N84-29244

LMSC-HREC TR D951498

SPARTAN RELEASE ENGAGEMENT MECHANISM (REM) STRESS AND FRACTURE ANALYSIS

19 June 1984

Contract NAS8-35599

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER, AL 35812

by

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FOREWORD

This report presents a summary of the results of work performed by the Lockheed Missiles & Space Company, Inc., Huntsville Research & Engineering Center under Contract NAS8-35599 for the NASA-Marshall Space Flight Center, Huntsville, Alabama. The NASA-MSFC Contracting Officer's Representative for the study is N.C. Schlemmer, EP46.

INTRODUCTION

This document contains the revised stress and fracture analysis of the Spartan REM hardware for current load conditions and mass properties. The Spartan REM structure is shown in Fig. 1. Figure 2 depicts a detail of the latching mechanism.

The stress analysis was performed using a NASTRAN math model of the Spartan REM adapter, base, and payload. Appendix A contains the material properties, loads, and stress analysis of the hardware. The computer output and model description are in Appendix B.

Factors of safety used in the stress analysis were 1.4 on tested items and 2.0 on all other items.

Fracture analysis of the items considered fracture critical was accomplished using the MSFC Crack Growth Analysis code. Loads and stresses were obtained from the stress analysis. The fracture analysis notes are located in Appendix A and the computer output in Appendix B.

All items analyzed met design and fracture criteria.

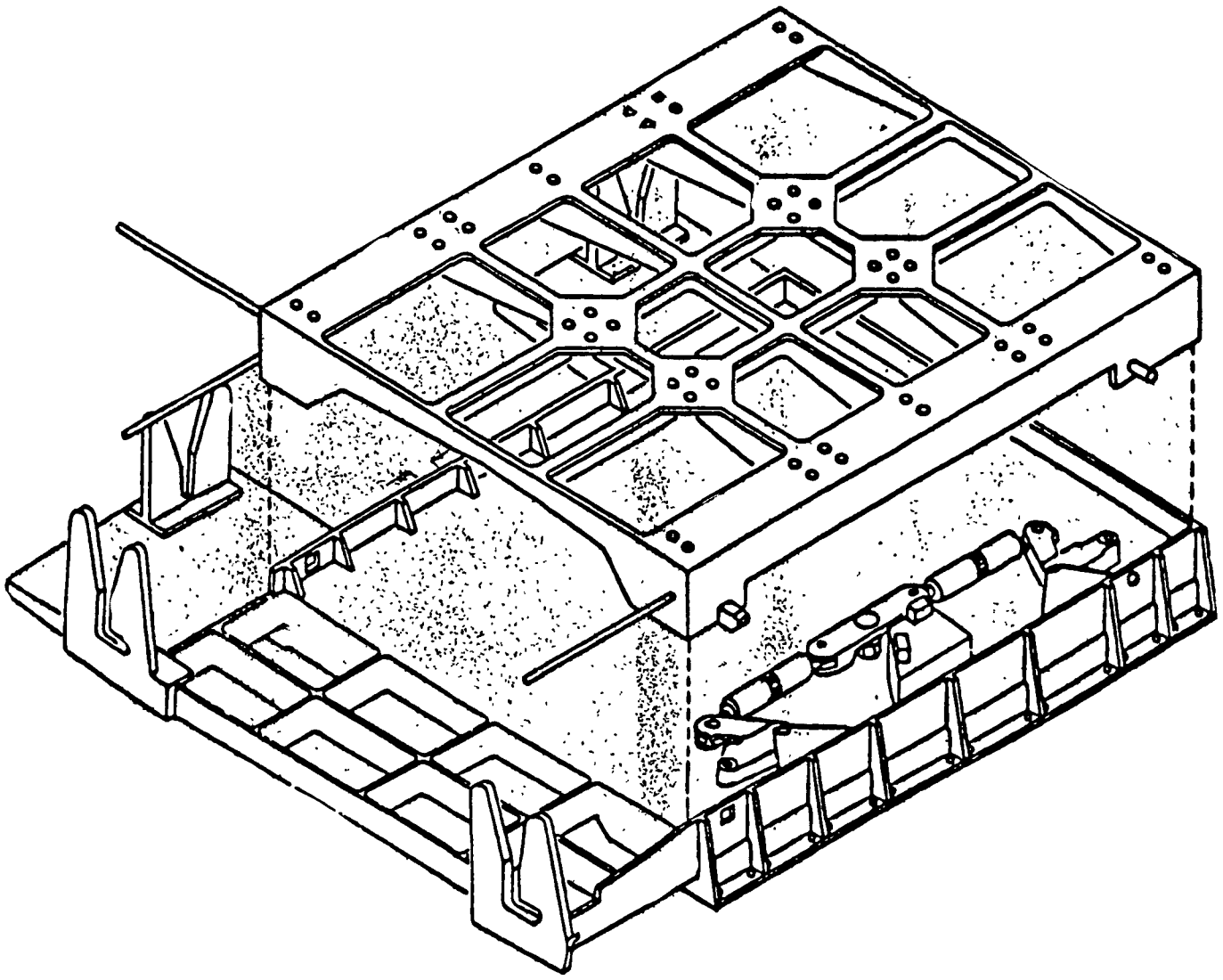

Fig. 1 Spartan REM

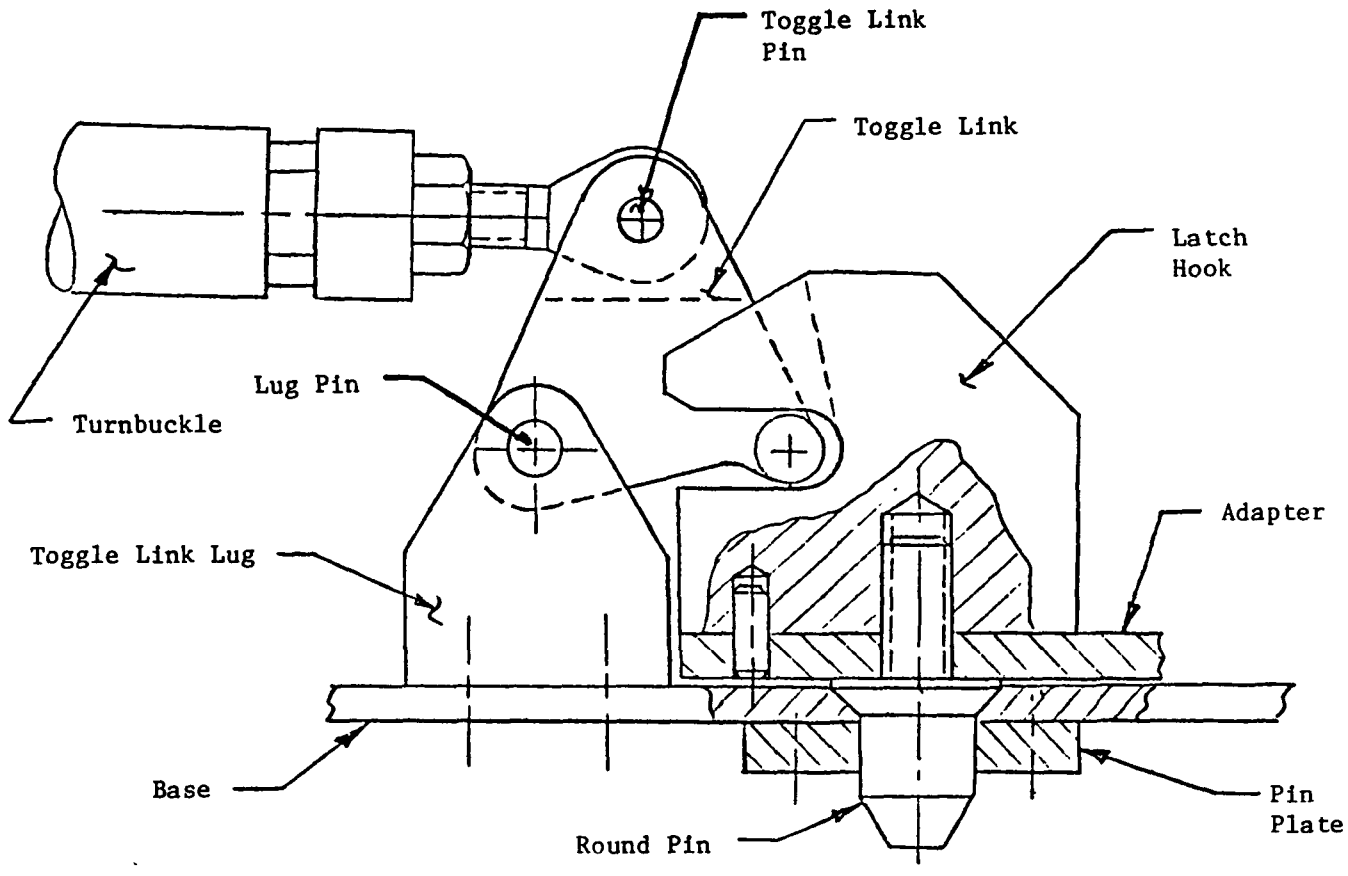

Fig. 2 Latching Mechanism

SPARTAN REM MARGIN SUMMARY

Item	Load Case	M.S.	Page	Comment
Toggle Link (30A60695)	4.3/-2.0/7.1	3.21	4.12	Transverse Load on Lug (Turnbuckle Connection
		1.95	4.14.1	Shear on Latching Post
		5.9	4.15.1	Transverse Load on Lug (Support)
Toggle Link Lug (30A60694)	4.3/-2.0/7.1	2.51	4.4.0	Transverse Load on Lug
		0.38	4.5.1	Bending
Mounting Bolt	4.3/-2.0/7.1	0.71	4.9.0	Interaction
Lug Pin (30A60698)	4.3/-2.0/7.1	2.39	4.12	Shear
		1.08	4.15.2	Bending
Toggle Link Pin (30A60700)	4.3/-2.0/7.1	1.22	4.13	Shear
		0.53	4.14.0	Bending
Turnbuckle (30A60699)	4.3/-2.0/7.1	1.81	4.16	Bearing
		2.15	4.17	Tension on Threads
Bellcrank (30A60696)	Torque 1521 in.-lb	0.6	4.18	Shear on Spline
		0.42	4.20	Limit Torque on Shaft
		0.88	4.20	Torsion on Shaft
		0.09	4.21	Compressive Stress on Spline
		3.3	4.23	Lug Tension
Round Pin (30A60642)	4.3/-2.0/7.1	0.78	4.24	Shank Shear
Square Pin 30A60643	4.3/-2.0/7.1	0.78	4.24	Shank Shear
Round Pin Plate (30A60645)	4.3/-2.0/7.1	0.8	4.30	Shear Tear Out
		1.25	4.31	Shear
		1.92	4.32	Bearing
Mounting Bolts NAS1960C	4.3/-2.0/7.1	1.30	4.30	Bolt Shear
Square Pin Plate (30A60644)	4.3/-2.0/7.1	1.81	4.32	Shear Tear Out
		0.37	4.33	Bending

SPARTAN REM MARGIN SUMMARY (Concluded)

Item	Load Case	M.S.	Page	Comment
Rod Holder Screws (30A60647)	Max Rod Load 1560/1b	0.39	4.36	Interaction
30A60648	Double Strike	0.33	4.38	Shear
Base Mounting Bolts	4.3/-2.0/7.1	0.96	4.39	Interaction
Base/PDM Bolts	4.3/-2.0/7.1	0.63	4.40	Interaction
Nuts		0.60	4.40	Tension
Adapter	4.3/-2.0/7.1	2.15	4.45	Tension
Base	4.3/-2.0/7.1	1.29	4.45	Tension
Adapter/Pin Interface	4.3/-2.0/7.1	0.798	4.25	Shear Tear Out
Pin Bearing on Conical Start	4.3/-2.0/7.1	Large	4.27.1	
Hole to be Drilled in Adapter	4.3/-2.0/7.1	7.28	4.49	Tension
Locator Rod 30A60649	1560 1b	0.015	4.38.1	Plastic Bending

REM FRACTURE CONTROL SUMMARY

DRAWING NO.	DESCRIPTION	MATL	CLASSIFICATION		RATIONALE	PFC CAT.		CRITICAL CRACK SIZE (IN)	INSPECTION	
			EXP	PFC		NFC	FC		LIMIT (IN)	TYPE
30A60641	ADAPTER	2219-T87AL		X	REDUNDANT LOAD PATH	X				DP
30A60681	BASE	2219-T87AL	X		REDUNTANT LOAD PATH					
30A60697	BELCRANK SHAFT	A286 CRES		X	LOW STRESSES	X				ET
30A60696	BELCRANK	4340 STL		X			X	.415	.25	MP
30A60699	TURNBUCKLE	4340 STL		X	ACT ONLY 5% OF PRELOAD	X				
30A60695	TOGGLE LINK	4340 STL		X			X	.23	.05	ET
30A60700	TOGGLE LINK PIN	INCONEL 718		X			X	.104	.1	ET
30A60694	TOGGLE LINK LUG	INCONEL 718		X			X	.165	.05	ET
30A60698	LUG PIN	INCONEL 718		X			X	.146	.10	ET
30A60690	LATCH HOOK	INCONEL 718		X	LOW COMPRESSIVE LOAD	X				
30A60642	ROUND PIN	INCONEL 718		X			X	—*	.1	ET
30A60645	ROUND PIN PLATE	INCONEL 718		X			X	1.065	.05	ET
30A60643	SQUARE PIN	INCONEL 718		X			X	—*	.1	ET
30A60644	SQUARE PIN PLATE	INCONEL 718		X			X	.98	.05	ET
NAS1960O	MOUNTING BOLTS	A286 CRES	X		REDUNDANT LOAD PATH					
30A60702	LINK HOUSING	4340 STL		X	LOAD STRESSES	X				
30A60703	LINK ROD	4340 STL		X	↓	X				
30A60647	ROD HOLDER - 1 & 4	2219-T87AL		X	LOW STRESS	X		—*	—	NONE
30A60648	ROD HOLDER - 2 & 3	2219-T87AL		X	LOW STRESS	X		—*	—	NONE
30A60649	LOCATOR ROD	2219-T87AL		X	LOW STRESS	X		.18	.10	ET
30A60684	AFT GUIDE - 1	2219-T87AL	X		LOW COMPRESSIVE LOADS					
30A60685	AFT GUIDE - 2	2219-T87AL	X		↓					
30A60686	POST GUIDE - 3	2219-T87AL	X							
30A60687	POST GUIDE - 4	2219-T87AL	X							
30A60701	GUIDE BAR	2219-T87AL	X		↓					
NAS1955C	PLATE BOLTS	A286 CRES	X		REDUNDANT LOAD PATH					
NAS1955C	GUIDE HOLDER BOLT	A286 CRES	X		LOW COMPRESSIVE LOADS					

*NO CRACK GROWTH; ET - Eddy Current; MP - Magnetic Particle.

REM FRACTURE CONTROL SUMMARY (Concluded)

DRAWING NO.	DESCRIPTION	MATL	CLASSIFICATION		RATIONALE	PFC CAT		CRITICAL CRACK SIZE (IN)	INSPECTION	
			EXP	PFC		NFC	FC		LIMIT (IN)	TYPE
30A60682	SHELF - POS. 3	2219-T87 AL	X		LOW COMPRESSIVE LOADS					
30A60683	SHELF - POS. 4	2219-T87 AL	X							
NAS1955C	SHELF BOLTS	A286 CRES	X							
30A60021	PIN - WORM	MP35N STL		X		X		.09	.1	ET
30A60043	PIN - WORM GEAR	MP35N STL		X		X		.106	.1	ET
30A60099	WORM GEAR	416 CRES		X			X	.1	.1	ET
30A60100	WORM	416 CRES		X		X		- *	-	-
30A60102	WORM SHAFT	416 CRES		X		X		.125	.1	ET

*NOT DONE.