SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
DOWNGRADING OR DECLASSIFICATION STAMP

CLASSIFICATION CHANGED TO: U	AUTHORITY: R. B. Craner
Emelda Selph 7/30/98	
PERSON CHANGING MARKING & DATE	RECORD ID: 98SN3175
WC Layne 7/30/98	
PERSON VERIFYING MARKING & DATE	DATED: 7/28/98

UNCLASSIFIED 1328

Case No. 607.00
Ref. Sym: 1612-(132)
Project No. TM-216

AUG 2 3 1954

SANDIA SYSTEMATIC DECLASSIFICATION REVIEW

1st Review Date: 7/27/98	Determination (Circle Numbers)
Authority: ☐ADC ☒ADD	1. Classification Retained
Name: W. Layne	2. Classification Changed to: U
2nd Review Date: 7/28/98	3. Contains No DOE Classified Information
Authority: ADD	4. Coordinate With:
Name: RBCraner	5. Contains UCAI? W
	6. Comments:

MR. D. R. COTTER - 1326

Attention: A. V. Engel - 1326-4

Re: Dynamic Ejector Test of the XW-7 BoAR

Summary of Results

A dynamic ejector test of the XW-7 BoAR was conducted to determine stresses in the weapon load beam, as well as shock damage to the warhead assembly, fuse and tail components. Tests were conducted using the following three types of ejectors: Douglas powder actuated, Republic pneumatic and McLean powder actuated. Full powder charges were used with the powder actuated ejectors and air pressures of 1850 and 2400 psi were used with the pneumatic ejector.

The maximum measured stress in the load beam was 15,700 psi tension when using the Douglas ejector, 5,000 psi tension when using the Republic ejector with 2400 psi air and 10,800 psi tension when using the McLean ejector.

Some rivets in the ejector area of the case center section popped out slightly after the weapon was ejected with the Douglas ejector.

Air pressure of 5 psi above ambient could not be maintained in the forward compartment of the weapon due to improper seating of the forward compartment relief valves.

No electrical failures occurred.

The maximum accelerations measured during the tests were: 29.9 g vertical (with respect to the longitudinal axis of the BoAR) at the C. G. of the weapon when using the Douglas ejector, 28.1 g vertical at the nose of the weapon when using the Republic ejector with 2400 psi air and 65.7 g vertical at the C. G. of the weapon when using the McLean ejector.

Object of Test

The object of this test was to determine the stresses in the weapon load beam, as well as shock damage to the warhead assembly, fuse and tail components when using the following types of ejector racks and loads: Douglas powder actuated with full powder charges, Republic pneumatic with air pressures of 1850 psi and 2400 psi and McLean powder actuated with full powder charges.

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CD' No.
ACCOUNTABILITY CARD
FILE No. XW 7 / Bm
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Reason for Test

This test was performed in accordance with a Work Order Authorization dated May 17, 1954, from R. N. Browne, 1263, to P. H. Adams 1612.

Summary of Past Tests

A previous dynamic ejector test was conducted using a TX-7 weapon. The results of this test were published in a memorandum, Dynamic Ejector Performance Test of the TX-7 (Concrete-Filled Space Chamber), by J. H. Atkinson, R. C. Dove and B. W. Duggin, dated July 16, 1952, Project No. TM-59, Ref. Sym: 1532-(31).

For the previous test the following ejectors were tested: (1) Douglas cartridge type. (2) Republic air piston type. (3) McLean air piston type. (4) McLean cartridge type.

With the two cartridge type ejectors, the energy output (which has been computed from the weight of the TX-7 weapon and the ejection displacement) is a linear function of the amount of charge. With the air piston type of ejectors, the energy output increases with increased charge pressure only up to a pressure of 2000 psi; at higher charge pressures the energy output of the air piston ejectors remains unchanged or is slightly decreased.

The various ejectors may be listed in order of increasing maximum energy output as follows: McLean air piston type ejector, Republic air piston type ejector, Douglas cartridge type ejector and McLean cartridge type ejector.

At maximum energy output the duration of the ejector power strokes varied from 0.065 to 0.196 second with the various ejectors.

On the basis of maximum vertical acceleration (with respect to the longitudinal axis of the TX-7) at the center of gravity, the various ejectors may be listed in the following order: McLean cartridge type, 3.7 g (orifice size has little effect on maximum vertical acceleration at the center of gravity); Republic air piston type, 6.6 g; McLean air piston type 8.2 g; and Douglas cartridge type 8.8 g.

For all the ejectors tested, the stresses measured on the weapon were below the yield point stress of the material.

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Setup for Test

The dynamic jig was modified with a pendulum suspended from the main top beam. The XW-7 BoAR was suspended in the test jig as shown in Figs. 1 and 2. The ejector fixture and pendulum were made adjustable to allow for proper alignment. An arresting device, consisting of two overriding clutches mounted on the pendulum rods and riding on cables, was used to prevent back swings.

[redacted]

An XW-7 BoAR consisting of components as tabulated in Table I was used as the test weapon.

The following equipment was used to perform the tests:

Douglas ejector, powder actuated, 14 and 30 inch-4 hook, Douglas Aircraft Co. Drawing No. 5431554 as shown attached to the weapon in Fig. 3.

Republic ejector, pneumatic, 20 inch - 3 hook, pylon and rack as shown attached to the weapon in Fig. 4.

McLean ejector, powder actuated, 20 inch-3 hook, McLean Development Labs. Drawing No. 10170-R as shown attached to the weapon in Fig. 5.

Air compressor for compressing air to 2400 psi.

Air compressor for compressing air to 5 psi.

Dynamic jig No. 1.

Miller amplifiers, Type C-3, Model CA12 Serial Nos. 3 and 7.

Miller oscillograph, Model J, Serial No. 99.

The test weapon was instrumented as follows:

Four Baldwin SR-4 strain gages Type A-3, resistance-ohms 120 ± 0.2, gage factor 2.04 ± 1%, Lot No. 236, were mounted on the load beam as shown in Fig. 6

Two 10,000 pound Baldwin load cells, Serial Nos. 655 and 658 as shown in Fig. 5

Allen Bradley Type JU, 25,000 ohm linear potentiometer as shown in Fig. 5

Lateral and vertical accelerometers were mounted on the nose of the BoAR, on the junction box, on the dummy rocket motor and on the tail cone as shown in Figs. 7 to 10 inclusive. Longitudinal, vertical and lateral accelerations were measured at the center-of-gravity of the BoAR as shown in Fig. 11. The directions of the acceleration measurements as stated are relative to the axes of the weapon in normal flight orientation. The Statham accelerometers used are as tabulated in Table II.

Figures 14 through 17 inclusive are plots of the force (vertical with respect to the weapon) measured at each of the McLean ejector mounting bolts vs. time. A composite (total force vertical with respect to the weapon) curve is also plotted which is the sum of the two measured forces. The composite (total force vertical with respect to the weapon) curves were correlated with the angular movement of the thrust arm on the McLean ejector as shown in Figs. 18 to 20 inclusive.

The maximum accelerations and their associated frequencies, measured during the tests are as given in Table IV. Figures 21, 22 and 23 show typical records of the signals when using the Douglas, Republic and McLean ejectors respectively.

The XF-7 BoAR swung through a circular arc under the impulse of the ejection. The approximate chord length of the arc was measured, and from this measurement, the vertical displacement of the unit was computed. The energy output of the ejector was then taken as the potential energy gain of the XF-7 BoAR (the product of the weight and vertical displacement of the BoAR). The chord lengths were not exact measurements due to slippage of the overriding clutches and small loads applied by elastic cords to insure engagement of the overriding clutches. Approximate chord lengths, vertical displacements, and computed values of energy output are tabulated in Table V.

Conclusions

The weapon as tested with the dummy rocket motor and dummy ITD, is satisfactory for ejection with the ejectors tested.

WHC:1612-1:ach

W. H. Cross
W. H. CROSS - 1612-1

B. W. Duggin
B. W. DUGGIN - 1612-1

Leo Navoda
LEO NAVODA - 1612-1

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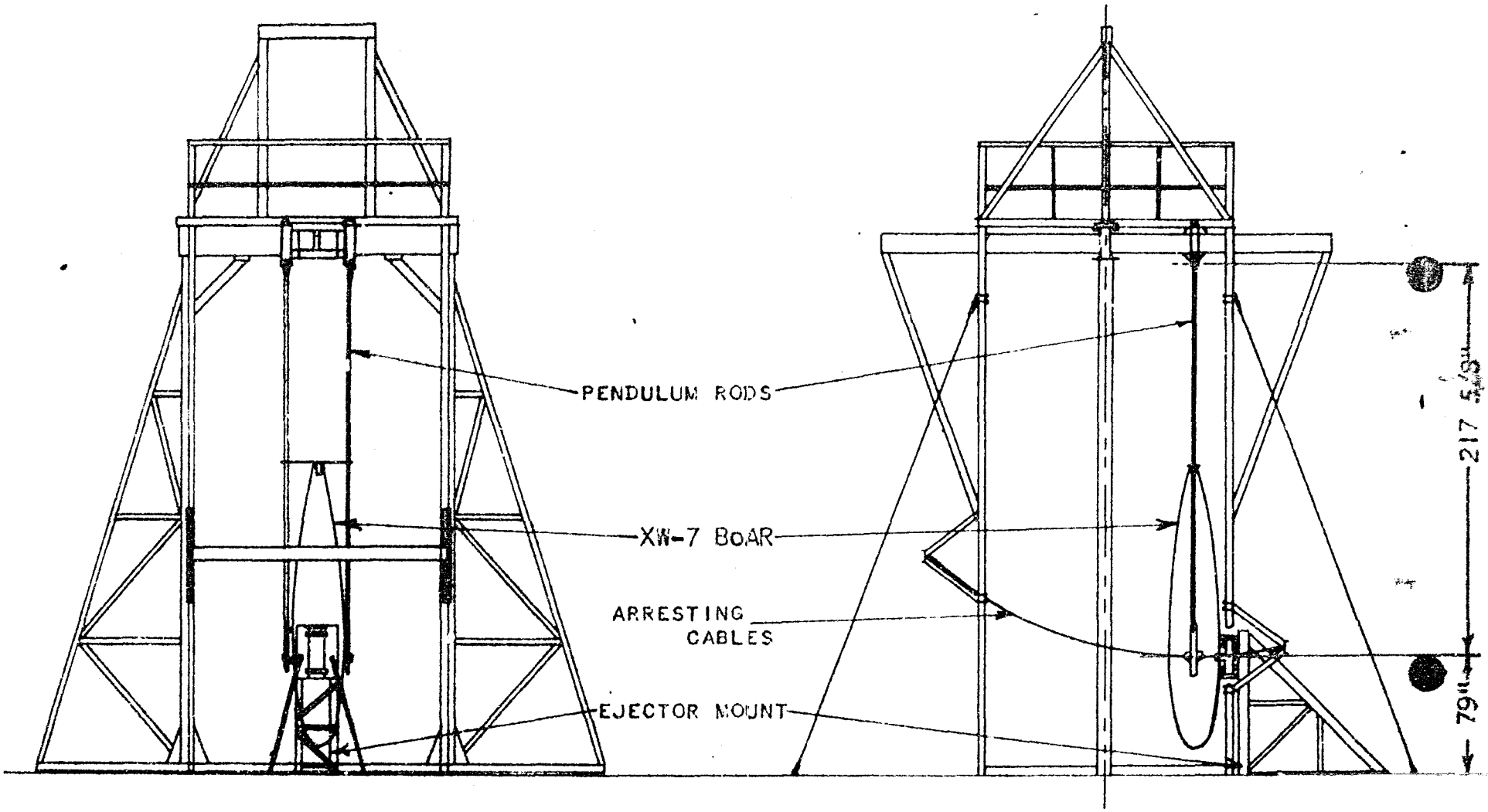

FIG. 1 EJECTION TEST FIXTURE-DYNAMIC EJECTOR TEST OF THE XW-7 BOAR.

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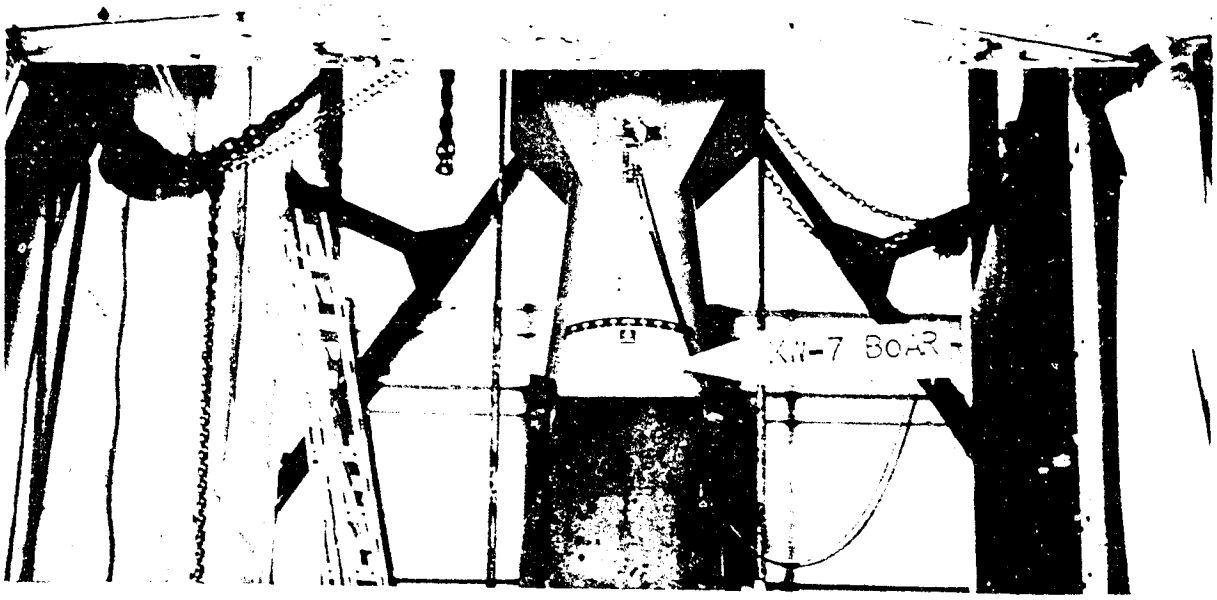

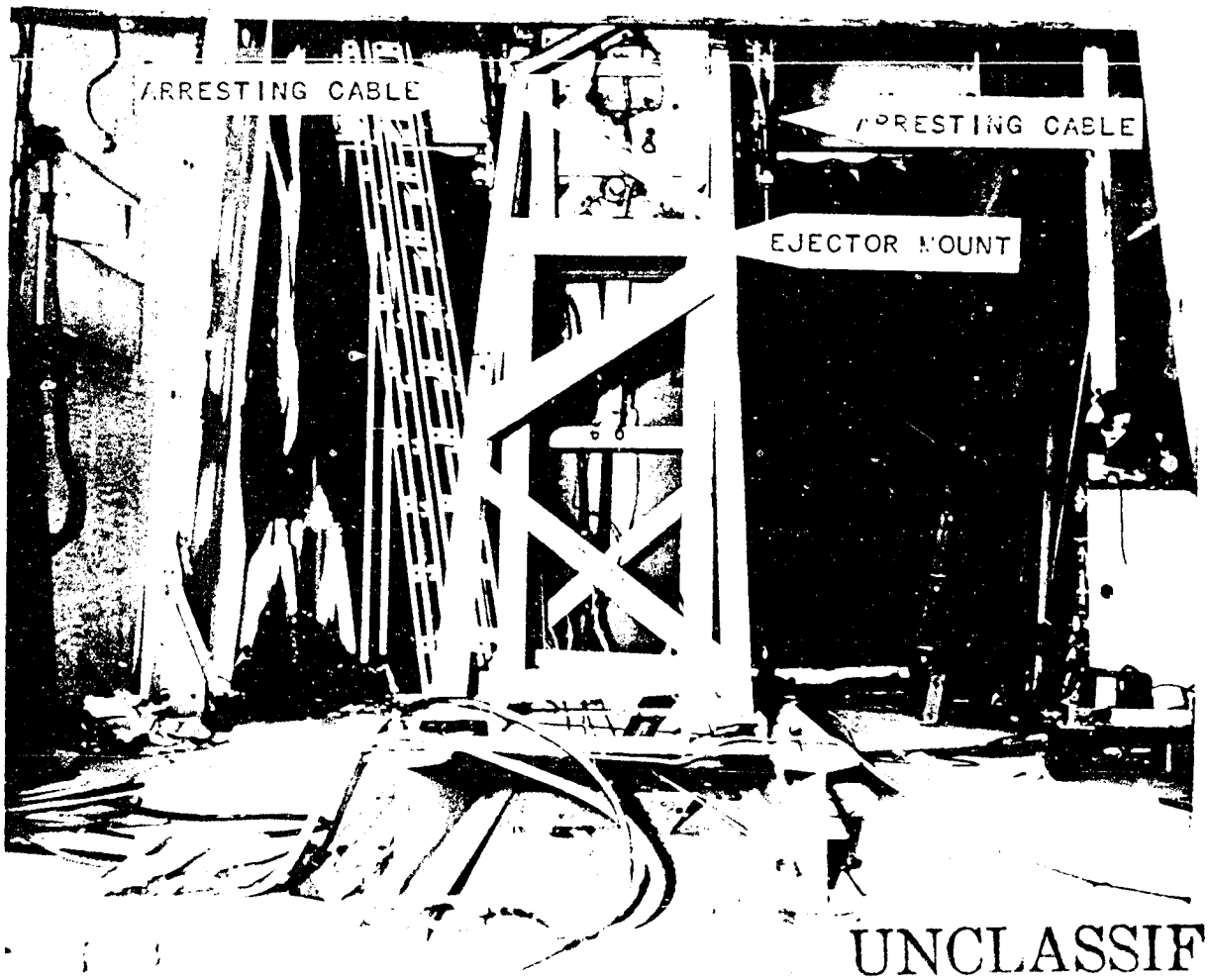

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FIG.2 XN-7 BOAR SUSPENDED IN EJECTION TEST FIXTURE-DYNAMIC EJECTOR TEST OF THE XN-7 BOAR.

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REF. SYM. 1612(132)

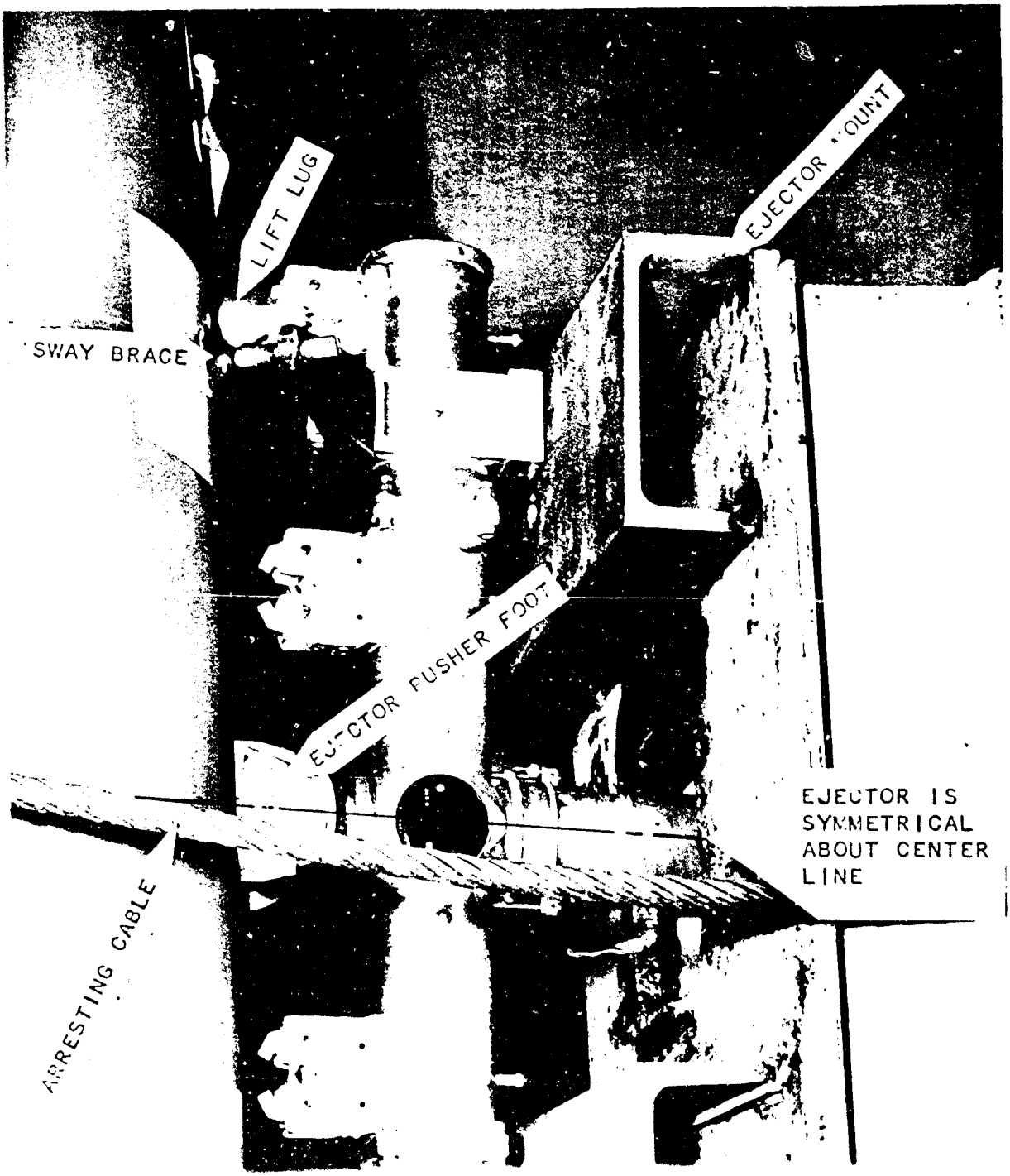

FIG.3 XW-7 BOAR ATTACHED TO THE DOUGLAS EJECTOR-DYNAMIC EJECTOR TEST OF THE XW-7 BOAR.

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REF.SYM. 1612(132)

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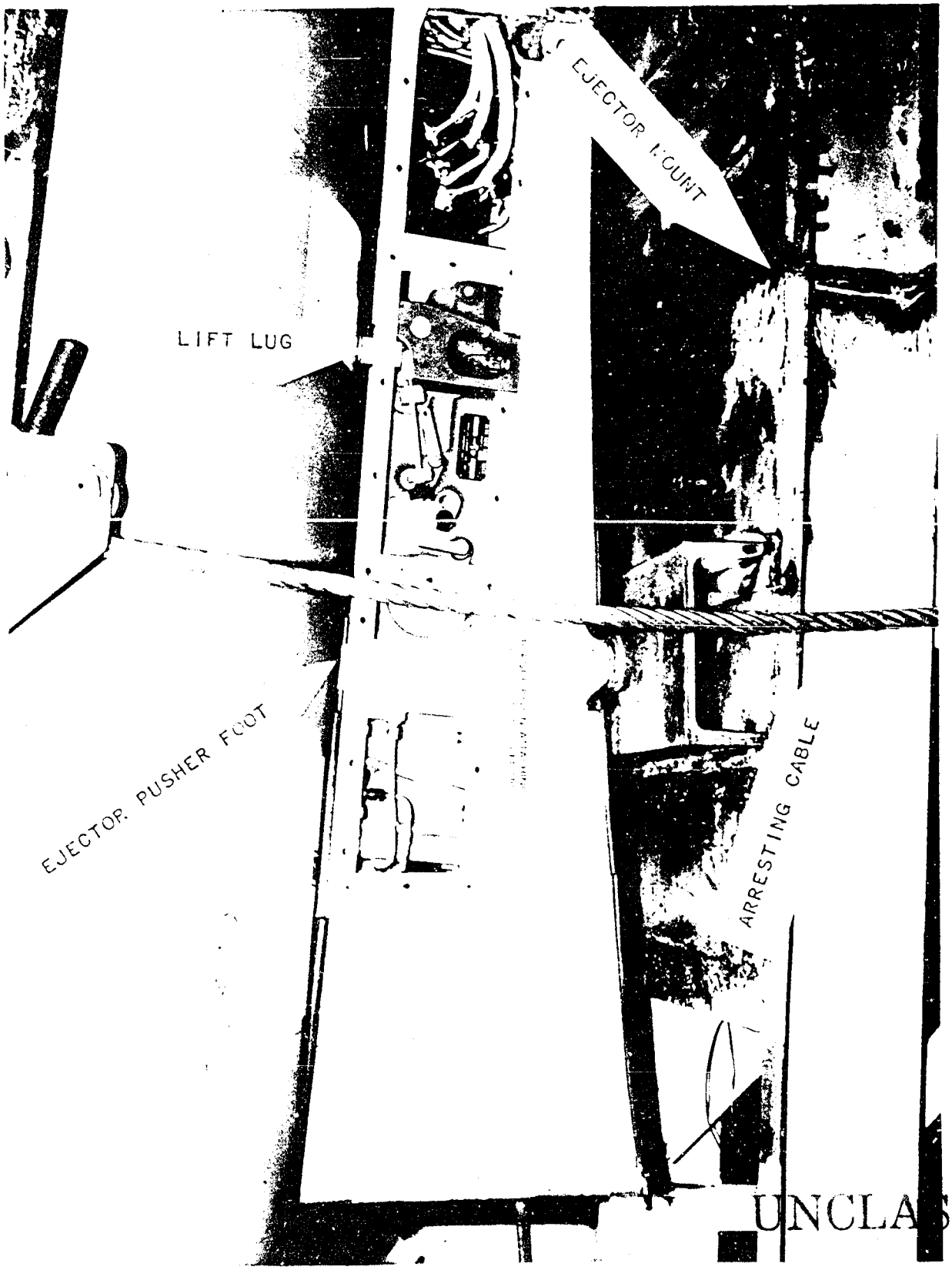

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FIG.4 XM-7 BOAR ATTACHED TO THE REPUBLIC PNEUMATIC EJECTOR-DYNAMIC EJECTOR TEST OF THE XM-7 BOAR.

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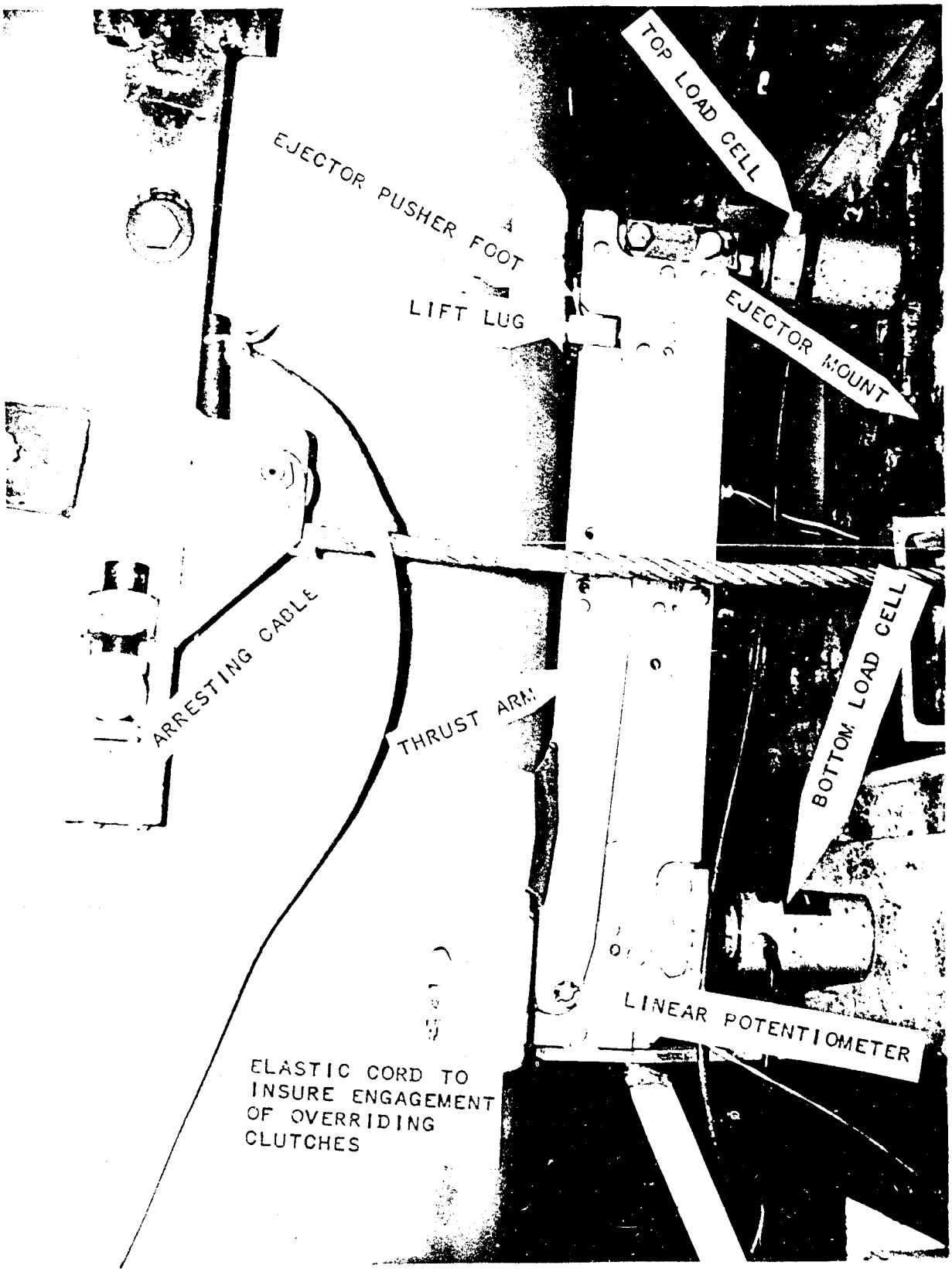

FIG.5 XN-7 BOAR ATTACHED TO THE McLEAN EJECTOR-DYNAMIC EJECTOR TEST OF THE XN-7 BOAR.

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REF. SYM. 1612(132)

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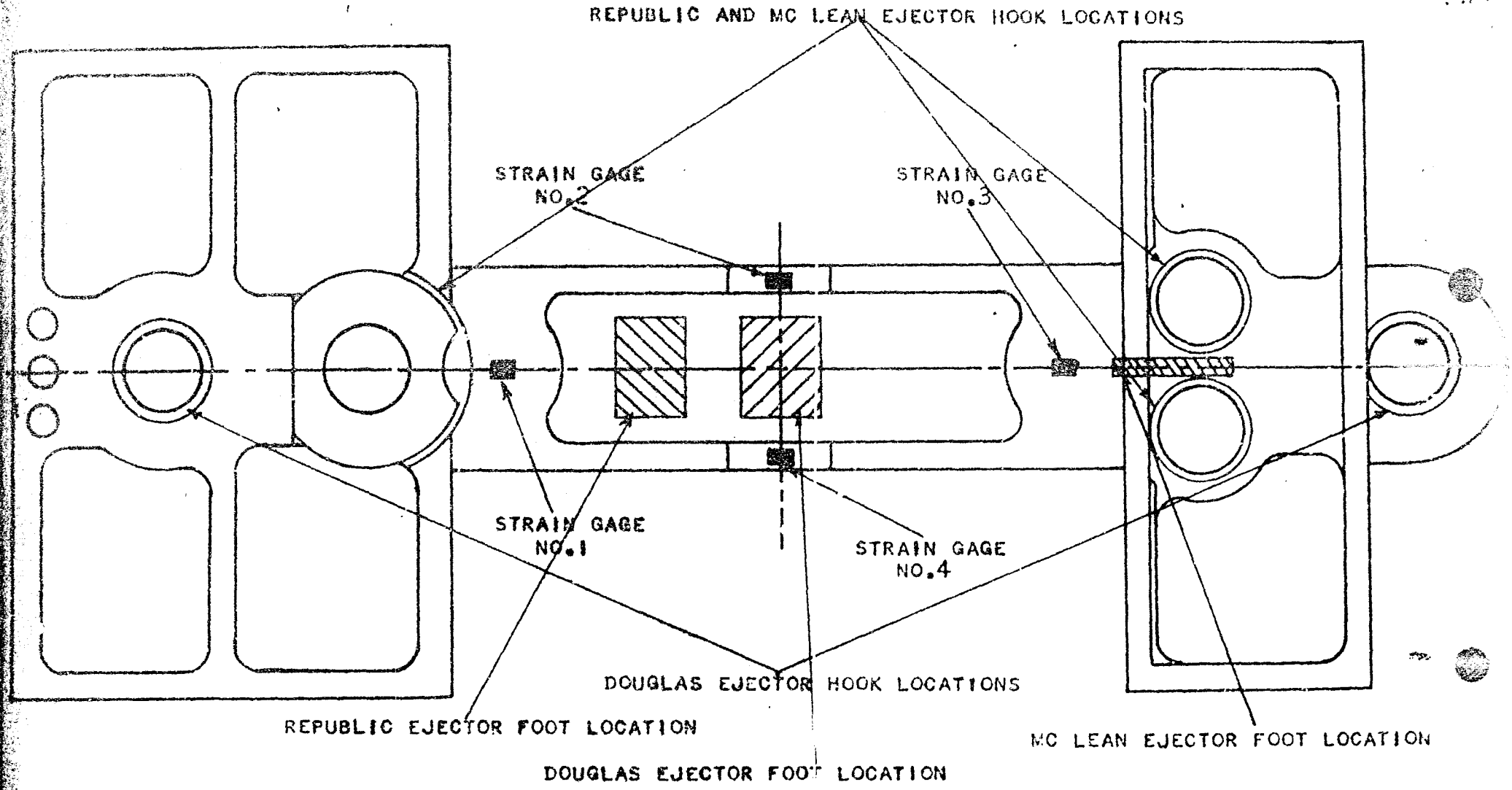

FIG.6 STRAIN GAGE LOCATIONS ON LOAD BEAM-DYNAMIC EJECTOR TEST OF THE XN-7 BOAR.

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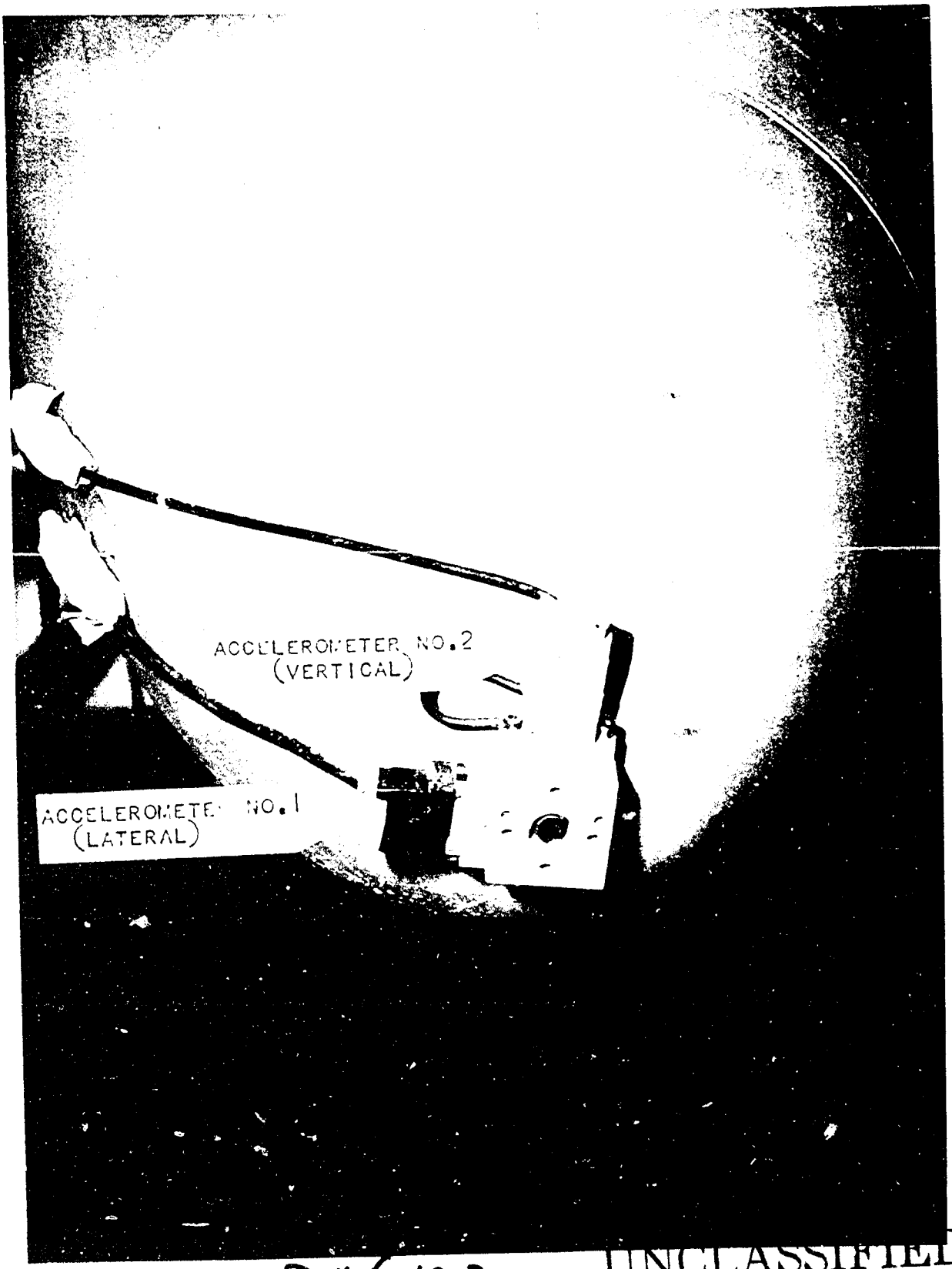

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FIG.7 ACCELEROMETERS LOCATED ON THE NOSE OF THE XW-7 BOMB-DYNAMIC EJECTOR TEST OF THE XW-7 BOMB.

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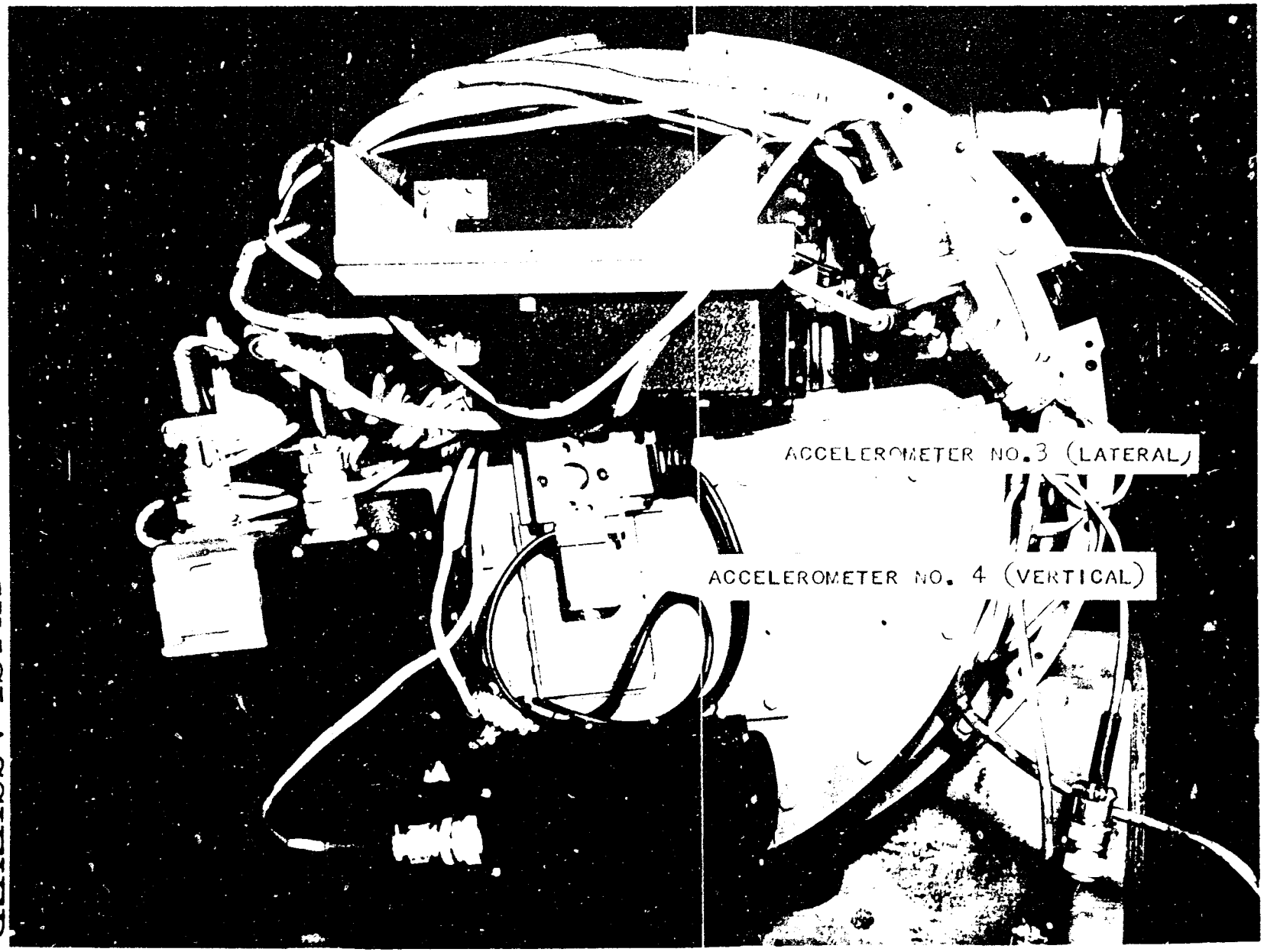

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FIG. 8 ACCELEROMETERS LOCATED ON THE JUNCTION BOX-DYNAMIC EJECTOR TEST OF THE XM-7 30AR.

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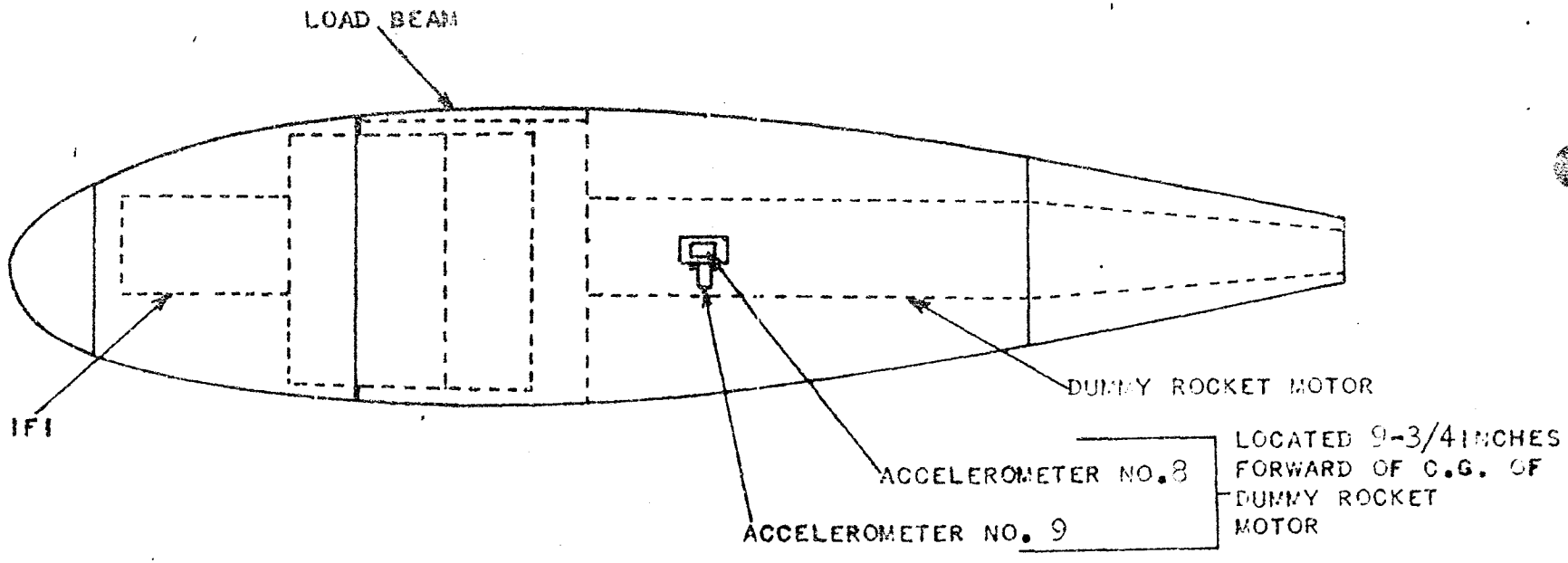

FIG.9 ACCELEROMETERS LOCATED ON THE DUMMY ROCKET MOTOR-DYNAMIC EJECTOR TEST OF THE XN-7 BOAR.

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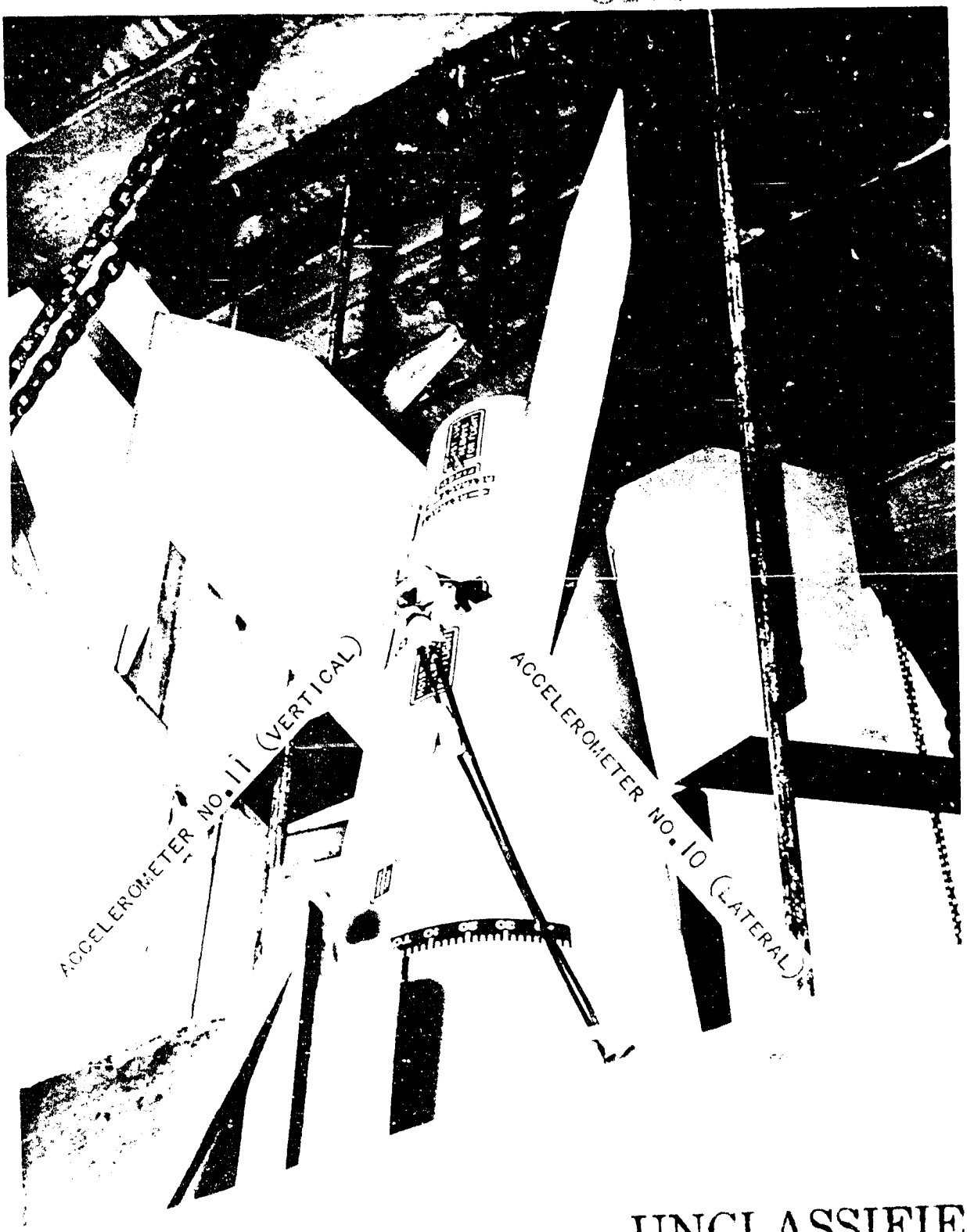

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FIG. 10 ACCELEROMETERS LOCATED ON THE TAIL CONE AT STATION 253.75-DYNAMIC EJECTOR TEST OF THE XN-7 BOAR.

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FIG.11 ACCELEROMETERS LOCATED AT THE C.G. OF THE BOAR, STATION 174.0, -DYNAMIC EJECTOR TEST OF THE XW-7 BOAR.

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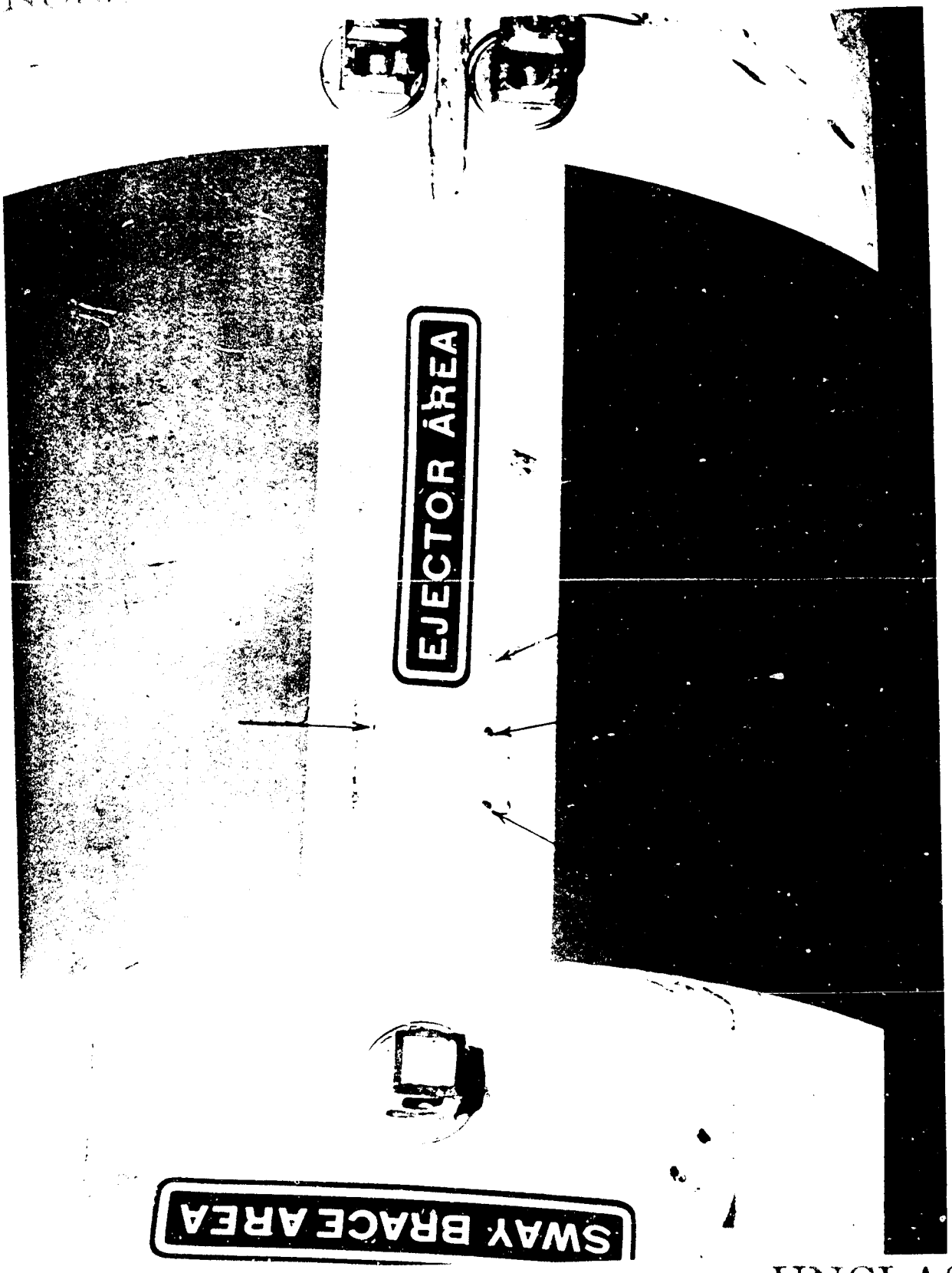

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FIG. 12 FLUFFED RIVETS ON CASE CENTER SECTION EJECTOR AREA-- DYNAMIC EJECTOR TEST OF THE XM-7 BOMB.

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REF. SYM. 1612(132)

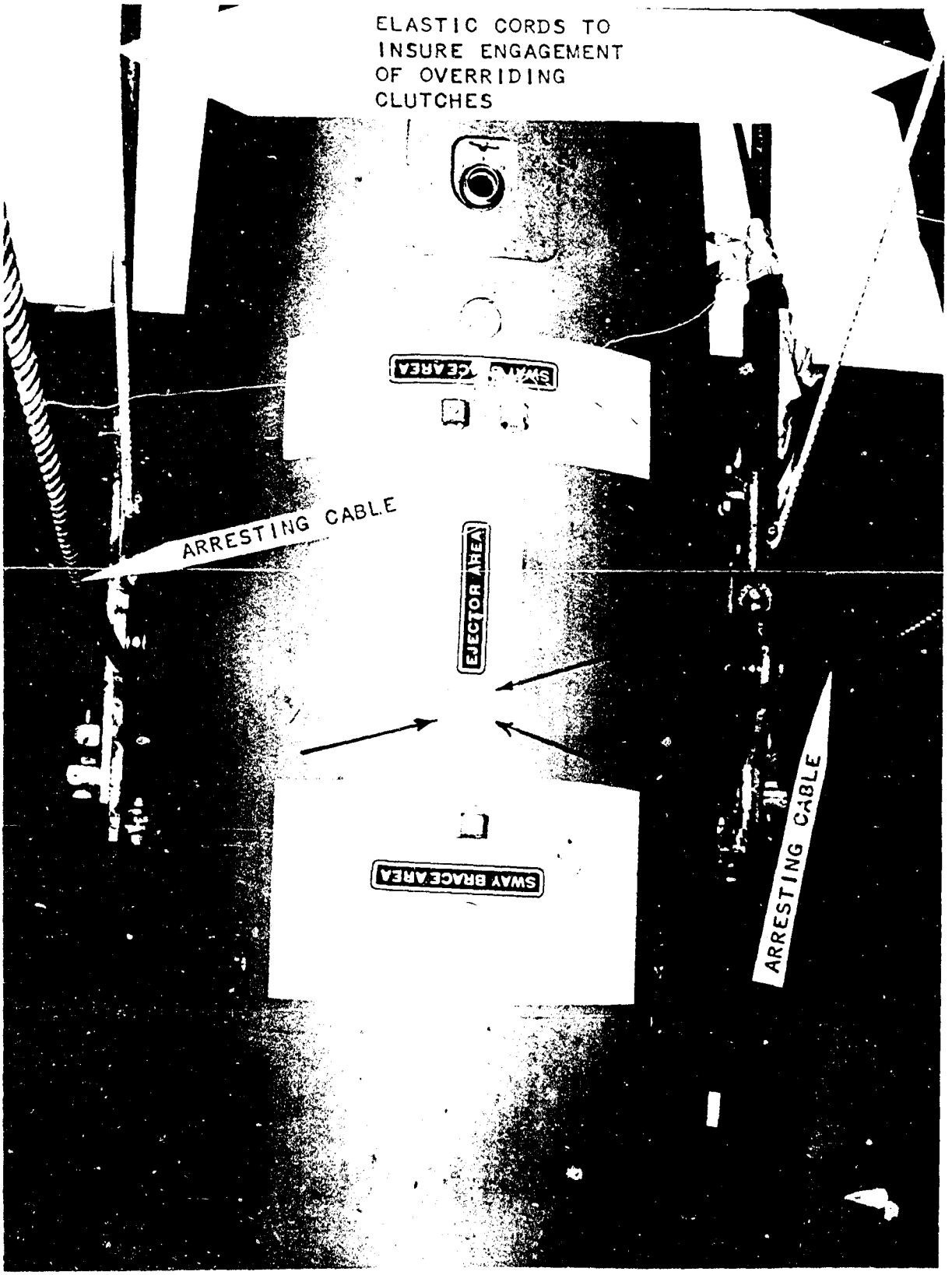

FIG.13 POPPED RIVETS ON CASE CENTER SECTION EJECTOR AREA-
DYNAMIC EJECTOR TEST OF THE XW-7 BOAR.

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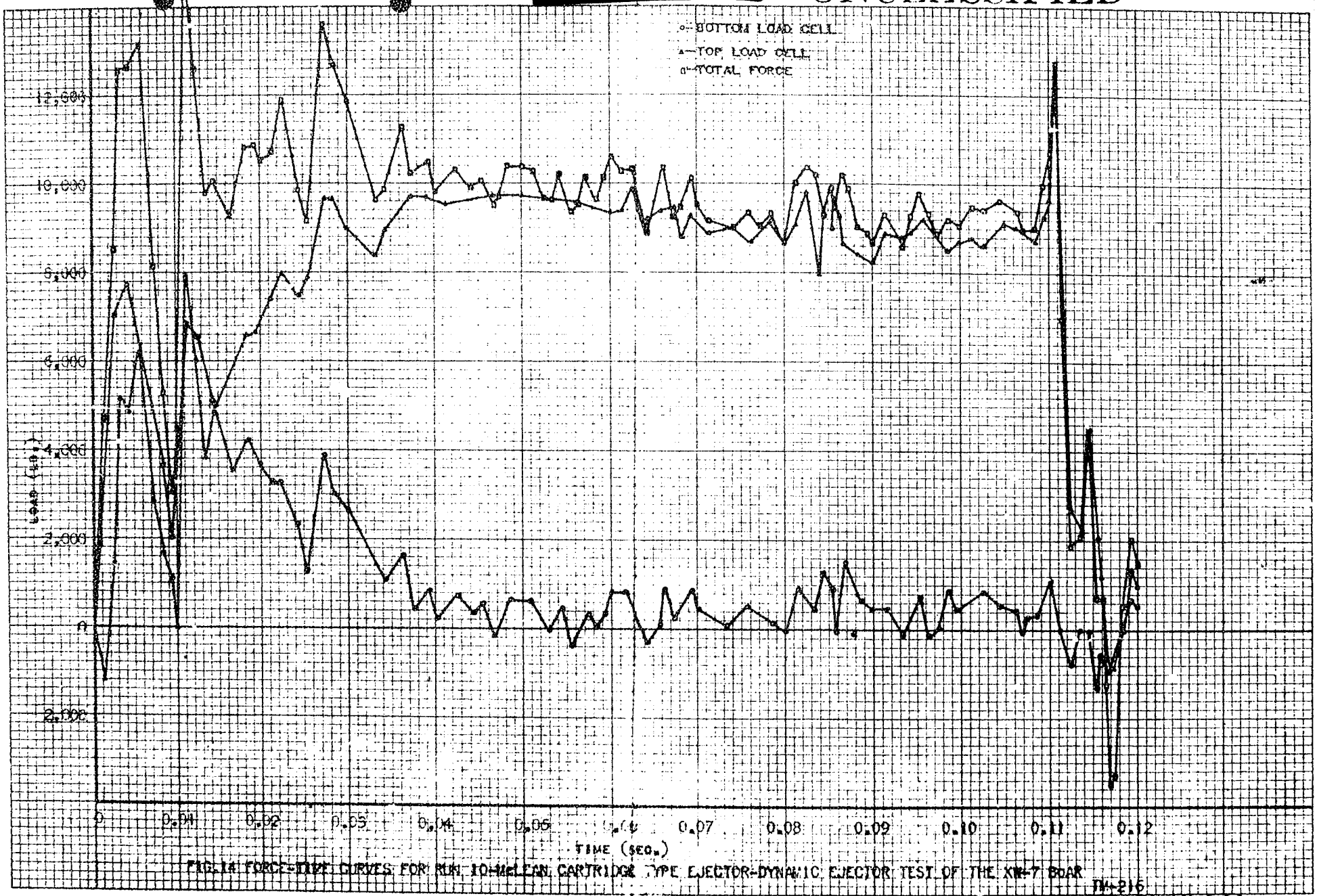

FIG. 14 FORCE-TIME CURVES FOR RUN 10-McLEAN CARTRIDGE TYPE EJECTOR-DYNAMIC EJECTOR TEST OF THE XM-7 BOAR

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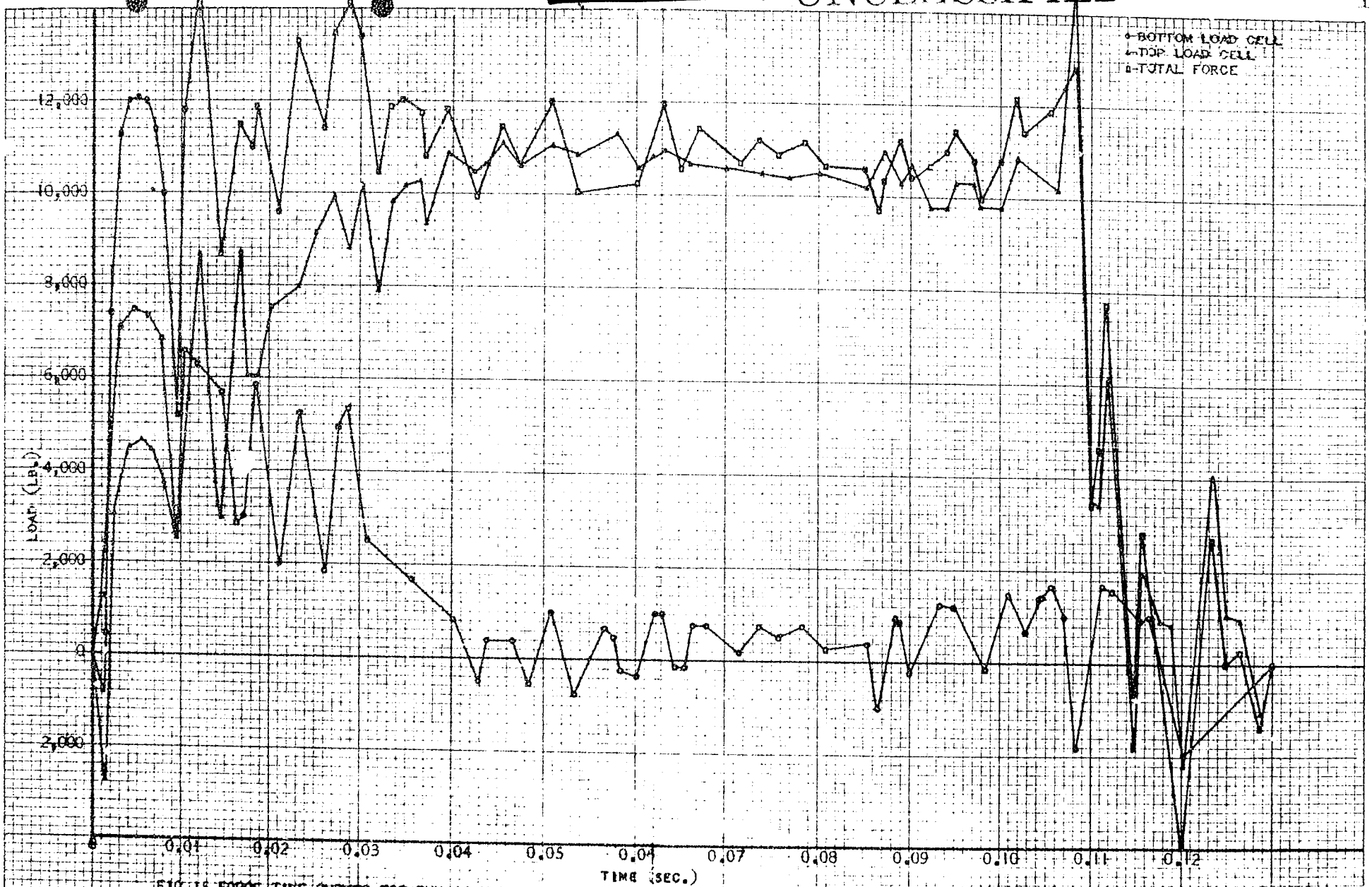

FIG. 15 FORCE-TIME CURVES FOR RUN 11-McLEAN CARTRIDGE TYPE EJECTOR-DYNAMIC EJECTOR TEST OF THE XM-7 BOAR.
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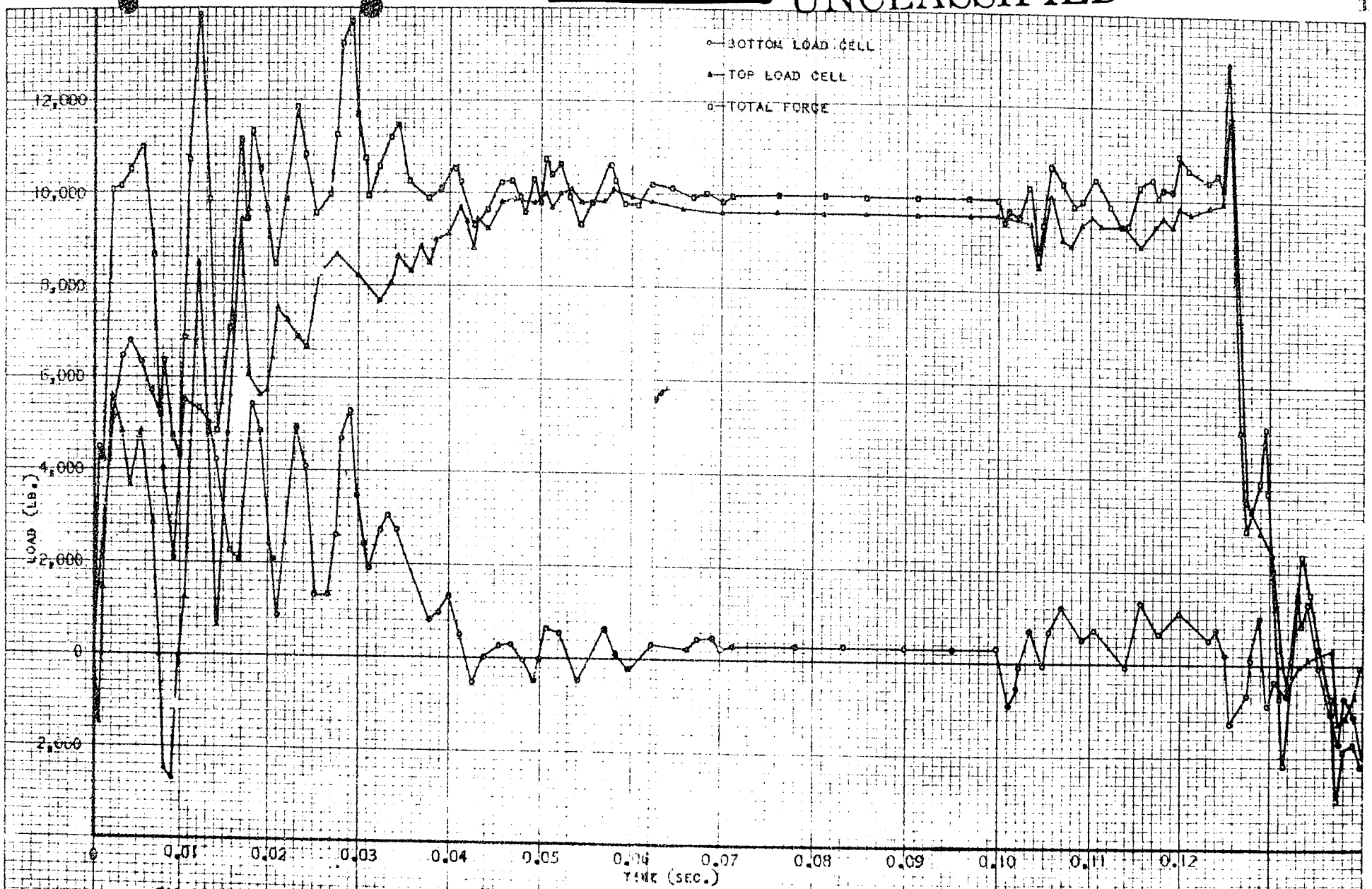

FIG. 16 FORCE-TIME CURVES FOR RUN 12-McLEAN CARTRIDGE TYPE EJECTOR-DYNAMIC EJECTOR TEST OF THE XM-7 BOAR.

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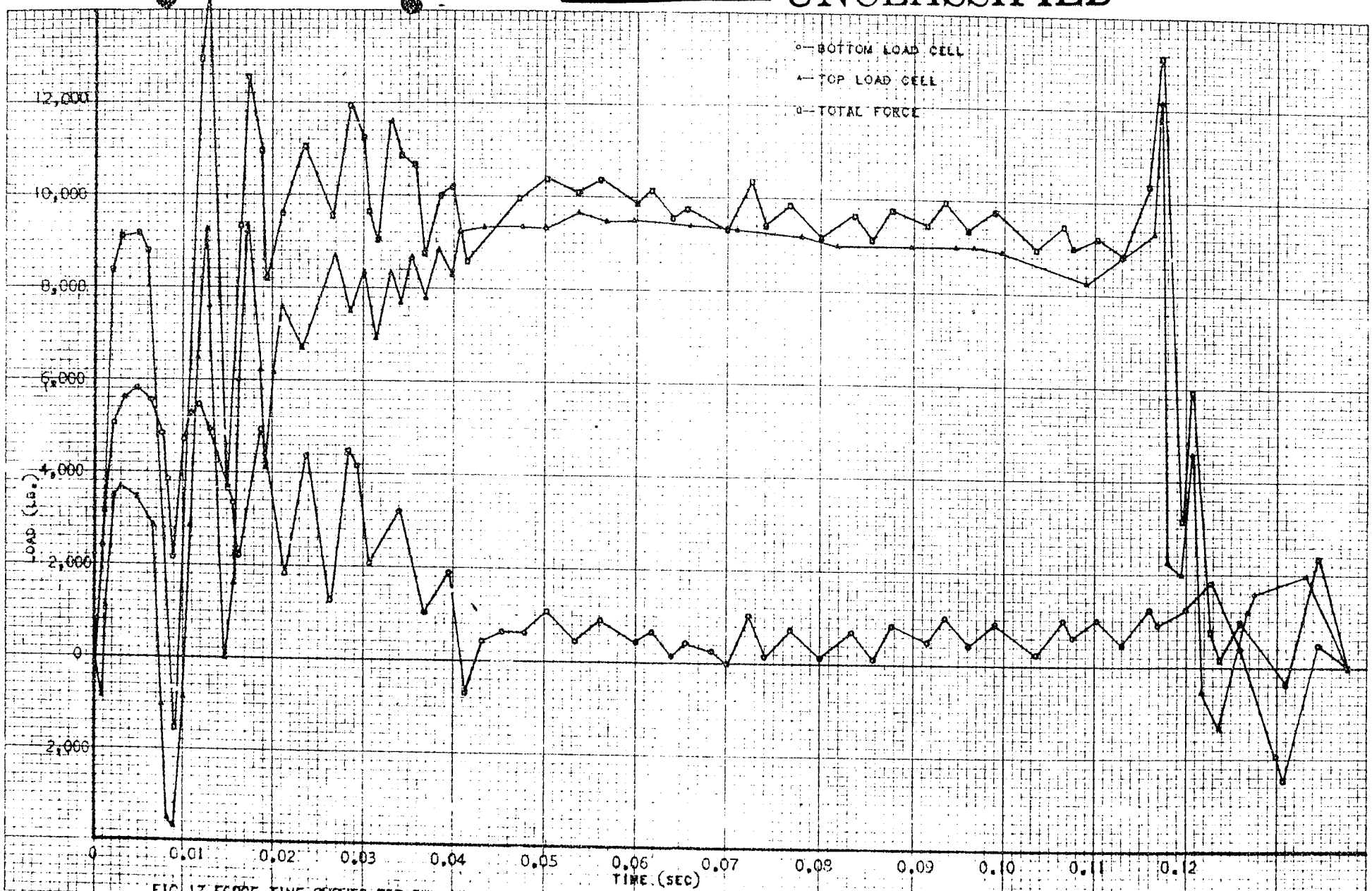

FIG. 17 FORCE-TIME CURVES FOR RUN 15-McLEAN CARTRIDGE TYPE EJECTOR-DYNAMIC EJECTOR TEST OF THE XM-7 BOAR.

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REF. SYM. 1612(132)

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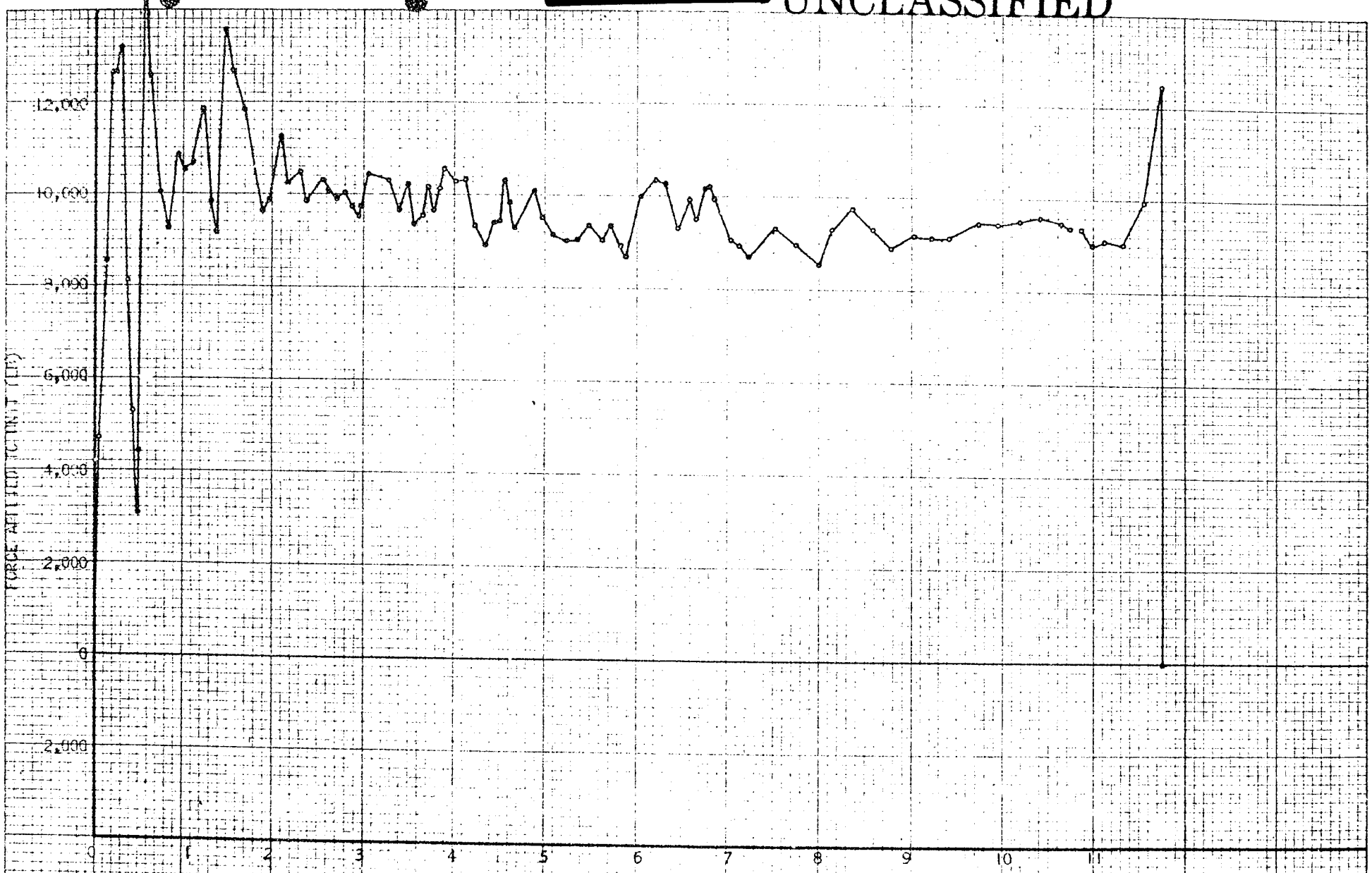

FIG. 18 FORCE APPLIED TO THE BOAR VS. ANGULAR MOVEMENT OF THE THRUST ARM ON THE McLEAN EJECTOR FOR RUN 10 - DYNAMIC EJECTOR TEST OF THE XW-7 BOAR

REF. GM : 1612-(132)
TN-216

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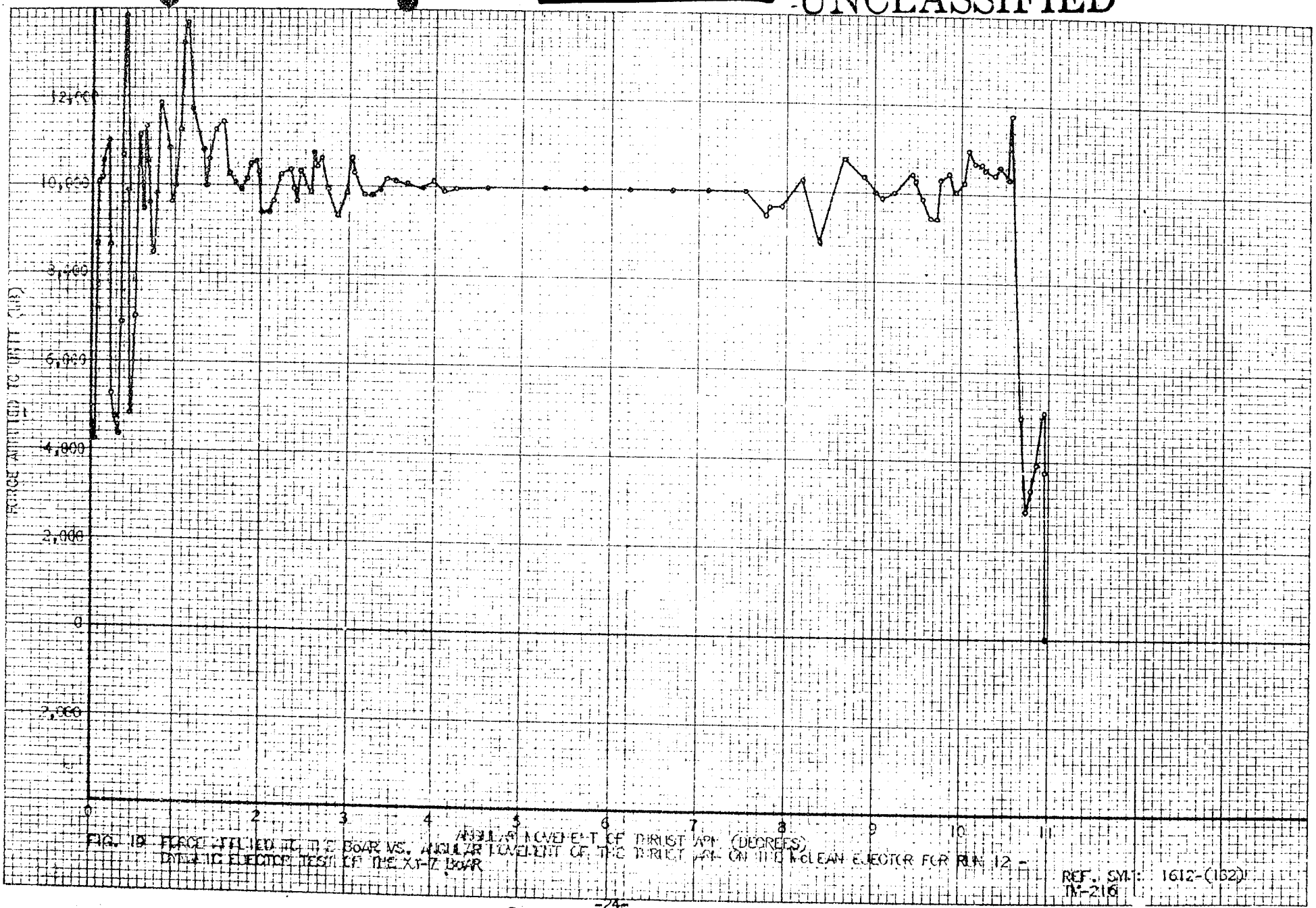

FIG. 19 FORCE APPLIED TO THE BOAR VS. ANGULAR MOVEMENT OF THE THRUST ARM ON THE McLEAN EJECTOR FOR RUN 12 - DYNAMIC EJECTOR TEST OF THE XY-Z BOAR

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FIG. 20 FORCE AFFLICTED TO THE BOAR VS. ANGULAR MOVEMENT OF THE THRUST ARM ON THE McLEAN EJECTOR FOR RUN 14 DYNAMIC EJECTOR TEST OF THE XW-7 BOAR

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TM-216

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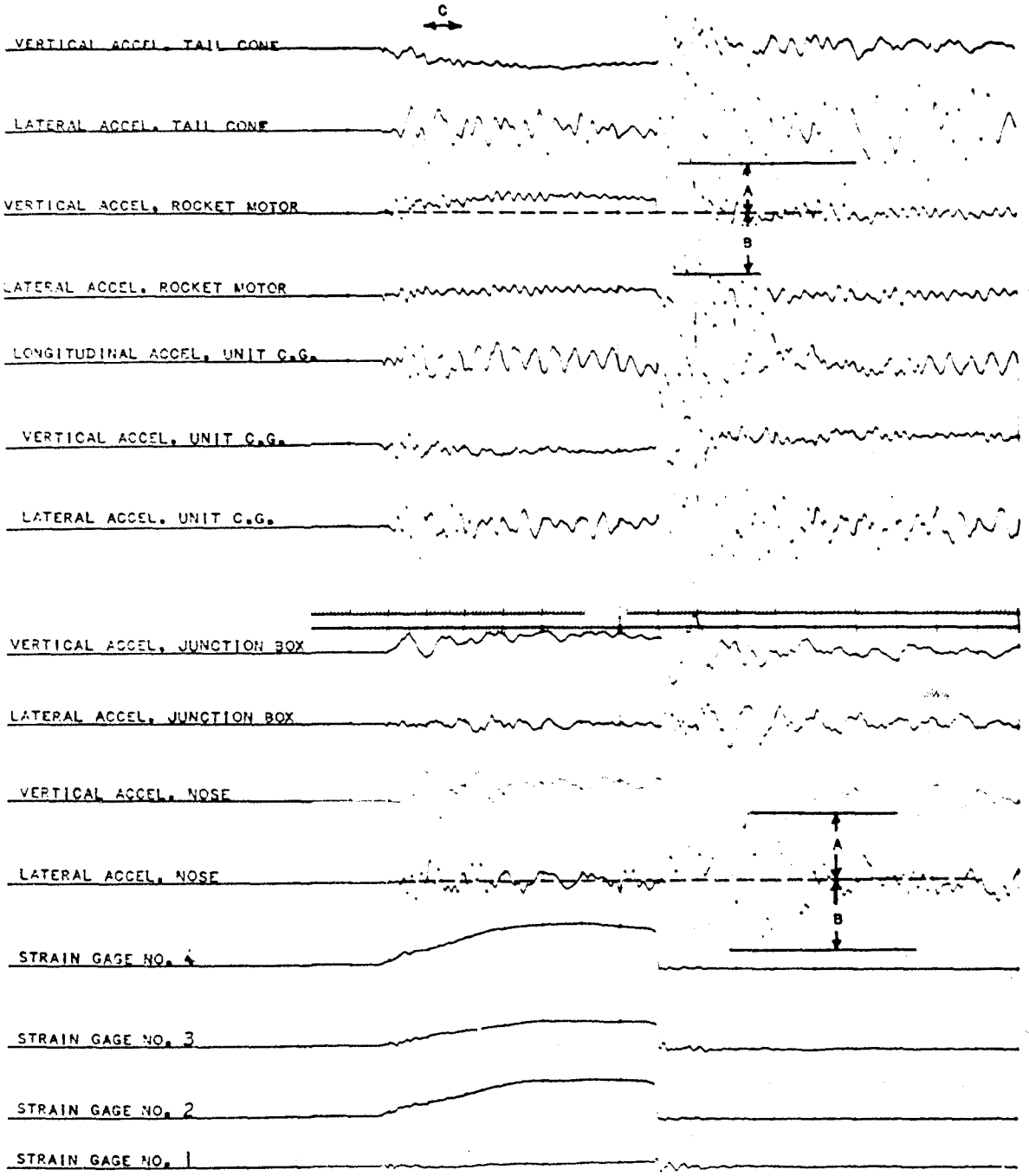

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A - MAXIMUM PEAK SIGNAL HEIGHT (+)
B - MAXIMUM PEAK SIGNAL HEIGHT (-)
C - 0.01 SECOND

FIG.21 TYPICAL RECORD WITH A DOUGLAS CARTRIDGE TYPE EJECTOR-DYNAMIC EJECTOR TEST OF THE XN-7 BOAR

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REF. SYM. 1612(132)

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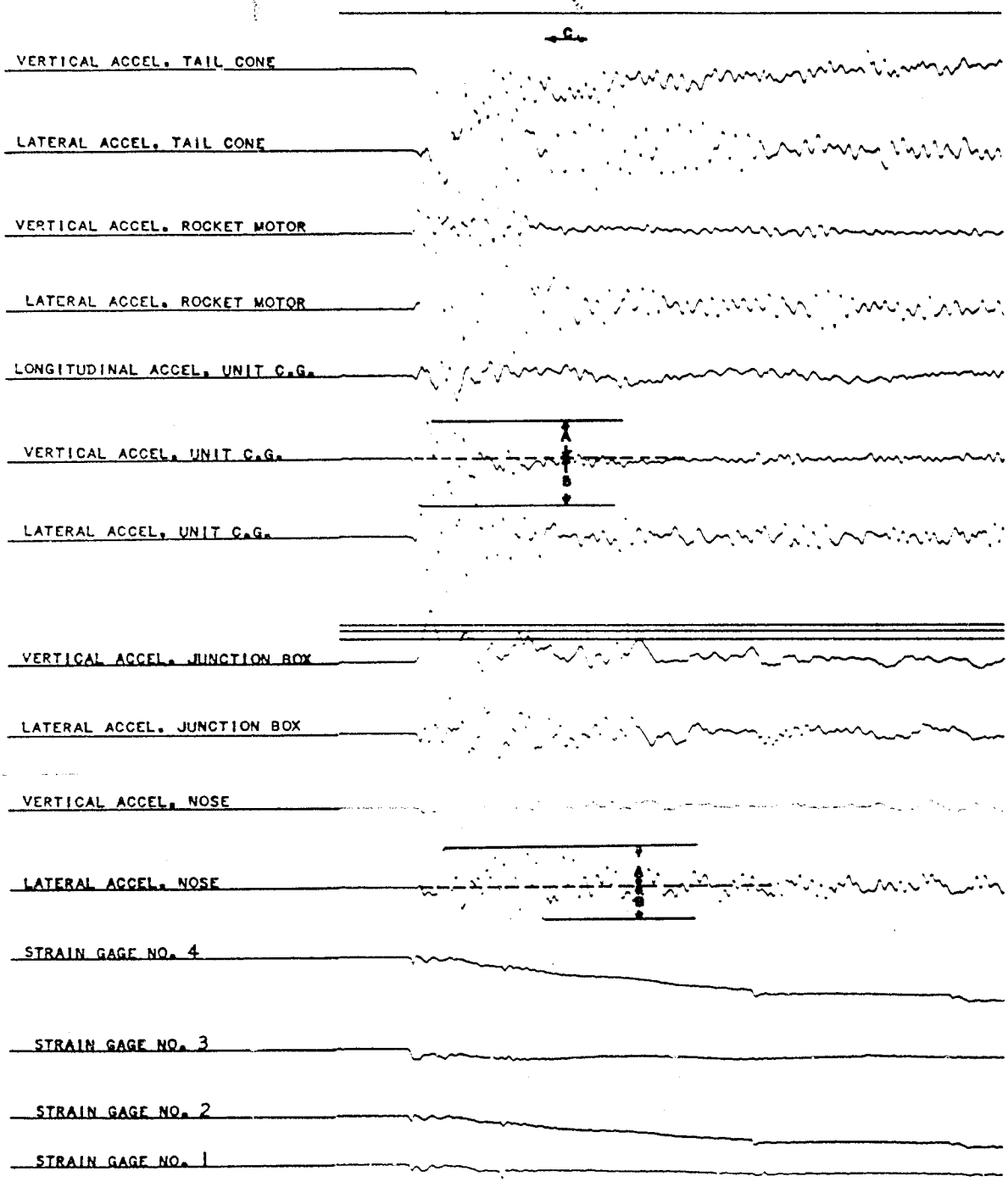

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A - MAXIMUM PEAK SIGNAL HEIGHT (+)
B - MAXIMUM PEAK SIGNAL HEIGHT (-)
C - 0.01 SECOND

FIG. 22 TYPICAL RECORD WITH A REPUBLIC PNEUMATIC TYPE EJECTOR-DYNAMIC EJECTOR TEST OF THE XM-7 BOAR

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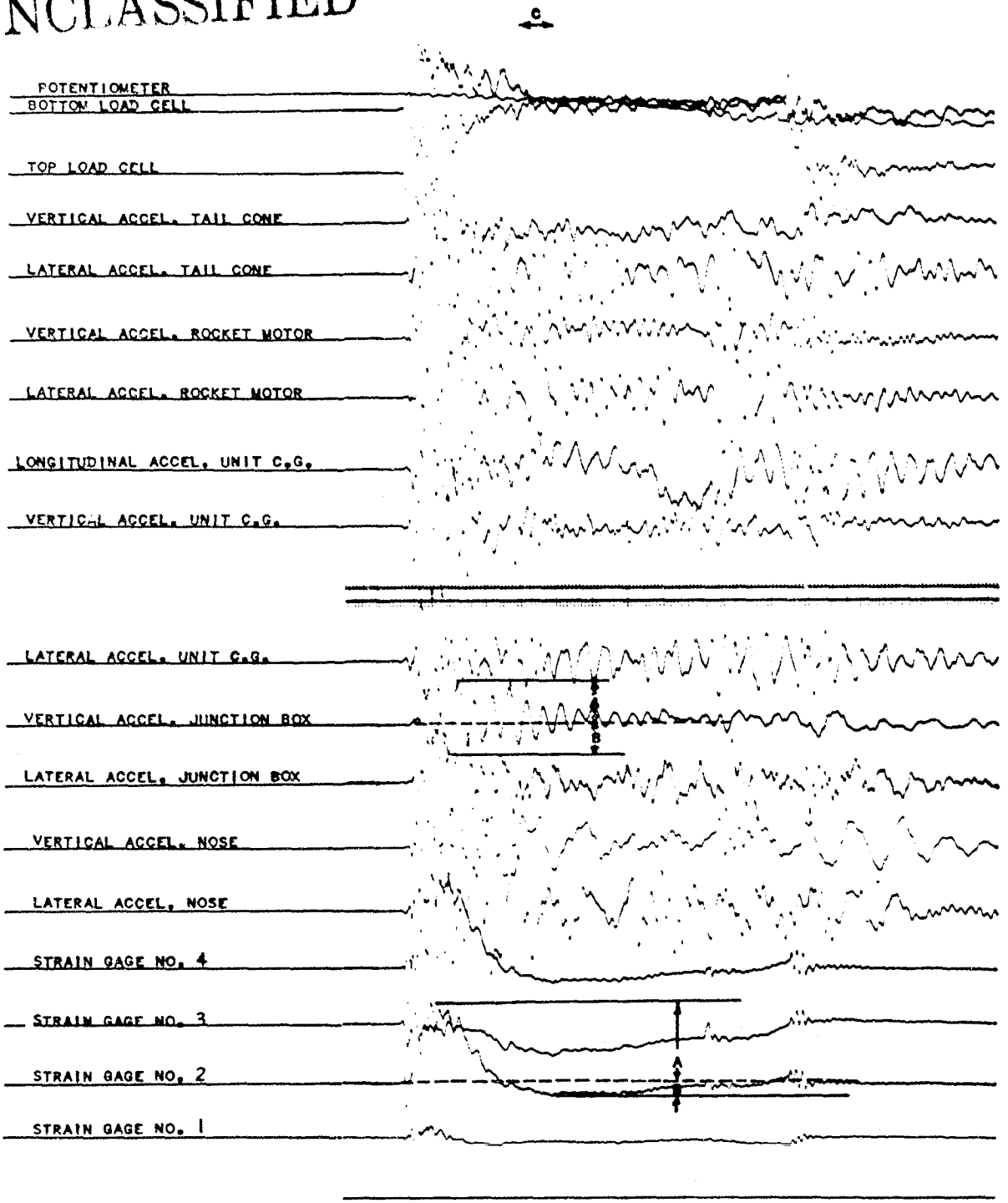

D# 51133

A - MAXIMUM PEAK SIGNAL HEIGHT (+)
B - MAXIMUM PEAK SIGNAL HEIGHT (-)
C - 0.01 SECOND

FIG. 23 TYPICAL RECORD WITH A MC LEAN CARTRIDGE TYPE EJECTOR-DYNAMIC EJECTOR TEST OF THE XM-7 BOAR

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REF. SYM. 1612(132)

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TABLE I

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COMPONENTS USED ON XW-7 BoAR UNIT

Dynamic Ejector Test of the XW-7 BoAR

Item	Drawing No.	Serial No.
Case Center Section	Douglas 5437503	2
Nose Cover Assembly	Douglas 5437505	None
Forward Cover Assembly	Douglas 5437502	None
Tail Assembly	Douglas 5437504	None
Fin Assembly	Douglas 5437533	None
Cartridge Structure (NOTS Type)	Not Available	7
Drop Timer (NOTS Model 525)	Not Available	None
MC-43	102293	CL658E3
MC-44	102321	CL606B3
MC-251	117720	AF6148C4
MC-251	117720	AF5984B4
MC-73	113800	24-L3 (NOTS No.)
XMC-348	115496	GB058A4

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TABLE II

ACCELEROMETERS USED IN DYNAMIC EJECTOR TEST OF THE XW-7 BoAR

No.	Location	Serial No.	Range (g)	Statham Model No.	Natural Frequency C.P.S.
1	Lateral - Nose	1662	± 12	A5B-12-180	350
2	Vertical - Nose	654	± 50	A5A-50-300	490
3	Lateral-Junction Box	1659	± 12	A5B-12-180	360
4	Vertical - Junction Box	635	± 50	A5A-50-300	550
5	Lateral - Unit C.G.	1656	± 12	A5B-12-180	360
6	Vertical - Unit C.G.	639	± 50	A5A-50-300	500
7	Longitudinal - Unit C.G.	1653	± 12	A5B-12-180	350
8	Lateral - Rocket Motor	1657	± 12	A5B-12-180	365
9	Vertical - Rocket Motor	521	± 50	A5A-50-300	700
10	Lateral - Tail Cone	1658	± 12	A5B-12-180	370
11	Vertical - Tail Cone	655	±50	A5A-50-300	490

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TABLE LIX

MAXIMUM STRESSES AND STRAINS MEASURED ON THE LOAD BEAM

DYNAMIC EJECTOR TEST OF THE XM-7 BOAR

Douglas Ejector

STRAIN GAGE NO.	Run 1 Max. Strain Tension μ in/in	Run 1 Max. Strain Comp. μ in/in	Run 1 Max. Stress Tension psi	Run 1 Max. Stress Comp. psi	Run 2 Max. Strain Tension μ in/in	Run 2 Max. Strain Comp. μ in/in	Run 2 Max. Stress Tension psi	Run 2 Max. Stress Comp. psi	Run 3 Max. Strain Tension μ in/in	Run 3 Max. Strain Comp. μ in/in	Run 3 Max. Stress Tension psi	Run 3 Max. Stress Comp. psi	Run 4 Max. Strain Tension μ in/in	Run 4 Max. Strain Comp. μ in/in	Run 4 Max. Stress Tension psi	Run 4 Max. Stress Comp. psi
1	0	0	0	0	20	7	230	70	20	15	230	150	20	10	190	120
2	1070	80	11000	800	1000	130	10300	1340	1000	160	10300	1600	1500	140	15700	1400
3	70	0	730	0	60	17	630	175	60	20	640	200	70	20	700	190
4	1300	0	13300	0	1075	80	11100	830	1100	120	11300	1200	1100	140	11100	1400

Republic Ejector

STRAIN GAGE NO.	Run 5 - 1700 psi Max. Strain Tension μ in/in	Run 5 Max. Strain Comp. μ in/in	Run 5 Max. Stress Tension psi	Run 5 Max. Stress Comp. psi	Run 6 - 1900 psi Max. Strain Tension μ in/in	Run 6 Max. Strain Comp. μ in/in	Run 6 Max. Stress Tension psi	Run 6 Max. Stress Comp. psi	Run 7 - 1875 psi Max. Strain Tension μ in/in	Run 7 Max. Strain Comp. μ in/in	Run 7 Max. Stress Tension psi	Run 7 Max. Stress Comp. psi	Run 8 - 1850 psi Max. Strain Tension μ in/in	Run 8 Max. Strain Comp. μ in/in	Run 8 Max. Stress Tension psi	Run 8 Max. Stress Comp. psi	Run 9 - 2400 psi Max. Strain Tension μ in/in	Run 9 Max. Strain Comp. μ in/in	Run 9 Max. Stress Tension psi	Run 9 Max. Stress Comp. psi
1	0	0	0	0	40	0	440	0	20	0	200	0	30	0	310	0	30	0	350	0
2	300	0	3100	0	350	0	3560	0	350	0	3560	0	340	0	3500	0	450	0	4600	0
3	0	0	0	0	0	0	0	0	20	0	200	0	20	0	200	0	30	0	300	0
4	300	0	3100	0	370	0	3800	0	360	0	3700	0	370	0	3800	0	500	0	5000	0

McLean Ejector

STRAIN GAGE NO.	Run 10 Max. Strain Tension μ in/in	Run 10 Max. Strain Comp. μ in/in	Run 10 Max. Stress Tension psi	Run 10 Max. Stress Comp. psi	Run 11 Max. Strain Tension μ in/in	Run 11 Max. Strain Comp. μ in/in	Run 11 Max. Stress Tension psi	Run 11 Max. Stress Comp. psi	Run 12 Max. Strain Tension μ in/in	Run 12 Max. Strain Comp. μ in/in	Run 12 Max. Stress Tension psi	Run 12 Max. Stress Comp. psi	Run 13 Max. Strain Tension μ in/in	Run 13 Max. Strain Comp. μ in/in	Run 13 Max. Stress Tension psi	Run 13 Max. Stress Comp. psi	Run 14 Max. Strain Tension μ in/in	Run 14 Max. Strain Comp. μ in/in	Run 14 Max. Stress Tension psi	Run 14 Max. Stress Comp. psi
1	Not readable				80	20	800	250	80	30	800	300		No record			80	20	800	200
2	Not readable				900	200	9100	1900	900	200	9000	2000		No record			800	170	8000	1700
3	Not readable				40	100	400	950	30	100	350	1000		No record			50	100	450	1000
4	Not readable				900	250	9600	2400	1000	300	10000	3000		No record			900	250	9500	2600

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TABLE IV

MAXIMUM ACCELERATIONS * AND ASSOCIATED FREQUENCIES

DYNAMIC EJECTOR TEST OF THE XW-7 BOAR

ACCELEROMETER LOCATION	Accel. No.	Douglas Ejector												Republic Ejector								
		Run 1			Run 2			Run 3			Run 4			Run 5 - 1700 psi			Run 6 - 1900 psi			Run 7 - 1875 psi		
		Max. Accel+	Max. Accel-	Freq. (cps)	Max. Accel+	Max. Accel-	Freq. (cps)	Max. Accel+	Max. Accel-	Freq. (cps)	Max. Accel+	Max. Accel-	Freq. (cps)	Max. Accel+	Max. Accel-	Freq. (cps)	Max. Accel+	Max. Accel-	Freq. (cps)	Max. Accel+	Max. Accel-	Freq. (cps)
Lateral Nose	1	8.8	8.3	133	5.8	6.9	120	8.4	6.2	97	8.1	8.4	99	4.3	6.4	368	17.6	13.2	394	5.9	6.6	393
Vertical Nose	2	6.5	11.4	98	22.2	14.2	100	25.1	15.0	83	23.5	15.3	94	9.7	17.7	88	11.6	20.8	85	12.1	20.0	81
Lateral JB	3	2.8	4.5	82	3.0	2.4	115	3.0	3.1	112	3.3	3.0	112	1.6	2.1	116	2.3	2.3	128	2.0	2.3	118
Vertical JB	4	12.8	11.6	230	13.4	11.4	210	12.3	11.2	225	12.5	10.8	110	9.7	5.8	234	11.4	7.3	224	11.0	7.6	207
Lateral C.G.	5	4.4	6.2	216	6.2	5.5	171	6.5	5.3	153	6.4	5.7	157	4.6	3.3	405	4.4	4.7	412	4.3	5.1	417
Vertical C.G.	6	19.0	29.9	348	17.1	24.4	362	16.5	25.3	375	14.0	28.0	426	17.1	9.1	438	20.5	11.7	455	20.1	11.3	428
Longitudinal C.G.	7	Not Readable			4.0	5.1	250	3.7	5.3	200	4.7	5.7	183	4.8	3.2	420	5.6	3.7	440	3.8	2.5	230
Lateral Rocket Motor	8	7.2	5.2	354	4.9	6.7	290	6.0	8.3	391	6.6	8.6	400	4.5	4.9	272	4.1	16.5	348	5.4	6.8	315
Vertical Rocket Motor	9	11.9	16.2	352	12.5	17.8	308	15.0	20.4	327	16.5	19.1	393	12.1	5.0	282	10.3	5.8	335	12.5	6.6	336
Lateral Tail Cone	10	6.6	5.7	236	4.8	4.7	273	4.5	5.1	300	4.7	5.2	309	4.8	4.8	316	4.0	3.7	296	4.9	3.2	321
Vertical Tail Cone	11	7.8	10.0	289	8.8	11.3	118	10.2	11.6	109	9.6	11.7	110	9.7	3.5	250	4.6	11.0	248	10.3	4.2	218

ACCELEROMETER LOCATION	Accel. No.	Republic Ejector						McLean Ejector														
		Run 8 - 1850 psi			Run 9 - 2400 psi			Run 10			Run 11			Run 12			Run 13			Run 14		
		Max. Accel+	Max. Accel-	Freq. (cps)	Max. Accel+	Max. Accel-	Freq. (cps)				Max. Accel+	Max. Accel-	Freq. (cps)	Max. Accel+	Max. Accel-	Freq. (cps)				Max. Accel+	Max. Accel-	Freq. (cps)
Lateral Nose	1	7.6	7.9	381	4.6	5.7	380	NOT READABLE			14.8	19.5	366	27.0	24.4	350	NO RECORD			28.4	19.1	352
Vertical Nose	2	12.5	21.0	80	14.5	28.1	83				27.5	52.7	75	30.3	42.4	105				32.5	61.7	78
Lateral JB	3	2.5	2.7	142	2.2	2.3	110				5.8	6.0	129	6.7	6.7	117				9.1	9.4	114
Vertical JB	4	11.0	8.1	246	14.2	10.2	118				30.7	21.3	215	31.2	22.6	212				27.2	19.6	216
Lateral C.G.	5	4.6	4.8	400	4.9	6.2	471				14.6	16.5	305	12.5	18.5	309				15.5	20.4	200
Vertical C.G.	6	20.8	12.0	409	27.8	21.6	495				46.7	64.1	366	51.4	65.7	350				-	-	-
Longitudinal C.G.	7	3.9	2.6	400	4.3	2.3	507				10.2	5.9	500	14.1	8.2	491				14.3	9.1	512
Lateral Rocket Motor	8	5.5	5.9	321	3.9	7.3	377				20.6	21.9	350	19.2	20.6	292				17.7	12.3	255
Vertical Rocket Motor	9	14.5	6.4	320	14.0	6.4	314				43.5	35.8	368	41.2	37.7	311				34.2	33.3	366
Lateral Tail Cone	10	5.4	3.4	320	7.1	7.5	353				14.2	26.3	332	13.1	20.3	500				14.3	26.5	314
Vertical Tail Cone	11	5.7	11.6	246	15.8	9.1	330				34.8	18.3	438	30.2	18.6	389				33.9	18.9	366

* Directions for (+) Accelerations are (with respect to the Weapon):

Longitudinal - Toward nose Vertical - Toward top Lateral - To right when looking in direction of nose

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TABLE V

EJECTOR ENERGY OUTPUT - DYNAMIC EJECTOR TEST OF THE XW-7 BoAR

Ejector & Run	C-Chord Length of Pendulum Swing (in)	h* - Vertical Displacement of Unit G.G. (in.)	E** - Potential Energy Gain of Unit (in.-lb.)	Average Potential Energy Gain of Unit (in.-lb.)
Douglas				
Run 1	96.0	21.6	42,120	
Run 2	95.5	21.4	41,730	
Run 3	93.0	20.3	39,580	
Run 4	97.5	22.3	43,480	41,720
Republic				
Run 5	56.5	7.5	14,620	
Run 6	59.5	8.3	16,180	15,400
Run 7	No Record			
Run 8	No Record			
Run 9	67.5	10.7	20,360	20,360
McLean				
Run 10	145.5	49.8	97,110	
Run 11	128.0	38.5	75,070	
Run 12	126.5	37.6	73,320	
Run 13	127.5	38.2	74,490	
Run 14	122.8	35.4	69,030	77,300

$$* \; h = \frac{c^2}{2 \times \text{Pendulum Length}} = \frac{c^2}{2 \times 217.6}$$

$$** E = \text{Weight of BoAR} \times h = 1950 \times h$$