LMSC-HREC PR D951498-A

NASA-CR-171092

MATERIAL PROPERTIES, LOADS, AND STRESS ANALYSIS - SPARTAN REM

Appendix A

19 June 1984

Contract NAS8-35599

Prepared for

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

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(NASA-CR-171092) MATERIALS PROPERTIES, LOADS, AND STRESS ANALYSIS, SPARTAN REM: APPENDIX A (Lockheed Missiles and Space Co.) 124 p HC A06/MF A01 CSCL 20K

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COLOR PHOTOGRAPH

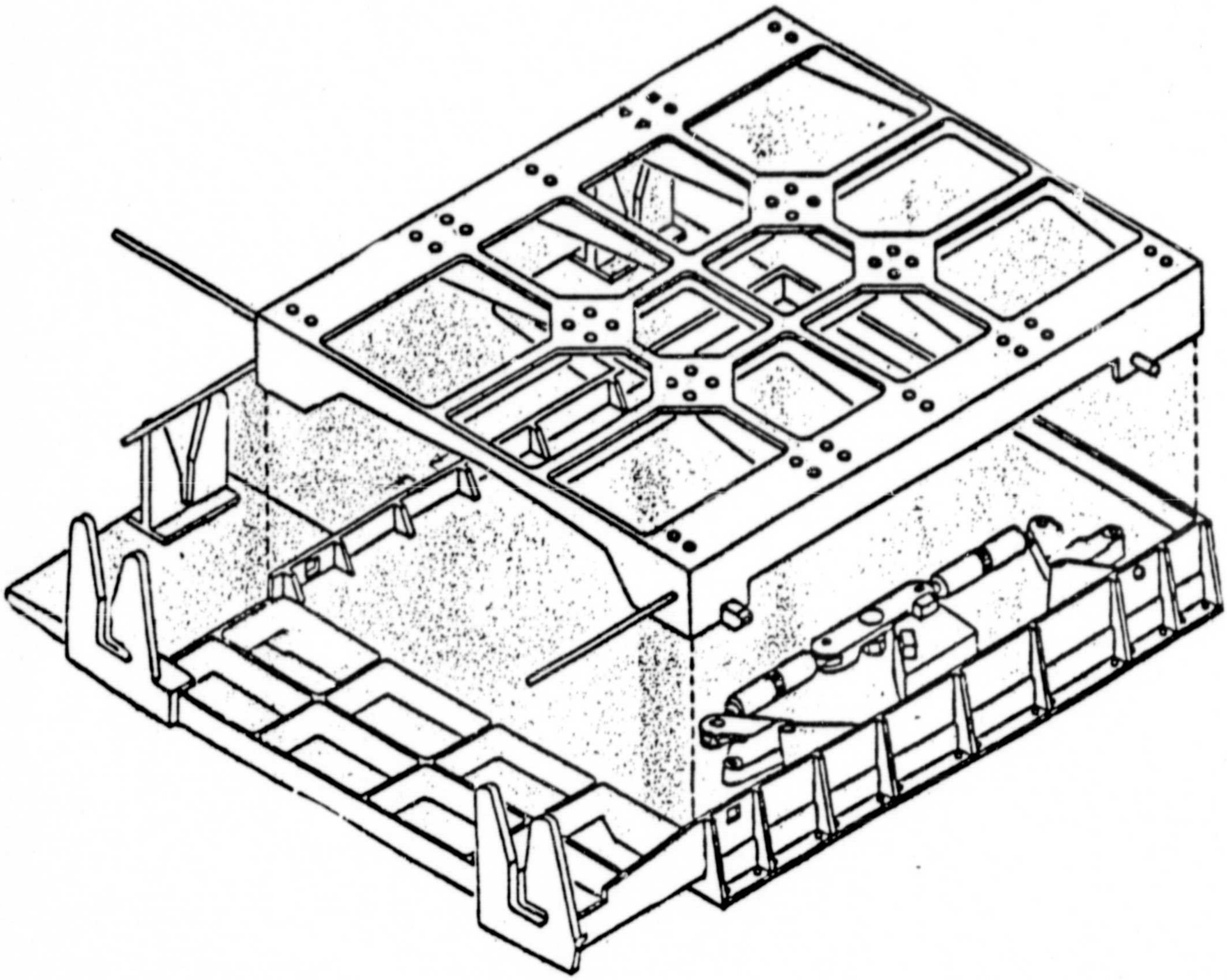

Fig. A-1 Spartan REM

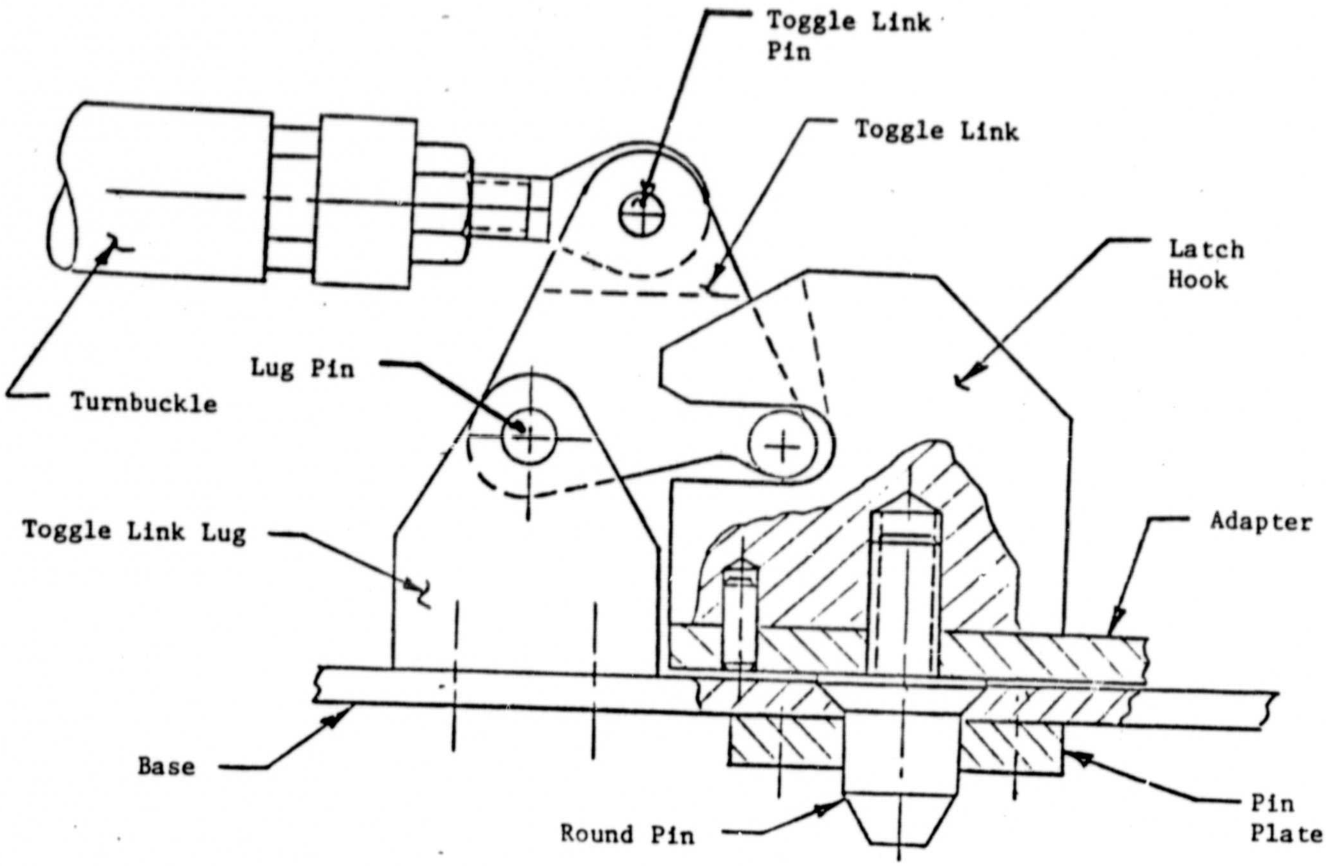

Fig. A-2 Latching Mechanism

LOADS

Prepared by: DSM	Date 6/84	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page Temp. Perm. 2.1 (2.2)
Checked by:	Date	Title SPARTAN REM	Model
Approved by:	Date		Report No.

LOADS (REF ED23-84-24 FEB 16, 1984)

LOW FREQUENCY ACCELERATIONS

$\ddot{X}$	$\ddot{Y}$	$\ddot{Z}$
± 4.3	± 2.0	+7.1/-3.8

LOAD COMBINATIONS

CASE	$\ddot{X}$	$\ddot{Y}$	$\ddot{Z}$
1	4.3	2.0	7.1
2	-4.3	2.0	7.1
3	4.3	-2.0	7.1
4	-4.3	-2.0	7.1
5	4.3	2.0	-3.8
6	-4.3	2.0	-3.8
7	4.3	-2.0	-3.8
8	-4.3	-2.0	-3.8

FORM LMSC 362 B-3

R. HURFORD (MSFC)

4/9/84

SPARTAN REM

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WEIGHT:

ADAPTER = 167 LB
BASE ASSY. = 420 LB

TOTAL 587 LB

CALCULATED CYCLES

BERTHING LOAD 4000 IN-LB TORQUE

LIMIT CYCLES = 100
LIFE FACTOR = 4
TOTAL REQUIRED DESIGN CYCLE LIFE =
100 X 4 = 400 CYCLES

MAJOR FLIGHT LOADING CYCLE LIFE

TIME = 50 SEC. + 20 SEC./MISSION
FOUR MISSION DESIGN TIME = 50 + 80 SEC. = 130 SEC.
LIFE FACTOR = 4
USE 50 Hz = NATURAL FREQUENCY

TOTAL REQUIRED DESIGN CYCLE LIFE
130 X 4 X 50 = 26,000 CYCLES

SPARTEN REM MASS PROPERTIES

(P R E L I M I N A R Y)

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FIGURF 1
MASS PROPERTIES COORDINATE SYSTEM
(BASE)

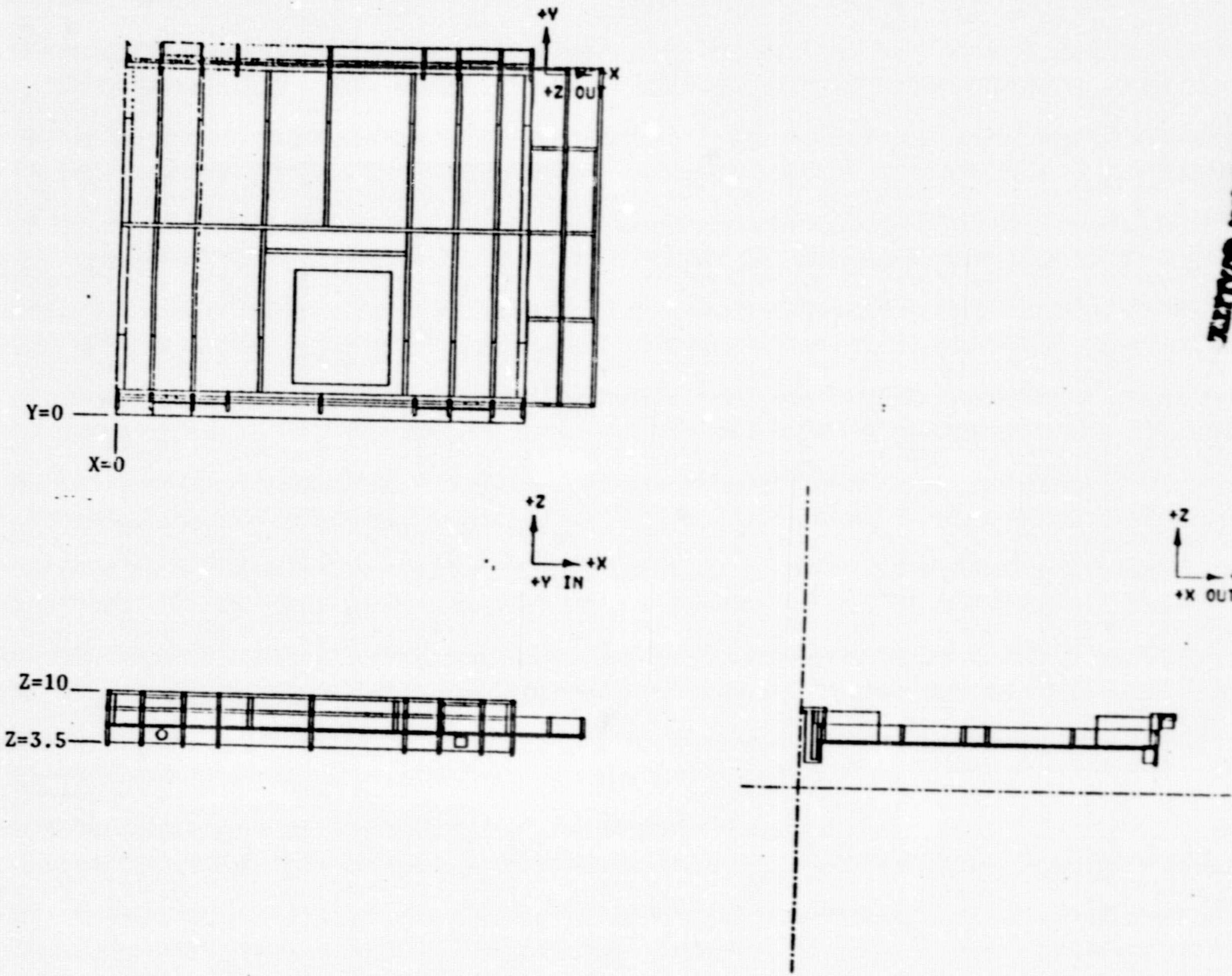
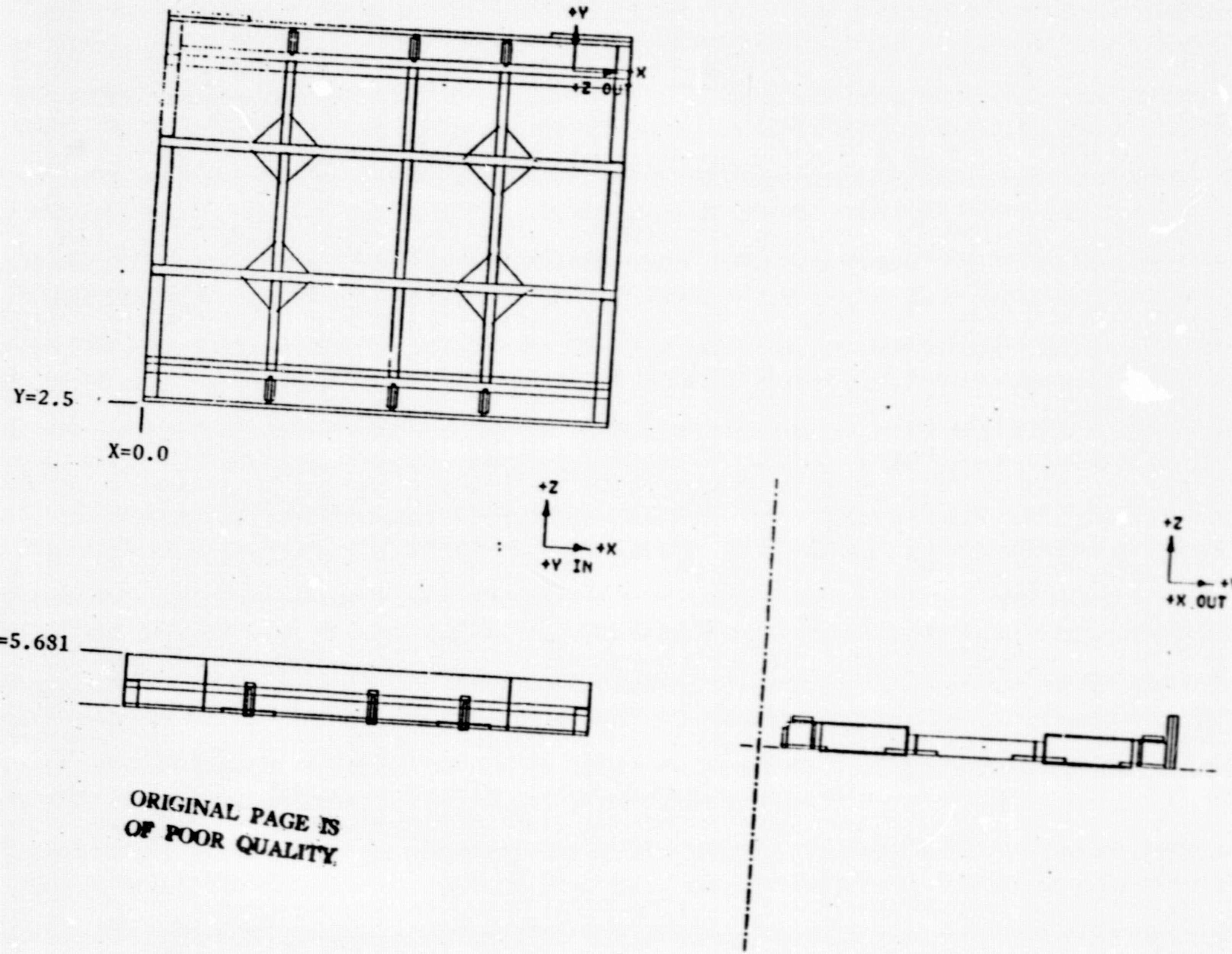


FIGURE 2
MASS PROPERTIES COORDINATE SYSTEM
(ADAPTER)



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BASE SUBASSEMBLY (30A60680-1) 9114 SEP 7, 1983

					WEIGHT POUNDS	X STATION-INCHES	Y	Z	IX POUND-INCHES-SQUARED	IY	IZ
10[illegible]	BASE		30A60681-1	CR	224.50	30.32	23.19	6.98	58415.6	81664.5	139216.7
2607	LINK HOUSING		30A60702-1	CR	5.99	16.29	8.38	4.16	3.2	54.9	55.7
2608	LINK ROD		30A60703-1	CR	0.92	13.09	8.00	4.16	0.2	1.5	1.5
2609	ROD END		SURMLH-7	A	0.30	10.66	7.71	4.16	0.0	0.2	0.2
2610	ROD END		SURM-7	A	0.30	22.03	9.07	4.40	0.0	0.2	0.2
2611	NUT 9/16-18 LH		AN316C-9L	CR	0.17	10.85	7.73	4.40	0.0	0.0	0.0
2612	NUT 9/16-18 RH		AN316C-9R	CR	0.17	21.78	9.04	4.40	0.0	0.0	0.0
2613	THREADED PIN	3	30A60711-1	CR	0.37	12.63	7.94	4.40	0.1	0.0	0.0
2614	SPRING BELLVILLE	15	R1250-0895	A	1.25	13.94	8.10	4.40	0.3	0.4	0.4
2615	LINK HOUSING		30A60702-1	CR	5.99	34.57	7.49	4.40	2.4	55.7	55.7
2616	LINK ROD		30A60703-1	CR	0.92	31.34	7.49	4.40	0.2	1.5	1.5
2617	ROD END		SURMLH-7	A	0.30	28.89	7.49	4.40	0.0	0.2	0.2
2618	ROD END		SURM-7	A	0.30	40.34	7.49	4.40	0.0	0.2	0.2
2619	NUT 9/16-18 LH		AN316C-9L	CR	0.17	29.08	7.49	4.40	0.0	0.0	0.0
2620	NUT 9/16-18 RH		AN316C-9R	CR	0.17	40.09	7.49	4.40	0.0	0.0	0.2
2621	THREADED PIN	3	30A60711-1	CR	0.37	30.8[illegible]	7.49	4.40	0.1	0.0	0.2
2622	SPRING BELLVILLE	15	R1250-0895	A	1.25	32.[illegible]	7.49	4.40	0.3	0.4	0.4
2623	BELLCRANK		30A60696-1	CR	1.85	25.30	8.20	4.40	1.5	7.1	7.9
2624	LATCH LINK		30A60695-3	CR	1.79	10.19	[illegible].41	4.38	1.4	1.6	2.2
2625	LATCH LINK SUPPORT		30A60694-1	CR	1.22	11.00	4.71	4.38	1.3	1.2	1.8
2626	LATCH LINK SUPPORT		30A60694-1	CR	1.22	40.00	4.72	4.38	1.3	1.2	1.8
2627	LUG PIN		30A60698-1	CR	0.20	11.00	5.10	4.42	0.0	0.2	0.2
2628	LUG PIN		30A60698-1	CR	0.20	40.00	5.10	[illegible]	0.0	0.2	0.2
2629	LATCH LINK PIN		30A60700-1	CR	1.79	9.85	7.60	4.44	0.3	0.3	0.2
2630	LATCH LINK PIN		30A60700-1	CR	1.79	41.20	7.50	4.44	0.3	0.3	0.2
2631	LATCH LINK PIN		30A60700-3	CR	1.80	22.70	9.15	4.44	0.4	0.4	0.2
2632	LATCH LINK PIN		30A60700-3	CR	1.80	27.85	7.40	4.44	0.4	0.4	0.2
2633	'Y' GUIDE, POS 1		30A60684-1	CR	9.10	59.78	5.53	1.83	150.4	85.9	65.3
2634	'Y' GUIDE, POS 2		30A60685-1	CR	6.11	59.78	48.23	1.83	126.4	57.7	45.2
2635	'Y' GUIDE, POS 3		30A60686-1	CR	5.38	48.49	55.81	1.83	50.8	79.3	28.8
2636	'Y' GUIDE, POS 4		30A60687-1	CR	6.25	3.69	55.81	1.83	59.1	90.1	31.6
2637	GUIDE BAR		30A60701-1	CR	0.51	2.93	5.90	4.61	1.4	0.3	1.4
2638	SHELF, POSITION 3		30A60682-1	CR	9.57	50.76	50.00	6.65	100.5	262.4	354.9
2639	SHELF, POSITION 4		30A60683-1	CR	5.33	4.85	50.00	6.65	56.0	44.1	95.6
2640	BKT, HOUSING SU MTG		30A60706-1	CR	1.76	28.14	47.88	7.48	7.5	3.8	9.7
2641	MOUNTING DECK		30A60025-1	CR	9.82	28.35	11.93	5.53	163.1	206.2	368.5
2642	SWITCH, POS. IND.		30A60740-1	A	0.41	6.82	3.77	7.09	0.4	0.4	0.4
2643	SWITCH, POS. IND.		30A60740-1	A	0.41	44.30	3.77	7.09	0.4	0.4	0.4
2644	SWITCH, POS. IND.		30A60740-1	A	0.41	28.14	48.06	7.09	0.4	0.4	0.4
2645	BELLCRANK SHAFT		30A60697-1	CR	1.09	25.27	8.23	4.40	0.0	0.0	0.0
2646	5/16-24X1.25 CAP	4	MS16996-33	CR	0.17	58.77	5.57	5.60	1.1	0.0	1.1
2647	5/16-24 S.L. NUT	4	MS21045-C5	A	0.06	58.77	5.57	5.60	0.4	0.0	0.4
2648	5/16 WASHER, FLAT	4	MS15795-812	CR	0.03	58.77	5.57	5.60	0.2	0.0	0.2

---> TABLE IS CONTINUED, 46 MORE LINES <---

					WEIGHT POUNDS	X STATION-INCHES	Y	Z	IX POUND-INCHES-SQUARED	IY	IZ
2649	5/16-24X1.25 CAP	4	MS16996-33	CR	0.17	58.77	48.27	5.60	1.1	0.0	1.1
2650	5/16-24 S.L. NUT	4	MS21045-C5	A	0.06	58.77	48.27	5.60	0.4	0.0	0.4
2651	5/16 WASHER, FLAT	4	MS15795-812	CR	0.03	58.77	48.27	5.60	0.2	0.0	0.2
2652	5/16-24X1.25 CAP	4	MS16996-33	CR	0.17	47.65	54.97	5.60	0.0	1.1	1.1
2653	5/16-24 S.L. NUT	4	MS21045-C5	A	0.06	47.65	54.97	5.60	0.0	0.4	0.4
2654	5/16 WASHER, FLAT	4	MS15795-812	CR	0.03	47.65	54.97	5.60	0.0	0.2	0.2
2655	5/16-24X1.25 CAP	4	MS16996-33	CR	0.17	4.19	54.97	5.60	0.0	1.1	1.1
2656	5/16-24 S.L. NUT	4	MS21045-C5	A	0.06	4.19	54.97	5.60	0.0	0.4	0.4
2657	5/16 WASHER, FLAT	4	MS15795-812	CR	0.03	4.19	54.97	5.60	0.0	0.2	0.2
2658	7/16-20X2.25 CAP S	4	NAS1351-7-36	A	0.50	25.74	2.33	4.40	0.3	42.5	42.8
2659	7/16-20 SL NUT	4	MS21045-C7	A	0.14	25.74	2.33	4.40	0.0	11.6	11.7
2660	7/16 FLAT WASHER	4	MS15795-816	CR	0.05	25.74	2.33	4.40	0.0	3.9	3.9
2661	6-40X.625 FH SCRW	4	MS24693-C229	CR	0.01	6.82	3.77	5.90	0.0	0.0	0.0
2662	6-40 S.L. NUT	4	NAS1291-C04	A	0.00	6.82	3.77	5.90	0.0	0.0	0.0
2663	#6 FLAT WASHER	4	MS15795-806	CR	0.01	6.82	3.77	5.90	0.0	0.0	0.0
2664	6-40X.625 FH SCRW	4	MS24693-C229	CR	0.01	44.30	3.77	5.90	0.0	0.0	0.0
2665	6-40 S.L. NUT	4	NAS1291-C04	A	0.01	44.30	3.77	5.90	0.0	0.0	0.0
2666	#6 FLAT WASHER	4	MS15795-806	CR	0.03	44.30	3.77	5.90	0.0	0.0	0.0
2667	6-40X.625 FH SCRW	4	MS24693-C229	CR	0.01	28.14	48.06	5.90	0.0	0.0	0.0
2668	6-40 S.L. NUT	4	NAS1291-C04	A	0.01	28.14	48.06	5.90	0.0	0.0	0.0
2669	#6 FLAT WASHER	4	MS15795-806	CR	0.03	28.14	48.06	5.90	0.0	0.0	0.0
2670	#6-40X1.125 FL HD	8	MS24693-C233	CR	0.04	2.93	5.90	5.90	0.0	0.0	0.0
2671	6-40 S.L. NUT	8	NAS1291-C04	A	0.00	2.93	5.90	5.90	0.0	0.0	0.0
2672	#6 FLAT WASHER	8	MS15795-806	CR	0.01	2.93	5.90	5.90	0.0	0.0	0.0
2673	LATCH LINK		30A60695-1	CR	1.79	41.08	6.32	4.38	1.4	1.6	2.0
2674	CONTACT BKT, BASE		30A60709-1	CR	0.27	23.95	27.39	4.40	0.2	0.3	0.2
2675	CONTACT BKT, BASE		30A62709-1	CR	0.27	31.24	27.39	4.40	0.2	0.3	0.2
2676	ELECTRICAL FITG		NB7E14-19PNC	CR	0.09	23.78	44.50	2.93	0.0	0.0	0.0
2677	ELECTRICAL FITG		NB7E14-19PNC	CR	0.09	33.09	44.50	2.93	0.0	0.0	0.0
2678	ELECTRICAL FITG		NB7E14-5PNC	CR	0.08	35.52	44.50	2.93	0.0	0.0	0.0
2679	ELECTRICAL FITG		NB7E12-10P	CR	0.05	40.13	44.50	2.93	0.0	0.0	0.0
2680	1/4-28X1.50 FL HD	3	MS51960-88	CR	0.10	27.84	4.65	5.90	0.0	1.5	1.5
2681	FLAT WSHR .256X.48	3	AN960-C416	A	0.01	27.84	4.65	5.90	0.0	0.1	0.1
2682	SL NUT 1/4-28	3	MS21045-C4	A	0.02	27.84	4.65	5.90	0.0	0.5	0.4
2683	1/4-28X.75 CAP SC	4	MS16996-23	CR	0.07	27.64	27.39	5.90	0.0	0.0	0.0
2684	FLAT WSHR .256X.48	4	AN960-C416	A	0.01	27.84	4.65	5.90	0.0	0.2	0.2
2685	SL NUT 1/4-28	4	MS21045-C4	A	0.04	27.84	4.65	5.90	0.0	0.6	0.6
2686	5/16-24X1.75 CAP	4	MS51100-11	A	0.13	28.14	44.50	7.06	0.0	0.1	0.2
2687	5/16-24 S.L. NUT	4	MS21045-C5	A	0.06	28.14	44.50	7.06	0.0	0.0	0.0
2688	5/16 WASHER, FLAT	4	MS15795-812	CR	0.03	28.14	44.50	7.06	0.0	0.0	0.0
2689	5/16-24X2.13 CAP	2	MS51958-103	CR	0.13	6.78	43.66	6.77	0.0	0.2	0.2
2690	5/16-24 S.L. NUT	2	MS21045-C5	A	0.03	6.78	43.66	6.77	0.0	0.0	0.0
2691	5/16 WASHER, FLAT	2	MS15795-812	CR	0.01	6.78	43.66	6.77	0.0	0.0	0.0

---> TABLE IS CONTINUED,   3 MORE LINES <---

BASE SUBASSEMBLY (30AE0680-1) 9:15 SEP 7, 1973

					WEIGHT POUNDS	X	Y	Z	IX	IY	IZ
						STATION-INCHES			POUND-INCHES-SQUARED		
2692	5/16-24X2.13 CAP	2	MS51958-103	CR	0.13	44.30	43.66	6.77	0.0	0.2	0.2
2693	5/16-24 S.L. NUT	2	MS21045-C5	A	0.03	44.30	43.66	6.77	0.0	0.0	0.0
2694	5/16 WASHER, FLAT	2	MS15795-812	CR	0.01	44.30	43.66	6.77	0.0	0.2	2.0
	TOTAL				318.56	30.99	23.67	6.18	102969.7	116854.9	216842.6

420 LB.

TABLE II

ADAPTER SUBASSY (30A60640-1) 9:16 SEP 7, 1983

					WEIGHT POUNDS	X	Y	Z	IX	IY	IZ
						STATION-INCHES			POUND-INCHES-SQUARED		
105	ADAPTER		30A60641-1	A	154.00	25.61	24.76	1.18	38765.4	41177.2	79510.5
3545	INSERT, SCREW THD	4	MS21209-C8-20	A	0.07	25.52	23.94	1.50	9.1	16.0	25.2
3546	SWITCH BKT ADAPTER		30A60710-1	CR	0.39	23.20	29.46	2.62	0.6	0.7	0.3
3547	SWITCH BKT ADAPTER		30A60710-1	CR	0.39	30.98	29.46	2.62	0.6	0.7	0.3
3548	RETAINER, BEARING, SL		30A60705-1	CR	0.10	1.99	4.01	4.71	0.0	0.0	0.0
3549	BEARING, SLIDE		30A60704-1	CR	0.05	1.99	3.76	4.71	0.0	0.0	0.0
3550	PIN-ROUND		30A60642-1	CR	0.94	6.88	2.50	4.65	1.1	0.4	1.1
3551	PIN-ROUND		30A60642-1	CR	0.94	6.88	44.48	4.65	1.1	0.4	1.1
3552	PIN-SQUARE		30A60643-1	CR	1.23	44.28	2.50	4.65	1.6	0.7	1.6
3553	PIN-SQUARE		30A60643-1	CR	1.23	44.28	44.48	4.65	1.6	0.7	1.6
3554	LATCH HOOK		30A60690-1	CR	4.63	43.23	5.23	4.65	5.3	7.9	11.3
3555	LATCH HOOK		30A60690-1	CR	4.63	6.28	5.23	4.65	5.3	7.9	11.3
3556	NUT, SL .88		MS21045-C14	A	0.21	6.88	45.67	4.65	0.0	0.0	2.0
3557	WASHER .88 FLAT		MS15795-824	CR	0.08	6.88	45.46	4.65	0.0	0.0	2.0
3558	PIN, SPRING, SLTD		MS16562-246	CR	0.01	7.71	3.34	4.65	0.0	0.0	2.0
3559	SCREW, MACH, FH	4	MS51960-90	CR	0.13	1.99	3.68	4.78	0.0	0.0	2.0
3560	NUT, SL, HEX	4	MS21045C4	A	0.04	1.99	4.27	4.78	0.0	0.0	2.0
3561	WASHER, FLAT, .25	4	AN960-C416	A	0.01	1.99	4.27	4.78	0.0	0.0	2.0
3562	BOLT, HEX .25-28	4	MS20034-12	CR	0.13	26.90	30.68	0.97	0.0	0.8	2.9
3563	SWITCH, LIFTOFF		GA43-101	E	0.20	23.64	29.51	3.70	0.0	0.0	2.0
3564	NUT, SL .88		MS21045-C14	A	0.21	44.28	45.67	4.65	0.0	0.0	2.0
3565	WASHER .88 FLAT		MS15795-824	CR	0.08	44.28	45.46	4.65	0.0	0.0	2.0
3566	PIN, SPRING, SLTD		MS16562-246	CR	0.01	41.67	3.34	4.68	0.0	0.0	2.0
3567	NUT, SL, HEX	4	MS21045C4	A	0.04	26.90	31.18	0.97	0.0	0.3	2.3
3568	WASHER, FLAT, .25	4	AN960-C416	A	0.01	26.90	31.18	0.97	0.0	0.0	0.0
3569	SWITCH, LIFTOFF		GA43-101	E	0.20	31.05	29.51	3.70	0.0	0.0	0.0
	TOTAL				169.98	25.60	23.73	1.49	44669.5	46479.5	90381.6

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TABLE III

SPARTEN REM ASSY (30A60630-1) 9:16 SEP 7, 1983

					WEIGHT POUNDS	X STATION-INCHES	Y	Z	IX POUND-INCHES-SQUARED	IY	IZ
104	BASE SUBASSEMBLY		30A60682-1		318.56	30.99	23.67	6.18	102569.7	116854.9	216842.6
106	ADAPTER SUBASSEMBLY		30A60640-1		169.98	25.60	23.73	1.49	44669.5	46479.5	92381.6
4503	NUT PLATE, ROUND HOLE		30A60652-1	CR	1.54	6.88	1.80	8.00	0.9	2.5	2.1
4504	NUT PLATE, SQUARE HL		30A60651-1	CR	1.04	44.28	1.80	8.00	0.6	1.9	1.4
4505	NUT PLATE, ROUND HOLE		30A60645-1	CR	1.28	6.88	43.79	8.00	0.5	2.3	1.7
4506	NUT PLATE, SQUARE HL		30A60644-1	CR	1.09	44.28	43.79	8.00	0.5	1.9	1.5
4507	7/16-20X1.50 FL H	4	MS51960-128	CR	0.30	6.88	1.97	8.00	0.0	0.2	0.3
4508	7/16-20 NUT SL	4	MS21045-C7	CR	0.13	6.88	1.97	8.00	0.0	0.1	0.1
4509	7/16 FLAT WSHR	4	MS15795-816	CR	0.05	6.88	1.97	8.00	0.0	0.0	0.0
4510	7/16-20X1.50 FL H	4	MS51960-128	CR	0.30	44.28	1.97	8.00	0.0	0.2	0.3
4511	7/16-20 NUT SL	4	MS21045-C7	CR	0.13	44.28	1.97	8.00	0.0	0.1	0.1
4512	7/16 FLAT WSHR	4	MS15795-816	CR	0.05	44.28	1.97	8.00	0.0	0.0	0.0
4513	7/16-20X1.50 FL H	4	MS51960-128	CR	0.30	6.88	43.75	8.00	0.0	0.2	0.3
4514	7/16-20 NUT SL	4	MS21045-C7	CR	0.13	6.88	43.75	8.00	0.0	0.1	0.1
4515	7/16 FLAT WSHR	4	MS15795-816	CR	0.05	6.88	43.75	8.00	0.0	0.0	0.0
4516	7/16-20X1.50 FL H	4	MS51960-128	CR	0.30	44.28	43.75	8.00	0.0	0.2	0.3
4517	7/16-20 NUT SL	4	MS21245-C7	CR	0.13	44.28	43.75	8.00	0.0	0.1	0.1
4518	7/16 FLAT WSHR	4	MS15795-816	CR	0.05	44.28	43.75	8.00	0.0	0.0	0.0
4519	5/8-18X2-40LG	2	NAS1960-24	CR	0.56	6.78	0.96	10.00	0.3	1.1	0.9
4520	5/8-18 NUT SL	2	MS21045-C10	CR	0.19	6.78	0.96	10.00	0.0	0.4	0.3
4521	5/8 FLAT WASHER	2	MS15795-820	CR	0.07	6.78	0.96	10.00	0.0	0.1	0.1
4522	5/8-18X2-40LG	2	NAS1960-24	CR	0.56	44.42	0.96	10.00	0.3	1.1	0.9
4523	5/8-18 NUT SL	2	MS21045-C10	CR	0.19	44.42	0.96	10.00	0.0	0.4	0.3
4524	5/8 FLAT WASHER	2	MS15795-820	CR	0.07	44.42	0.96	10.00	0.0	0.1	0.1
4525	5/8-18X2-40LG	2	NAS1960-24	CR	0.56	6.78	45.67	10.00	0.3	1.1	0.9
4526	5/8-18 NUT SL	2	MS21045-C10	CR	0.19	6.78	45.67	10.00	0.0	0.4	0.3
4527	5/8 FLAT WASHER	2	MS15795-820	CR	0.07	6.78	45.67	10.00	0.0	0.1	0.1
4528	5/8-18X2-40LG	2	NAS1960-24	CR	0.56	44.42	45.67	10.00	0.3	1.1	0.9
4529	5/8-18 NUT SL	2	MS21045-C10	CR	0.19	44.42	45.67	10.00	0.0	0.4	0.3
4530	5/8 FLAT WASHER	2	MS15795-820	CR	0.07	44.42	45.67	10.00	0.0	0.1	0.1
4531	HOLDER, ROD 4		30A60647-1	CR	1.06	3.31	4.64	-0.07	1.0	1.8	2.4
4532	ADAPTER, SWITCH BKT		30A60708-1	CR	0.61	27.68	46.96	3.52	1.3	0.9	1.0
4533	1/4-28X1.25 FL HD	4	MS51960-87	CR	0.08	27.68	45.04	3.52	0.0	0.0	0.0
4534	1/4-28 NUT S.L.	4	MS21045-C4	A	0.04	27.68	45.04	3.52	0.0	0.0	0.0
4535	1/4 FLAT WSHR	4	AN960-C416	A	0.01	27.68	45.04	3.52	0.0	0.0	0.0
4536	BLANKET, BOTTOM		30A60126-1	CR	0.86	28.35	11.93	7.59	21.5	26.5	44.8
4537	ISULATOR-THERMAL		30A60065-1	CR	0.95	28.35	11.93	5.90	12.1	15.7	27.2
4538	ISULATOR-THERMAL		30A60065-1	CR	0.95	28.35	11.93	6.77	12.1	15.7	27.2
4539	SPACER, THERMAL		30A60055-1	CR	0.00	34.67	3.80	6.25	0.0	0.0	0.0
4540	SPACER, THERMAL		30A60055-1	CR	0.00	34.67	18.80	6.25	0.0	0.0	0.0
4541	SPACER, THERMAL		30A60055-1	CR	0.00	21.65	3.80	6.25	0.0	0.0	0.0
4542	SPACER, THERMAL		30A60055-3	CR	0.00	21.65	18.80	6.25	0.0	0.0	0.0
4543	BLANKET, TOP		30A60125-1	CR	0.83	28.35	11.93	5.40	20.8	23.2	44.0

---) TABLE IS CONTINUED, 43 MORE LINES (---

TABLE III

SPARTEN REM ASSY (30A60630-1)   9:16 SEP 7, 1983

					WEIGHT POUNDS	X	Y	Z	IX	IY	IZ
						STATION-INCHES			POUND-INCHES-SQUARED		
4544	SHIELD, INSUL ASSY		30A60124-1	E	4.30	28.35	11.93	5.21	107.4	118.7	226.1
4545	POWER TRAIN ASSY		30A60425-1	A	44.00	28.14	11.80	7.20	739.4	735.4	1392.5
4546	3/8-24X1.25 HEX B	44	NAS1956C-11	CR	2.41	25.05	23.69	-0.20	276.0	417.0	651.9
4547	3/8 NOM FLT WSHR	44	AN960-C616L	A	0.07	25.05	23.69	-0.20	8.6	12.9	21.4
4548	CLAMP, CABLE	8	MC636-24	E	0.01	25.33	23.24	6.00	2.0	2.8	4.9
4549	SCREW 10-32X?	AR	MS16996-12	E	0.08	25.33	23.24	6.00	11.9	16.9	28.8
4550	NUT 10-32 SL	AR	NAS1291-C3M	E	0.02	25.33	23.24	6.00	3.1	4.5	7.6
4551	WASHER, FLAT	AR	AN960-C10	E	0.02	25.33	23.24	6.00	2.4	3.4	5.9
4552	PIN, SPRG, SLOT		MS16562-241	A	0.89	44.28	3.13	4.65	0.2	0.2	0.0
4553	PIN, SPRG, SLOT		MS16562-241	A	0.89	6.88	3.13	4.65	0.2	0.2	0.0
4554	PIN, SPRG, SLOT		MS16562-241	A	0.89	44.28	45.08	4.65	0.2	0.2	0.0
4555	PIN, SPRG, SLOT		MS16562-241	A	0.89	6.88	3.13	4.65	0.2	0.2	0.0
4556	5/16-24X2.25 FH	4	MS51960-106	CR	0.22	3.31	46.75	4.49	0.4	0.5	0.4
4557	5/16-24 NUT SL	4	MS21045-C5	CR	0.08	3.31	46.75	4.49	0.1	0.2	0.1
4558	5/16 FLAT WSHR	4	MS15795-812	CR	0.03	3.31	46.75	4.49	0.0	0.0	0.0
4559	5/16-24X2.25 FH	4	MS51960-106	CR	0.22	51.20	6.27	4.49	0.5	0.4	0.4
4560	5/16-24 NUT SL	4	MS21045-C5	CR	0.08	51.20	6.27	4.49	0.2	0.1	0.1
4561	5/16 FLAT WSHR	4	MS15795-812	CR	0.03	51.20	6.27	4.49	0.0	0.0	0.0
4562	5/16-24X2.25 FH	2	MS51960-106	CR	0.11	47.24	46.75	4.49	0.2	0.1	0.0
4563	5/16-24 NUT SL	2	MS21045-C5	CR	0.04	47.24	46.75	4.49	0.0	0.0	0.0
4564	5/16 FLAT WSHR	2	MS15795-812	CR	0.01	47.24	46.75	4.49	0.0	0.0	0.0
4565	5/16-24X3.5 FH	2	NAS1975-50	CR	0.17	49.50	4.64	4.49	0.4	0.2	0.2
4566	1/4-28X.750 CP SC	2	MS16996-23	CR	0.04	3.31	47.50	4.49	0.0	0.0	0.0
4567	1/4-28 SL HELICOIL	2	MS21209-F4-15	A	0.00	3.31	47.50	4.49	0.0	0.0	0.0
4568	1/4-28X.750 CP SC	2	MS16996-23	CR	0.04	11.14	2.47	4.49	0.0	0.0	0.0
4569	1/4-28 SL HELICOIL	2	MS21209-F4-15	A	0.00	11.14	2.47	4.49	0.0	0.0	0.0
4570	1/4-28X.750 CP SC	2	MS16996-23	CR	0.04	50.05	46.58	4.49	0.0	0.0	0.0
4571	1/4-28 SL HELICOIL	2	MS21209-F4-15	A	0.00	50.00	46.58	4.49	0.0	0.0	0.0
4572	1/4-28X.750 CP SC	2	MS16996-23	CR	0.04	53.05	6.28	4.49	0.0	0.0	0.0
4573	1/4-28 SL HELICOIL	2	MS21209-F4-15	A	0.00	52.68	6.28	4.49	0.0	0.0	0.0
4574	LOCATOR ROD, POS 4		30A60649-7	CR	1.20	3.31	52.91	4.49	0.1	0.1	0.1
4575	LOCATOR ROD, POS 3		30A60649-5	CR	0.95	47.24	52.66	4.49	7.0	0.1	7.0
4576	BASE, ROD, POS 2&3		30A60648-1	CR	1.66	47.24	46.76	4.49	2.7	5.2	4.0
4577	LOCATOR ROD, POS 2		30A60649-3	CR	1.22	56.81	46.59	4.49	0.2	16.3	16.3
4578	LOCATOR ROD, POS 1		30A60649-1	CR	1.20	58.13	6.33	4.53	0.2	8.9	8.9
4579	HOLDER, ROD 1		30A60652-1	CR	0.78	51.81	6.23	4.49	1.5	0.5	1.4
4580	BRACKET, CONN.		30A60715-1	CR	0.31	19.12	43.70	4.12	0.2	0.7	0.5
4581	120 PIN CONN-FEMALE		DBA79-61-OPN	E	0.20	18.92	43.55	2.93	0.0	0.0	0.0
4582	120 PIN CONN-MALE		DBA70-61-OPN	E	0.20	18.92	45.00	2.93	0.0	0.0	0.0
4583	10-32X.88 CRES FH	4	MS51960-68	CR	0.03	19.12	43.70	4.12	0.0	0.0	0.0
4584	10-32 NUT S.L.	4	MS21045C3	A	0.02	19.12	43.70	4.12	0.0	0.0	0.0
4585	#10 FLAT WASHER	4	AN960-C10	A	0.01	19.12	43.70	4.12	0.0	0.0	0.0
4586	CABLE W1		30A60752-1	E	0.50	24.70	23.40	2.93	70.1	101.7	171.7
	TOTAL				567.81	29.03	22.71	4.81	170266.2	181497.1	341938.8

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TABLE IV

SEPARATED BASE 9:17 SEP 7, 1983

					WEIGHT POUNDS	X	Y	Z	IX	IY	IZ
						STATION-INCHES			POUND-INCHES-SQUARED		
104	BASE SUBASSEMBLY		30A60680-1		318.56	30.99	23.67	6.18	102969.7	116854.9	216842.6
4503	NUT PLATE, ROUND HOLE		30A60650-1	CR	1.54	6.88	1.80	8.00	0.9	2.9	2.1
4504	NUT PLATE, SQUARE HL		30A60651-1	CR	1.04	44.28	1.80	8.00	0.6	1.9	1.4
4505	NUT PLATE, ROUND HOLE		30A60645-1	CR	1.28	6.88	43.79	8.00	0.5	2.2	1.7
4506	NUT PLATE, SQUARE HL		30A60644-1	CR	1.09	44.28	43.79	8.00	0.5	1.9	1.5
4507	7/16-20X1.50 FL H	4	MS51960-128	CR	0.30	6.88	1.97	8.00	0.0	0.2	0.3
4508	7/16-20 NUT SL	4	MS21045-C7	CR	0.13	6.88	1.97	8.00	0.0	0.1	0.1
4509	7/16 FLAT USHR	4	MS15795-816	CR	0.05	6.88	1.97	8.00	0.0	0.0	0.0
4510	7/16-20X1.50 FL H	4	MS51960-128	CR	0.30	44.28	1.97	8.00	0.0	0.2	0.3
4511	7/16-20 NUT SL	4	MS21045-C7	CR	0.13	44.28	1.97	8.00	0.0	0.1	0.1
4512	7/16 FLAT USHR	4	MS15795-816	CR	0.05	44.28	1.97	8.00	0.0	0.0	0.0
4513	7/16-20X1.50 FL H	4	MS51960-128	CR	0.30	6.88	43.75	8.00	0.0	0.2	0.3
4514	7/16-20 NUT SL	4	MS21045-C7	CR	0.13	6.88	43.75	8.00	0.0	0.1	0.1
4515	7/16 FLAT USHR	4	MS15795-816	CR	0.05	6.88	43.75	8.00	0.0	0.0	0.0
4516	7/16-20X1.50 FL H	4	MS51960-128	CR	0.30	44.28	43.75	8.00	0.0	0.2	0.3
4517	7/16-20 NUT SL	4	MS21045-C7	CR	0.13	44.28	43.75	8.00	0.0	0.1	0.1
4518	7/16 FLAT USHR	4	MS15795-816	CR	0.05	44.28	43.75	8.00	0.0	0.0	0.0
4519	5/8-18X2-40LG	2	NAS1960-24	CR	0.56	6.78	0.96	12.00	0.3	1.1	0.9
4520	5/8-18 NUT SL	2	MS21045-C10	CR	0.19	6.78	0.96	12.00	0.0	0.4	0.3
4521	5/8 FLAT WASHER	2	MS15795-820	CR	0.07	6.78	0.96	12.00	0.0	0.1	0.1
4522	5/8-18X2-40LG	2	NAS1960-24	CR	0.56	44.42	0.96	12.00	0.3	1.1	0.9
4523	5/8-18 NUT SL	2	MS21045-C10	CR	0.19	44.42	0.96	12.00	0.0	0.4	0.3
4524	5/8 FLAT WASHER	2	MS15795-820	CR	0.07	44.42	0.96	12.00	0.0	0.1	0.1
4525	5/8-18X2-40LG	2	NAS1960-24	CR	0.56	6.78	45.67	12.00	0.3	1.1	0.9
4526	5/8-18 NUT SL	2	MS21045-C10	CR	0.19	6.78	45.67	12.00	0.0	0.4	0.3
4527	5/8 FLAT WASHER	2	MS15795-820	CR	0.07	6.78	45.67	12.00	0.0	0.1	0.1
4528	5/8-18X2-40LG	2	NAS1960-24	CR	0.56	44.42	45.67	12.00	0.3	1.1	0.5
4529	5/8-18 NUT SL	2	MS21045-C10	CR	0.19	44.42	45.67	12.00	0.0	0.4	0.3
4530	5/8 FLAT WASHER	2	MS15795-820	CR	0.07	44.42	45.67	12.00	0.0	0.1	0.1
4536	BLANKET, BOTTOM		30A60126-1	CR	0.86	28.35	11.93	7.59	21.5	26.5	44.8
4537	ISULATOR-THERMAL		30A60065-1	CR	0.55	28.35	11.93	5.90	12.1	15.7	27.2
4538	ISULATOR-THERMAL		30A60065-1	CR	0.55	28.35	11.93	6.77	12.1	15.7	27.2
4539	SPACER, THERMAL		30A60055-1	CR	0.00	34.67	3.80	6.25	0.0	0.0	0.0
4540	SPACER, THERMAL		30A60055-1	CR	0.00	34.67	18.80	6.25	0.0	0.0	0.0
4541	SPACER, THERMAL		30A60055-1	CR	0.00	21.65	3.80	6.25	0.0	0.0	0.0
4542	SPACER, THERMAL		30A60055-3	CR	0.00	21.65	18.80	6.25	0.0	0.0	0.0
4543	BLANKET, TOP		30A60125-1	CR	0.83	28.35	11.93	5.40	20.8	23.2	44.0
4544	SHIELD, INSUL ASSY		30A60124-1	E	4.30	28.35	11.93	5.21	107.4	118.7	226.1
4545	POWER TRAIN ASSY		30A60425-1	A	44.00	28.14	11.80	7.20	739.4	735.4	1392.5
4548	CLAMP, CABLE	8	MC636-24	E	0.01	25.33	23.24	6.00	2.0	2.8	4.9
4549	SCREW 10-32X?	AR	MS16996-12	E	0.08	25.33	23.24	6.00	11.9	16.9	28.8
4550	NUT 10-32 SL	AR	NAS1291-C3M	E	0.02	25.33	23.24	6.00	3.1	4.5	7.6
4551	WASHER, FLAT	AR	AN960-C10	E	0.02	25.33	23.24	6.00	2.4	3.4	5.9

---) TABLE IS CONTINUED, 7 MORE LINES <---

TABLE IV

SEPARATED BASE 9:17 SEP 7, 1983

						WEIGHT POUNDS	X	Y	Z	IX	IY	IZ
							STATION-INCHES			POUND-INCHES-SQUARED		
4580	BRACKET, CONN.		30A60715-1	CR		0.31	19.12	43.70	4.12	0.2	0.7	0.5
4581	120 PIN CONN-FEMALE		DBA79-61-OPN	E		0.20	18.92	43.55	2.93	0.0	0.0	0.0
4582	120 PIN CONN-MALE		DBA70-61-CPN	E		0.20	18.92	45.00	2.93	0.0	0.0	0.0
4583	10-32X.88 CRES FH	4	MS51960-68	CR		0.03	19.12	43.70	4.12	0.0	0.0	0.0
4584	10-32 NUT S.L.	4	MS21045C3		A	0.02	19.12	43.70	4.12	0.0	0.0	0.0
4585	#10 FLAT WASHER	4	AN960-C10		A	0.01	19.12	43.70	4.12	0.0	0.0	0.0
4586	CABLE W1		30A60752-1	E		0.50	24.70	23.40	2.93	70.1	101.7	171.7
	TOTAL					382.01	30.40	22.07	6.34	115398.0	122466.3	234539.9

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TABLE V

SEPARATED ADAPTER 9:18 SEP 7, 1983

					WEIGHT POUNDS	X STATION-INCHES	Y STATION-INCHES	Z STATION-INCHES	IX POUND-INCHES-SQUARED	IY POUND-INCHES-SQUARED	IZ POUND-INCHES-SQUARED
106	ADAPTER SUBASSEMBLY		30A60640-1		169.98	25.60	23.73	1.49	44669.5	46479.5	90381.6
4531	HOLDER, ROD 4		30A60647-1	CR	1.06	3.31	4.64	-0.07	1.0	1.8	2.4
4532	ADAPTER, SWITCH BKT		30A60728-1	CR	0.61	27.68	46.96	3.52	1.3	0.9	1.0
4533	1/4-28X1.25 FL HD	4	MS51962-87	CR	0.08	27.68	45.04	3.52	0.0	0.2	0.0
4546	3/8-24X1.25 HEX B	44	NAS1956C-11	CR	2.41	25.05	23.69	-0.20	276.0	417.2	651.9
4547	3/8 NOM FLT USHR	44	AN960-C616L	A	0.07	25.05	23.69	-0.20	8.6	12.9	21.4
4552	PIN, SPRG, SLOT		MS16562-241	A	0.89	44.28	3.13	4.65	0.2	0.2	0.0
4553	PIN, SPRG, SLOT		MS16562-241	A	0.89	6.88	3.13	4.65	0.2	0.2	0.0
4554	PIN, SPRG, SLOT		MS16562-241	A	0.89	44.28	45.08	4.65	0.2	0.2	0.0
4555	PIN, SPRG, SLOT		MS16562-241	A	0.89	6.88	3.13	4.65	0.2	0.2	0.0
4556	5/16-24X2.25 FH	4	MS51960-106	CR	0.22	3.31	46.75	4.49	0.4	0.5	0.4
4557	5/16-24 NUT SL	4	MS21045-C5	CR	0.08	3.31	46.75	4.49	0.1	0.2	0.1
4558	5/16 FLAT USHR	4	MS15795-812	CR	0.03	3.31	46.75	4.49	0.0	0.0	0.0
4559	5/16-24X2.25 FH	4	MS51960-106	CR	0.22	51.20	6.27	4.49	0.5	0.4	0.4
4560	5/16-24 NUT SL	4	MS21045-C5	CR	0.08	51.20	6.27	4.49	0.2	0.1	0.1
4561	5/16 FLAT USHR	4	MS15795-812	CR	0.03	51.20	6.27	4.49	0.0	0.0	0.0
4562	5/16-24X2.25 FH	2	MS51960-106	CR	0.11	47.24	46.75	4.49	0.2	0.1	0.0
4563	5/16-24 NUT SL	2	MS21045-C5	CR	0.04	47.24	46.75	4.49	0.0	0.0	0.0
4564	5/16 FLAT USHR	2	MS15795-812	CR	0.01	47.24	46.75	4.49	0.0	0.0	0.0
4565	5/16-24X3.5 FH	2	NAS1975-50	CR	0.17	49.50	4.64	4.49	0.4	0.2	0.2
4566	1/4-28X.750 CP SC	2	MS16996-23	CR	0.04	3.31	47.50	4.49	0.0	0.0	0.0
4567	1/4-28 SL HELICOIL	2	MS21209-F4-15	A	0.00	3.31	47.50	4.49	0.0	0.0	0.0
4568	1/4-28X.750 CP SC	2	MS16996-23	CR	0.04	11.14	2.47	4.49	0.0	0.0	0.0
4569	1/4-28 SL HELICOIL	2	MS21209-F4-15	A	0.00	11.14	2.47	4.49	0.0	0.0	0.0
4570	1/4-28X.750 CP SC	2	MS16996-23	CR	0.04	50.05	46.58	4.49	0.0	0.0	0.0
4571	1/4-28 SL HELICOIL	2	MS21209-F4-15	A	0.00	50.00	46.58	4.49	0.0	0.0	0.0
4572	1/4-28X.750 CP SC	2	MS16996-23	CR	0.04	53.05	6.28	4.49	0.0	0.0	0.0
4573	1/4-28 SL HELICOIL	2	MS21209-F4-15	A	0.00	52.68	6.28	4.49	0.0	0.0	0.0
4574	LOCATOR ROD, POS 4		30A60649-7	CR	1.00	3.31	52.91	4.49	0.1	0.1	0.1
4575	LOCATOR ROD, POS 3		30A60649-5	CR	0.95	47.24	52.66	4.49	7.0	0.1	7.0
4576	BASE, ROD, POS 2&3		30A60648-1	CR	1.66	47.24	46.76	4.49	2.7	5.2	4.0
4577	LOCATOR ROD, POS 2		30A60649-3	CR	1.22	56.81	46.59	4.49	0.2	16.3	16.3
4578	LOCATOR ROD, POS 1		30A60649-1	CR	1.20	58.13	6.33	4.53	0.2	8.9	8.9
4579	HOLDER, ROD 1		30A60652-1	CR	0.78	51.81	6.23	4.49	1.5	0.5	1.4
4534	1/4-28 NUT S.L.	4	MS21045-C4	A	0.04	27.68	45.04	3.52	0.0	0.0	0.0
4535	1/4 FLAT USHR	4	AN960-C416	A	0.01	27.68	45.04	3.52	0.0	0.0	0.0
	TOTAL				185.80	26.23	24.01	1.66	51654.5	54113.5	104757.7

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MATERIAL PROPERTIES

3.1 2219 AL
3.3 Inconel 718
3.5 4340 STEEL
MP35N
416 STAINLESS

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FORM LMSC 362 B-3

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2219 ALUMINUM ALLOY SHEET AND PLATE (BARE)
Specifications QQ-A-250/30
SUMMARY OF ROOM TEMPERATURE PROPERTIES

Basis	99% Minimum				Prelim[a]
Condition	T87				
Material Thickness (in.)	0.020-0.249	0.250-3.000	3.001-4.000	4.001-5.000	5.001-6.000
F_{tu} (ksi) L	63	63	61	60	58
LT	64	64	62	61	59
ST		-	-	-	-
F_{ty} (ksi) L	51	51	50	49	47
LT	52	51	50	49	47
ST		-	-	-	-
F_{cy} (ksi) L	52	51	50	49	47
LT	55	54	50	49	47
ST		-	-	-	-
F_{su} (ksi)	37	37	36	35	34
F_{bru} (ksi)[b] e/D = 1.5	91	91	88	86	84
e/D = 2.0	113	113	109	107	104
F_{bry} (ksi)[b] e/D = 1.5	71	71	70	69	66
e/D = 2.0	86	86	84	83	79
e (percent) L					
LT	5	6	4	3	3
ST		-	-	-	-

Physical Properties (average)

E (10^6 psi)	10.5
E_c (10^6 psi)	10.8
G (10^6 psi)	4.0
μ	0.33
K (BTU-in./hr-sq in.-°F)	6.2
α (10^{-6} in./in.-°F)	12.4 (70 F to 212 F, see p. 02.24.02.01)
C (BTU/lb-°F)	0.23 (at 212 F)
ρ (lb/cu.in.)	0.102

[a] Properties shown for 5.001-6.000 inches thick are preliminary, pending negotiation with suppliers.

[b] Bearing allowables include the lubricated pin reduction factor. When the hole axis is parallel with the plane of the plate, F_{bru} values must be adjusted per p. 01.00.00.11.

REF ROCKWELL MATERIALS MANUAL P 2.24.01.02

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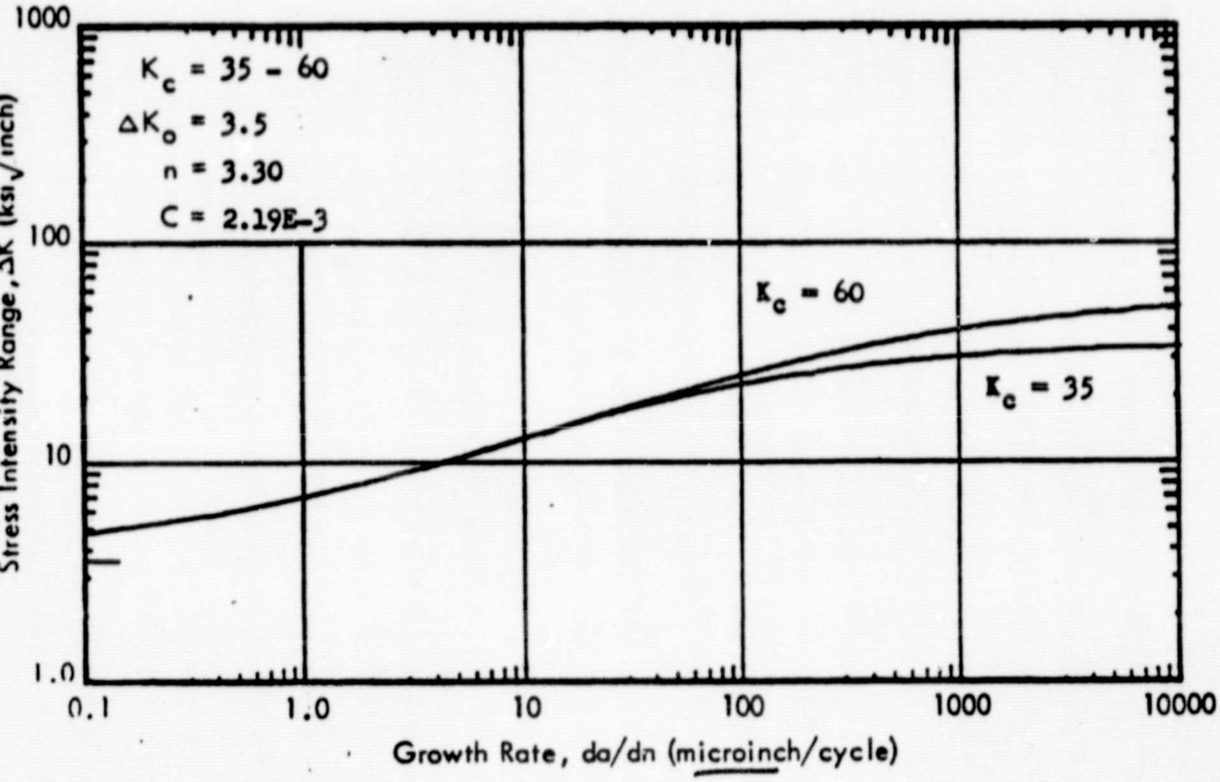
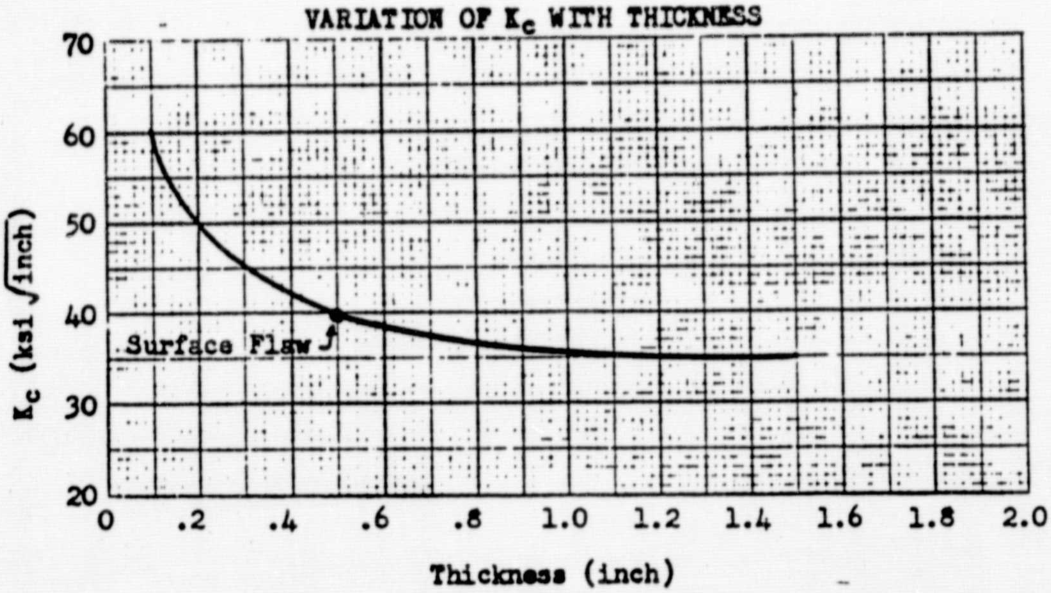
2219-T87 Aluminum Alloy Sheet and Plate, 0.10 to 1.5 Inch Thick
TL Orientation

CYCLIC CRACK GROWTH RATE AT ROOM TEMPERATURE



VARIATION OF K_c WITH THICKNESS



Nomenclature for growth rate constants is given on page 01.00.00.09

REF. ROCKWELL MATL MANUAL

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Inconel 718 Sheet, Plate, Bar, and Forgings
Specifications MB0170-071, -074, -075, 076, and MA011-303
AMS 5596, 5597, 5663

SUMMARY OF ROOM TEMPERATURE PROPERTIES
99 Percent Probability Minimum Values

Form	All	Sheet and Plate	Bar and Forgings
Condition	Annealed	Solution Treated and Aged (STA)	
Material Thickness (in.)	≤0.500 Inch		
F_{tu}(ksi) L	110	180	185
LT	110	180	180
F_{ty}(ksi) L	50	150	150
LT	50	150	150
F_{cy}(ksi) L	50	150	150
LT	50	150	150
F_{su}(ksi)	70	113	113
F_{bru}(ksi)			
e/D = 1.5		~~248~~	248
e/D = 2.0	200	320	320
F_{bry}(ksi)			
e/D = 1.5		~~210~~	210
e/D = 2.0	85	240	240
e (percent) L	30	12	12
LT			6 (Bar); 10 (Forgings)

Physical Properties (average)	
E (10^6 psi)	29.5
E_c (10^6 psi)	29.5
G (10^6 psi)	11.4
μ	0.29
K (BTU-in./hr-sq in.-°F)	0.53 (STA, 68 F)
α (10^{-6}in./in.-°F)	7.2 (68 F to 200 F)
C (BTU/lb-°F)	0.104
ρ (lb/cu.in.)	0.297

ref. ROCKWELL MATL MANUAL
P. 7.02.01.01

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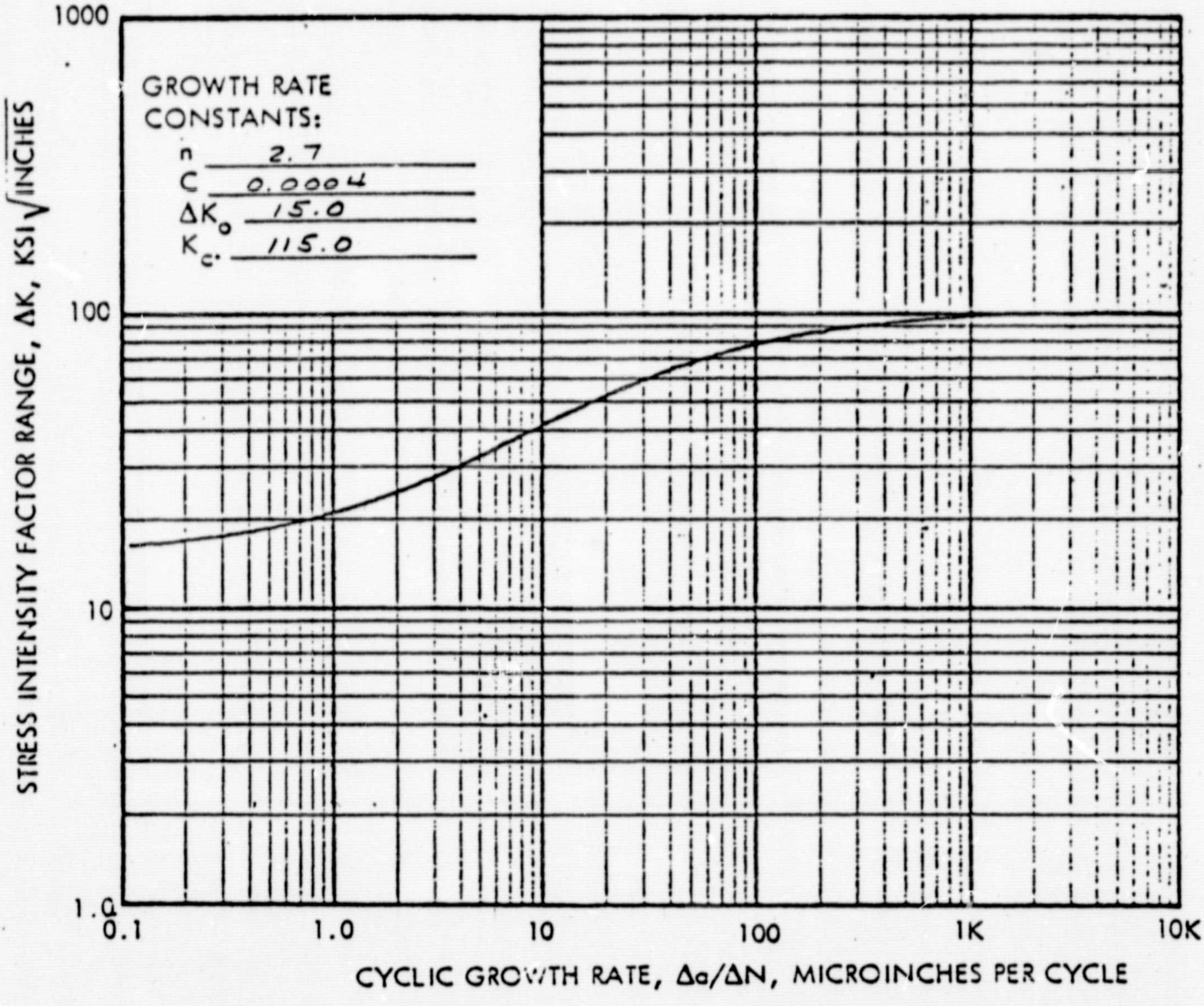
CYCLIC CRACK GROWTH RATE DATA

MATERIAL: 403 INCONEL 718 STA,LTS AND TLS ORIENTATIONS, ROOM TEMPERATURE

YS (0.2% O.S.) KSI 150.0



[illegible] [illegible] CONTRACT

FRACTURE MECHANICS DATA

1. 4340 PLATE 180KSI MIN
2. INCONEL 718 PLATE 180KSI MIN
3. MP35N ST & CW & AGED ROD 260 KSI MIN
4. 416 STAINLESS 120KSI

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NEQ=1 COLLIPRIEST EQUATION PARAMETERS

	4340	~~INCONEL 718~~	MP35N	416 SS
~~4340~~				
(4) ΔK_0 (KSI$\sqrt{\text{INCH}}$)	6.3	~~7.2~~	5.5	5.5
(2) N	2.38	~~4.00~~	3.40	4.00
(1) C	2.36×10^{-9}	~~1.39×10^{-9}~~	8.88×10^{-11}	2.333×10^{-10}
(3) K_{IC} (KSI$\sqrt{\text{INCH}}$)	80	~~80~~	100	40
ΔK	KSI$\sqrt{\text{INCH}}$	~~KSI$\sqrt{\text{INCH}}$~~	KSI$\sqrt{\text{INCH}}$	KSI$\sqrt{\text{INCH}}$
da/dN crack growth rate	INCH/CYCLE	~~INCH/CYCLE~~	INCH/CYCLE	INCH/CYCLE

R. L. Paige (MSFC)
11/22/83

1) $$\frac{da}{dN} = C(\Delta K)^N$$

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SPARTAN REM
STRESS ANALYSIS

FORM LMSC 362 B-3

Prepared by: DSM	Date 6/84	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page 4.0.1
Checked by: ESW	Date 6/84	Title SPARTAN REM	Model
Approved by:	Date		Report No.

MARGIN SUMMARY

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ITEM	LOAD CASE	M.S.	PAGE (SEC 4.0)	COMMENTS
TOGLE LINK (30A60695)	+/-/+	3.21	12	TRANSVERSE LOAD ON LUG (TURNBUCKLE CONNECTION)
		1.95	14.1	SHEAR ON LATCHING POST
		5.9	15.1	TRANSVERSE LOAD ON LUG (℄ SUPPORT)
TOGLE LINK LUG (30A60694)	+/-/+	2.51	4.0	TRANSVERSE LOAD ON LUG
		.38	5.1	BENDING
MOUNTING BOLT		.71	9.0	INTERACTION
LUG, PIN (30A60698)	+/-/+	2.39	12	SHEAR
		1.05	15.2	BENDING
TOGLE LINK PIN (30A60700)	+/-/+	1.22	13	SHEAR
		.53	14.0	BENDING
TURNBUCKLE (30A60699)	+/-/+	1.81	16	BEARING
		2.15	17	tension on threads
BELLCRANK (30A60696)	TORQUE 1521 in-lb	.6	18	SHEAR ON SPLINE
		.42	20	LIMIT TORQUE ON SHAFT
		.85	20	TORSION ON SHAFT
		.09	21	COMPRESSIVE STRESS ON SPLINE
		3.3	23	LUG TENSION
ROUND PIN (30A60642) SQUARE PIN 30A60643	+/-/+	.78 ↓	24 ↓	SHANK SHEAR ↓
ROUND PIN PLATE (30A60645)	+/-/+	.8	30	SHEAR TEAR OUT
		1.25	31	SHEAR
		1.92	32	BEARING
MOUNTING BOLTS (NAS1600)		1.30	30	BOLT SHEAR
SQUARE PIN PL (30A60644)	+/-/+	1.81	32	SHEAR TEAR OUT
		.37	33	BENDING

FORM LMSC 3628-3

Prepared by: DSM	Date 6/84	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page 4.02
Checked by: EJW	Date 6/84	Title SPARTAN REM	Model
Approved by:	Date		Report No.

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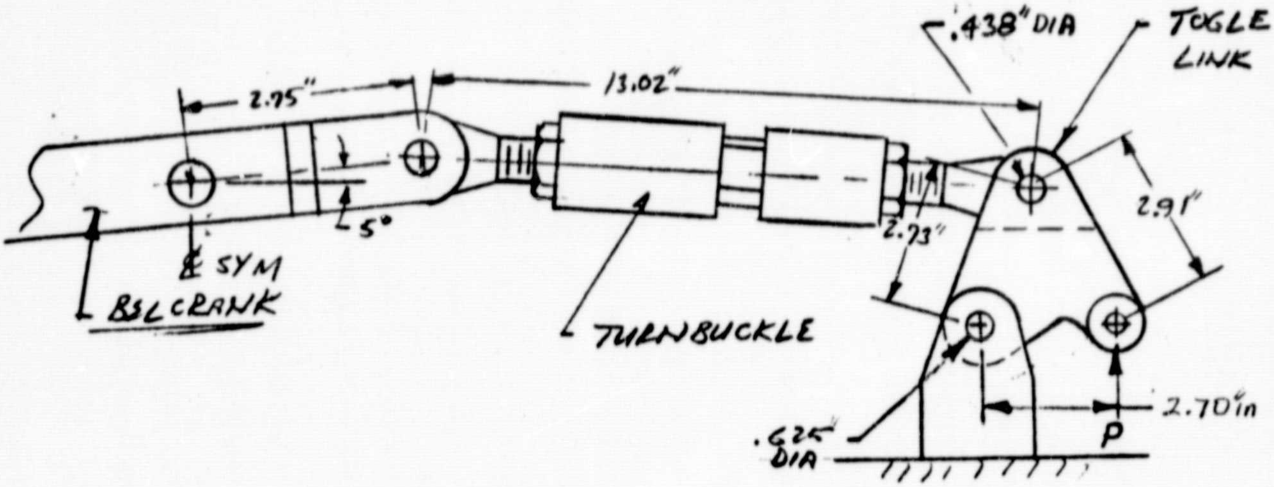
ITEM	LOAD CASE	M.S.	PAGE	COMMENTS
ROD HOLDER (30A6...) SCREWS	MAX ROD LOAD 1560 lb	.39	36	INTERACTION
30A6601648	DOUBLE SHEAR	.33	38	SHEAR
BASE MOUNTING BOLTS	+/-/+	.96	39	INTERACTION
BASE/PDM BOLTS NUTS	+ -/+	.63 .60	40 40	INTERATION TENSION
ADAPTER	-/-/+	2.15	45	TENSION
BASE	+/+/+	1.29	45	TENSION
ADAPTER/PIN INTERFACE	+/-/+	.798	25	SHEAR TEAROUT
PIN BEARING ON CONICAL SHAFT	+/-/+	LARGE	27.1	
HOLE TO BE DRILLED IN ADAPTER	+/-/+	7.28	49	TENSION
LOCATOR ROD (30A6...)	1560 lb BERTHING	.015	38.1	

FORM LMSC 362 B-3

Prepared by: DSM	Date 4/84	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page 1.0 Temp. 4.1 Perm.
Checked by: EJW	Date 6/84	Title	Model
Approved by:	Date	SPARTAN REM	Report No.

LATCHING MECHANISM

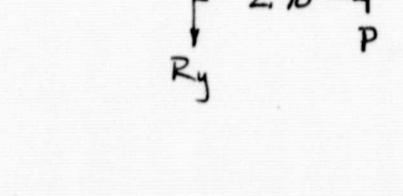


PAYLOAD + FRAME WT = 2500 lb
2.0 G -Y AXIS ACC.

LATCH MECHANISM REACTS TOTAL Y AXIS LOAD

MAX P = 5.19 kips (ref. p 51 PIN REACTION SUMMARY)

LINKAGE FORCES



$$F_T = \frac{P(2.70)}{2.45} = 5.72 \text{ kip}$$

$$R_x = -F = -5.720$$

$$R_y = -P + F_T \sin 1.05°$$

F_T = TURNBUCKLE FORCE

$$= F/\cos 1.05°$$

$$= \frac{5.72}{\cos 1.05°} = 5.720 \text{ kips}$$

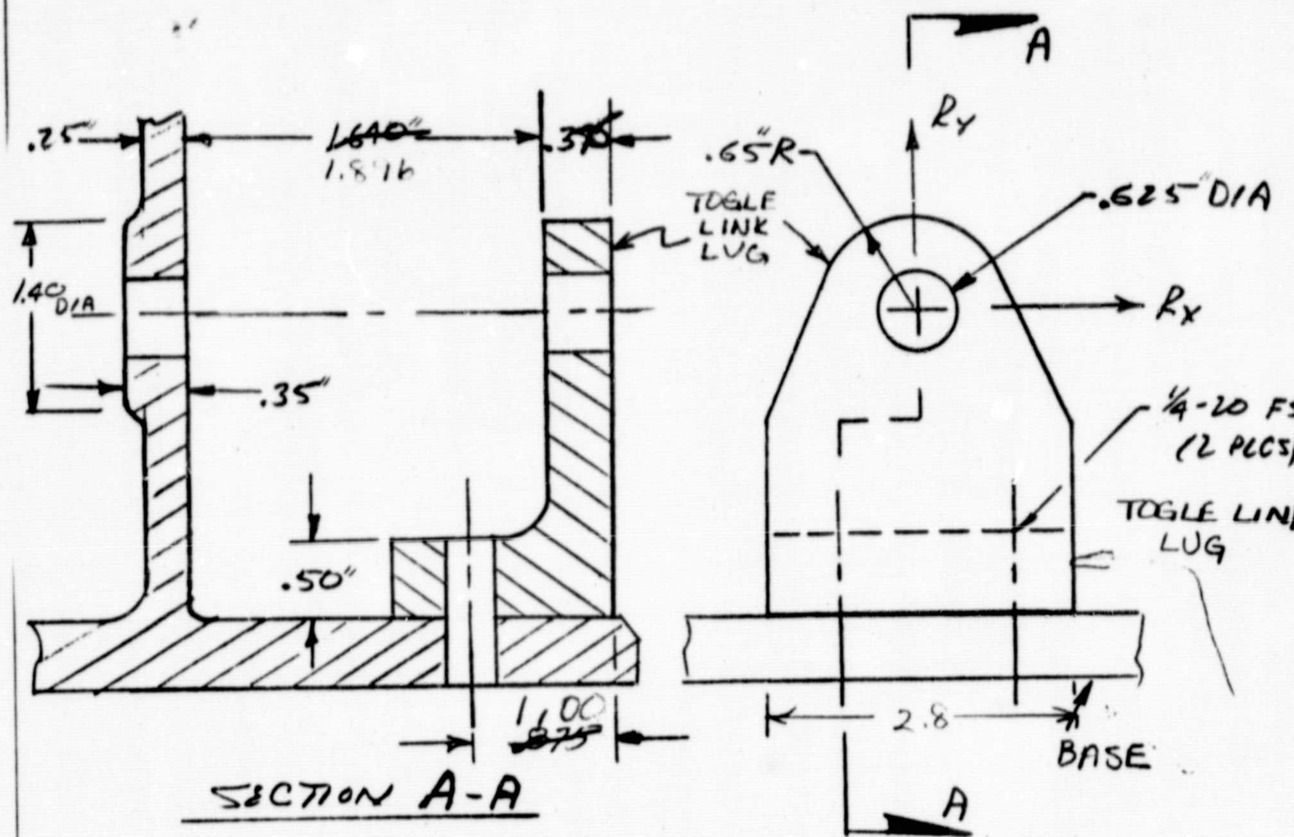
$$R_y = -5.19 + 5.72 \sin 1.05°$$

$$= -5.19 + .105$$

$$R_y = -5.09 \text{ kip}$$

FORM LMSC 362 B-3

LATCHING MECHANISM



MATL - INC 718
F_{tu} = 180 KSI
F_{su} = 113 KSI

TOGLE LINK LUG (30A60694)
(LOADING from NASTRAN RUN N0003111 - App. I
SUMMARY p. 51.)

MAX y AXIS PIN REATION - R_Y = 5.19 Kips

Resulting REACTION - from p 1.0

R_X = 5.72 kip
R_y = 5.09 kip

effective LUG WIDTH @ HOLE = 2(.65") = 1.30 IN

FORM LMSC 362 B-3

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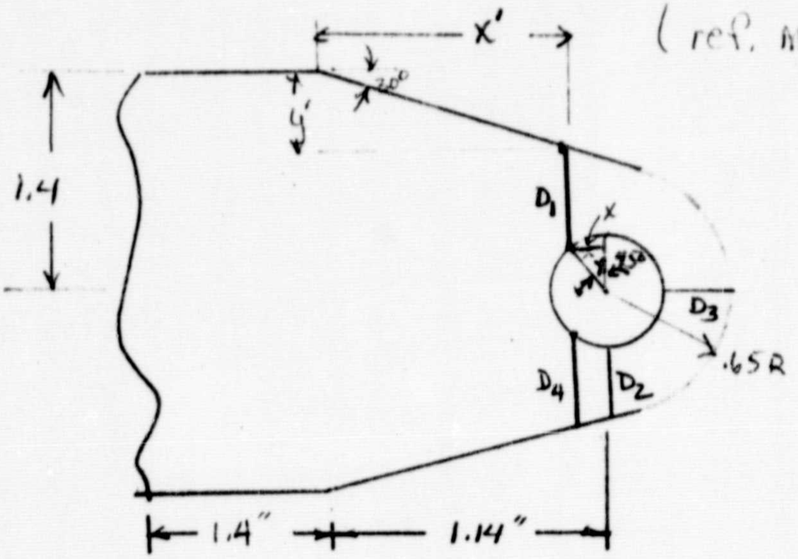
Approved by:	Date		Report No.

LATCHING MECHANISM — TOGLE LINK LUG TRANSVERSE LOADS

ref. fig p2

(ref. MSFC STRUCTURES MANUAL B2)



DIA = .625"

$D_3 = .65 - \frac{.625}{2}$
$= .3375$

$D_2 \approx D_3 = .3375$

$A_{br} = Dt = .625(.375)$
$= .234$

$y = (\cos 45^\circ).3125 = .221$

$\frac{x}{y} = \tan 45^\circ \Rightarrow x = y = .221$

$x' = 1.14 - x = .919''$

$y' = x' \tan 30^\circ = .919(.577)$
$= .531''$

$D_1 = D_4 = 1.4 - y - y' = 1.4 - .221 - .531$
$= .648\text{ IN}$

$t = .375''$

$A_1 = D_1 t = .648(.375) = .243\text{ in}^2$

$A_2 = A_3 = D_2(t) = .3375(.375) = .1266\text{ in}^2$

$A_4 = D_4 t = D_1 t = .243\text{ in}^2$

$$A_V = \frac{6}{3/A_1 + 1/A_2 + 1/A_3 + 1/A_4} = \frac{6}{\frac{4}{A_1} + \frac{2}{A_2}} = .186$$

$\frac{A_{AV}}{A_{br}} = \frac{.186}{.234}$
$= .795$

LATCHING MECHANISM (cont.)

TOGLE LINK LUG (30A60694)

from p. 3.0 $\frac{A_{av}}{A_{br}} = .795 in^2,\ A_{br} = .234 in^2$

SHEAR BEARING

$P_{tru} = K_{tru} A_{br} F_{tu}$

from graph on p. 4.1 $K_{tru} = .59$

$P_{tru} = .59(.234)(180000) = 24.85$ kips

AXIAL

$e/D = 1.04,\ W/D = \frac{1.3}{.625} = 2.08,\ \frac{D}{t} = \frac{.625}{.375} = 1.67,\ A_t = \frac{W-D}{t} = 1.8$

from graph p 4.2, $K_{br} = .86$

SHEAR BEARING

$P_{tu} = K_{br} A_{br} F_{tu} = .86(.234)(180000) = 36.22$ kips

COMBINED AXIAL & TRANSVERSE LOADING

LOADING ON LUG — (p. 2.0)

$R_x' = 5.72/2 = 2.86$ kips

$R_y' = 5.09/2 = 2.55$ kips

$R_A = \frac{2.86(2)}{36.22} = .158$ $\qquad R_{tr} = \frac{2.55(2)}{24.85} = .21$

$$M.S._u = \frac{1}{(R_a^{1.6} + R_{tR}^{1.6})^{.625}} - 1$$

$$= \frac{1}{.0522 + .082} - 1 = \underline{2.51}$$ ULT SHEAR BEARING

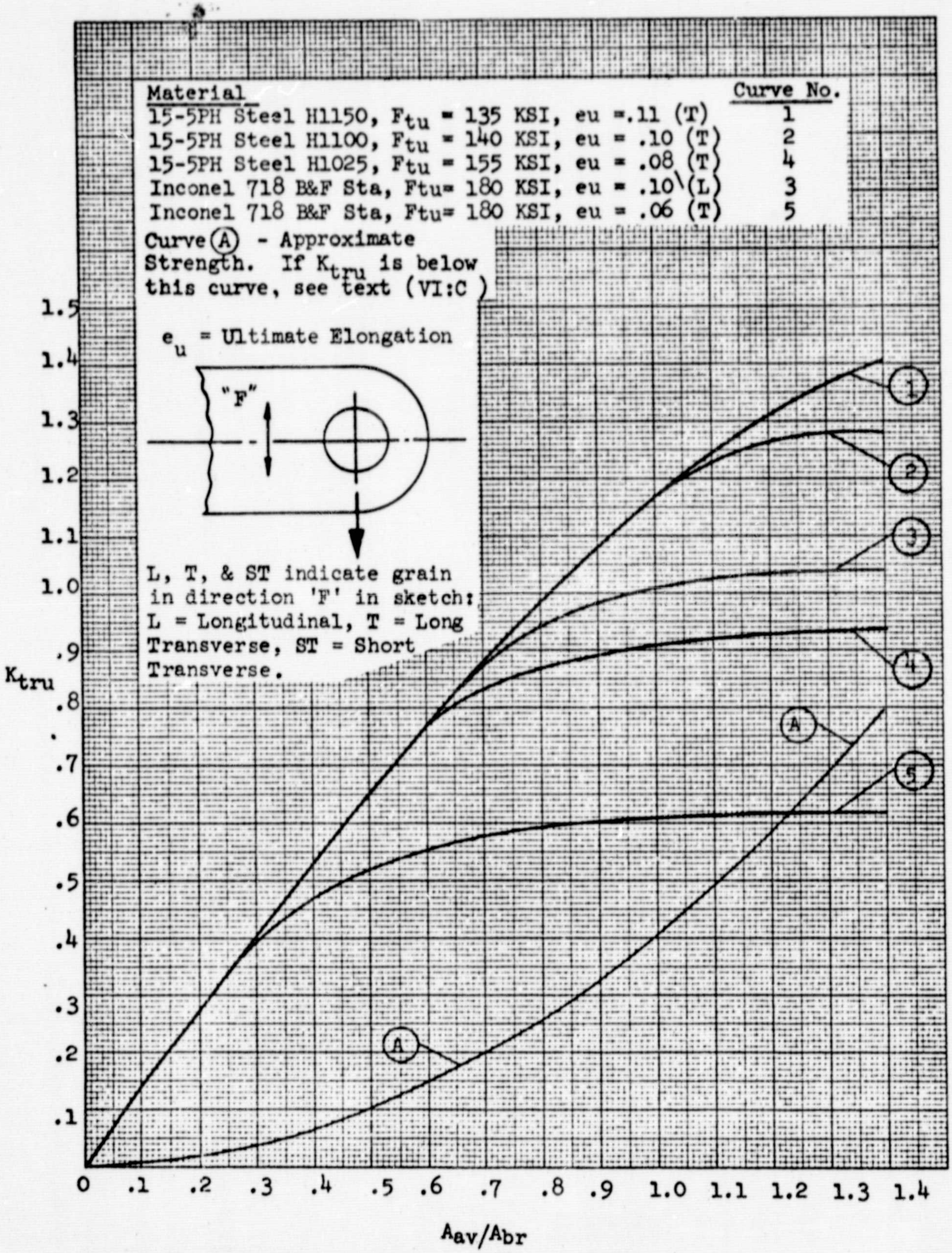


FIGURE 7e EFFICIENCY FACTORS OF LUGS FOR TRANSVERSE LOADING, ALLOY STEEL AND HEAT RESISTANT ALLOYS

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CALIFORNIA COMPANY

LOCKHEED-CALIFORNIA COMPANY

DRIG...

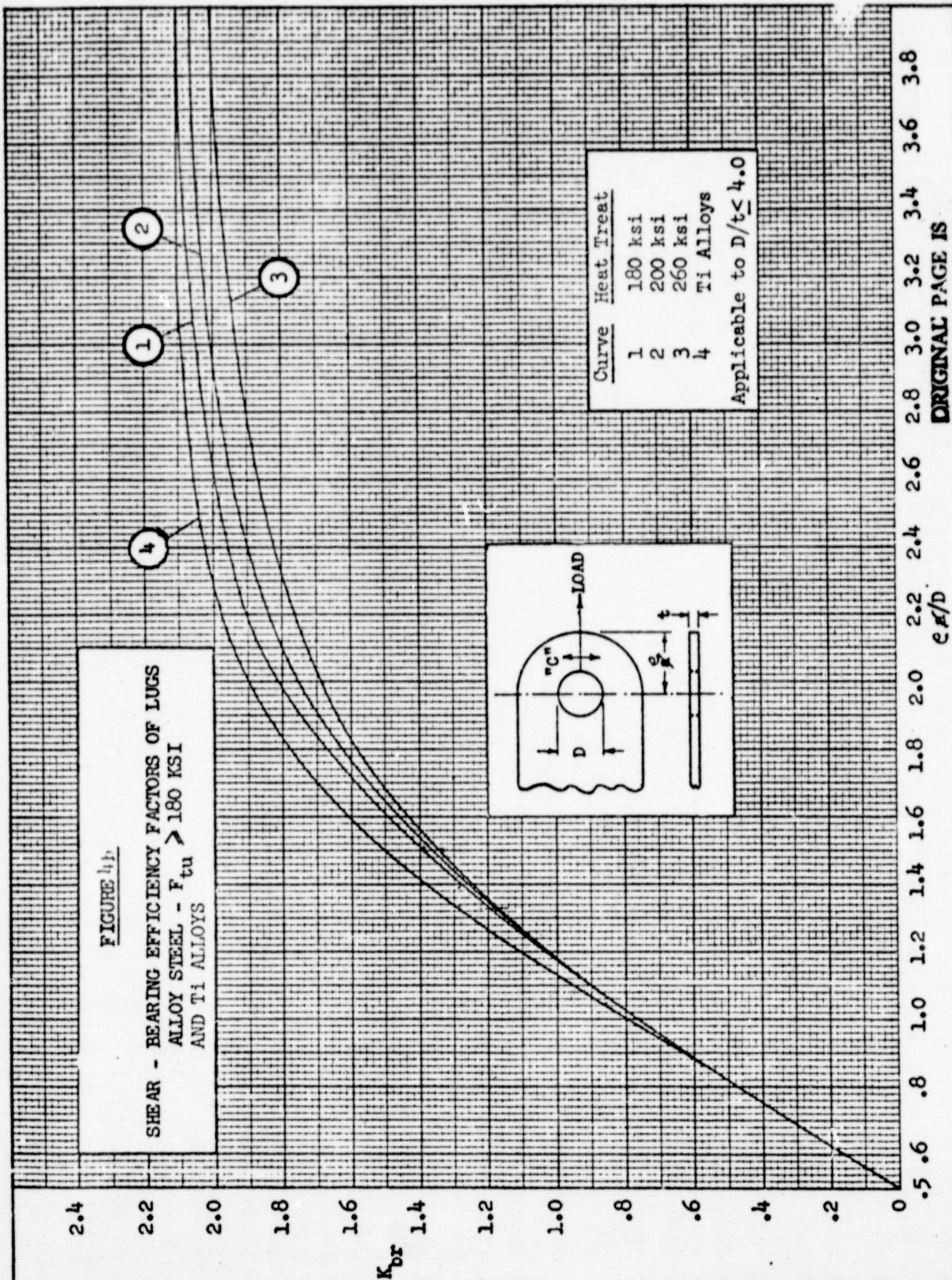

FIGURE 4b

SHEAR - BEARING EFFICIENCY FACTORS OF LUGS ALLOY STEEL - $F_{tu} > 180$ KSI AND Ti ALLOYS

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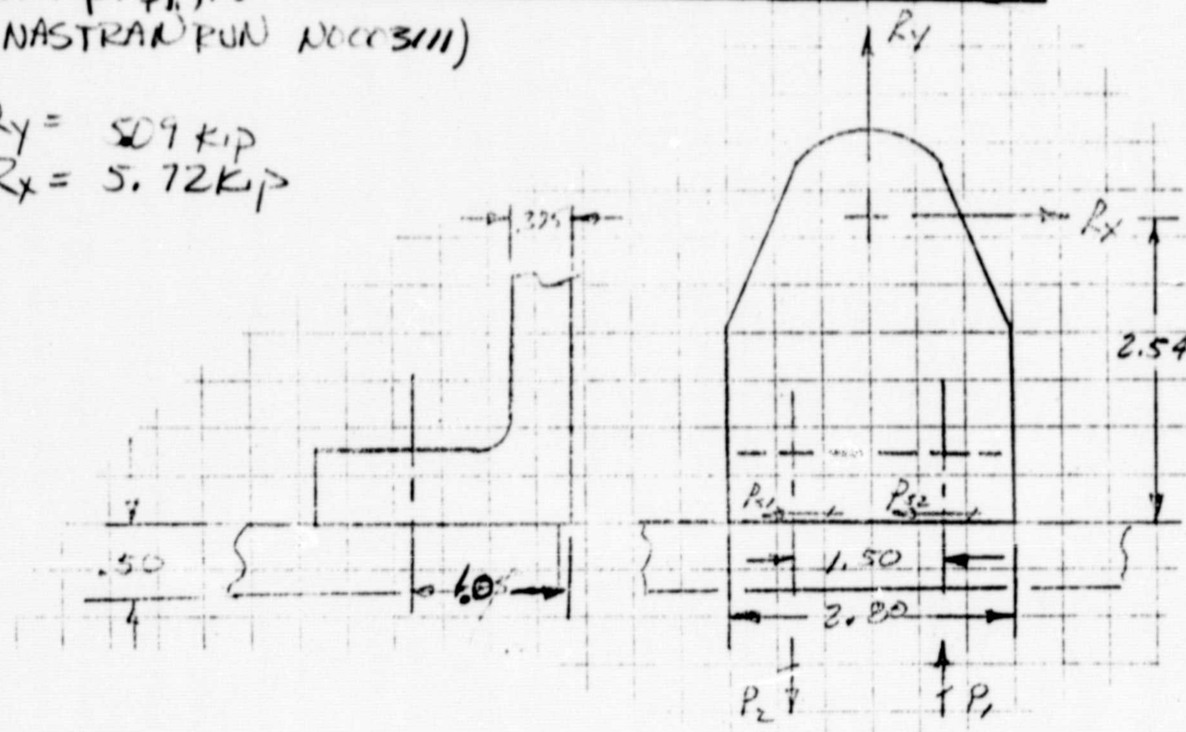
LATCHING MECHANISM (cont.)

TOGLE LINK LUG INTERFACE

FROM P. 51, 1.0
(NASTRAN RUN N0003111)

$R_y = 5.09$ Kip
$R_x = 5.72$ Kip



@BASE INTERFACE

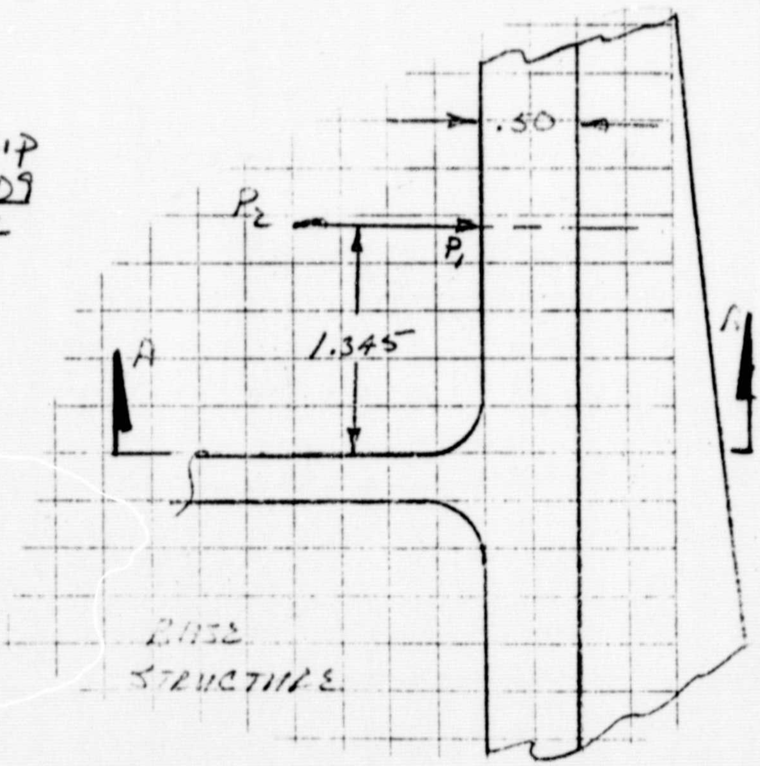
$$P_{s1} = P_{s2} = \frac{5.72}{2} = 2.86 \text{ Kip}$$

$$P_2 = \frac{5.72(2.54)}{1.5} + \frac{5.09}{2}$$

$$\underline{P_2 = 12.23 \text{ Kip}}$$

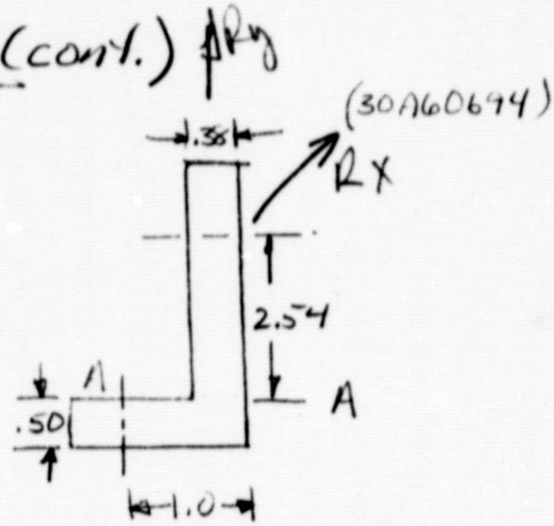
$$P_1 = -5.72\,\frac{2.54}{1.5} + \frac{5.09}{2}$$

$$\underline{P_1 = -7.14 \text{ Kip}}$$



LATCHING MECHANISM (cont.)

LUG BENDING @ BASE



SECTION A-A

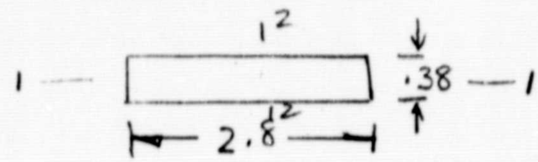
$A = 2.8(.38) = 1.064\ in^2$

$I_1 = \frac{bh^3}{12} = \frac{2.8(.38)^3}{12} = .0128\ in^4$

$I_2 = \frac{.38(2.8)^3}{12} = .695\ in^4$

$I_1/c = \frac{.0128}{.19} = .067\ in^3$

$I_2/c = \frac{.695}{1.4} = .496\ in^3$



$R_x = 5.72$ kip
$R_y = 5.09$ kip $\Big\}$ ref p. 1.0

$M_{11} = R_y\left[(1.0) - \frac{.38}{2}\right] = 5.09(.81) = 4.12$ in-kip

$M_{22} = R_{xx}(2.54) = 14.53$ in-kip

$f_{b1} = \frac{M_{11}}{I_1/c} = \frac{4.12}{.067} = 61.49$ ksi

$f_{b2} = \frac{14.53}{.496} = 29.29$ ksi

FROM MSFC STRUC. MANUAL, B4
K = 1.5

$f_{b\,MAX} = 61.49 + 29.29 = \underline{90.78\ ksi}$

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$f_t = \frac{R_y}{A} = \frac{5.09}{1.064} = 4.78$ ksi

$F_{bu} = 270$ ksi $\quad R_b = \frac{(2)(90.78)}{270} = .67, \quad R_t = \frac{2(4.78)}{180} = .053$

$M.S._u = \frac{1}{R_b + R_t} - 1 = \underline{.38}$

FORM LMSC 362 B-3

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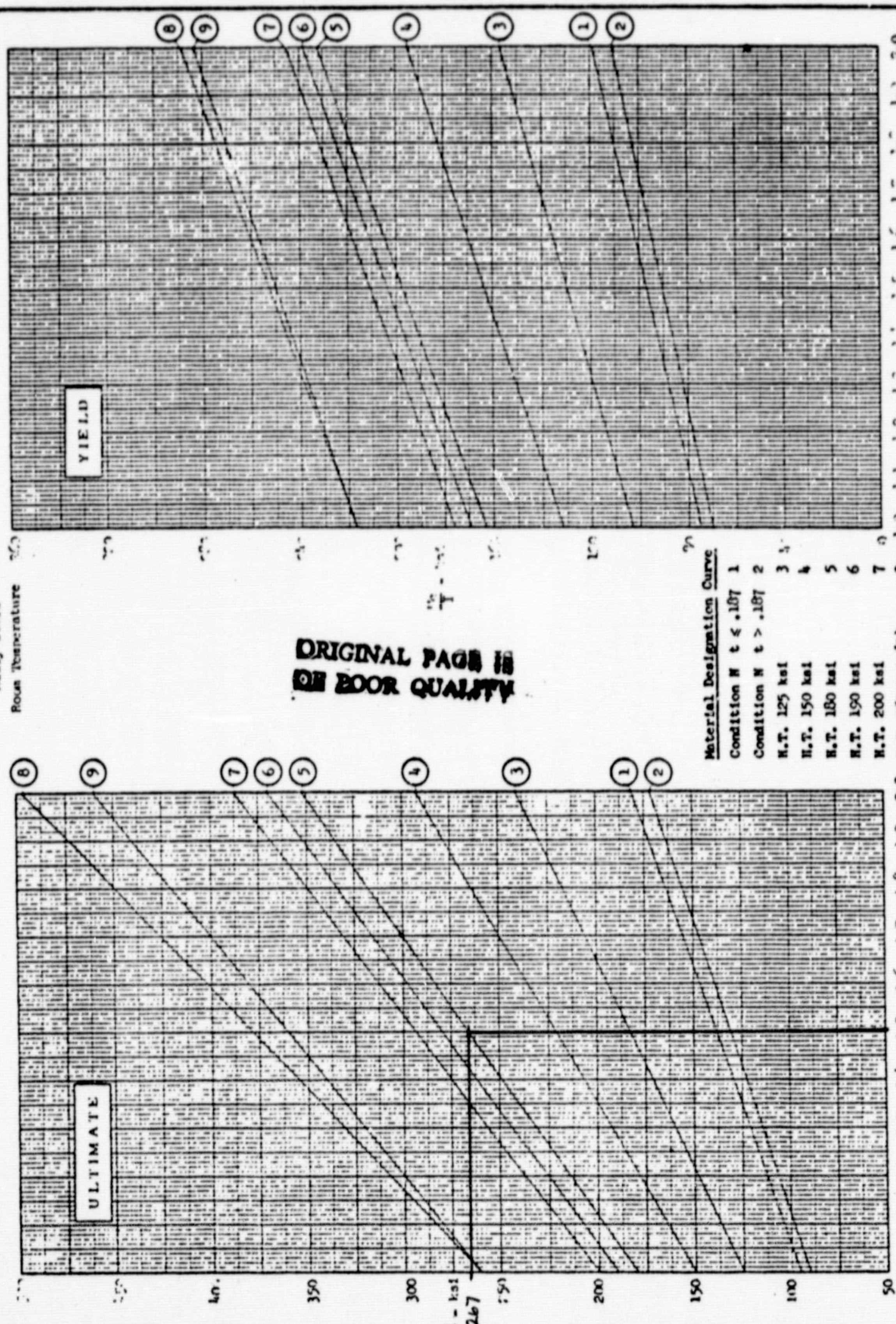
4.6.1

FIGURE 5b

Ultimate and Yield Values of $\frac{Mc}{I}$ for Symmetrical Sections

Alloy Steel

Room Temperature



Material Designation	Curve
Condition N $t \leq .187$	1
Condition N $t > .187$	2
H.T. 125 ksi	3
H.T. 150 ksi	4
H.T. 180 ksi	5
H.T. 190 ksi	6
H.T. 200 ksi	7
H.T. 260 ksi (L)	8
H.T. 260 ksi (T)	9

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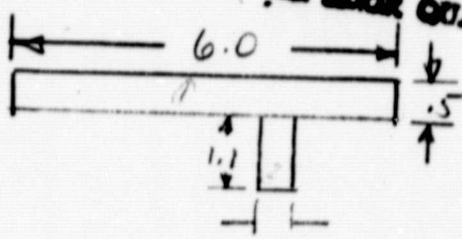
LATCHING MECHANISM (cont.)

NO	A	Y	Ay	Ay²	Io
1	3.0	.25	.75	.187	.062
2	.42	1.05	.441	.463	.042
	3.42		1.191	.65	.114

$\bar{y} = .348 \text{ in}$ $\quad C_{MAX} = 1.252$

$I_y = .350 \text{ in}^4$

$I/C_{MAX} = .279 \text{ in}^3$



SECTION A-A
(from SKETCH on previous page)

$M_{AA} = (P_2 - P_1)\,1.345 = 5.09(1.345)$
$= 6.85 \text{ in-lb}$

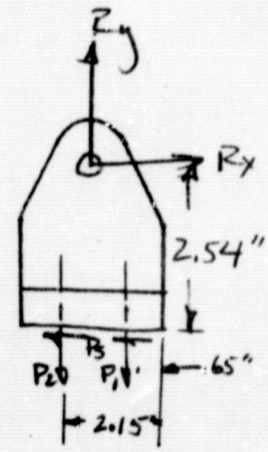
$f_b = \dfrac{6.85}{.279} = 24.55 \text{ KSI}$

$F_{bu} = 1.5 \times 63 = 94.5 \text{ KSI}$

$M.S._u = \dfrac{94.5}{2(24.55)} - 1 = \underline{.92}$

MOUNTING BOLT LOADS

from NASTRAN RUN N0003111, #1
$R_x = 5.72 \text{ KIP}$
$R_y = 5.01 \text{ KIP}$



DUE TO R_x LOAD
$P_2(2.15) + .65P_1 = 5.72(2.54)$
$P_1 = \dfrac{.65}{2.15} P_2$

$\therefore\ 2.15P_2 + \dfrac{.65^2}{2.15} P_2 = 14.53 \text{ K}$

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LATCHING MECHANISM (cont.)

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LUG MOUNTING BOLTS (cont.)

$$2.346\,P_2 = 14.53$$
$$P_2 = 6.19 \text{ kip}$$

$$P_1 = \frac{.65}{2.15}(6.19) = 1.87 \text{ kip}$$

Due to Ry loading (ref. Ry on previous page)

$$P_1 = P_2 = \frac{5.09}{2} = 2.545 \text{ kip}$$

$$P_{2_T} = 2.545 + 6.19 = 8.735 \text{ kip}$$

$$P_{1_T} = 2.545 + 1.87 = 4.415 \text{ kip}$$

BOLTS 5/16 DIA NAS1957C

$$P_{TU} = 23.2 \text{ kip}$$
$$P_{su_{ss}} = 16.25 \text{ kip}$$

SINCE BOLTS ARE TESTED ITEMS - F.S = 1.4

$$M.S._u = \frac{23.2}{1.4(8.735)} - 1 = .897 \quad \text{TENSION}$$

$$\text{BOLT SHEAR} = \frac{5.72}{2} = 2.86 \text{ kip/BOLT}$$

$$M.S._u = \frac{16.25}{1.4(2.86)} - 1 = 3.05 \quad \text{SHEAR}$$

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LATCHING MECHANISM (CONT.)

TOGLE LINK LUG INTERFACE (CONT.)

BOLT INTERACTION -

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$$R_t = \frac{1.4\,(8.735)}{23.2} = .527$$

$$R_s = \frac{1.4\,(2.86)}{16.25} = .246$$

$$M.S._u = \frac{1}{.527} - 1 = \underline{.71} \quad \text{ULT INTERACTION}$$

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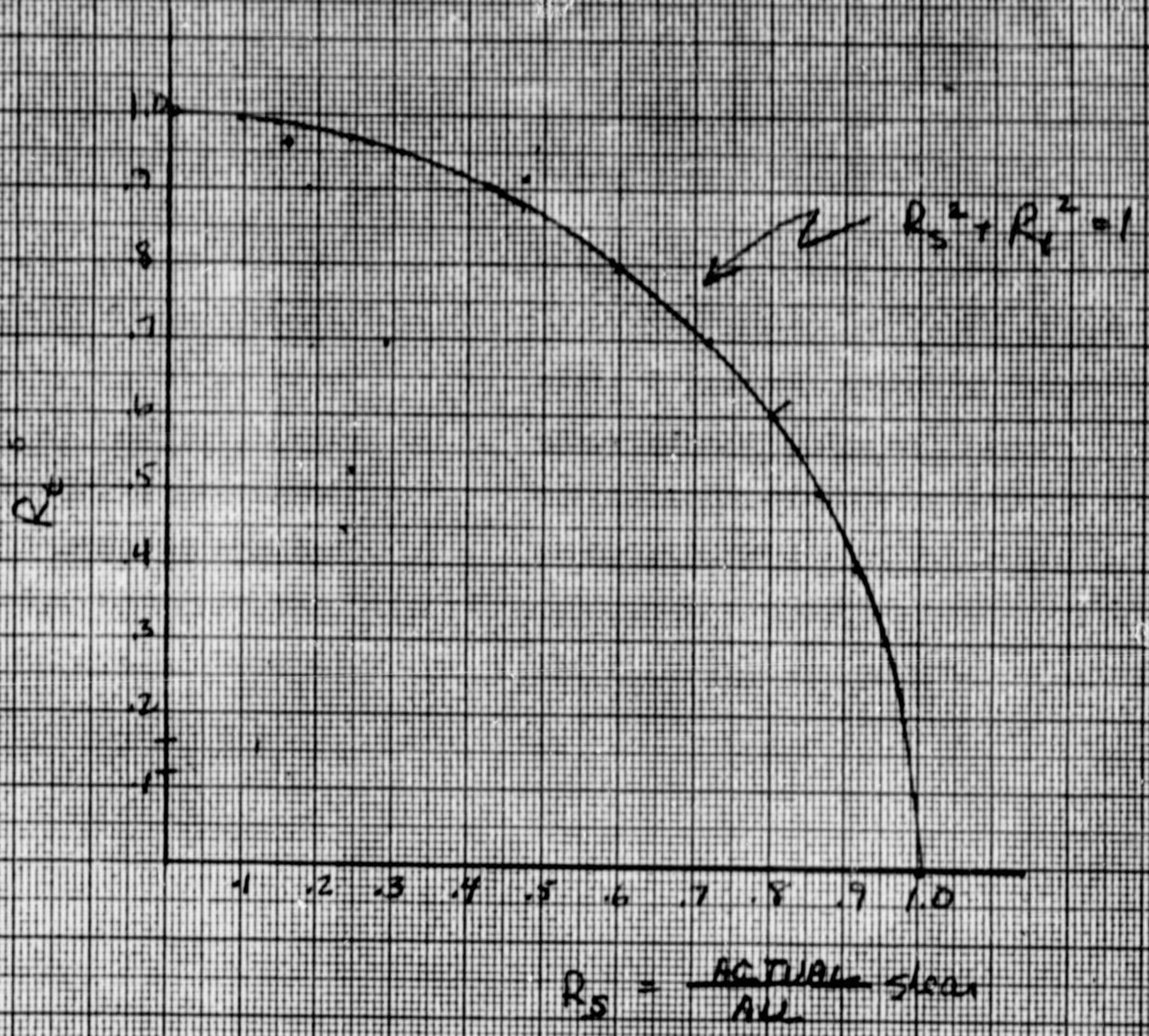

BOLT INTERACTION

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LATCHING MECHANISM

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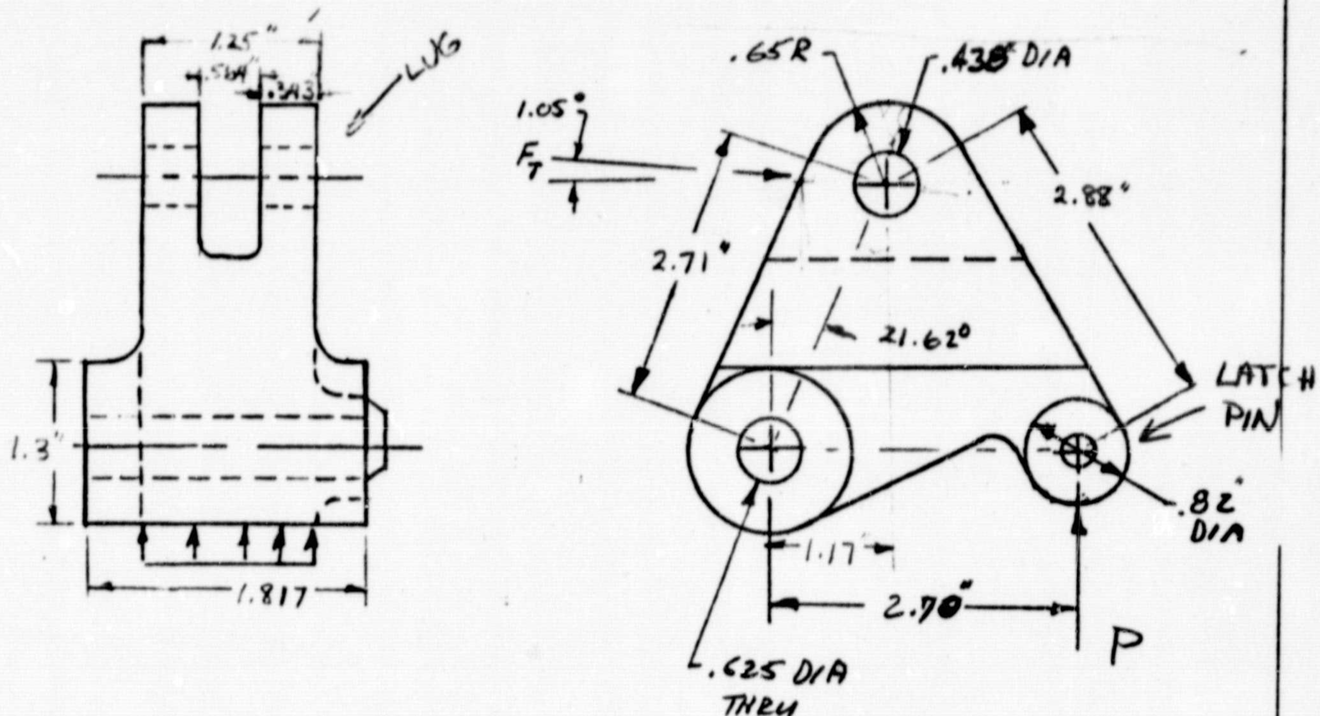
TOGLE LINK (30A60695)



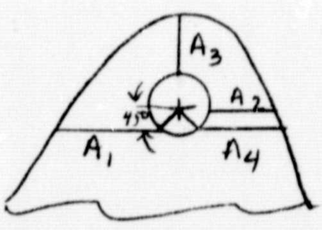
FROM NASTRAN SUMMARY $P_{MAX} = 5.19$ kips (p. 10)

$$F_t = \frac{5.19(2.7)}{2.45} = 5.72 \text{ kips}$$

$$LOAD/LUG = \frac{5.72}{2} = 2.86 \text{ kips}$$

MATL 4340 STL
$F_{tu} = 180$ KSI

$A_{Brg} = .438(.343) = .15 \text{ in}^2$, $A_t = (1.3 - .438)t = .296 \text{ in}^2$



ref p 3 for procedure

$A_1 \cong A_4 = .343(.61) = .21 \text{ in}^2$

$A_3 \cong A_2 = (.65 - .219)t = .148 \text{ in}^2$

$$A_{vg} = \frac{6}{\frac{3}{A_1} + \frac{1}{A_2} + \frac{1}{A_3} + \frac{1}{A_4}} = \frac{6}{\frac{4}{A_1} + \frac{2}{A_2}} = .184, \quad \frac{A_v}{A_{Br}} = \frac{.184}{.15} = 1.23$$

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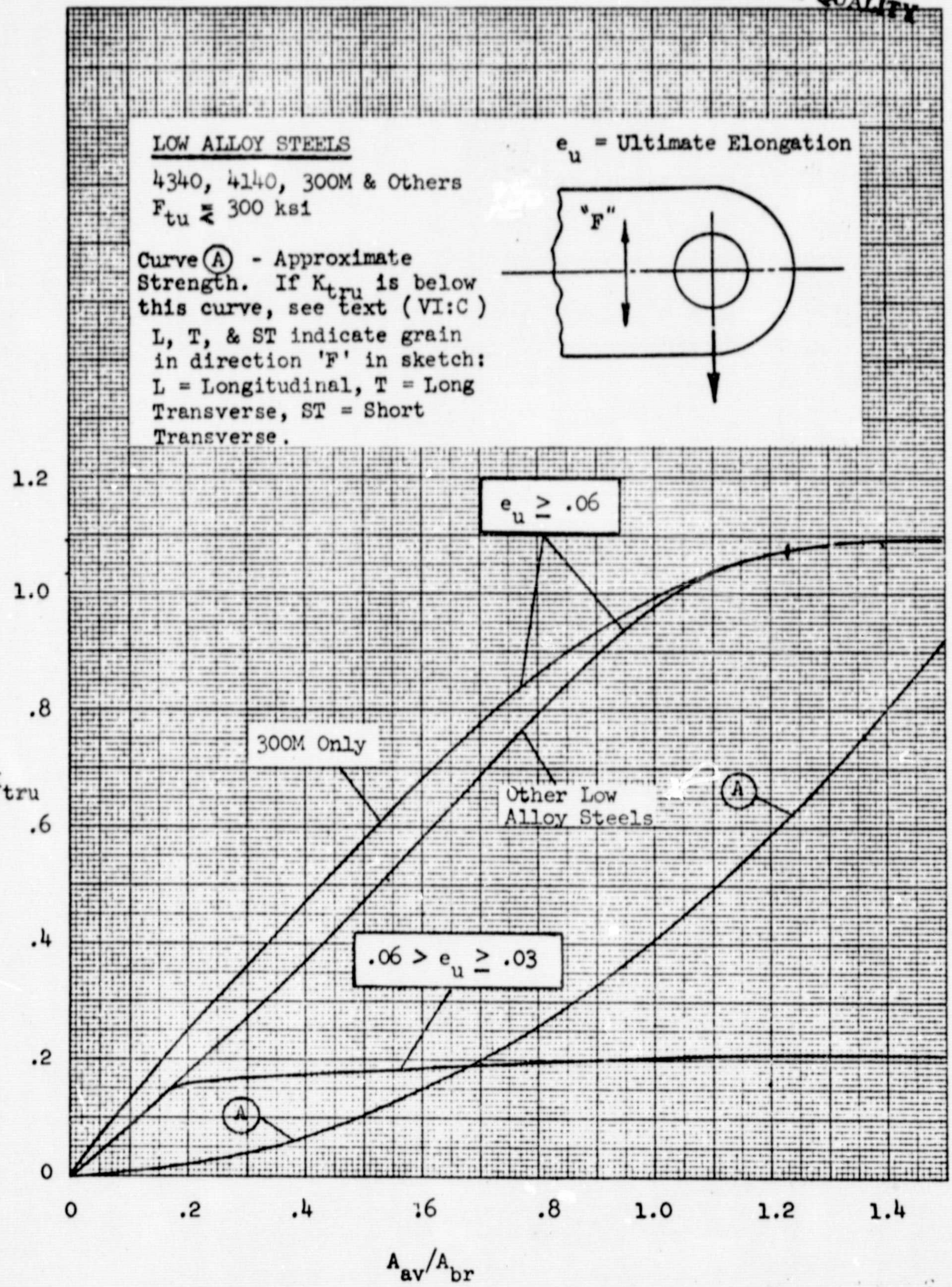

FIGURE 7d EFFICIENCY FACTORS OF LUGS FOR TRANSVERSE LOAD LOW-ALLOY STEELS

TOGLE LINK (CONT.)

TRANSVERSE LOADS – SHEARBEARING

$P_{TRU} = K_{TRU} A_{BR} F_{tu}$

from graph on p. 11 $\quad K_{TRU} = 1.07$

$P_{TRU} = 1.07(.15)(150) = 24.10$ kips

$$M.S_u = \frac{24.10}{2(2.86)} - 1 = \underline{3.21 \quad ULT}$$

LUG DIA (30A60698) SHEAR

from p. 1.0 $\quad R_x = 5.72$ kip
$R_y = 5.09$ kip

PIN DIA = .625"
$A = .306\ in^2$

MATL – INC 718
$F_{su} = 113$ KSI

$P_s = \sqrt{5.72^2 + 5.09^2} = 7.66$ kips

$$f_s = \frac{4/3\ P_s}{2A} = \frac{4}{3}\ \frac{7.66}{2(.306)} = 16.69\ KSI$$

$$M.S._{su} = \frac{113}{2(16.69)} - 1 = \underline{2.39 \quad ULT\ SHEAR}$$

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LATCHING MECHANISM (cont.)

TOGLE LINK PIN (30A60700)

MATL INC 718
$F_{su} = 113$ KSI
$F_{tu} = 180$ KSI

SHEAR

REF P 1.0 , $t = 5.72$ Kip

PIN DIA = .438"
$A_s = .15 \text{ in}^2$

$$S_{max} = \frac{4/3(5.72)}{2(.15)} = 25.42$$

$$M.S._u = \frac{113}{2(25.42)} - 1 = 1.22 \text{ ULT SHEAR}$$

LATCHING MECHANISM (CONT.)
TOGLE LINK PIN (30A60700)

BENDING - ref MSFC STRUCTURES MANUAL, B2

from p 10
$t_1 = .343"$
$t_2 = .47"$
$D = .438"$

$P_{br_2} = 32.14$ kips

e = .3625"

$r = \left(\frac{e}{D} - \frac{1}{2}\right)\frac{D}{t_2}$ for INNER LUG

$= \left(\frac{.5625}{.438} - \frac{1}{2}\right)\frac{.438}{.47} = .731$

$g = \frac{.564 - .47}{2}$

$= .047$

$P_u / A_{br} F_{tu} = \frac{32.14}{.206(150)} = 1.04$

REDUCTION FACTOR - from Fig B2.1.0-6 $\gamma = .525$

moment ARM $b = \frac{t_1}{2} + g + \gamma \frac{t_2}{4} = \frac{.343}{2} + .047 + \frac{.525(.47)}{4}$

$= .1715 + .047 + .062$

$.281$

$M = P\left(\frac{b}{2}\right) = P(.1405)$

from p 14 P = 5.72 kip , M = .804 KIPS-IN

$f_b = \frac{My}{I} = \frac{.804(.219)}{.0018} = 97.82$ KSI

$I = .0018$ in^4

$y = \frac{.438}{2} = .219$

PLASTIC BENDING $F_{bu} \cong 300$ KSI

$M.S. = \frac{300}{2(97.82)} - 1 = \underline{.53}$

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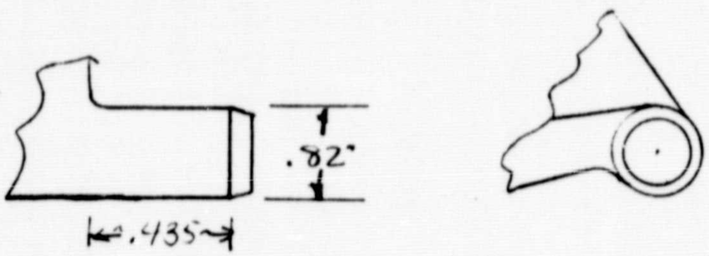
LATCHING MECHANISM cont.

TOGLE LINK (cont.) (30A60695)

BENDING OF LATCH PIN -
THIS IS THE PIN THAT ENGAGES WITH THE LATCH HOOK



BENDING NOT CRITICAL DUE TO SHORT LENGTH .435"

SHEAR ON PIN

$A = \left(\frac{.82}{2}\right)^2 \pi = .528 \, in^2$ $\qquad P = 5.72 \, kips$ (p. 1.10)

$f_{s_{MAX}} = \frac{4}{3} \frac{P}{A} = \frac{4}{3} \frac{(5.72)}{.528} = 14.44 \, ksi$

$M.S._u = \frac{85.5}{2(14.44)} - 1 = 1.95$ ULT SHEAR

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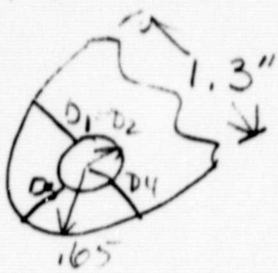
LATCHING MECHANISM (CONT.)

TOGLE LINK

LUG PIN HOLE (.625")



SEE P. 3 FOR PROCEDURE

assume $D_1 = D_4 = D_2 = .3375$
$D_3 = .3375$

$$A = 1.817(.3375) = .613 \text{ in}^2$$

$$A_{AV} = \frac{6}{6/A} = A = .613$$

$$A_{br} = Dt = .625(1.817) = 1.14 \text{ in}^2$$

$$\frac{A_V}{A_{BR}} = \frac{.613}{1.14} = .54 \qquad K_{tru} = .52$$

TRANSVERSE

$$P_{TRU} = K_{tru} A_{br} F_{tu} = .52(1.14)(150)$$
$$= 88.92 \text{ kips}$$

AXIAL

$\frac{e}{D} = \frac{.165}{.625}$, $\frac{W}{D} = \frac{1.3}{.625}$ $\frac{D}{t} = \frac{.625}{1.817}$ $A_t = (1.3 - .625)(1.817)$

$\frac{e}{D} = 1.84$ $\frac{W}{D} = 2.08$ $\frac{D}{t} = .344$ $= 1.23 \text{ in}$

from graph on p. 15.3 $K_t = .94$

$$P_{TU} = K_t A_t F_{tu} = .94(1.23)(150) = 173.4$$

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LATCHING MECHANISM (CONT.)

TOGLE LINK - LUG PIN HOLE (CONT.)

COMBINED AXIAL & TRANSVERSE LOADS
p. 4

$R_x = 5.72$ kips
$R_y = 5.09$ kips

$$R_A = \frac{2(5.72)}{173.4} = .07 \qquad R_{TR} = \frac{5.09(2)}{88.92} = .114$$

$$M.S._u = \frac{1}{(.07^{1.6} + .114^{1.6})^{.625}} - 1 = \underline{5.9 \quad ult}$$

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LATCHING MECHANISM cont.

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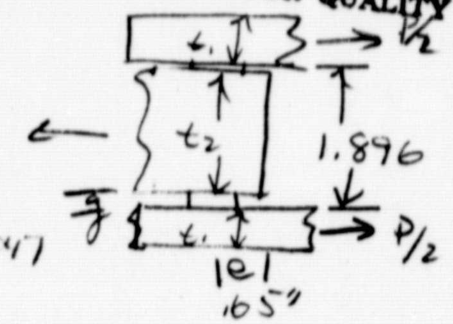
LUG PIN (30A60698)



BENDING

$t_1 = .35$ IN

$t_2 = 1.817$

$g = \text{gap} = \dfrac{1.896 - 1.817}{2} = .047$

$P_{TRU} = 28.89$

ref MSFC STRUCT. MANUAL p B2.5

$r = \left[\frac{e}{D} - \frac{1}{2}\right]\frac{D}{t_2} = \left(\frac{.65}{.625} - \frac{1}{2}\right)\frac{.625}{1.817} = .27$

from graph B2.1.0-6

from p. $P_u = 88.72$ kips

$\dfrac{P_u}{A_{br} F_{tu}} = .52$ from graph B2.1.0-6 MSFC STRUCT MAN.

$r = .52$

$\therefore b = \dfrac{.35}{2} + .047 + .52\left(\dfrac{1.817}{4}\right)$

$= .458$

$M = \dfrac{Pb}{2} = \dfrac{7.66}{2}(.458) = 1.75$ IN-kips

$S_b = \dfrac{My}{I} = \dfrac{1.75(.3125)}{.0075} = 72.9$ ksi

$k = 1.7$ $F_{bu} = 300$ ksi PLASTIC BENDING

$M.S._u = \dfrac{300}{72.9(2)} - 1 = \underline{1.05 \quad ULT}$

4.15.3

LOCKHEED-CALIFORNIA COMPANY

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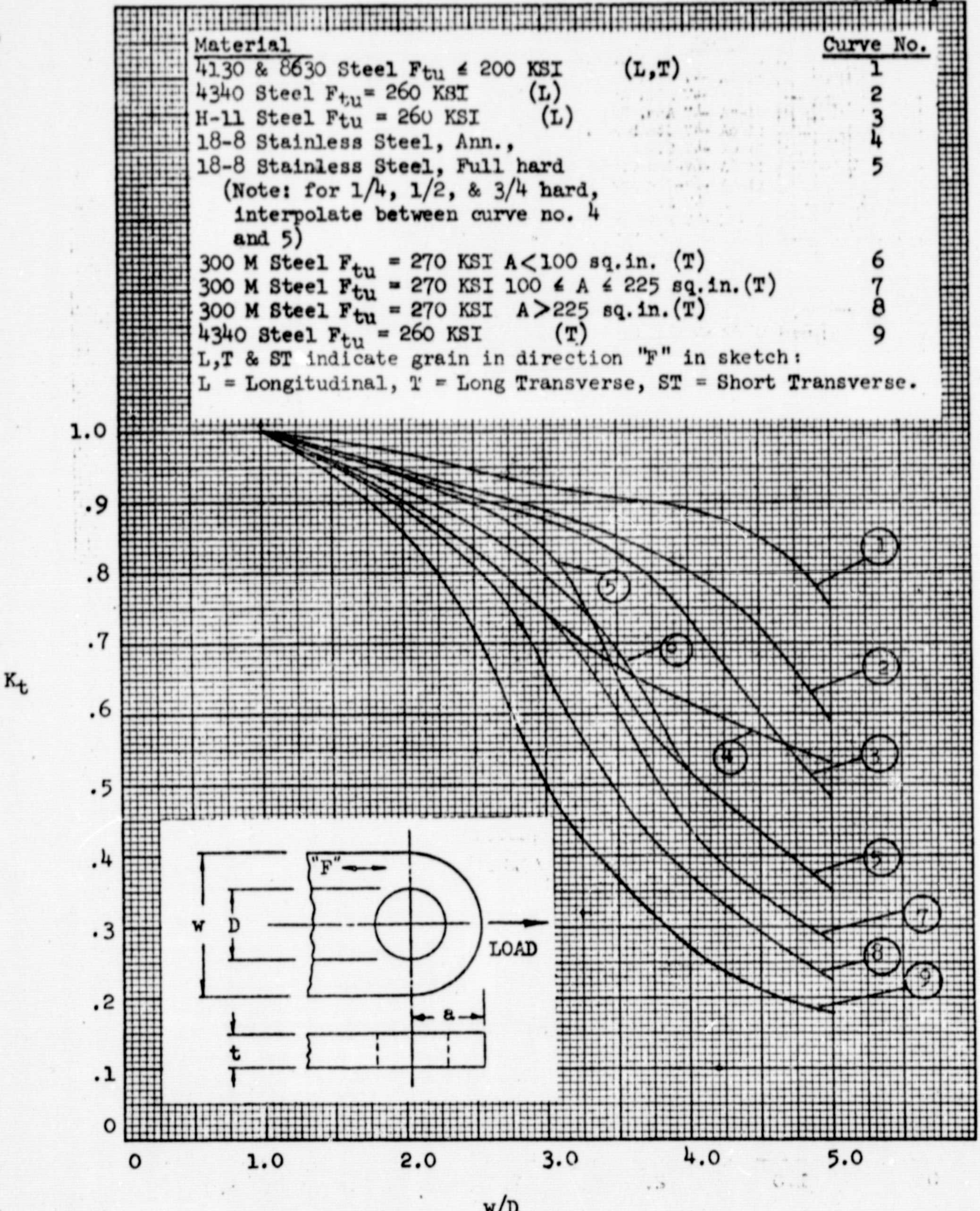

FIGURE 5c TENSION EFFICIENCY FACTORS OF LUGS FOR AXIAL LOADING
STEEL

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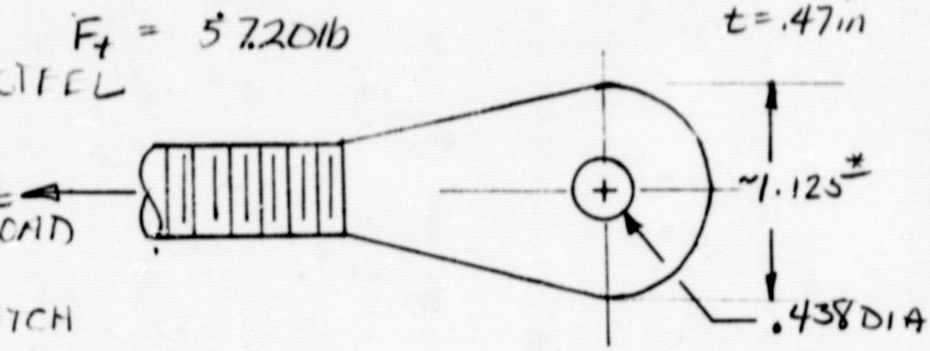
LATCHING MECHANISM (cont.)

TURNBUCKLE ROD END

from p. 1.12 F_t = 5720 lb

MATL 4340 STEEL

F_{tu} = 150 ksi



MAX TENSION LOAD
– ASSUMES LOAD REVERSAL IN LATCH

* MEASURED OFF ASSEMBLY 30A60699

$\frac{a}{D} = \frac{.5625}{.438} = 1.28''$, $\frac{D}{t} = \frac{.438}{.47} = .93''$

$\frac{w}{D} = \frac{1.125}{.438} = 2.57''$

$A_{BRG} = .438(.47) = .206\ in^2$, $A_t = (1.125 - .438)(.47) = .323\ in^2$

SHEAR BEARING –

$P_{BRU} = K_{BR} A_{BR} F_{tu}$

$= 1.04(.206)(150000)$

$P_{BRU} = 32136\ lb$

$K_{BR} = 1.04$
ref MSFC STRUC. MANUAL B2

TENSION –

$P_{tu} = K_t A_t F_{tu}$

$= .915(.323)(150000)$

$P_{tu} = 44,332\ lb$

$k_t = .915$

$M.S._u = \frac{32.14}{(2)(5.72)} - 1 = 1.81$ ULT SHEAR BEARING

TURNBUCKLE BARREL ADEQUATE BY INSPECTION.

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LATCHING MECHANISM (CONT.)

THREADED SECTION

5/8 - 18 THDS $A_R = .24 in^2$

$$f_t = \frac{5.72}{.24} = 23.83 \text{ ksi}$$

$$M.S._u = \frac{150}{(.2)(23.83)} - 1 = \underline{2.15}$$

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LATCHING MECHANISM (cont.)

BELLCRANK
(30A600696)

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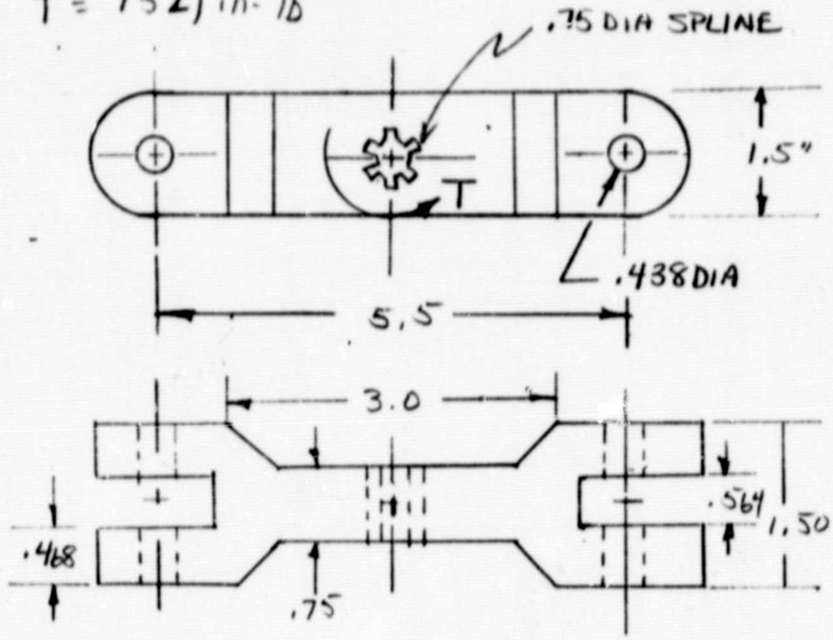
$T = 1521$ in-lb



SPLINE STRESSES

Shear stress @ PITCH DIA OF TEETH:
ref. MACHINERY'S HDBK p 1023

$$f_s = \frac{4 T K_A K_m}{D N L_e t K_f}$$

$K_A = 1.2$, $K_m = 1.0$, $K_f = 1.0$
$L_e = .70$, $t = .186$
(assumes 1/2 of teeth reacting T)

$$f_s = \frac{4(1521)(1.2)(1.0)}{.75(6)(.70)(.186)(1.0)}$$

$S_s = 12460$ psi , $F_{su} = 40$ ksi (ref MACHINERY's HDBK TABLE 5)

$$M.S._u = \frac{40}{2(12.46)} - 1 = .60 \quad ULT$$

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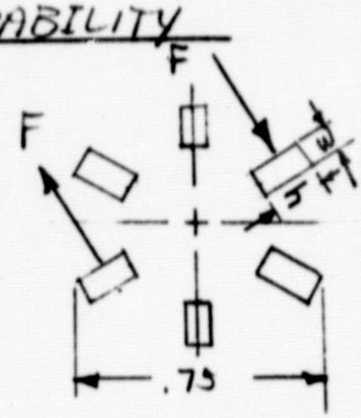
LATCHING MECHANISM (cont.)

MAXIMUM SPLINE TORQUE CAPABILITY



MATL - 4340 STEEL

$F_{tu} = 180$ ksi

$F_{su} = 108$ ksi

$F_{cy} = 173$ ksi

$L = .75$ in, $h = .094$ in

$w = .188$ in

FOR SHEAR FAILURE

$T_s = F d N$, $N = 3$ SETS OF TEETH ON SPLINE

$$f_s = \frac{1.5F}{A_s} = \frac{1.5}{.75(.188)} F$$

$$F = \frac{.75(.188)(108000)}{1.5} = 10,150 \text{ lb}$$

$$T_s = 10150(.75)(3) = 22840 \text{ in-lb}$$

ASSUMING 1/2 OF SPLINE TEETH TRANSMIT TORQUE

$$T_s' = \frac{T_s}{F.S.(2)} = \frac{22840}{2(2)} = 5710 \text{ in-lb}$$

COMPRESSION FAILURE

$T_c = F d N$, $f_c = F/A_c \Rightarrow F = A_c f_c = .75(.094)(173,000)$

$F = 12196$ lb

$$T_c = 12196(.75)(3) = 27440 \text{ in-lb}$$

$$T_c' = \frac{27440}{2(2)} = 6860 \text{ in-lb}$$

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LATCHING MECHANISM (CONT.)

SHAFT DESIGN TORQUE

T = 4000 in-lb (REF: ED23-82-166, 12/6/82)

From p 11, LIMIT TORQUE = 5710 in-lb

$$M.S. = \frac{5710}{4000} - 1 = .42$$

TORSION ON MINIMUM SHAFT SECTION

$$f_{s_{MAX}} = \frac{16T}{\pi d^3} = \frac{16(4000)}{\pi(.7499)^3} \qquad d = .7499 \text{ in}$$

$$= 48{,}300 \text{ psi}$$

SHAFT - A286 CRES
F_{tu} = 140 KSI
F_{su} = 91 KSI

$$M.S._u = \frac{91}{48.3} - 1 = .88$$

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LATCHING MECHANISM (cont.)

BELLCRANK SPLINE cont.

Compressive stress on sides of teeth –

$$f_c = \frac{2 T K_m K_A}{9 D N L_e h K_f} \qquad h = .094$$

$$= \frac{2(1521)(1.2)(1.0)}{9(.75)(6)(.70)(.094)(1.0)}$$

$$f_c = 1370 \text{ psi}$$

$F_{cu} = 3$ ksi ref: Machinery's HDBK p 1024

$$MS_u = \frac{3.0}{2(1.37)} - 1 = \underline{.09}$$

TENSILE STRESS IN SPLINE ref: Machinery's HDBK p 1024

RADIAL TENSILE STRESS $f_{t1} = \dfrac{T \tan\phi}{\pi D t_w L}$

ϕ = PRESSURE $\angle$ = 30°
D = .75 in, L = .75 in.
t_w = .562 in

$$f_{t1} = \frac{1521 \tan 30°}{\pi(.75)(.562)(.75)} = 884 \text{ psi}$$

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LATCHING MECHANISM (CONT.)

BELLCRANK SPLINE (CONT.)

BEAM LOADING TENSILE STRESS

$$f_{t_3} = \frac{4T}{D^2 Le Y}$$

$Le = .70$, $Y = 1.5$ $\Longrightarrow$ $f_{t_3} = \dfrac{4(1521)}{.75^2(.70)(1.5)} = 10300\,psi$

TOTAL TENSILE STRESS —

$f_T = \dfrac{K_A K_M}{K_f}(f_{t_1} + f_{t_3})$, $K_A = 1.2$, $K_f = 1.0$, $K_M = 1.0$

from p. 13 $f_{t_1} = 884\,psi$

$$f_T = \frac{1.2(1.0)}{1.0}(884 + 10{,}300) = 13420\,psi$$

$F_{TU} = 45\,ksi$ (ref TBL 7, MACHINERY'S HDBK)

$$M.S._u = \frac{45}{2(13.42)} - 1 = \underline{.67}$$

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LATCHING MECHANISM (cont.)

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BELLCRANK LUGS

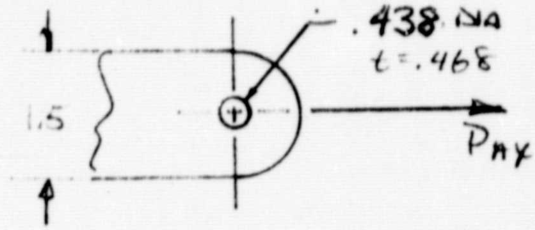
MATL - 4340 STEEL

MAX TENSION LOAD - CONSERVATIVELY ASSUMING LOAD REVERSAL

From P.4

$P_{AXIAL} = 5.72$ lb

or 2.86 lb/LUG



$\frac{e}{D} = \frac{.75}{.438} = 1.71$, $\frac{W}{D} = \frac{1.5}{.438} = 3.42$;

$\frac{D}{t} = \frac{.438}{.468}$ .94

$A_{BRG} = .438(.468) = .205\ in^2$

$A_t = (1.5 - .438)(.468) = .50\ IN^2$

SHEAR BEARING

$K_{BR} = 1.6$.

$P_{BRU} = K_{BRU} A_{BR} F_{TU} = 1.60(.205)(150000)$

49.2 kips

TENSION

$K_t = .93$

$P_{TU} = K_T A_T F_{TU} = .93(.50)(150000)$

$= 69.75$ kips

$M.S._u = \frac{49200}{(2)\ 5{,}720} - 1 = \underline{3.30}$

LUG BENDING @ JOGGLE ADEQUATE BY INSPECTION!

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LATCHING MECHANISM (cont.)

ROUND PIN - (30A60642)

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OF POOR QUALITY

SHEAR PIN DIA = .875 IN (SHANK)

(from NASTRAN RUN N0003111)
ref p. 51)

$F_Z = 11.73$ kip
$F_X = 7.91$ kip
} LOAD CASE 2

$R = \sqrt{11.73^2 + 7.91^2} = 14.15$ kips

$A_s = \frac{\pi(.875)^2}{4} = .60 \text{ in}^2$

$f_{s_{MAX}} = \frac{4}{3}\frac{R}{A} = \frac{4}{3}\frac{14.15}{.60} = 31.44$ KSI

INC 718 $F_{su} = 113$ KSI

$M.S._u = \frac{113}{2(31.44)} - 1 = \underline{.78}$ ULT SHEAR

SQUARE PIN (SAME SHANK AS ROUND PIN)

∴ SAME M.S.

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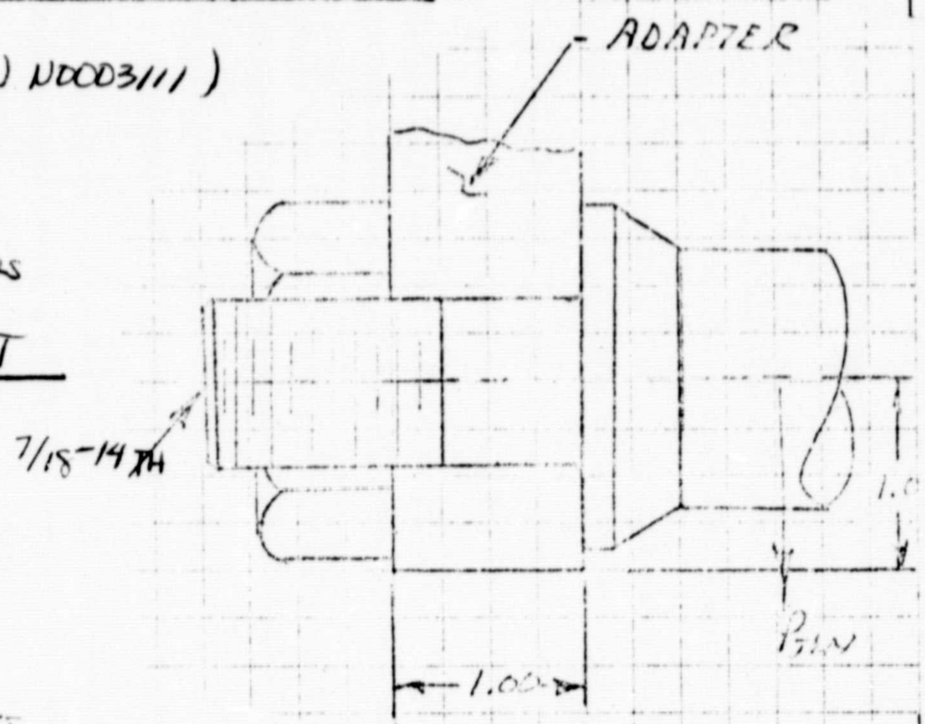
LATCHING MECHANISM (cont.)

ADAPTER / PIN INTERFACE

(from NASTRAN RUN N0003111)
ref. p. 51



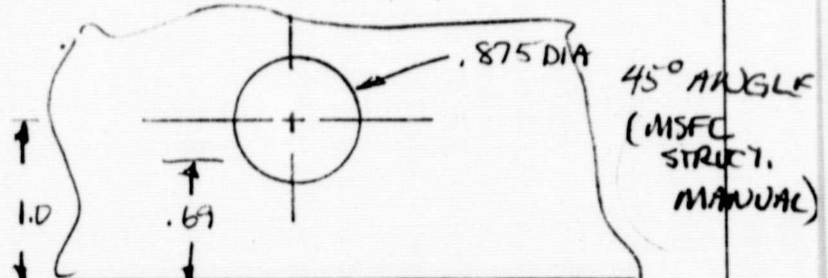
LOADCASE 7
$P_{TEN} = 9.47$ kips

SHEAR TEAR OUT

$A_s = 1.0(.69)2$
$= 1.38\ in^2$

$f_{s\,max} = 3/2\ \frac{P_T}{A_s}$
$= \frac{3}{2}\ \frac{(9.47)}{1.38}$
$= 10.29$ ksi

2219-T87 AL
$F_{tu} = 63$ KSI
$F_{su} = 37$ KSI



$M.S._u = \frac{37}{2(10.29)} - 1 = .798$ ULT SHEAR

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ORIGINAL PAGE IS OF POOR QUALITY

ADAPTER / PINS (cont.)

ref p. 51 for PIN REACTIONS

$P_H = 5.19$ kip

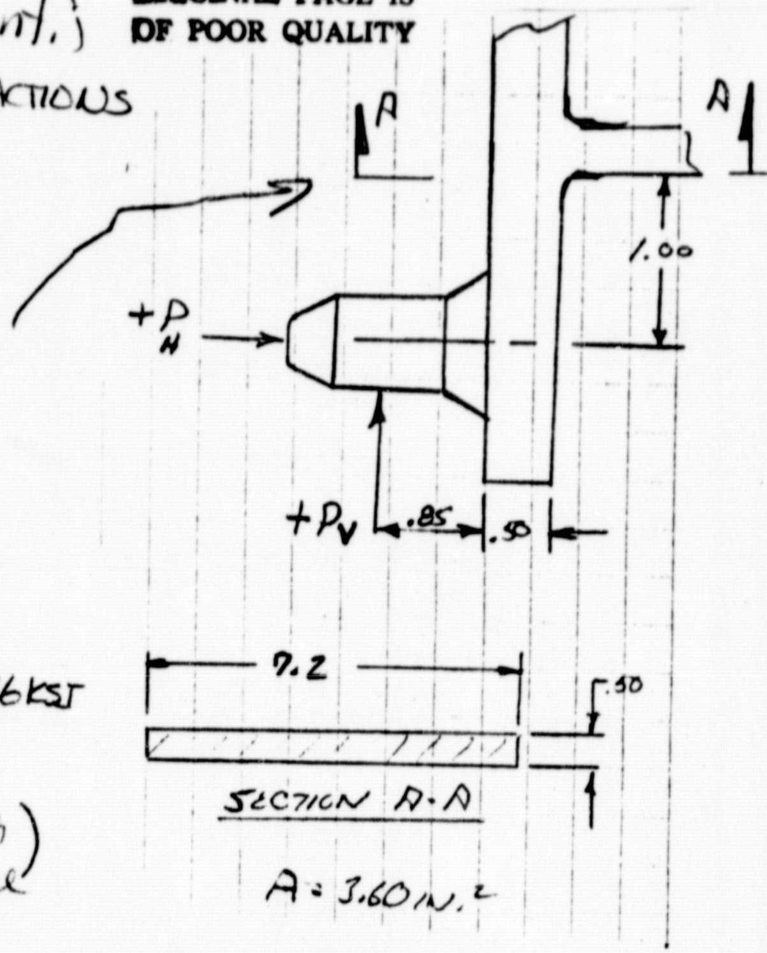
$P_V = 11.73$ kip

$I/c = .3 \text{ in}^3$

$M_{AA} = 1.0 P_H - P_V(1.1)$

$= 5.19 - 12.9$

$= 7.713$ in-kip



A = 3.60 in.²

$f_b = \frac{7.7}{.3} = 25.7$ KSI

$f_t = \frac{P_V}{A} = \frac{11.73}{3.6} = 3.26$ KSI

PLASTIC BENDING

$F_{bu} = 97$ KSI (see graph next page)

$R_b = \frac{2(25.7)}{97} = .53$

$R_t = \frac{2(3.26)}{62} = .11$

$M.S._u = \frac{1}{.53 + .11} - 1 = .56$ ULT

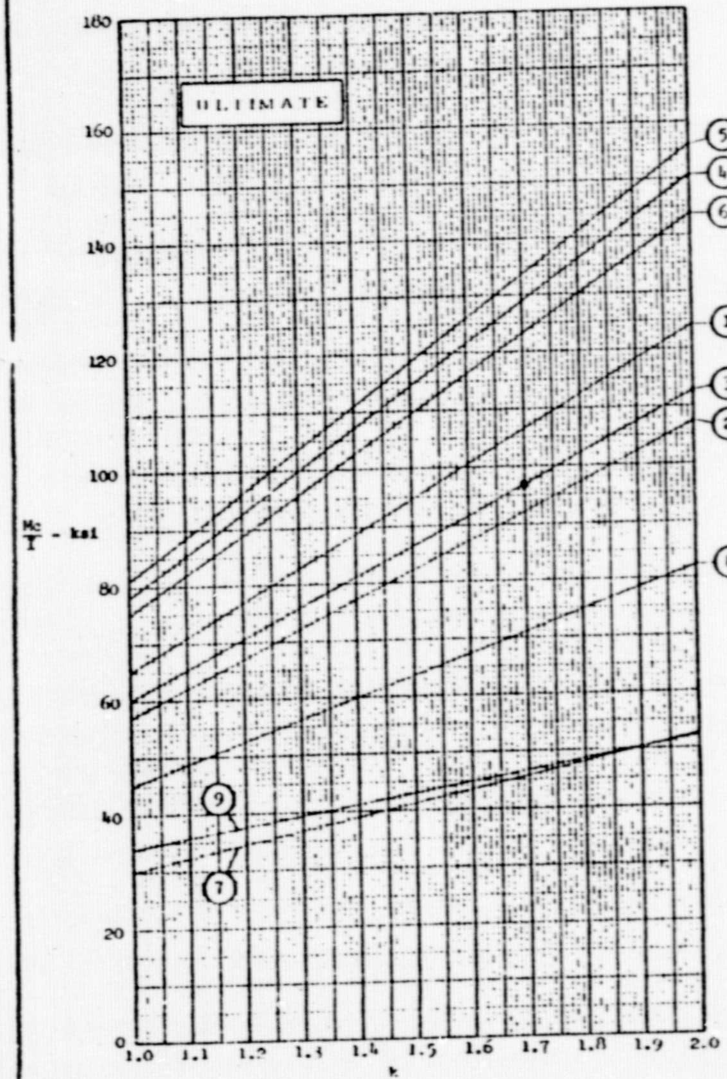
FORM LMSC 362 B-3

FIGURE 5a

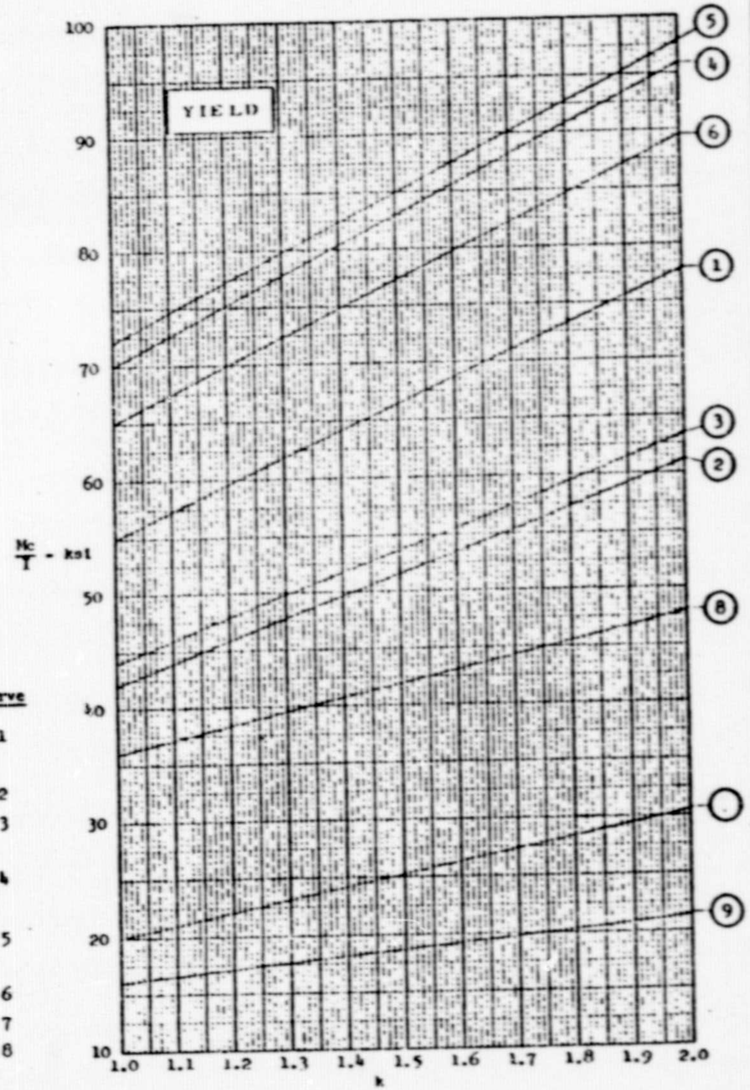
Ultimate and Yield Values of $\frac{Mc}{I}$ for Symmetrical Sections

Aluminum and Magnesium Alloy

Room Temperature



Material Designation	Curve
2014-T6 Die Forging	1
2024-T4 Extrusion	
t < .250	2
.250 ≤ t < 3.00	3
7075-T6 Extrusion	
t < .250	4
7075-T6 & -T651 Extrusion	
.250 ≤ t < 3.00	5
7075-T6 Die Forging	
t ≤ 2.00	6
356-T6 Sand Casting	7
ZK60A-T5 Extrusion	8
AZ63A-T6 & AZ19C-T6	
Sand & Perm Mold Casting	9



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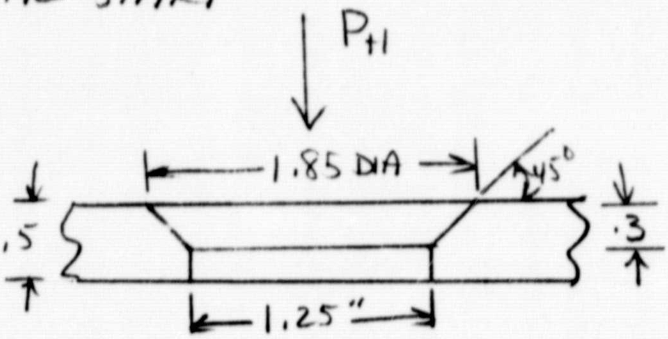
LATCHING MECHANISM (CONT.)

BEARING ON CONICAL START

REM P. 51

$P_{H_{MAX}} = 5.19$ Kip



Avg DIA = 1.55 IN

CIR = $\pi(1.55) = 4.869"$

$$A_{BRG} = \frac{.3}{.707}(4.869) = 2.066 \text{ in}^2$$

$$f_{brg} = \frac{5.19}{2.066} = 2.51 \text{ KSI}$$

MAT'L 2219 T87 AL

$F_{BRU} = 99$ KSI

$$M.S._{u} = \frac{99}{2(2.51)} - 1 = \underline{\text{LARGE}}$$

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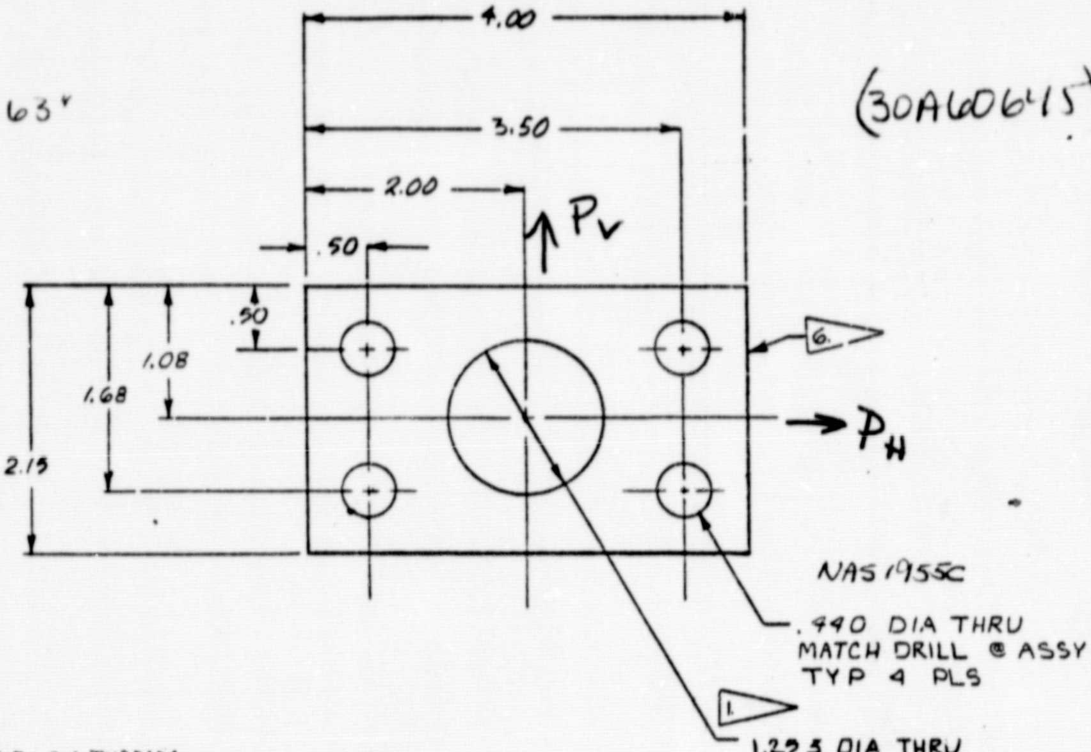
ADAPTOR / BASE PINS

ORIGINAL PAGE IS OF POOR QUALITY

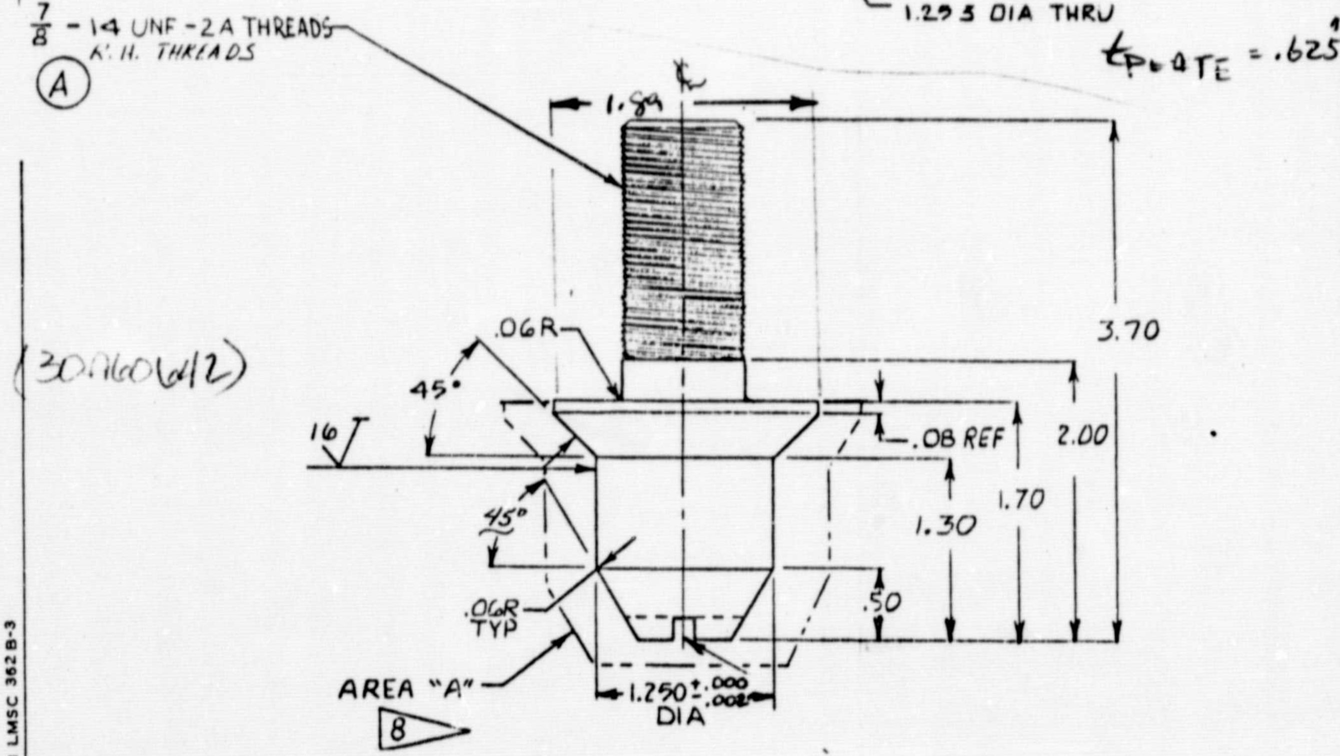
from p. 51 MAX PIN REACTIONS - $P_V = 11.73$ kip
$P_H = 15.19$ kip

$t = .63"$

(30A60645)



$t_{PLATE} = .625$



(30A60612)

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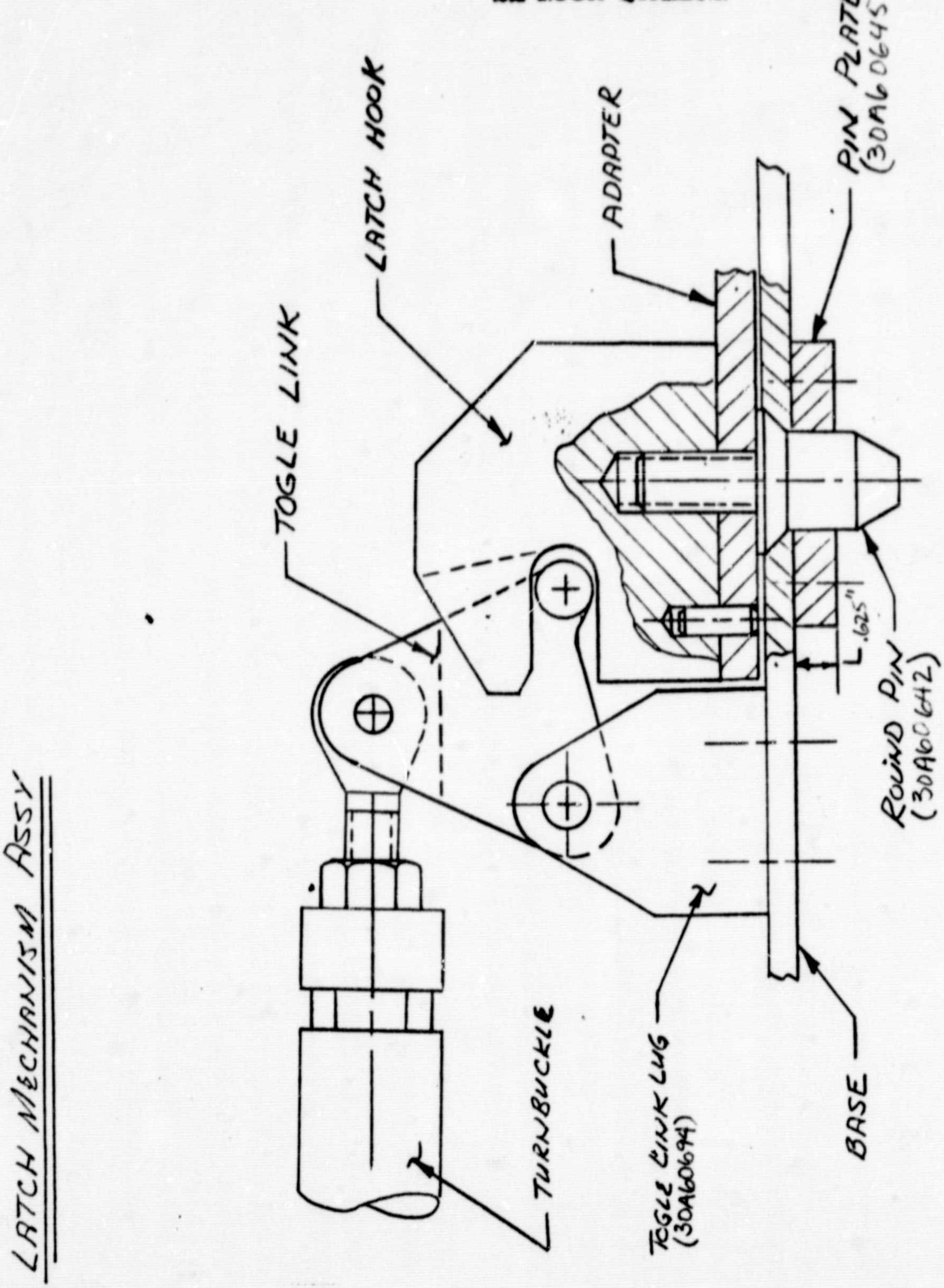


ADAPTER / BASE PINS (CONT.)

(4) NAS1957C
from p. (51)
$P_x = 7.91$
$P_z = 11.73$
$P_y = 5.19$

SHEAR ON MOUNTING BOLTS

$P_s = \sqrt{11.73^2 + 7.91^2} = 14.14$ kip

P_s / BOLT = 14.14/4 =

P_s = 3.54 kip/BOLT

$M.S._u = \frac{16.25}{2(3.54)} - 1 = 1.30$ ULT SHEAR

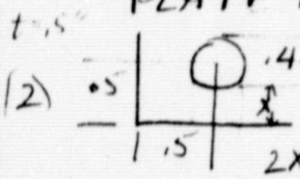
BEARING

$A_{BRG} = .437(.5) = .2185\ in^2$

$f_{br} = \frac{3.54}{.2185} = 16.2$ ksi (LOW)

SHEAR TEAR OUT IN PLATE

PLATE MATL - INC 718 $F_{tu} = 180$ ksi
$F_{su} = 113.4$ ksi



$A_s = 2xt = (2)(.50)(.56) = .56$

$2x = (1.5 - \frac{.44}{2})2(.28)2 = .56$

$f_s = \frac{3}{2}\ \frac{11.73}{.56} = 31.42$ KSI

$M.S._u = \frac{113.4}{(2)(31.42)} - 1 = .80$

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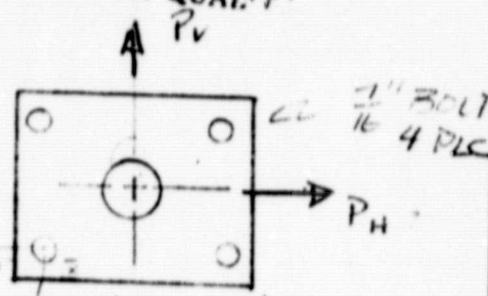
BASE PIN PLATE (cont.)

(FROM NASTRAN RUN N0003111)
(ref. P. 55) LOAD CASE 2



$2x = (.5 - \frac{.44}{2}) = .56$

$P_H = -7.91$ Kip
$P_V = 11.73$ Kip

ref diagram on p.24

$A_S = [(.625)(2)(.56)] = .70$

MAT'L - INCONEL 718
$F_{tu} = 180$ ksi
$F_{su} = 113$ ksi

$f_{s\,max} = \frac{3}{2}\left(\frac{11.73}{.70}\right) = 25.14$ KSI

$M.S._u = \frac{113}{2(25.14)} - 1 = \underline{1.25}$

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LATCHING MECHANISM (CONT.)

ROUND PIN/ADAPTER BEARING

$A_{BRG} = .875(1.0) = .875\ IN^2$ (ref. fig. p. 48)

$f_{brg} = \frac{14.15}{.875} = 16.17\ KSI$

$F_{bru} = 94.5\ KSI$

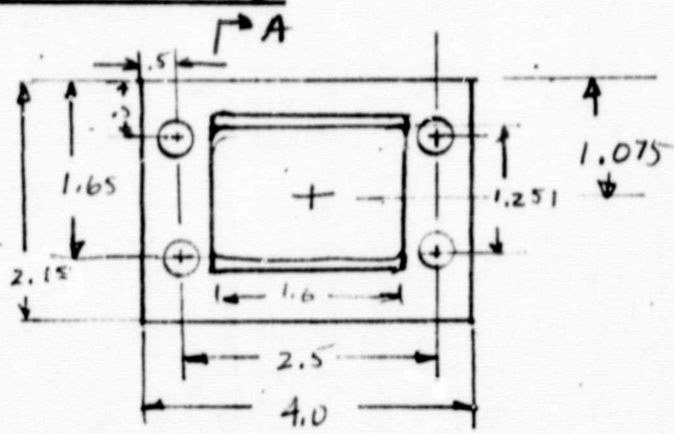
$M.S._{bru} = \frac{94.5}{2(16.17)} - 1 = \underline{1.92\ \text{ULT BEARING}}$

SQ PIN PLATE (30A60644) INC 718

SHEAR TEAROUT

(FROM NASTRAN RUN N000511)

ref p. 51



MAX VERT SHEAR = 11.69 kp

$A_S = (1.075 - .625)(.625)2$
$= .5625\ in^2$

$f_{s\,MAX} = \frac{11.69(3/2)}{.5625} = 31.17\ ksi$

$F_{su} = 113\ KSI$

$M.S._{u} = \frac{113}{2(31.17)} - 1 = \underline{.81\ \text{ULT SHEAR}}$

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LATCHING MECHANISM cont.

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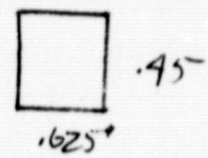
SG PIN PLATE - BENDING

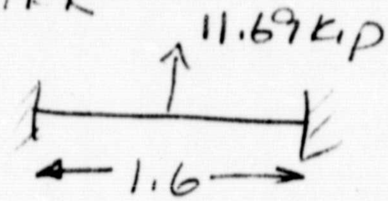
(REFERENCE PREVIOUS PAGE)

$$I_{AA} = \frac{.45^3(.625)}{12} = .004746 \text{ IN}^4$$

$$I/c = \frac{.004746}{.45/2} = .0211 \text{ in}^3$$



USING PT LOAD @ CENTER



$$M = \frac{PL}{8} = \frac{11.69(1.6)}{8}$$

$$= 2.358 \text{ in-Kip}$$

$$f_b = \frac{2.358}{.0211} = 111.75 \text{ KSI}$$

$$F_{tu} = 180 \text{ KSI}$$

$$F_{bu} = 180(1.7) = 306$$

$$M.S._u = \frac{306}{2(111.75)} - 1 = \underline{.37}$$

SHEAR

$$R = \frac{11.69}{2} = 5.845 \text{ Kip}$$

INC 718

$$F_{su} = 113.4 \text{ KSI}$$

$$f_s = \frac{3/2(5.845)}{.625(.45)} = 31.17 \text{ KSI}$$

$$M.S._u = \frac{113.4}{2(31.17)} - 1 = \underline{.82}$$

FORM LMSC 362 B-3

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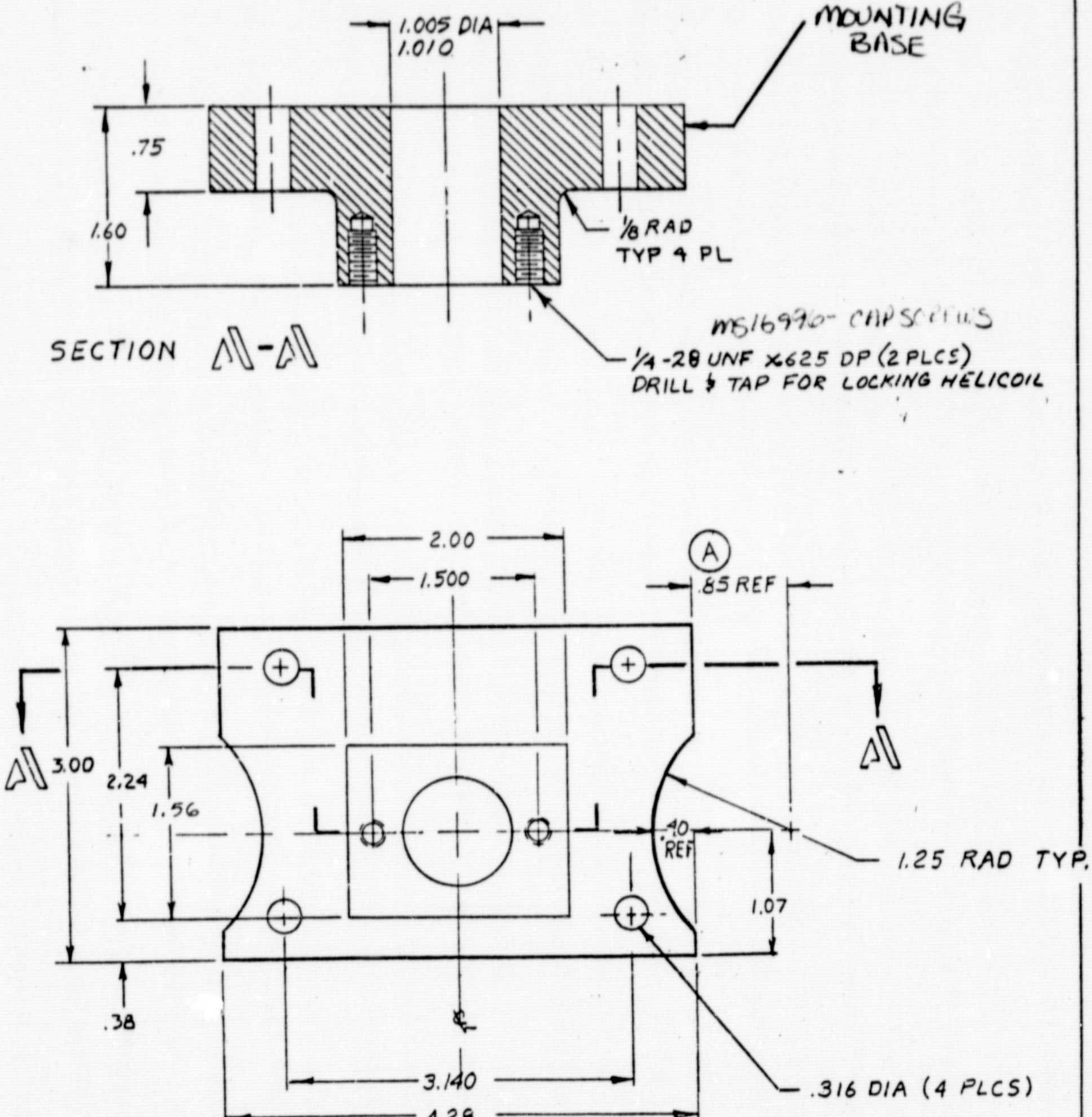
30A60647 RODS HOLDER, POSITION 4



SINGLE ROD HOLDER

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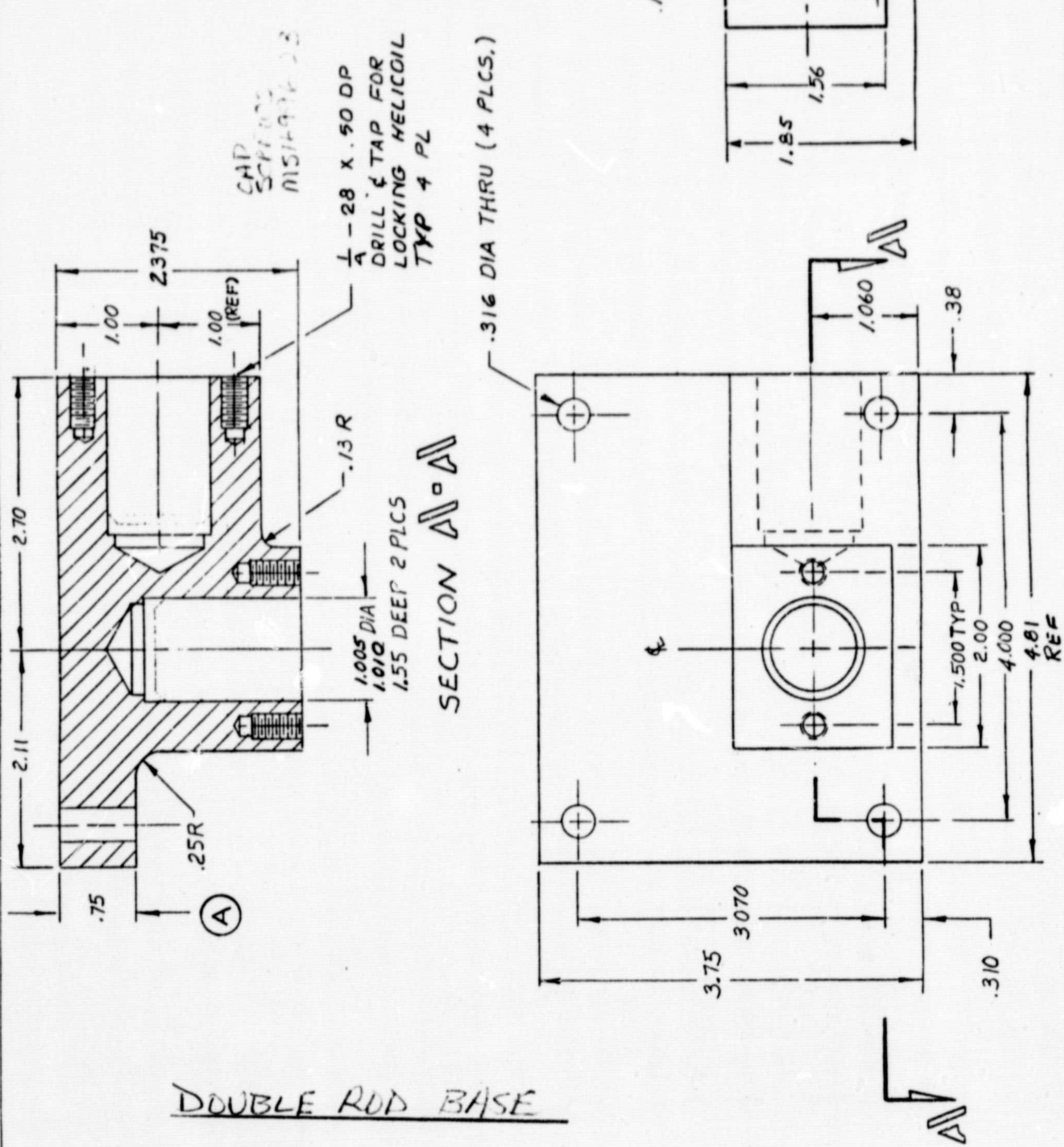
30A66648
BASE ROD
POSITIONS 2 & 3



DOUBLE ROD BASE

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LOCATOR ROD BASE FTG

SINGLE ROD BASE (30A62647
MOUNTING FASTENERS -

(4) 5/16-24 SCREWS MS51960-106

$P_{tu} = 4.64$ kip
$P_{su} = 4.06$ kip (BASED ON 53 KSI CRES STEEL
(AND 5/16 DIA)

MAX ROD LOAD - 1560 lb (ref. ED23-83-42
3/20/83)

Moment @ BASE - (SEE Fig p 34)

$$M = 1560(3 + 1.6) = 7.176 \text{ in-kip}$$

TENSION -

$$P/\text{FASTENER} = \frac{7.176}{2.24(2)} = 1.6 \text{ kip}$$

Shear

$$P_s = 1560/4 = .39 \text{ kip}$$

INTERACTION (ref p 4.9.1)

$$R_t = \frac{2(1.6)}{4.64} \; .69 \qquad R_s = \frac{2(.39)}{4.06} = .\text{19}$$

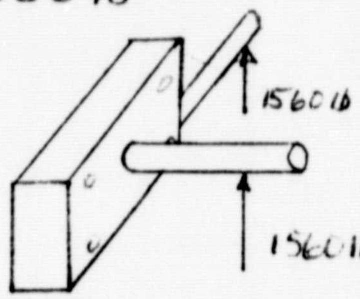
$$M.S. = \frac{.96}{.69} - 1 = \underline{.39 \text{ INTERACTION}}$$

LOCATOR ROD BASE FTG (cont.)

MOUNTING FASTENERS

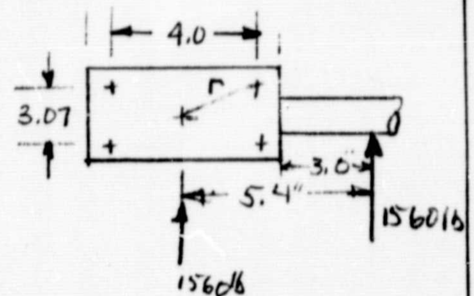
DOUBLE ROD BASE - 30A60648

ASSUME BOTH RODS STRIKE "Y" FTGs @ THE SAME TIME. (ref p. 17)



ULT SHEAR

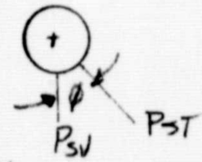
$P_S = \dfrac{1560(2)}{4} = 780\ \text{lb/FASTENER}$



$r = \sqrt{2.0^2 + \left(\frac{3.07}{2}\right)^2} = 2.52\ \text{in.}$

$P_{ST} = \dfrac{1560\ (5.4)}{4\ (2.52)} = 835.7\ \text{lb/FAST}$

$\tan\phi = \dfrac{1.535}{2.0} = .7675$



$\phi = 37.5°$

$P_{STV} = 835.7\ \cos(37.5°) = 663.0\ \text{lb}$

$P_{STH} = 835.7\ \sin(37.5°) = 508.7\ \text{lb}$

RESULTANT SHEAR

$P_{SR} = \left[(P_{STV} + P_{SV})^2 + P_{SH}{}^2\right]^{1/2} = \left[(663 + 780)^2 + (508.7)^2\right]$

$= 1530.0\ \text{lb}$

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LOCATOR ROD BASE FTG (cont.)

MOUNTING FASTENERS

DOUBLE ROD BASE (cont.)

from p. 13, $P_{SR} = 1.530$ kips

5/16-24 FASTENERS $P_{TU} = 4.64$ kip
$P_{SU} = 4.06$ kip

$$M.S._u = \frac{4.06}{2(1.53)} - 1 = .33, \text{ ULT SHEAR}$$

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GUIDE RODS (30A60649)

MATL' 2219-T87 AL $F_{tu} = 63$ KSI, $F_{su} = 38$ KSI

LOAD = 1560 lb (ref 4.36)
@ 3" from BASE

ROD DIA 1"

$$I = \frac{\pi (1)^4}{64} = .049 \text{ IN}^4$$

$$f_b = \frac{1560(3)(.5)}{.049} = 47.76 \text{ KSI}$$

plastic bending (ref p. 4.27)

$F_{bu} = 97$ KSI

$$M.S. = \frac{97}{2(47.76)} - 1 = \underline{.015 \quad \text{PLASTIC BENDING}}$$

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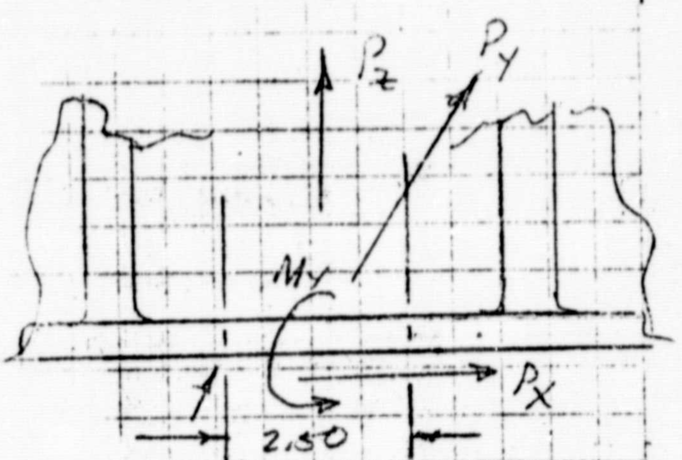
REM BASE MOUNTING BOLTS

(NASTRAN RUN N0CC8311)
from p. 51

$P_x = +5.07$ Kips
$P_y = 5.79$ Kips
$P_z = +10.64$ Kips
$M_y = 14.4$ in-kips



NAS 1960 C BOLTS
2 PLCS (5/8 DIA)
$P_{tu} = 49{,}000$ LBS
$P_{su} = 33{,}150$ LBS/SINGLE SH.

$$P_T = \frac{P_z}{2} \pm \frac{M_y}{2.5}$$

$$= \frac{10.64}{2} \pm \frac{14.4}{2.5}$$

$= 11.08$ Kips/BOLT

SHEAR

$$P_s = \left[\left(\frac{P_x}{2}\right)^2 + \left(\frac{P_y}{2}\right)^2\right]^{1/2} = \left[\left(\frac{5.07}{2}\right)^2 + \left(\frac{5.79}{2}\right)^2\right]^{1/2}$$

$= 3.85$ Kips/BOLT

$$R_s = \frac{(2)(3.85)}{33.15} = .23 \qquad R_t = \frac{2(11.08)}{49} = .45$$

INTERACTION — (ref 4.9.1)

$$M.S._u = \frac{.88}{.45} - 1 = .96$$

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REM BASE / PDM FSTNRS

NAS1960C BOLT 5/8" DIA $P_{TU} = 49000$ lb

$P_{SU_{SS}} = 33150$ lb

FROM P 51 . MAX TENSION LOAD IS $P_t = 10.66$ lb

$P_x = 4.26$ lb

$P_y = 5.69$ lb

$$P_{S_{MAX}} = \sqrt{4.26^2 + 5.69^2} = 7.11 \text{ lb}$$

$$R_t = \frac{(2)(10.66)}{49.0} = .435 \qquad R_S = \frac{(2)(7.11)}{33.15} = .43$$

$$M.S._u = \frac{.71}{.435} - 1 = \underline{.63 \text{ ULT INTERACTION}}$$

for NUT - MS21045C 5/8-18UNF-3B
(per M. Lieberman)

$P_{tu} = 34130$ lb

$$M.S._u = \frac{34.13}{(2)(10.66)} - 1 = \underline{.60 \text{ ult tension}}$$

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REM ADAPTER STRESS SUMMARY

FM NASTRAN RUN NCCC3111 4/24/84

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LOAD CASE	ELT	STRESS (KSI) MAX	MIN
1	78	4.10	-1.54
	23	6.14	-3.29
2	3	6.04	-3.22
	6	7.10	-4.80
	18	6.55	-6.98
3	3	4.27	-2.69
	6	6.36	-4.09
	16	9.8	-5.87
	23	9.72	-5.39
4	2	8.47	-4.5
	3	9.83	-5.43
5	6	4.88	-7.83
	28	4.86	-4.58
6	2	1.47	-1.92
	6	2.92	-4.21
	11	4.85	-7.85
	23	4.05	-7.44
	28	4.19	-6.46
7	3	2.17	-3.94
	6	3.5	-4.66
	16	3.22	-2.48
	28	6.83	-5.24

FORM LMSC 362B-3

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ADAPTER STRESS SUMMARY (CONT.)

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LOAD	FIE	STRESS (KSI) MAX	MIN
8	4	2.65	-2.16
	16	3.55	-4.83

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NASTRAN RUN N0003111
APRIL 24, 1984

REM BASE STRESS SUMMARY

LOAD CASE	ELE	STRESS (KSI) MAX	MIN
1	82	7.08	-5.37
1	32	6.19	-2.85
1	122	6.18	-7.13
1	134	7.06	-7.43
1	138	10.57	-11.14
1	128	13.51	-14.56
1	157	22.95	-22.5
1	158	20.97	-21.4
1	163	15.47	-15.67
2	82	7.42	-4.47
2	83	3.16	-3.01
2	84	2.32	-2.87
2	87	7.16	-2.7
2	157	22.35	-22.05
2	158	21.4	-20.8
2	163	15.6	-15.3
3	82	7.49	-5.57
3	83	2.55	-2.54
3	87	6.72	-3.2
3	157	22.88	-22.43
3	158	21.0	-21.4
3	163	15.4	-15.6
4	82	7.83	-4.45
4	83	2.85	-2.94
4	157	22.4	-22.7
4	158	21.3	-20.8
4	163	15.49	-15.21
5	82	3.83	-4.36
5	83	2.75	-1.999
5	157	12.22	-11.88
5	158	10.96	-11.5
5	163	8.05	-8.3

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REM BASE STRESS SUMMARY (cont.)

LOAD CASE	ELE	STRESS (KSI) MAX	STRESS (KSI) MIN
6	82	4.43	-4.02
6	83	3.26	-1.86
6	157	11.94	-12.37
6	158	11.63	-11.19
6	163	8.45	-8.18
7	82	3.85	-3.95
7	83	2.82	-2.31
7	157	12.18	-11.84
7	158	11.0	-11.55
7	163	8.1	-8.41
8	82	4.22	-3.61
8	83	3.33	-1.85
8	157	12.0	-12.41
8	158	11.6	-11.15
8	163	8.5	-8.25

STRESSES IN ELE 157, 158, 163 ARE DUE TO CONCENTRATED FORCES ON BASE AT GRID 132 REPRESENTING THE BASE MASS. THEREFORE THESE ARE NOT REALISTIC STRESSES AND WILL NOT BE CONSIDERED.

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REM ADAPTER STRESSES —

FROM STRESS SUMMARY p. 41 & 42
LOAD CASE 4, ELE 3

$S_{MAX} = 9.83$ KSI

2219-T87 AL

$F_{tu} = 62$ KSI

$$M.S._u = \frac{62}{2(9.83)} - 1 = 2.15$$

REM BASE STRESSES

FROM SUMMARY p. 43, 44
LOAD CASE 1, ELE 128

$S_{MAX} = 13.51$ KSI

$$M.S._u = \frac{62}{2(13.51)} - 1 = 1.29$$

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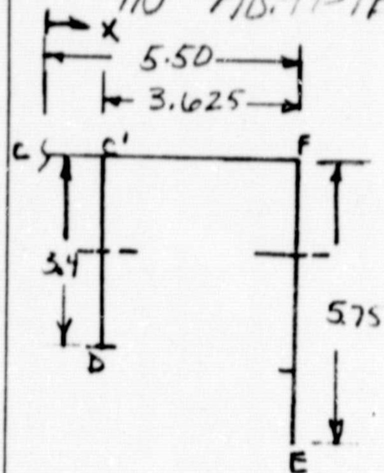
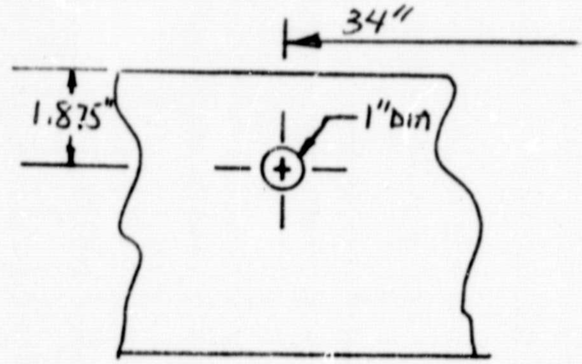
CHECK STRESSES AROUND HOLE TO BE DRILLED IN ADAPTER





FROM NASTRAN MODEL ELEMENT 48
STRESSES @ PTS

σ BENDING –		σ AXIAL
C	265.3 psi	793.2 psi
D	1403.7 psi	
E	625.3 psi	
F	1453.8 psi	

ASSUME A LINEAR STRESS DISTRIBUTION FROM POINT TO POINT –

STRESS @ PT C'

$$\sigma_B^{c'} = \left(\frac{-1453.8-265.3}{5.5}\right)X + 265.3 = -312.6X + 265.3$$

@ C' = 5.5 − 3.625 = 1.875

$\sigma_B^{c'} = -320.8$ psi

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ADAPTER HOLE STRESSES (cont.)

STRESS IN SECTION C'-D

$$\sigma_B^{C'-D} = \left(\frac{320.8 + 1403.7}{3.4}\right) X - 320.8 = 507.2 X - 320.8$$

STRESS IN SECTION F-E

$$\sigma_B^{F-E} = \left(\frac{1453.8 + 623.3}{5.75}\right) X - 1453.8$$
$$= 361.2 X - 1453.8$$

$$\sigma_{TOTAL} = \sigma_B + \sigma_{AXIAL}$$

FOR STRESSES @ HOLE EDGE, $X = 1.875 - R$
$= 1.875 - .5 = 1.375$

$$\sigma_B^{C'-D} = 507.2(1.375) - 320.8$$
$$= 376.6 \text{ psi}$$

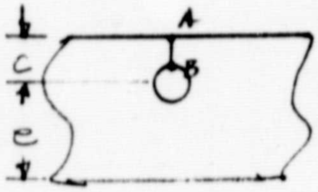
$$\sigma_B^{F-E} = 361.2(1.375) - 1453.8$$
$$= -957.15 \text{ psi}$$

TOTAL STRESS

$$\sigma_T^{C'-D} = 376.6 + 793.2 = 1166.8 \text{ psi} \quad (C'-D)$$

$$\sigma_T^{E-F} = -957.15 + 793.2 = -163.95 \text{ psi} \quad (E-F)$$

ADAPTER HOLE STRESSES (CONT.)



DIA = 1"

FOR SECTION C'-D (INNERWALL)

$e = 1.875''$

$c = 3.4 - 1.875 = 1.525$

$A\text{-}B = c - \frac{1}{2} = 1.375$

$e/c = \frac{1.875}{1.525} = 1.23$

$r/c = \frac{.50}{1.875} = .2667$

FROM GRAPH P. -

$\frac{\sigma_{MAX}}{\sigma} = \underline{3.26}$

FOR SECTION E-F (OUTERWALL)

$c = 1.875$

$e = 5.75 - 1.875 = 3875$

$A\text{-}B = 1.375$

$e/c = \frac{3.875}{1.875} = 2.067$

$r/c = .5/1.875 = .2667$

FROM GRAPH P

$\frac{\sigma_{MAX}}{\sigma} = \underline{3.24}$

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ADAPTER HOLE STRESSES (CONT.)

USING STRESS CONCENTRATIONS -

SECTION C-D

$\sigma_{MAX} = 3.26\,\sigma$

$\sigma_T^{C\text{-}D} = 1166.8 \qquad \therefore \sigma_{MAX} = 3.26(1166.8) = \underline{3803.8\,psi}$

SECTION E-F

$\sigma_{MAX} = 3.24\,\sigma$

$\sigma_T^{E\text{-}F} = 163.95\,psi$

$\therefore \sigma_{MAX} = 3.24\,(163.95) = \underline{531.20\,psi}$

$$M.S._u = \frac{63000}{(2)(3803.8)} - 1 = \underline{7.28}$$

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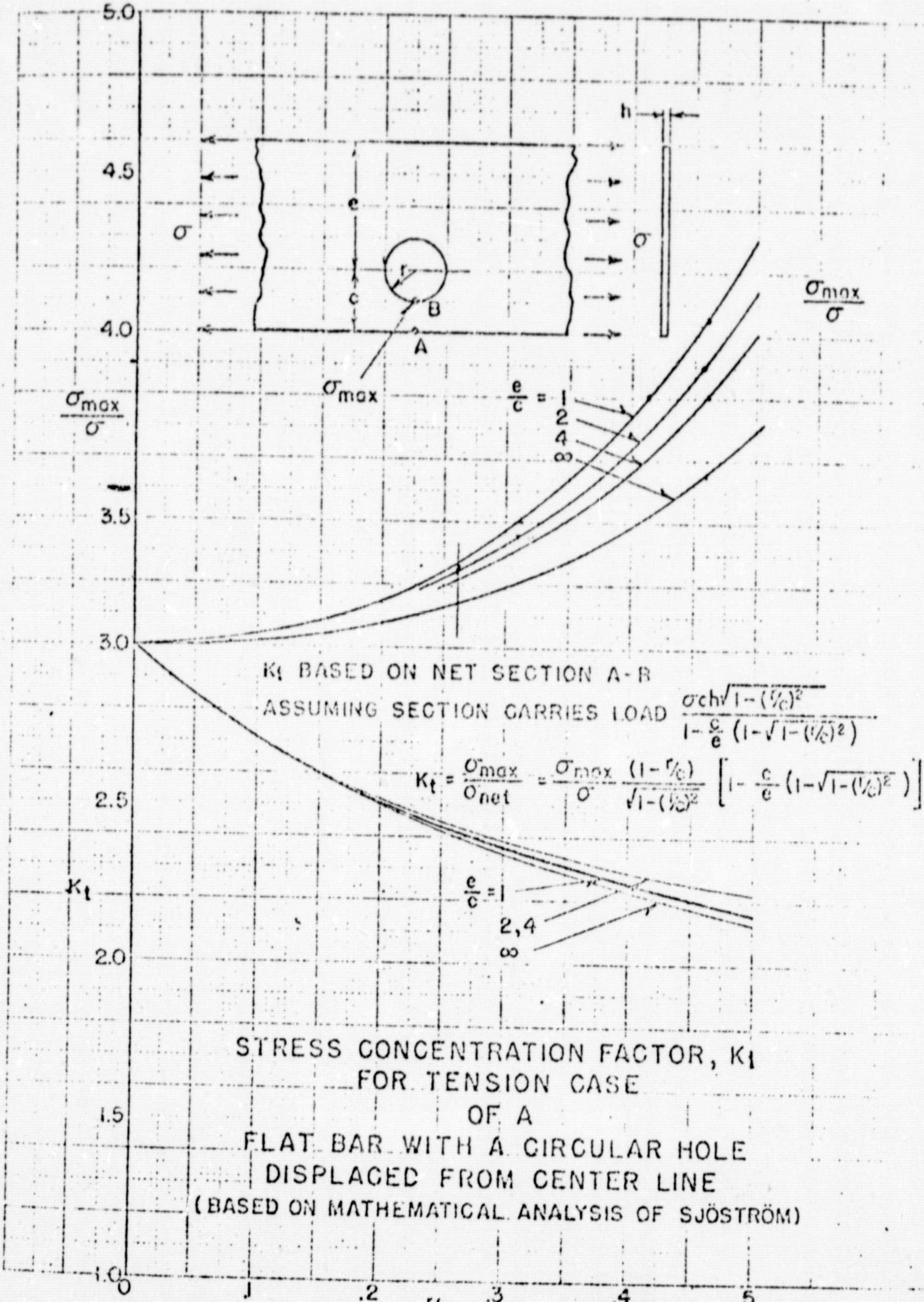
FORM LMSC 362 B-3

4.50



STRESS CONCENTRATION FACTOR, K_t
FOR TENSION CASE
OF A
FLAT BAR WITH A CIRCULAR HOLE
DISPLACED FROM CENTER LINE
(BASED ON MATHEMATICAL ANALYSIS OF SJÖSTRÖM)

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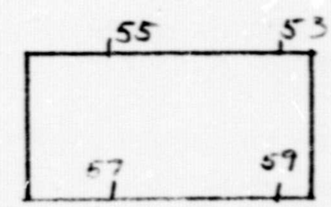
LOAD CASE	REM PIN REACTIONS (KIPS)											
	53			55			57			59		
	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz
1	-7.89	-.21	1.02	0	-5.12	11.69	0	0	5.72	3.58	0	.52
2	7.91	-5.14	11.73	0	-.19	.98	0	0	.56	-3.56	0	5.68
3	-7.96	3.19	-2.37	0	.14	8.44	0	0	8.96	3.52	0	3.91
4	7.85	.26	8.34	0	5.07	-2.26	0	0	3.81	-3.62	0	9.07
5	-7.86	-.25	-6.17	0	-5.09	4.45	0	0	-1.59	3.61	0	-6.83
6	7.95	-5.19	4.46	0	-.14	-6.4	0	0	-6.80	-3.52	0	-1.79
7	-7.93	5.16	-9.47	0	.17	1.34	0	0	1.71	3.54	0	-3.39
8	7.88	.22	1.16	0	5.11	-9.5	0	0	-3.5	-3.59	0	1.71

REF: NASTRAN RUN NOOD3111 4/24/84



FORM LMSC 362 B-3

DSM 5/84
EJW 6/84

SPARTANREM

REM BASE REACTIONS

PT	Force	LOAD CASE 1	2	3	4	5	6	7	8
201	Fx	-3.74	1.34	-3.78	1.3	-1.87	3.21	-1.90	3.18
	Fy	2.65	2.21	4.21	3.77	-2.28	-2.72	-.719	-1.16
	Fz	6.85	.80	10.15	4.1	-1.56	-7.66	1.79	-4.3
203	Fx	-1.46	3.85	-1.35	3.96	-3.38	1.93	-3.27	2.04
	Fy	2.45	2.81	4.05	4.41	-2.81	-2.46	-1.21	-.86
	Fz	.77	6.81	4.23	10.3	-7.7	-1.72	-4.19	1.79
205	Fx	-3.3	5.59	-3.34	5.52	-4.99	3.87	-5.07	3.79
	Fy	-4.1	-7.4	.58	-2.7	1.13	-2.16	5.79	2.5
	Fz	1.09	13.26	-2.36	9.8	-7.3	4.81	-10.64	1.44
207	Fx	-4.8	2.49	-4.8	2.5	-3.0	4.26	-3.03	4.26
	Fy	-7.2	-3.84	-2.66	.70	-2.2	1.16	2.32	5.69
	Fz	13.2	1.05	9.9	-2.26	4.8	-7.48	1.62	-10.66

- LOAD FACTORS APPLIED TO PAYLOAD, ADAPTER & BASE CG'S.
- ALL FORCES IN KIPS
- $-F_Z$ INDICATES TENSION IN FASTENERS

(FROM NASTRAN RUN N0003111 4/24/84)

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FRACTURE ANALYSIS

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		REDUNDANT 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	ΔT 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
NAS19600	MOUNTING BOLTS	A286 CRES	X		REDUNDANT LOAD PATH					
30A60702	LINK HOUSING	4340 STL		X	LOW STRESSES	X				
30A60703	LINK ROD	4340 STL		X		X				
30A60647	ROD HOLDER - 1 & 4	2219-T87AL		X		X		—*	—	NONE
30A60648	ROD HOLDER - 2 & 3	2219-T87 AL		X		X		—*	—	NONE
30A60649	LOCATOR ROD	2219-T87 AL		X		X		.18	.10	ET
30A60684	AFT GUIDE - 1	2219-T87 AL	X		LOW COMPRESSIVE LOADS					
30A60685	AFT GUIDE - 2	2219-T87 AL	X							
30A60686	POST GUIDE - 3	2219-T87 AL	X							
30A60687	POST GUIDE - 4	2219-T87 AL	X							
30A60701	GUIDE BAR	2219-T87 AL	X							
NAS1955C	PLATE BOLTS	A286 CRES	X		REDUNDANT LOAD PATH					
NAS1955C	GUIDE HOLDER BOLT	A286 CRES	X		LOW COMPRESSIVE LOADS					

* NO CRACK GROWTH

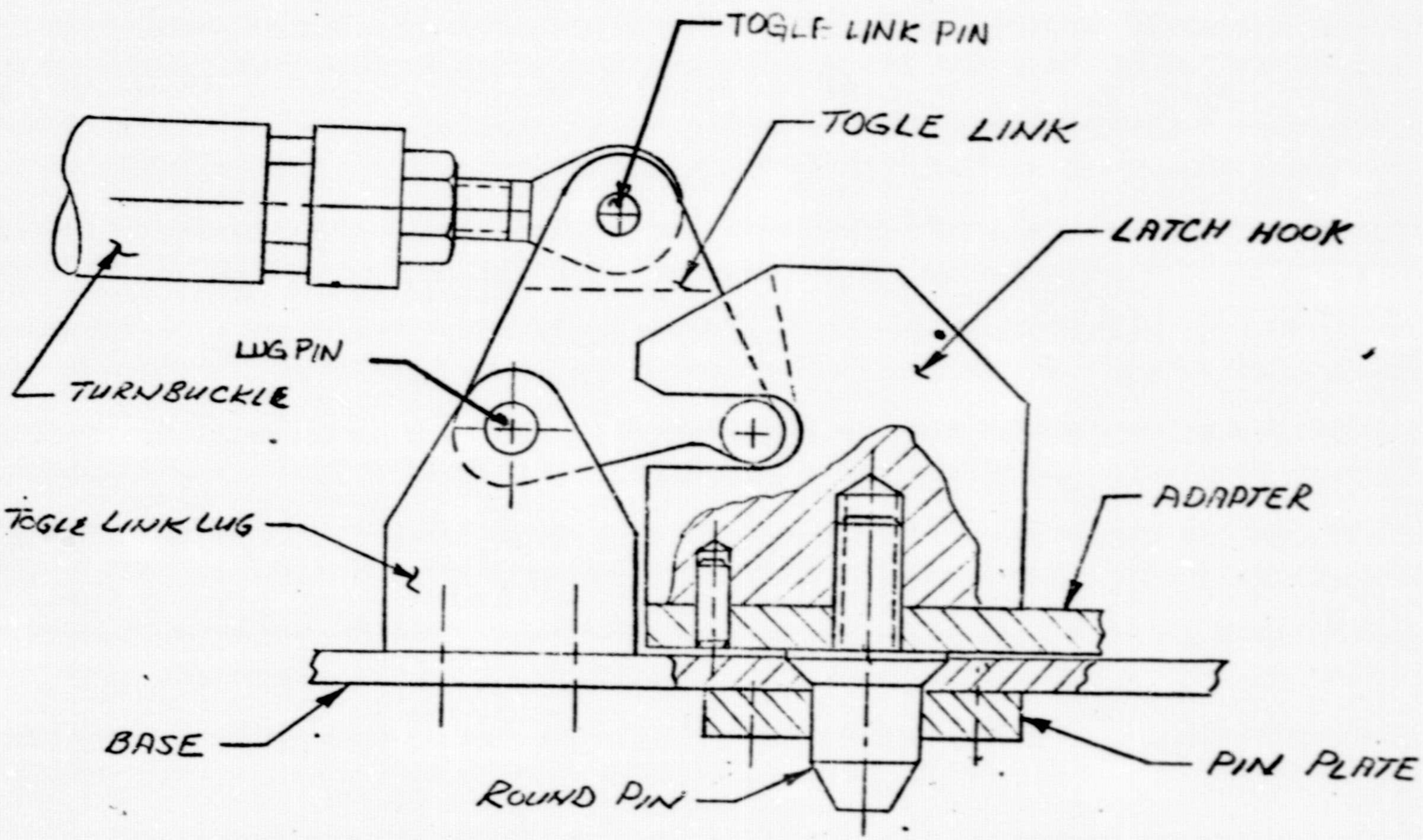
ET - EDDY CURRENT
MP - MAGNETIC PARTICLE

REM FRACTURE CONTROL SUMMARY

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.

LATCH MECHANISM ASSY



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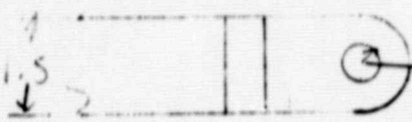
Approved by:	Date		Report No.		

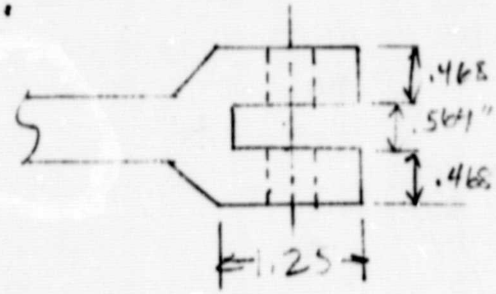
FRACTURE ANALYSIS
BELLCRANK LUG. (30[illegible])



D = .343" DIA

MAT'L – 4340 STEEL

F_t = 5.72 kips (REF 4.1)
or 2.86 kip/LUG



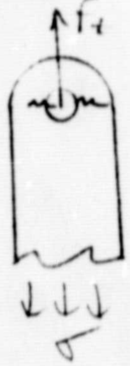
ASSUME F_{MIN} = 0 KSI
(CONSERVATIVE)

LOADED 26000 cycles
(4 MISSIONS WITH S.F.=4)

CHECKING FOR CRACKS OFF HOLE

MODEL

WORST CASE DBL CRACKS



t = .468"
r = .219"

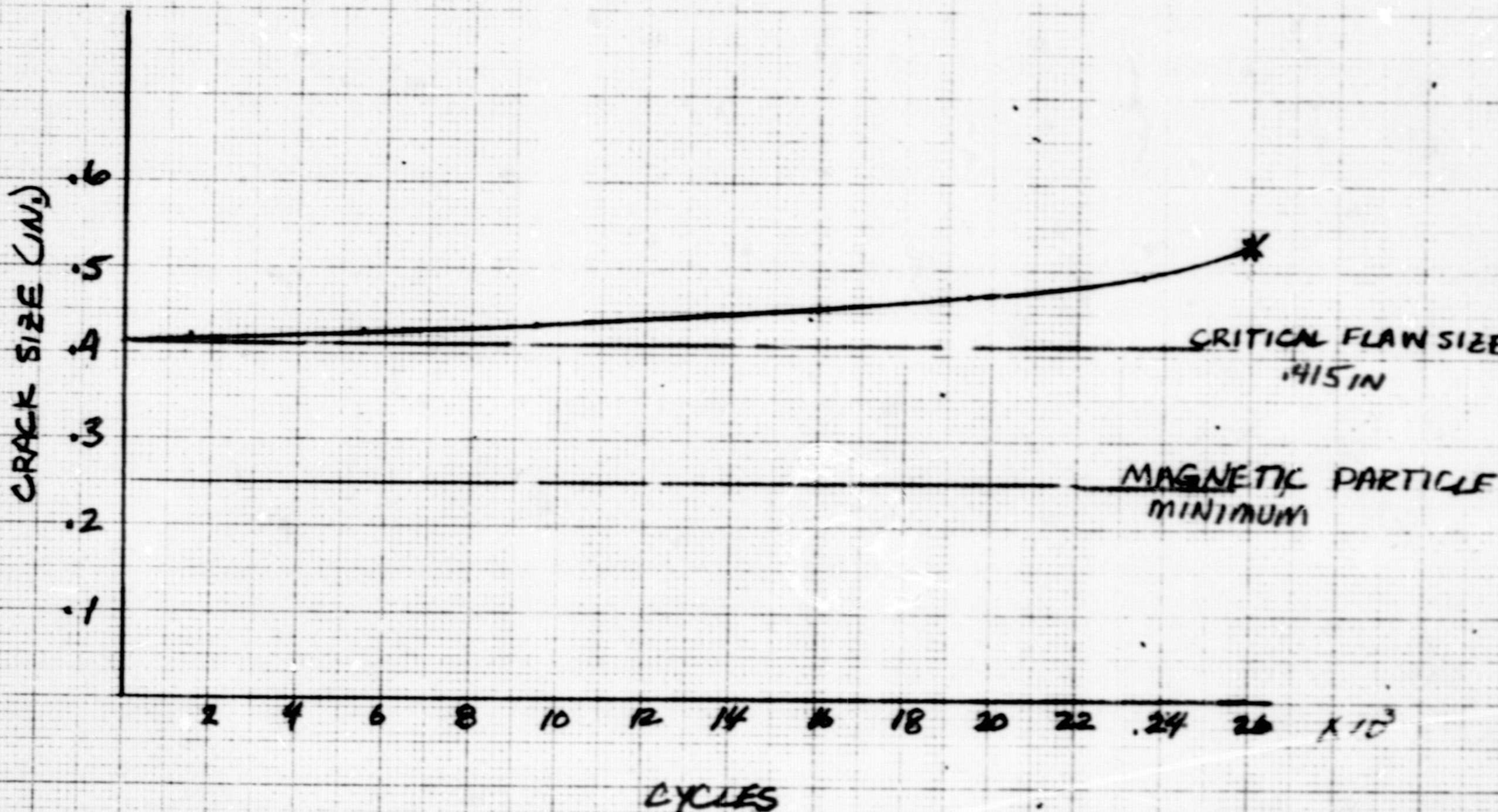
FROM COMPUTER ANALYSIS –
CF = .415 IN

INSPECTION – MAGNETIC PARTICLE
LIMITS – .25 IN

CF > INSP. LIMIT

.415 > .25

FORM LMSC 362 B-3



BELLCRANK LUG (30A60696) - DOUBLE CRACK IN HOLE

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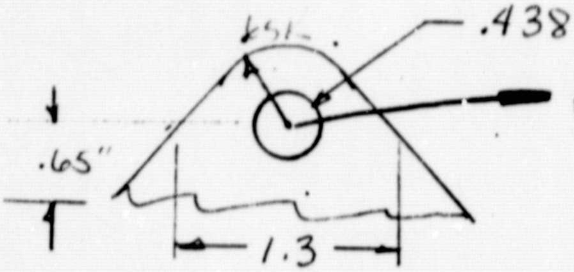
FRACTURE ANALYSIS —

TOGLE LINK (DA60695)

t = .313"



LUG AREA

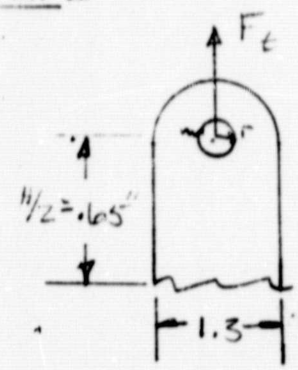
MATL 4340 STL
LOADED 26000 CYCLES
— 4 MISSIONS WITH
S.F. = 4

FROM STRESS ANALYSIS

From p 4.10, F_T = 5.72 kips → LOAD/LUG = 2.86 kips

ASSUME P_{MIN} = 0 (CONSERVATIVE)

MODEL



r = .219"
t = .313

CHECK — CRACK OFF HOLE

from computer ANALYSIS
CF = .230 in.

INSPECTION - EDDY CURRENT
MINIMUM SIZE - .05 IN

CF > INSP. LIMIT

.23 > .05

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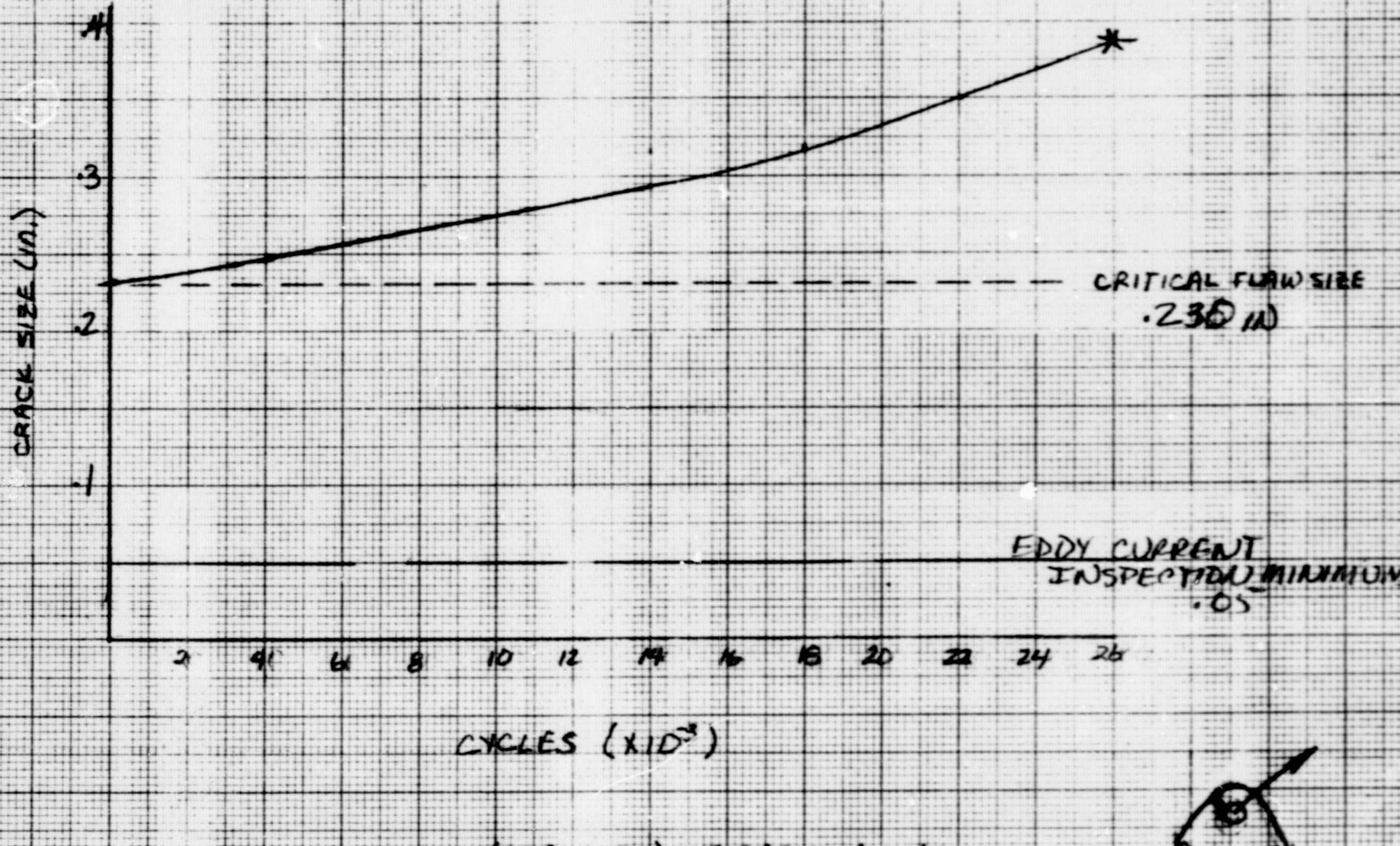
FORM LMSC 3628-3



TOGGLE LINK (30A60695) - CRACK IN LUG

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C 2

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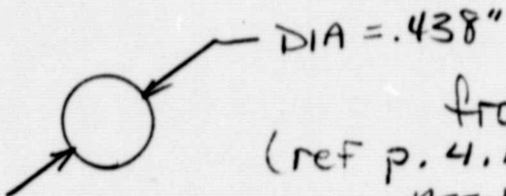
FRACTURE ANALYSIS

TOGLE LINK PIN (30A60700)

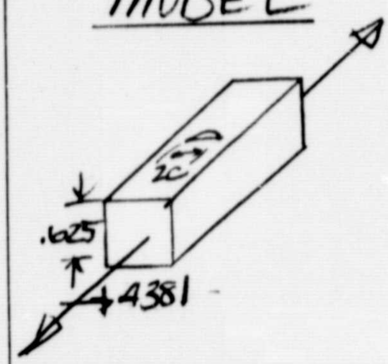
MATL - INC 718



from STRESS ANALYSIS -
(ref p. 4.14) σ_{MAX} = 92.78 KSI
ASSUME σ_{MIN} = 0 KSI (CONSERVATIVE)

LOADED 26000 cycles (INCLUDES 4 MISSIONS WITH S.F. = 4)

MODEL



ASSUME ROD IN TENSION
check for surface flaws

from computer ANALYSIS
$\frac{1}{2}$CF = .052
or CF = .104

INSPECTION -
EDDY CURRENT
LIMITS - .1 IN MINIMUM

.104 > .1

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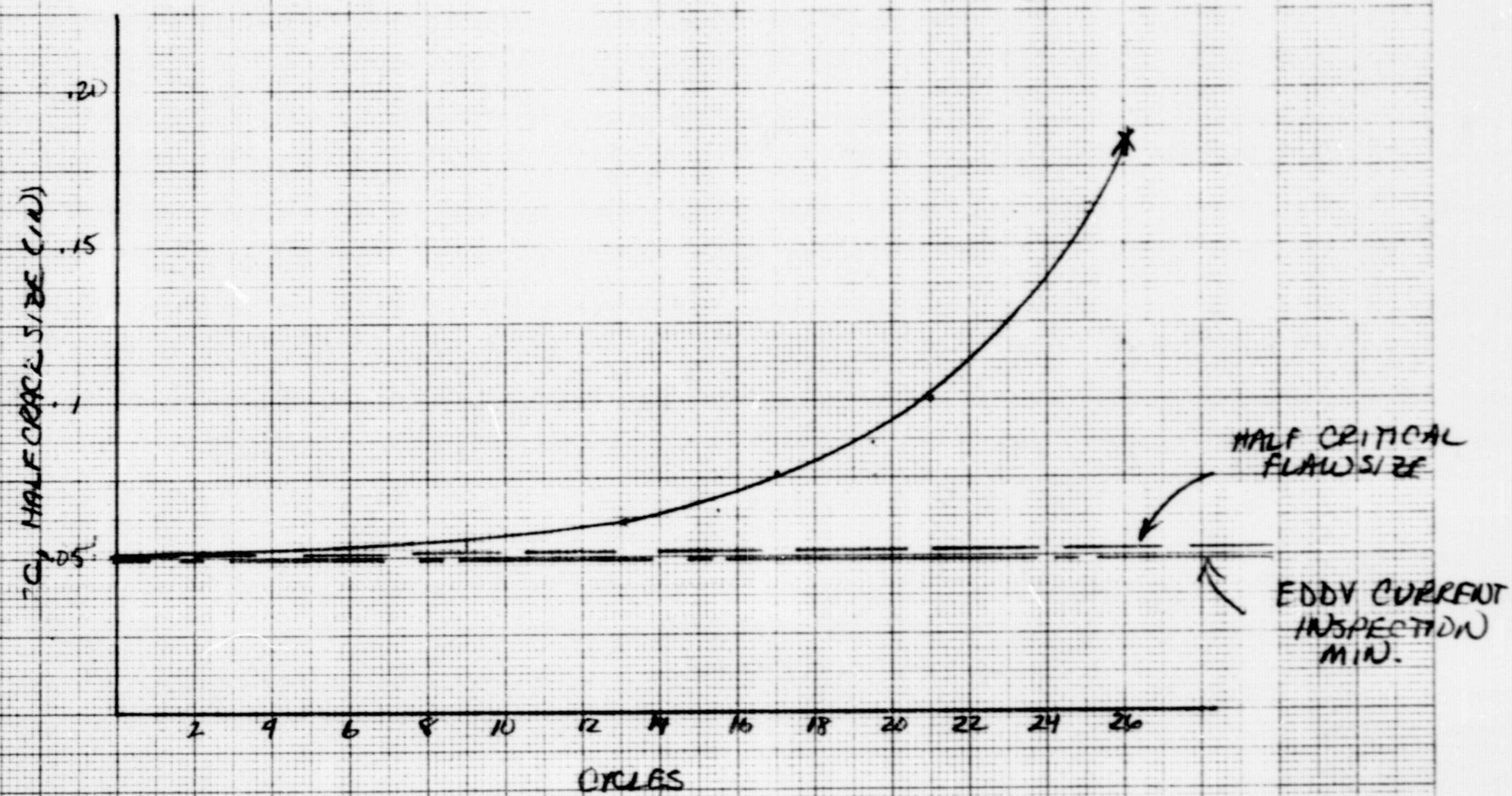
FORM LMSC 362 B-3



TOGLE LINK PIN (30A60700) - SURFACE FLAW

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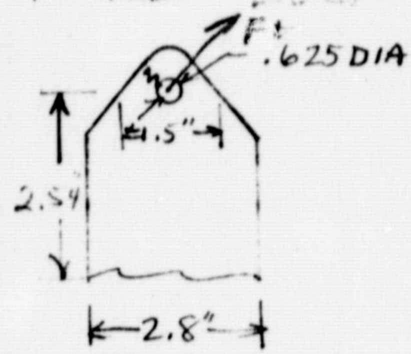
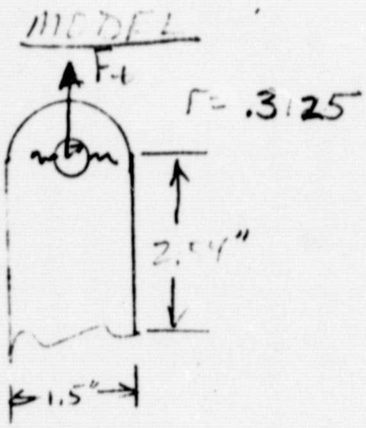
FRACTURE ANALYSIS

TOGLE LUG (30A60694)



MATL — INC 718
(CONSERVATIVELY LET ONE LUG CARRY FULL REACTION)
$F_{t\,MAX}$ = 7.66 kips (p 4.4)
ASSUME F_{MIN} = 0 (CONSERVATIVE)

LOADED 26000 CYCLES — 4 MISSION WITH S.F. = 4



CHECK FOR CRACKS OFF HOLE

FROM COMPUTER ANALYSIS —
CF = .165 IN

INSPECTION - EDDY CURRENT
MIN SIZE — .05 IN

CF > INSP. LIMIT
.165 > .05

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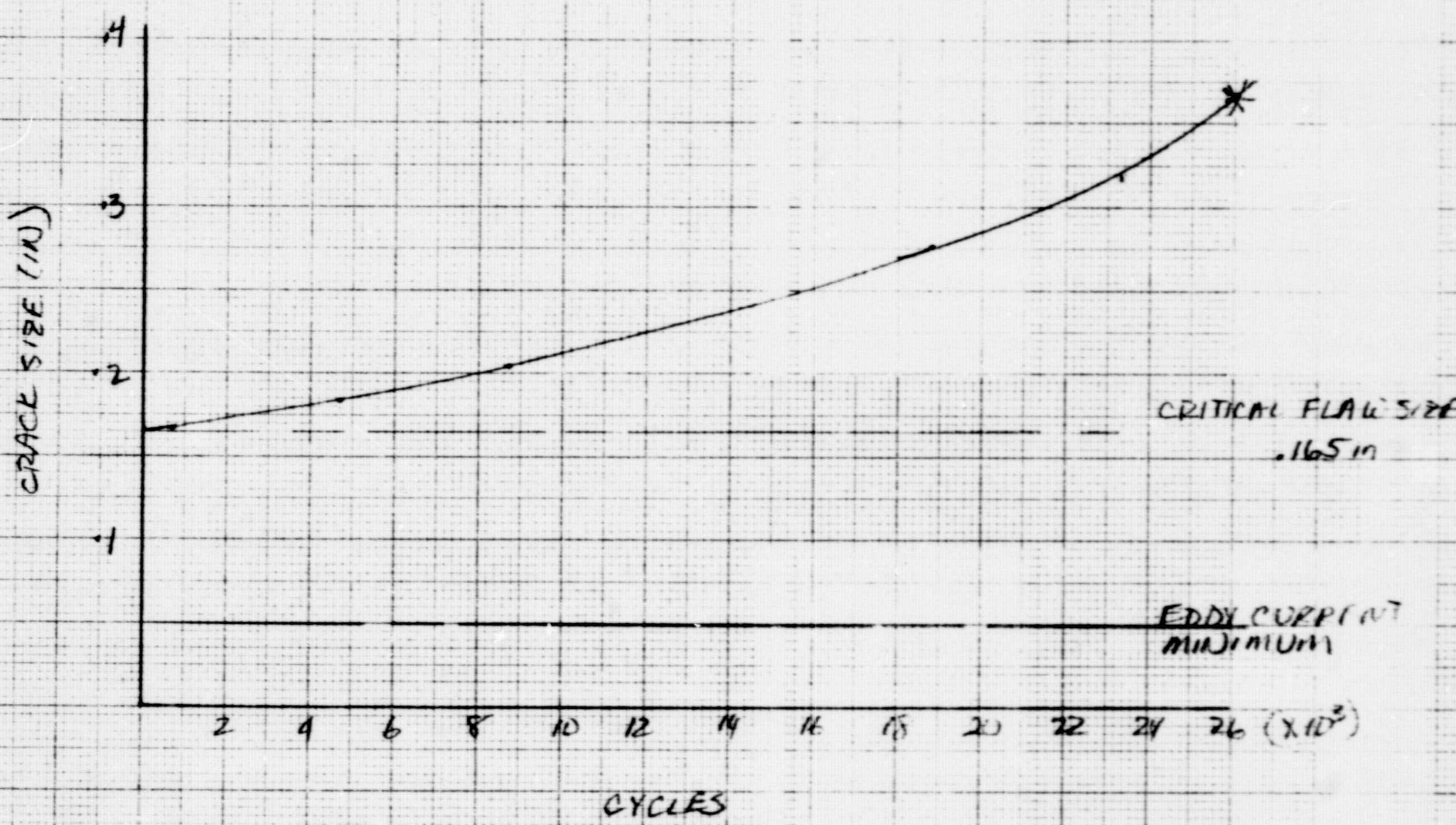
FORM LMSC 362 B-3



TOGLE LINK LUG (30A60694) – DBL CRACK OFF HOLE

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Checked by: EJC	Date 6/84	Title SPARTAN PEA	Model
Approved by:	Date		Report No.

FRACTURE ANALYSIS
LUG PIN (30A6C698)

.625 DIA

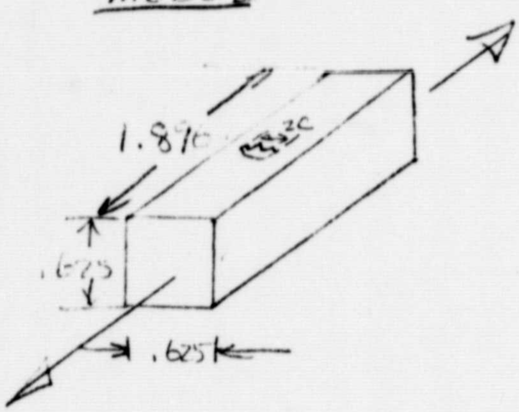
MATL - 718 INC
S.F. = 4

Leff 1.64 in

LOADING IS FOR 4 MISSIONS @ 50 HZ WITH SF=4, OR 26000 cycles

(ref. p 4.15.2) σ_{MAX} = 72.8 KSI
ASSUME σ_{MIN} = 0 KSI (CONSERVATIVE)

MODEL -



ASSUME ROD IN TENSION

CHECK FOR SURFACE FLAWS
from COMPUTER ANALYSIS
$\frac{1}{2}$CF = .073
or .146

INSPECTION DONE WITH EDDY CURRENT -
MIN LIMITS ARE .1 IN

.146 > .1

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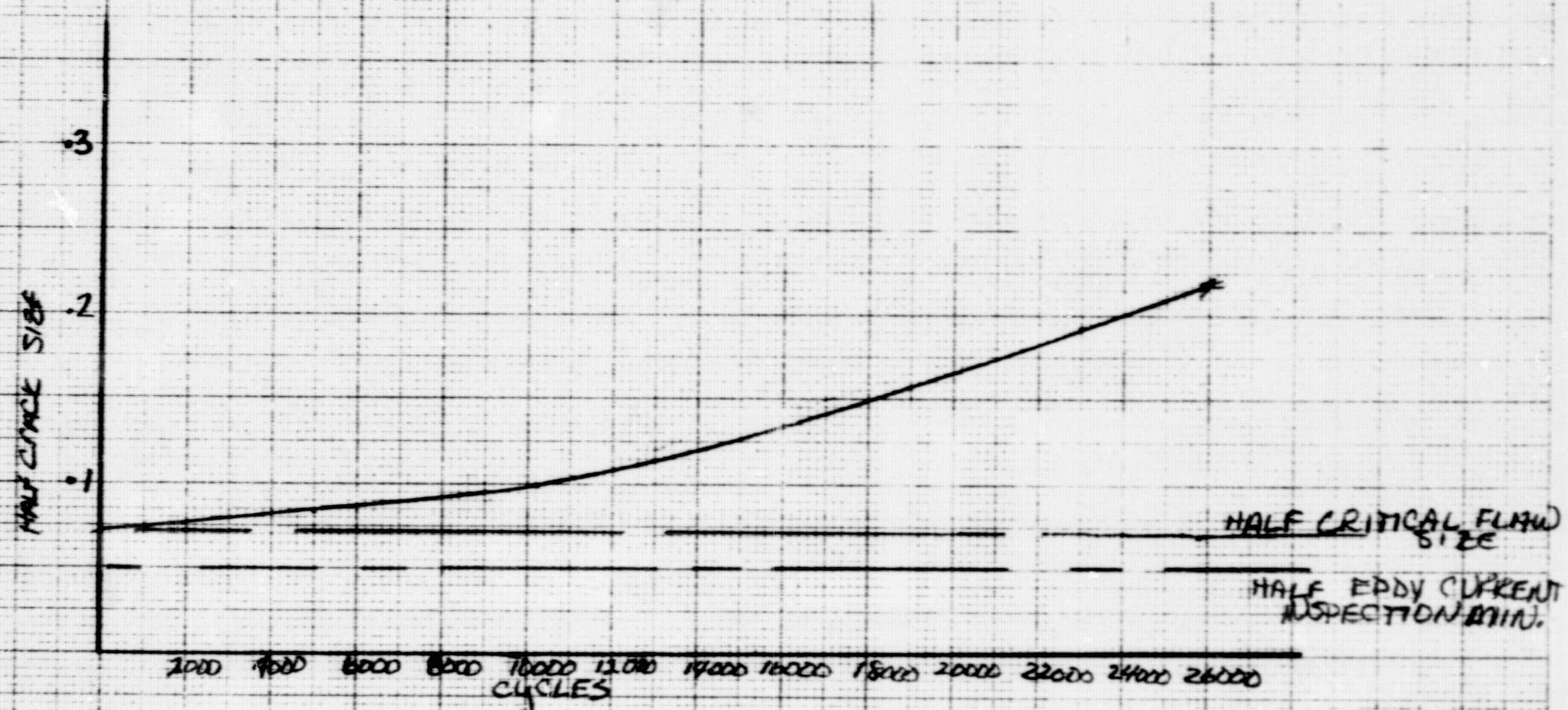
FORM LMSC 362 B-3



LUG PIN (30A60698) - SURFACE FLAW

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FRACTURE ANALYSIS

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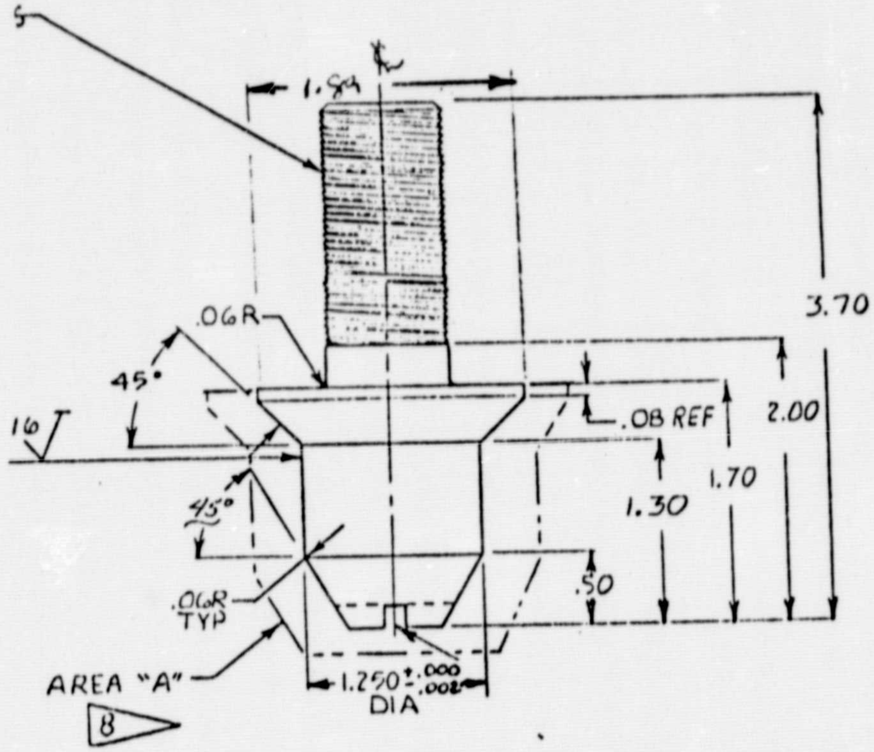
ROUND PIN (30A60642)

MATL - INC 718



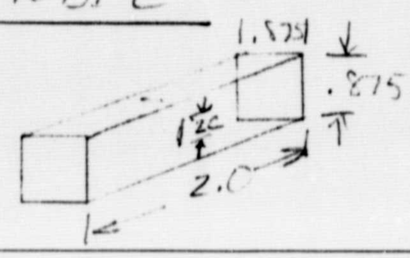
$$\text{SHANK AREA} = \frac{(.875)^2 \pi}{4} = .601 \text{ in}^2$$

From Stress Analysis - $P_{MAX} = \underline{5.19}$ kips (p4.51)

$$\sigma_{MAX} = f = \frac{5.19}{.601} = 8.63 \text{ KSI}$$

ASSUME $\sigma_{MIN} = 0$ KSI (CONSERVATIVE)

MODEL



ASSUME ROD IN TENSION
LOADED 26000 cycles
(for 4 missions
AND S.F. 4)

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FRACTURE ANALYSIS

ROUND PIN (CONT.)

INSPECTION - EDDY CURRENT
LIMITS - .1 IN

From computer ANALYSIS -

WITH INITIAL FLAWS OF 80% OF THE PIN DIAMETER THERE WAS NO CRACK GROWTH AFTER 200,000 cycles

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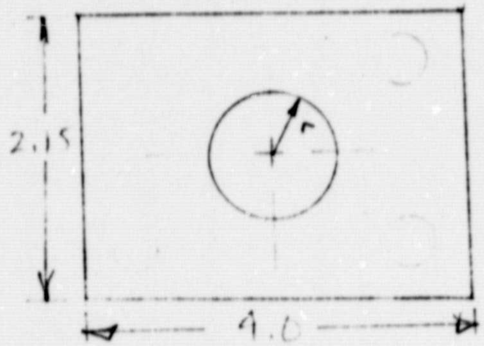
ROUND PIN PLATE (3C[illegible])



t = .625"   MATL' - INC 718

r = .625"

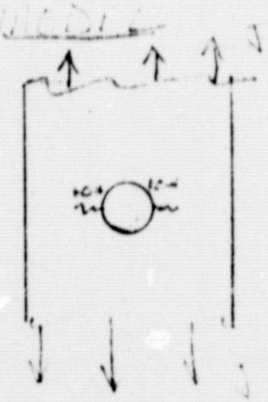
LOADED 26000 cy
(4 MISSIONS WITH
S.F. = 4)

FROM STRESS ANALYSIS -
$P_{V_{MAX}} = 11.73$ kips   (ref p. 4.28)

$A_t = (4.0 - 1.25)(.625) = 1.71\ in^2$

$\sigma = \frac{P_V}{A_t} = 6.86$ ksi   , ASSUME $\sigma_{MIN} = 0$
(CONSERVATIVE)

MODEL



check ROUND PIN
HOLE FOR CRACKS

from computer ANALYSIS -
CF = 1.0625 IN.

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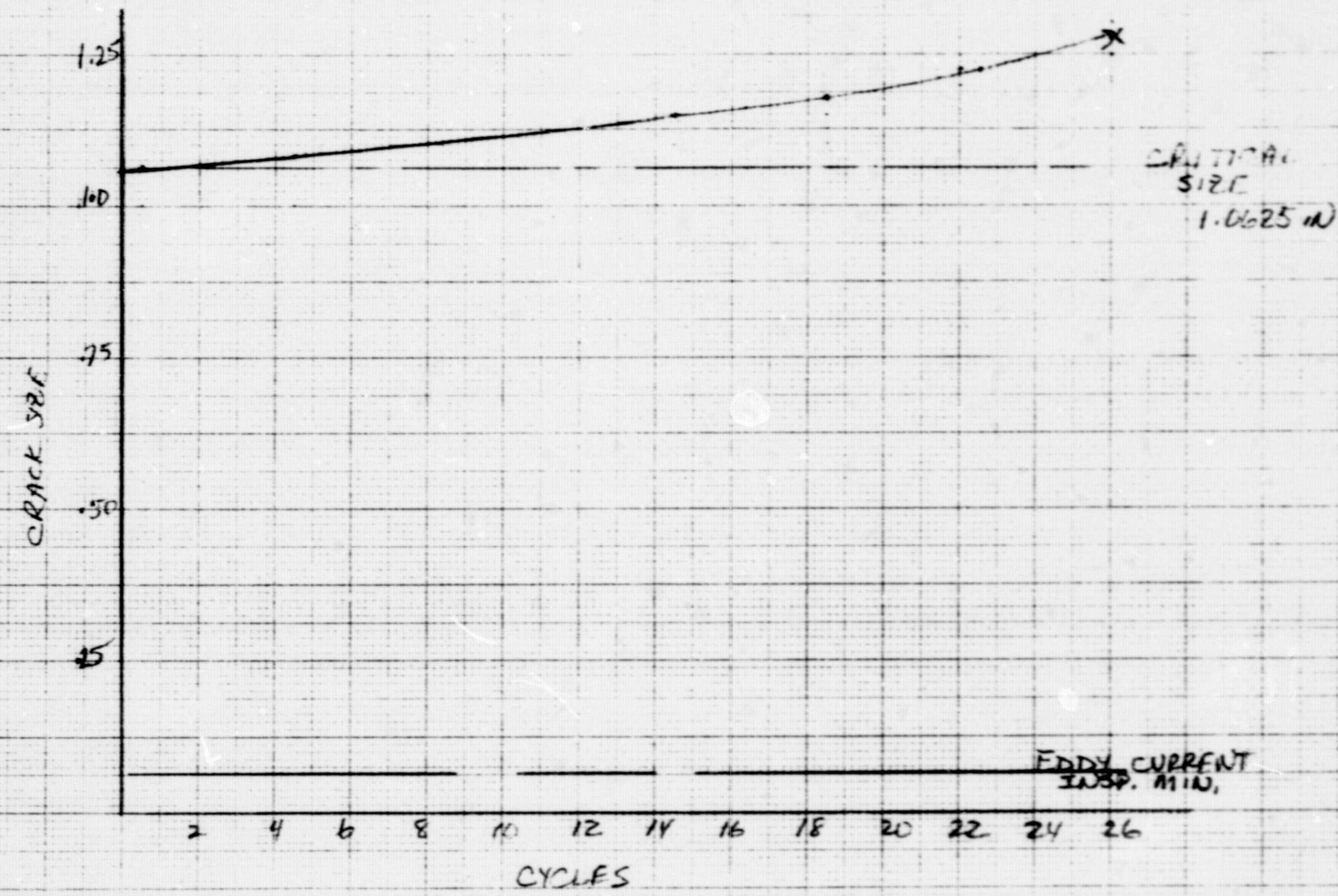
INSPECTION - EDDY CURRENT
MINIMUM SIZE = .05 IN

CF > INSP MIN.
1.0625 > .05



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ROUND PIN PLATE - 30A60645 (DOUBLE CRACK OFF ROUND PIN HOLE)

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FRACTURE ANALYSIS

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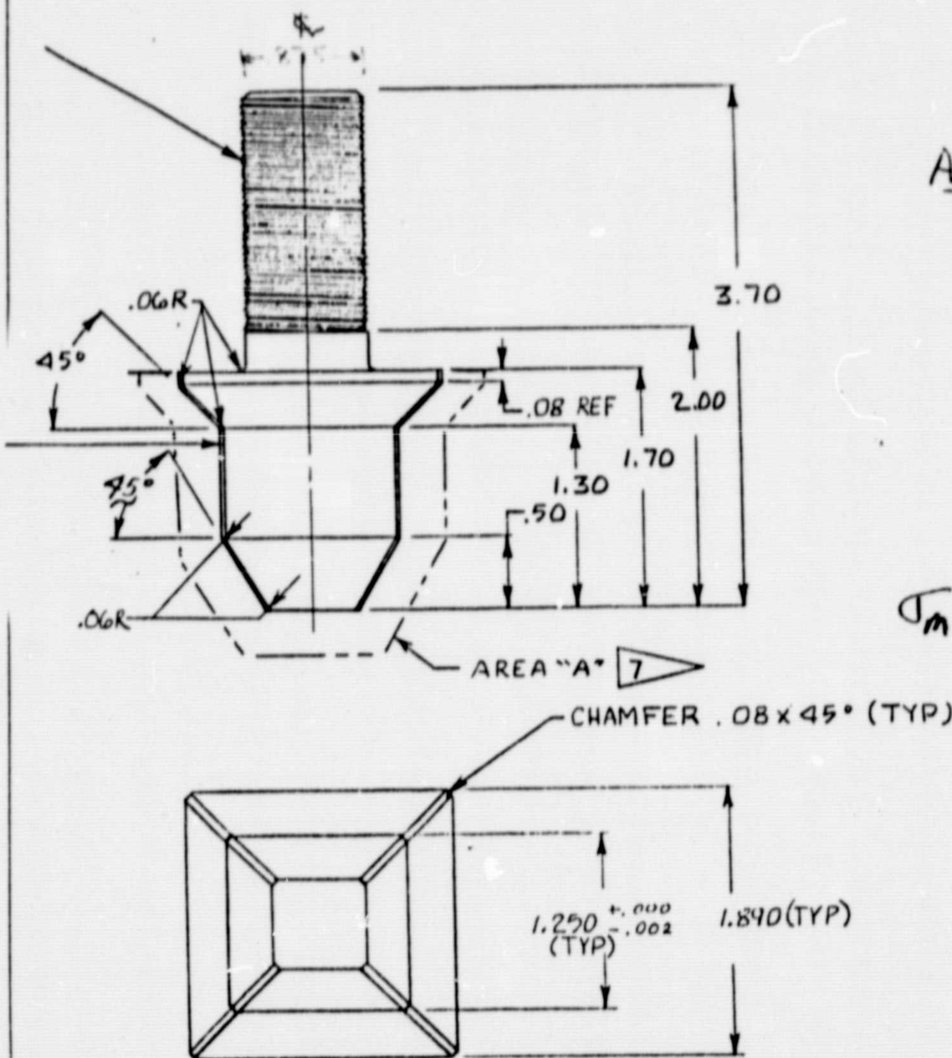
SQUARE PIN (30A60643)



MATL - INC 718

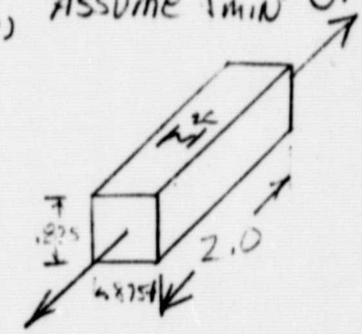
SHANK AREA -
$A_s = .875 \times .875 = .765^2$

FROM STRESS ANALYSIS
MAX LOAD -
5.19 KIPS (P 4.28)

$A_s = .875^2$
$= .762 \text{ in}^2$

$\sigma_{MAX} = f = \frac{5.19}{.762} = 6.88 \text{ KSI}$

ASSUME $\sigma_{MIN} = 0$.



CHECKING FOR SURFACE FLAWS ON SHANK

WITH INITIAL FLAW SIZES OF 80% OF THE SHANK AREA there WAS NO CRACK GROWTH AFTER 260,000 CYCLES

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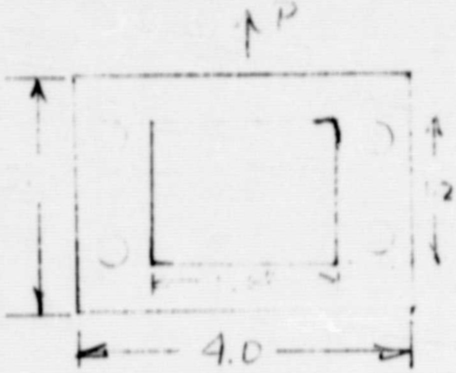
FRACTURE ANALYSIS
[illegible] PIN PLATE (3DA60649)



MATL INC 718

LOADED 26000 cycles
(4 MISSIONS with S.F. = 4)

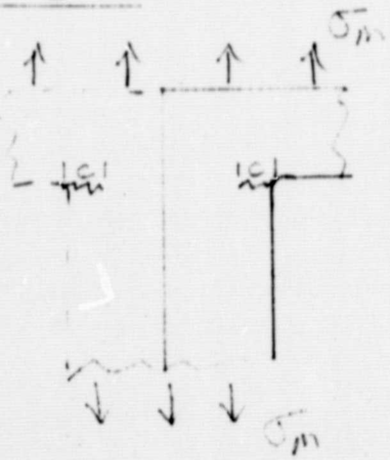
FROM STRESS ANALYSIS - TENSION

$P_{V\,MAX} = 11.69$ kips (p4.51)

$A_t = (4 - 1.6)(.625) = 1.5\ in^2$

$\sigma = \frac{P_V}{A_t} = \frac{11.69}{1.5} = 7.79$ ksi ; ASSUME $\sigma_{MIN} = 0$ (CONSERVATIVE)

MODEL

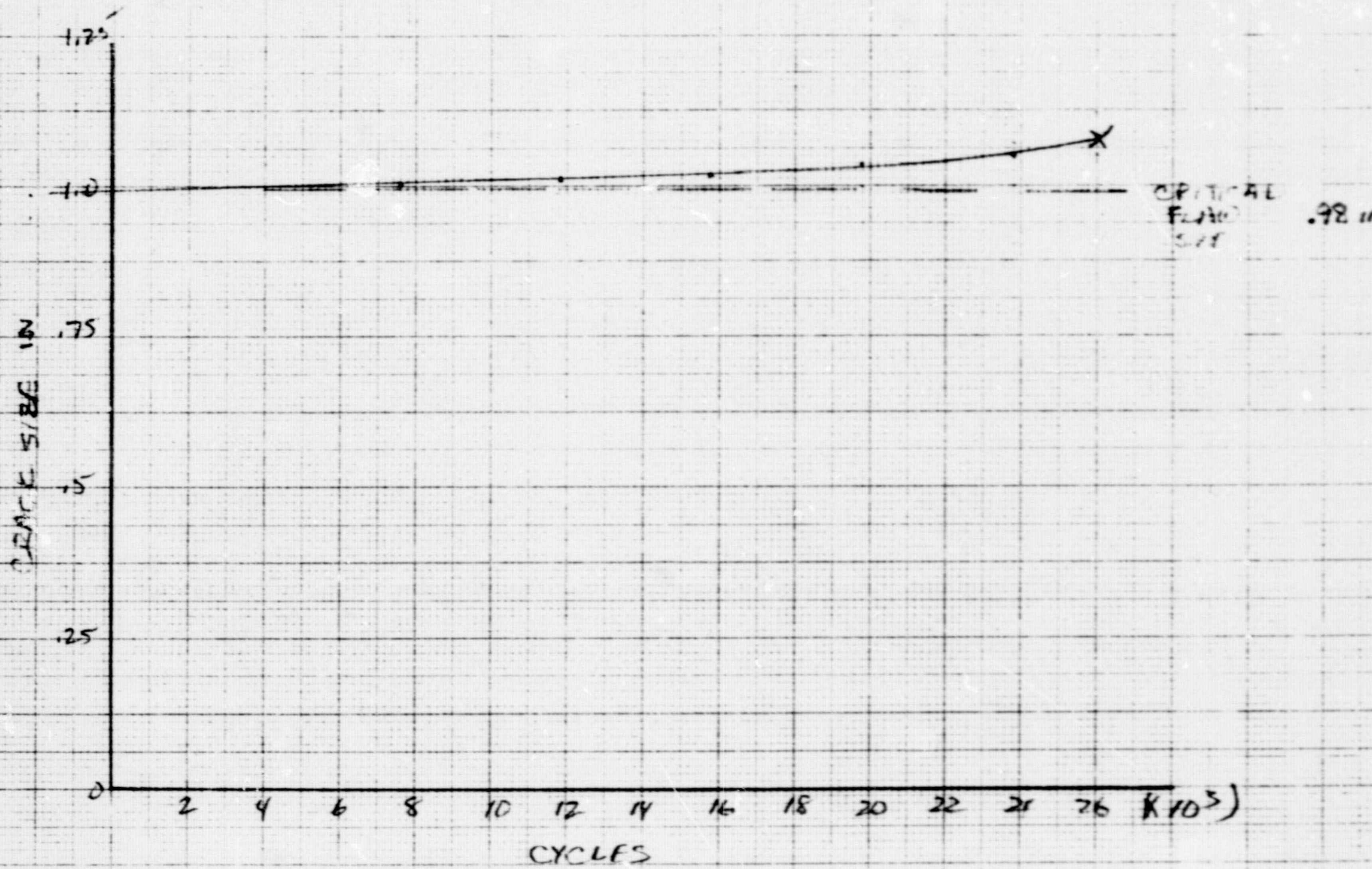


CHECK SQUARE HOLE CORNERS FOR CRACKS

From computer ANALYSIS
CF = .98 IN

EDDY CURRENT INSPECTION
MIN SIZE = .05

CF > INSP. MIN.
.98 > .05



SQUARE PIN PLATE (3DA60644) - CRACK AT CORNERS I

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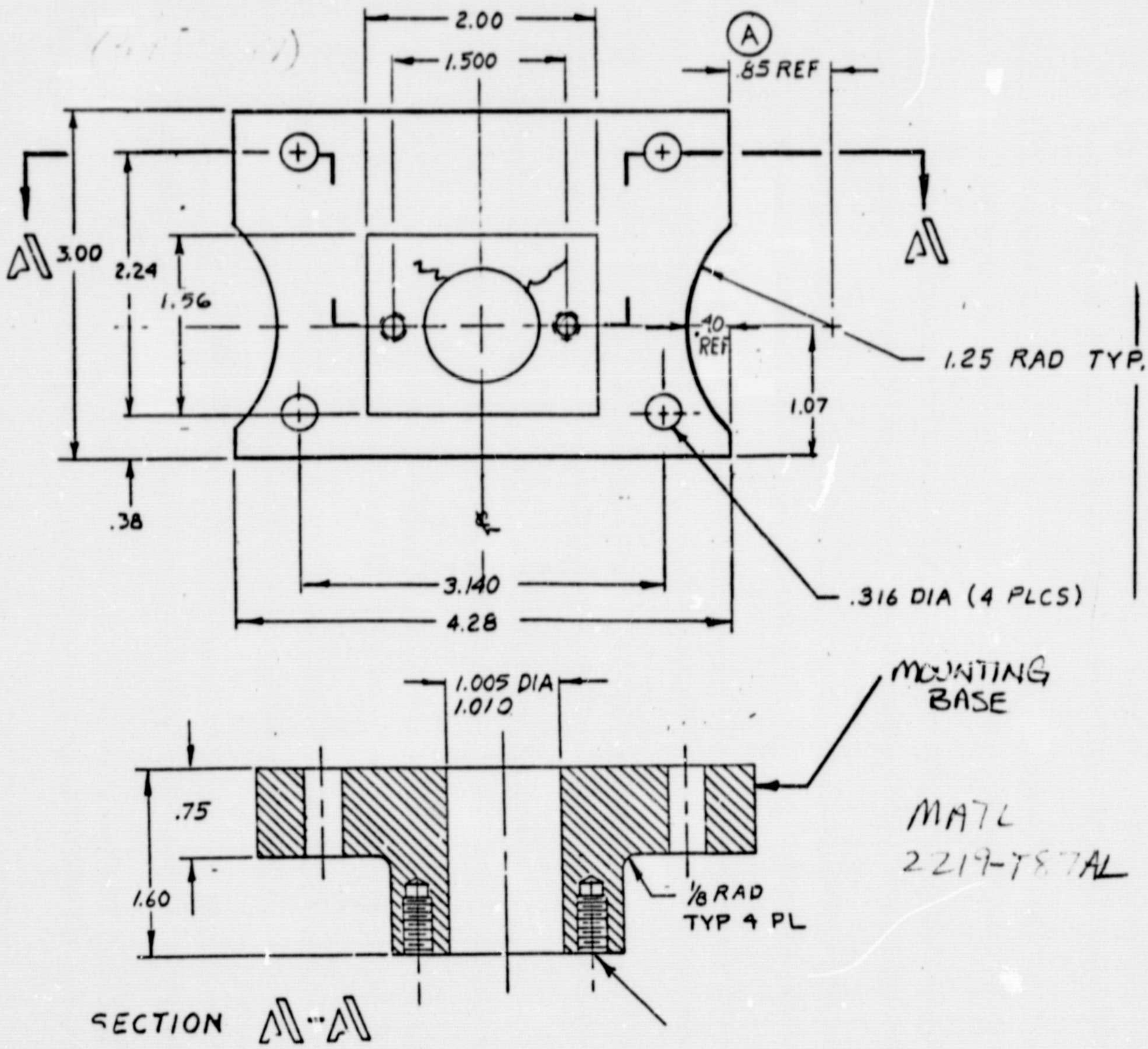
FRACTURE ANALYSIS

ROD HOLDERS (30A6-647, 648)



MATL 2219-T87 AL

CRACK OFF ROD HOLE - CHECK
LOAD - BERTHING LOADS
FROM STRESS ANALYSIS - MAX LOAD = 1560 lb
ASSUME $P_{MIN} = 0$ (CONSERVATIVE)

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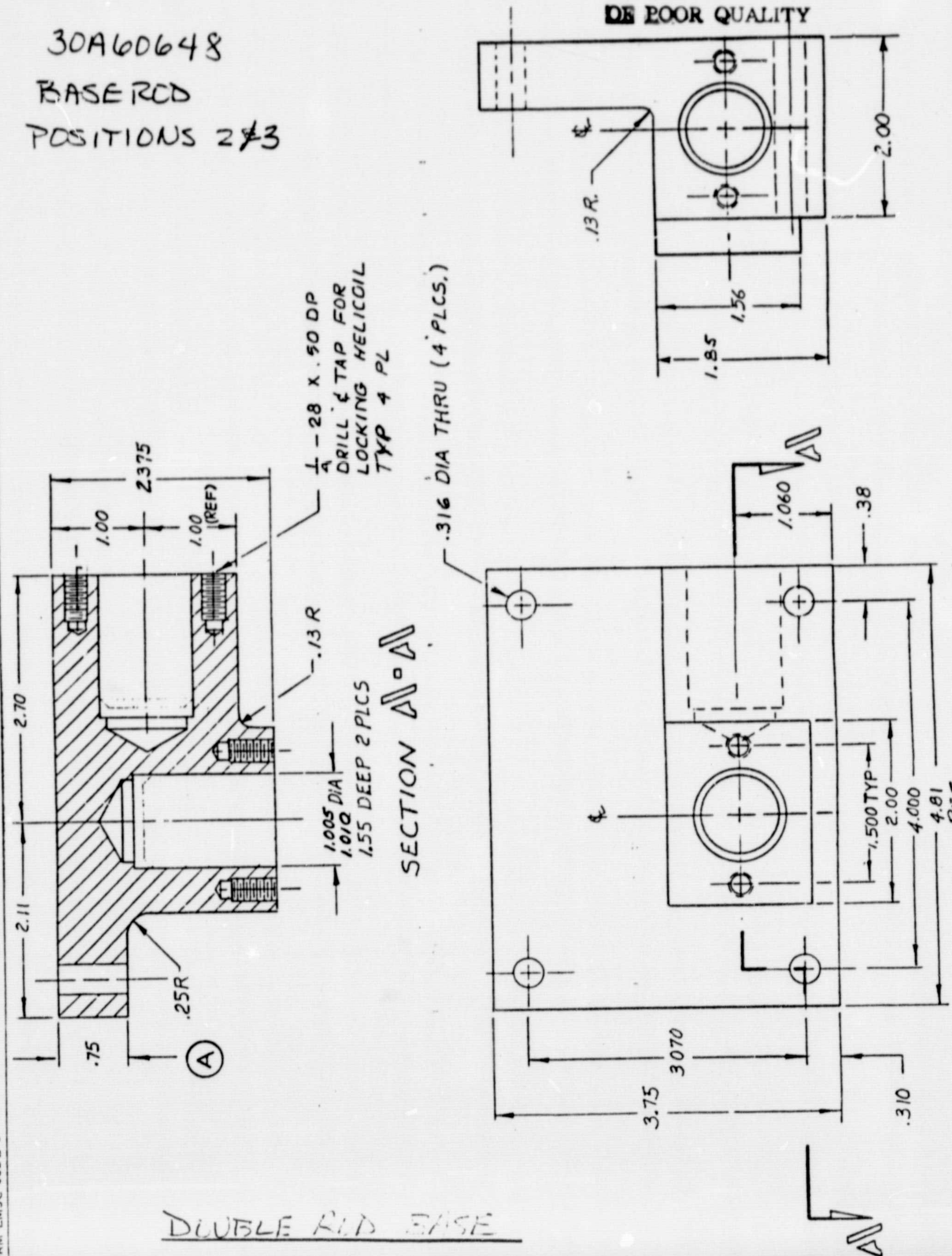
30A60648
BASE RCD
POSITIONS 2&3



DOUBLE RCD BASE

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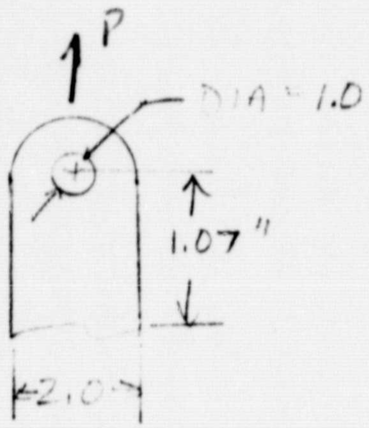
R/S HOLDERS -(CONT)

LUG

ASSUME PIN LOADED LUG



FROM COMPUTER ANALYSIS -

$t = 1.6$ in

INITIAL CRACKS OF 20% OF LUG AREA SHOW NO GROWTH

P = 1560 lb
ref p 4.36

DOUBLE R/S HOLDER - (32A60645)

SAME AS (32A60647) SINGLE R/S HOLDER

NO GROWTH

NOTE - NO INSPECTION CURRENTLY DONE
NONE RECOMENDED

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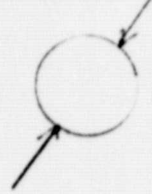
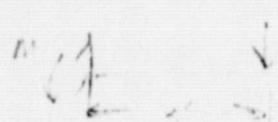
FRACTURE ANALYSIS

LINK ROD (30[illegible]649)

MATL: [illegible]-T87 AL



FROM STRESS ANALYSIS - MAX LOAD = 1560 lb



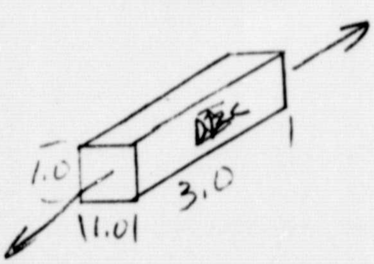
$m = 3P = 4680\ \text{in-lb}$

$\sigma_{MAX} = \frac{Mc}{I} = \frac{4680}{.05}(.5) = 46.8\ \text{KSI}$

ASSUME $\sigma_{min} = 0$

$I = \frac{\pi}{64} d^4 = \frac{\pi}{64} = .05\ \text{in}^4$

MODEL

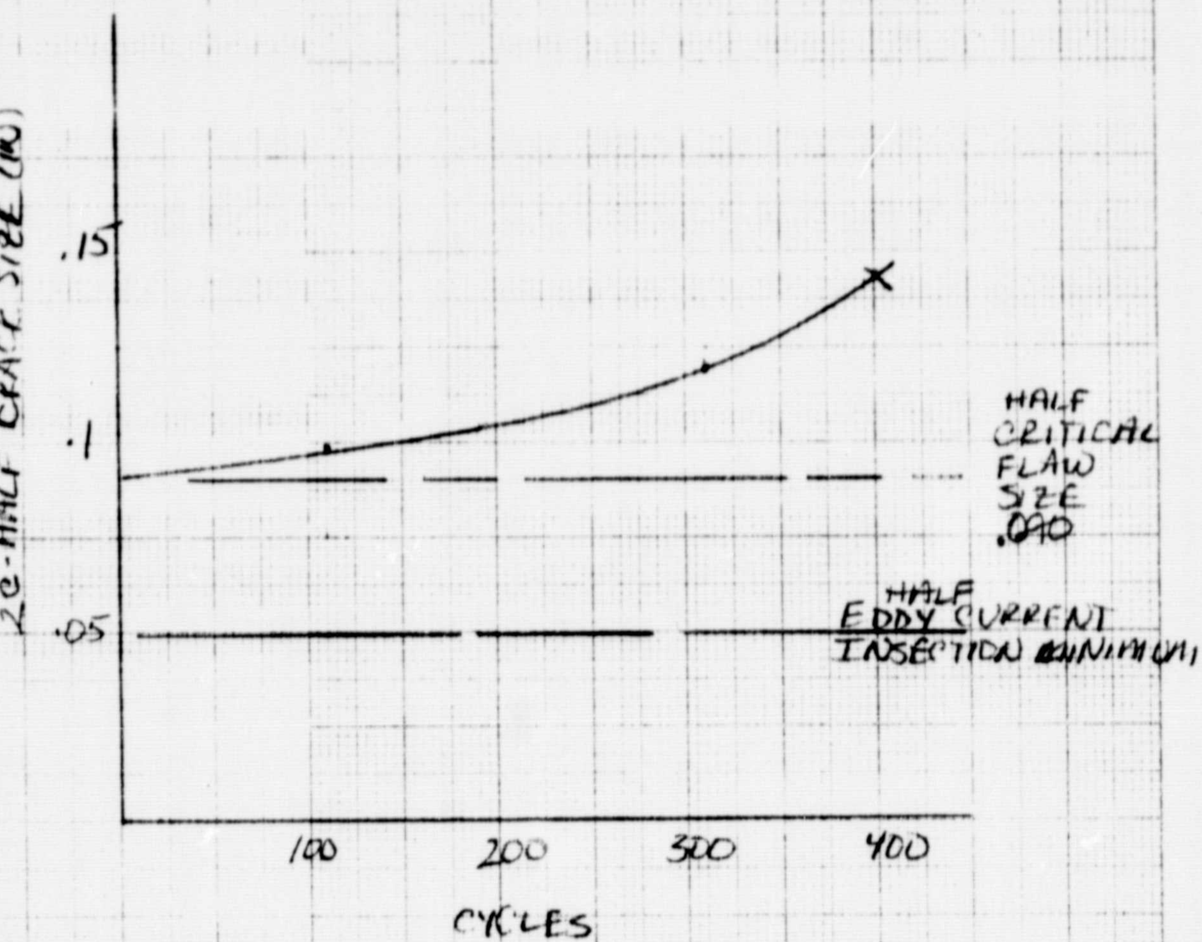


ASSUME ROD

from COMPUTER ANALYSIS -
$\frac{1}{2}$ CF = .090
or CF = .18 IN

INSPECTION - EDDY CURRENT
LIMITS - .1 IN

.18 > .1



LOCATOR ROD (30A60649)
SURFACE FLAW

Prepared by: DSA	Date 6/84	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page Temp. 5.23 Perm.
Checked by: G W	Date 6/84	Title SPARTAN DPM	Model
Approved by	Date		Report No.

(36A6007)

MATL - 416 CRES

l .2

from stress ANALYSIS

$\sigma_{MAX} = \sigma_g = 66.78$ KSI* (from previous ANALYSIS)

CONSERVATIVELY LET

$\sigma_{MIN} = 0$

LIFE FACTOR = 4

DESIGN LIFE = 100 cycles X LF

= 100 X 4 = 400 cycles

CHECK CRACK ON TOOTH SURFACE

MODEL

critical flaw size from computer ANALYSIS -

2CF = .05 in.

OR CF = .1 IN

EDDY CURRENT INSPECTION

MIN SIZE - .1

CF = MIN SIZE

.1 = .1

*FROM EARLIER ANALYSIS - LOADS UNCHANGED

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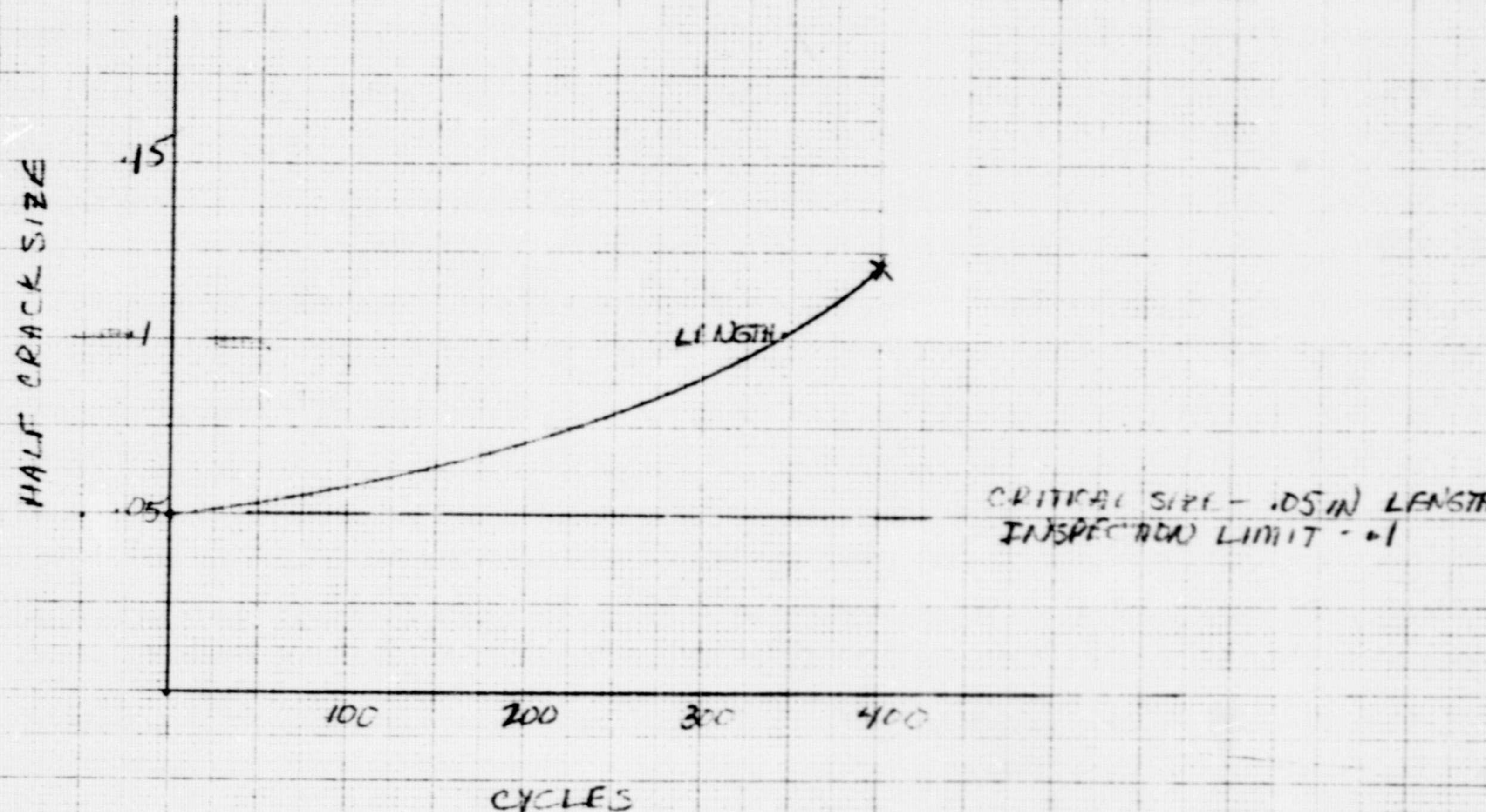

WORM GEAR - 30A60099 - FLAW ON TOOTH

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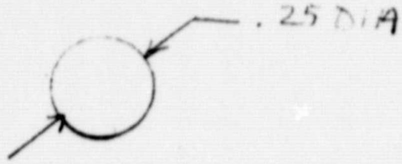
FRACTURE ANALYSIS

WORM GEAR PIN (30A60043)



MATL - MP35N STL

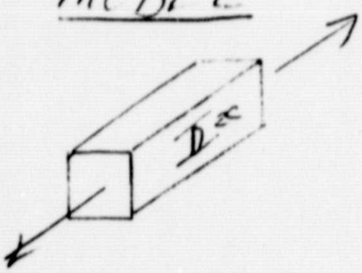
from STRESS ANALYSIS -

$\sigma_{max} = 145.3$ KSI *

ASSUME $\sigma_{min} = 0$ (CONSERVATIVE)

LOAD CYCLES = 100 X SF
= 100 X 4 = 400

MODEL



ASSUME ROD IN TENSION
check FOR SURFACE FLAW

from computer ANALYSIS
$\frac{1}{2}$ CF = .053 IN
OR CF = .106 IN

EDDY CURRENT INSPECTION LIMIT — .1 IN

.106 > .1

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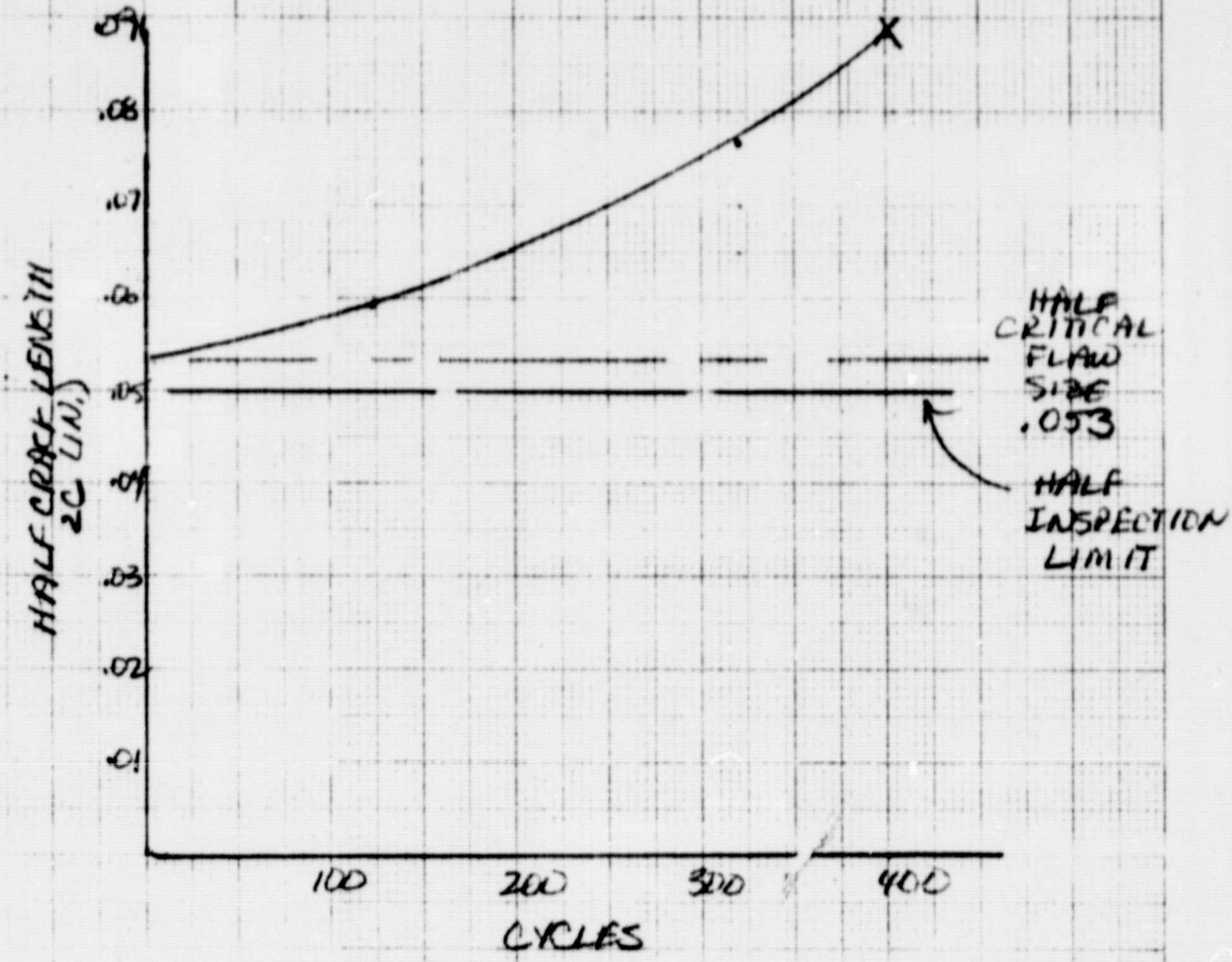
* FROM previous SPARTAN REM ANALYSIS
LOADS UNCHANGED

FORM LMSC 362 R-3



WORM GEAR PIN (30A60043)
SURFACE FLAW

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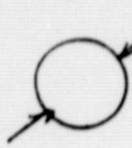
FRACTURE ANALYSIS

WORM P/N (30A60021)

.1249 DIA



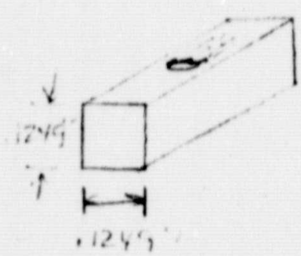
MATL - MP35N ST

from stress analysis -
σ_{MAX} = 92.8 KSI *
LET σ_{MIN} = 0 (CONSERVATIVE)

LOADED 400 cycles INCLUDING a LIFE FACTOR OF 4.

MODEL

ASSUME A ROD IN TENSION

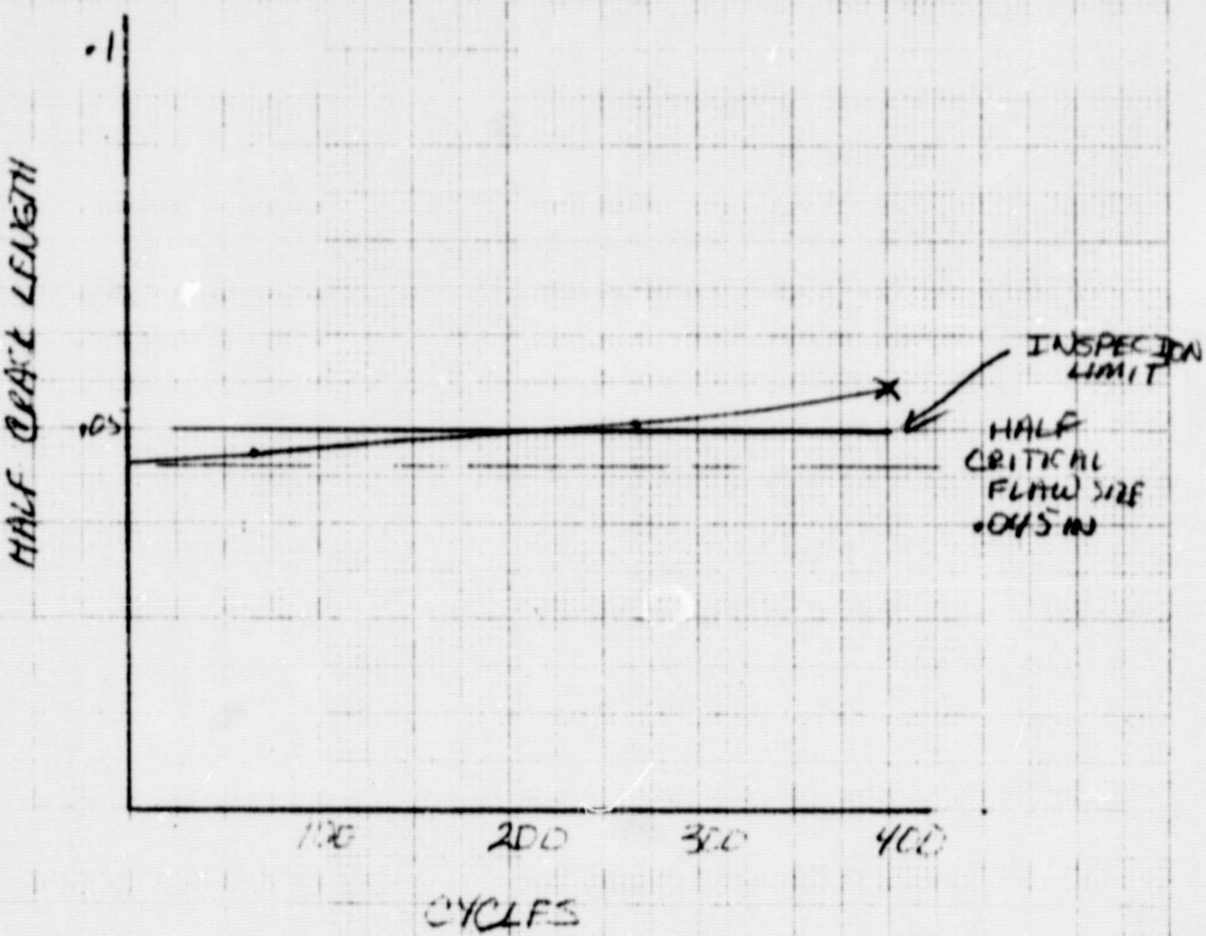


from computer analysis
2CF = .045 IN
or CF = .09 IN

EDDY CURRENT INSPECTION LIMIT
= .1 IN

* CF < INSP LIMIT

* FROM PREVIOUS SPARTAN REM ANALYSIS
LOADS UNCHANGED



WORM PIN - (30A60021) SURFACE FLAW

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FRACTURE ANALYSIS

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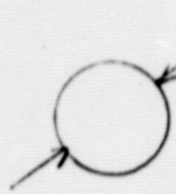
WORM SHAFT (30A86102)

.50 DIA

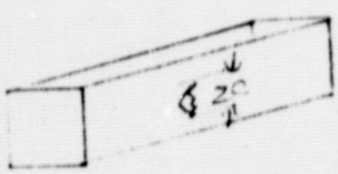


MATL- 416 CRES

from stress analysis
$\sigma_{max} = 66.78$ ksi*
conservatively let $\sigma_{min} = 0$

LOADED 400 cycles
400 = 100 cycle X LIFE FACTOR
LIFE FACTOR = 4

[illegible]



ASSUME ROD IN TENSION WITH SURFACE FLAW

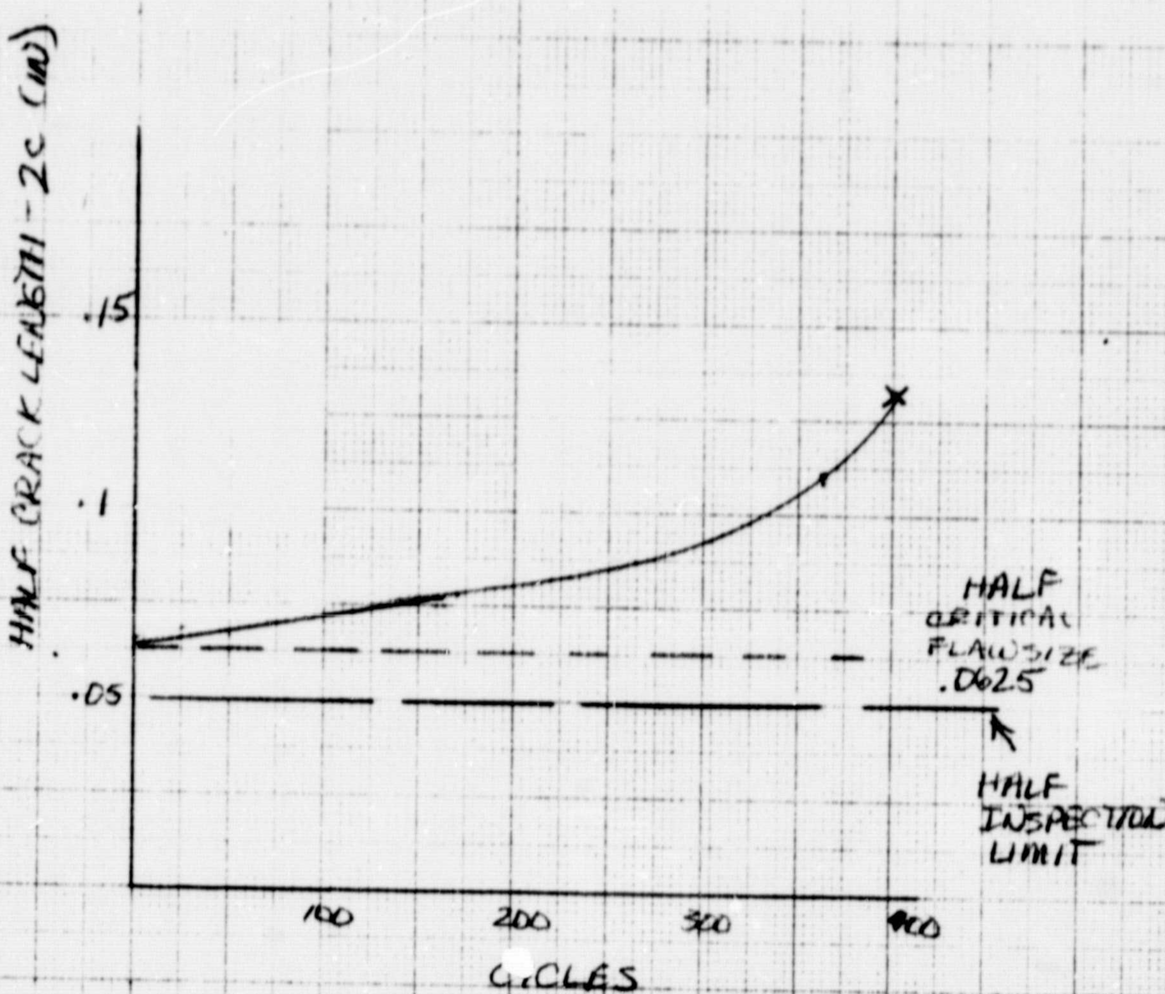
from computer analysis
$\frac{1}{2}$ CF = .0625 IN
or CF = .125 IN

INSPECTION - EDDY CURRENT
MIN INSPECTION SIZE = .1 IN

CF > INS SIZE
.125 > .1

* FROM PREVIOUS SPARTAN RFM ANALYSIS
LOADS UNCHANGED

FORM LMSC 362 B-3



WORM SHAFT (30A60102) - SURFACE FLAW