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JUL 10 1957
Case No. 661.00
Ref. Sym: 1612 (429)
Project No. TM-493
File: XH-541, 3-2

MR. L. A. DUNN - 1284

Re: Drop and Vibration Test of the XH-541

Summary of Results

Drop tests as per SCS-5, 3.4.1, and vibration tests in a longitudinal and lateral plane were conducted, in the order mentioned, on an XH-541 containing an XW-31 dummy warhead, to determine if the H-541 is adequately designed to meet handling and shipping requirements. The vibration test was as per SCS-5, 2.6 in the longitudinal plane. In the lateral plane, vibration tests were conducted for five minutes only.

No damage was done during the drop tests, as indicated from a visual inspection. During the vibration tests in the lateral plane, excessive vibration amplitude at a resonant frequency of 18 to 22 cps, indicated that damage to the XH-541 was imminent. For this reason, the consultant requested a one-minute cycling period instead of the specified 10-minute cycling period, in order to pass through resonance more rapidly; consequestly, the recorded accelerations on the unit may not have reached their peak values. The test was stopped after approximately five minutes of cycling, upon request of the consultant. The sheet metal welded to the bottom of the XH-541 was vibrated loose on one side. No damage resulted during the vibration tests in the longitudinal plane. The unit was inspected visually only.

Maximum measured faired vertical acceleration in the vertical plane of the XW-31 CG during the drop tests was 8.9 g. Maximum amplification factors determined during the vibration tests were 3.43 at 11.8 cps in the longitudinal plane and 2.9 at 18 cps in the lateral plane. Amplification factor was calculated as the ratio between the maximum plus to minus acceleration recorded at the plane of the XW-31 CG and the maximum plus to minus input acceleration to the vibration table; both accelerations were measured parallel to the vibratory motion.

During the vibration test in the lateral plane, the magnitude of the accelerations recorded peaked markedly at approximately 18 cps. With an input of 3.8 g to the vibration table, accelerations of 25.1 g laterally and 21.4 g vertically were recorded on the XH-541 cradle, and 11.0 g was recorded laterally in the plane of the XW-31 CG. All accelerations were measured maximum plus to minus values.

THIS DOCUMENT CONSISTS OF 17 PAGE(S)

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Object of Test

The object of this test was to determine if the H-541 is adequately designed to meet simulated handling and shipping conditions, as specified in SCS-5, 3.4.1 and SCS-5, 2.6.

Reason for Test

This test was requested in a Request for Materials Laboratory Investigation from L. A. Dunn, 1284, to P. H. Adams, 1612, dated January 9, 1957.

Function of Object Tested

The XH-541 is a shipping and storage container for the XW-31 warhead.

Summary of Past Tests

No previous drop or vibration tests on the XH-541 have been conducted by Division 1612.

Setup for Test

Figures 1 and 2 show the XH-541 in drop position.

Figures 3 and 4 show the XH-541 mounted on the Sonntag vibration table for vibration in the longitudinal and lateral planes, respectively.

The components tested consisted of an XH-541 shipping and storage can, Drawing No. 321194, and an XW-31 Ballistic mockup of warhead, Drawing No. DS(1333)52369.

Test equipment used was as follows:

William Miller Oscillograph, Model J, Serial No. 99
William Miller Amplifiers, Type C-3, Model CA-12, Serial No. 7.
Sonntag Vibration Table No. 3, 10 to 60 cps.
William Miller Oscillograph, Model H, Serial No. 198.
Hathaway Amplifiers, Type MRC-21, Serial No. 5492-1.

Accelerometers used during all tests are listed in Table I and shown in Figs. 1 through 4.

Procedure

Drop tests as per SCS-5, 3.4.1, were performed on the XH-541 and contained dummy XW-31. Accelerometers were mounted on the XH-541 and XW-31 as shown

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in Figs. 1 and 2. A chain hoist was fastened to a four-arm cable sling with turnbuckles attached to the XH-541 for leveling. The XH-541 was raised to the proper heights, released by means of a quick-release mechanism, and allowed to impact on the concrete floor. Accelerations were recorded from accelerometers A-1 through A-4.

After the drop tests, the XH-541 was mounted on the Sonntag vibration table, first with the longitudinal axis of the unit parallel to the vibratory motion (Fig. 3). The double-amplitude table displacement varied between 0.058 and 0.060 inches. Four 12-minute cycle vibration tests were run with a frequency input of 10 to 55 cps. Accelerations were recorded from accelerometers A-5 through A-11.

The H-541 was next mounted on the Sonntag vibration table with the lateral axis of the unit parallel to the vibratory motion (Fig. 4). The input frequency was varied between 10 and 55 cps with a double amplitude displacement of 0.058 to 0.060 inches. The test was stopped upon request of the consultant after approximately five minutes of cycling, because at a resonant frequency of 18 - 22 cps, the vibration amplitude of the system indicated that further vibration would result in damage to the unit. At the consultant's request, a one-minute cycling period was used instead of the specified 10-minute period, so that the resonant frequency could be passed through more rapidly.

Accelerations were recorded by accelerometers A-8, A-9, A-12, A-13, and A-14.

Results

No visual damage resulted to the XH-541 or the contained dummy XW-31 from the drop tests. The unit was visually inspected only.

Accelerations, rise times, and pulse durations recorded during the drop tests are recorded in Table II.

Figure 5 shows a typical oscillograph record of the drop tests.

During the vibration tests, no damage was done when vibrating the unit longitudinally. However, during the vibrations in the lateral plane, excessive vibration amplitude of the system at an input frequency of approximately 18 - 22 cps indicated that damage was imminent; therefore, the test was terminated after about five minutes of cycling. Also upon request, a one-minute cycling period was used rather than the 10-minute period so that the resonant frequency could be passed through rapidly; therefore, the accelerations recorded on the unit may not have reached their peak values at resonance. During this cycling time, the sheet metal fastened to the base of the XH-541 by spot welding was vibrated loose on one side (Fig. 6).

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Figure 7 is a plot of amplification factor versus frequency calculated for vibration tests in both planes. Tables III and IV list accelerations recorded at different frequencies during the longitudinal and lateral vibration test. The highest accelerations were recorded during the lateral vibration test. They were 25.1 g laterally and 21.4 g vertically on the XH-541 cradle, with an input acceleration on the vibration table of 3.8 g. At the same frequency, 11.0 g lateral was measured in the vertical-lateral plane of the XW-31 CG.

Figures 8 and 9 are typical oscillograph records of the vibration tests in the longitudinal and lateral planes, respectively.

Conclusions

The XH-541 is adequately designed to meet the requirements of SCS-5, 3.4.1, drop tests. The unit will pass the requirements of SCS-5, 2.6, vibration tests in a longitudinal plane. It was not vibrated as per SCS-5, 2.6, in the lateral plane, because at a resonant frequency of approximately 18 to 22 cps, the vibration amplitude of the system increased to such a magnitude that damage appeared imminent. For this reason, at the consultant's request, a one-minute cycling time was used rather than the specified 10-minute period, and the test was stopped after only five minutes of vibration. It is very unlikely that the XH-541 would have passed a vibration test as per SCS-5, 2.6, in the lateral plane.

G. M. WILLSON - 1612-1

Approved by: PAUL H. ADAMS - 1612

GMW:1612-1:as

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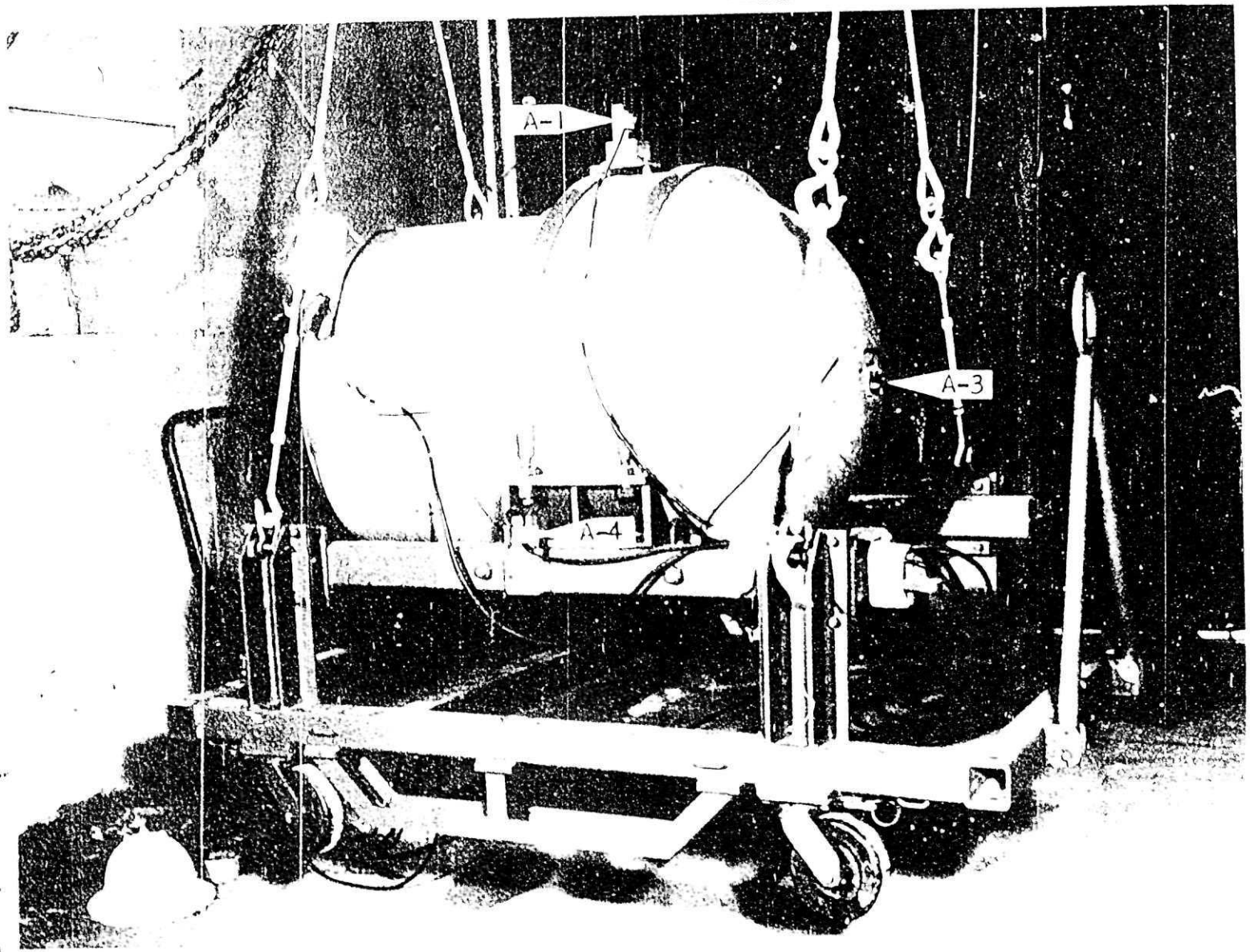

FIG. 1 XH-541 SUSPENDED IN DROP POSITION SHOWING SOME OF THE ACCELEROMETERS USED ---- DROP AND VIBRATION TEST OF THE XH-541.

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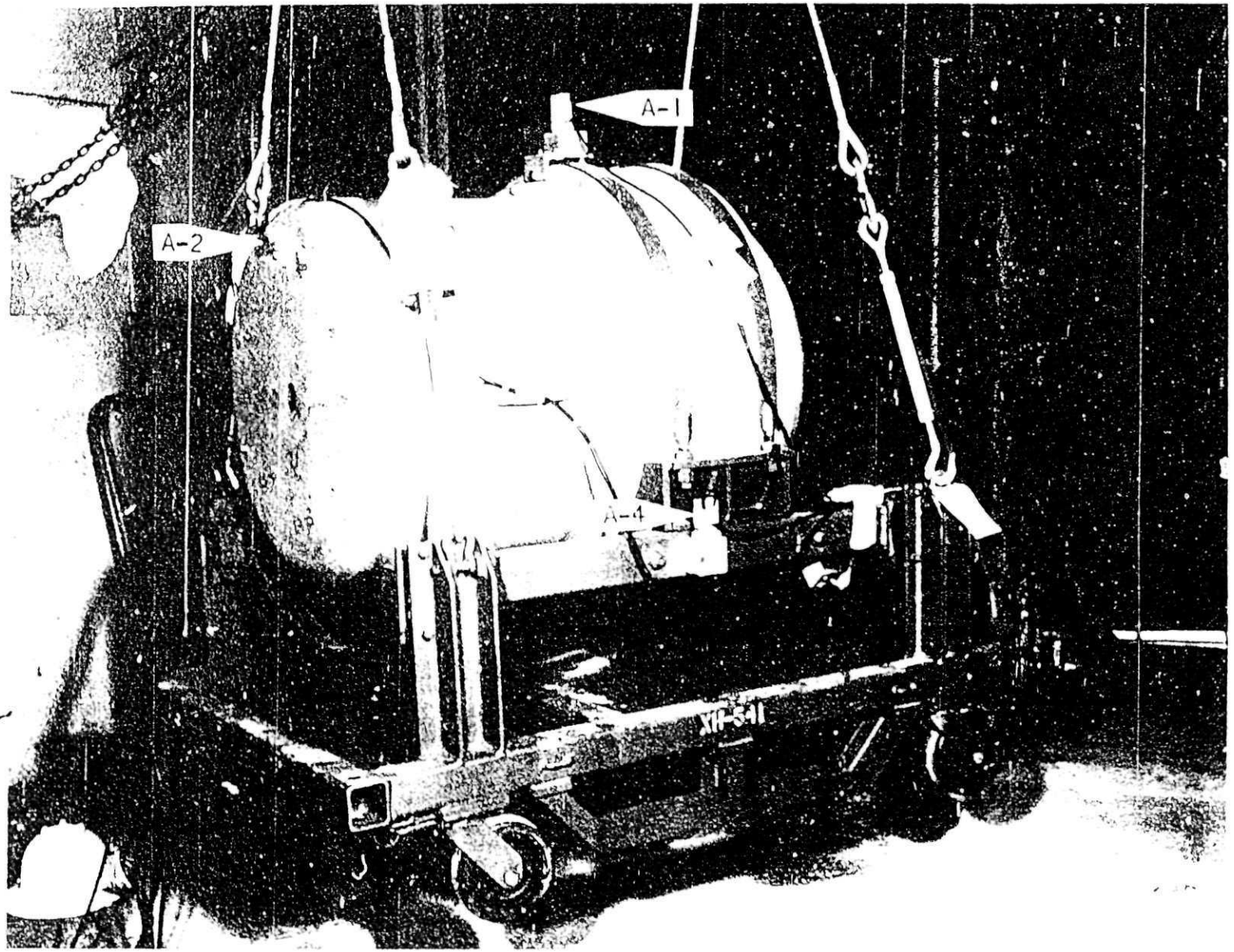

FIG. 2 XH-541 SUSPENDED IN DROP POSITION SHOWING SOME OF THE ACCELEROMETERS USED ---- DROP AND VIBRATION TEST OF THE XH-541.

REF. SYM. 1612(429)
TM-493

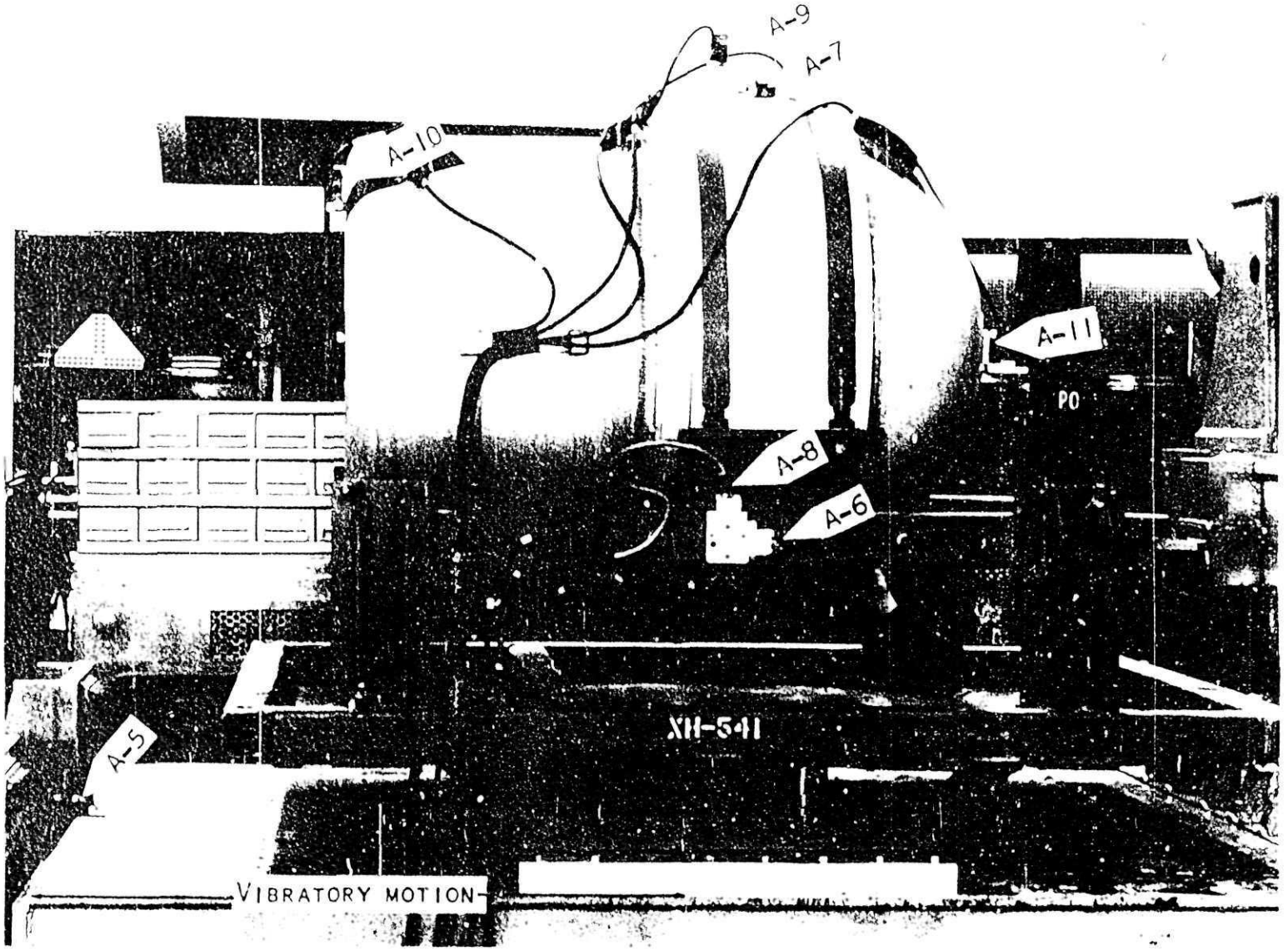

FIG. 3 XH-541 MOUNTED ON THE VIBRATION TABLE FOR THE LONGITUDINAL VIBRATION TEST----DROP AND VIBRATION TEST OF THE XH-541

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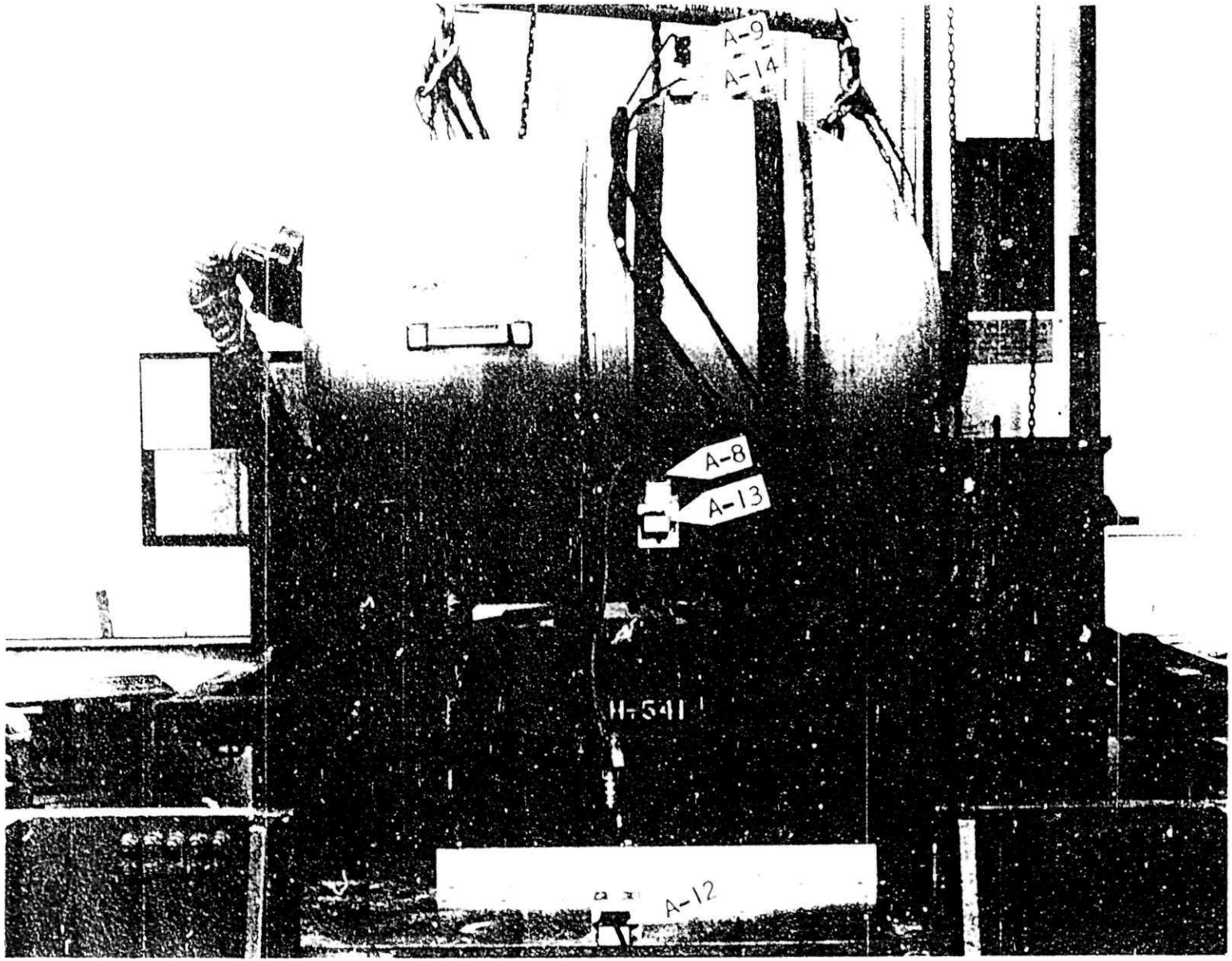

FIG. 4 XH-541 MOUNTED ON THE VIBRATION TABLE FOR THE LATERAL VIBRATION TEST----DROP AND VIBRATION TEST OF THE XH-541

REF. SYM. 1612(429)
TM-493

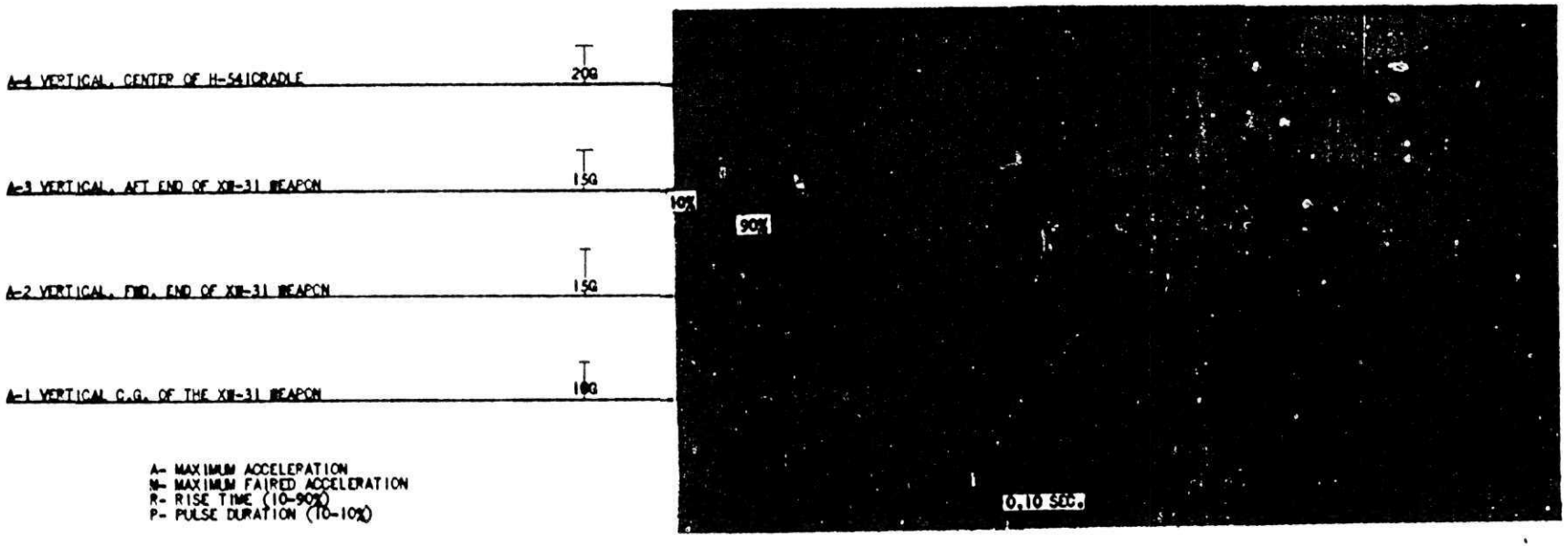

FIG. 5 TYPICAL OSCILLOGRAPH RECORD OF DROP TESTS OF THE M-541, (12 IN. DROP NO.3). DROP AND VIBRATION TEST OF THE M-541.

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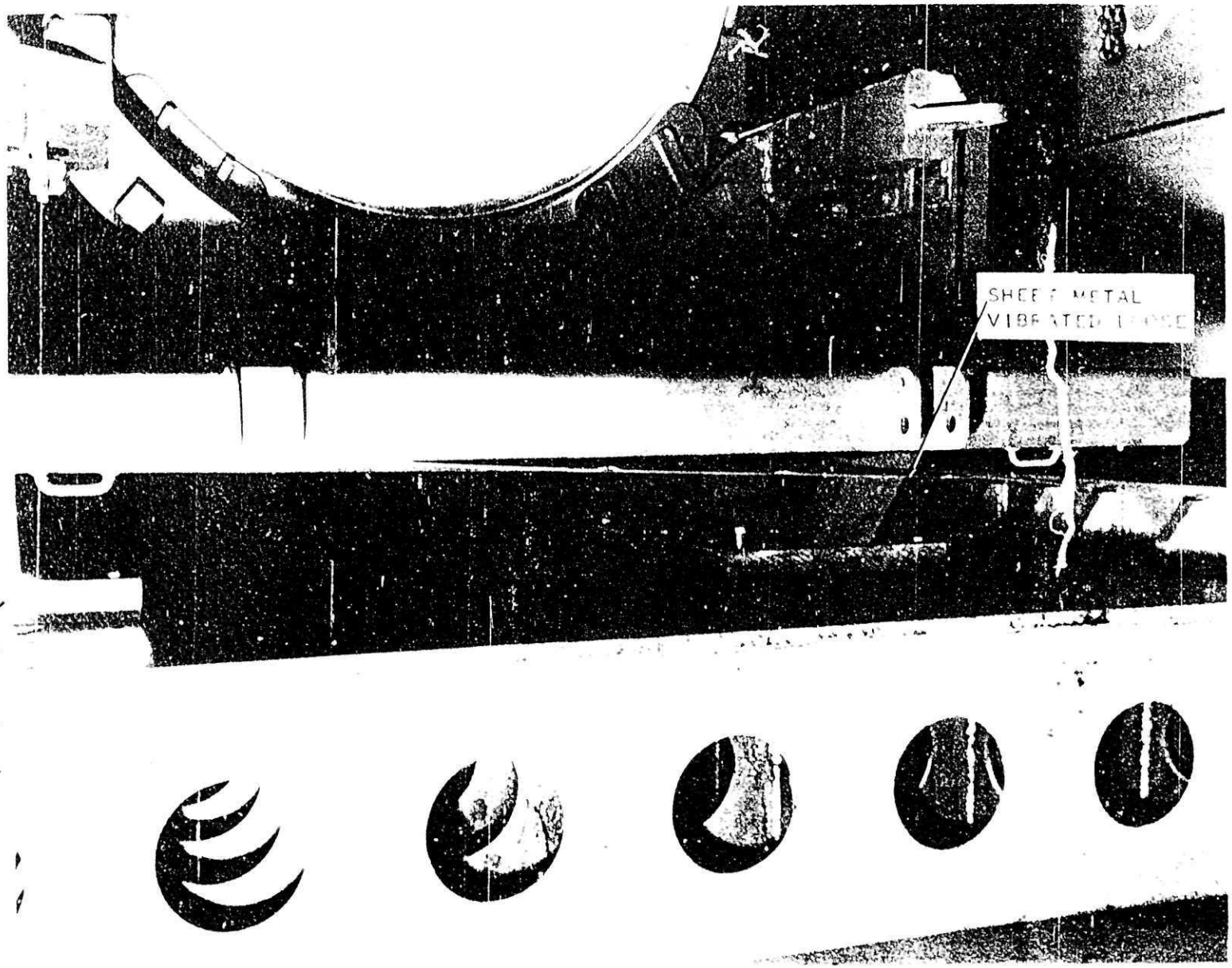

FIG. [illegible] VIEW SHOWING THE SHEET METAL CRACKED LOOSE FROM THE BASE OF THE [illegible] DURING THE LATERAL VIBRATION TEST -- DROP AND VIBRATION TEST OF THE [illegible]

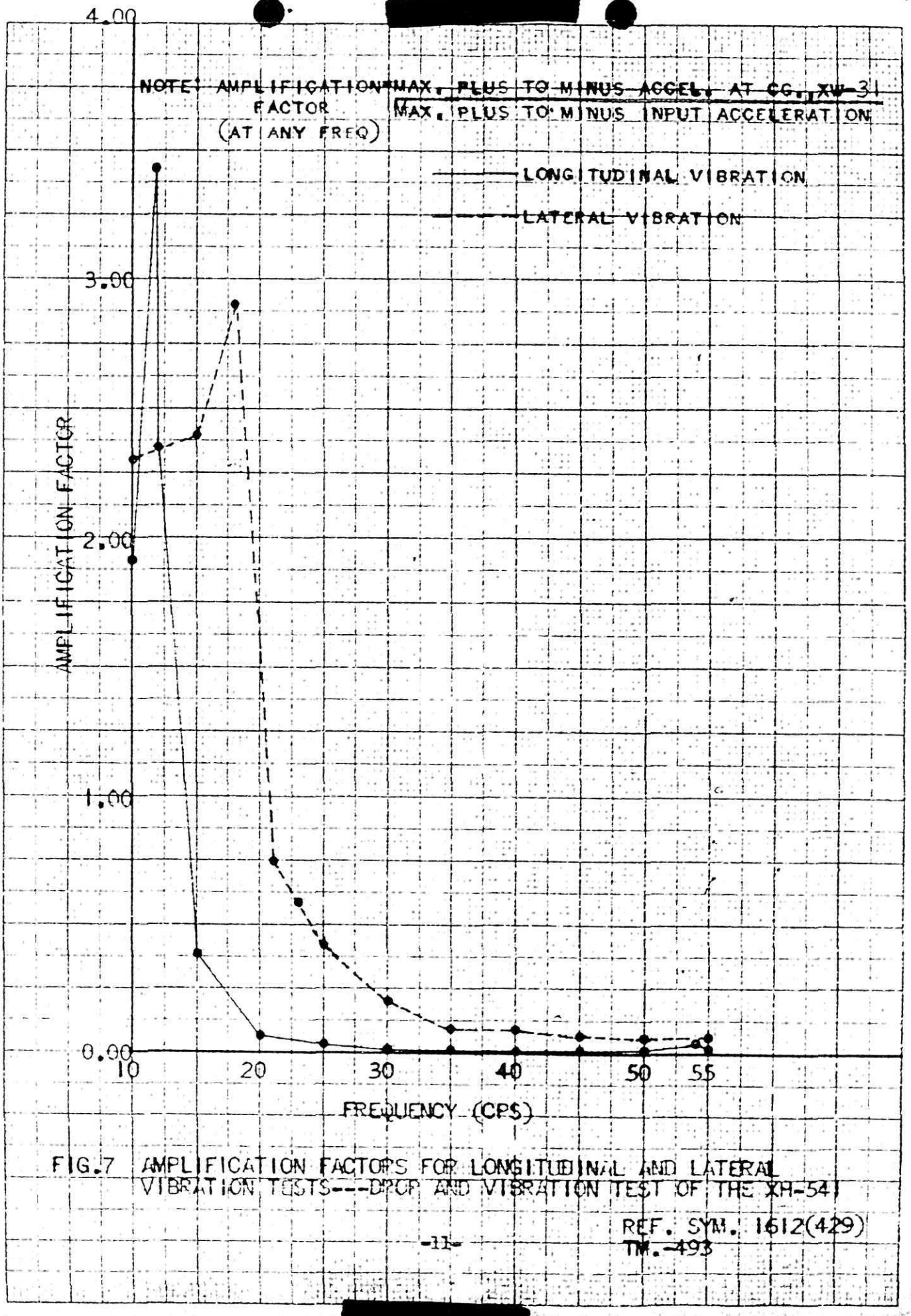

FIG. 7 AMPLIFICATION FACTORS FOR LONGITUDINAL AND LATERAL VIBRATION TESTS---DPCP AND VIBRATION TEST OF THE XH-541

REF. SYM. 1612(429)
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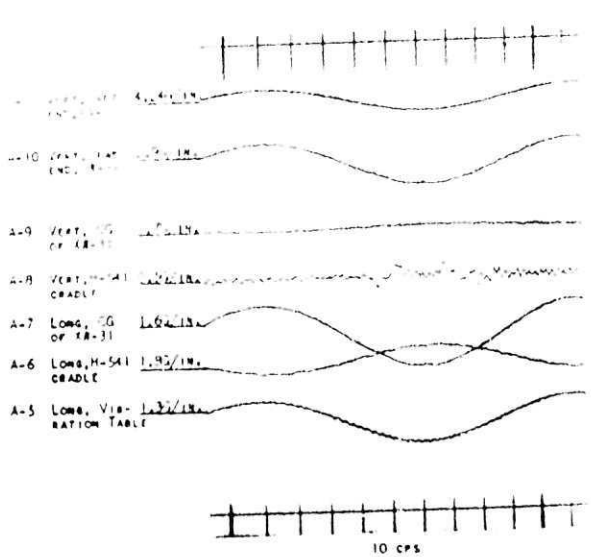
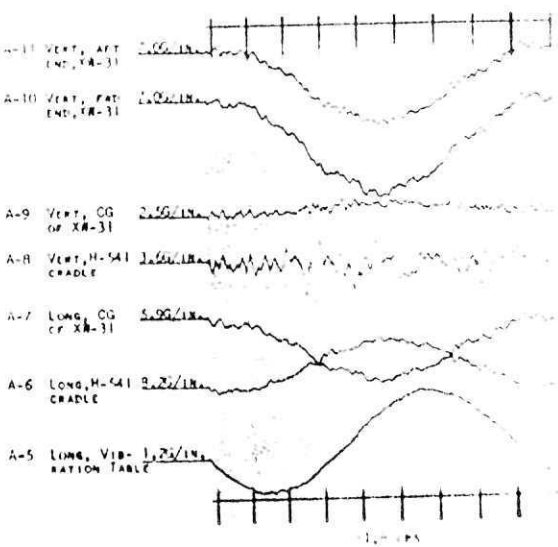
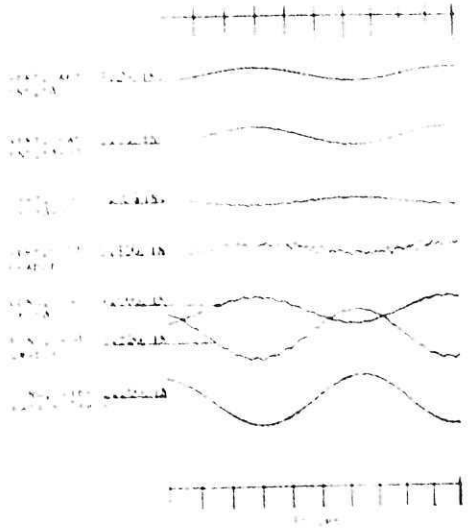
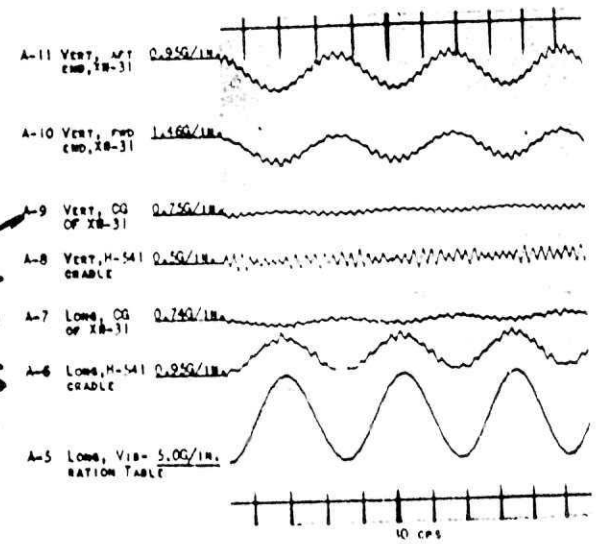
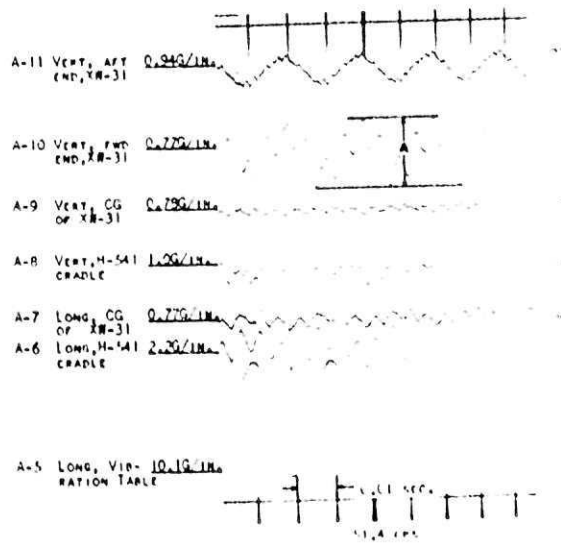
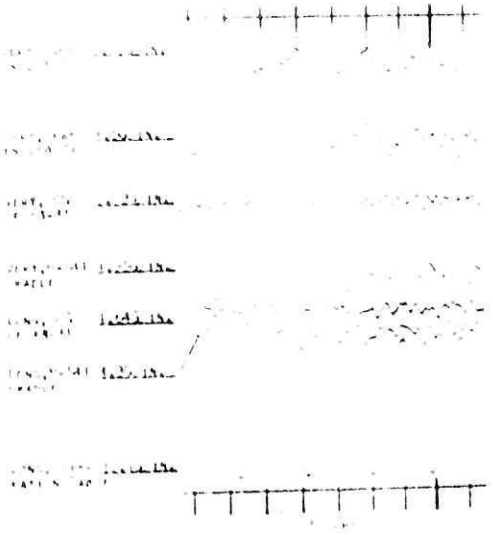










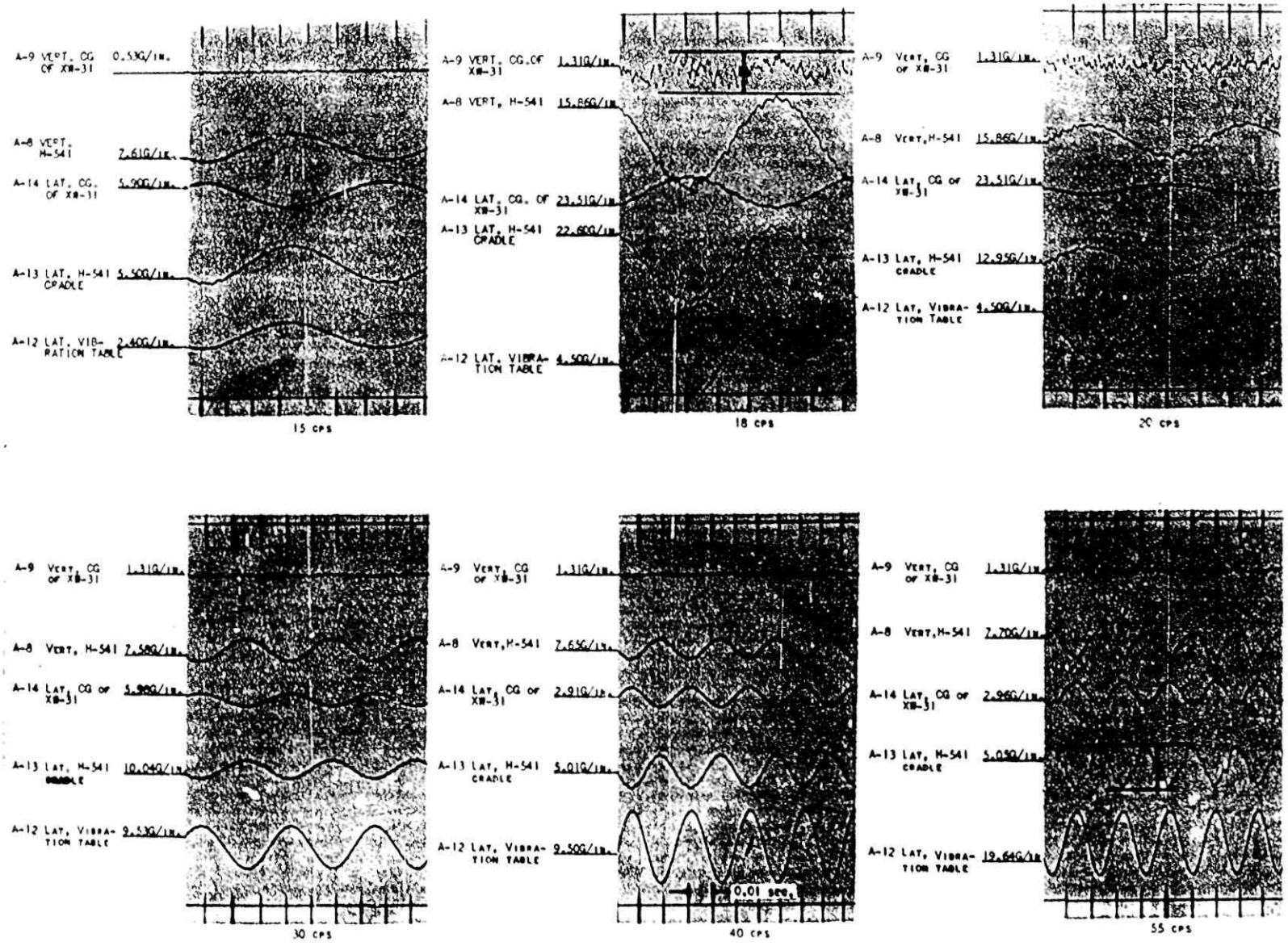


A = MAXIMUM ACCELERATION

NOTE: 1. ALL ACCELERATIONS ARE MEASURED MAXIMUM PLUS TO MAXIMUM MINUS VALUES

FIG. 8--TYPICAL OSCILLOGRAPH RECORDS OF LONGITUDINAL VIBRATION OF THE [illegible] AS VIBRATION IS [illegible] XR-541

REF. ENV. 1612(420) EC HCT [illegible] TV-403



A -- MAXIMUM ACCELERATION

NOTE: 1. ALL ACCELERATIONS WERE MEASURED MAXIMUM PLUS TO MAXIMUM MINUS VALUES

FIG. 9--TYPICAL OSCILLOGRAPH RECORDS OF LATERAL VIBRATIONS OF THE XH-541 ---DFDF AND VIBRATION TEST OF THE XH-541

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TABLE I

ACCELEROMETERS USED DURING DROP AND VIBRATION TEST OF THE XR-541

Accel. No.	Location*	Fig. Ref.	Serial No.	Statham Model No.	Range (g)	Natural Freq. (cps)	Test Used
A-1	Vert., Vert. Plane through CG of XW-31	1-2	632	A5A-100-350	±100	750	Drop Tests
A-2	Vert., Fwd. end, XW-31	2	2385	Fa-100-300	±100	360	Drop Tests
A-3	Vert., Aft End, XW-31	1	1301	F-100-300	±100	630	Drop Tests
A-4	Vert., XR-541 Cradle	1-2	633	A5A-100-350	±100	750	Drop Tests
A-5	Long., Vibration Table	3	1658	A5B-12-180	±12	370	Long. Vibration Tests
A-6	Long., XR-541 Cradle	3	1661	A5B-12-180	±12	325	Long. Vibration Tests
A-7	Long., Vert. Plane through CG of XW-31	3	1654	A5B-12-180	±12	350	Long. Vibration Tests
A-8	Vert., XR-541 Cradle	3-4	1655	A5B-12-180	±12	---	All Vibration Tests
A-9	Vert., Vert. Plane through CG of XW-31	3-4	1657	A5B-12-180	±12	360	All Vibration Tests
A-10	Vert., Fwd. End, XW-31	3	1663	A5B-12-180	±12	350	Long. Vibration Tests
A-11	Vert., Aft End, XW-31	3	1653	A5B-12-180	±12	---	Long. Vibration Tests
A-12	Lat., Vibration Table	4	1658	A5B-12-180	±12	370	Lat. Vibration Tests
A-13	Lat., H-541 Cradle	4	1661	A5B-12-180	±12	325	Lat. Vibration Tests
A-14	Lat., Vert. Plane through CG of XW-31	4	1654	A5B-12-180	±12	350	Lat. Vibration Tests

* All directions are with respect to the XW-31 axes.

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TABLE II

ACCELERATIONS, RISE TIMES, AND PULSE DURATIONS RECORDED DURING DROP TESTS
DROP AND VIBRATION TEST OF THE XH-541

Accel. No.	Location	4-Inch -- Drop No. 3 Max. Accel. (g) +	4-Inch -- Drop No. 3 Max. Accel. (g) -	Max. Faired Pulse (g)	Rise Time (sec)	Pulse Dur. (sec)	4-Inch -- Drop No. 4 Max. Accel. (g) +	4-Inch -- Drop No. 4 Max. Accel. (g) -	Max. Faired Pulse (g)	Rise Time (sec)	Pulse Dur. (sec)
A-1	Vert., CG of XW-31	12.1*	13.4*	-4.3	0.030	0.078	12.7*	14.6*	-4.8	0.028	0.081
A-2	Vert., Fwd. End of XW-31	7.2	14.4	-4.4	0.015	0.080	9.2	10.0	-5.2	0.023	0.072
A-3	Vert., Aft. End of XW-31	8.1	9.4	-5.1	0.020	0.081	8.4	8.4	-4.1	0.019	0.085
A-4	Vert., H-541 Cradle	47.2*	39.7*	-4.4	0.024	0.063	52.2*	40.7*	-5.2	0.024	0.070

Accel. No.	Location	12-Inch -- Drop No. 3 Max. Accel. (g) +	12-Inch -- Drop No. 3 Max. Accel. (g) -	Max. Faired Pulse (g)	Rise Time (sec)	Pulse Dur. (sec)	12-Inch -- Drop No. 4 Max. Accel. (g) +	12-Inch -- Drop No. 4 Max. Accel. (g) -	Max. Faired Pulse (g)	Rise Time (sec)	Pulse Dur. (sec)
A-1	Vert., CG of XW-31	26.3*	20.5*	-8.8	0.029	0.083	19.6*	19.6*	-8.9	0.028	0.080
A-2	Vert., Fwd. End of XW-31	12.3	11.7	-8.3	0.029	0.074	8.9	11.4	-8.2	0.024	0.074
A-3	Vert., Aft. End of XW-31	10.5	9.8	-8.6	0.032	0.081	11.4	9.9	-8.3	0.029	0.081
A-4	Vert., H-541 Cradle	35.0*	54.4*	-10.4	0.030	0.080	33.8*	23.8*	-8.9	0.031	0.083

NOTE: 1. All accelerations were measured parallel to the drop axis.
2. Plus accelerations are down.

* Frequency was 700-900 cps. Accelerations may be attenuated, as frequency was higher than the linear range of the accelerometers (approximately 0.6 natural frequency, as listed in Table I).

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TABLE III

RECORDED ACCELERATIONS AT DIFFERENT FREQUENCIES DURING LONGITUDINAL VIBRATION OF THE XH-541 DROP AND VIBRATION TEST OF THE XH-541

Input Frequency (cps)	Accelerometer No. and Location*						
	Accel. A-5 Long., Vibration Table	Accel. A-6 Long., XH-541 Cradle	Accel. A-7 Long., CG of XW-31	Accel. A-8 Vert., XH-541 Cradle	Accel. A-9 Vert., CG of XW-31	Accel. A-10 Vert., Fwd. End XW-31	Accel. A-11 Vert., Aft End XW-31
	(Maximum Recorded Accelerations)**						
10	0.68	0.62	1.30	0.14	0.05	1.58	1.23
11.8	1.39	5.47	4.76	3.22	0.65	8.39	6.79
12	1.41	3.79	3.31	0.20	0.32	2.98	3.01
15	1.51	1.15	0.57	0.11	0.09	0.74	0.70
20	2.48	0.74	0.18	0.15	0.04	0.65	0.70
25	3.77	0.27	0.11	0.11	0.05	0.55	0.49
30	5.31	0.41	0.09	0.10	0.07	0.54	0.46
35	7.08	0.44	0.08	0.10	0.05	0.48	0.39
40	8.95	0.44	0.04	0.08	0.06	0.43	0.38
45	11.13	0.47	0.07	0.13	0.05	0.41	0.33
50	13.60	1.11	0.15	0.47	0.10	0.44	0.40
54	15.56	1.12	0.63	1.35	0.25	0.98	0.81
55	16.90	1.31	0.38	1.21	0.31	0.84	0.47

* All locations are with respect to the XW-31 axes.
** All accelerations were measured maximum plus to maximum minus values.

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TABLE IV

RECORDED ACCELERATIONS AT DIFFERENT FREQUENCIES DURING LATERAL VIBRATION OF THE XH-541 -- DROP AND VIBRATION TEST OF THE XH-541

Input Frequency (cps)	Accelerometer No. and Location*				
	A-12 Lateral Vibration Table	A-13 Lateral XH-541 Cradle	A-14 Lateral CG of XW-31	A-8 Vertical XH-541 Cradle	A-9 Vertical CG of XW-31
	(Maximum Recorded Accelerations)**				
10	0.74	0.54	1.7	1.3	0.1
15	0.9	3.1	2.2	3.1	0.1
18	3.8	25.1	11.0	21.4	0.8
21	3.6	6.8	2.7	5.4	0.5
23	4.3	5.0	2.5	4.5	0.1
25	4.5	3.9	1.9	3.6	0.1
30	6.1	2.7	1.2	2.5	0.1
35	8.1	2.4	0.9	2.2	0.1
40	10.3	2.4	0.9	2.2	0.1
45	12.7	2.4	0.9	2.3	0.1
50	15.5	2.6	1.0	2.7	0.2
55	18.4	3.1	1.1	3.1	0.3

* All locations are with respect to the XW-31 axis.
** All accelerations were measured maximum plus to maximum minus values.

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