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JUN 29 1959
Case No. 433.00
Ref. Sym: 1612 (352)
Project No. TM-418
File: H-350/430, 3-2

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Review Date: 11/9/98
Authority: ADO WC Layne
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Comments: OK for Openet

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MR. L. A. DUNN - 1284 TCG-NNT-1

Attn: Mr. G. Neun - 1284-1

Re: Ramp and Drop Test of the Experimental H-350/430 with W173-5 Mounts

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Summary of Results

An experimental H-350/430 container, employing four Robinson No. W173-5 Met-L-Flex shock mounts and carrying an MC-502 cartridge, was subjected to a standard engineering-test-ramp and package-drop test, as required by SCS-5. The purpose of the test was to determine the ability of the shock mounts on the container to shock isolate the cartridge sufficiently to prevent the XMC-685 integrating accelerometers of the cartridge from sustaining shock accelerations in excess of 100 g during the ramp and drop tests.

Although the H-350/430 container is intended to be shipped oriented only in one direction, the possibility that it might be shipped in another orientation exists. Therefore, the handling equipment ramp test was performed with the container oriented on the test ramp dolly in two directions, the requested shipping direction and at 90° to this direction.

The maximum faired shock accelerations measured, during the ramp test with the container oriented in the requested shipping direction, on the test ramp dolly, the cartridge support flange, and on one integrating accelerometer were, respectively, 18.5 g, 28.3 g, and 21.6 g. Those measured during the ramp test with the container in the 90° orientation were, respectively, 18.7 g, 48.9 g, and 38.1 g.

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The maximum faired shock accelerations measured, during the drop test, on the cartridge support flange and the integrating accelerometer were, respectively, 96.5 g and 105.0 g.

The limiter pads of the Robinson No. W173-5 shock mounts on the H-350/430 container became somewhat deformed during the ramp test, so that the mounts were effectively loosened and the cartridge could be shifted a small distance horizontally on the mounts due to the deformations of the lower pads. A new set of mounts was employed for the drop test. Two of these mounts became deformed in a manner similar to the deformations of the mounts used for the ramp test. The other two mounts were severely deformed, so that the upper limiter pads did not regain their original shapes after being eccentrically deflected during the test.

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No other mechanical damage to the H-350/430 container or to the MC-502 cartridge was observed following the ramp and drop tests. The electrical components of the cartridge were non-functional, and so could not be tested for operating conditions following the test.

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H-350 3-2
FILE No. 17.4.2 3-1
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Object of Test

The object of this test was to subject the experimental H-350/430 container, utilizing four Robinson No. W173-5 (17-30 lb.) Met-L-Flex shock mounts and carrying an MC-502 cartridge, to standard ramp and drop tests per SCS-5 and to measure the shock accelerations sustained by the cartridge components and container during the tests. The ramp test was requested to be run with the container oriented in two orthogonal directions. The purpose of this test was to determine the ability of the container shock mounts to mitigate shocks received by the container sufficiently to prevent the XMC-685 integrating accelerometers of the cartridge from sustaining shock accelerations in excess of 100 g during the ramp and drop tests.

Reason for Test

This handling equipment test was requested in a Request for Materials Laboratory Investigation from L. A. Dunn, 1284, to P. H. Adams, 1612, dated May 14, 1956. G. Neun, 1284-1 was test consultant.

Summary of Past Tests

Two previous standard ramp tests and one drop test have been performed on H-350/430 containers with four Robinson No. 914-4A (45-75 lb.) Met-L-Flex vibration mounts on them, by Department 1610. The results of the two tests are reported in the following memoranda: Ramp Test of the H-350/430, Ref. Sym: 1612 (251), dated October 6, 1955, and Ramp and Drop Test of Two H-350/430 Containers, Ref. Sym: 1612 (267), dated February 6, 1956, both memos addressed to L. A. Dunn, 1284, from W. H. Cross, 1612.

During both of the previous ramp tests, as in the present test, the H-350/430 container was shock-loaded in two orthogonal directions, although carriers are requested to ship the container oriented only in one direction - with the container legs parallel to the direction of travel. The maximum faired longitudinal shock accelerations measured in the requested shipping direction during the first test were: 16.7 g on the ramp dolly, 26.5 g on the cartridge support flange, 41.9 g on one integrating accelerometer. Those measured during the second test were: 17.5 g on the ramp dolly, 24.7 g on the cartridge support flange, 28.7 g on the integrating accelerometer.

The maximum faired vertical shock accelerations measured during the drop test were 116 g on the cartridge support flange and 110 g on the integrating accelerometer.

The vibration mounts used on the H-350/430 containers (one set for each condition of test) were damaged somewhat during these ramp and drop tests, but were apparently not fractured. Also, no damage was observed to have occurred to the MC-502 cartridge components during the two tests. The several sets of vibration mounts were considered to be in satisfactory condition to support

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the cartridge and to further isolate it from vibration following the tests, although the majority of them were somewhat damaged during the tests and they provided insufficient shock isolation for the cartridge.

Due to the inadequate shock isolation of the Robinson No. 914-4A vibration mounts employed on the H-350/430 container during these two tests, Division 1284 decided to investigate the shock and vibration isolation properties of the Robinson No. W173-5 shock mounts, and so requested the present ramp and drop test.

Setup for Test

Although carriers are requested to ship the H-350/430 container oriented so that the legs of the container are parallel to the direction of travel, the container was given standard ramp tests oriented on the test ramp dolly both in the requested direction and at 90° to that direction. The methods of container shoring and tie-down employed for the tests in the two orientations are shown in Figs. 1 and 2. The ramp dolly was drawn up the ramp incline to a predetermined position for each test and then released and allowed to roll down the track and to impact upon one or two 4 x 4-inch pine impact blocks on the ramp stop, depending upon the impact velocity.

The method of suspending the container in the dynamic jig for the standard drop test, during which the container was dropped from the release mechanism and allowed to impact on the concrete floor of the jig, is pictured in Fig. 3.

The individual components of the MC-502 cartridge and the experimental H-350/430 container given the ramp and drop test and their drawing and serial numbers are listed in Table I.

Instrumentation recording, and test equipment employed for the ramp and drop tests included the following:

Nine Statham accelerometers (Table II and Figs. 1 and 4 thru 8).
Ramp dolly velocity gage (Fig. 2).
Miller Type C-3, Model CA-12 amplifier unit, Serial No. 3.
Miller Model J recording oscillograph, Serial No. 99.
Remote control console.

Engineering test ramp.
Pine impact blocks.
Dynamic Jig. No. 1.

Procedure

The MC-502 cartridge and the experimental H-350/430 container were instrumented with accelerometers installed at the locations described in Table II and shown in Figs. 1 and 4 thru 8.

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The container was shored and tied down on the engineering test ramp dolly in the manner shown in Fig. 1 for the ramp tests with the container oriented in the requested shipping direction, for which the container legs were parallel to the direction of dolly travel (0° orientation). Seven tests were run with the container in this orientation. The ramp dolly was released from positions ranging from 7 ft. to 11 ft. 5 in., as marked on the ramp incline, for these tests. Impact velocities ranged from 5.3 to 6.9 mph. One impact block was used on the ramp stop for Runs 1 - 3, and two were used for Runs 4 - 7. Accelerations were recorded during all the ramp tests, in both the 0° and 90° orientations, with Accelerometers Nos. 1 - 9. Ramp dolly velocity data were recorded during all tests with the velocity gage, which consisted of a micro-switch traveling on the dolly and actuated by contact arms on the track a known distance apart (Fig. 2).

For the ramp tests with the container in the 90° orientation, the container was mounted on the ramp dolly in the manner shown in Fig. 2. Six tests were run for this orientation of the container. The ramp dolly release positions on the ramp incline ranged from 6 ft. 8 in. to 11 ft. 6 in. The dolly impact velocities ranged from 5.0 to 7.0 mph. One impact block was employed on the ramp stop for Runs 8 - 9 and two were used for Runs 10 - 13.

Following the completion of the ramp test, the MC-502 cartridge and H-350/430 container were given a visual inspection by the consultant of Division 1284, and the container shock mounts, which had become somewhat deformed during the ramp test, were replaced with new mounts for use during the drop test.

The test setup employed in the dynamic jig for the drop test of the H-350/430 container is illustrated in Fig. 3. As required by SCS-5, the container and contents were dropped a distance of 4 inches onto concrete for twelve tests and a distance of 12 inches for six tests. Impact shock accelerations were recorded with Accelerometers Nos. 4, 5, 7, and 9 (Figs. 7 and 8) during Drops 1, 10, 11, 13, and 14.

Following the completion of the drop test, the cartridge and container were given a visual inspection by Division 1284.

Results

During the visual inspections of the MC-502 cartridge and the experimental H-350/430 container performed by the consultant of Division 1284 following the ramp test and following the drop test, no damage was observed to have occurred to the cartridge components.

Following the ramp test, it was found that the shock mounts on the container had loosened, so that the cartridge could be moved up to about 3/16-inch horizontally on the mounts. Subsequent disassembly of one of the mounts revealed that the lower limiter pads of the mounts had been crushed, so that the center studs of the mounts were free to move measureable distances within the holes

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through the pads. The extent to which the stud of one of the mounts could be shifted off center due to this pad deformation is illustrated in Fig. 9, which is a close-up view of the mount shown in the foreground of Fig. 7. In addition, the upper limiter pads had taken permanent sets of nearly 1/16 inch in their approximately 3/8 inch thickness. Therefore, the mounts were replaced with new ones for the drop test.

Following the drop test, it was again found that the lower limiter pads of the mounts had been permanently deformed at the stud holes, so that the studs could be moved up to a maximum of about 3/16 inch in the holes. The upper pads on two of the mounts had taken permanent sets of about 1/16 inch as during the ramp test. However, pads of the other two mounts were peformed from about 1/16 to 5/32 inch in an askew manner, as shown in Fig. 10.

Since two of the shock mounts of the H-350/430 container were severely deformed during the drop test, a static load-deflection test was performed on one of these mounts, one of the slightly deformed mounts, and on a new, unused mount, in order to approximately determine how the load bearing characteristics of the container mounts had changed under drop test shock loading, as compared to the characteristics of a new mount. Each of the three mounts was compressively loaded from 0 to 2800 lb. in the Baldwin Testing Machine and the mount deflections were measured. The 2800 lb. loads corresponded approximately to the loads which the mounts would sustain in use on the H-350/430 container when the MC-502 cartridge was statically loaded to slightly over 100 g. The load-deflection curves obtained from the tests are shown in Fig. 11. The curves show that the mounts which were subjected to a standard drop test per SCS-5 while on the container have markedly different static load-deflection characteristics from those of the new mount. The shock-loaded mounts are much stiffer than the new mount under loads up to about 20 g, but are only slightly stiffer than the new one in the range from about 20 to 100 g, with the severely deformed mount being somewhat stiffer than the other. Neither mount had "bottomed out" and become rigid at the 100 g load.

No other damage, in addition to that which was incurred to the shock mounts, was sustained by the H-350/430 container during the course of the ramp and drop tests.

The shock acceleration data derived from representative oscillograph records are given in Table III. The acceleration parameters given in the table are those defined in SCS-10 and illustrated in Fig. 12, which shows one of the oscillograms recorded during the ramp test with the H-350/430 container in the 0° orientation. Figures 13 and 14 show oscillograms from the ramp test with the container in the 90° orientation and from a 12-inch drop test, respectively.

Reference to the maximum faired accelerations measured on the cartridge support flange and on the integrating accelerometer shows that the cartridge support received pulse accelerations up to nearly 100 g and the integrating accelerometer accelerations in excess of 100 g, which is the maximum shock load to which the accelerometer may be safely subjected.

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Conclusions

Since the instrumented XMC-685 integrating accelerometer sustained shock accelerations in excess of the maximum allowable magnitude during the drop test phase of the standard handling equipment test specified in SCS-5 and since the mounts became permanently deformed and changed characteristics during the test, it is concluded that the Robinson No. W173-5 shock mounts employed on the experimental H-350/430 container for the test are inadequate to provide the required shock isolation for the MC-502 cartridge.

R. A. BUCK - 1612-1

W. C. CLARK - 1612-1

J. H. STOEVER - 1612-1

Approved by: P. H. ADAMS - 1612

RAB:1612-1:as

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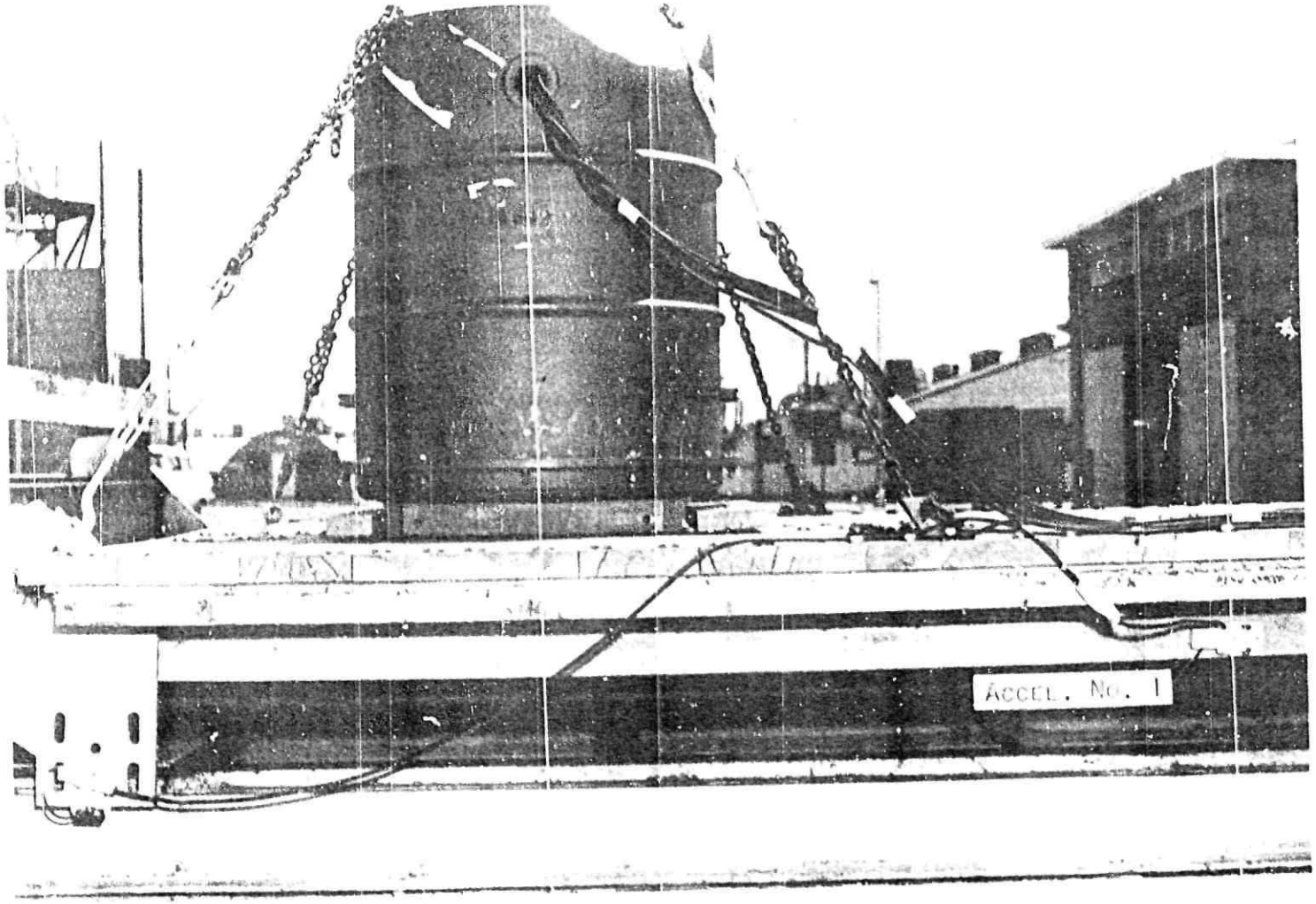

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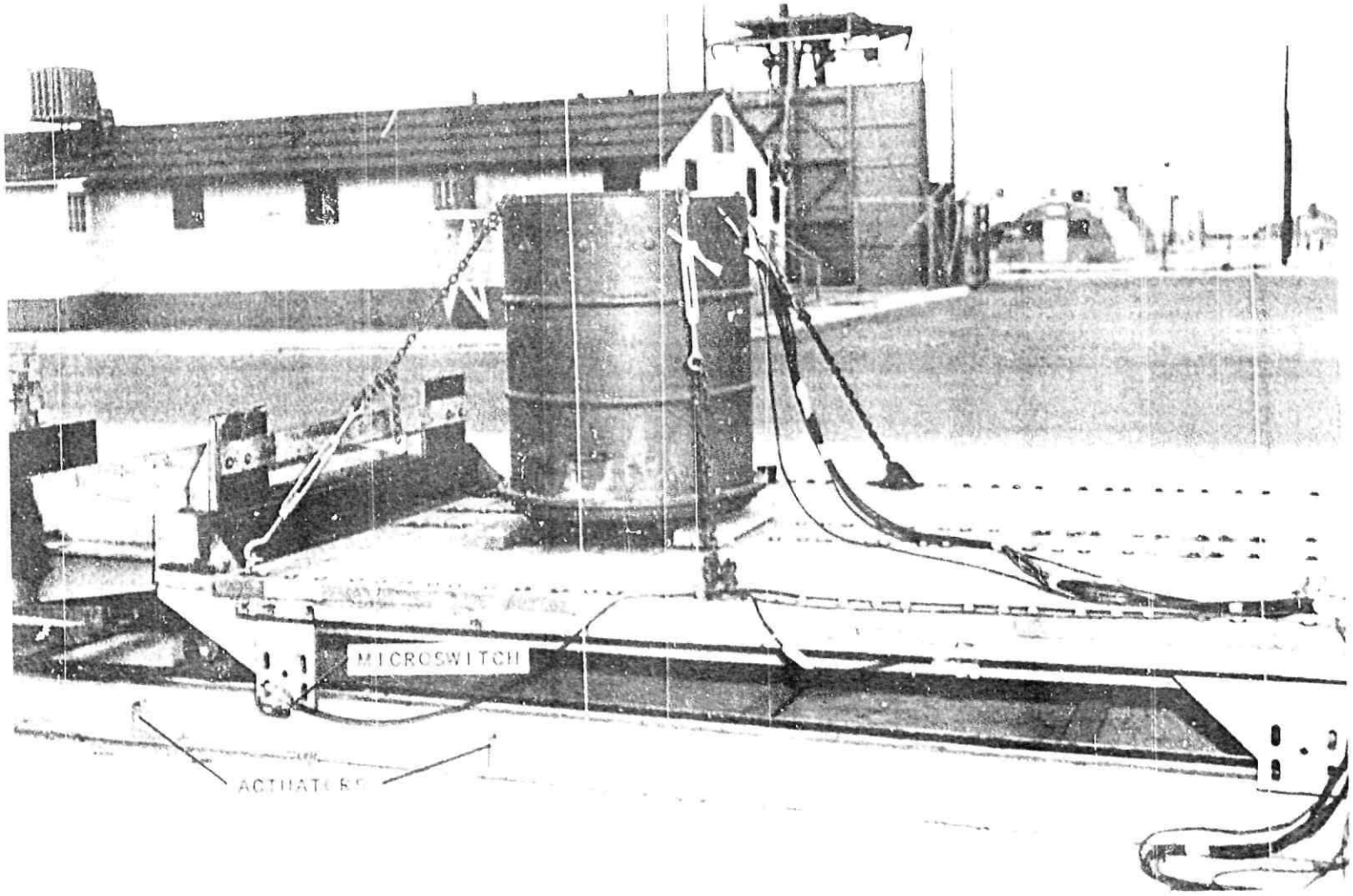

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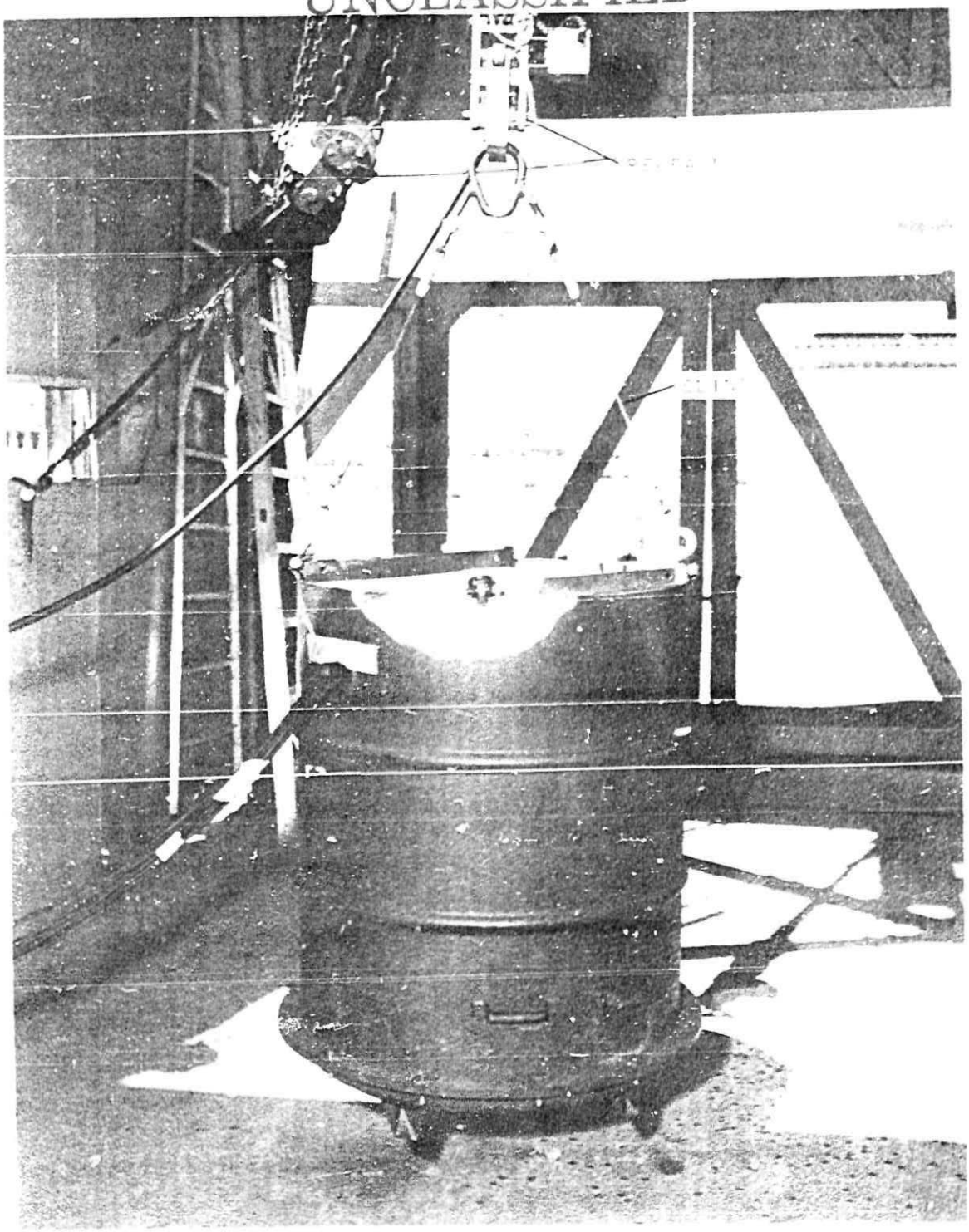

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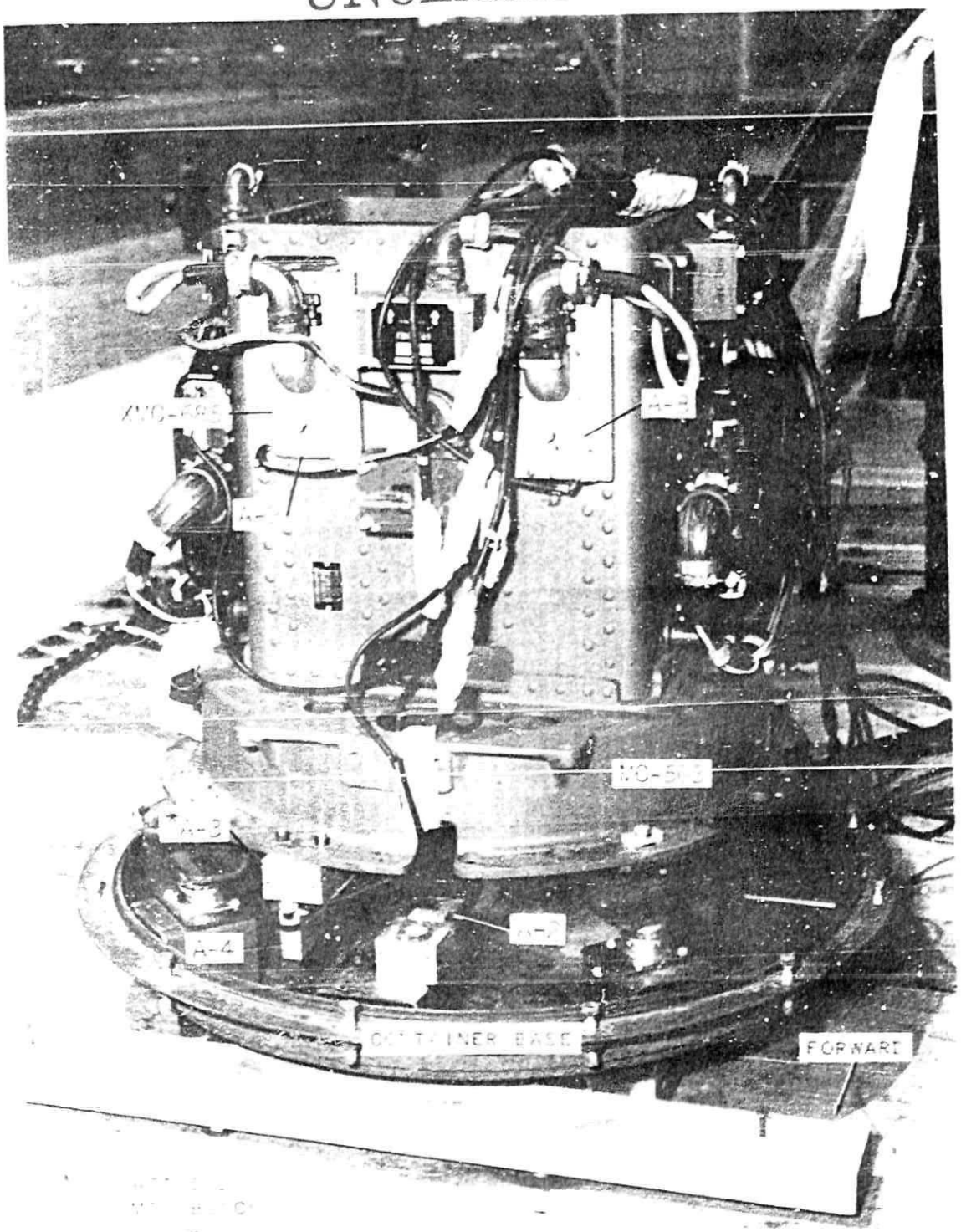

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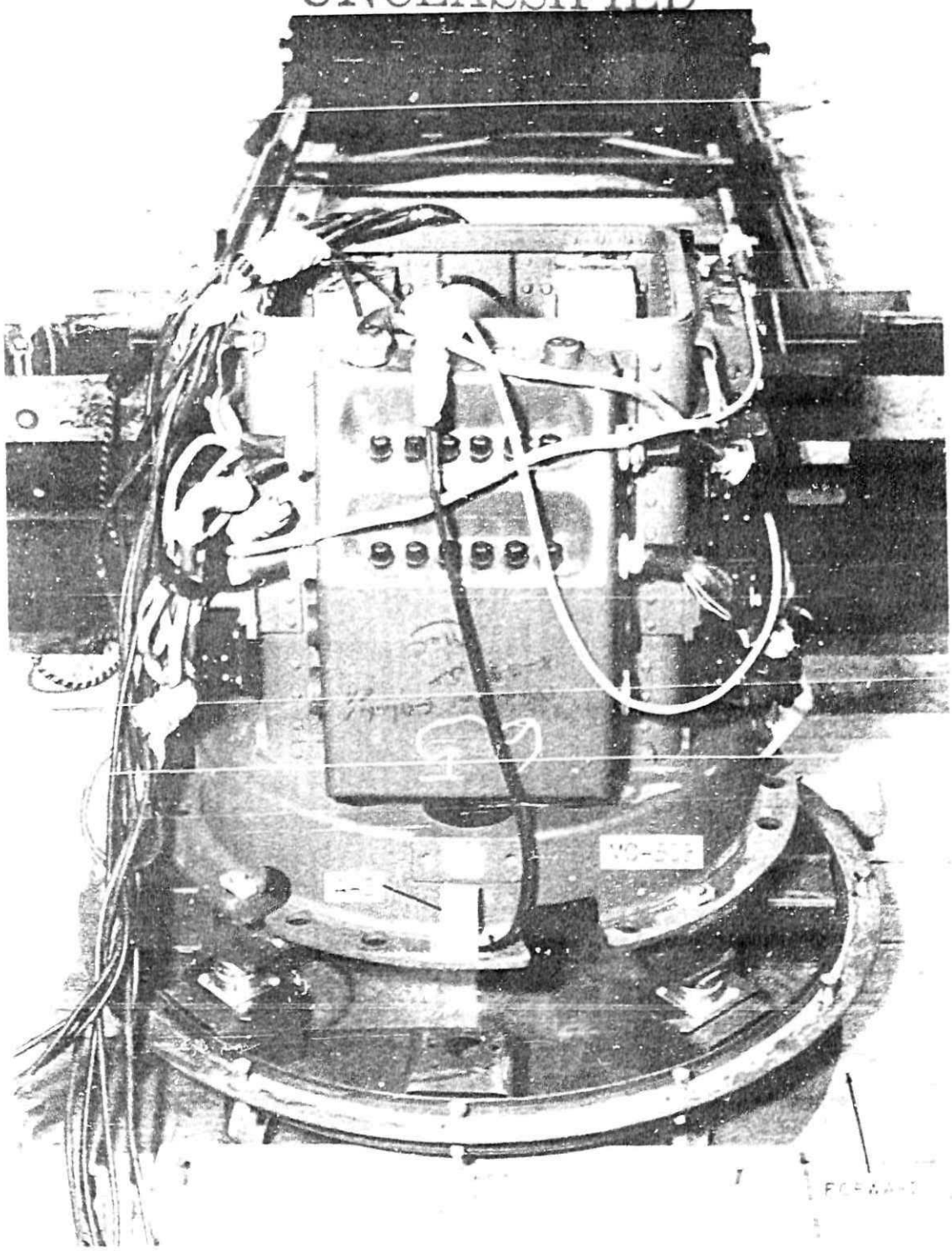

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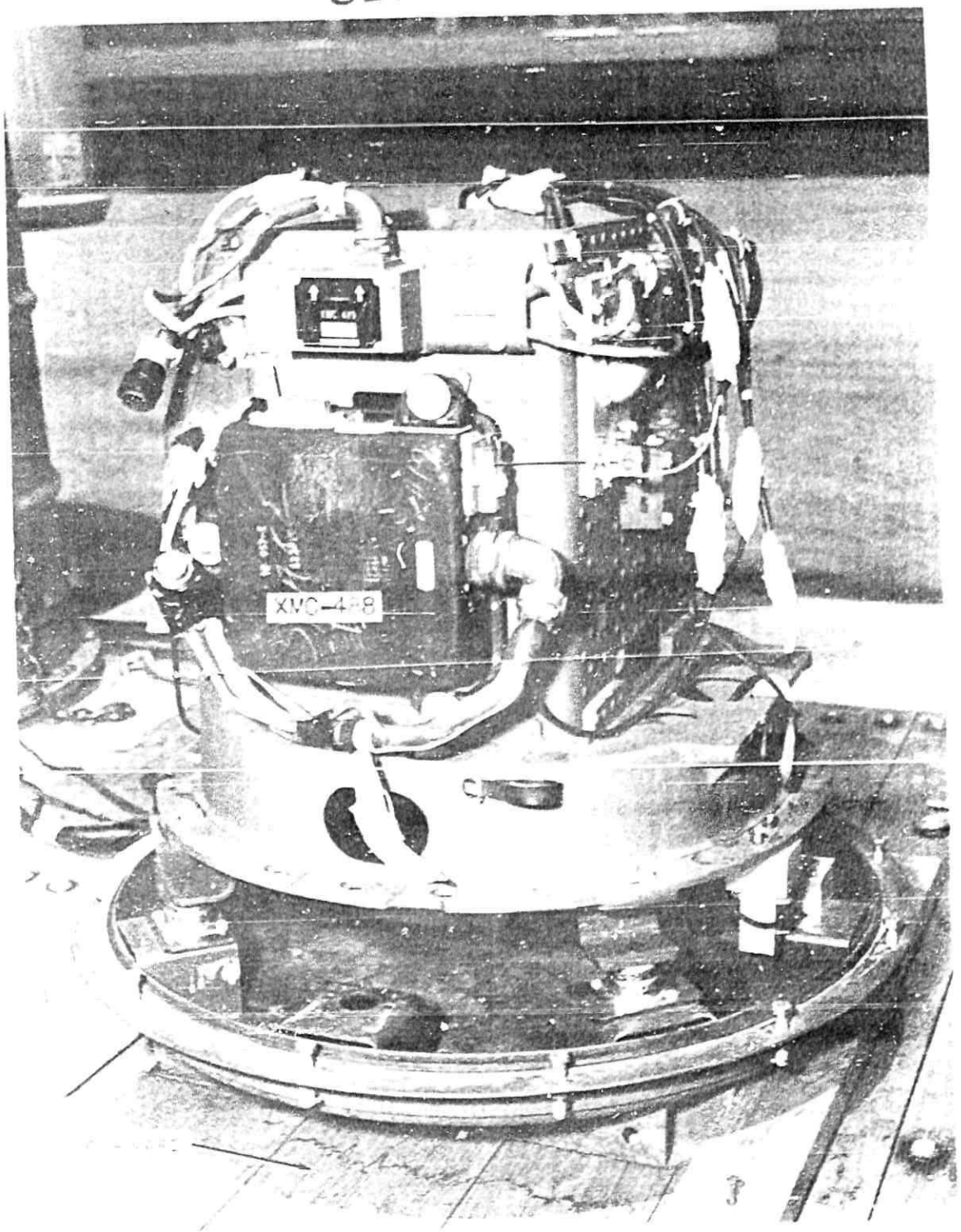

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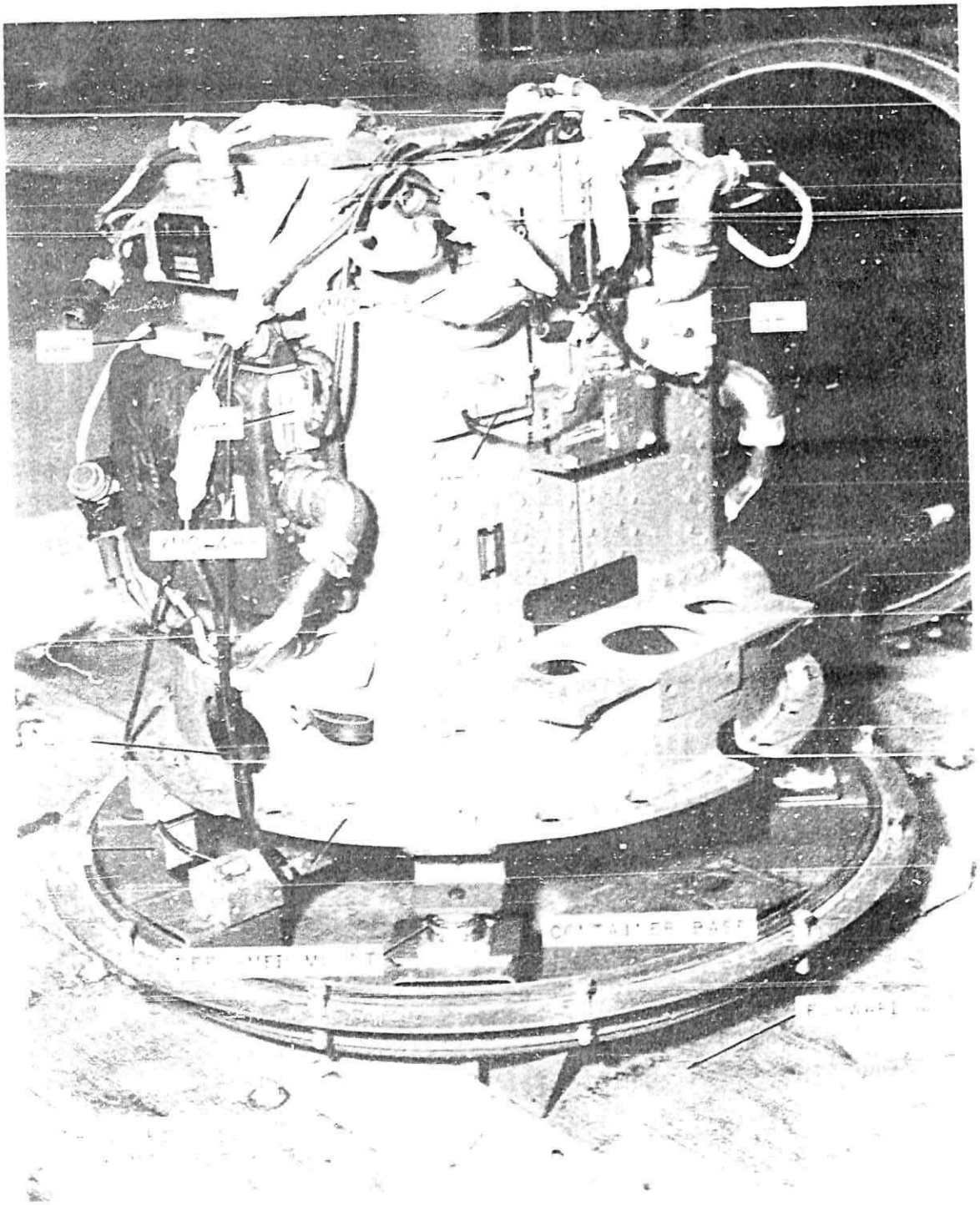

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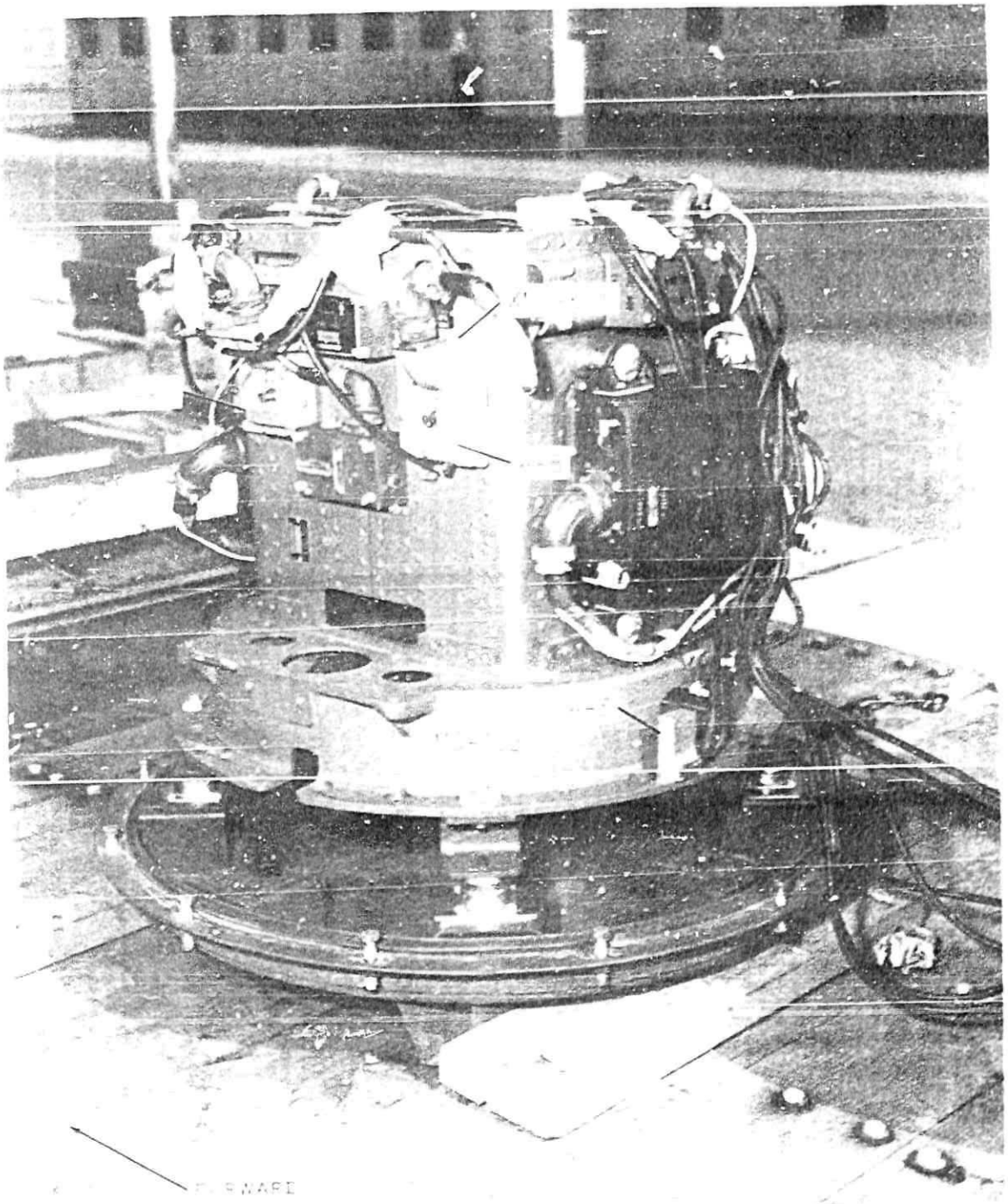

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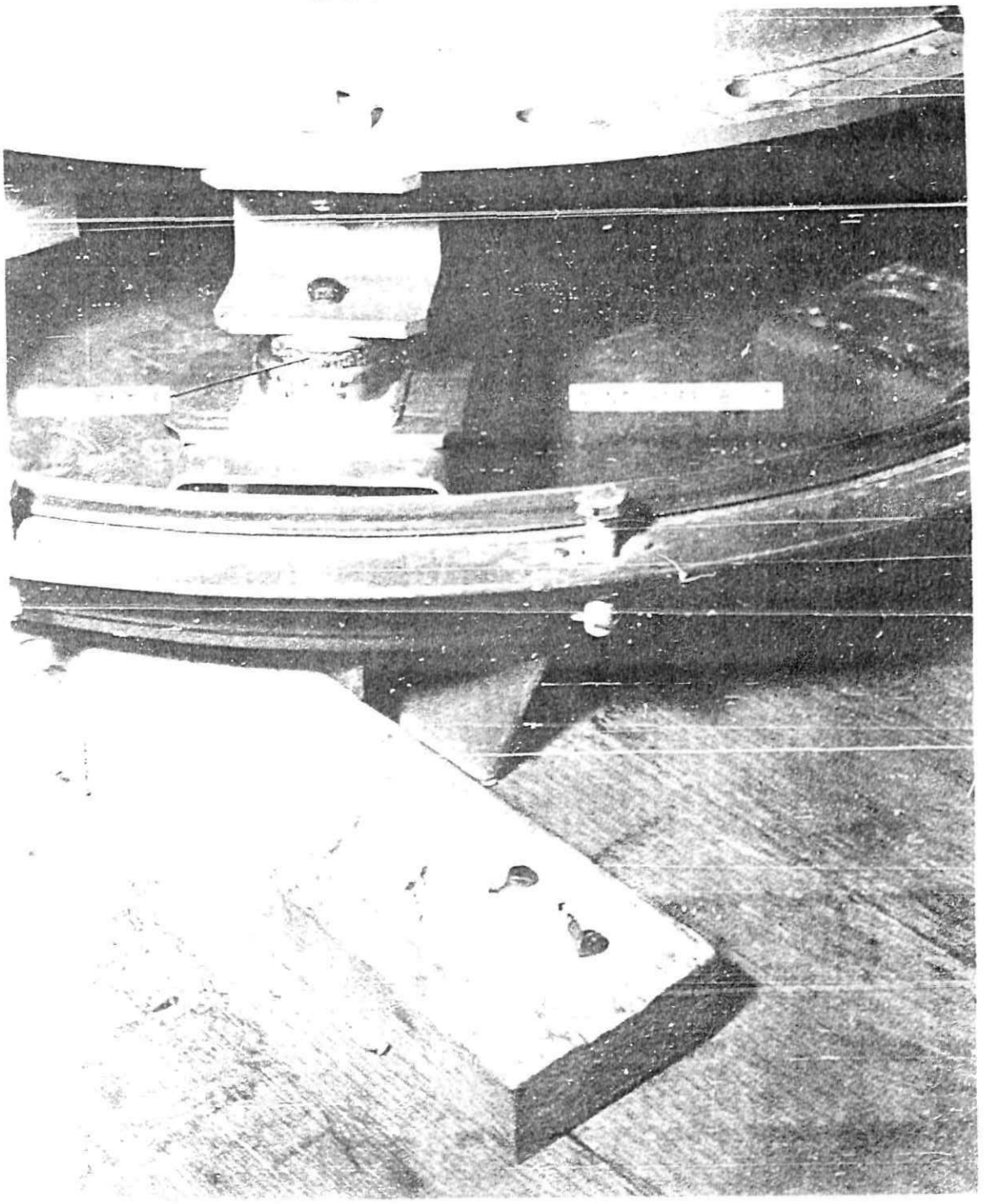

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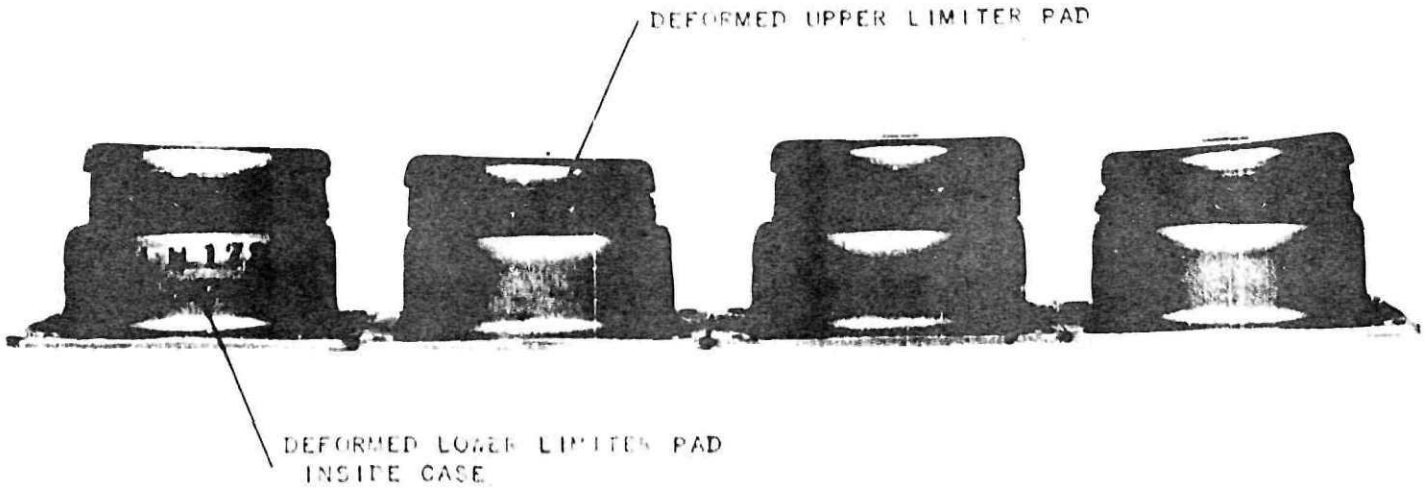

FIG. 10 - ROBINSON NO. W173-5 SHOCK MOUNTS DEFORMED DURING DROP TEST.
RAMP AND DROP TEST OF THE H-350,430 WITH W173-5 MOUNTS.

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TM-41[illegible]

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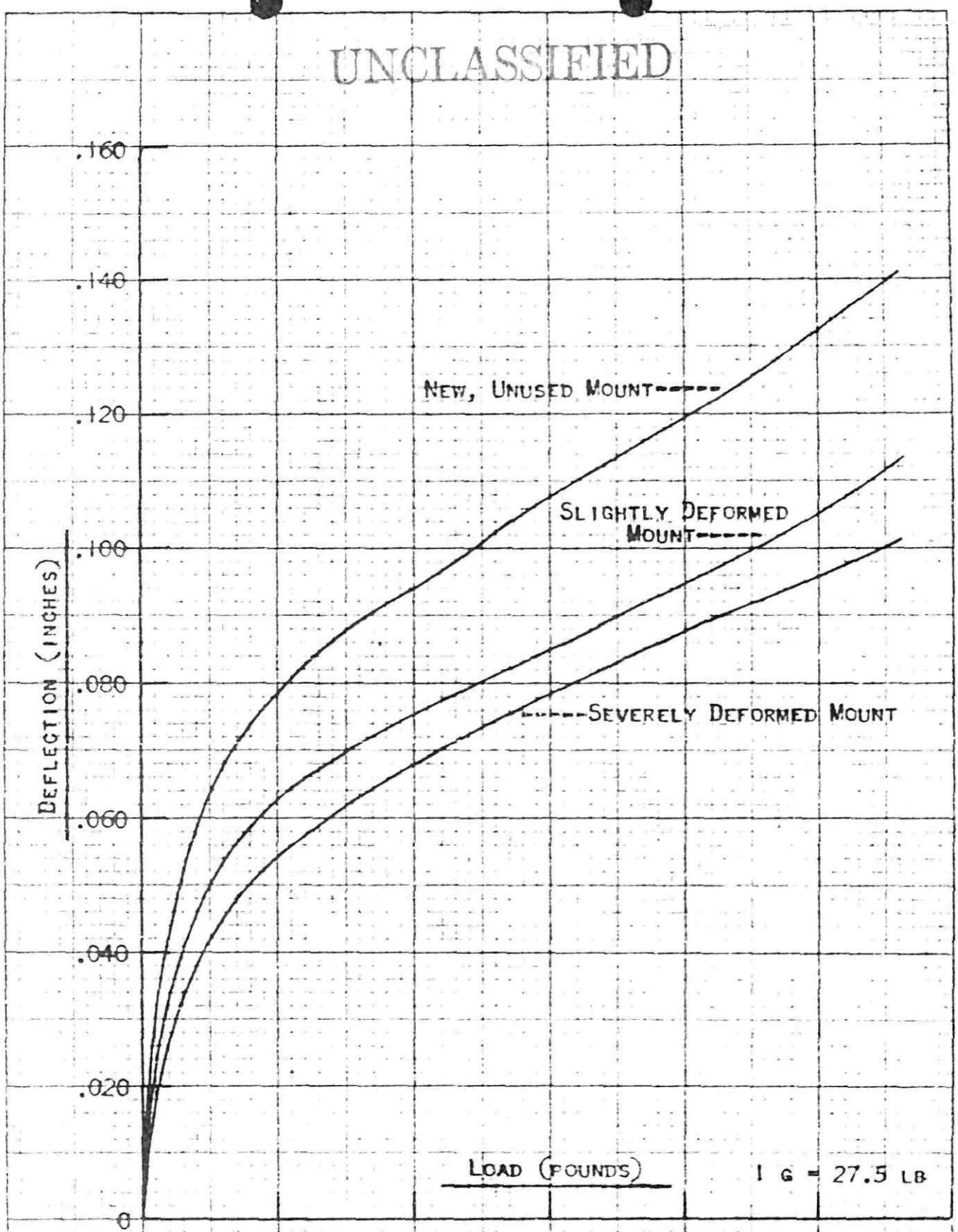

FIG. 11 - LOAD-DEFLECTION CURVES FOR ROBINSON NO. W173-5 SHOCK MOUNTS. RAMP AND DROP TEST OF THE H-350/430 WITH W173-5 MOUNTS.

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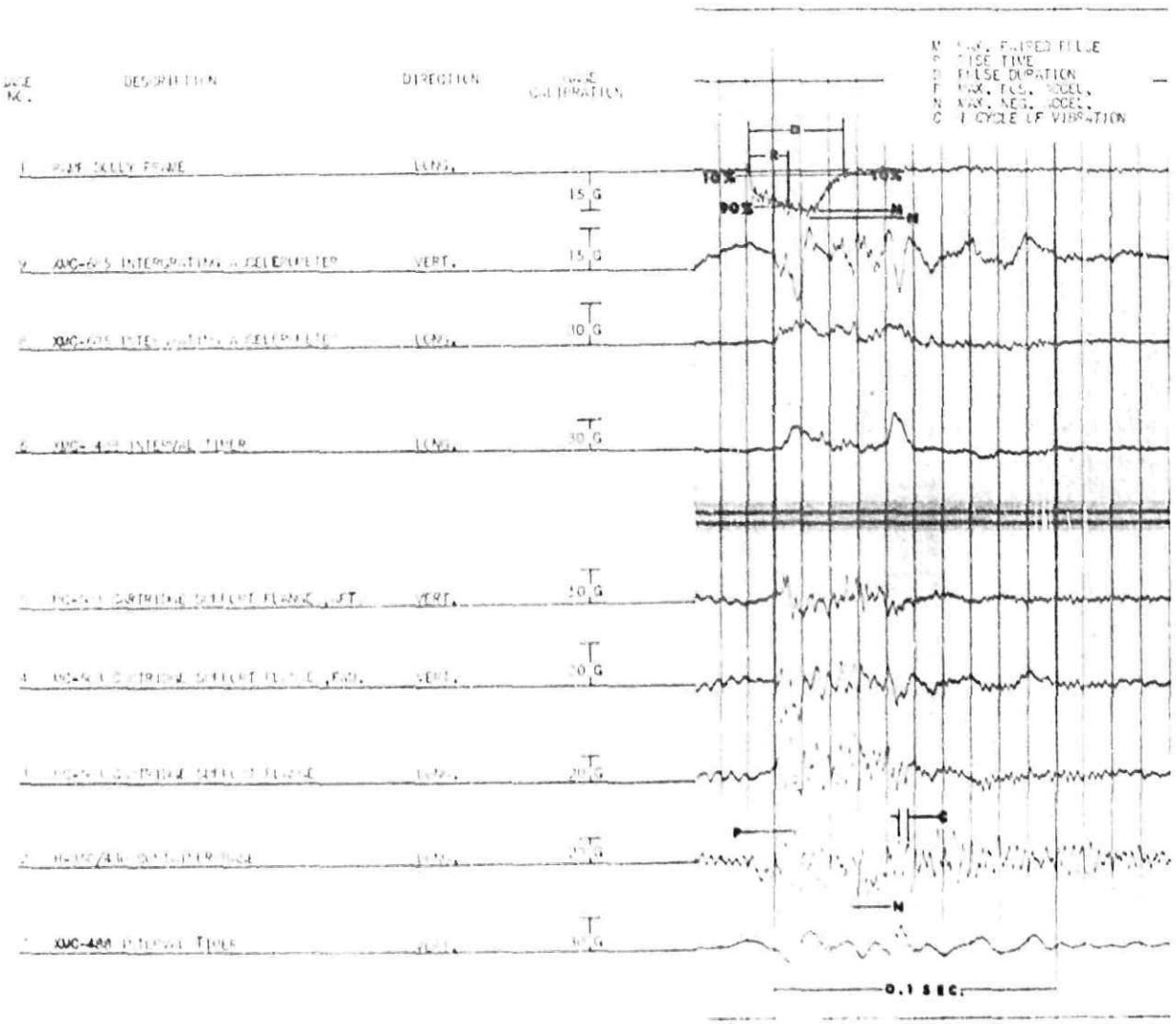

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GAGE NO.	DESCRIPTION	DIRECTION	GAGE CALIBRATION
1	RAMP DOLLY FRAME	LONG.	20 G
9	XMC-685 INTERGRATING ACCELEROMETER	VERT.	30 G
8	XMC-685 INTERGRATING ACCELEROMETER	LONG.	30 G
6	XMC-488 INTERVAL TIMER	LONG.	40 G
5	MC-503 CARTRIDGE SUPPORT FLANGE, AFT.	VERT.	40 G
4	MC-503 CARTRIDGE SUPPORT FLANGE, FWD.	VERT.	40 G
3	MC-503 CARTRIDGE SUPPORT FLANGE	LONG.	40 G
2	H-350/430 CONTAINER BASE	LONG.	40 G
7	XMC-488 INTERVAL TIMER	VERT.	30 G

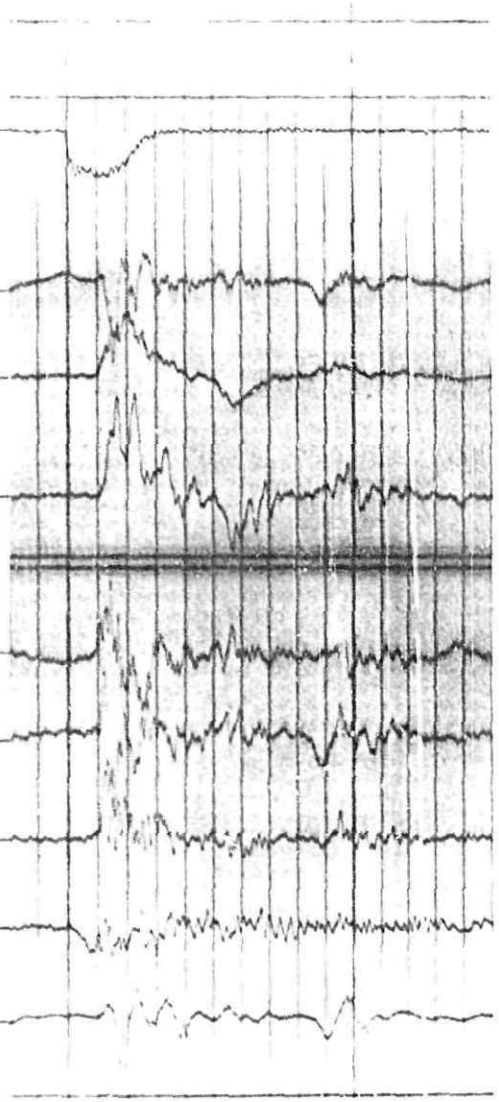

FIG. 13 - OSCILLOGRAM RECORDED DURING RAMP TEST WITH H-[illegible] CONTAINER IN THE 90° ORIENTATION (RUN 12 - 6.8 MPH)
RAMP [illegible] DROP TEST OF THE H-[illegible] WITH [illegible] MOUNTS

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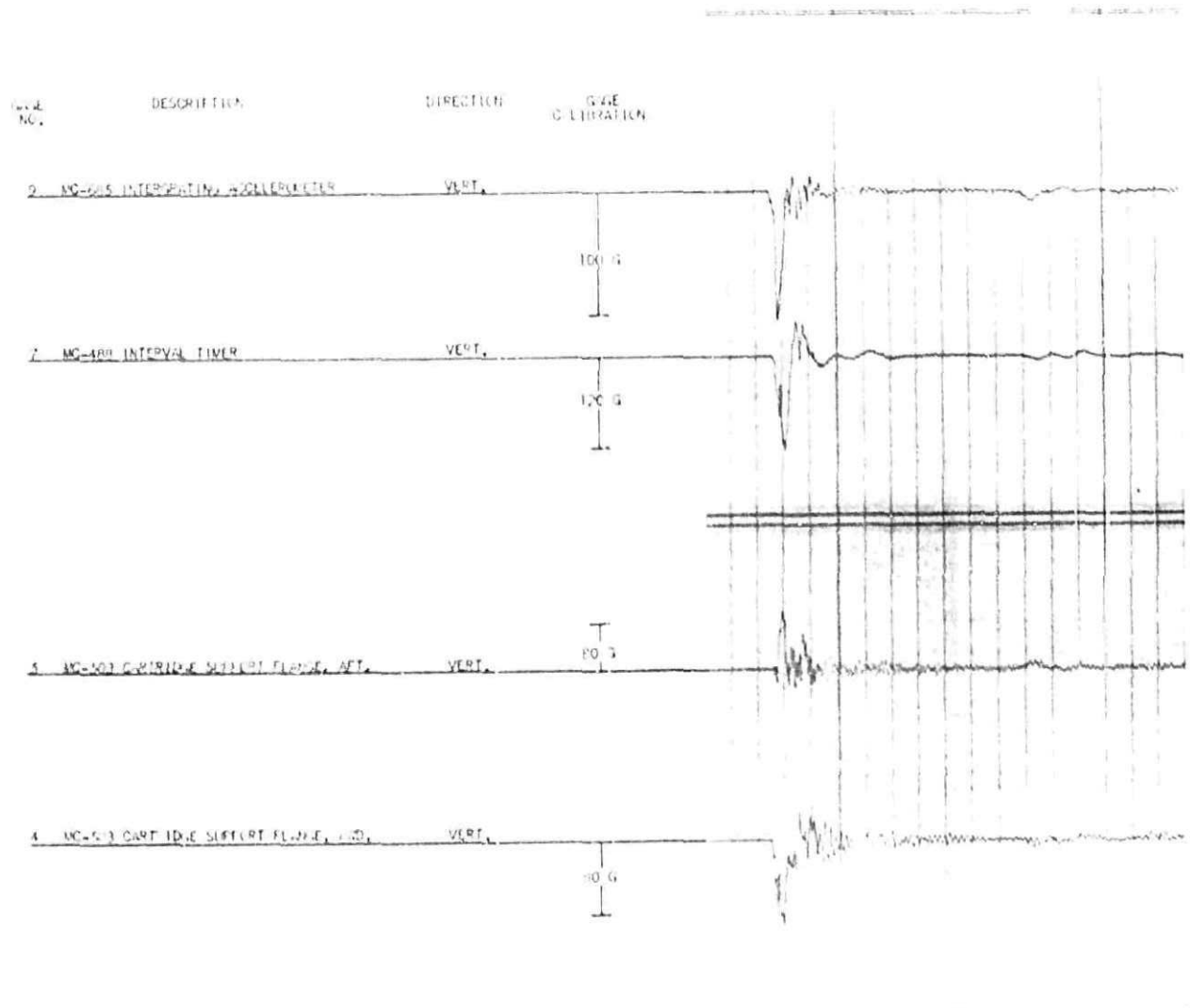

FIG. 14 - [illegible] DURING DROP TEST OF [illegible]
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TABLE I

COMPONENTS OF EXPERIMENTAL H-350/430 CONTAINER AND MC-502 CARTRIDGE

RAMI AND DROP TEST OF THE H-350/430 WITH W173-5 MOUNTS

	Component	Drawing No.	Serial No.
H-350	Container, Cartridge	320018-00	FK-1262-E5
H-430 (Experimental)	Adapter Kit, Cartridge to Container, With Robinson No. W173-5 Mounts (4)	320062	None
XMC-488	Timer, Interval	310022	021
XMC-488	Timer, Interval	310022	029
XMC-489	Switch, Acceleration	310023	246
XMC-489	Switch, Acceleration	310023	247
XMC-489	Switch, Acceleration	310023	FX-2118-A5
XMC-489	Switch, Acceleration	310023	FX-2131-A5
XMC-497	Interconnecting Box	310029	AA-0018-E5
MC-503	Support, Cartridge	310040	CE-62935
XMC-685	Accelerometer, Integrating	310250	GP-0025-J5
XMC-685	Accelerometer, Integrating	310250	GP-0027-J5

TABLE II

ACCELEROMETER DATA

RAMP AND DROP TEST OF THE H-350/430 WITH W173-5 MOUNTS

Accel. No.	Location	Direction	Serial No.	Range (g)	Model No.	Natural Frequency (cps)	Figure Reference
1	Ramp Dolly Main Frame	Longitudinal	652	±100	A5A-100-300	480	1
2	H-350/430 Container Base (Vibration Mount Bracket)	Longitudinal	276	±50	A5A-50-240	680	4, 7
3	MC-503 Cartridge Support Flange	Longitudinal	284	±50	A5A-50-240	580	4, 7
4	MC-503 Cartridge Support Flange, fwd.	Vertical	1665	±100	A5A-100-335	940	4, 7
5	MC-503 Cartridge Support Flange, Aft.	Vertical	1666	±100	A5A-100-335	920	5, 8
6	XMC-488 Timer, Interval	Longitudinal	681	±50	F-50-300	470	6, 7
7	XMC-488 Timer, Interval	Vertical	2080	±100	F-100-300	510	6, 7
8	XMC-685 Accelerometer, Integrating	Longitudinal	1377	±50	F-50-300	500	4, 7, 8
9	XMC-685 Accelerometer, Integrating	Vertical	1300	±100	F-100-300	630	4, 7, 8

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Ref. 1612 (352)
Project No. TM-418

TABLE III

SHOCK ACCELERATIONS MEASURED ON THE H-350/430 CONTAINER AND MC-502 CARTRIDGE
RAMP AND DROP TEST OF THE H-350/430 WITH W173-5 MOUNTS

Accelerometer No. and Location	Ramp Run 6 - 6.8 mph - 0° Orientation						Ramp Run 7 - 6.9 mph - 0° Orientation						Ramp Run 12 - 6.8 mph - 90° Orientation						Ramp Run 13 -
	Max. Faired Pulse (g)	Rise Time (ms)	Pulse Duration (ms)	Max. + Accel. (g)	Max. - Accel. (g)	Assoc. Freq. (cps)	Max. Faired Pulse (g)	Rise Time (ms)	Pulse Duration (ms)	Max. + Accel. (g)	Max. - Accel. (g)	Assoc. Freq. (cps)	Max. Faired Pulse (g)	Rise Time (ms)	Pulse Duration (ms)	Max. + Accel. (g)	Max. - Accel. (g)	Assoc. Freq. (cps)	Max. Faired Pulse (g)	Rise Time (ms)	Puls Durat (ms
1. Ramp Dolly Frame--Long.	-18.5	5	27		19.8	700+*	-14.8	14	35		16.9	700+*	-16.0	6	29		17.9	500+*	-18.7	5	27
2. H-350/430 Container Base--Long.	-22.5	7	20	30.1	40.4	360	-18.8	19	28	22.9	35.3	310	-26.0	4	30	19.9	34.2	280+	-27.1	4	30
3. MC-503 Cartridge Support Flange--Long.	-28.3	4	9	24.1	46.2	500+	-17.5	6	26	13.5	43.6	300+	-42.3	3	26	20.4	79.7	500	-48.9	3	15
4. MC-503 Cartridge Support Flange, Fwd.--Vert.				28.7	18.6	390				27.3	13.3	250+				39.9	33.2	450+			
5. MC-503 Cartridge Support Flange, Aft.--Vert.				48.8	42.3	390				34.4	29.1	250+				56.6	42.1	500+			

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Ref. 1612 (352)
Project No. TM-418

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TABLE III

SHOCK ACCELERATIONS MEASURED ON THE H-350/430 CONTAINER AND MC-502 CARTRIDGE
RAMP AND DROP TEST OF THE H-350/430 WITH W173-5 MOUNTS

Ramp Run 6 - 6.8 mph - 0° Orientation						Ramp Run 7 - 6.9 mph - 0° Orientation						Ramp Run 12 - 6.8 mph - 90° Orientation						Ramp Run 13 - 7.9 mph - 90° Orientation					
Max. Faired Pulse (g)	Rise Time (ms)	Pulse Duration (ms)	Max. + Accel. (g)	Max. - Accel. (g)	Assoc. Freq. (cps)	Max. Faired Pulse (g)	Rise Time (ms)	Pulse Duration (ms)	Max. + Accel. (g)	Max. - Accel. (g)	Assoc. Freq. (cps)	Max. Faired Pulse (g)	Rise Time (ms)	Pulse Duration (ms)	Max. + Accel. (g)	Max. - Accel. (g)	Assoc. Freq. (cps)	Max. Faired Pulse (g)	Rise Time (ms)	Pulse Duration (ms)	Max. + Accel. (g)	Max. - Accel. (g)	Assoc. Freq. (cps)
-18.5	5	27		19.8	700+*	-14.8	14	35		16.9	700+*	-16.0	6	29		17.9	500+*	-18.7	5	27		20.5	500+*
-22.5	7	20	30.1	40.4	360	-18.8	19	28	22.9	35.3	310	-26.0	4	30	19.9	34.2	280+	-27.1	4	30	28.3	53.3	280
-28.3	4	9	24.1	46.2	500+	-17.5	6	26	13.5	43.6	300+	-42.3	3	26	20.4	79.7	500	-48.9	3	15	54.8	72.3	480
			28.7	18.6	390				27.3	13.3	250+				39.9	33.2	450+				27.2	26.5	450+
			48.8	42.3	390				34.4	29.1	250+				56.6	42.1	500+				42.9	48.2	500+

6. XMC-488 Timer--Long.	-32.6	5	16	11.3	36.0	300+	-21.3	4	27	7.5	33.6	400+	-39.0	4	25	30.8	57.3	140+	-41.9	3	24
7. XMC-488 Timer--Vert.				26.2	30.6	90				16.4	21.1	95				47.6	30.3	650+			
8. XMC-685 Accel., Integrating--Long.	-21.6	7	19	12.1	24.6	600+	-13.7	7	30	4.1	16.8	550	-32.4	9	27	15.4	33.3	600	-38.1	8	25
9. XMC-685 Accel., Integrating--Vert.				24.7	17.2	95				19.1	8.2	110				43.5	16.5	130			
	Drop Test 10 - 4 Inches						Drop Test 11 - 4 Inches						Drop Test 13 - 12 Inches						Drop Test 14		
4. MC-503 Cartridge Support Flange, Fwd.-- Vert	+58.9	3	7	58.9	15.5	550	+50.3	3	7	62.1	17.6	500+	+82.9	3	9	89.0	29.7	500+	+92.6	3	9
5. MC-503 Cartridge Support Flange, Aft.--Vert.	+47.9	2	4	56.3	27.6	750	+57.5	2	8	77.7	23.9	800	+84.8	1	4	96.4	30.0	800+	+96.5	1	3
7. XMC-488 Timer-Vert.	+82.6	3	6	87.4	37.4	500	+82.1	4	6	90.9	40.6	500	+119	3	6	123	46.9	400*	+133	3	5
9. XMC-685 Integrating Accelerometer--Vert.	+61.8	2	5	62.1	7.5	--	+66.8	2	4	68.7	12.3	--	+105	2	6	105	11.9	500*	+104	2	5

\+ Approximate value.
* Frequency associated with maximum negative acceleration.

NOTE: 1. Positive (+) accelerations given for the ramp and drop tests are forward (WRT Test Ramp) and upward. Negative (-) accelerations are in the opposite directions.

2. Acceleration magnitudes shown for vibrations at frequencies greater than 0.6 of the resonant frequencies of the recording accelerometers (see Table II) are generally smaller than the actual values, due to attenuation of the accelerometer sensitivities in this frequency range.

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-32.6	5	16	11.3	36.0	300+	-21.3	4	27	7.5	33.6	400+	-39.0	4	25	30.8	57.3	140+	-41.9	3	24	33.7	73.4	140+
			26.2	30.6	90				16.4	21.1	95				47.6	30.3	650+				72.9	26.7	700
-21.6	7	19	12.1	24.6	600+	-13.7	7	30	4.1	16.8	550	-32.4	9	27	15.4	33.3	600	-38.1	8	25	18.9	40.3	—
			24.7	17.2	95				19.1	8.2	110				43.5	16.5	130				44.6	22.9	130
Drop Test 10 - 4 Inches						Drop Test 11 - 4 Inches						Drop Test 13 - 12 Inches						Drop Test 14 - 12 Inches					
+58.9	3	7	58.9	15.5	550	+50.3	3	7	62.1	17.6	500+	+82.9	3	9	89.0	29.7	500+	+92.6	3	9	108	38.1	500
+47.9	2	4	56.3	27.6	750	+57.5	2	8	77.7	23.9	800	+84.8	1	4	96.4	30.0	800+	+96.5	1	3	119	45.2	800
+82.6	3	6	87.4	37.4	500	+82.1	4	6	90.9	40.6	500	+119	3	6	123	46.9	400*	+133	3	5	133	63.5	400*
+61.8	2	5	62.1	7.5	—	+66.8	2	4	68.7	12.3	—	+105	2	6	105	11.9	500*	+104	2	5	108	14.9	450*

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ed with maximum negative acceleration.

NOTE: 1. Positive (+) accelerations given for the ramp and drop tests are forward (WRT Test Ramp) and upward. Negative (-) accelerations are in the opposite directions.

2. Acceleration magnitudes shown for vibrations at frequencies greater than 0.6 of the resonant frequencies of the recording accelerometers (see Table II) are generally smaller than the actual values, due to attenuation of the accelerometer sensitivities in this frequency range.

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