CONTRACT NAS5-1520

# Aerospace Systems Pyrotechnic Shock Data

## (Ground Test and Flight)

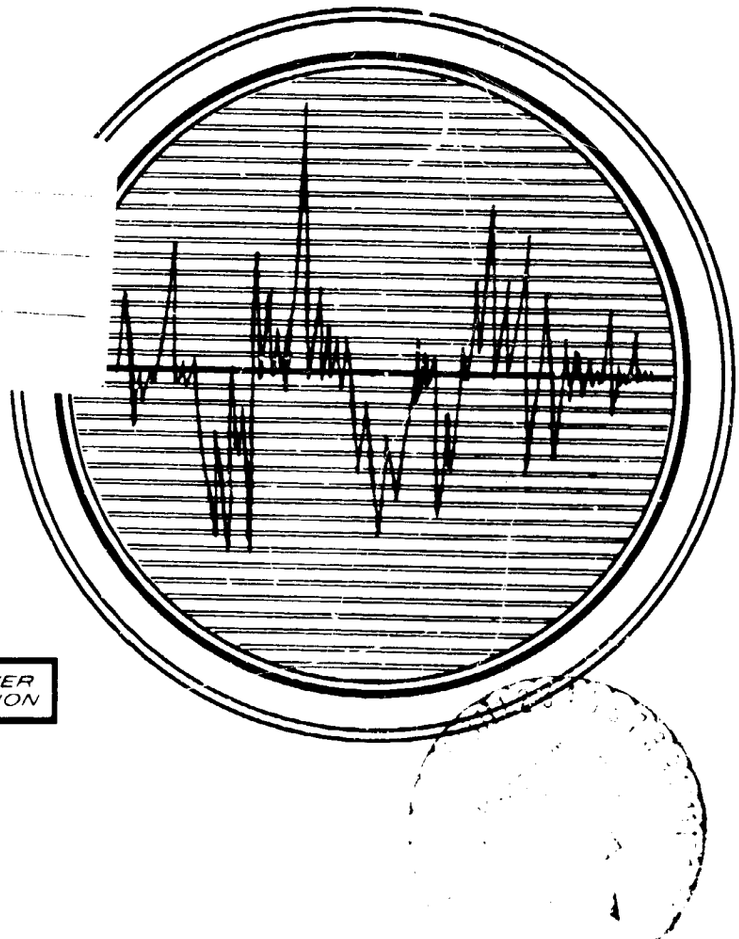
**Final Report**

**7 March 1970**

**Volume III**

**Data**

N71-17902
(ACCESSION NUMBER)
117
(PAGES)
CR-116101
(NASA CR OR TMX OR AD NUMBER)
(THRU)
(CODE)
(CATEGORY)
FACILITY FORM 602



Prepared by

MARTIN MARIETTA CORPORATION DENVER DIVISION

for

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

FINAL REPORT

For

# Aerospace Systems Pyrotechnic Shock Data (Ground Test and Flight)

June 1968 to March 1970

VOLUME III

Contract No.: NAS5-15208

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## FOREWORD TO VOLUME III

The pyrotechnic shock data for aerospace systems compiled under Contract NAS5-15208 is contained in two volumes. The two volumes are divided into five divisions and the divisions are further subdivided into parts. The separation of data among the five divisions is as follows:

VOLUME II

Division I - Pyrotechnic shock data associated with structure cutting charges such as mild detonating fuse (MDF) and flexible linear shaped charge (FLSC).

VOLUME III

Division II - Pyrotechnic shock data associated with explosive nuts and bolts.

Division III - Pyrotechnic shock data associated with pressure cartridge actuated devices such as pin pullers and cable cutters.

Division IV - Pyrotechnic shock data associated with extensive test programs on three space vehicles.

Division V - Pyrotechnic shock data from flight events.

The first three divisions are further subdivided into three parts each depending on the type of structure on which the data were measured. These subdivisions are as follows:

Part A - Data from skin-ring-frame structures.

Part B - Data from truss structures.

Part C - Data from structures other than skin-ring-frame or truss structure.

The separate parts are further divided into sections and each section is a complete unit of data.

Division IV contains shock data from three extensive tests programs on three different space vehicles. Each test program is a separate part of Division IV and contains data from several different types of pyrotechnic devices on the particular vehicle. These data are contained in a separate division for ease in comparing the effects of different pyrotechnic devices on a space vehicle.

Division V contains flight data from four flight programs. Because of the limitations inherent in flight telemetry systems, the quantity and quality of available data is limited.

Each volume of data contains a complete table of contents for all the data. Each of the five divisions contains a table of contents describing the data within that division except Division I, which has a table of contents for each part.

The numbering system used in these data volumes is as follows: each section within a part is given a three character identification. The first character is a Roman Numeral which associates the section with one of the five divisions that make up the two data volumes. The second character is a capital letter (A, B, or C) that associates the section with one of the three Parts in a given Division. The third character is the number of the section in a particular Part. The first section of Part A in Division I would be numbered I.A.1. The tables and figures in a section are identified by the section number followed by the number of the figure or table in the section. For example, the third figure in Section I.B.2 would be cited as Figure I.B.2-3.

The data within a section is presented in such a manner that is can stand by itself. Generally, pertinent information about a Section is presented

in outline form consisting of brief descriptions of the purpose, the test configuration, the pyrotechnic, the structure, and the data acquisition/reduction systems. Additional information and remarks are sometimes included to further describe the data. These discussions are not analyses or conclusions; they are intended to complete the description of the data. The analyses are contained in a separate volume. The descriptive summary is followed by the necessary tables and figures. Finally, the data are presented in the form of shock spectra with their corresponding acceler... time histories.

In some cases the data from a single test program may logically fit at two or more locations within the data volumes. This happens when either a single structure is subjected to more than one type of pyrotechnic device or when the shock from a single explosive device is measured in more than one type of structure. In these cases, the data is presented in one of the logical parts, and reference to it is made in the other logical Part(s).

Under a subcontract to this study Lockheed Missiles and Space Company compiled shock data that summarized their experience in the field of shock testing and analysis. This report

is contained in Volumes IV and V entitled "Compilation of Pyrotechnic Data". Each part in Volume II and III contains a list citing areas of the Lockheed report which would apply to that Part.

The data in each section is presented in the form of shock spectra and the associated time histories when available. Unless otherwise stated the shock spectra in each section are absolute acceleration shock spectra; i.e. the absolute acceleration of a mass when subjected to base acceleration plotted as a function of the natural frequency of the damped single degree of freedom system.

The shock spectra data were anlyzed by both analog and digital techniques. The type of analysis for each set of data is stated in the description of data for that section. The majority of spectra were analyzed using a damping factor of Q = 10. The damping factor (Q) is stated in the description of data for each section and is not presented on the individual data sheets.

Whenever possible the data is presented in such a manner as to afford a measure of repeatability between similar and/or identical tests.

TABLE OF CONTENTS

VOLUME III

FOREWORD TO VOLUME III

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

II. EXPLOSIVE BOLTS AND NUTS

FOREWORD TO DIVISION II

TABLE OF CONTENTS TO DIVISION II

II.A. SKIN-RING-FRAME STRUCTURES

II.A.1 POGO Shroud Separation Tests

Location of Additional Data

Location of Related Lockheed Data

II.B TRUSS STRUCTURES

II.B.1 Martin Ground Tests-Task K

II.B.2 Titan III-M Separation Nut Tests

II.B.3 Payload Truss Shock Propagation Tests

Location of Additional Data

Location of Related Lockheed Data

III. CARTRIDGE ACTUATED DEVICES

FOREWORD TO DIVISION III

TABLE OF CONTENTS FOR DIVISION III

III.A SKIN-RING-FRAME STRUCTURES

Location of Additional Data

Location of Related Lockheed Data

TABLE OF CONTENTS

(Cont.)


| | Page No. |
|---|---|
| III.B. TRUSS-TYPE STRUCTURES | 357 |
| III.B.1 OV5-1 Satellite Release Tests | 358 |
| III.B.2 Separation Shock Tests of TCS-F Spacecraft | 360 |
| III.B.3 OAO Separation Test | 378 |
| Location of Additional Data | 409 |
| III.C STRUCTURES OTHER THAN SKIN-RING-FRAME OR TRUSS | 410 |
| III.C.1 IDCSP/A Development Model 2 Separation Test | 411 |
| III.C.2 OGO-F Separation Test | 423 |
| III.C.3 OGO-F Antenna Ejection Test | 446 |
| Location of Additional Data | 480 |
| Location of Related Lockheed Data | 481 |
| IV. SPACE VEHICLE TEST DATA | 482 |
| FOREWORD TO DIVISION IV | 493 |
| TABLE OF CONTENTS FOR DIVISION IV | 494 |
| IV. [illegible] | [illegible] |
| IV. .1 Booster Separation | [illegible] |
| IV. . Parachute Hot Gas Separation | [illegible] |
| IV. .3 Process Photographic Mortar | [illegible] |
| IV. .4 Process Charge Separation | [illegible] |

TABLE OF CONTENTS

(CONT.)


| | | Page No. |
|---|---|---|
| IV.B | MARINER (VENUS & MARS) '67 FLIGHT ACCEPTANCE TEST | 541 |
| | IV.B.1 Shroud V-Band Release | 542 |
| | IV.B.2 Spacecraft V-Band Release | 555 |
| | IV.B.3 Solar Panel Deployment | 571 |
| | IV.B.4 Post Injection Propulsion System Pyro 1 | 584 |
| | IV.B.5 Post Injection Propulsion System Pyro 2 | 595 |
| | IV.B.6 Antenna Deployment | 606 |
| | IV.B.7 Umbilical Door Slam | 616 |
| IV.C | SURVEYOR FLIGHT EVENTS | 627 |
| | IV.C.1 Atlas/Centaur Separation | 635 |
| | IV.C.2 Shroud Separation | 641 |
| | IV.C.3 Insulation Panel Jettison | 645 |
| | IV.C.4 Omni Antenna Deploy | 651 |
| | IV.C.5 Non-Pyrotechnic Shock Transients | 655 |
| V. | FLIGHT PYROTECHNIC SHOCK DATA | 662 |
| | PRECEDING PAGE BLANK-NOT FILMED | 663 |
| | TABLE OF CONTENTS FOR PART V | 664 |
| | V.1 Flight of Lunar Orbiters I and II-Shroud Jettison | 665 |
| | V.2 Flight Test of Delta Vehicle (TO8-A)-Solid Motor and Fairing Jettison | 671 |
| | V.3 Flight Test of Delta Vehicle 43 (BIO8-A)-Spacecraft Separation | 682 |
| | V.4 Flight Test of Delta Vehicle 51 (BI [illegible]-Spacecraft Separation and Fairing Jettison | 689 |
| | Location of Additional Flight Data | 697 |

TABLE OF CONTENTS

VOLUME II


| | Page No. |
|---|---|
| FOREWORD TO VOLUME II | ii |
| TABLE OF CONTENTS | vi |
| LIST OF ABBREVIATIONS | xi |
| I. STRUCTURE CUTTING CHARGES | 1 |
| FOREWORD TO DIVISION I | 2 |
| I.A. SKIN-RING-FRAME STRUCTURES | 3 |
| Table of Contents for Part A | 4 |
| I.A.1 Spartan Short Cylinder Separation Test | 5 |
| I.A.2 Spartan Long Cylinder Test | 38 |
| I.A.3 Spartan Second/Third Stage Separation Test | 65 |
| I.A.4 Minuteman III R/S Shock Determination Tests | 137 |
| I.A.5 Minuteman III PBV Shock Determination Tests | 200 |
| I.A.6 Centaur Insulation Panel Separation Tests | 404 |
| I.A.7 SRB Booster Separation Tests | 424 |
| Location of Additional Data | 439 |
| Location of Related Lockheed Data | 440 |
| I.B TANK STRUCTURES | 441 |
| Table of Contents for Part B | 442 |
| I.B.1 Titan III-C Standard Payload Fairing Separation Tests | 443 |

TABLE OF CONTENTS

(CONT)


| | | Page No. |
|---|---|---|
| I.B.2 | Titan III-C Metal Fairing Separation Test | 468 |
| I.B.3 | Titan III-C Universal Payload Fairing Separation Tests | 494 |
| | Location of Additional Data | 557 |
| | Location of Related Lockheed Data | 558 |
| I.C | STRUCTURES OTHER THAN MAIN-RING-FRAME OR TRUSS | 559 |
| | Table of Contents for Part C | 560 |
| I.C.1 | MSS Shroud Separation Test | 561 |
| I.C.2 | Apollo Service Module Panel Separation Test | 584 |
| I.C.3 | Athena Re-entry Vehicle Separation Test | 598 |
| | Location of Additional Data | 606 |
| | Location of Related Lockheed Data | 607 |

## LIST OF ABBREVIATIONS

## USED IN VOLUME III

| | | |
|---|---|---|
| APAC | - | Antenna pointing angle change |
| ATS | - | Applications Technology Satellite |
| DAC | - | Douglas Aircraft Corporation |
| EMT | - | Equipment mounting truss |
| FLSC | - | Flexible linear shaped charge |
| LES-6 | - | Lincoln experimental satellite No. 6 |
| LMSC | - | Lockheed Missiles and Space Company |
| MDF | - | Mild detonating fuse |
| mg | - | Milligrams |
| M-67 | - | Mariner 67 |
| OAO | - | Orbiting Astronomical Observatory |
| OGO | - | Orbiting Geophysical Observatory |
| OV5-2 | - | Orbiting Vehicle No. 5-2 |
| PIPS | - | Post injection propulsion system |
| POGO | - | Polar Orbiting Geophysical Observatory |
| SSA | - | Shock spectrum analyzer |
| STA | - | Station |

# DIVISION II

# EXPLOSIVE BOLTS AND NUTS

## FOREWORD TO DIVISION II

Division II contains pyrotechnic shock data associated with explosive bolts and nuts on skin-ring-frame and truss structures. Cartridge initiated separation nuts were the pyrotechnics associated with much of the test data presented in Division II. However, such a pyrotechnic is effectively an explosive nut rather than a cartridge actuated device. Thus, the data from a test involving a cartridge actuated separation nut is presented in Division II rather than Division III.

A large portion of the data (456 spectra and time histories) in this division is associated with a controlled ground test conducted at Martin Marietta to obtain data for use in this study. Most of the data was obtained on truss structures. Another test containing 302 shock spectra compares the shock levels due to various types of separation hardware. In particular it compares single and dual cartridge separation nuts. A third section compares the shock levels in a light-weight truss structure due to single and multiple charges.

TABLE OF CONTENTS

DIVISION II

EXPLOSIVE BOLTS AND NUTS

PART II.A

Skin-Ring-Frame Structures


| Section | Title | Pyrotechnic Device | Number of Shock Spectra | Page No. |
|---|---|---|---|---|
| II.A.1 | POGO Shroud Separation Tests. | Explosive Bolts | 13 | 5 |
| Location of Additional Data | | | | 18 |


PART II.B

Truss Structures


| Section | Title | Pyrotechnic Device | Number of Shock Spectra | Page No. |
|---|---|---|---|---|
| II.B.1 | Martin Ground Tests-Task K | Explosive Nuts | 456 | 21 |
| II.B.2 | Titan III-M Separation Nut Tests | Explosive Nuts | 202 | 193 |
| II.B.3 | Payload Truss Shock Propagation Tests | Explosive Nuts | 83 | 278 |
| Location of Additional Data | | | | 329 |

# PART II.A

## PYROTECHNIC SHOCK DATA COMPILED FOR

## EXPLOSIVE BOLTS AND NUTS IN SKIN-RING-FRAME STRUCTURES

SECTION II.A.1

POGO SHROUD SEPARATION TEST

PURPOSE OF TEST

A series of various confidence tests were performed on the Polar Orbiting Geophysical Observatory (POGO). The shock testing phase was conducted to determine the shock loads on the spacecraft and the spacecraft adapter ring due to shroud separation.

DESCRIPTION OF EVENT

Separation is initiated by the detonation of six explosive bolts, four holding the two shroud-band assemblies together, and two at the aft end of the shroud. The nose joint latch mechanism is released when the bands separate, and the separation thruster system, consisting of two springs in the conical section and two springs at the base of the shroud, move the shroud halves in opposite (+Y, -Y) directions, perpendicular to the X axis. Pivot hinge fittings, located on the aft end of each shroud half and the forward end of the vehicle midbody cause the separated shroud halves to pivot and rotate until they disengage from the vehicle and fall free. The test set-up for simulating this event is depicted in Figure II.A.1-1.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of time histories | 0 |
| No. of shock spectra | 13 |
| Type of analysis | digital |
| Frequency range | Table II.A.1-1 |
| Frequency increments | Table II.A.1-2 |
| Damping | Q=10 |

These shock spectra are presented as Figures II.A.1-4 through II.A.1-10.

DESCRIPTION OF DATA PYROTECHNIC

Six explosive bolts located as discussed in "Description of Event."

DESCRIPTION OF STRUCTURE

The clamshell shroud consists of two halves of laminar phenolic fiberglass with a fiberglass nose dome structurally attached to one of the halves. See Figures II.A.1-1 through II.A.1-3.

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2225

Location: Figures II.A.1-2 and II.A.1-3

Axis of Sensitivity: Table II.A.1-1

DESCRIPTION OF DATA ACQUISITION SYSTEM

Tape recorders: Ampex FR-114 (0-10,000 frequency response)

Amplifiers: Endevco 2614B

Glennite FT2500

TABLE II.A.1-1

FREQUENCY RANGE OF MEASUREMENTS PRESENTED

| Accelerometer Number | Sensitive Axis | Frequency Range (Hz) | Figure Number |
|---|---|---|---|
| 1 | X | 20-5,000 | II.A.1-4 |
| 2 | Y | 20-5,000 | II.A.1-4 |
| 3 | X | 20-2,000 | II.A.1-5 |
| 4 | Y | 20-5,000 | II.A.1-5 |
| 5 | X | 20-2,000 | II.A.1-6 |
| 7 | Y | 20-2,000 | II.A.1-6 |
| 9 | Y | 20-2,000 | II.A.1-7 |
| 10 | Z | 20-2,000 | II.A.1-7 |
| 11 | X | 20-10,000 | II.A.1-8 |
| 12 | Z | 20-2,000 | II.A.1-8 |
| 13 | X | 20-2,000 | II.A.1-9 |
| 14 | Y | 20-2,000 | II.A.1-9 |
| PL 20 | X | 20-2,000 | II.A.1-10 |

TABLE II.A.1-2

FREQUENCY INCREMENTS USED IN VARIOUS FREQUENCY RANGES

| Frequency Range (Hz) | Frequency Increment Used in Analysis (Hz) |
|---|---|
| 0- 2,000 | 20 |
| 2,000- 5,000 | 30 |
| 5,000-10,000 | 50 |

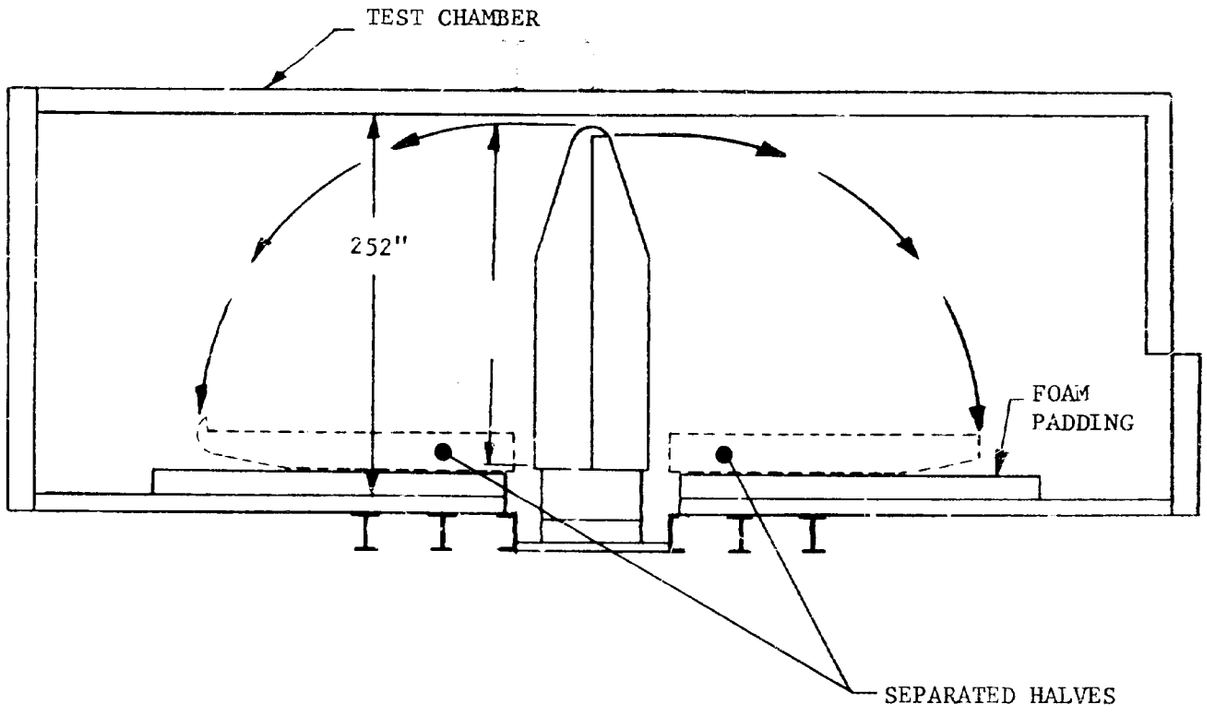



FIGURE II.A.1-1

TEST CONFIGURATION

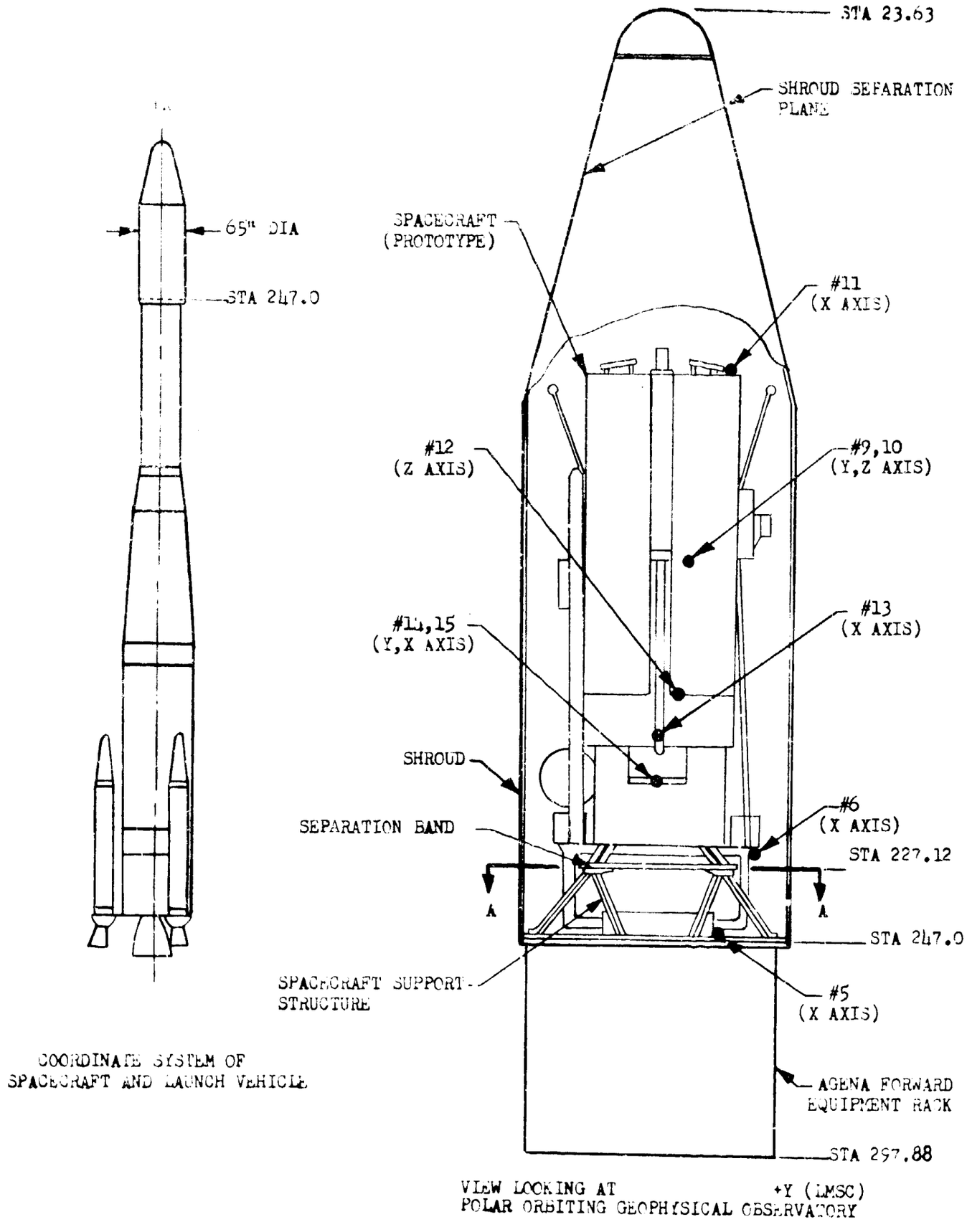
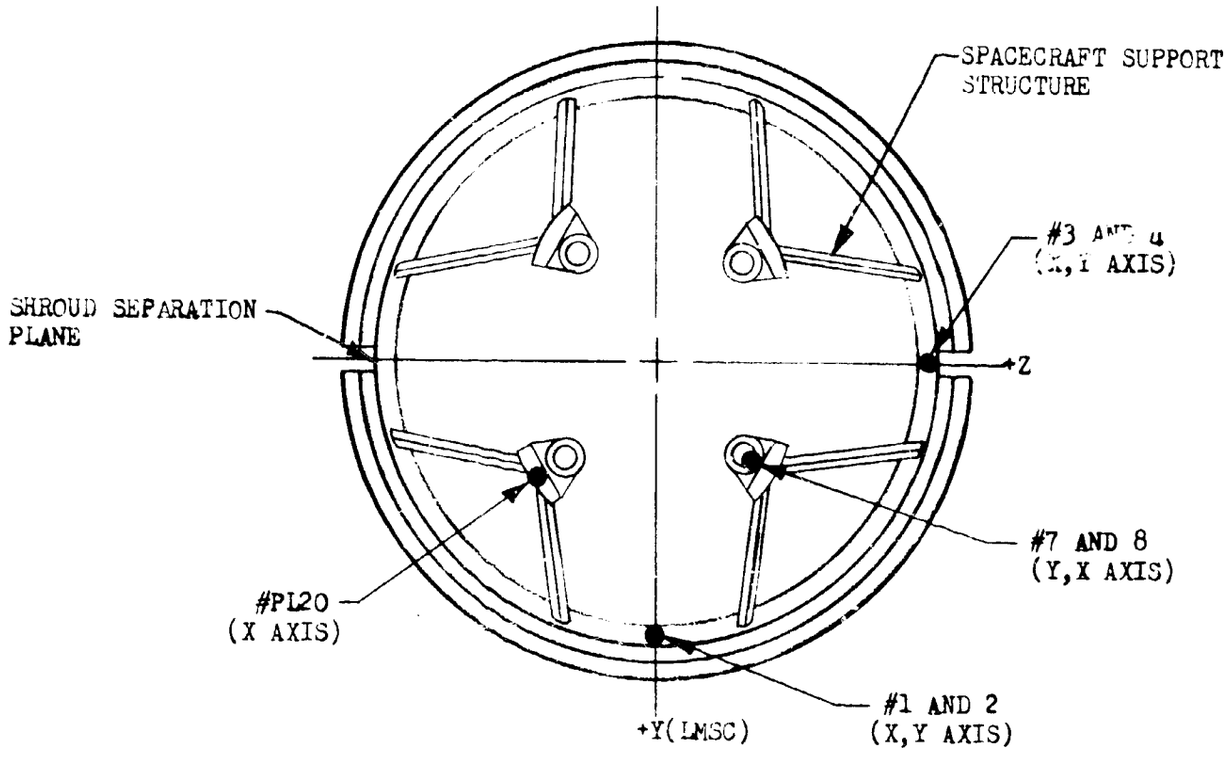



FIGURE II.A.1-2

ACCELEROMETER LOCATIONS FOR POGO SHROUD SEPARATION TESTS




SECTION A-A

FIGURE II.A.1-3

ACCELEROMETER LOCATIONS FOR POGO SHROUD SEPARATION TESTS

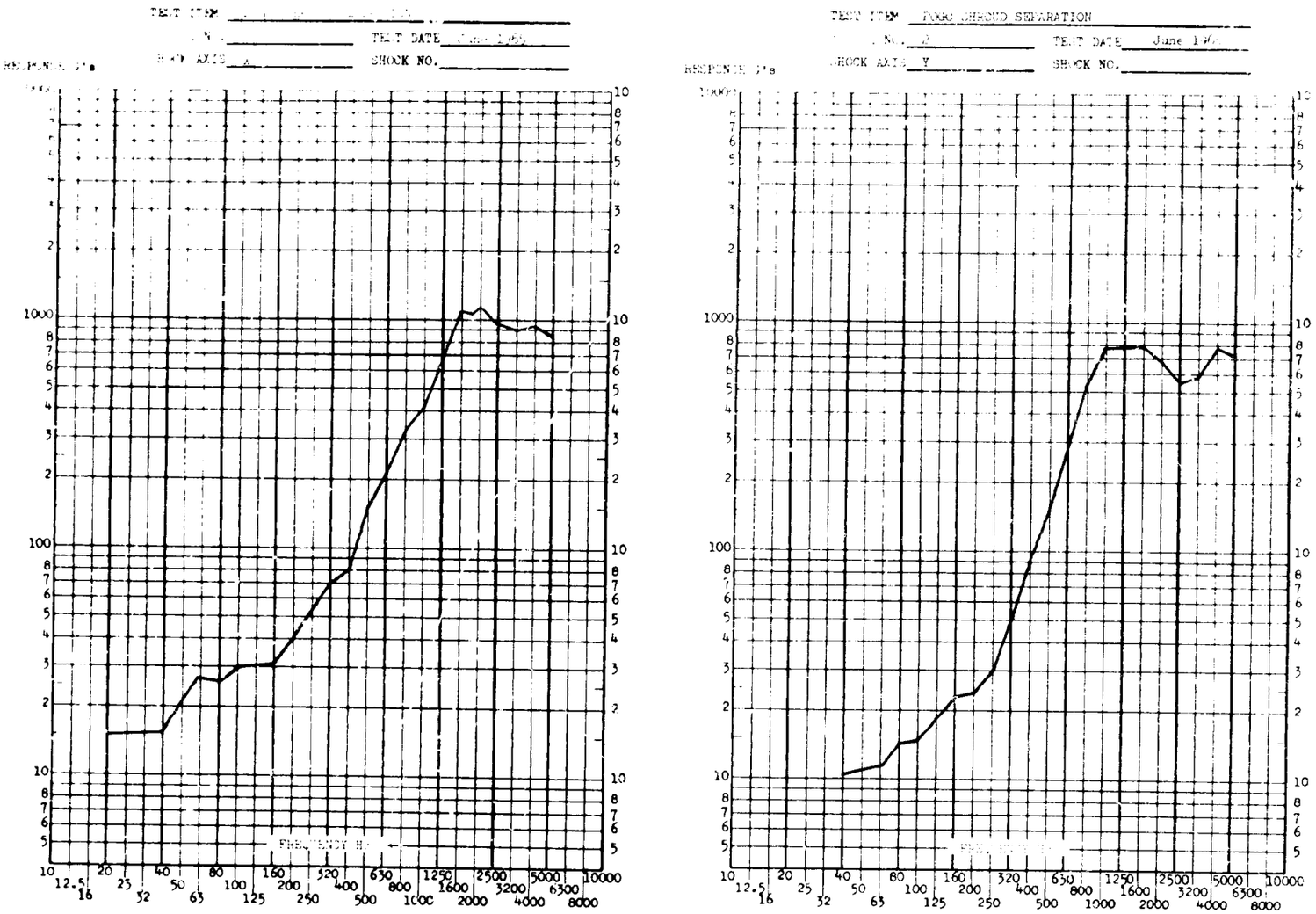
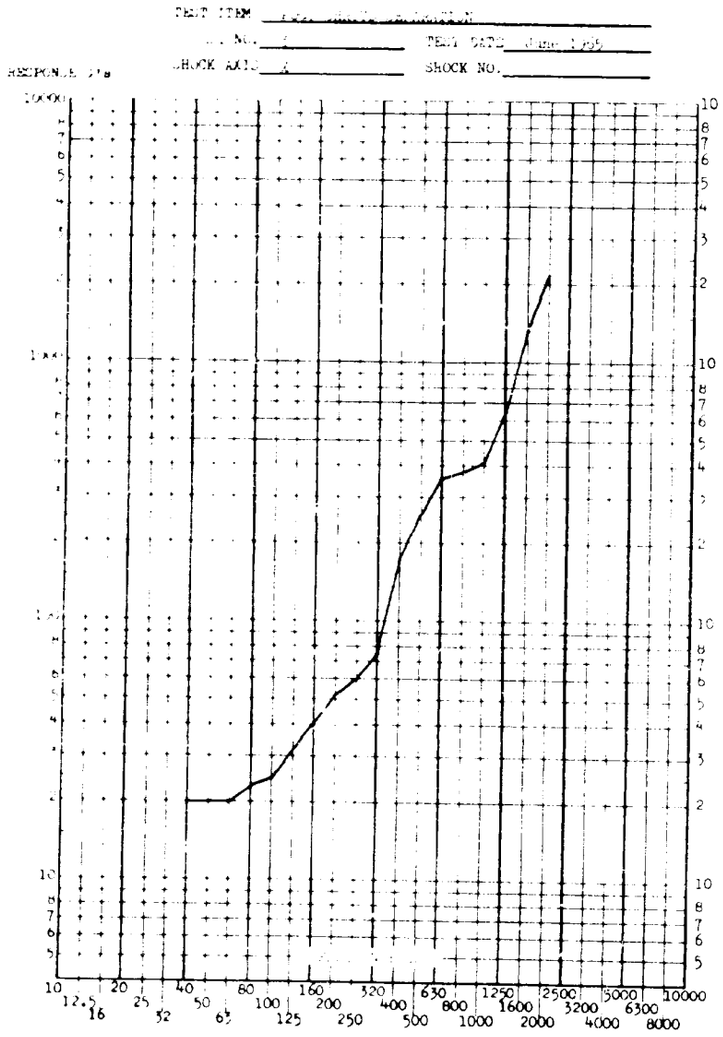



FIGURE II.A.1-4



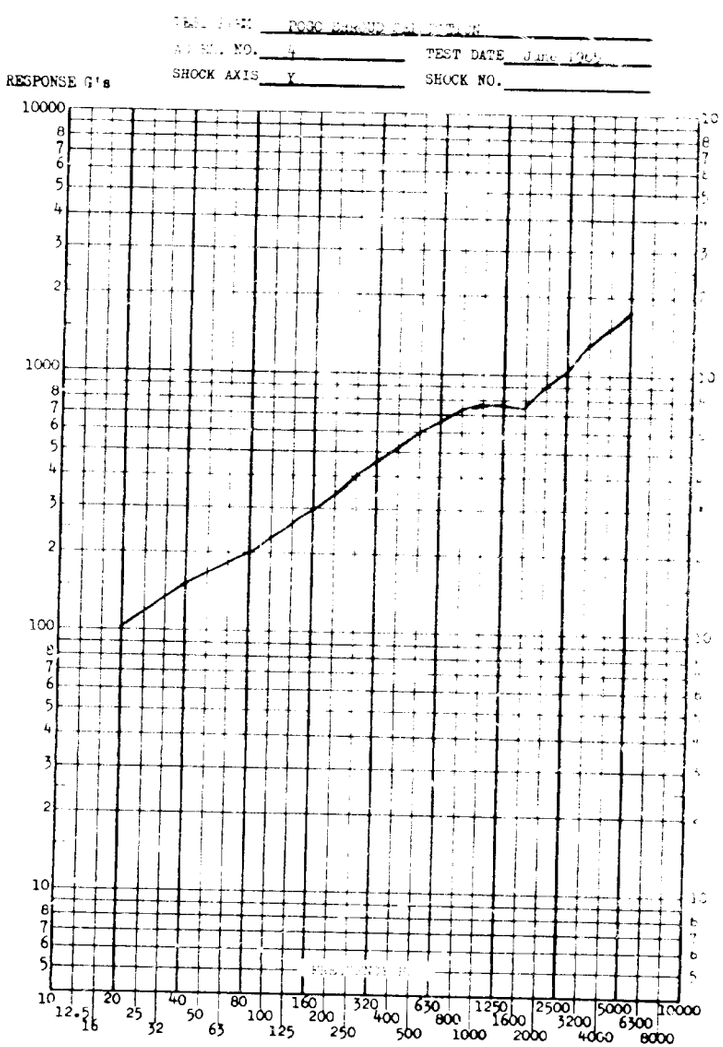
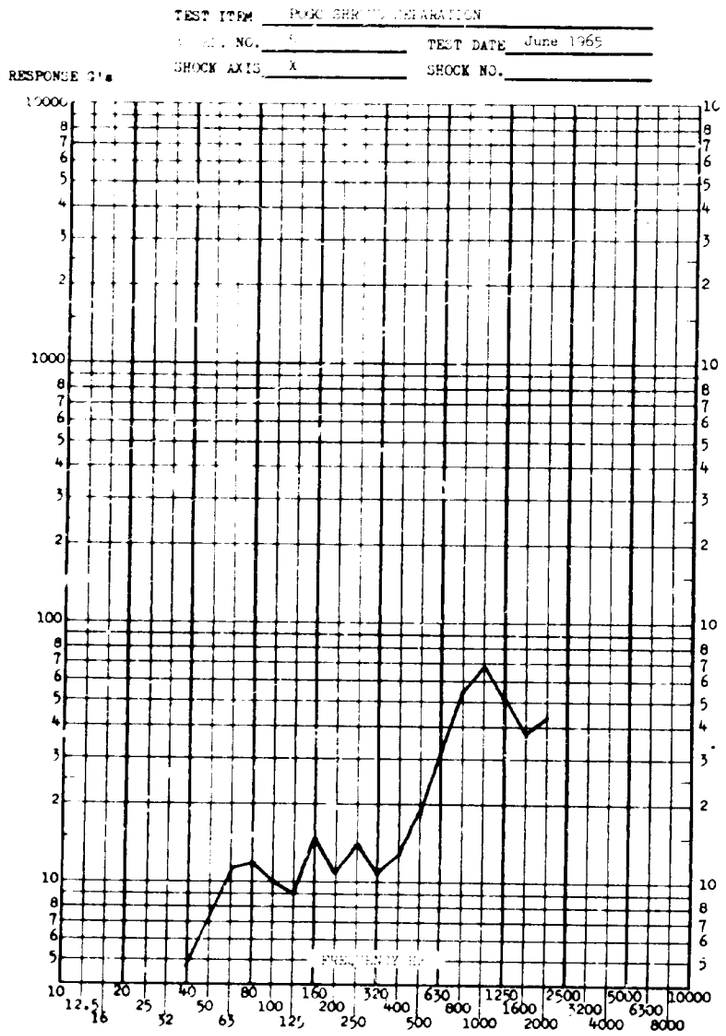




FIGURE II.A.1-5



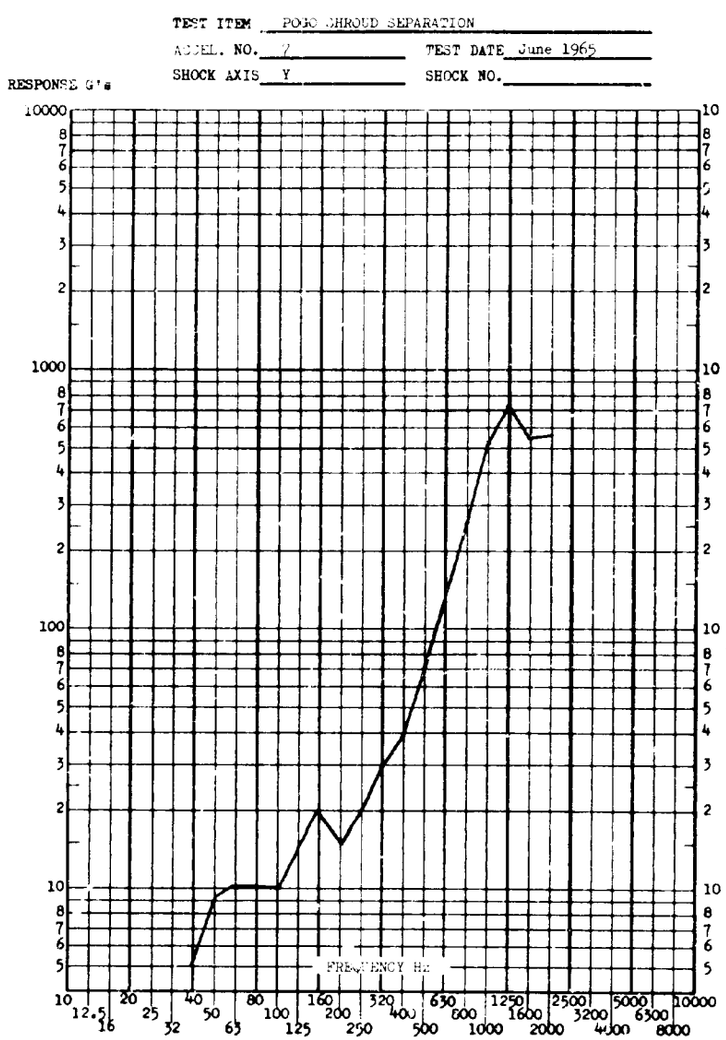




FIGURE II.A.1-6

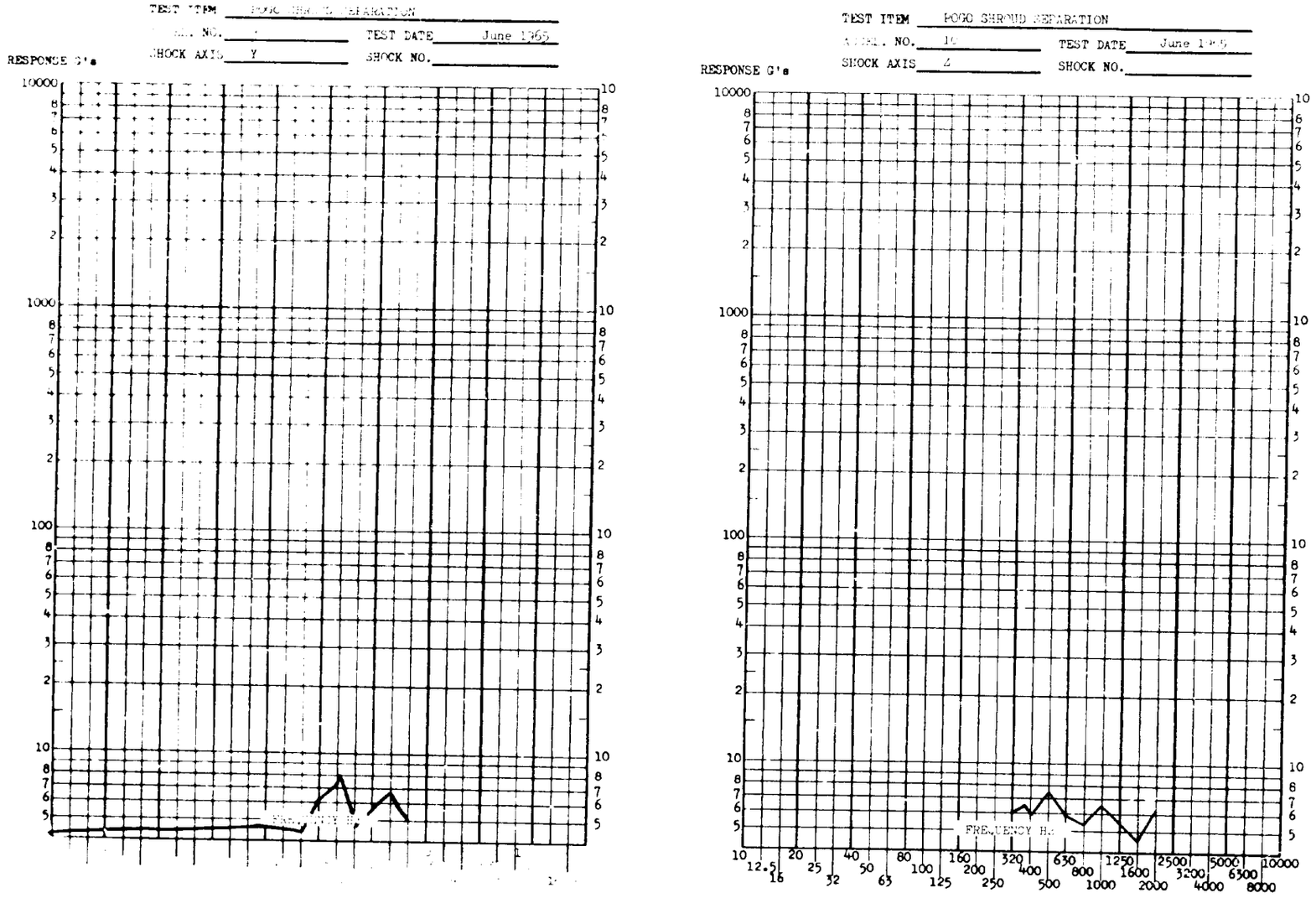



FIGURE II.A.1-7

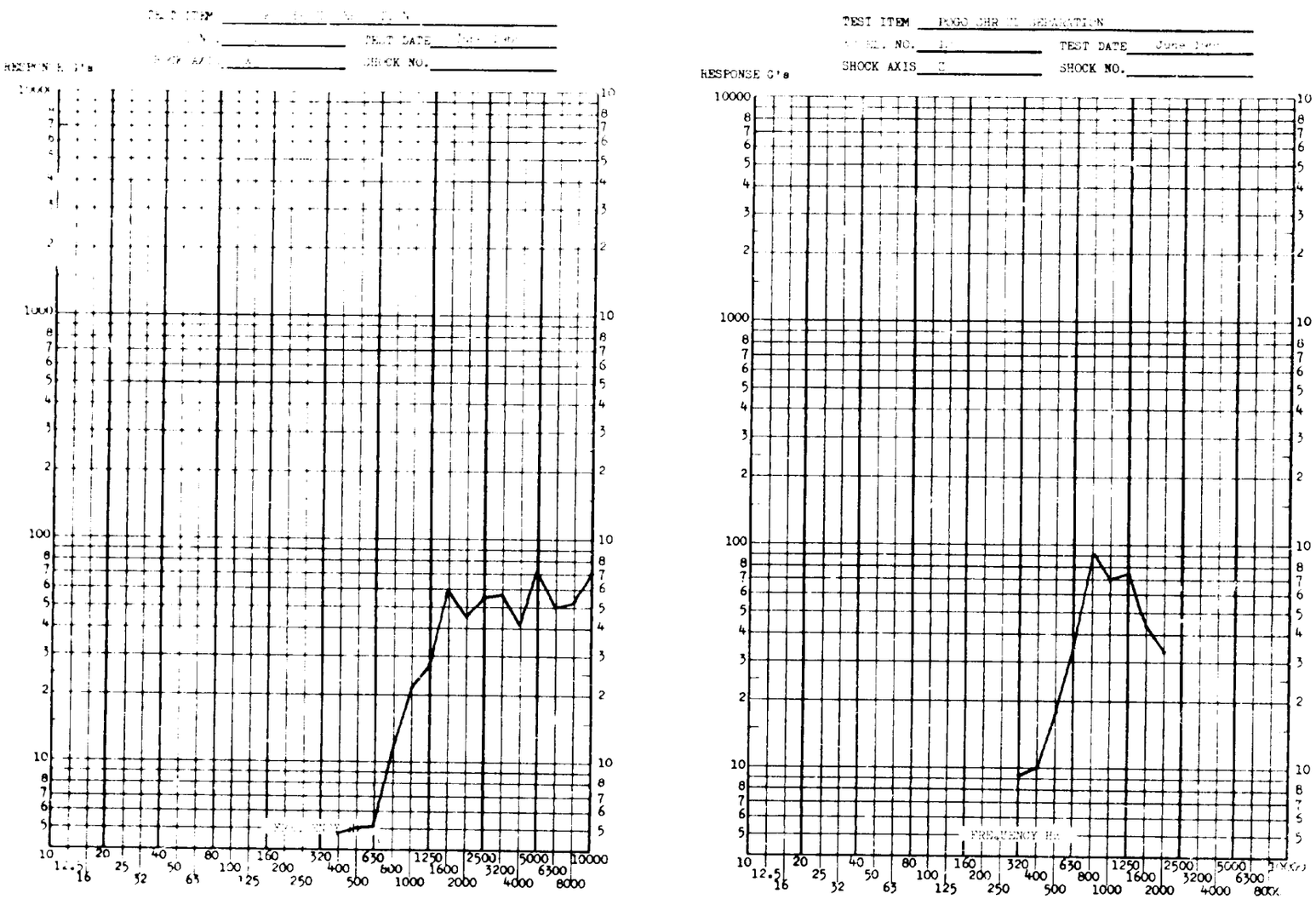


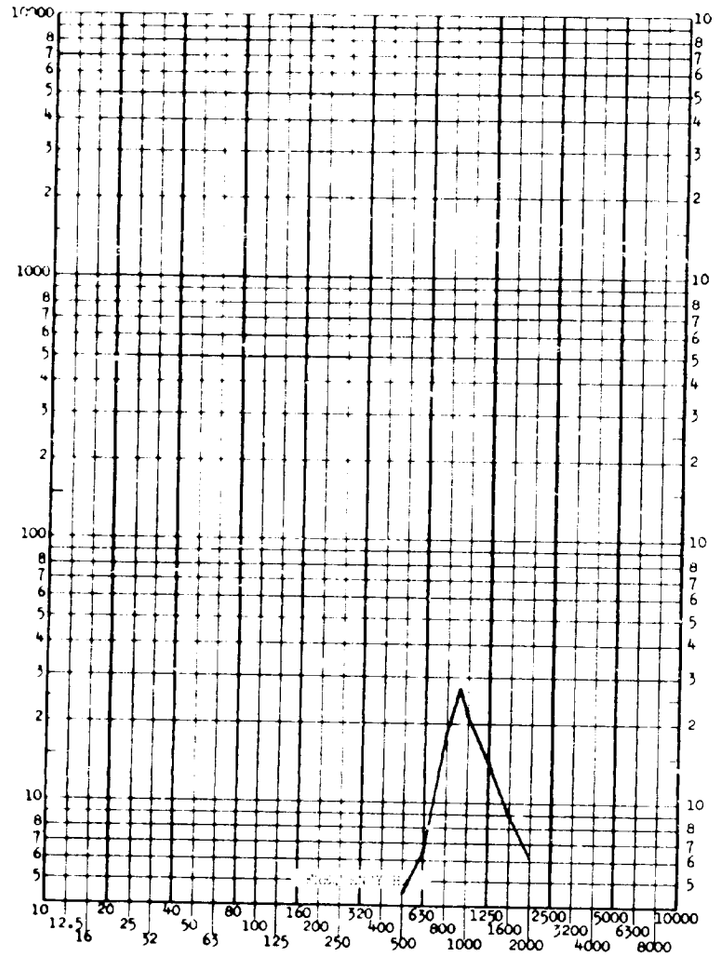

FIGURE II.A.1-8

TEST ITEM POGO SHROUD SEPARATION

ACCEL. NO. 4 TEST DATE June 1965

SHOCK AXIS X SHOCK NO.

RESPONSE G's




TEST ITEM POGO SHROUD SEPARATION

ACCEL. NO. 14 TEST DATE June 1965

SHOCK AXIS Y SHOCK NO.

RESPONSE G's

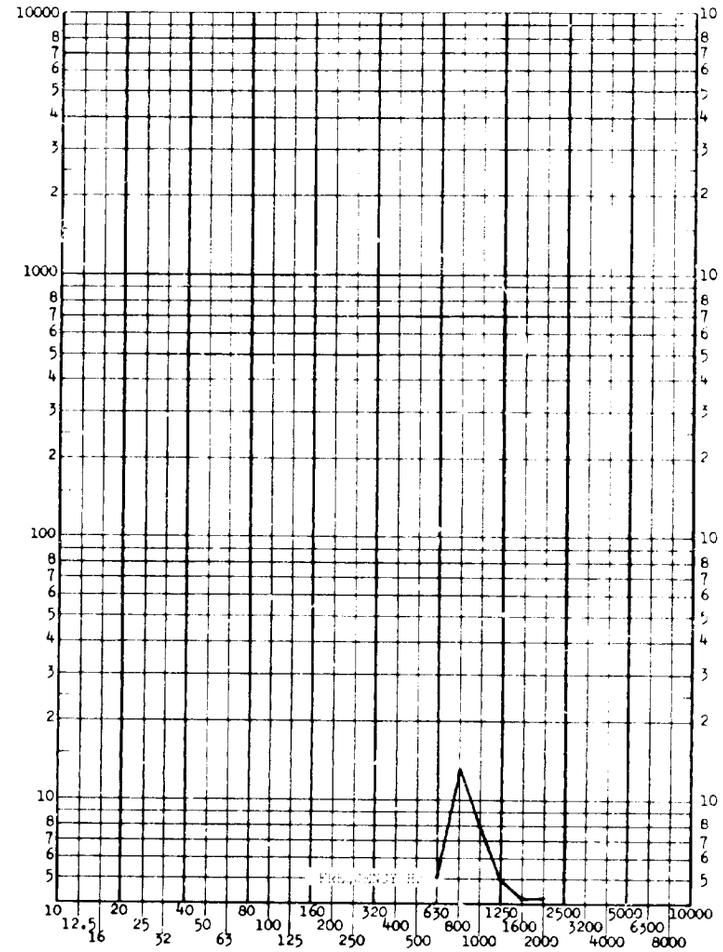



FIGURE II.A.1-9

TEST ITEM POGO SHROUD SEPARATION

ACCEL. NO. PL 20 TEST DATE June 1965

SHOCK AXIS X SHOCK NO.

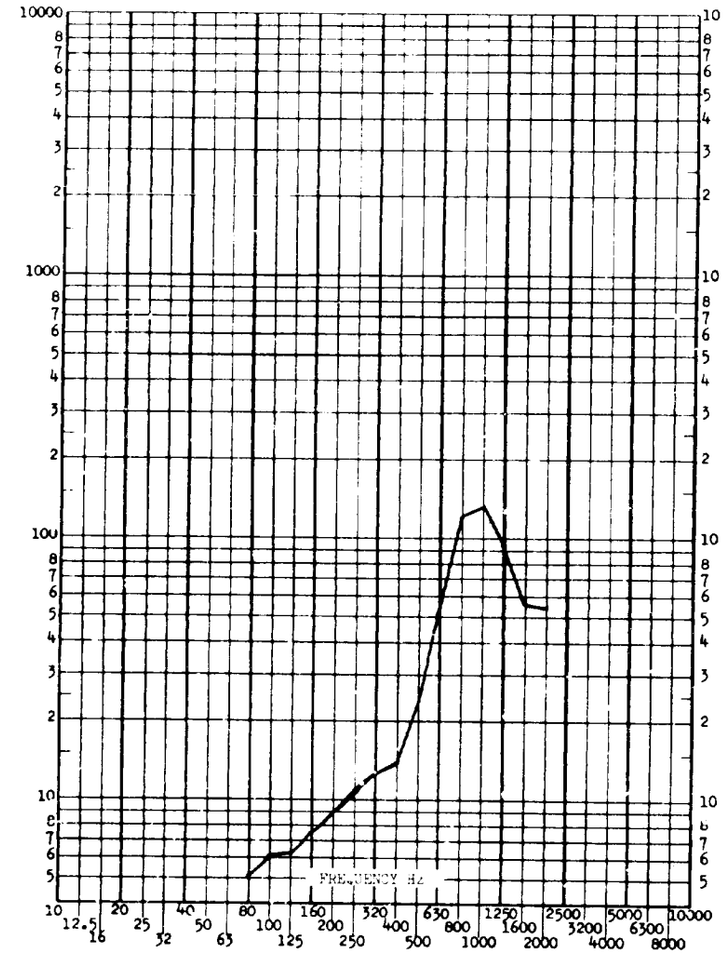



FIGURE II.A.1-10

## LOCATION OF ADDITIONAL DATA

Additional pyrotechnic shock data compiled for explosive nuts and bolts with propagation in skin-ring-frame structure may be found in the following sections of this data volume:

| | |
|---|---|
| II.B.1 | Figures 38 through 61 |
| II.B.2 | Data for accelerometers 1, 2, 3 and 16 through 24 |
| V.2 | Figures 3, 4, and 5 |
| V.3 | Entire section |
| V.4 | Engire section |

## LOCATION OF RELATED LOCKHEED DATA

Additional pyrotechnic shock data for explosive nuts with propagation in skin-ring-frame structures may be found in the following sections of the Lockheed data compilation:

II.A.4

II.B.3

# PART II.B

# PYROTECHNIC SHOCK DATA COMPILED FOR EXPLOSIVE BOLTS AND NUTS IN TRUSS STRUCTURES

SECTION II.B.1

MARTIN GROUND TESTS --- TASK K

PURPOSE OF TESTS

Full scale Titan III components were utilized in the performance of a controlled pyrotechnic shock test program performed to determine:

1) The repeatability of pyrotechnic shock measurements.

2) The influence of intervening structure on shock propagation and attenuation characteristics.

3) The collection of information to aid in the determination of structural simulation requirements for pyrotechnic shock systems.

DESCRIPTION OF EVENT

A total of nineteen (19) tests were conducted on four different configurations of the Titan III Payload Truss (Figures II.B.1-1 and II.B.1-2) as follows:

Configuration I - Payload Truss installed on transtage skirt

Configuration IIa - Payload Truss freely suspended

Configuration IIb - Payload Truss freely suspended with dummy satellites installed

Configuration III - Payload Truss installed on hydrostatic test tool (rigid fixture).

Configuration IV - Payload Truss installed on channel adapter simulating longitudinal stiffness of transtage skirt

These four mounting configurations are depicted in Figures II.B.1-3 through II.B.1-6, respectively. Dummy satellites (Figures II.B.1-7 and II.B.1-8) were mounted in all configurations except IIa.

For each test one separation nut was detonated, and that nut was always located at the truss attach point indicated in Figure II.B.1-1. The separation nut employed was of the gas pressure cartridge actuated variety: the nut separates into four segments following the build-up of pressure in the nut supplied by the cartridge. Figures II.B.1-9 and II.B.1-10 illustrates the nut/pressure cartridge configuration.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of time histories | 456 |
| No. of shock spectra | 456 |
| Type of analysis | analog |
| Analog machine | Ling SSA-100 |

| | |
|---|---|
| Frequency range | 50-10,000 Hz |
| Frequency increment | 3 points per octave |
| Damping | Q=10 |

These shock spectra are presented along with their corresponding time histories as Figures II.B.1-14 through II.B.1-157 as indexed in Table II.B.1-1. The data are presented by configuration in order of measurement number. See also Table II.B.1-4

DESCRIPTION OF PYROTECHNIC

Pressure cartridge actuated separation nut. A description of the pressure cartridge charge follows:

Prime charge: 90 mg pressed zirconium

Base charge: 346 mg boron and potassium nitrate

Booster charge: 86 mg boron and potassium nitrate

Sustainer charge: 193 mg ammonium nitrate and rubber

Location: Figures II.B.1-1 through II.B.1-7 indicate nut orientation for the various test configurations. Figures II.B.1-9 and II.B.1-10 depict the nut/pressure cartridge assembly.

DESCRIPTION OF STRUCTURE

Payload truss tubular members of various diameter

Transtage skirt

Skin: aluminum, 0.028 inch thick

Longeron: aluminum section, see Figure II.B.1-11

Ring-frame: aluminum section, see Figure II.B.1-11.

See also Figures II.B.1-1 through II.B.1-8

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2225

Locations: Table II.B.1-2 and Figures II.B.1-1, II.B.1-2, II.B.1-12, and II.B.1-13

Axis of Sensitivity: Table II.B.1-3

DESCRIPTION OF DATA ACQUISITION SYSTEM

Tape Recorders: Ampex ES-100 (0-20,000 Hz frequency response)

Amplifiers: Kistler 504A (0-100,000 Hz frequency response)

Galvenometers: CEC Type 7-362

COMMENTS

The accelerometer instrumentation equated volts RMS to g's peak and thus the acceleration data is valid to a level of 1.414 greater than the noted calibration level.

TABLE II.B.1-1

INDEX OF DATA PRESENTED

| Figure No | Test Configuration | Shock No(s) | Accelerometer Location | Sensitive Axis |
|---|---|---|---|---|
| II.B.1-14 | I | 7,8,11,12 | 1 | longitudinal |
| -15 | I | 7,8,11,12 | 1 | lateral |
| -16 | I | 7,8,11,12 | 1 | vertical |
| -17 | I | 7,8 | 2 | longitudinal |
| -18 | I | 7,8 | 2 | lateral |
| -19 | I | 7,8 | 2 | vertical |
| -20 | I | 7,8,12 | 3 | longitudinal |
| -21 | I | 7,8,12 | 3 | lateral |
| -22 | I | 7,8,12 | 3 | vertical |
| -23 | I | 7,8 | 4 | longitudinal |
| -24 | I | 7,8 | 4 | lateral |
| -25 | I | 7,8 | 4 | vertical |
| -26 | I | 7,8 | 5 | longitudinal |
| -27 | I | 7,8 | 5 | lateral |
| -28 | I | 7,8 | 5 | vertical |
| -29 | I | 7,8,12 | 6 | longitudinal |
| -30 | I | 7,8,12 | 6 | lateral |
| -31 | I | 7,8,12 | 6 | vertical |
| -32 | I | 7,8 | 7 | longitudinal |
| -33 | I | 7,8 | 7 | lateral |

TABLE II.B.1-1 (continued)

INDEX OF DATA PRESENTED

| Figure No | Test Configuration | Shock No(s) | Accelerometer Location | Sensitive Axis |
|---|---|---|---|---|
| II.B.1-34 | I | 7,8 | 7 | vertical |
| -35 | I | 7,8,12 | 8 | longitudinal |
| -36 | I | 7,8,12 | 8 | lateral |
| -37 | I | 7,8,12 | 8 | vertical |
| -38 | I | 9,10 | 11 | longitudinal |
| -39 | I | 9,10 | 11 | tangential |
| -40 | I | 9,10 | 11 | radial |
| -41 | I | 9,10,11 | 12 | longitudinal |
| -42 | I | 9,10,11 | 12 | tangential |
| -43 | I | 9,10,11 | 12 | radial |
| -44 | I | 9,10,11,12 | 13 | longitudinal |
| -45 | I | 9,10,11,12 | 13 | tangential |
| -46 | I | 9,10,11,12 | 13 | radial |
| -47 | I | 9,10,11,12 | 14 | longitudinal |
| -48 | I | 9,10,11,12 | 14 | tangential |
| -49 | I | 9,10,11,12 | 14 | radial |
| -50 | I | 9,10,11,12 | 15 | longitudinal |
| -51 | I | 9,10,11,12 | 15 | tangential |
| -52 | I | 9,10,11,12 | 15 | radial |
| -53 | I | 9,10,11 | 16 | longitudinal |

TABLE II.B.1-1 (continued)

INDEX OF DATA PRESENTED

| Figure No | Test Configuration | Shock No(s) | Accelerometer Location | Sensitive Axis |
|---|---|---|---|---|
| II.B.1-54 | I | 9,10,11 | 16 | tangential |
| -55 | I | 9,10,11 | 16 | radial |
| -56 | I | 9,10,11,12 | 17 | longitudinal |
| -57 | I | 9,10,11,12 | 17 | tangential |
| -58 | I | 9,10,11,12 | 17 | radial |
| -59 | I | 9,10,11 | 18 | longitudinal |
| -60 | I | 9,10,11 | 18 | tangential |
| -61 | I | 9,10,11 | 18 | radial |
| -62 | IIa | 1,2,3 | 1 | longitudinal |
| -63 | IIa | 1,2,3 | 1 | lateral |
| -64 | IIa | 1,2,3 | 1 | vertical |
| -65 | IIa | 1,2,3 | 2 | longitudinal |
| -66 | IIa | 1,2,3 | 2 | lateral |
| -67 | IIa | 1,2,3 | 2 | vertical |
| -68 | IIa | 1,2,3 | 3 | longitudinal |
| -69 | IIa | 1,2,3 | 3 | lateral |
| -70 | IIa | 1,2,3 | 3 | vertical |
| -71 | IIa | 1,2,3 | 4 | longitudinal |
| -72 | IIa | 1,2,3 | 4 | lateral |
| -73 | IIa | 1,2,3 | 4 | vertical |

TABLE II.B.1-1 (continued)

INDEX OF DATA PRESENTED

| Figure No | Test Configuration | Shock No(s) | Accelerometer Location | Sensitive Axis |
|---|---|---|---|---|
| II.B.1-74 | IIa | 1,2,3 | 5 | longitudinal |
| -75 | IIa | 1,2,3 | 5 | lateral |
| -76 | IIa | 1,2,3 | 5 | vertical |
| -77 | IIa | 1,2,3 | 6 | longitudinal |
| -78 | IIa | 1,2,3 | 6 | lateral |
| -79 | IIa | 1,2,3 | 6 | vertical |
| -80 | IIa | 1,2,3 | 7 | longitudinal |
| -81 | IIa | 1,2,3 | 7 | lateral |
| -82 | IIa | 1,2,3 | 7 | vertical |
| -83 | IIa | 1,2,3 | 8 | longitudinal |
| -84 | IIa | 1,2,3 | 8 | lateral |
| -85 | IIa | 1,2,3 | 8 | vertical |
| -86 | IIb | 4,5,6 | 1 | longitudinal |
| -87 | IIb | 4,5,6 | 1 | lateral |
| -88 | IIb | 4,5,6 | 1 | vertical |
| -89 | IIb | 4,5,6 | 2 | longitudinal |
| -90 | IIb | 4,5,6 | 2 | lateral |
| -91 | IIb | 4,5,6 | 2 | vertical |
| -92 | IIb | 4,5,6 | 3 | longitudinal |
| -93 | IIb | 4,5,6 | 3 | lateral |

TABLE II.B.1-1 (continued)

INDEX OF DATA PRESENTED

| Figure No. | Test Configuration | Shock No(s) | Accelerometer Location | Sensitive Axis |
|---|---|---|---|---|
| II.B.1-94 | IIb | 4,5,6 | 3 | vertical |
| -95 | IIb | 4,5,6 | 4 | longitudinal |
| -96 | IIb | 4,5,6 | 4 | lateral |
| -97 | IIb | 4,5,6 | 4 | vertical |
| -98 | IIb | 4,5,6 | 5 | longitudinal |
| -99 | IIb | 4,5,6 | 5 | lateral |
| -100 | IIb | 4,5,6 | 5 | vertical |
| -101 | IIb | 4,5,6 | 6 | longitudinal |
| -102 | IIb | 4,5,6 | 6 | lateral |
| -103 | IIb | 4,5,6 | 6 | vertical |
| -104 | IIb | 4,5,6 | 7 | longitudinal |
| -105 | IIb | 4,5,6 | 7 | lateral |
| -106 | IIb | 4,5,6 | 7 | vertical |
| -107 | IIb | 4,5,6 | 8 | longitudinal |
| -108 | IIb | 4,5,6 | 8 | lateral |
| -109 | IIb | 4,5,6 | 8 | vertical |
| -110 | III | 13,14,15 | 1 | longitudinal |
| -111 | III | 13,14,15 | 1 | lateral |
| -112 | III | 13,14,15 | 1 | vertical |

TABLE II.B.1-1 (continued)

INDEX OF DATA PRESENTED

| Figure No | Test Configuration | Shock No(s) | Accelerometer Location | Sensitive Axis |
|---|---|---|---|---|
| II.B.1-113 | III | 13,14,15 | 2 | longitudinal |
| -114 | III | 13,14,15 | 2 | lateral |
| -115 | III | 13,14,15 | 2 | vertical |
| -116 | III | 13,14,15 | 3 | longitudinal |
| -117 | III | 13,14,15 | 3 | lateral |
| -118 | III | 13,14,15 | 3 | vertical |
| -119 | III | 13,14,15 | 4 | longitudinal |
| -120 | III | 13,14,15 | 4 | lateral |
| -121 | III | 13,14,15 | 4 | vertical |
| -122 | III | 13,14,15 | 5 | longitudinal |
| -123 | III | 13,14,15 | 5 | lateral |
| -124 | III | 13,14,15 | 5 | vertical |
| -125 | III | 13,14,15 | 6 | longitudinal |
| -126 | III | 13,14,15 | 6 | lateral |
| -127 | III | 13,14,15 | 6 | vertical |
| -128 | III | 13,14,15 | 7 | longitudinal |
| -129 | III | 13,14,15 | 7 | lateral |
| -130 | III | 13,14,15 | 7 | vertical |
| -131 | III | 13,14,15 | 8 | longitudinal |
| -132 | III | 13,14,15 | 8 | lateral |

TABLE II.B.1-1 (continued)

INDEX OF DATA PRESENTED

| Figure No | Test Configuration | Shock No(s) | Accelerometer Location | Sensitive Axis |
|---|---|---|---|---|
| II.B.1-133 | III | 13,14,15 | 8 | vertical |
| -134 | IV | 16,17,18,19 | 1 | longitudinal |
| -135 | IV | 16,17,18,19 | 1 | lateral |
| -136 | IV | 16,17,18,19 | 1 | vertical |
| -137 | IV | 16,17,18,19 | 2 | longitudinal |
| -138 | IV | 16,17,18,19 | 2 | lateral |
| -139 | IV | 16,17,18,19 | 2 | vertical |
| -140 | IV | 16,17,18,19 | 3 | longitudinal |
| -141 | IV | 16,17,18,19 | 3 | lateral |
| -142 | IV | 16,17,18,19 | 3 | vertical |
| -143 | IV | 16,17,18,19 | 4 | longitudinal |
| -144 | IV | 16,17,18,19 | 4 | lateral |
| -145 | IV | 16,17,18,19 | 4 | vertical |
| -146 | IV | 16,17,18,19 | 5 | longitudinal |
| -147 | IV | 16,17,18,19 | 5 | lateral |
| -148 | IV | 16,17,18,19 | 5 | vertical |
| -149 | IV | 16,17,18,19 | 6 | longitudinal |
| -150 | IV | 16,17,18,19 | 6 | lateral |
| -151 | IV | 16,17,18,19 | 6 | vertical |
| -152 | IV | 16,17,18,19 | 7 | longitudinal |

TABLE II.B.1-1 (continued)

INDEX OF DATA PRESENTED

| Figure No | Test Configuration | Shock No(s) | Accelerometer Location | Sensitive Axis |
|---|---|---|---|---|
| II.B.1-153 | IV | 16,17,18,19 | 7 | lateral |
| -154 | IV | 16,17,18,19 | 7 | vertical |
| -155 | IV | 16,17,18,19 | 8 | longitudinal |
| -156 | IV | 16,17,18,19 | 8 | lateral |
| -157 | IV | 16,17,18,19 | 8 | vertical |

TABLE II.B.1-2

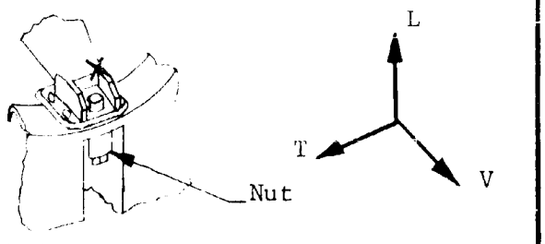
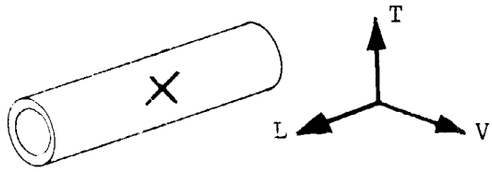
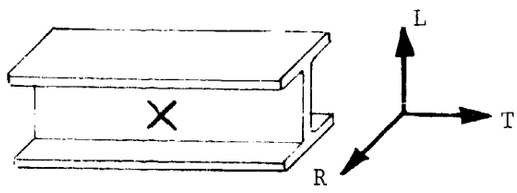
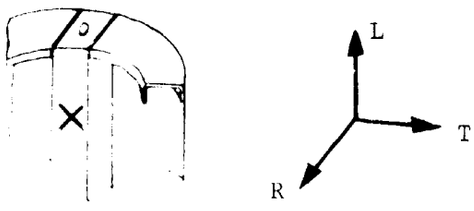
ACCELEROMETER LOCATIONS

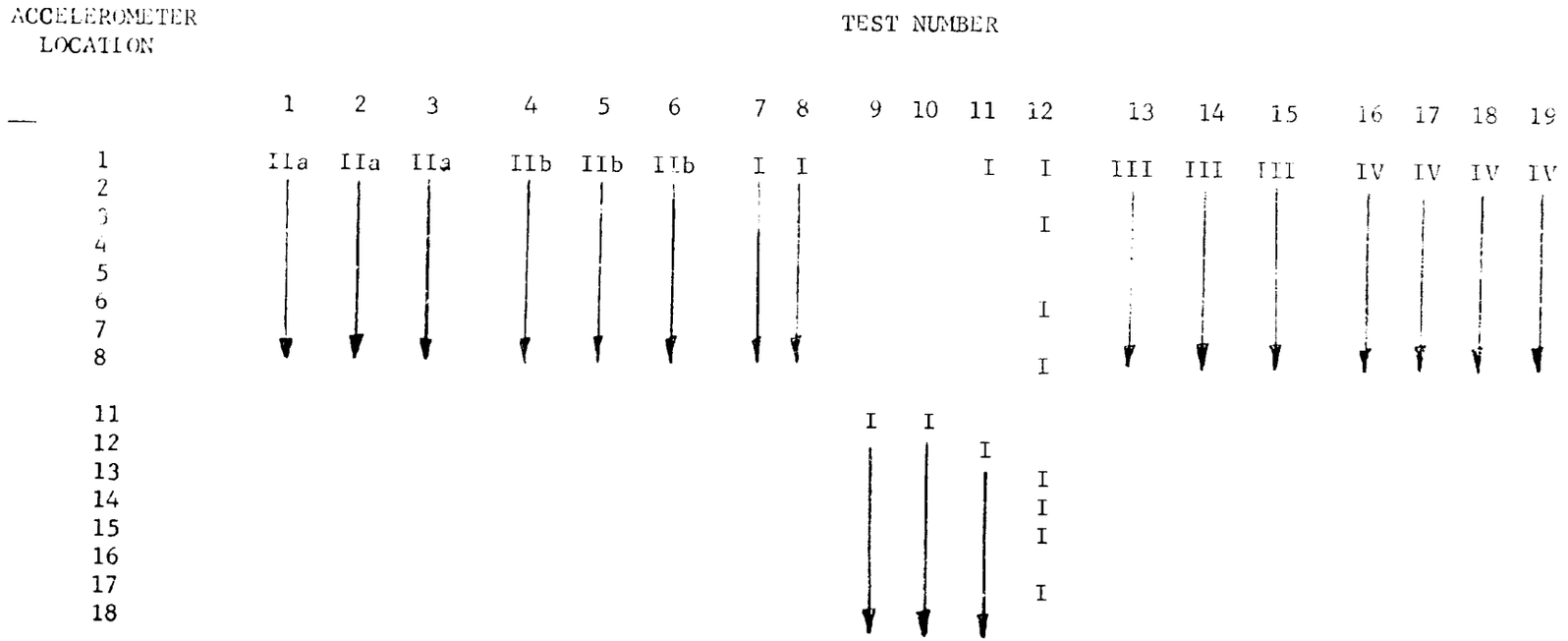
| Payload Truss Locations | Distance From Shock Sources (Inches) | Transtage Skirt Locations | Distance From* Shock Source (Inches) |
|---|---|---|---|
| 1 | 3 | 11 | 3 |
| 2 | 35 | 12 | 18 |
| 3 | 65 | 13 | 36 |
| 4 | 104 | 14 | 55 |
| 5 | 114 | 15 | 68 |
| 6 | 38 | 16 | 102 |
| 7 | 57 | 17 | 160 |
| 8 | 76 | 18 | 216 |

*These distances were determined based on shock propagation through the longerous and ring-frames and not the skin.

TABLE II.B.1-3

DIRECTIONS OF ACCELEROMETER SENSITIVITY

| Accelerometer Locations | Directions Monitored | Description of Directions |
|---|---|---|
| 1 | longitudinal (L)<br>lateral (T)<br>vertical (V) |  |
| 2,3,4,5,6 | longitudinal (L)<br>lateral (T)<br>vertical (V) | Oriented with axes of truss member<br>  |
| 7,8 | longitudinal (L)<br>lateral (T)<br>vertical (V) | Oriented with vehicle axes<br>  |
| 11,12,13,14<br>15,16,17,18 | longitudinal (L)<br>tangential (T)<br>radial (R) |  |




TEST CONFIGURATIONS

I - Truss on Transtage Skirt
IIa- Truss freely suspended
Iib- Truss freely suspended with dummy satellites
III- Truss on test tool
IV - Truss on channel adaptors

TABLE II.B.1-4

MATRIX SHOWING TEST CONFIGURATION FOR
ACCELEROMETER LOCATION AND TEST NUMBER

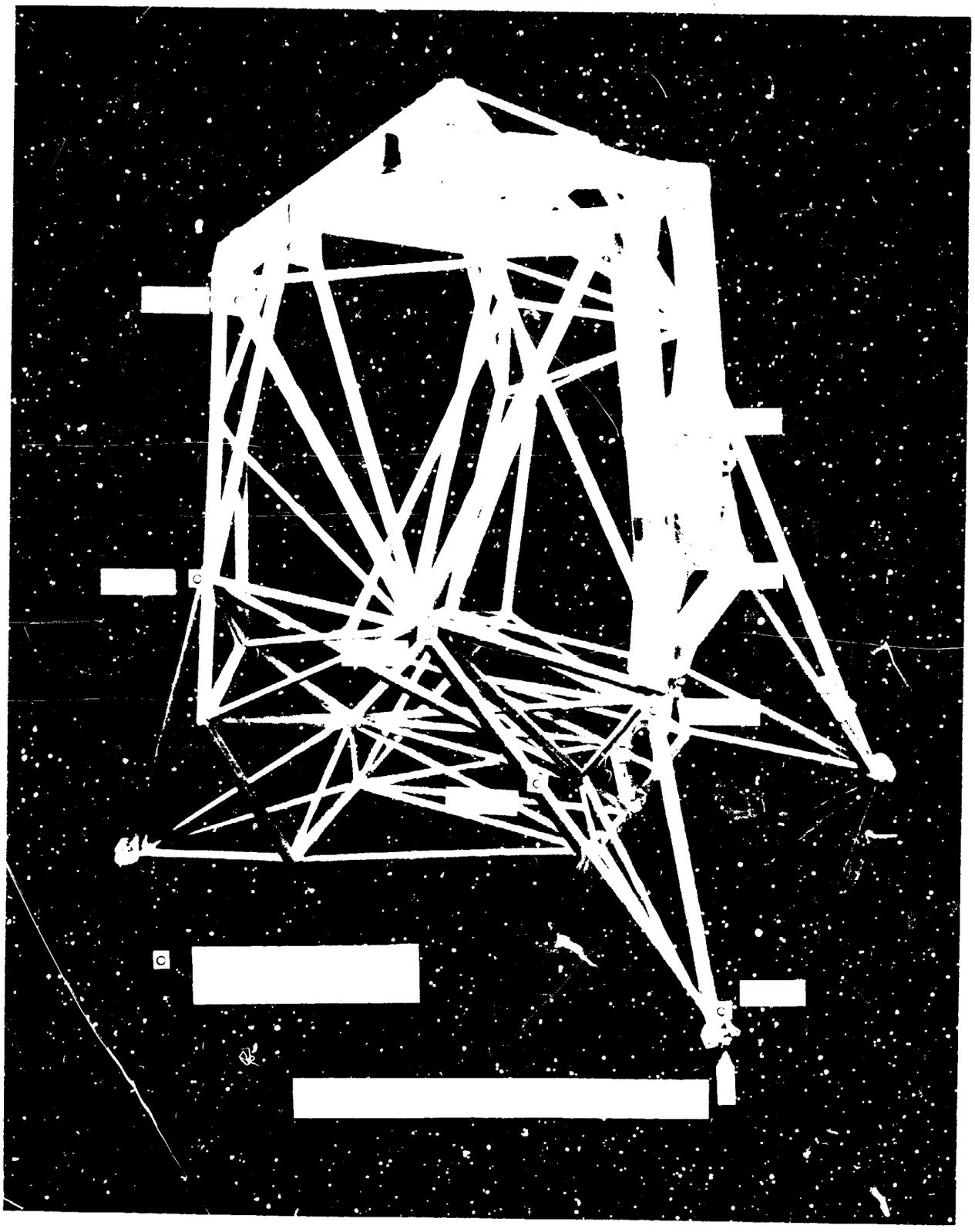


FIGURE II.B.1-1

PHOTOGRAPH OF MODEL TRUSS

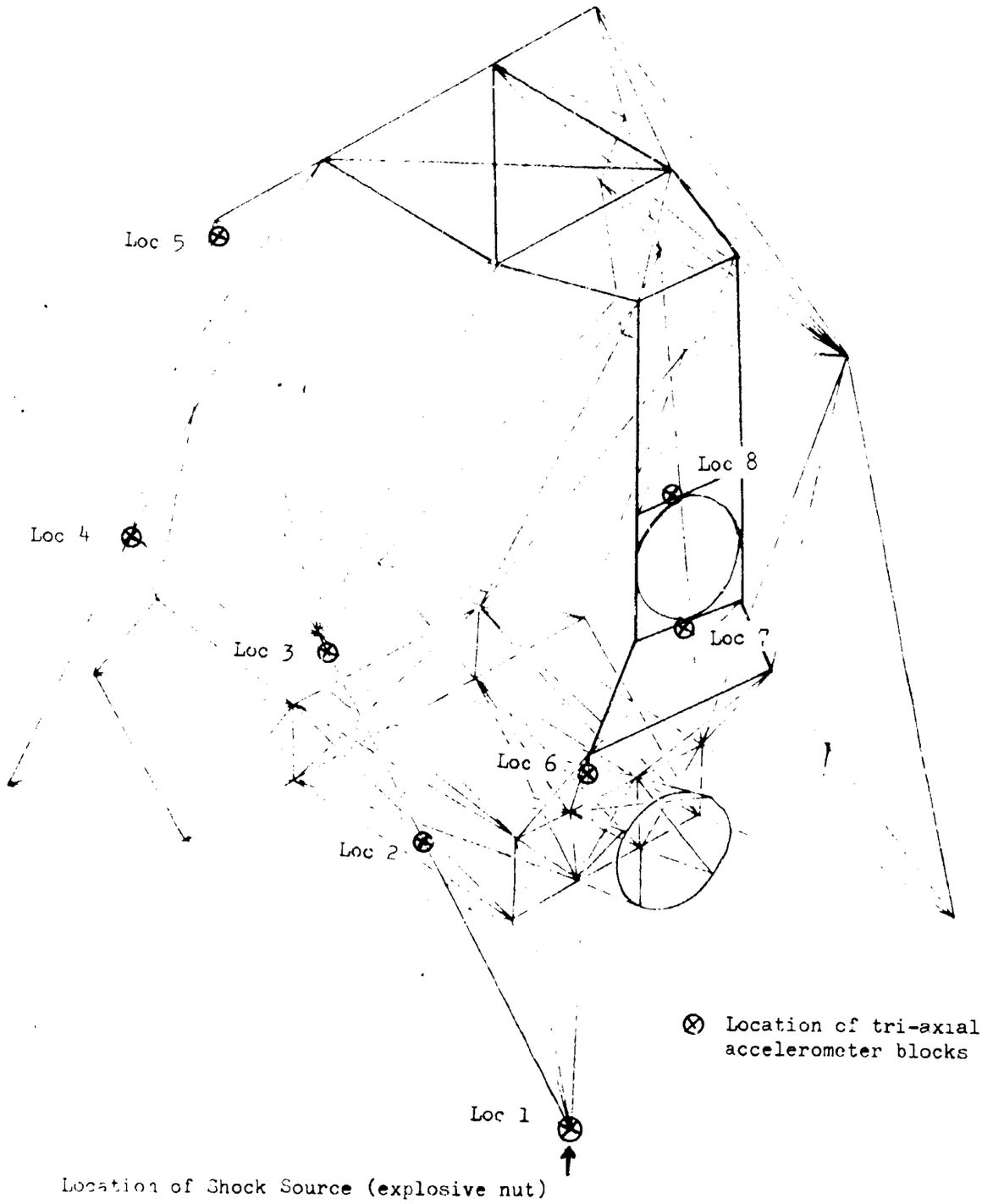
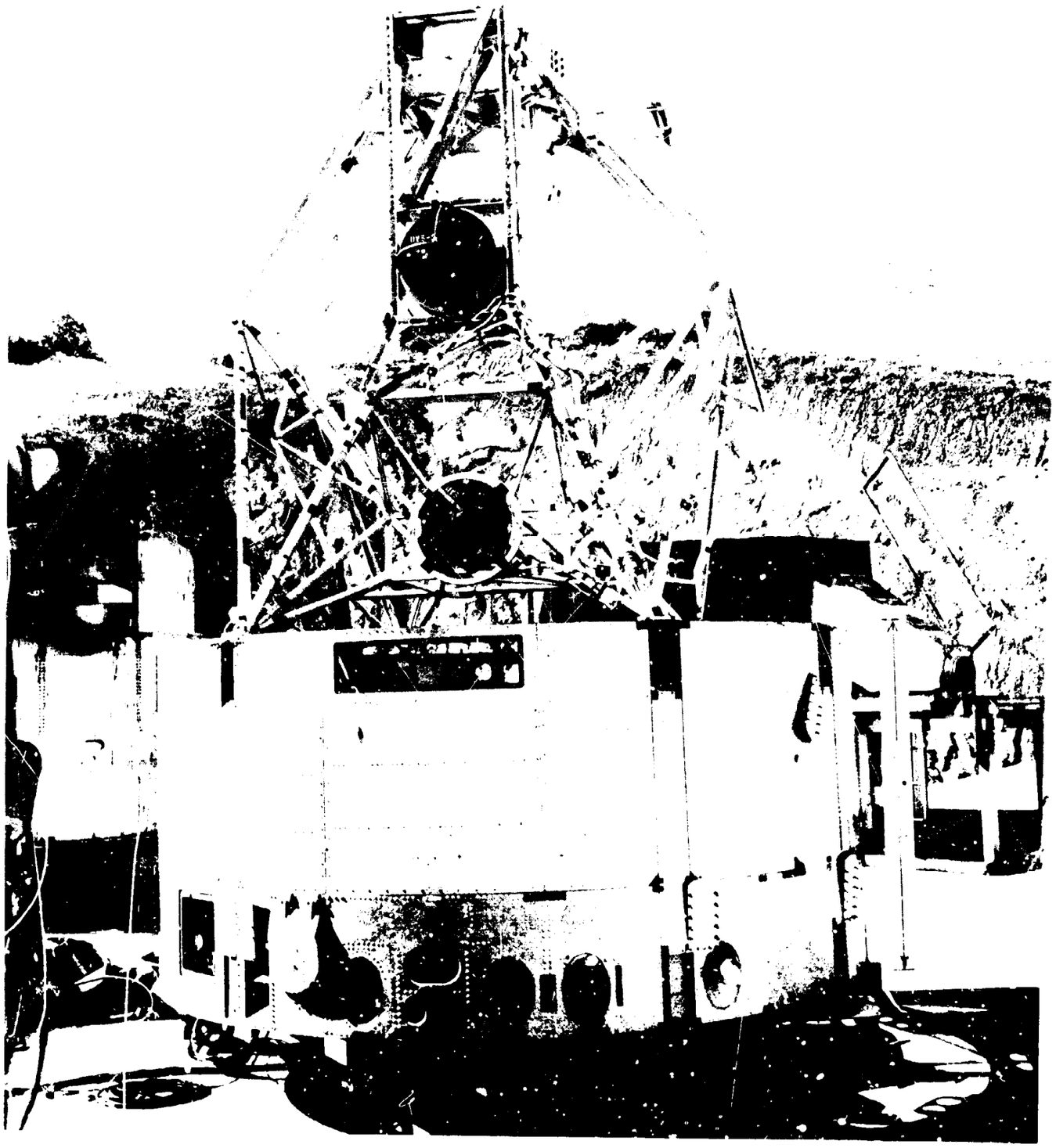
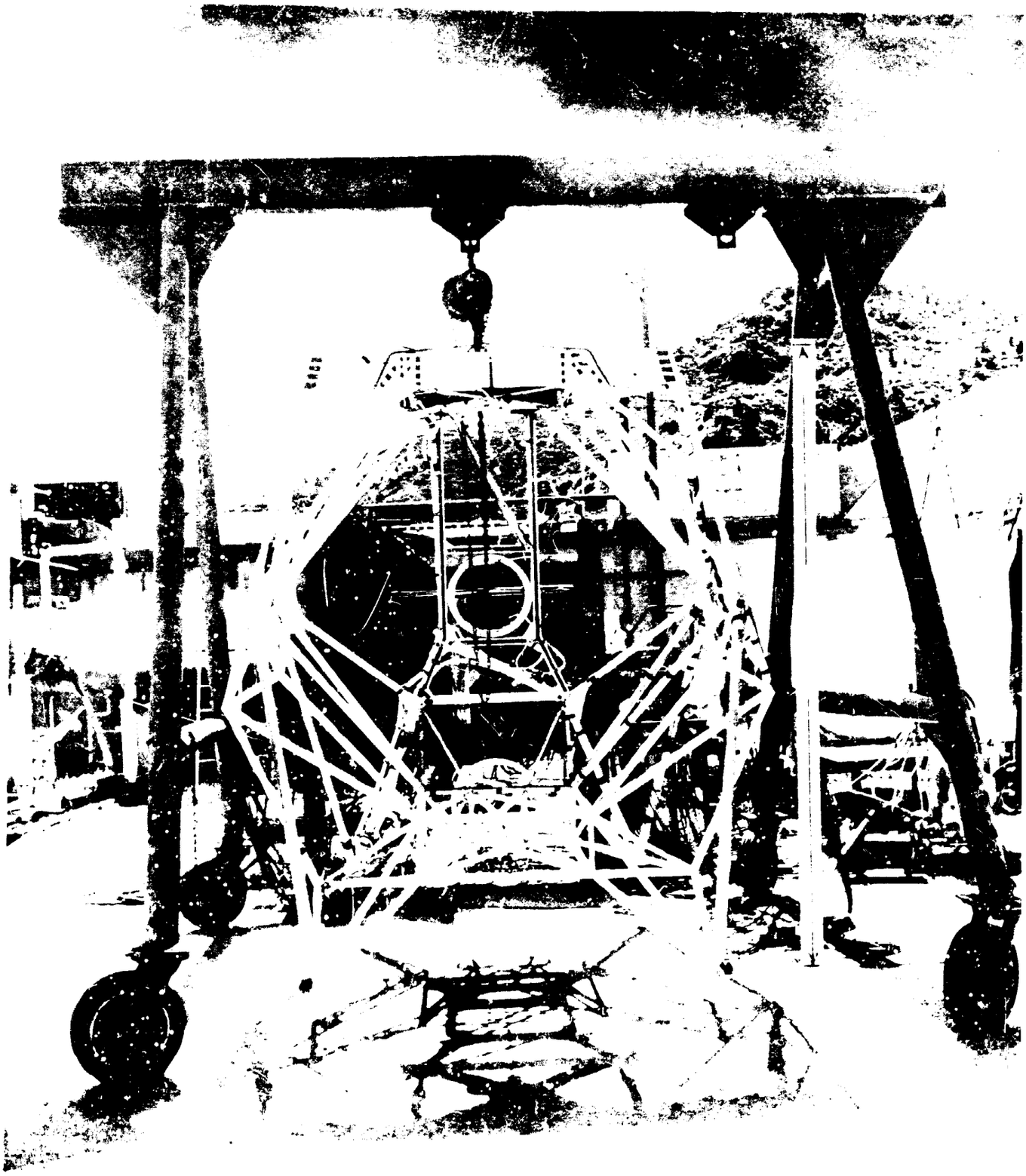
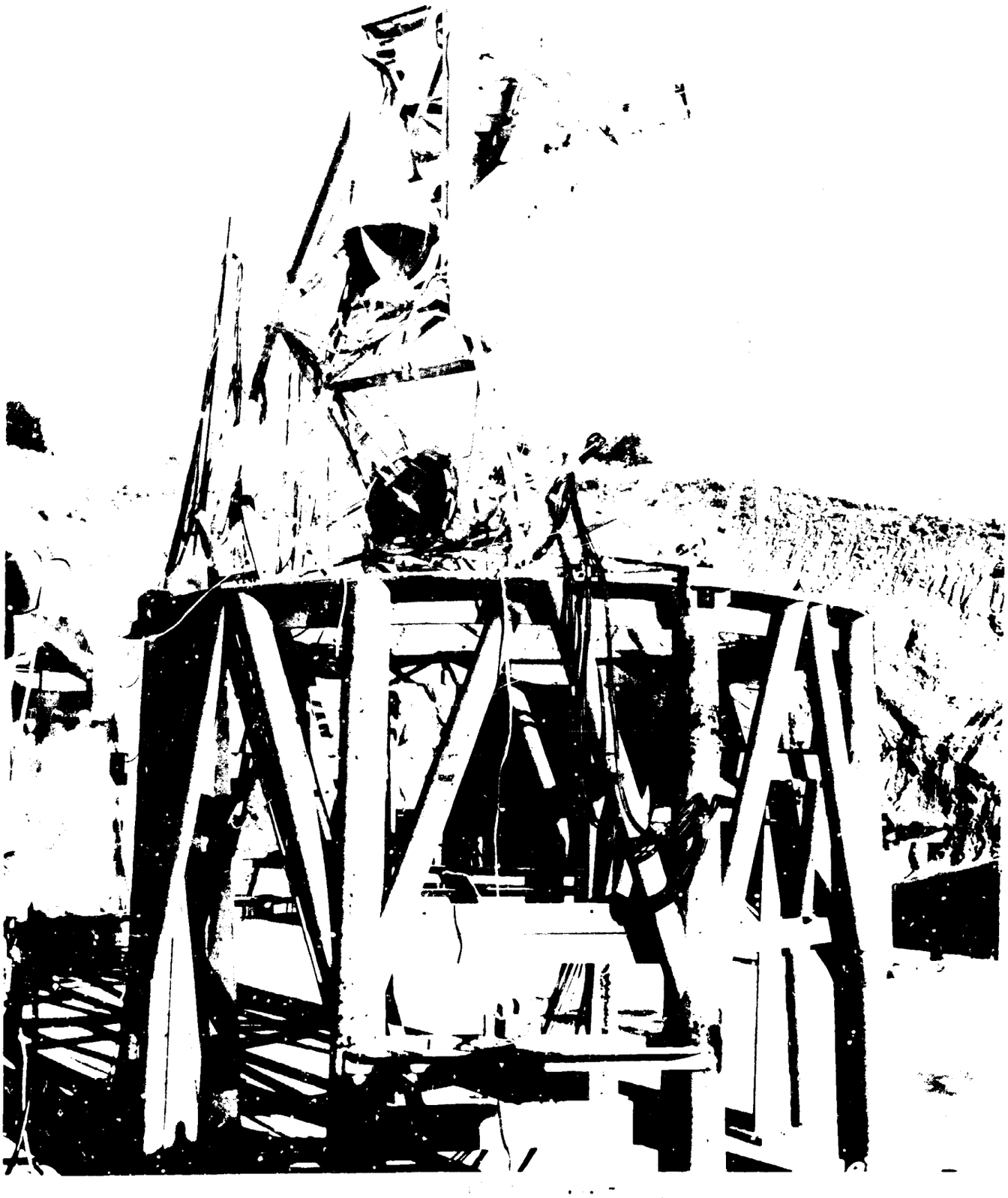



FIGURE II.B.1-2

LOCATIONS OF ACCELEROMETERS ON PAYLOAD TRUSS







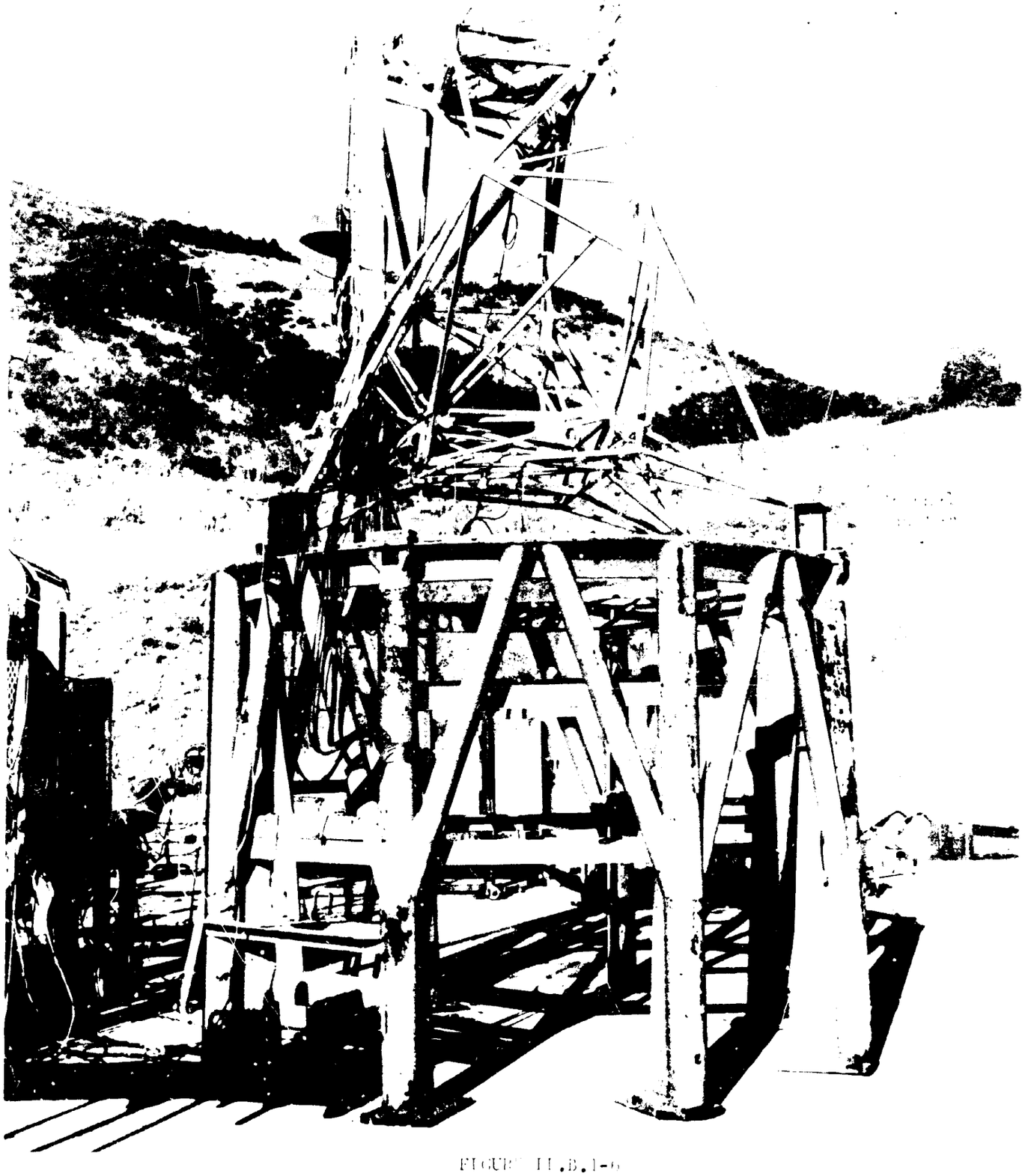


FIGURE II.B.1-6



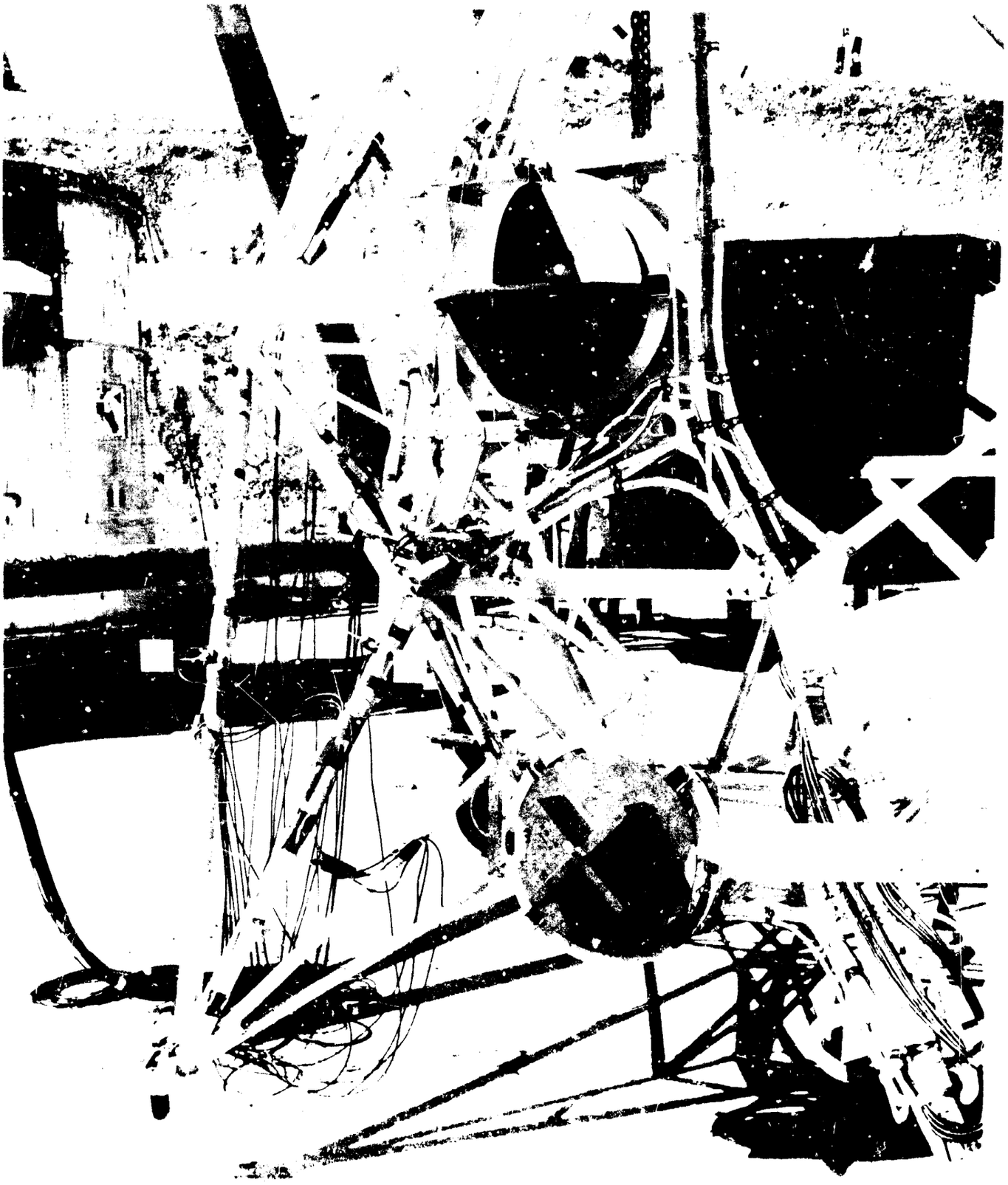




FIGURE II.B.1-9

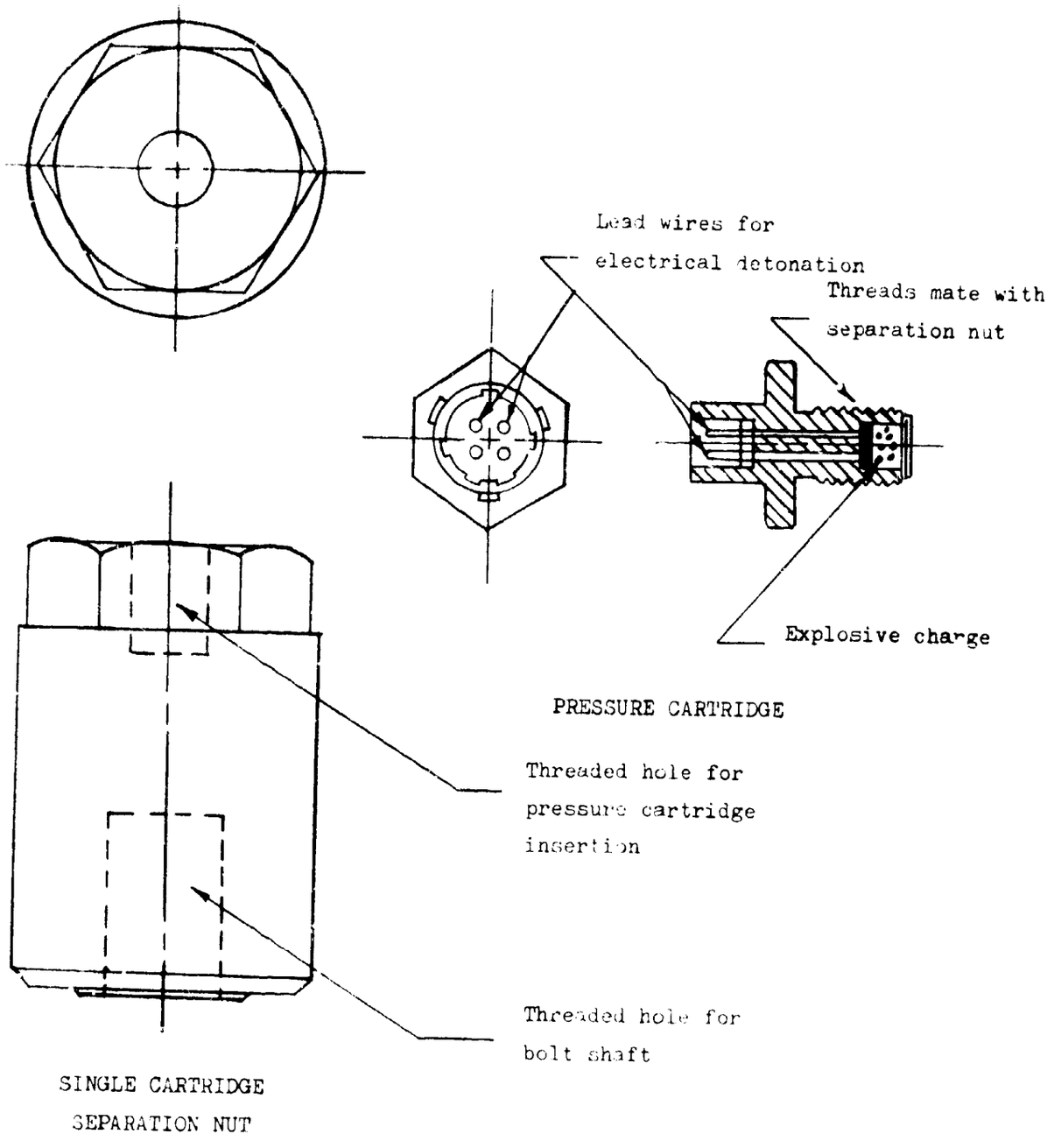
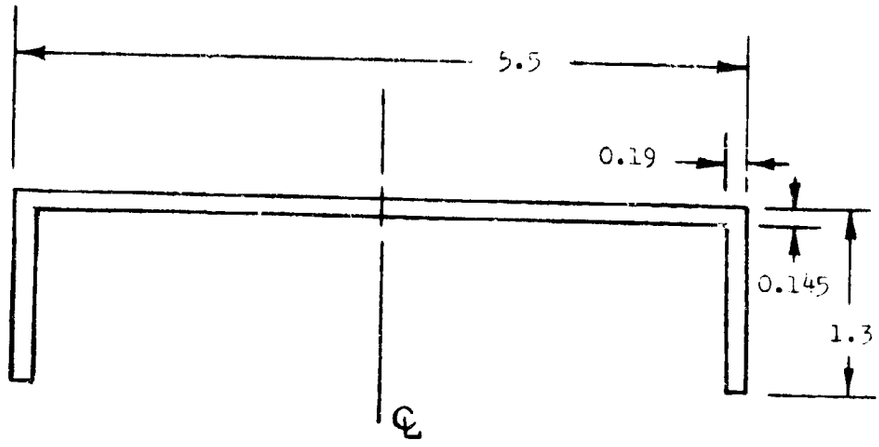


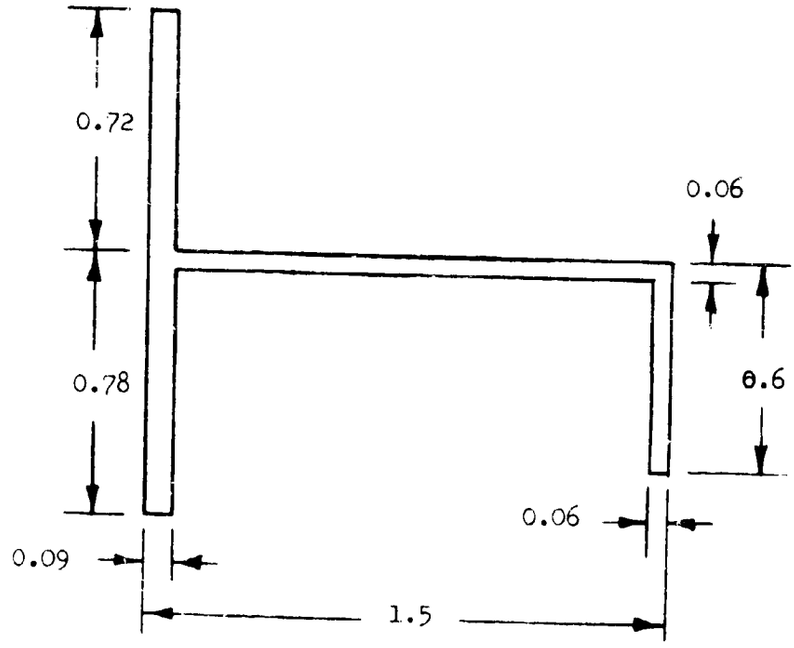

FIGURE II.B.1-10

SEPARATION NUT




RING-FRAME

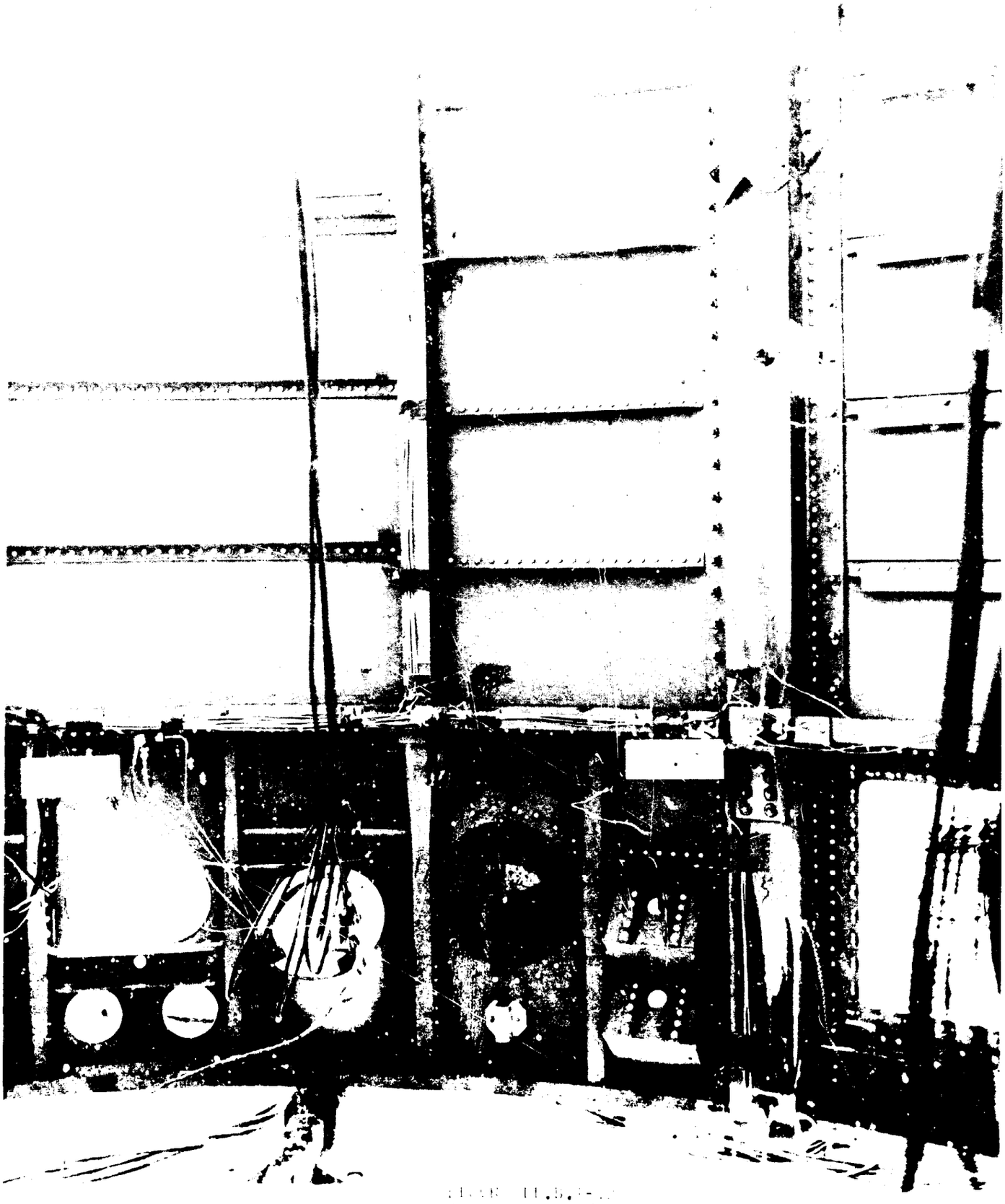
DIMENSION OF SECTION AT STATION 77



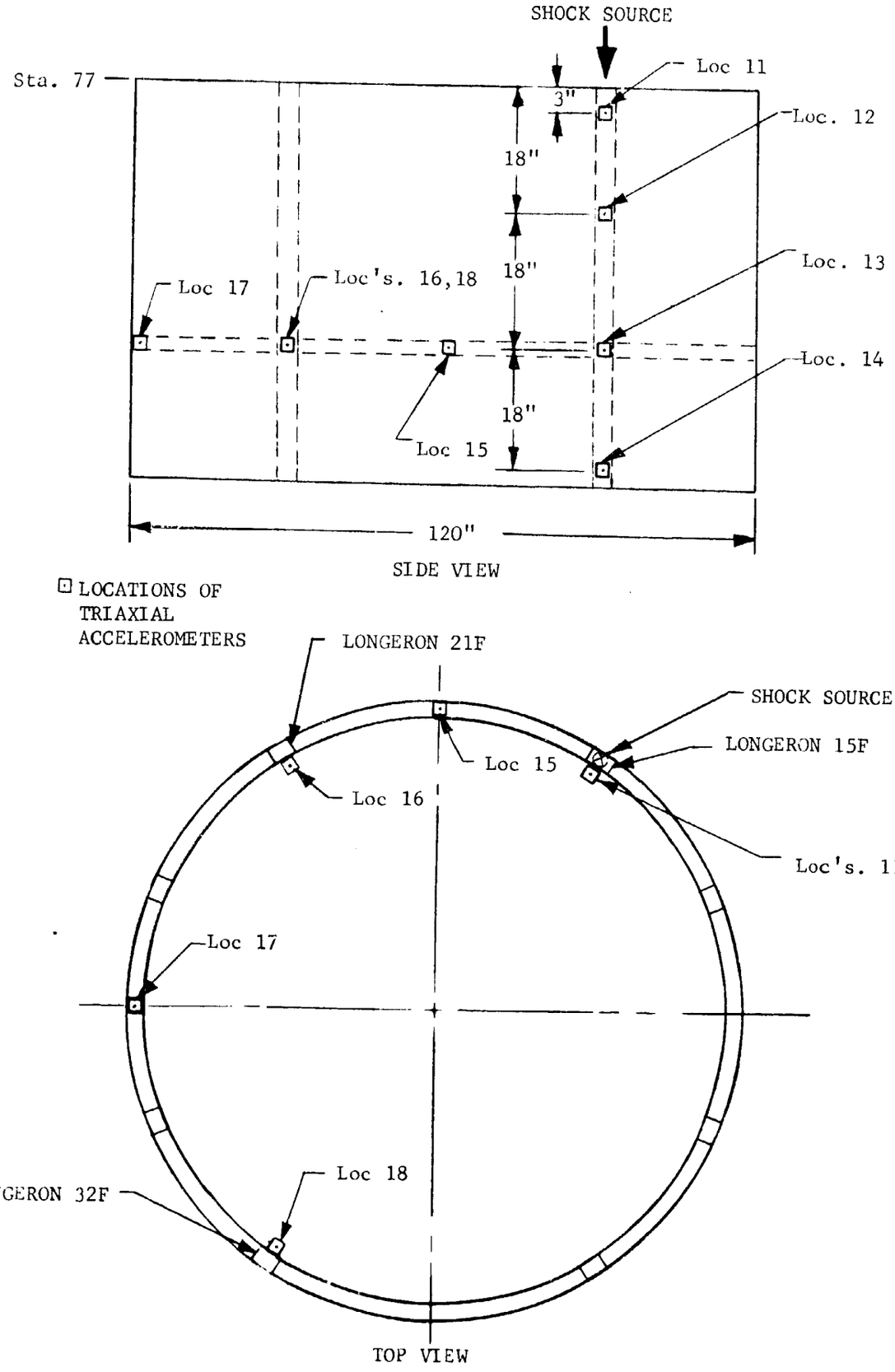

DIMENSIONS OF LONGERON SECTION

FIGURE II.B.1-11

SECTIONAL DIMENSIONS

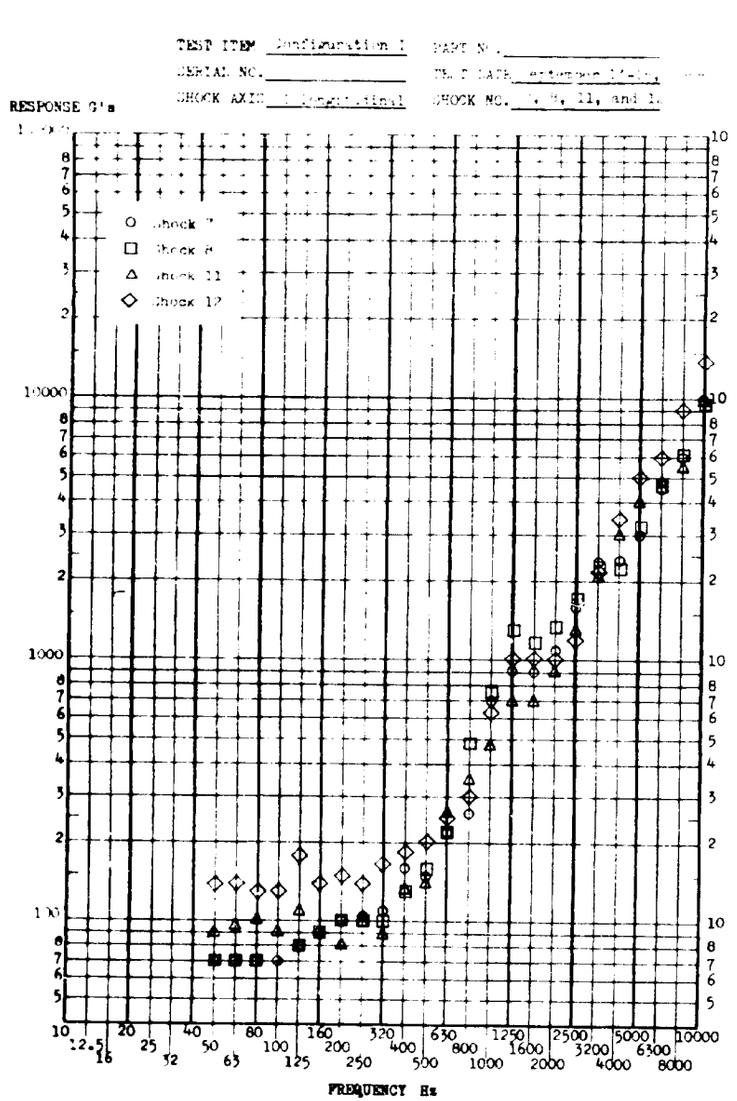


REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR.




LOCATIONS OF ACCELEROMETERS IN TRANSTAGE SKIRT

FIGURE II.B.1-13



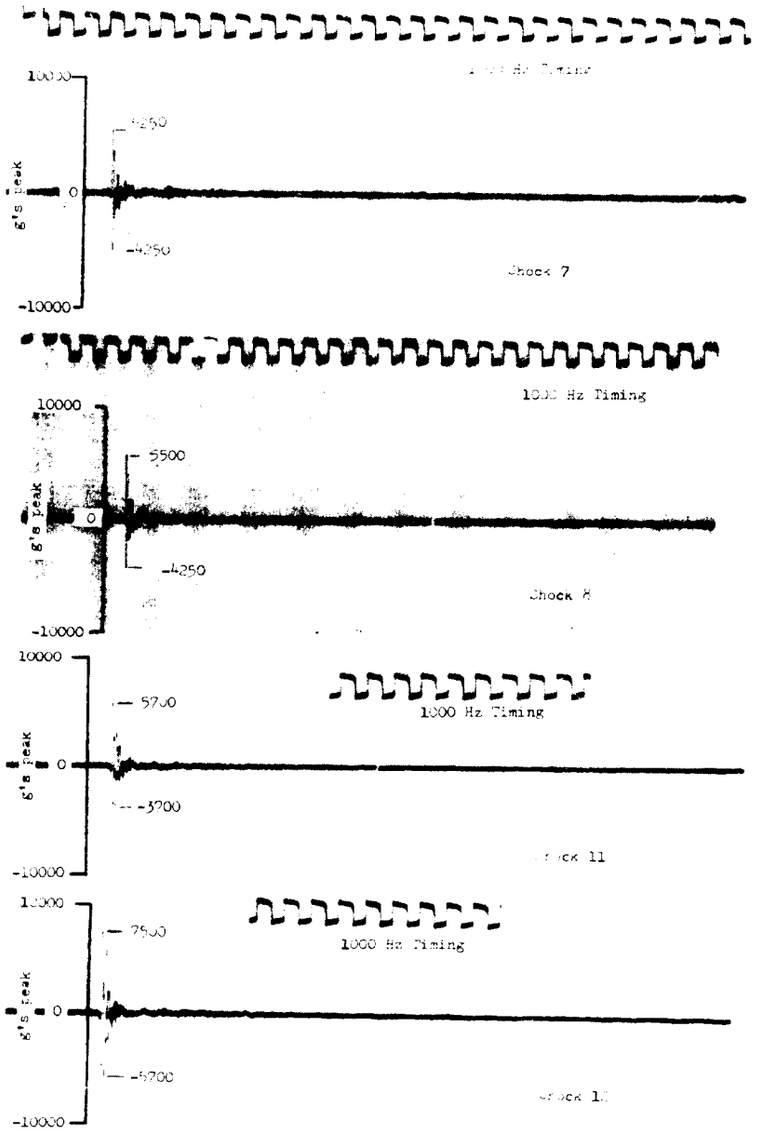
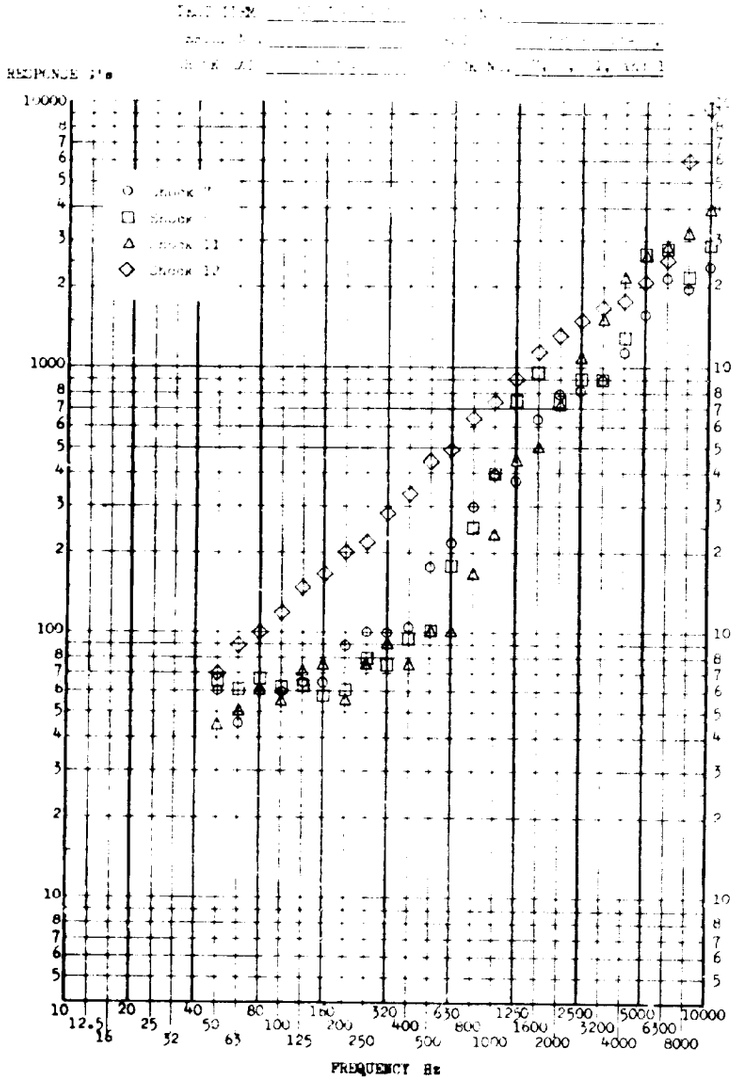




FIGURE 11.8.1-14



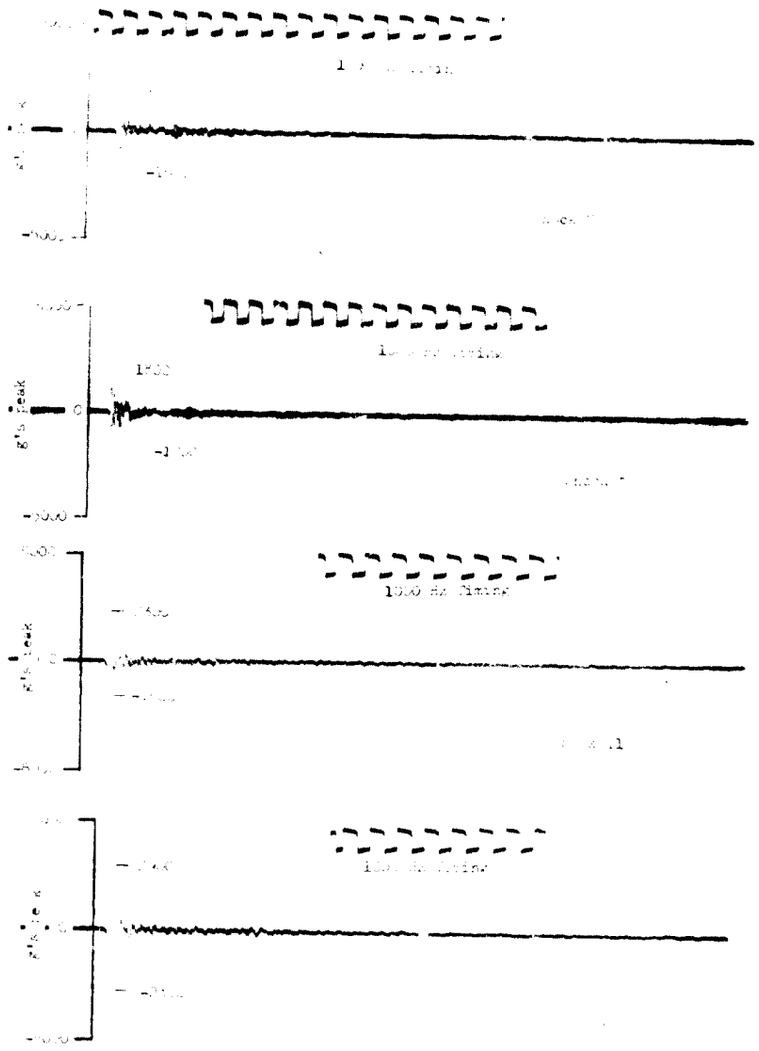



FIGURE 11.B.1-15

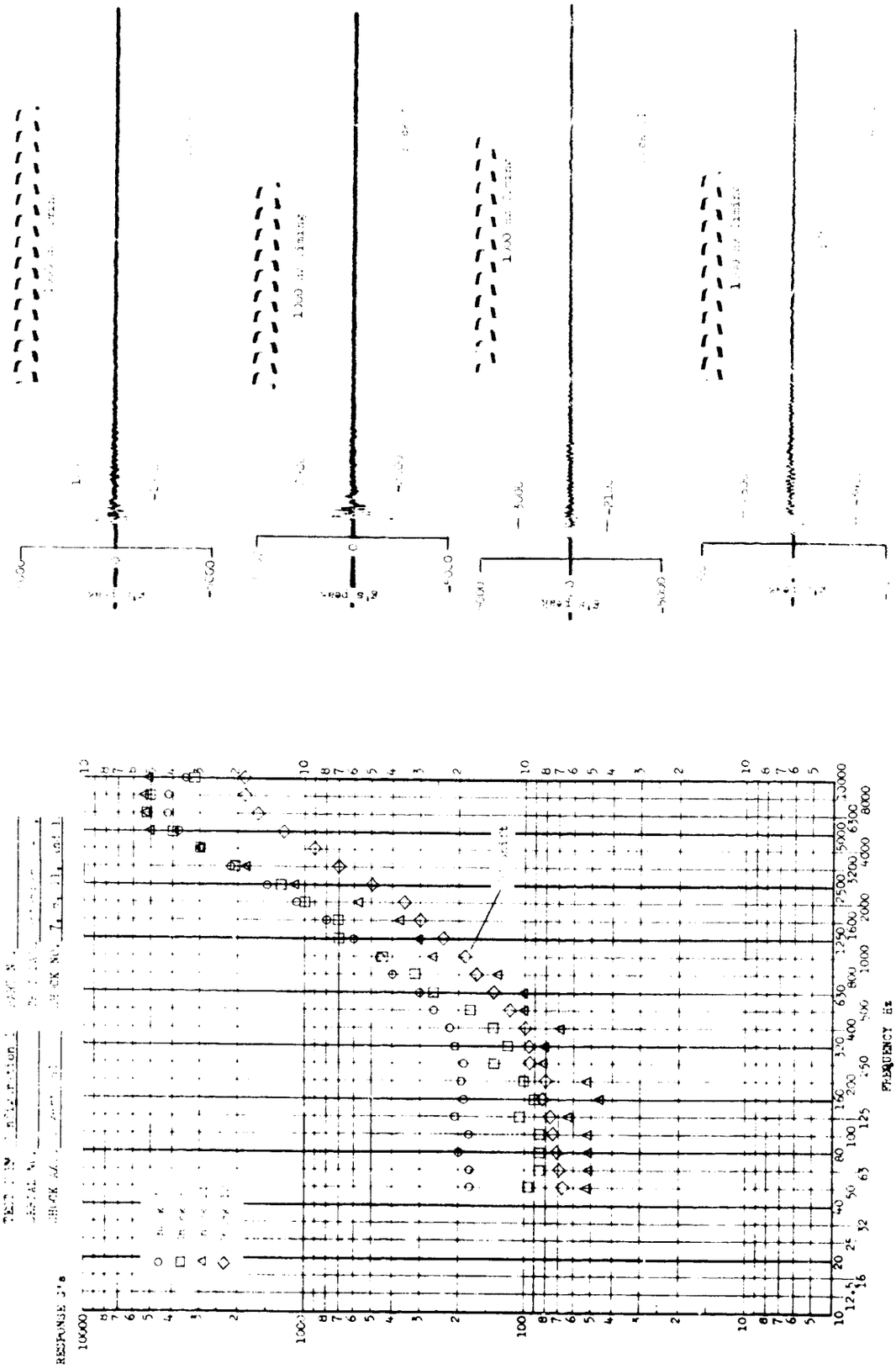


FIGURE 11.B.1-16

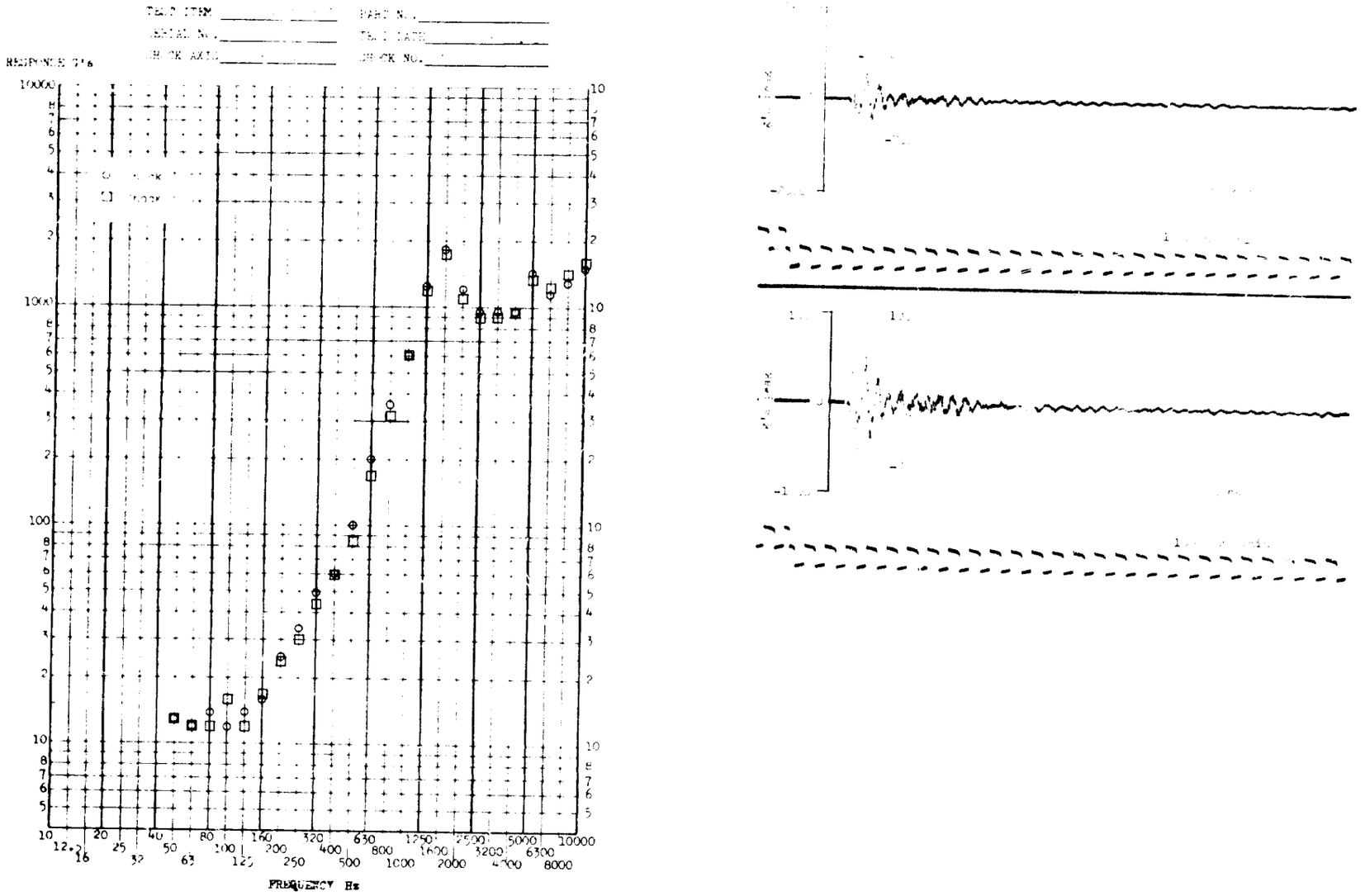



FIGURE 11.8.1-17

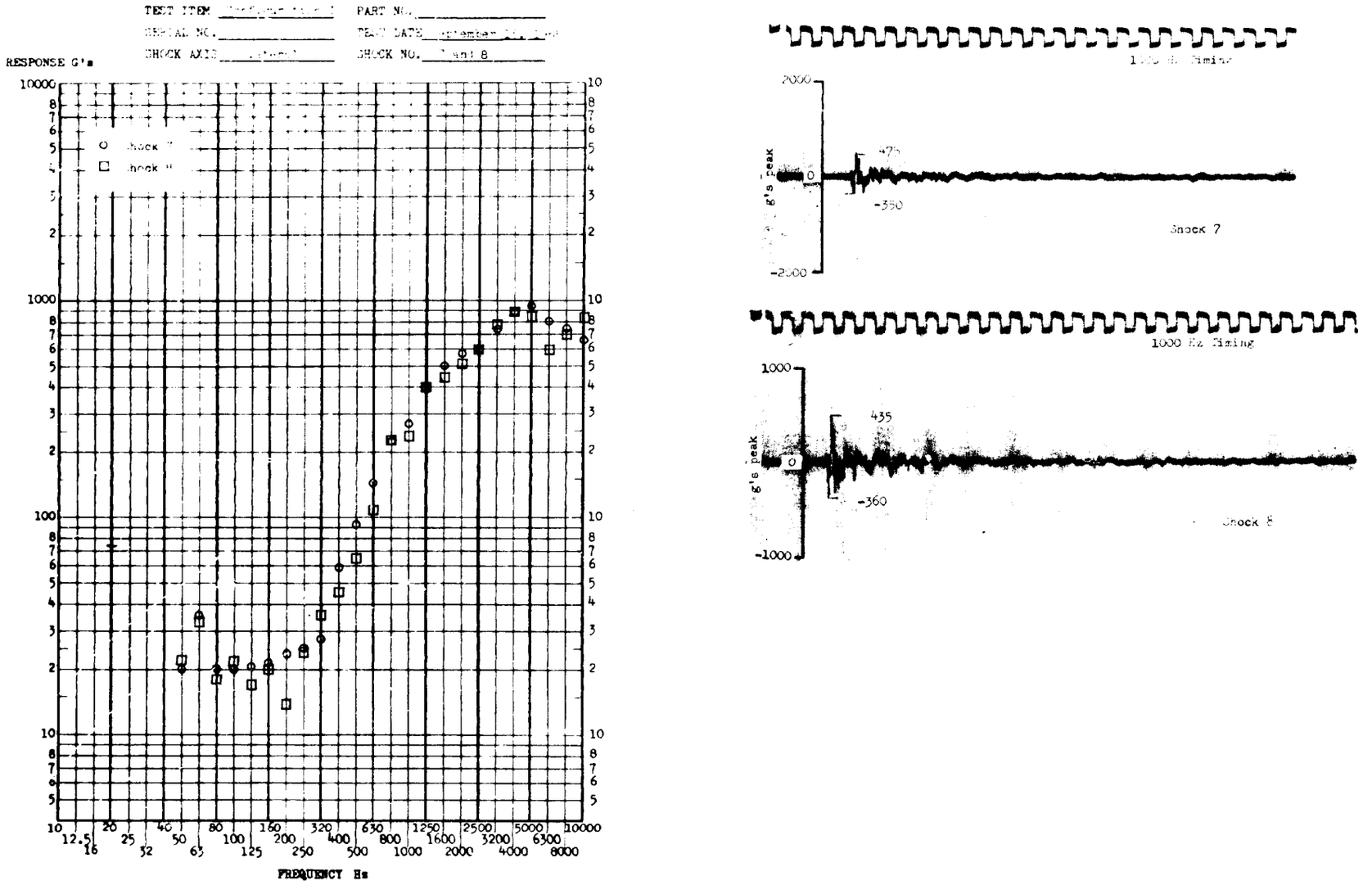



FIGURE II.B.1-18

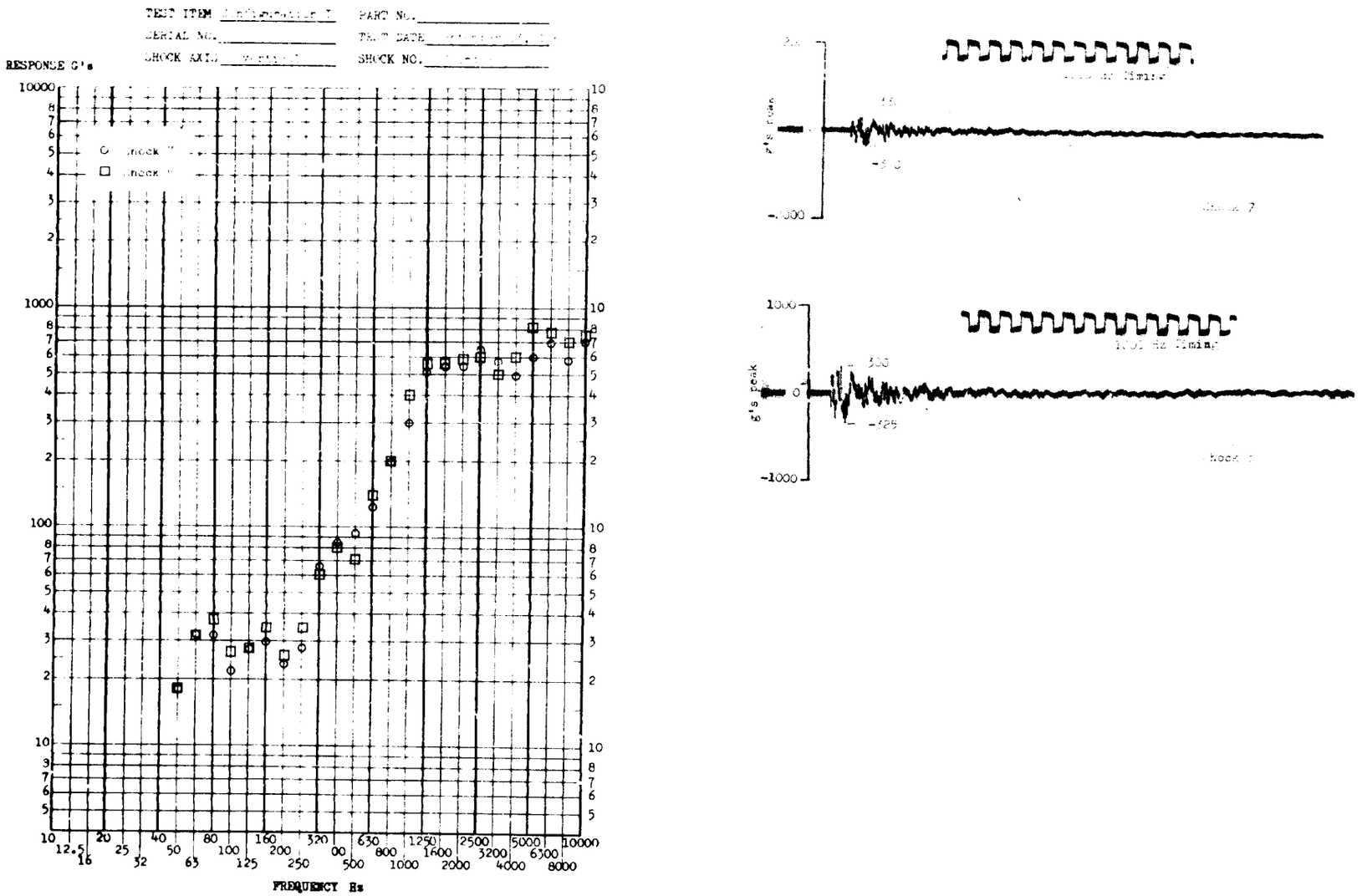
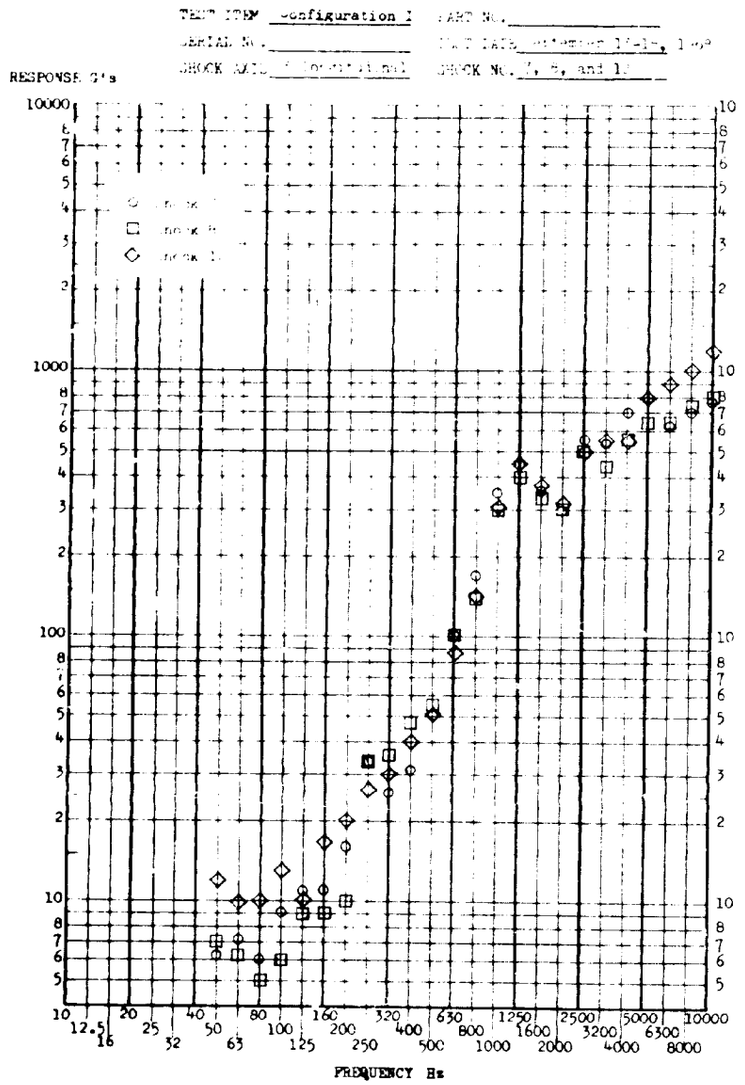



FIGURE II.B.1-19



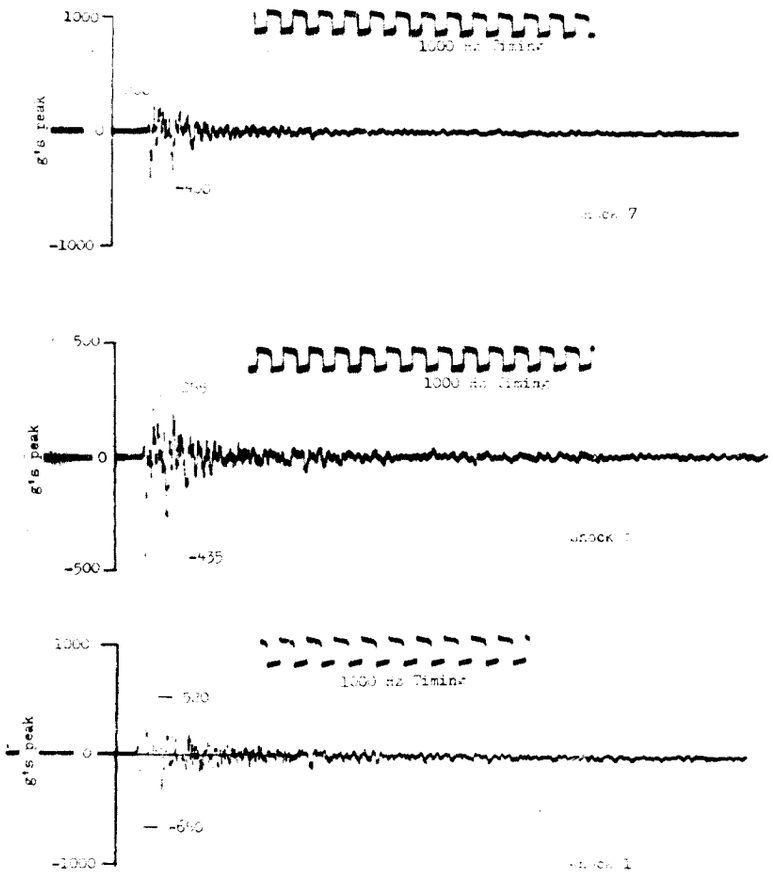
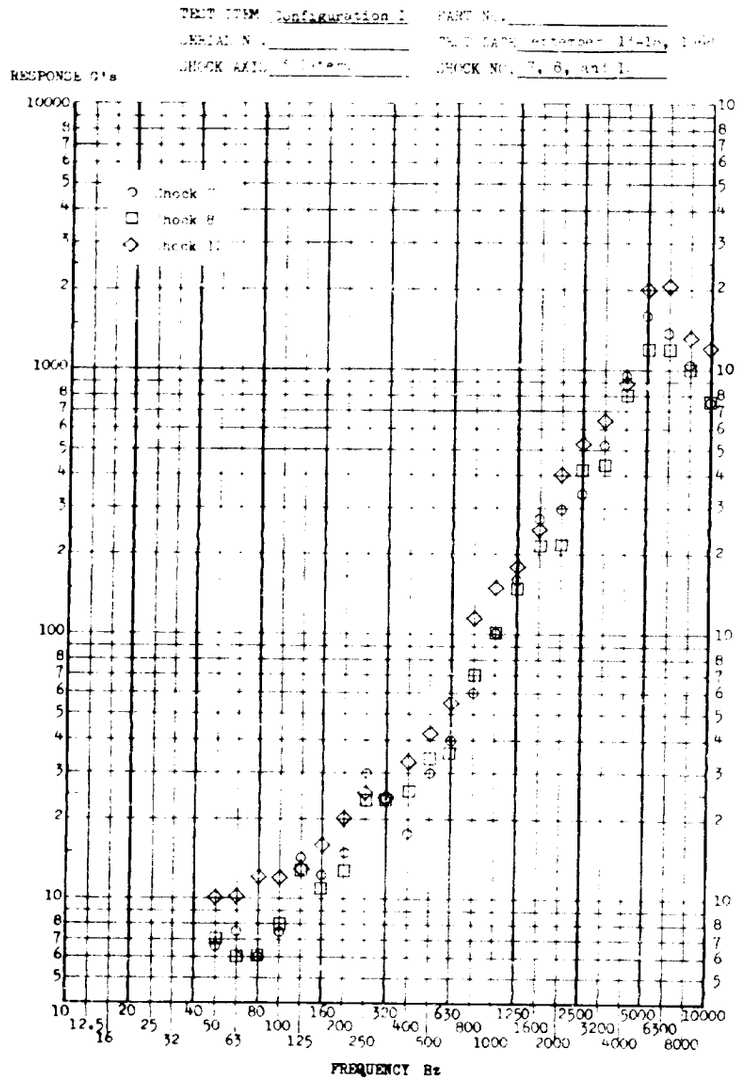




FIGURE II.B.1-20



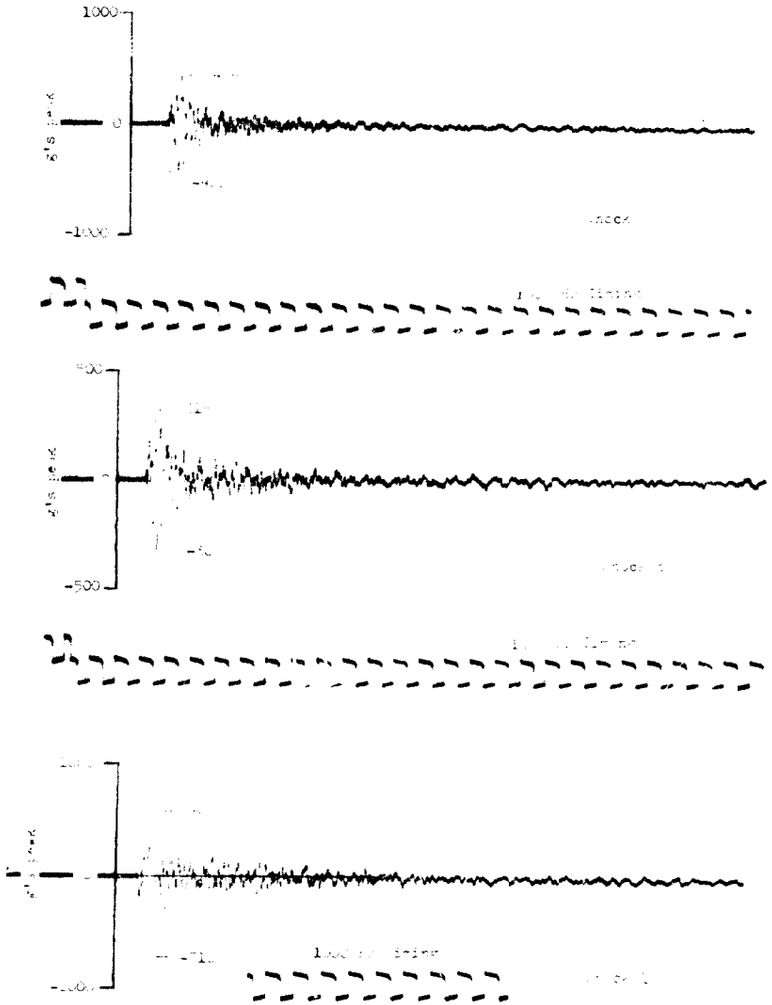
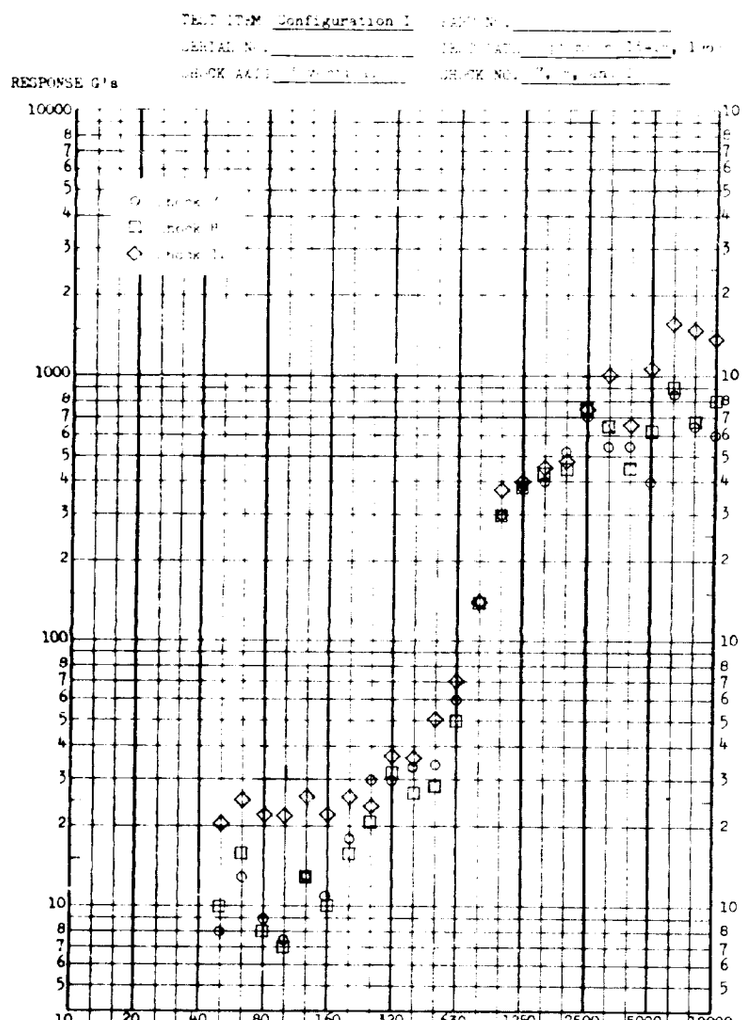




FIGURE II.B.1-21



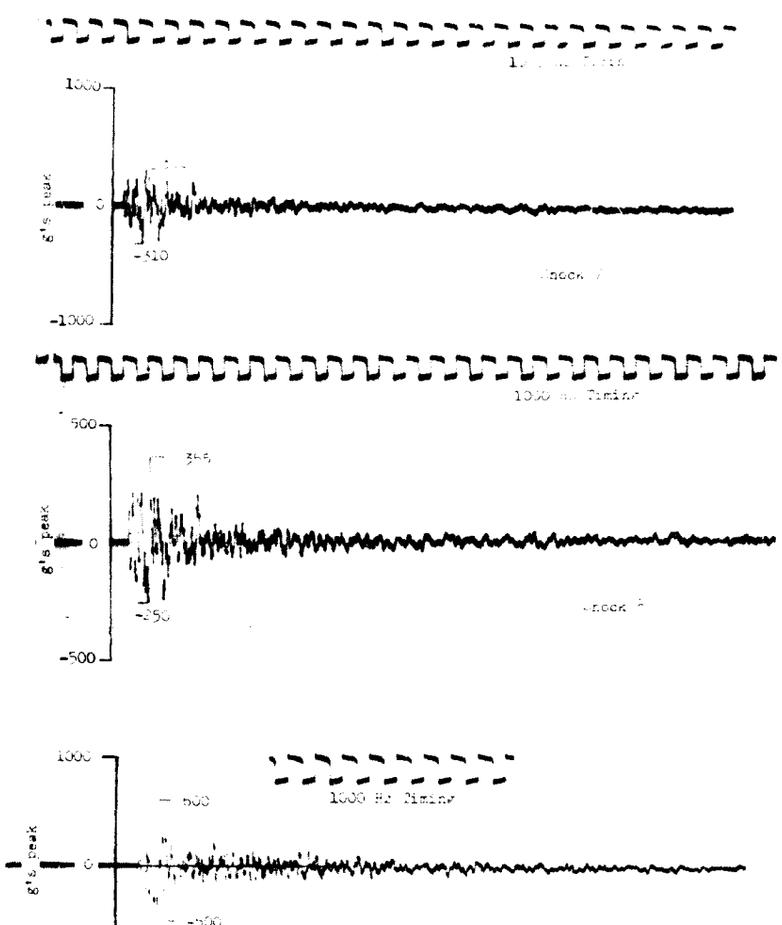
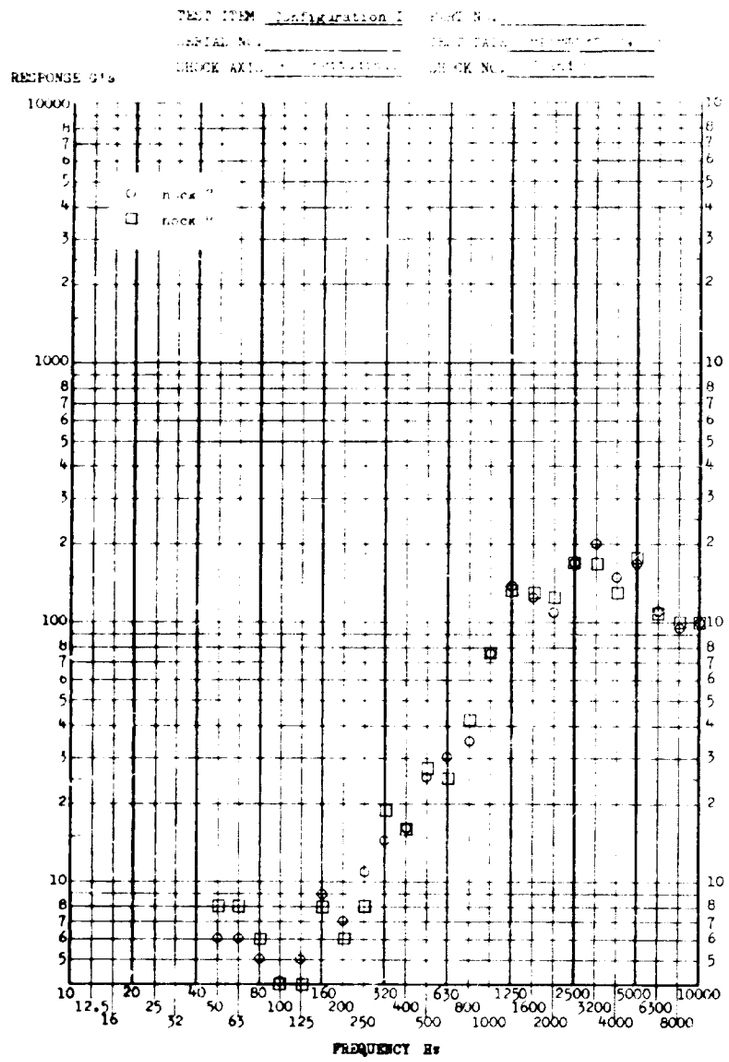




FIGURE II.B.1-22



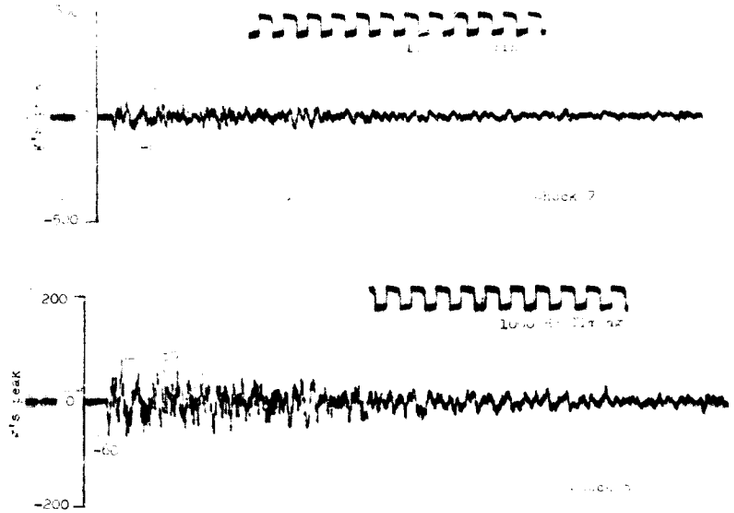
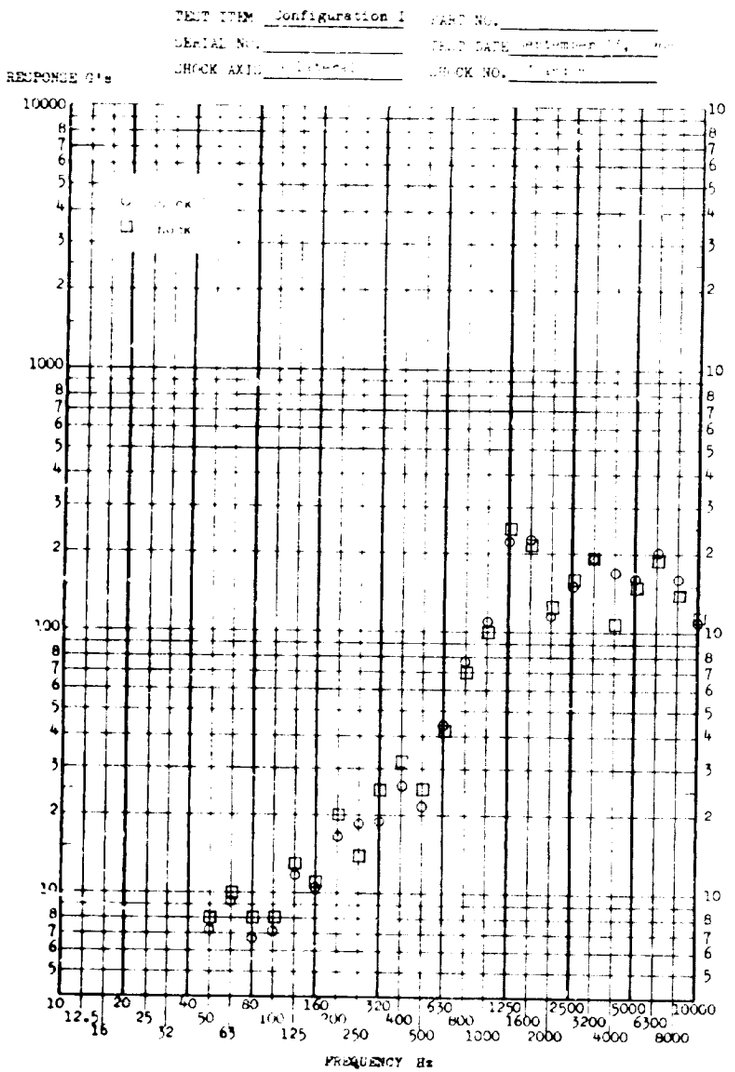




FIGURE II.B.1-23



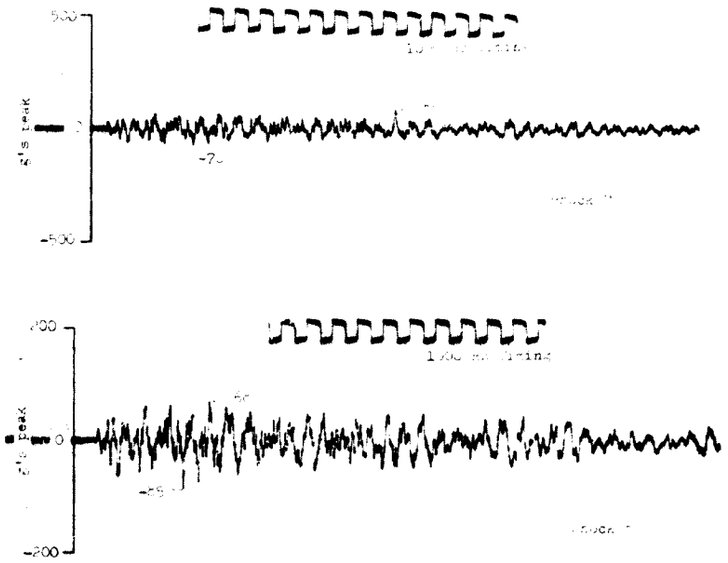
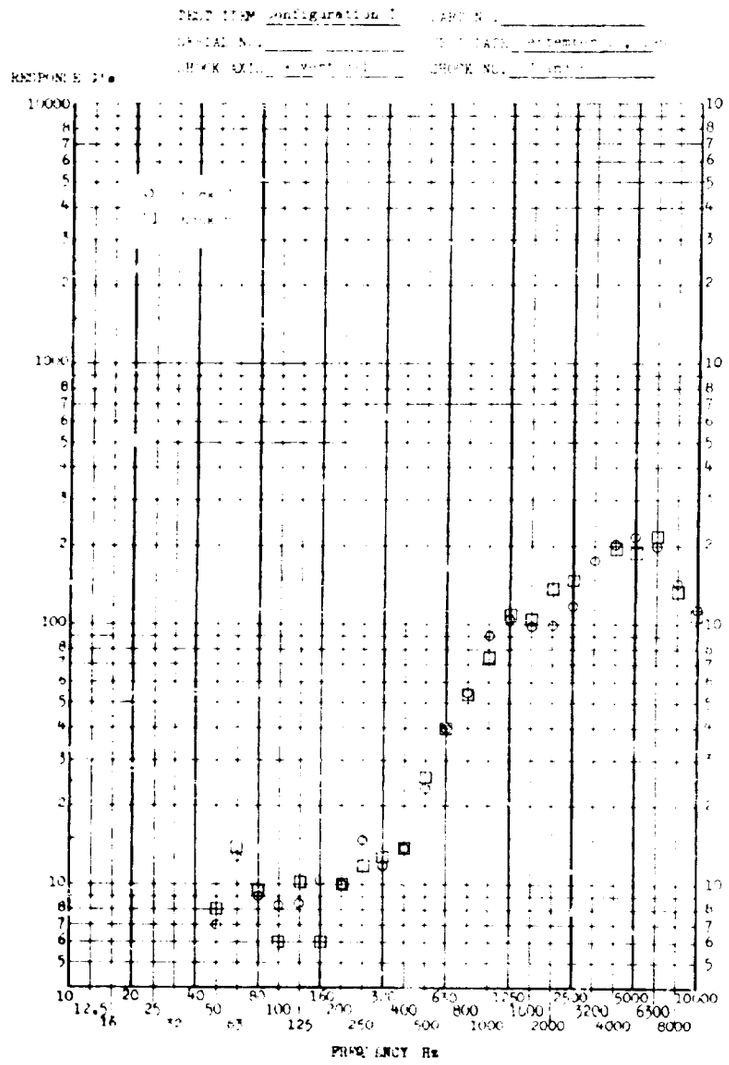




FIGURE II.B.1-24



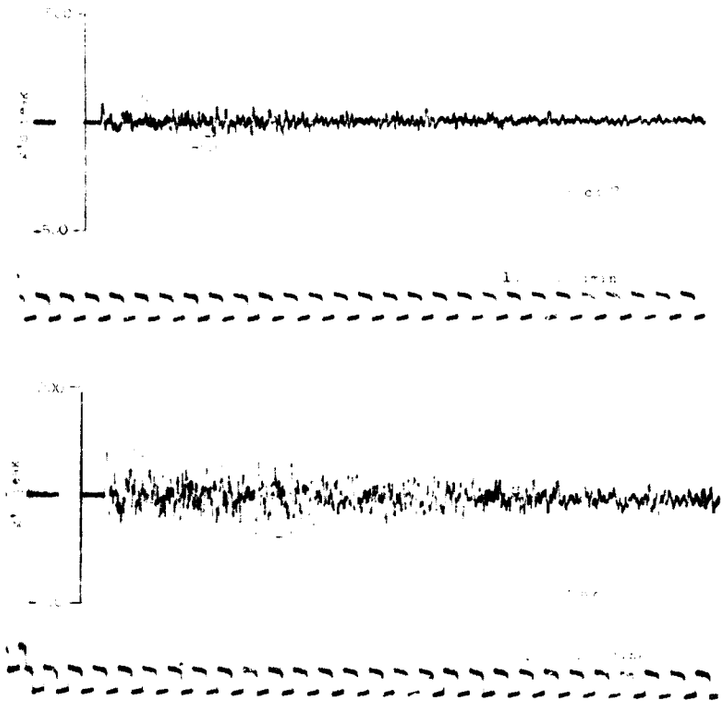
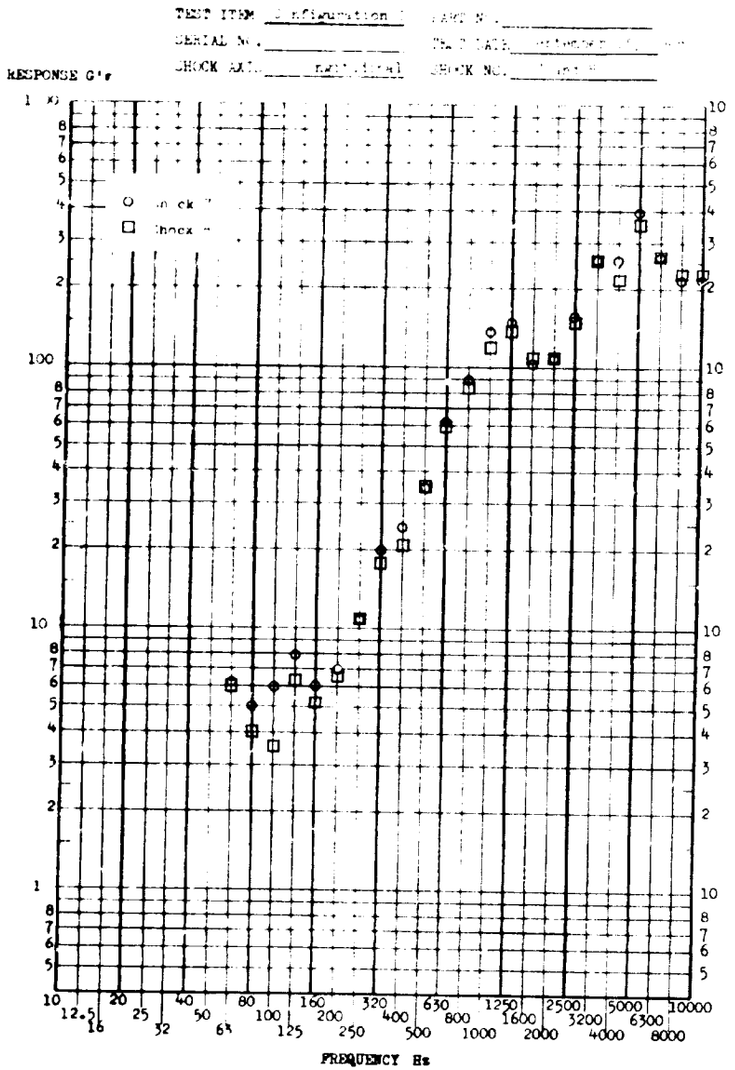



FIGURE 11.B.1-25



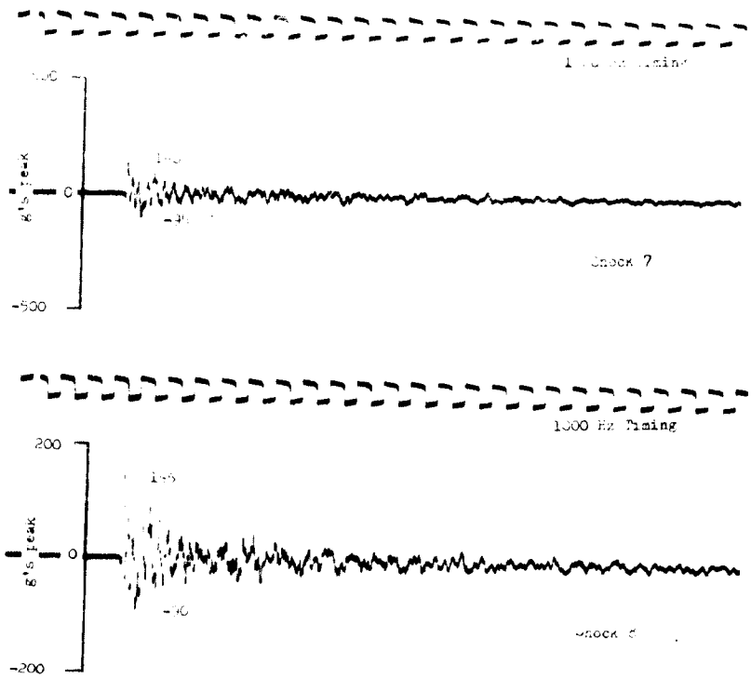
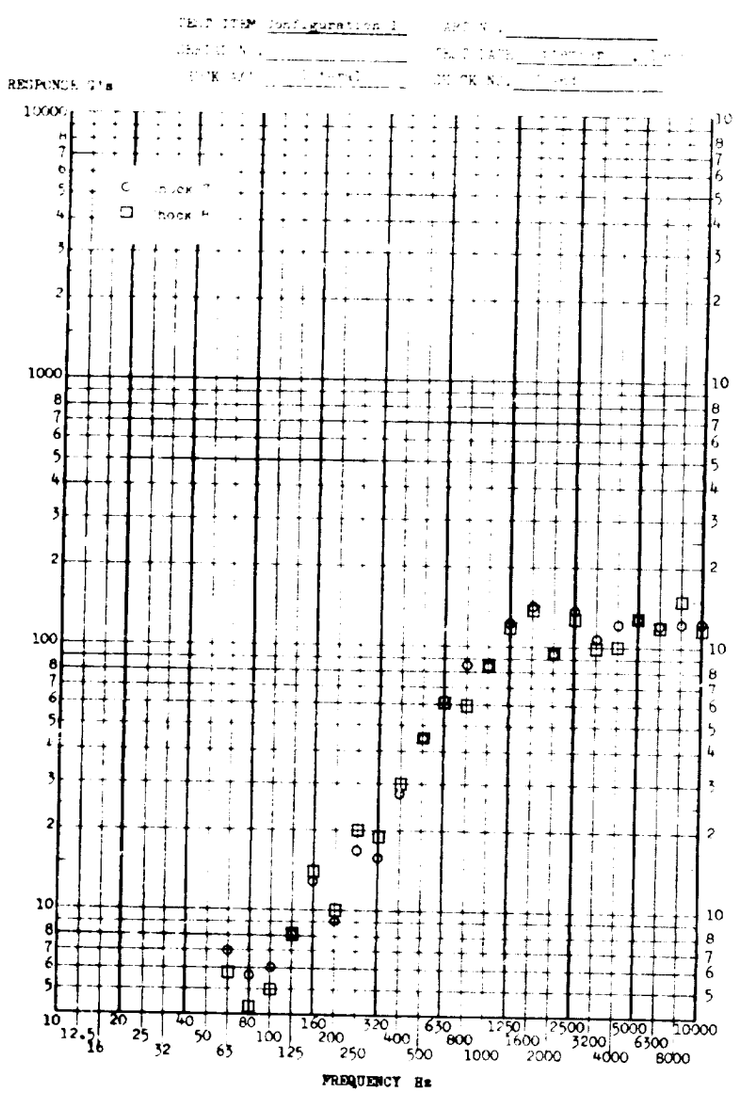




FIGURE 11.B.1-26



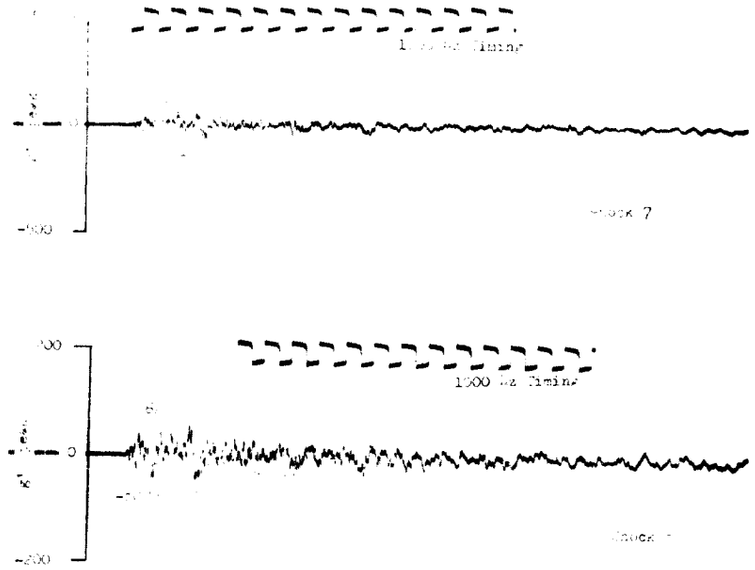




FIGURE II.B.1-27

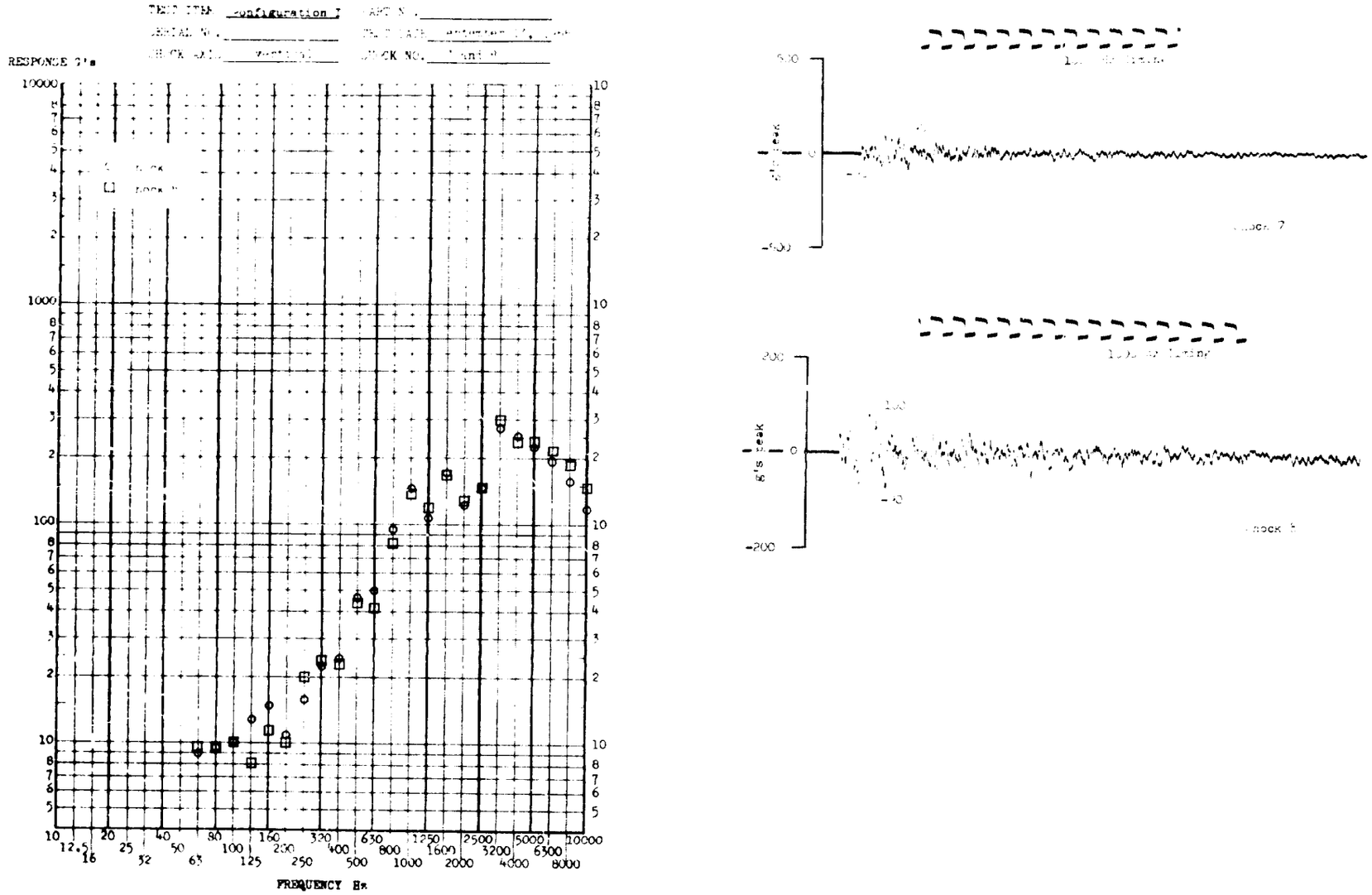



FIGURE II.B.1-28

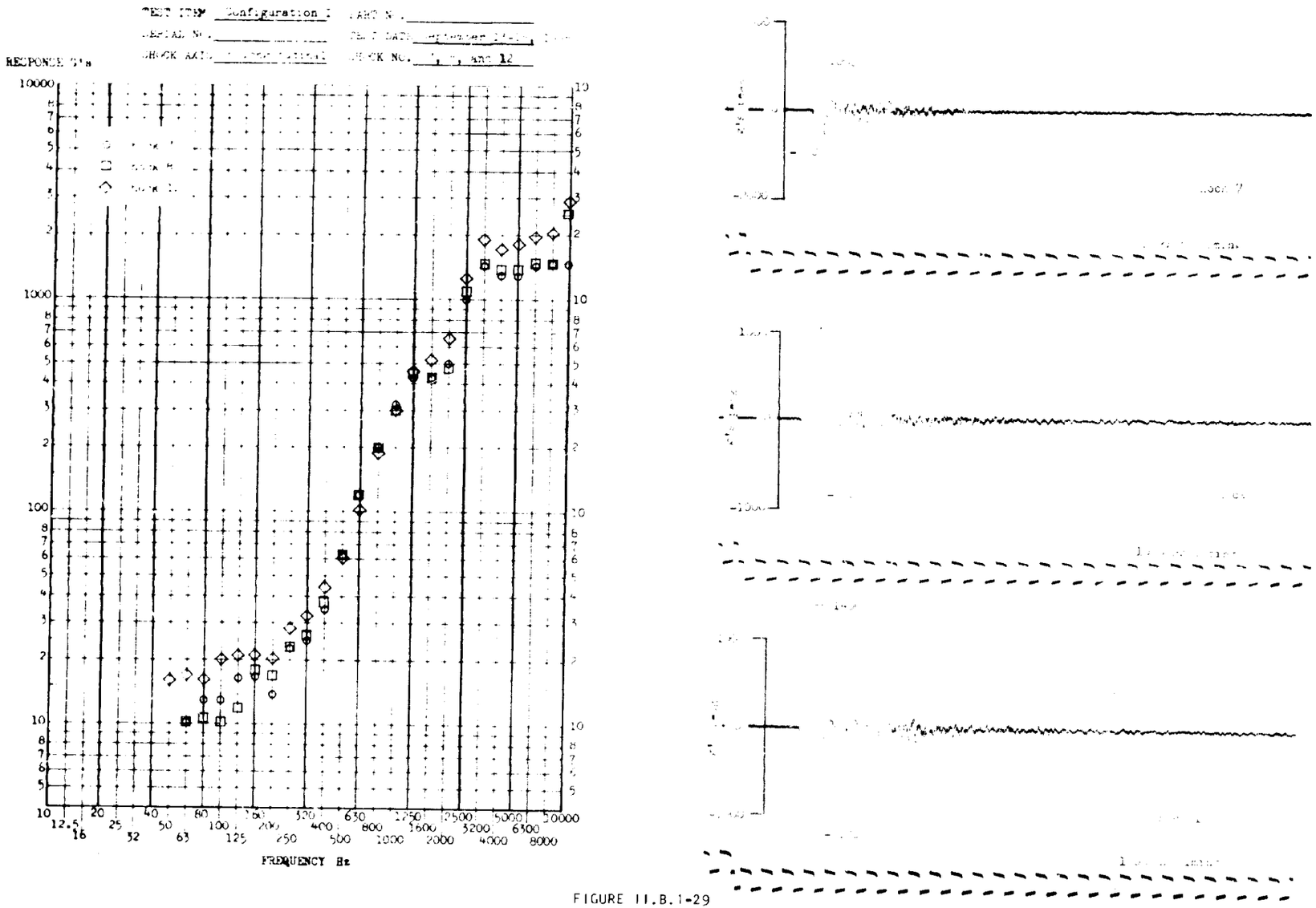



FIGURE II.B.1-29

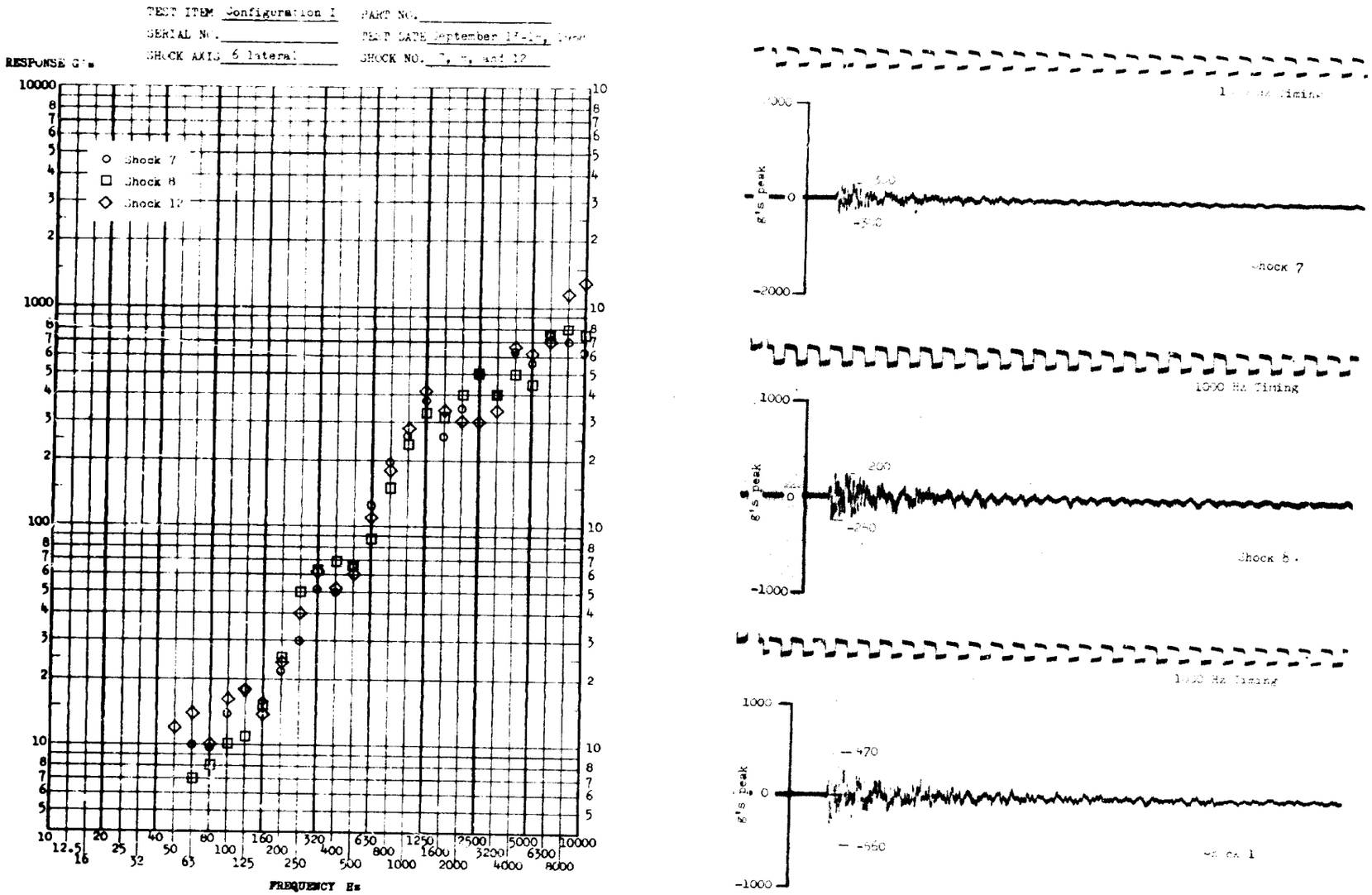



FIGURE II.B.1-30

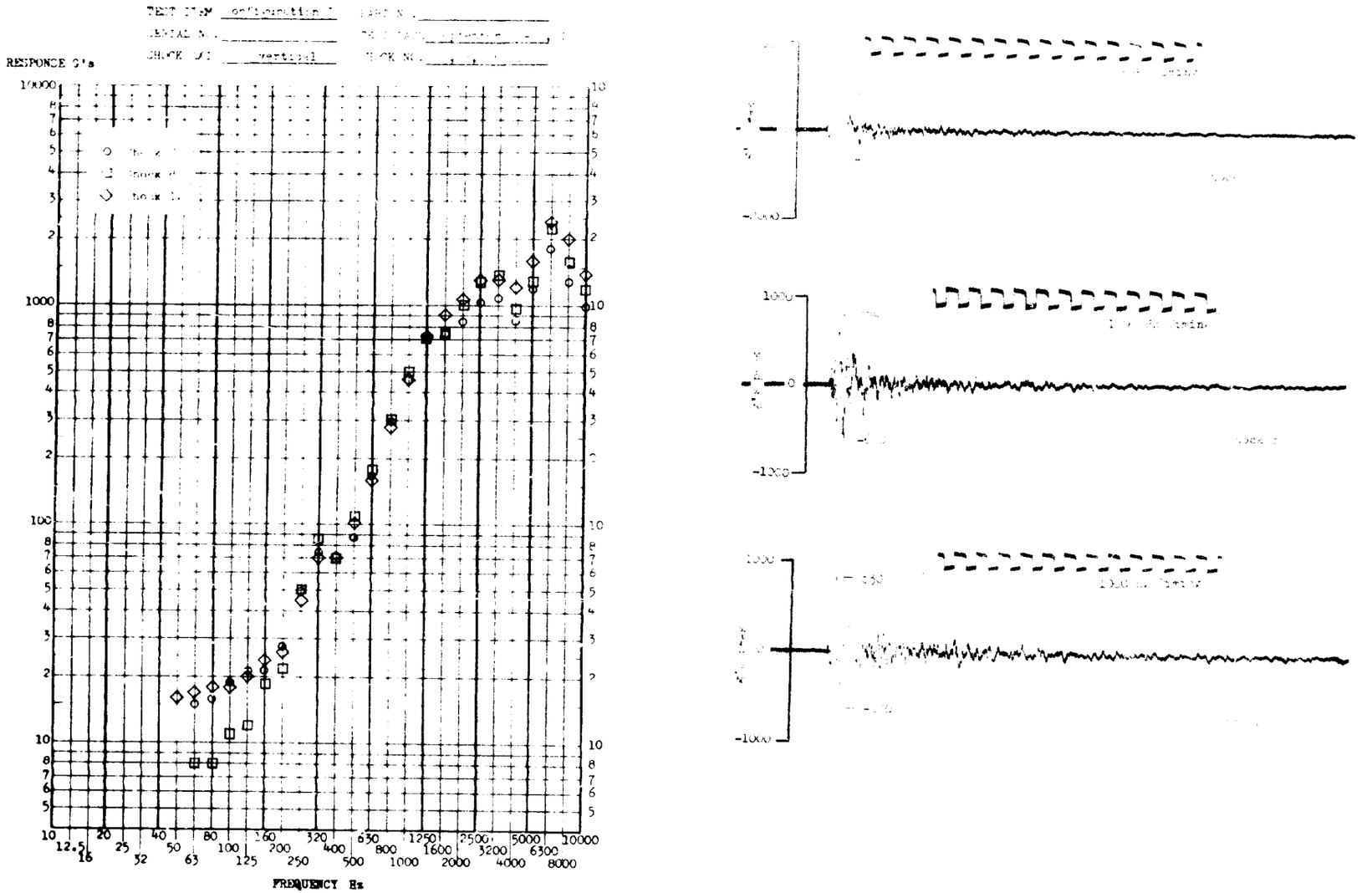
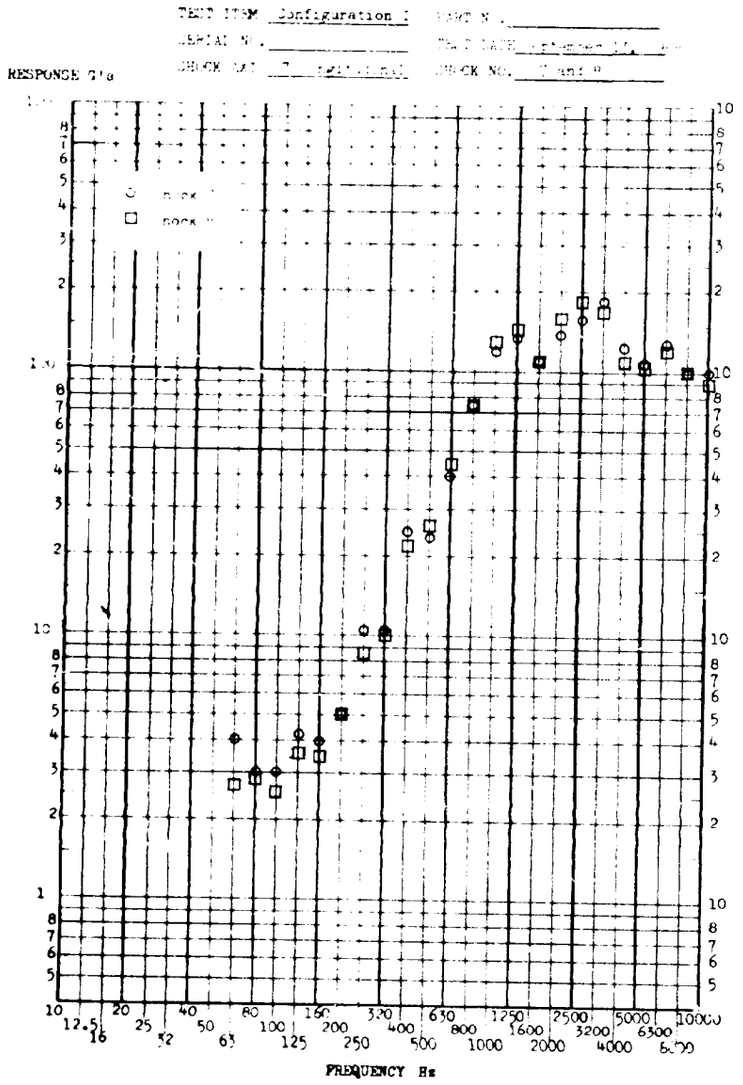
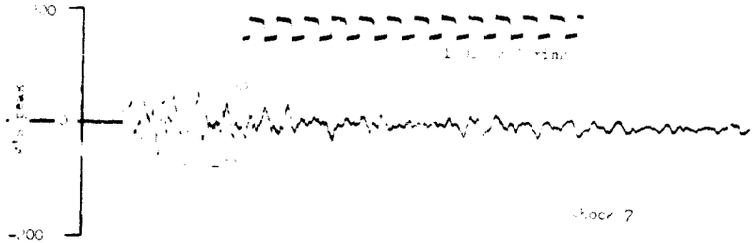



FIGURE II.B.1-31



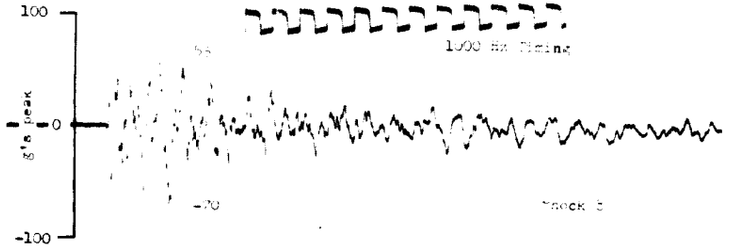
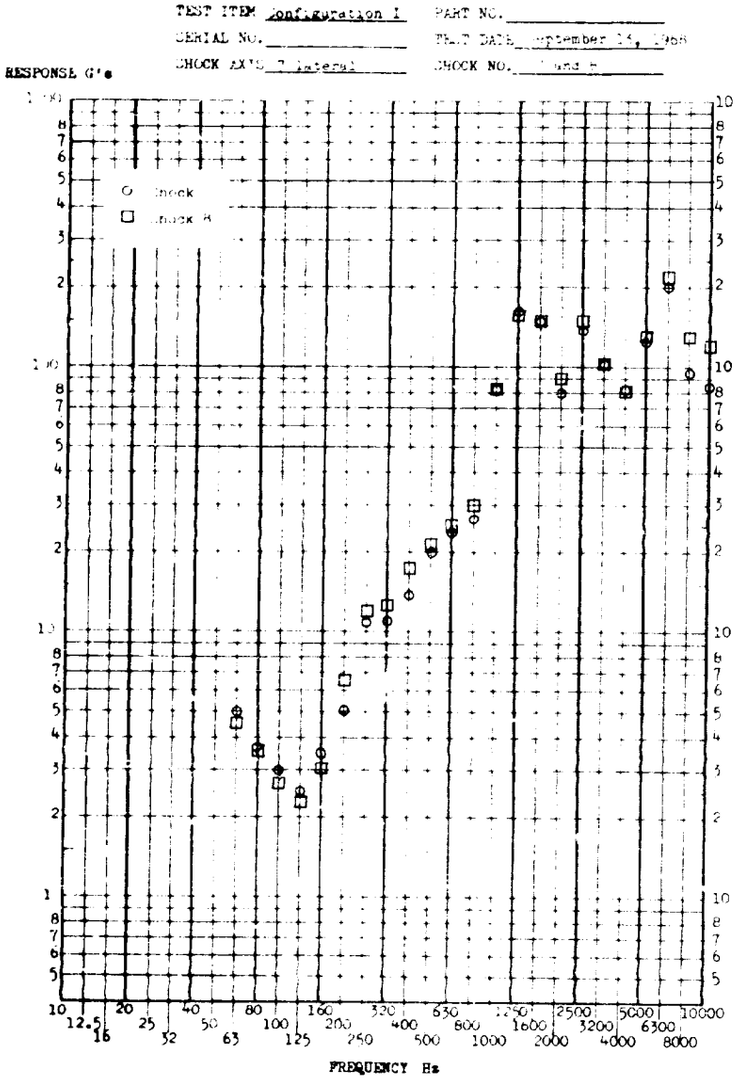




FIGURE II.B.1-32



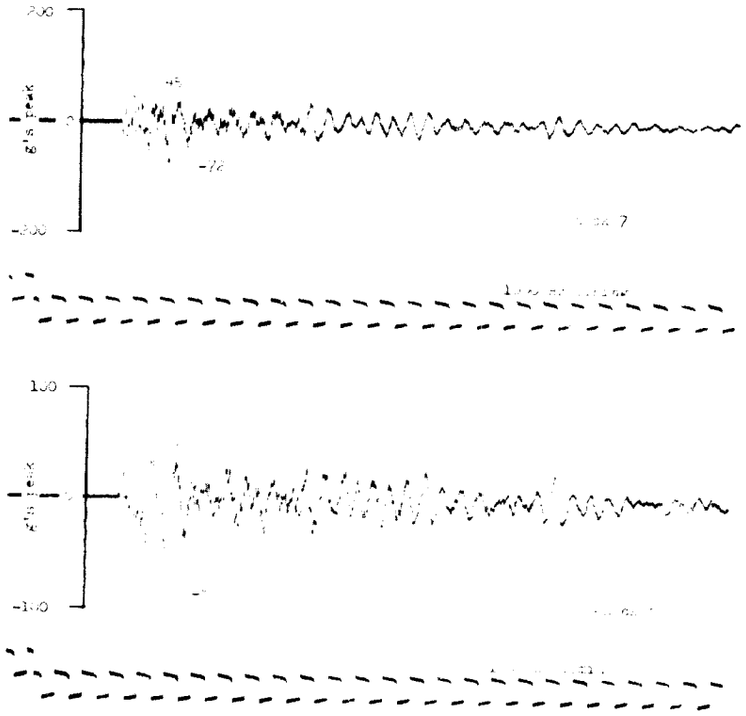
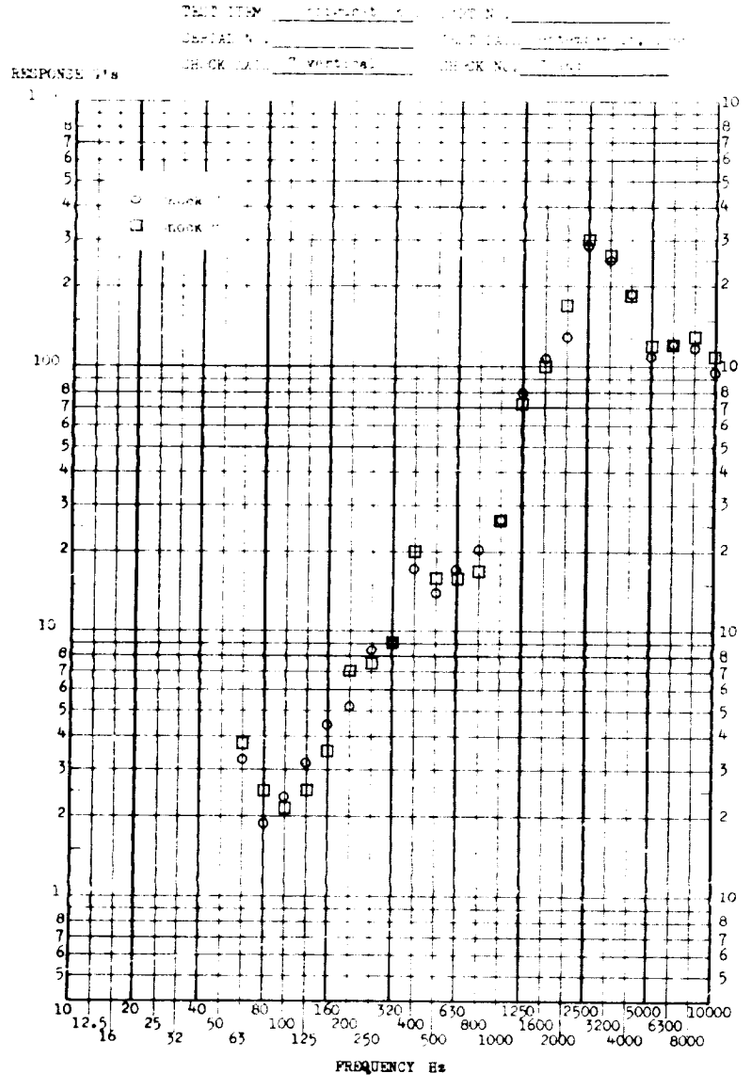



FIGURE 11.8.1-33



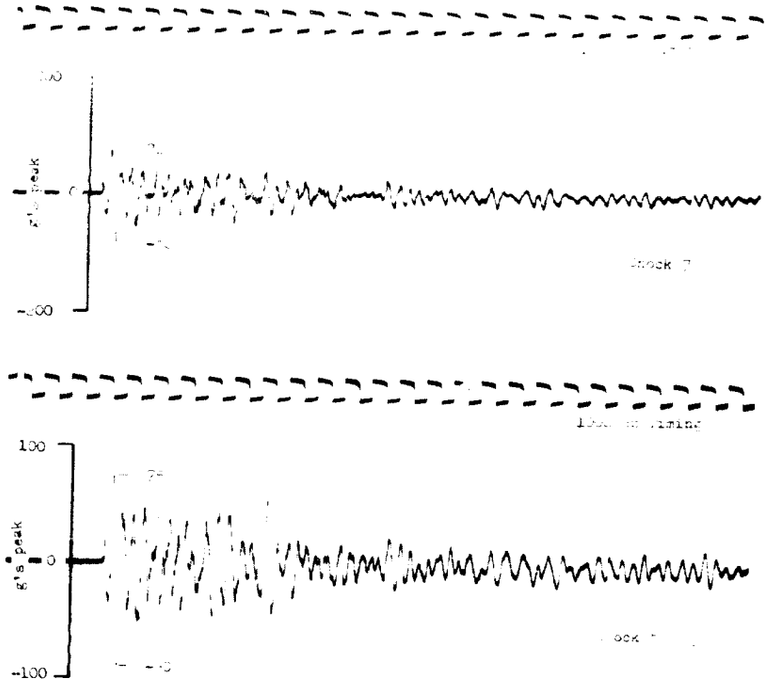




FIGURE II.B.1-34

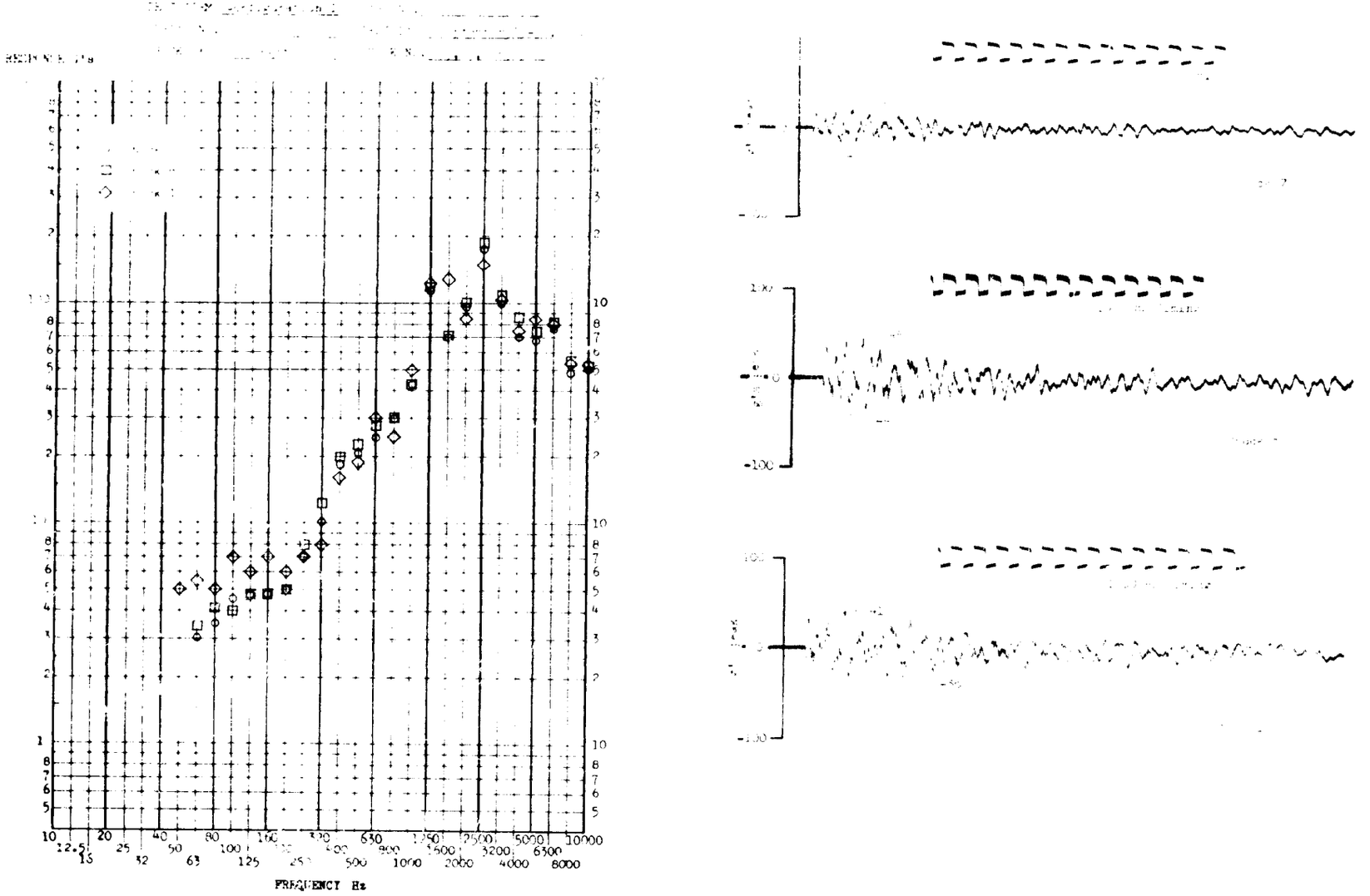



FIGURE II.B.1-35

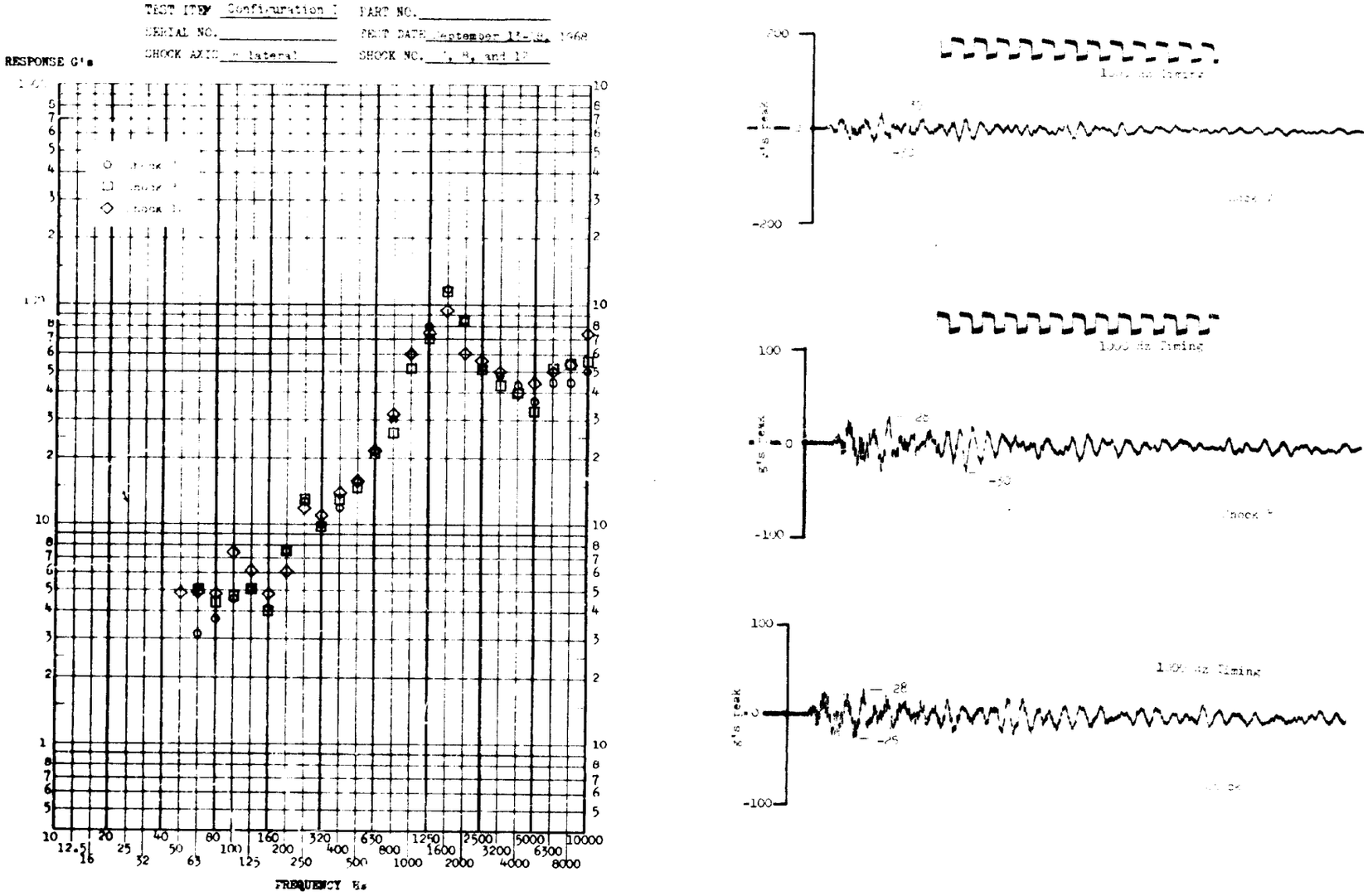
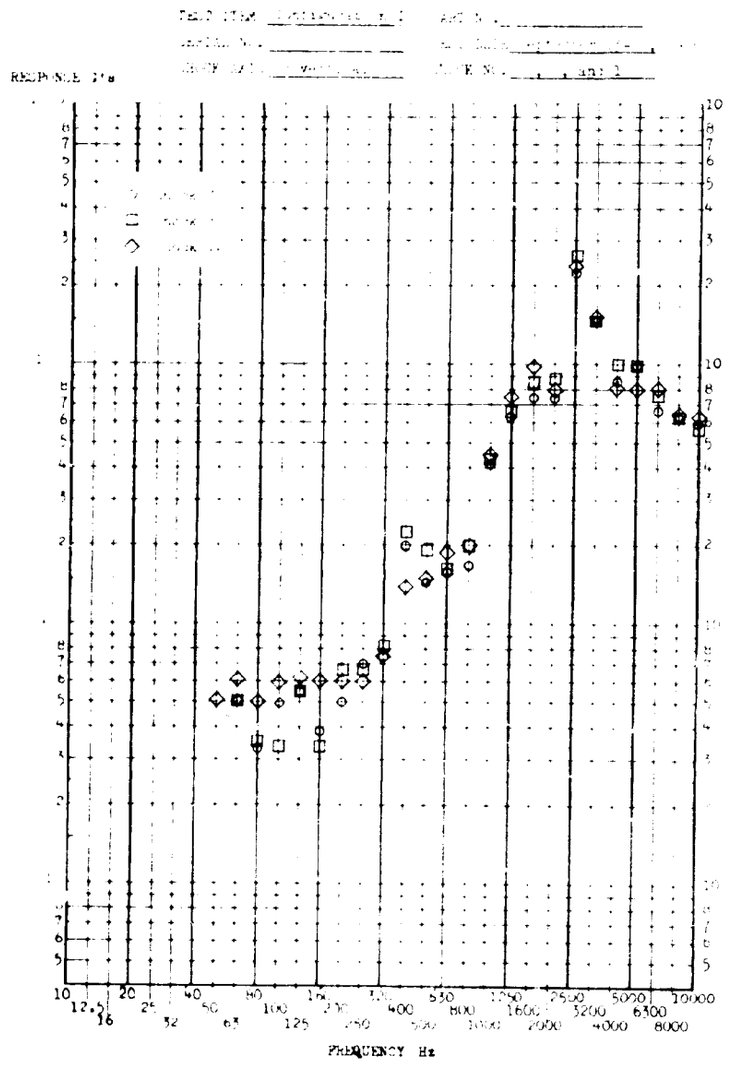



FIGURE II.B.1-36



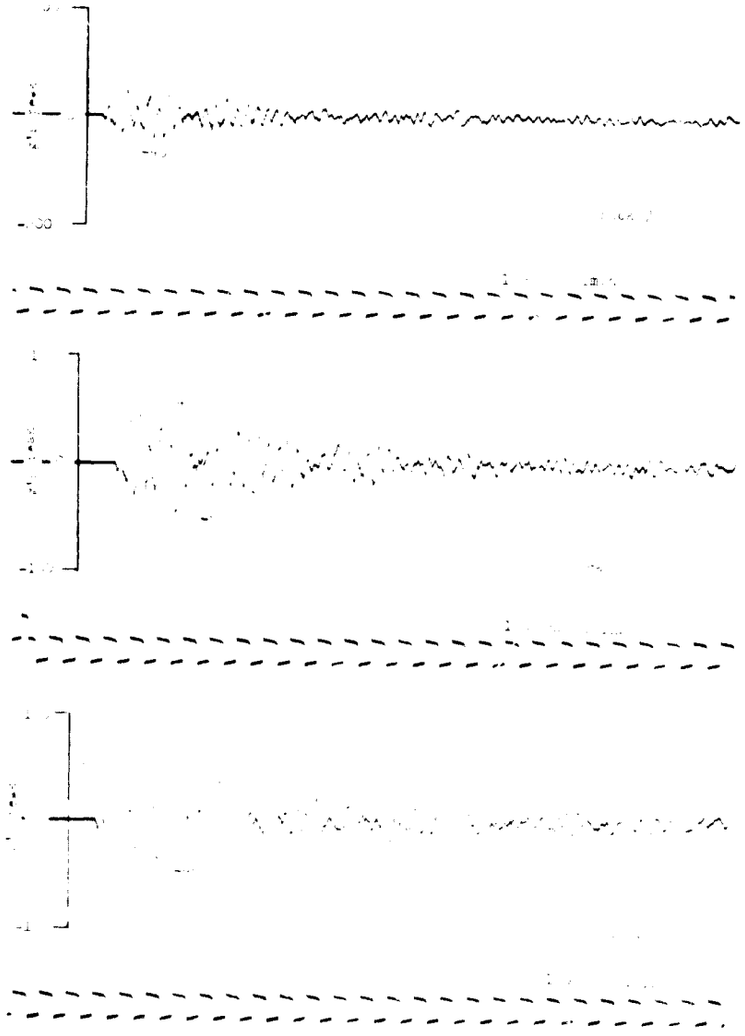



FIGURE II.B.1-37

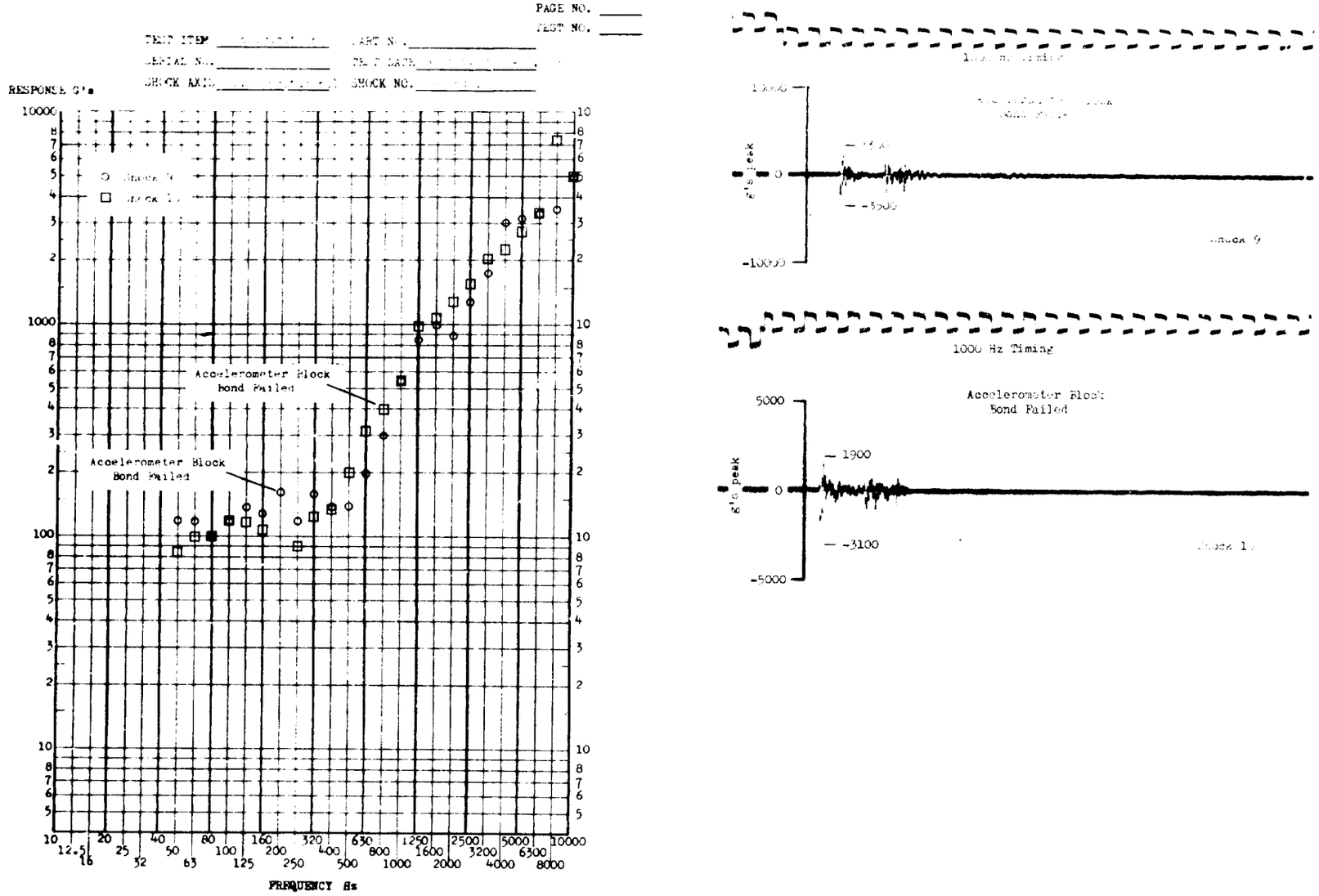
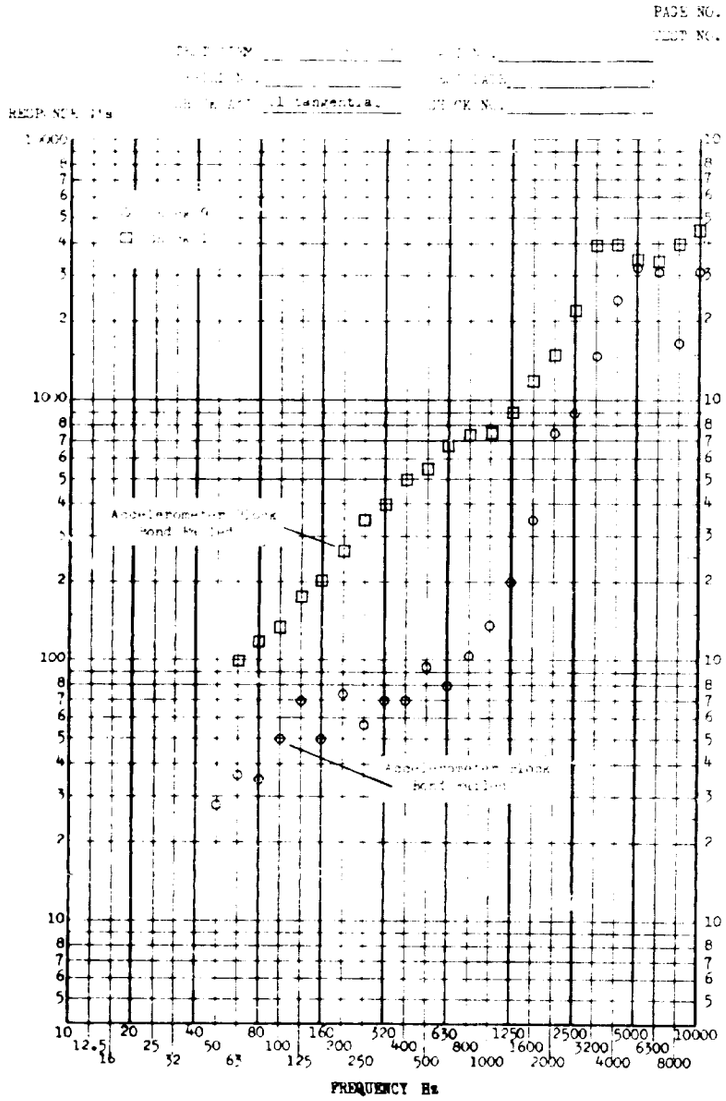



FIGURE II.B.1-38



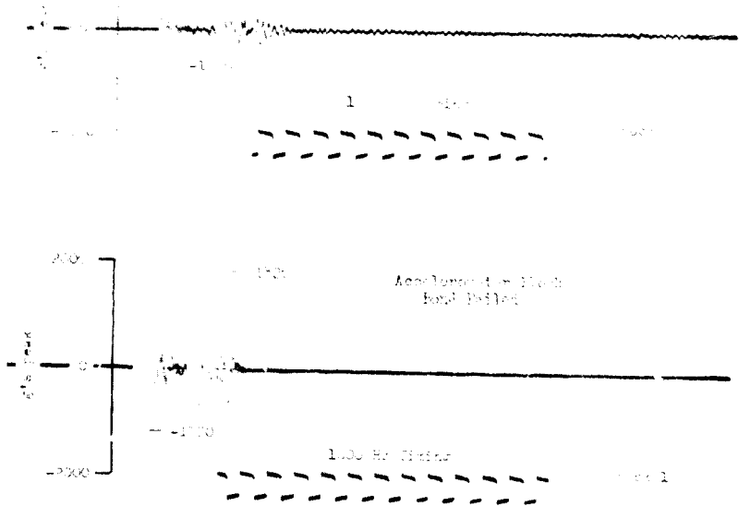
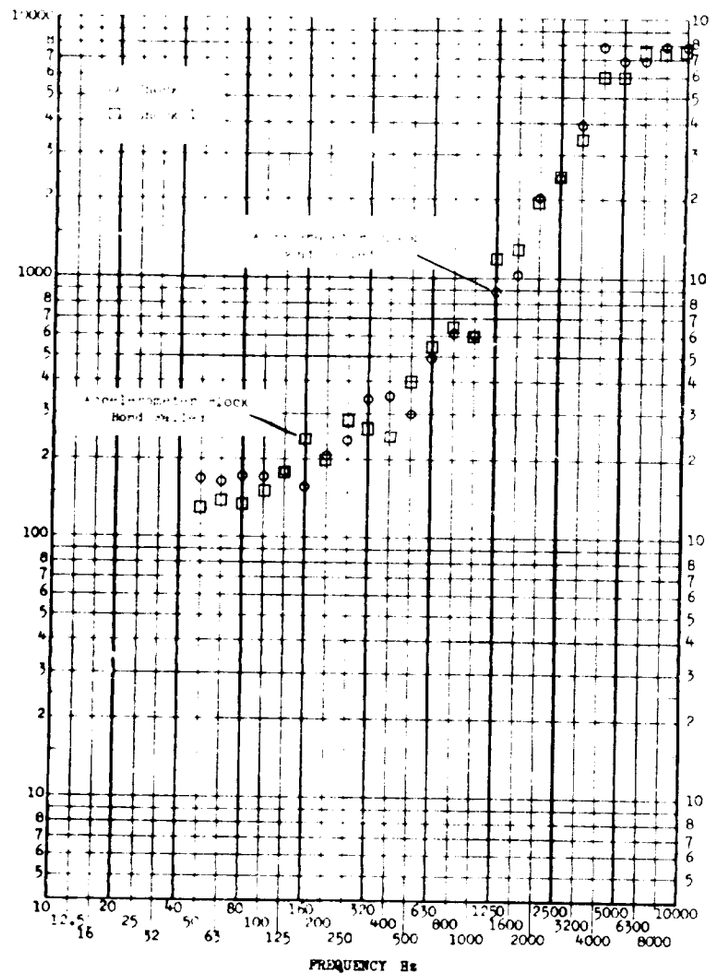



FIGURE 11.8.1-39

PAGE NO. ____
TEST NO. ____

TEST ITEM _____ PART NO. _____
SERIAL NO. _____ TEST DATE _____
SHOCK AXIS 1) radial SHOCK NO. _____

RESPONSE G's



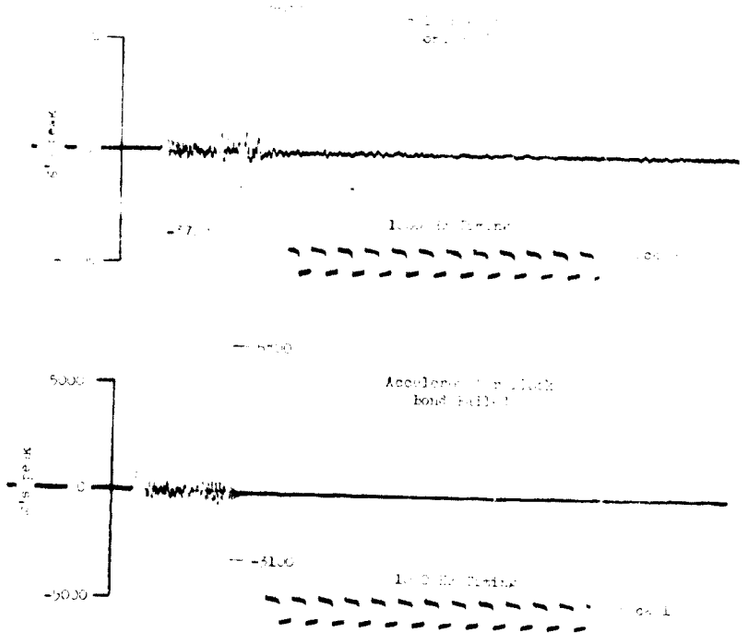




FIGURE 11.B.1-40

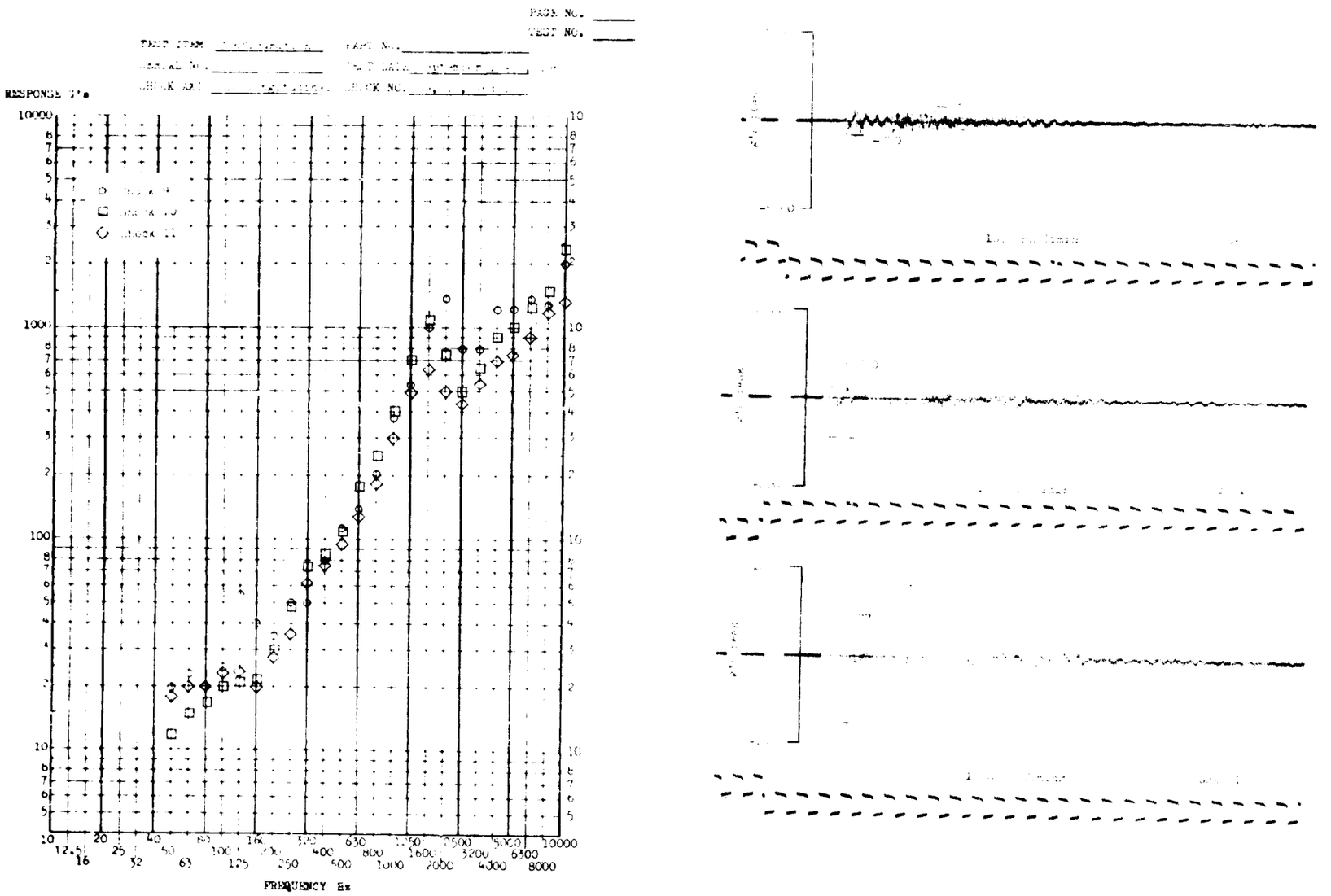
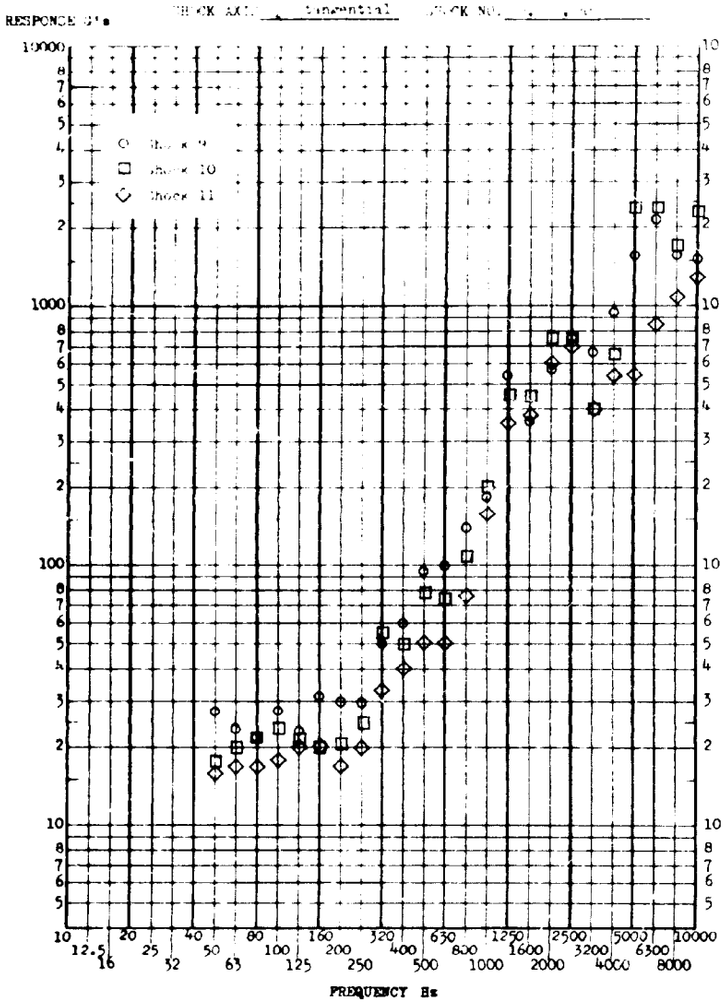
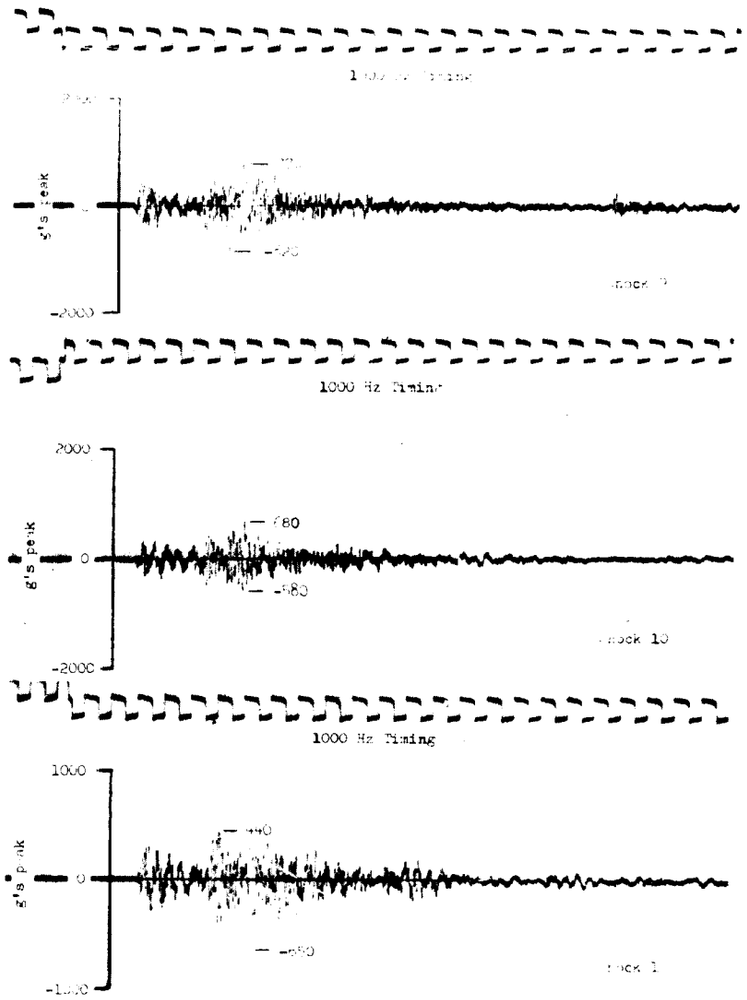



FIGURE 11.8.1-41

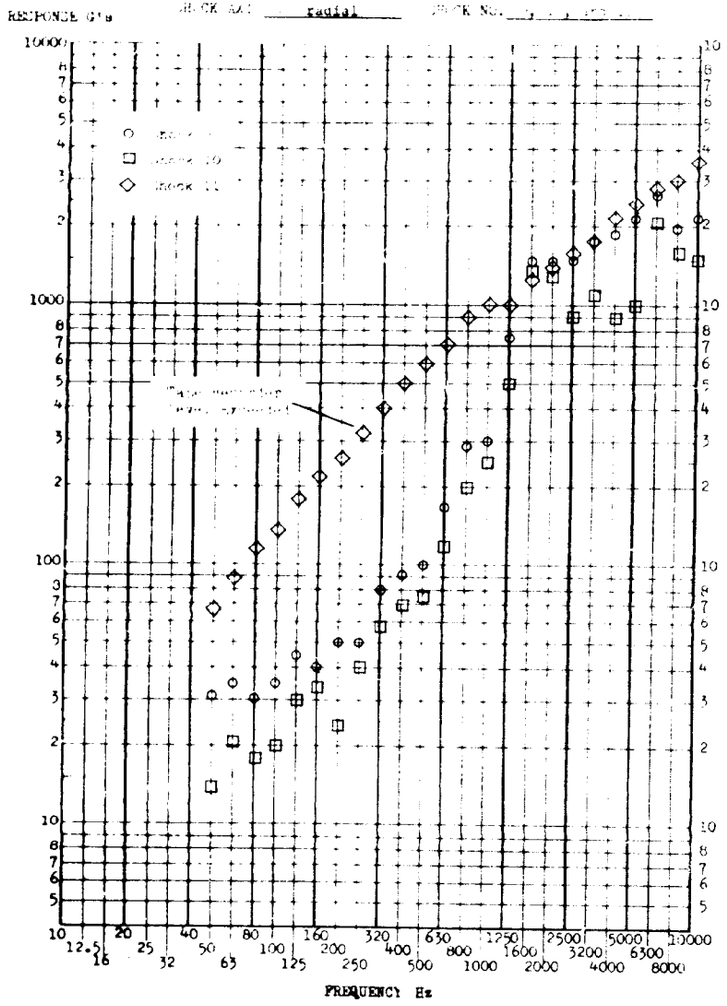
PAGE NO. _____
TEST NO. _____

TEST ITEM _____ ART N. _____
SERIAL NO. _____ TEST DATE _____
SHOCK AXIS Fin-vertical SHOCK NO. _____



PAGE NO. _____
TEST NO. _____



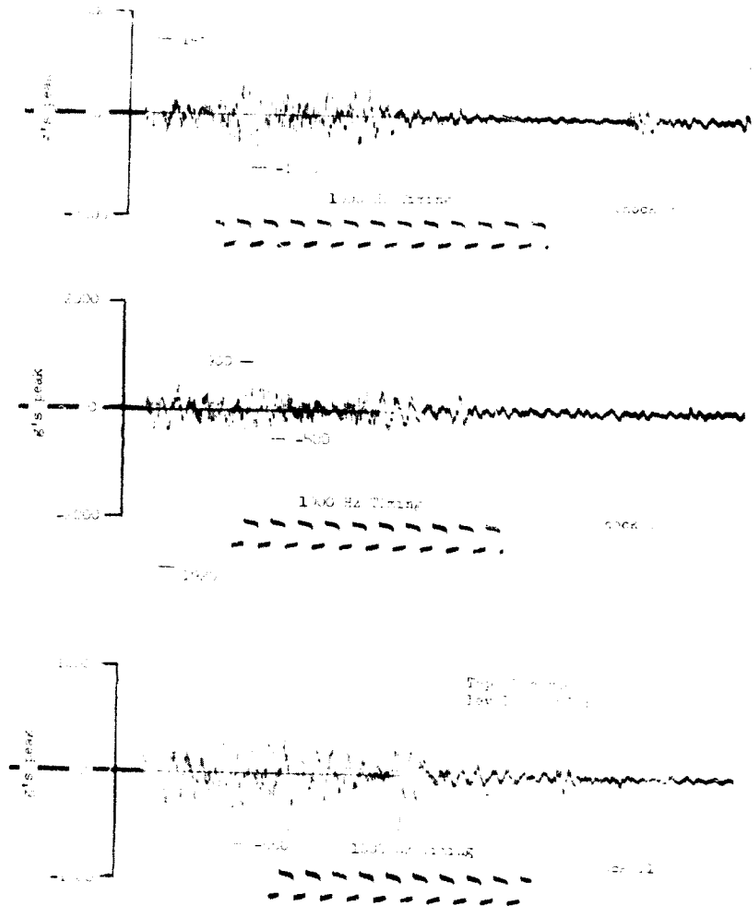



FIGURE 11.B.1-43

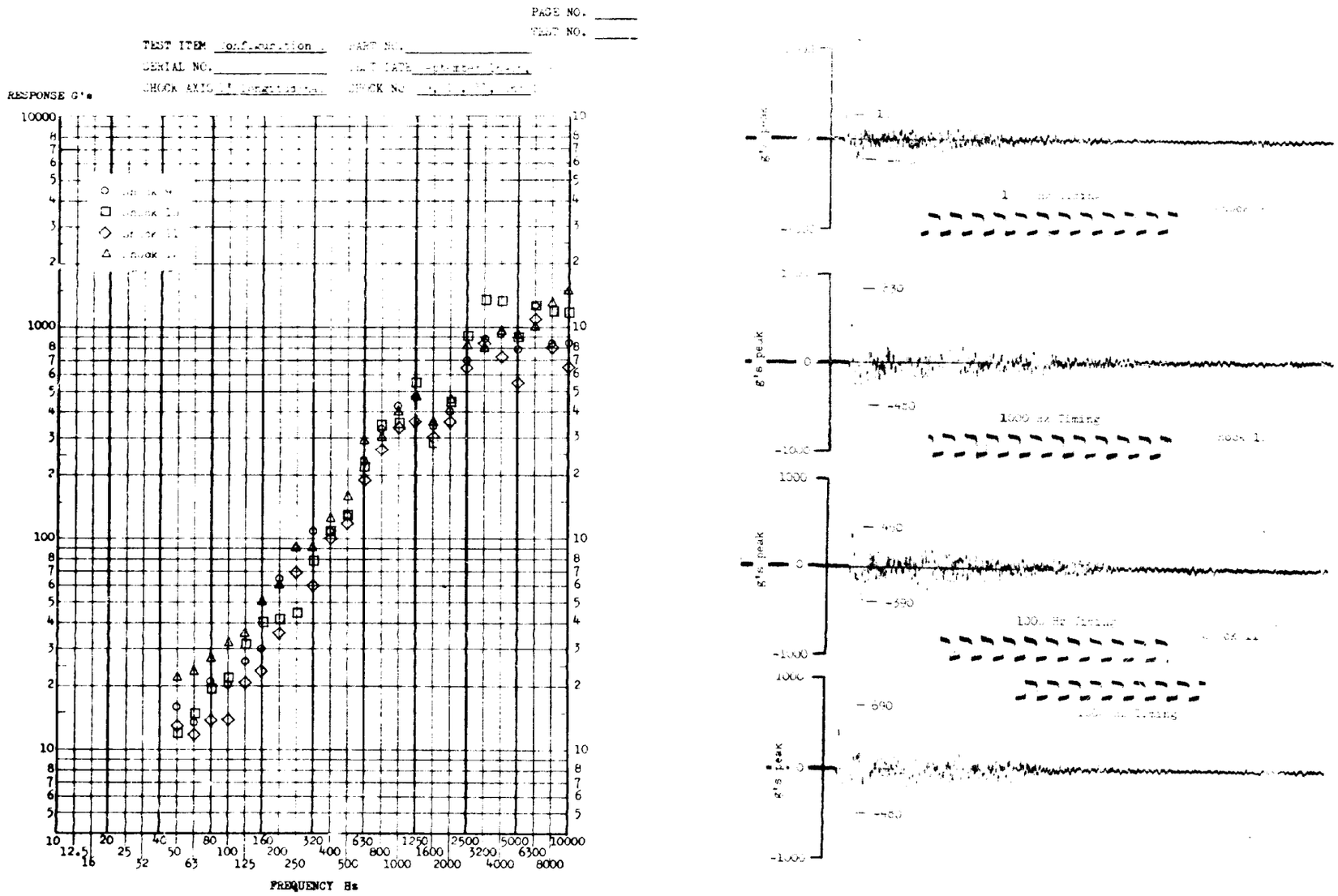
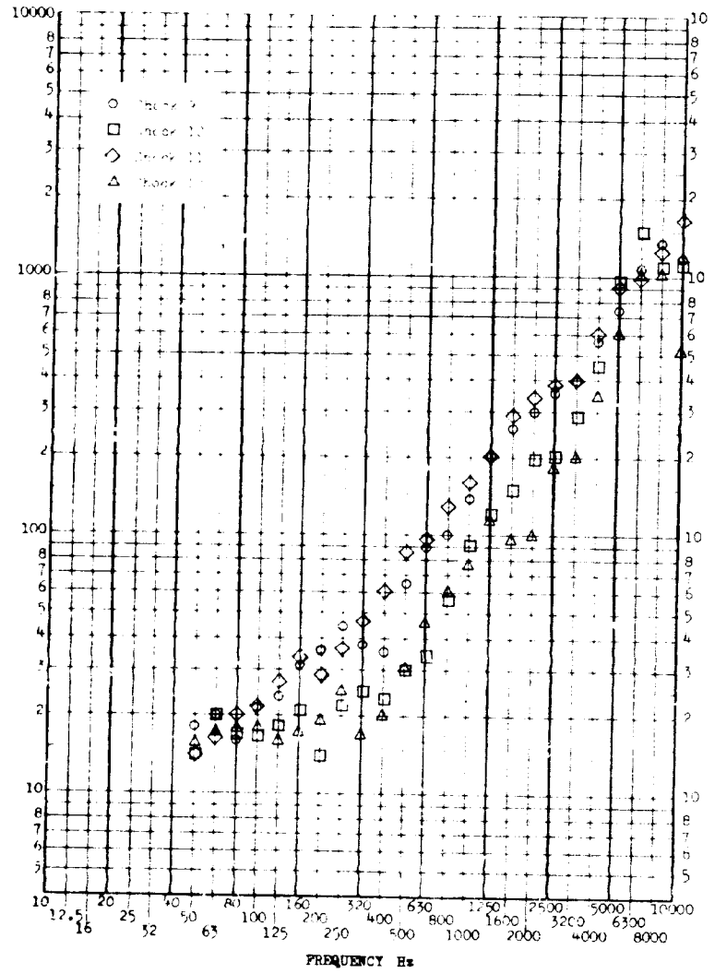



FIGURE II.B.1-44

PAGE NO. _____
TEST NO. _____

TEST ITEM _____ PART NO. _____
SERIAL NO. _____ TEST DATE _____
SHOCK AXIS _____ SHOCK NO. _____

RESPONSE G's



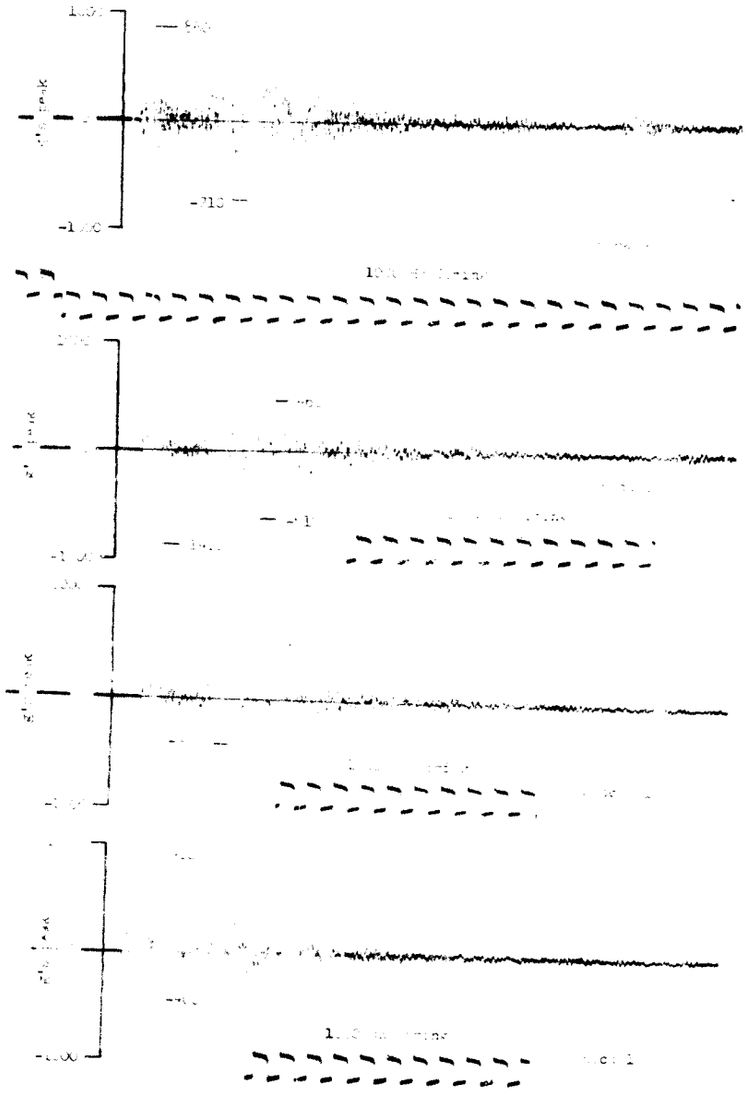
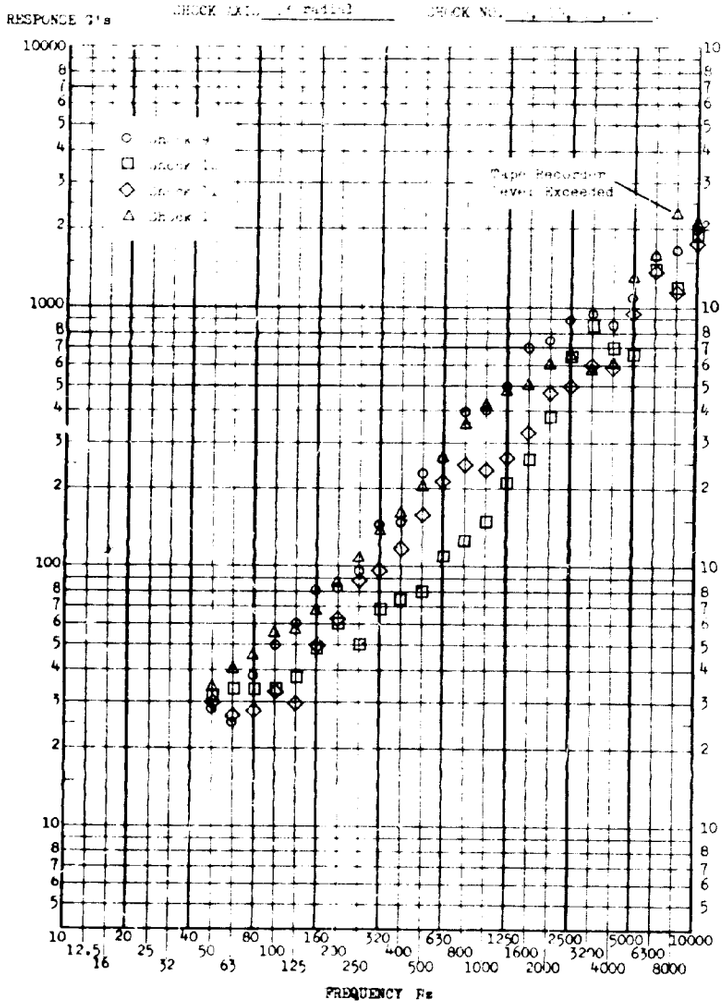



FIGURE II.B.1-45

PAGE NO. _____
TEST NO. _____

TEST ITEM _____ PART NO. _____
SERIAL NO. _____ TEST DATE _____
SHOCK DATA _____ SHOCK NO. _____



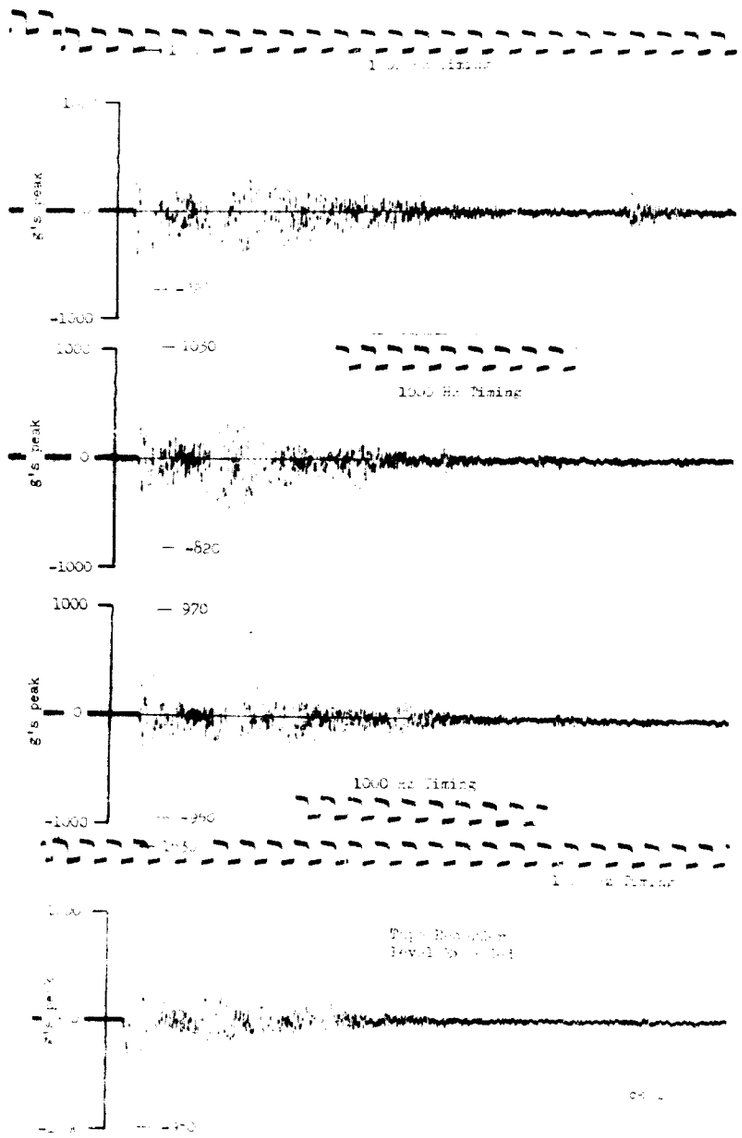




FIGURE II.B.1-46

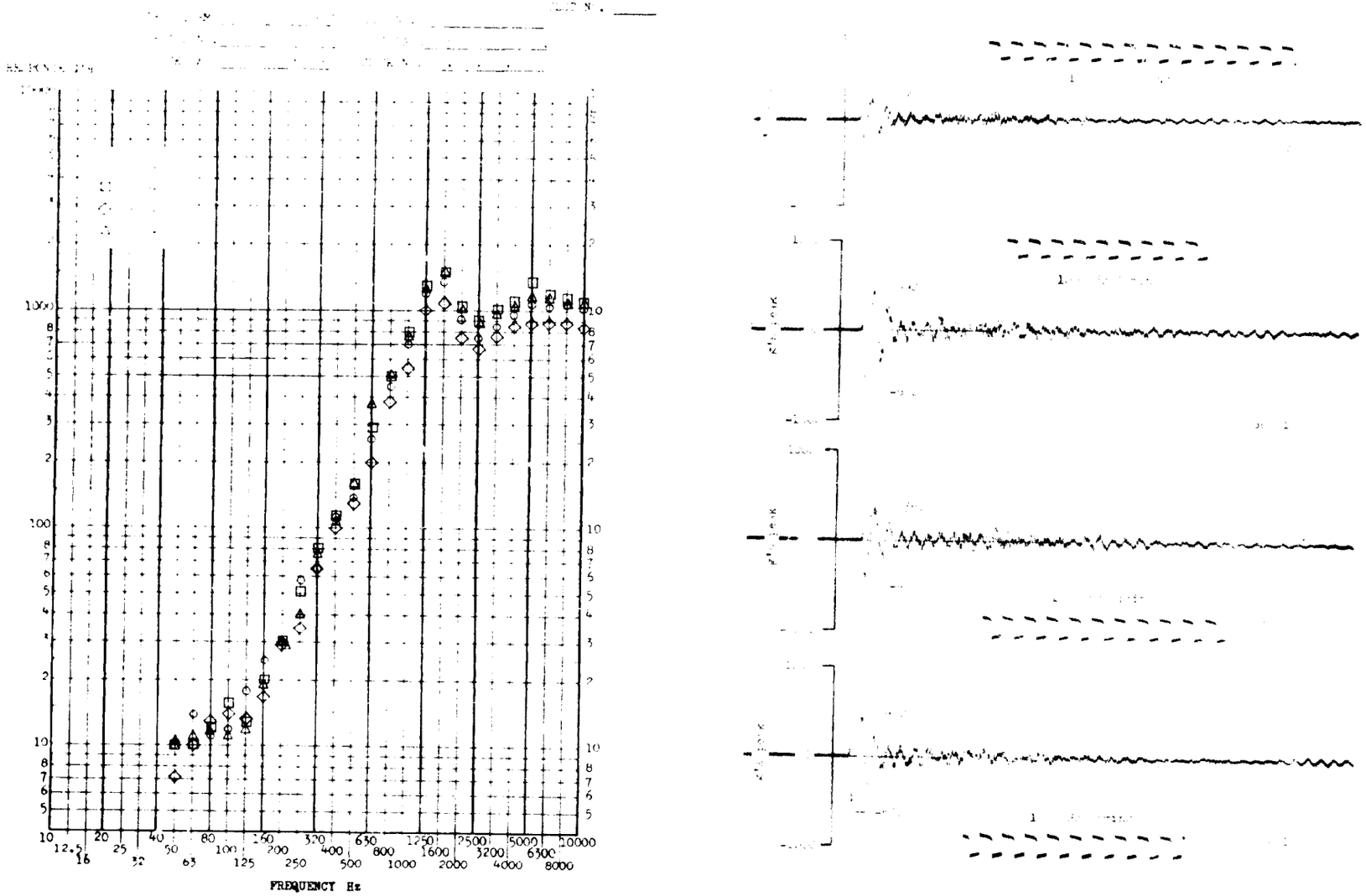



FIGURE II.B.1-47

PAGE NO. _____
TEST NO. _____

TEST ITEM _____ PART N. _____
SERIAL NO. _____ TEST DATE _____
SHOCK AXIS tangential SHOCK No. _____

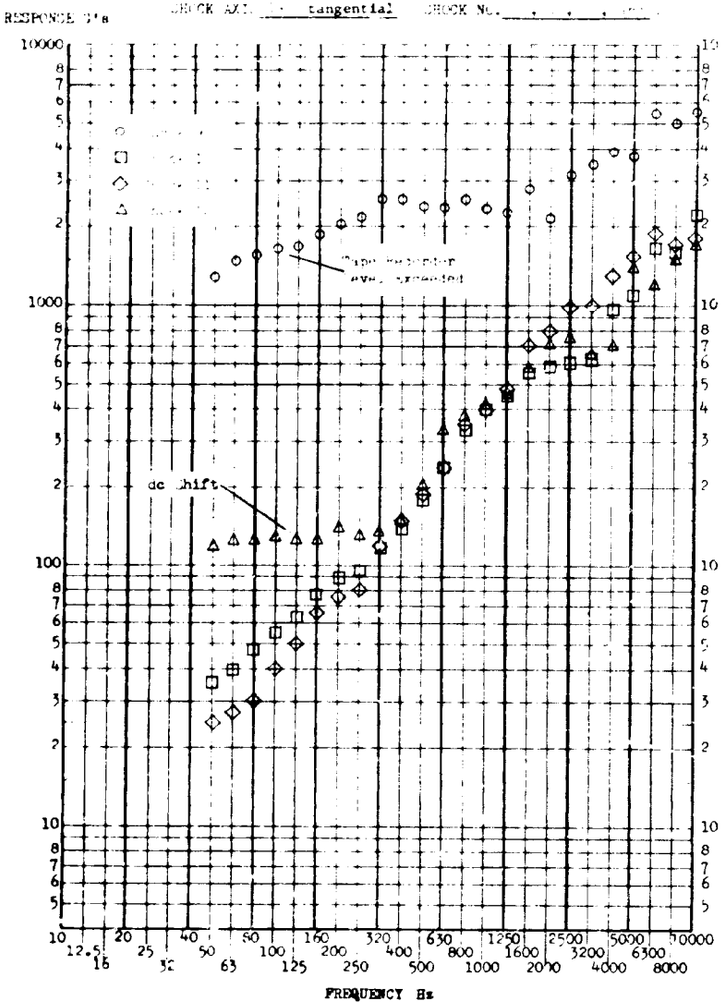
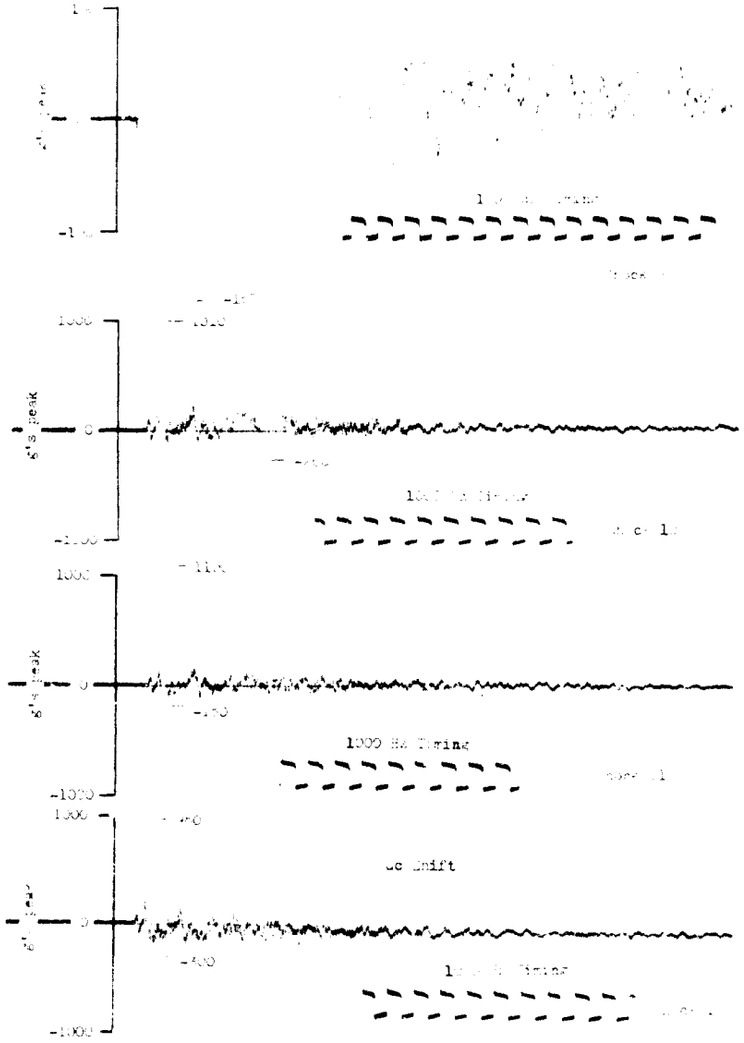



FIGURE II.B.1-48



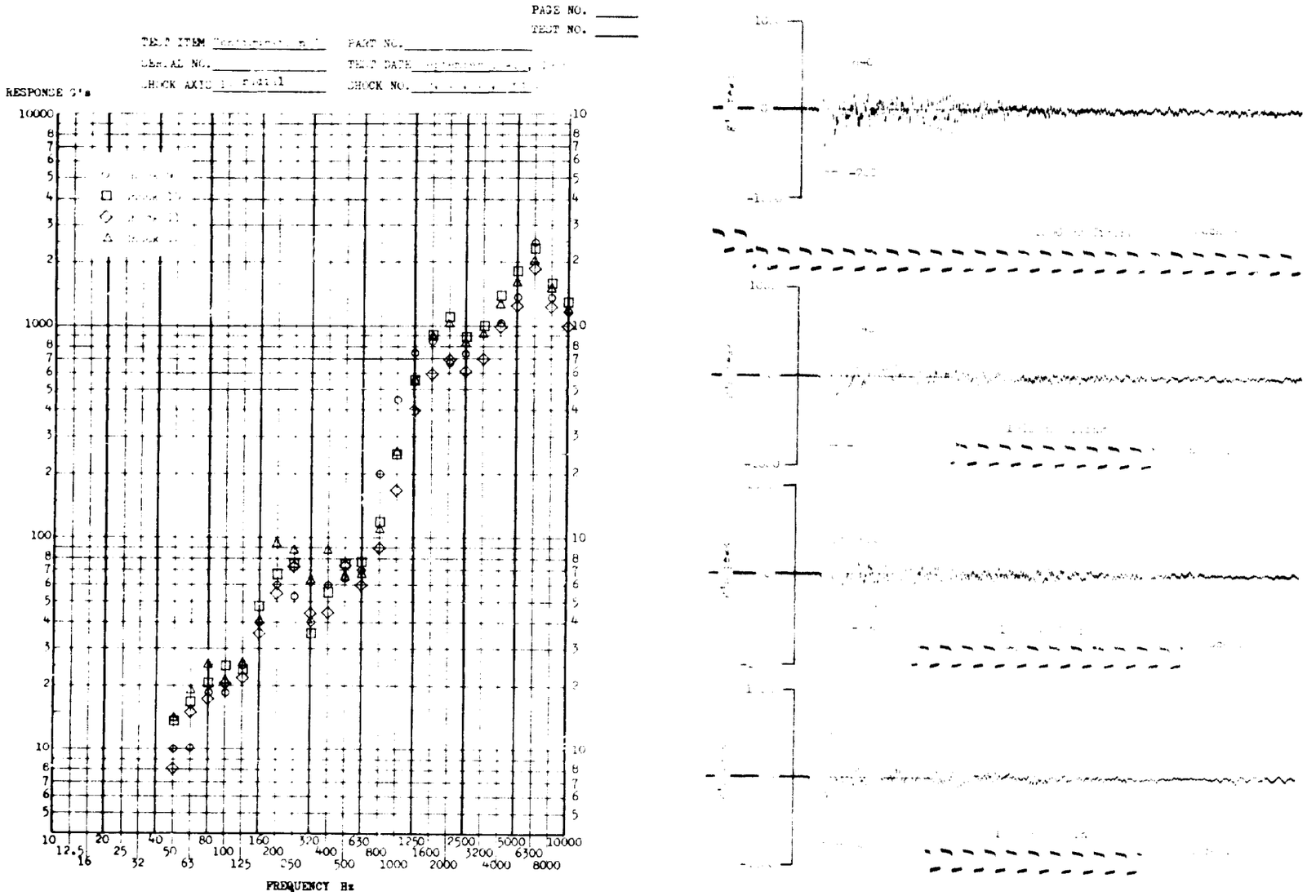
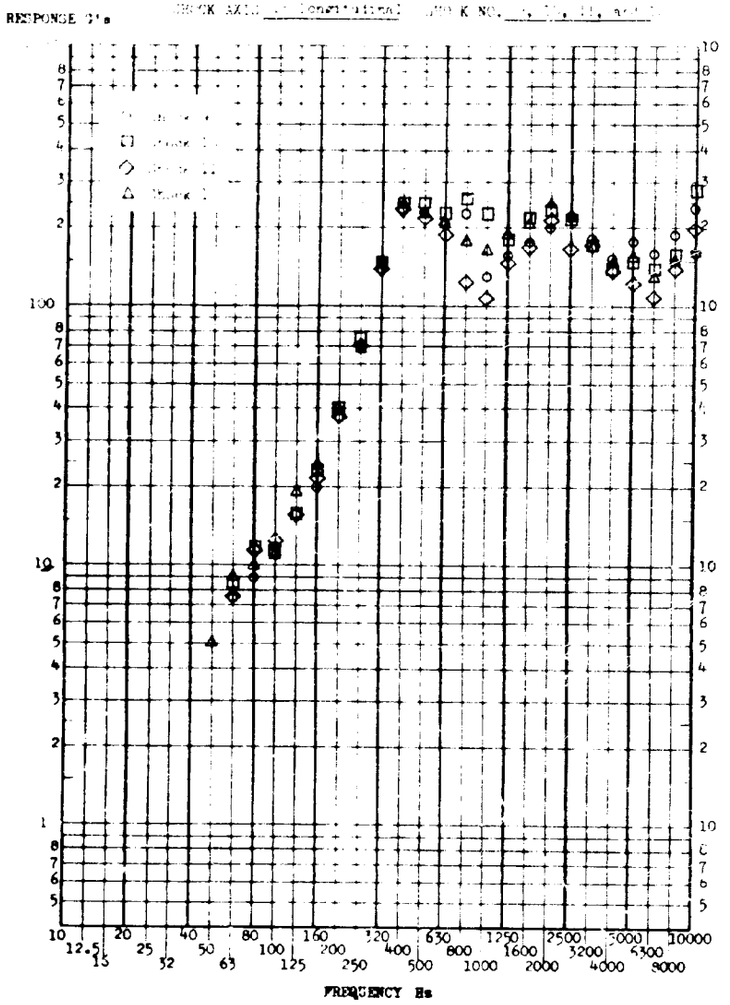



FIGURE II.B.1-49

PAGE NO. _____
TEST NO. _____



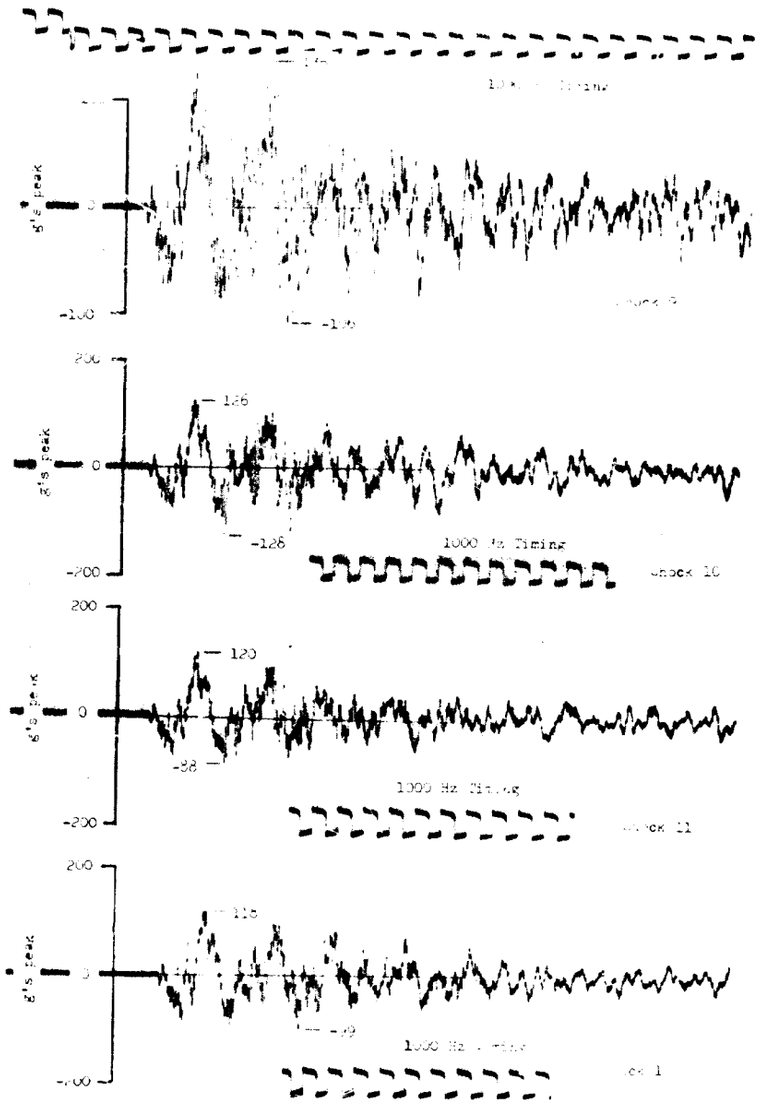




FIGURE II.B.1-50

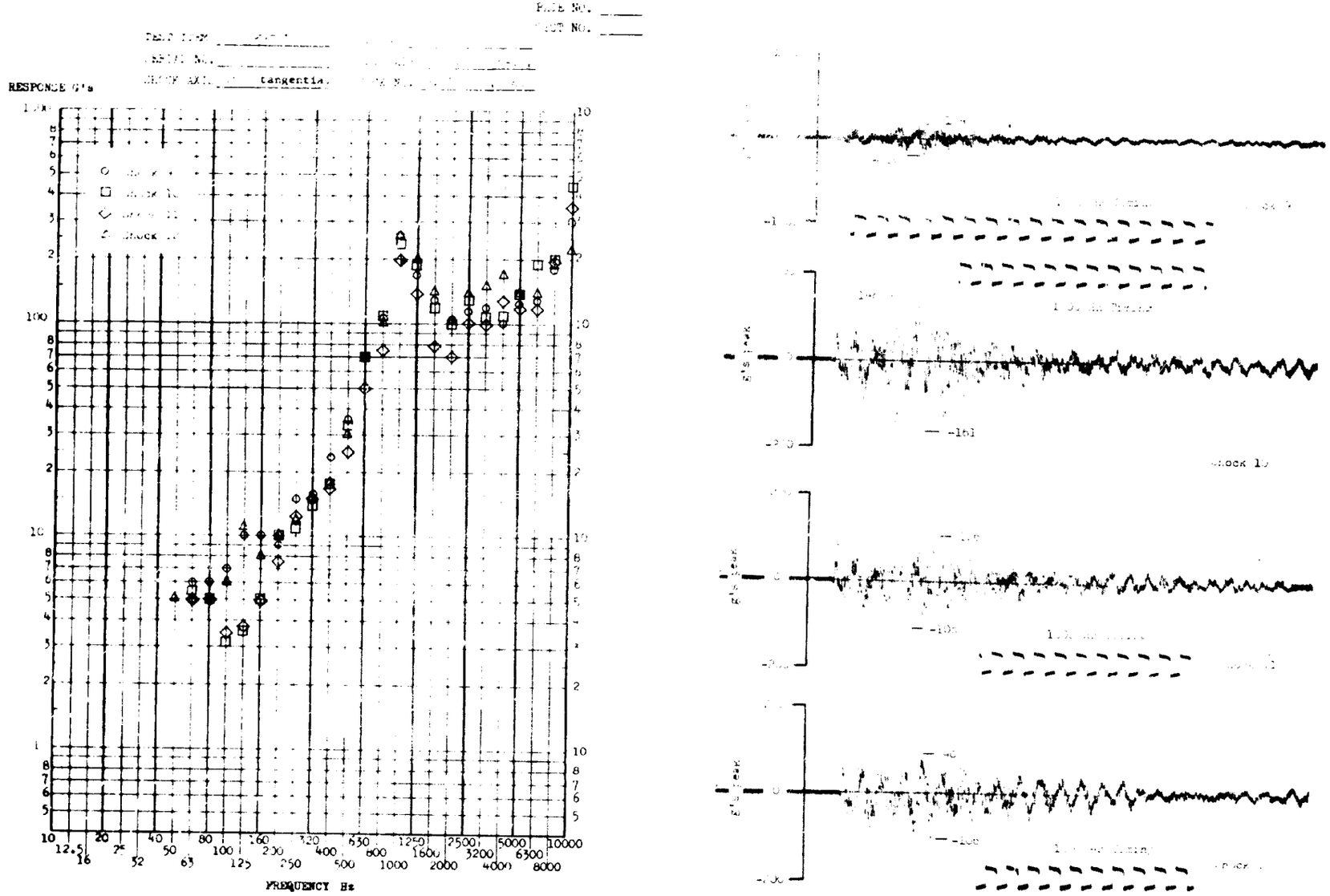
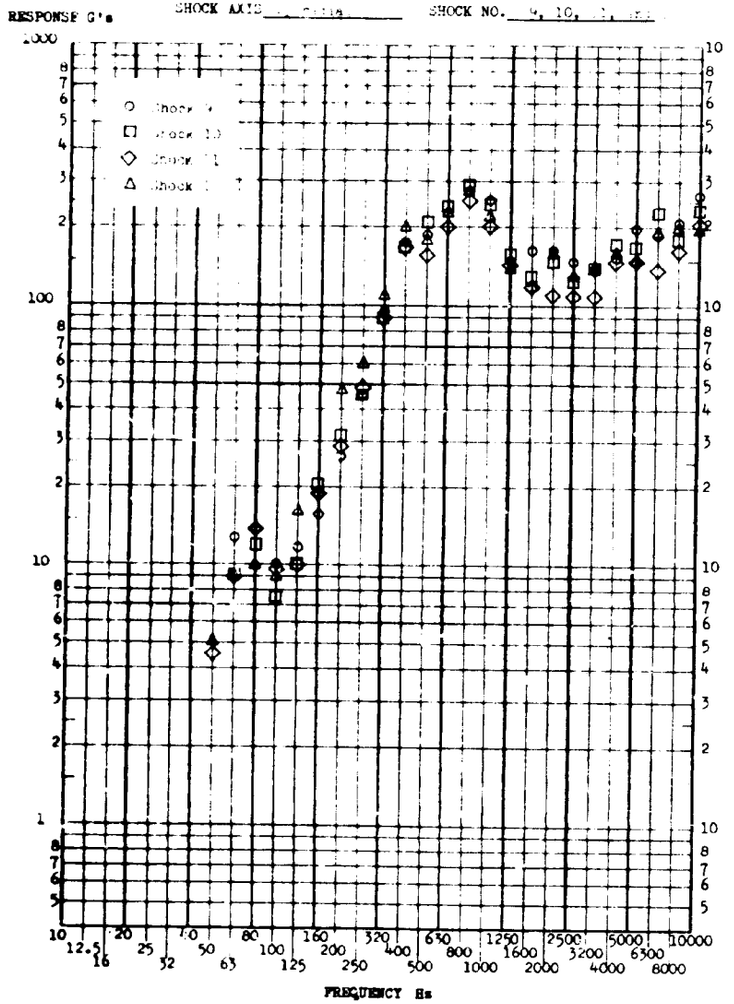



FIGURE II.B.1-51

PAGE NO. ____
TEST NO. ____

TEST ITEM [illegible] PART NO. ____
SERIAL NO. ____ TEST DATE [illegible]
SHOCK AXIS [illegible] SHOCK NO. [illegible]



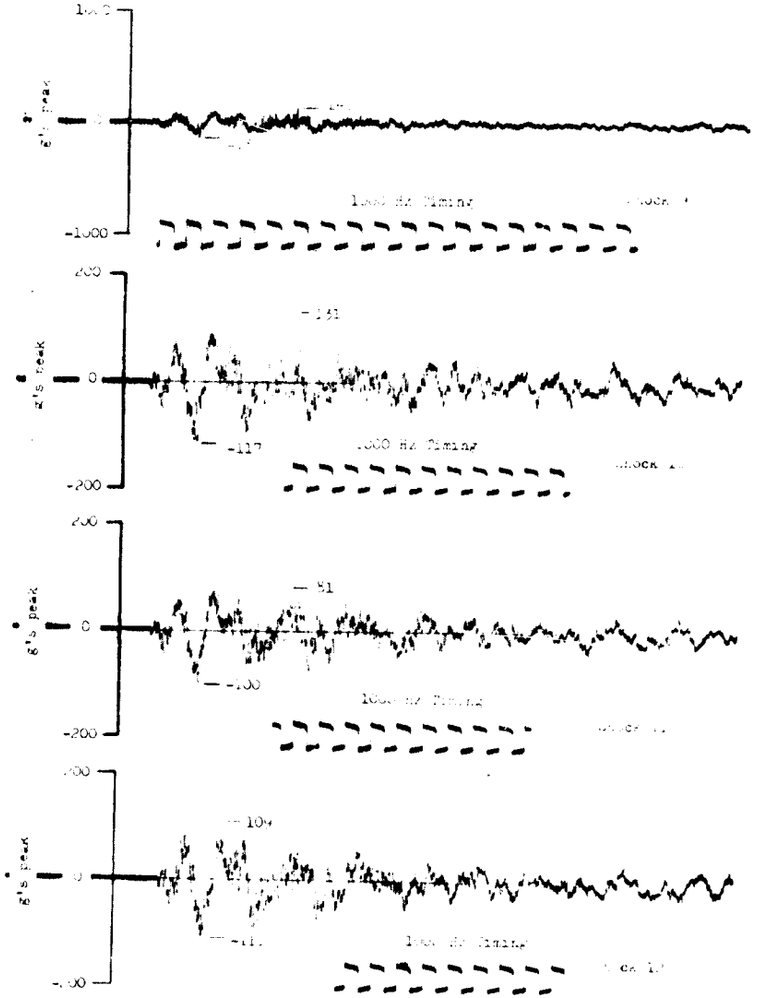
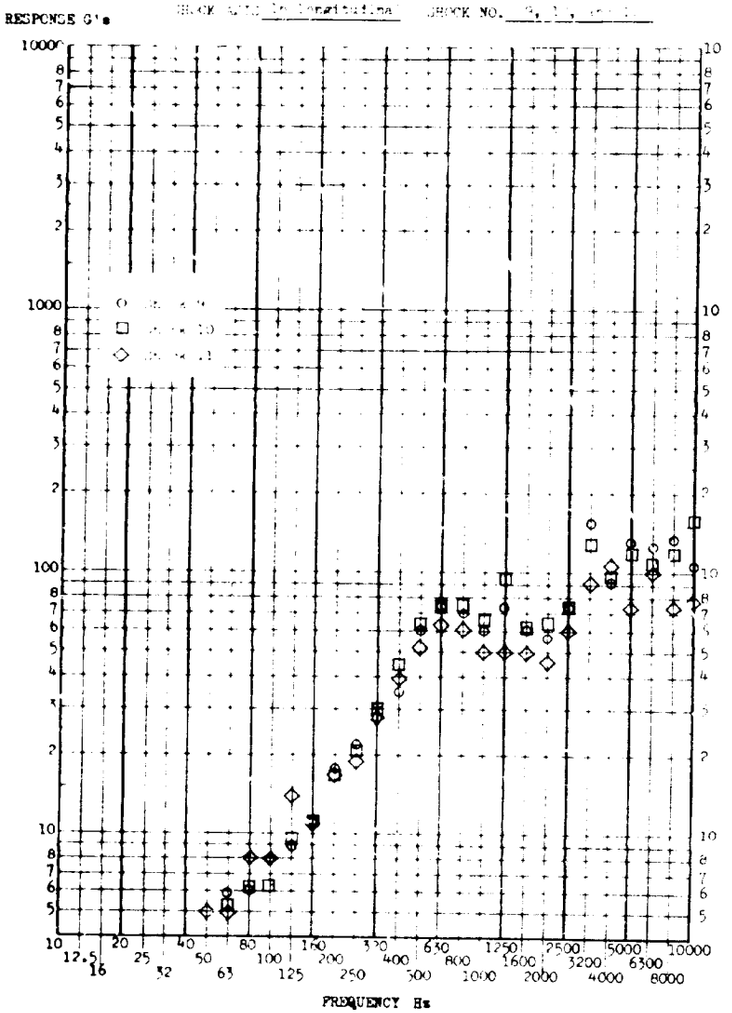




FIGURE 11.B.1-52

PAGE NO. _____
TEST NO. _____



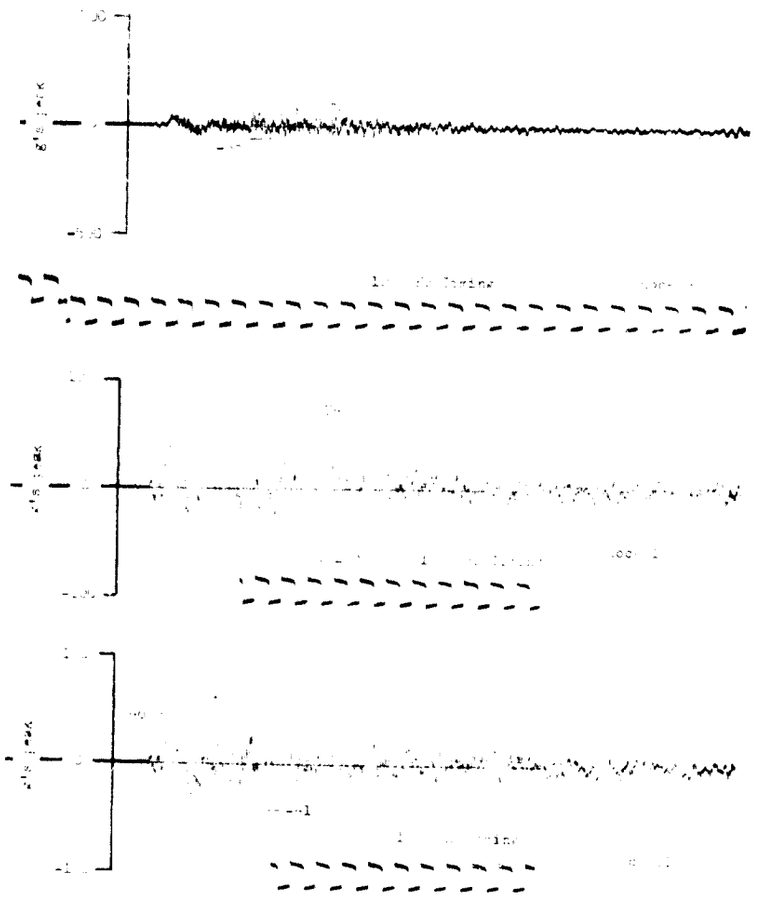
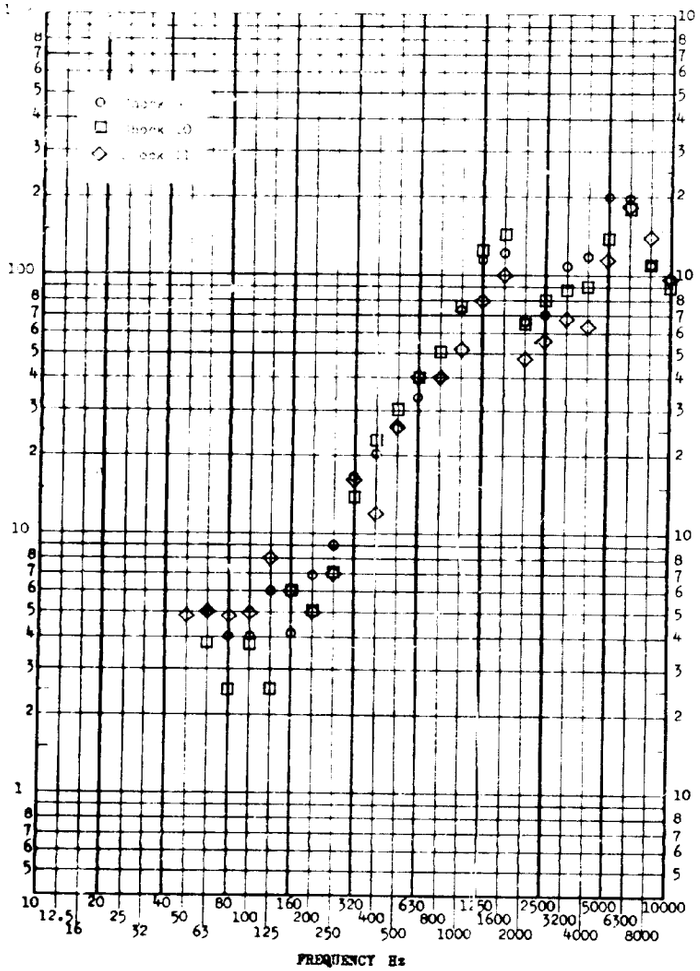



FIGURE II.B.1-53

PAGE NO. _____
TEST NO. _____

TEST ITEM _____ PART NO. _____
SERIAL NO. _____ TEST DATE _____
SHOCK AXIS tangential SHOCK NO. _____

RESPONSE G's



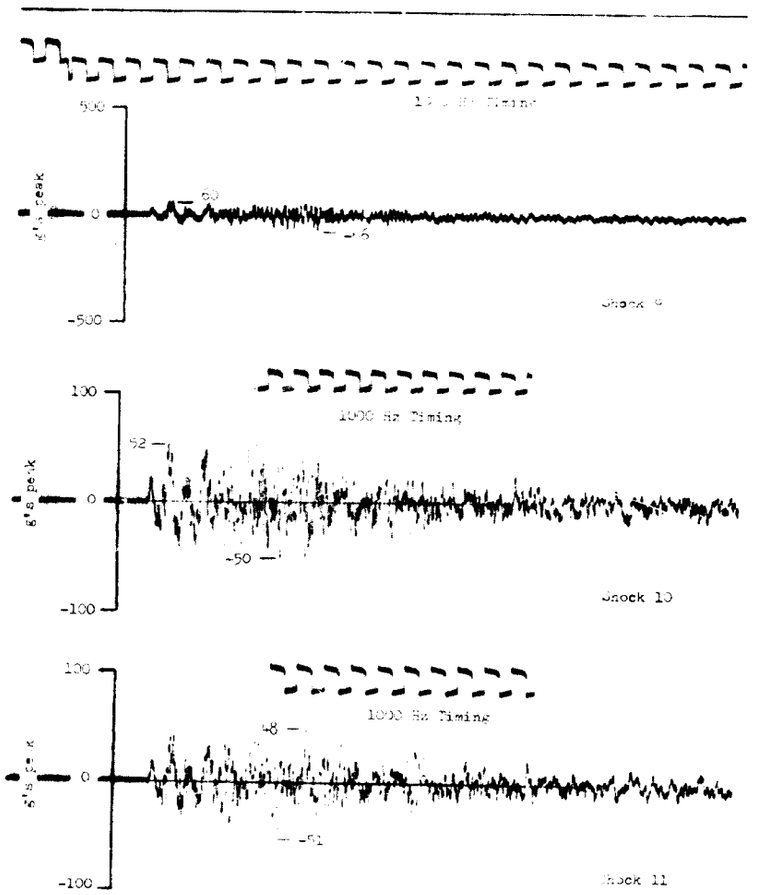
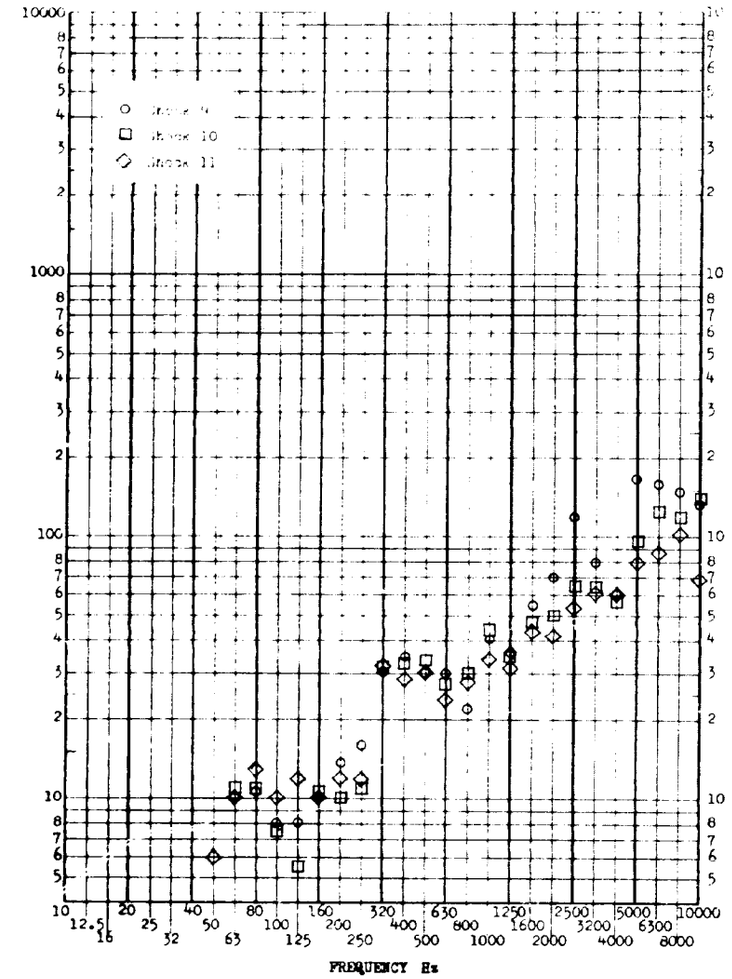




FIGURE II.B.1-54

PAGE NO. _____
FILE NO. _____

TEST ITEM _____ PART NO. _____
SERIAL NO. _____ TEST DATE _____
SHOCK AXIS radial SHOCK NO. _____

RESPONSE 2%



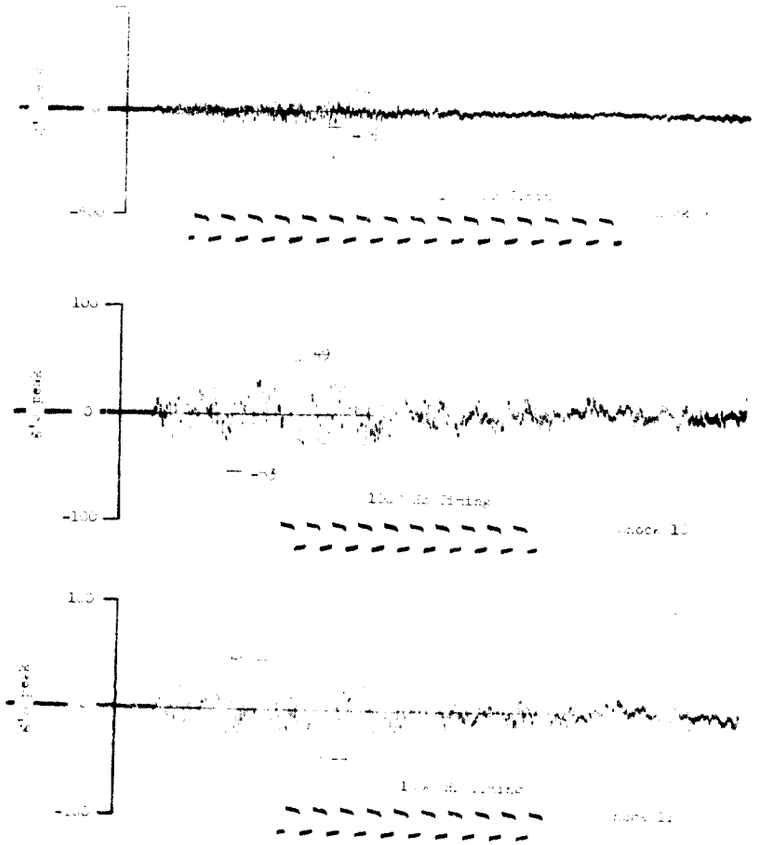
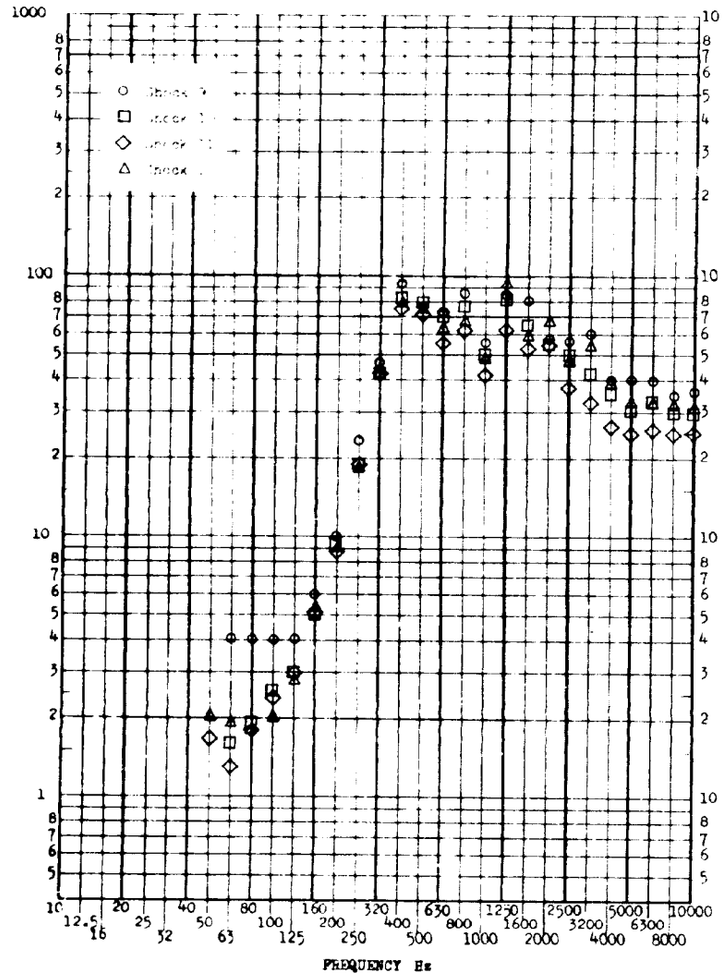



FIGURE II.B.1-55

PAGE NO. _____
TEST NO. _____

TEST ITEM _____ PART NO. _____
SERIAL NO. _____ TEST DATE _____
SHOCK AXIS _____ SHOCK NO. _____



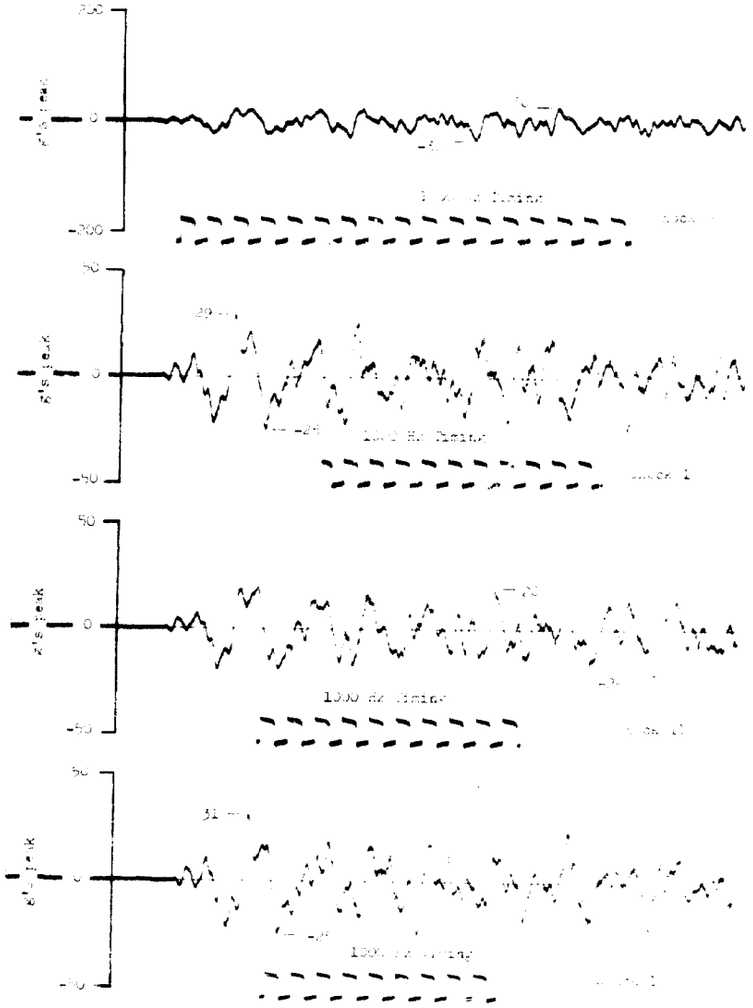



FIGURE II.B.1-56

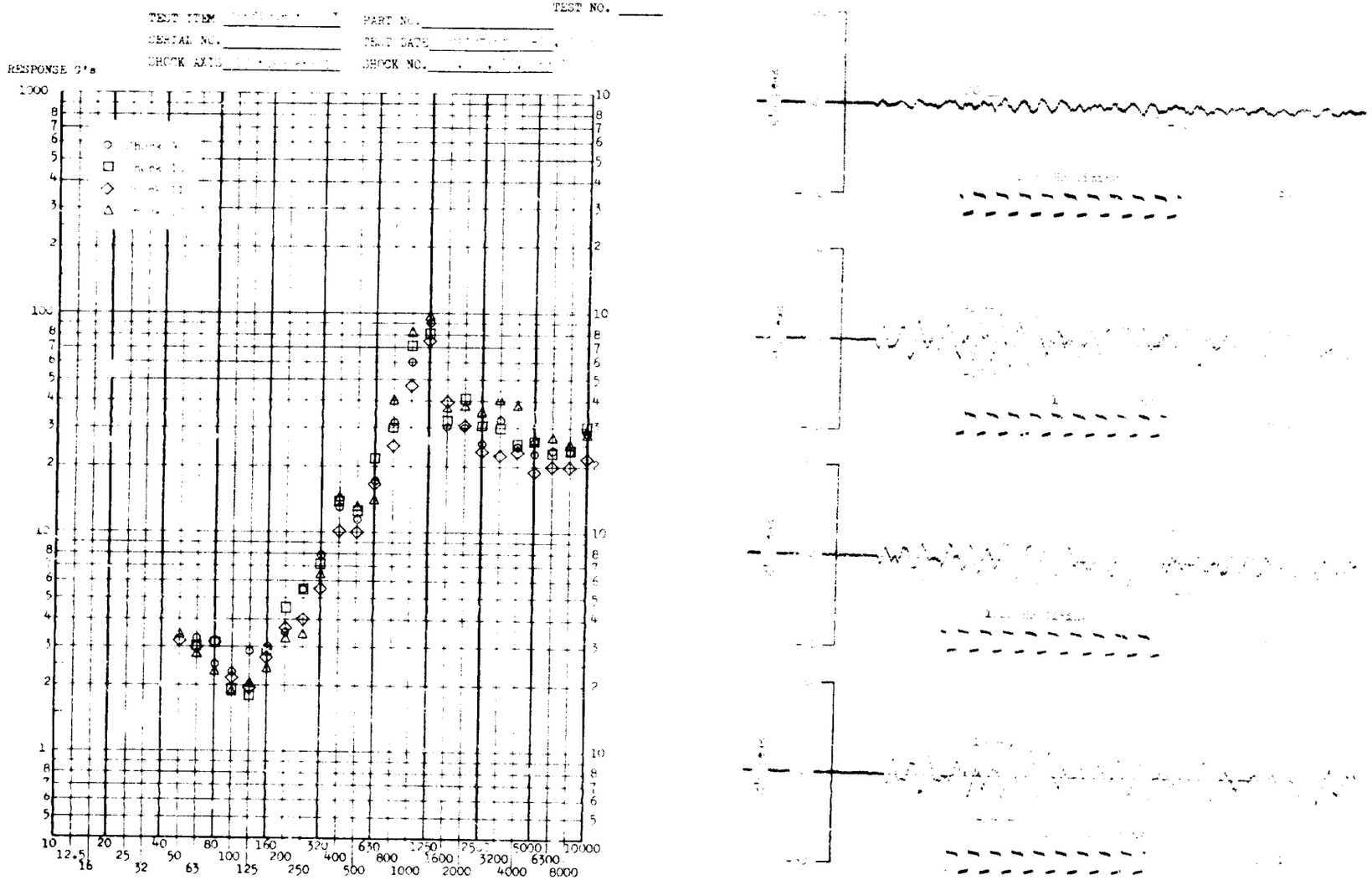



FIGURE II.B.1-57

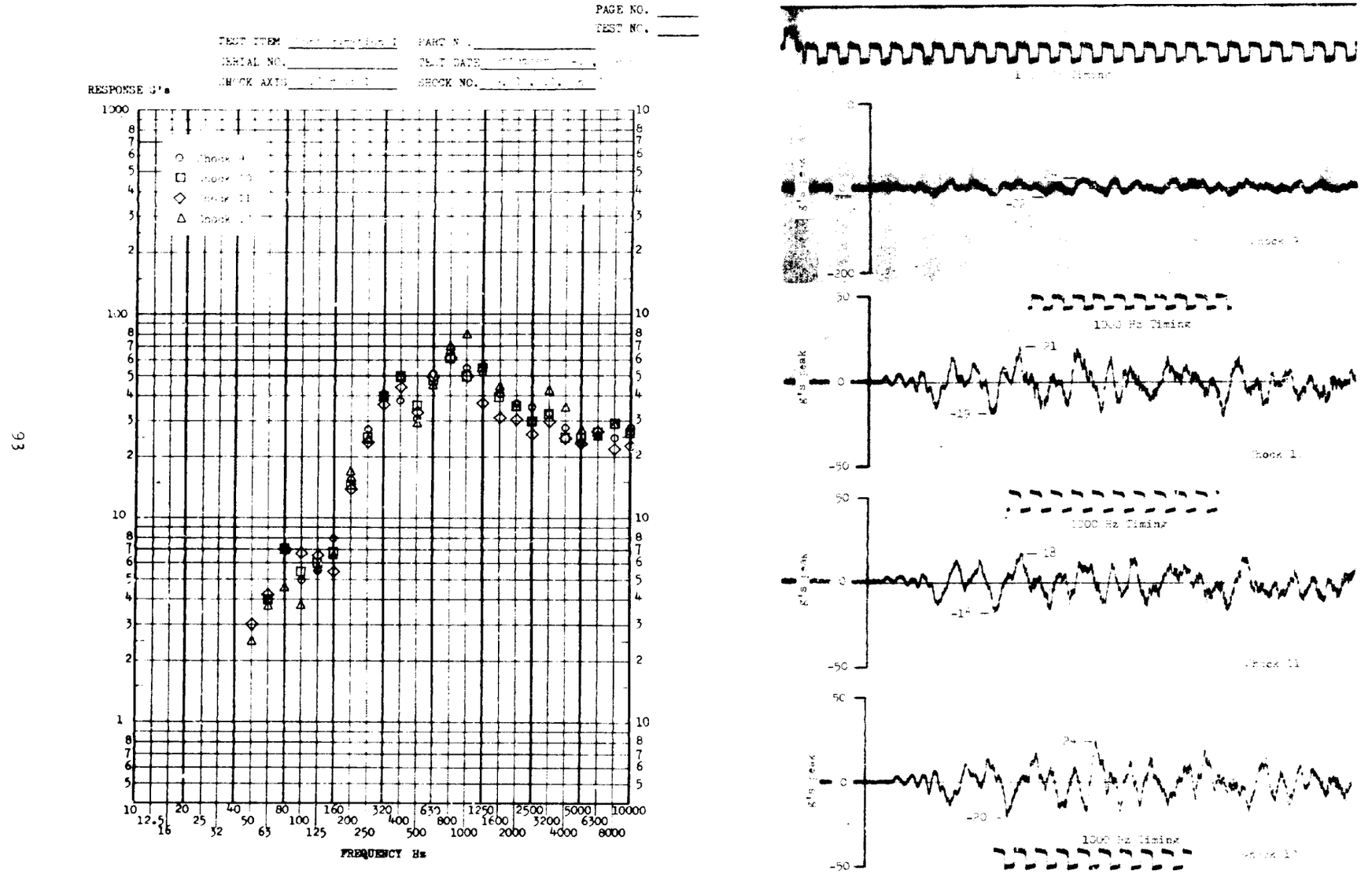



FIGURE II.B.1-58

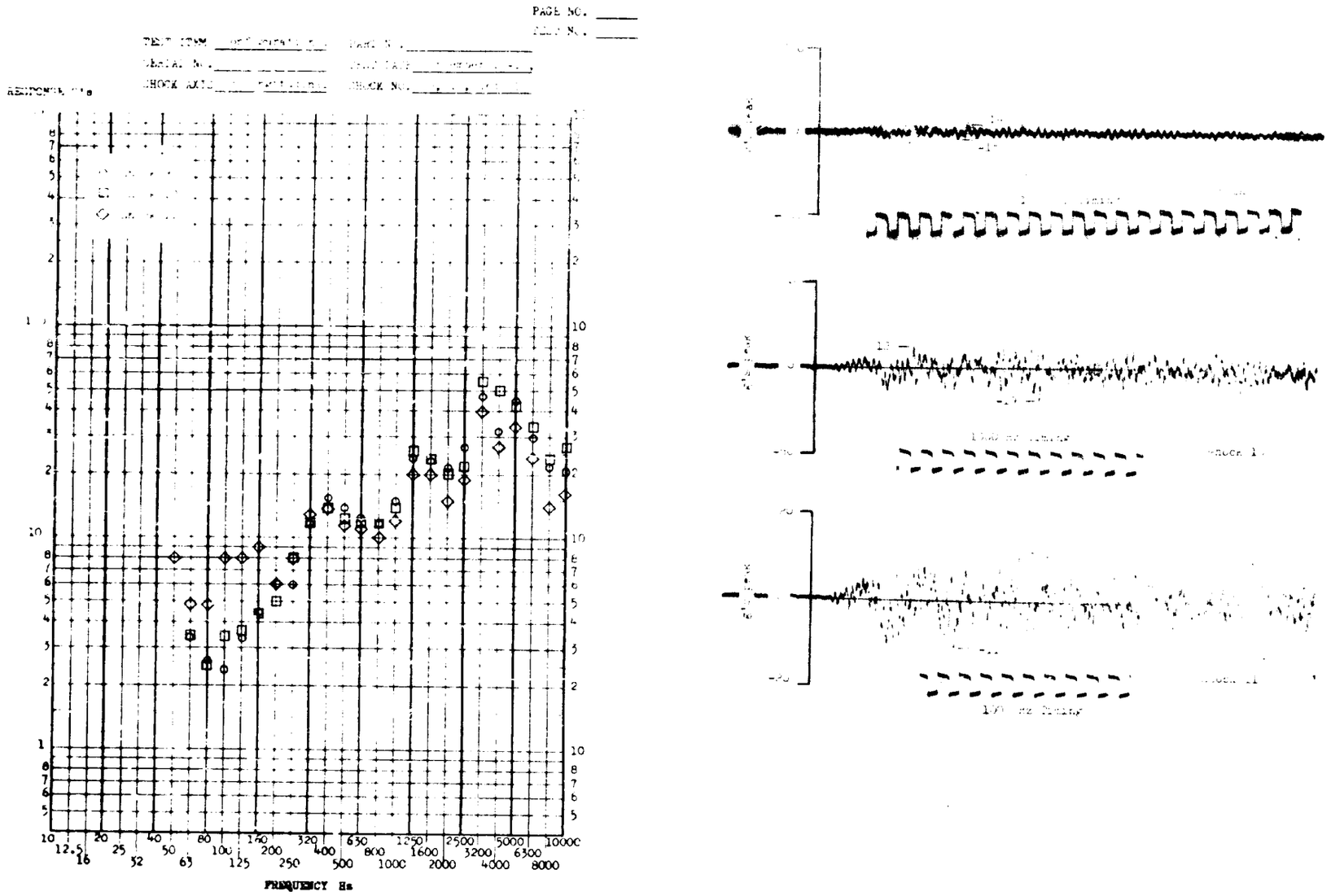



FIGURE II.B.1-59

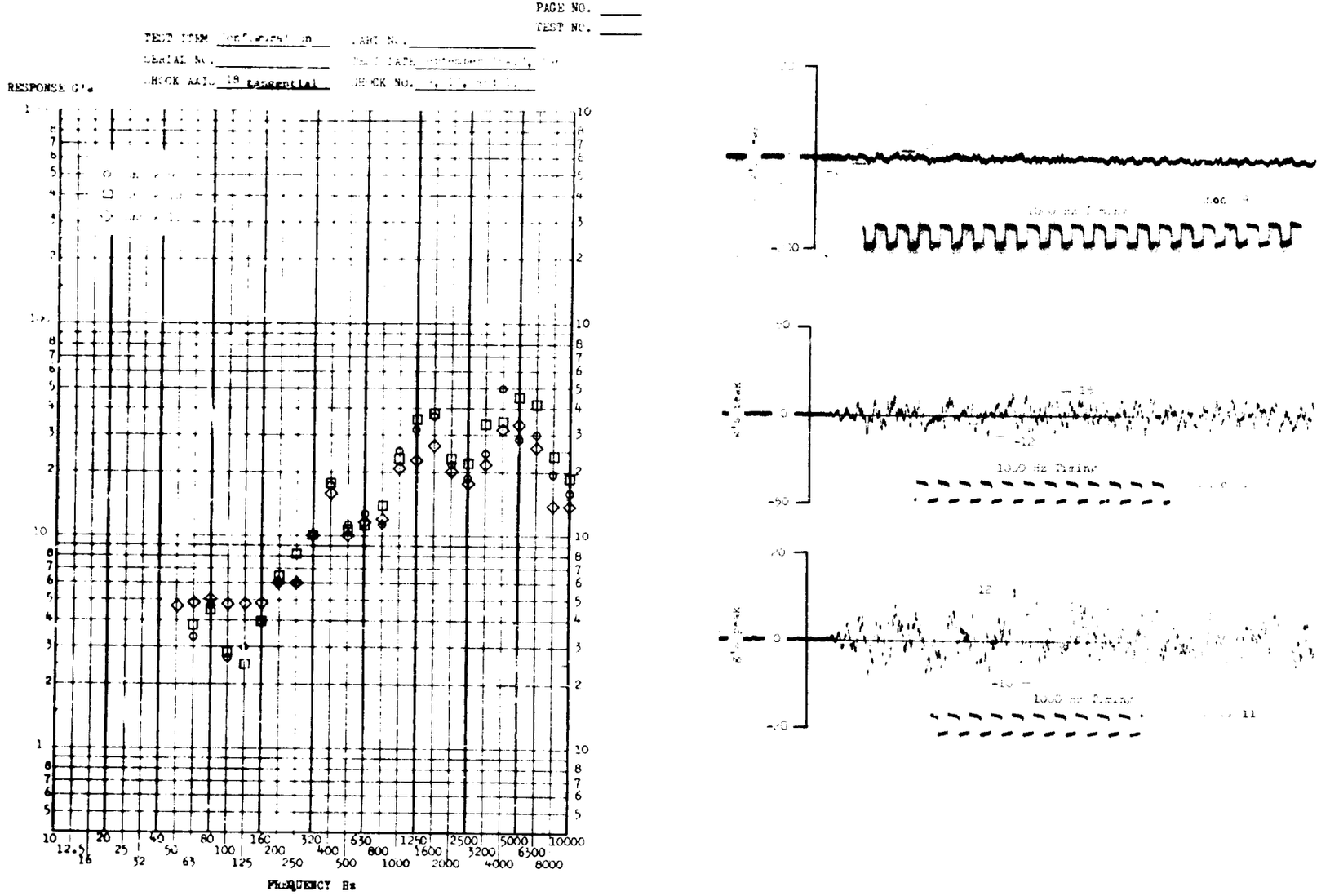



FIGURE 11.B.1-60

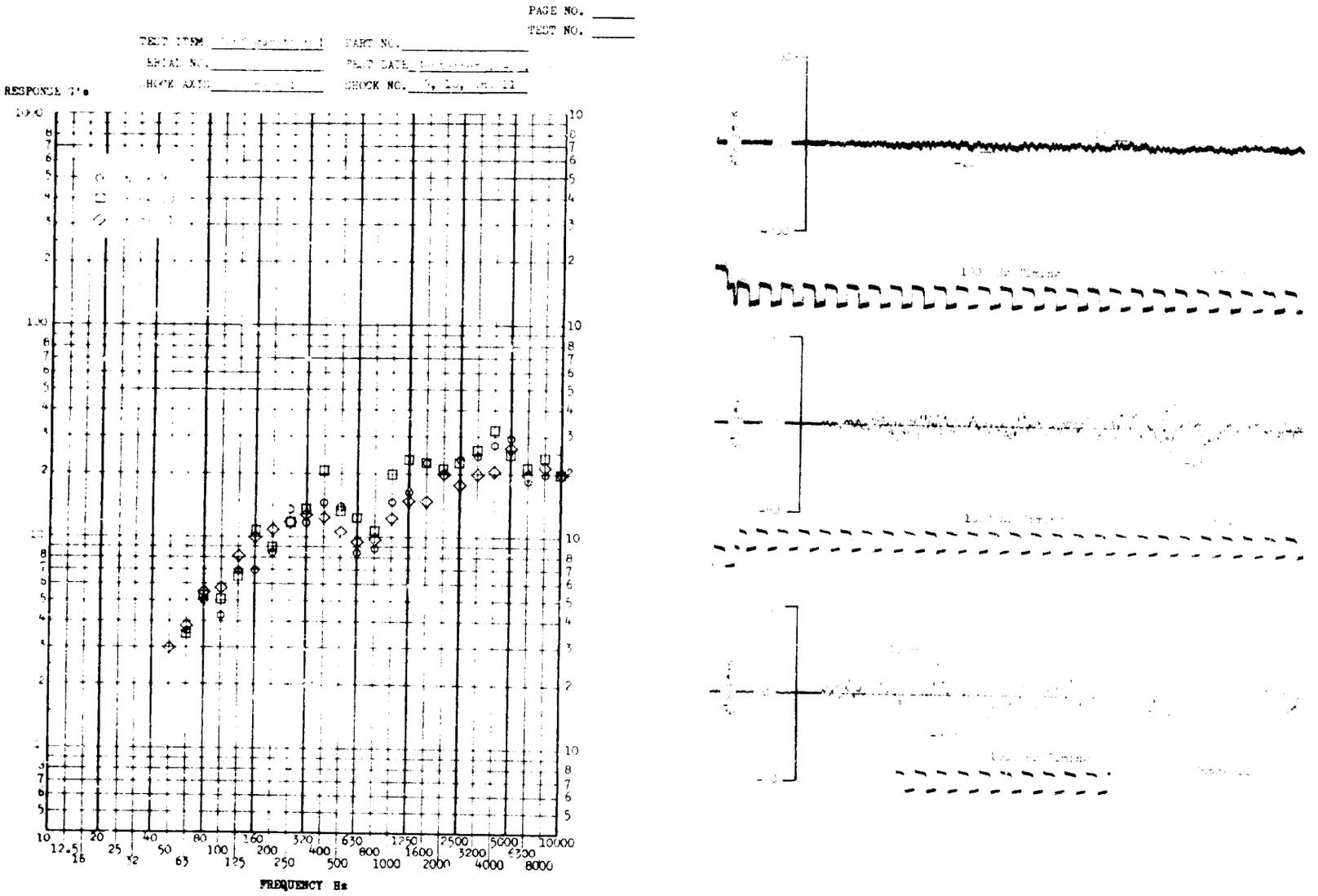
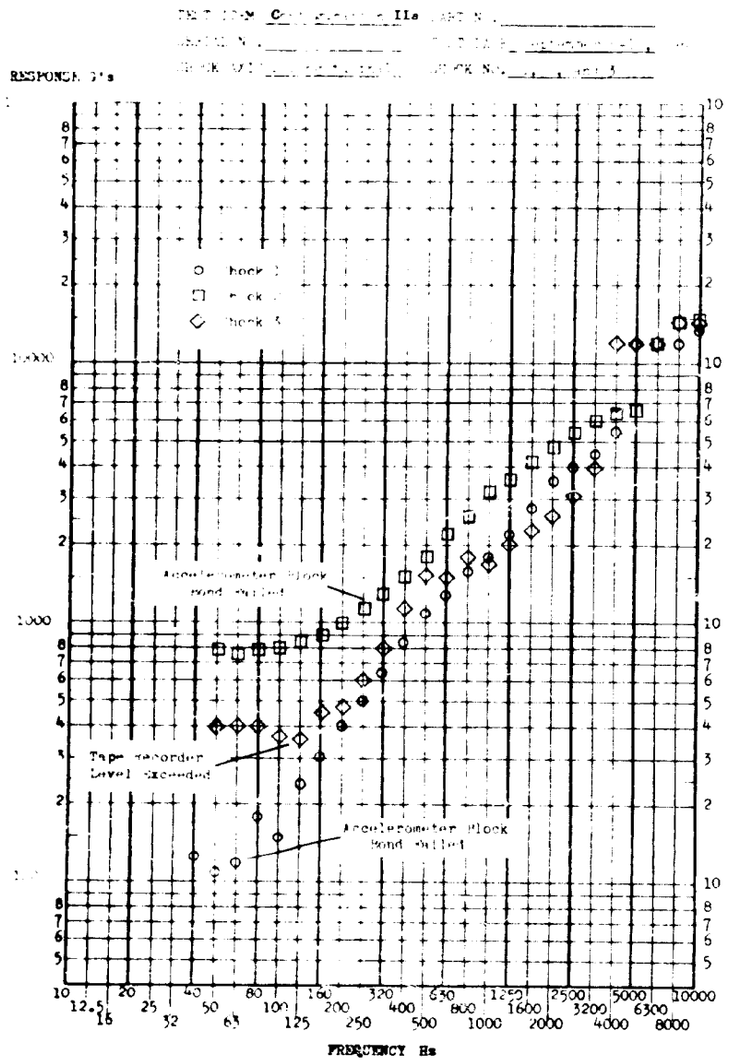



FIGURE II.B.1-61



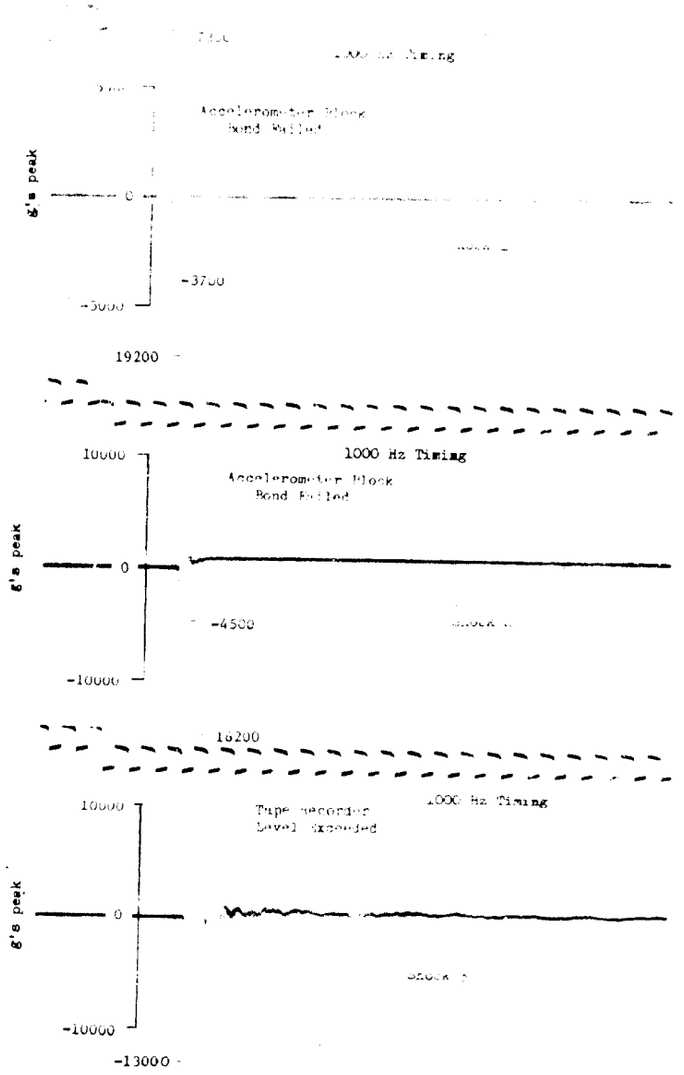




FIGURE II.B.1-62

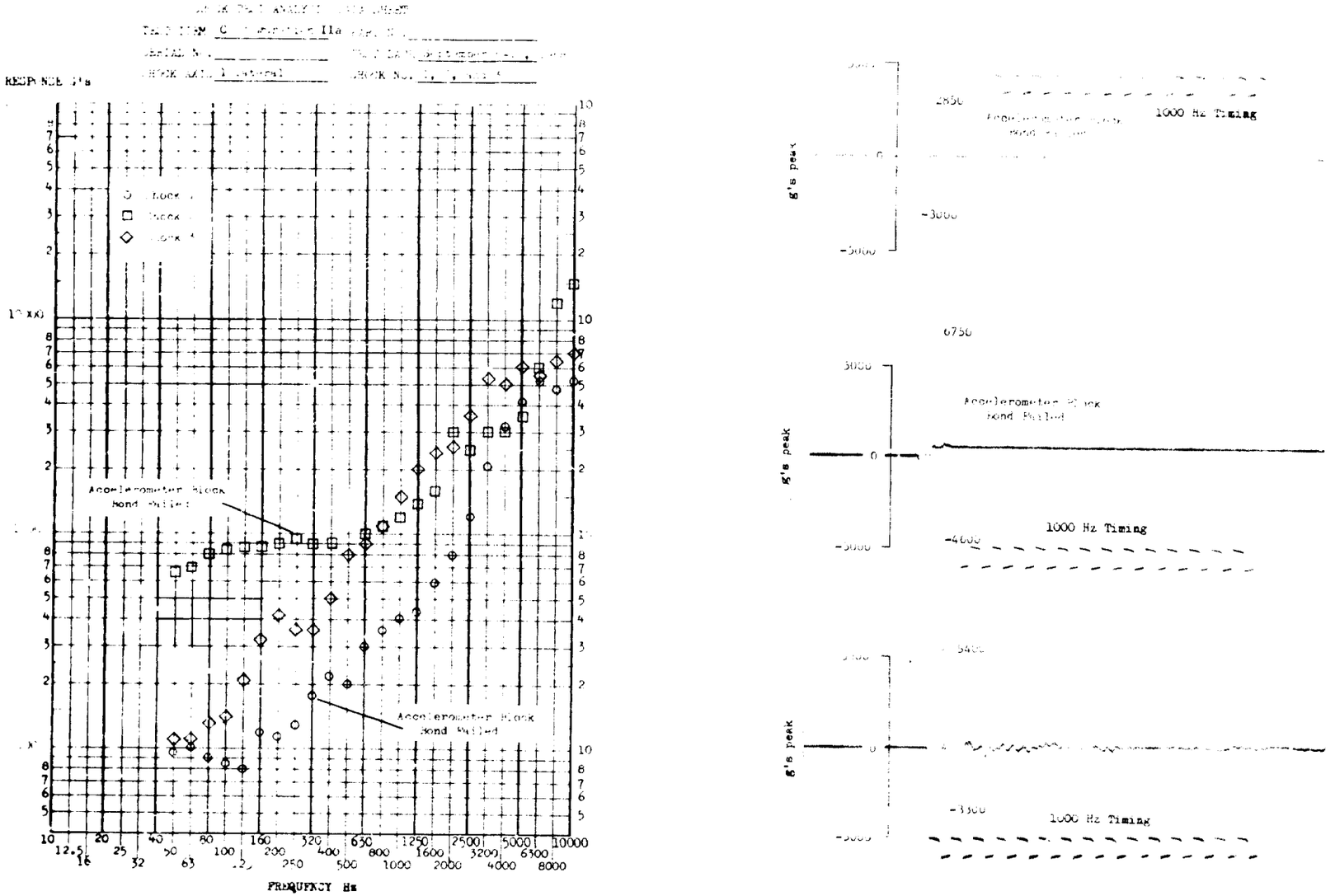
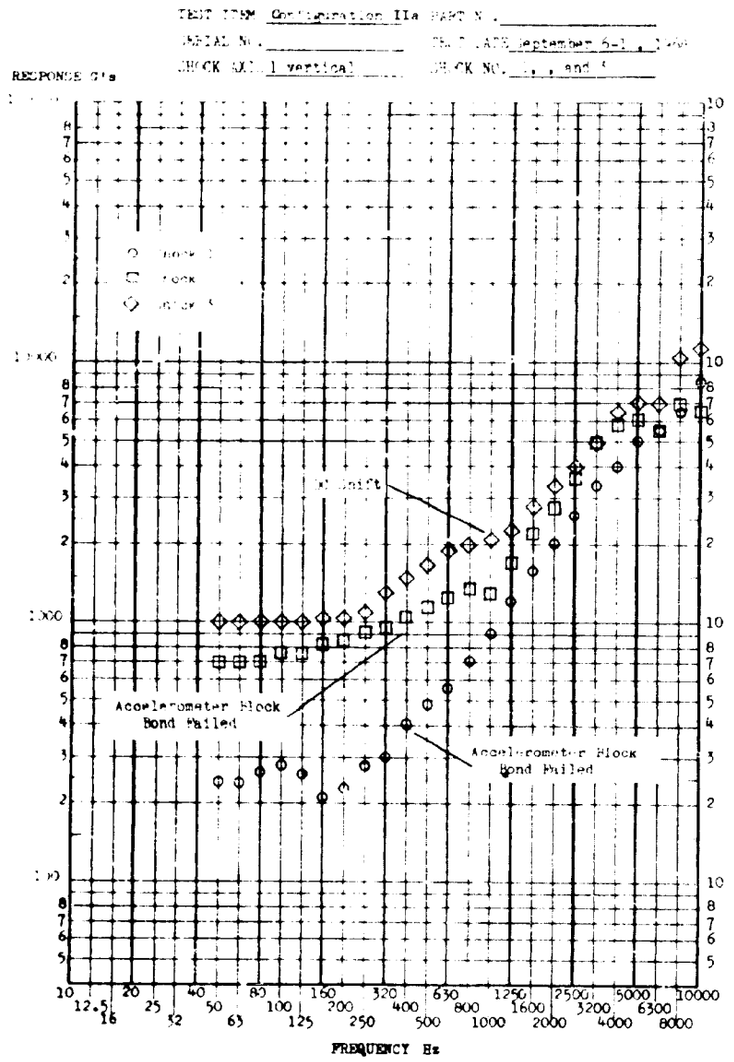



FIGURE 11.B.1-63



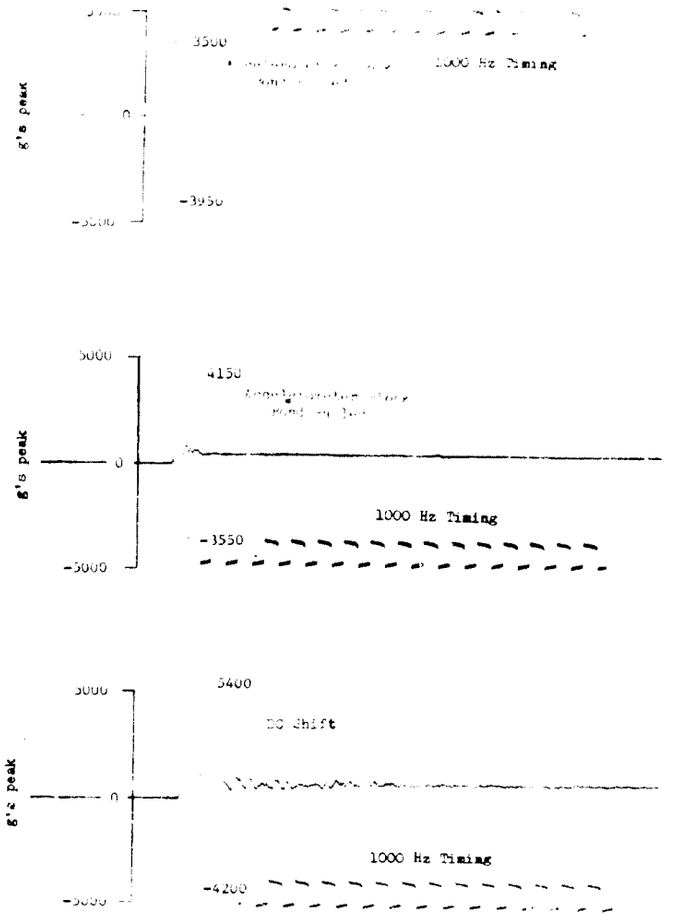
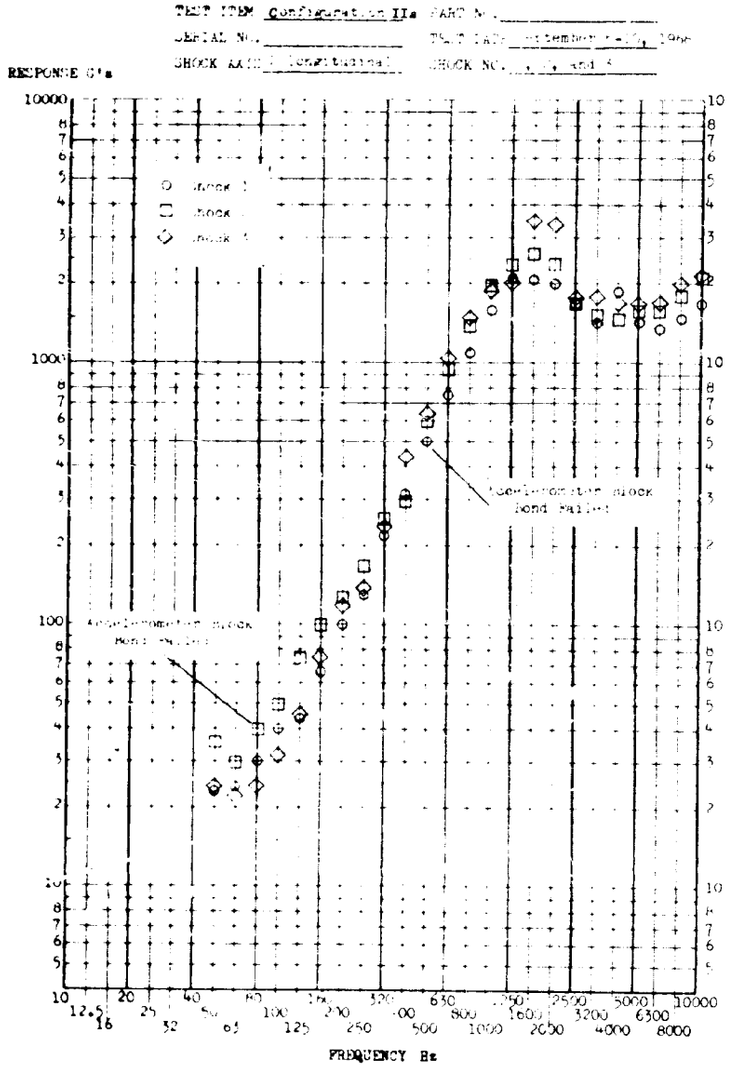




FIGURE 11.8.1-64



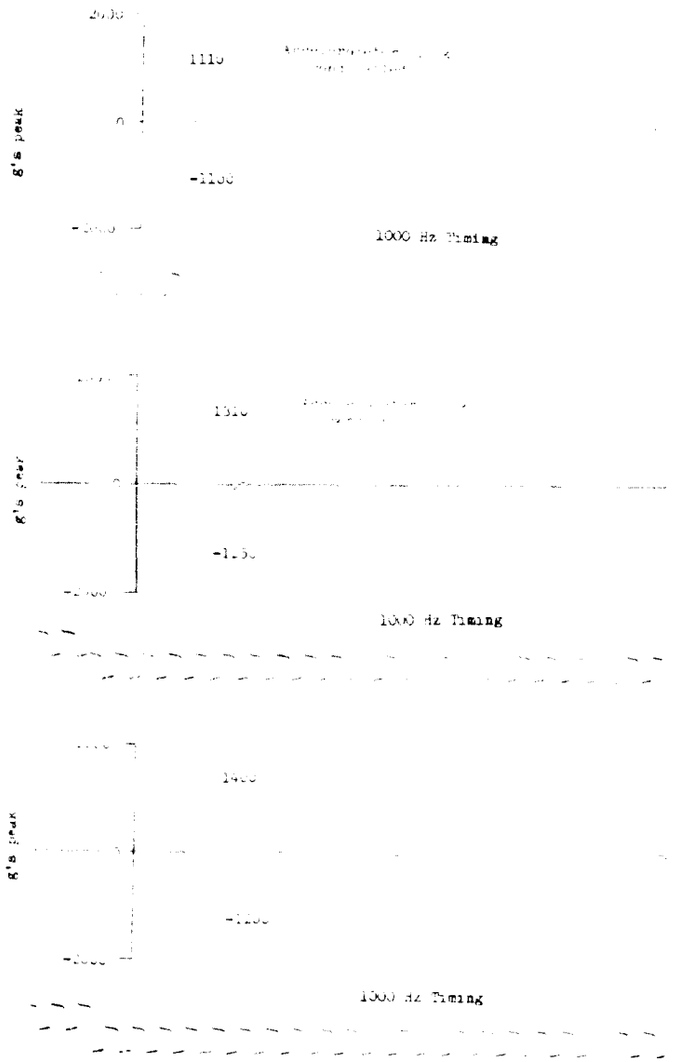




FIGURE II.B.1-65

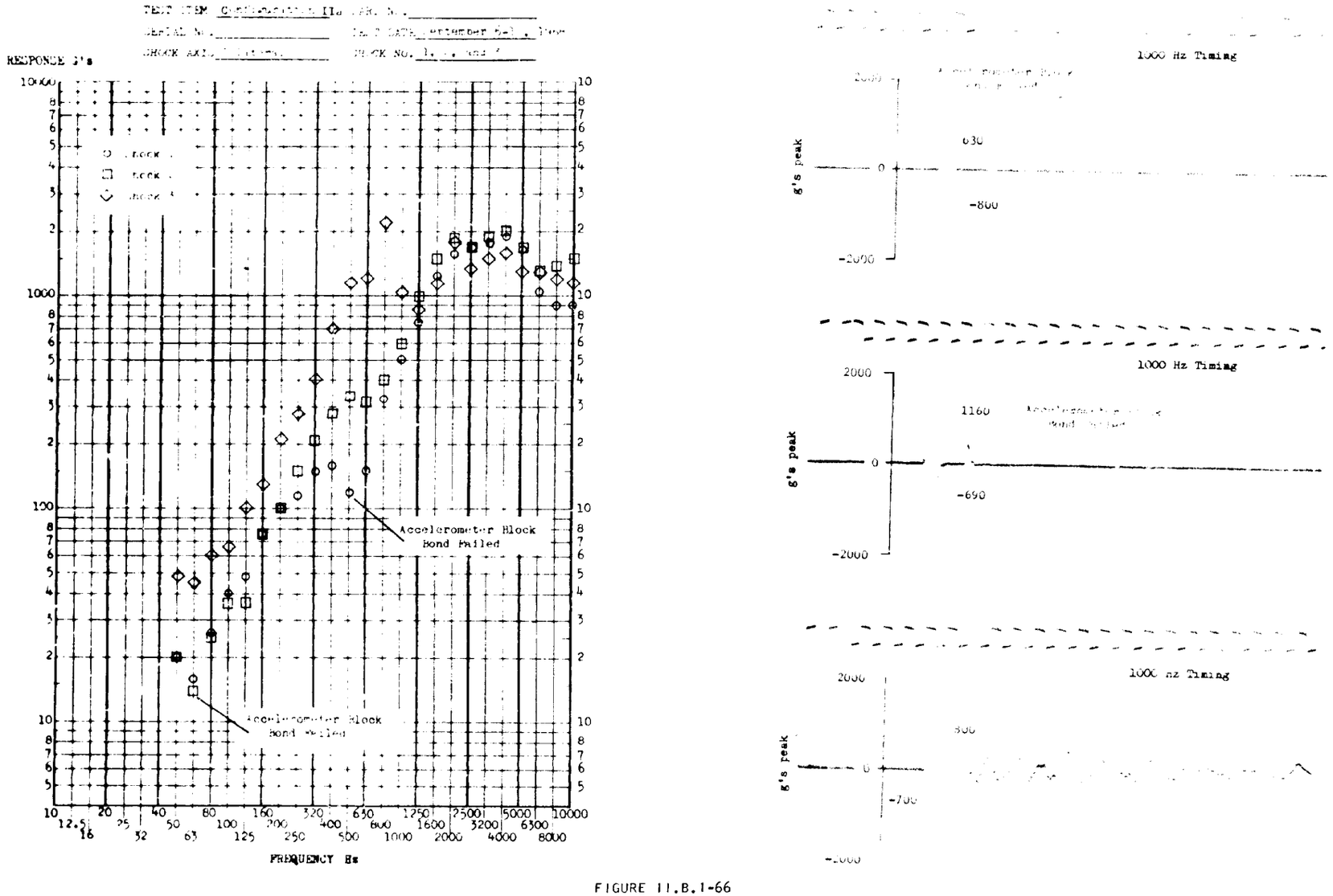



FIGURE II.B.1-66

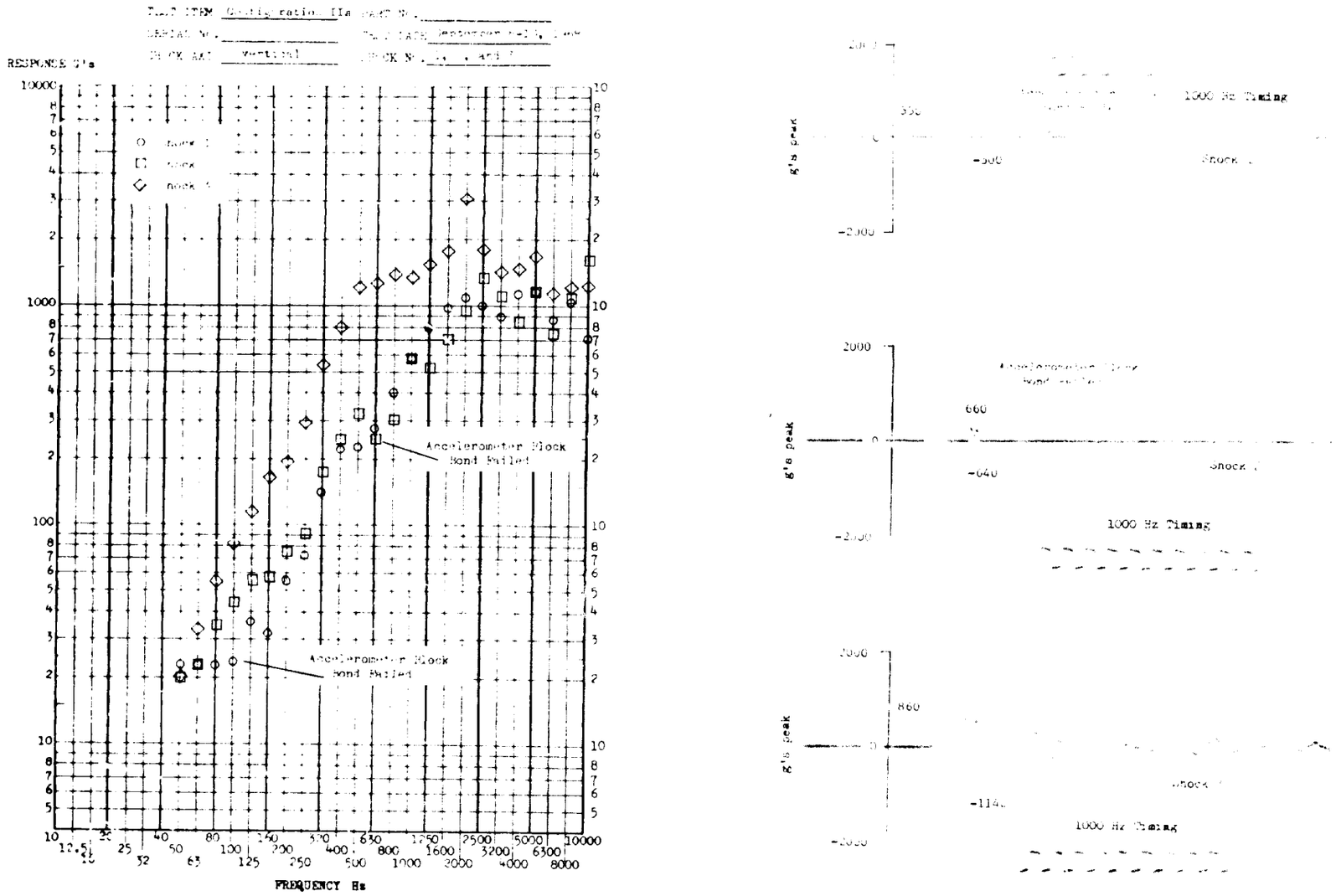
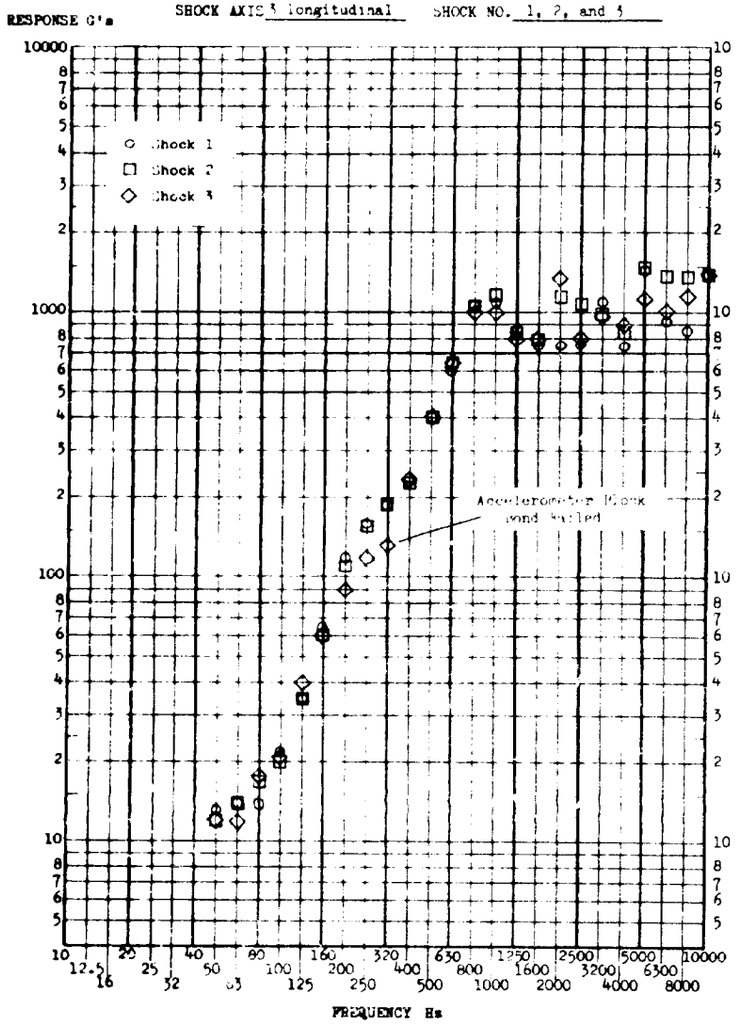



FIGURE II.B.1-67

TEST ITEM Configuration IIa PART NO. _____

SERIAL NO. _____ TEST DATE September 6-10, 1968

SHOCK AXIS Longitudinal SHOCK NO. 1, 2, and 3



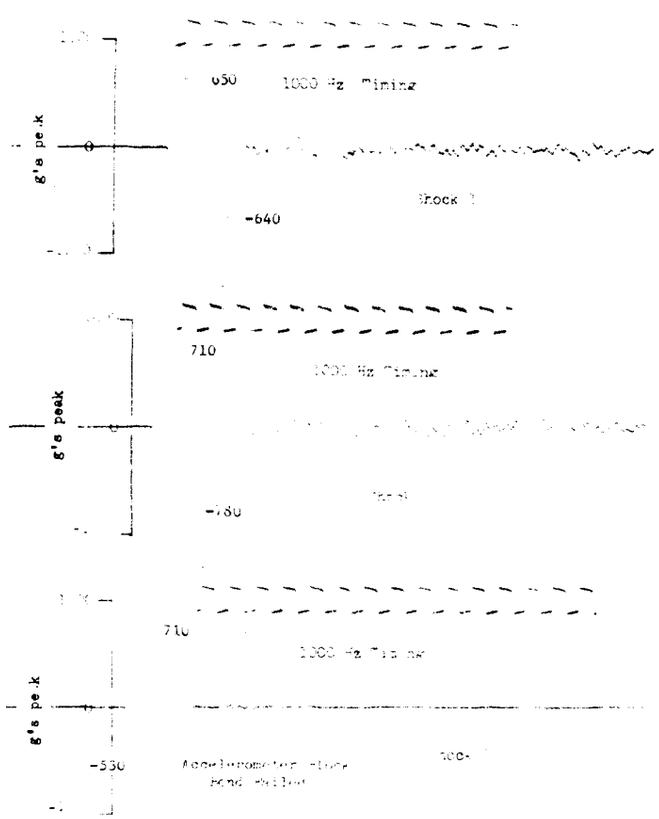




FIGURE II.B.1-68

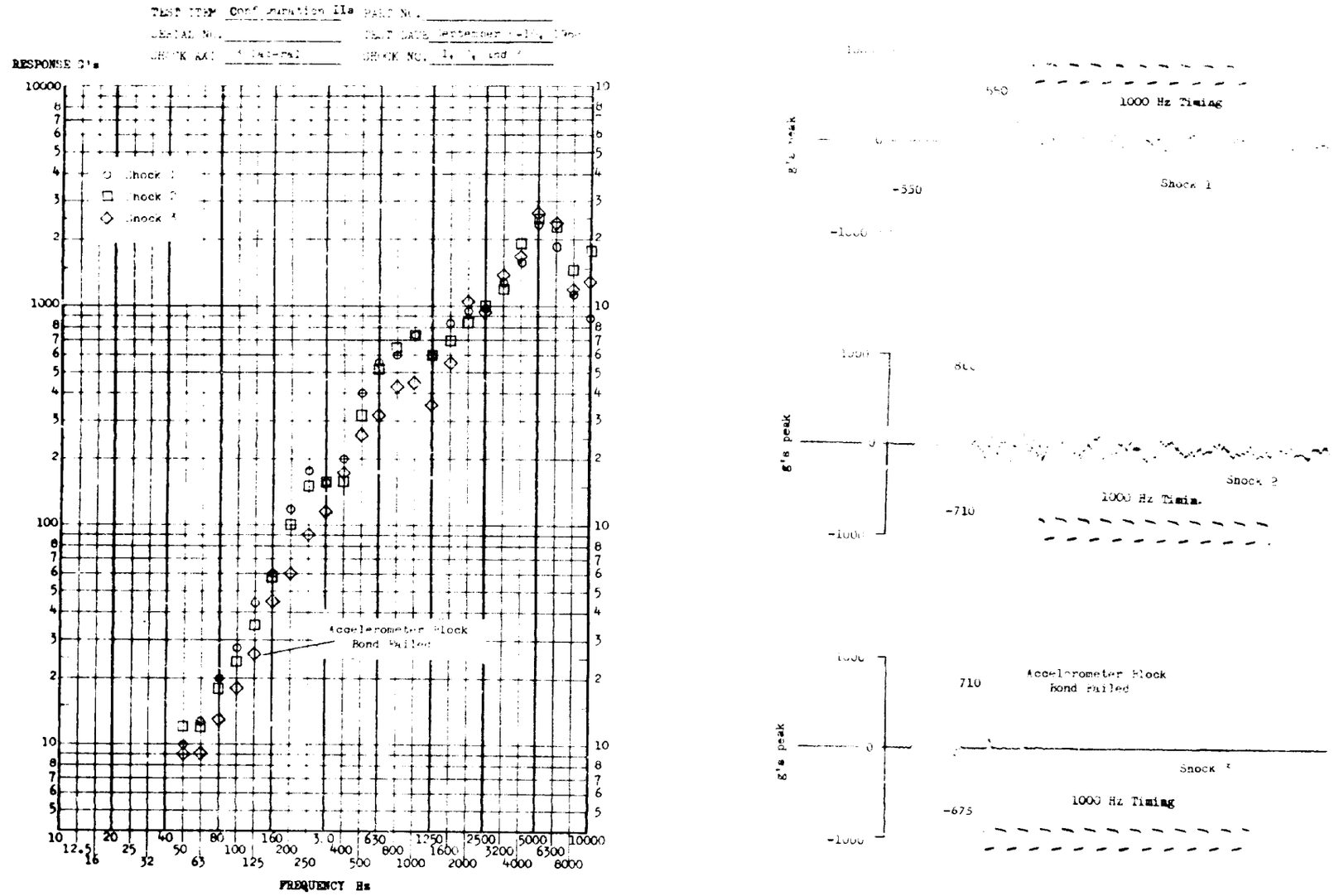
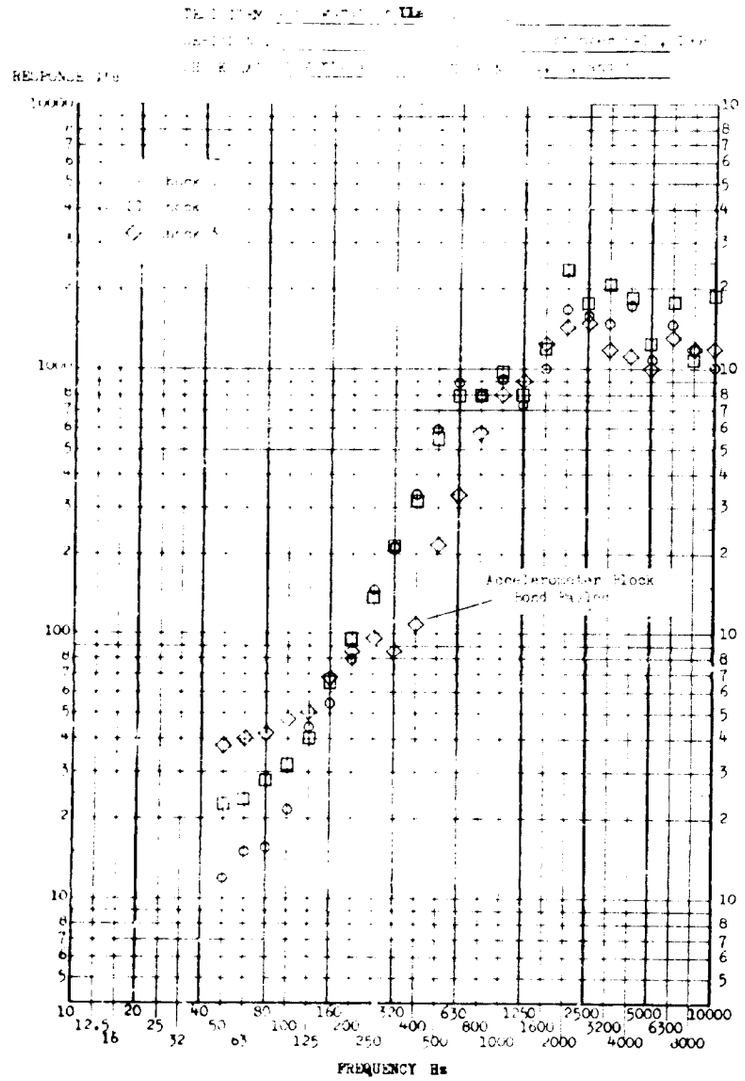



FIGURE II.B.1-69



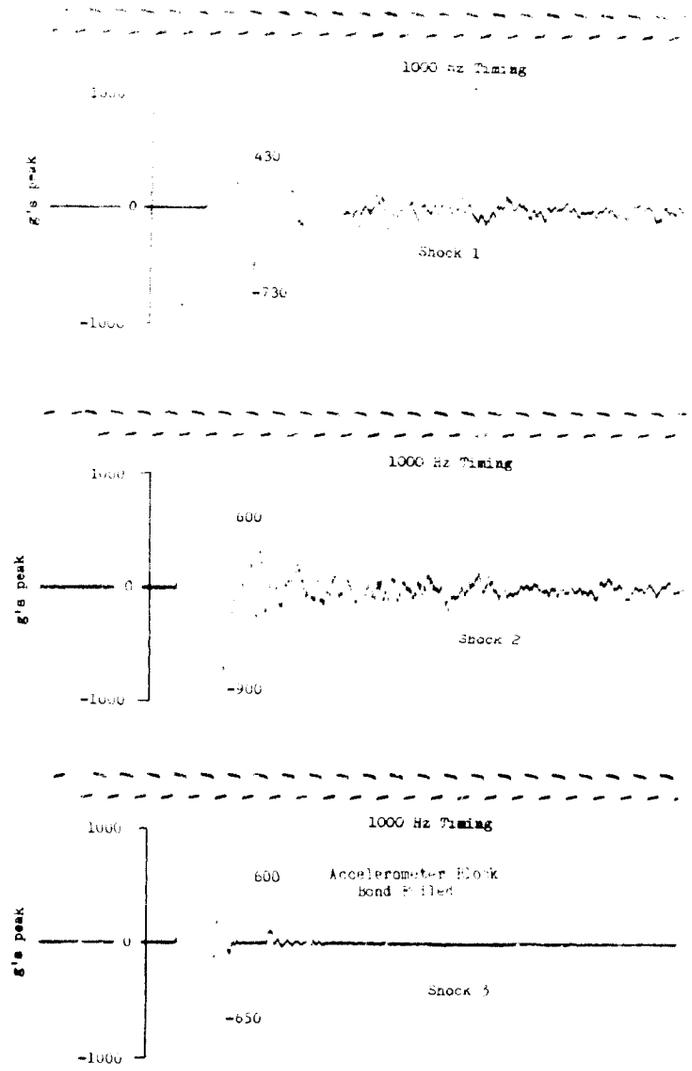




FIGURE II.B.1-70

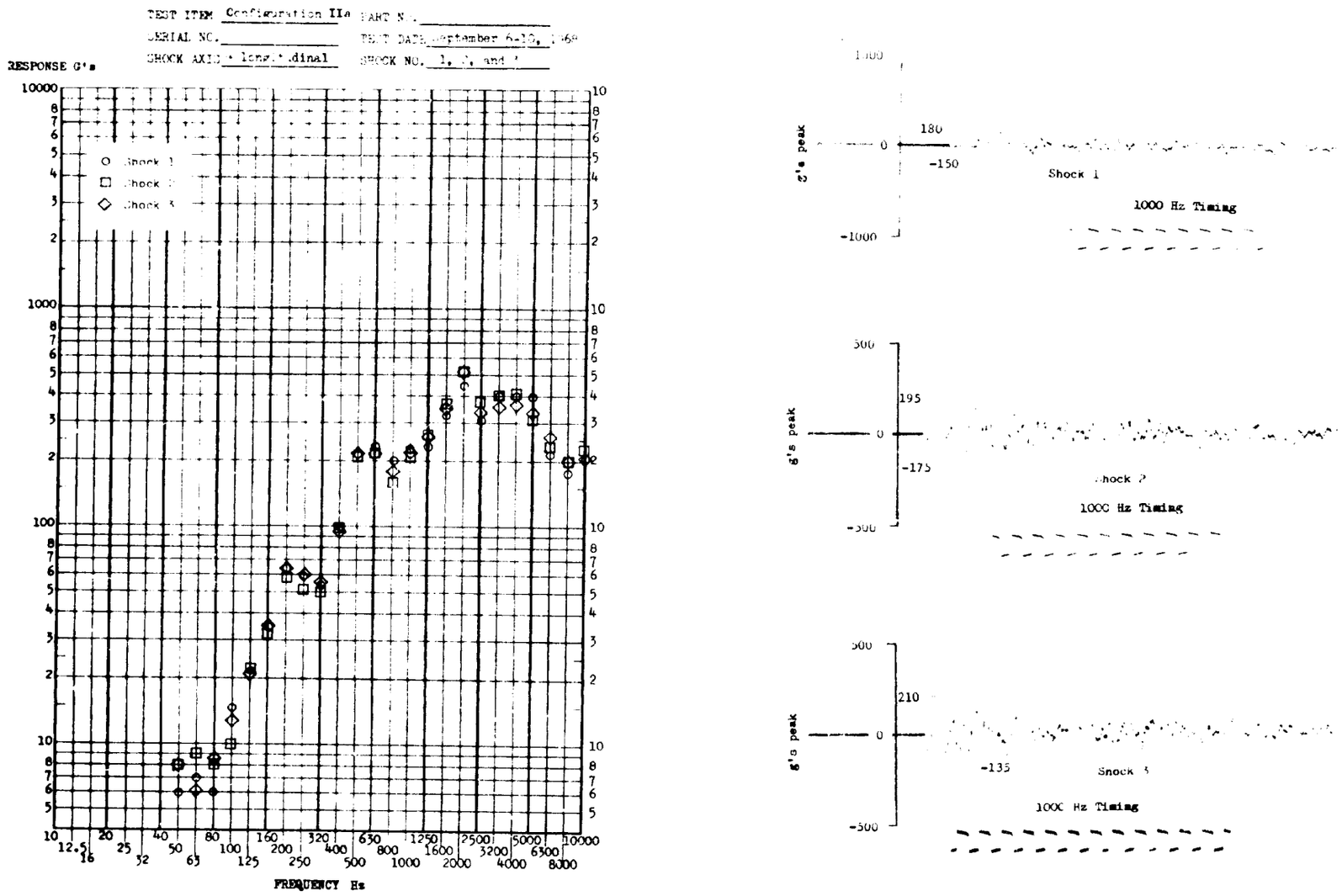



FIGURE II.B.1-71

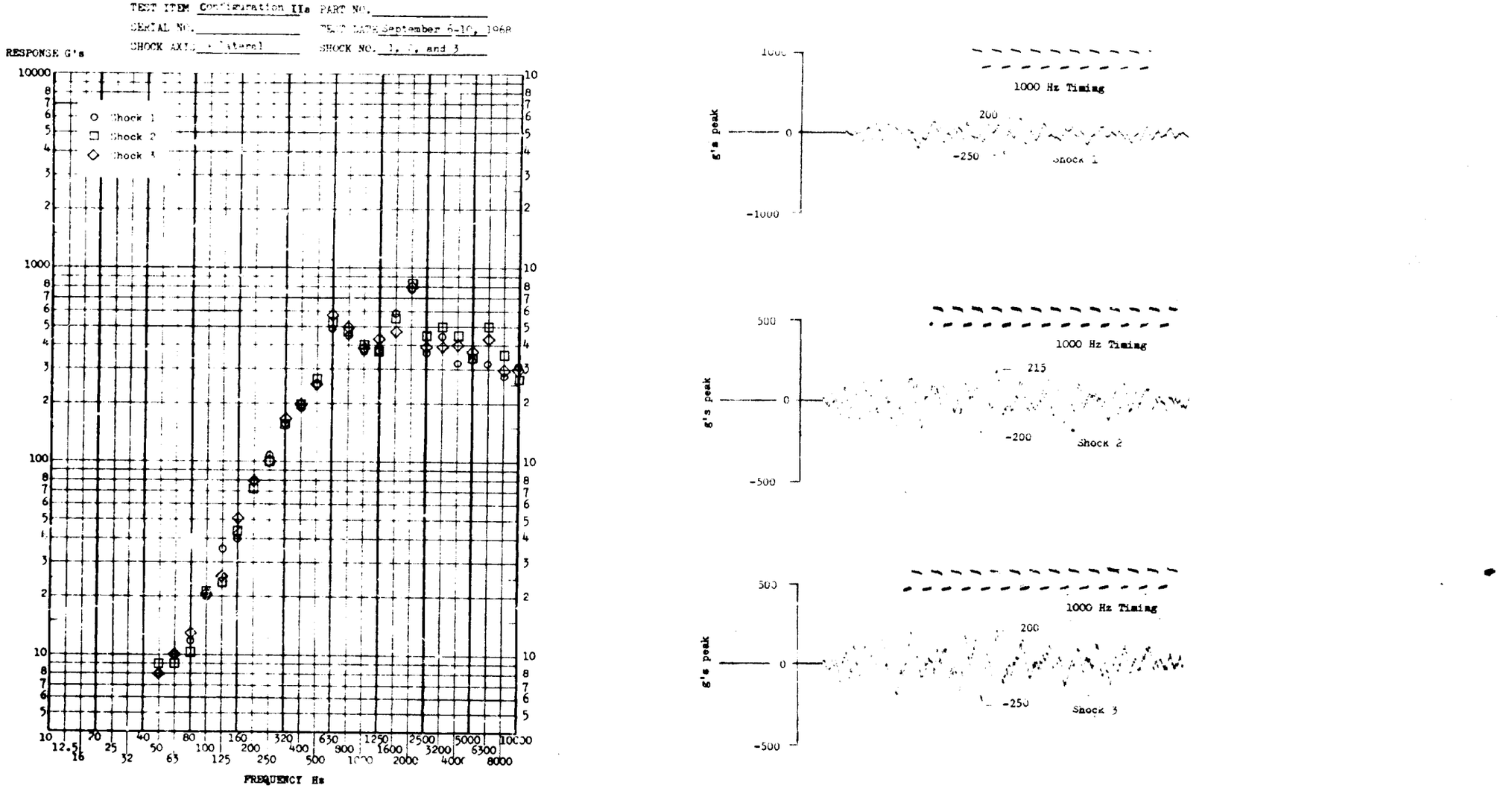



FIGURE II.B.1-72

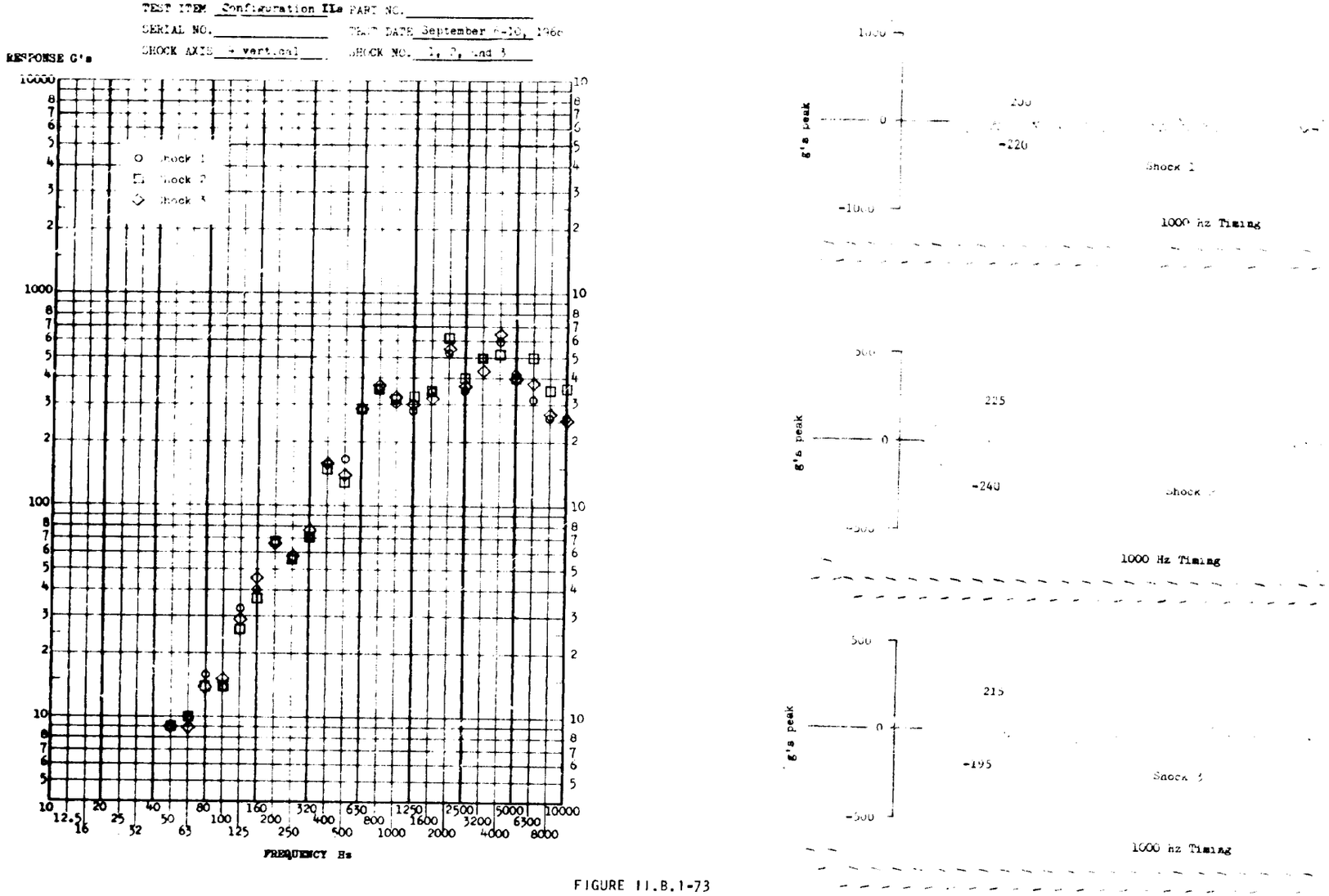



FIGURE II.B.1-73

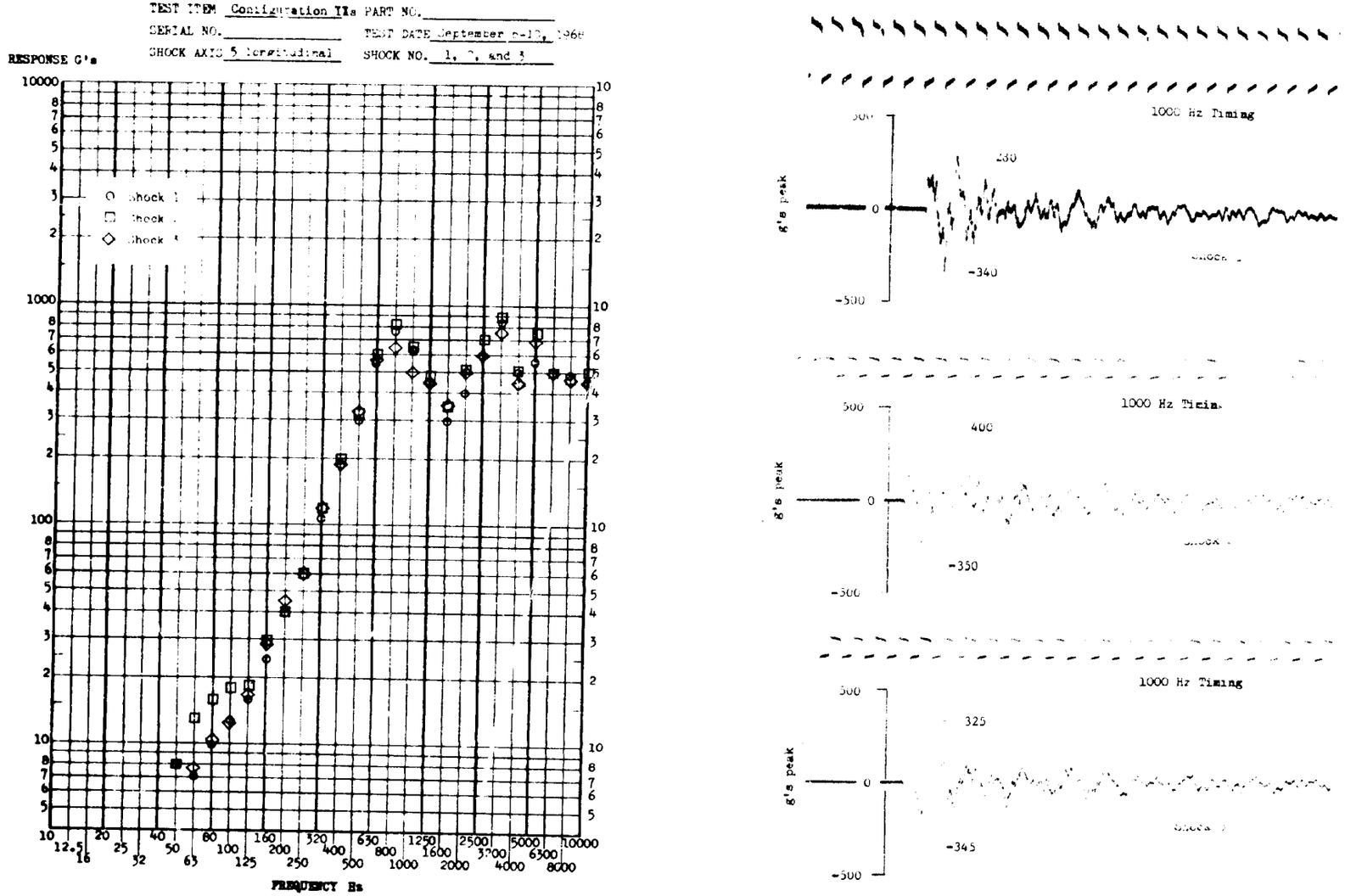
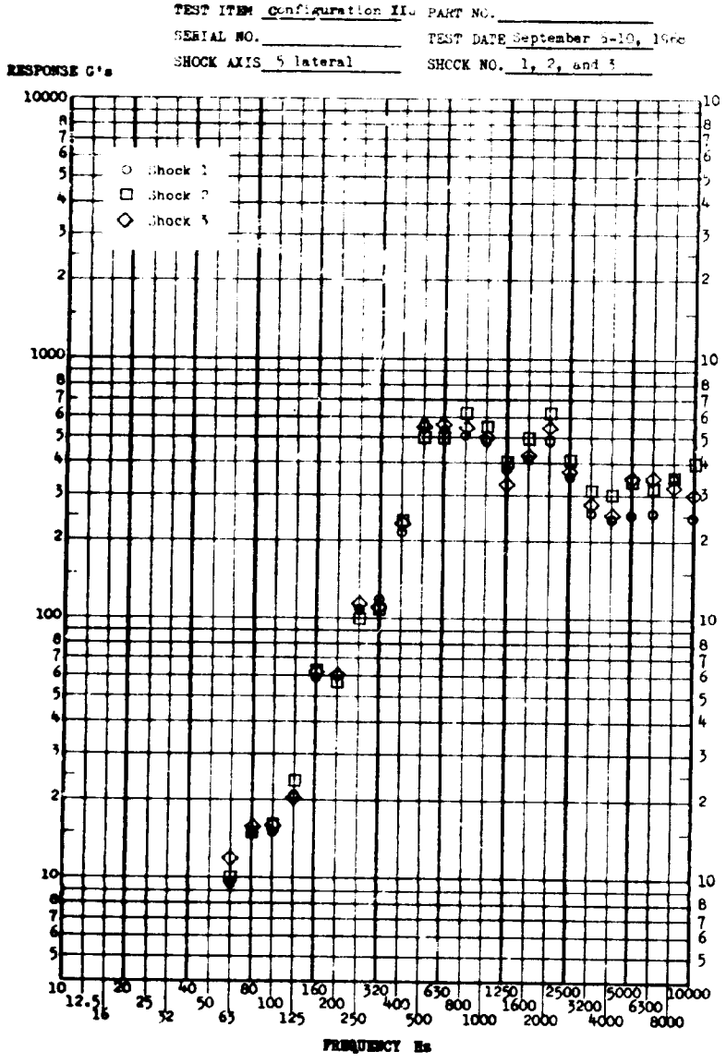



FIGURE II.B.1-74



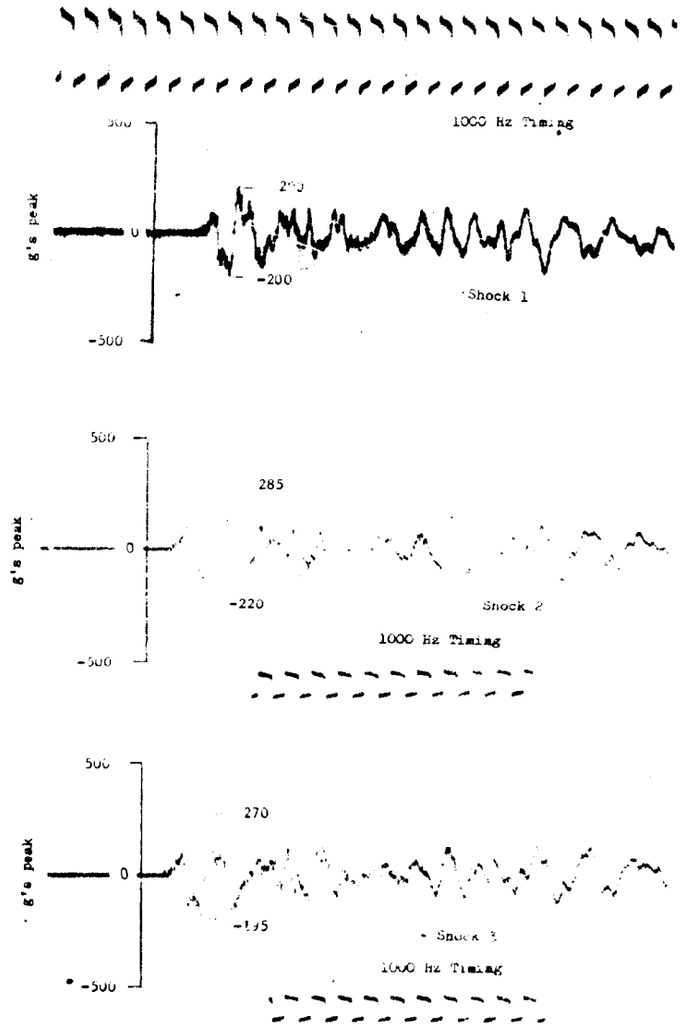




FIGURE II.B.1-75

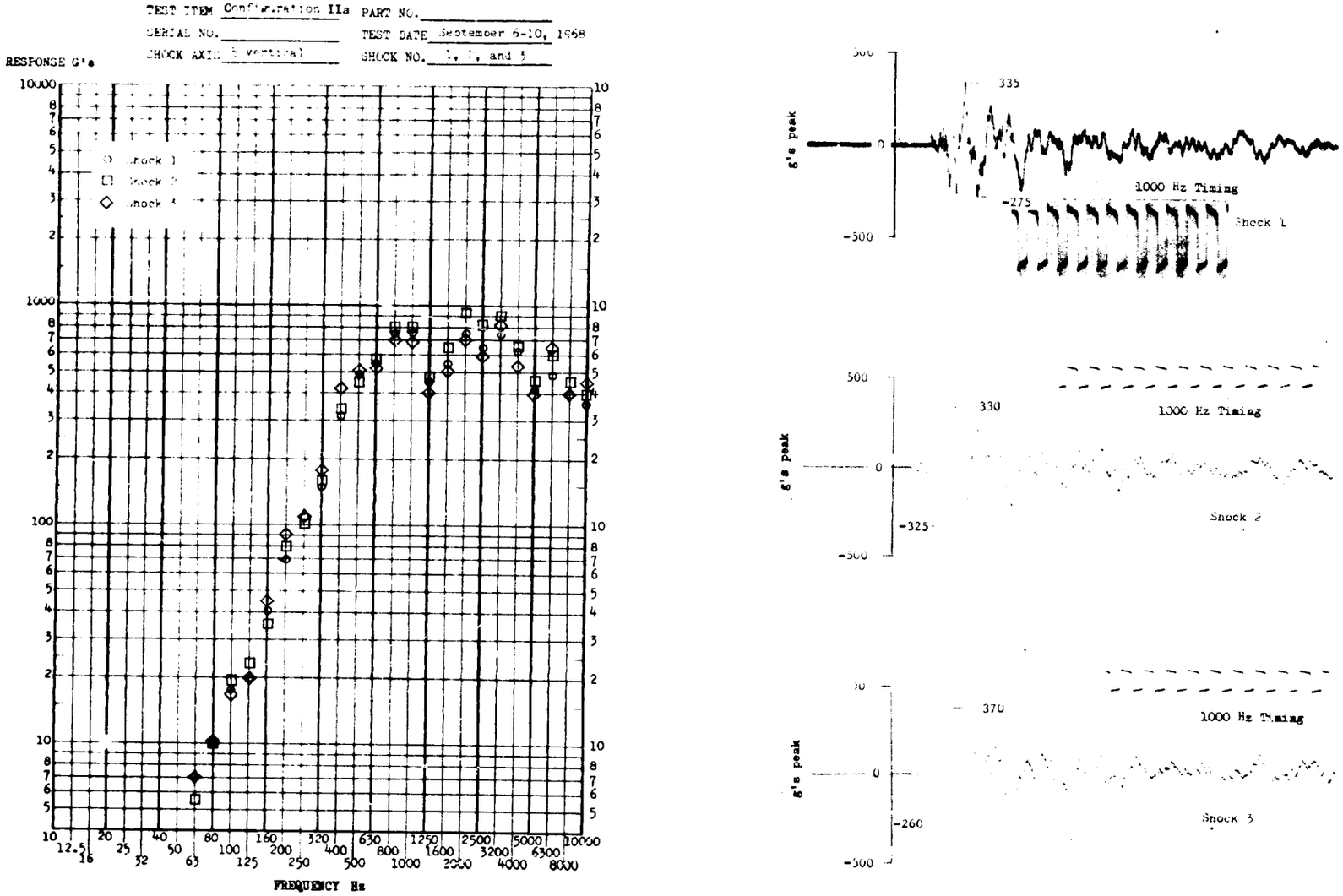
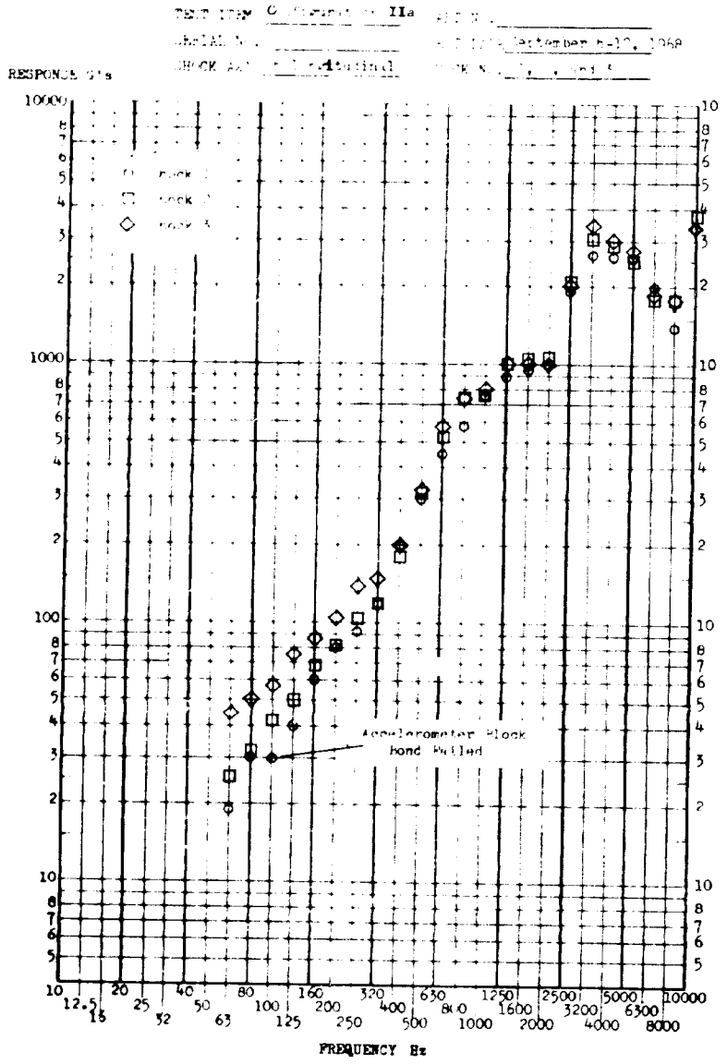



FIGURE II.B.1-76



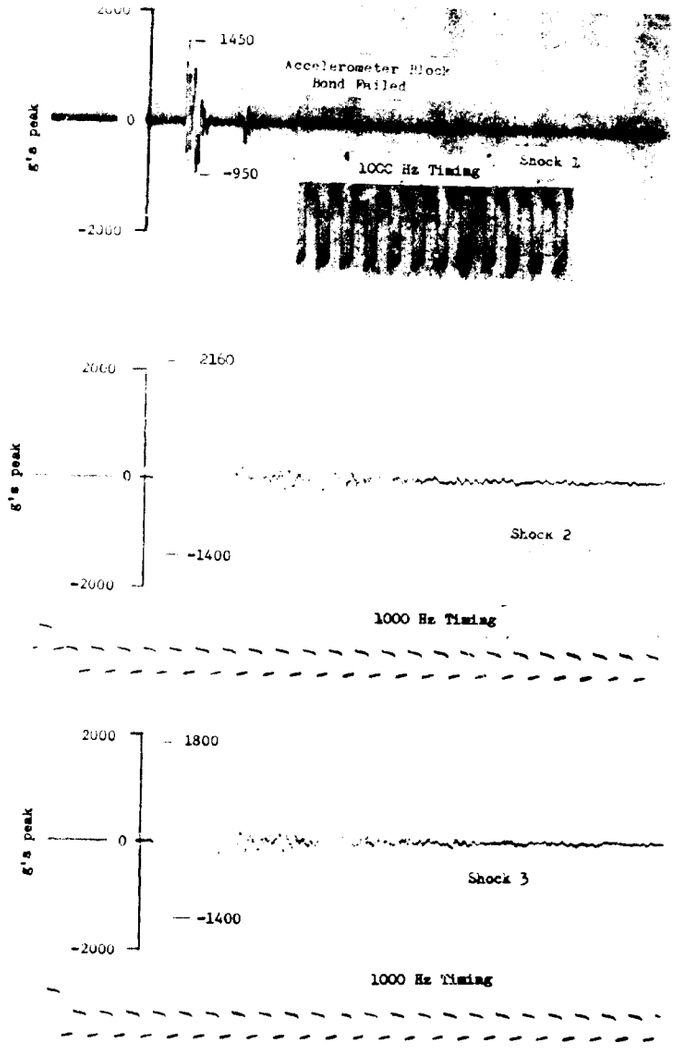




FIGURE II.B.1-77

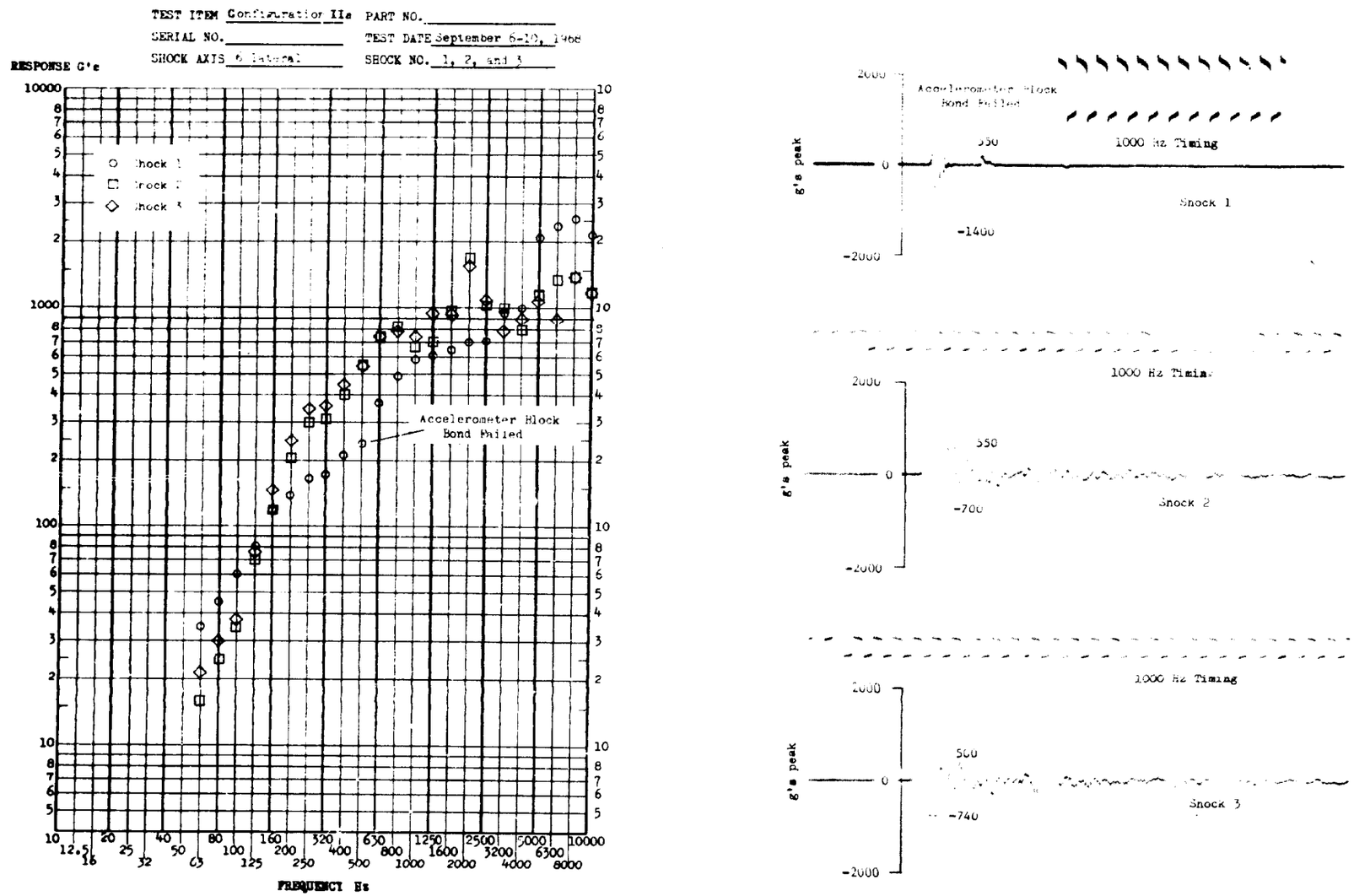


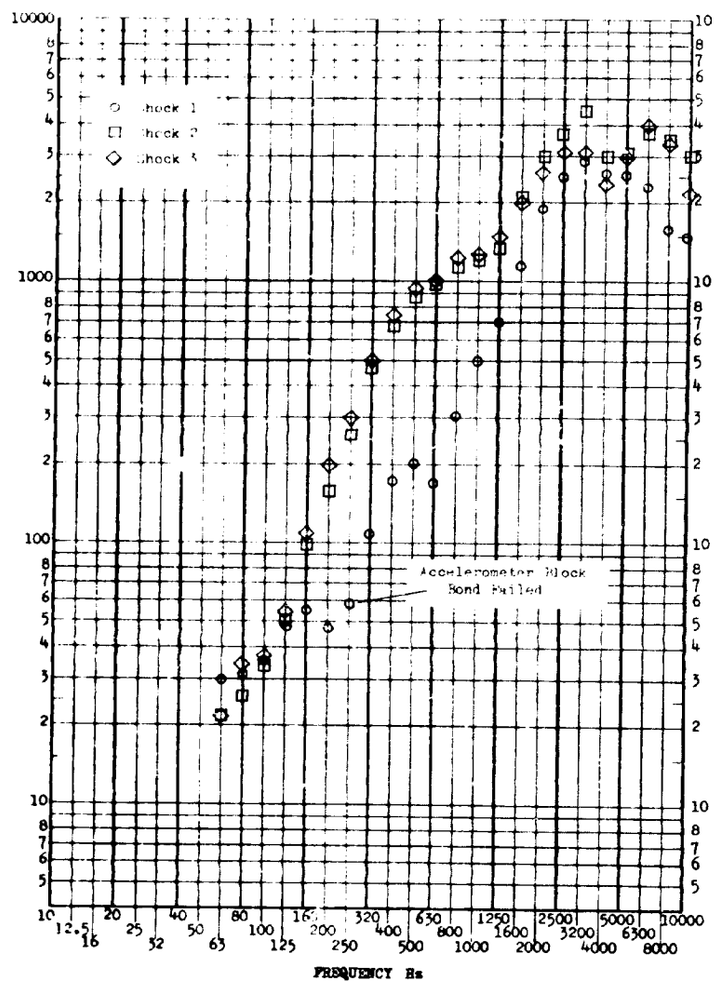

FIGURE II.B.1-78

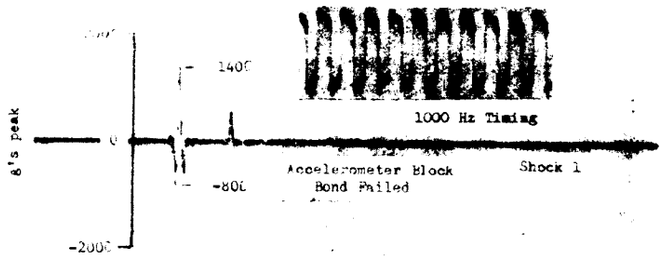
TEST ITEM [illegible] PART NO. [illegible]

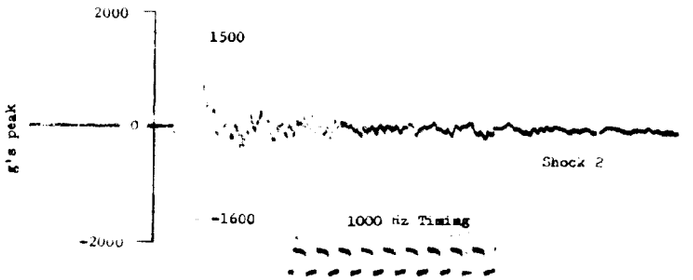
SERIAL NO. [illegible] TEST DATE [illegible]

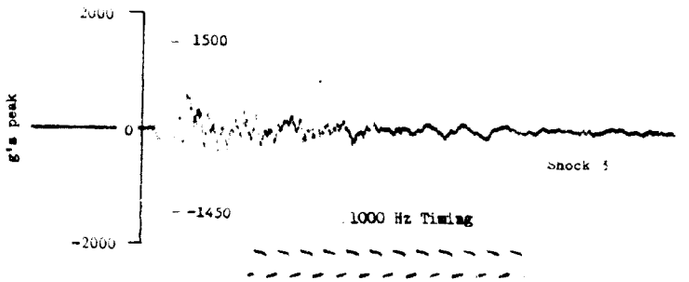
SHOCK AXIS [illegible] SHOCK NO. [illegible]

RESPONSE G's



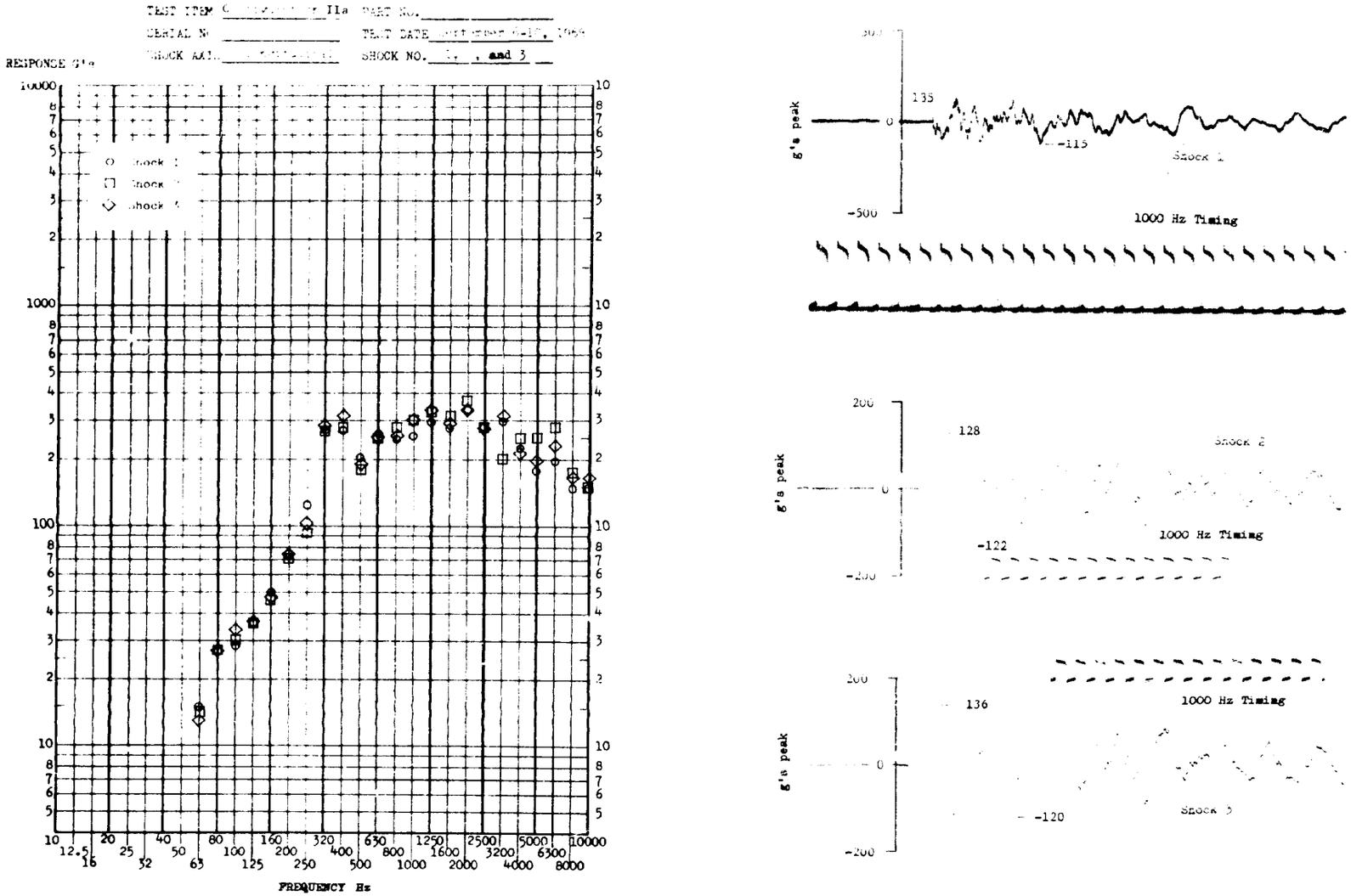



FIGURE 11.B.1-80

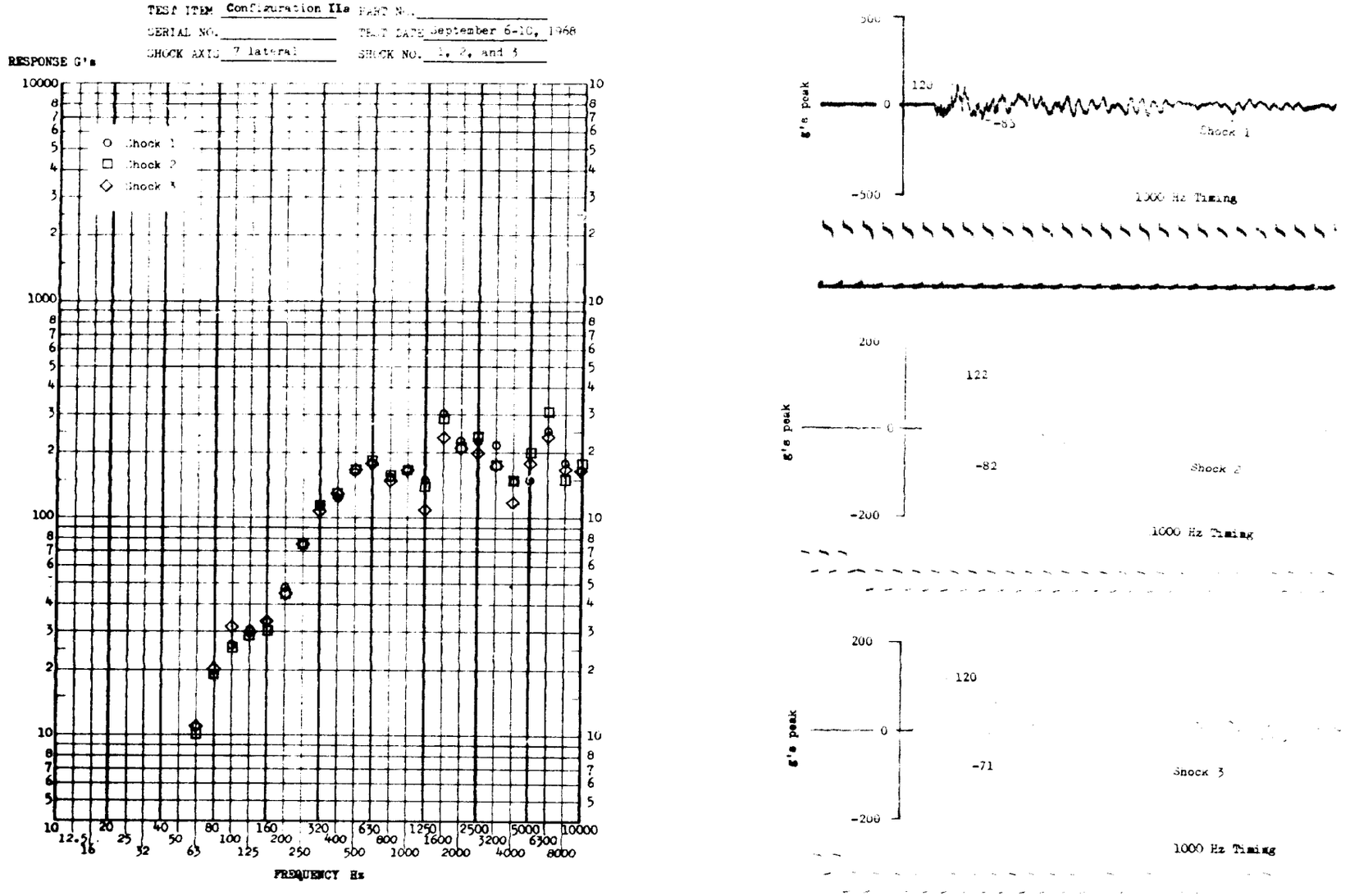
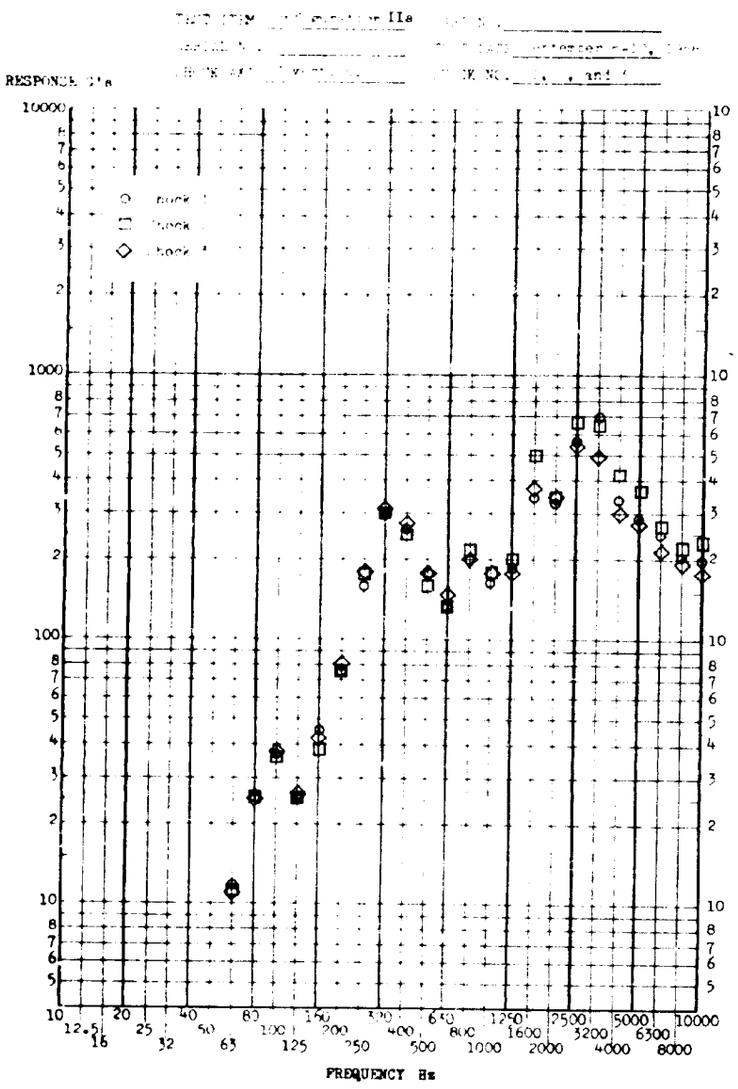



FIGURE II.B.1-81



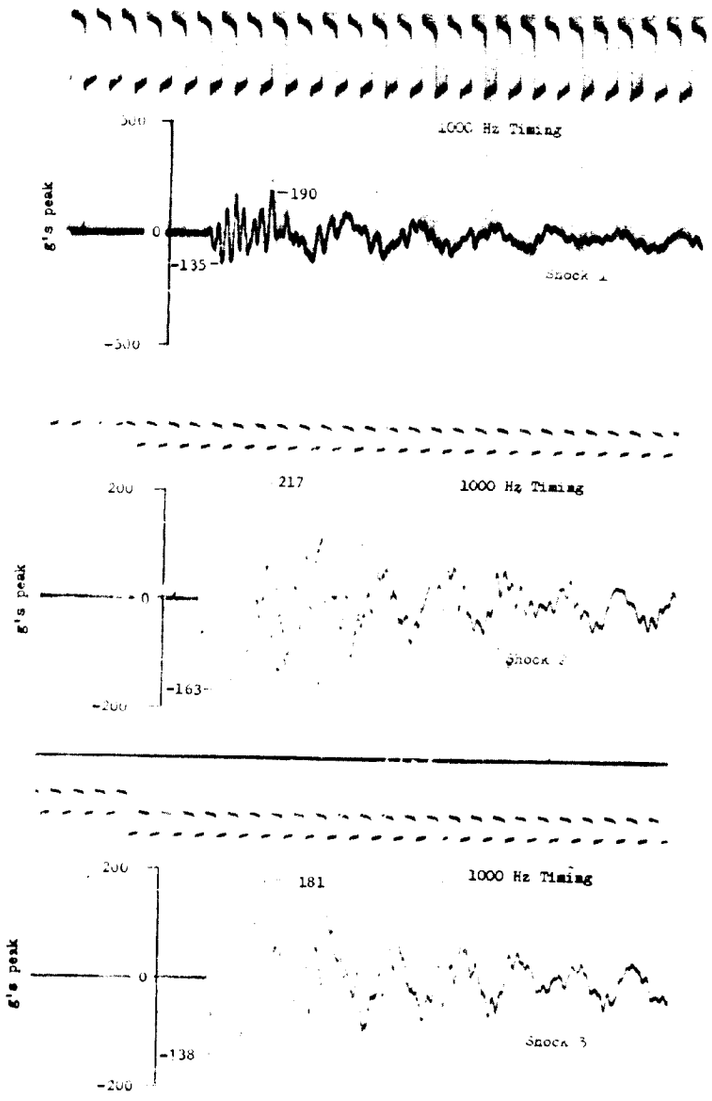
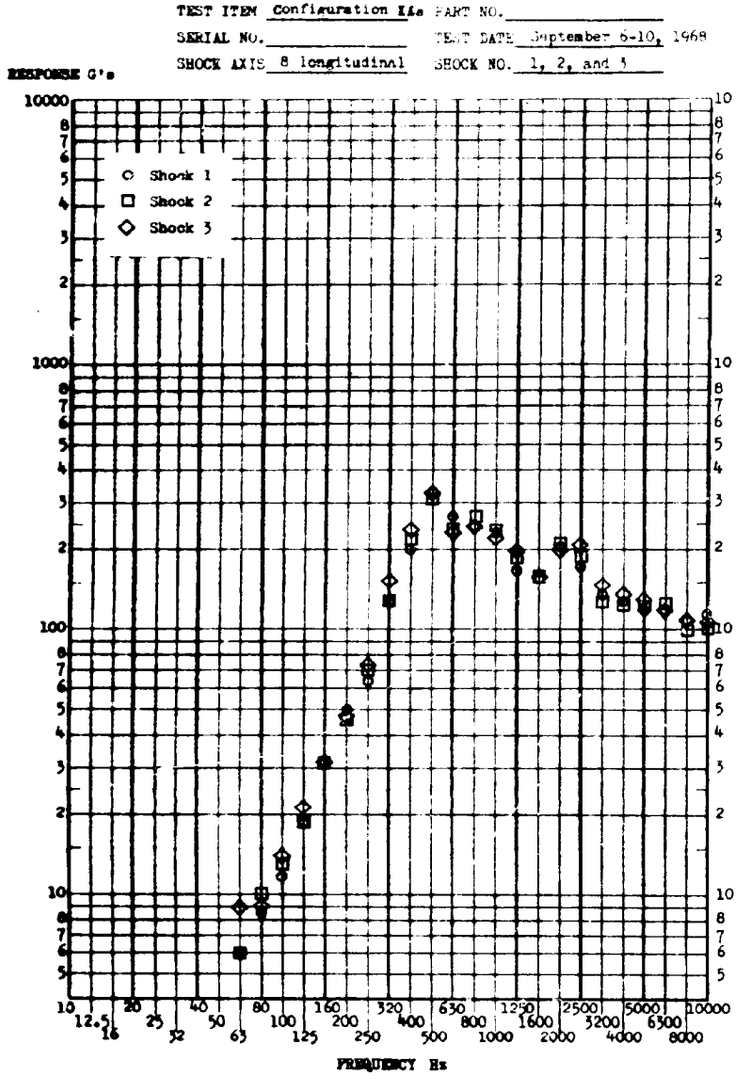




FIGURE II.B.1-82



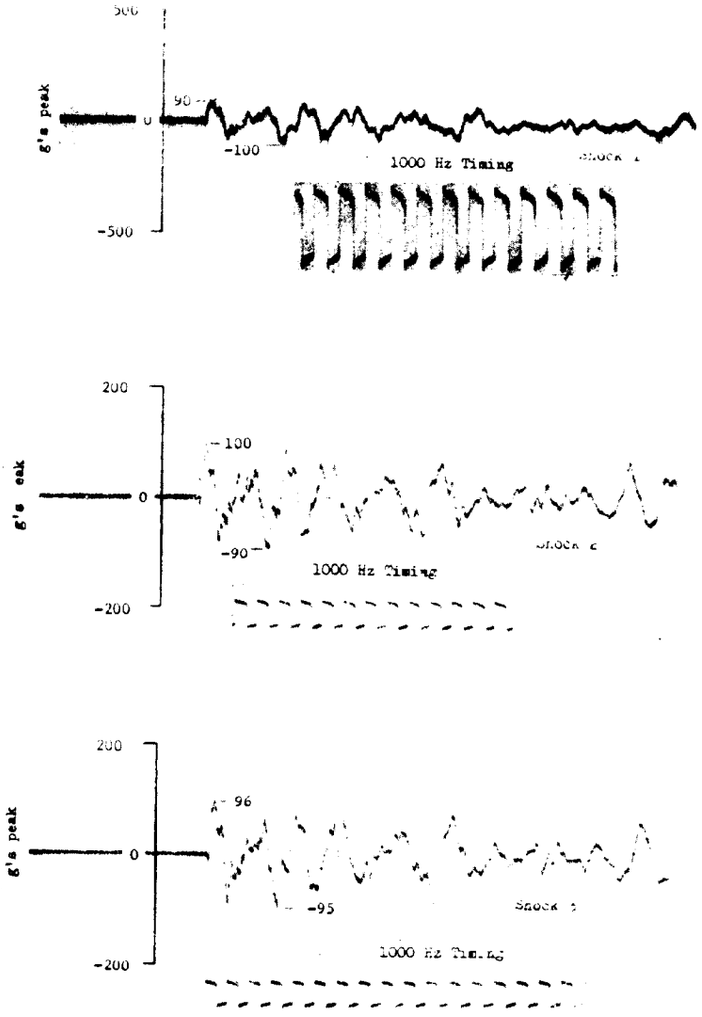




FIGURE 11.B.1-83

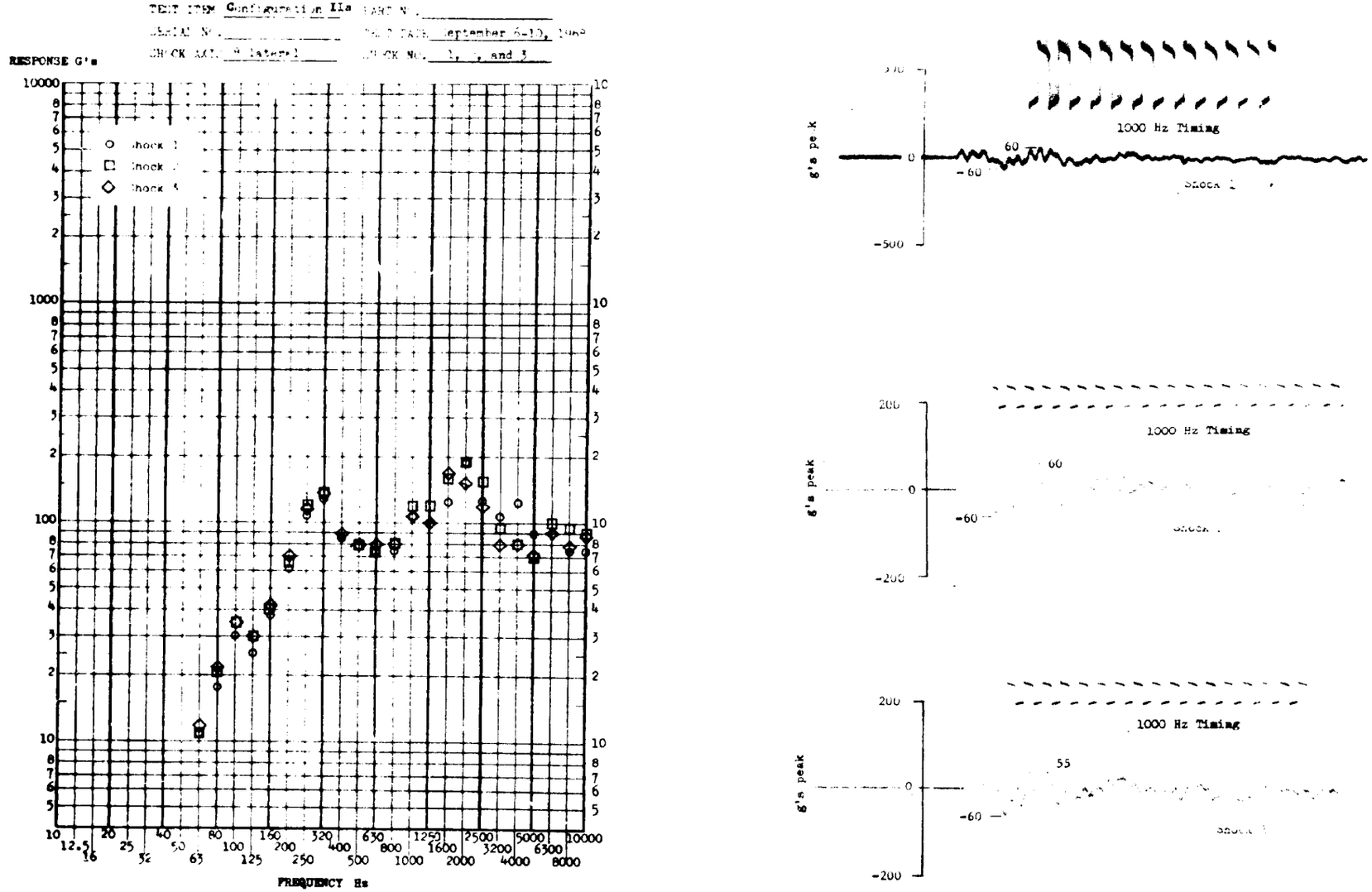
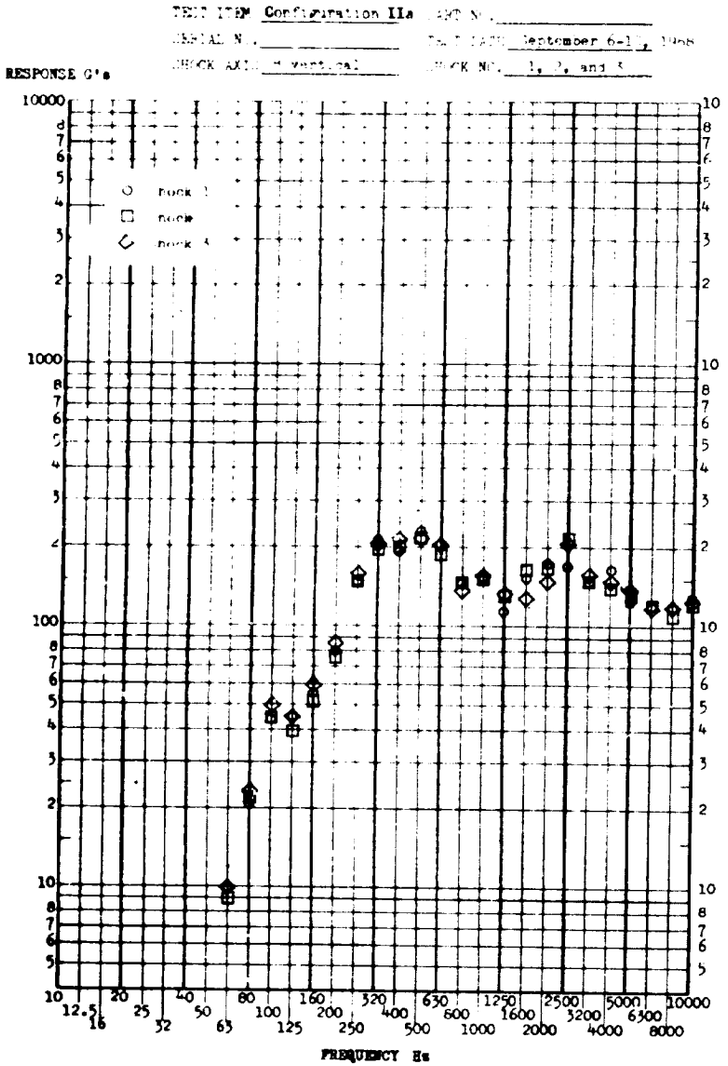



FIGURE II.B.1-84



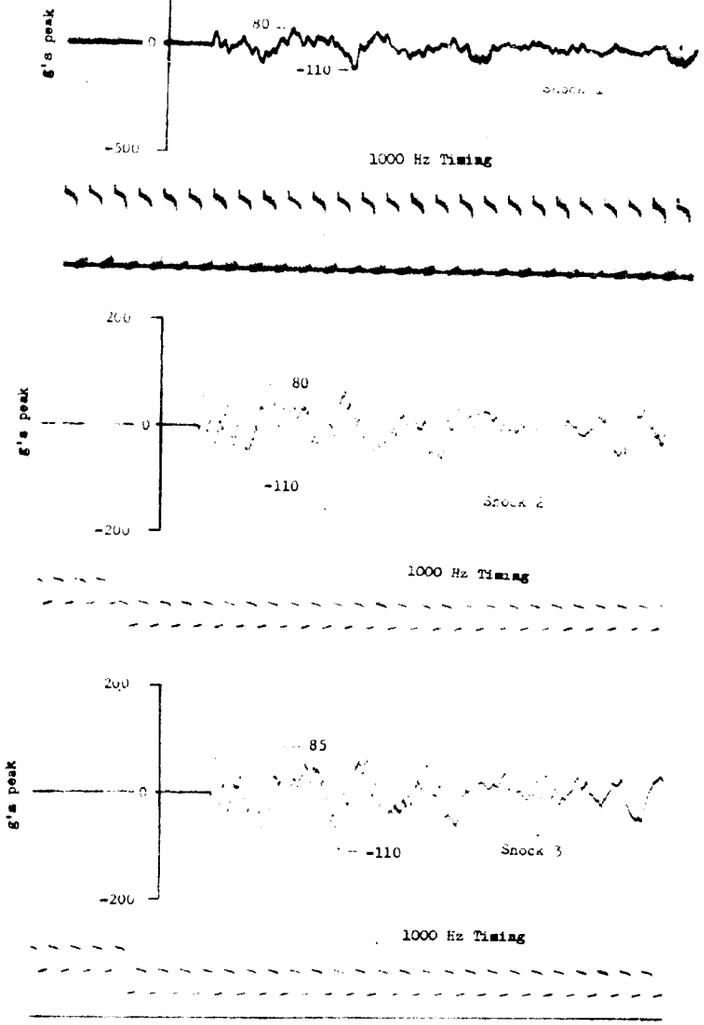
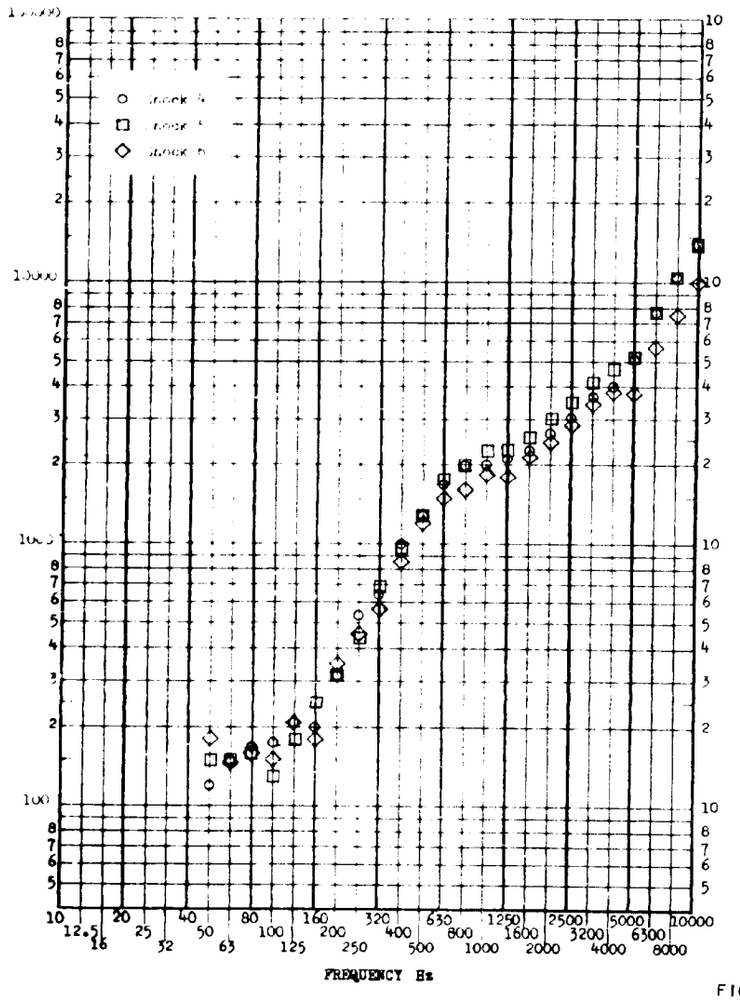




FIGURE II.B.1-85

TEST ITEM Configuration IIb PART NO.

SERIAL NO. TEST DATE September 10-11, 1968

SHOCK AXIS Longitudinal SHOCK NO. 4, 5, and 6



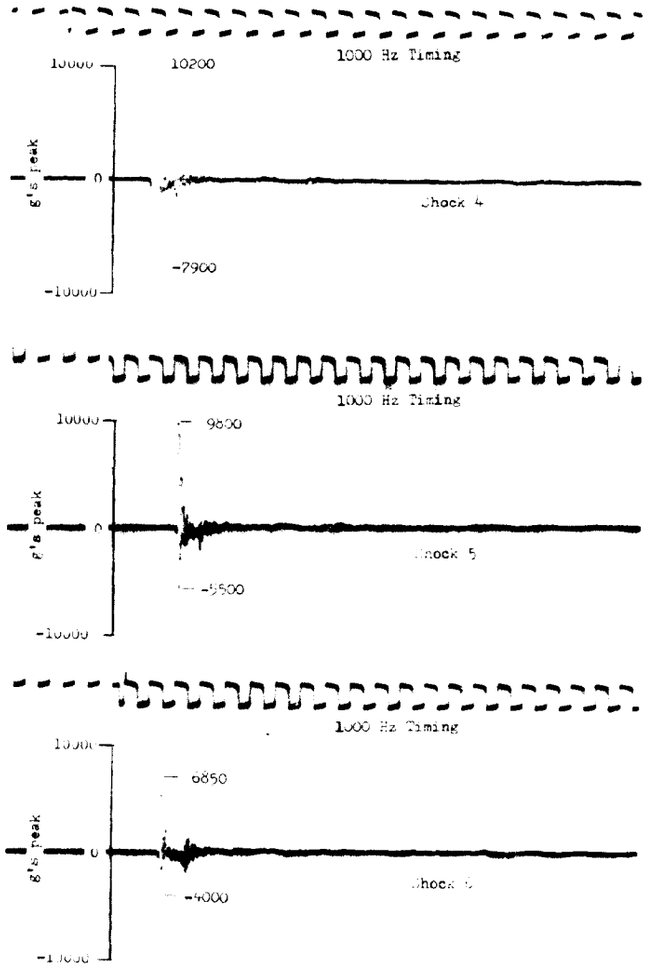




FIGURE II.B.1-86

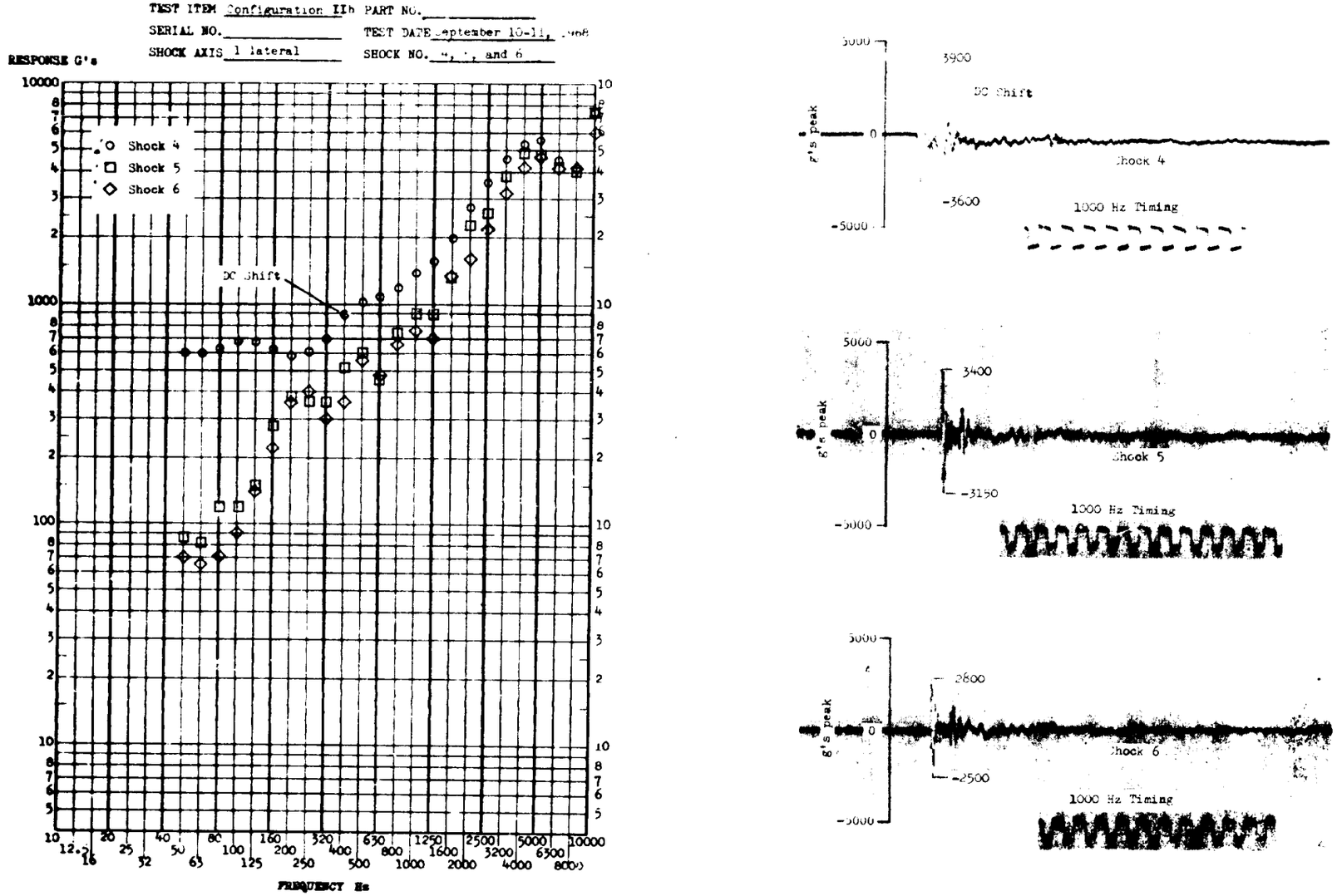
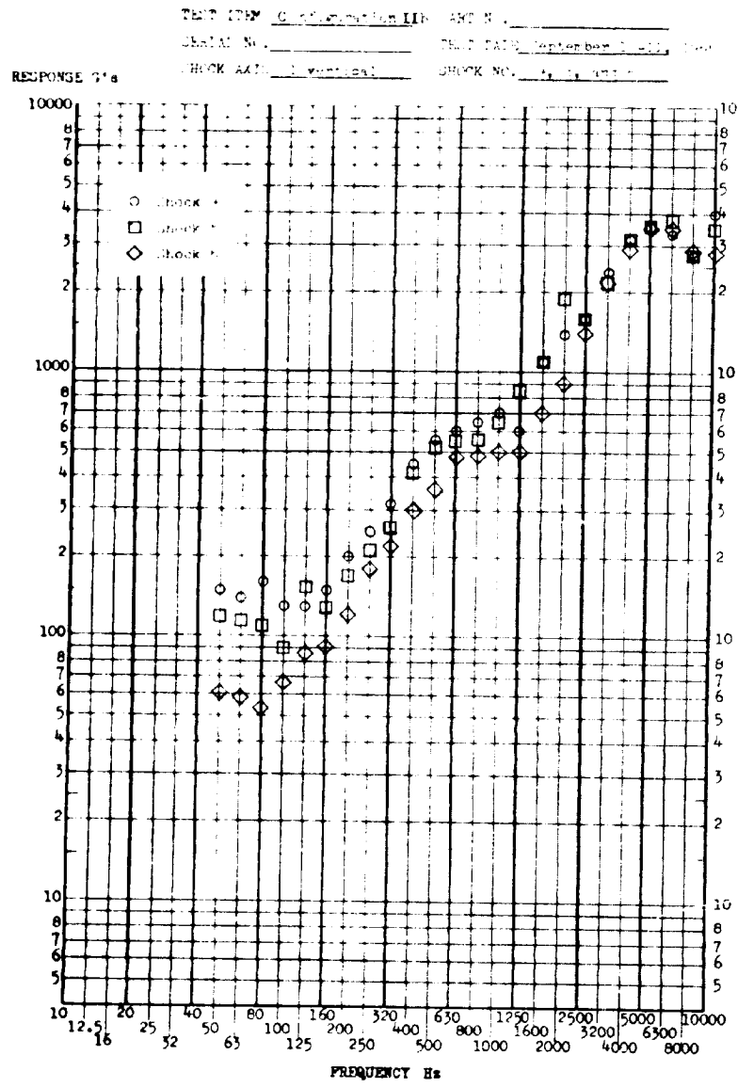



FIGURE II.B.1-87



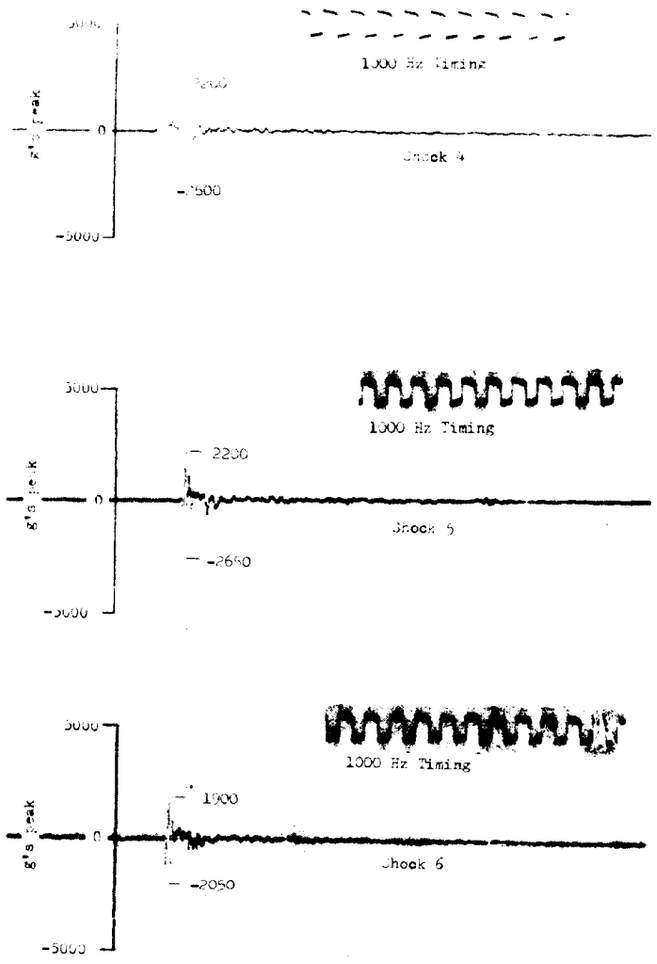




FIGURE II.B.1-88

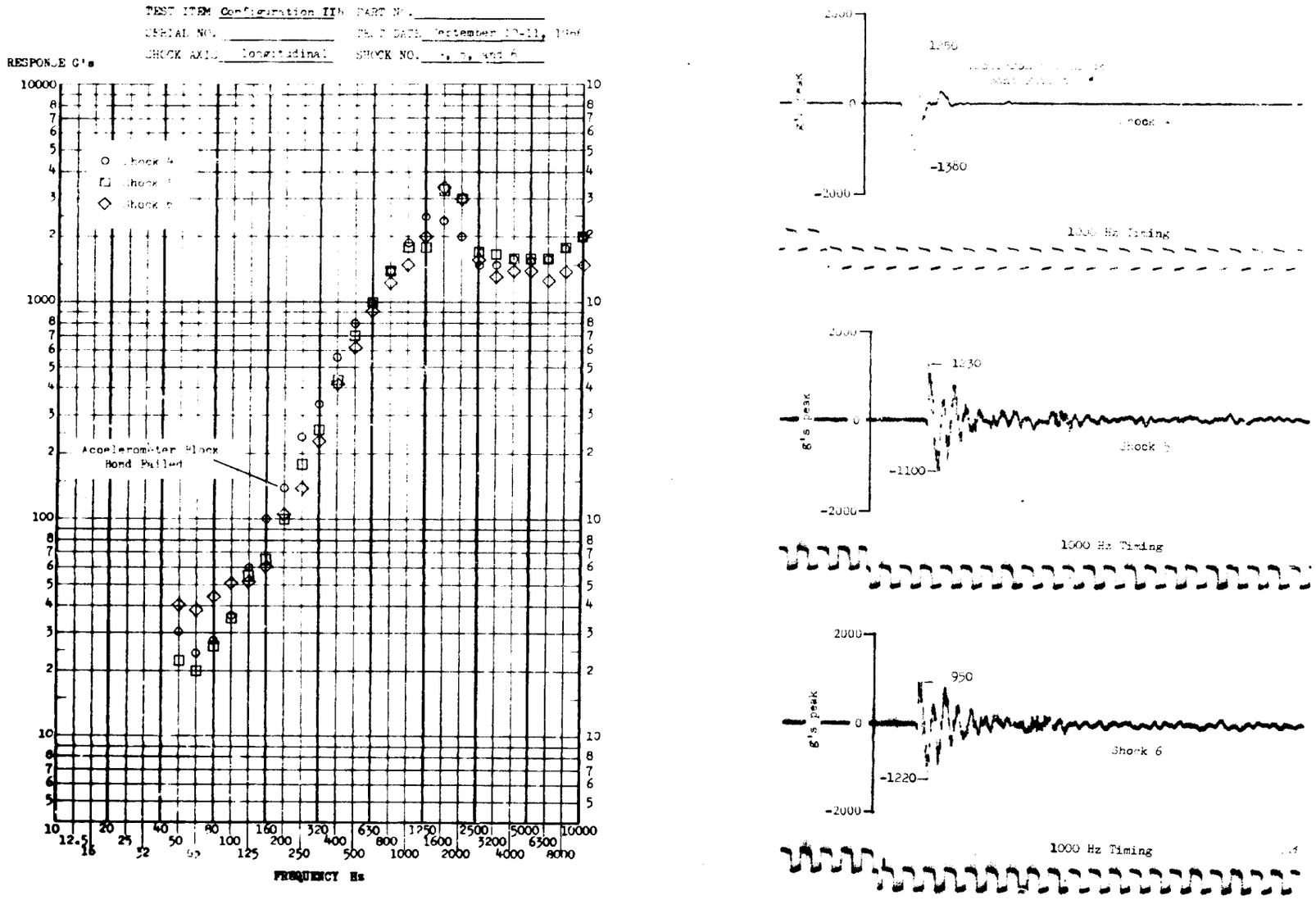



FIGURE II.B.1-89

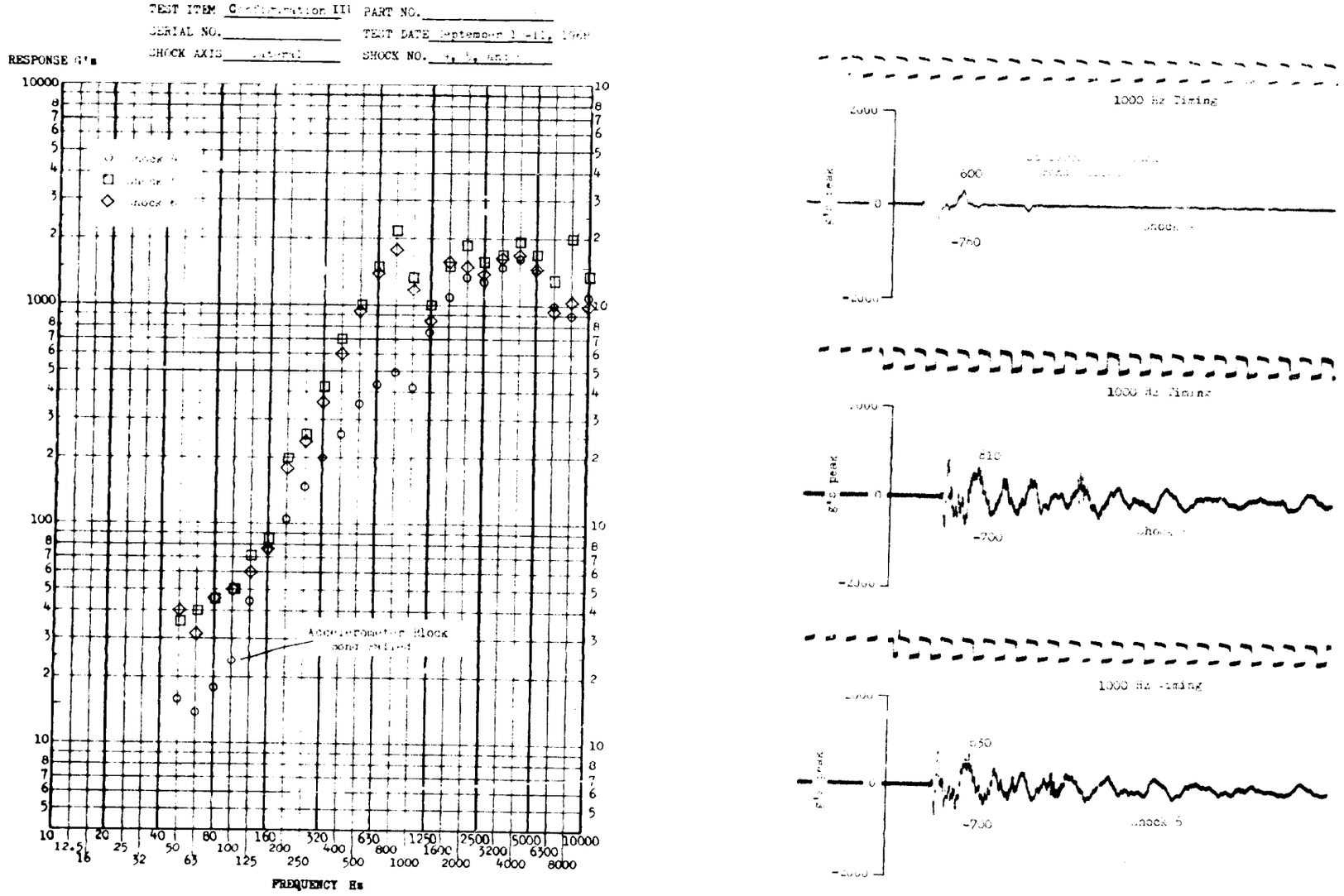



FIGURE 11.8.1-90

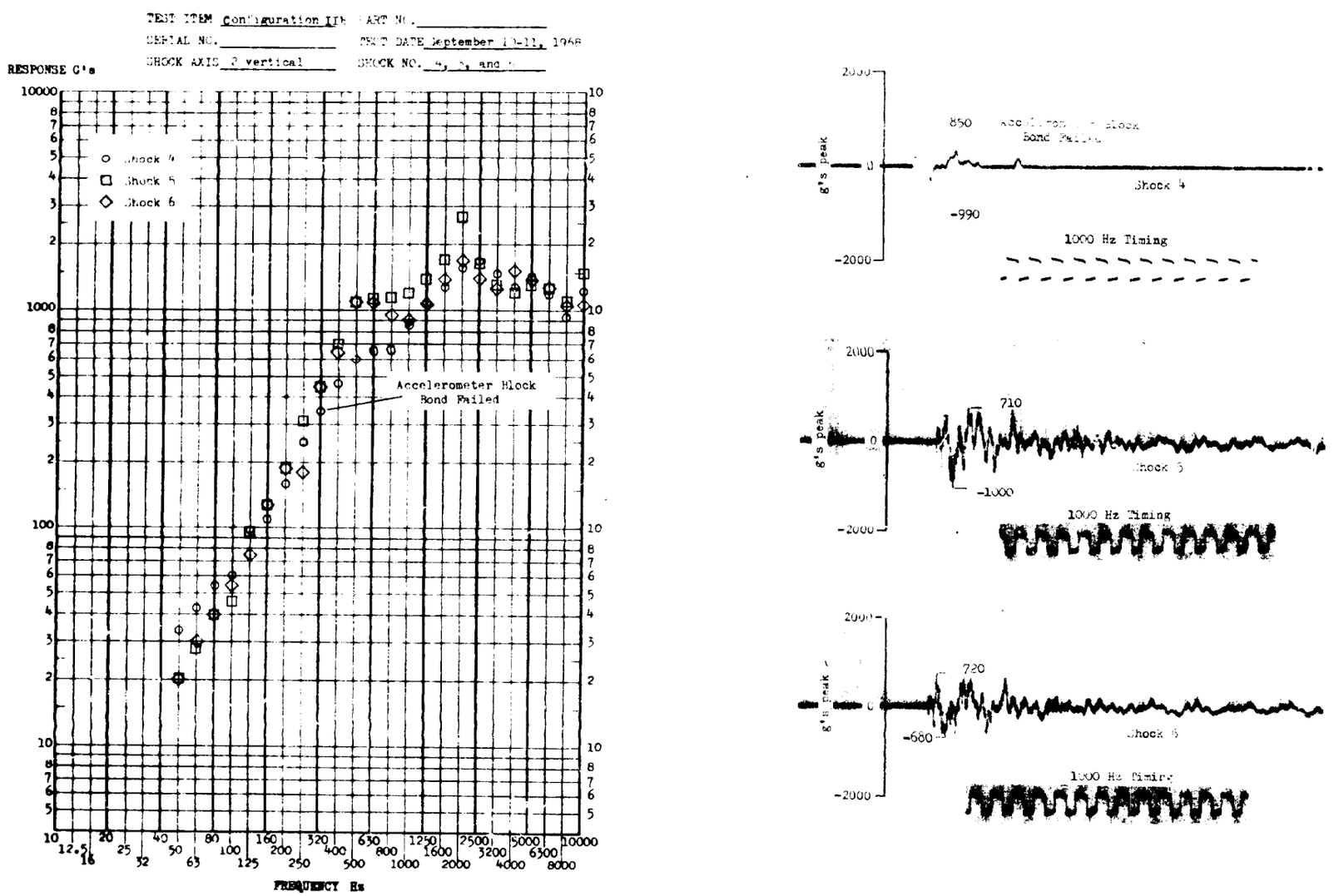
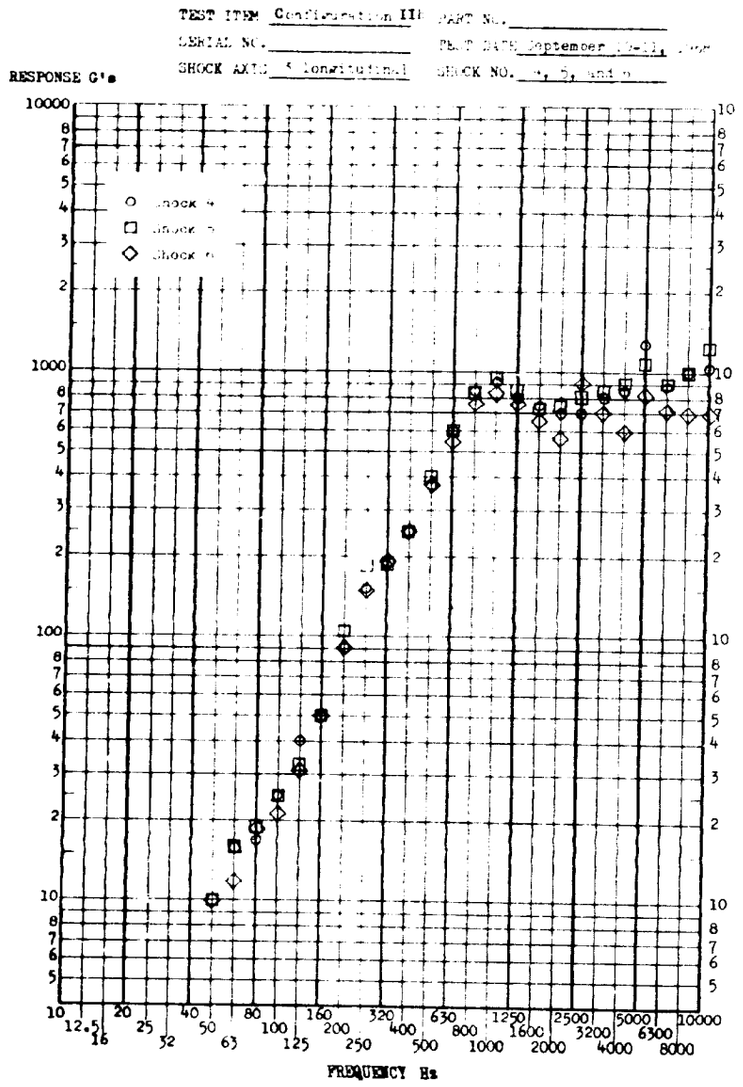



FIGURE 11.B.1-91



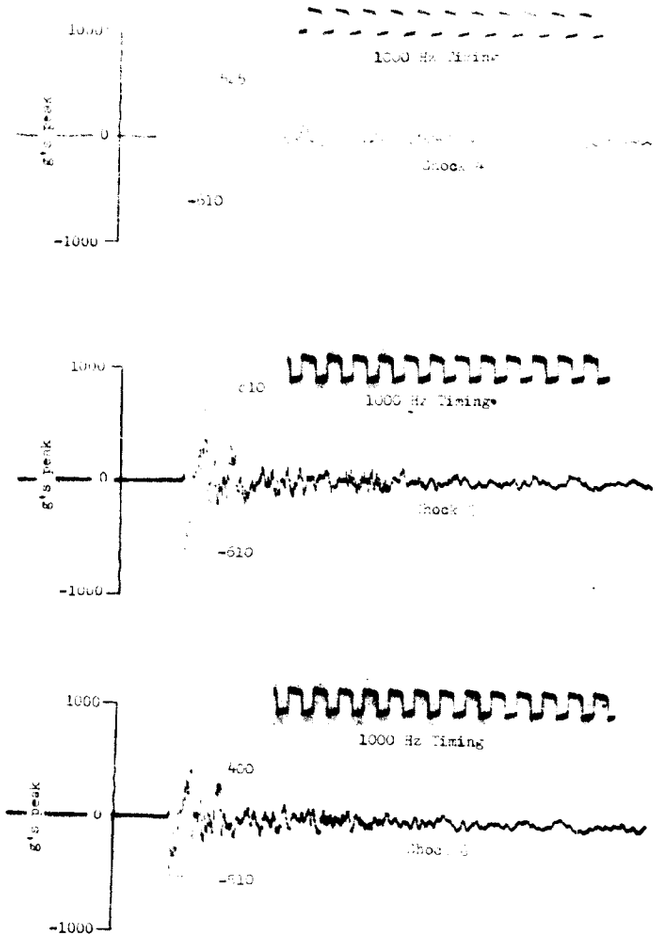




FIGURE II.B.1-92

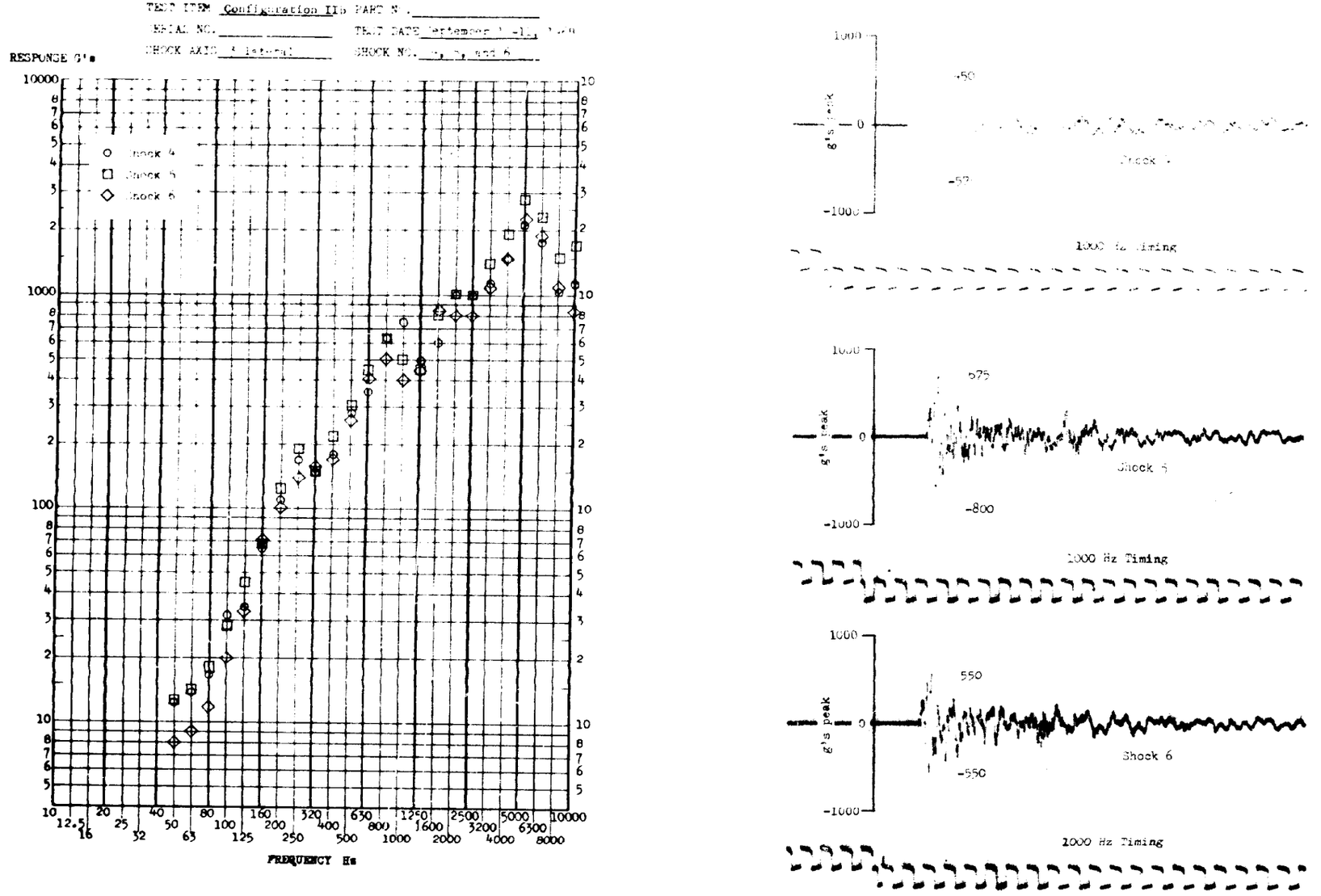



FIGURE II.B.1-03

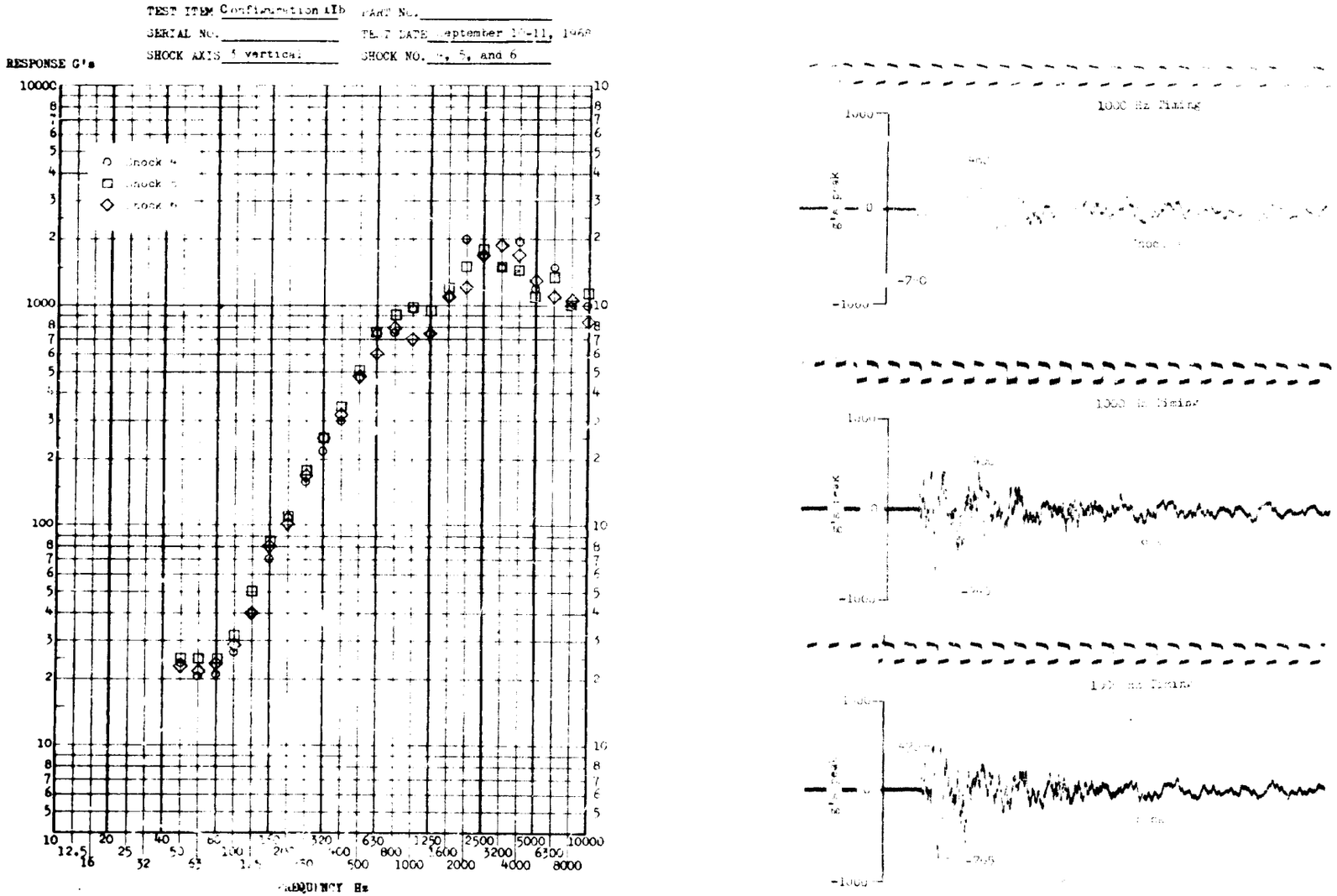



FIGURE II.B.I-94

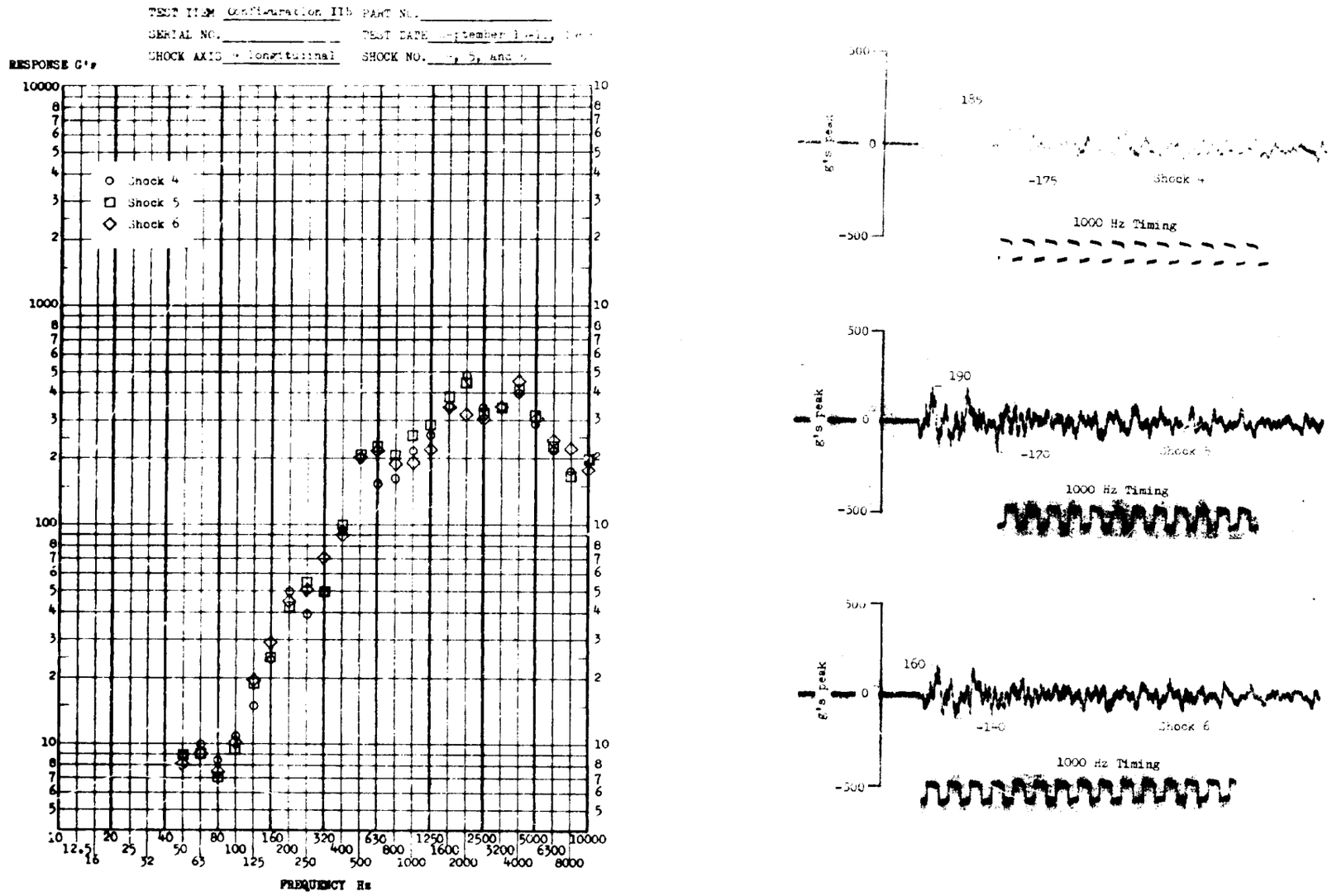
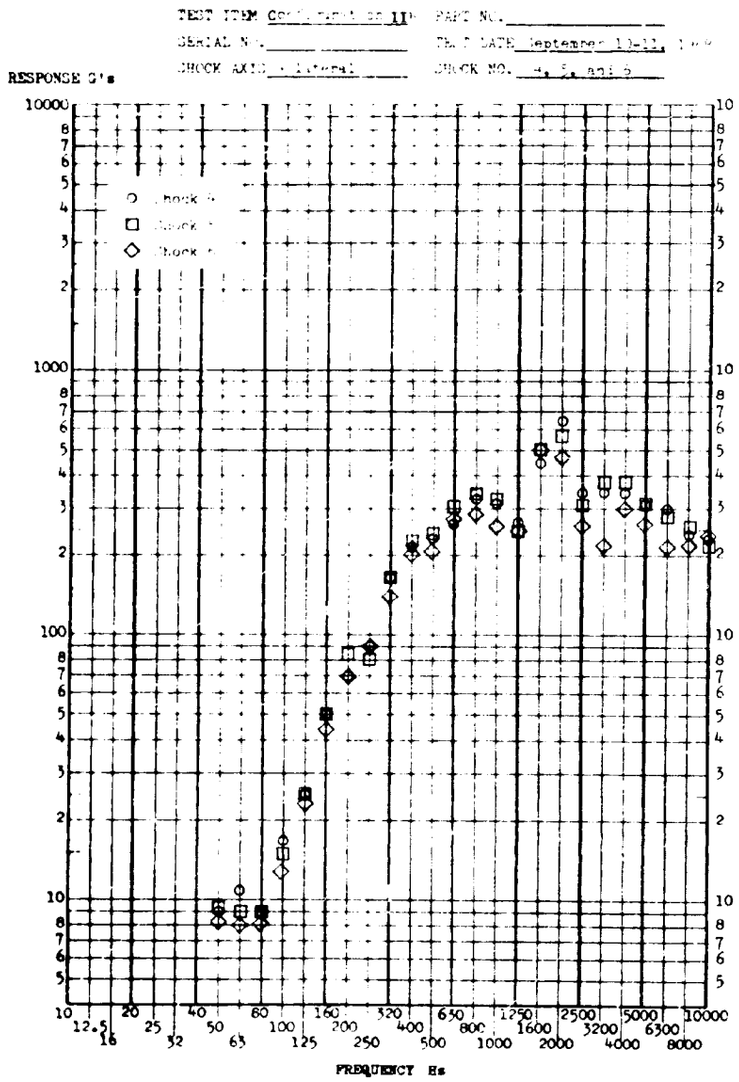



FIGURE II.B.1-95



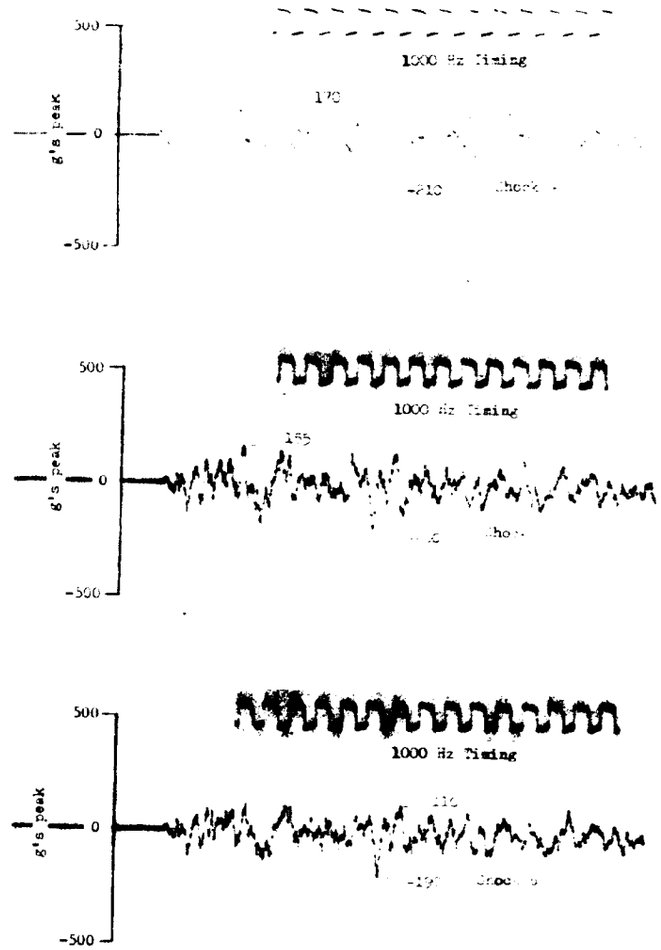




FIGURE II.B.1-96

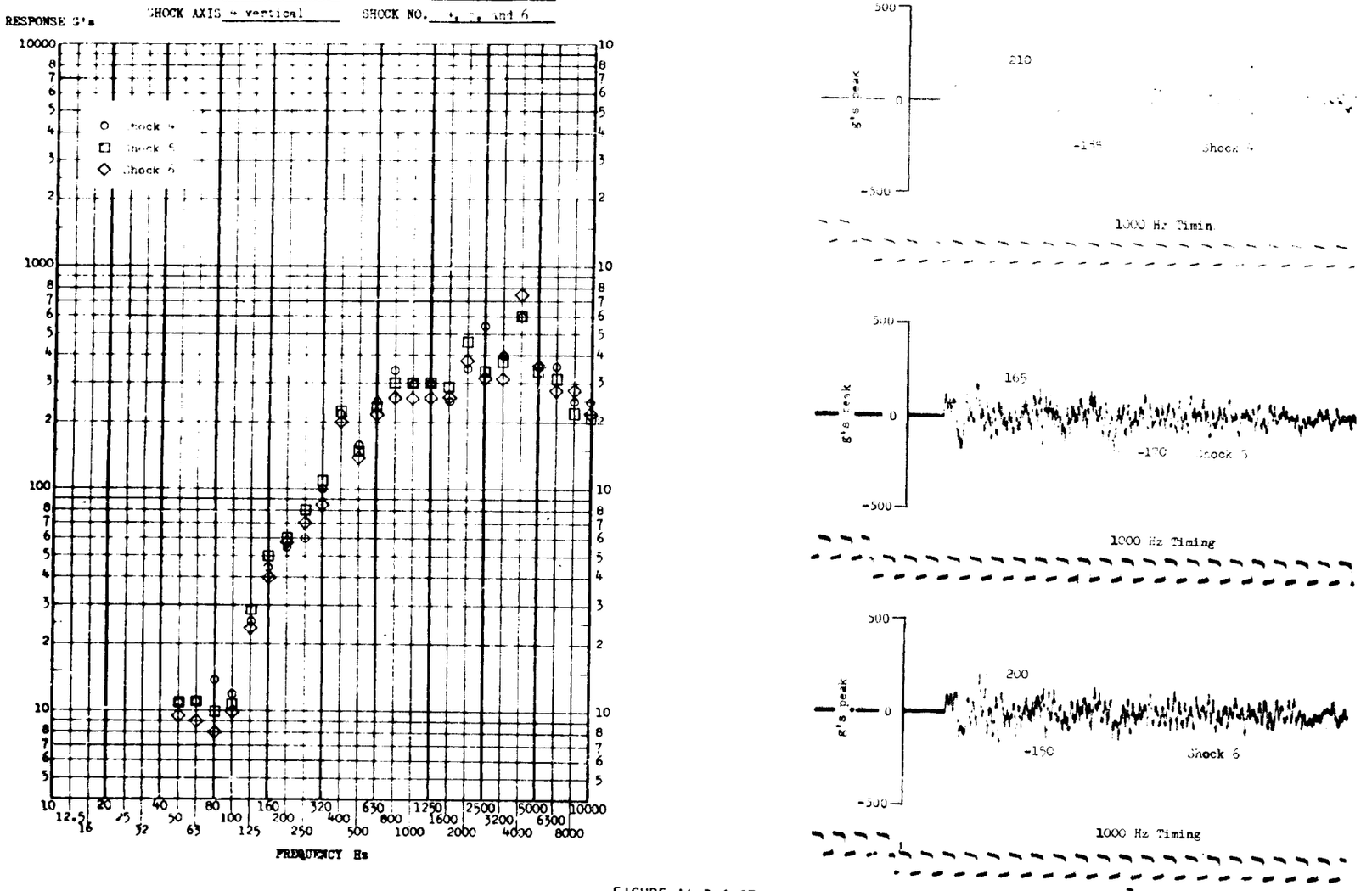
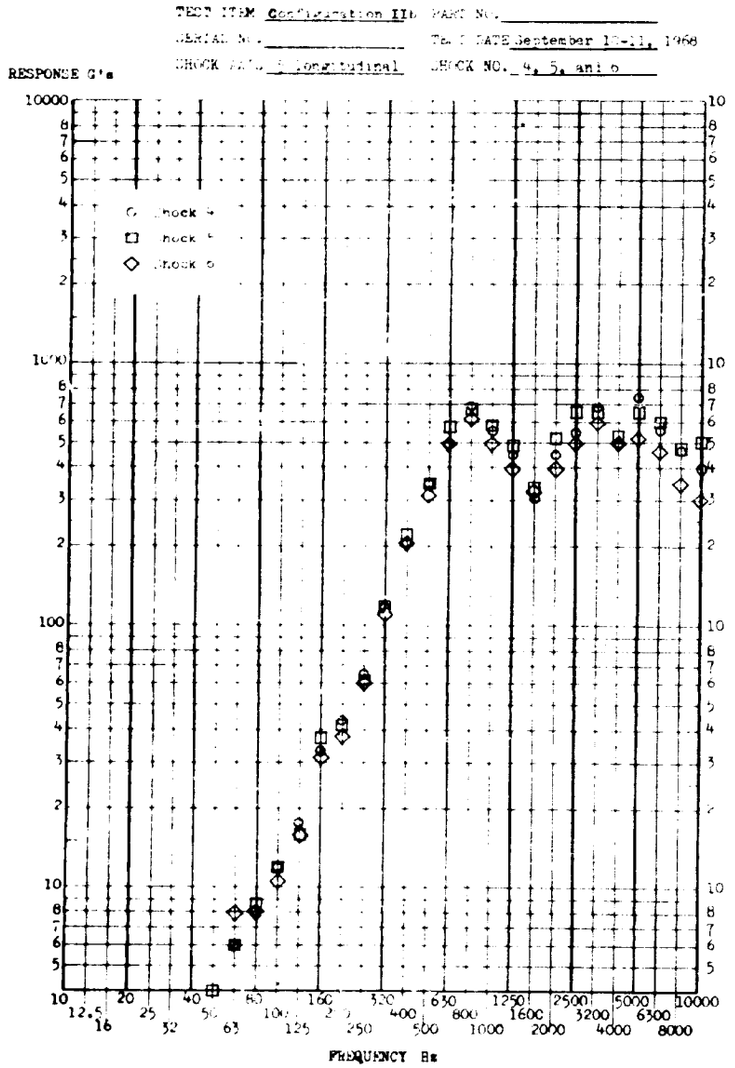



FIGURE II.B.1-97



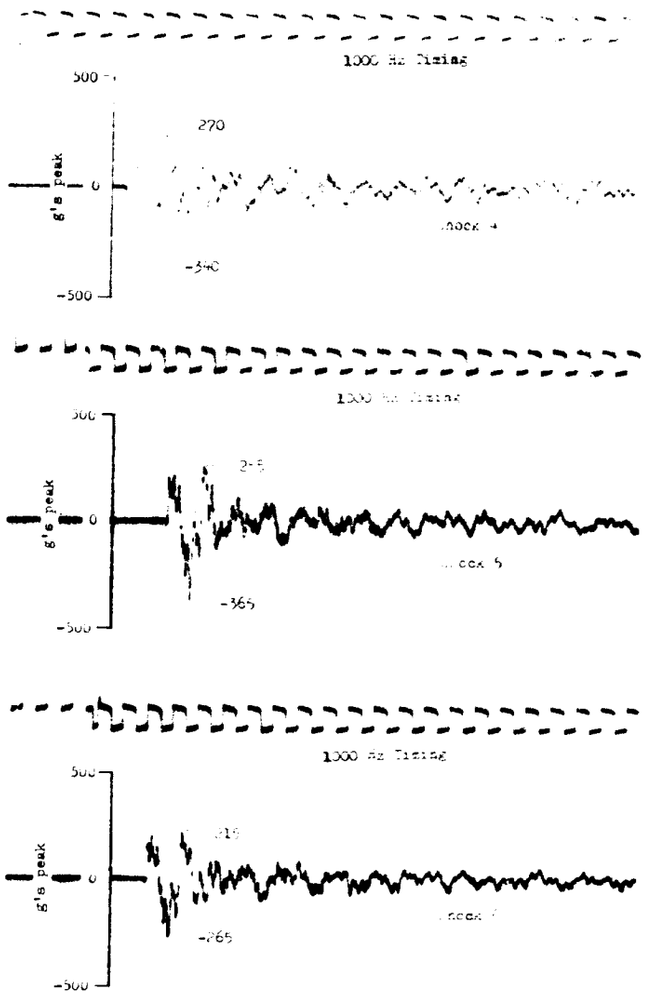
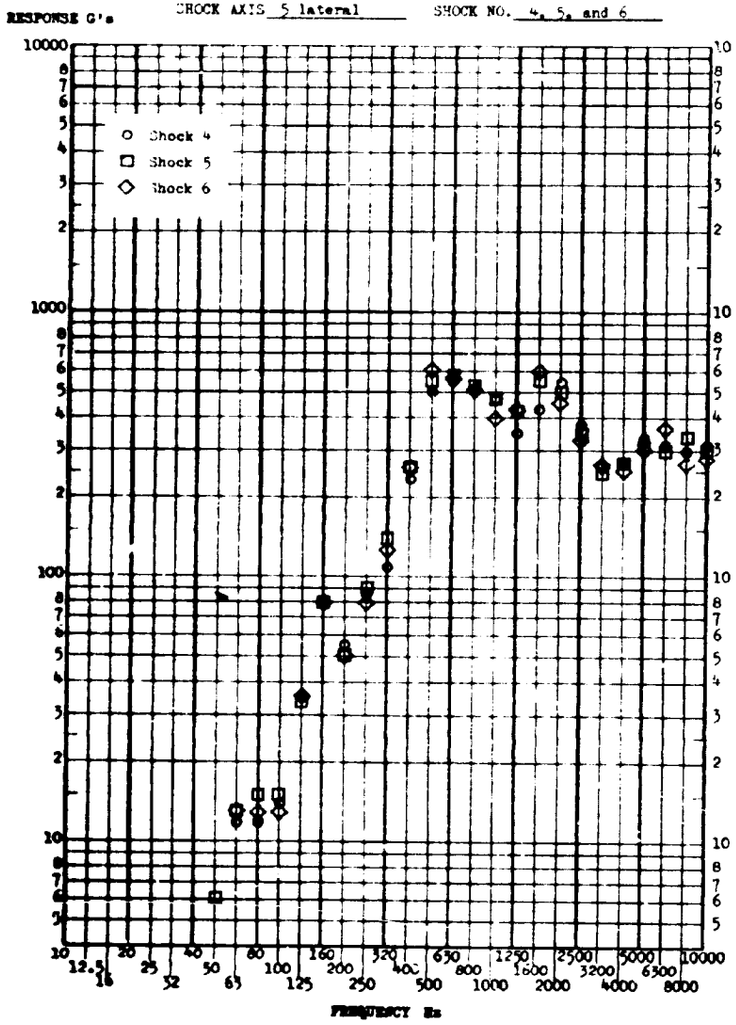




FIGURE II.B.1-98

TEST ITEM Configuration IIb PART NO.

SERIAL NO. TEST DATE September 10-11, 1968

SHOCK AXIS 5 lateral SHOCK NO. 4, 5, and 6



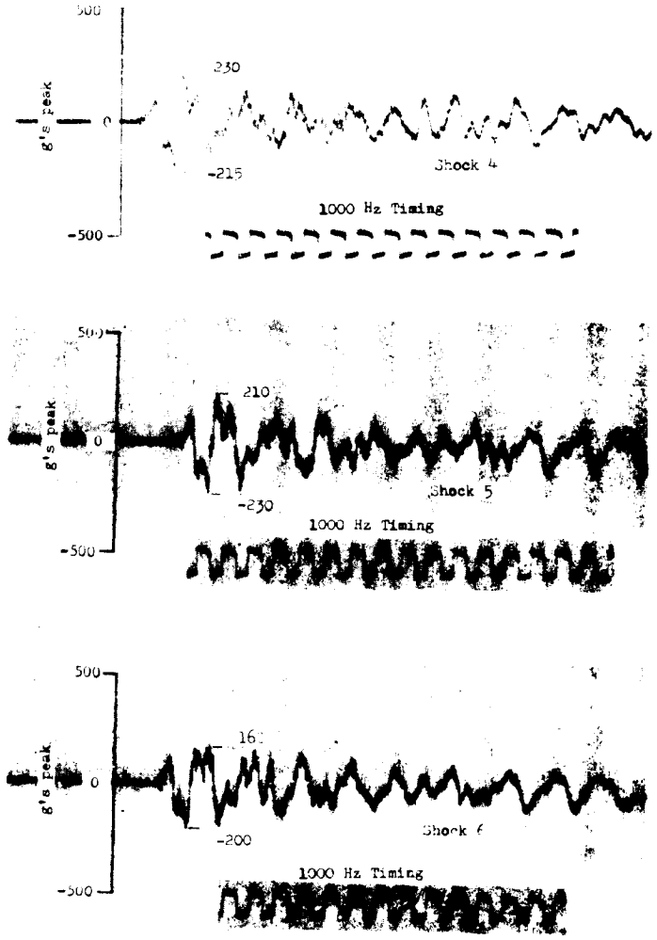
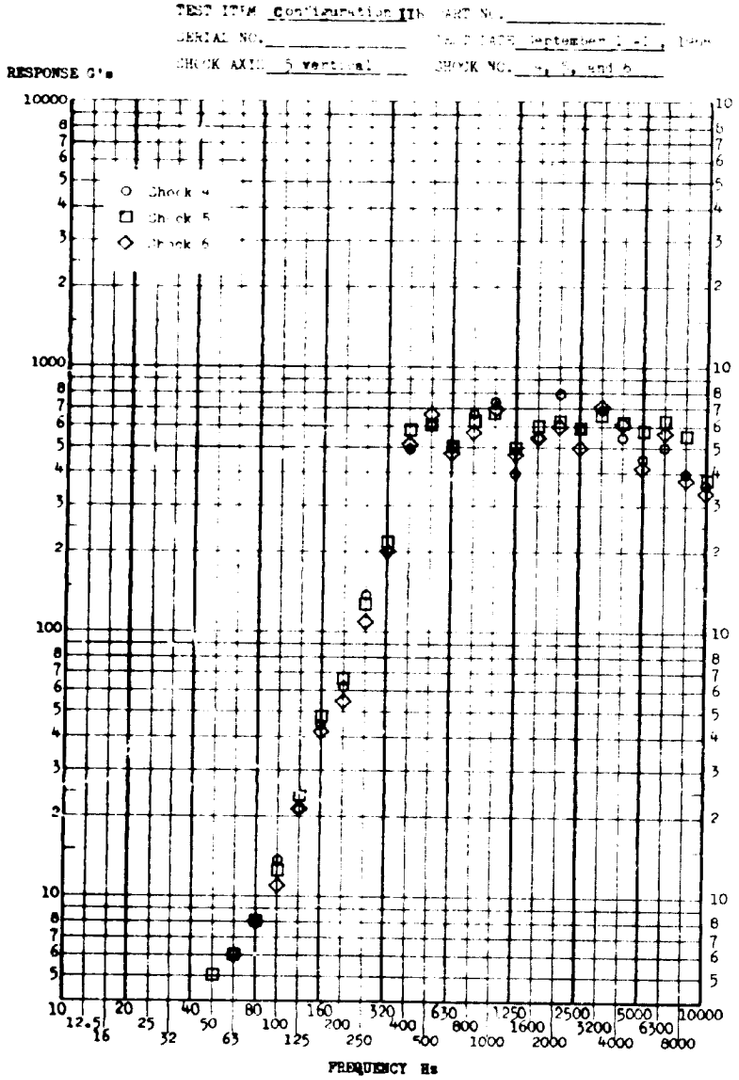




FIGURE II.B.1-99



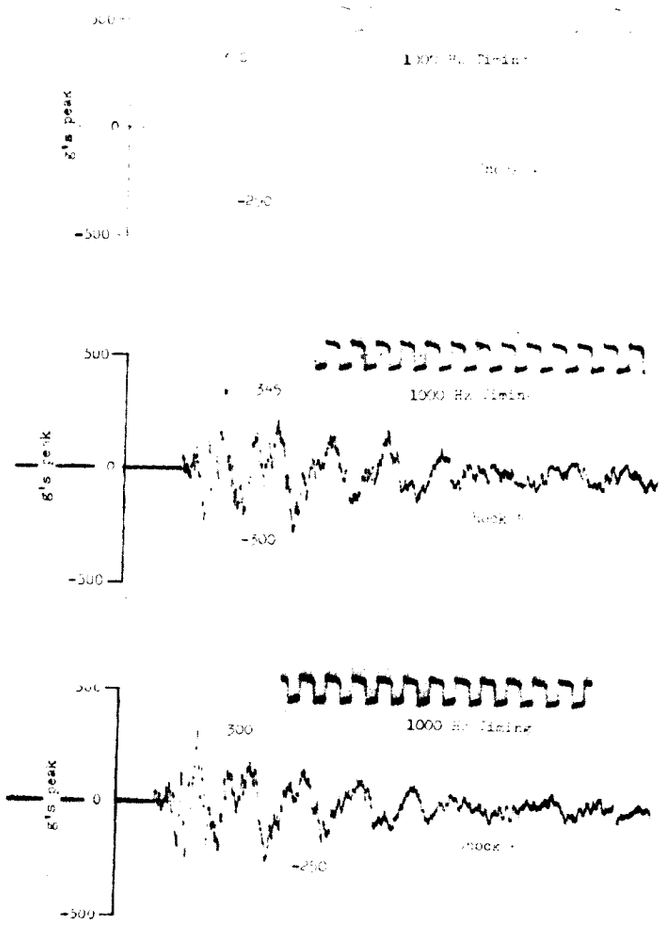
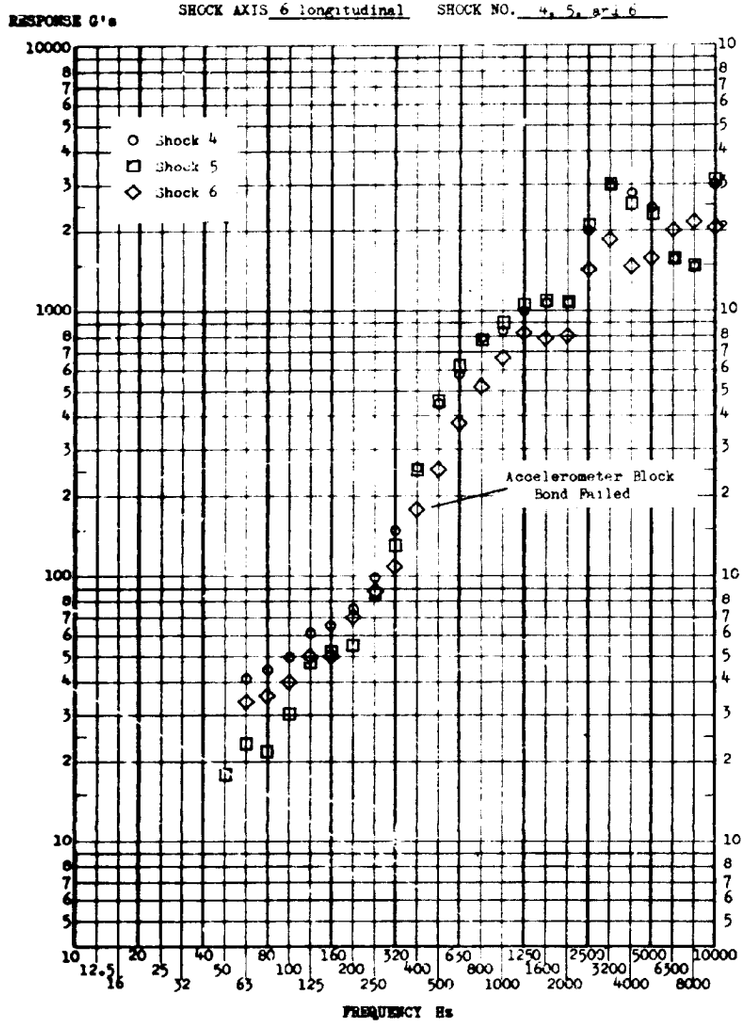




FIGURE II.B.1-100

TEST ITEM Configuration IIb PART NO._____

SERIAL NO._____ TEST DATE September 10-11, 1968

SHOCK AXIS 6 longitudinal SHOCK NO. 4, 5, and 6



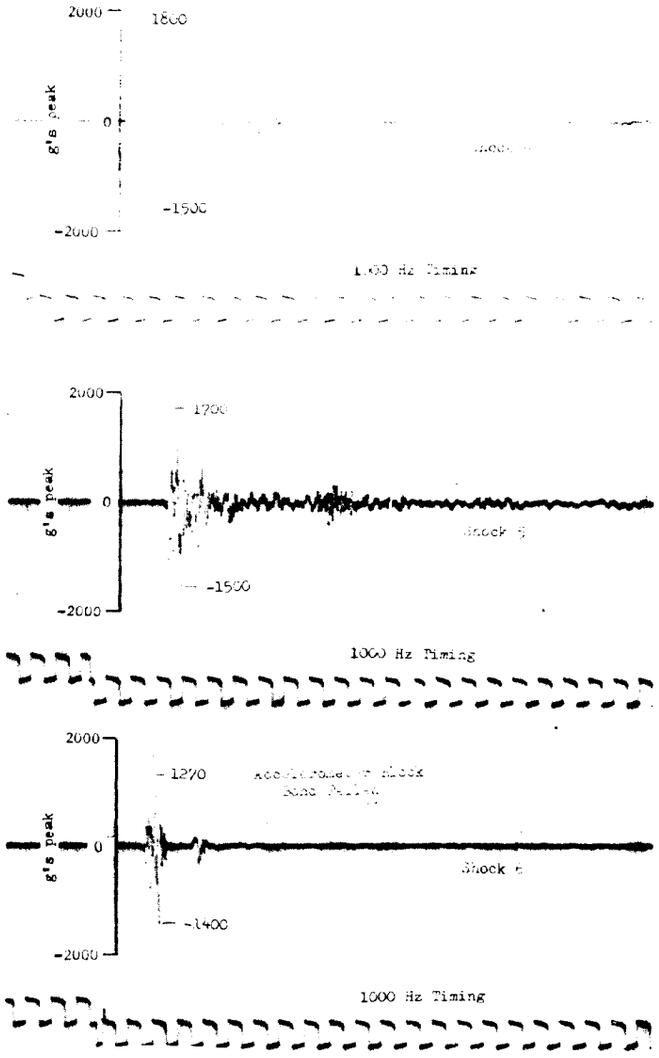
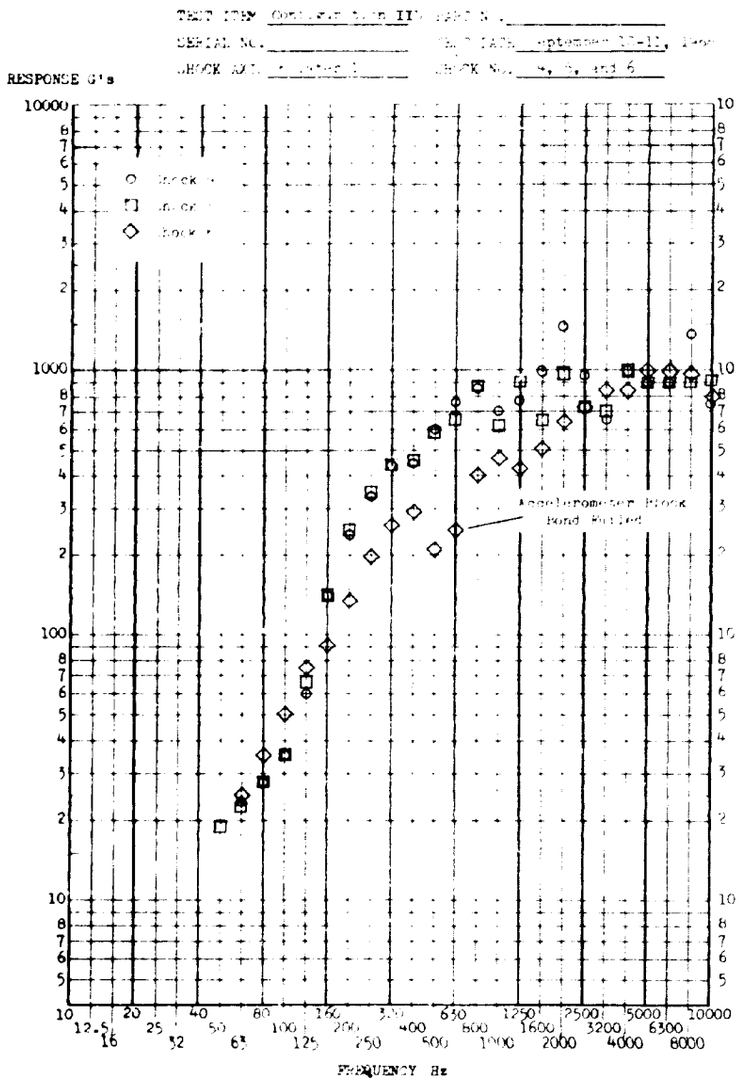




FIGURE II.B.1-101



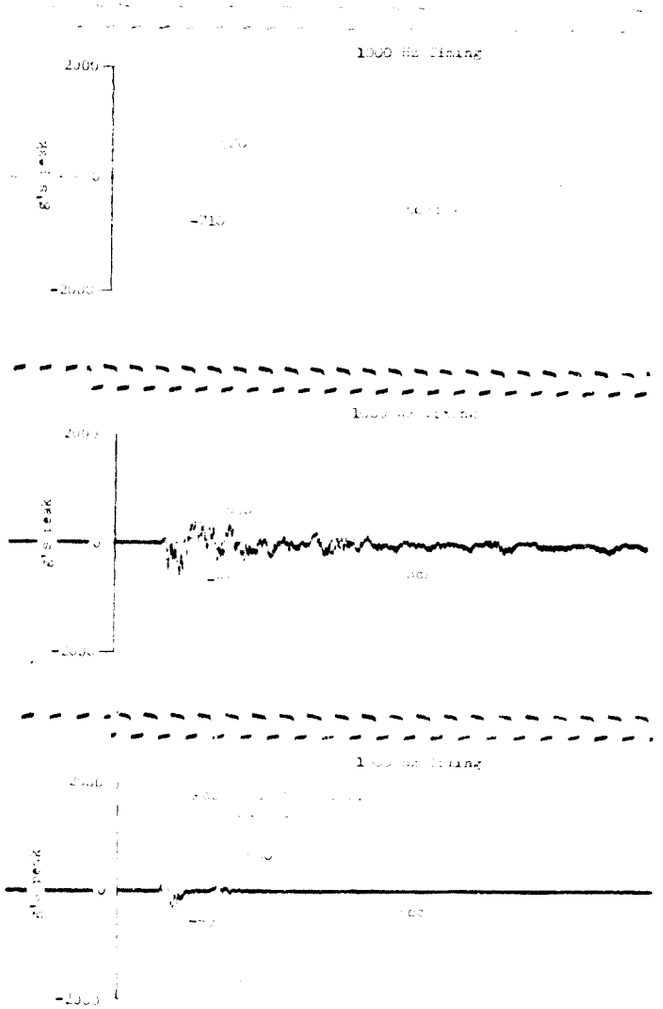




FIGURE II.B.1-102

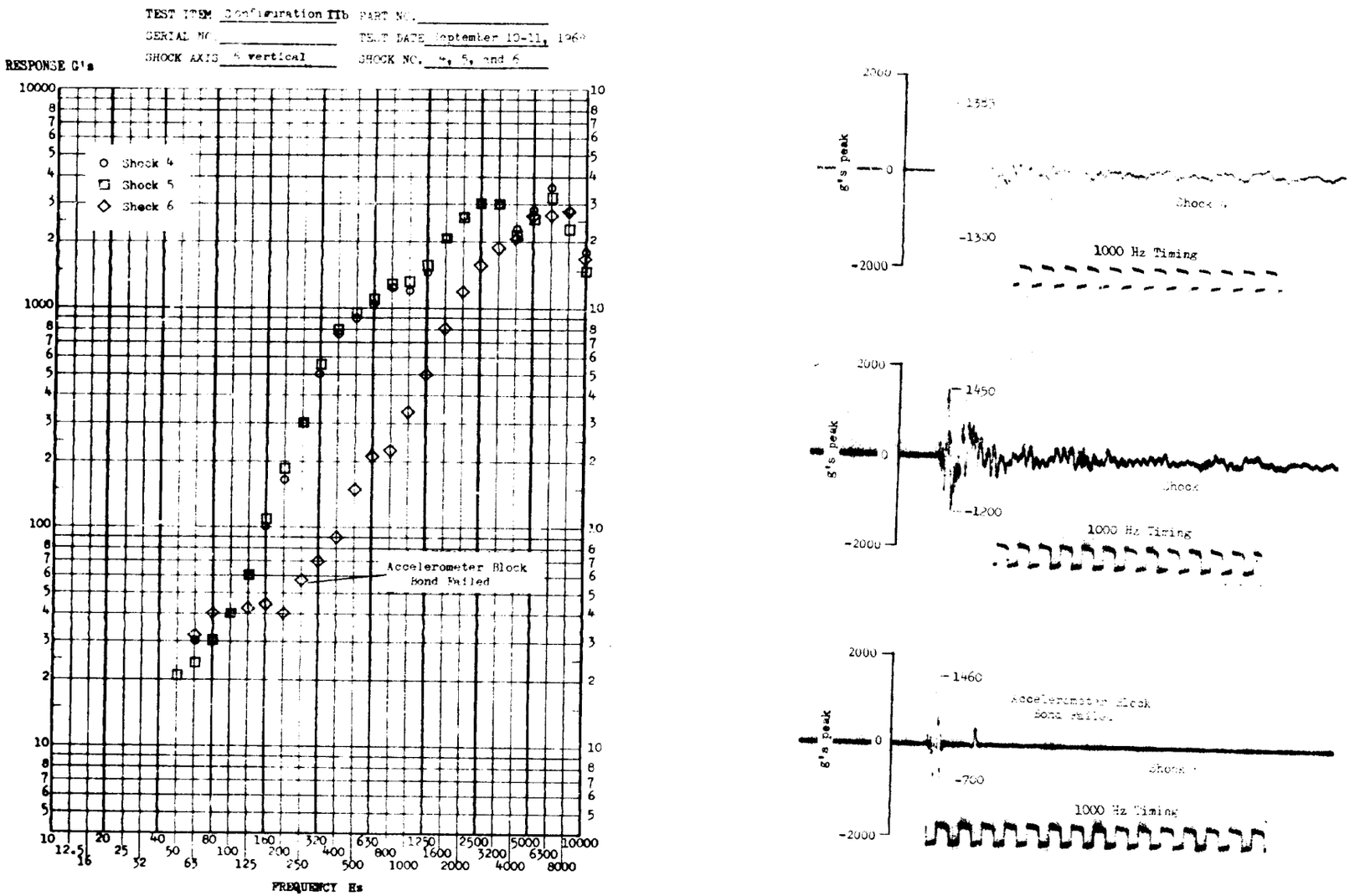



FIGURE II.B.1-103

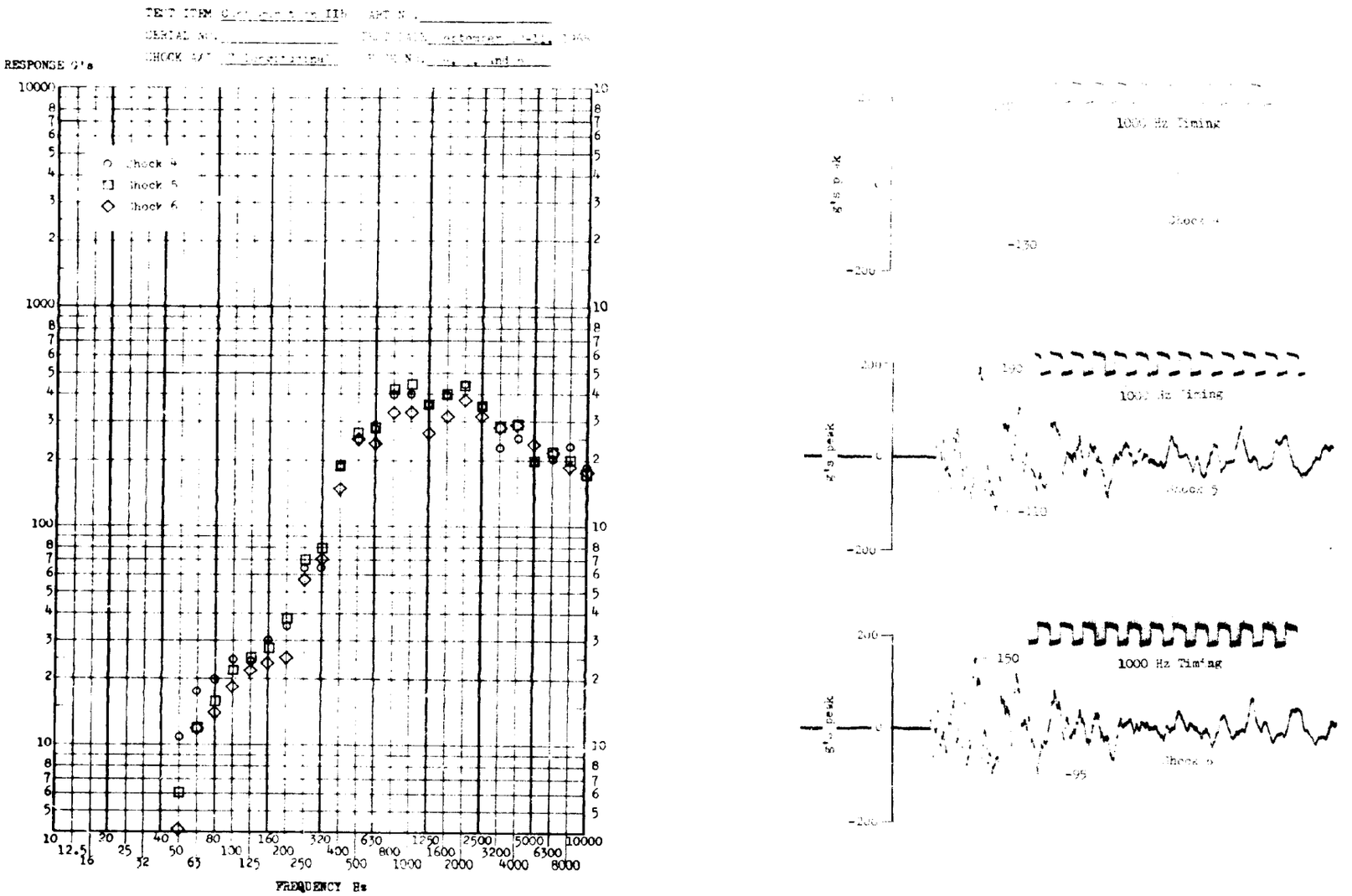
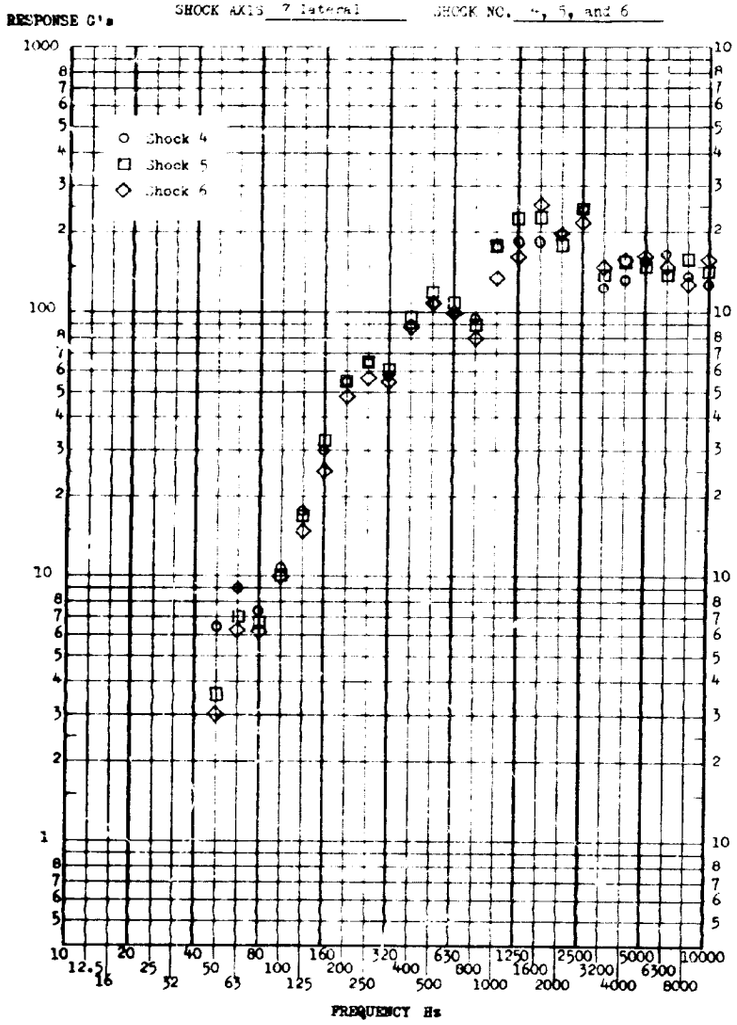



FIGURE 11.8.1-104

TEST ITEM Configuration IIb PART N. _____

SERIAL NO. _____ TEST DATE September 10-11, 1968

SHOCK AXIS Y lateral SHOCK NO. 4, 5, and 6



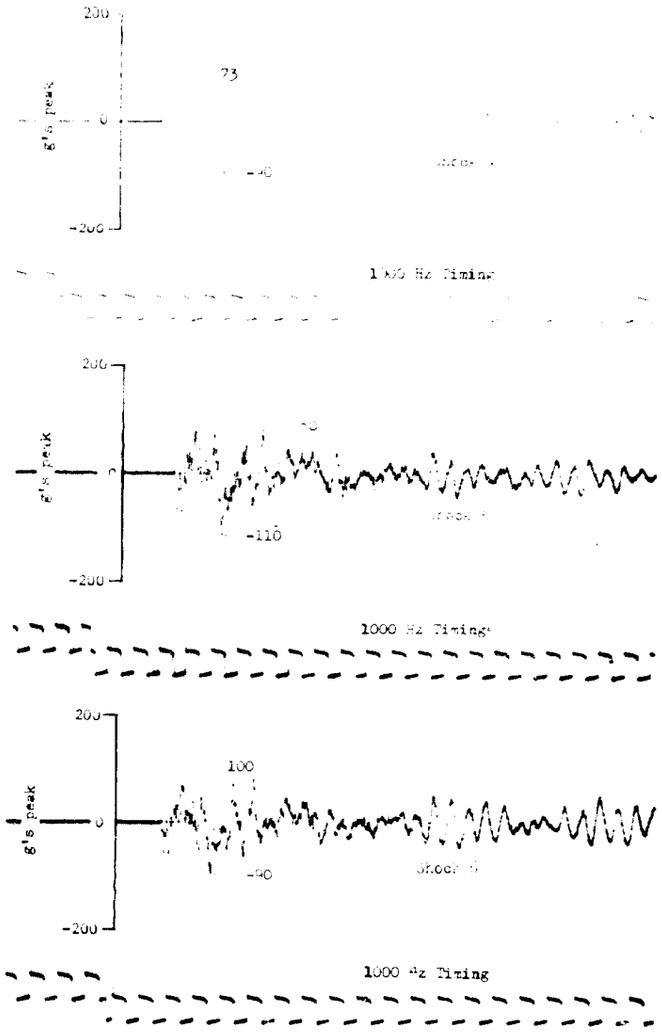




FIGURE II.B.1-105

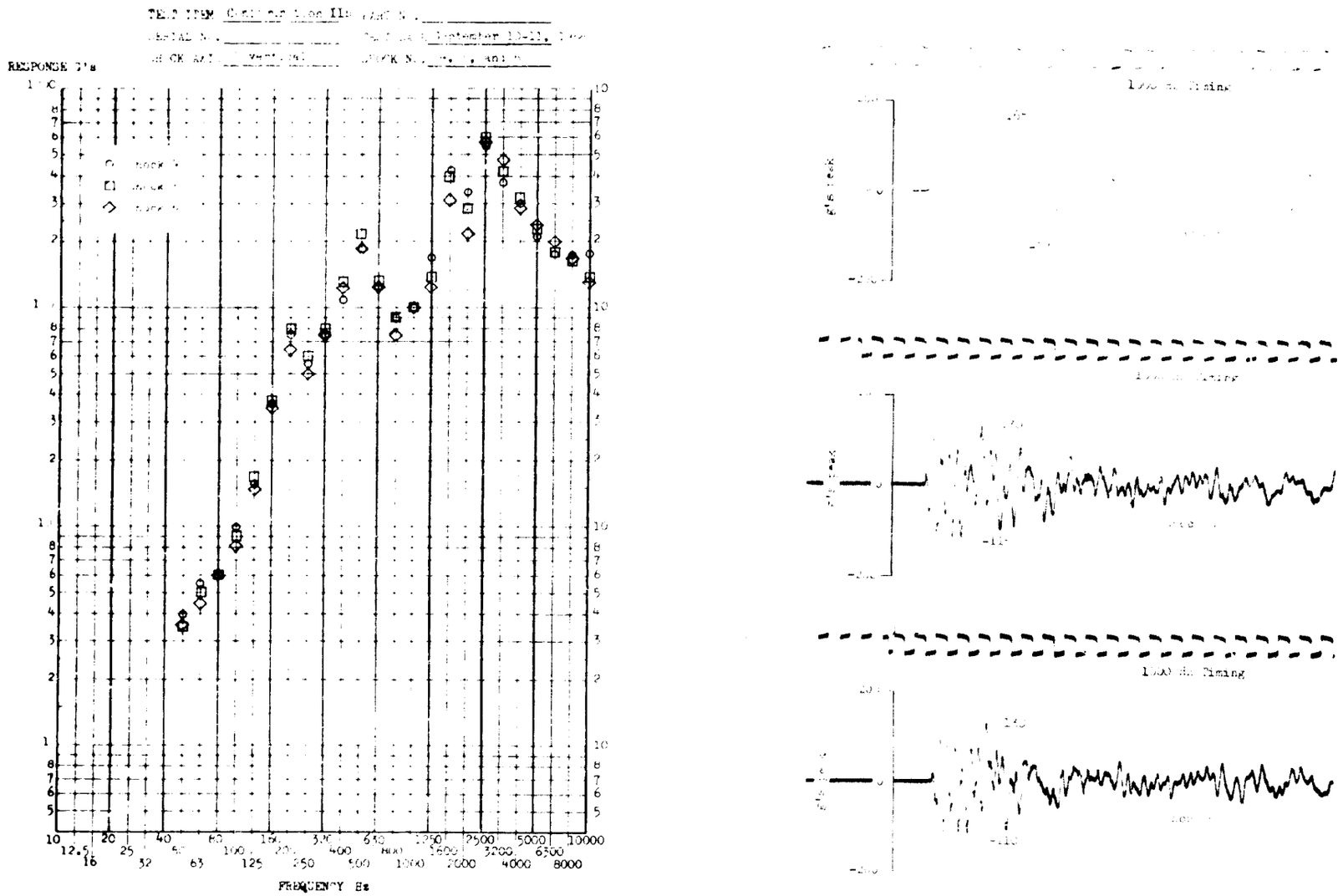



FIGURE II.B.1-106

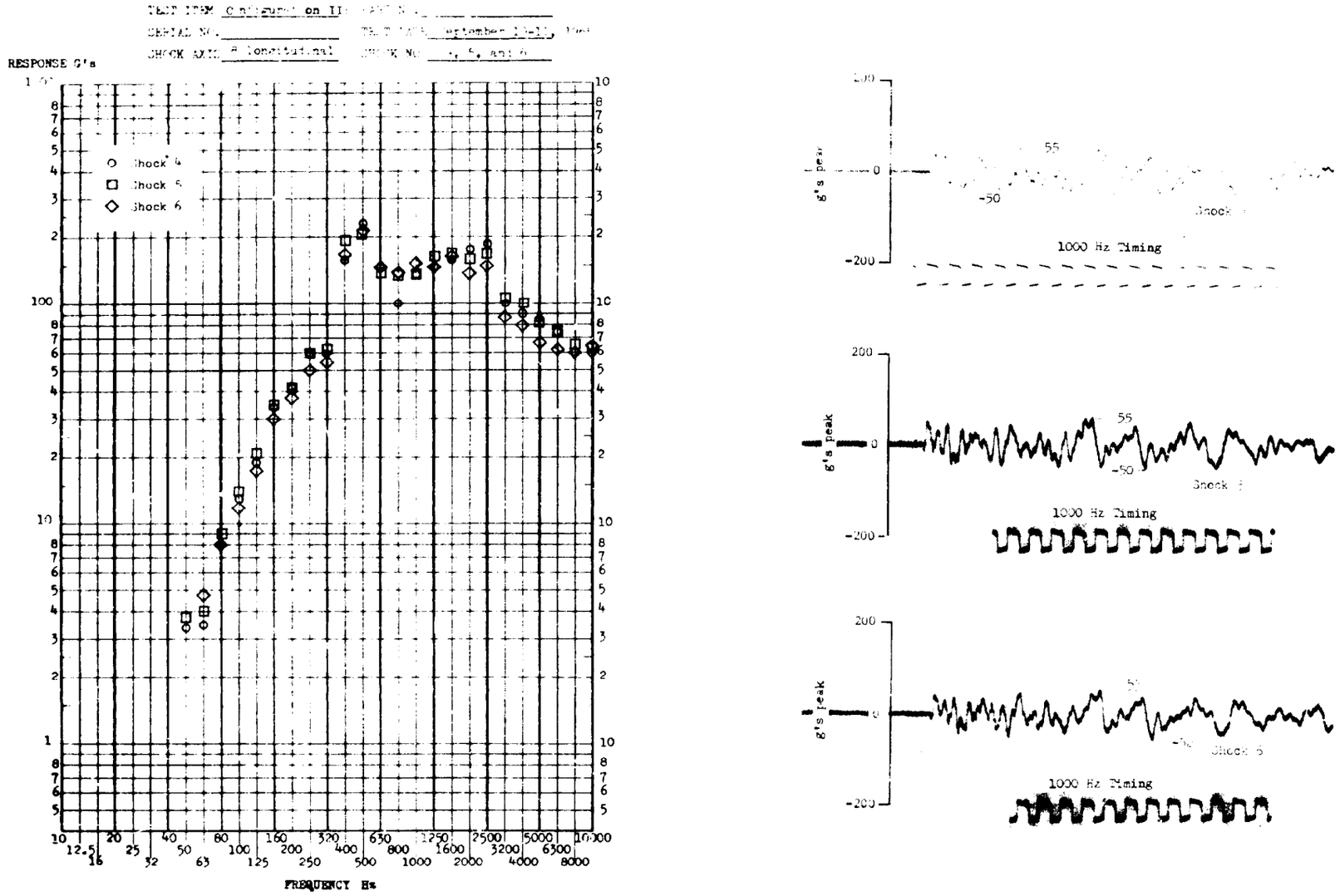



FIGURE 11.B.1-107

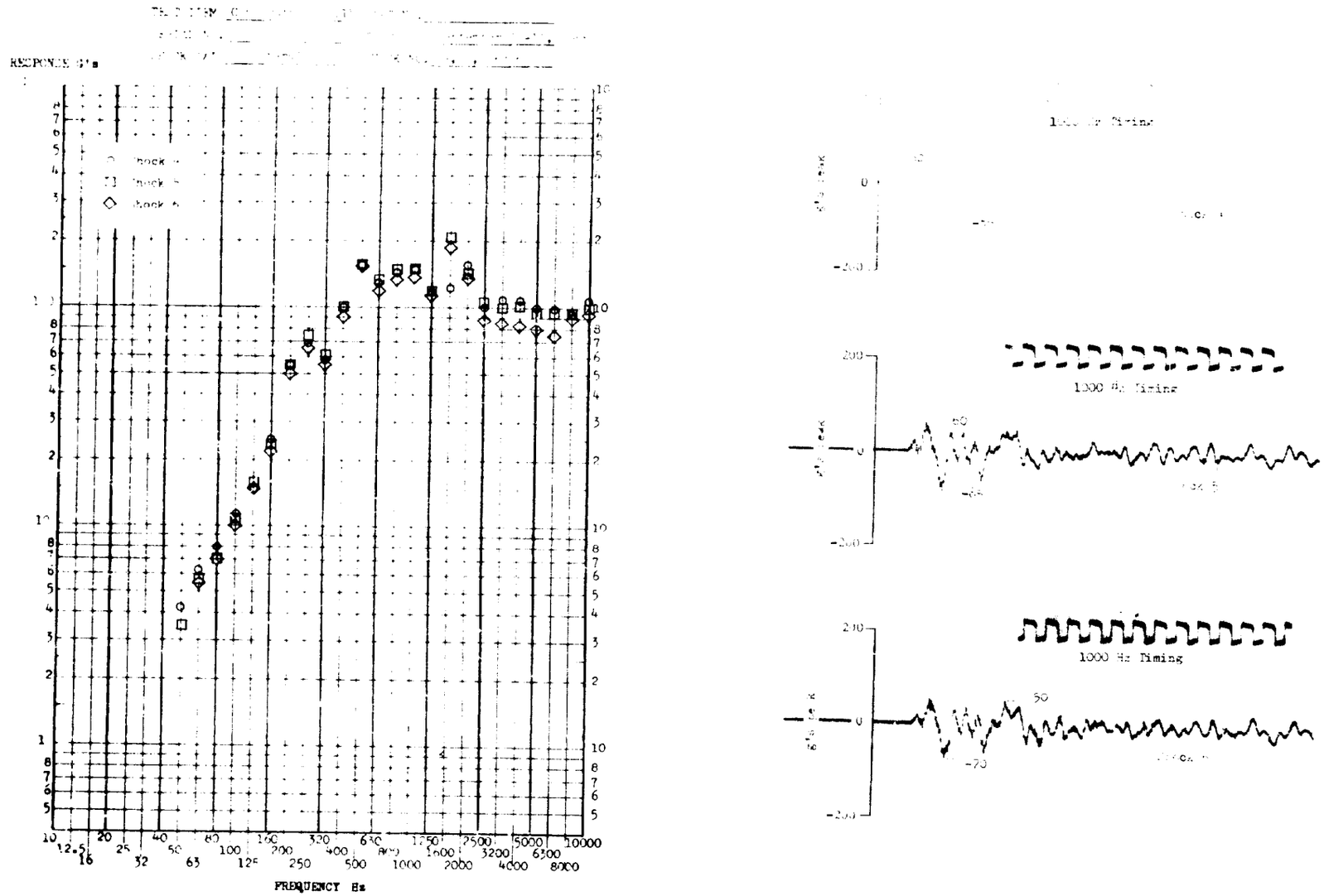
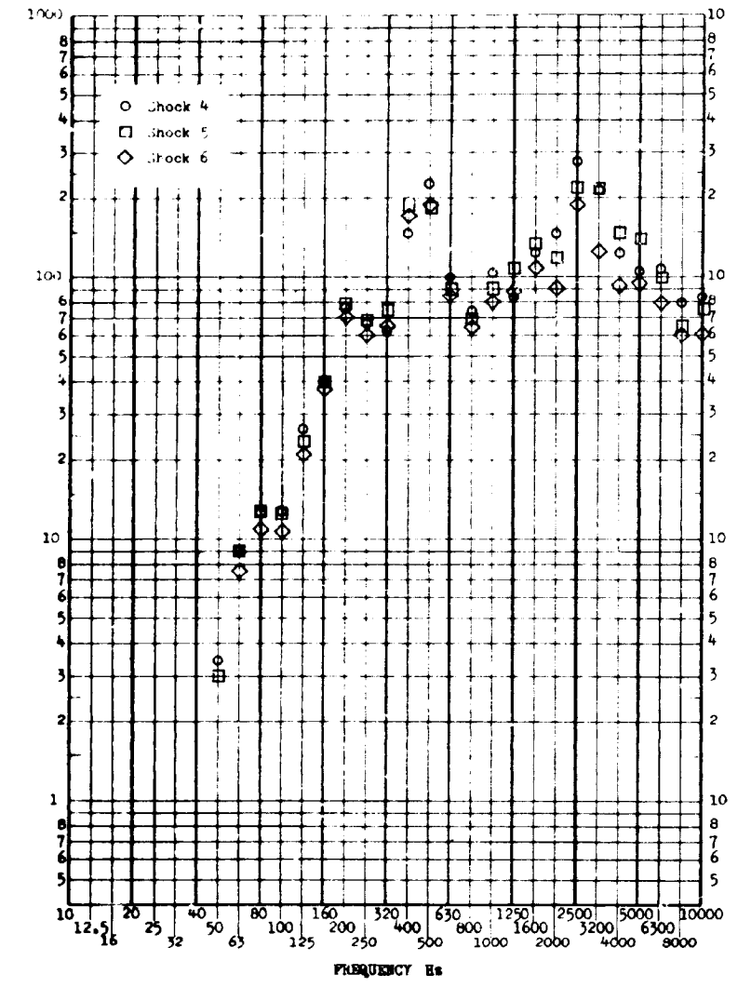



FIGURE 11.B.1-108

TEST ITEM Configuration II PART NO.

SERIAL NO. TEST DATE September 14-15, 1966

SHOCK AXIS Z vertical SHOCK NO. 4, 5, and 6



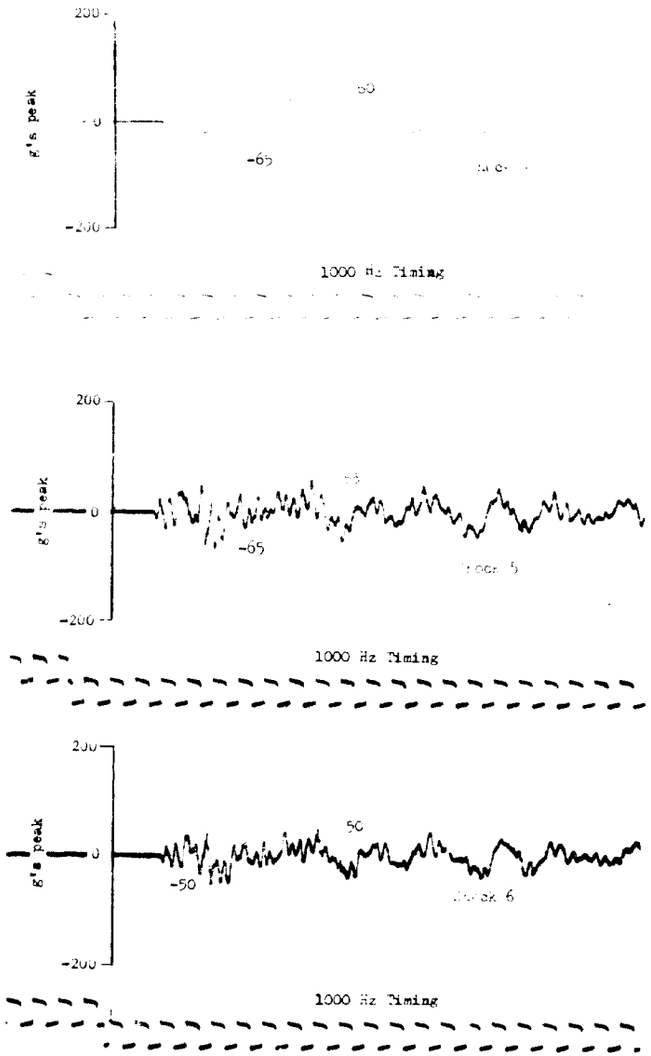
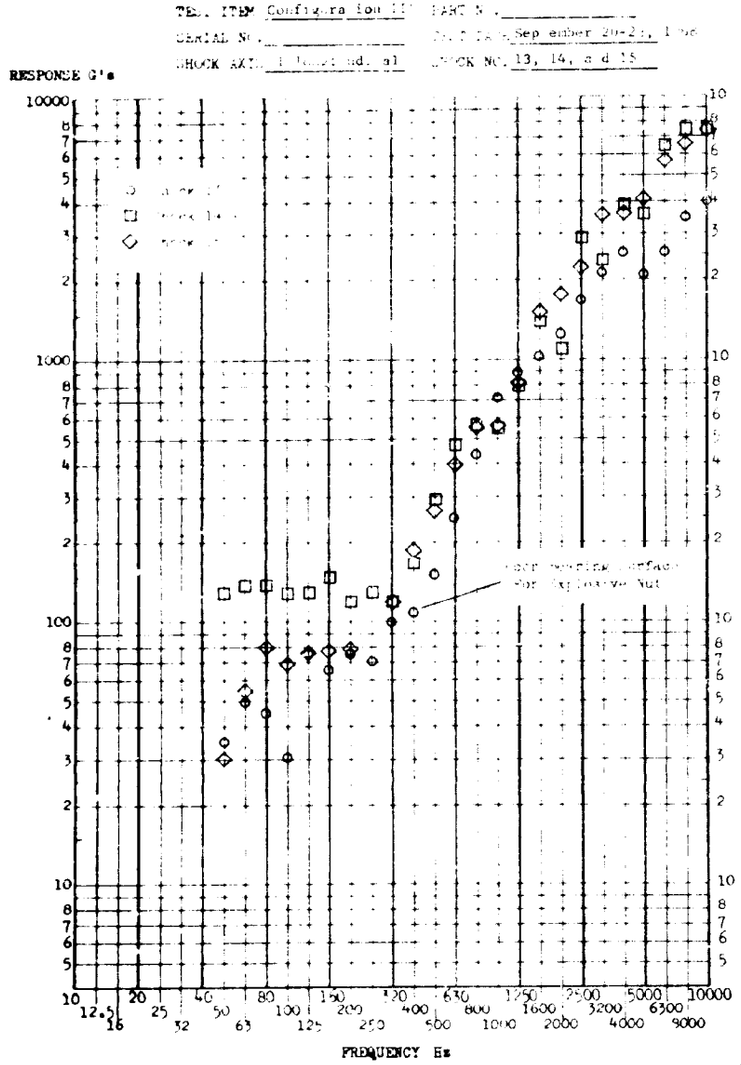




FIGURE II.B.1-109



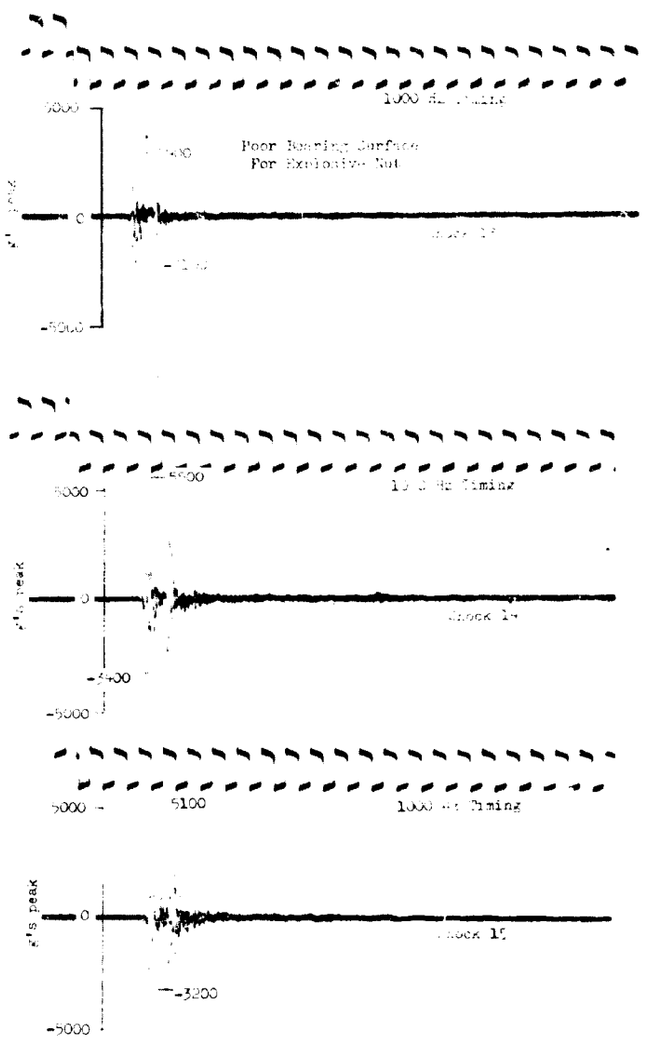
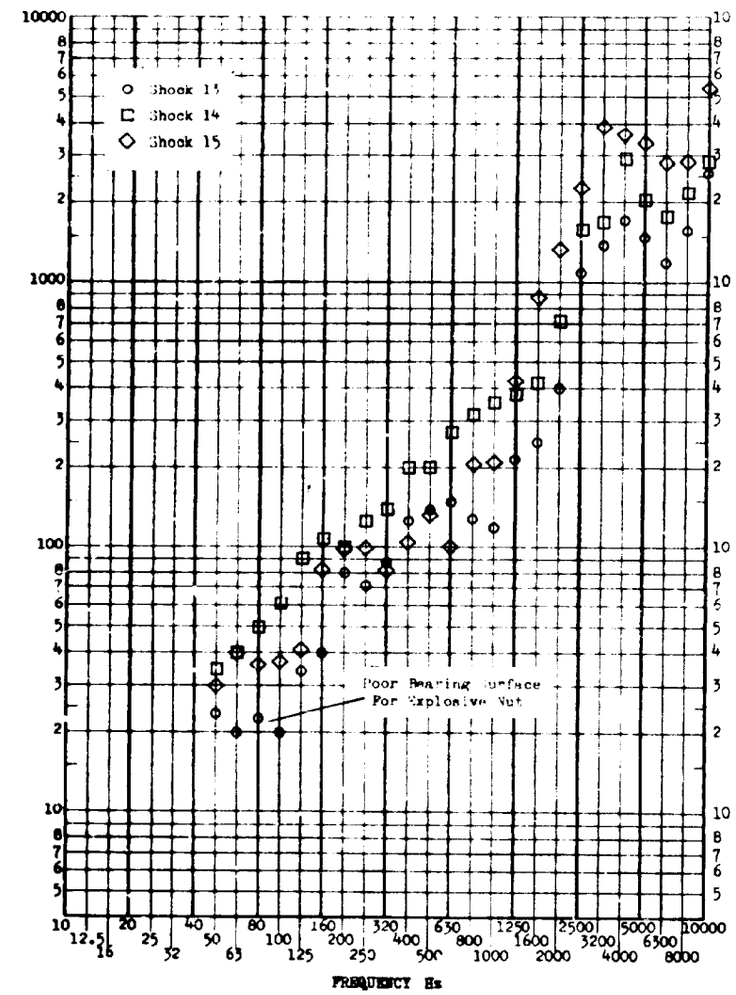
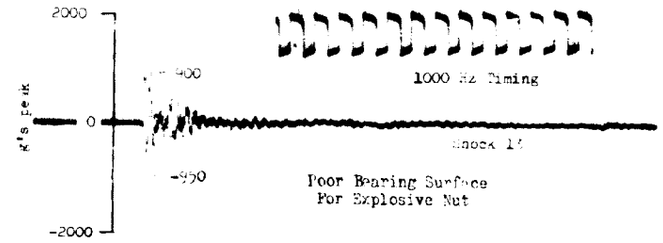
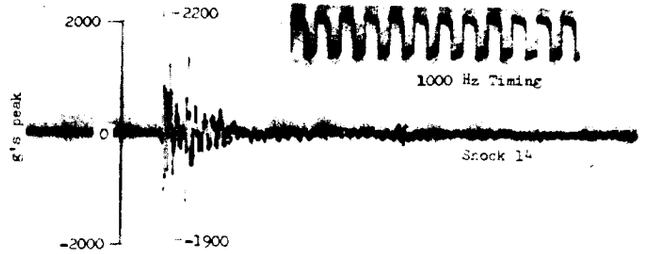




FIGURE II.B.1-110

TEST ITEM Configuration III PART NO.
SERIAL NO. TEST DATE September 20-23, 1965
SHOCK AXIS 1 lateral SHOCK NO. 13, 14, and 15



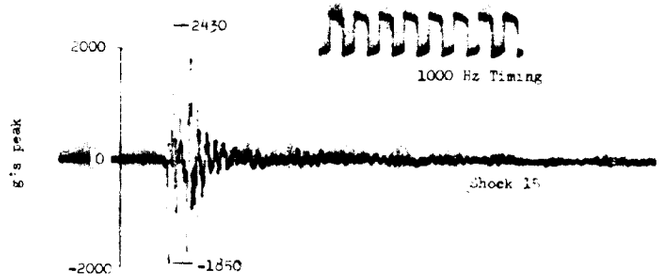
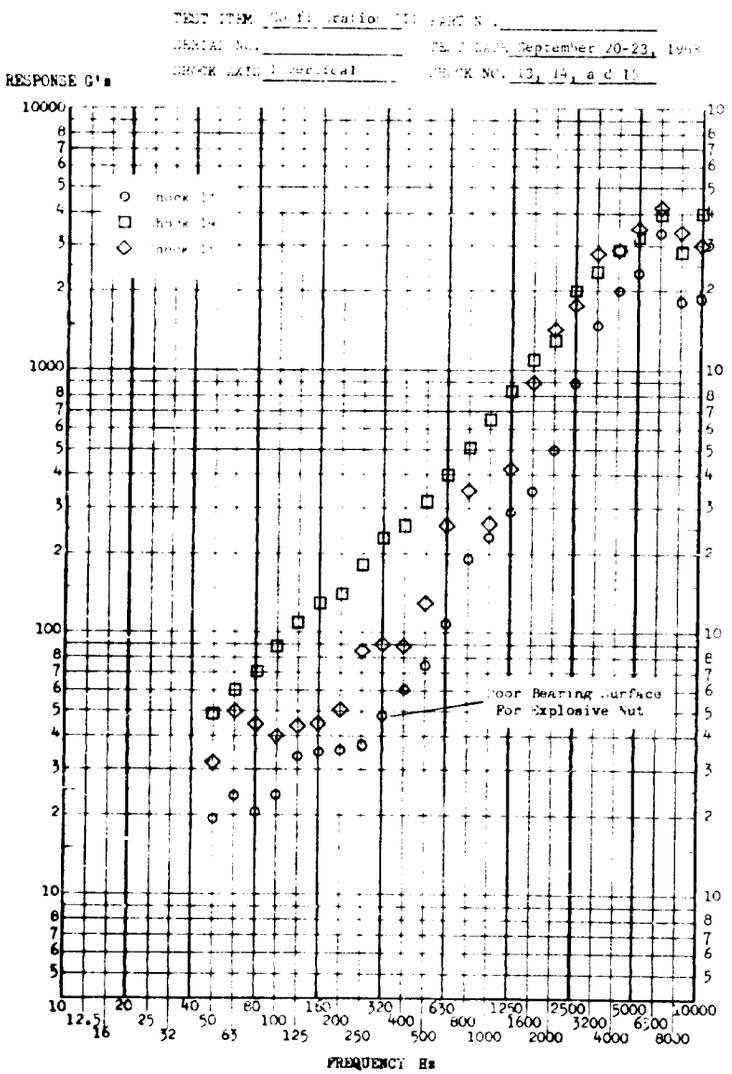




FIGURE II.B.1-111



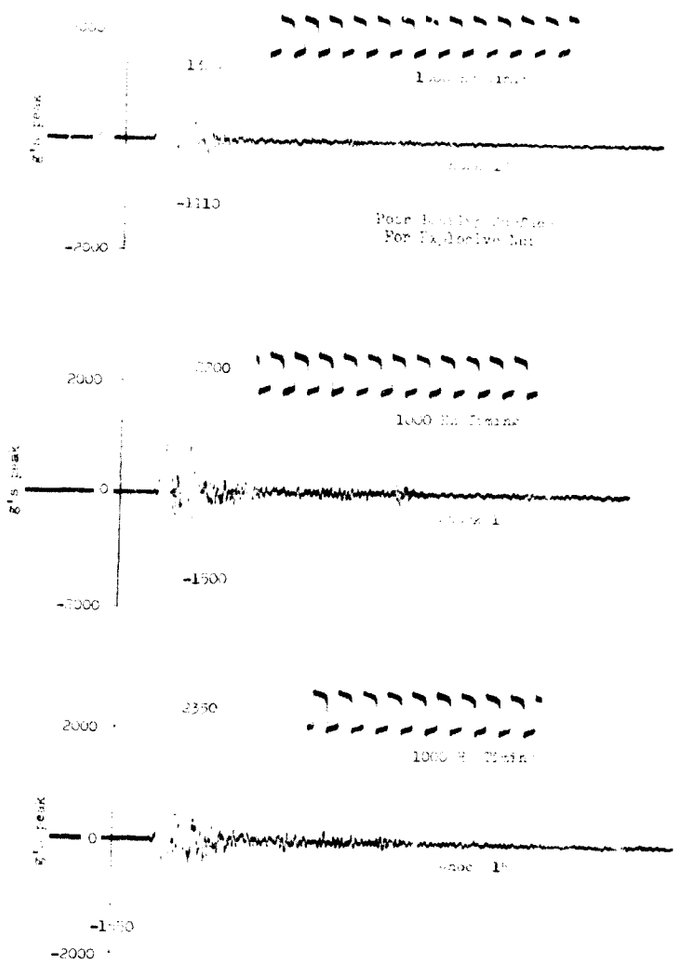




FIGURE II.B.1-112

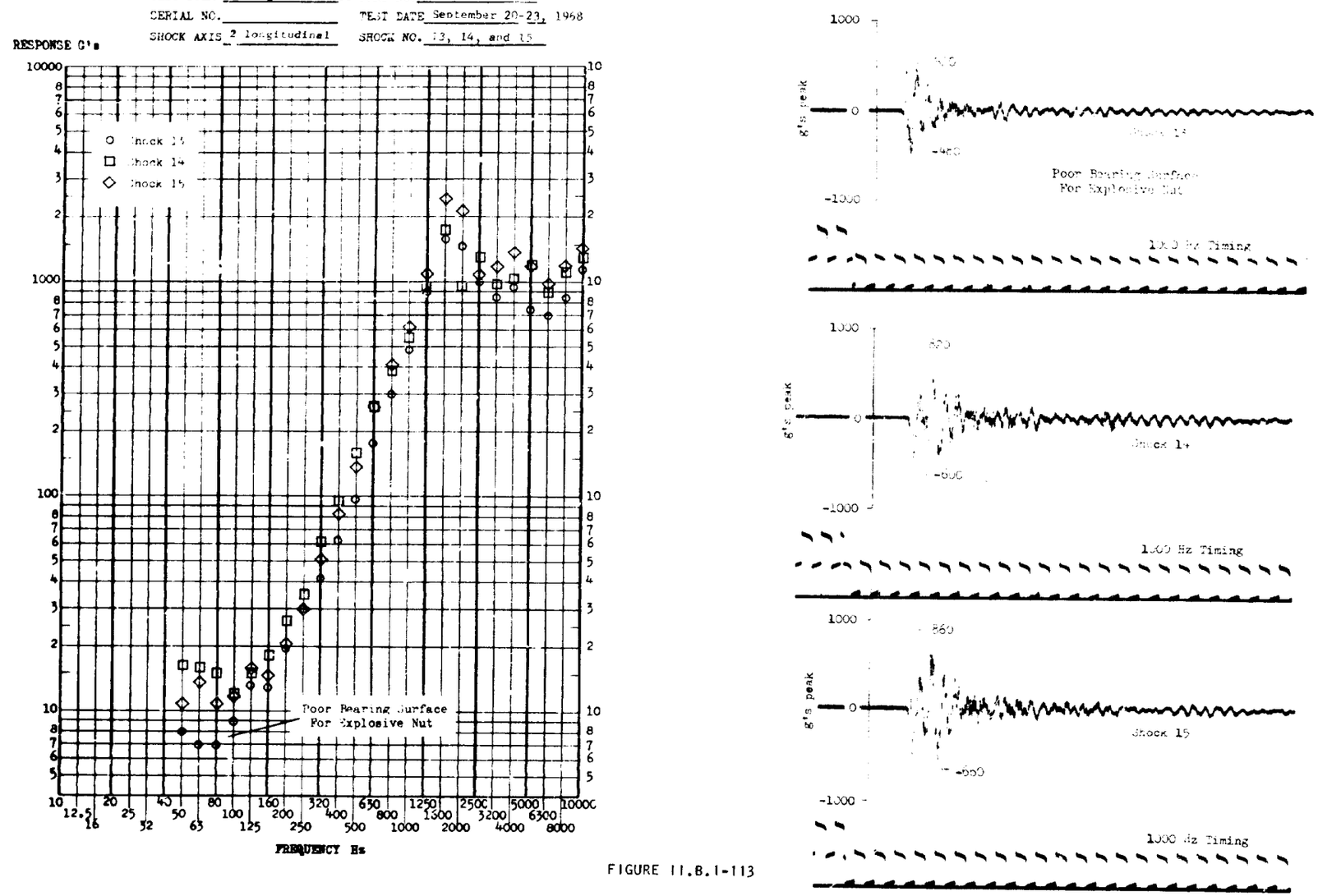
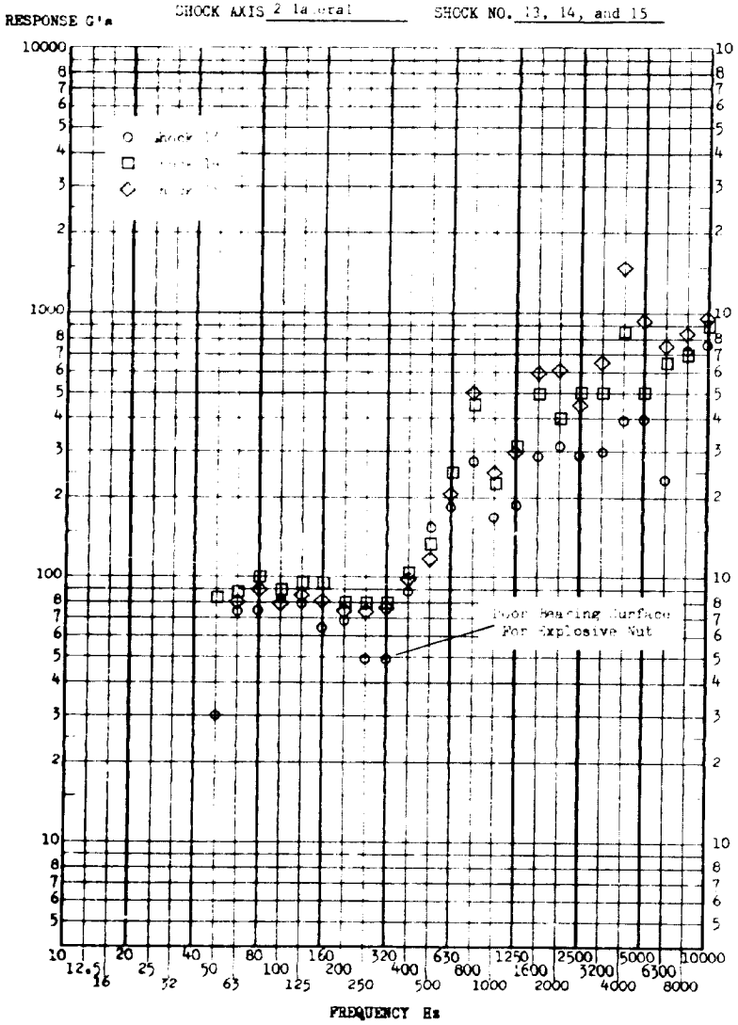



FIGURE II.B.1-113

TEST ITEM Configuration III PART NO. _____

SERIAL NO. _____ TEST DATE September 20-23, 1968

SHOCK AXIS 2 lateral SHOCK NO. 13, 14, and 15



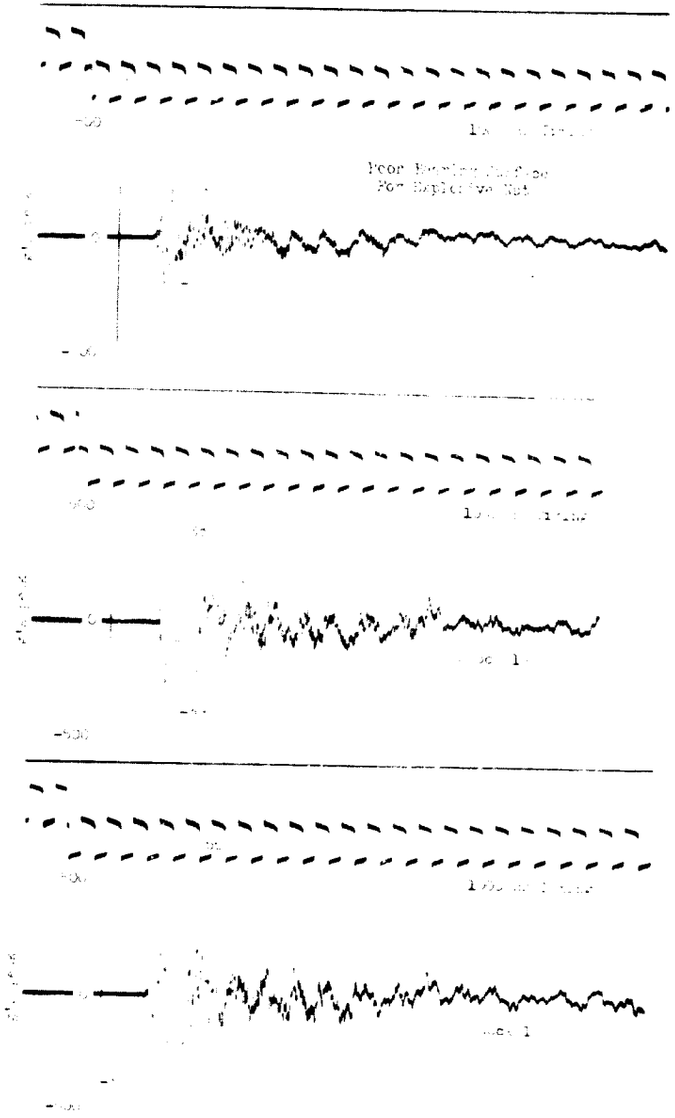




FIGURE II.B.1-114

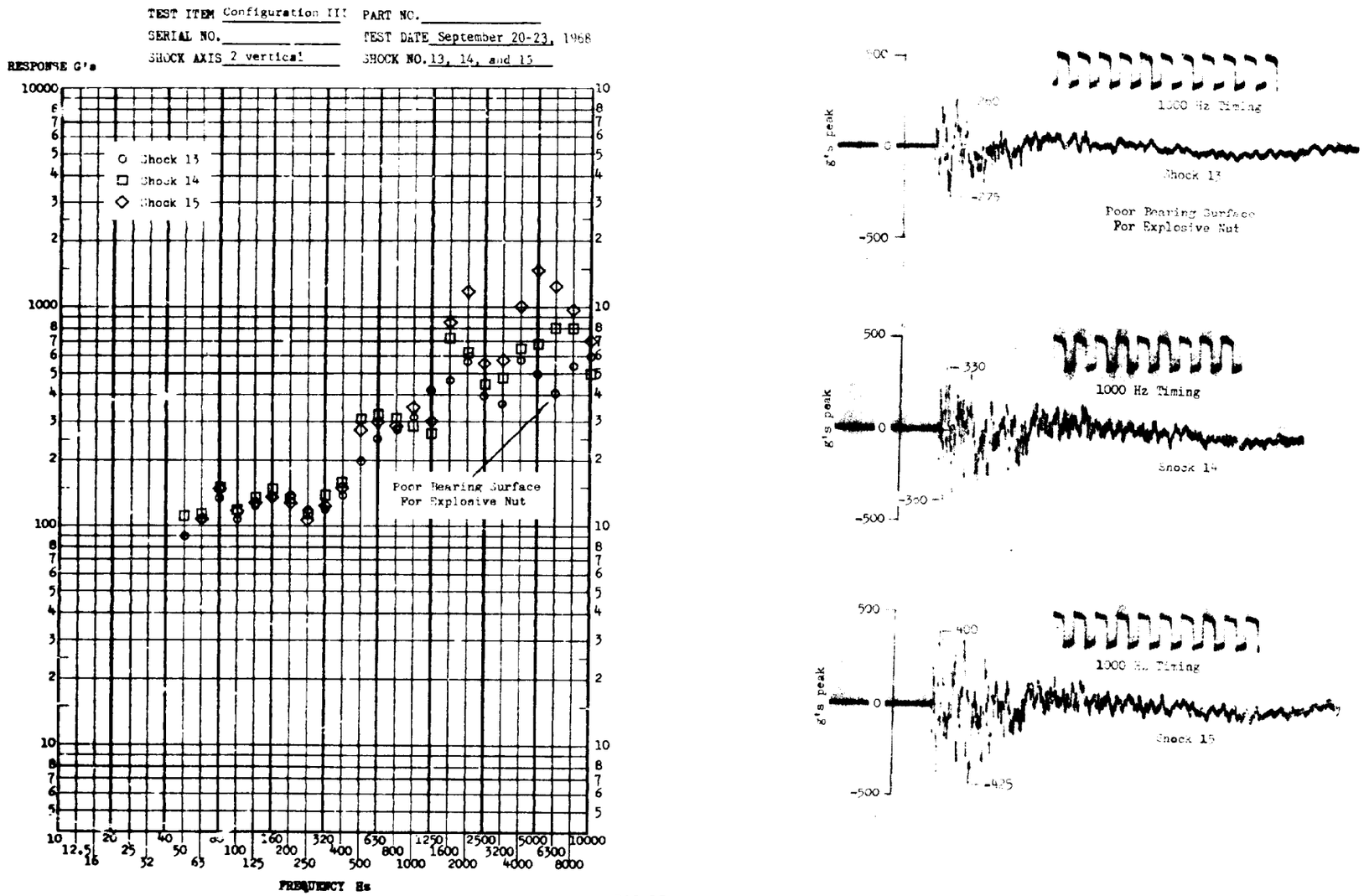
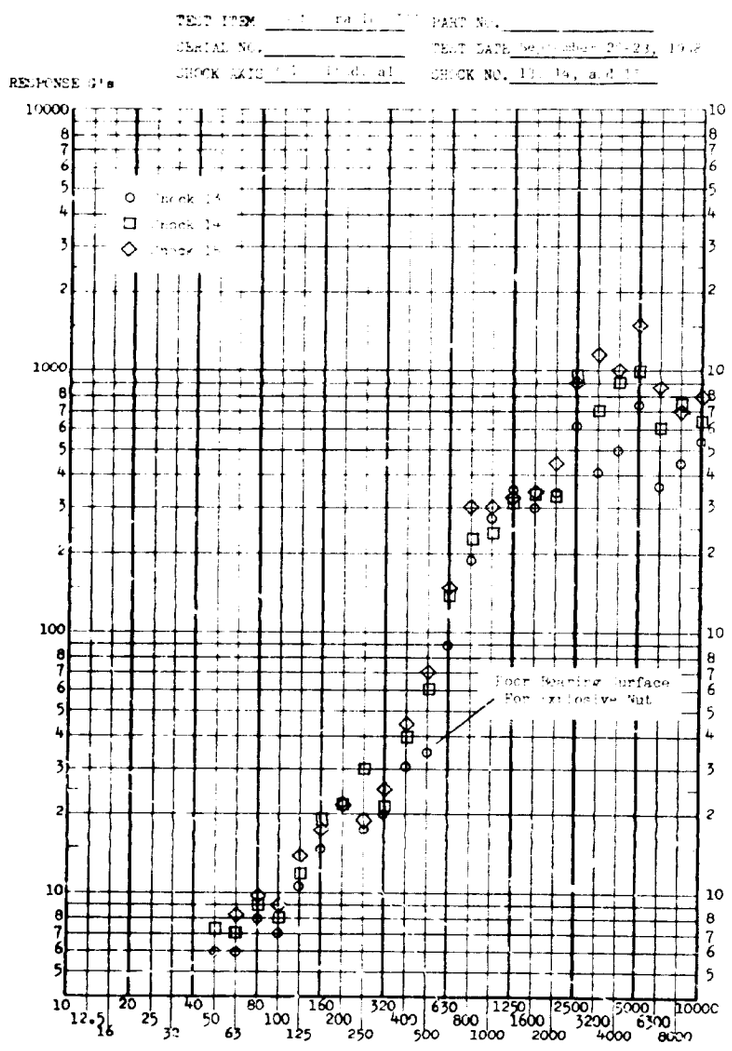



FIGURE II.B.1-115



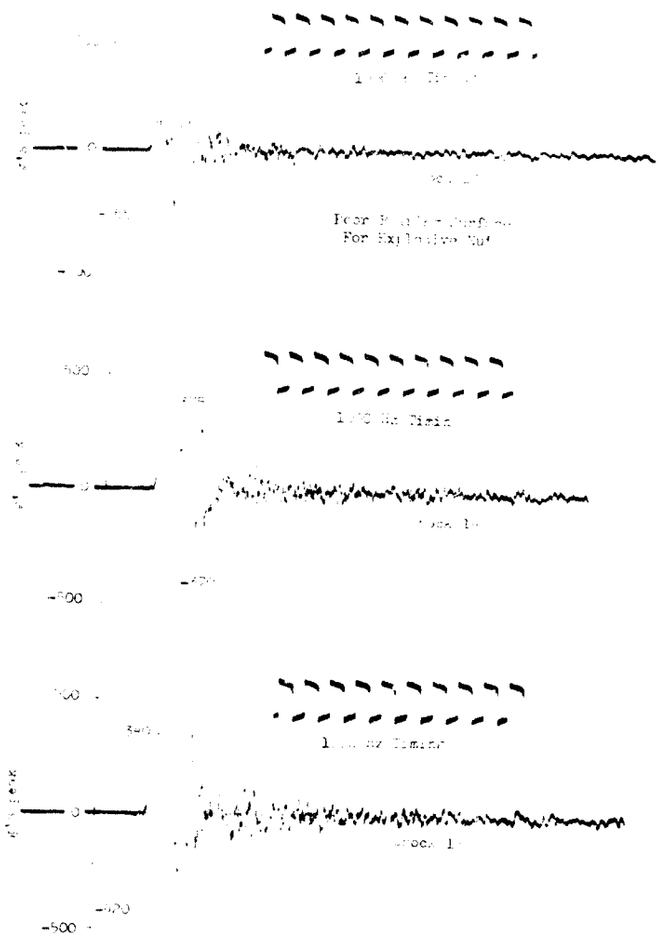




FIGURE II.B.1-116

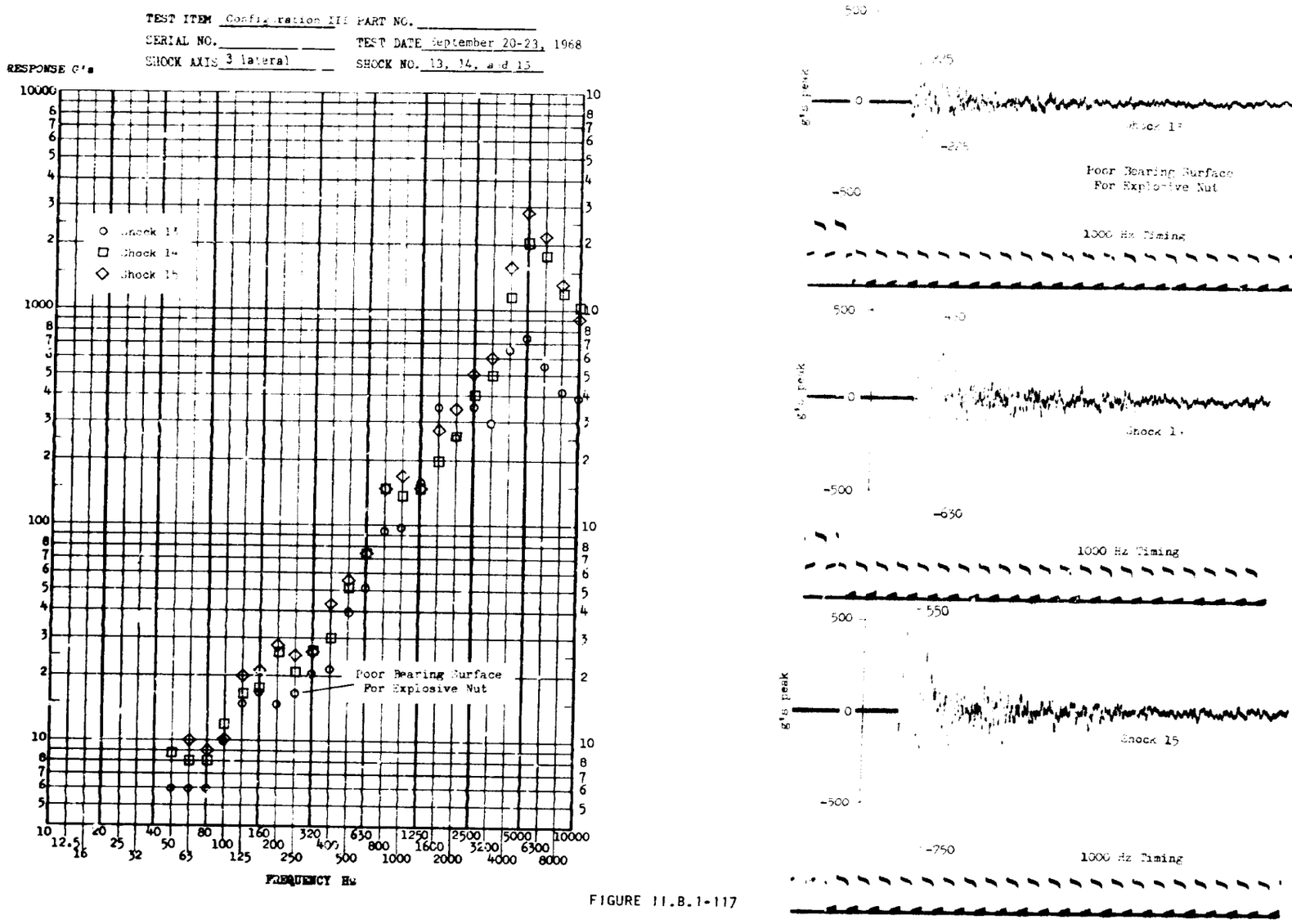



FIGURE II.B.1-117

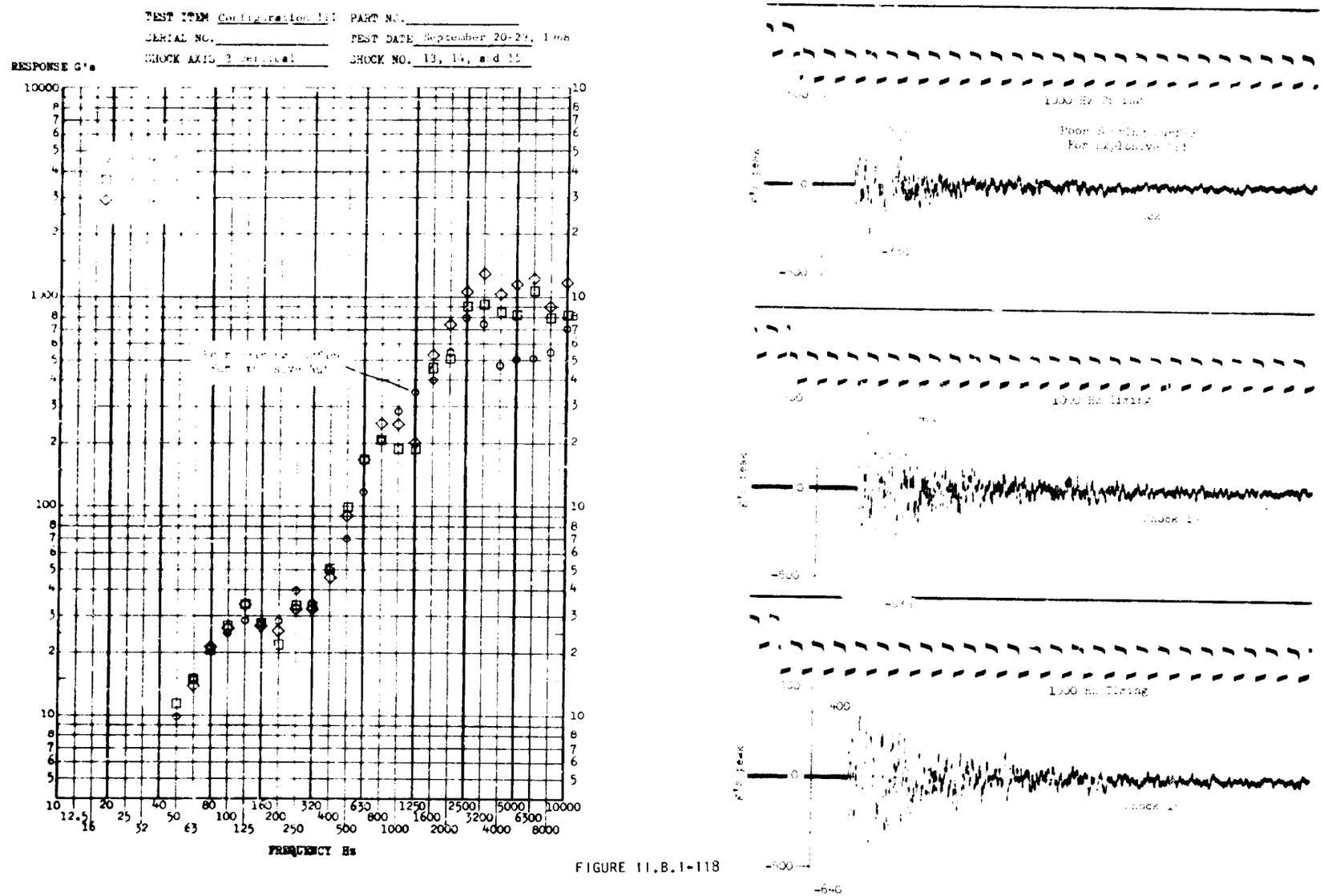
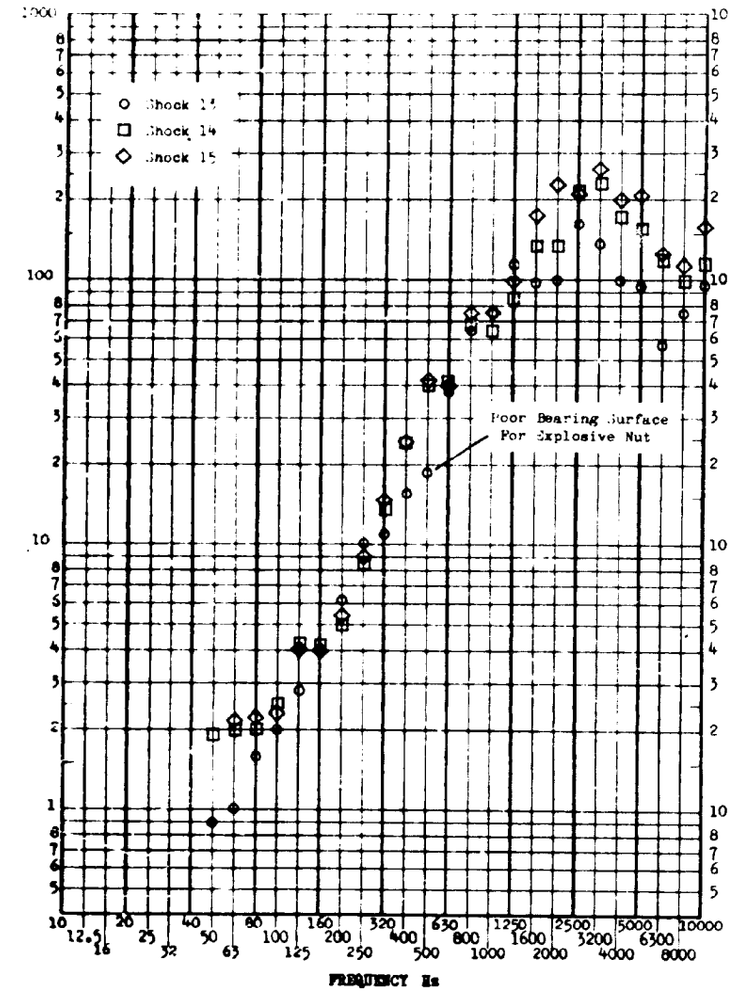



FIGURE II.B.1-118

TEST ITEM Configuration II PART NO.
SERIAL NO. TEST DATE September 20-23, 1962
SHOCK AXIS + Longitudinal SHOCK NO 13, 14, and 15



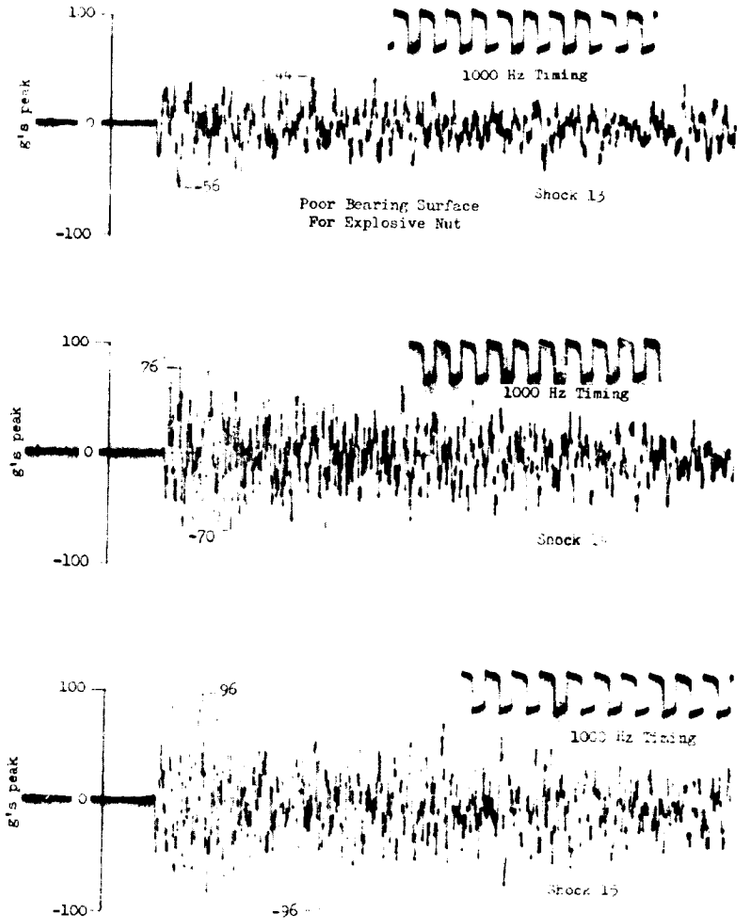




FIGURE II.B.1-119

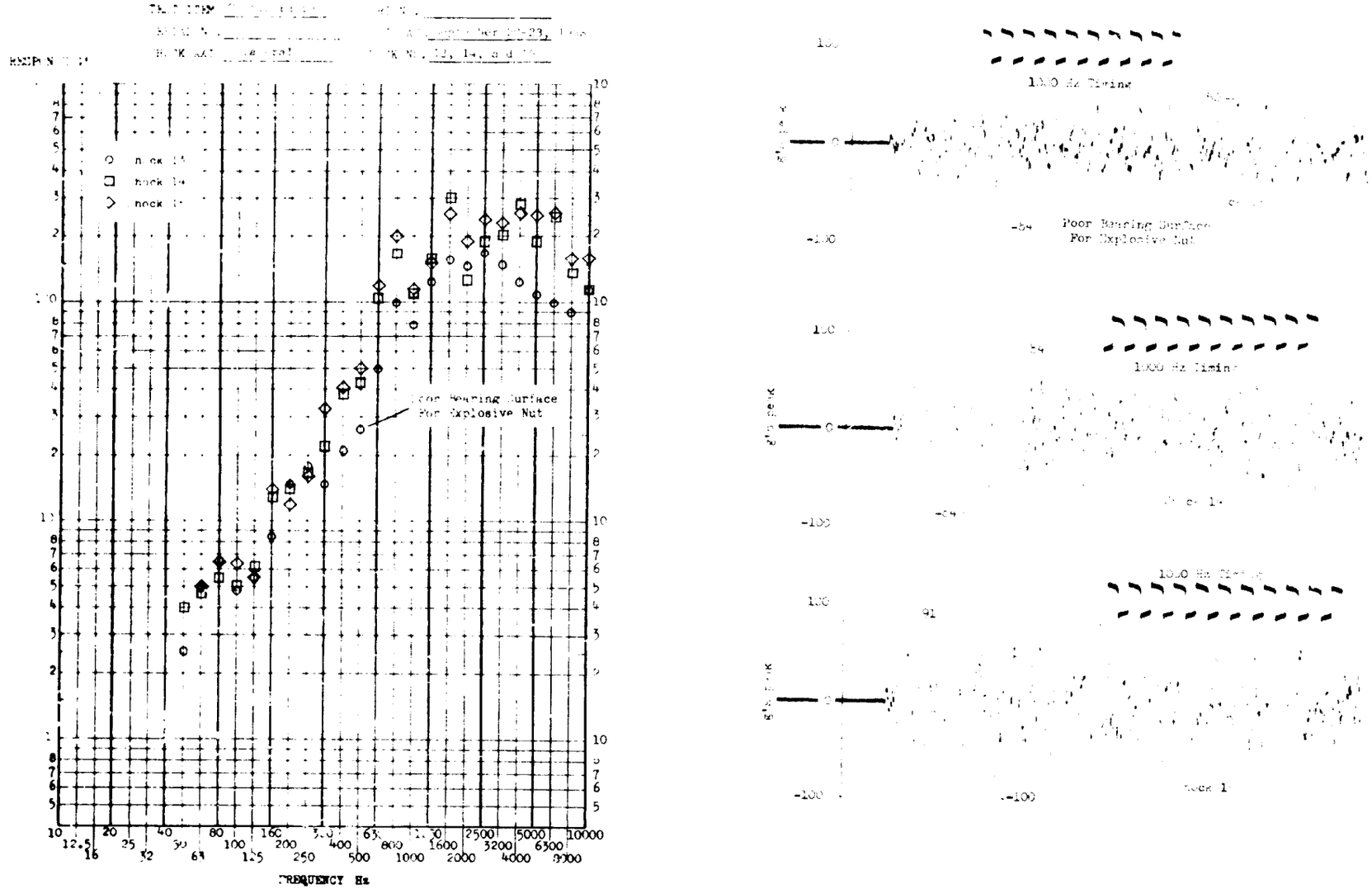



FIGURE II.B.1-120

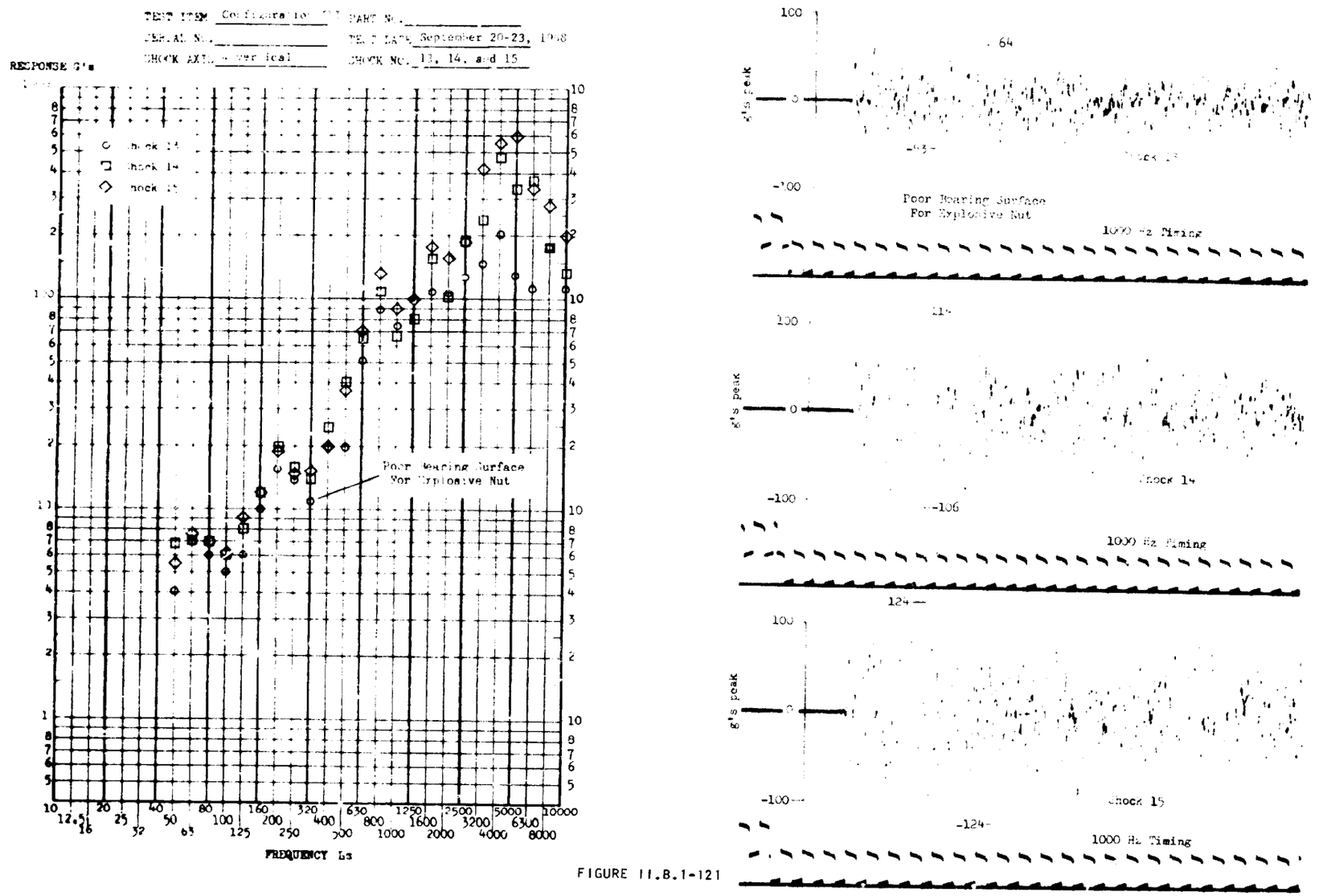
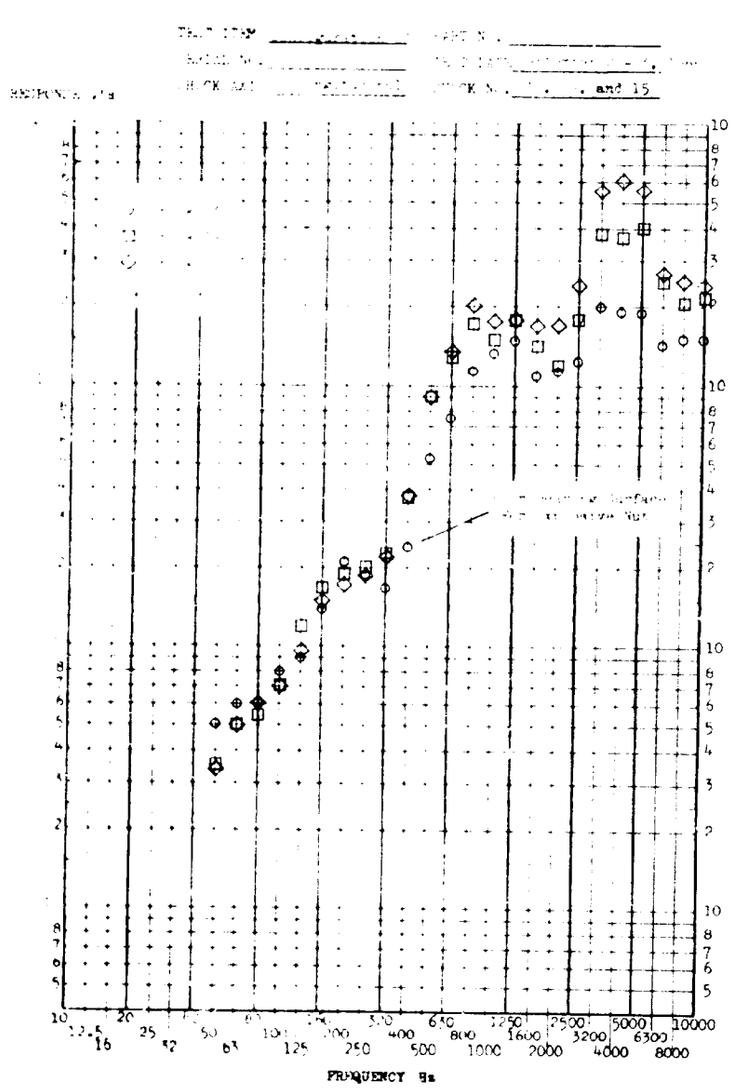



FIGURE II.B.1-121



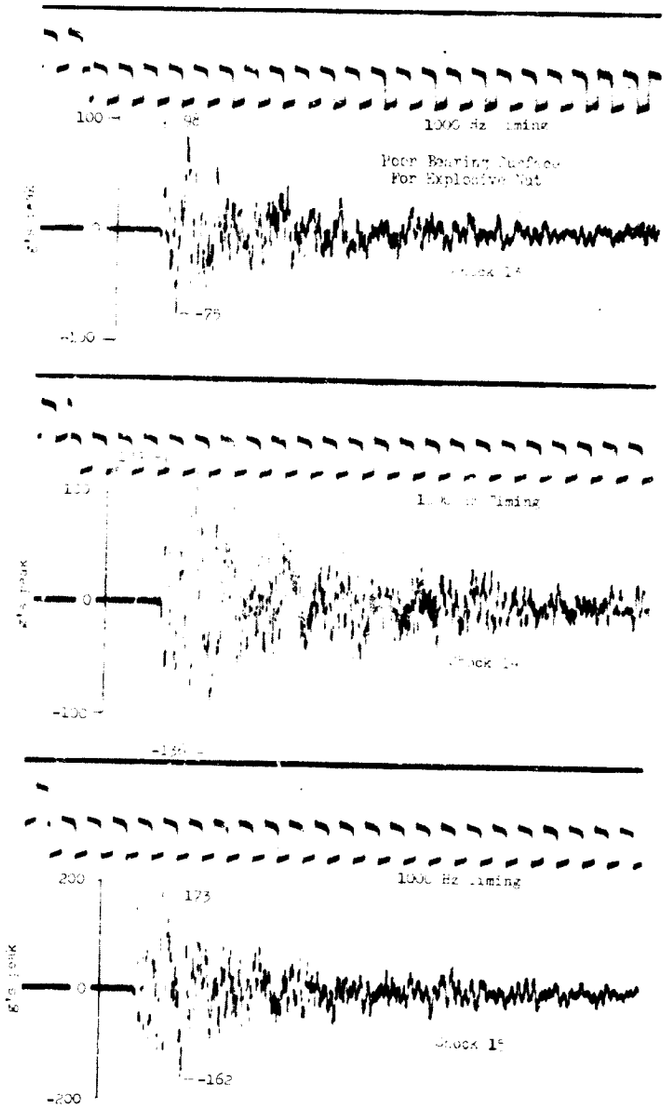
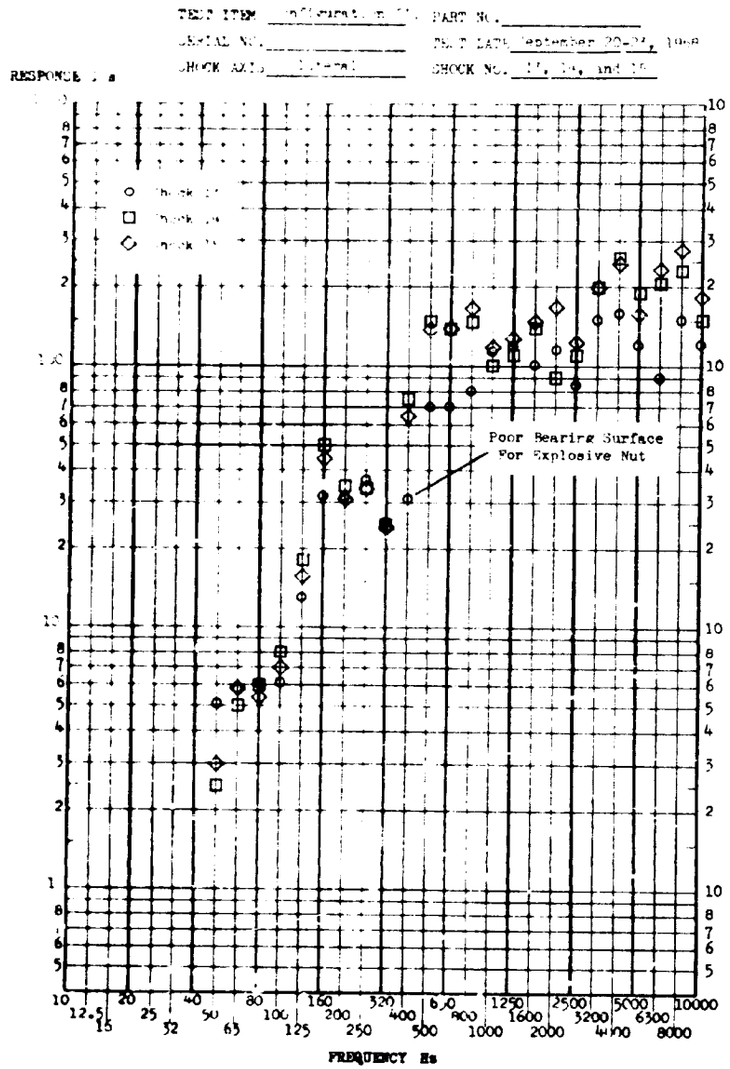




FIGURE II.B.1-122



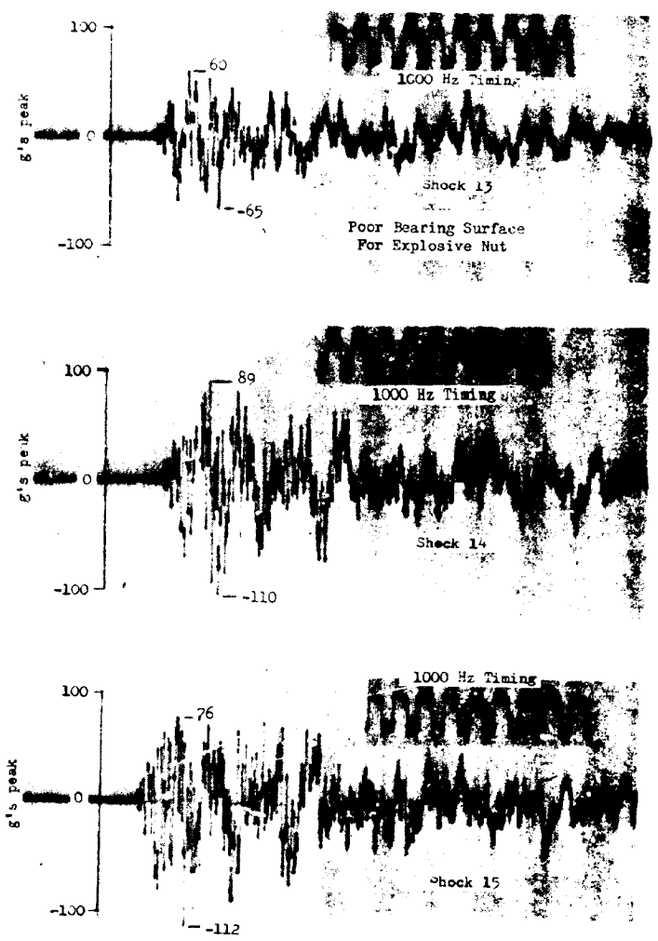
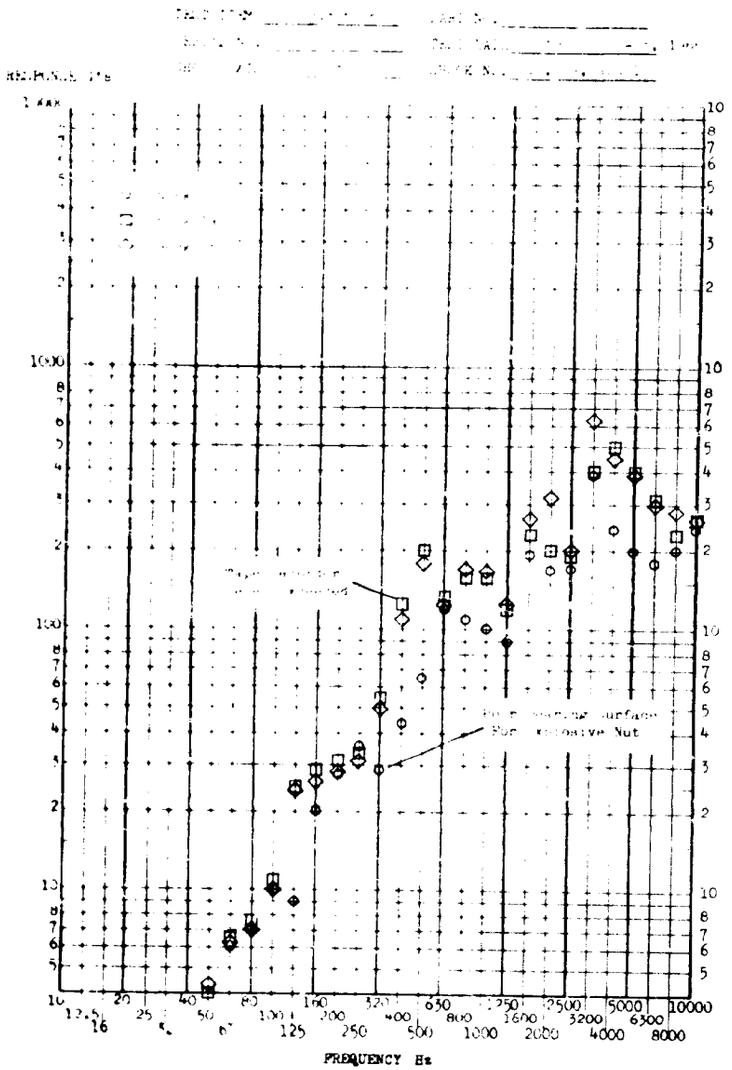




FIGURE 11.B.1-123



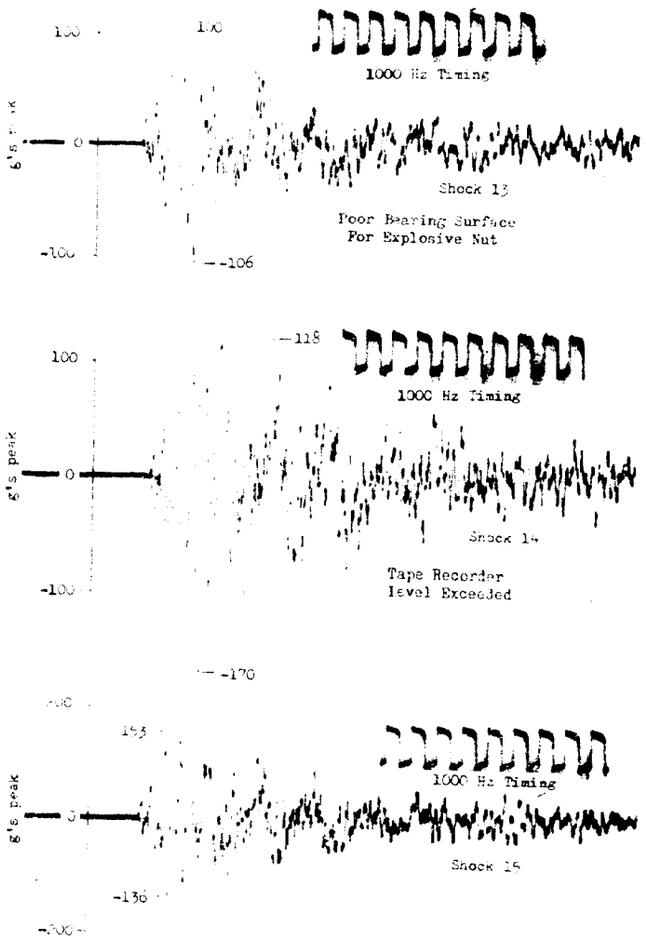
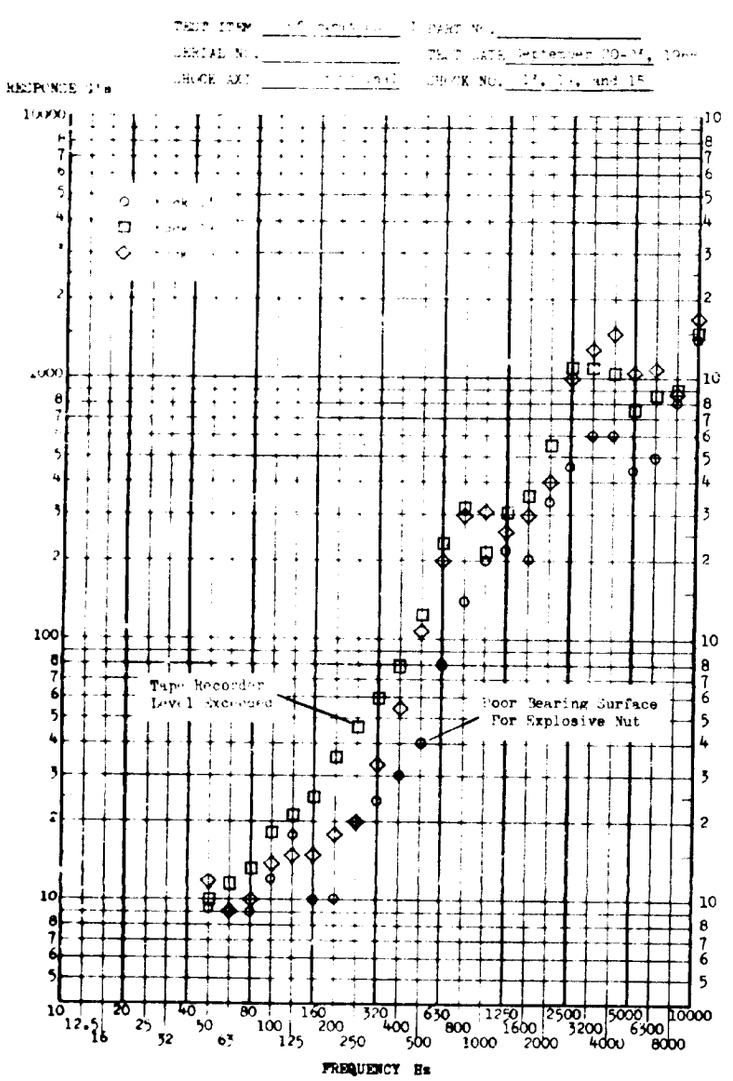




FIGURE II,B.1-124



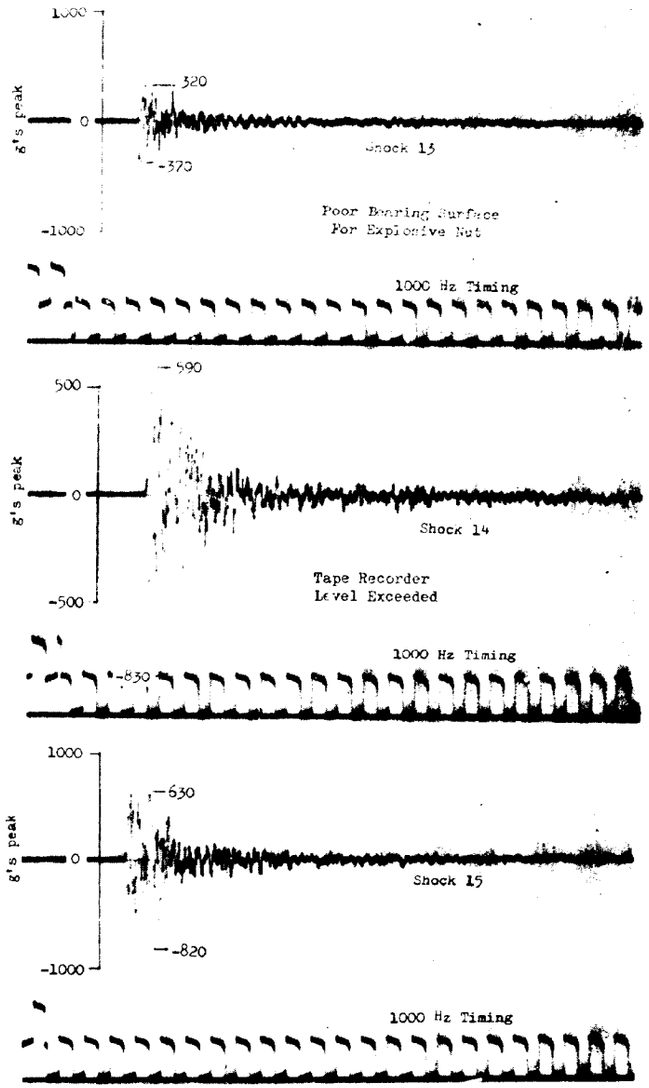
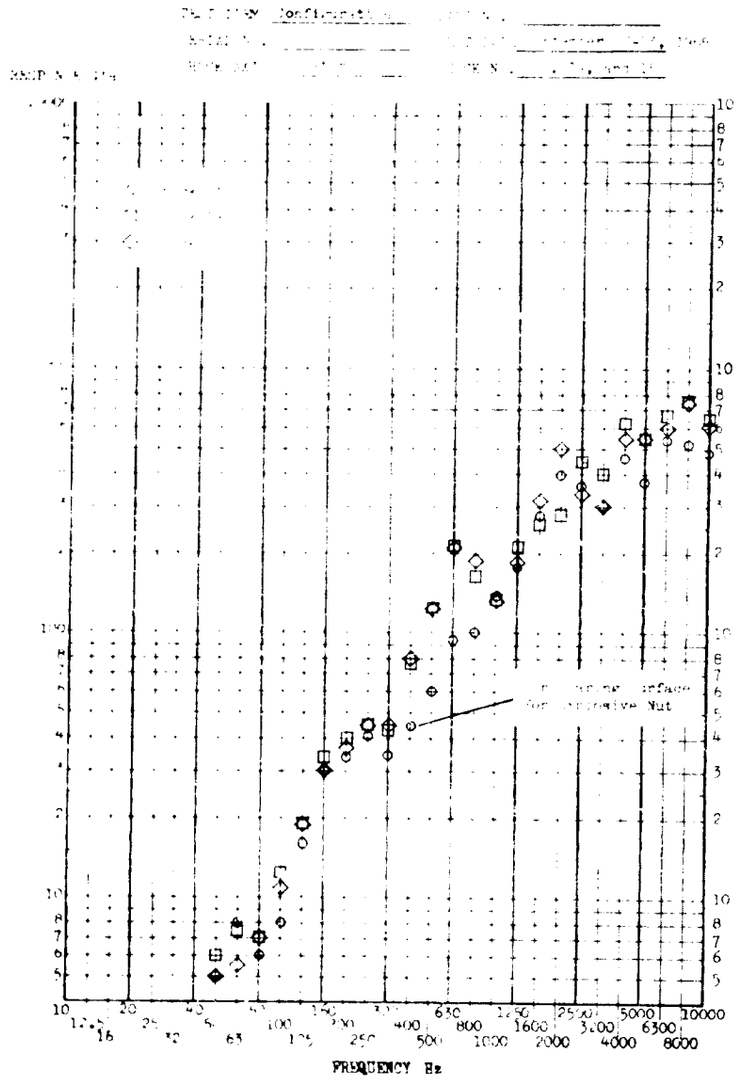




FIGURE II.B.1-125



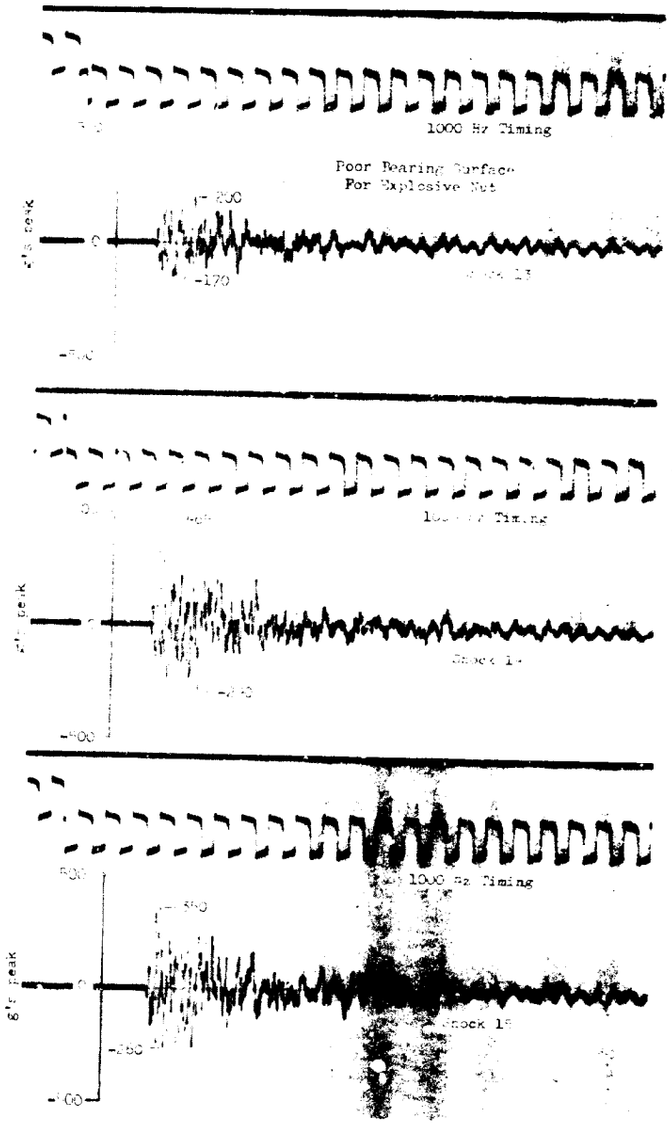
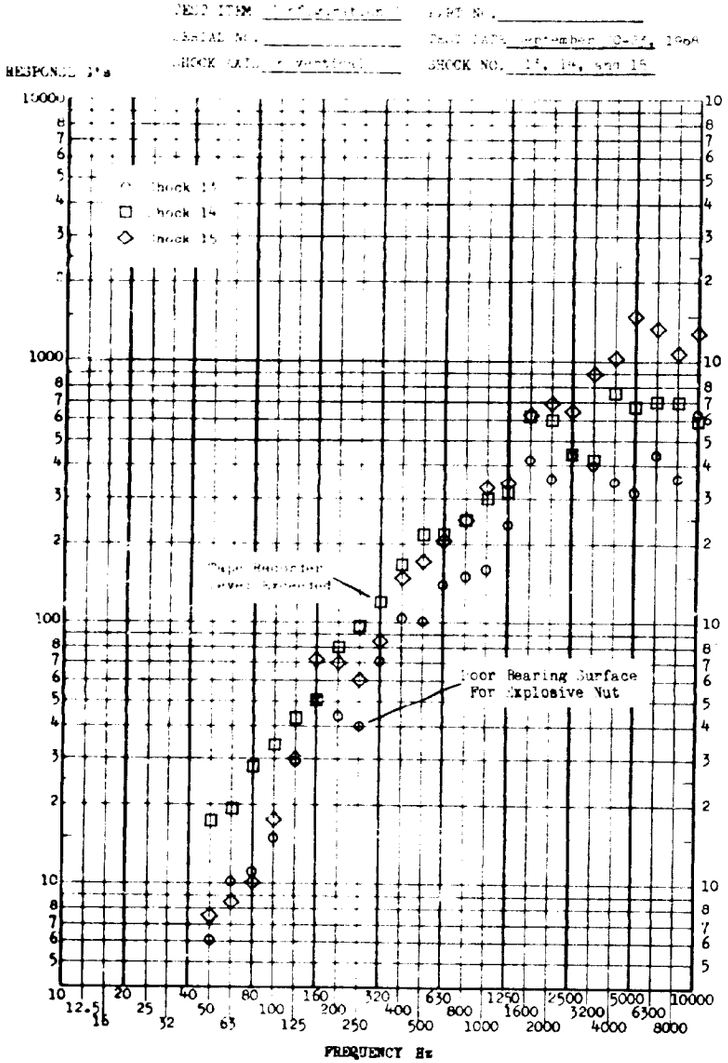




FIGURE 11.B.1-126



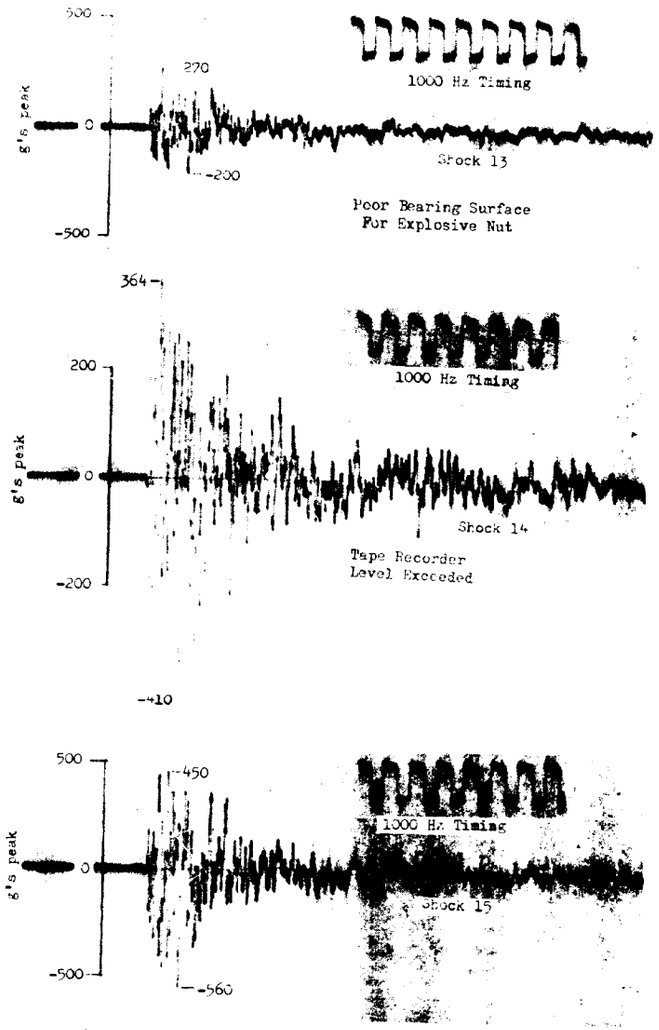
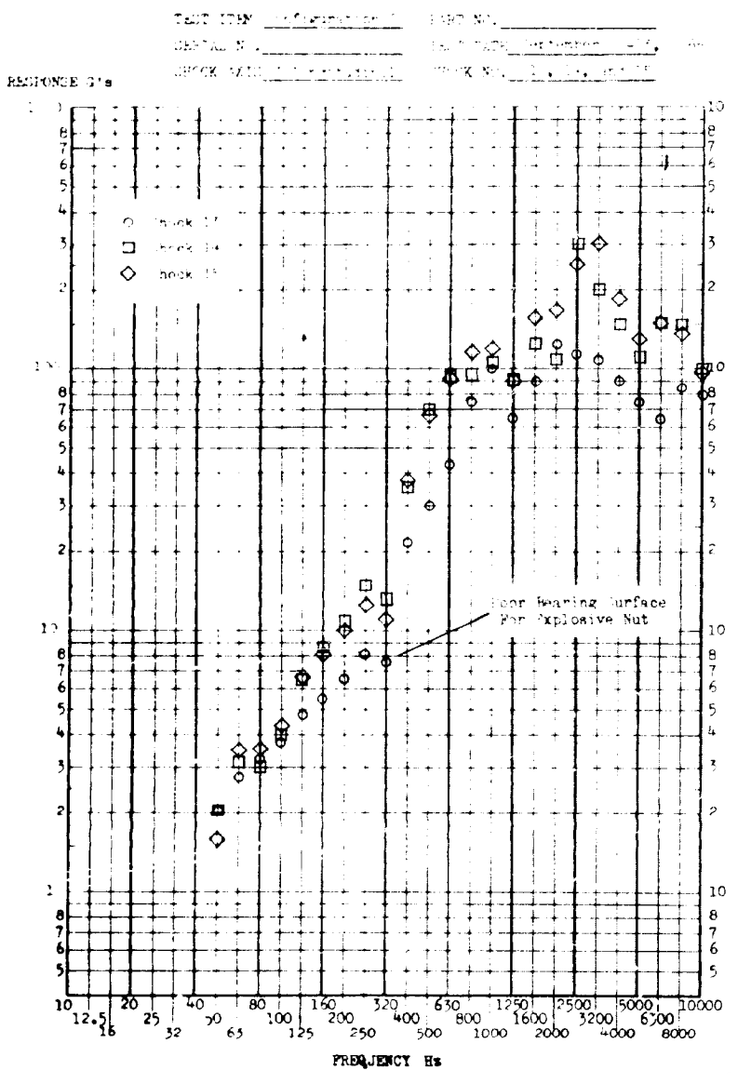




FIGURE II.B.1-127



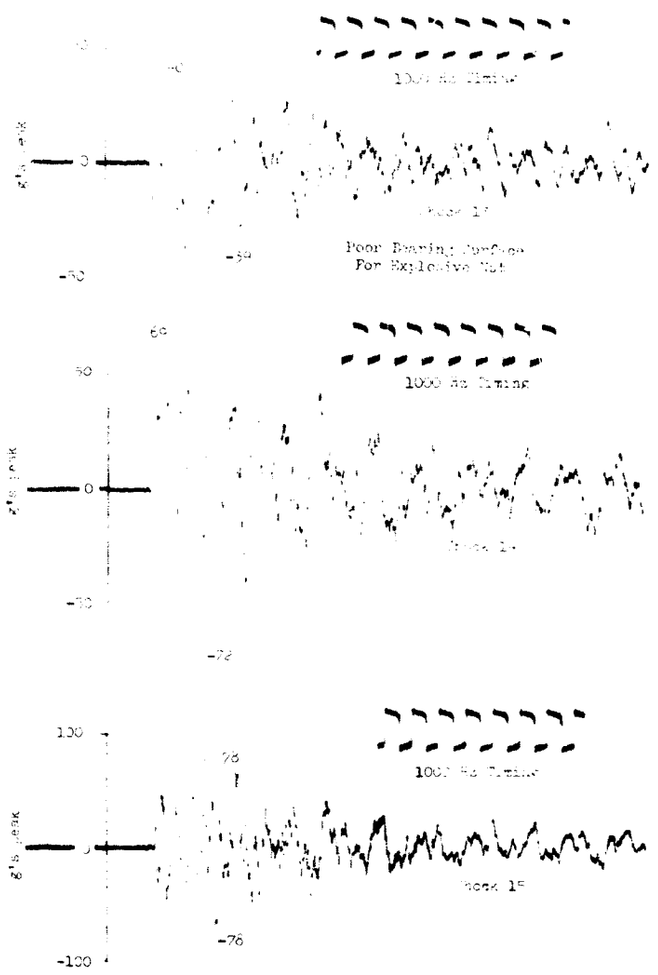




FIGURE II.B.1-128

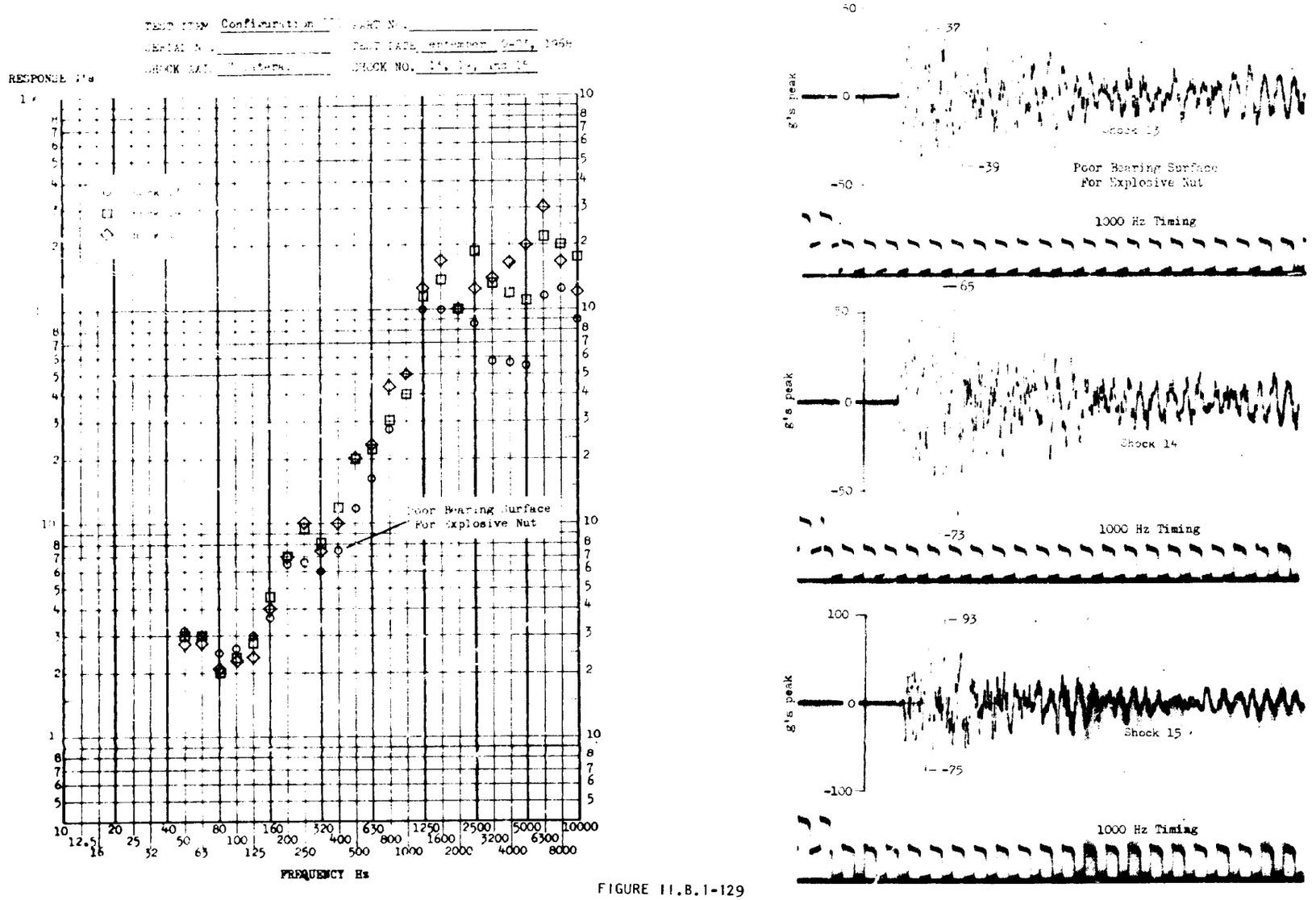
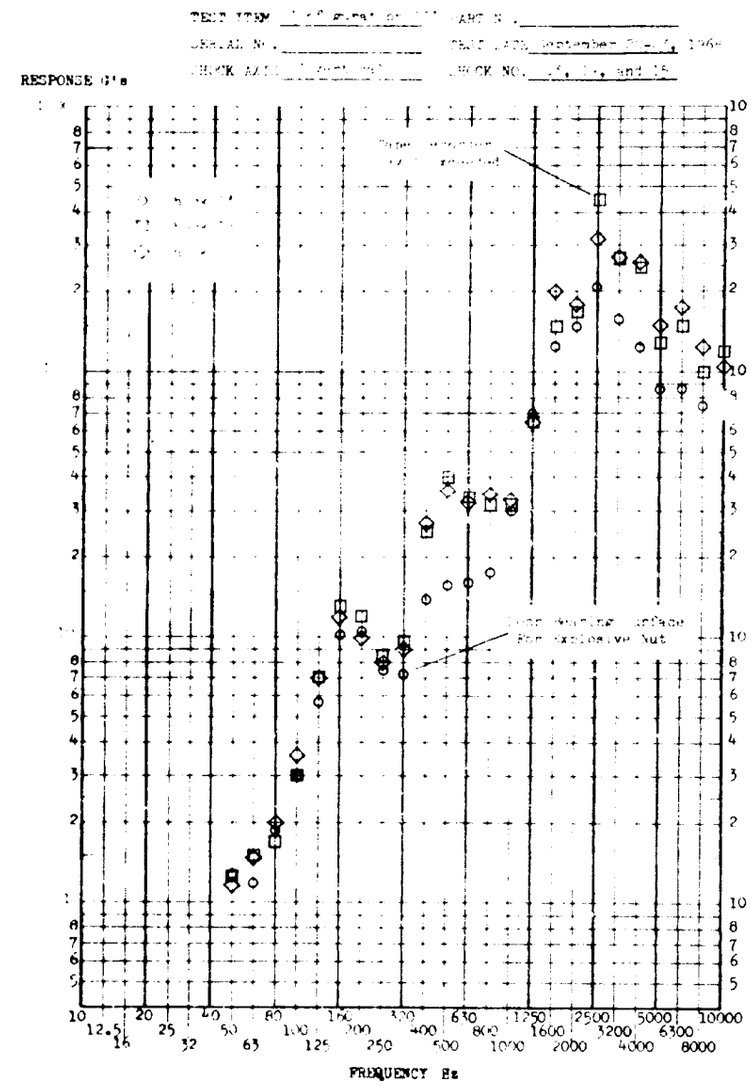






FIGURE 11.B.1-129



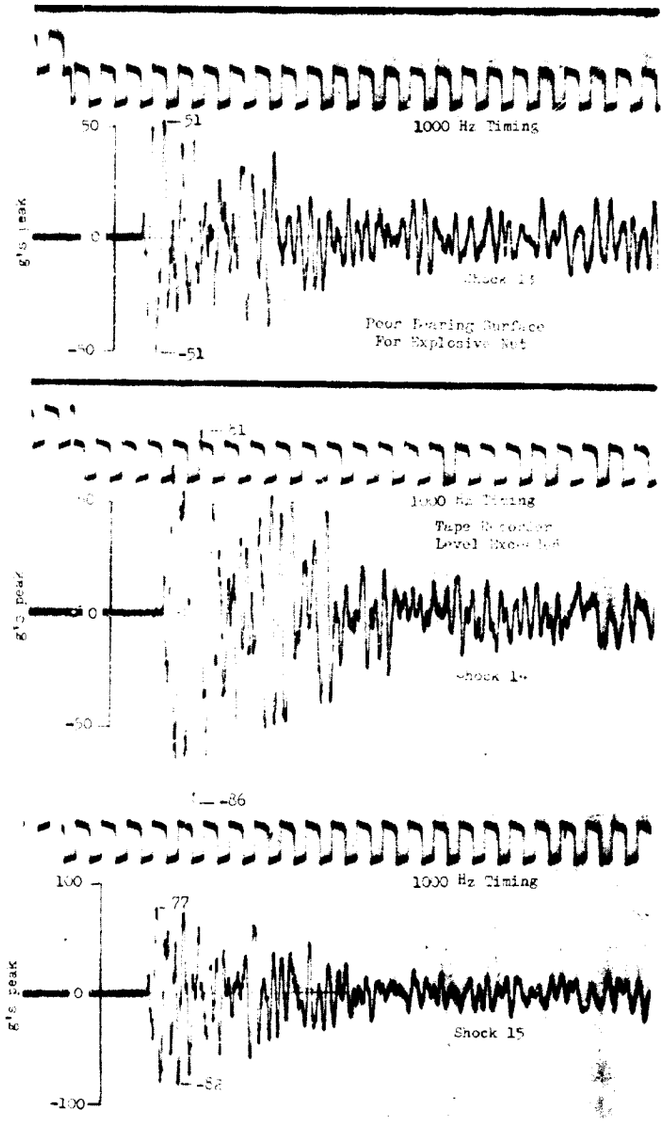




FIGURE 11.8.1-130

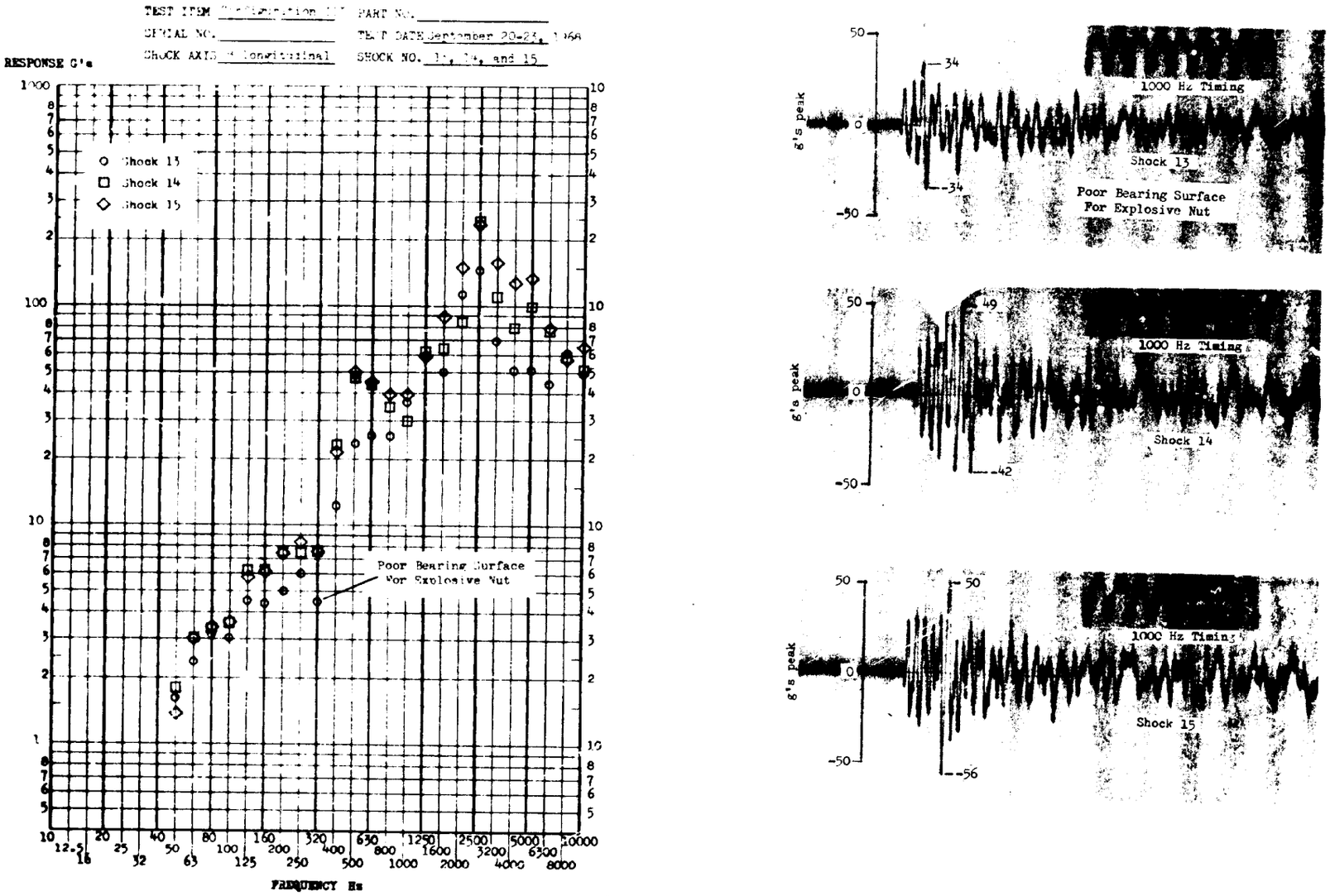
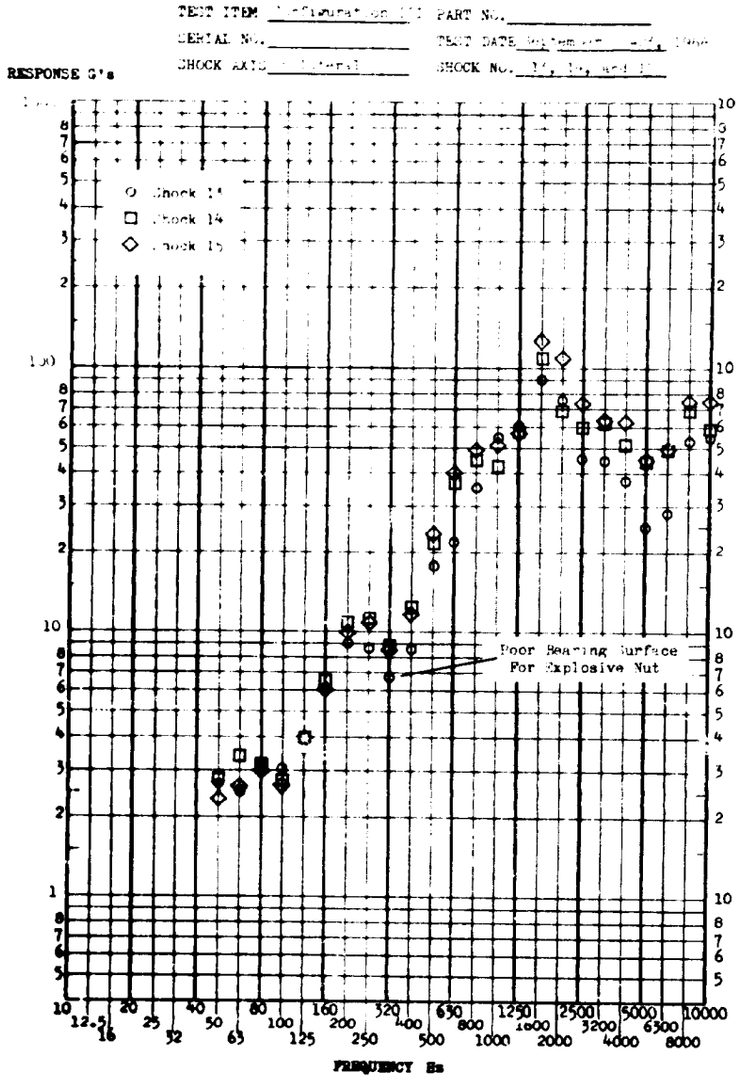






FIGURE 11.B.1-131



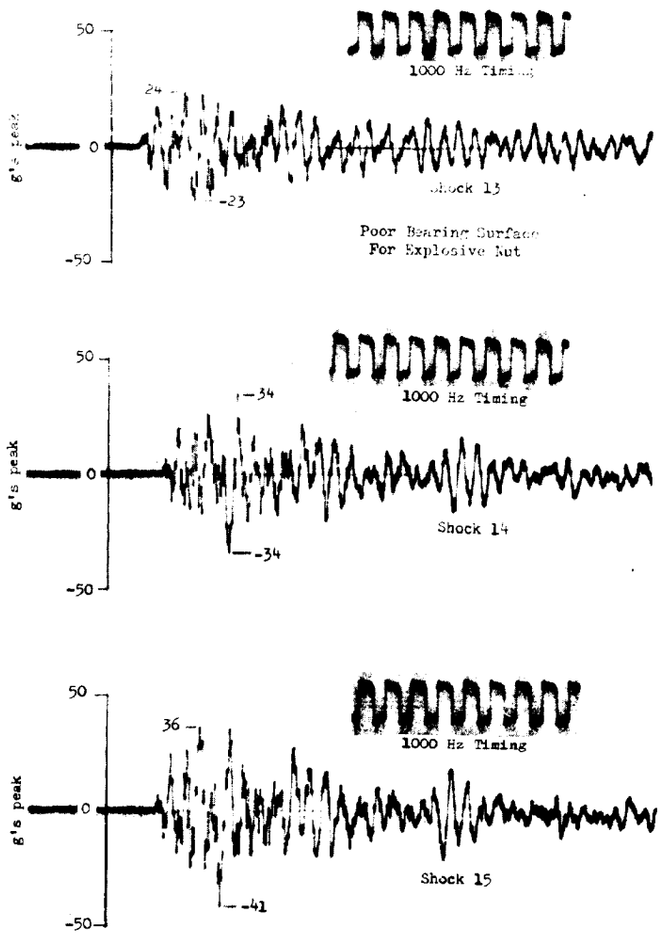
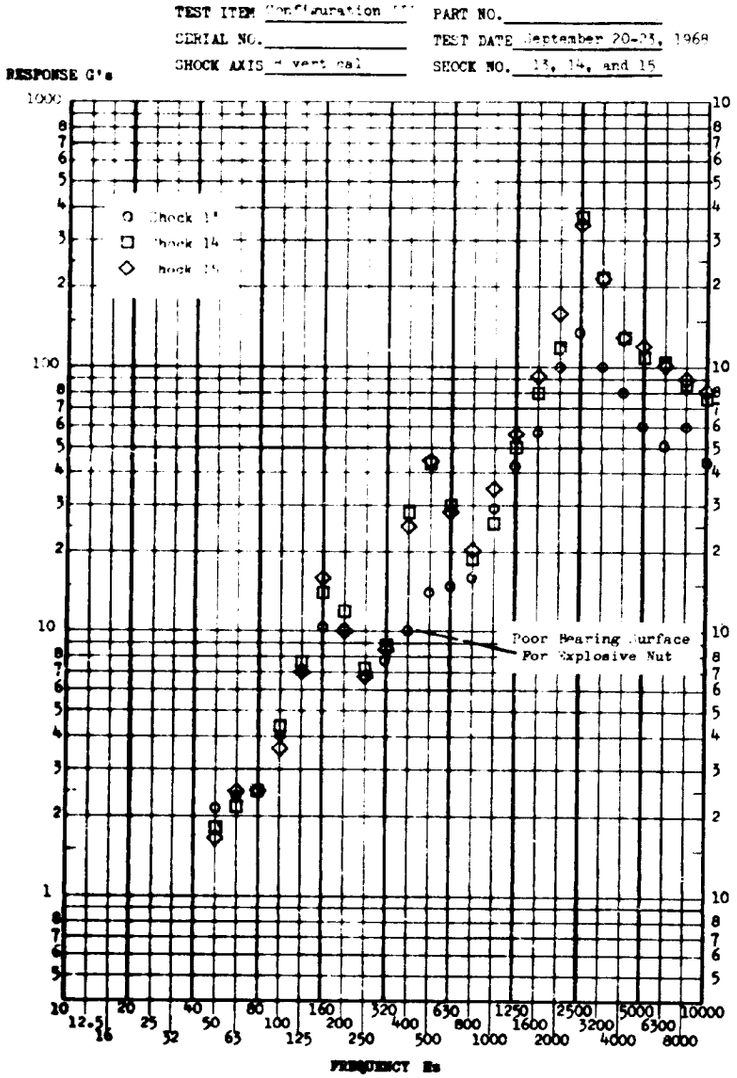




FIGURE 11.B.1-132



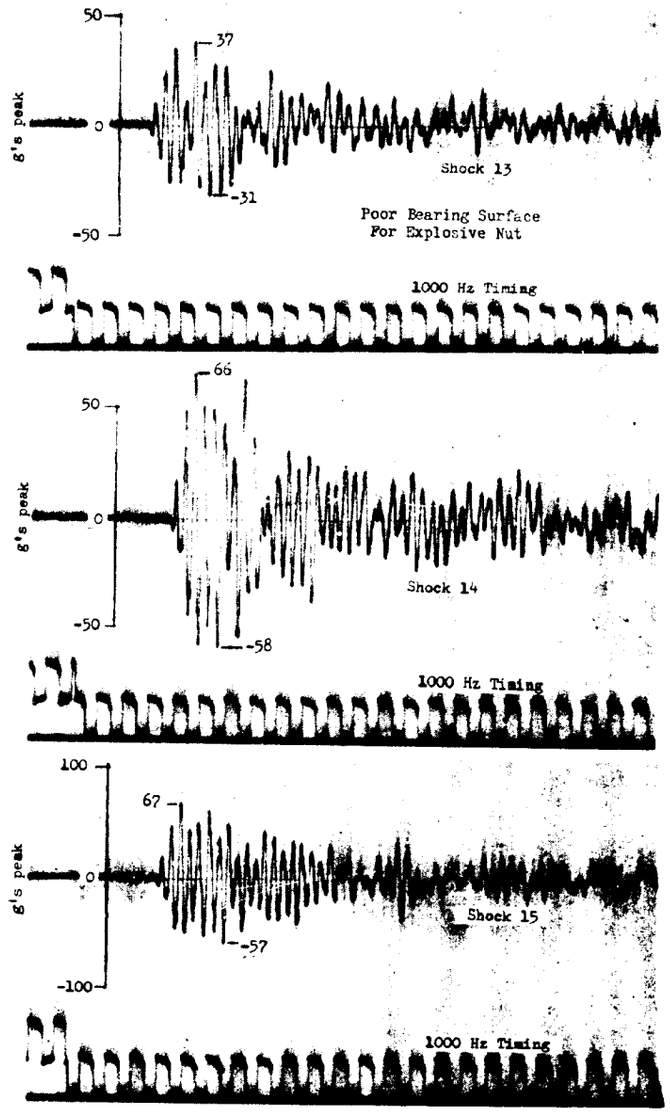
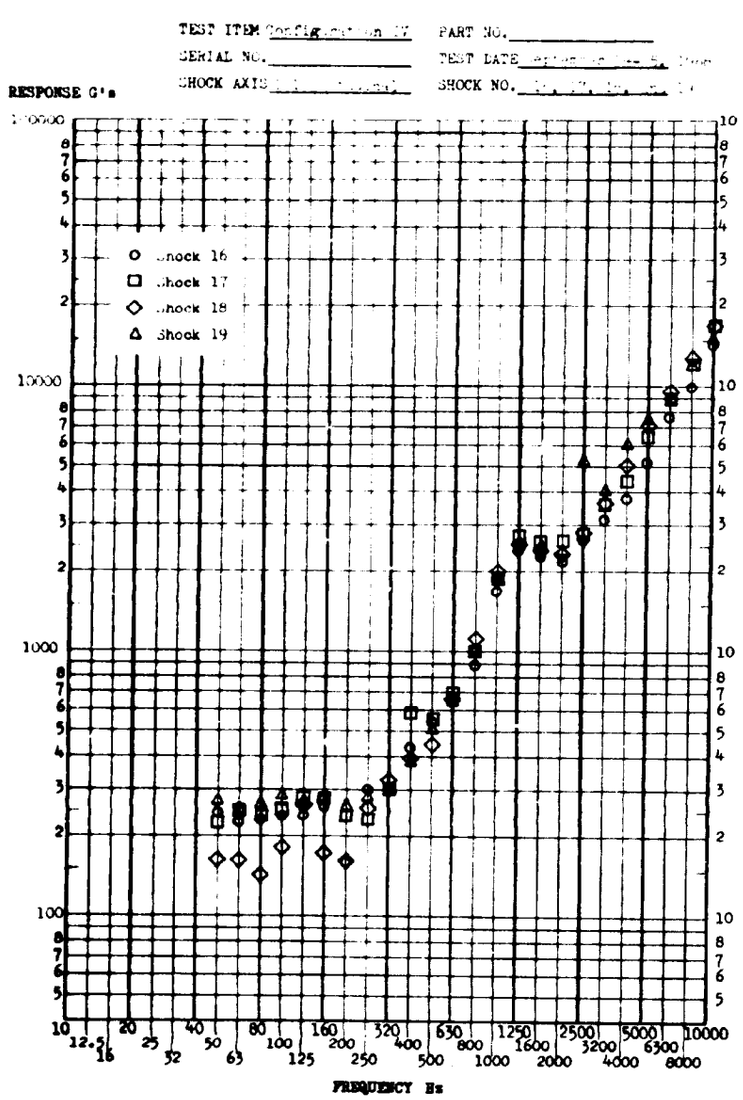




FIGURE II.B.1-133



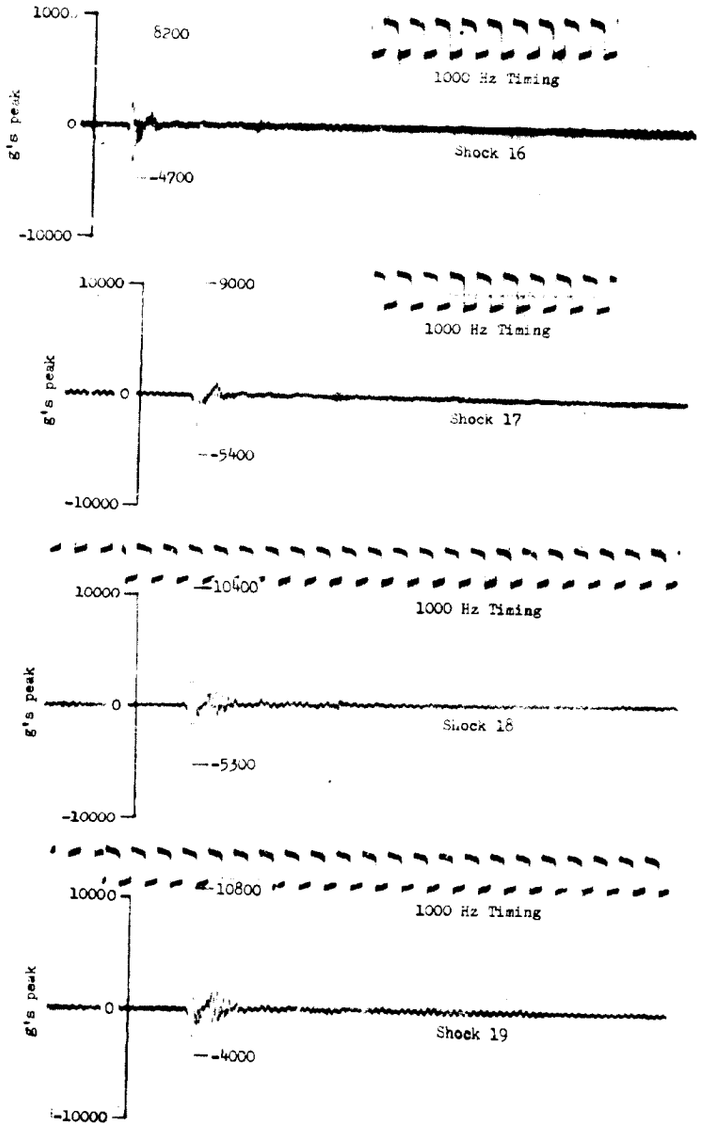




FIGURE 11.B.1-134

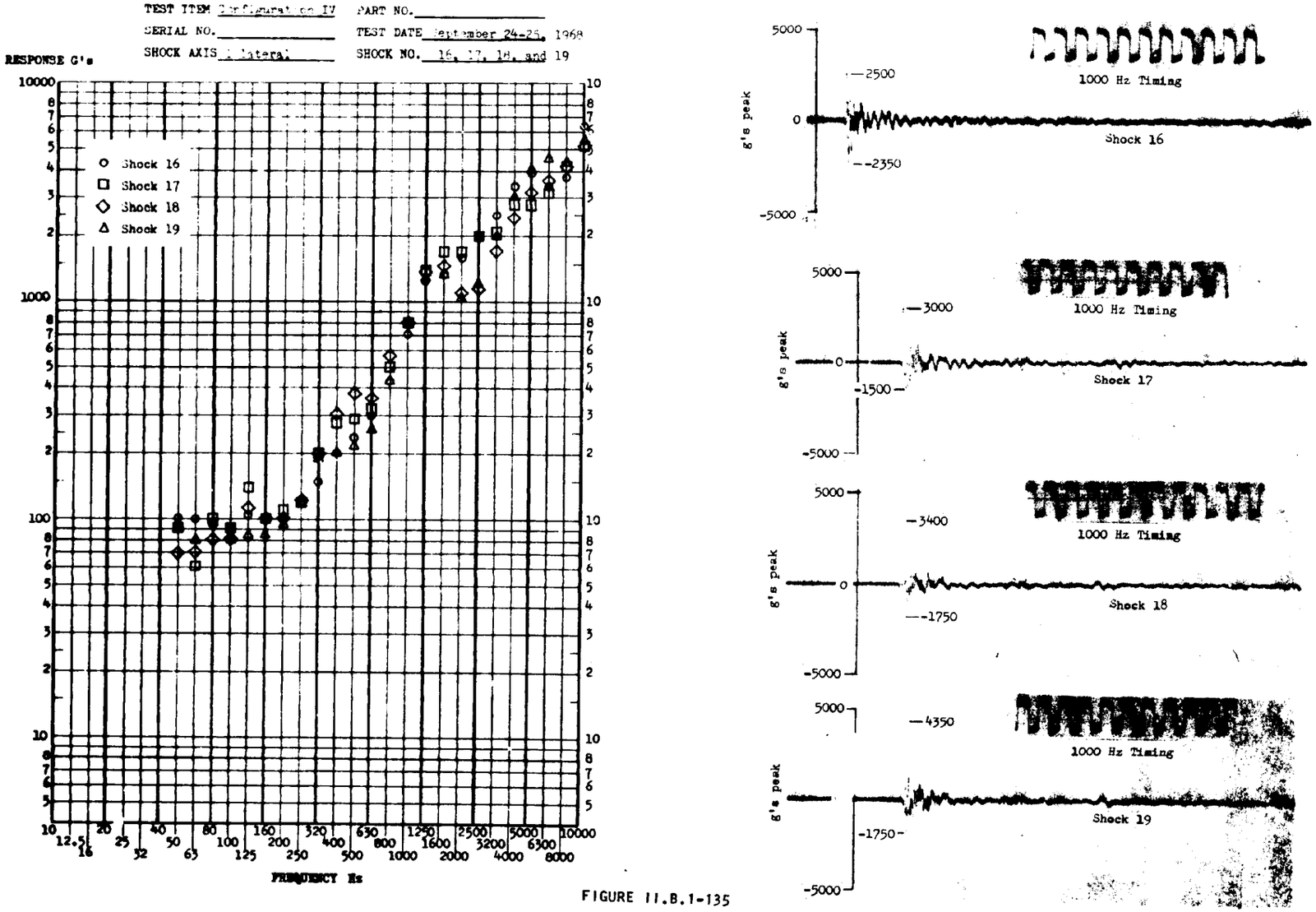



FIGURE II.B.1-135

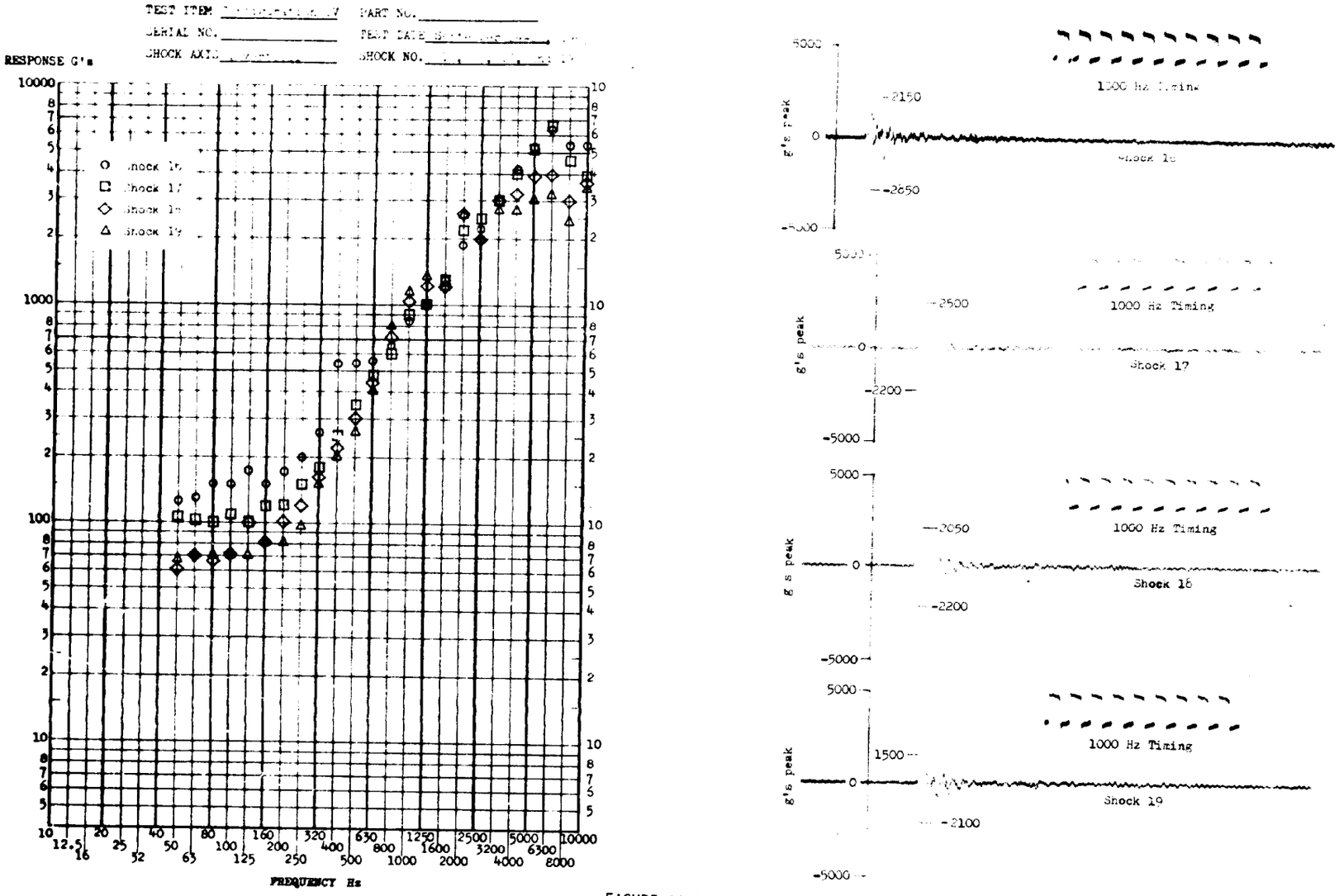



FIGURE 11.B.1-136

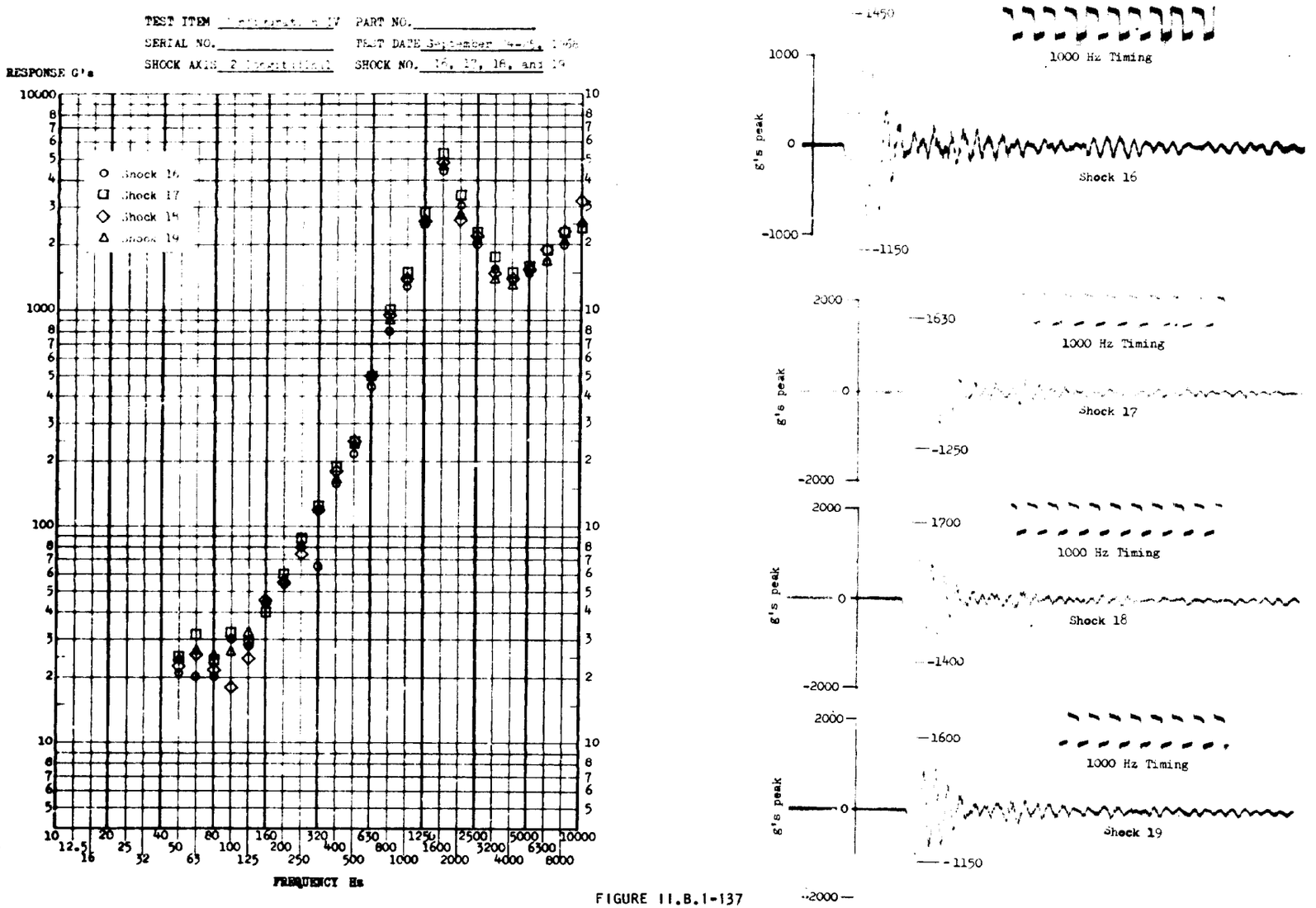



FIGURE 11.B.1-137

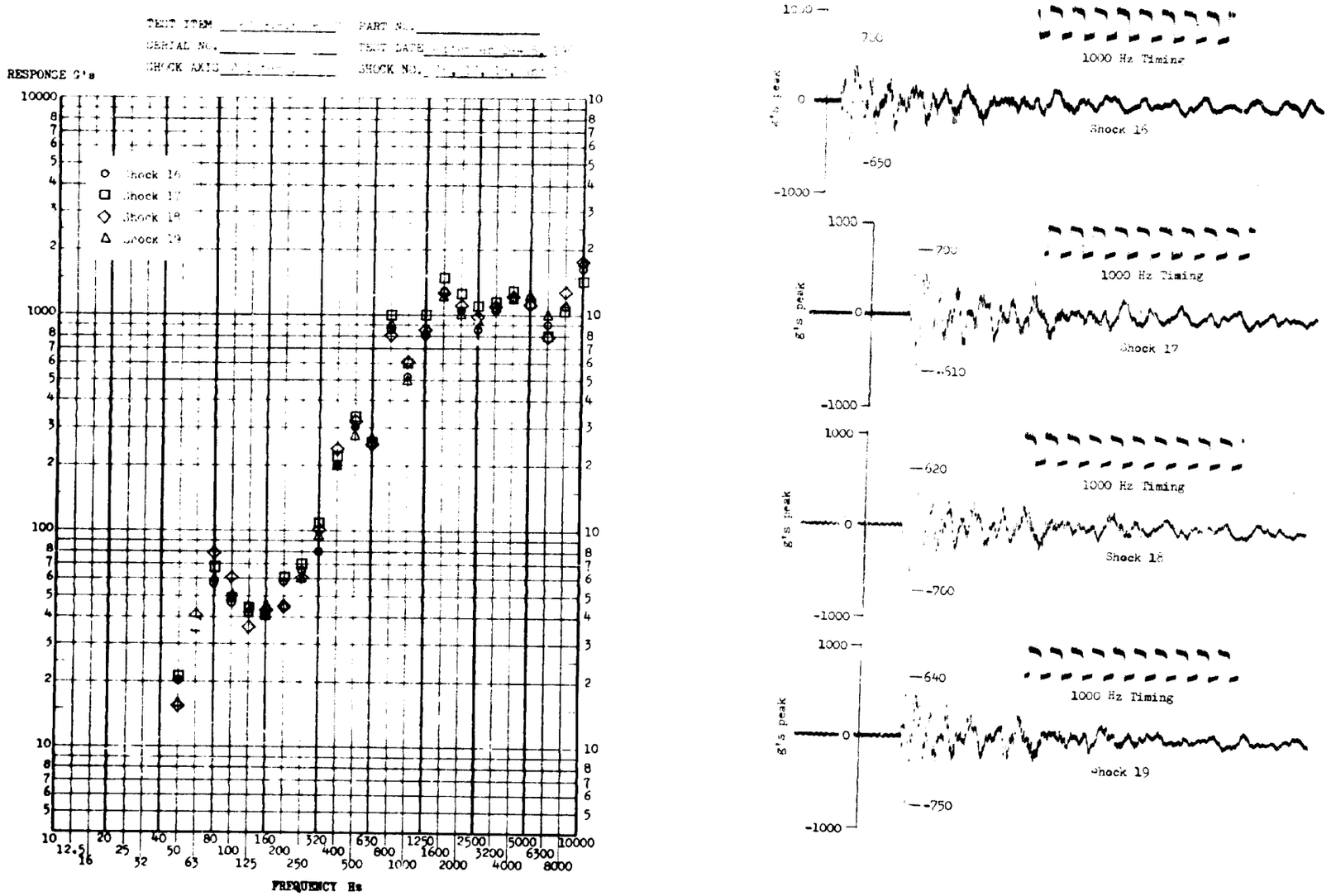



FIGURE II.B.1-138

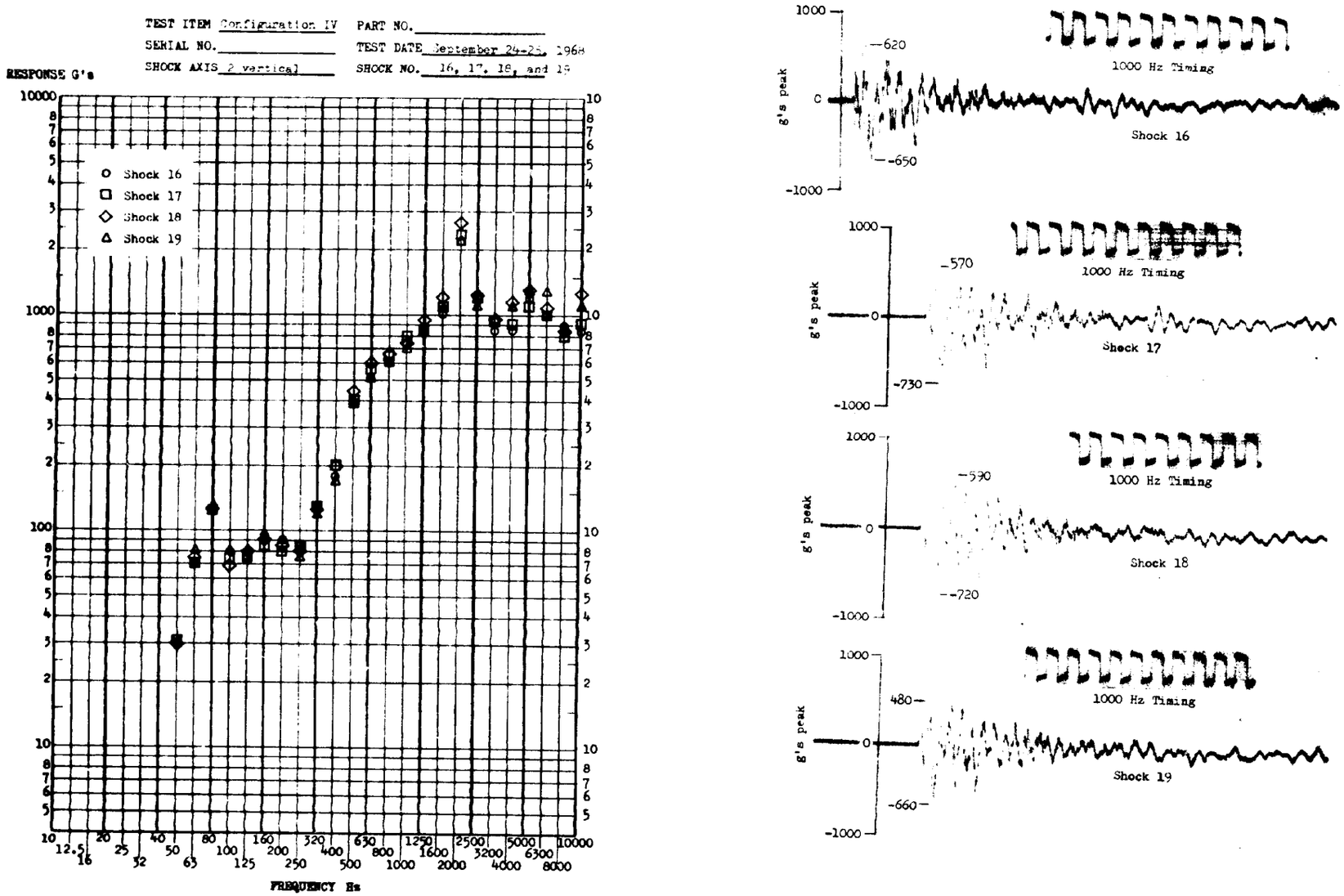
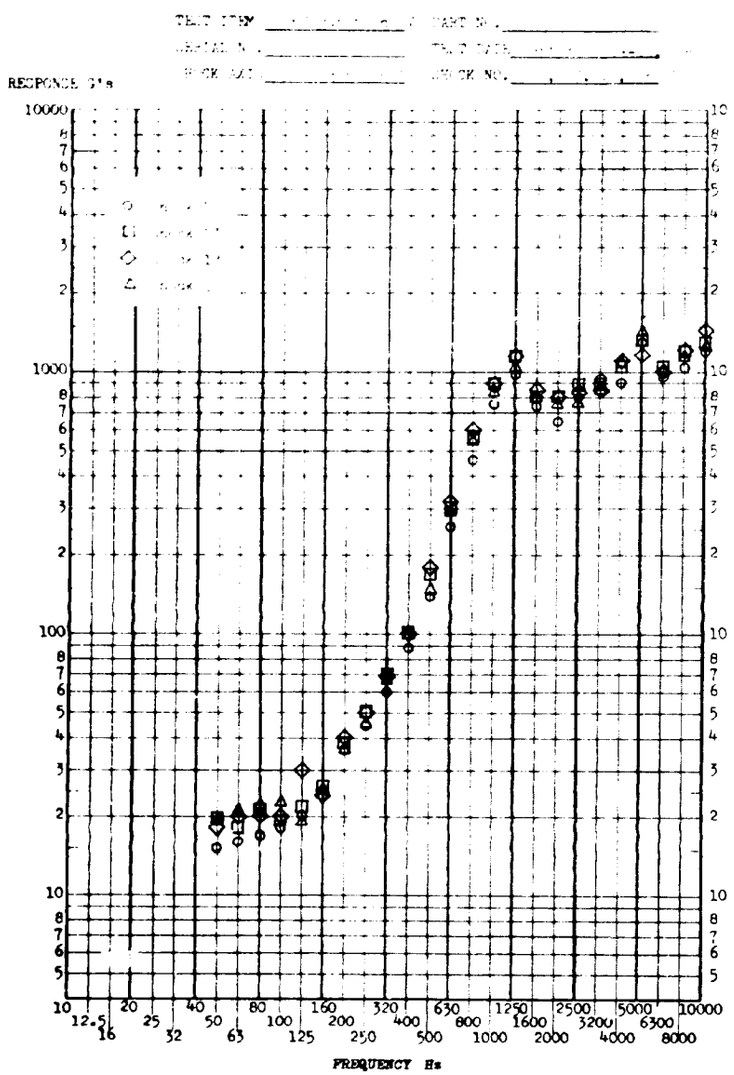



FIGURE II.B.1-139



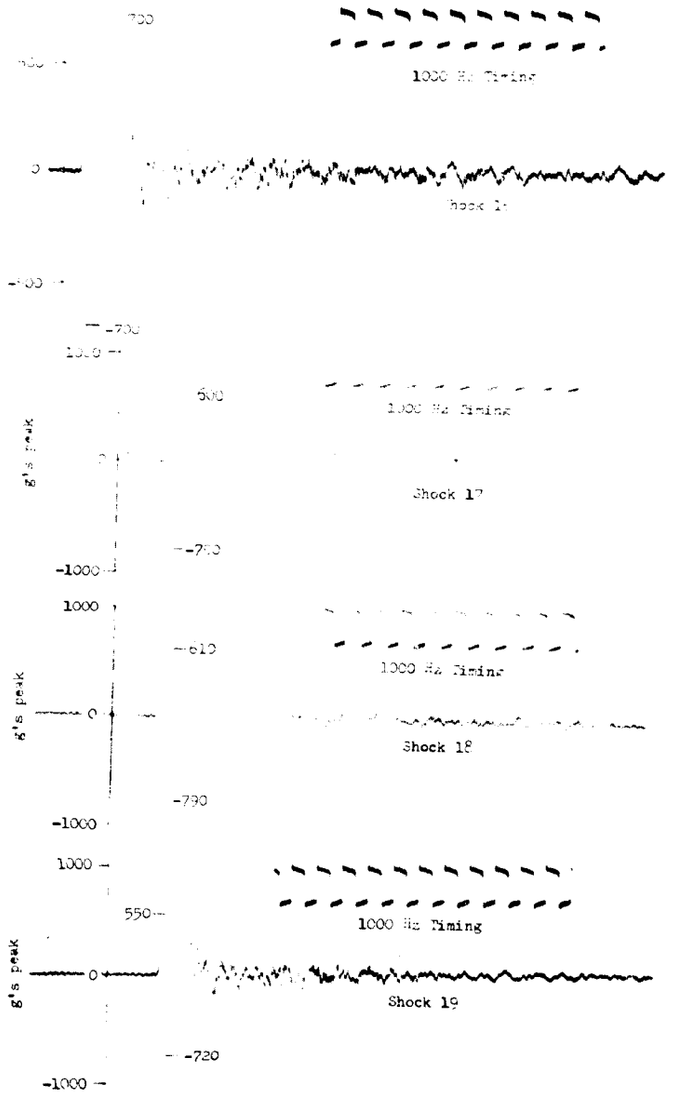




FIGURE 11.8.1-40

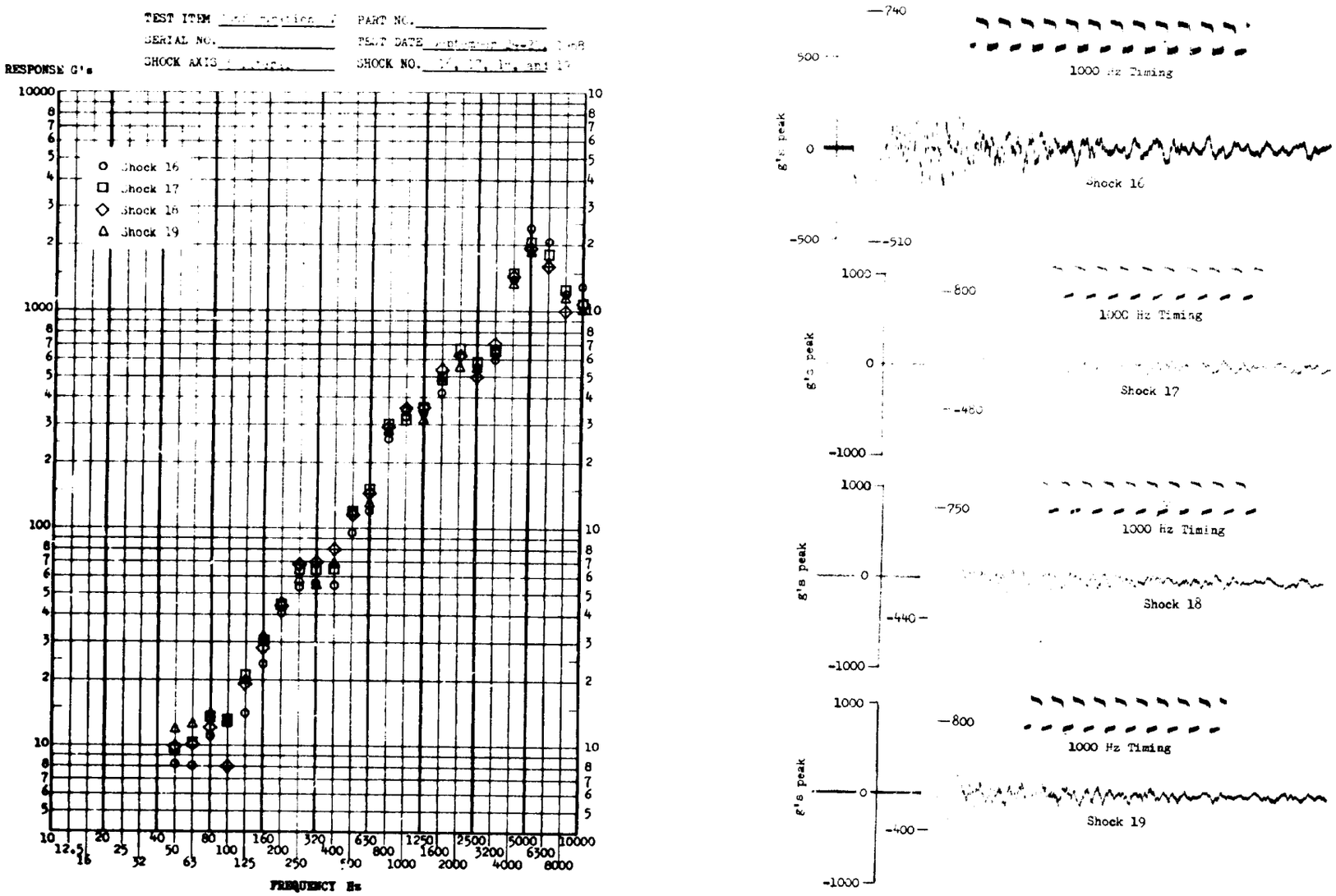



FIGURE 11.8.1-141

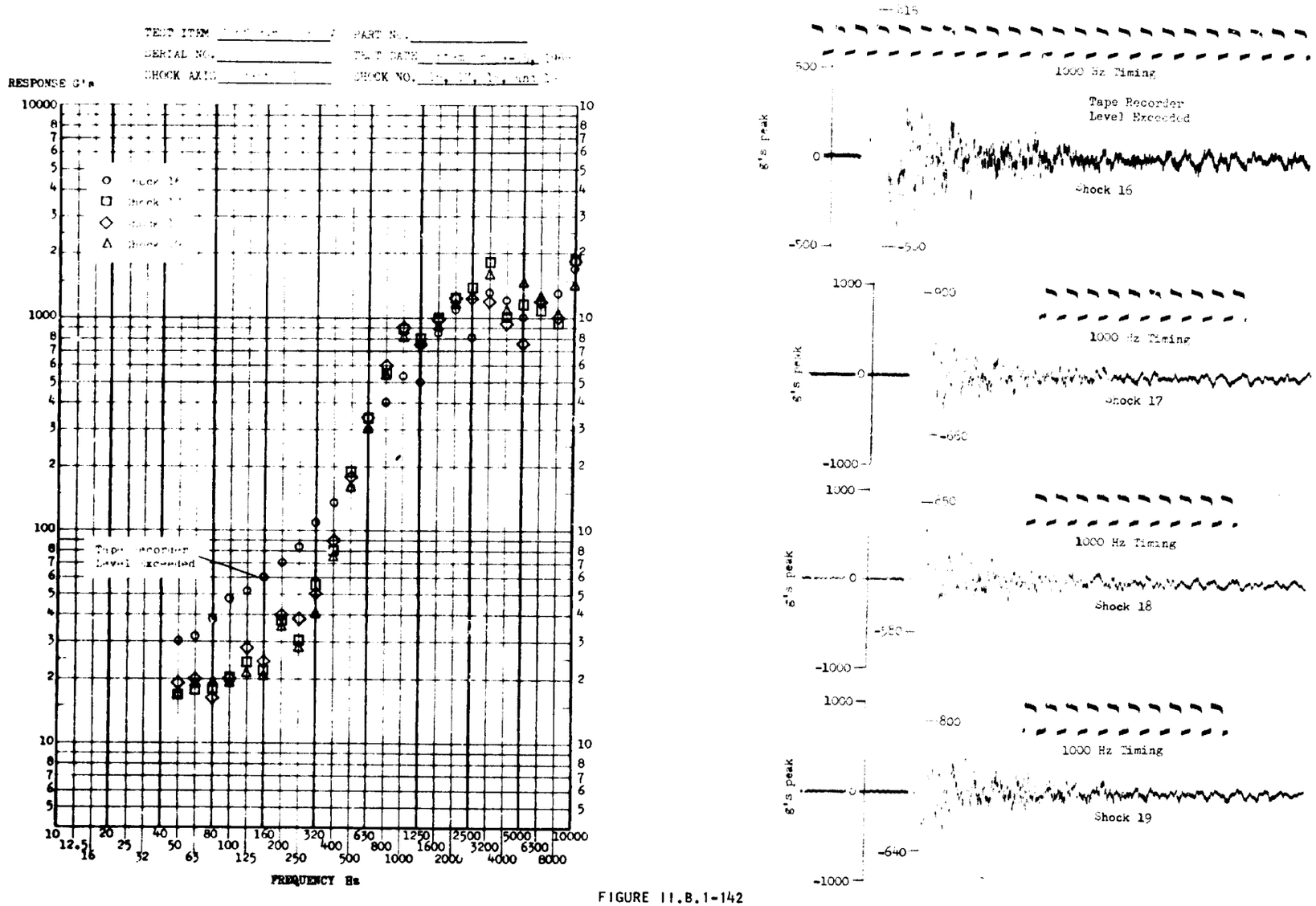
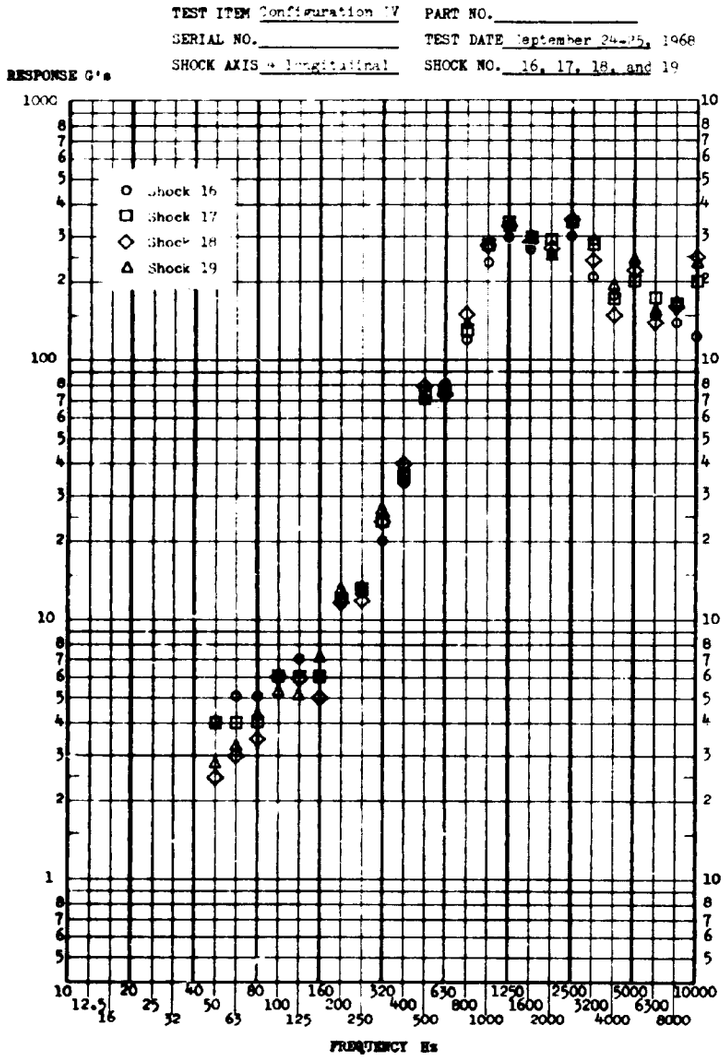






FIGURE 11.B.1-142



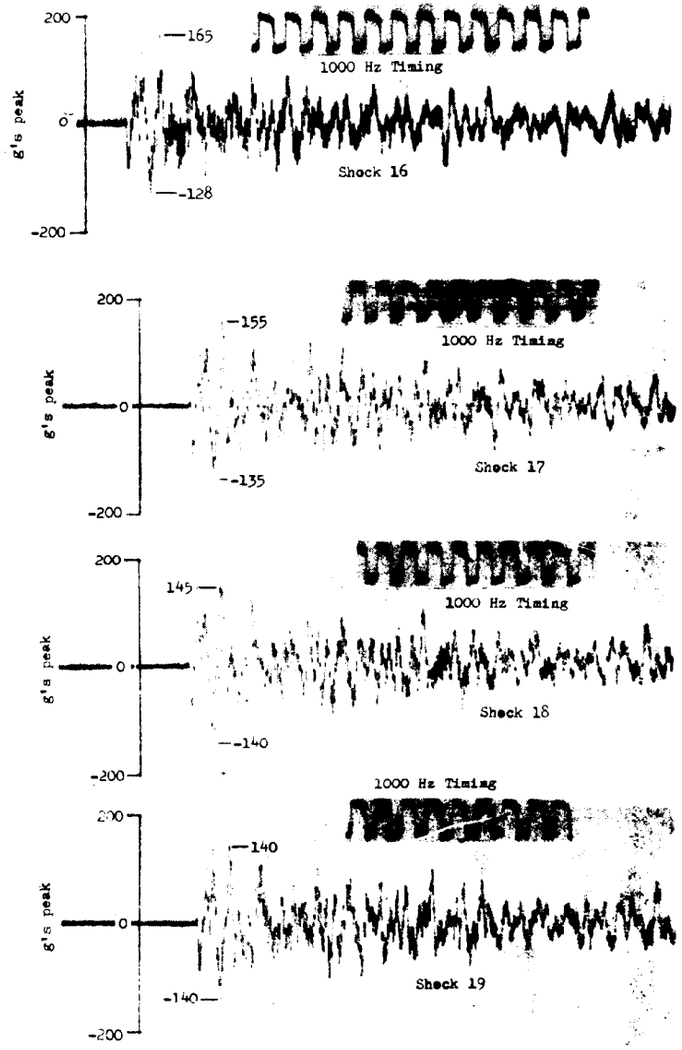




FIGURE II.B.1-143

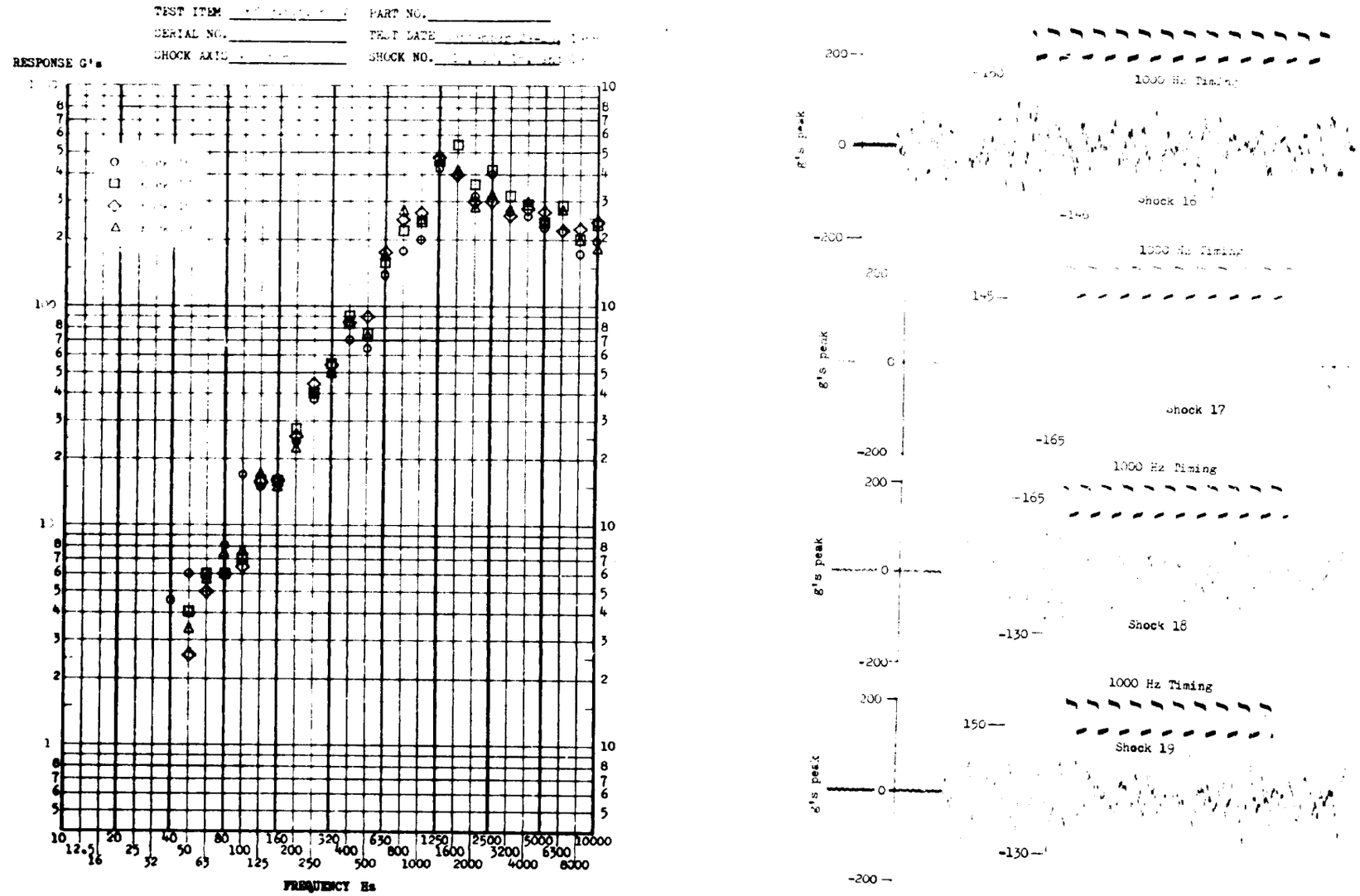



FIGURE 11.B.1-144

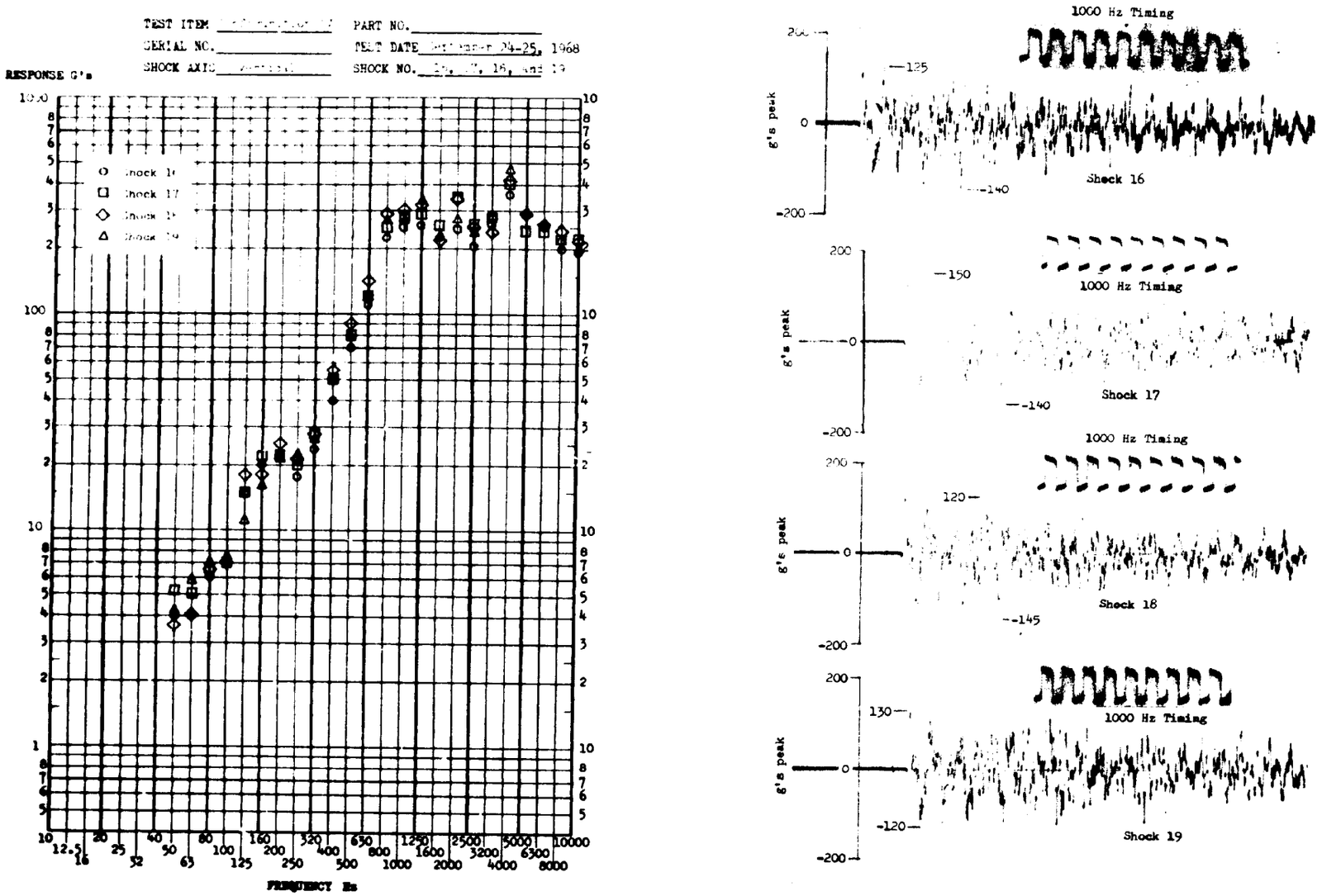
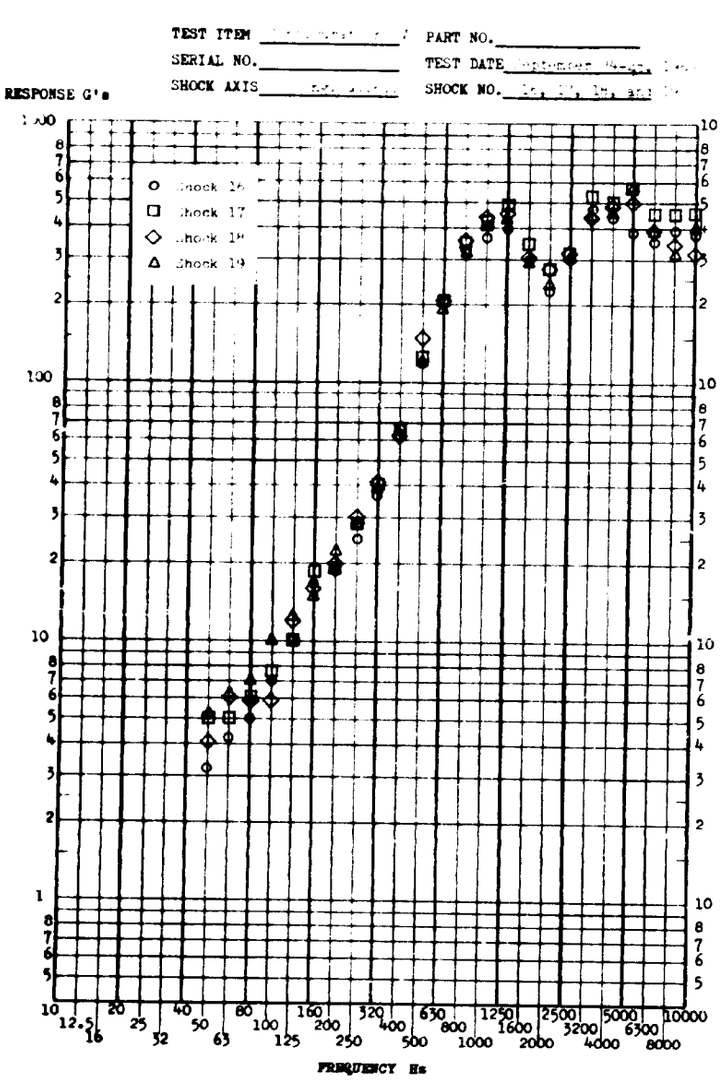



FIGURE 11.8.1-145



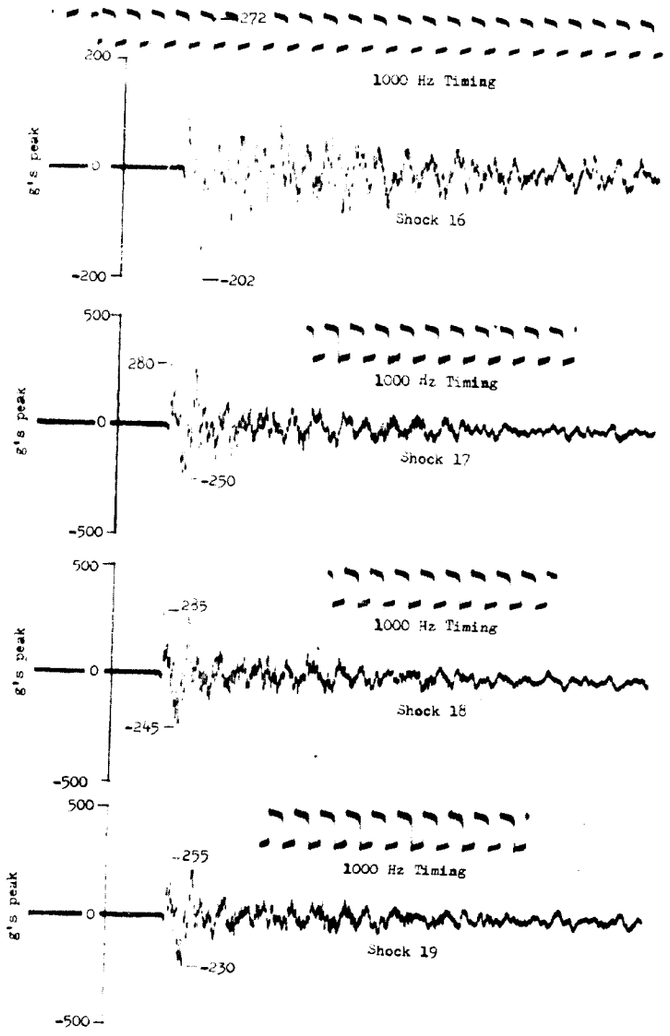
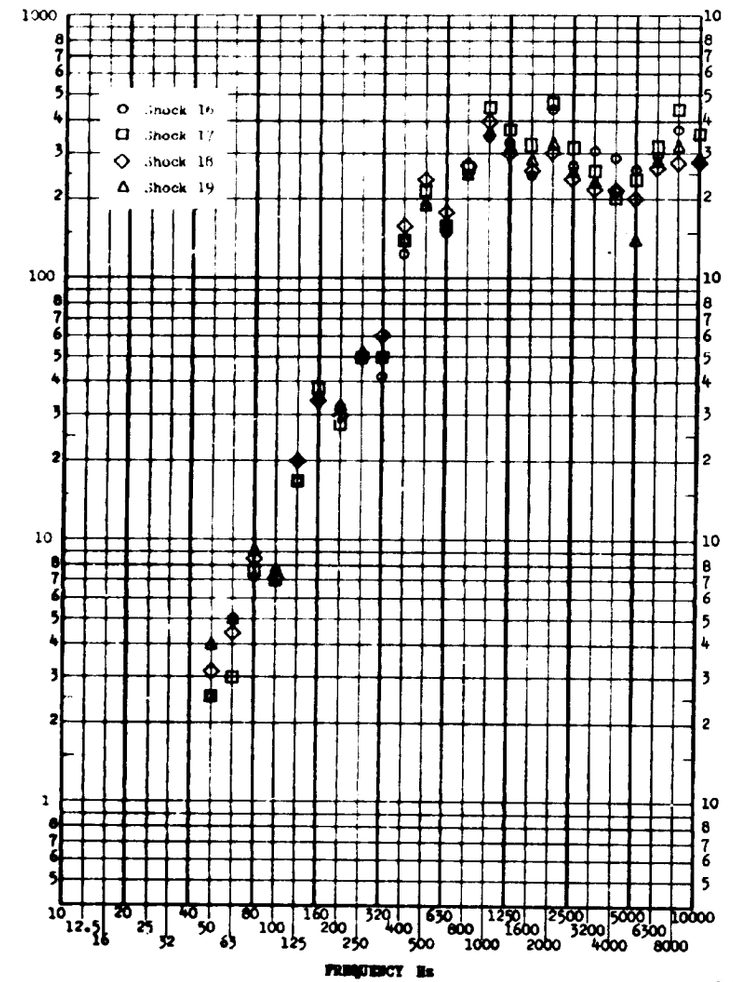




FIGURE 11.8.1-146

TEST ITEM [illegible] PART NO. _____

SERIAL NO. _____ TEST DATE September 24-26, 1969

SHOCK AXIS [illegible] SHOCK NO. 16, 17, 18, and 19



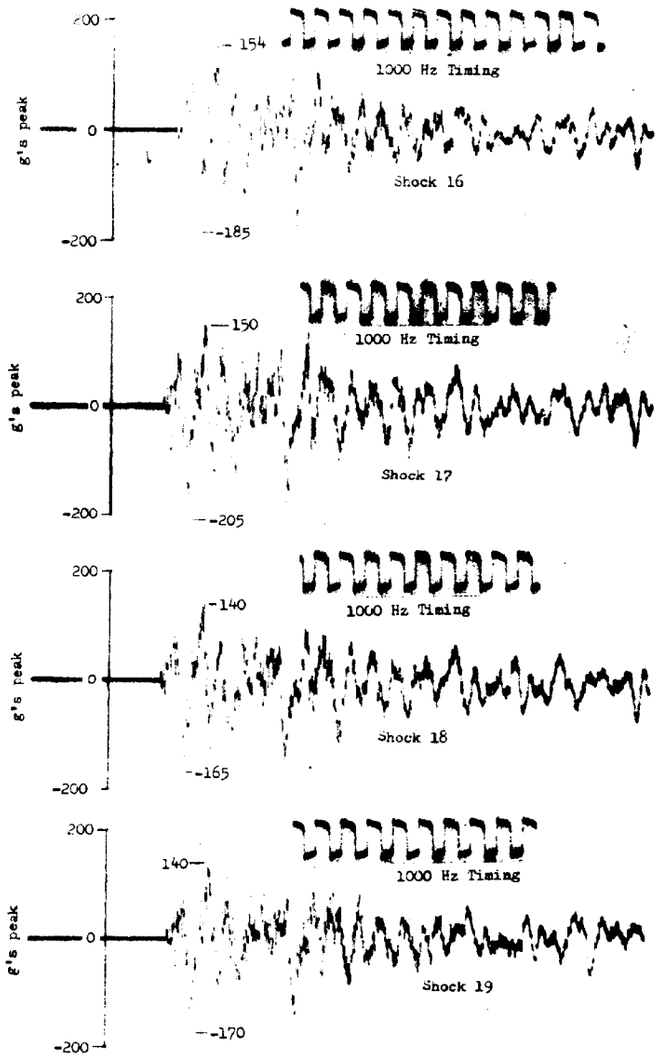




FIGURE II.B.1-147

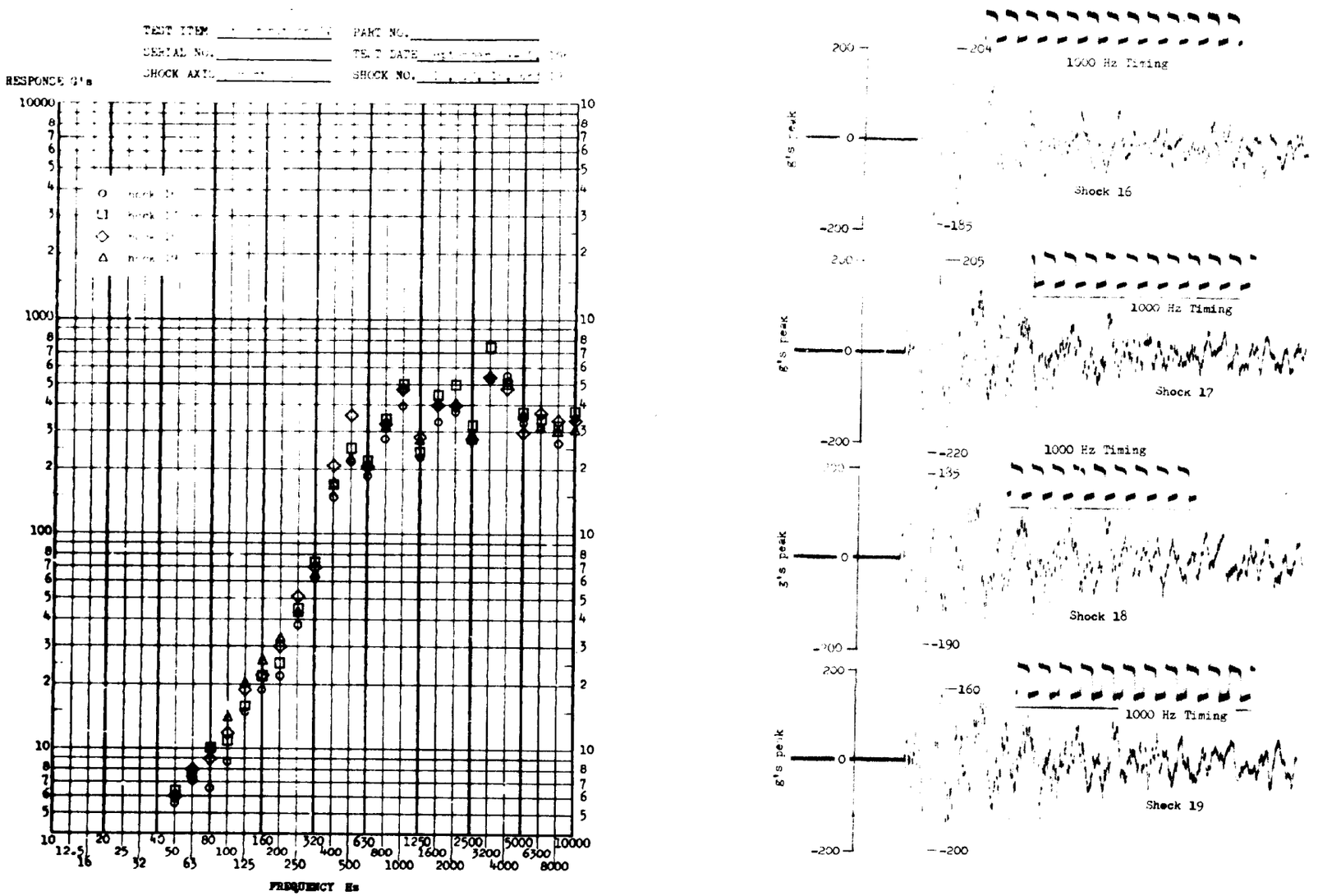






FIGURE II.B.1-148

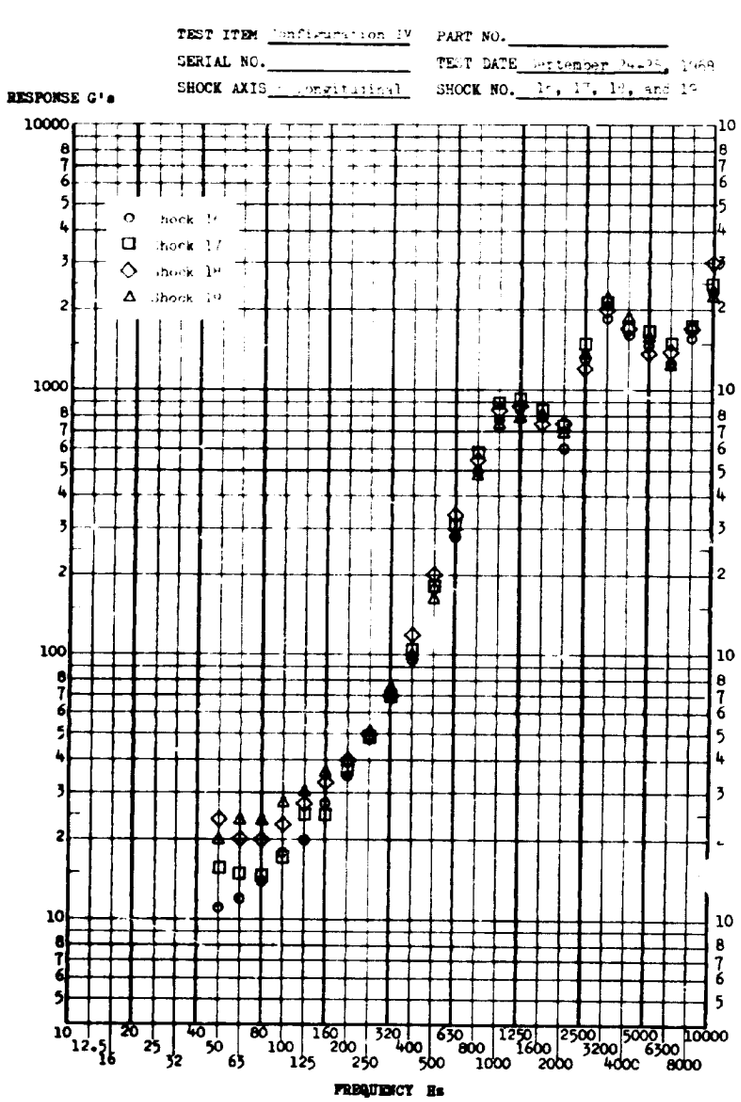
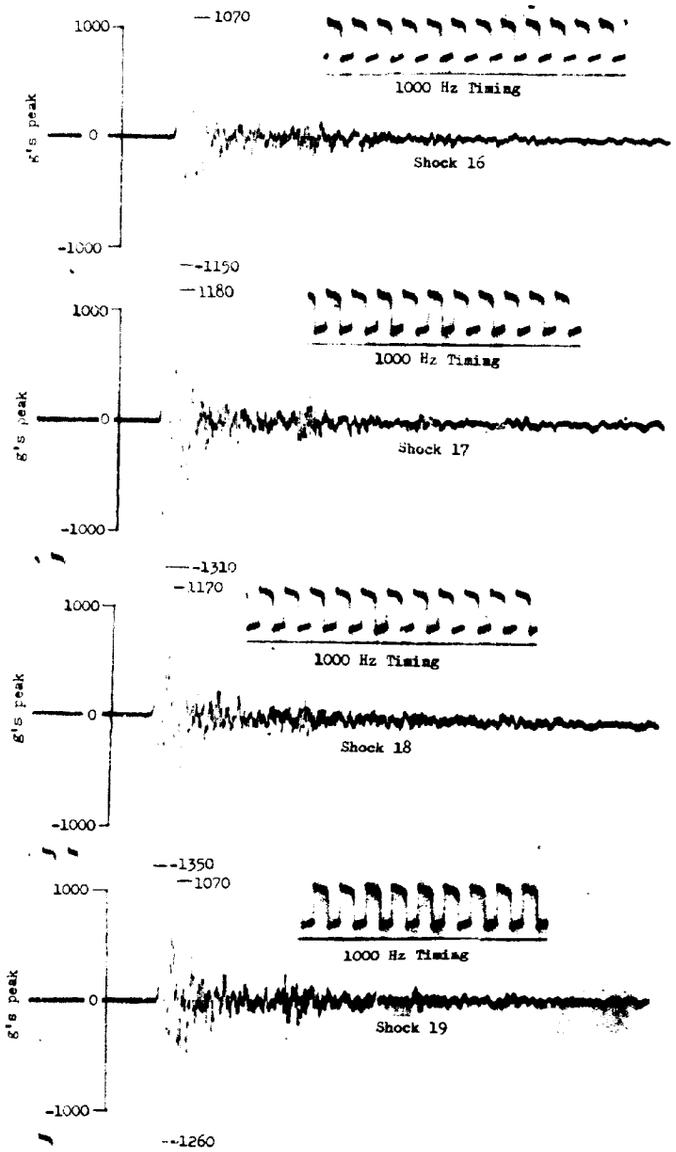



FIGURE II.B.1-149



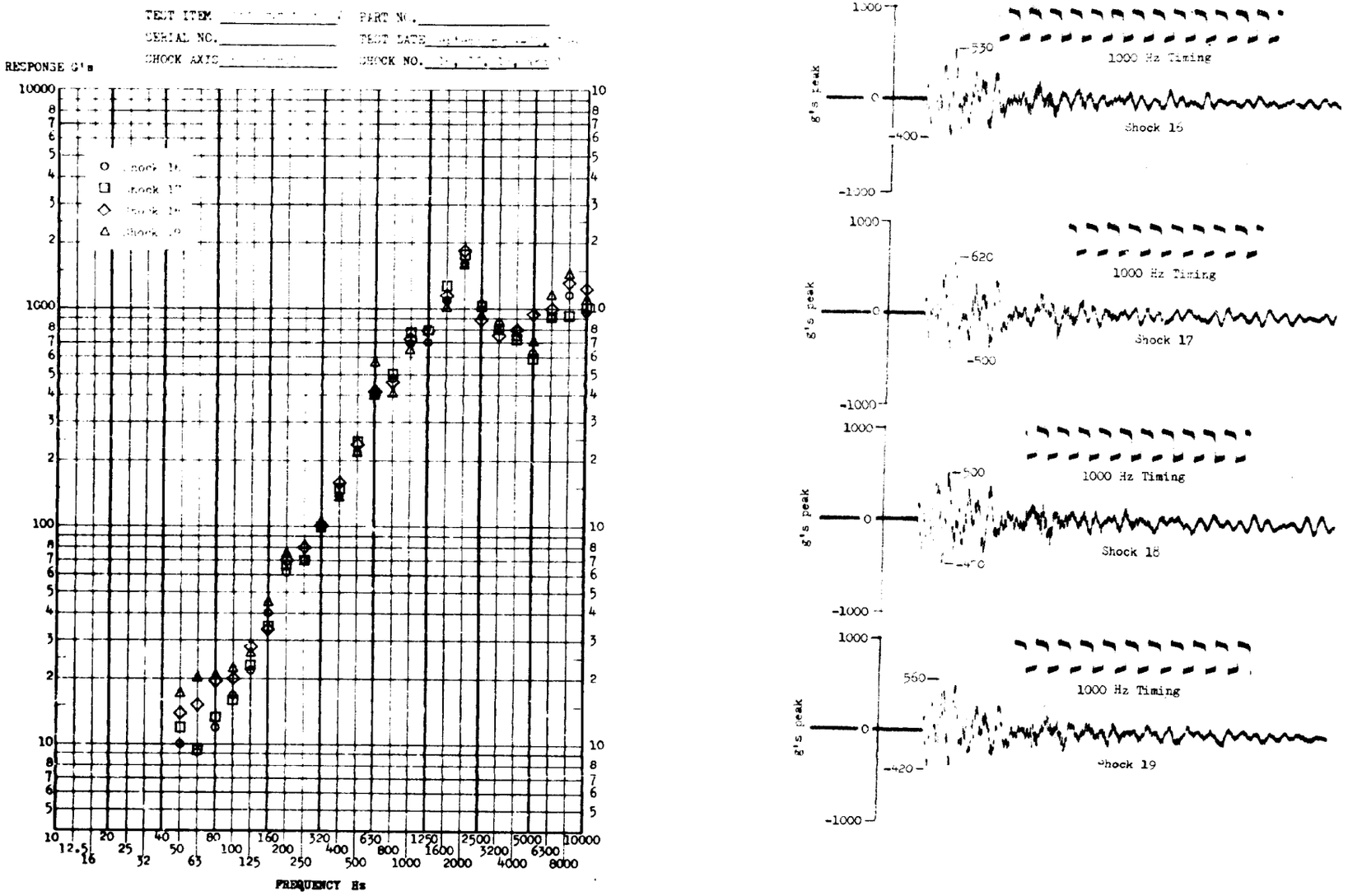



FIGURE 11.B.1-150

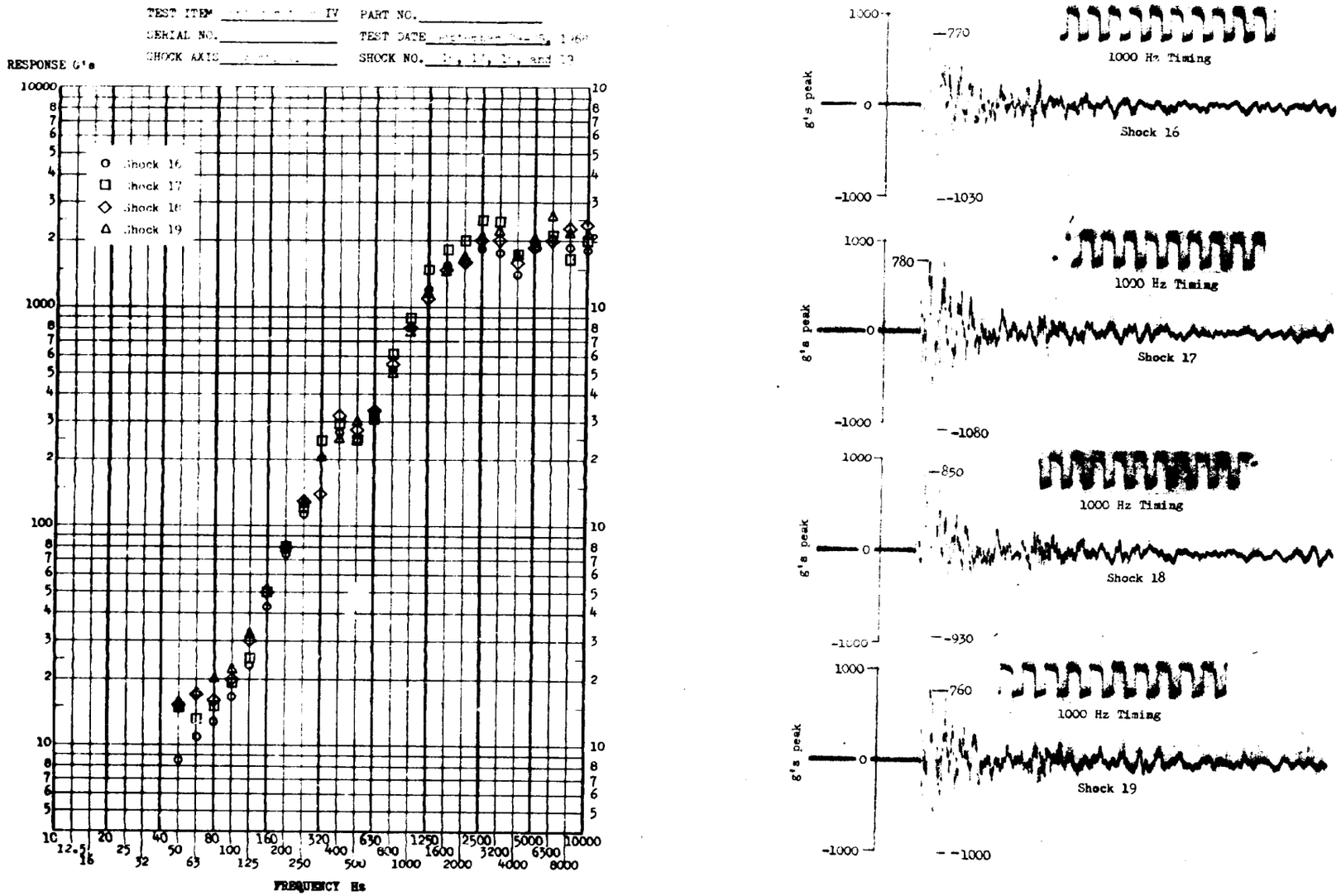
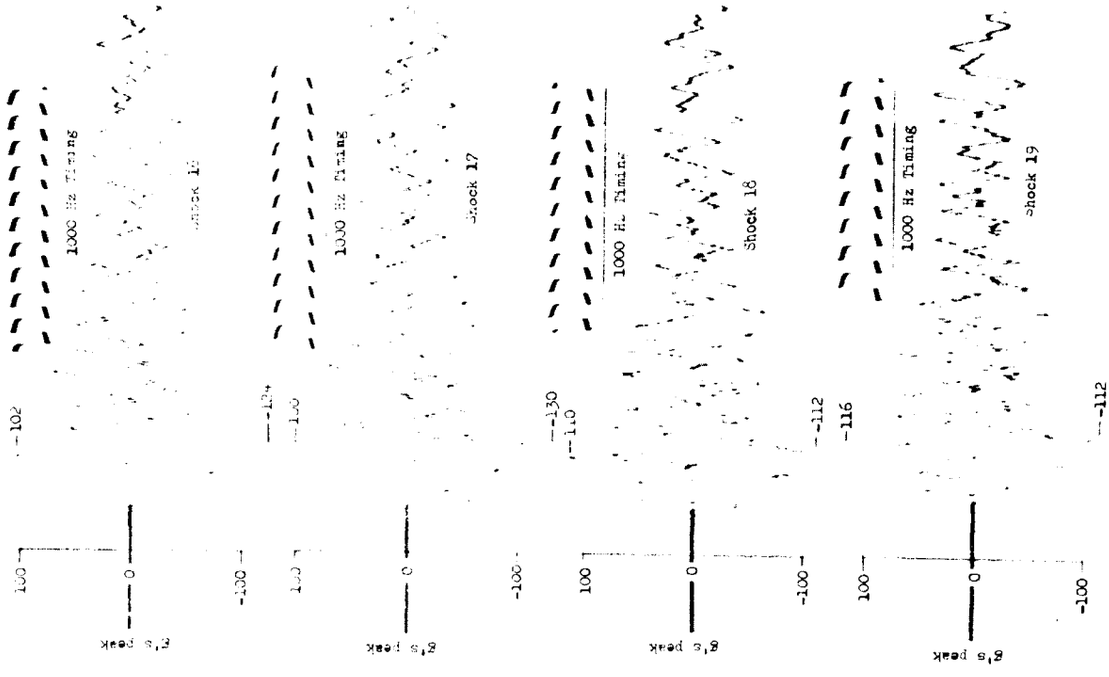



FIGURE 11.B.1-151



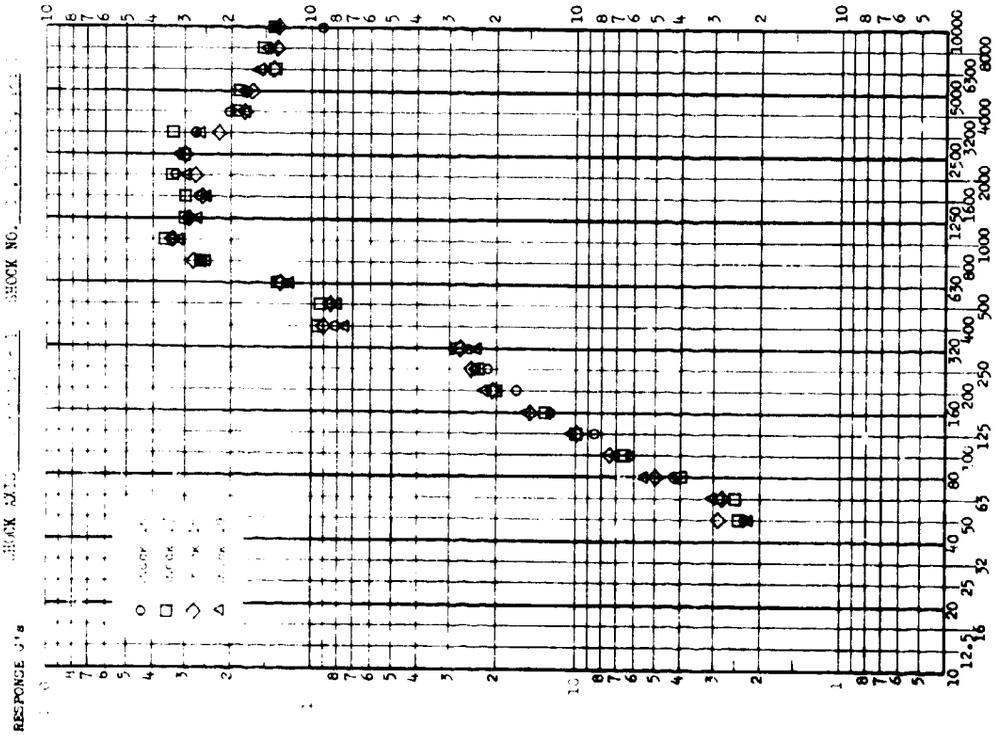




FIGURE II.B.1-152

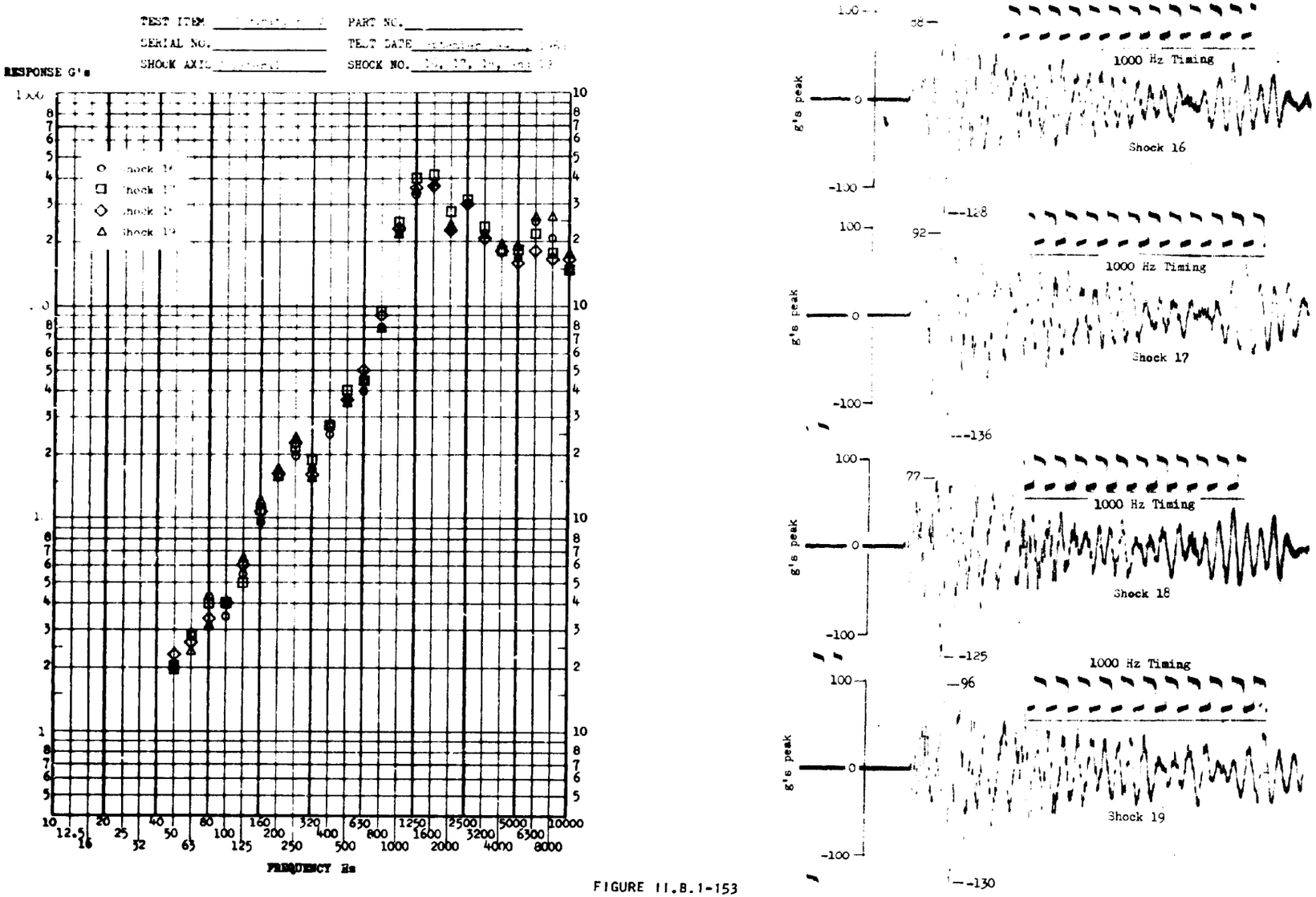



FIGURE 11.8.1-153

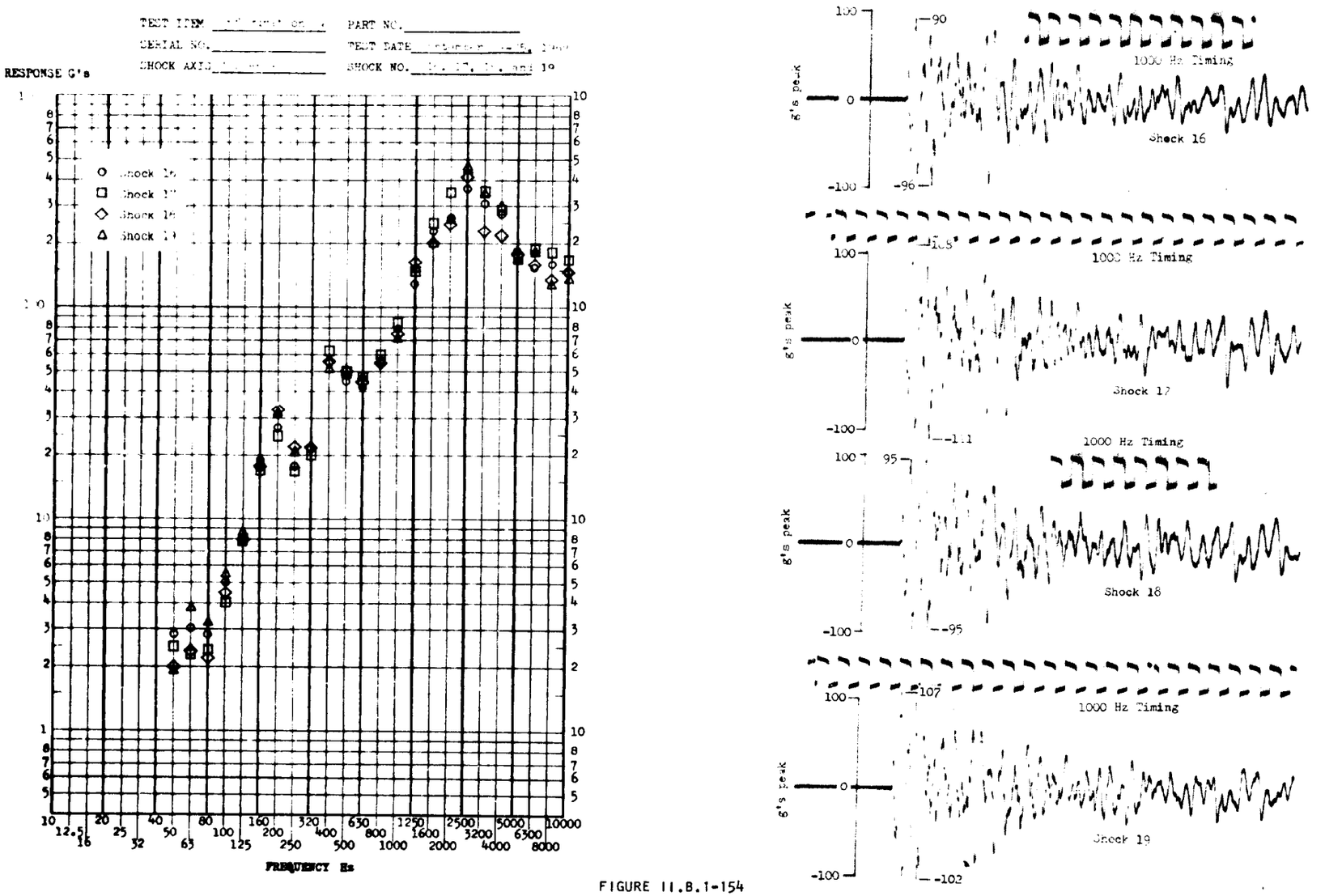



FIGURE II.B.1-154

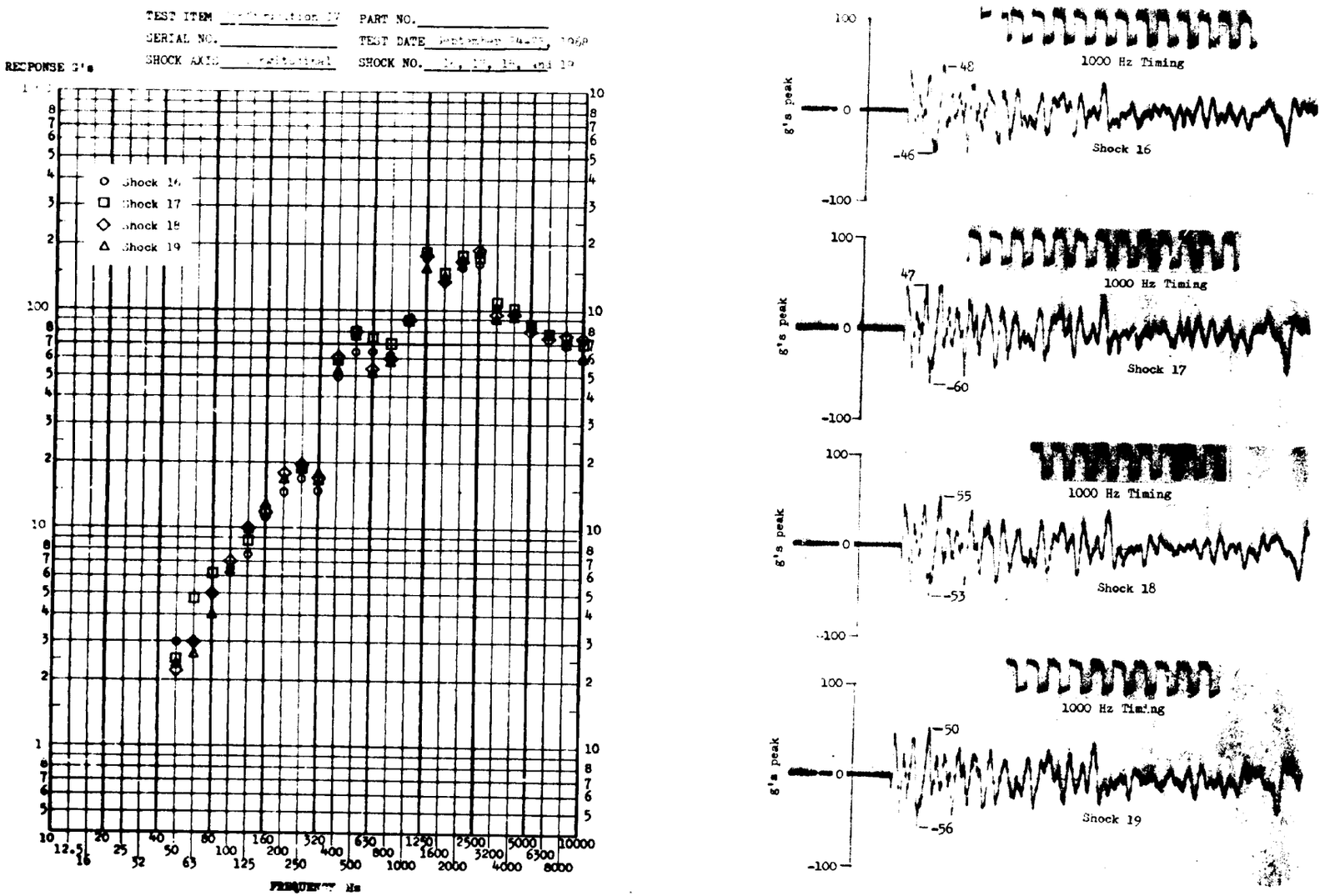



FIGURE 11.B.1-155

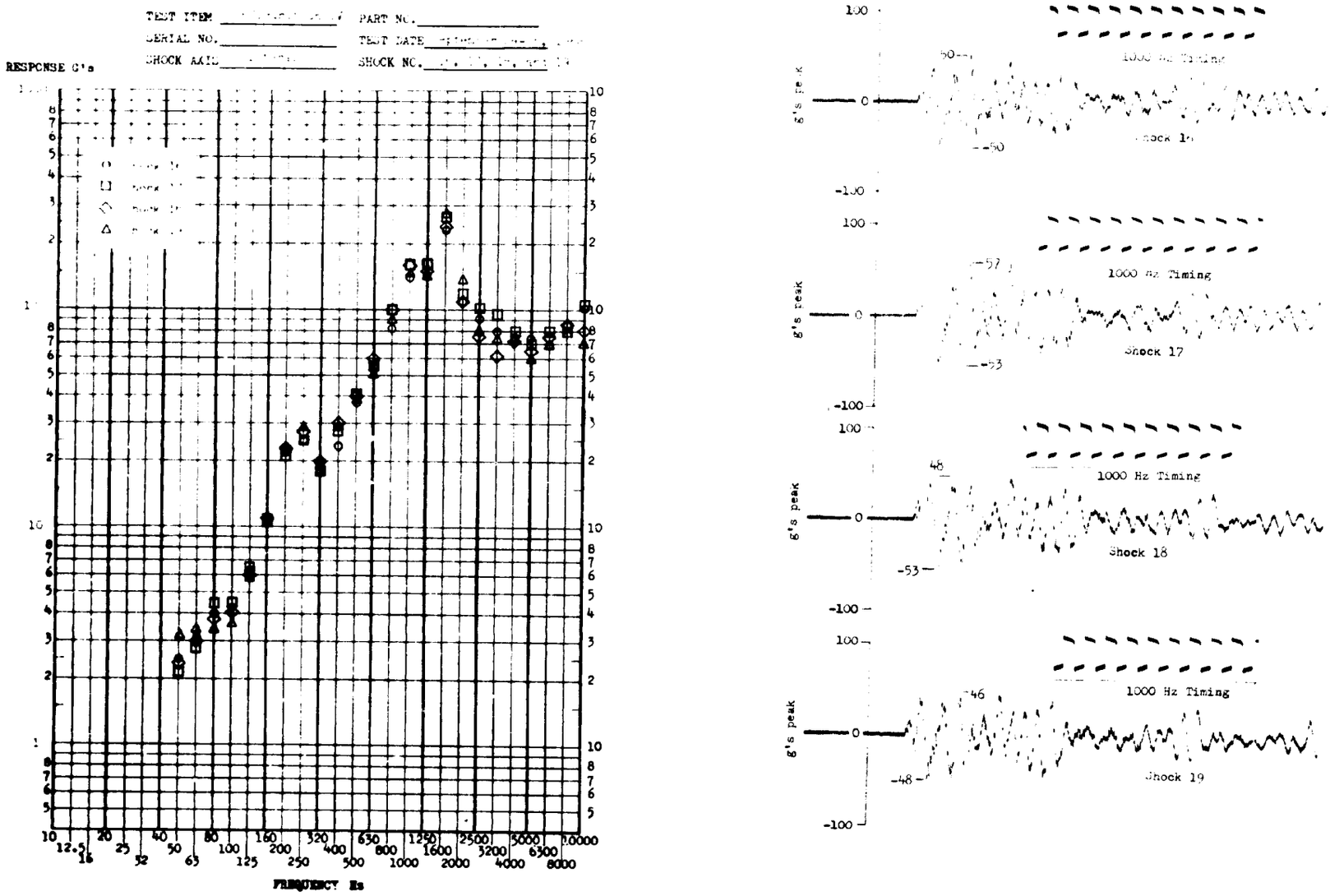



FIGURE II.B.1-156

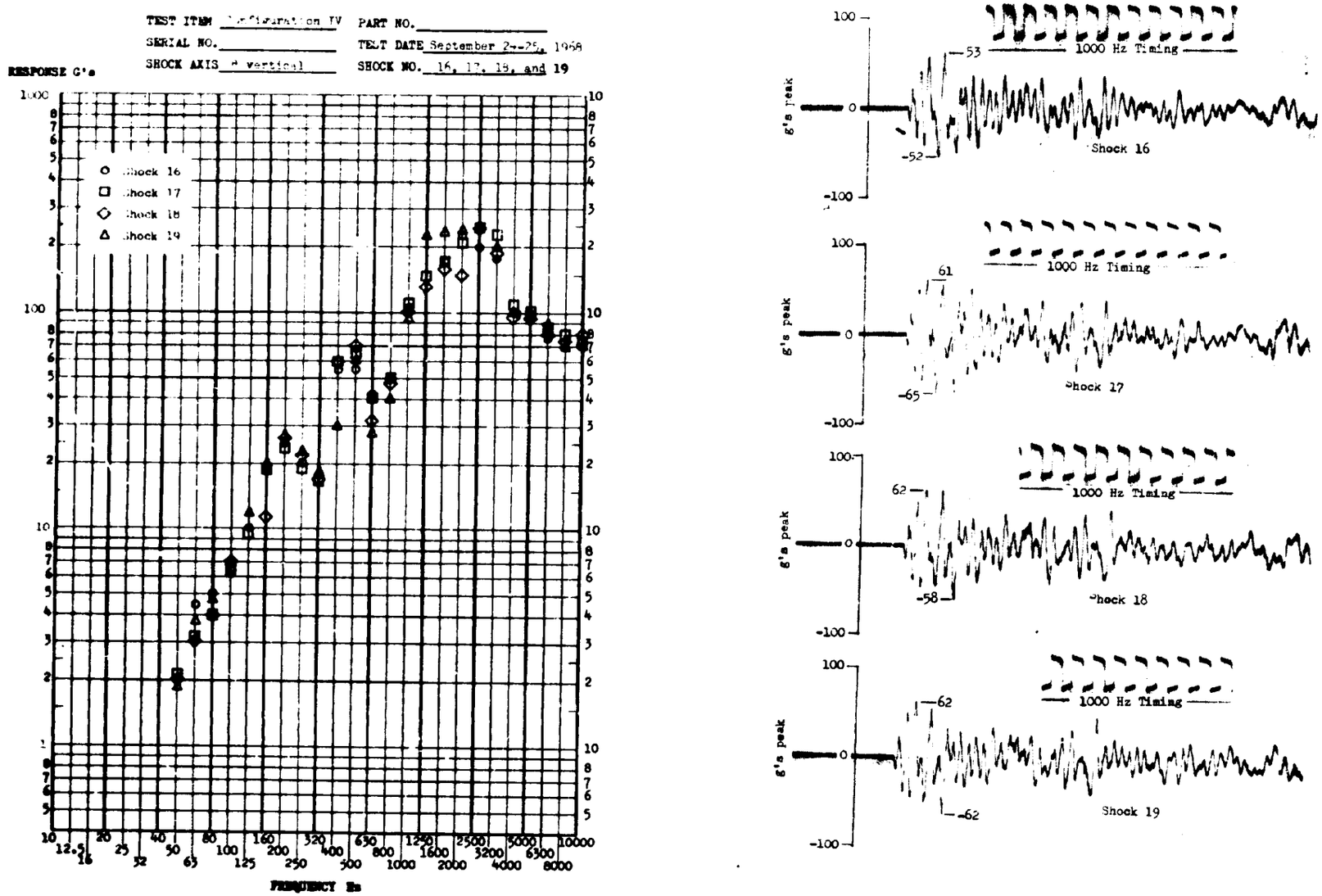



FIGURE 11.8.1-157

SECTION II.B.2

TITAN III-M SEPARATION NUT TESTS

PURPOSE OF TESTS

A series of test detonations of different types of separation hardware was conducted to compare the shock levels produced by Titan III-C separation nuts with those produced by the separation nuts proposed for use on Titan III-M.

DESCRIPTION OF EVENTS

The test installation (Figures II.B.2-1 and II.B.2-2) consisted of two Titan III-C transtage skirt sections used to simulate the separation interface. One skirt section containing guidance and instrumentation trusses was attached to a base fixture. The second skirt section was inverted and attached at each of the four matching longerons using the separation hardware applicable for each test. For each test all four separation nuts were detonated.

Three different separation nut configurations were tested, and three tests were conducted for each configuration. Table II.B.2-1 indicates the separation hardware associated with the various tests. Each nut was caused to divide into four segments by the detonation and pressure

build up of the attached pressure cartridge(s). The nut/ pressure cartridge configurations are shown schematically in Figures II.B.2-3 and II.B.2-4.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of time histories | 204 |
| No. of shock spectra | 202 |
| Type of analysis | analog |
| Analog machine | Ling SSA-100 |
| Frequency range | 50-10,000Hz |
| Frequency increments | 3 points per octave |
| Damping | Q=10 |

These shock spectra are presented with their corresponding time histories as Figures II.B.2-8 through II.B.2-79.

DESCRIPTION OF PYROTECHNIC

Pressure cartridges actuate separation nuts. A description of pressure cartridge charge follows:

Prime charge: 90 mg pressed zirconium

Base Charge: 346 mg boron and potassium nitrate

Booster charge: 86 mg boron and potassium nitrate

Sustainer charge: 193 mg ammonium nitrate and rubber

Locations: Nuts located 4 place symmetrically around specimen. Figures II.B.2-1 and II.B.2-2.

Configuration at each location: Table II.B.2-1 and Figures II.B.2-3 and II.B.2-4.

DESCRIPTION OF STRUCTURE

Longeron: aluminum, Figure II.B.2-7

Skin: aluminum, 0.028 inch thick

Ring-frame: aluminum, Figure II.B.2-7

Truss members: aluminum, 1.5 inch square section, 0.0625 inch wall thickness

Figures II.B.2-2, II.B.2-5 and II.B.2-6 for overall picture.

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2225

Locations: Table II.B.2-2 and Figures II.B.2-5 and II.B.2-6

Axis of sensitivity: Table II.B.2-2 and Figures II.B.2-5 and II.B.2-6.

DESCRIPTION OF DATA ACQUISITION SYSTEM

Tape recorder: Ampex ES-100 (0-20,000Hz frequency response)

Amplifiers: Kistler 504A (0-100,000Hz frequency response)

COMMENTS

The following shock spectra show a lack of correlation between the time history peak accelerations and shock spectra peak accelerations and are questionable data:

| | Shot No. | Acc. No. |
|---|---|---|
| Figure II.B.2-20 | 2 | 3A 13 |
| 2-21 | 2 | 3A 14 |
| 2-22 | 2 | 3A 15 |
| 2-24 | 1,2 | 3A 17 |
| 2-25 | 1,2 | 3A 18 |
| 2-28 | 1 | 3A 21 |
| 2-31 | 1 | 3A 24 |

TABLE II.B.2-1

DESCRIPTION OF SEPARATION NUTS TESTED

| Test Run Numbers | Nut Diameter | Number of Nuts at Each Location | Description of Nuts | Number of Pressure Cartridges for Each Nut | Description of Pressure Cartridges |
|---|---|---|---|---|---|
| 1-3 | 3/4 inch | 2 | single nut PD3350007-005(mfg.: Hi Shear Corp.) | 1 | PD6050129-505 (mfg.:McCormick-Selph Associates) |
| 4-6 | 3/4 inch | 1 | dual nut PD3350007-003(mfg.: Hi Shear Corp.) | 2 | Same as above |
| 7-9 | 1 inch | 1 | dual nut PD3350008-001(mfg.: Hi Shear Corp.) | 2 | Same as above |

TABLE II.B.2-2

| Accelerometer Number | Measurement Location | Sensitive Axis |
|---|---|---|
| 1 | Stringer 3C on longeron at station 114 near guidance truss attach point | longitudinal |
| 2 | | radial |
| 3 | | tangential |
| 4 | Guidance truss | longitudinal |
| 5 | | vertical |
| 6 | | lateral |
| 7 | Guidance truss | longitudinal |
| 8 | | vertical |
| 9 | | lateral |
| 10 | Guidance truss | longitudinal |
| 11 | | vertical |
| 12 | | lateral |
| 13 | Guidance truss | longitudinal |
| 14 | | vertical |
| 15 | | lateral |
| 16 | Stringer 3C on longeron at station 97 | longitudinal |
| 17 | | radial |
| 18 | | tangential |
| 19 | On ring-frame at target at station 97 | longitudinal |
| 20 | | radial |
| 21 | | tangential |
| 22 | Stringer 26C on longeron at station 97 | longitudinal |
| 23 | | radial |
| 24 | | tangential |

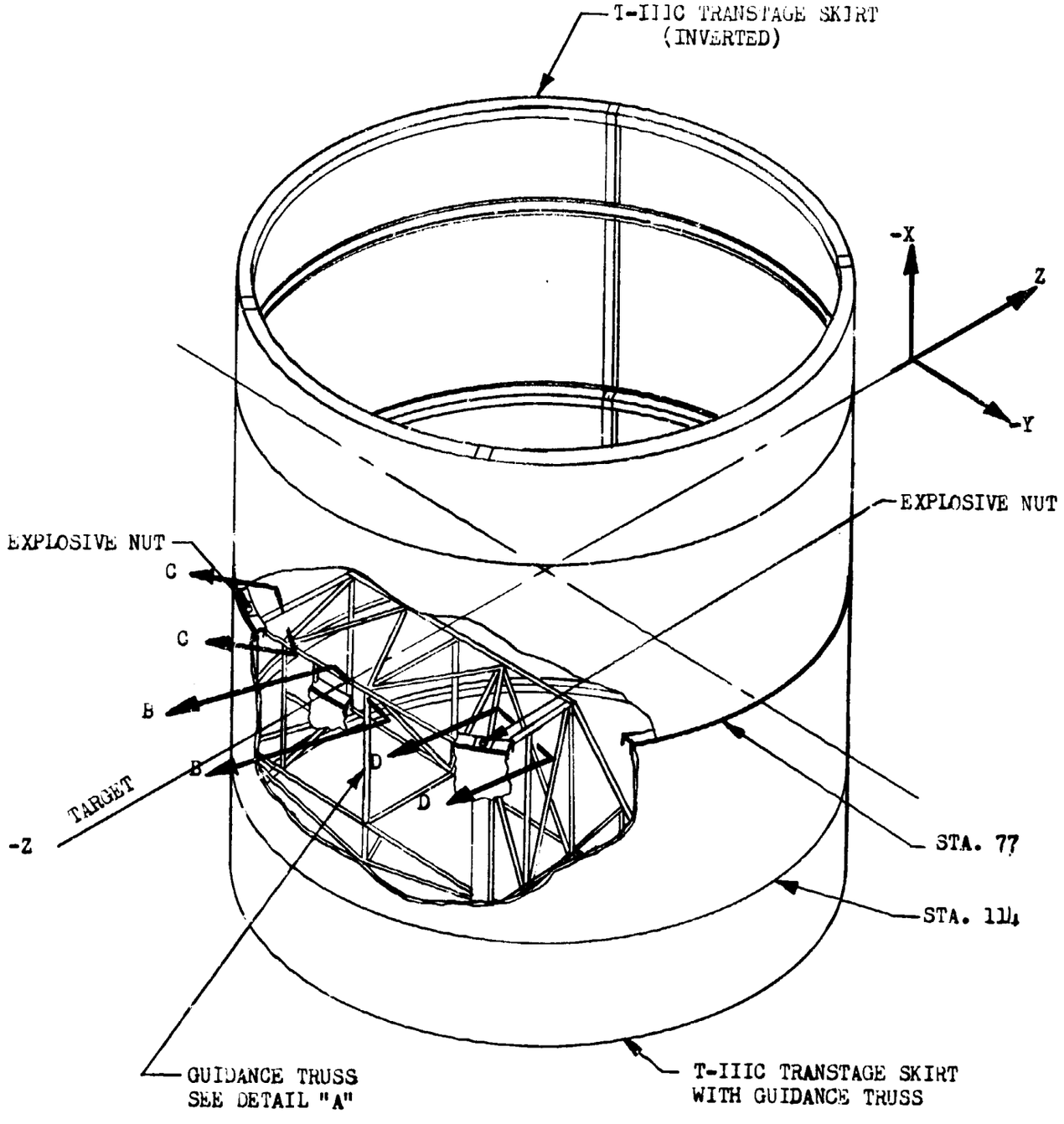



FIGURE II.P.2-1
T-IIIM SEPARATION NUT TEST

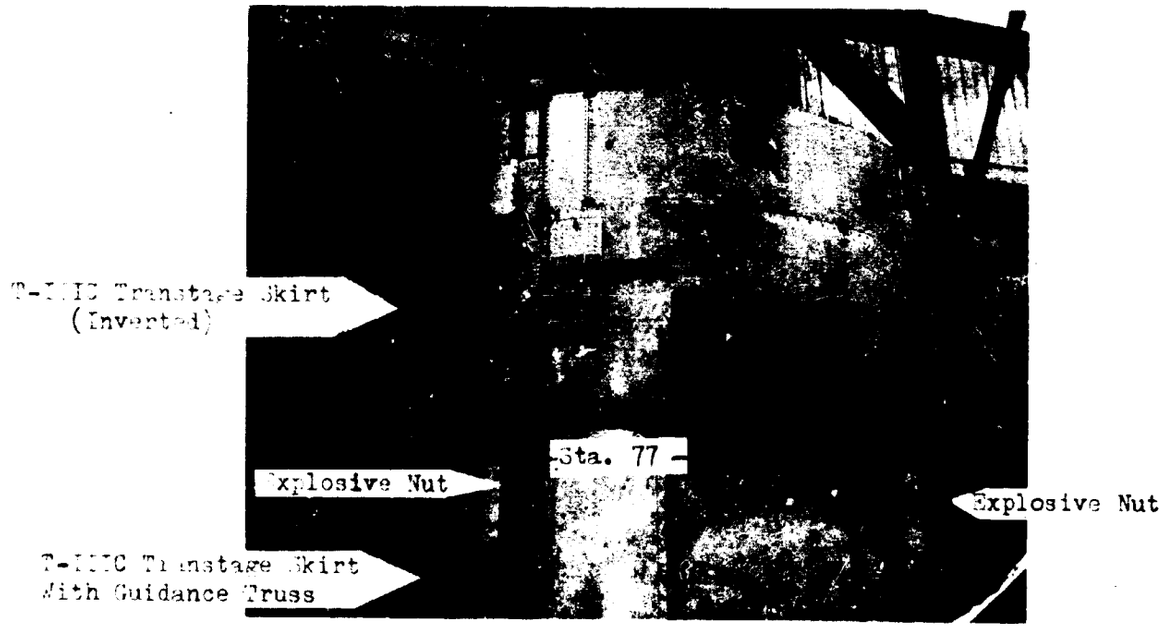



**FIGURE II.B.2-2**

**TEST INSTALLATION**

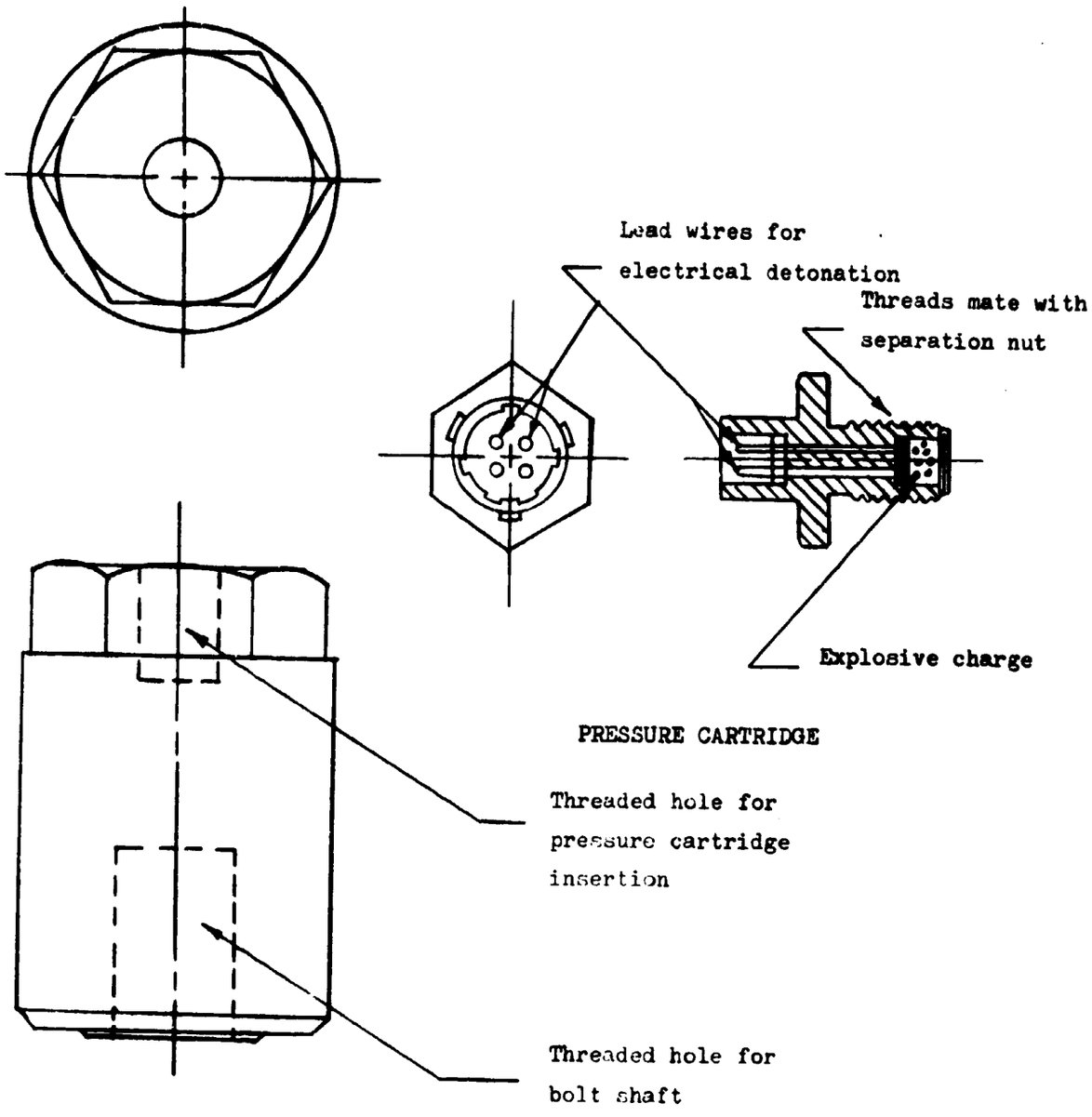



FIGURE II.B.2-3

SINGLE CARTRIDGE SEPARATION NUT

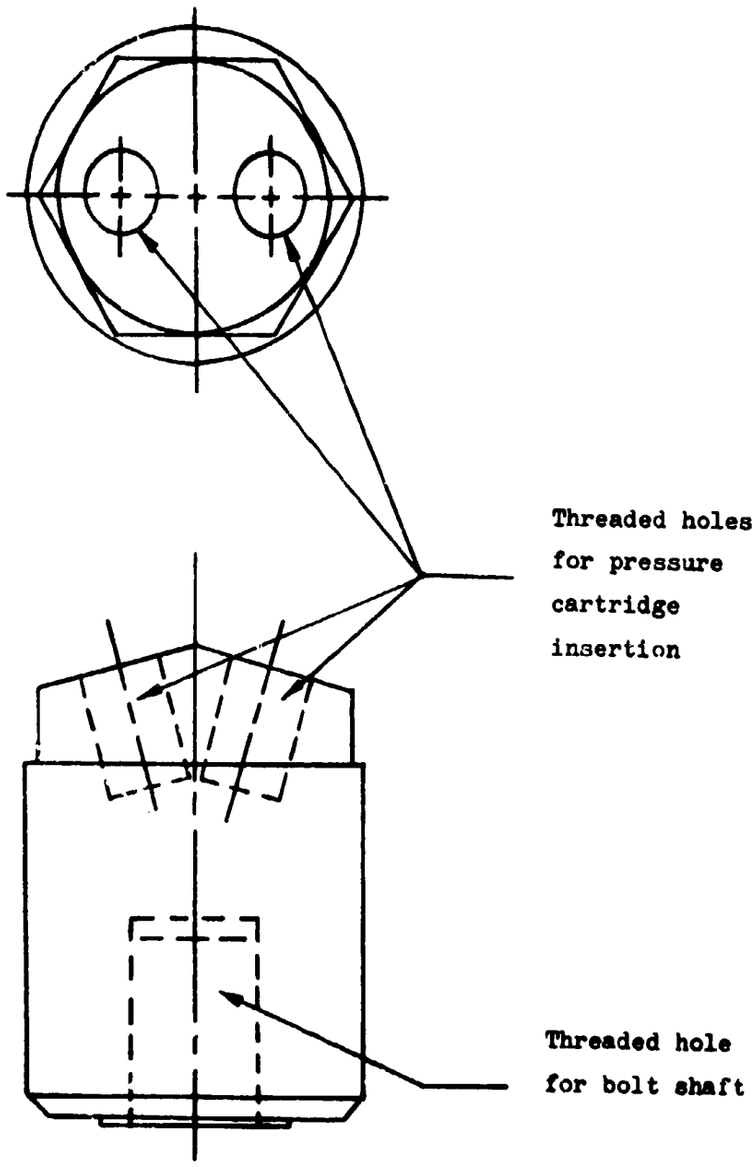
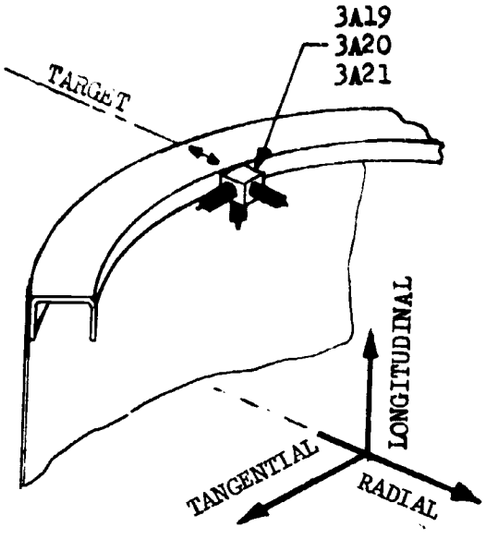
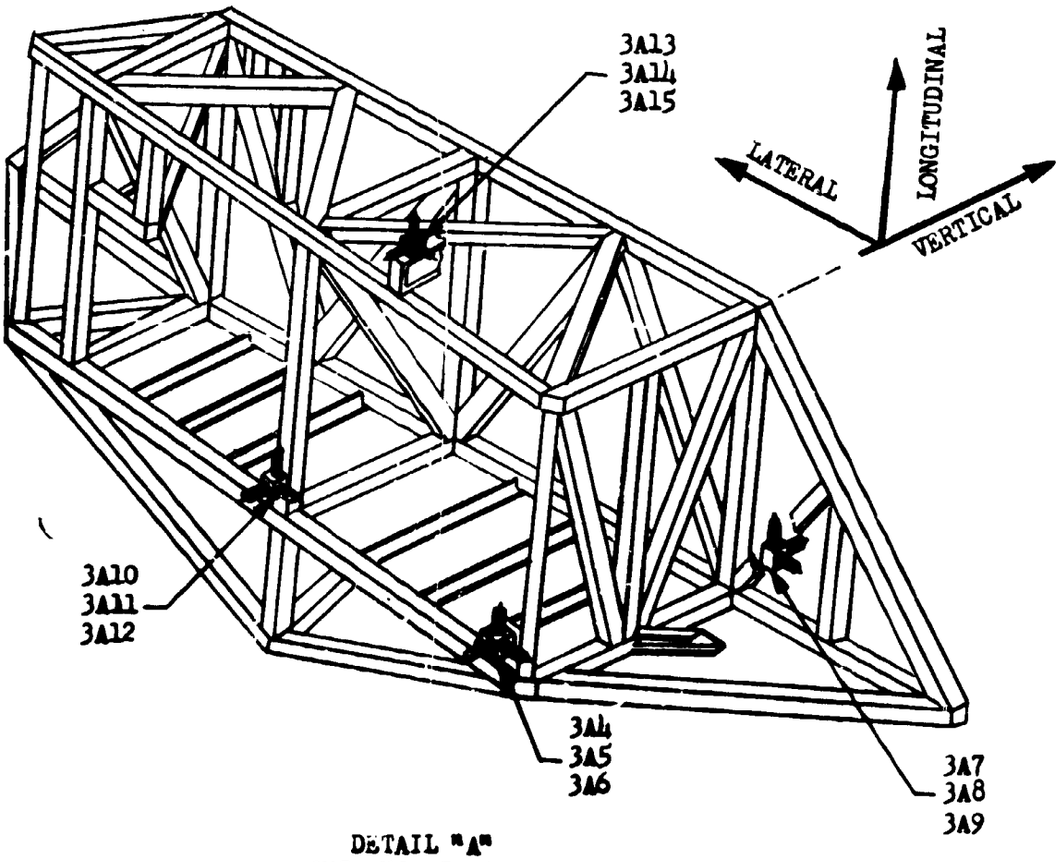



FIGURE II.B.2-4

DUAL CARTRIDGE SEPARATION NUT

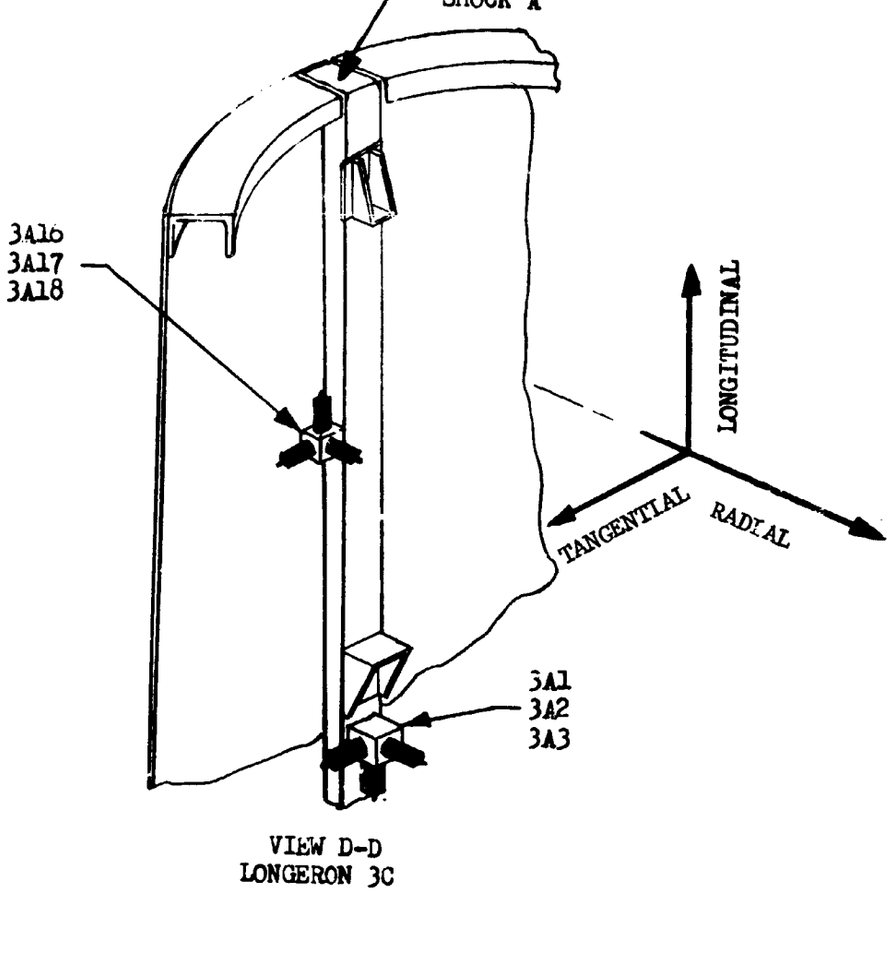



VIEW B-B
RING FRAME AT TARGET

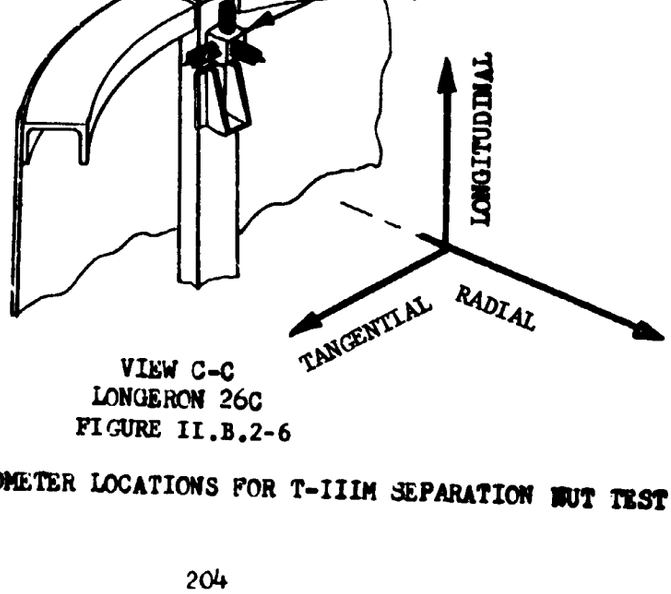



DETAIL "A"
GUIDANCE TRUSS
FIGURE II.3.2-5

ACCELEROMETER LOCATIONS FOR T-IIIM SEPARATION NUT TEST

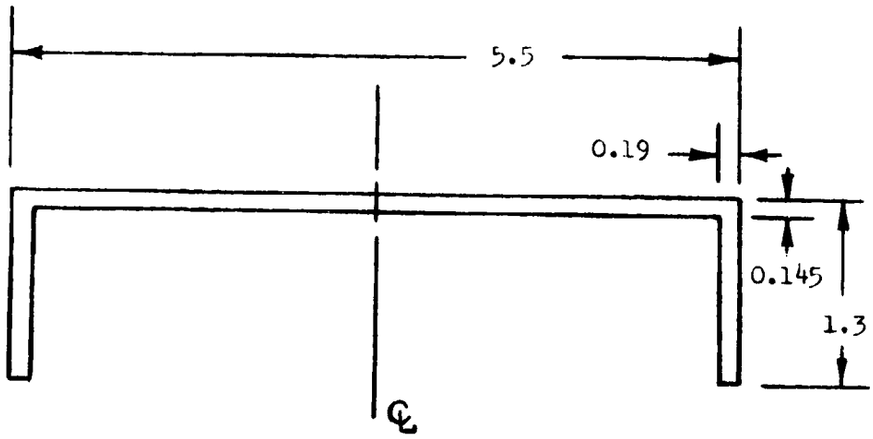



VIEW D-D
LONGERON 3C



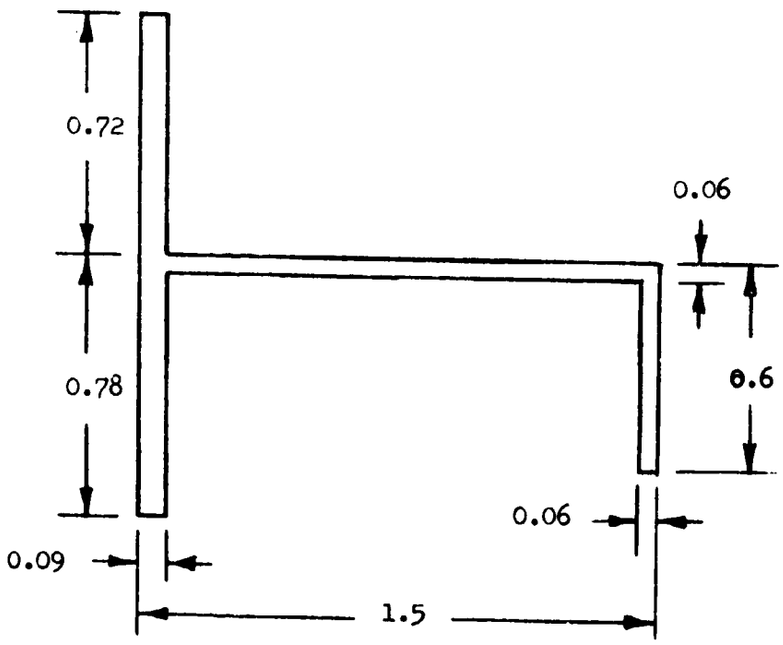

VIEW C-C
LONGERON 26C
FIGURE II.B.2-6

ACCELEROMETER LOCATIONS FOR T-IIIM SEPARATION NUT TEST




RING-FRAME

DIMENSION OF SECTION AT STATION 77




DIMENSIONS OF LONGERON SECTION

FIGURE II.B.2-7

SECTIONAL DIMENSIONS

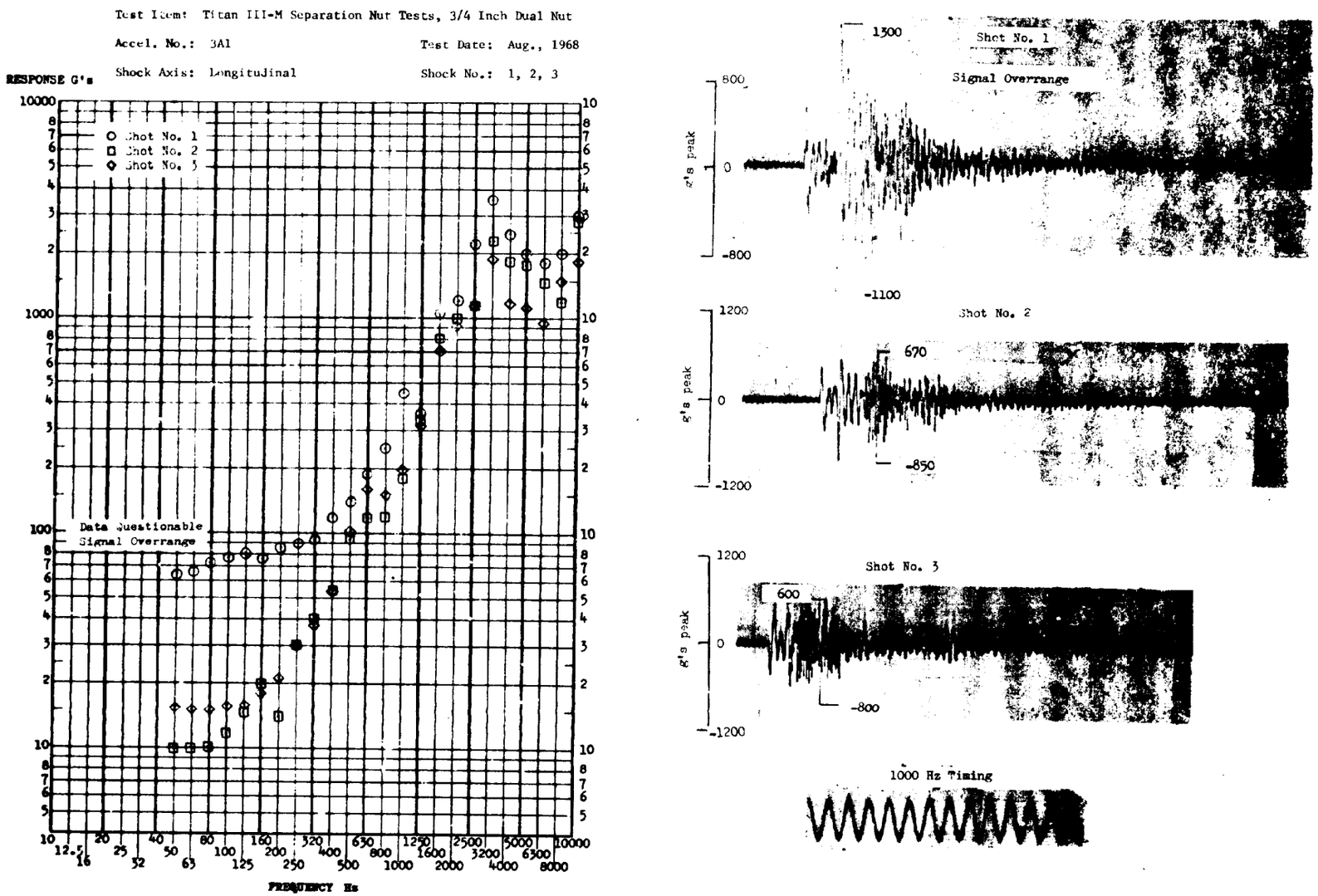



FIGURE II.B.2-8

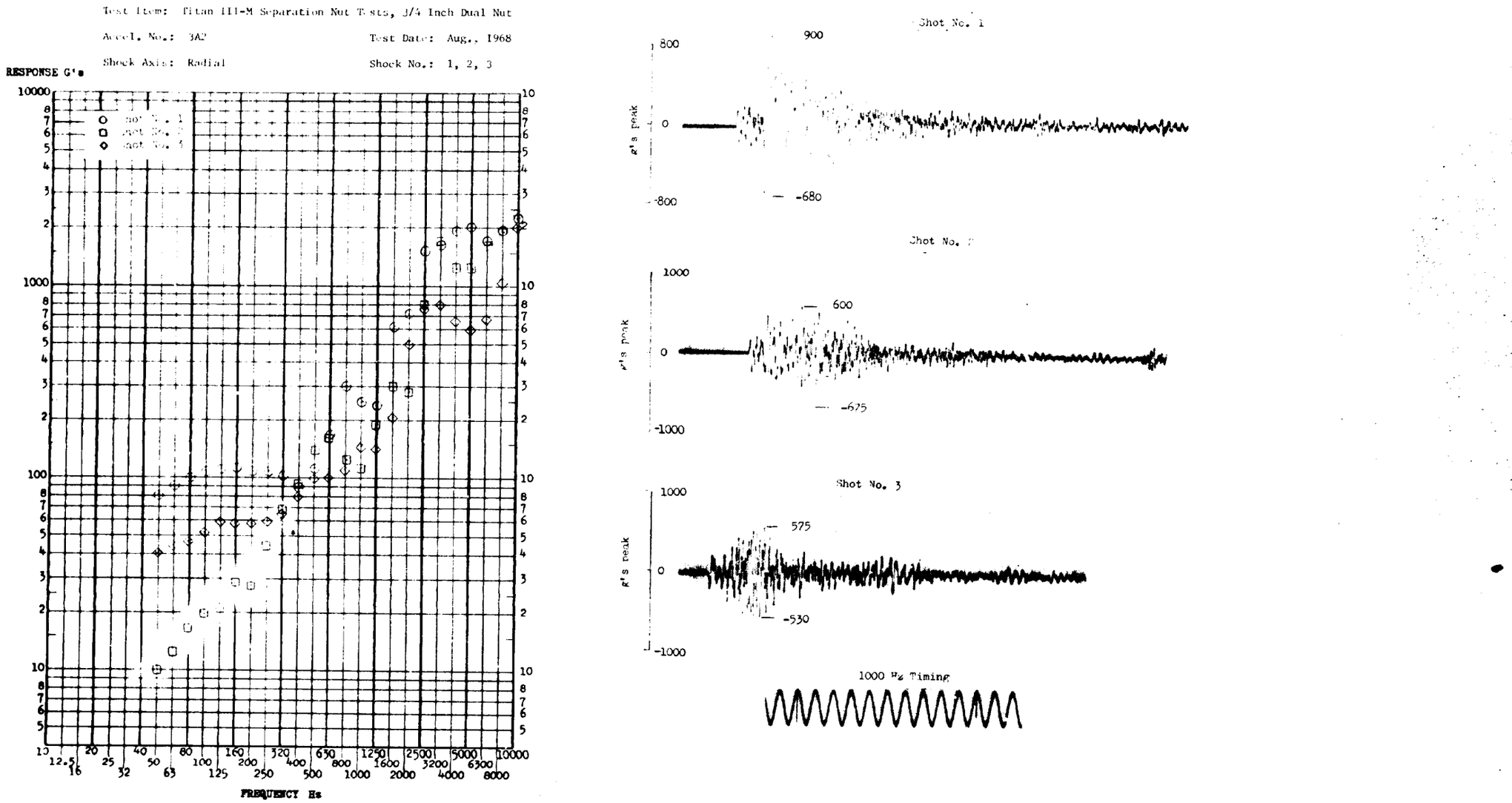
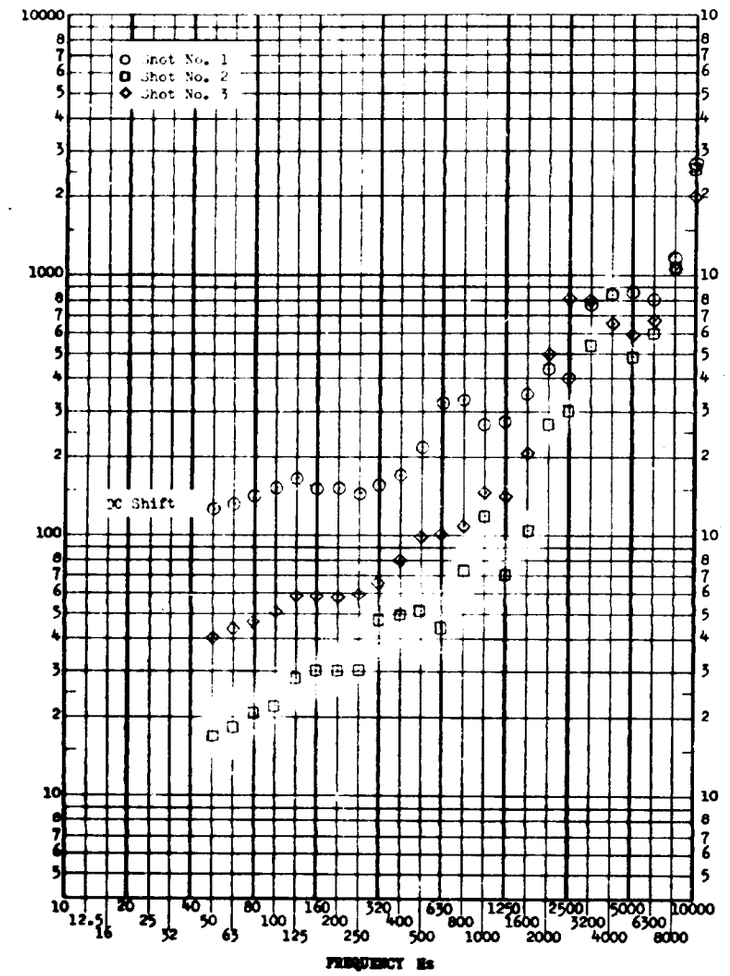



FIGURE II.B.2-9

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Dual Nut

Art. 1. No.: 8A3 Test Date: Aug., 1968

Shock Axis: Tangential Shock No.: 1, 2, 3



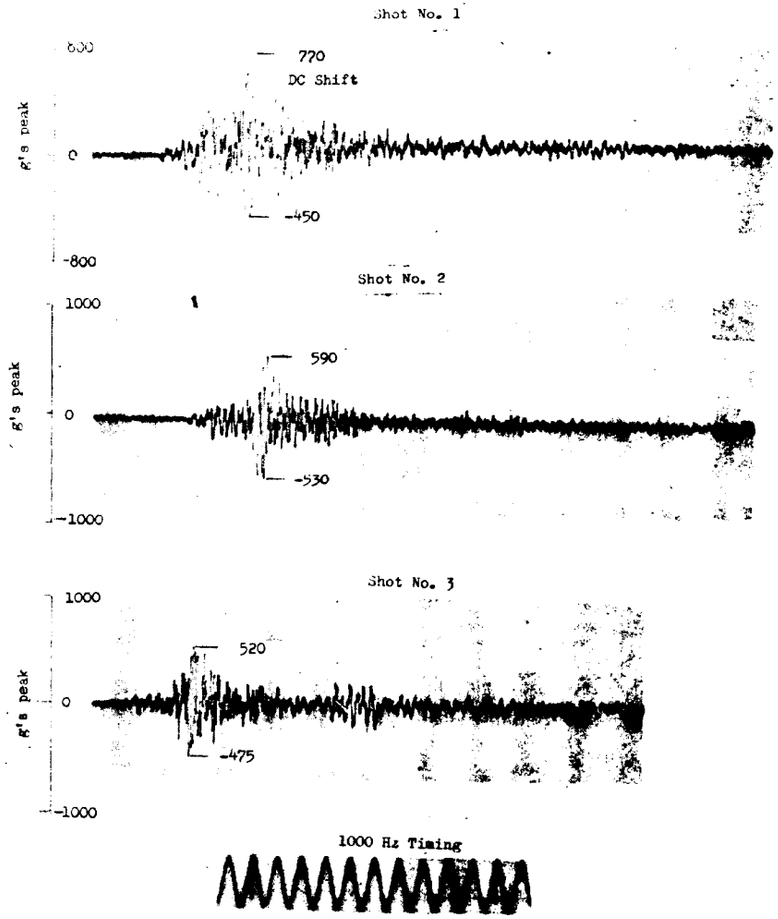




FIGURE II.B.2-10

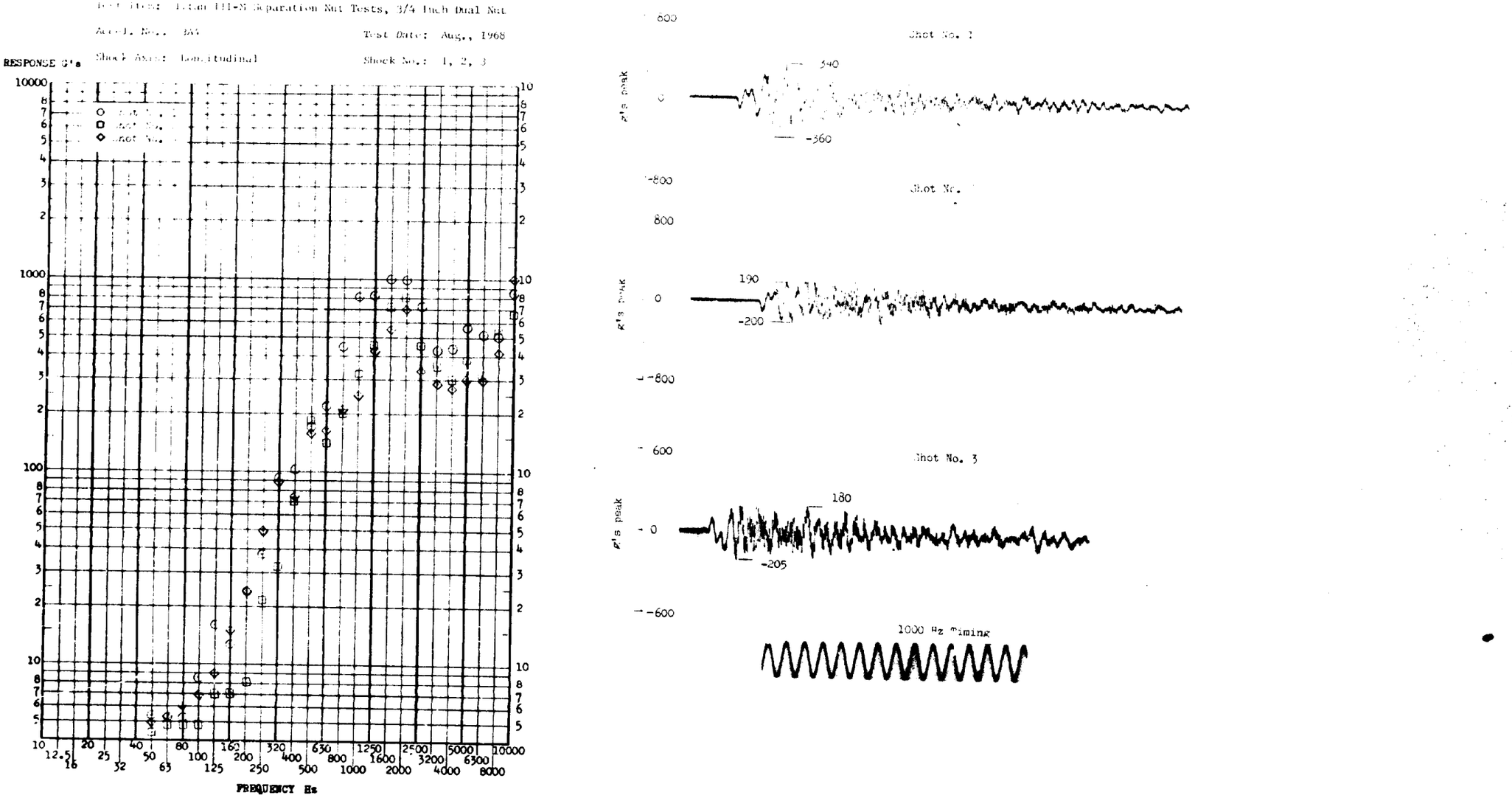



FIGURE II.B.2-11

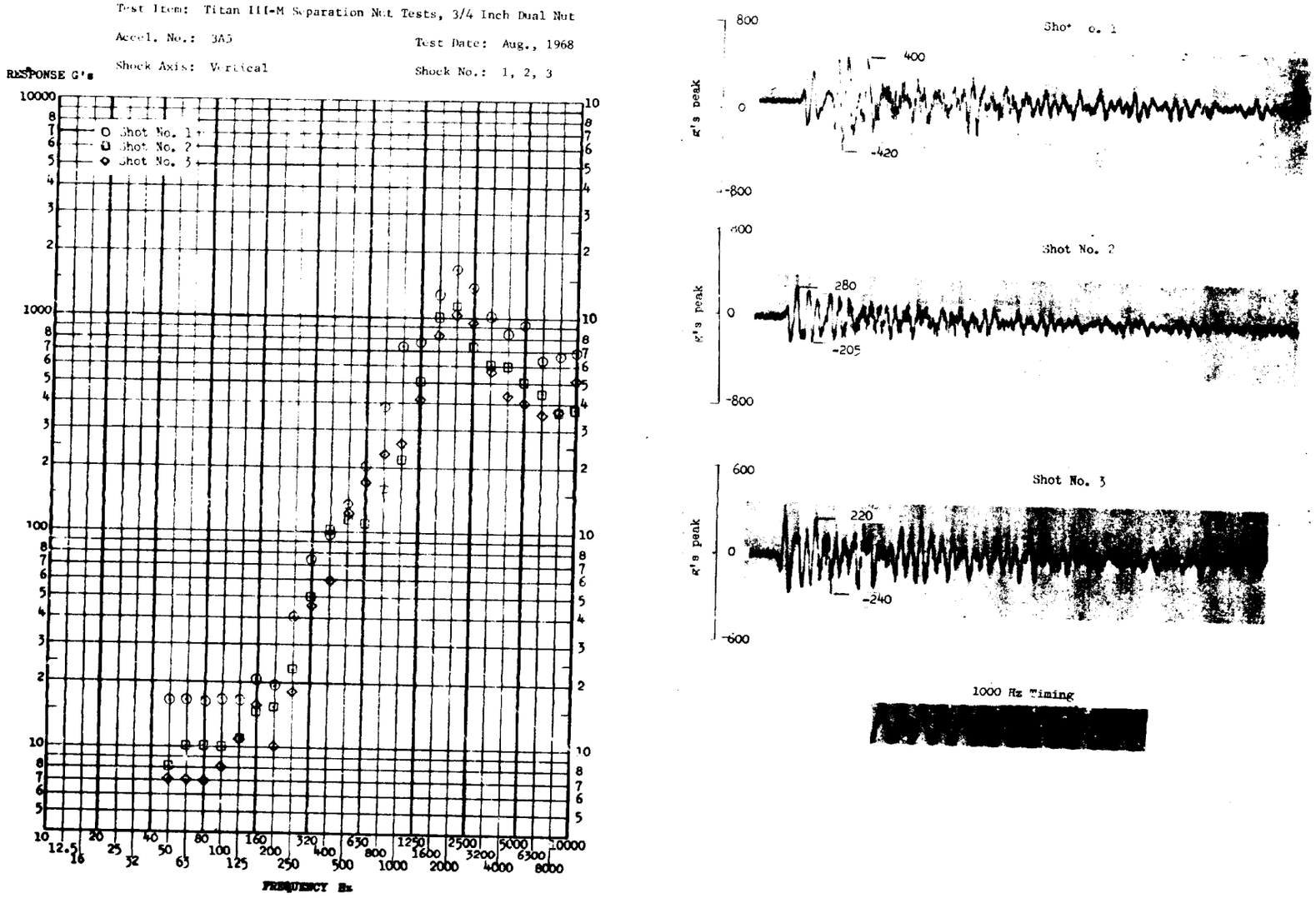



FIGURE 11.3.2-12

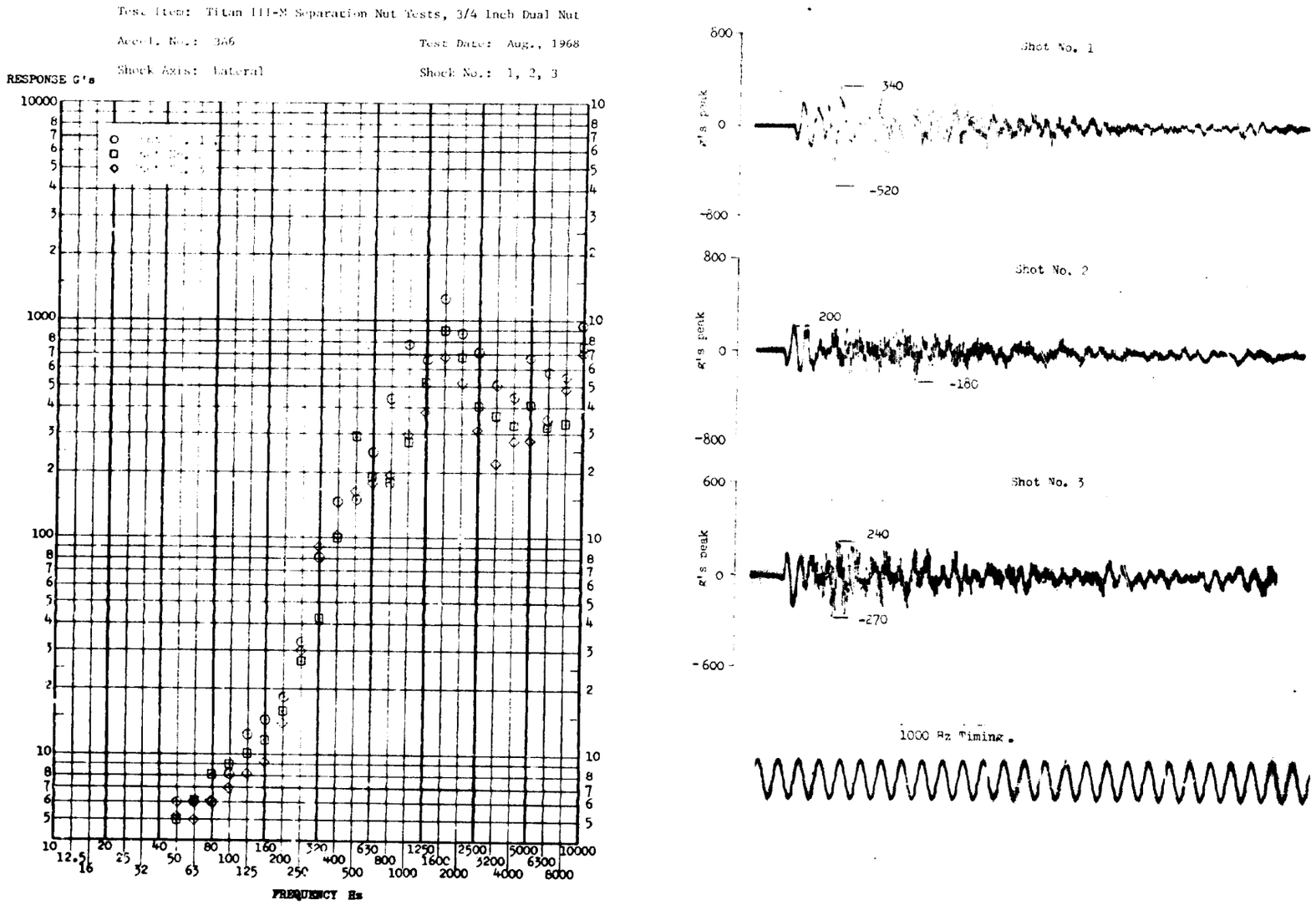



FIGURE 11.B.2-13

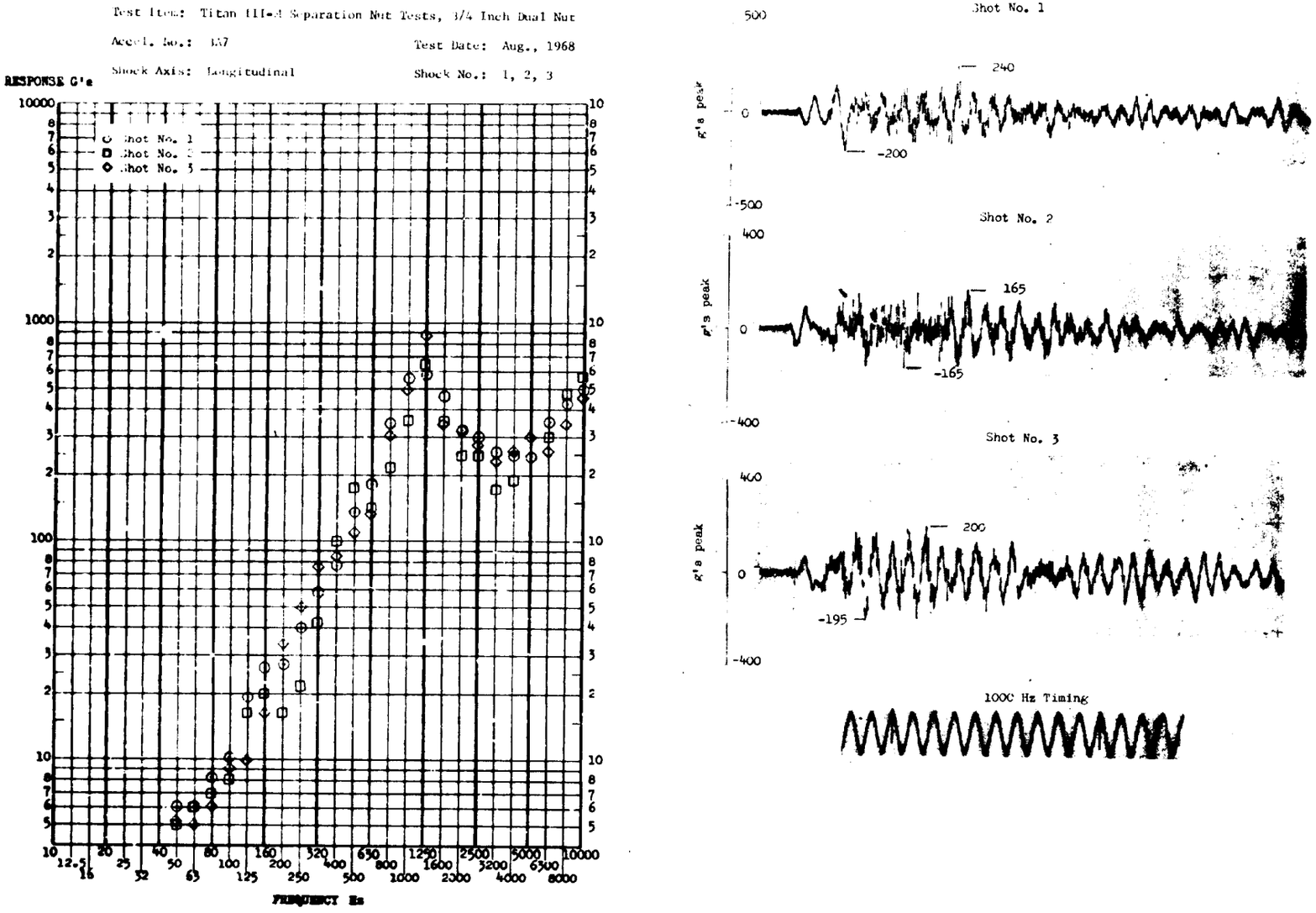



FIGURE II.B.2-14

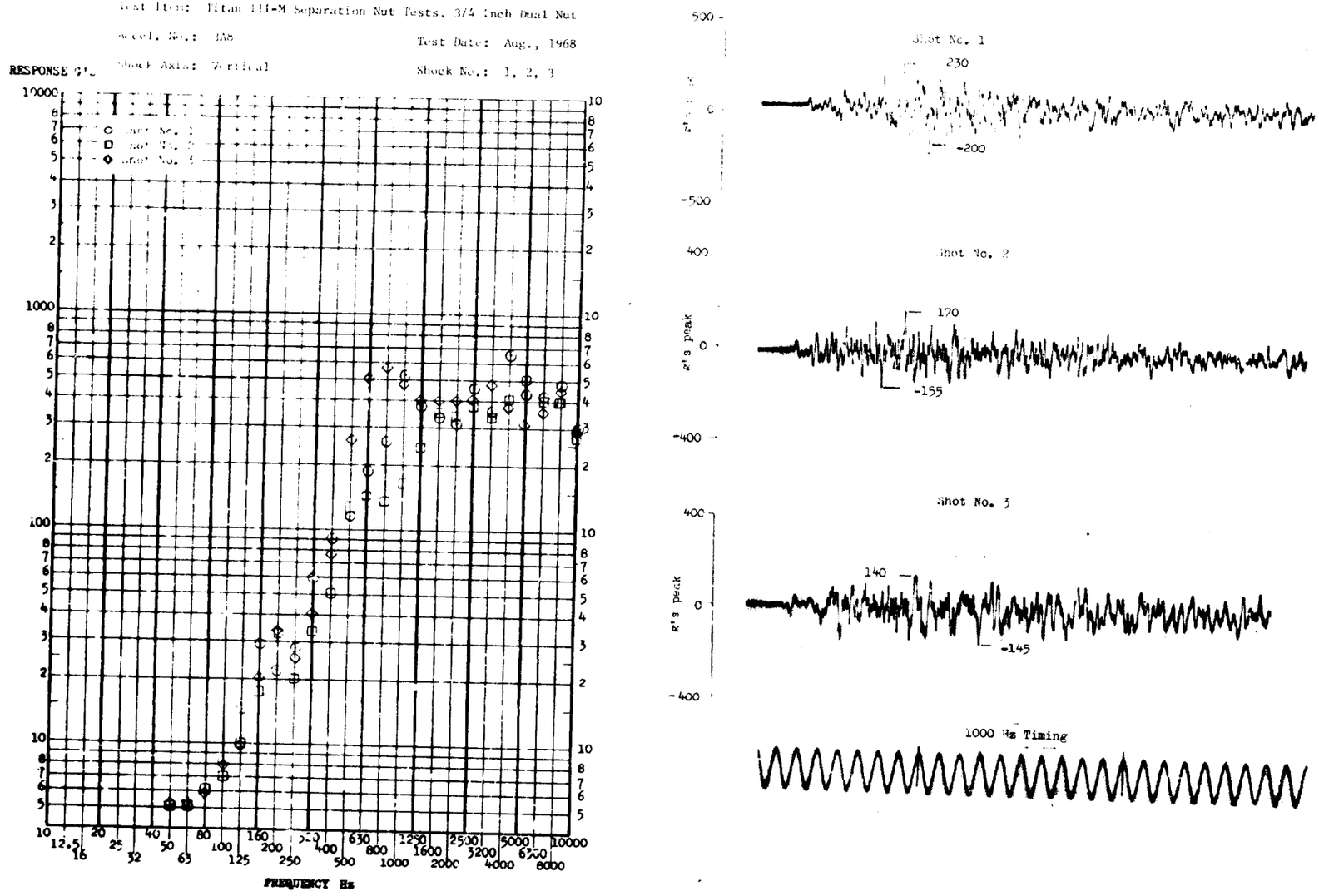



FIGURE II.B.2-15

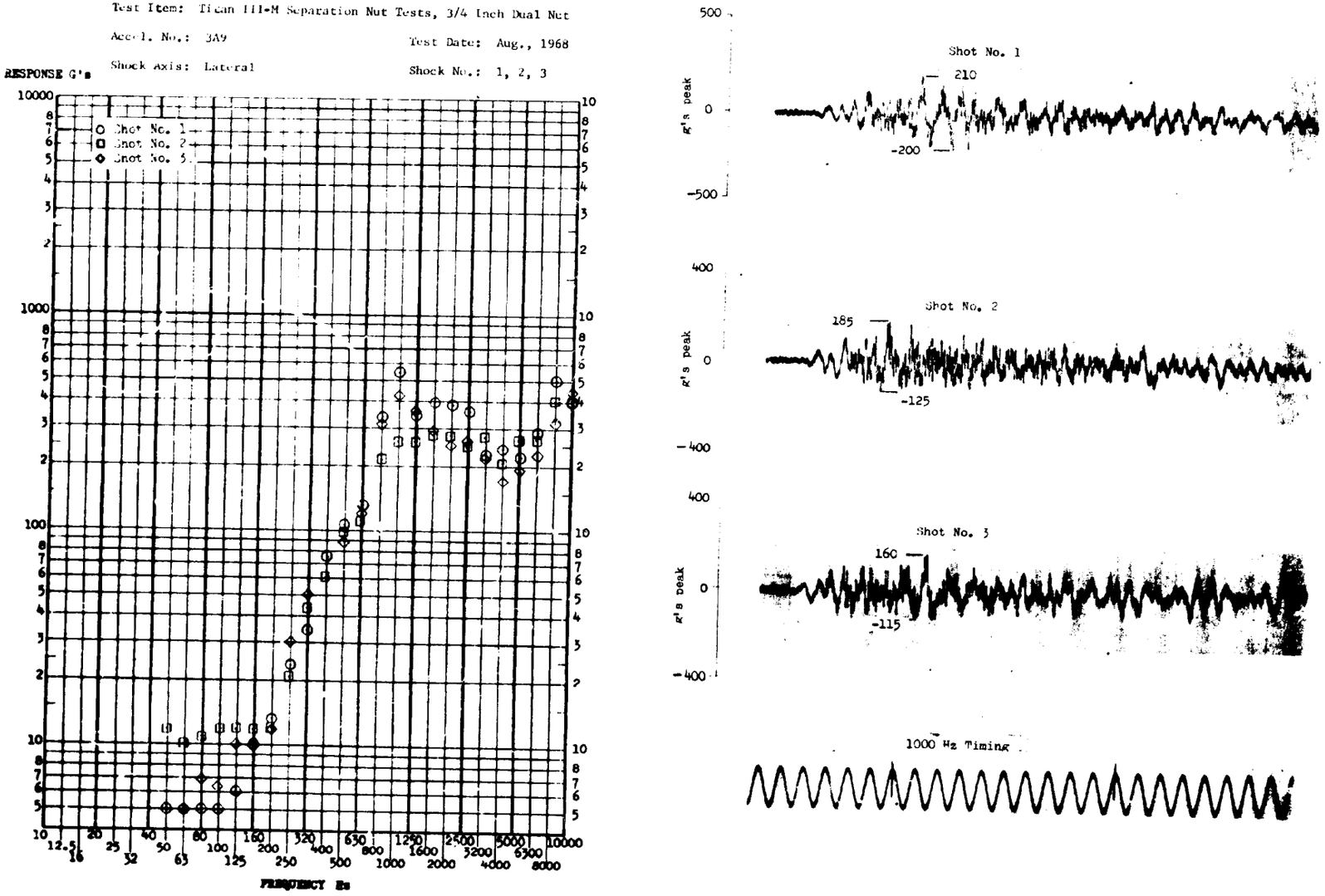



FIGURE 11.8.2-16

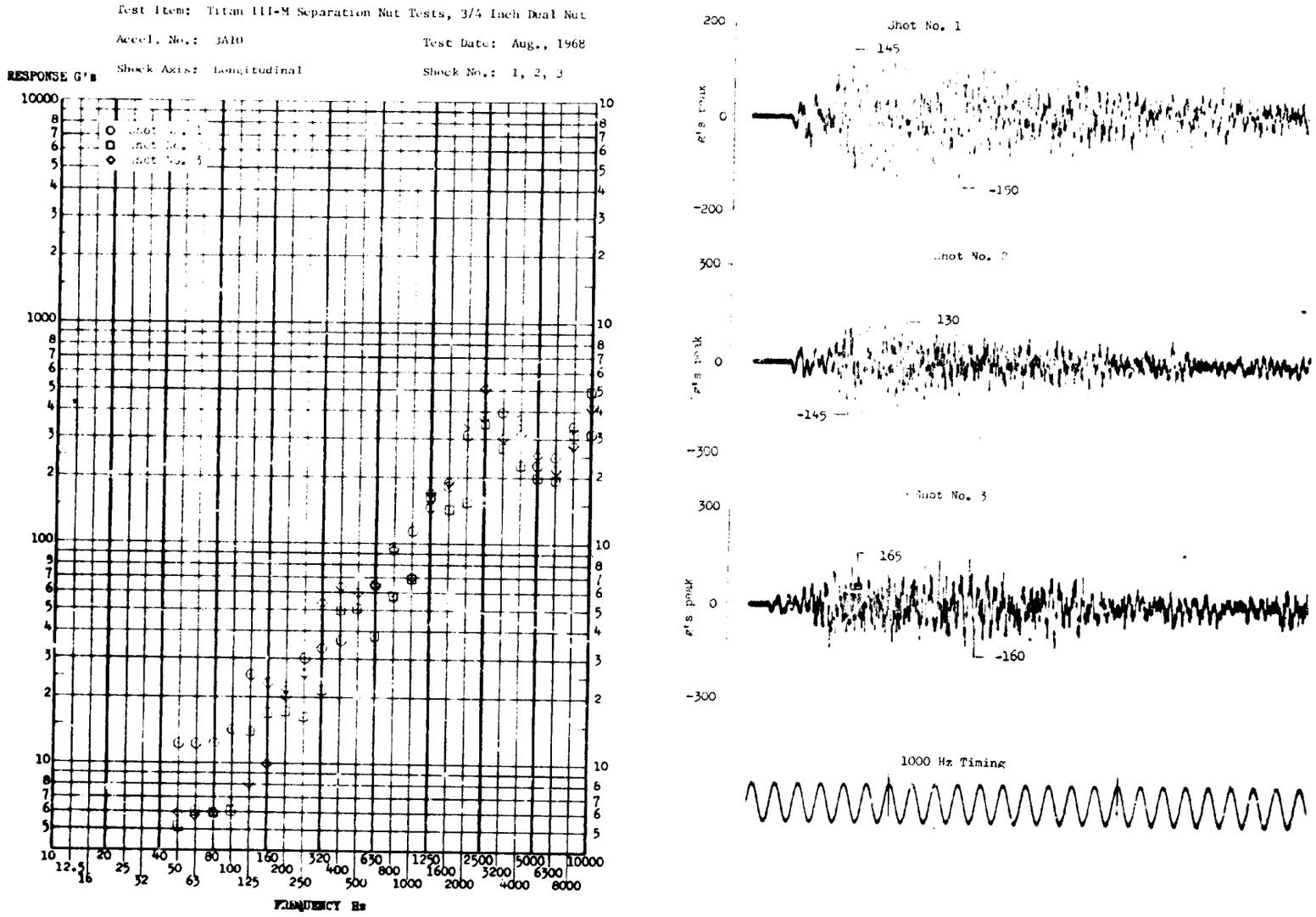
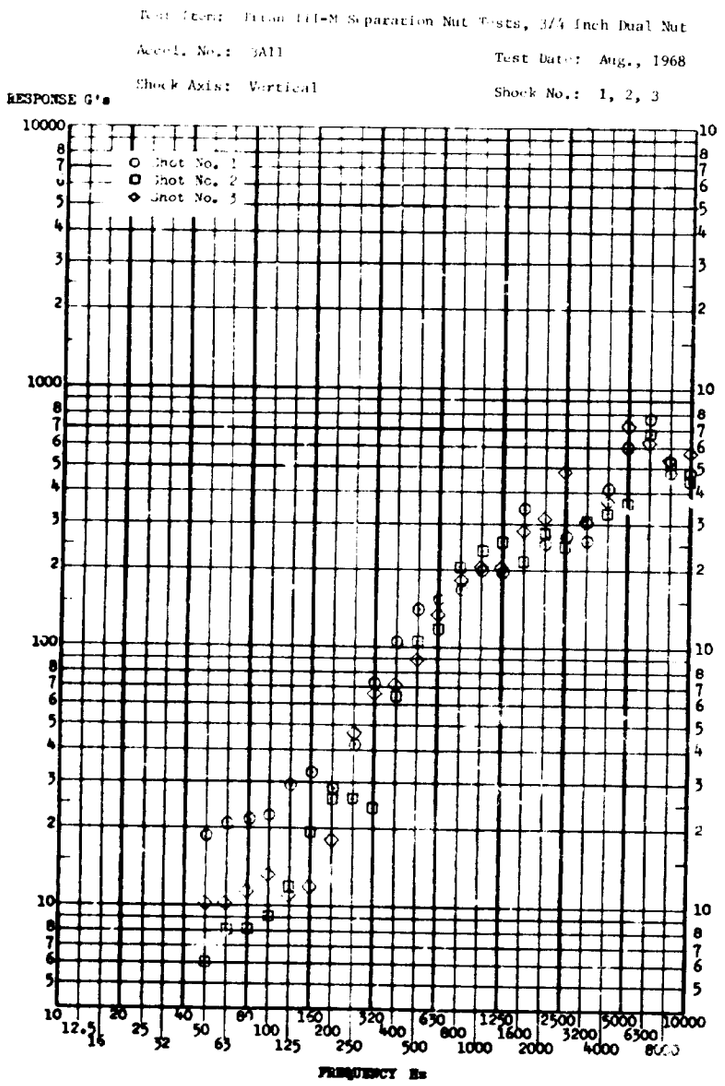



FIGURE II.B.2-17



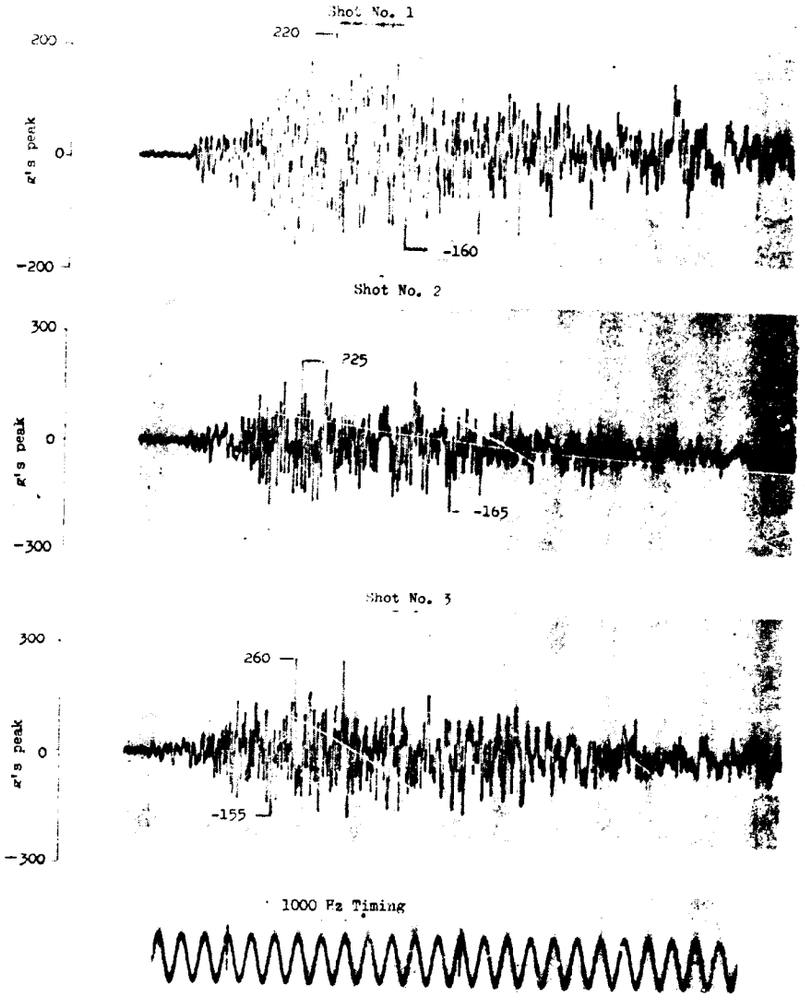




FIGURE 11.B.2-18

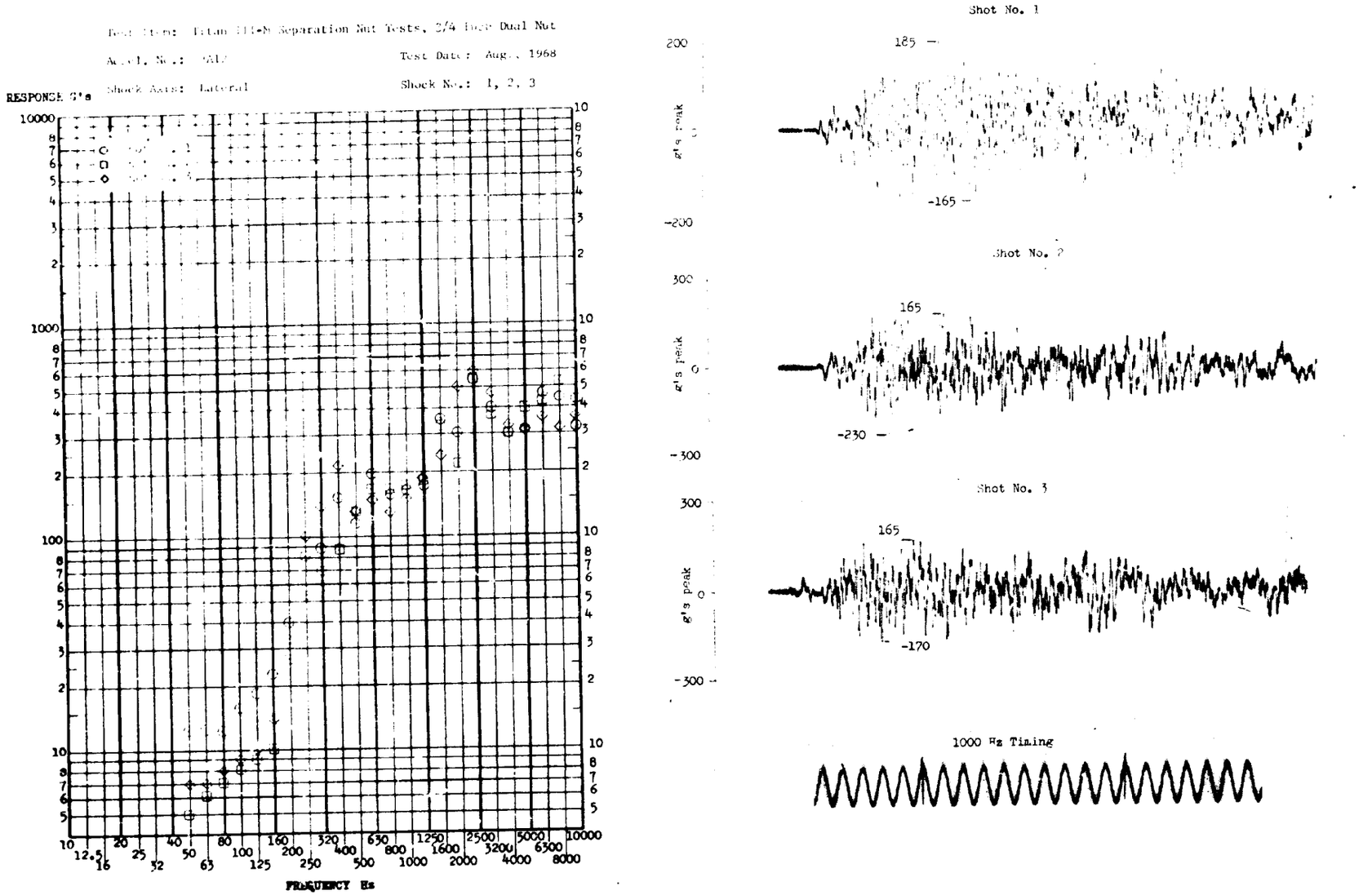



FIGURE 11.B.2-19

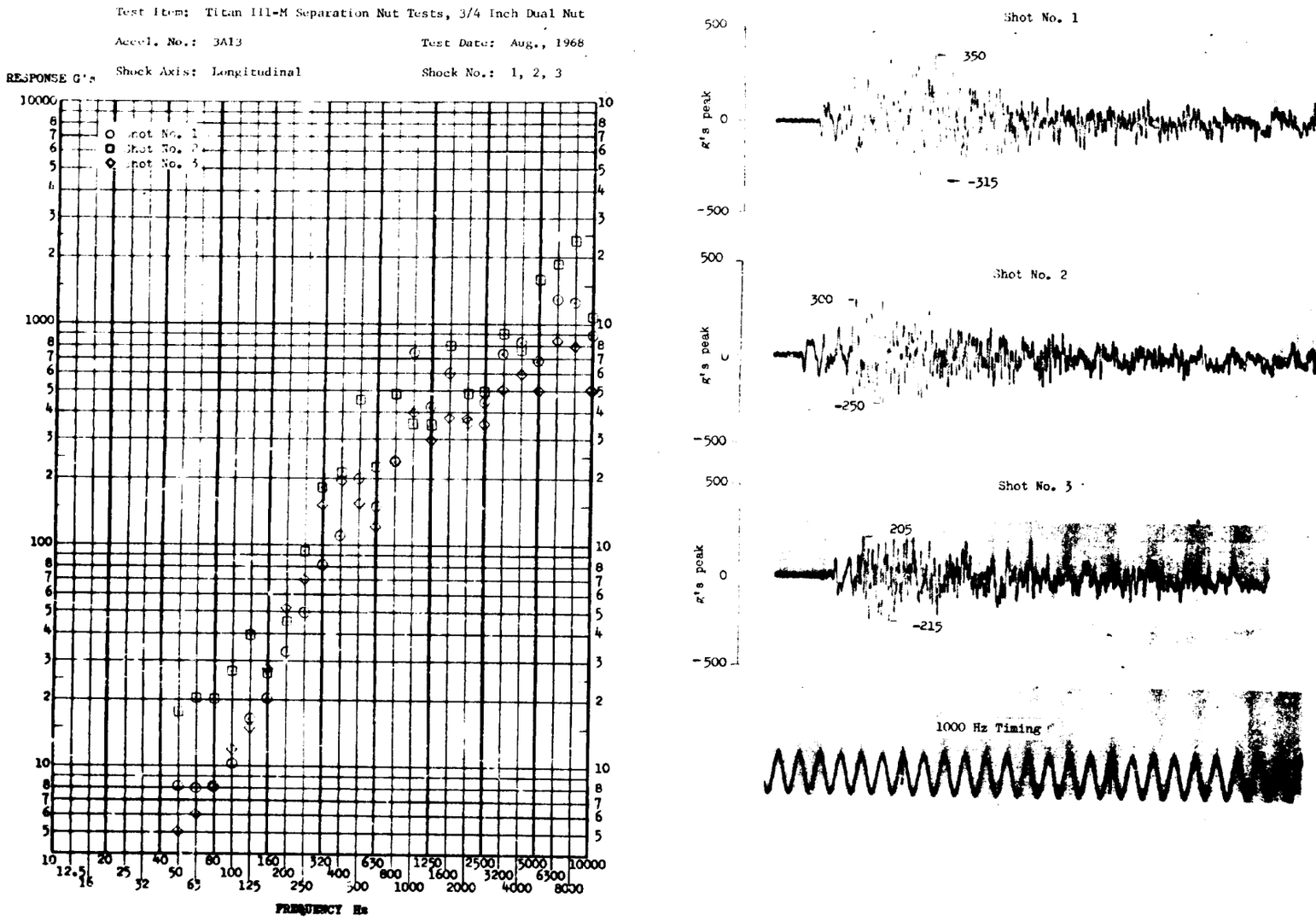



FIGURE II.B.2-20

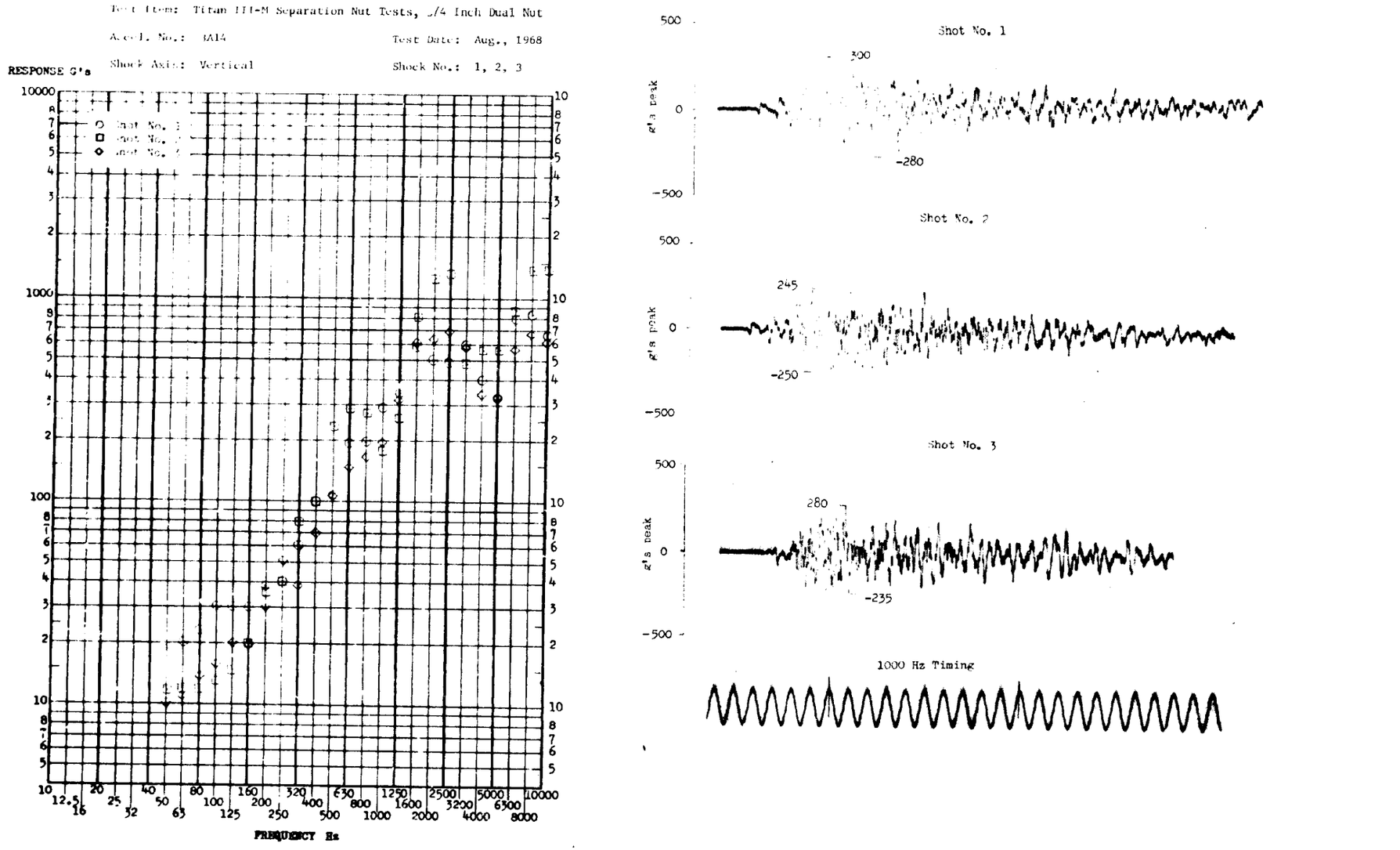
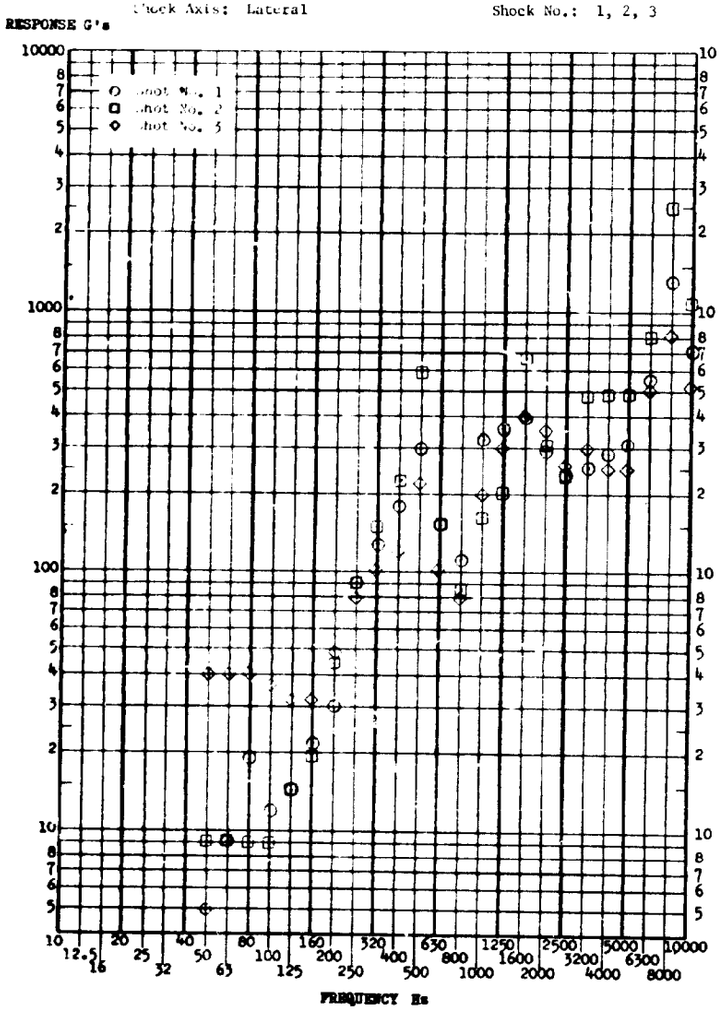



FIGURE II.B.2-21

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Dual Nut

Accel. No.: 3A15 Test Date: Aug., 1968

Shock Axis: Lateral Shock No.: 1, 2, 3



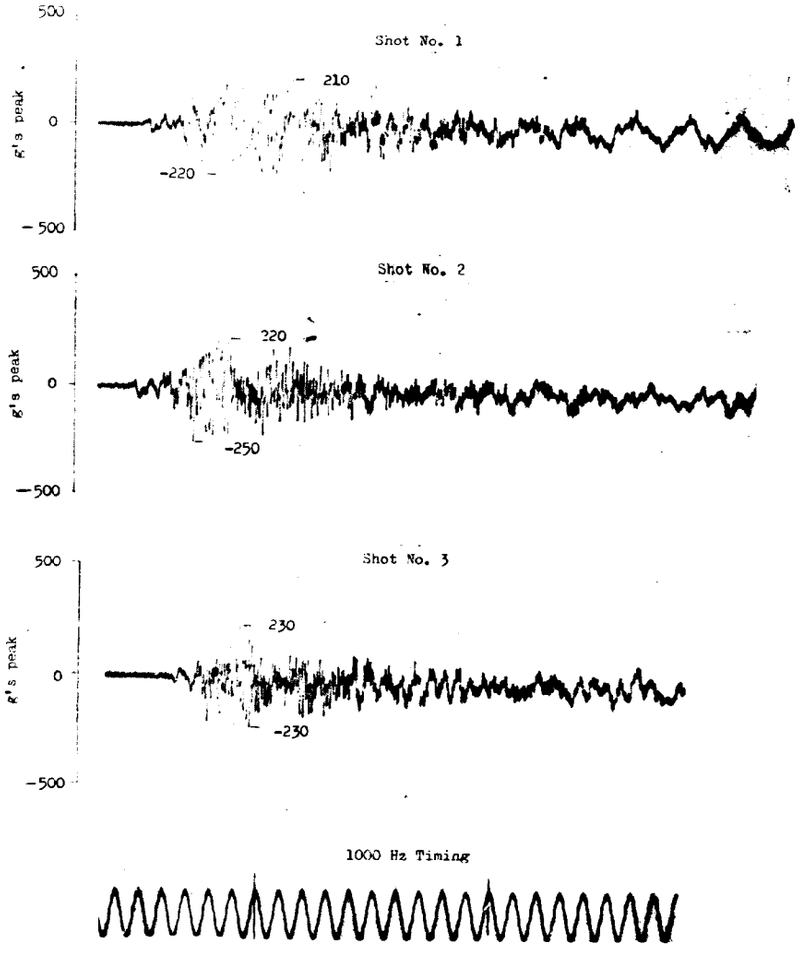




FIGURE II.B.2-22

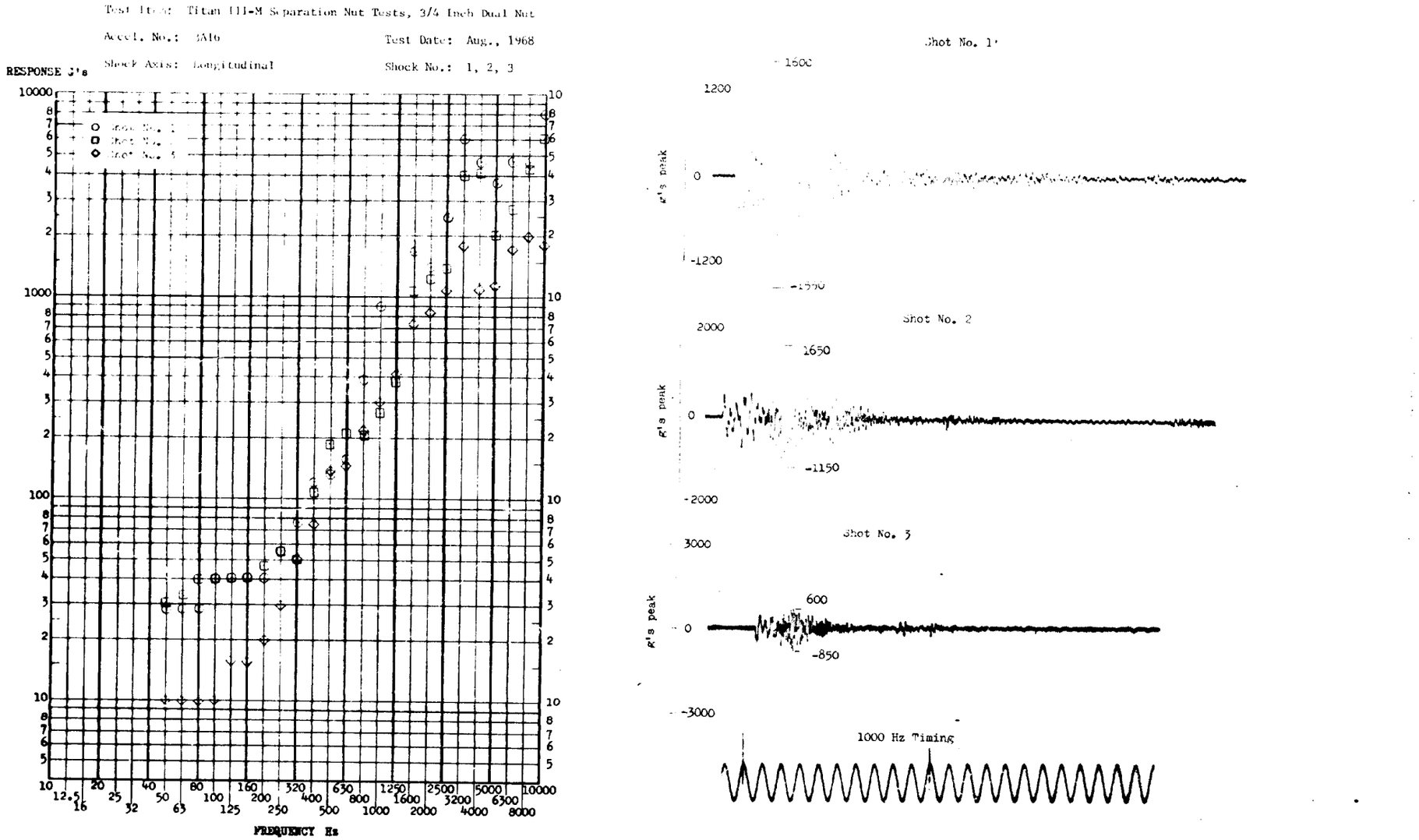
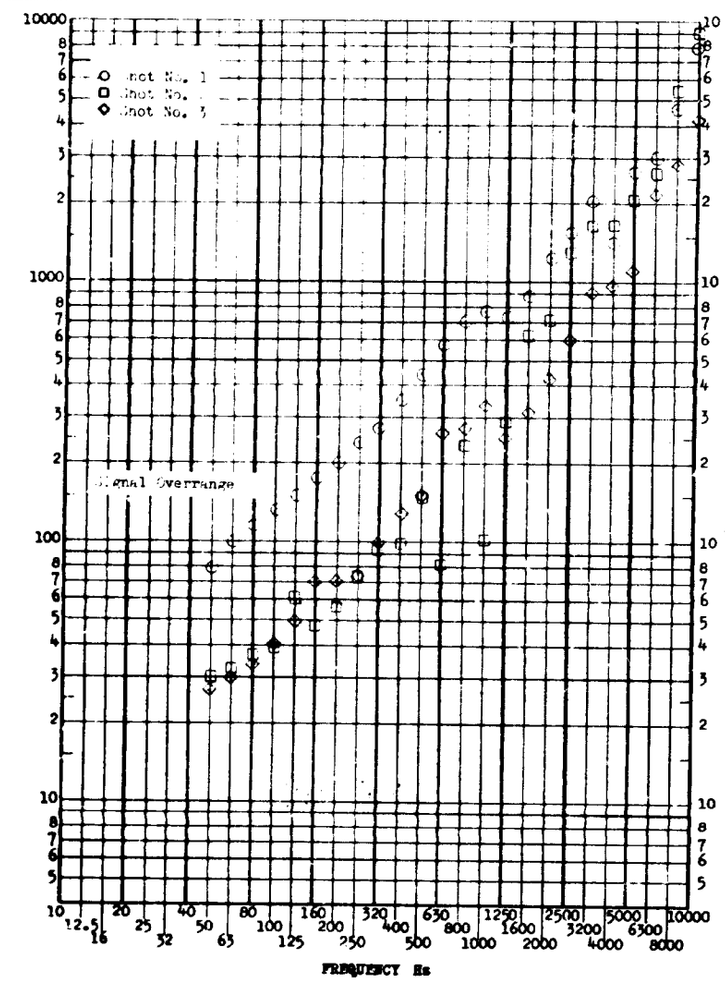



FIGURE II.B.2-23

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Dual Nut

Accel. No.: CA17 Test Date: Aug., 1968

Shock Axis: Radial Shock No.: 1, 2, 3



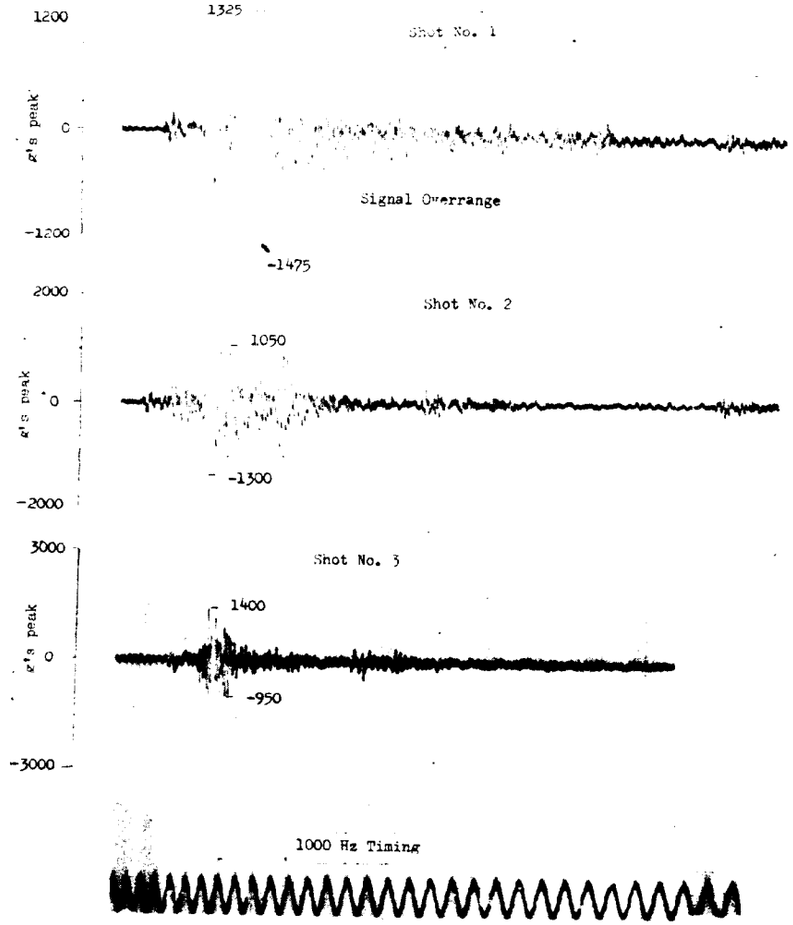




FIGURE 11.8.2-24

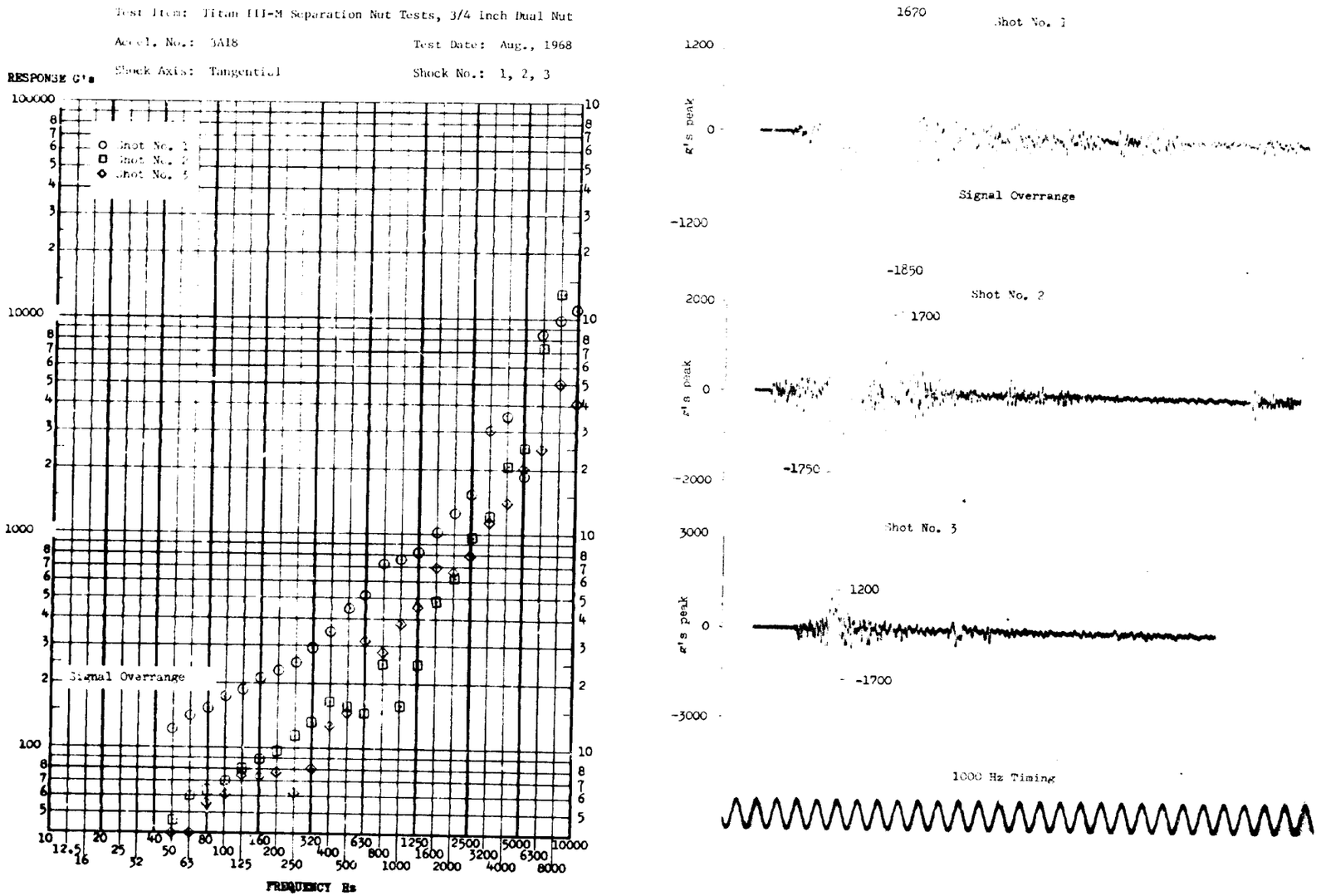



FIGURE 11.B.2-25

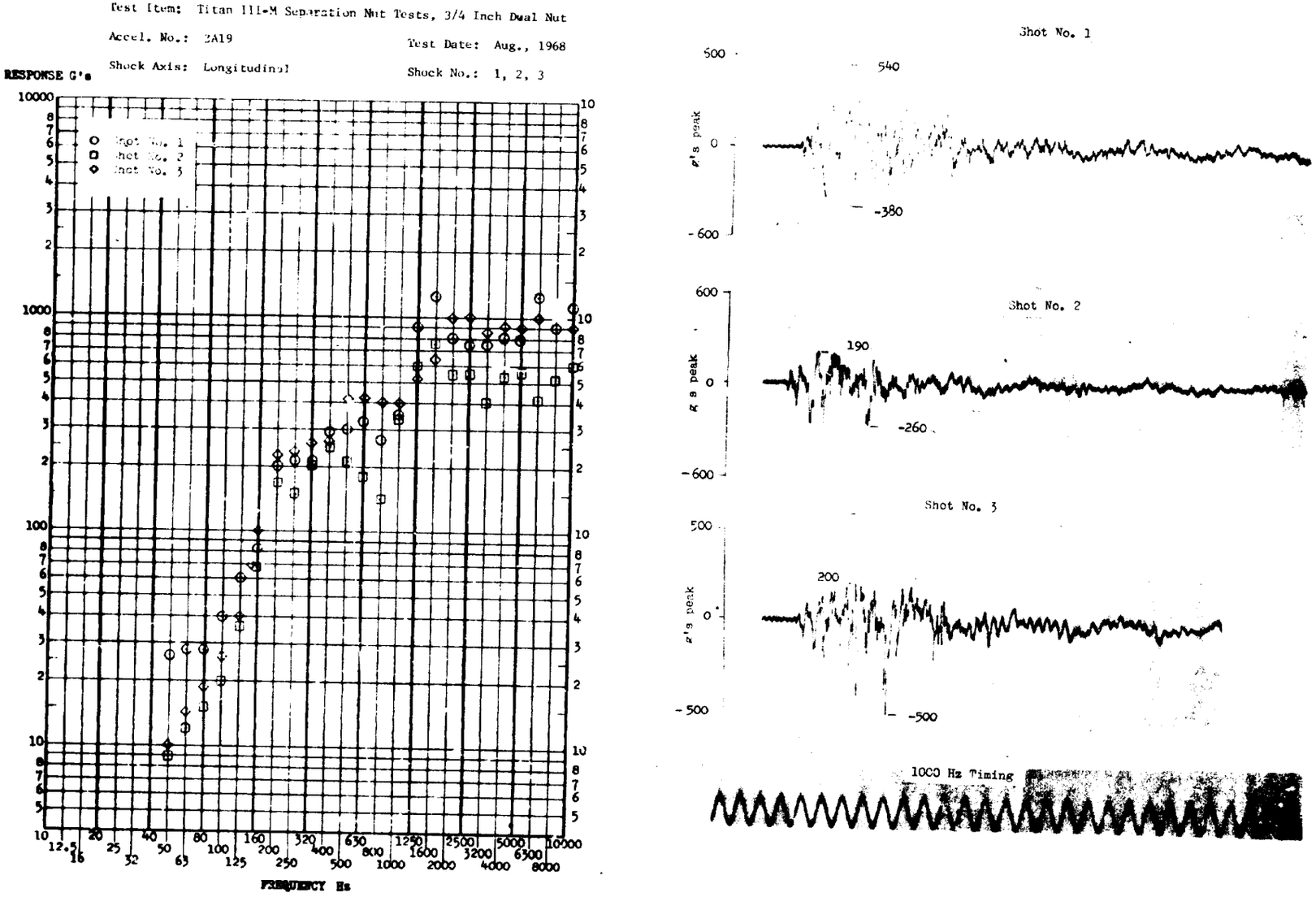
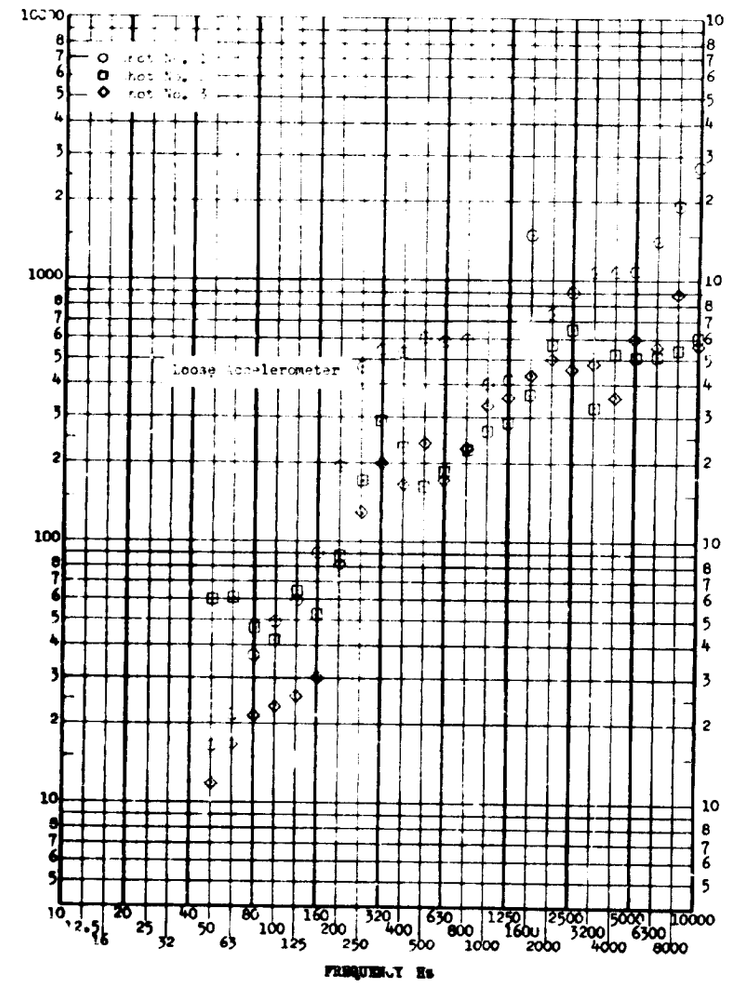



FIGURE 11.B.2-26

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Dual Nut

Accel. No.: 9A70 Test Date: Aug., 1968

Shock Axis: Radial Shock No.: 1, 2, 3



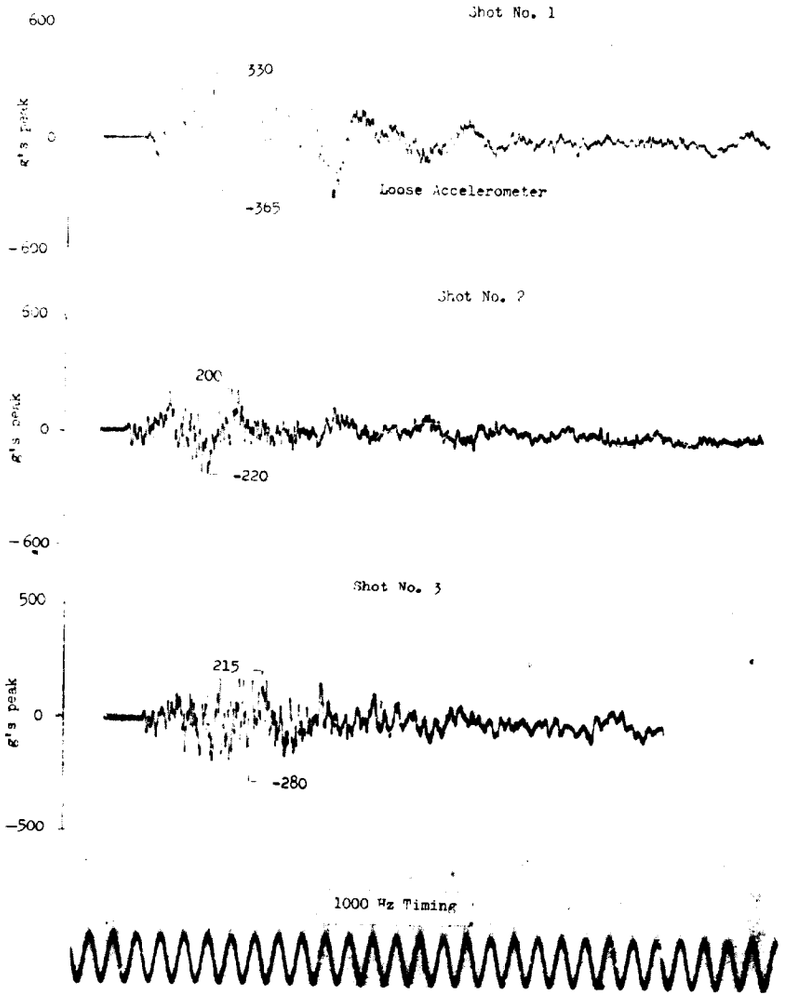




FIGURE 11.8.2-27

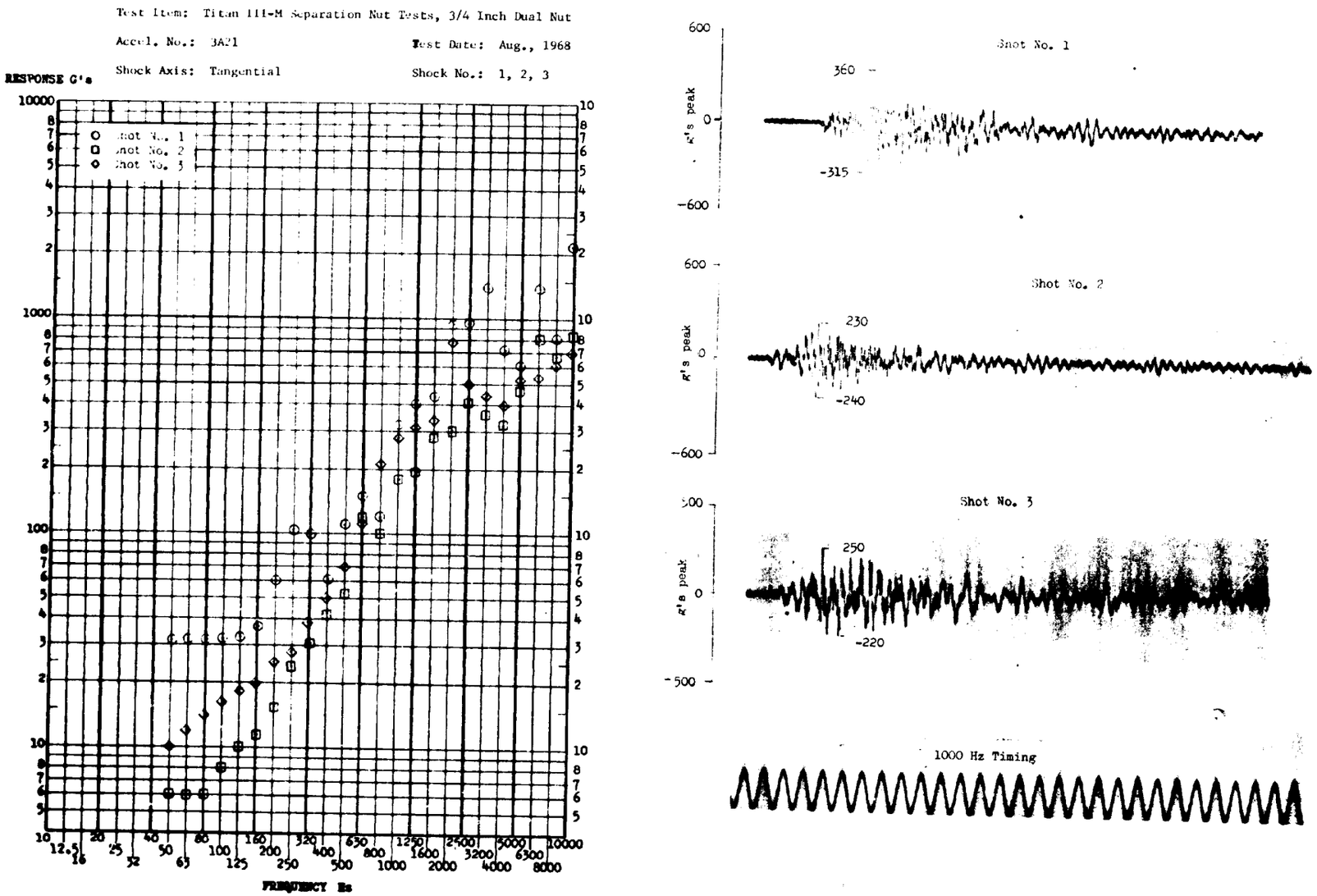



FIGURE 11.8.2-28

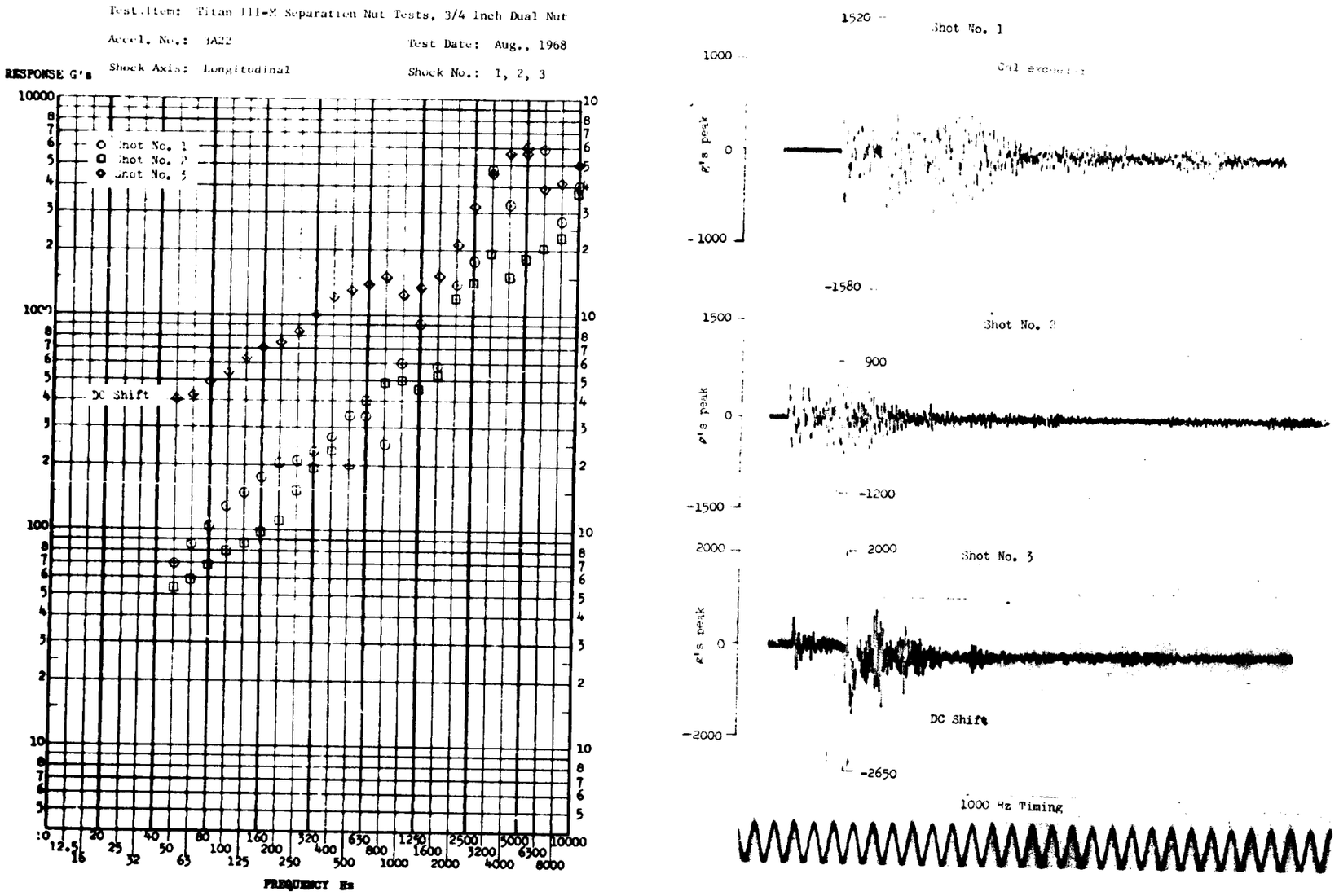
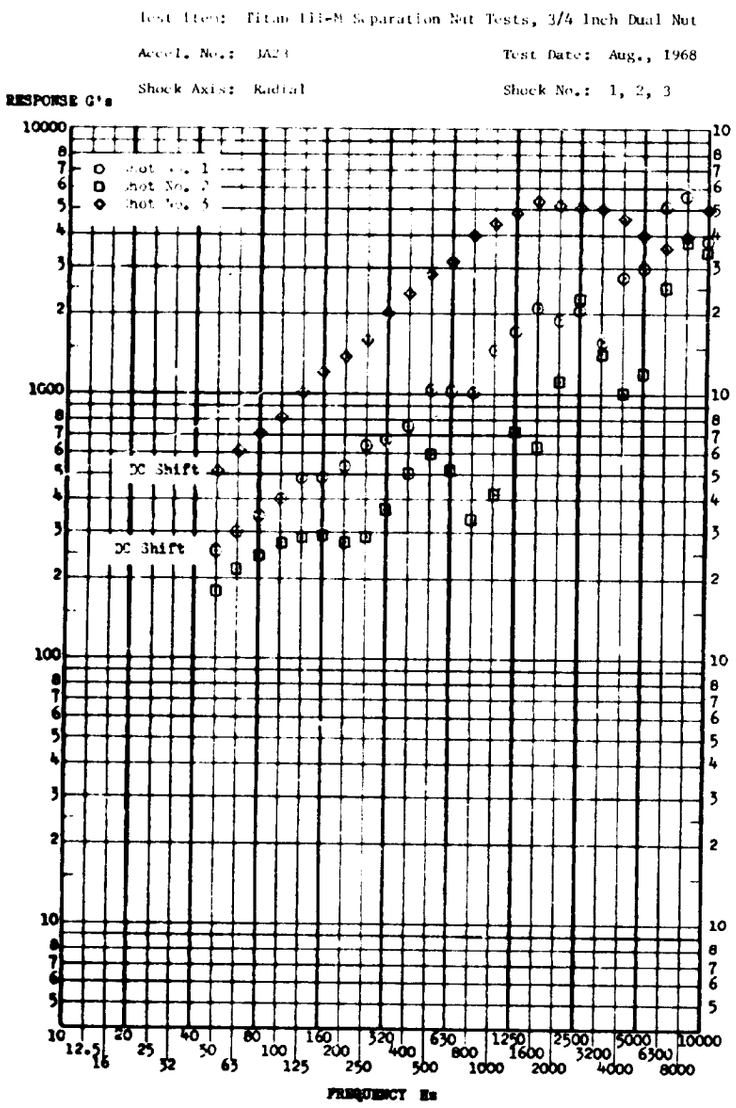



FIGURE 11.B.2-29



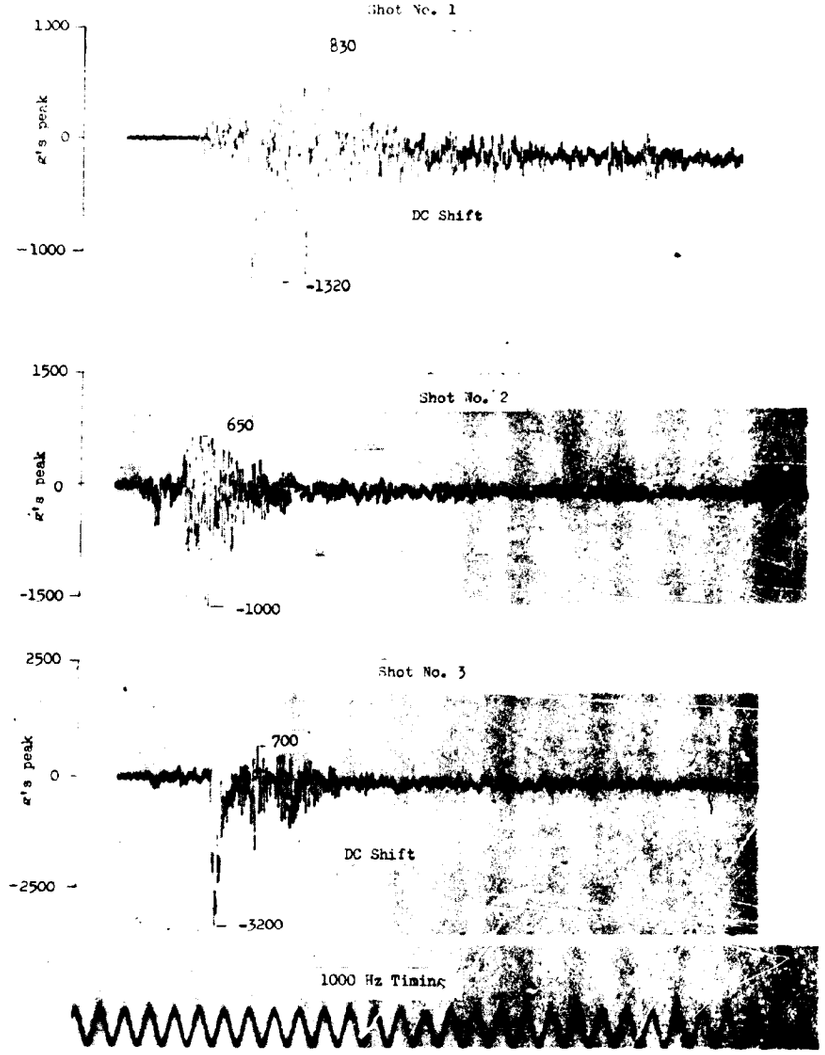




FIGURE II.B.2-30

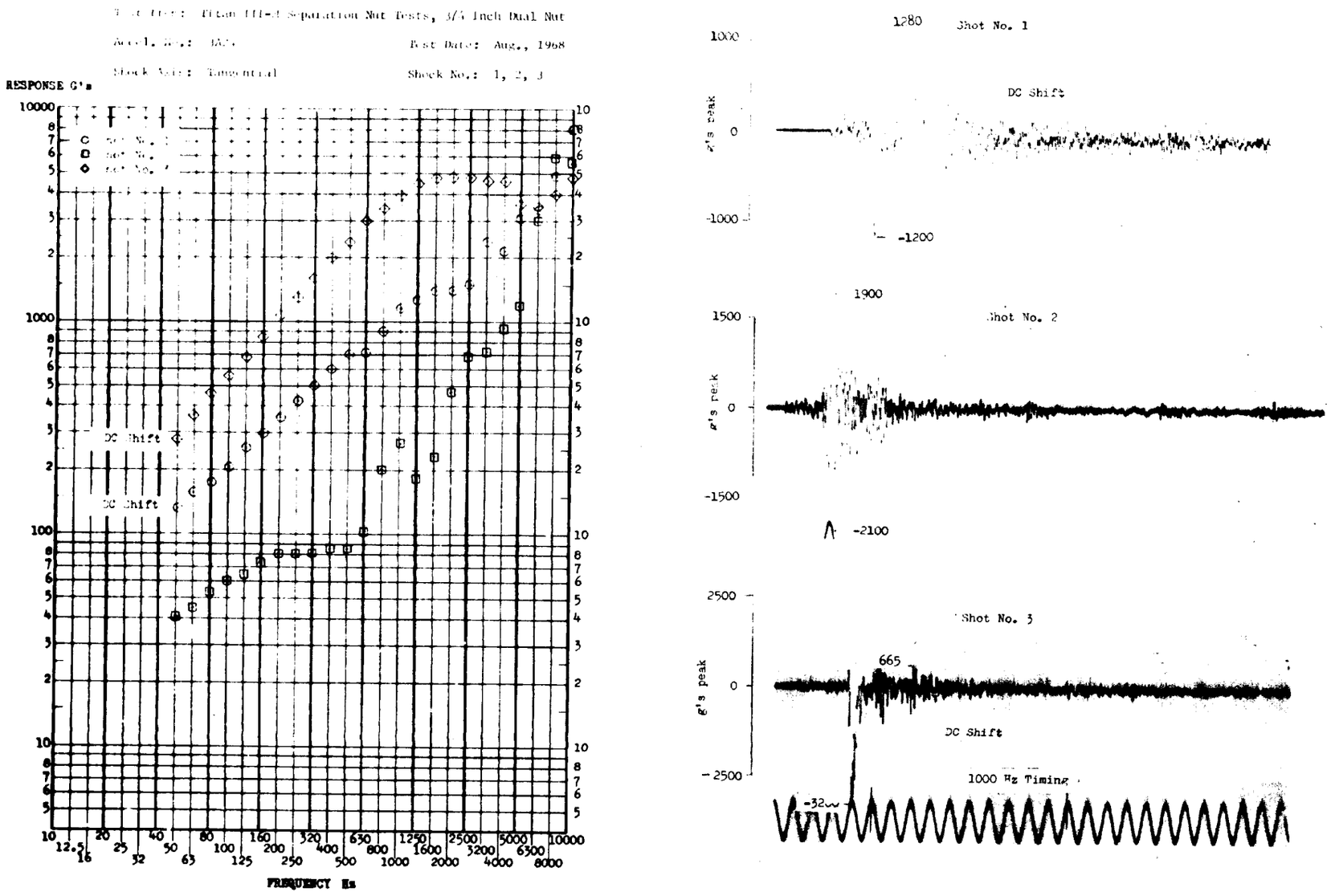



FIGURE 11.B.2-31

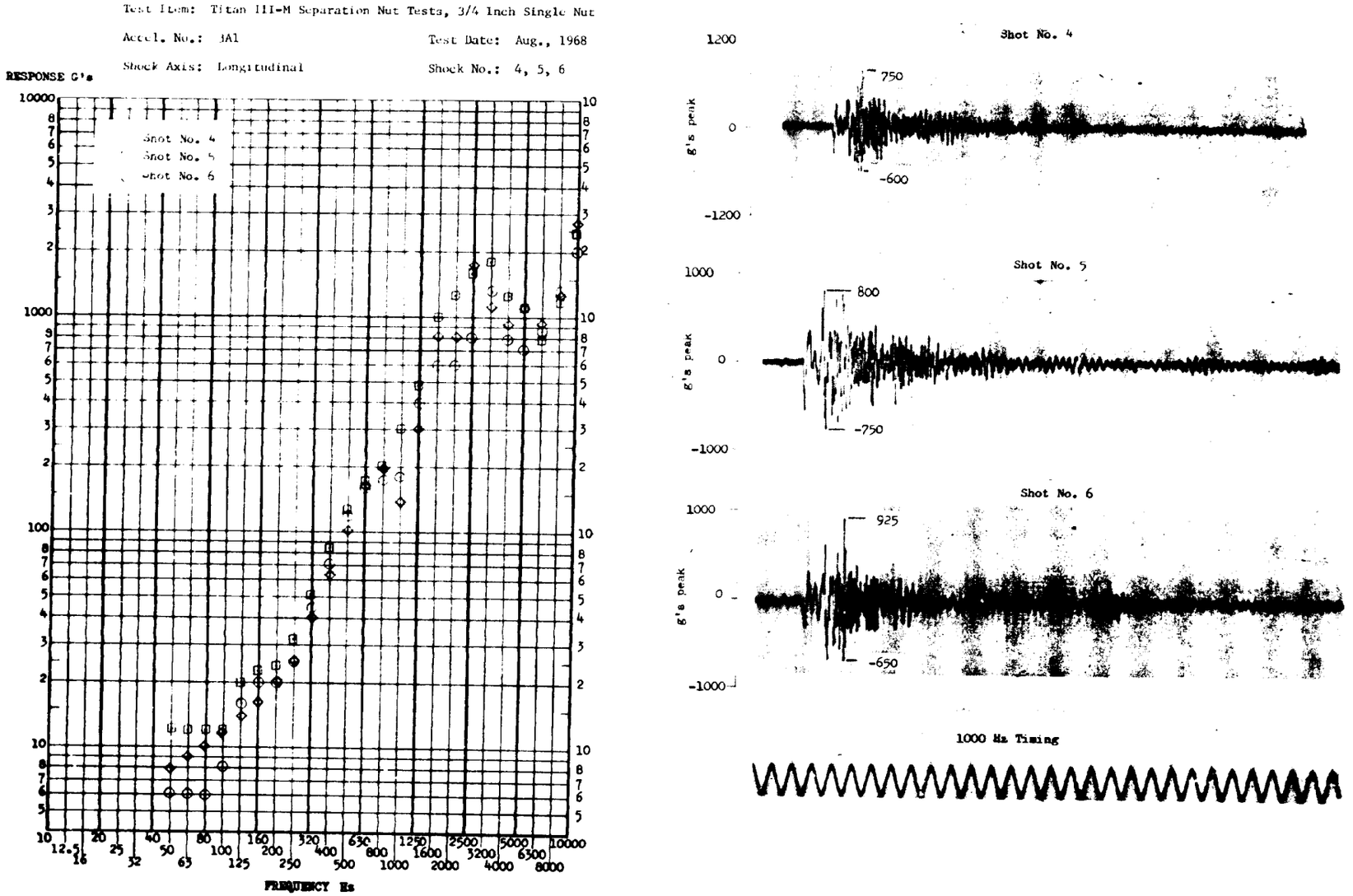



FIGURE 11.8.2-32

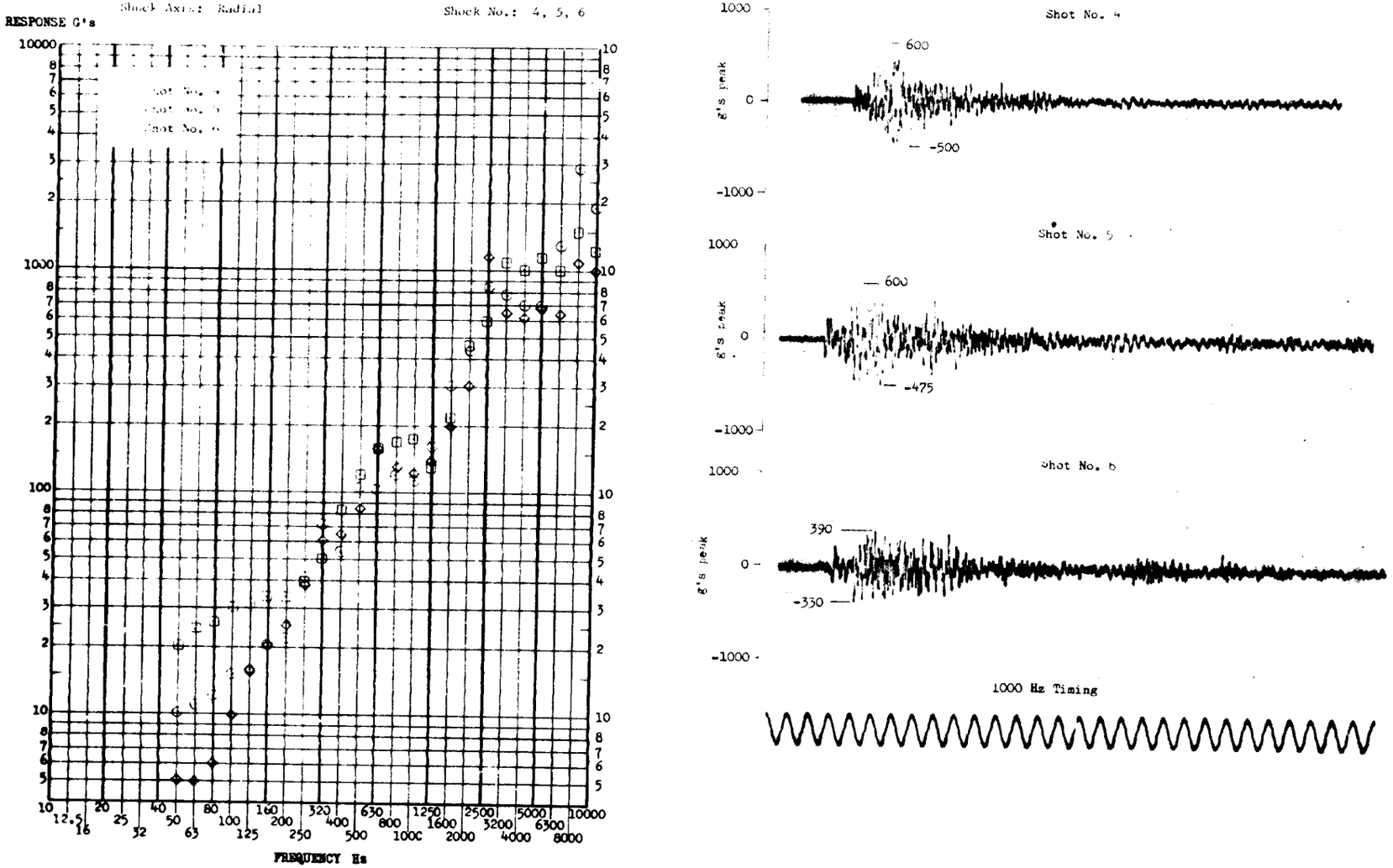



FIGURE II.B.2-33

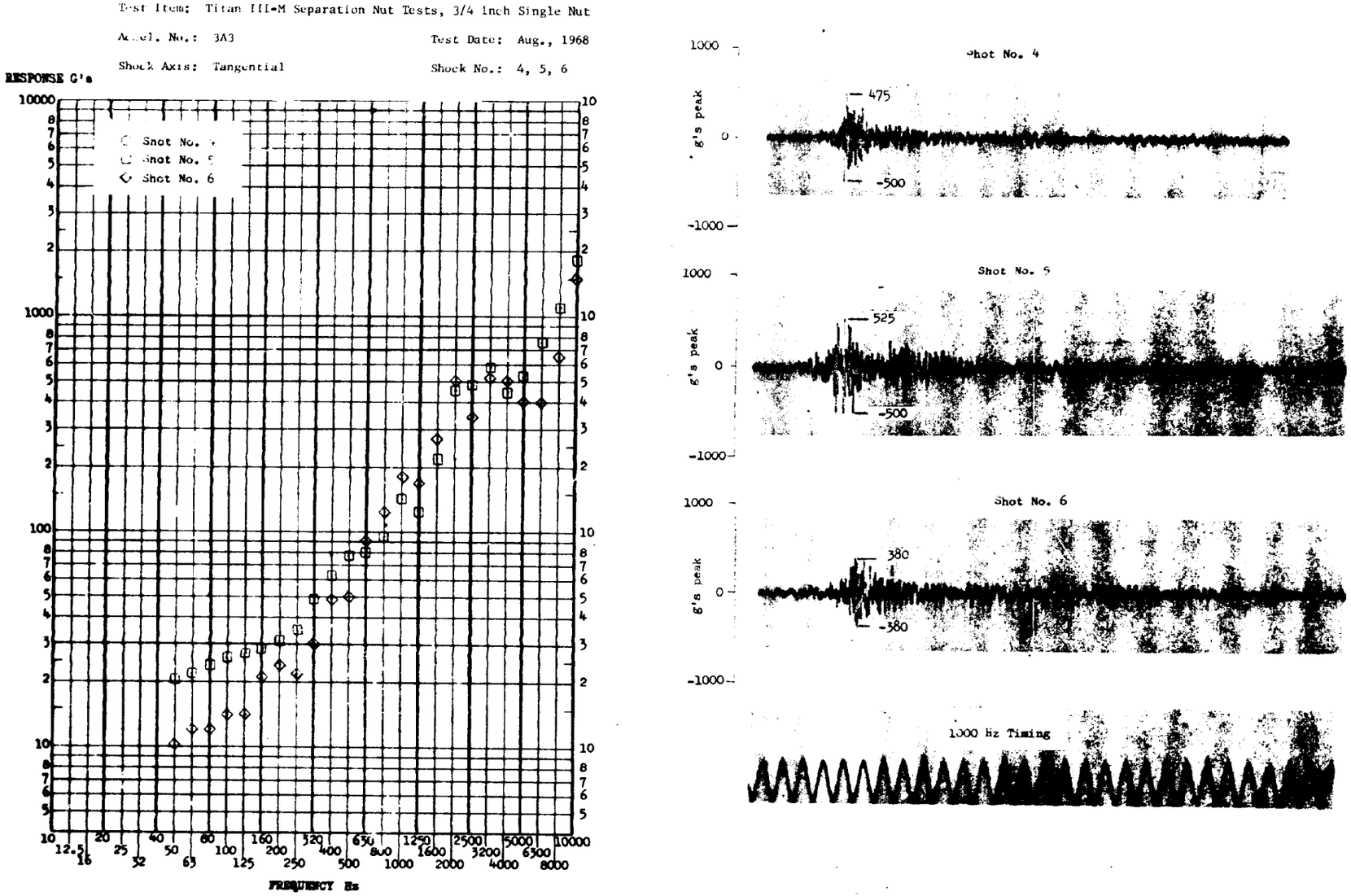
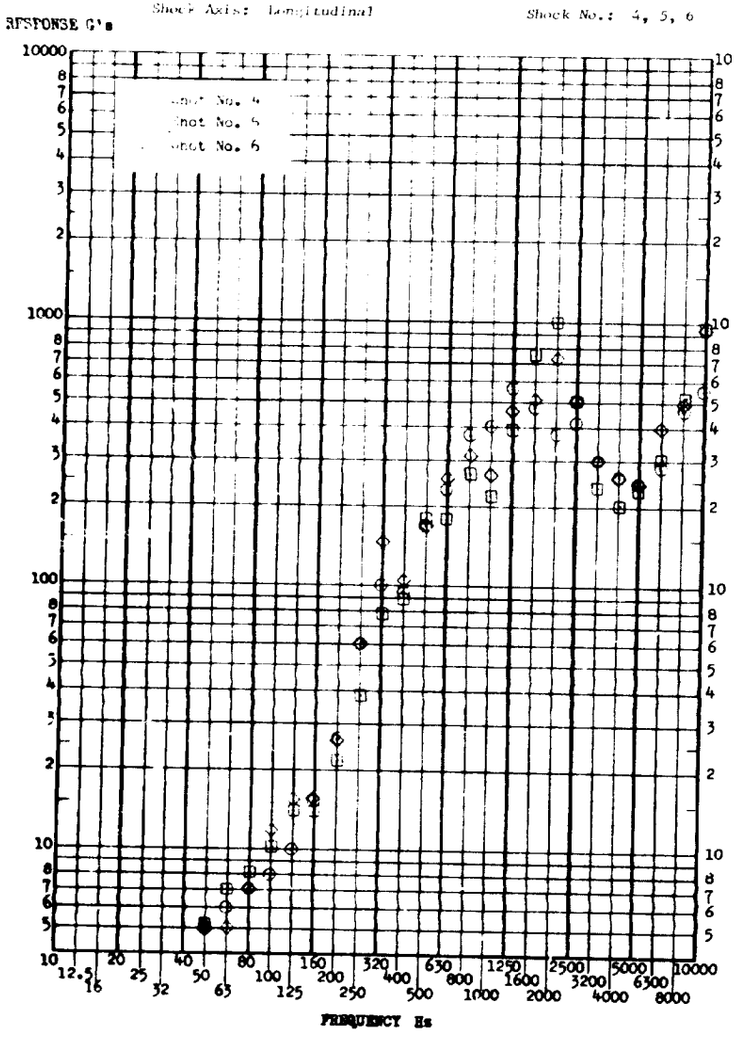



FIGURE II.B.2-34

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

Accel. No.: 3AA Test Date: Aug., 1968

Shock Axis: Longitudinal Shock No.: 4, 5, 6



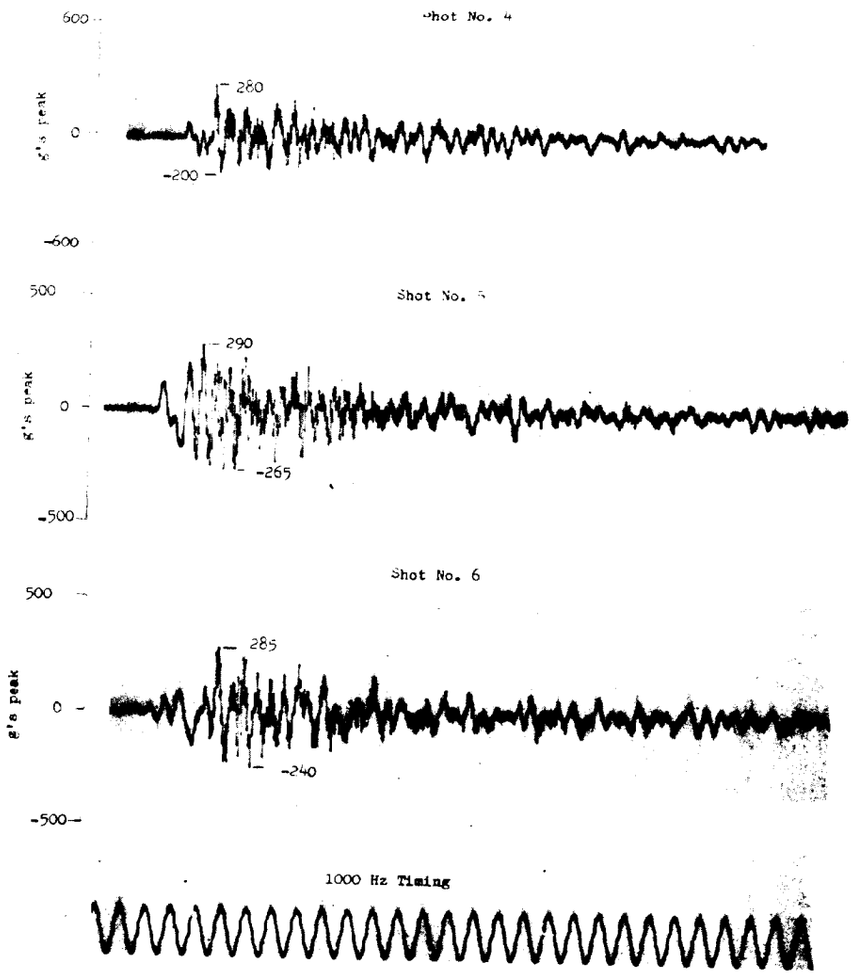
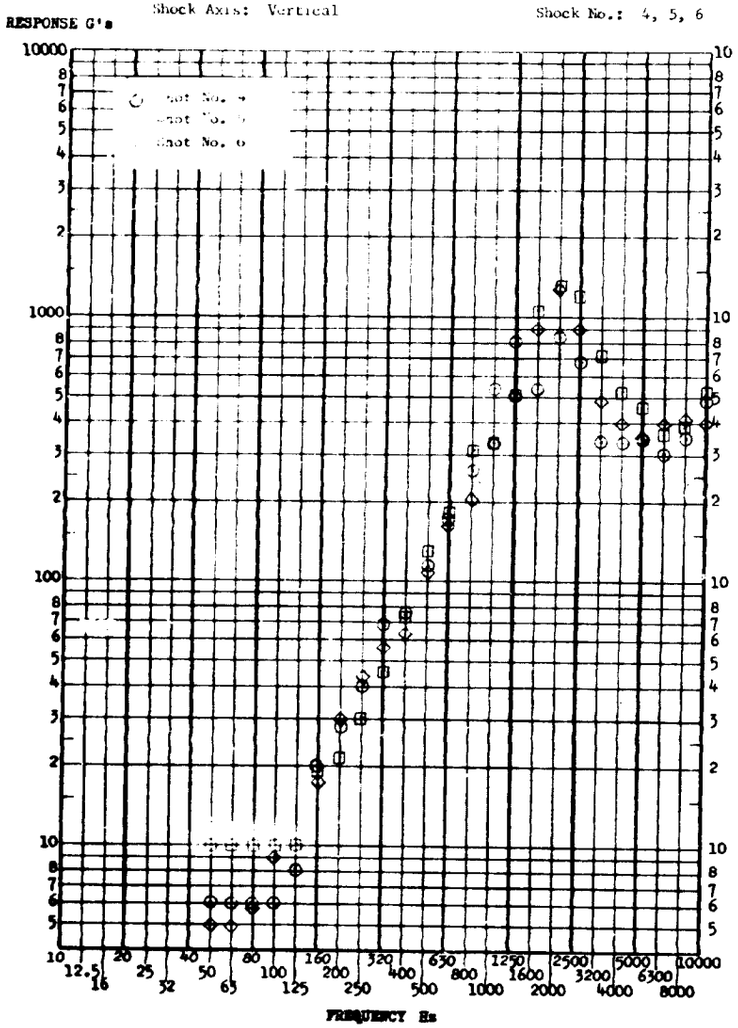




FIGURE II.B.2-35

Test Item. Titan IIIC-M Separation Nut Tests, 3/4 Inch Single Nut

Accel. No.: 3A5 Test Date: Aug., 1968

Shock Axis: Vertical Shock No.: 4, 5, 6



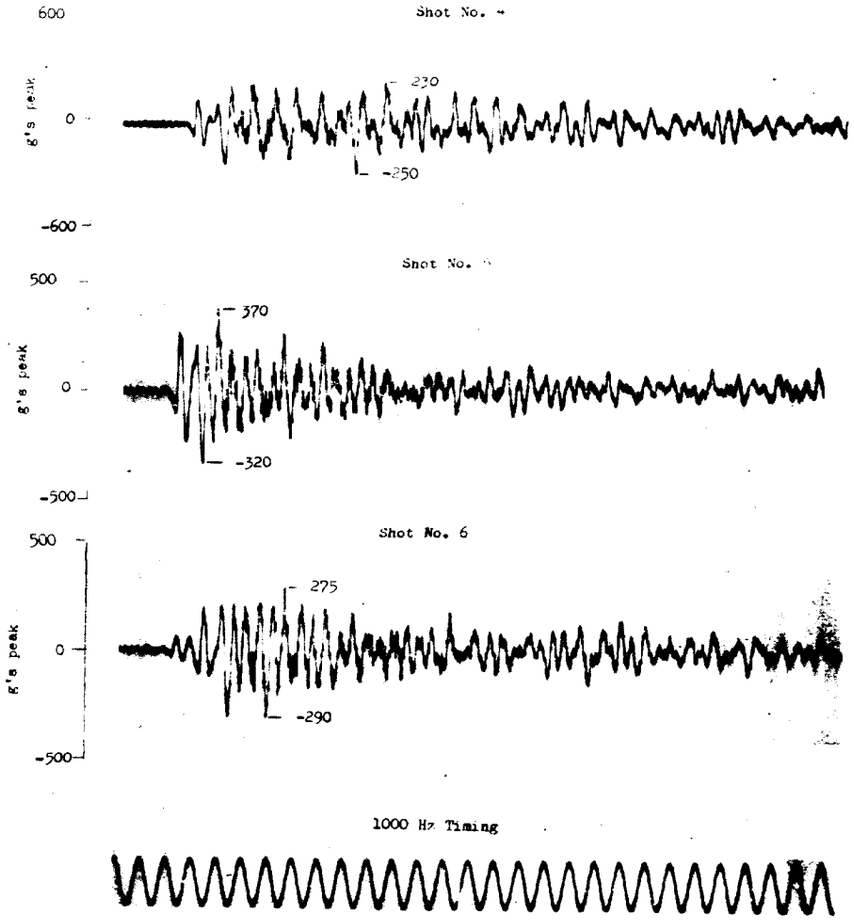




FIGURE II.B.2-36

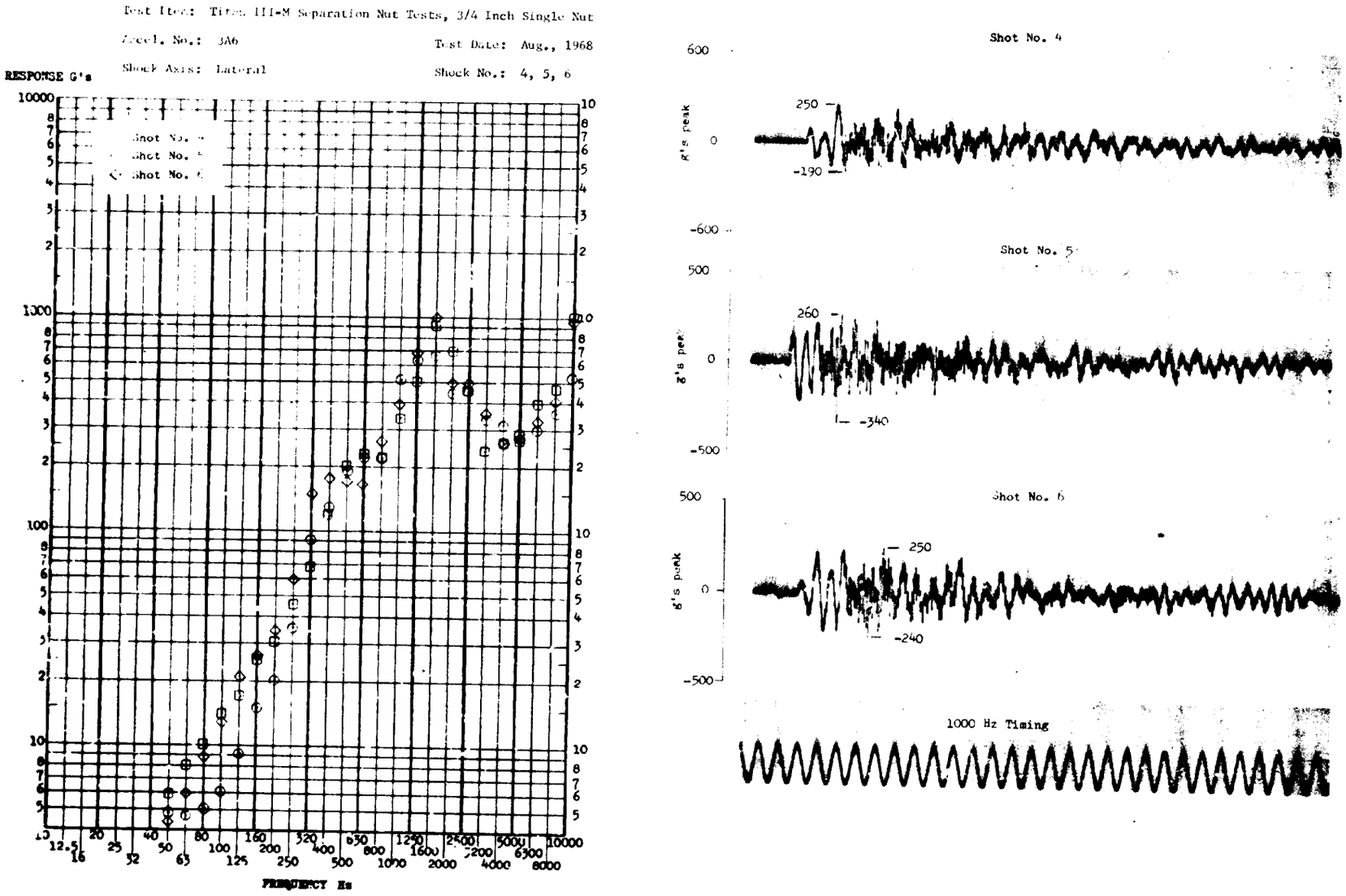



FIGURE II.B.2-37

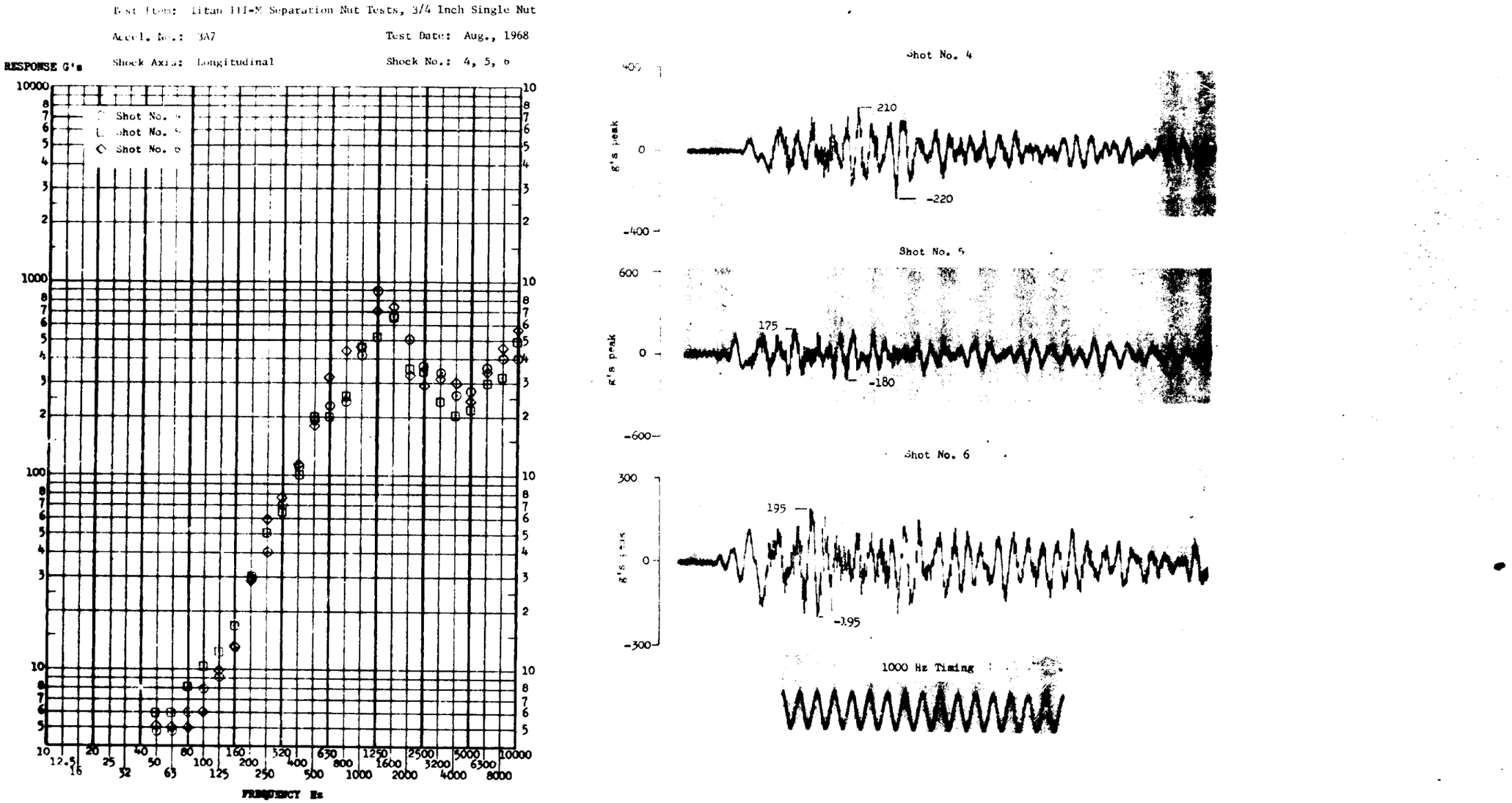
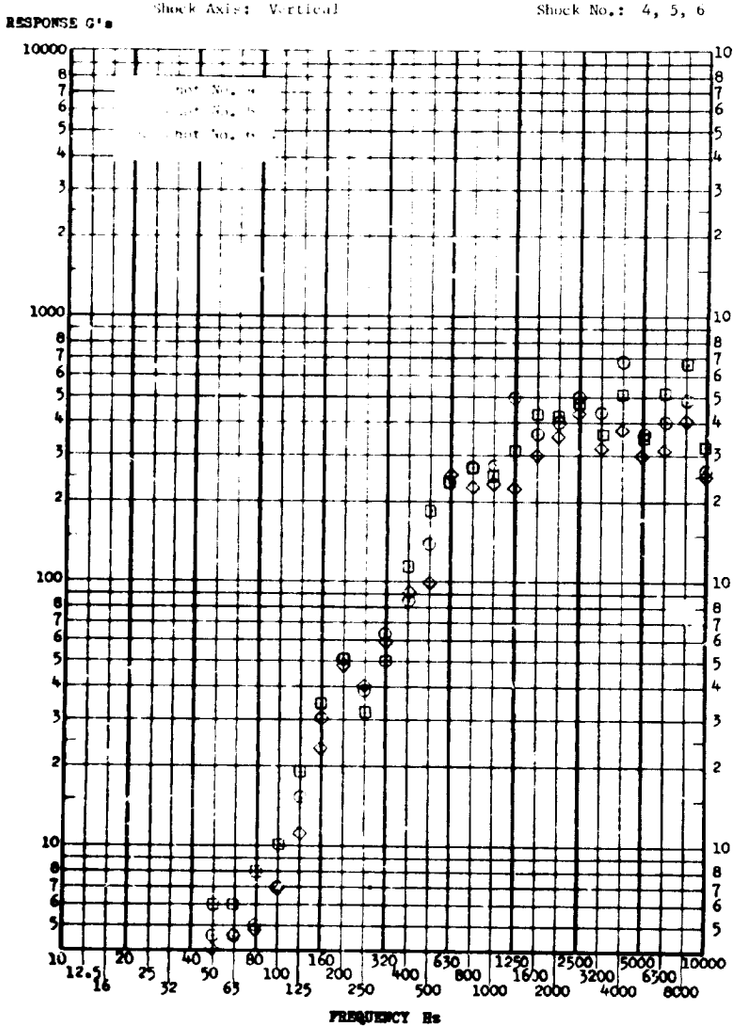



FIGURE 11.B.2-38

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

Accel. No.: 3A8 Test Date: Aug., 1968

Shock Axis: Vertical Shock No.: 4, 5, 6



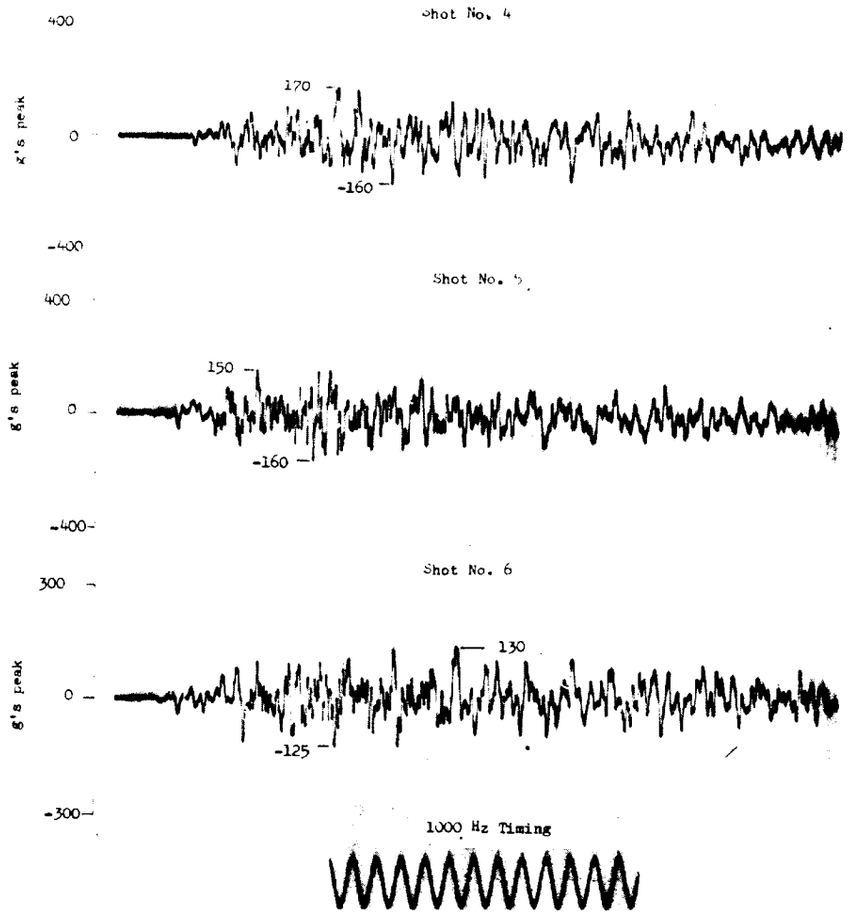
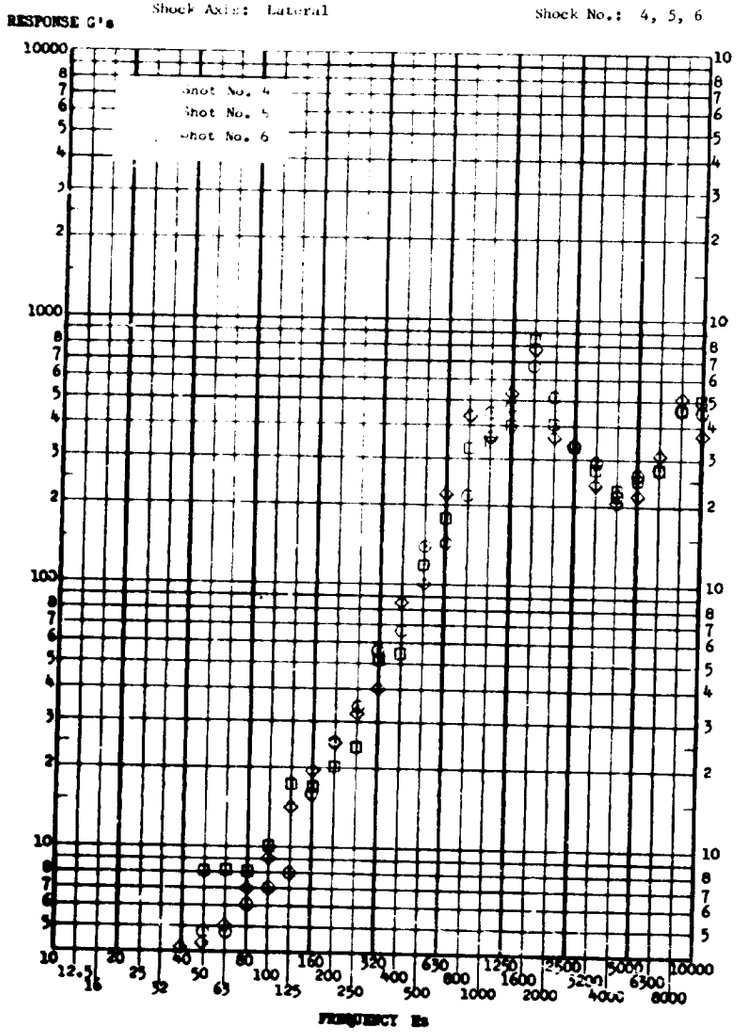




FIGURE II.B.2-39

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

Accel. No.: 3A9 Test Date: Aug., 1968

Shock Axis: Lateral Shock No.: 4, 5, 6



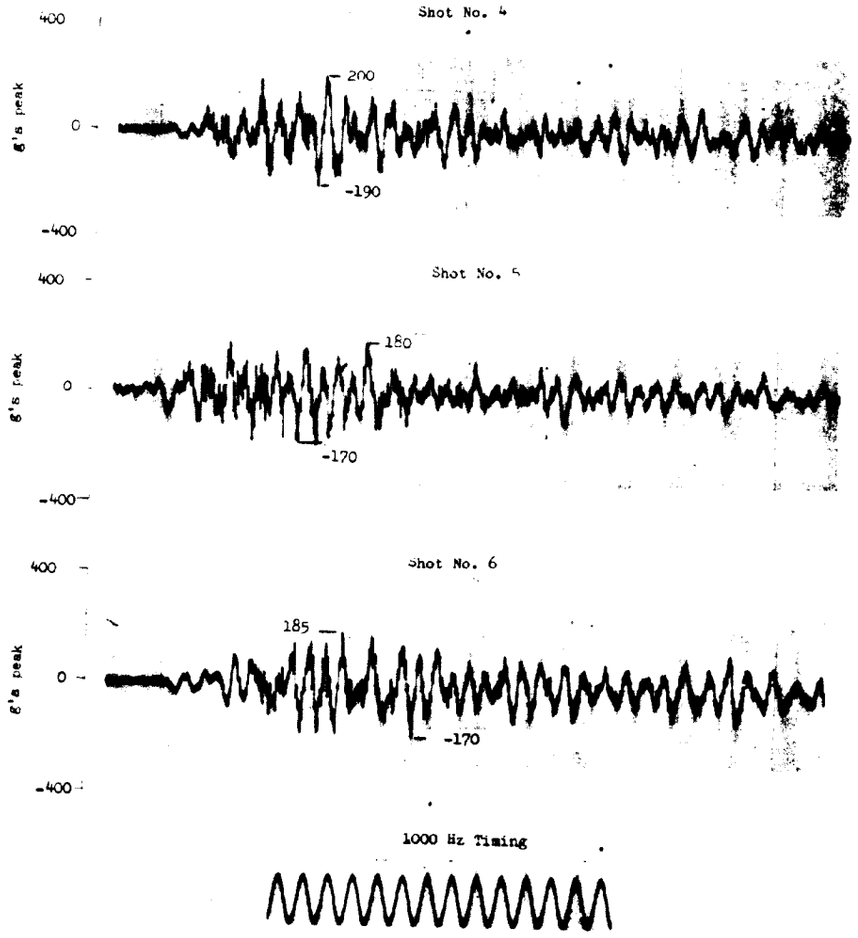




FIGURE 1.B.2-40

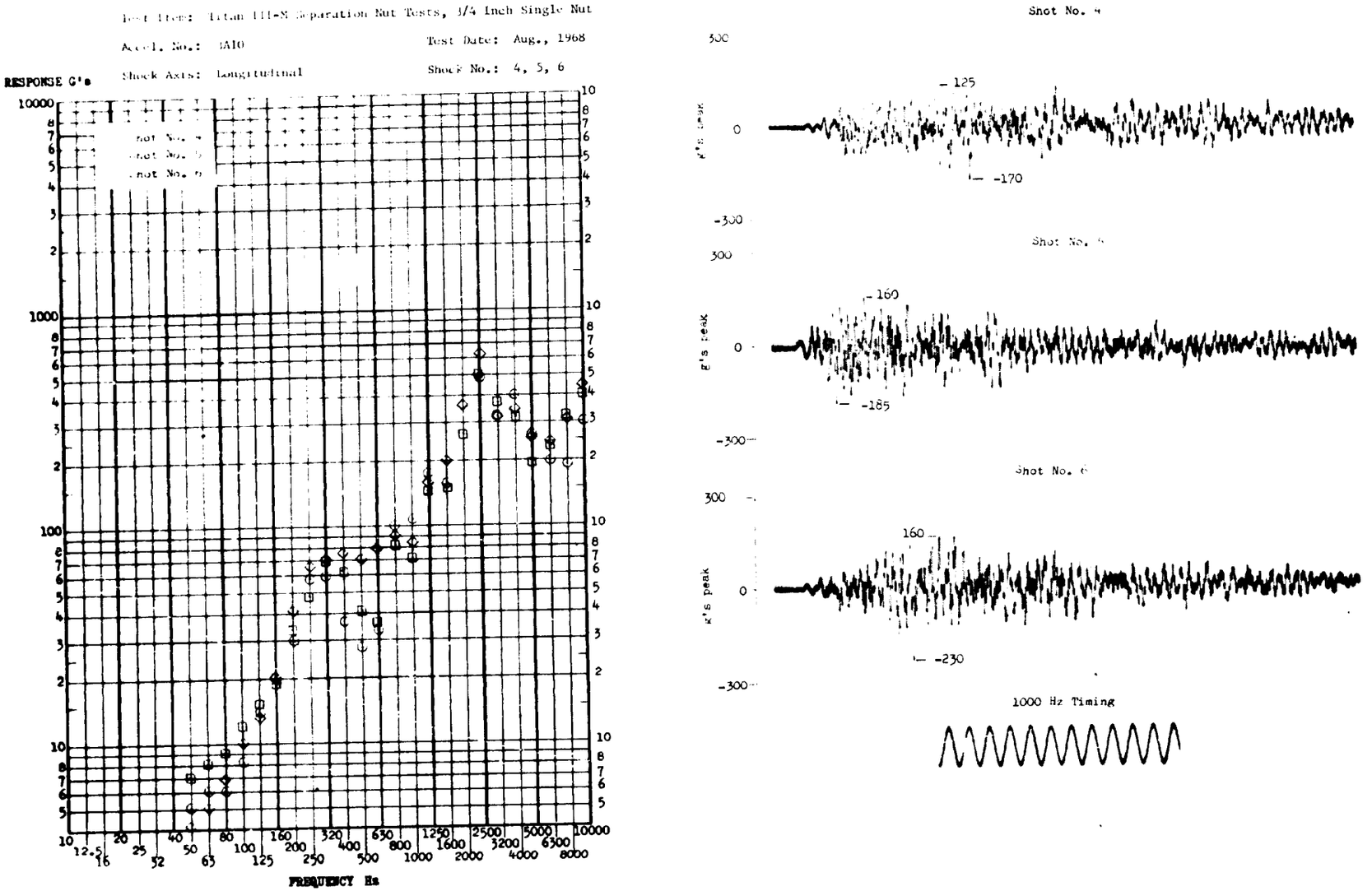
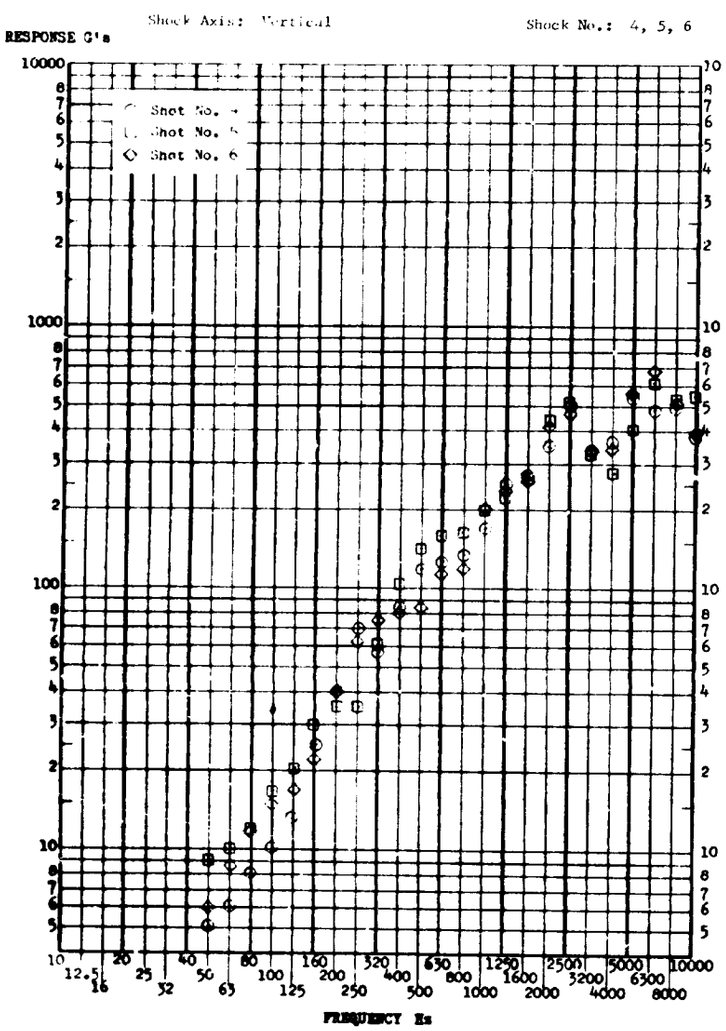



FIGURE II.B.2-41



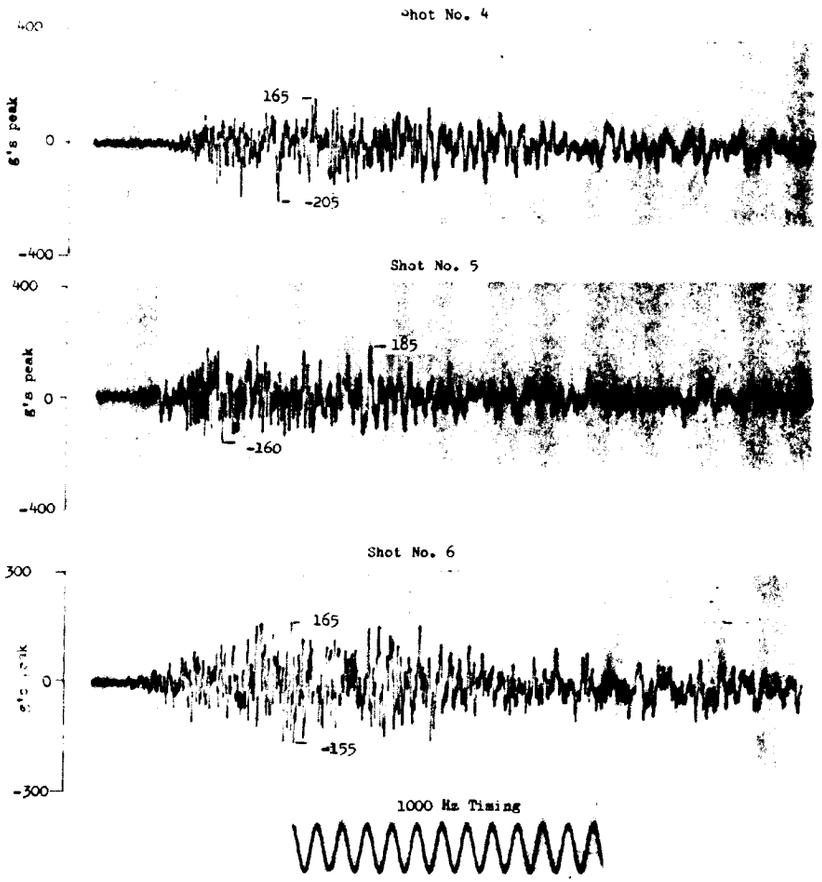




FIGURE II.B.2-42

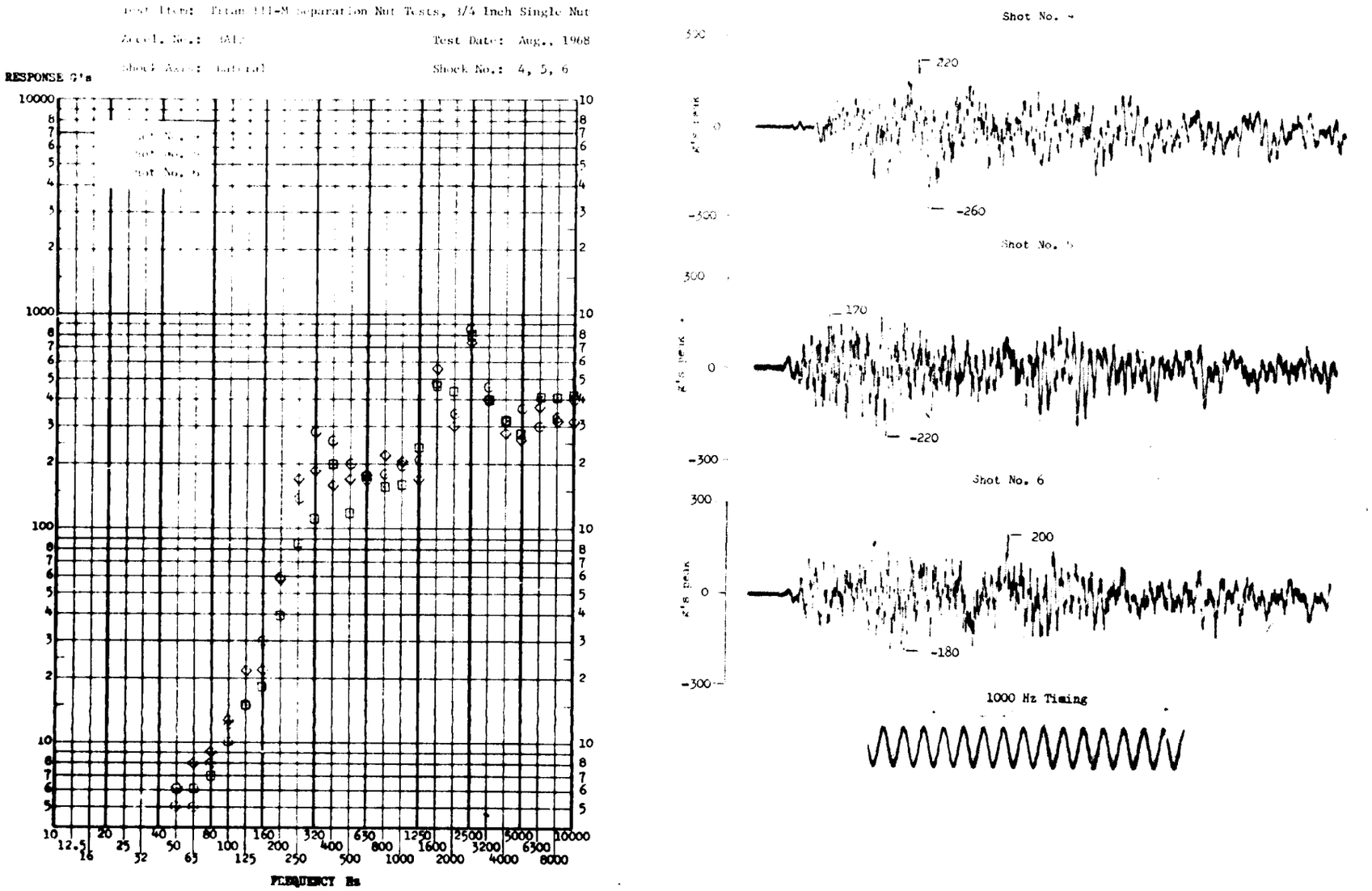
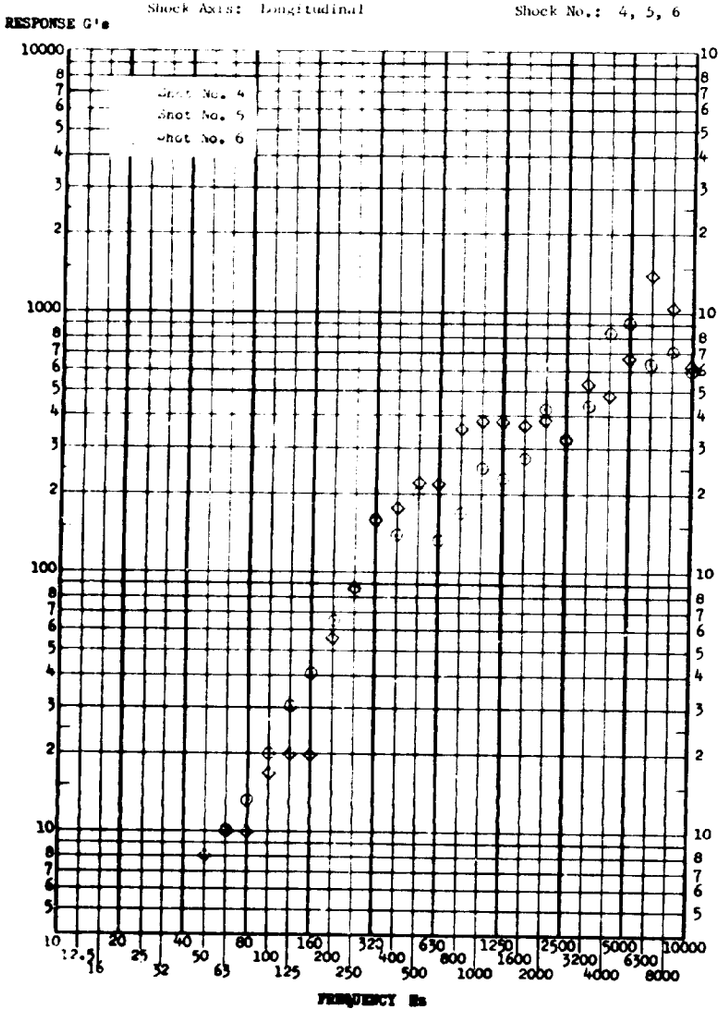


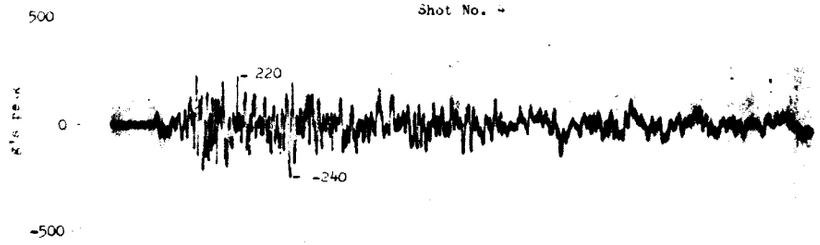

FIGURE 11.8.2-43

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

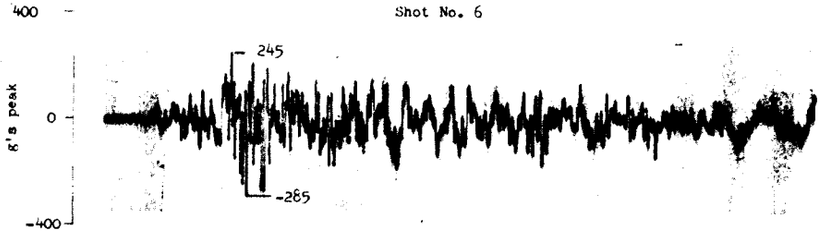
Accel. No.: 9A13 Test Date: Aug., 1968

Shock Axis: Longitudinal Shock No.: 4, 5, 6




Shot #5 No Data




1000 Hz Timing

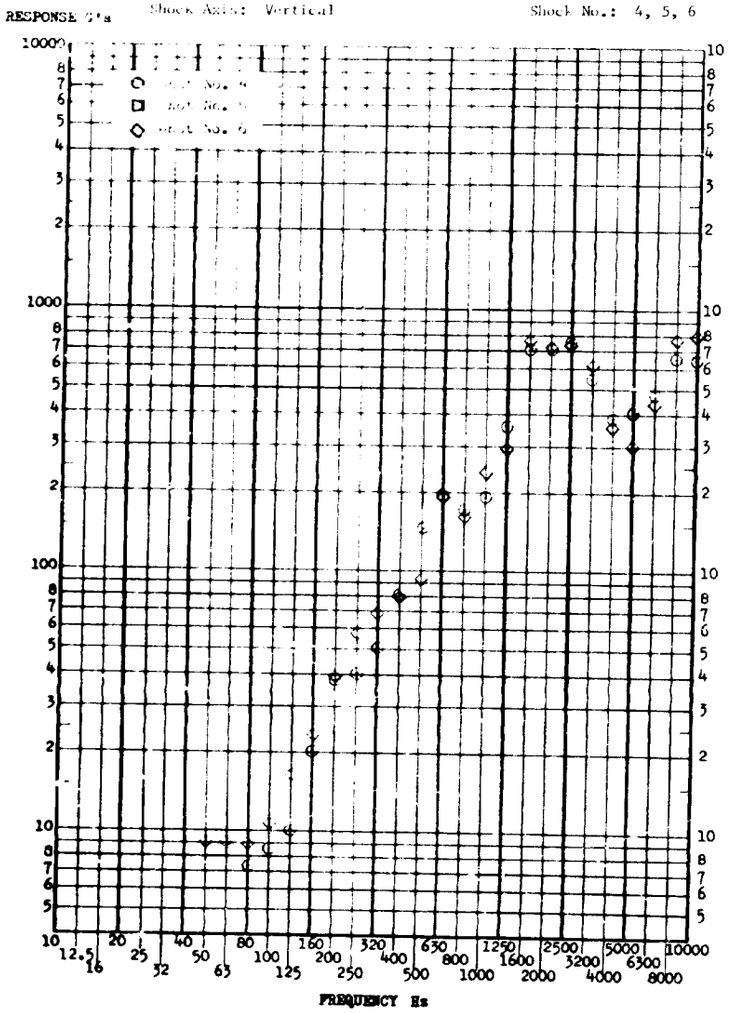


FIGURE 11.B.2-44

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

Accel. No.: 3814 Test Date: Aug., 1968

Shock Axis: Vertical Shock No.: 4, 5, 6

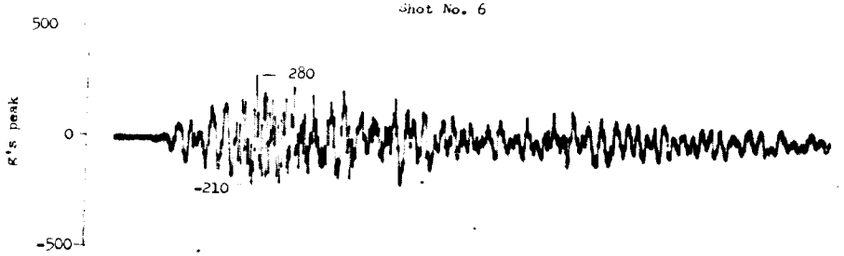



Shot No. 4




Shot #5 No Data

Shot No. 6




1000 Hz Timing

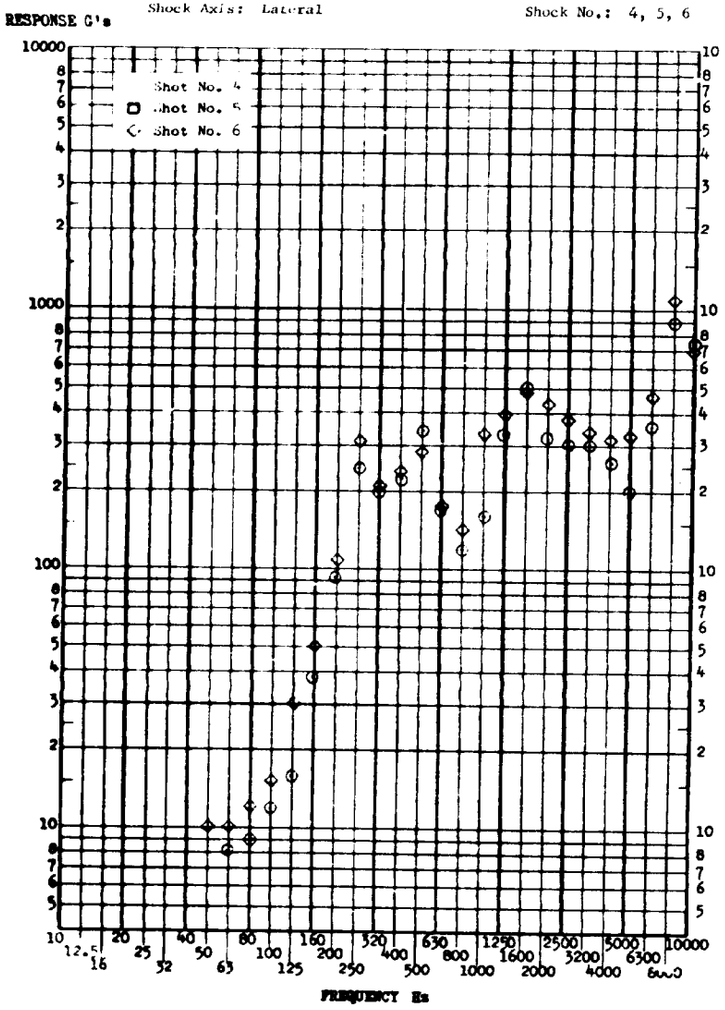


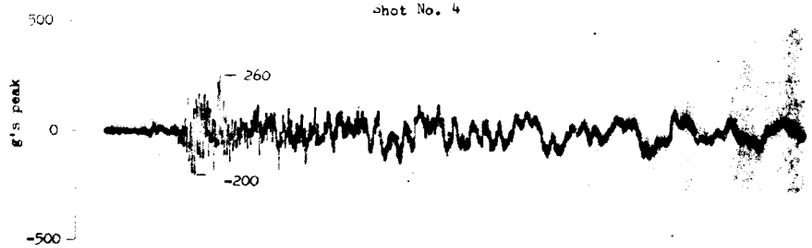
FIGURE II.B.2-45

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

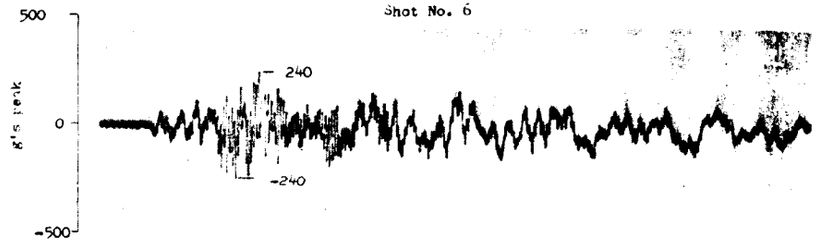
Accel. No.: 3A15 Test Date: Aug., 1968

Shock Axis: Lateral Shock No.: 4, 5, 6




Shot #5 No Data



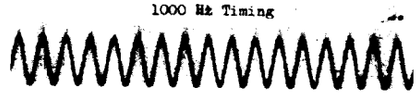
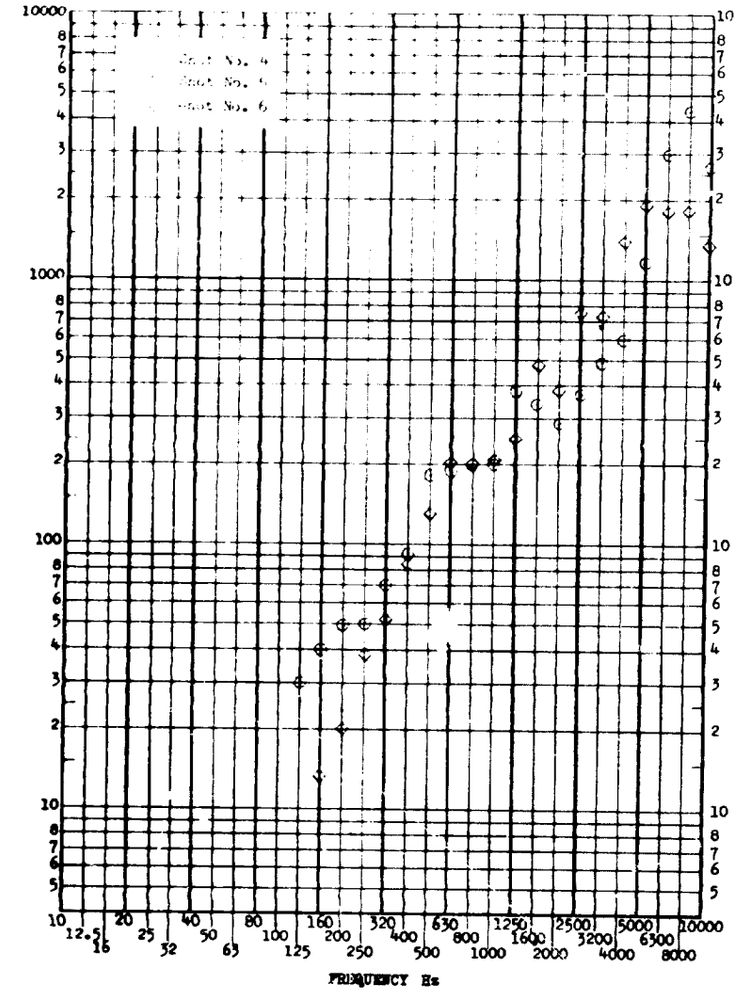




FIGURE II.B.2-46

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

Accel. No.: 3A16 Test Date: Aug., 1968

Shock Axis: Longitudinal Shock No.: 4, 5, 6



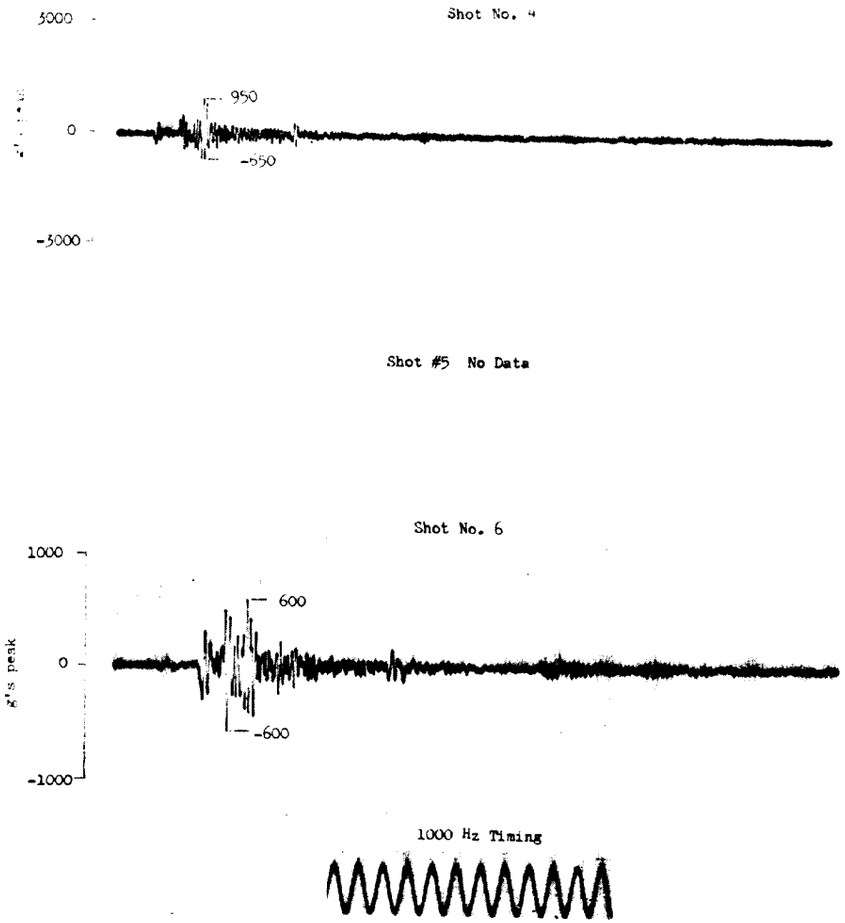
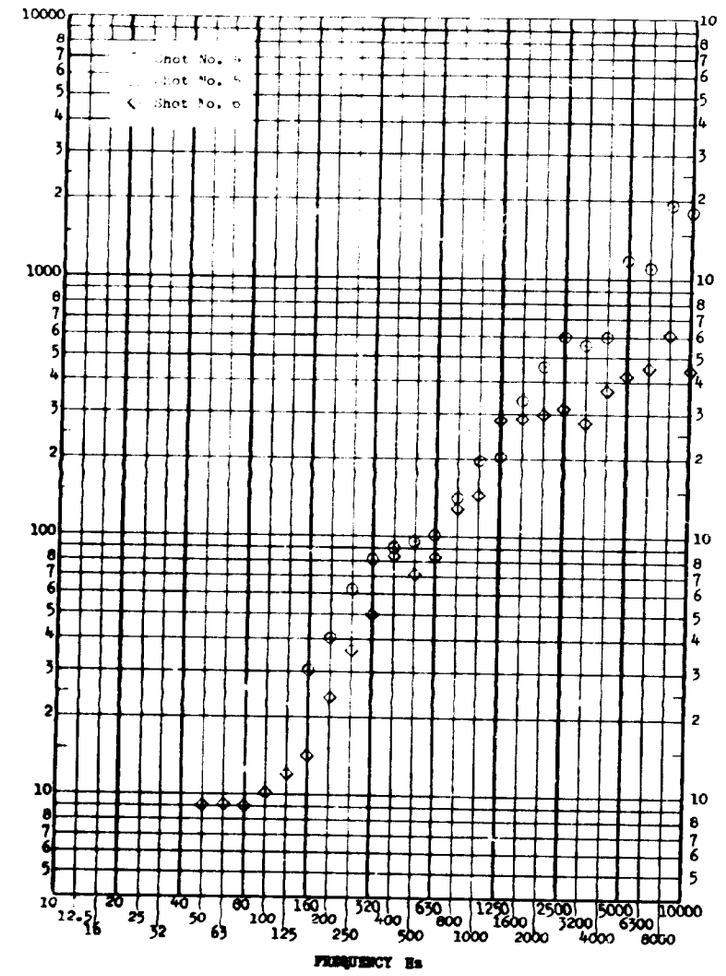



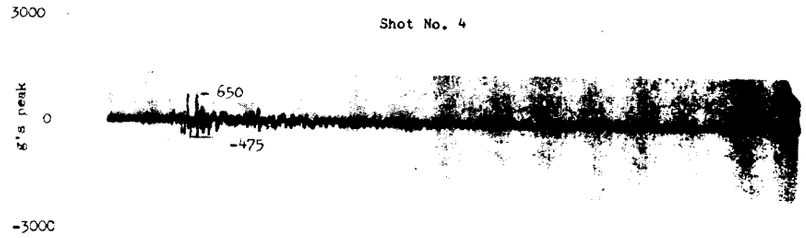

FIGURE 11.8.2-47

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

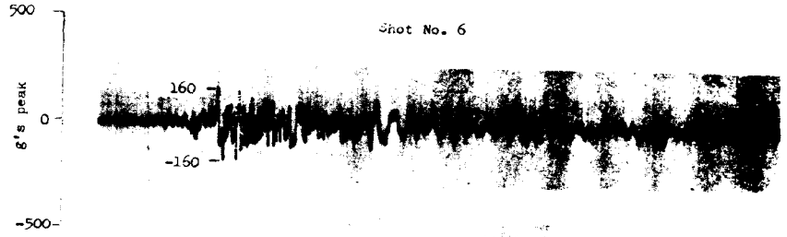
Accel. No.: 3A17 Test Date: Aug., 1968

Shock Axis: Radial Shock No.: 4, 5, 6




Shot #5 No Data



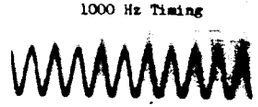
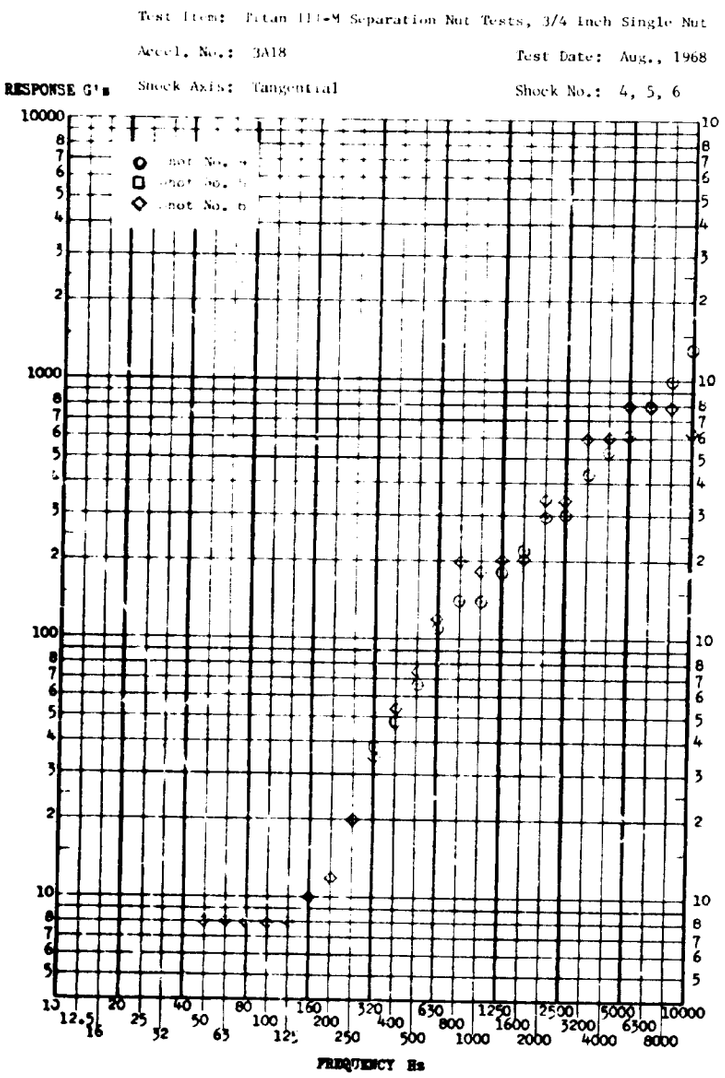
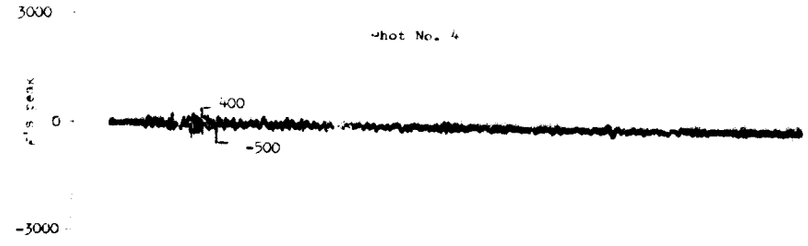
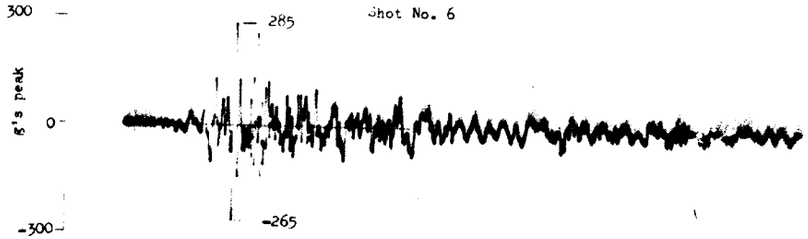




FIGURE 11.B.2-48




Shot #5 No Data



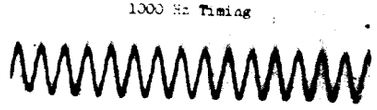
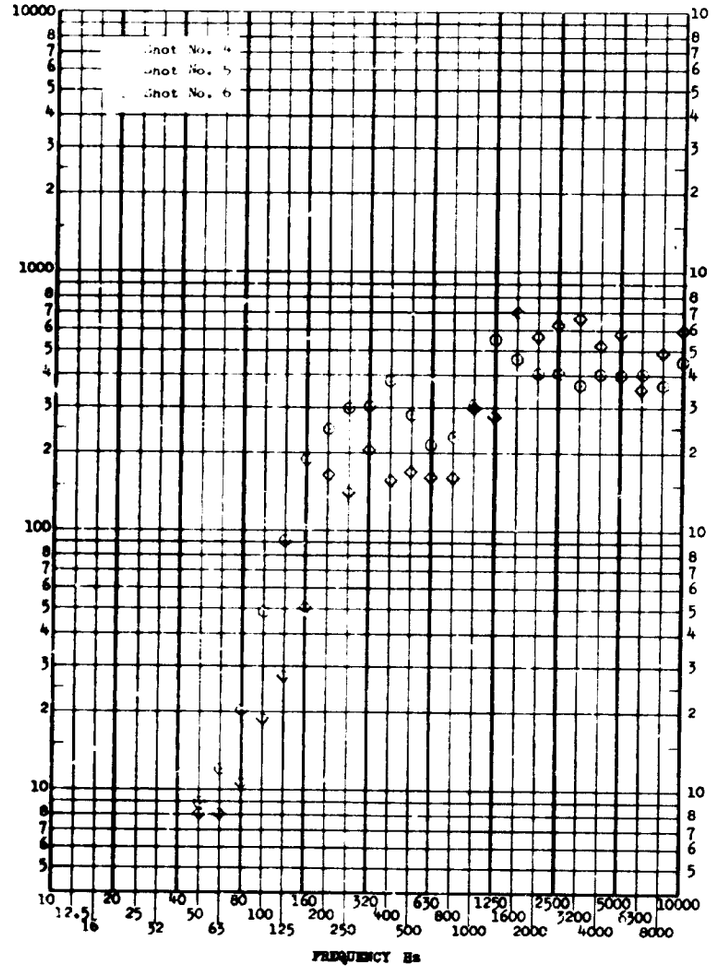



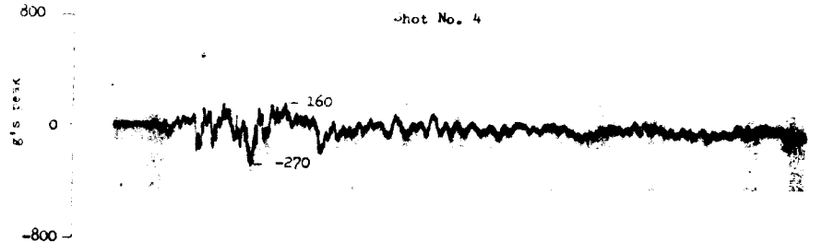

FIGURE 11.8.2-49

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

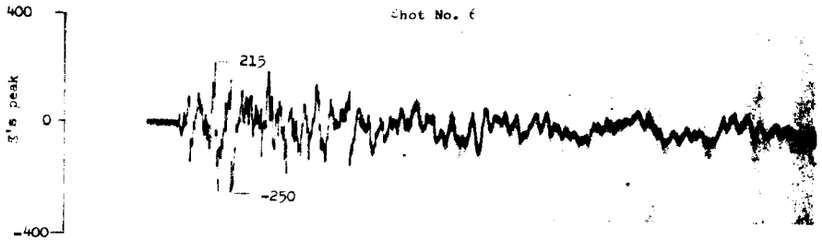
Accel. No.: 4A19 Test Date: Aug., 1968

RESPONSE G's Shock Axis: Longitudinal Shock No.: 4, 5, 6




Shot #5 No Data



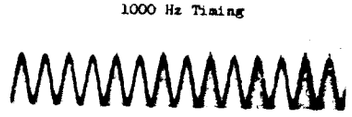
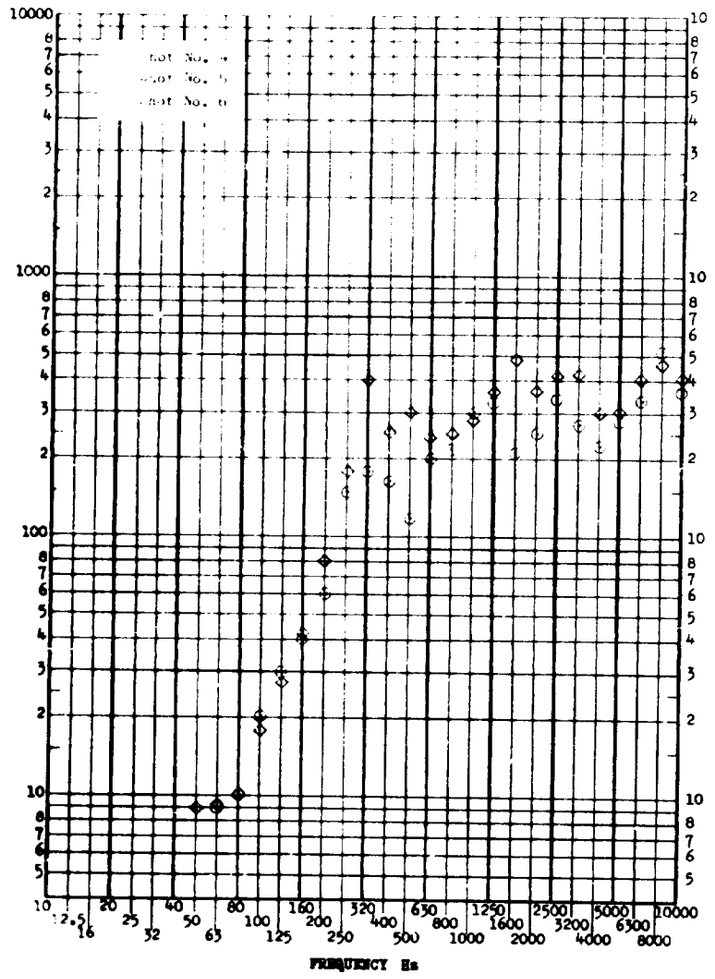




FIGURE II.B.2-50

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

Accel. No.: 1A76 Test Date: Aug., 1968

Shock Axis: Radial Shock No.: 4, 5, 6

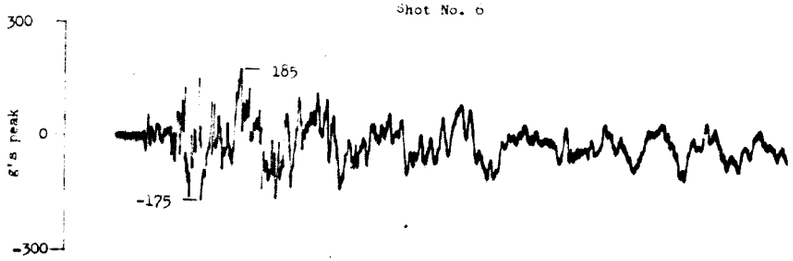



Shot No. 4




Shot #5 No Data

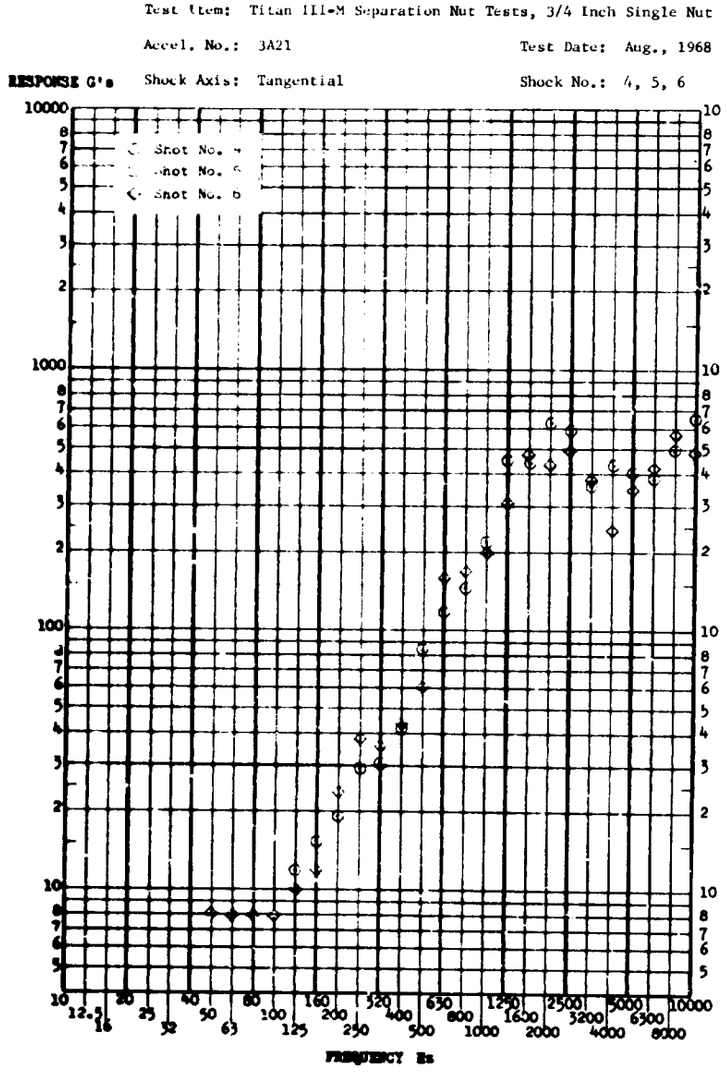
Shot No. 6




1000 Hz Timing



FIGURE II.B.2-51



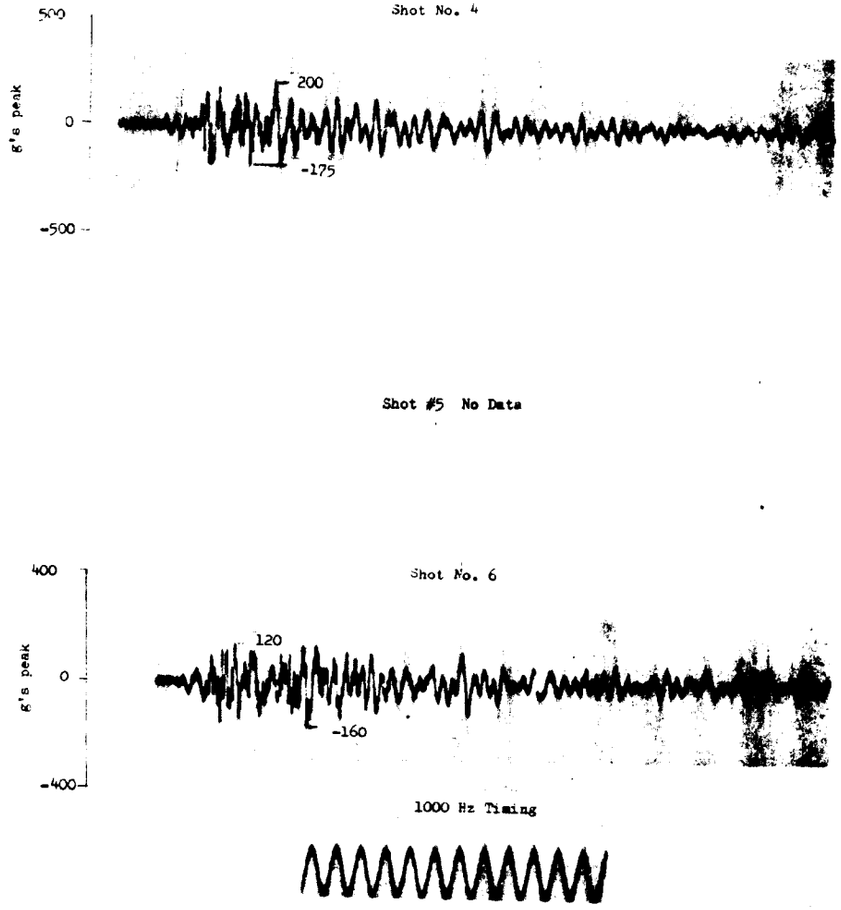
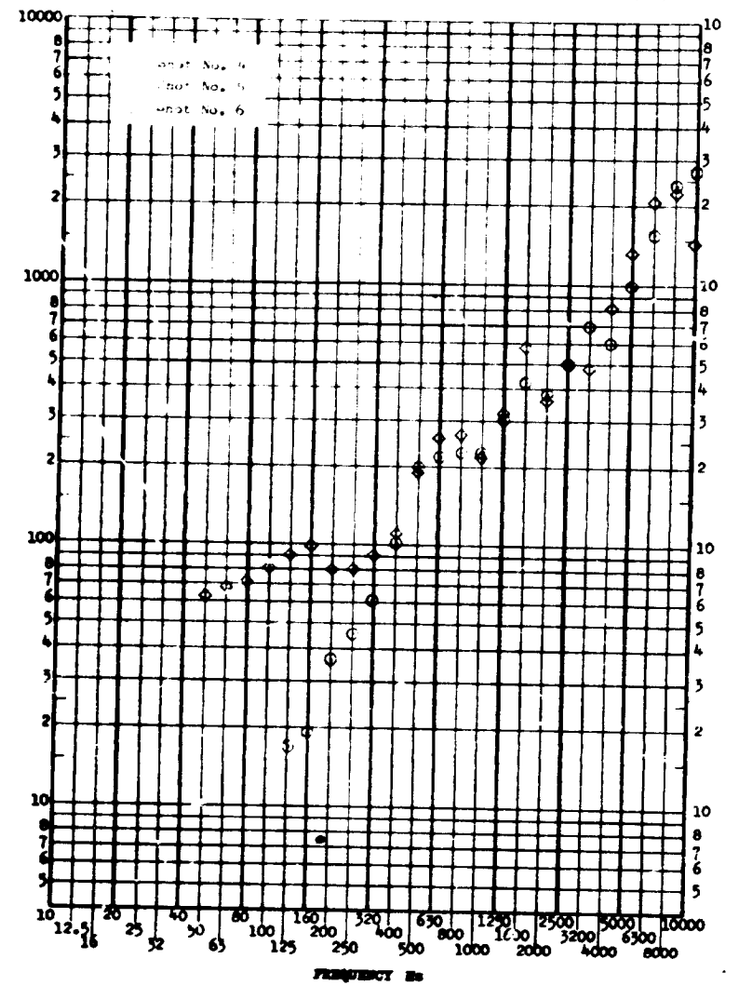



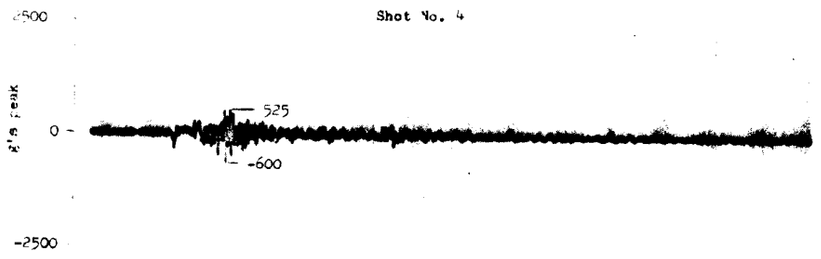

FIGURE 11.B.2-52

Test Item: Titan III-M Separation Nut Tests, 3/4 Inch Single Nut

Accel. No.: 1A22 Test Date: Aug., 1968

Shock Axis: Longitudinal Shock No.: 4, 5, 6




Shot #5 No Data

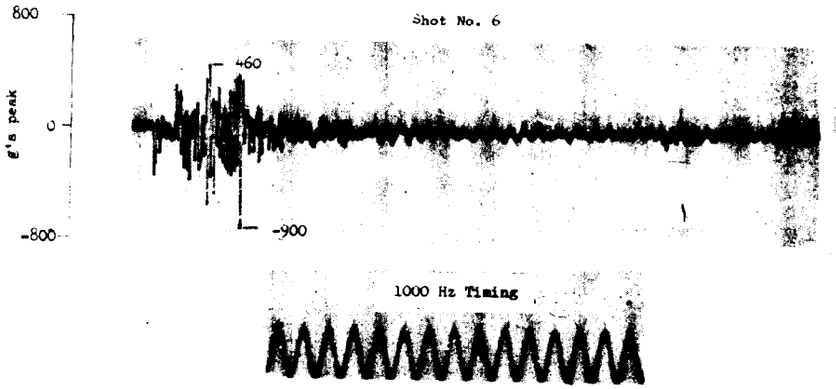
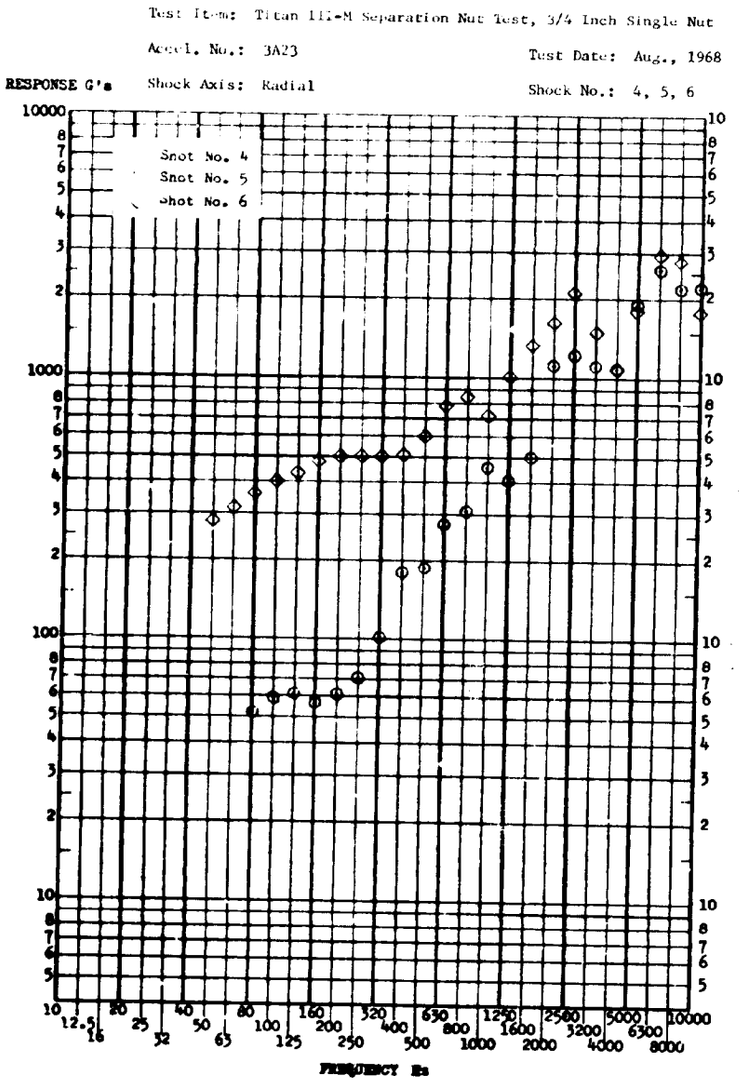
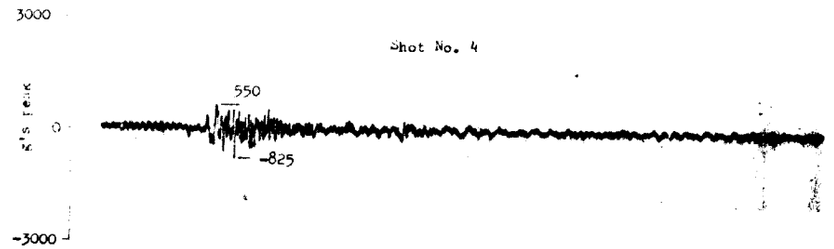



FIGURE 11.8.2-53




**Shot #5 No Data**

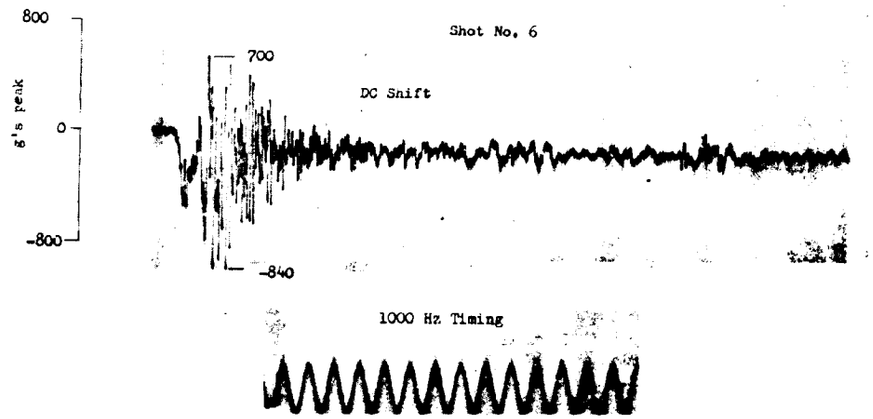
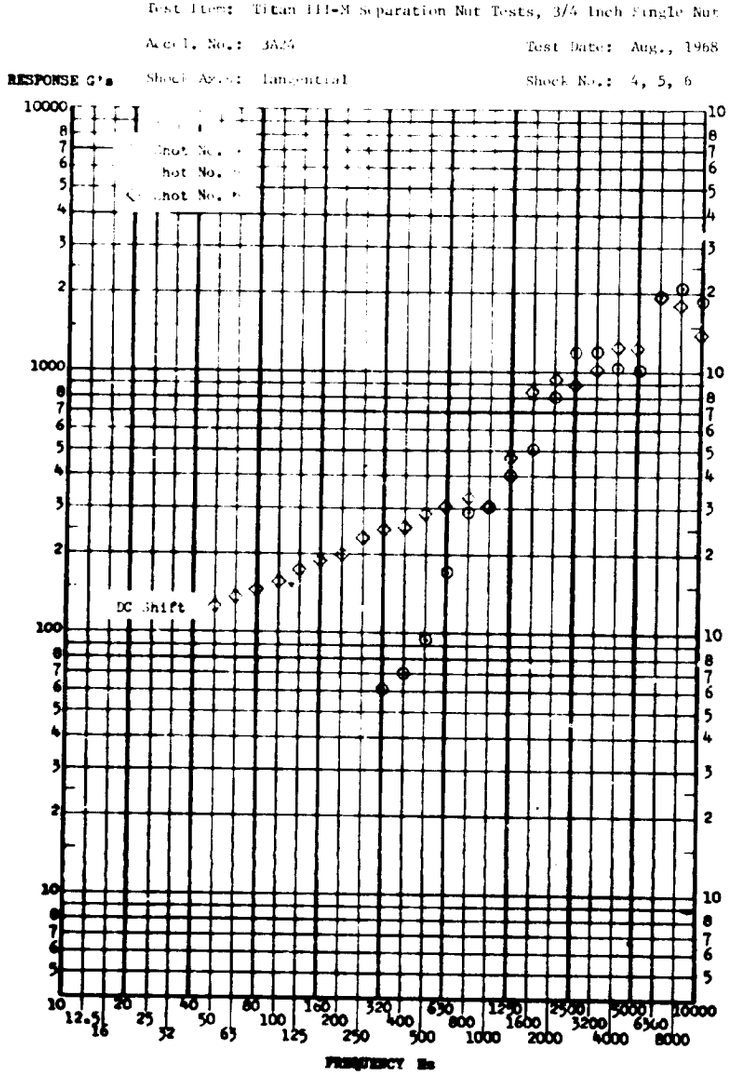
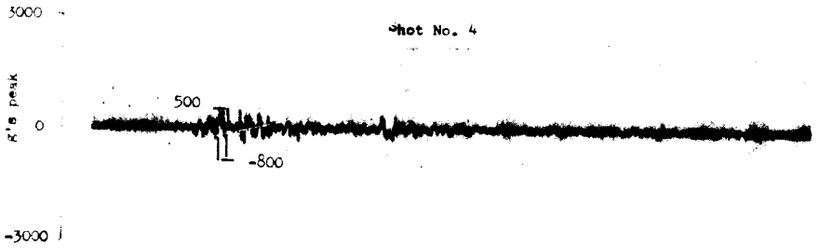



FIGURE 11.B.2-54




Shot #5 No Data

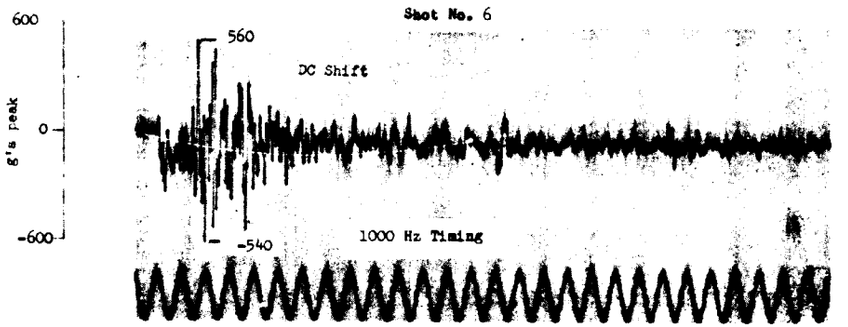
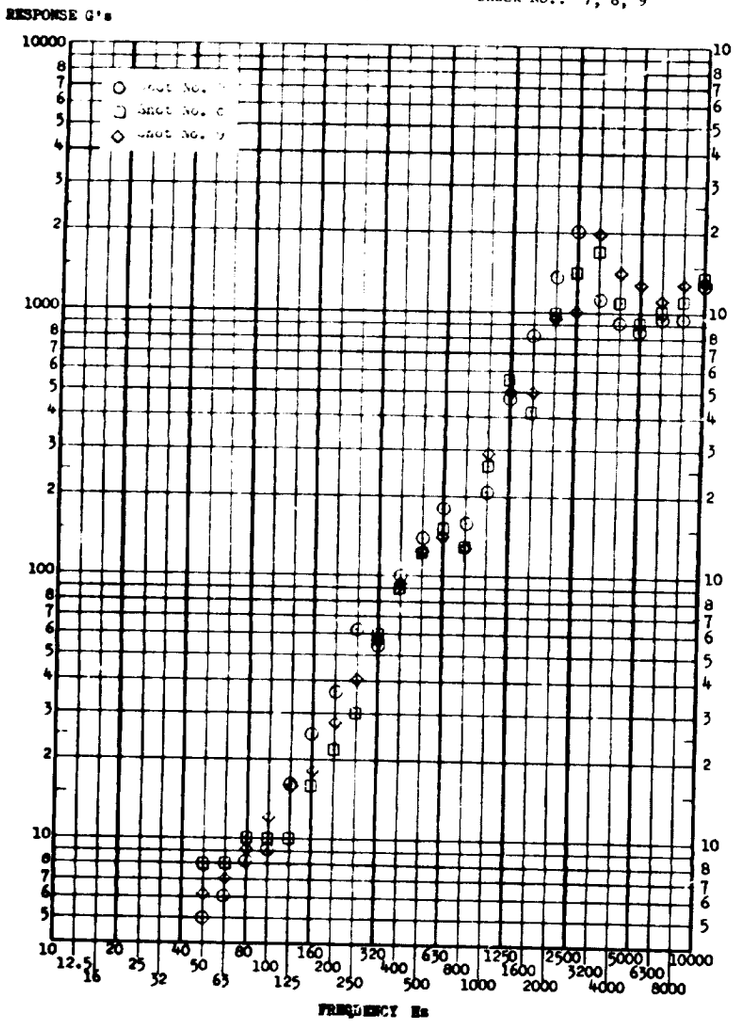



FIGURE 11.8.2-55

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A1 Test Date: Aug., 1968

Shock Axis: Longitudinal Shock No.: 7, 8, 9



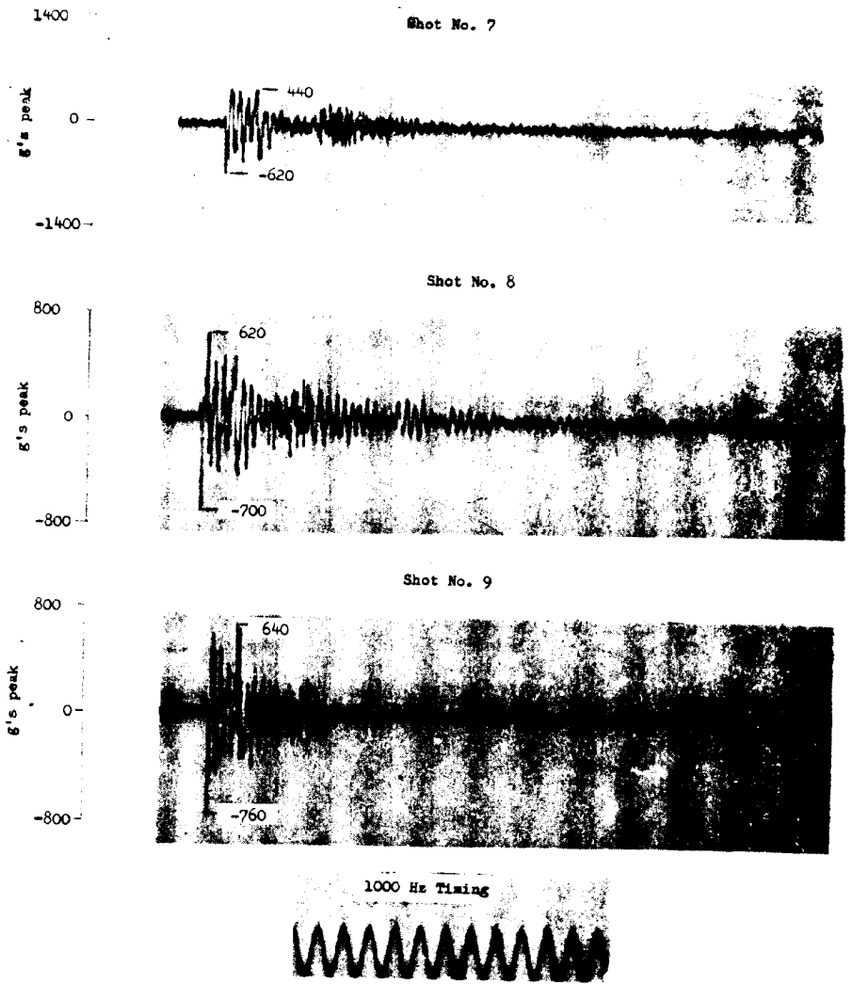
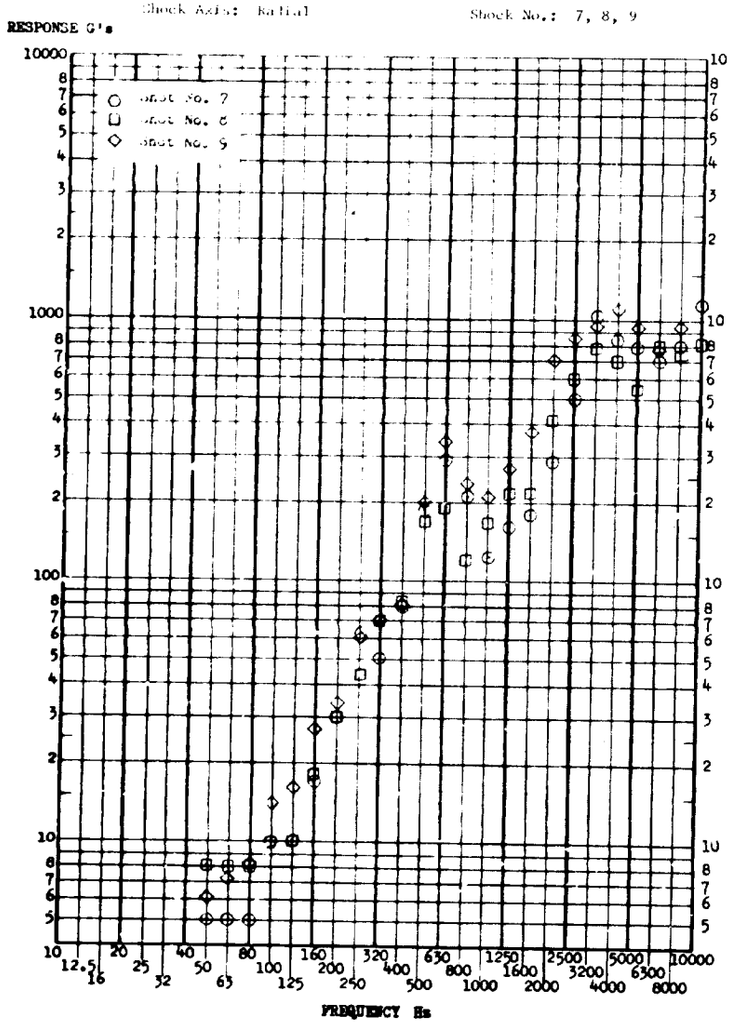




FIGURE II.B.2-56

Test Item: Titan I-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A2 Test Date: Aug., 1968

Shock Axis: Radial Shock No.: 7, 8, 9



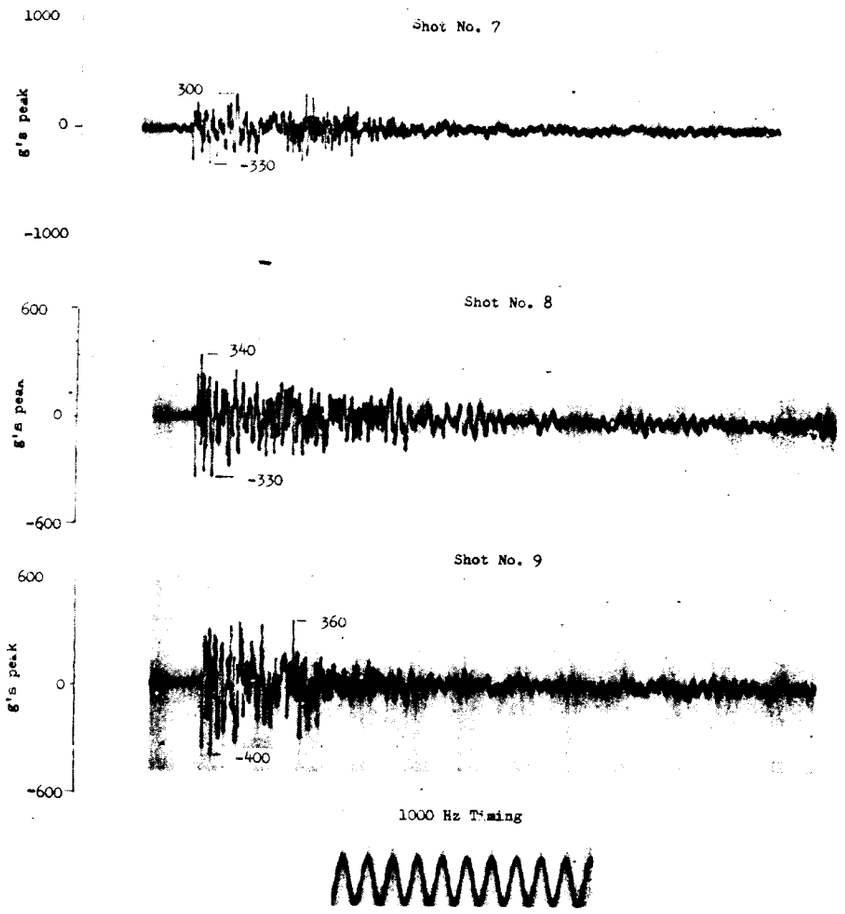
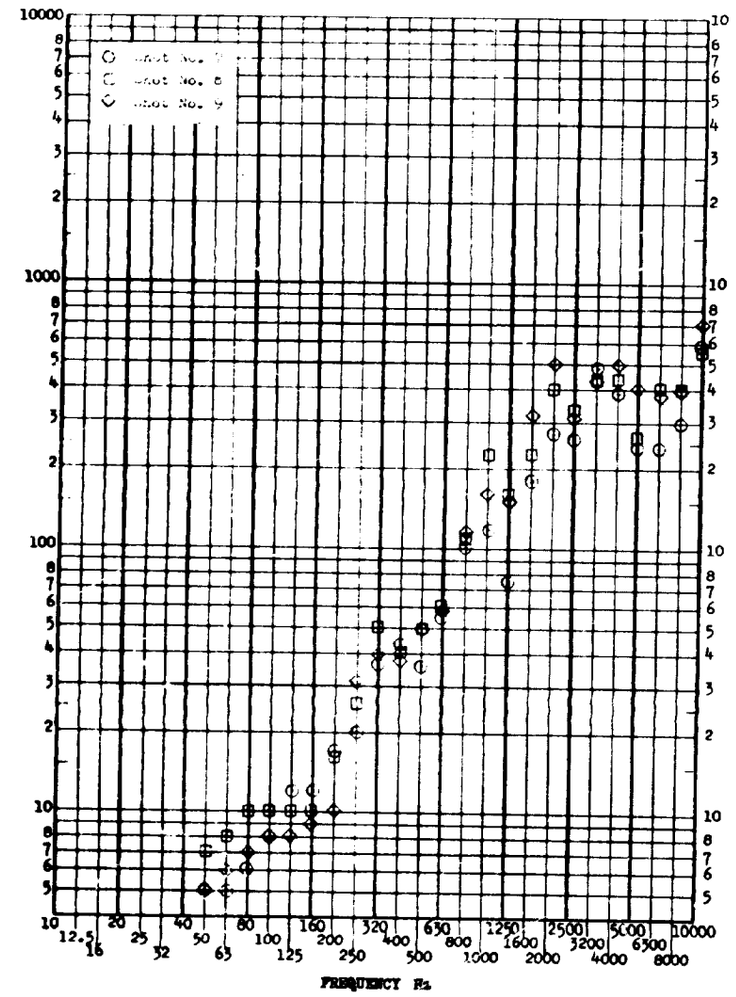




FIGURE 11.B.2-57

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A3 Test Date: Aug., 1968

Shock Axis: Tangential Shock No.: 7, 8, 9



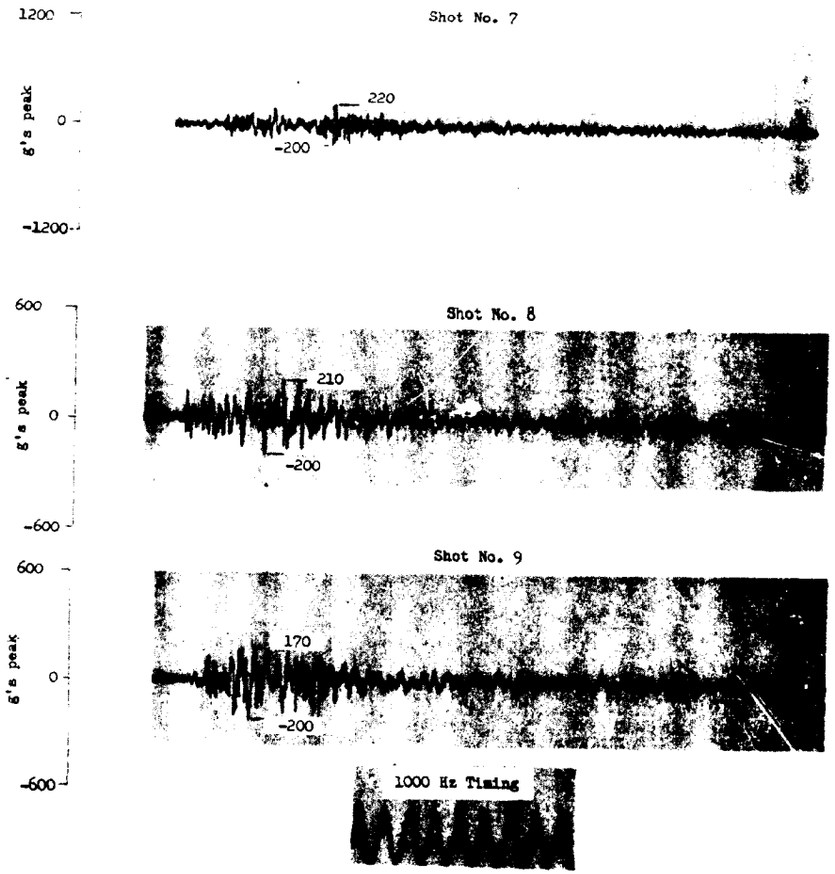
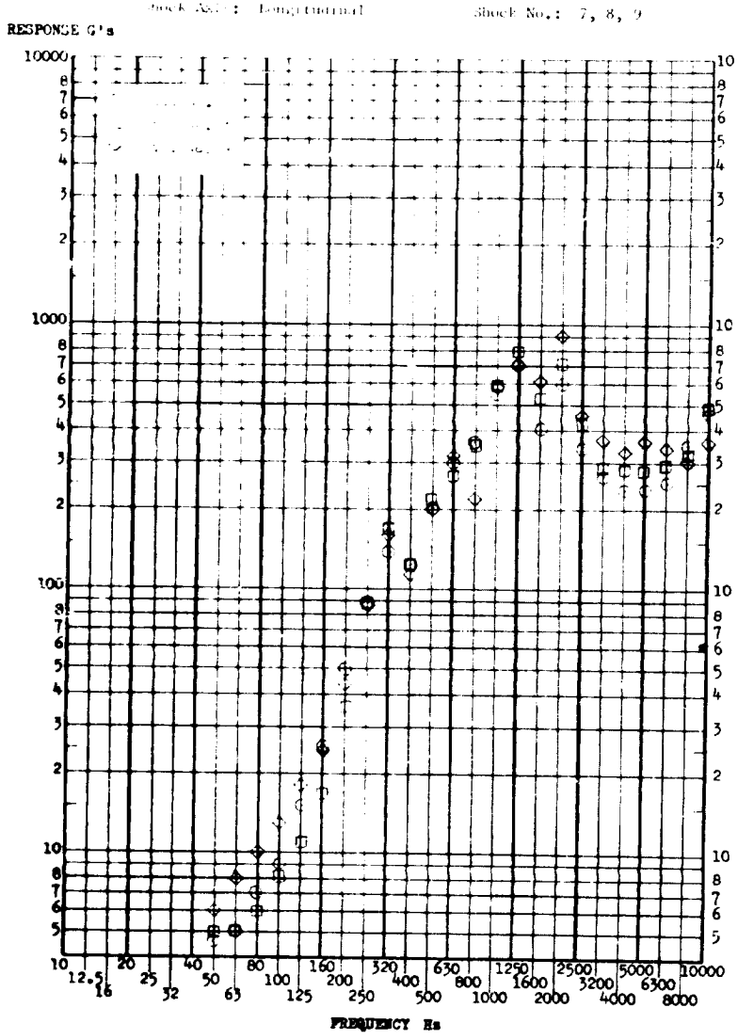




FIGURE 11.8.2-58

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: [illegible]  Test Date: Aug., 1968

Shock Axis: Longitudinal  Shock No.: 7, 8, 9



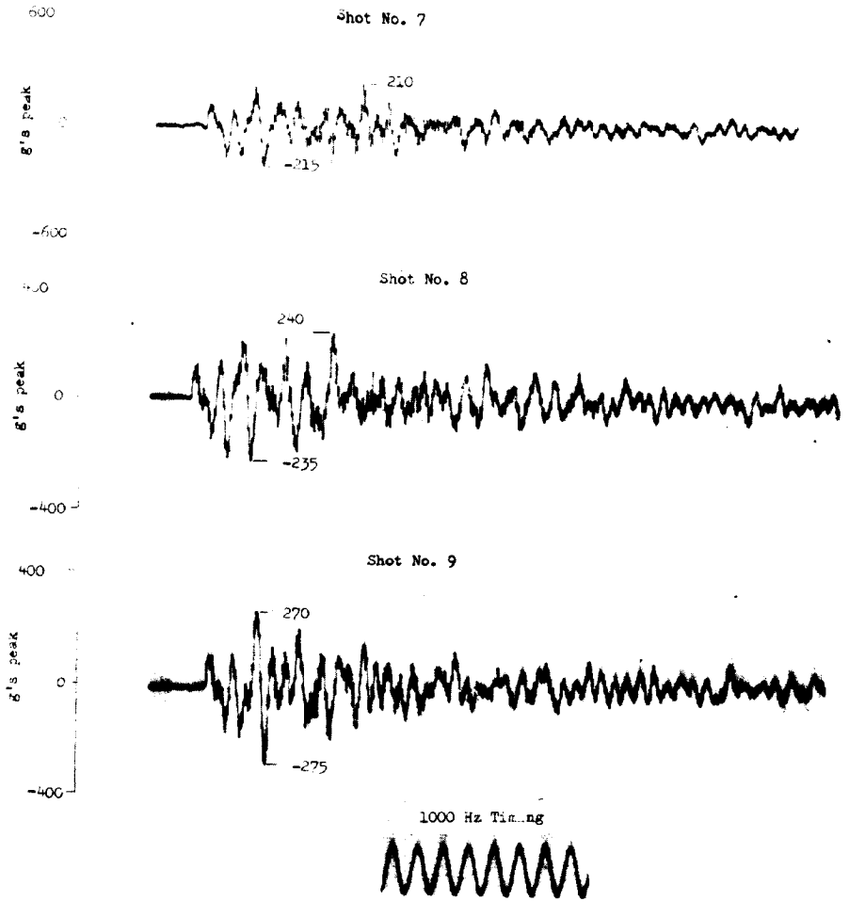
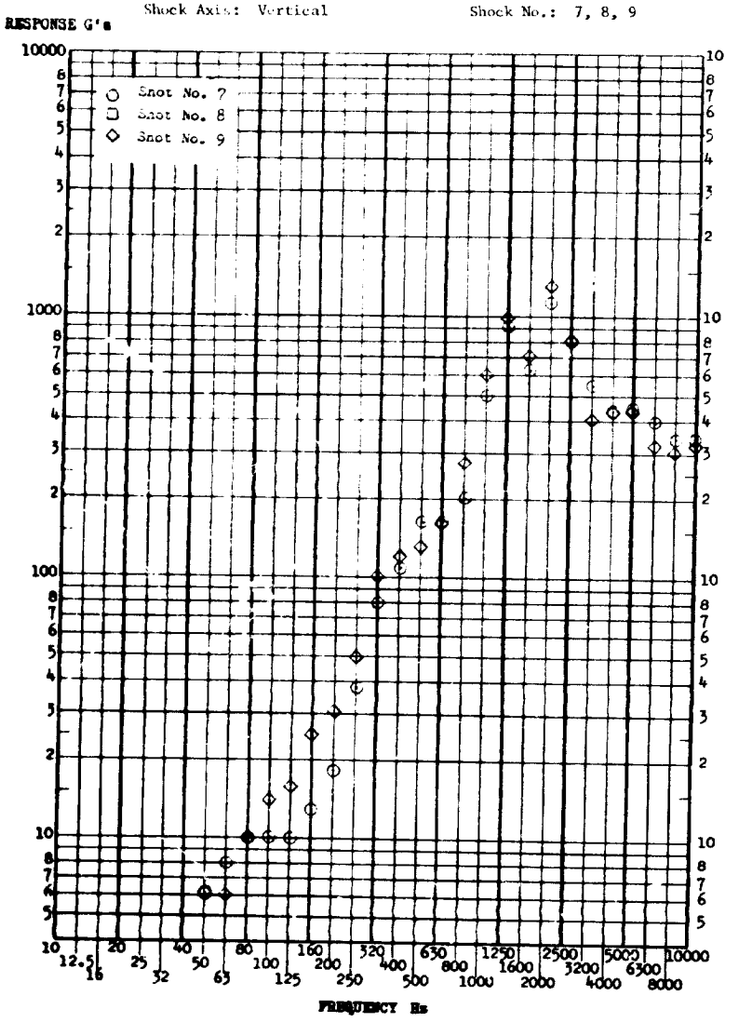




FIGURE II.B.2-59

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A5 Test Date: Aug., 1968

Shock Axis: Vertical Shock No.: 7, 8, 9



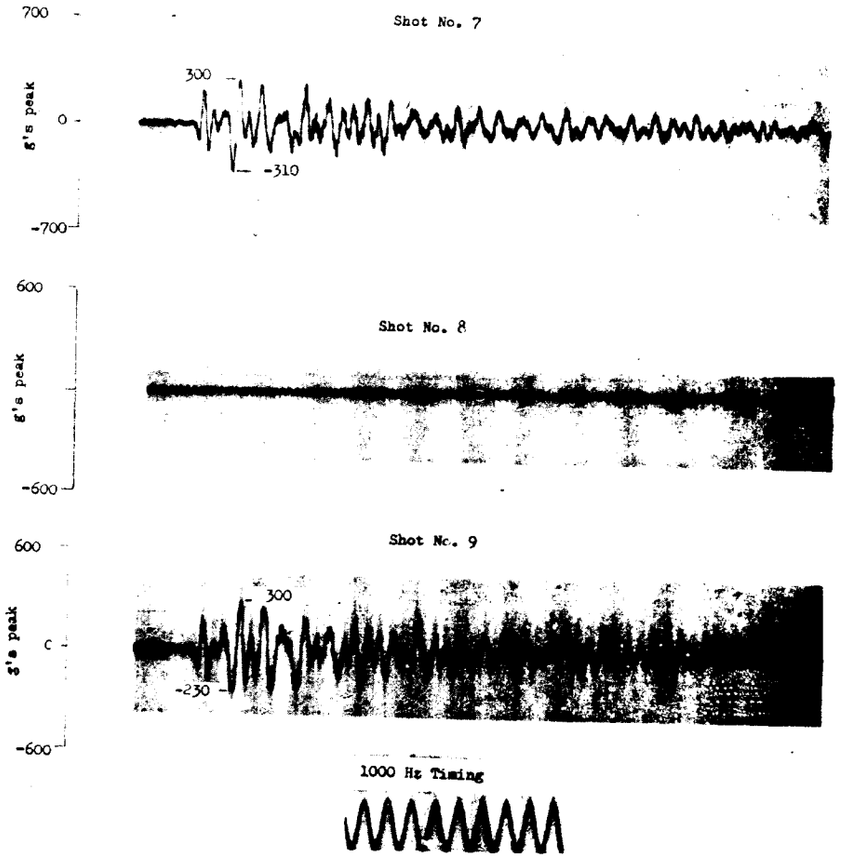
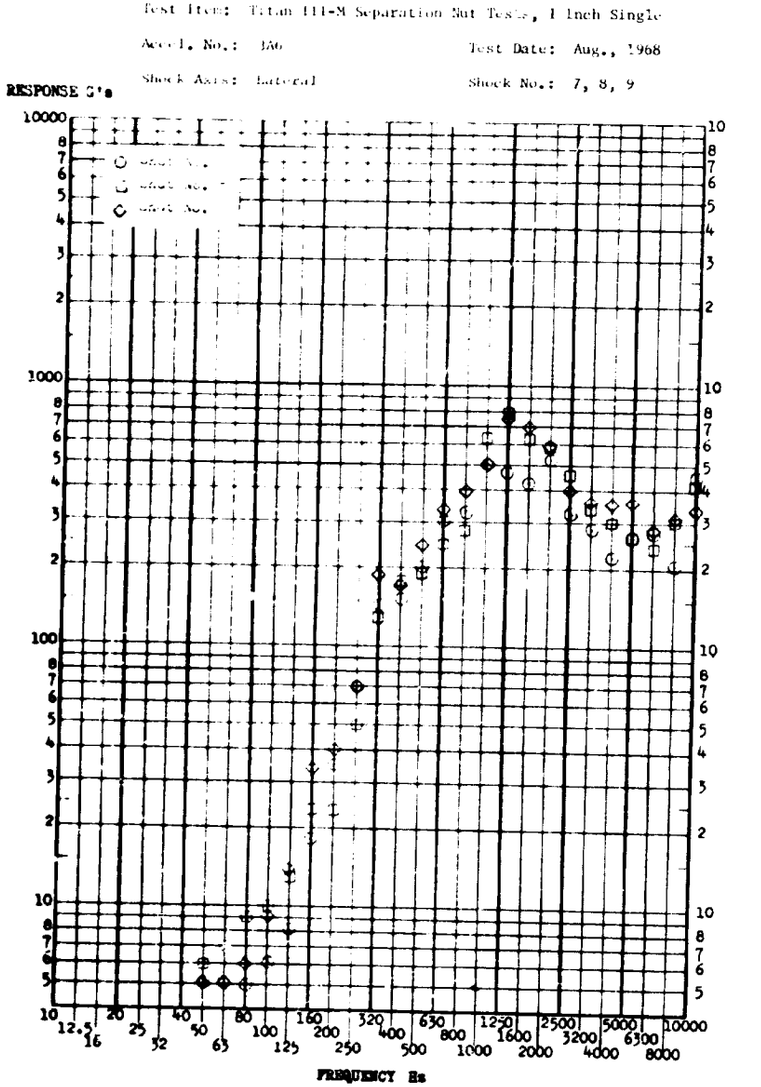




FIGURE 11.8.2-60



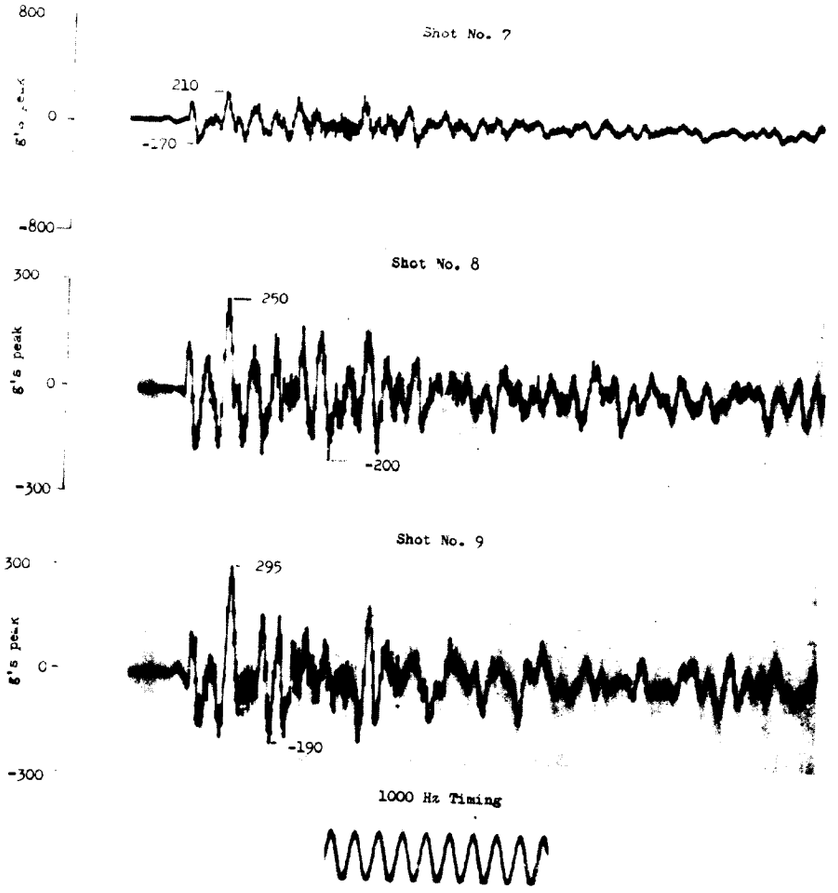
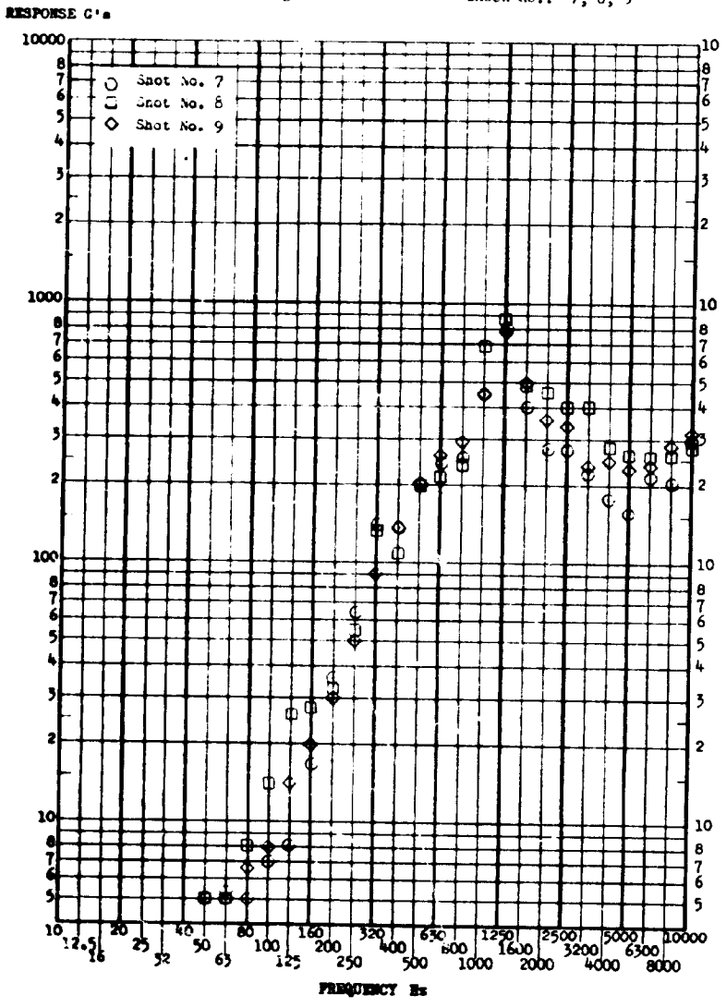



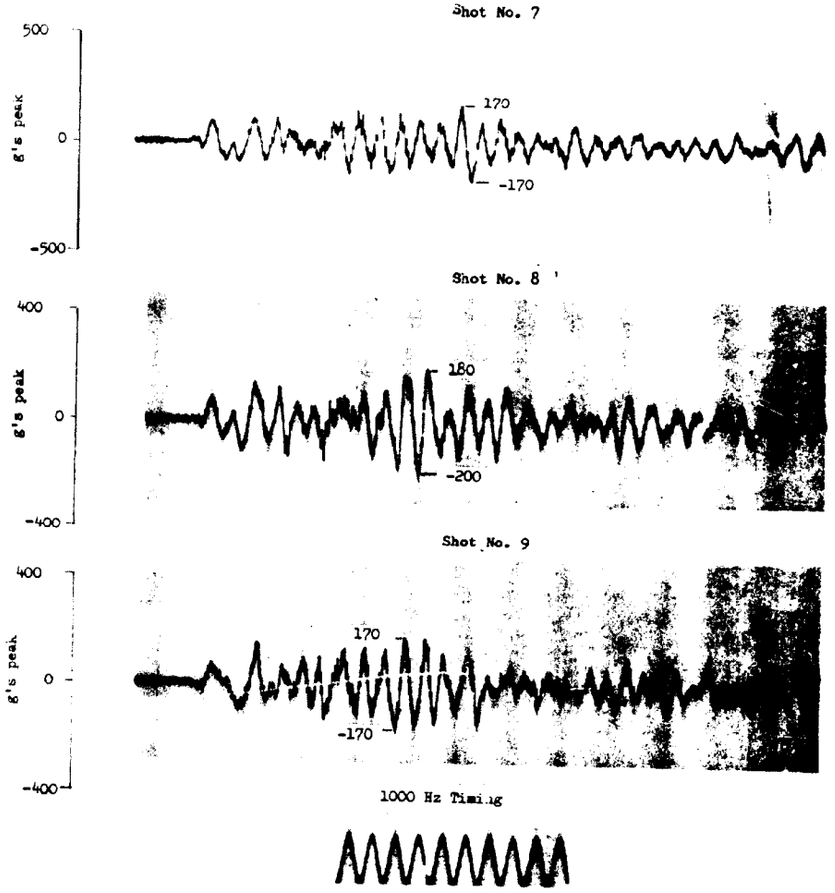

FIGURE II.B.2-61

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A7 Test Date: Aug., 1968

Shock Axis: Longitudinal Shock No.: 7, 8, 9



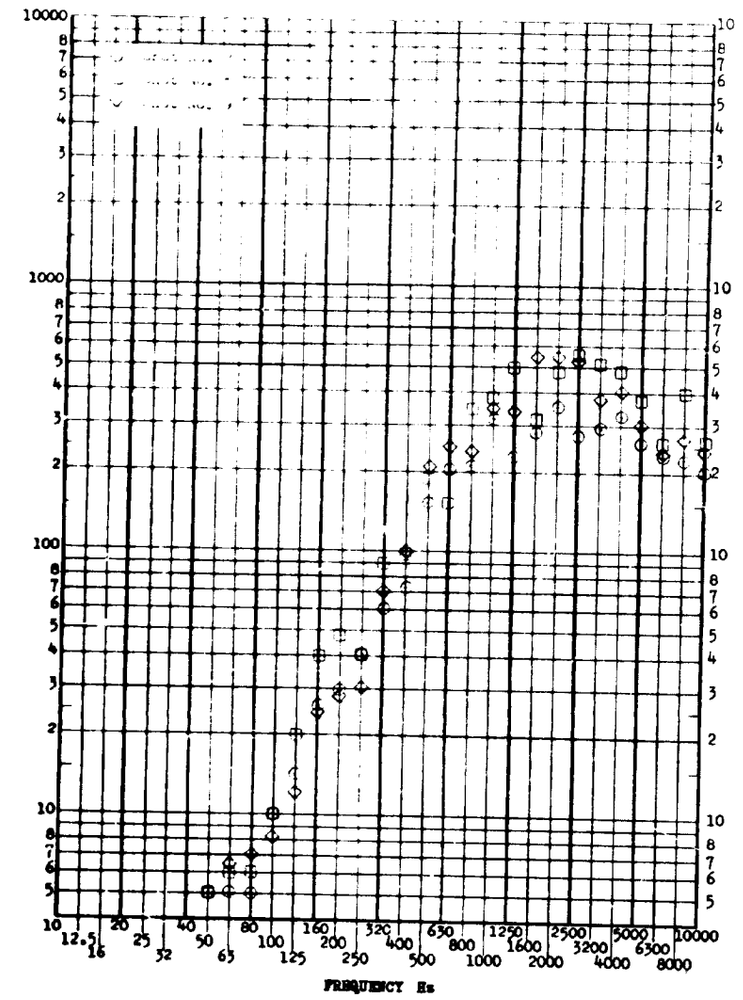




FIGUPE 11.B.2-62

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 588 Test Date: Aug., 1968

Shock Axis: Vertical Shock No.: 7, 8, 9



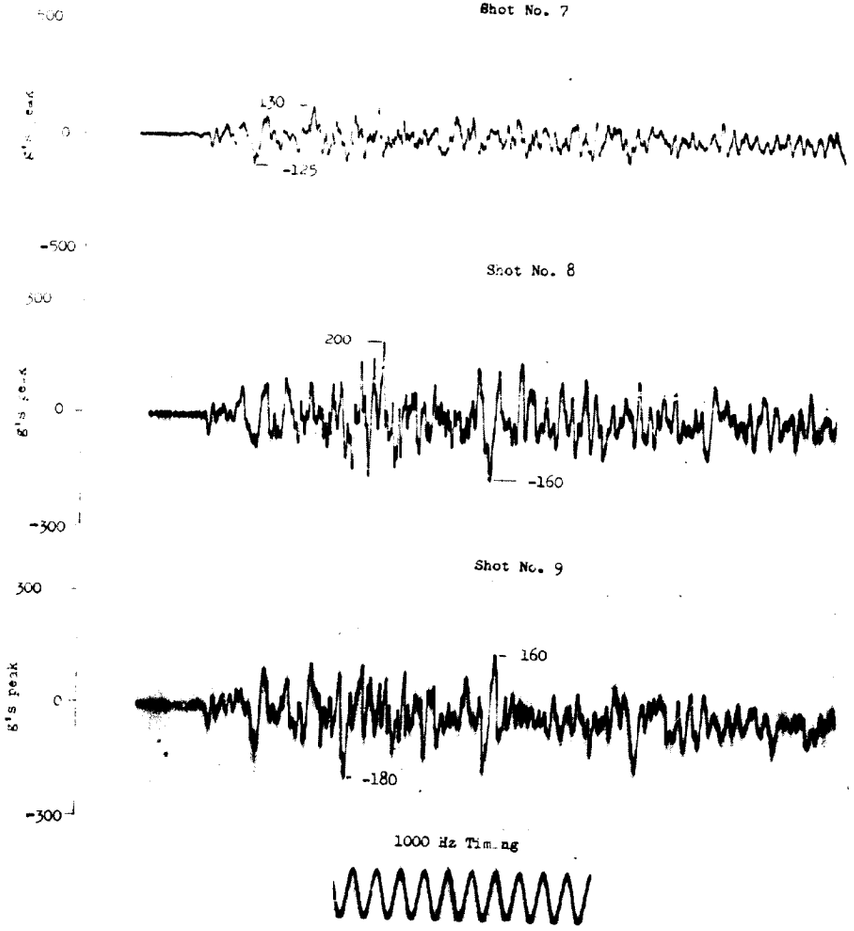




FIGURE 11.B.2-63

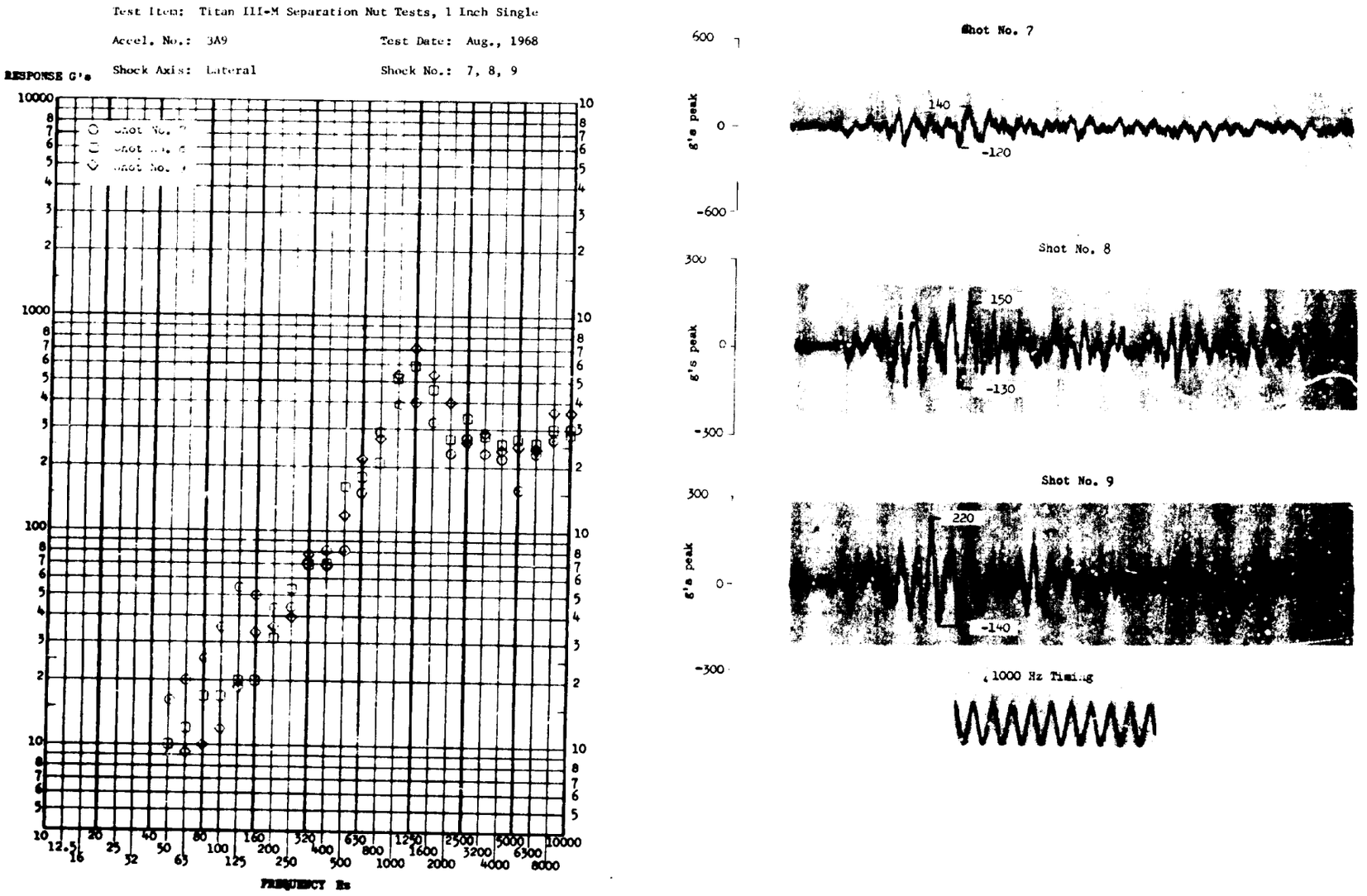
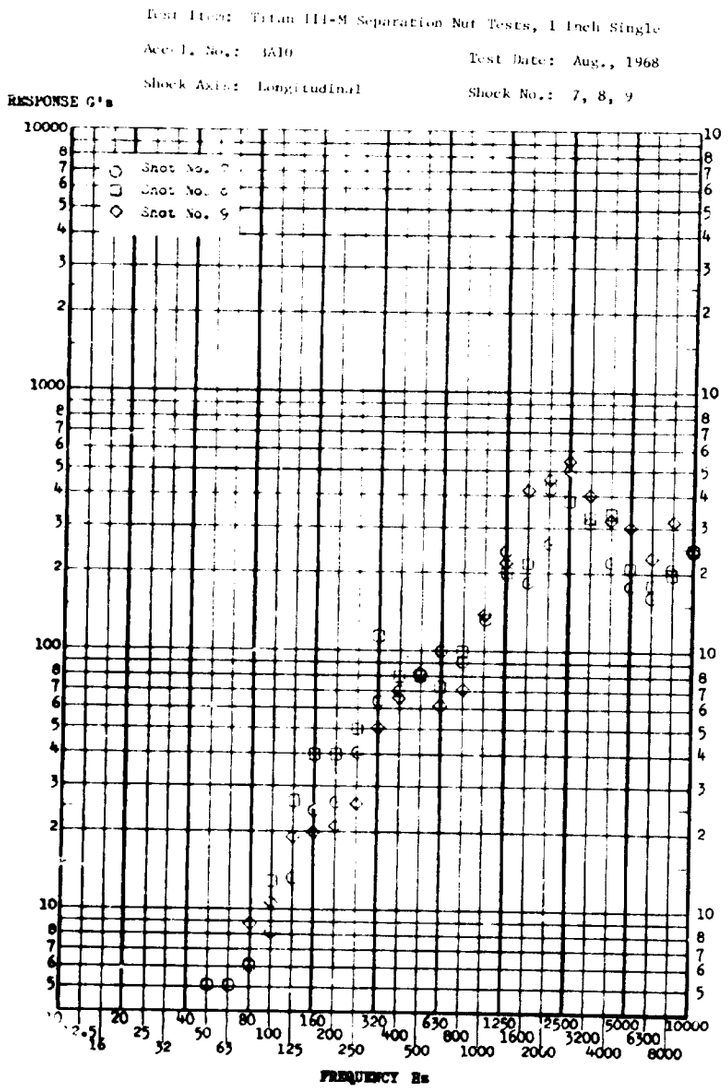



FIGURE II.B.2-64



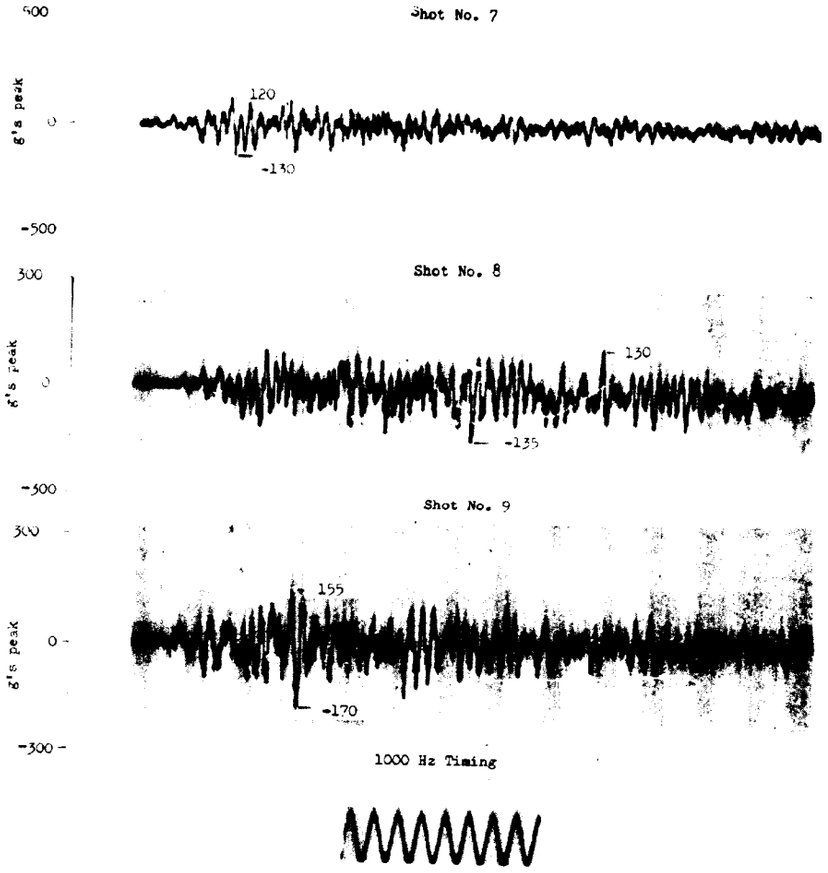
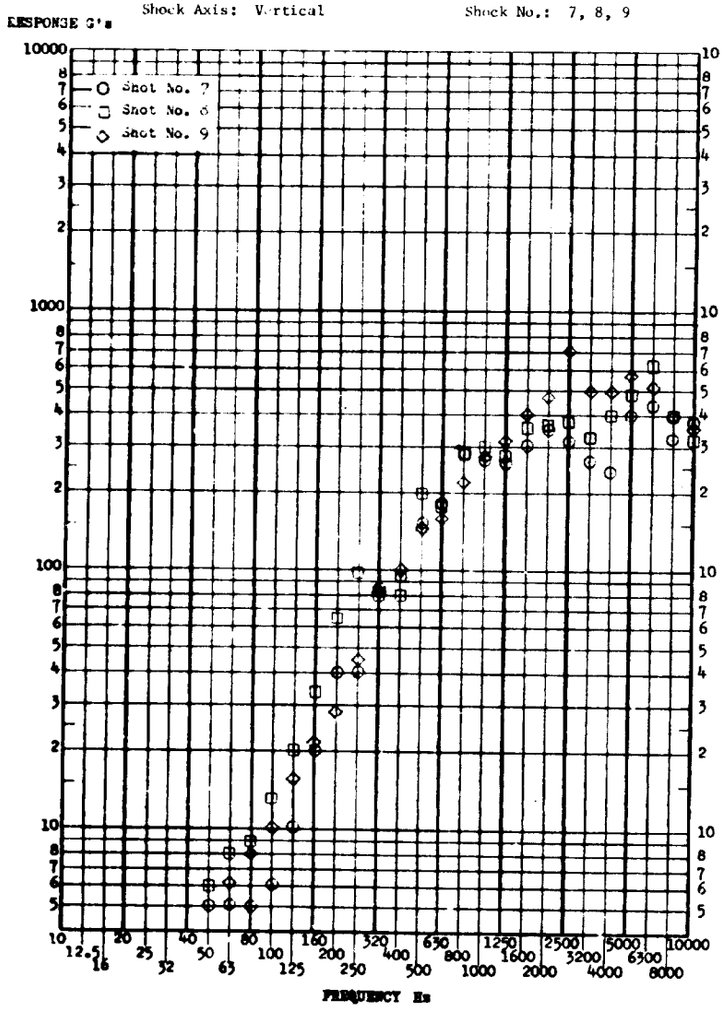




FIGURE II.B.2-65

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A11 Test Date: Aug., 1968

Shock Axis: Vertical Shock No.: 7, 8, 9



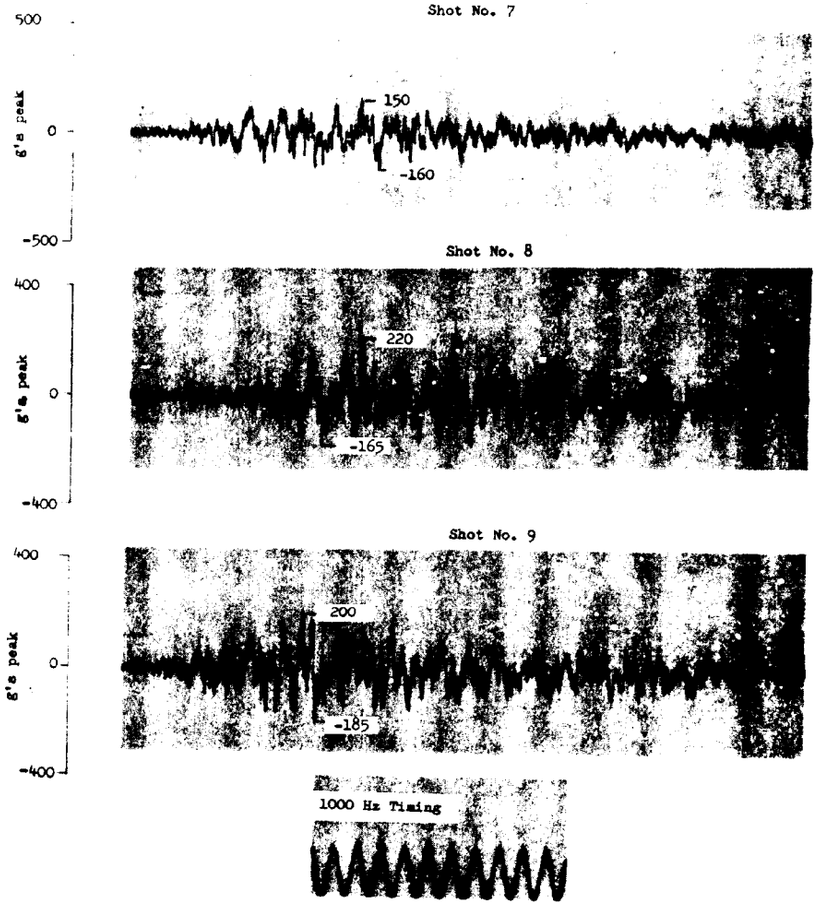
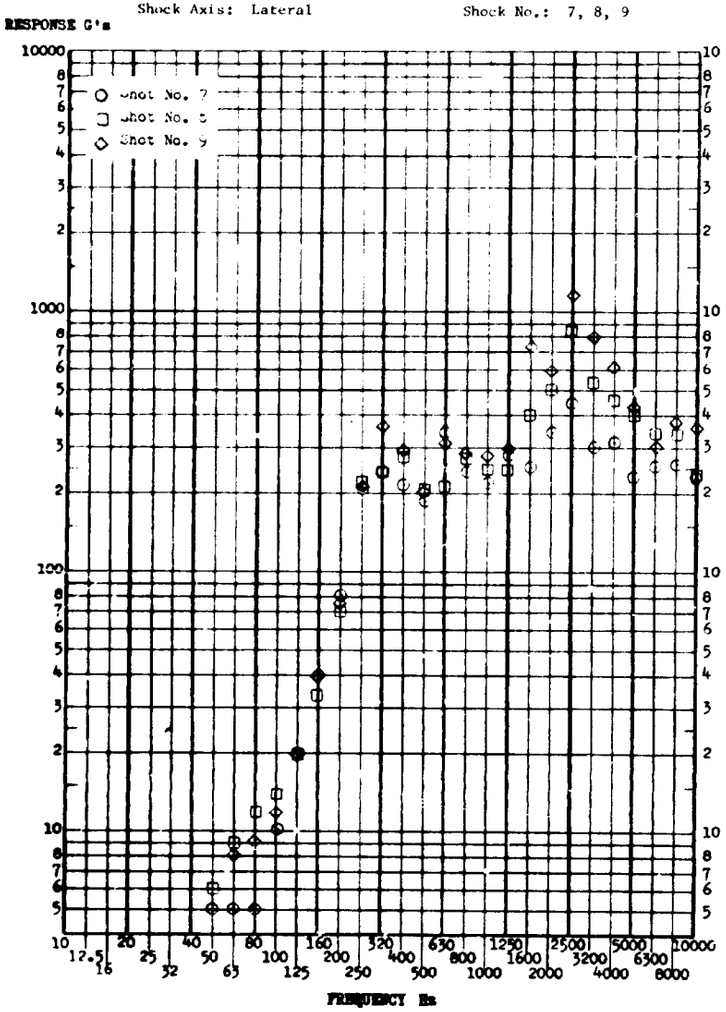




FIGURE II.B.2-66

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A12 Test Date: Aug., 1968

Shock Axis: Lateral Shock No.: 7, 8, 9



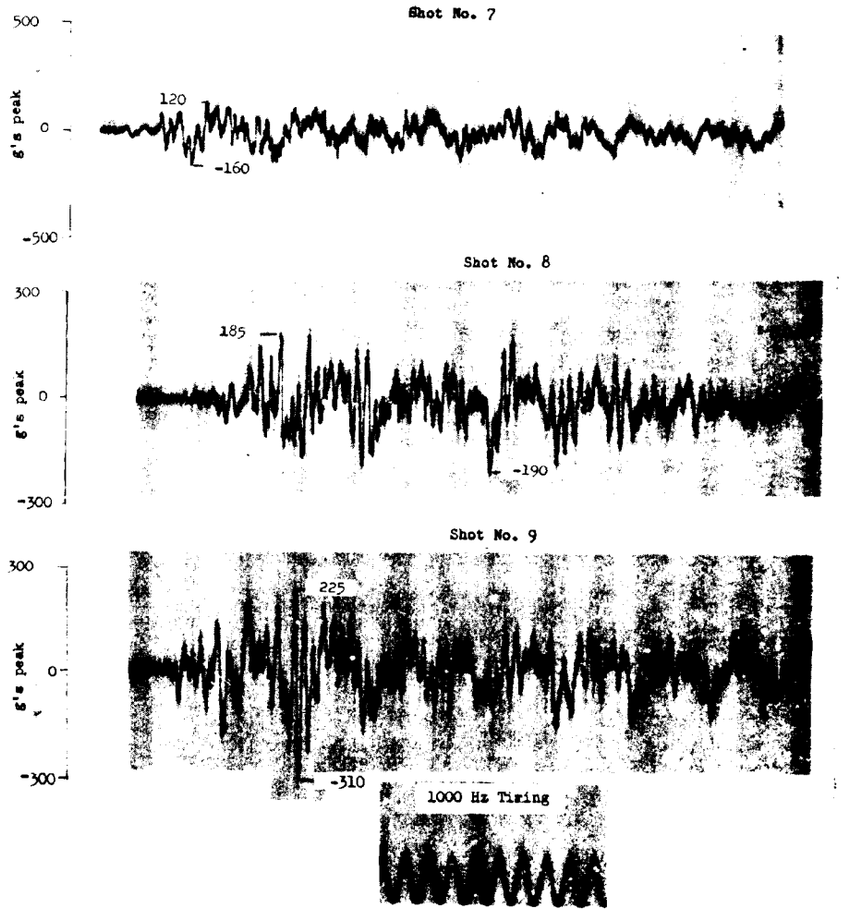
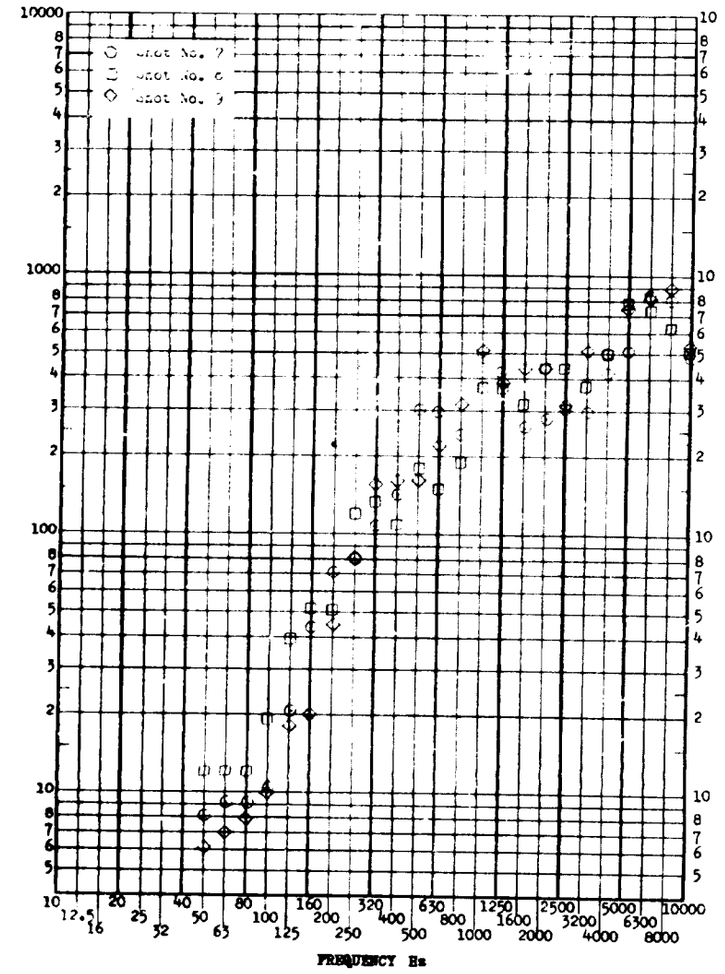




FIGURE II.B.2-67

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A13 Test Date: Aug., 1968

Shock Axis: Longitudinal Shock No.: 7, 8, 9



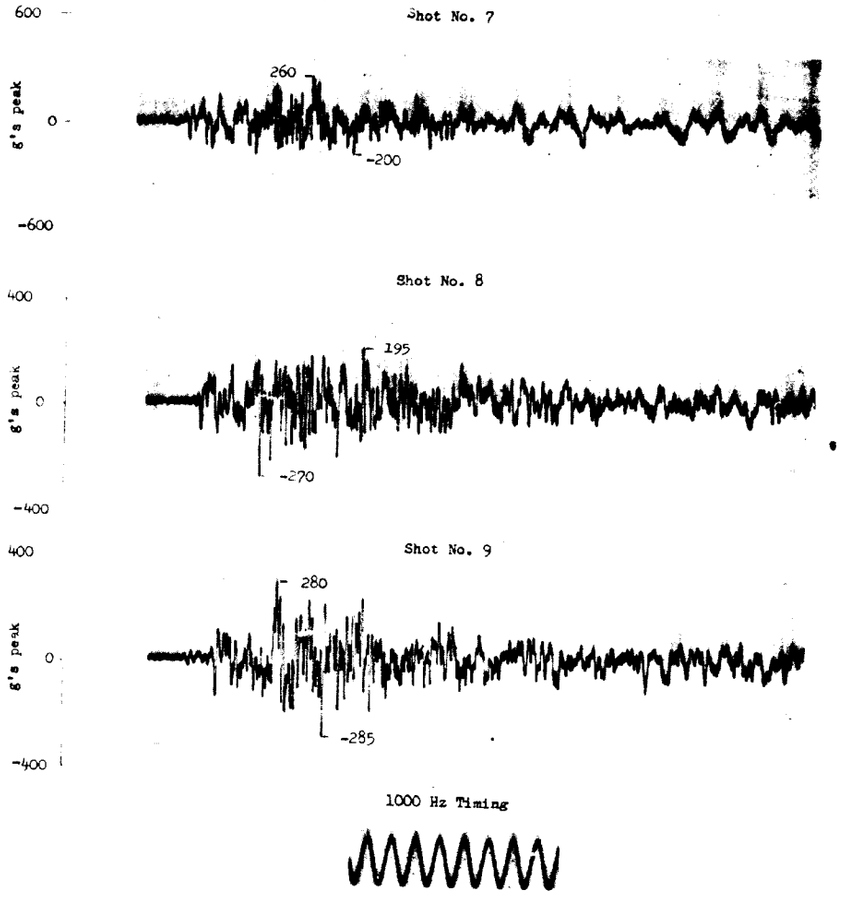
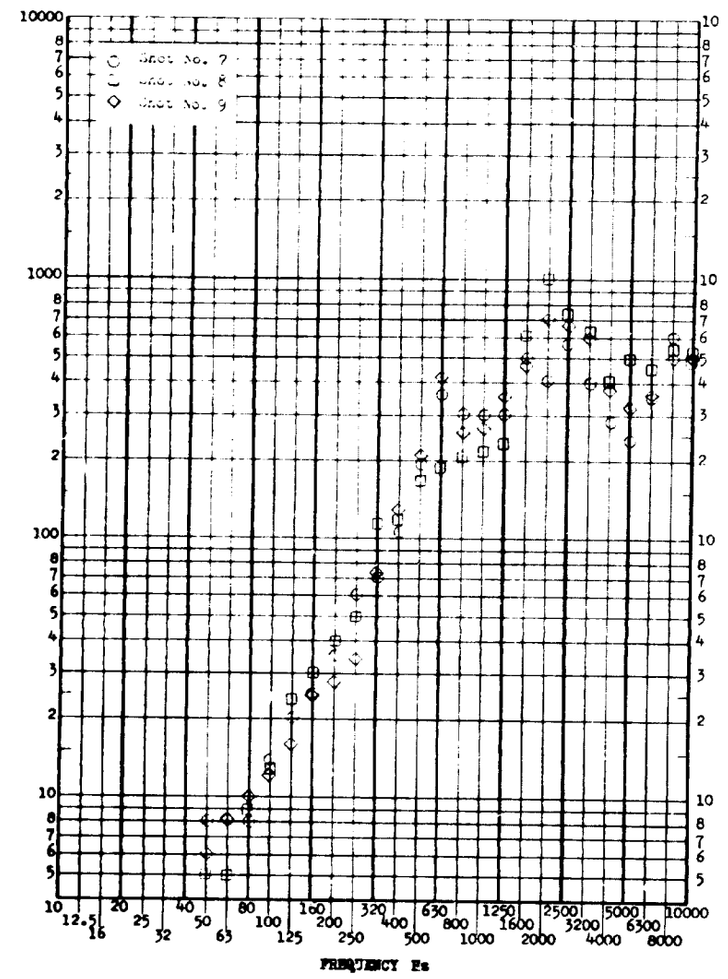




FIGURE II.B.2-68

Test Item: Titan III-M Separation Nut Tests, 1 inch Single

Accel. No.: 3A14 Test Date: Aug., 1968

Shock Axis: Vertical Shock No.: 7, 8, 9



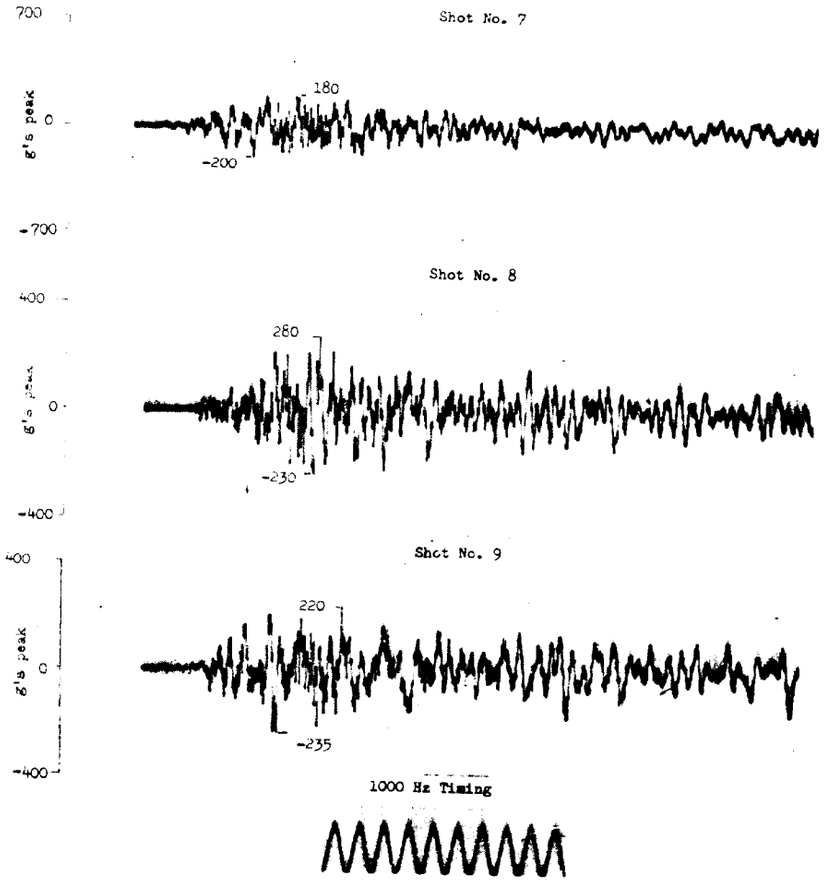
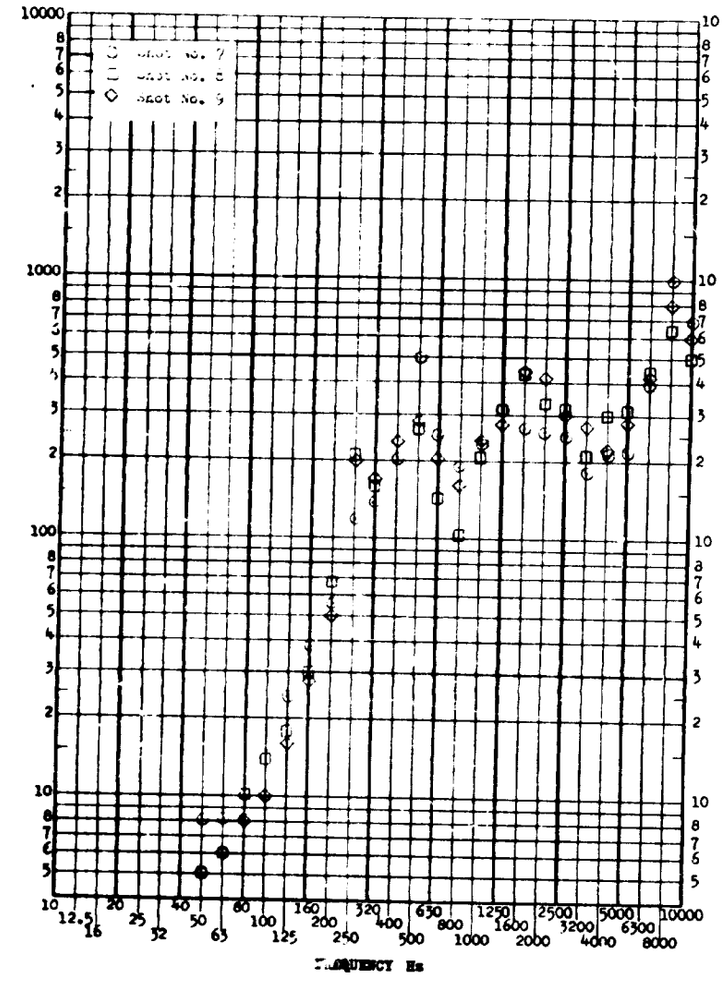




FIGURE II.B.2-69

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A15 Test Date: Aug., 1968

Shock Axis: Lateral Shock No.: 7, 8, 9



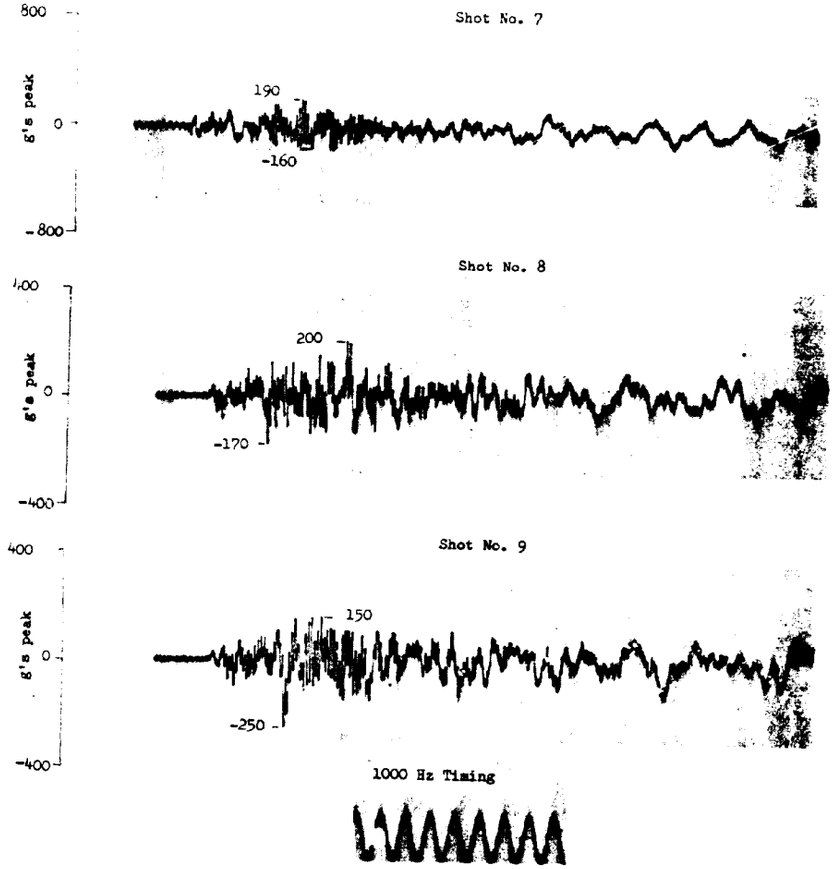




FIGURE 11.8.2-70

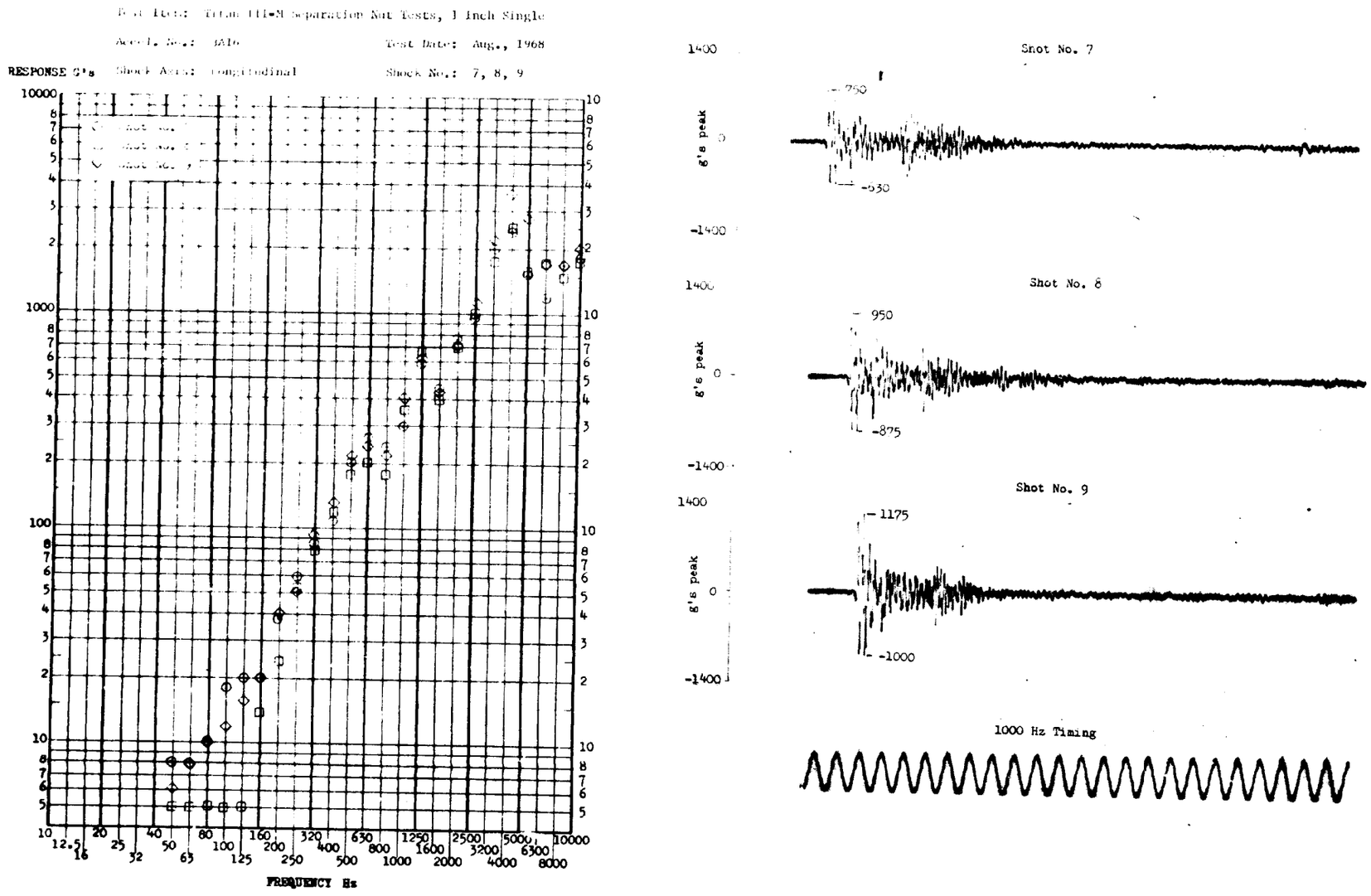



FIGURE II.B.2-71

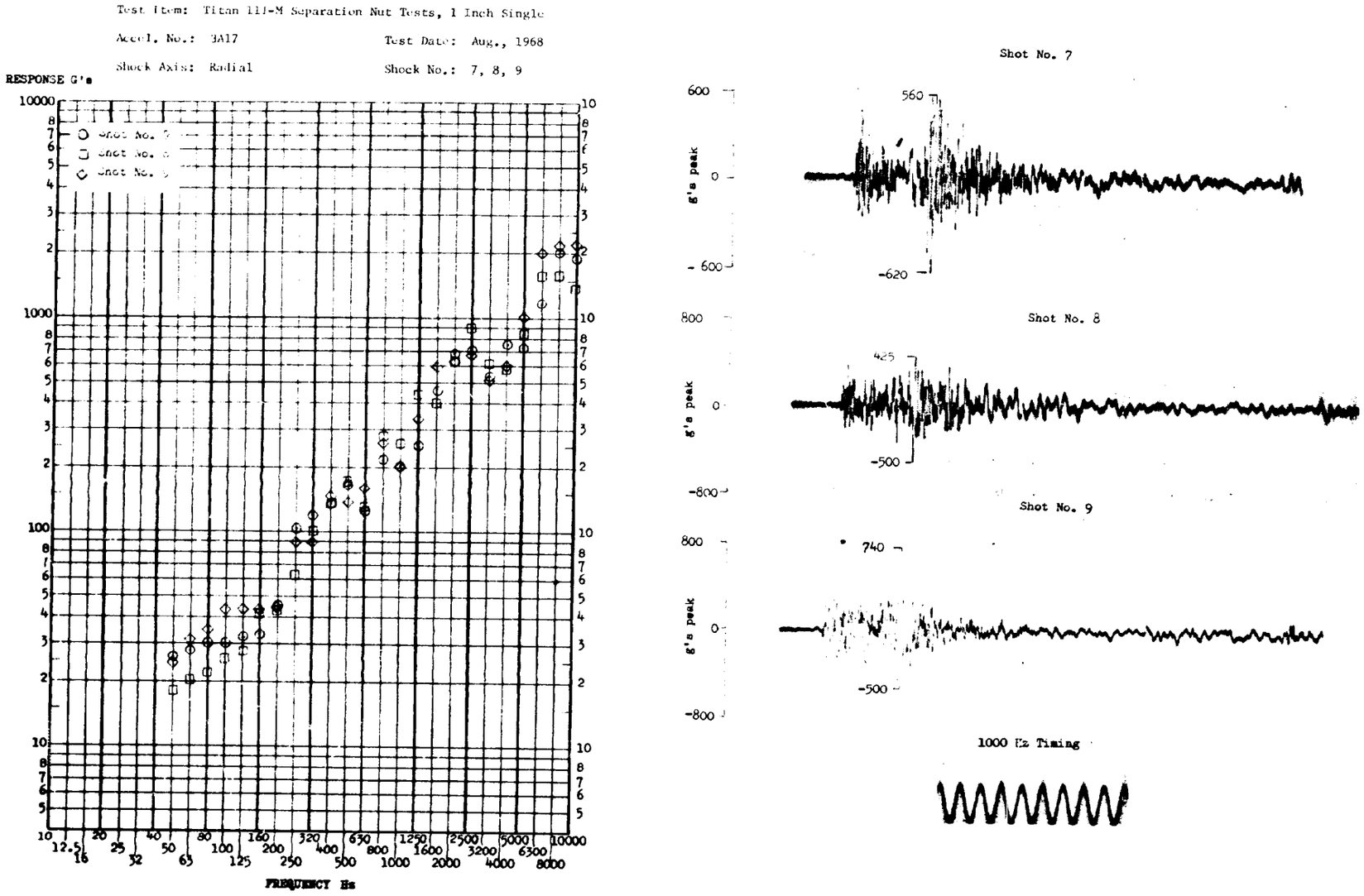



FIGURE 11.B.2-72

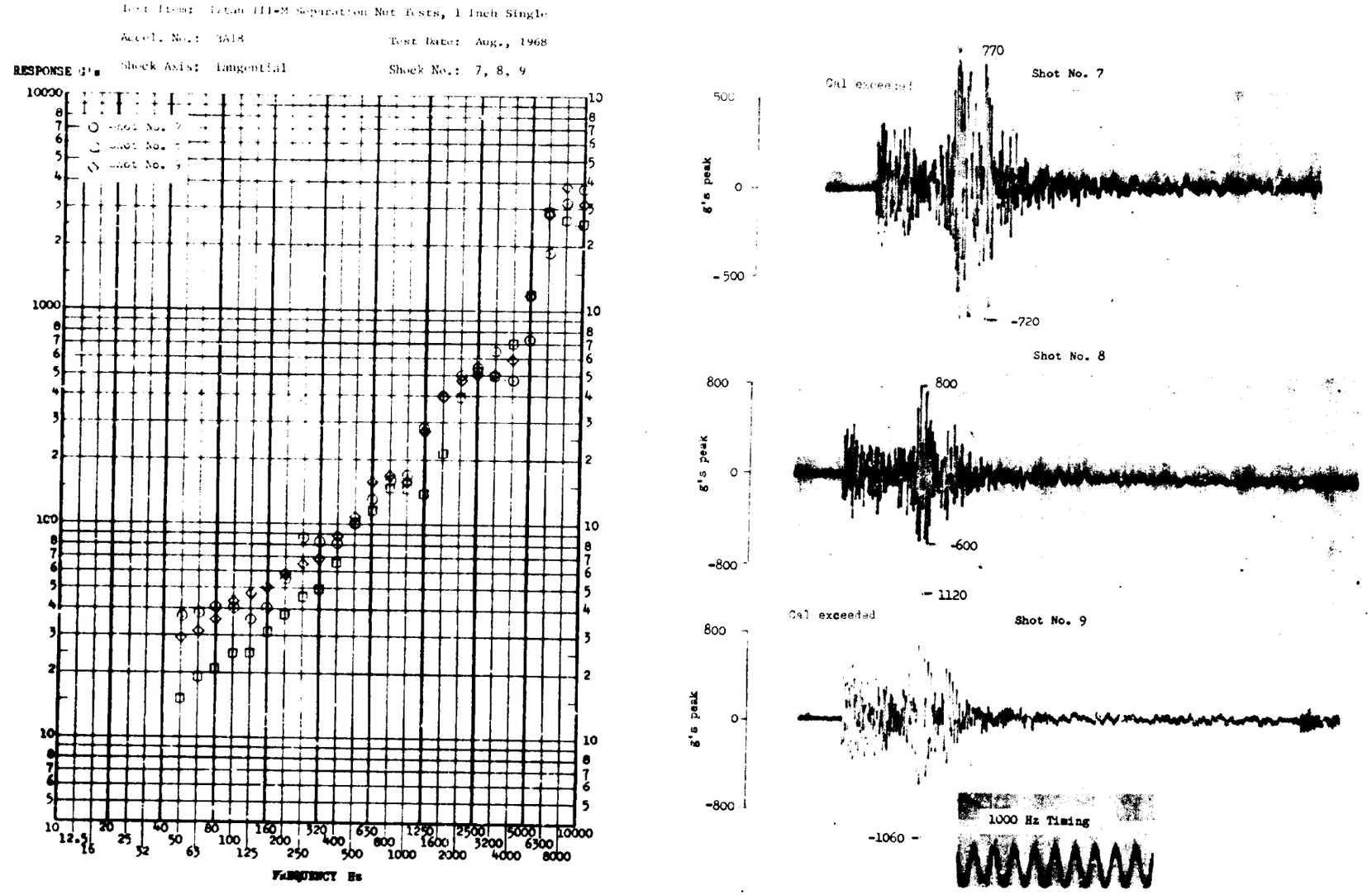
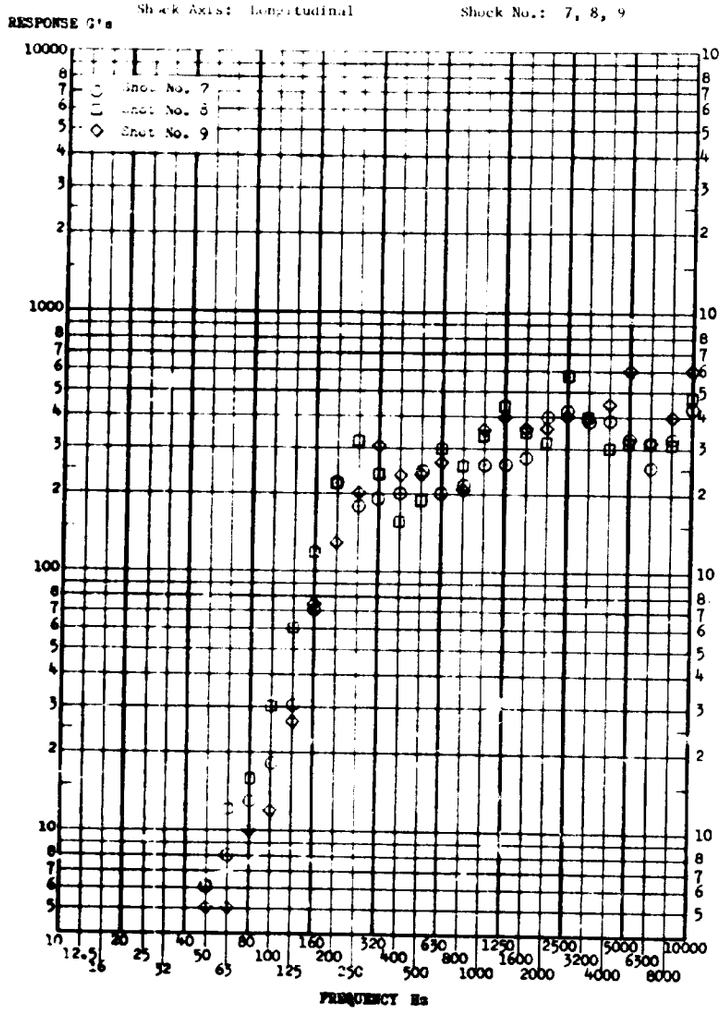



FIGURE 11.B.2-73

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: SA19 Test Date: Aug., 1968

Shock Axis: Longitudinal Shock No.: 7, 8, 9



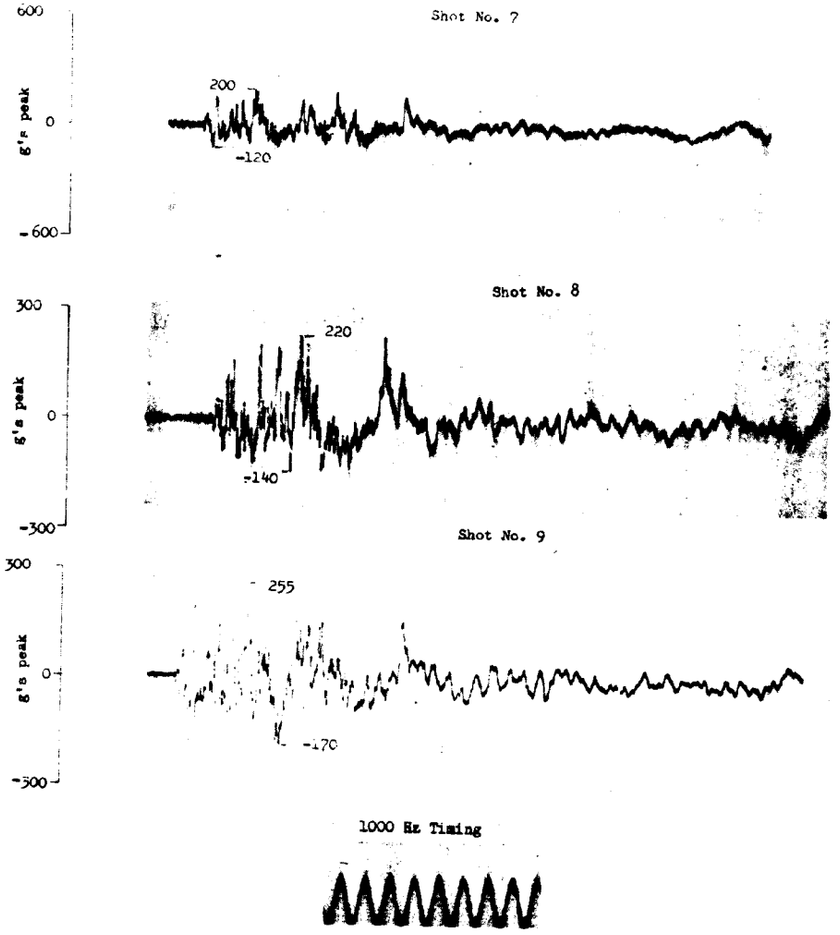




FIGURE 11.B.2-74

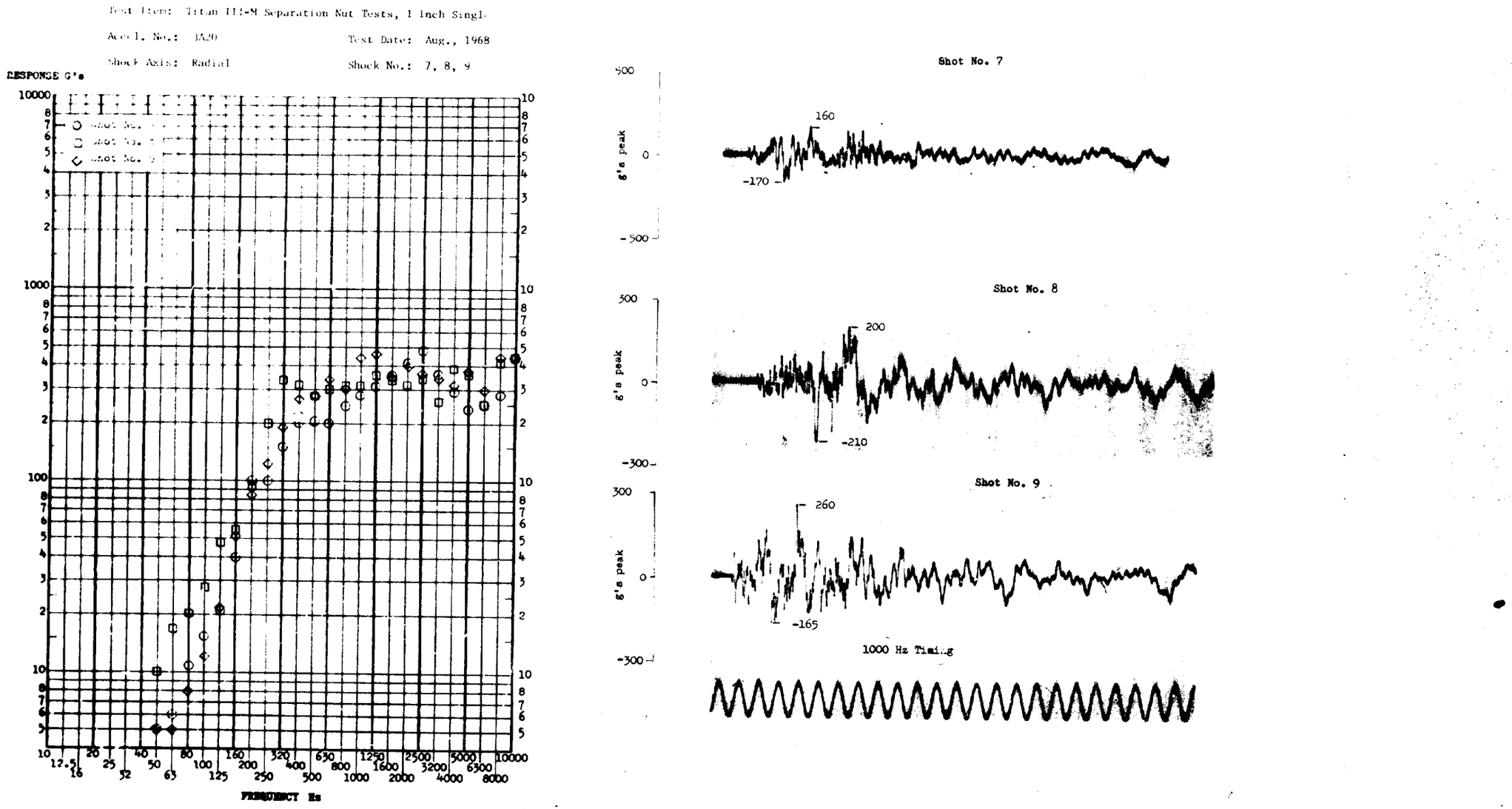
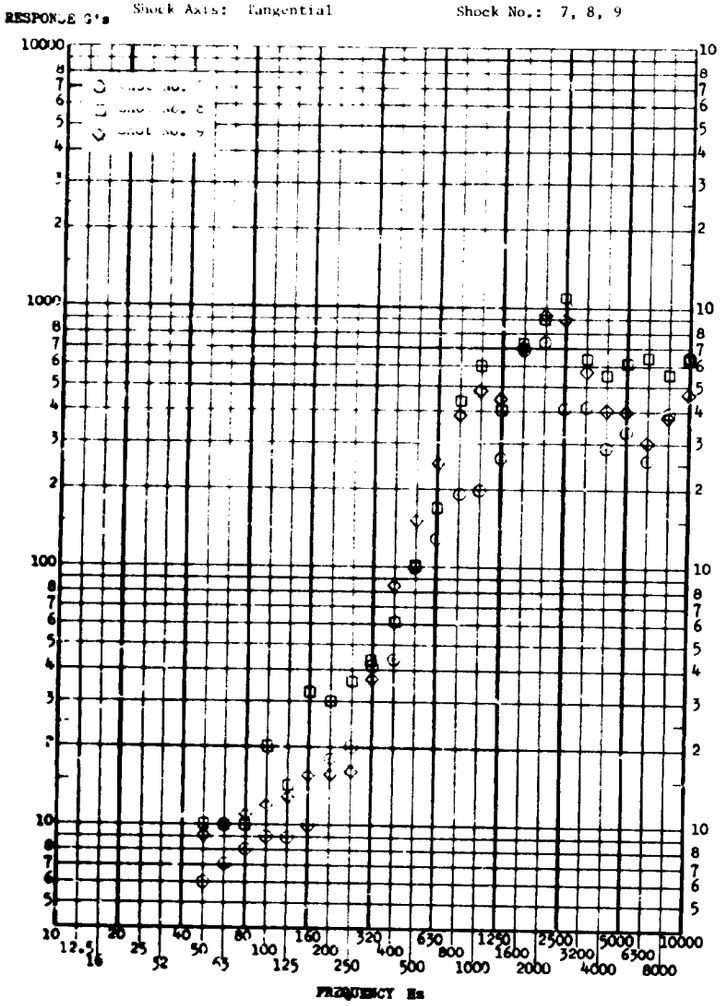



FIGURE II.B.2-75

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A21 Test Date: Aug., 1968

Shock Axis: Tangential Shock No.: 7, 8, 9



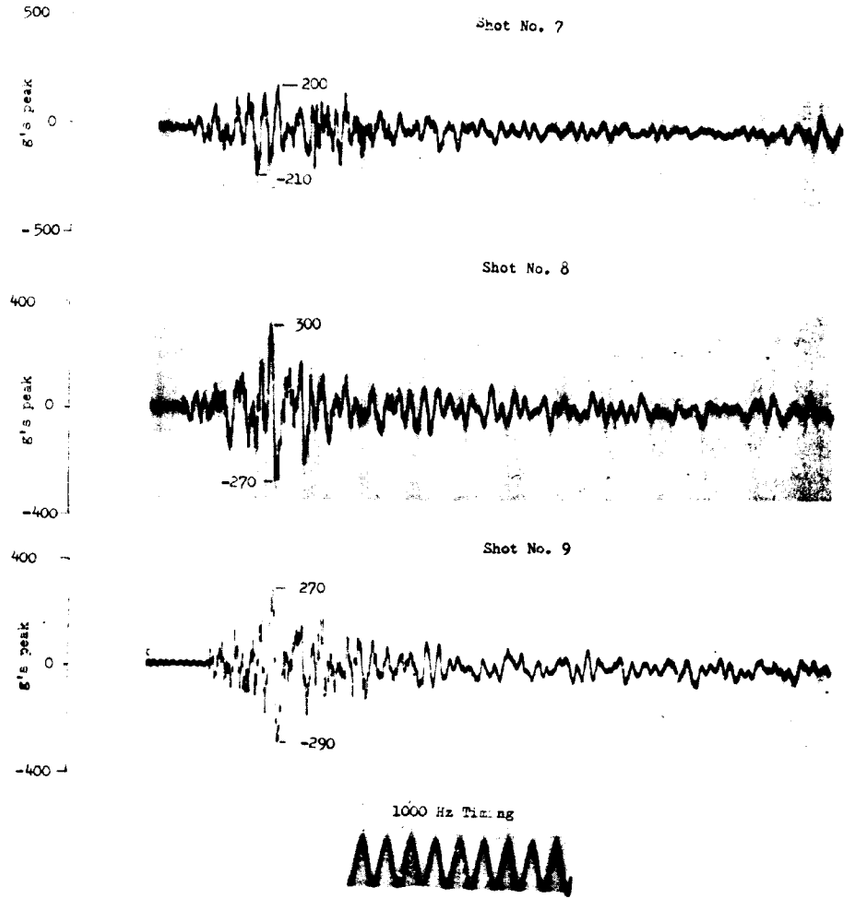




FIGURE II.B.2-76

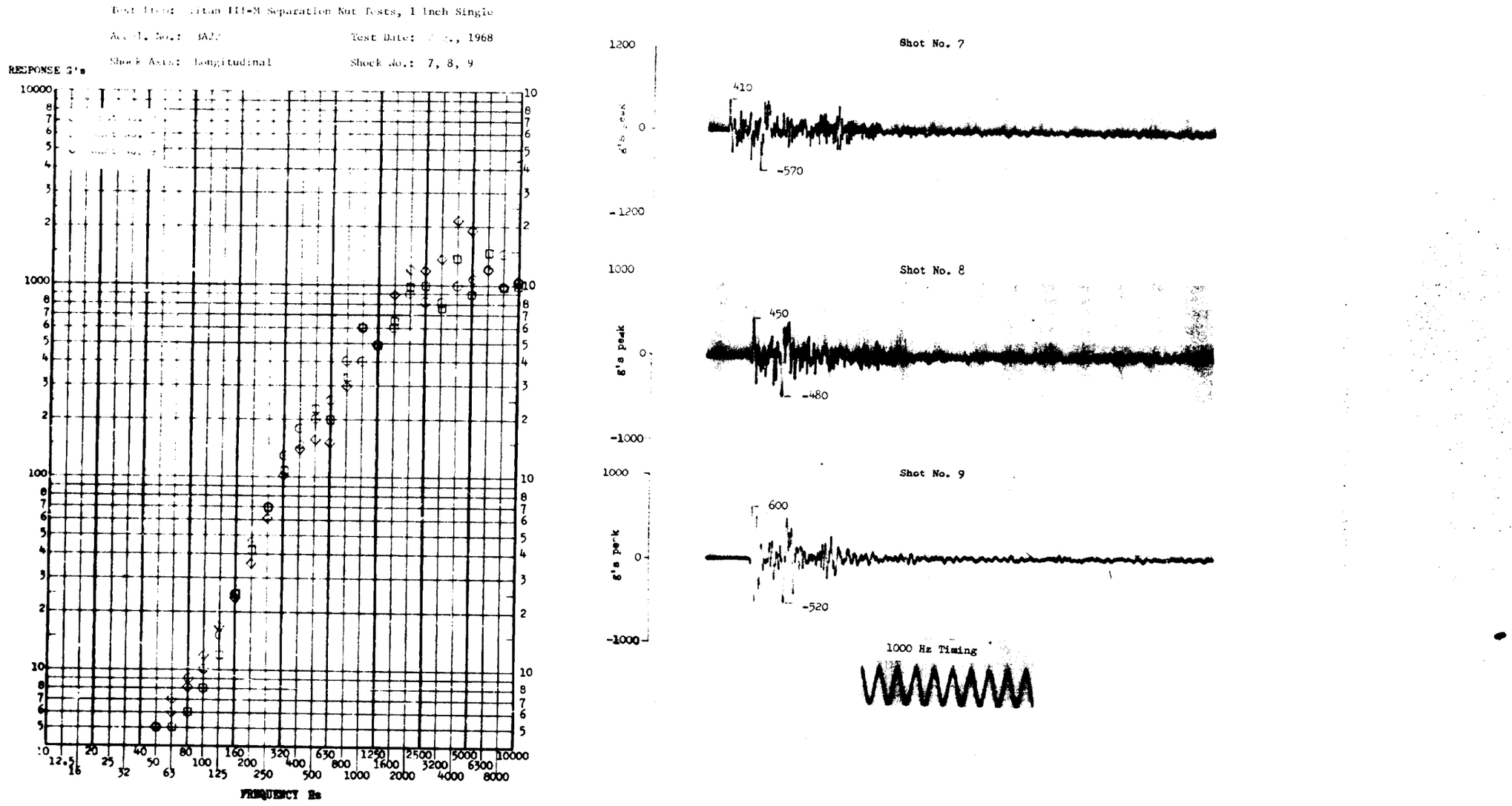



FIGURE 11.8.2-77

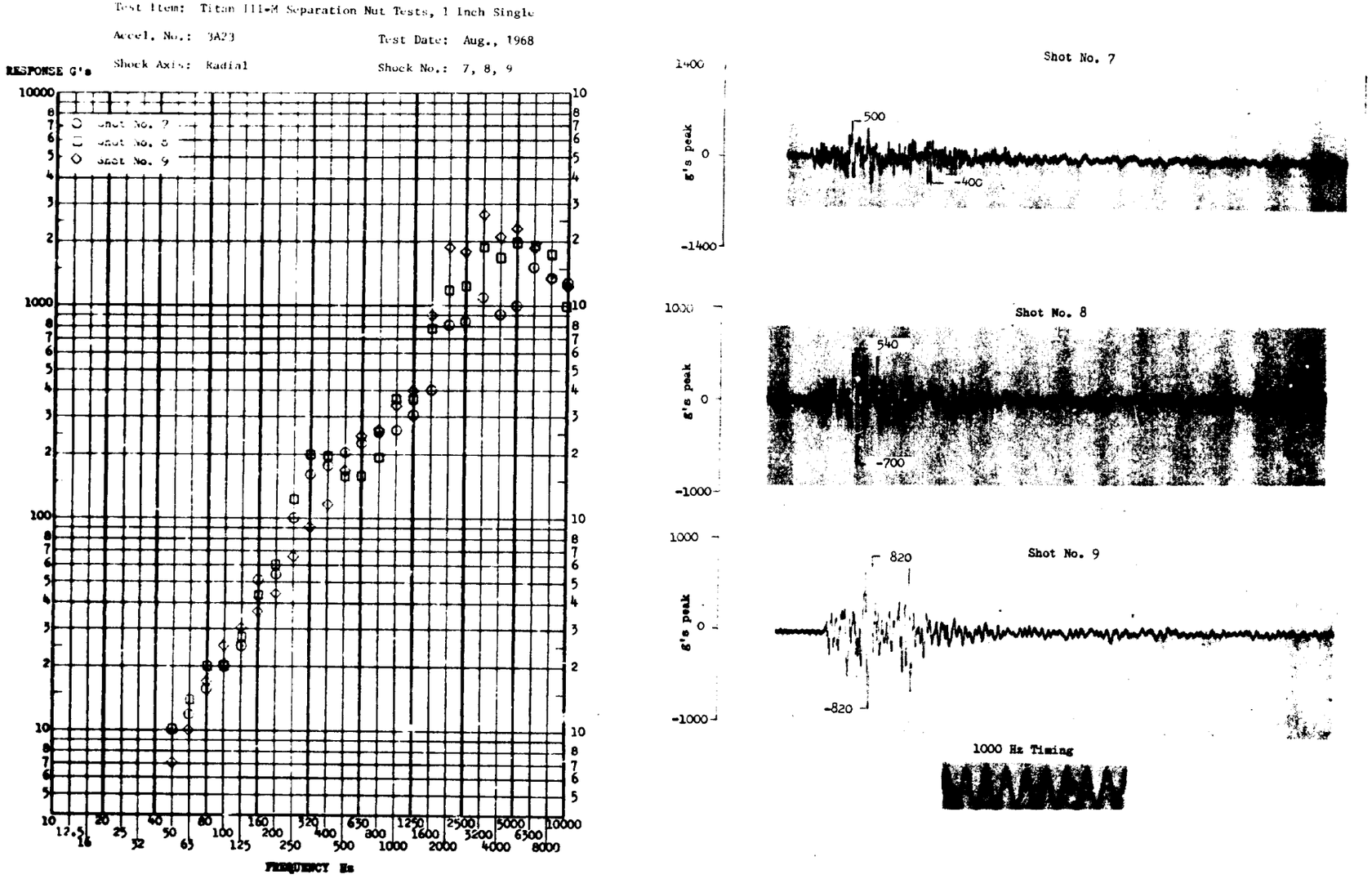
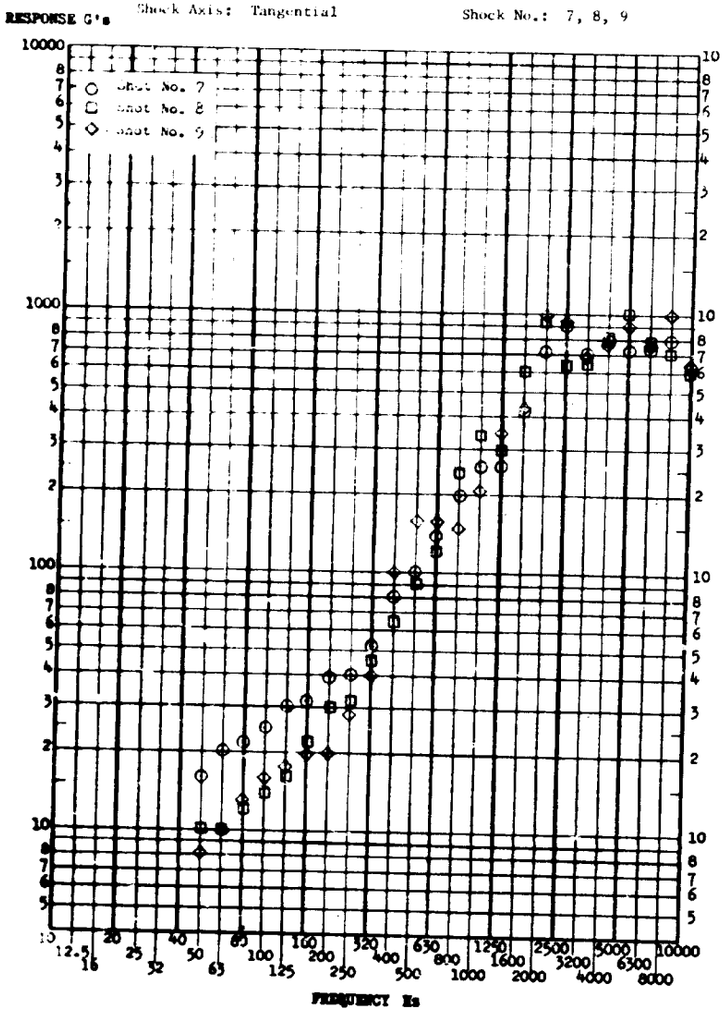



FIGURE 11.8.2-78

Test Item: Titan III-M Separation Nut Tests, 1 Inch Single

Accel. No.: 3A24 Test Date: Aug., 1968

Shock Axis: Tangential Shock No.: 7, 8, 9



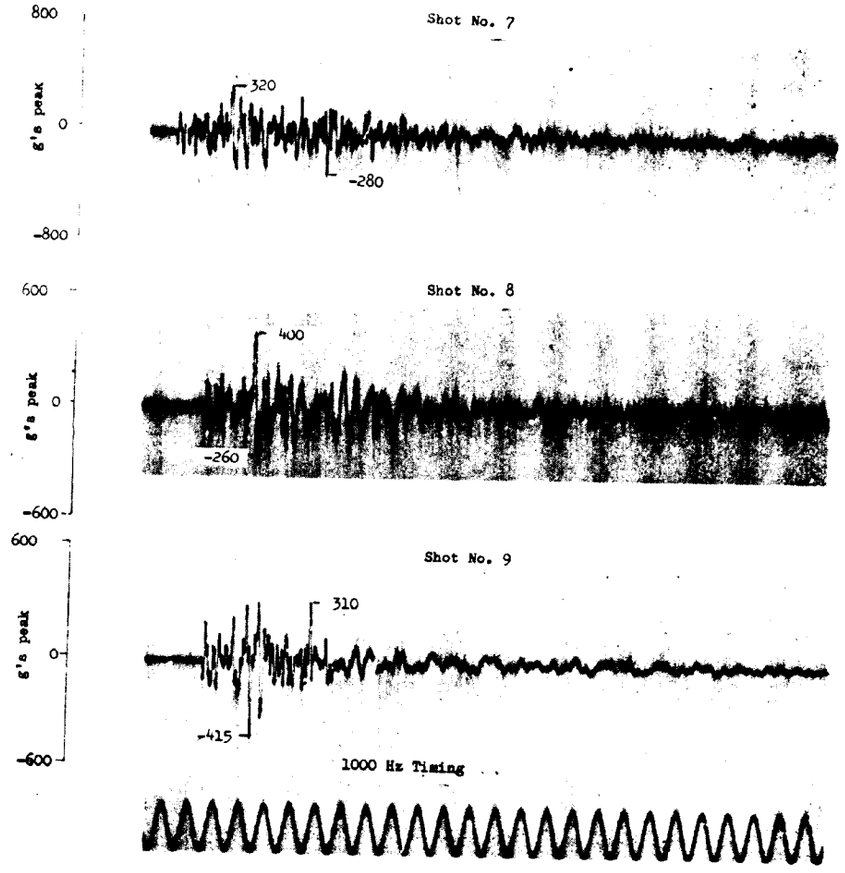




FIGURE II.B.2-79

## SECTION II.B.3

## PAYLOAD TRUSS SHOCK PROPAGATION TESTS

### PURPOSE OF TESTS

These tests were conducted to obtain shock propagation and attenuation data for light-weight truss structures. A second major objective was to compare the result of using multiple charges with the effect of using a single charge.

### DESCRIPTION OF EVENTS

The Article 5 Payload Truss (SESP) was attached to the Titan IIIC transtage with separation nuts and bolts at each longeron as shown in Figure II.B.3-1. Dummy satellites were installed in the truss, and safety cables were attached to the truss to prevent excessive movement of the truss during the test.

Testing consisted of seven shots detonating either one or all four of the separation nuts. Each nut was caused to separate into four segments by the detonation and pressure build up produced by the attached pressure cartridge. The nut/pressure cartridge configuration is depicted in Figure II.B.3-2. Table II.B.3-1 indicates the quadrant(s) in which the explosive nut(s) were actuated for each test. The locations of the quadrants

are called out in Figure II.B.3-3.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of time histories | 83 |
| No. of shock spectra | 83 |
| Type of analysis | analog |
| Analog machine | Ling SSA-100 |
| Frequency Range | 50-10,000 Hz |
| Frequency Increments | 3 points per octave |
| Damping | Q=10 |

These shock spectra are presented along with their corresponding time histories as Figures II.B.3-4 through II.B.3-43. Due to the various combinations of pyrotechnic configurations and measurement locations, Table II.B.3-2 has been prepared to facilitate convenience in locating particular measurements.

DESCRIPTION OF PYROTECHNIC

Single cartridge 3/4 inch separation nuts were used with one nut at each location.

Nuts: PD3350007-005 (mfg.: Hi Shear Corp.)

Nut and cartridge configuration: Figure II.B.3-2

Pyrotechnic locations: Table II.B.3-1 and Figures II.B.3-1 and II.B.3-3

Pressure cartridge: PD60S0129-505 (mfg.: McCormick-Selph Associates)

The charges contained in the pressure cartridges are as follows:

Prime charge: 90 mg pressed zirconium

Base charge: 346 mg boron and potassium nitrate

Booster charge: 86 mg boron and potassium nitrate

Sustainer charge: 193 mg ammonium nitrate and rubber

DESCRIPTION OF STRUCTURE

Figure II.B.3-1

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2225

Locations: Table II.B.3-3 and Figure II.B.3-3

Axis of Sensitivity: Figure II.B.3-3

DESCRIPTION OF DATA ACQUISITION SYSTEM

Tape recorder: Ampex ES-100 (0-20,000 Hz frequency response)

Amplifiers: Kistler 504A (0-100,000 Hz frequency response)

COMMENTS

A number of time histories appear to be beyond the noted calibration level. However, the instrumentation equated volts RMS to g's peak. Thus, the acceleration data is valid to a level of 1.414 greater than the noted calibration level. Those cases where the acceleration level is beyond the range of the instrumentation are noted on the time histories.

TABLE II.B.3-1

DIFFERENCES AMONG TEST RUNS

| Shot Number | Number of Nuts Fired | Location of Nut(s) Fired | Accelerometer Locations Monitored |
|---|---|---|---|
| 1 | 1 | Quandrant I | 1,2,5,6 |
| 2 | 1 | Quandrant II | 1,2,5,6 |
| 3 | 4 | Quandrants I,II,III,IV | 1,4,5,10 |
| 4 | 4 | Quandrants I,II,III,IV | 1,4,7,8 |
| 5 | 1 | Quandrant I | 1,3,4,6 |
| 6 | 1 | Quandrant II | 2,6,12,13 |
| 7 | 1 | Quandrant II | 2,6,9,11 |

TABLE II.B.3-2

INDEX OF DATA CONTAINED IN FIGURES

| Figure Number | Test Number(s) | Accelerometer Location(s) Monitored |
|---|---|---|
| II.B.3-4 | 1,2,5 | 1 BL |
| -5 | 3,4 | 1 BL |
| -6 | 1,2,5 | 1 WL |
| -7 | 3,4 | 1 WL |
| -8 | 1,2,5 | 1 Vert. |
| -9 | 3,4 | 1 Vert. |
| -10 | 1,2 | 2 BL |
| -11 | 6 | 2 BL |
| -12 | 1,2 | 2 WL |
| -13 | 6,7 | 2 WL |
| -14 | 1,2 | 2 Vert. |
| -15 | 6,7 | 2 Vert. |
| -16 | 5 | 3 BL, 3 WL |
| -17 | 5 | 3 Vert., 4 BL |
| -18 | 3,4 | 4 BL |
| -19 | 3,4 | 4 WL |
| -20 | 5 | 4 WL, 4 Vert. |
| -21 | 3,4 | 4 Vert. |
| -22 | 1,2 | 5 BL |
| -23 | 3 | 5 BL, 5 WL |

TABLE II.B.3-2

INDEX OF DATA CONTAINED IN FIGURES

| Figure Number | Test Number(s) | Accelerometer Location(s) Monitored |
|---|---|---|
| II.B.3-24 | 1,2 | 5 WL |
| -25 | 1,2 | 5 Vert. |
| -26 | 3 | 5 Vert. |
| -27 | 1,2 | 6 BL |
| -28 | 5,6,7 | 6 BL |
| -29 | 1,2 | 6 WL |
| -30 | 5,6,7 | 6 WL |
| -31 | 1,2 | 6 Vert. |
| -32 | 5,6,7 | 6 Vert. |
| -33 | 4 | 7 BL, 7 WL |
| -34 | 4 | 7 Vert., 8 BL |
| -35 | 4 | 8 WL, 8 Vert. |
| -36 | 7 | 9 BL, 9 WL |
| -37 | 7/3 | 9 Vert/10 BL |
| -38 | 3 | 10 WL, 10 Vert |
| -39 | 7 | 11 BL, 11 WL |
| -40 | 7/6 | 11 Vert., 12 BL' |
| -41 | 6 | 12 WL, 12 Vert. |
| -42 | 6 | 13 BL, 13 WL |
| -43 | 6 | 13 Vert. |



VI

TABLE II.B.3-3

DISTANCE OF ACCELEROMETER LOCATIONS FROM SHOCK SOURCE

| Accelerometer Location No. | Distance in Inches | | |
|---|---|---|---|
| | Shots 1 and 5 | Shots 3 and 4 | Shots 2,6 and 7 |
| 1 | 0 | 0 | 105 |
| 2 | 105 | * | 0 |
| 3 | 42 | * | * |
| 4 | 72 | 42 | * |
| 5 | 68 | 63 | 100 |
| 6 | 100 | * | 68 |
| 7 | * | 68 | * |
| 8 | * | 112 | * |
| 9 | * | * | 156 |
| 10 | * | 112 | * |
| 11 | * | * | 138 |
| 12 | * | * | 116 |
| 13 | * | * | 106 |

*Indicates that no measurement was taken.



FIGURE II.B.3-1

TEST INSTALLATION - SESP PAYLOAD TRUSS SHOCK TEST

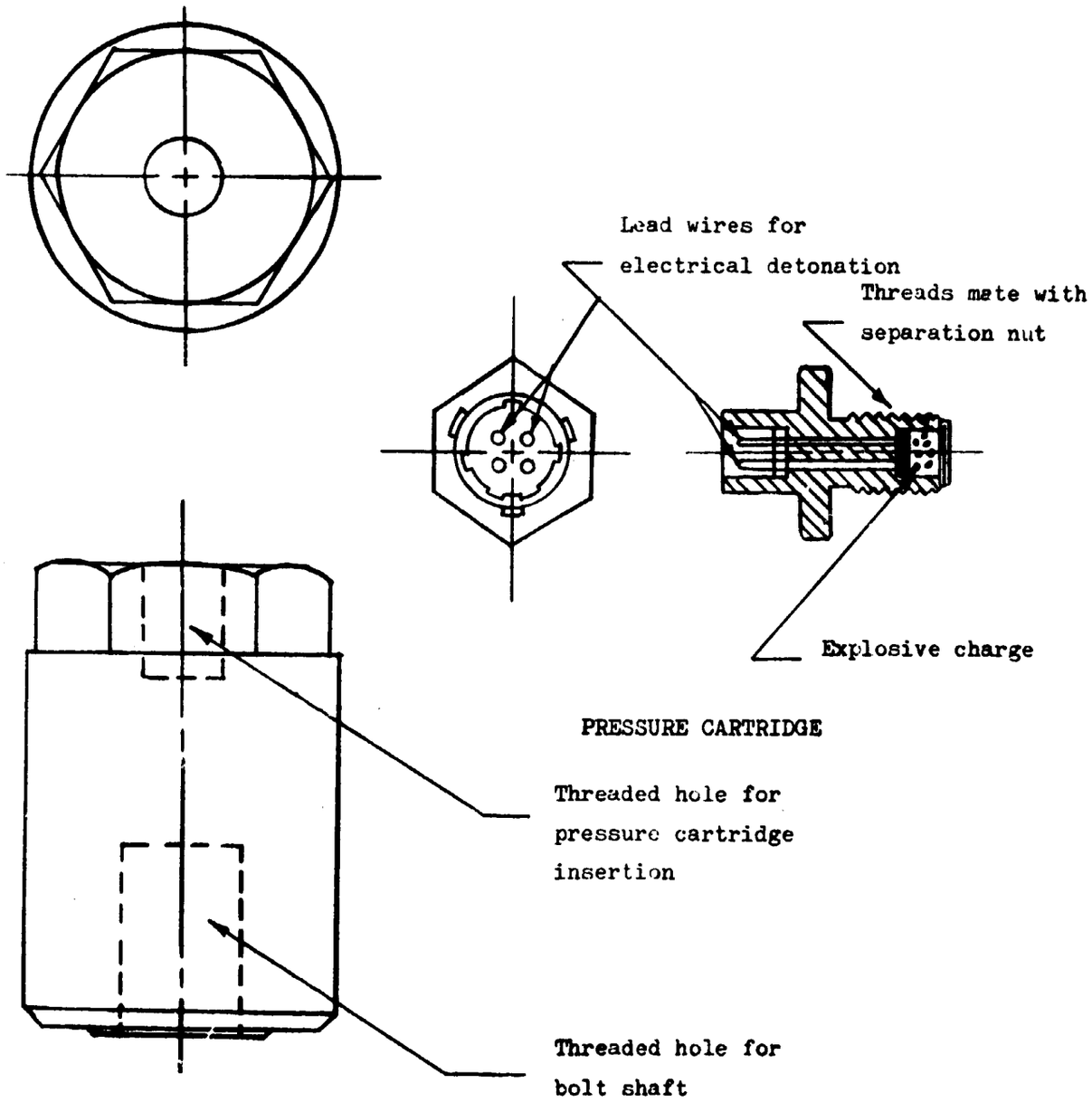



**FIGURE II.B.3-2**
**SEPARATION NUT**

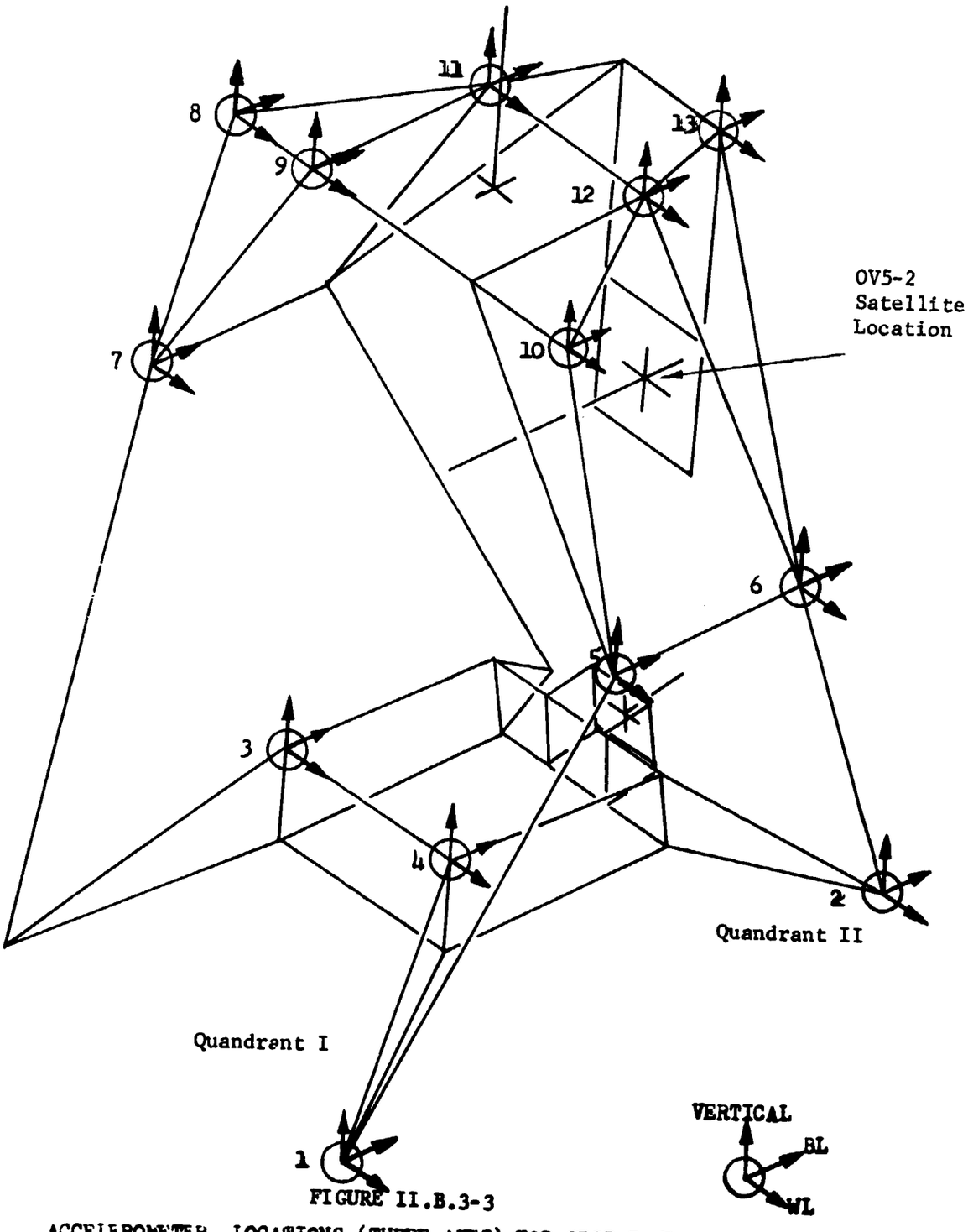



FIGURE II.B.3-3

ACCELEROMETER LOCATIONS (THREE AXES) FOR SESP PAYLOAD TRUSS SHOCK TEST

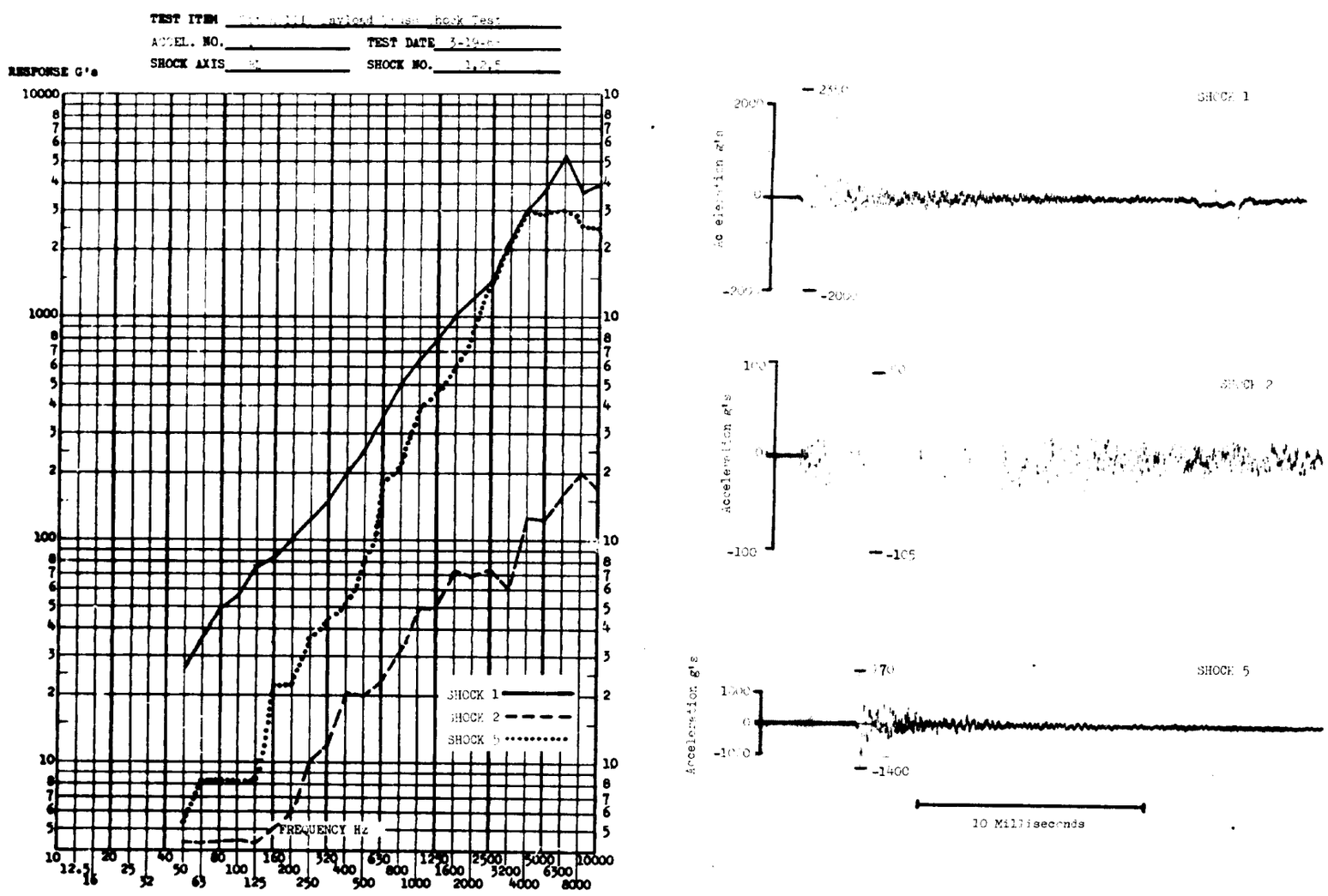
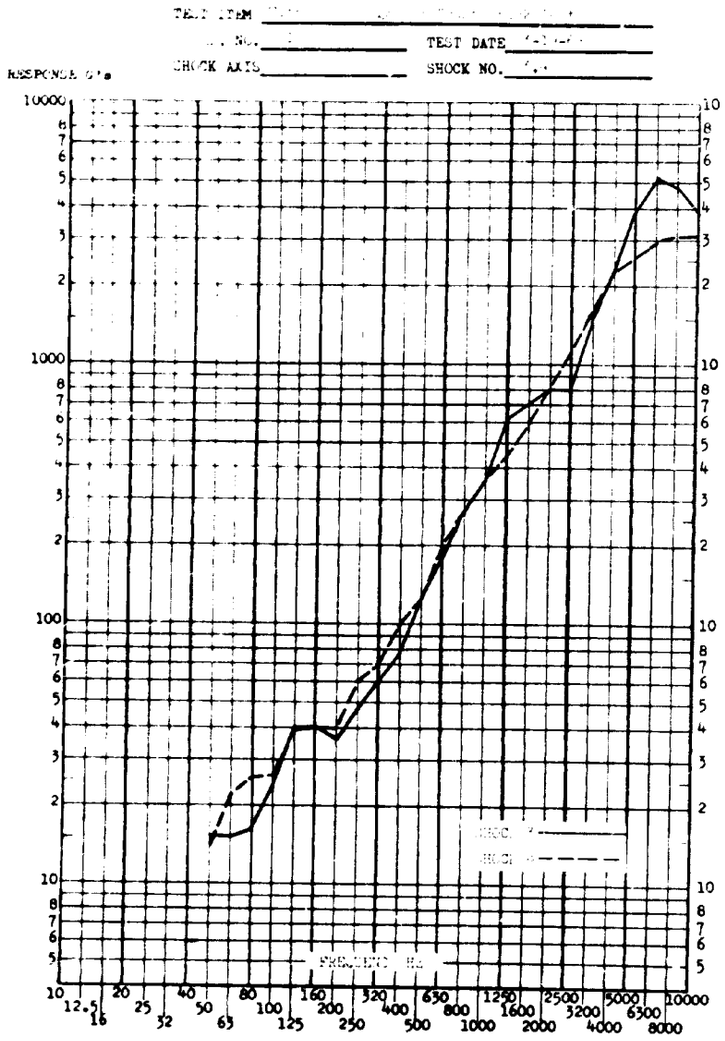



FIGURE II.B.3-4



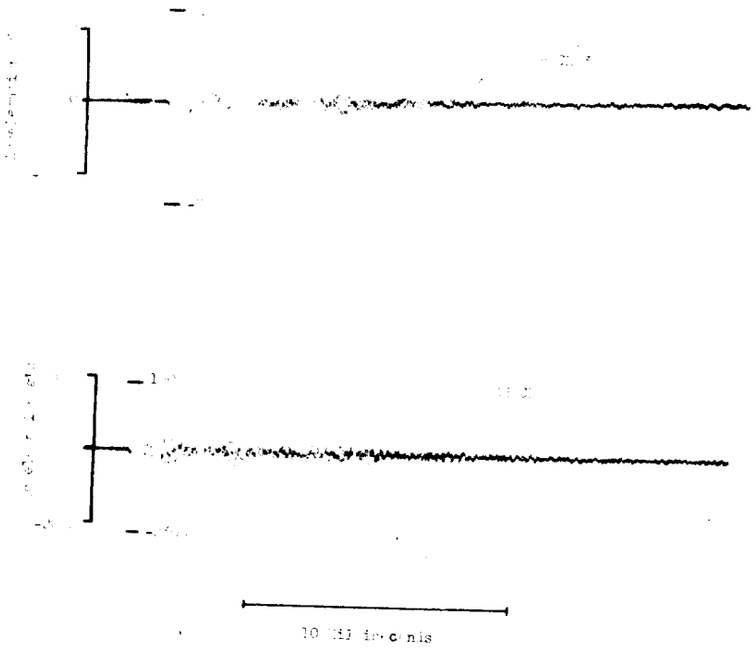



FIGURE 11.B.3-5

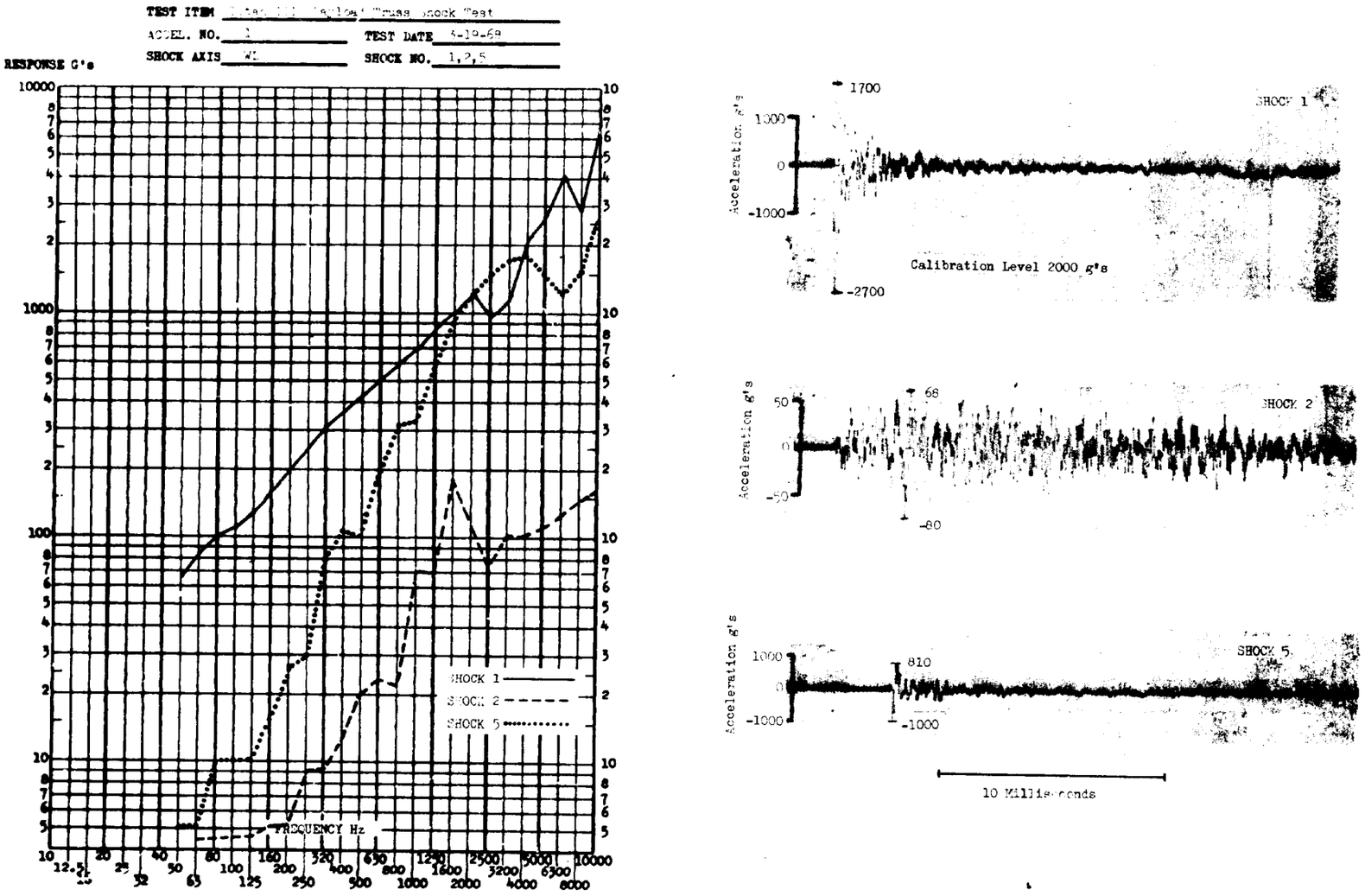



FIGURE II.B.3-6

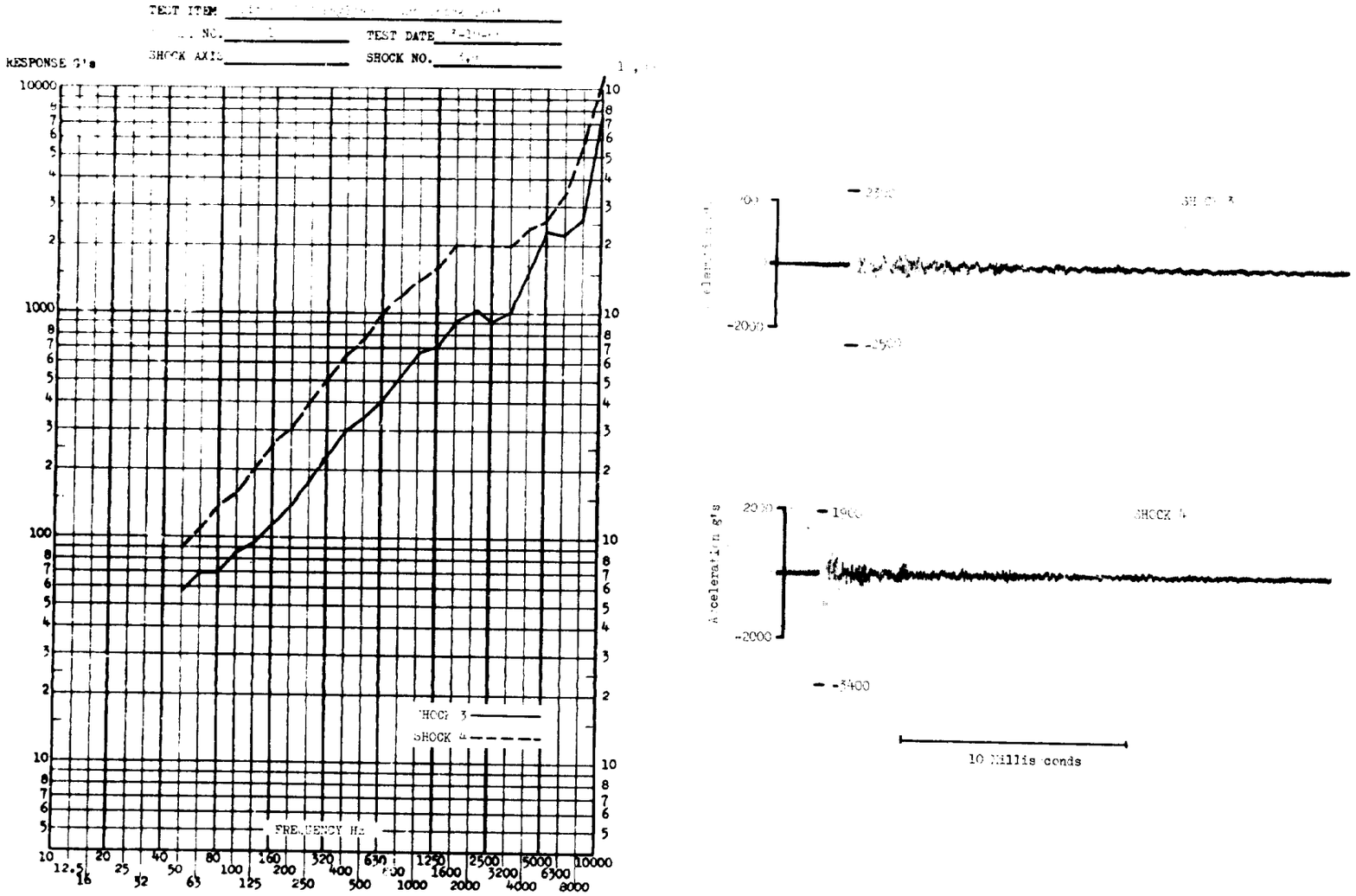



FIGURE 11.B.3-7

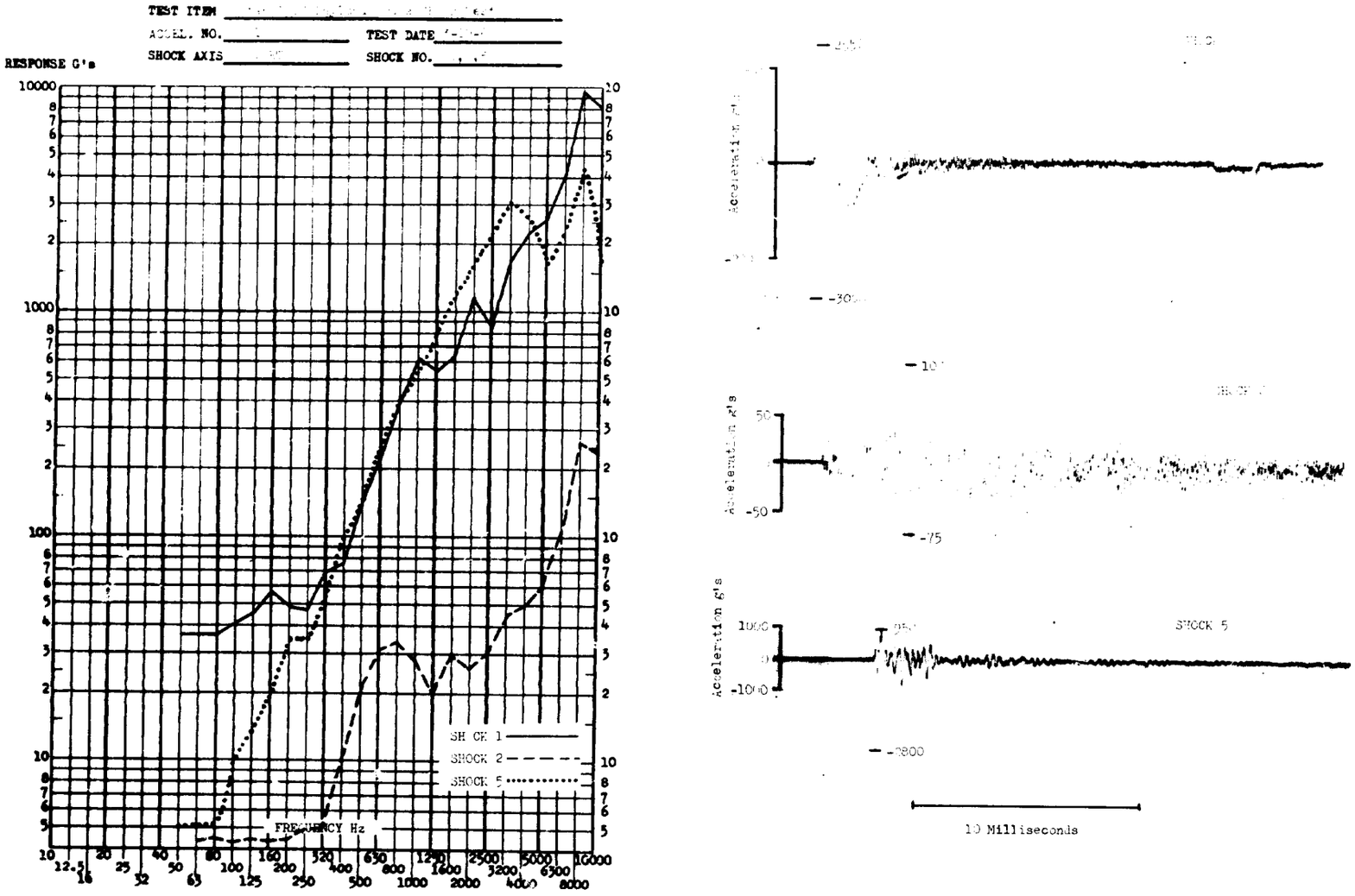



FIGURE II.B.3-8

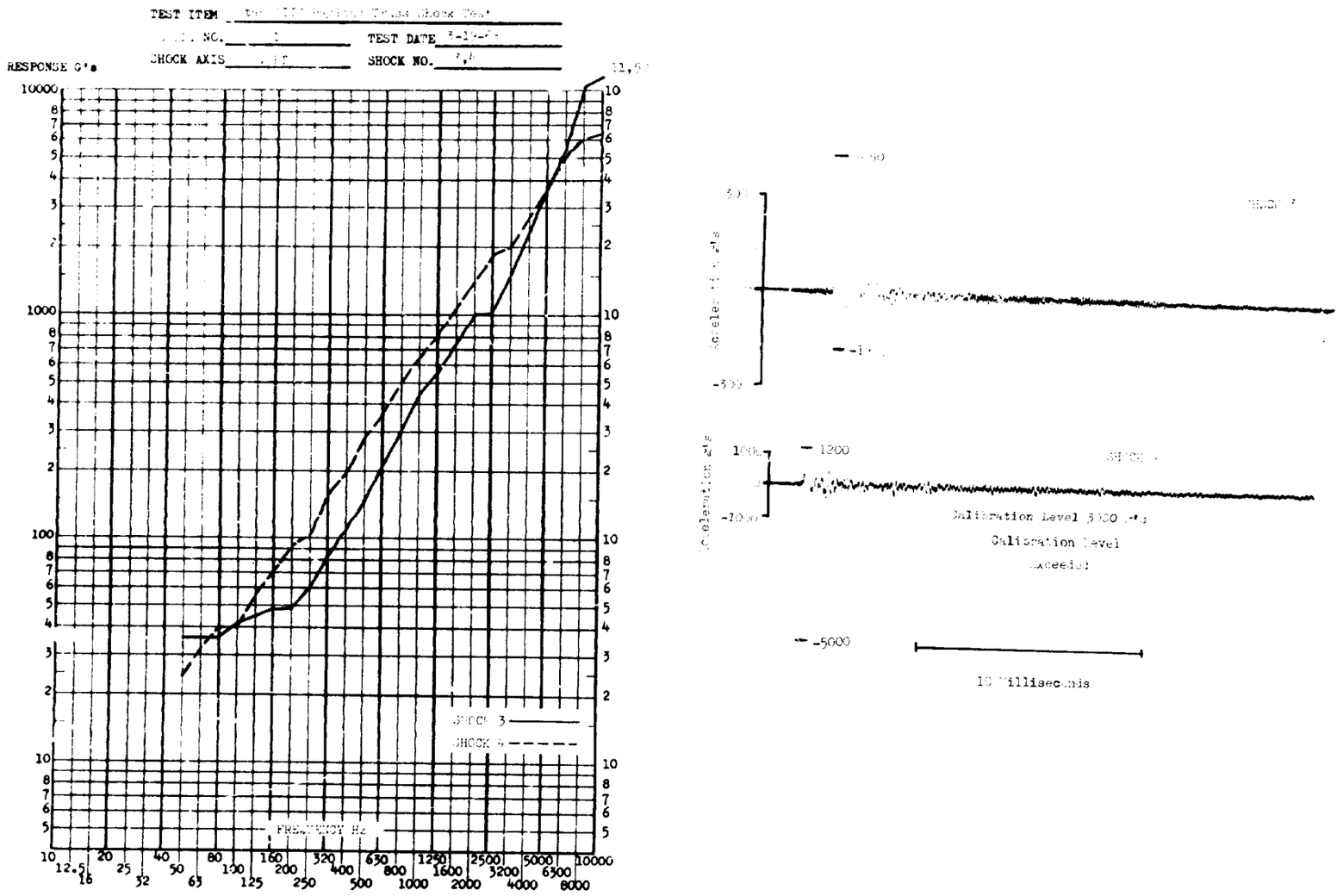
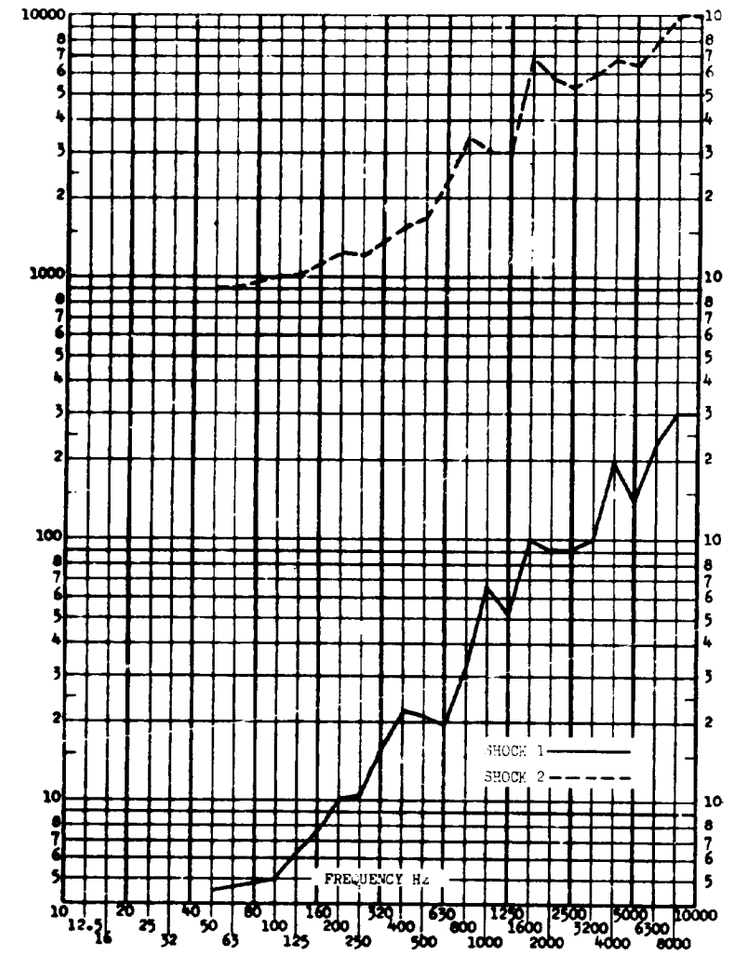



FIGURE II.B.3-9

TEST ITEM: Titan III Payload Transp. Rock Test

ACCEL. NO. [illegible] TEST DATE 7-19-68

SHOCK AXIS SL SHOCK NO. 1,2



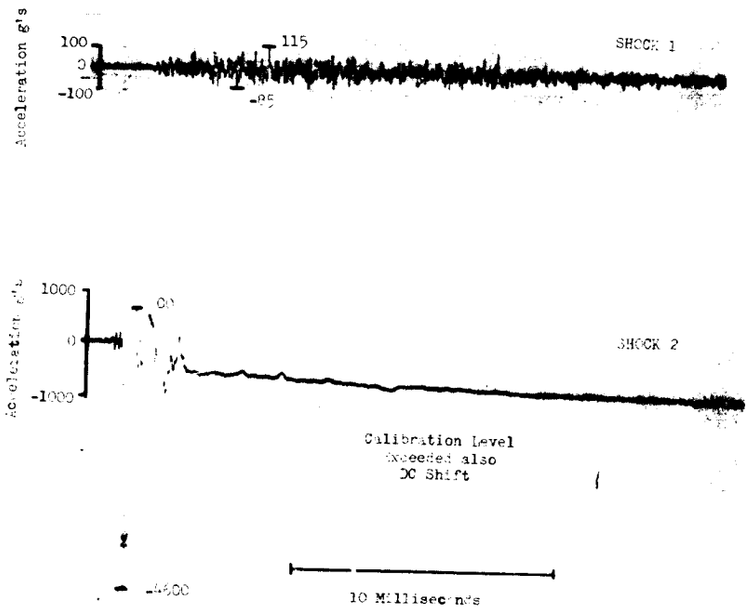




FIGURE 11.B.3-10

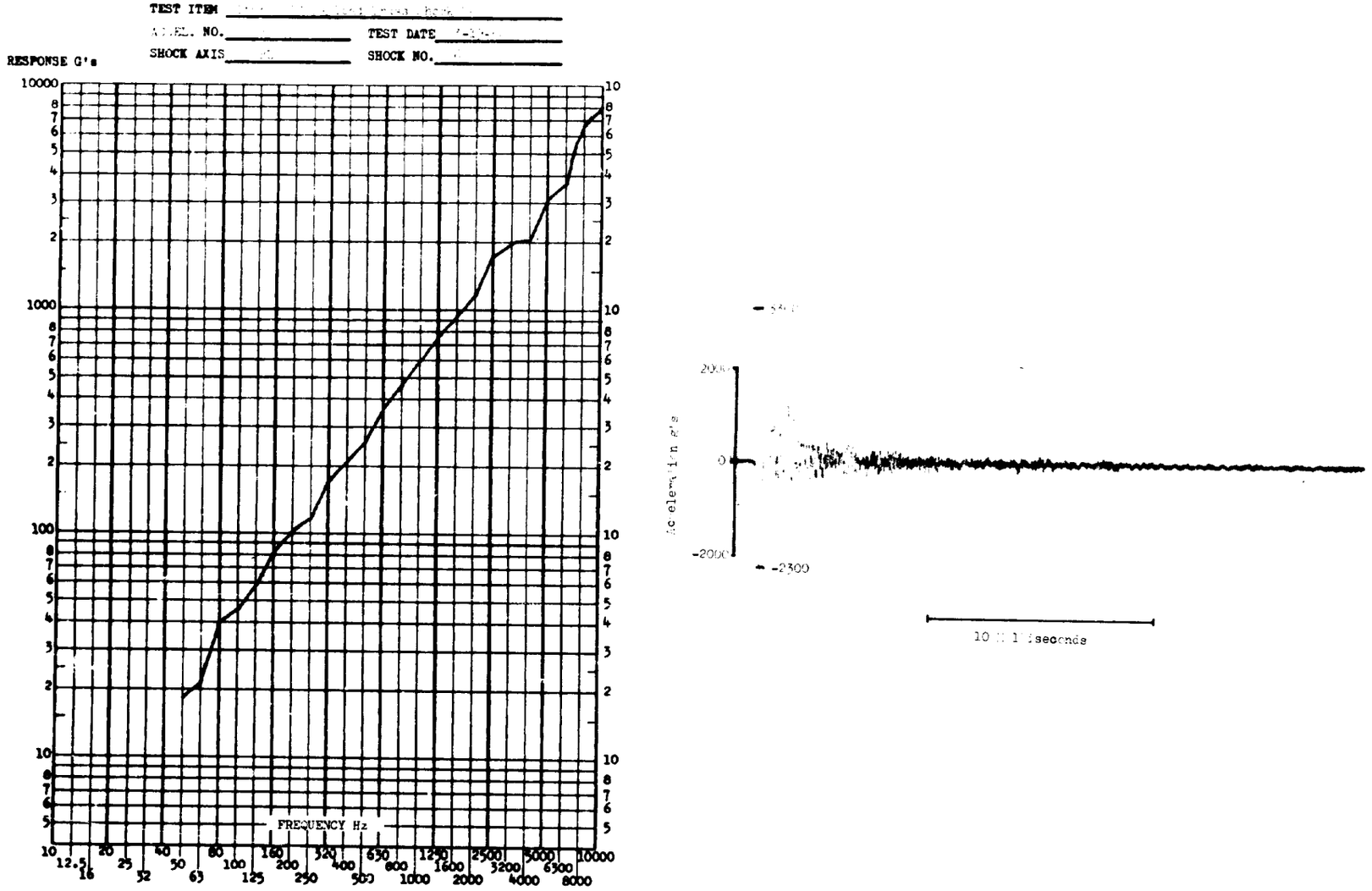



FIGURE 11.B.3-11

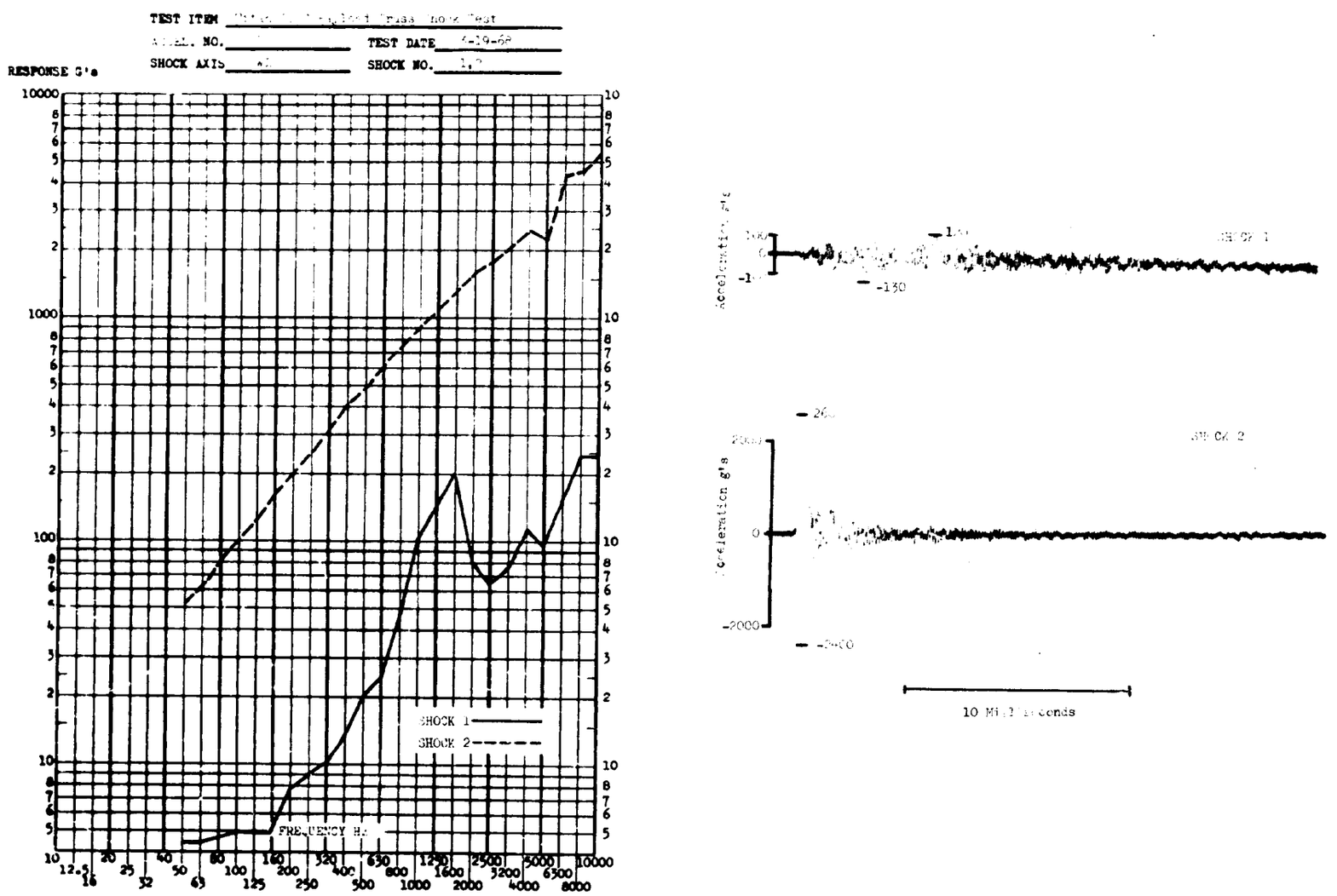
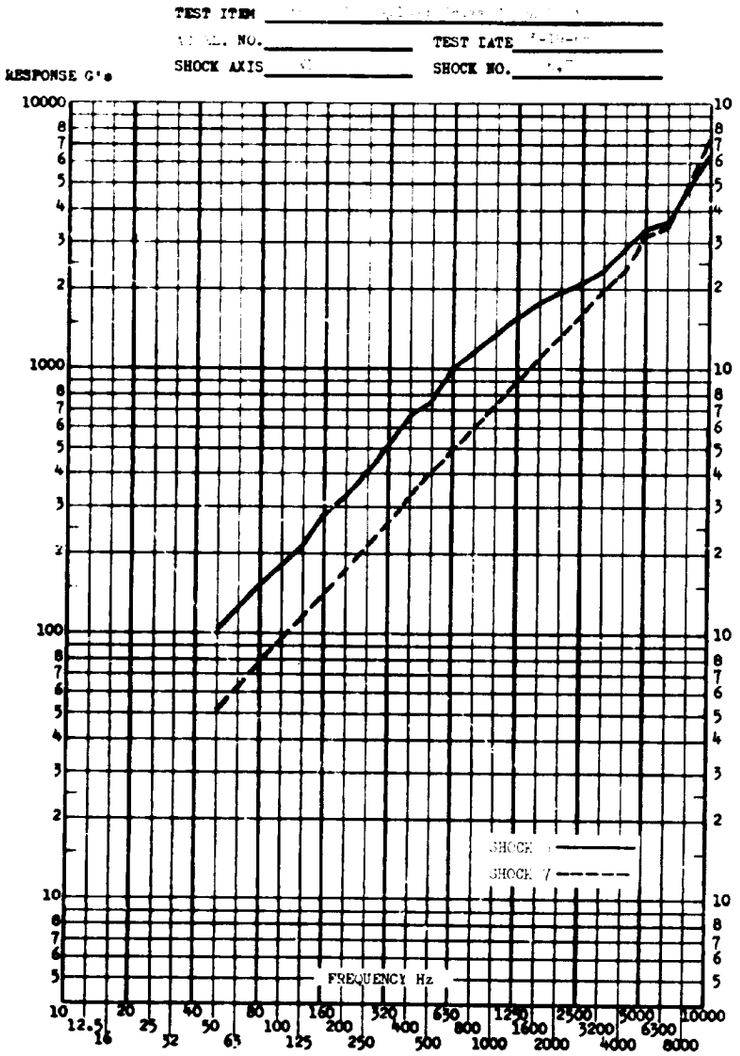



FIGURE 11.8.3-12



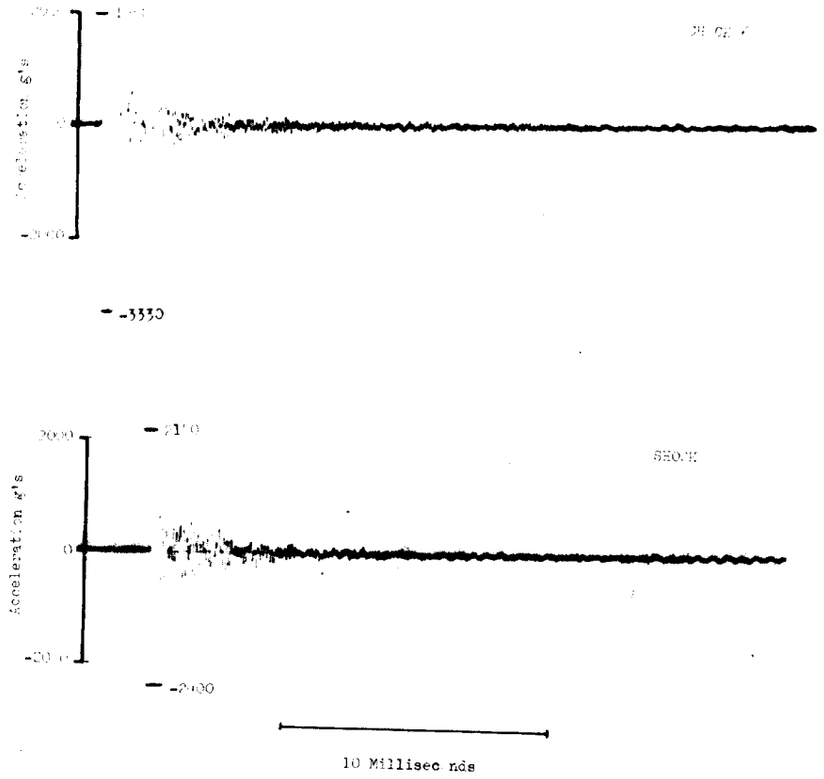




FIGURE 11.8.3-13

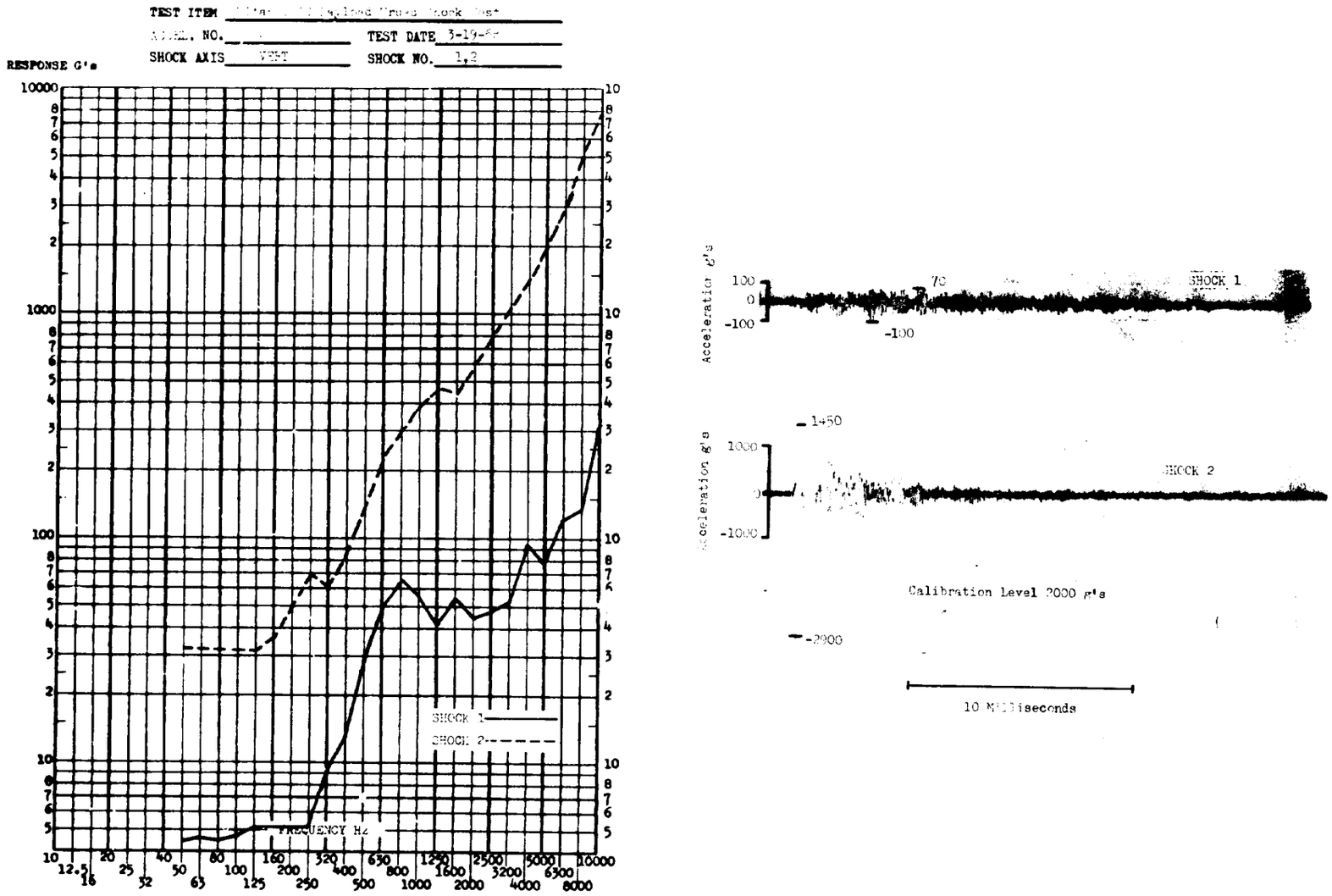



FIGURE 11.8.3-14

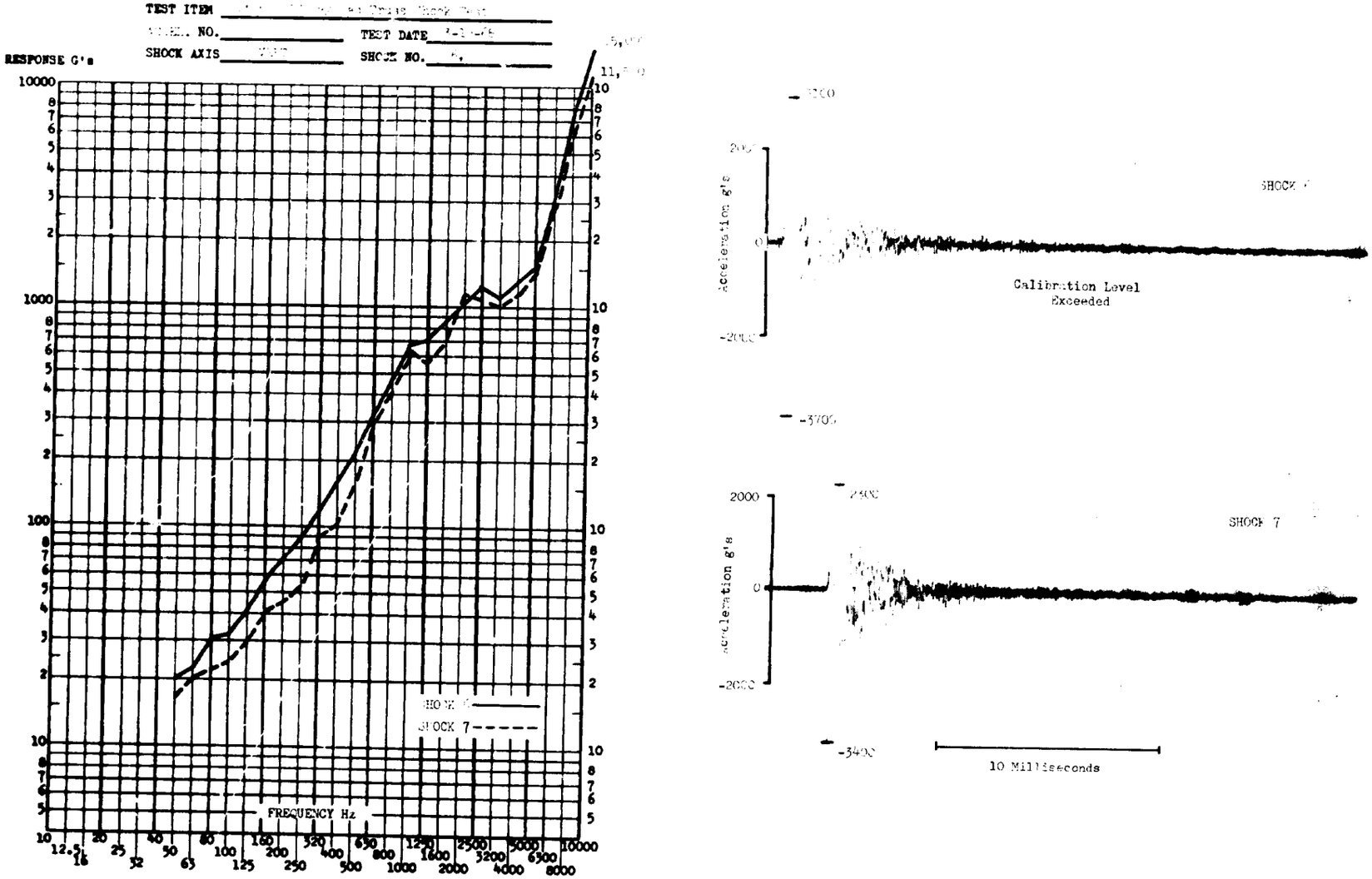



FIGURE II.B.3-15

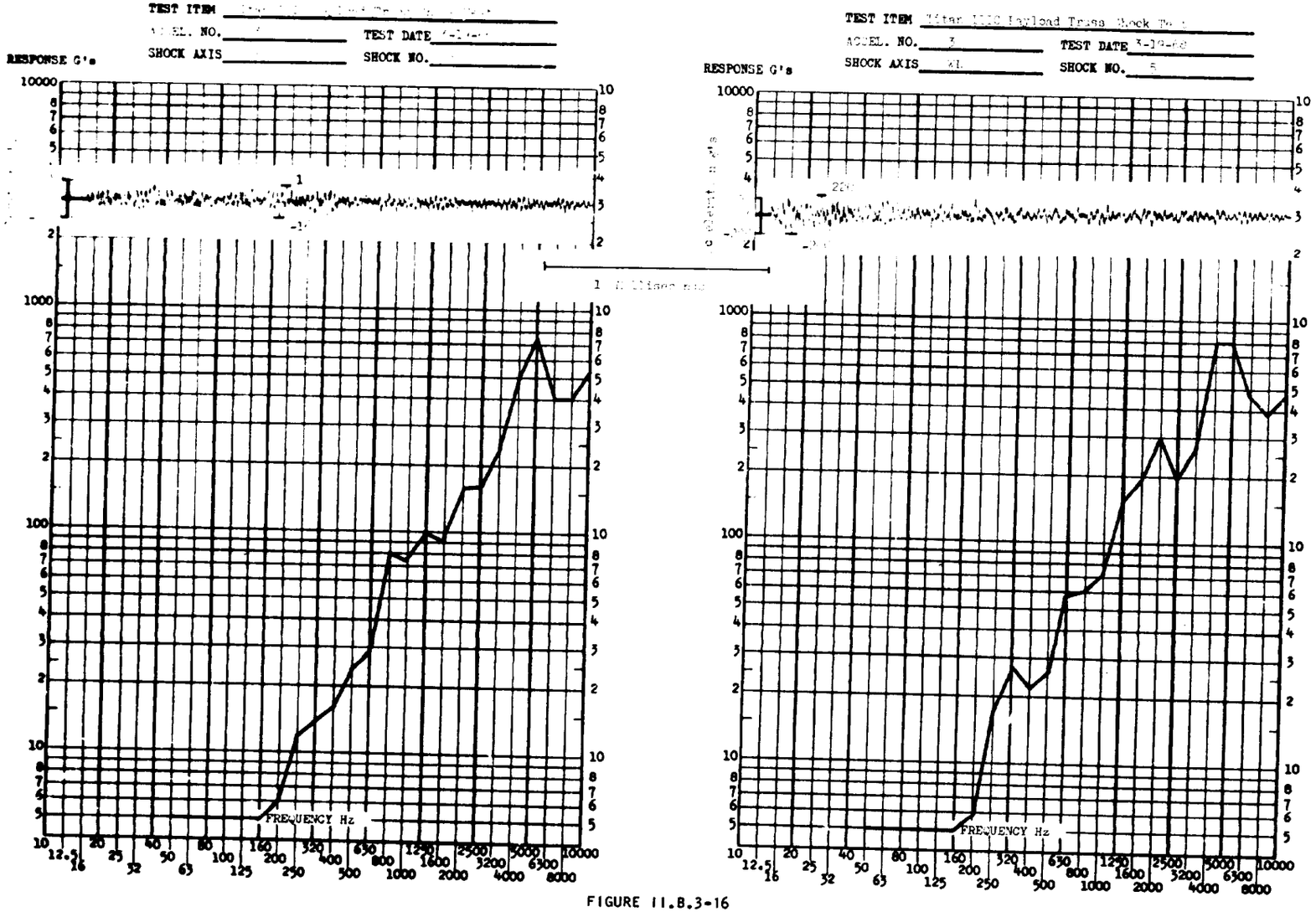



FIGURE 11.8.3-16

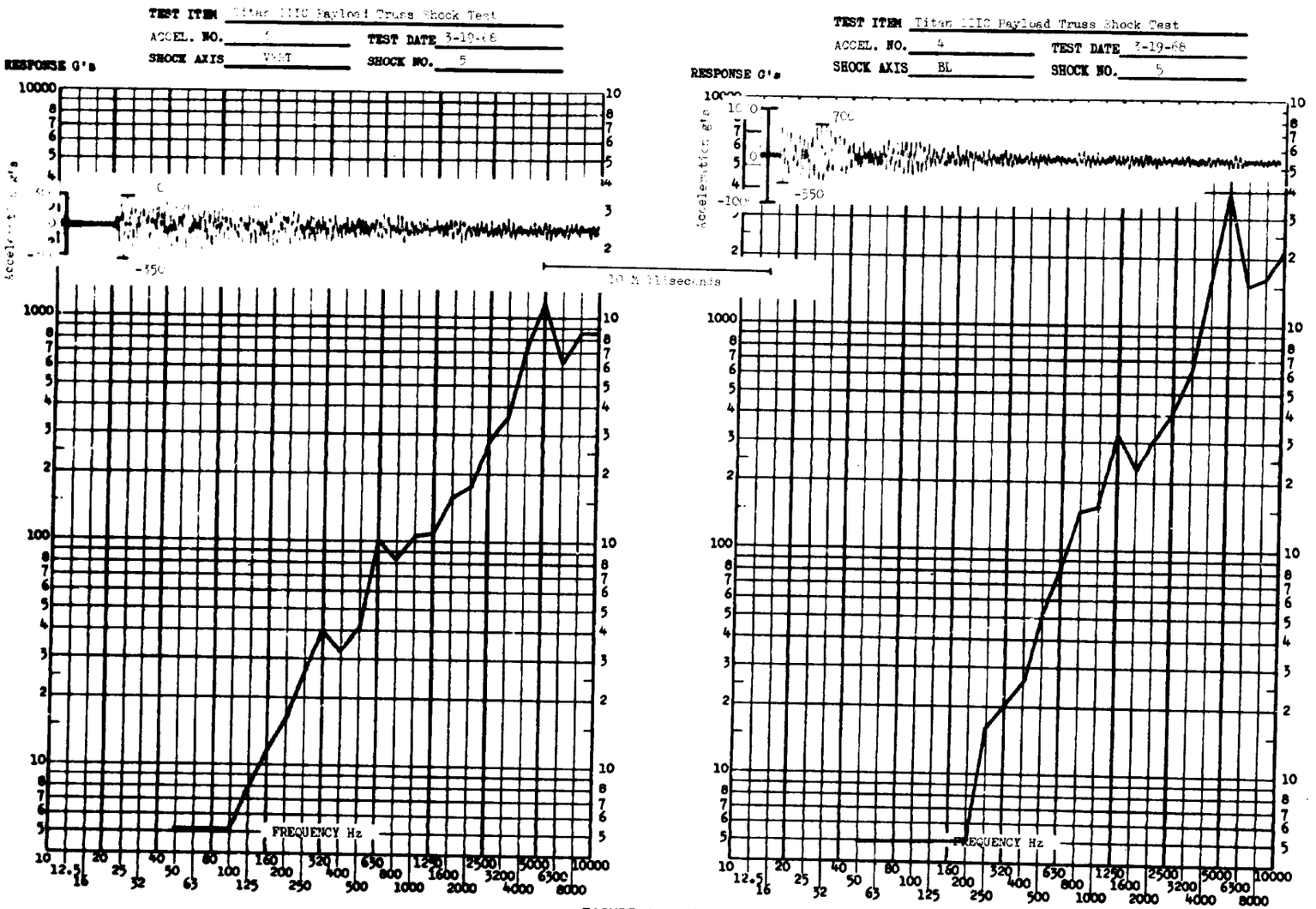



FIGURE II.B.3-17

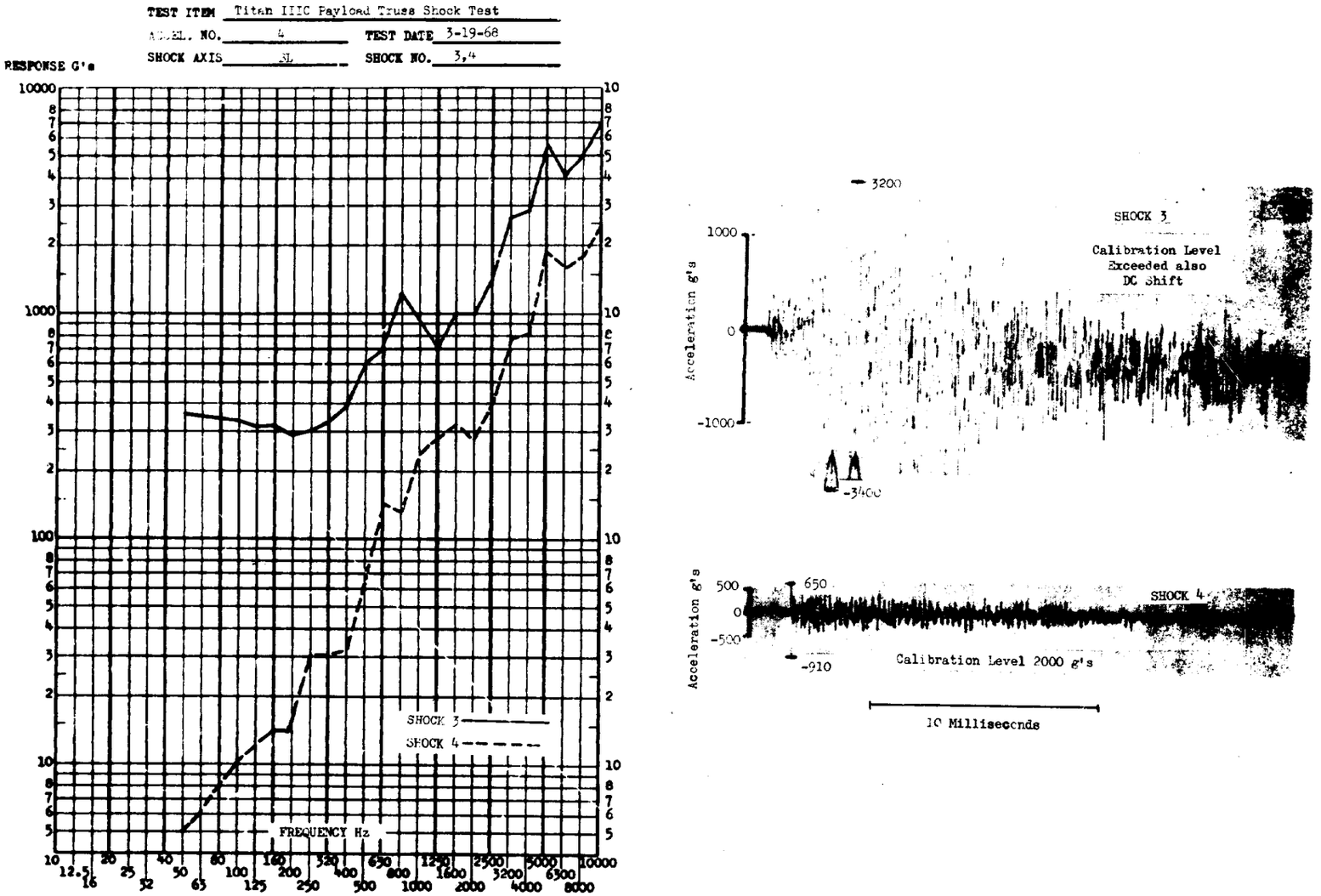



FIGURE II.B.3-18

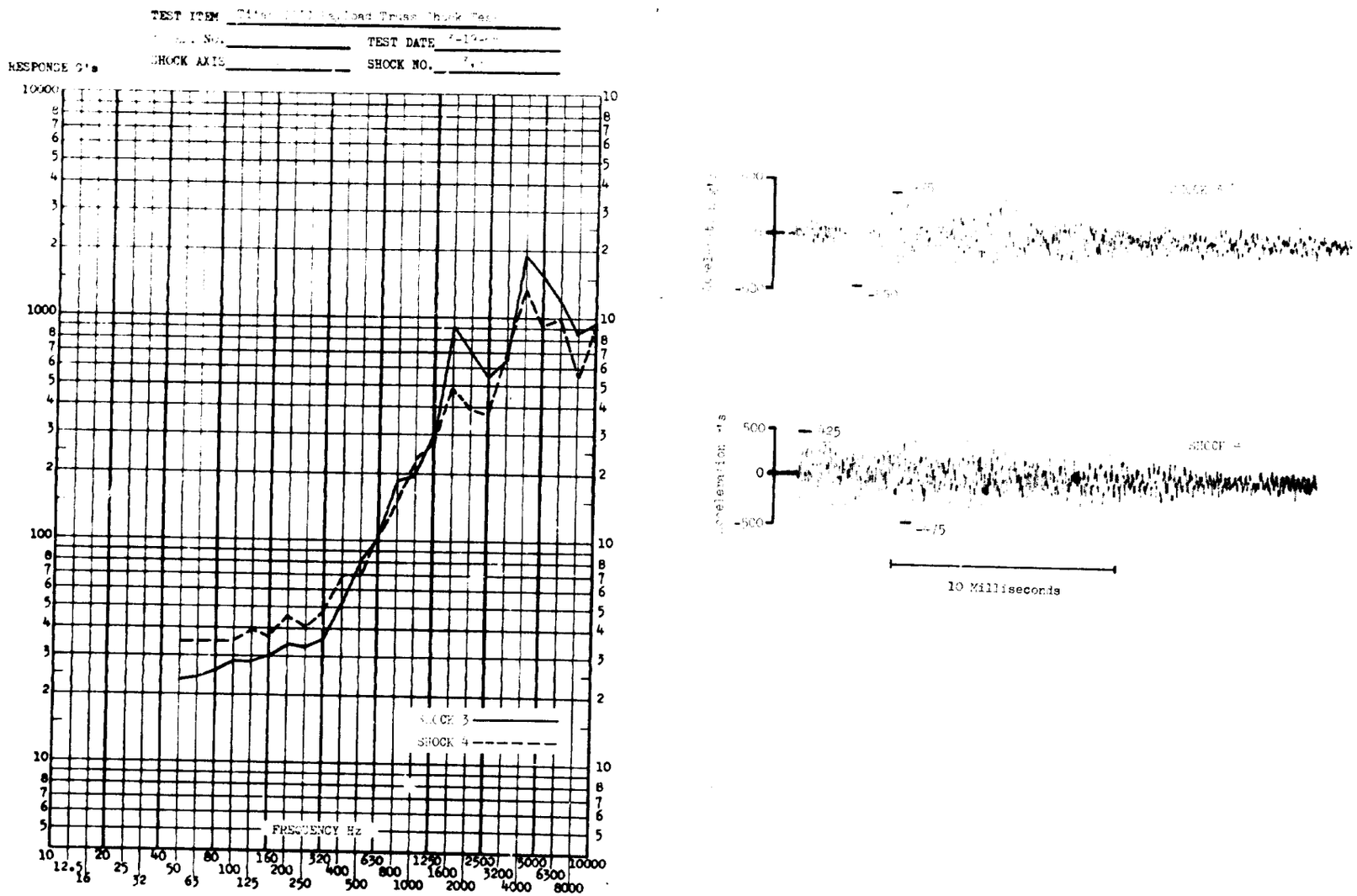






FIGURE 11.8.3-19

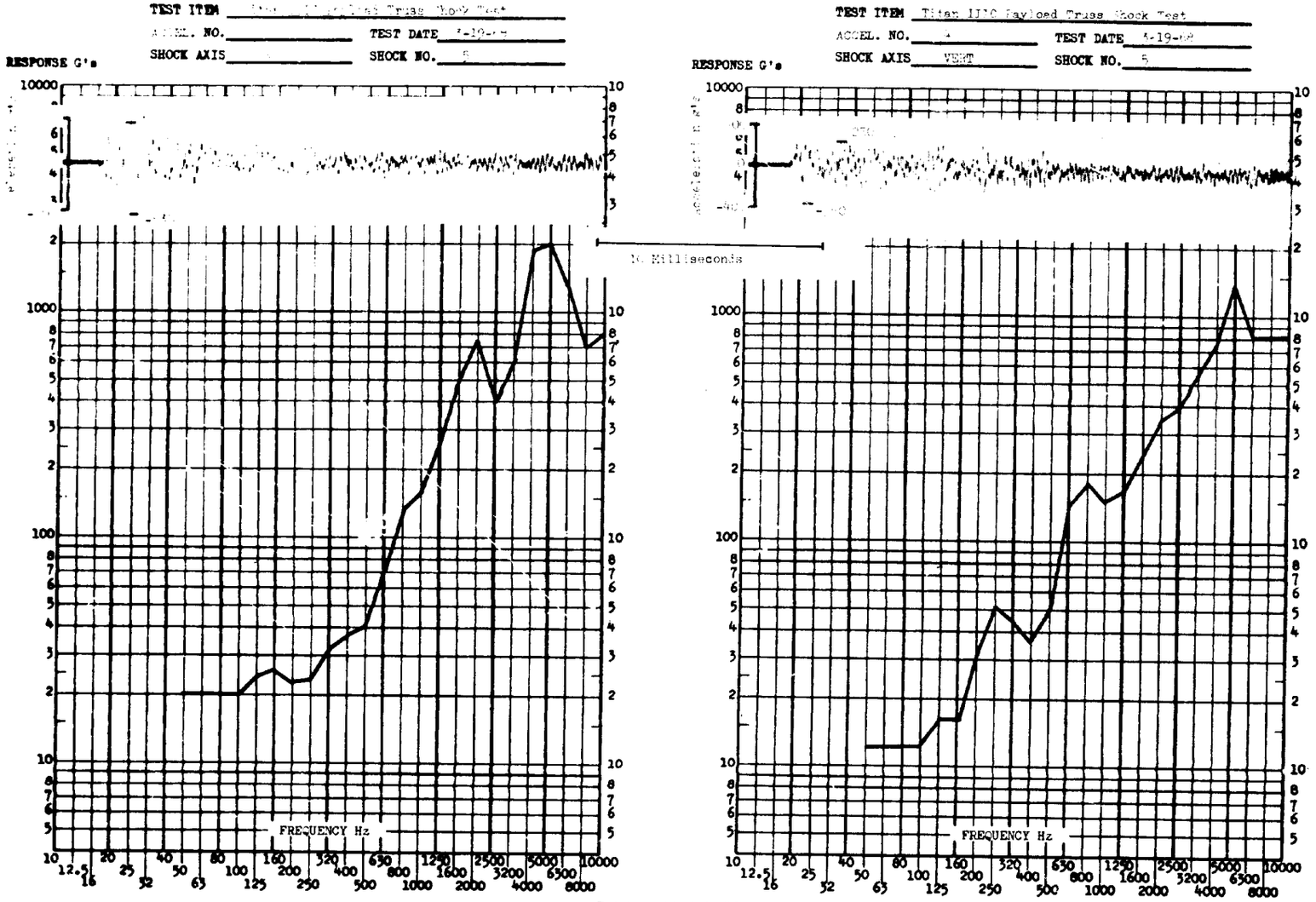
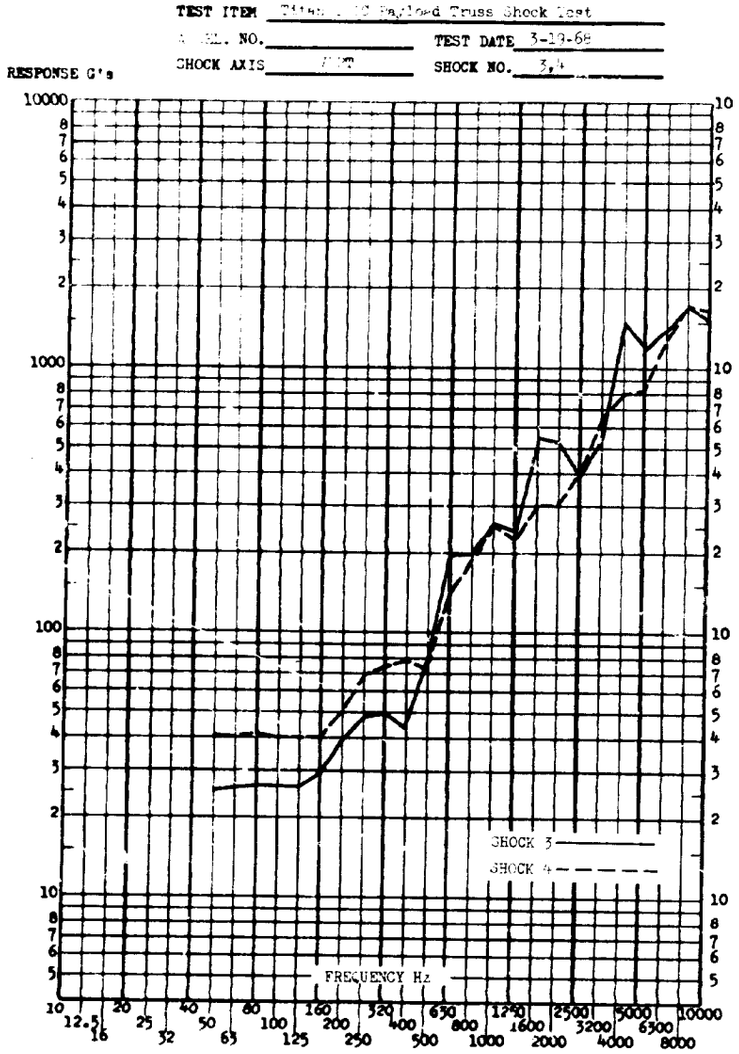



FIGURE II.B.3-20



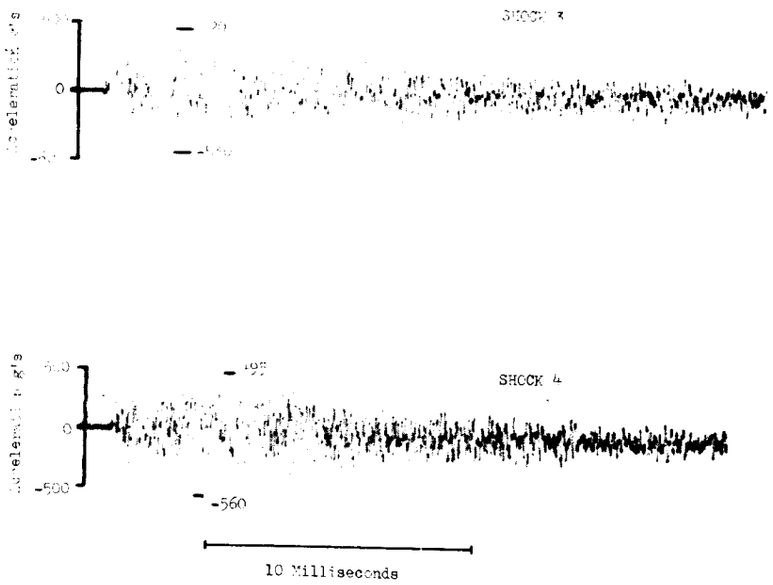




FIGURE II.B.3-21

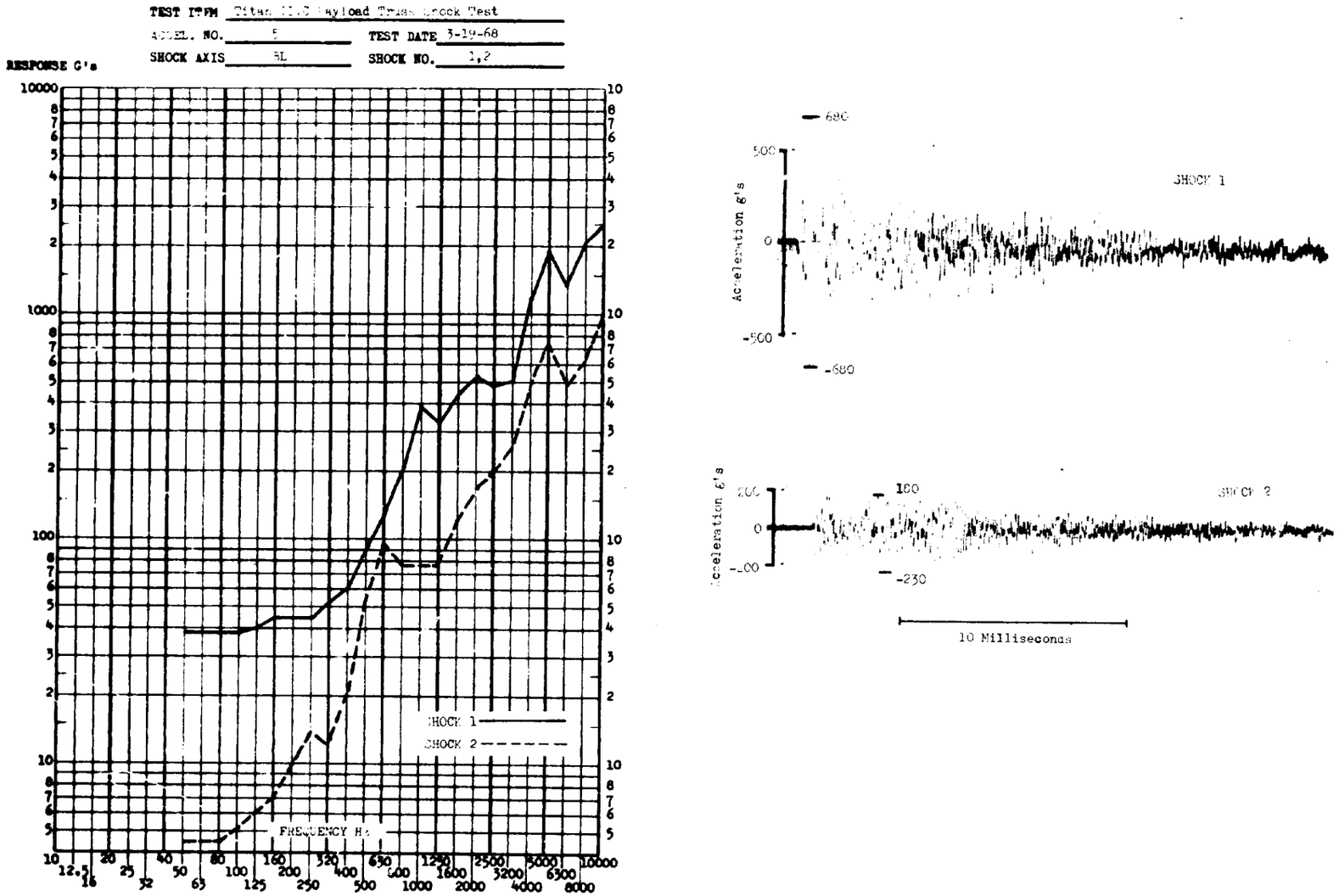



FIGURE II.B.3-22

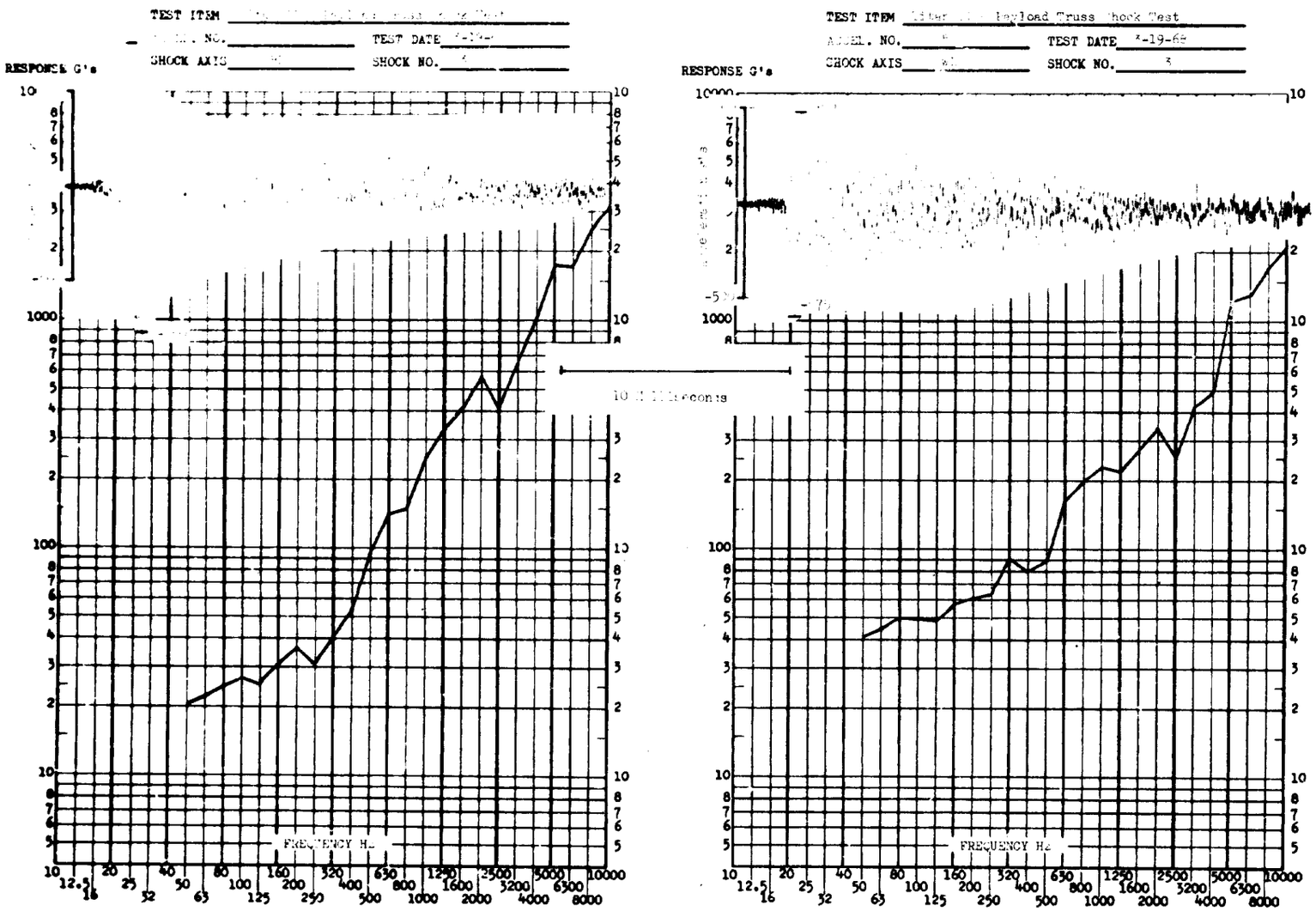
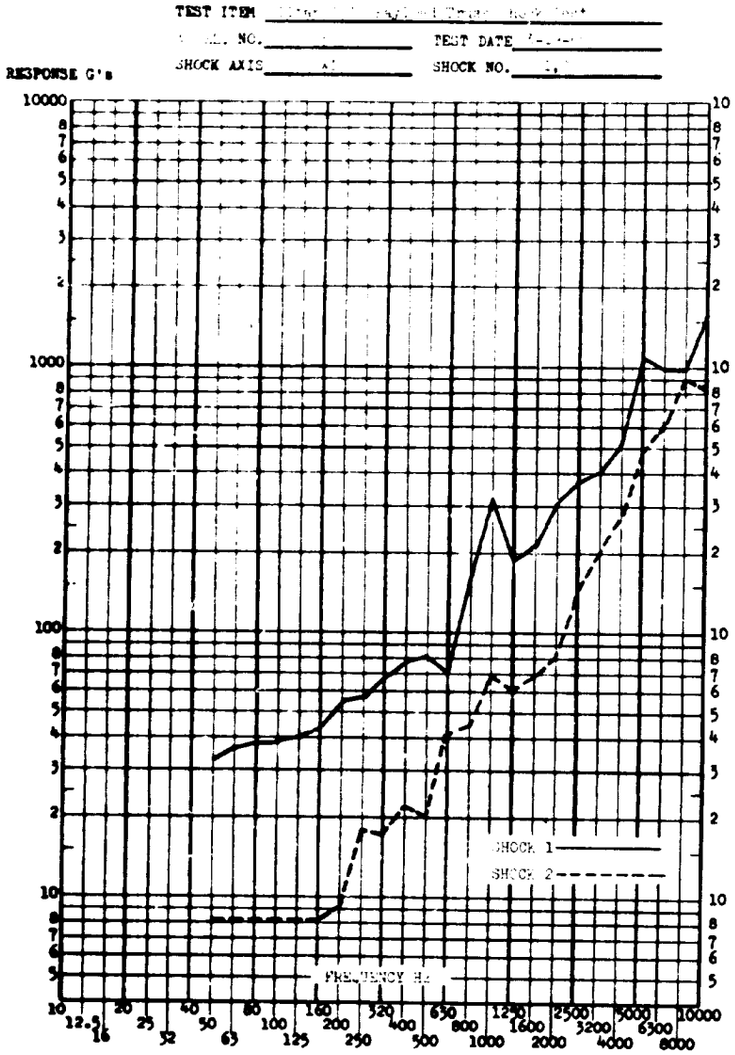



FIGURE 11.B.3-23



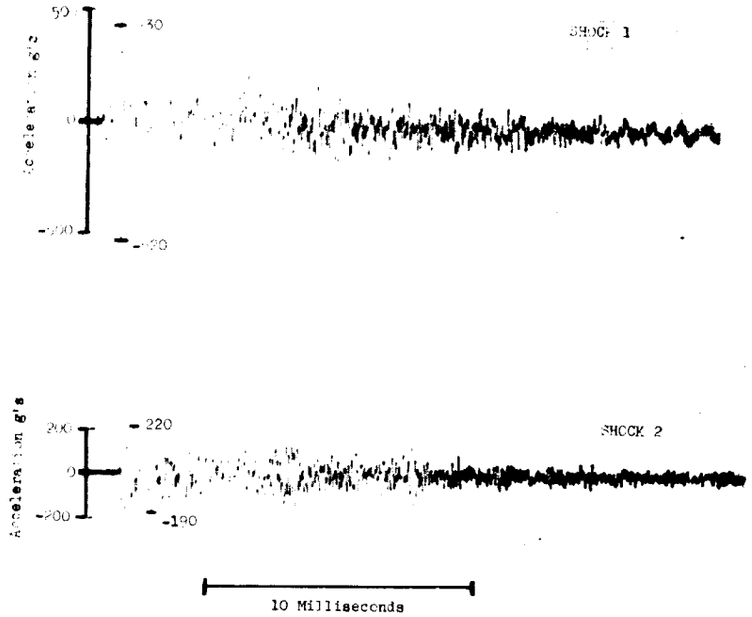




FIGURE 11.B.3-24

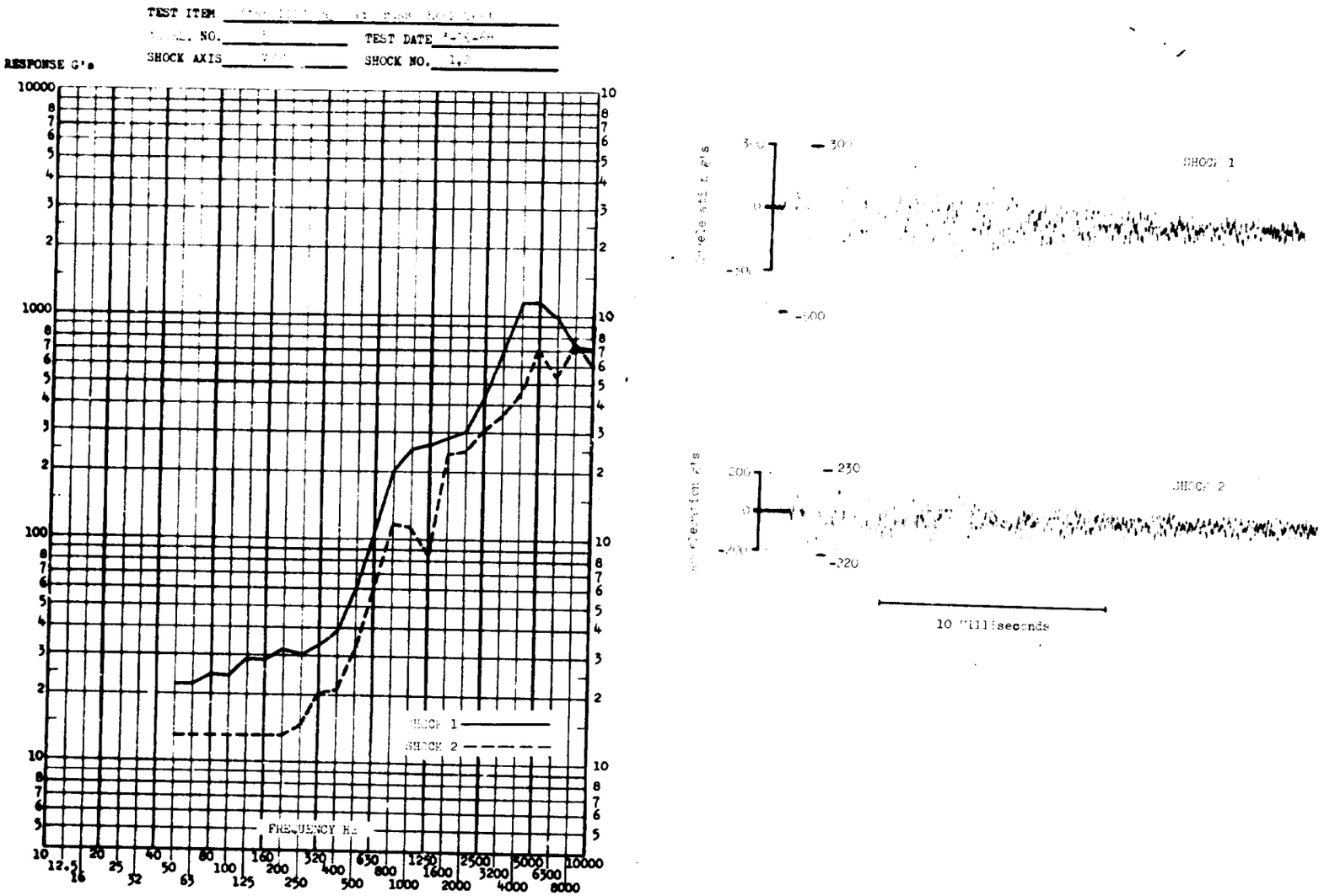
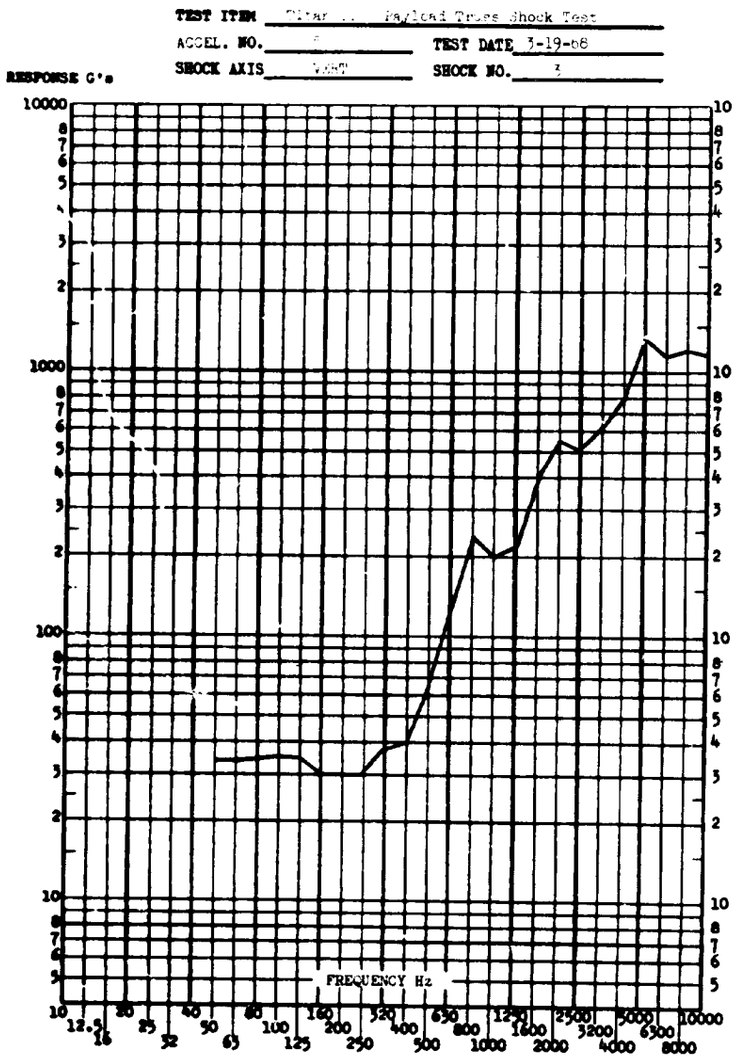



FIGURE 11.B.3-25



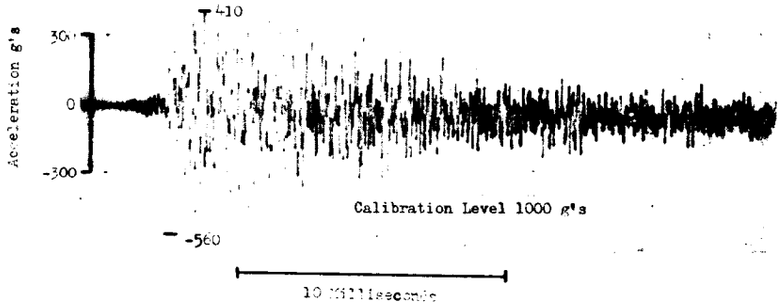




FIGURE II.B.3-26

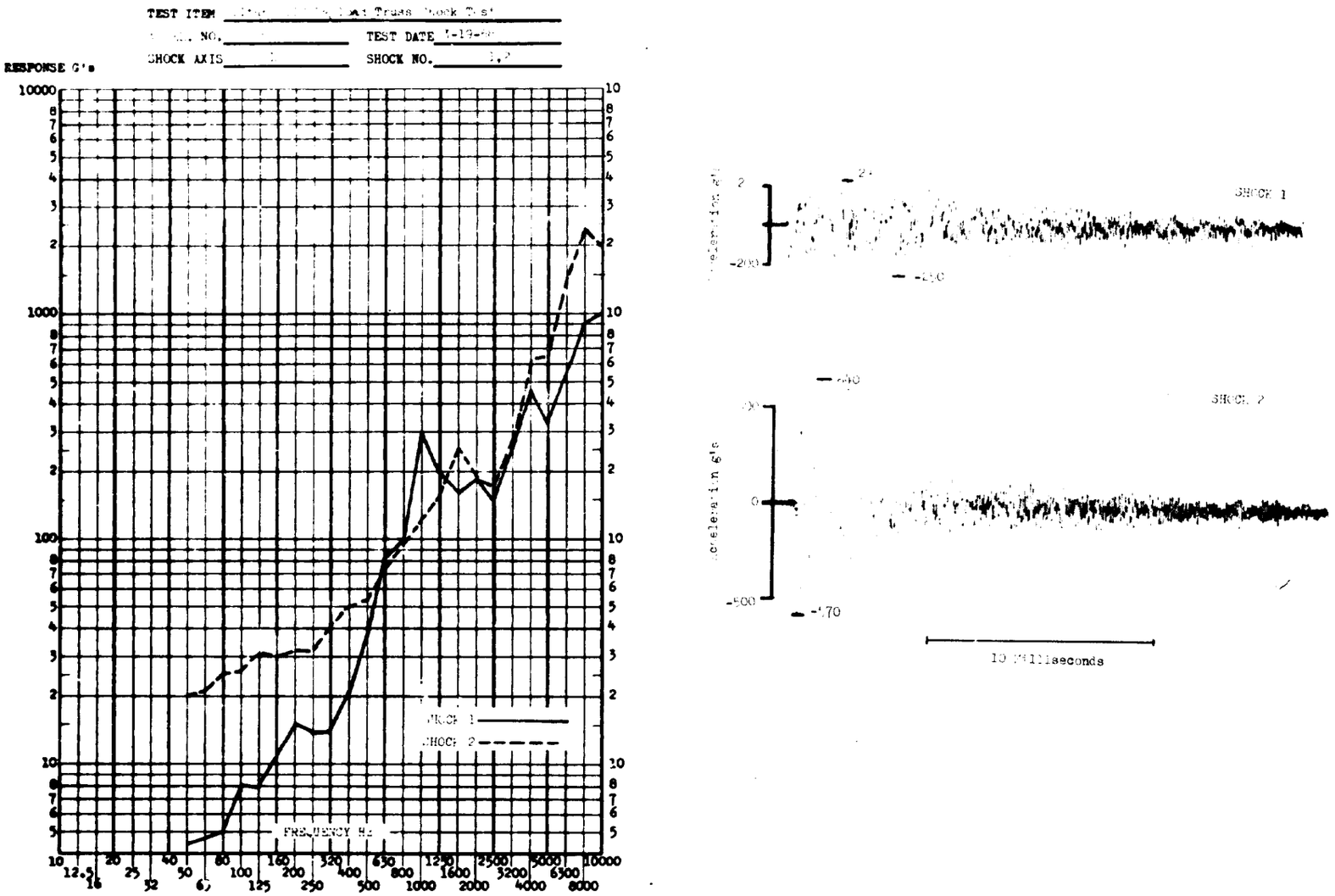



FIGURE 11.8.3-27

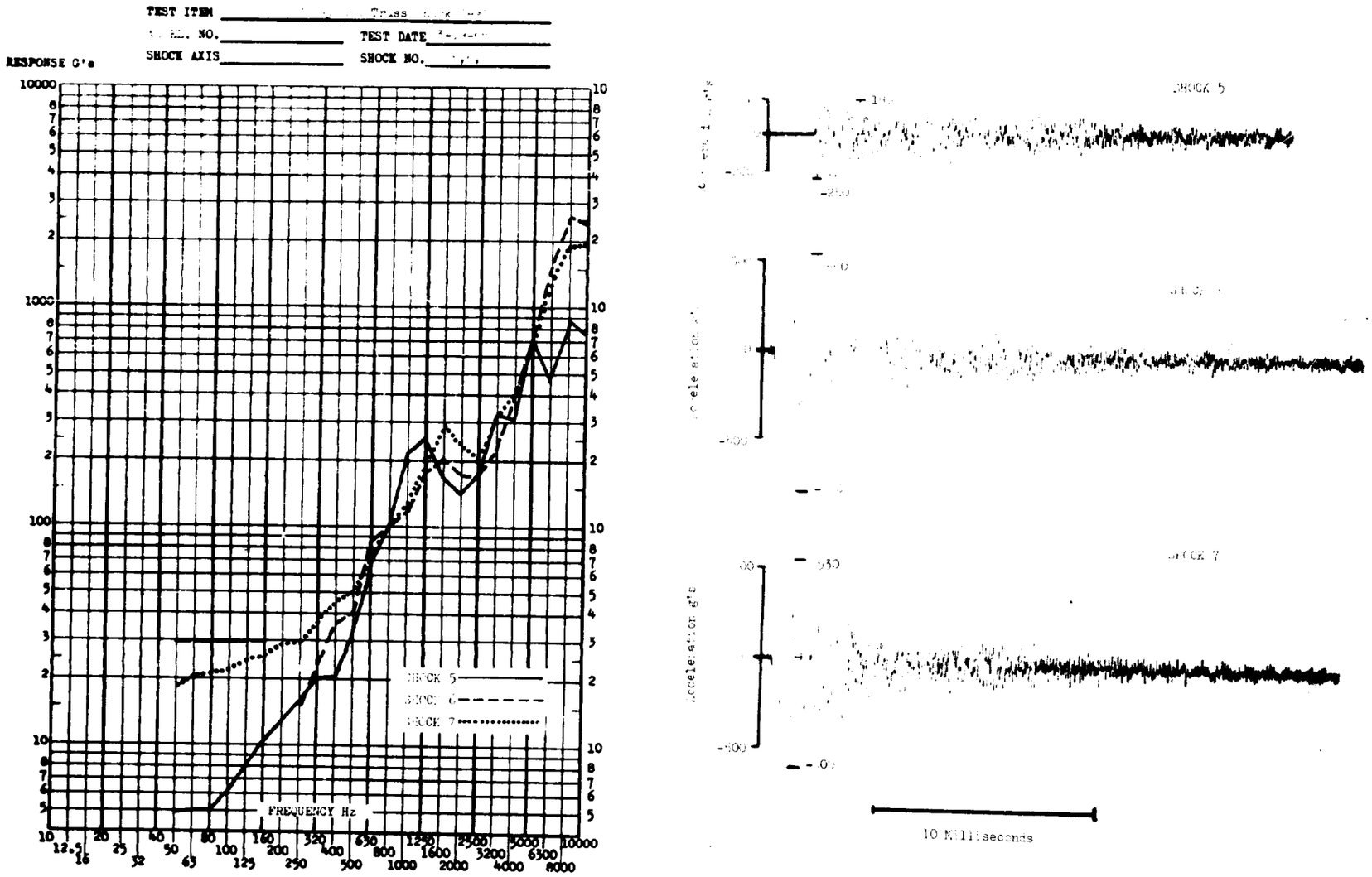



FIGURE II.B.3-28

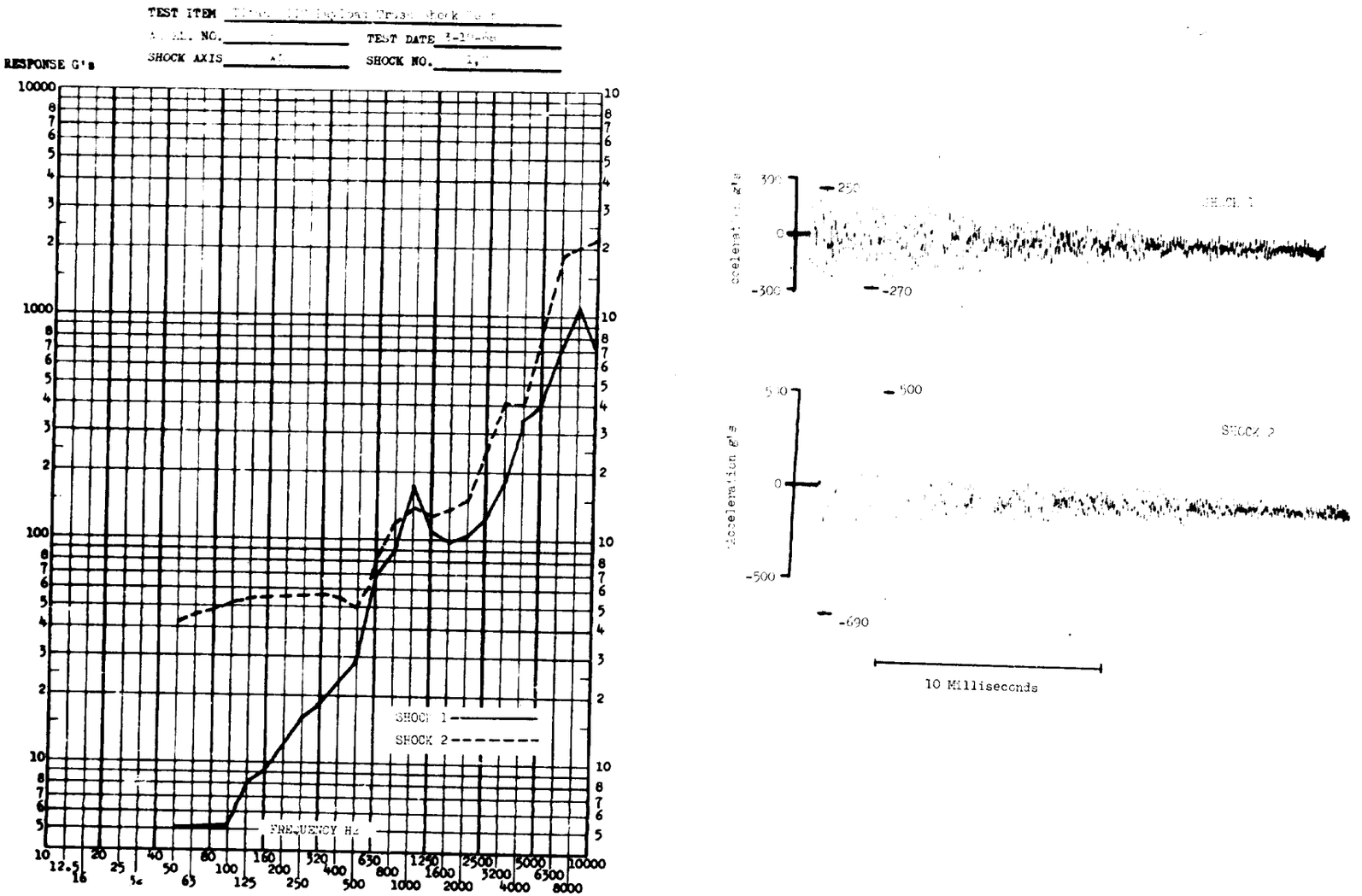






FIGURE 11.8.3-29

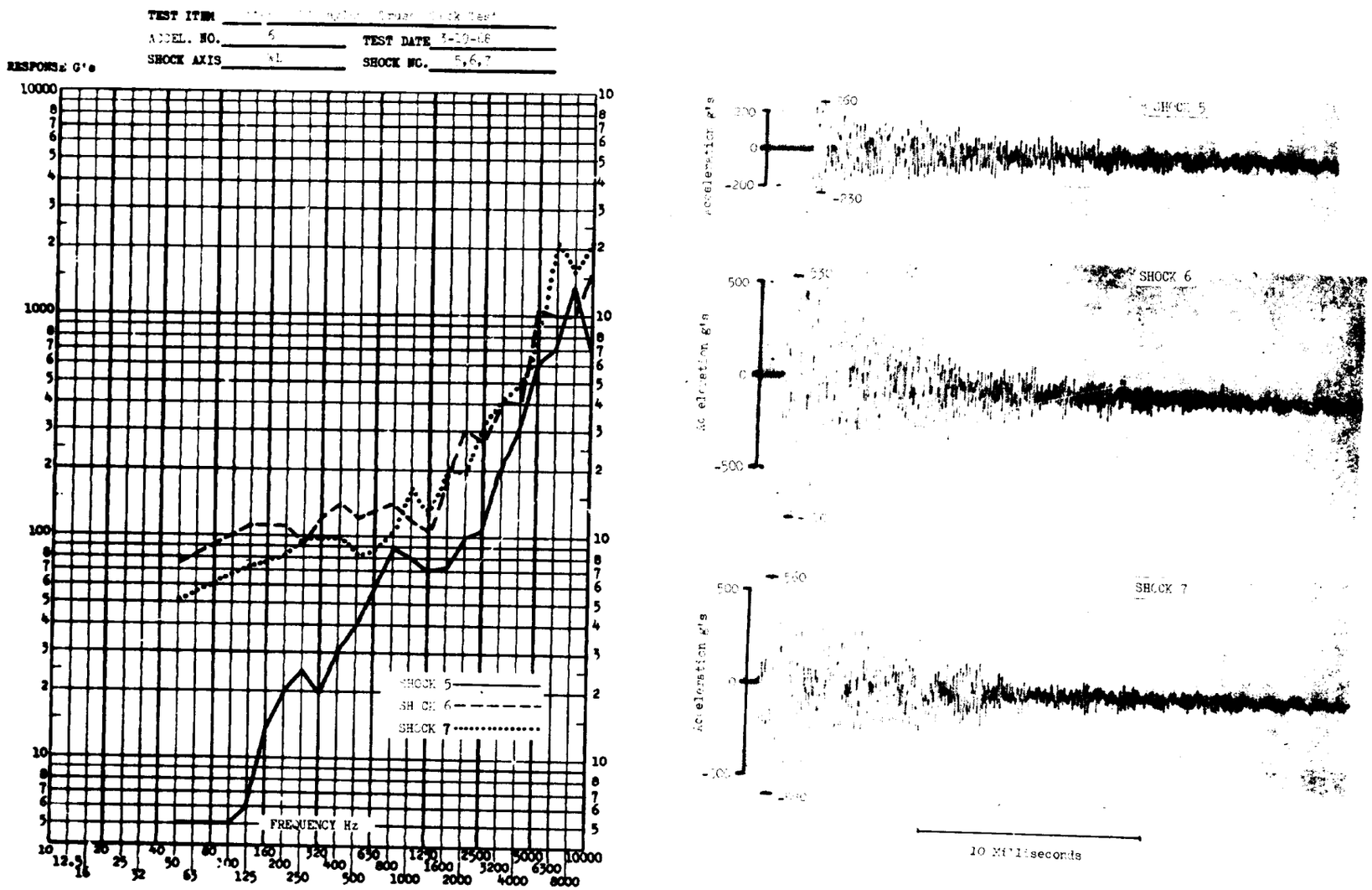



FIGURE II.B.3-30

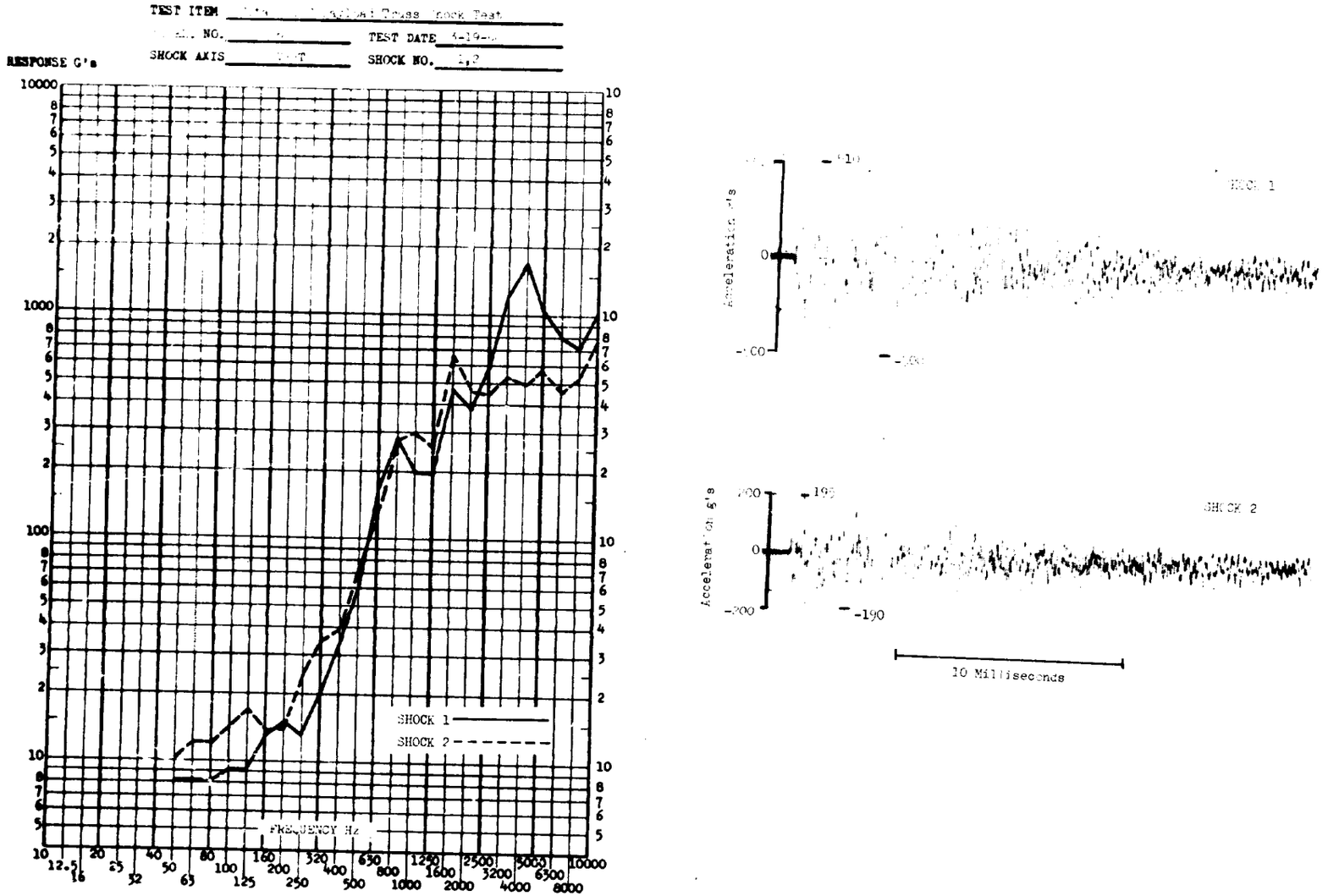



FIGURE II.B.3-31

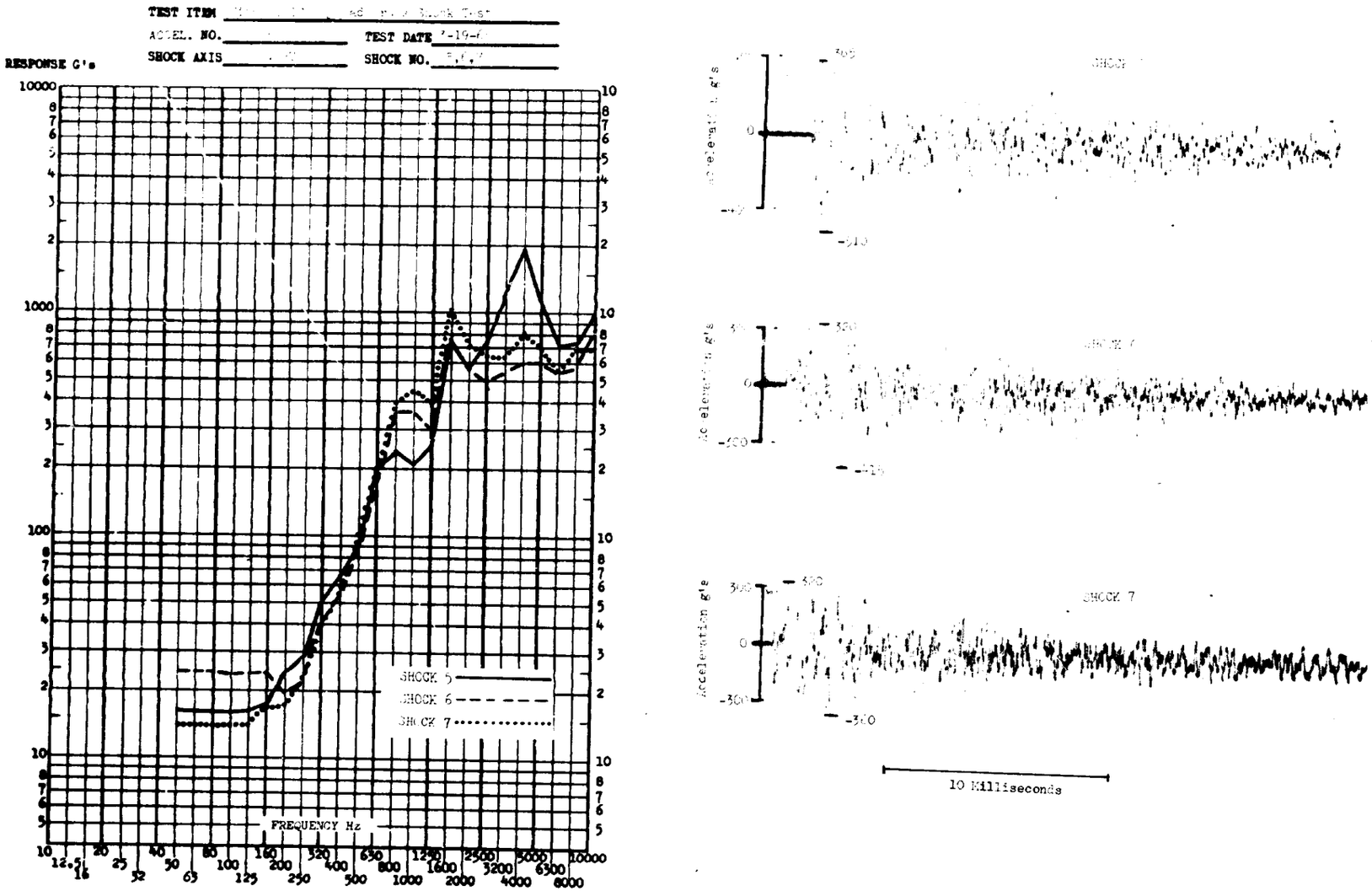



FIGURE 11.8.3-32

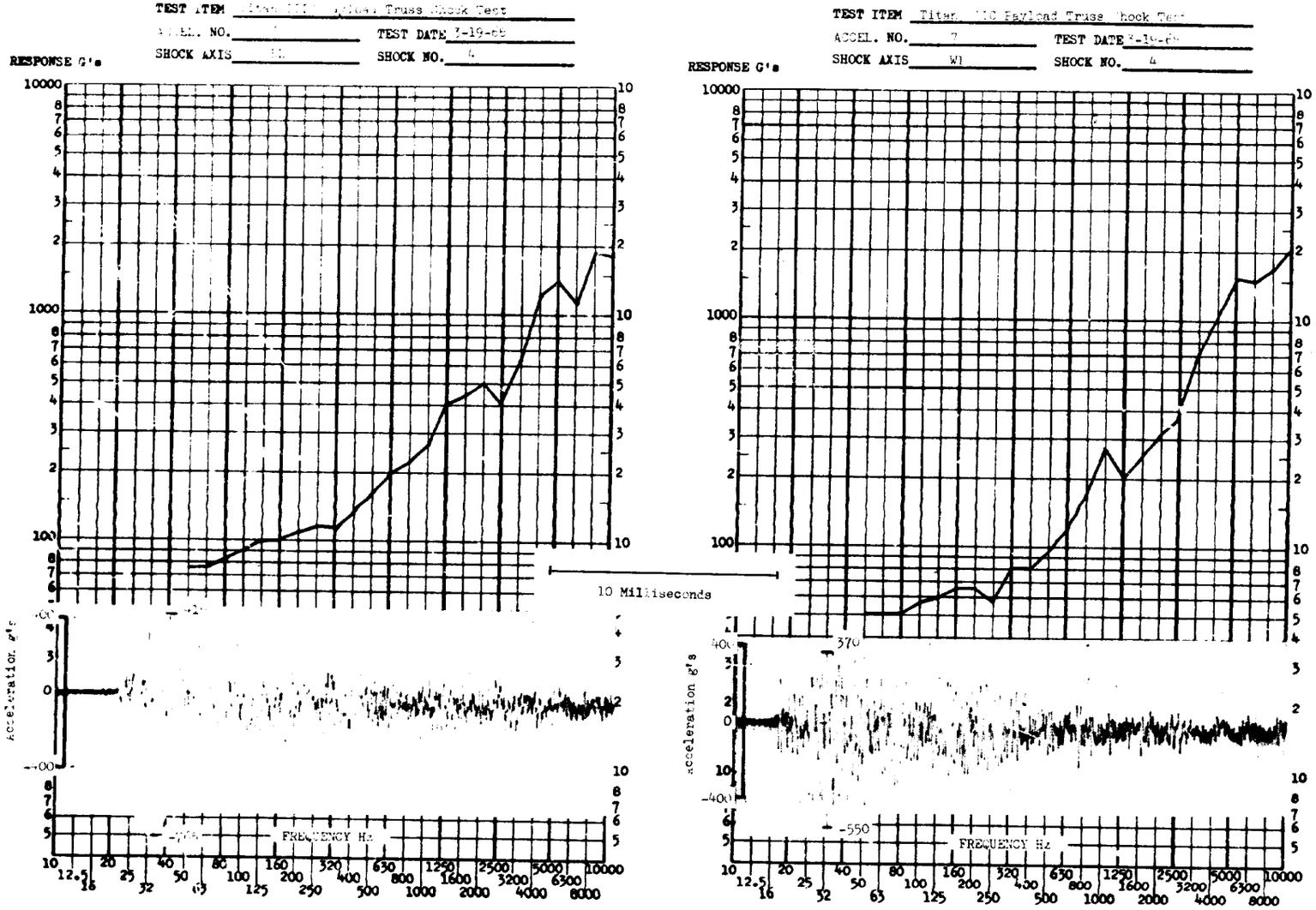






FIGURE II.B.3-33

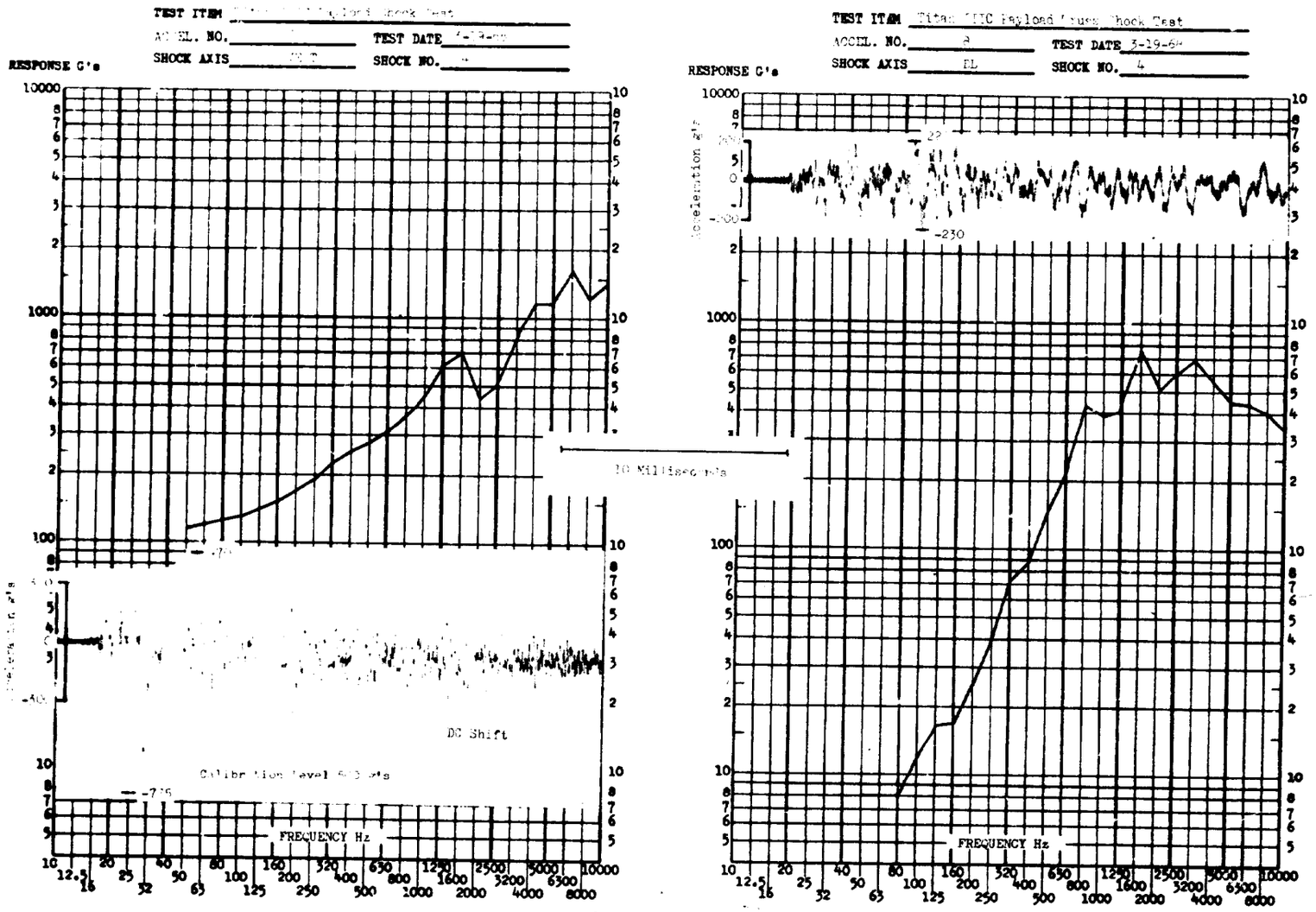



FIGURE II.B.3-34

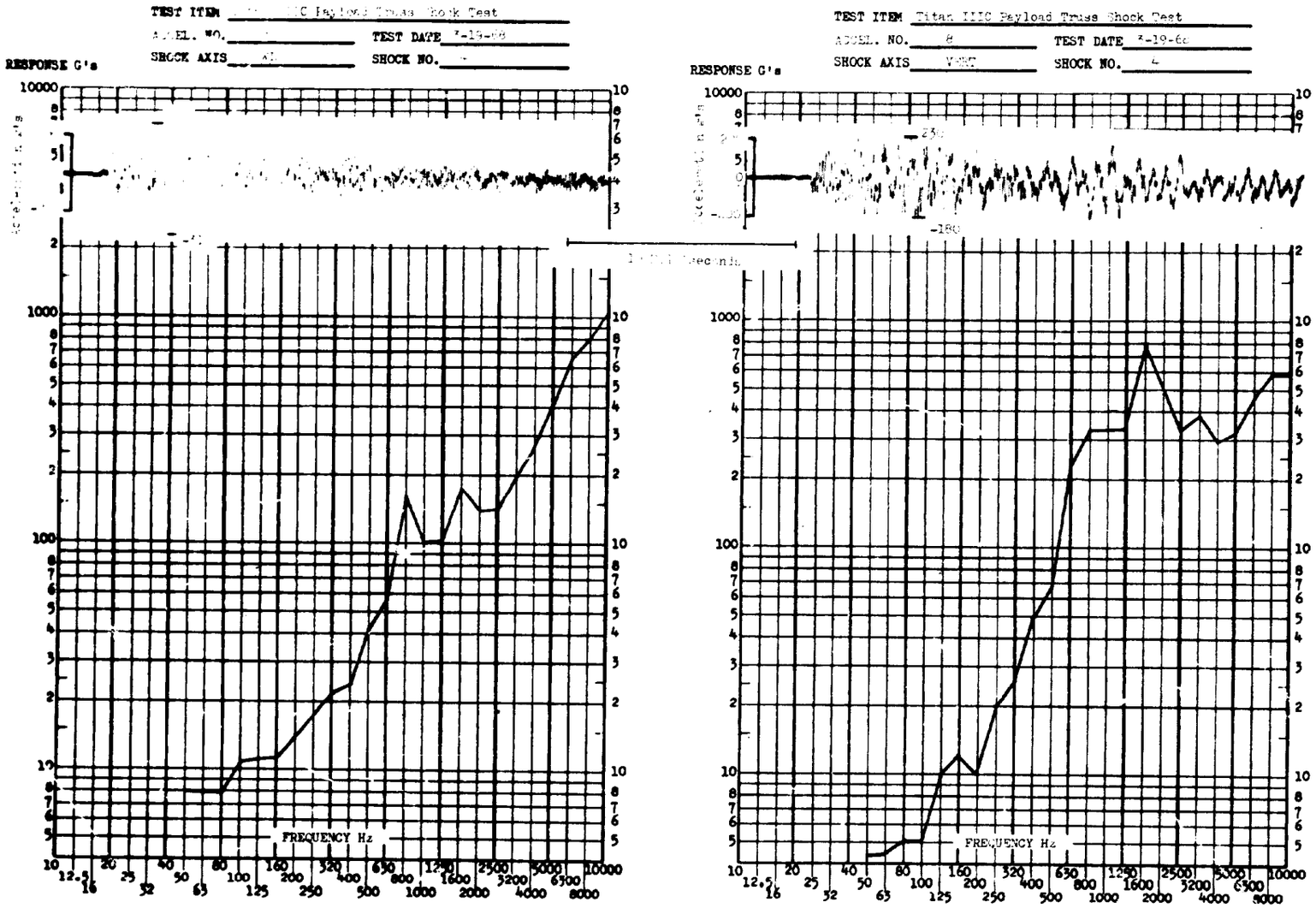



FIGURE II.B.3-35

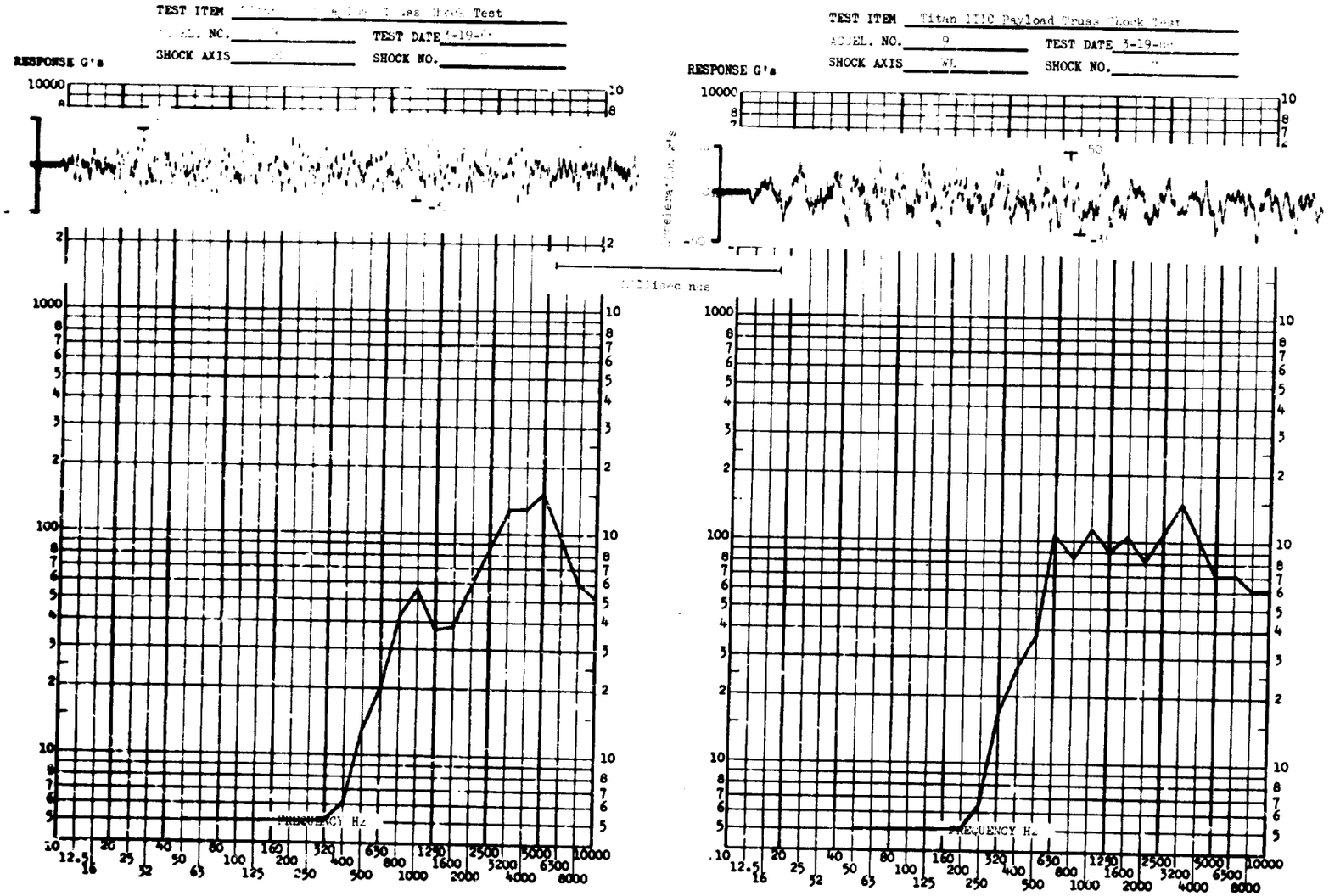



FIGURE 1:.B.3-36

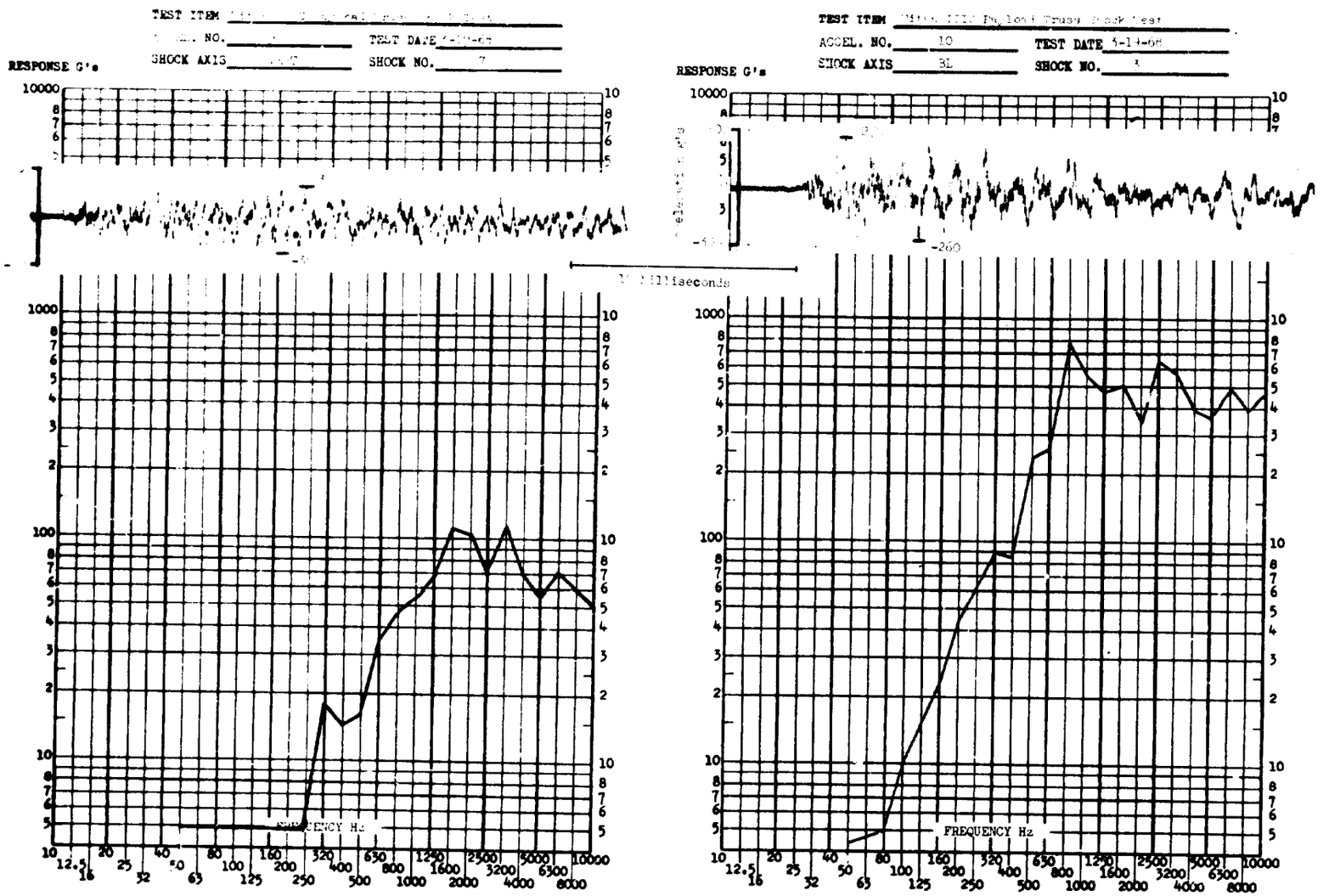



FIGURE 11.B.3-37

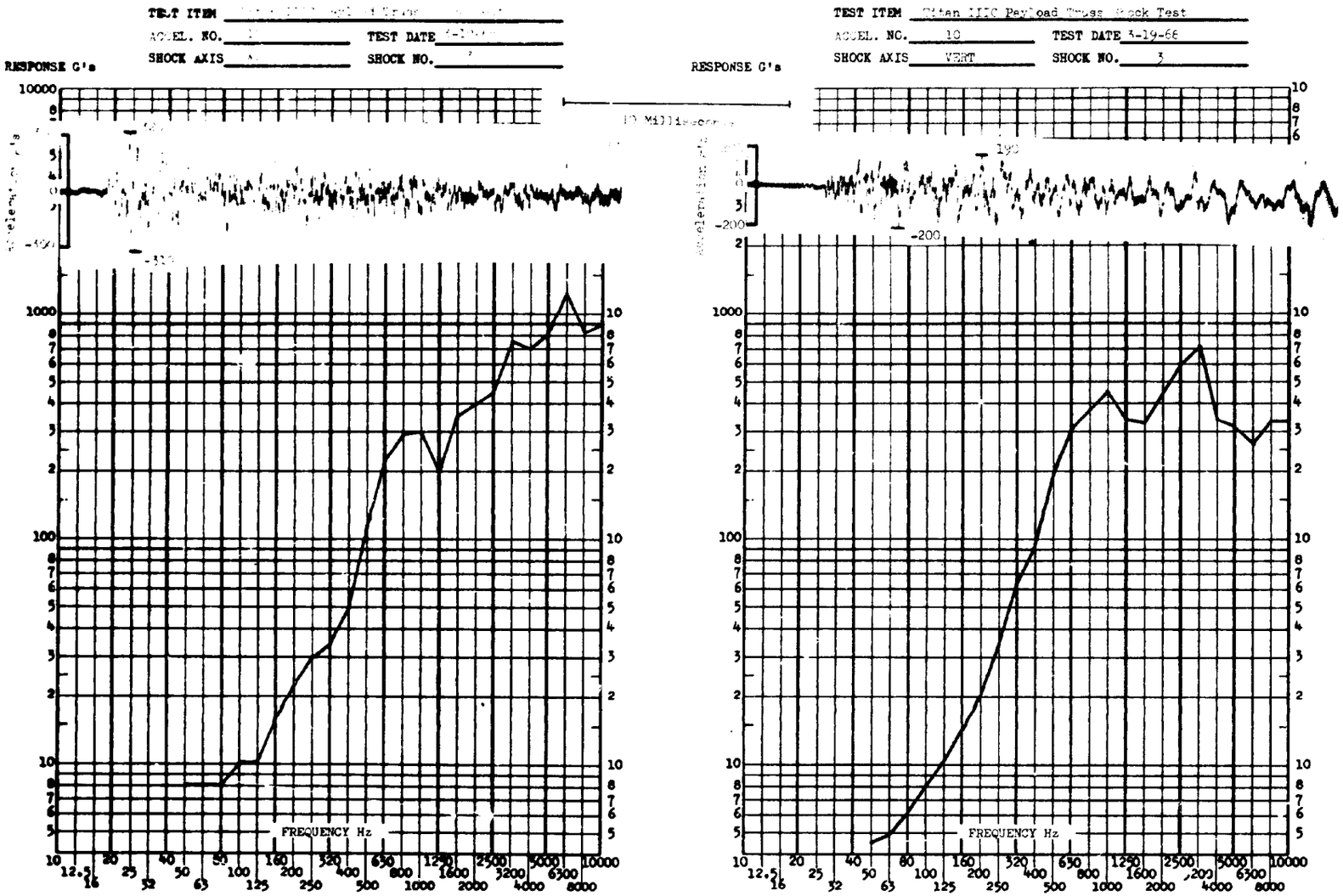



FIGURE 11.B.3-38

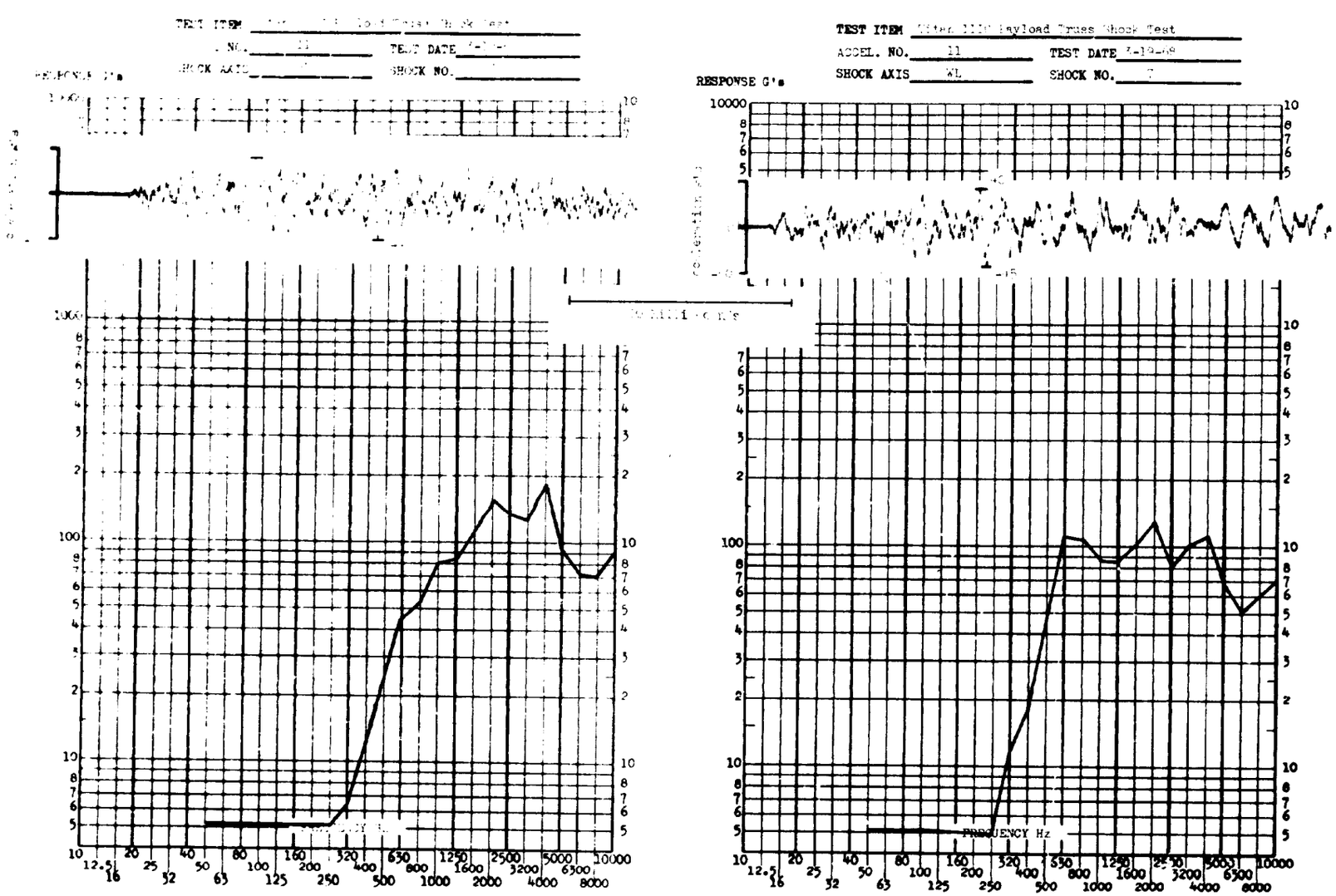



FIGURE 11.B.3-39

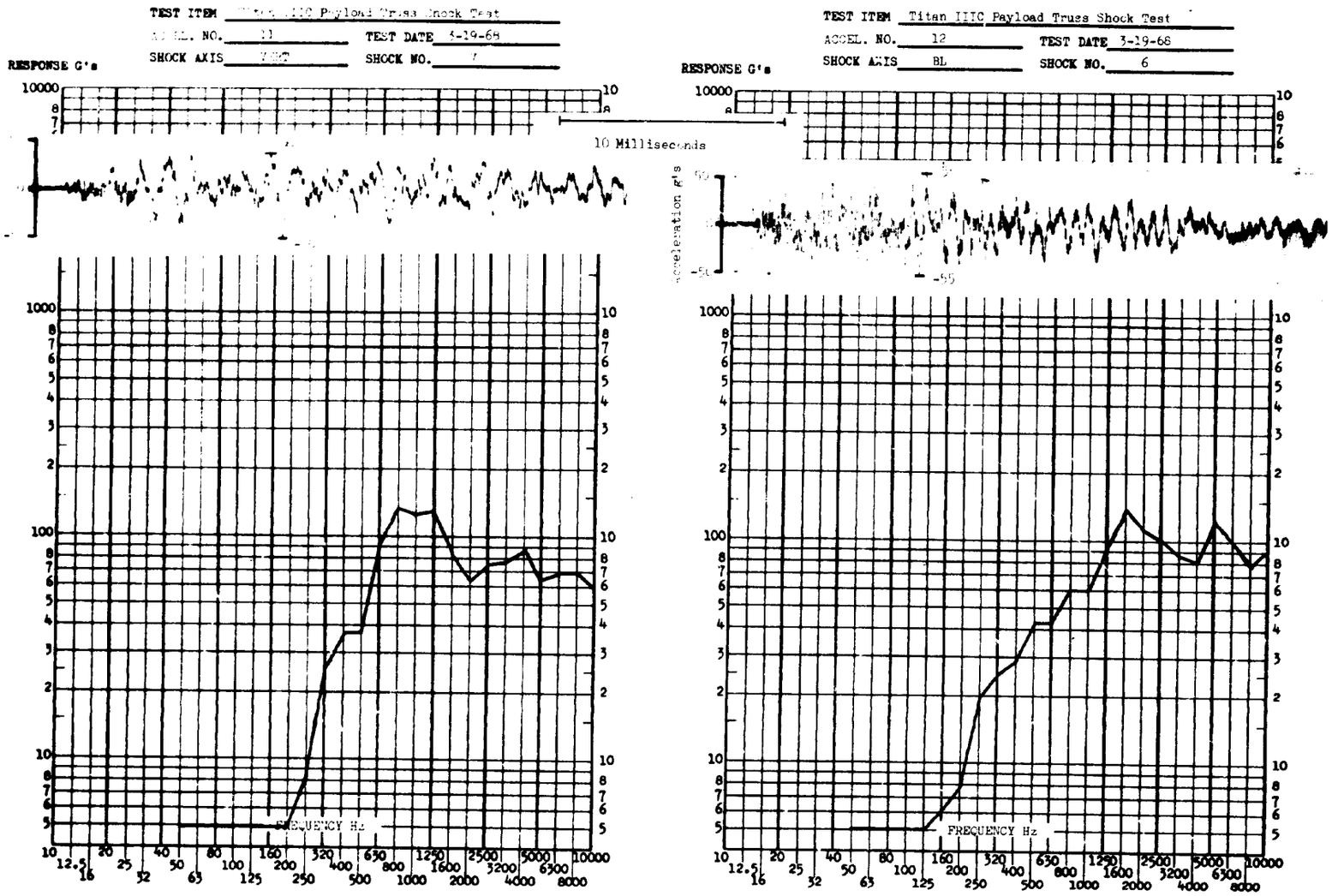



FIGURE 11.B.3-40

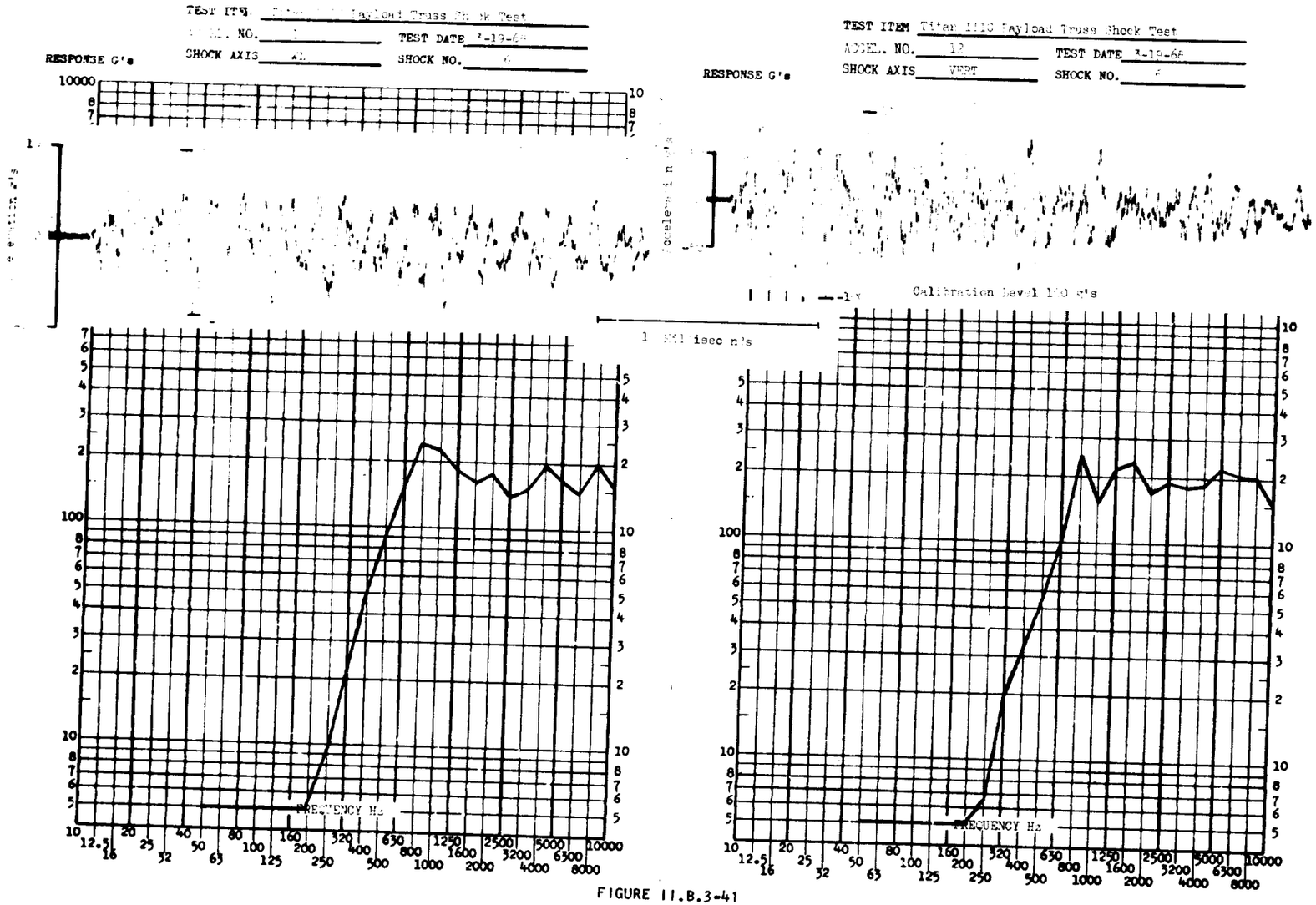


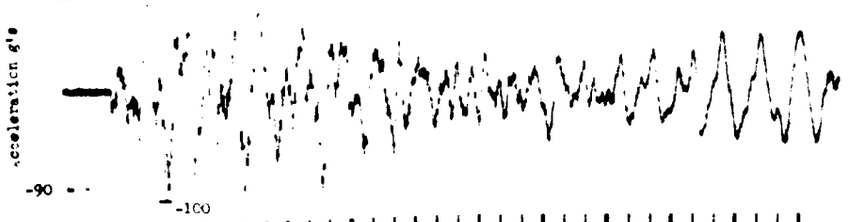

FIGURE II.B.3-41

TEST ITEM [illegible] Payload Truss Shock Test

ACCEL. NO. [illegible] TEST DATE [illegible]

SHOCK AXIS [illegible] SHOCK NO. [illegible]

RESPONSE G's

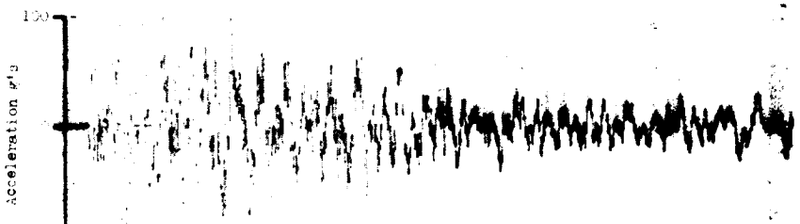



TEST ITEM Titan IIIC Payload Truss Shock Test

ACCEL. NO. 13 TEST DATE 3-19-68

SHOCK AXIS WL SHOCK NO. 6

RESPONSE G's



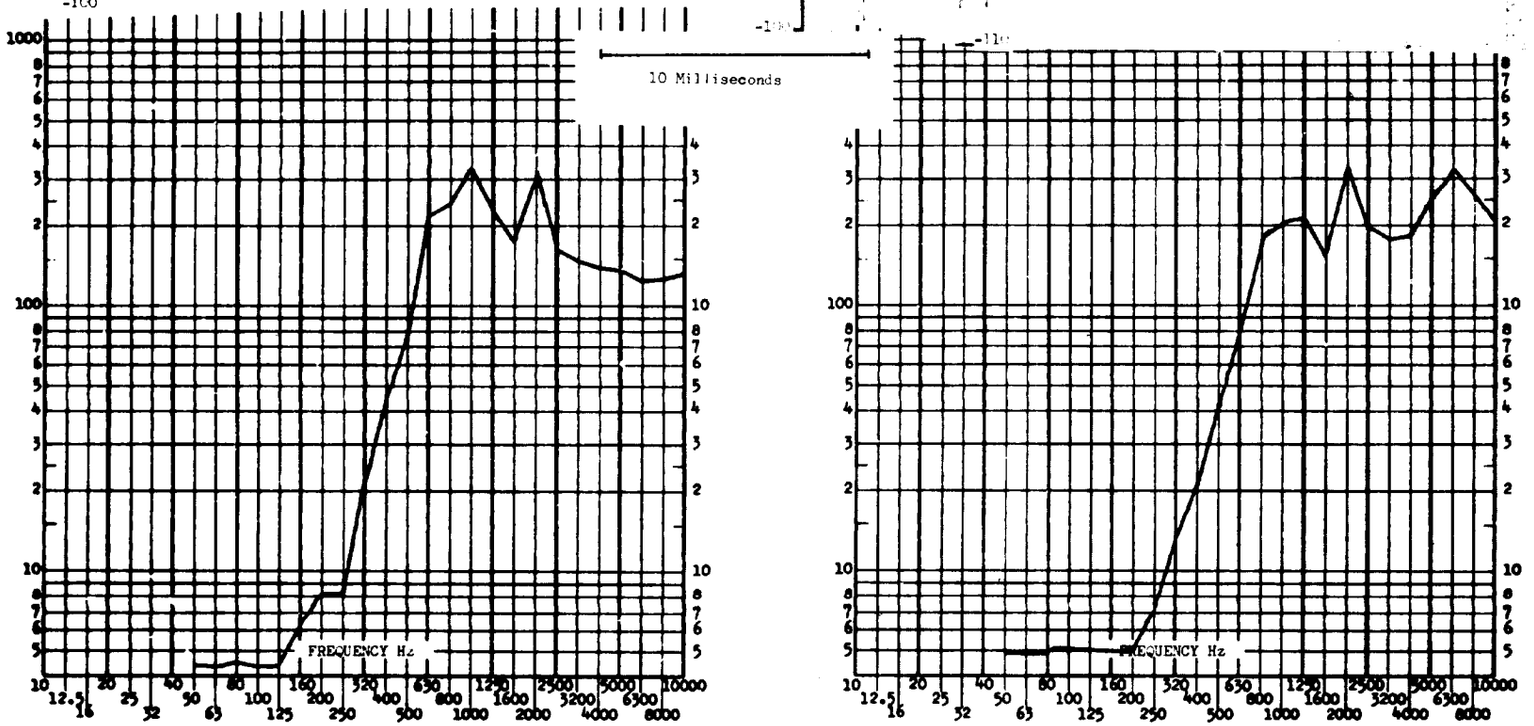




FIGURE II.B.3-42

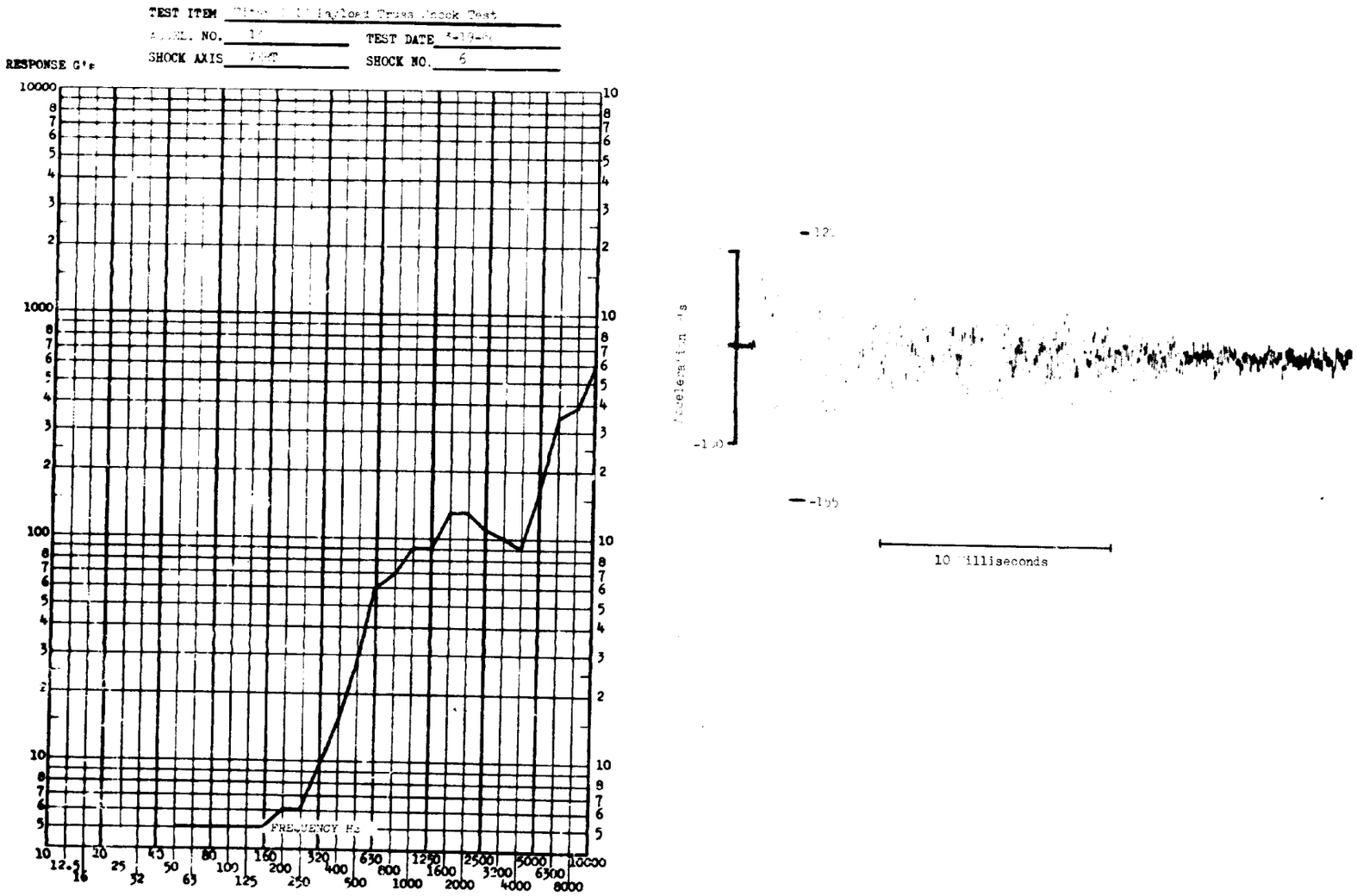






FIGURE II.B.3-43

# PART II.C

# PYROTECHNIC SHOCK DATA COMPILED FOR EXPLOSIVE NUTS AND BOLTS ON STRUCTURES OTHER THAN SKIN-RING-FRAME OR TRUSS

## LOCATION OF ADDITIONAL DATA

Additional pyrotechnic shock data compiled for explosive nuts and bolts with propagation in structures other than truss or skin-ring-frame may be found in the following sections of this volume:

| | |
|---|---|
| IV.A.1 | Entire section |
| IV.A.4 | Entire section |
| IV.B.1 | Entire section |
| IV.B.2 | Entire section |
| V.1 | Entire section |
| V.2 | Figure 6 |

## LOCATION OF RELATED LOCKHEED DATA

Additional pyrotechnic shock data for explosive nuts with propagation in truss structures may be found in the following section of the Lockheed data compilation:

II.A.4

# DIVISION III

# CARTRIDGE ACTUATED DEVICES

## FOREWORD TO DIVISION III

Division III contains pyrotechnic shock data associated with cartridge actuated devices (other than cartridge actuated separation nuts) on truss and spacecraft structures. Part A contains references to shock data from skin-ring-frame structures presented in other sections of this report and in the Lockheed data volumes. Parts B and C contain 6 sections of data from various types of spacecraft shock tests which used cartridge actuated pin pullers and bolt cutters.

TABLE OF CONTENTS


Page No.

DIVISION III

CARTRIDGE ACTUATED DEVICES

PART III.A

Skin-Ring-Frame Structures

Location of Additional Data 335

Location of Related Lockheed Data 336

PART II.B

Truss Structures

| Section | Title | Pyrotechnic Device | Number Shock Spectra | |
|---|---|---|---|---|
| III.B.1 | Satellite Release Tests | Pin Puller | 32 | 338 |
| III.B.2 | Separation Shock Tests of TOS-M Spacecraft | Bolt Cutter | 68 | 360 |
| III.B.3 | OAO Separation Test | Bolt Cutter | 23 | 378 |

Location of Additional Data

PART II.C

Structures Other Than Skin-Ring-Frame or Truss

| | | | | |
|---|---|---|---|---|
| III.C.1 | IDCSP/A Development Model 2 Separation Test | Bolt Cutter | 6 | 411 |
| III.C.2 | ATS Separation Test | Bolt Cutter | 14 | 423 |
| III.C.3 | OGO-F Antenna Ejection | Bolt Cutter | 8 | 436 |

Location of Additional Data 450

Location of Related Lockheed Data 451

# PART III.A

# PYROTECHNIC SHOCK DATA COMPILED FOR CARTRIDGE ACTUATED DEVICES IN SKIN-RING-FRAME STRUCTURES

## LOCATION OF ADDITIONAL DATA

Additional pyrotechnic shock data compiled for cartridge actuated devices for propagation in skin-ring-frame structure may be found in the following sections of Volume II:

I.A.5 Figure 7 through 58

I.B.3 Figures 10, 11 and 22 through 33.

## LOCATION OF RELATED LOCKHEED DATA

Additional pyrotechnic shock data for cartridge actuated devices propagation in skin-ring-frame structures may be found in the following sections of the Lockheed data compilation:

II.B.1

II.B.2

# PART III.B

# PYROTECHNIC SHOCK DATA COMPILED FOR CARTRIDGE ACTUATED DEVICES IN TRUSS STRUCTURES

SECTION III.B.1

OV5-2 SATELLITE EJECTION TESTS

PURPOSE OF TESTS

The objective of these tests was to obtain the shock levels associated with the OV5-2 satellite ejection.

DESCRIPTION OF EVENT

The OV5-2 satellite depicted in Figures III.B.1-1 and III.B.1-2 was ejected by a pin puller, located as shown in Figures III.B.1-6 and III.B.1-7, pulls a pin which releases a pre-loaded compression spring. Following release, the OV5-2 satellite would be ejected free of the payload truss into orbit. However, during the three tests performed the release mechanism only pushed the satellite 4 to 6 inches its motion was arrested by friction with the mounting canister.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of time histories | 30 |
| No. of shock spectra | 30 |
| Type of analysis | analog |
| Analog system | Ling SSA-100 |
| Frequency range | to 10,000 Hz |
| Frequency increment | 3 points per octave |
| Damping | Q = 10 |

These shock spectra are presented along with their corresponding time histories as Figures II.B.1-8 through III.B.1-19.

DESCRIPTION OF PYROTECHNIC

The pressure cartridge actuated pin-puller system uses two PD60S0129-505 pressure cartridges (manufactured by McCormick-Selph Associates). The charges contained in each pressure cartridge are as follows:

Prime charge: 90 mg pressed zirconium

Base charge: 346 mg boron and potassium nitrate

Booster charge: 86 mg boron and potassium nitrate

Sustainer charge: 193 mg ammonium nitrate and rubber

Although both pressure cartridges fired during testing, only one cartridge is required, while the presence of the second cartridge is to insure satellite release in the event of a misfire.

DESCRIPTION OF STRUCTURE

Aluminum truss structure and satellite mounting bracket. See Figures III.B.1-3 through III.B.1-7.

DESCRIPTION OR DATA ACQUISITION SYSTEM

Tape recorder: Ampex ES-100 (0-20,000 Hz frequency response)

Amplifiers: Kistler 504A (0-100,000 Hz frequency response)

TABLE III.B.1-1

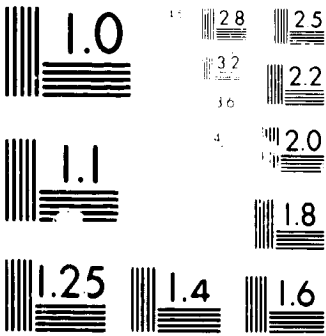
DESCRIPTION OF OV5-2 SHOCK MEASUREMENTS

| Accelerometer Number | Location | Shot No. | Sensitive Axis | Distance from source (Inches) | Figure No. |
|---|---|---|---|---|---|
| 1 | Canister base opposite pin puller | 1 | 45° off BL (pin puller axis) | 5 | III.B.1-8 |
| 2 | OV5-2 side of truss ring ( rt. side) | 2,3 | BL | 13 | III.B.1-9 |
| 3 | OV5-2 side of truss ring (rt. side) | 1,2,3 | WL | 13 | III.B.1-10 |
| 4 | OV5-2 side of truss ring (FWD side) | 1,2,3 | BL | 15 | III.B.1-11 |
| 5 | OV5-2 side of truss ring (FWD side) | 1,2,3 | FWD | 15 | III.B.1-12 |
| 6 | LES-6 side, cylinder flange (right side) | 1,2,3 | BL | 8.5 | III.B.1-13 |
| 7 | LES-6 side, cylinder flange (right side) | 1,2,3 | WL | 8.5 | III.B.1-14 |
| 8 | LES-6 side, cylinder flange (FWD side ) | 2,3 | BL | 11 | III.B.1-15 |
| 9 | LES-6 side, cylinder flange (FWD side) | 1,2,3 | FWD | 11 | III.B.1-16 |
| 10 | LES-6 side, cylinder flange (left side) | 2,3 | BL | 8.5 | III.B.1-17 |
| 11 | LES-6 side, equipm't platform (right side) | 1,2,3 | BL | 38 | III.B.1-18 |
| 12 | LES-6 side equipm't platform (right side) | 1,2,3 | WL | 38 | III.B.1-19 |



Figure III.8.1-1. Payload Truss with OV5-2 and LES-6 Satellites Installed

OF
7902




MICROCOPY RESOLUTION TEST CHART

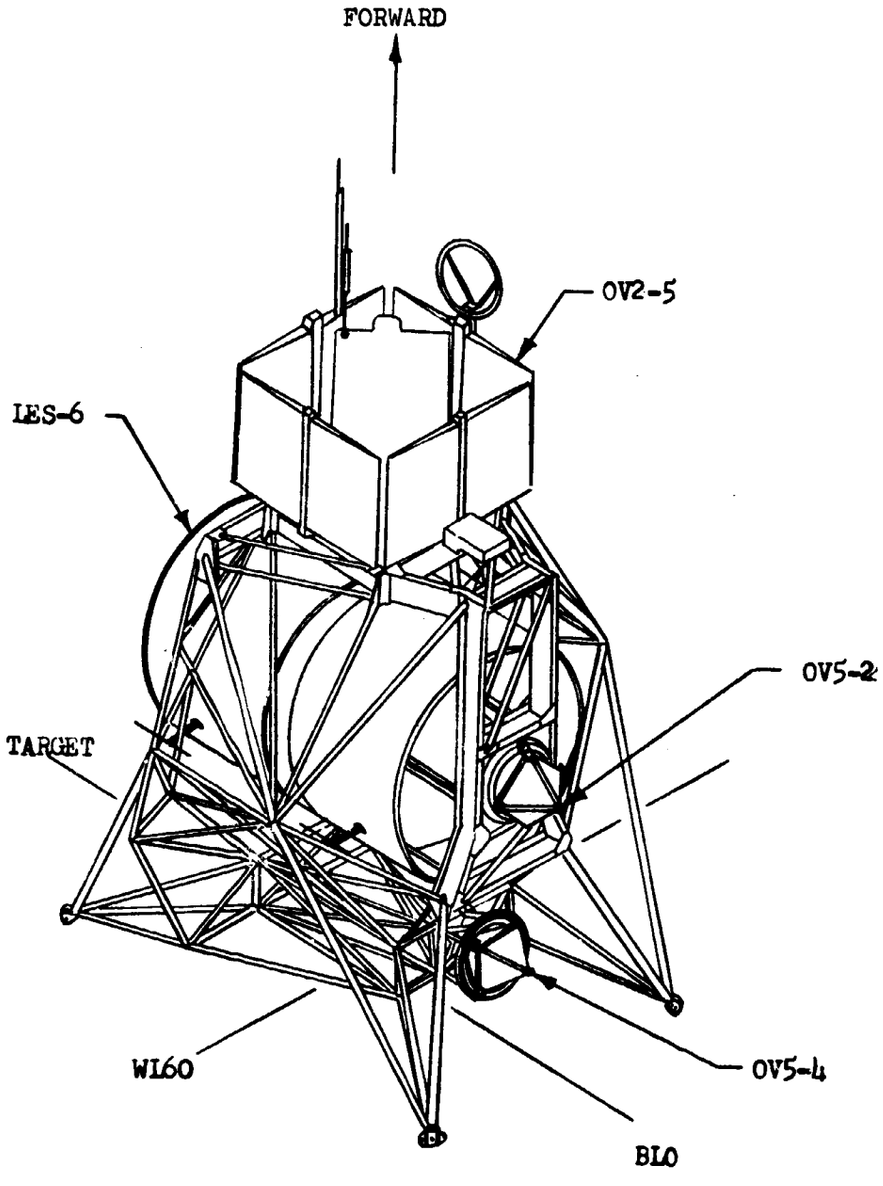



**Figure III.B.1-2. Payload Truss - Showing Satellite Locations**



V11

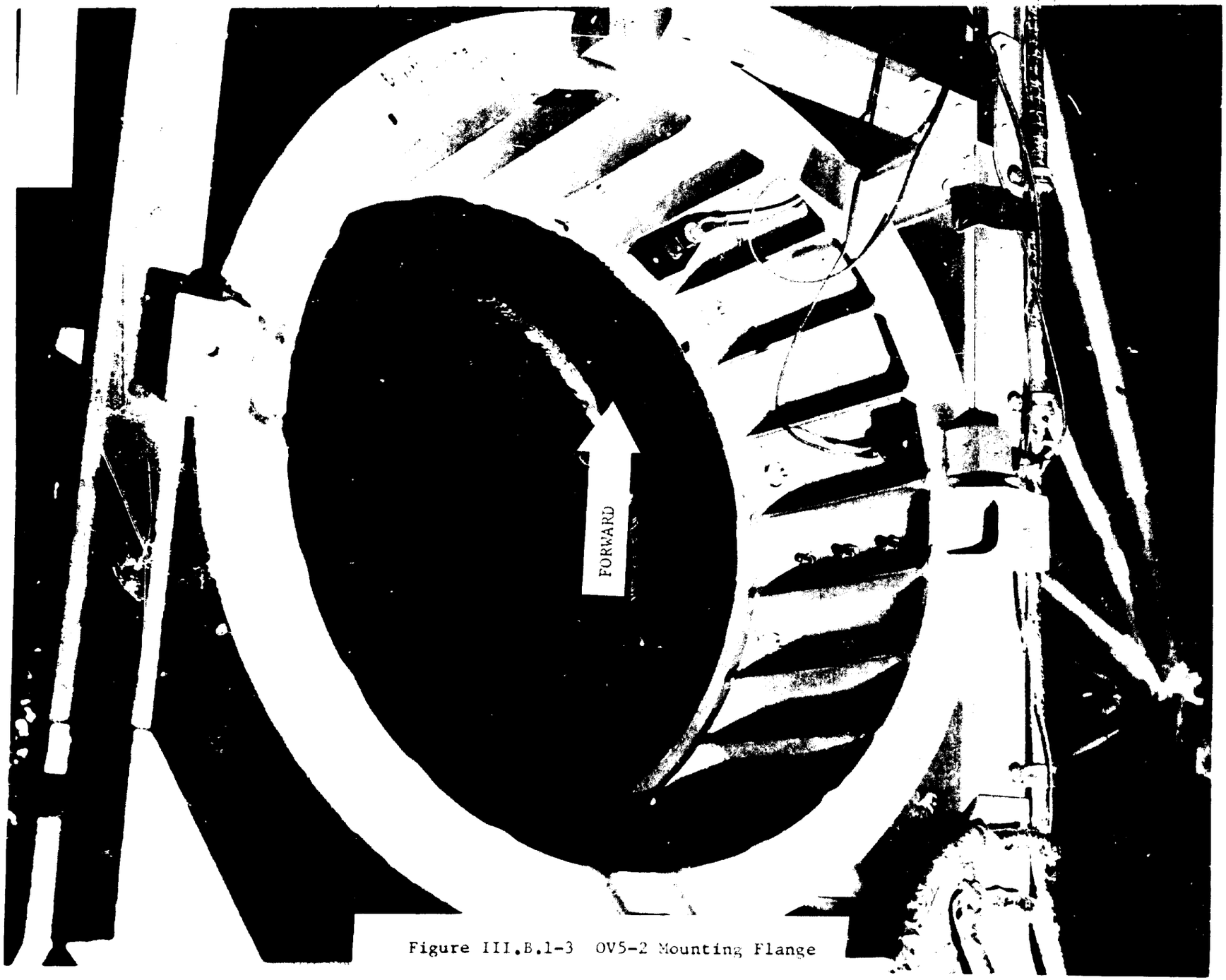



Figure III.B.1-3 OV5-2 Mounting Flange

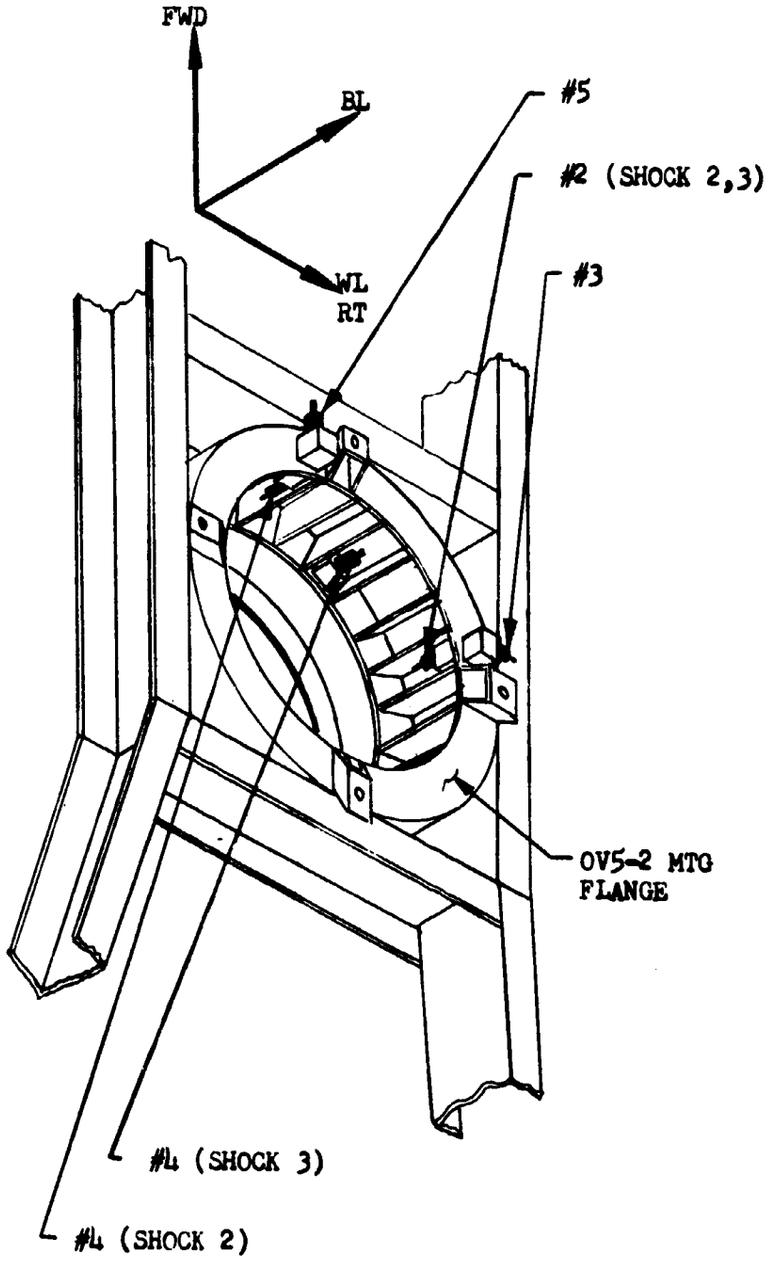



Figure III.B.1-4. Accelerometer Location for OV5-2 Satellite Release Shock Test

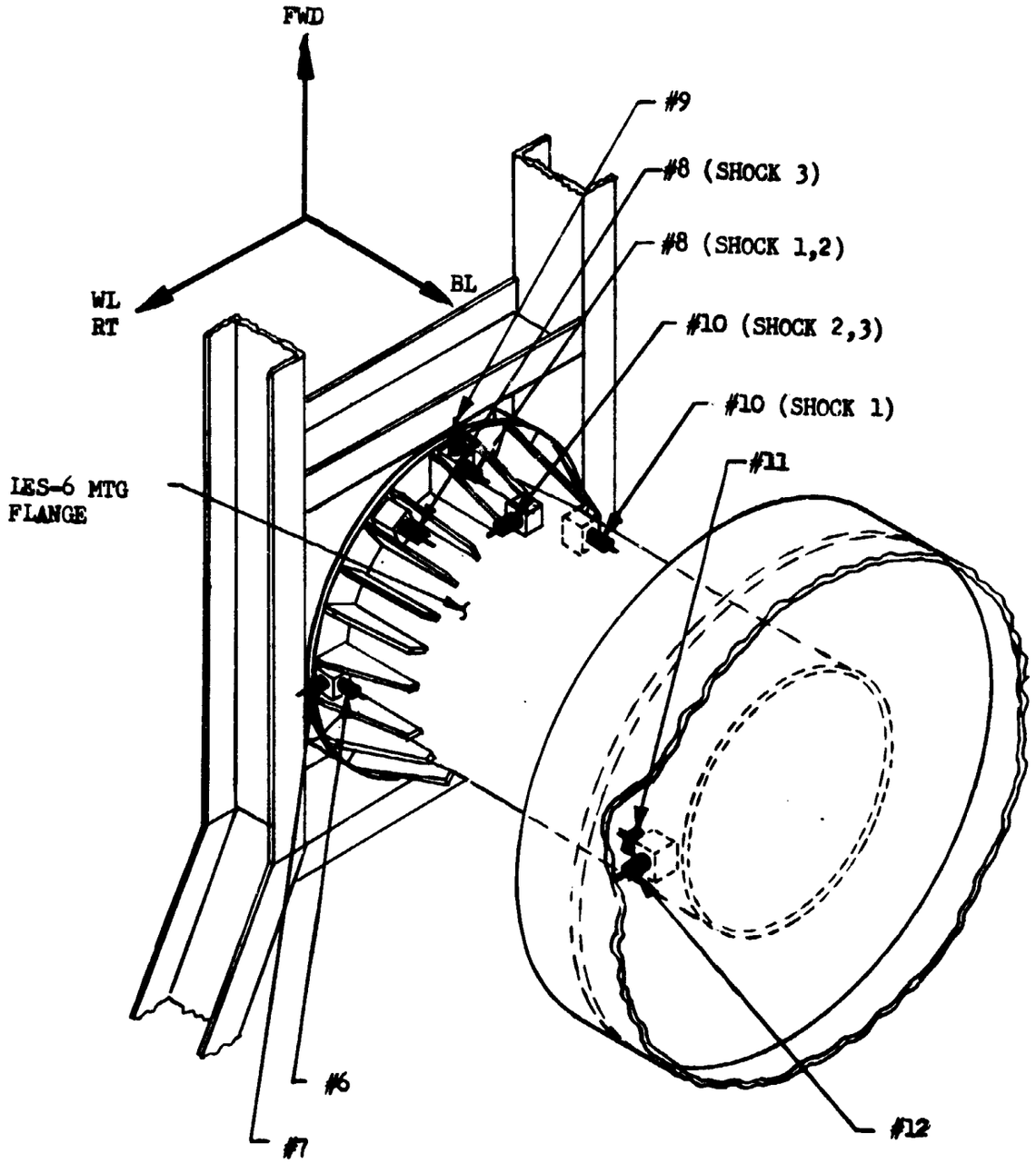



Figure III.B.1-5. Reverse Side of OV5-2 Mtg. Flange (LES-6 Mtg. Pedestal)

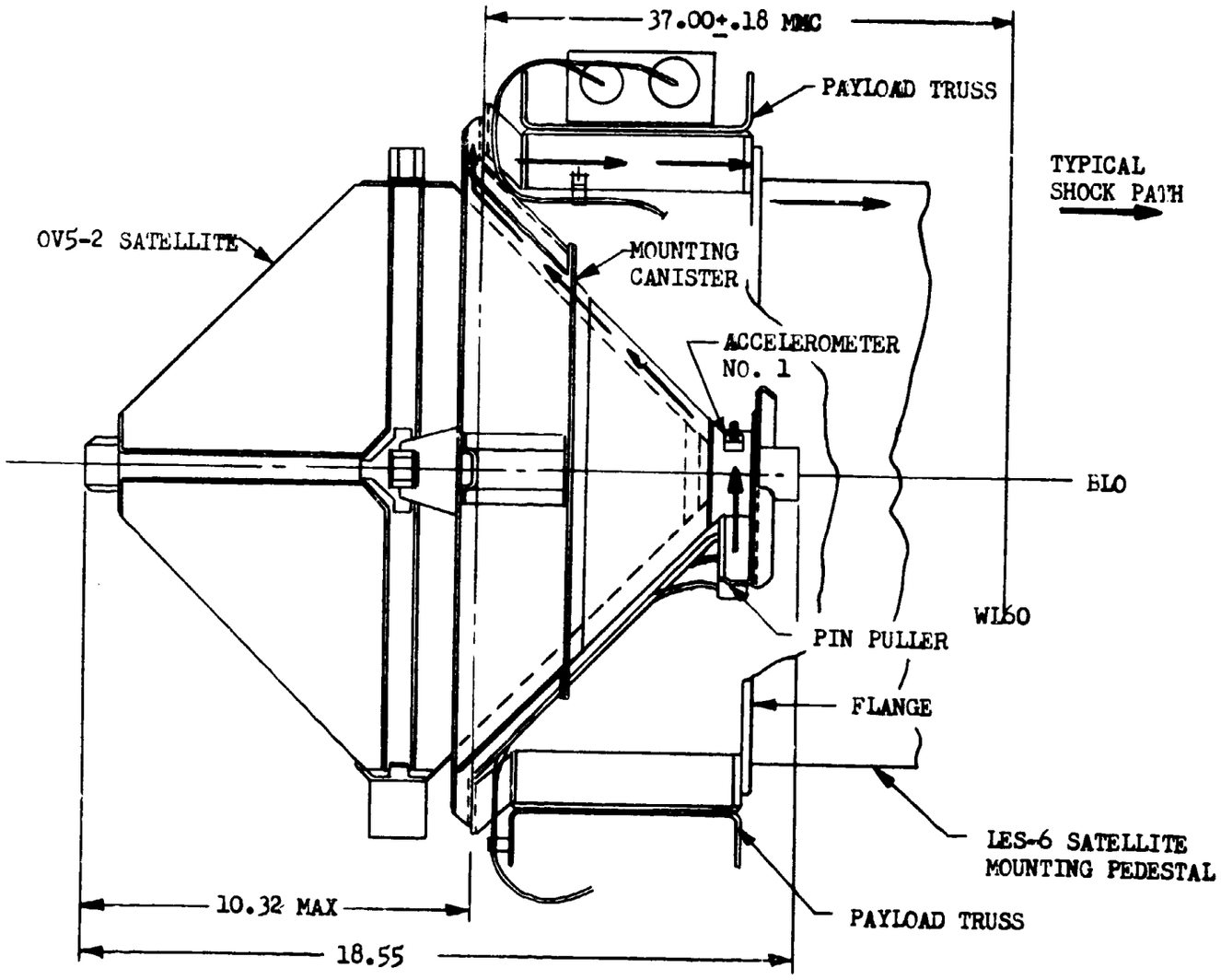



**Figure III.B.1-6. OV5-2 Satellite Installation and Release Mechanism, Top View**

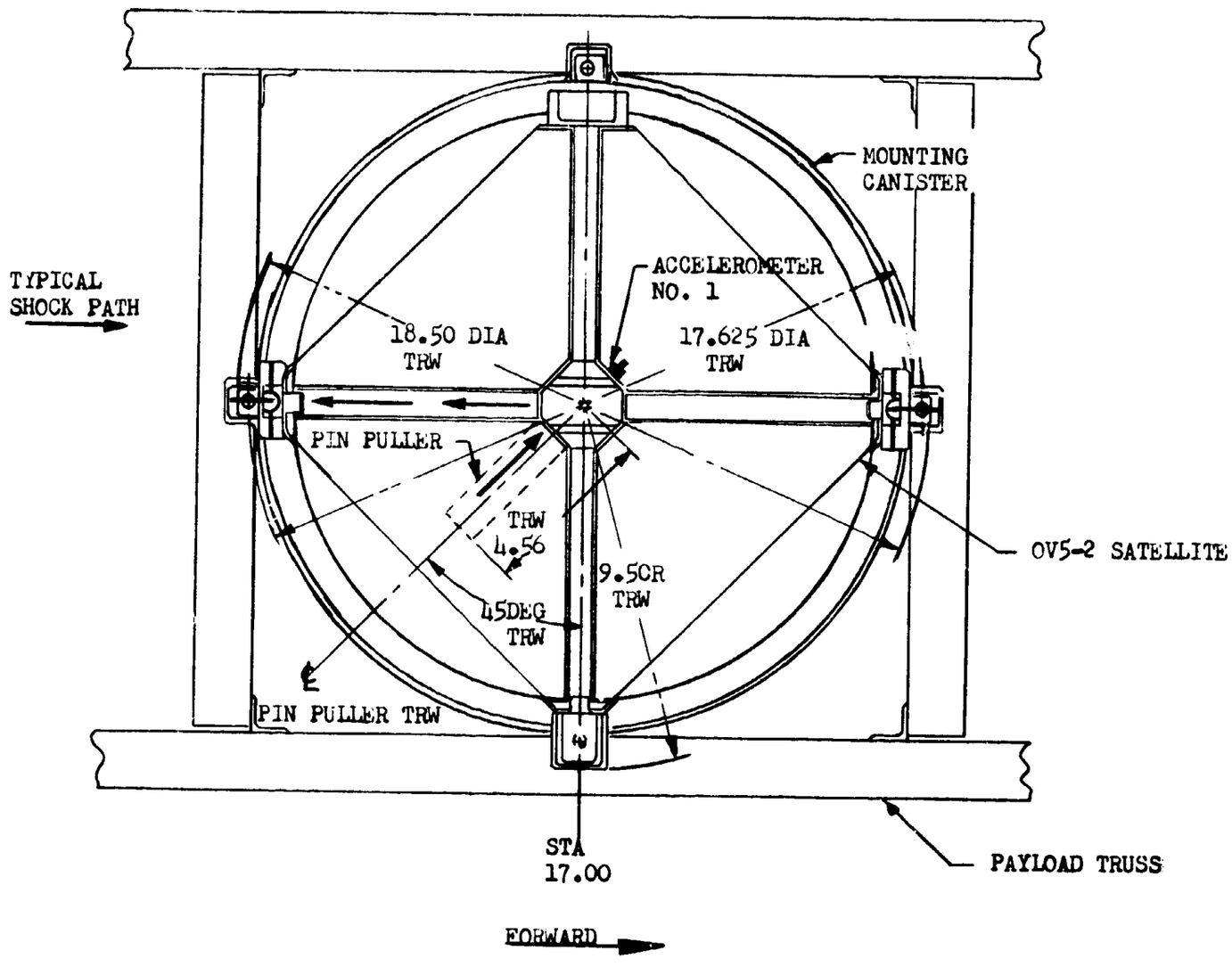
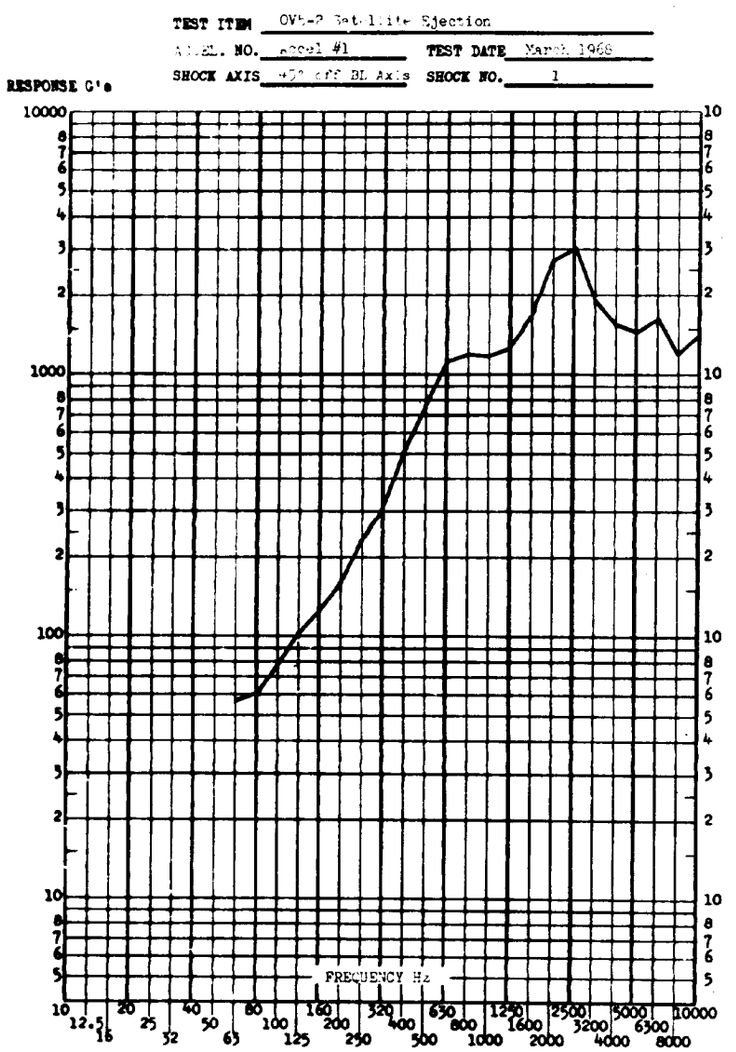



Figure III.B.1-7. OV5-2 Satellite Installation and Release Mechanism, Front View



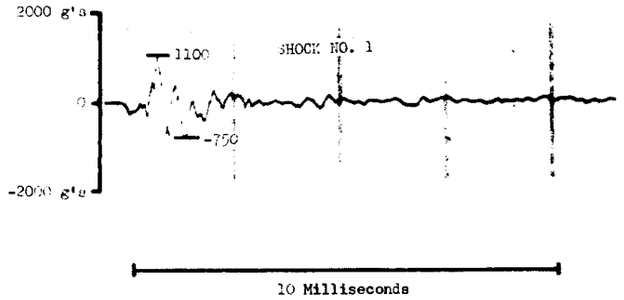




FIGURE III.B.1-8

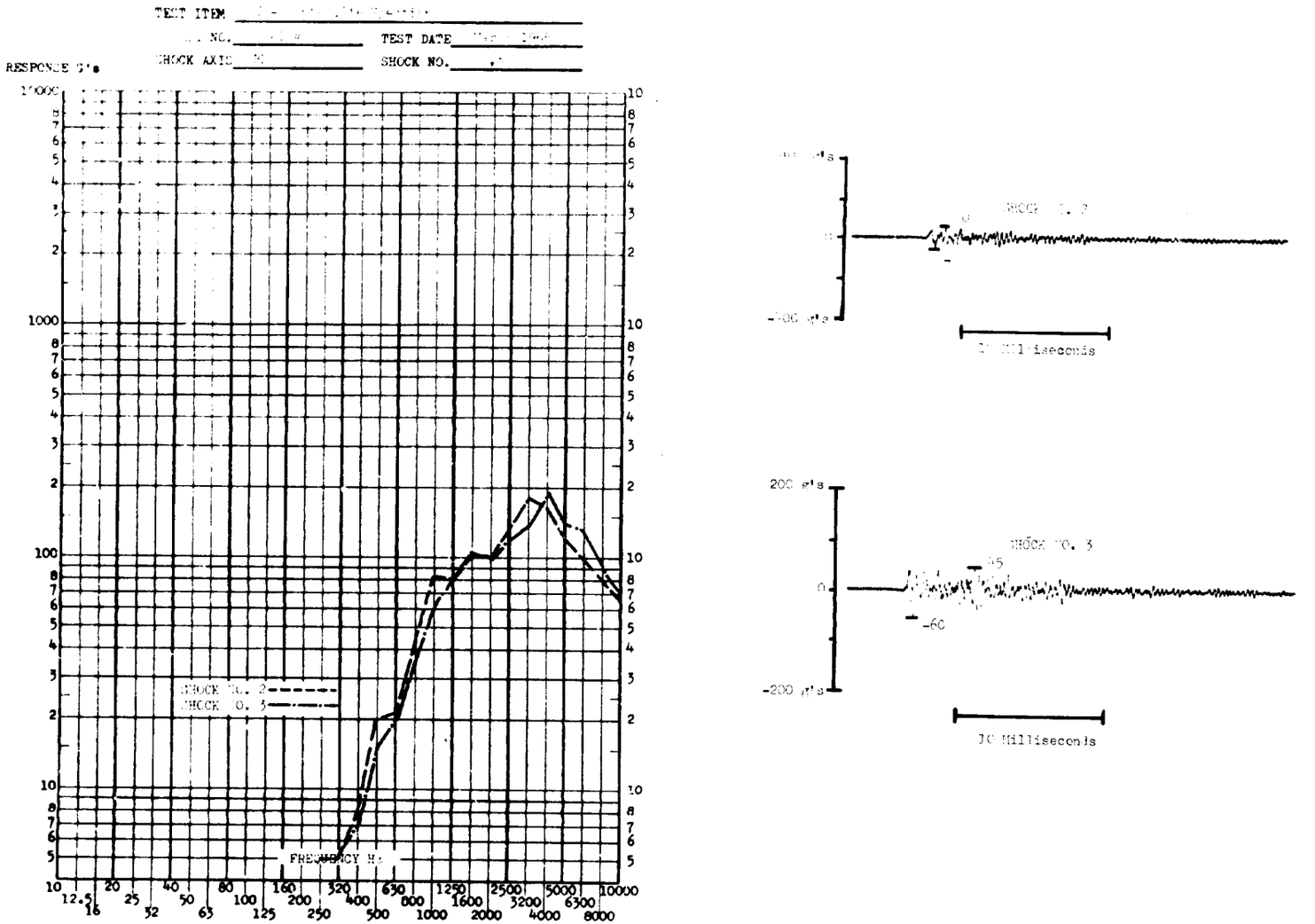









FIGURE III.B.1-9

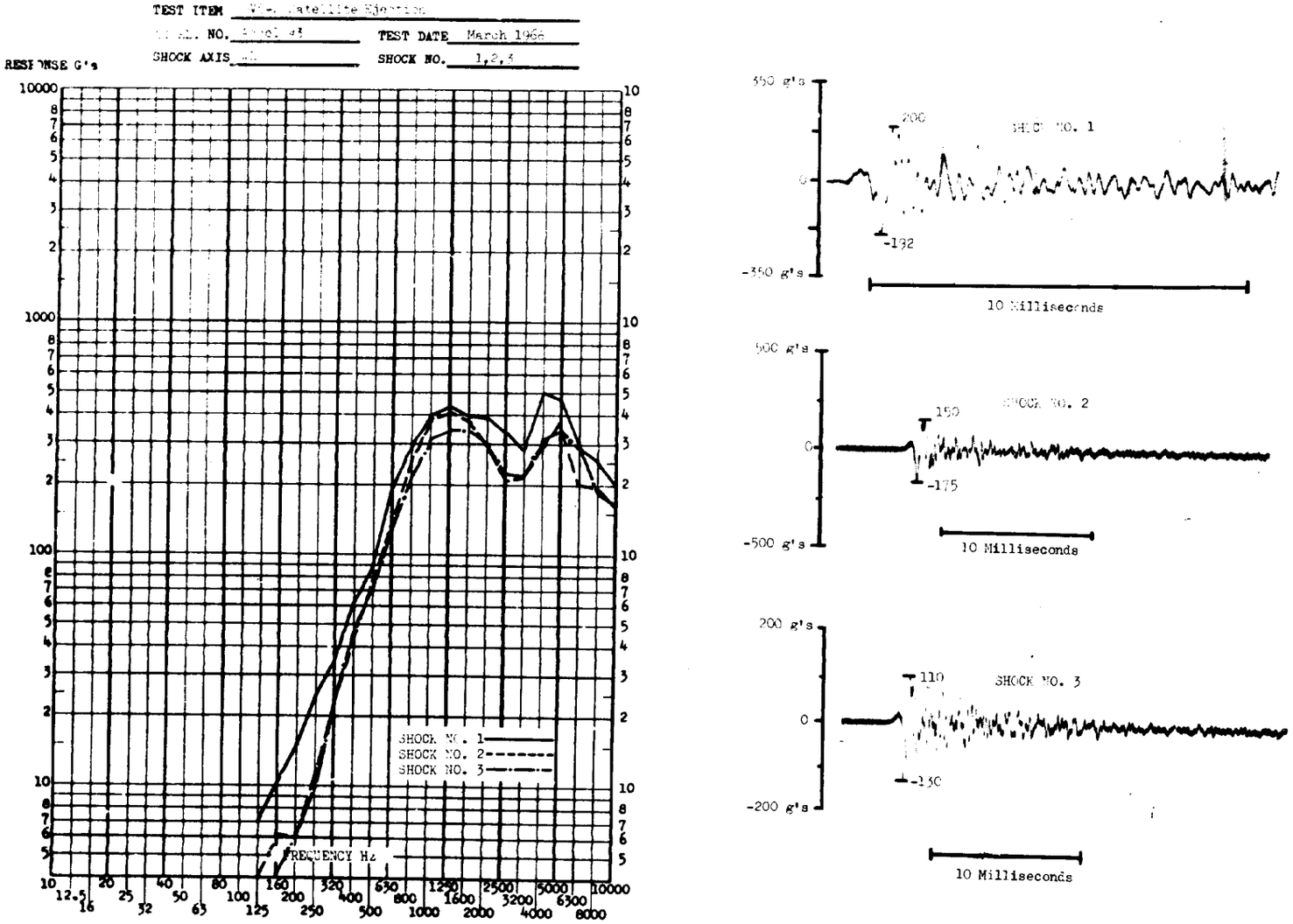



FIGURE III.B.1-10

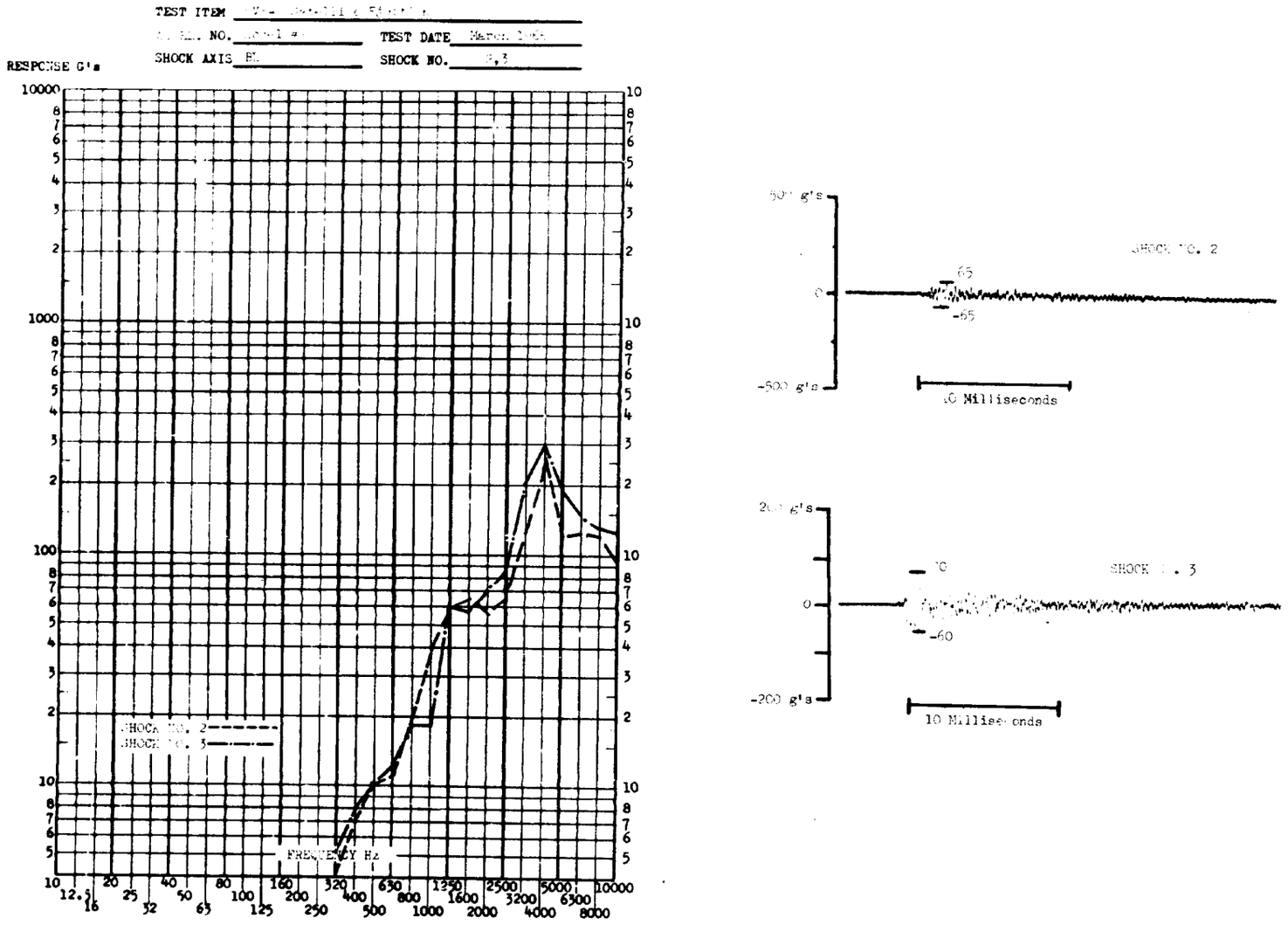









FIGURE III.B.1-11

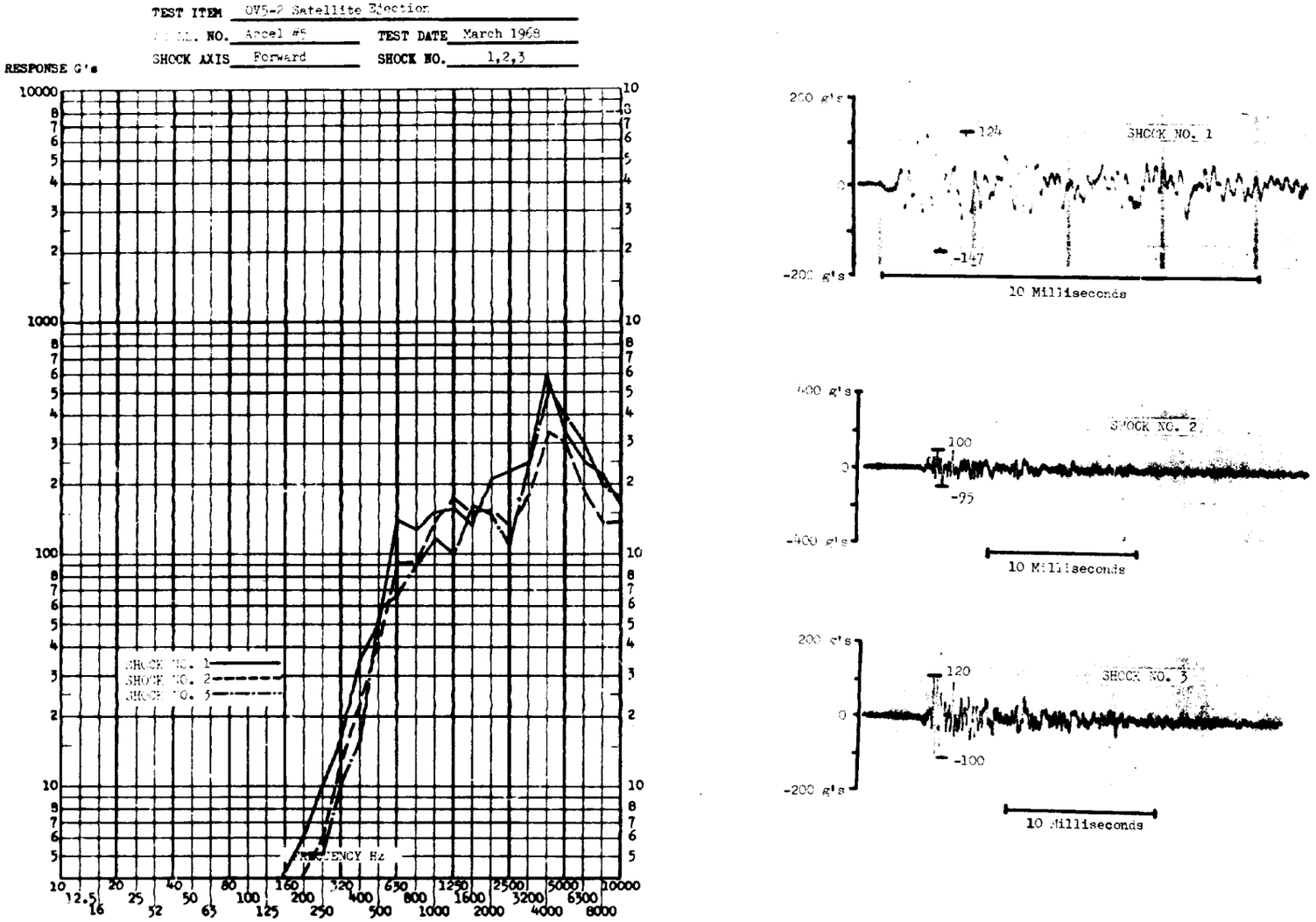












FIGURE III.B.1-12

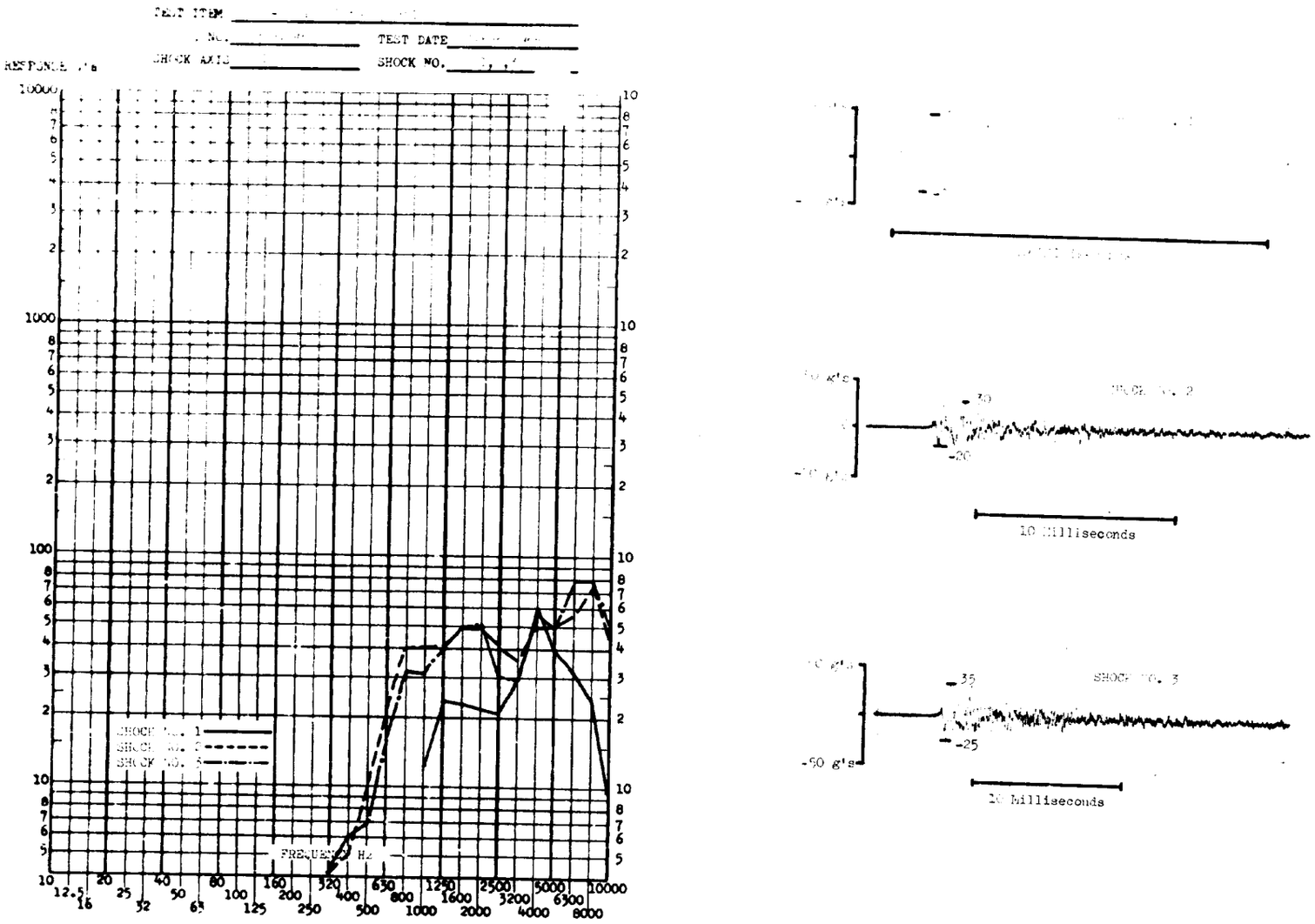



FIGURE III.B.1-13

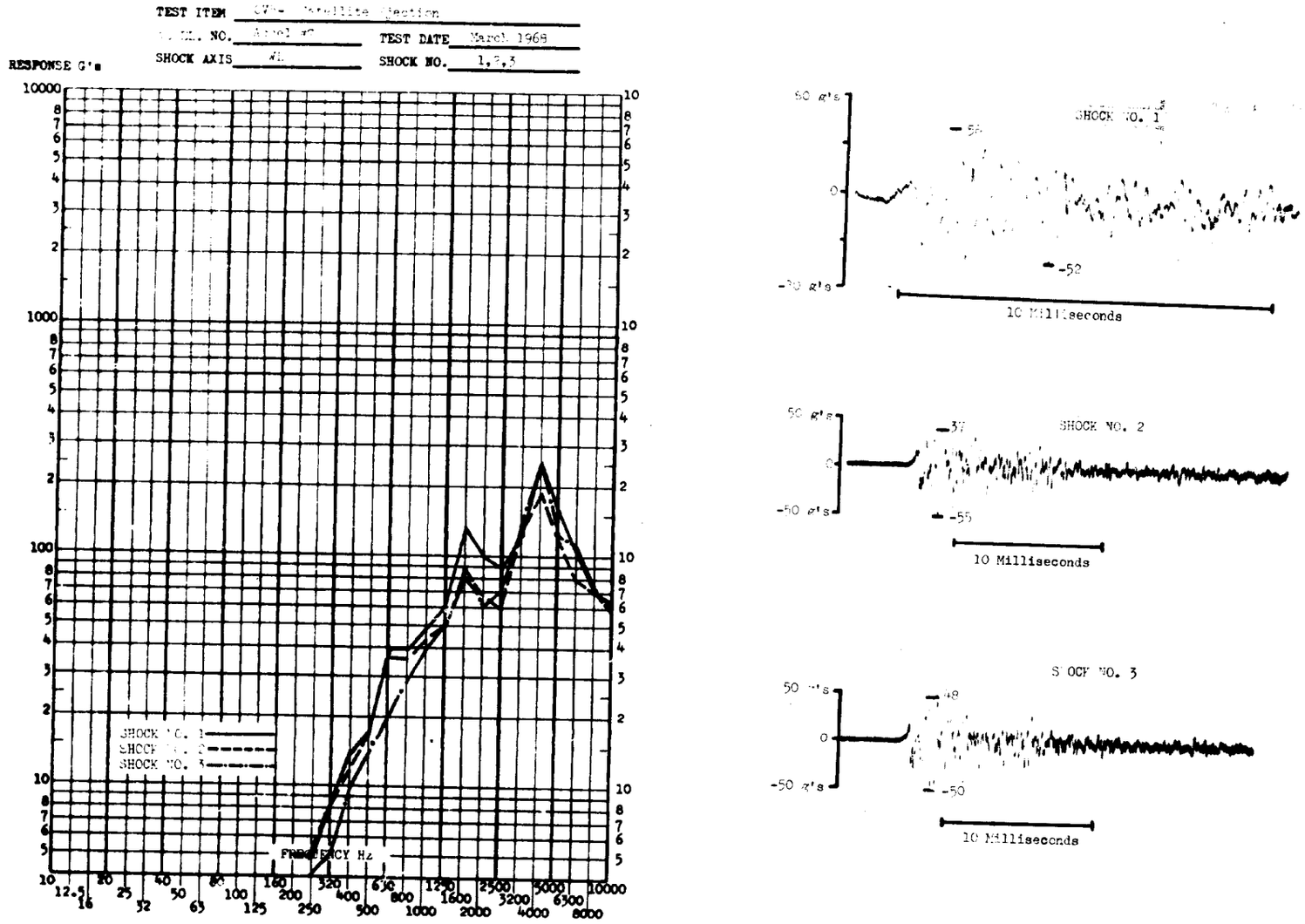



FIGURE III.B.1-14

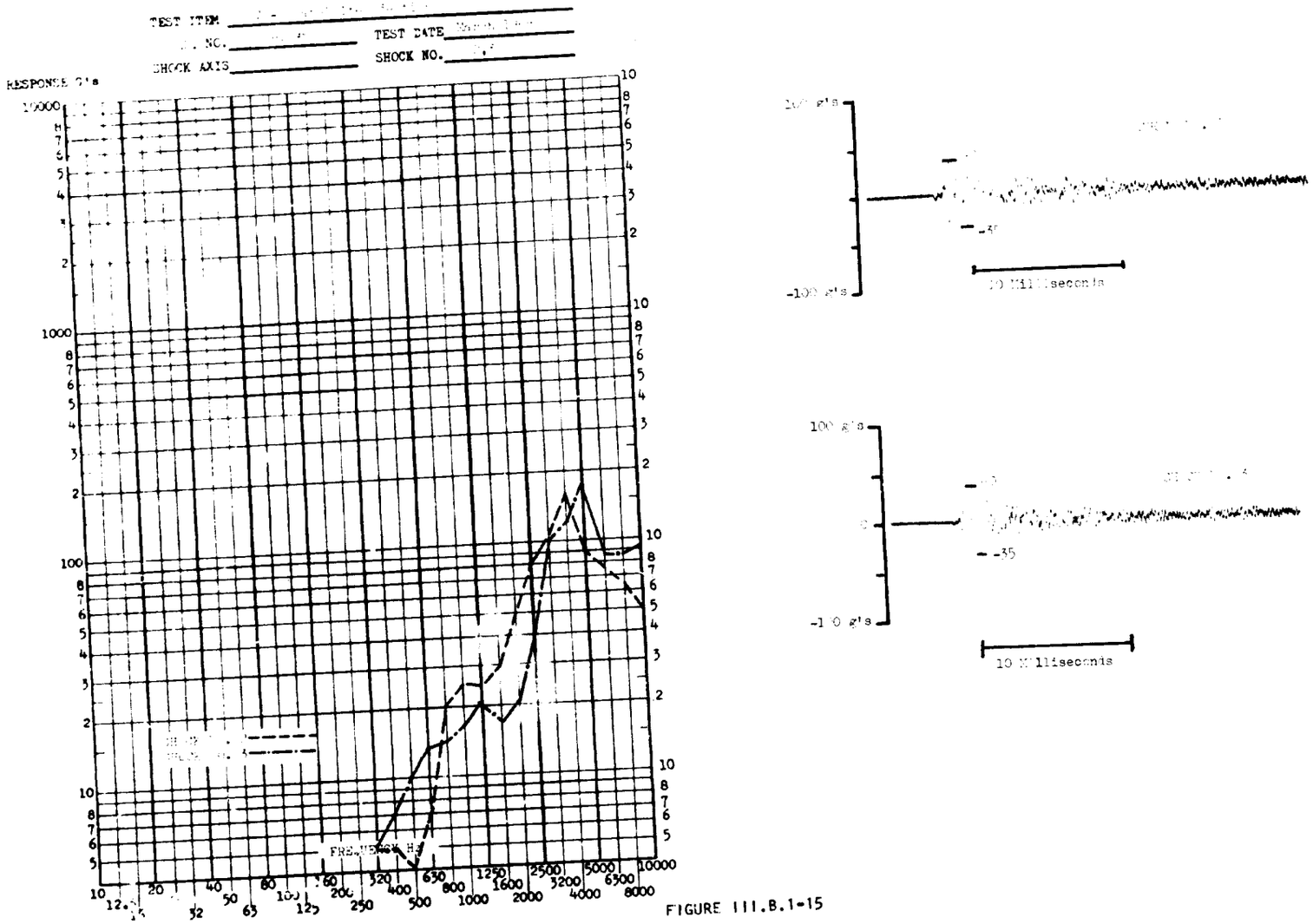



FIGURE III.B.1-15

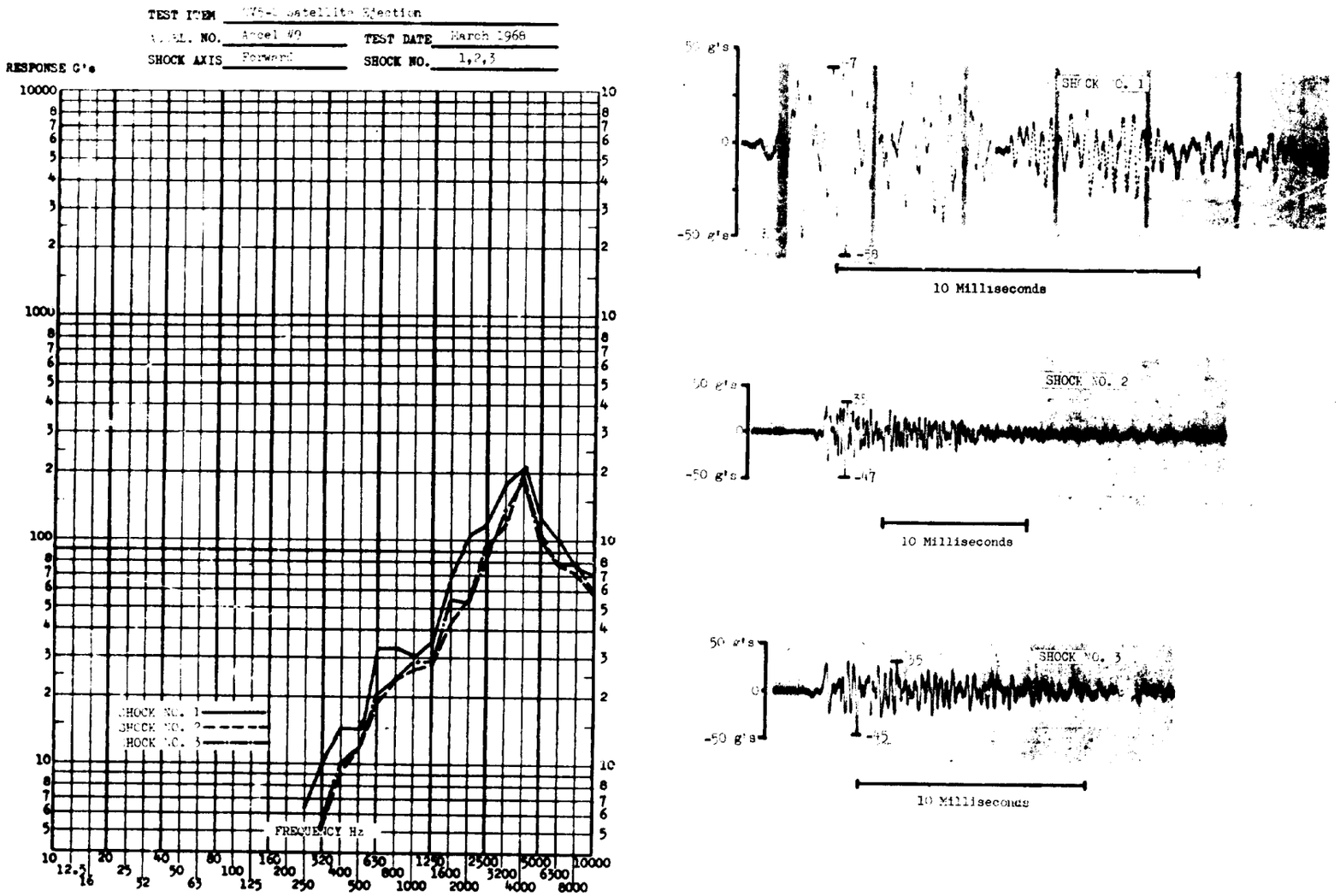



FIGURE III.B.1-16

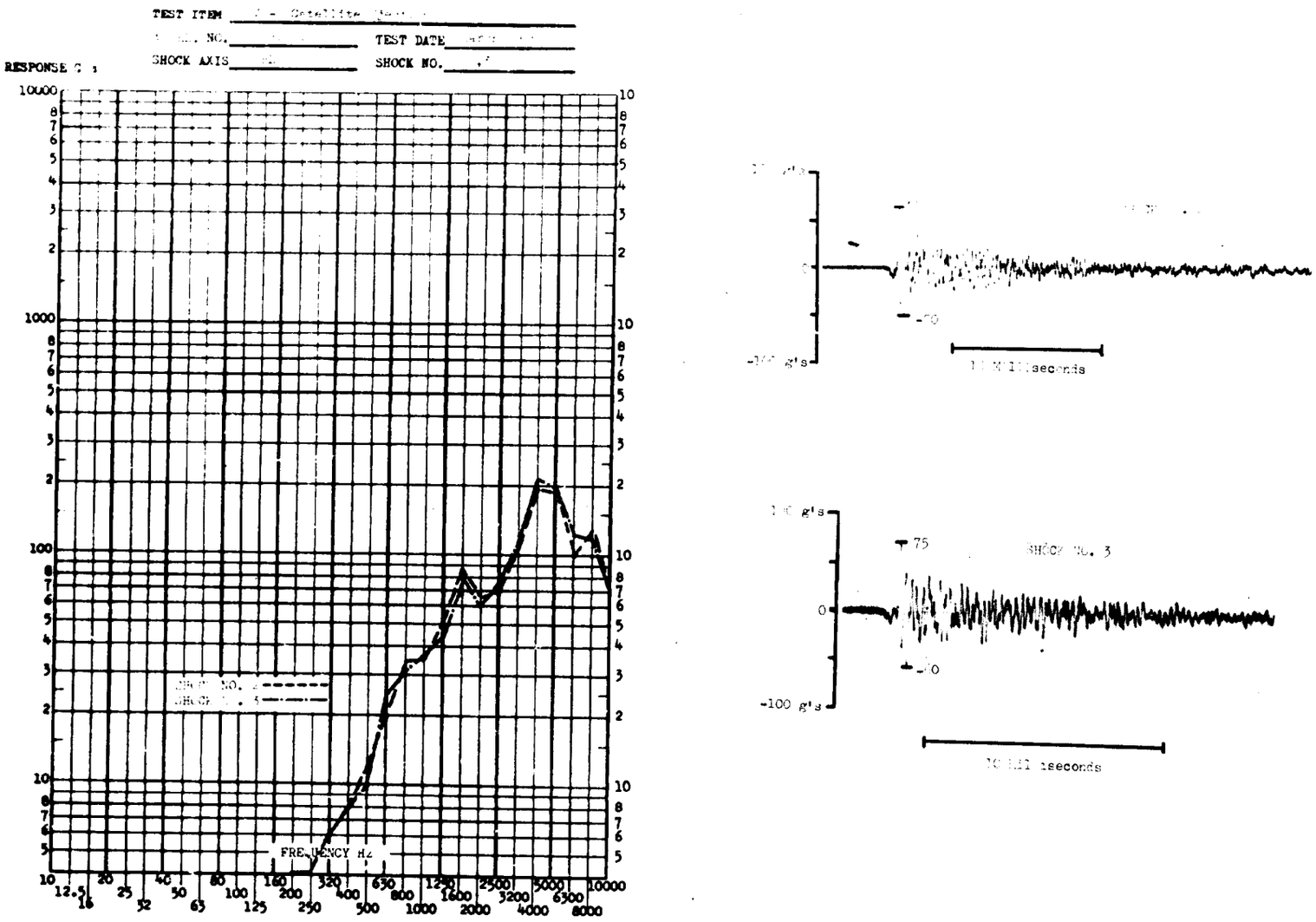



FIGURE III.B.1-17

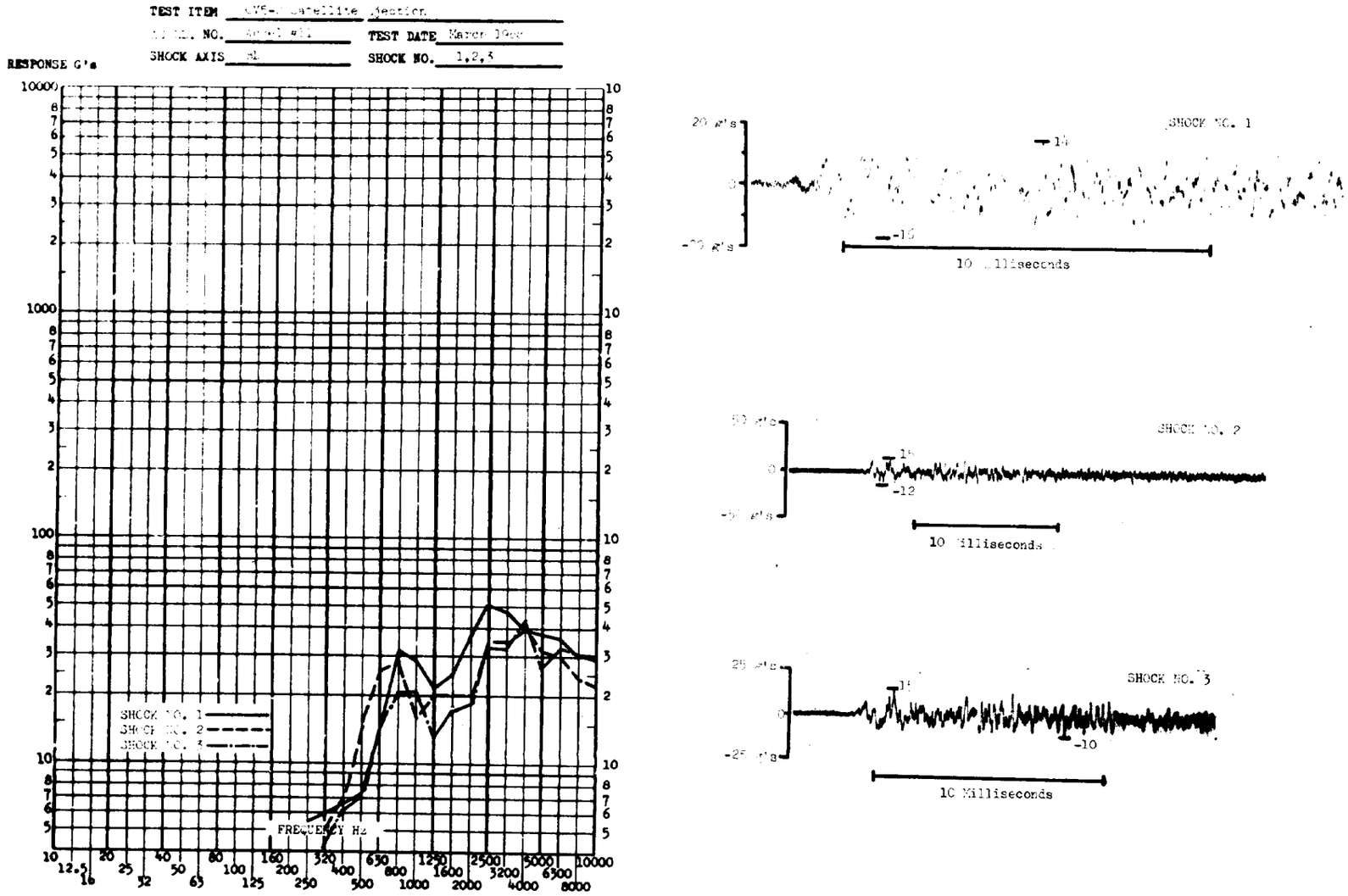



FIGURE III.B.1-18

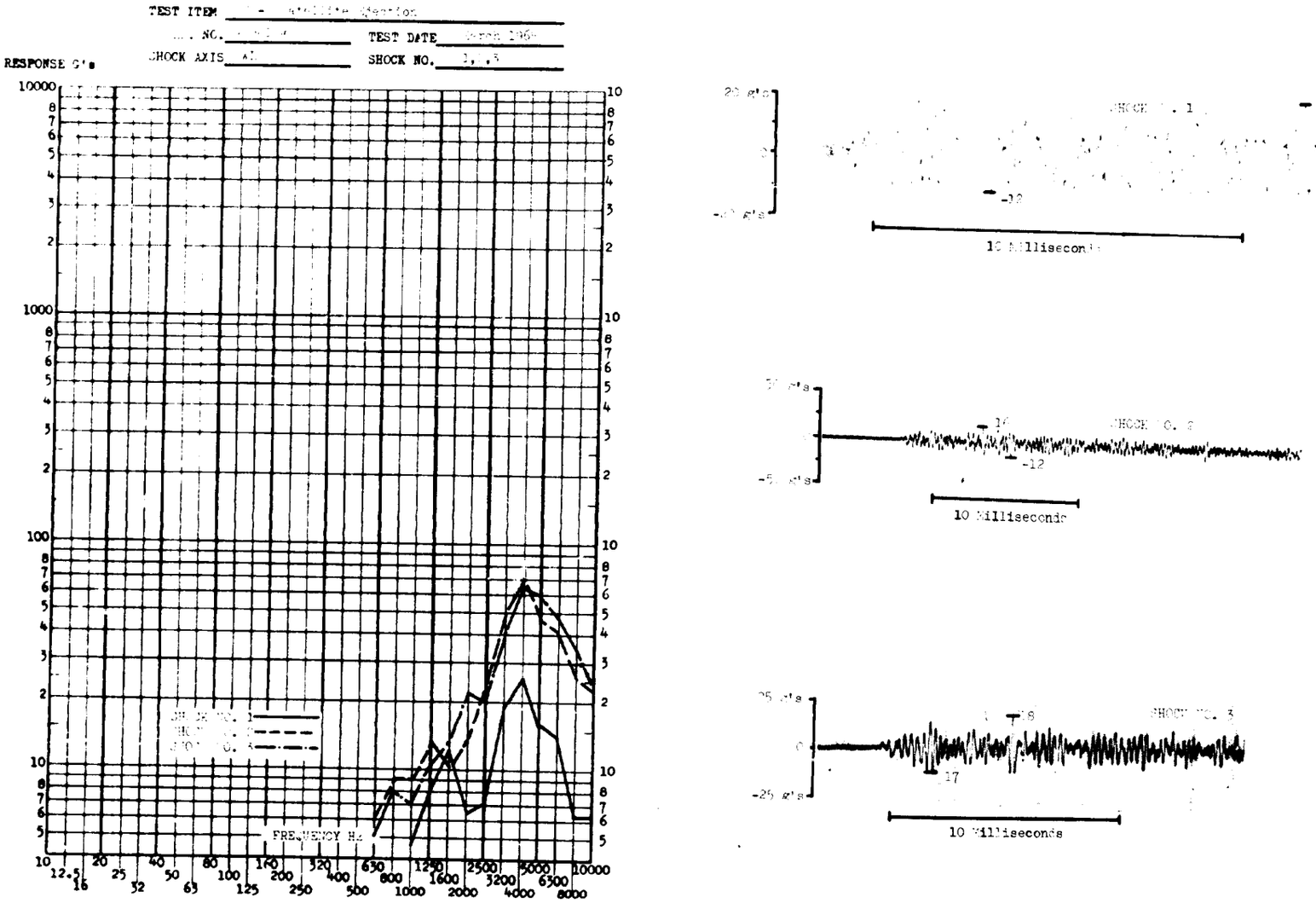



FIGURE III.B.1-19

SECTION III.B.2

SEPARATION SHOCK TESTS OF TOS-M SPACECRAFT

PURPOSE OF TESTS

The objective of these tests was to determine the typical shock environment associated with TOS-M spacecraft separation from the third stage booster of the Thor/Delta launch vehicle.

DESCRIPTION OF EVENTS

For these tests the TOS-M Dynamic Test Unit, shown in Figure III.B.2-1, was suspended by counter weight/hoist suspension system. A 37-inch diameter attach fitting simulating the Delta third stage was mounted to the bottom of the Dynamic Test Unit by means of a separation attach clamp. The separation event was simulated by actuating the two ordnance bolts cutters integrated into the attach clamp system. Following the action of the bolt cutters, separation springs and gravity forced the simulated third stage with the attach fitting away from the spacecraft without further interaction. Ten such tests were conducted; however, tests 5,6,7 and 10 used only one bolt cutter instead of the normal two.

DESCRIPTION OF DATA

Twelve different accelerometer locations were monitored during testing. Either five or six shock spectra are

presented for each measurement location.

| | |
|---|---|
| No. of time histories | 12 |
| No. of shock spectra | 68 |
| Type of analysis | digital |
| Sample rate | 20,000/second |
| Frequency range | 10-7,500 Hz |
| Frequency increment | 20 points per octave |
| Damping | Q=10 |

These shock spectra are presented along with the time histories for Separation Test No. 1 as Figures III.B.2-3 through III.B.2-14. Table III.B.2-1 is an index indicating which test afforded data for the various accelerometer locations.

DESCRIPTION OF PYROTECHNIC

Ordnance bolt cutters integrated into attach clamp assembly as illustrated in Figure III.B.2-2 were used. The explosive cutter is defined by DAC drawing 1B20802-1.

DESCRIPTION OF STRUCTURE

Figure III.B.2-2

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2225

Locations: Table III.B.2-1 and Figure III.B.2-2

Axis of sensitivity: Table III.B.2-1 and Figure III.B.2-2

## DESCRIPTION OF DATA ACQUISITION SYSTEM

Tape recorder: Sangamo Model 471-RB

Amplifiers: Unholtz Dickie Model 8PMCV charge amplifiers

TABLE III.B.2-1

INDEX OF MEASUREMENTS PRESENTED AND THEIR LOCATIONS

| Accelerometer No. | Location | Test Nos. | Sensitive Axis | Figure No |
|---|---|---|---|---|
| 1 | Adapter ring, inside flange | 1,7,8,9,10 | radial | III.B.2-3 |
| 2 | Adapter ring, inside flange | 1,7,8,9,10 | axial | III.B.2-4 |
| 3 | Adapter ring, inside flange | 1,7,8,9,10 | radial | III.B.2-5 |
| 4 | Adapter ring, inside flange | 1,7,8,9,10 | axial | III.B.2-6 |
| 5 | Baseplate, rib 5 | 1-6 | radial | III.B.2-7 |
| 6 | Baseplate, rib 5 | 1-6 | axial | III.B.2-8 |
| 7 | Baseplate, rib 5 | 1-6 | tangential | III.B.2-9 |
| 8 | Baseplate, rib 5 | 1-6 | radial | III.B.2-10 |
| 9 | Baseplate, rib 5 | 1-6 | axial | III.B.2-11 |
| 10 | Baseplate, rib 5 | 1-6 | tangential | III.B.2-12 |
| 11 | Back panel, top center | 1-6 | axial | III.B.2-13 |
| 12 | Back panel, top center | 1-6 | lateral | III.B.2-14 |

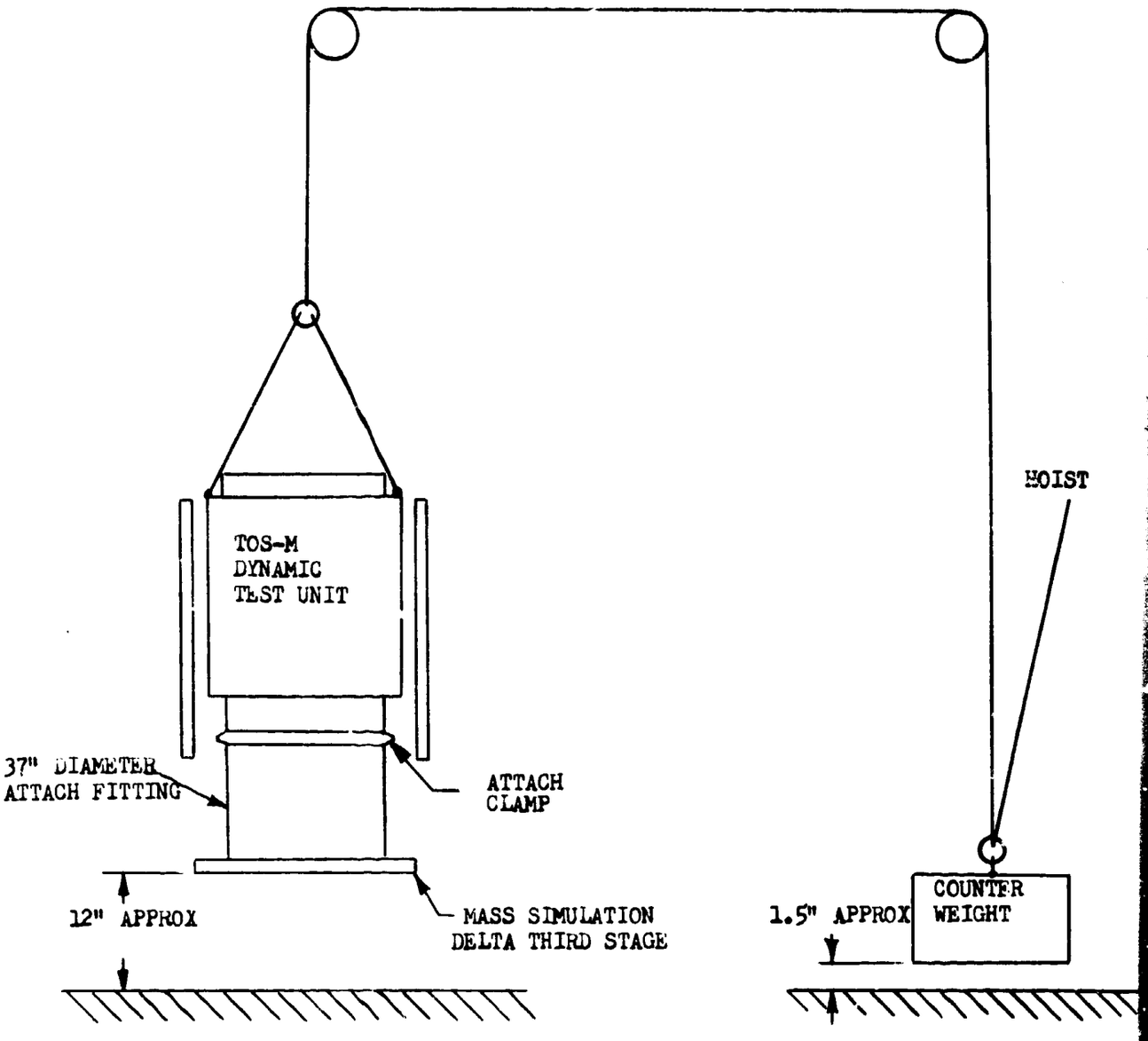
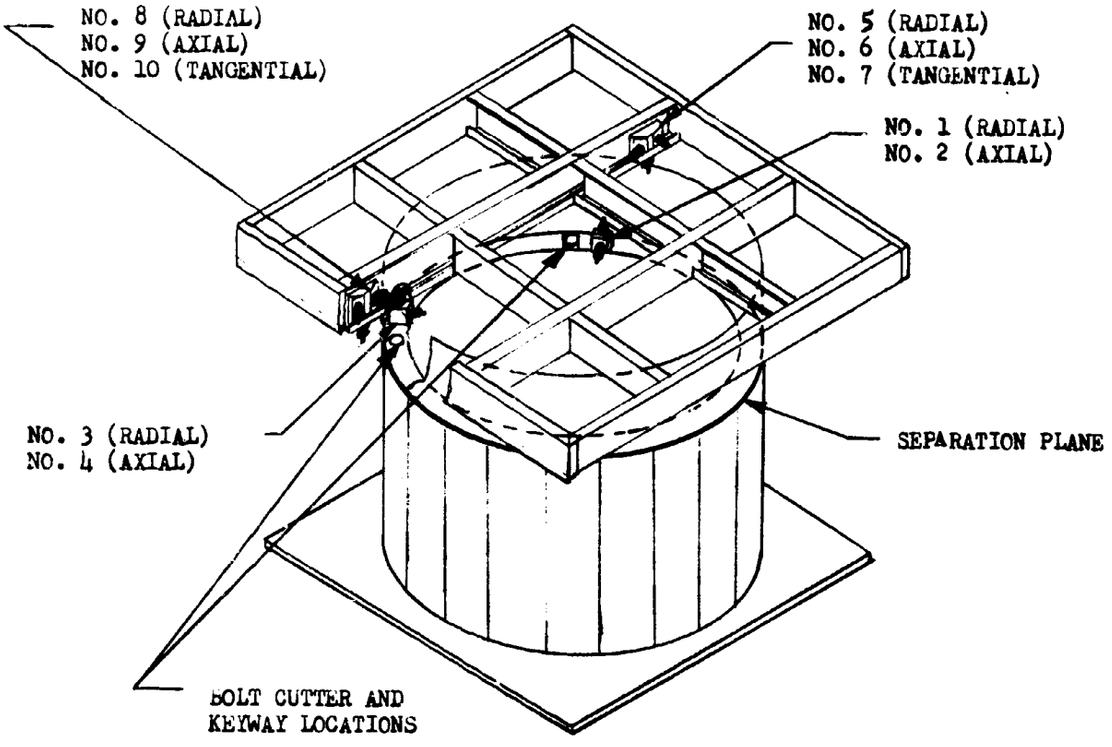



FIGURE III.B.2-1

DIAGRAM OF TOS-M DYNAMIC TEST SET-UP




SECTION A-A

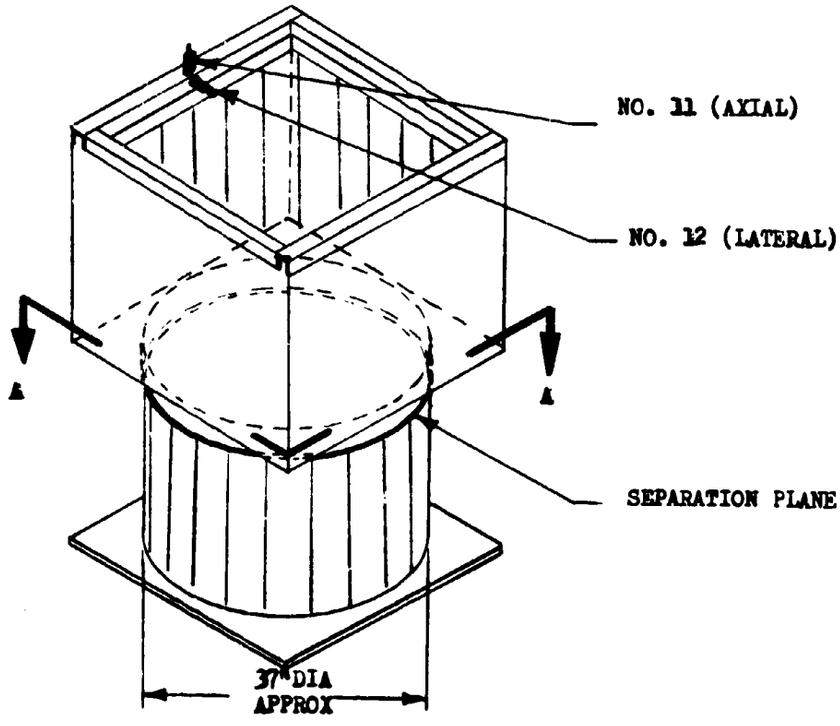
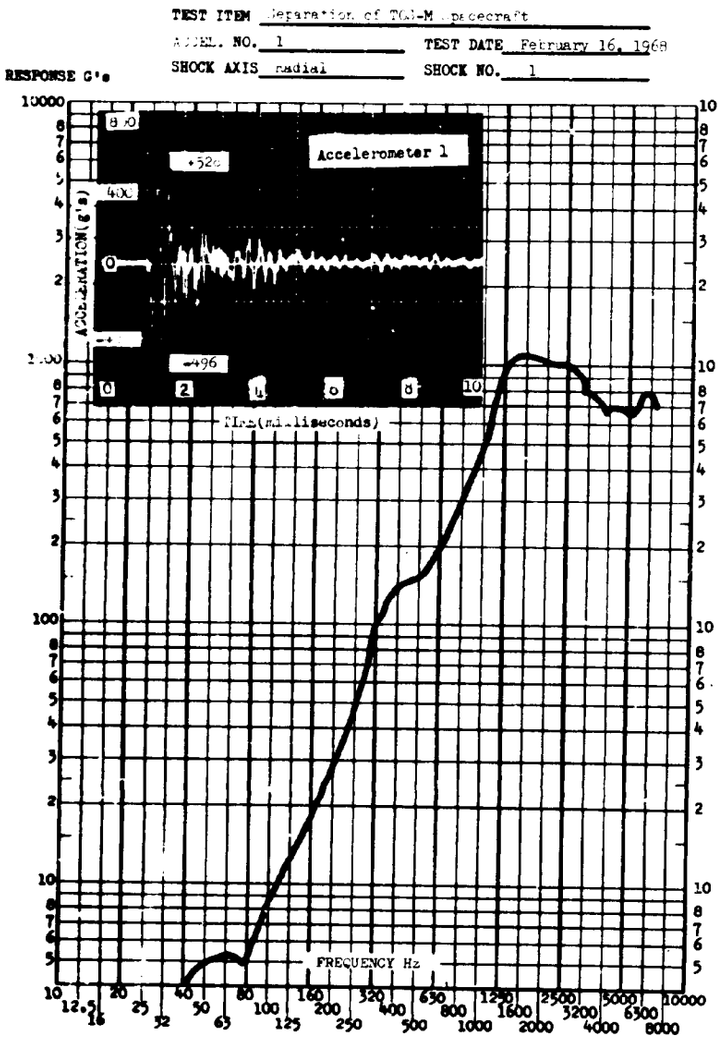



FIGURE III.B.2-2
LOCATION OF ACCELEROMETERS FOR TOS-1 DYNAMIC TESTS



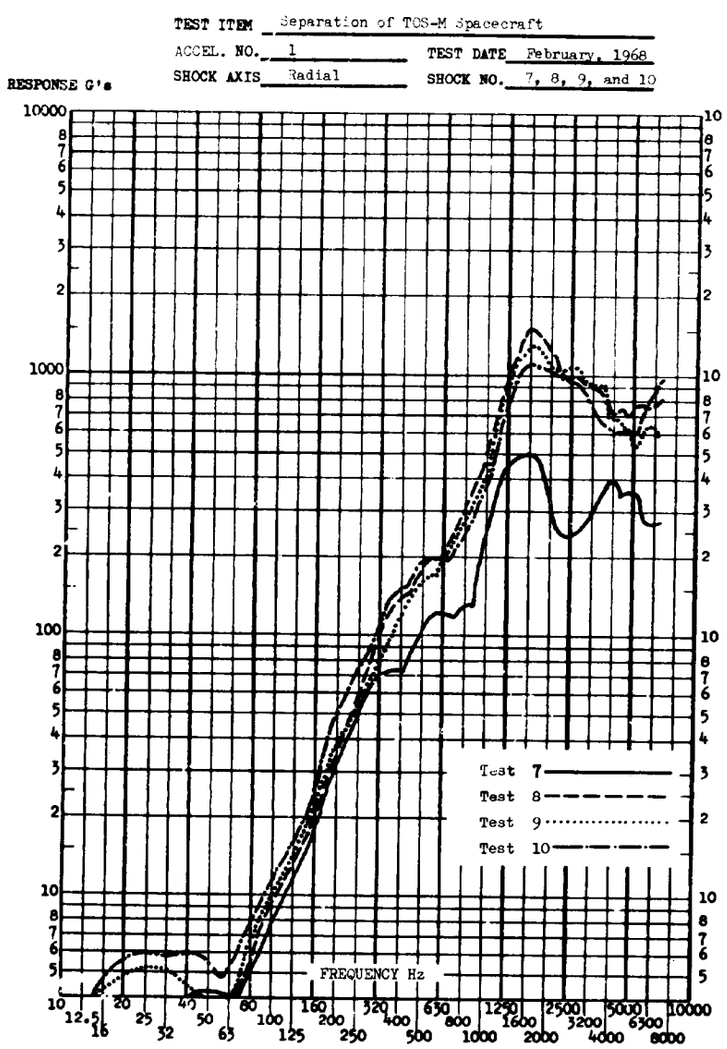
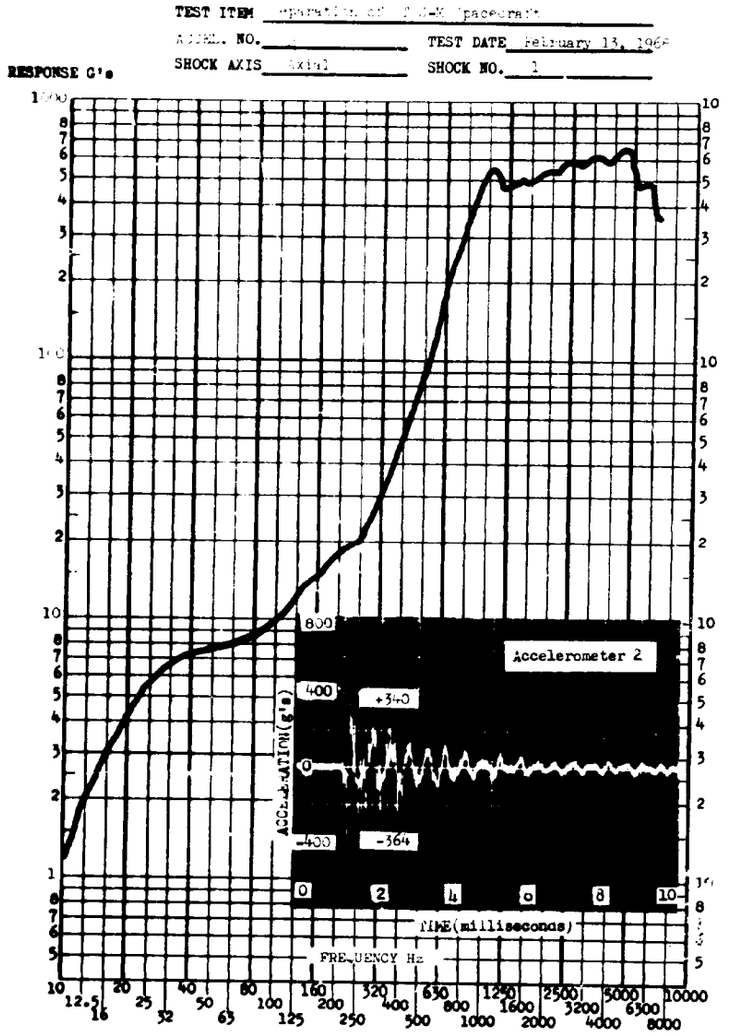




FIGURE III.B.2-3



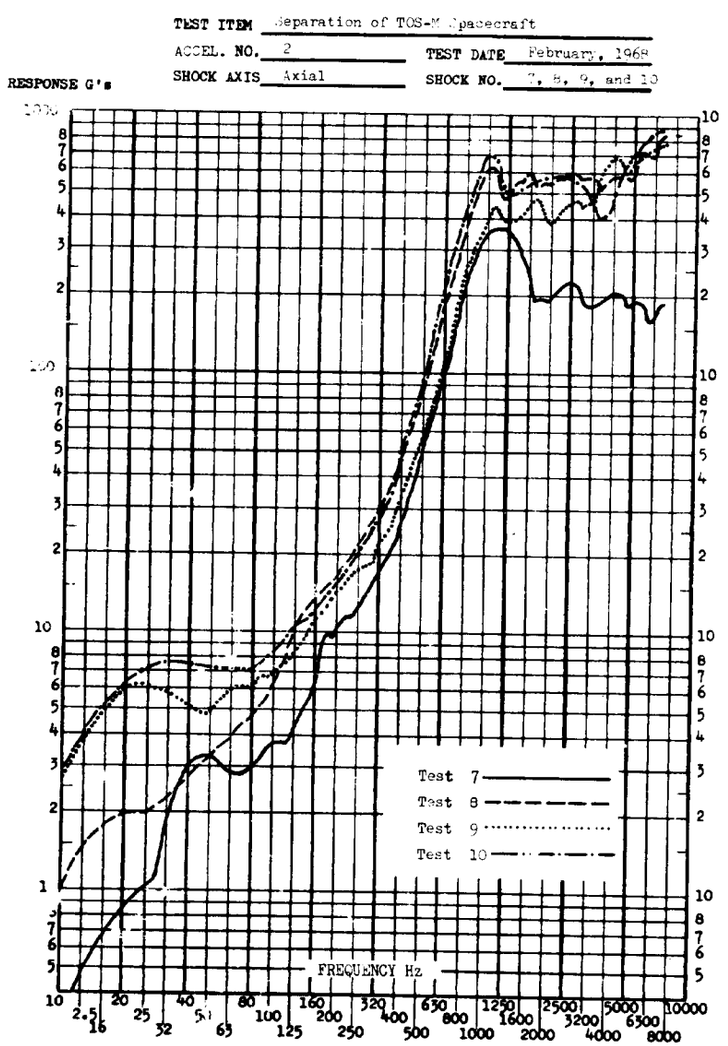
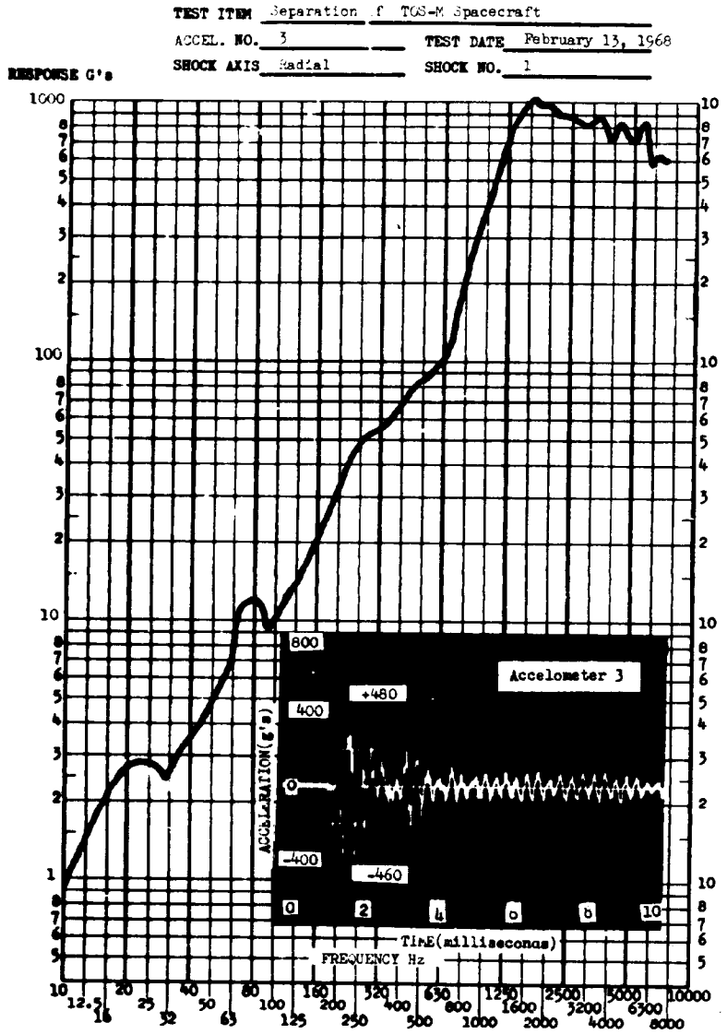




FIGURE III.B.2-4



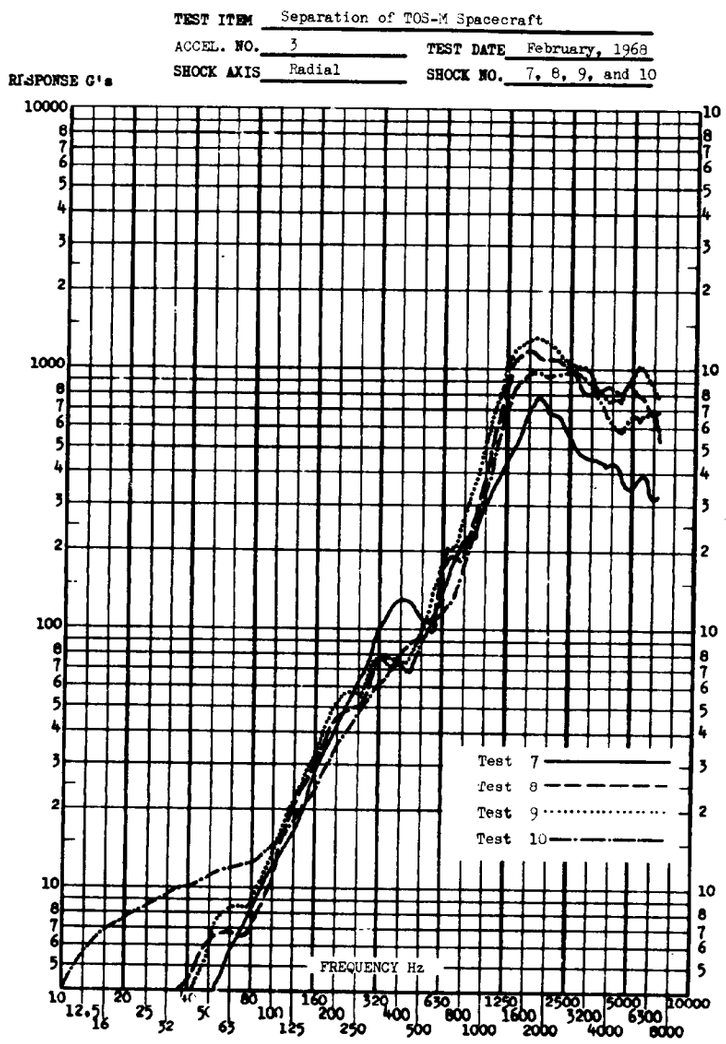
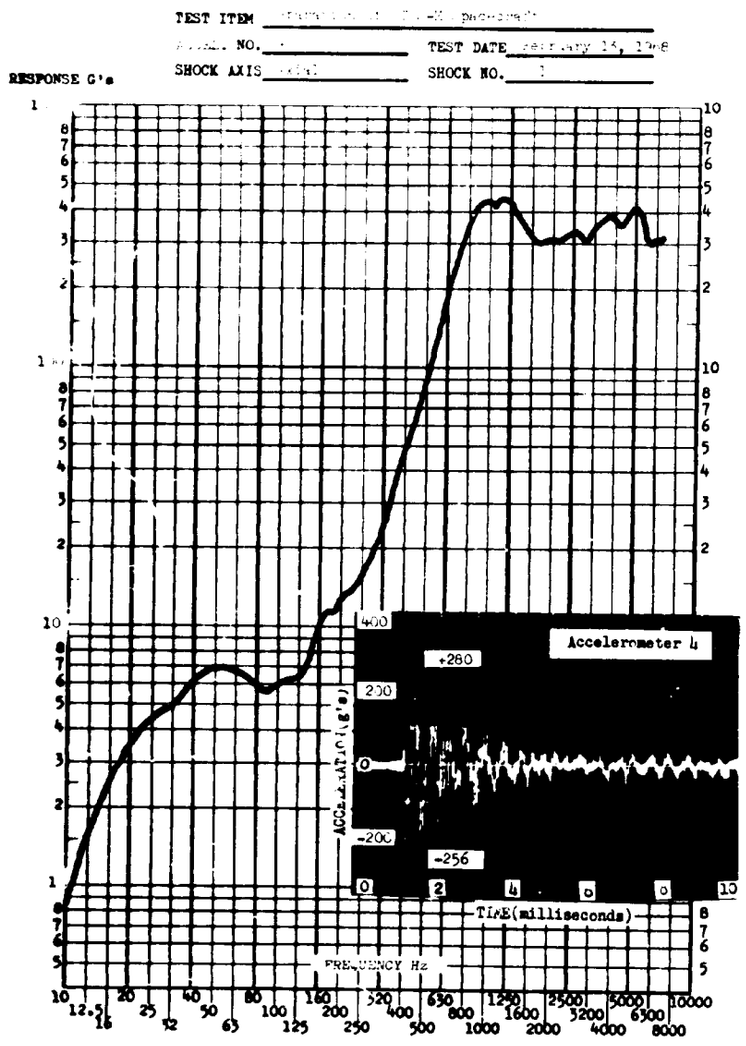




FIGURE III.B.2-5



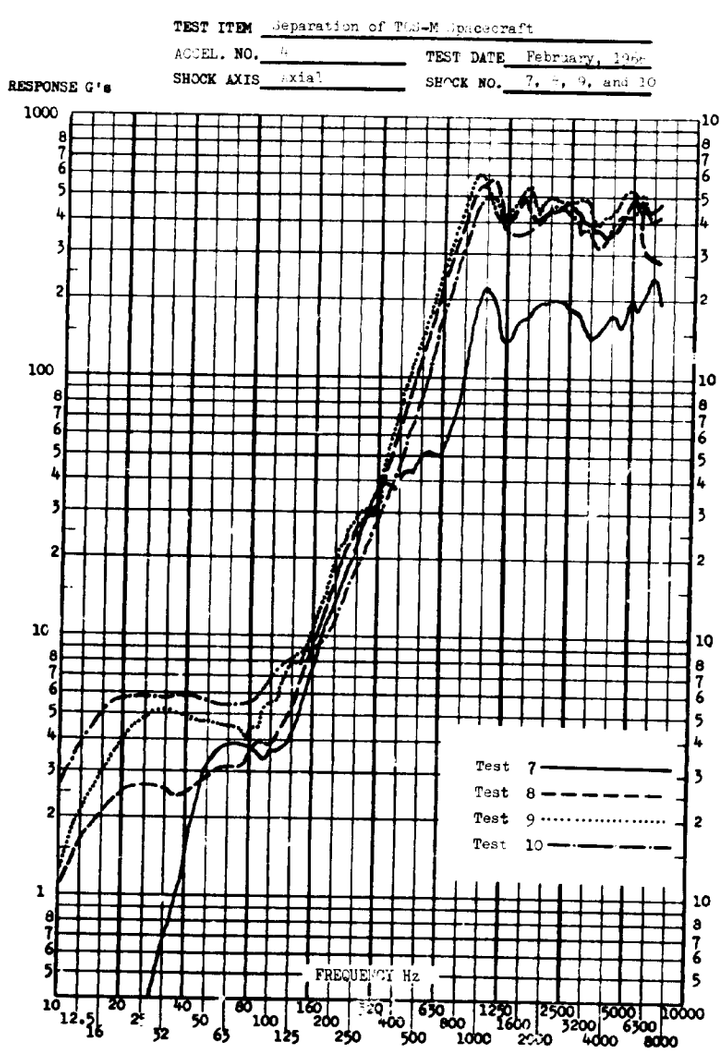
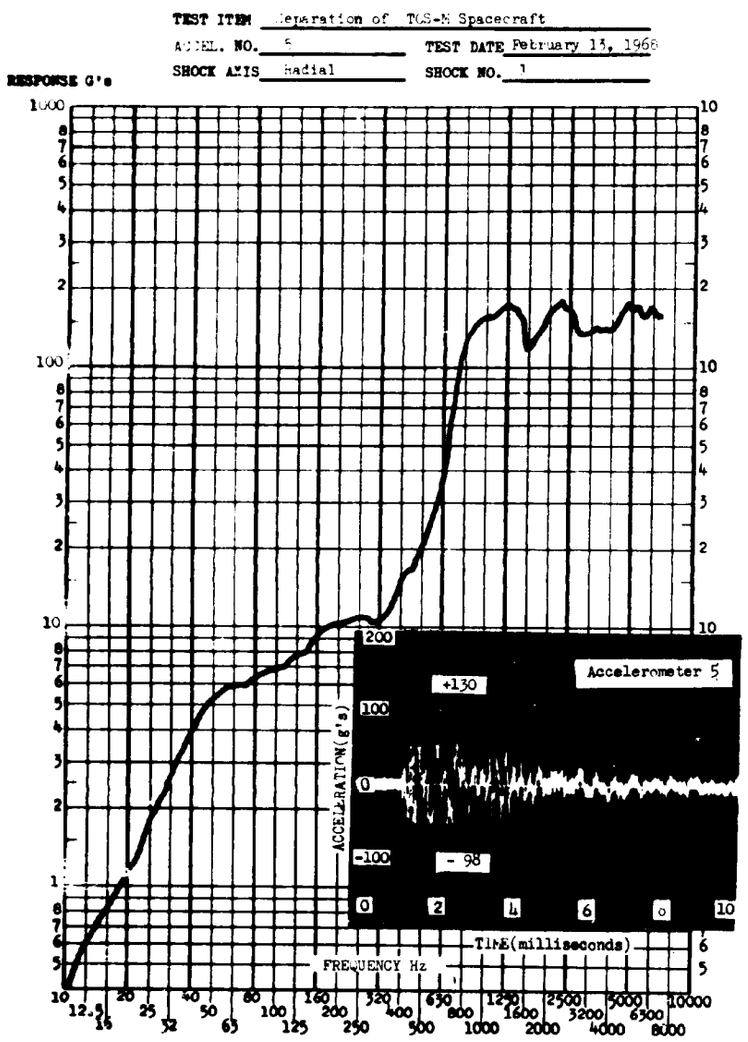




FIGURE III.B.2-6



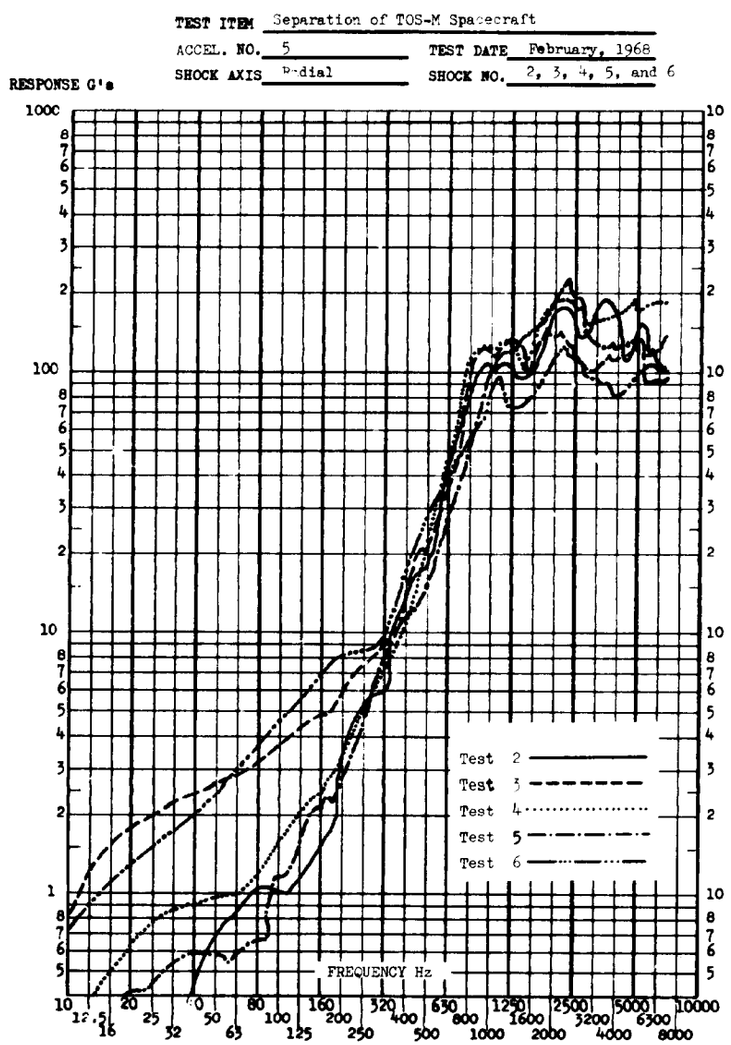
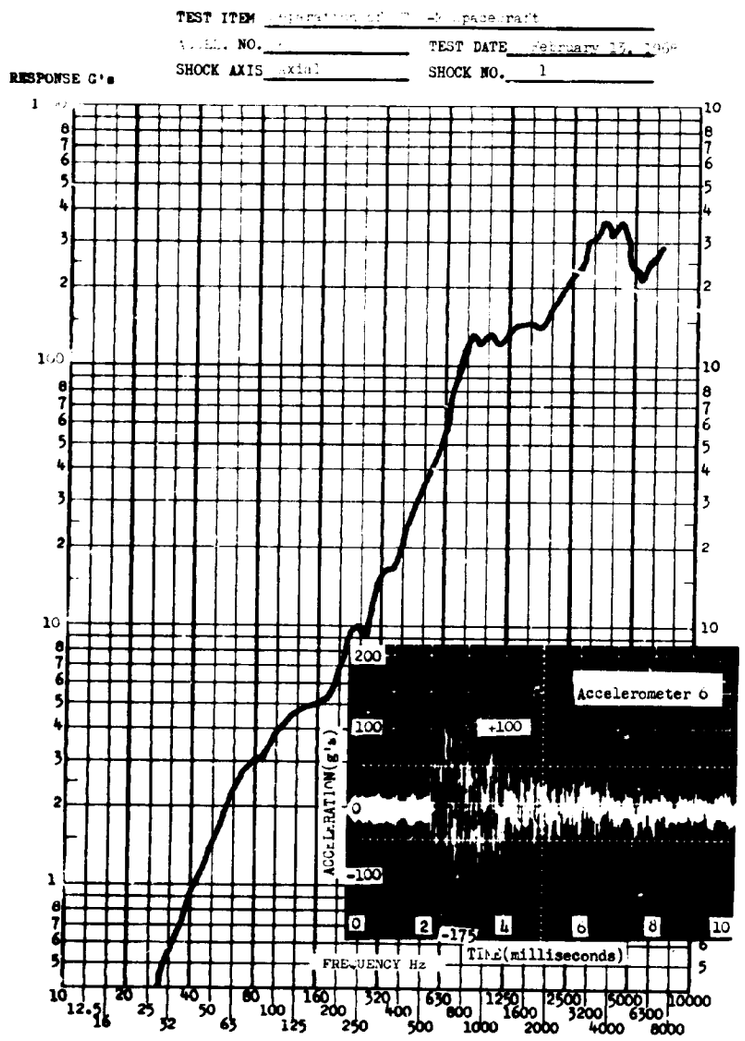




FIGURE III.B.2-7



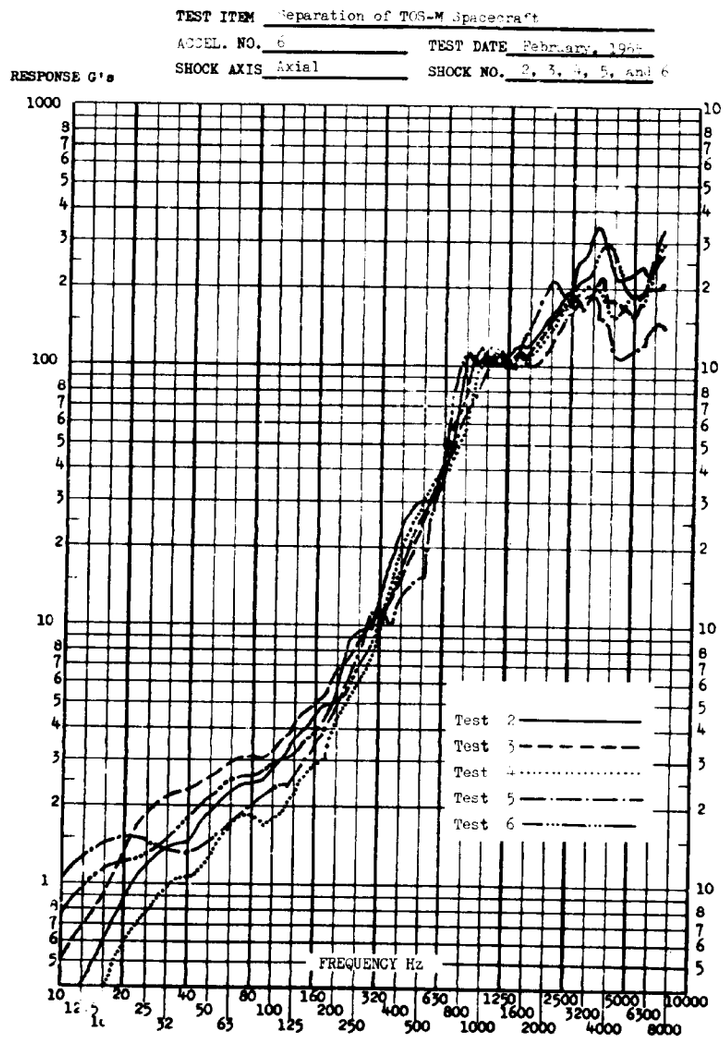




FIGURE III.B.2-8

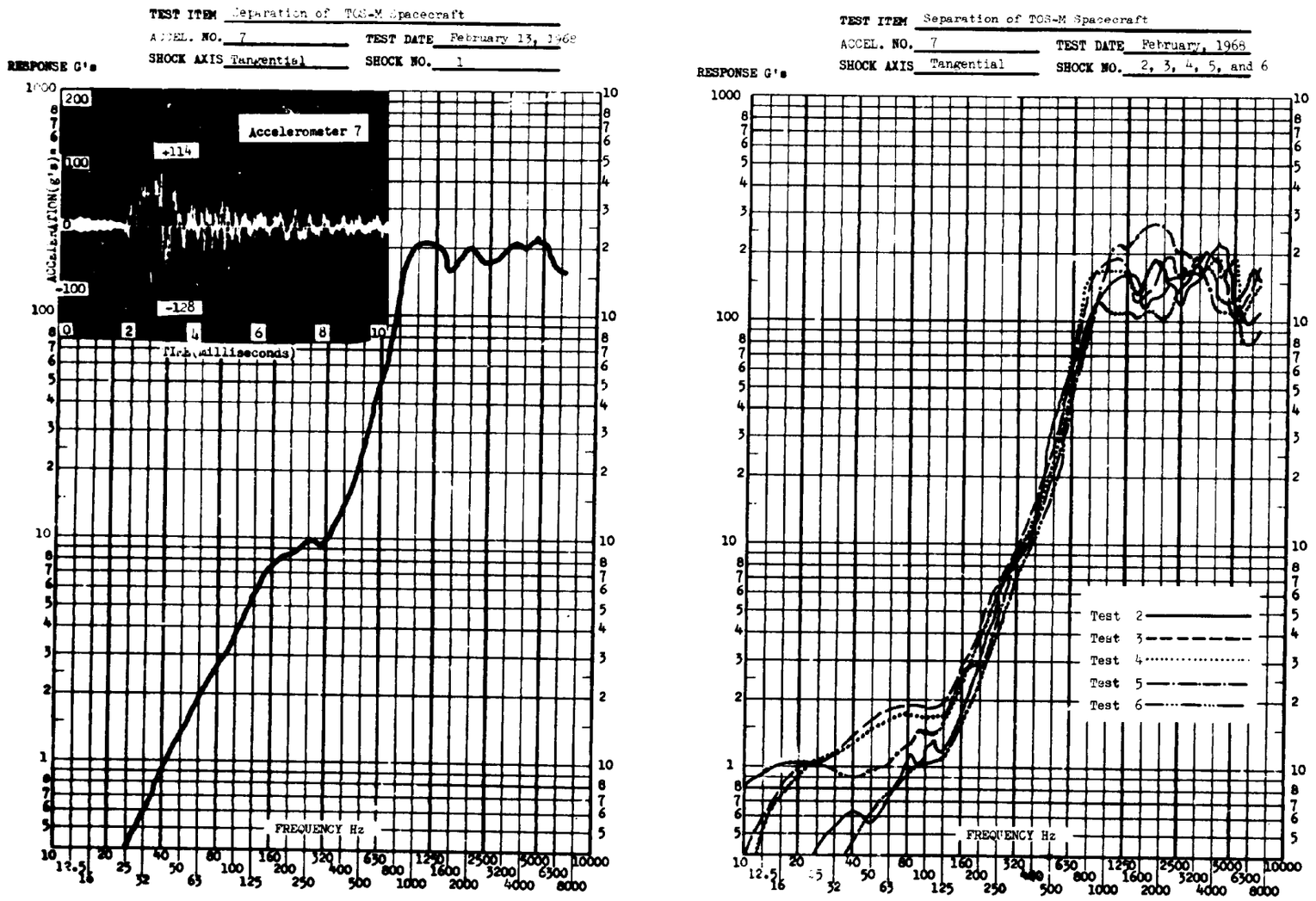
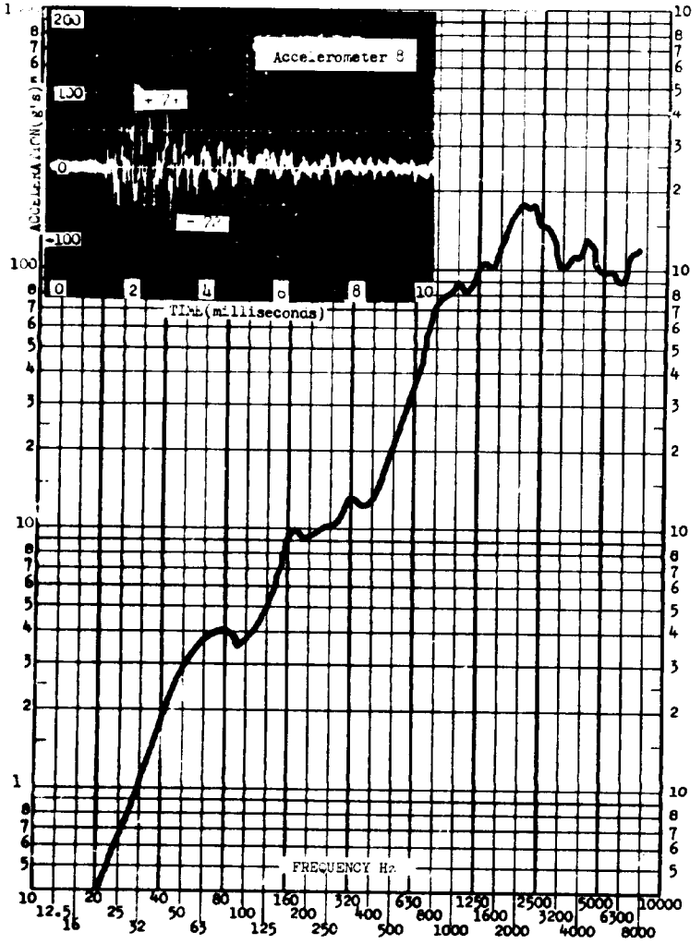



FIGURE III.B.2-9

TEST ITEM [illegible] Spacecraft
ACCEL. NO. [illegible] TEST DATE February 23, 1966
SHOCK AXIS Radial SHOCK NO. 1

RESPONSE G's




TEST ITEM Separation of TOS-M Spacecraft
ACCEL. NO. 8 TEST DATE February, 1966
SHOCK AXIS Radial SHOCK NO. 2, 3, 4, 5 and 6

RESPONSE G's

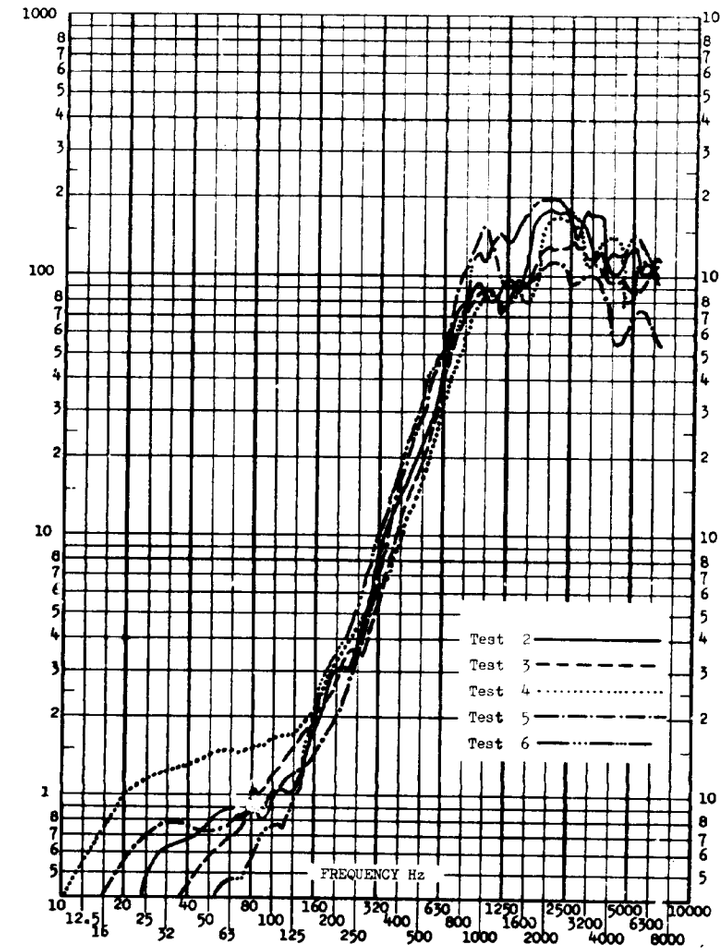
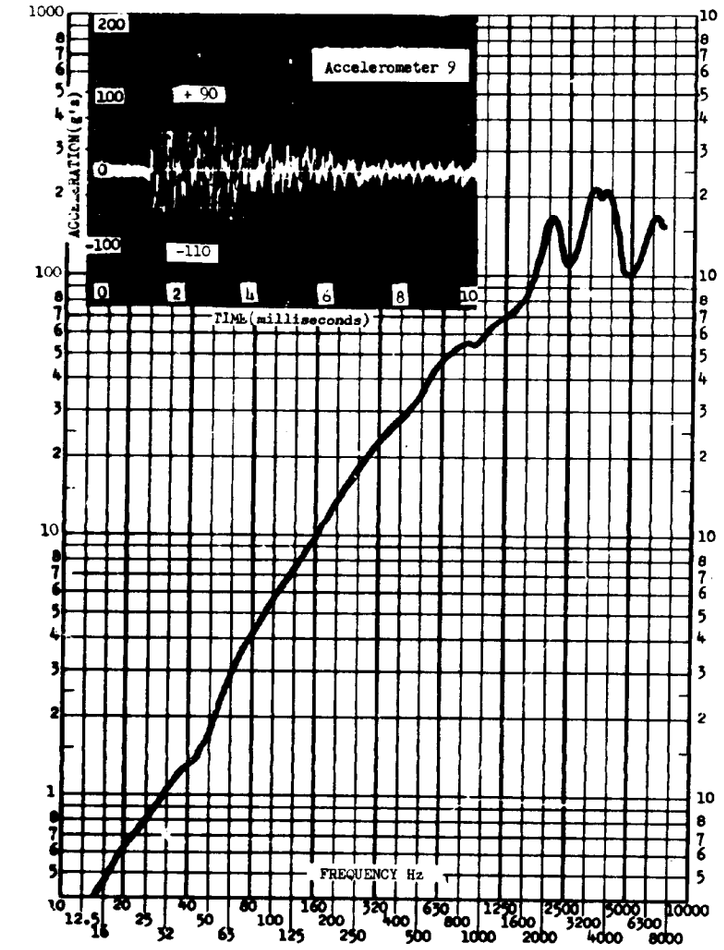



FIGURE III.B.2-10

TEST ITEM Separation of TOS-M Spacecraft
ACCEL. NO. 9 TEST DATE February 13, 1968
SHOCK AXIS Axial SHOCK NO. 1




TEST ITEM Separation of TOS-M Spacecraft
ACCEL. NO. 9 TEST DATE February, 1968
SHOCK AXIS Axial SHOCK NO. 2, 3, 4, 5, and 6

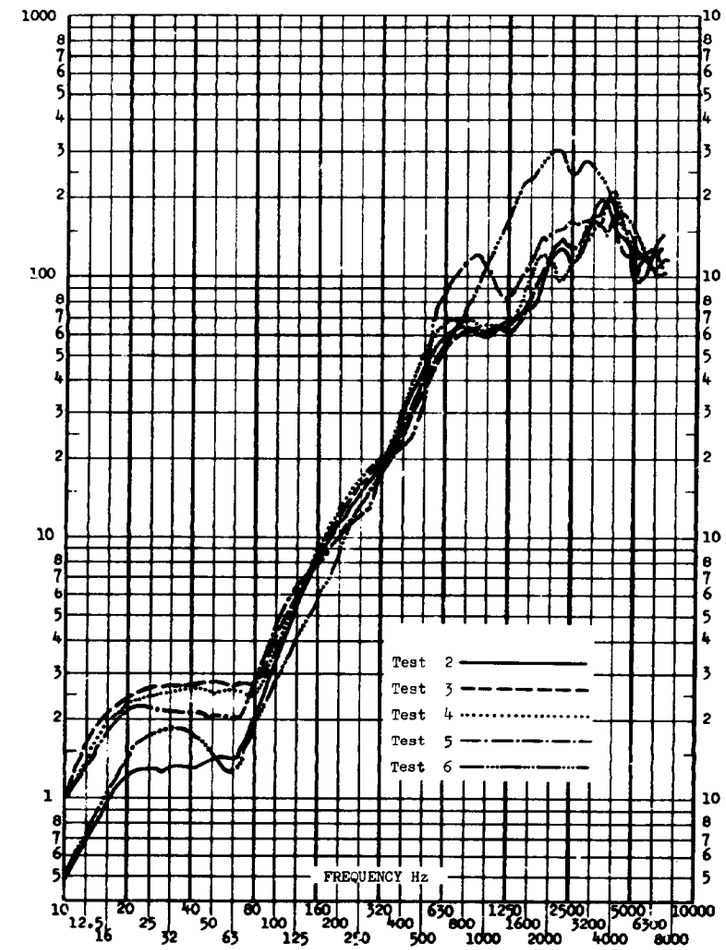
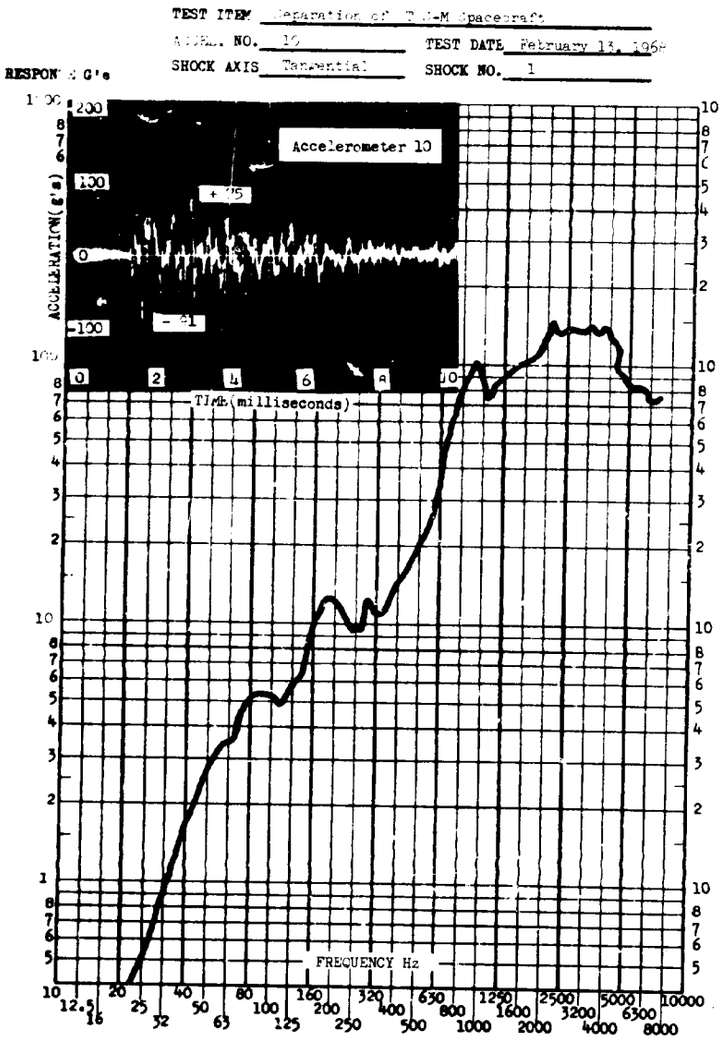



FIGURE III.B.2-11



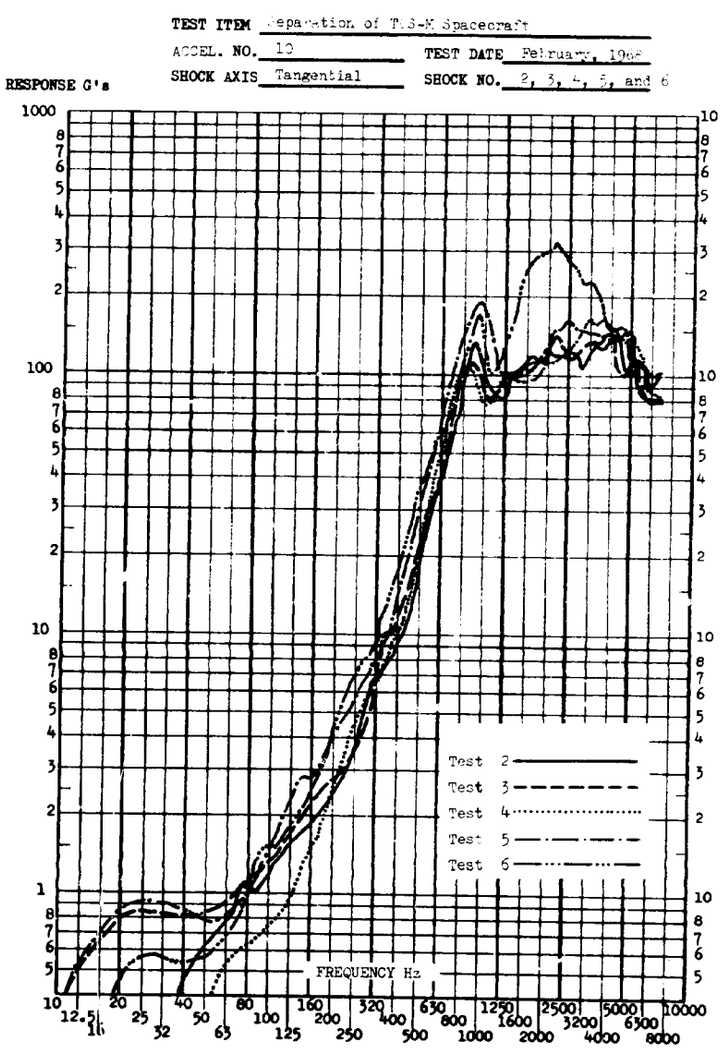
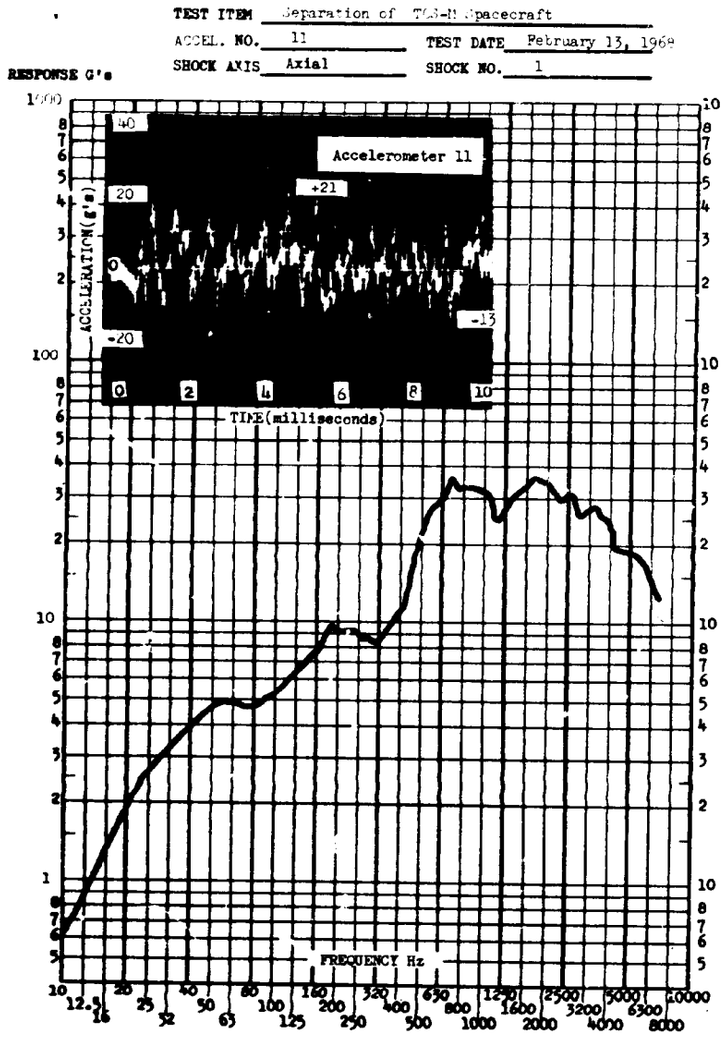




FIGURE III.B.2-12



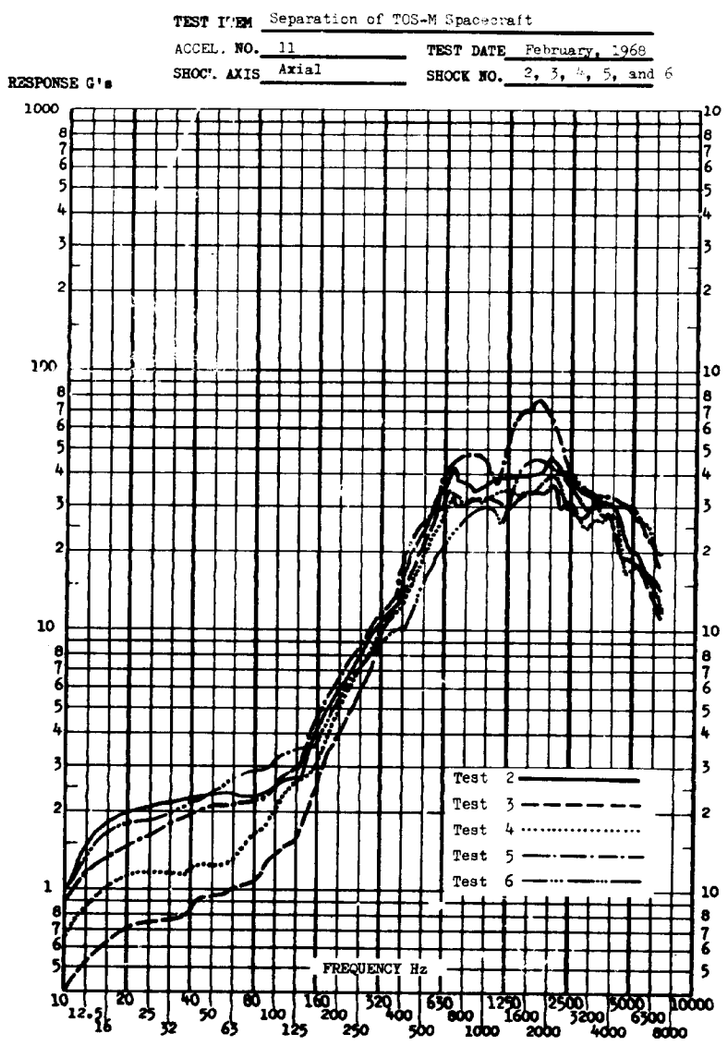
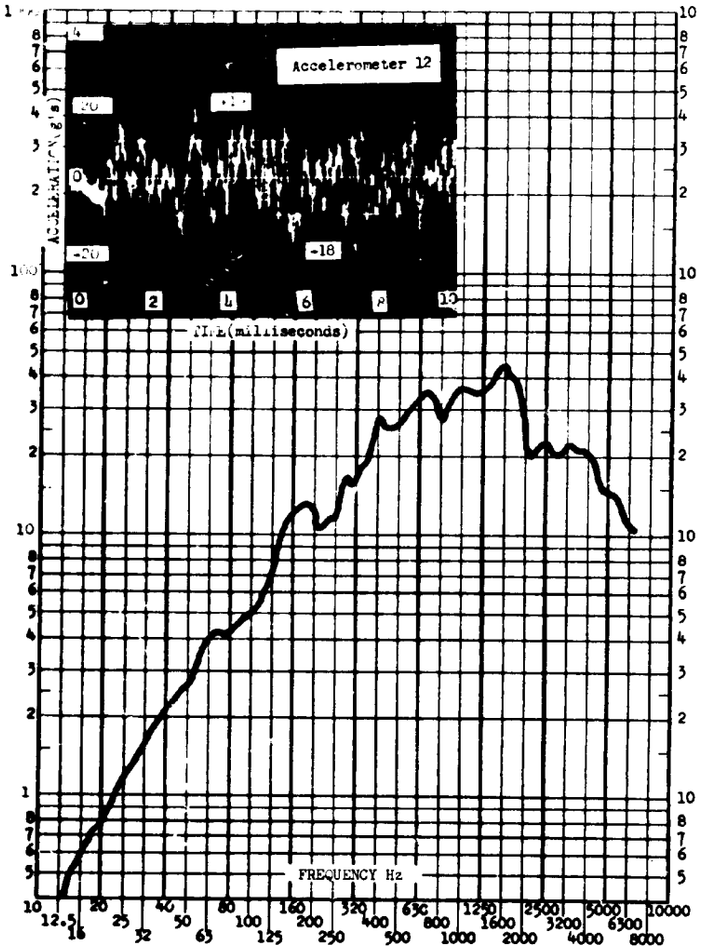




FIGURE III.B.2-13

TEST ITEM Separation of TOS-N Spacecraft
ACCEL. NO. 1 TEST DATE February 13, 1966
SHOCK AXIS Lateral SHOCK NO. 1

RESPONSE G's




TEST ITEM Separation of TOS-N Spacecraft
ACCEL. NO. 12 TEST DATE February, 1966
SHOCK AXIS Lateral SHOCK NO. 2, 3, 4, 5, and 6

RESPONSE G's

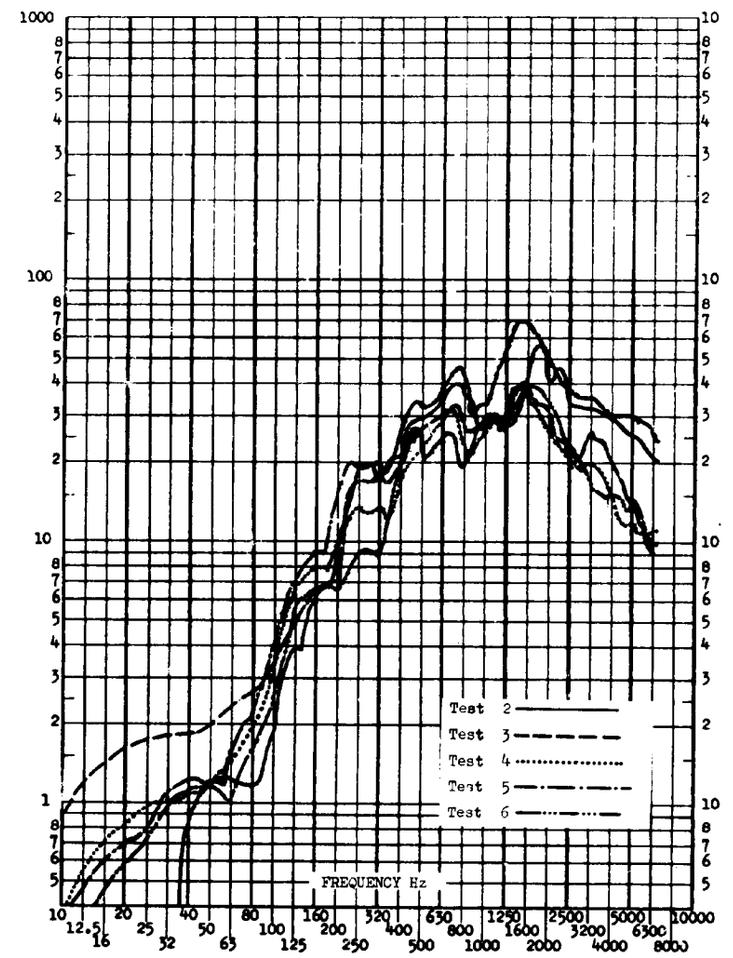



FIGURE III.8.2-14

SECTION III.B.3

ORBITING ASTRONOMICAL OBSERVATORY (OAO) SEPARATION TEST

PURPOSE OF TEST

The objective of this test was to determine the shock levels produced in the OAO spacecraft by the spacecraft separation event.

DESCRIPTION OF EVENT

The OAO spacecraft in flight configuration as illustrated in Figure III.B.3-1 was suspended with an adapter section attached to the aft end. The separation mechanism was a marmon clamp having 4 bolt cutters located ($90^{o}$ apart) around the spacecraft/adapter interface. The bolt cutter locations are shown in Figures III.B.3-2 and III.B.3-4. After detonation of the bolt cutters, the adapter section fell freely away from the spacecraft and was brought to rest by a net as depicted in Figure III.B.3-3.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of time histories | 23 |
| No. of shock spectra | 23 |
| Type of Analysis | digital |
| Sample rate | 12,500/second |
| Duration | see time histories |

| | |
|---|---|
| Frequency range | 20-5000 Hz |
| Frequency increment | 10 Hz |
| Damping | Q=10 |

These shock spectra are presented along with their corresponding time histories as Figures III.B.3-5 through Figure III.B.3-27

DESCRIPTION OF PYROTECHNIC

Each of the four bolt cutter assemblies is released by the detonation of a pressure cartridge that shears the heads off four bolts at each location. However, the attachment assembly consists of a hinge type fitting such that the large load carrying bolt is not cut, but smaller bolts (approximately No. 10 screws) were severed to affect spacecraft separation.

The pressure cartridge used was a McCormick-Selph part No. 5401.

DESCRIPTION OF STRUCTURE

The OAO spacecraft is a structure of octagonal cross section consisting of a central cylindrical shell surrounded by a region of truss structure where all the experiments are housed. A truss type structure divides the outer region into eight longitudinal bays with letter names as indicated in Figure III.B.3-4. A longitudinal truss member separating two bays is denoted by the letters of the two adjacent

bays. In other words, the members between bays A and B would be cited as "truss AB". Furthermore, there are two longitudinal truss members associated with the description "truss AB": an outter member at the corner of the octagon and an inboard member at the junction of the central cylinder.

The structure also subdivides each bay into six segments (shelves) stacked one above the other. These segments are designated by numbers from 1 to 6, numbering from the top down. Hence, the next to the bottom segment in Bay D would be designated as location "D-5". Figure III.B.3-1 presents a view of the entire structure.

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2221C

Locations: Table III.B.3-1 and Figure III.C.3-4

Axis of Sensitivity: Table III.B.3-1 with the coordinate system in Figure III.B.3-4.

DESCRIPTION OF DATA ACQUISITION SYSTEM

Tape recorder: Ampex FR1200

Amplifiers: Charge type amplifiers manufactured by Endevco, Dynamics and Unholtz-Dickie.

COMMENTS

Due to the rather low sampling rate of 12,500 samples per second, the shock spectra are considered to loose validity at frequencies above 1250 to 1600 Hz.

TABLE III.B.3-1

DESCRIPTION OF ACCELEROMETERS

| Accelerometer Location No. | Location | Station | Sensitive Axis | Figure No(s). |
|---|---|---|---|---|
| 11 | EMT* Bay B-1 | 45 | X | III.B.3-5 |
| 16 | EMT Bay B-6 | 150 | X,Y | -6,-7 |
| 35 | EMT Bay D-6 | 150 | X,Y,Z | -8,-9,-10 |
| 49 | EMT Bay F-1 | 50 | X,Z | -11,-12 |
| 58 | EMT Bay F-6 | 156 | X,Y,Z | -13,-14,-15 |
| 73 | EMT Bay H-6 | 150 | X,Y | -16,-17 |
| 90 | Inboard Truss EF | 156 | X,Y | -18,-19 |
| 100 | Outter Truss EF | 138 | X,Y,Z | -20,-21,-22 |
| 106 | Outter Truss EF | 80 | X,Z | -23,-24 |
| 121 | Inboard Truss AB | 120 | X,Y,Z | -25,-26,-27 |

*EMT = equipment mounting point on a truss structure called the star tracker frame.




FIGURE III.B.3-1. Overall View of OAO Test Configuration

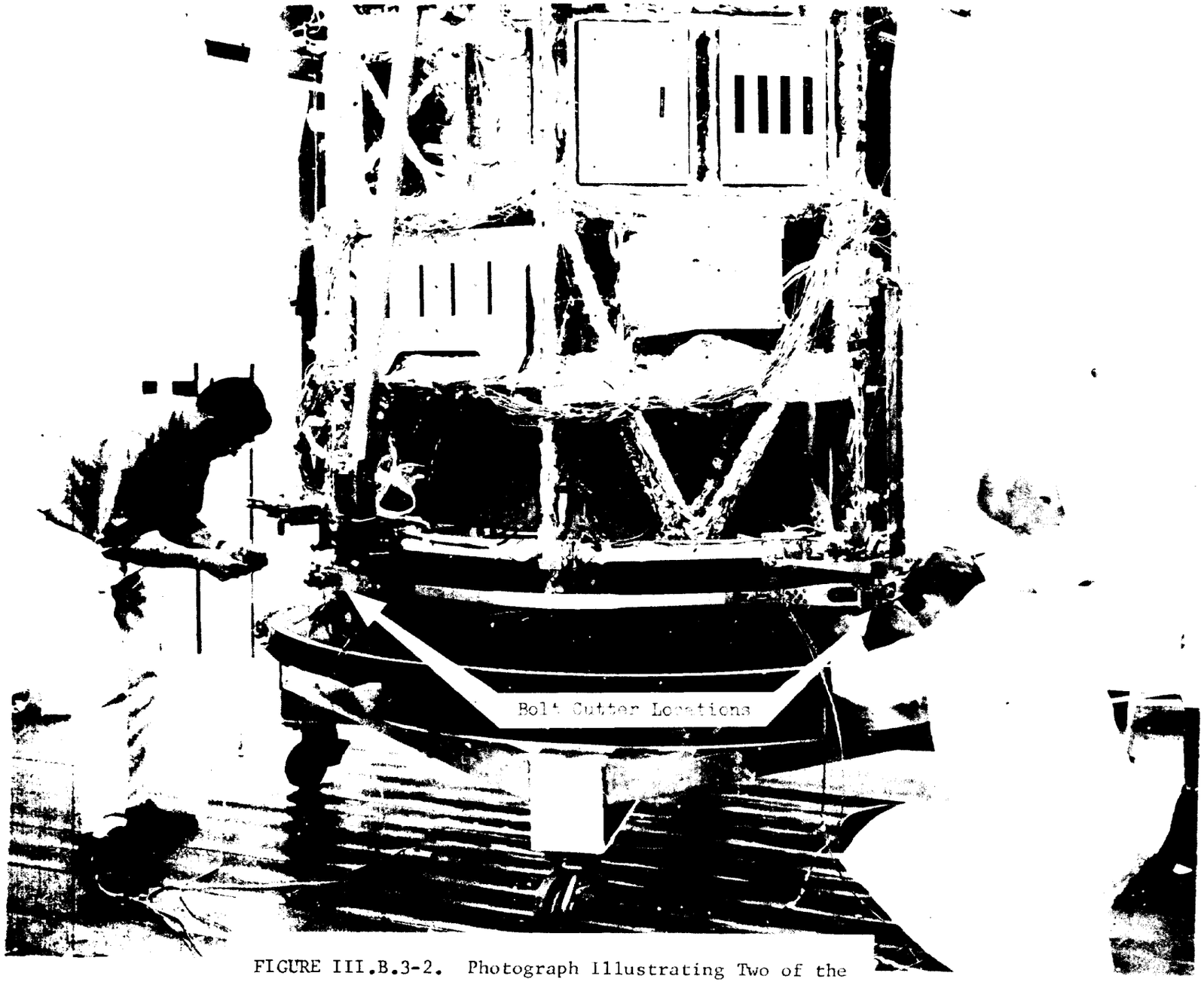



FIGURE III.B.3-2. Photograph Illustrating Two of the Four Bolt Cutter Locations

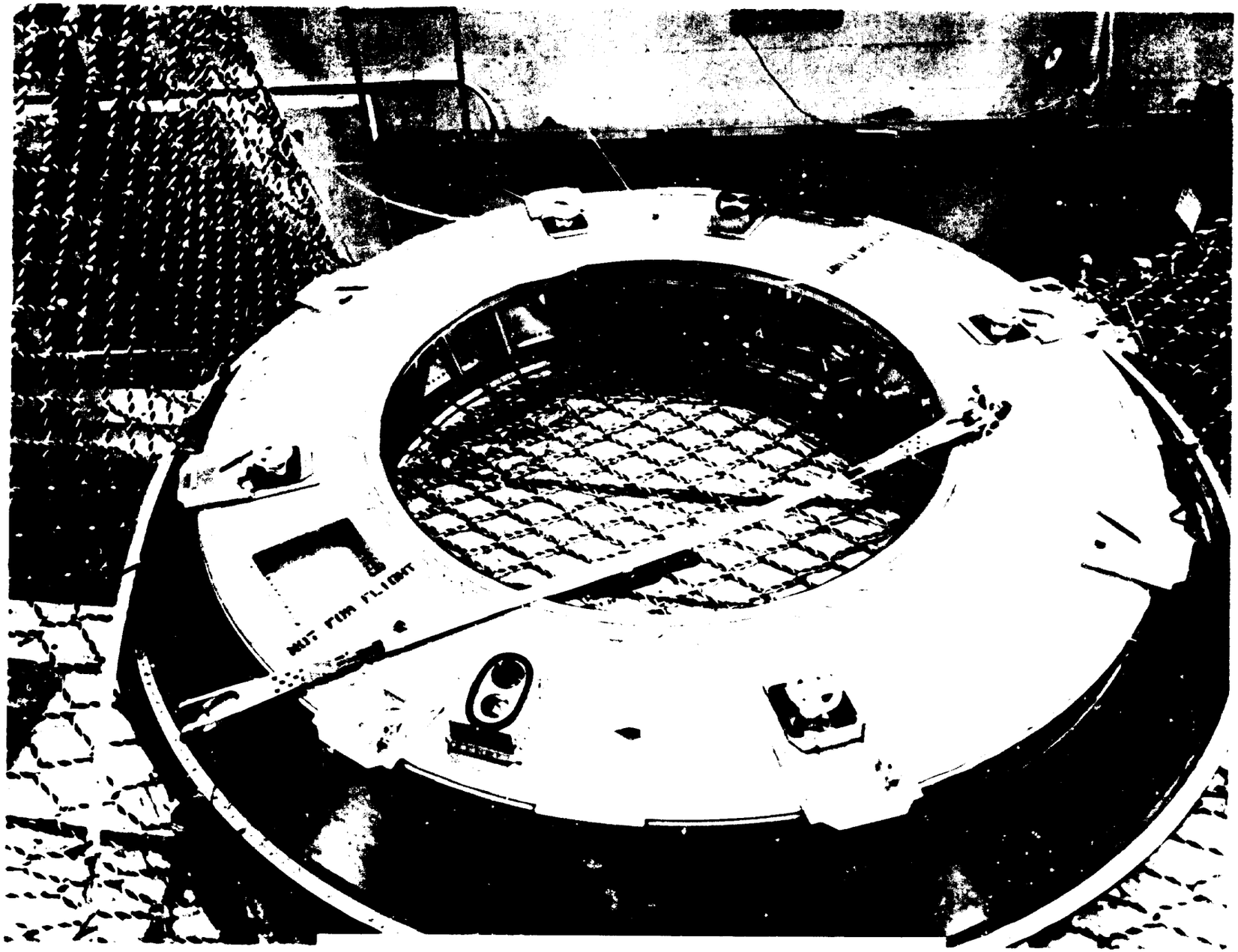



FIGURE III.B.3-3. View of Separated Adapter Section

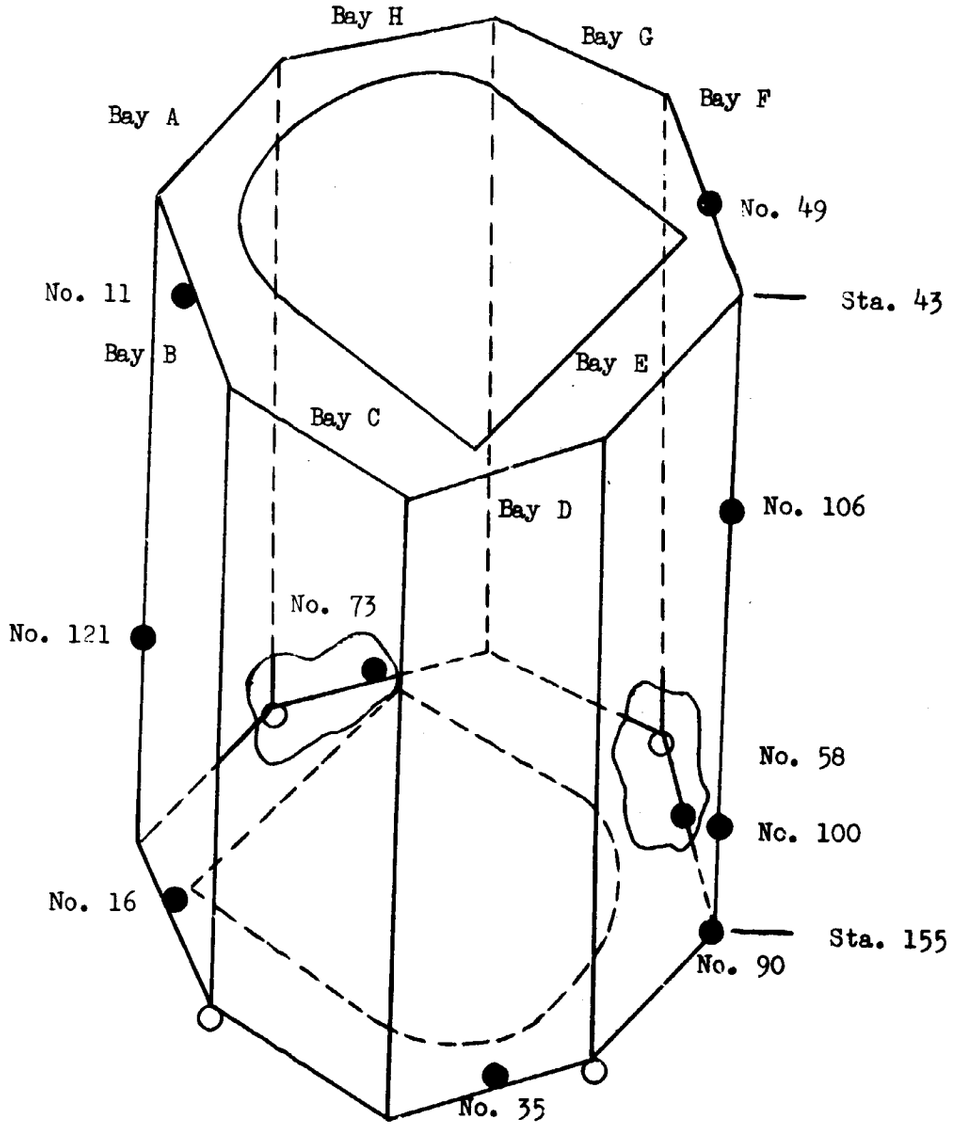
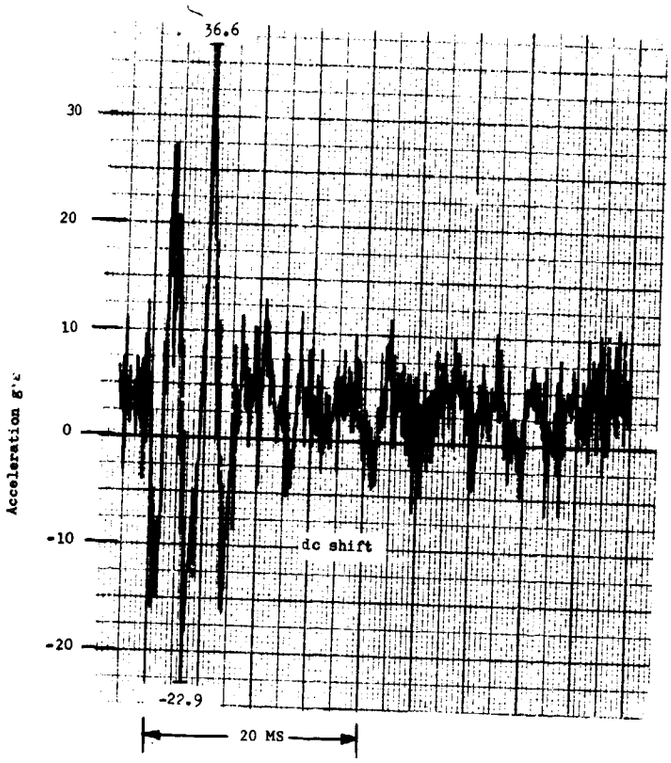



Figure III.B.3-4. Schematic of Accelerometer Locations



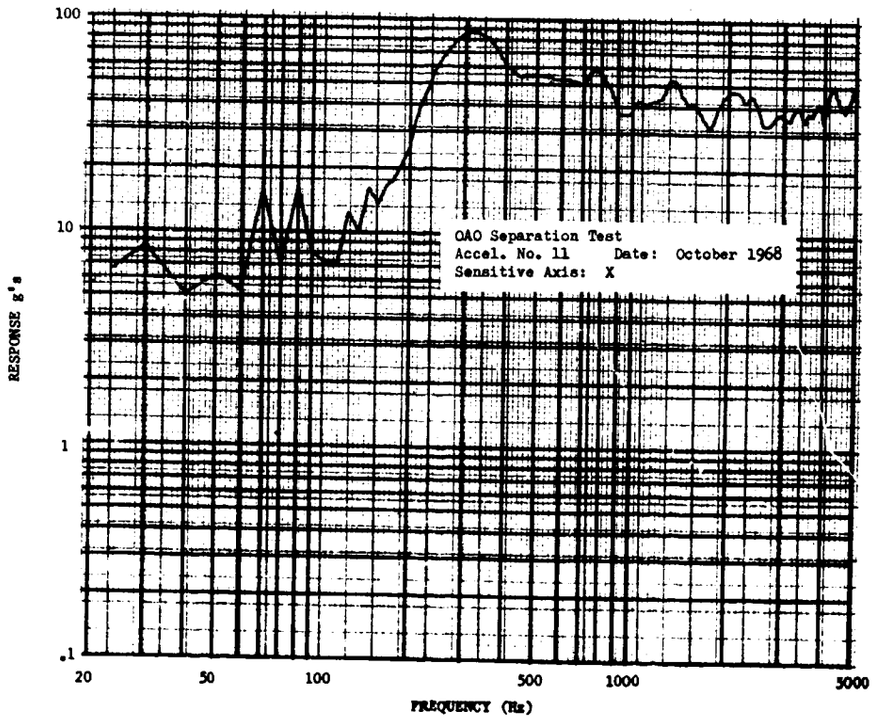
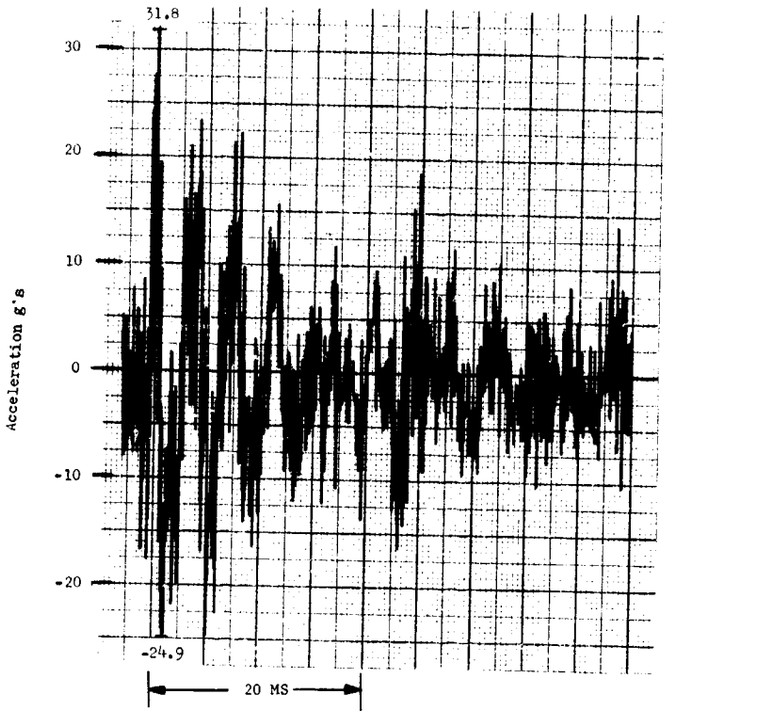




FIGURE III.B.3-5



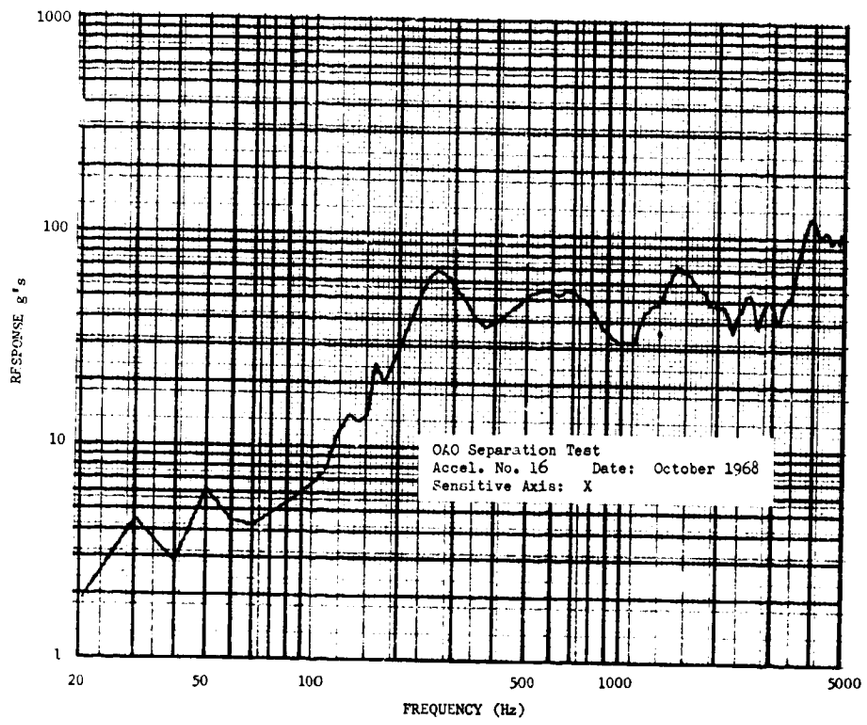
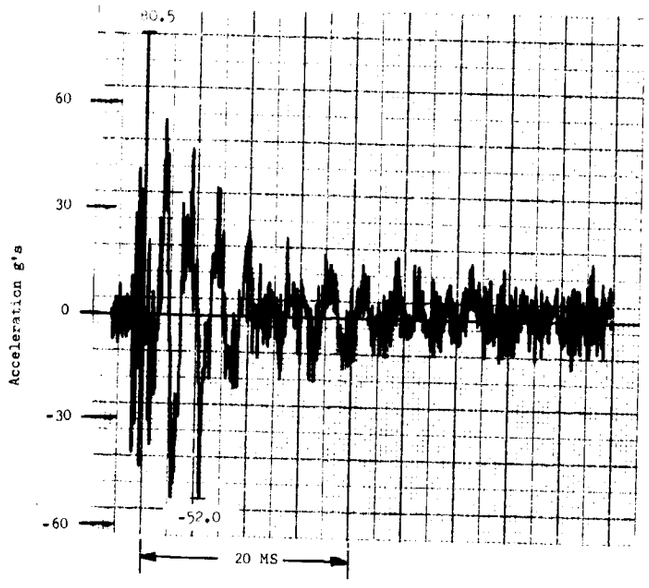




FIGURE III.B.3-6



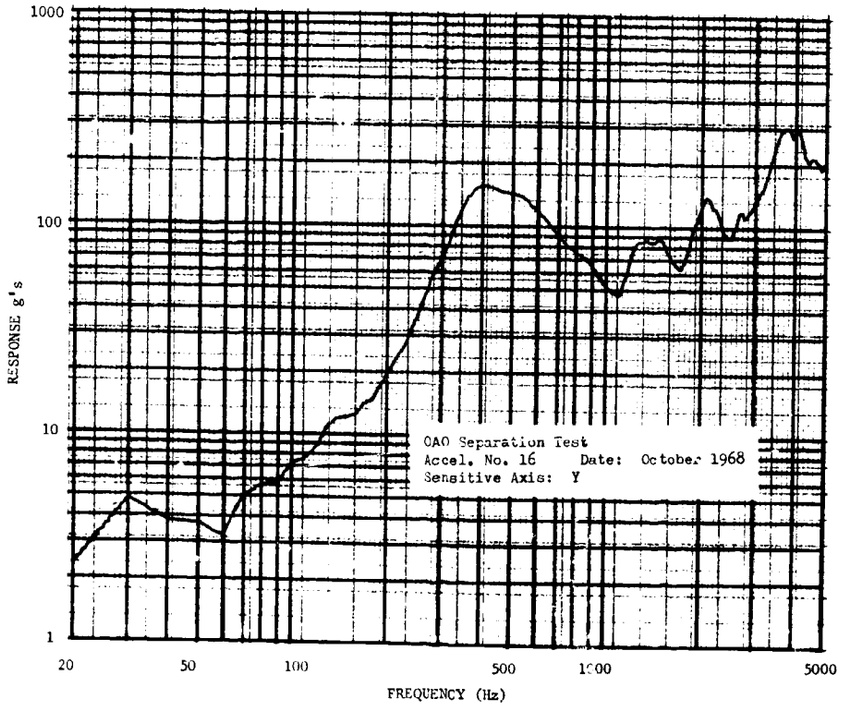




FIGURE III.B.3-7

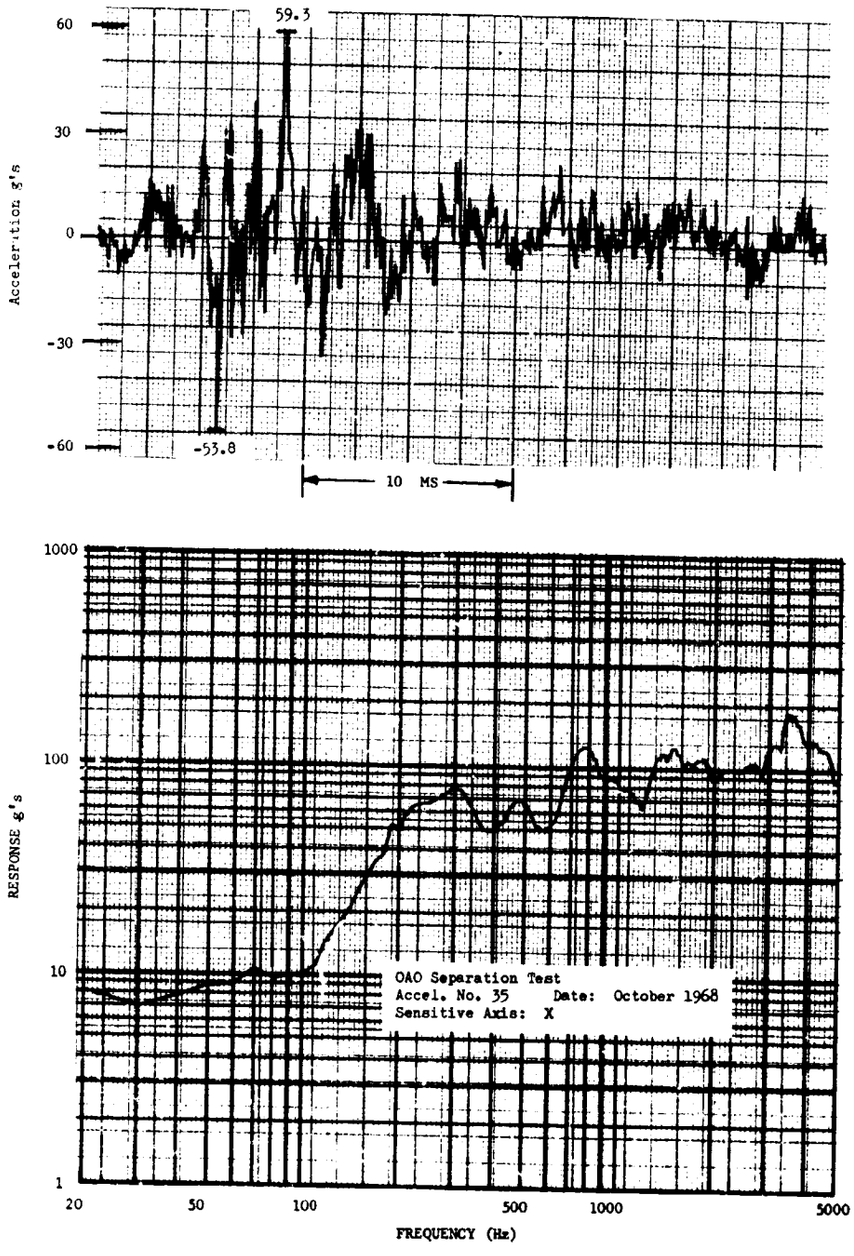



FIGURE III.B.3-8

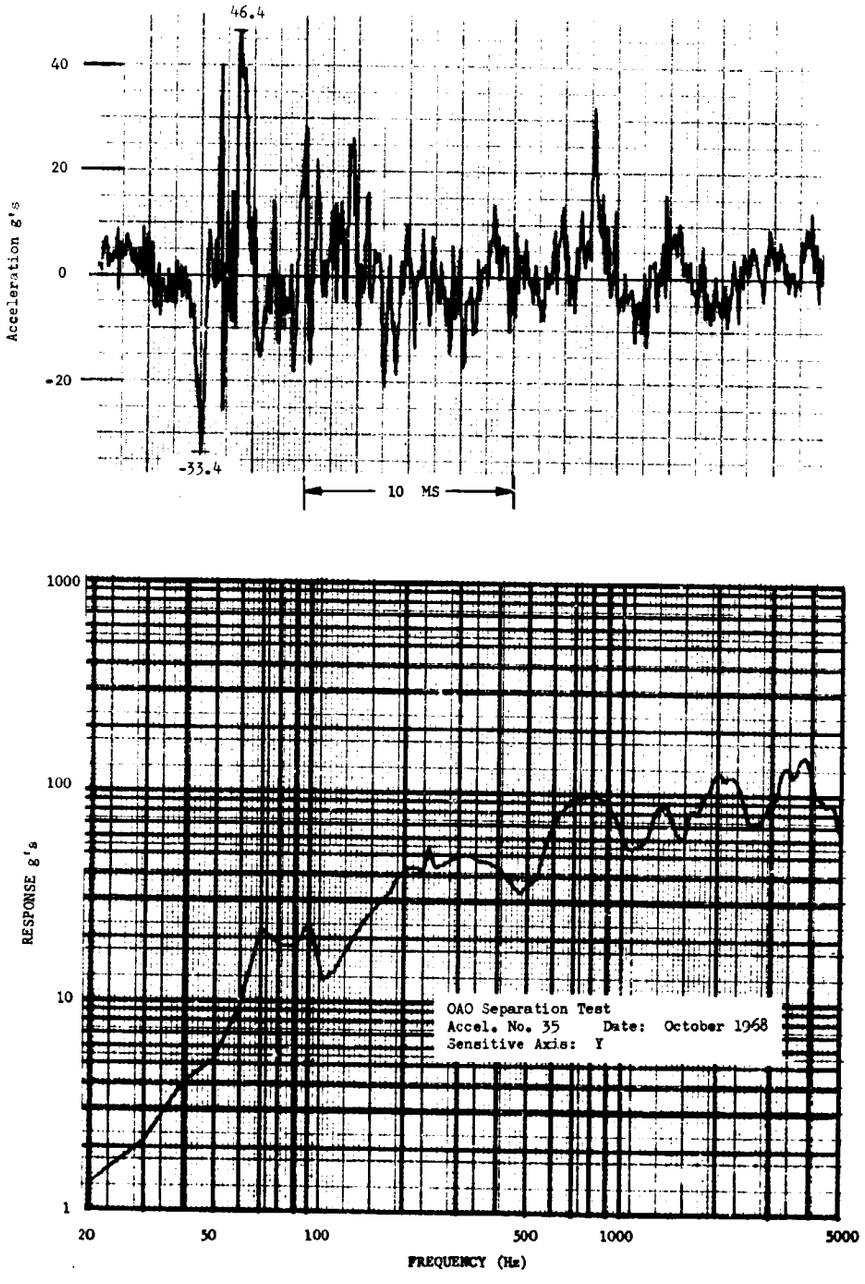
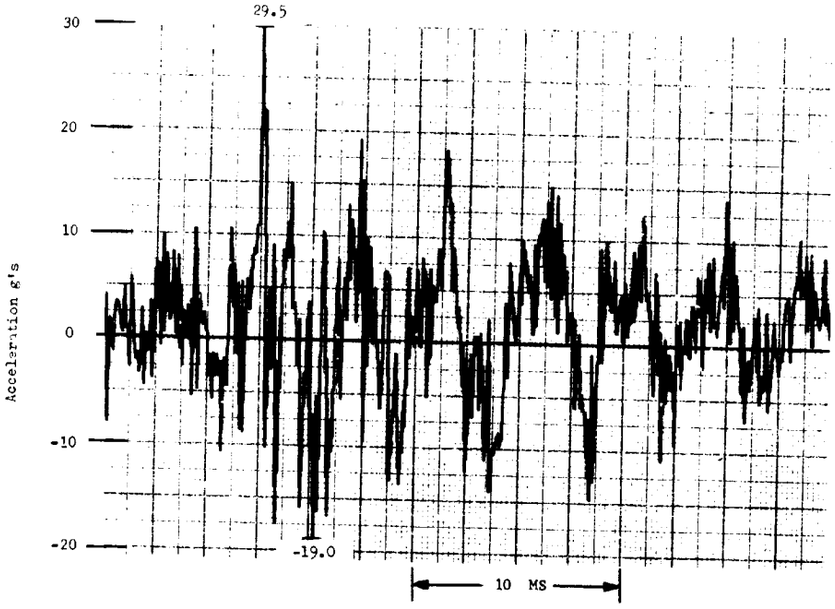



FIGURE III.B.3-9



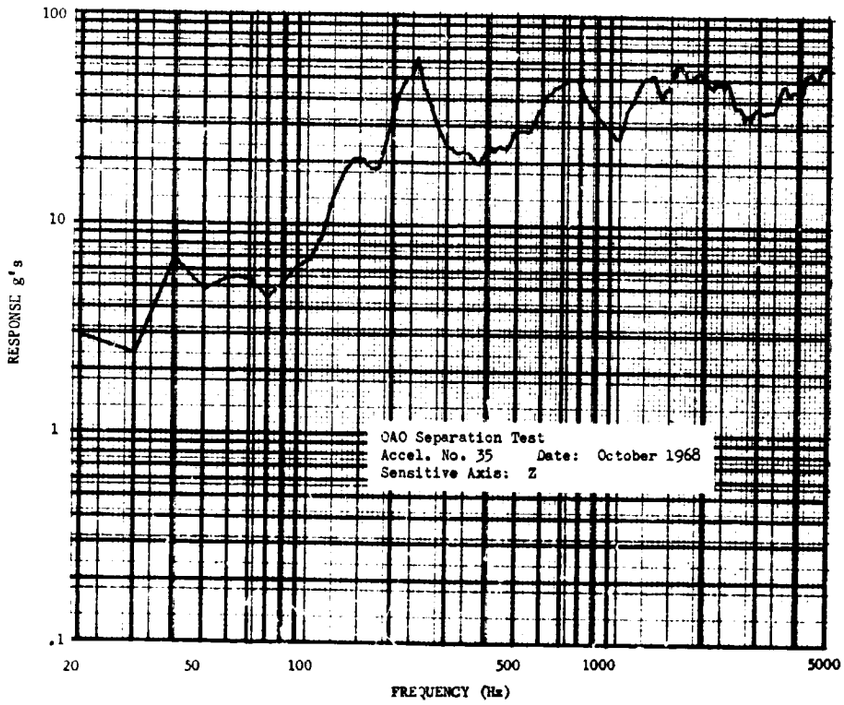
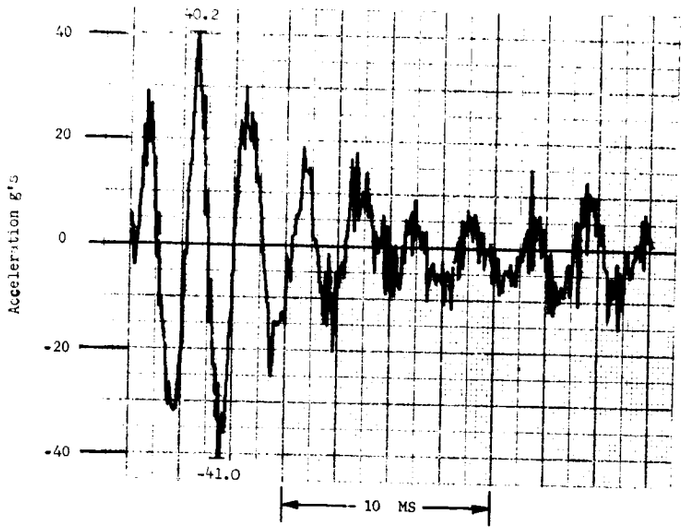




FIGURE III.B.3-10



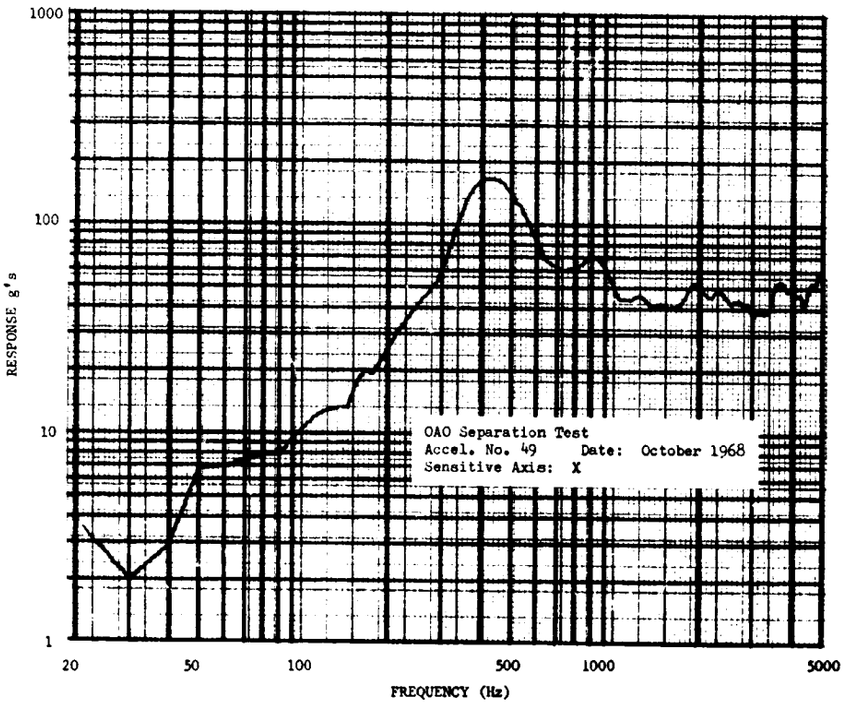
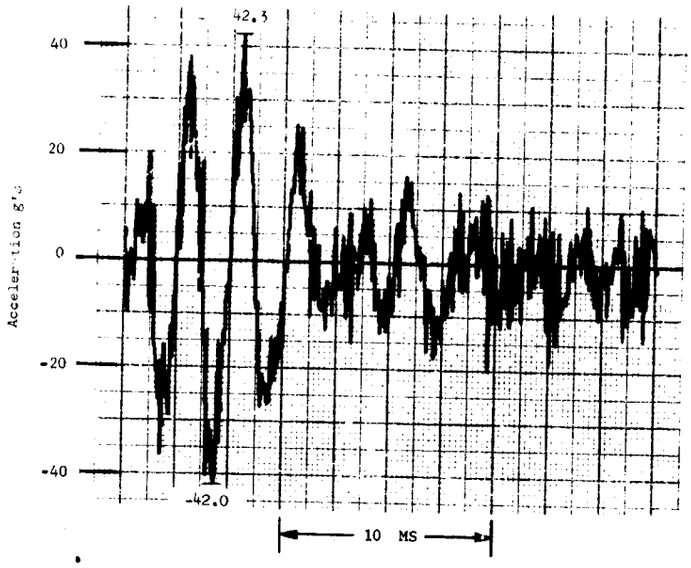




FIGURE III.B.3-11



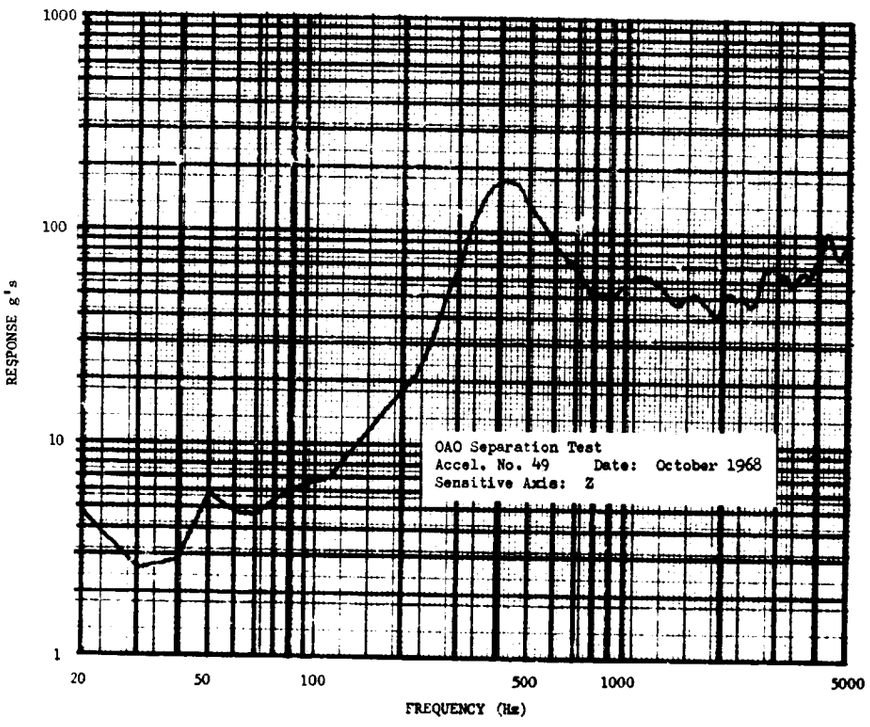
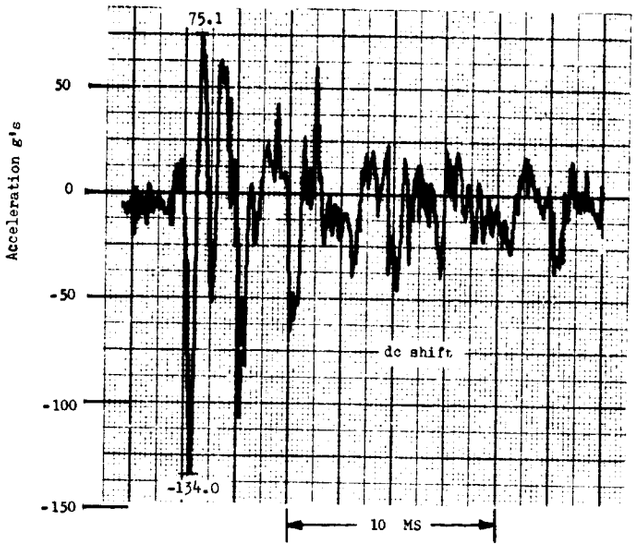




FIGURE III.B.3-12



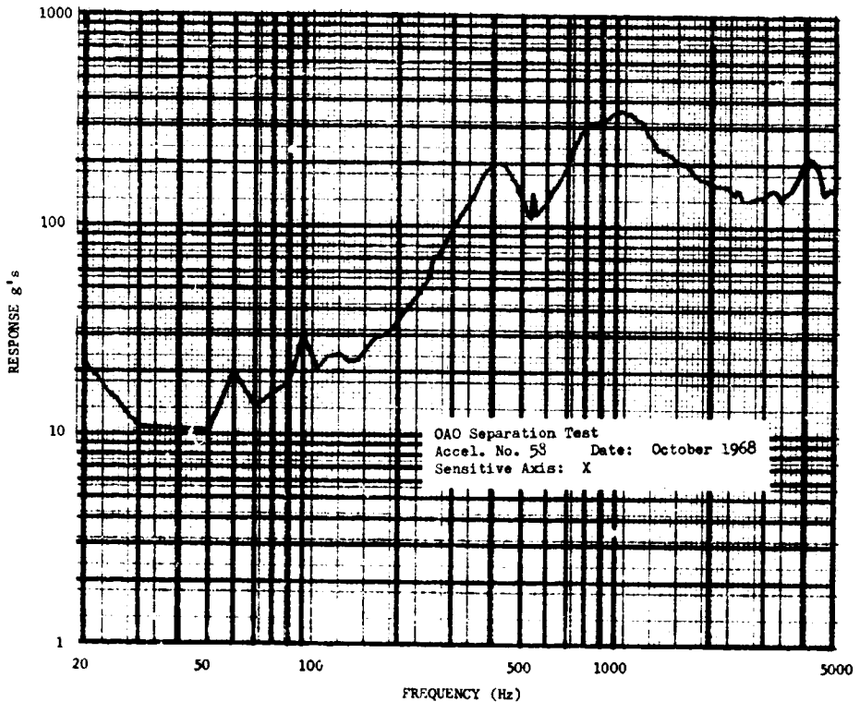
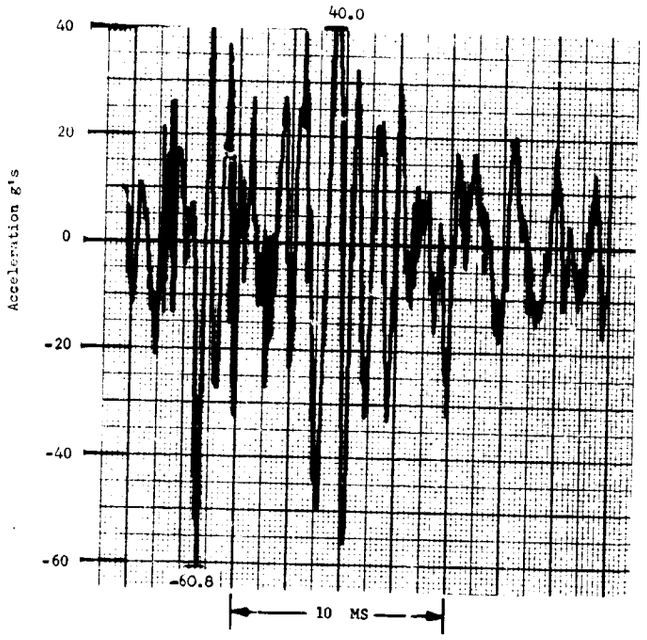




FIGURE III.B.3-13



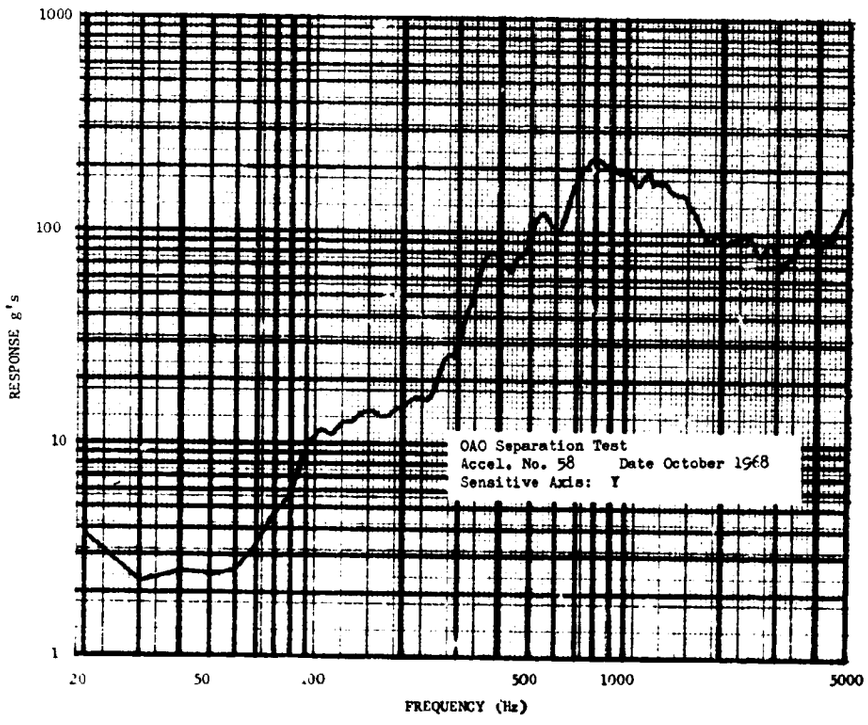
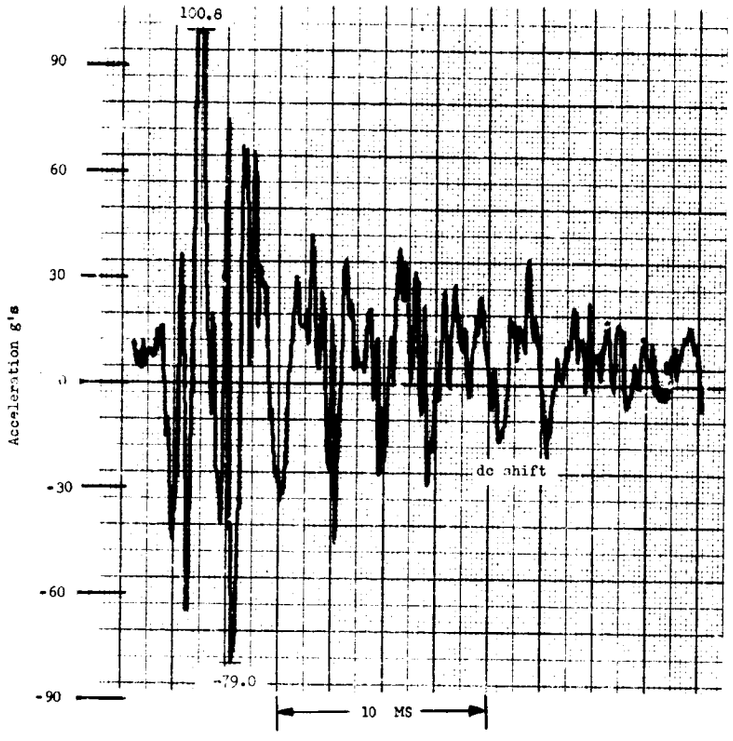




FIGURE III.B.3-14



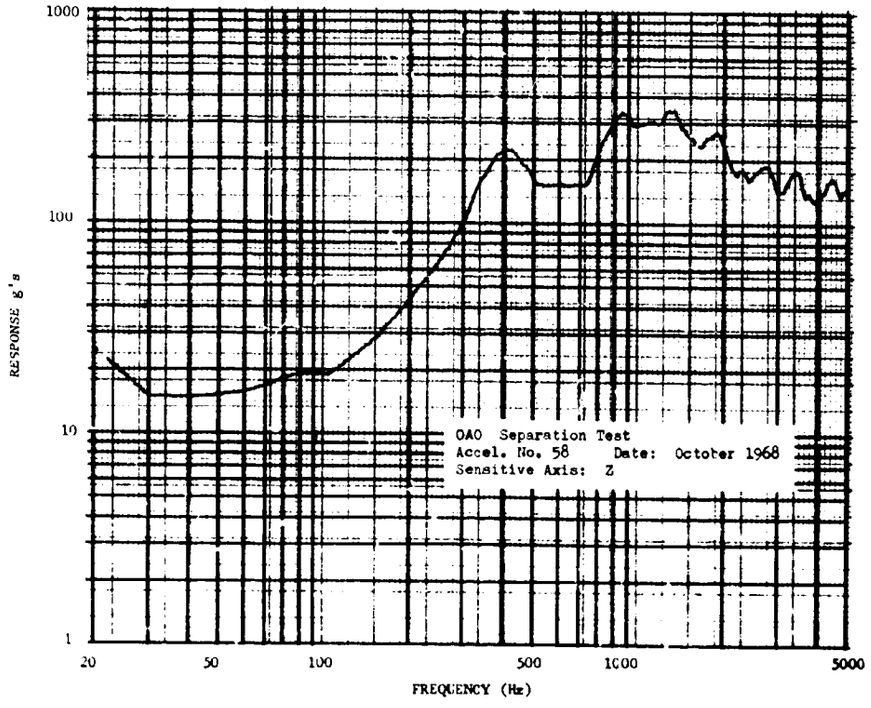
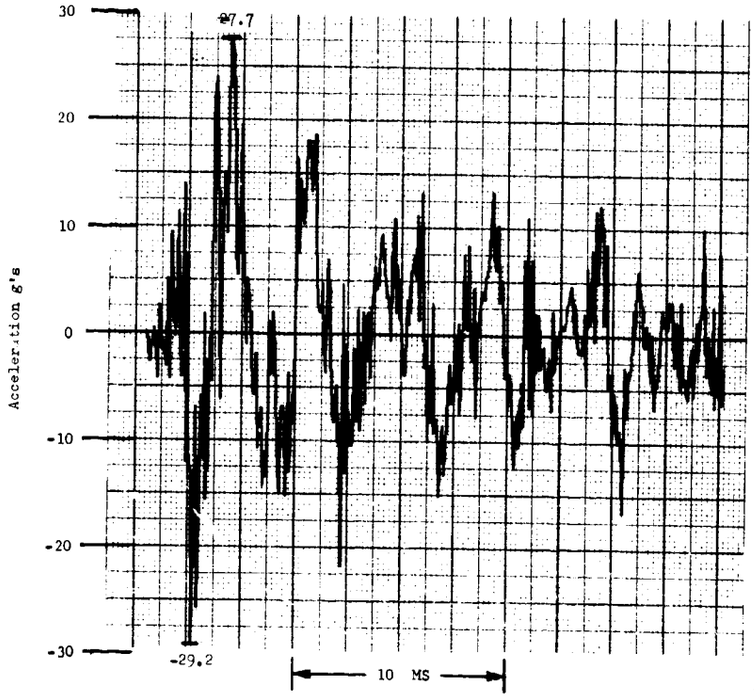




FIGURE III.B.3-15



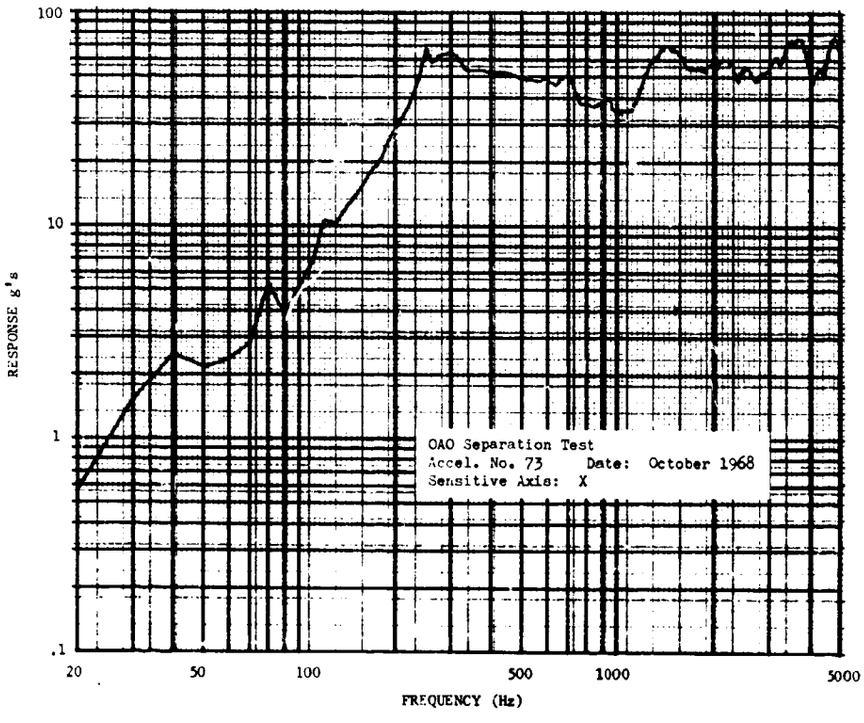
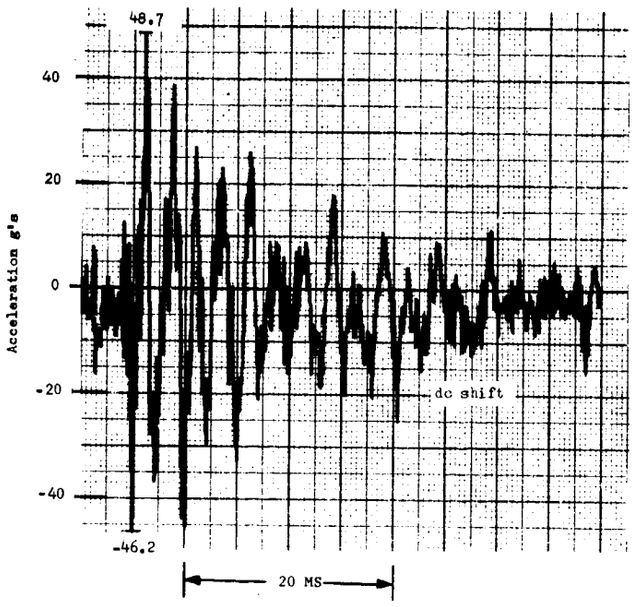




FIGURE III.B.3-16



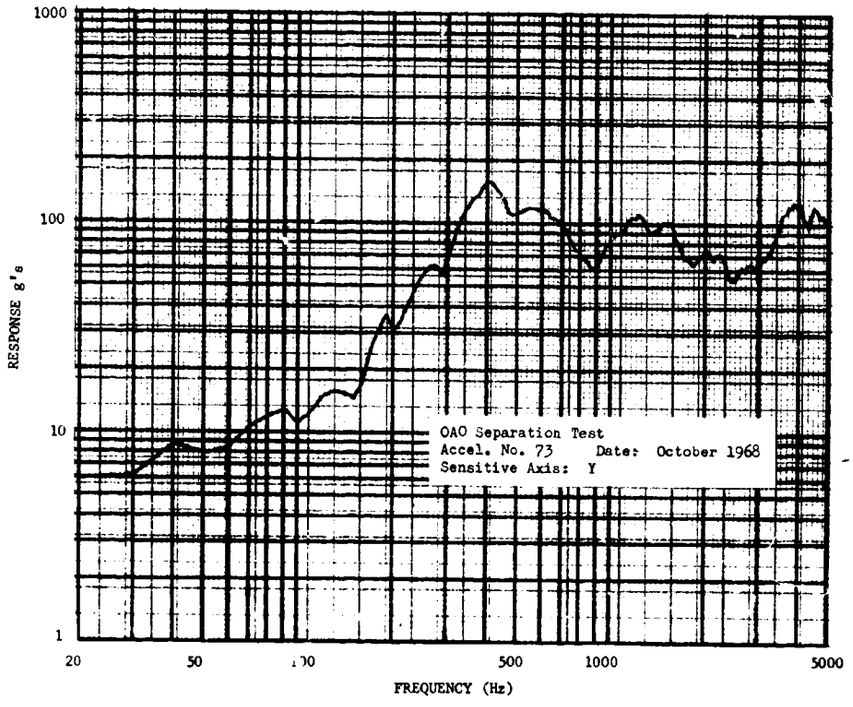
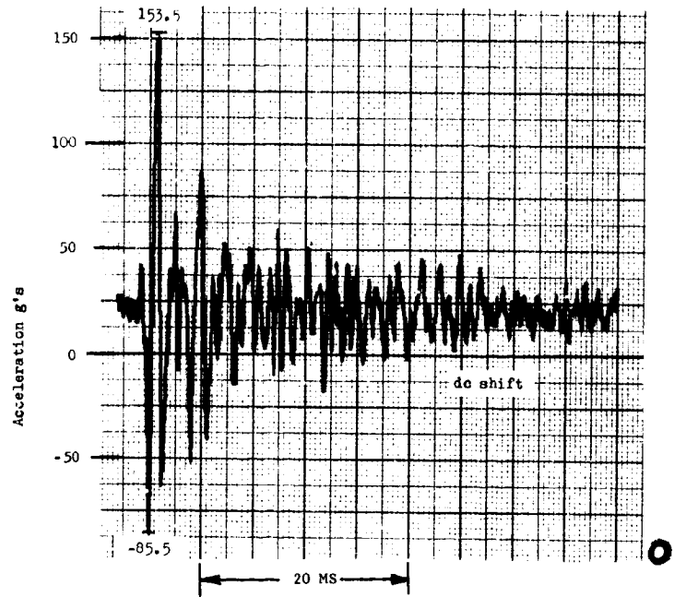




FIGURE III.B.3-17



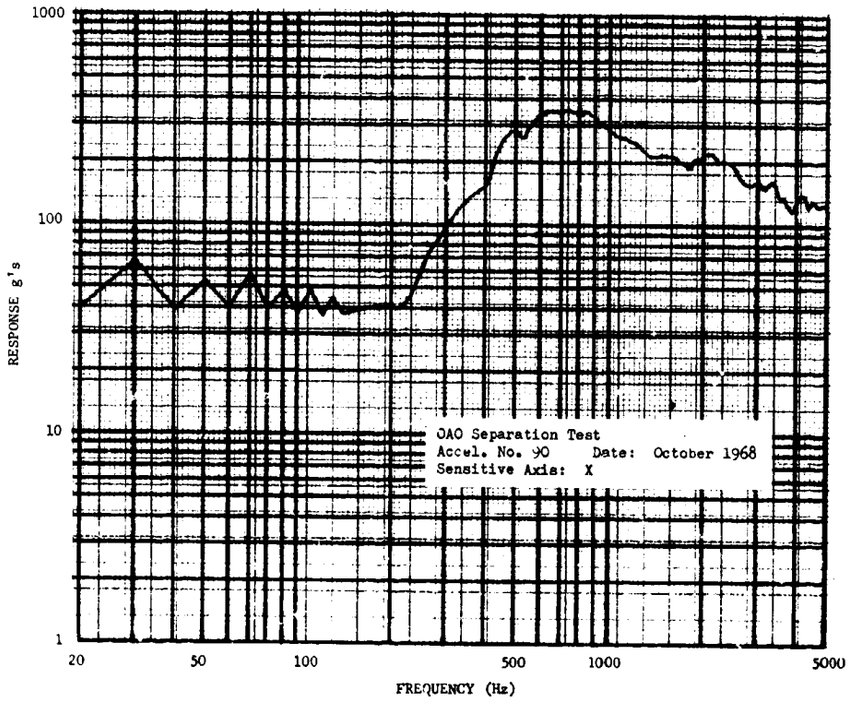
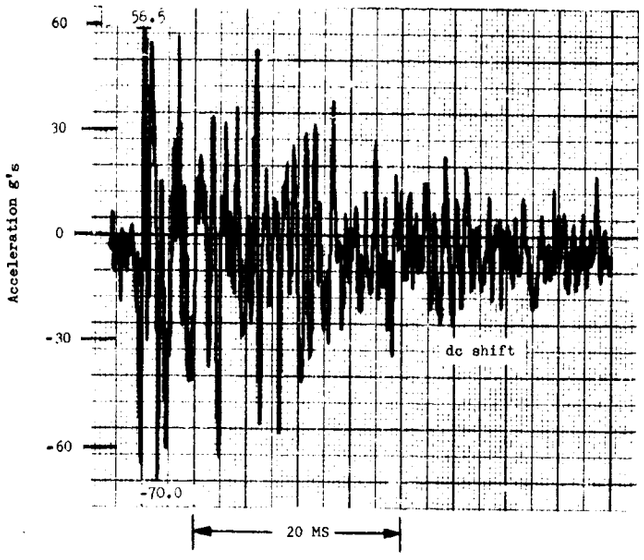




FIGURE III.B.3-18



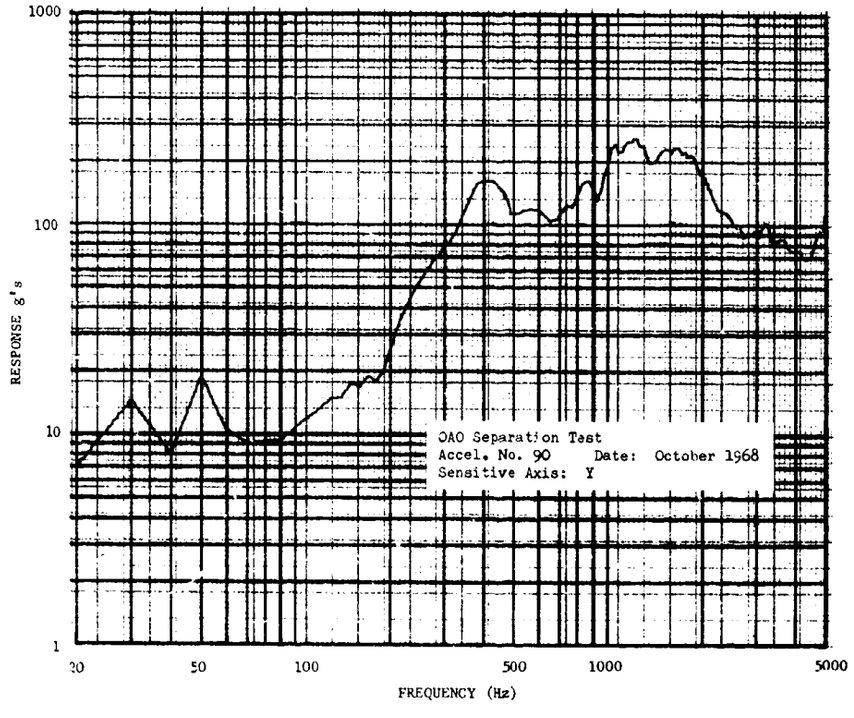
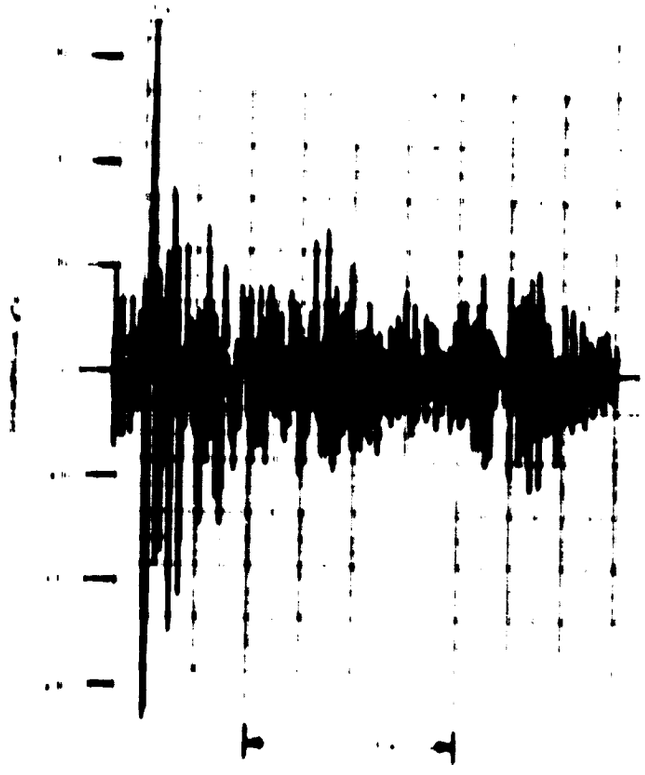
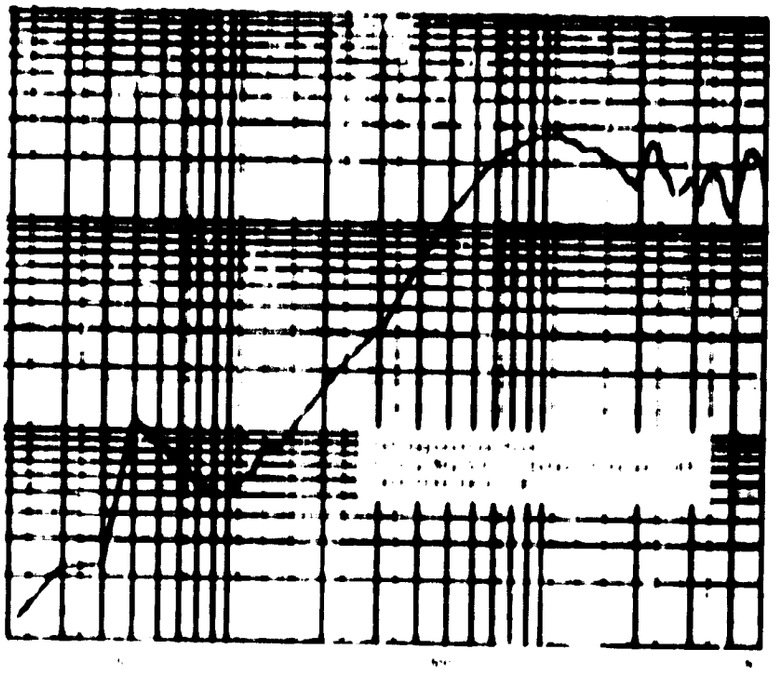
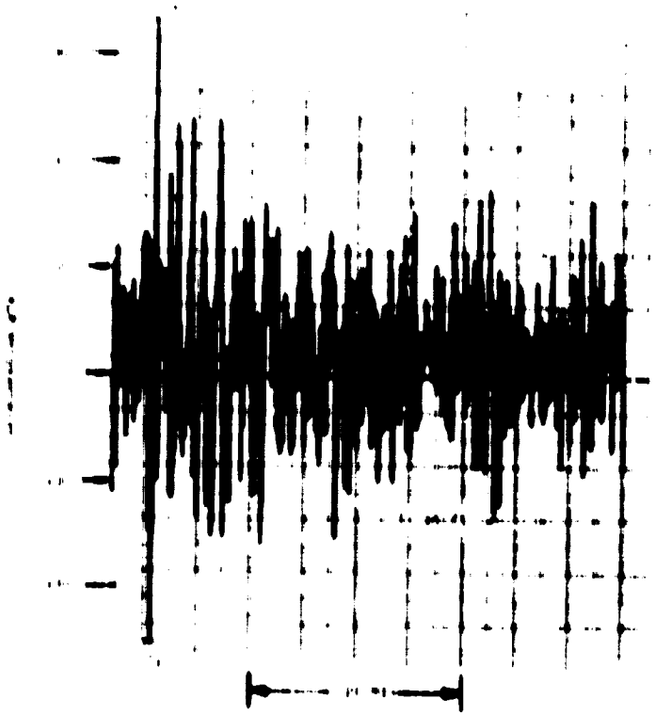



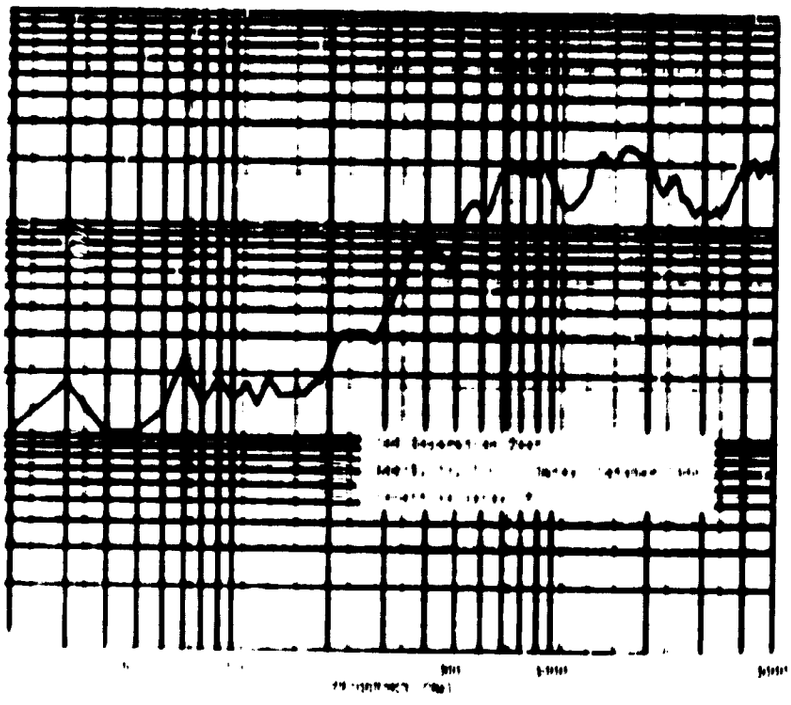

FIGURE III.B.3-19





J01





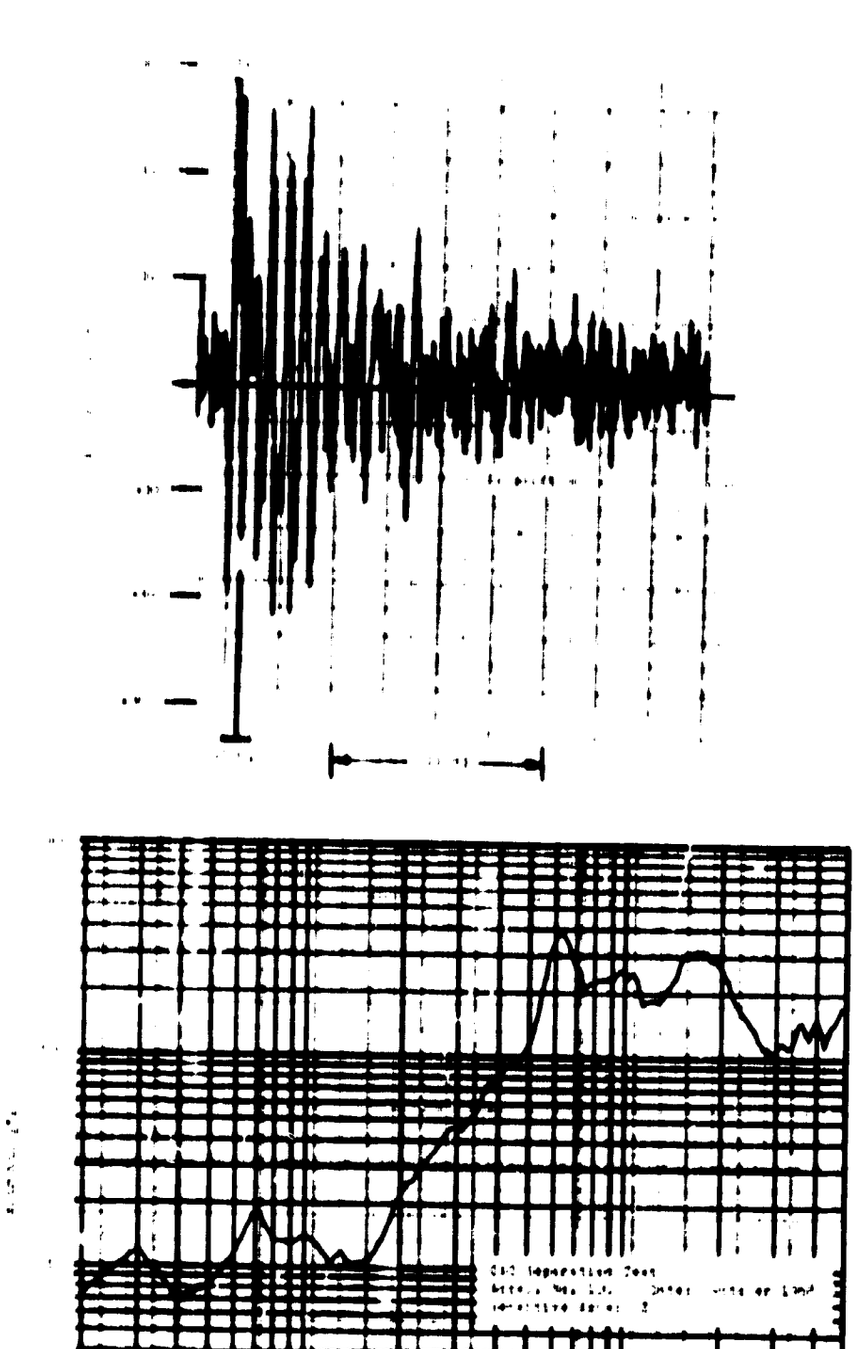
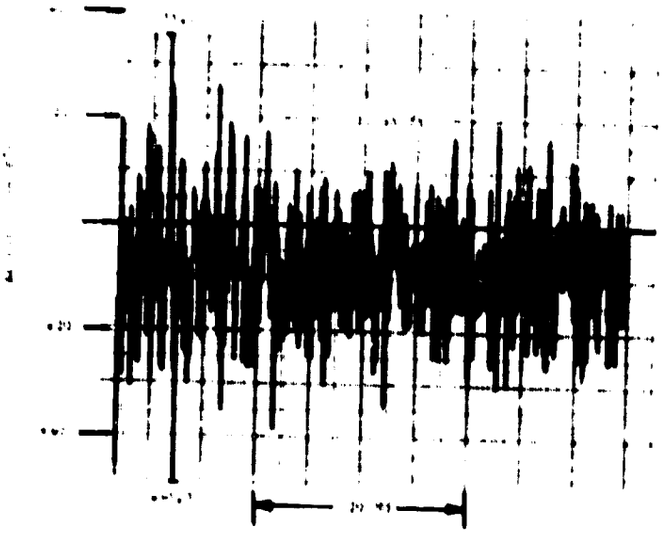


FIGURE III.B.1-22



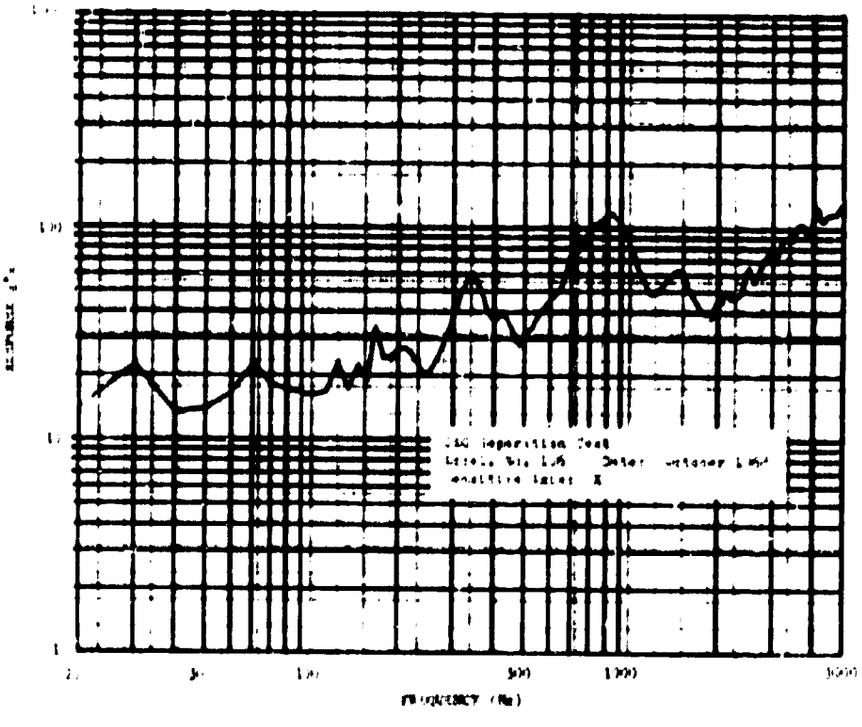
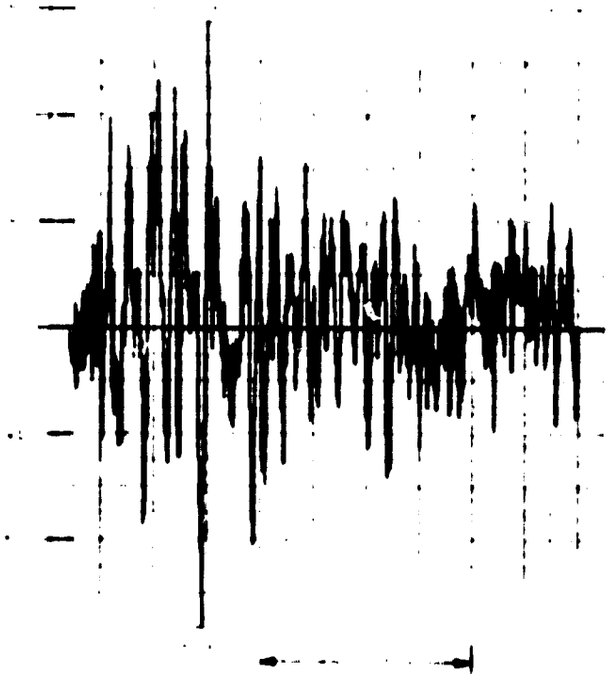
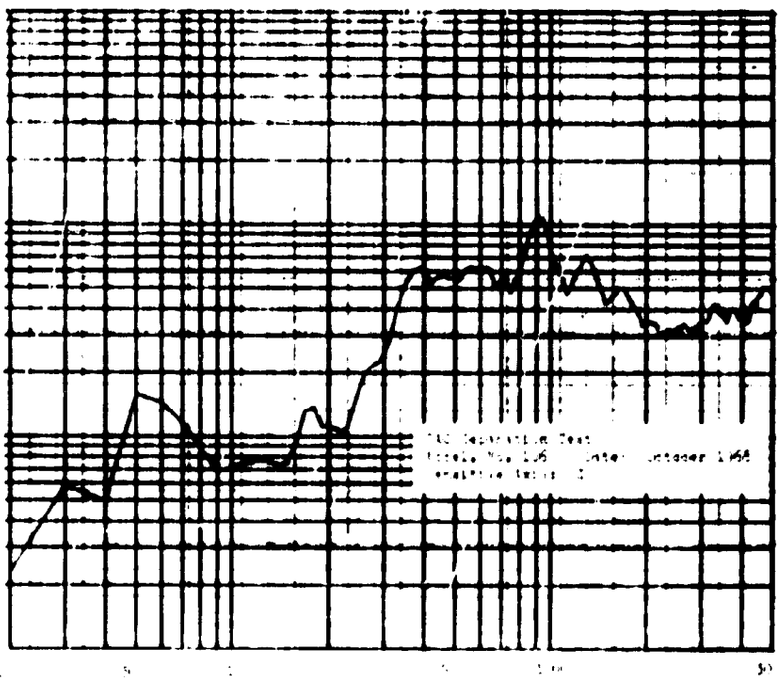
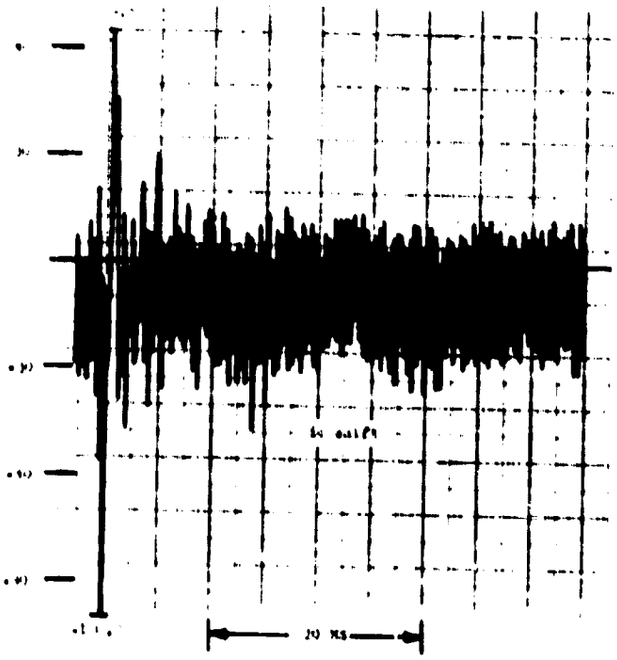


FIGURE III.B.3-23







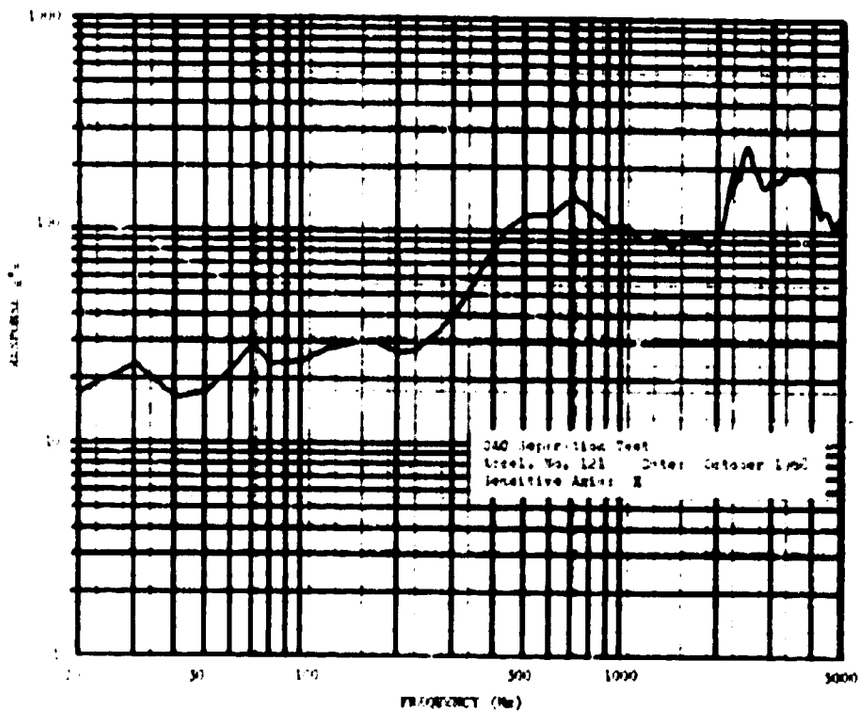
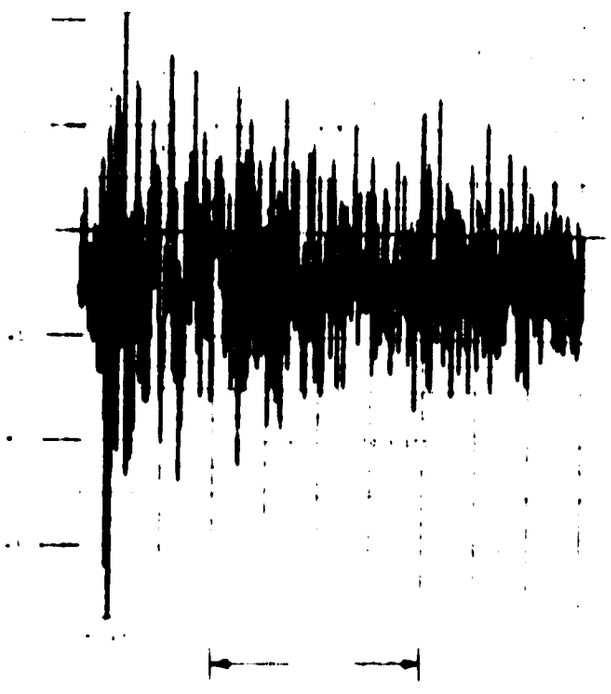
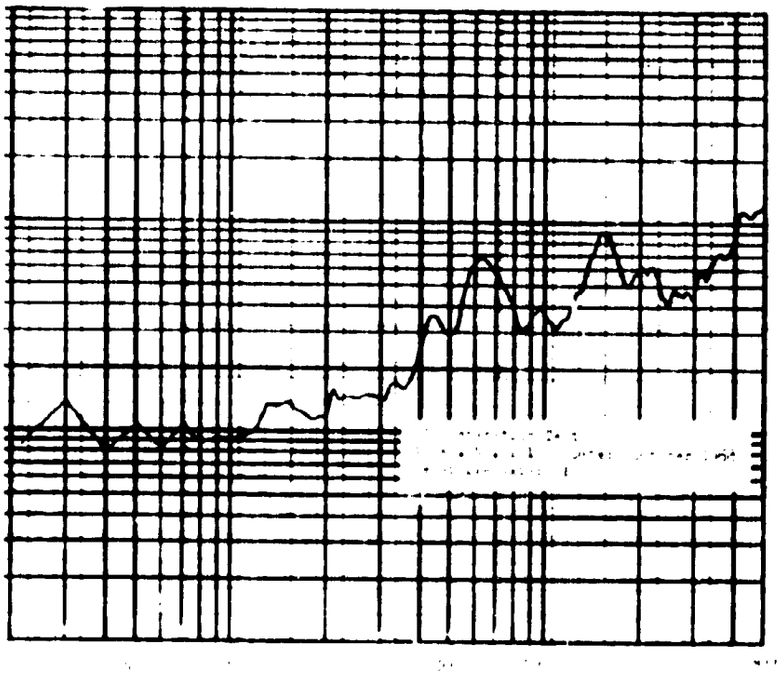
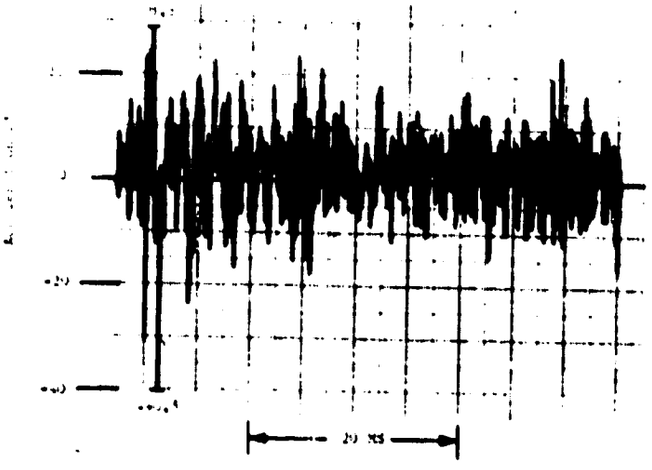




FIGURE III.B.3-25







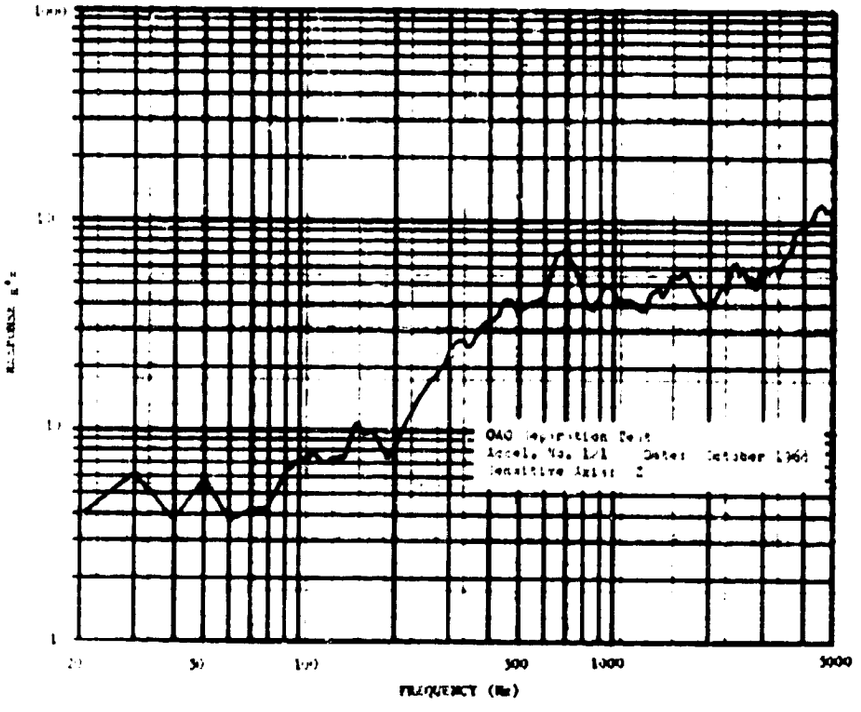



FIGURE III.B.3-27

## LOCATION OF ADDITIONAL DATA

Additional pyrotechnic shock data compiled for cartridge actuated devices for propagation in truss structure may be found in the following section of Volume II:

I.B.3 Figures 12 through 21

# PART III.C

# PYROTECHNIC SHOCK DATA COMPILED FOR CARTRIDGE ACTUATED DEVICES IN STRUCTURES OTHER THAN SKIN-RING-FRAME OR TRUSS

SECTION III.C.1

IDCSP/A DEVELOPMENT MODEL 2 SEPARATION SHOCK TEST

PURPOSE OF TEST

The primary objective of the test was to develop and verify shock testing techniques for use in follow-on qualification tests on the apogee boost motor and the qualification spacecraft.

DESCRIPTION OF EVENT

The test configuration depicted in Figure III.C.1-1 consisted of the IDCSP/A Development Model 3 Spacecraft supported by a spring suspension system from the ceiling of the test chamber. A marmon attach clamp identical to the flight article connected the adapter section, simulating the expanded third stage booster, to the aft end of the spacecraft. Separation consisted of the firing of two ordnance bolts cutters which severed their respective bolts to allow the release of the marmon clamp. Upon separation, the adapter section fell freely for three feet, a fall which was arrested by a foam pad on the floor.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of time histories | 6 |
| Duration | 0.10 seconds (approx.) |
| No. of shock spectra | 6 |

| | |
|---|---|
| Type of analysis | digital |
| Sample rate | 10,000/second |
| Frequency range | to 10,000 Hz |
| Valid frequency range | not above 2,000 Hz |
| Damping | Q=10 |

These shock spectra are presented along with their corresponding time histories as Figures III.C.1-3 through III.C.1-8.

DESCRIPTION OF PYROTECHNICS

Two ordnance bolt cutters located in the marmon attach clamp as shown in Figure III.C.1-2.

DESCRIPTION OF STRUCTURE

The structure is illustrated in Figure III.C.1-1.

The weights of the two primary components are as follows:

Spacecraft = 525 lb.

Adapter section = 155 lb

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2225

Locations: Table III.C.1-1 and Figures III.C.1-1 and III.C.1-2

Axis of sensitivity: Table III.C.1-1

## CONCLUSIONS

The time histories in Figures III.C.1-4 and III.C.1-7 appear to have a DC offset. The effect of this offset can be observed as a constant acceleration in the low frequency range on the shock spectra.

Due to the rather low sampling rate of 1,000 per second the shock spectra are not considered valid for frequencies above 1,000 to 2000 Hz.

TABLE III.C.1-1

IDENTIFICATION AND LOCATION OF ACCELEROMETERS

| Accelerometer No. | Location | Sensitive Axis | Figure No |
|---|---|---|---|
| 7 | Separation flange at bolt cutter between -Y and -Z axes | axial | III.C.1-3 |
| 8 | Separation flange at bolt cutter between -Y and -Z axes | tangential | III.C.1-4 |
| 9 | Separation flange at bolt cutter between -Y and -Z axes | radial | III.C.1-5 |
| 10 | Separation flange 90° from bolt cutter between +Y and -Z axes | tangential | III.C.1-6 |
| 11 | Separation flange 90° from bolt cutter between +Y and -Z axes | axial | III.C.1-7 |
| 12 | Separation flange 90° from bolt cutter between +Y and -Z axes | radial | III.C.1-8 |

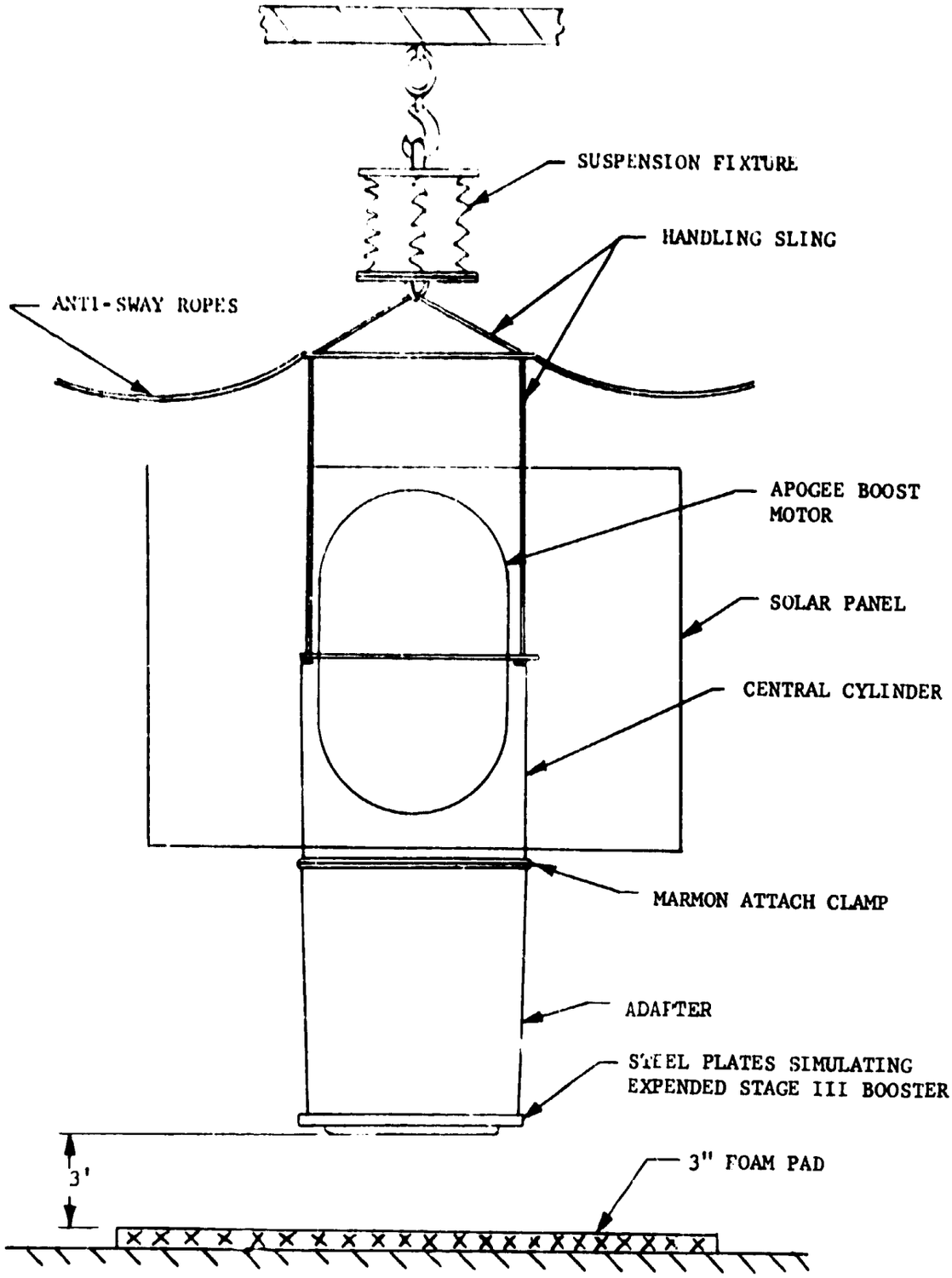



FIGURE III.C.1-1

SEPARATION SHOCK TEST CONFIGURATION

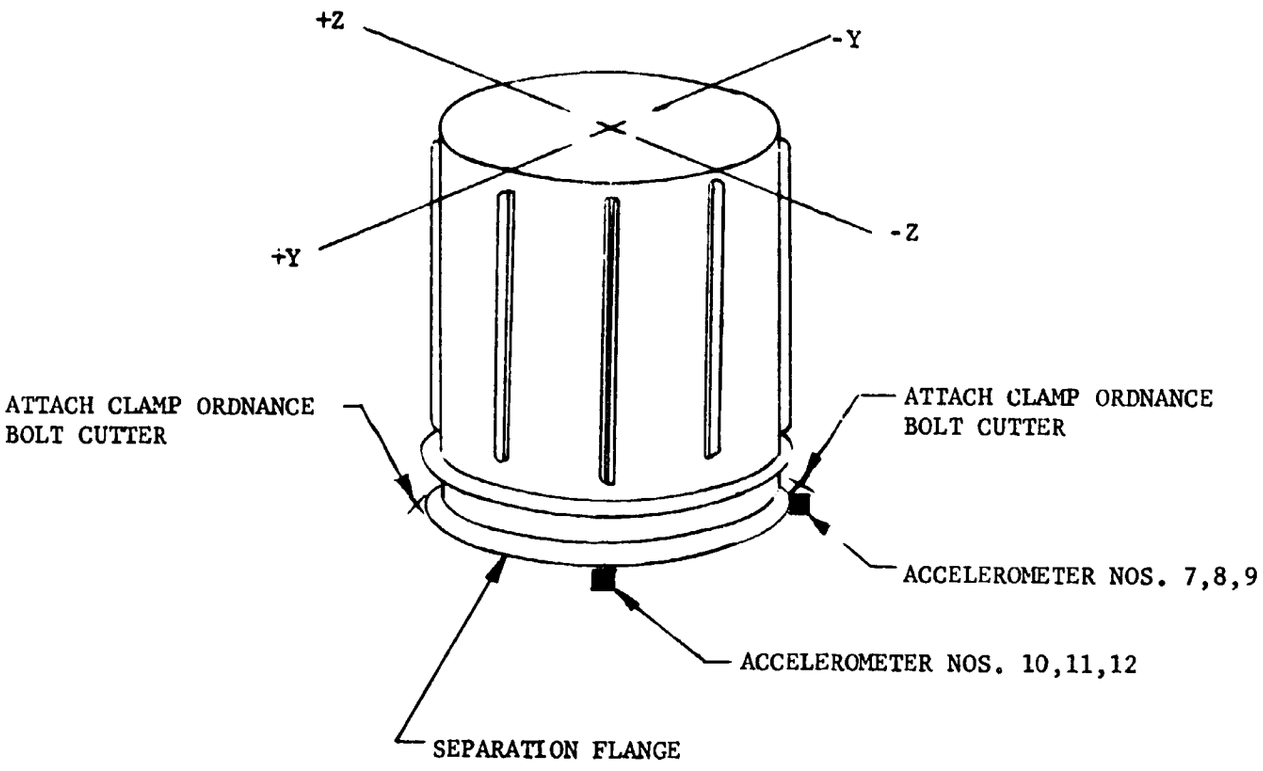


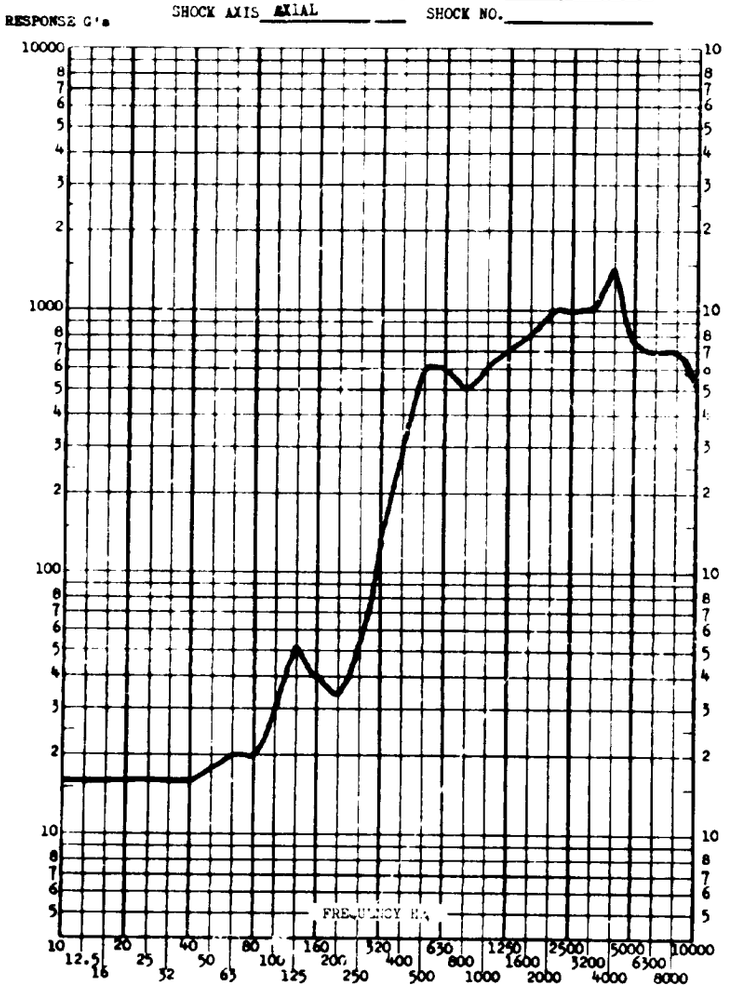

FIGURE III.C.1-2

ACCELEROMETER LOCATIONS ON CENTRAL CYLINDER

TEST ITEM IDCSP/A DEVELOPMENT MODEL 2 SPACECRAFT

A[illegible] NO. 7 TEST DATE APRIL 1968

SHOCK AXIS AXIAL SHOCK NO.



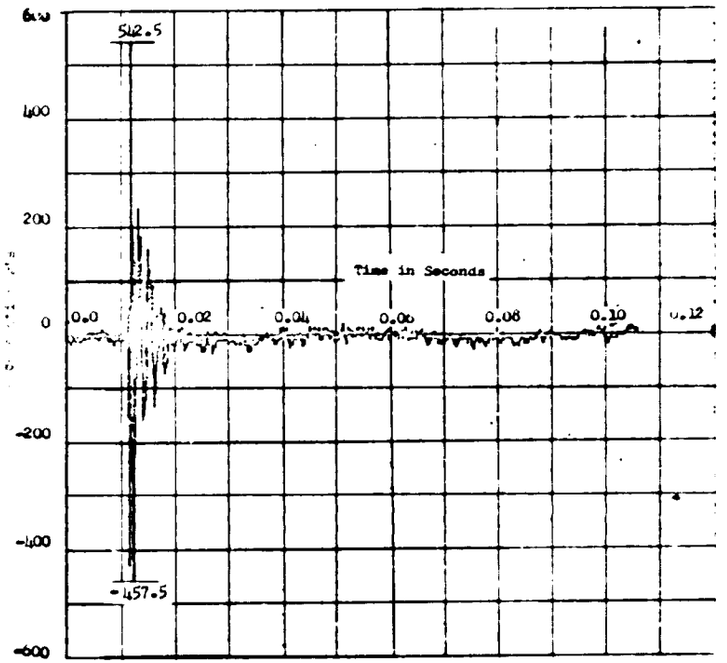
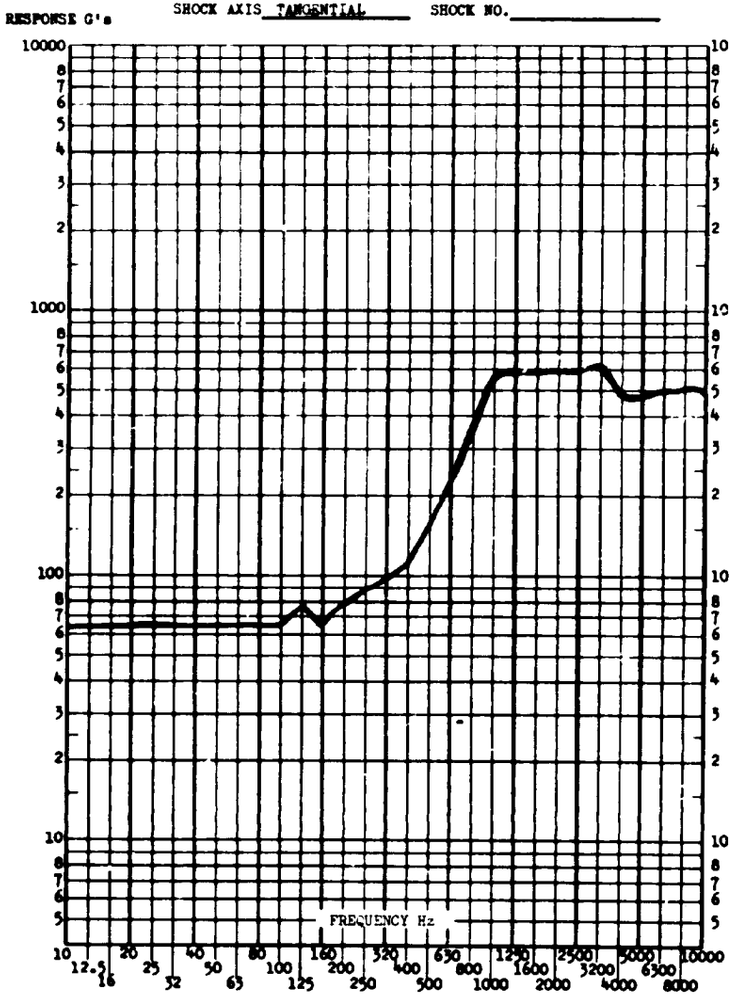




FIGURE III.C.1-3

TEST ITEM LOSP/A DEVELOPMENT MODEL 2 SPACECRAFT

LEVEL NO. 8 TEST DATE APRIL, 1968

SHOCK AXIS TANGENTIAL SHOCK NO.



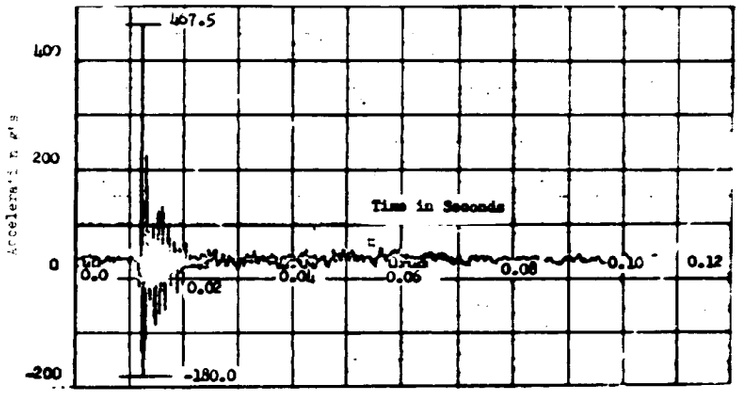




FIGURE III.C.1-4

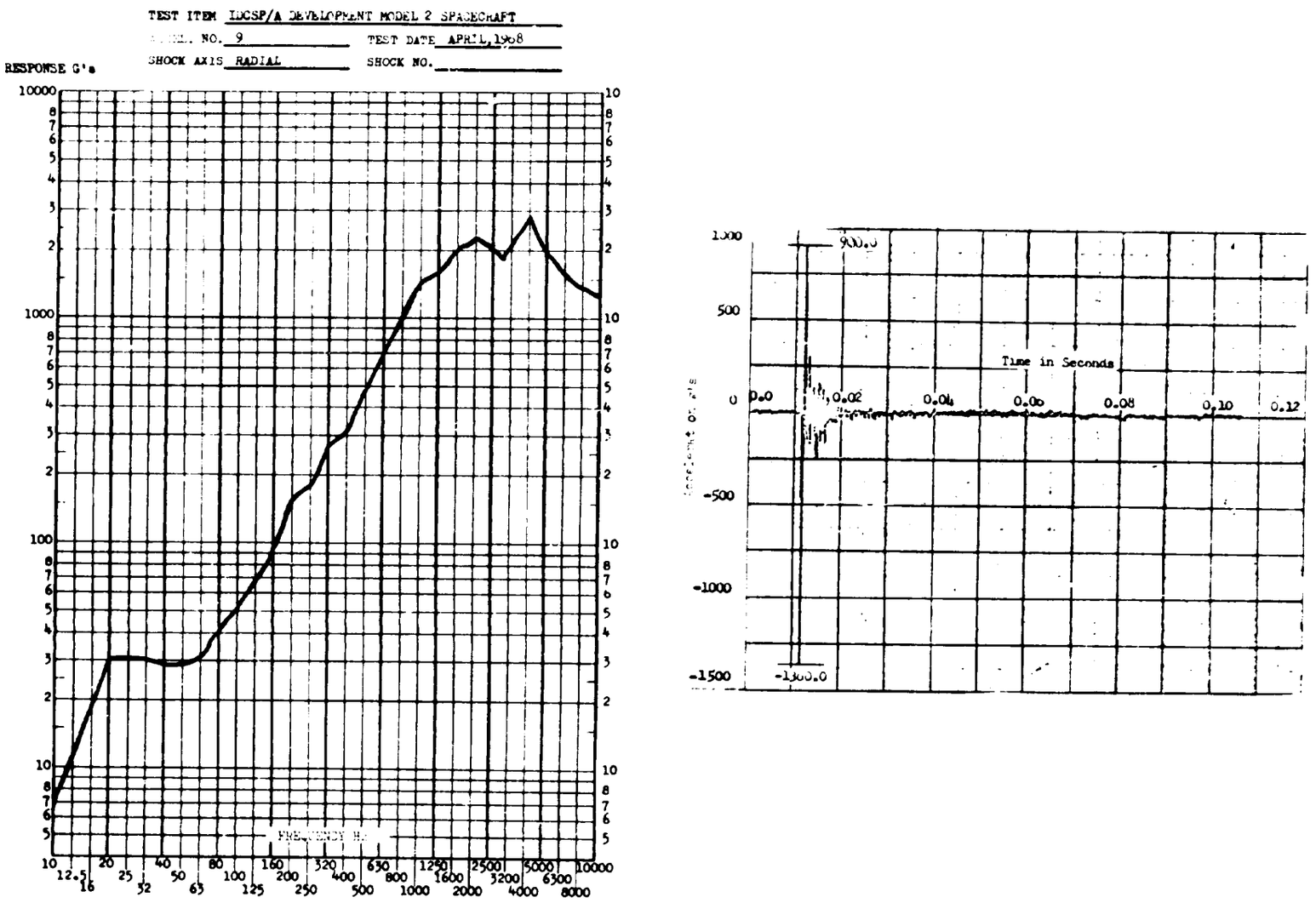
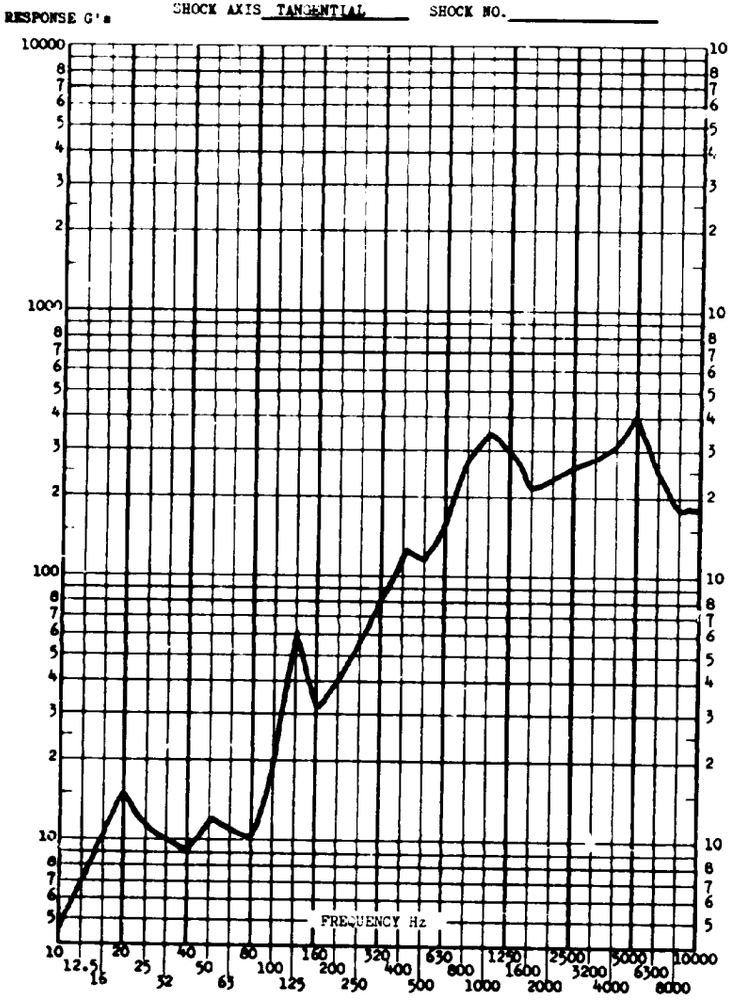



FIGURE III.C.1-5

TEST ITEM LCSP/A DEVELOPMENT MODEL 2 SPACECRAFT

MODEL NO. 10 TEST DATE APRIL, 1968

SHOCK AXIS TANGENTIAL SHOCK NO.



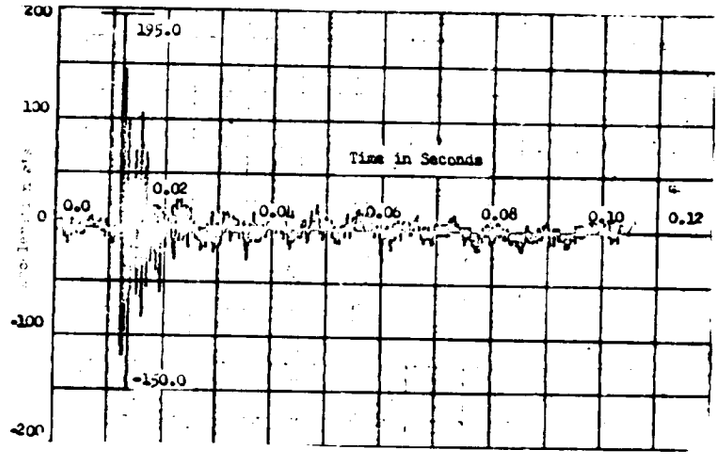




FIGURE III.C.1-6

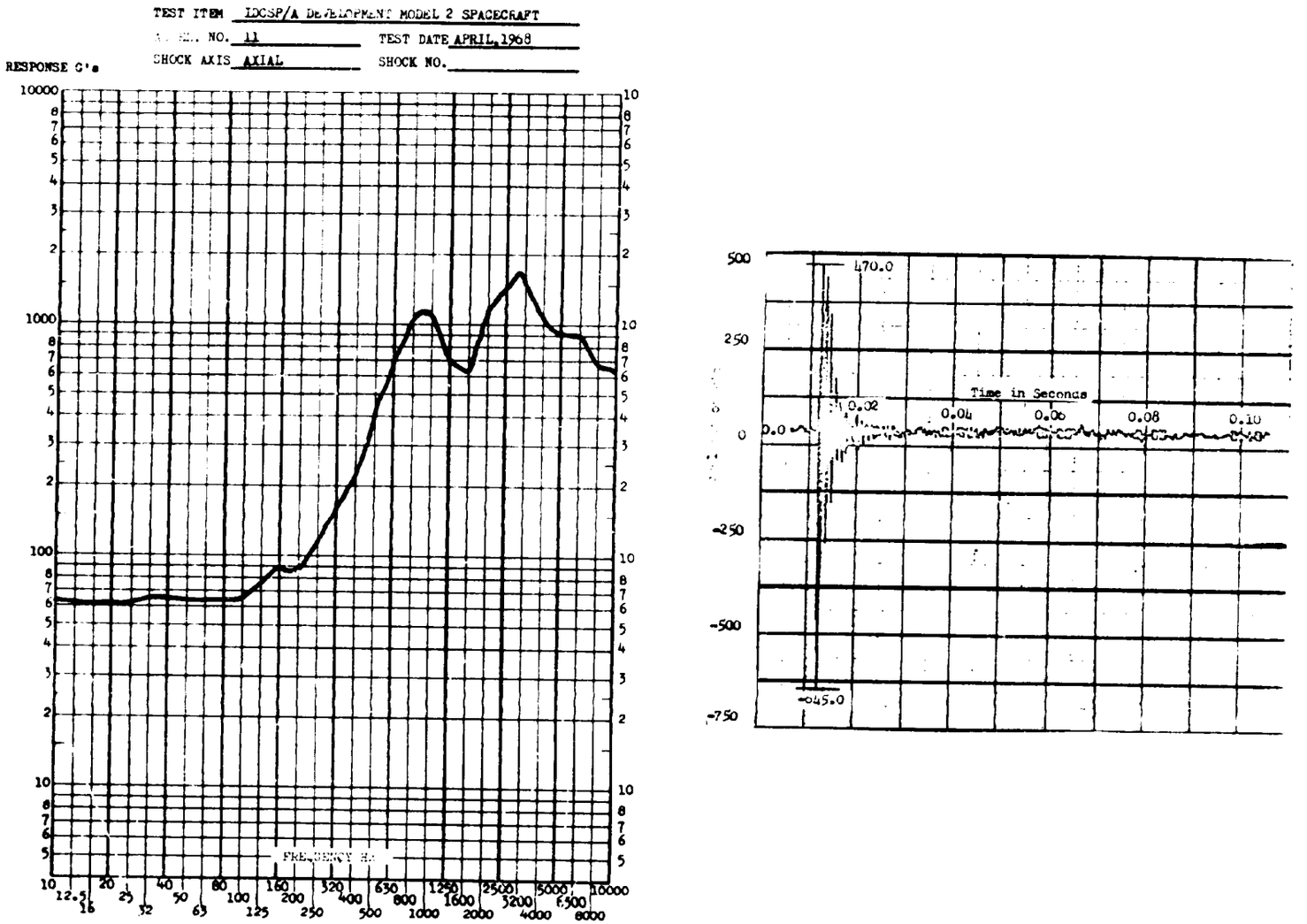
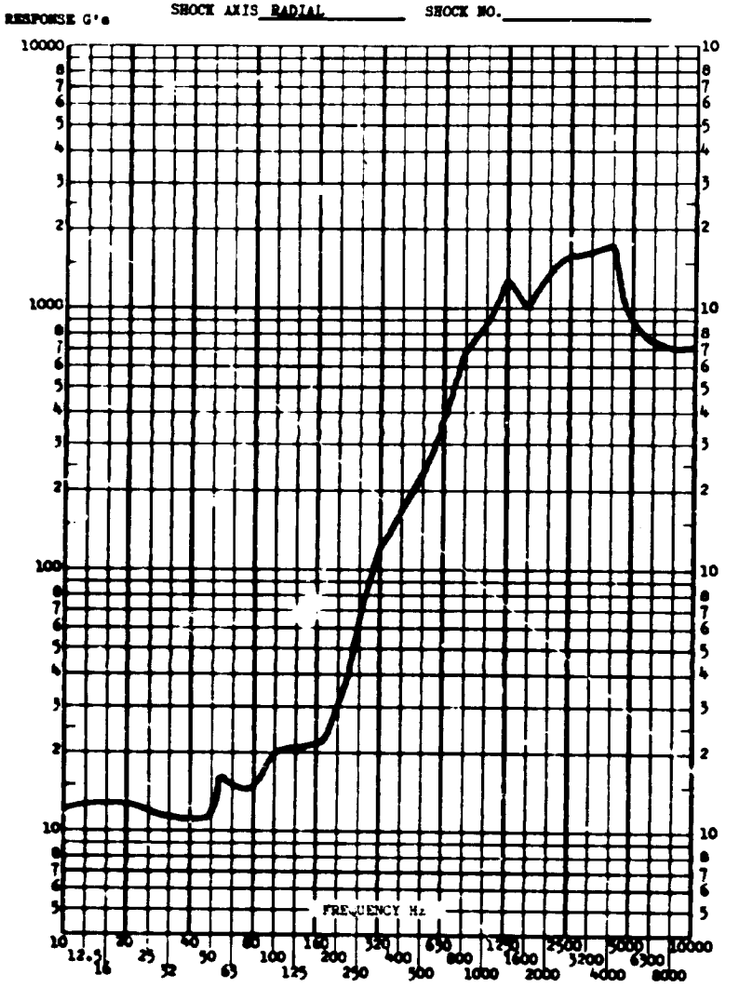



FIGURE III.C.1-7

TEST ITEM IDCSP/A DEVELOPMENT MODEL 2 SPACECRAFT

ACCEL. NO. 12 TEST DATE APRIL 1968

SHOCK AXIS RADIAL SHOCK NO.



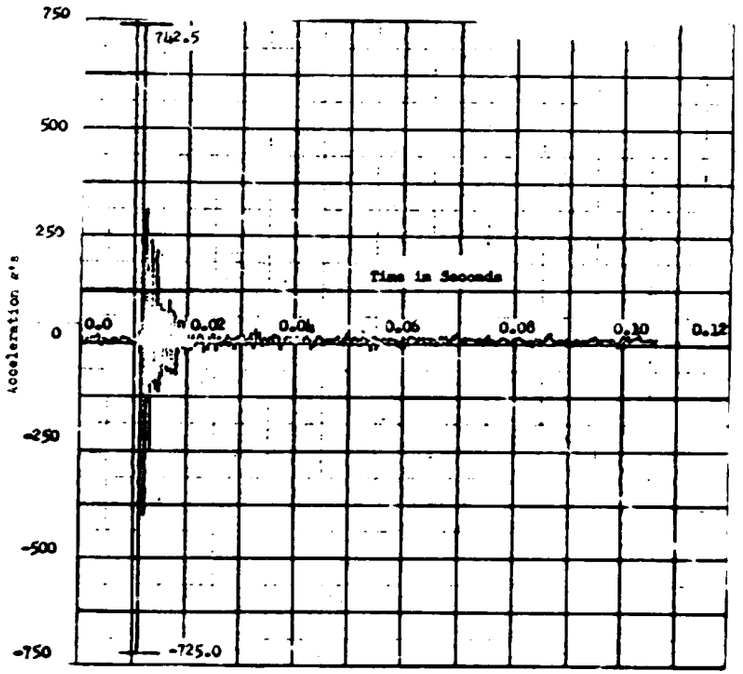




FIGURE III.C.1-8

## SECTION III.C.2

## ATS (APPLICATIONS TECHNOLOGY SATELLITE V) SEPARATION TEST

### PURPOSE OF TEST

The objective of this test was to determine the shock levels produced in the ATS vehicle due to the booster separation event.

### DESCRIPTION OF EVENT

The Applications Technology Satellite was suspended in the configuration depicted in Figure III.C.2-1. The satellite consisted of cylindrical solar arrays connected by a load carrying thrust tube. The lower stage adapter section was attached to the aft end of the satellite thrust tube by means of a V-band separation joint. The two self-contained (no fragments) separation bolts the V-band assembly were detonated and allowed the release of preloaded spring actuators at the separation plane. Following separation, the adapter section containing the expended V-band was allowed to fall away from the satellite. Figure III.C.2-2 illustrates the separation plane (aft end of thrust tube) after the release event. In this photograph the majority of the lower solar array has been removed.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of time histories | 14 |
| No. of shock spectra | 14 |
| Type of analysis | digital |
| Sample rate | 12,500/second |
| Frequency range | to 2000 Hz |
| Frequency increment | 5 Hz |
| Damping | Q = 10 |

These shock spectra are presented along with their corresponding time histories as Figures III.C.2-3 through III.C.2-9.

DESCRIPTION OF PYROTECHNIC

Each bolt was of 0.5 inch diameter (approx.) and required the use of a self-contained pressure cartridge/piston assembly to weaken and fail the bolt in tension. The pressure cartridge consisted of a 20 mg igniter charge and a main charge of 90 mg of Zerclo. The maximum pressure developed in the piston device was [illegible] psi. The two separation bolts were located as shown in Figure III.C.2-1.

DESCRIPTION OF STRUCTURE

Both the upper and lower solar arrays are hollow cylinders of aluminum honeycomb roughly 1/2 inch thick connected together by means of the cylindrical thrust

tube forming a yo-yo appearing configuration. The thrust tube is the load carrying structure and supports numerous radial beams and panels containing the experiments and equipment associated with the ATS mission. A closer examination of the detail at the top of Figure III.C.2-2 reveals some of these equipment locations.

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2221

Locations: Figure III.C.2-1

Axis of Sensitivity: Table III.C.2-1

DESCRIPTION OF DATA ACQUISITION SYSTEM

Tape recorder: Ampex model 1300

Amplifiers: Endevco model 7302 PT charge type amplifiers

COMMENTS.

Due to the rather low sampling rate of 12,500 samples per second, the shock spectra are considered to loose validity at frequencies above 1250 to 1600 Hz.

TABLE III.C.2-1

INDEX OF DATA LOCATIONS

| Accelerometer Location No.s | Sensitive Axis | Figure Number |
|---|---|---|
| 3 | Long., Rad. | III.C.2-3 |
| 4 | Long., Rad. | III.C.2-4 |
| 5 | Long., Rad. | III.C.2-5 |
| 6 | Long,, Rad. | III.C.2-6 |
| 7,8 | Longitudinal | III.C.2-7 |
| 9 | Long., Rad. | III.C.2-8 |
| 11 | Long., Rad. | III.C.2-9 |

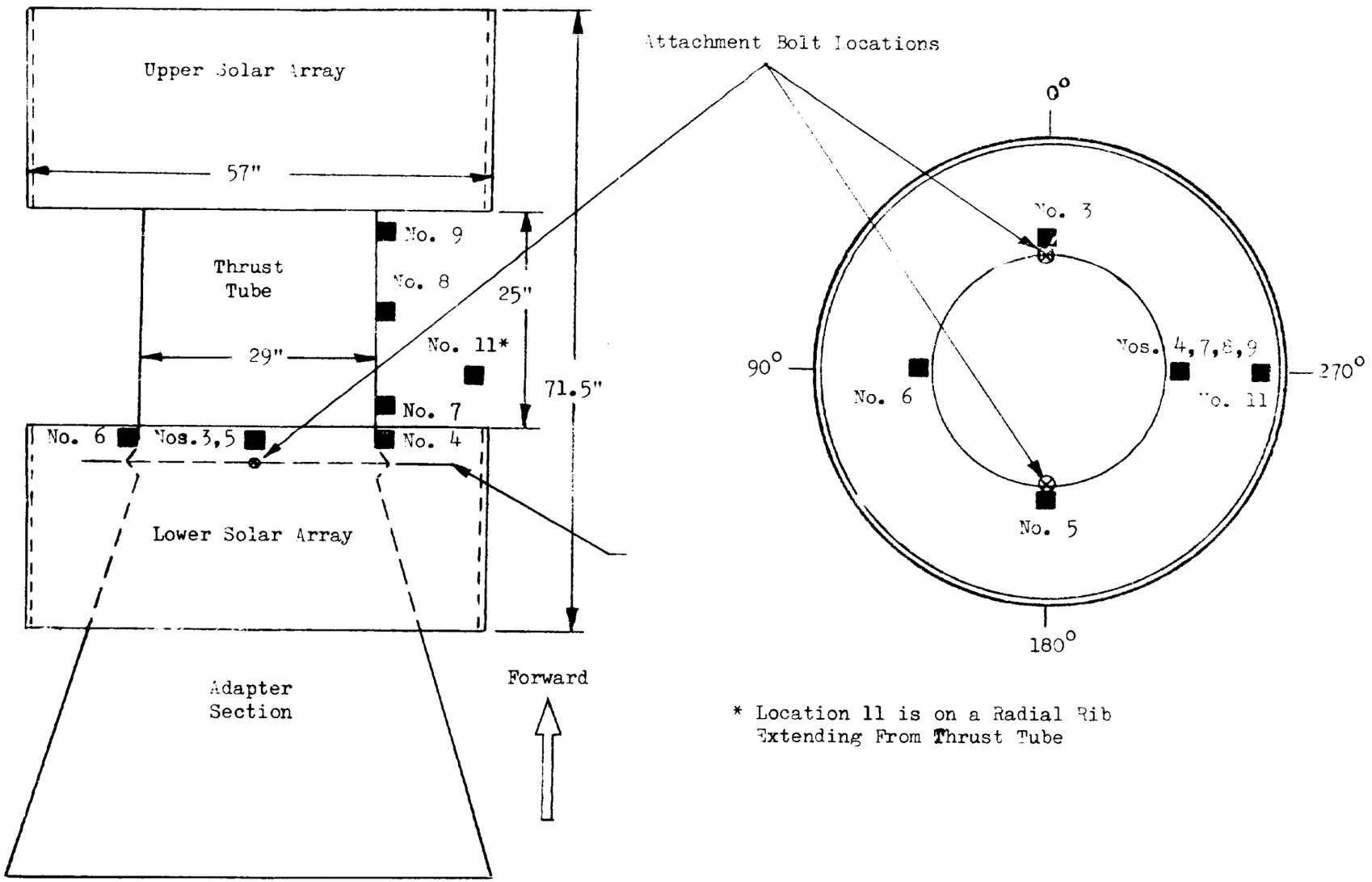
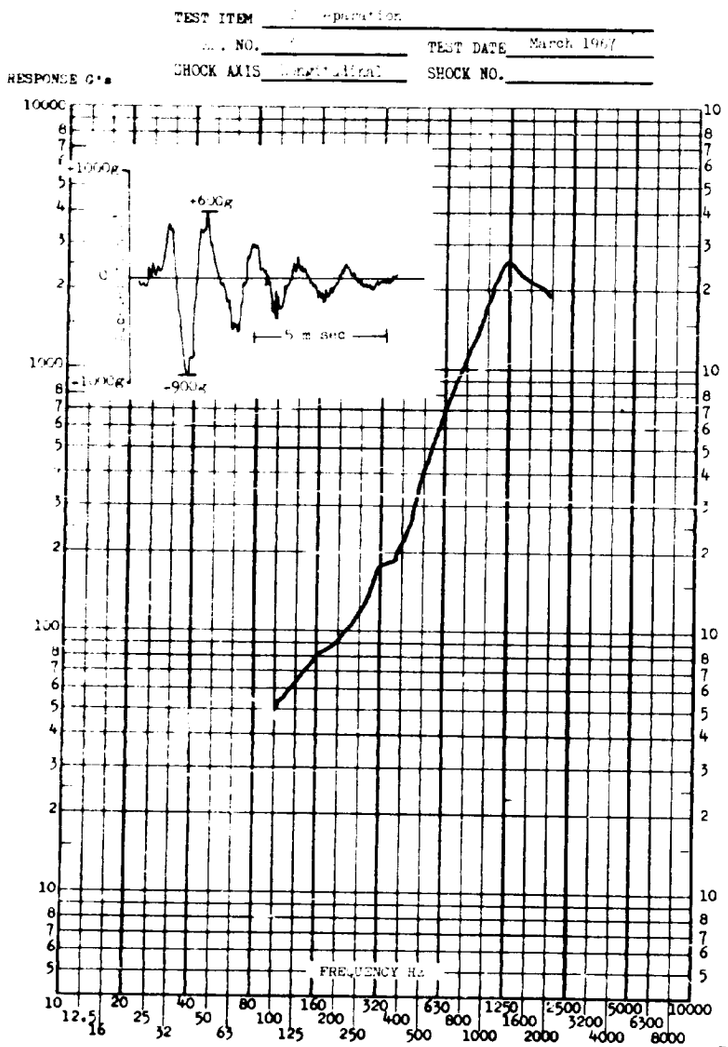



Figure IV.C.2-1. Test Configuration and Accelerometer Locations for ATS Separation Test



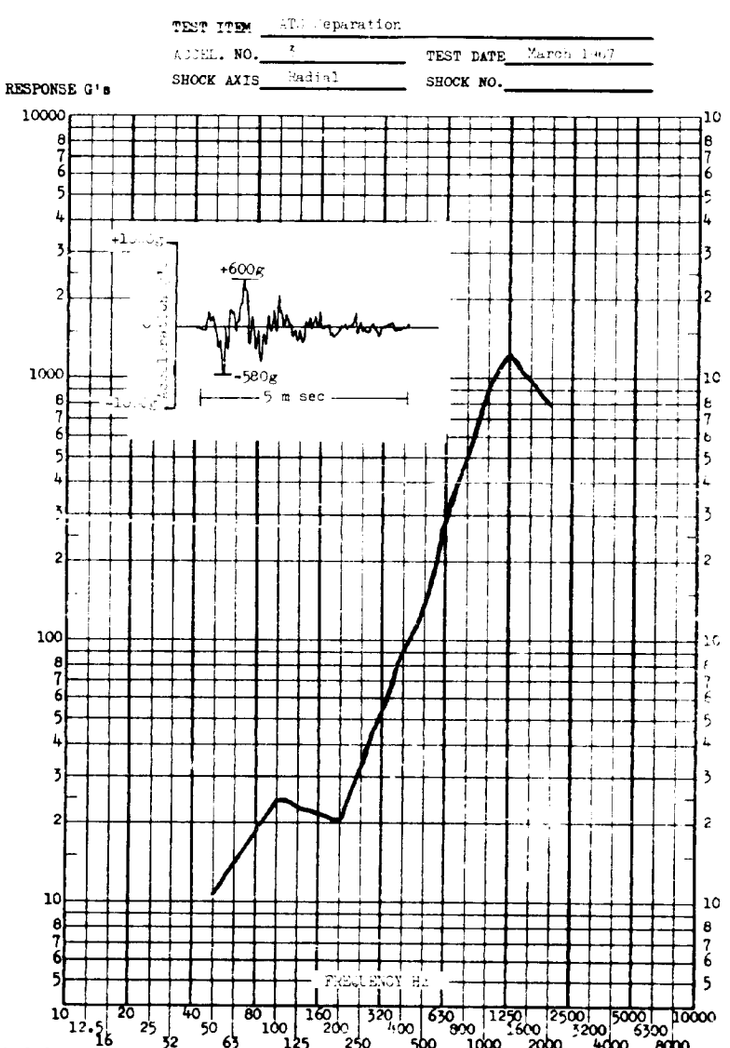
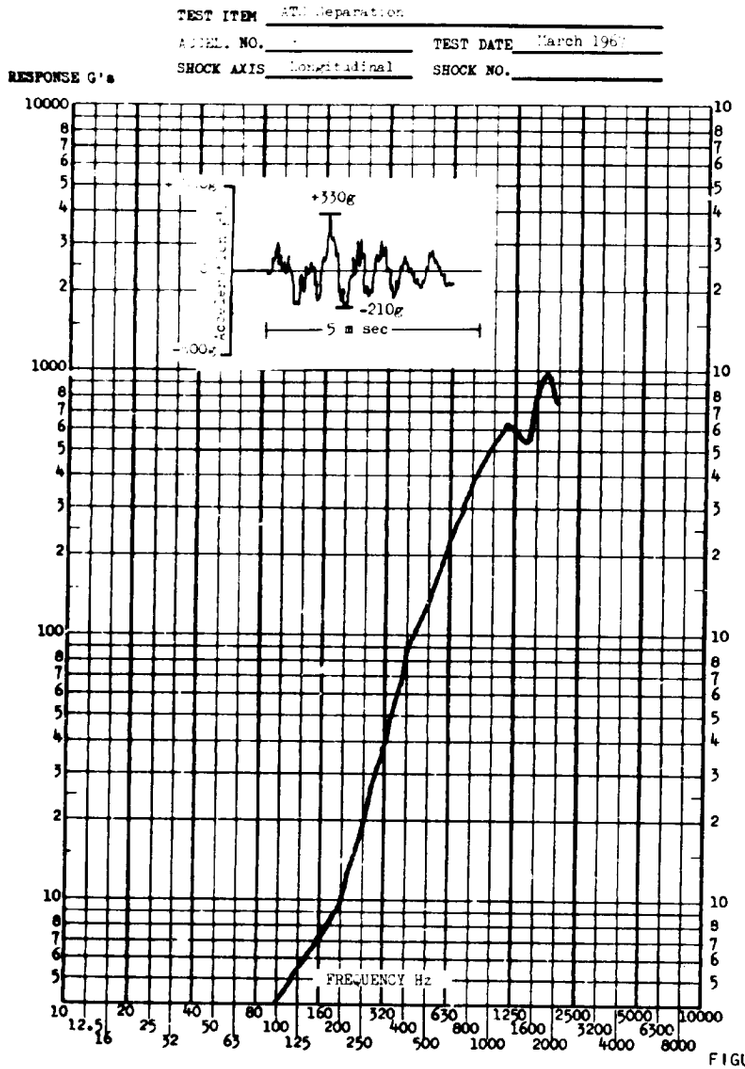




FIGURE III.C.2-3



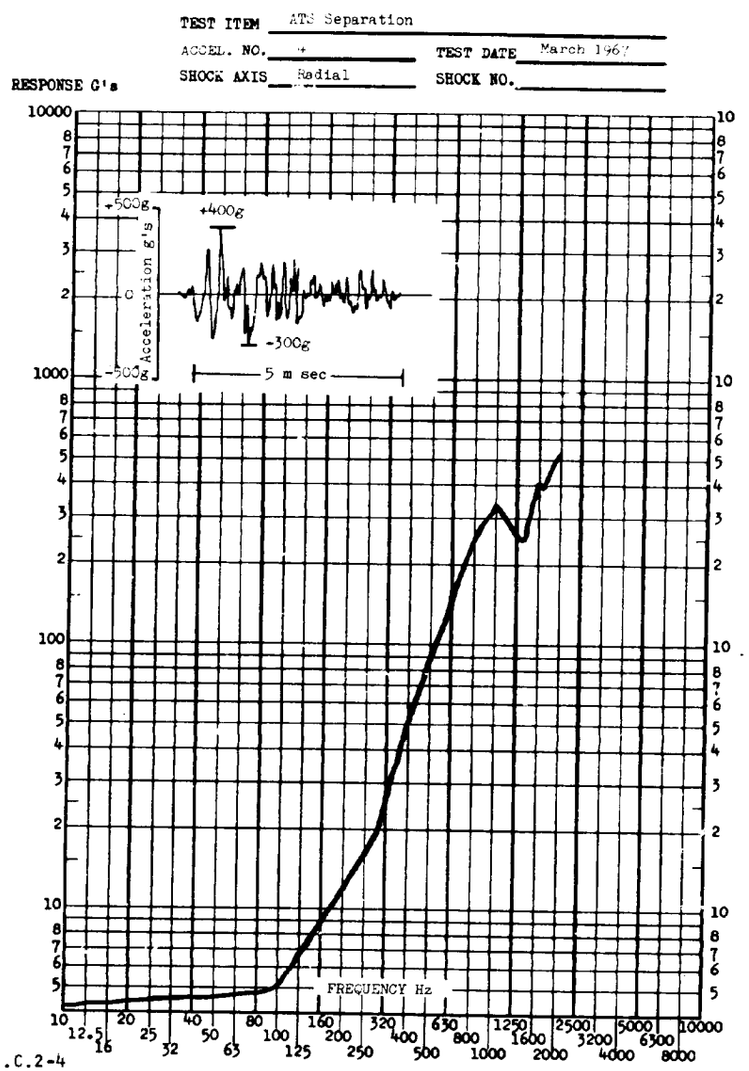




FIGURE III.C.2-4

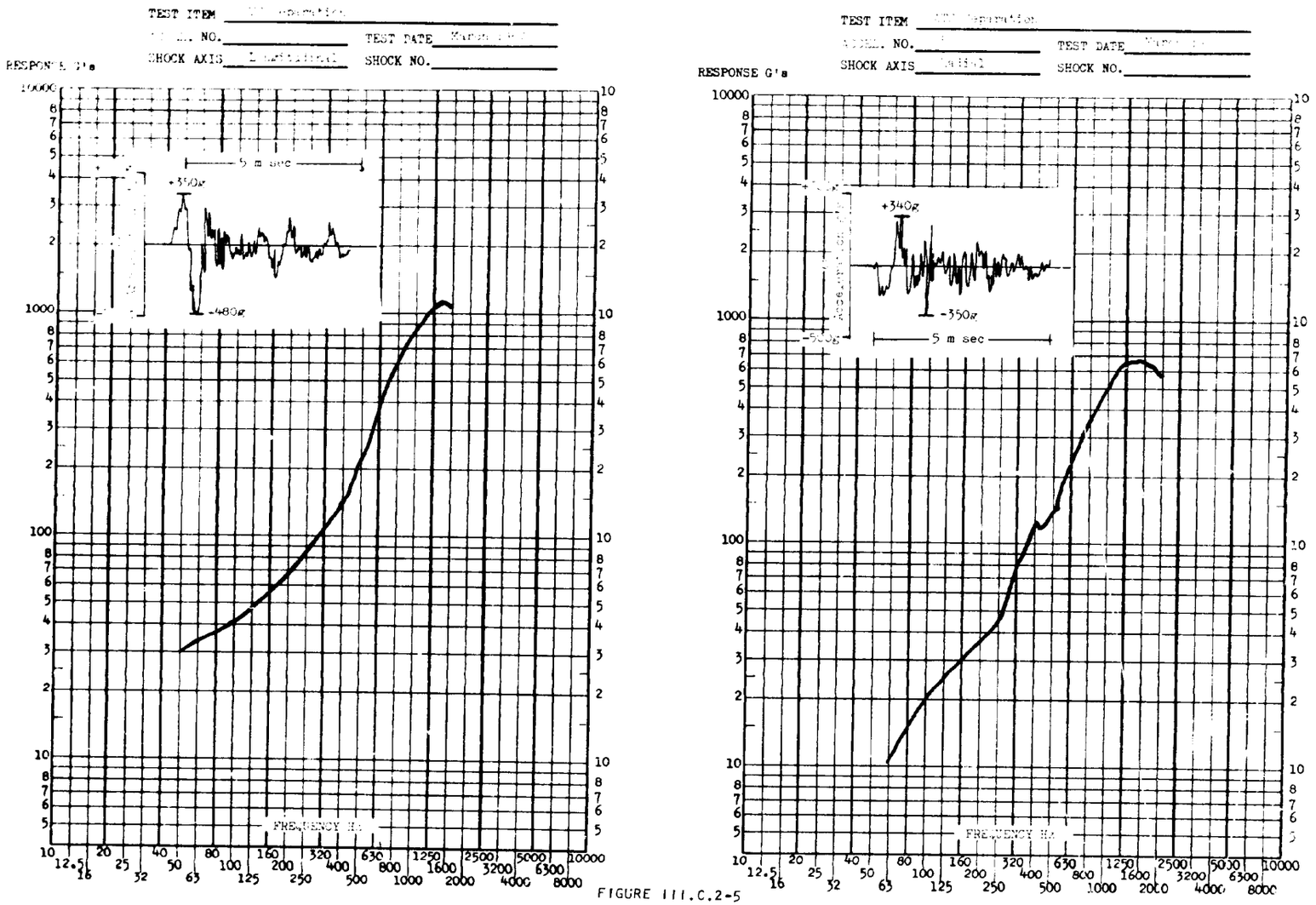
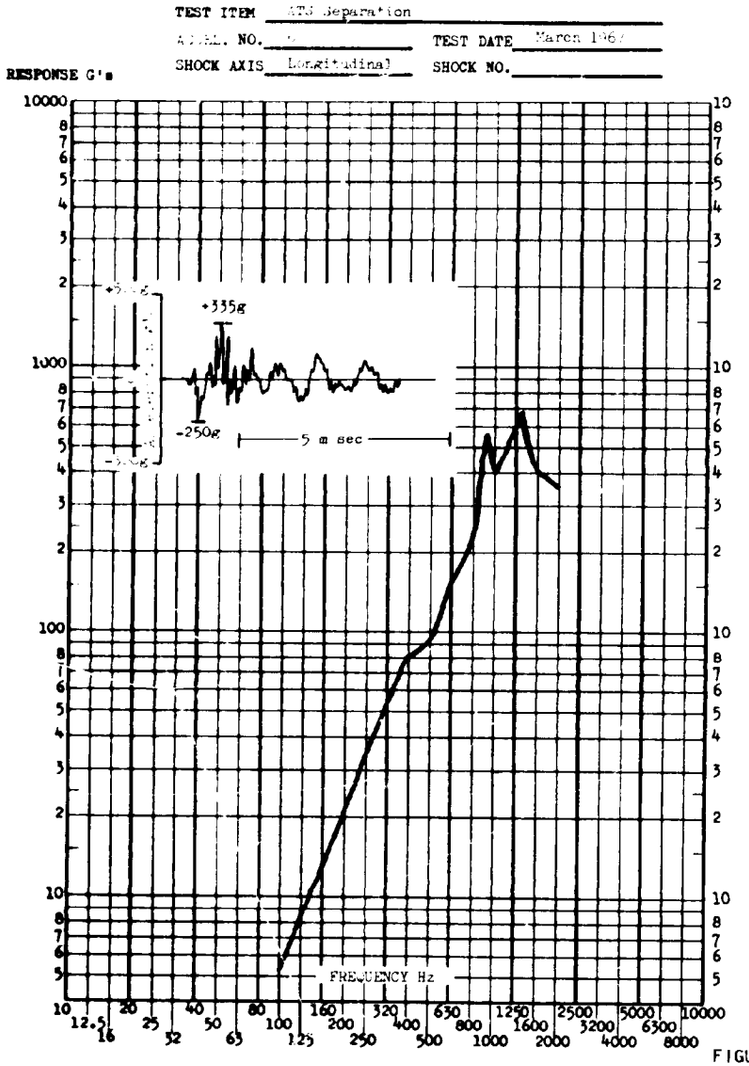



FIGURE III.C.2-5



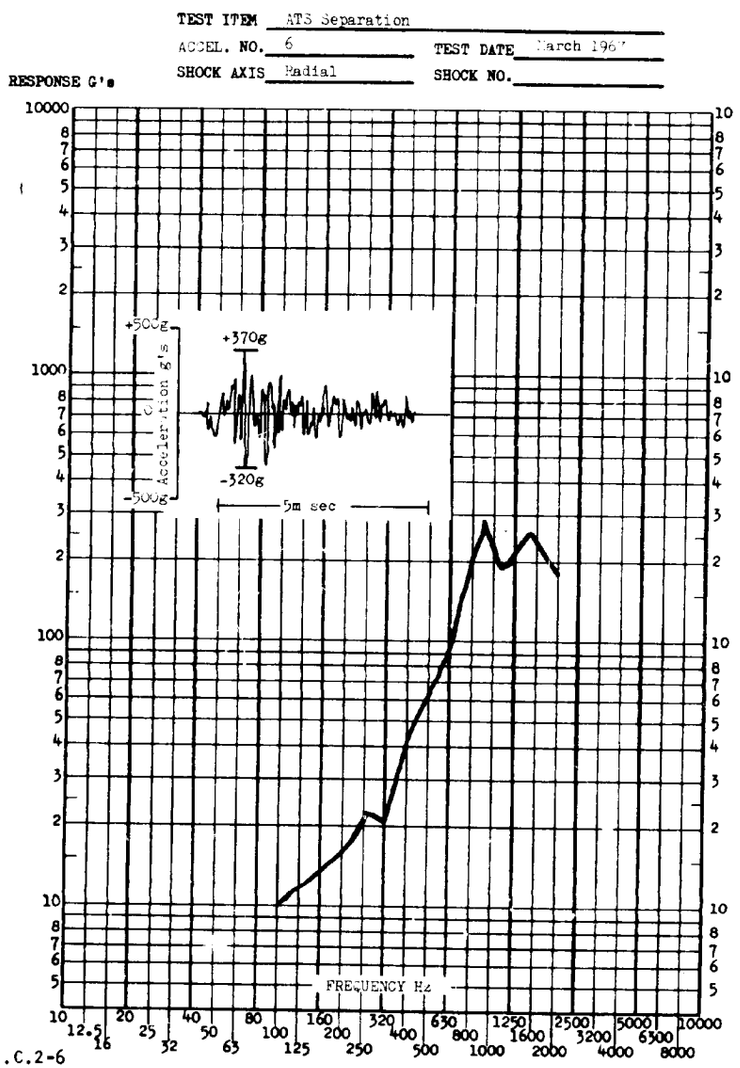
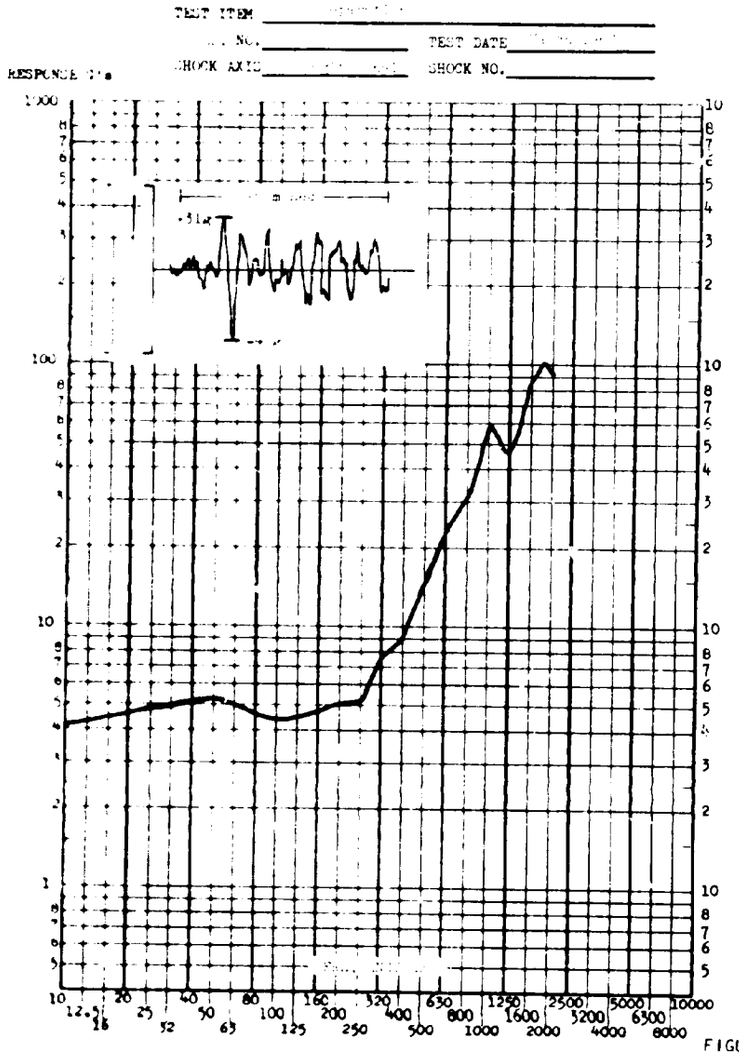




FIGURE III.C.2-6



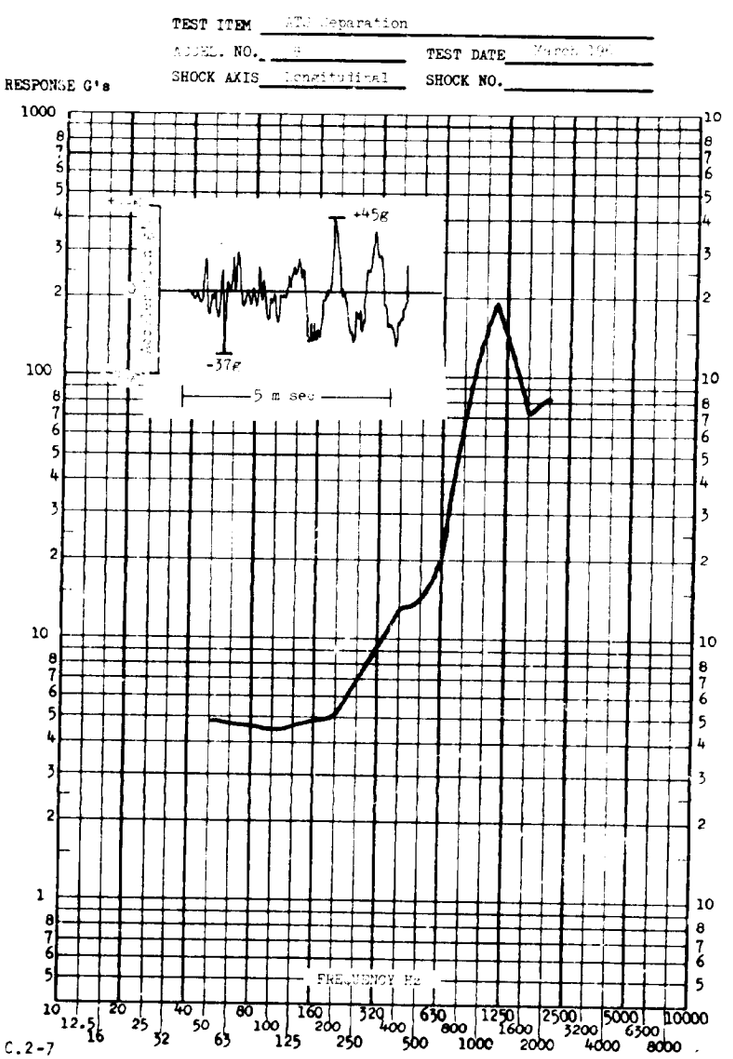




FIGURE III.C.2-7

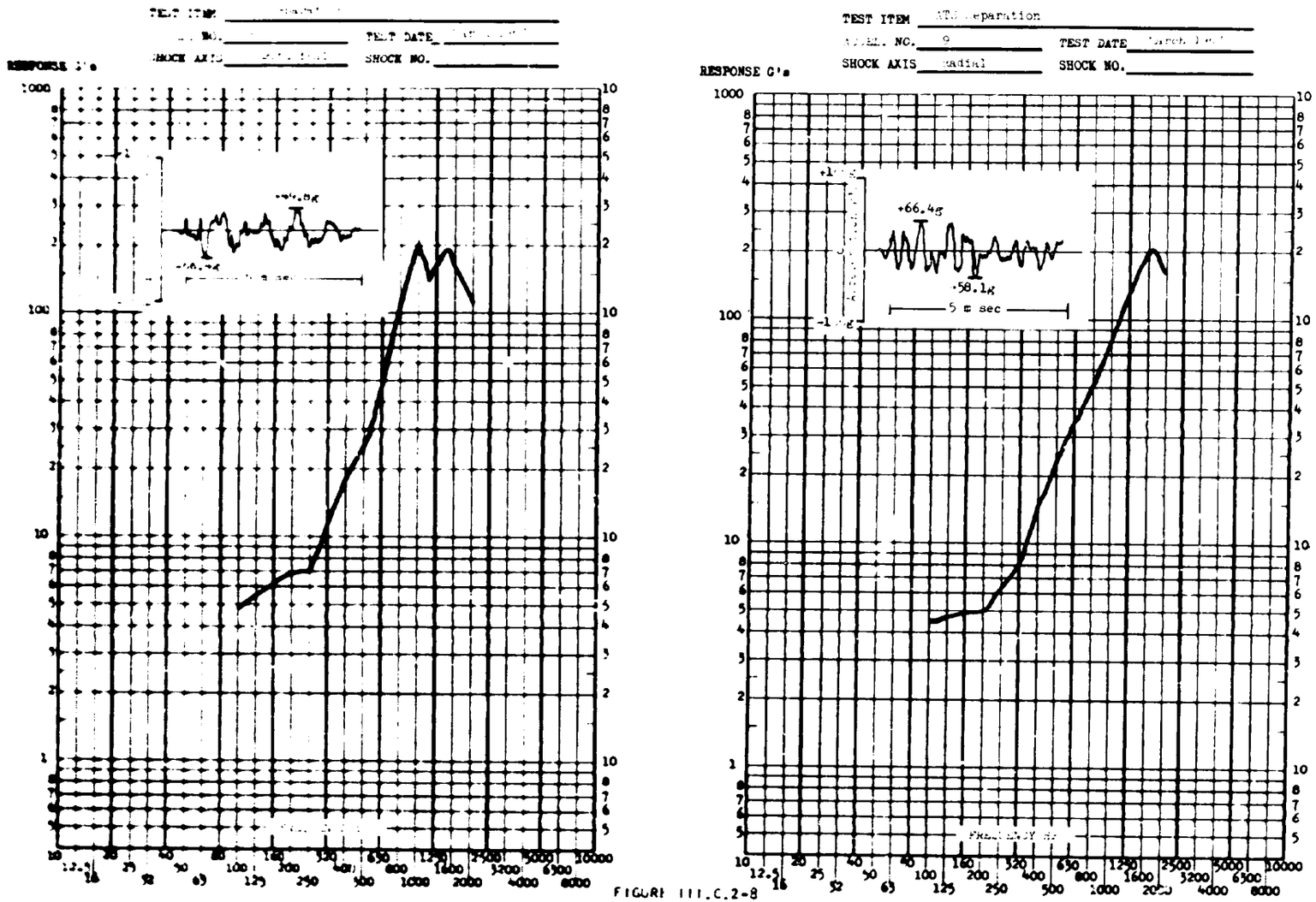
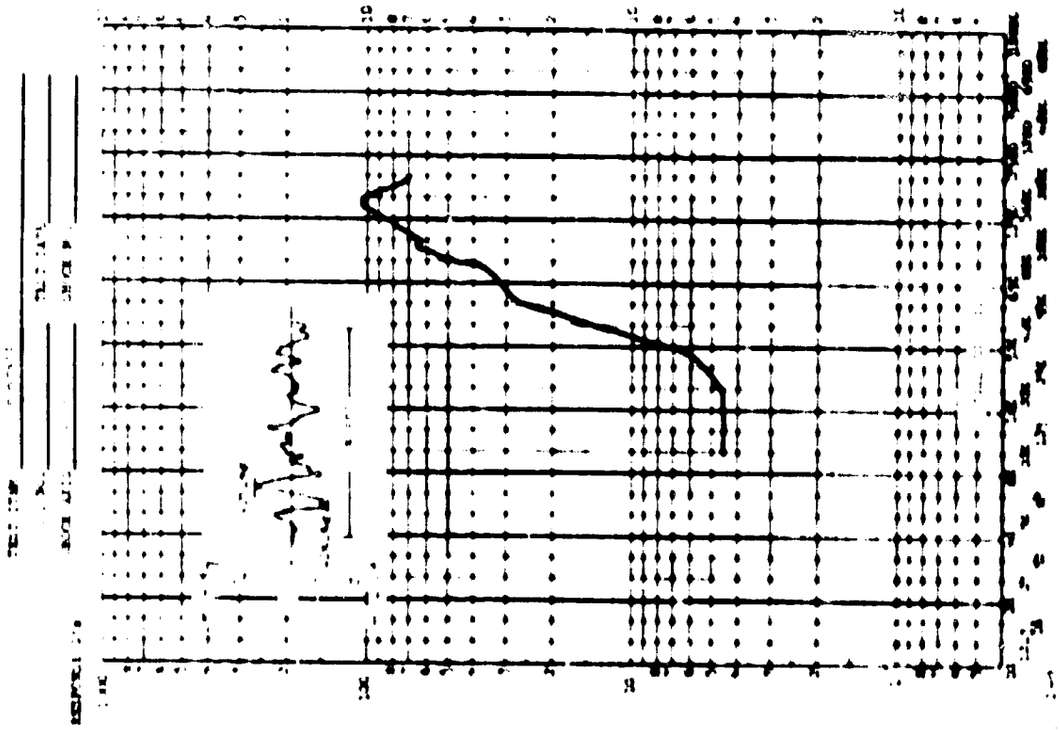
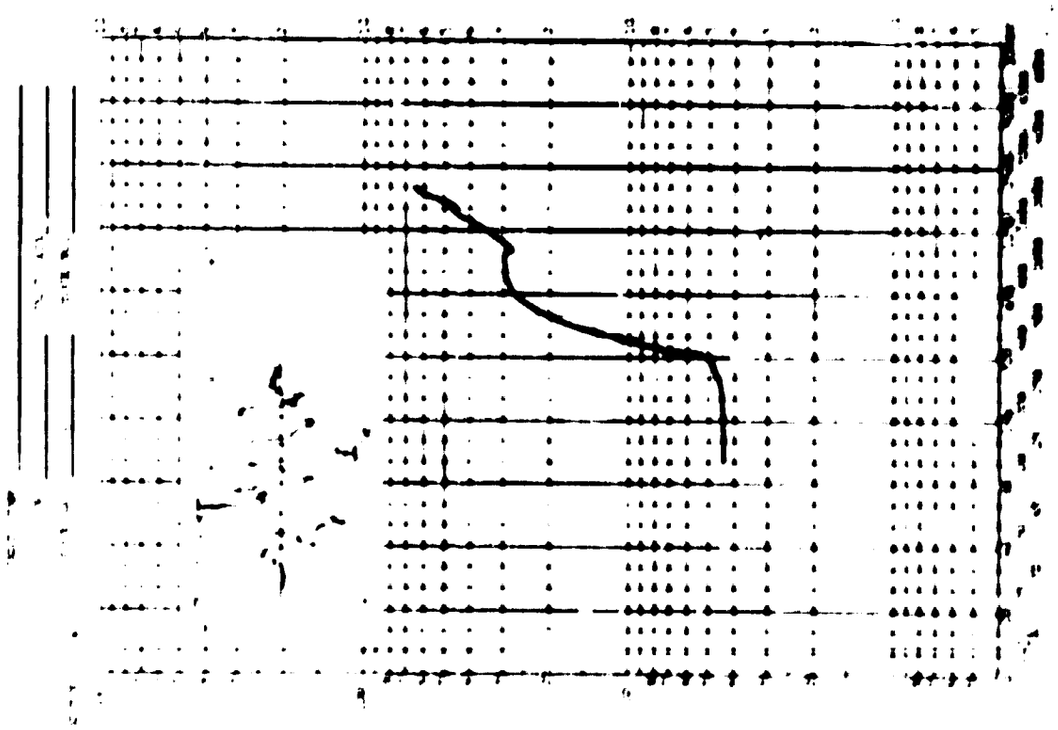



FIGURE III.C.2-8





SECTION III.C.3

OGO-F Antenna Ejection Test
(Orbiting Geophysical Observatory)

PURPOSE OF TEST

The test objective was to measure the shock levels produced in the OGO-F search coils due to the OGO-F F-24 Antenna Ejection event.

DESCRIPTION OF EVENT

The OGO-F F-24 antenna ejection test item consisted of a mass model of the antenna and three search coils as shown in Figure III.C.3-1. The antenna and its fiberglass base are supported by four aluminum legs attached to a honeycomb panel. Two search coils are mounted in delrin (a nylon - like material) which is attached to the honeycomb base. These two search coils are orthogonal, one above the other, parallel to the honeycomb panel, and diagonal to the four upright legs. The third coil is mounted upright near the edge of the honeycomb panel.

The separable protion of the antenna was held to the antenna base by two diagonally opposed shoes which received their clamping force from an interconnecting bolt. A bolt cutter freed the antenna, and separation was achieved by two separation springs and a counterweight suspension.

The antenna was slightly over counterweighted to achieve a good separation. The separated configuration is depicted in Figure III.C.3-2.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of time histories | 8 |
| No. of shock spectra | 8 |
| Type of analysis | digital |
| Sample rate | 50,000 per second |
| Duration | see time histories |
| Frequency range | 20-5000 Hz |
| Frequency increment | 50 points per decade |
| Damping | Q = 10 |

These shock spectra are presented along with their corresponding time histories as Figures III.C.3-3 through Figure III.C.3-10.

DESCRIPTION OF PYROTECHNIC

The bolt cutter was a No. 2802 Holex Guillotine Cutter. It cut a bolt at the unthreaded part where the diameter was 0.138 inch. The bolt location is indicated in Figure III.C.3-2.

DESCRIPTION OF STRUCTURE

See Figure III.C.3-1 and III.C.3-2, Also, see "Description of Event".

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2225

Locations: Table III.C.3-1 and Figures III.C.3-1 and III.C.3-2.

Axis of Sensitivity: Longitudinal

DESCRIPTION OF DATA ACQUISITION SYSTEM

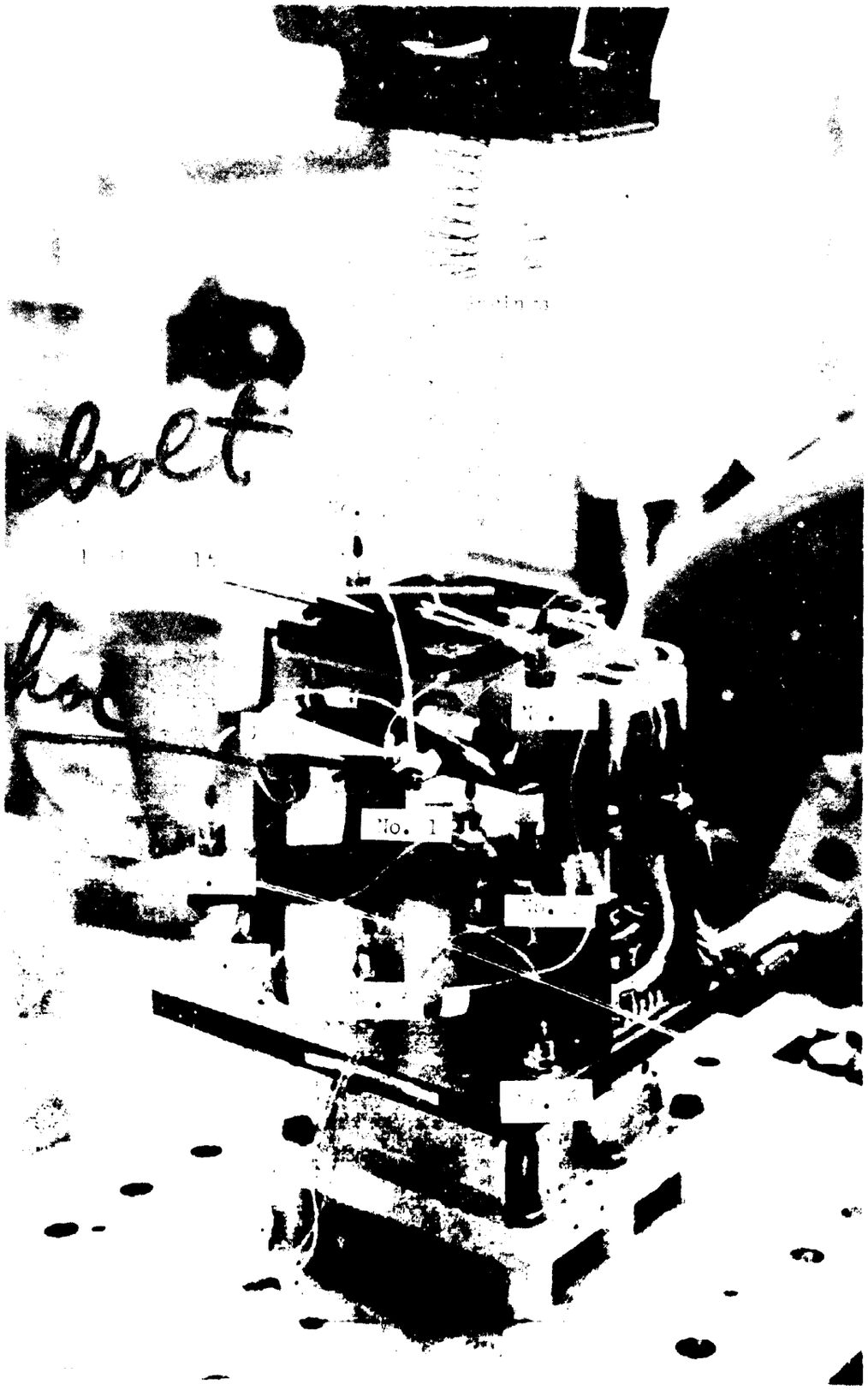
Tape recorder: Ampex FR 1300

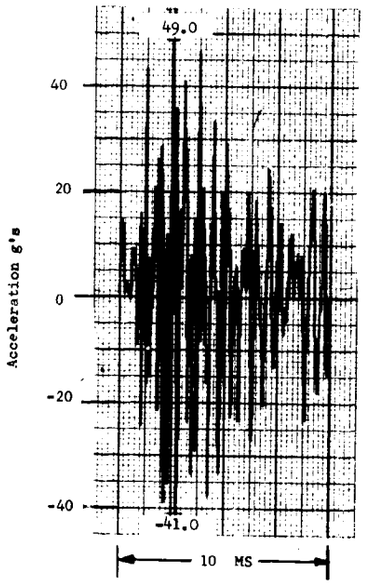
Amplifiers: Unholtz-Dickie model 8P charge amplifiers.

TABLE III.C.3-1

INDEX OF DATA LOCATIONS

| Accelerometer Numbers | Accelerometer Locations | Figure Number |
|---|---|---|
| 1 | upper coil, center | III.C.3-3 |
| 2 | lower coil, near center | III.C.3-4 |
| 3 | lower deck, center | III.C.3-5 |
| 4 | top, near separation plane | III.C.3-6 |
| 5 | lower deck, near leg | III.C.3-7 |
| 6 | lower deck, near leg | III.C.3-8 |
| 7 | top, near separation plane | III.C.3-9 |
| 8 | upper coil, near end | III.C.3-10 |


bolt
No. 1



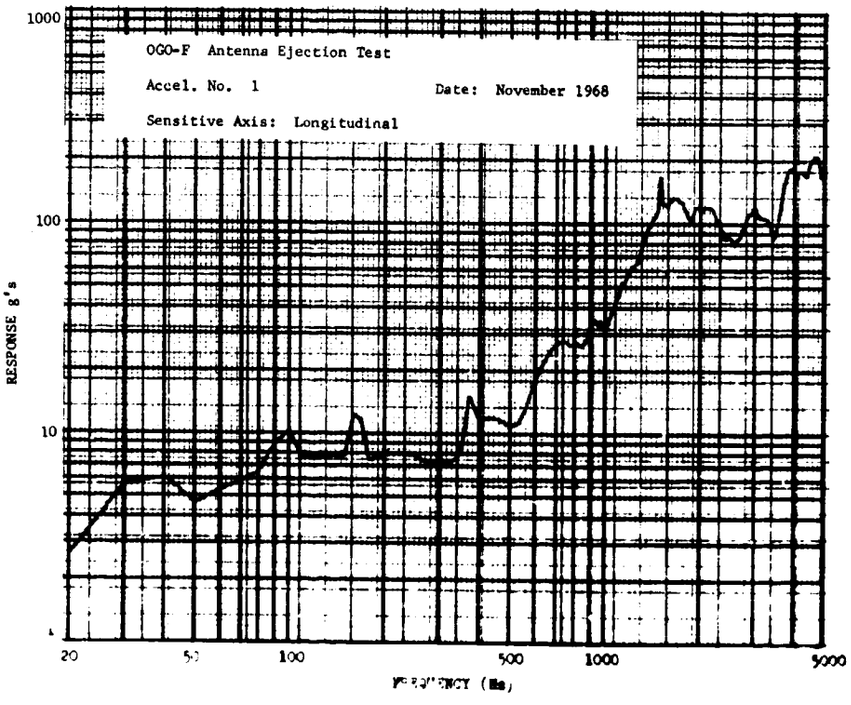
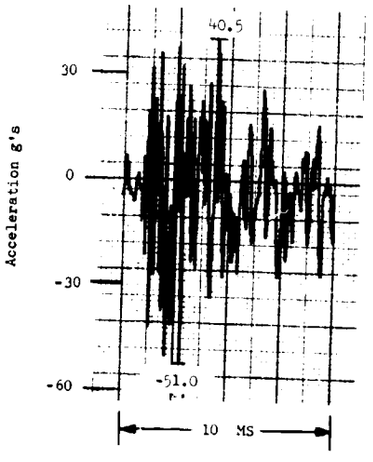




FIGURE III.C.3-3



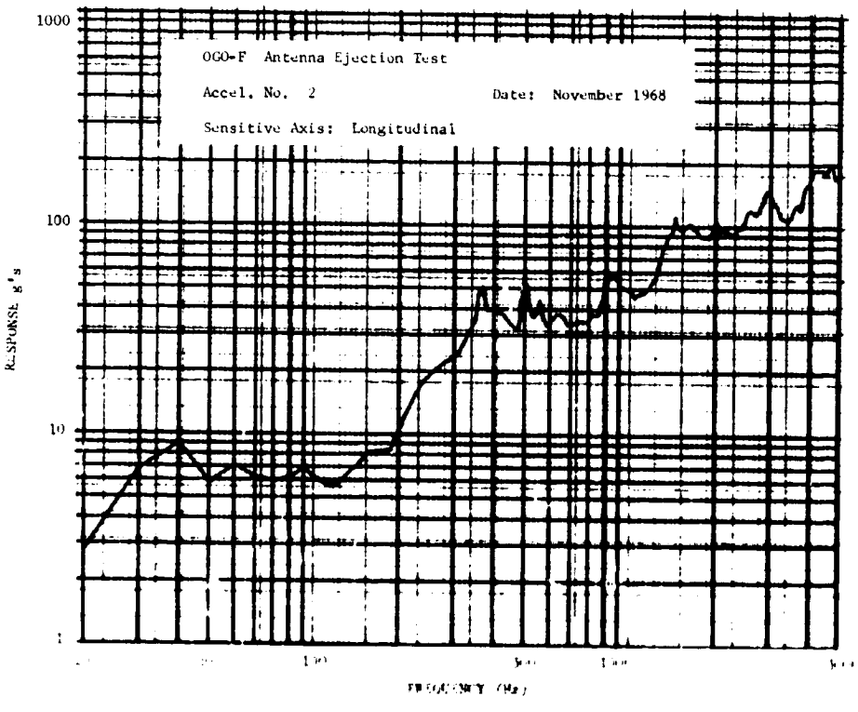
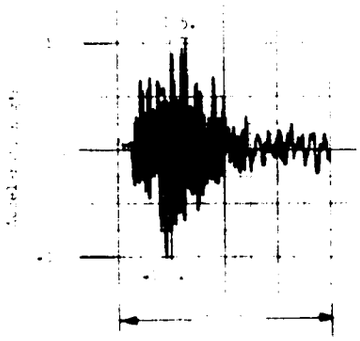
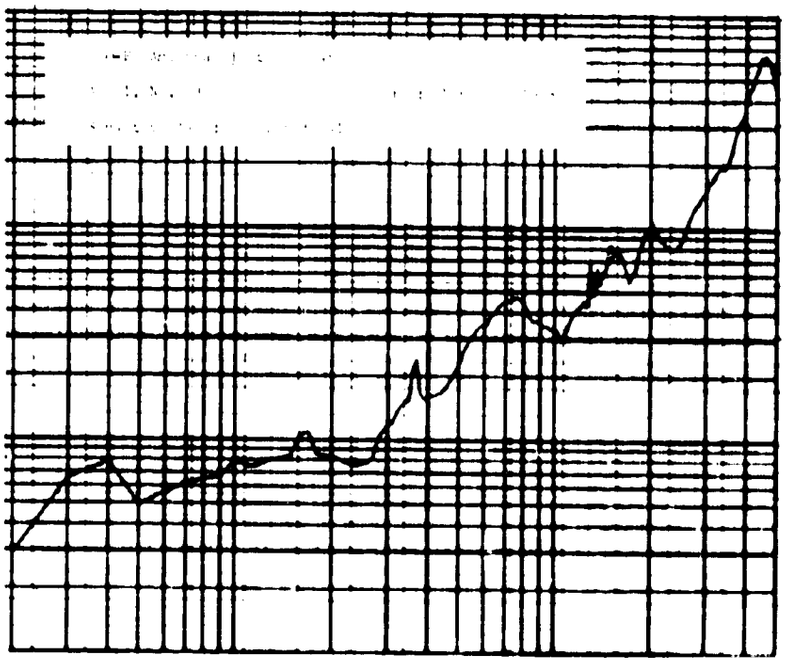
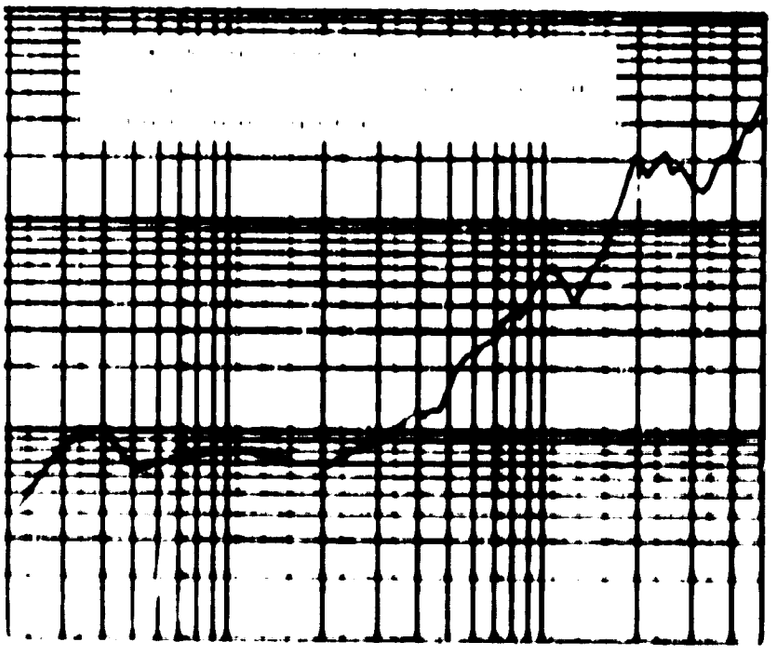




FIGURE III.C.3-4

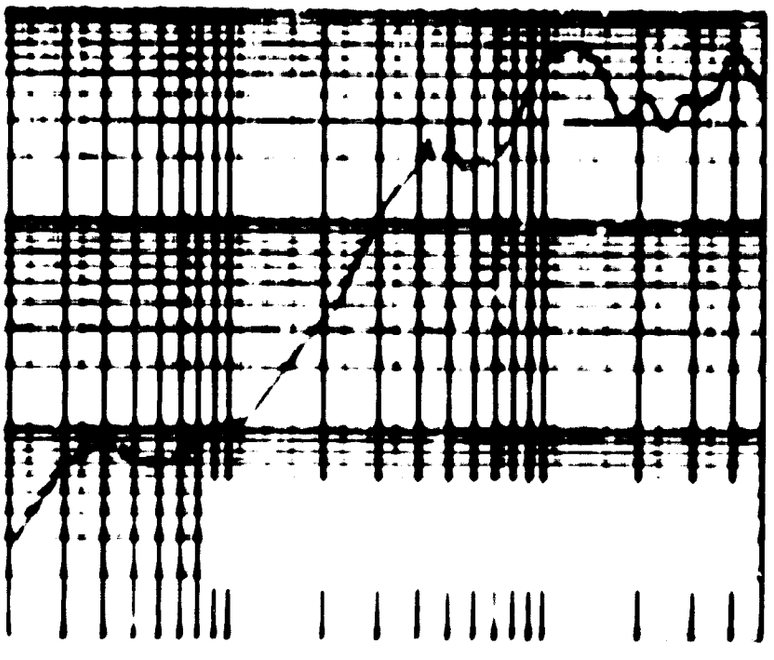




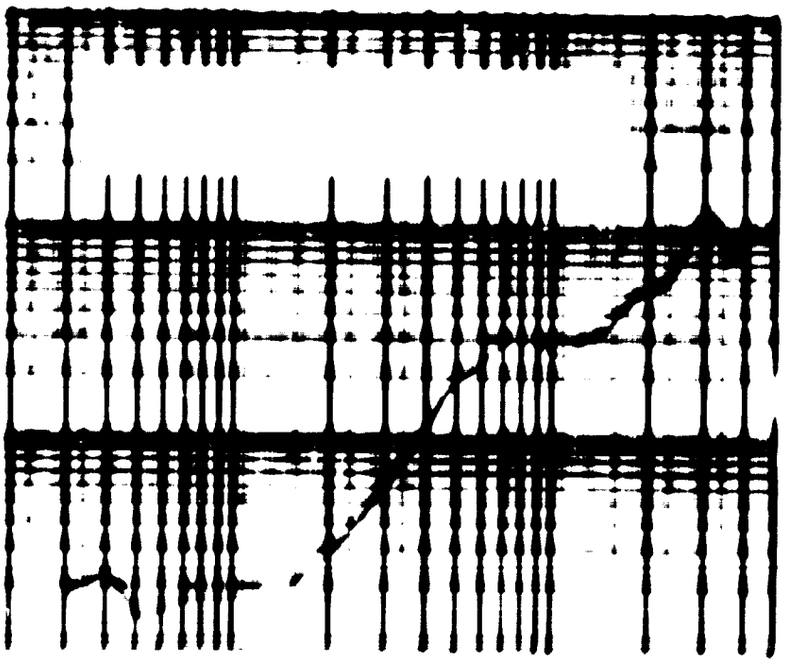


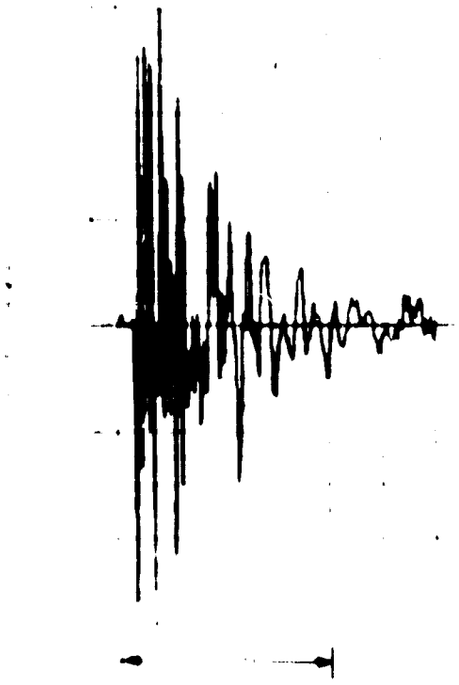


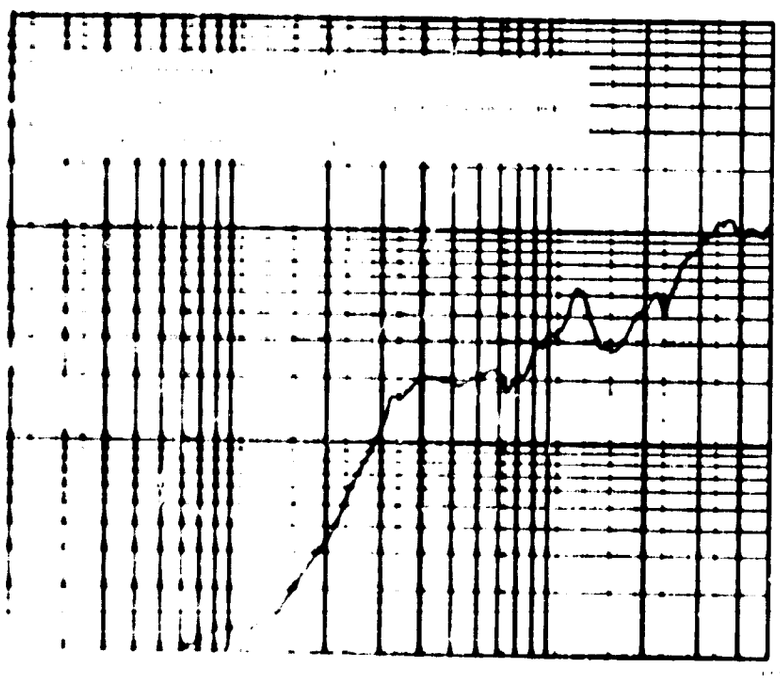


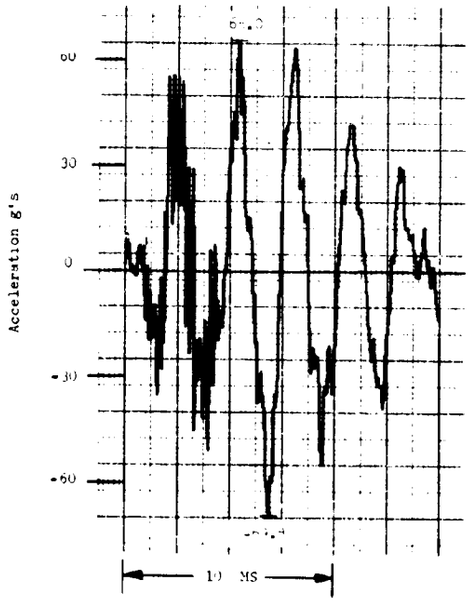












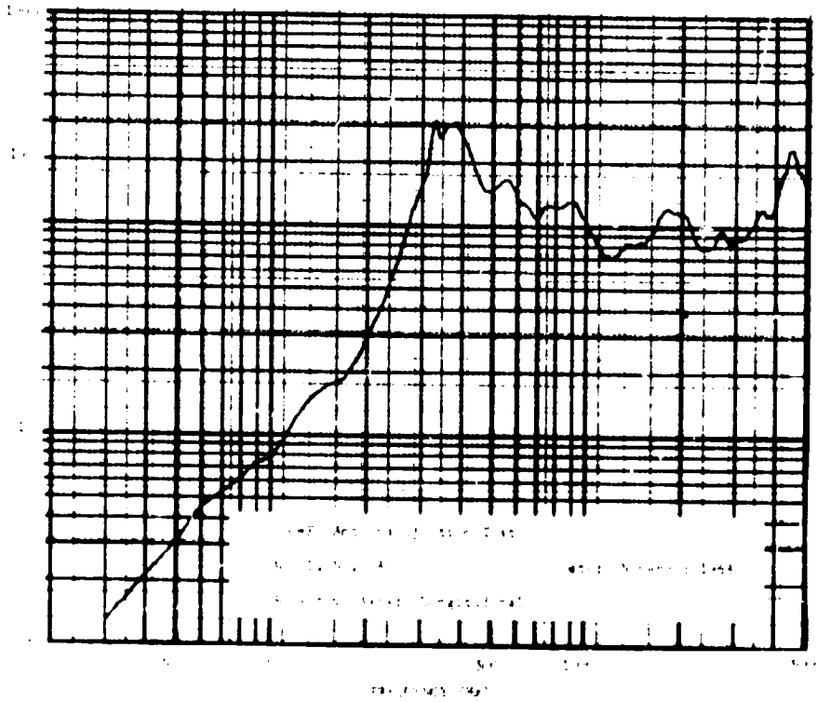



FIGURE III.C.3-10

## LOCATION OF ADDITIONAL DATA

Additional pyrotechnic shock data compiled for cartridge actuated devicws for propagation in structure other than skin-ring-frame or truss may be found in the following sections of this volume:

IV.A.3 Entire section

IV.B.3 Entire section

IV.B.4 Entire section

IV.B.5 Entire section

IV.B.6 Entire section

## LOCATION OF RELATED LOCKHEED DATA

Additional pyrotechnic shock data for cartridge actuated devices propagating in structures other than skin-ring-frame or truss may be found in the following sections of the Lockheed data compilation:

II.A.2

II.C.1

II.C.2

# DIVISION IV

# SPACE VEHICLE TEST DATA

## FOREWORD TO DIVISION IV

Division IV contains a comprehensive collection of shock data for several different pyrotechnic events associated with each of three space vehicles: the PRIME (lifting body, re-entry vehicle), the Mariner, and the Surveyor. These data are presented in a separate portion of the data compilation for two primarly reasons:

1) Because of the diversity of the pyrotechnic events involved in these three programs, no other organizational scheme would be any more realistic.

2) Presenting these data in one location of the compilation provides the user with additional ease in comparing relative shock levels produced in any one of three structural configurations by a variety of pyrotechnic devices.

The Mariner and Surveyor data presented here also include some data for non-pyrotechnic events such as launch and landing gear extension. These data are made available so that the relative effects of such events and other sources of excitation may be quantitatively compared.

TABLE OF CONTENTS

Prime Re-Entry Vehicle Shock Tests


| Section | Event | Pyrotechnic Device | Number of Shock Spectra | |
|---|---|---|---|---|
| IV.A.1 | Booster Separation | Explosive Bolt | 27 | [illegible] |
| IV.A.2 | Parachute Hatch Separation | FLSC | 59 | [illegible] |
| IV.A.3 | Drogue Chute Ejection Mortar | Mortar | 25 | [illegible] |
| IV.A.4 | Drogue Chute Separation | Explosive Nut | 33 | [illegible] |


PART IV.B

Mariner (Venus & Mars) '69
Flight Acceptance Test


| Section | Event | Pyrotechnic Device | Number of Shock Spectra | |
|---|---|---|---|---|
| IV.B.1 | Shroud Y-Band Release | [illegible] | 13 | [illegible] |
| IV.B.2 | [illegible] | [illegible] | [illegible] | [illegible] |
| IV.B.3 | Solar Panel Deployment | [illegible] | 22 | [illegible] |
| IV.B.4 | Post Injection Propulsion System Type I | [illegible] | 17 | [illegible] |
| IV.B.5 | Post Injection Propulsion System Type J | [illegible] | 17 | [illegible] |
| IV.B.6 | Antenna Deployment | [illegible] | 14 | [illegible] |
| IV.B.7 | [illegible] | [illegible] | 17 | [illegible] |

TABLE OF CONTENTS

(CONT.)

Page No.

PART IV.C

Surveyor Pyrotechnic Acceptance Tests


| Section | Event | Pyrotechnic Device | Number of Shock Spectra | |
|---|---|---|---|---|
| IV.C.1 | Atlas/Centaur Separation | FLSC | 19 | [illegible] |
| IV.C.2 | Shroud Separation | Explosive Nuts | 11 | [illegible] |
| IV.C.3 | Insulation Panel Jettison | MDF & Flad | 16 | [illegible] |
| IV.C.4 | Omni Antenna Deploy | [illegible] | 10 | [illegible] |
| IV.C.5 | Flight Shock Transients | [illegible] | 21 | [illegible] |

[redacted]

[redacted] vehicle shock validation tests on the [redacted] vehicle

[redacted]

[redacted] shock tests were performed on a test article of the [redacted] vehicle to experimentally determine the shock environment levels induced by the major pyrotechnic devices.

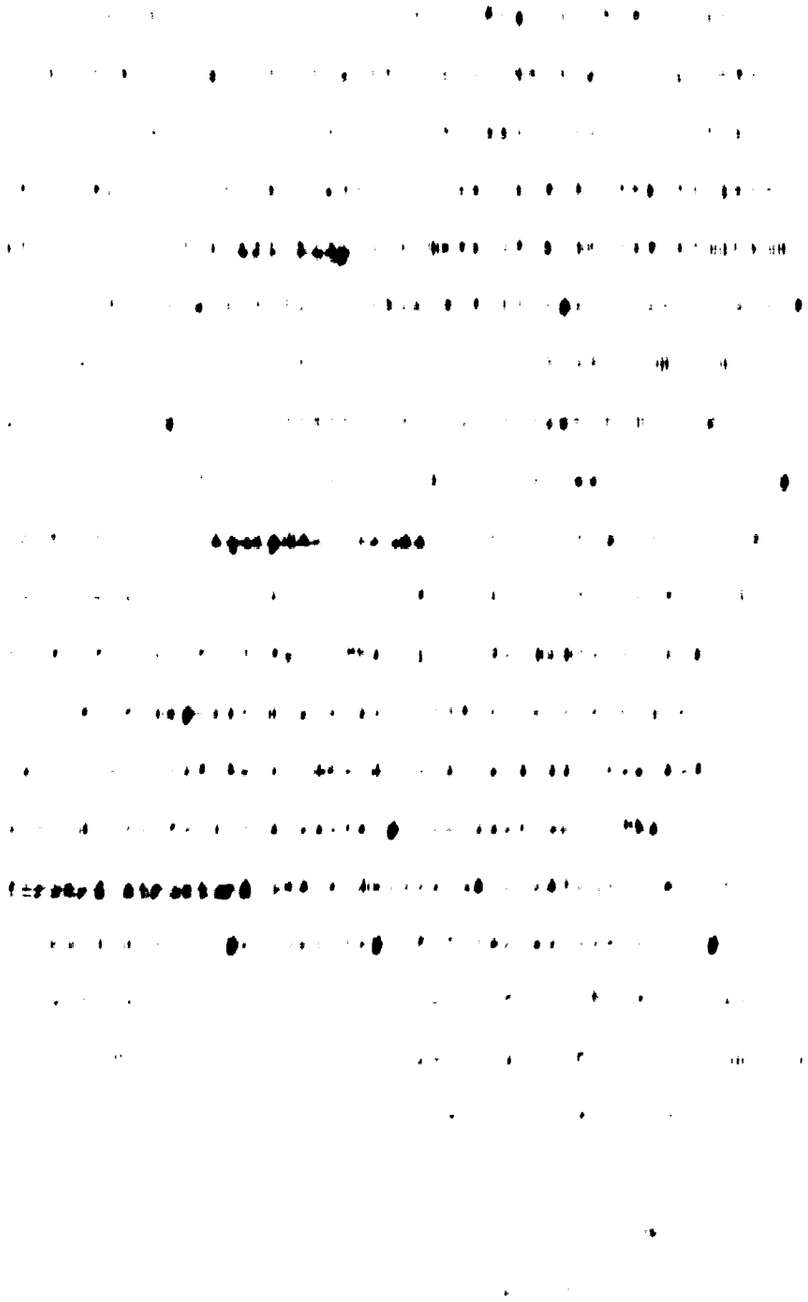
[redacted]

The four major pyrotechnic events associated with this test program are listed below:

1. [redacted] separation (explosive nut and bolt) (Section [redacted])
2. [redacted] nose cone separation (Section [redacted])
3. [redacted] cable cutter (explosive) - (Section [redacted])
4. [redacted] separation (explosive) (Section [redacted])

Figure [redacted] depicts the approximate locations of these pyrotechnic devices.

Two copies of these were performed - in each the [redacted] in the [redacted] to a fully [redacted] condition, using [redacted] test dummies. Each [redacted] was [redacted] to provide a [redacted]



thickness on the external surface of the vehicle except for selected areas where the actual heat shield was installed.

DESCRIPTION OF ACCELEROMETERS

Type: Endevco Model 2225

Locations: Figure IV.A-1 and IV.A-6

DESCRIPTION OF ACQUISITION SYSTEM

Tape recorders: CEC VR-3400

CEC 5-702

Amplifiers: 12 Endevco model 2713A charge amplifiers

6 Endevco model 2702B voltage amplifiers

2 Kistler 566 charge amplifiers

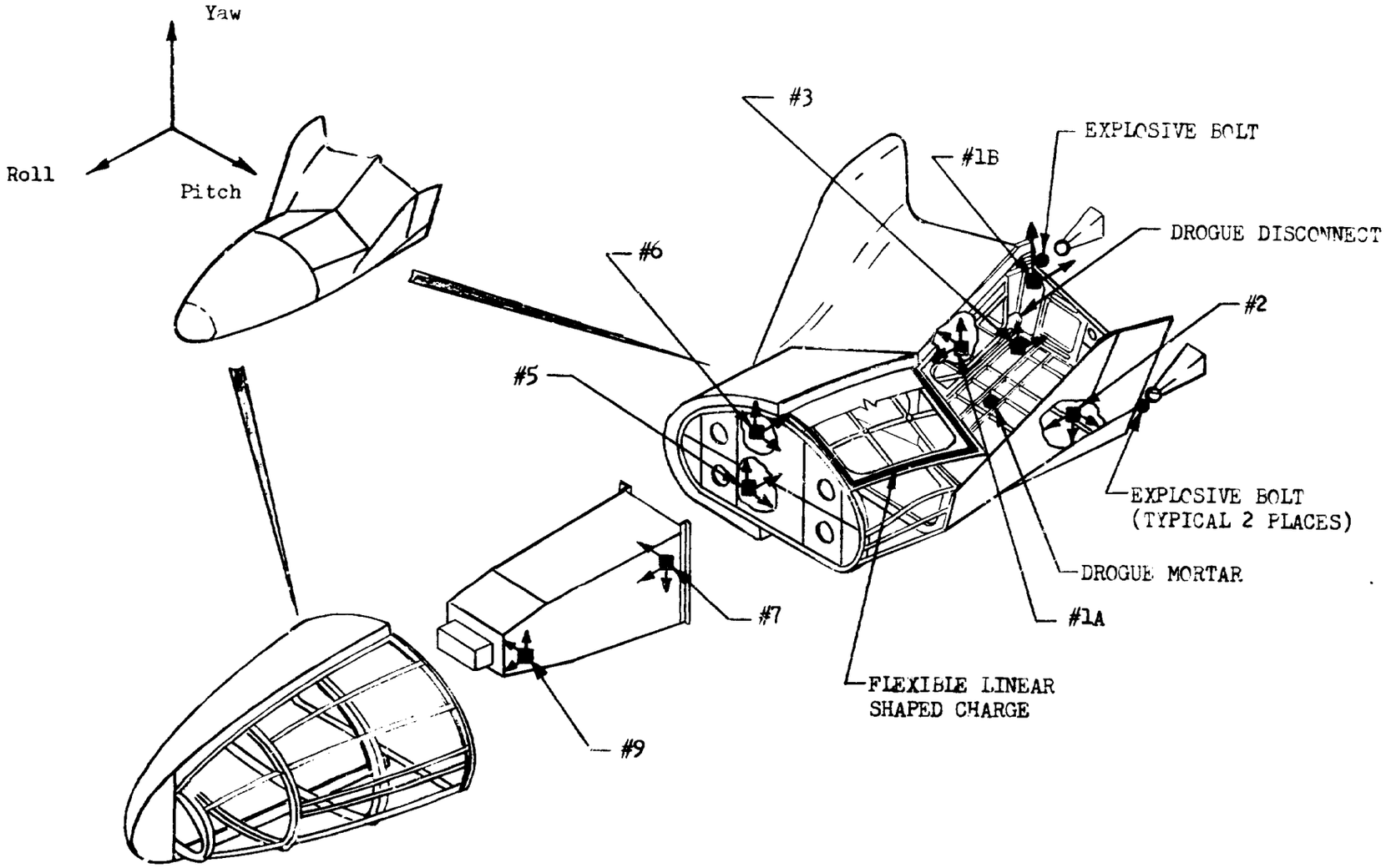
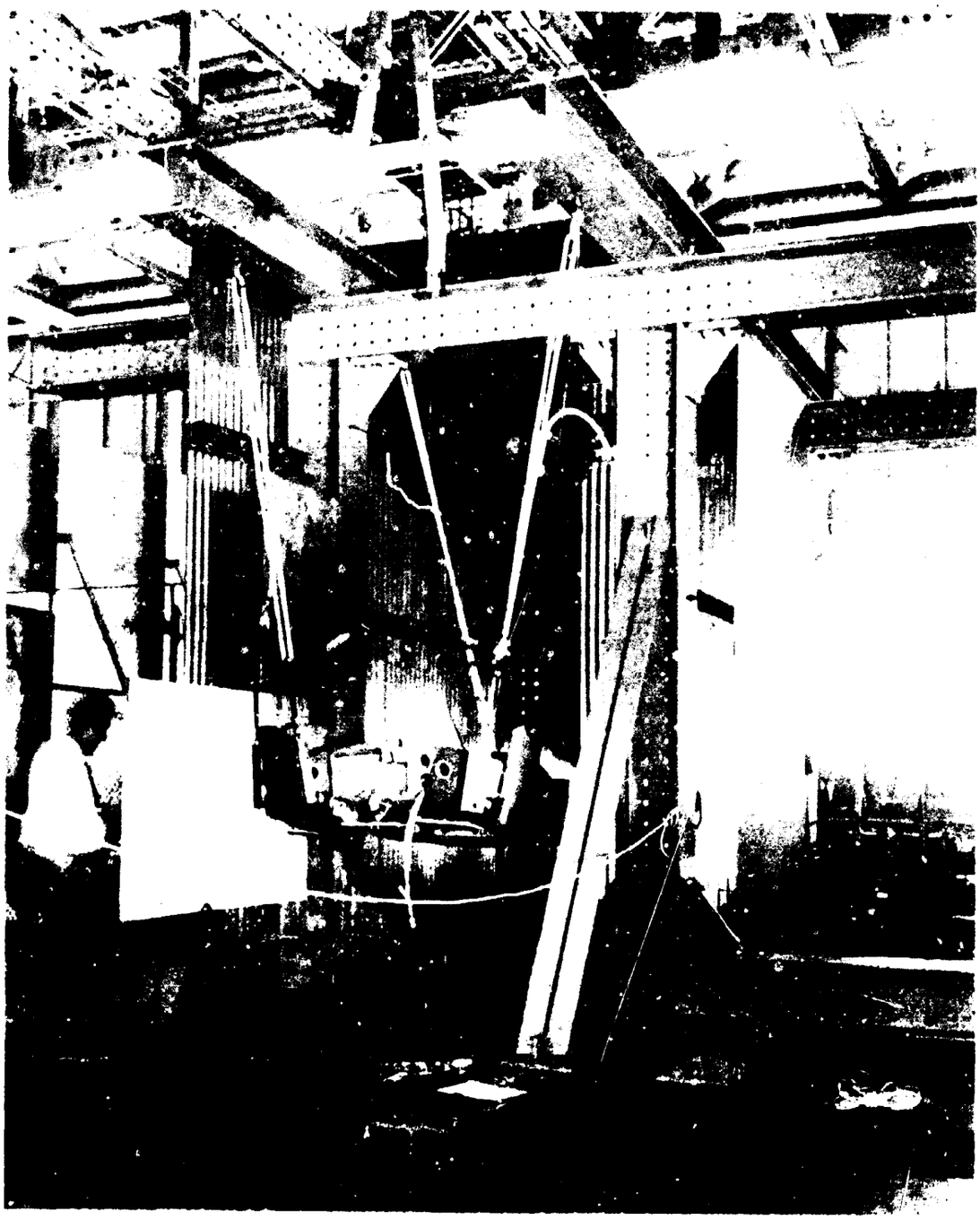
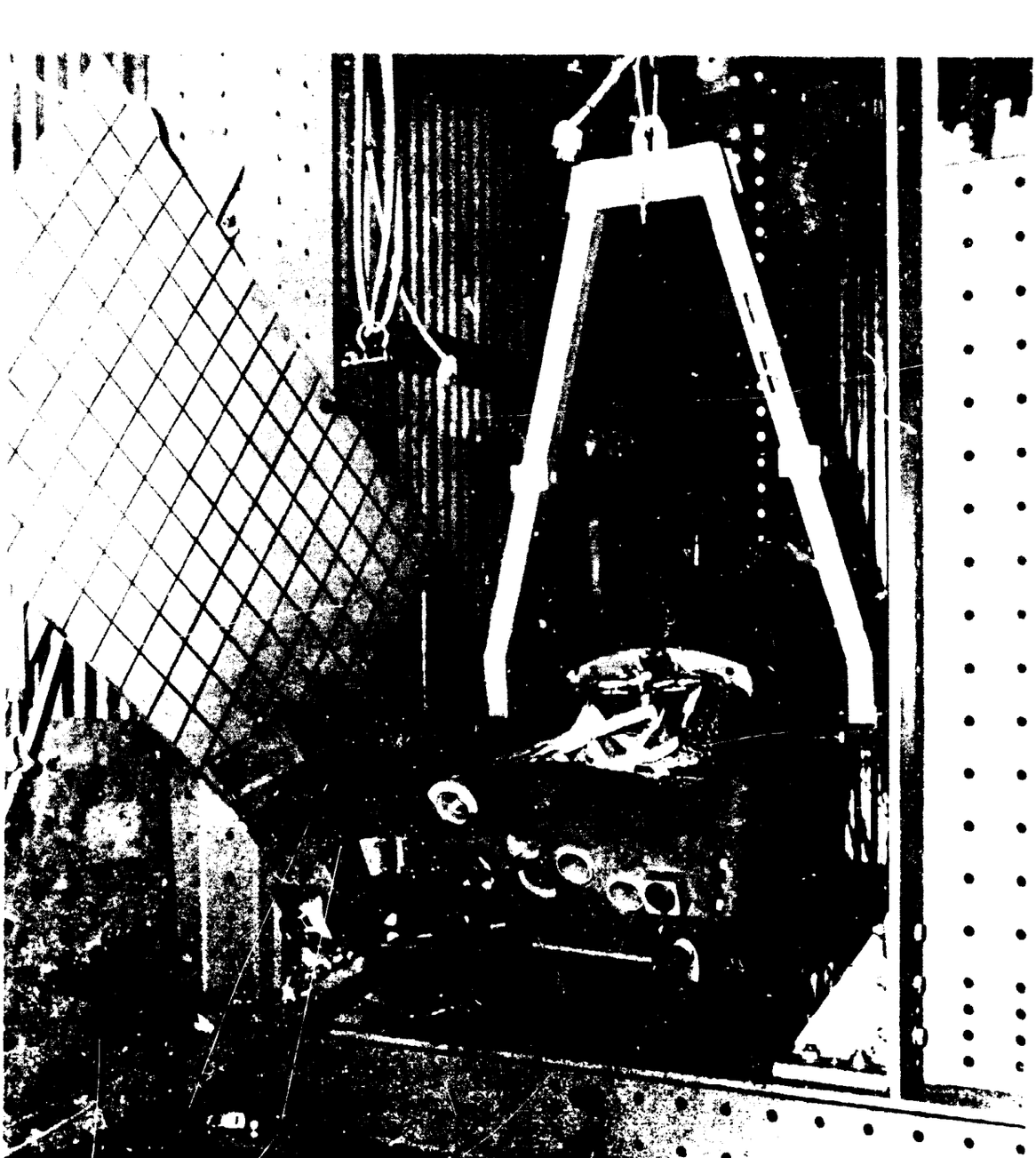
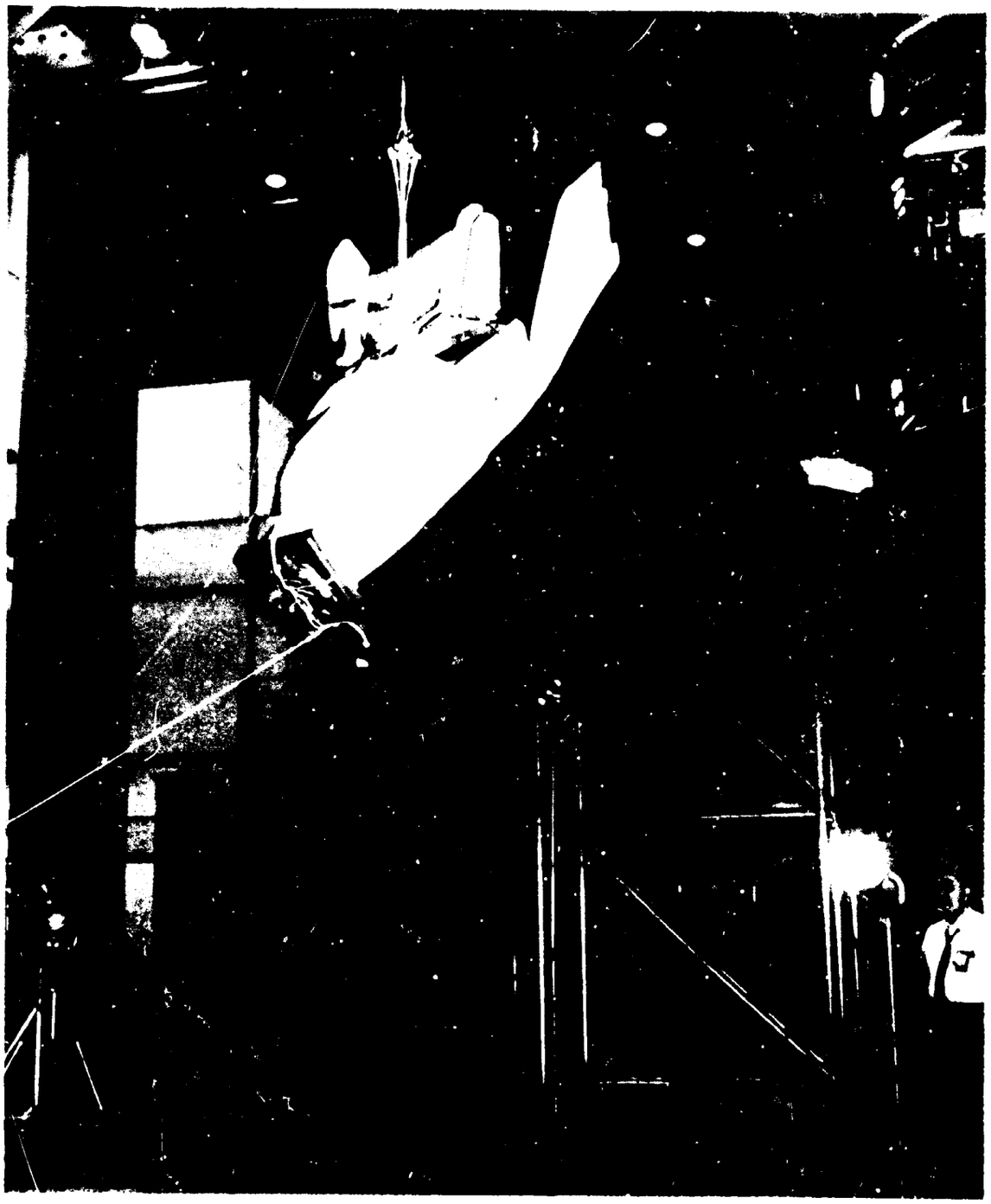



FIGURE IV.A-1. LOCATION OF PYROTECHNIC DEVICES AND ACCELEROMETERS FOR PRIME RE-ENTRY VEHICLE









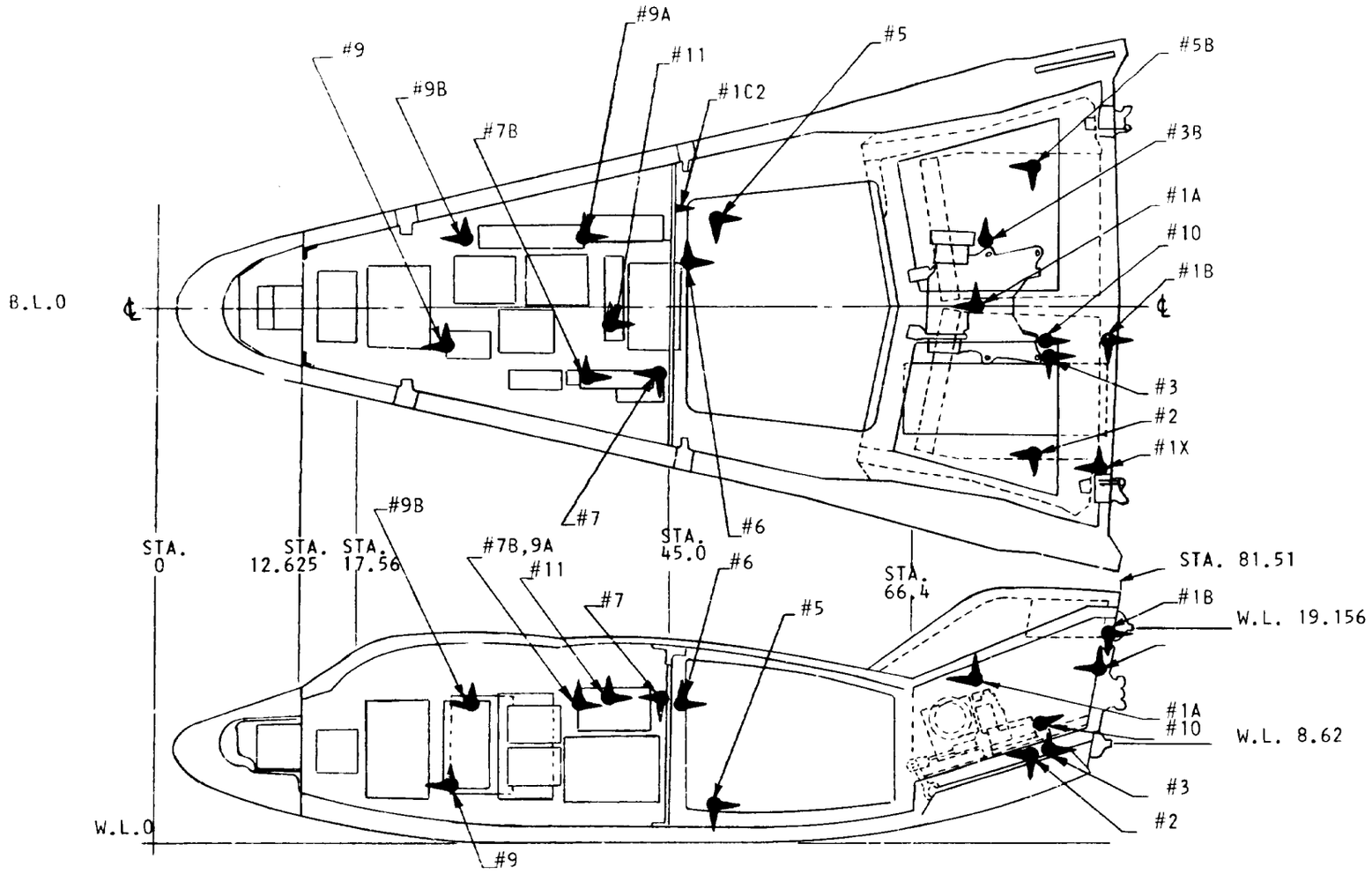



FIGURE IV.A-6. ACCELEROMETER LOCATIONS ON PRIME RE-ENTRY VEHICLE

SECTION IV.A.1

PRIME BOOSTER SEPARATION TESTS

DESCRIPTION OF PYROTECHNIC EVENTS

The test configuration for Shot 1 utilized three explosive bolts like the one depicted in Figure IV.A.1-1 with 3.1 $lb/ft^3$ honeycomb shock absorbers installed. The test results indicated that there was a time lag of approximately 12 milliseconds between the firing of the center bolt and that of the two outboard bolts. Each bolt produced a shock which occurred during ignition and a second shock which occurred approximately 1 to 2 milliseconds later. All honeycomb shock absorbers were completely crushed.

In an effort to find a way of attenuating the shock, a single bolt was fired in the center location using a high crushing force honeycomb absorber (5.7 $lb/ft^3$). The results of this test are presented in Figure IV.A.1-12.

To continue the study of attenuation characteristics, shot 5 was conducted using explosive nuts rather than explosive bolts. The 5.7 $lb/ft^3$ honeycomb absorbers were again used.

The results of shots 1 and 5 are compared in figures IV.A.1-2 through IV.A.1-11.

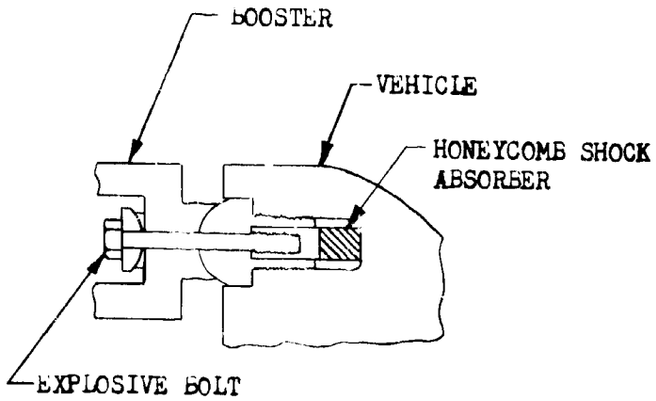
DESCRIPTION OF DATA

Figures IV.A.1-2 through IV.A.1-12 present 27 shock spectra for the three tests described above as itemized in Table IV.A.1-1.

TABLE IV.A.1

INDEX OF DATA LOCATIONS

| Shock No. | Accelerometer No.s | Figure No. |
|---|---|---|
| 1 and 5 | 1A, 1A roll | IV.A.1-2 |
| 1 and 5 | 2 ptich, 2 roll | IV.A.1-3 |
| 1 and 5 | 2 yaw, 3 roll | IV.A.1-4 |
| 1 and 5 | 3 pitch, 3 yaw | IV.A.1-5 |
| 5 | 1X pitch, 1X yaw | IV.A.1-6 |
| 5 | 1B pitch, 3B yaw | IV.A.1-7 |
| 5,1 | 5B ptich, 6 yaw | IV.A.1-8 |
| 1 | 6 roll, 7 pitch | IV.A.1-9 |
| 1 | 7 roll, 7 yaw | IV.A.1-10 |
| 1 | 9 roll, 9 yaw | IV.A.1-11 |
| Booster Bolt Test | 1A, 2 pitch | IV.A.1-12 |




EXPLOSIVE BOLT (BOOSTER SEPARATION)

FIGURE IV.A.1-1 EXPLOSIVE BOLT/SHOCK ABSORBER CONFIGURATION

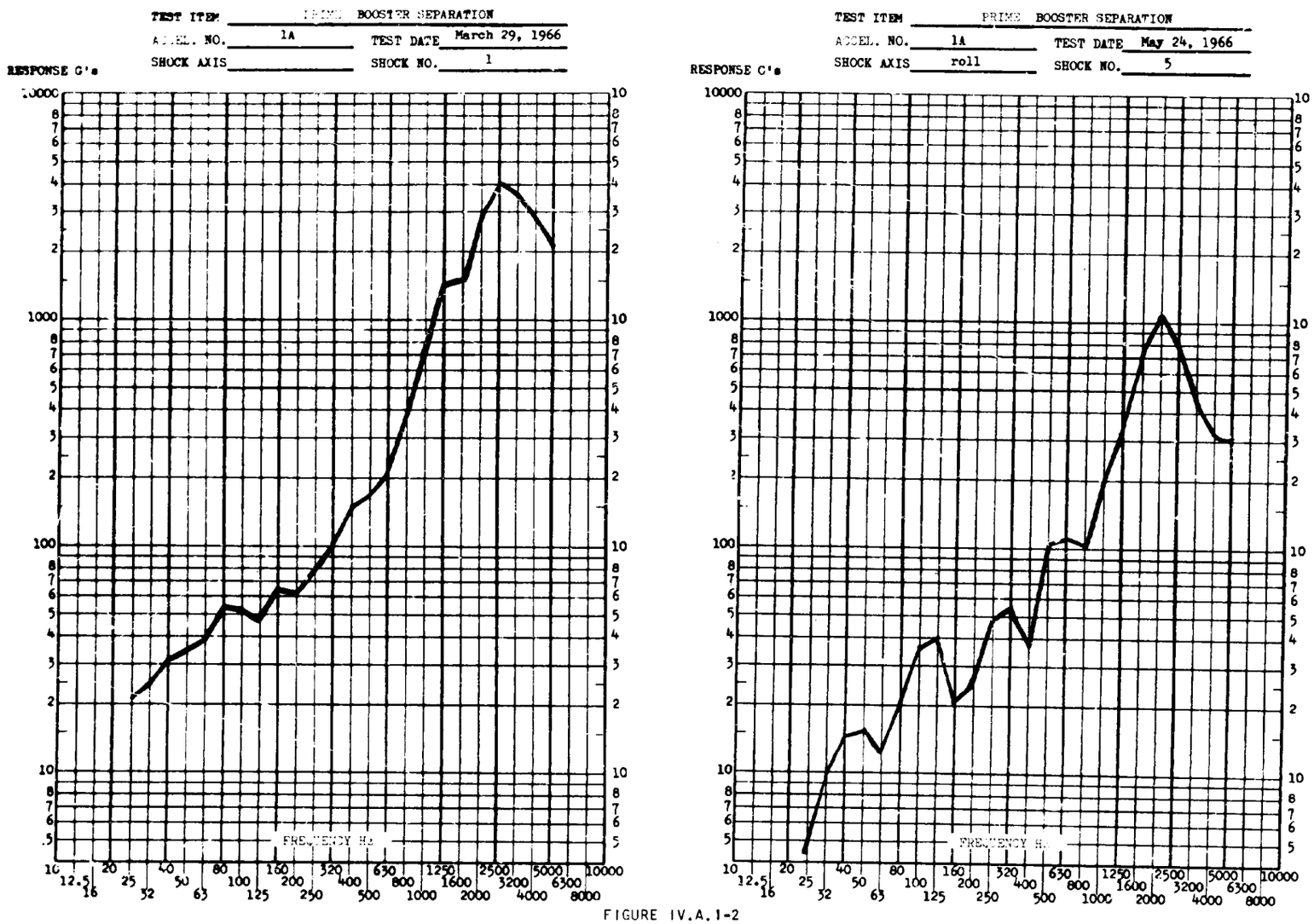
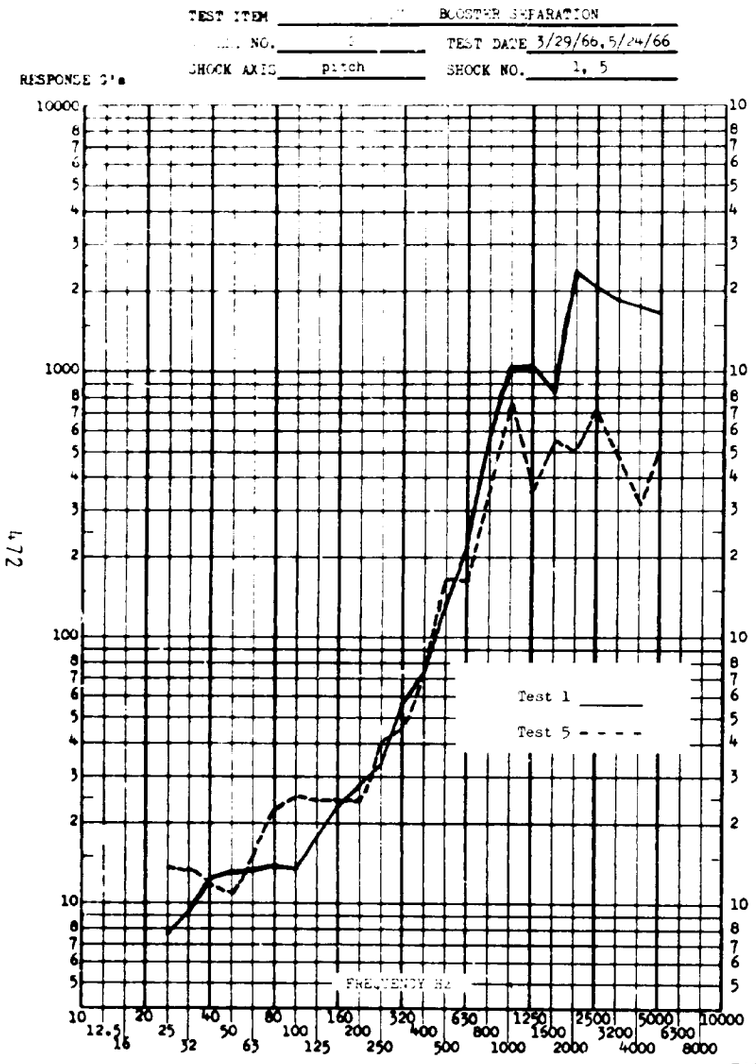



FIGURE IV.A.1-2



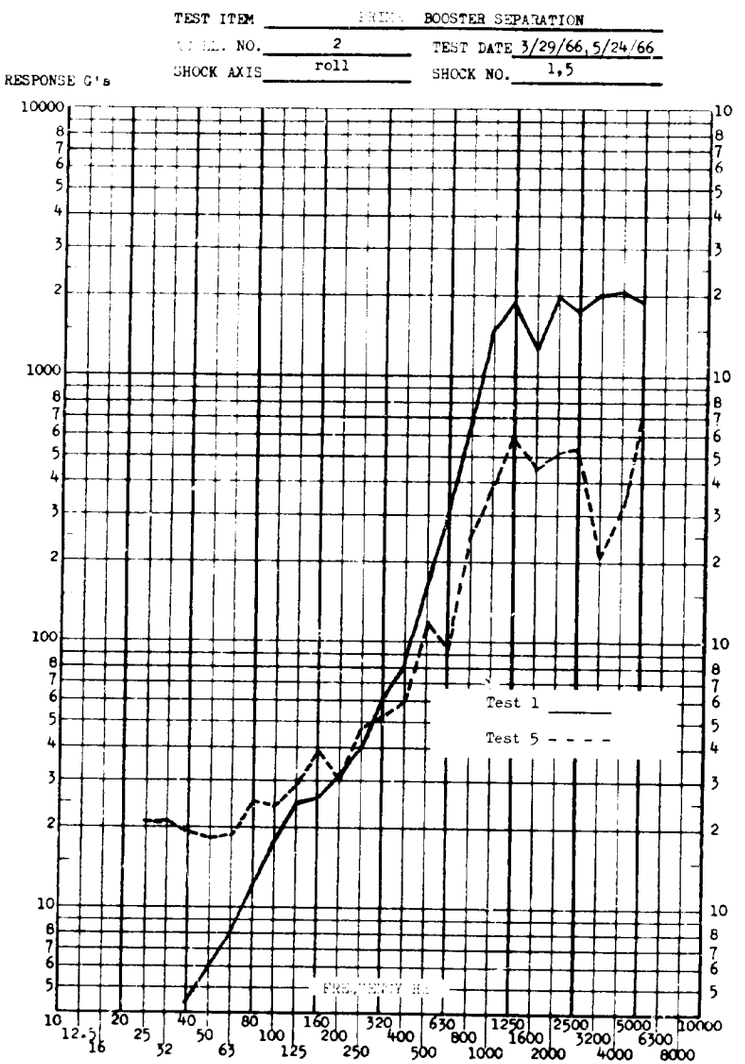
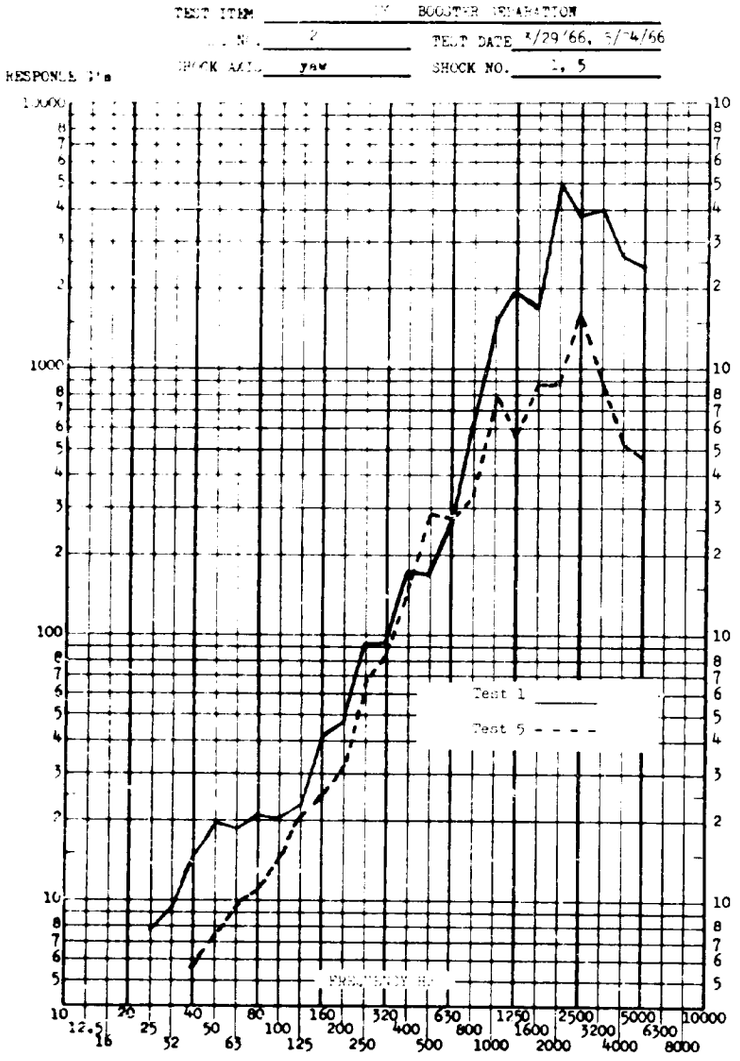




FIGURE IV.A.1-3



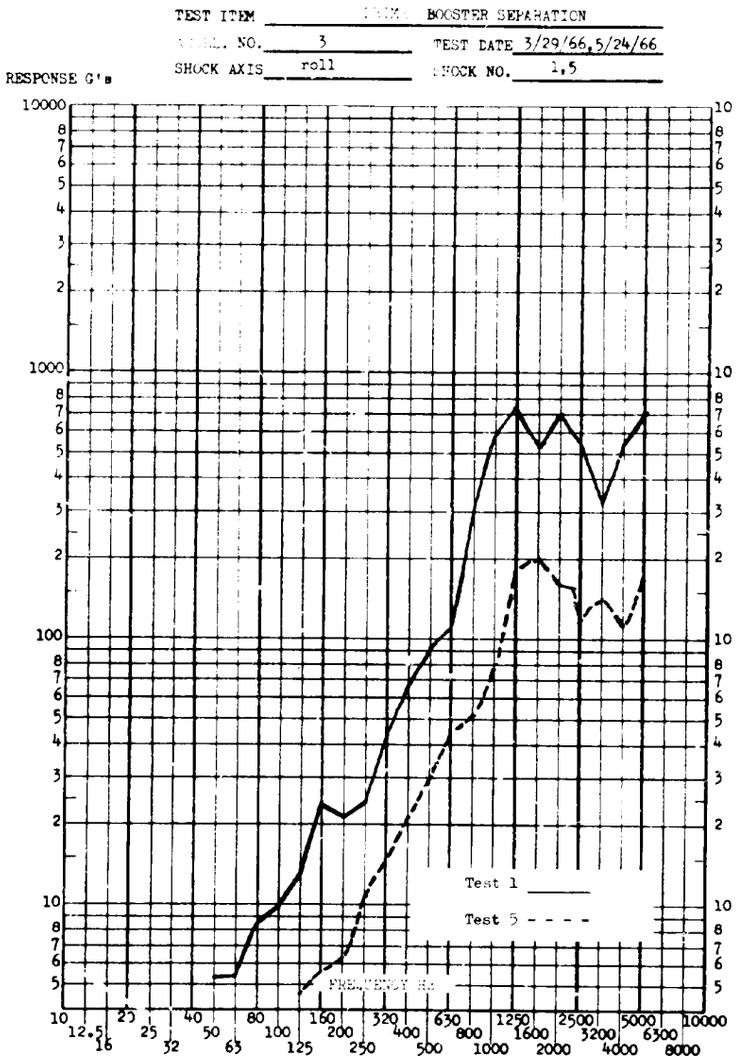



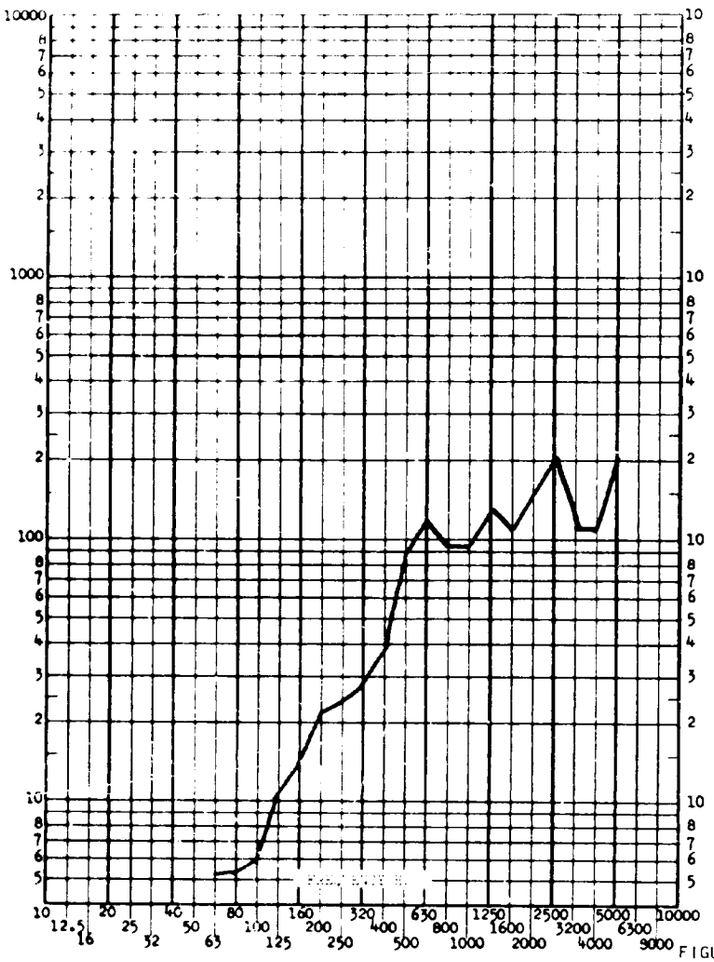

FIGURE IV.A.1-4

TEST ITEM [illegible] BOOSTER SEPARATION

MODEL NO. 3 TEST DATE May 24, 1966

SHOCK AXIS pitch SHOCK NO. 5

RESPONSE G's




TEST ITEM [illegible] BOOSTER SEPARATION

MODEL NO. 3 TEST DATE 3/29/66, 5/24/66

SHOCK AXIS yaw SHOCK NO. 1,5

RESPONSE G's

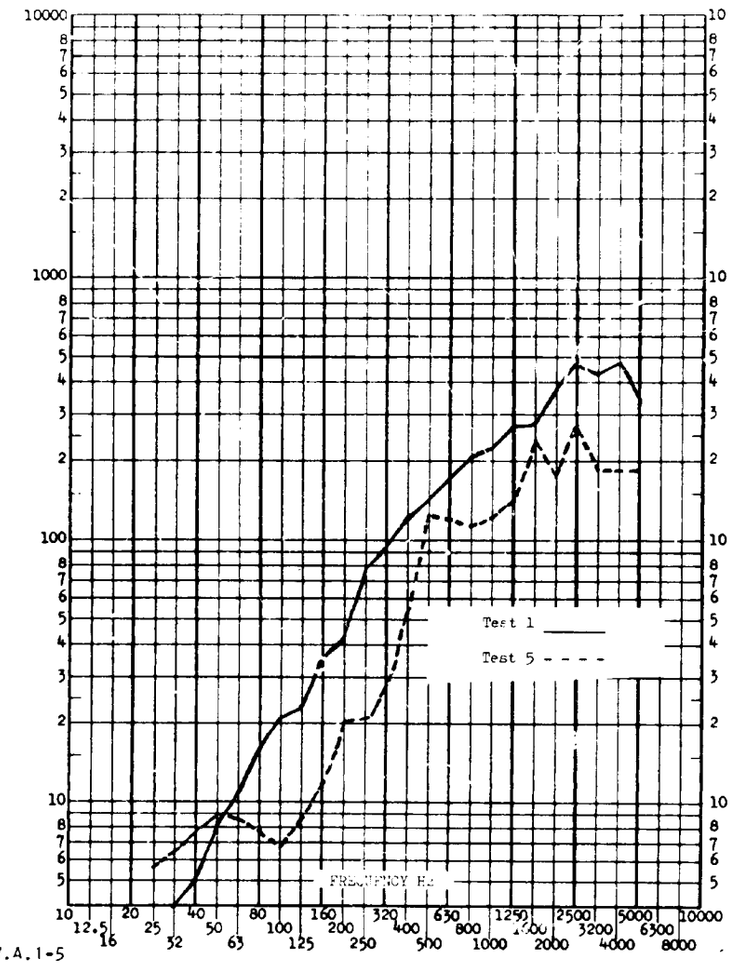
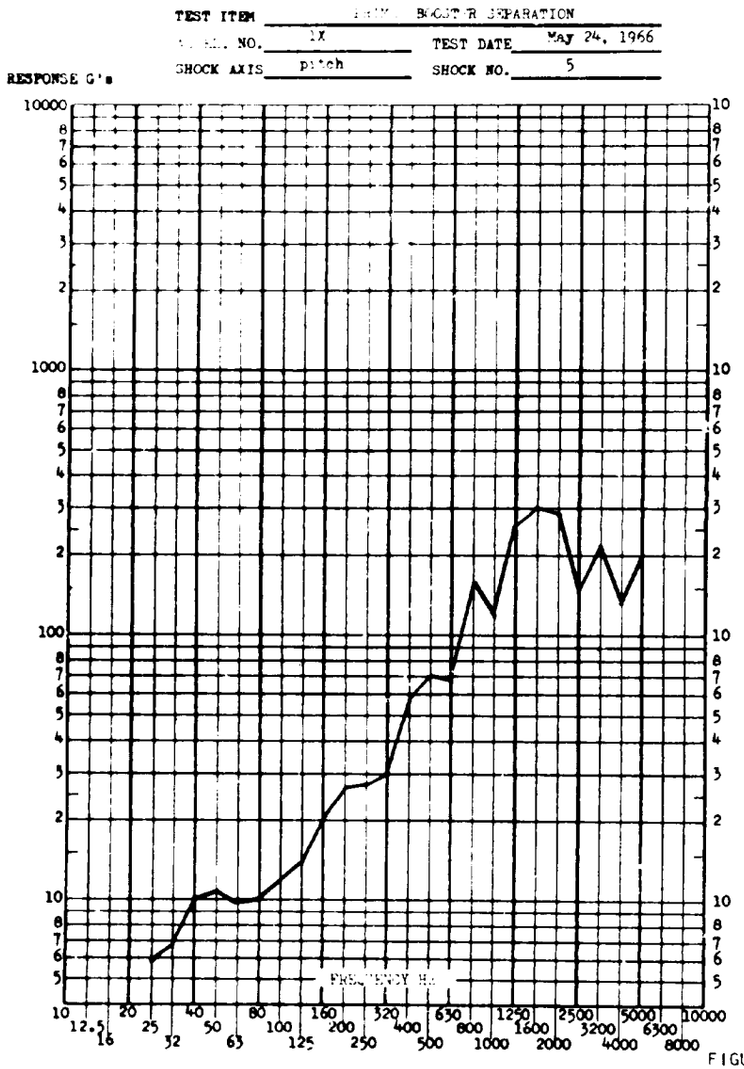



FIGURE IV.A.1-5



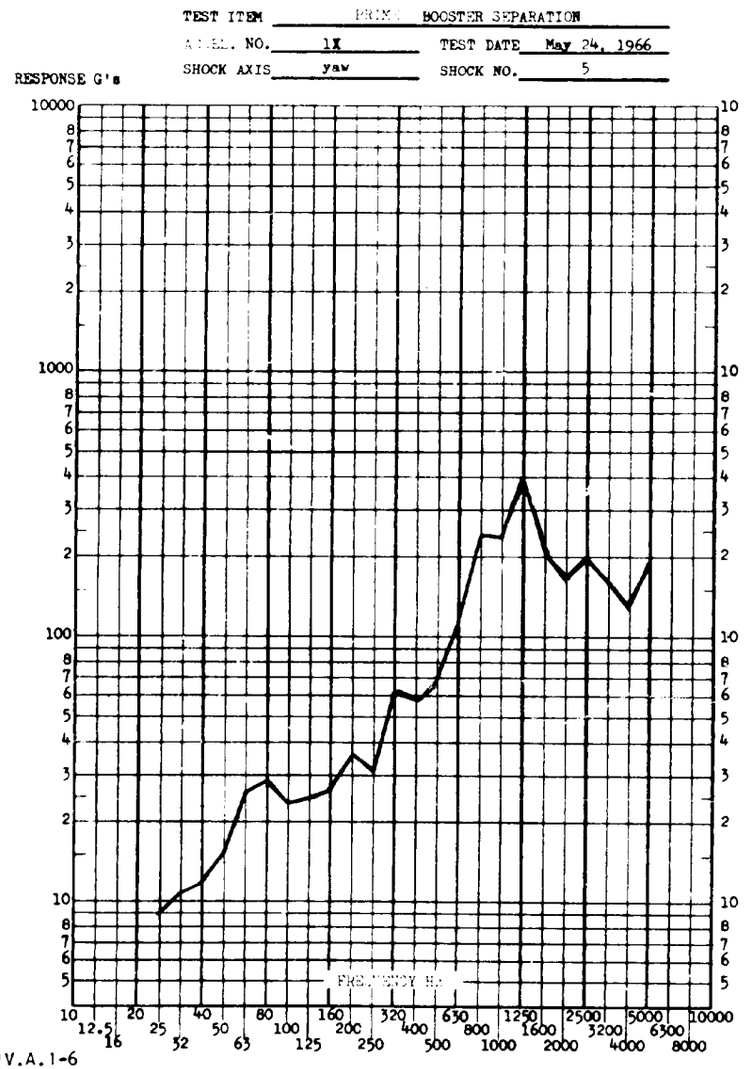
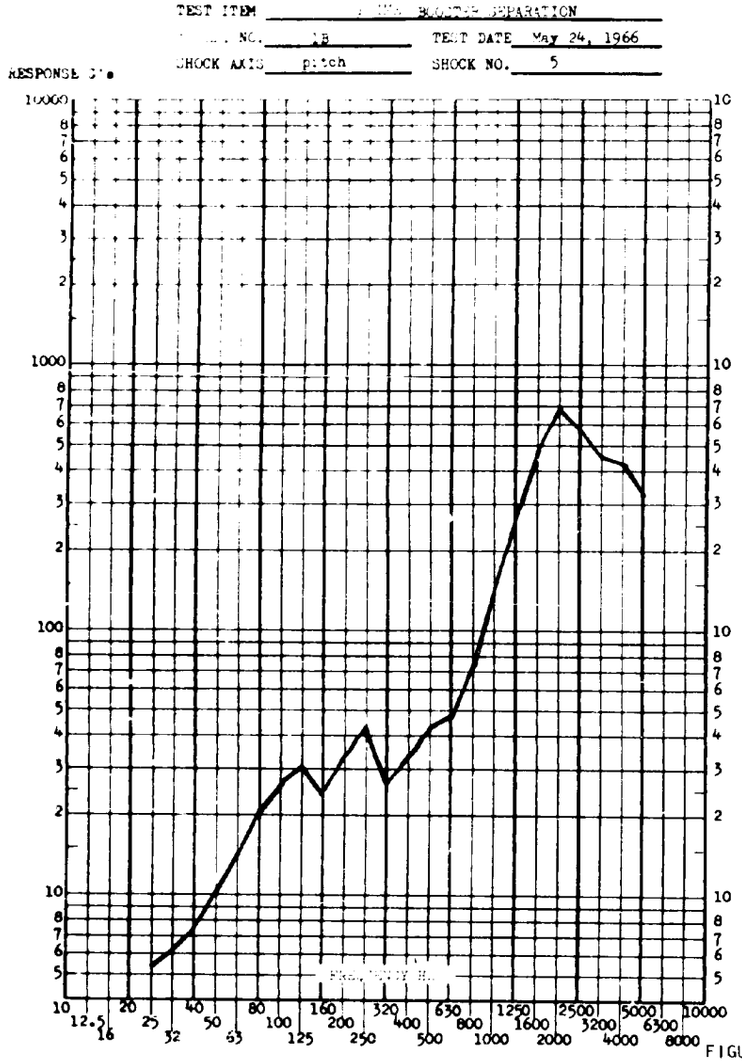




FIGURE IV.A.1-6



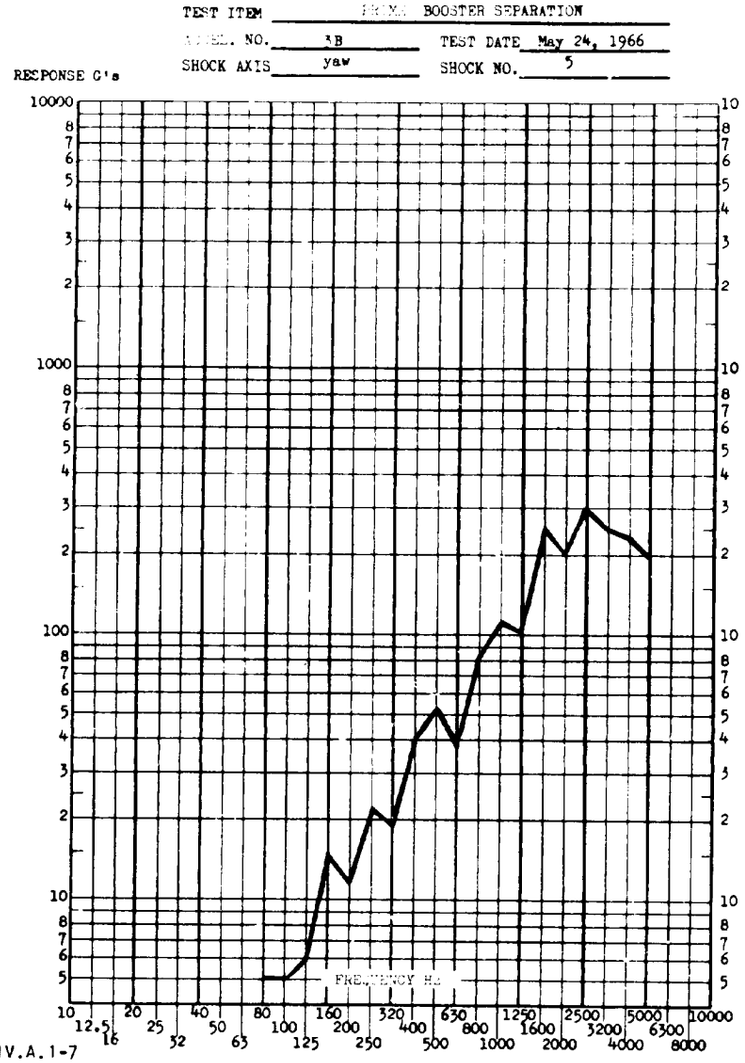
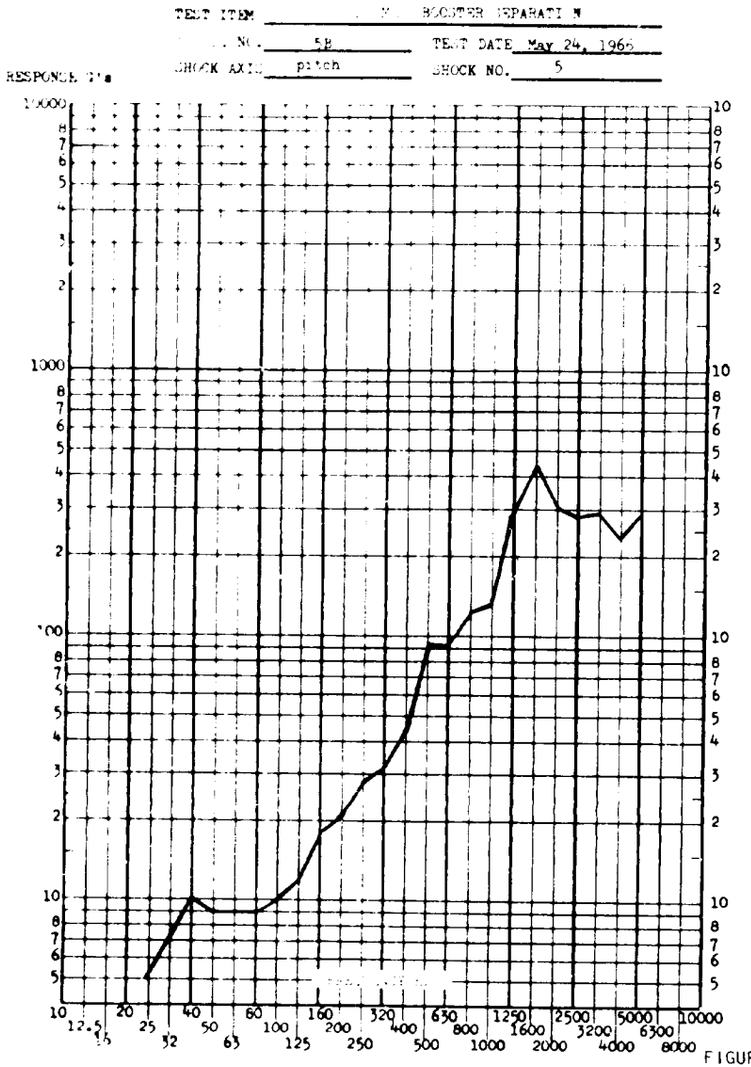




FIGURE IV.A.1-7



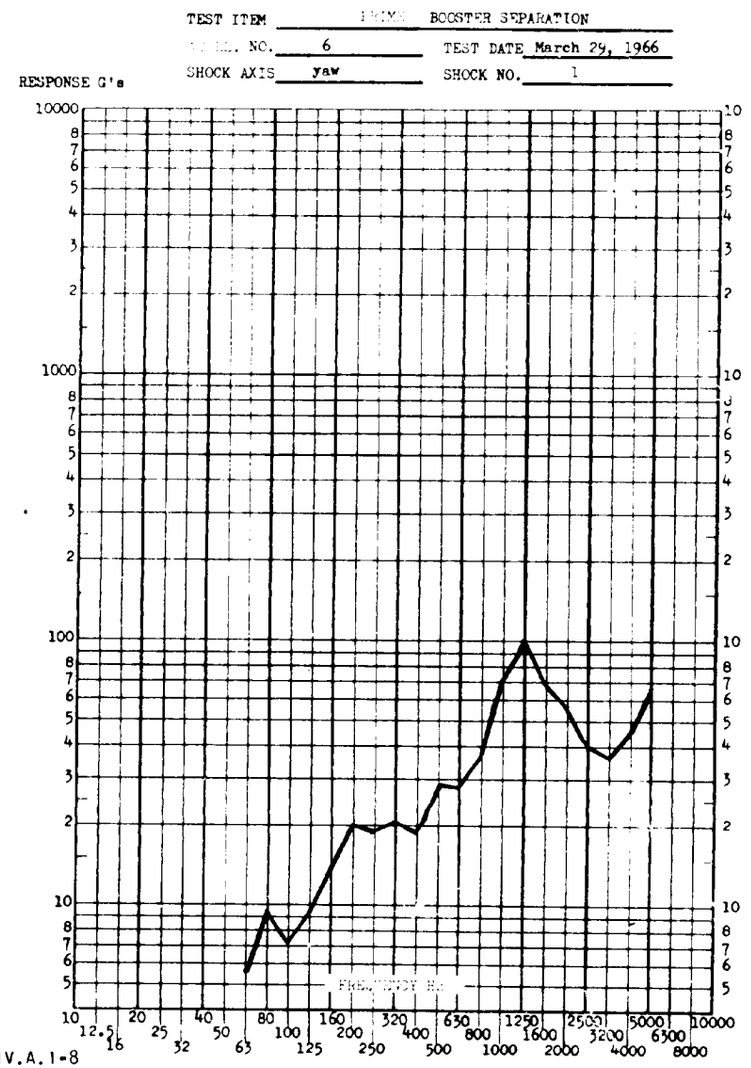




FIGURE IV.A.1-8

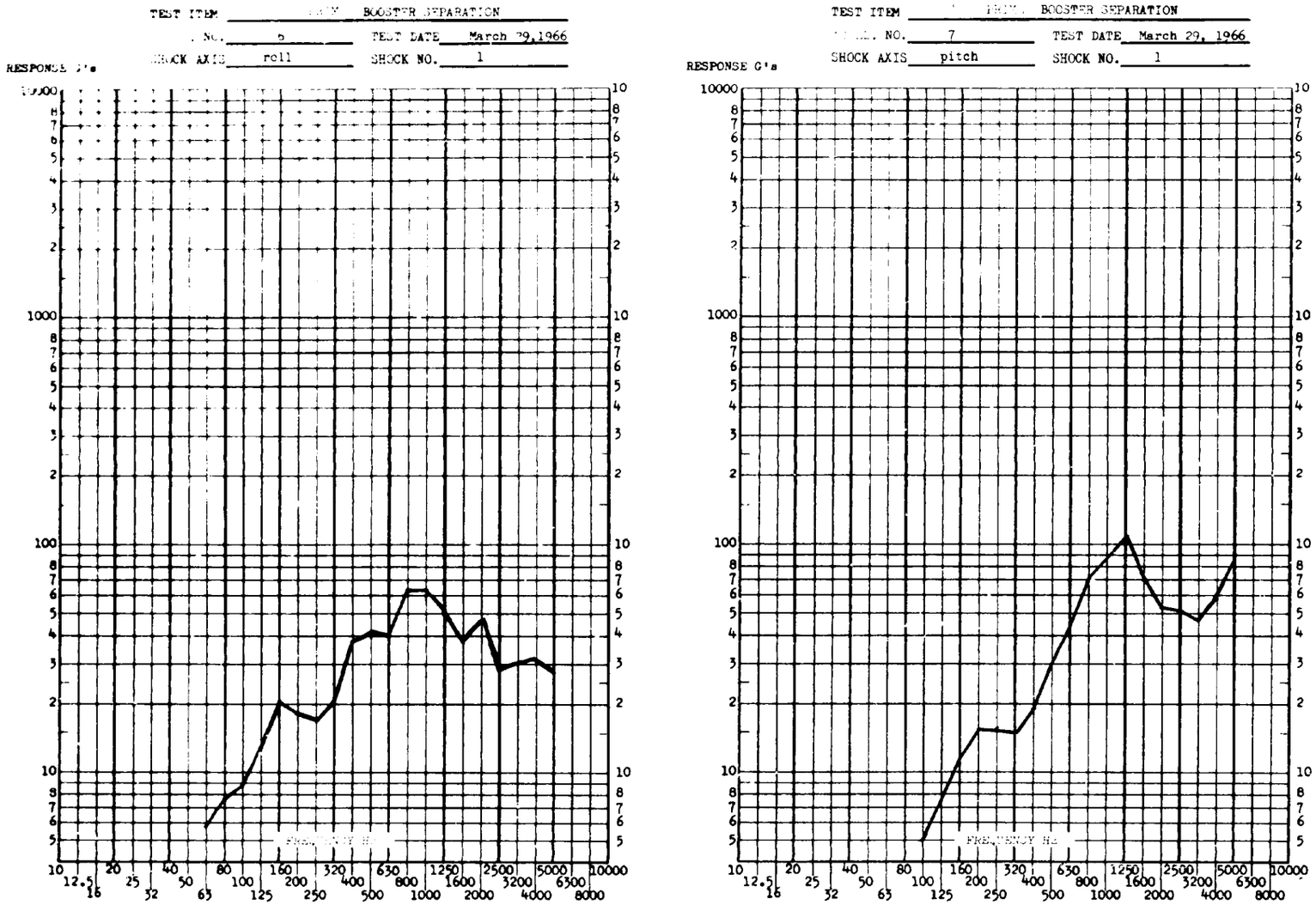
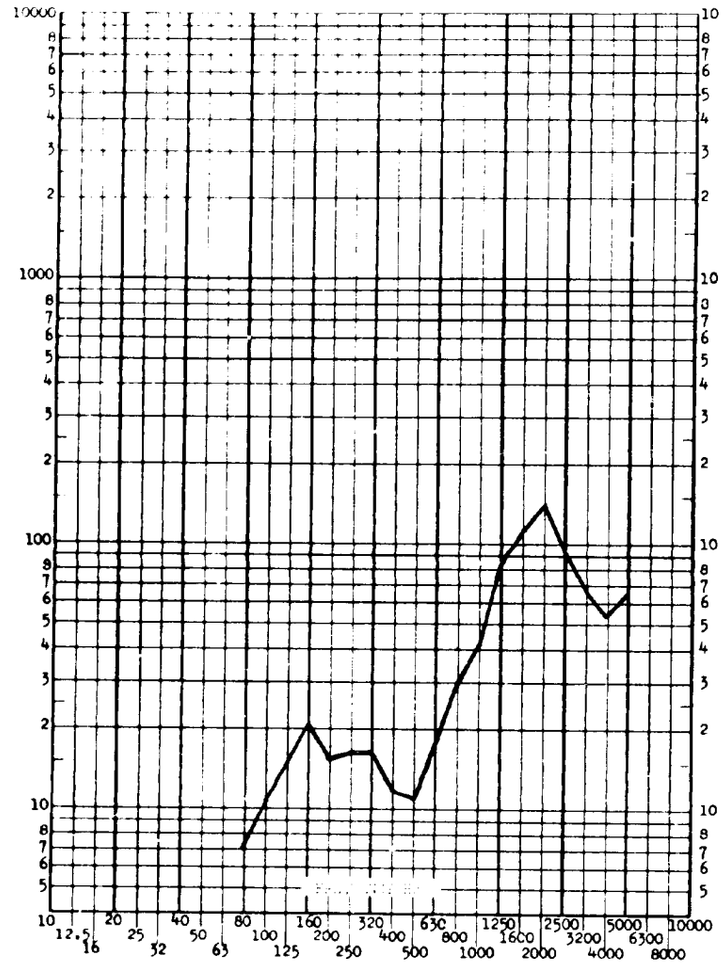



FIGURE IV.A.1-9

TEST ITEM [illegible] BOOSTER SEPARATION
[illegible] NO. 7 TEST DATE March 29, 1966
SHOCK AXIS roll SHOCK NO. 1

RESPONSE G's




TEST ITEM [illegible] BOOSTER SEPARATION
[illegible] NO. 7 TEST DATE March 29, 1966
SHOCK AXIS yaw SHOCK NO. 1

RESPONSE G's

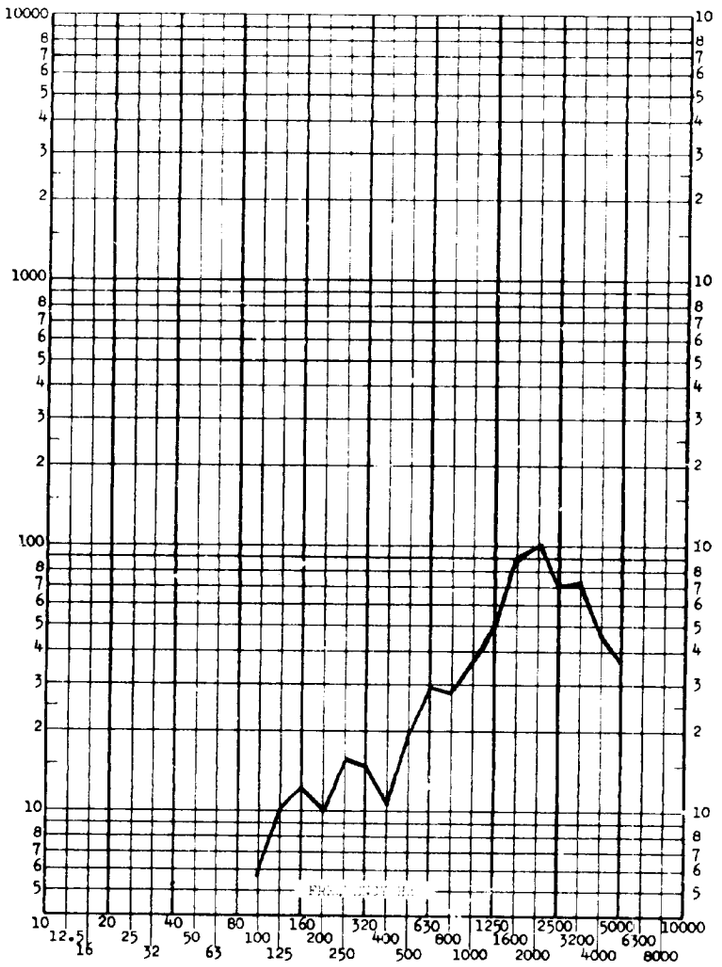
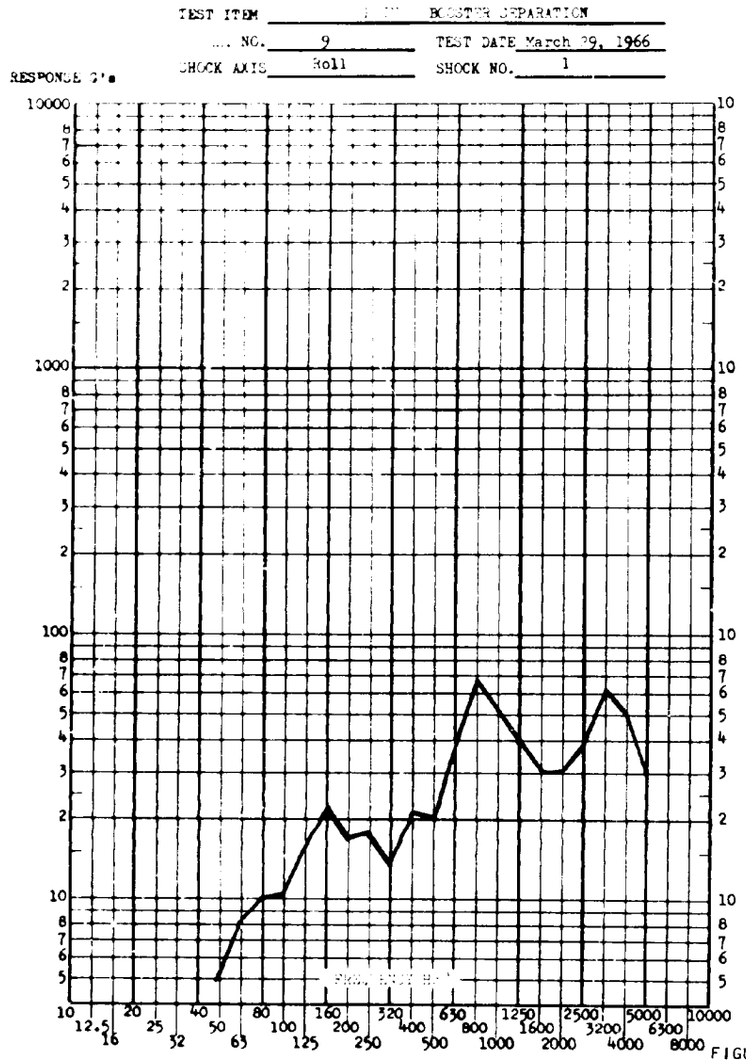



FIGURE IV.A.1-10



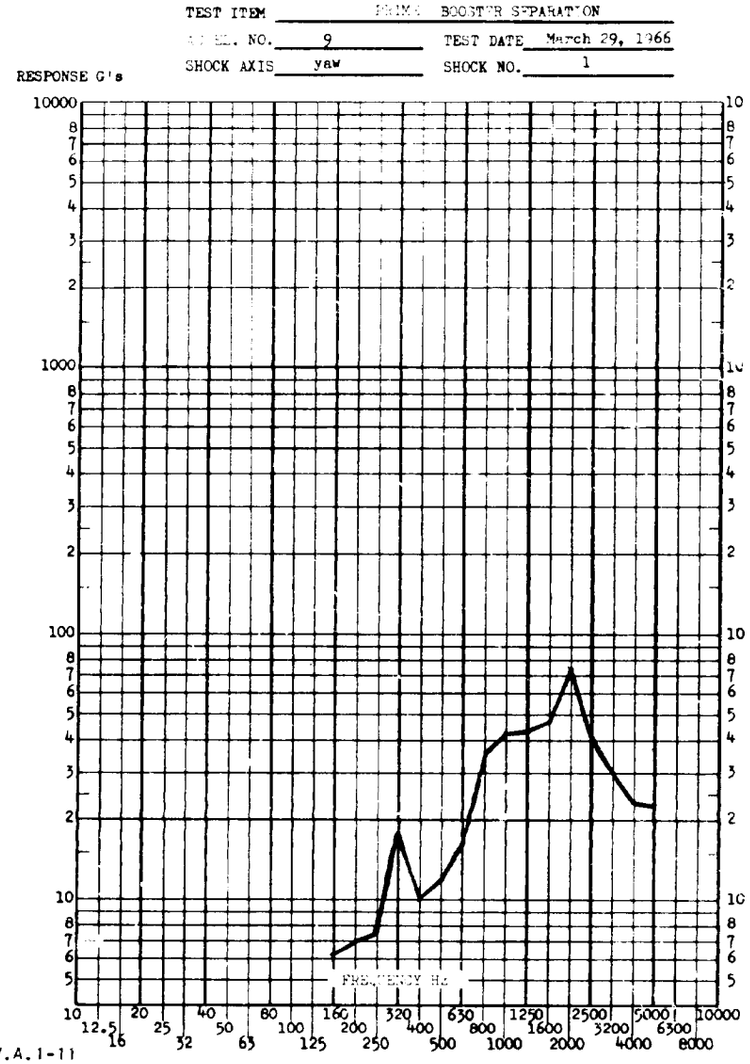
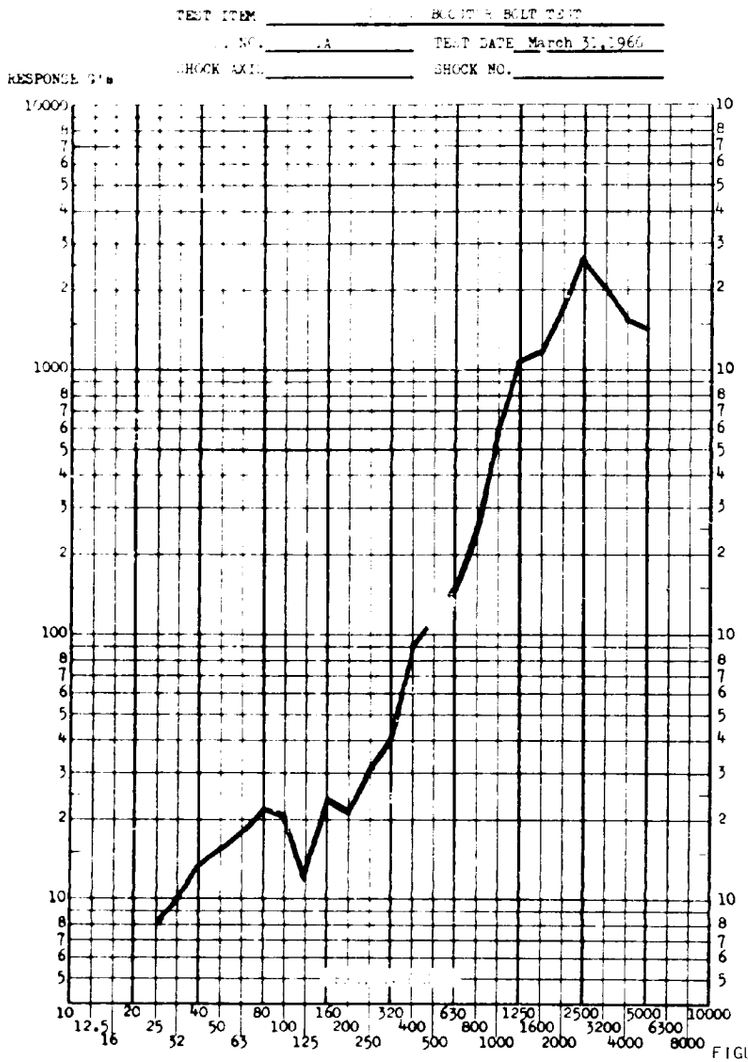




FIGURE IV.A.1-11



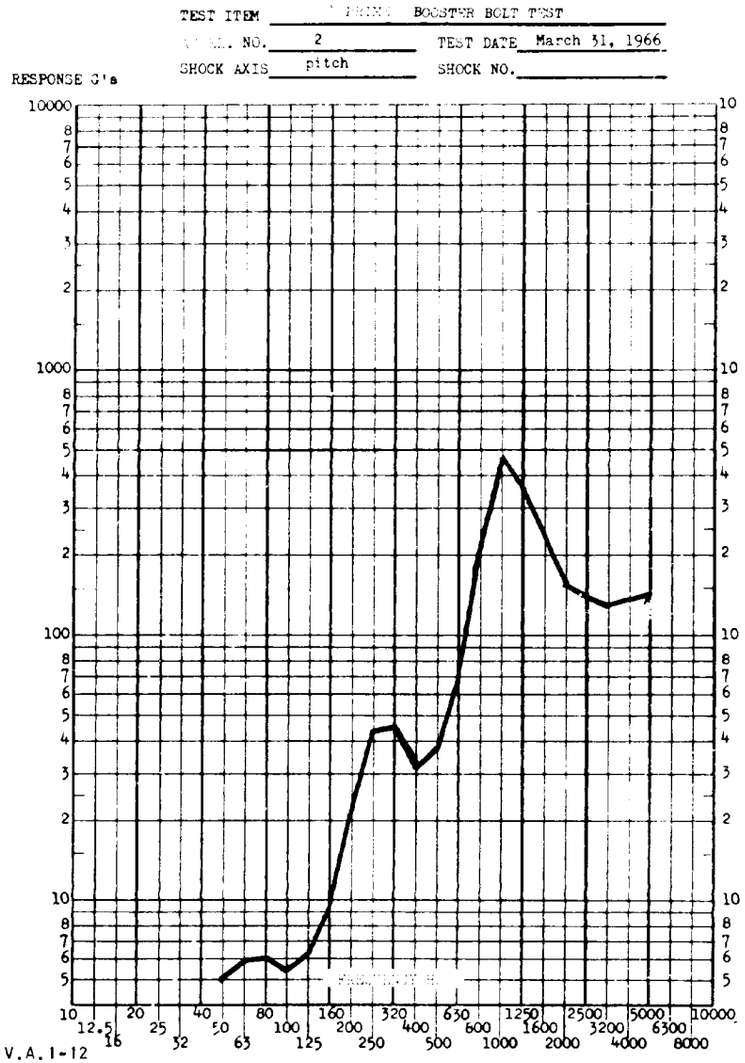




FIGURE IV.A.1-12

SECTION IV.A.2

PRIME PARACHUTE HATCH SEPARATION TESTS

DESCRIPTION OF EVENTS

Six hatch separation tests were conducted, and some of the resulting shock spectra for shots 2 through 6 are presented. The important differences among the attenuation devices employed from test to test are cited in Table IV.A.2-1.

DESCRIPTION OF DATA

Fifty-nine shock spectra are presented in Figures IV.A.2-1 through IV.A.2-19 as itemized in Table IV.A.2-2.

DESCRIPTION OF PYROTECHNIC

Type: FLSC

Size: 5 grains per foot

TABLE IV.A.2-1

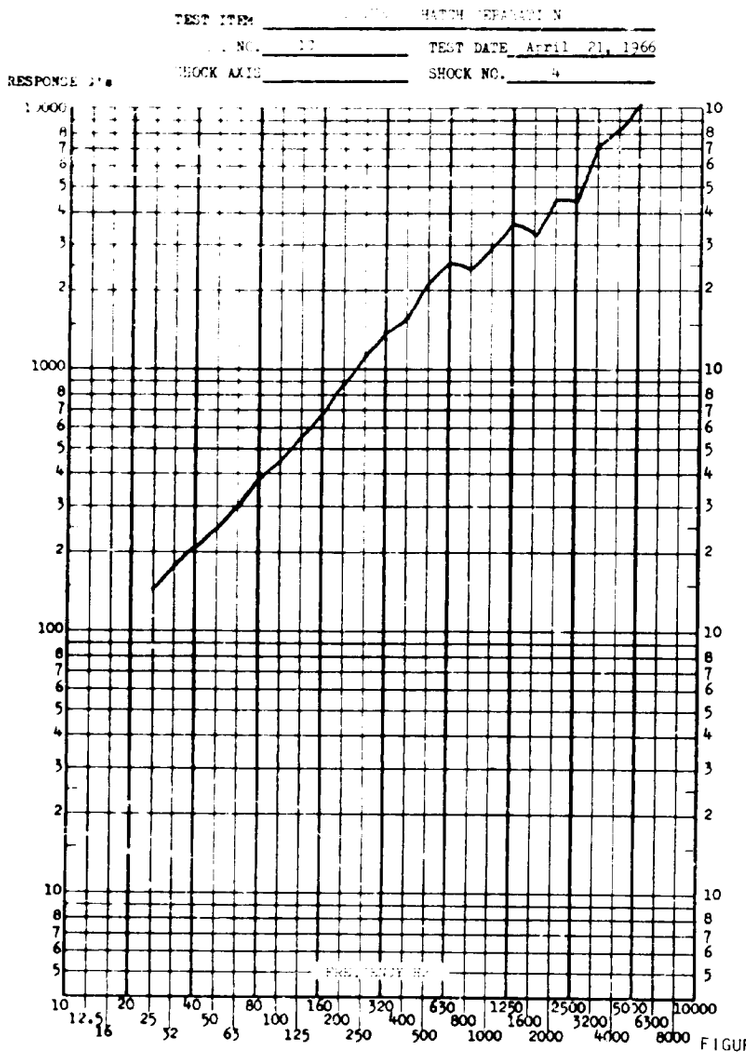
VARIATIONS IN ATTENUATION DEVICES

| Shock Number | Attenuation Devices | Effected Accelerometer Locations |
|---|---|---|
| 2 | standard | |
| 3 | rubber washers at recovery can | 5 |
| | 0.07 inch Pyrotex inserts for equipment beam mounting points | 7,9 |
| 4 | LORD Mounts and Pyrotex inserts at recovery can | 5 |
| | 2-0.07 inch Pyrotex inserts for equipment beam mounting points | 7,9 |
| 5 | Lower attach points of recovery can were riveted and LORD mounts were again used at the upper attach points | 5 |
| | Layers of fairprene at equipment beam's primary mounting points | 7,7B 9A,9B |
| 6 | Pyrotex inserts at equipment beam's primarily attach points and rubber inserts at other attachment points. | 7,7,B |

TABLE IV.A.2-2

INDEX OF DATA LOCATIONS

| Figure No. | Graph 1 | | Graph 2 | |
|---|---|---|---|---|
| | Shock No.s | Accel. No.s | Shock No.s | Accel. No.s |
| IV.A.2-1 | 4 | 1C | 5, 6 | 1C2 |
| IV.A.2-2 | 2,3 | 2 roll | 2, 3 | 2 pitch |
| IV.A.2-3 | 2,3 | 2 yaw | 2, 3 | 3 roll |
| IV.A.2-4 | 3 | 3 yaw | 4 | 3B yaw |
| IV.A.2-5 | 2,3 | 5 roll | 4, 5 | 5 roll |
| IV.A.2-6 | 2,3 | 5 pitch | 5 | 5 pitch |
| IV.A.2-7 | 4 | 5 yaw | 2, 3 | 6 roll |
| IV.A.2-8 | 2 | 6 yaw | 2, 3 | 7 roll |
| IV.A.2-9 | 4,5,6 | 7 roll | 2, 3 | 7 pitch |
| IV.A.2-10 | 5,6 | 7 pitch | 2, 3 | 7 yaw |
| IV.A.2-11 | 6 | 7 yaw | 5, 6 | 7B roll |
| IV.A.2-12 | 5,6 | 7B pitch | 5, 6 | 7B yaw |
| IV.A.2-13 | 2,3 | 9 roll | 4 | 9 roll |
| IV.A.2-14 | 2,3 | 9 pitch | 3 | 9 yaw |
| IV.A.2-15 | 4,5 | 9A roll | 4, 5 | 9A pitch |
| IV.A.2-16 | 5 | 9B roll | 4 | 9A yaw |
| IV.A.2-17 | 5 | 9B ptich | 5 | 9B yaw |
| IV.A.2-18 | 6 | 11 roll | 6 | 11 pitch |
| IV.A.2-19 | 6 | 11 yaw | --- | --- |



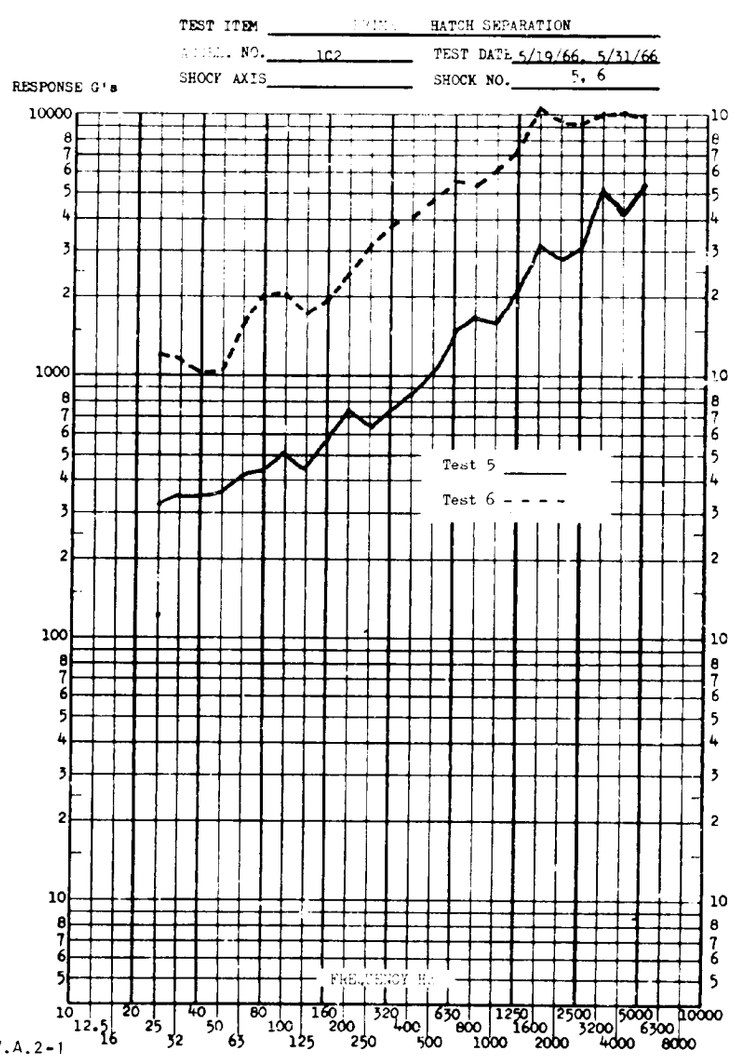
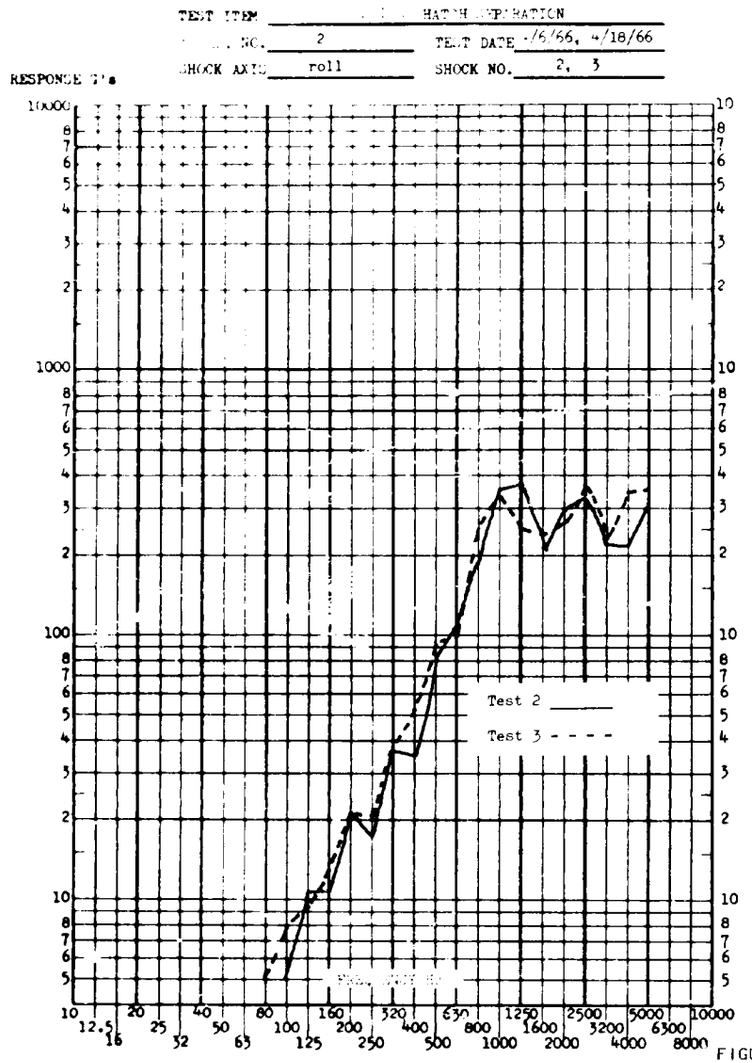




FIGURE IV.A.2-1



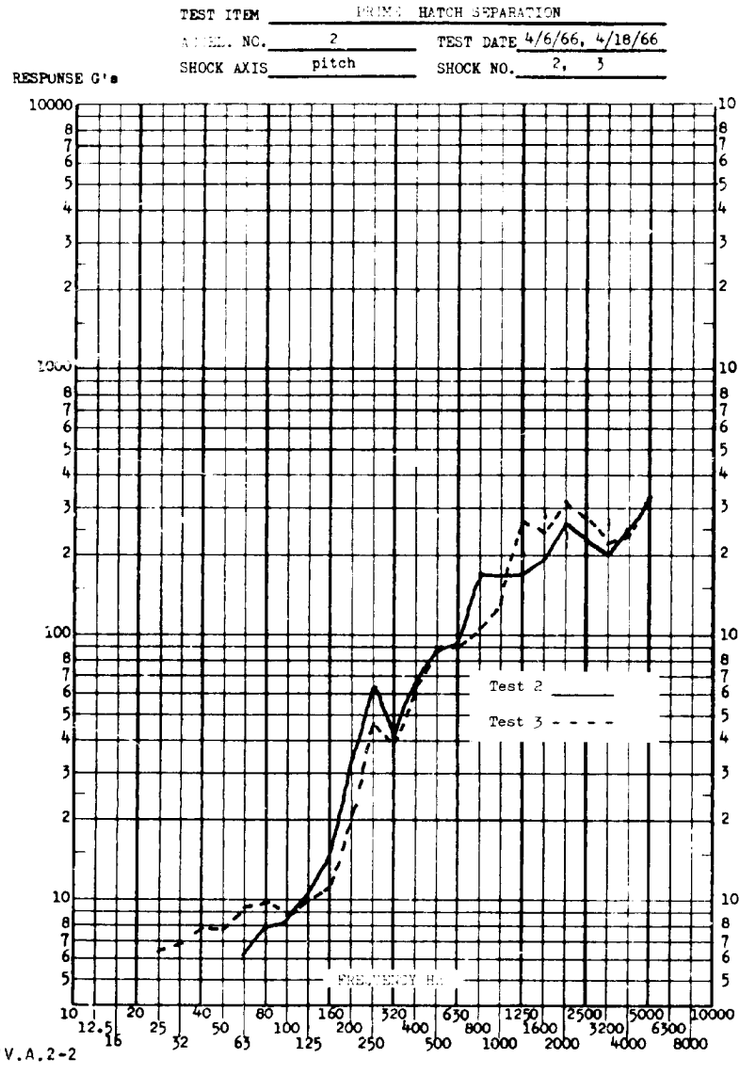
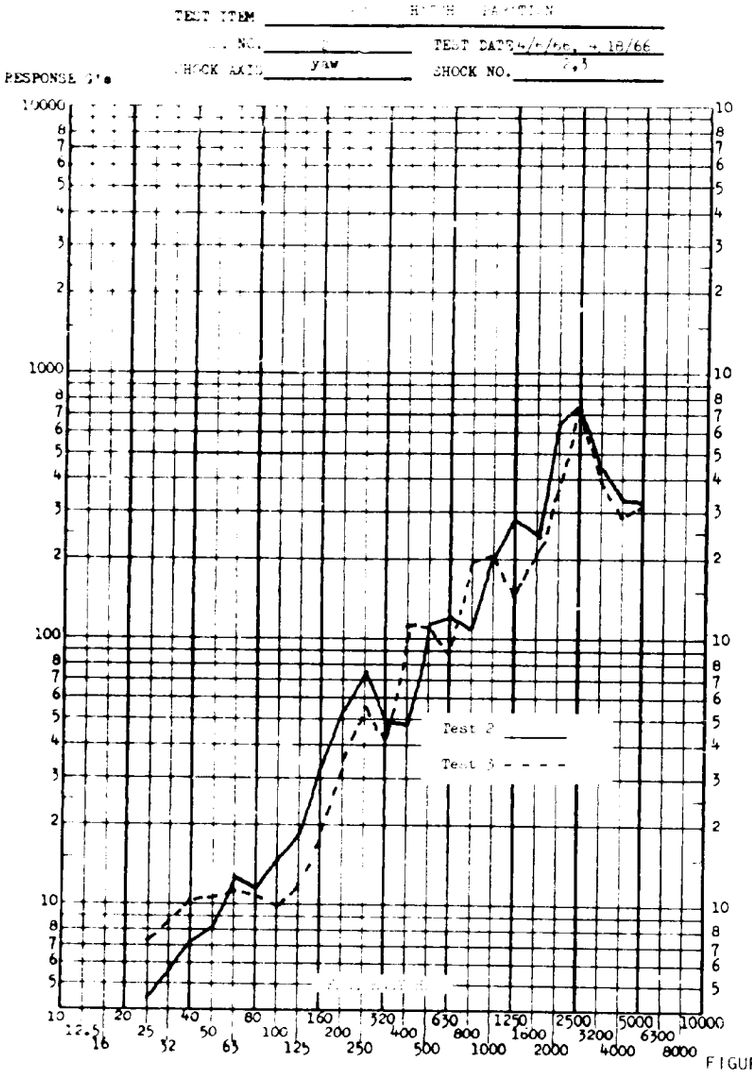




FIGURE IV.A.2-2



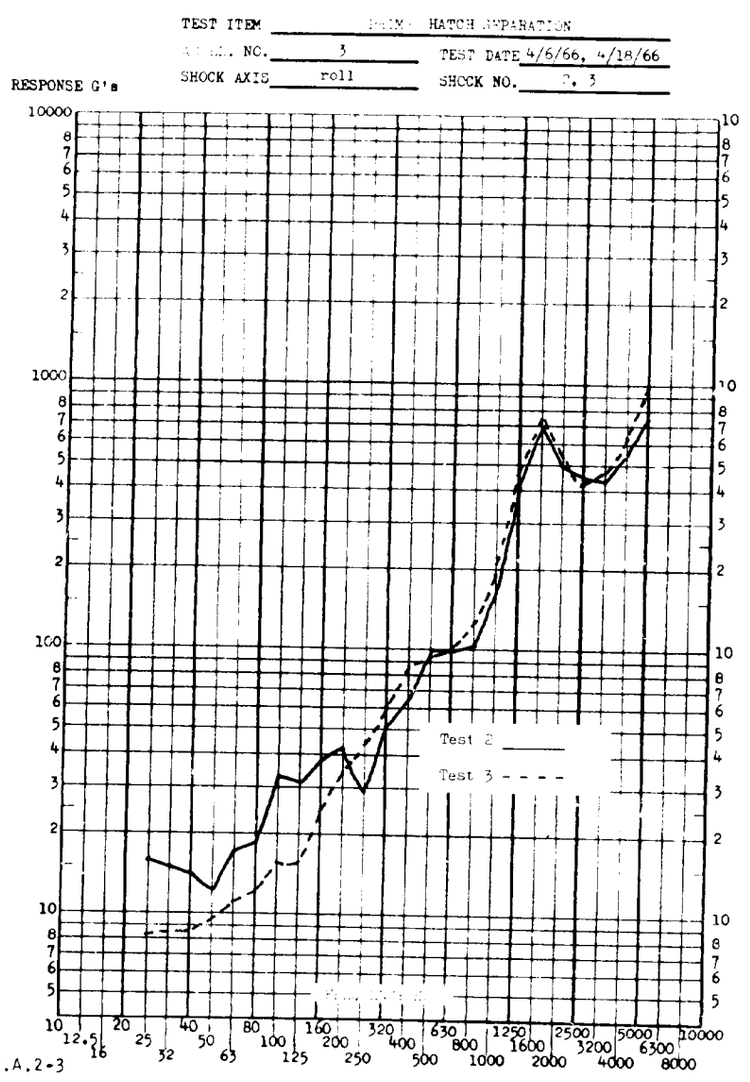
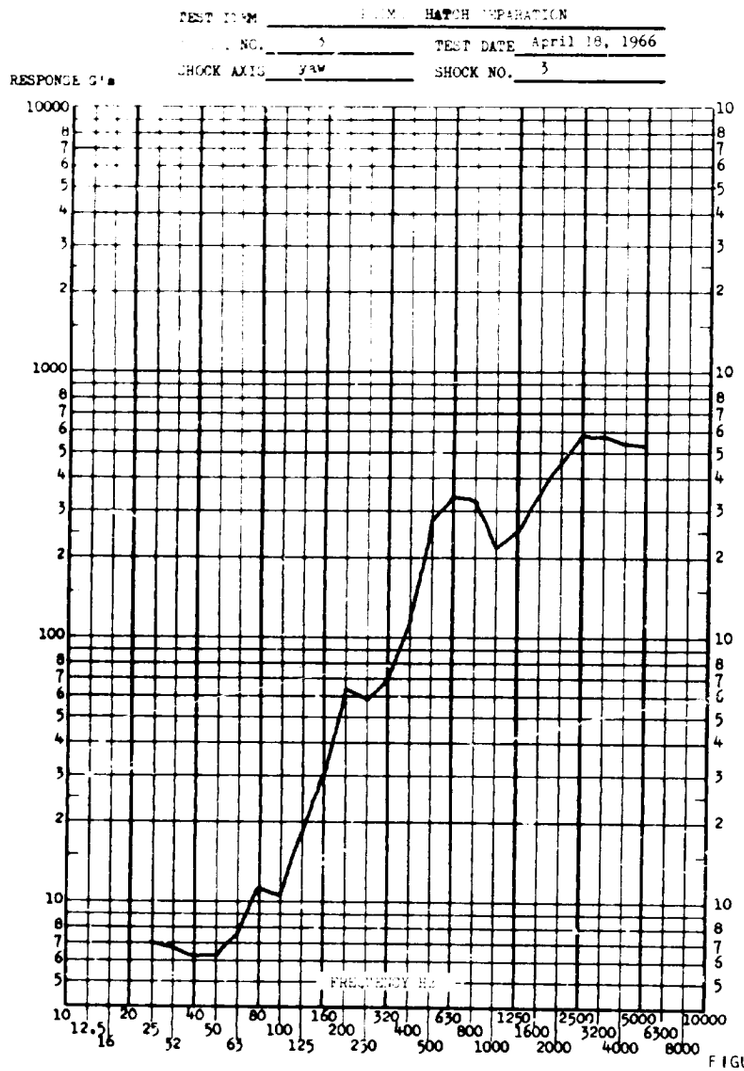




FIGURE IV.A.2-3



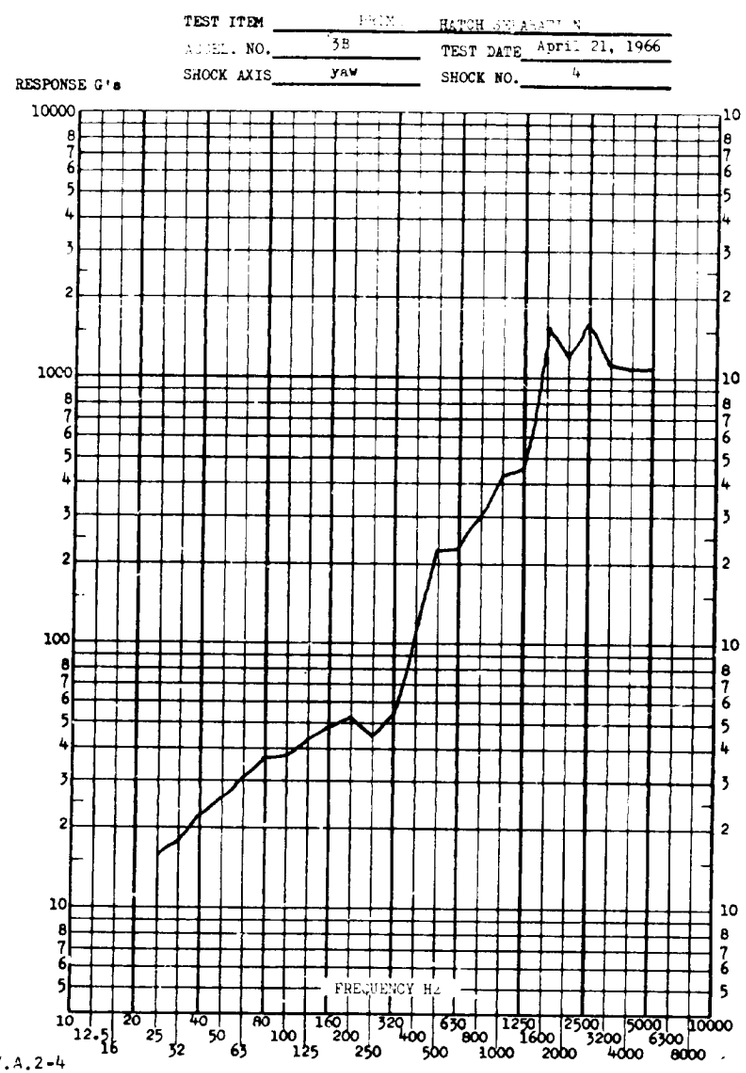
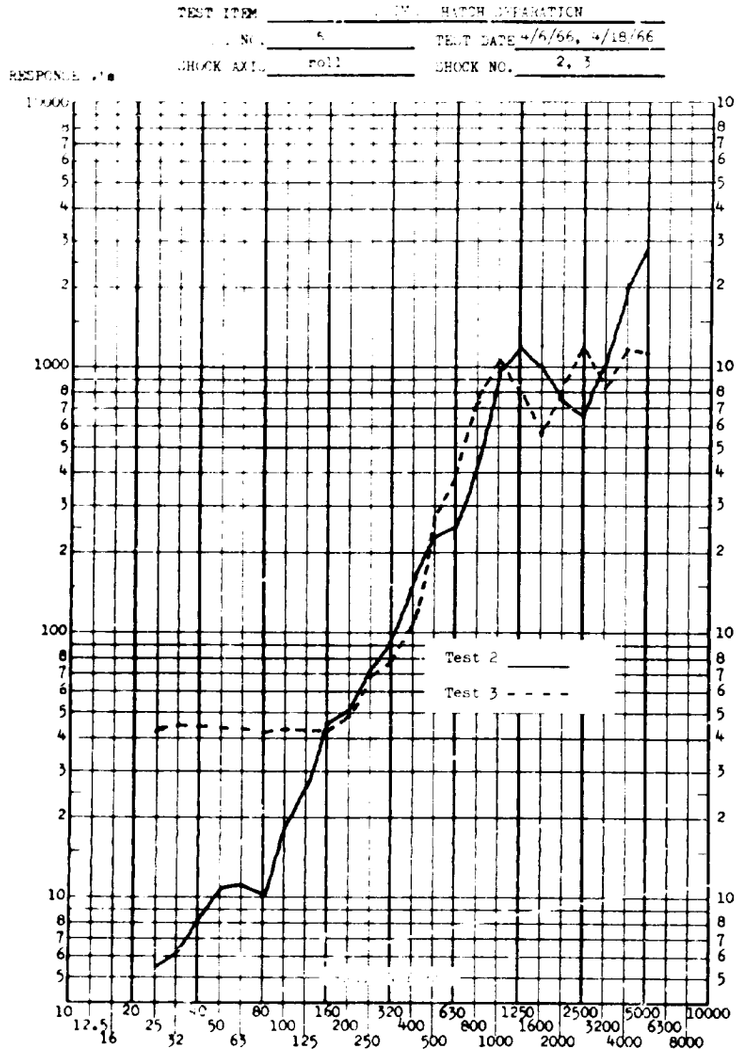




FIGURE IV.A.2-4



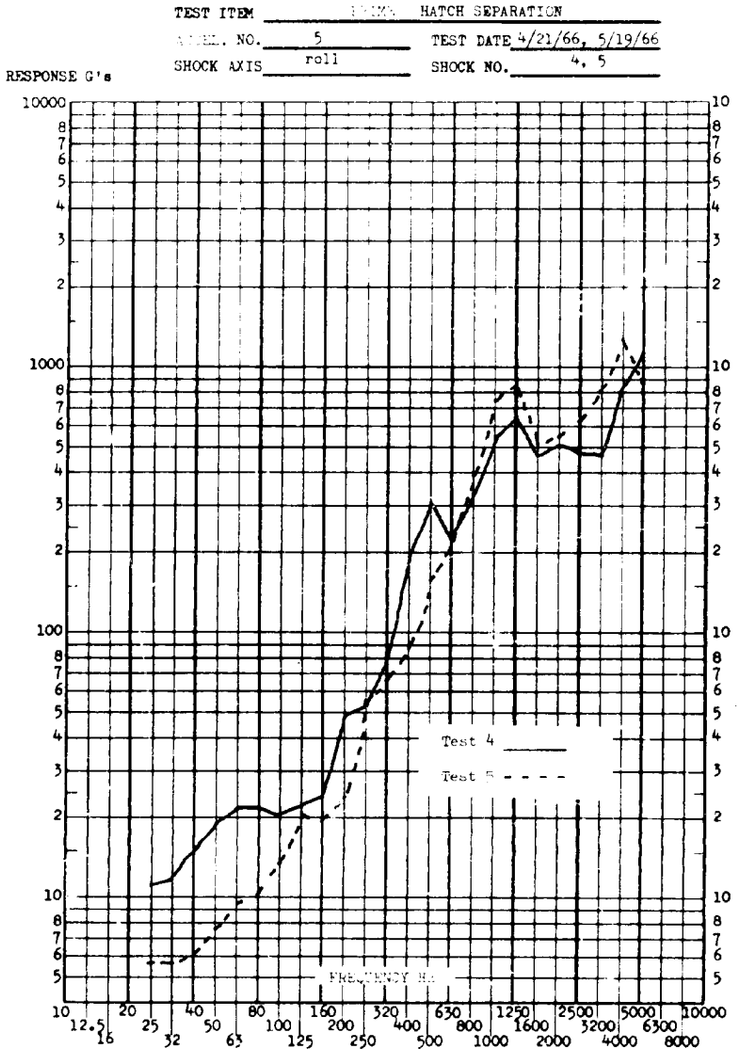
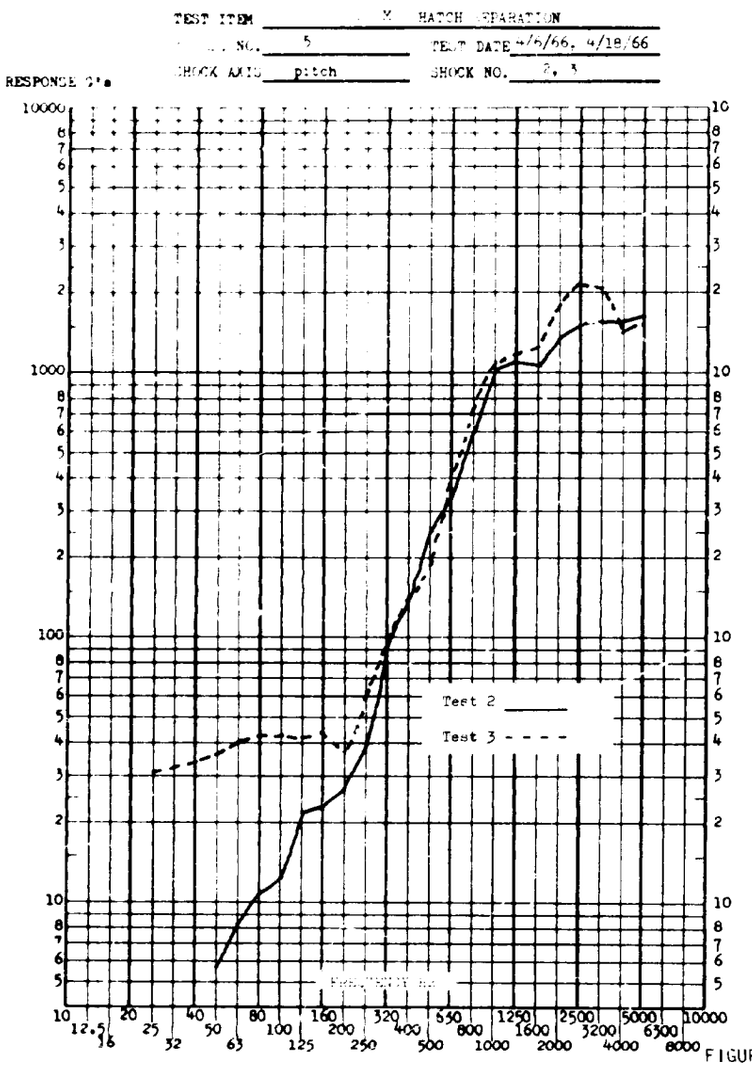




FIGURE IV.A.2-5



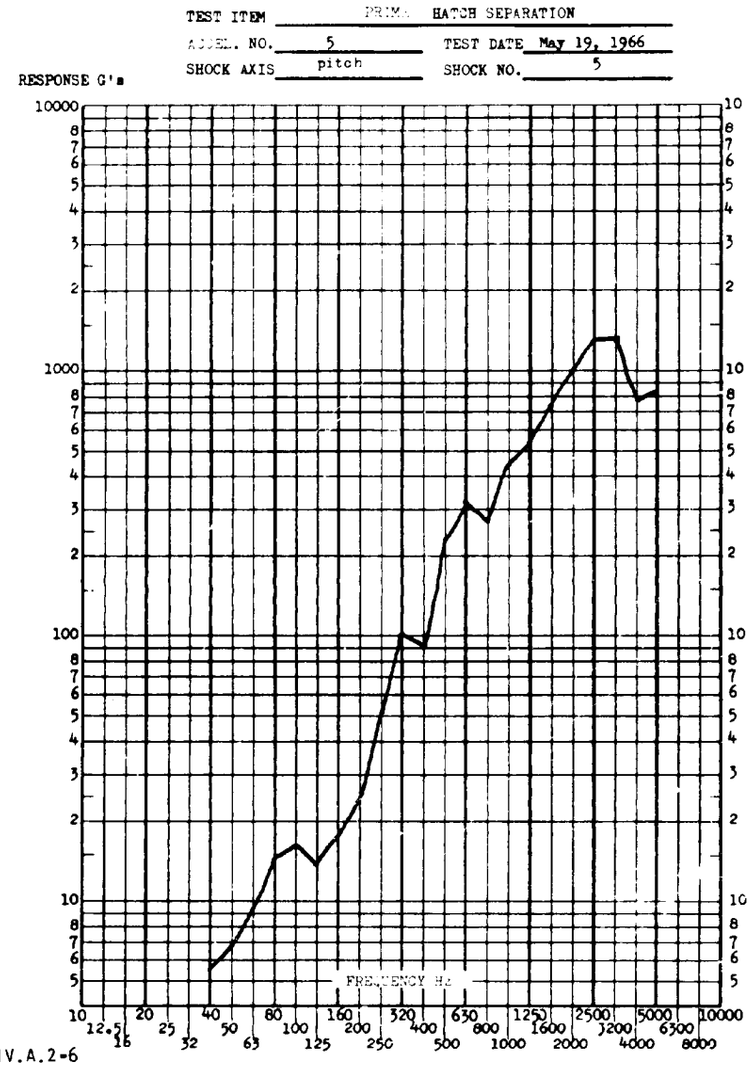
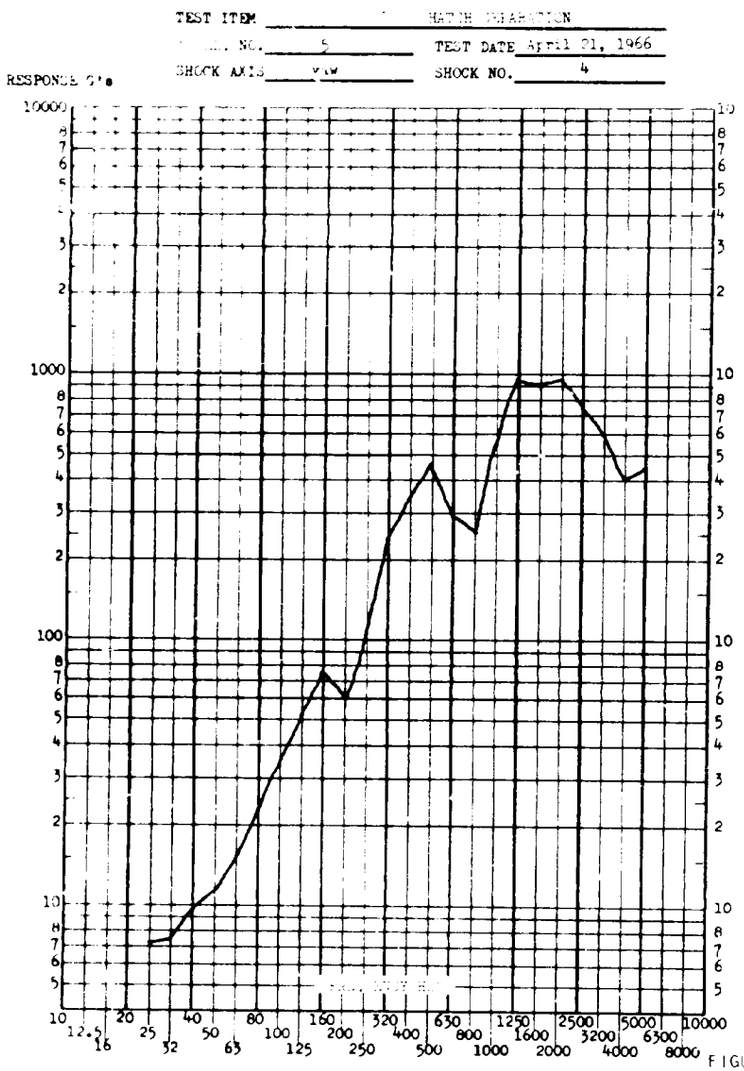




FIGURE IV.A.2-6



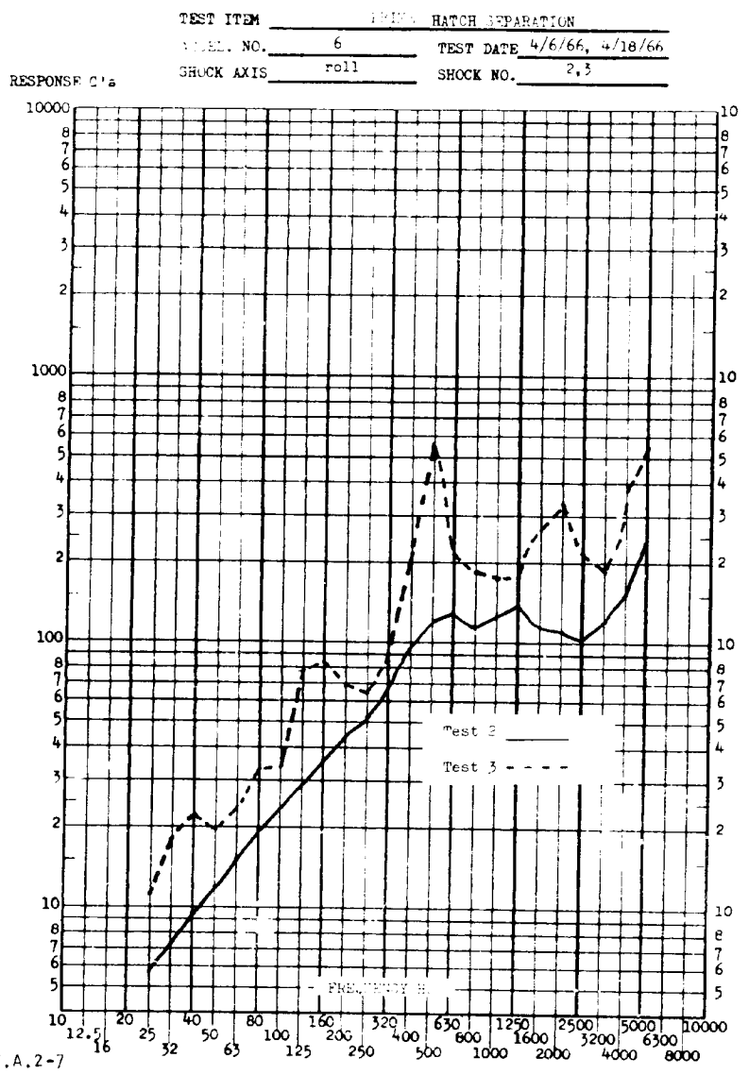
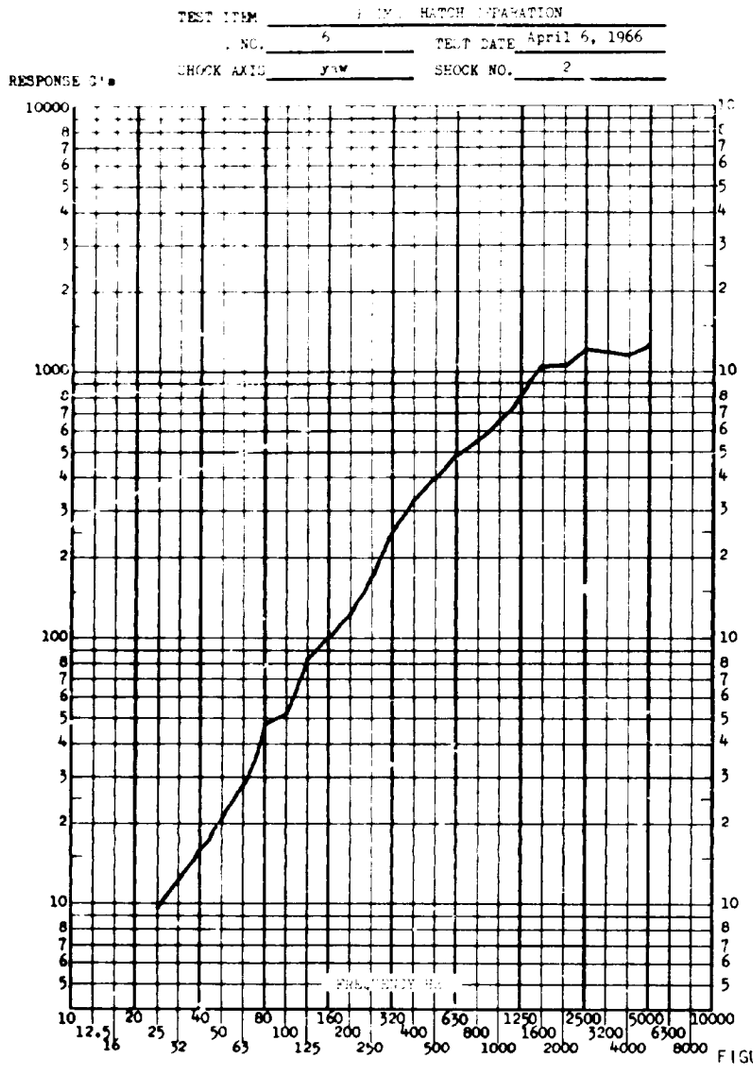




FIGURE IV.A.2-7



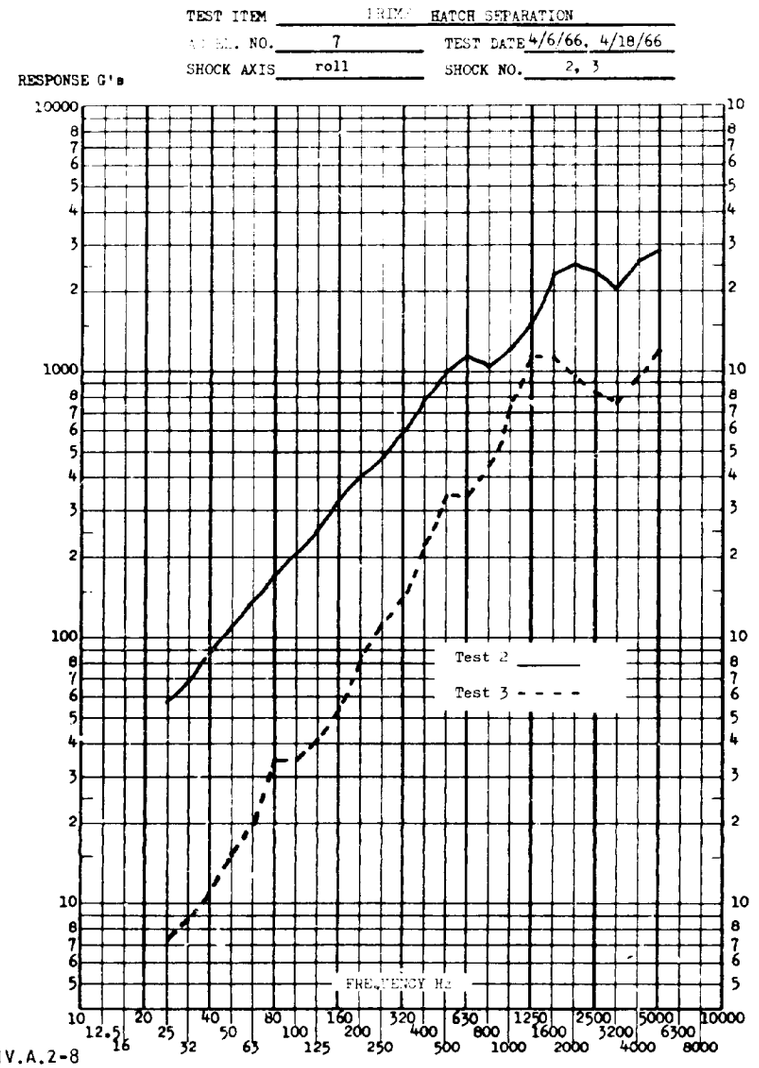
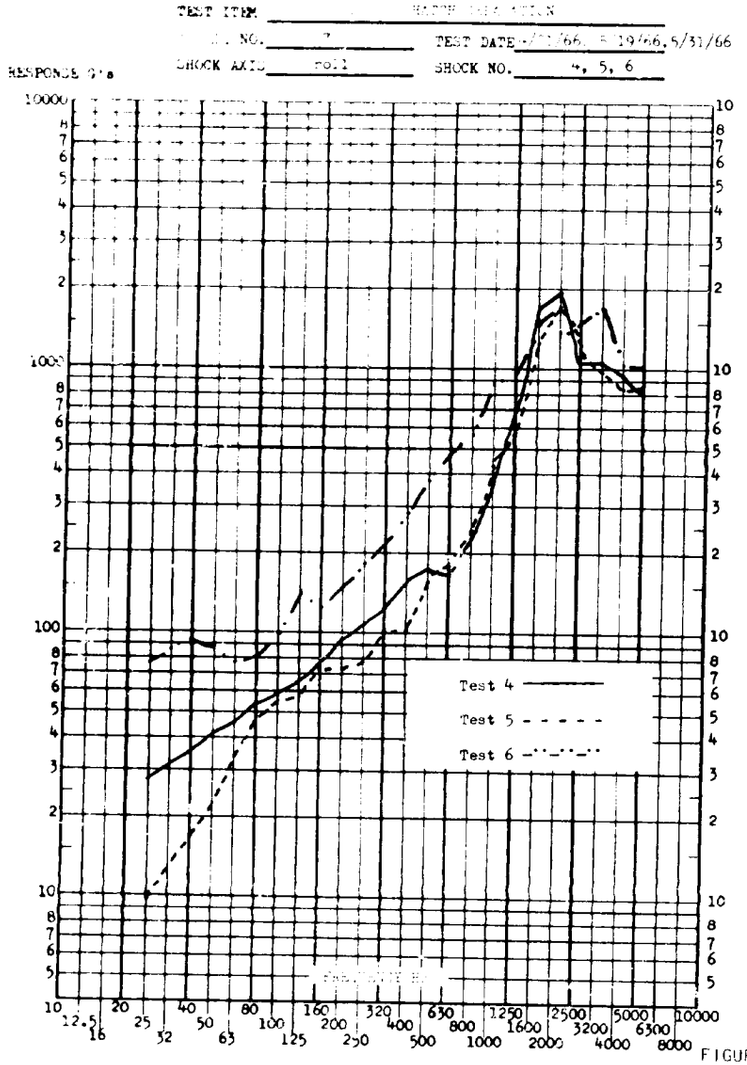




FIGURE IV.A.2-8



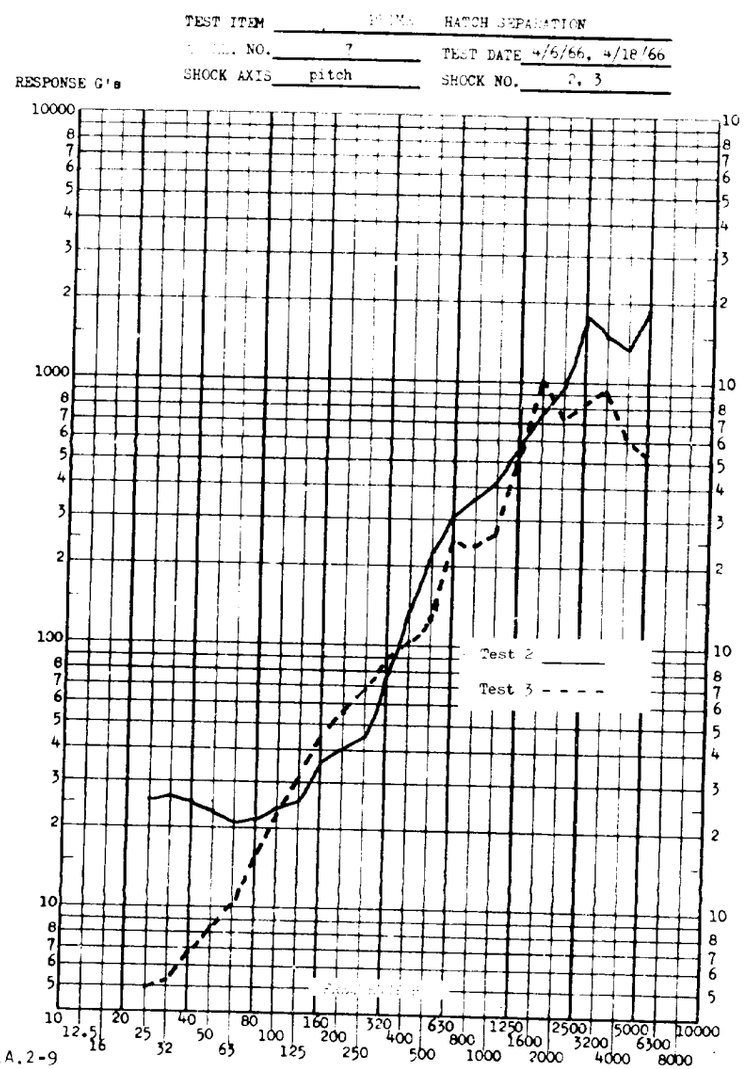



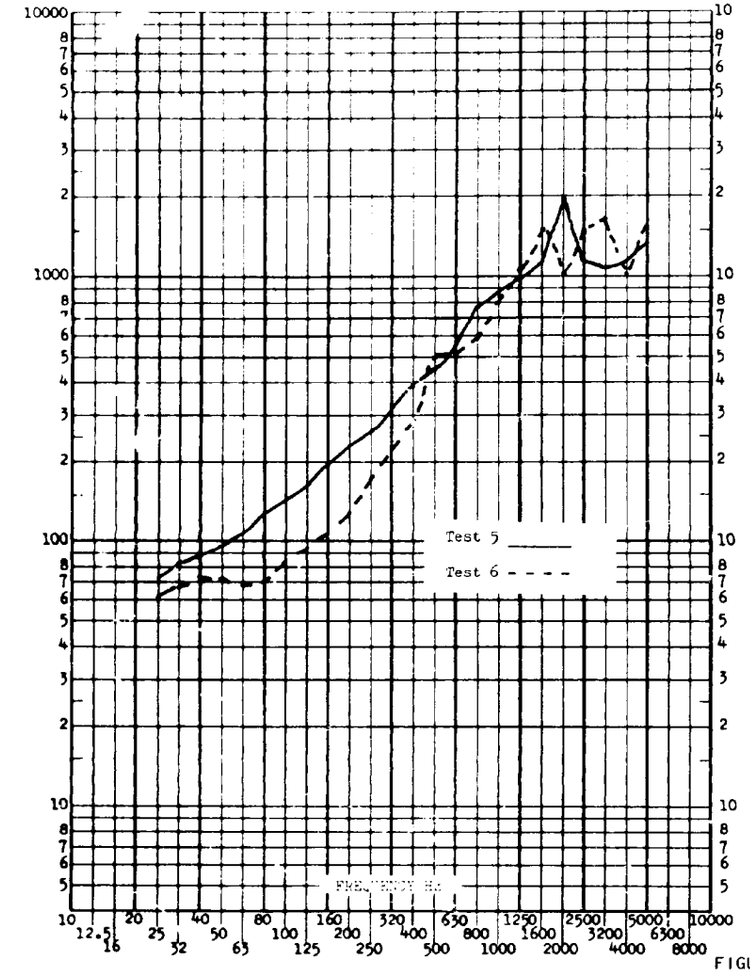

FIGURE IV.A.2-9

TEST ITEM [illegible] HATCH SEPARATION

[illegible]. NO. 7 TEST DATE 5/19/66, 5/31/66

SHOCK AXIS pitch SHOCK NO. 5, 6

RESPONSE G's




TEST ITEM PRIME HATCH SEPARATION

MODEL. NO. 7 TEST DATE 4/6/66, 4/18/66

SHOCK AXIS yaw SHOCK NO. 2,3

RESPONSE G's

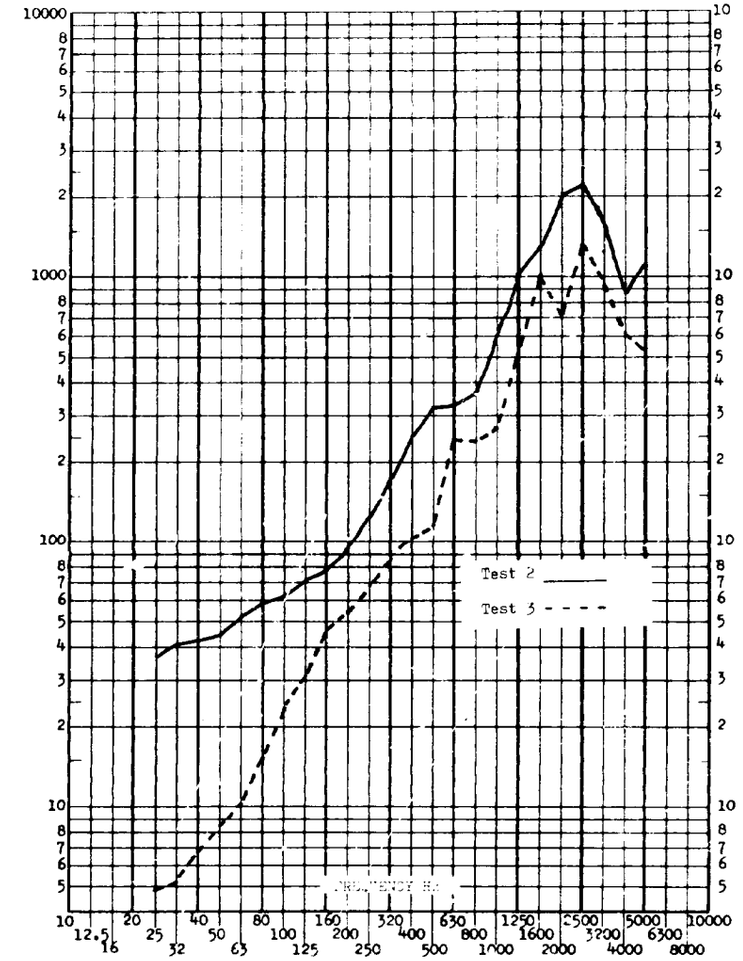
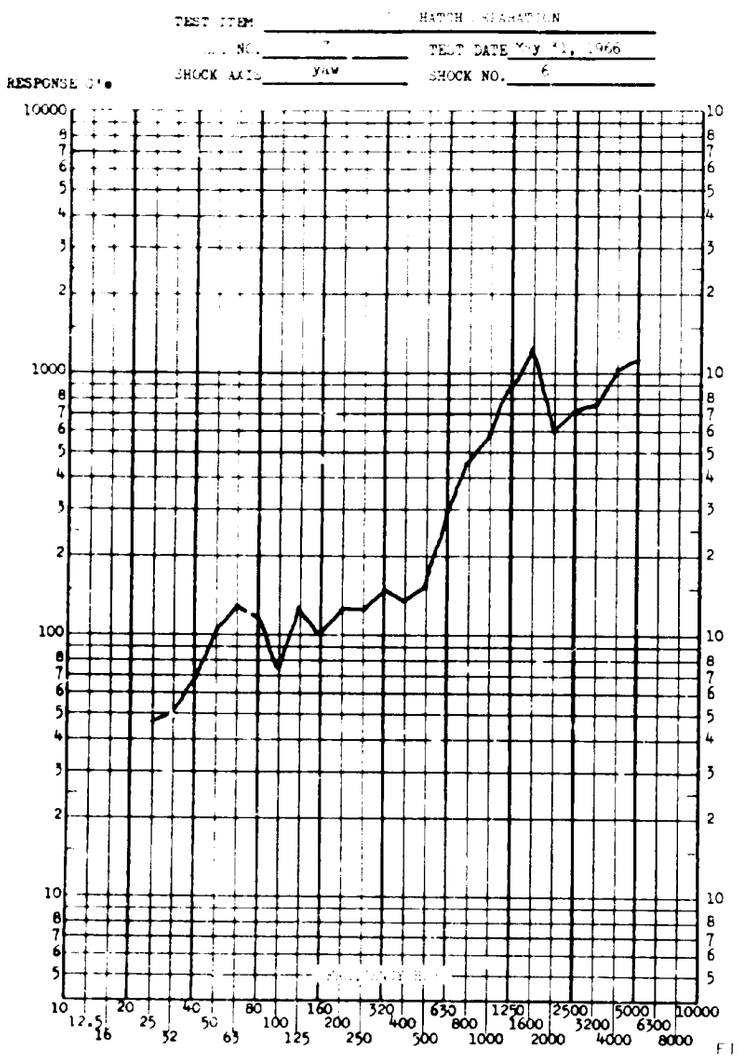



FIGURE IV.A.2-10



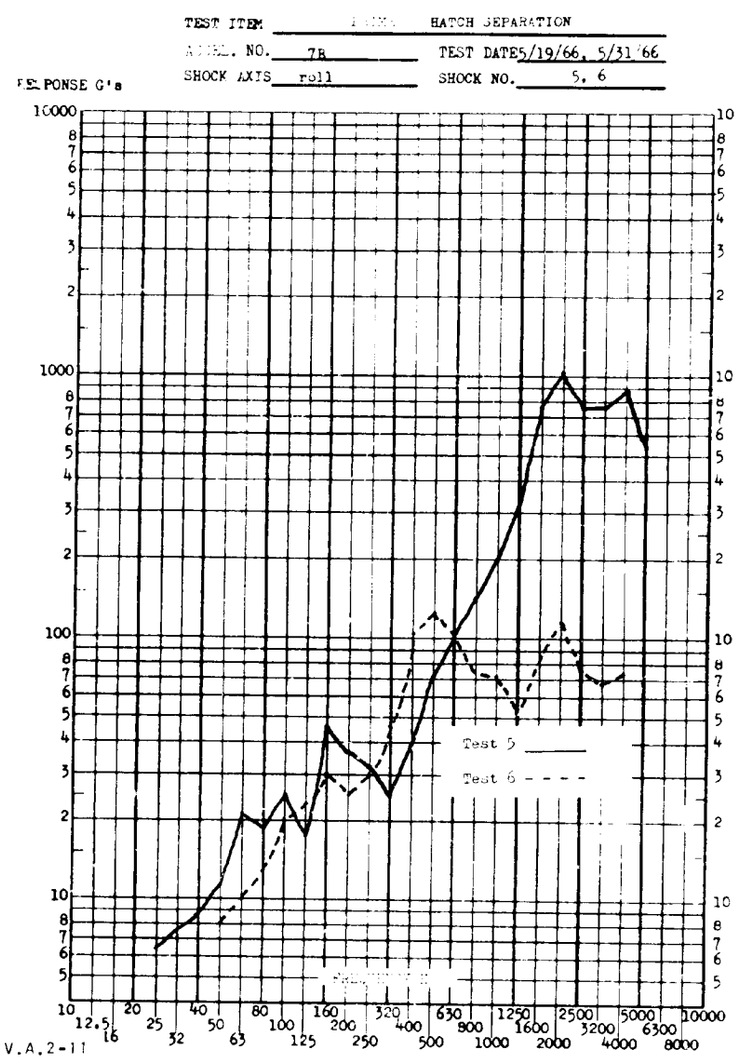




FIGURE IV.A.2-11

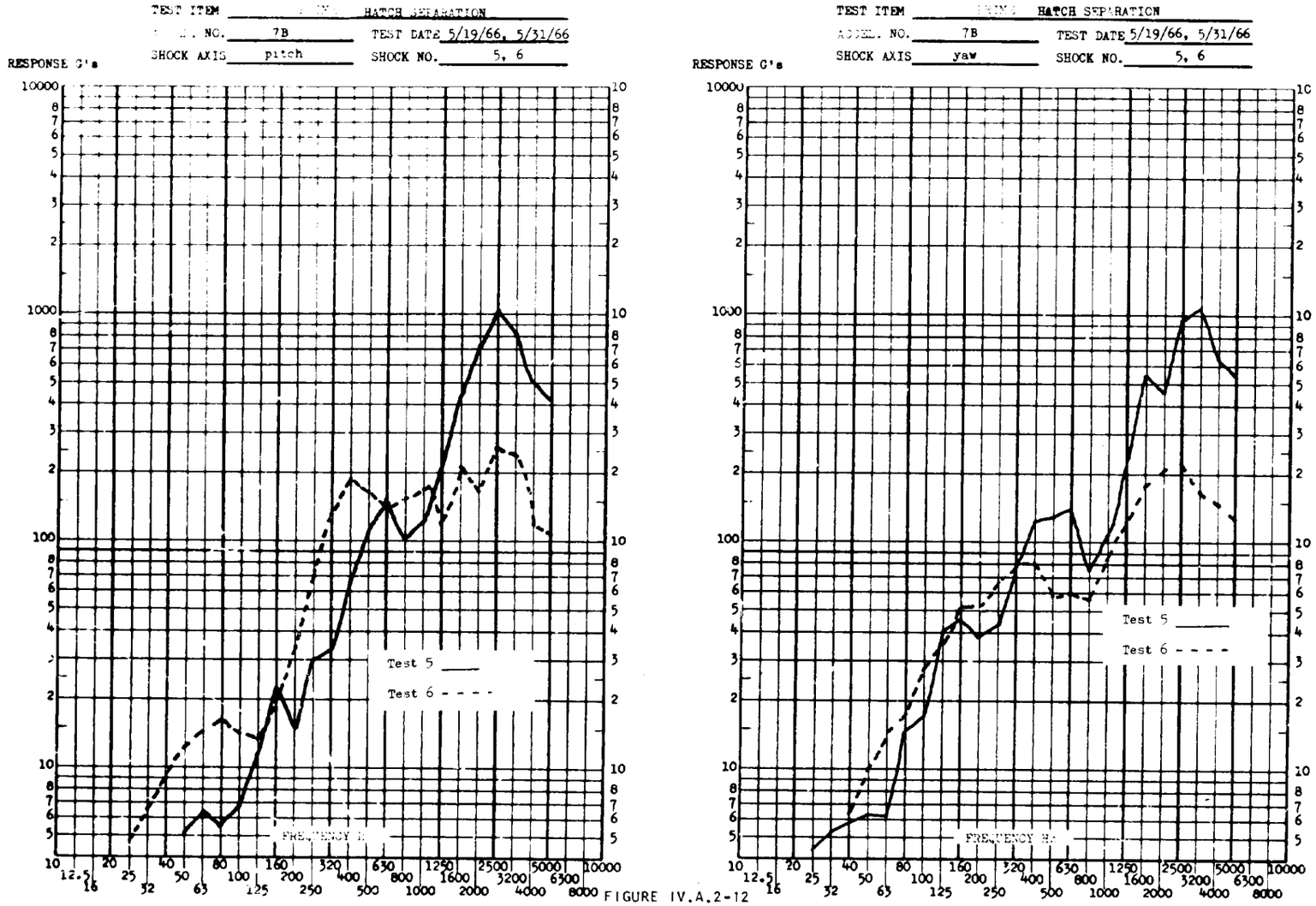
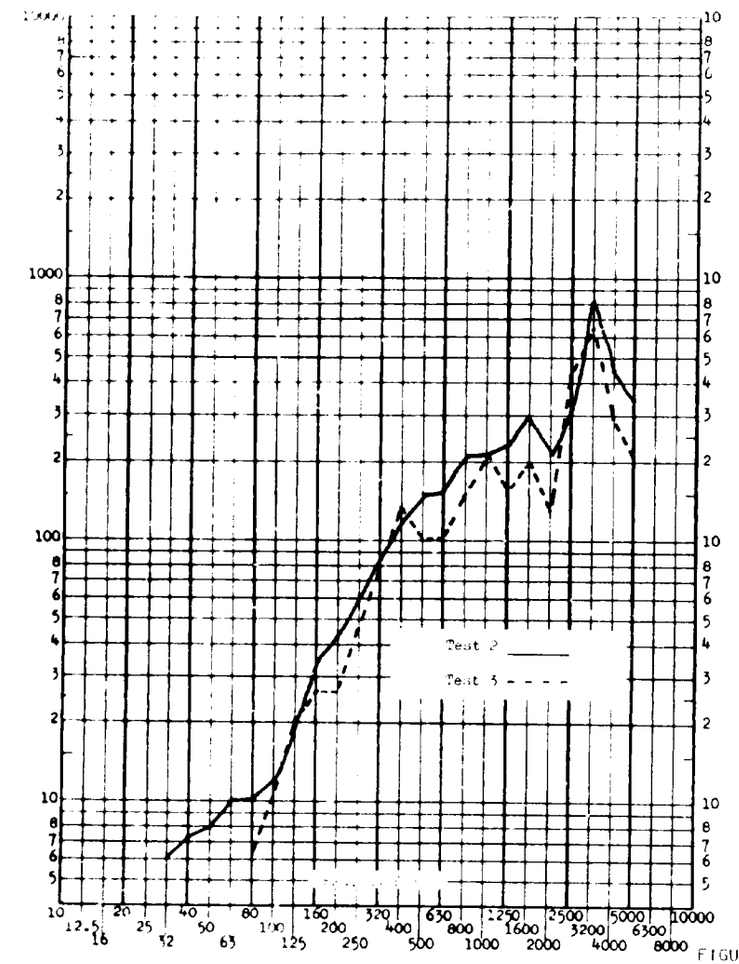



FIGURE IV.A.2-12

TEST ITEM HATCH SEPARATION

S/C NO. 9 TEST DATE 4/6/66, 4/18/66

SHOCK AXIS roll SHOCK NO. 2, 3




TEST ITEM HATCH SEPARATION

S/C NO. 9 TEST DATE April 21, 1966

SHOCK AXIS roll SHOCK NO. 4

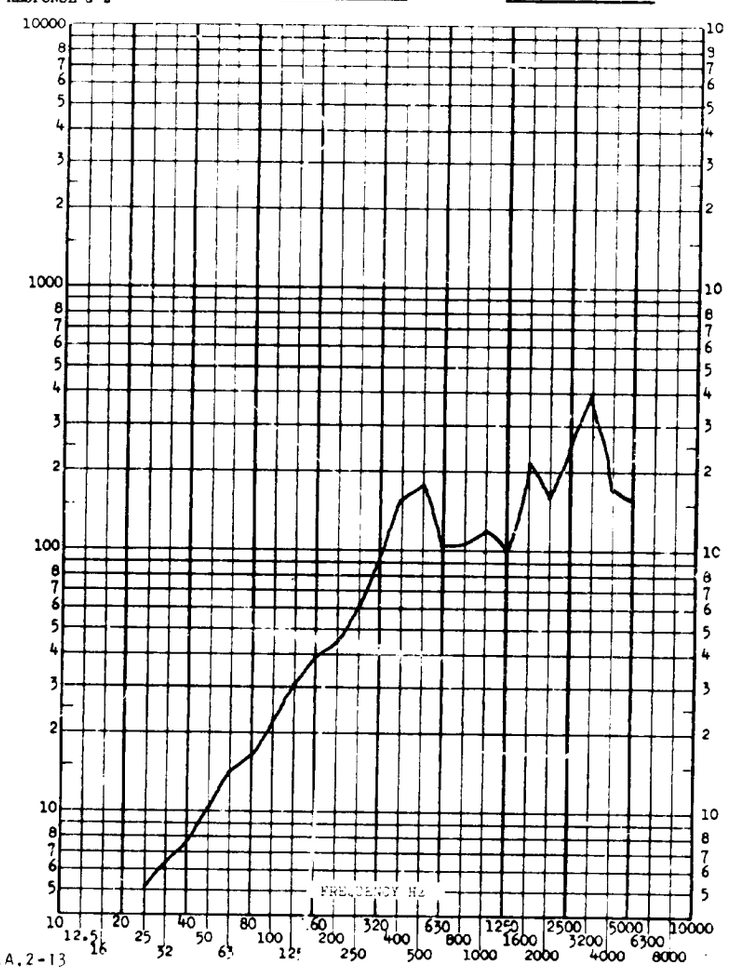


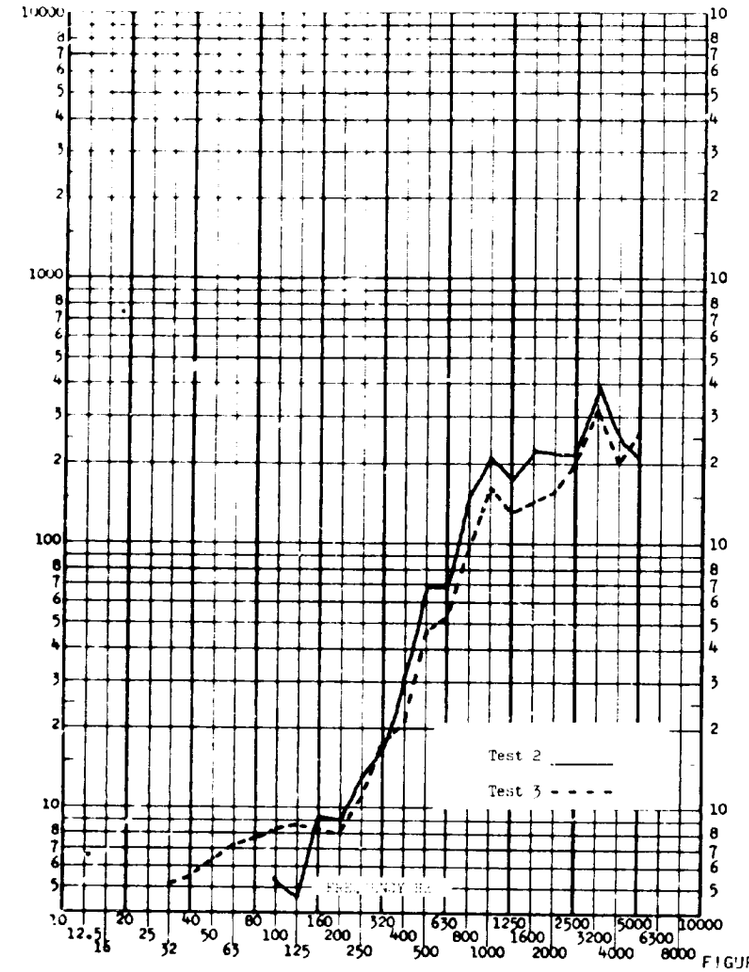

FIGURE IV.A.2-13

TEST ITEM [illegible] HATCH SEPARATION

... NO. 9 TEST DATE 4/6/66, 4/18/66

SHOCK AXIS pitch SHOCK NO. 2, 3

RESPONSE G's




TEST ITEM [illegible] HATCH SEPARATION

ANGEL NO. 9 TEST DATE April 18, 1966

SHOCK AXIS yaw SHOCK NO. 3

RESPONSE G's

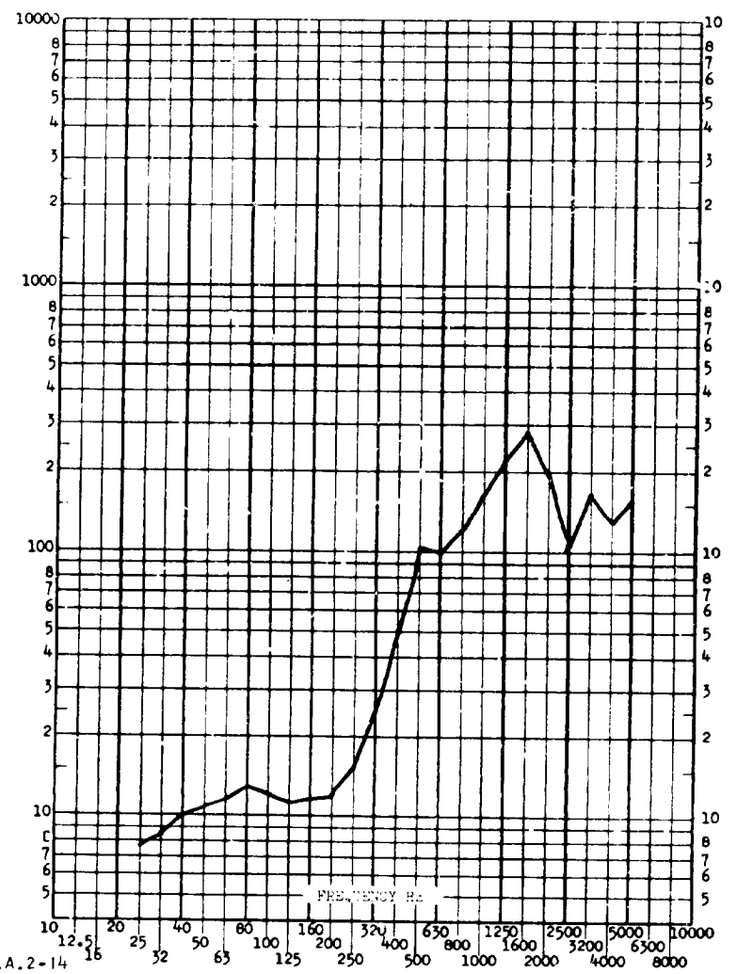
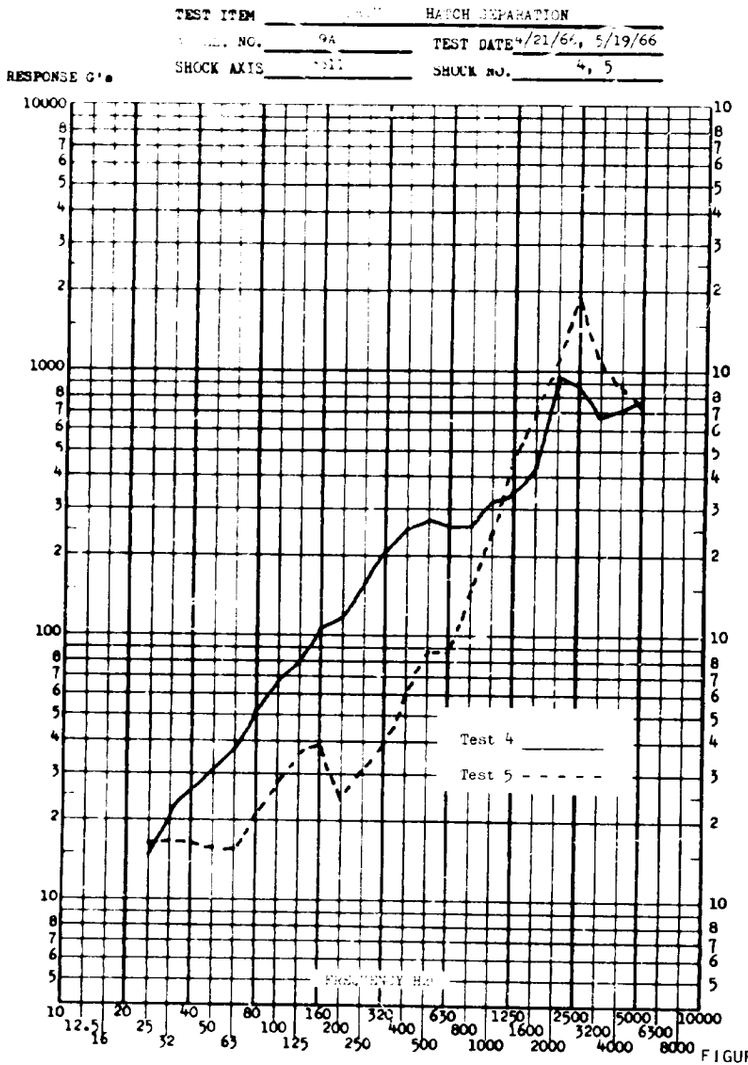



FIGURE IV.A.2-14



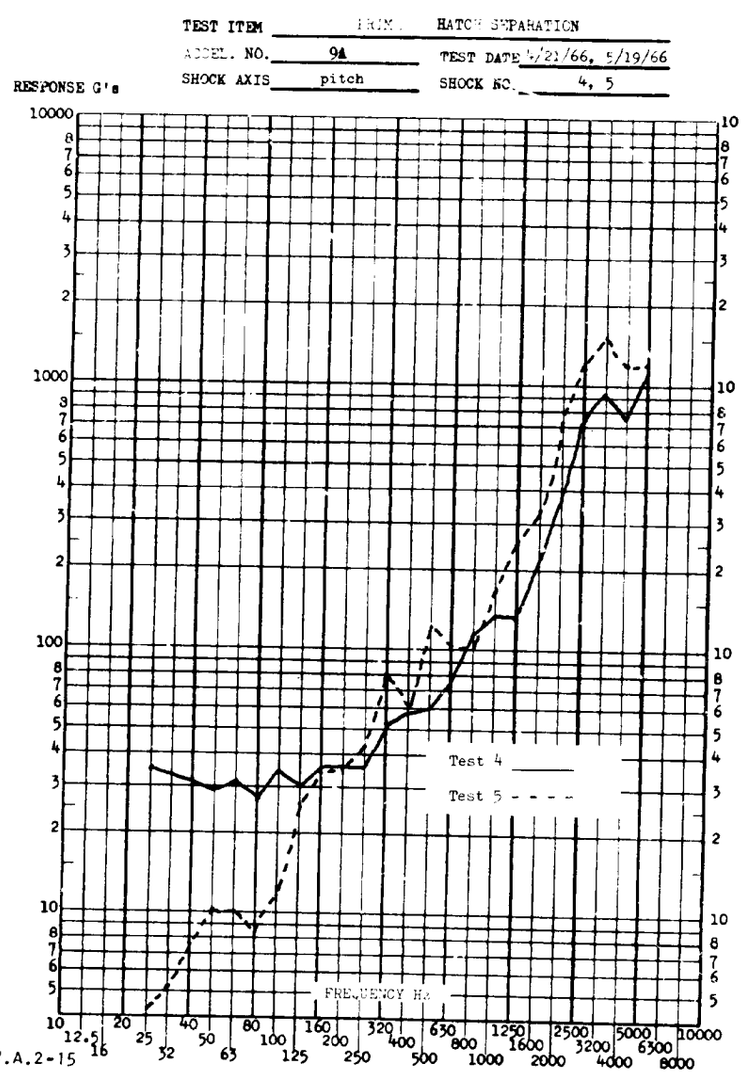
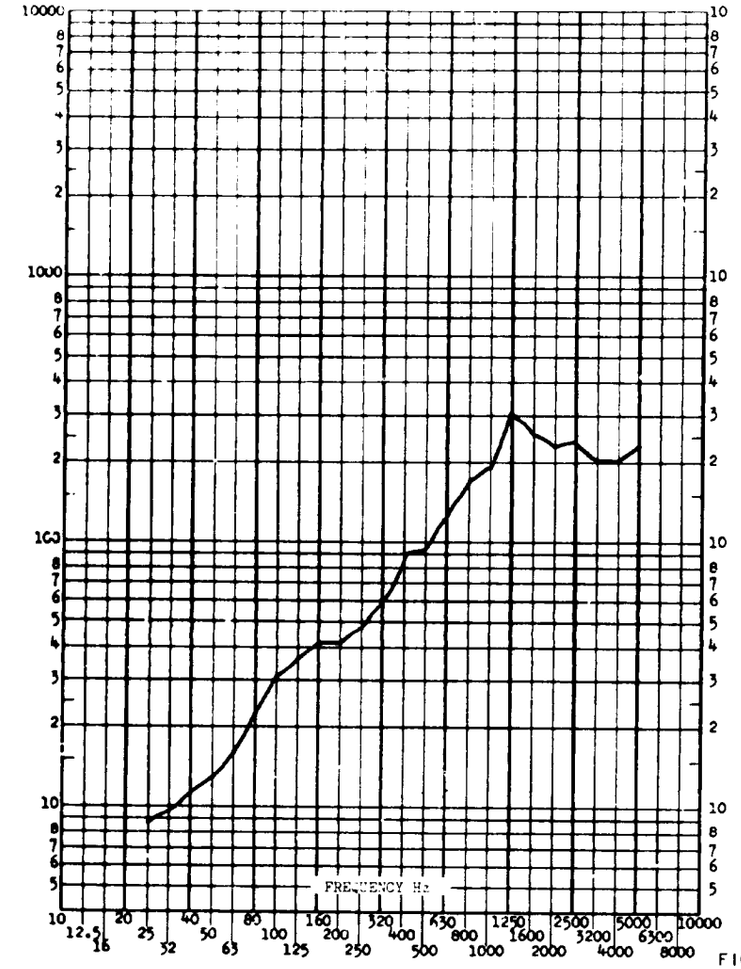




FIGURE IV.A.2-15

TEST ITEM [illegible] HATCH SEPARATION
ACCEL. NO. 9B TEST DATE May 19, 1966
SHOCK AXIS roll SHOCK NO. 5




TEST ITEM PRIME HATCH SEPARATION
ACCEL. NO. 9A TEST DATE April 21, 1966
SHOCK AXIS yaw SHOCK NO. 4

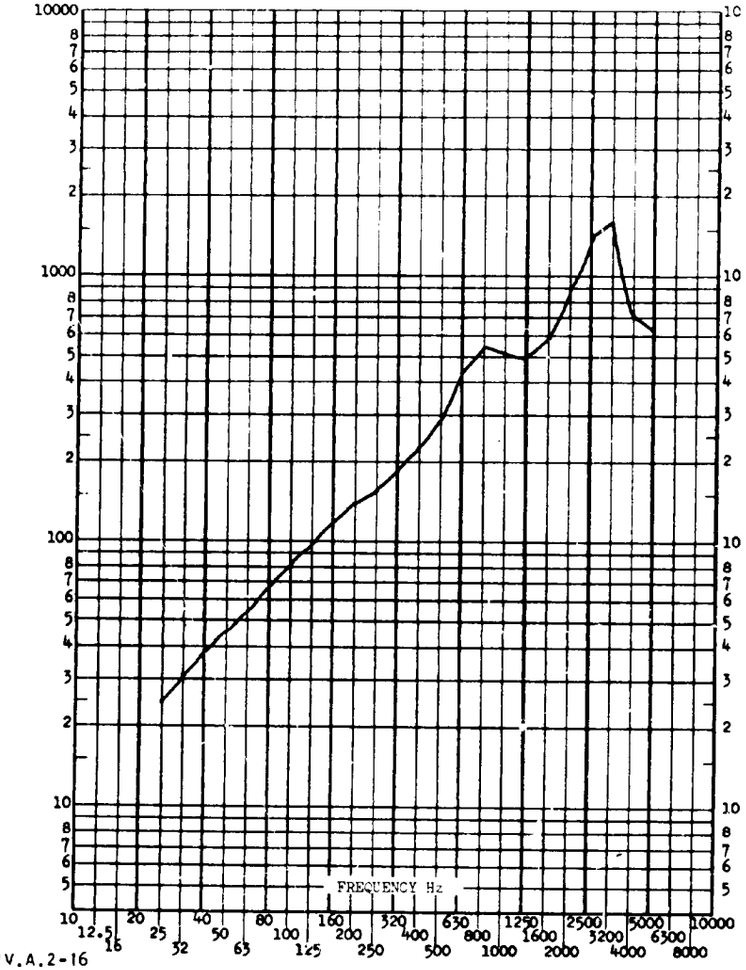


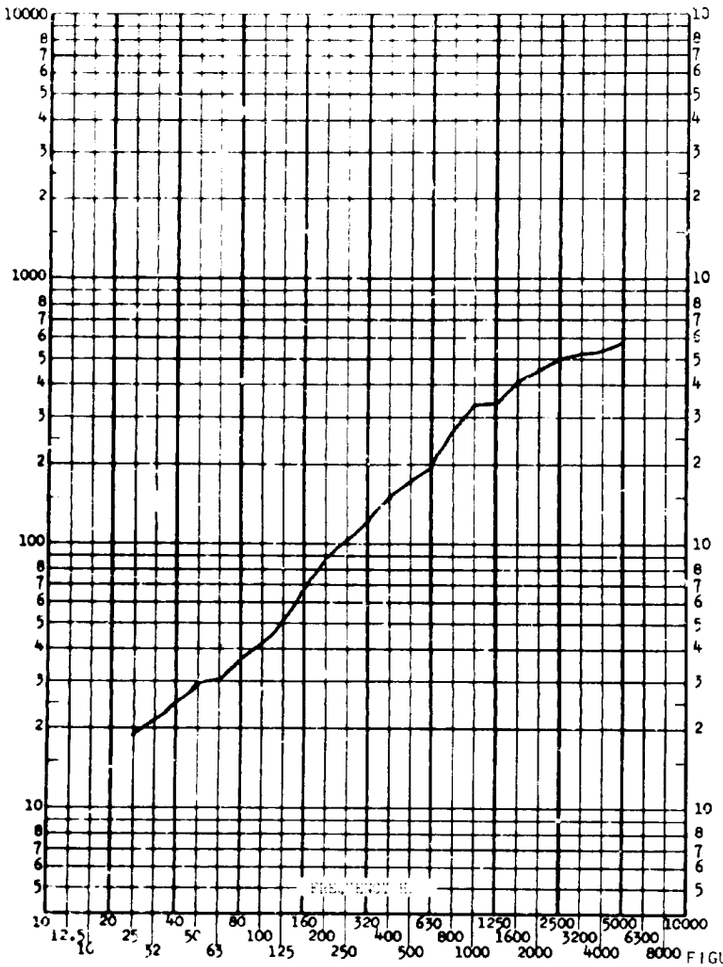

FIGURE IV.A.2-16

TEST ITEM [illegible] HATCH SEPARATION

ACCEL. NO. 9B TEST DATE May 19, 1966

SHOCK AXIS pitch SHOCK NO. 5

RESPONSE G's




TEST ITEM PRIME HATCH SEPARATION

ACCEL. NO. 9B TEST DATE May 19, 1966

SHOCK AXIS yaw SHOCK NO. 5

RESPONSE G's

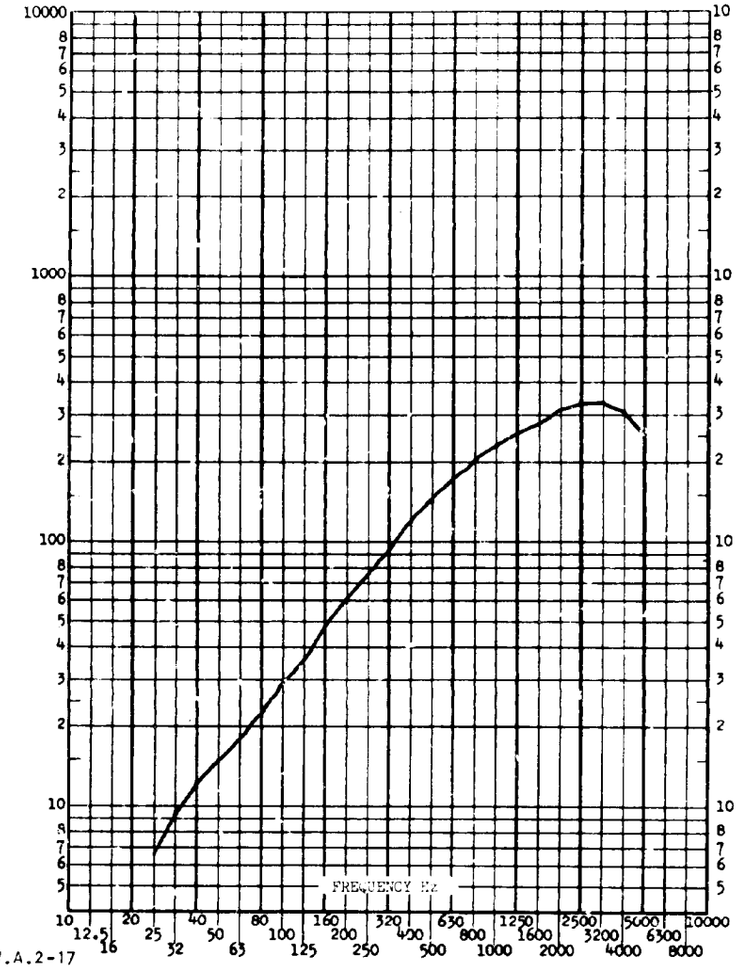
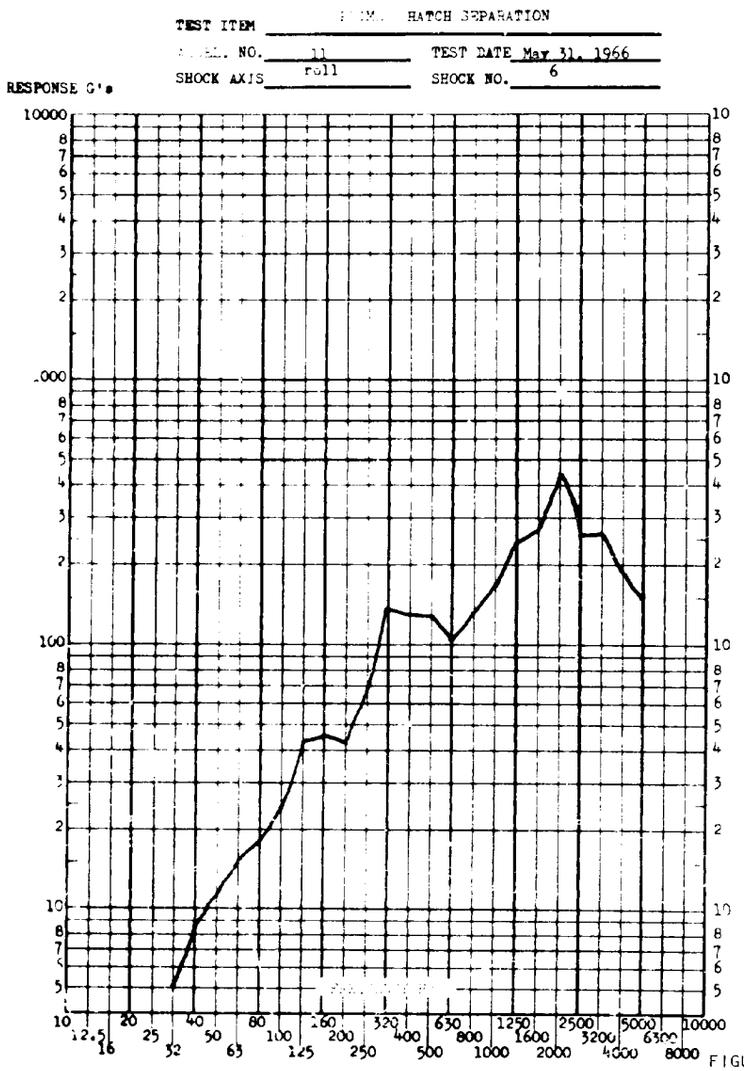



FIGURE IV.A.2-17



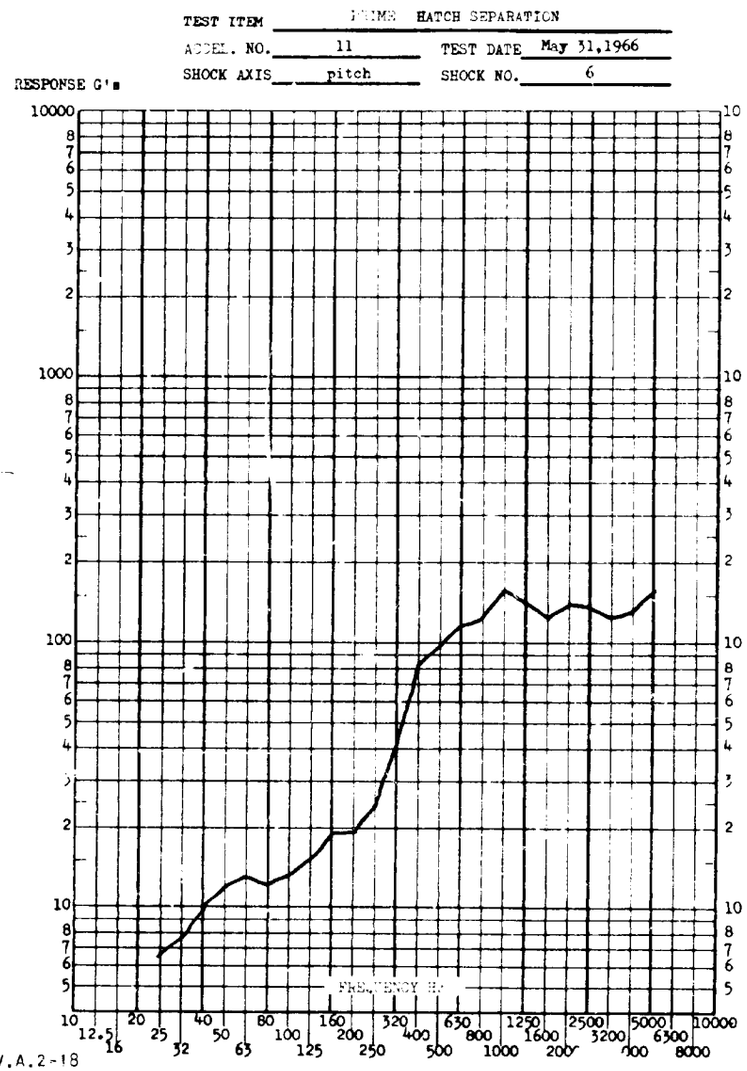




FIGURE IV.A.2-18

TEST ITEM [illegible] HATCH SEPARATION

[illegible] NO. 11 TEST DATE May 31, 1966

SHOCK AXIS yaw SHOCK NO. 6

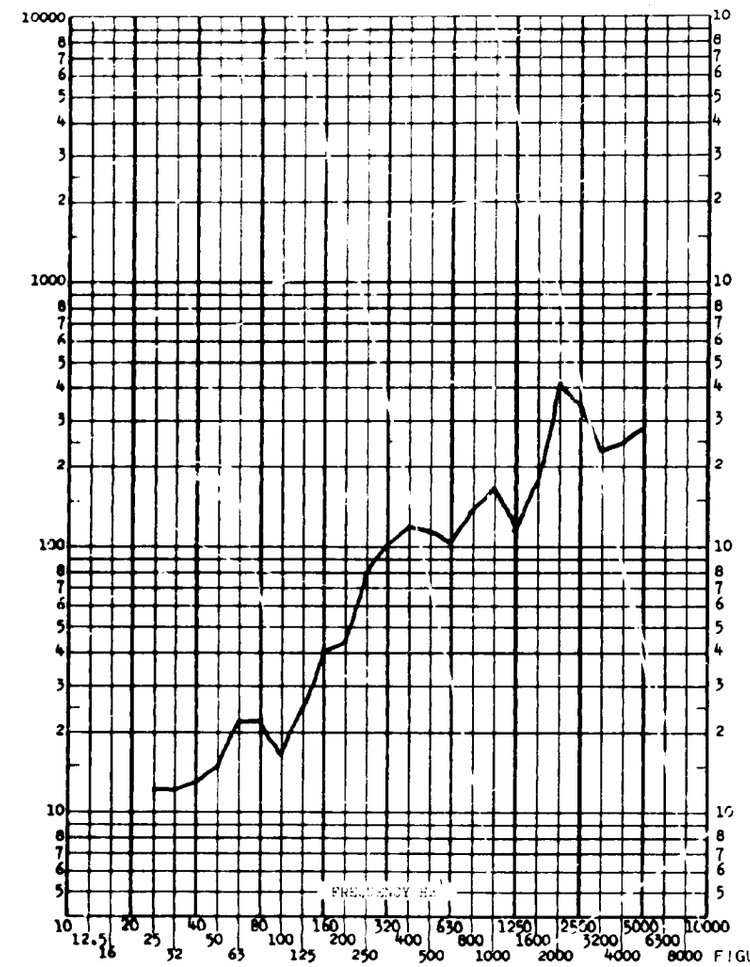



FIGURE IV.A.2-19

## SECTION IV.A.3

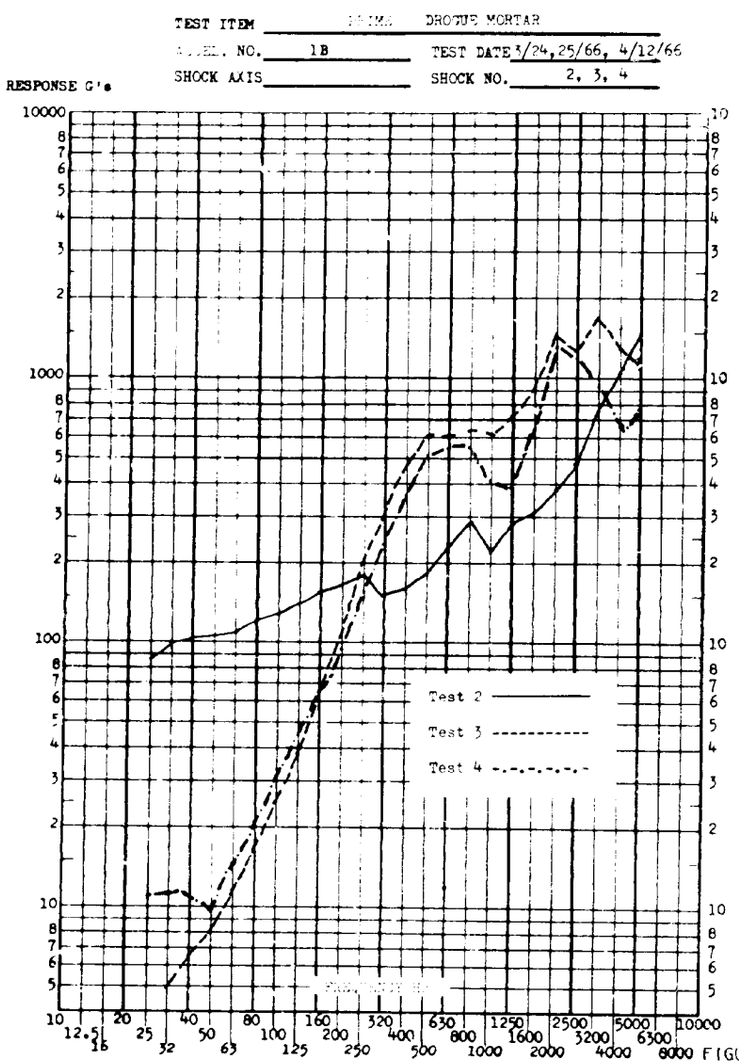
## PRIME DROGUE CHUTE EJECTION MORTOR TESTS

Four firings of the drogue mortar were performed. No data were obtained from the first firing, and only partial data were obtained from the second firing due to accelerometer sensitivity settings. The 25 shock spectra obtained for shots 2, 3, and 4 are presented in Figures IV.A.3-1 through IV.A.3-8 as indexed in Table IV.A.3-1.

TABLE IV.A.3-1

INDEX OF DATA LOCATIONS

| Figure | Graph 1 | | Graph 2 | |
|---|---|---|---|---|
| | Shot No.s | Accel. No.s | Shot No.s | Accel. No.s |
| IV.A.3-1 | 2,3,4 | 1B | 3,4 | 2 pitch |
| IV.A.3-2 | 3,4 | 2 roll | 2,3,4 | 3 roll |
| IV.A.3-3 | 2,3,4 | 3 yaw | 4 | 5 pitch |
| IV.A.3-4 | 2,3 | 5 roll | 3 | 5 yaw |
| IV.A.3-5 | 4 | 6 pitch | 3 | 6 roll |
| IV.A.3-6 | 4 | 7 pitch | 4 | 7 yaw |
| IV.A.3-7 | 4 | 9 pitch | 3 | 9 yaw |
| IV.A.3-8 | 3,4 | 10 roll | --- | --- |



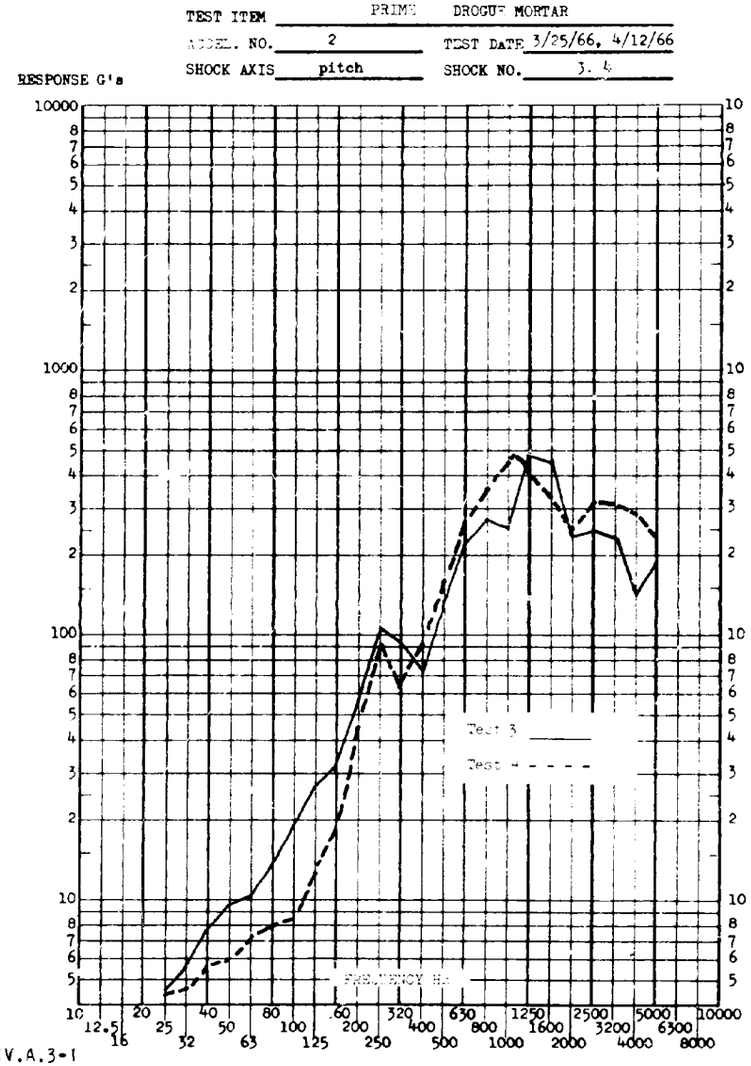
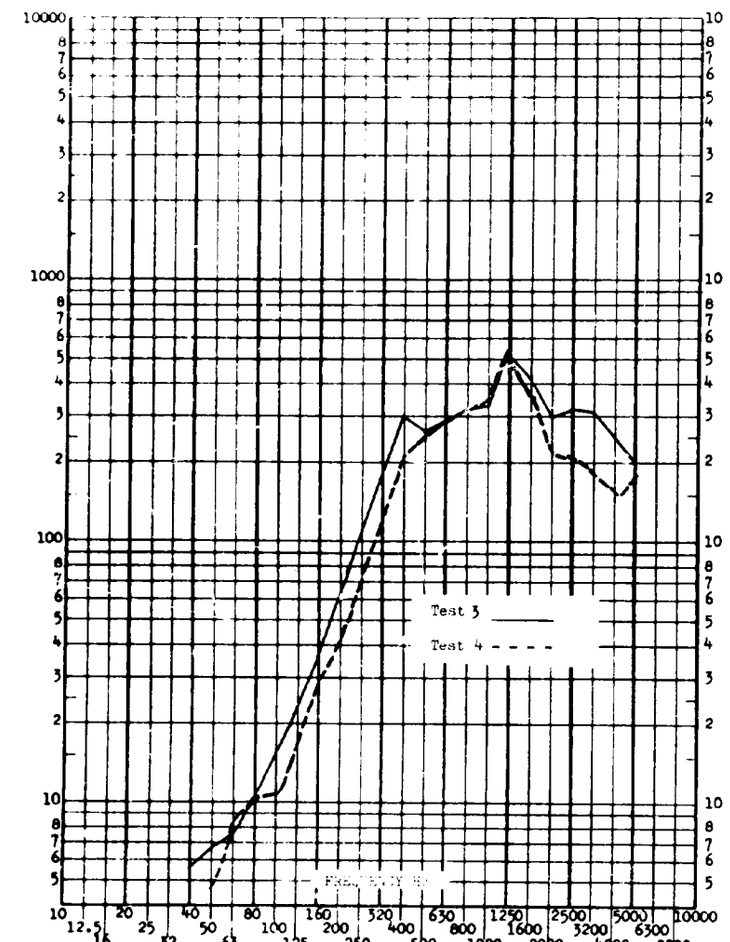




FIGURE IV.A.3-1

TEST ITEM [illegible] DROGUE MORTAR
ACCEL. NO. 2 TEST DATE 3/25/66, 4/12/66
SHOCK AXIS roll SHOCK NO. 3, 4




TEST ITEM PRIME DROGUE MORTAR
ACCEL. NO. 3 TEST DATE 3/24,25/66, 4/12/66
SHOCK AXIS roll SHOCK NO. 2, 3, 4

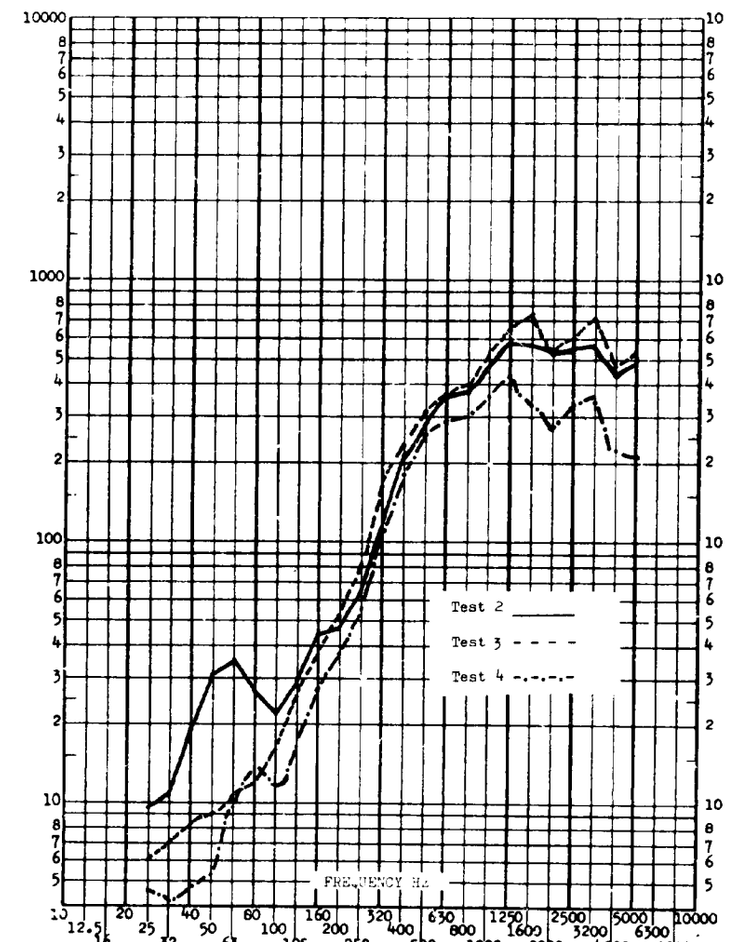
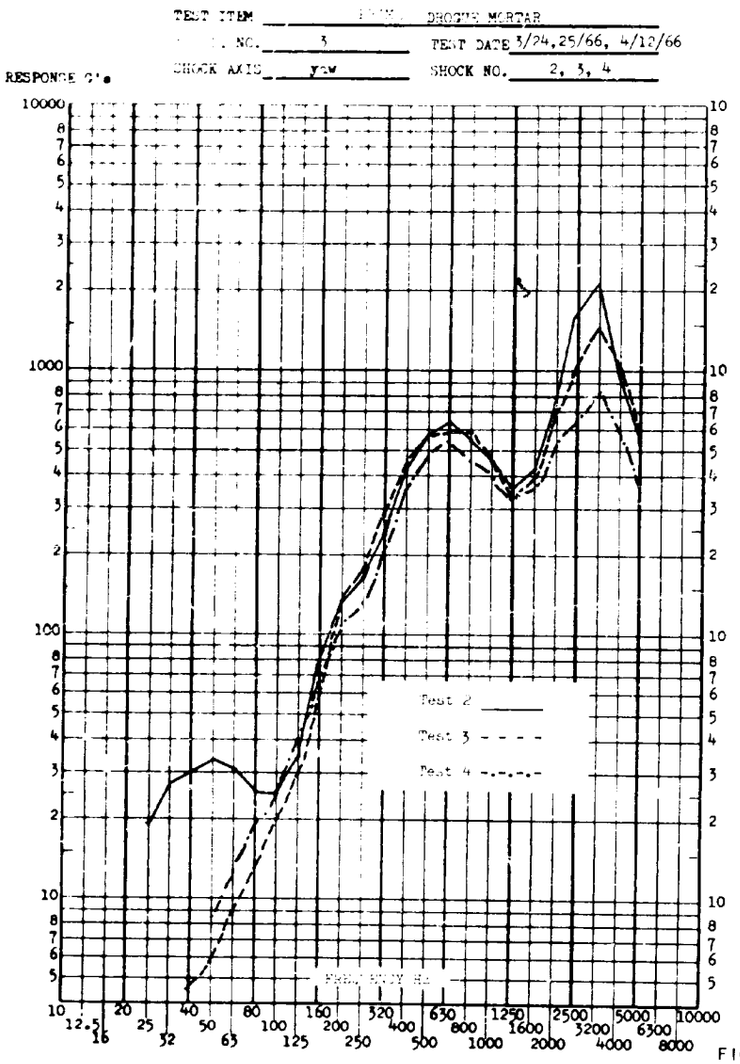



FIGURE IV.A.3-2



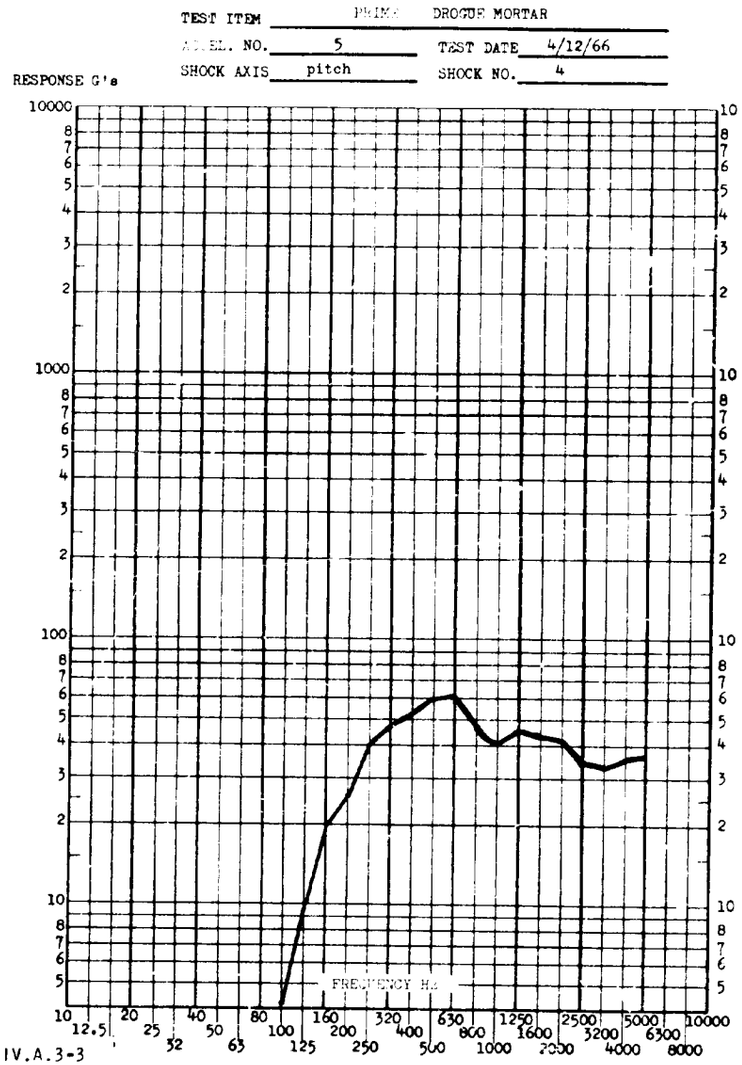
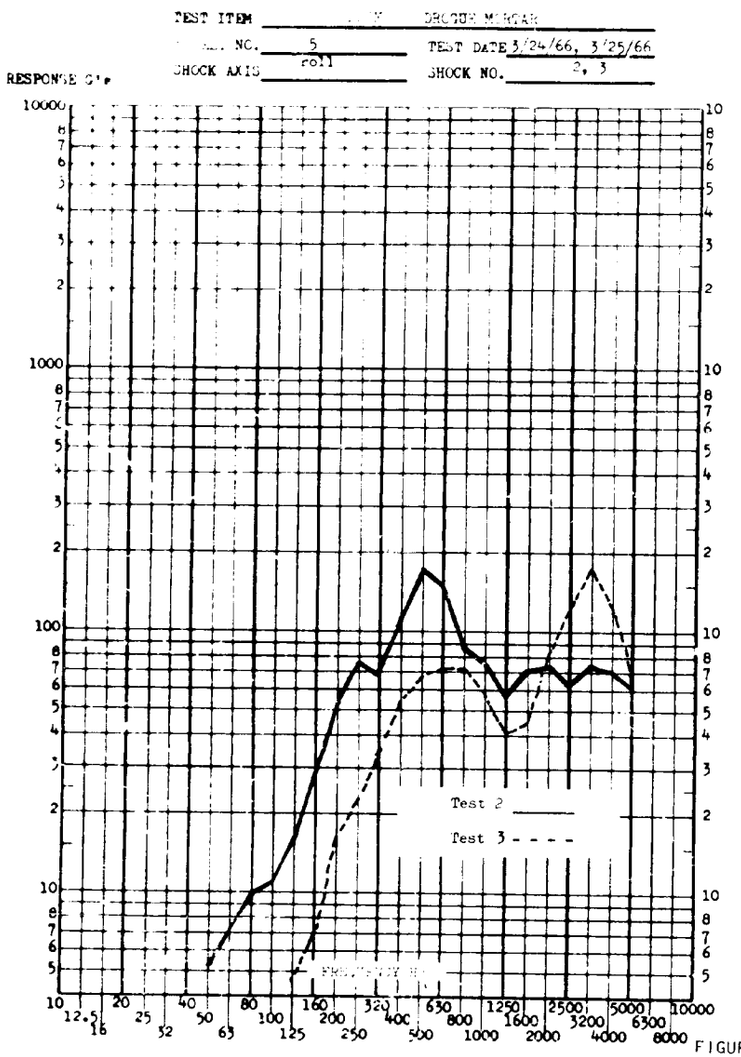




FIGURE IV.A.3-3



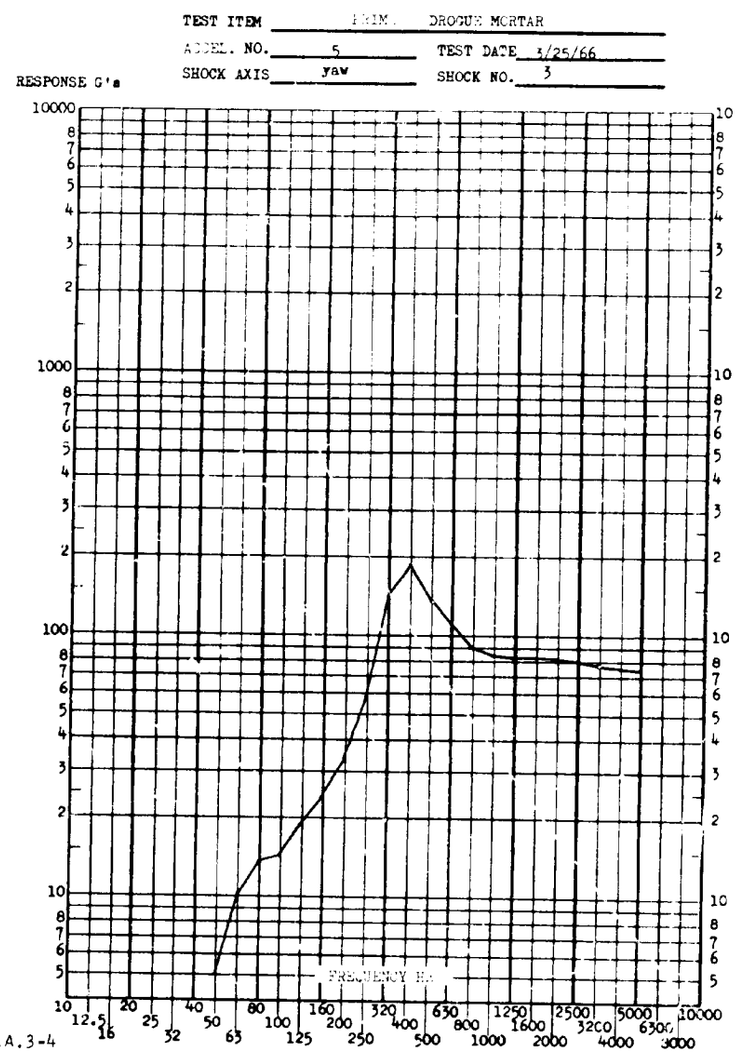
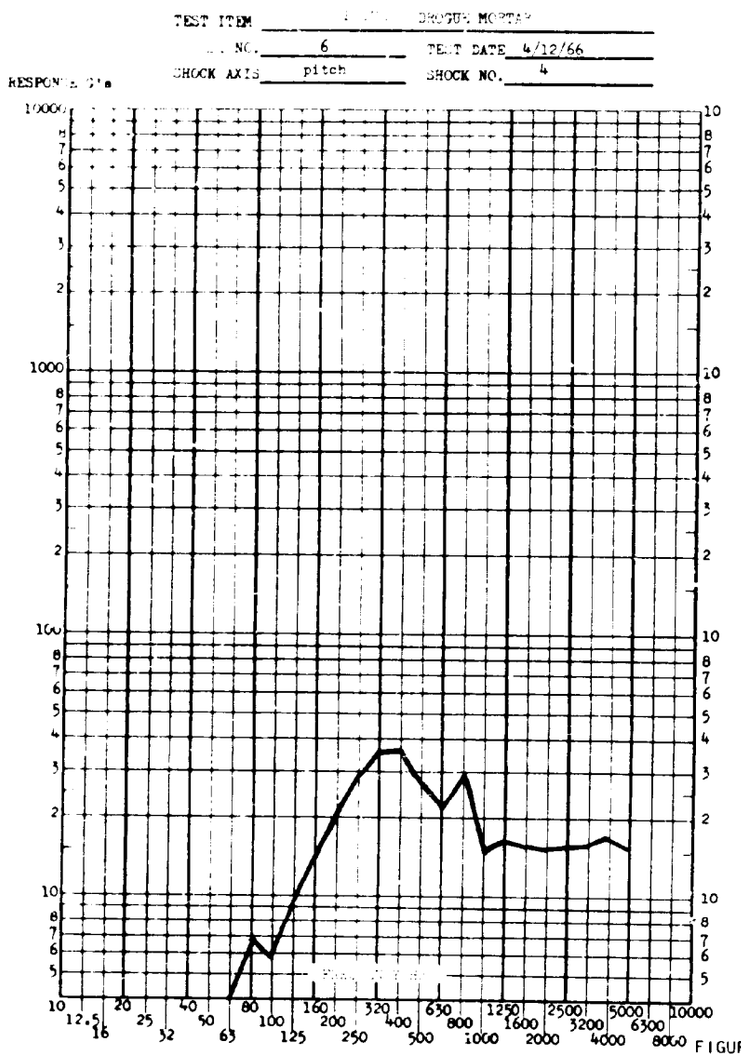




FIGURE IV.A.3-4



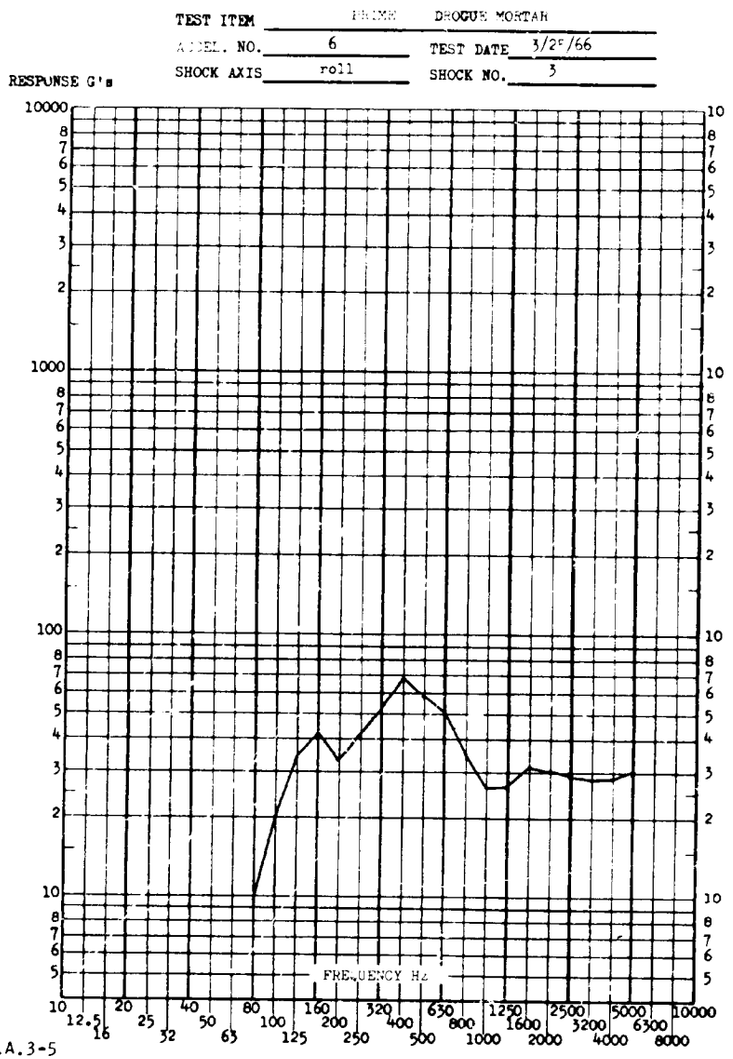
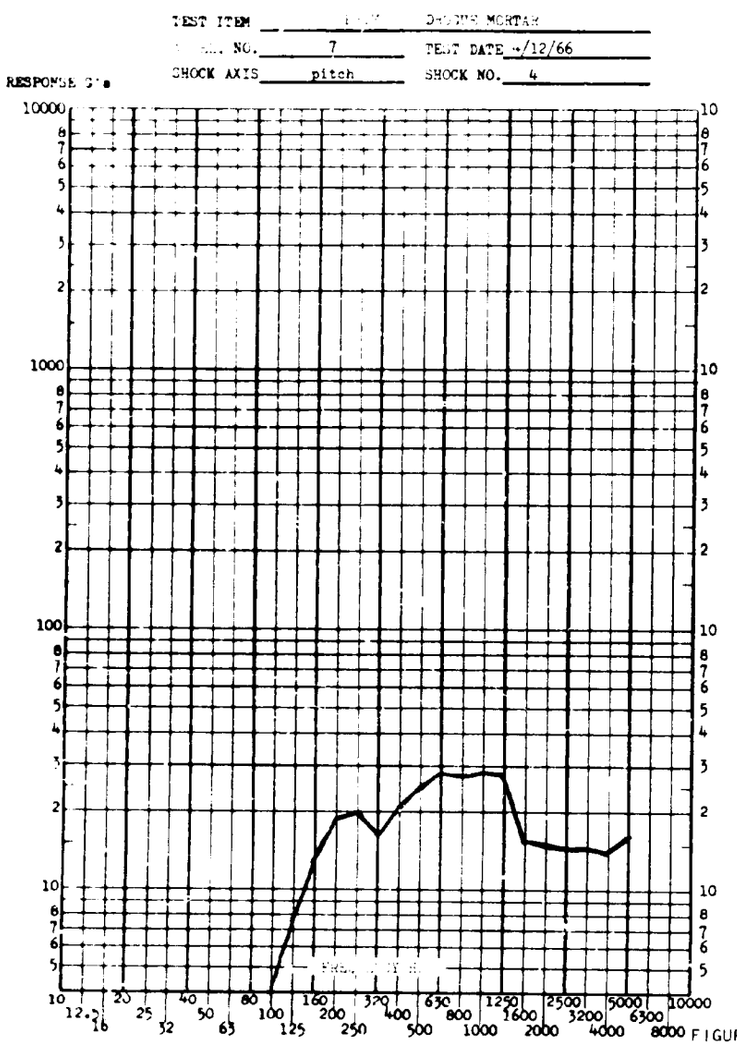




FIGURE IV.A.3-5



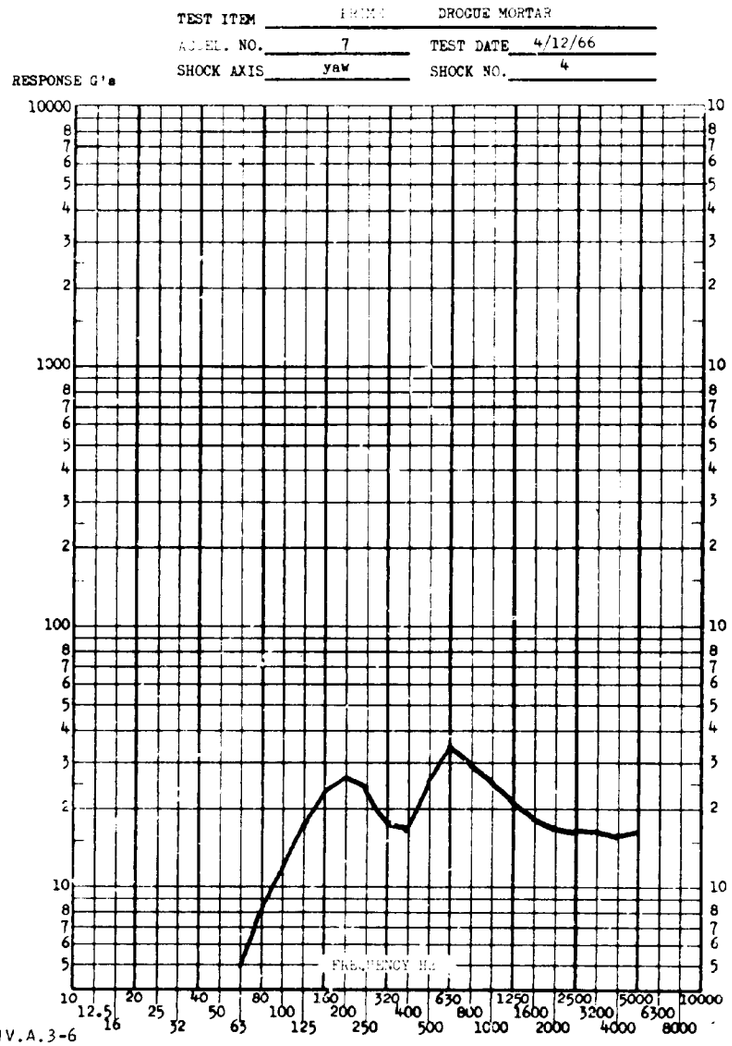
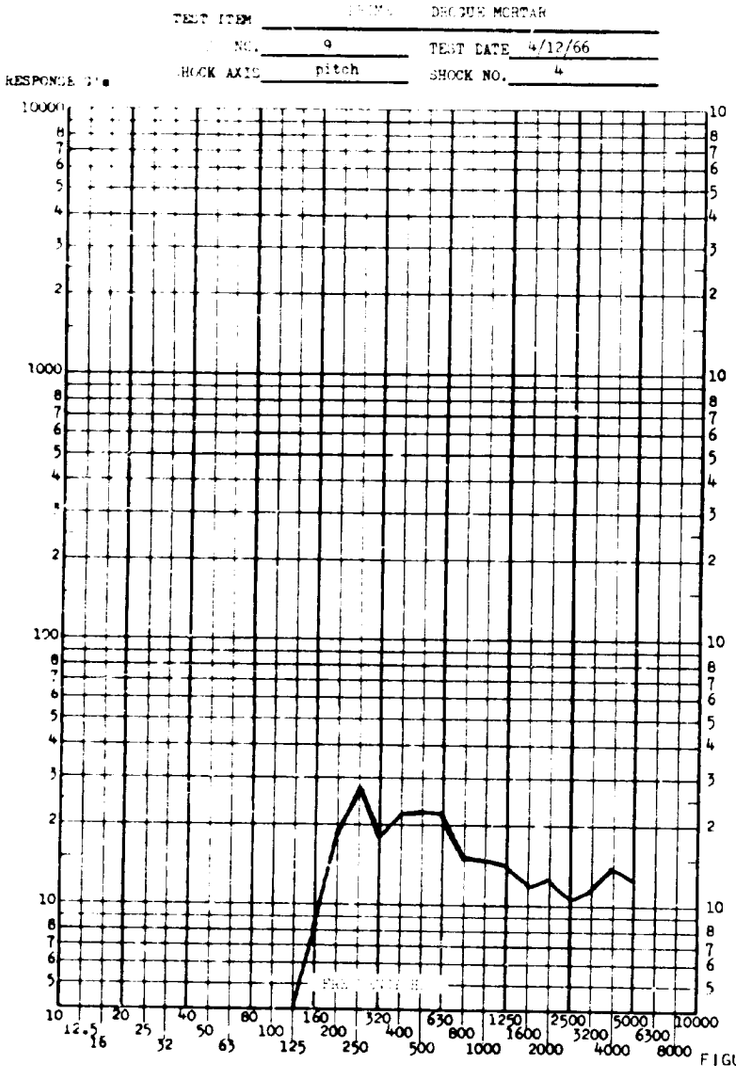




FIGURE IV.A.3-6



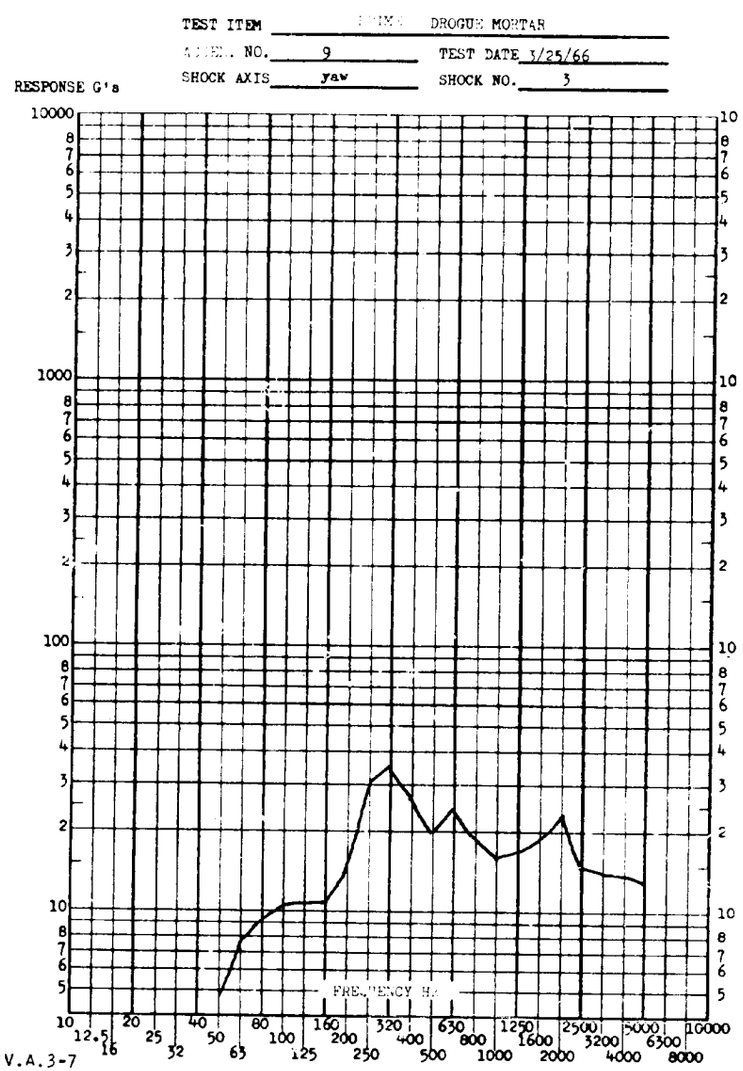




FIGURE IV.A.3-7

TEST ITEM [illegible] DROGUE MORTAR

[illegible] NO. [illegible] TEST DATE 3/25/66, 4/12/66

SHOCK AXIS roll SHOCK NO. 3, 4

RESPONSE G's

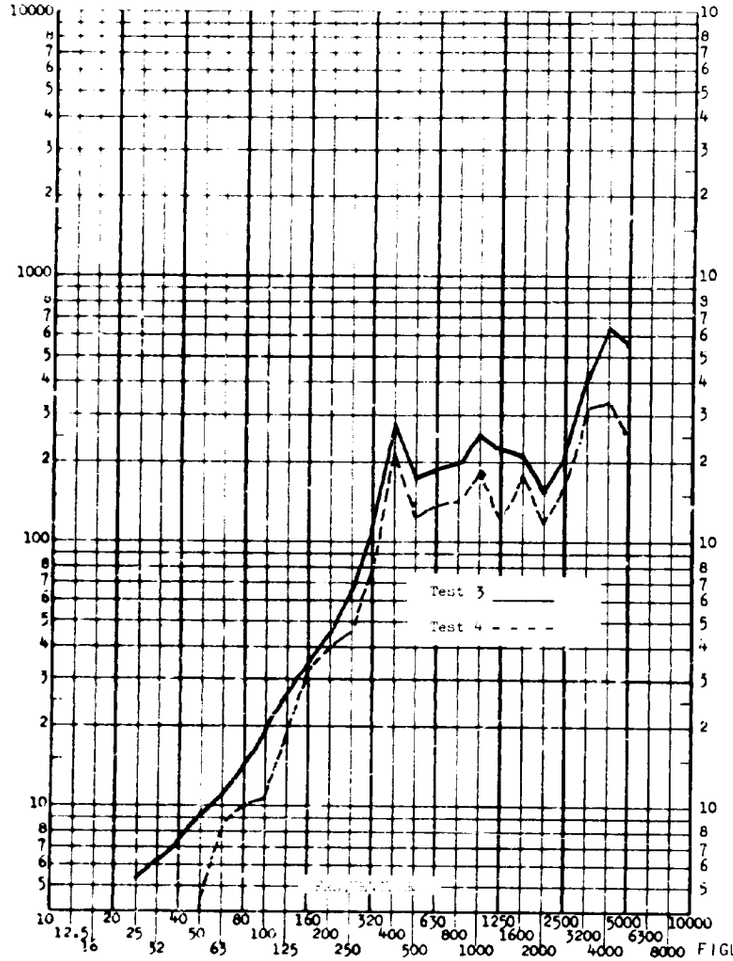



FIGURE IV.A.3-8

SECTION IV.A.4

PRIME DROGUE CHUTE SEPARATION TESTS

Shock data are presented for four firings of the drogue disconnect hardware and for one functional disconnect test. In all tests the separation nut configuration shown in Figure IV.A.4-1 produced the pyrotechnic shock activity. Shots 1, 2 and 3 and the functional test were performed on the standard configuration; however, shot 6 made use of a Pyrotex washer as a shock absorber to reduce the shock levels at locations 1B and 2.

Figures IV.A.4-2 through IV.A.4-15 present the shock spectra for these five tests in the order indicated by Table IV.A.4-1.

TABLE IV.A.4-1

INDEX OF DATA LOCATIONS

| Figure Number | Graph 1 | | Graph 2 | |
|---|---|---|---|---|
| | Shot No.s | Accel. No.s | Shot No.s | Accel. No.s |
| IV.A.4-2 | 1,2,5 | 1B | 6 | 1B |
| IV.A.4-3 | 5 | 2 pitch | 6 | 2 pitch |
| IV.A.4-4 | 1,2,5 | 2 roll | 6 | 2 roll |
| IV.A.4-5 | 1,2,5 | 3 roll | 6 | 3 roll |
| IV.A.4-6 | 1,5 | 3 yaw | 6 | 3 yaw |
| IV.A.4-7 | 5 | 5 pitch | 5 | 5 roll |
| IV.A.4-8 | 5 | 5 yaw | 5 | 6 roll |
| IV.A.4-9 | 5 | 6 yaw | 5 | 7 roll |
| IV.A.4-10 | 5 | 7 yaw | 5 | 9 roll |
| IV.A.4-11 | 5 | 9 yaw | 5 | 10 roll |
| IV.A.4-12 | 6 | 10 roll | --- | --- |
| | | Functional test | | |
| IV.A.4-13 | | 1B | | 2 roll |
| IV.A.4-14 | | 3 roll | | 3 yaw |
| IV.A.4-15 | | 10 roll | | ----- |

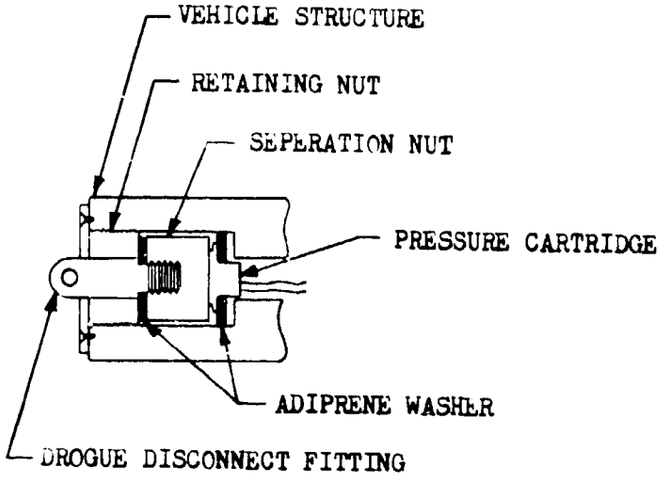
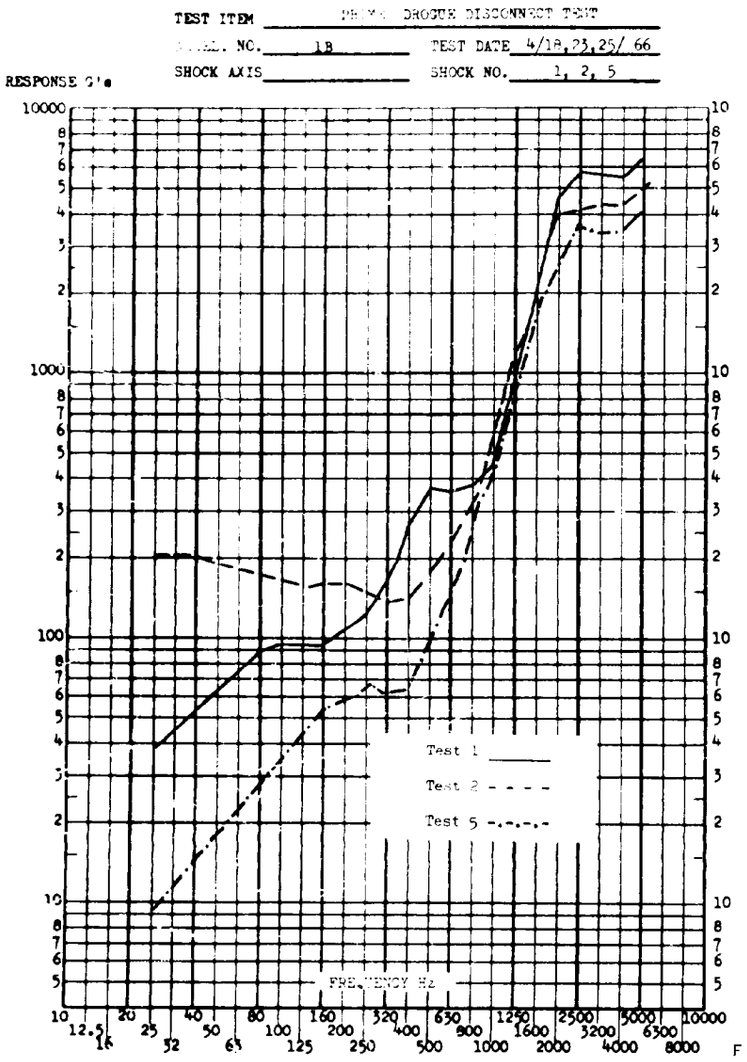



FIGURE IV.A.4-1 SEPARATION NUT CONFIGURATION FOR DROGUE DISCONNECT



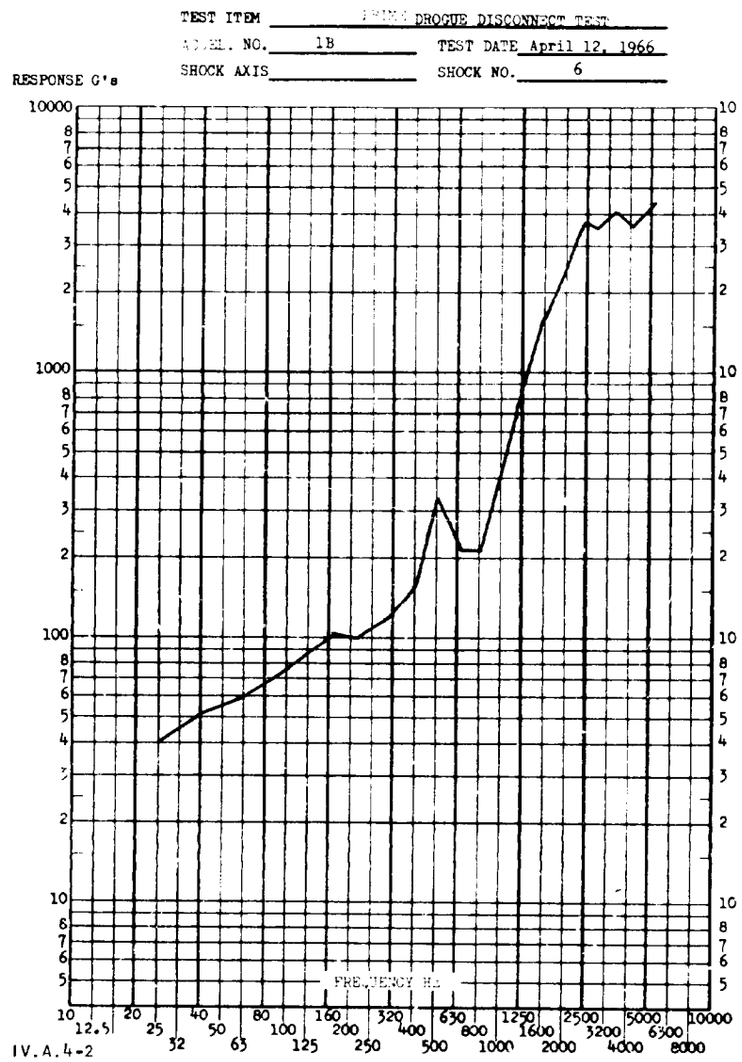



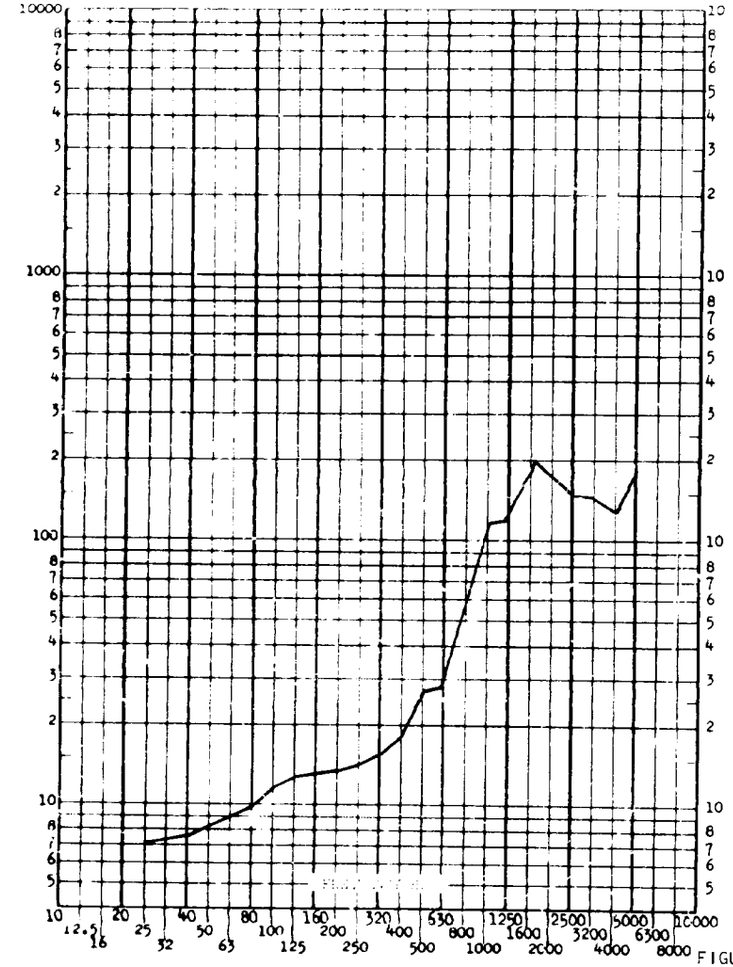

FIGURE IV.A.4-2

TEST ITEM PRIME DROGUE DISCONNECT TEST

MODEL NO. 2 TEST DATE March 25, 1966

SHOCK AXIS pitch SHOCK NO. 5

RESPONSE G's




TEST ITEM PRIME DROGUE DISCONNECT TEST

MODEL NO. 2 TEST DATE April 12, 1966

SHOCK AXIS pitch SHOCK NO. 6

RESPONSE G's

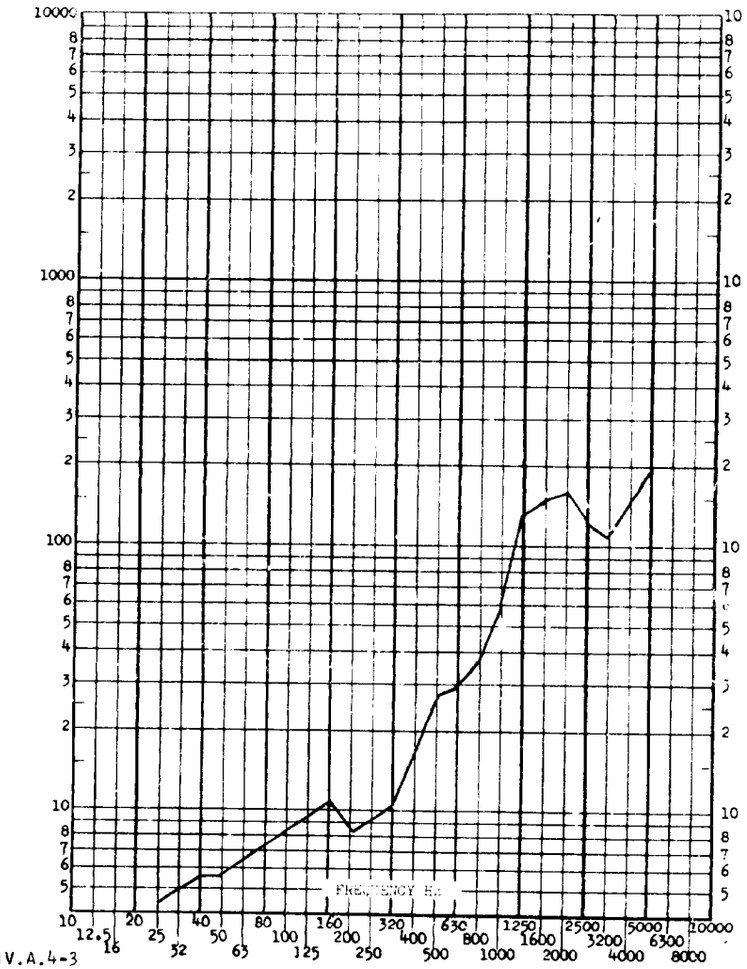
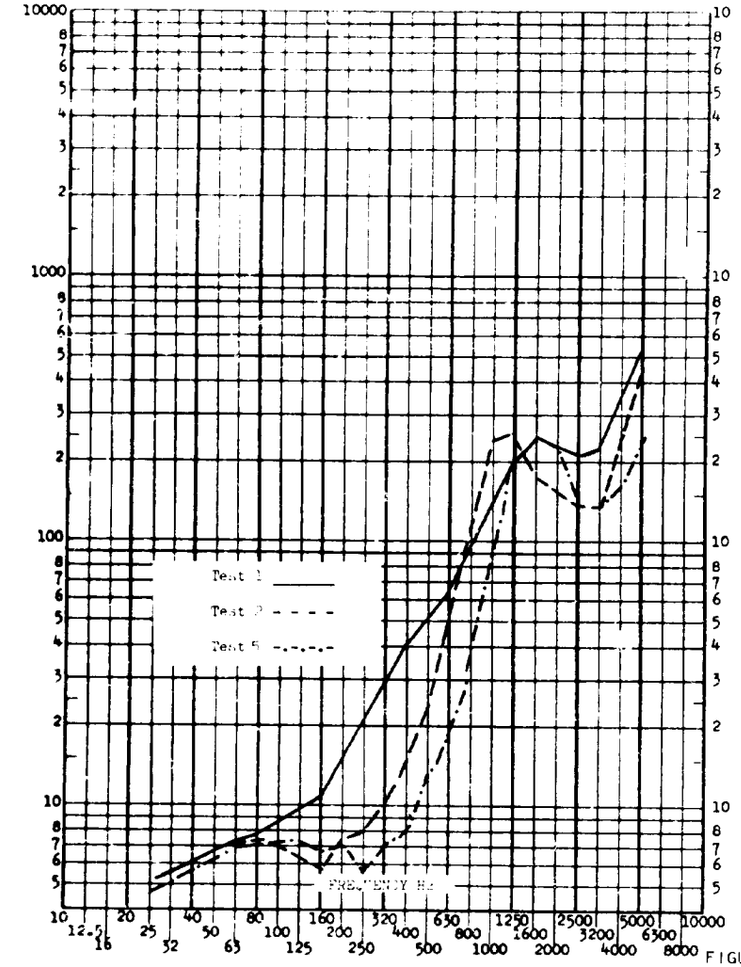



FIGURE IV.A.4-3

TEST ITEM PRIME DROGUE DISCONNECT TEST
ACCEL. NO. 2 TEST DATE 4/18,23,25/66
SHOCK AXIS roll SHOCK NO. 1, 2, 5

RESPONSE G's




TEST ITEM PRIME DROGUE DISCONNECT TEST
ACCEL. NO. 2 TEST DATE April 12, 1966
SHOCK AXIS roll SHOCK NO. 6

RESPONSE G's

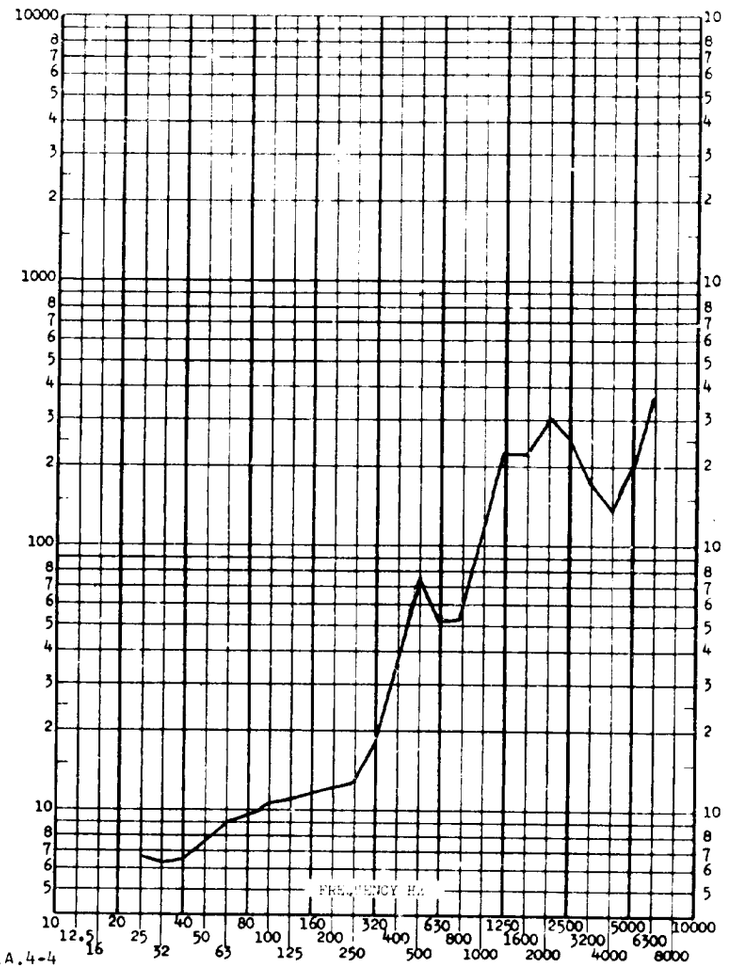
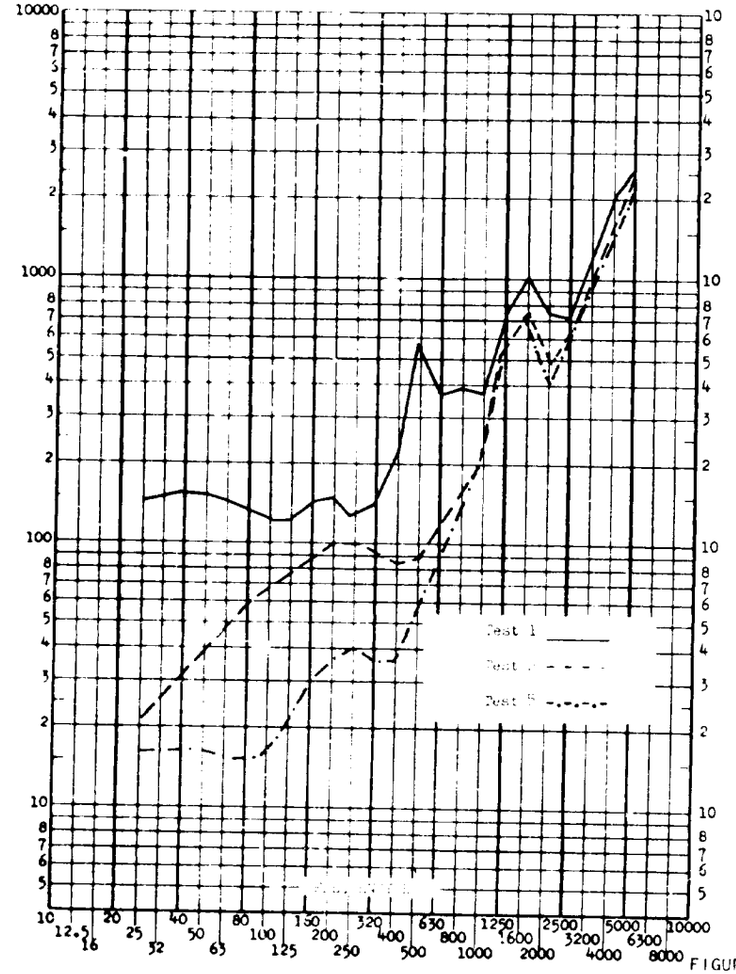



FIGURE IV.A.4-4

TEST ITEM PRIME DROGUE DISCONNECT TEST
ACCEL. NO. 3 TEST DATE 4/18,23,25/66
SHOCK AXIS roll SHOCK NO. 1, 2, 5

RESPONSE G's




TEST ITEM PRIME DROGUE DISCONNECT TEST
ACCEL. NO. 3 TEST DATE April 12, 1966
SHOCK AXIS roll SHOCK NO. 6

RESPONSE G's

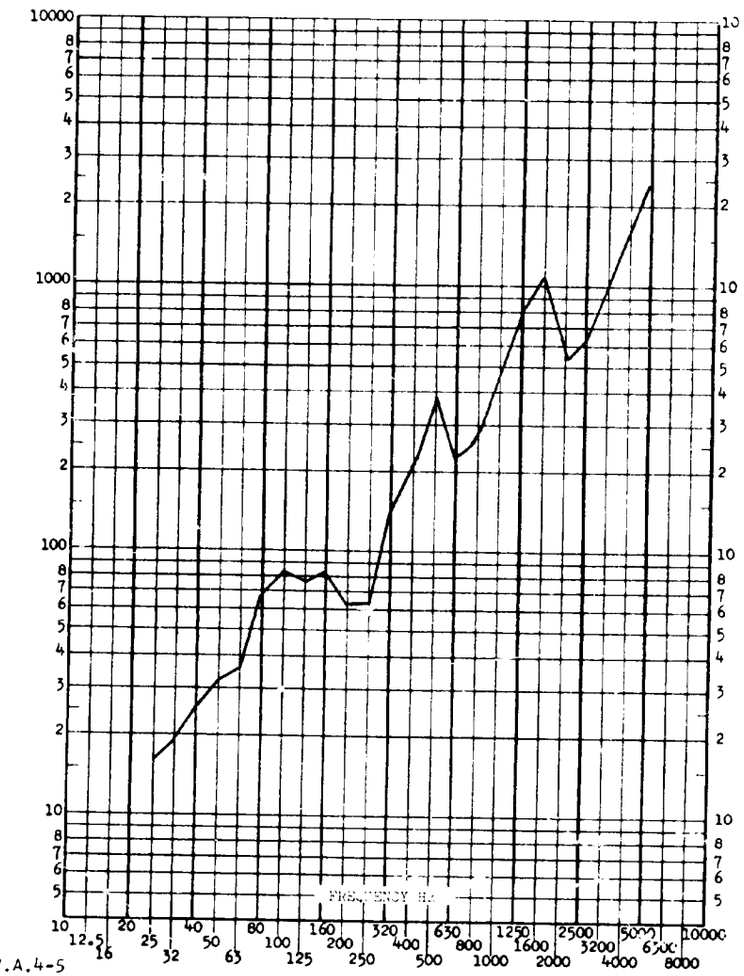



FIGURE IV.A.4-5

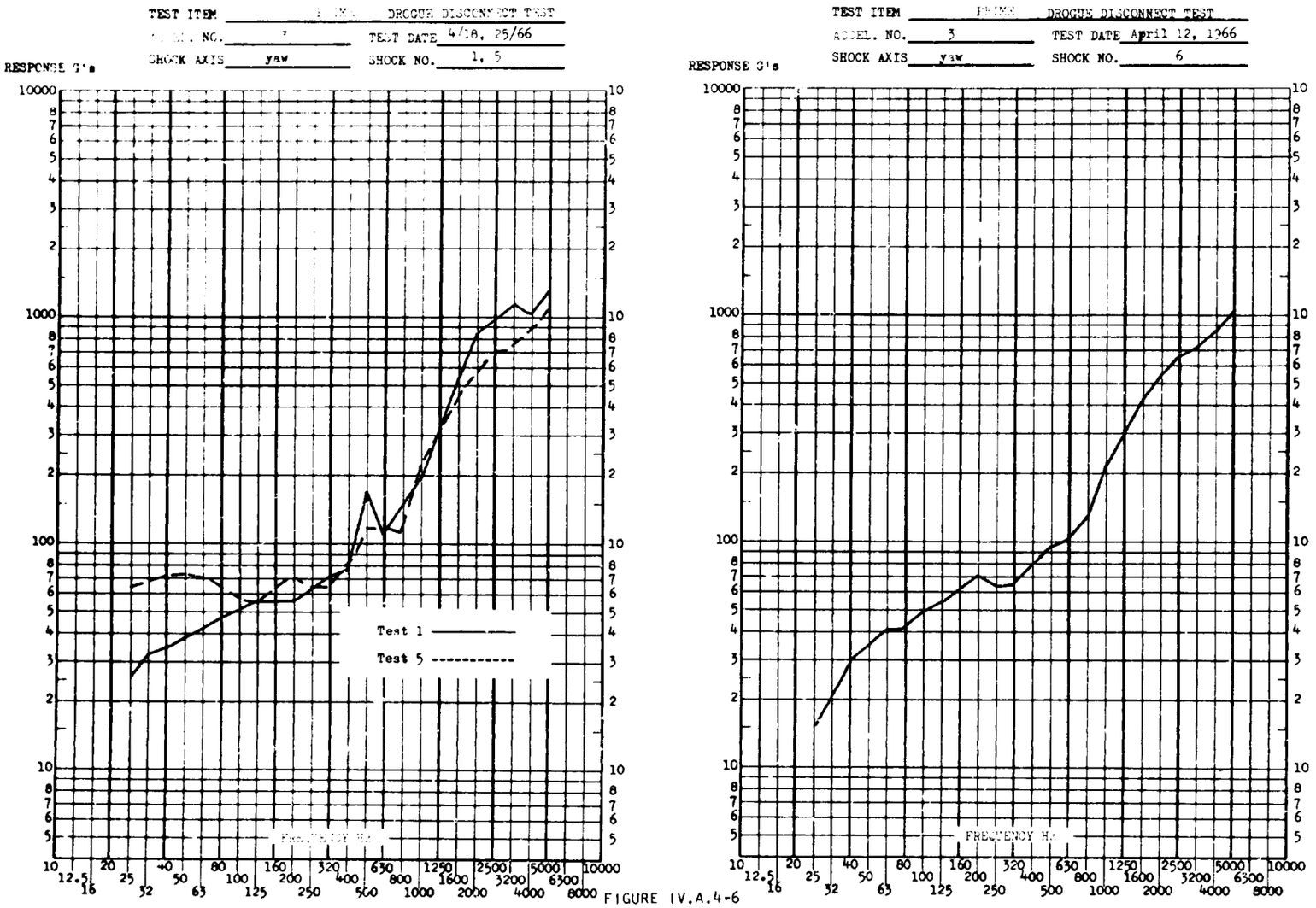
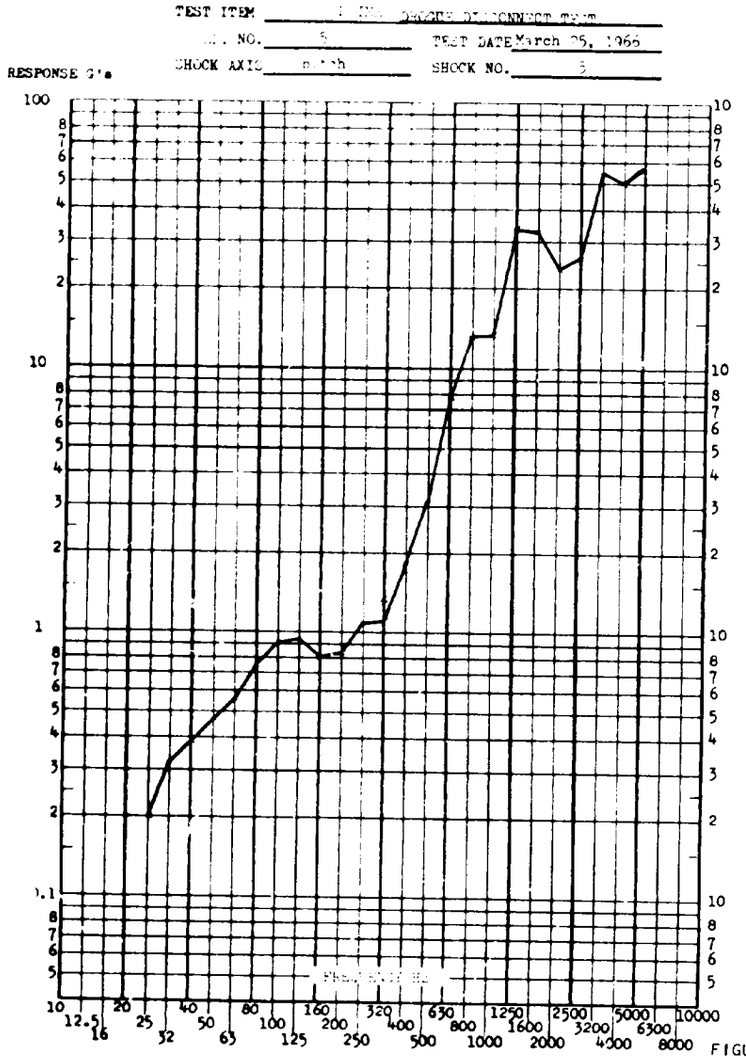



FIGURE IV.A.4-6



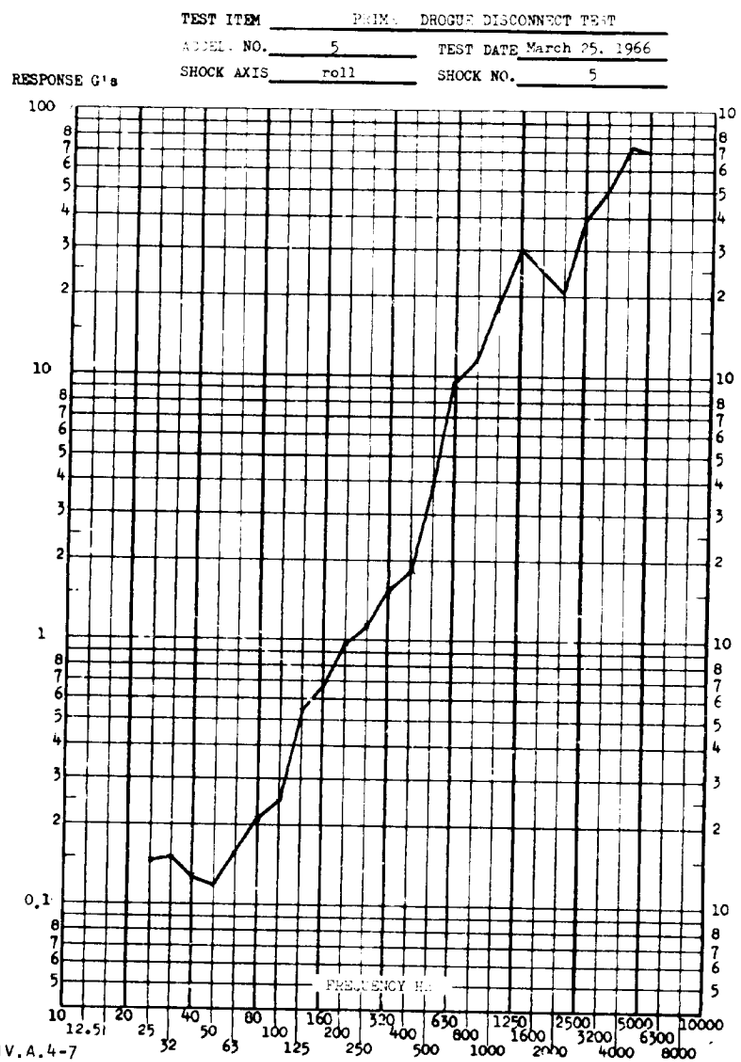
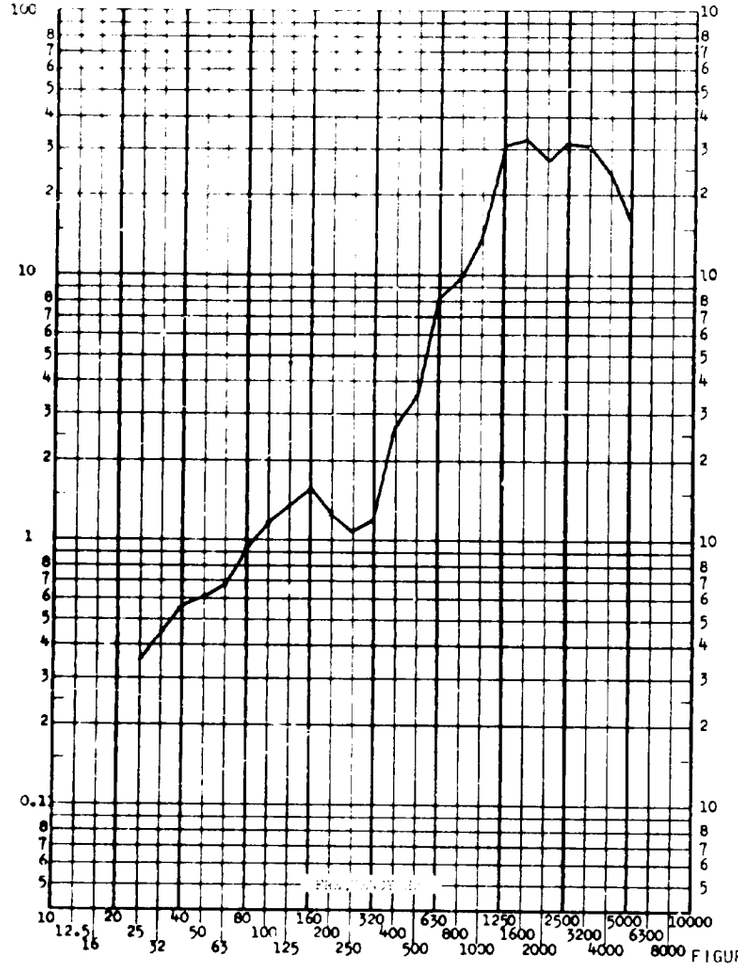




FIGURE IV.A.4-7

TEST ITEM [illegible] DROGUE DISCONNECT TEST
ACCEL. NO. 5 TEST DATE March 25, 1966
SHOCK AXIS yaw SHOCK NO. 5

RESPONSE G's




TEST ITEM PRIME DROGUE DISCONNECT TEST
ACCEL. NO. 6 TEST DATE March 25, 1966
SHOCK AXIS roll SHOCK NO. 5

RESPONSE G's

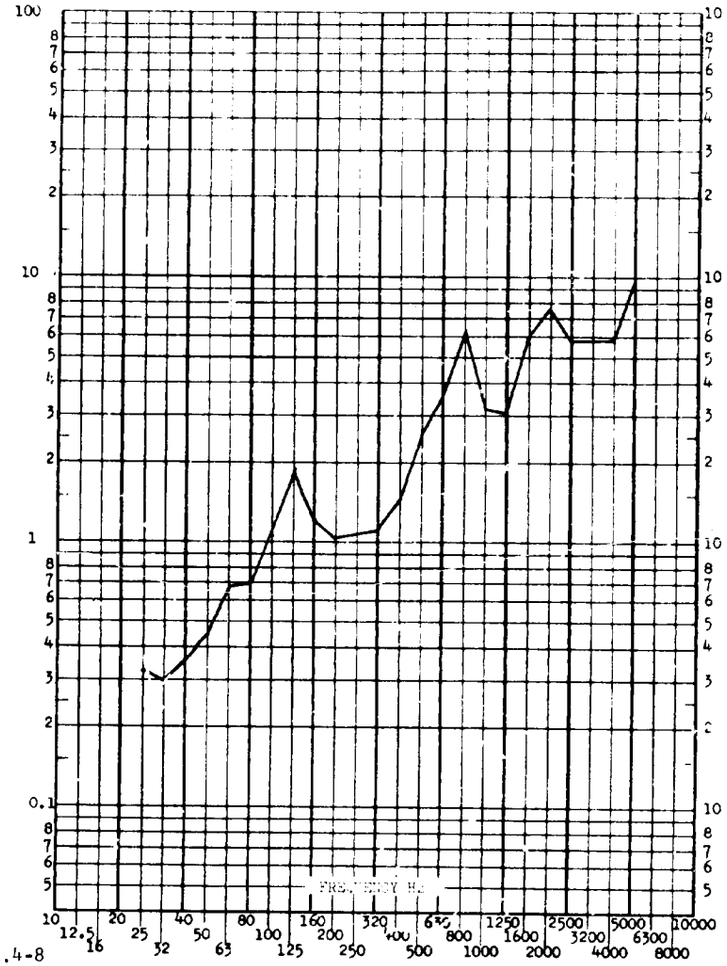
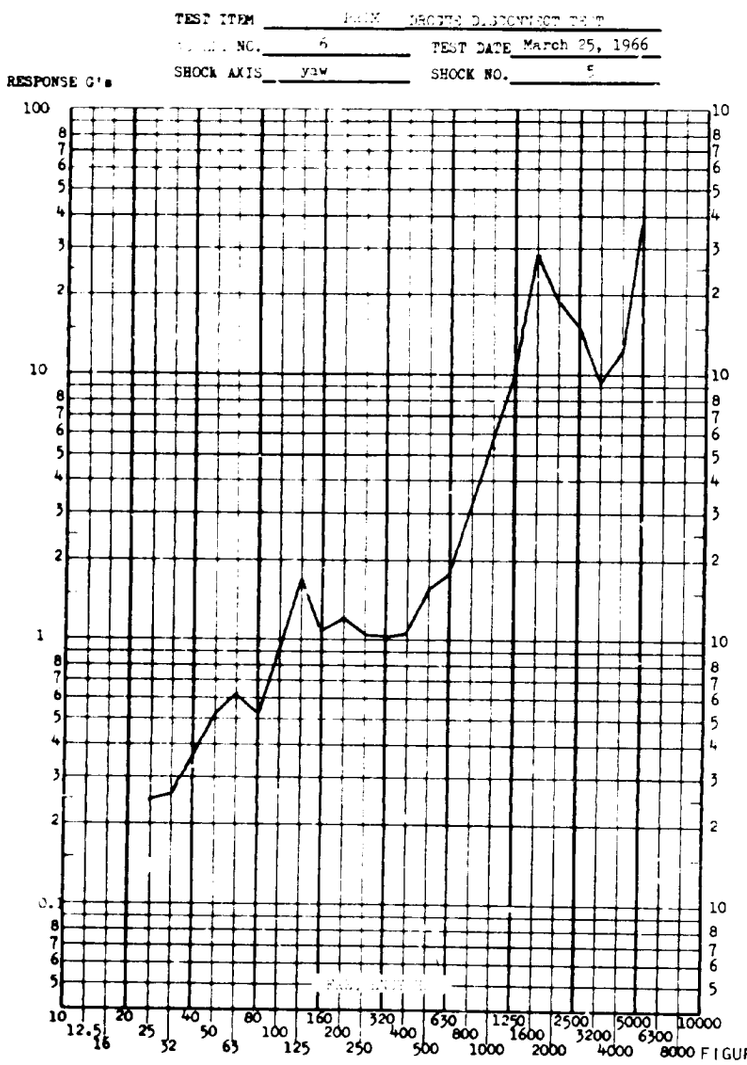



FIGURE IV.A.4-8



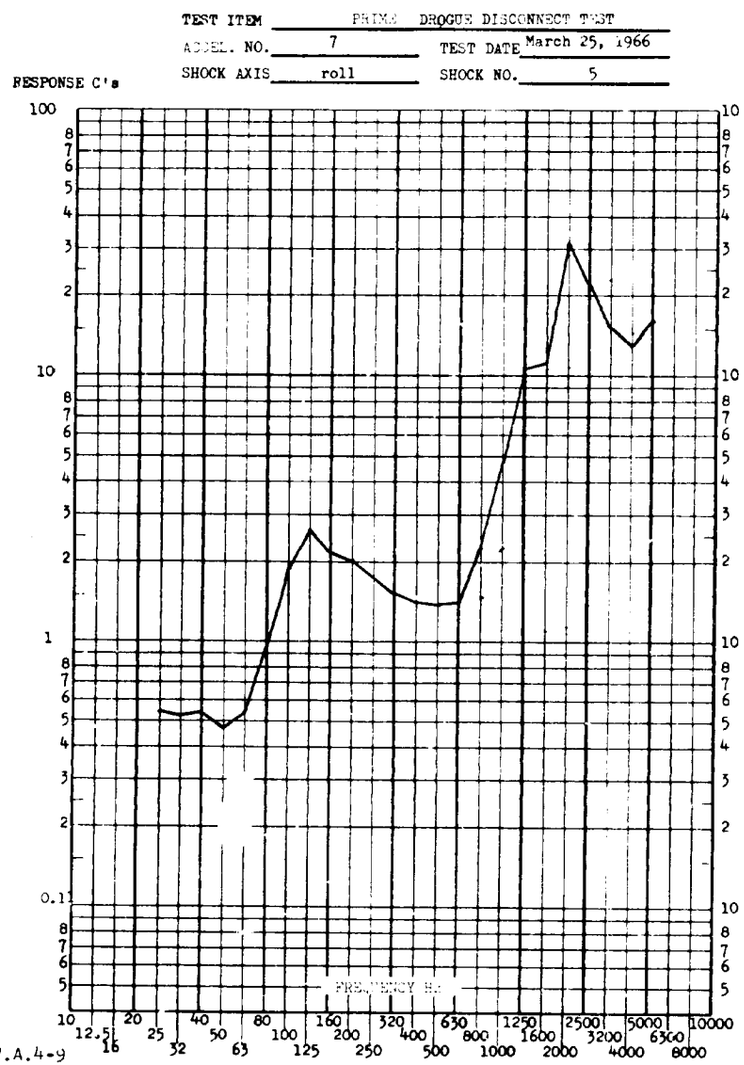



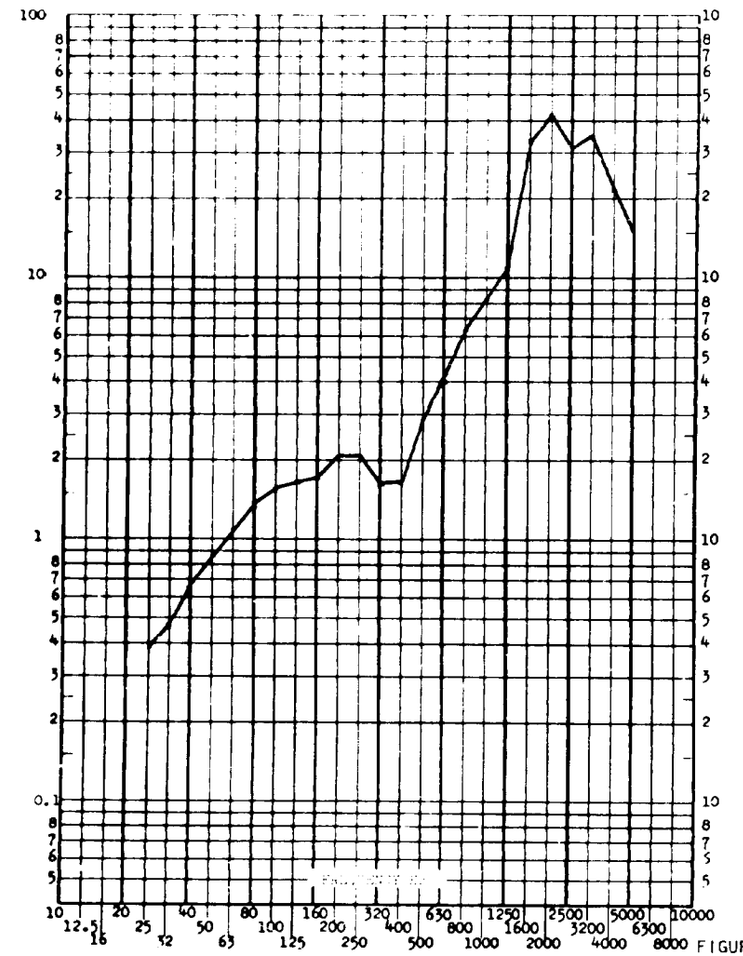

FIGURE IV.A.4-9

TEST ITEM [illegible] DROGUE DISCONNECT TEST

ACCEL. NO. 7 TEST DATE March 25, 1966

SHOCK AXIS yaw SHOCK NO. 5

RESPONSE G's




TEST ITEM [illegible] DROGUE DISCONNECT TEST

ACCEL. NO. 9 TEST DATE March 25, 1966

SHOCK AXIS roll SHOCK NO. 5

RESPONSE G's

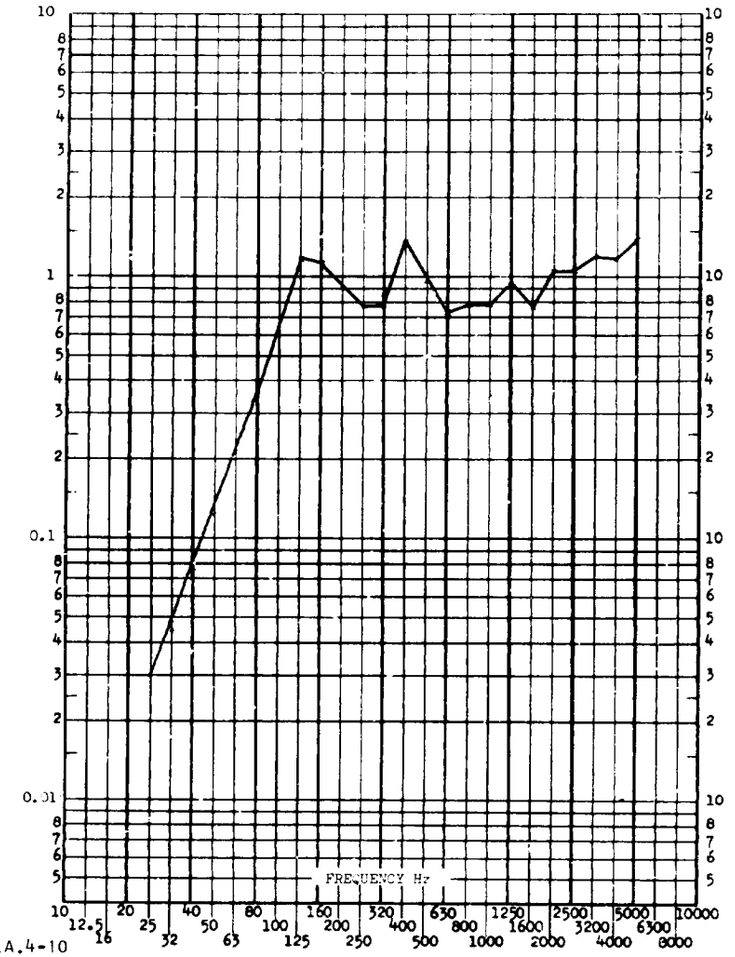
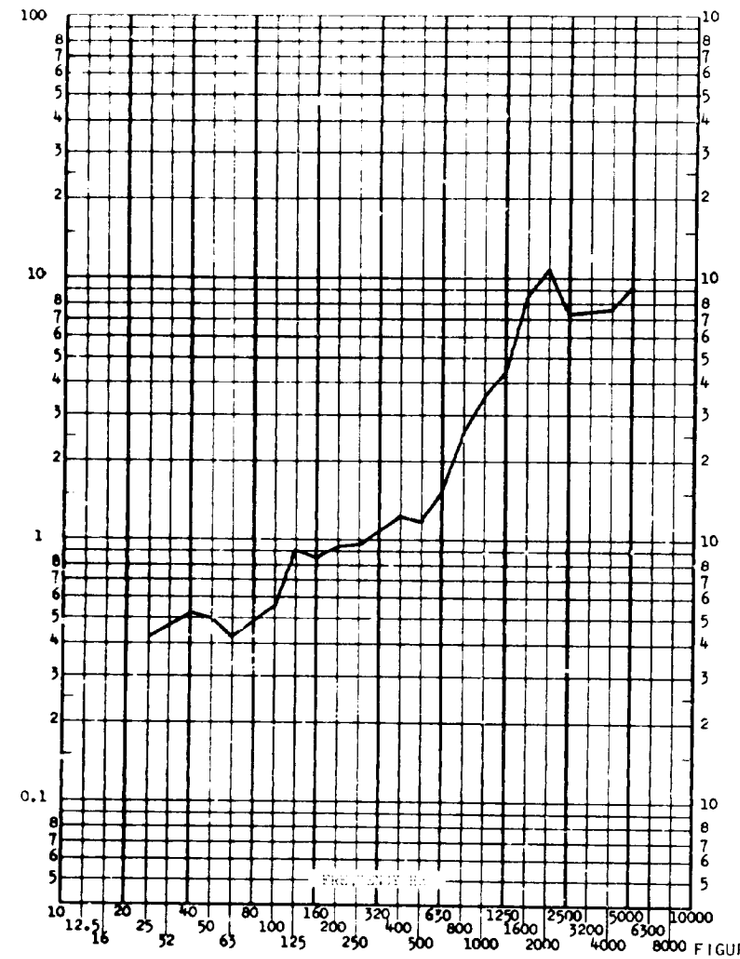



FIGURE IV.A.4-10

TEST ITEM [illegible] DROGUE DISCONNECT TEST
ACCEL. NO. 9 TEST DATE March 25, 1966
SHOCK AXIS yaw SHOCK NO. 5




TEST ITEM PRIMARY DROGUE DISCONNECT TEST
ACCEL. NO. 10 TEST DATE March 25, 1966
SHOCK AXIS roll SHOCK NO. 5

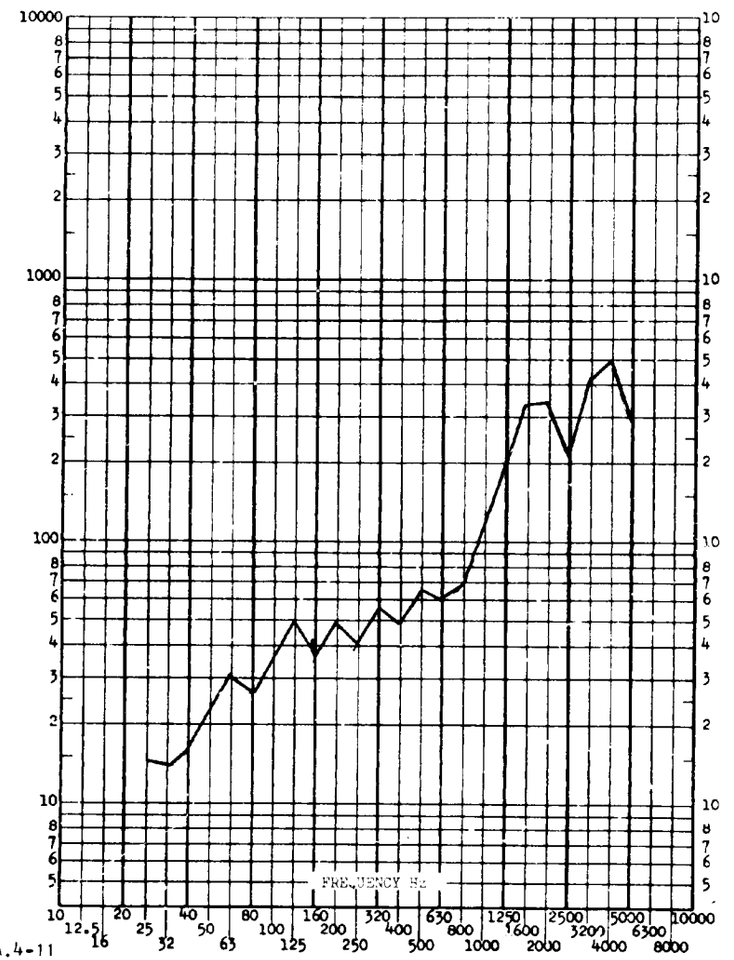



FIGURE IV.A.4-11

TEST ITEM: [illegible] DROGUE DISCONNECT TEST

MODEL NO. 10 TEST DATE April 12, 1966

SHOCK AXIS roll SHOCK NO. 6

RESPONSE G's

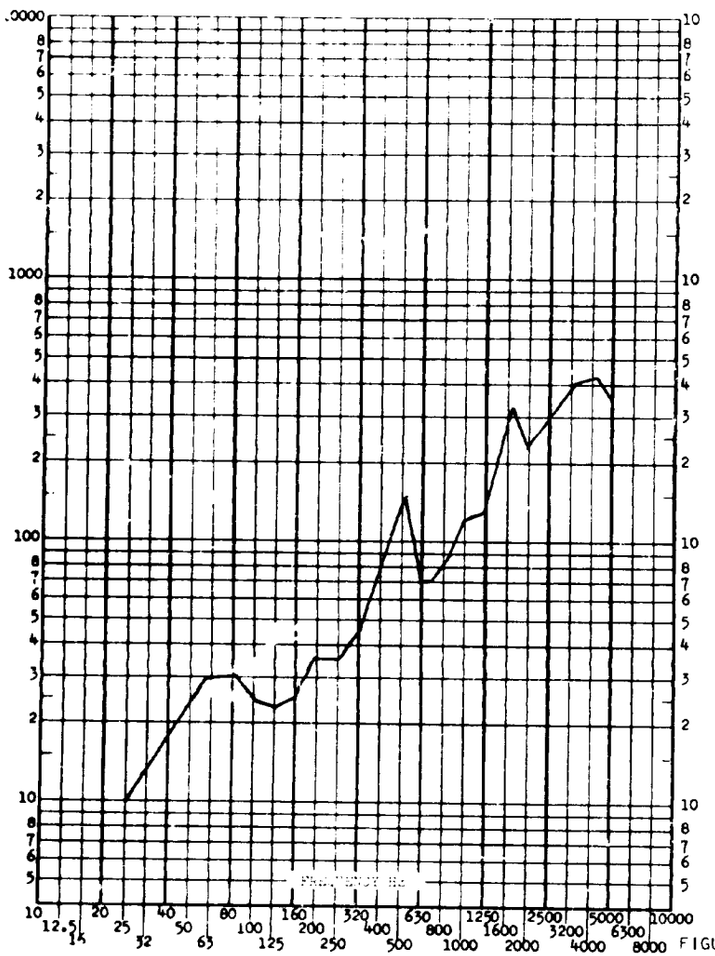
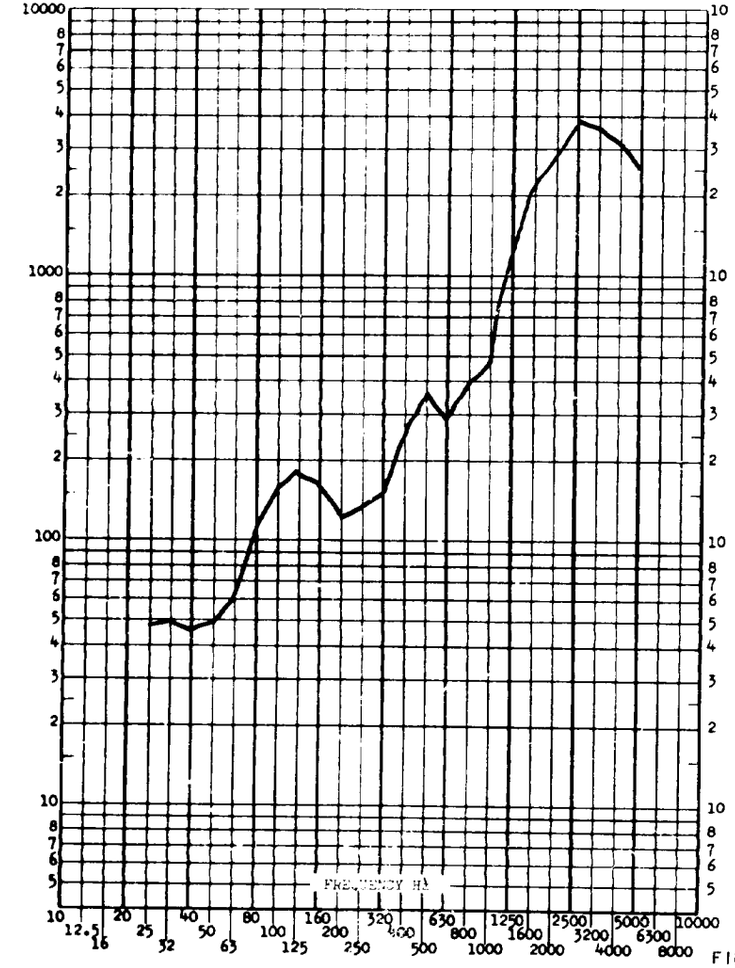



FIGURE IV.A.4-12

TEST ITEM PRIME DROGUE DISCONNECT FUNCTIONAL TEST
ACCEL. NO. 1 TEST DATE April 26, 1966
SHOCK AXIS _____ SHOCK NO. 1




TEST ITEM PRIME DROGUE DISCONNECT FUNCTIONAL TEST
ACCEL. NO. 2 TEST DATE April 26, 1966
SHOCK AXIS roll SHOCK NO. 1

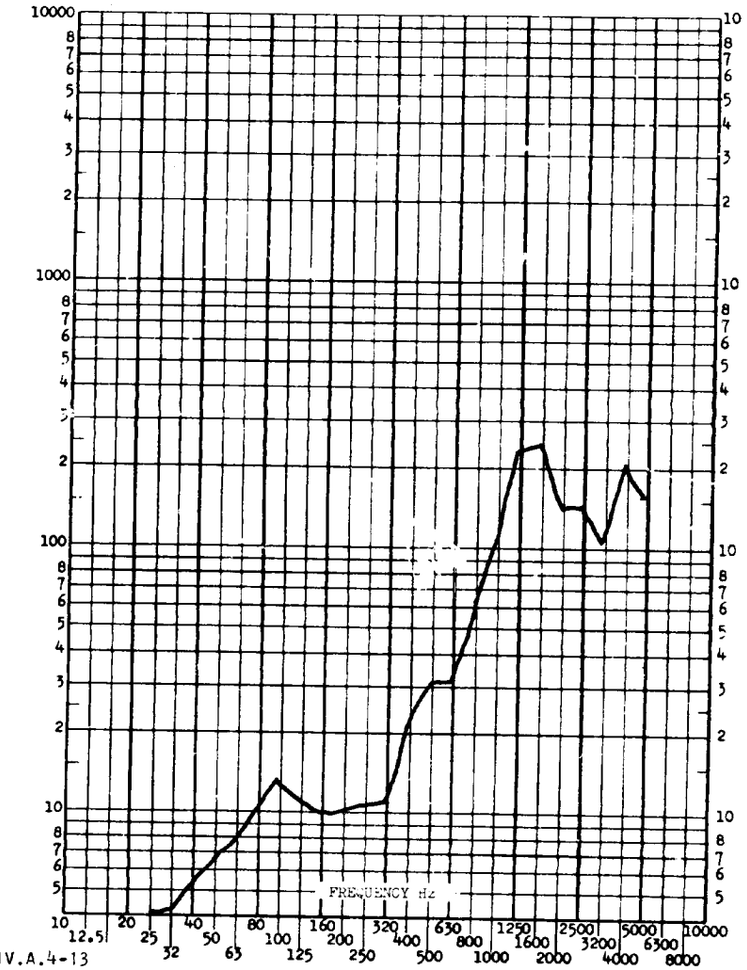
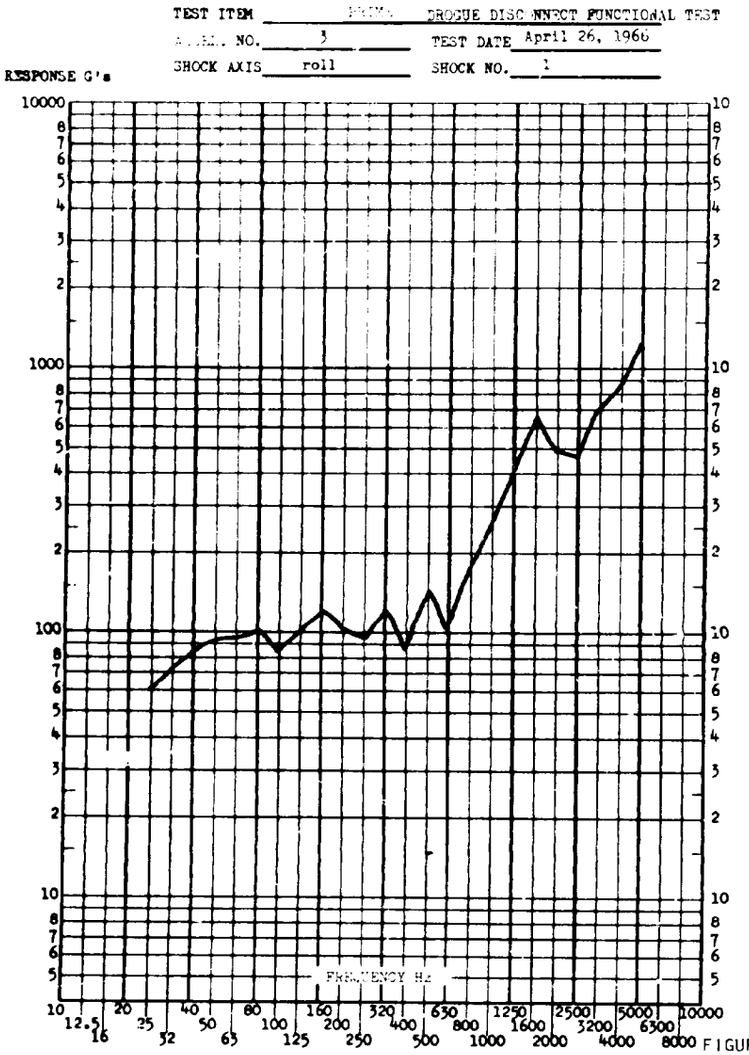



FIGURE IV.A.4-13



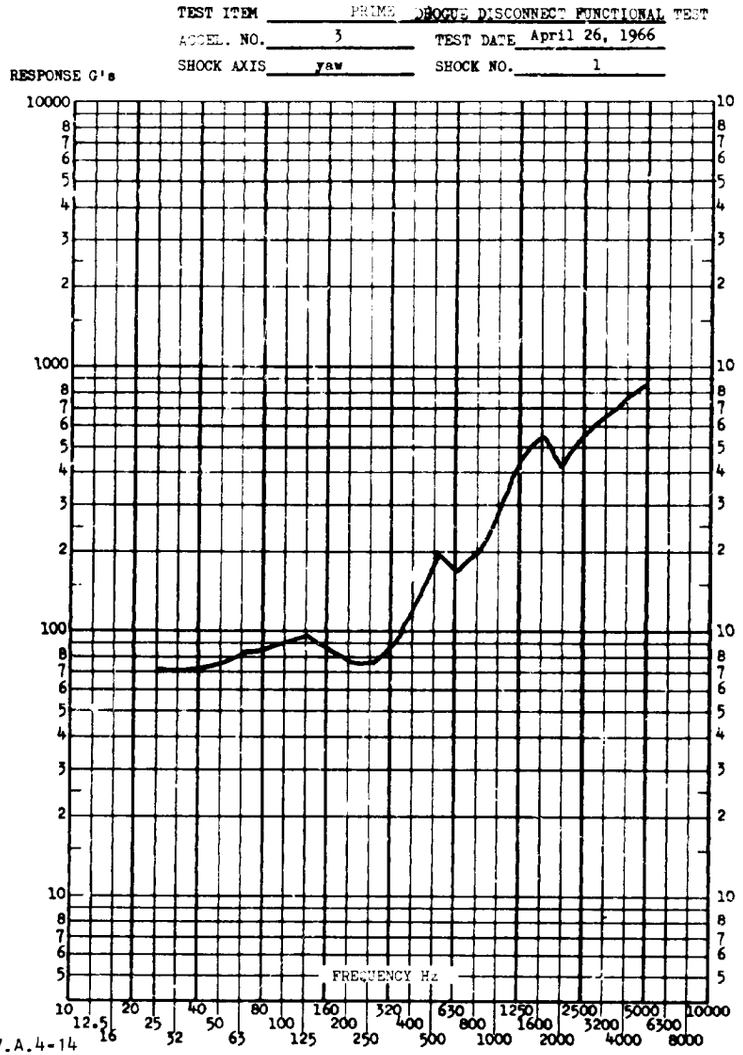




FIGURE IV.A.4-14

TEST ITEM PRIMARY DROGUE DISCONNECT FUNCTIONAL TEST

[illegible] NO. 10 TEST DATE April 26, 1966

SHOCK AXIS roll SHOCK NO. 1

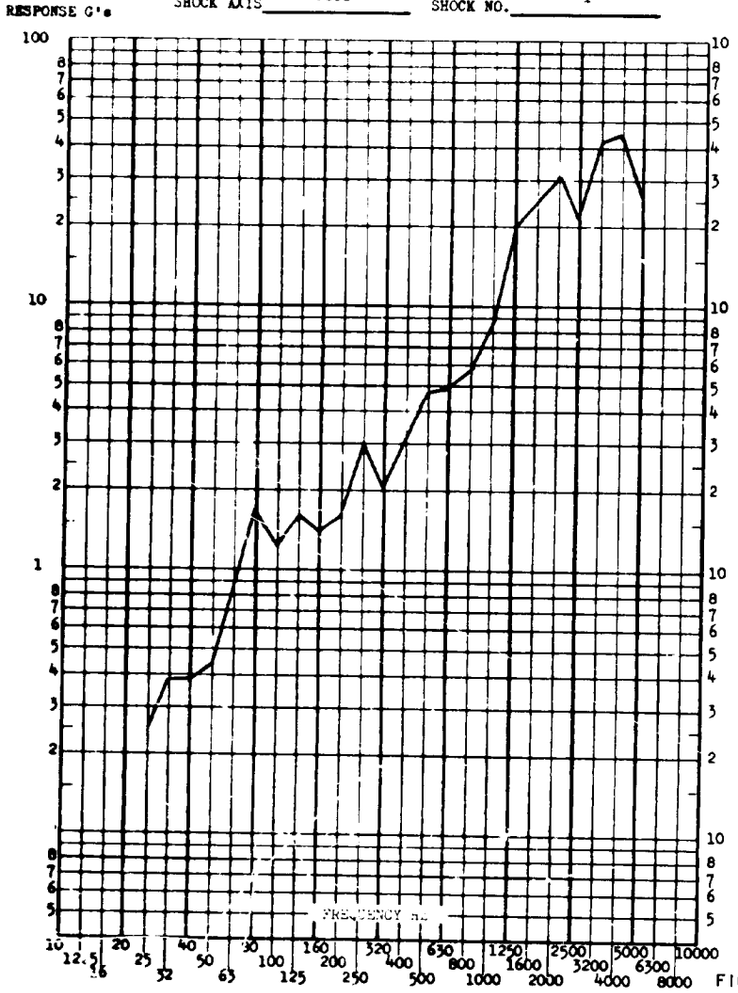



FIGURE IV.A.4-15

# PART IV.B

# PYROTECHNIC SHOCK DATA COMPILED FOR MARINER (VENUS & MARS) '67 FLIGHT ACCEPTANCE TESTS

PART IV.B

MARINER VENUS 67 FLIGHT ACCEPTANCE PYROTECHNIC TESTS

PURPOSE OF TESTS

The objectives of the pyrotechnic shock acceptance tests of the M67-1 (Mariner Venus) and M67-2 (Mariner V) are listed below:

1. To initiate all pyro devices on or near the spacecraft in the natural flight sequence in order to verify the operation of the pyrotechnics and their associated control systems.
2. To verify that the spacecraft operation was not adversely affected by the detonation of the pyrotechnics.
3. To measure, record, and analyze the shock transients at selected locations on the vehicle.

DESCRIPTION OF EVENTS

The test vehicles for these test programs were the M67-1 and M67-2 spacecraft. The M67-1 flight acceptance pyro test was conducted with the spacecraft in its flight configuration secured atop the LMSC adapter and on the Agena forward equipment rack. The rack, in turn, was bolted to a 2-inch-thick steel plate. Prior to shroud V-band pyro release, the test configuration was as shown in Figure IV.B-1. The

shroud was secured to the adapter by a tensioned shroud V-band. The spacecraft was also secured to the adapter with another V-band, which secured the eight feet of the spacecraft to eight mating surfaces on the adapter. Figure IV.B-2 shows the adapter interfaces with both the shroud and the spacecraft.

The M67-1 test consisted of firing all six of the pyro devices on or near the spacecraft in the sequence they would be fired during an actual mission. In addition, the spring loaded umbilical door in the LMSC shroud was opened fully and allowed to slam shut. Hence, the test program included the following events:

1. Shroud V-band pyro release (initiates shroud separation from Agena booster) - Section IV.B.1.
2. Spacecraft V-band pyro release (initiates spacecraft separation from Agena) - Section IV.B.2.
3. Solar panel deployment - Section IV.B.3.
4. Post injection propulsion system pyro 1 (PIPS1) - Section IV.B.4.
5. Post injection propulsion system pyro 2 (PIPS2) - Section IV.B.5.
6. High-gain antenna pointing angle change (APAC) pyrotechnic - Section IV.B.6.
7. Umbilical door slam (non-pyrotechnic event - two runs) Section IV.B.7.

The test configuration for the M67-2 was identical to the M67-1, except for the shroud, which was omitted in M67-2 because there was no shroud V-band pyro event specified. In addition, the M67-2 spacecraft adapter was not mounted on the Agena forward equipment rack but was secured to a handling fixture.

The M67-2 test sequence consisted of firing only those pyros that would produce the maximum shock levels throughout the spacecraft. From the experience gained in the M67-1 tests, the events selected were:

1. Spacecraft V-band pyro release.
2. Solar panel deployment
3. APAC

All events and their associated pyrotechnic devices are discussed in greater detail along with the data presentation in Sections IV.B.1 through IV.B.7.

DESCRIPTION OF DATA

The following information is characteristic of the data presented for each test event:

| | |
|---|---|
| Type of shock spectra analyses | digital |
| Duration of time history analyzed | 30 milliseconds |
| Sample rate | 160,000/sec |
| Valid frequency range | Table IV.B-1 |
| Frequency increment | 10 points per decade |
| Damping | Q = 20 |
| Aliasing filter | none |

DESCRIPTION OF STRUCTURE

Figures IV.B-1 through IV.B-5.

DESCRIPTION OF ACCELEROMETERS

Type: Endevco model 2225 and other Endevco models having the frequency ranges indicated in Table IV.B-1.

Location: Table IV.B-1 and Figures IV.B-3 through IV.B-5.

Axis of sensitivity: Table IV.B-1 and Figures IV.B-3 through IV.B-5

DESCRIPTION OF DATA ACQUISITION SYSTEM

Tape recorders: Ampex 1300 with Ampex ES100 FM electronics (flat to 20 K Hz.)

Amplifiers: Dynamics 6443 charge amplifiers (flat to 30 K Hz.)

TABLE IV.B-1

ACCELEROMETER DESCRIPTIONS

| Accelerometer Number | General Location | Sensitive Axis | Maximum Useful Frequency (Hz) |
|---|---|---|---|
| B3* | Upper bus leg B | Z | 8000 |
| F4* | Adapter bay II | Z | 8000 |
| F1* | Adapter foot G | Radial | 20,000 |
| F3* | Adapter foot C | Tangential | 20,000 |
| F4A* | Adapter near F4 | Z | 20,000 |
| B1A | Bus top leg B | X | 20,000 |
| B2A | " " " " | Y | 20,000 |
| B3A | " " " " | Z | 20,000 |
| B4 | Bus top leg F | X | 9000 |
| B5 | " " " " | Y | 9000 |
| B6 | " " " " | Z | 9000 |
| BB1 | Bus bottom leg B | X | 20,000 |
| BB2 | " " " " | Y | 20,000 |
| BB3 | " " " " | Z | 20,000 |
| SS4A | Secondary Structure (near bay IV) | Z | 7500 |
| SS5A | " " " " " | XY bays IV-VIII | 7500 |
| SS6A | " " " " " | XY bays II-VI | 7500 |
| AS1 | Antenna superstructure | 1 antenna axis | 15,000 |
| AS2 | " " | II antenna axis | 15,000 |
| IC4 | Solar panel 1 (lower center) | X | 15,000 |
| 3T3 | Solar panel 3 (Rt. tip) | Y | 15,000 |
| MCV1 | PIPS nitrogen valve | XY bays II-VI | 20,000 |
| MCV4 | PIPS fuel valve | XY bays II-VI | 20,000 |
| MC4 | PIPS frame | XY bays II-VI | 20,000 |

* These measurements were the only ones used on M67-2

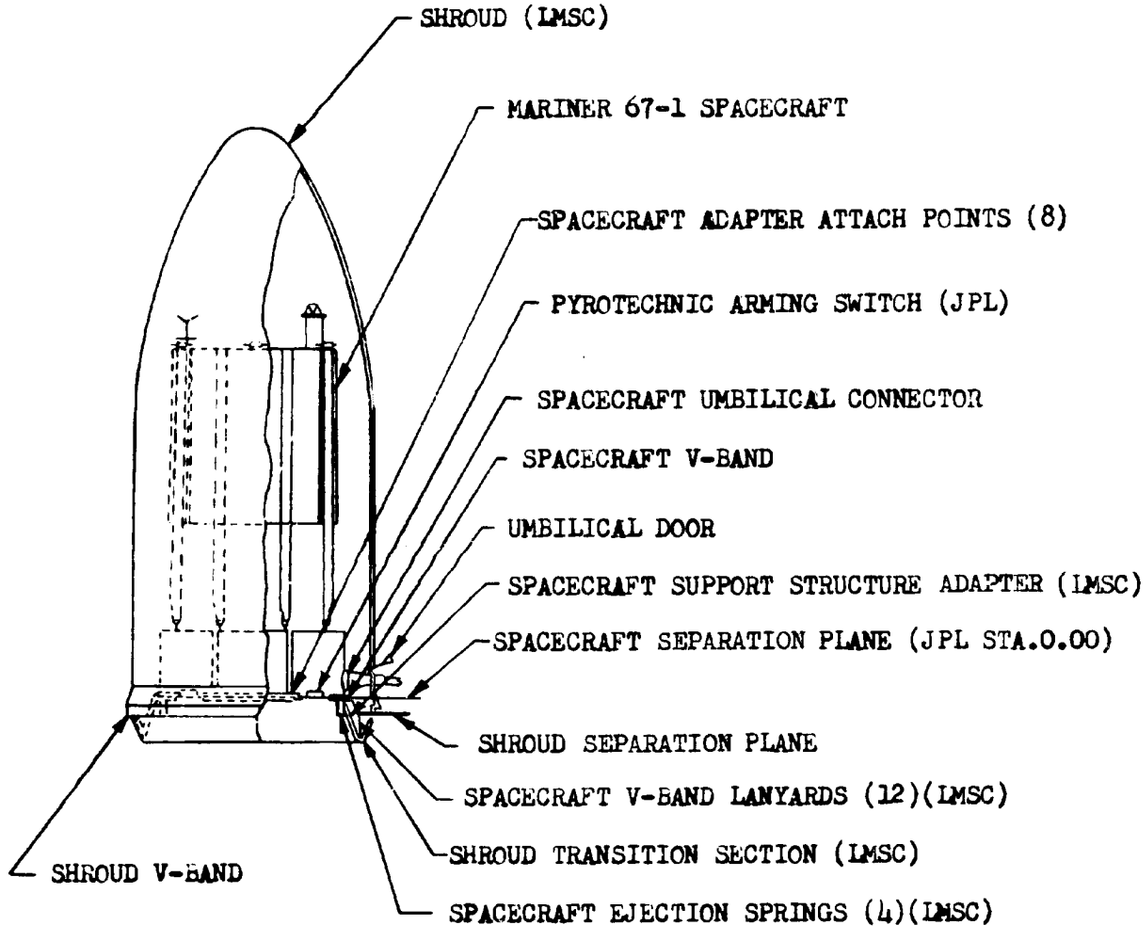



FIGURE IV.B-1. M67-1 SPACECRAFT PYRO TEST CONFIGURATION SHOWING SHROUD, SPACECRAFT AND ADAPTER

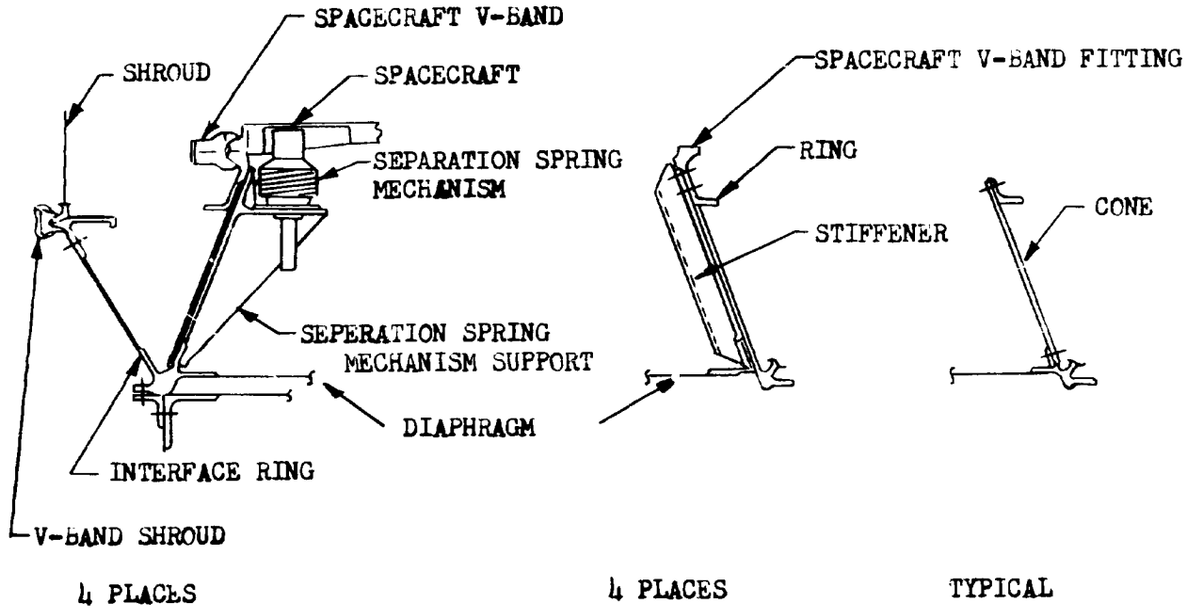



FIGURE IV.B-2. SPACECRAFT ADAPTER INTERFACING WITH SHROUD AND SPACECRAFT

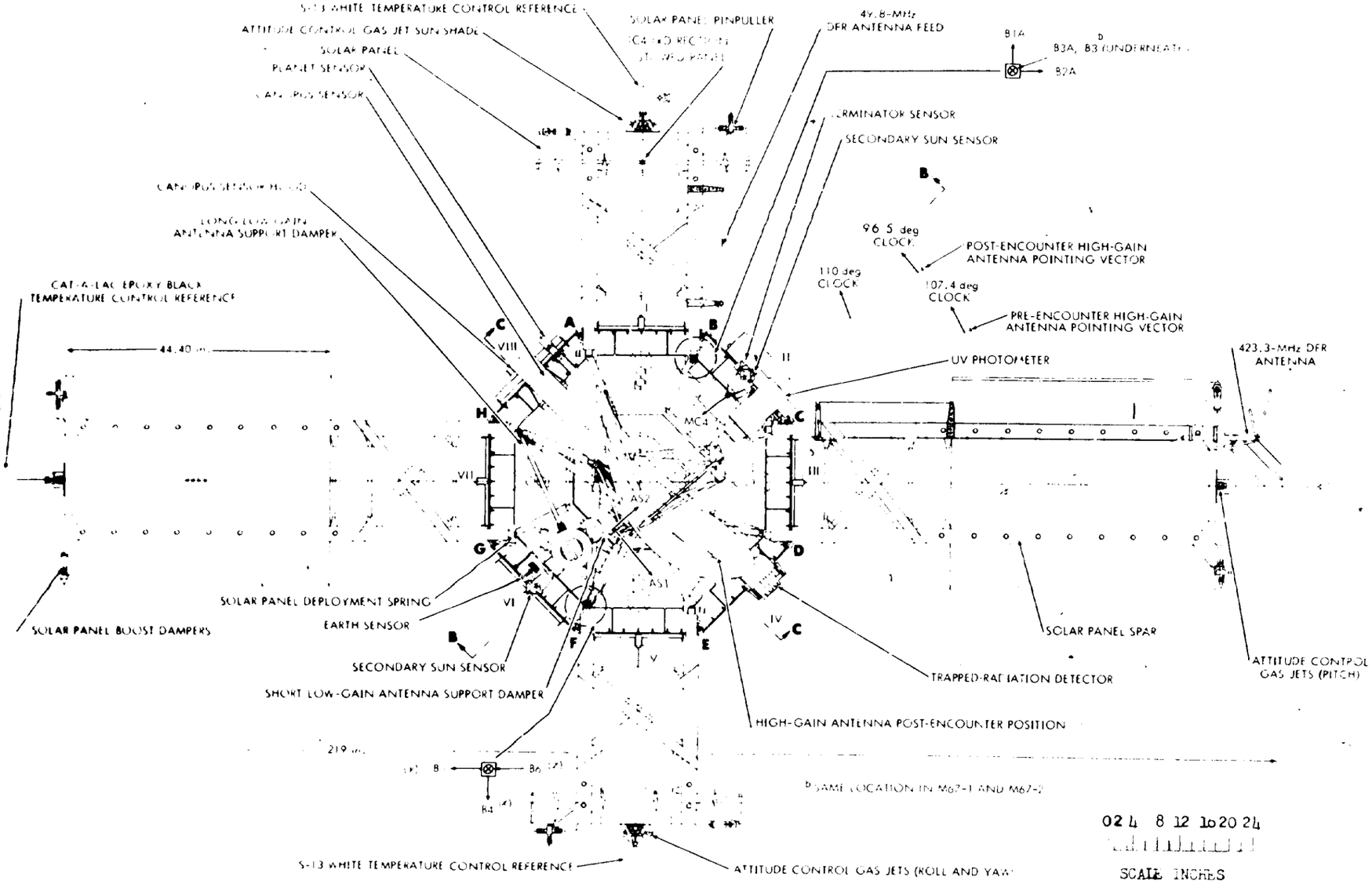



FIGURE IV.B.3. ACCELEROMETER LOCATIONS FOR MARINER VENUS 67 FLIGHT ACCEPTANCE TEST

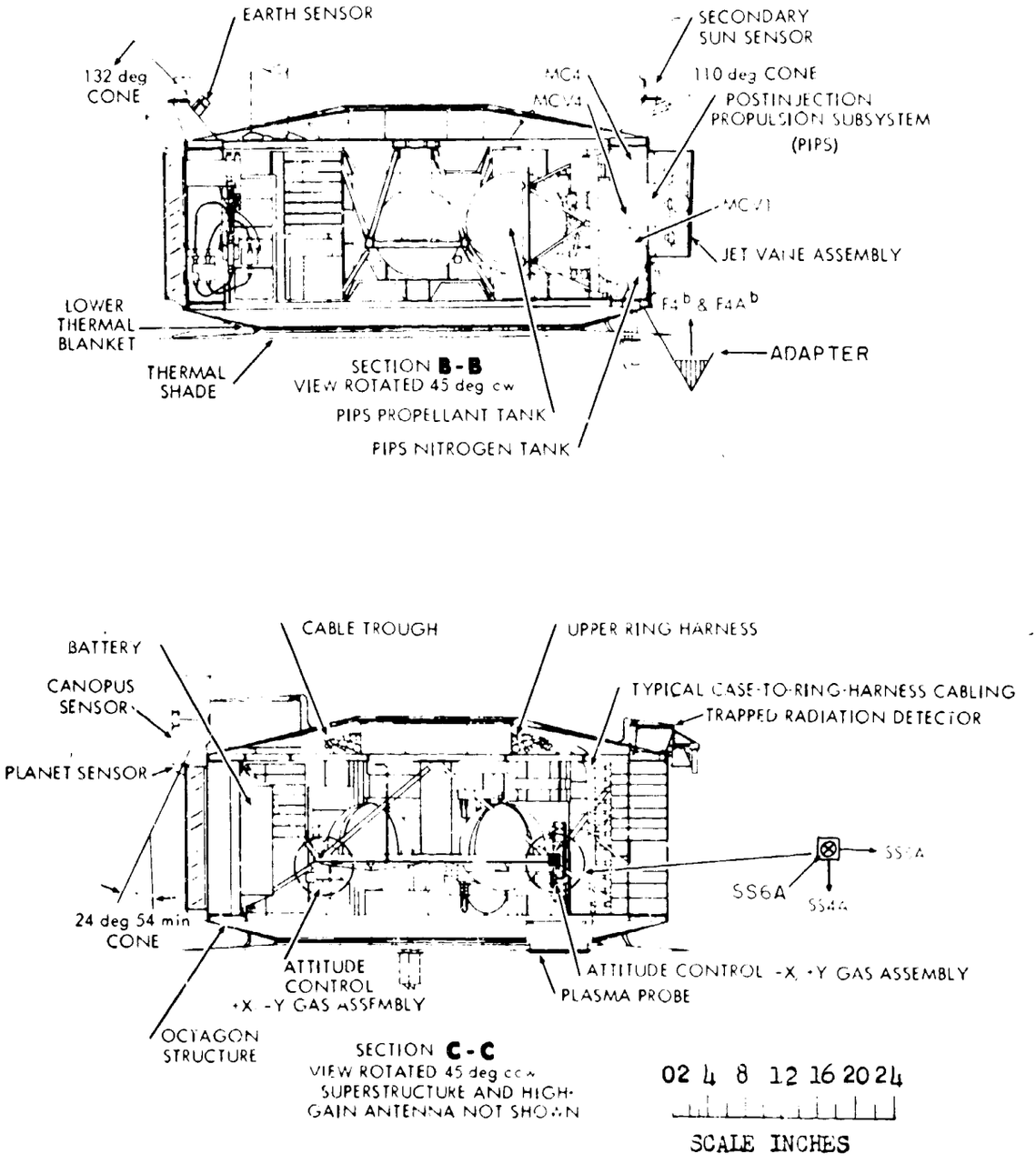



FIGURE IV.B.4. ACCELEROMETER LOCATIONS FOR MARINER VENUS 67 FLIGHT ACCEPTANCE TEST

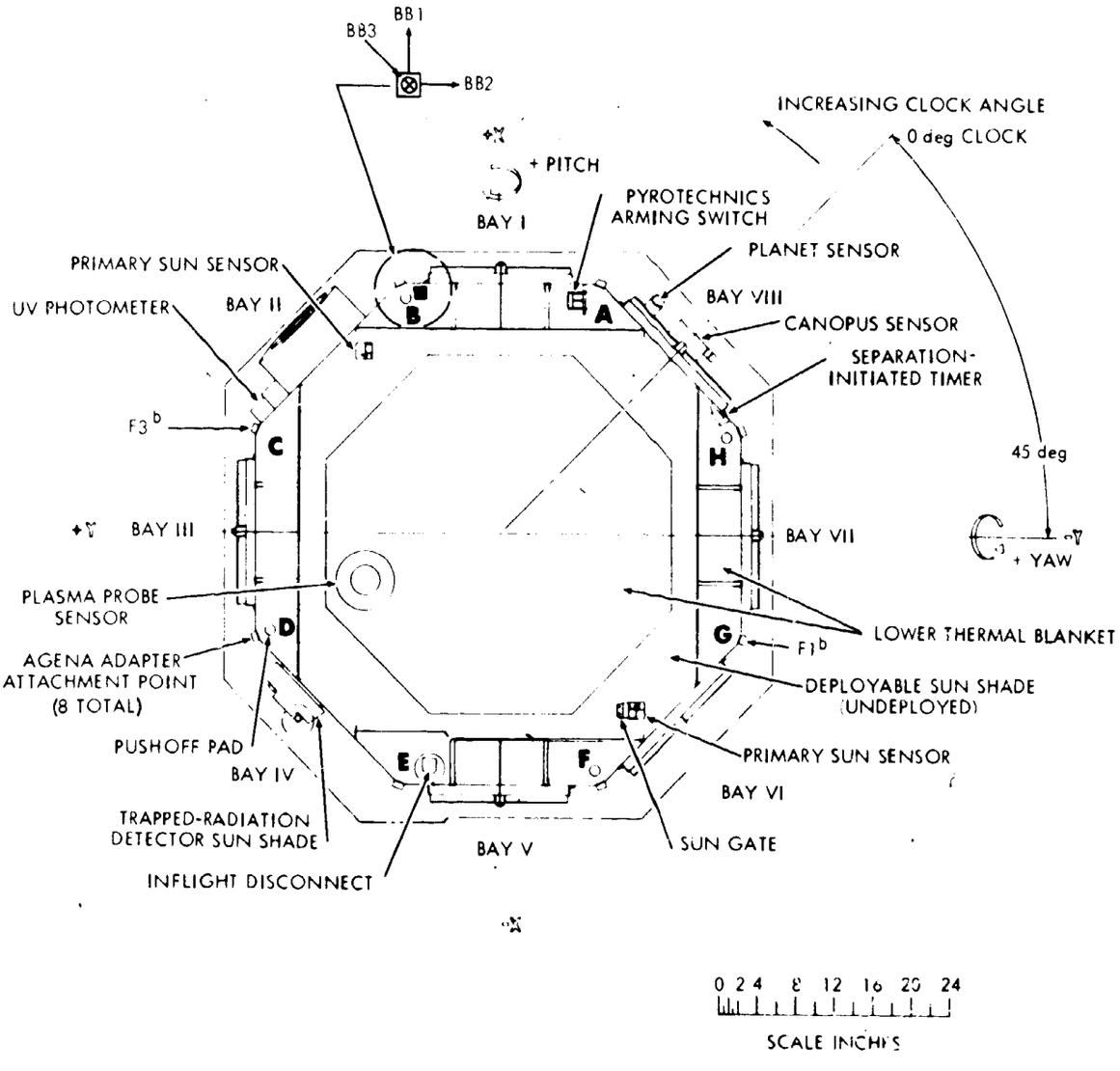



FIGURE IV.B.5. ACCELEROMETER LOCATIONS FOR MARINER VENUS 67 FLIGHT ACCEPTANCE TEST

## SECTION IV.B.1

## M67-1 SHROUD V-BAND RELEASE

One test of the shroud V-band release was conducted for the M67-1 configuration. The V-band pyrotechnic release mechanism employed is illustrated in Figure IV.B.1-1. Nineteen shock spectra for this event are presented along with their corresponding time histories in Figures IV.B.1-2 through IV.B.1-11 as indexed in Table IV.B.1-1.

TABLE IV.B.1-1

INDEX OF DATA LOCATIONS

| Accelerometer No.s | Figure No. |
|---|---|
| B3, F4 | IV.B.1-2 |
| F1, F3 | IV.B.1-3 |
| F4A, B1A | IV.B.1-4 |
| B2A, B3A | IV.B.1-5 |
| B4, B5 | IV.B.1-6 |
| B6, BB1 | IV.B.1-7 |
| BB2, BB3 | IV.B.1-8 |
| AS1 | IV.B.1-9 |
| IC4, 3T3 | IV.B.1-10 |
| MC4 | IV.B.1-11 |

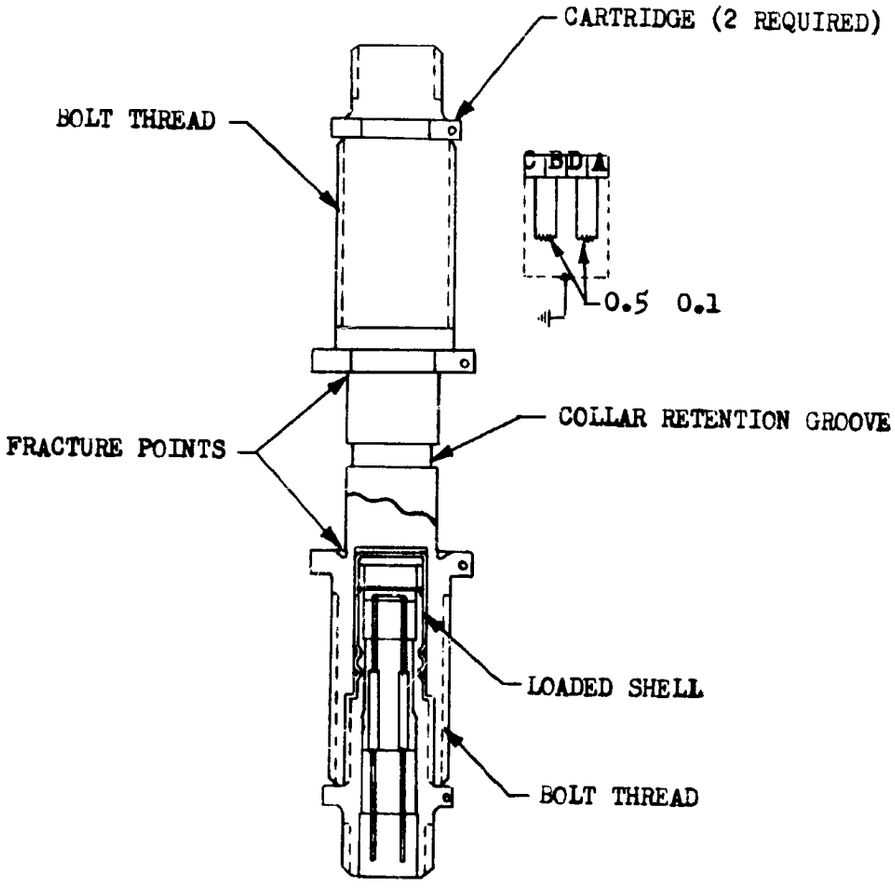
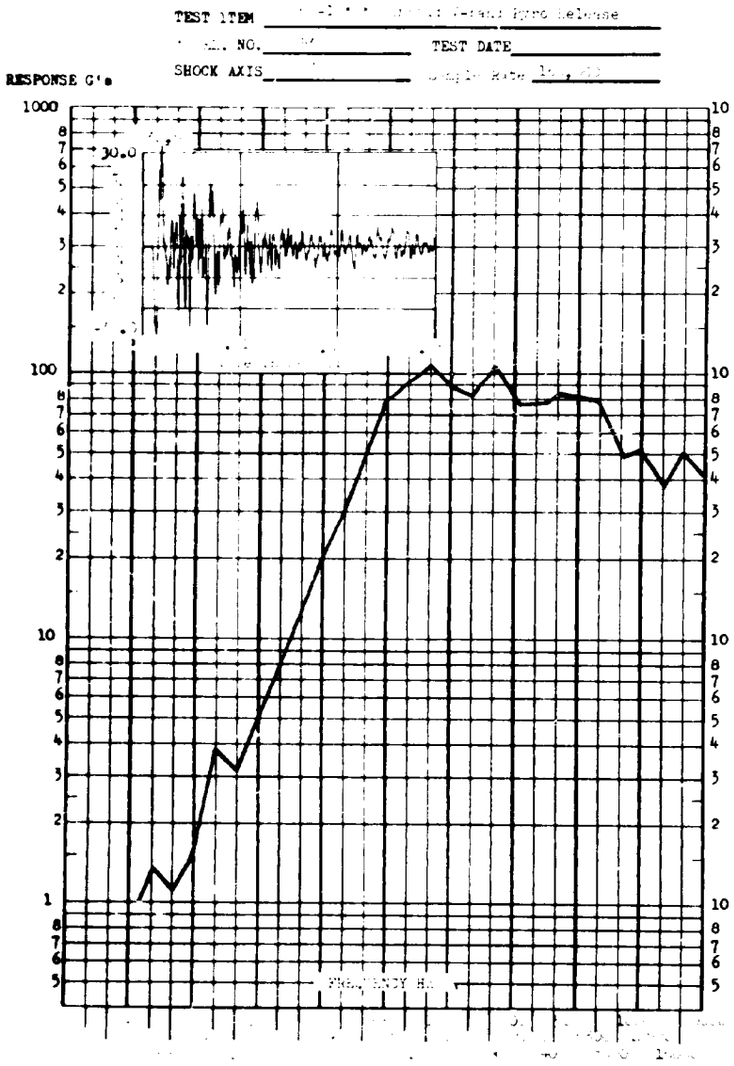



FIGURE IV.B.1-1

SHROUD V-BAND EXPLOSIVE BOLT RELEASE ASSEMBLY



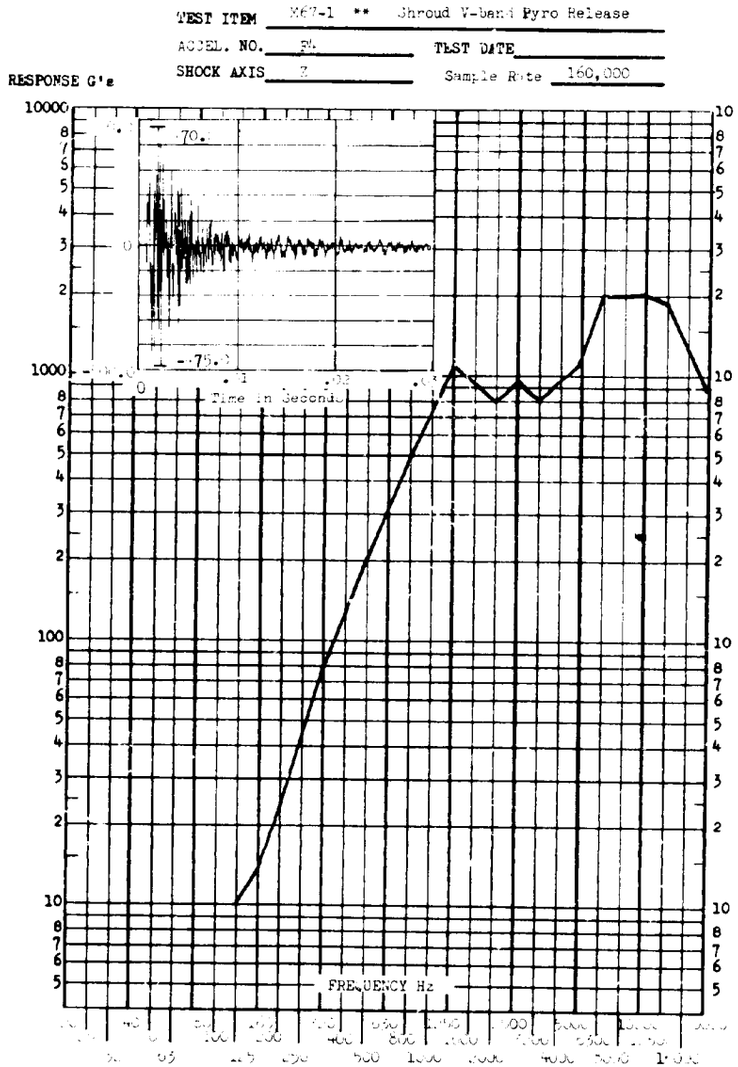




FIGURE IV.B.1-2

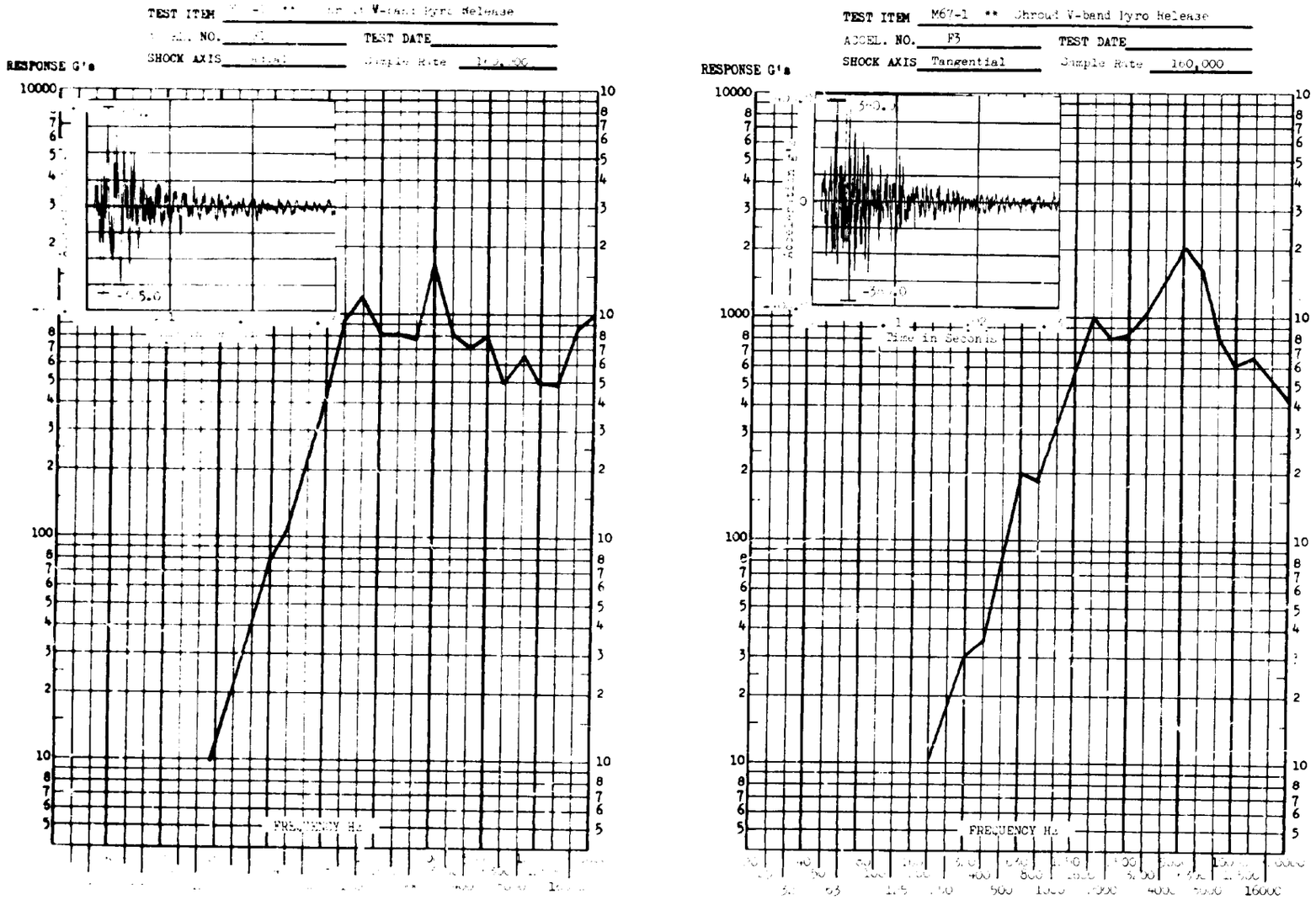
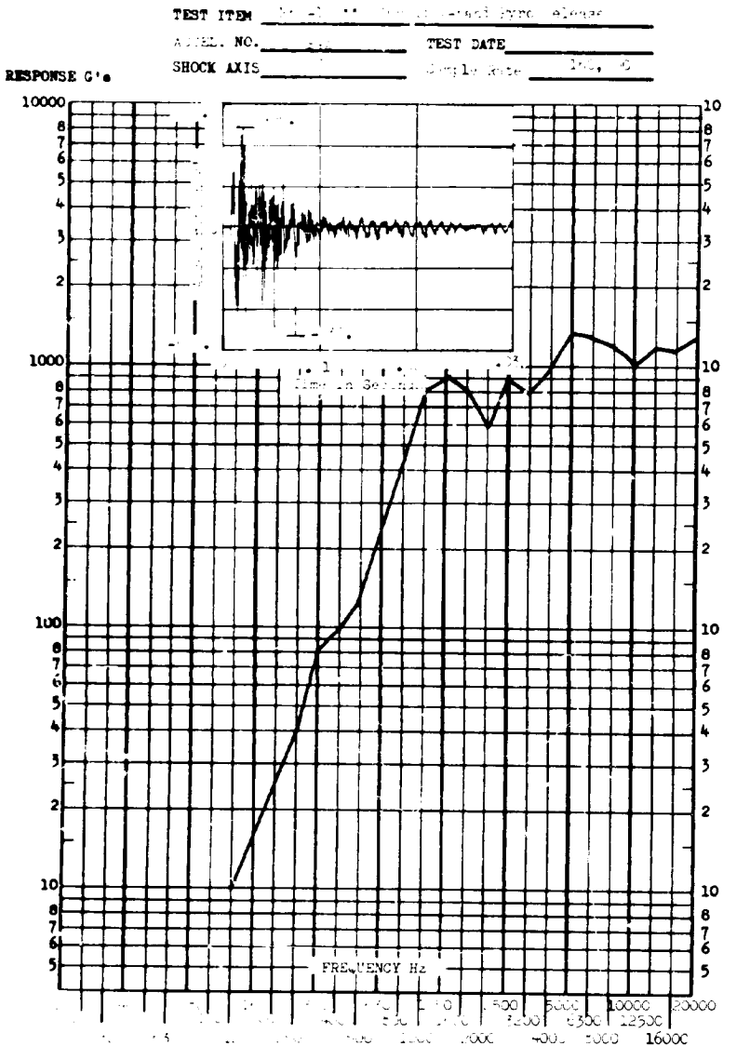



FIGURE IV.B.1-3



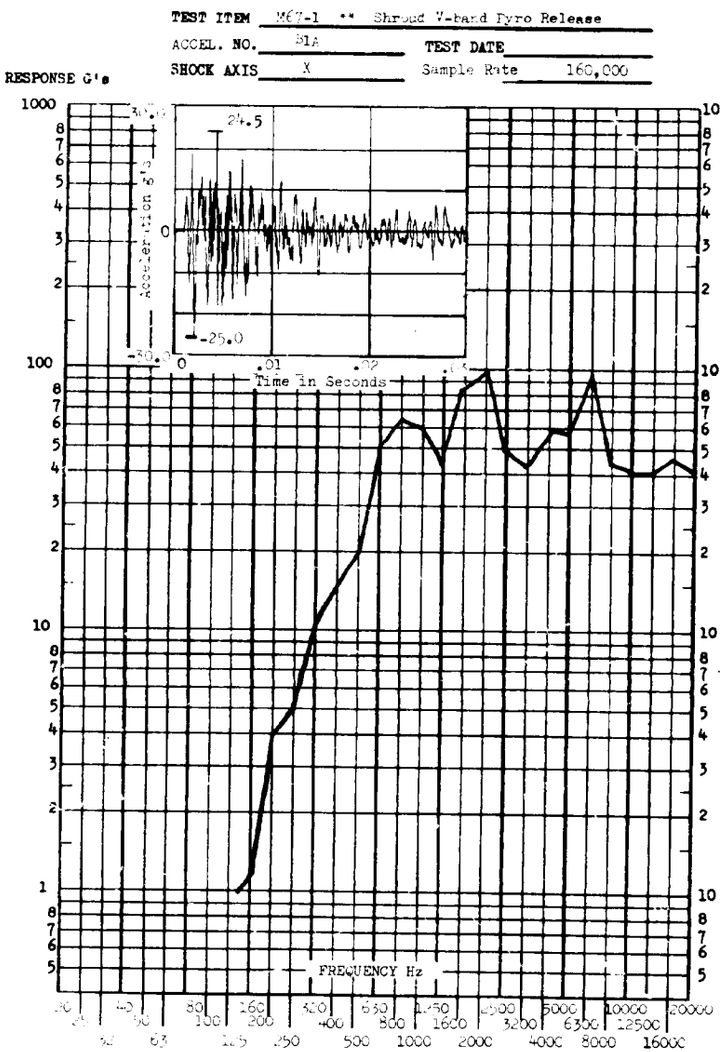
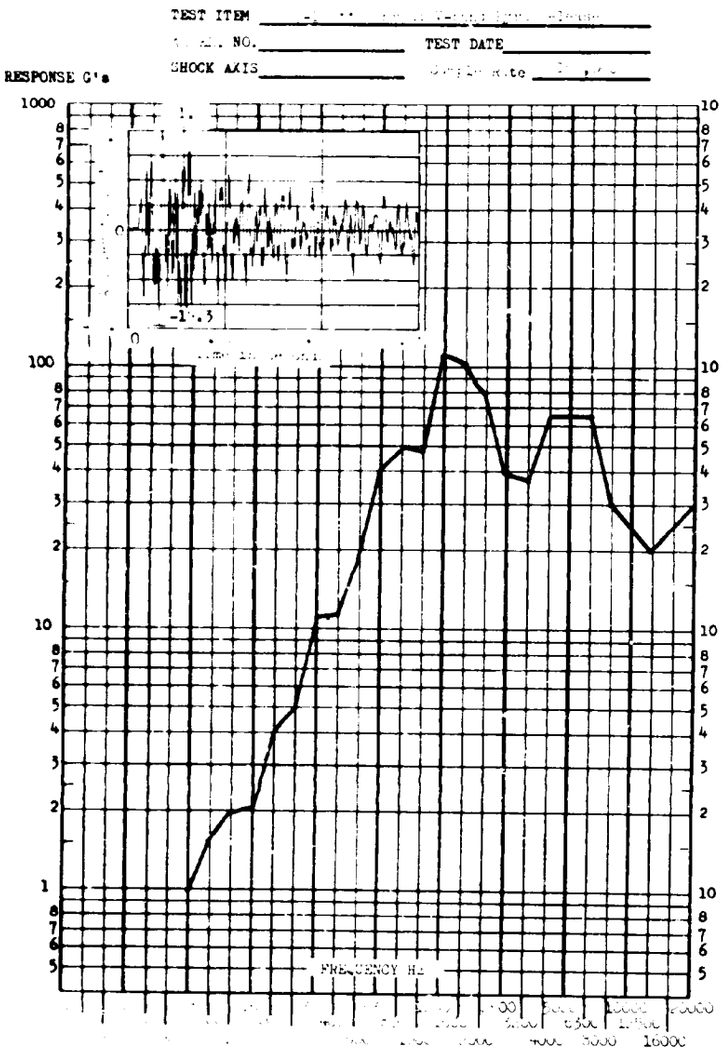




FIGURE IV.B.1-4



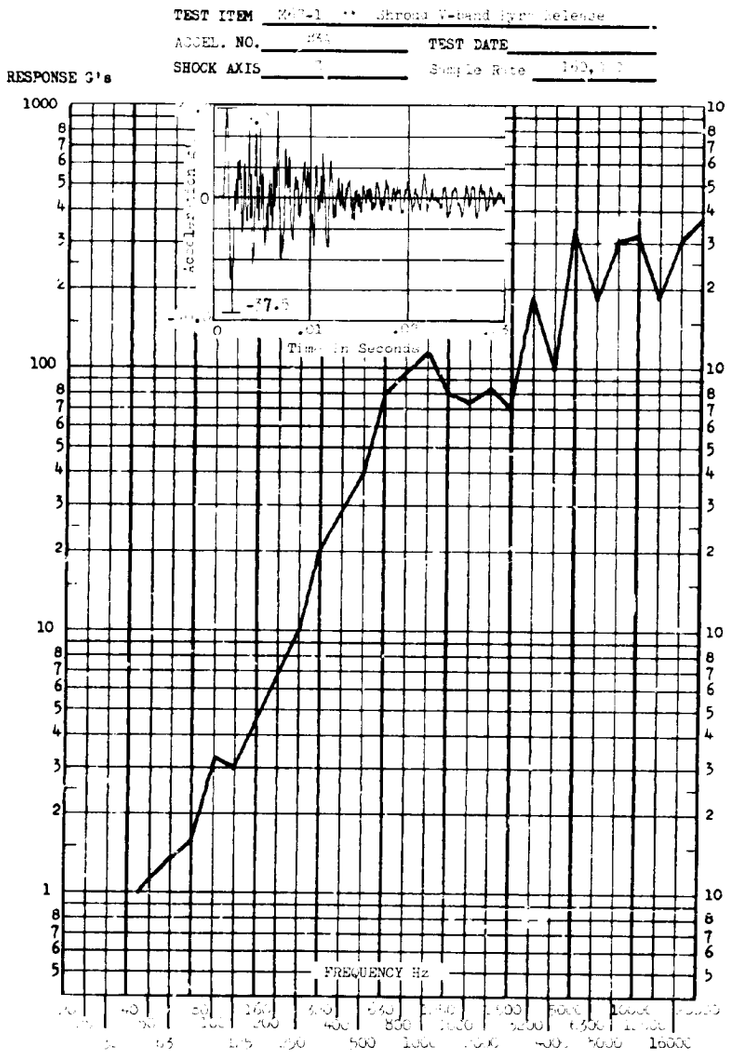




FIGURE IV.B.1-5

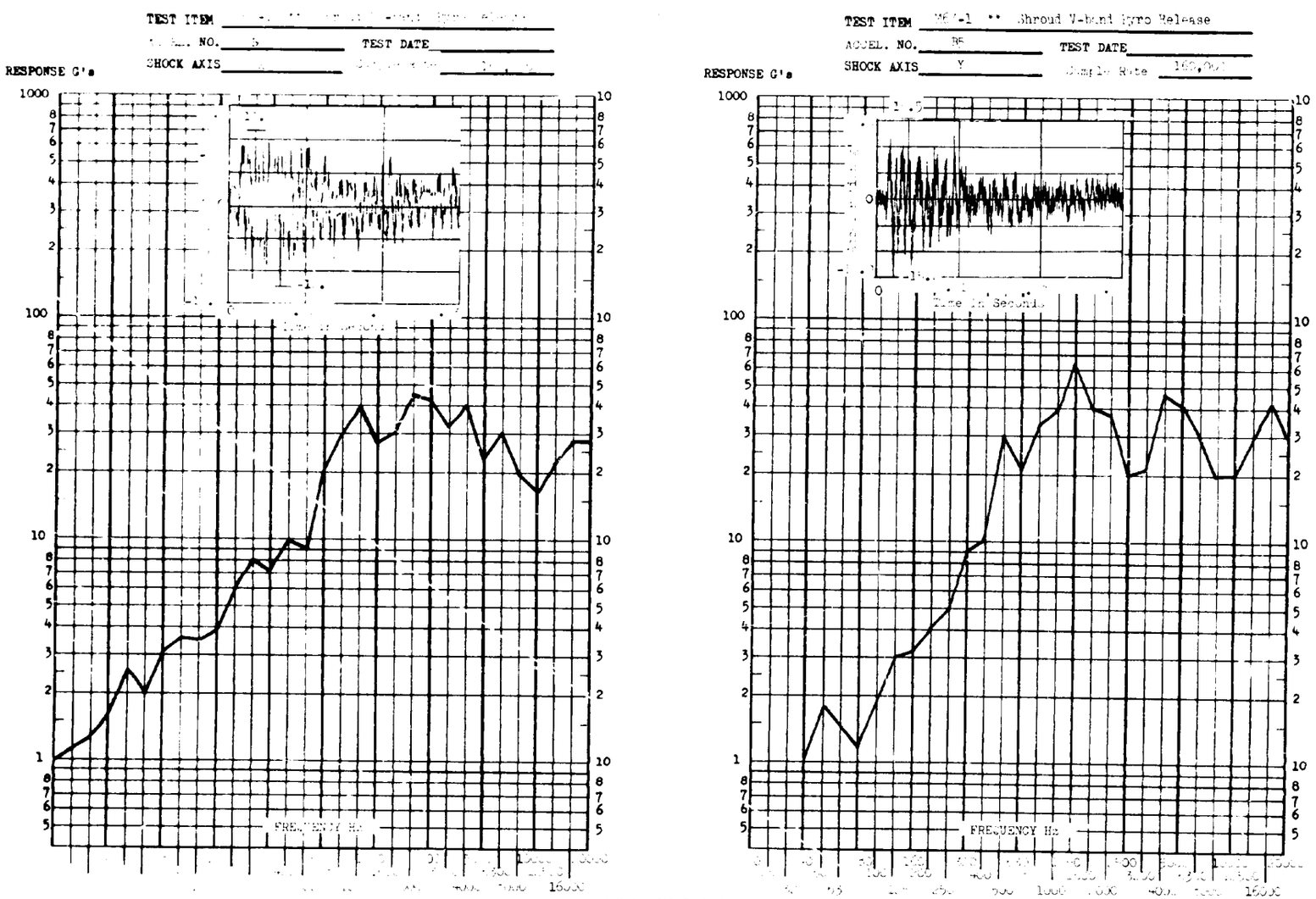
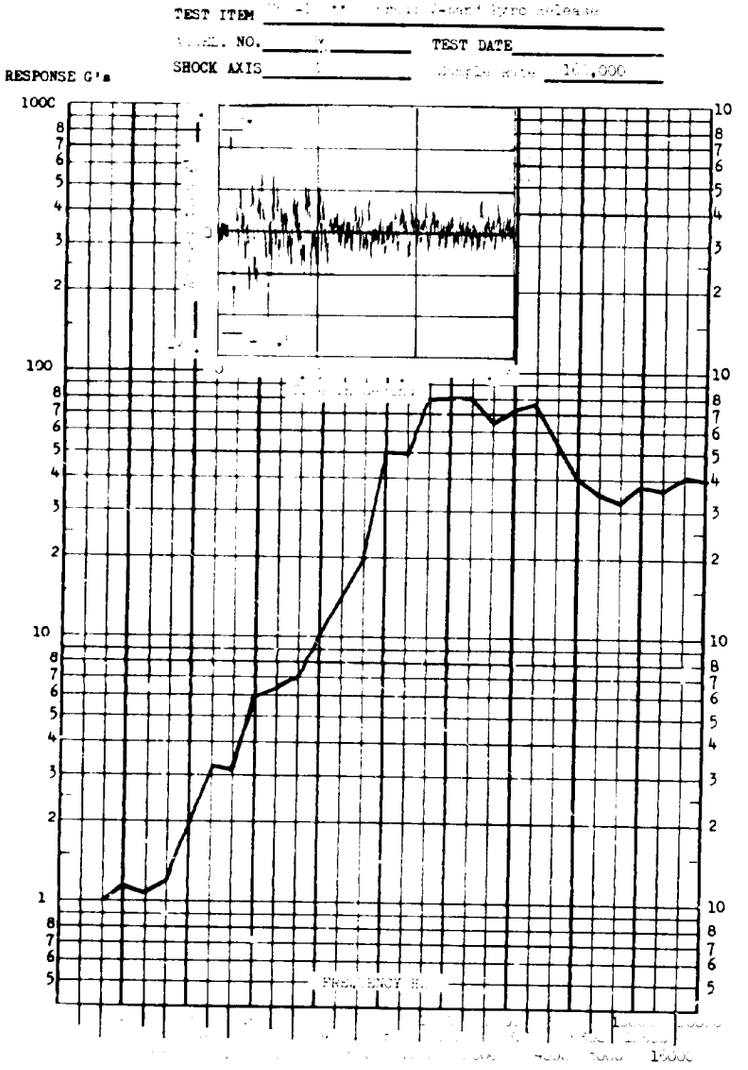



FIGURE IV.B.1-6



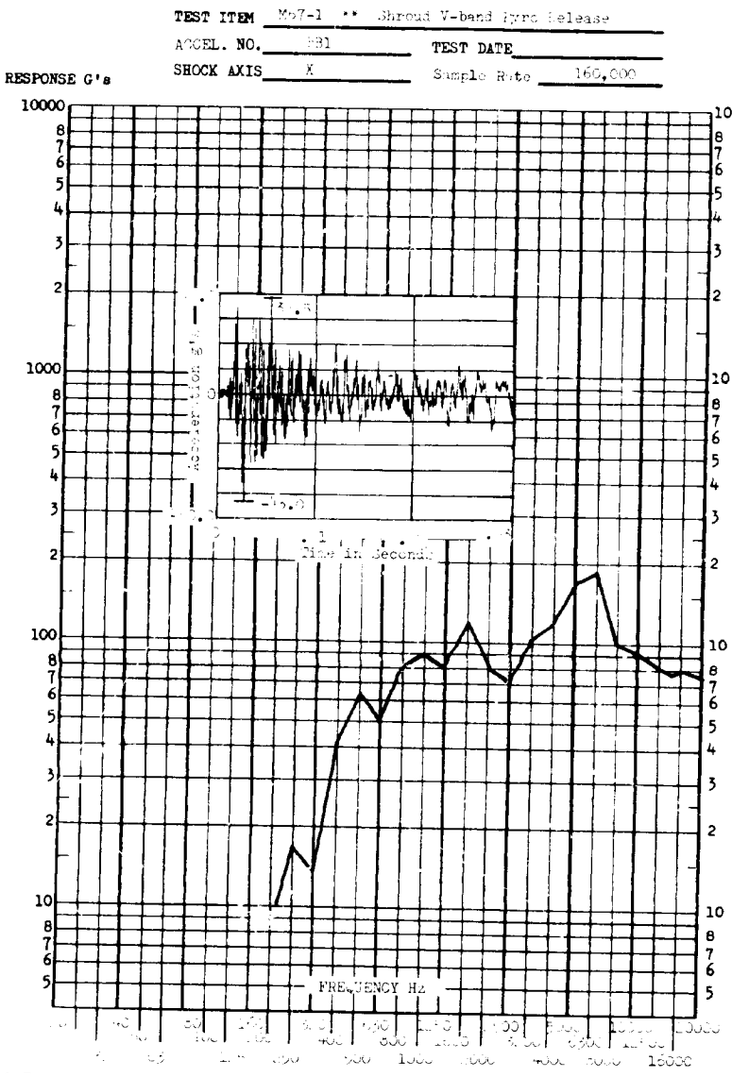




FIGURE IV.B.1-7

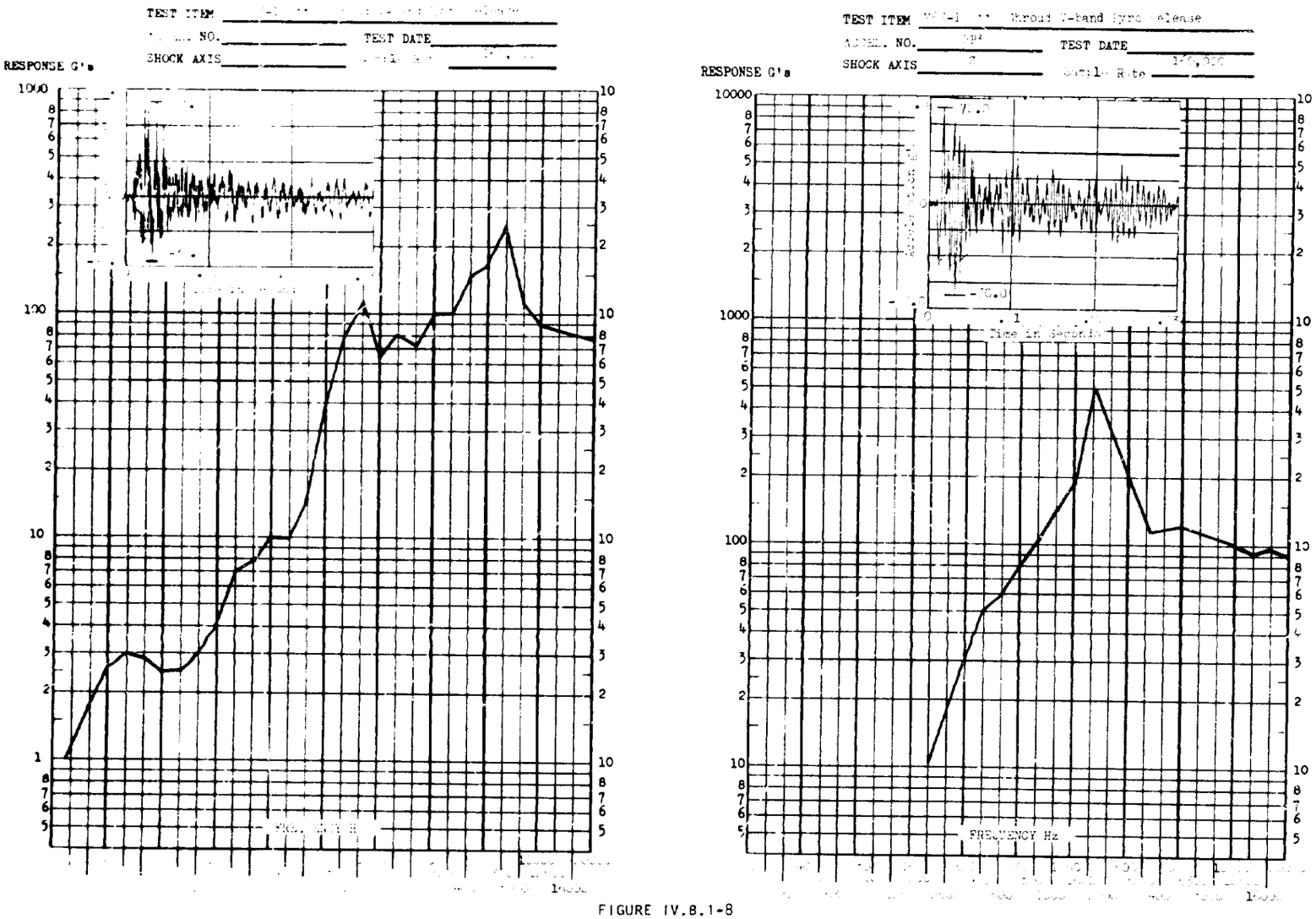






FIGURE IV.8.1-8

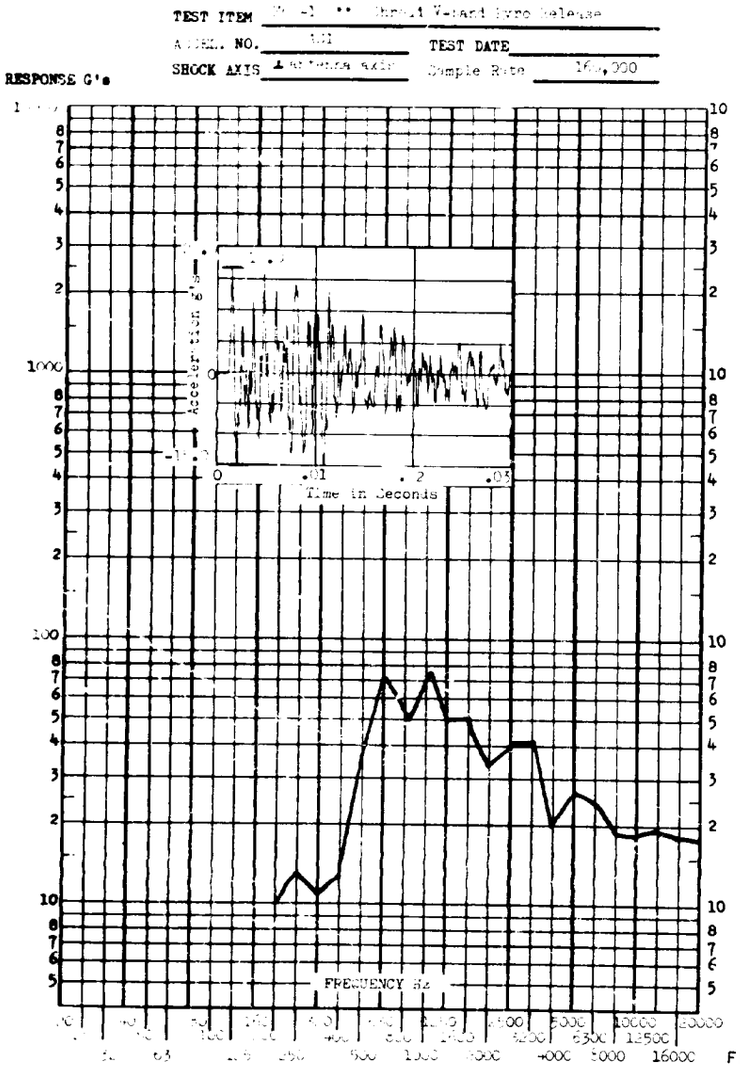



FIGURE IV.B.1-9

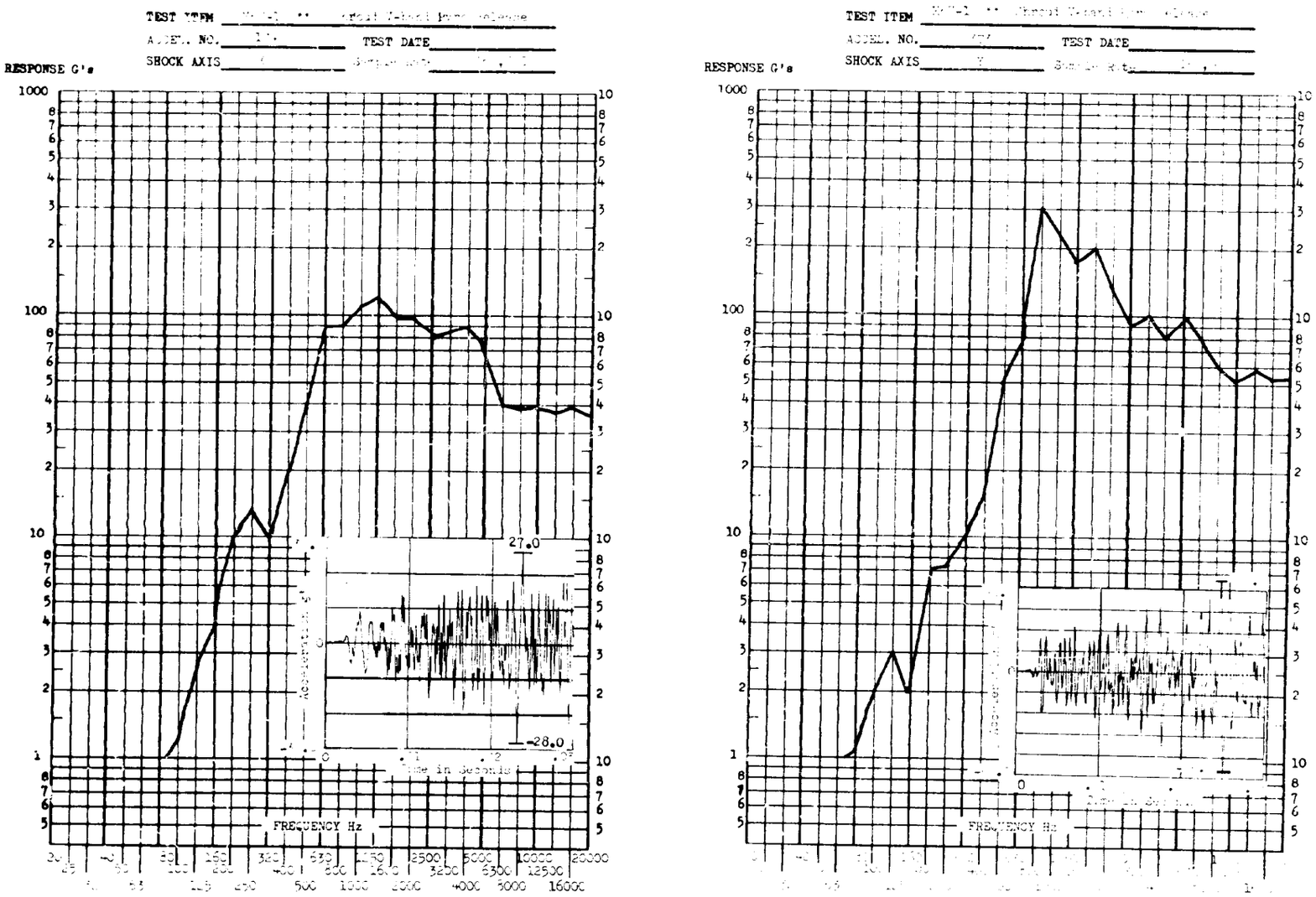



FIGURE IV.6.1-10

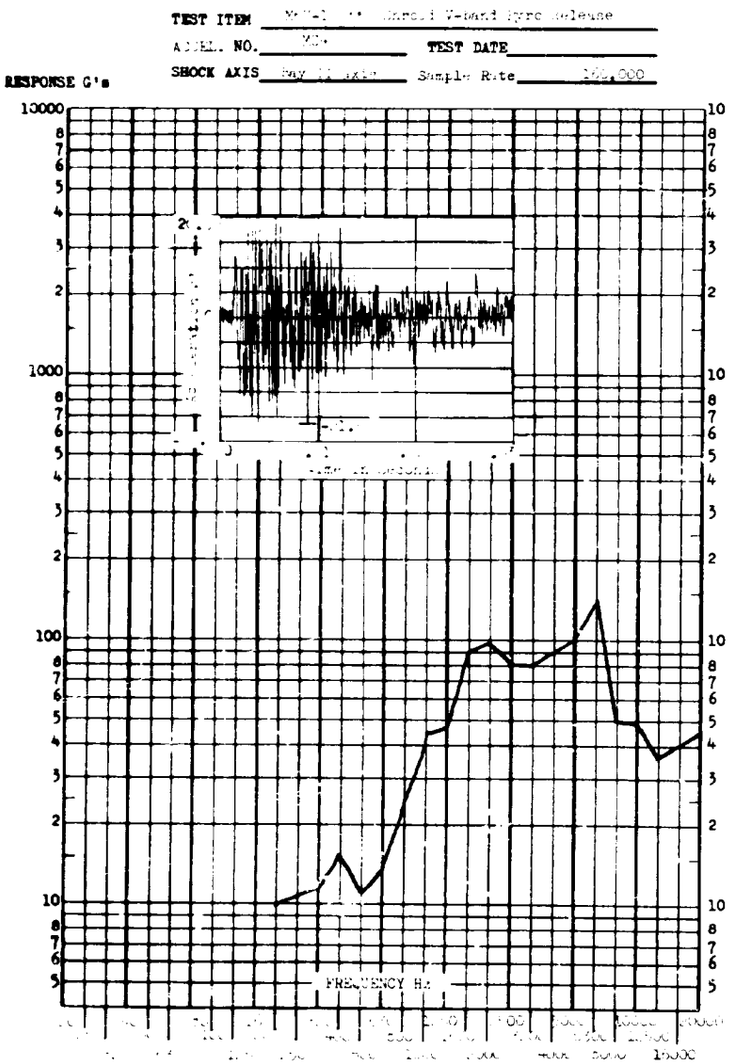



FIGURE IV.B.1-11

## SECTION IV.B.2

## M67 SPACECRAFT V-BAND RELEASE

One test of the spacecraft V-band release was conducted for both the M67-1 and M67-2 configurations. The V-band pyrotechnic release mechanism employed is illustrated in Figure IV.B.2-1. Twenty-five shock spectra for this event are presented along with their corresponding time histories in Figures IV.B.2-2 through IV.B.2-14 as indexed in Table IV.B.2-1.

TABLE IV.B.2-1

INDEX OF DATA LOCATIONS

| Accelerometer No.s | Configuration | Figure Number |
|---|---|---|
| B3 | M67-1, -2 | IV.B.2-2 |
| F4 | M67-1, -2 | IV.B.2-3 |
| F1 | M67-1, -2 | IV.B.2-4 |
| F3 | M67-1, -2 | IV.B.2-5 |
| F4A | M67-1, -2 | IV.B.2-6 |
| B1A, B2A | M67-1 | IV.B.2-7 |
| B3A, B4 | M67-1 | IV.B.2-8 |
| B5, B6 | M67-1 | IV.B.2-9 |
| BB1, BB2 | M67-1 | IV.B.2-10 |
| BB3, SS5A | M67-1 | IV.B.2-11 |
| SS6A, AS1 | M67-1 | IV.B.2-12 |
| IC4, 3T3 | M67-1 | IV.B.2-13 |
| MC, SS4A | M67-1 | IV.B.2-14 |

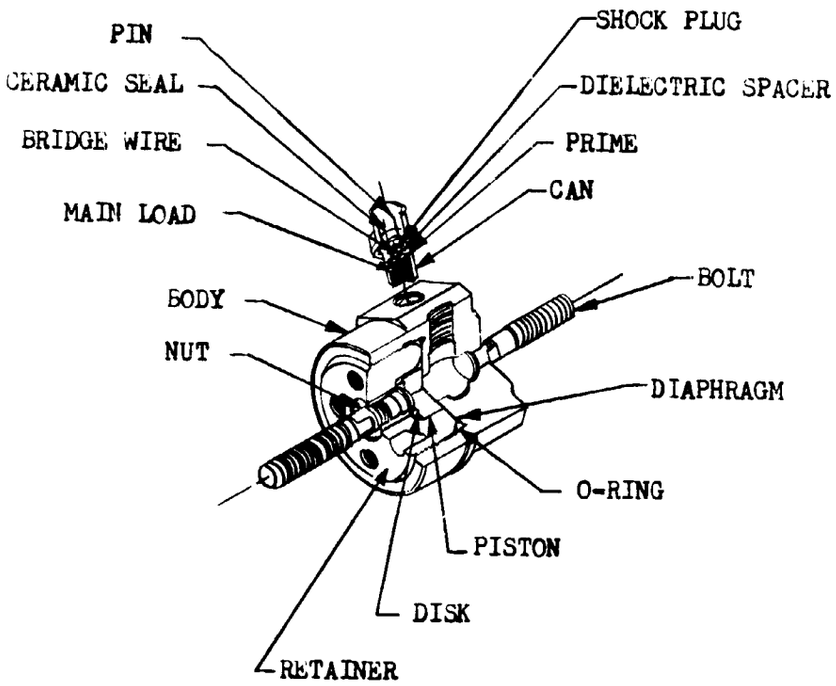



FIGURE IV.B.2-1

SPACECRAFT V-BAND RELEASE ASSEMBLY

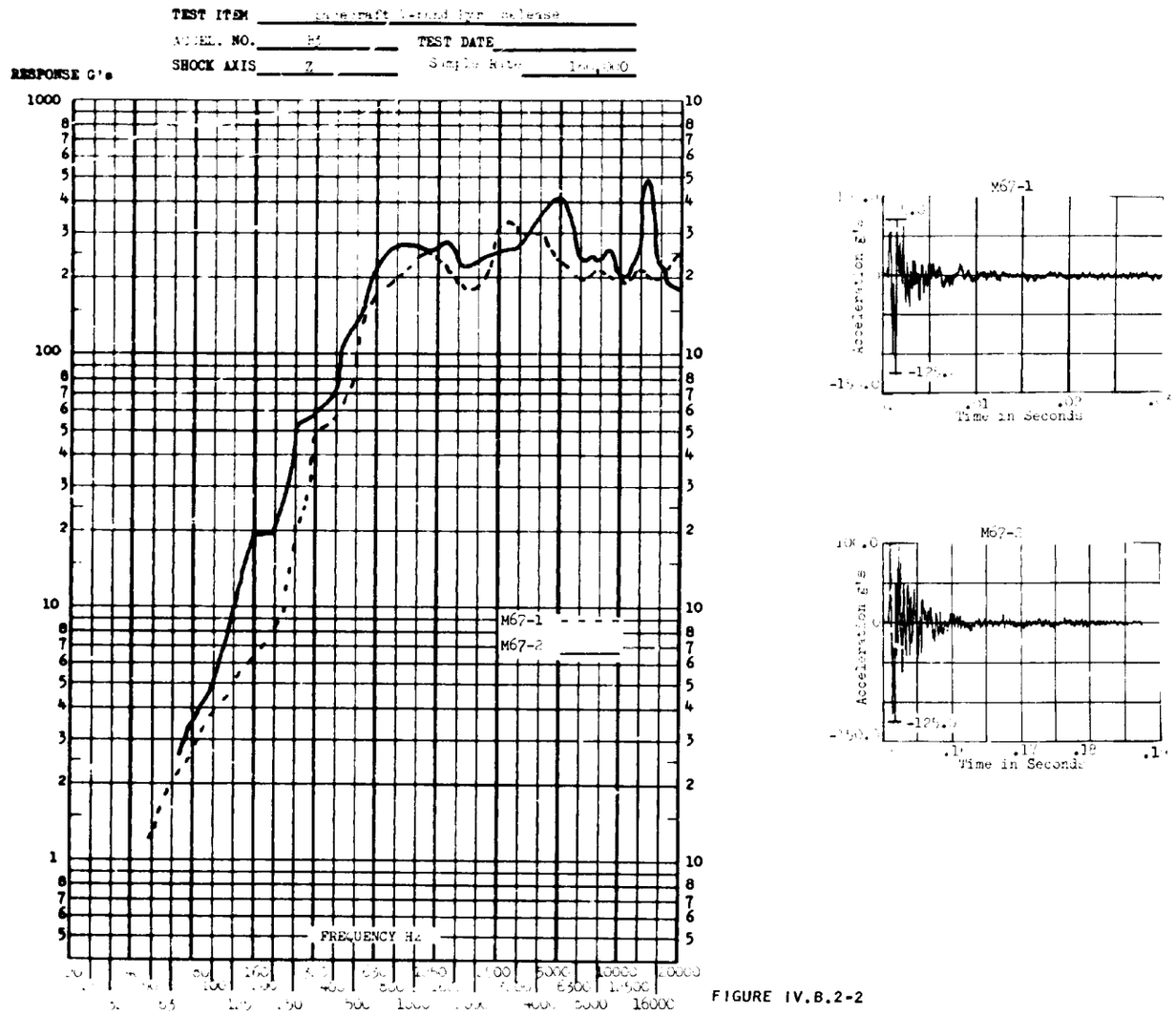
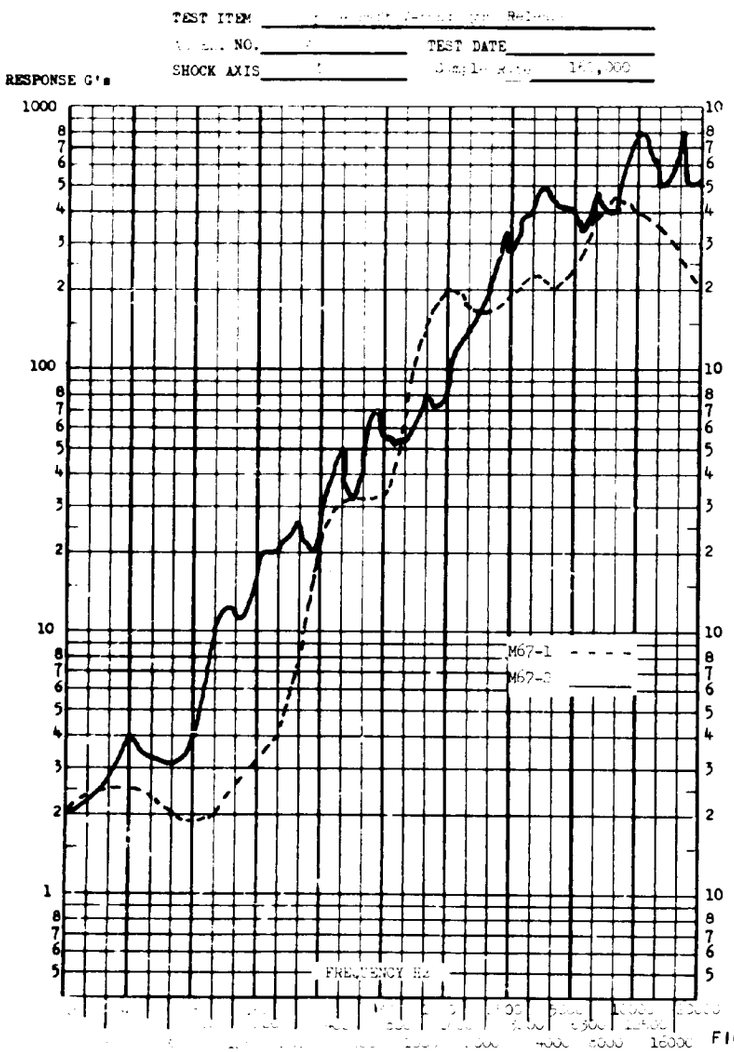


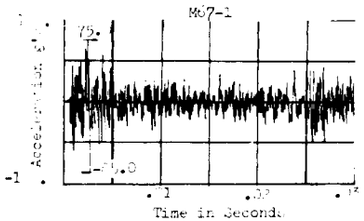







FIGURE IV.B.2-2



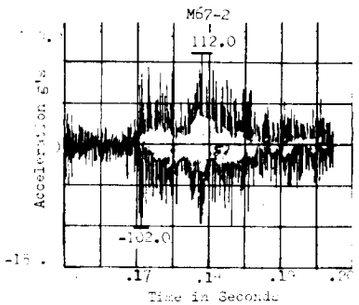
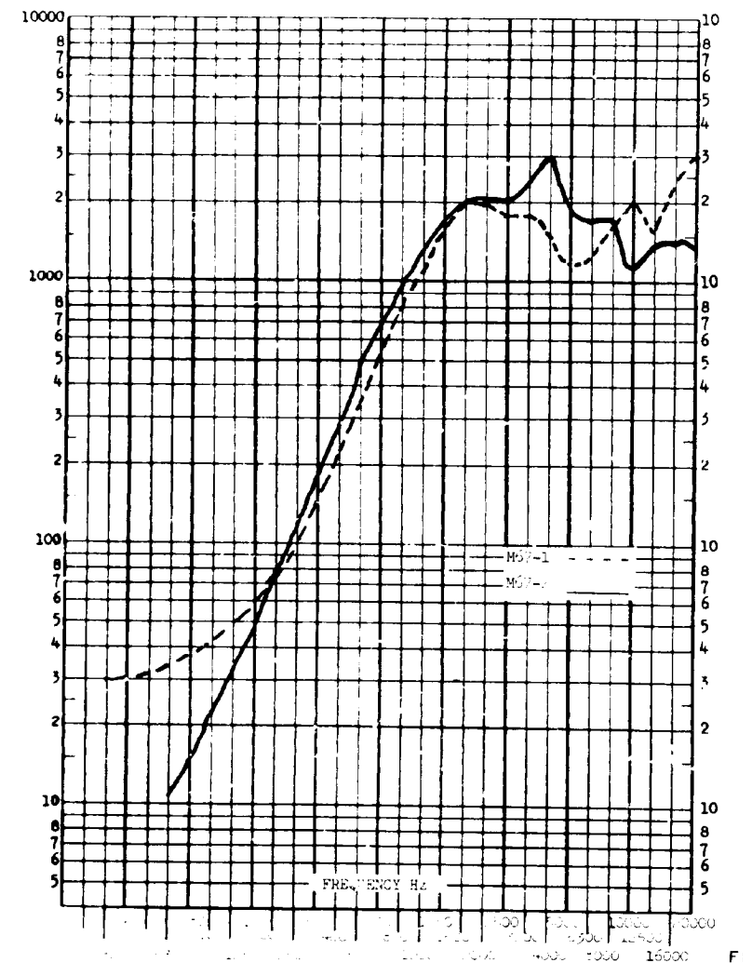



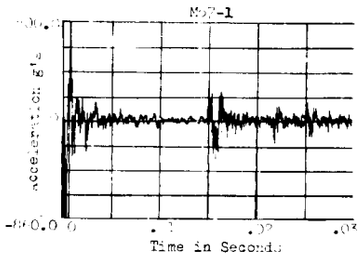

FIGURE IV.B.2-3

TEST ITEM [redacted]

[redacted] NO. [redacted] TEST DATE [redacted]

SHOCK AXIS Radial [redacted]



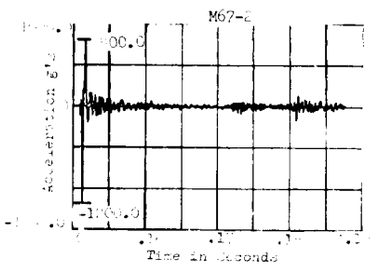
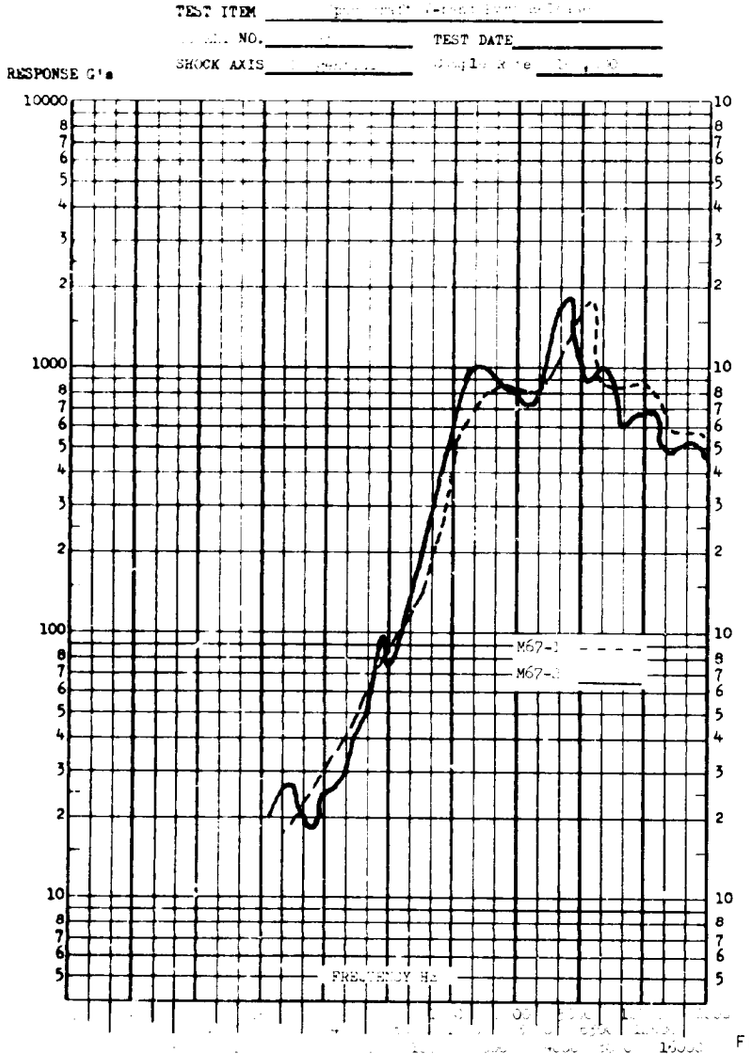
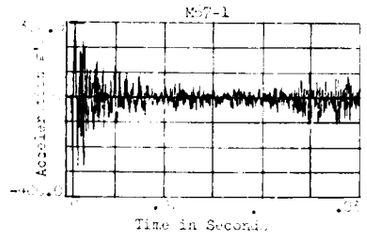




FIGURE IV.B.2-4



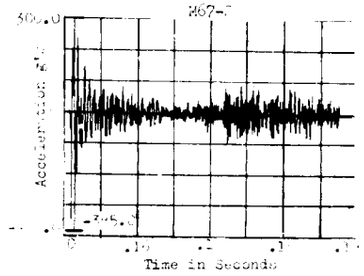
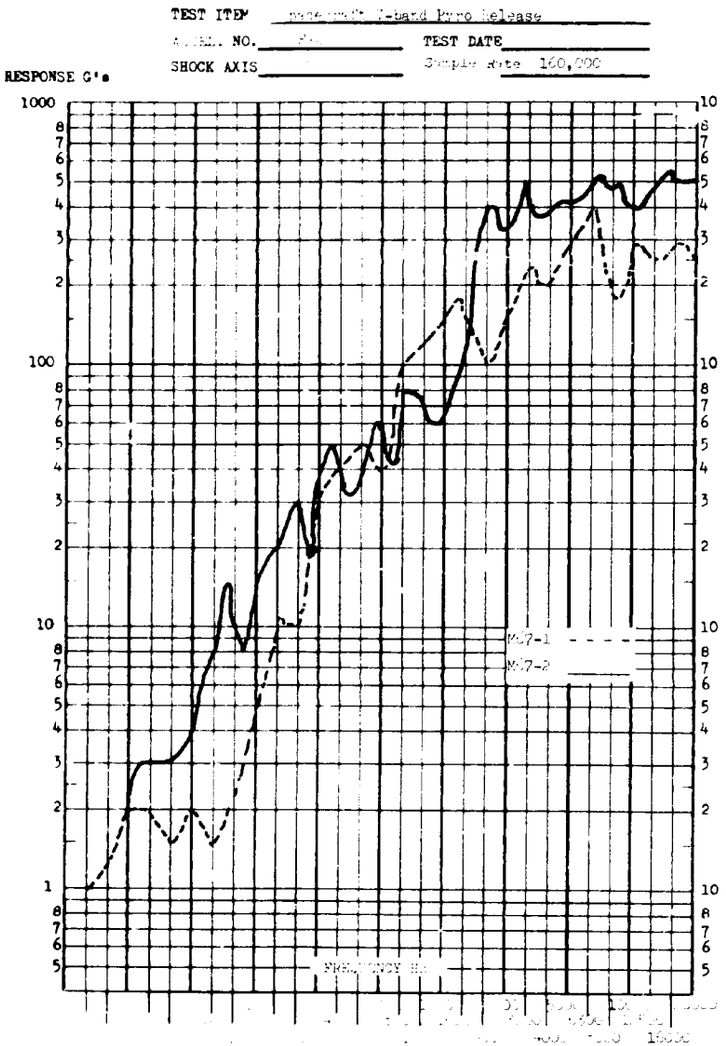
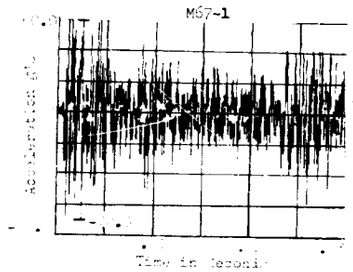




FIGURE IV.B.2-5



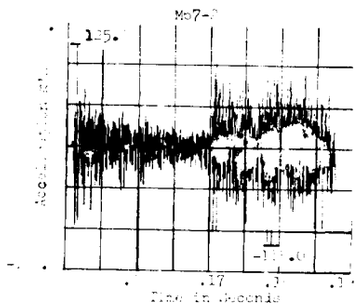
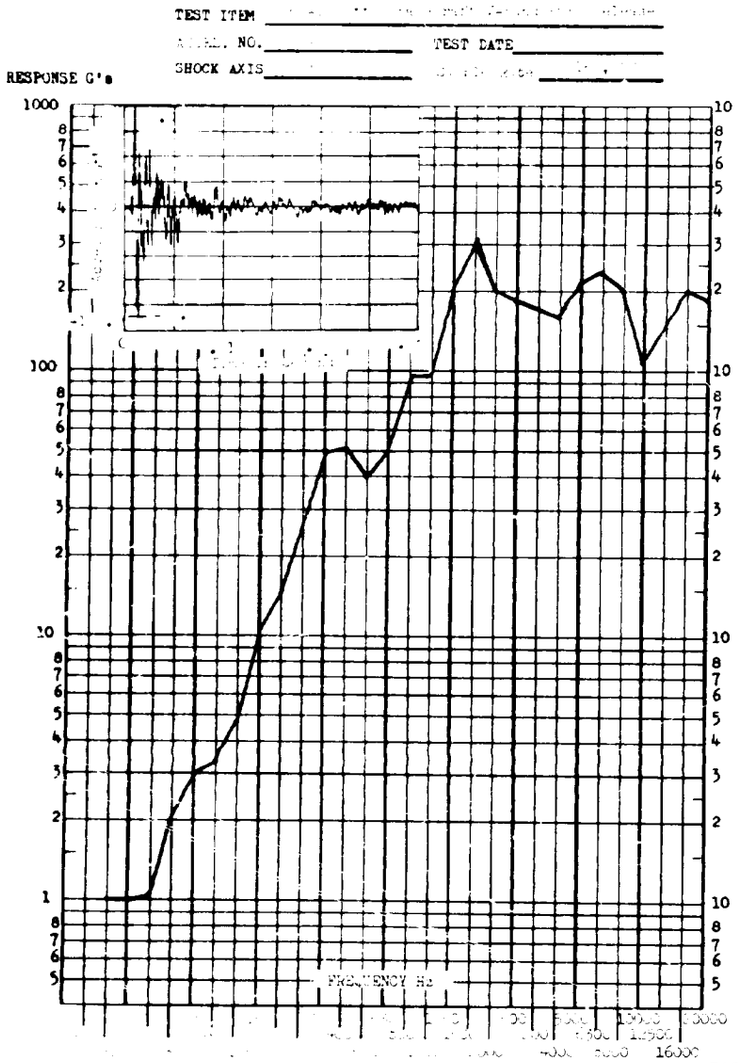




FIGURE IV.B.2-6



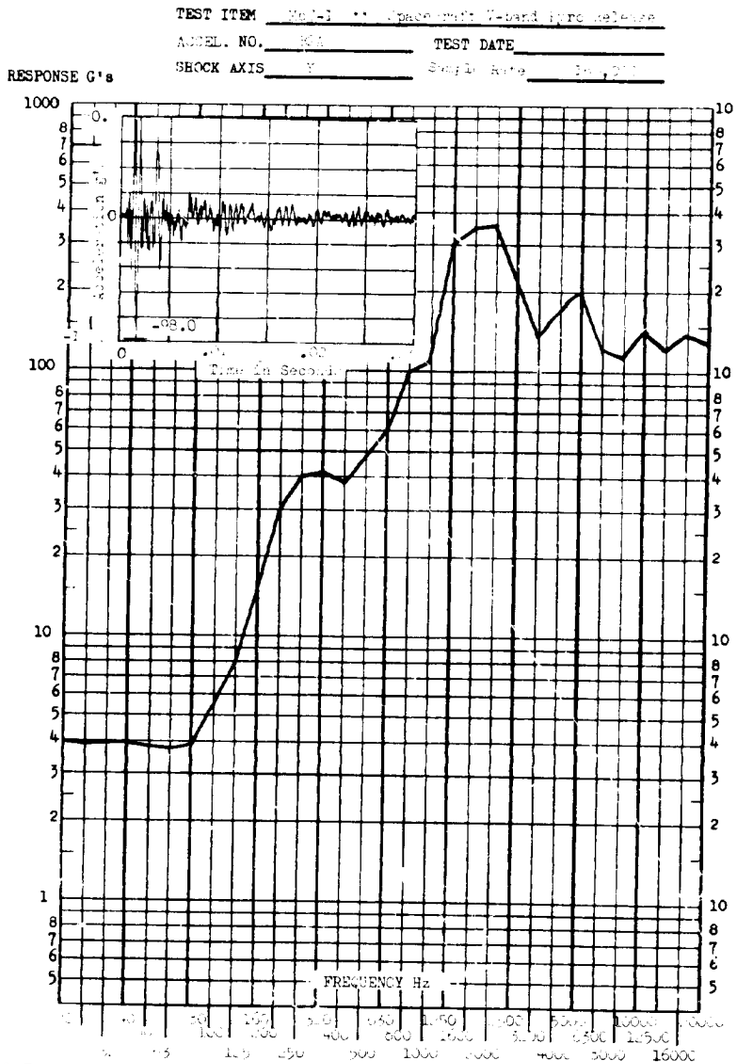
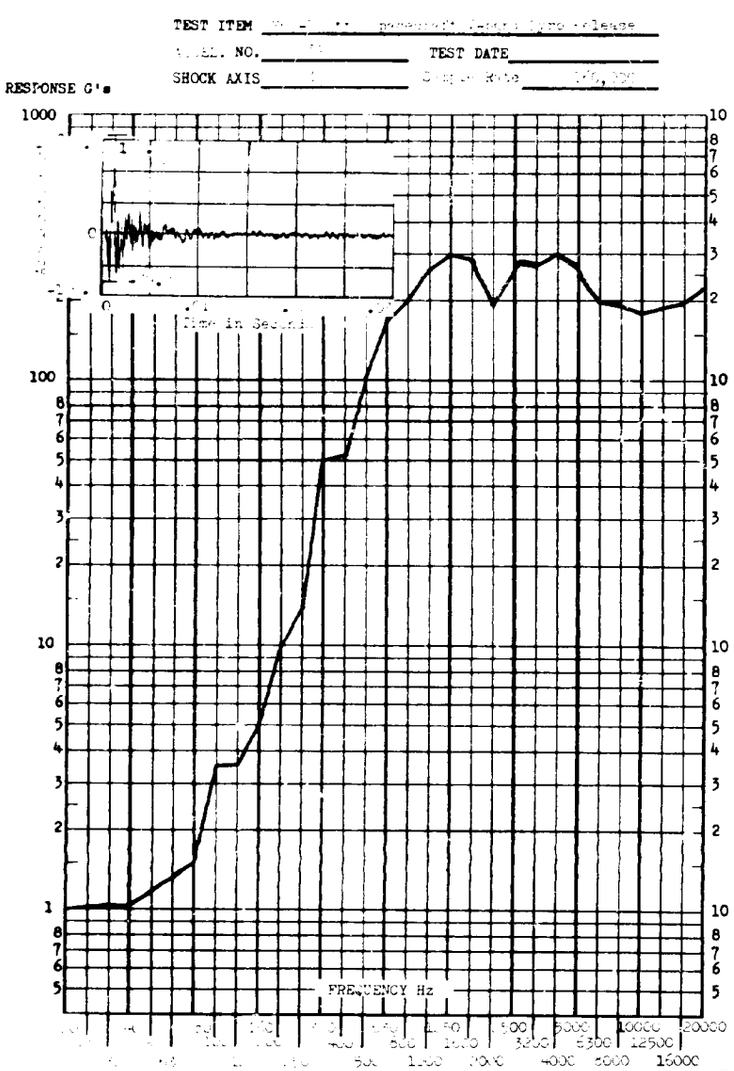




FIGURE IV.B.2-7



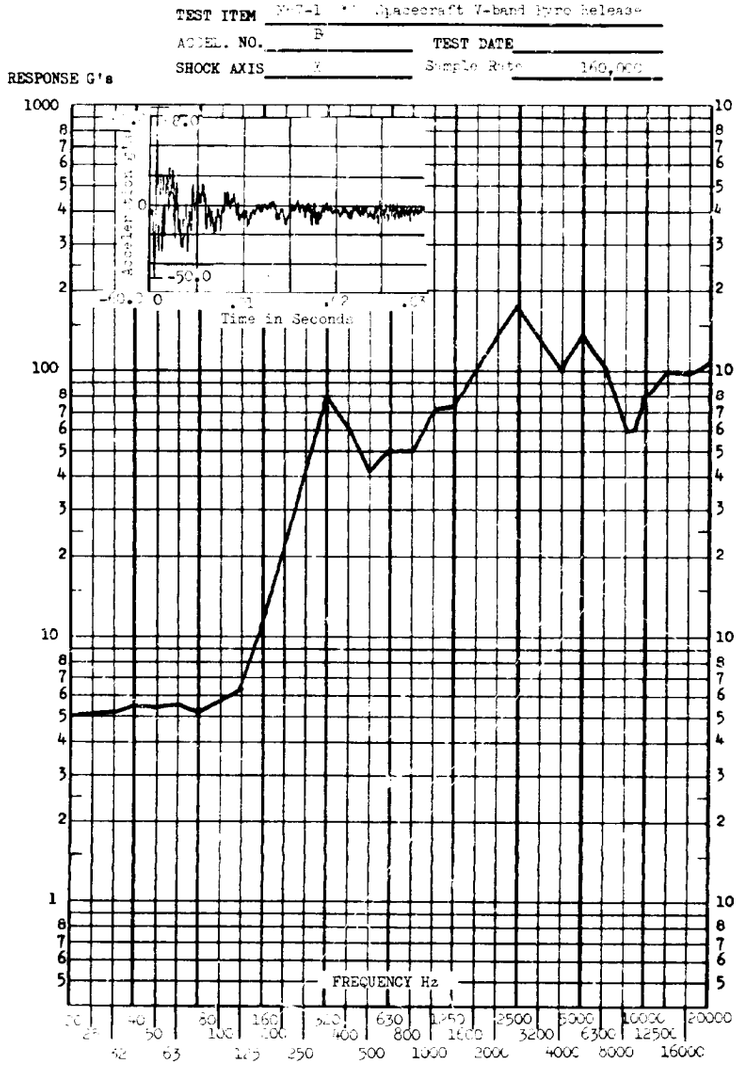




FIGURE IV.B.2-8

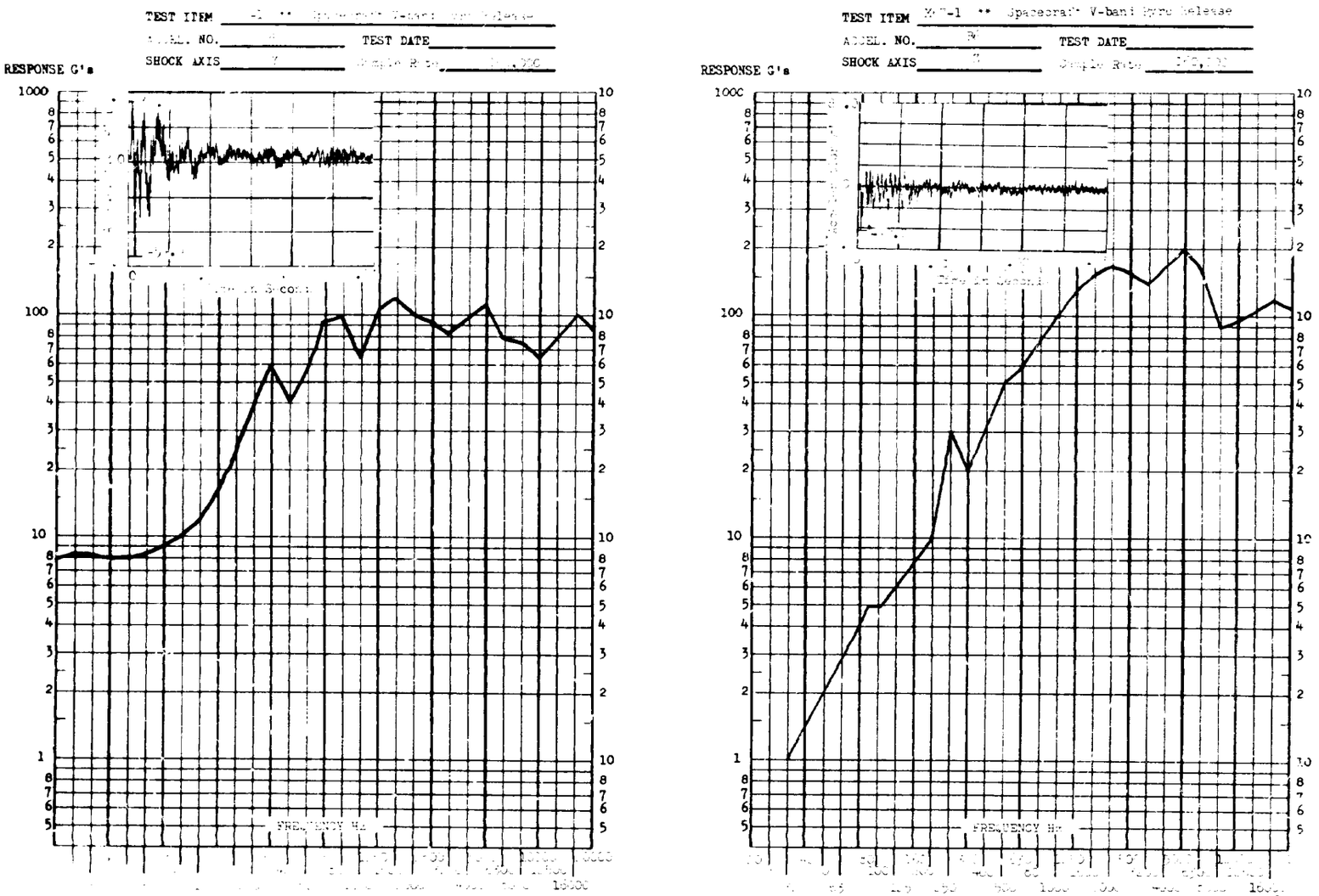
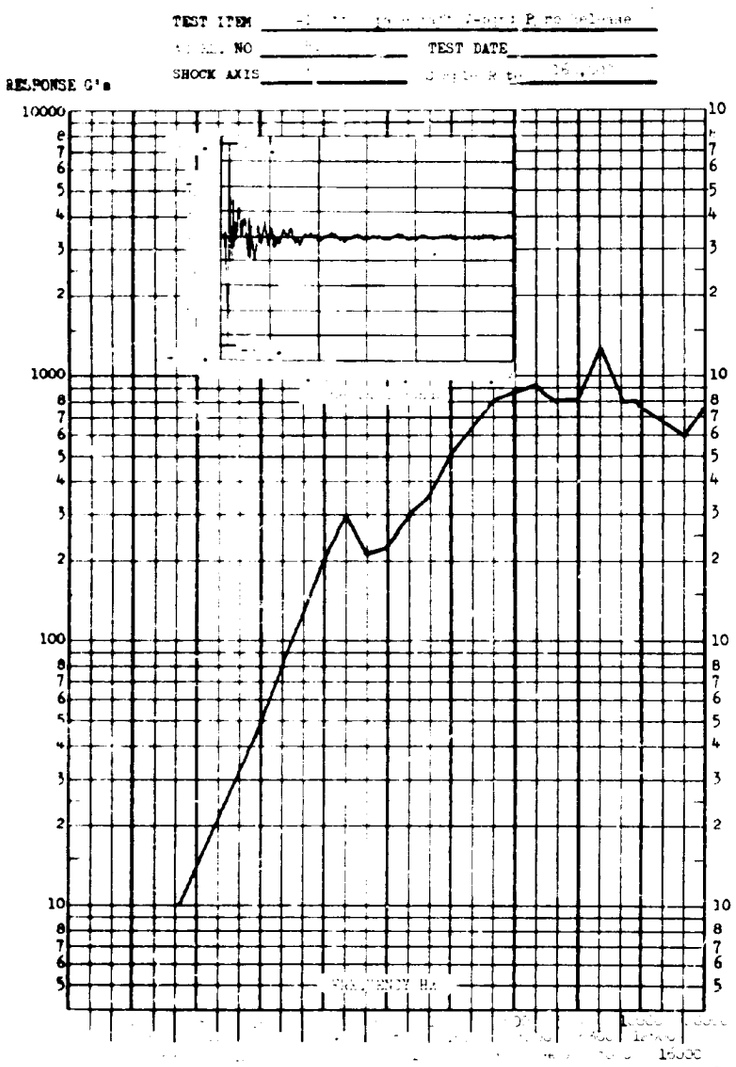



FIGURE IV.B.2-9



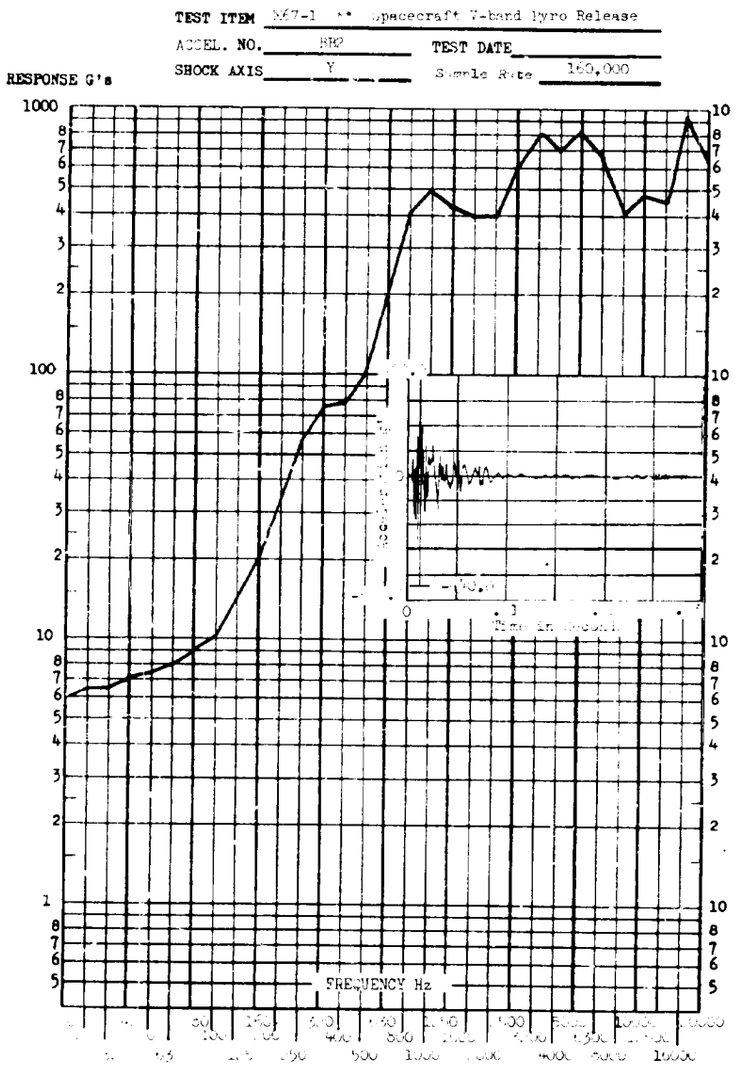
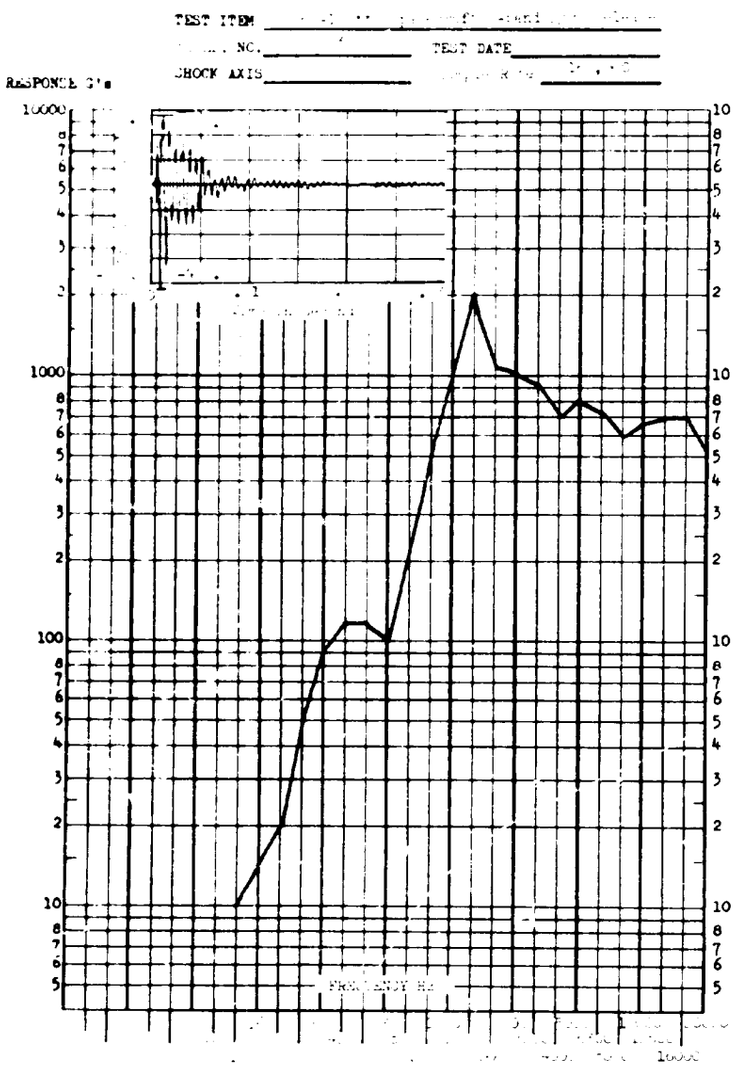




FIGURE IV.B.2-10



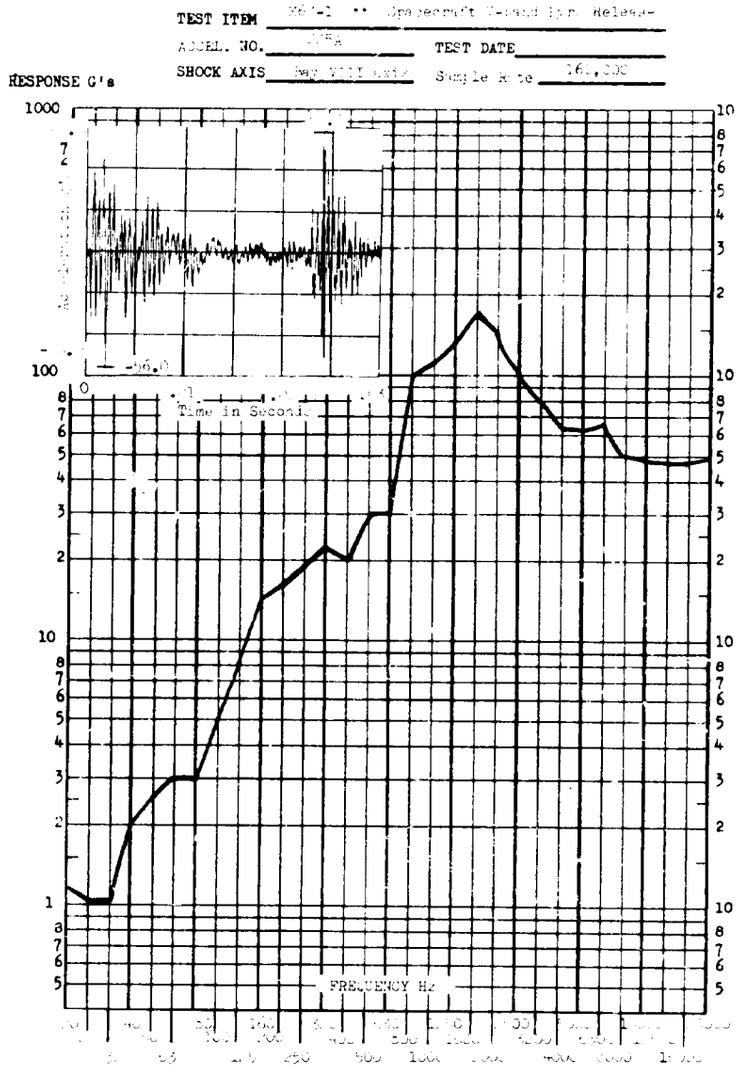




FIGURE IV.B.2-11

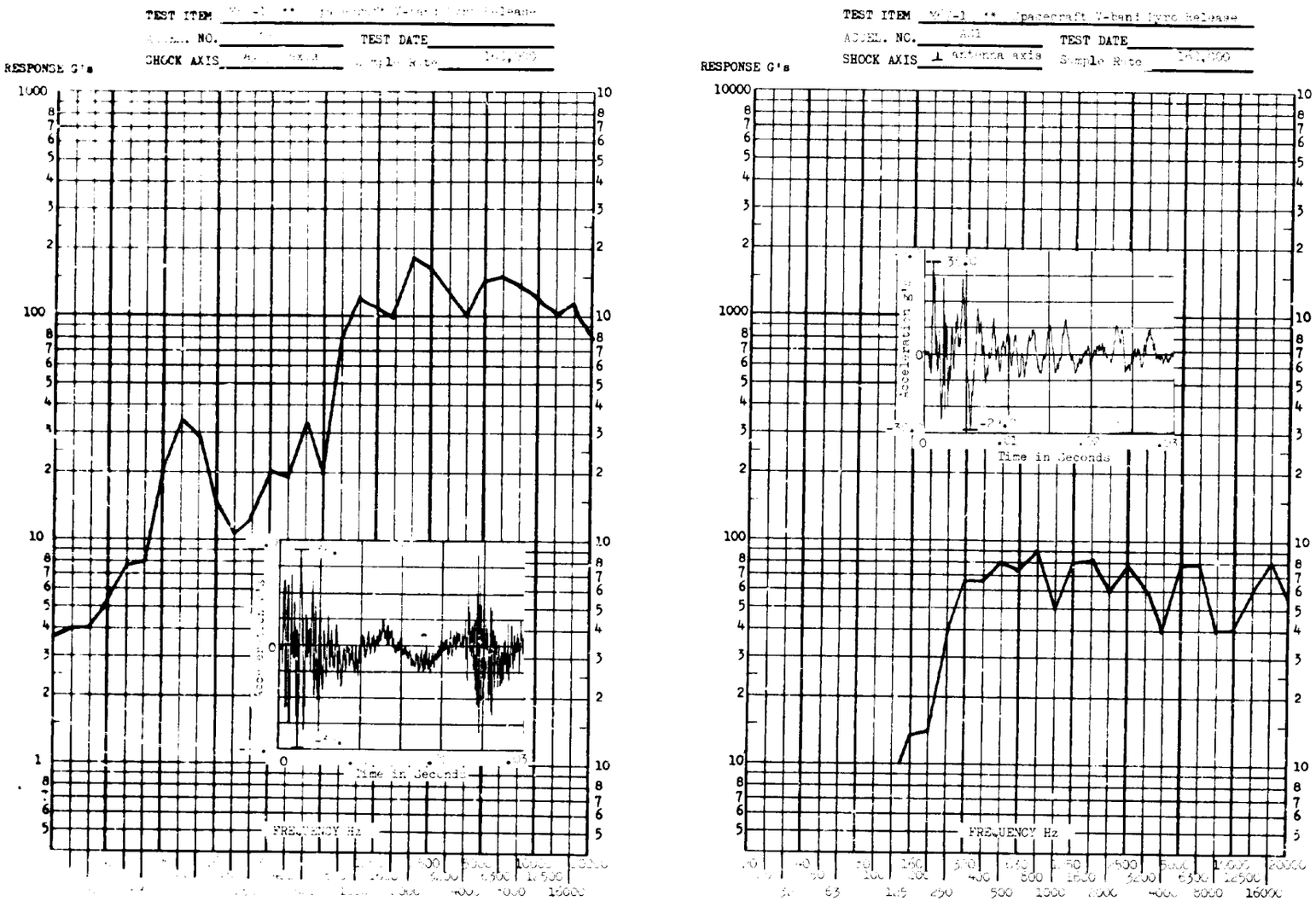


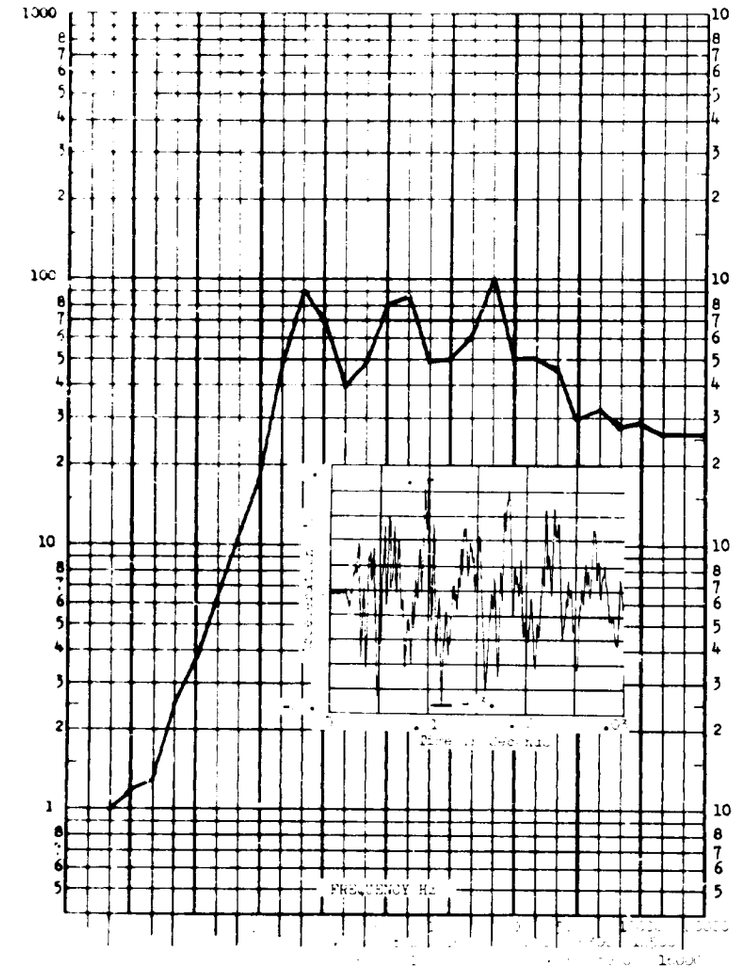

FIGURE IV.B.2-12

TEST ITEM [illegible] ** [illegible] V-band Pyro Release

ACCEL. NO. 10[illegible] TEST DATE [illegible]

SHOCK AXIS [illegible] Sample Rate [illegible]

RESPONSE G's




TEST ITEM M67-1 ** Spacecraft V-band Pyro Release

ACCEL. NO. XT3 TEST DATE [illegible]

SHOCK AXIS Y Sample Rate 100,000

RESPONSE G's

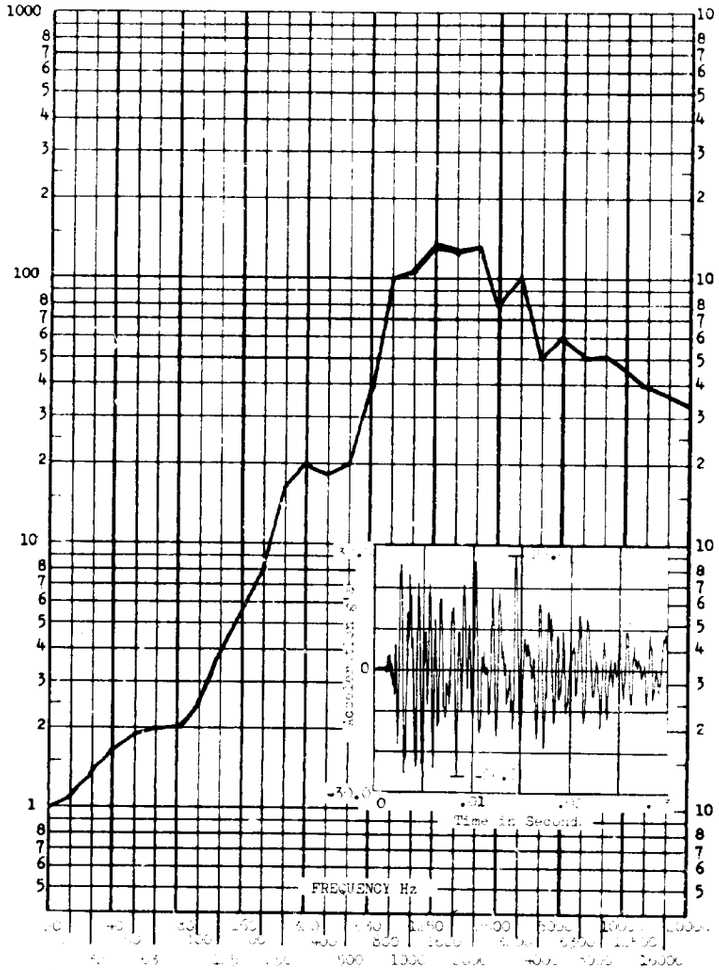
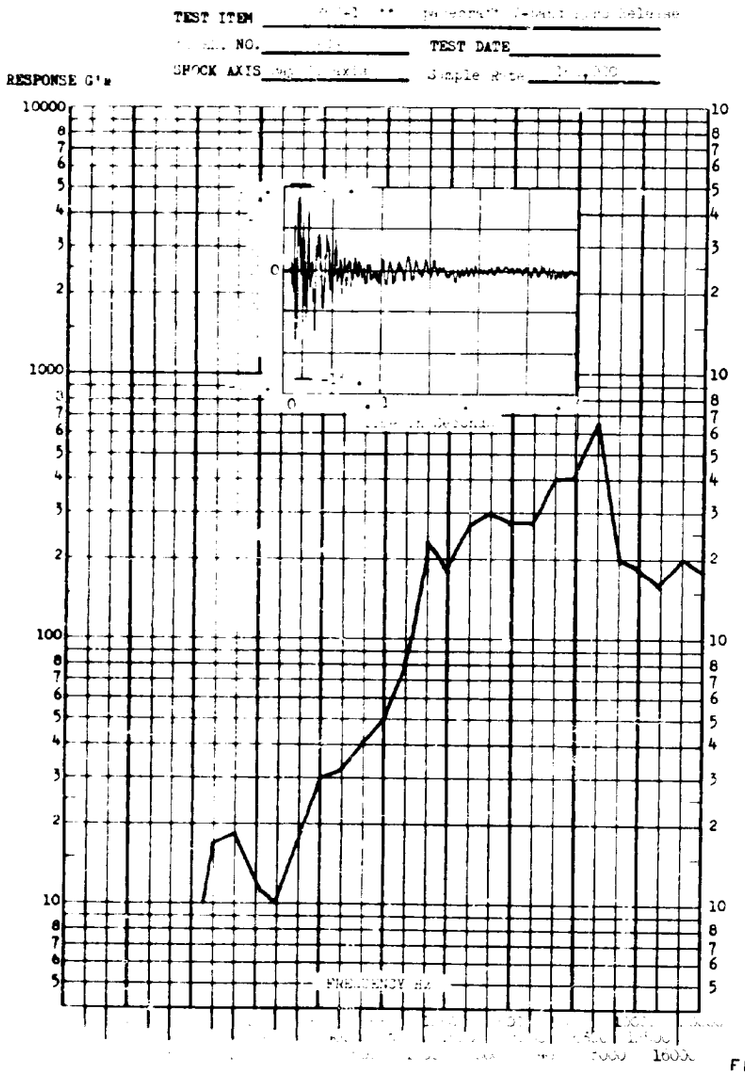



FIGURE IV.B.2-13



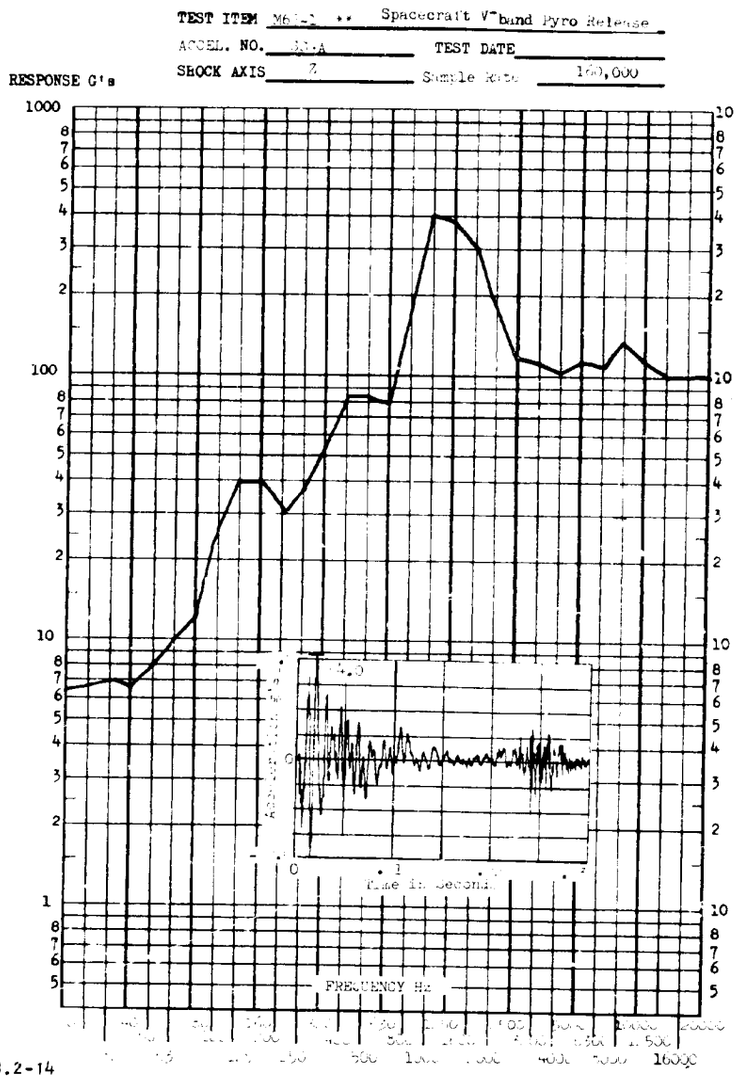




FIGURE IV.B.2-14

SECTION IV.B.3

M67 SOLAR PANEL DEPLOY EVENT

One test of the Solar Panel Deployment was conducted for both the M67-1 and M67-2. The deployment mechanism was a pin-pulling device. Twenty-two shock spectra for this event are presented along with their corresponding time histories in Figures IV.B.3-1 through IV.B.3-11 as indexed in Table IV.B.3-1.

TABLE IV.B.3-1

INDEX OF DATA LOCATIONS

| Accelerometer Number | Configuration | Figure No. |
|---|---|---|
| B3 | M67-1, -2 | IV.B.3-1 |
| F1 | M67-1, -2 | IV.B.3-2 |
| F3 | M67-1, -2 | IV.B.3-3 |
| F4A | M67-1, -2 | IV.B.3-4 |
| B2A, B3A | M67-1 | IV.B.3-5 |
| B4, B5 | M67-1 | IV.B.3-6 |
| B6, BB2 | M67-1 | IV.B.3-7 |
| BB3, SS4A | M67-1 | IV.B.3-8 |
| SS5A, SS6A | M67-1 | IV.B.3-9 |
| AS1, IC4 | M67-1 | IV.B.3-10 |
| 3T3, MC4 | M67-1 | IV.B.3-11 |

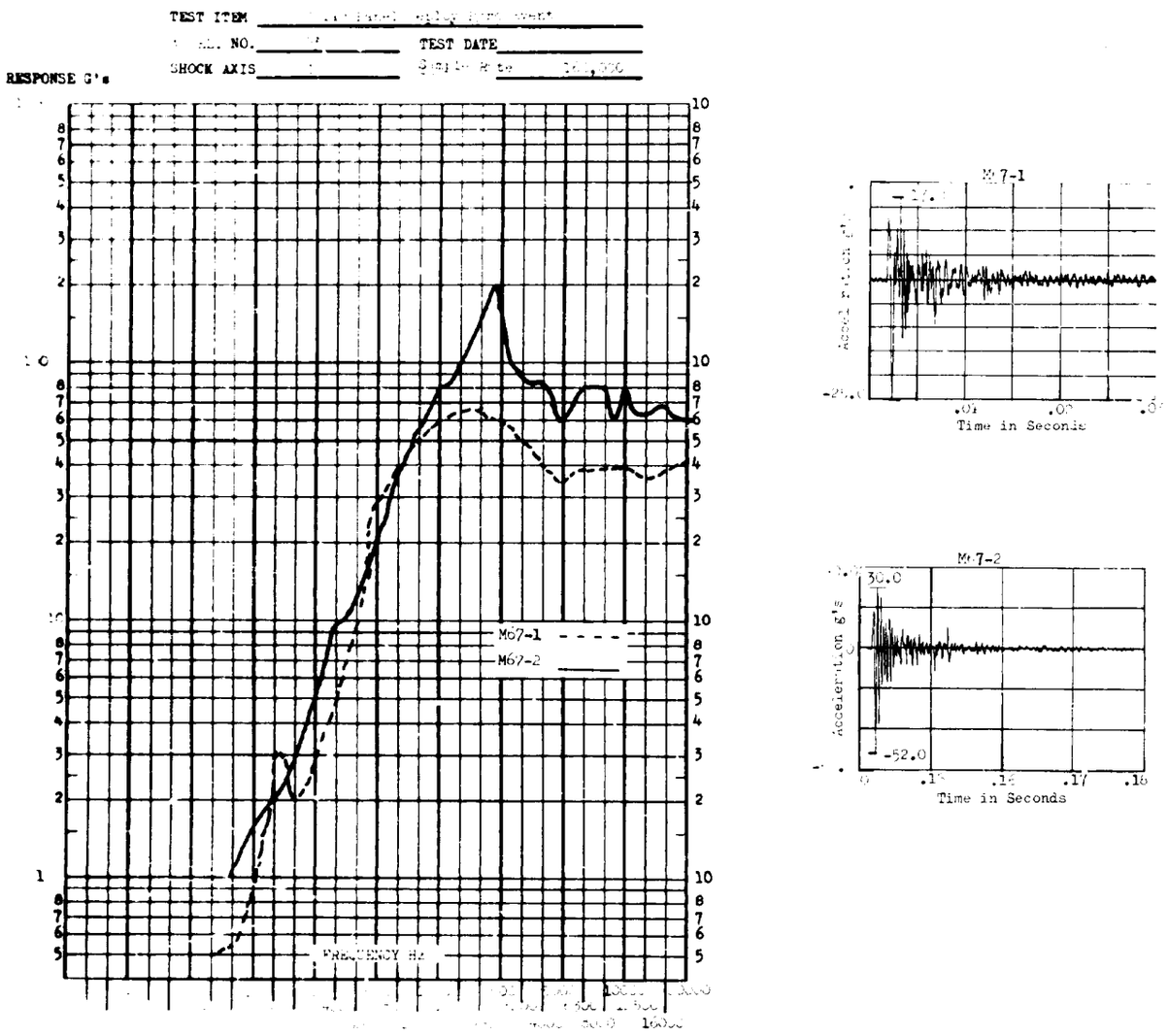






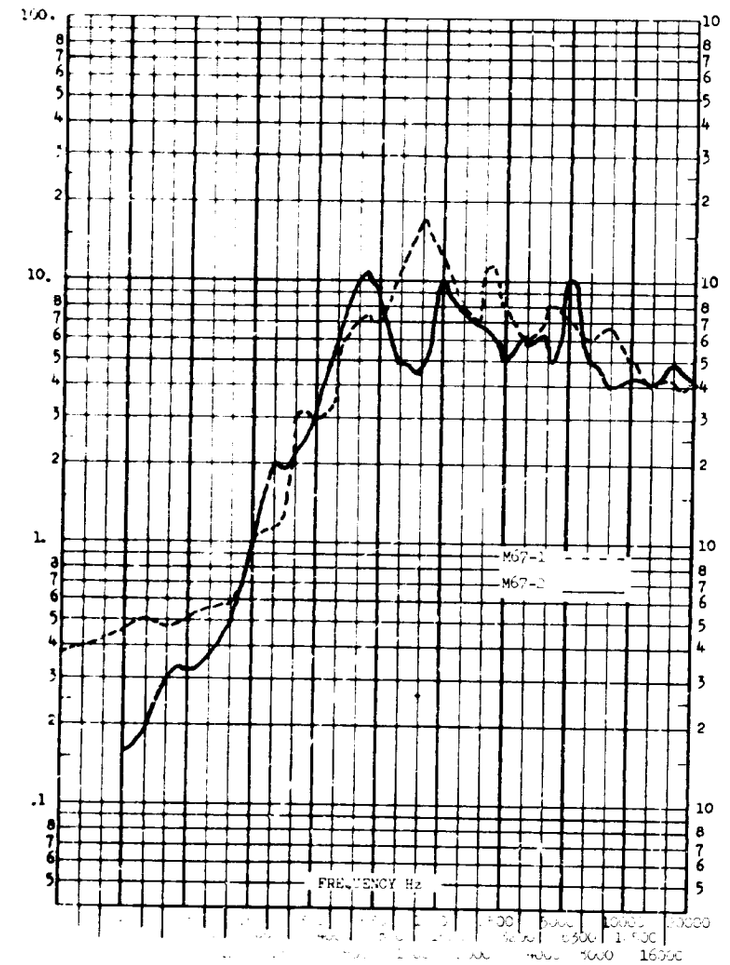


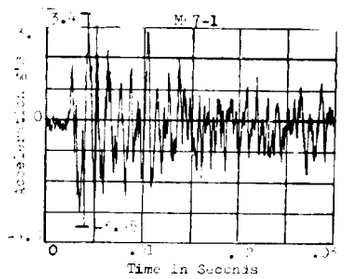

FIGURE IV.B.3-1

TEST ITEM [illegible]

[illegible] NO. [illegible] TEST DATE

SHOCK AXIS [illegible] Sample Rate 16,000



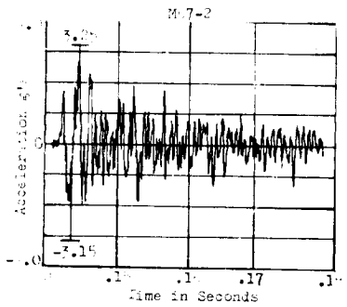




FIGURE IV.B.3-2

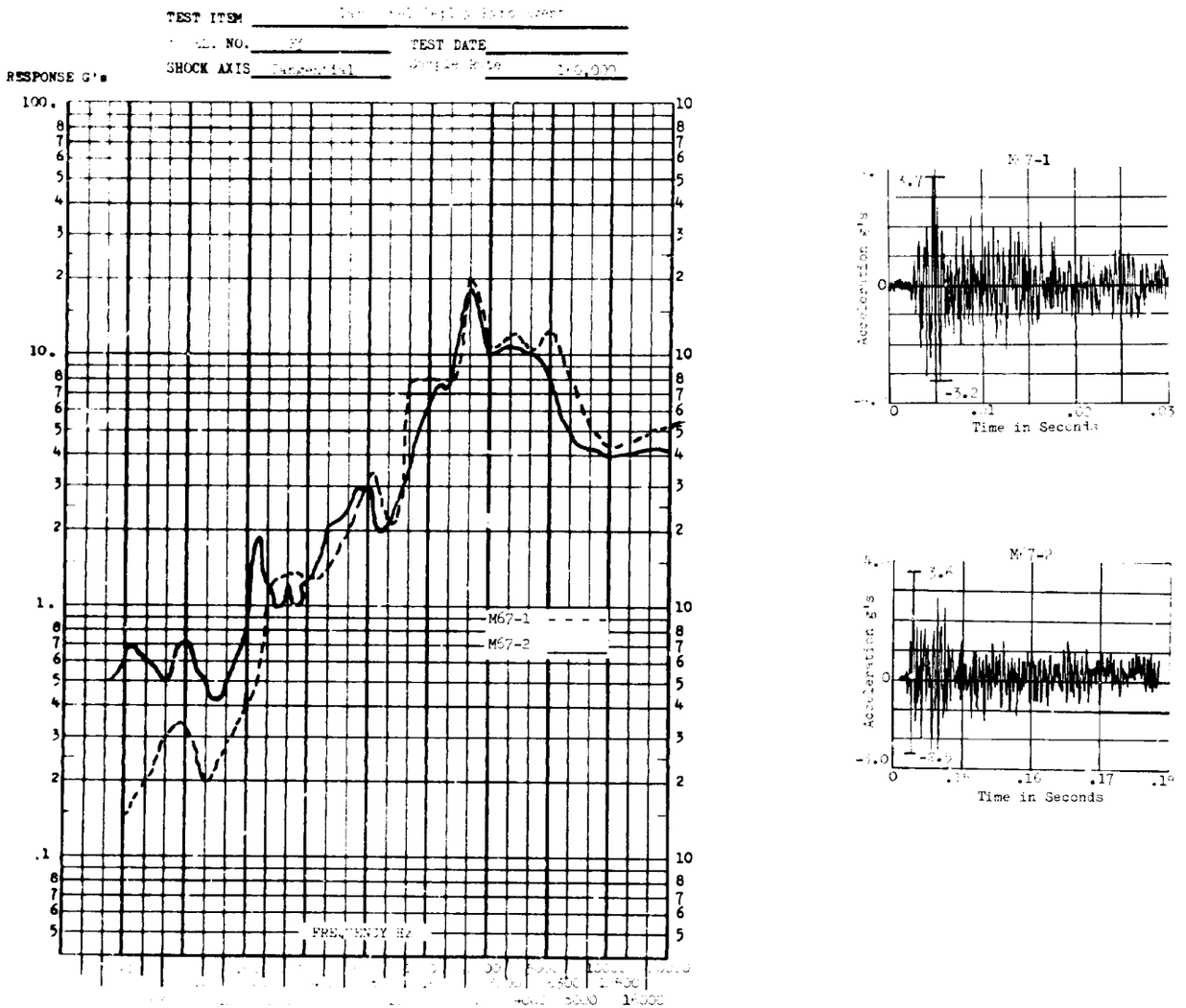






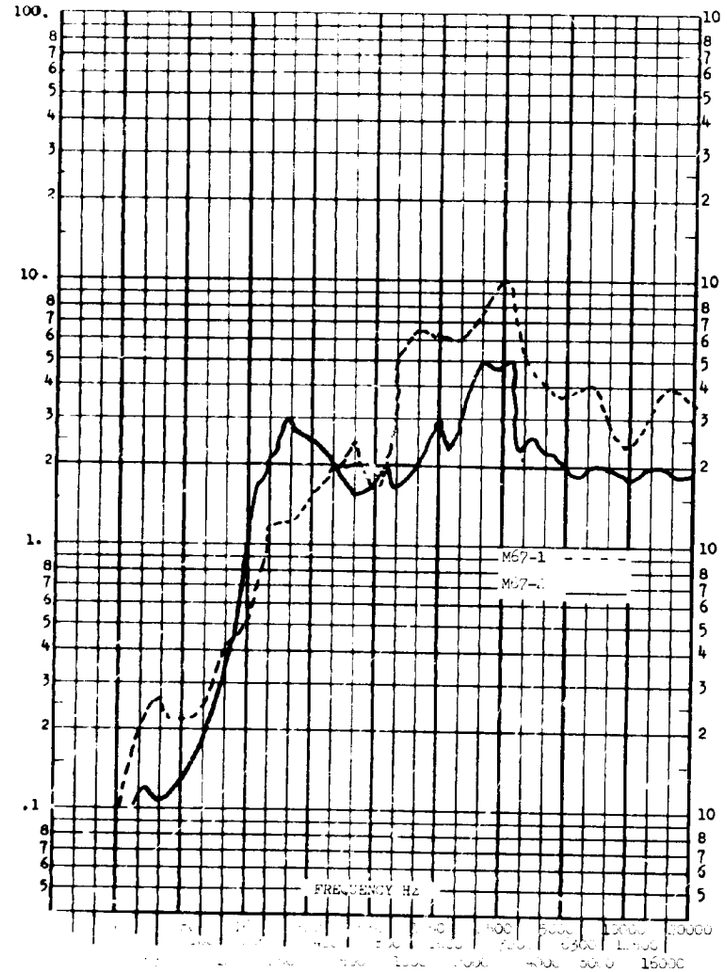


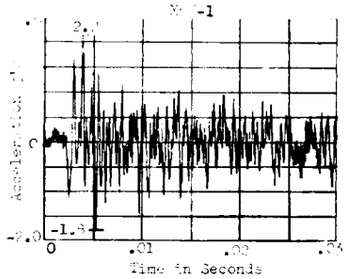

FIGURE IV.B.3-3

TEST ITEM _____

SHOCK AXIS _____ TEST DATE _____

RESPONSE G's



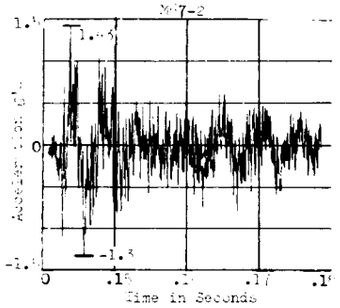
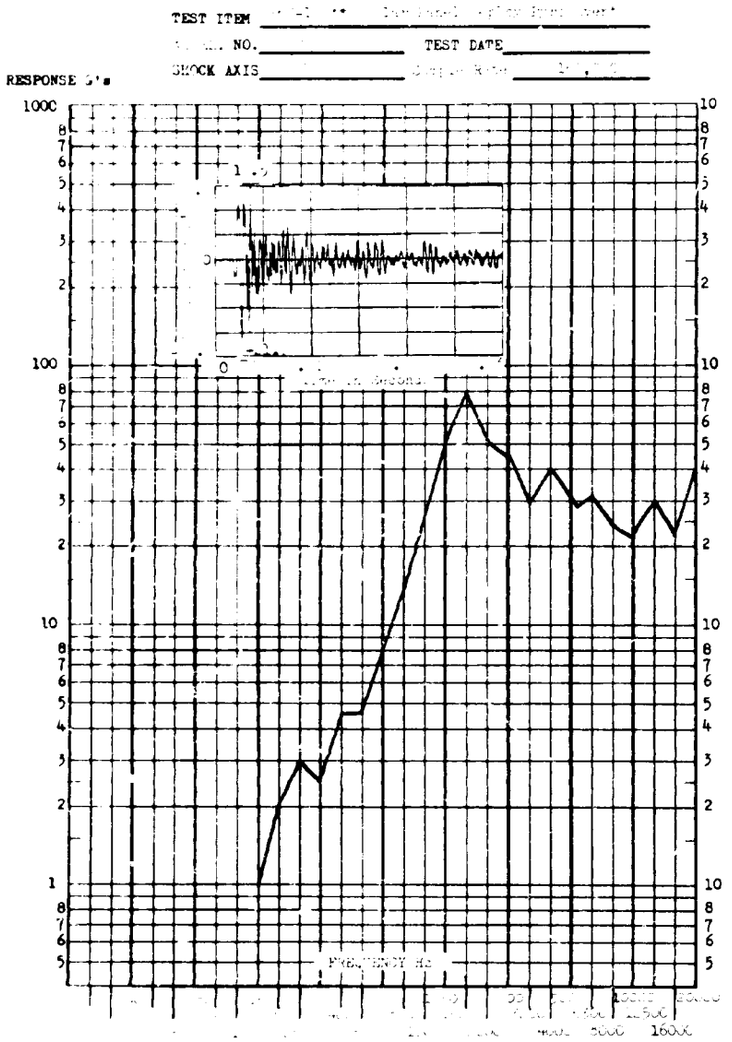




FIGURE IV.B.3-4



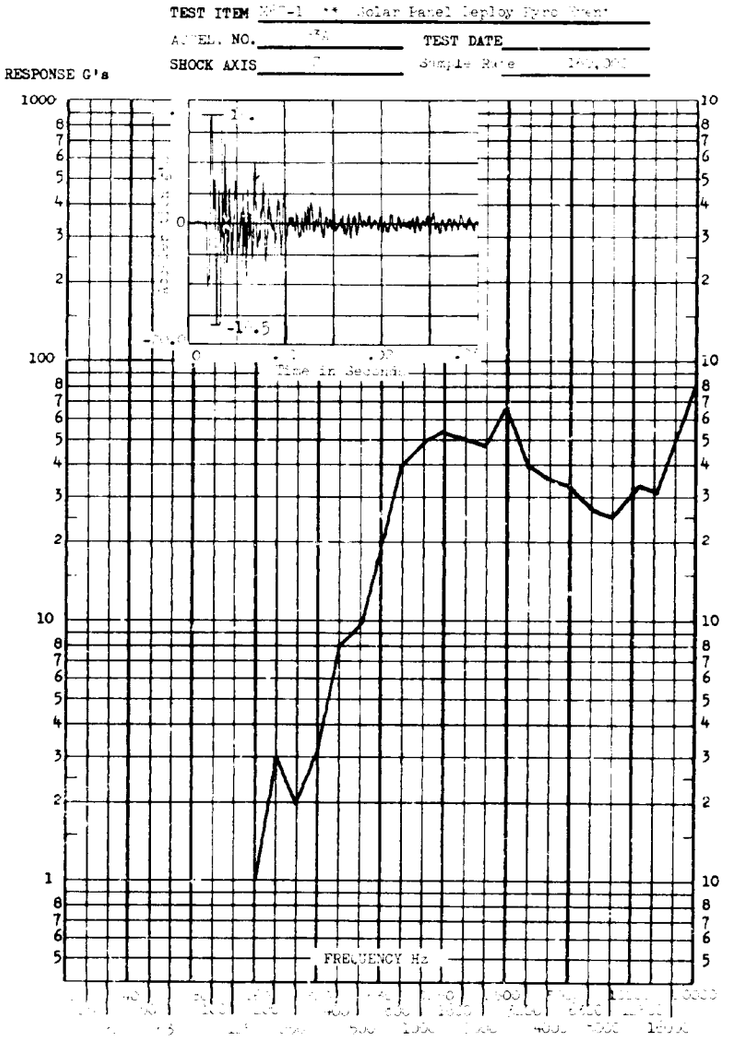
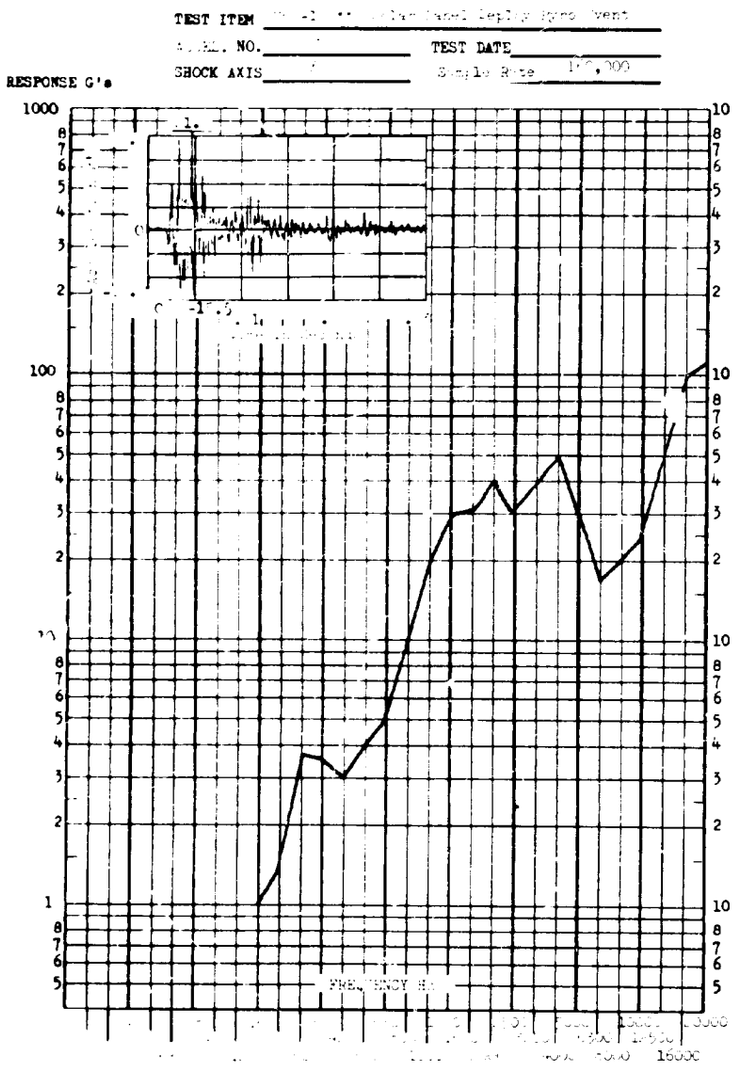




FIGURE IV.B.3-5



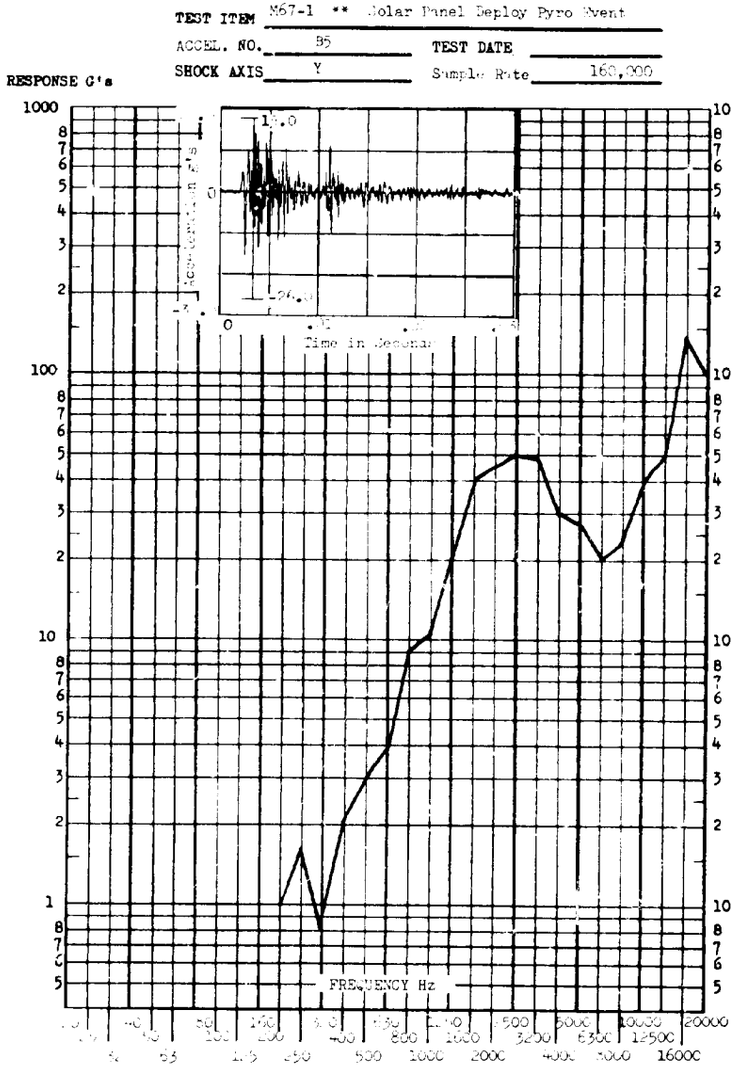




FIGURE IV.B.3-6

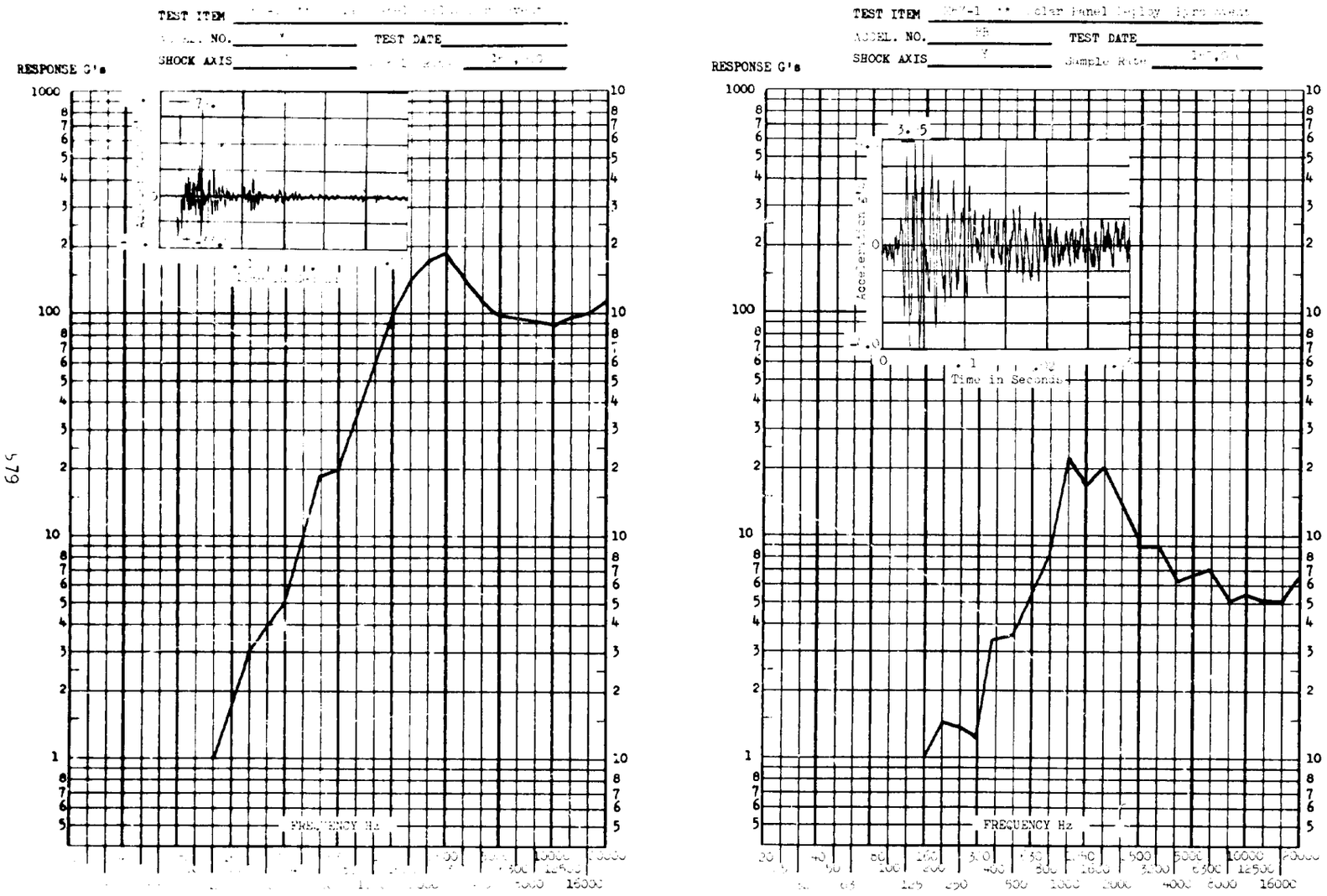
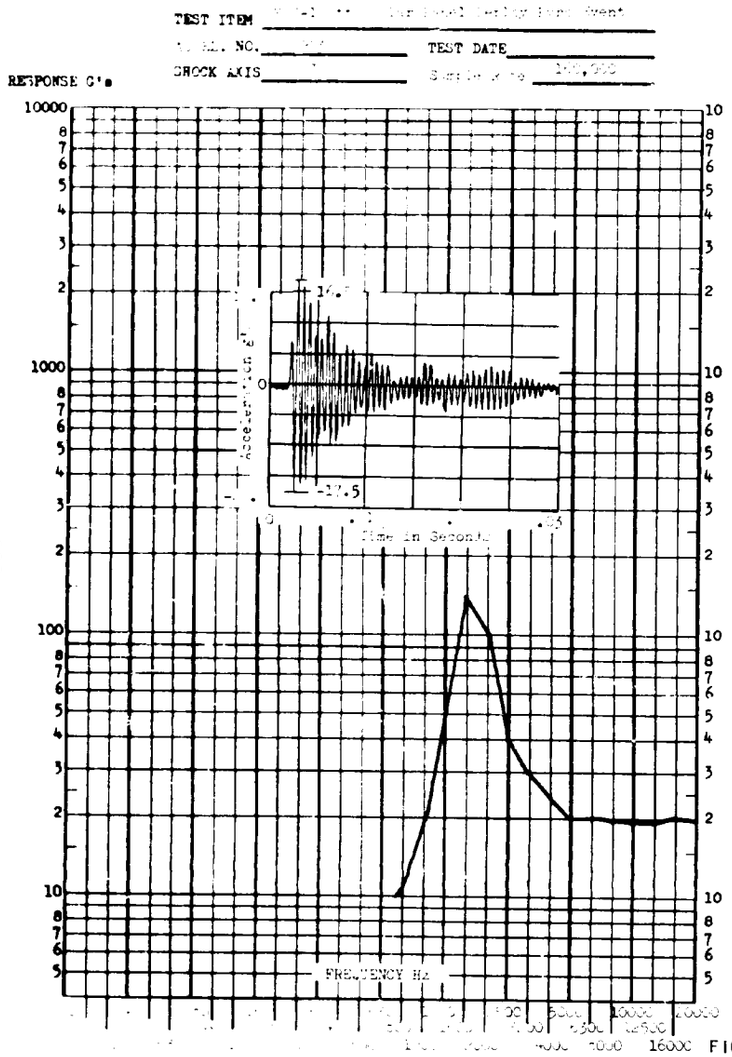



FIGURE IV.B.3-7



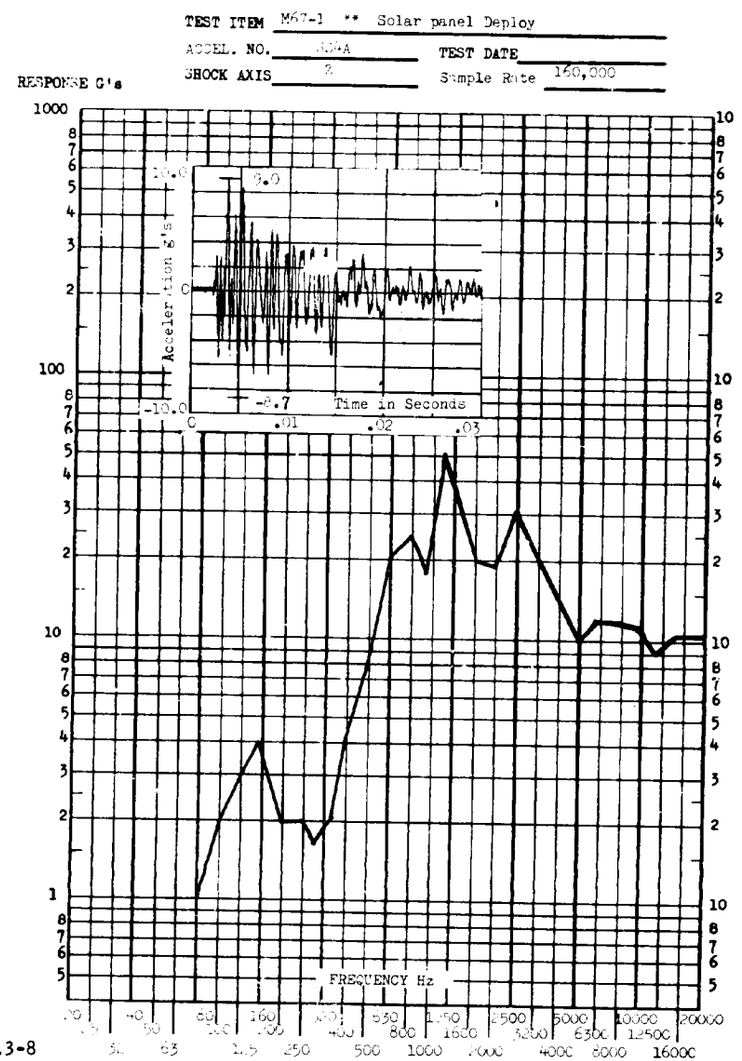
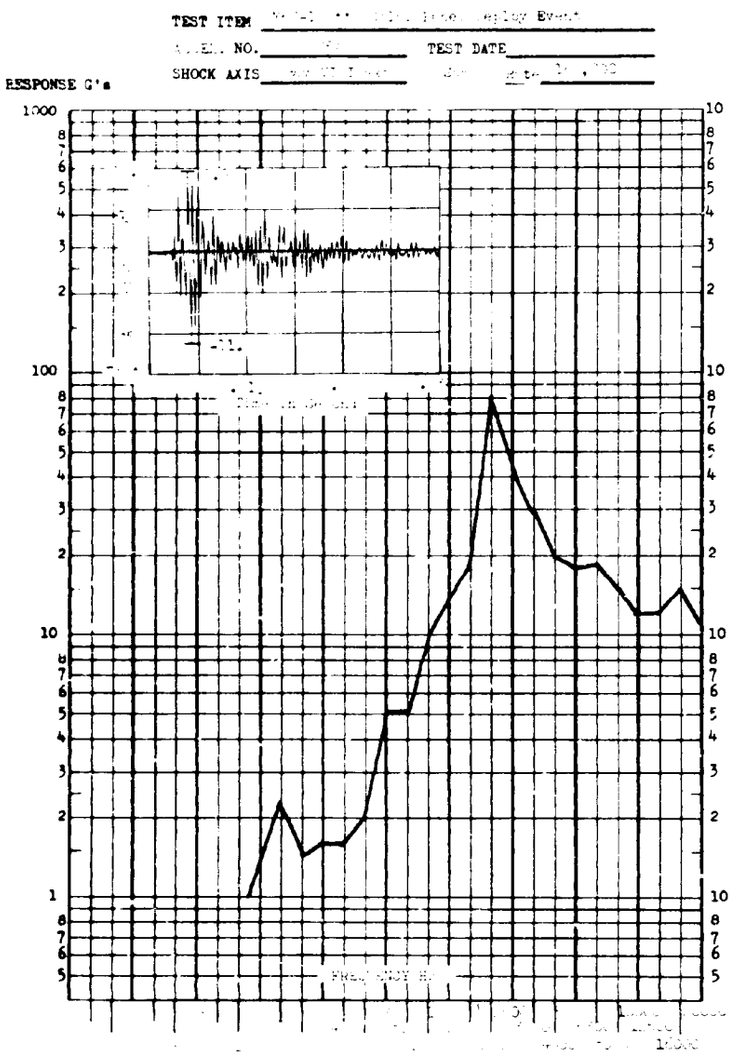




FIGURE IV.B.3-8



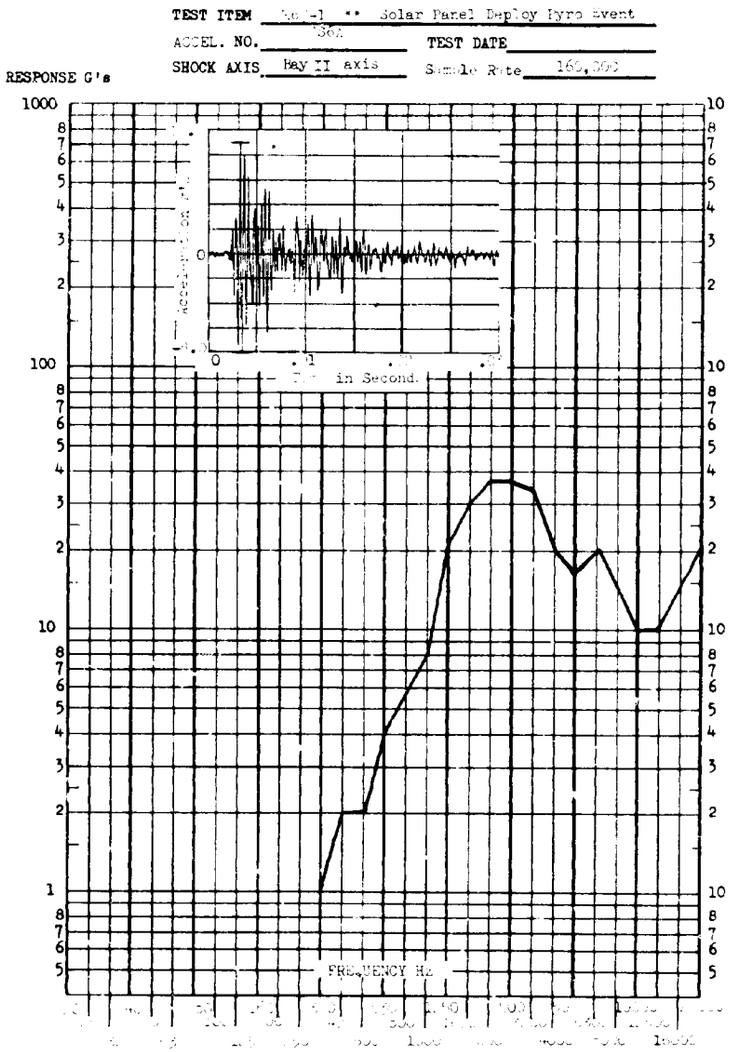
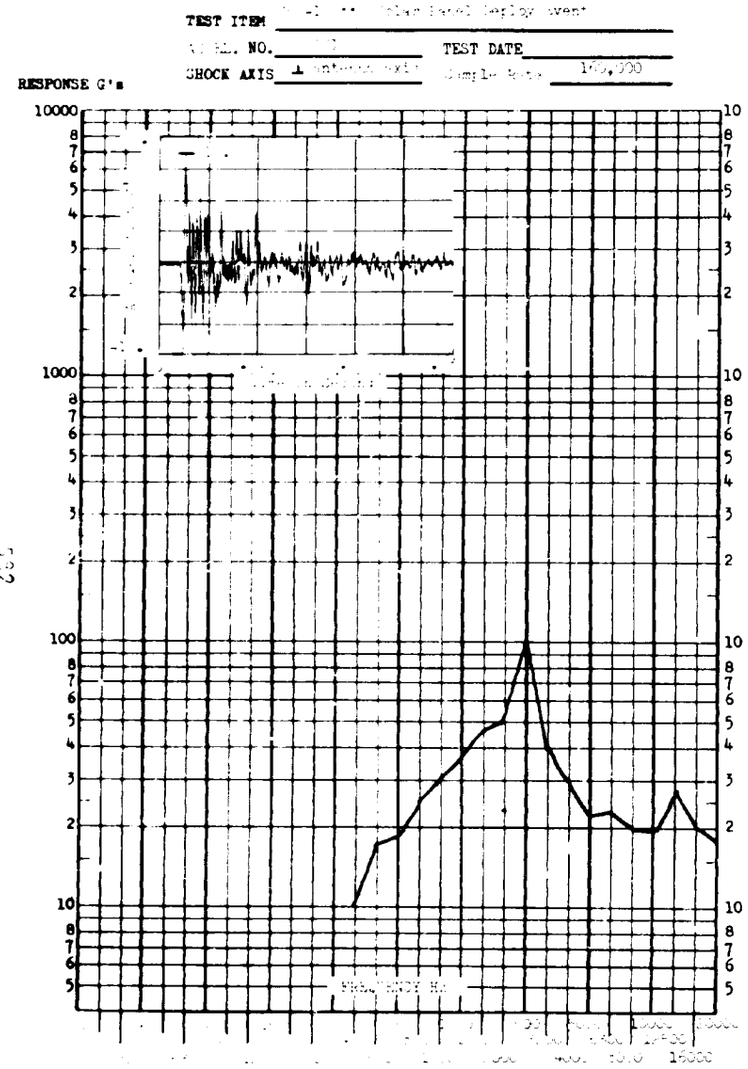




FIGURE IV.B.3-9



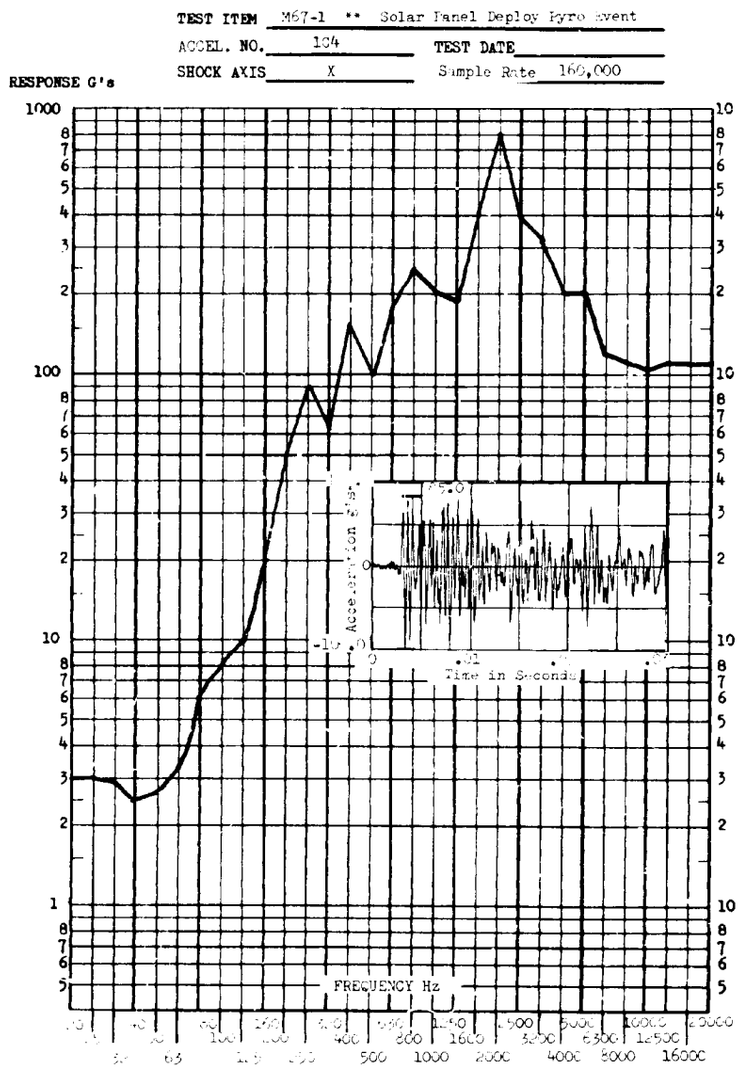
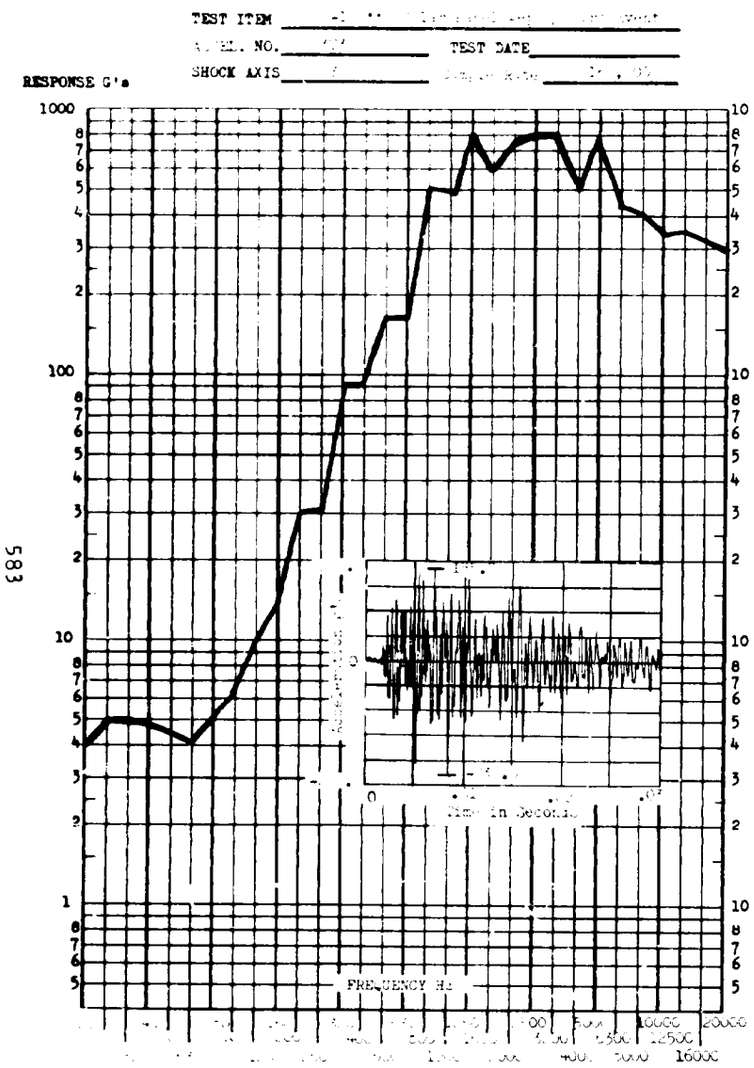




FIGURE IV.B.3-10



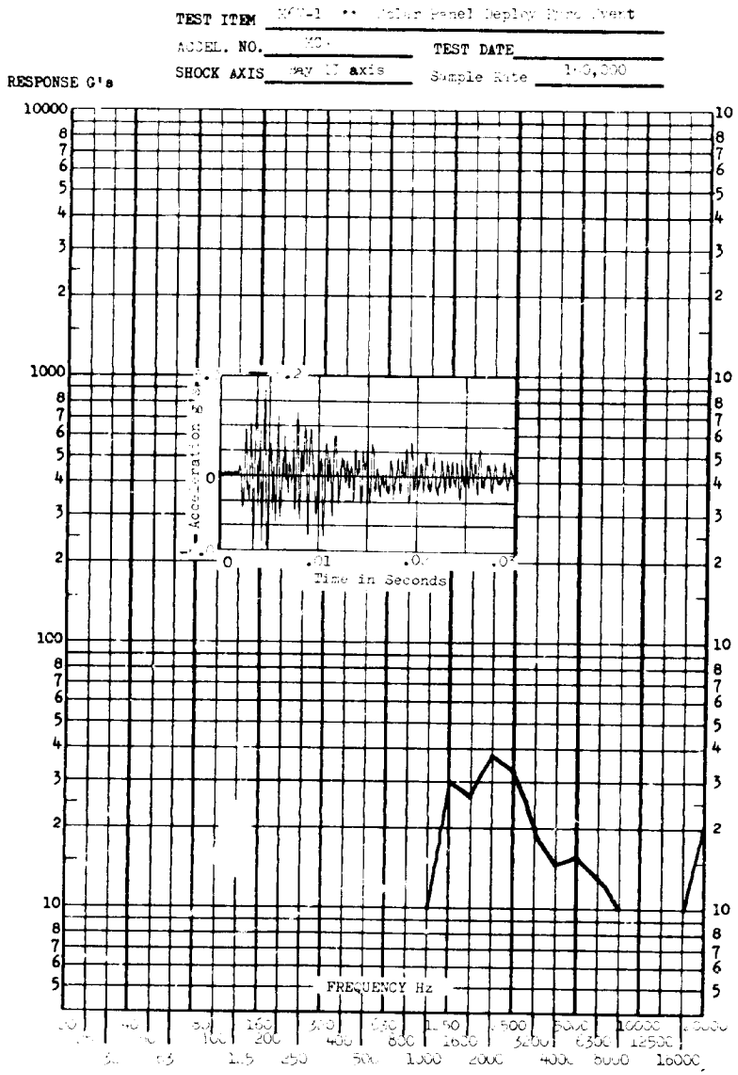




FIGURE IV.B.3-11

## SECTION IV.B.4

## M67-1 PIPS 1 EVENT

One test of the post injection propulsions system pyro 1 was conducted for the M67-1. The pyrotechnic employed was a pin-pulling device. Seventeen shock spectra for this event are presented along with their corresponding time histories in Figures IV.B.4-1 through IV.B.4-9 as indexed in Table IV.B.4-1.

TABLE IV.B.4-1

INDEX OF DATA LOCATIONS

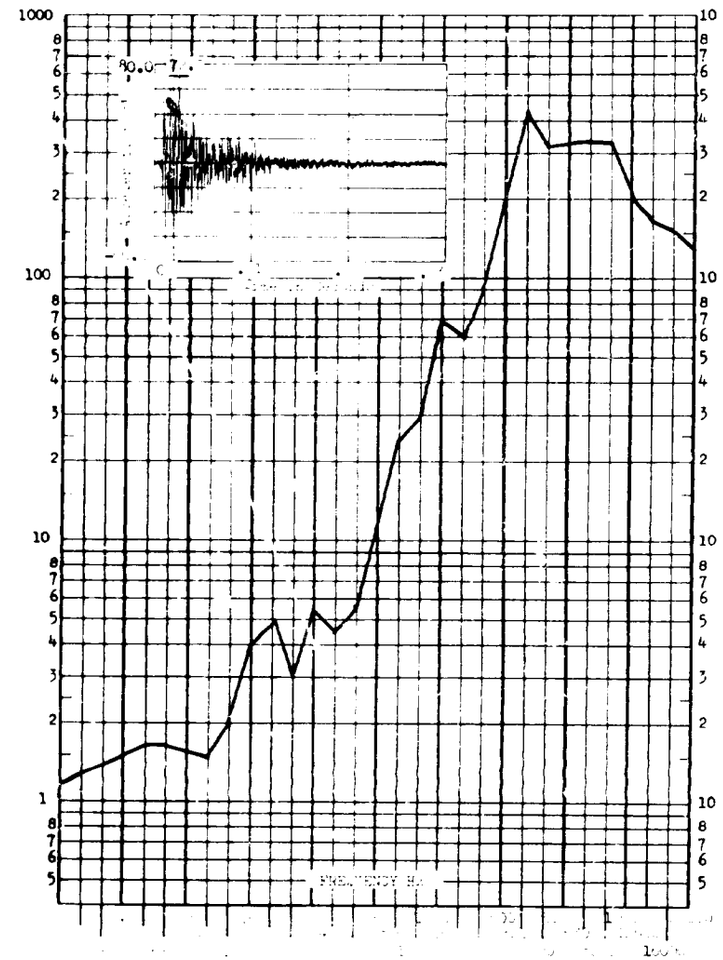
| Accelerometer Numbers | Figure Number |
|---|---|
| B3, F4 | IV.B.4-1 |
| F4A, B1A | IV.B.4-2 |
| B2A, B3A | IV.B.4-3 |
| BB1, BB2 | IV.B.4-4 |
| BB3, SS4A | IV.B.4-5 |
| SS5A, SS6A | IV.B.4-6 |
| IC4, 3T3 | IV.B.4-7 |
| MCV1, MCV4 | IV.B.4-8 |
| MC4 | IV.B.4-9 |

TEST ITEM [illegible]

ACCEL. NO. [illegible] TEST DATE

SHOCK AXIS [illegible] Sample Rate 160,000

RESPONSE G's




TEST ITEM M67-1 ** PIDS 1

ACCEL. NO. F4 TEST DATE

SHOCK AXIS Z Sample Rate 160,000

RESPONSE G's

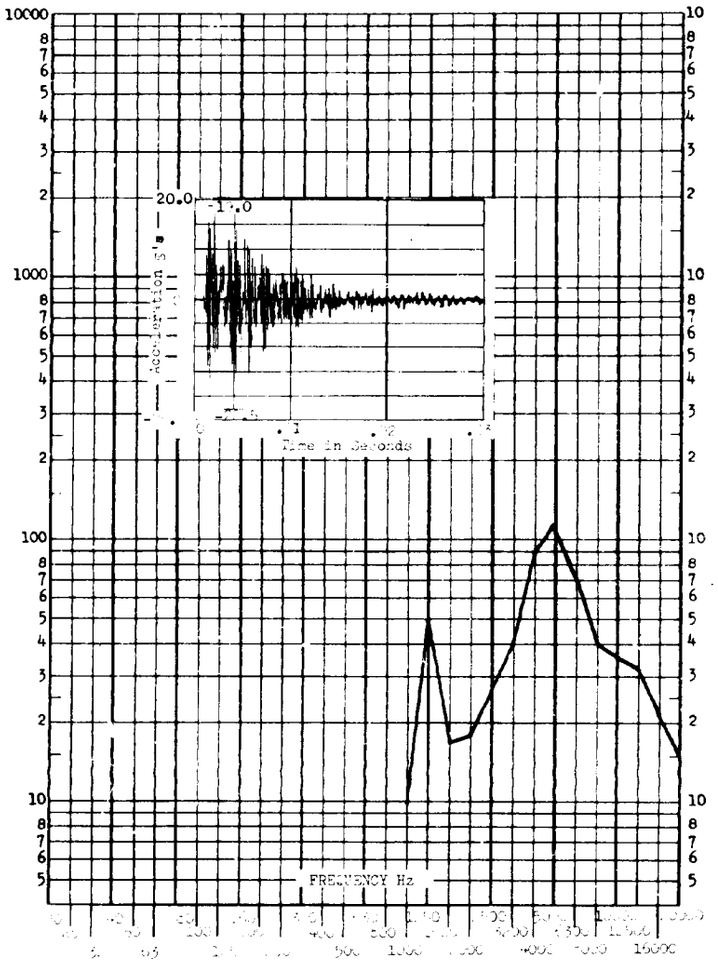



FIGURE IV.B.4-1

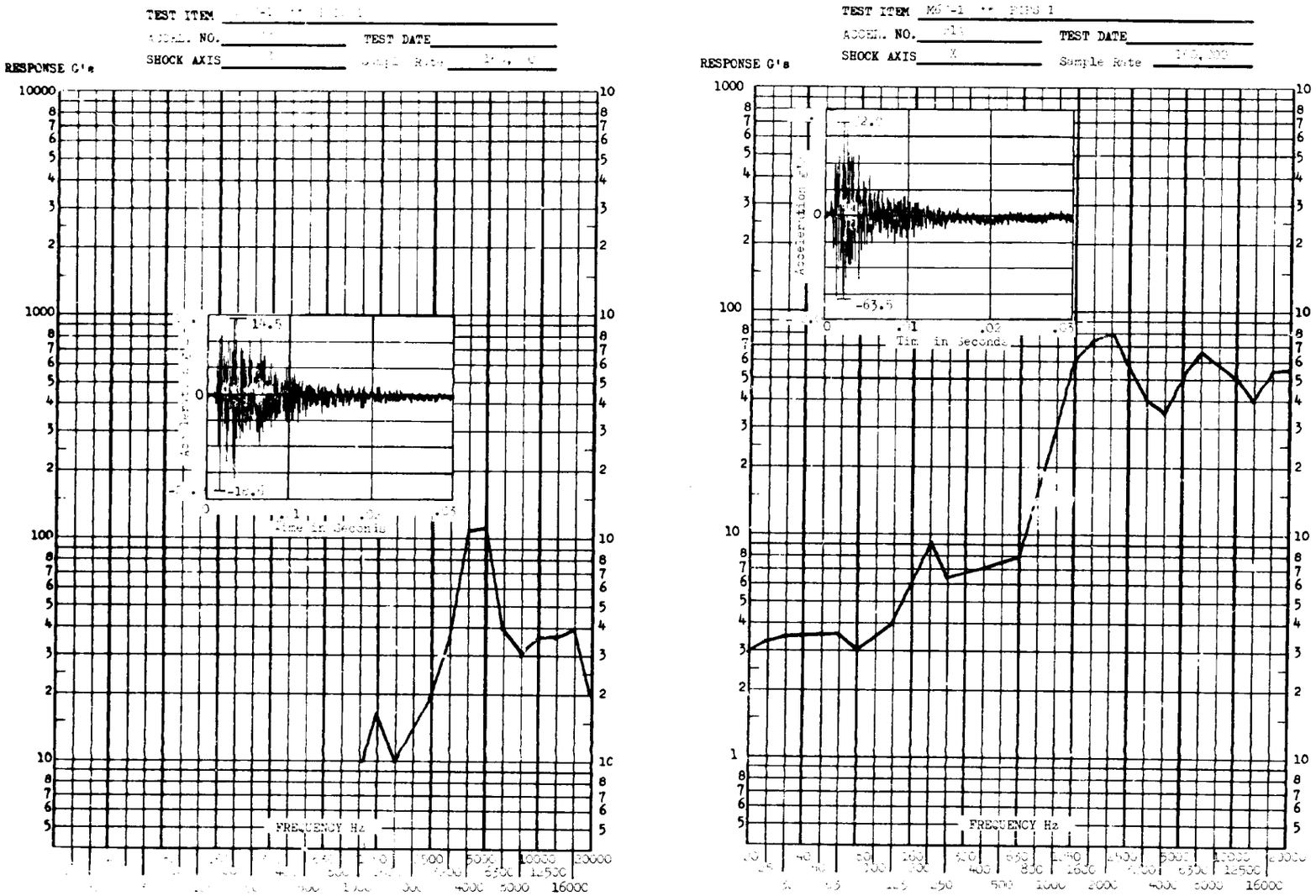



FIGURE IV.B.4-2

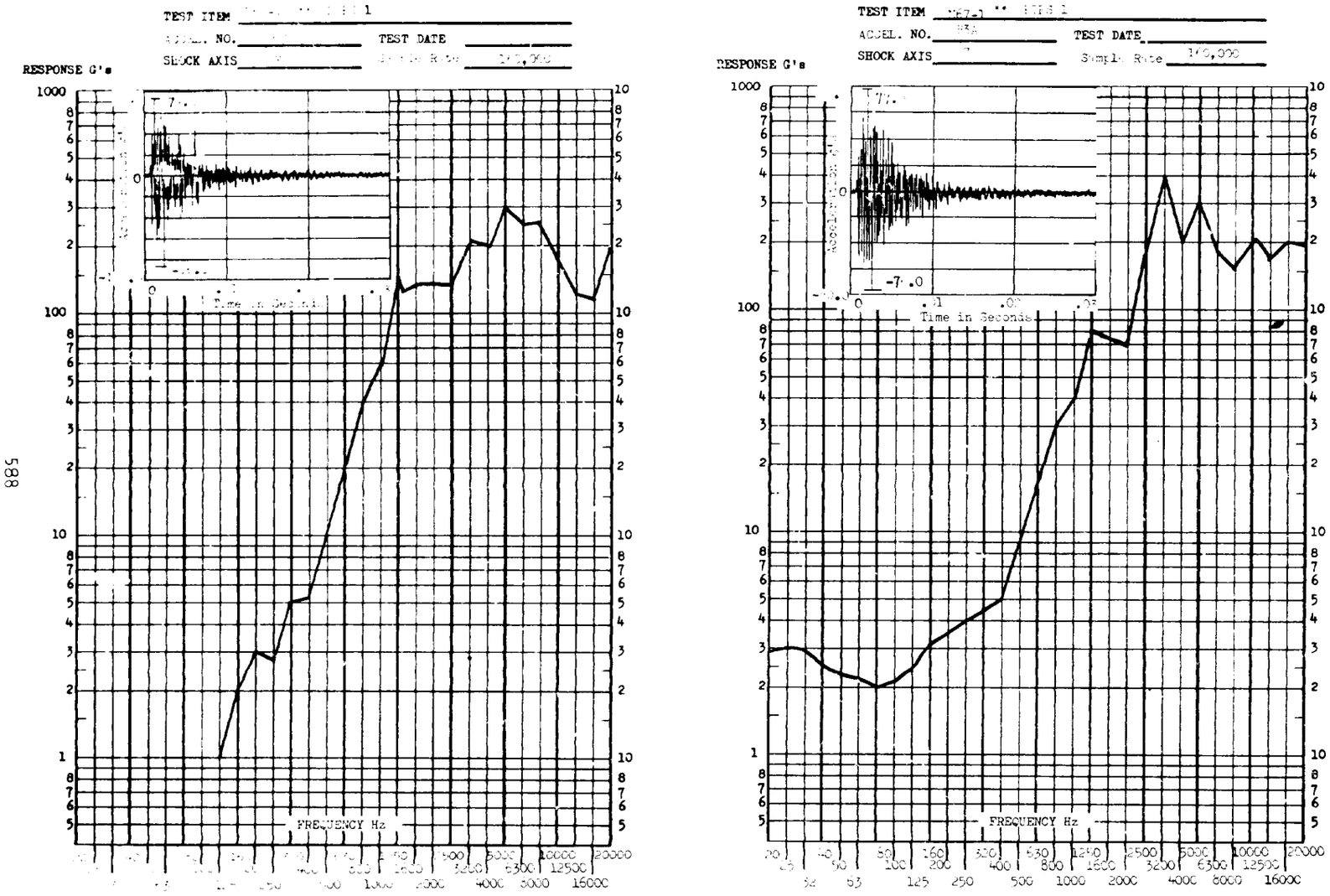
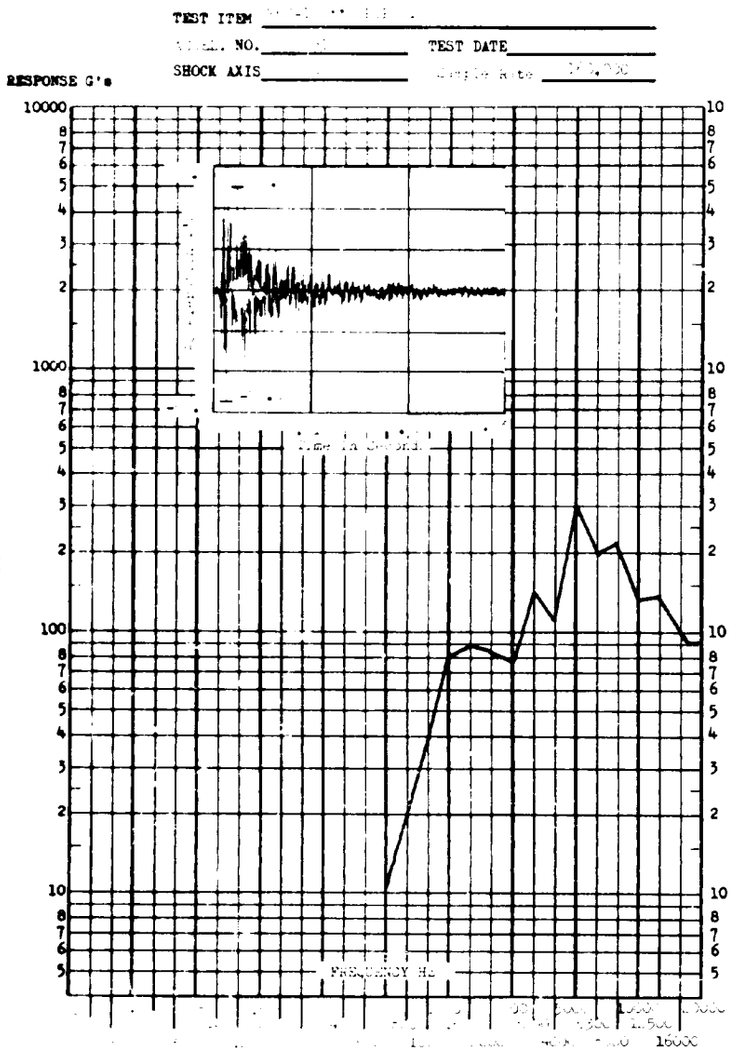



FIGURE IV.8.4-3



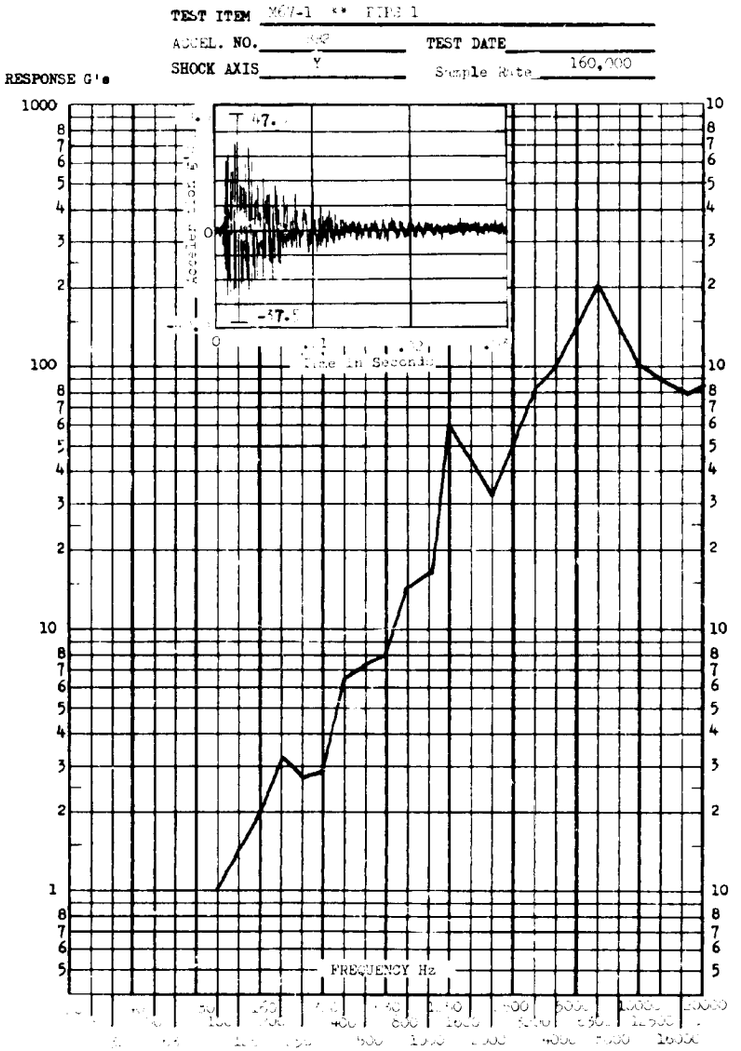
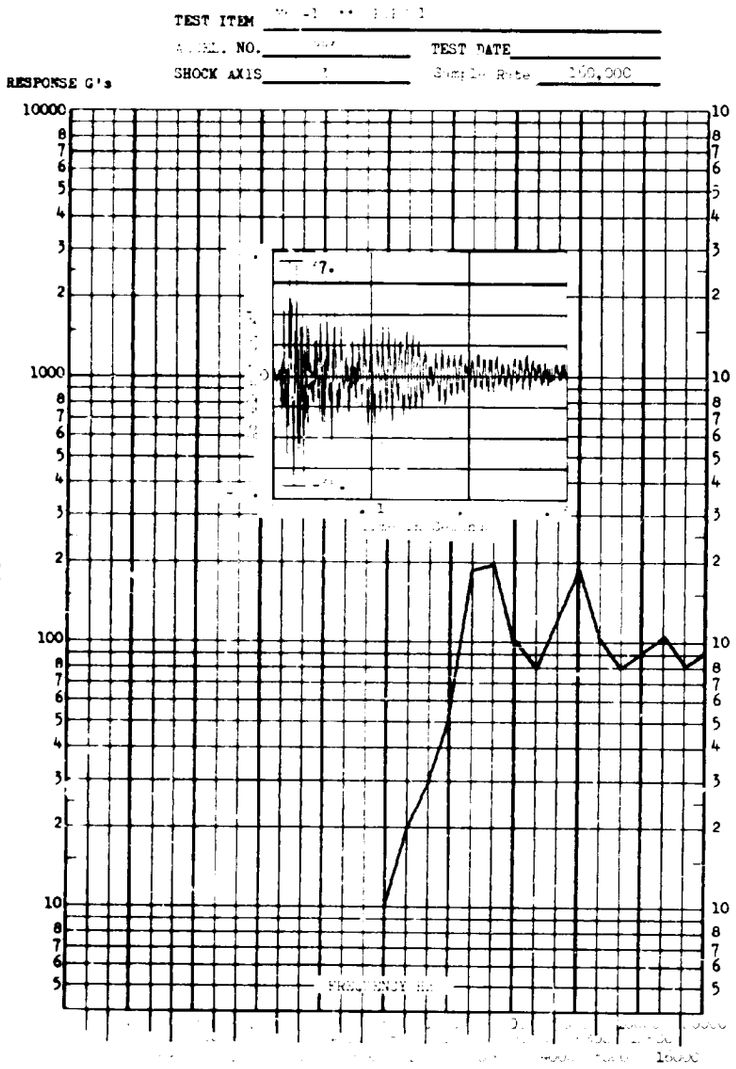




FIGURE IV.B.4-4



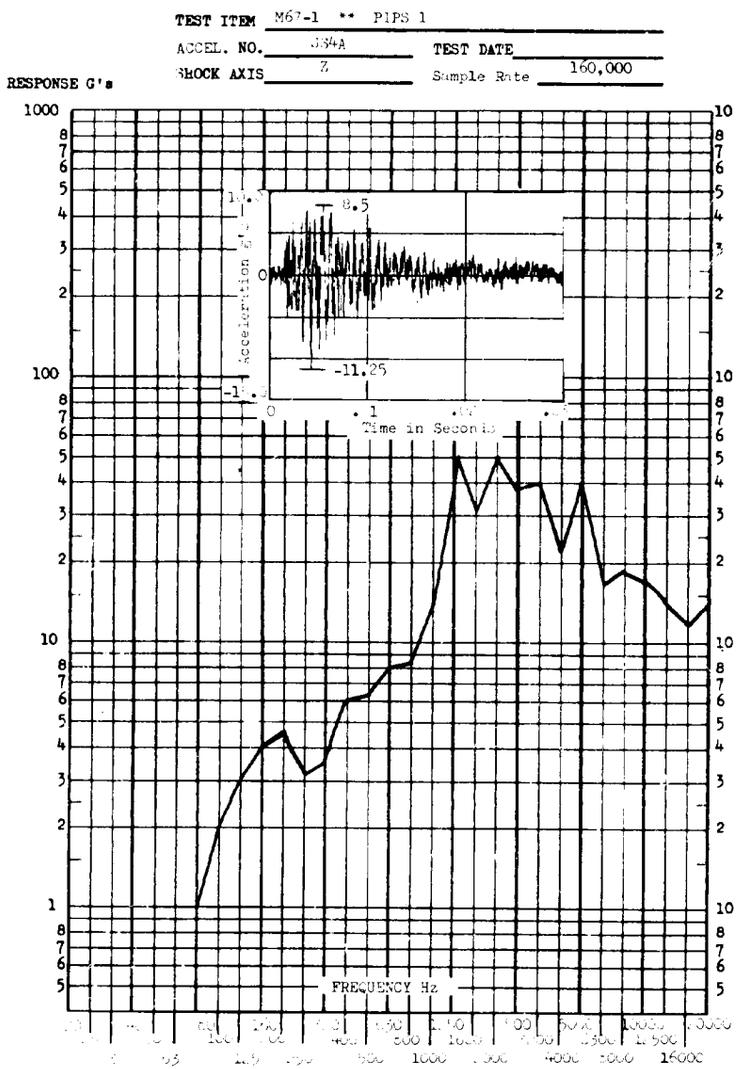




FIGURE IV.B.4-5

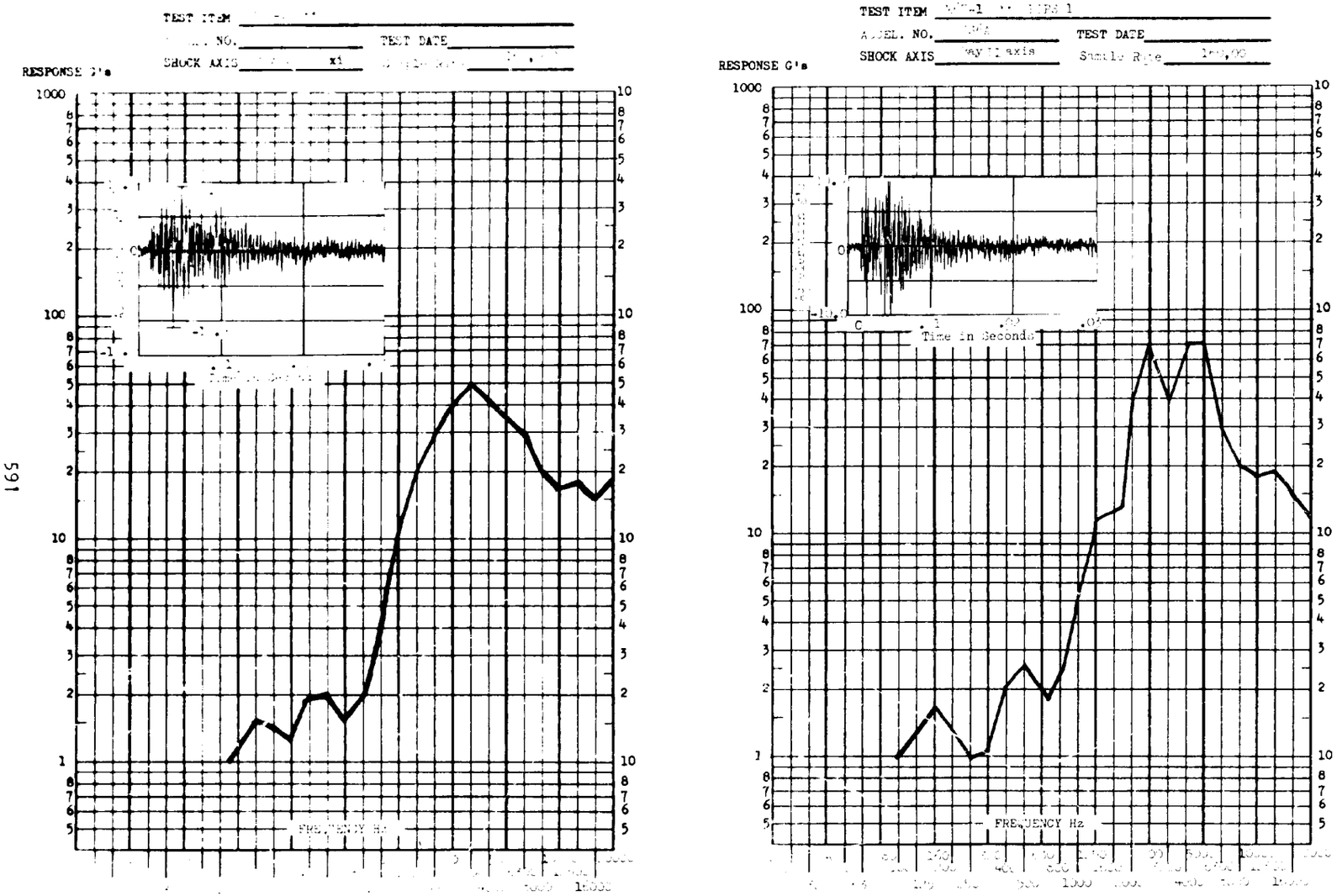



FIGURE IV.B.4-6

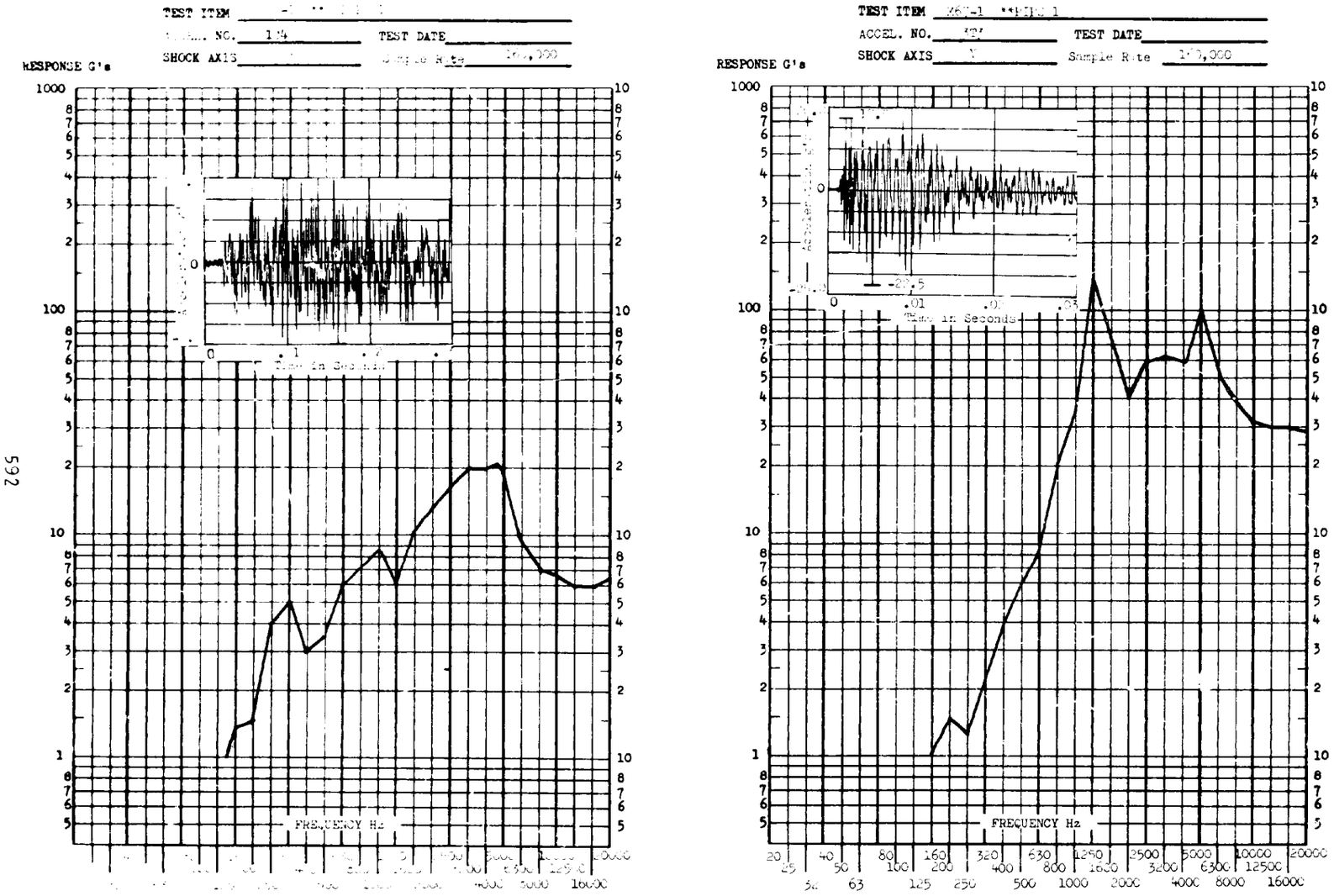
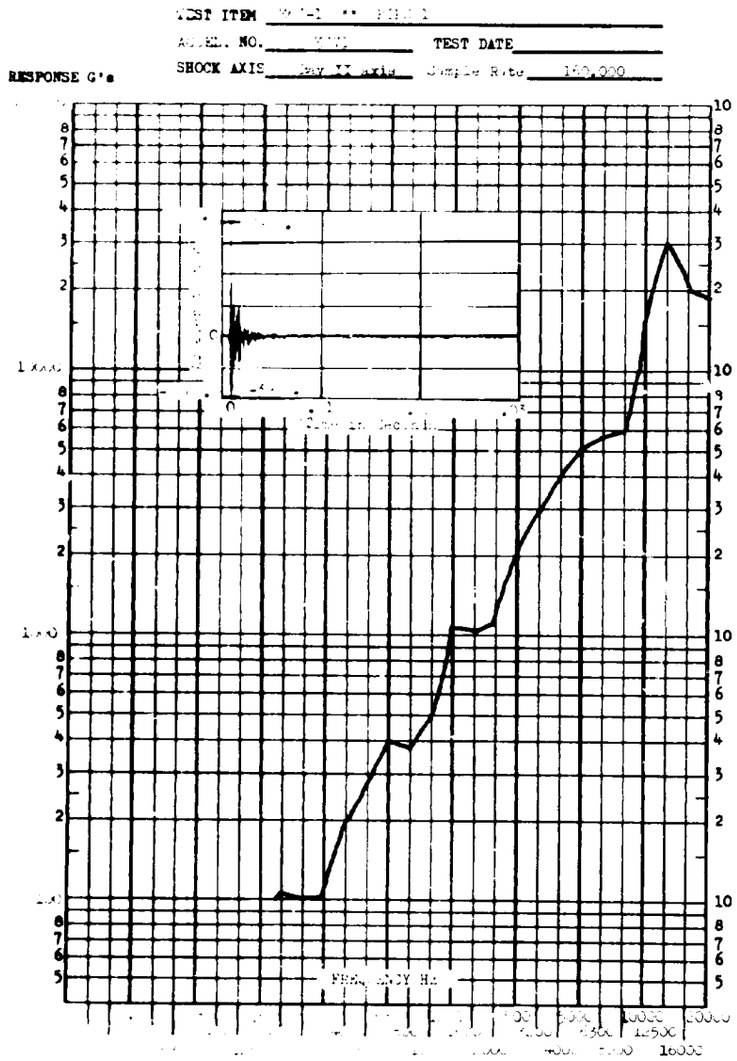



FIGURE IV.B.4-7



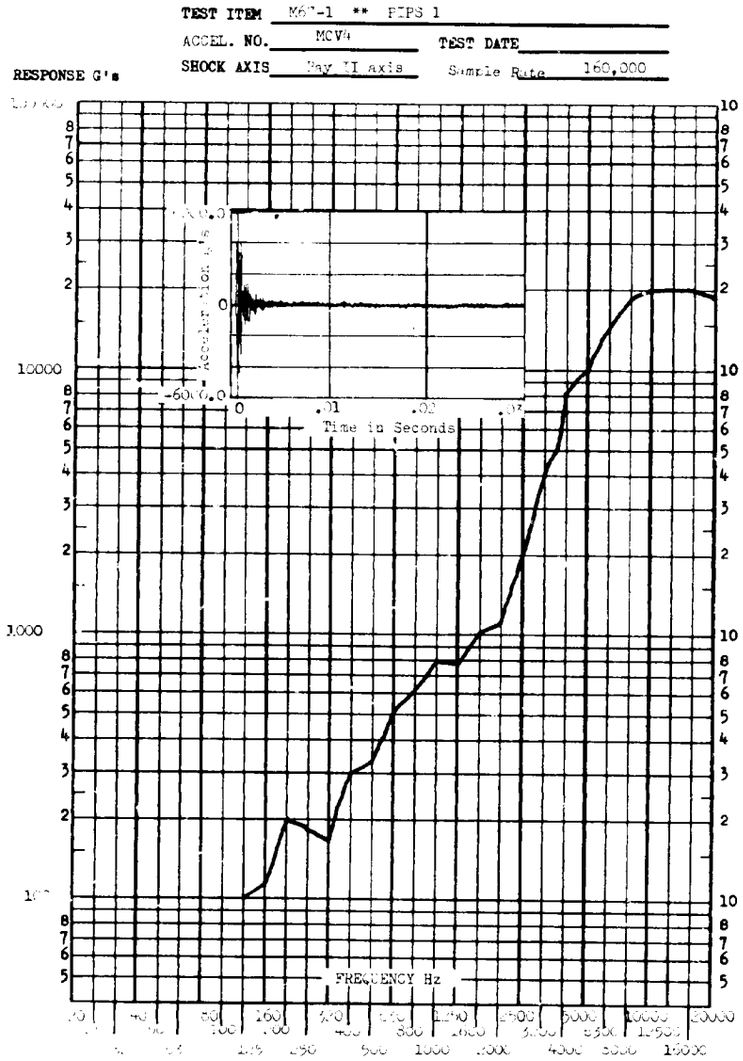




FIGURE IV.B.4-8

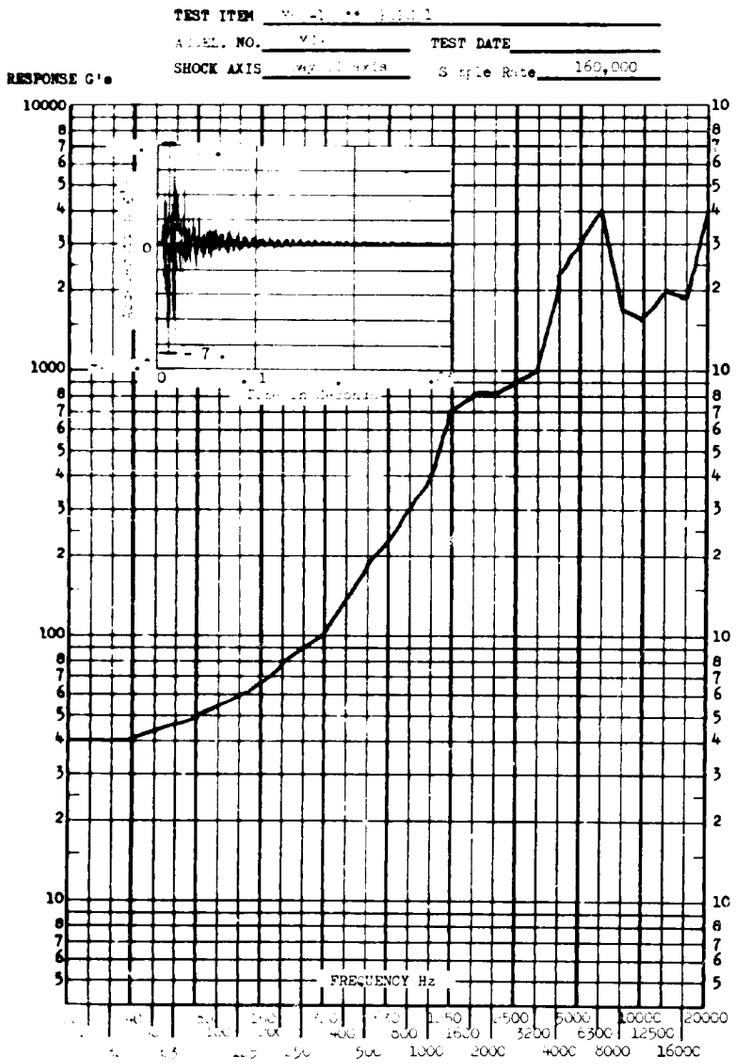



FIGURE IV.B.4-9

## SECTION IV.B.5

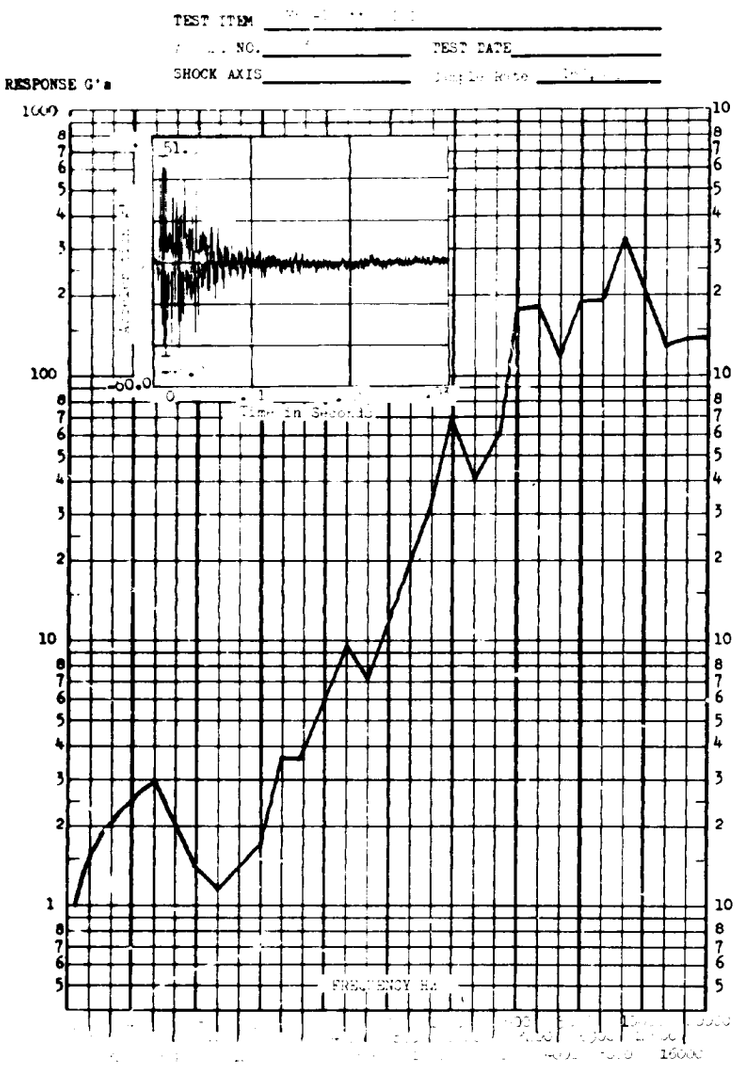
## M67-1 PIPS 2 EVENT

One test of the post injection propulsion system pyro 2 was conducted for the M67-1. The pyrotechnic employed was a pin-pulling device. Seventeen shock spectra for this event are preserted along with their corresponding time histories in Figures IV.B.5-1 through IV.B.5-9 as indexed in Table IV.B.5-1.

TABLE IV.B.5-1

INDEX OF DATA LOCATIONS

| Accelerometer Number | Figure Number |
|---|---|
| B3, F4 | IV.B.5-1 |
| F3, F4A | IV.B.5-2 |
| B2A, B3A | IV.B.5-3 |
| BB1, BB2 | IV.B.5-4 |
| BB3, SS4A | IV.B.5-5 |
| SS5A, SS6A | IV.B.5-6 |
| IC4, 3T3 | IV.B.5-7 |
| MCV1, MCV4 | IV.B.5-8 |
| MC4 | IV.B.5-9 |



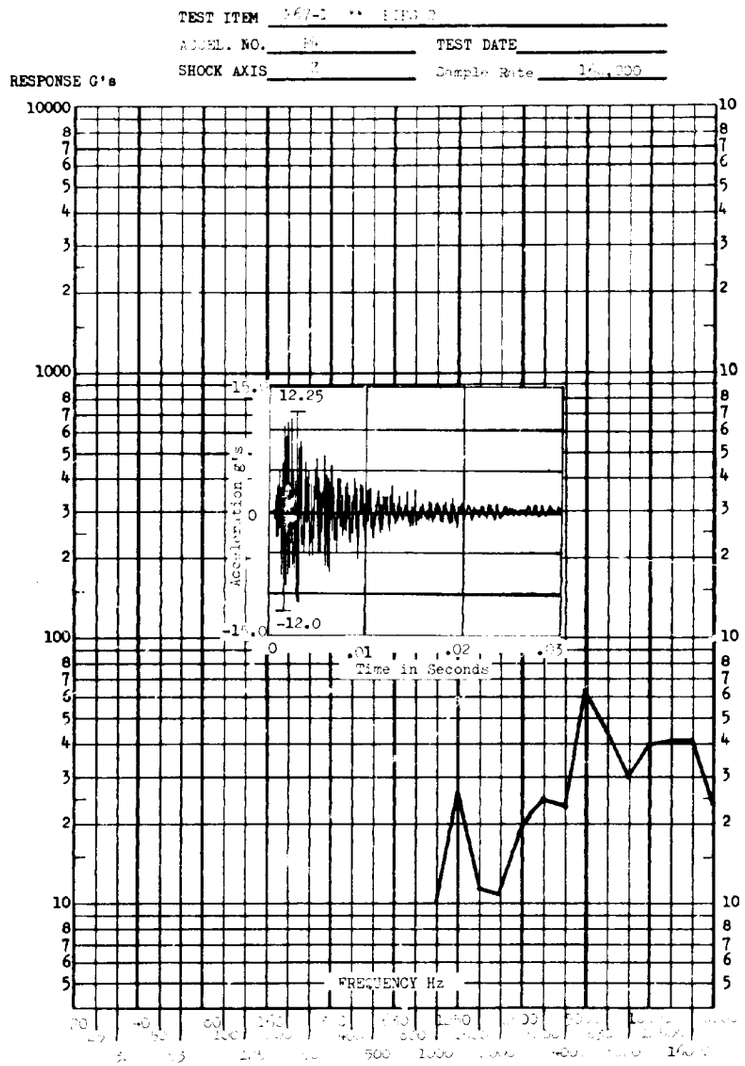
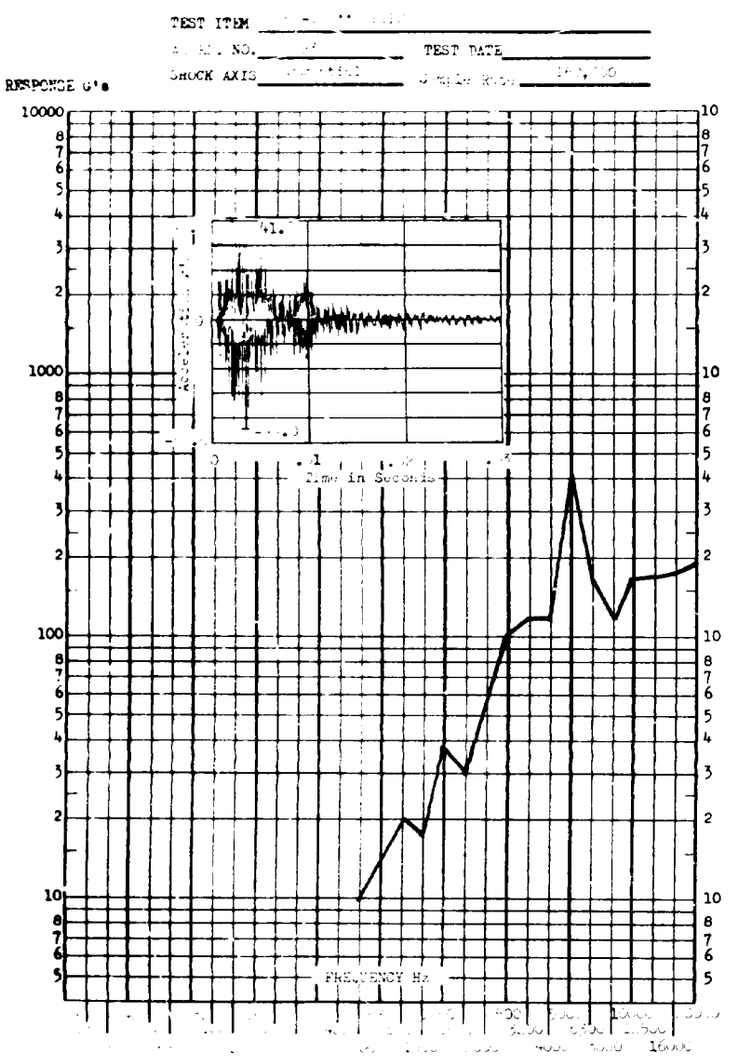




FIGURE IV.B.5-1



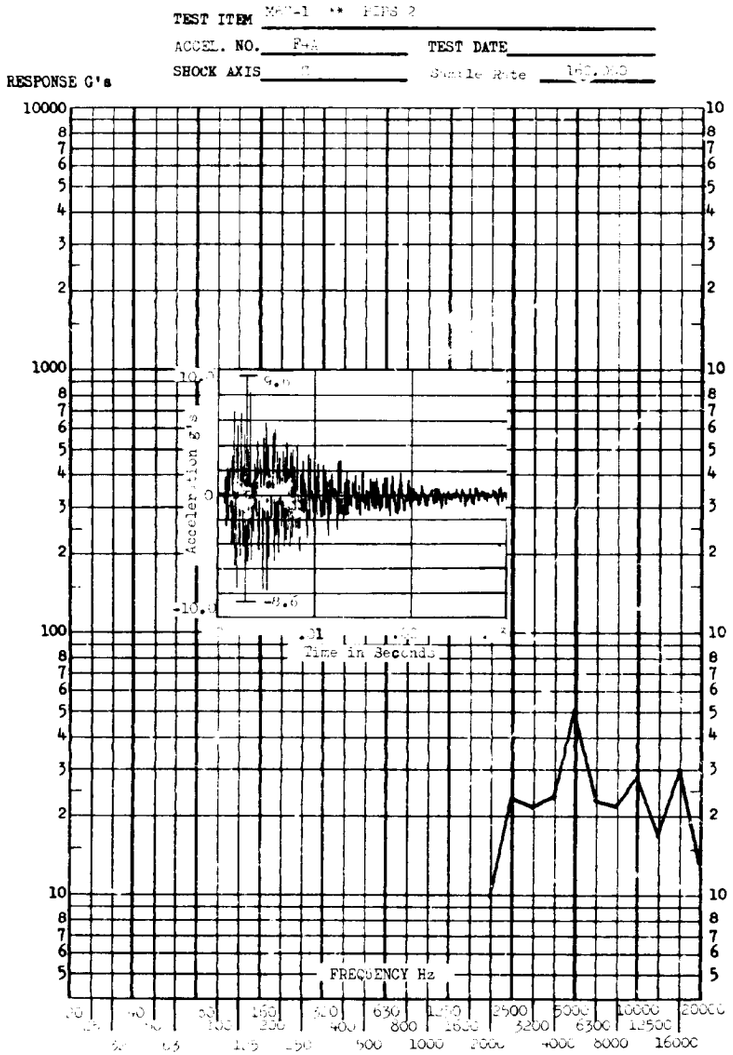




FIGURE IV.B.5-2

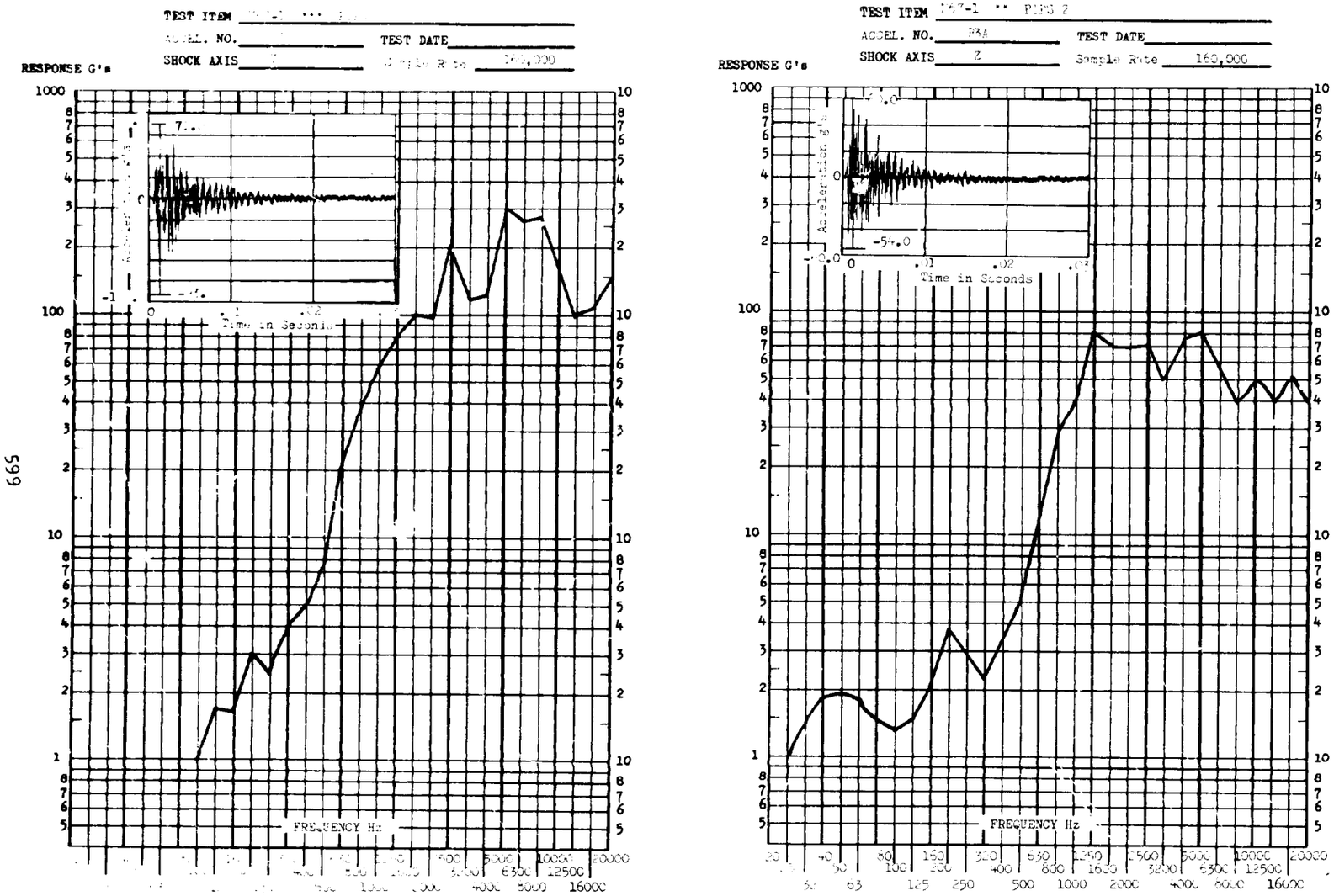



FIGURE IV.B.5-3

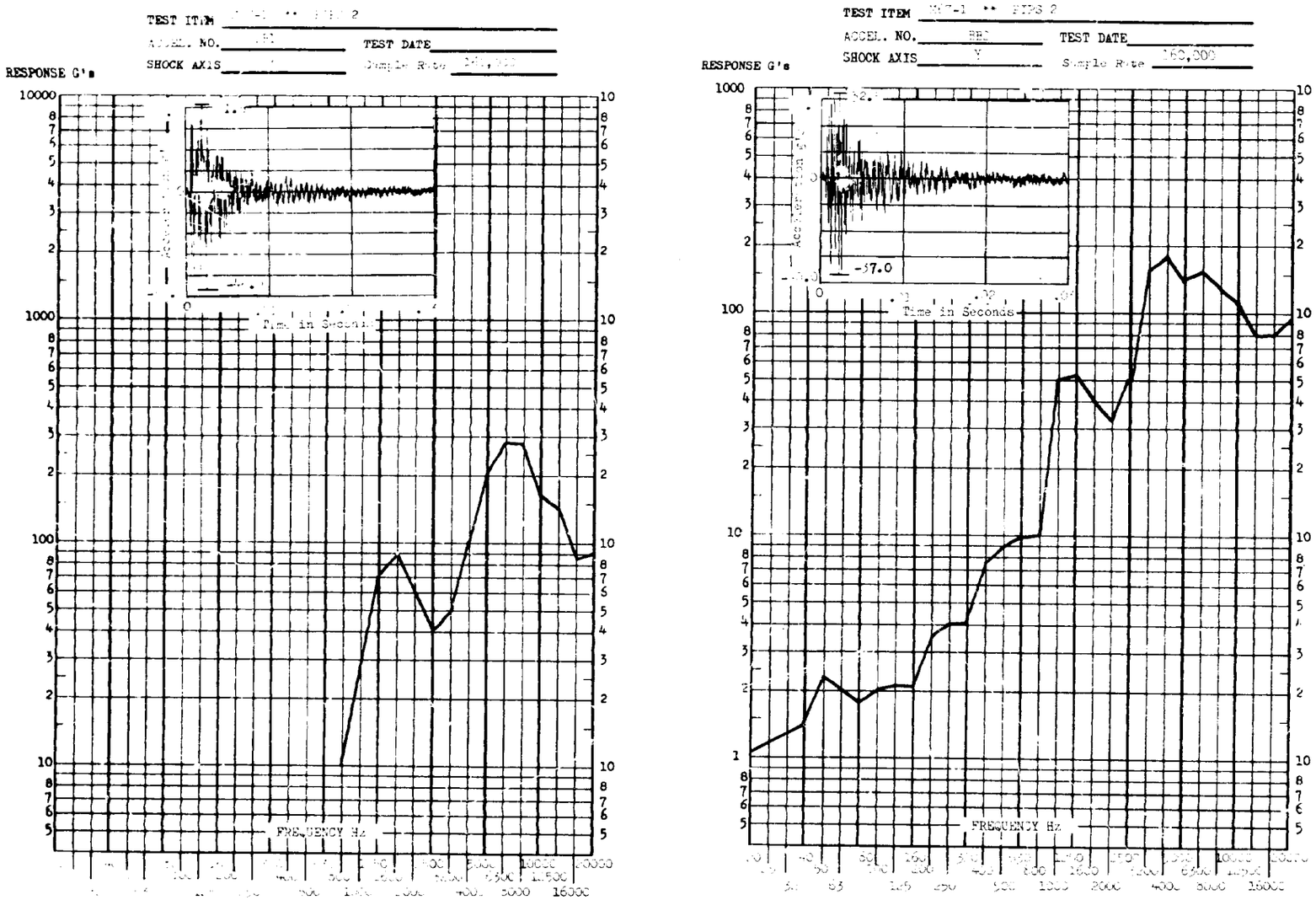



FIGURE IV.B.5-4

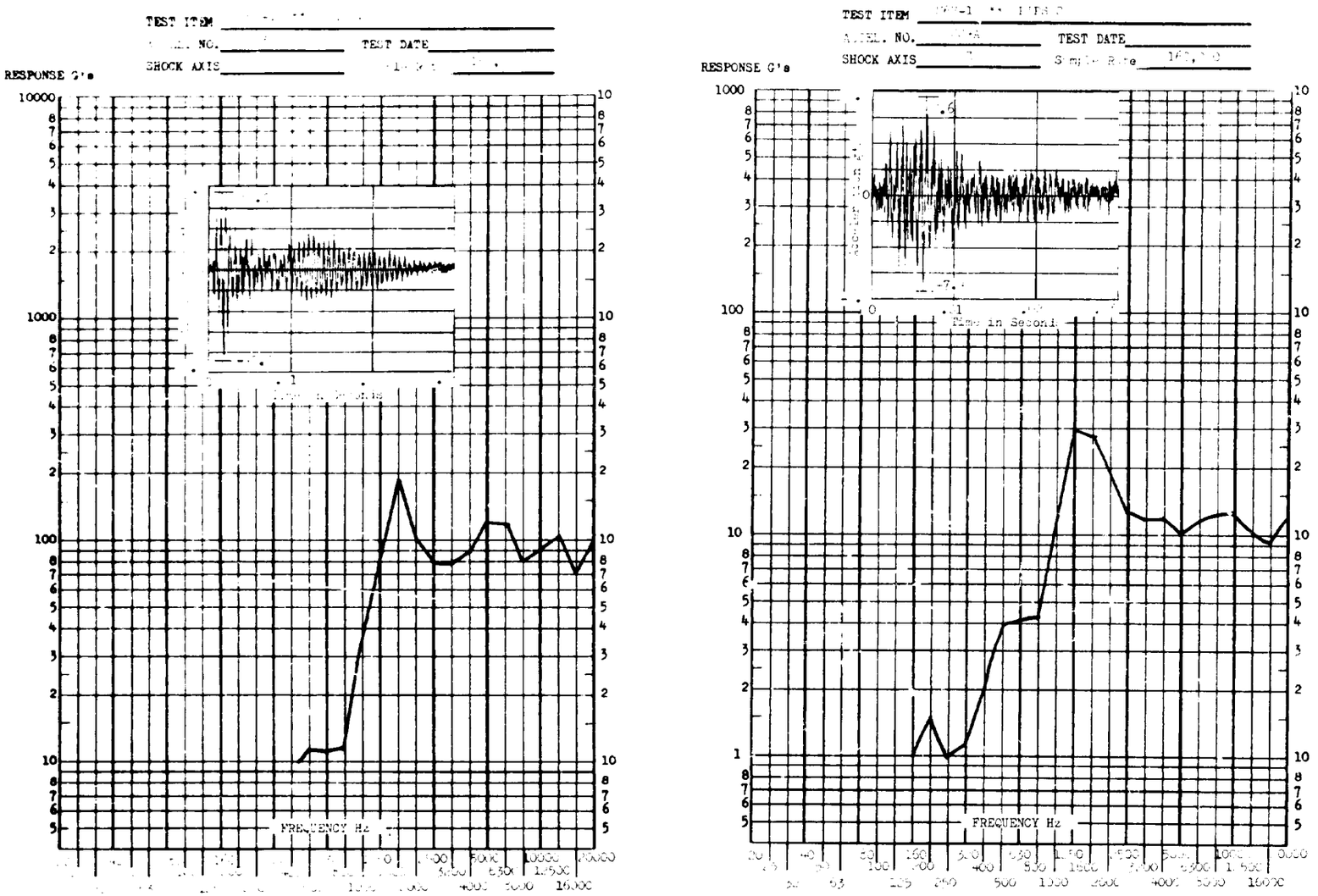



FIGURE IV.B.5-5

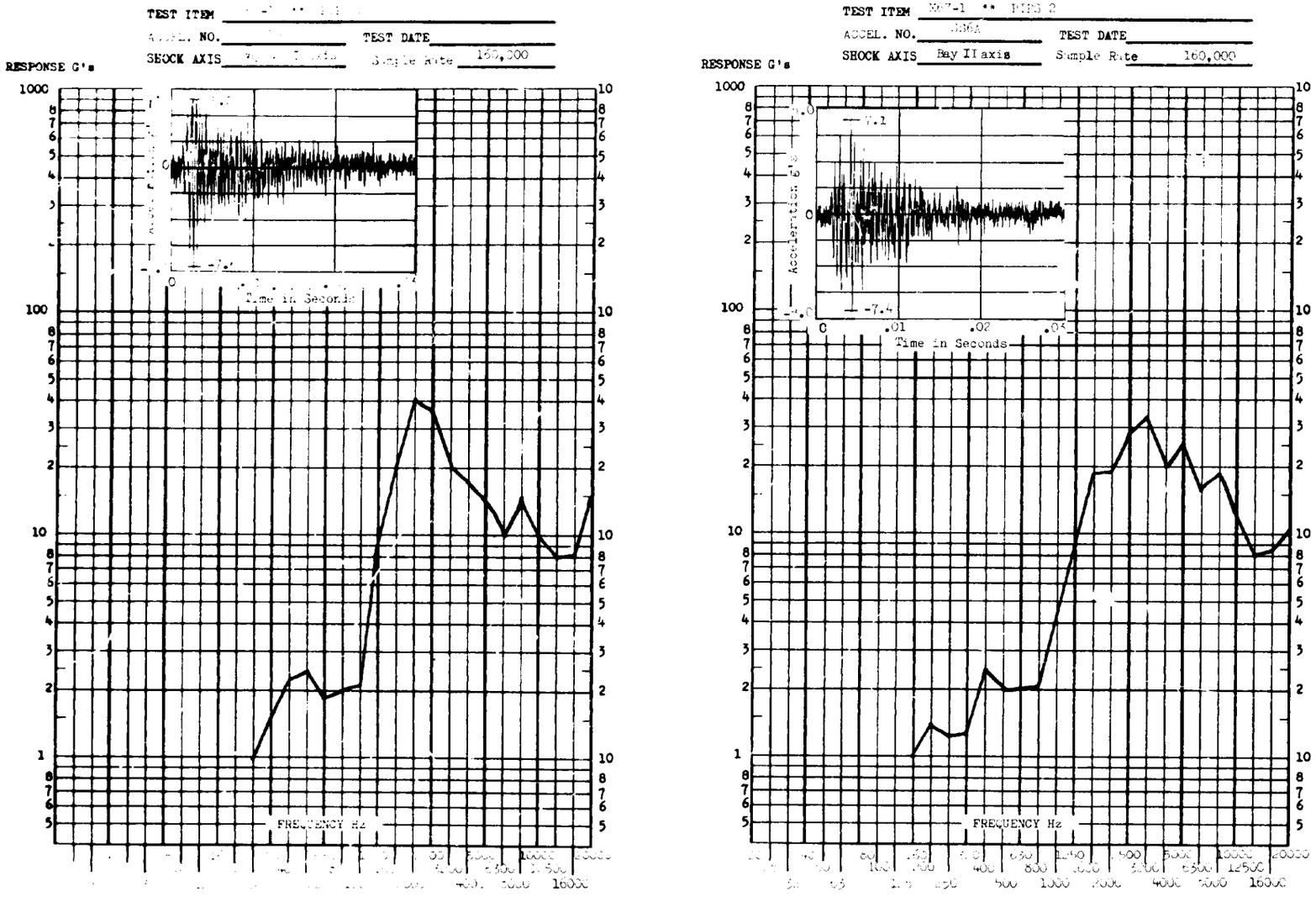



FIGURE IV.B.5-6

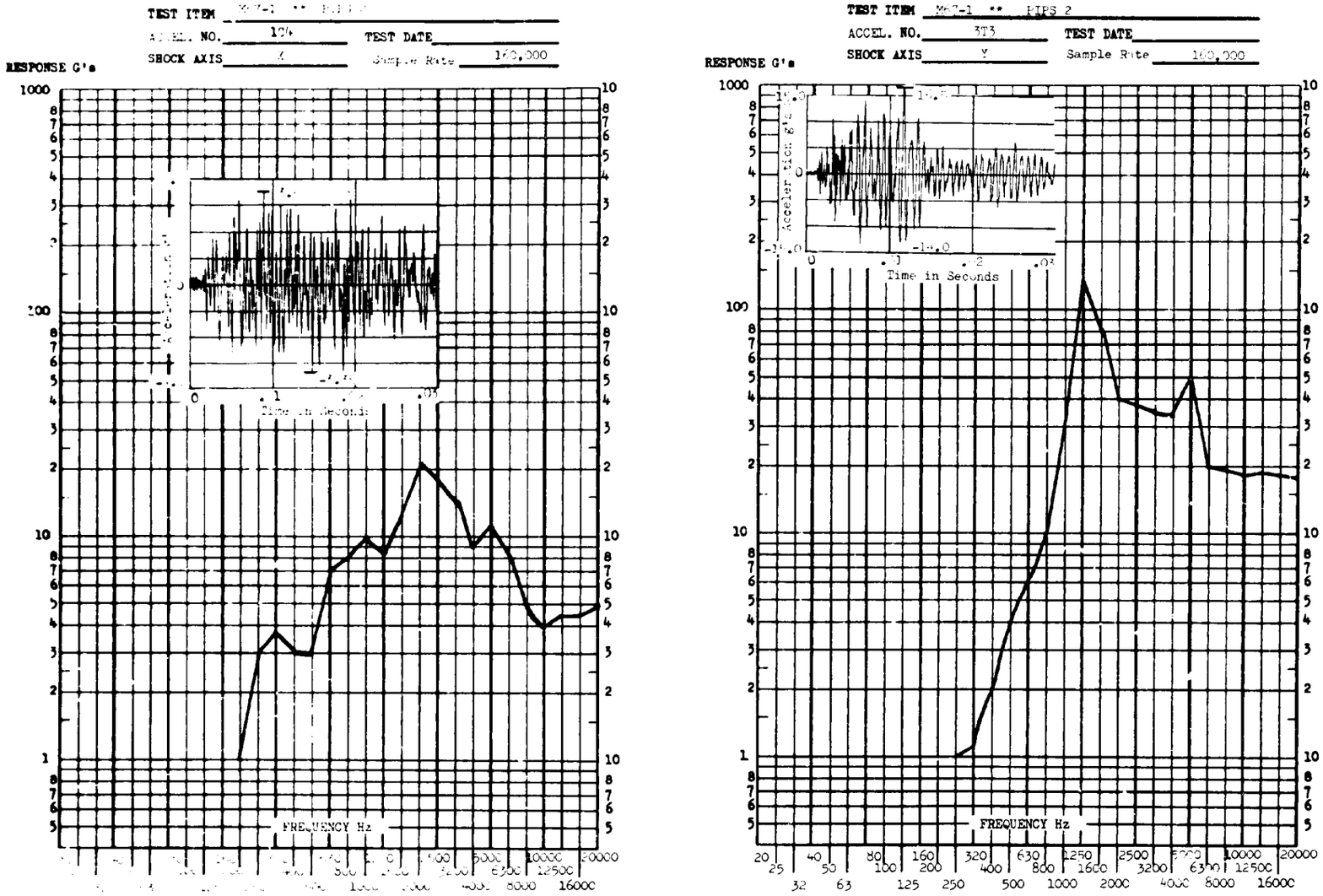



FIGURE IV.B.5-7

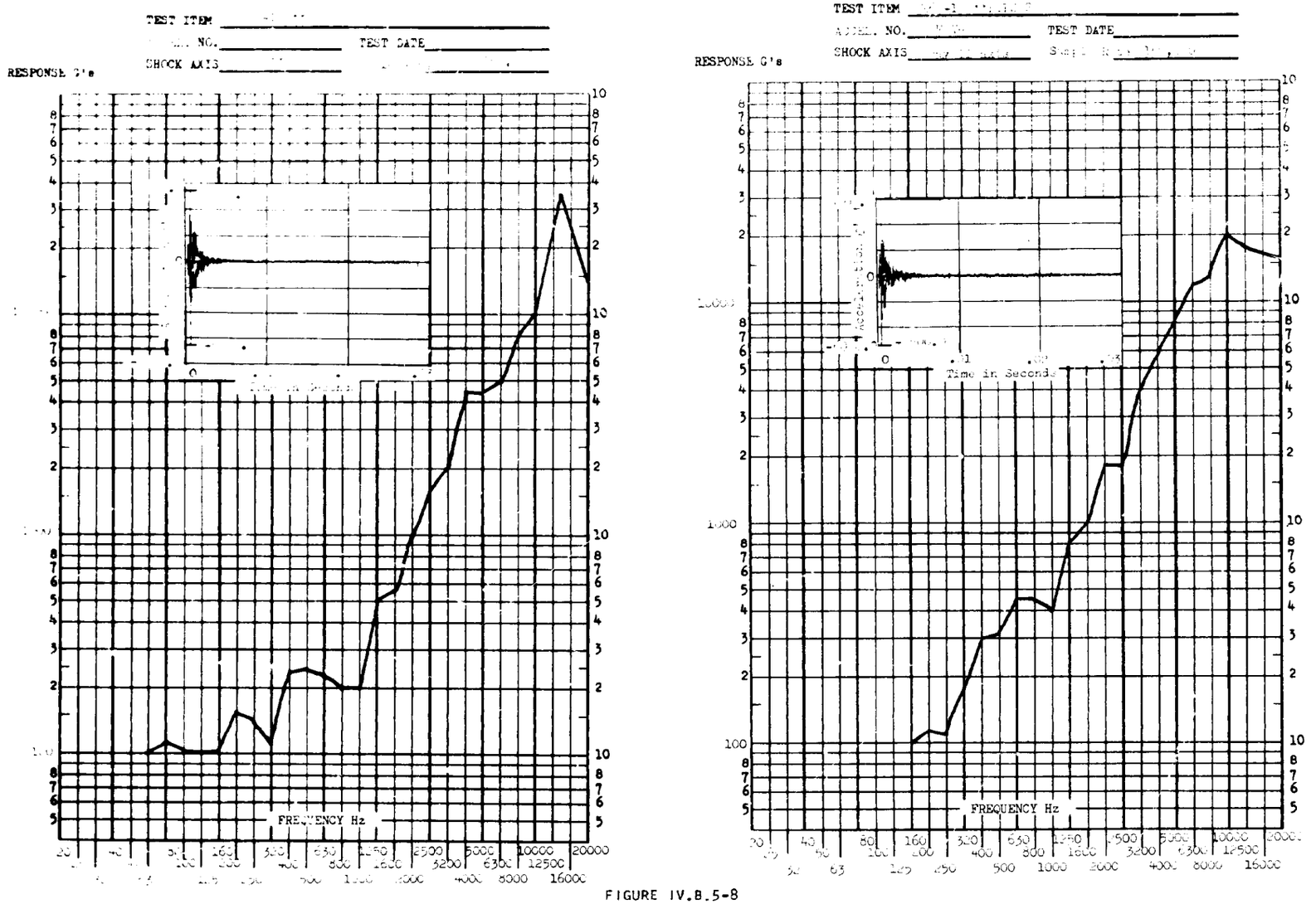



FIGURE IV.B.5-8

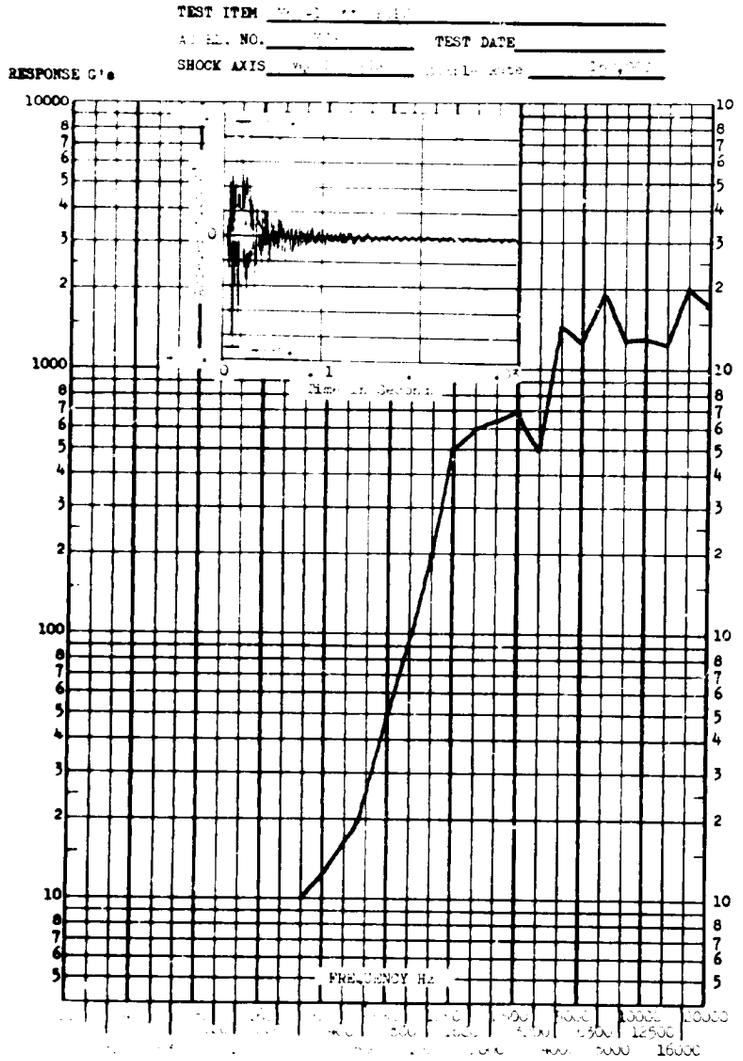



FIGURE IV.B.5-9

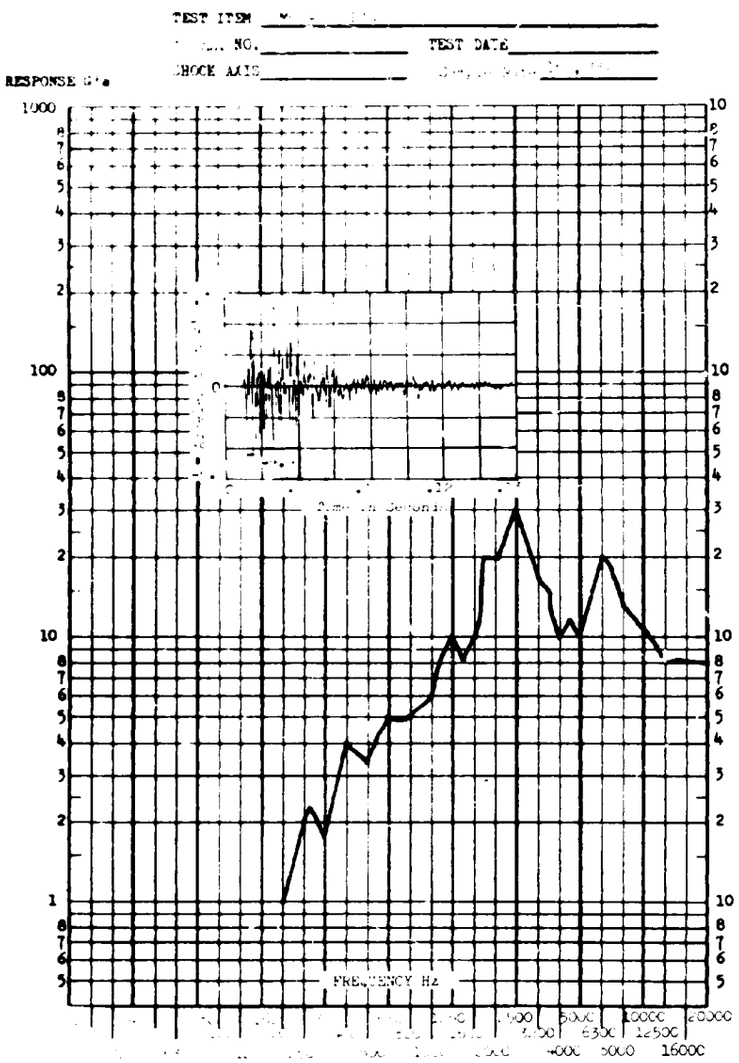
## SECTION IV.B.6

## M67 APAC EVENT

One firing of the high-gain antenna pointing angle change pyrotechnic was conducted on both M67-1 and M67-2. The pyrotechnic employed was a pin-pulling device. Fifteen shock spectra of this event are presented along with their corresponding time histories in Figures IV.B.6-1 through IV.B.6-8 as indexed in Table IV.B.6-1

TABLE IV.B.6-1

| Accelerometer Numbers | Configuration (s) | Figure Number |
|---|---|---|
| B3, F4 | M67-2 | IV.B.6-1 |
| F1 | M67-1, -2 | IV.B.6-2 |
| F3 | M67-1, -2 | IV.B.6-3 |
| F4A | M67-2 | IV.B.6-4 |
| B4, 3T3 | M67-1 | IV.B.6-5 |
| B5, B6 | M67-1 | IV.B.6-6 |
| SS4A, SS5A | M67-1 | IV.B.6-7 |
| SS6A, AS2 | M67-1 | IV.B.6-8 |



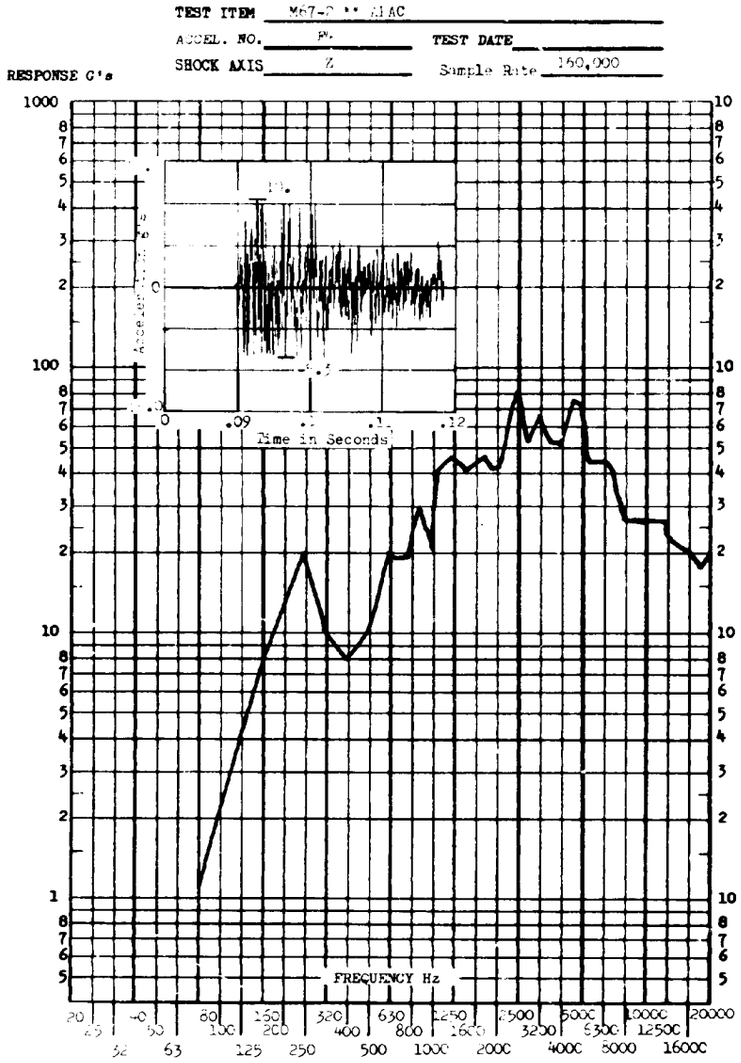




FIGURE IV.B.6-1

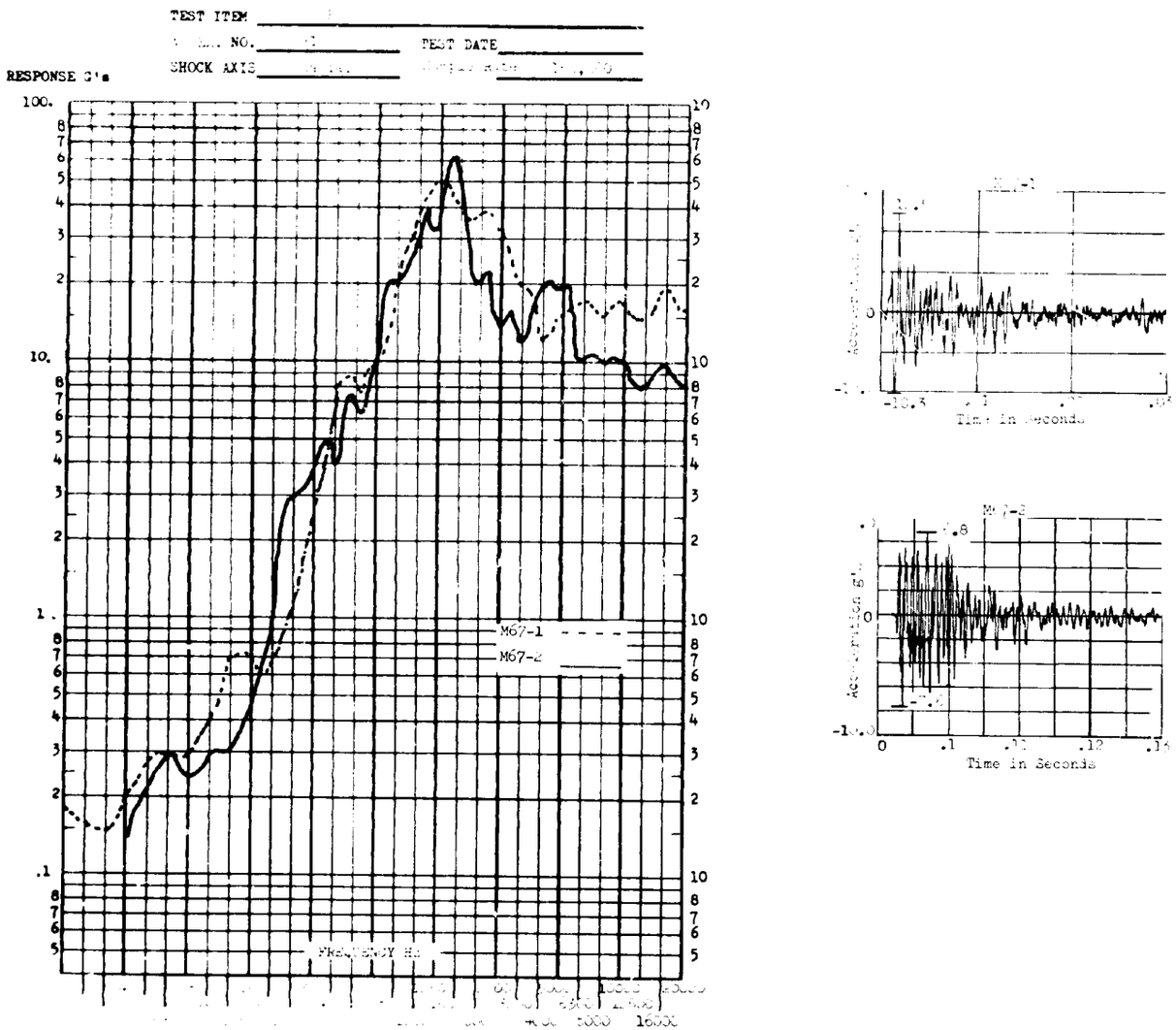









FIGURE IV.B.6-2

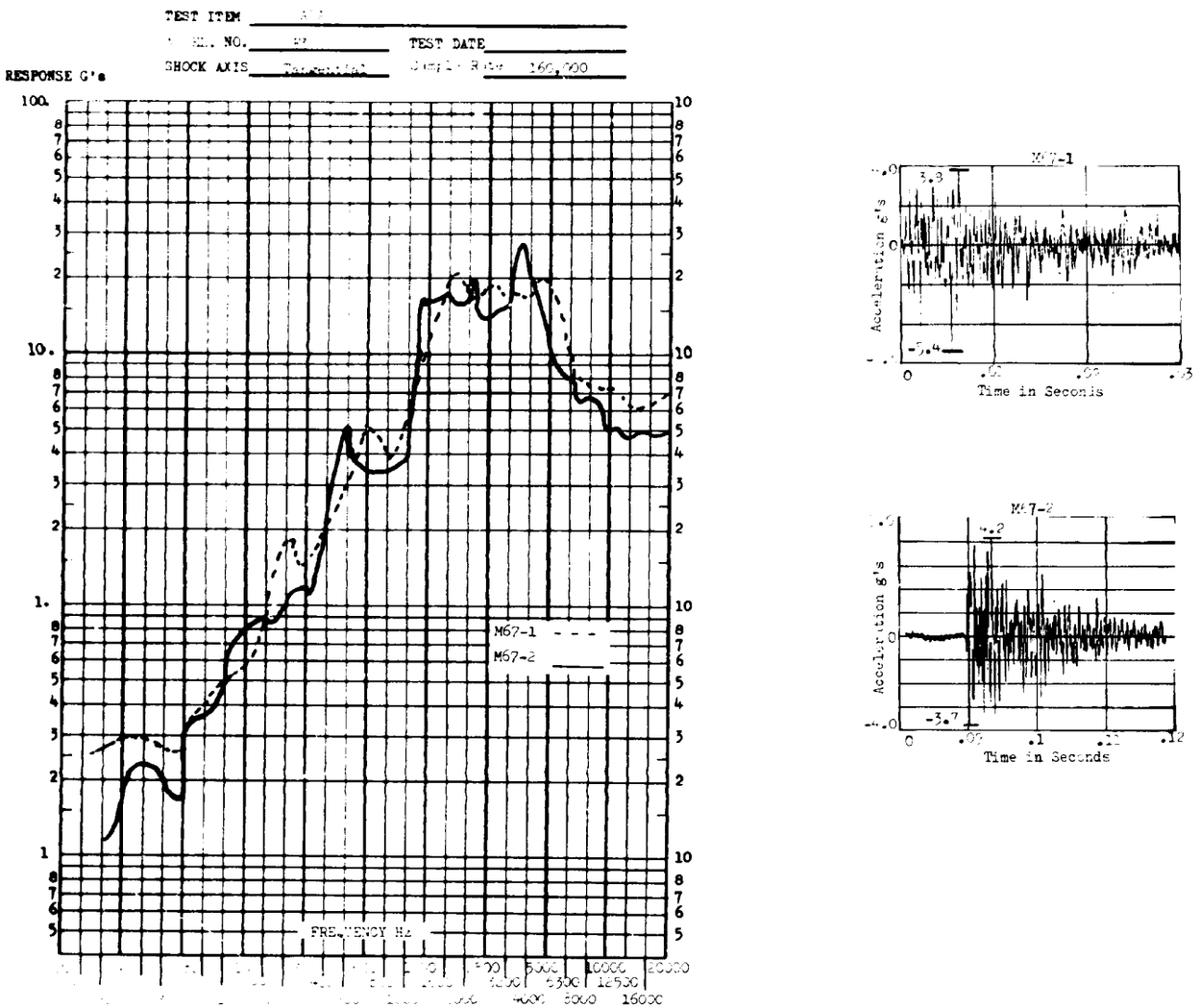









FIGURE IV.B.6-3

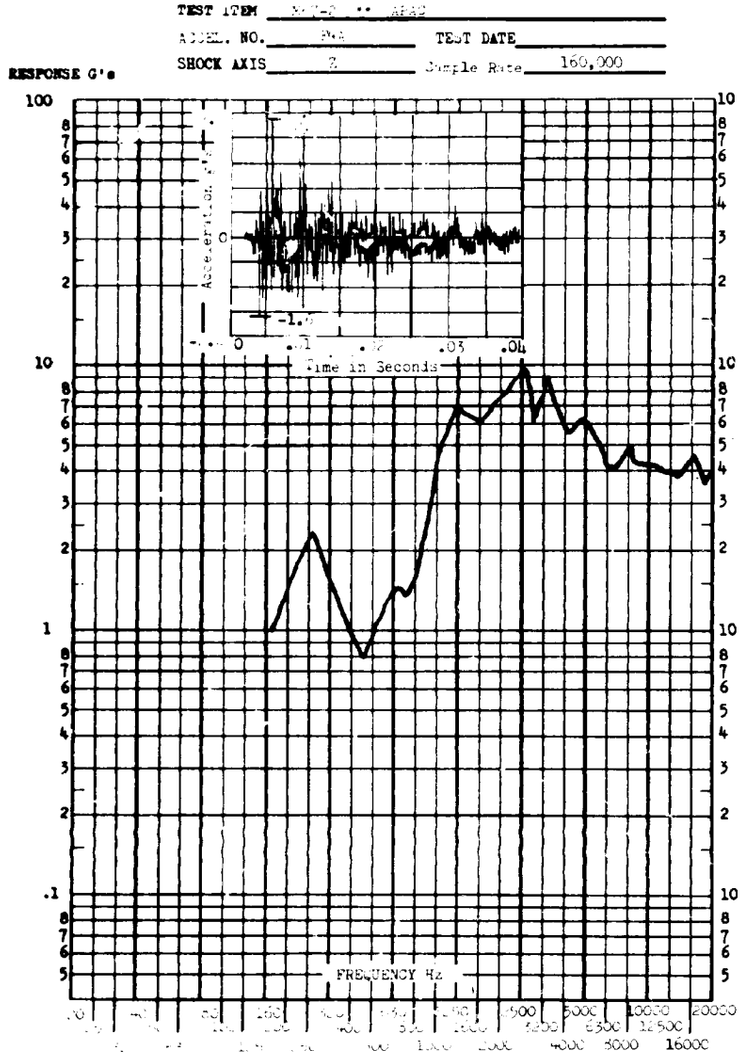



FIGURE IV.B.6-4

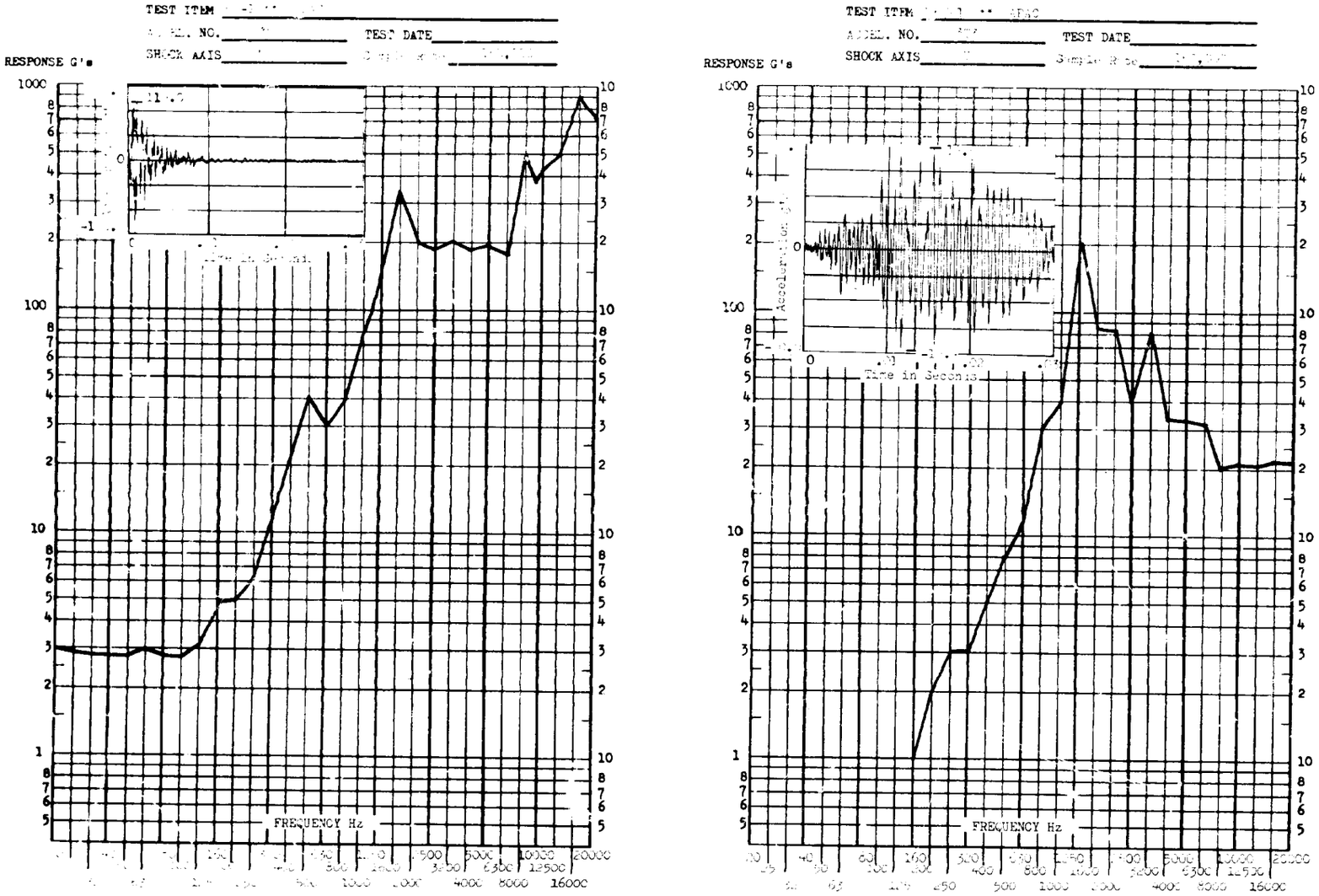



FIGURE IV.B.6-5

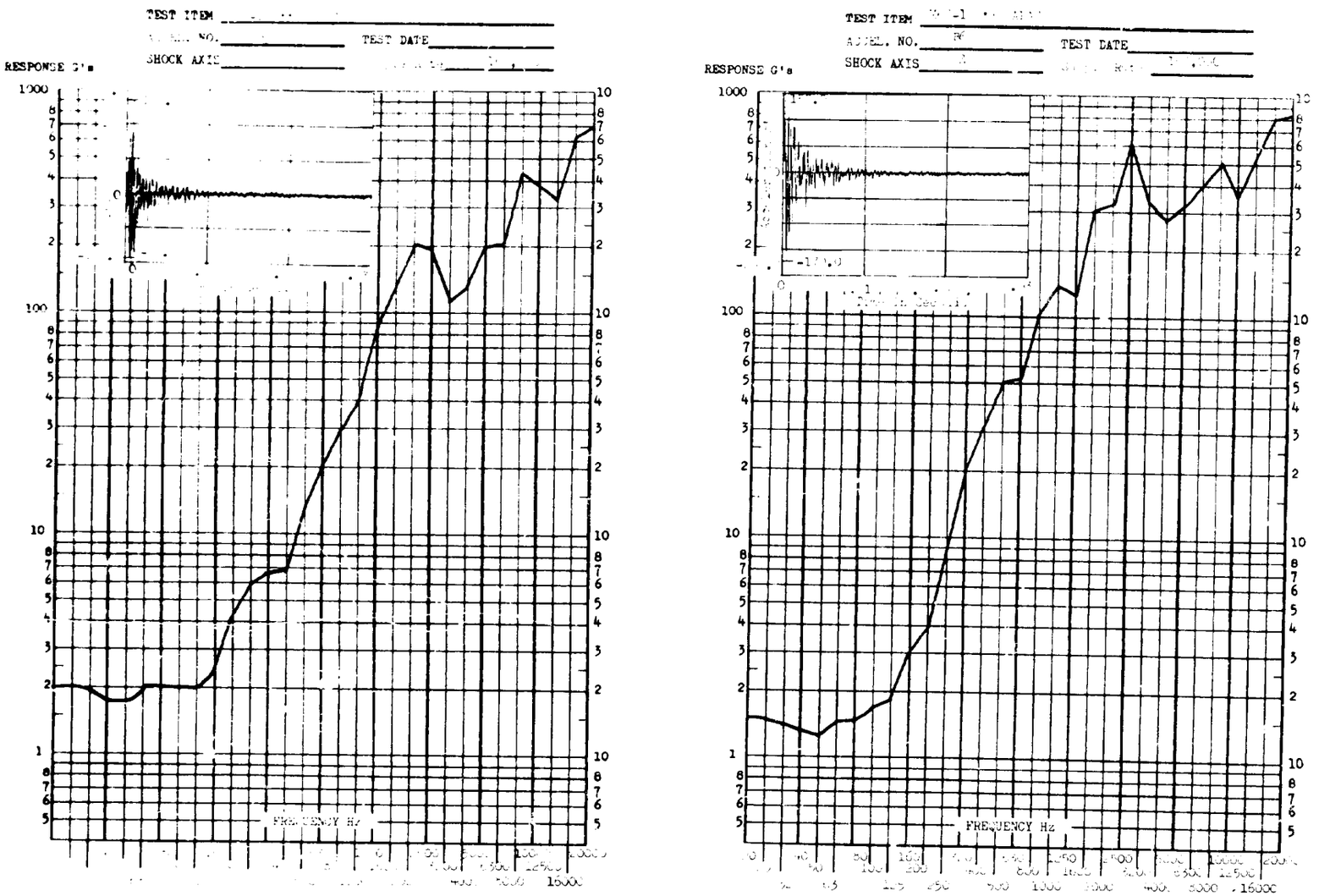
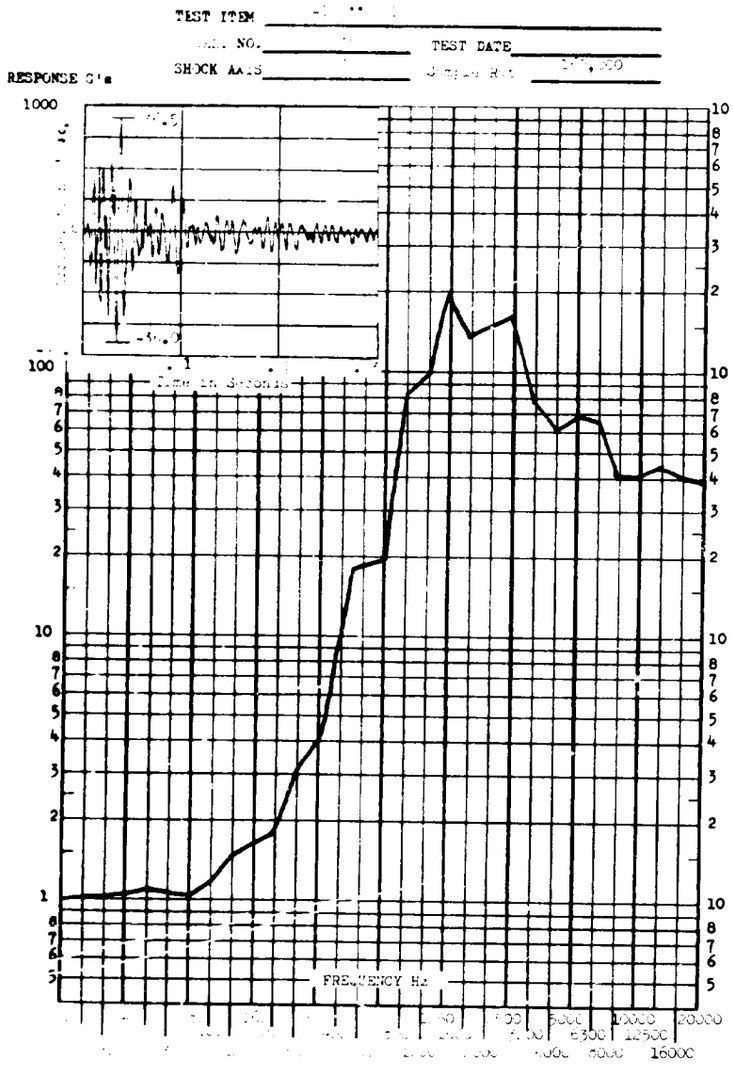



FIGURE IV.B.6-6



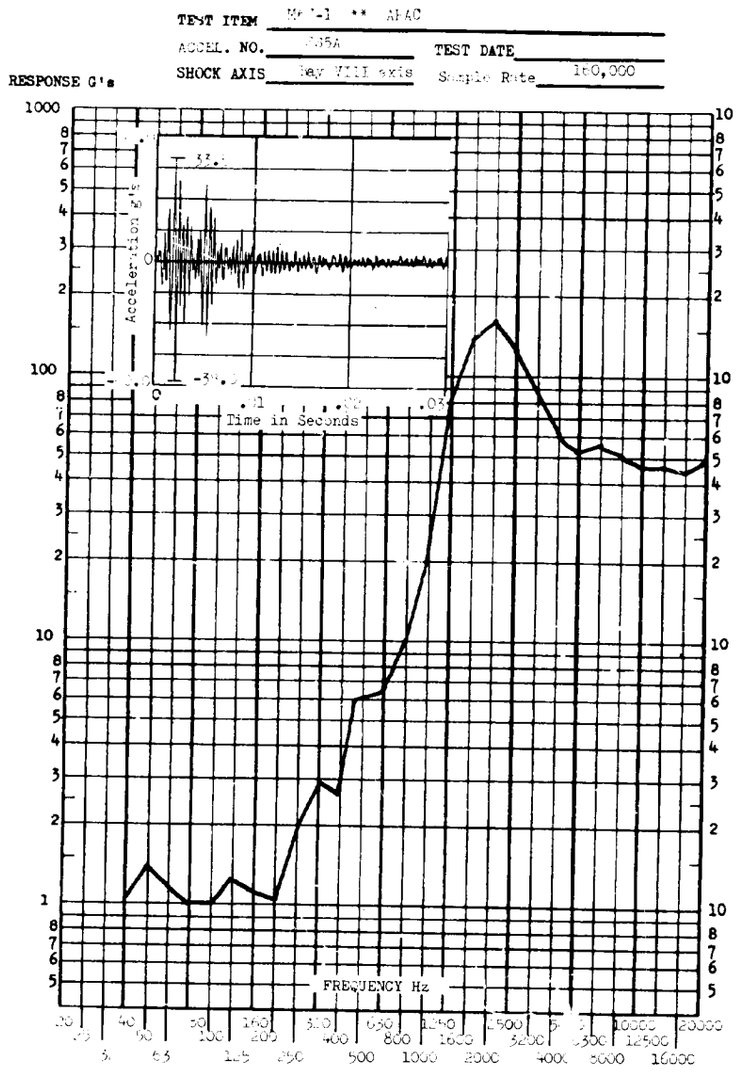




FIGURE IV.B.6-7

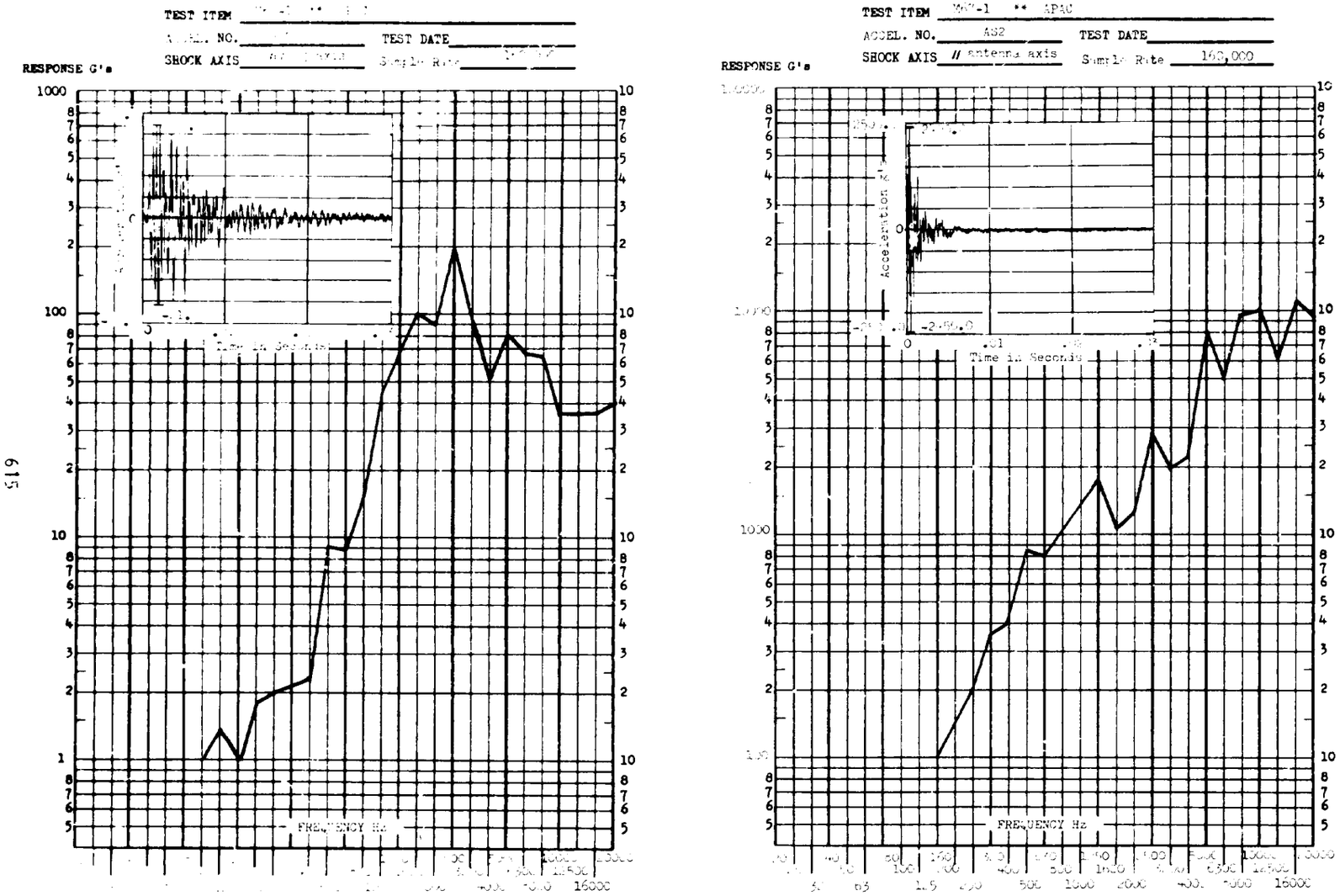



FIGURE IV.8.6-8

## SECTION IV.B.7

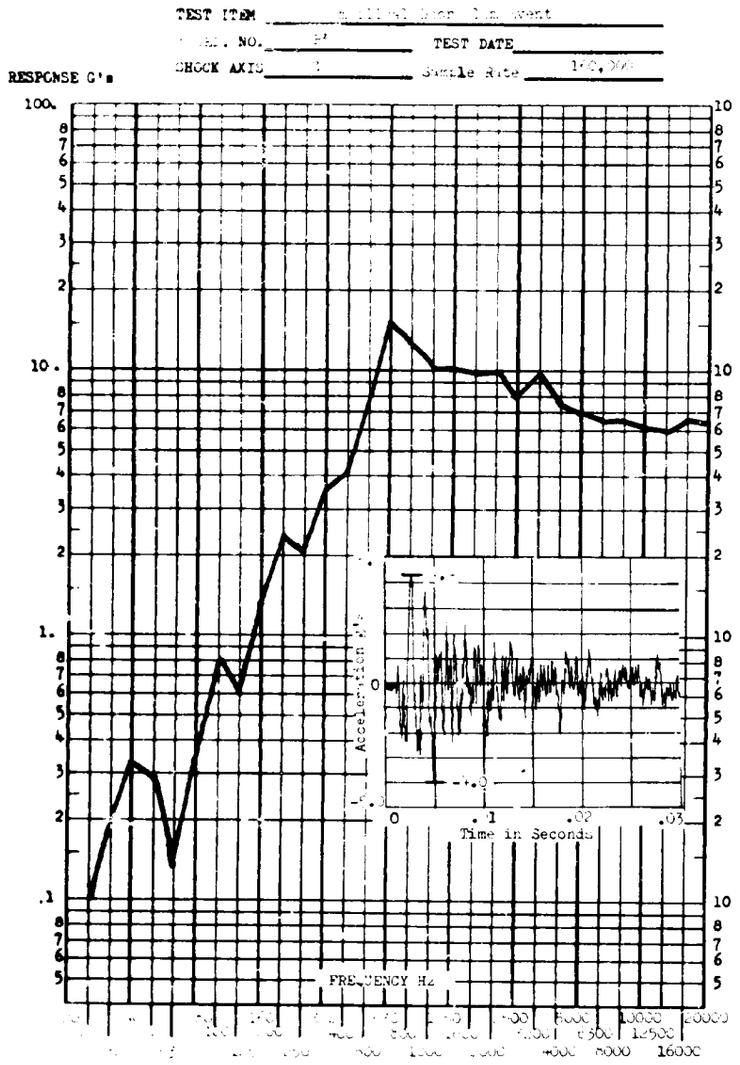
## M67-1 UMBILICAL DOOR SLAM EVENT

Two umbilical door slam tests were conducted on the M67-1 configuration. The spring loaded umbilical door in the LMSC shroud was opened fully and allowed to slam shut. Although this was not a pyrotechnic event, it was considered important to ascertain the mechanical shock levels produced in the Mariner vehicle due to the door slam event. Seventeen shock spectra envelopes of this event are presented along with typical time histories as Figures IV.B.7-1 through IV.B.7-9 as indexed in Table IV.B.7-1

TABLE IV.B.7-1

INDEX OF DATA LOCATIONS

| Accelerometer Numbers | Figure Number |
|---|---|
| B3, F4 | IV.B.7-1 |
| F1, F3 | IV.B.7-2 |
| F4A, B1A | IV.B.7-3 |
| B2A, B3A | IV.B.7-4 |
| BB1, BB2 | IV.B.7-5 |
| BB3, A32 | IV.B.7-6 |
| IC4, 3T3 | IV.B.7-7 |
| MCV1, MCV4 | IV.B.7-8 |
| MC4 | IV.B.7-9 |



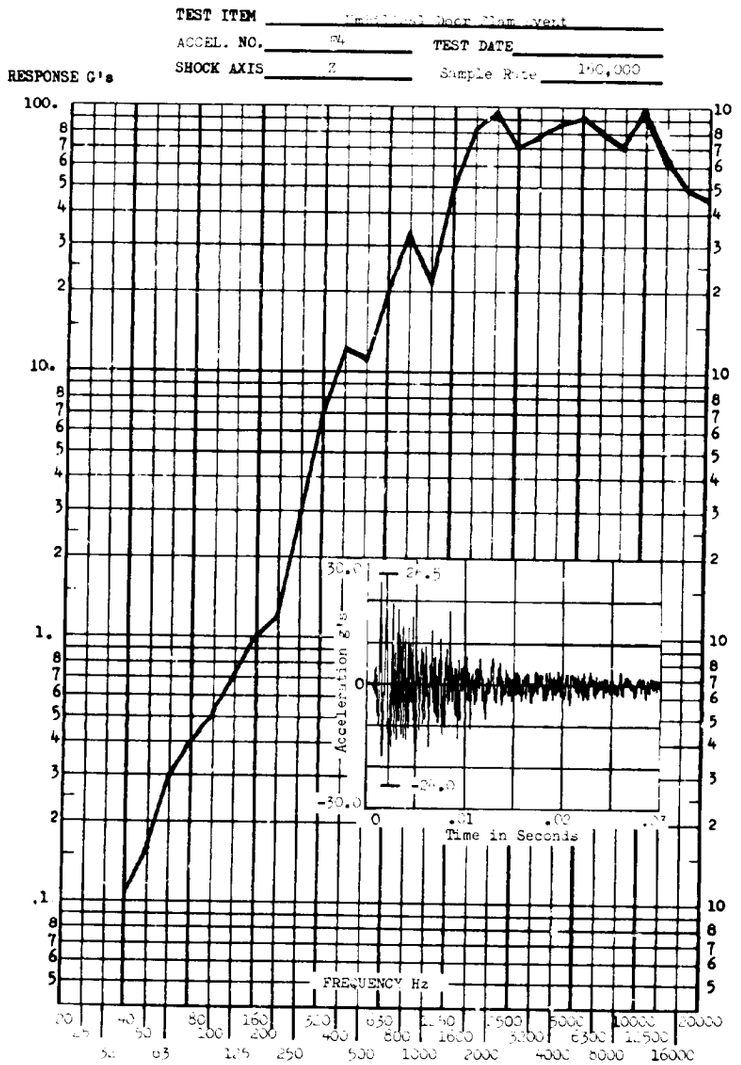
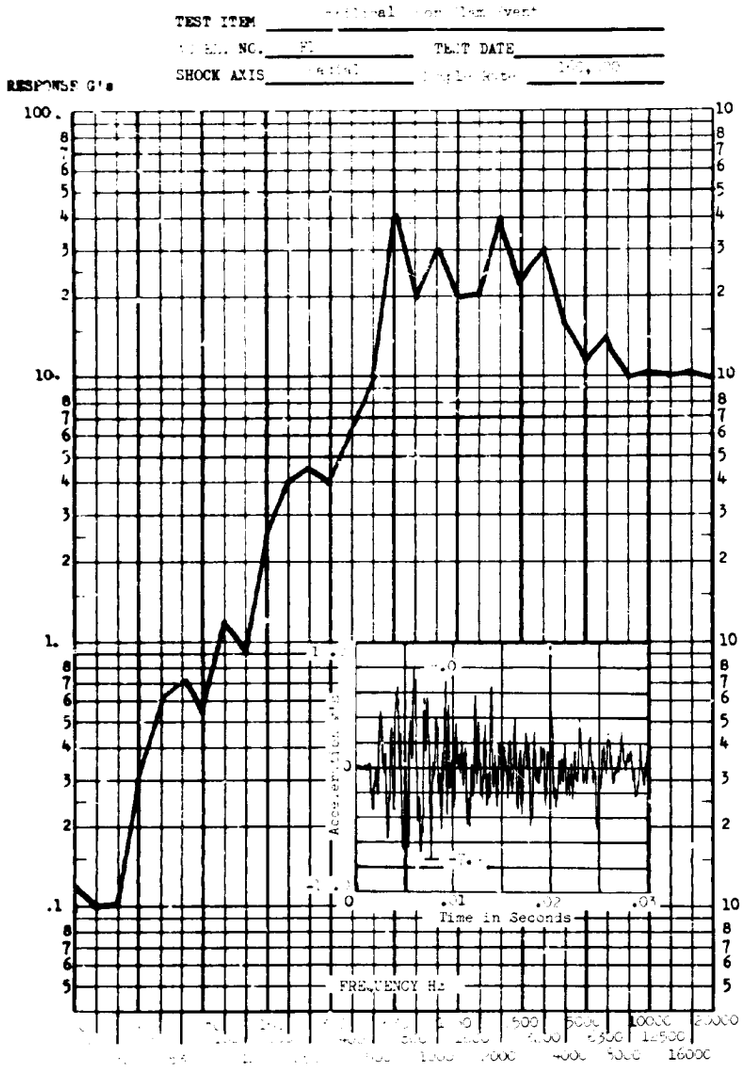




FIGURE IV.B.7-1



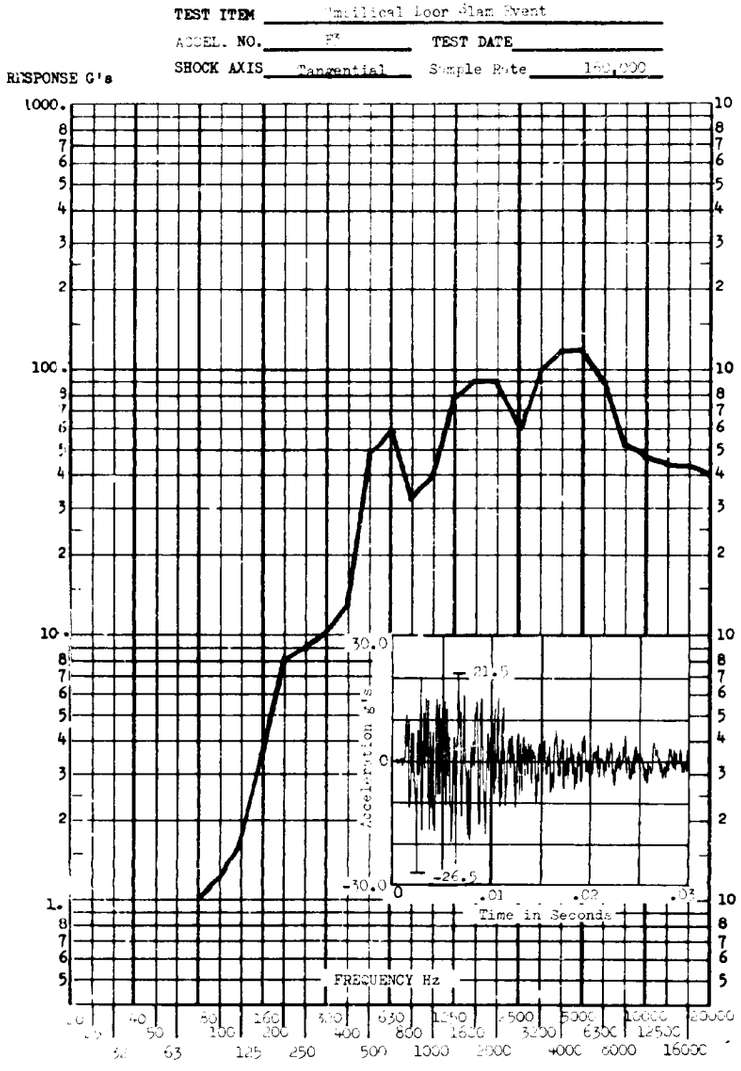




FIGURE IV.B.7-2

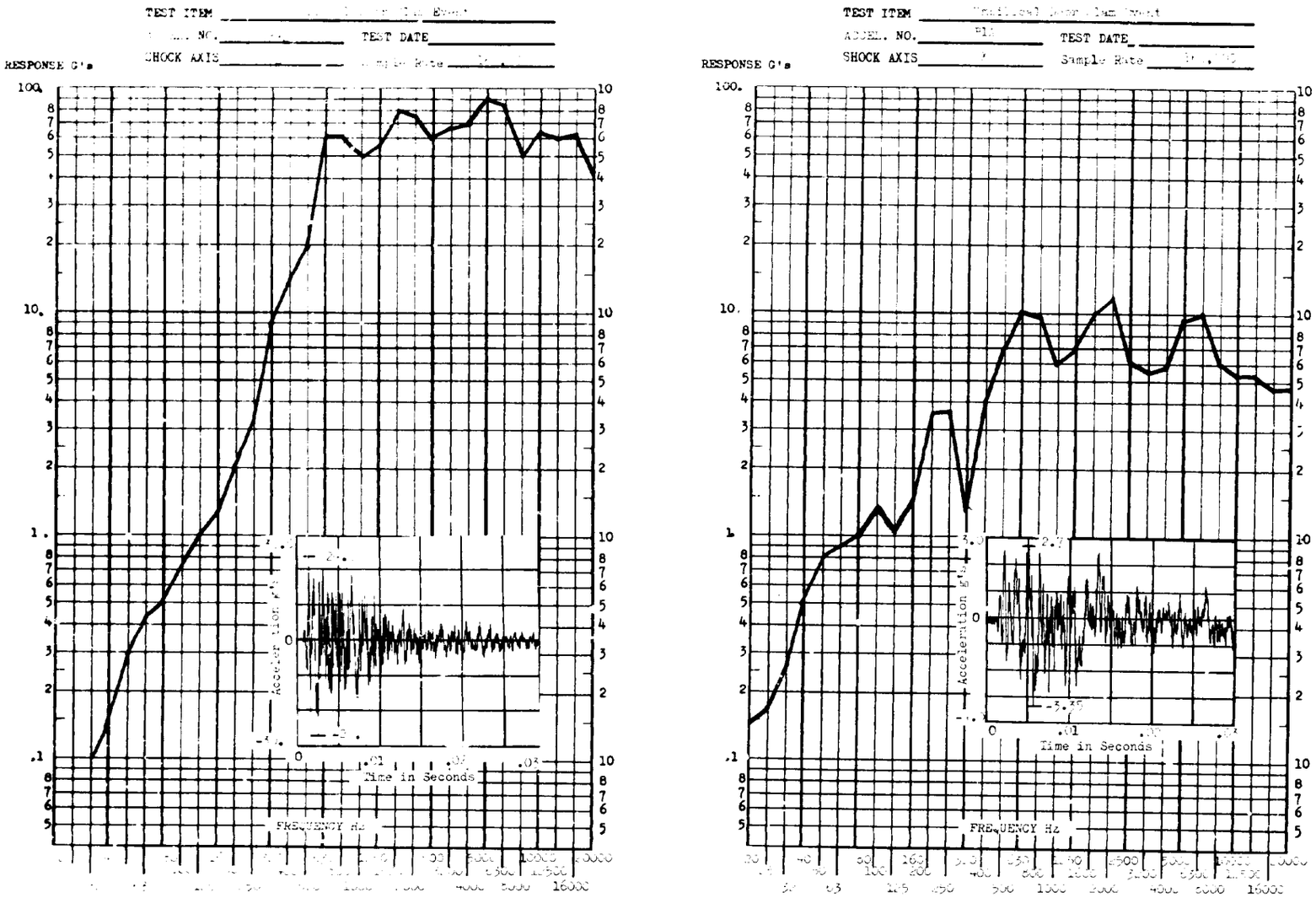



FIGURE IV.B.7-3

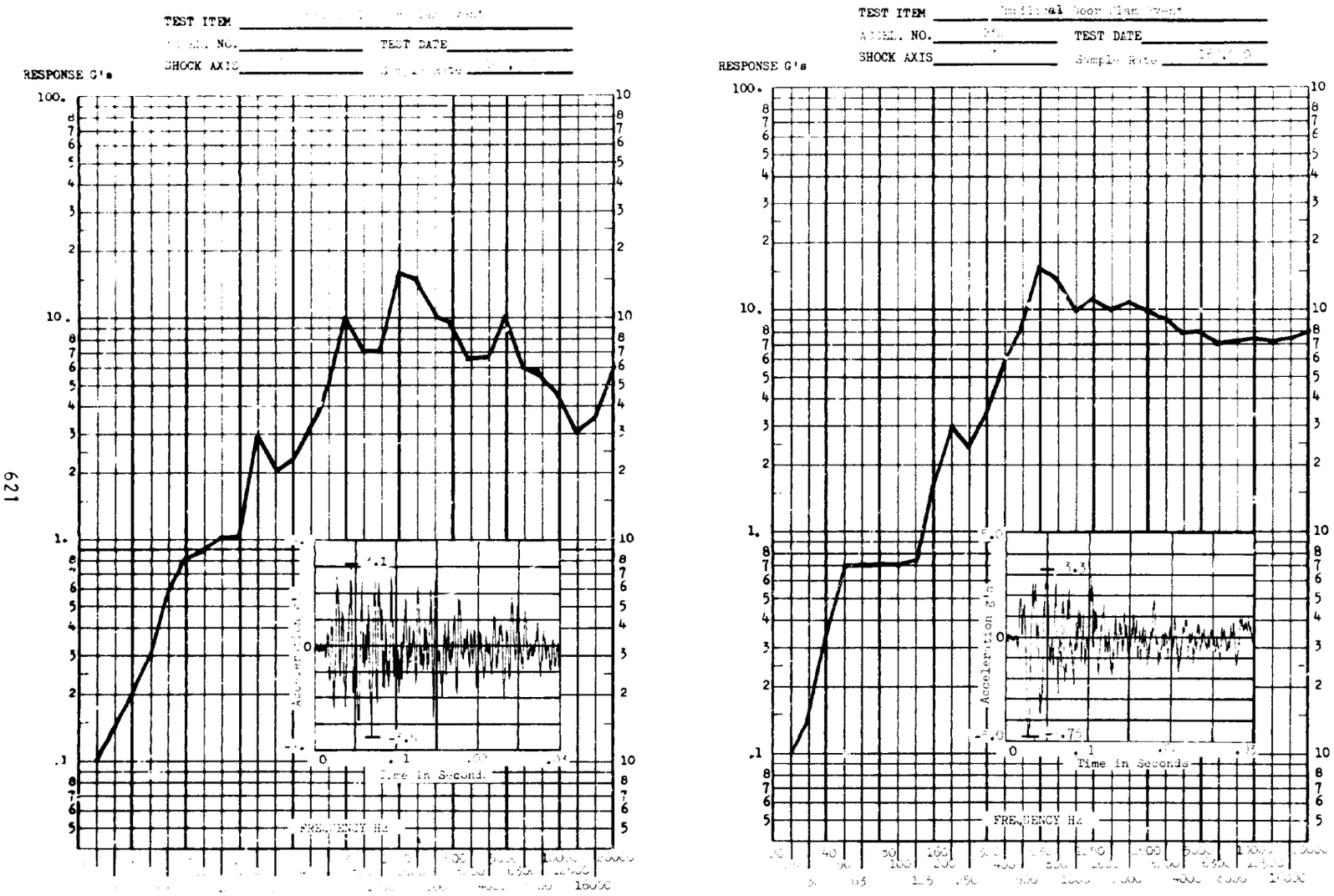


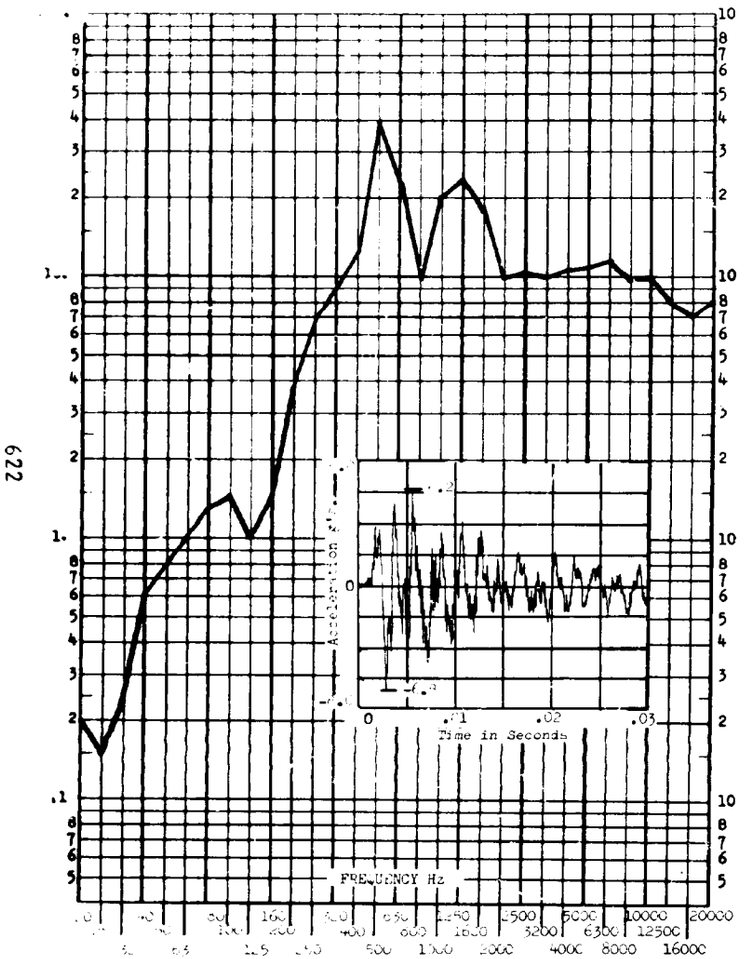

FIGURE IV.B.7-4

TEST ITEM [illegible] Vertical Floor Slam Event

ACCEL. NO. [illegible] TEST DATE

SHOCK AXIS [illegible] Sample Rate [illegible]

RESPONSE G's




TEST ITEM Vertical Floor Slam Event

ACCEL. NO. 3B2 TEST DATE

SHOCK AXIS Y Sample Rate 1-0,000

RESPONSE G's

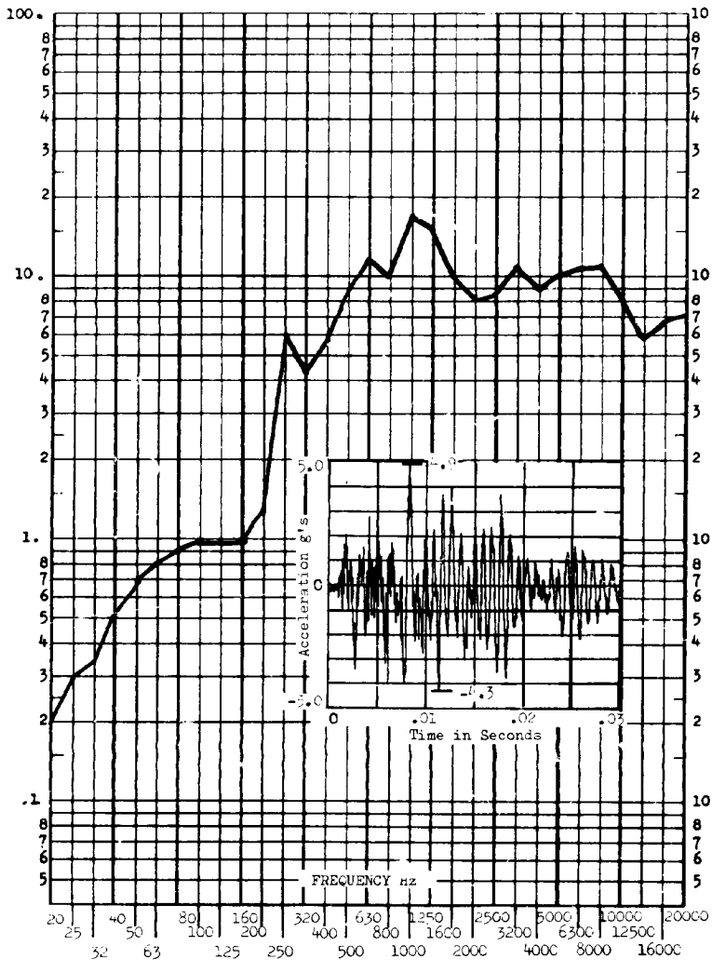
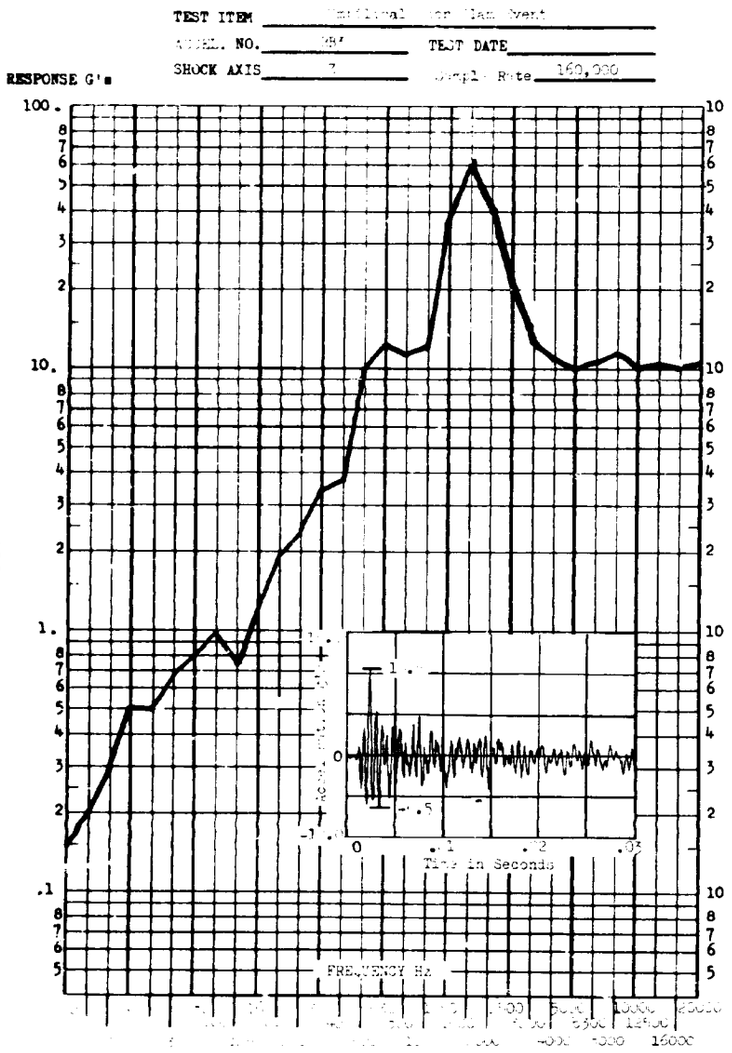



FIGURE IV.8.7-5



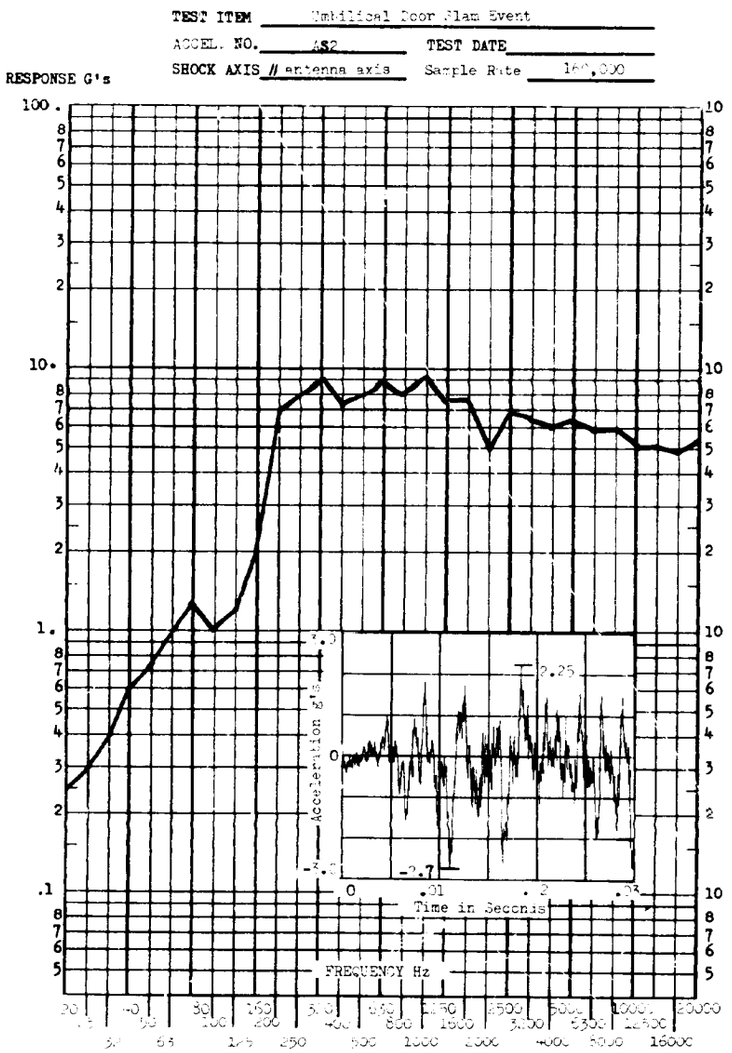
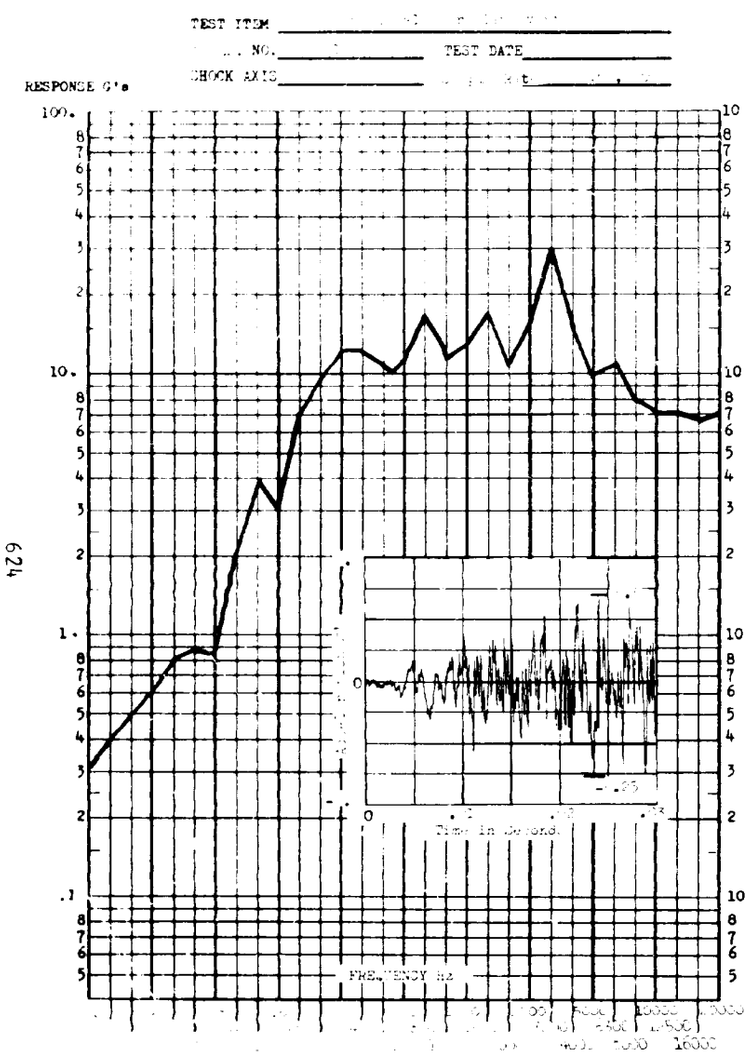




FIGURE IV.B.7-6



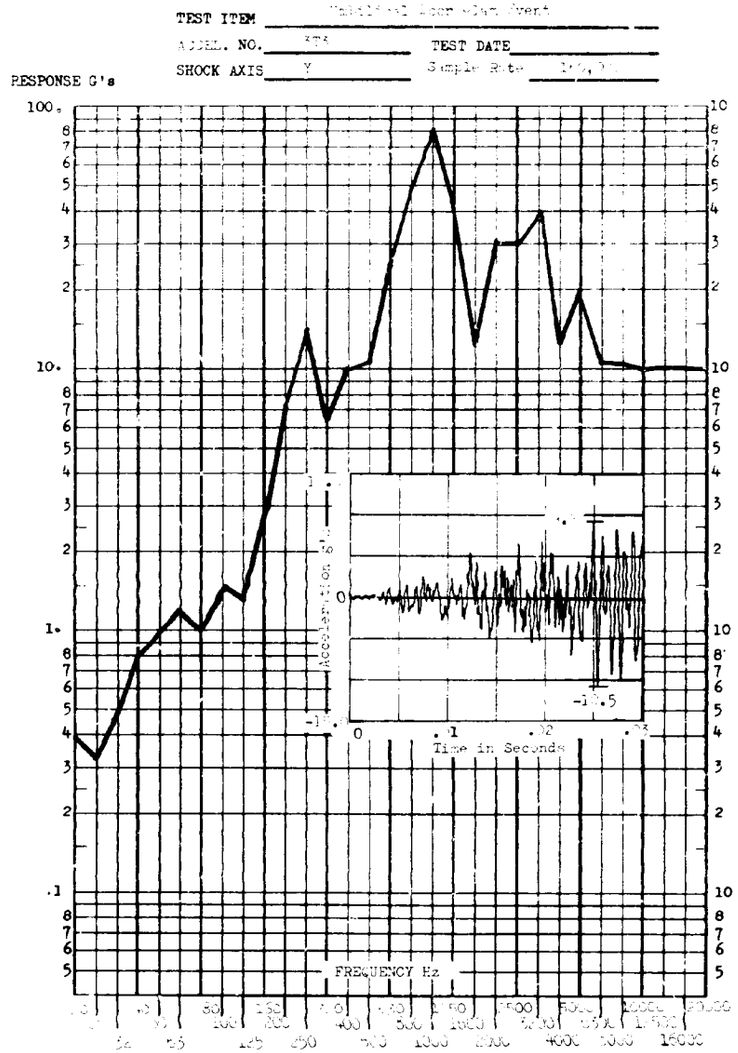




FIGURE IV.B.7-7

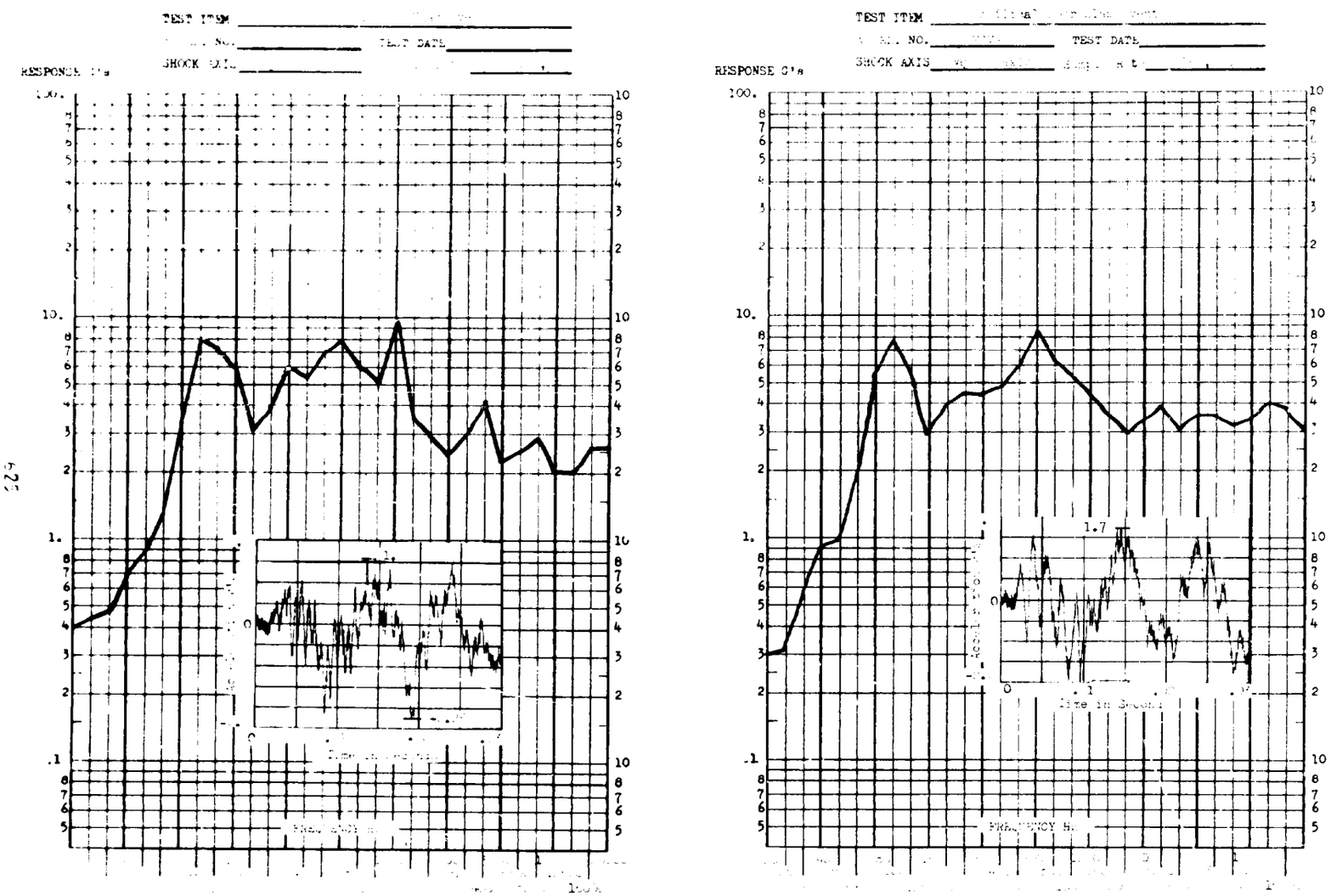



FIGURE IV.3.7-8

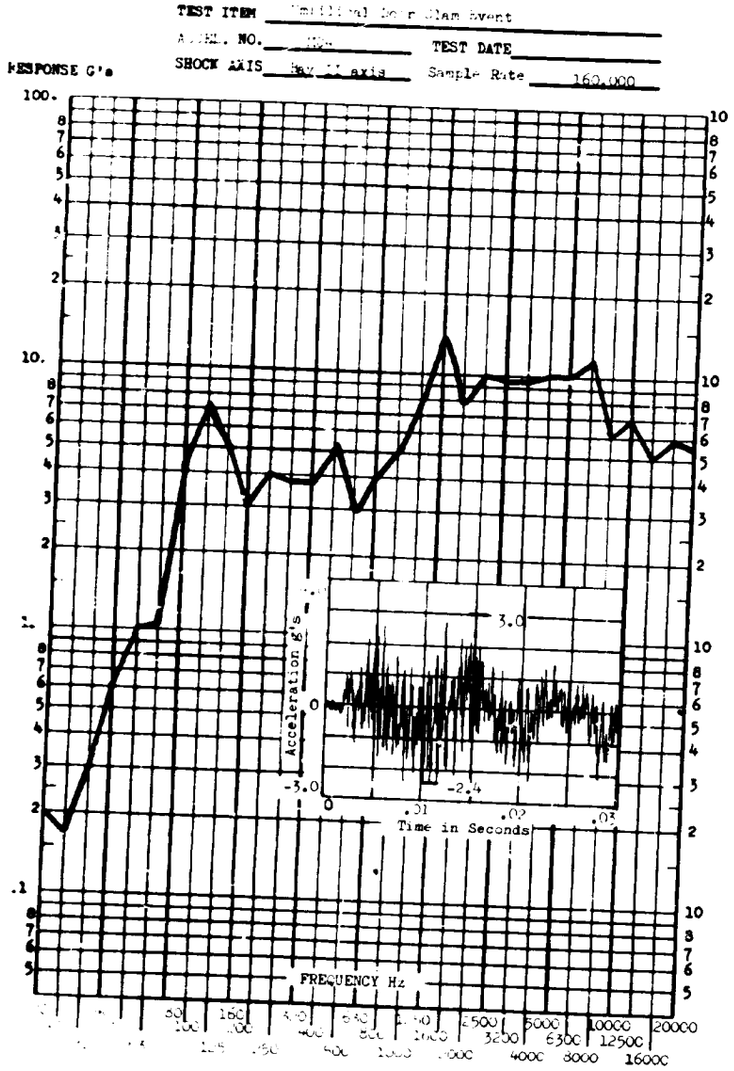



FIGURE IV.B.7-9

# PART IV.C

# PYROTECHNIC SHOCK DATA COMPILED FOR SURVEYOR PYROTECHNIC ACCEPTANCE TESTS

PART IV.C

SHOCK EVENTS FROM SURVEYOR FLIGHTS

DESCRIPTION OF FLIGHT ARTICLES

Two different configurations of the Surveyor vehicle were flown. The first two flights, designated SD-1 and SD-2, were dynamic models of the operational spacecraft as depicted in Figure IV.C.-1. Each consisted of an operation-type spaceframe with dummy components simulating the msss properties of those items they represented. These spacecraft were the same overall physical size as the operational vehicle, being approximately 86 inches across at the widest point (landing legs folded) and approximately 100 inches tall. The SD-1 spacecraft weighed approximately 1600 lb, and the SD-2 weighed approximately 2200 lbs, which was the weight of the operational spacecraft. The seven operational Surveyor spacecraft launches that succeeded the dynamic model flights were designated SC-1 through SC-7 and had the configuration depicted in Figure IV.C.-2.

DESCRIPTION OF EVENTS

Shock data were recorded and reduced for all the transient events associated with each surveyor flight. Section IV.C.1 through IV.C.5 present

data for the events listed below:

1) Atlas/Centaur Separation (Section IV.C.1)

2) Shroud Separation (Section IV.C.2).

3) Insullation Panel Jettison (Section IV.C.3)

4) Omni Antenna Deploy (Section IV.C.4)

5) Other Shock Events of a non-pyrotechnic nature (Section IV.C.5)

Accompanying the data in each section is a brief description of the particular event and the pyrotechnic involved.

DESCRIPTION OF DATA

The following information is representative of the data reduction for all the data in Sections IV.C.1 through IV.C.5.

| | |
|---|---|
| Type of analysis | digital |
| Sample rate | Table IV.C.-2 |
| Frequency range | Table IV.C.-1 |
| Frequency increments | Table IV.C.-2 |
| Damping | Q = 20 |

DESCRIPTION OF ACCELEROMETERS

Locations: Table IV.C.1 and Figure IV.C.3

Axis Sensitivity: Table IV.C.1

COMMENTS

Because these data were taken from flight events, Part IV.C could have been presented in Division V. Also since the pyrotechnics for the various flight events are conventional, some of the data might just as well have been presented in Parts I.C and II.C.

Whenever a data sheet shows several spectra and one time history, the time history is "typical" for all the spectra and is not necessarily associated with anyone of them.

TABLE IV.C.1

ACCELEROMETER INFORMATION

| Accelerometer Number | Location | Sensitive Axis | Frequency Range (Hz) SD Vehicles | SC Vehicles |
|---|---|---|---|---|
| CY 490 | Attach Point | X | 2-125 | ---------- |
| CY 500 | Attach Point | Y | 2-200 | ---------- |
| CY 510 | Attach Point | Tangential | 2-300 | ---------- |
| CY 520 | Attach Point | Z | 2-500 | 2-1150 |
| CY 530 | Attach Point | Z | 2-700 | 2-970 |
| CY 540 | Attach Point | Z | 2-800 | 2-970 |
| CA7720 | Adapter | Radial | ----- | 2-2300 |
| CA7730 | Adapter | Z | ----- | 2-970 |

TABLE IV.C.2

DATA REDUCTION STATISTICS

| Flight Designation Nos | Sample Rate | Frequency Increments |
|---|---|---|
| SD-1 thru SC-2 | 10 times the highest frequency present on plots | 50 points over the frequency range present on plots |
| SC-3 thru SC-7 | 20,000/second | 20 points per decade |

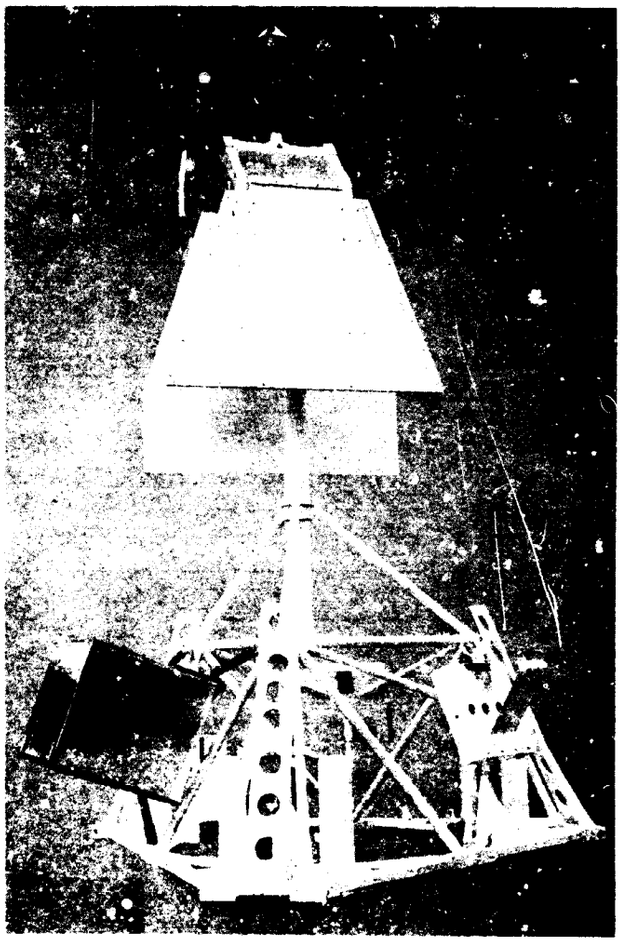


FIGURE IV.C.1. SURVEYOR DYNAMIC MODEL

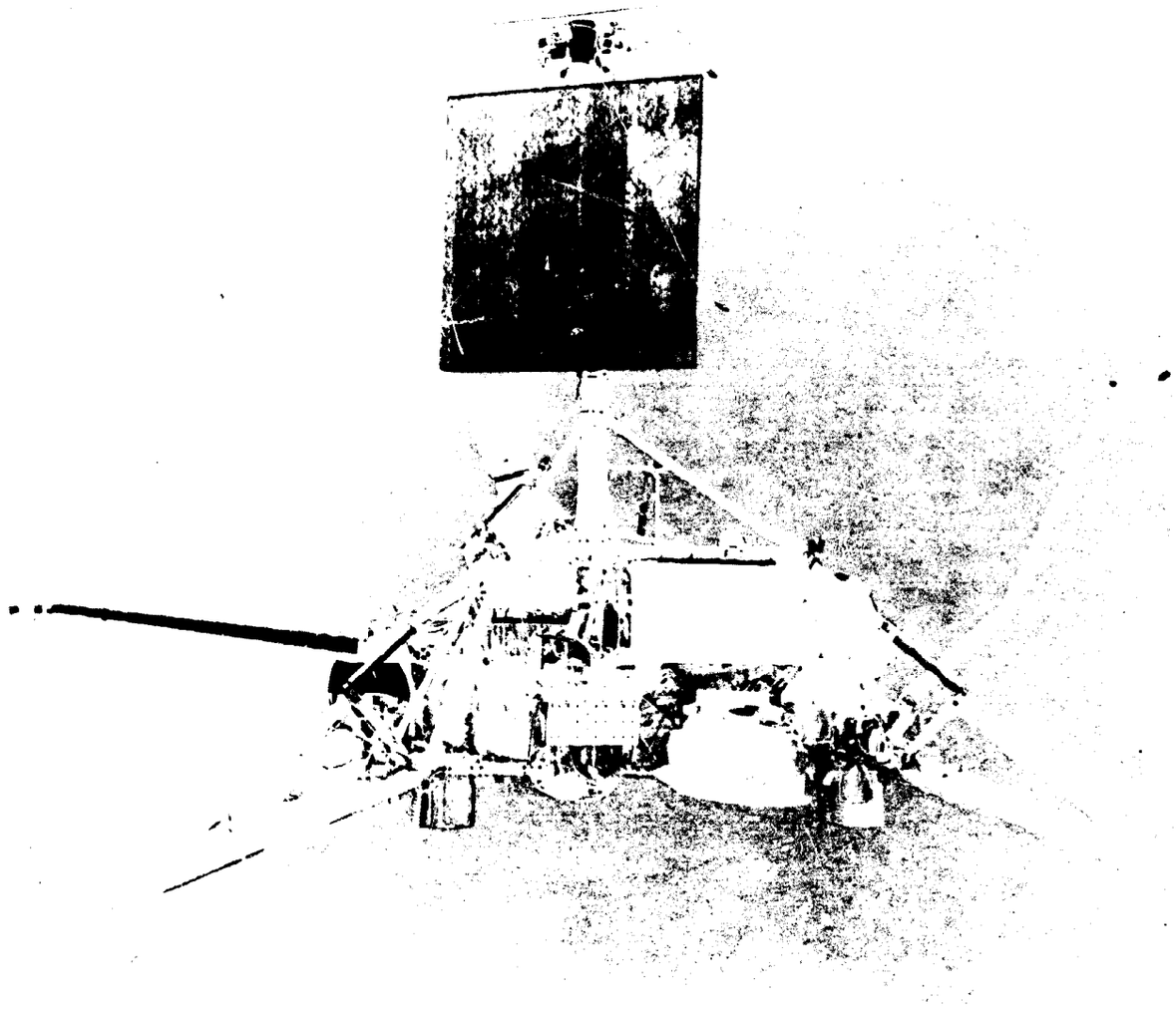


FIGURE IV.C.2. SURVEYOR SPACECRAFT

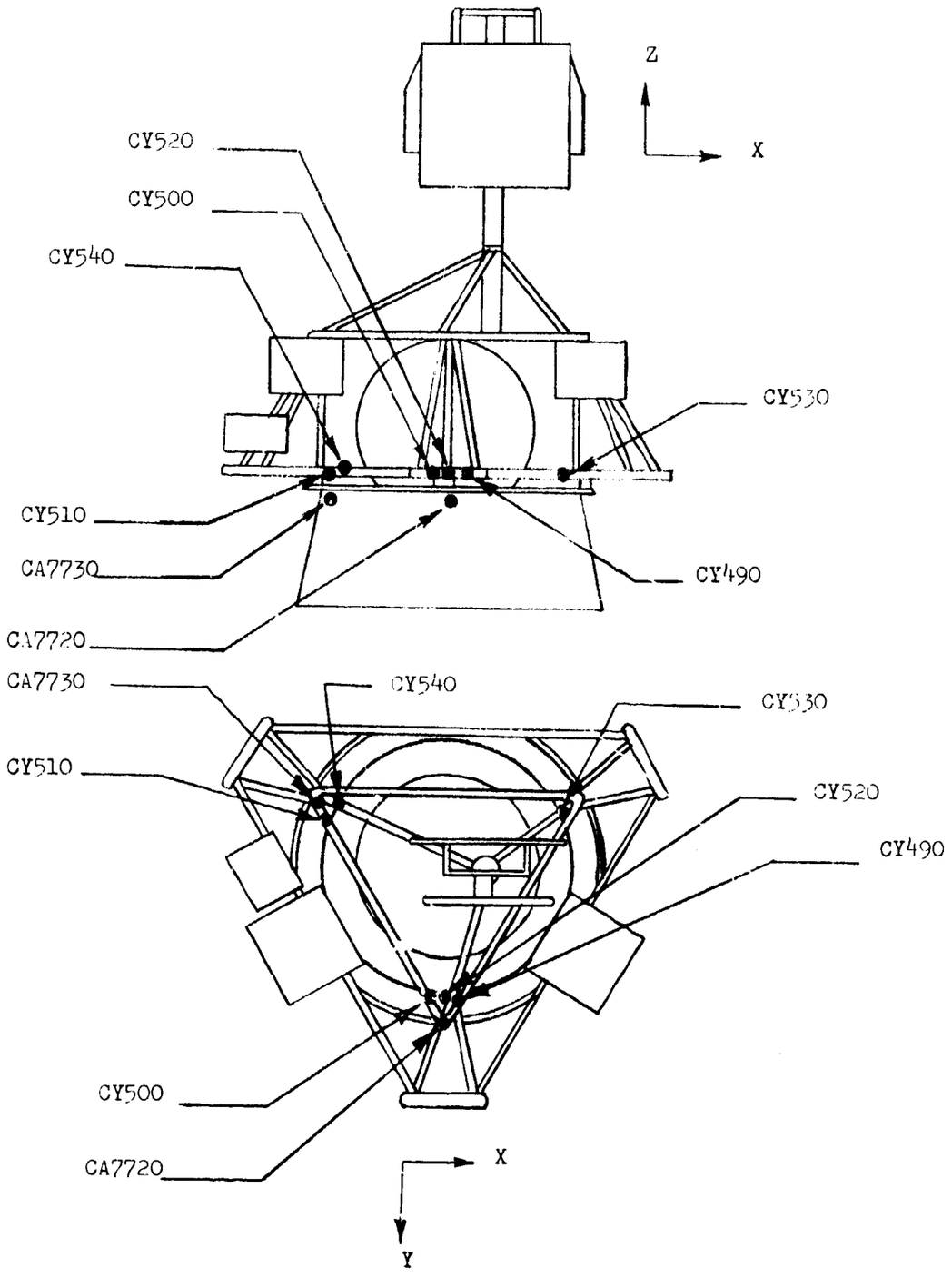



FIGURE IV.C.-3. ACCELEROMETER LOCATIONS

## SECTION IV.C.1

## ATLAS/CENTAUR SEPARATION EVENT

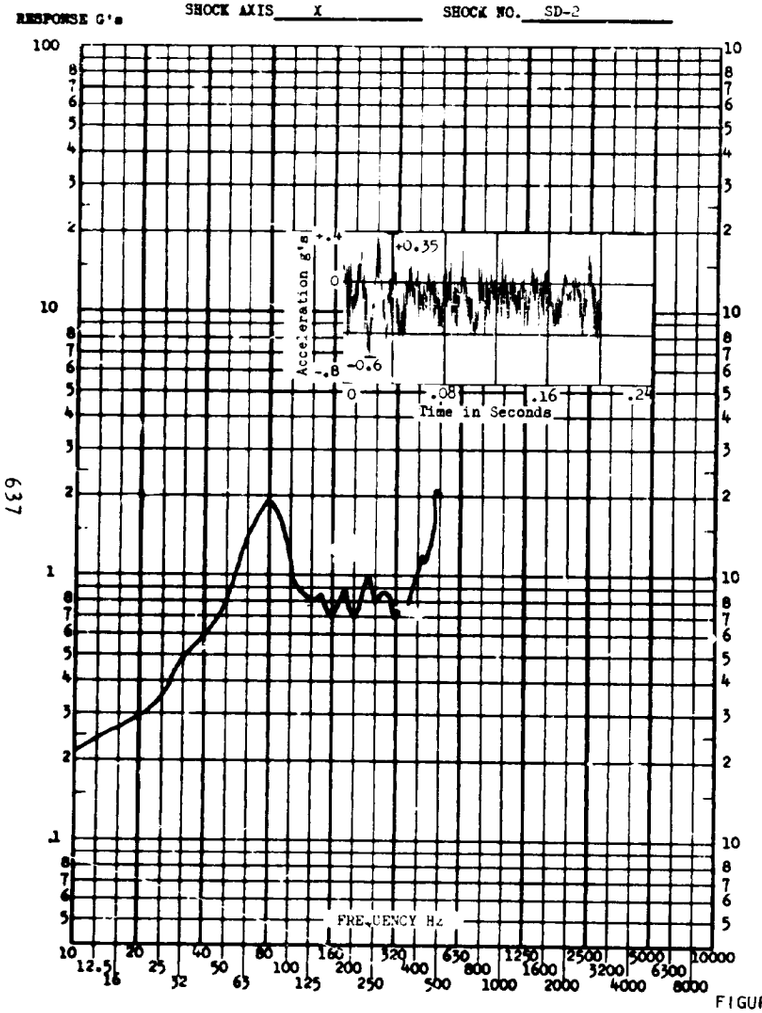
The Atlas/Centaur Separation utilized two circumferential strands of FLSC at 15 grains per foot. This FLSC consisted of RDX core having a burning velocity of 6000 meters per second. The 15 shock spectra and 7 time histories for this event are presented in Figures IV.C.1-1 through IV.C.1-4 as indexed in Table IV.C.1-1.

TABLE IV.C.1-1

INDEX OF DATA CONTAINED IN THIS SECTION

| Accelerometer Numbers | Flight Designation Numbers | Figure Number |
|---|---|---|
| CY 490 | SD-2 | IV.C.1-1 |
| CY 500 | SD-2 | IV.C.1-1 |
| CY 510 | SD-2 | IV.C.1-2 |
| CY 520 | SD-2; SC-1, -3, -4 | IV.C.1-2 |
| CY 530 | SD-2, SC-1 | IV.C.1-3 |
| CA 7720 | SC-5, -6, -7 | IV.C.1-3 |
| CA 7730 | SC-5, -6, -7 | IV.C.1-4 |

TEST ITEM Atlas/Centaur Separation
ACCEL. NO. CY490 TEST DATE Sept. 15, 1968
SHOCK AXIS X SHOCK NO. SD-2




TEST ITEM Atlas/Centaur Separation
ACCEL. NO. CY500 TEST DATE September 15, 1968
SHOCK AXIS Y SHOCK NO. SD-2

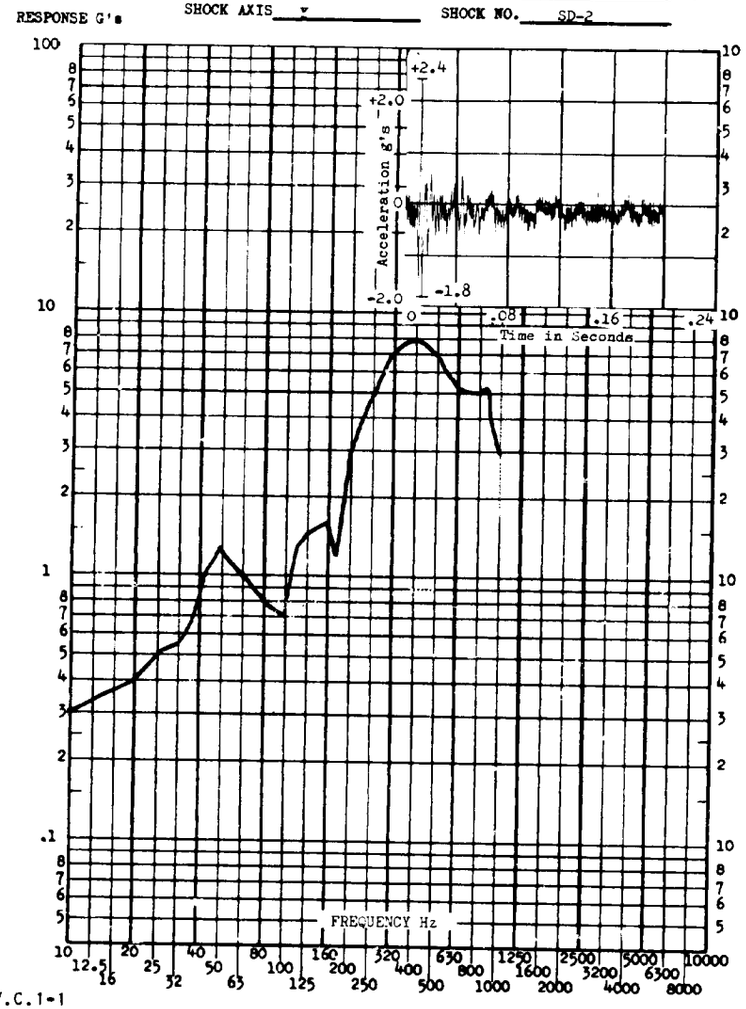
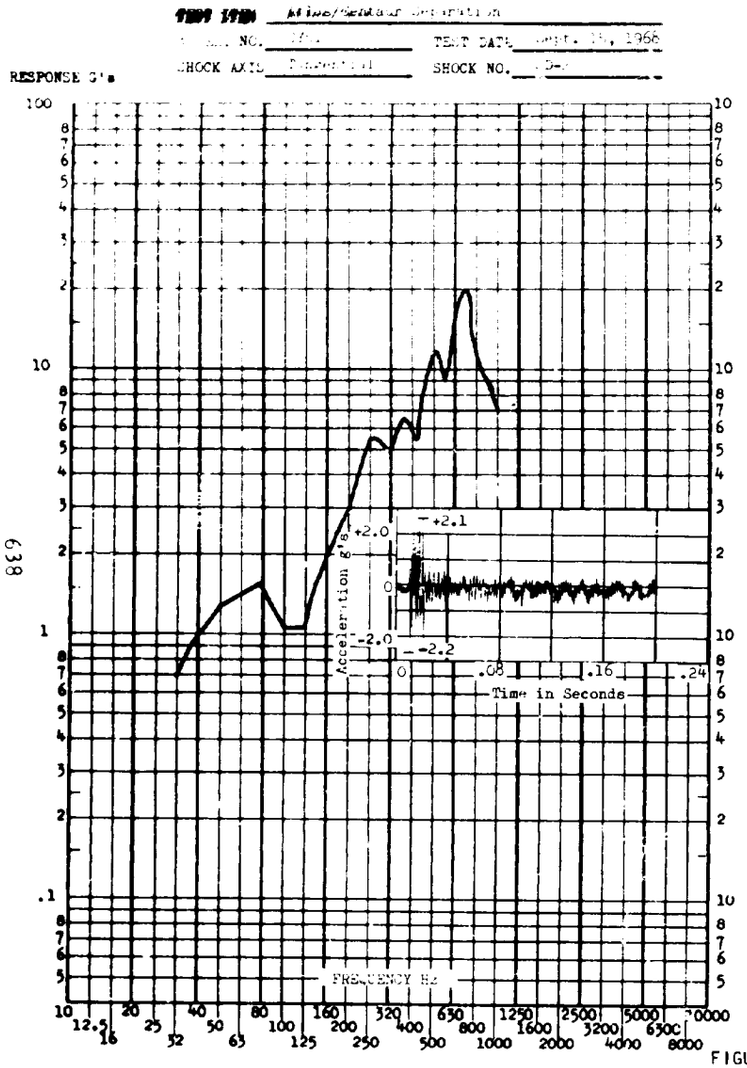



FIGURE IV.C.1-1



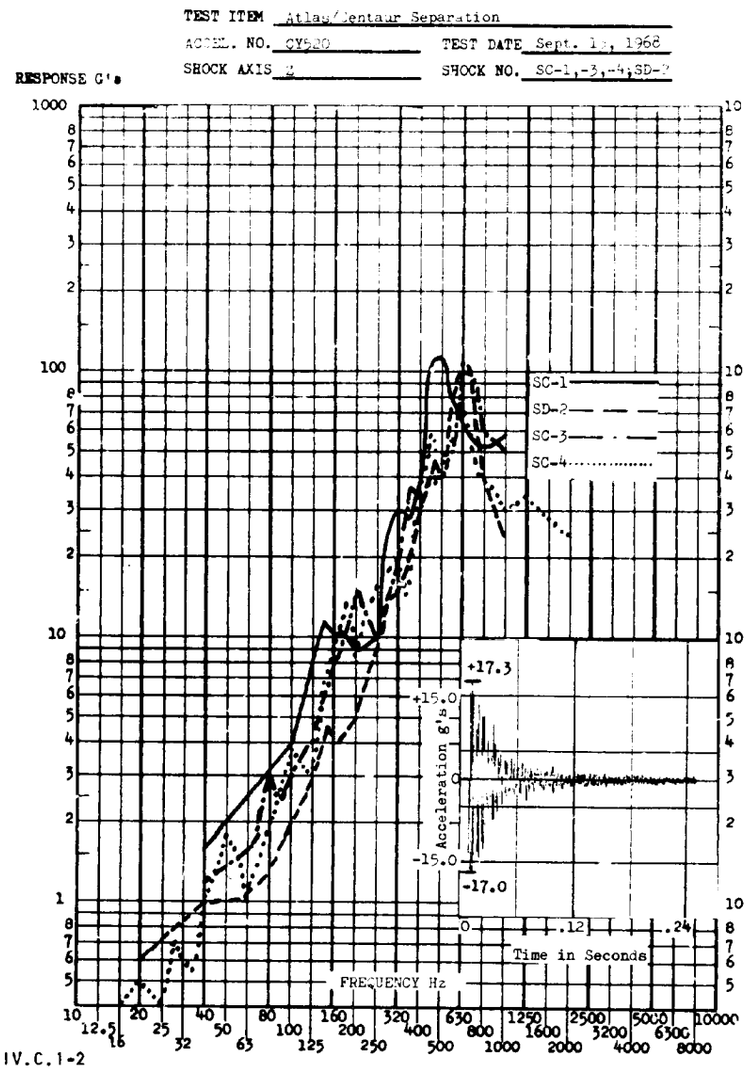
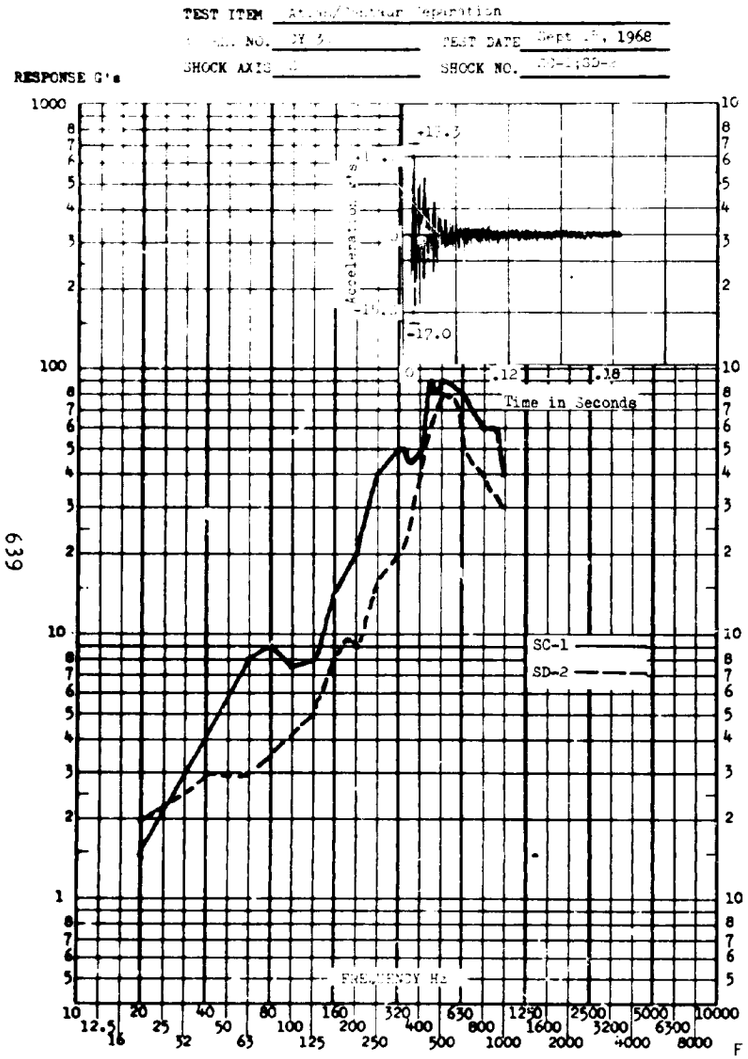




FIGURE IV.C.1-2



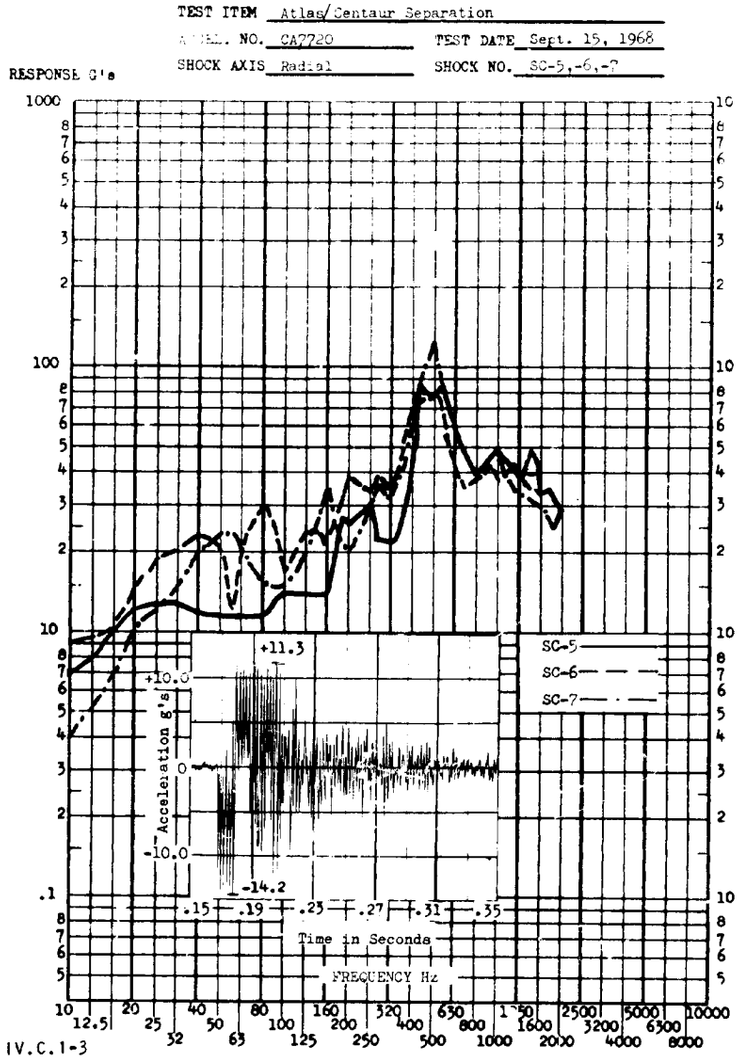




FIGURE IV.C.1-3

TEST ITEM Atlas/Centaur Separation

ACCEL. NO. CA7730 TEST DATE Sept. 15, 1968

SHOCK AXIS Z SHOCK NO. SC-5,-6,-7

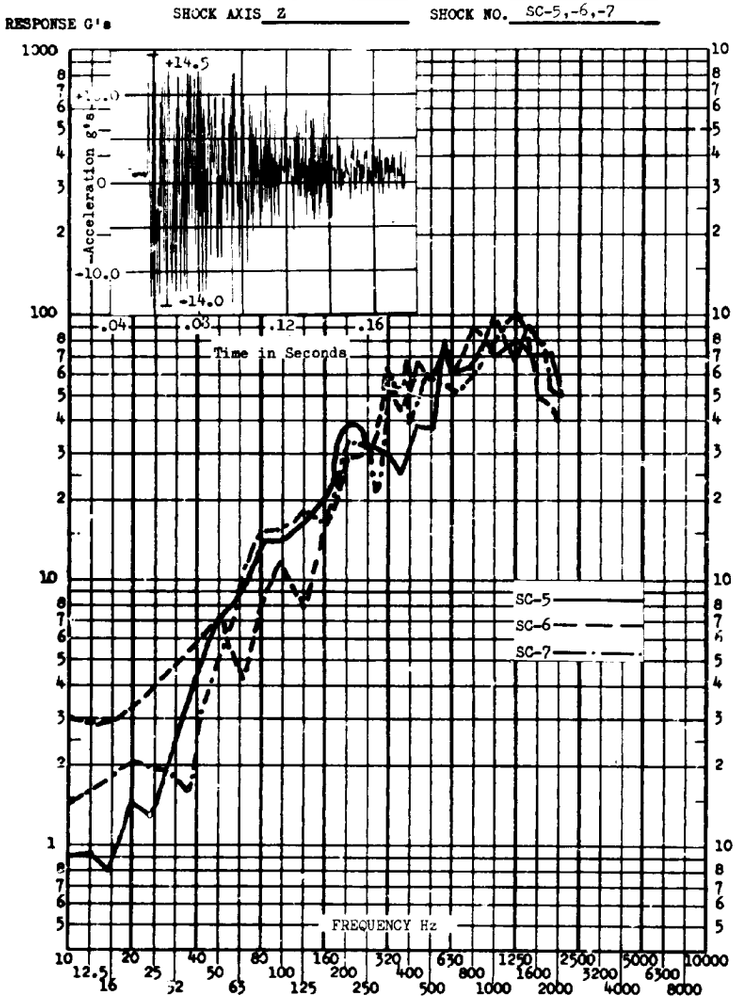



FIGURE IV.C.1-4

## SECTION IV.C.2

## SHROUD SEPARATION EVENT

The Surveyor Shroud Separation involved the use of 16 pyro latch assemblies. Each latch consisted of a dual cartridge separation nut. The nut and pressure cartridge specifications are shown below:

Separation nut - Part Number 939321 manufactured by Hi Shear Corporation

Pressure Cartridge - Part Number 939693 manufactured by Hi Shear Corporation

This section presents 11 shock spectra along with 4 of the corresponding time histories for this event in Figures IV.C.2-1 and IV.C.2-2 as indexed in Table IV.C.2-1.

TABLE III.C.2-1

INDEX OF DATA CONTAINED IN THIS SECTION

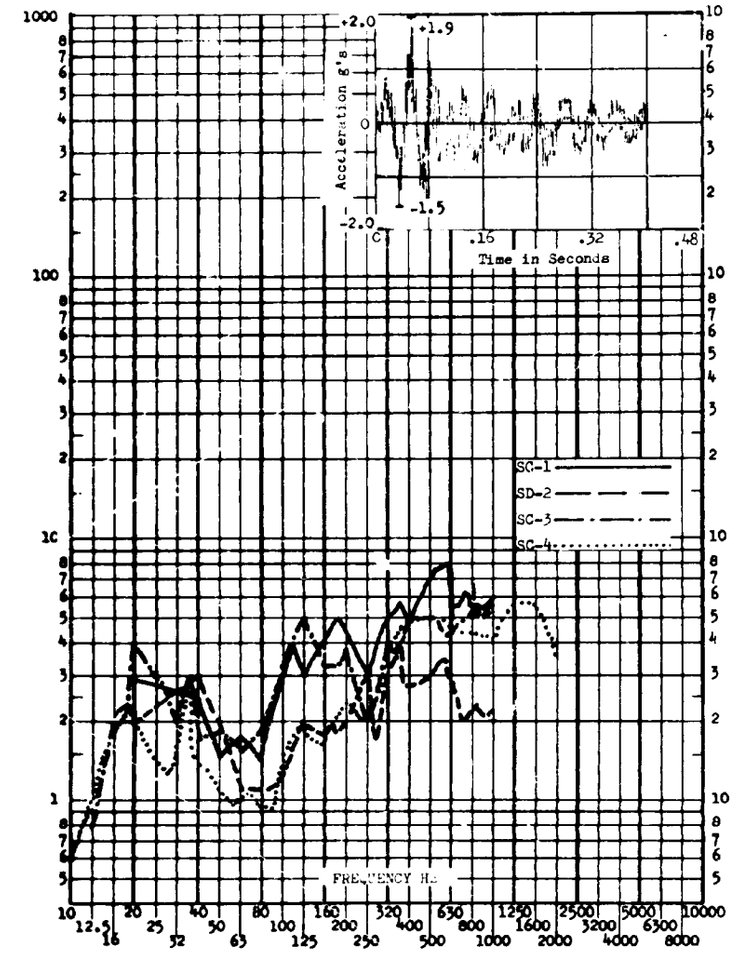
| Accelerometer Numbers | Flight Designation No.s | Figure Numbers |
|---|---|---|
| CY 520 | SD-2; SC-1, -3, -4 | IV.C.2-1 |
| CY 540 | SD-2 | IV.C.2-1 |
| CA 7720 | SC-5, -6, -7 | IV.C.2-2 |
| CA 7730 | SC-5, -6, -7 | IV.C.2-2 |

TEST ITEM Surveyor Shroud Separation

ACCEL. NO. CY520 TEST DATE Sept. 15, 1968

SHOCK AXIS Z SHOCK NO. SC-1,-3,-4;SD2

RESPONSE G's




TEST ITEM Surveyor Shroud Separation

ACCEL. NO. CY540 TEST DATE Sept. 15, 1968

SHOCK AXIS Z SHOCK NO. SD-2

RESPONSE G's

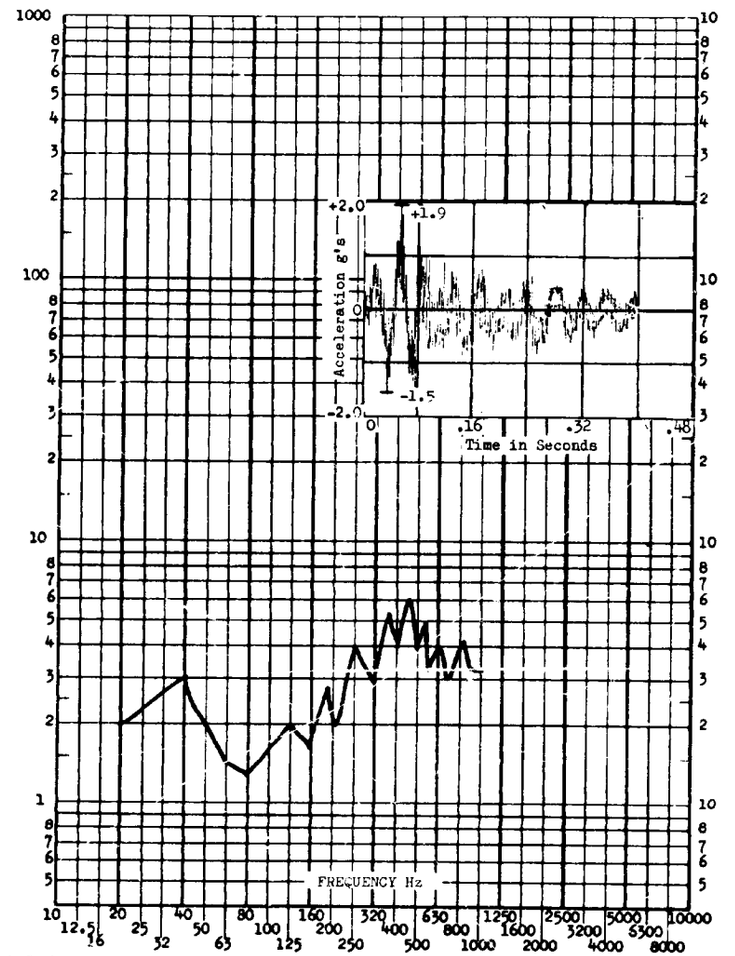
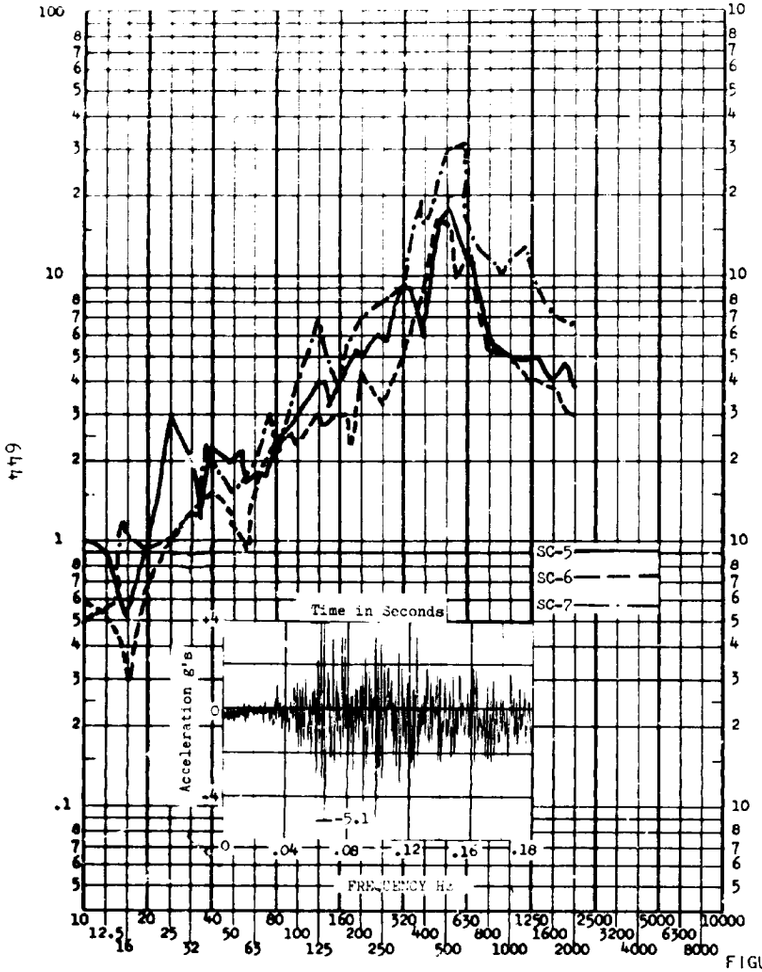



FIGURE IV.C.2-1

TEST ITEM [illegible] Separation
MODEL NO. [illegible] TEST DATE Sept. 15, 1968
SHOCK AXIS [illegible] SHOCK NO. SC-5,-6,-7

RESPONSE G's




TEST ITEM Surveyor Shroud Separation
MODEL NO. CA0730 TEST DATE Sept. 15, 1968
SHOCK AXIS Z SHOCK NO. SC-5,-6,-7

RESPONSE G's

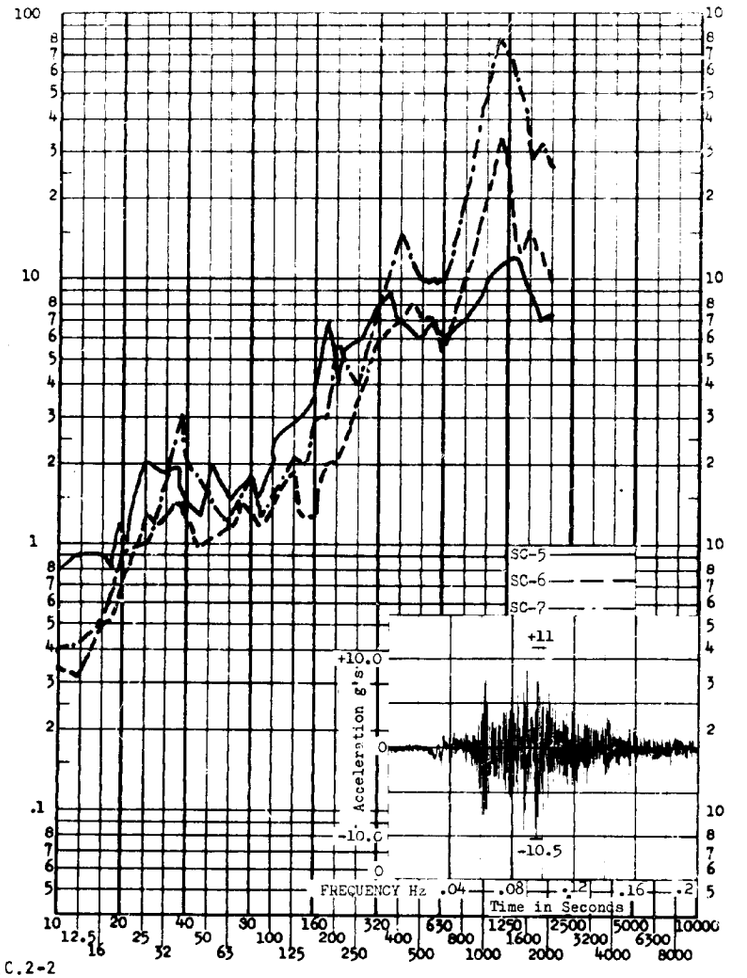



FIGURE IV.C.2-2

## SECTION IV.C.3

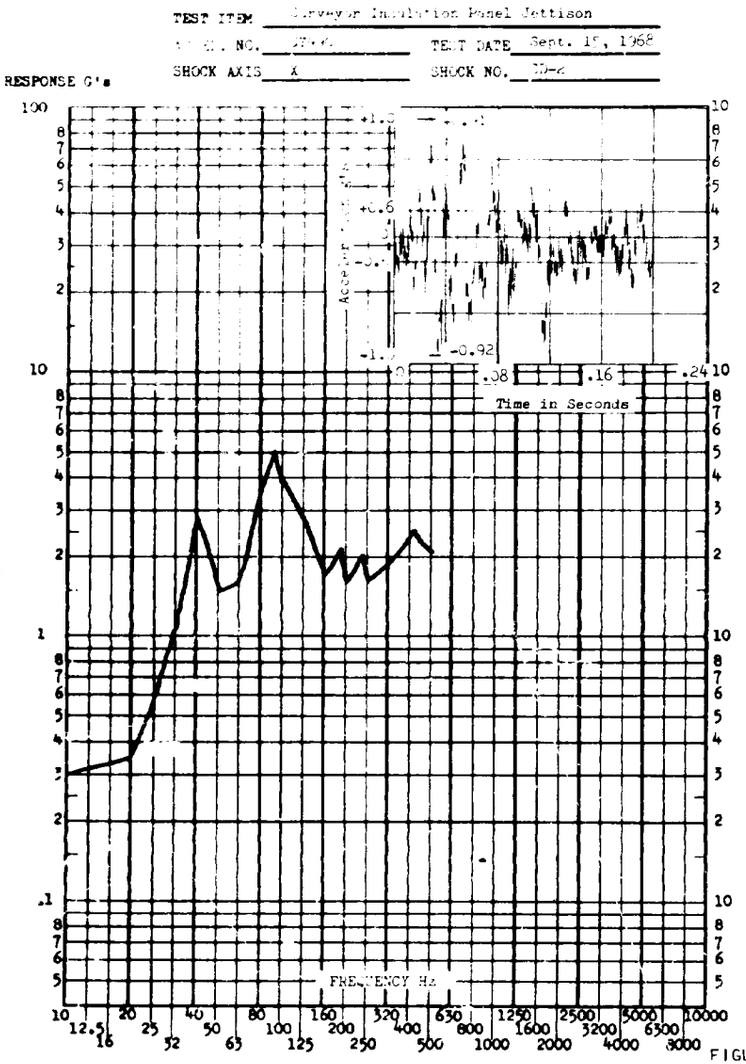
## INSULLATION PANEL JETTISON EVENT

The data presented in this section includes 14 shock spectra and 7 of the corresponding time histories for the Centaur Insulation Panel Jettison events during the Surveyor flights. FLSC and MDF were the pyrotechnics used to jettison the panels. The pyrotechnic configuration employed in the Surveyor mission was identical to that discussed in Section I.A.6, Centaur Insullation Panel Jettison Tests. Reference to this section is made for a more detailed description of the pyrotechnic event. The data are presented in Figures IV.C.3-1 through IV.C.3-4 as indexed in Table IV.C.3-1.

TABLE IV.C.3-1

INDEX OF DATA CONTAINED IN THIS SECTION

| Accelerometer Numbers | Flight Designation No.s | Figure Number |
|---|---|---|
| CY 490 | SD-2 | IV.C.3-1 |
| CY 500 | SD-2 | IV.C.3-1 |
| CY 510 | SD-2 | IV.C.3-2 |
| CY 520 | $S_d$-2, SC-1, -3, -4 | IV.C.3-2 |
| CY 530 | SD-2 | IV.C.3-3 |
| CA 7720 | SC-5, -6, -7 | IV.C.3-3 |
| CA 7730 | SC-5, -6, -7 | IV.C.3-4 |



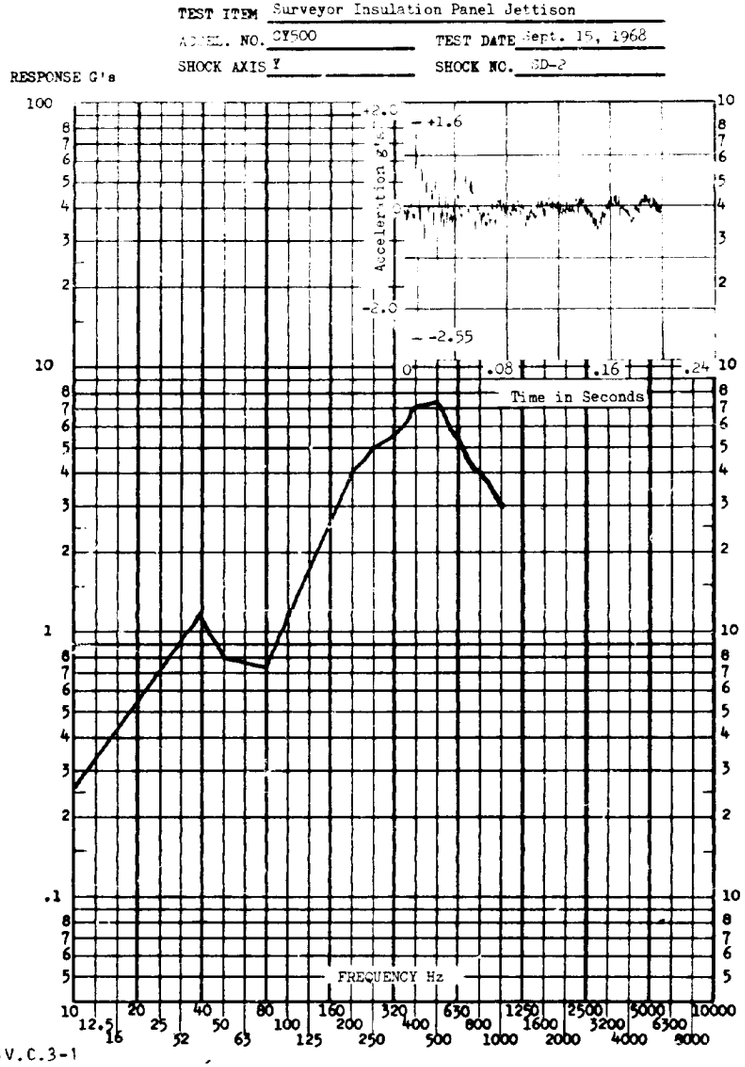
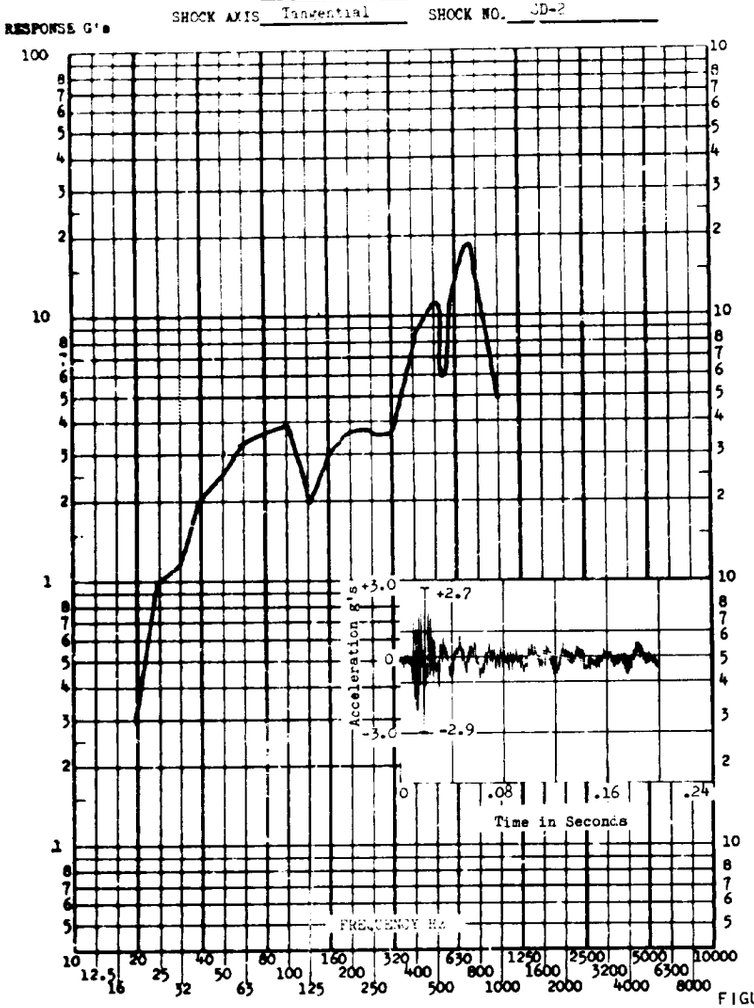




FIGURE IV.C.3-1

TEST ITEM Surveyor Insulation Panel Jettison
ACCEL. NO. CY510 TEST DATE Sept. 15, 1968
SHOCK AXIS Tangential SHOCK NO. SD-2




TEST ITEM Surveyor Insulation Panel Jettison
ACCEL. NO. CY520 TEST DATE Sept. 15, 1968
SHOCK AXIS Z SHOCK NO. SC-1,-3,-4;SD-2

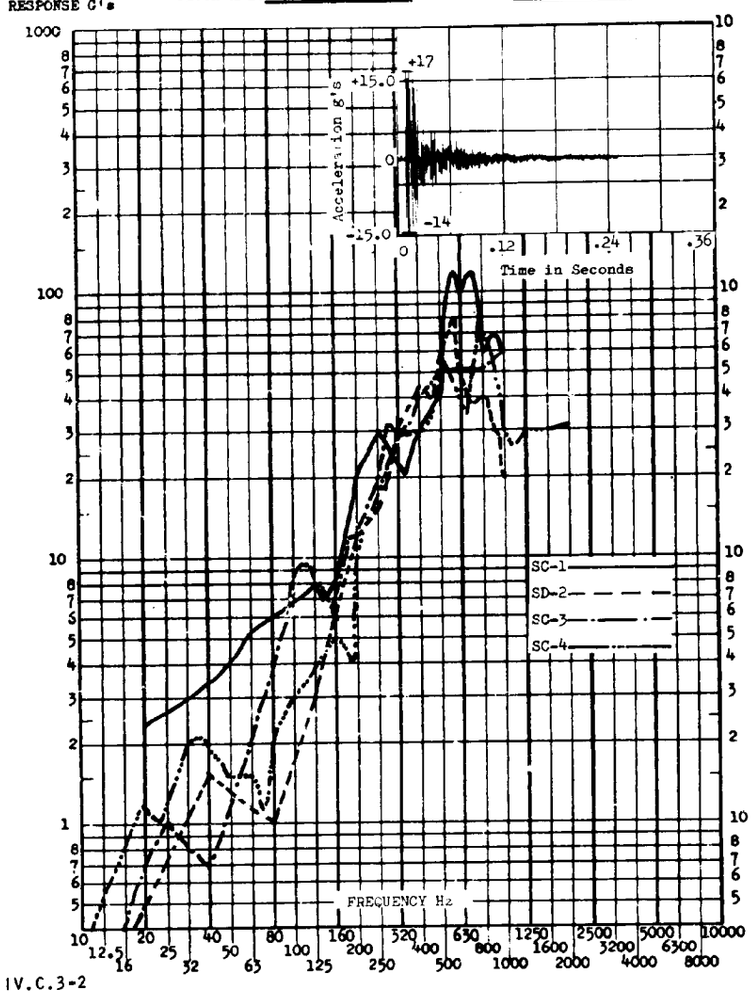
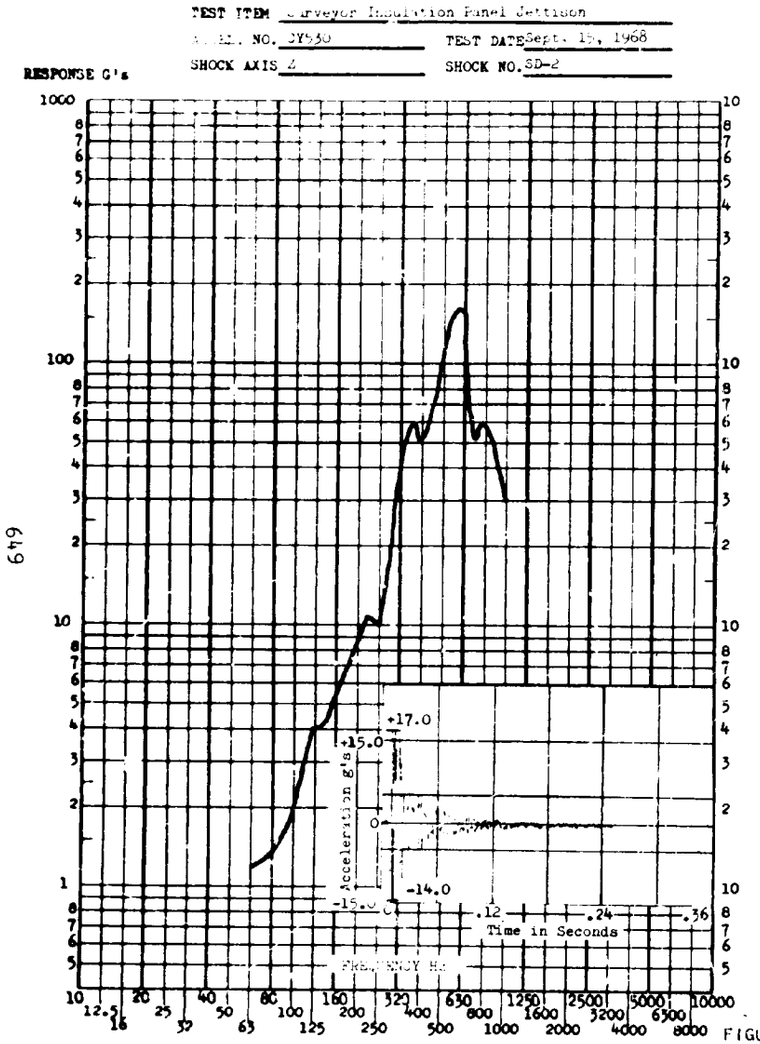



FIGURE IV.C.3-2



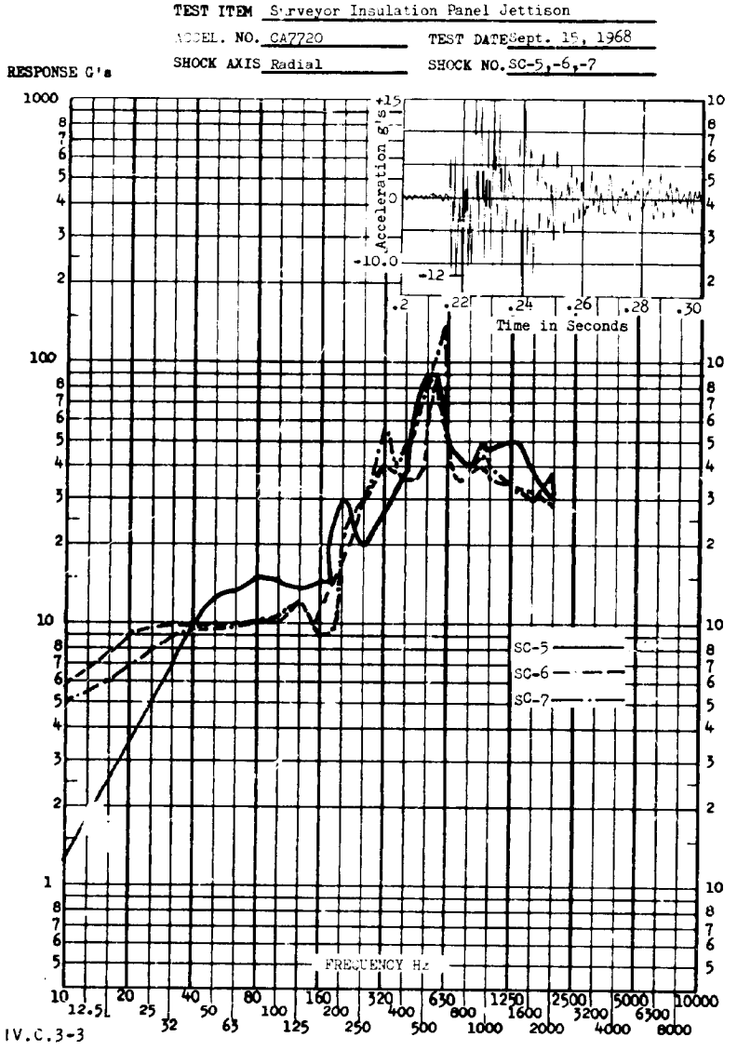




FIGURE IV.C.3-3

TEST ITEM Surveyor Insulation Panel Jettison

MODEL NO. CA7770 TEST DATE Sept. 15, 1968

SHOCK AXIS Z SHOCK NO. SC-5,-6,-7

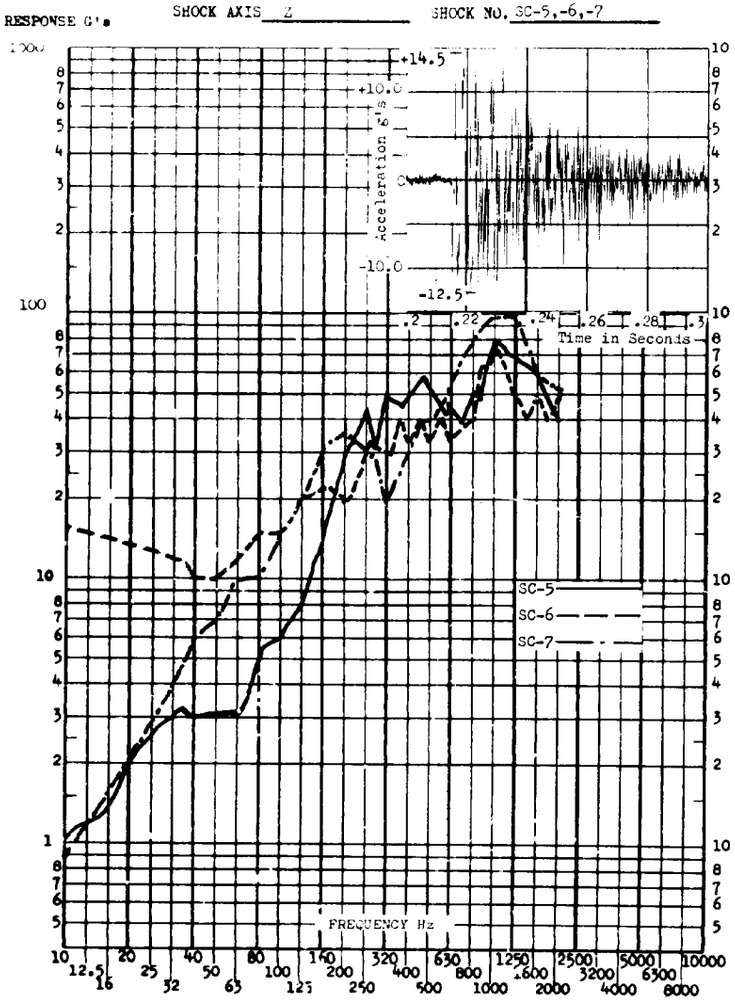



FIGURE IV.C.3-4

## SECTION IV.C.4

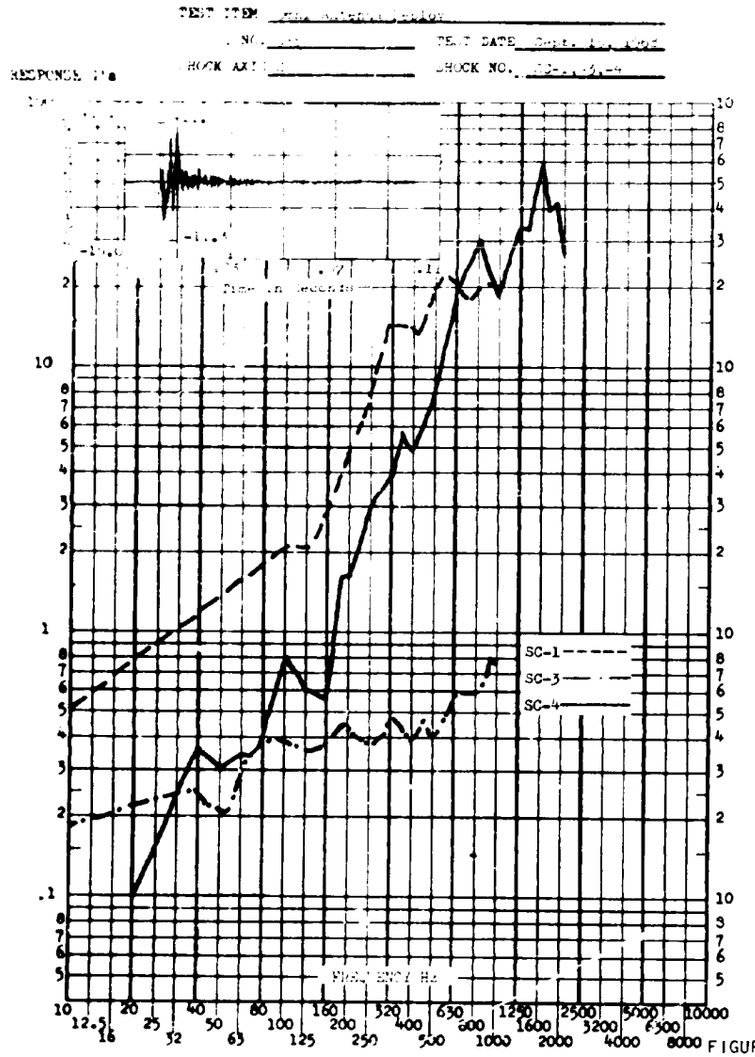
## OMNI ANTENNA DEPLOY EVENT

This section presents 10 shock spectra along with 4 of the corresponding time histories for the Surveyor OMNI Antenna Deploy event. These data are shown in Figures IV.C.4-1 and IV.C.4-2 as indexed in Table IV.C.4-1.

TABLE IV.C.4-1

INDEX OF DATA CONTAINED IN THIS SECTION

| Accelerometer Number | Flight Designation No.s | Figure Number |
|---|---|---|
| CY 520 | SC-1, -3, -4 | IV.C.4-1 |
| CY 540 | SC-1 | IV.C.4-1 |
| CA 7720 | SC-5, -6, -7 | IV.C.4-2 |
| CA 7730 | SC-5, -6, -7 | IV.C.4-2 |



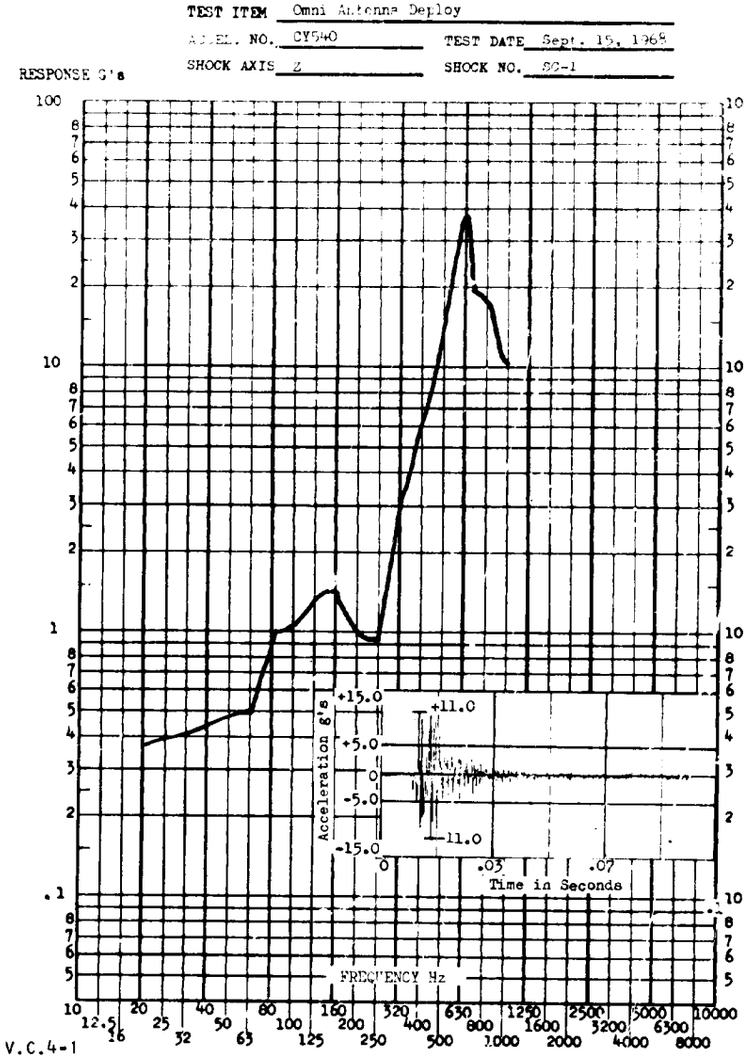
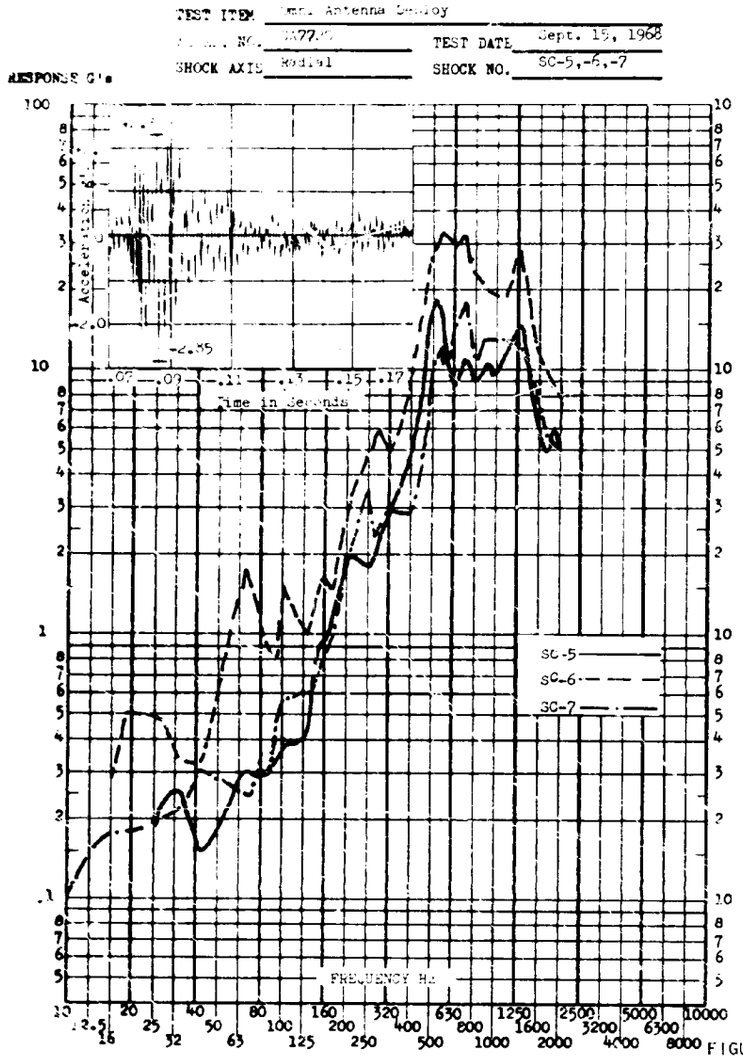




FIGURE IV.C.4-1



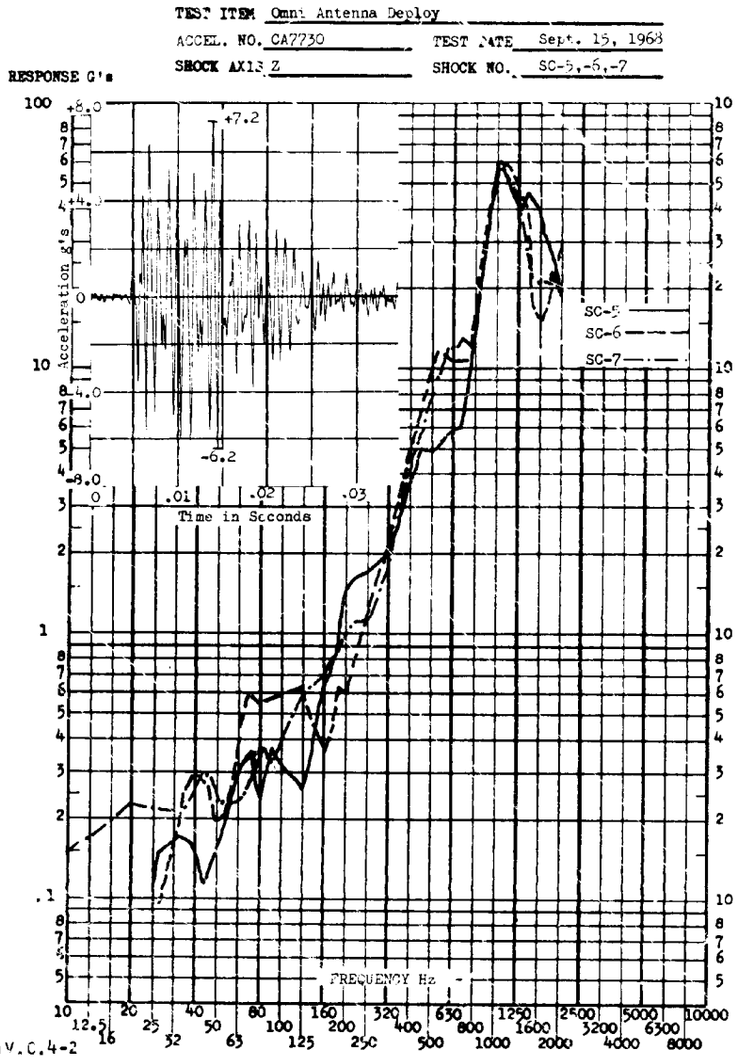




FIGURE IV.C.4-2

## SECTION IV.C.5

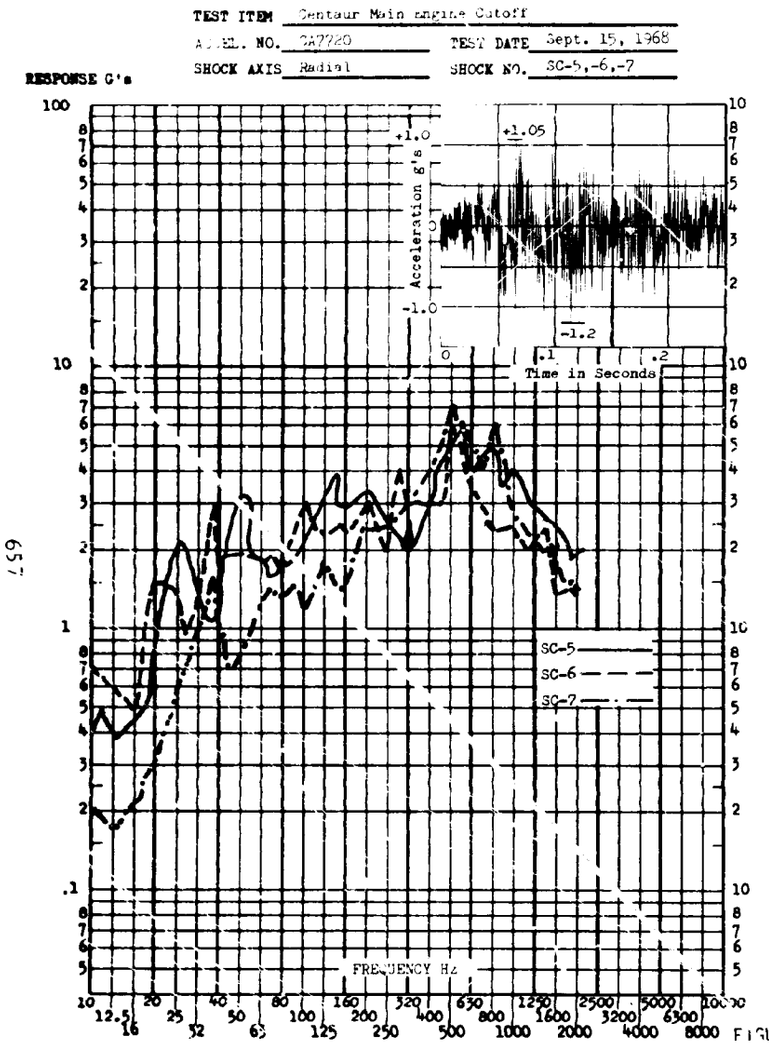
## NON-PYROTECHNIC SHOCK EVENTS

The data presented in this section includes 21 shock spectra and 9 time histories for Surveyor flight events that were not of pyrotechnic origin. These data describe the shock produced by the two main engine cutoff events, the landing gear extension, and landing gear lock events. These shock spectra are presented along with their corresponding time histories in Figures IV.C.5-1 through IV.C.5-5 as indexed in Table IV.C.5-1.

TABLE IV.C.5-1

INDEX OF DATA CONTAINED IN THIS SECTION

| Event | Accelerometer Number | Flight Designation No.s | Figure Number |
|---|---|---|---|
| Centaur Main Engine Cut-off | CA 7720 | SC-5, -6, -7 | IV.C.5-1 |
| Centuar Main Engine Cut-off 2 | CA 7720 | SC-5, -6, -7 | IV.C.5-1 |
| Landing Gear Extension | CY 540 | SC-1 | IV.C.5-2 |
| | CY 520 | SC-1, -3, -4 | IV.C.5-2 |
| | CA 7720 | SC-5, -6 | IV.C.5-3 |
| | CA 7730 | SC-5, -6 | IV.C.5-3 |
| Landing Gear Lock | CY 520 | SC-1, -3, -4 | IV.C.5-4 |
| | CA 7720 | SC-5, -6 | IV.C.5-5 |
| | CA 7730 | SC-5, -6 | IV.C.5-5 |



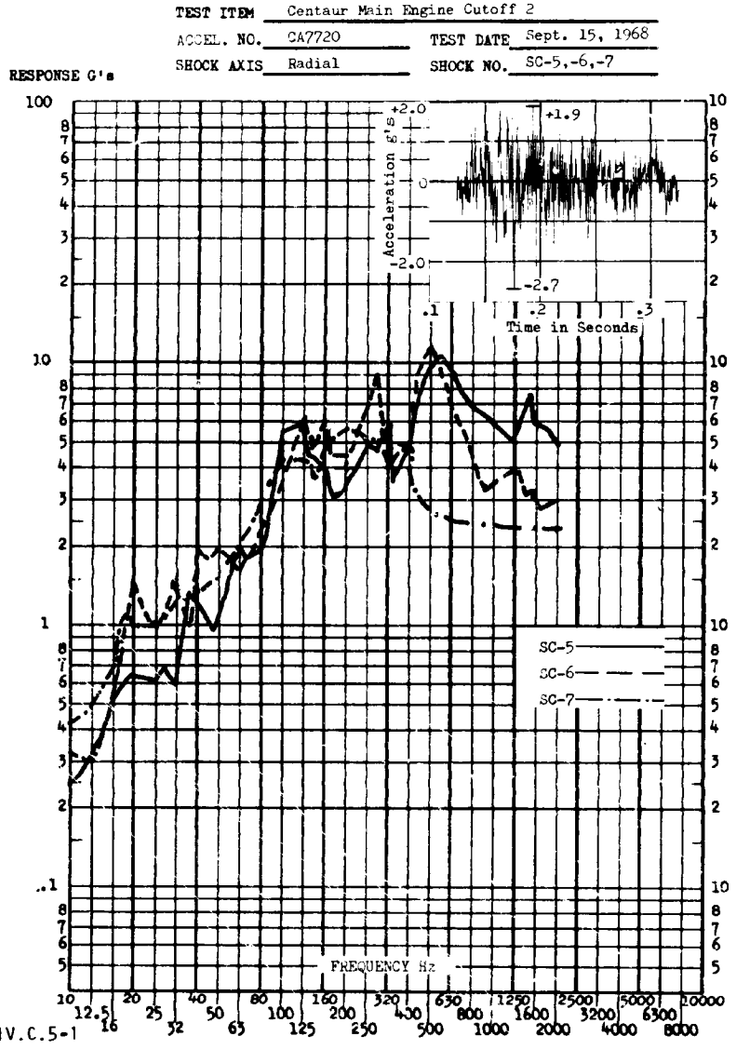
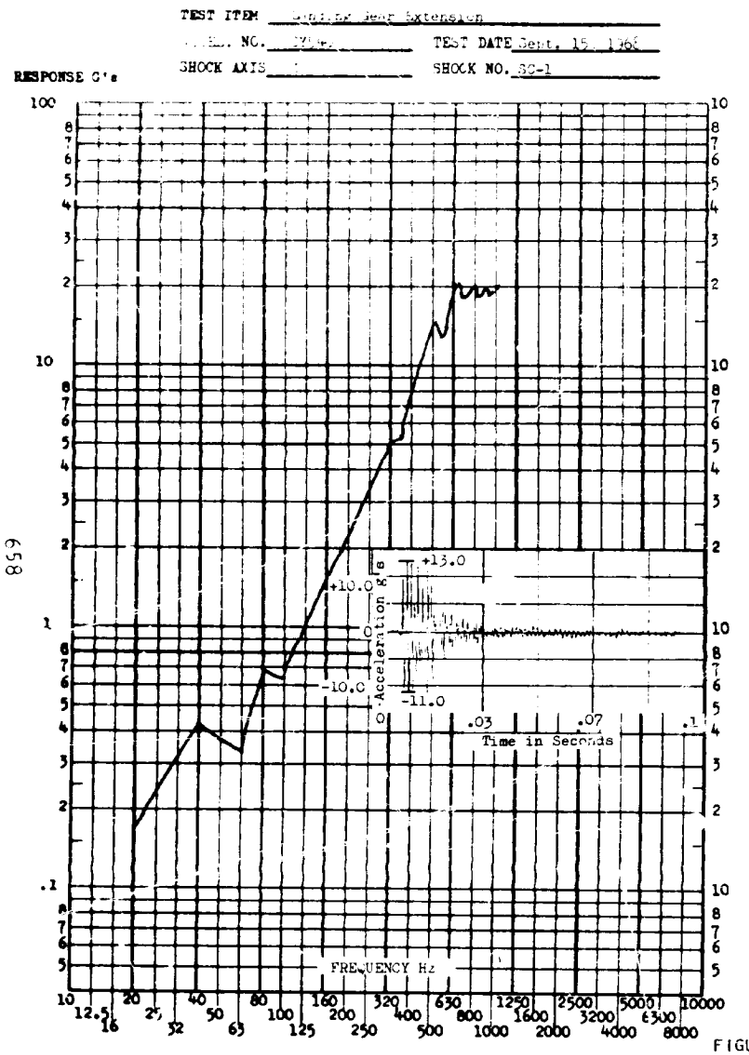




FIGURE IV.C.5-1



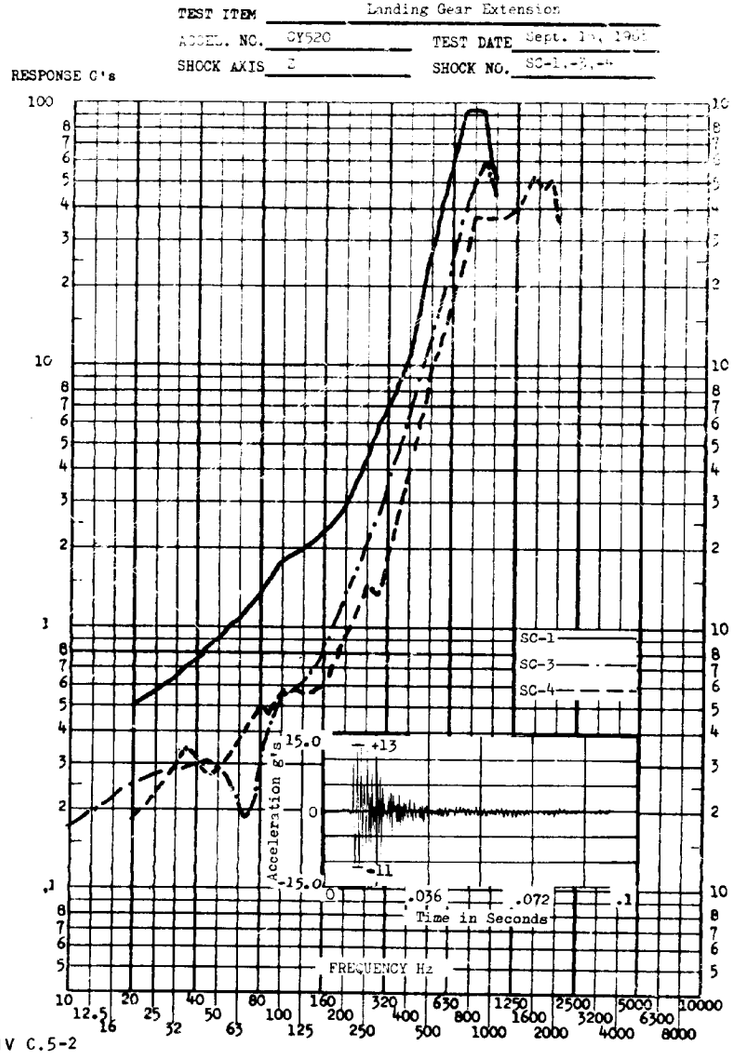
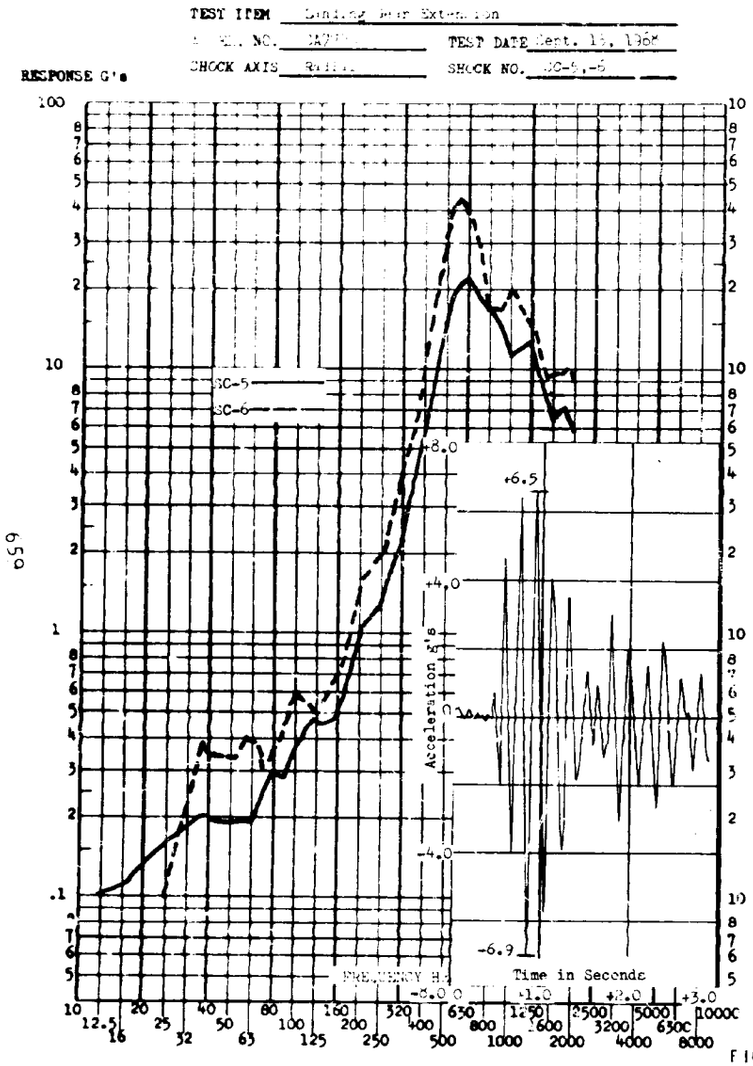




FIGURE IV C.5-2



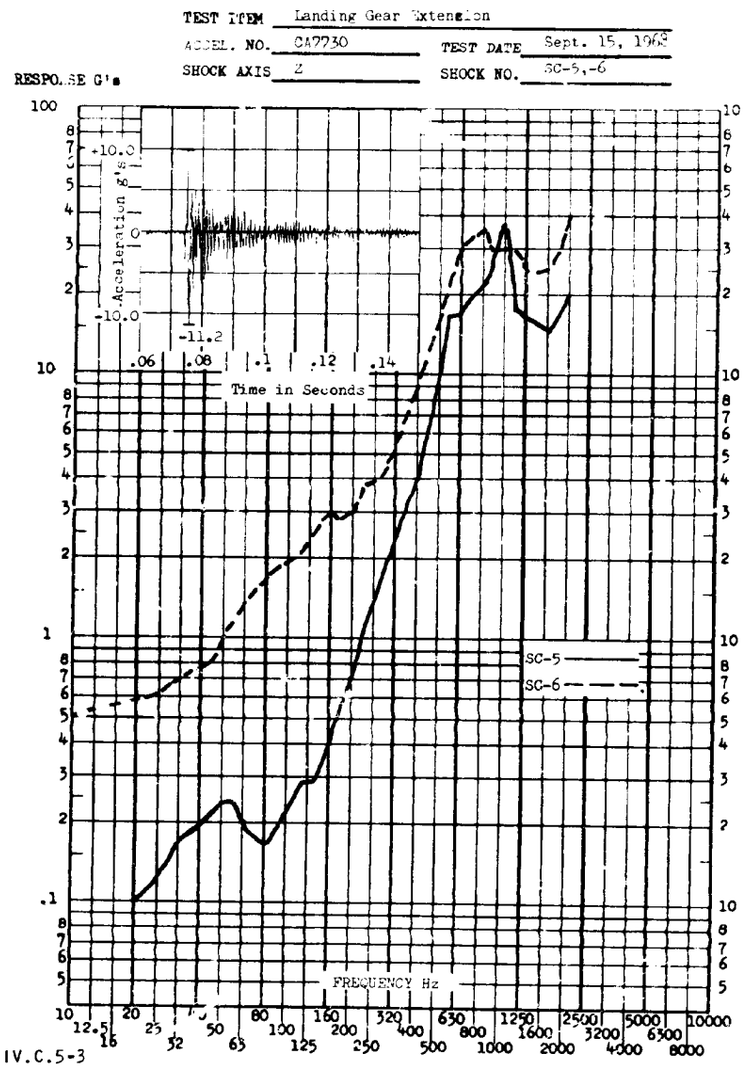




FIGURE IV.C.5-3

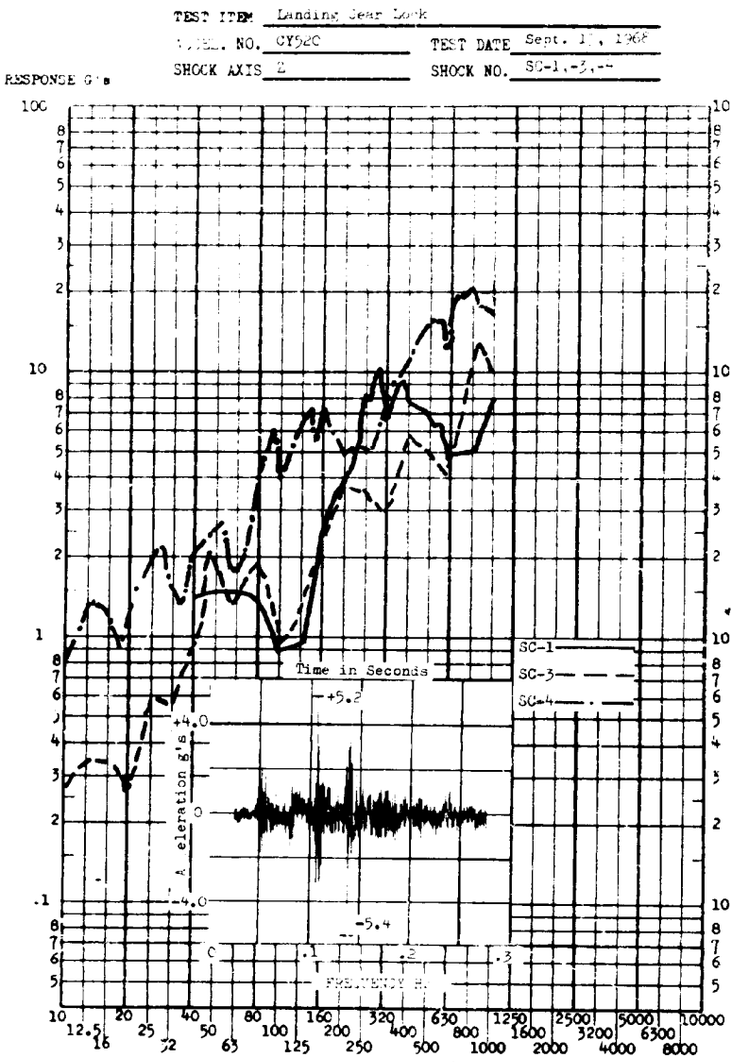



FIGURE IV.C.5-4

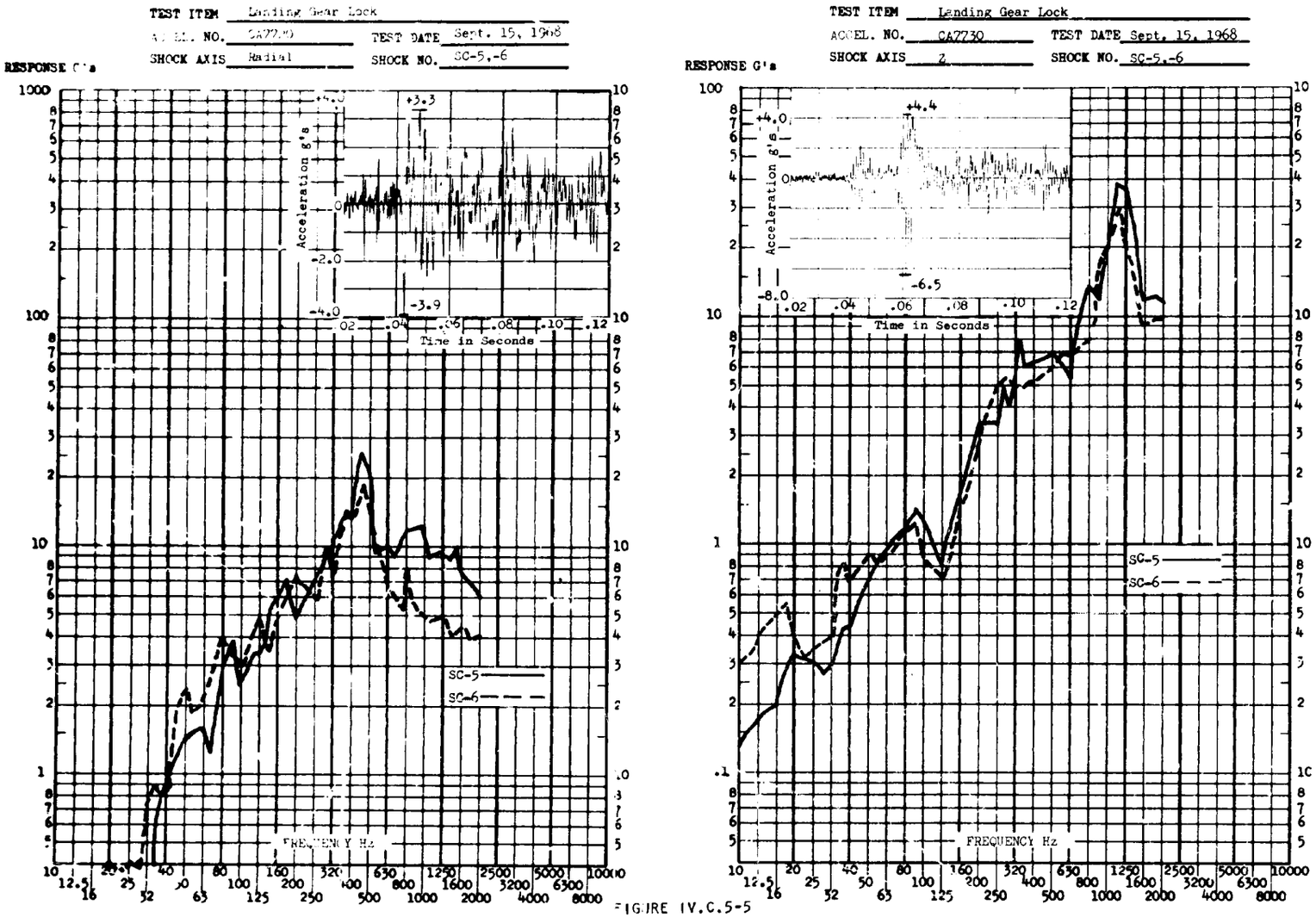



FIGURE IV.C.5-5

# DIVISION V

# FLIGHT-PYROTECHNIC SHOCK DATA

## FOREWORD TO DIVISION V

Division V contains pyrotechnic shock data from four flight tests. Due to the limitations of telemetry systems the amount of data is small, totaling 41 spectra for the four sections. These four sections were organized into a separate division to show the type of data that have been obtained from flight measurements.

TABLE OF CONTENTS


| Section | Title | Number of Shock Spectra | Page No. |
|---|---|---|---|
| | DIVISION V | | |
| | Flight-Pyrotechnic Shock Data | | |
| V.1 | Flight of Lunar Orbiters I and II-Shroud Jettison | 7 | 665 |
| V.2 | Flight Test of Delta Vehicle (TOS-A)-Solid Motor and Fairing Jettison | 7 | 671 |
| V.3 | Flight Test of Delta Vehicle 43 (BIOS-A)-Spacecraft Separation | 12 | 682 |
| V.4 | Flight Test of Delta Vehicle 51 (BIOS-B)-Spacecraft Separation and Fairing Jettison | 15 | 693 |
| Location of Additional Data | | | 707 |

SECTION V.1

FLIGHT OF LUNAR ORBITERS I AND II-SHROUD JETTISON

DESCRIPTION OF EVENT

During the course of Lunar Orbiter flights I and II, standard Atlas-Agena pyrotechnics were used to separate and jettison an over the nose fairing to expose the orbiter.

DESCRIPTION OF DATA

| | |
|---|---|
| No. of shock spectra | 7 |
| Type of analysis | digital |
| Sample rate | 8000/second |
| Frequency range | to 1000 Hz |
| Damping | Q=10 |

These shock spectra are presented as Figures V.1-2 and V.1-3.

DESCPIPTION OF STRUCTURE

Figure V.1-1

DESCRIPTION OF ACCELEROMETERS

Table V.1-1 and Figure V.1-1

COMMENTS

Three contacts, were made in an effort to obtain additional information regarding these events; however, the description above was all that could be learned.

From comparing the frequency limits to which the data are presented with the frequency information in Table V.1-1, the following is noted:

| Accelerometer Number | Frequency limits for which the shock spectra are not questionable |
|---|---|
| 12 | 160 Hz |
| 13 | 220 Hz |
| 17 | 790 Hz |
| 18 | 1000 Hz |

TABLE V.1-1

FLIGHT INSTRUMENTATION DATA

| Accelerometer Number | Location | Sensitive Axis | Accelerometer Frequency Response (Hz) | Channel Frequency Response (Hz) | Data Location Figure Number |
|---|---|---|---|---|---|
| 12 | Spacecraft | Transverse | 5- 800 | 160 | V.1-2 |
| 13 | Spacecraft | Longitudinal | 5-1100 | 220 | V.1-2 |
| 17 | Spacecraft Adapter | Longitudinal | 20-2000 | 790 | V.1-3 |
| 18 | Spacecraft Adapter | Transverse | 20-2000 | 1050 | V.1-3 |

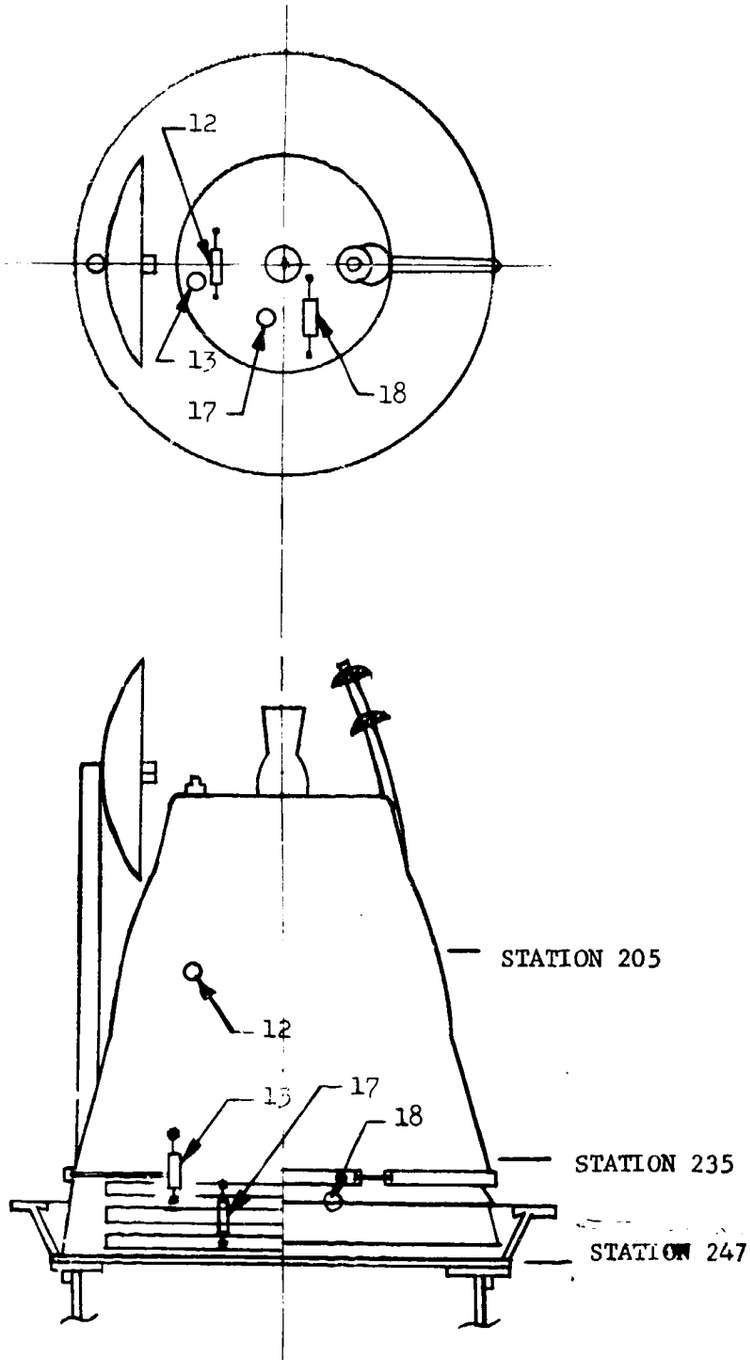



FIGURE V.1-1

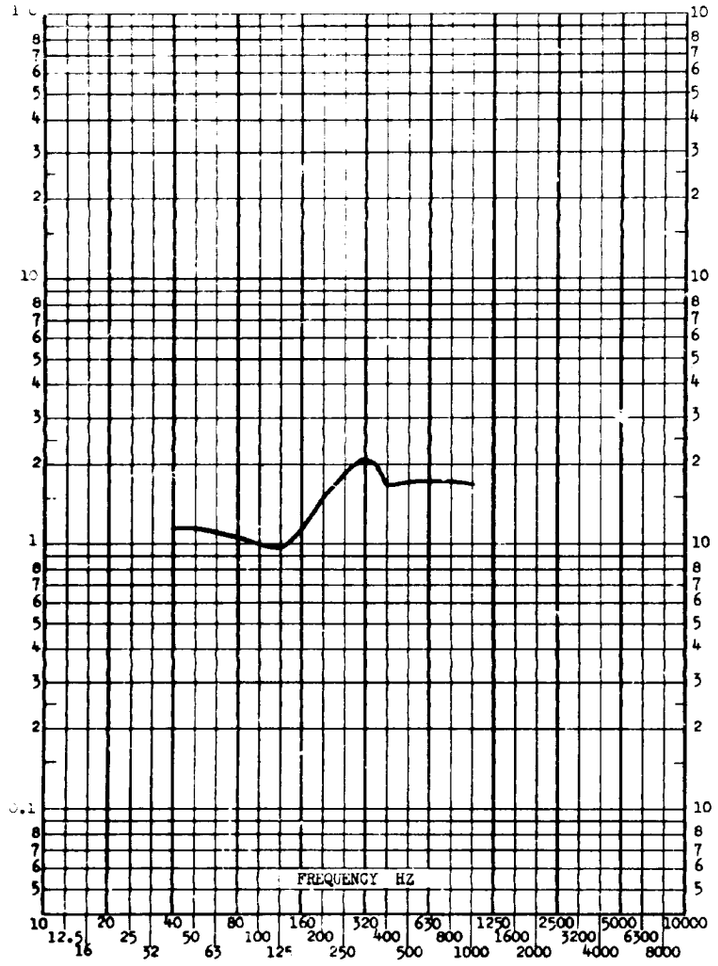
Accelerometer Locations on the Lunar Orbiter

TEST ITEM [illegible]

ACCEL. NO. 12 TEST DATE

SHOCK AXIS SHOCK NO.

RESPONSE G's




TEST ITEM Lunar Orbiter I & Lunar Orbiter II

ACCEL. NO. 13 TEST DATE

SHOCK AXIS SHOCK NO.

RESPONSE G's

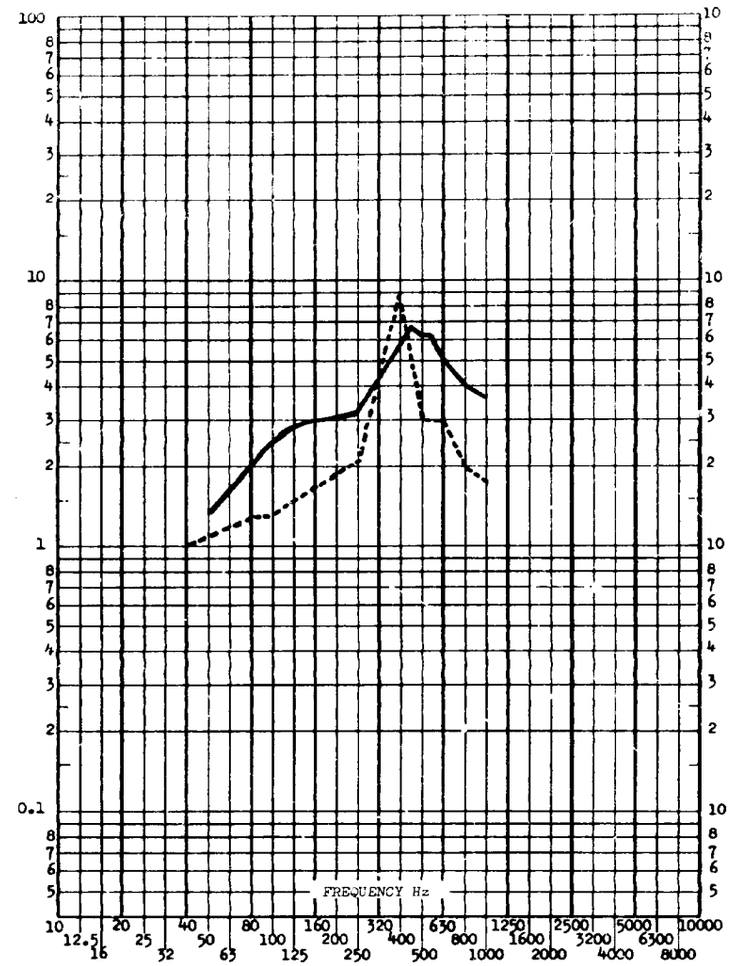
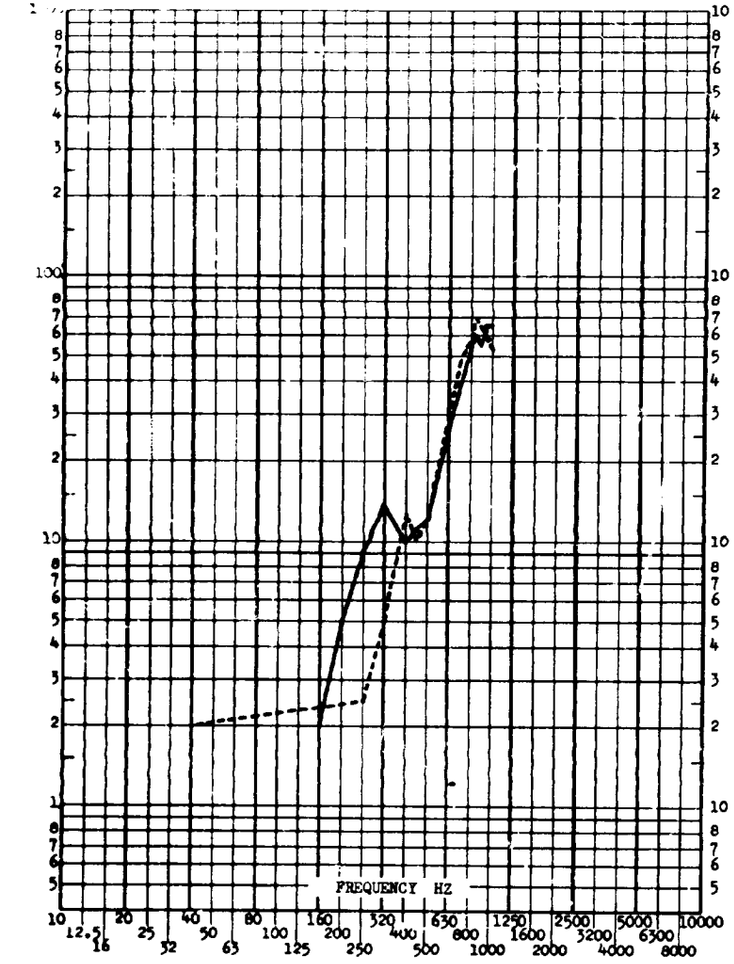



FIGURE V.1-2

TEST ITEM [illegible] Lunar Orbiter II
ACCEL. NO. 18 TEST DATE
SHOCK AXIS SHOCK NO.

RESPONSE G's




TEST ITEM Lunar Orbiter I & Lunar Orbiter II
ACCEL. NO. 17 TEST DATE
SHOCK AXIS SHOCK NO.

RESPONSE G's

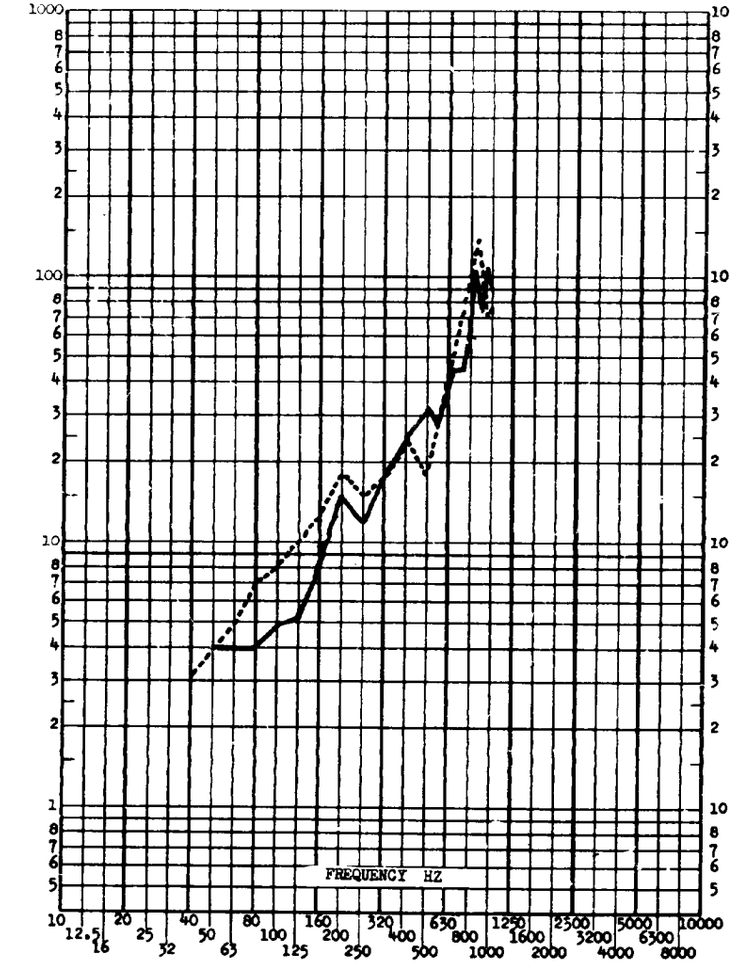



FIGURE V.1-3

SECTION V.2

FLIGHT TEST OF DELTA VEHICLE 41 ---- TOS-A

DESCRIPTION OF EVENTS

During the flight of Delta Vehicle 41, there were two notable pyrotechnic events for which some data were available:

1) solid motor jettison (explosive bolts)

2) fairing jettison (explosive bolts)

Fairing jettison was initiated by the detonation of six explosive bolts at the separation plane. This released the six alternately spaced, preloaded spring actuators which imparted a relative velocity to the fairing. Figures V.2-1 and V.2-2 indicate the locations of the solid motors, the fairing, the separation plane, and the accelerometers.

DESCRIPTION OF DATA

Solid Motor Jettison Event

| | |
|---|---|
| No. of time histories | 5 |
| Duration | Table V.2-1 |
| No. of shock spectra | 5 |
| Type of analysis | digital |
| Sample rate | 2500 per second |
| Frequency range | Table V.2-1 |
| Frequency increments | 40 points per octave |

Damping Q=10

These data are presented with their corresponding time histories as Figures V.2-3 through V.2-6

Fairing Jettison

No. of time histories 2

Duration Table V.2-1

No. of shock spectra 2

Type of analysis digital

Sample rate 2500

Frequency range Table V.2-1

Frequency increments 40 points per octave

Damping Q=10

These shock spectra are presented with their corresponding time histories as Figure V.2-6

DESCRIPTION OF PYROTECHNIC

Six explosive bolts for the fairing jettison event. See Figure V.2-2 for location.

DESCRIPTION OF STRUCTURE

Figures V.2-1 and V.2-2

DESCRIPTION OF ACCELEROMETERS

Type: Table V.2-2

Location and axis of sensitivity: Table V.2-2 and Figures V.2-1 and V.2-2

DESCRIPTION OF DATA ACQUISITION SYSTEM

FM telemetry

COMMENTS

Due to the limitations of the accelerometers used, the shock spectra presented here are questionable above 50 hz (Table V.2-2).

TABLE V.2-1

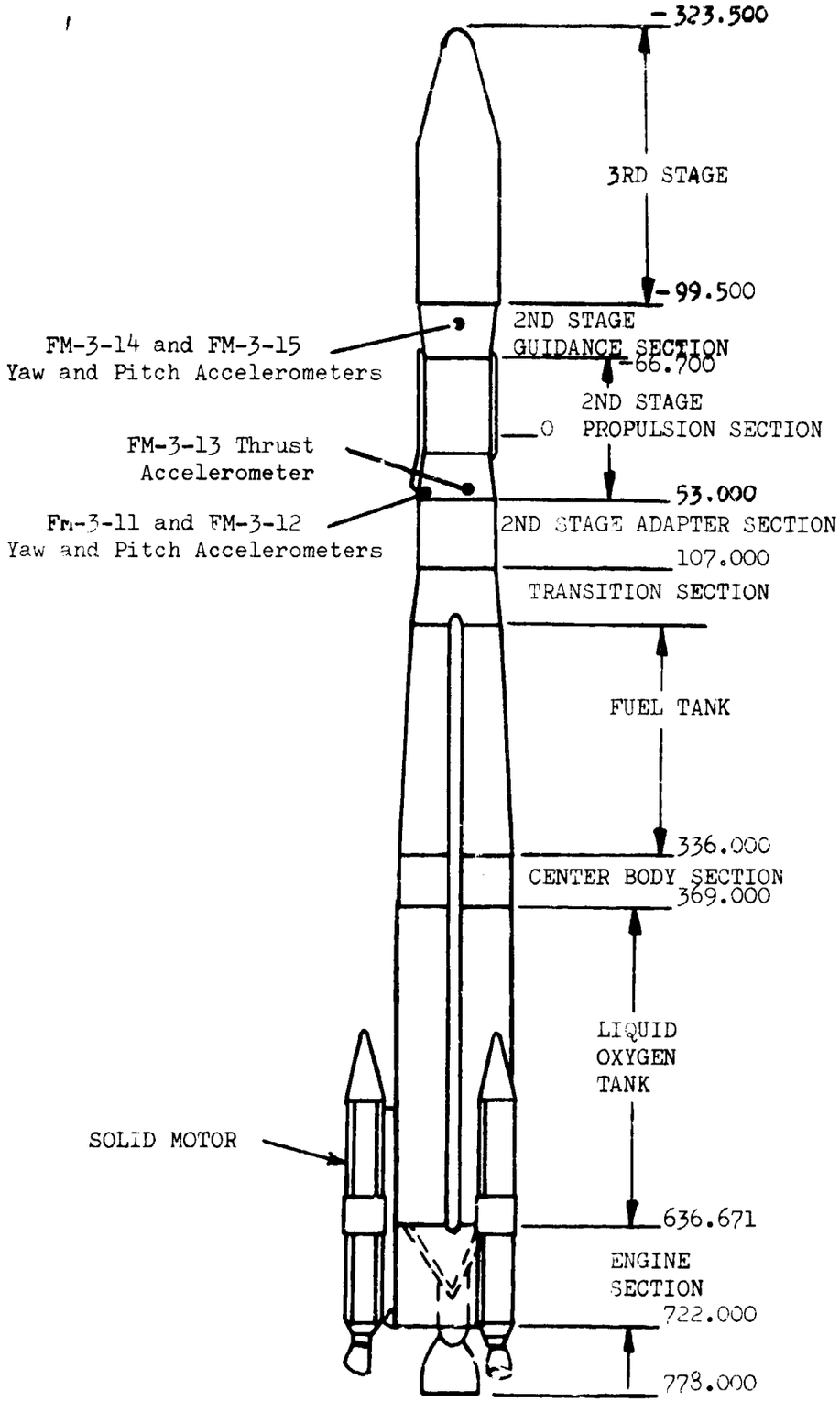
DATA REDUCTION INFORMATION

| Accelerometer Number | Duration of Time History Used in Shock Spectrum Analysis (seconds) | Frequency Range (limited by telemetry) | Figure Number |
|---|---|---|---|
| | Solid Motor Jettison Event | | |
| FM-3-11 | 0.9 | 1.0-110 Hz | V.2-3 |
| FM-3-12 | 0.9 | 1.0-160 Hz | V.2-3 |
| FM-3-13 | 0.9 | 1.0-200 Hz | V.2-4 |
| FM-3-14 | 0.7 | 1.0-300 Hz | V.2-4 |
| FM-3-15 | 0.9 | 1.0-350 Hz | V.2-5 |
| | Fairing Jettison Event | | |
| FM-3-14 | 0.8 | 1.0-300 Hz | V.2-6 |
| FM-3-15 | 1.0 | 1.0-350 Hz | V.2-6 |

TABLE V.2-2

DESCRIPTION OF ACCELEROMETERS

| Accelerometer Number | Sensitive Axis | Location | Description of Accelerometers |
|---|---|---|---|
| FM-3-11 | yaw | sta. 47.2 quad. I-IV | Statham Strain Gauge Model A404TC-2 Valid Range=0-50 Hz |
| FM-3-12 | pitch | sta. 47.2 quad. I-IV | Statham Strain Gauge Model A404TC-2 Valid Range=0-50 Hz |
| FM-3-13 | thrust | sta. 44.8 quad. I-II | CEC Strain Gauge Valid Range=0-40 Hz |
| FM-3-14 | yaw | cross beam intersection sta. -90 | Statham Strain Gauge Model A404TC-2 Valid Range=0-50 Hz |
| FM-3-15 | pitch | cross beam intersection sta. -90 | Statham Strain Gauge Model A404TC-2 Valid Range=0-50 Hz |




Accelerometer Locations on the Delta Vehicle 41.

FICURE V.2

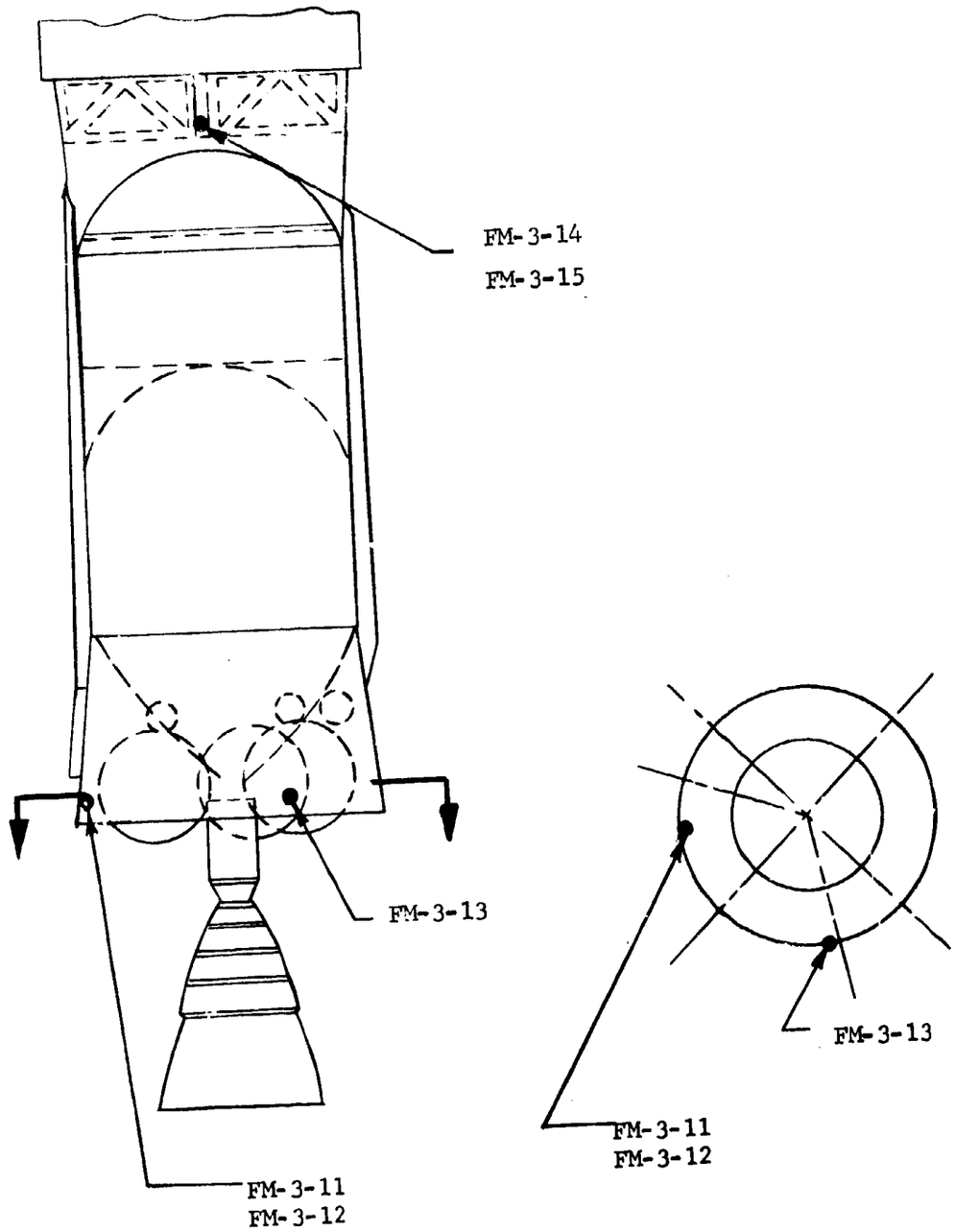
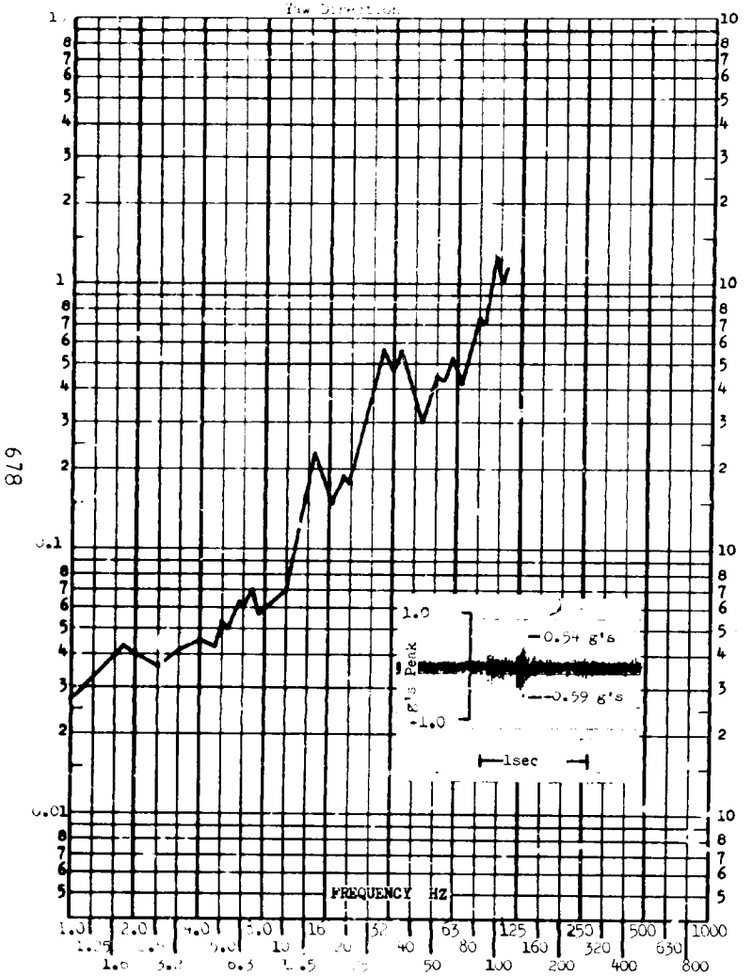



FIGURE V.2-2
ACCELEROMETER LOCATIONS

TEST ITEM Flight Test of Delta Vehicle 41 PART NO.
TEST DATE December 1966
SHOCK AXIS Measm't FM-3-11 SHOCK NO. Solid Motor Jettison
Pitch Direction

RESPONSE G's




TEST ITEM Flight Test of Delta Vehicle 41 PART NO.
TEST DATE December 1966
SHOCK AXIS Measm't FM-3-12 SHOCK NO. Solid Motor Jettison
Pitch Direction

RESPONSE G's

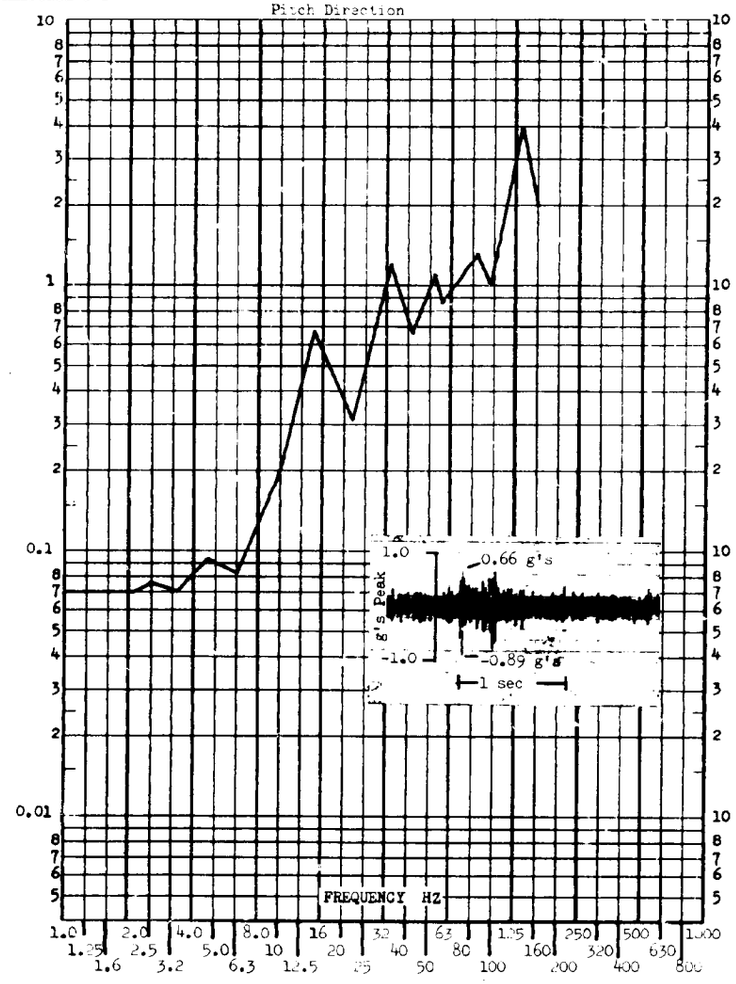
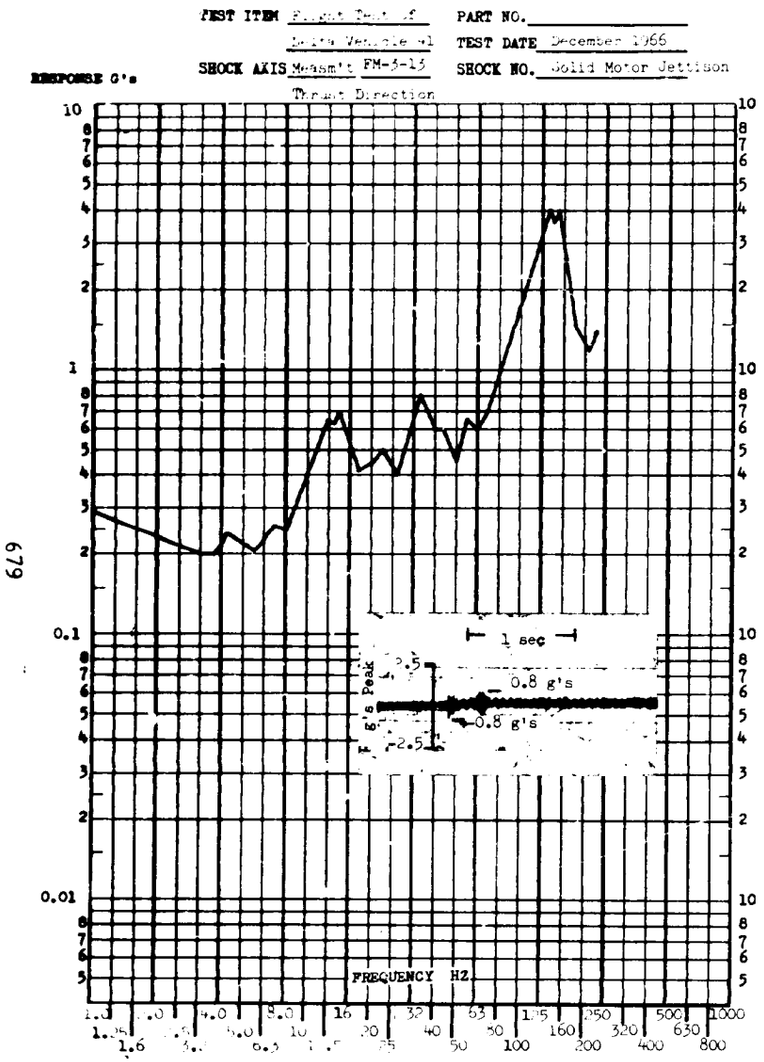



FIGURE V.2-3


TEST ITEM Flight Test of
Delta Vehicle #1
PART NO.
TEST DATE December 1966
SHOCK AXIS Measm't FM-5-13
SHOCK NO. Solid Motor Jettison
Thrust Direction
RESPONSE G's
FREQUENCY HZ
1 sec
0.8 g's
-0.8 g's
g's Peak

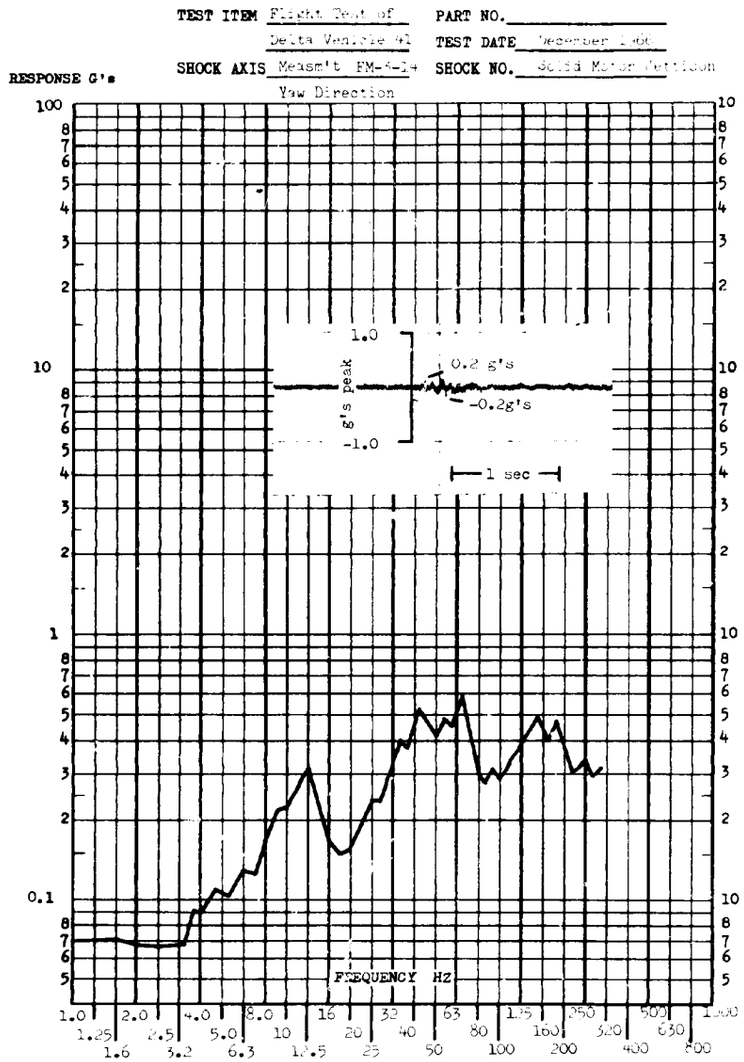

TEST ITEM Flight Test of
Delta Vehicle #1
PART NO.
TEST DATE December 1966
SHOCK AXIS Measm't FM-5-14
SHOCK NO. Solid Motor Jettison
Yaw Direction
RESPONSE G's
FREQUENCY HZ
1 sec
0.2 g's
-0.2g's
1.0
-1.0
g's peak

FIGURE V.2-4

TEST ITEM _____ PART NO. _____

TEST DATE _____

SHOCK AXIS _____ SHOCK NO. _____

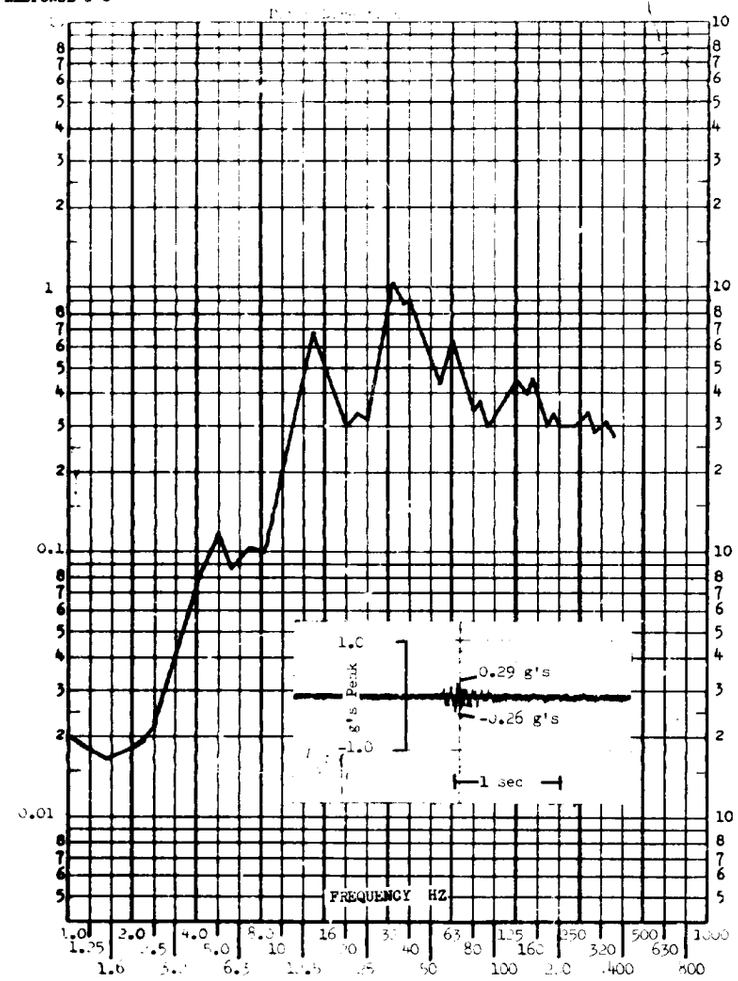



FIGURE V.2-5

SHOCK TEST ANALYSIS DATA SHEET

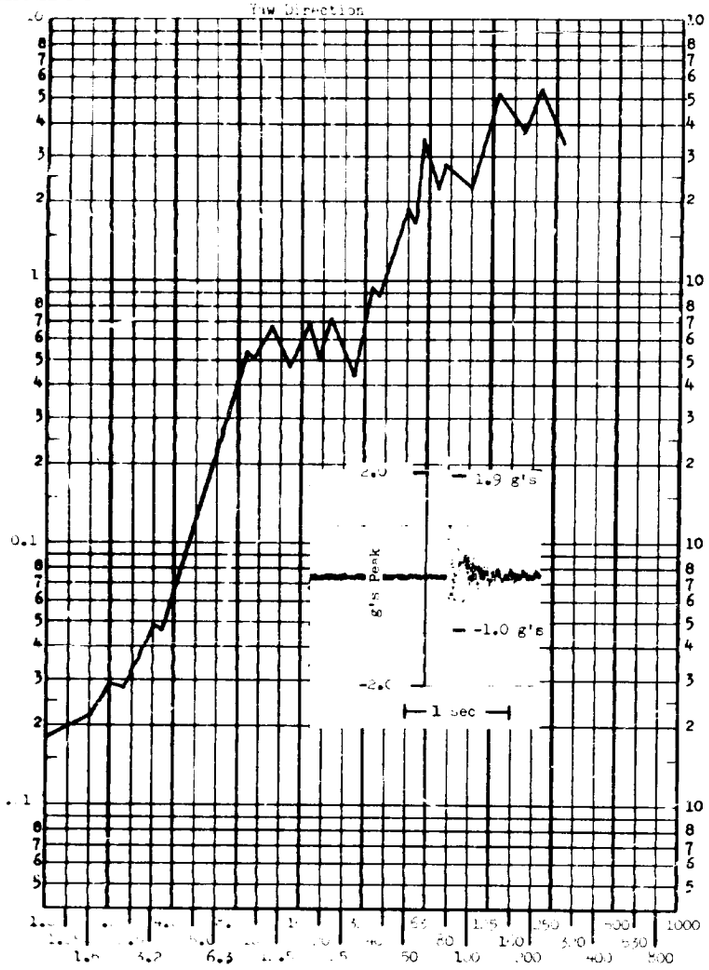
TEST ITEM Flight Test of Delta Vehicle #1 PART NO.

TEST DATE December 1966

SHOCK AXIS Measm't FM-3-14 SHOCK NO. Fairing Jettison

RESPONSE G's

Yaw Direction




TEST ITEM Flight Test of Delta Vehicle #1 PART NO.

TEST DATE December 1966

SHOCK AXIS Measm't FM-3-15 SHOCK NO. Fairing Jettison

RESPONSE G's

Pitch Direction

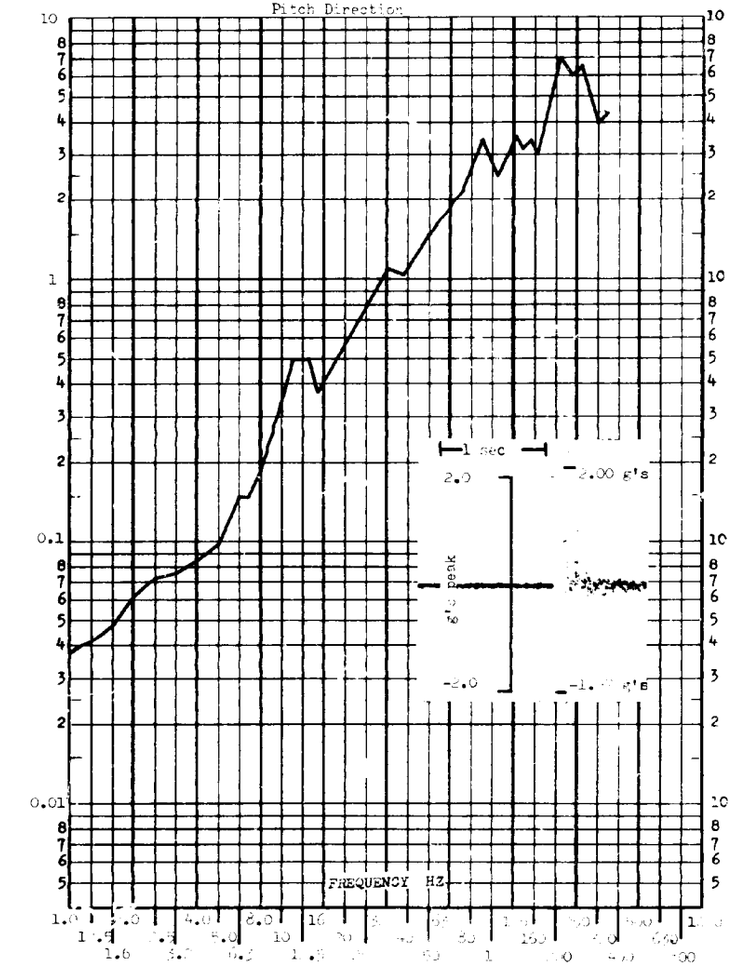



FIGURE V.2-6

SECTION V.3

FLIGHT TEST OF DELTA VEHICLE 43-BIOS-A

DESCRIPTION OF EVENT

During the flight of Delta Vehicle 43, two transient responses were observed at spacecraft separation. These transients were attributed to 1) a combination of explosive bolt detonation and explosive nut impact within its retainer and 2) bottoming of the actuator springs upon release. Figure V.3-1 illustrates the locations of the four explosive bolts atternately spaced with the four actuator springs.

DESCRIPTION OF DATA

Seven accelerometers were prepared to monitor this event; however, accelerometer FM-3-13 failed to transmit data earlier in the flight. The other six accelerometer in the separation region produced useful data depicting both events.

| | |
|---|---|
| No. of time histories | 12 |
| Duration | 0.2 second/event (approx.) |
| No. of shock spectra | 12 |
| Type of analysis | ditital |
| Frequency range | Table V.3-1 |
| Frequency increment | 30 points per octave |
| Damping | Q = 10 |

These shock spectra are presented with their corresponding time histories as Figures V.3-3 through V.3-8.

DESCRIPTION OF PYROTECHNIC

Four explosive bolts.

DESCRIPTION OF STRUCTURE.

Diameter = 58 inches

Weight = 940 pounds

See Figures V.3-1 and V.3-2

DESCRIPTION OF ACCELEROMETERS

Locations: Table V.3-1 and Figure V.3-2

Axis of sensitivity: Table V.3-1.

TABLE V.3-1

INFORMATION ABOUT ACCELEROMETER
AND DATA

| Accelerometer Number | Location | Sensitive Axis | Frequency Range | Figure Number |
|---|---|---|---|---|
| FM-3-11 | Sta. 115 | Tangential | 660 Hz | V.3-3 |
| FM-3-12 | Sta. 115 | Radial | 900 Hz | V.3-4 |
| FM-3-14 | Sta. 101 | Radial | 1600 Hz | V.3-5 |
| FM-3-15 | Sta. 101 | Tangential | 2500 Hz | V.3-6 |
| FM-3-16 | Sta. 101 | Thrust | 5000 Hz | V.3-7 |
| FM-3-17 | Sta. 101 | Tantential | 5000 Hz | V.3-8 |

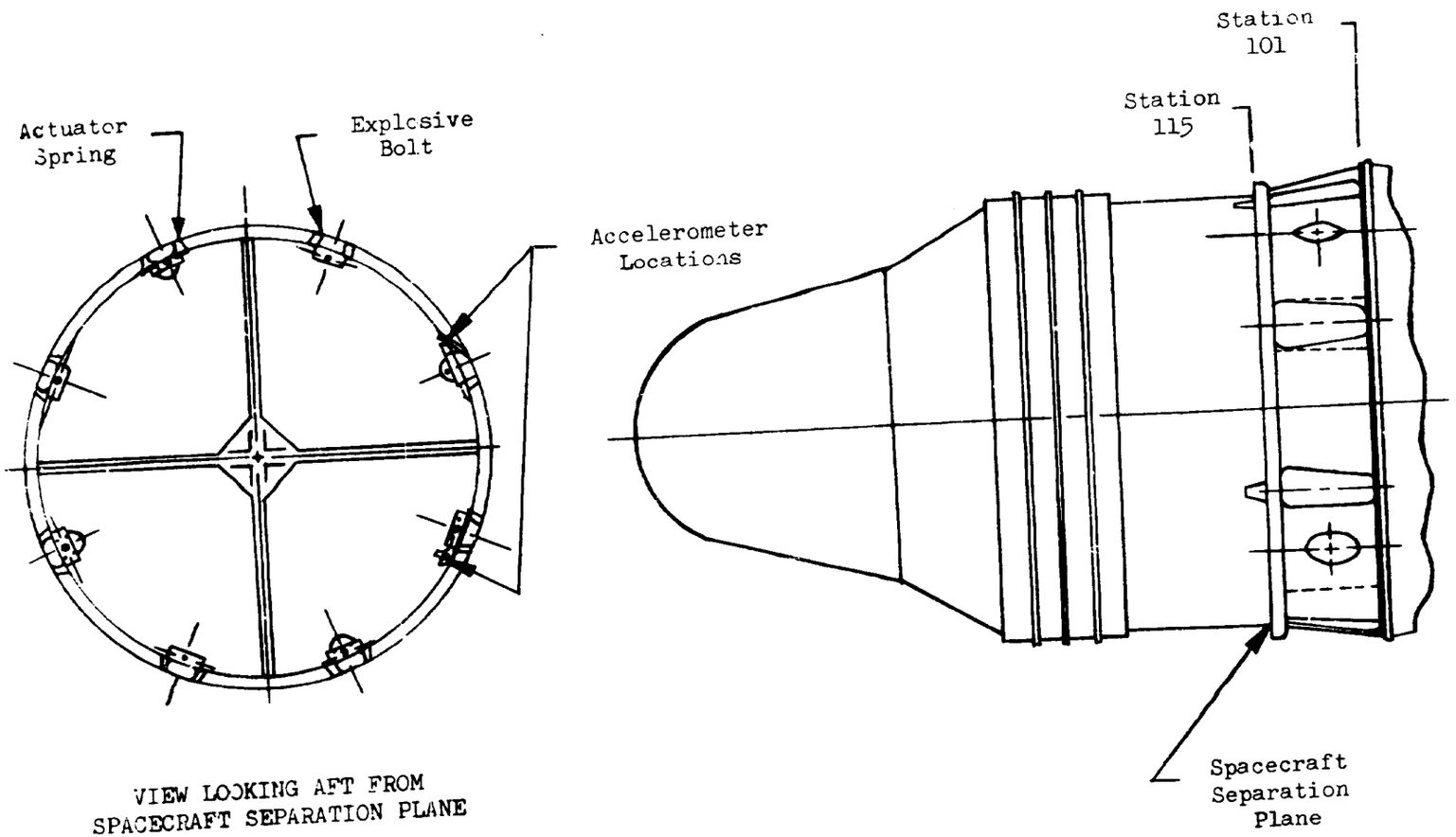



**Figure V.3-1. Location of Pyrotechnic Devices on the Delta 43-BIOS-A Spacecraft**

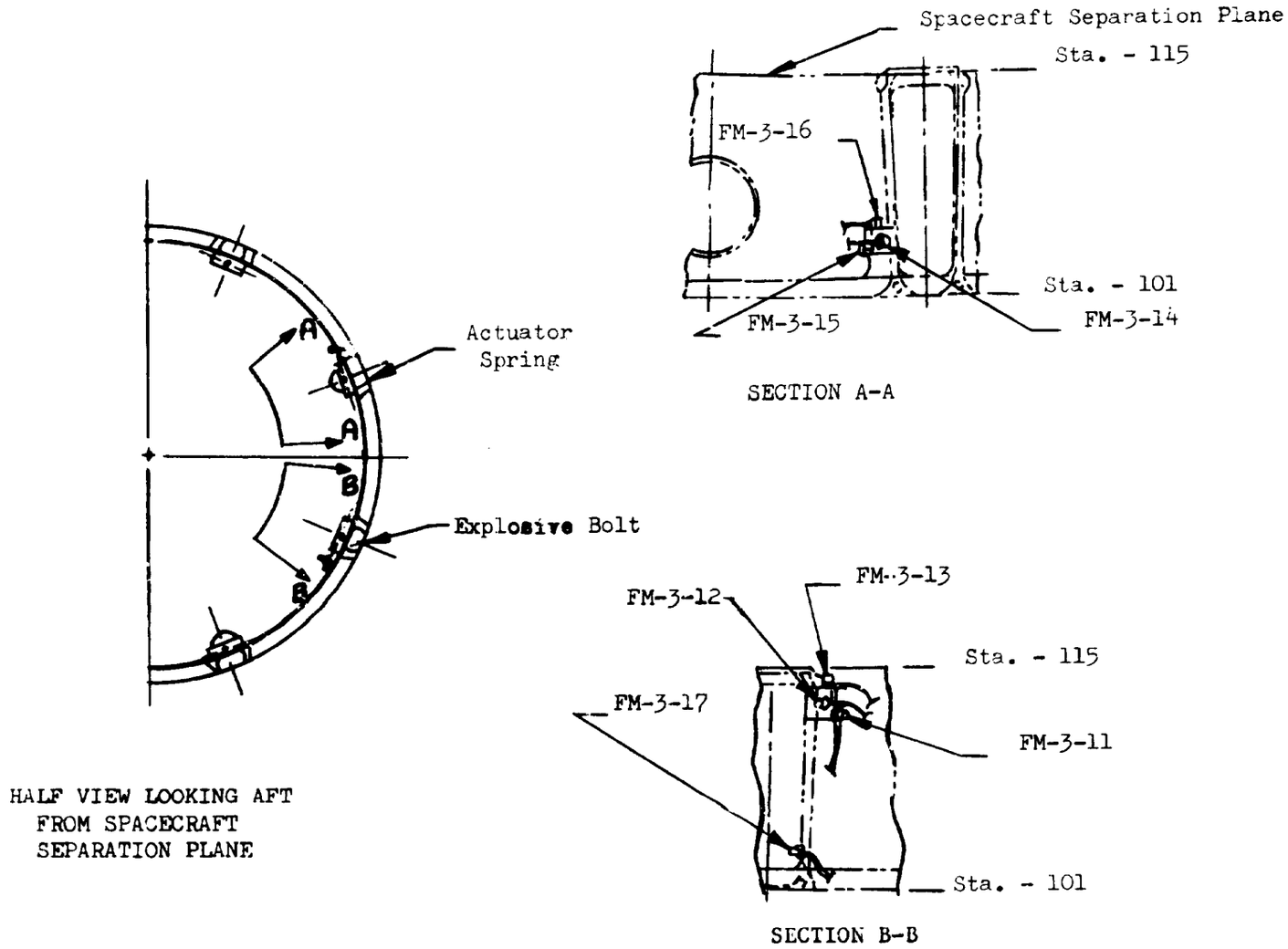
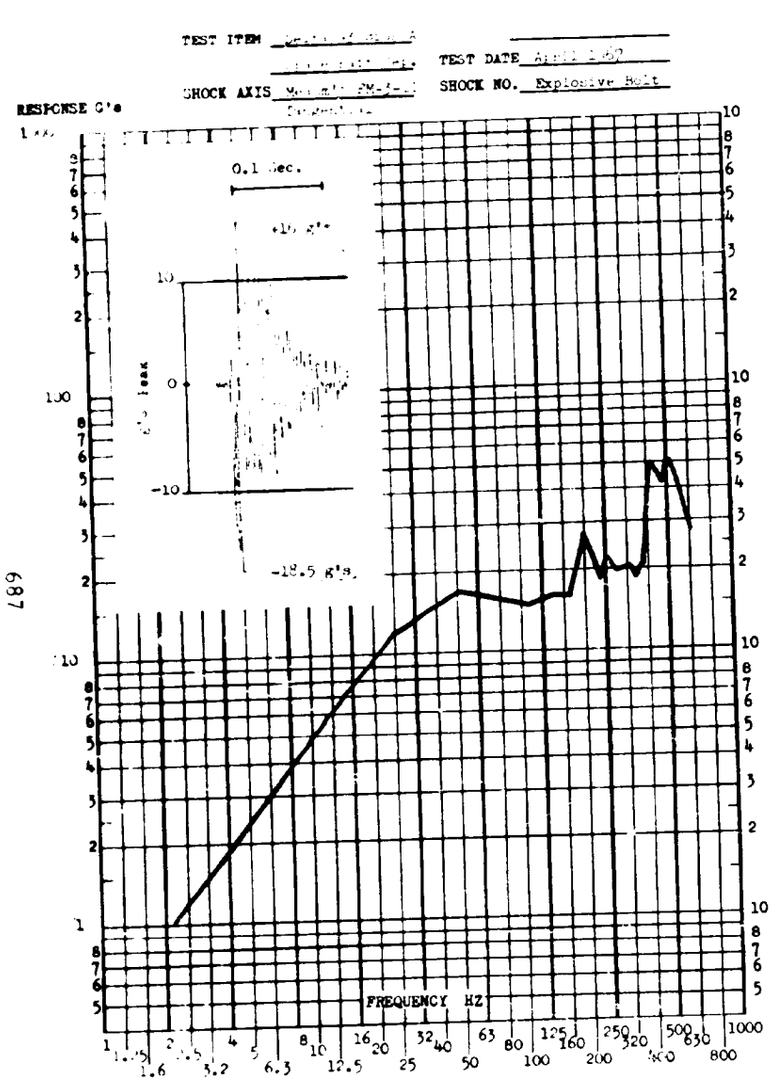



Figure V.3-2. Description of Accelerometer Locations for the Delta 43-BIOS-A Separation


TEST ITEM
TEST DATE
SHOCK AXIS
SHOCK NO. Explosive Bolt
RESPONSE G's
0.1 Sec.
+10 g's
-18.5 g's
FREQUENCY HZ

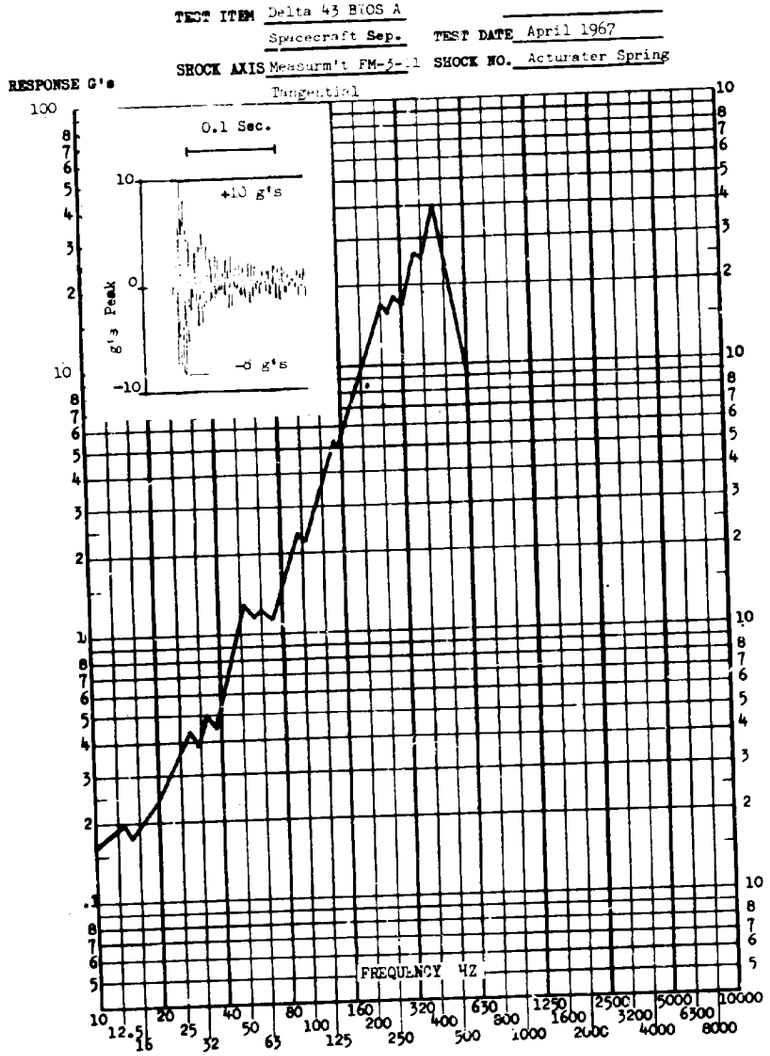
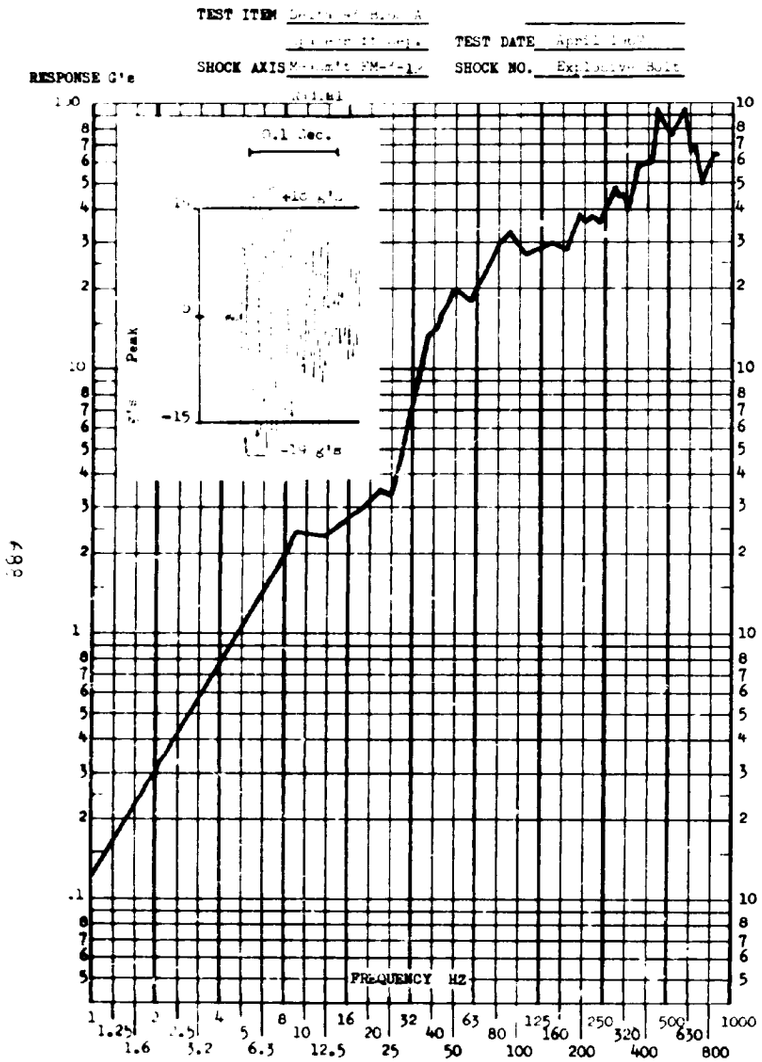

TEST ITEM Delta 43 BIOS A
Spacecraft Sep.
TEST DATE April 1967
SHOCK AXIS Measurm't FM-3-1
Tangential
SHOCK NO. Acturater Spring
RESPONSE G's
0.1 Sec.
+10 g's
-6 g's
g's Peak
FREQUENCY HZ

FIGURE V.3-3


TEST ITEM
TEST DATE April 1967
SHOCK AXIS
SHOCK NO. Explosive Bolt
RESPONSE G's
Radial
0.1 Sec.
+15 g's
-15
-14 g's
Peak
FREQUENCY HZ
1 1.25 1.6 2 2.5 3.2 4 5 6.3 8 10 12.5 16 20 25 32 40 50 63 80 100 125 160 200 250 320 400 500 630 800 1000

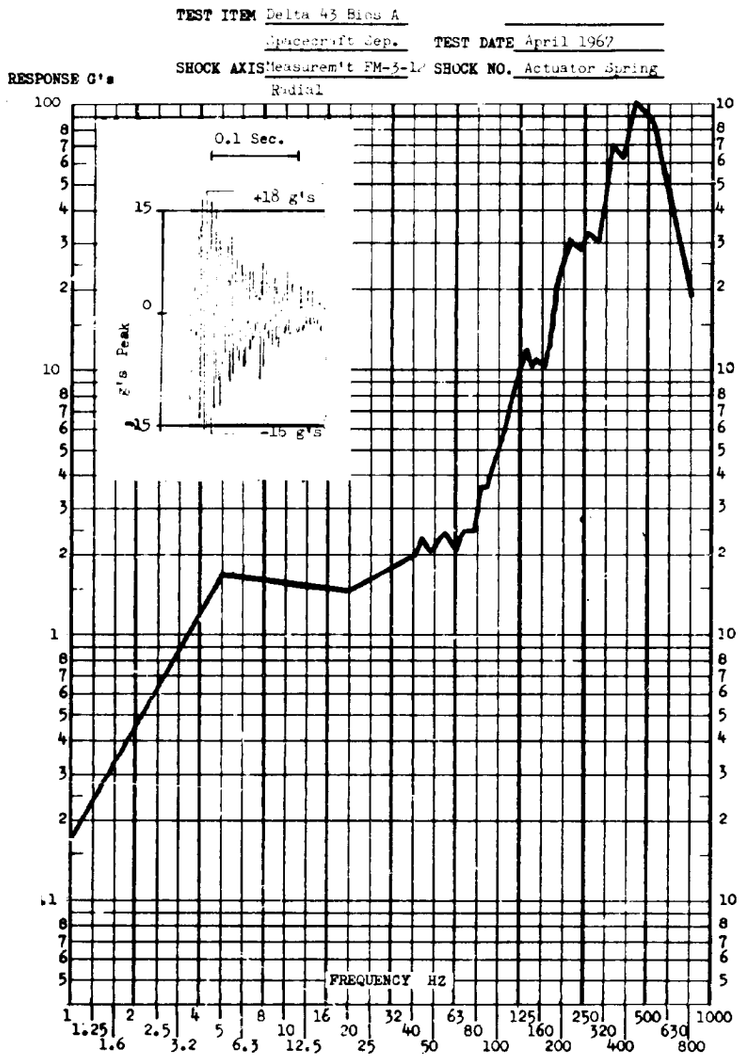
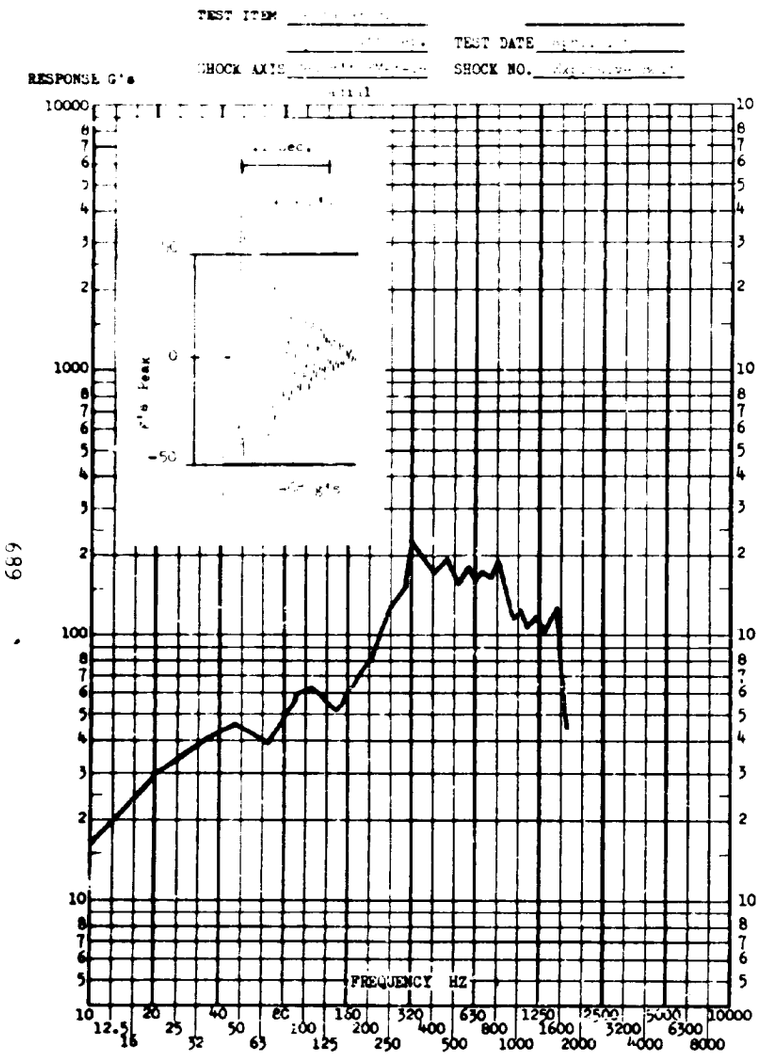

TEST ITEM Delta 43 Bird A
Spacecraft Sep.
TEST DATE April 1967
SHOCK AXIS Measurem't FM-3-1/
SHOCK NO. Actuator Spring
RESPONSE G's
Radial
0.1 Sec.
+18 g's
15
0
-15
-15 g's
g's Peak
FREQUENCY HZ
1 1.25 1.6 2 2.5 3.2 4 5 6.3 8 10 12.5 16 20 25 32 40 50 63 80 100 125 160 200 250 320 400 500 630 800 1000

FIGURE V.3-4


RESPONSE G's
FREQUENCY HZ
0.1 sec.
g's Peak
0
-50
-45 g's

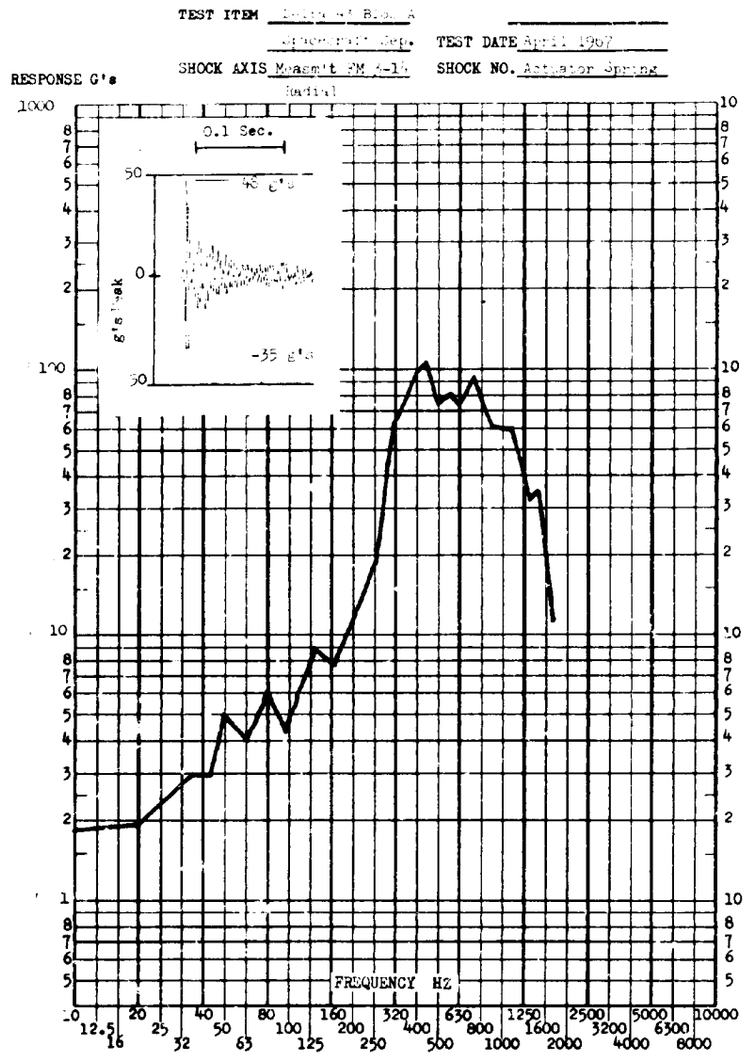
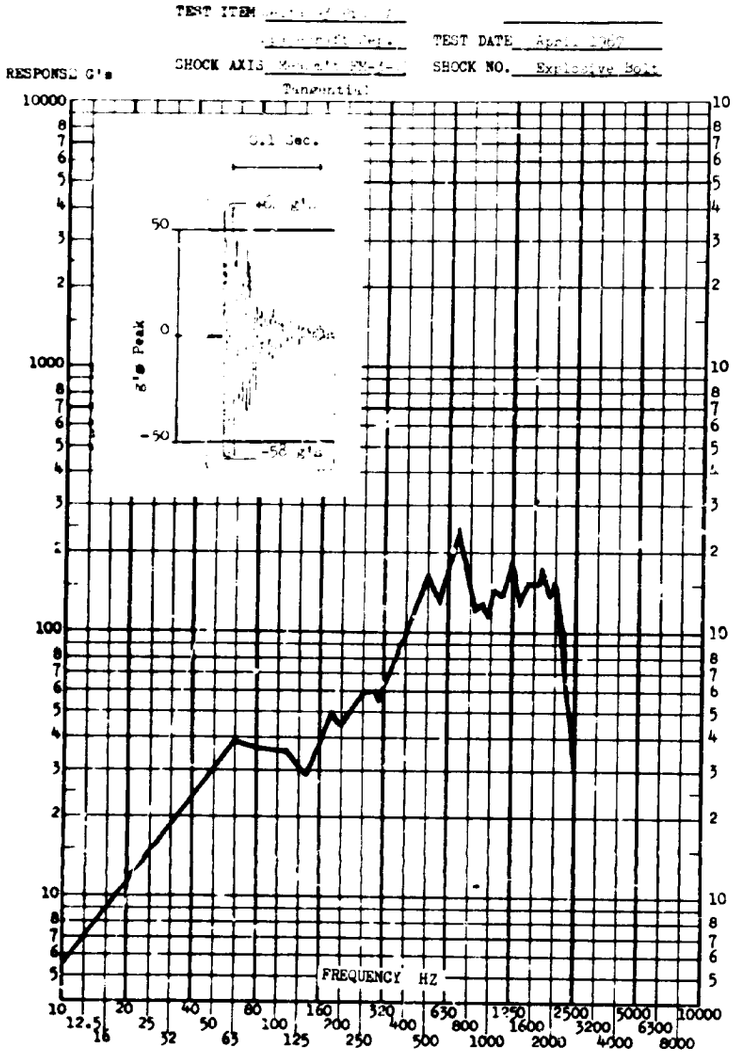

TEST ITEM
TEST DATE April 1967
SHOCK AXIS
SHOCK NO. Actuator Spring
RESPONSE G's
FREQUENCY HZ
0.1 Sec.
50
0
-50
-35 g's

FIGURE V.3-5


TEST ITEM
TEST DATE April 1967
SHOCK AXIS
SHOCK NO. Explosive Bolt
RESPONSE G's
Tangential
0.1 Sec.
50
0
-50
g's Peak
FREQUENCY HZ
10000
1000
100
10
12.5
16
20
25
32
40
50
63
80
100
125
160
200
250
320
400
500
630
800
1000
1250
1600
2000
2500
3200
4000
5000
6300
8000
10000

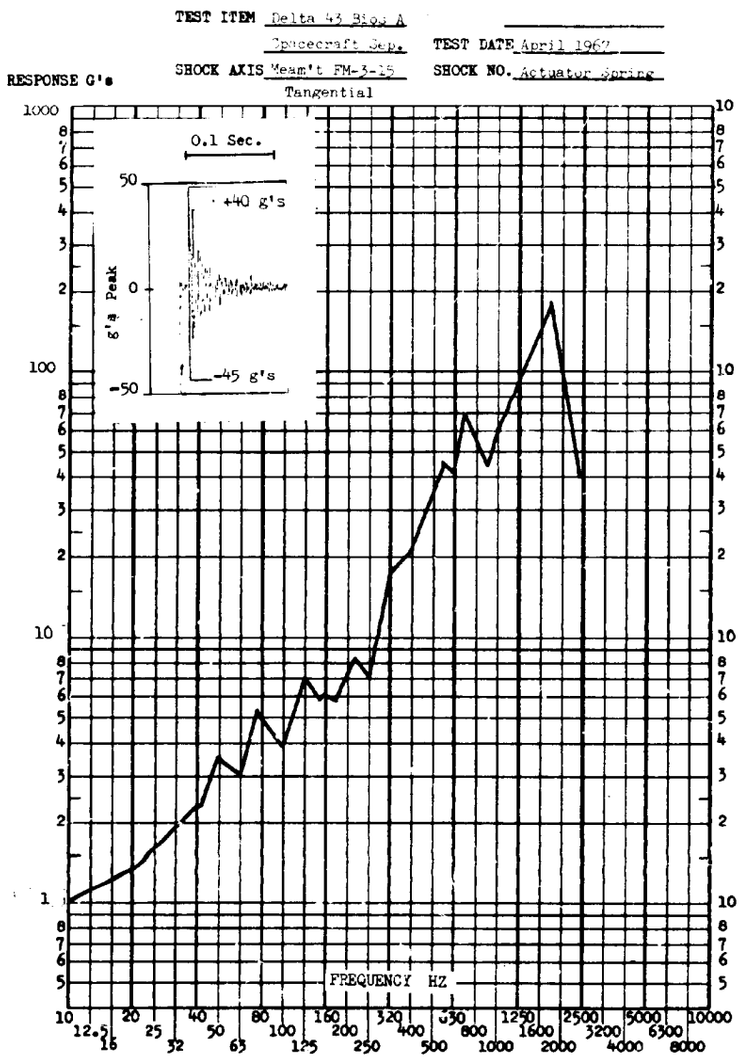
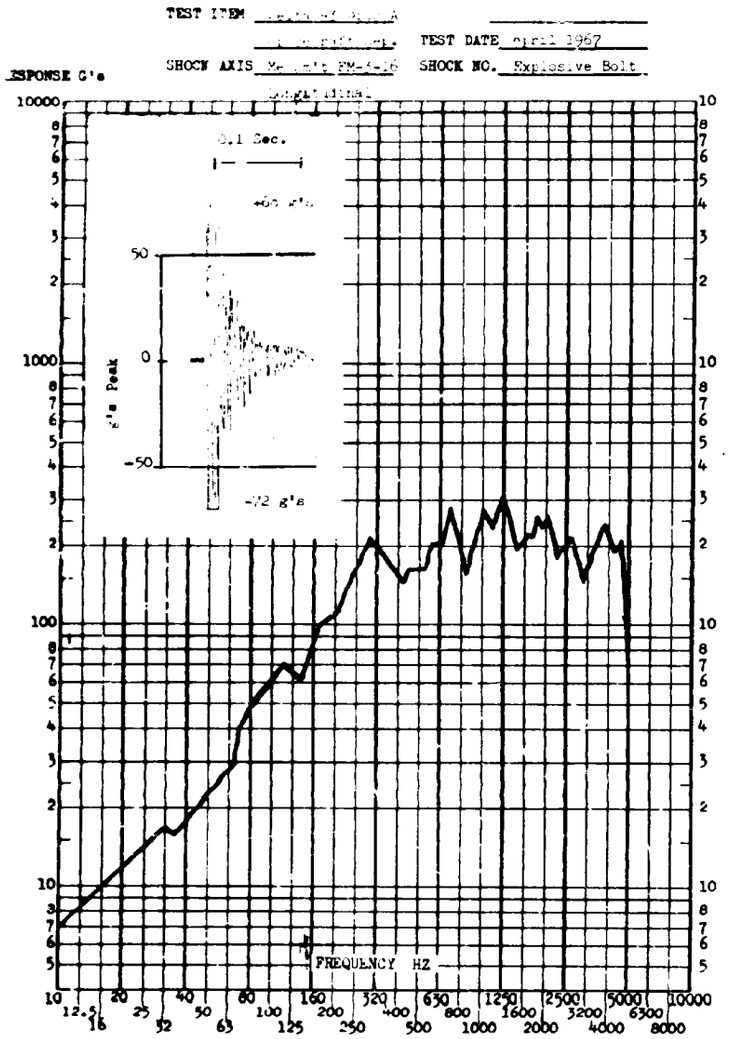

TEST ITEM Delta 43 Biog A
Spacecraft Sep.
TEST DATE April 1967
SHOCK AXIS Meam't FM-3-15
SHOCK NO. Actuator Spring
RESPONSE G's
Tangential
0.1 Sec.
50
+40 g's
0
-45 g's
-50
g's Peak
FREQUENCY HZ
1000
100
10
1
12.5
16
20
25
32
40
50
63
80
100
125
160
200
250
320
400
500
630
800
1000
1250
1600
2000
2500
3200
4000
5000
6300
8000
10000

FIGURE V.3-6


TEST ITEM
TEST DATE April 1967
SHOCK AXIS
SHOCK NO. Explosive Bolt
RESPONSE G's
Longitudinal
0.1 Sec.
+68 g's
50
0
-50
g's Peak
-72 g's
FREQUENCY HZ
10000
1000
100
10
12.5
16
20
25
32
40
50
63
80
100
125
160
200
250
320
400
500
630
800
1000
1250
1600
2000
2500
3200
4000
5000
6300
8000
10000

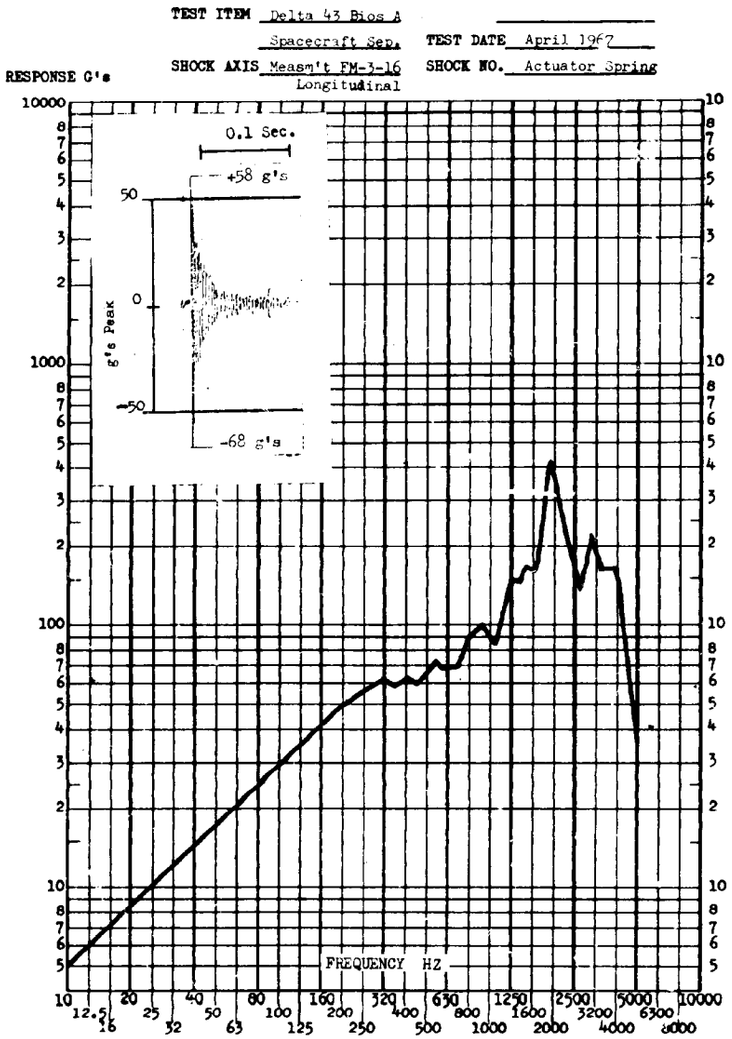
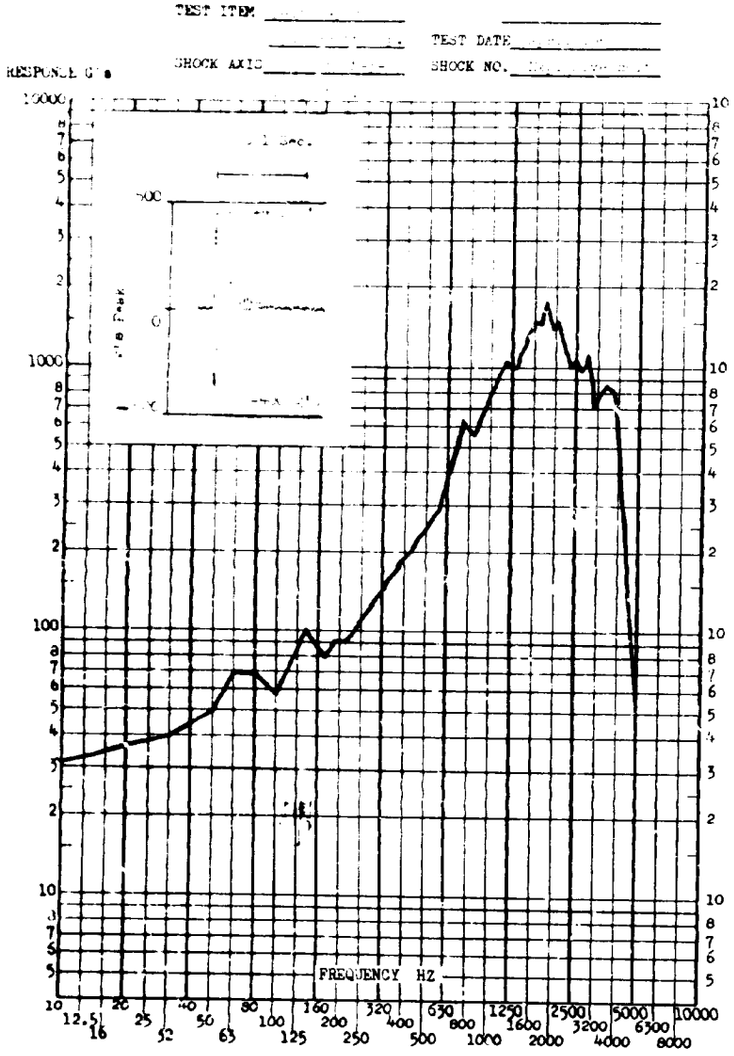

TEST ITEM Delta 43 Bios A
Spacecraft Sep.
TEST DATE April 1967
SHOCK AXIS Measm't FM-3-16
SHOCK NO. Actuator Spring
RESPONSE G's
Longitudinal
0.1 Sec.
+58 g's
50
0
-50
g's Peak
-68 g's
FREQUENCY HZ
10000
1000
100
10
12.5
16
20
25
32
40
50
63
80
100
125
160
200
250
320
400
500
630
800
1000
1250
1600
2000
2500
3200
4000
5000
6300
8000
10000

FIGURE V.3-7


TEST ITEM
TEST DATE
SHOCK AXIS
SHOCK NO.
RESPONSE G's
0.1 Sec.
500
0
g's Peak
FREQUENCY HZ
10
12.5
16
20
25
32
40
50
63
80
100
125
160
200
250
320
400
500
630
800
1000
1250
1600
2000
2500
3200
4000
5000
6300
8000
10000

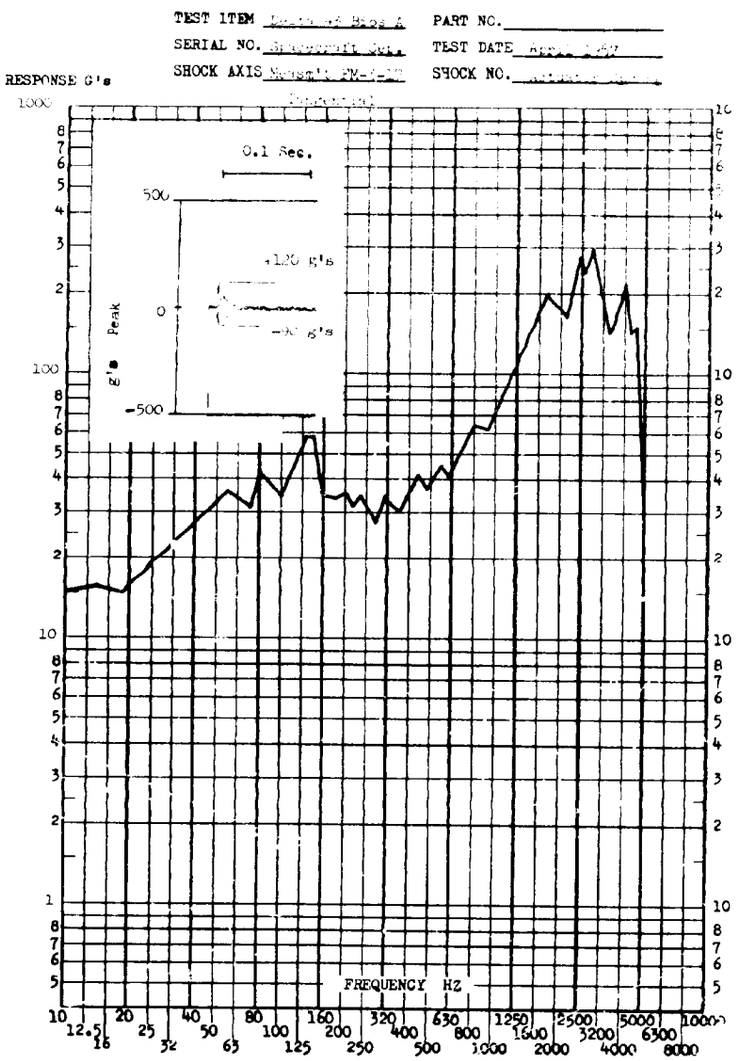

TEST ITEM
PART NO.
SERIAL NO.
TEST DATE
SHOCK AXIS
SHOCK NO.
RESPONSE G's
0.1 Sec.
500
+120 g's
0
-500
g's Peak
FREQUENCY HZ
10
12.5
16
20
25
32
40
50
63
80
100
125
160
200
250
320
400
500
630
800
1000
1250
1600
2000
2500
3200
4000
5000
6300
8000
10000

FIGURE V.3-8

SECTION V.4

FLIGHT TEST OF DELTA VEHICLE 51-BIOS-B

DESCRIPTION OF EVENT

During the flight of Delta Vehicle 51, there were two notable pyrotechnic events:

1) Fairing jettison (explosive bolts)

2) Spacecraft separation (explosive bolts)

The shock excitation imparted to the spacecraft adapter results from detonation of the six fairing explosive bolts and impact of each fairing half against the pivot brackets. This impact velocity was produced by six alternately spaced, preloaded spring actuators. The location of the fairing is indicated in Figure V.4-1.

During spacecraft separation, two distinct transients responses were observed. These transients were attributed to 1) a combination of explosive bolt detonation and explosive nut impact within its retainer and 2) bottoming of the actuator springs upon release. Figure V.4-2 illustrates the locations of the four explosive bolts alternately spaced with the four actuator springs.

DESCRIPTION OF DATA

| | |
|---|---|
| Fairing Jettison Event | |
| No. of time histories | 5 |
| Duration | (see time histories) |
| No. of shock spectra | 5 |
| Type of analysis | digital |
| Frequency range | Table V.4-1 |
| Frequency increment | 30 points per octave |
| Damping | Q = 10 |

These shock spectra are presented along with their corresponding time histories as Figures V.4-3 through V.4-5.

Spacecraft Separation Event (Explosive bolts and actuator springs)

| | |
|---|---|
| No. of time histories | 5 |
| Duration | 0.15 sec (approx.) |
| No. of shock spectra | 10 |
| Type of analysis | digital |
| Sample rate | |
| Frequency range | Table V.4-1 |
| Frequency increment | 30 points per octave |
| Damping | Q = 10 |

Table V.4-1

DESCRIPTION OF MEASUREMENTS

| Accelerometer Number | Location | Sensitive Axis | Frequency Range | Figure Number Fairing Event | Figure Number Separation Event |
|---|---|---|---|---|---|
| FM-3-10 | Sta. 115 17.250 from Quad. III to Quad. II | Thrust | 10-550 Hz | V.4-3 | V.4-6 |
| FM-3-11 | " | Pitch | 10-550 Hz | V.4-3 | V.4-7 |
| FM-3-12 | " | Yaw | 10-800 Hz | V.4-4 | V.4-8 |
| FM-3-13 | Sta. 115 17.250 from Quad. II to Quad. III | Thrust | 10-1000 Hz | V.4-4 | V.4-9 |
| FM-3-A | " | Tangential | 5-2000 Hz | V.4-5 | V.4-10 |

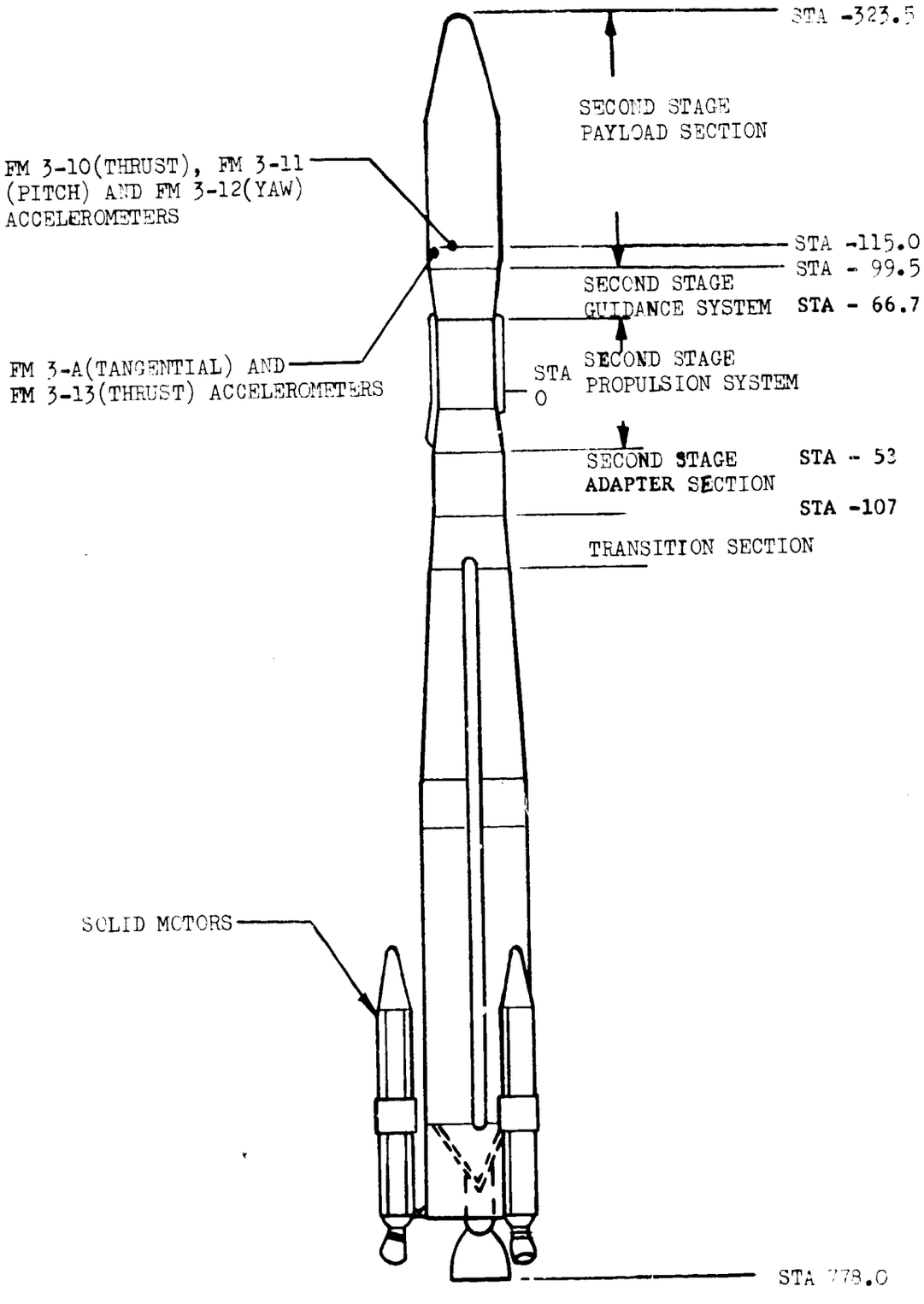



**Figure V.4-1 Accelerometer Locations on the Delta Vehicle #51-BIOS-B**



XIII

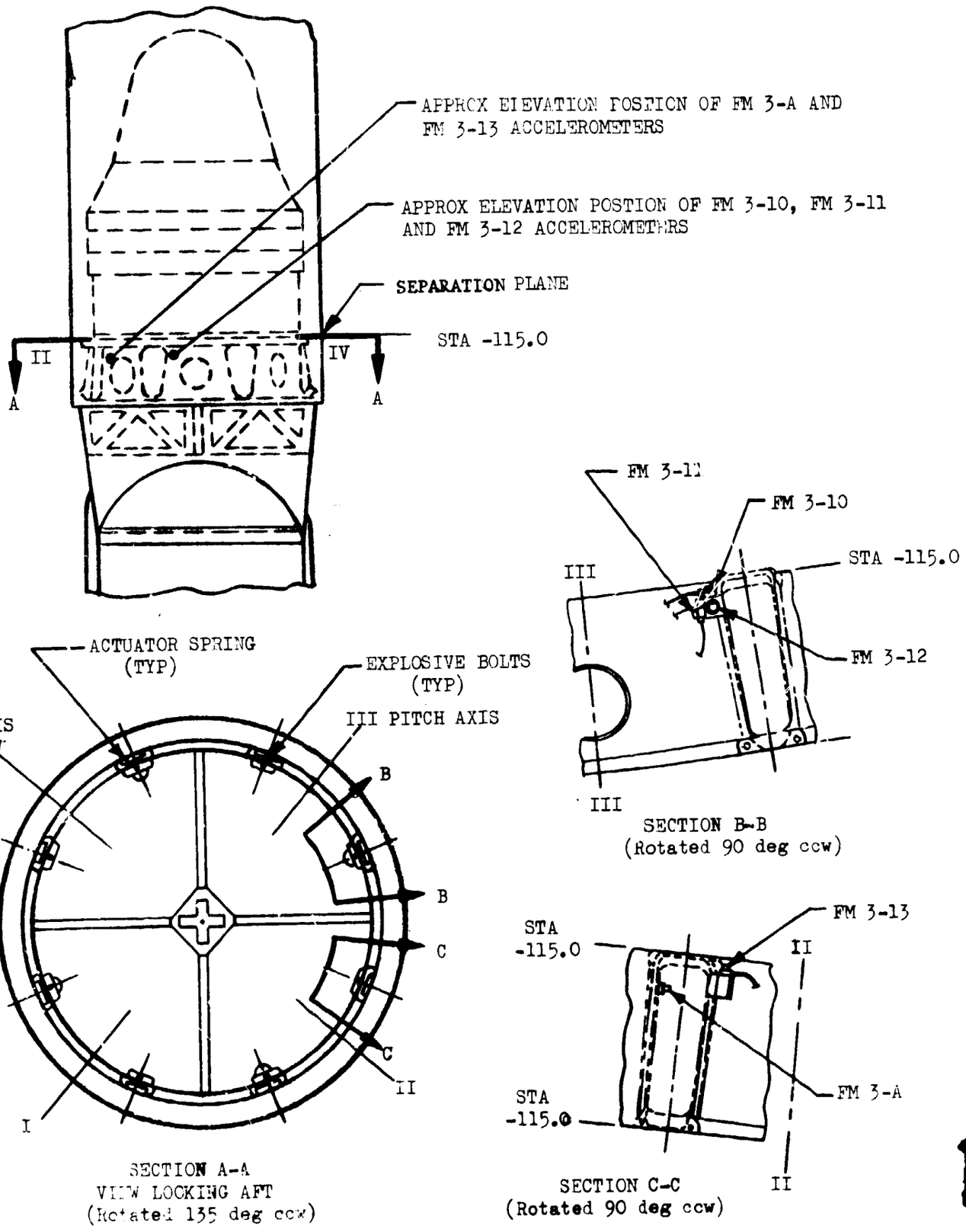



Figure V.4-2. Location of Accelerometers and Pyrotechnic

The number of shock spectra quoted for this event includes a spectrum for both the explosive bolt and actuator spring portions of the event for each of the five measurements. A careful examination of these time histories will reveal both portions of the event. These shock spectra and their corresponding time histories are presented as Figure V.4-6 through V.4-10.

DESCRIPTION OF PYROTECHNIC

Explosive bolts for both events.

DESCRIPTION OF STRUCTURE

Figure V.4-1 and V.4-2

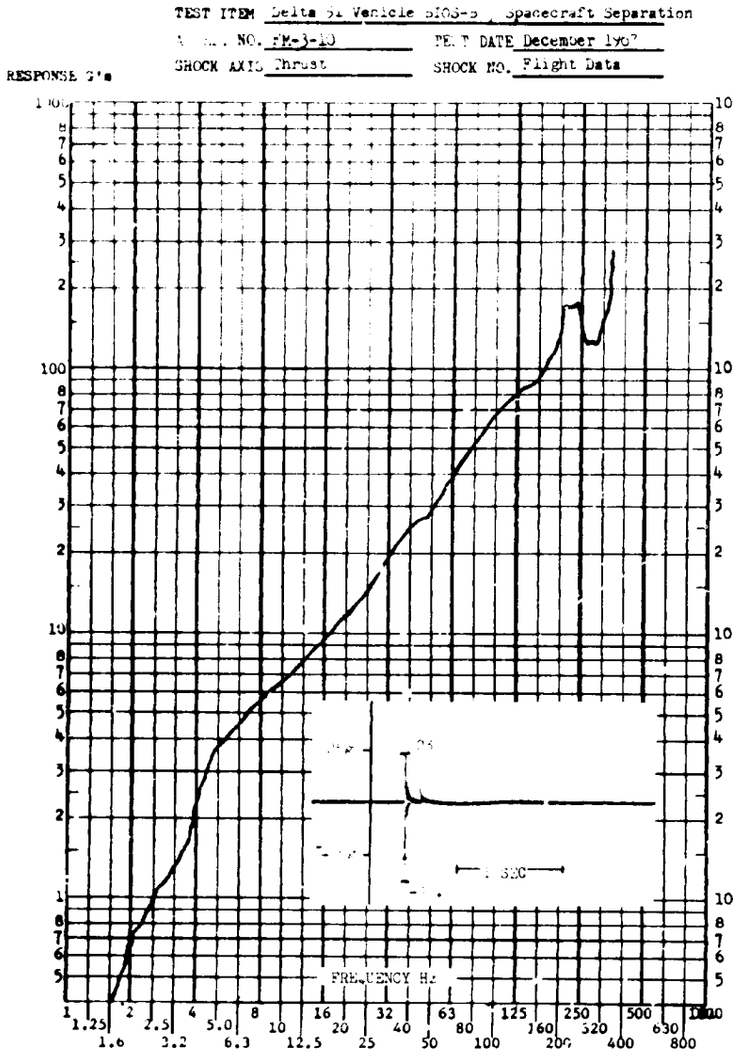
DESCRIPTION OF ACCELEROMETERS

Type: Endevco (Model unknown)

Locations and Axis of Sensitivity: Table V.4-1 and Figures V.4-1 and V.4-2

COMMENTS

Notice that the data for the spacecraft separation includes a shock spectrum for both the separation event and the actuator spring release event. Although the time histories are difficult to read, those for the spacecraft separation reveal the presence of both events.


TEST ITEM Delta 51 Vehicle BIOS-5 , Spacecraft Separation
MODEL NO. FM-3-10
TEST DATE December 1967
SHOCK AXIS Thrust
SHOCK NO. Flight Data
RESPONSE G's
1 SEC
FREQUENCY Hz
1 1.25 1.6 2 2.5 3.2 4 5.0 6.3 8 10 12.5 16 20 25 32 40 50 63 80 100 125 160 200 250 320 400 500 630 800 1000

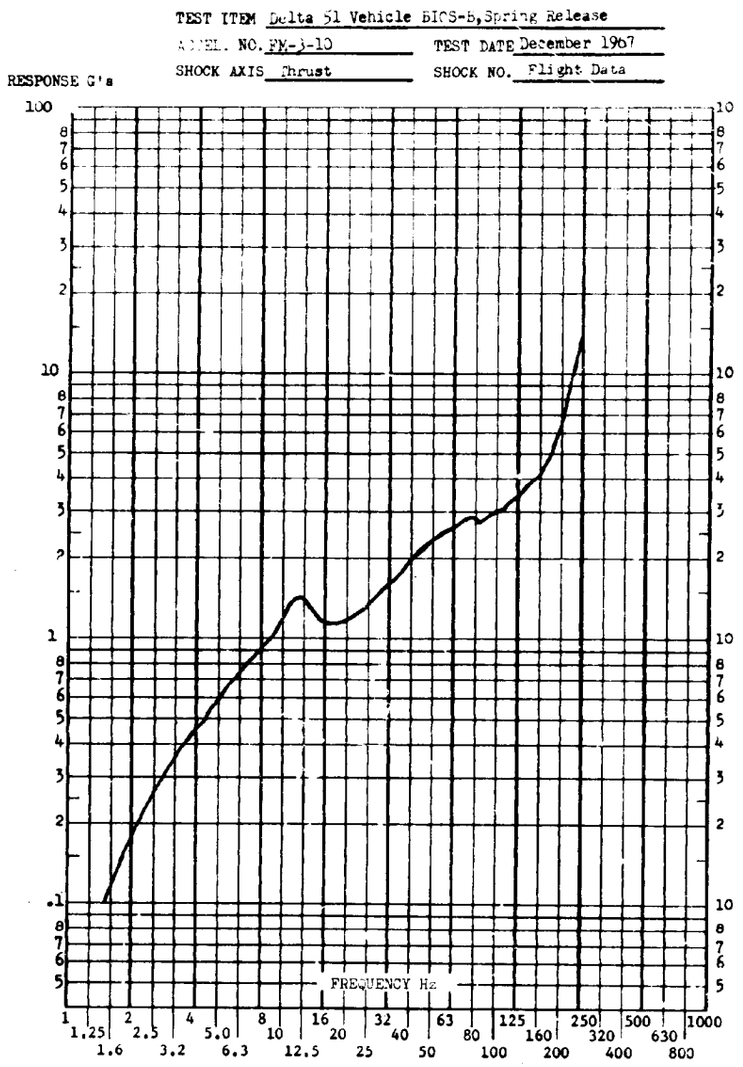
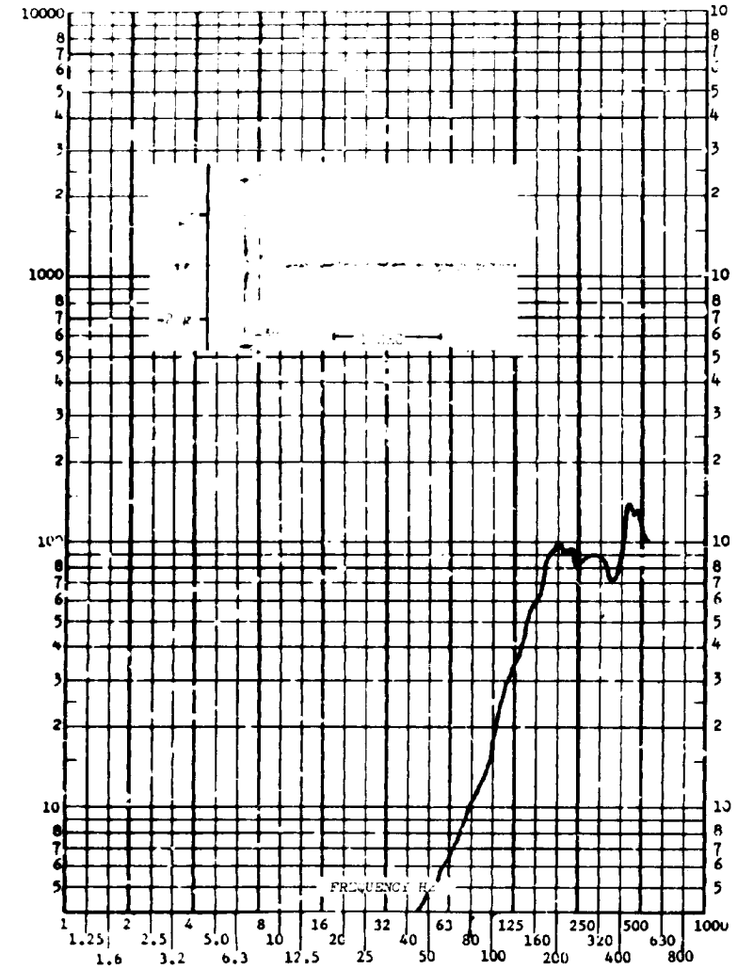

TEST ITEM Delta 51 Vehicle BIOS-5, Spring Release
MODEL NO. FM-3-10
TEST DATE December 1967
SHOCK AXIS Thrust
SHOCK NO. Flight Data
RESPONSE G's
100
10
1
.1
FREQUENCY Hz
1 1.25 1.6 2 2.5 3.2 4 5.0 6.3 8 10 12.5 16 20 25 32 40 50 63 80 100 125 160 200 250 320 400 500 630 800 1000

FIGURE V.4-3

TEST ITEM Delta 51 Vehicle BIOS-E, Spacecraft Separation
ACCEL. NO. FM-3-11 TEST DATE December 1967
SHOCK AXIS Pitch SHOCK NO. Flight Data




TEST ITEM Delta 51 Vehicle BIOS-E Spring Release
ACCEL. NO. FM-3-11 TEST DATE December 1967
SHOCK AXIS Pitch SHOCK NO. Flight Data

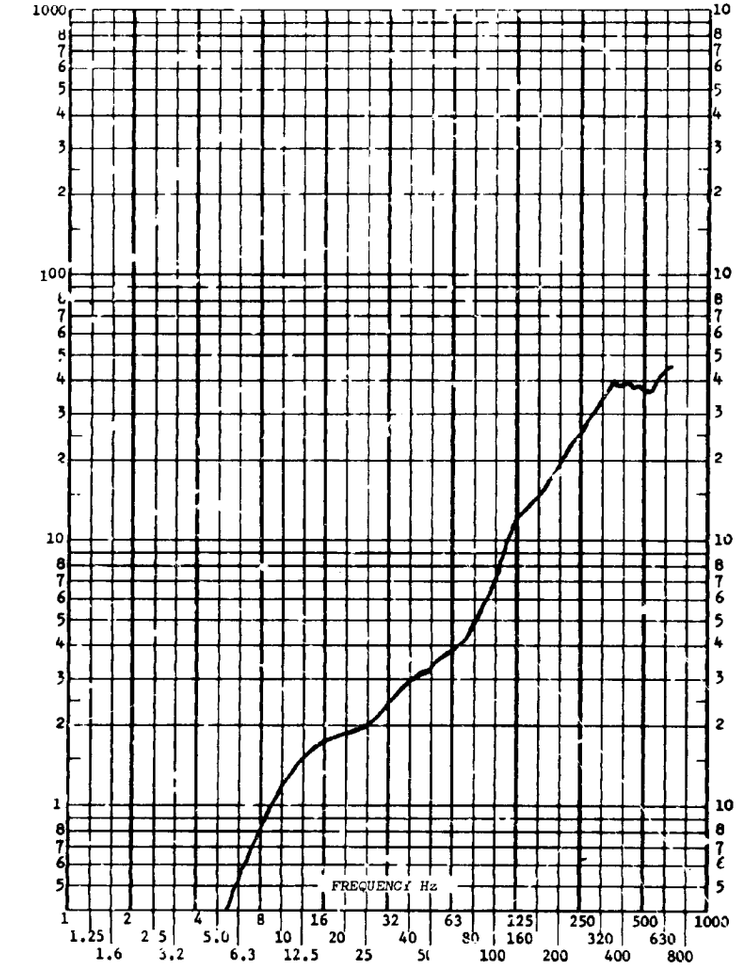
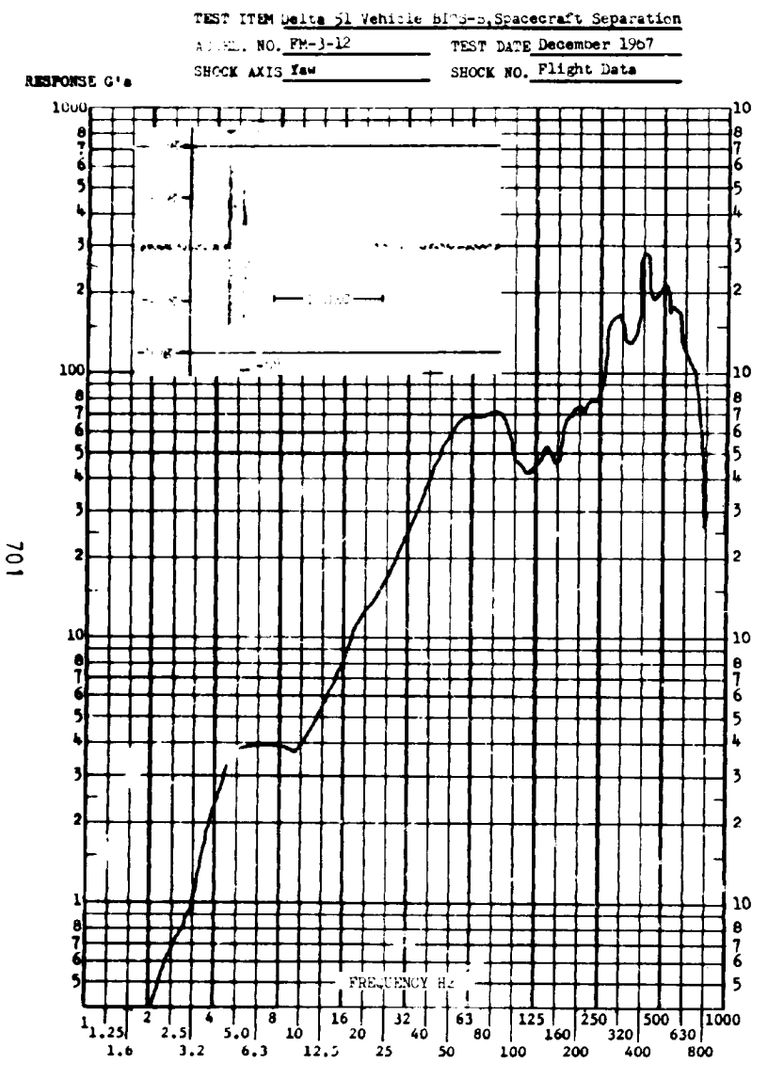



FIGURE V.4-4


TEST ITEM Delta 51 Vehicle bIOS-B,Spacecraft Separation
ACCEL. NO. FM-3-12
TEST DATE December 1967
SHOCK AXIS Yaw
SHOCK NO. Flight Data
RESPONSE G's
FREQUENCY Hz
1 1.25 1.6 2 2.5 3.2 4 5.0 6.3 8 10 12.5 16 20 25 32 40 50 63 80 100 125 160 200 250 320 400 500 630 800 1000

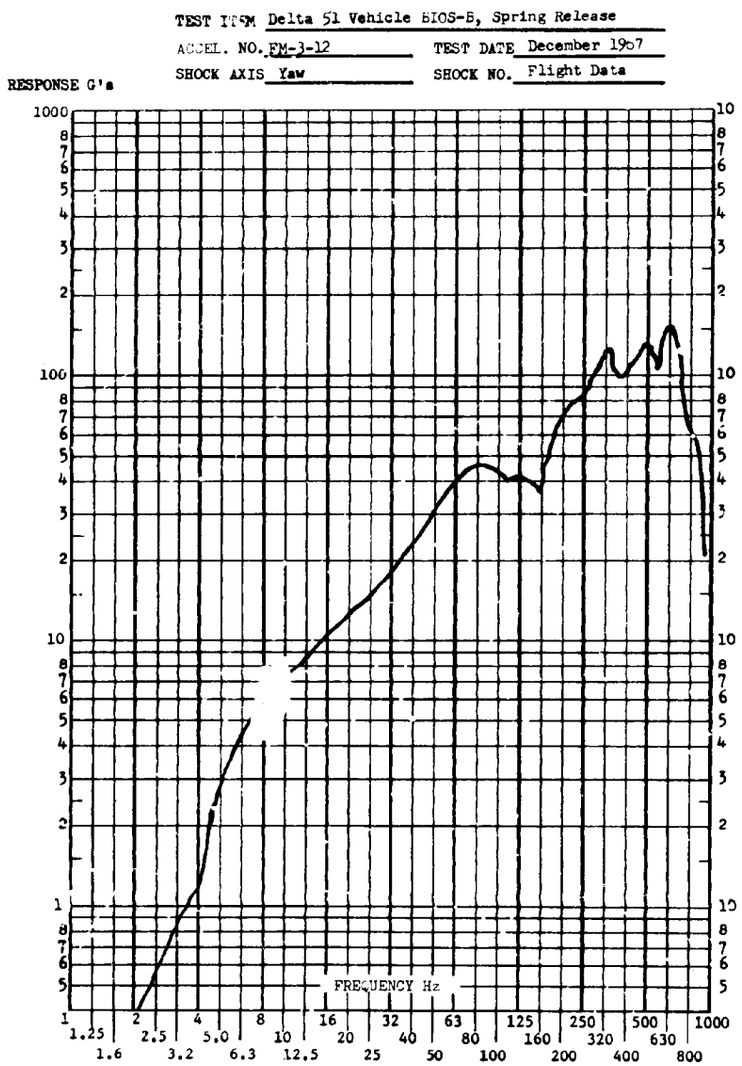
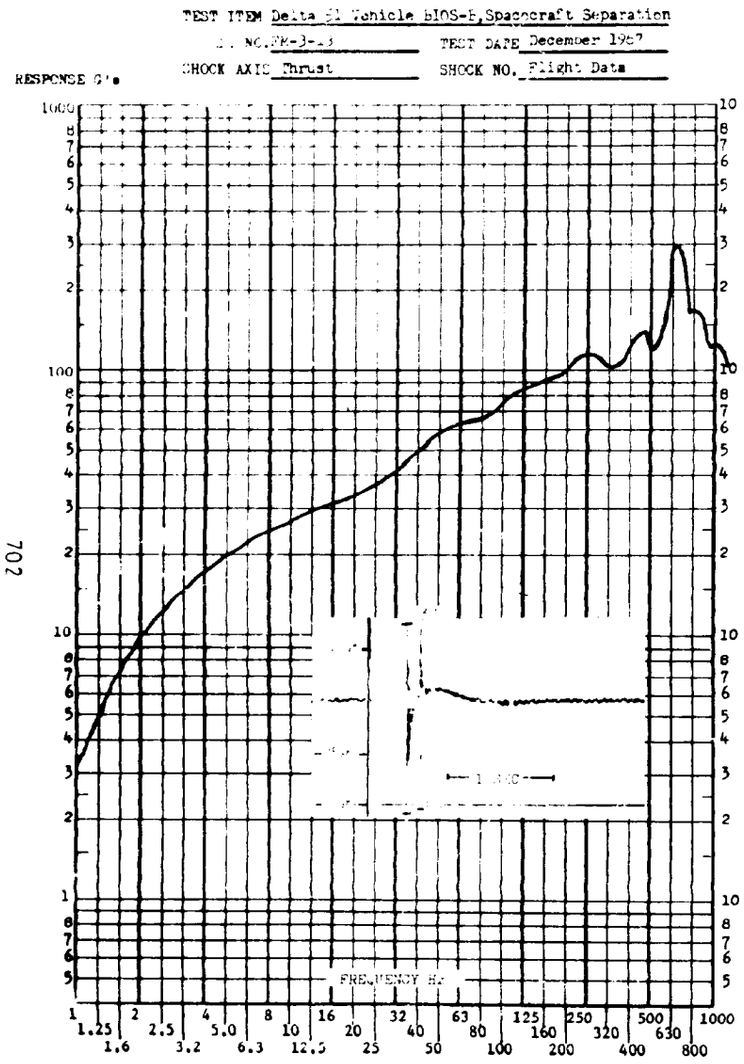

TEST ITEM Delta 51 Vehicle bIOS-B, Spring Release
ACCEL. NO. FM-3-12
TEST DATE December 1967
SHOCK AXIS Yaw
SHOCK NO. Flight Data
RESPONSE G's
FREQUENCY Hz
1 1.25 1.6 2 2.5 3.2 4 5.0 6.3 8 10 12.5 16 20 25 32 40 50 63 80 100 125 160 200 250 320 400 500 630 800 1000

FIGURE V.4-5


TEST ITEM Delta 51 Vehicle BIOS-B, Spacecraft Separation
ACCEL. NO. FM-3-13
TEST DATE December 1967
SHOCK AXIS Thrust
SHOCK NO. Flight Data
RESPONSE G's
FREQUENCY Hz
1 SEC

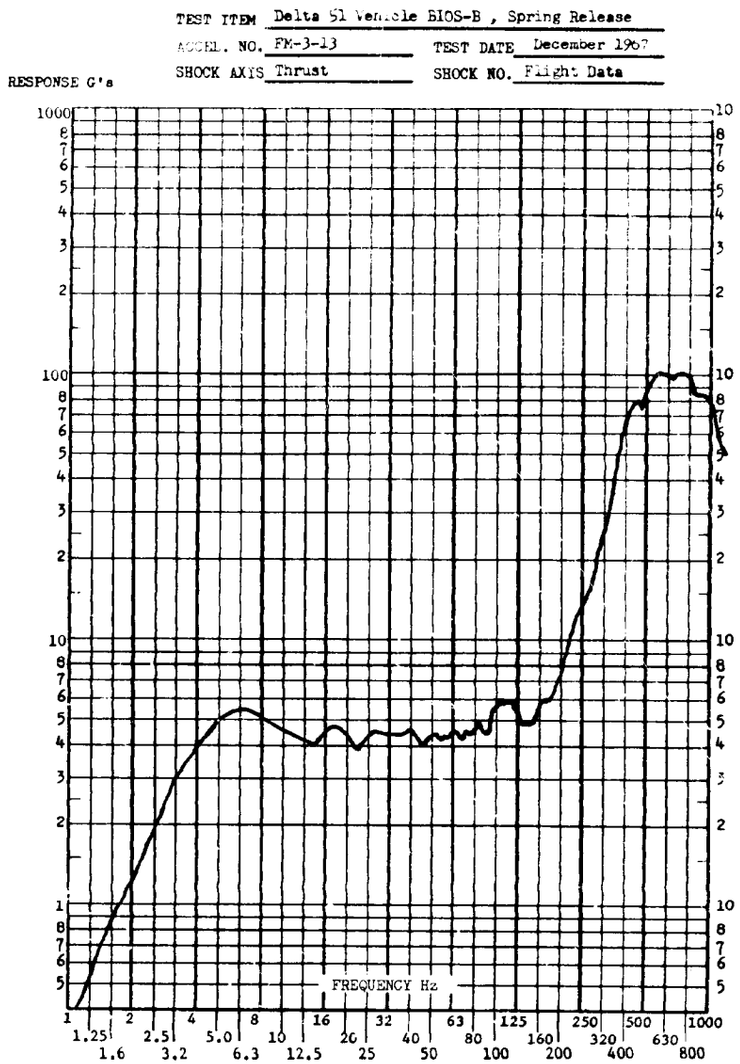
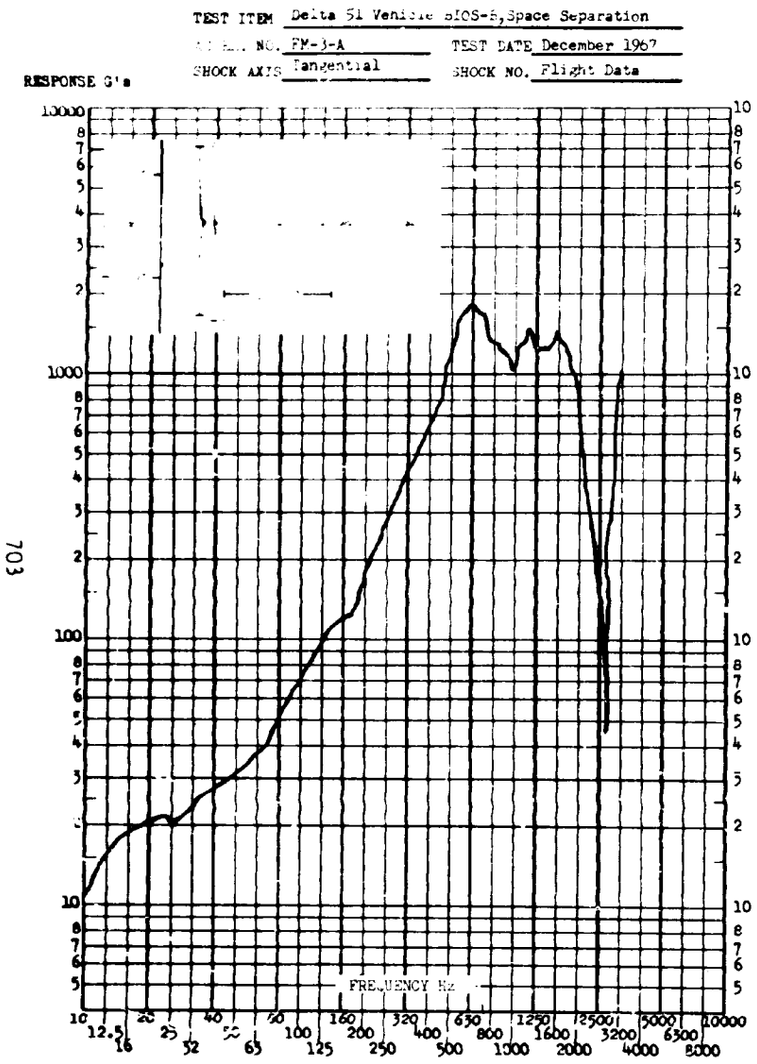

TEST ITEM Delta 51 Vehicle BIOS-B , Spring Release
ACCEL. NO. FM-3-13
TEST DATE December 1967
SHOCK AXIS Thrust
SHOCK NO. Flight Data
RESPONSE G's
FREQUENCY Hz

FIGURE V.4-6


TEST ITEM Delta 51 Vehicle BIOS-B, Space Separation
MODEL NO. FM-3-A
TEST DATE December 1967
SHOCK AXIS Tangential
SHOCK NO. Flight Data
RESPONSE G's
FREQUENCY Hz

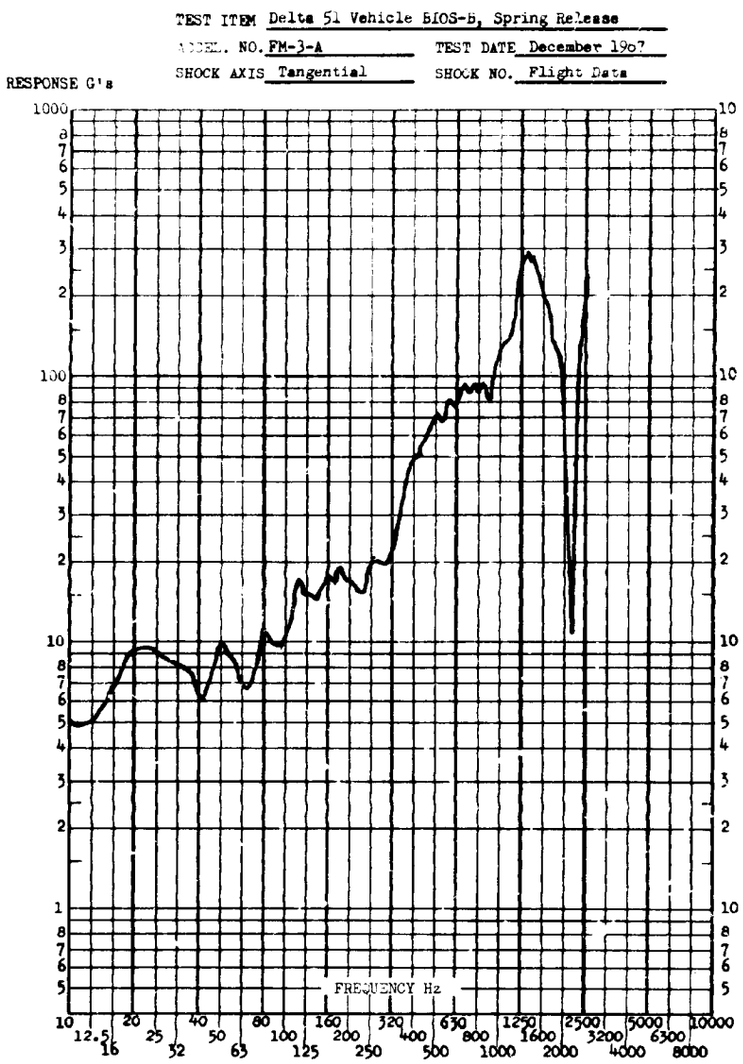
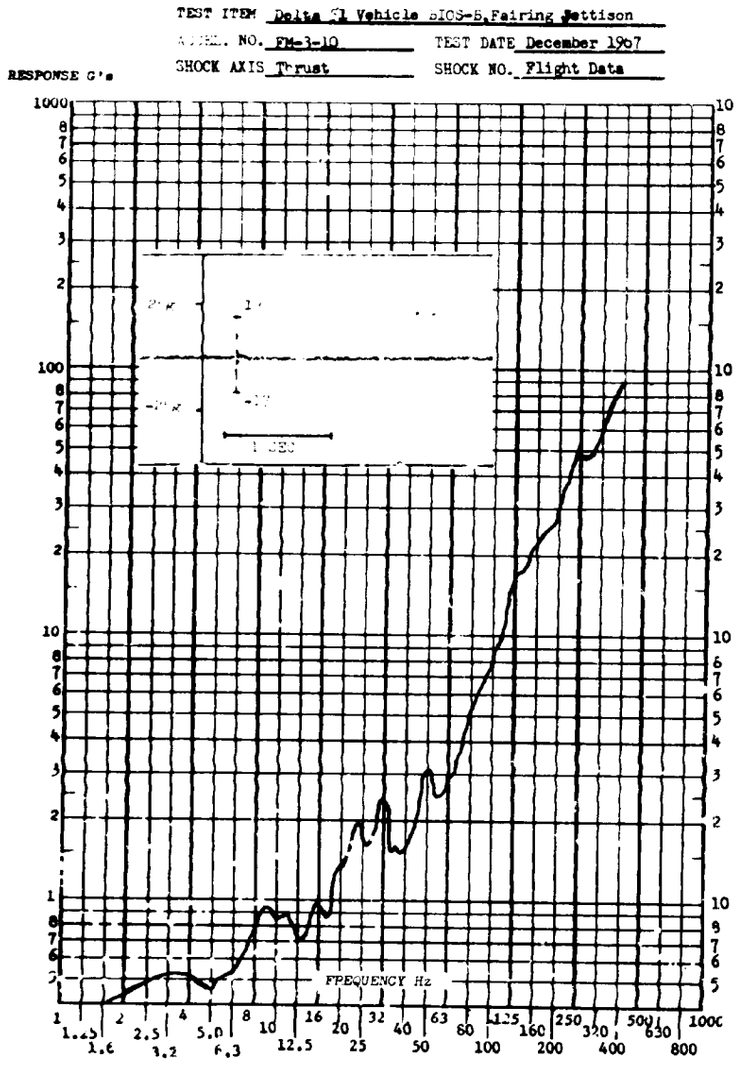

TEST ITEM Delta 51 Vehicle BIOS-B, Spring Release
MODEL NO. FM-3-A
TEST DATE December 1967
SHOCK AXIS Tangential
SHOCK NO. Flight Data
RESPONSE G's
FREQUENCY Hz

FIGURE V.4-7


TEST ITEM Delta 51 Vehicle BIOS-5 Fairing Jettison
ACCEL. NO. FM-3-10
TEST DATE December 1967
SHOCK AXIS Thrust
SHOCK NO. Flight Data
RESPONSE G's
1 SEC
FREQUENCY Hz

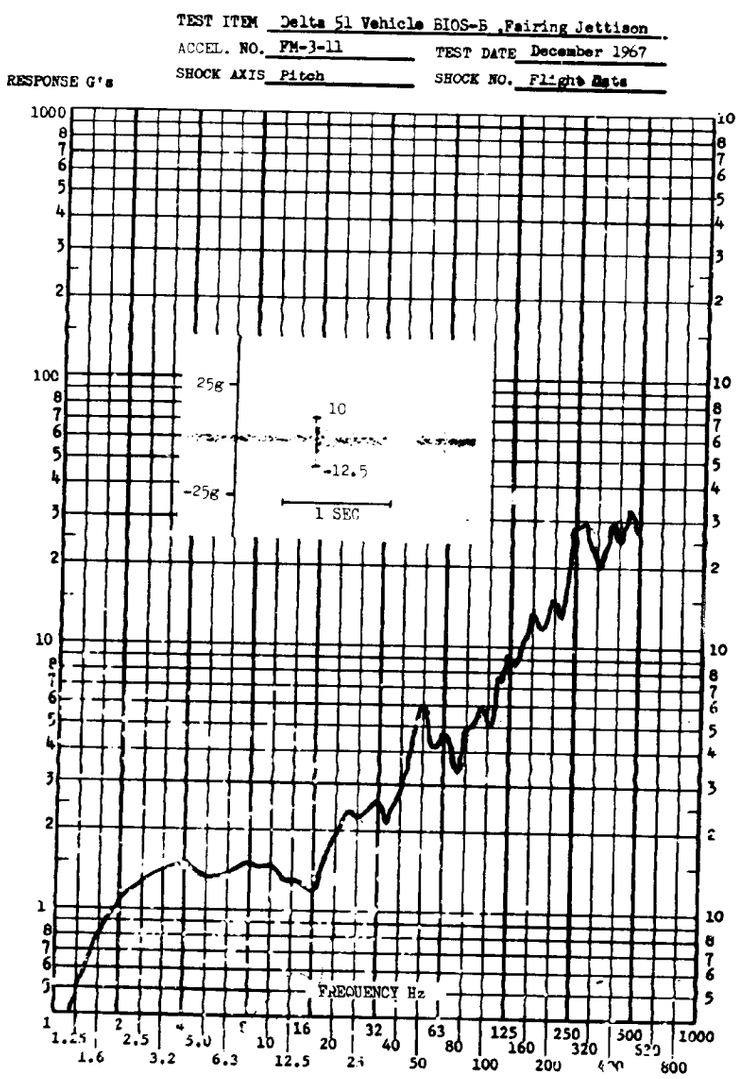
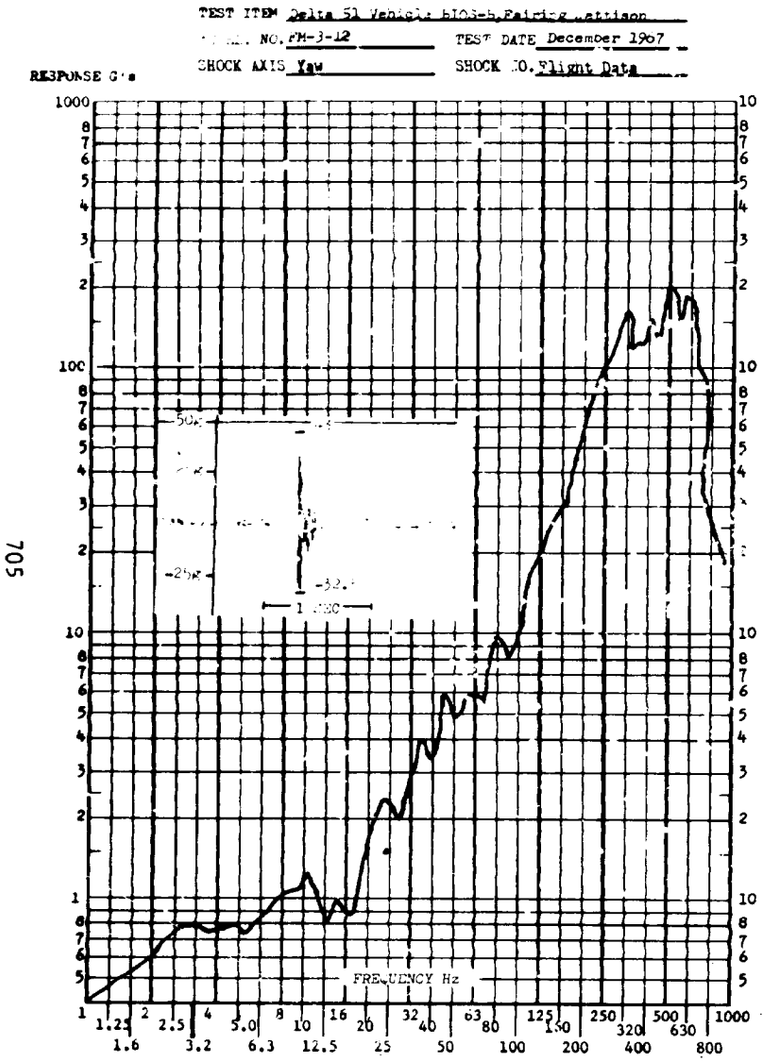

TEST ITEM Delta 51 Vehicle BIOS-5 Fairing Jettison
ACCEL. NO. FM-3-11
TEST DATE December 1967
SHOCK AXIS Pitch
SHOCK NO. Flight Data
RESPONSE G's
25g
10
-12.5
-25g
1 SEC
FREQUENCY Hz

FIGURE V.4-8


TEST ITEM Delta 51 Vehicle BIOS-B,Fairing Jettison
ACCEL. NO. FM-3-12
TEST DATE December 1967
SHOCK AXIS Yaw
SHOCK NO. Flight Data
RESPONSE G's
FREQUENCY Hz
1 SEC

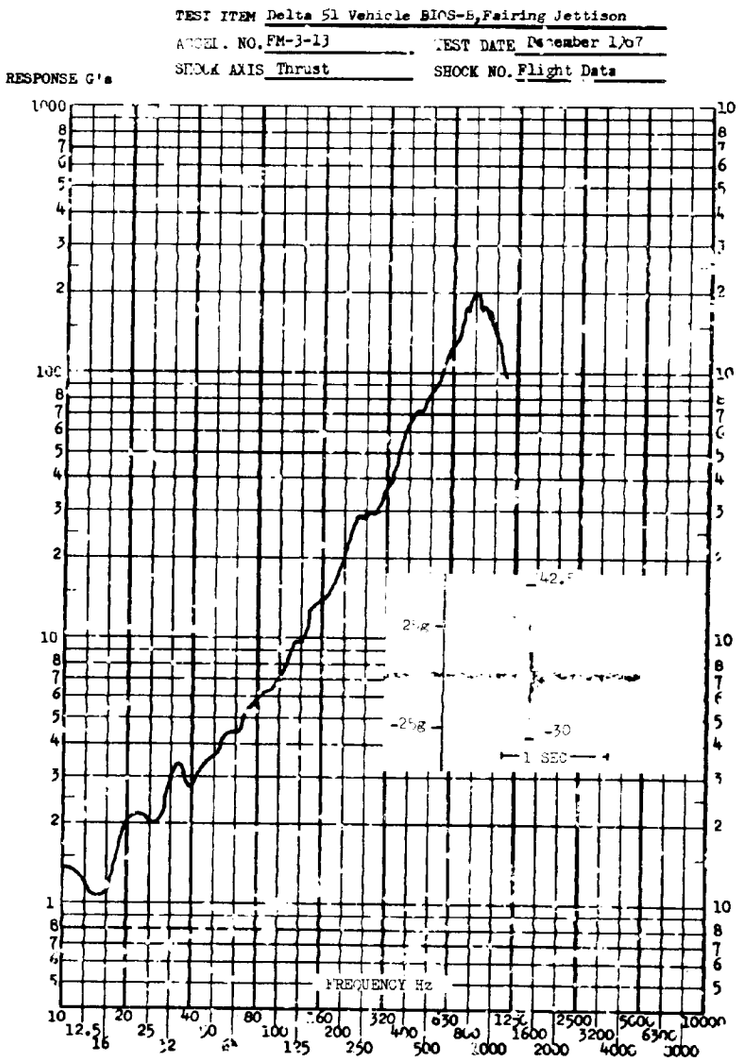

TEST ITEM Delta 51 Vehicle BIOS-B,Fairing Jettison
ACCEL. NO. FM-3-13
TEST DATE December 1967
SHOCK AXIS Thrust
SHOCK NO. Flight Data
RESPONSE G's
FREQUENCY Hz
1 SEC

FIGURE V.4-9

TEST ITEM Delta 91 Vehicle SIOS-b,Fairing Jettison

[illegible] NO. FM-3-A TEST DATE December 1967

SHOCK AXIS Tangential SHOCK NO. Flight Data

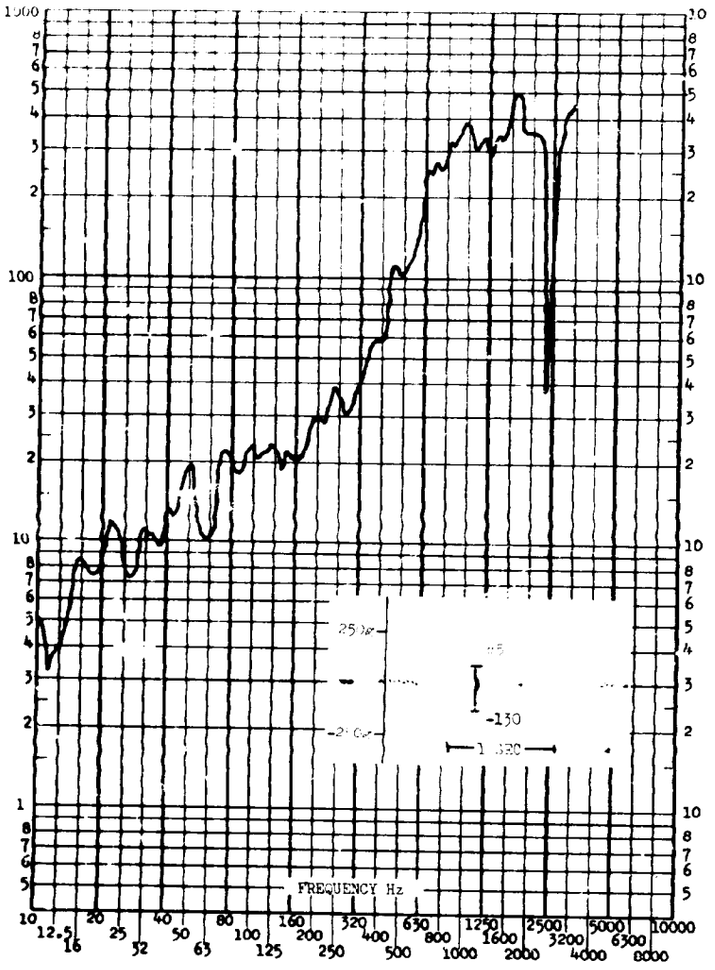



FIGURE V.4-10

## LOCATION OF ADDITIONAL FLIGHT DATA

The Surveyor data presented in Part IV.C is all flight data and might well be compared with the other data in Division V to provide a more complete description of the characteristics to be associated with flight shock data.

END

DATE

FILMED

MAR 31 1971