.3420	1 3474	.0111
3	(.135)(1.24) =	.1674	3 940	6596	2 5987	.0214
4	(.79)(1.682)=	1 3288	1.335	1.7739	2 3682	0691
5	(.94)(1 592)=	1.4965	.470	.7033	3306	.1102
Σ	0	4.5715		8.8425	25.9275	1 9416

$$\bar{Y} = \frac{\Sigma AY}{\Sigma A} = \frac{8\ 8425}{4.5715} = 1.9343 \text{ IN}$$

CG 3 5757

$$I_{NA} = \Sigma I_o + \Sigma AY^2 - \bar{Y}\, \Sigma AY$$

$$= 1.9416 + 25.9275 - (1.9343)(8.8425)$$

$$= 10.7651 \text{ IN}^4$$

PREPARED BY GFP
CHECKED BY
DATE 7-30-69

NORTH AMERICAN AVIATION, INC
SPACE and INFORMATION SYSTEMS DIVISION

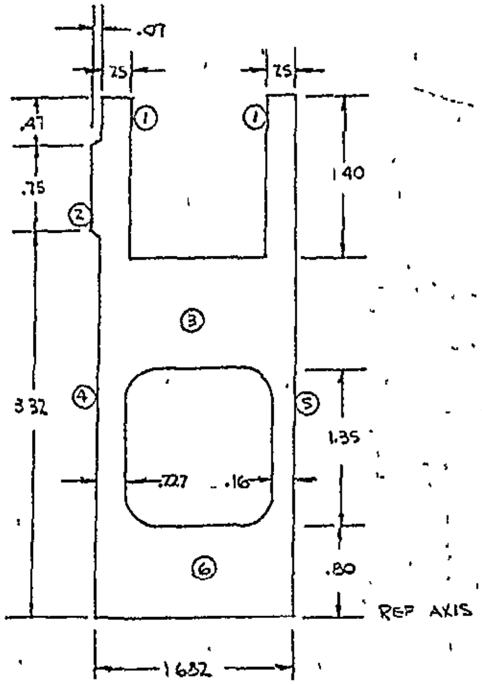
RESCUE MISSION
SLA

PAGE NO 8 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO 8V24-321003

REF

ANALYSIS

SECTION PROPERTIES AT X = 4.15



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RESCUE MISSION
SLA

PAGE NO 9 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO 8V24-321003

REF

ANALYSIS

SECTION PROPERTIES, AT X = 4.15

SECTION	AREA		Y	AY	AY^2	I_o
1	(1.40)(.50) =	.7000	3.84	2.6820	10.3219	.1143
2	(.75)(.07) =	.0525	3.695	.1940	.7168	.0025
3	(.99)(1.682) =	1.6652	2.645	4.4044	11.6496	.1360
4	(1.35)(.222) =	.2997	1.475	.4421	.6520	.0455
5	(1.35)(.16) =	.2160	1.475	.3186	.4699	.0328
6	(.80)(1.682) =	1.3456	.40	.5382	.2153	.0718
	Σ	4.279		8.5853	24.0255	.4029

$$\bar{Y} = \frac{\Sigma AY}{\Sigma A} = \frac{8.5853}{4.279} = 2.0064 \text{ IN}$$

$$I_{NA} = \Sigma I_o + \Sigma AY^2 - \bar{Y}\,\Sigma AY$$

$$= .4029 + 24.0255 - (2.0064)(8.5853)$$

$$= 7.2029 \text{ IN}^4$$

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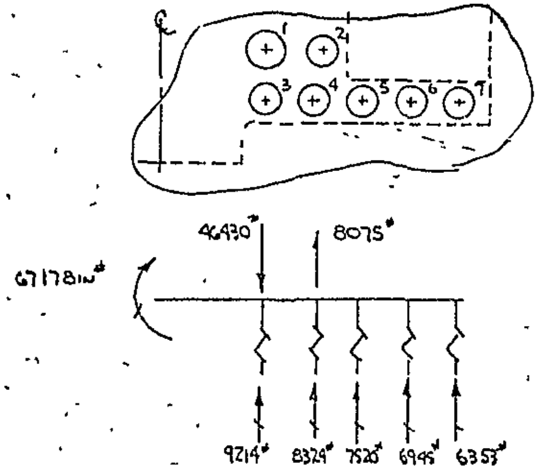
SLA

PAGE NO 10 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DRWG NO 8V24-321003

ANALYSIS

USING THE SECTION PROPERTIES CALCULATED ON THE PREVIOUS PAGES, THE MODEL SHOWN ON PAGE 3 AND THE END BOOST LOADS SHOWN ON PAGE 2, THE LOAD DISTRIBUTION IS AS SHOWN BELOW.



MC-YDK-S
8.12.1(a)
3.2.3.0(d)

FASTENER 1 ~ NAS 1135C
$F_{su} = 6980$#
F_{bru} IN .125 2024-T81
$= (.125)(.3125)(127000) = 4953$#

FASTENERS 2 THRU 7 ~ NAS 1134C
$F_{su} = 4470$#
F_{bru} IN .125 2024-T81
$= (.125)(.25)(127000) = 3962$#

FORM 994-B NEW 2-64

FORM T994 B REV 3-68

PREPARED BY: GFP
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DATE: 7-30-69

TULSA DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 11 OF 12
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO 8V24-321003

ANALYSIS

ASSUME 50% OF THE LOAD IS CARRIED BY THE OUTER FACE SHEET AND 50% BY THE INNER FACE SHEET.

FASTENER	TOTAL LOAD	LOAD/FACE SH	ALLOWABLE	M.S.
1	4607	2304	4953	1.15
2	4162	2081	3962	.90
3	4607	2304	3962	.72
4	4162	2081	3962	.90
5	7520	3760	3962	05
6	6945	3473	3962	.14
7	6353	3177	3962	.25

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TULSA DIVISION
NORTH AMERICAN ROCKWELL CORPORATION
RESCUE MISSION
SLA

PAGE NO 12 OF 12
REPORT NO SD 70-203
MODEL NO SKYLAB
DWG NO 8V24-321003

REF

ANALYSIS

THE 67178 IN# MOMENT AT THE ℄ IS ACTING ON THE SECTION, AT X=0 (PAGE 3).

TENSION IN THE 8V24-321108 AL BEAM

$$f_t = \frac{(67178)(3\ 0162)}{8.4249} = 24050$$

MIL-HDBK-5 3.27.0(f)

$$F_{tu} = 78000 \text{ psi}$$

$$M.S. = \frac{78000}{24050} - 1 = \quad \underline{\underline{2.24}}$$

COMPRESSION IN THE 8V24-321110 TITANIUM FITTING

$$f_c = \frac{(67178)(5\ 485-3.0162)}{8.4249} = 19686 \text{ psi}$$

THIS IS THE STRESS BASED ON AN ALUMINUM CROSS-SECTION

$$f_{TITANIUM} = \frac{E_T}{E_a} f_c$$

$$= \frac{16}{10.3}(19686) = 30580 \text{ psi}$$

MB 0170-033

F_c IS NOT GIVEN IN THE SPEC. USE F_{cy} FOR A SECTION THICKNESS OF 3 - 6 IN

$$\therefore F_c = 130000 \text{ psi}$$

$$N.S. = \frac{130000}{30580} - 1 = \quad \underline{\underline{\text{HIGH}}}$$

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DATE: 10/13/72

SPACE DIVISION
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SLA

PAGE NO. 1 OF 1
REPORT NO SD 70-203
MODEL NO SKYLAB
DWG NO 8V24-321104

REF
N/A
8V24321
002

BRACKET - THRUSTER SUPPORT, LM JETTISON, ASSY OF

NO STRUCTURAL CHNGS — N/A CHANGE ONLY

NO FURTHER ANALYSIS REQUIRED

PREPARED BY: [illegible]
CHECKED BY: G F
DATE: 9/11/72

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RESCUE MISSION
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PAGE NO. 1 OF 1
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO 8V24-323002.

REF.
N/A
8V24-320
003

SUPPORT INSTALLATION - ELECTRICAL, SLA 16 + SUBS

NO STRUCTURAL DIFFERENCES

NO FURTHER ANALYSIS REQUIRED.

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RESCUE MISSION
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PAGE NO. OF
REPORT NO SD 70-205
MODEL NO SKYLAB
DWG NO 2V5E 008002

REF

GENERAL ASSY - SLA

THE FOLLOWING DRAWINGS CONSTITUTE THE CONFIGURATION OF S/C 114 (SLA 21) AND S/C 117 (SLA 23) FOR COMPARISON:

S/C 114		S/C 117
V24-328002-811	ADAP. ASSY	8V24-320003-11
V24-008004-11	MARKINGS	* V24-008004-21
8V24-790343-11	WIRE INST	* 8V24-790343-21
V24-590001	SEP. SYST	V24-590001-11

SEE INDIVIDUAL S/C 117 DRAWING PAGES FOR REVIEW OF DIFFERENCES.

* NON-STRUCTURAL DRAWING. NO ANALYSIS REQUIRED