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Construction and Physical Properties of Type I, Carbon Steel and Corrosion Resistant Steel Wire

Nominal Diameter of Wire Rope	Tolerance on Diameter (Plus Only)	Allowable Increase of Diameter at Cut End	Construction	Minimum Breaking Strength of Composition A*	Minimum Breaking Strength of Composition B**	Approximate Weight per 100 feet
in.	in.	in.		lb.	lb.	lb.
1/32	.006	.006	3 x 7	110	110	0.16
3/64	.008	.008	7 x 7	270	270	0.42
1/16	.010	.009	7 x 7	480	480	0.75
1/16	.010	.009	7 x 19	480	480	0.75
1/32	.012	.010	7 x 7	920	920	1.60
3/32	.012	.010	7 x 19	1,000	920	1.74
1/8	.014	.011	7 x 19	2,000	1,760	2.90
5/32	.016	.017	7 x 19	2,800	2,400	4.50
3/16	.018	.019	7 x 19	4,200	3,700	6.50
7/32	.018	.020	7 x 19	5,600	5,000	8.60
1/4	.018	.021	7 x 19	7,000	6,400	11.00
9/32	.020	.023	7 x 19	8,000	7,800	13.90
5/16	.022	.024	7 x 19	9,000	9,000	17.30
3/8	.026	.027	7 x 19	14,400	12,000	24.30

* carbon steel
** stainless steel

From MIL-W-83420C Spec Wire Rope

FOREWORD AND IMPORTANT INFORMATION

For more than 30 years NICOPRESS SLEEVES have been used with aircraft control cable, wire rope, and fiber rope. NICOPRESS OVAL SLEEVES are used to eye-splice, and NICOPRESS STOP SLEEVES are used to terminate cable and rope.

For convenient and proper compression of Nicopress Sleeves both in the field and in the shop, many types of Nicopress Tools are available.

They include:

Bench Tools	Manual Hydraulic Tools
Hand Tools	Power Hydraulic Tools

Detailed instruction sheets showing proper tool operation and adjustment, plus gauges for checking sleeve compression are packaged with each tool. For customers wishing to utilize their own power press equipment, we will furnish the necessary die groove dimensions required to fabricate special dies.

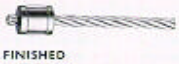
We have determined through pull testing that copper and plated copper Nicopress Oval Sleeves will hold military specification grade aircraft control cable in tension until it breaks, when the cable is made to military specifications: MIL-W-83420, dated 9-7-73 for cable constructions 3x7, 7x7, and 7x19, and MIL-W-1511A-4 dated 2-20-64 and MIL-W-5424B dated 1-10-72 for cable construction 6x19IWRC.

However, other types and grades of cable exist and may be used with Nicopress Sleeves. In order to establish the exact holding power of a Nicopress Sleeve when used with other types of cable, we recommend pull testing prior to use. This step insures the proper selection of materials, the correct pressing procedure, and an adequate margin of safety for the intended use.

Nicopress Sleeves are available in other materials such as aluminum and stainless steel.

Nicopress® OVAL SLEEVES STOP SLEEVES

NICOPRESS OVAL SLEEVE — FINISHED EYE SPLICE



NICOPRESS STOP SLEEVE — FINISHED STOP

COPPER OVAL SLEEVES

CABLE SIZE	NICOPRESS OVAL SLEEVE STOCK NO.		NICOPRESS HAND TOOL STOCK NO.	APPROX. WEIGHT PER 1000 SLEEVES LBS.	SLEEVE LENGTH BEFORE COMPRESSED APPROX.	SLEEVE LENGTH AFTER COMPRESSED APPROX.
	PLAIN COPPER	ZINC-PLATED COPPER				
1/32"	17-1-B	27-1-B	*17-BA	0.6	1/4"	5/16"
3/64"	18-11-B4	28-11-B4	51-B4-887	2	3/8"	7/16"
1/16"	18-1-C	28-1-C	51-C-887	3	3/8"	7/16"
3/32"	18-2-G	28-2-G	51-G-887	5	3/8"	7/16"
1/8"	18-3-M	28-3-M	51-M-850	17	9/16"	3/4"
5/32"	18-4-P	28-4-P	51-P-850	23	5/8"	7/8"
3/16"	18-6-X	28-6-X	51-X-850	49	15/16"	1-3/16"
7/32"	18-8-F2	28-8-F2	51-F2-850	56	7/8"	1-1/16"
1/4"	18-10-F6	28-10-F6	3-F6-950	80	1-1/8"	1-1/2"
5/16"	18-13-G9	28-13-G9	3-G9-950	114	1-1/16"	1-3/8"
NO. 635 HYDRAULIC TOOL DIES						
3/8"	18-23-H5	28-23-H5	Oval H5	153	1-1/4"	1-5/8"
7/16"	18-24-J8	28-24-J8	Oval J8	302	1-3/4"	2-5/16"
1/2"	18-25-K8	28-25-K8	Oval K8	410	1-7/8"	2-1/2"
9/16"	18-27-M1	28-27-M1	Oval M1	551	2"	2-5/8"
5/8"	18-28-N5	28-28-N5	Oval N5	802	2-3/8"	3-1/8"

COPPER STOP SLEEVES

CABLE SIZE	NICOPRESS STOP SLEEVE STOCK NO.	NICOPRESS HAND TOOL STOCK NO.	OUTSIDE DIAMETER OF SLEEVE	APPROX. WEIGHT PER 1000 SLEEVES LBS.	SLEEVE LENGTH BEFORE COMPRESSED APPROX.	** TYPICAL HOLDING STRENGTH OF STOP SLEEVE LBS.
1/32"	871-32-B	*17-BA	1/8"	3/4	1/4"	120
3/64"	871-12-B4	51-B4-887	11/64"	1-1/2	7/32"	240
1/16"	871-1-C	51-C-887	13/64"	2	7/32"	430
1/16"	***871-1-Q	51-Q-929	1/4"	2	5/32"	425
3/32"	871-17-J (Yellow)	51-MJ	21/64"	8	5/16"	600
3/32"	***871-3-Q	51-Q-929	1/4"	2	5/32"	550
1/8"	871-18-J (Red)	51-MJ	21/64"	8	5/16"	900
5/32"	871-19-M	51-MJ	27/64"	13	5/16"	1,200
3/16"	871-20-M (Black)	51-MJ	27/64"	12	5/16"	1,600
7/32"	871-22-M	51-MJ	7/16"	20	5/8"	2,500
1/4"	871-23-F6	3-F6-950	21/32"	60	11/16"	3,500
5/16"	871-26-F6	3-F6-950	21/32"	60	11/16"	4,000

*Formerly 17-1 Tool.
**Holding strengths shown are based on use of galvanized aircraft cable.
***Electro Galvanized Steel Sleeves.

Steel Aircraft Bolts - Strength Requirements

	Ultimate Tensile Strength (lb)[1]		Double Sheer Strength (lb)[2]
Size	Eyebolts	Fine Thread[3] Hexagon Head	All Bolts
No. 6	-	-	2,120
No. 8	-	-	3,000
No. 1	1,150	2,210	4,250
1/4	2,450	4,080	7,360
5/16	3,910 (AN44)	6,500	11,500
5/16	5,290 (AN45)	6,500	11,500
3/8	7,015	10,100	16,560
7/16	9,200	13,600	22,500
½	14,375	18,500	29,400
9/16	10,125	23,600	37,400
5/8	-	30,100	46,000
3/4	-	44,000	66,300
7/8	-	60,000	90,100
1	-	80,700	117,800
1-1/8	-	101,800	147,500
1/14	-	130,200	182,100

[1] The values shown for the ultimate tensile strength are for minimum values and are based on 125,000 psi for non-corrosion-resistant and corrosion-resistant steel.

The strength values shown for the eyebolts are based on the strength of the eye. The root area of the thread is the basis of calculation for the tensile strength of hexagon head bolts.

Clevis bolts shall have tensile strengths equal to one-half of the requirements for hexagon-head bolts when used with AN320 or MS21083 nuts. Clevis bolts are intended primarily for use in shear applications.

[2] Ultimate shear strengths are computed on the basis of 60 percent of the ultimate tensile strengths.

[3] Class of thread is as specified on the applicable standard drawing.

[4] Different from size 5/16 above in the design of the eye section.

STANDARD FASTENERS *INFORMATION*

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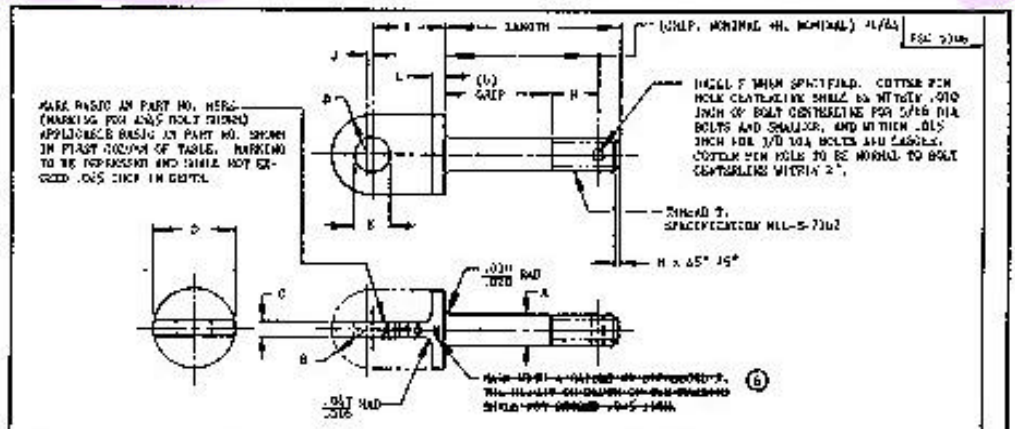
STANDARD GUIDE FOR FASTENER SELECTION AND PRODUCT MARKING REQUIREMENTS

Product Grade Identification	Industry Standards	Material	Nominal Product Diameters	Tensile Strength PSI	Product Hardness Rockwell	Marking Requirement For Matching Nut
	SAE J429 Grade 1	1010 - 1020 Low Carbon Steel	1/4 thru 1 1/2 and bolts longer than 6"	60,000	B70 - B100	
	SAE J429 Grade 2	1018 - 1020 Low Carbon Steel	1/4 thru 3/4	74,000	B80 - B100	
			over 3/4 to 1 1/2	60,000	B70 - B100	
5.8	ISO R898 Property Class 5.8 SAE J1199	Low or Medium Carbon Steel, cold worked	M5 thru M24	75,400 (520 MPa)	B82 - B95	
	ASTM A449 Type 1 SAE J429 Grade 5	1035-1038 Medium Carbon Steel, heat treated	1/4 thru 1	120,000	C25 - C34	
			Over 1 thru 1 1/2	105,000	C19 - C30	
8.8	ISO R898 Property Class 8.8 SAE J1199	1035-1038 Medium Carbon Steel, heat treated	M4 thru M16	116,000 (800 MPa)	C20 - C30	
			M17 thru M36	120,350 (830 MPa)	C25 - C34	
B-7	ASTM A193 B - 7	4140-4145H Chromium-Molybdenum Alloy Steel	Threaded Rod and Studs 2 1/2 and Under	125,000	—	
	SAE J429 Grade 8	Carbon steel	1/4 thru 3/4	150,000	C33 - C39	
		1541 Carbon Steel	7/16 and Smaller			
		Medium Carbon alloy	other sizes			
KARTITE A354 - BD	ASTM A354 Grade BD	Special Alloy Steel, oil Quenched & Tempered	1/4 thru 1 1/2	150,000	C33 - C39	
10.9	SAE J429 Grade 8.2 SAE J1199	Low Carbon Boron Martensite Steel, Quenched & Tempered, Limited Use	Hex and Flange 1/4 thru 1	150,000	C33 - C39	
KARALLOY 10.9	ISO R898 Property Class 10.9, ASTM F568	Medium Carbon Alloy Steel, oil Quenched & Tempered	M6 thru M36	150,800 (1040 MPa)	C33 - C39	
KARALLOY	Karalloy Special	Proprietary Fine Grained Alloy Steel, oil Quenched & Tempered	1/4 thru 1	180,000 200,000	C38 - C42	

* All fastener products (nuts, bolts, studs, washers, etc.) are required to be permanently marked to identify the grade or property class and the manufacturer's or private label distributor's identification symbol



BASIC AN PART NO.	THREAD T	A DIA MAX	A DIA MIN	B RAD	C ±.005	D DIA	E DIA HAN	E DIA MCH	F ±.005	(a) H REF	J	K	L	M	RATED STRENGTH, POUNDS TENSILE STRENGTH OF BOLT	RATED STRENGTH, POUNDS SHEAR STRENGTH OF BOLT	(a) PIN DIA REF
(c) AN42	NO. 10-32UNF-3A	.189	.186	1/32	.004	7/16	.192	.190	.030	17/64	1/32	13/32	3/16	1/32	1 190	660	1/16
(c) AN43	1/4-28 UNF-3A	.249	.245	1/4	.125	1/2	.192	.190	.030	5/16	1/32	15/32	5/64	1/32	2 190	1 360	1/16
AN45	5/16-24 UNF-3A	.312	.309	5/16	.188	5/8	.251	.250	.035	21/64	3/64	17/32	3/32	3/64	3 910	3 000	1/8
AN45	5/16-24 UNF-3A	.312	.309	13/32		21/32	.316	.313	.035	21/64		19/32			5 390	4 050	5/16
AN46	3/8-24 UNF-3A	.374	.371	7/8		3/4	.376	.375	.035	7/16		19/32			7 015	5 715	3/8
AN47	7/16-20 UNF-3A	.437	.433	7/16	.250	7/8	.378	.375	.035	31/64	1/16	23/32		3/64	9 300	7 055	3/8
AN48	1/2-20 UNF-3A	.499	.495	1/2	.313	1	.443	.438	.035	9/16	1/16	13/15	1/8	3/64	14 325	11 050	7/16
AN49	9/16-18 UNF-3A	.562	.558	19/32	.375	1-3/16	.566	.500	.035	9/16	5/64	15/16		1/16	20 525	15 630	1/2

(a) REFERENCE DIMENSIONS ARE FOR DESIGN PURPOSES ONLY AND ARE NOT AN INSPECTION REQUIREMENT.

(b) GRIP LENGTH OF BOLTS SHALL BE MEASURED FROM THE UNDERSIDE OF THE HEAD TO THE END OF THE FULL CYLINDRICAL PORTION OF THE SHANK. COMPLETE THREADS SHALL REACH WITHIN TWO THREAD PITCH MAXIMUM. TWO THREAD PITCH MAXIMUM MAY CONSIST OF INCOMPLETE THREAD OR EXTENSION ANGLE.

(c) BOLTS WITH BASIC PART NUMBERS AN42 AND AN43 INACTIVE FOR DESIGN AFTER 8 APRIL 1955. IN LIEU THEREOF, USE BOLTS WITH BASIC PART NUMBERS AN42B AND AN43B.

FOR DEFINITION AND APPLICATION OF DRAWING STATUS NOTES, SEE AFA DIRECTIVE NO. 931.

MATERIAL: NON-CORROSION-RESISTANT STEEL OR CORROSION-RESISTANT STEEL. SEE PROCUREMENT SPECIFICATION.

(d) FINISH: SEE PROCUREMENT SPECIFICATION.

ADD A ROTOR DASH NUMBER FOR BOLT WITHOUT DRILLED HOLE IN SHANK.

ADD A ROTOR DASH NUMBER FOR CORROSION-RESISTANT STEEL BOLT.

EXAMPLES OF PART NUMBERS: AN42-10 - 1/8-24 NON-CORROSION-RESISTANT STEEL EYE BOLT, 1-3/4 LONG HAVING 7/16 GRIP AND WITH DRILLED HOLE IN SHANK.
AN42-10A - 1/8-24 NON-CORROSION-RESISTANT STEEL EYE BOLT, 1-3/4 LONG HAVING 7/16 GRIP AND WITHOUT DRILLED HOLE IN SHANK.
AN42-C10 - 1/8-24 CORROSION-RESISTANT STEEL EYE BOLT, 1-3/4 LONG HAVING 7/16 GRIP AND WITH DRILLED HOLE IN SHANK.
AN42-C10A - 1/8-24 CORROSION-RESISTANT STEEL EYE BOLT, 1-3/4 LONG HAVING 7/16 GRIP AND WITHOUT DRILLED HOLE IN SHANK.
AN43-C12A - 1/4-28 CORROSION-RESISTANT STEEL EYE BOLT, 2-1/2 LONG HAVING 9/16 GRIP AND WITHOUT DRILLED HOLE IN SHANK.

BOLTS SHALL BE FREE FROM ALL HANDING BURRS AND SLIVERS WHICH MIGHT BECOME DISLODGED UNDER USAGE.

COUNTERSINKING OF DRILLED HOLE IN SHANK IS OPTIONAL. THIS HOLE E SHALL NOT BE COUNTERSUNK.

DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES: FRACTIONS ±1/64.

(5) FOR CHANGES SEE SHEET 1.

PROCUREMENT SPECIFICATION	AIR FORCE-NAVY AERONAUTICAL STANDARD	AN42 THRU AN49
MIL-B-6832	BOLT, EYE	SHEET 1 OF 2

SUPERSEDES FORMER AIR FORCE AND NAVY STANDARD ISSUES OF AN42 THROUGH AN49.

DASH NO.	AN42, AN42B		AN43, AN43B		AN44		AN45		AN46		AN47		AN48		AN49	
	GRIP	LENGTH +1/32 -1/64	GRIP	LENGTH +1/32 -1/64	GRIP	LENGTH +1/32 -1/64	GRIP	LENGTH +1/32 -1/64	GRIP	LENGTH +1/32 -1/64	GRIP	LENGTH +1/32 -1/64	GRIP	LENGTH +1/32 -1/64	GRIP	LENGTH +1/32 -1/64
3	1/16	15/32														
4	1/8	17/32	1/16	17/32	1/16	19/32	1/16	39/64								
5	1/4	21/32	3/16	21/32	3/16	23/32	3/16	23/32	1/16	45/64	1/16	23/32				
6	3/8	25/32	5/16	25/32	5/16	27/32	5/16	27/32	3/16	53/64	3/16	27/32	1/16	27/32	1/16	31/32
7	1/2	29/32	7/16	29/32	7/16	31/32	7/16	31/32	5/16	61/64	5/16	31/32	3/16	31/32	1/8	1-1/32
10	5/8	1-1/32	9/16	1-1/32	9/16	1-3/32	9/16	1-3/32	7/16	1-5/64	7/16	1-3/32	5/16	1-3/32	1/4	1-5/32
11	3/4	1-5/32	11/16	1-5/32	11/16	1-7/32	11/16	1-7/32	9/16	1-13/64	9/16	1-7/32	7/16	1-7/32	3/8	1-9/32
12	7/8	1-9/32	13/16	1-9/32	13/16	1-11/32	13/16	1-11/32	11/16	1-21/64	11/16	1-11/32	9/16	1-11/32	1/2	1-13/32
13	1	1-13/32	15/16	1-13/32	15/16	1-15/32	15/16	1-15/32	13/16	1-29/64	13/16	1-15/32	11/16	1-15/32	5/8	1-17/32
14	1-1/8	1-17/32	1-1/16	1-17/32	1-1/16	1-19/32	1-1/16	1-19/32	15/16	1-37/64	15/16	1-19/32	13/16	1-19/32	3/4	1-21/32
15	1-1/4	1-21/32	1-3/16	1-21/32	1-3/16	1-23/32	1-3/16	1-23/32	1-1/16	1-45/64	1-1/16	1-23/32	15/16	1-23/32	7/8	1-25/32
16	1-3/8	1-25/32	1-5/16	1-25/32	1-5/16	1-27/32	1-5/16	1-27/32	1-3/16	1-53/64	1-3/16	1-27/32	1-1/16	1-27/32	1	1-29/32
17	1-1/2	1-29/32	1-7/16	1-29/32	1-7/16	1-31/32	1-7/16	1-31/32	1-5/16	1-61/64	1-5/16	1-31/32	1-3/16	1-31/32	1-1/8	2-1/32
20	1-5/8	2-1/32	1-9/16	2-1/32	1-9/16	2-3/32	1-9/16	2-3/32	1-7/16	2-5/64	1-7/16	2-3/32	1-5/16	2-3/32	1-1/4	2-5/32
21	1-3/4	2-5/32	1-11/16	2-5/32	1-11/16	2-7/32	1-11/16	2-7/32	1-9/16	2-13/64	1-9/16	2-7/32	1-7/16	2-7/32	1-3/8	2-9/32
22	1-7/8	2-9/32	1-13/16	2-9/32	1-13/16	2-11/32	1-13/16	2-11/32	1-11/16	2-21/64	1-11/16	2-11/32	1-9/16	2-11/32	1-1/2	2-13/32
23	2	2-13/32	1-15/16	2-13/32	1-15/16	2-15/32	1-15/16	2-15/32	1-13/16	2-29/64	1-13/16	2-15/32	1-11/16	2-15/32	1-5/8	2-17/32
24	2-1/8	2-17/32	2-1/16	2-17/32	2-1/16	2-19/32	2-1/16	2-19/32	1-15/16	2-37/64	1-15/16	2-19/32	1-13/16	2-19/32	1-3/4	2-21/32
25	2-1/4	2-21/32	2-3/16	2-21/32	2-3/16	2-23/32	2-3/16	2-23/32	2-1/16	2-45/64	2-1/16	2-23/32	1-15/16	2-23/32	1-7/8	2-25/32
26	2-3/8	2-25/32	2-5/16	2-25/32	2-5/16	2-27/32	2-5/16	2-27/32	2-3/16	2-53/64	2-3/16	2-27/32	2-1/16	2-27/32	2	2-29/32
27	2-1/2	2-29/32	2-7/16	2-29/32	2-7/16	2-31/32	2-7/16	2-31/32	2-5/16	2-61/64	2-5/16	2-31/32	2-3/16	2-31/32	2-1/8	3-1/32
30	2-5/8	3-1/32	2-9/16	3-1/32	2-9/16	3-3/32	2-9/16	3-3/32	2-7/16	3-5/64	2-7/16	3-3/32	2-5/16	3-3/32	2-1/4	3-5/32
31	2-3/4	3-5/32	2-11/16	3-5/32	2-11/16	3-7/32	2-11/16	3-7/32	2-9/16	3-13/64	2-9/16	3-7/32	2-7/16	3-7/32	2-3/8	3-9/32
32	2-7/8	3-9/32	2-13/16	3-9/32	2-13/16	3-11/32	2-13/16	3-11/32	2-11/16	3-21/64	2-11/16	3-11/32	2-9/16	3-11/32	2-1/2	3-13/32
33	3	3-13/32	2-15/16	3-13/32	2-15/16	3-15/32	2-15/16	3-15/32	2-13/16	3-29/64	2-13/16	3-15/32	2-11/16	3-15/32	2-5/8	3-17/32
34	3-1/8	3-17/32	3-1/16	3-17/32	3-1/16	3-19/32	3-1/16	3-19/32	2-15/16	3-37/64	2-15/16	3-19/32	2-13/16	3-19/32	2-3/4	3-21/32
35	3-1/4	3-21/32	3-3/16	3-21/32	3-3/16	3-23/32	3-3/16	3-23/32	3-1/16	3-45/64	3-1/16	3-23/32	2-15/16	3-23/32	2-7/8	3-25/32
36	3-3/8	3-25/32	3-5/16	3-25/32	3-5/16	3-27/32	3-5/16	3-27/32	3-3/16	3-53/64	3-3/16	3-27/32	3-1/16	3-27/32	3	3-29/32
37	3-1/2	3-29/32	3-7/16	3-29/32	3-7/16	3-31/32	3-7/16	3-31/32	3-5/16	3-61/64	3-5/16	3-31/32	3-3/16	3-31/32	3-1/8	4-1/32
40	3-5/8	4-1/32	3-9/16	4-1/32	3-9/16	4-3/32	3-9/16	4-3/32	3-7/16	4-5/64	3-7/16	4-3/32	3-5/16	4-3/32	3-1/4	4-5/32
41	3-3/4	4-5/32	3-11/16	4-5/32	3-11/16	4-7/32	3-11/16	4-7/32	3-9/16	4-13/64	3-9/16	4-7/32	3-7/16	4-7/32	3-3/8	4-9/32
42	3-7/8	4-9/32	3-13/16	4-9/32	3-13/16	4-11/32	3-13/16	4-11/32	3-11/16	4-21/64	3-11/16	4-11/32	3-9/16	4-11/32	3-1/2	4-13/32
43	4	4-13/32	3-15/16	4-13/32	3-15/16	4-15/32	3-15/16	4-15/32	3-13/16	4-29/64	3-13/16	4-15/32	3-11/16	4-15/32	3-5/8	4-17/32
44	4-1/8	4-17/32	4-1/16	4-17/32	4-1/16	4-19/32	4-1/16	4-19/32	3-15/16	4-37/64	3-15/16	4-19/32	3-13/16	4-19/32	3-3/4	4-21/32
45	4-1/4	4-21/32	4-3/16	4-21/32	4-3/16	4-23/32	4-3/16	4-23/32	4-1/16	4-45/64	4-1/16	4-23/32	3-15/16	4-23/32	3-7/8	4-25/32
46	4-3/8	4-25/32	4-5/16	4-25/32	4-5/16	4-27/32	4-5/16	4-27/32	4-3/16	4-53/64	4-3/16	4-27/32	4-1/16	4-27/32	4	4-29/32
47	4-1/2	4-29/32	4-7/16	4-29/32	4-7/16	4-31/32	4-7/16	4-31/32	4-5/16	4-61/64	4-5/16	4-31/32	4-3/16	4-31/32	4-1/8	5-1/32
50	4-5/8	5-1/32	4-9/16	5-1/32	4-9/16	5-3/32	4-9/16	5-3/32	4-7/16	5-5/64	4-7/16	5-3/32	4-5/16	5-3/32	4-1/4	5-5/32
51	4-3/4	5-5/32	4-11/16	5-5/32	4-11/16	5-7/32	4-11/16	5-7/32	4-9/16	5-13/64	4-9/16	5-7/32	4-7/16	5-7/32	4-3/8	5-9/32
52	4-7/8	5-9/32	4-13/16	5-9/32	4-13/16	5-11/32	4-13/16	5-11/32	4-11/16	5-21/64	4-11/16	5-11/32	4-9/16	5-11/32	4-1/2	5-13/32
53	5	5-13/32	4-15/16	5-13/32	4-15/16	5-15/32	4-15/16	5-15/32	4-13/16	5-29/64	4-13/16	5-15/32	4-11/16	5-15/32	4-5/8	5-17/32
54	5-1/8	5-17/32	5-1/16	5-17/32	5-1/16	5-19/32	5-1/16	5-19/32	4-15/16	5-37/64	4-15/16	5-19/32	4-13/16	5-19/32	4-3/4	5-21/32
55	5-1/4	5-21/32	5-3/16	5-21/32	5-3/16	5-23/32	5-3/16	5-23/32	5-1/16	5-45/64	5-1/16	5-23/32	4-15/16	5-23/32	4-7/8	5-25/32
56	5-3/8	5-25/32	5-5/16	5-25/32	5-5/16	5-27/32	5-5/16	5-27/32	5-3/16	5-53/64	5-3/16	5-27/32	5-1/16	5-27/32	5	5-29/32
57	5-1/2	5-29/32	5-7/16	5-29/32	5-7/16	5-31/32	5-7/16	5-31/32	5-5/16	5-61/64	5-5/16	5-31/32	5-3/16	5-31/32	5-1/8	6-1/32
60	5-5/8	6-1/32	5-9/16	6-1/32	5-9/16	6-3/32	5-9/16	6-3/32	5-7/16	6-5/64	5-7/16	6-3/32	5-5/16	6-3/32	5-1/4	6-5/32
61	5-3/4	6-5/32	5-11/16	6-5/32	5-11/16	6-7/32	5-11/16	6-7/32	5-9/16	6-13/64	5-9/16	6-7/32	5-7/16	6-7/32	5-3/8	6-9/32
62	5-7/8	6-9/32	5-13/16	6-9/32	5-13/16	6-11/32	5-13/16	6-11/32	5-11/16	6-21/64	5-11/16	6-11/32	5-9/16	6-11/32	5-1/2	6-13/32
63	6	6-13/32	5-15/16	6-13/32	5-15/16	6-15/32	5-15/16	6-15/32	5-13/16	6-29/64	5-13/16	6-15/32	5-11/16	6-15/32	5-5/8	6-17/32
64	6-1/8	6-17/32	6-1/16	6-17/32	6-1/16	6-19/32	6-1/16	6-19/32	5-15/16	6-37/64	5-15/16	6-19/32	5-13/16	6-19/32	5-3/4	6-21/32
65	6-1/4	6-21/32	6-3/16	6-21/32	6-3/16	6-23/32	6-3/16	6-23/32	6-1/16	6-45/64	6-1/16	6-23/32	5-15/16	6-23/32	5-7/8	6-25/32
66	6-3/8	6-25/32	6-5/16	6-25/32	6-5/16	6-27/32	6-5/16	6-27/32	6-3/16	6-53/64	6-3/16	6-27/32	6-1/16	6-27/32	6	6-29/32
67	6-1/2	6-29/32	6-7/16	6-29/32	6-7/16	6-31/32	6-7/16	6-31/32	6-5/16	6-61/64	6-5/16	6-31/32	6-3/16	6-31/32	6-1/8	7-1/32
70	6-5/8	7-1/32	6-9/16	7-1/32	6-9/16	7-3/32	6-9/16	7-3/32	6-7/16	7-5/64	6-7/16	7-3/32	6-5/16	7-3/32	6-1/4	7-5/32
71	6-3/4	7-5/32	6-11/16	7-5/32	6-11/16	7-7/32	6-11/16	7-7/32	6-9/16	7-13/64	6-9/16	7-7/32	6-7/16	7-7/32	6-3/8	7-9/32
72	6-7/8	7-9/32	6-13/16	7-9/32	6-13/16	7-11/32	6-13/16	7-11/32	6-11/16	7-21/64	6-11/16	7-11/32	6-9/16	7-11/32	6-1/2	7-13/32
73	7	7-13/32	6-15/16	7-13/32	6-15/16	7-15/32	6-15/16	7-15/32	6-13/16	7-29/64	6-13/16	7-15/32	6-11/16	7-15/32	6-5/8	7-17/32
74	7-1/8	7-17/32	7-1/16	7-17/32	7-1/16	7-19/32	7-1/16	7-19/32	6-15/16	7-37/64	6-15/16	7-19/32	6-13/16	7-19/32	6-3/4	7-21/32
75	7-1/4	7-21/32	7-3/16	7-21/32	7-3/16	7-23/32	7-3/16	7-23/32	7-1/16	7-45/64	7-1/16	7-23/32	6-15/16	7-23/32	6-7/8	7-25/32
76	7-3/8	7-25/32	7-5/16	7-25/32	7-5/16	7-27/32	7-5/16	7-27/32	7-3/16	7-53/64	7-3/16	7-27/32	7-1/16	7-27/32	7	7-29/32
77	7-1/2	7-29/32	7-7/16	7-29/32	7-7/16	7-31/32	7-7/16	7-31/32	7-5/16	7-61/64	7-5/16	7-31/32	7-3/16	7-31/32	7-1/8	8-1/32
80	7-5/8	8-1/32	7-9/16	8-1/32	7-9/16	8-3/32	7-9/16	8-3/32	7-7/16	8-5/64	7-7/16	8-3/32	7-5/16	8-3/32	7-1/4	8-5/32
85									8-1/16	8-45/64						

APPROVED 12 Jun 43 REVISED (3) 1 Apr 50 (5) FOR CHANGES SEE SHEET 1 (4) 4 Aug 52

PROCUREMENT SPECIFICATION

MIL-B-6812

AIR FORCE-NAVY AERONAUTICAL STANDARD

BOLT, EYE

AN42 THRU AN49

SHEET 2

SWIVELS

TIMKEN® TAPERED ROLLER THRUST BEARING EQUIPPED

S-1 JAW & HOOK

S-3 JAW & EYE

S-5 EYE & EYE

Load Rated

Working Load Limit* (metric tons)	Type	Swivel Number	Wire Rope Size	Weight (lbs)
3	S-1	3-S-1	½	9.50
3	S-2	3-S-2	½	9.25
3	S-3	3-S-3	½	9.00
3	S-4	3-S-4	½	9.00
3	S-5	3-S-5	½	8.50
3	S-6	3-S-6	½	9.00
5	S-1	5-S-1	⅝	16.50
5	S-2	5-S-2	⅝	14.25
5	S-3	5-S-3	⅝	13.50
5	S-4	5-S-4	⅝	13.75
5	S-5	5-S-5	⅝	12.25
5	S-6	5-S-6	⅝	15.25
8½	S-1	8½-S-1	¾	33.50
8½	S-2	8½-S-2	¾	29.25
8½	S-3	8½-S-3	¾	29.25
8½	S-4	8½-S-4	¾	29.00
8½	S-5	8½-S-5	¾	29.25
8½	S-6	8½-S-6	¾	32.00
10	S-1	10-S-1	⅞	46.75
10	S-2	10-S-2	⅞	45.75
10	S-3	10-S-3	⅞	43.50
10	S-4	10-S-4	⅞	44.00
10	S-5	10-S-5	⅞	42.00
10	S-6	10-S-6	⅞	45.50
15	S-1	15-S-1	1	73.75
15	S-2	15-S-2	1	62.75
15	S-3	15-S-3	1	61.00
15	S-4	15-S-4	1	61.00
15	S-5	15-S-5	1	61.00
15	S-6	15-S-6	1	74.00
25	S-1	25-S-1	—	140.00
25	S-2	25-S-2	—	140.00
25	S-3	25-S-3	—	135.00
25	S-4	25-S-4	—	135.00
25	S-5	25-S-5	—	130.00
25	S-6	25-S-6	—	135.00
35	S-1	35-S-1	—	220.00
35	S-2	35-S-2	—	155.00
35	S-3	35-S-3	—	150.00
35	S-4	35-S-4	—	150.00
35	S-5	35-S-5	—	145.00
35	S-6	35-S-6	—	215.00
45	S-1	45-S-1	—	250.00
45	S-2	45-S-2	—	235.00
45	S-3	45-S-3	—	225.00
45	S-4	45-S-4	—	225.00
45	S-5	45-S-5	—	215.00
45	S-6	45-S-6	—	270.00

*Individually Proof tested to 2 times the Working Load Limit. Ultimate Load is 5 times the Working Load Limit. Please order by Swivel Number.

S-2 JAW & JAW

S-4 EYE & JAW

S-6 EYE & HOOK

LINKS AND RINGS

WELDLESS SLING LINKS Self Colored or Hot Dip Galvanized

Diameter Stock (in)	Inside Length (in)	Inside Width Small End	Inside Width Large End	Weight (lbs)	Working Load Limit.* Single Pull (lbs)
⅜	2¼	¾	1½	.13	1600
½	3	1	2	.55	2900
⅝	3¾	1¼	2½	1.10	4200
¾	4½	1½	3	1.95	6000
⅞	5¼	1¾	3½	2.78	8300
1	6	2	4	4.30	10800
1¼	7¾	2½	5	8.50	16750
1⅜	8¼	2¾	5½	11.50	20500

*Minimum Ultimate Load is 6 times the Working Load Limit.

- Forged from special bar quality carbon or alloy steels.
- Weldless
- Quenched and tempered.

G-341 S-341
WELDLESS SLING LINKS

WELDLESS RINGS

DIMENSIONS		Weight (lbs)	Working Load Limit* Single Pull (lbs)
Diameter Stock (in)	Inside Diameter (in)		
⅞	4	2.70	7200
⅞	5½	3.40	5600
1	4	3.50	10800
1⅛	6	6.50	10400
1¼	5	7.00	17000
1⅜	6	10.63	19000

*Minimum Ultimate Load is 6 times the Working Load Limit.

S-643
Weldless Rings meet
Federal Specification
RR-C271b Type VI

WELDLESS END LINKS Self Colored or Hot Dip Galvanized

Diameter Stock (in)	Inside Length (in)	Inside Width (in)	Weight (lbs)	Working Load Limit* (lbs)
5/16	1¾	½	.15	2500
⅜	1⅞	9/16	.23	3800
½	2⅜	¾	.45	6500
⅝	3¼	1	.95	9300
¾	3½	1⅛	1.51	14000
⅞	5⅛	2	2.75	12000
1	5¾	2¼	3.95	15200
1¼	7	2½	7.30	26400
1⅜	7¾	2¾	10.38	30000

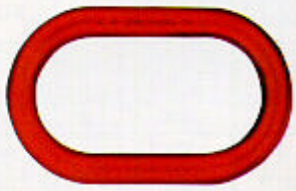
*Minimum Ultimate Load is 5 times the Working Load Limit.

G-340 S-340
WELDLESS END LINKS

WELDLESS ALLOY MASTER LINK

Diameter Stock (in)	Inside Length (in)	Inside Width (in)	Weight (lbs)	Working Load Limit* [Single Pull] (lbs)
½	5	2½	.89	4100
⅝	6	3	1.63	5500
¾	5½	2¾	2.25	8600
1	7	3.5	5.00	20300
1¼	8¾	4⅜	9.75	29300
1½	10.5	5.25	17.12	39900
1¾	12	6	26.12	52100
2	14	7	41.12	81400
†2¼	16	8	54.80	99500
†2½	16	8	71.60	122750
†2¾	16	9½	87.70	148500
†3	18	9	115.00	190000
†3¼	20	10	145.00	218500
†3½	24	12	200.00	232500

Minimum Ultimate Load is 6 times Working Load Limit. [Single Pull]
†Welded Master Link
*For Working Load Limit [Double Pull at 60° Included Angle] Multiply by 1.73



A-342
WELDLESS ALLOY MASTER LINK
Individually proof tested

FORGED SHACKLES

G-209 S-209

Screw pin anchor shackles meet Federal Specification RR-C-271b Type IV Class 1.

Load Rated

- Working Load Limit permanently shown on every shackle.
- Forged, Quenched and Tempered, with alloy pins.
- Capacities ⅓ thru 150 tons.
- Look for the red color . . . mark of genuine Crosby-Laughlin quality.
- Shackles can be furnished proof tested with certificates to designated standards (i.e., ABS, Lloyds, etc.). Charges for proof testing and certification available upon request.
- Hot Dip Galvanized or Self Colored

G-213 S-213

Round pin anchor shackles meet Federal Specification RR-C-271b Type IV Class 4.

ANCHOR SHACKLES

Working Load Limit (tons)	Nominal Shackle Size (in)	DIMENSIONS (in)							Weight (lbs)	
		Inside Length	Inside Width		Diameter		Tolerance Plus or Minus			
			at Pin	at Bow	Pin	Outside of Eye	Length	Width	213	209
† ⅓	3/16	⅞	⅜	11/16	¼	9/16	1/16	1/16	—	.05
½	¼	1⅛	½	25/32	5/16	11/16	1/16	1/16	.13	.12
¾	5/16	17/32	17/32	27/32	⅜	13/16	1/16	1/16	.17	.19
1	⅜	1 7/16	21/32	1 1/32	7/16	31/32	⅛	1/16	.25	.31
1½	7/16	1 11/16	23/32	1 5/32	½	1 1/16	⅛	1/16	.38	.38
2	½	1⅞	13/16	1 5/16	⅝	1 3/16	⅛	1/16	.70	.63
3¼	⅝	2⅜	1 1/16	1 11/16	¾	1 9/16	⅛	1/16	1.50	1.38
4¾	¾	2 13/16	1¼	2	⅞	1⅞	¼	1/16	2.32	2.25
6½	⅞	3 5/16	1 7/16	2 9/32	1	2⅛	¼	1/16	3.40	3.38
8½	1	3¾	1 11/16	2 11/16	1⅛	2⅜	¼	1/16	5.00	5.32
9½	1⅛	4¼	1 13/16	2 29/32	1¼	2⅝	¼	1/16	6.97	6.81
12	1¼	4 11/16	2 1/32	3¼	1⅜	3	¼	1/16	9.75	9.50
13½	1⅜	5⅜	2¼	3½	1½	3 5/16	¼	⅛	13.25	13.25
17	1½	5¾	2⅜	3⅞	1⅝	3⅝	¼	⅛	17.25	17.70
25	1¾	7	2⅞	5	2	4 5/16	¾	⅛	29.46	30.38
35	2	7¾	3¼	5¾	2¼	5	¾	⅛	45.75	45.00
†55	2½	10½	4⅛	7¼	2¾	6	¾	¼	—	85.75

†Furnished in screw pin only.

S-2131

Trawling shackle with thin square head screw pin.

TRAWLING SHACKLES

Self Colored only

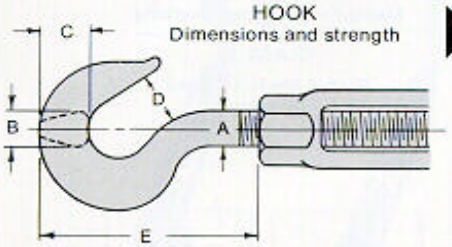
Working Load Limit (tons)	Nominal Shackle Size (in)	DIMENSIONS (in)						Weight (lbs)
		Inside Length	Inside Width at Pin	Diameter		Tolerances Plus or Minus		
				Pin	Outside of Eye	Length	Width	
2	½	1⅝	13/16	⅝	1 3/16	⅛	1/16	.75
3¼	⅝	2	1 1/16	¾	1 9/16	⅛	1/16	1.24
4¾	¾	2⅜	1¼	⅞	1⅞	¼	1/16	2.18
6½	⅞	2 13/16	1 7/16	1	2⅛	¼	1/16	3.28

NOTE: Maximum Proof Load is 2.2 times the Working Load Limit or as designated. Minimum Ultimate Strength is 6 times the Working Load Lim

TURNBUCKLE ENGINEERING DATA

Proof Load twice Working Load Limit • Ultimate Load five times Working Load Limit.

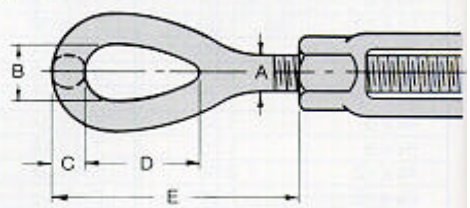
HOOK
Dimensions and strength



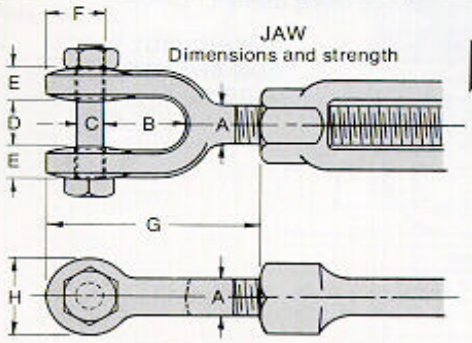
HOOK	Dimensions (in)				Working Load Limit (lbs)
A	B	C	D	E	
1/4	1/4	13/32	23/64	1 21/32	400
5/16	5/16	1/2	1/2	1 31/32	700
3/8	3/8	39/64	9/16	2 23/64	1,000
1/2	1/2	25/32	21/32	2 15/16	1,500
5/8	5/8	1	27/32	3 11/16	2,250
3/4	3/4	1 13/64	63/64	4 23/64	3,000
7/8	7/8	1 7/8	1 1/8	5 3/16	4,000
1	1	1 17/32	1 1/4	5 27/32	5,000
1 1/4	1 1/4	1 31/16	1 1/2	7 7/32	5,000
1 1/2	1 5/16	1 3/4	1 7/8	8 11/32	7,500

EYE
Dimensions and strength

EYE	Dimensions (in)				Working Load Limit (lbs)
A	B	C	D	E	
1/4	11/32	7/32	25/32	1 25/32	500
5/16	7/16	5/32	15/16	2 3/16	800
3/8	17/32	11/32	1 1/8	2 9/16	1,200
1/2	23/32	7/16	1 7/16	3 7/32	2,200
5/8	5/8	1/2	1 3/4	3 7/8	3,500
3/4	1	5/8	2 1/8	4 11/16	5,200
7/8	1 1/4	3/4	2 3/8	5 1/4	7,200
1	1 7/16	7/8	3	6 3/4	10,000
1 1/4	1 13/16	1 1/8	3 9/16	7 3/4	15,200
1 1/2	2 1/8	1 1/4	4 1/8	8 5/8	21,400
1 3/4	2 3/8	1 1/2	4 11/16	10	28,000
2	2 11/16	1 3/4	5 3/4	12 1/8	37,000
2 1/2	3 1/8	2	6 1/2	13 9/16	60,000
2 3/4	3 1/4	2 1/4	7	15	75,000



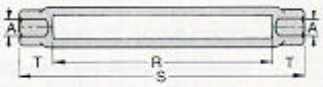
JAW
Dimensions and strength



JAW	Dimensions (in)								Working Load Limit (lbs)
A	B	C	D	E	F	G	H		
1/4	5/8	1/4	13/32	9/32	1/2	1 5/8	5/8		500
5/16	7/8	1/4	15/32	9/32	1/2	2	11/16		800
3/8	7/8	5/16	1/2	5/16	19/32	2 3/16	13/16		1,200
1/2	1 1/16	3/8	5/8	13/32	3/4	2 3/4	1		2,200
5/8	1 5/16	1/2	3/4	1/2	1 1/32	3 1/2	1 5/16		3,500
3/4	1 1/2	5/8	15/16	9/16	1 9/32	4 1/8	1 5/8		5,200
7/8	1 3/4	3/4	1 1/8	11/16	1 15/32	4 27/32	1 7/8		7,200
1	2 1/16	7/8	1 3/16	25/32	1 21/32	5 17/32	2 1/8		10,000
1 1/4	2 13/16	1 1/8	1 3/4	1	2 3/32	7 5/16	2 5/8		15,200
1 1/2	2 13/16	1 3/8	2 1/16	1 1/16	2 15/32	7 7/8	3 1/8		21,400
1 3/4	3 5/8	1 5/8	2 3/8	1 1/4	2 29/32	9 3/8	3 1/2		28,000
2	3 11/16	2	2 1/2	1 3/16	3 17/32	10 7/8	4 5/16		37,000
2 1/2	4 7/16	2 1/4	2 7/8	1 9/16	4 5/8	13 11/32	5 5/8		60,000
2 3/4	4 3/16	2 3/4	3 1/2	1 5/8	5 3/8	15	6 1/8		75,000

BODY
Dimensions and strength

BODY	Dimensions (in)			Working Load Limit (lbs)
A	R	S	T	
1/4	4	4 1/4	3/8	500
5/16	4 1/2	5 1/16	11/32	800
3/8	6	7 1/8	9/16	1,200
1/2	6	7 1/2	3/4	2,200
5/8	6	7 7/8	15/16	3,500
3/4	6	8 1/4	1 1/8	5,200
7/8	6	8 5/8	1 3/16	7,200
1	6	9	1 1/2	10,000
1	12	15	1 1/2	10,000
1	18	21	1 1/2	10,000
1	24	27	1 1/2	10,000
1 1/4	12	15 1/4	1 9/16	15,200
1 1/4	18	21 1/4	1 9/16	15,200
1 1/2	12	15 1/4	1 7/8	21,400
1 1/2	18	21 1/4	1 7/8	21,400
1 3/4	18	22 1/8	2 3/16	28,000
2	24	29	2 1/2	37,000
2 1/2	24	31	3 1/2	75,000



Alloy steel u-joints as advertised in Boston Gear Mechanical Product Catalog are recommended:

Boston Cat. No.	Maximum Recommended Payload (Pounds)
J 150	1100
J 175	1300
J 200	1800
J 250	2400
J 300	3000

Insulation Data

Name	α	Σ	Density (lb/ft')	Conductivity (Btu[in/ft']hr. °F)	Specific Heat
Ethafoam	0.655	0.78	2.2	0.35	0.5
Dark Blue Foam	0.442	0.725	1.8	0.23	0.5
Light Blue Foam	0.61	0.836	2.1	0.185	0.27

Thermal Surface Samples

Sample Number	Description	Sherwin Williams Identity	α	Σ	A/Σ
I	Tracom Black	A61350	0.928	0.92	I.01
2	Waifer Grey	A6A37	0.663	0.908	0.73
3	Old Tavern Brown	A6N53	0.905	0.915	0.99
4	Plantation Brown	A6N56	0.83	0.718	0.90
5	Fairfax Brown	A6N8l	0.86	0.918	0.94
6	Cape Hatteras Blue	A6L52	0.778	0.913	0.87
7	Peace Yellow	A6Y61	0.269	0.897	0.30
8	Admiral Gold	A6Y69	0.495	0.903	0.55
9	Sandpiper	A6A58	0.536	0.903	0.59
10	Sundance Yellow	A6Y68	0.33	0.908	0.36
11	King Yellow	A6Y56	0.365	0.901	0.40
12	1larvest Gold	A6Y63	0.51	0.909	0.56
13	Leatherstocking Green	A6N51	0.815	0.915	0.8
14	Buchs County Gold	A6G55	0.89	0.916	0.88
15	Ardmore Green	A6G124	0.873	0.916	0.95
16	Sage Green	A6G99	0.605	0.907	0.66
17	Colony Green	A6G54	0.779	0.915	0.85
18	Provincial Gold	A6Y55	0.709	0.913	0.78
19	Woodland Olive	A6G125	0.78	0.913	0.85
20	Super White	A6W40	0.236	0.895	0.29
21	White Tape		0.375	0.917	0.41
22	Light Blue Foam		0.61	0.836	0.73
23	Dark Blue Foam		0.442	0.725	0.61
24	Ethafoam		0.655	0.78	0.84

NSBF uses Sherwin Williams white appliance paint #1400878 on most metal surfaces. This epoxy base spray enamel adheres well to metal without extensive surface preparation.

The following problem shows how crush pad requirements can be calculated for a given gondola. The first solution is a simplistic approach which does not take into account all of the conditions affecting the gondola at landing. The second solution considers a more realistic set of impact conditions.

PROBLEM: Provide ground impact protection for a science payload weighing 3000 lbs., and allow a maximum stopping load of 10 g.

DEFINITIONS:	**W**	**=**	**Weight**
	V	**=**	**Velocity**
	Vi	**=**	**Velocity Immediately Prior to Impact**
	K.E.	**=**	**Kinetic Energy**
	S	**=**	**Minimum Allowable Stopping Distance**
	S'	**=**	**Actual Available Stopping Distance**
		=	**Total Required Payload/Crush Pad Contact Area**
	Tc	**=**	**Total Required Minimum Thickness of CrushPad**
	Ti	**=**	**Crush Pad Thickness Increment**
	Tu	**=**	**Usable Crush Pad Thickness**
	Tt	**=**	**Actual Total Thickness Used**
	N	**=**	**Integer Number of Crush Pad Thickness Increments (Ti) to Use**
	C.S.	**=**	**Crush Strength of Crush Pad**
		=	**10 lb/in2 = 1440 lb/ft'**
	G	**=**	**Maximum Allowable Stopping Acceleration**
	g	**=**	**Acceleration Due to Gravity**
		=	**32.2 ft/sec/sec**
GIVEN:	**Vi**	**=**	**20 ft/sec**
	Ti	**=**	**4 in**
	Tu	**=**	**0.7 (70%)**
	C.S.	**=**	**10 lb/in2**
	G	**=**	**10 g**

SOLUTION 1

K.E.	=	½ x W/g x V^2
	=	½ x 3000 / 32.2 x 20^2
	=	18,633 ft -lb
S	=	$V/^2$(2 x g x G)
	=	20^2/(2 x 32.2 x 10)
	=	0.62 ft = 7.5 in
Tc	=	S/Tu
	=	7.5/0.7
	=	10.7 in
Tt	=	N x Ti > Tc
	=	N x 4 > 10.7
N	=	3
Tt	=	12 in
S’	=	Tt x Tu
	=	12 x 0.7
	=	8.4 in = 0.7 ft
K.E.	=	A x C.S. x S'
or A	=	K.E./C.S./S'
	=	18,633/1,440/0.7
	=	8.5 ft ft^2

Therefore, a square crush pad arrangement 4.3 ft. on each side and 12 in. (three layers) deep will provide the needed protection.

CAUTION: SOLUTION 1 ASSUMES THAT THE PAYLOAD WILL IMPACT THE GROUND IN AN UPRIGHT ORIENTATION (NO SWINGING); IN MOST CASES THIS IS AN UNREALISTIC SITUATION. IT ALSO ASSUMES THAT THE CENTER 18.5 SQUARE FEET OF THE GONDOLA CAN SUPPORT 30,000 LBS WITH NO DAMAGE, THIS MAY OR MAY NOT BE TRUE.

SOLUTION 2

Solution 2 assumes, more realistically, that the gondola may not be upright at impact and that, for this reason, crush pad should be located at the corners rather than at the center of the gondola.

For this example, assume that a design analysis indicates that each corner can withstand 2.5W without deformation. Therefore, if the gondola impacts upright on all four corners, it can withstand 10 g; if it impacts mainly on two corners, it can withstand 5 g; and if it impacts mainly on one corner, it can withstand 2.5 g. (These assumptions may be different for an actual gondola.)

The kinetic energy will be the same no matter how many corners impact simultaneously.

$$K.E. = \tfrac{1}{2} \times W/g \times V^2 = \tfrac{1}{2} \times 3000/32.2 \times 20^2 = 18{,}633 \text{ ft-lb}$$

For the case where all corners impact simultaneously, a 10 g acceleration is allowable.

$$S = V/^2(2 \times g \times G) = 20^2/(2 \times 32.2 \times 10) = 0.62 \text{ ft} = 7.5 \text{ in}$$

$$Tc = S/Tu = 7.5/0.7 = 10.7 \text{ in}$$

$$Tt = N \times Ti > Tc = N \times 4 > 10.7$$

$$N = 3$$

$$Tt = 12 \text{ in}$$

$$S' = Tt \times Tu = 12 \times 0.7 = 8.4 \text{ in} = 0.7 \text{ ft}$$

$$K.E. = A \times C.S. \times S'$$

or

$$A = K.E./C.S./S' = 18{,}633/1{,}440/0.7 = 18.5 \text{ ft}'$$

Therefore, a square crush pad arrangement on each corner 3/1 feet on each side and 12 inches (three layers)deep will provide the needed protection.

For the case where two corners impact simultaneously, a 5 g acceleration is allowable.

	S	=	$V^2/(2 \times g \times G)$
		=	$20^2/(2 \times 32.2 \times 5)$
		=	1.24 ft = 14.9 in
	Tc	=	S/Tu
		=	14.9/0.7
		=	21.36 in
	Tt	=	N x Ti > Tc
		=	N x 4 > 21 . 3
	N	=	6
	Tt	=	24 in
	S'	=	Tt x Tu
		=	24 x 0.7
		=	16.8 in = 1.4 ft
	K.E.	=	A x C.S. x S'
or	A	=	K.E./C.S./S'
		=	18,633/1,440/1.4
		=	$9.25\ ft^2$

Therefore, a square crush pad arrangement on each corner 2.2 feet on each side and 24 inches (six layers) deep will provide the needed protection.

For the case where one corner impacts initially, a 2.5 g acceleration is allowable.

	S	=	$V^2/(2 \times g \times G)$
		=	$20^2/(2 \times 32.2 \times 2.5)$
		=	2.49 ft = 29.8 in
	Tc	=	S/Tu
		=	29.8/0.7
		=	45.6 in
	Tt	=	N x Ti > Tc
		=	N x 4 > 45.6
	N	=	12
	Tt	=	48 in
	S'	=	Tt x Tu
		=	48 x 0.7
		=	33.6 in = 2.8 ft
	K.E.	=	A x C.S. x S'
or	A	=	K.E./C.S./S'
		=	18,633/1,440/2.8
		=	$4.62\ ft^2$

Therefore, a square crush pad arrangement on each corner 2.2 feet on each side and 2.2 feet on each side and 48 inches (twelve layers) deep will provide the needed protection.

CONCLUSION

An inverted pyramid configuration of three crush pad layers 3 ft. on each side, followed by three layers 2.5 ft. on each side, followed by three layers 2 ft. on each side, with one pyramid on each corner would protect this gondola under the given conditions. The upper corners of the gondola should also be protected from tipover upon ground impact.

CAUTION: THE PRECEDING CALCULATIONS ONLY APPLY UNDER THE GIVEN CONDITIONS. THIS SOLUTION WILL NOT ADEQUATELY PROTECT ALL 3000-POUND GONDOLAS.

Table V 1.3 NSBF Launch Vehicle Capabilities

Launch Vehicle	Distance from Pin Fitting to Ground (Ft.)	Gondola Height Suspension Point to Ground (Ft.)	Maximum Gondola Weight (Lb.)
Tiny Tim	36.5	31	6500
Crane	26	21	5500
BST	22	17	3000
Ascend 11	16.5	12	2400

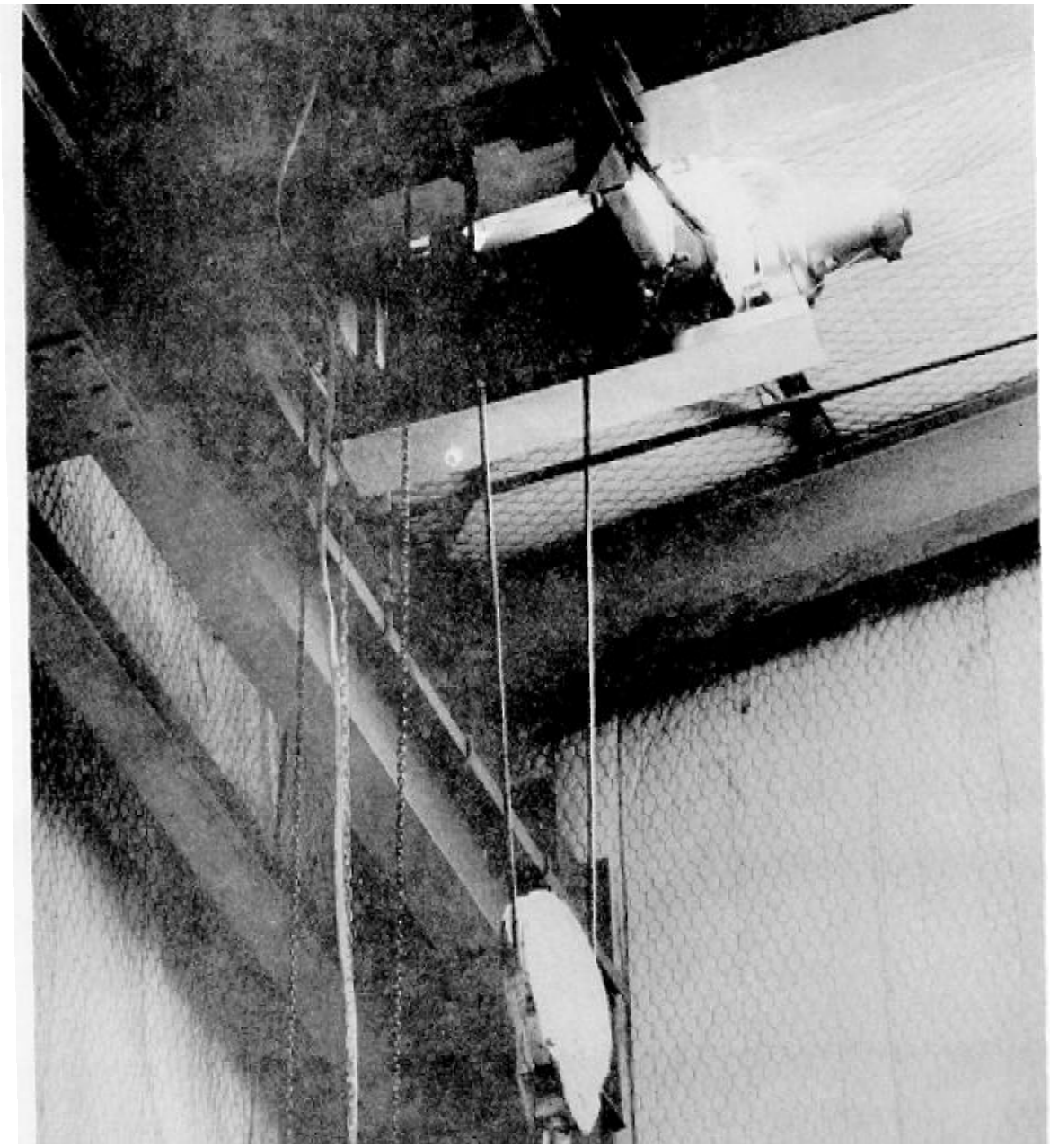


Figure 1 Staging Area Hoist.

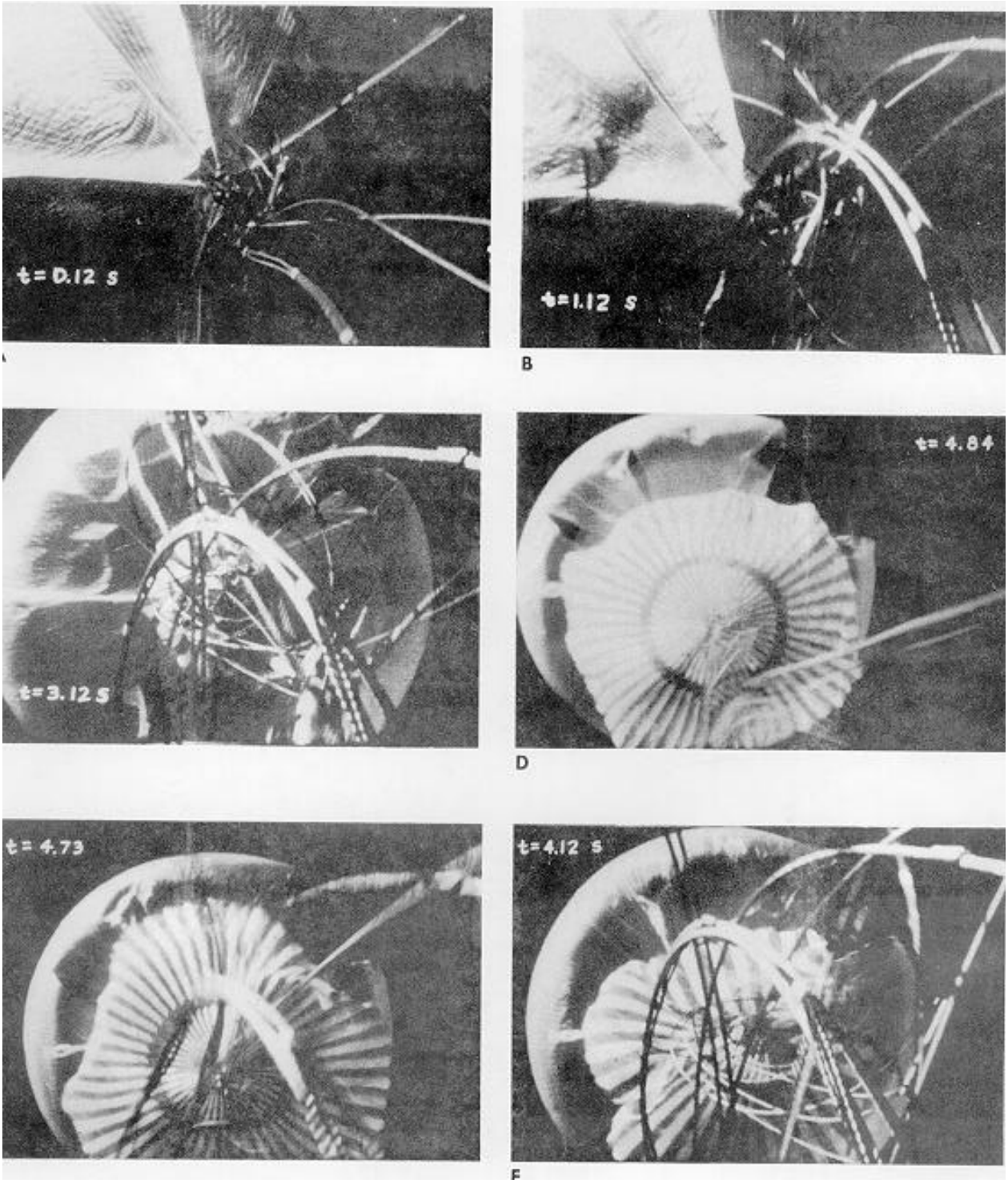


Figure 2 This sequence, timed in seconds shows the recoil of the parachute toward the payload following termination.

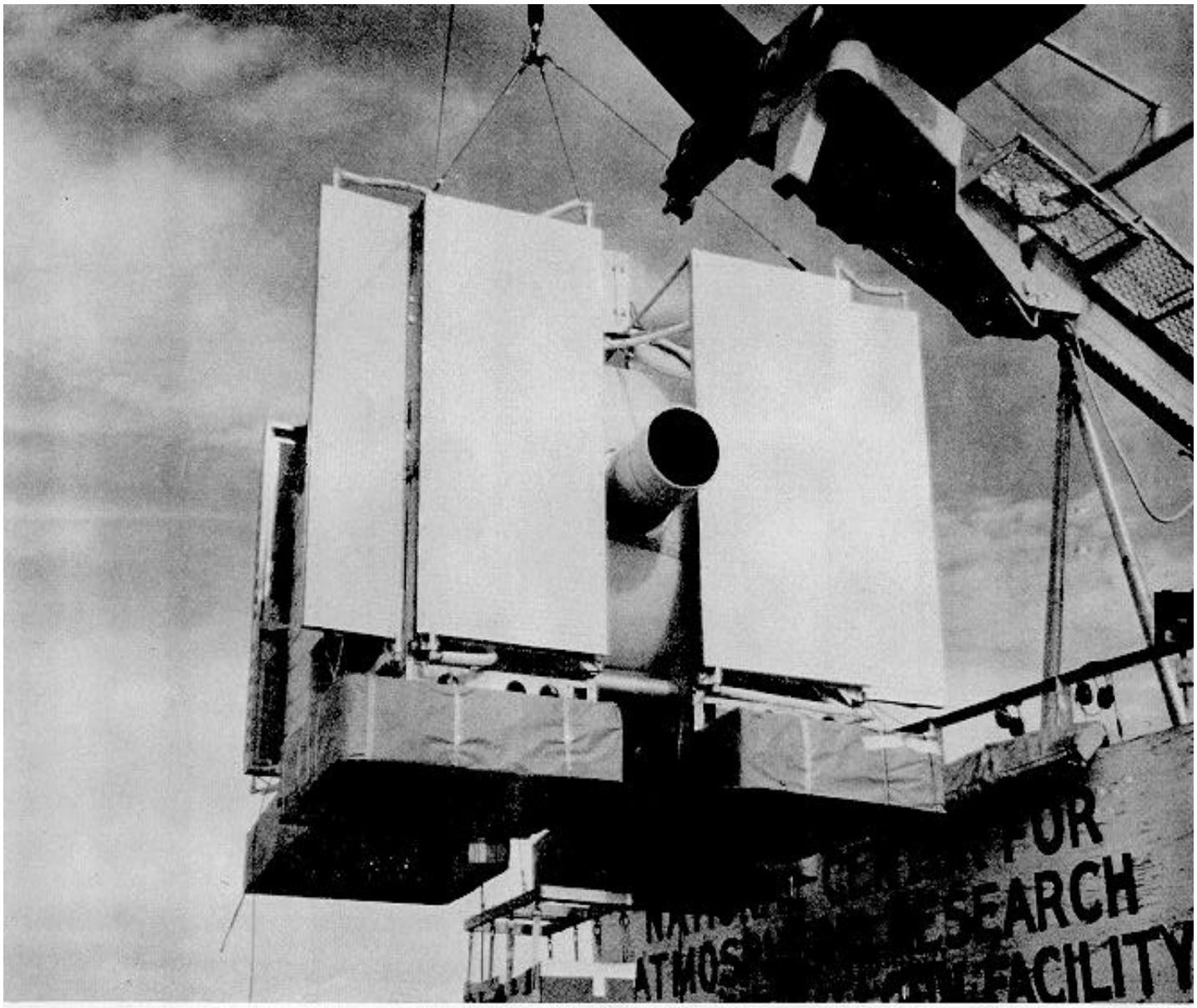


Figure 3 Radiator Panels

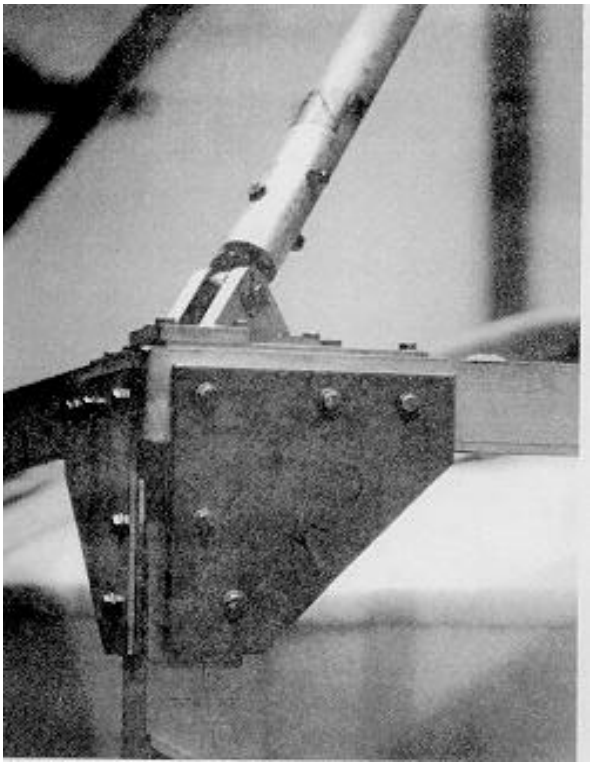


Figure 4 Bolted Gusset Plate.

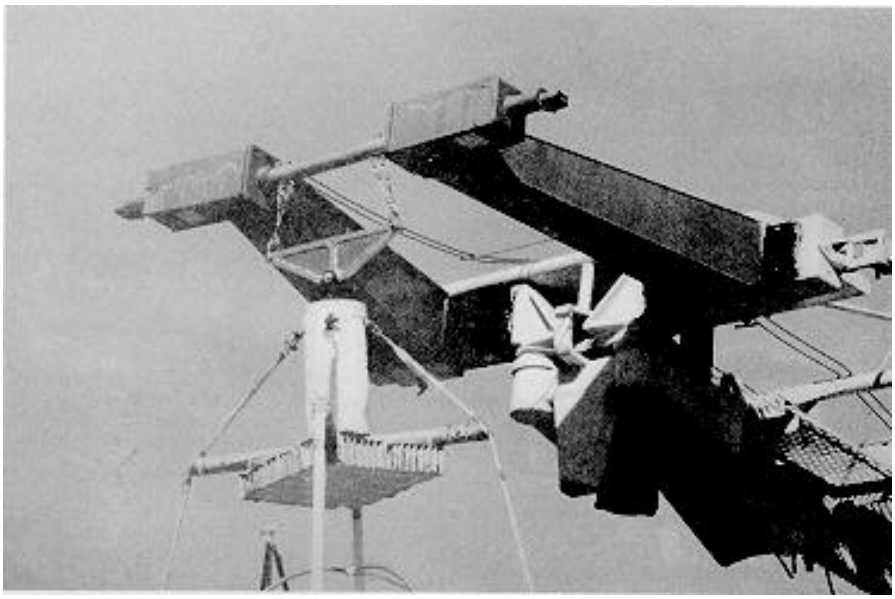
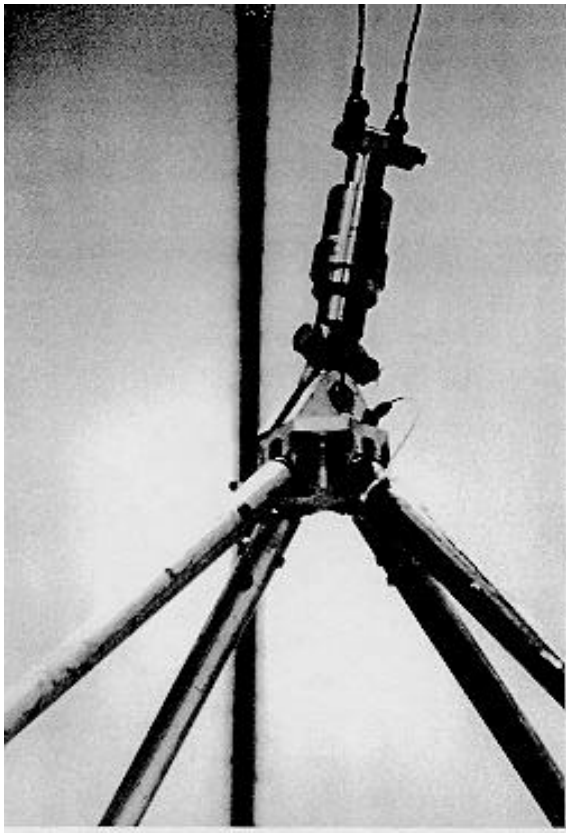
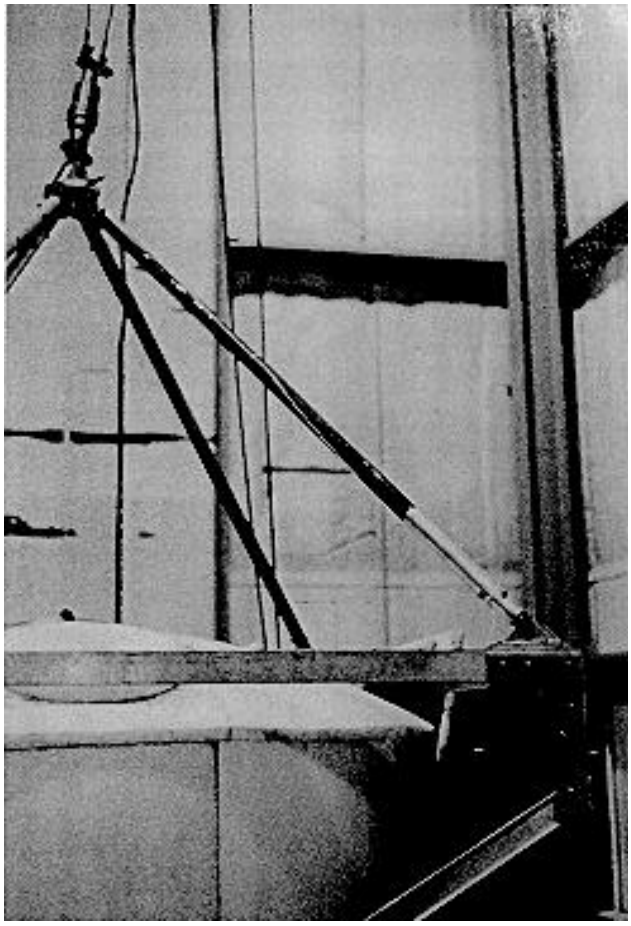


Figure 5 Gondola suspension points can be configured in a variety of ways. For this payload, the scientist provided a triangular plate to which the NSBF attached two clevises. The clevises were then suspended from the launch pin.



A



B

Figure 6 Rigid Suspension System
(A) upper portion and
(B) the entire rigid member.

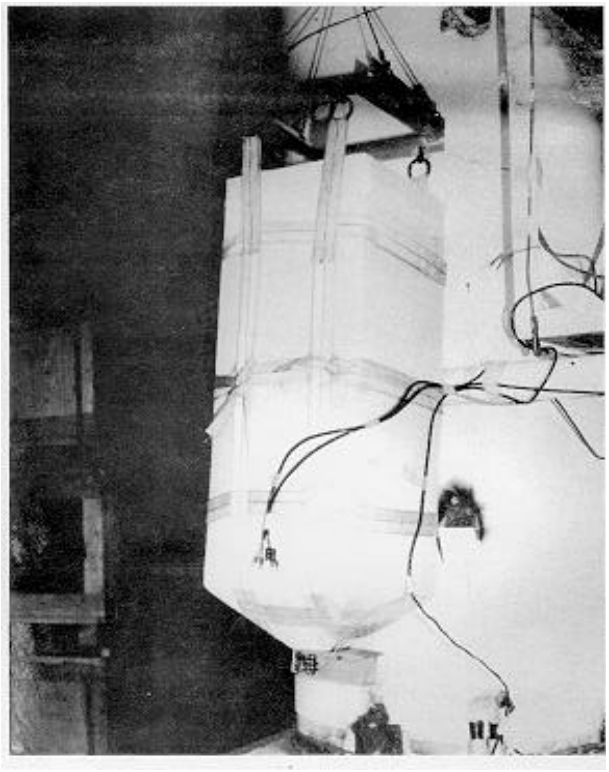


Figure 7 Standard Ballast Hopper

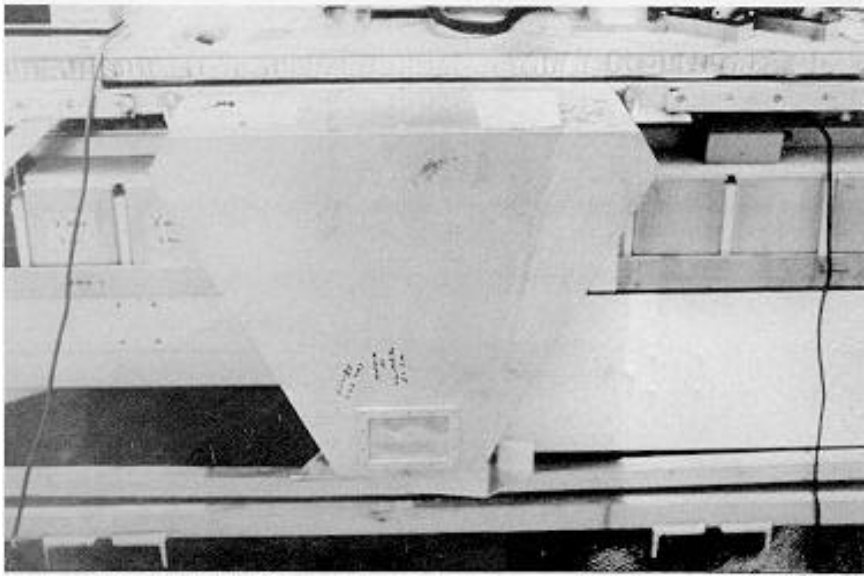


Figure 8 Side Mounted Ballast Hopper

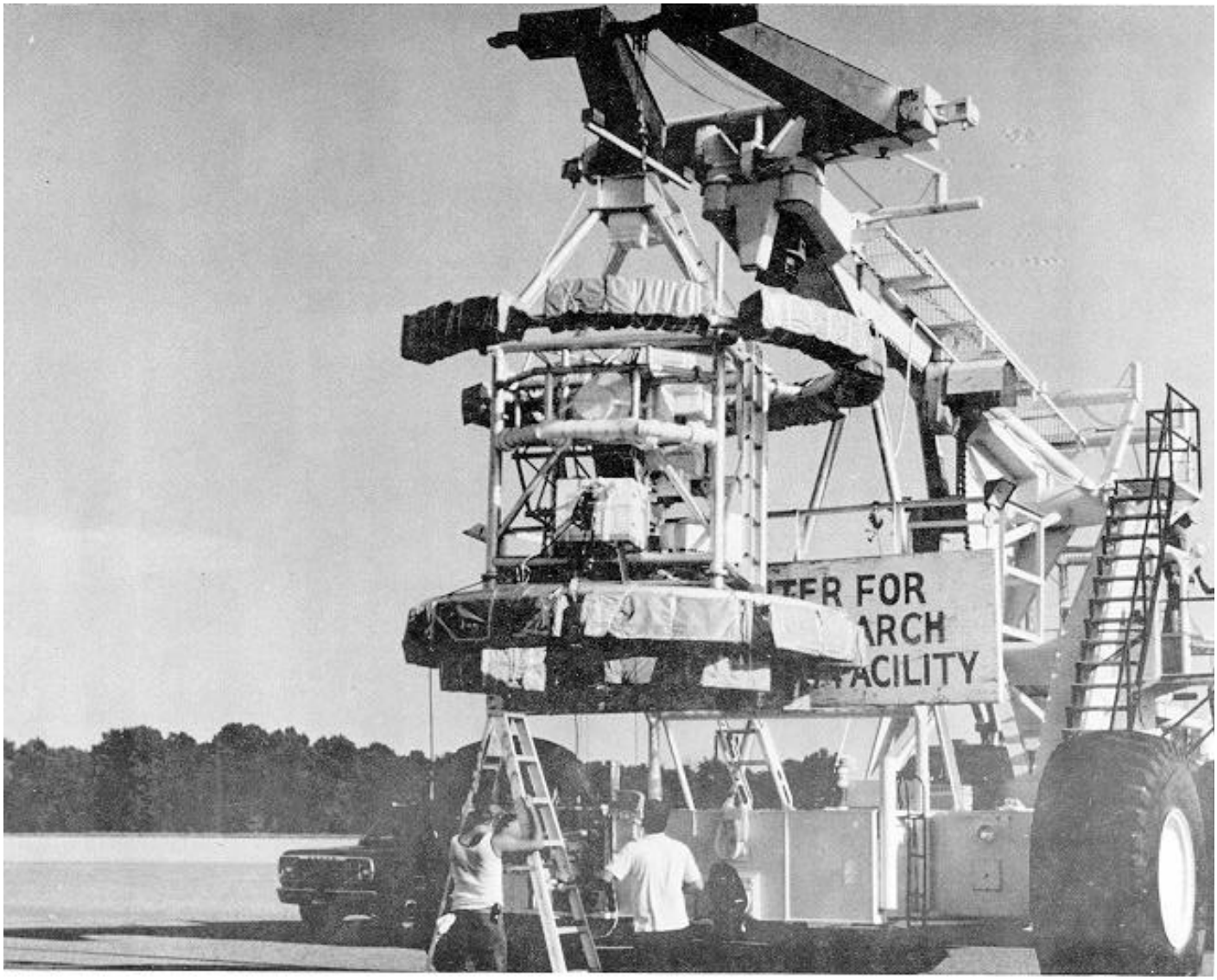


Figure 9 **Crush pad can be positioned to protect the gondola against horizontal and vertical impact forces.**