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XW-31, 3-2
Project No. T-16096
Case No. 161.00
Ref. Sym: 1613(92)

SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
1st Review Date: 8/25/98
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Name: W Layne
Determination (Circle Number(s)): 1 Classification Retained; 2 Classification Changed to: U; 3 Contains No DOE Classified Information; 4 Coordinate With:; 5 Contains UCNI; 6 Comments:
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Re: Vibration Test of the XW-31

Test Summary

An XW-31 warhead was vibrated in each of three mutually perpendicular planes. Two four minute cycles from 80-500-80 cps were conducted in each plane.

For Run 1, longitudinal orientation, no visible structural damage occurred. The maximum peak-to-peak acceleration (in excess of 230 g with an amplification factor greater than 23) measured during Run 1 occurred on the XW3-816 plug at 210 cps. The input varied from 5.0 to 11 g peak-to-peak.

For Run 2, vertical orientation, no oscillograph records were obtained; so, Run 3 was conducted as a repeat of Run 2. The maximum peak-to-peak acceleration (190 g with an amplification factor of 38) measured during Run 3 occurred at 166 cps on the MC-742 adaption kit in the longitudinal direction. The input varied from 5.0 to 10 g peak-to-peak. Relay chatter occurred intermittently during Runs 2 and 3 and the gas bottle bracket was observed to be broken after the completion of Run 3.

XW-31 3-2

For Run 4, lateral orientation, no visible structural damage occurred as a result of testing; however, relay chatter occurred intermittently. The maximum peak-to-peak acceleration (62 g with an amplification factor of 12) measured during Run 4 occurred on the MC-742 adaption kit at 172 cps. The input varied from 5.0 to 8.0 g peak-to-peak.

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Object of Test

This test was conducted to recheck the structural adequacy of the XW-31 warhead in response to vibration cycling from 80-500-80 cps in each of three mutually perpendicular planes. The test was setup to simulate actual missile flight vibration as determined from flight records.

Authorization for Test

This test was requested in a Work Order Authorization from J. P. Ford, 1247, to R. S. Hooper, 1613-3, dated May 27, 1959. Mr. A. J. Aldrich, 1247-2, was the consultant.

Summary of Past Tests

The first vibration test of the XW-31 warhead was written up in the memorandum

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DATED: 9/10/98

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"Vibration Test of the XW-31" from Dale Buchanan, 1612, to J. P. Ford, 1247, Case No. 661.00, Ref. Sym: 1612(775) Project No. TM-820, File: XW-31, 3-2.

For this test an XW-31 warhead with an MC-742 was fastened to an adapter ring and vibrated in accordance with a modified SCS-5, paragraphs 2.4.1, 2.4.2 and 2.4.3. The maximum allowable input accelerations were reduced to 2 g peak-to-peak during the resonance survey and 5 g peak-to-peak during vibration at resonance and during vibration cycling. The range of peak-to-peak table input accelerations, applied during the hardware runs, for the resonance survey and for vibration at resonance were: 1. Longitudinal (Hardware Run 1), 2.3 g to 5.0 g and 6.8 g to 7.3 g at 190 cps. 2. Vertical (Hardware Run 2), 1.8 g to 3.2 g and 5.6 g to 7.1 g at 82 cps. 3. Lateral (Hardware Run 3), 2.0 g to 3.1 g and 4.5 g to 5.8 g at 84 cps. 4. Longitudinal (Hardware Run 4), repeat of Hardware Run 1, 2.0 g to 2.7 g and 4.6 g to 6.7 g at 196 cps.

For the HE runs, the range of peak-to-peak table input accelerations applied for the resonance survey and for vibration at resonance were: 1. Longitudinal (HE Run 1), 0.8 g to 2.3 g and 5.3 g to 6.5 g at 190 cps (major warhead resonance) and 3.9 g to 4.1 g at 108 cps (minor warhead resonance). 2. Vertical (HE Run 2), 1.8 g to 4.9 g and 5.9 g to 7.0 g at 82 cps. 3. Lateral (HE Run 3) 1.9 g to 4.1 g and 5.3 g to 5.6 g at 76 cps.

The MC-742 mounting flange of the cover assembly failed during hardware Run 2. The mounting studs of the K-103 relay failed during vibration at resonance of Hardware Run 3. The Nemo structure contained within the pit failed during testing.

During HE Run 2, the mounting studs on three relays in the MC-742 failed; some of the MC-743 wiring harness leads broke; the gas bottle strap failed; and two cracks occurred in the gas bottle bracket. In addition, the gas tube clamp failed and one detonator cable clamp broke.

The following maximum amplification factors occurred during vibration at resonance of the HE runs at the following locations: 1. Longitudinal orientation (190 cps), MC-742 - 5.8 A.F., "A" case at 0° - 1.4 A.F., and the adapter ring at 180° - 1.1 A.F. 2. Vertical orientation (82 cps), MC-742 - 8.7 A.F., "A" case at 0° - 2.3 A.F., and the adapter ring at 180° - 0.6 A.F. 3. Lateral orientation (76 cps) MC-742 - 6.6 A.F., "A" case at 90° - 2.0 A.F., and the adapter ring at 270° - 0.9 A.F. The maximum zero-to-peak strains occurred during vibration at resonance in the lateral orientation (76 cps) and were: 1220 microinches per inch on the gas bottle strap, and 360 microinches per inch on the adapter ring at 90°.

The second vibration test of the XW-31 was: "Vibration Test of the XW-31 with MC-742", from Dale Buchanan, 1615, to Distribution, Case No. 661.00, Ref. Sym: 1613(36), Project No. T-16130, dated July 8, 1959.

A vibration test was conducted in accordance with SCS-3, paragraph 2.7 on an KW-31 (HE) with an MC-742 cartridge and adapter ring to re-check its structural adequacy. Vibration was conducted in each of the three orthogonal planes for 10 minutes at their respective resonant frequencies. For Run #1, longitudinal orientation, the resonant frequency was 220 cps but it shifted to 218 cps after 8 minutes of vibration at 220 cps. No failures occurred during this run. The maximum longitudinal peak-to-peak accelerations measured on the adapter ring, on the "A" case, and on the MC-742 were 6.6 g, 10 g, and 86 g respectively, with corresponding amplification factors of 1.0, 1.6 and 13.

During Run #2, vertical orientation, (resonant frequency - 80 cps) the following failures occurred: 1. Relay chatter 2. The gas bottle bracket cracked 3. The gas bottle strap broke 4. The hold-down bolts on the support structure loosened 5. All of the spot welds that attached the AK mounting flange to the cover assembly failed. The maximum vertical peak-to-peak accelerations measured on the adapter ring, on the "A" case, and on the MC-742 were 10 g, 24 g and 89 g respectively with corresponding amplification factors of 2.1, 5.0 and 18.

During Run #3, lateral orientation (resonant frequency - 83 cps) the following failures occurred: 1. Relay chatter 2. One hold-down bolt on the support structure failed, the rest loosened. The maximum lateral peak-to-peak acceleration measured on the adapter ring, on the "A" case, and on the MC-742 were 5.5 g, 3.8 g and 55 g respectively, with corresponding amplification factors of 1.7, 1.2 and 17.

Upon completion of testing, the following checks were performed: 1. C. A. T. - showed all components to be operable. 2. D. C. O. - showed the pit vacuum to be satisfactory. An F.A.T. - check was attempted, but inspection revealed that several of the leads in the MC-743 Wiring Harness Relay Assembly had broken loose from the external connectors and terminal boards. These loose leads may have been the cause of the indicated relay chatter. A radiograph of the M. E. assembly showed no failures.

Setup for Test

Figure 1 shows the setup used for Run 1, longitudinal orientation.

Figure 2 shows the setup used for Runs 2 and 3, vertical orientation (pitch plane).

Figure 3 shows the setup used for Run 4, lateral orientation (yaw plane).

Components tested are listed in Table I

Test Equipment Used:

MB-4 electrodynamic shaker

16 Channel relay monitor, S. C. Serial No. 811-7
William Miller Carrier amplifier system - type C-3
Model A 11162, S. No. 2
Consolidated recording oscillograph - Type 5-119 P4-
36 RW, Serial No. 8148

Accelerometers used are listed in Table II and shown in Figs. 4 thru 12.

Procedure

For Run 1, longitudinal orientation, the XW-31 warhead was mounted on the vibration machine as shown in Fig. 1. Two four minute cycles were conducted from 80-500-80 cps with an input that varied from 5.0 to 11 g peak-to-peak. Upon completion of Run 1, a visual inspection of the warhead was conducted.

For Run 2, vertical orientation, the XW-31 warhead was mounted on the vibration machine as shown in Fig. 2. Two four minute cycles were conducted from 80-500-80 cps with an input that varied from 5 to 10 g peak-to-peak. No oscillograph records were obtained during these cycles so Run 3 was conducted as a repeat of Run 2. One four minute cycle was conducted from 80-500-80 cps with an input that varied from 5.0 to 10 g peak-to-peak and oscillograph records were obtained successfully. Upon completion of Run 3, a thorough visual inspection was conducted of the XW-31 warhead and of the MC-742 adaption kit.

For Run 4, lateral orientation, the XW-31 warhead was mounted on the vibration machine as shown in Fig. 3. Two four minute cycles were conducted from 80-500-80 cps with an input that varied from 5.0 to 8.0 g peak-to-peak.

Results

Run 1, longitudinal orientation, caused no visible structural damage. No relay chatter occurred. The maximum response of all monitored components occurred at 210 cps. The maximum measured peak-to-peak acceleration was greater than 250 g, with a corresponding amplification factor in excess of 23 and occurred on the XMC-816 plug. The maximum measured peak-to-peak accelerations for Run 1 are recorded in Table III.

During Run 2, vertical orientation, relays K-102 and K-202, in parallel, indicated chatter at 140, 150 and 160 cps; relays K-105 and K-205, in series, indicated chatter at 80, 140 and 150 cps. During Run 3 the two sets of relays mentioned above chattered at 150 to 190, 214, 236 to 247, 350 to 420, 420 to 350, and 278 to 130 cps. The gas bottle bracket cracked as a result of runs 2 and 3. No other visible structural damage was observed in the XW-31 warhead or the MC-742 adaption kit. The maximum peak-to-peak acceleration measured during Run 3 was 180 g with a corresponding amplification factor of 36, and occurred on the MC-742 adaption kit in the longitudinal direction at 166 cps. The maximum peak-to-peak accelerations recorded during Run 3 are listed in Table III.

During Run 4, lateral orient..ion, relays K-102 and K-202, in parallel, indicated chatter at 80 and 165 cps; relays K-105 and K-205, in series, indicated chatter from 80 to 100 cps. No structural damage was visible. The maximum peak-to-peak acceleration measured during Run 4, was 62 g, with a corresponding amplification factor of 12, and occurred on the MC-742 adaption kit in the lateral direction at 172 cps. The maximum peak-to-peak accelerations measured during Run 4 are recorded in Table III.

Table III contains the maximum peak-to-peak accelerations measured during Runs 1, 3 and 4. It also contains the corresponding amplification factors and the frequency at which the maximum acceleration occurred.

Conclusions and Recommendations

The XW-31 is not adequate to survive missile flight vibration as simulated in this test. However, amplification between the table and the weapon mounting surface of the jig resulted in higher inputs to the warhead in lateral directions than those determined from flight test records.

Dale Buchanan
D. K. BUCHANAN - 1615-2

1613 Project Engineer: D. W. BAUDER - 1613-3

Approved by: R. S. HOOPER - 1613-3

DKB:1615-2:ec

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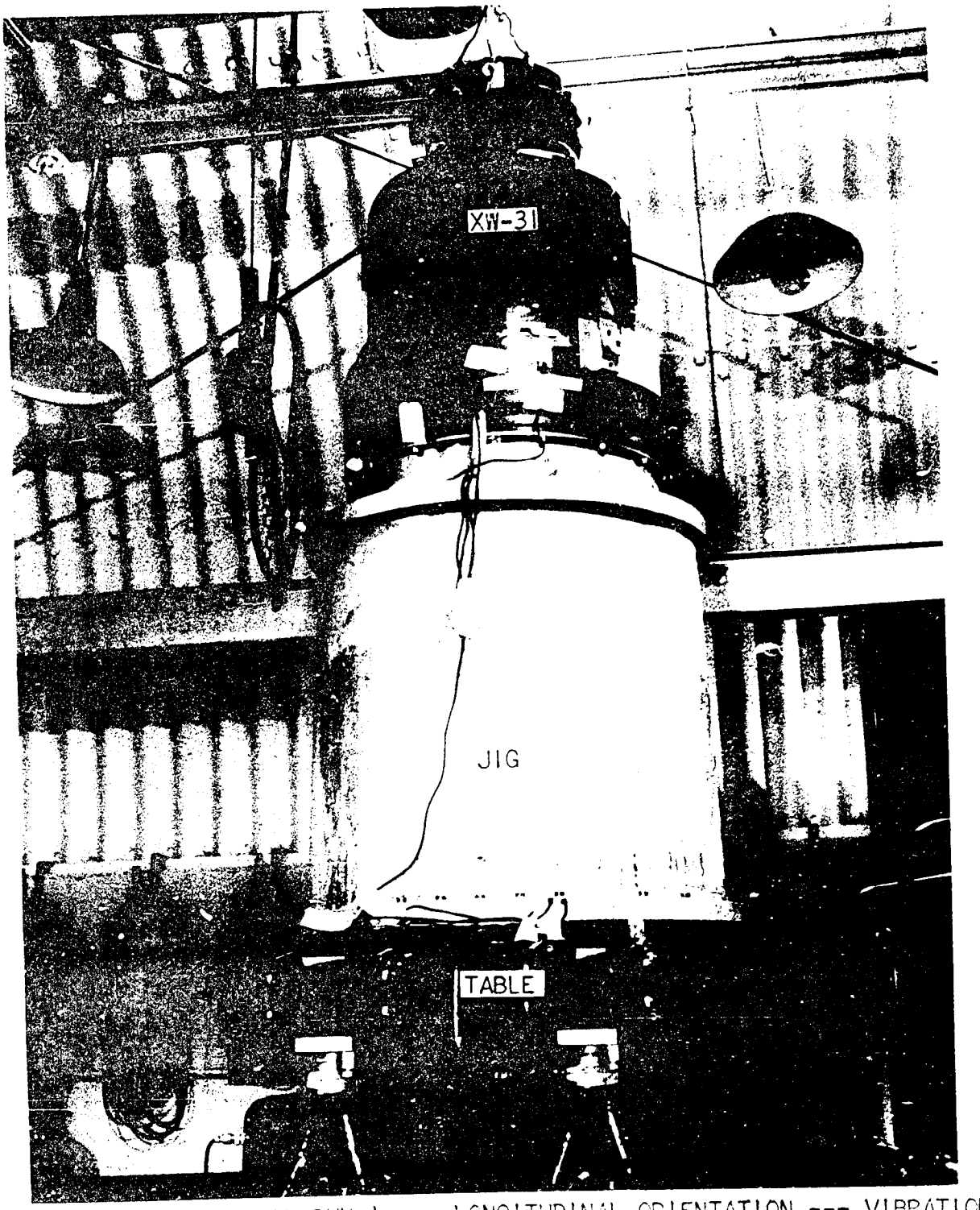

FIG. 1 --- SETUP FOR RUN 1 --- LONGITUDINAL ORIENTATION --- VIBRATION TEST OF THE XW-31

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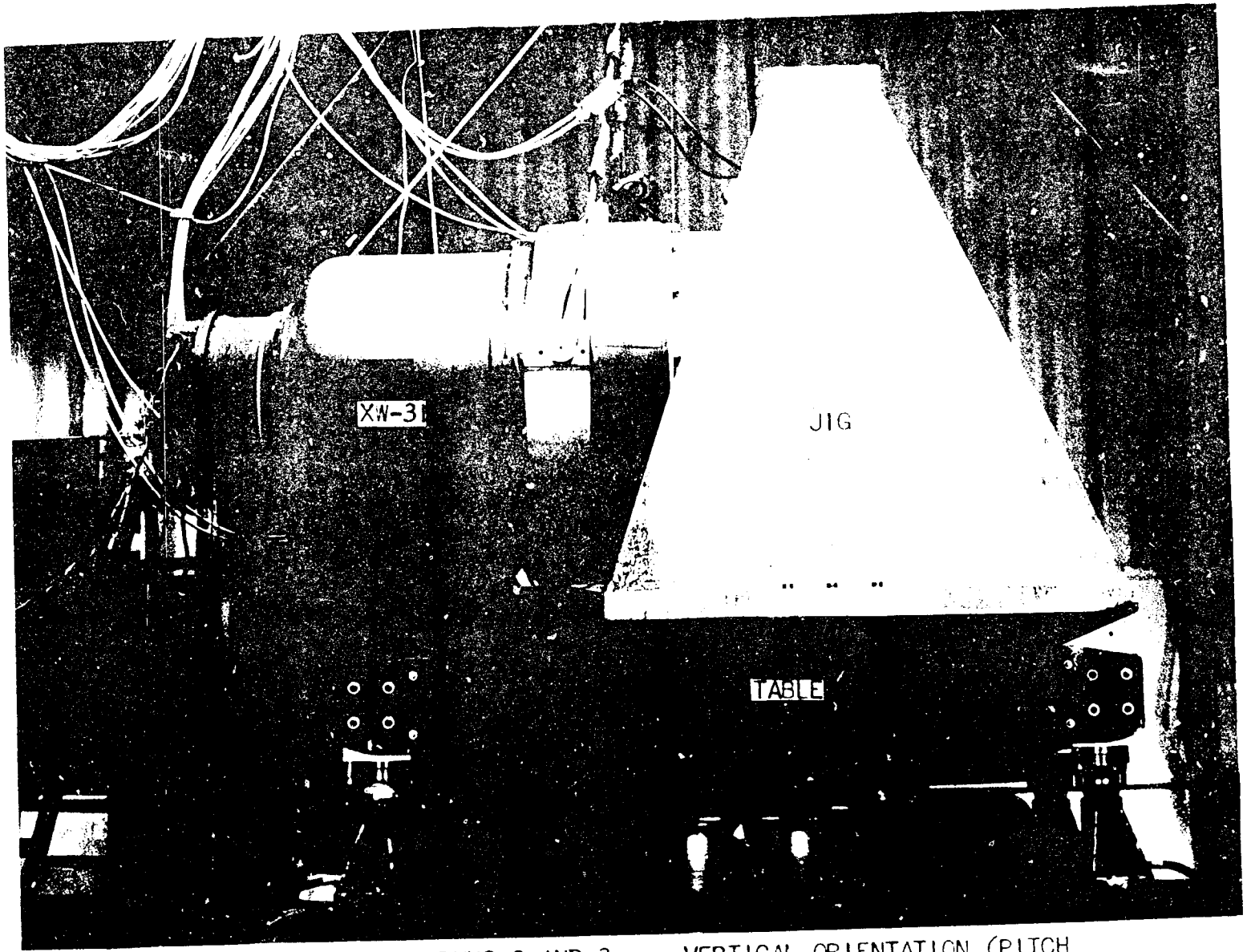

FIG. 2 --- SETUP FOR RUNS 2 AND 3 --- VERTICAL ORIENTATION (PITCH PLANE) --- VIBRATION TEST OF THE XW-31

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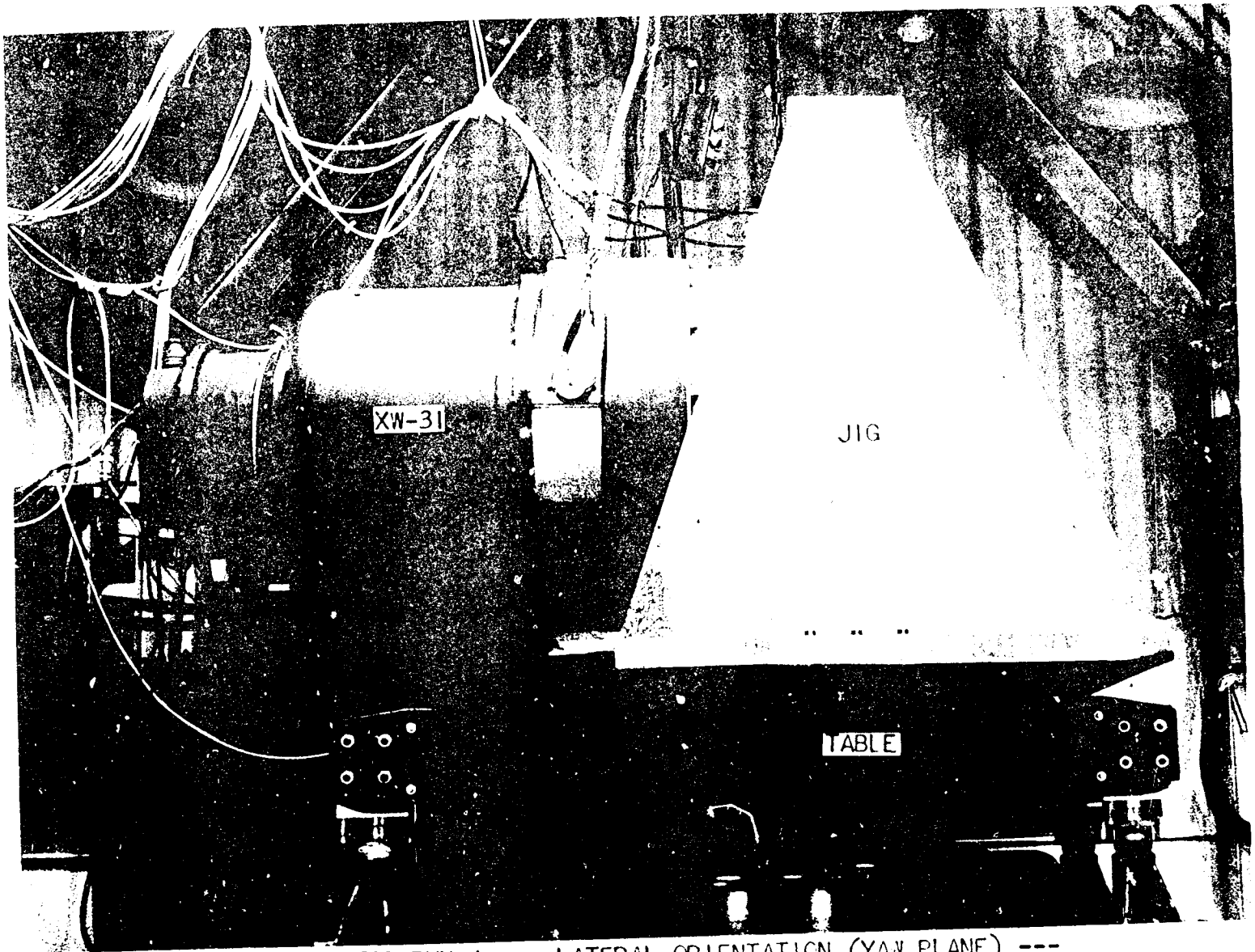

FIG. 3 --- SETUP FOR RUN 4 --- LATERAL ORIENTATION (YAW PLANE) ---
VIBRATION TEST OF THE XW-31

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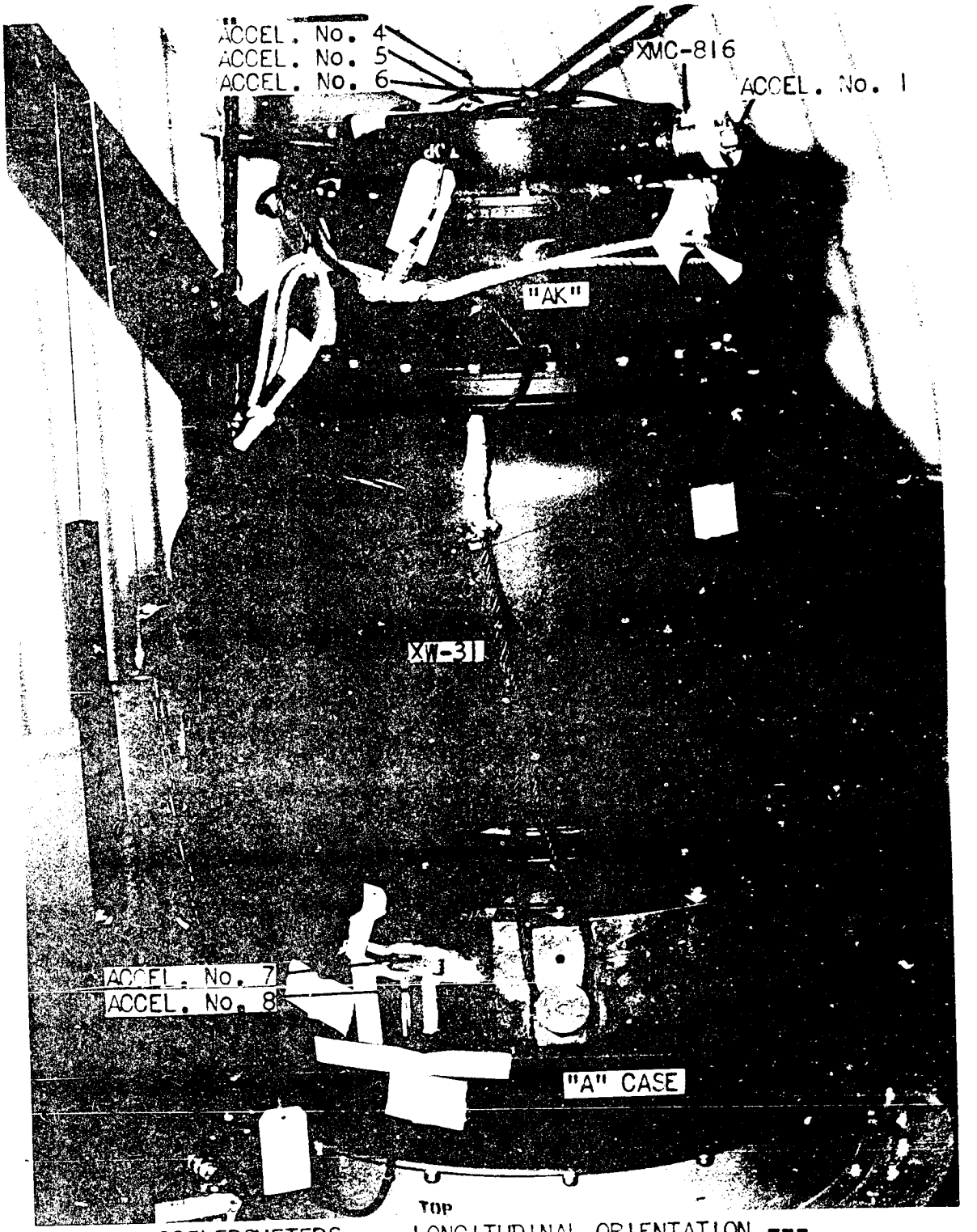

FIG. 4 --- ACCELEROMETERS --- LONGITUDINAL ORIENTATION --- VIBRATION TEST OF THE XW-31

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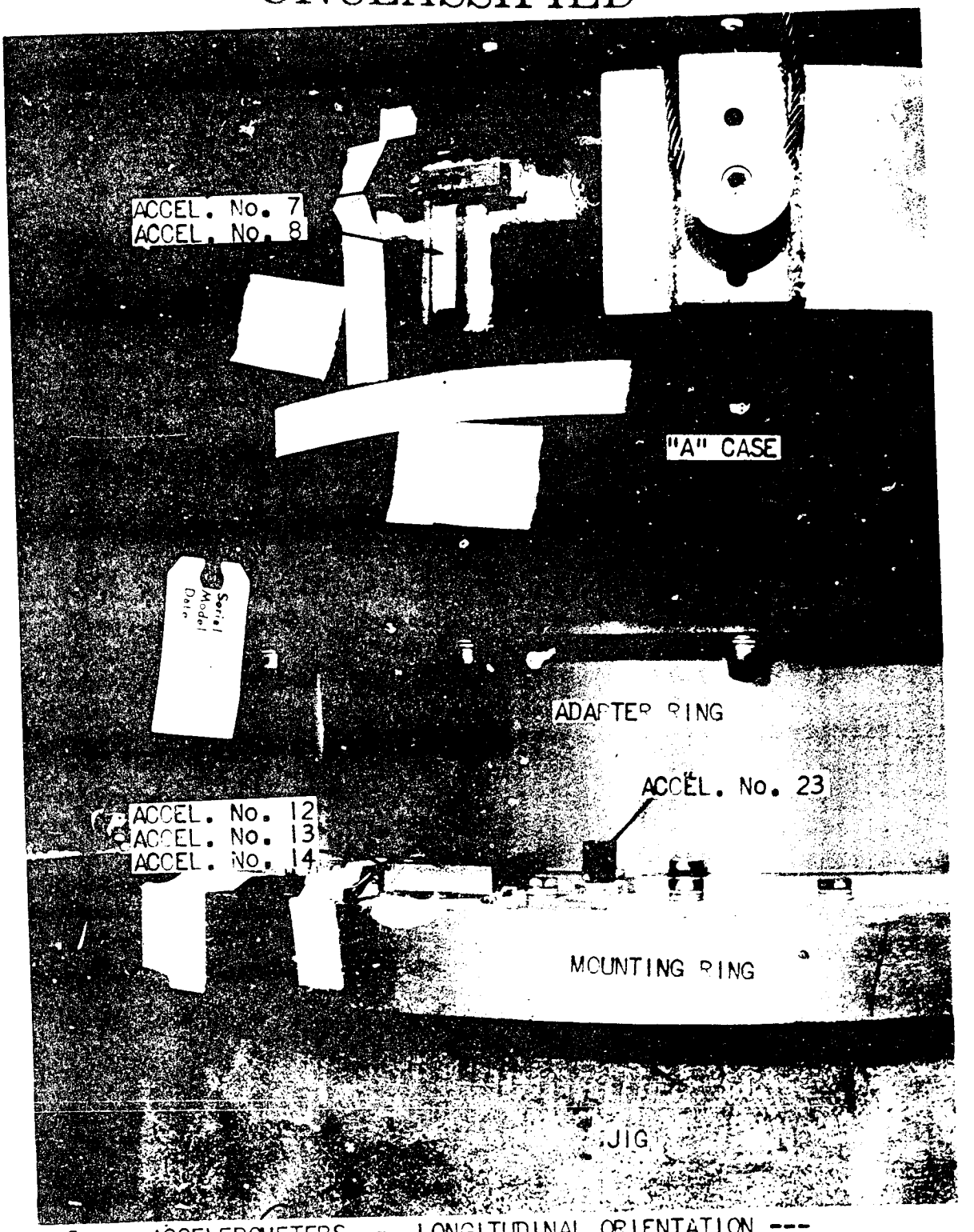

FIG. 5 --- ACCELEROMETERS --- LONGITUDINAL ORIENTATION --- VIBRATION TEST OF THE XW-31

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FIG. 6 --- ACCELEROMETERS --- LONGITUDINAL ORIENTATION --- VIBRATION TEST OF THE XW-31

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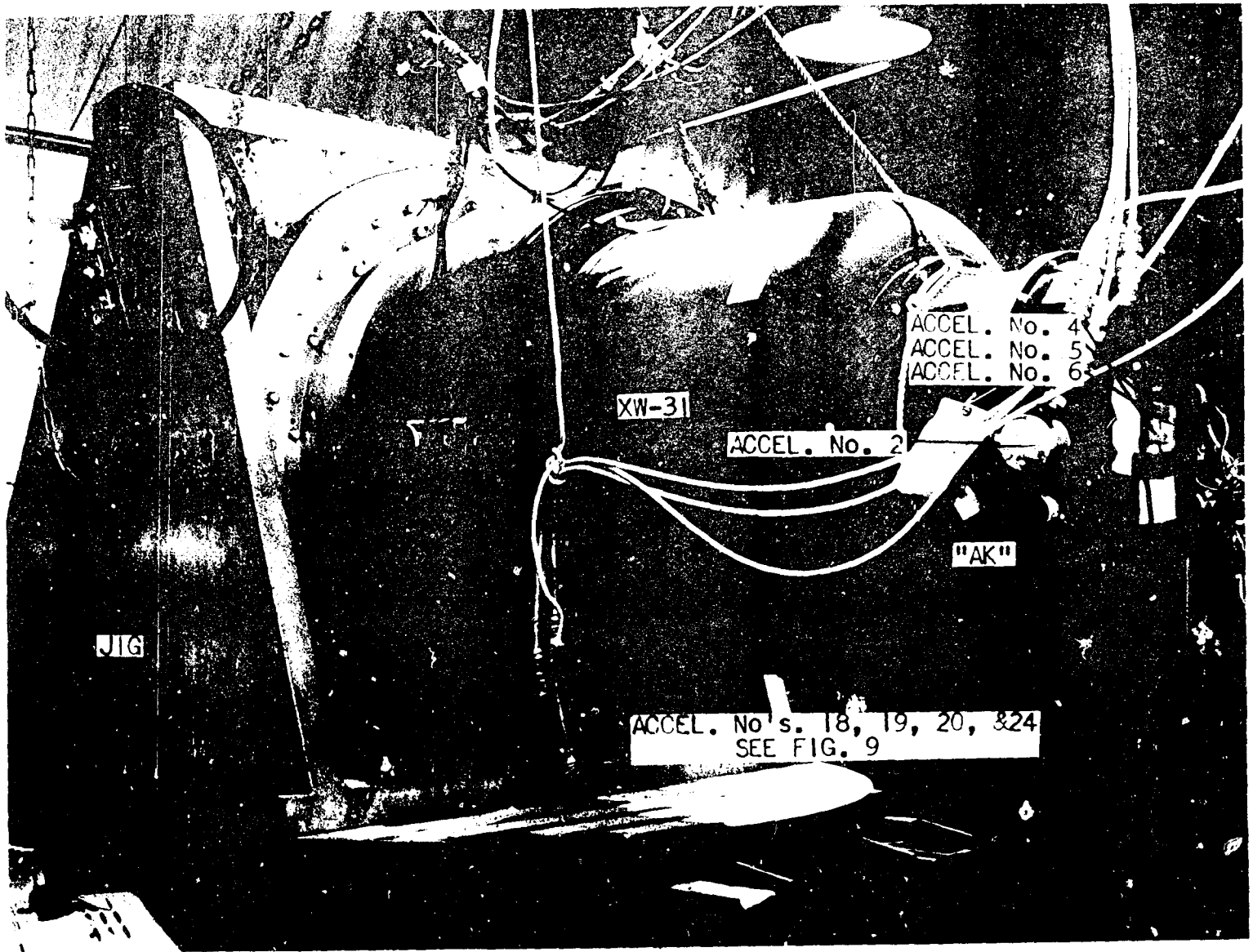

FIG. 7 --- ACCELEROMETERS --- VERTICAL ORIENTATION ---
VIBRATION TEST OF THE XW-31

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FIG. 8 --- ACCELEROMETERS --- VERTICAL ORIENTATION ---
VIBRATION TEST OF THE XW-31

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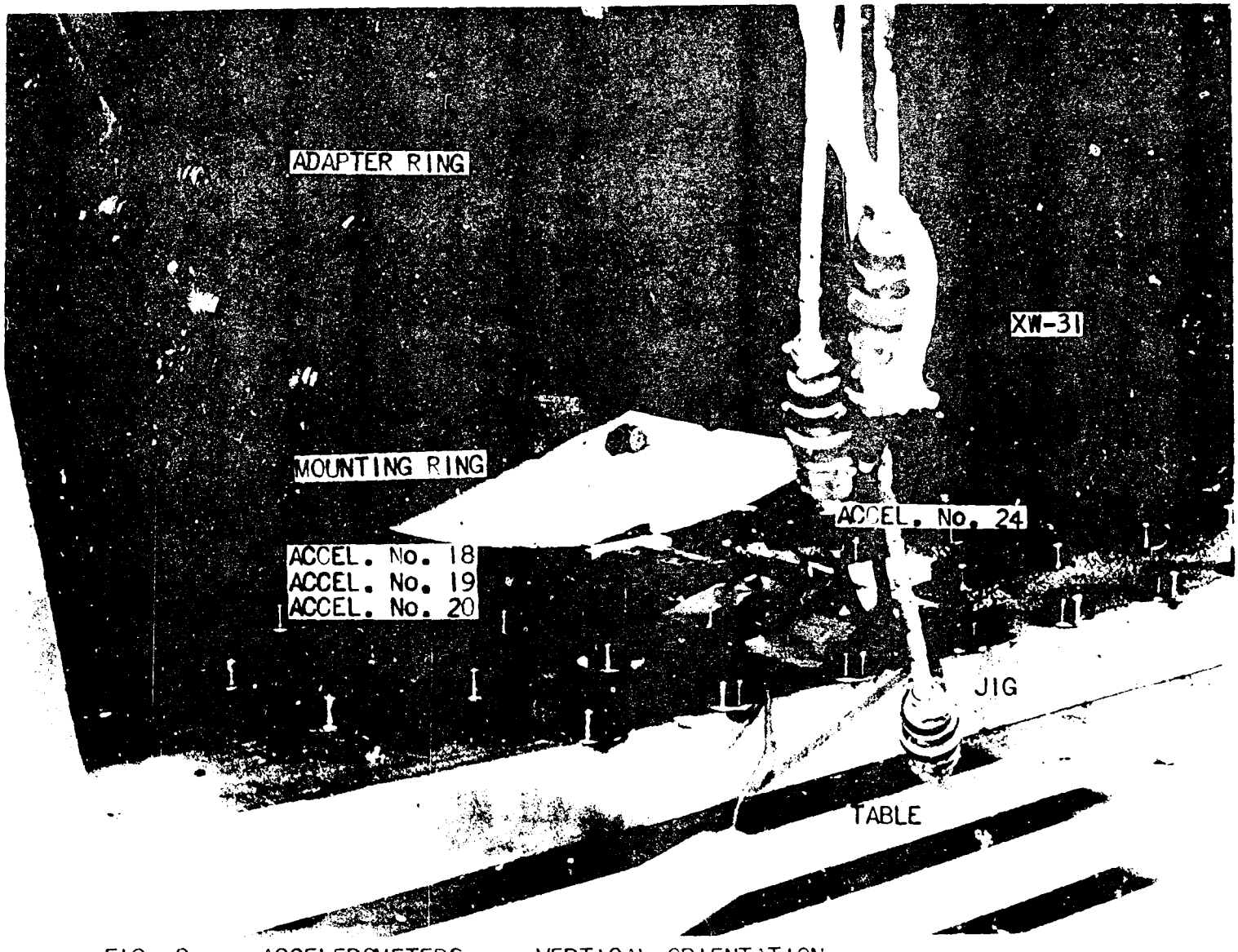

FIG. 9 --- ACCELEROMETERS --- VERTICAL ORIENTATION ---
VIBRATION TEST OF THE XW-31

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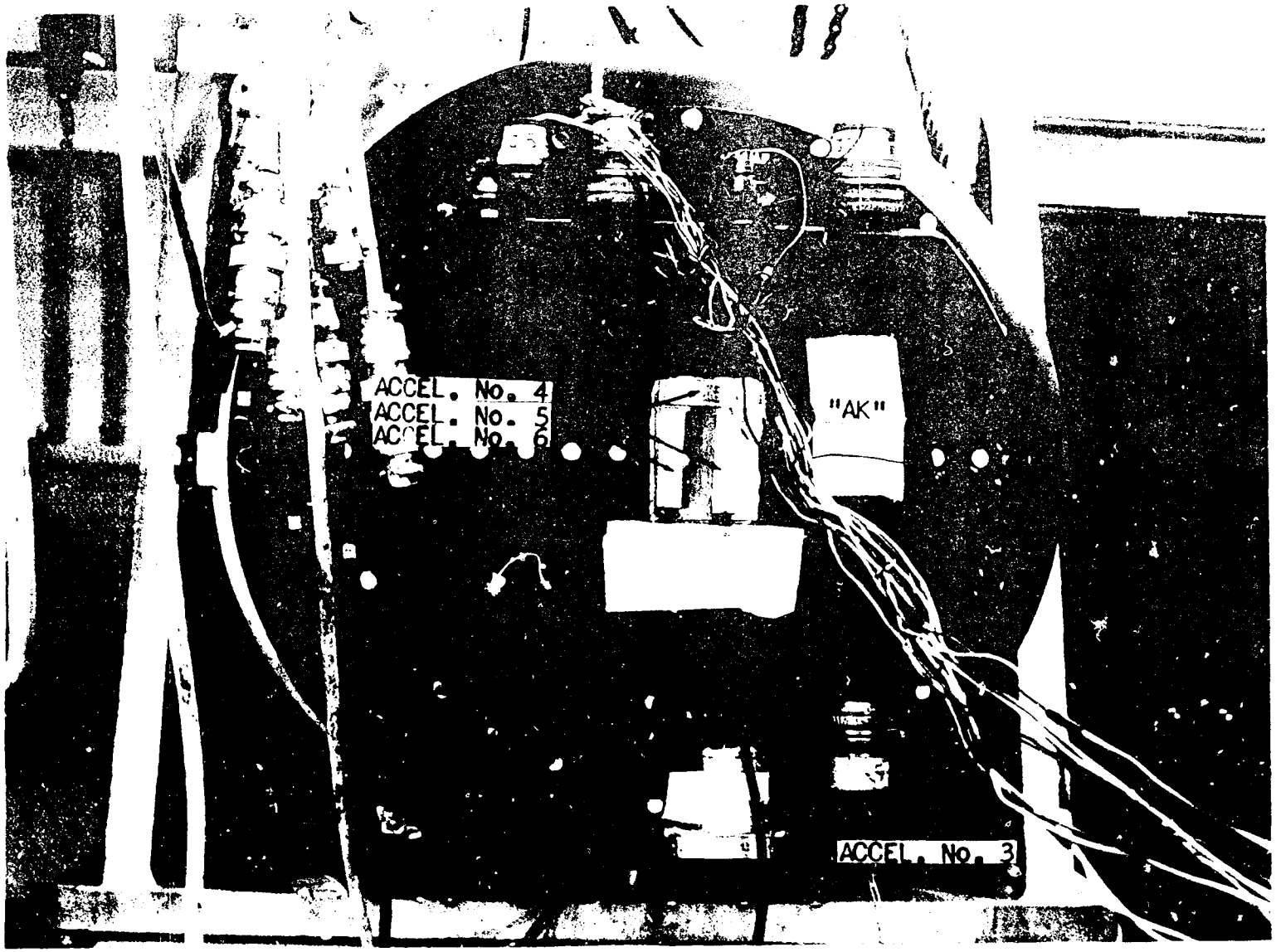

FIG. 10 --- ACCELEROMETERS --- LATERAL ORIENTATION ---
VIBRATION TEST OF THE XW-31

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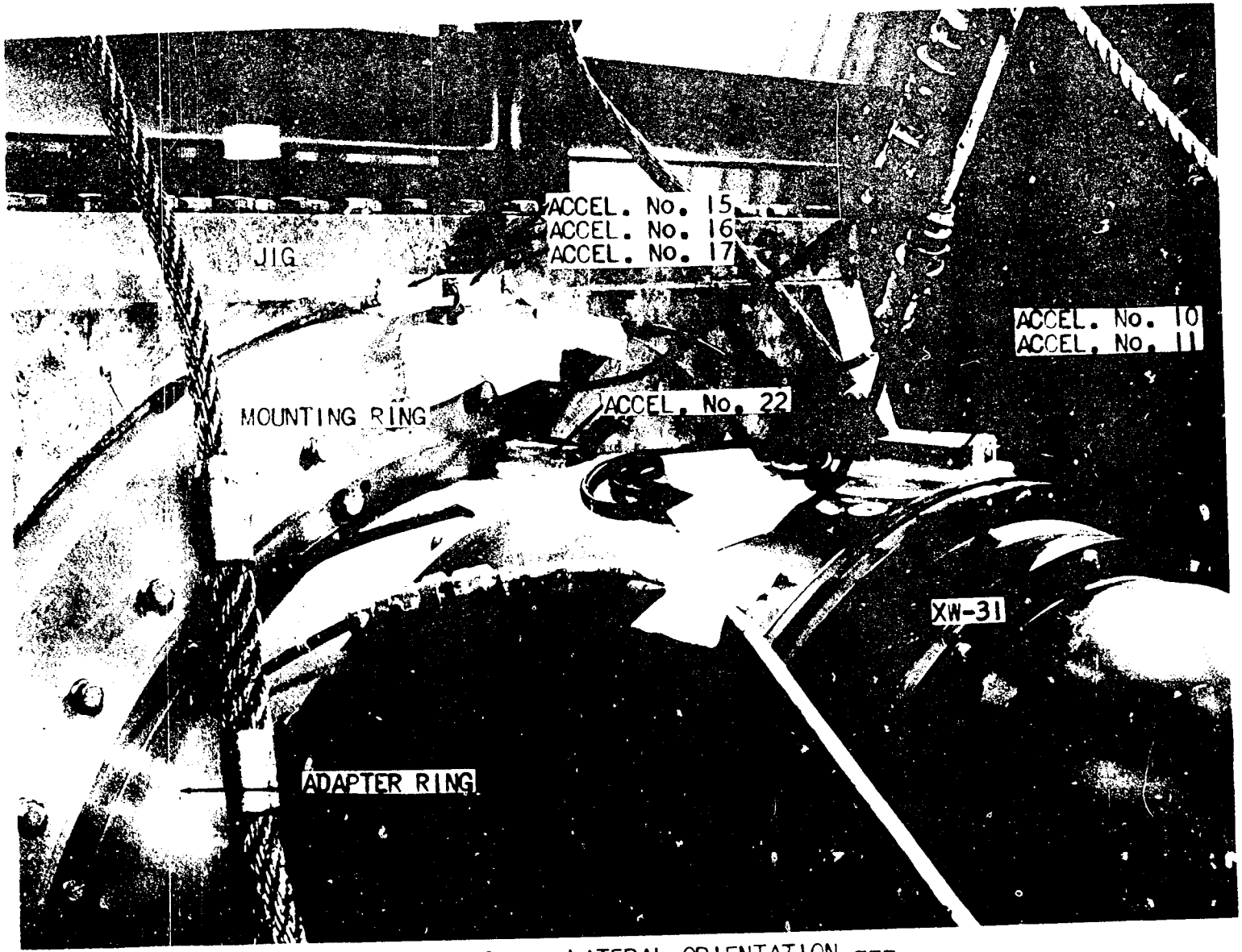

FIG. 11 --- ACCELEROMETERS --- LATERAL ORIENTATION ---
VIBRATION TEST OF THE XW-31

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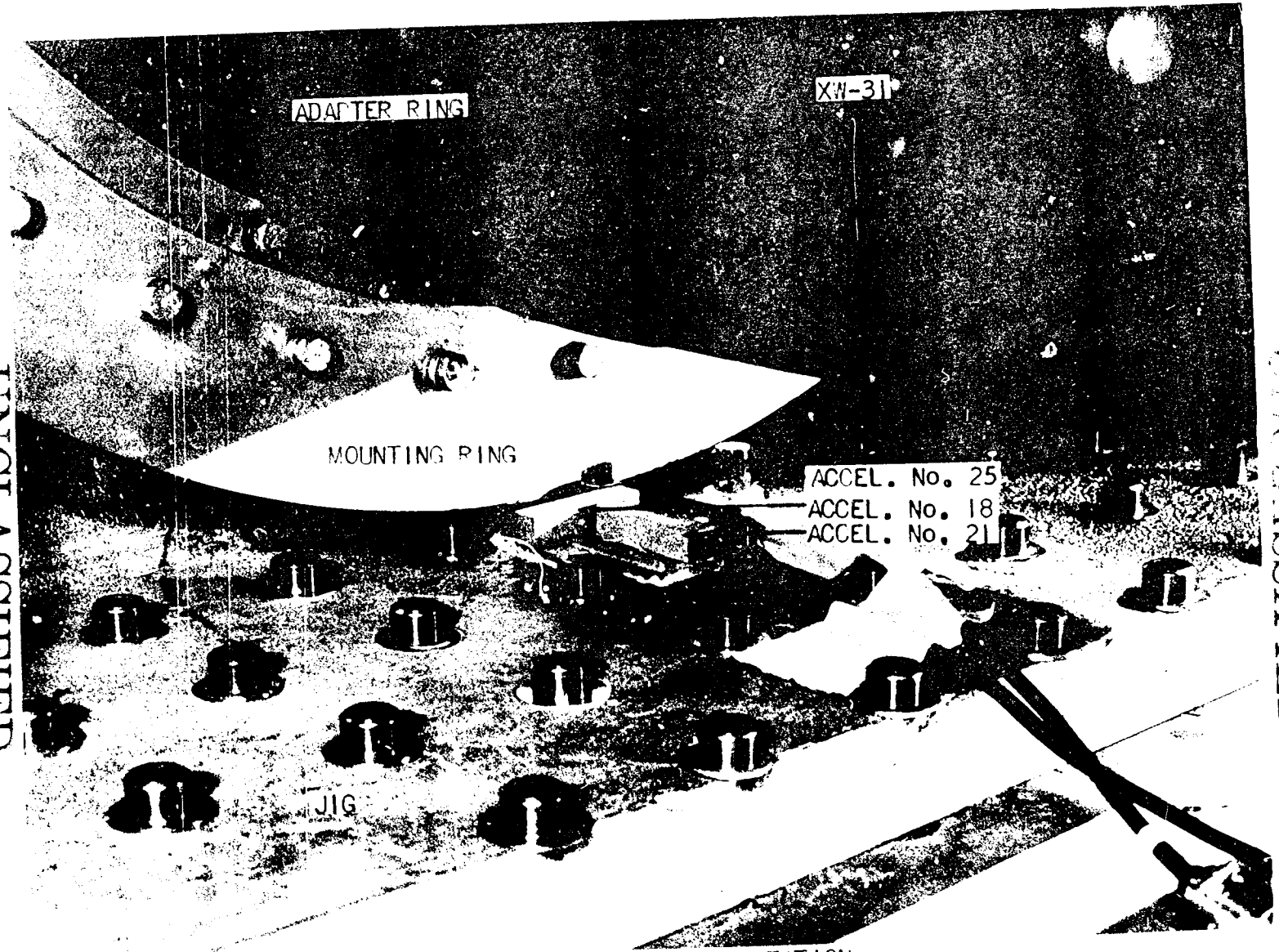

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FIG. 12 --- ACCELEROMETERS --- LATERAL ORIENTATION ---
VIBRATION TEST OF THE XW-31

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TABLE I - COMPONENTS TESTED - VIBRATION TEST OF THE XW-31

COMPONENT	DWG. NO.	SERIAL NO.
XW-31	300411	None
MC-661, Firing Set	310224	AA-1003-C7
MC-739, Case, H.E. Sphere	310339	AA-0048-B8
MC-745, Battery Pack, Thermal (2)	310345	AA-1011-H-7 AA-1003-G7
MC-891, Generator, Neutron (2)	310589	GC-100805-L7 GC-100825-A8
MC-742 Adaption Kit Components:		
MC-577 Safe-Arm Switch (2)	F-8785758	88-1 129-1
MC-586 Baroswitch (2)	D-8786200	AH-2127-C8 AH-2219-B8
MC-742 Adaption Kit	8801539	None
MC-743 Wiring Harness - Relay Assembly	F-8801593	None
XMC-816 Electrical Plug (Dummy)	8801519	1-2

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TABLE II - ACCELEROMETERS USED - VIBRATION TEST OF THE XW-31

A - STATHAM ACCELEROMETERS

ACCEL. NO.	LOCATION & DIRECTION *		SERIAL NO.	STATHAM MODEL	NAT'L FREQ.	FIG. REF.
1	XMC-816 Plug	Long.	2387	FA-100-300	406	4
2	XMC-816 Plug	Vert.	2387	FA-100-300	406	7
3	XMC-816 Plug	Lat.	2387	FA-100-300	406	10
4	MC-742	Long.	2380	FA-50-300	-	4,7,10
5	MC-742	Vert.	2382	F-50-300	-	4,7,10
6	MC-742	Lat.	2381	F-50-300	-	4,7,10
7	"A" Case at 0°	Long.	2076	F-50-300	4,5	
8	"A" Case at 0°	Vert.	1376	F-50-300	470	4,5,6
9	"A" Case at 0°	Lat.	2076	F-50-300	-	8
10	"A" Case at 90°	Vert.	2076	F-50-300	-	11
11	"A" Case at 90°	Lat.	1376	F-50-300	470	11
12	Mounting Ring-0°	Long.	2869	A6A-50-350	276	5,8
13	Mounting Ring-0°	Vert.	2870	A6A-50-350	285	5,8
14	Mounting Ring-0°	Lat.	2872	A6A-50-350	290	5,8
15	Mounting Ring-90°	Long.	2869	A6A-50-350	276	11
16	Mounting Ring-90°	Vert.	2870	A6A-50-350	285	11
17	Mounting Ring-90°	Lat.	2872	A6A-50-350	290	11
18	Jig	Long.	2808	A6A-100-350	375	6,9,12
19	Jig	Vert.	2874	A6A-50-350	300	6,9
20	Jig	Lat.	2314	F-100-350	700	6,9
21	Jig	Lat.	2874	A6A-100-350	300	12
22	Adapter Ring at 90°	Lat.	2314	F-100-350	700	11

B - ENDEVCO ACCELEROMETERS

				ENDEVCO MODEL		
23	Jig	Long.	3584	2213		5
24	Jig	Vert.	3584	2213		9
25	Jig	Lat.	4542	2213		12

* Directions are with respect to warhead axes.

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TABLE III - MAXIMUM PEAK-TO-PEAK ACCELERATIONS WITH CORRESPONDING AMPLIFICATION FACTORS AND RESPONSE RATIOS AND THE FREQUENCIES AT WHICH THEY OCCURRED - VIBRATION TEST OF THE XM-31

ACCEL NO.	LOCATION AND DIRECTION *		ACCEL. S. N.	RUN #1 - LONG. PEAK-TO-PEAK ACC. (g)	RUN #1 - LONG. A. F.'S AND RESPONSE RATIOS	RUN #1 - LONG. FREQ. OF MAX. ACC. (CPS)	RUN #3, VERT. PEAK-TO-PEAK ACC. (g)	RUN #3, VERT. A.F.'S AND RESPONSE RATIOS	RUN #3, VERT. FREQ. OF MAX. ACC. (CPS)	RUN #4, LAT. PEAK-TO-PEAK ACC. (g)	RUN #4, LAT. A.F.'S & RESPONSE RATIOS	RUN #4, LAT. FREQ. OF MAX. ACC. (CPS)
1	XMC-816 Plug	Long.	2387	>250	>23	210	~	~	~	~	~	~
2	XMC-816 Plug	Vert.	2387	~	~	~	140	28	166	47	9.4	131
3	XMC-816 Plug	Lat.	2387	~	~	~	~	~	~	23	4.6	230
4	MC-742	Long.	2380	100	9.1	210	180	36	166	20	4.0	168
5	MC-742	Vert.	2382	31	2.8	210	94	19	166	62	12	172
6	MC-742	Lat.	2381	30	2.7	210	15	3.0	166	~	~	~
7	"A" Case at 0°	Long.	2076	19	1.7	210	~	~	~	~	~	~
8	"A" Case at 0°	Vert.	1376	4.4	0.4	210	17	3.1	366	~	~	~
9	"A" Case at 0°	Lat.	2076	~	~	~	4.0	0.7	366	~	~	~
10	"A" Case at 90°	Vert.	2076	~	~	~	~	~	~	3.0	0.6	177
11	"A" Case at 90°	Lat.	1376	~	~	~	~	~	~	3.8	0.8	168
12	Mounting Ring 0°	Long.	2869	11	1.0	210	37	6.8	366	~	~	~
13	Mounting Ring 0°	Vert.	2870	6.8	0.6	210	2.2	0.6	418	~	~	~
14	Mounting Ring 0°	Lat.	2872	1.8	0.2	210	50	14	397	~	~	~
15	Mounting Ring 90°	Long.	2869	~	~	~	~	~	~	10	2.0	366
16	Mounting Ring 90°	Vert.	2870	~	~	~	~	~	~	15	4.3	392
17	Mounting Ring 90°	Lat.	2872	~	~	~	~	~	~	61	17	392
18	Jig	Long.	2808	11	1.0	210	22	4.4	188	14	2.8	183
19	Jig	Vert.	2874	1.8	0.2	210	10	1.0	85	~	~	~
20	Jig	Lat.	2314	2.3	0.2	210	3.5	0.7	170	~	~	~
21	Jig	Lat.	2874	~	~	~	~	~	~	8.0	1.0	202
22	Adapter Ring 90°	Lat	2314	~	~	~	~	~	~	59	12	366
23	Jig	Long.	3584	8.0	0.7	210	7.5	0.8	85	~	~	~
24	Jig	Vert.	3584	~	~	~	~	~	~	~	~	~
25	Jig	Lat.	4642	~	~	~	~	~	~	5.0	0.6	202

~ Accelerometer not read this run.
No oscillograph records were obtained during Run 2.

* Directions are with respect to warhead axes.