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MLM-2106

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LES 8/9 Vibration Test on a Multihundred Watt FSA

C. G. Anderson and C. O. Brewer

May 2, 1974

MOUND LABORATORY
Miamisburg, Ohio
operated by
MONSANTO RESEARCH CORPORATION
a subsidiary of Monsanto Company
for the
U. S. ATOMIC ENERGY COMMISSION
U. S. Government Contract No. AT-33-1-GEN-53

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ABSTRACT

A random vibration test was performed on a $^{238}PuO_2$ fueled Multihundred Watt (MHW) fuel sphere assembly (FSA). The FSA (MHFT-11) was mounted in a Mound Laboratory test fixture and subjected to sinusoidal and random vibration energies on three orthogonal axes while in a simulated operational condition. The FSA temperature was maintained at 1000°C during the vibration test. Visual and radiographic inspections subsequent to the test indicated no apparent degradation of the FSA.

The MHFT-11 fuel sphere assembly (FSA) was vibrated to determine its ability to withstand the vibration environment levels expected to be encountered during the powered flight phase of a Titan III C vehicle during a LES 8/9 launch. The tests were designed to evaluate the effect of the graphite/metal and metal/fuel clearances as well as vent performance. Safety considerations and dynamic response characteristics were incorporated into the test fixture.

The original test requested was a LES 8/9 qualification-level test utilizing a $^{238}PuO_2$ fueled FSA (MHFT-11). Pre- and post-baseline tests were conducted. General Electric, Energy Systems Program (GE/ESP) provided Monsanto Research Corporation, Mound Laboratory (Mound) with a modified LES 8/9 qualification-level spectrum (Schedule A). This schedule reflects vibrations input to an FSA as observed during a generator-simulated shaker test on a heat source assembly conducted at GE/ESP.

GE/ESP analyzed the Mound vibration data for Runs 1-21 which used Schedule A. After this data reduction, Schedule B was provided to Mound. Schedule B was a qualification test schedule that took into account the transmittance responses of the Mound test fixture. Schedule B was used by Mound for the tests on MHFT-11, Runs 22-27.

Schedule C was submitted to Mound by GE/ESP as an acceptance test schedule for LES 8/9 after data reduction indicated Schedule B was valid as a qualification test. Schedule C was used for the dynamic tests which were performed subsequent to the PuO_2 fueled tests on the seven fueled safety sequential test (SST) units.

The test data, as well as the inspections conducted after the tests, indicated that the FSA is satisfactory for its intended use.

ATTACHMENTS

ATTACHMENT A

1. ALPHA FUELS ENVIRONMENTAL TEST FACILITY

Fueled FSA Fixture Vibration Test Procedure

The fueled FSA fixture shall be subjected to a vibration environment to determine its ability to withstand the specified vibration levels and duration.

1.0 Objectives

To evaluate the performance of an FSA under the LES 8/9 vibration environment, such as would be encountered during the powered flight phase of a Titan III C launch vehicle.

a) Evaluate the effect of the clearance between the fuel sphere and the PISA (post-impact sphere assembly) on the integrity of the fuel sphere, particularly the production of fines resulting from exposure to a vibration environment.

b) Evaluate the effect of the clearance between the fuel sphere and the PICS (post-impact containment shell) on the integrity of the iridium PICS.

c) Evaluate the performance of the PISA vent after exposure to a vibration environment.

d) Time permitting, evaluate the effect of clearance between the PISA and the Graphite Impact Shell.

2.0 Scope

The fueled FSA fixture will be subjected to sinusoidal and random vibration in three orthogonal axes while in a simulated operational condition.

3.0 Facilities and Equipment

3.1 Test Fire Facility

3.1.1 Random Frequency Generator

3.1.2 XY Recorder

3.2 Alpha Fuels Facility

3.2.1 M.B. Electronics

3.2.1.1 Shaker, Model C21
3.2.1.2 Exciter, Model 1025
3.2.1.3 Accelerometer, MB304
3.2.1.4 Liner Driver
3.2.1.5 Zero Drive Amplifier, N400

3.2.2 Vibration Readout Equipment

3.2.2.1 XY Recorder Input Selector, MB N-74
3.2.2.2 Log Convertor, Hewlett Packard, 7560 AM
3.2.2.3 XY Recorder, Hewlett Packard, 135
3.2.2.4 Oscilloscope, Tekronics
3.2.2.5 True RMS Voltmeter, Ballantine Lab M320
3.2.2.6 DC-AC Calibrator, Ballantine Lab M421A

3.2.3 Functional Readout Equipment

3.2.3.1 Digital Voltmeter, Weston, 1240
3.2.3.2 Recorder, Bausch & Lomb, VOM5

3.2.4 Miscellaneous Electrical Equipment

3.2.4.1 Volt-Ohm Meter, Simpson 260

3.2.5 Hand Tools

3.2.5.1 Test Fixture Handling Gloves
3.2.5.2 Torque Wrench
3.2.5.3 Allen Wrench Set
3.2.5.4 Slip Table Wrench Set
3.2.5.5 Open End Wrench Set

3.3 Hardware

The following hardware will be utilized:

- Vibration Test Fixture - Drawing SK-D-2380, Figure 1, designed and fabricated by MRC.
- PuO_2 - Fueled PISA - S/N MHFT-11.
- ThO_2 - Simulated PISA - S/N MHT-3.
- Graphite Impact Shell - S/N 854134 (HITCO).
- Graphite Impact Shell - S/N Body 420 with Cap 415B (Sanders).
- Graphite Impact Shell - S/N Body 421 with Cap 416A (Sanders).

4.0 Overall Instructions

4.1 Handling

4.1.1 Lift the FSA fixture, using the handling gloves, properly held by the fins.

4.2 Operating

4.2.1 The rate of change in the fin root temperature should not exceed 33°F in 10 min.

4.2.2 The PISA temperature should not exceed 2100°F.

4.2.3 The fin root temperature should not exceed 360°F.

4.2.4 Record data at approximately 20 min intervals during generator instability, and note in log any irregularities. When temperatures are stable, 1-hr intervals are adequate.

4.2.5 The temperature is to be 1832°F - 2100°F during testing.

4.3 Abort Conditions

4.3.1 A PISA temperature exceeding 2100°F may require termination of the test.

4.3.2 A sudden decrease in output power will terminate the test until adjustments are made.

4.4 Health Physics

4.4.1 Health Physics documents and/or requirements will be considered a part of this procedure.

4.4.2 In the event of a spill or health physics hazard, the test is terminated and the health physics supervisor will assume command of the operation, others will assist in any way possible.

4.4.2.1 Primary consideration will be given to reduce further hazard.

4.4.2.2 Secondary consideration will be given to reduce damage and waste of equipment.

5.0 Pretest Procedure

5.1 Open log.

5.2 Record date, time, and serial number of parts and test section generator.

5.3 Make a general survey to determine that all facilities and equipment are ready to perform the required tests and that sufficient standards lab calibrations have been made to validate the tests.

5.4 Zero and calibrate the recorders used for temperature and power.

5.5 Accept the FSA fixture in hot hall behind the test cell.

5.6 Visually inspect fixture for good physical condition and make log notation.

5.7 Move fixture into cell and connect power and instrumentation.

5.8 Record data and note acceptable condition in log.

6.0 Test Plan and Sequence

6.1 Test 1 - Hot Thermal Checkout Bench Test (This is not a shake test)

This test uses simulated PISA S/N MHT-3 and graphite impact shell S/N Body 420 with Cap 415B.

- Heat-treat simulated (ThO_2) PISA 1 hr at 1500°C according to specific instructions.
- Assemble simulated FSA in test fixture.
- Instrument PISA and fixture.
- Power up to 1832°F - 2100°F, as measured on the PISA, steady state.
- Record fixture and PISA temperatures after they reach steady state.
- Record power and temperature at several points as power is applied.
- Record temperature in accelerometer and shaker table mounting plate areas.
- Verify by post-test examination that preload and differential thermal expansion are acceptable.

6.2 Test 2 - Cold Dynamic Test

This test uses graphite impact shell S/N Body 421 with Cap 416A.

- Mount one accelerometer on fixture.
- Mount one accelerometer in metal simulated fuel core.

- Assemble simulated FSA in test fixture according to specific instructions.
- Perform both the sine sweep and random vibration test on two axes; the excluded axis is either one of the two symmetrical axes.
- Perform a 1-*G* sine sweep from 20 to 2000 Hz in 3 min.
- Perform the random vibration test spectrum, Schedule A.
- Verify by post-test examination the cold dynamic structural integrity of the fixture.

6.3 Test 3 - Hot Safety Test With Simulated FSA

This test uses simulated (ThO_2) PISA S/N MHT-3 and graphite impact shell S/N Body 420 with Cap 415B (same as Test 1).

- Assemble simulated FSA in test fixture.
- Mount one accelerometer on fixture upper extremity.
- Mount one accelerometer on shaker mounting plate at bolt circle.
- Connect fixture and FSA thermocouples and instrument fixture external surface.
- Attain steady state FSA temperature of 1832°F - 2100°F.
- Perform a 1-*G* sine sweep similar to Test 2 on the same two axes.
- Perform the random vibration test spectrum, Schedule A, similar to Test 2 on the same two axes.
- Monitor thermocouples and heater power.
- Verify by post-test examination adequacy of fixture assembly.
- Retain assembled simulated FSA intact for future GE evaluation.

6.4 Test 4 - Fueled FSA Dynamic Test

This test uses PuO_2 fueled PISA S/N MHFT-11 and graphite impact shell S/N 854134.

- Heat-treat PISA 18 hr at 1500°C, according to specific directions.
- Open fueled PISA burst disk.
- Assemble fueled FSA.
- Assemble FSA in test fixture.

- Mount one accelerometer on fixture upper extremity similar to Test 3.
- Mount one accelerometer on shaker mounting plate similar to Test 3.
- Connect fixture thermocouples.
- Attain steady state FSA temperature of 1832°F - 2100°F.
- Perform the random vibration test spectrum, Schedule B, on x axis; and record response.
- Radiograph PISA, while in the fixture, through the PISA poles and at two points 90° apart through the equator.
- Attain required steady state temperature; perform the random vibration test, Schedule B, on y axis; and record response.
- Radiograph PISA, while in the fixture, through the PISA poles and at two points 90° apart through the equator.
- Attain required steady state temperature; perform the random vibration test, Schedule B, on the z axis; and record response.

7.0 Post-Test Procedure

7.1 Remove the FSA fixture from the vibration equipment.

7.2 Record in the log the results of a complete physical condition inspection.

7.3 Close out log, making comment as required.

Post-Test Evaluation - Phase 1:

Performed at MRC:

- Remove FSA from fixture.
- Drill out FSA lock pin.
- Remove PISA from FSA.
- Swipe components for fuel release.
- Visually inspect components.
- Radiograph PISA through the poles and at two points 90° apart through the equator.
- Test PISA for helium leak.
- Reassemble PISA in FSA (using new lock pin).

- Ship fueled FSA intact (PuO_2 fueled PISA S/N MHFT-7 and Graphite Impact Shell S/N 854134) to LASL for post-test evaluation - Phase 2.

- Provide to GE for further independent evaluation the following hardware:

  - Simulated FSA intact (ThO_2 PISA S/N MHT-3 and Graphite Impact Shell S/N Body 420 with Cap 415B).

  - Graphite Impact Shell - S/N Body 421 with Cap 416A.

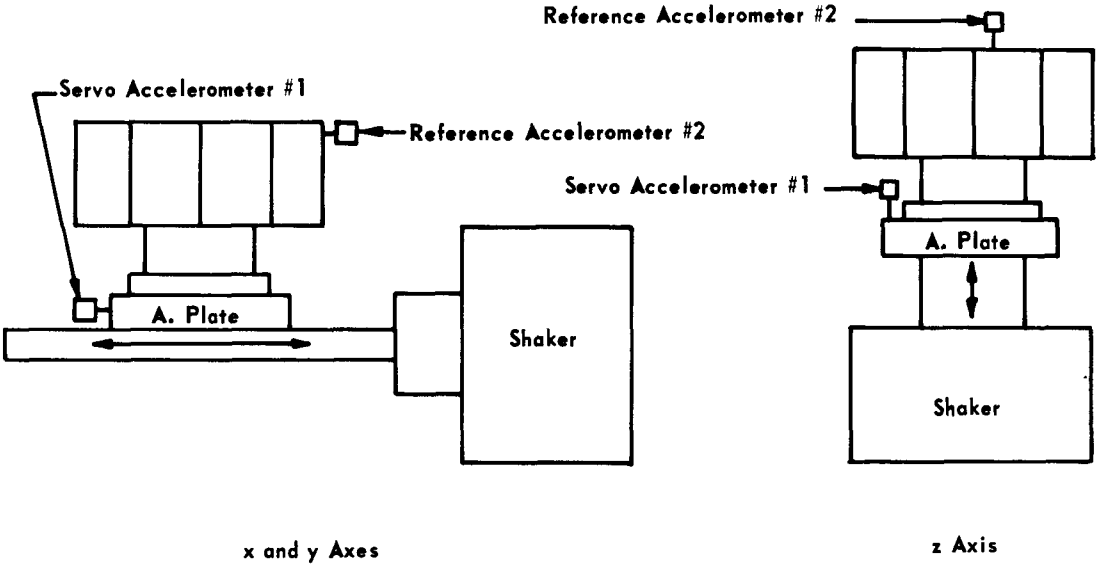

FIGURE 1 - Generator and pickup mounting.

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ATTACHMENT A

2. HEALTH PHYSICS PROCEDURE FOR THE VIBRATION TEST OF THE PIONEER SOURCE

Objective

The purpose of this procedure is to ensure good health physics precautions are used during the vibration test of the Pioneer Source and Generator.

I. The building will be checked out by a health physics surveyor before the source is removed from the universal shipping container.

   A) The air sample pump will be started and new air samples will be installed.

      1) The time the air samples are changed will be recorded.

      2) The changed air samples will be counted by the SM counting room for background reference.

   B) The stack monitors will be checked out to ensure they are in operating condition.

      1) New filter media will be installed.

      2) The instruments will be set on the X1 scale, alarm at 50 counts/min, and the air flow at 40 liters/min.

   C) The air monitors in the building will be checked with a source and set to operating levels.

II. Cell 107 shall be prepared by the following:

   A) Five to ten general wipes shall be taken throughout the cell to check for levels of contamination.

   B) A plastic sheet shall be installed over the entrance to the cell to act as a contamination control barrier between the cell and the cell main door and operating Corridor 114.

   C) Film badges shall be worn at all times by the operating personnel, and personnel working with the source will be issued wrist badges.

D) Work shall be done in two-piece whites, safety shoes, and respirators (worn either in use or around the neck).

E) The operating corridors will be treated as a yellow control zone.

III. The source will be monitored for unloading inside the cell.

A) Gamma-neutron readings shall be taken on the generator at approximately those distances where personnel will be working.

B) Wipes shall be taken on the generator to check for alpha contamination which may be present from a possible ruptured capsule.

C) If no high levels of contamination are present, the capsule will be permitted to be prepared for the test. When the preparation of the capsule is completed, the personnel in the cell shall be checked for contamination upon their clothes and person before leaving the cell. After checkout, personnel shall leave the cell by the hole in the plastic barrier, and the plastic barrier shall be sealed and the cell main door shut.

IV. Before and during the test, health physics shall monitor the outside operating corridors by:

A) Performing gamma-neutron surveys at the cell window and walls.

B) Checking air samples in the corridors.

C) Observing the air monitor inside the cell to notice any increase in the meter or the alarming of the monitor by the flashing of the red visual alarm if a release has occurred.

D) Checking the air monitors in the corridors for increases on the meters and possible alarming.

E) Taking spot wipes in the corridors to check contamination levels.

V. Upon reentry into the cell, the cell main door shall be opened and the plastic barrier shall be wiped on the outside to check for alpha contamination. The plastic barrier shall then be cut and wipes shall be taken on the inside of the plastic to check for contamination. If no, or low level, contamination is present, operating personnel shall be allowed to enter the cell for preparation of the capsule. General wipes shall be taken on the inside of the cell for contamination checks.

Exiting from the cell shall be in the same manner as prescribed in III.

VI. If, during the preparation or testing of the source, the source should accidently rupture, appropriate health physics actions shall be taken to protect all operating personnel from high levels of contamination, and the spread of contamination from the cell.

VII. After the tests are completed on the source:

A) All air samples shall be collected and counted.

B) Wipe surveys shall be taken of cell 107, the operating corridors and of all areas in the yellow control zone.

C) Records will be gathered and a report issued on the health physics aspects of the test.

VIII. The source will be loaded into the shipping cask at the completion of the test. The health physics surveyor will take the necessary surveys to return the source into the shipping cask.

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ATTACHMENT B

MHW TEST RUN SUMMARY SHEET

TEST #	NAME	RUN #	PURPOSE	REMARKS
1	Bench Test	---	To validate vibration fixture temperature and structure capabilities.	After several runs Kanthal D (0.020) wire was final choice. Expansion was not a problem. See Temperature vs. Input Power Plot.
2	Dynamic	1-8	To validate vibration fixture dynamic strength capability and dynamic transfer functions.	No tape cal. signal on tape. Random Schedule A.
3	Electric Heater Hot Safety Test	9-10	To validate fixture safety and heater capability.	(1) Tape Cal. on tape but not satisfactory to GE. Heater burned out during run -- did not affect test. Heater wire was changed to Kanthal A-1 (0.051) and potted in with Dylon-C cement. (2) Random Schedule A.

(1) GE wanted this test run while previous tapes were analyzed.

(2) GE wanted to re-run dynamic tests immediately.

MHW TEST RUN SUMMARY SHEET (Continued)

TEST #	NAME	RUN #	PURPOSE	REMARKS
2	Dynamic	11-19	Re-run of Dynamic runs using F.S. Tape Cal. & Added Accelerometer Data After Run 13.	Runs OK Per GE. Random Schedule A
3	Hot Safety and Elec. Heat	20-21	Re-run of Safety and Electric Heater Tests	Runs OK. Random Schedule A
4	Real Fuel Test	22-27	LES 8/9 Test on Fueled Capsule	Runs OK. Random Schedule B
2	Dynamic	28A-51A	Post Fueled Test Dynamic Test	More data desired by GE after above tests. Random Schedule C.
4	Safety Sequential	52-58	Launch Power Phase Vibration Input to FSA	Runs OK. Random Schedule C

ATTACHMENT C

RANDOM VIBRATION SCHEDULES

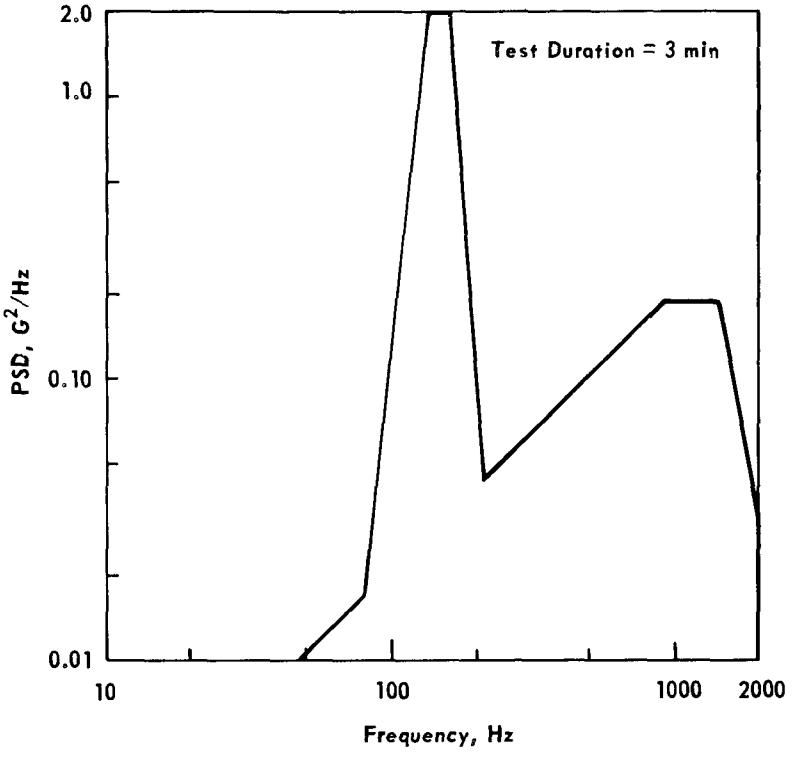

FIGURE 2 - Random vibration test schedule A.

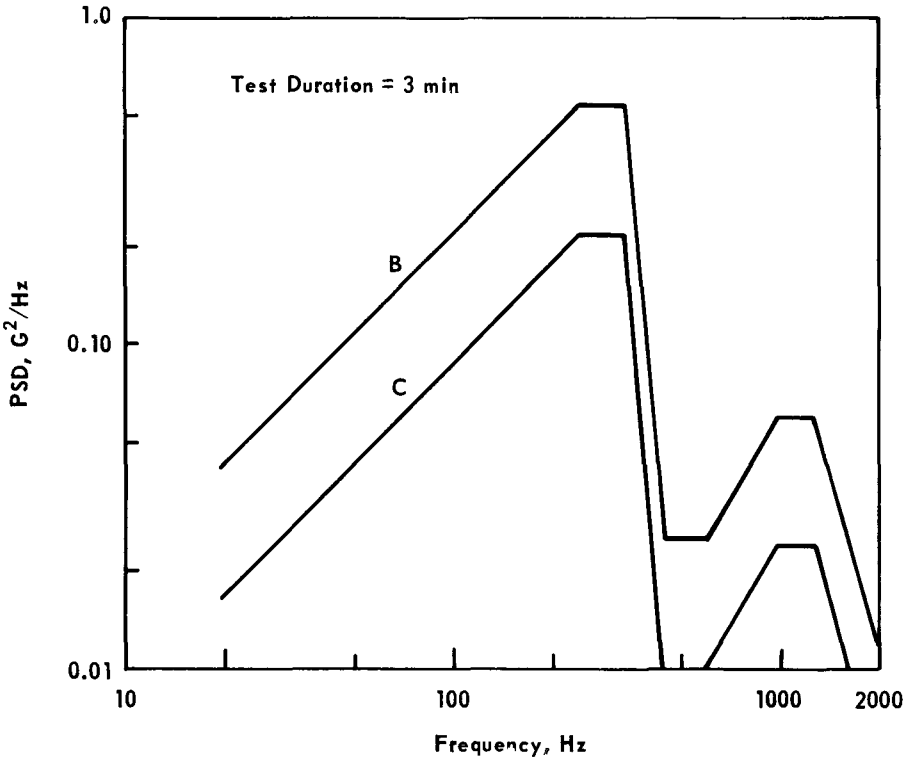

FIGURE 3 - Random vibration test schedule B & C.

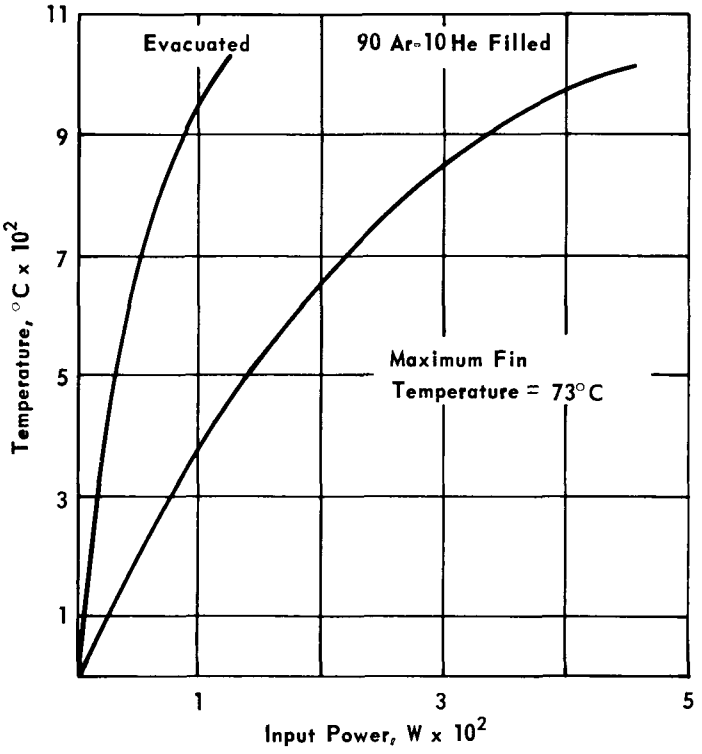

FIGURE 4 - MHW Test #1.

ATTACHMENT D

VIBRATION DATA SHEET

DATE 9/26/72 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 1 SERIAL # -- EQUIPMENT MB

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2			4	Metal Ball	300 grams simulated fuel ball
3			5	Graph - Same Axis	
4			6	Graph - Off Axis	

VIBRATION DATA SHEET

DATE 9/26/72 TEST PIECE Dynamic VIBRATION SCHEDULE A, Random

RUN # 2 SERIAL # -- EQUIPMENT Test Fire

Random Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	
2			4	Metal Ball	
3			5	Graphite - Same Axis	
4			6	Graph - Off Axis	

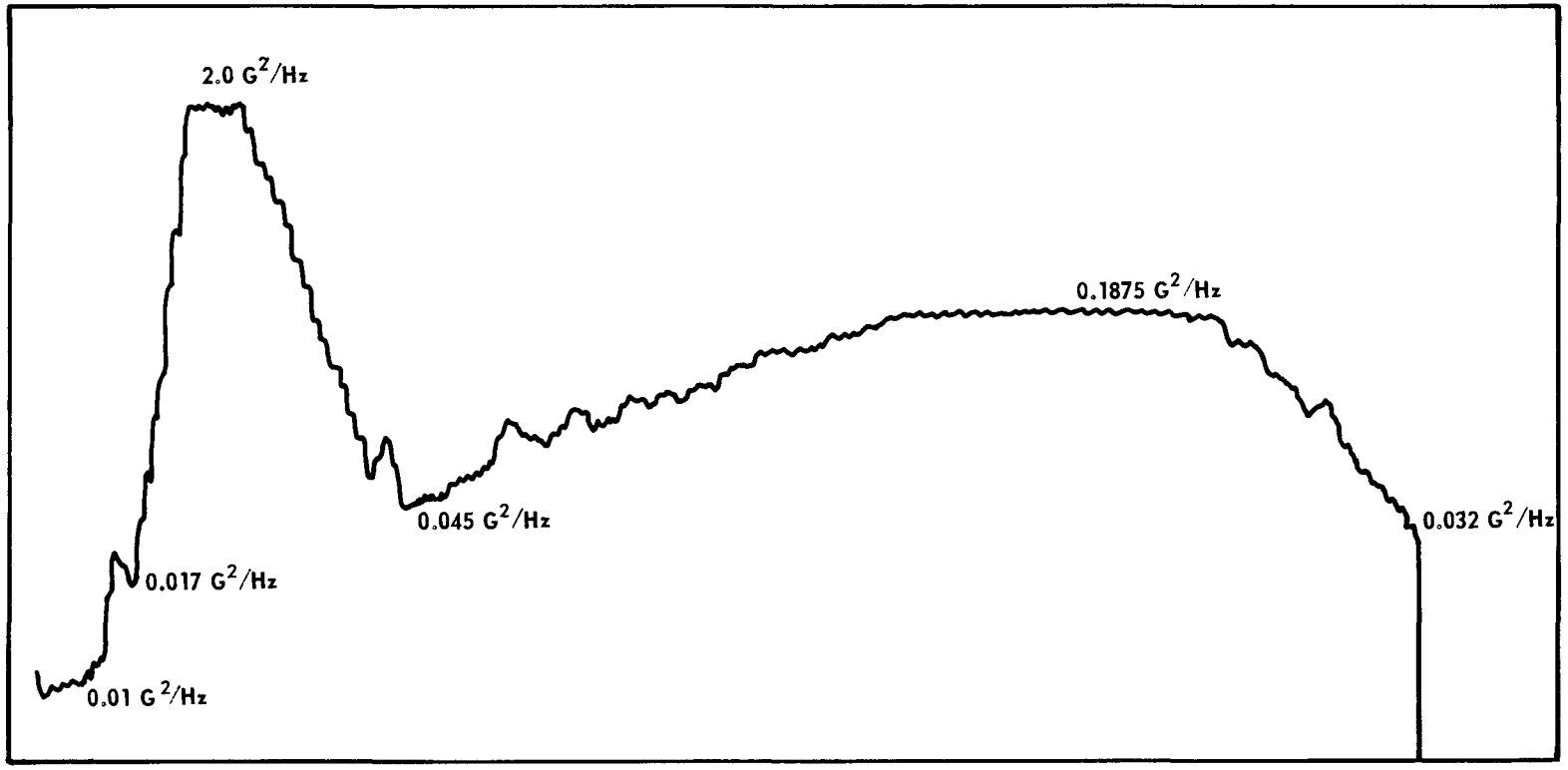

FIGURE 5 - Test #2, Run #2 (Sept. 26, 1972).

VIBRATION DATA SHEET

DATE 10/2/72 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 3 SERIAL # --- EQUIPMENT

Sine X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2			4	Metal Ball	
3			5	Graph - Same Axis	
4			6	Graph - Off Axis	

VIBRATION DATA SHEET

DATE 10/2/72 TEST PIECE Dynamic VIBRATION SCHEDULE A, Random

RUN # 4 SERIAL #--- EQUIPMENT Test Fire

Random X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2		4		Metal Ball	
3		5		Graph - Same Axis	
4		6		Graph - Off Axis	

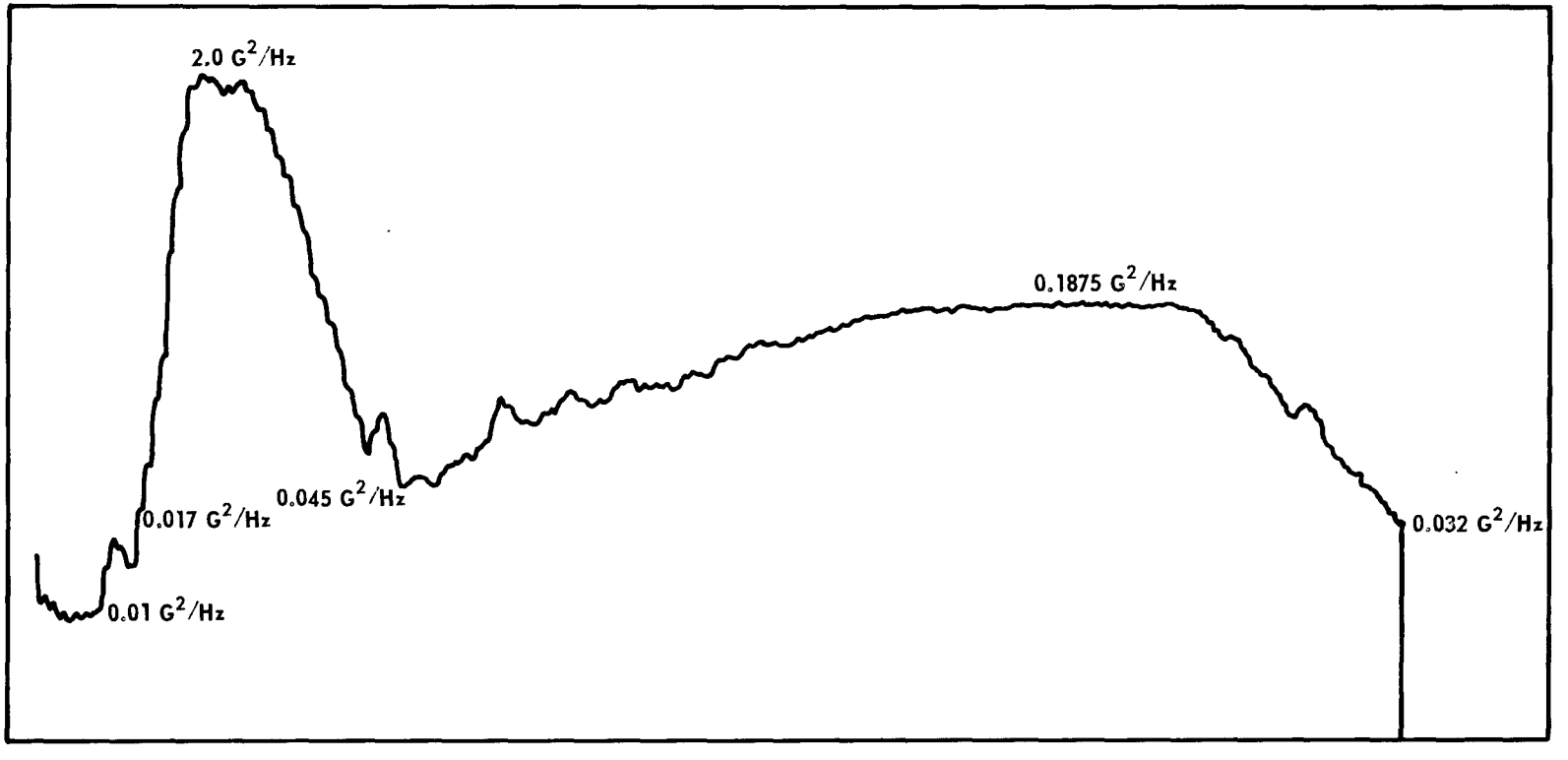

FIGURE 6 - Test #2, Run #4 (Oct. 2, 1972).

VIBRATION DATA SHEET

DATE 10/4/72 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 5 SERIAL # -- EQUIPMENT M.B.

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2	.92	30	4	Metal Ball	
3	.94	30	5	Graphite - Same Axis	
4	.93	30	6	Graph - Off Axis	

VIBRATION DATA SHEET

DATE 10/4/72 TEST PIECE Dynamic VIBRATION SCHEDULE A, Random

RUN # 6 SERIAL # -- EQUIPMENT Test Fire

Random Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2	.92	100	4	Metal Ball	
3	.94	100	5	Graph - Same Axis	
4	.93	100	6	Graph - Off Axis	

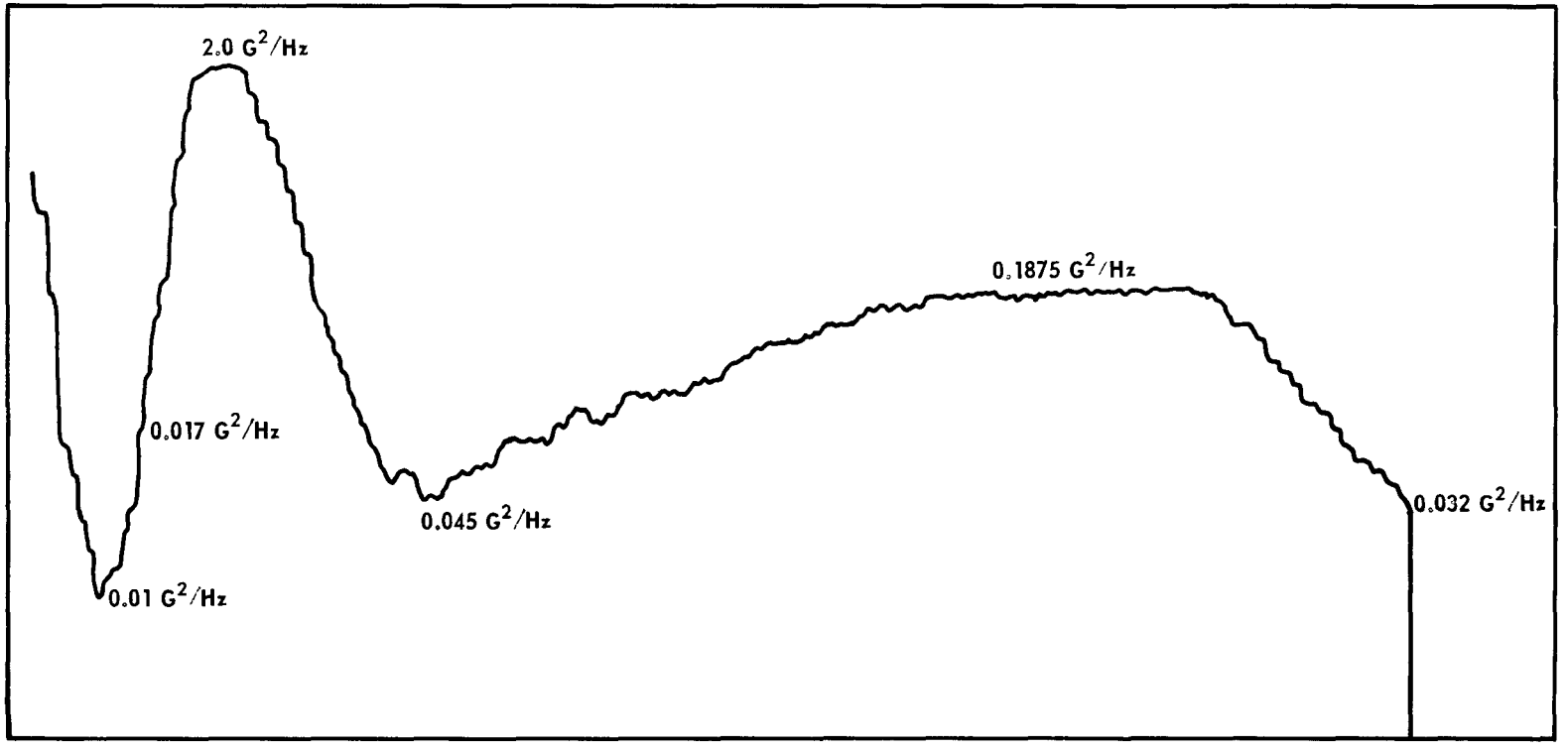

FIGURE 7 - Test #2, Run #6 (Oct. 4, 1972).

VIBRATION DATA SHEET

DATE 10/5/72 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 7 SERIAL # -- EQUIPMENT M.B.

Sine X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2	.92	30	4	Metal Ball	
3	.94	30	5	Graph - Same Axis	
4	.93	30	6	Graph - Off Axis	

VIBRATION DATA SHEET

DATE 10/5/72 TEST PIECE Dynamic VIBRATION SCHEDULE A, Random

RUN # 8 SERIAL # -- EQUIPMENT Test Fire

Random X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2	.92	100	4	Metal Ball	
3	.94	100	5	Graph - Same Axis	
4	.93	100	6	Graph - Off Axis	

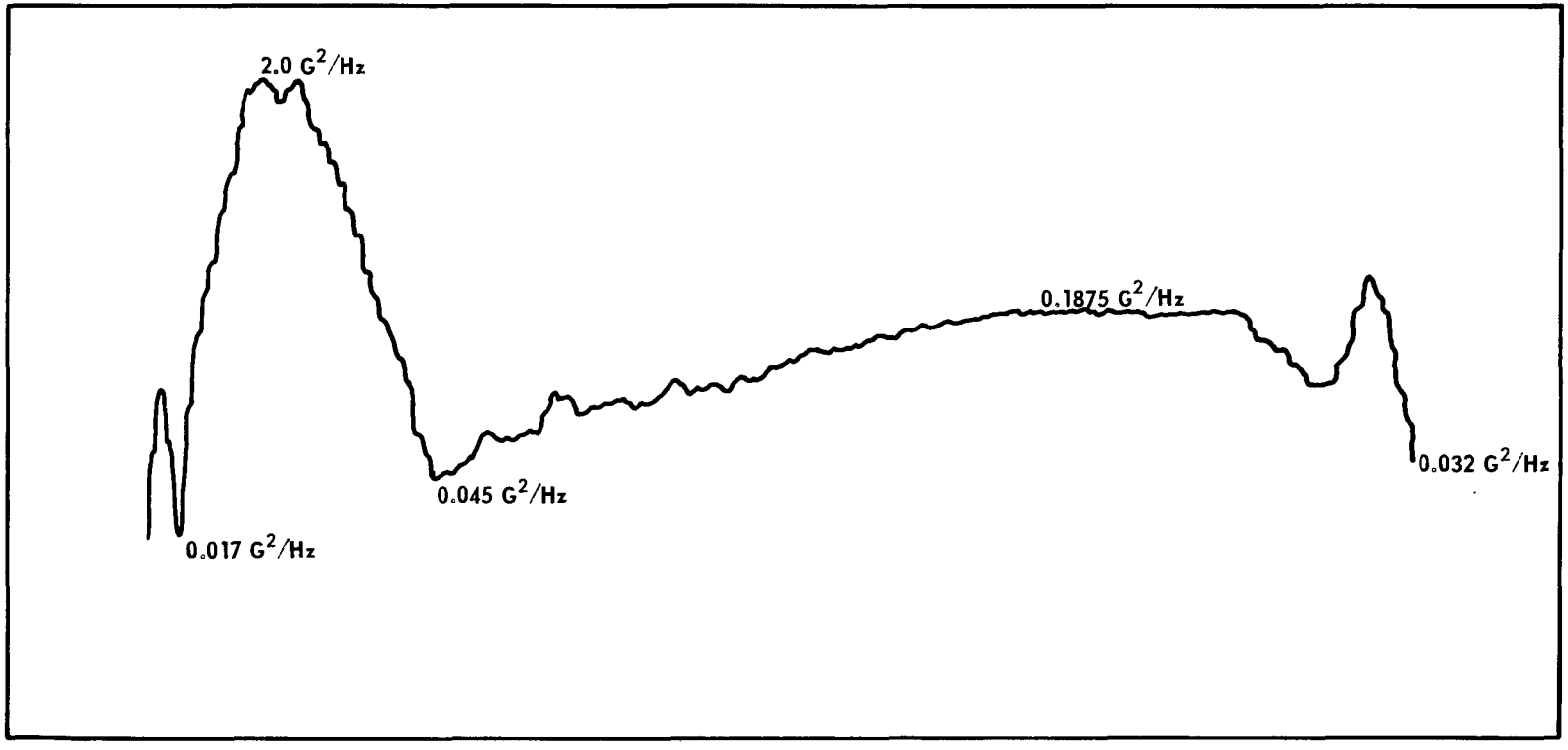

FIGURE 8 - Test #2, Run #8 (Oct. 5, 1972).

VIBRATION DATA SHEET

DATE 10/16/72 TEST PIECE ThO_2 Electric Heat VIBRATION SCHEDULE Sine .707G's RMS 20-2000 HZ

RUN # 9 SERIAL # -- EQUIPMENT M.B.

Sine X Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2				MTG Plate @ 180°	

VIBRATION DATA SHEET

DATE 10/16/72 TEST PIECE ThO_2 Electric Heat VIBRATION SCHEDULE A, Random

RUN # 10 SERIAL # EQUIPMENT Test Fire

Random X Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2				MTG Plate @ 180°	

VIBRATION DATA SHEET

DATE 11/8/72 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 11 SERIAL # -- EQUIPMENT M.B.

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	3	4	MTG Plate	
2	3	3	5	Metal Ball	
3	3	3	6	Graph - Same Axis	

VIBRATION DATA SHEET

DATE 11/8/72 TEST PIECE Dynamics VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 12 SERIAL # -- EQUIPMENT M.B.

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG Plate	Servo
2	3	10	5	Metal Ball	
4	3	10	6	Graph - Off Axis	

VIBRATION DATA SHEET

DATE 11/8/72 TEST PIECE Dynamic VIBRATION SCHEDULE A, Random

RUN # 13 SERIAL # -- EQUIPMENT Test Fire

Random Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG Plate	
2	3	100	5	Metal Ball	
3	3	100	6	Graph - Same Axis	
1A				MTG Plate @ 180°	Servo

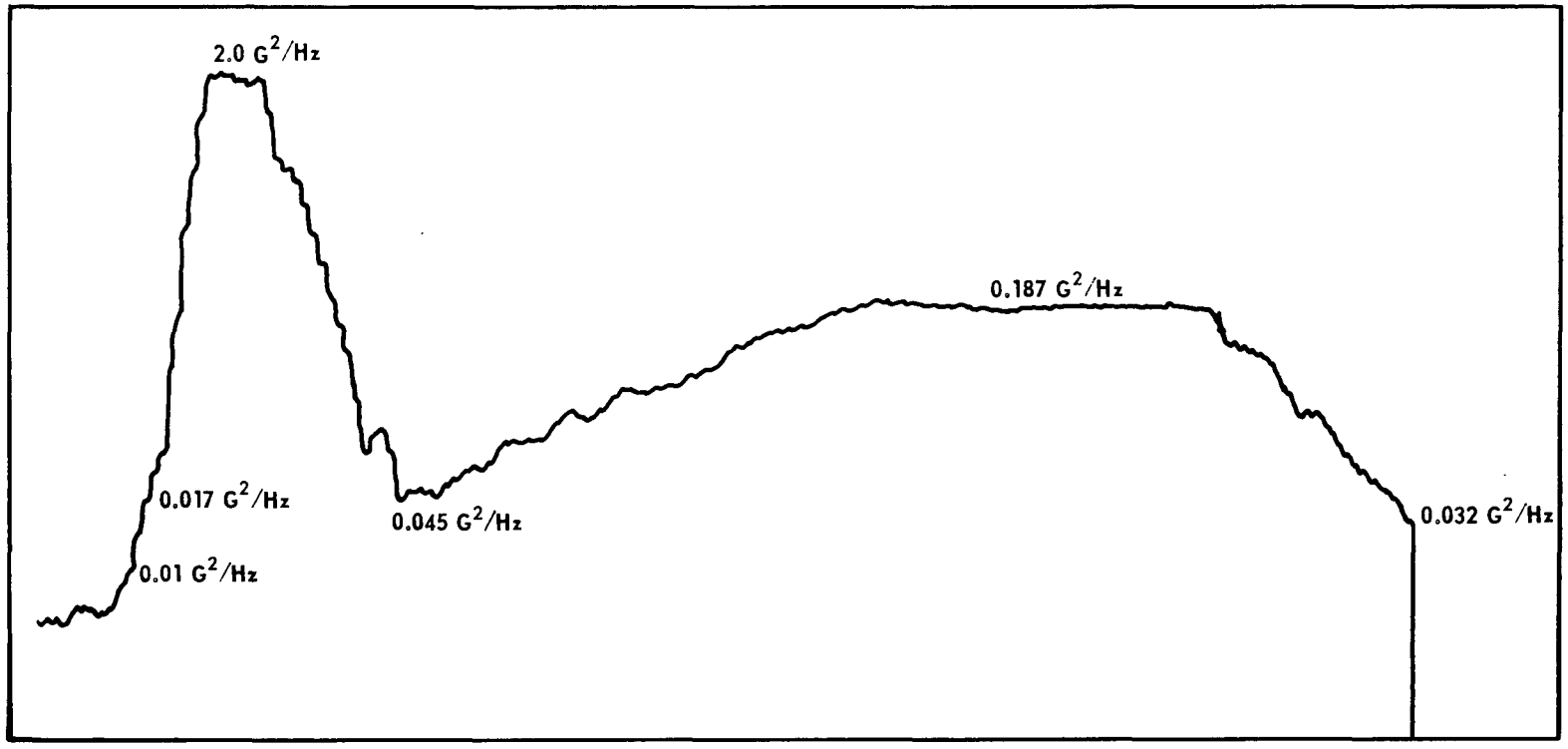

FIGURE 9 - Test #2, Run #13 (Nov. 8, 1972).

VIBRATION DATA SHEET

DATE 11/9/72 TEST PIECE Dynamic VIBRATION SCHEDULE A, Random

RUN # 15 SERIAL # -- EQUIPMENT Test Fire

Random Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG Plate	
2	3	100	5	Metal Ball	
4	3	100	6	Graph - Off Axis	
1A					Servo

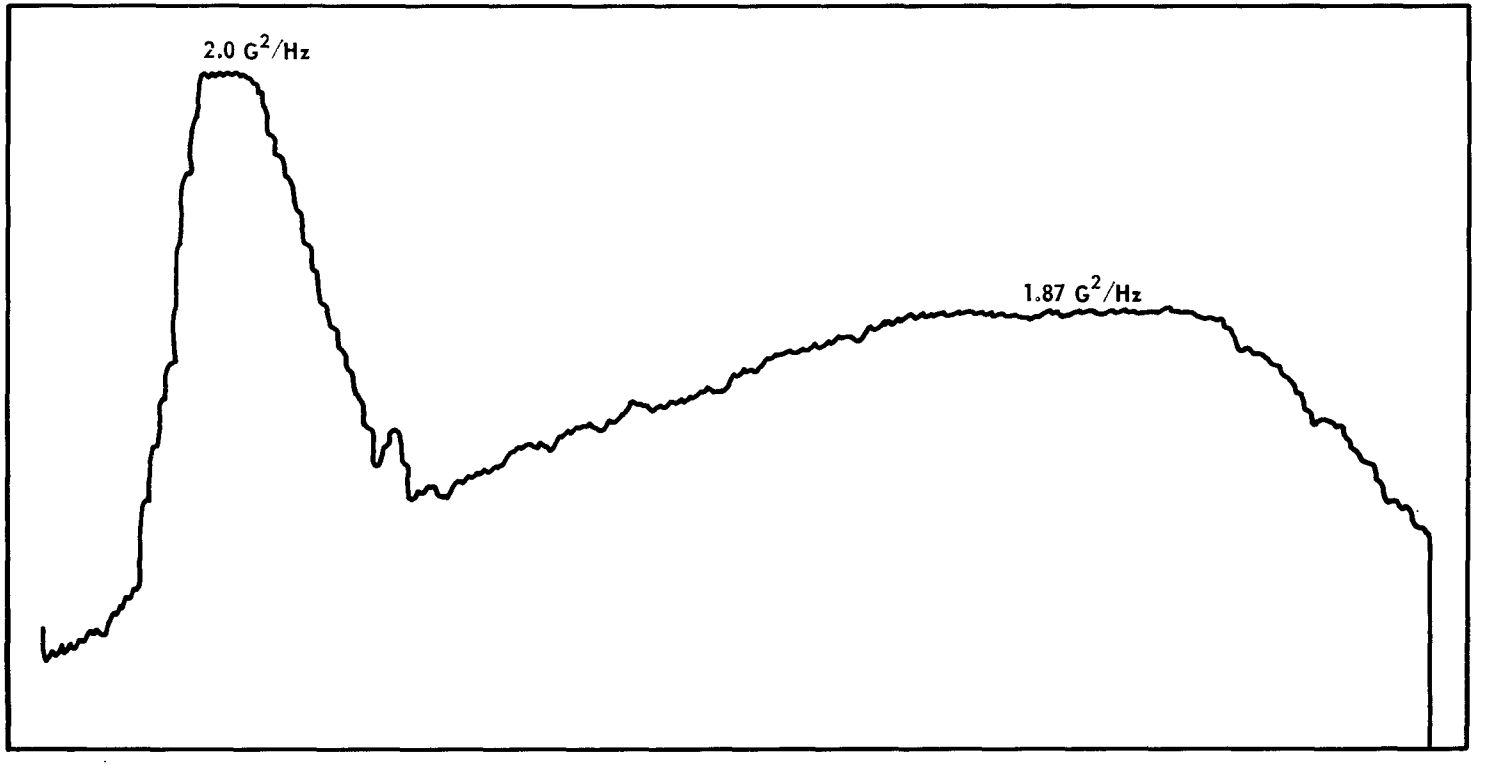

FIGURE 10 - Test #2, Run #15 (Nov. 9, 1972).

VIBRATION DATA SHEET

DATE 11/10/72 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 16 SERIAL # -- EQUIPMENT M.B.

Sine X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG Plate	
2	3	10	5	Metal Ball	
3	3	10	6	Graph - Same Axis	

VIBRATION DATA SHEET

DATE 11/10/72 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 17 SERIAL # -- EQUIPMENT M.B.

Sine X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG Plate	Servo
2	3	10	5	Metal Ball	
4	3	10	6	Graph - Off Axis	

VIBRATION DATA SHEET

DATE 11/10/72 TEST PIECE Dynamic VIBRATION SCHEDULE A, Random

RUN # 18 SERIAL # - - EQUIPMENT Test Fire

Random X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG Plate	
2	3	100	5	Metal Ball	
3	3	100	6	Graph - Same Axis	
1A				MTG Plate @ 180°	Servo

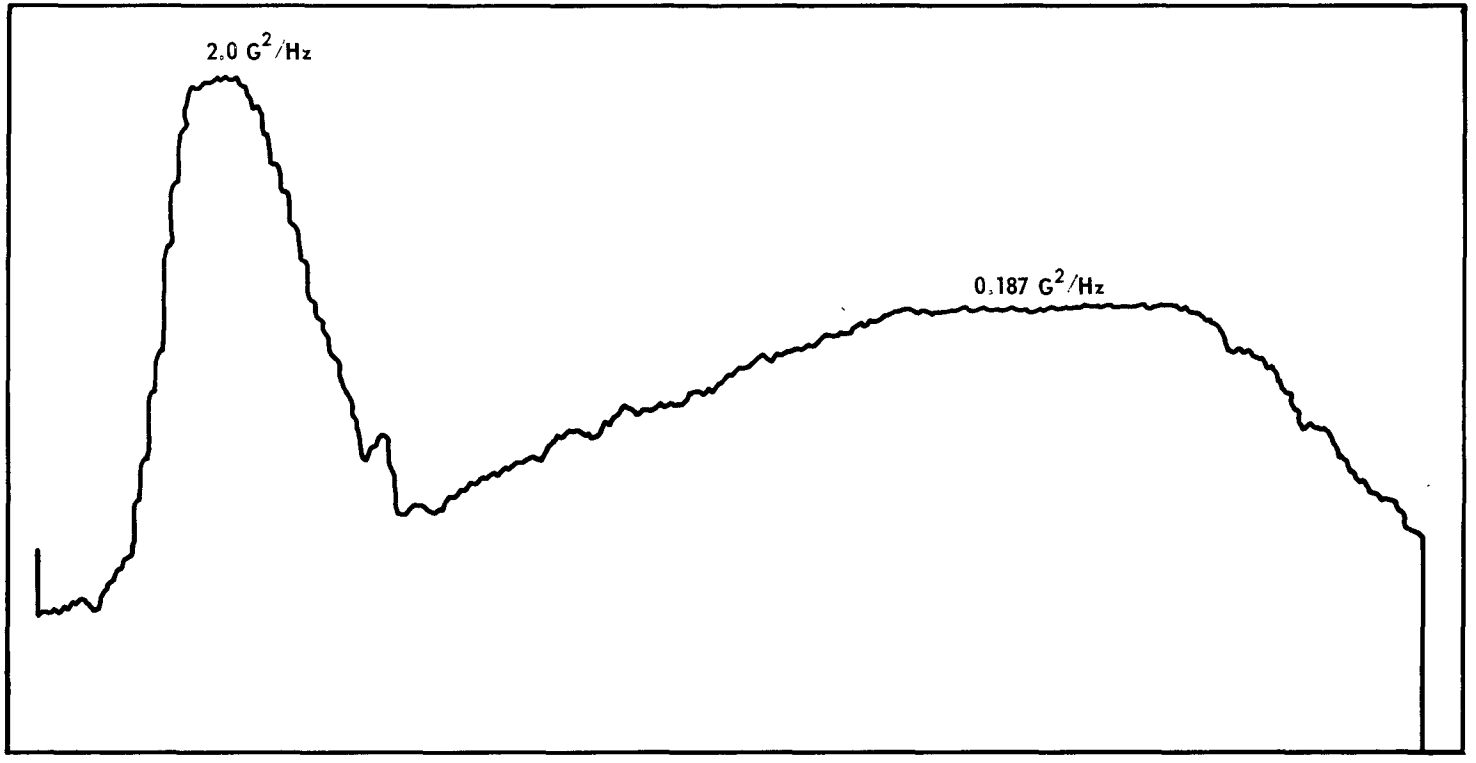

FIGURE 11 - Test #2, Run #18 (Nov. 10, 1972).

VIBRATION DATA SHEET

DATE 11/10/72 TEST PIECE Dynamic VIBRATION SCHEDULE A, Random

RUN # 19 SERIAL # -- EQUIPMENT Test Fire

Random X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG Plate	
2	3	100	5	Metal Ball	
4	3	100	6	Graph - Off Axis	
1A				MTG Plate @ 180°	Servo ToTF

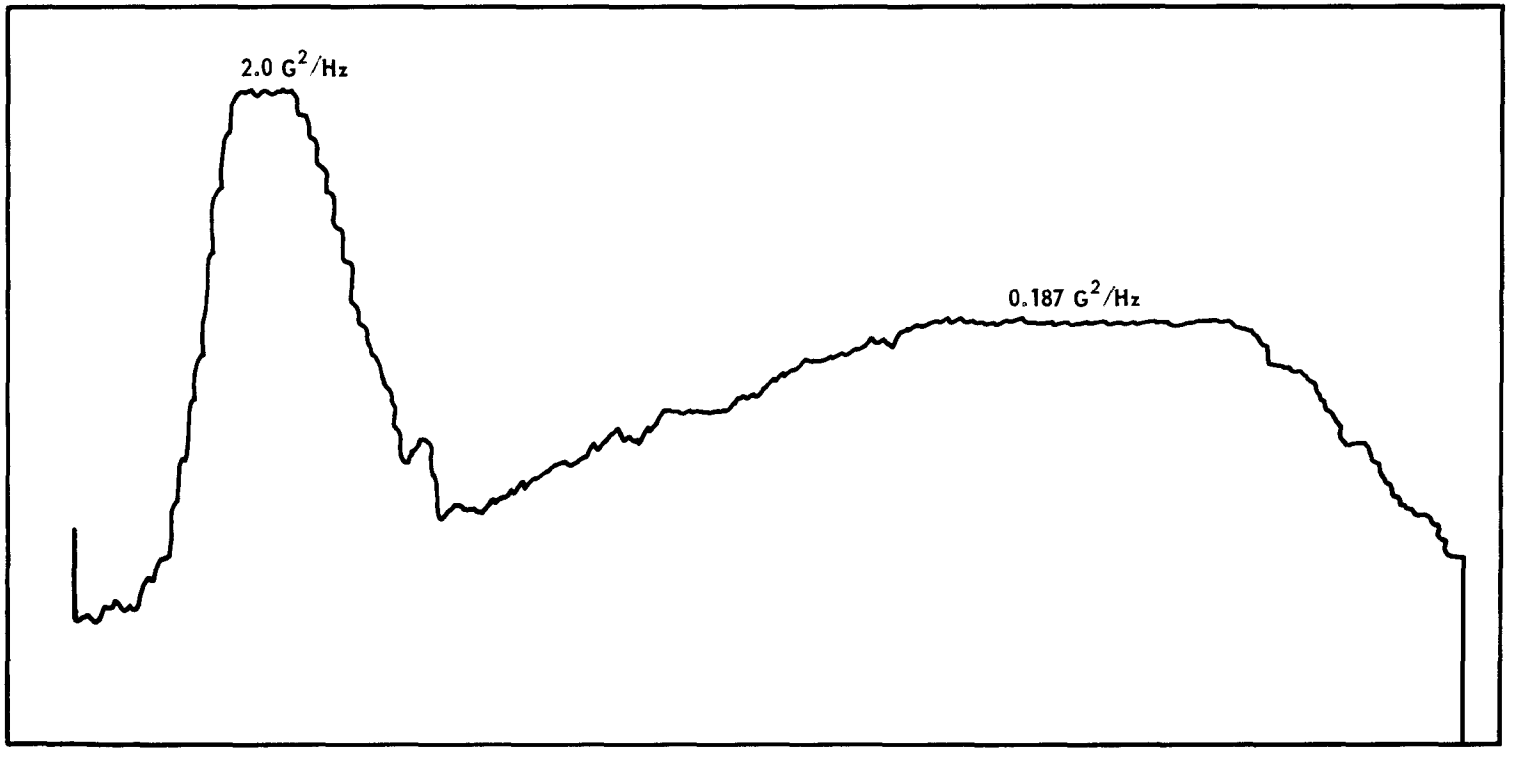

FIGURE 12 - Test #2, Run #19 (Nov. 10, 1972).

VIBRATION DATA SHEET

DATE 11/22/72 TEST PIECE ThO_2 VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 20 SERIAL # -- EQUIPMENT M.B.

Sine X Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2	3	10	4	Same @ 180°	
3	3	10	5	Fix. Top - Same Axis	
4	3	10	6	Fix. Top - Off Axis	

VIBRATION DATA SHEET

DATE 11/22/72 TEST PIECE ThO_2 VIBRATION SCHEDULE A, Random

RUN # 21 SERIAL # -- EQUIPMENT Test Fire, M.B.

Random X Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1				MTG Plate	Servo
2	3	100	4	Same @ 180°	
3	3	100	5	Fix. Top - Same Axis	
4	3	100	6	Fix. Top - Off Axis	

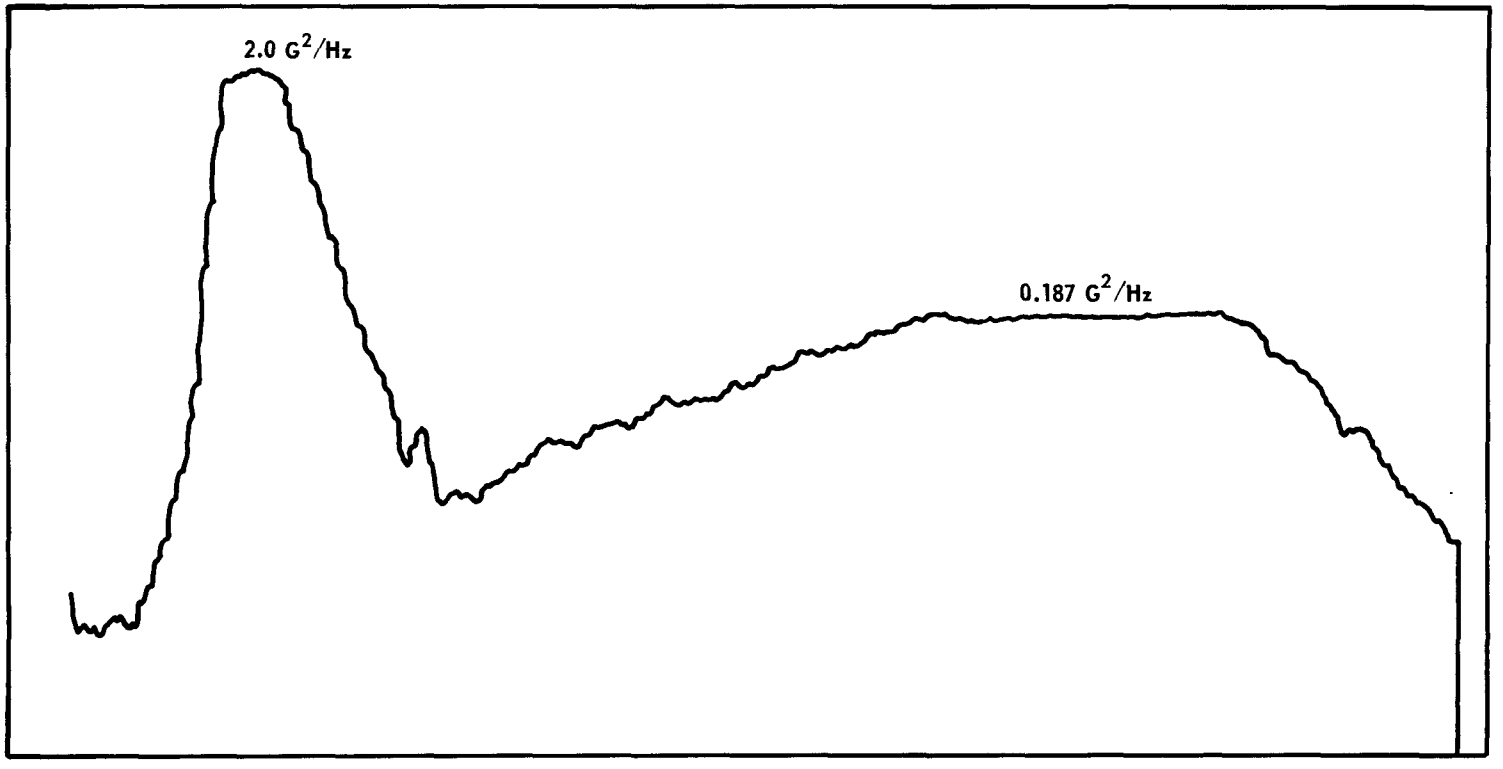

FIGURE 13 - Test #2, Run #21 (Nov. 22, 1972).

VIBRATION DATA SHEET

DATE 12/9/72 TEST PIECE Real FSA VIBRATION SCHEDULE Sine .707 RMS 20-2000 cps

RUN # 22 SERIAL # MHFT-11 EQUIPMENT M.B.

Sine Z Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1		10	--	MTG Plate	Servo Accel.
2	3	10	4	Same Above @ 180°	
3	3	10	5	Fix. Top - Same Axis	
4	3	10	6	Fix. Top - Off Axis	

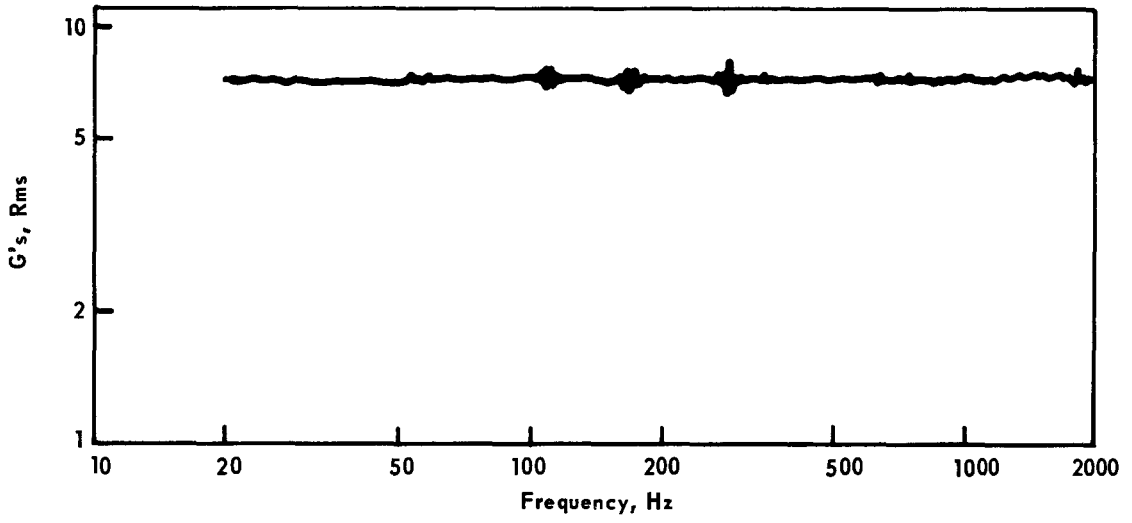

FIGURE 14 - Sine Run #22 (Dec. 9, 1972).

VIBRATION DATA SHEET

DATE 12/9/72 TEST PIECE Real FSA VIBRATION SCHEDULE E, Random

RUN # 23 SERIAL # MHFT-11 EQUIPMENT Test Fire - M.B.

Random Z Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1		100	--	MTG Plate	Servo Accel.-T.F.
2	3	100	4	Same Above @ 180°	
3	3	100	5	Fix. Top - Same Axis	
4	3	100	6	Fix. Top - Off Axis	

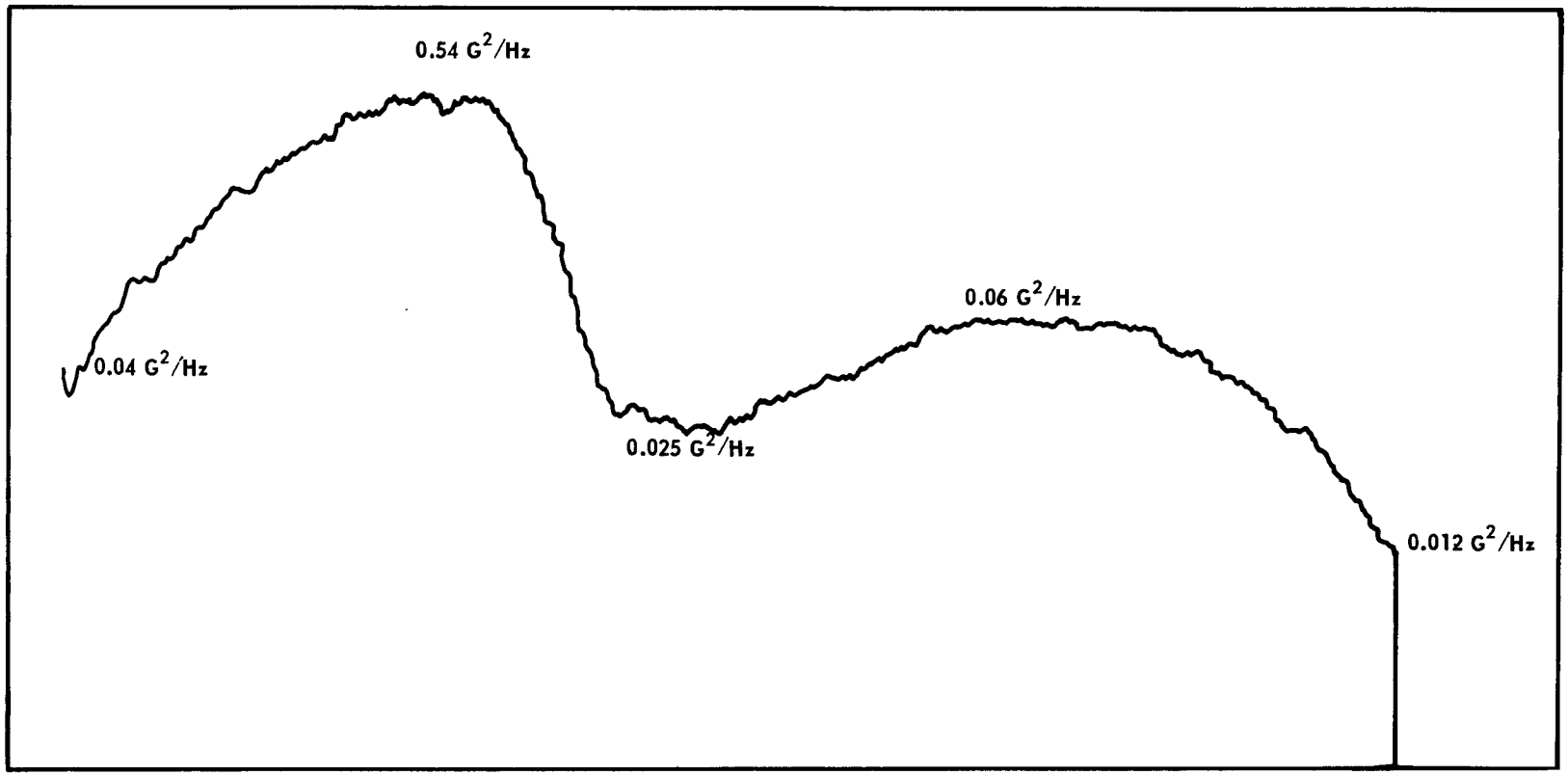

FIGURE 15 - Actual Run #23 (Dec. 9, 1972).

VIBRATION DATA SHEET

DATE 12/14/72 TEST PIECE Real FSA VIBRATION SCHEDULE Sine .707 G's RMS 20-2000 HZ

RUN # 24 SERIAL # MHFT-11 EQUIPMENT M.B.

Sine X Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1		10	--	MTG Plate	Servo
2	3	10	4	Same @ 180°	
3	3	10	5	Fix. Top - Same Axis	
4	3	10	6	Fix. Top - Off Axis	

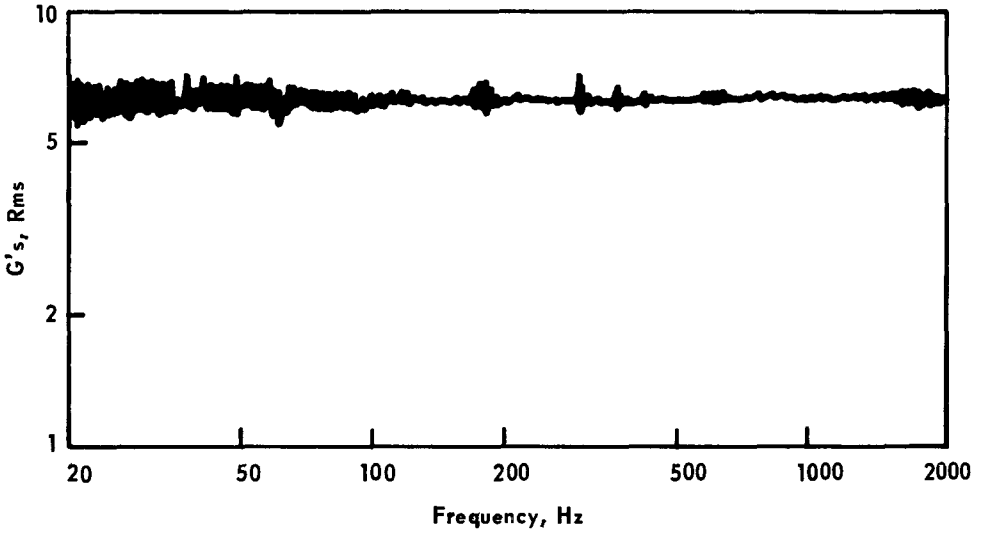

FIGURE 16 - Sine Run #24, x axis (Dec. 14, 1972).

VIBRATION DATA SHEET

DATE 12/14/73 TEST PIECE Real FSA VIBRATION SCHEDULE E, Random

RUN # 25 SERIAL # MHFT-11 EQUIPMENT Test Fire

Random X Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1		-	-	MTG. Plate	Servo
2	3	100	4	Same @ 180°	
3	3	100	5	Fix. Top - Same Axis	
4	3	100	6	Fix. Top - Off Axis	

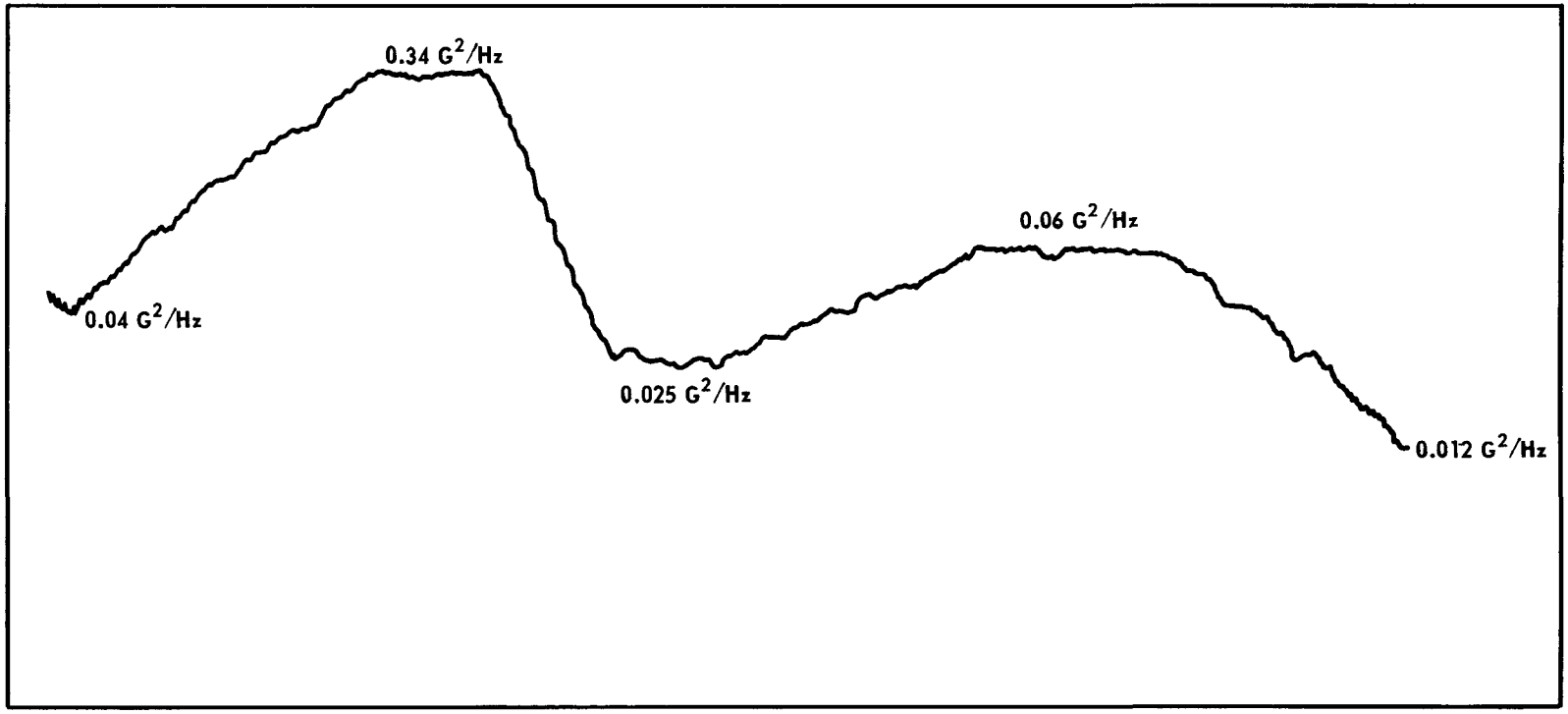

FIGURE 17 - Actual Run #25 (Dec. 14, 1972).

VIBRATION DATA SHEET

DATE 12/15/72 TEST PIECE Real FSA VIBRATION SCHEDULE Sine - .707 G's RMS 20-2000 HZ

RUN # 26 SERIAL # MHFT-11 EQUIPMENT M.B.

Sine Y Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1		-	-	MTG Plate	Servo
2	3	10	4	Same @ 180°	
3	3	10	5	Fix. Top - Same Axis	
4	3	10	6	Fix. Top - Off Axis	

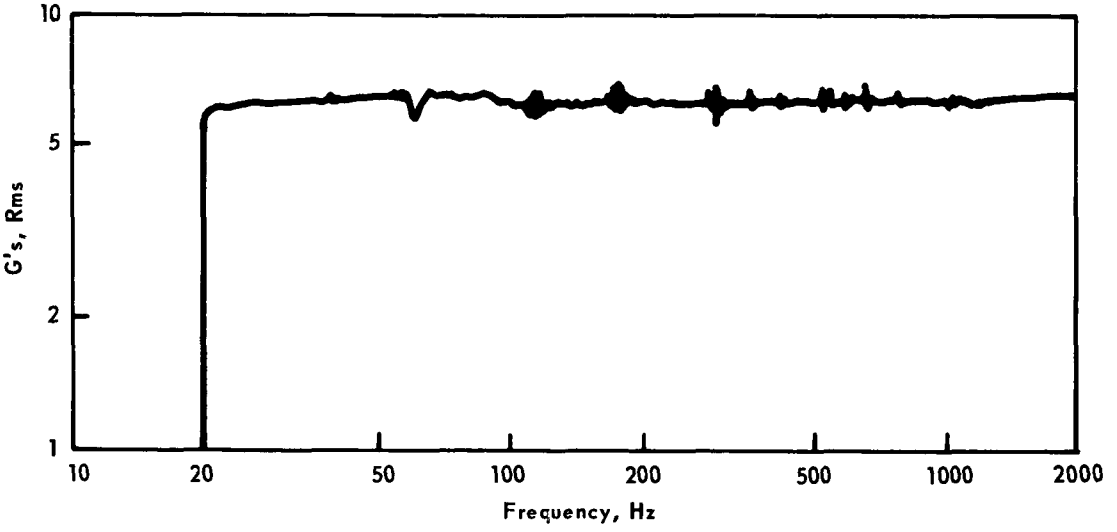

FIGURE 18 - Sine Run #26, y axis (Dec. 15, 1972).

VIBRATION DATA SHEET

DATE 12/15/72 TEST PIECE Real FSA VIBRATION SCHEDULE E, Random

RUN # 27 SERIAL # MHFT-11 EQUIPMENT Test Fire - M.B.

Random Y Axis TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1			-	MTG. Plate	Servo
2	3	100	4	Same @ 180°	
3	3	100	5	Fix. Top - Same Axis	
4	3	100	6	Fix. Top - Off Axis	

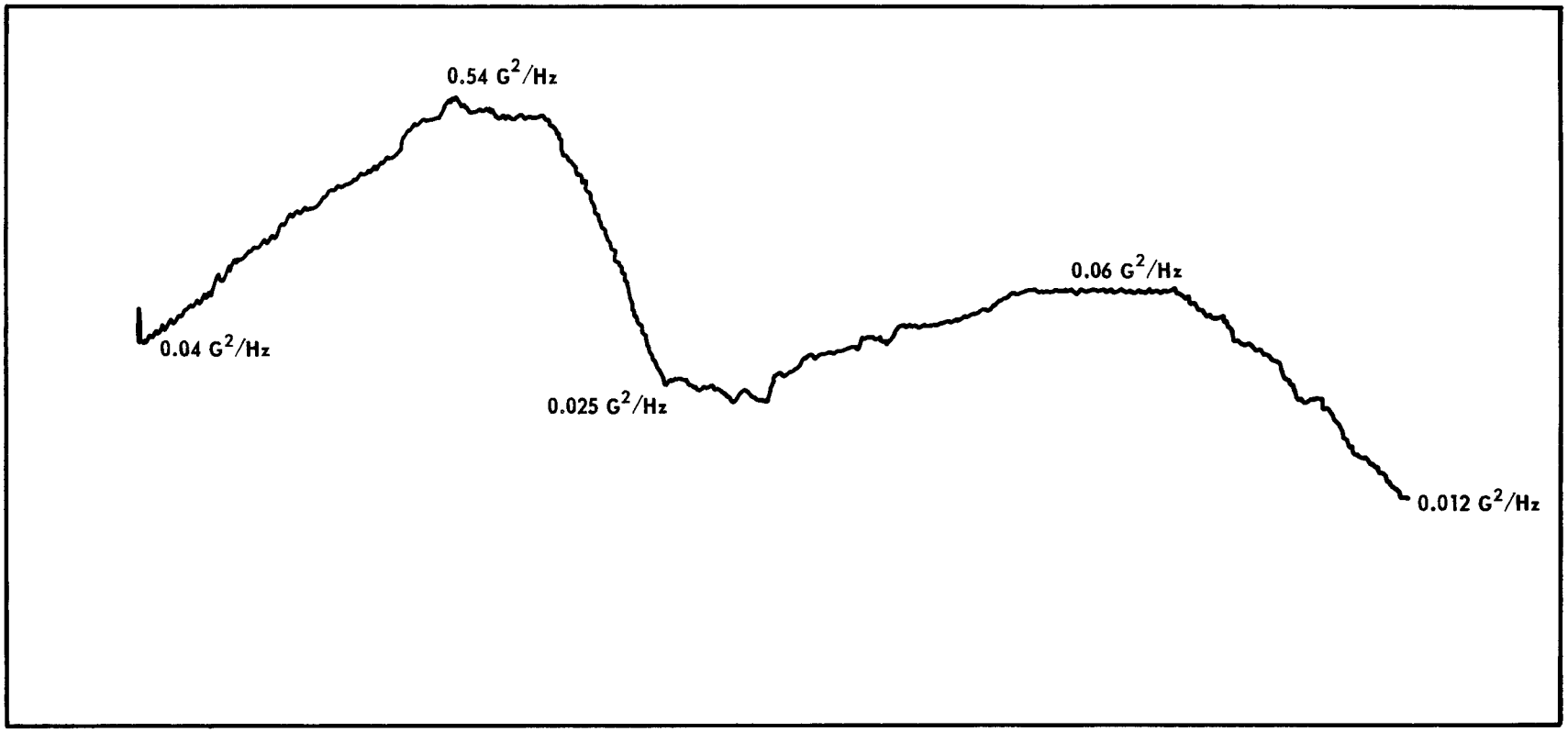

FIGURE 19 - Actual Run #27 (Dec. 15, 1972).

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ATTACHMENT E

POST-TEST INSPECTION COMMENTS

Date: 12-19-72

RADIOGRAPHIC INSPECTION REPORT
ITEM: MULTIHUNDRED WATT SPHERE

The sphere was radiographed at 0°, 90°, and pole to inspect for condition of the sphere after tests.

Inspection results are as follows:

MHFT-11

(1) The sphere appears to be broken into three or four major sections with several smaller pieces.

(2) No indication of any appreciable amount of fine material in fuel cavity.

(3) No apparent damage to sphere encapsulation.

NOTE: Before tests, radiographs indicated three to five cracks in the sphere 0.3 in. to 0.7 in. in length but the sphere appeared to be intact.

Inspected by: _____

Applied Technology, TR-27

January 3, 1973

Telephone Conversation Between
C. O. Brewer and R. N. R. Mulford
of LASL

S. G. Abrahamson

Mr. Mulford called to give the preliminary visual observations of MHFT-11, the vibration test capsule. He said that the inside of the iridium was very clean with no visual black deposit. The only damage noted was the weld shield bond had broken away at the tack welds.

The fuel sphere was broken into eight (8) pieces, five (5) large and three (3) small; however, no fines had been determined to date.

C. O. Brewer

COB:tr

VIBRATION DATA SHEET

DATE 2/5/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G RMS 20-2000 HZ

RUN # 28A SERIAL # EQUIPMENT M.B.

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3.0	10	4	MTG. Plate	Servo
2	3.0	10	5	Metal Ball	
3	3.0	10	6	Graph - Same Axis	
5	3.0	10	7	Fix. Top - Same Axis	

VIBRATION DATA SHEET

DATE 2/5/73 TEST PIECE Dynamic VIBRATION SCHEDULE Random

RUN # 29A SERIAL # EQUIPMENT Test Fire

Random Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	
2	3	100	5	Metal Ball	
3	3	100	6	Graph - Same Axis	
5	3	100	7	Fix. Top - Same Axis	
T.F.					Servo

VIBRATION DATA SHEET

DATE 2/6/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G RMS 20-2000 HZ

RUN # 30A SERIAL # EQUIPMENT M.B.

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG. Plate	Servo
2	3	10	5	Metal Ball	
4	3	10	6	Graph - Off Axis	
6	3	10	7	Fix. Top - Off Axis	

VIBRATION DATA SHEET

DATE 2/6/73 TEST PIECE Dynamic VIBRATION SCHEDULE Random

RUN # 31A SERIAL # EQUIPMENT Test Fire

Random Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	
2	3	100	5	Metal Ball	
4	3	100	6	Graph - Off Axis	
6	3	100	7	Fix. Top - Off Axis	
T.F.					Servo

VIBRATION DATA SHEET

DATE 2/7/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine

RUN # 34A SERIAL # EQUIPMENT M.B. .707 G RMS 20-2000 HZ

Sine X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG. Plate	Servo
2	3	10	5	Metal Ball	
4	3	10	6	Graph - Off Axis	
6	3	10	7	Fix. Top - Off Axis	

VIBRATION DATA SHEET

DATE 2/7/73 TEST PIECE Dynamic VIBRATION SCHEDULE Random

RUN # 35A SERIAL # -- EQUIPMENT Test Fire M.B.

X Axis OFF Axis Accels. TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	MHW Fixture
2	3	100	5	Metal Ball	
4	3	100	6	Graph - Off Axis	Chan. 6 Clipping Data
6	3	100	7	Fixture Top - off Axis	
T.F.					Servo

VIBRATION DATA SHEET

DATE 2/8/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G RMS 20-2000 HZ

RUN # 36A SERIAL # EQUIPMENT M.B.

Sine X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG. Plate	
2	3	10	5	Metal Ball	
3	3	10	6	Graph - Same Axis	
5	3	10	7	Fix. Top - Same Axis	
					Repeat of 32A

VIBRATION DATA SHEET

DATE 2/8/73 TEST PIECE Dynamic VIBRATION SCHEDULE Random

RUN # 37A SERIAL # EQUIPMENT Test Fire M.B.

X Axis
Same Axis Accels. TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	MHW Fixture
2	3	100	5	Metal Ball	
3	3	300	6	Graph - Same Axis	Chan. 6 Clipping Data
5	3	100	7	Fix. Top - Same Axis	
T.F.					Servo

VIBRATION DATA SHEET

DATE 2/14/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G RMS 20-2000 HZ

RUN # 38A SERIAL # EQUIPMENT M.B.

Sine X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG. Plate	Servo
2	3	10	5	Metal Ball	
3	3	100	6	Graph - Same Axis	
5	3	10	7	Fix. Top - Same Axis	

VIBRATION DATA SHEET

DATE 2/14/73 TEST PIECE Dynamic VIBRATION SCHEDULE Random

RUN # 39A SERIAL # - EQUIPMENT Test Fire M.B.

X Axis Same Axis Accels. TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	MHW Fixture
2	3	100	5	Metal Ball	
3	3	1000	6	Graph - Same Axis	
5	3	100	7	Fix. Top - Same Axis	
T.F.					

VIBRATION DATA SHEET

DATE 2/14/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G RMS 20-2000 HZ

RUN # 40A SERIAL # EQUIPMENT M.B.

Sine X Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG. Plate	Servo
2	3	10	5	Metal Ball	
4	3	100	6	Graph - Off Axis	
6	3	10	7	Fix. Top - Off Axis	

VIBRATION DATA SHEET

DATE 2/15/73 TEST PIECE Dynamic VIBRATION SCHEDULE Random

RUN # 41A SERIAL # EQUIPMENT Test Fire M.B.

X Axis Off Axis Accels. TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	MHW Fixture
2	3	100	5	Metal Ball	
4	3	1000	6	Graph - Off Axis	
6	3	100	7	Fix. Top - Off Axis	
T.T.					

VIBRATION DATA SHEET

DATE 2/15/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine

RUN # 42A SERIAL # EQUIPMENT .707 G RMS 20-2000 HZ M.B.

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG. Plate	Servo
2	3	10	5	Metal Ball	
3	3	100	6	Graph - Same Axis	
5	3	10	7	Fix. Top - Same Axis	

VIBRATION DATA SHEET

DATE 2/15/73 TEST PIECE Dynamic VIBRATION SCHEDULE Random

RUN # 43A SERIAL # EQUIPMENT Test Fire M.B.

Z Axis
Same Axis Accels. TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	MHW Fixture
2	3	100	5	Metal Ball	
3	3	1000	6	Graph - Same Axis	
5	3	100	7	Fix. Top - Same Axis	
T.F.					

VIBRATION DATA SHEET

DATE 2/15/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G RMS 20-2000 HZ

RUN # 44A SERIAL # EQUIPMENT M.B.

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG. Plate	Servo
2	3	10	5	Metal Ball	
4	3	100	6	Graph - Off Axis	
6	3	10	7	Fix. Top - Off Axis	

VIBRATION DATA SHEET

DATE 2/15/73 TEST PIECE Dynamic VIBRATION SCHEDULE Ramdom

RUN # 45A SERIAL # -- EQUIPMENT Test Fire M.B.

Z Axis
Off Axis Accels. TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	MHW Fixture
2	3	100	5	Metal Ball	
4	3	1000	6	Graph - Off Axis	
6	3	100	7	Fix. Top - Off Axis	
T.F.					

VIBRATION DATA SHEET

DATE 4/17/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G RMS 20-2000 HZ

RUN # 48A SERIAL # EQUIPMENT M.B.

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG. Plate	Servo
2	3	10	5	Metal Ball	
3	3	10	6	Graph - Off Axis	
4	3	10	7	Fix. Top - Off Axis	
					Repeat of 46A

VIBRATION DATA SHEET

DATE 4/17/73 TEST PIECE Dynamic VIBRATION SCHEDULE Random

RUN # 49A SERIAL # EQUIPMENT T/D

Z Axis
Off Axis Accels. TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	MHW Fixture
2	3	100	5	Metal Ball	
3	3	100	6	Graph - Off Axis	
4	3	100	7	Fix. Top - Off Axis	
T/D					Servo
					This run a repeat of
					47A which had 60 HZ
					noise.

VIBRATION DATA SHEET

DATE 4/17/73 TEST PIECE Dynamic VIBRATION SCHEDULE Sine .707 G RMS 20-2000 HZ

RUN # 50A SERIAL # EQUIPMENT M.B.

Sine Z Axis TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	10	4	MTG. Plate	
2	3	10	5	Metal Ball	
3	3	10	6	Graph - Same Axis	
4	3	10	7	Fix. Top - Same Axis	

VIBRATION DATA SHEET

DATE 4/17/73 TEST PIECE Dynamic VIBRATION SCHEDULE Random

RUN # 51A SERIAL # EQUIPMENT T/D

Z Axis
Same Axis Accels. TEMPERATURE Room Temperature

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
1	3	100	4	MTG. Plate	
2	3	100	5	Metal Ball	
3	3	100	6	Graph - Same Axis	
4	3	100	7	Fix. Top - Same Axis	
T/D					Servo

VIBRATION DATA SHEET

DATE 4/30/73 thru 5/25/73 | TEST PIECE FSA | VIBRATION SCHEDULE C. Random

RUN # 52 thru 58 | SERIAL # MHFT-25 thru -31 | EQUIPMENT T/D

TEMPERATURE 1000°C

ACCELEROMETER	FULL SCALE		RECORDER CHANNEL	ACCEL. LOCATION	REMARKS
	Volts	G's			
#5 to T/D via Endevco Chg. Ampl.	--	10	--	MTG. Plate	8.704 G's RMS
#1 to M.B. N 400 Ampl.	--	30	--	MTG. Plate @ 180°	

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ATTACHMENT F

SAFETY SEQUENTIAL TEST DOCUMENTATION

RANDOM SCHEDULE C

MHFT-25 THROUGH -31

```
                    1
    1 BANDWIDTH, HZ.:2048
    2 FREQUENCY RESOLUTION 64/128/256: 128
FREQUENCY INCREMENT, HZ.:    16

REFERENCE SPECTRUM:
    3 INITIAL SLOPE DB/OCT:     3
    4 FREQUENCY     HZ.:    16
      LEVEL  GSQR/HZ.:     0.0165
    5 FREQUENCY     HZ.:   256
      LEVEL  GSQR/HZ.:     0.216
    6 FREQUENCY     HZ.:   336
      LEVEL  GSQR/HZ.:     0.216
    7 FREQUENCY     HZ.:   448
      LEVEL  GSQR/HZ.:     0.01
    8 FREQUENCY     HZ.:   608
      LEVEL  GSQR/HZ.:     0.01
    9 FREQUENCY     HZ.:   992
      LEVEL  GSQR/HZ.:     0.024
   10 FREQUENCY     HZ.: 1296
      LEVEL  GSQR/HZ.:     0.024
   11 FINAL SLOPE   DB/OCT:    12
ACCEL. LEVEL, GRMS =     8.704
   12 START UP TIME     SEC:      3
   13 SHUT DOWN TIME    SEC:      3
   14 TEST TIME HRS,MIN,SEC:     0     3     0
   15 3 SIGMA CLIPPING 1=YES 0=NO:     1

CORRECTIONS 1=YES 0=NO: 0

LIST 1=YES 0=NO: 1
```

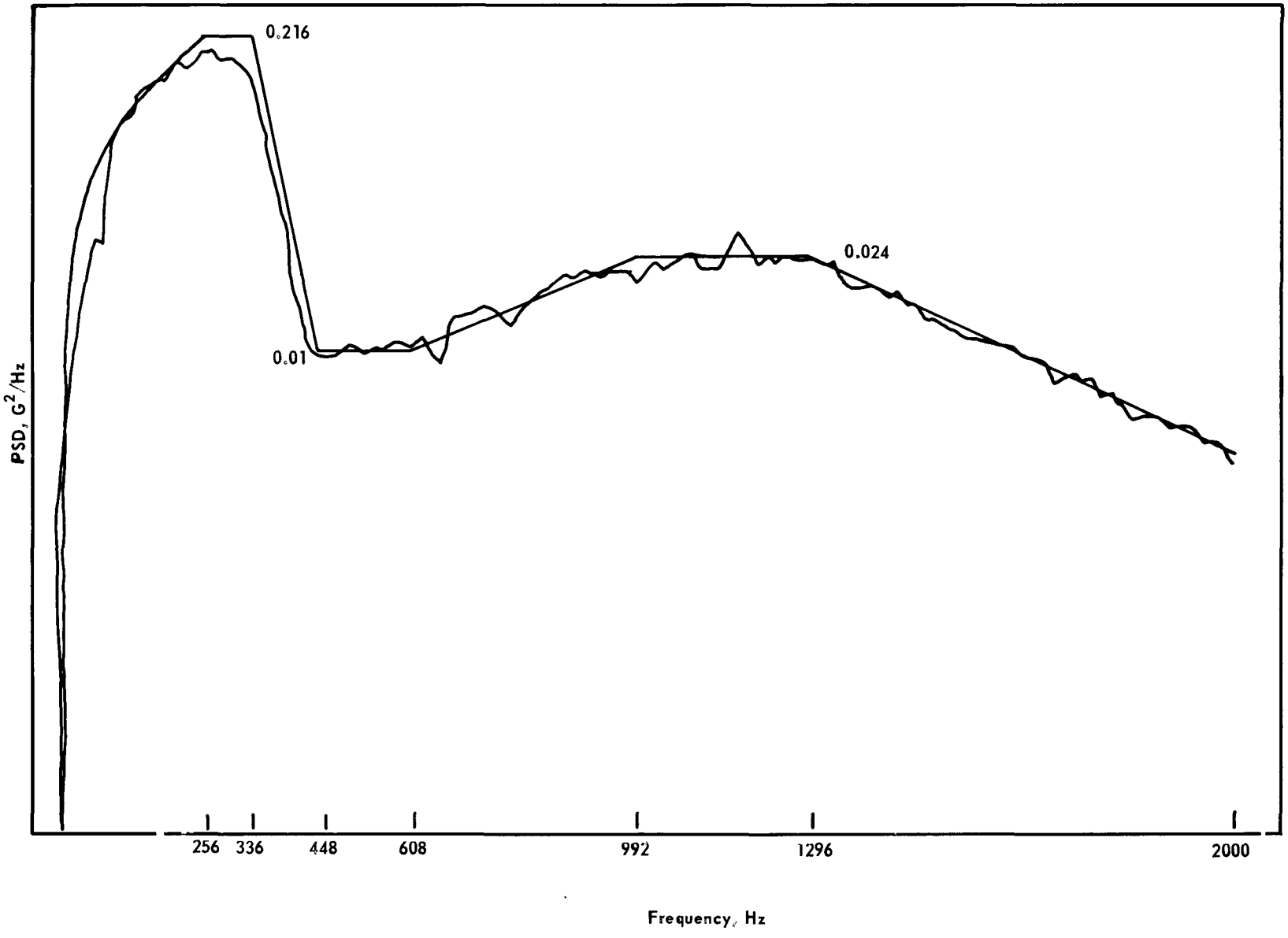
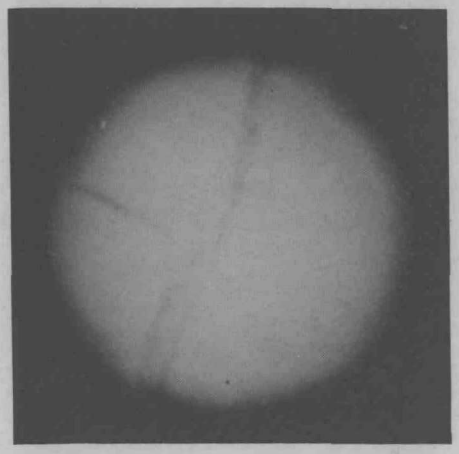


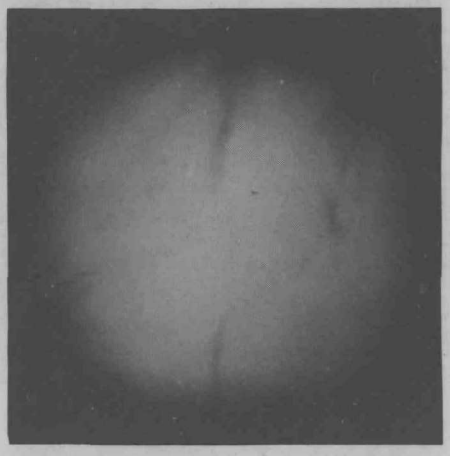
FIGURE 20 - Random run for MHFT-30, typical for MHFT-25 to 31.

ATTACHMENT G

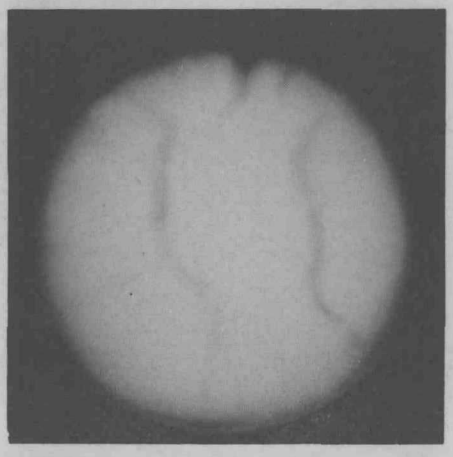
RADIOGRAPHS AND PHOTOGRAPHS



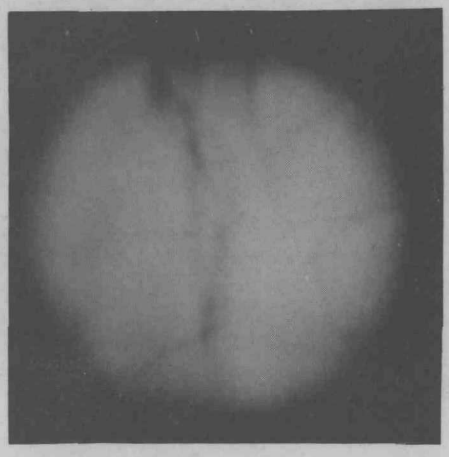
MHFT-25
0° View



MHFT-25
90° View



MHFT-26
0° View

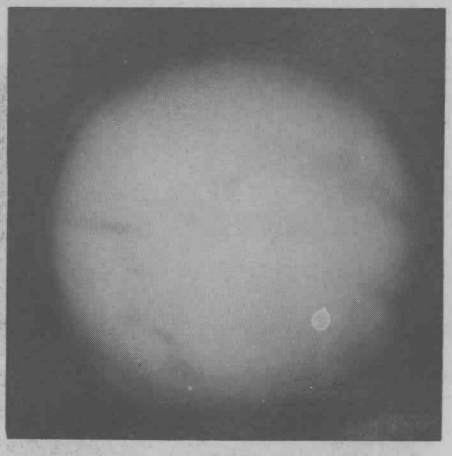


MHFT-26
90° View

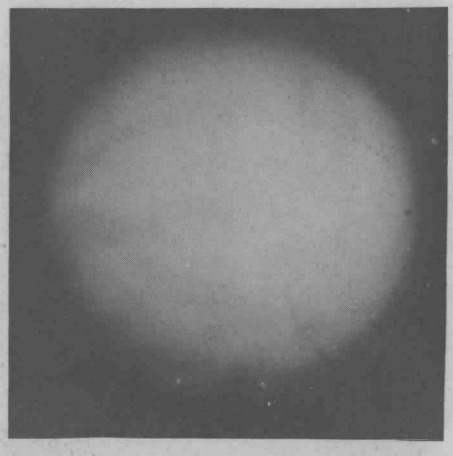
FIGURE 21 - Radiographs of safety sequential test capsules MHFT-25 and -26 after vibration.

MHFT-27
0° View

MHFT-27
90° View

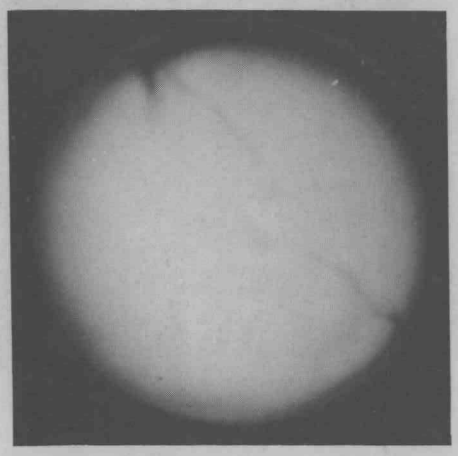


MHFT-28
0° View

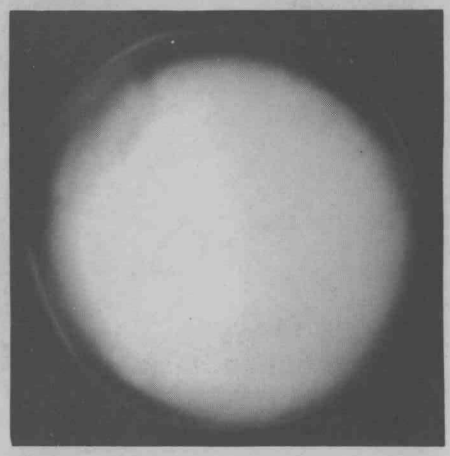


MHFT-28
90° View

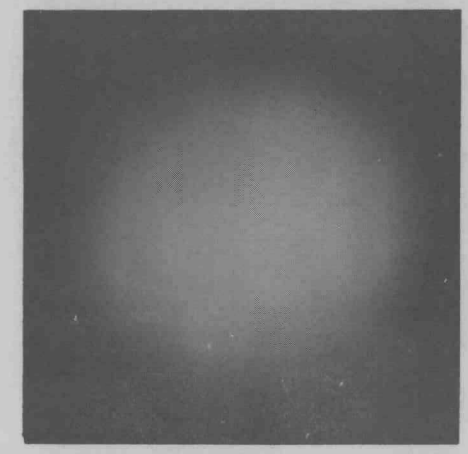
FIGURE 22 - Radiographs of safety sequential test capsules MHFT-27 and -28 after vibration.



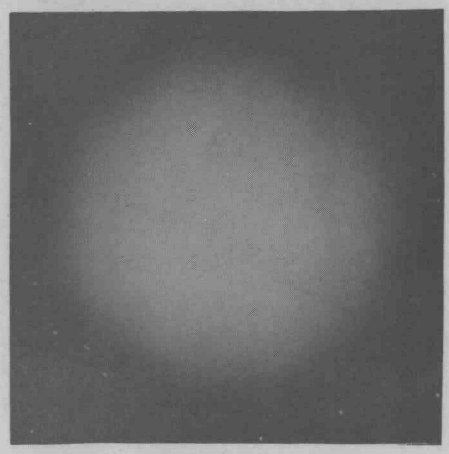
MHFT-29
0° View



MHFT-29
90° View

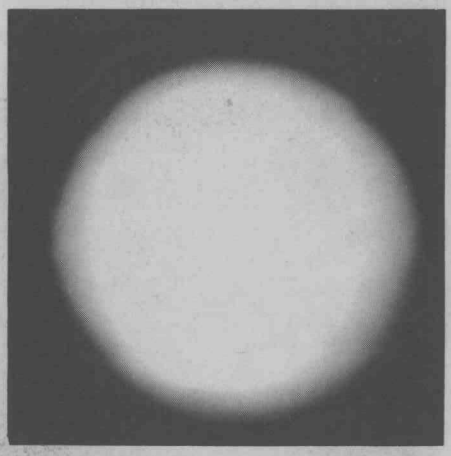


MHFT-30
0° View



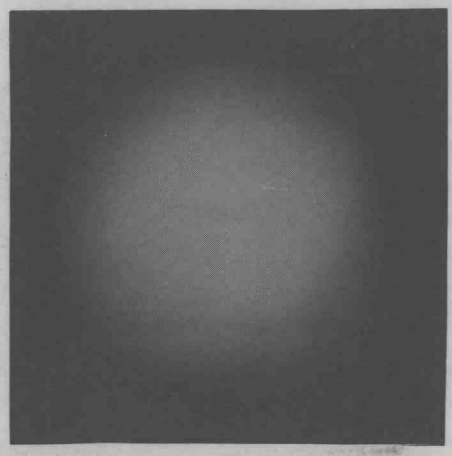
MHFT-30
90° View

FIGURE 23 - Radiographs of safety sequential test capsules MHFT-29 and -30 after vibration.



730966

MHFT-31
0° View



730967

MHFT-31
90° View

FIGURE 24 - Radiographs of safety sequential test capsule MHFT-31 after vibration.

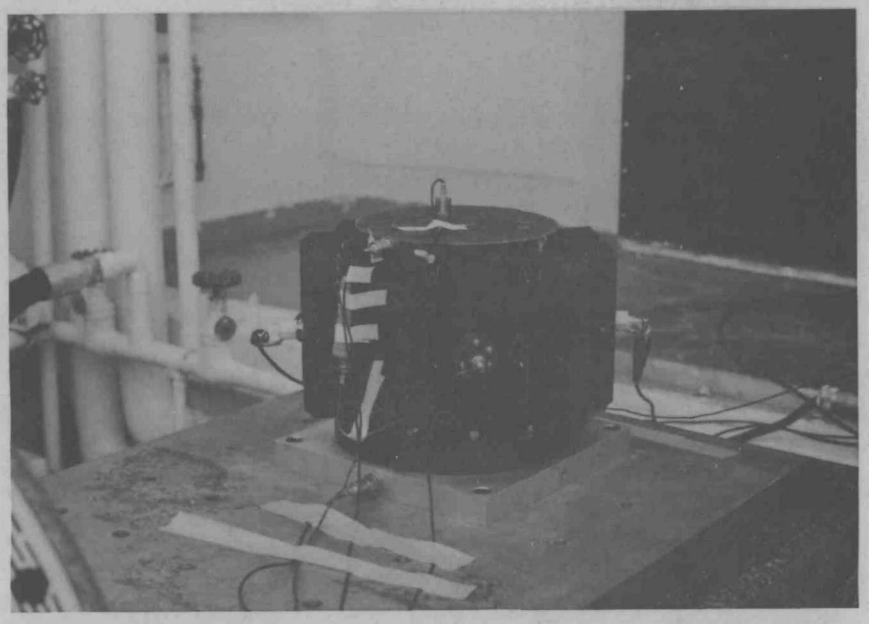


FIGURE 25 - MHW vibration test fixture.

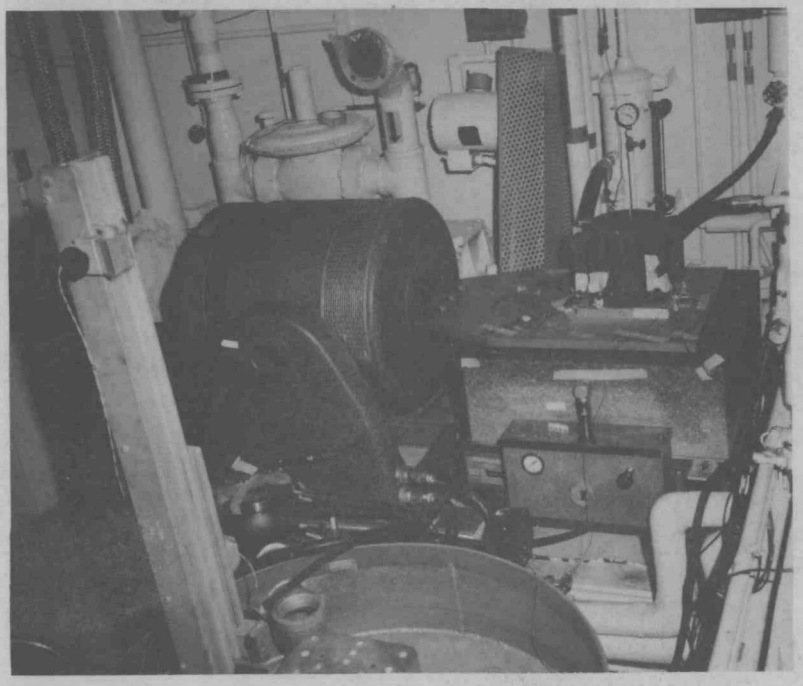


FIGURE 26 - C-21 vibration shaker.

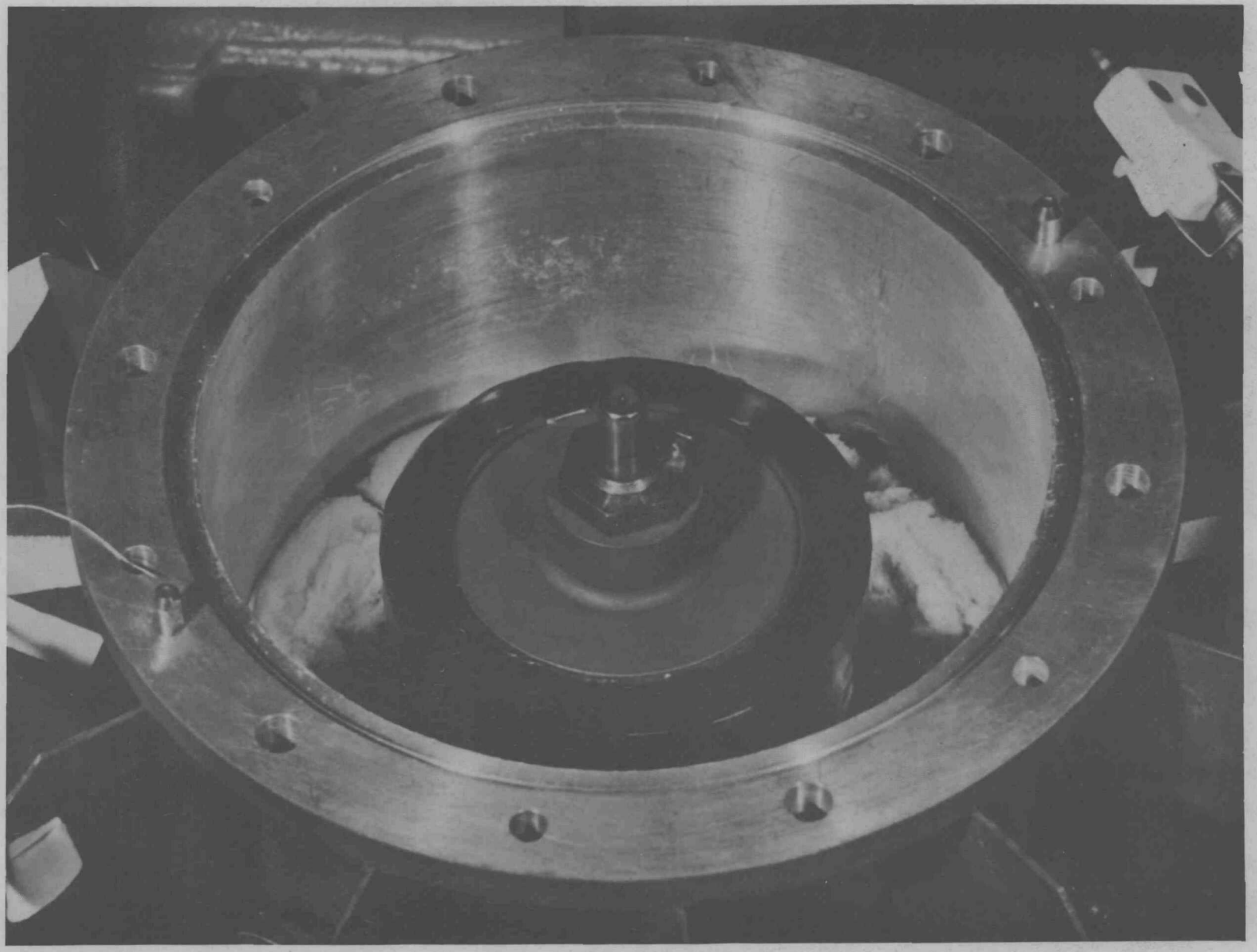


FIGURE 27 - Lid for vibration fixture graphite container.

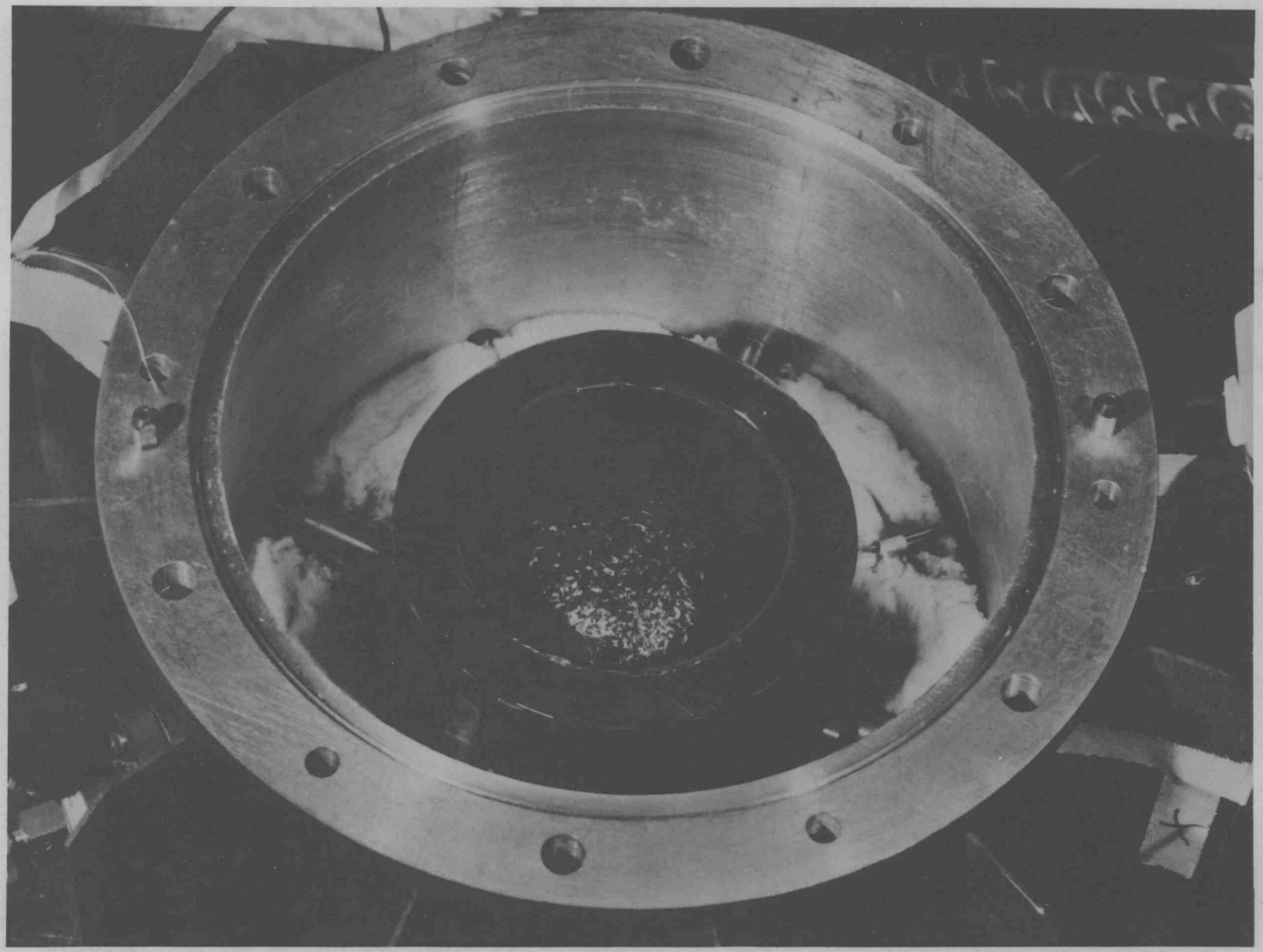


FIGURE 28 - FSA installed in vibration fixture container.