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CAPTIVE SLED TESTS OF A
VIBRATION INSTRUMENTED GCV-2

Organization 7300 Environmental Test Report

D. Preston, 7344

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CAPTIVE SLED TESTS OF A VIBRATION INSTRUMENTED GCV-2

Introduction

The object of this test was to obtain information about the track induced vibration environment which the GCV will have to withstand during rocket sled tests to a velocity of 410 fee per second (fps). GCV-2 was to be instrumented, captively mounted on an ejector sled, and tested over the same section of track and to the same velosicy as an actual GCV test. The information, recorded by telemetry, was then to be used as an input for vibration testing to be conducted by Organization 7324.

These tests were requested by T. T. Shishman, 9224, on March 6, 1967. D. L. Preston, 7344, was Test Engineer. Testing began on April 3, 1967, and was completed April 6, 1967.

Procedures and Results

A total of six captive tests were conducted to determine the capability of a GCV to withstand the track induced vibration environment. For each test, the unit was mounted, as in actual GCV testing, by placing it in the retro-fire position atop one of 7344's 56-1/2" ejector sleds. The units two lugs were contained in special pneumatically operated latches and military ejection rack sway braces were positioned against the unit. The ejector pad (saddle) was placed under the unit's center of gravity as for actual ejection testing. The lugs and sway braces were located as follows:

Unit Front Lug	Unit	Station	25.12
Unit Front Sway Brace	"	"	30.56
Ejection Pad Center (Unit cg)	"	"	38.22
Unit Rear Sway Brace	"	"	48.69
Unit Rear Lug	"	"	56.19

For each test, the sled was launched Northward from Station 95 on the 3000-foot track and for all but the last test, rocket power consisted of four live HVAR's and three empties for ballast. For the last test, a 150% overtest, seven HVAR motors were used.

Figures 1, 2, and 3, depict a captive GCV mounted on an ejector sled prior to testing. Please note that the unit shown is GCV-1, used only for the sixth and final captive test. This unit, unlike GCV-2 used for the other five tests, had a live rocket motor and an explosively actuated ejection switch simulator.

Vibration instrumentation consisted of up to nine accelerometers distributed, in triaxial groups, at any of three chosen locations. The locations, chosen by the position of vulnerable unit components, are as follows: 1) the unit attitude sensing gyros; 2) the unit forward lug; 3) the joint between the unit and the aft bulkhead of the rocket motor. The gyros, because of a vibration limit of 10g rms, 200 Hz maximum vibration, were instrumented by placing a vertical accelerometer on the top of the roll gyro, and lateral and longitudinal accelerometers on the top of the pitch gyro. So as to not damage live gyros during the preliminary evaluation tests, dummy gyros, having similar weight, cg and MI were constructed. They were used on the first four of the six tests conducted.

The front lug was chosen because of its good reference position for vibration inputs to the unit. A vertical accelerometer was placed on the unit skin right behind the lug. A lateral accelerometer and a longitudinal one were placed on the base of the lug. The interest in the rocket motor location stemmed from a seemingly conservative 10g rms estimate of maximum allowable rocket motor vibration. At this location, the vertical accelerometer was placed on the unit bottom (carried upward on the sled as the sled mounting is 180° different from normal carriage), and the lateral and longitudinal accelerometers were mounted on one side of the unit.

To transmit the vibration data, two telemetry systems were available. One system, mounted on the sled, was furnished by Organization 7335, and had a total of six channels. The other system, having three channels available for vibration data, was the GCV package inside the unit. When the GCV TM package was used, its accelerometers were mounted on the unit front lug.

Table I lists the accelerometers used for each test.

As it was felt that some type of vibration isolation might be needed, a set of rubber-isolated shoes was constructed for the ejector sled, rubber was obtained to be placed between the unit, saddle, and sway braces, and isolation devices were purchased for gyro mounts.

An isolated sled shoe consists of an aluminum shoe machined to inside dimensions 3/16" larger than the outside dimensions of a standard mild steel shoe liner. The shoe liner is then suspended inside the aluminum by 3/4" wide strips of 7/32" thick, 25 Shore durometer, silicon rubber compressed into the 3/16" clearance. There are two such strips on the top of the liner; one on each side and one on each lower lip.

The rubber used between the unit and supports was 1/16", 40 Shore durometer, silicon rubber.

The gyro isolators were commercially purchased items obtained by T. T. Shishman, 9224.

Table I indicates the isolation used on each test.

The first test, using isolated shoes, was conducted on April 3, 1967. Nine accelerometers were monitored, but the gyro lateral channel went bad before recording any valid information. To obtain the information lost on the final test and also to check environment repeatability, a second test was conducted on April 4, 1967. For this test, only the sled mounted telemetry system was used. Three accelerometers were placed on the gyros, and three on the unit front lug. Comparison of vibration band pass analyses of the two tests indicated repeatability; the vibration environment was very nearly identical. Sled velocities at the theoretical ejection point were 397 fps and 402 fps. As the vibration records for these and other tests were used as inputs for a series of vibration tests, they are not included in this report. They will, however, be placed in the report published by 7324 dealing with the GCV-2 vibration tests.

Two tests, Number's 3 and 4, were conducted on April 6, 1967. The final test used both isolated shoes and rubber between the unit and saddle and sway braces, while the second test was completely unisolated. All nine accelerometers were used on both tests, and velocities at the theoretical ejection point were 397 and 404 fps respectively.

Comparison of data from the above mentioned four tests indicates that the addition of 40 Shore durometer rubber between the unit and its mountings does not appreciably affect the environment. Secondly, though somewhat helpful, the isolated shoes do not make much difference in limiting vibration.

At this point, a series of vibration tests was conducted by Organization 7324. During this series, several gyro isolation devices were tried on the dummy gyros. The best isolation having been determined, one final, live gyro, vibration test was scheduled. It was then discovered that the dummy gyros provided were markedly heavier than their real counterparts. It was therefore necessary to estimate rather than evaluate the expected performance of the isolation systems.

On April 15, 1967, Test No. 5, a live gyro captive test was conducted using isolated shoes and isolated gyros. In comparison with the non-isolated dummy gyro track tests, the results indicate that the isolation reduces the frequency of the transmitted vibration, but does not appreciably reduce amplitude. The sled velocity of this shot was 413 fps.

The sixth and final captive test, conducted on April 24, 1967, utilized the live GCV-1, the unit scheduled for the first full scale GCV test. The unit, having no dummy components, was to undergo a full simulation of the actual test with the exception of unit ejection and ignition. For an added confidence factor, a 50% overtest was decided upon. An overtest, in

this instance, is not easily definable in that the variable of interest, track vibration environment, is not clearly predictable. As the vibration amplitude seems to have a fairly direct dependence on sled velocity, velocity was arbitrarily chosen as the overtest variable. Even though the sled velocity was increased, the time intervals between unit events were kept the same as the actual test by altering track stations. To simulate unit-sled separation, a Conox explosive latch pin was placed against the ejection switch, and initiated by the ejection screen box.

A list of times and events follows:

1.	Sled Launch	0.00 second
2.	Track Switch (1)	0.97 second
3.	Track Switch (2)	1.07 seconds
4.	Track Switch (3)	3.20 seconds
5.	Sled Water Brake	

Track Switch 1 uncaged the gyros and armed the unit hydraulic power. Switch 2 ignited the explosive latch pin to simulate unit ejection. Switch 3 recaged the gyros to prevent damage during sled water braking. To insure the electrical pulses activating the above mentioned events were of adequate length, the sled cutter bars served to close redundant MC824 circuits at each track switch. The switch closures connected a sled mounted battery to the unit.

After the test, the unit was completely dismantled and requalified for the first full scale GCV test. Included in the inspection was an x-ray analysis of the off-loaded TE-M-469 rocket motor. The entire re-examination indicated no component damage, thus closing this program and reopening the full scale GCV schedule (T-12190).

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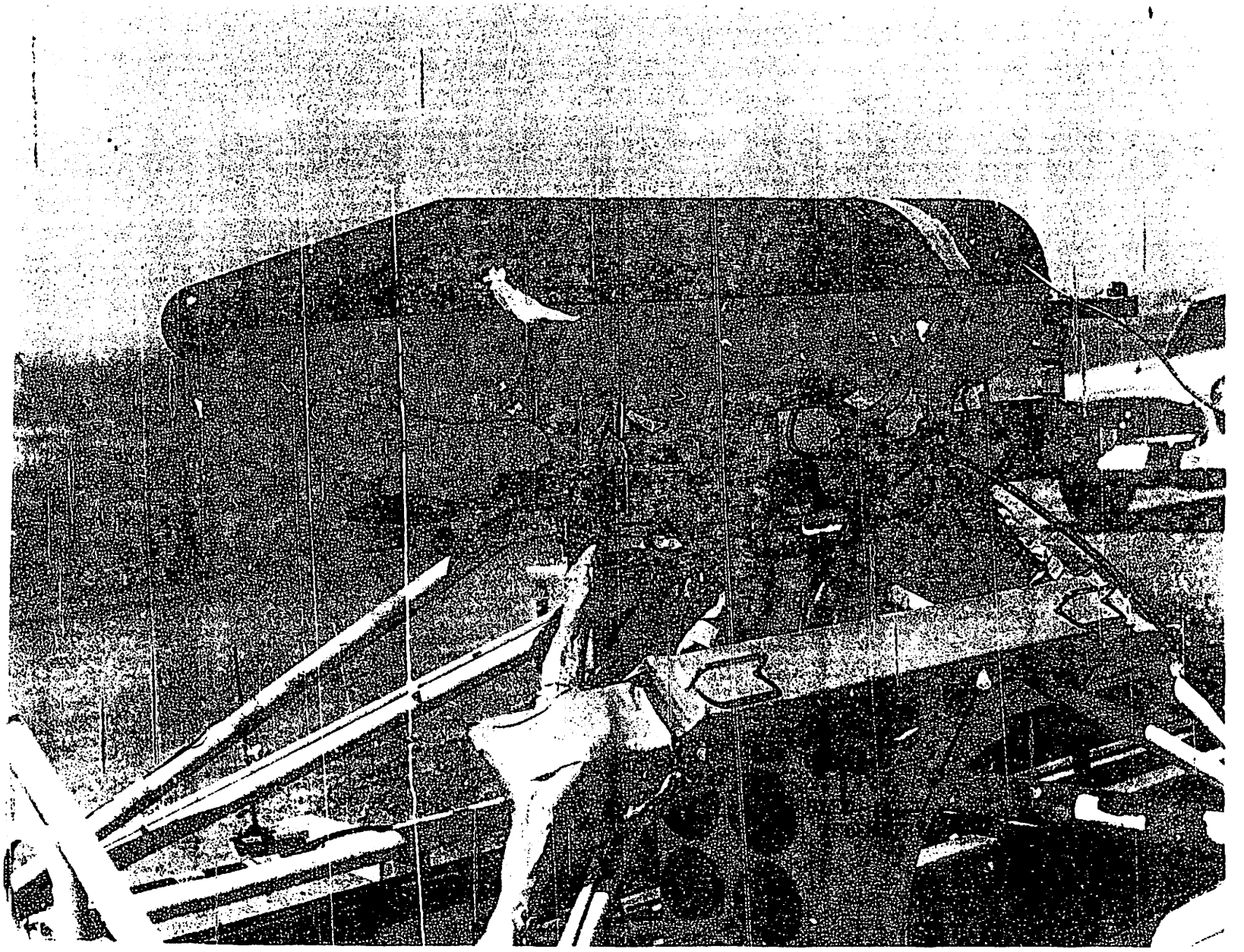

[illegible] CAPTIVE GCV PRIOR TO TESTING

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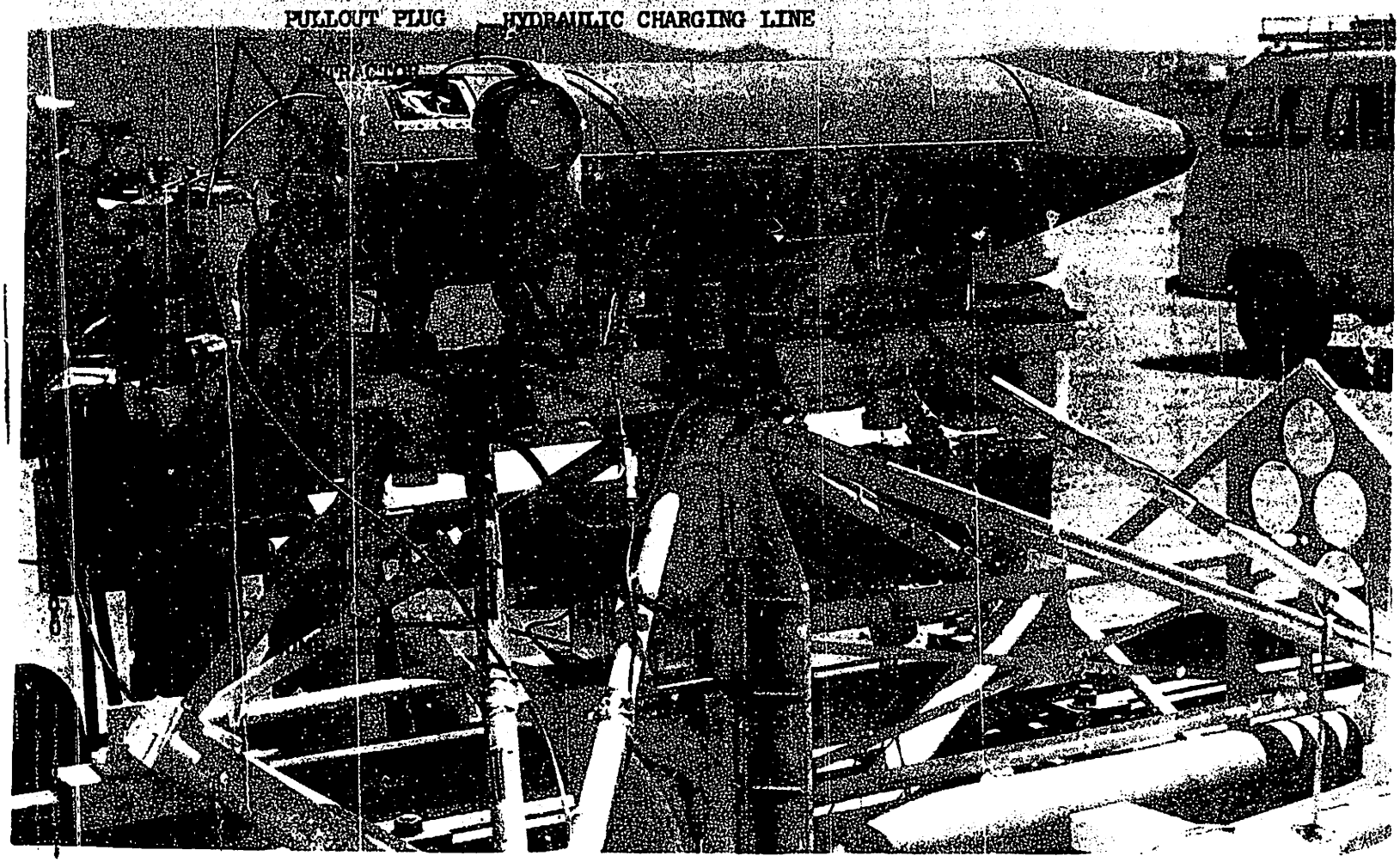

FIGURE 3. CAPTIVE GCV PRIOR TO TESTING

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TABLE 1

Sheet 1 of 1

TEST	DATE	SLED VELOCITY @ EJECTION POINT	ACCELEROMETERS: GYROS VERT	GYROS LAT	GYROS LONG	FWD LUG VERT	FWD LUG LAT	FWD LUG LONG	ROCKET AFT JOINT VERT	ROCKET AFT JOINT LAT	ROCKET AFT JOINT LONG	ISOLATION: SHOES	SHEET RUBBER	GYROS	DUMMY GYROS	DUMMY ROCKET
1	4-3-67	397 fps	X	X	X	X	X	X	X	X	X	X			X	X
2	4-4-67	402	X	X	X	X	X	X				X			X	X
3	4-6-67	397	X	X	X	X	X	X	X	X	X	X	X		X	X
4	4-6-67	404	X	X	X	X	X	X	X	X	X				X	X
5	4-15-67	413	X	X	X	X	X	X				X		X		
6	4-24-67	616				X	X	X				X				

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