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SEISMIC SIMULATION
Test Report

REPORT NO. 44213-1

WYLE JOB NO. 44213

CUSTOMER P. O. NO. P-94N3F-111611

PAGE 1 OF 277 PAGE REPORT

DATE October 5, 1994

SPECIFICATION (S) See References in Paragraph 5.0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

1.0 CUSTOMER Tennessee Valley Authority

ADDRESS Watts Bar Nuclear Plant, Spring City TN

2.0 TEST SPECIMEN Various Thermo-Lag Enclosure Configurations

3.0 MANUFACTURER Thermal Science, Inc.

4.0 SUMMARY

Various Thermo-Lag Enclosure Configurations, described in Paragraph 6.0 and hereinafter called the specimens, were subjected to a test program as required by TVA Purchase Order P-94N3F-111611 and Wyle Laboratories' Test Procedure No. 543/7925/DB, Rev. B This test program was performed on September 24, and 25, 1994.

The test program consisted of the following:

- Receipt Inspection
- Single-Axis Resonance Search Tests
- Random Multifrequency Seismic Tests
- Post-Seismic Inspection

The specimens successfully completed the test program.

Test requirements, procedures, and results are described in Paragraphs 9.0, 10.0, and 11.0 of this report.

STATE OF ALABAMA
COUNTY OF MADISON } ss. Alabama Professional Engineer Reg. No. 19571

Phil K. McNaught, P.E., being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

Phillip K. McNaught

SUBSCRIBED and sworn to before me this 6th day of Oct, 19 94

Susan A. Kosba SEAL

Notary Public in and for the State of Alabama at large.

My Commission expires September 1, 19 97

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PDR ADOCK 05000390
F PDR

Wyle shall have no liability for damages of any kind to person or property, including special or consequential damages, resulting from Wyle's providing the services covered by this report.

PREPARED BY David Bell 10/6/94
D. Bell, Project Engineer

APPROVED BY Rod Thornberry 10-06-94
Rod Thornberry, Seismic Engineer

WYLE Q. A. R. G. Thomas 10-6-94
R. G. Thomas, Q.A. Manager

(gsp)

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
HUNTSVILLE, ALABAMA

ENCLOSURE 1

WYLE LABORATORIES
SEISMIC SIMULATION TEST REPORT
FOR
VARIOUS THERMO-LAG ENCLOSURE CONFIGURATIONS

5.0 REFERENCES

- Tennessee Valley Authority Purchase Order Number P-94N3F-111611
- Wyle Laboratories' Test Procedure 543/7925/DB, Revision B.
- IEEE Standard 344-1975 Specification entitled "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."
- 10 CFR 21, "Reporting of Defects and Noncompliance."
- 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants."
- Wyle Laboratories' (Eastern Operations) Quality Assurance Program Manual dated June 1988.

6.0 SPECIMEN DESCRIPTION

The specimens for this test program were four Thermo-Lag Enclosure Configurations, as shown in Attachment A of Appendix IX and in Photographs 1 and 2. The specimens consisted of a multiple cable tray, a single cable tray with air drop, a ganged conduit and a single conduit configuration.

7.0 QUALITY ASSURANCE

All work on this test program was performed in accordance with Wyle Laboratories' Quality Assurance Program, which complies with the applicable requirements of 10 CFR 50 Appendix B, ANSI N45.2, and Regulatory Guides. Defects are reportable in accordance with the requirements of 10 CFR Part 21.

8.0 TEST EQUIPMENT AND INSTRUMENTATION

All instrumentation, measuring, and test equipment used in the performance of this test program were calibrated in accordance with Wyle Laboratories' Quality Assurance Program which complies with the requirements of Military Specification MIL-STD-45662A. Standards used in performing all calibrations are traceable to the National Institute of Standards and Technology (NIST) by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented.

9.0 REQUIREMENTS

The specimen shall be subjected to the following:

- Receipt Inspection
- Single-Axis Resonance Search Tests
- Random Multifrequency Seismic Tests
- Post-Seismic Inspection

The following acceptance criteria apply for this test program:

- Position retention of the Thermo-Lag material, per TVA Seismic Category I(L) acceptance criteria.
- Any failure to maintain position retention, based on visual observations during testing, will be recorded as a test anomaly. Any loose Thermo-Lag material larger than approximately one cubic inch that is found after each OBE, SSE and Resonance Search Test shall be measured, photographed and weighed. TVA will disposition test anomalies based on satisfying the position retention requirements.

10.0 PROCEDURES

10.1 Receipt Inspection

The specimens shall be inspected for obvious physical defects prior to testing.

10.2 Test Setup

10.2.1 Specimen Tie-Down and Orientation

The specimens described in Paragraph 6.0 were installed on TVA-fabricated test fixtures. The specimens were attached to the test fixtures by TVA using TVA personnel, procedures, drawings and specifications, as documented in Appendix X. The test fixtures were welded to the test table, as shown in Photographs 1 and 2.

The specimens were installed on the Wyle Triaxial Seismic Simulator Table such that the principal axes of the specimens were collinear with the input excitations of the test table.

10.2.2 Excitation Control and Specimen Response

Control accelerometers were mounted on the test table at a location near the base of the specimens. Six uniaxial piezoelectric accelerometers (two triaxial locations) were located on each of the multiple cable tray, single cable tray with air drop and the conduit specimen configurations. In addition, two accelerometers were located on the vertical support of the single cable tray with air drop test fixture. Refer to Photographs 3 through 8 for response accelerometer locations. Magnetic tape recorders provided a record of each accelerometer's response.

10.0 PROCEDURES (Continued)

10.2 Test Setup (Continued)

10.2.3 Temperature Control

Two thermocouples were surface mounted (one on the top and one on the bottom) on each of the specimens. Thermocouple outputs were recorded.

10.2.4 Specimen Temperature

The specimens were conditioned at a temperature of between 120 and 140°F in an environmental enclosure installed on the Wyle Triaxial Seismic Simulator Table, as shown in Photograph 9. The specimens were tested when the average of the four specimen thermocouples was between 120 and 140°F for a minimum of 6 hours.

Prior to the Random Multifrequency Test, the Resonance Search Test (described in Paragraph 10.3.1) was performed with the environmental enclosure installed on the test table. During the Random Multifrequency Tests (described in Paragraph 10.3.2) and the second Resonance Search Test, one end of the enclosure was removed, as shown in Photograph 10, to provide video coverage of the tests. Between tests, the end of the environmental enclosure was reinstalled. Specimen temperature was maintained between 120 and 140°F on a best effort basis.

10.3 Tests

Two series of Seismic Tests were performed. Series 1 consisted of the multiple cable tray and the single cable tray with air drop specimen configurations. Series 2 consisted of the ganged and single conduit specimen configurations.

10.3.1 Resonance Search Tests

A low-level (0.2g horizontally and vertically) single-axis sine sweep was performed in the lateral, longitudinal and vertical axes to determine resonant frequencies prior to and after the Random Multifrequency Tests. The sine sweep was performed from 1 to 35 Hz at a sweep rate of one octave per minute.

10.3.2 Random Multifrequency Tests

The specimens were subjected to 30-second duration triaxial multifrequency random motion which was amplitude-controlled in one-third octave bandwidths spaced one-third octave apart over the frequency range of 1 to 100 Hz. Three simultaneous, but independent, random signals were used as the excitation to produce phase-incoherent motions in the vertical and two horizontal axes. The amplitude of each one-third octave bandwidth was independently adjusted in each of the three axes until the Test Response Spectra (TRS) enveloped the Required Response Spectra (RRS) within the limitations of the test machine. The resulting table motion was analyzed by a response spectrum analyzer at the test damping and plotted at one-sixth octave intervals over the frequency range of 1 to 200 Hz.

10.0 PROCEDURES (Continued)

10.3 Tests (Continued)

10.3.2 Random Multifrequency Tests (Continued)

The specimens were subjected to two Operating Basis Earthquake (OBE) Tests prior to the application of a Safe Shutdown Earthquake (SSE) Test. The OBE and SSE RRS for each seismic series are shown in Figures 1 through 12.

10.4 Post-Test Inspection

The specimens were inspected for obvious physical damage after each test.

11.0 RESULTS

The specimens completed the test program and met the acceptance criteria specified in Paragraph 9.0.

During the Series 2 OBE Tests a small piece of Thermo-Lag material was seen coming from the interior of the ganged conduit specimen configuration and falling on the test table. The material was examined and found to be less than one cubic inch. However, it was photographed and is documented in Photograph 11.

Some reduction in specimen/fixture resonant frequencies was noted due to seismic testing as indicated by the pre- and post-resonance search transmissibility plots presented in Appendices IV and V.

A post-test inspection revealed slight cracking of the Thermo-Lag on the multiple cable tray specimen around the specimen-to-test fixture interface, as shown in Photograph 12.

The following appendices are included in this report:

Appendix	Contents
I	Tables (Test Run Descriptions and Temperature Profiles)
II	Figures
III	Photographs
IV	Series 1 Resonance Search Transmissibility Plots
V	Series 2 Resonance Search Transmissibility Plots
VI	Series 1 Random Multifrequency Test Response Spectrum Plots

APPENDIX I

TABLES

11.0 RESULTS (Continued)

Appendix	Contents
VII	Series 2 Random Multifrequency Test Response Spectrum Plots
VIII	Instrumentation Log, Equipment, and Data Sheets
IX	Wyle Laboratories' Test Procedure 543/7925/DB, Revision B
X	Thermo-Lag Installation Procedures, Drawings, Data Sheets and Photographs

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TABLE I

TEST RUN DESCRIPTIONS

Series No.	Run No.	Type of Test	Test Axis	Test Level	Input Acceleration (g) LATZPA	LONGZPA	VZPA
1	1	RS	LAT	0.2g	N/A	N/A	N/A
1	2	RS	LONG	0.2g	N/A	N/A	N/A
1	3	RS	V	0.2g	N/A	N/A	N/A
1	4	RMF	TRI	OBE	2.4	2.7	2.0
1	5	RMF	TRI	<OBE	1.7	1.9	1.3
1	6	RMF	TRI	OBE	2.4	1.9	1.3
1	7	RMF	TRI	SSE	4.0	3.2	2.9
1	8	RS	LAT	0.2g	N/A	N/A	N/A
1	9	RS	LONG	0.2g	N/A	N/A	N/A
1	10	RS	V	0.2g	N/A	N/A	N/A
2	1	RS	LAT	0.2g	N/A	N/A	N/A
2	2	RS	LONG	0.2g	N/A	N/A	N/A
2	3	RS	V	0.2g	N/A	N/A	N/A
2	4	RMF	TRI	OBE	2.3	2.5	1.7
2	5	RMF	TRI	OBE	2.3	2.4	1.6
2	6	RMF	TRI	SSE	3.9	3.6	2.8
2	7	RS	LAT	0.2g	N/A	N/A	N/A
2	8	RS	LONG	0.2g	N/A	N/A	N/A
2	9	RS	V	0.2g	N/A	N/A	N/A

LEGEND:

RS = Resonant Search
RMF = Random Multifrequency
LAT = Lateral
LONG = Longitudinal
V = Vertical
TRI = Triaxial
OBE = Operating Basis Earthquake
SSE = Safe Shutdown Earthquake
ZPA = Zero Period Acceleration

TABLE II

TEMPERATURE PROFILES

	Series No.	Run No.	Run Time	Temperature (°F) Specimen 1 Top	Specimen 1 Bottom	Specimen 2 Top	Specimen 2 Bottom
*	1	1	07:38	128	138	118	124
	1	2	to				
	1	3	07:53	127	138	118	124
	1	4	08:10:33	125	135	115	121
			to				
			08:11:14	125	134	115	121
	1	5	08:30:06	125	135	115	121
			to				
			08:30:47	124	134	115	120
	1	6	08:45:07	123	133	114	119
			to				
			08:45:44	123	133	113	119
	1	7	09:07:35	124	134	115	119
			09:08:18	123	133	115	119
	1	8	09:27	124	134	115	119
	1	9	to				
	1	10	09:42	118	126	108	112
**	2	1	07:05	122	137	127	126
	2	2	to				
	2	3	07:30	122	136	127	126
	2	4	07:35:54	120	133	125	124
			to				
			07:36:34	119	132	125	124
	2	5	07:45:19	119	132	125	124
			to				
			07:46:03	118	130	124	123
	2	6	08:01:55	119	132	125	124
			to				
			08:02:36	118	131	124	124

TABLE II

TEMPERATURE PROFILES (Continued)

Series No.	Run No.	Run Time	Temperature (°F) Specimen 1 Top	Specimen 1 Bottom	Specimen 2 Top	Specimen 2 Bottom
2	7	08:19	118	131	125	124
2	8	to				
2	9	08:40	110	118	116	116

NOTE: For Series 1, Specimen 1 was the multiple cable tray specimen configuration and Specimen 2 was the single cable tray with air drop specimen configuration. For Series 2, Specimen 1 was the ganged conduit specimen configuration and Specimen 2 was the single conduit specimen configuration.

* At 24:06 chamber temperature was 137°F and the average of the four specimen thermocouples was 122°F. At 07:53 chamber temperature was 138°F and the average of the four specimen thermocouples was 126°F.

** At 24:07 chamber temperature was 136°F and the average of the four specimen thermocouples was 126°F. At 07:02 chamber temperature was 136°F and the average of the four specimen thermocouples was 128°F.

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APPENDIX II

FIGURES

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FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

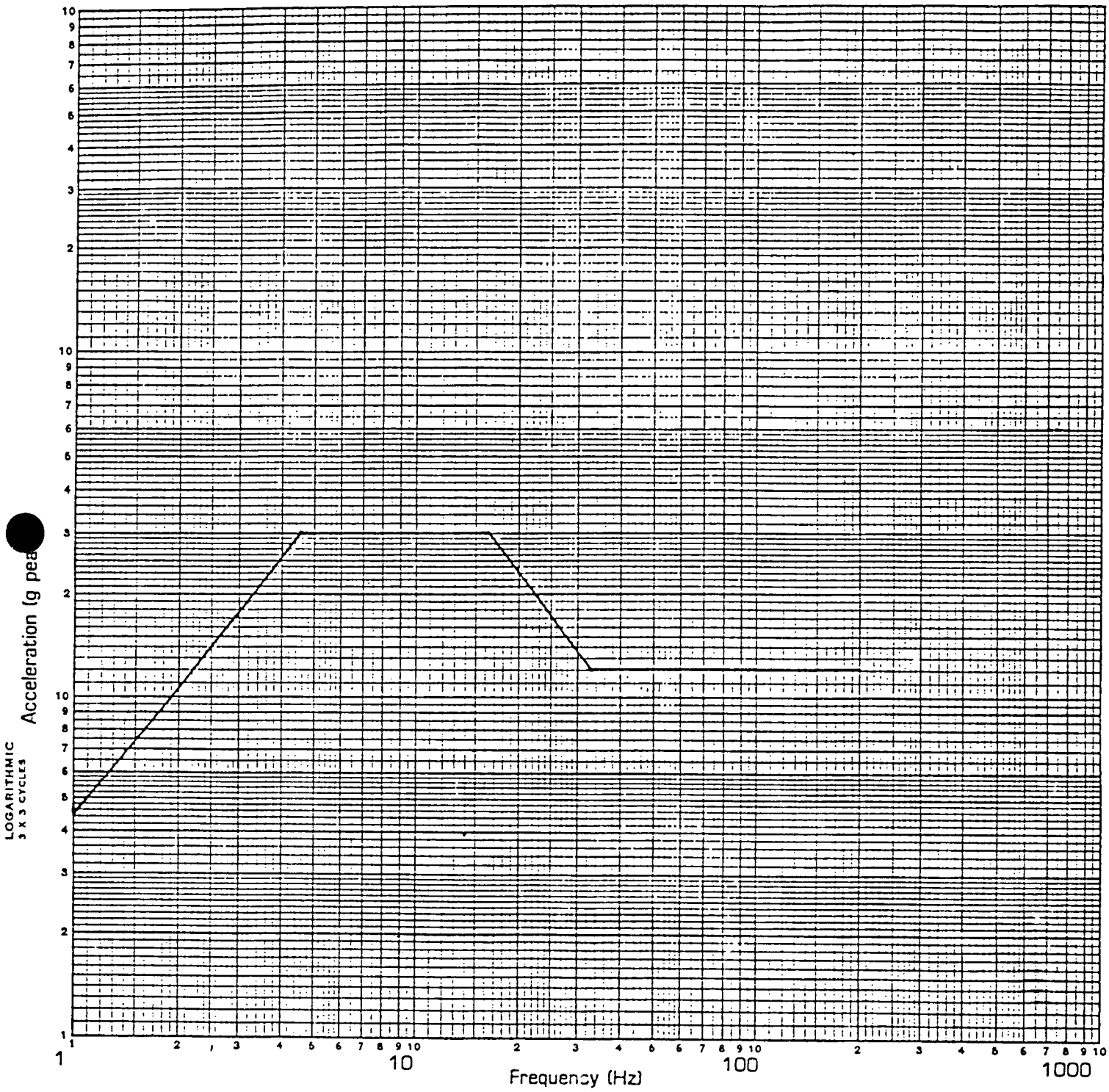

FIGURE 1. SERIES 1 LATERAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

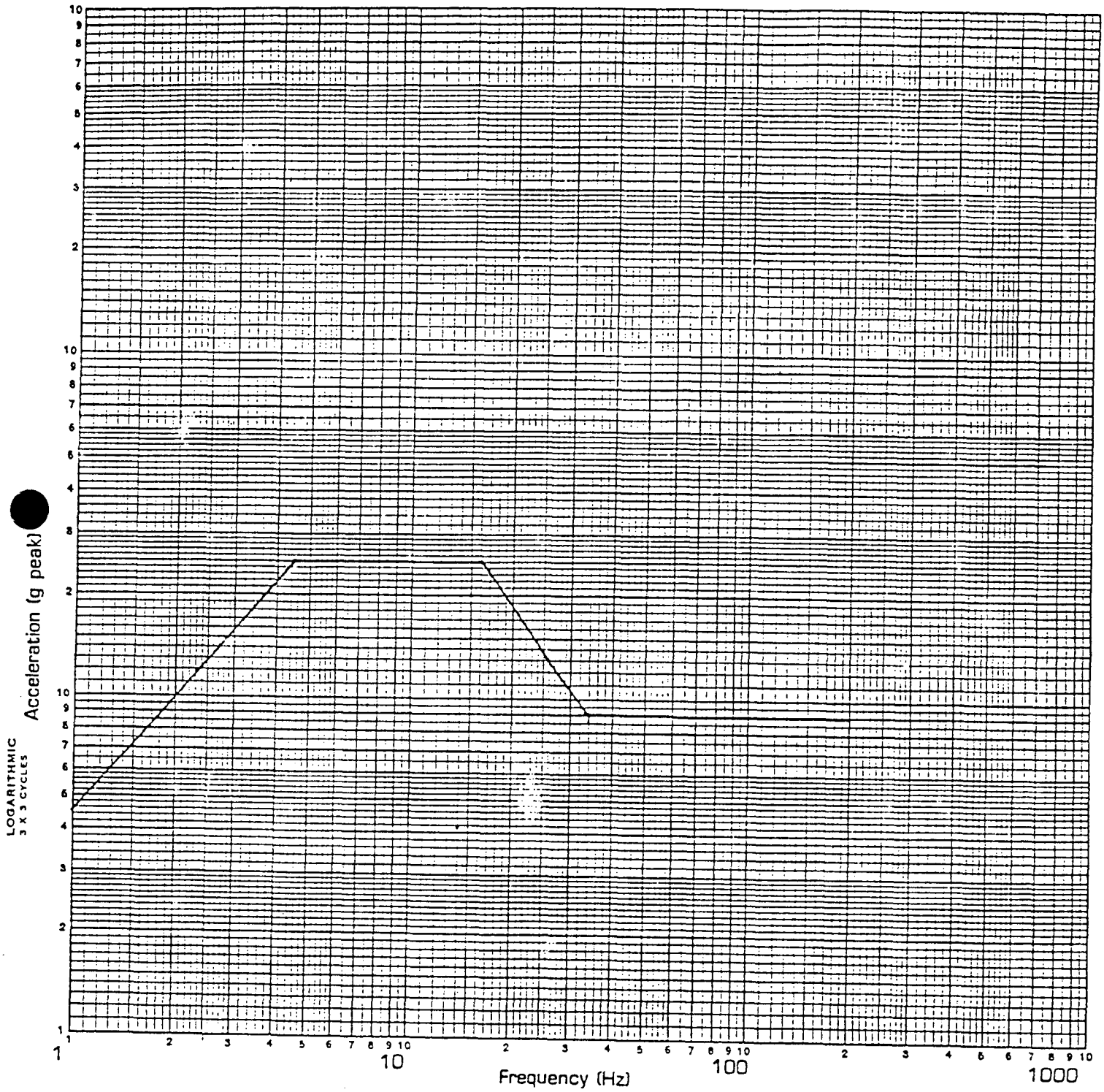

FIGURE 2. SERIES 1 LONGITUDINAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

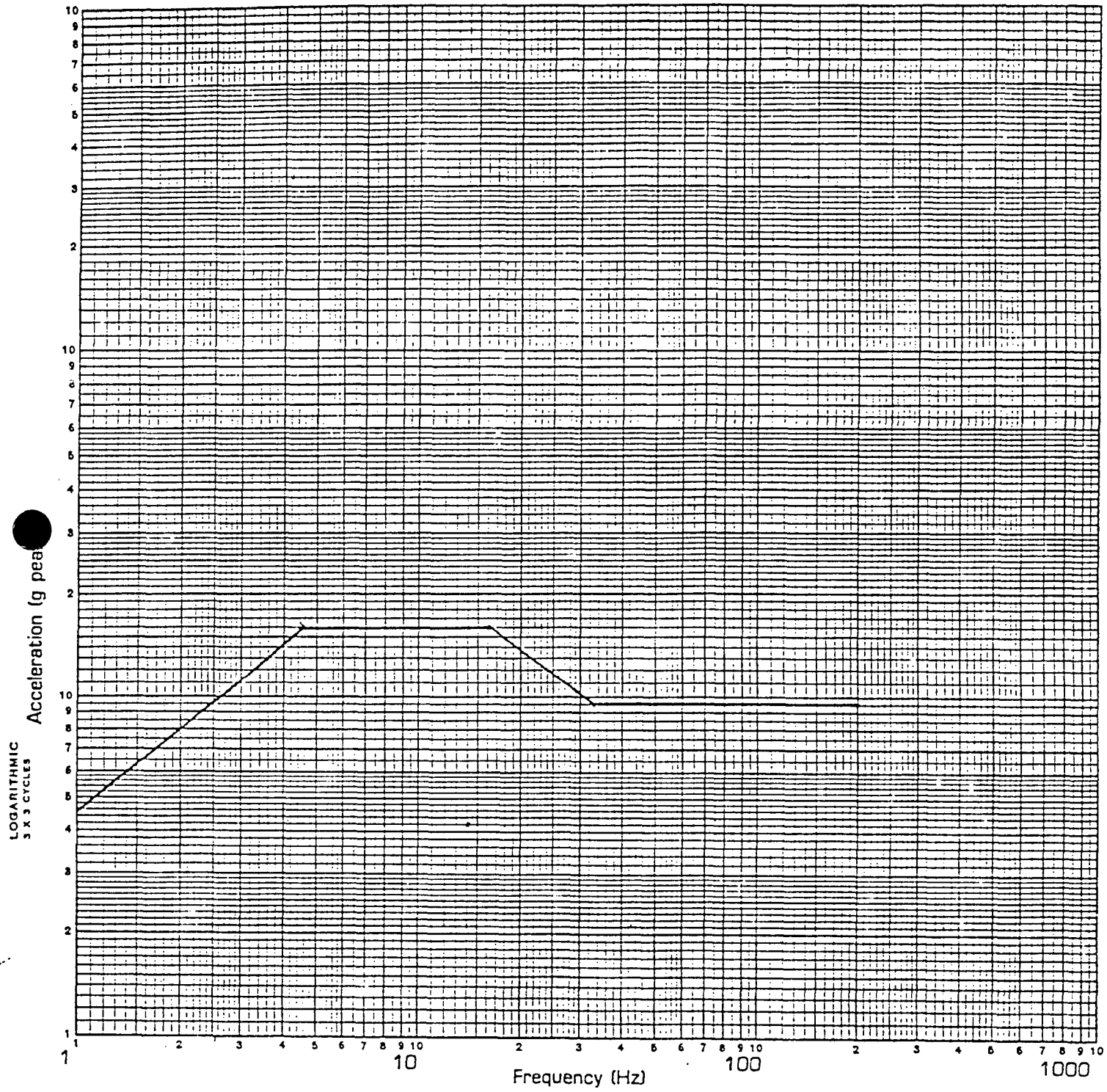

FIGURE 3. SERIES 1 VERTICAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

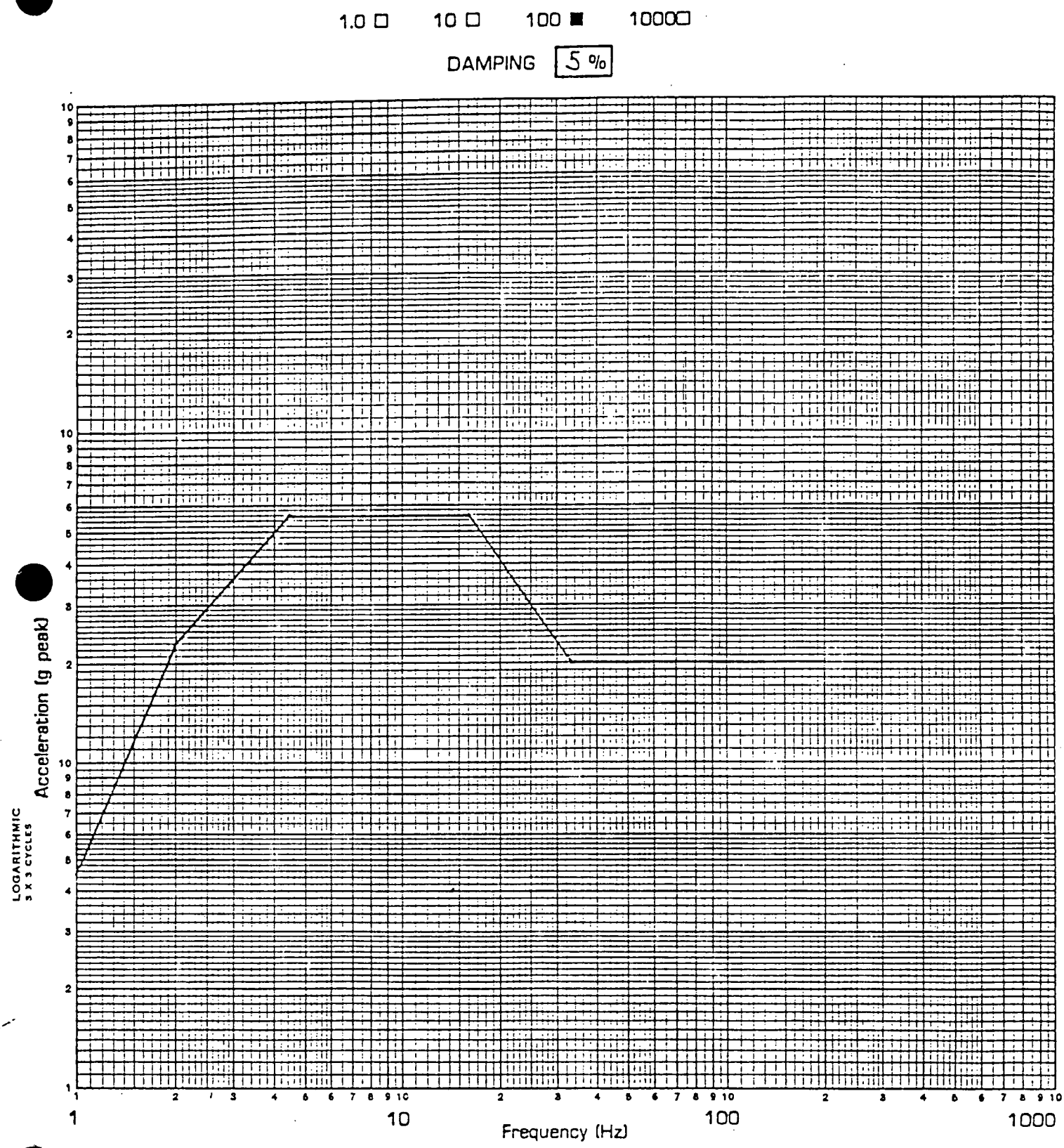

FIGURE 4. SERIES 1 LATERAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

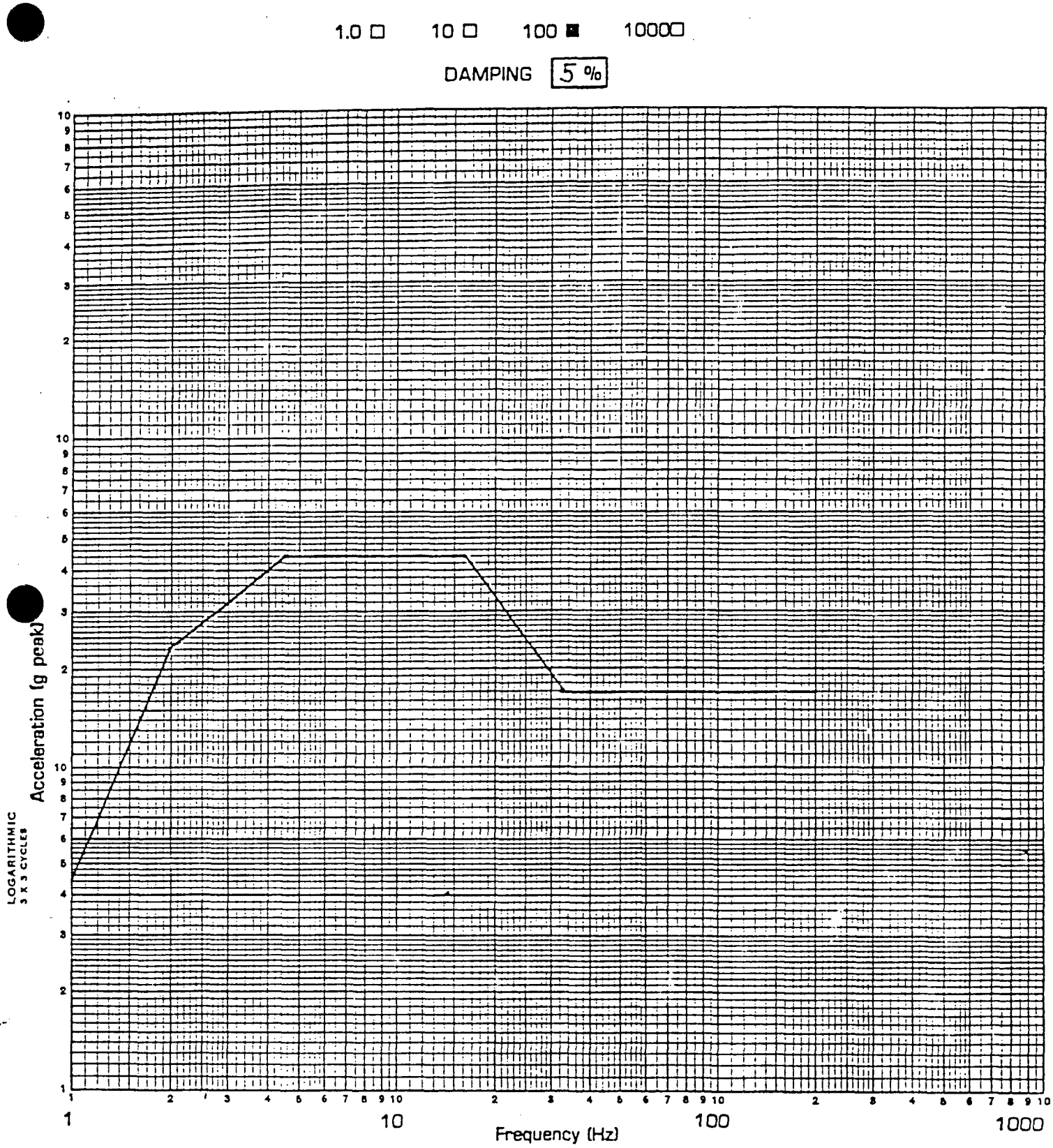

FIGURE 5. SERIES 1 LONGITUDINAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

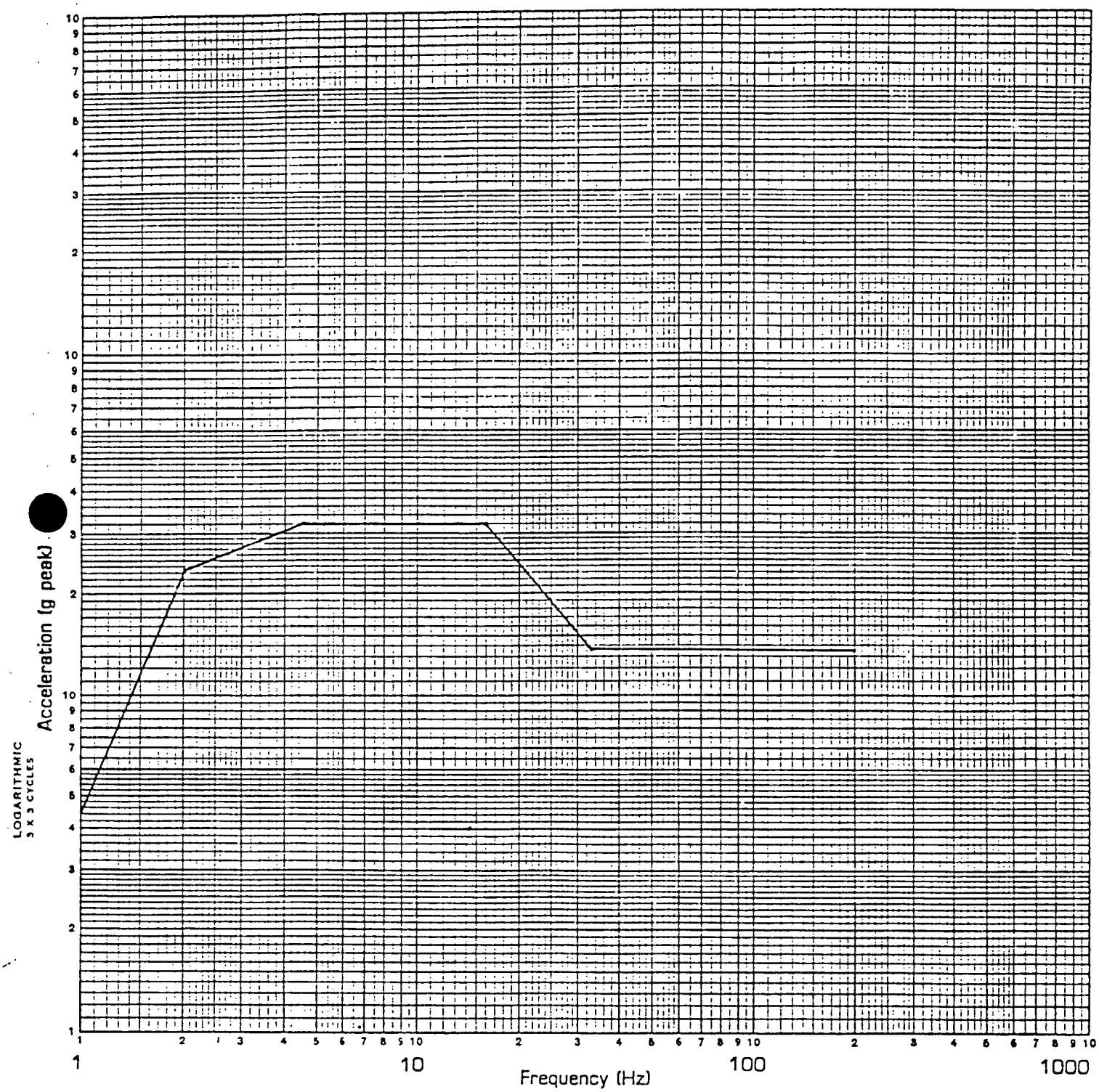

FIGURE 6. SERIES 1 VERTICAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

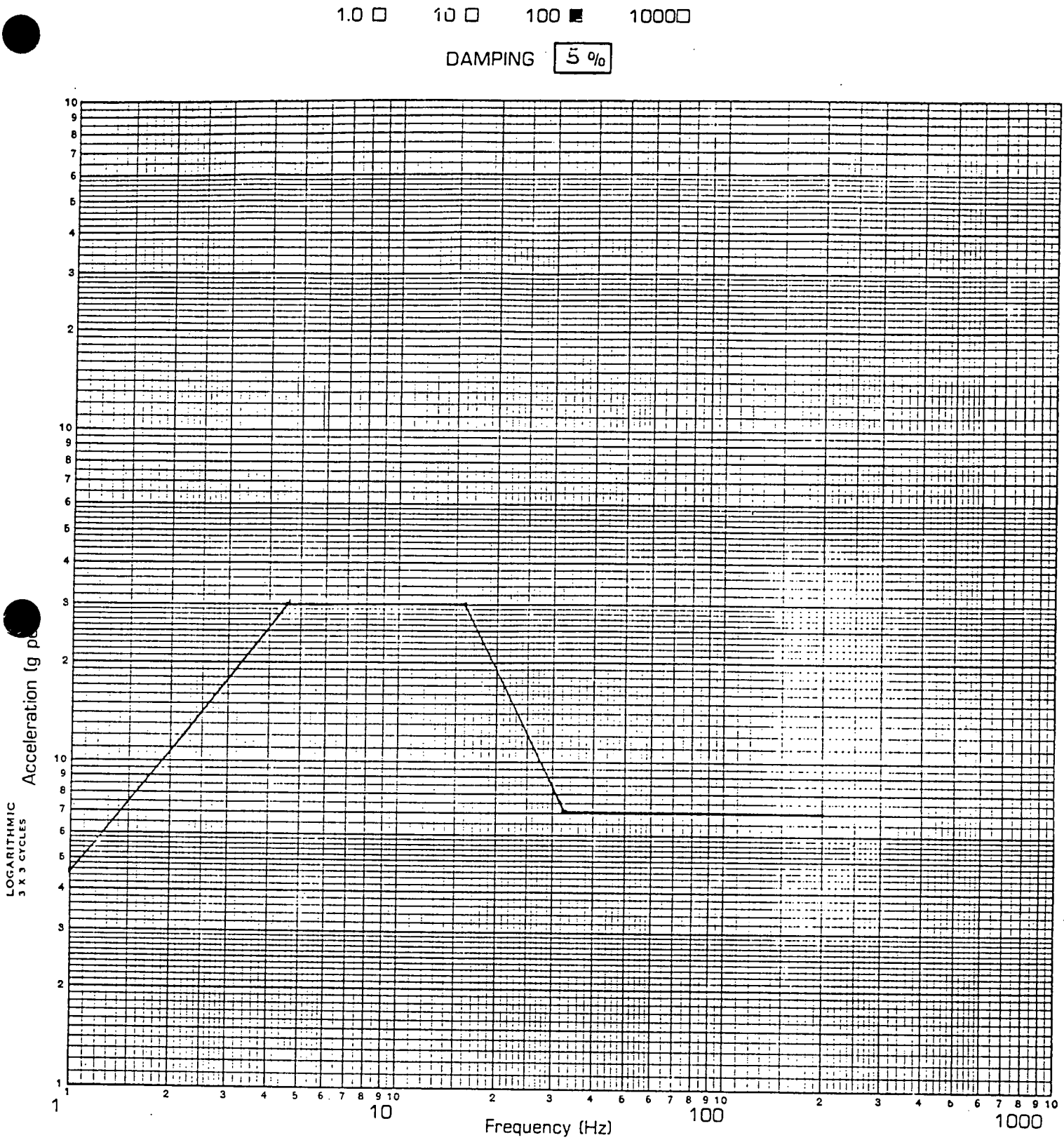

FIGURE 7. SERIES 2 LATERAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

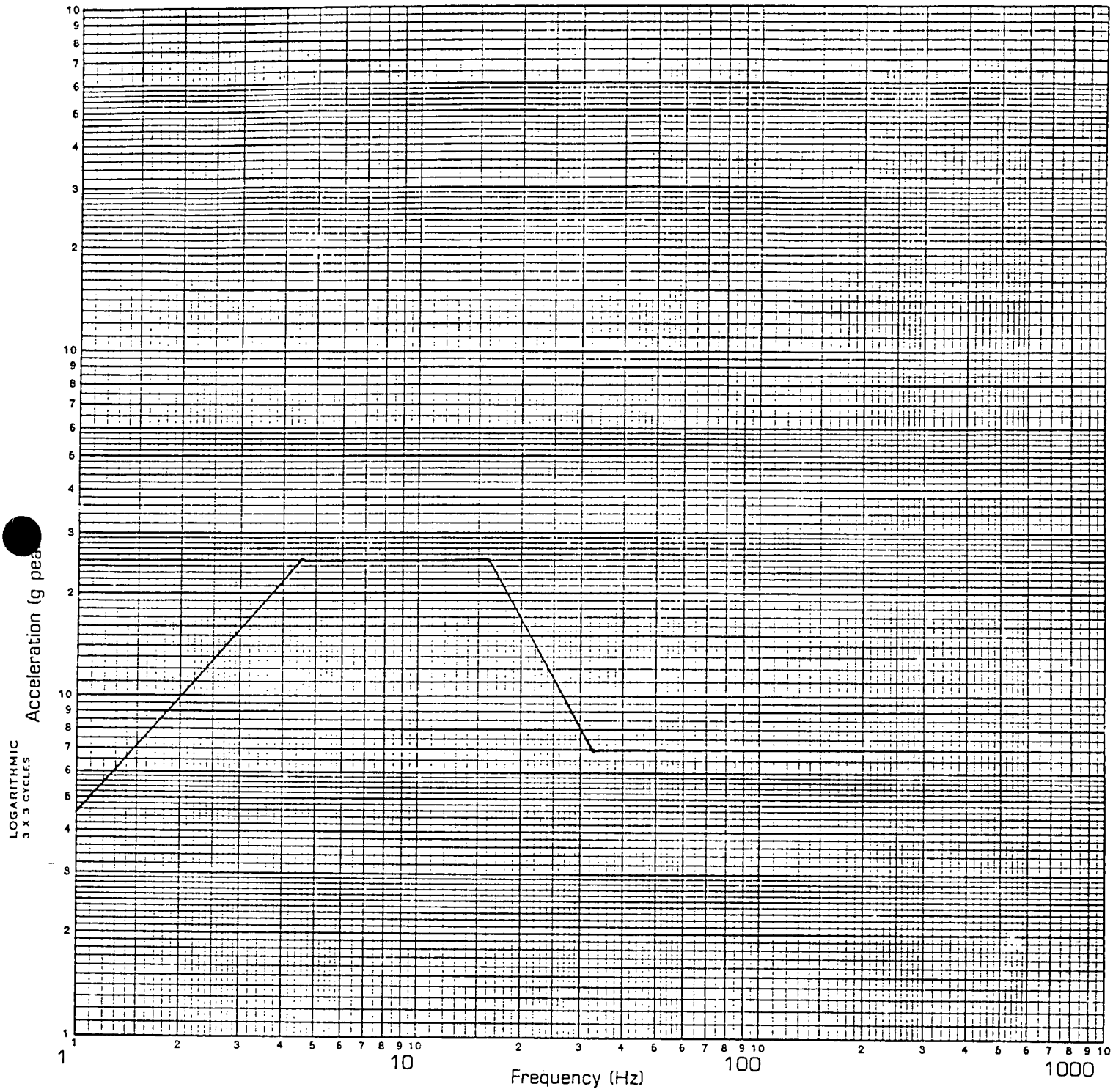

FIGURE 8. SERIES 2 LONGITUDINAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

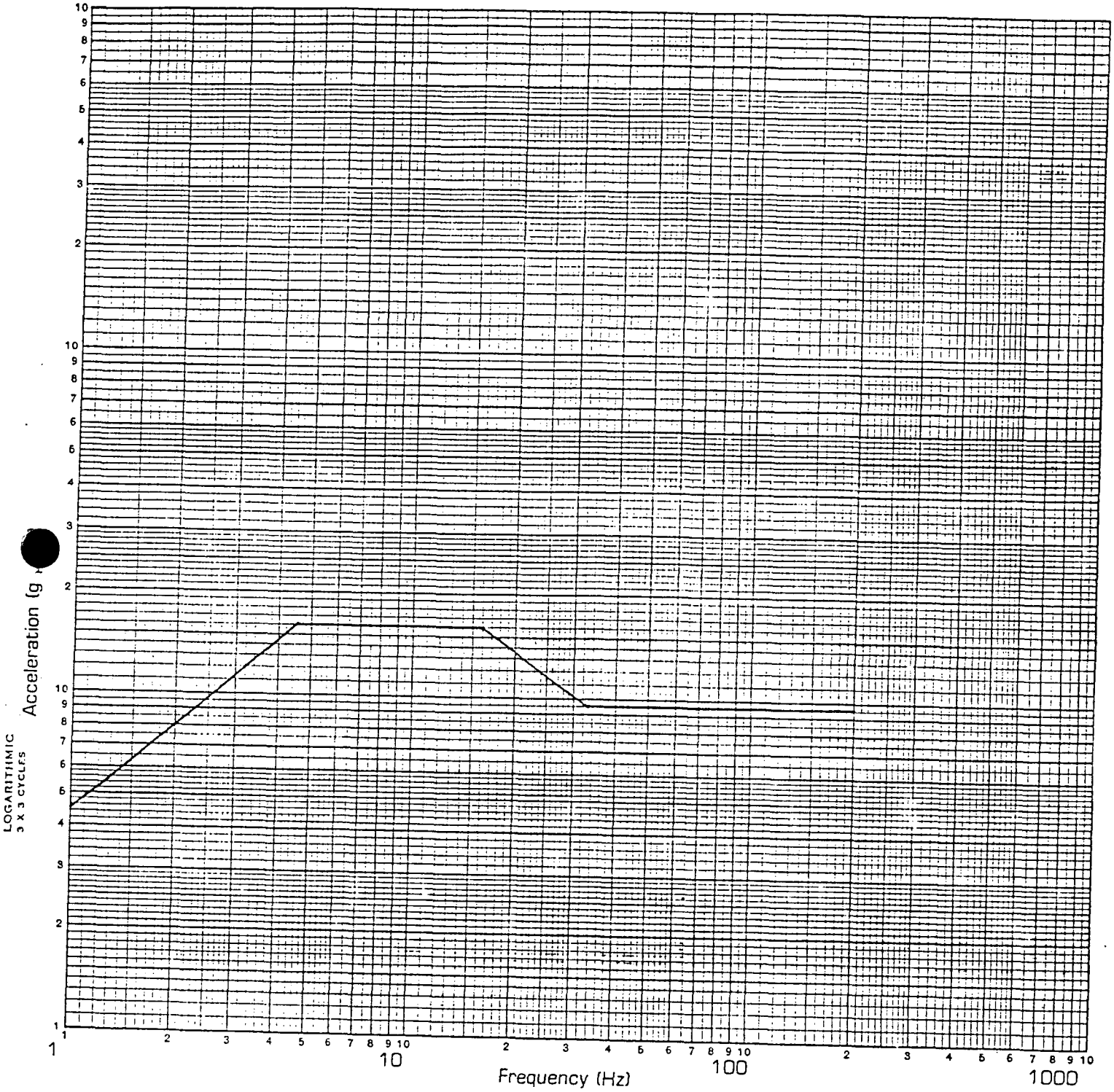

FIGURE 9. SERIES 2 VERTICAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

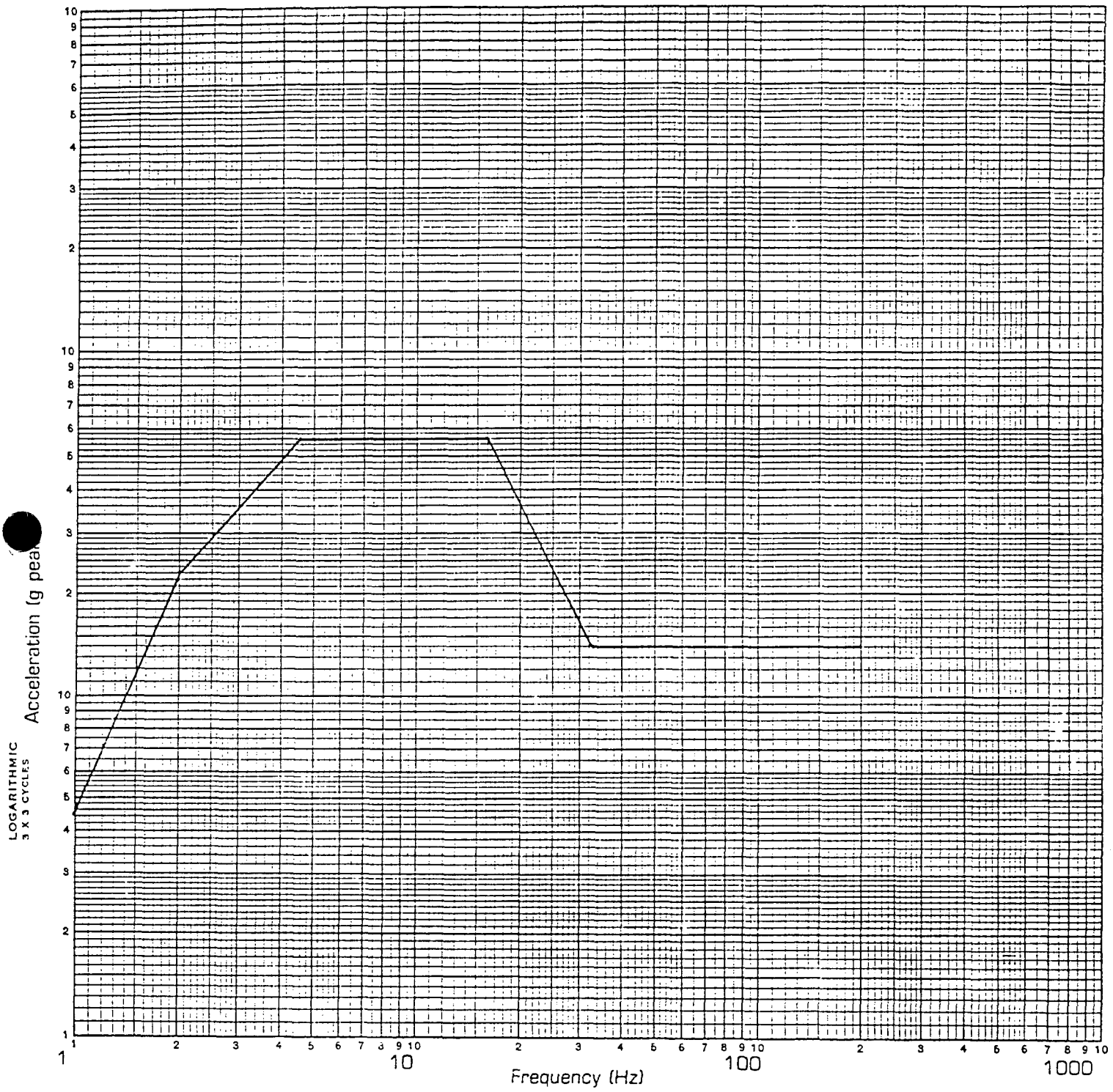

FIGURE 10. SERIES 2 LATERAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

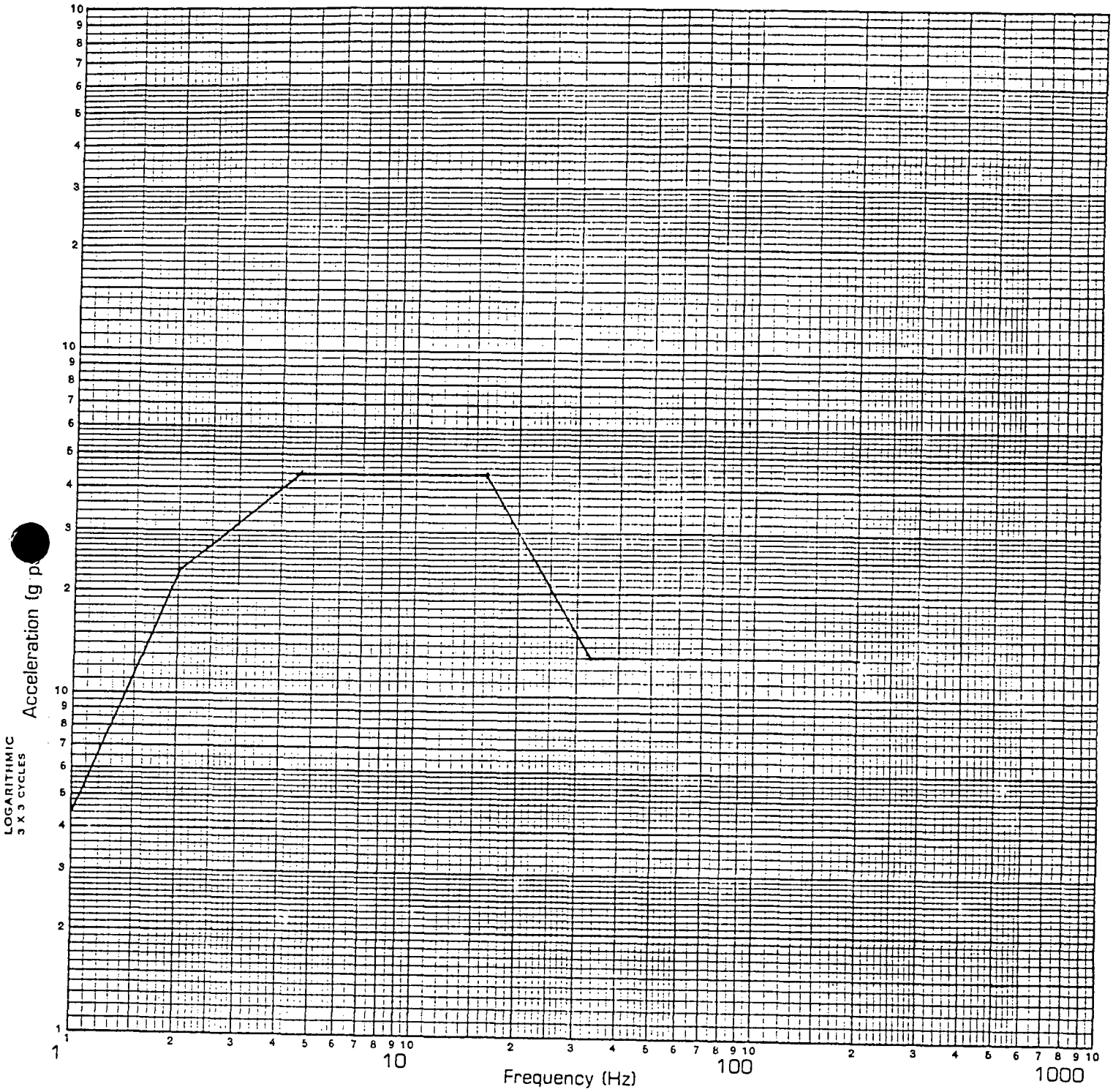

FIGURE 11. SERIES 2 LONGITUDINAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

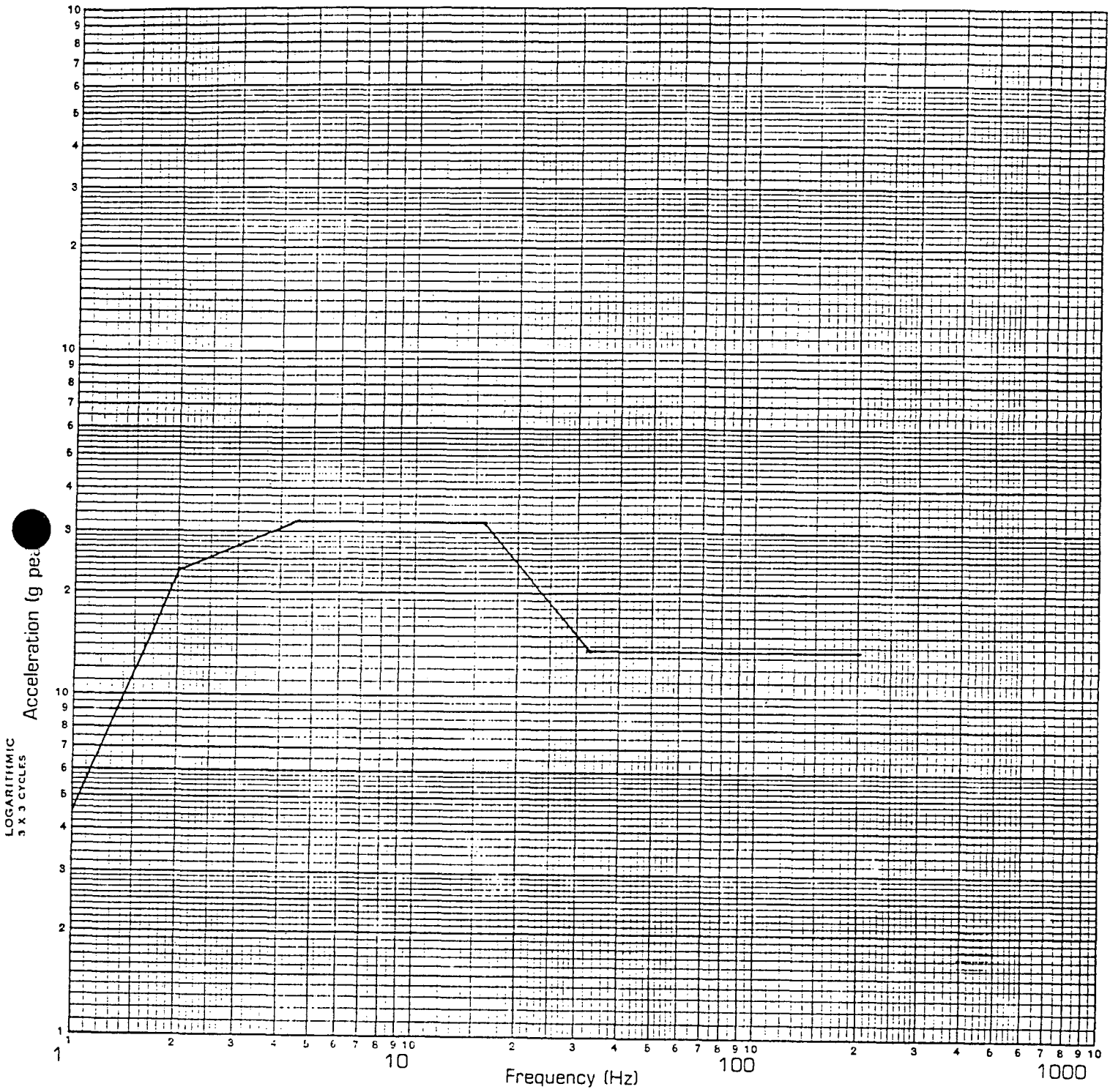

FIGURE 12. SERIES 2 VERTICAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

APPENDIX III

PHOTOGRAPHS

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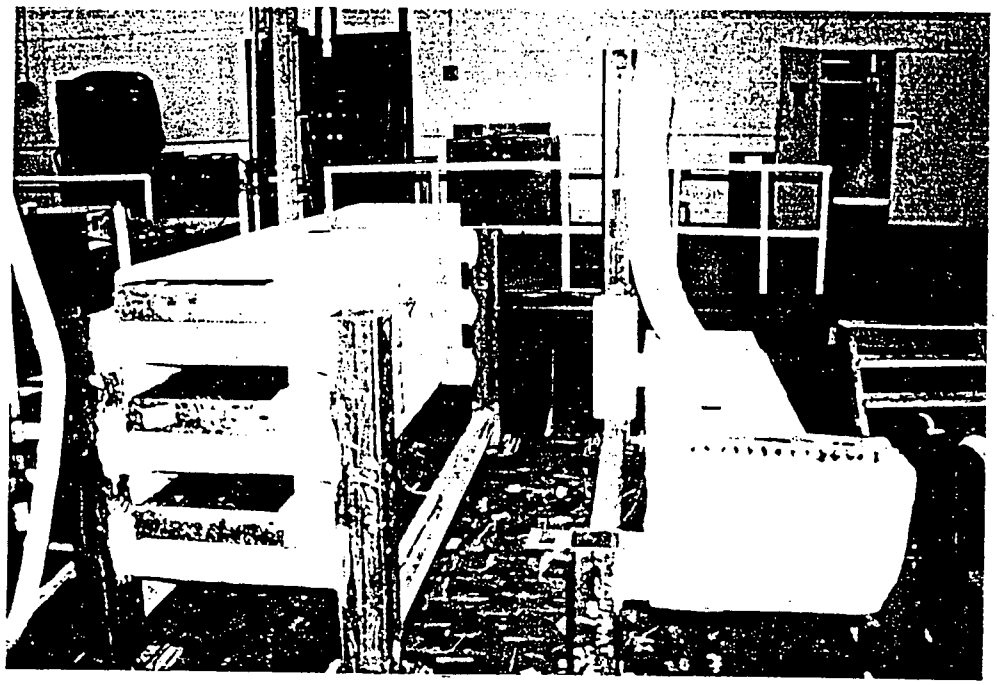
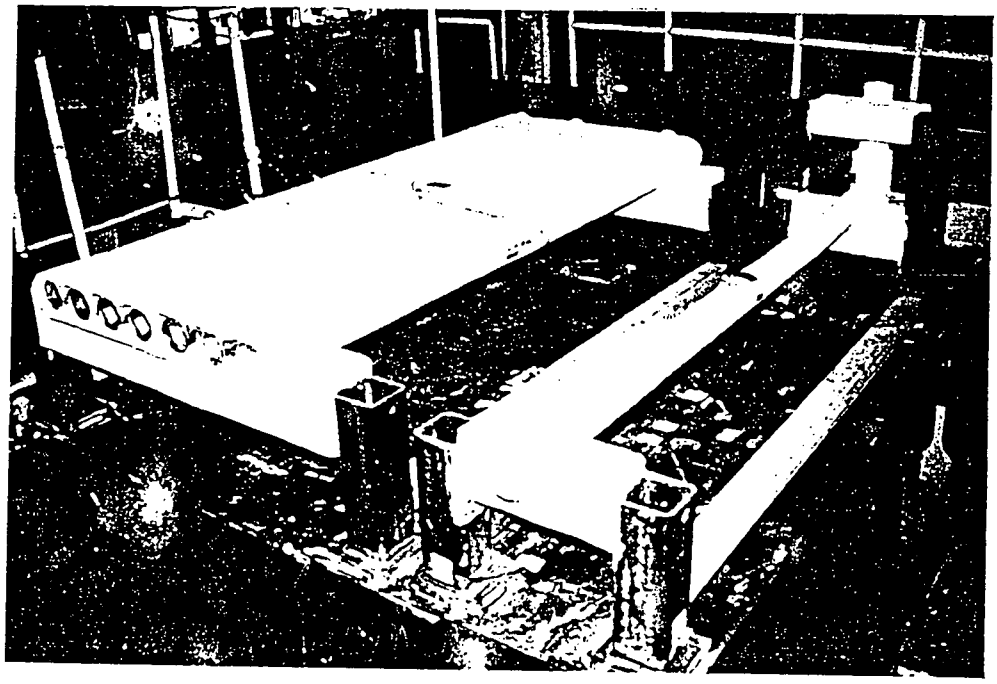


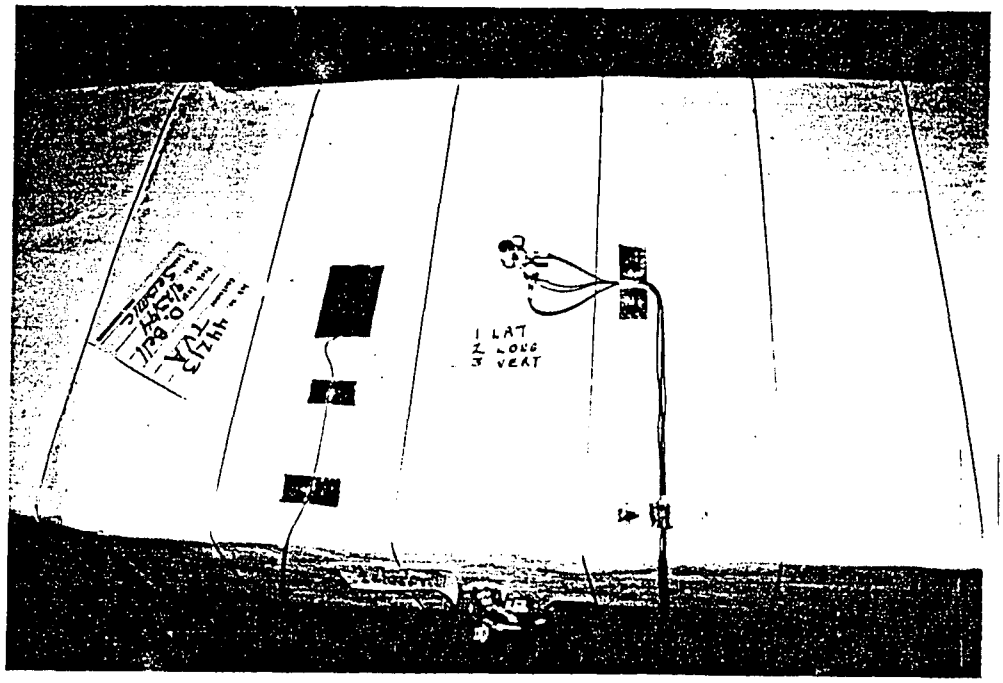
PHOTOGRAPH 1

MULTIPLE CABLE TRAY AND SINGLE CABLE WITH AIR DROP SPECIMEN CONFIGURATIONS
INSTALLED ON THE WYLE TRIAXIAL SEISMIC SIMULATOR TABLE



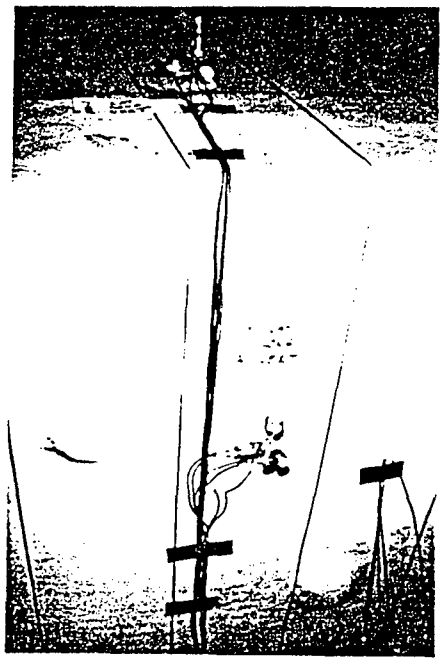
PHOTOGRAPH 2

GANGED CONDUIT AND SINGLE CONDUIT SPECIMEN CONFIGURATIONS
INSTALLED ON THE WYLE TRIAXIAL SEISMIC SIMULATOR TABLE



PHOTOGRAPH 3

SINGLE CABLE TRAY WITH AIR DROP SPECIMEN RESPONSE ACCELEROMETER LOCATIONS
1 LAT, 2 LONG, 3 V
4 LAT, 5 LONG, 6V

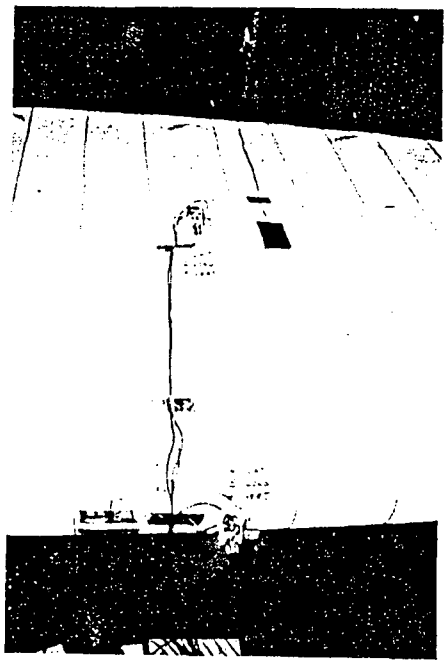


PHOTOGRAPH 4

MULTIPLE CABLE TRAY SPECIMEN RESPONSE ACCELEROMETER LOCATIONS
7 LAT, 8 LONG, 9V
10 LAT, 11 LONG, 12V

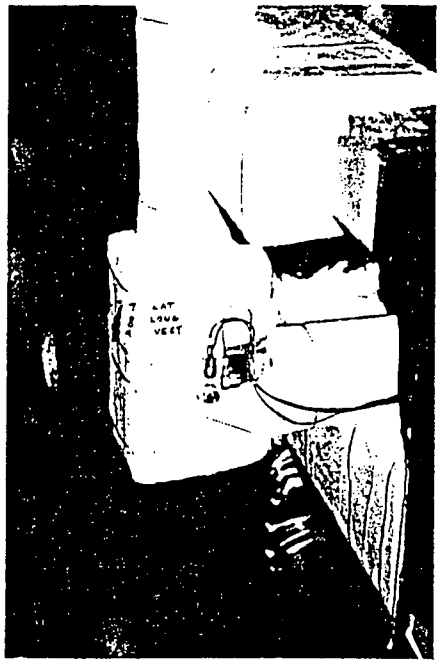
PHOTOGRAPH 5

SINGLE CABLE TRAY WITH AIR DROP TEST FIXTURE VERTICAL SUPPORT RESPONSE ACCELEROMETER LOCATIONS
16 LAT, 17 LONG



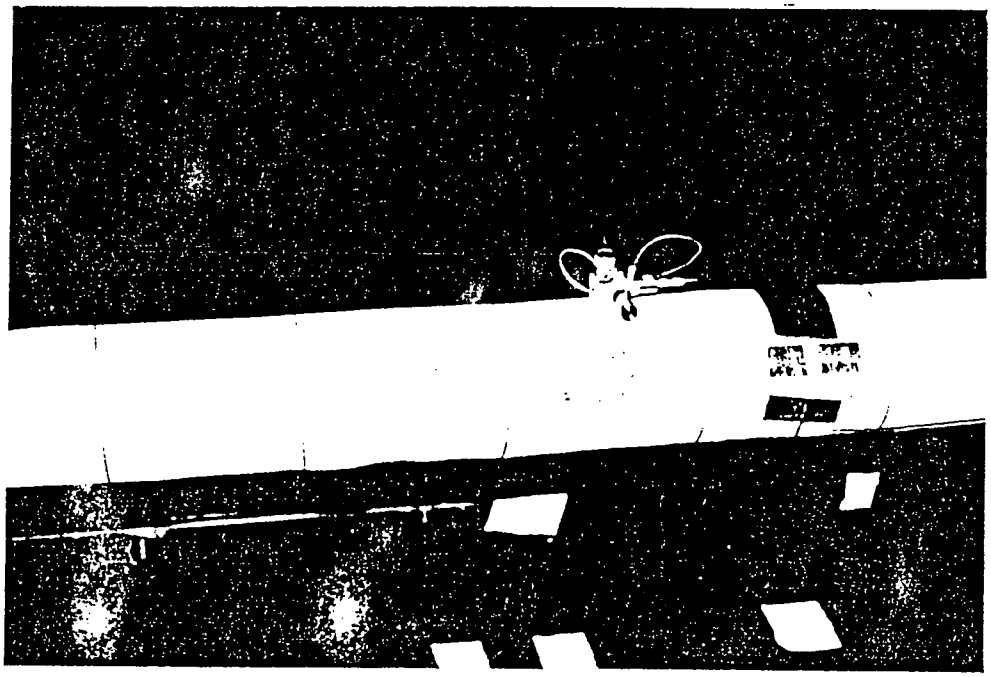
PHOTOGRAPH 6

GANGED CONDUIT SPECIMEN RESPONSE ACCELEROMETER LOCATIONS
1 LAT, 2 LONG, 3 V
4 LAT, 5 LONG, 6 V



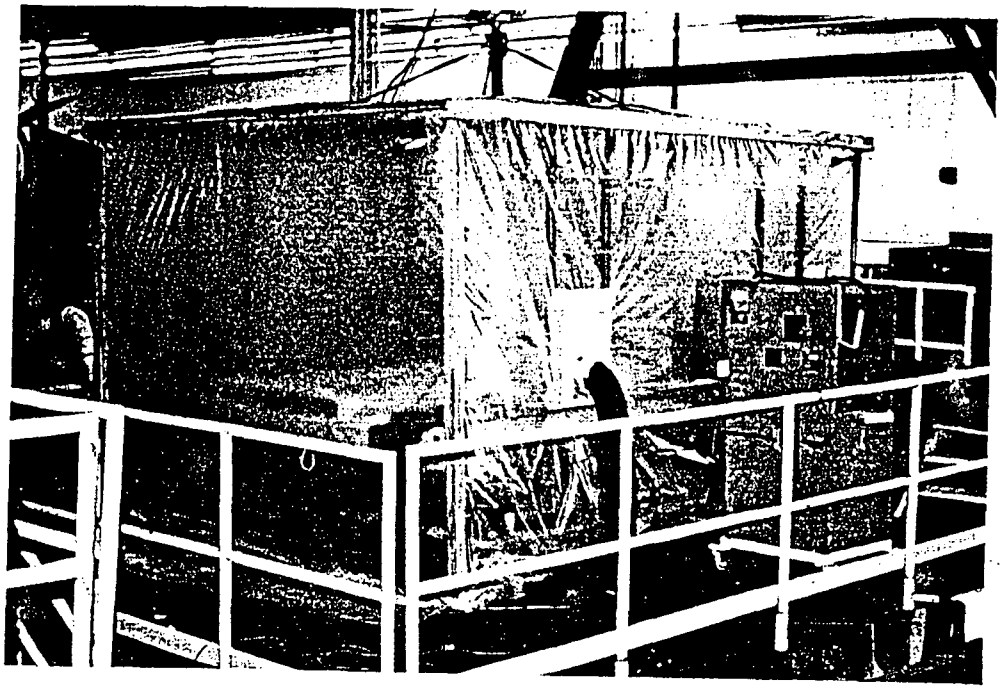
PHOTOGRAPH 7

SINGLE CONDUIT SPECIMEN RESPONSE ACCELEROMETER LOCATIONS
7 LAT, 8 LONG, 9 V



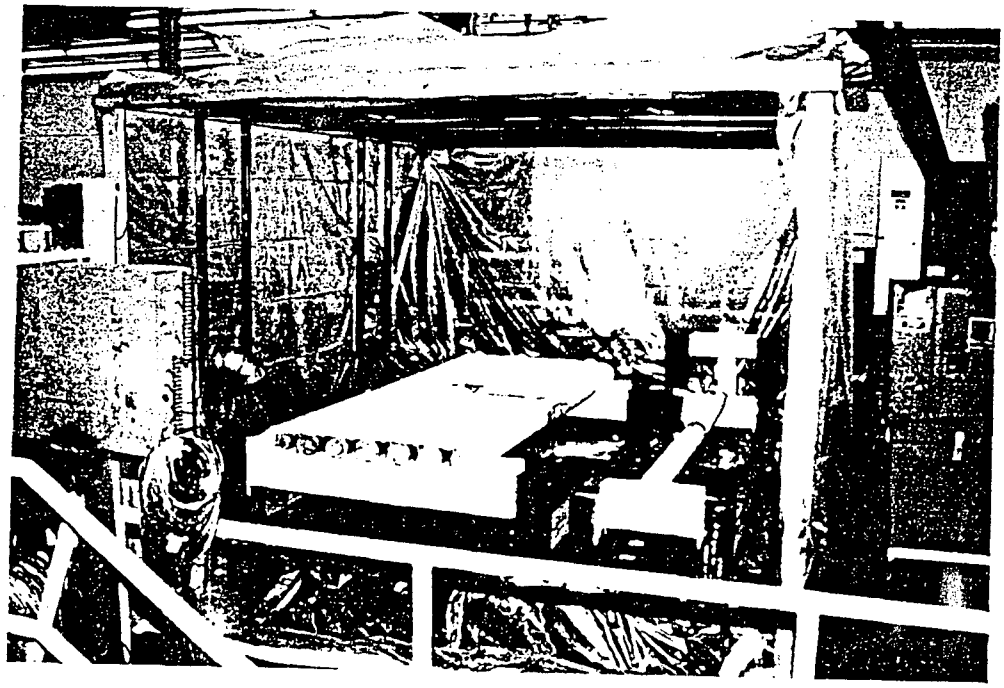
PHOTOGRAPH 8

SINGLE CONDUIT SPECIMEN RESPONSE ACCELEROMETER LOCATIONS
10 LAT, 11 LONG, 12 V



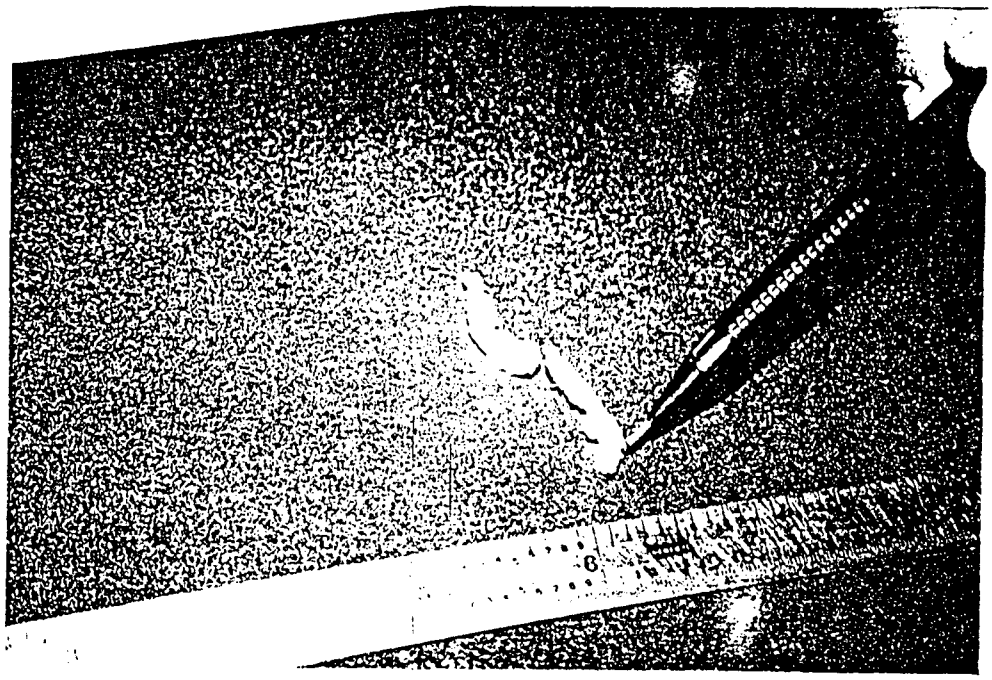
PHOTOGRAPH 9

ENVIRONMENTAL ENCLOSURE INSTALLED
ON THE
WYLE TRIAXIAL SEISMIC SIMULATOR TABLE



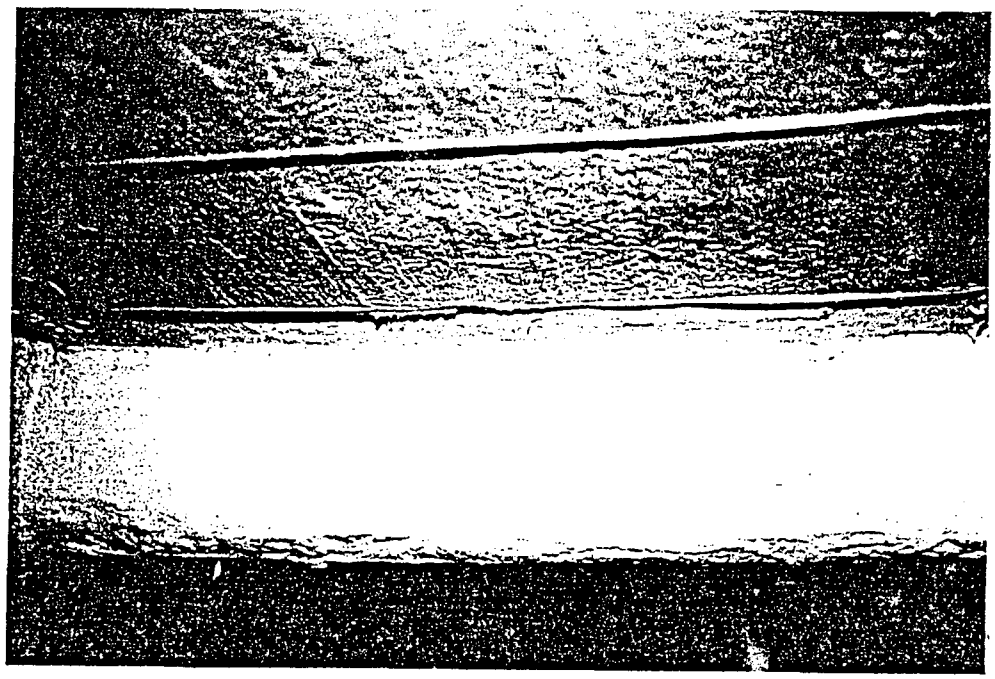
PHOTOGRAPH 10

ENVIRONMENTAL ENCLOSURE WITH SIDE REMOVED



PHOTOGRAPH 11

THERMO-LAG MATERIAL FOUND AFTER
SERIES 2 OBE TEST



PHOTOGRAPH 12

SLIGHT CRACKING OF THE THERMO-LAG
ON THE UNDERSIDE OF THE MULTIPLE CABLE TRAY SPECIMEN

APPENDIX IV

SERIES 1 RESONANCE SEARCH TRANSMISSIBILITY PLOTS

Test Run	Plots
1	Lateral Response Accelerometer/Lateral Control Accelerometer
2	Longitudinal Response Accelerometer/Longitudinal Control Accelerometer
3	Vertical Response Accelerometer/Vertical Control Accelerometer
8	Lateral Response Accelerometer/Lateral Control Accelerometer
9	Longitudinal Response Accelerometer/Longitudinal Control Accelerometer
10	Vertical Response Accelerometer/Vertical Control Accelerometer

LEGEND:

HCA	=	Horizontal Control Accelerometer
VCA	=	Vertical Control Accelerometer
LAT	=	Lateral
LONG	=	Longitudinal
V	=	Vertical

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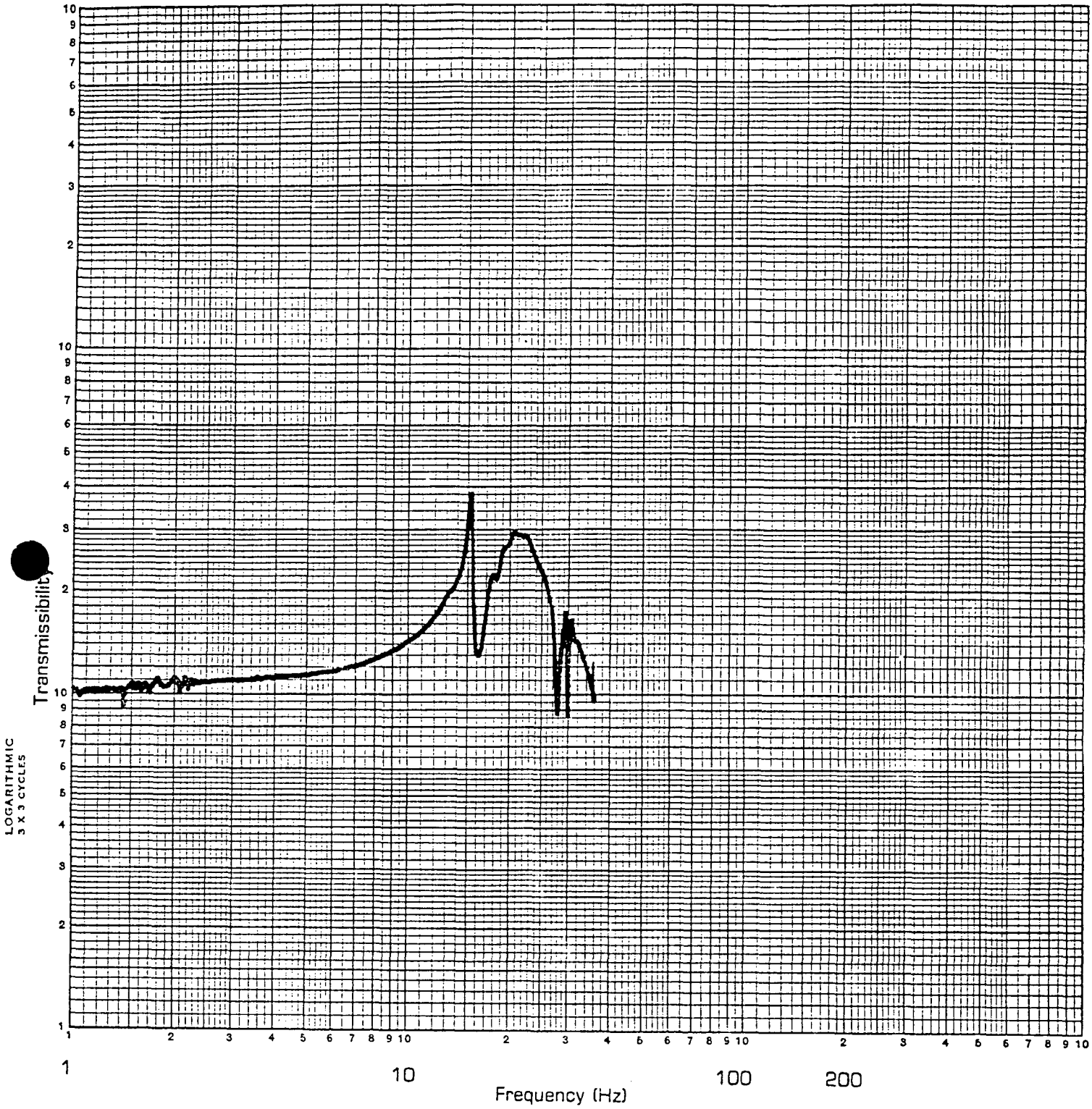
FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray with Air Drop

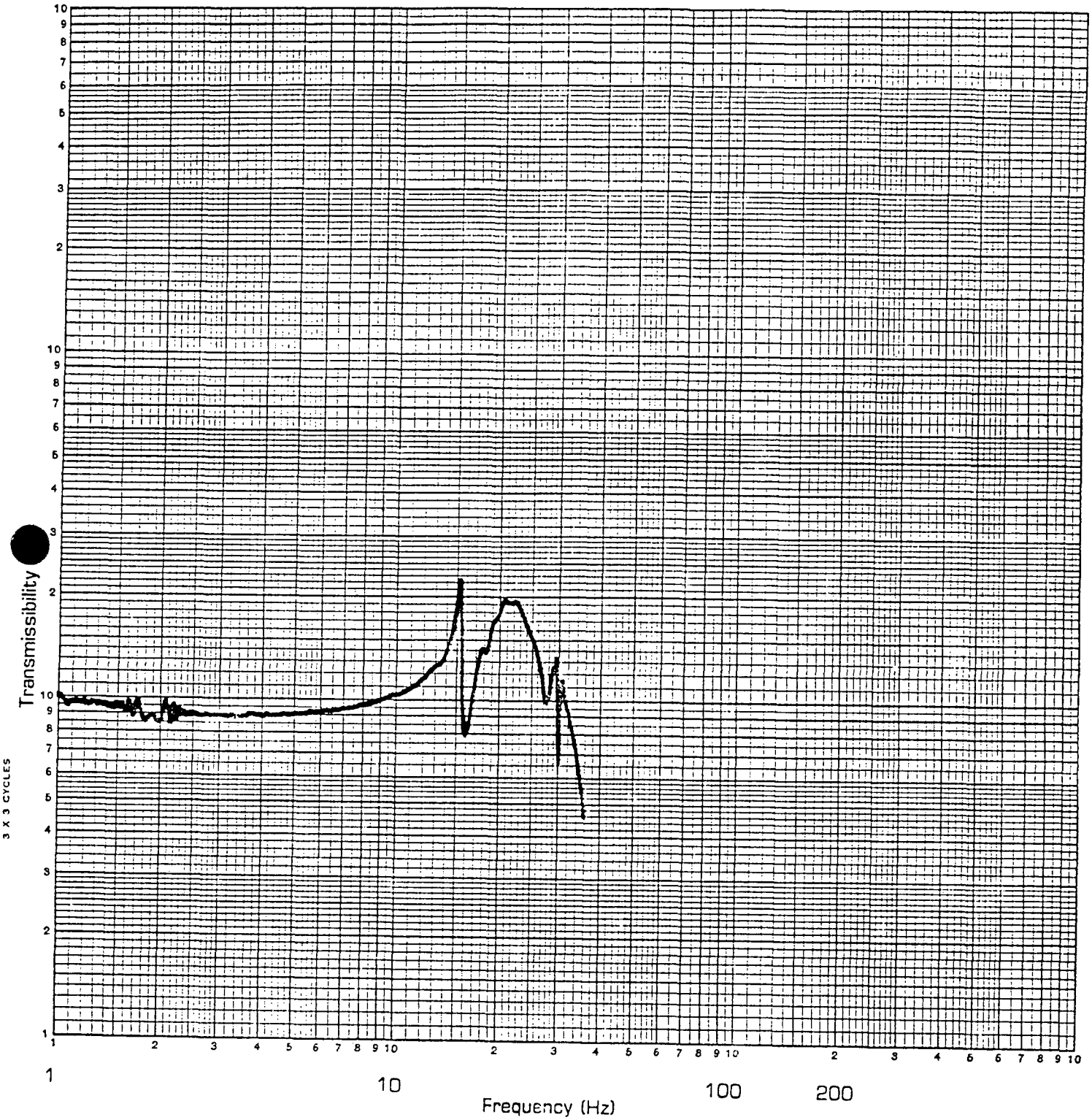
AXIS LAT

ACCEL. NO. 1LAT NO. LAT HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray with Air Drop

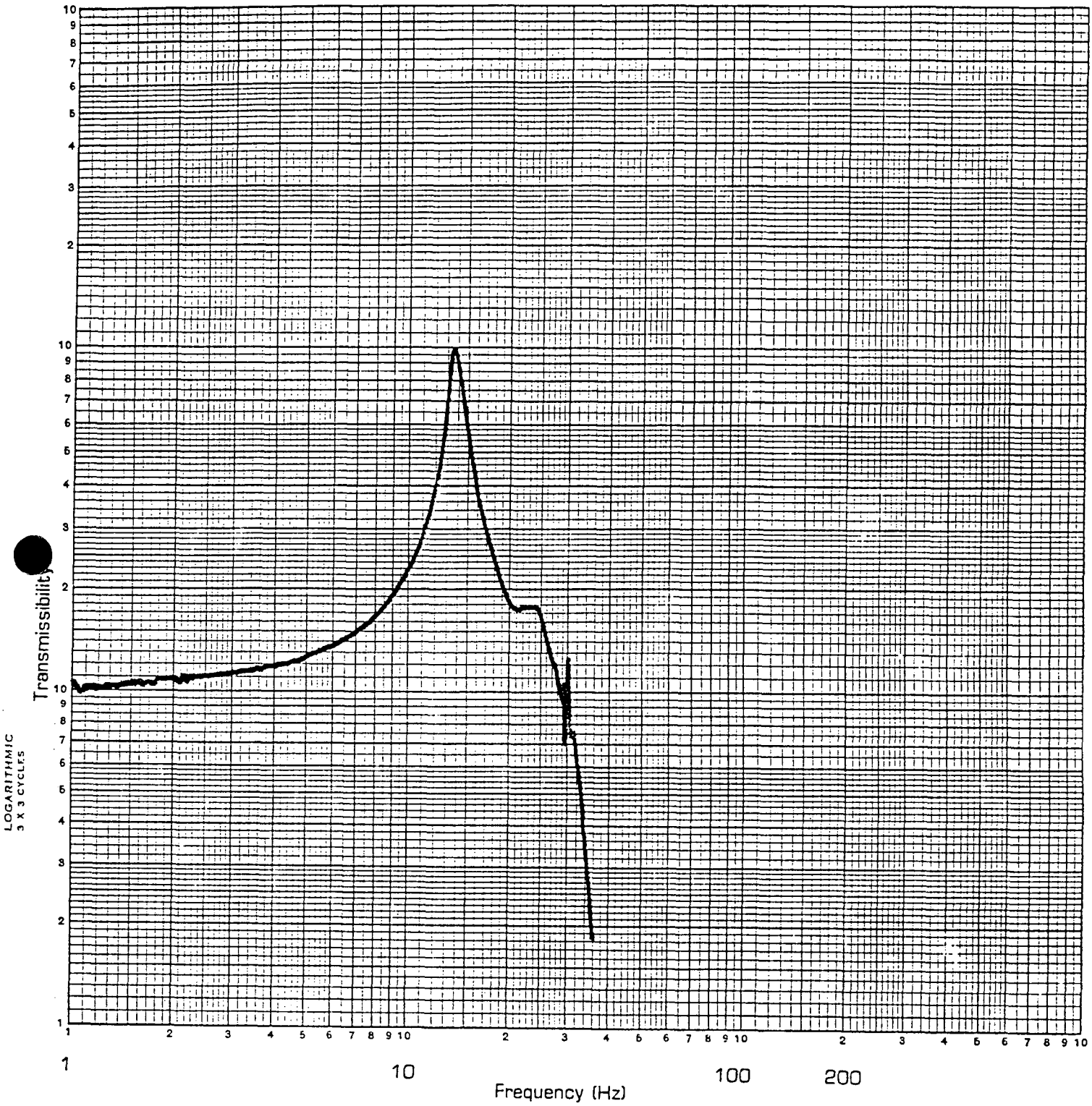
AXIS LAT

ACCEL. NO. 4LAT NO. LAT HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

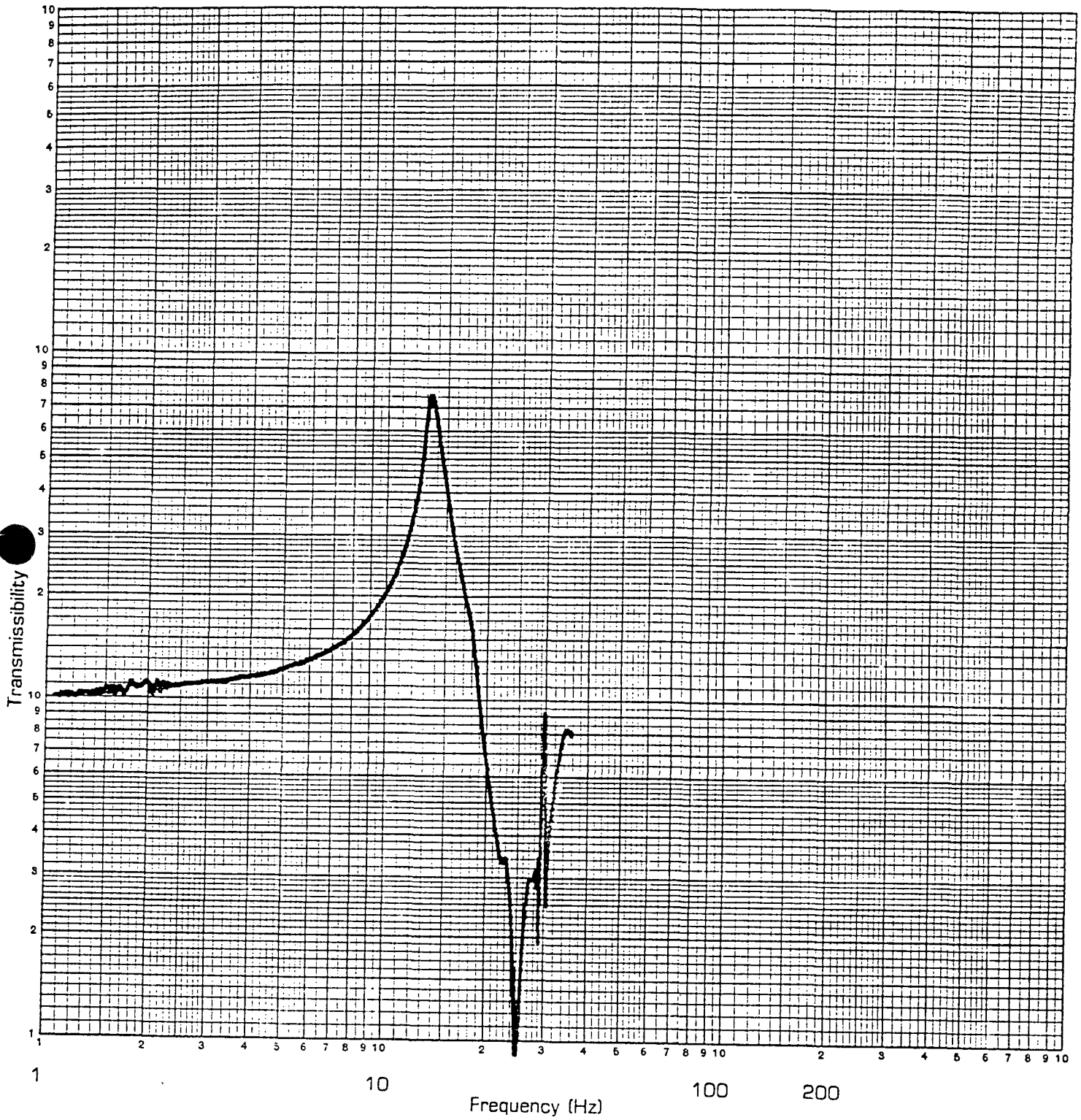
AXIS LAT

ACCEL. NO. 10LAT NO. LATHCH

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

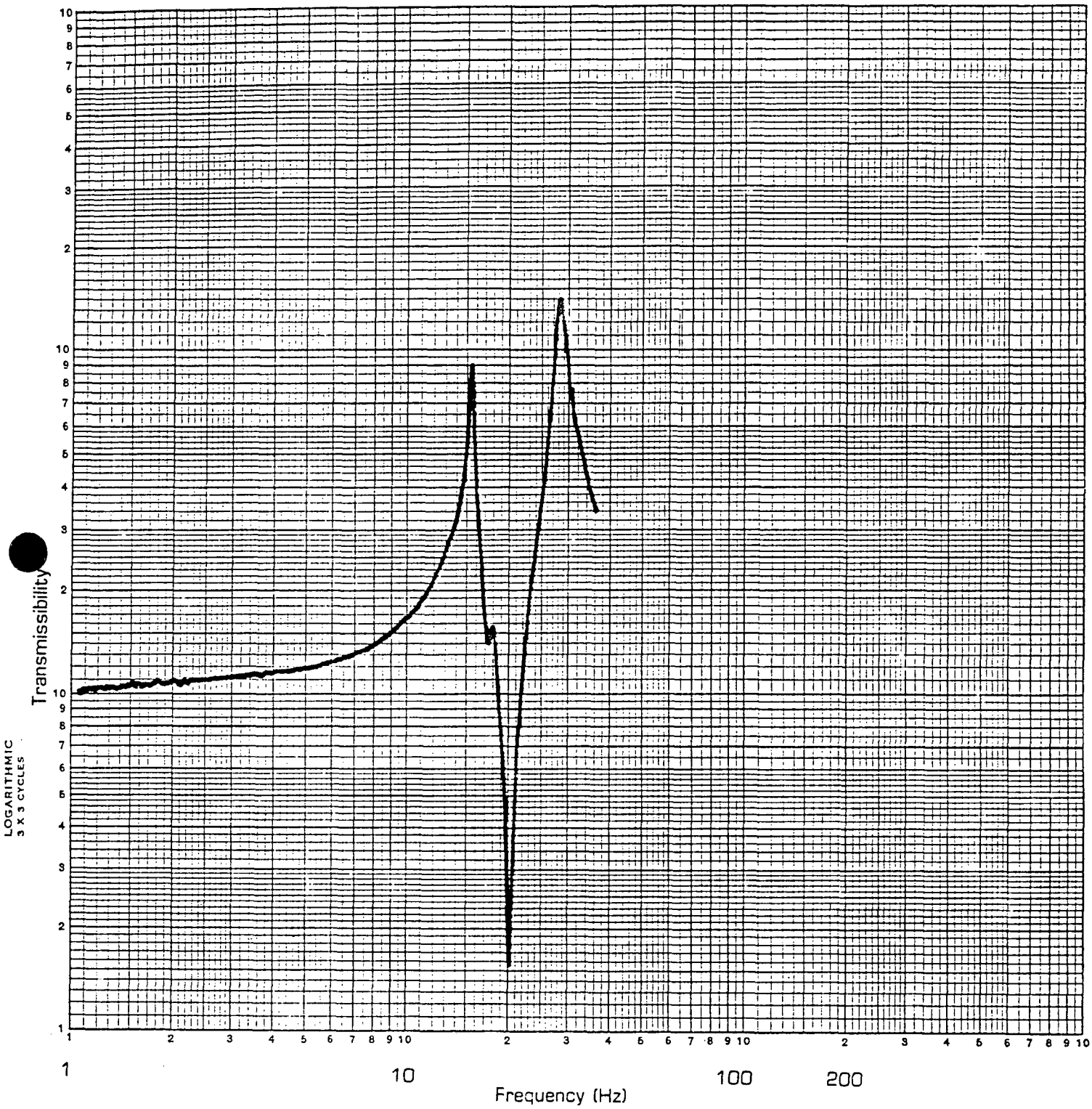
AXIS LAT

ACCEL. NO. 7 LAT NO. LATHCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray w/ Air Drop Support

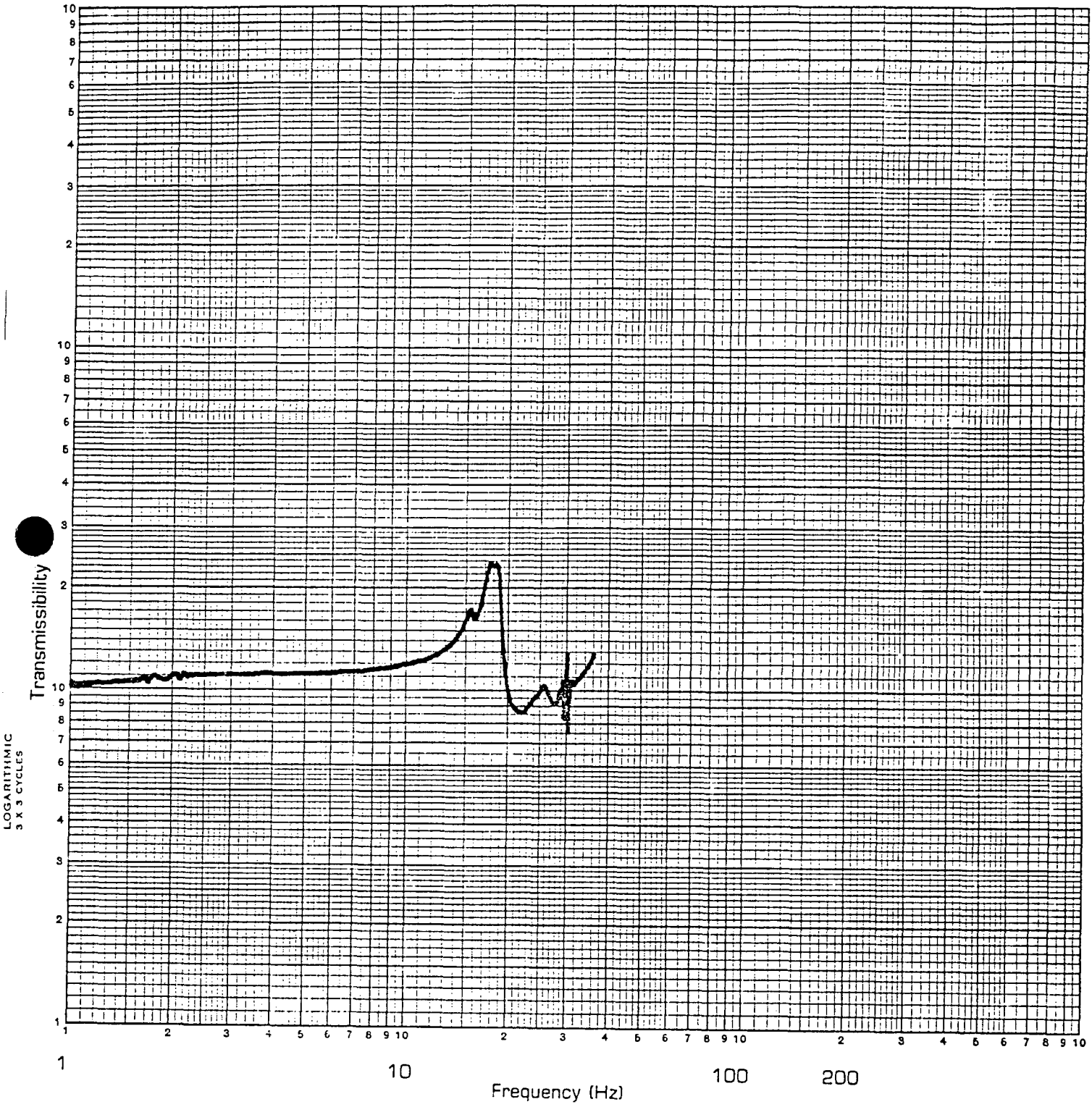
AXIS LAT

ACCEL. NO. 16 LAT NO. LAT HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray w/ Air Drop

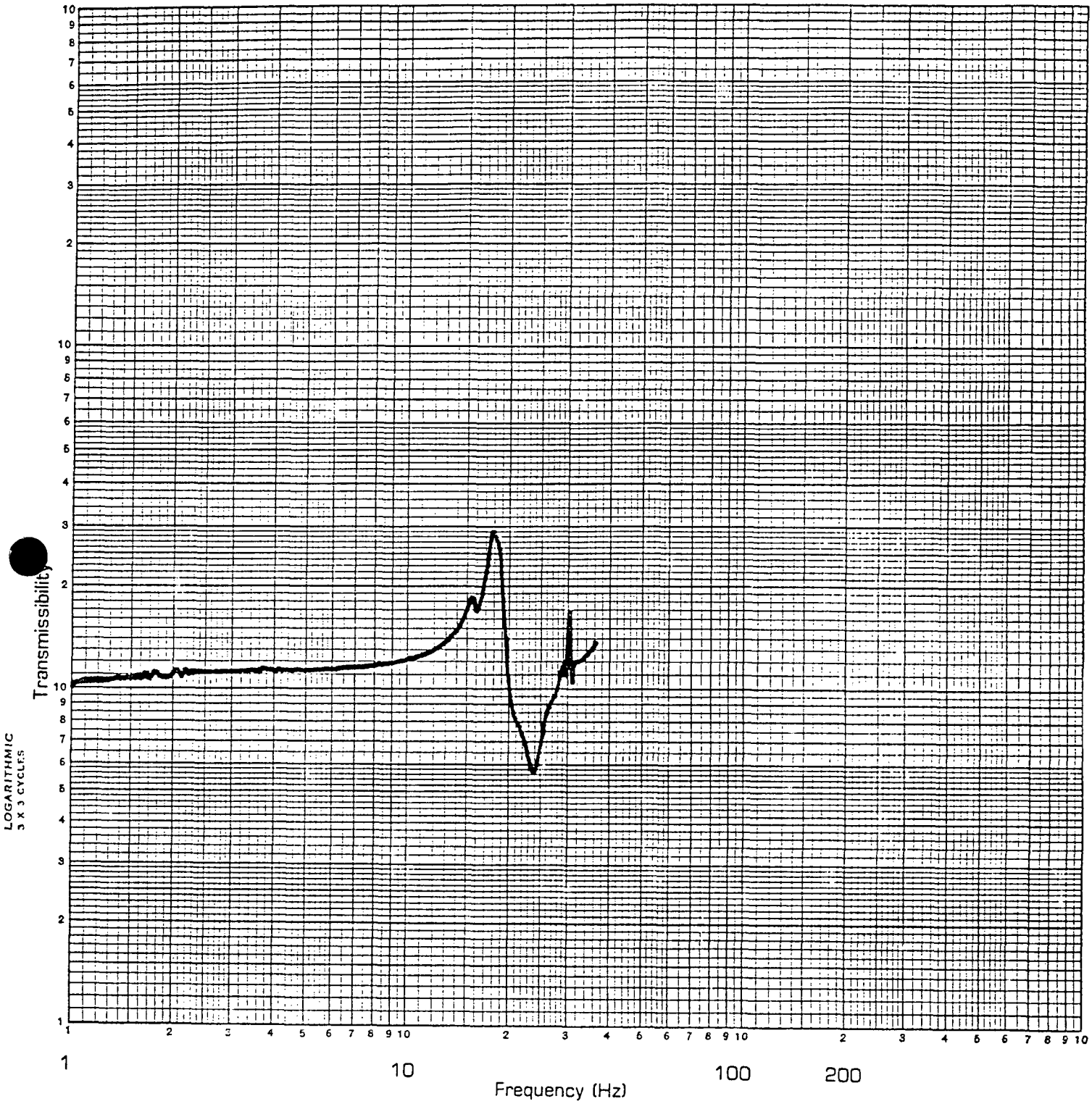
AXIS Long

ACCEL. NO. 2 Long NO. Long HCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray w/ Air Drop

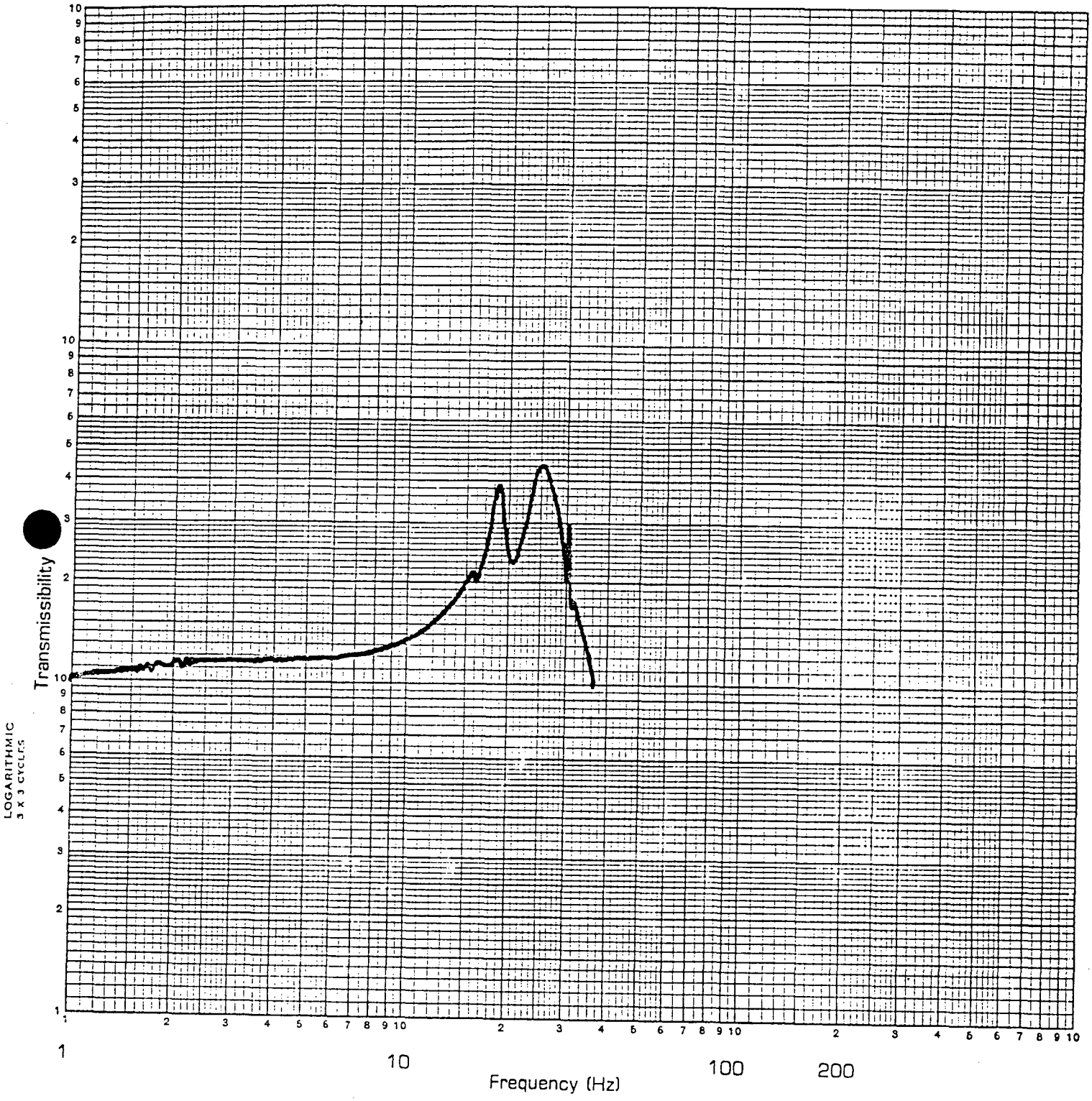
AXIS Long

ACCEL. NO. 5 Long NO. Long HCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

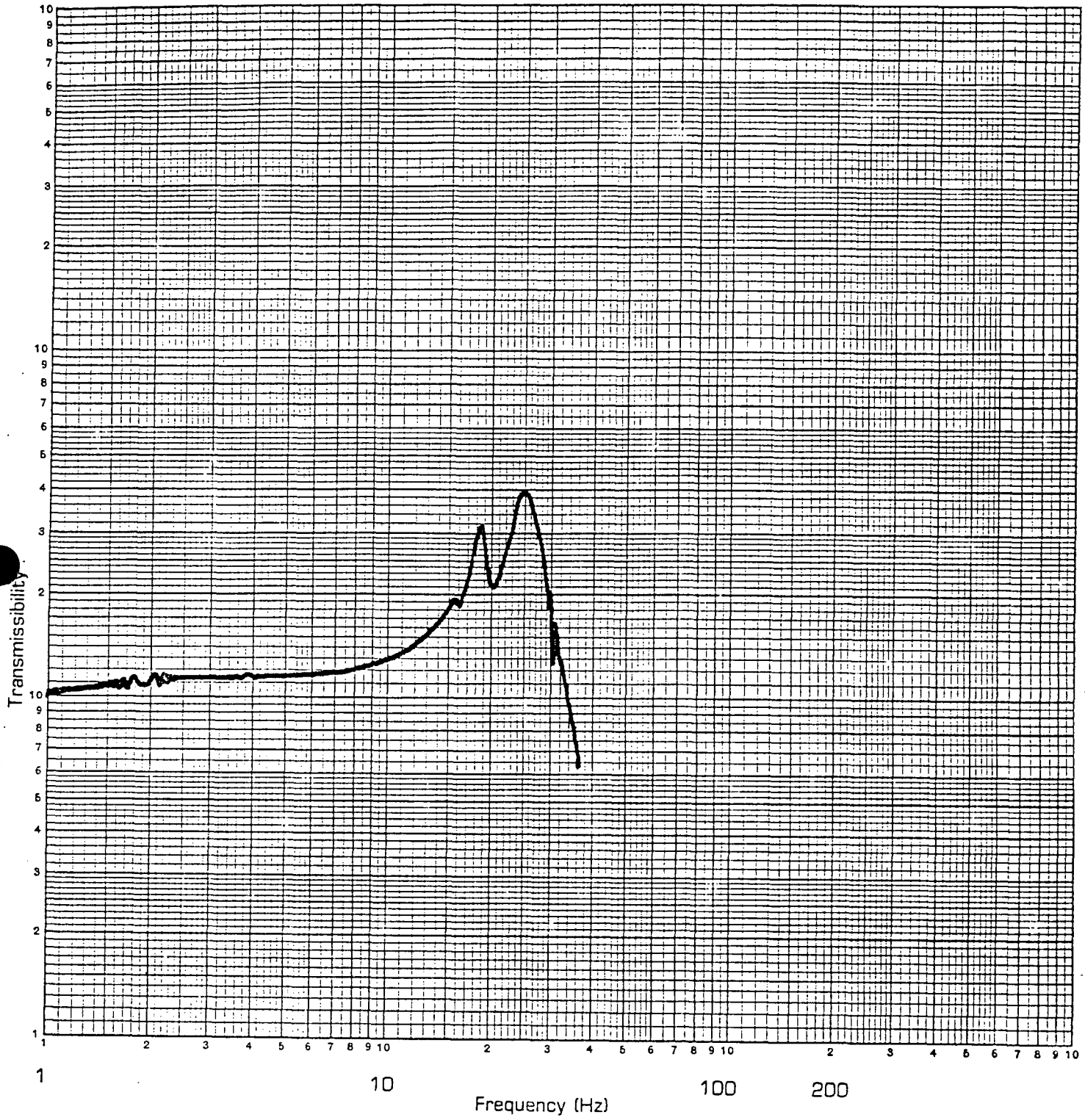
AXIS Long

ACCEL. NO. 8 Long NO. Long HCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

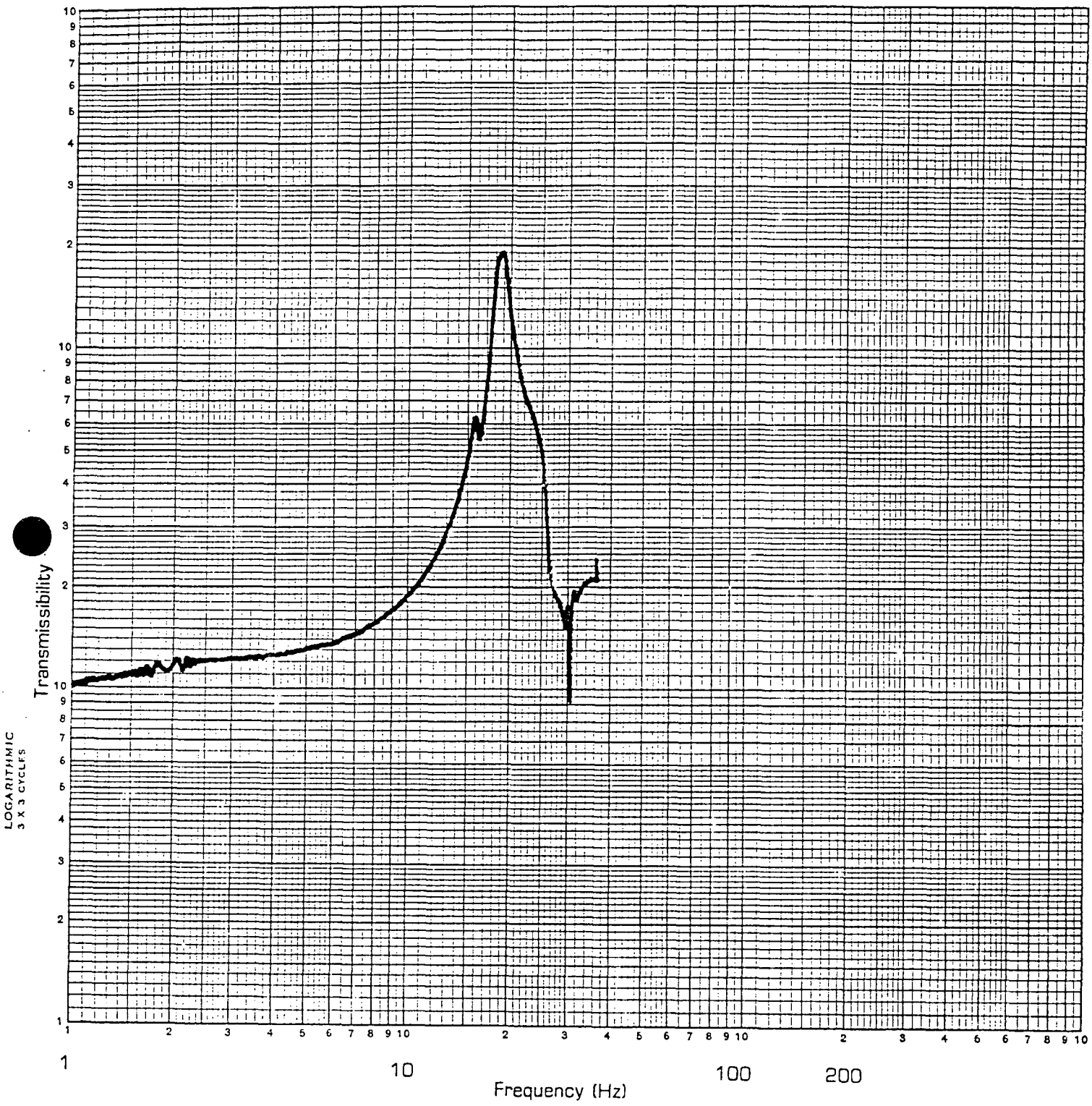
AXIS Long

ACCEL. NO. 11 Long NO. Long HCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single cable Tray w/ Air Drop Support

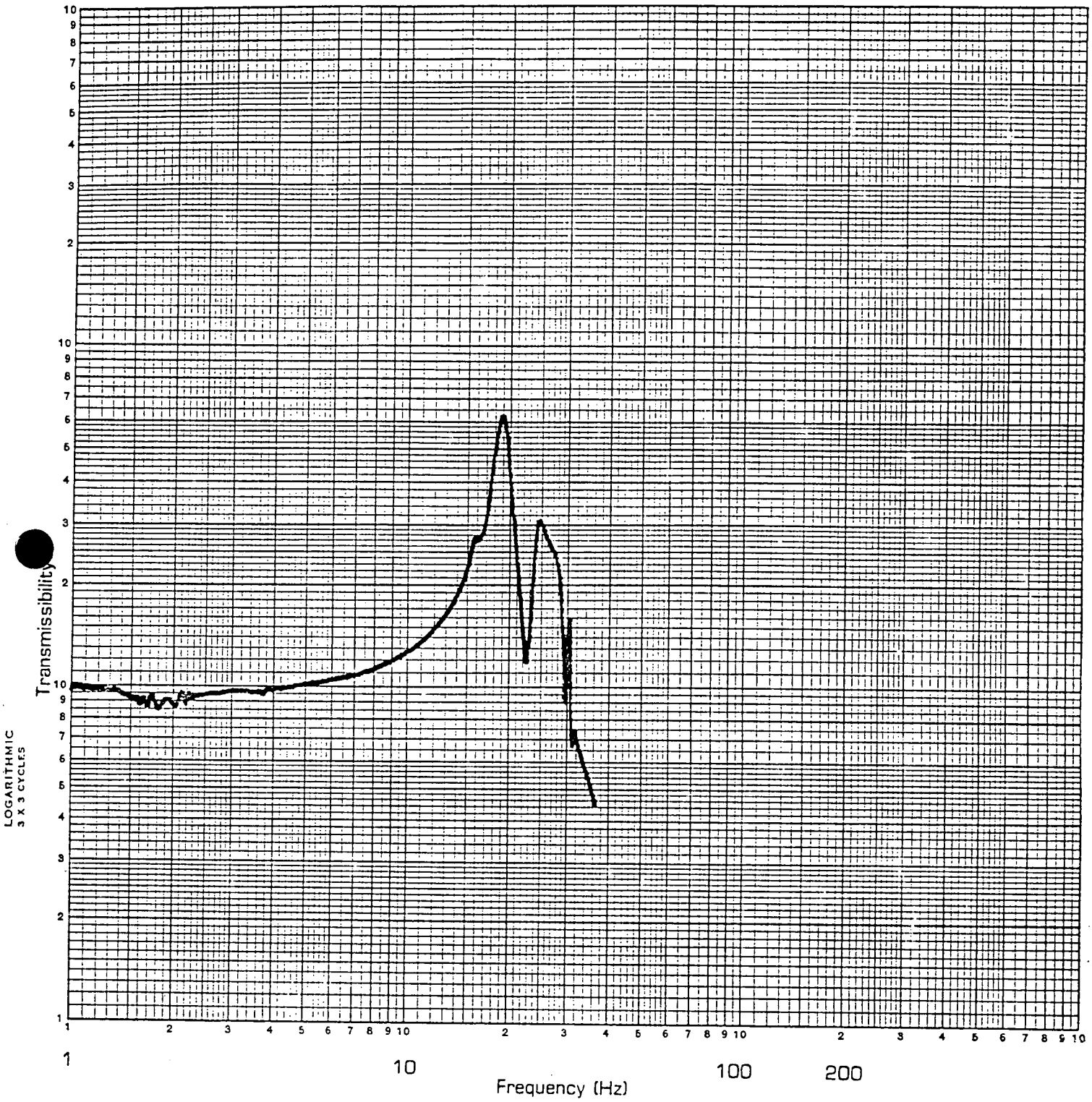
AXIS Long

ACCEL. NO. 17 Long NO. Long HGA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray w/ Air Drop

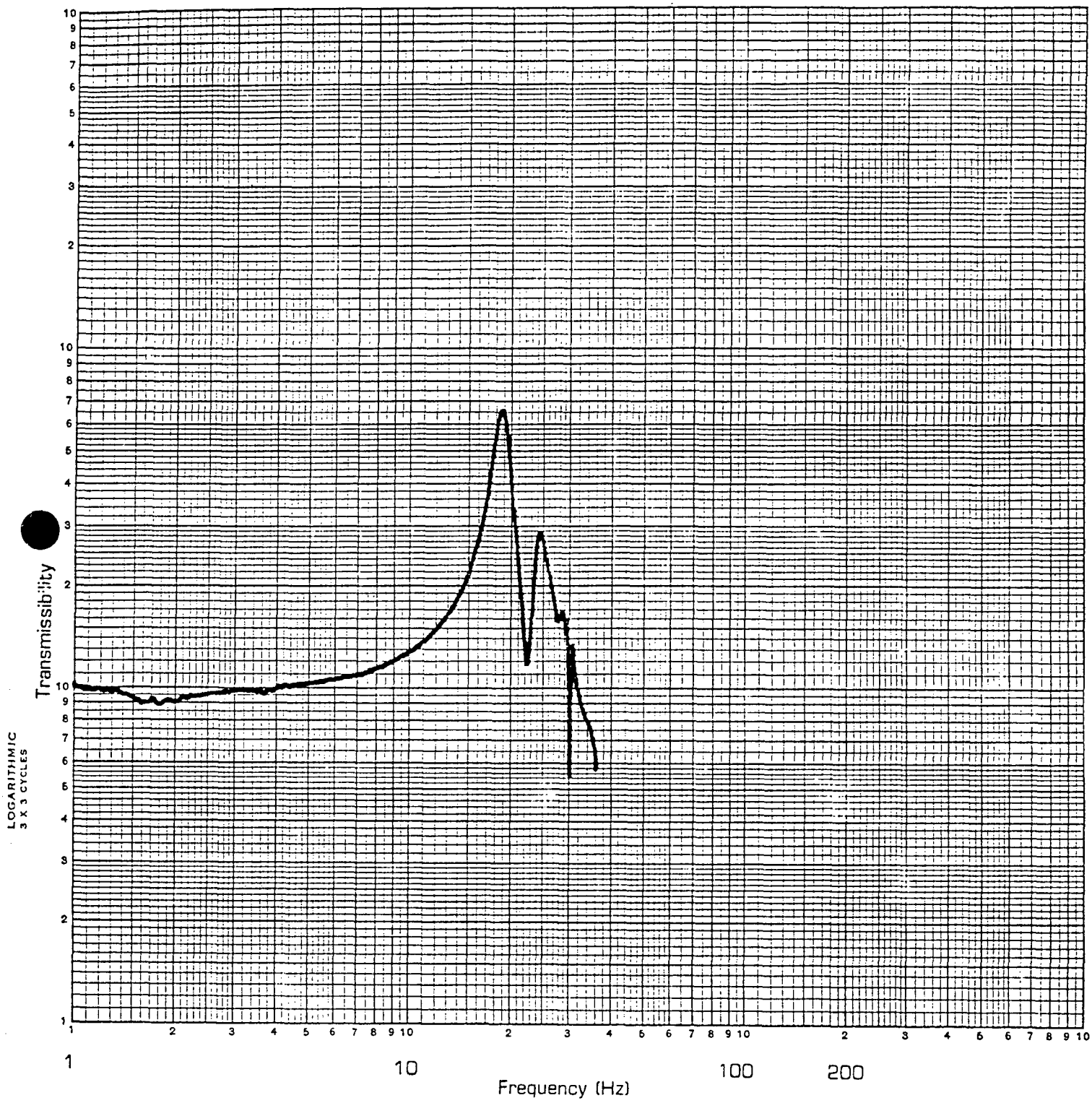
AXIS V

ACCEL. NO. 3U NO. VEA

TEST RUN NO. 3

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Single Cable Tray w/ Air Drop

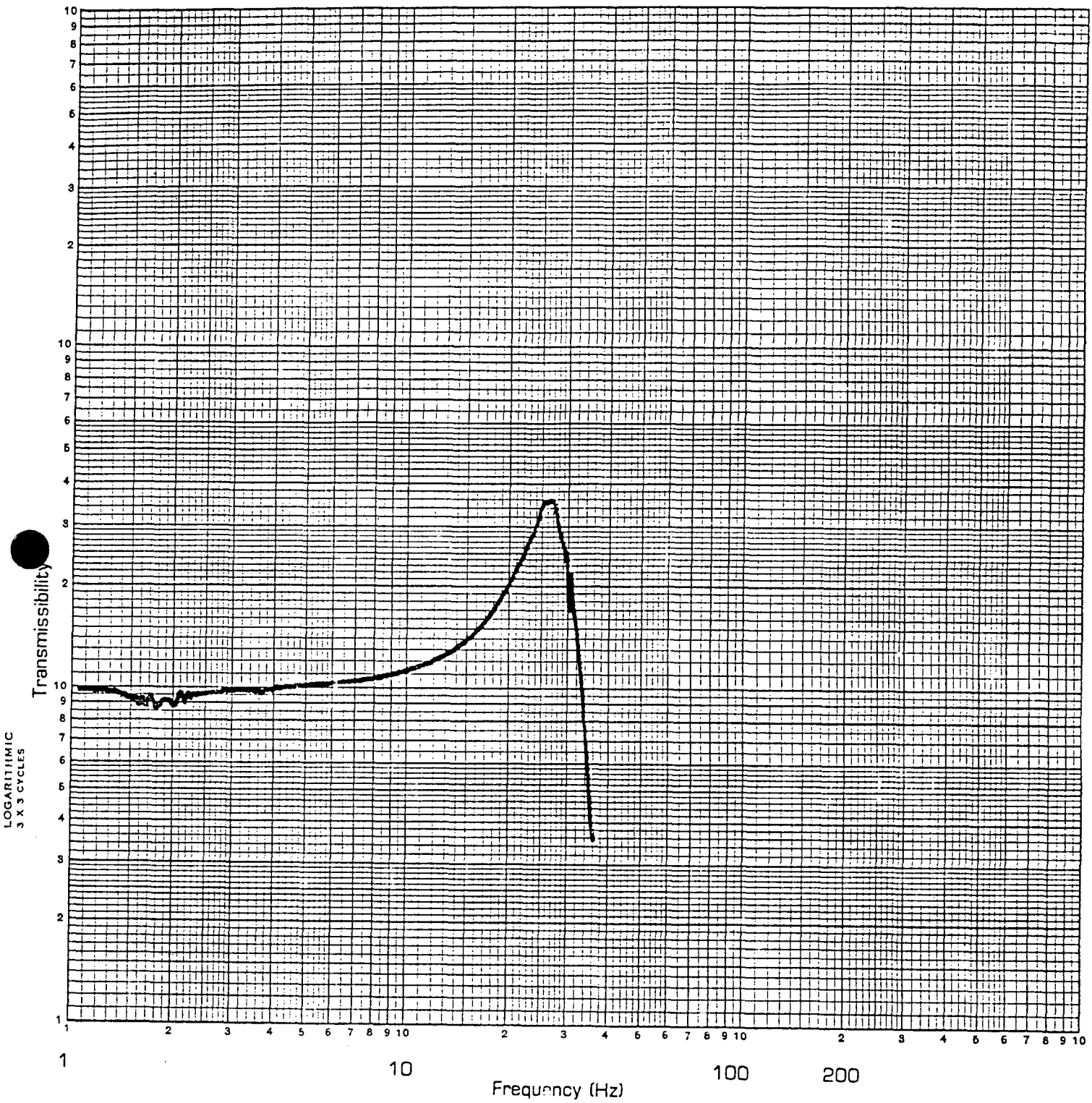
AXIS V

ACCEL. NO. 6V NO. VCA

TEST RUN NO. 3

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

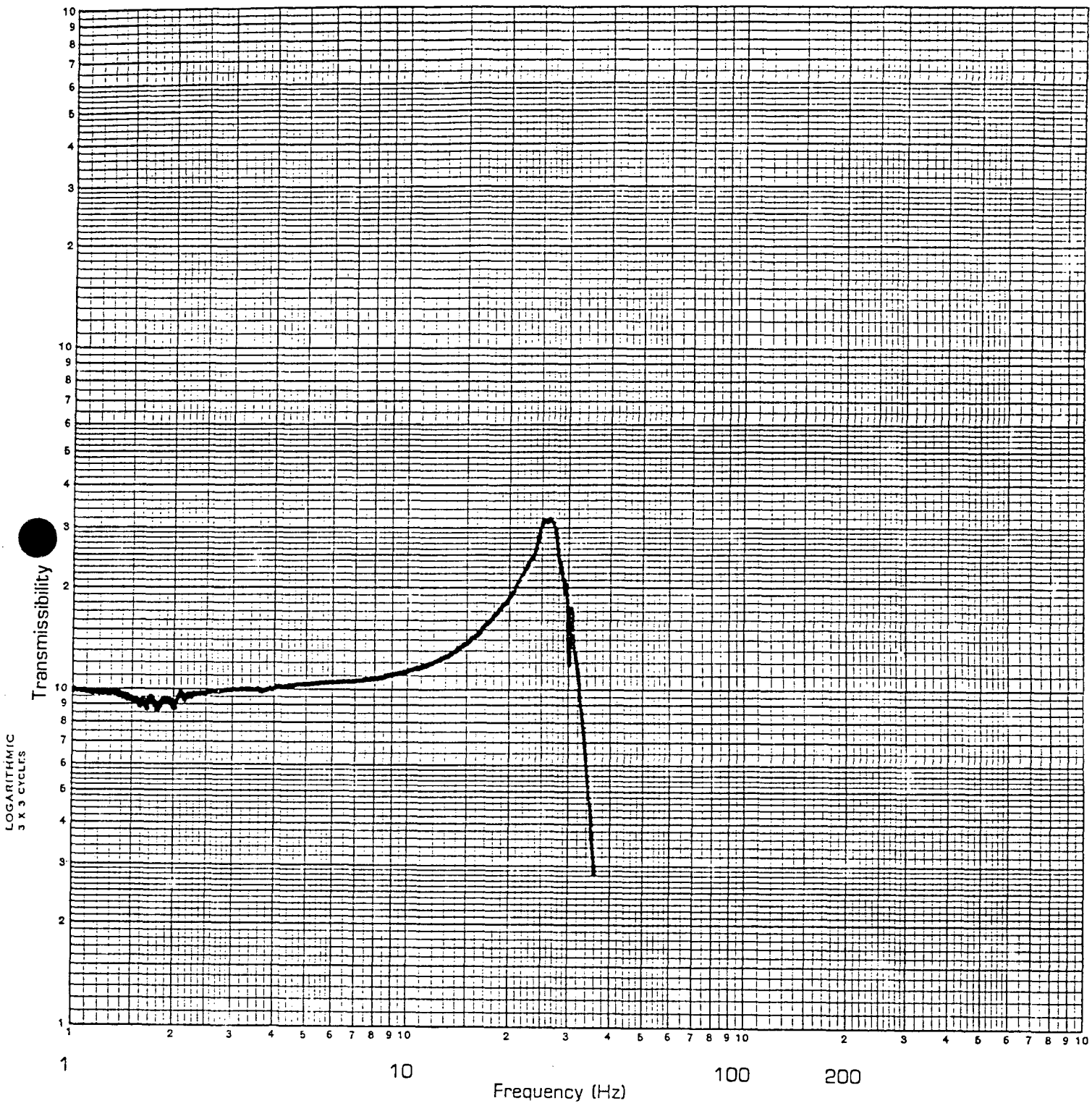
AXIS ✓

ACCEL. NO. 9V NO. VCA

TEST RUN NO. 3

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Mutiple Cable Tray

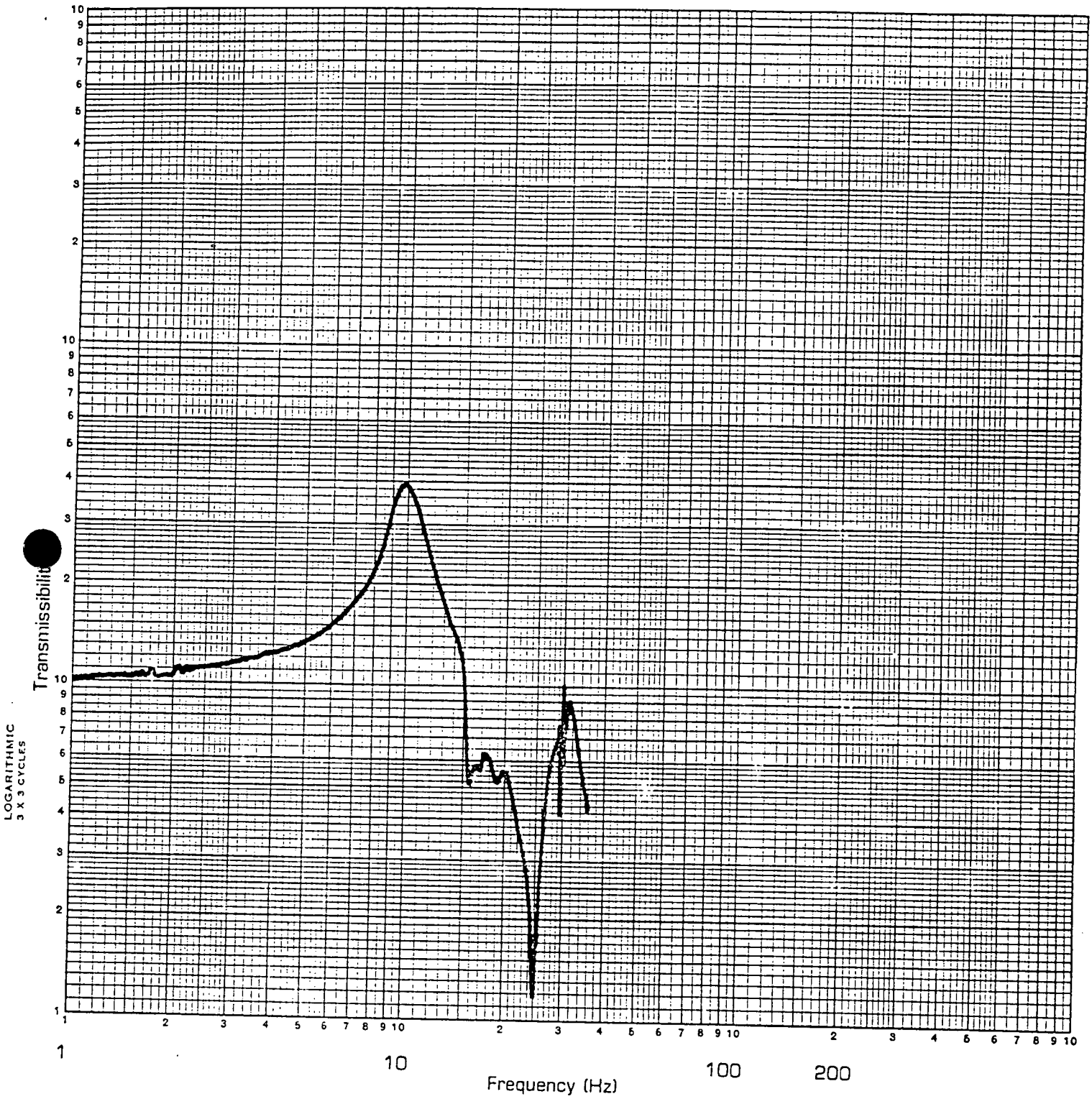
AXIS V

ACCEL. NO. 12 V NO. VCA

TEST RUN NO. 3

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray w/ Air Drop

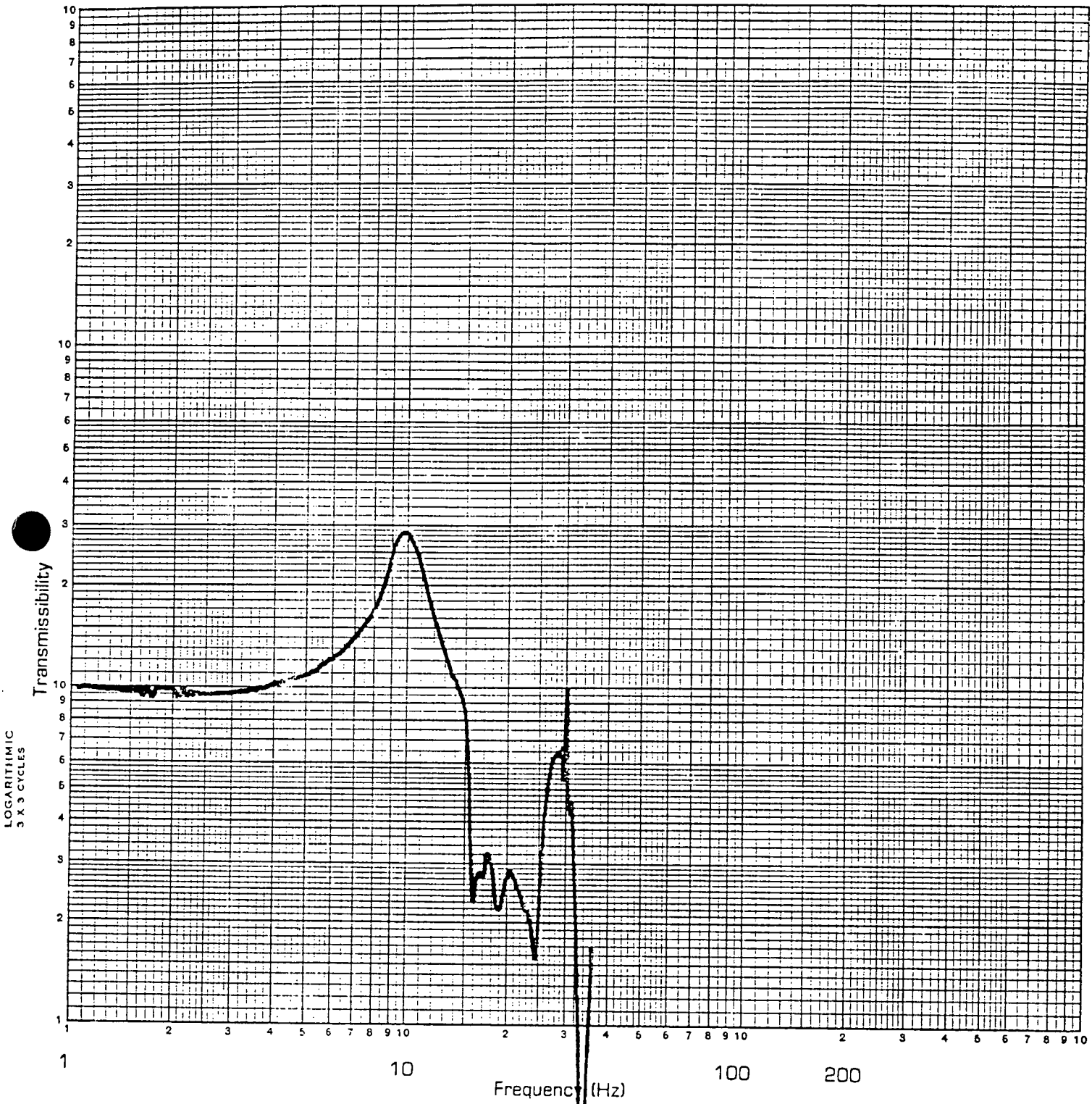
AXIS LAT

ACCEL. NO. 1 LAT NO. LAT HCA

TEST RUN NO. 8

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray w/ Air Drop

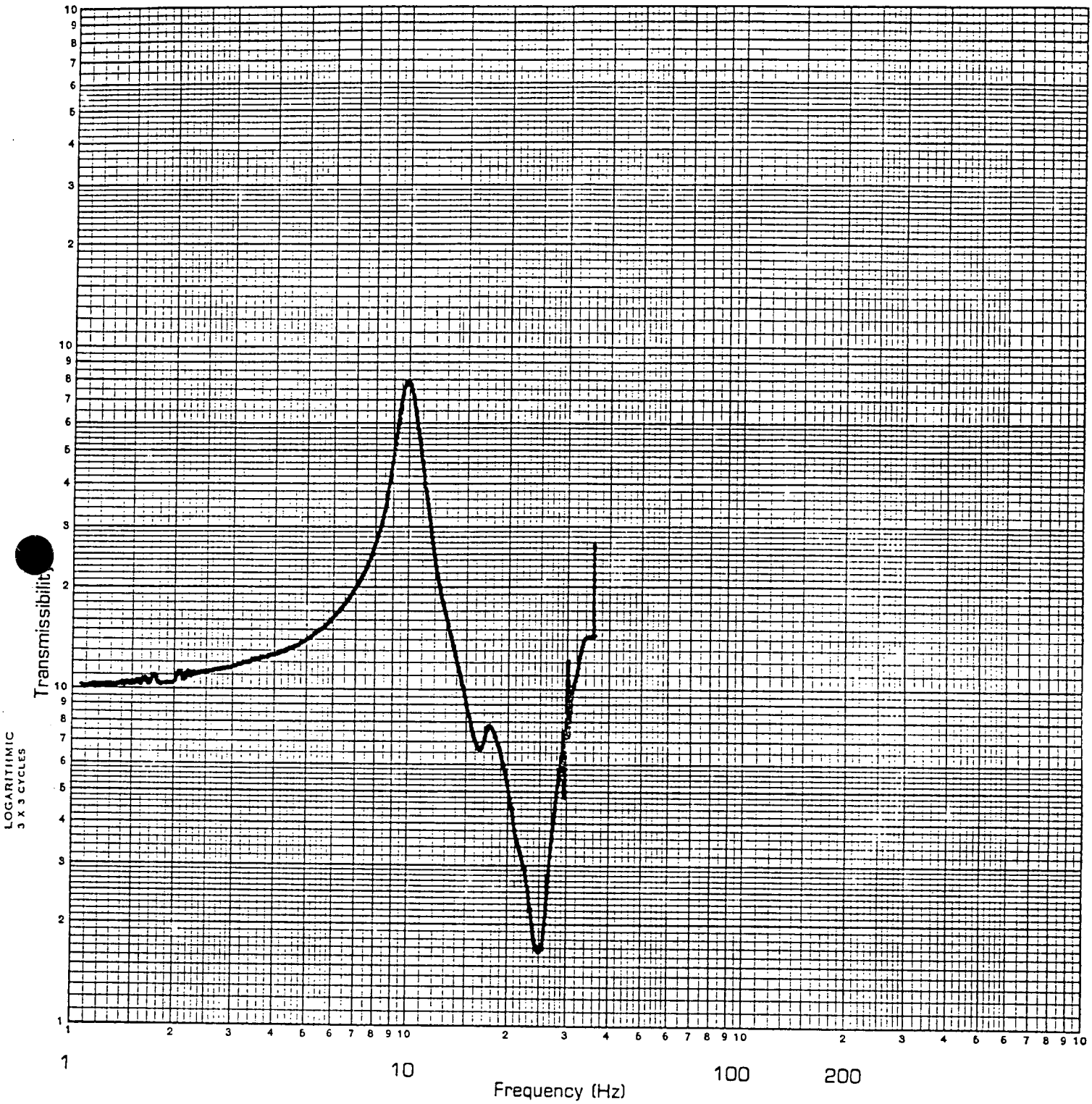
AXIS LAT

ACCEL. NO. 4 LAT NO. LAT HCA

TEST RUN NO. 8

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

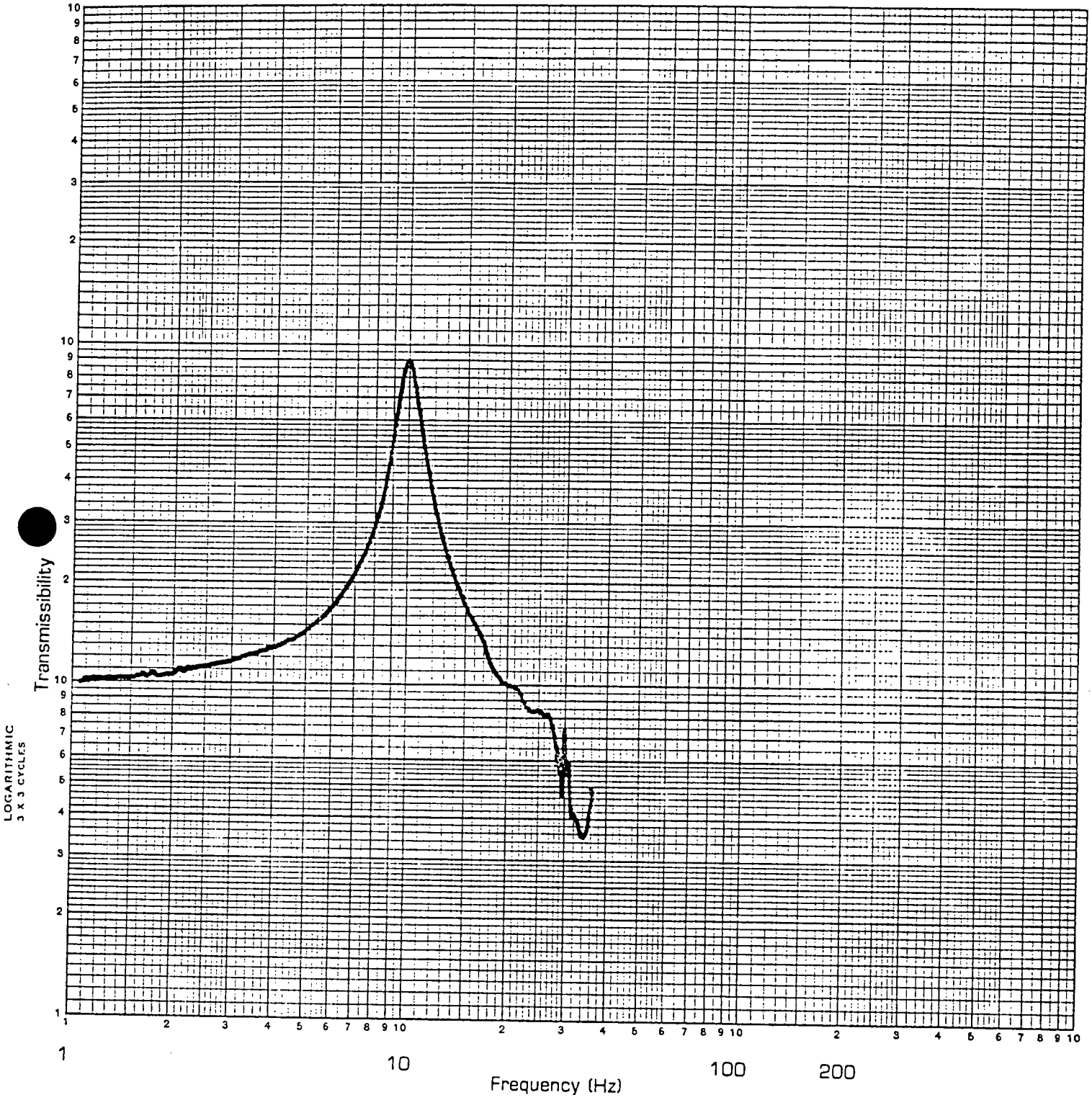
AXIS LAT

ACCEL. NO. 7LAT NO. LAT ACH

TEST RUN NO. 8

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Multiple Cable Tray

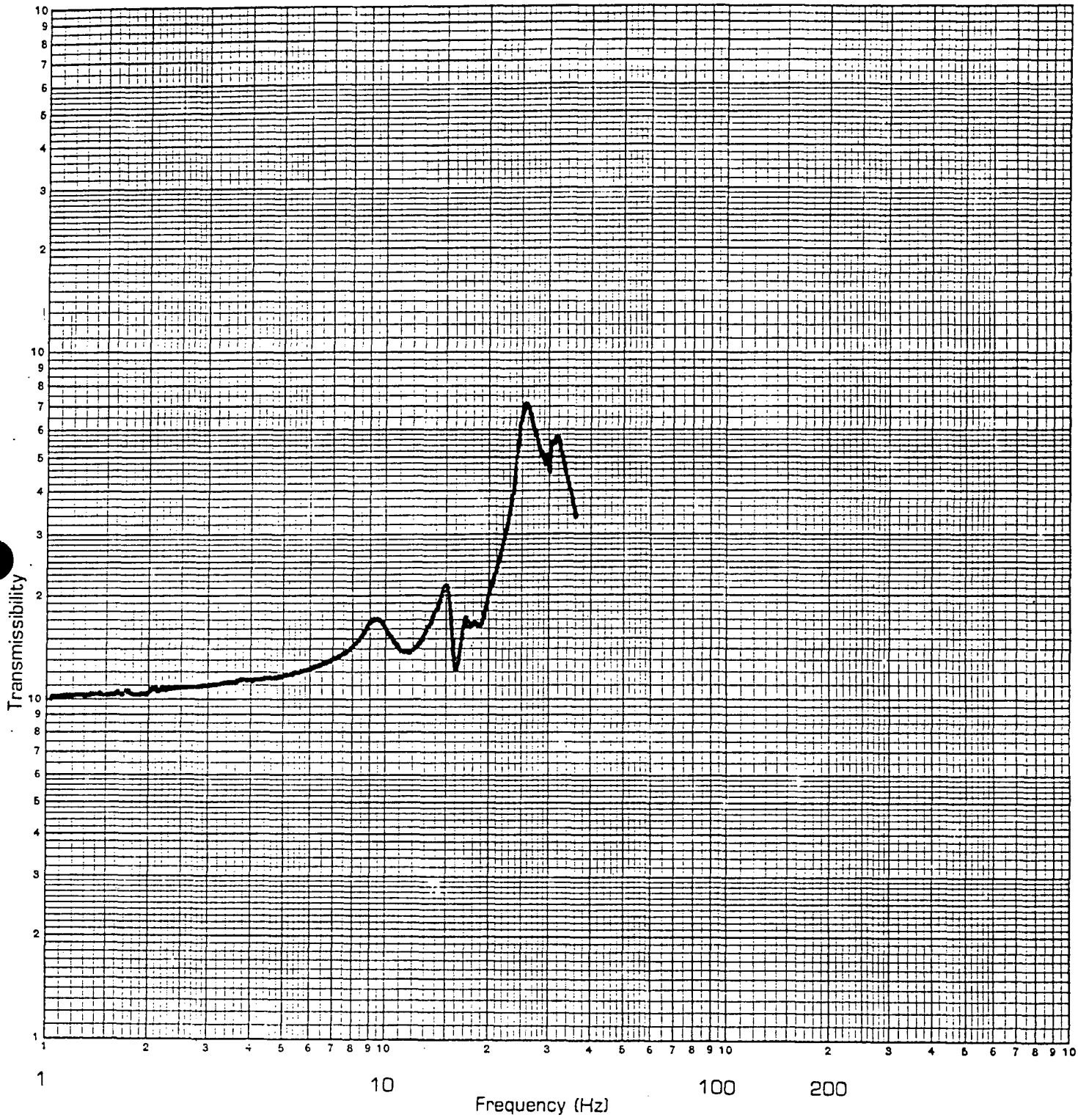
AXIS LAT

ACCEL NO. 10LAT NO. LAT ACA

TEST RUN NO. 8

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray w/ Air Drop Support

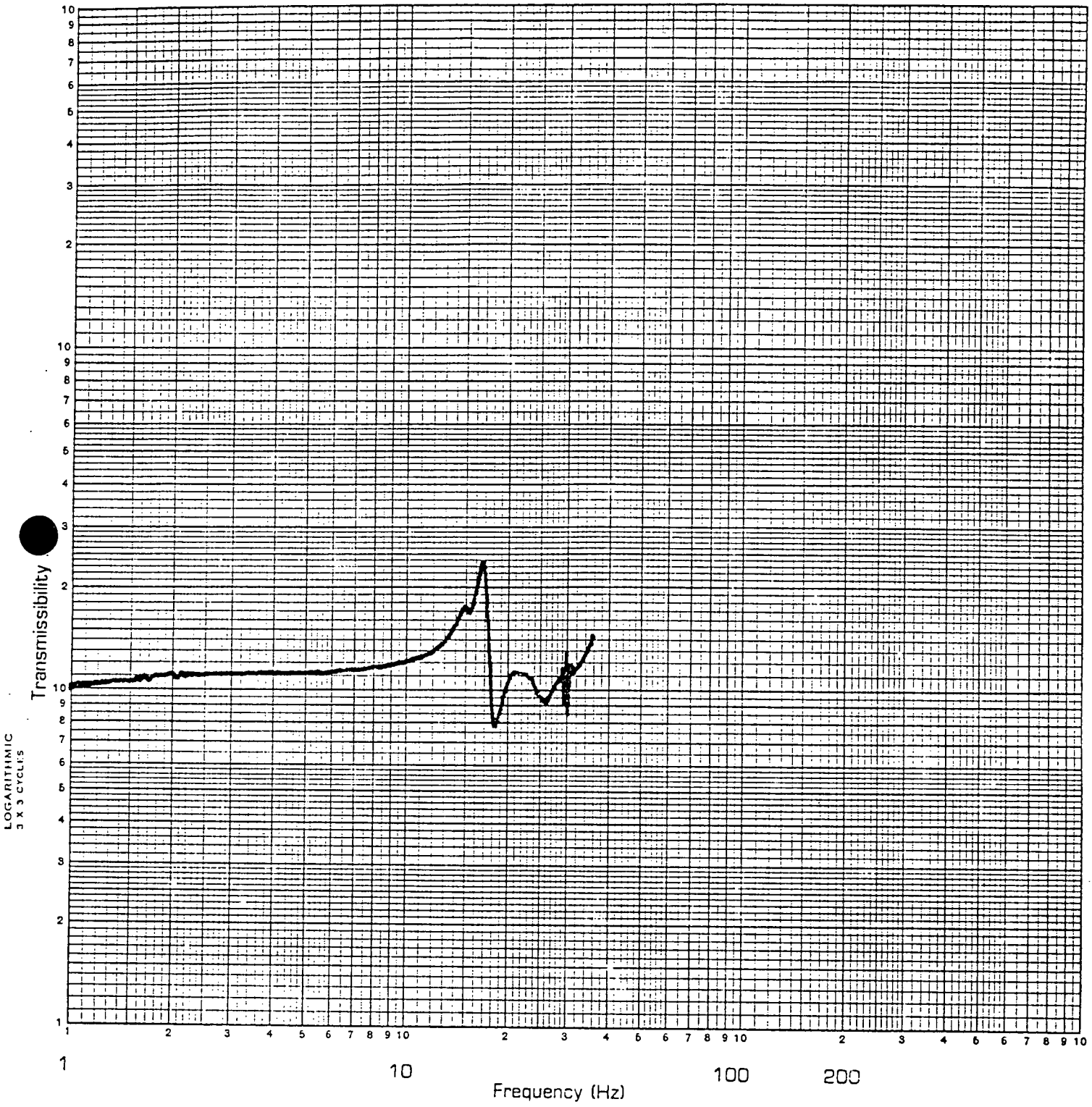
AXIS LAT

ACCEL. NO. 16LAT NO. LATHCA

TEST RUN NO. 5

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Single Cable Tray w/ Air Drop

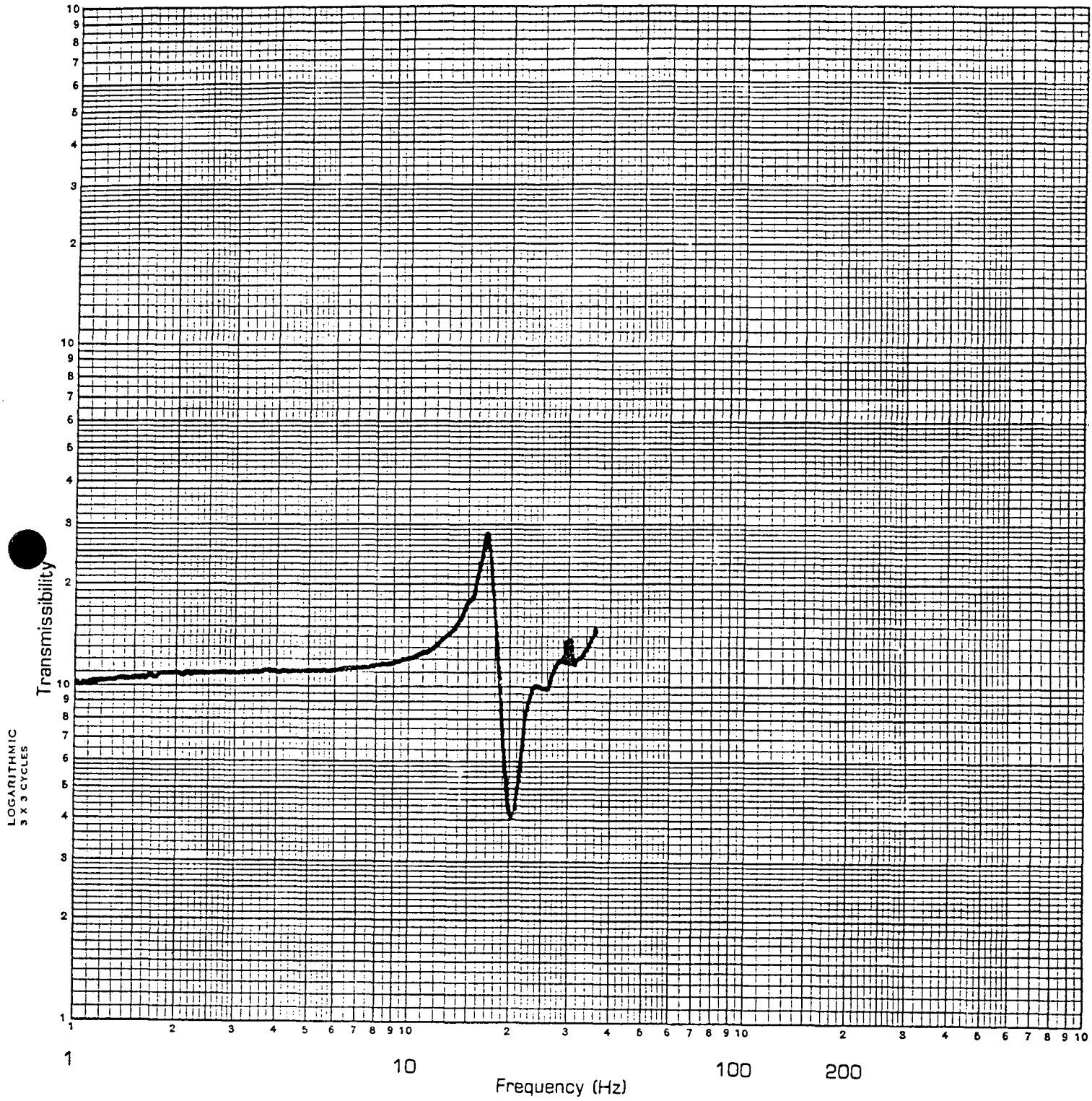
AXIS Long

ACCEL. NO. 2 Long NO. Long HCA

TEST RUN NO. 9

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray Air Drop

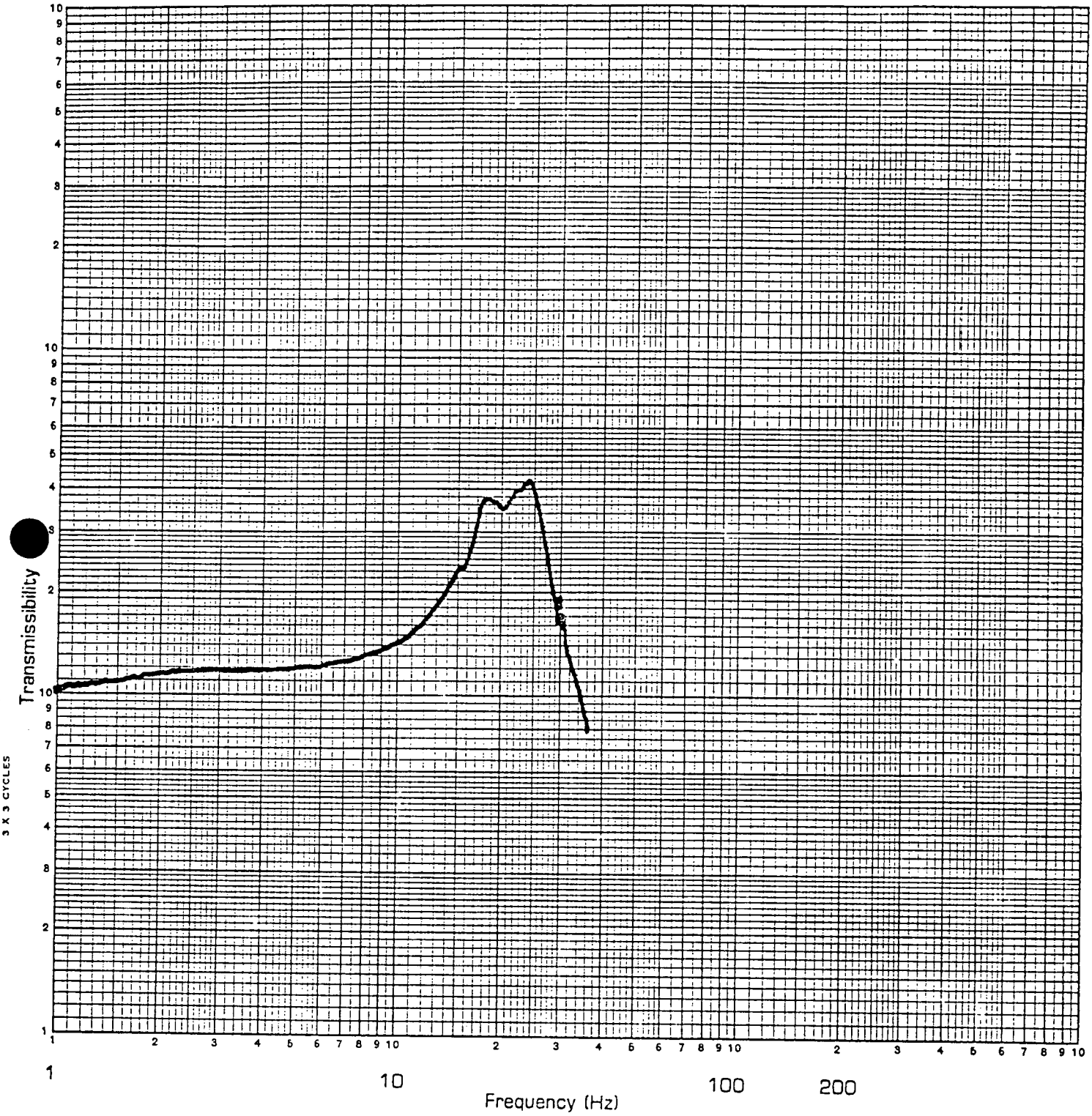
AXIS Long

ACCEL. NO. 5 Long NO. Long HCA

TEST RUN NO. 9

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

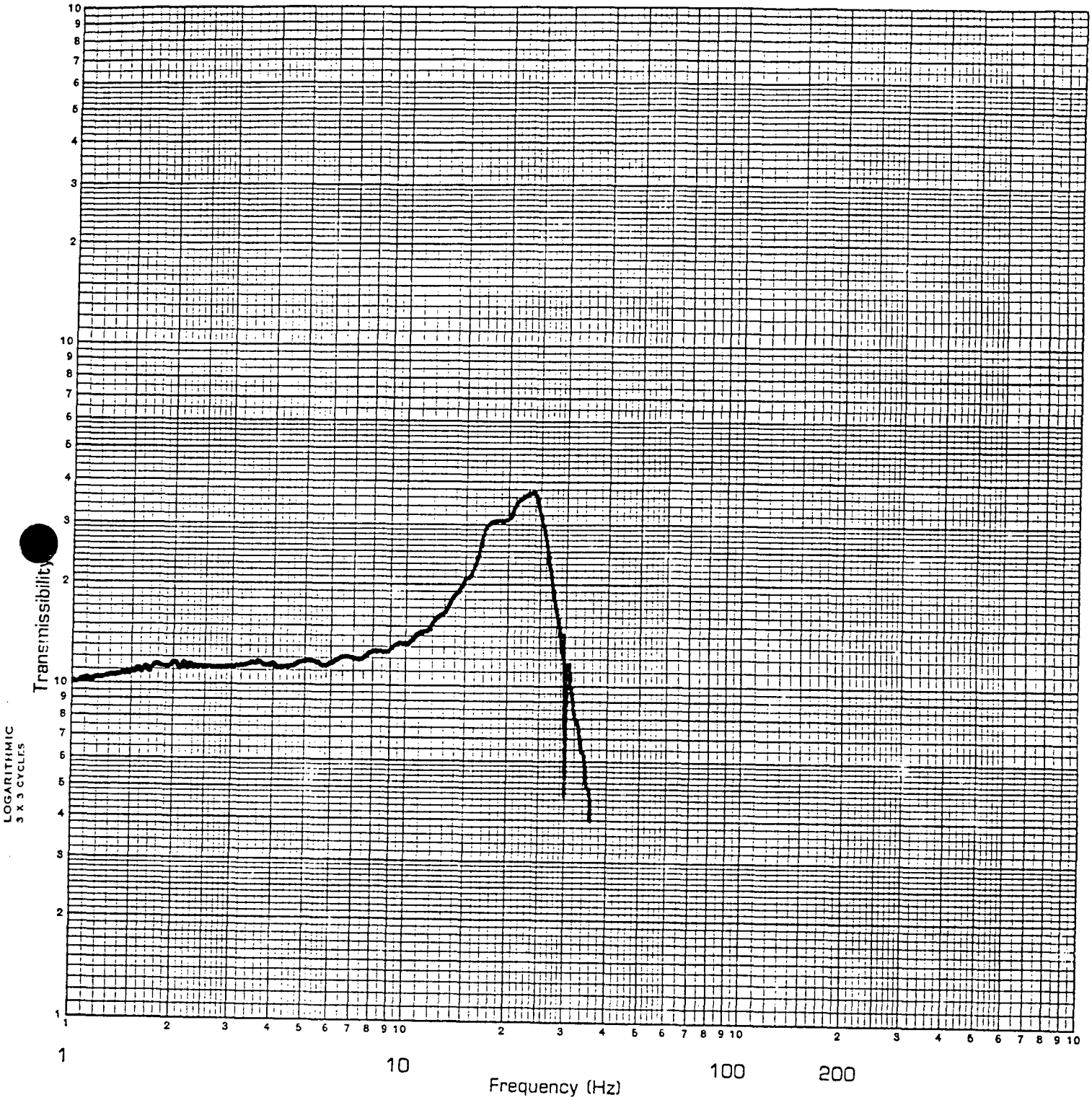
AXIS Long

ACCEL. NO. 8Long NO. Long HCA

TEST RUN NO. 9

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

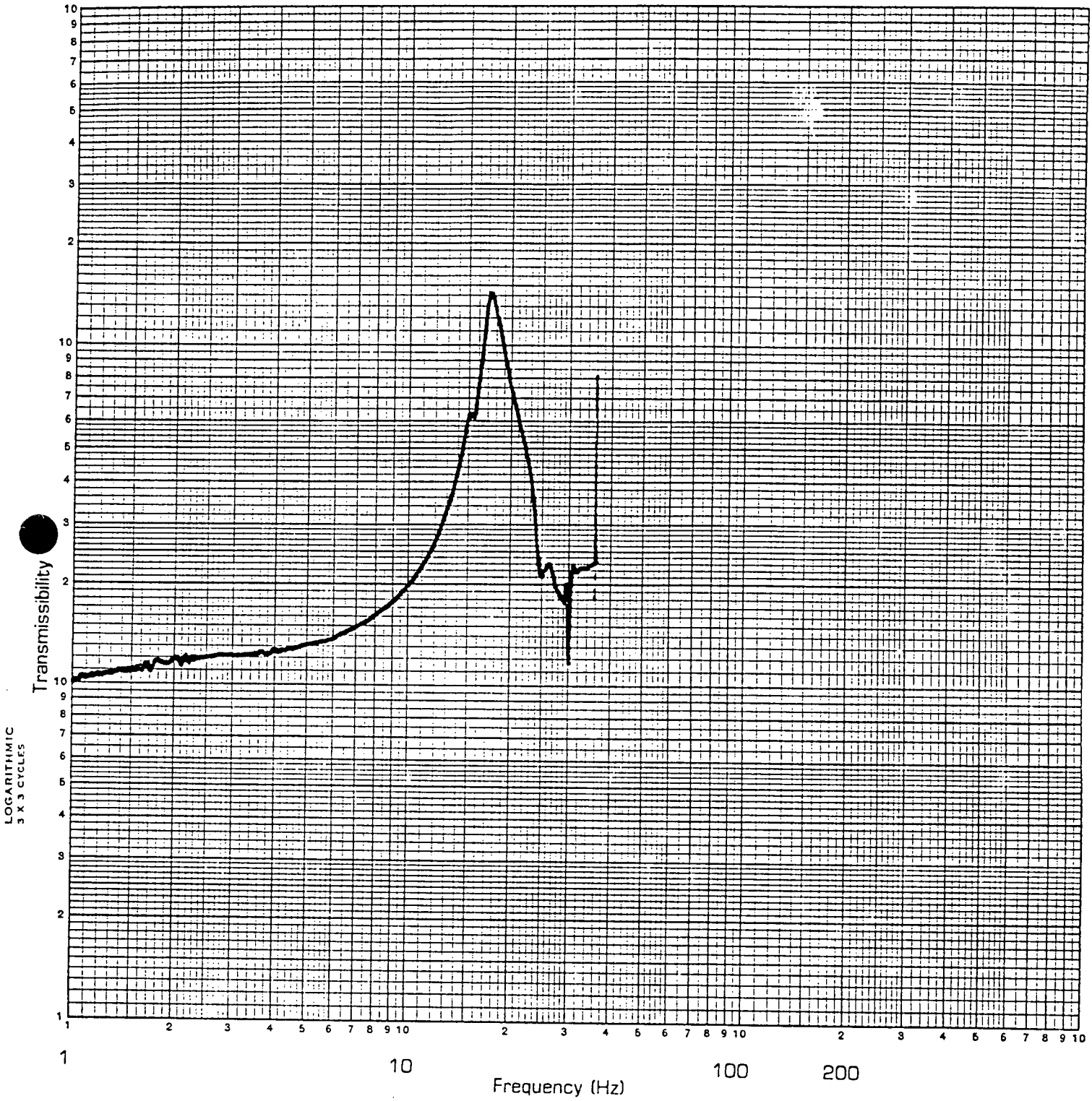
AXIS Long

ACCEL. NO. 11 Long NO. Long HCA

TEST RUN NO. 9

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray Air Drop Support

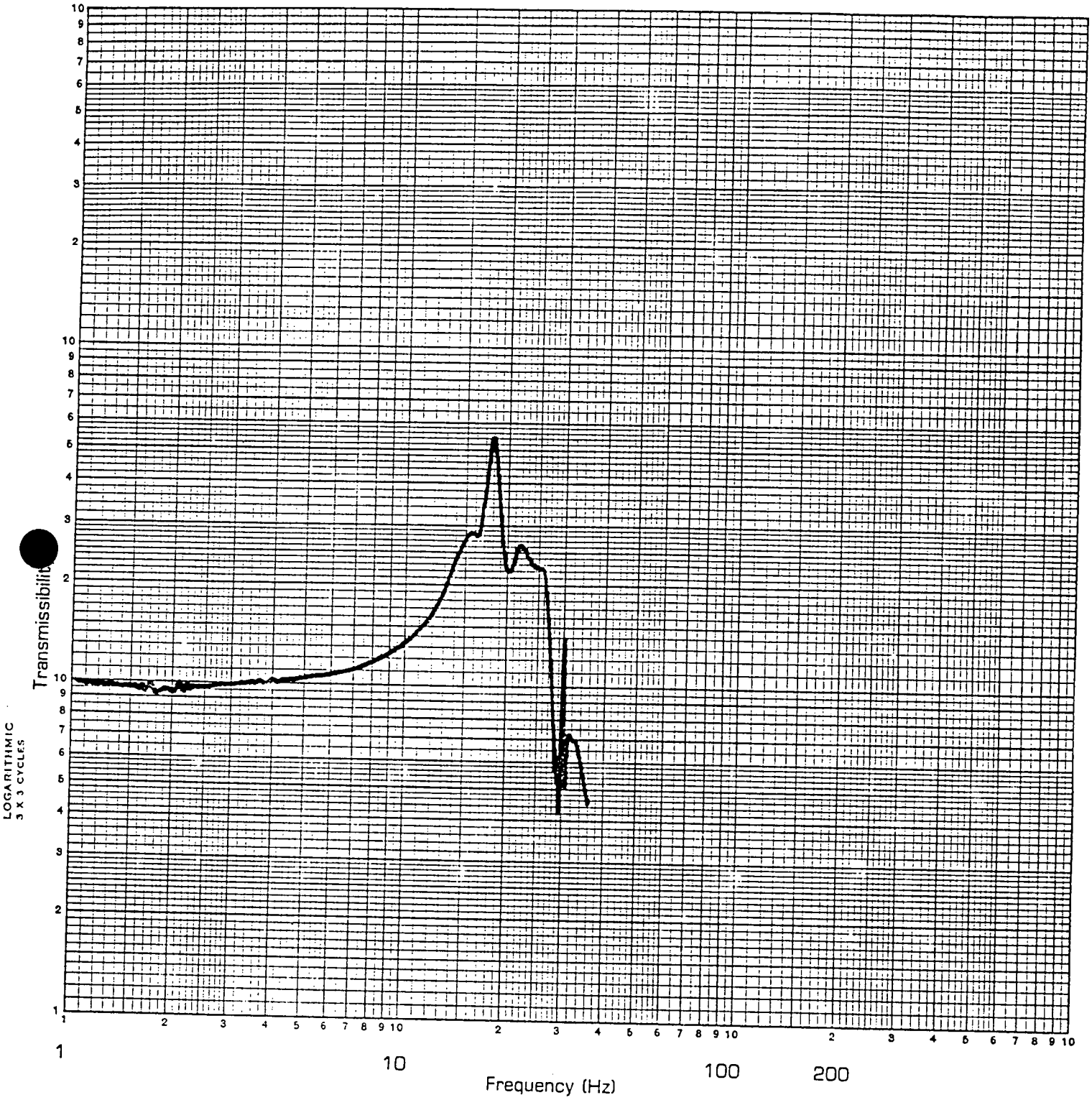
AXIS Long

ACCEL. NO. 17 Long NO. Long Half

TEST RUN NO. 9

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray Air Drop

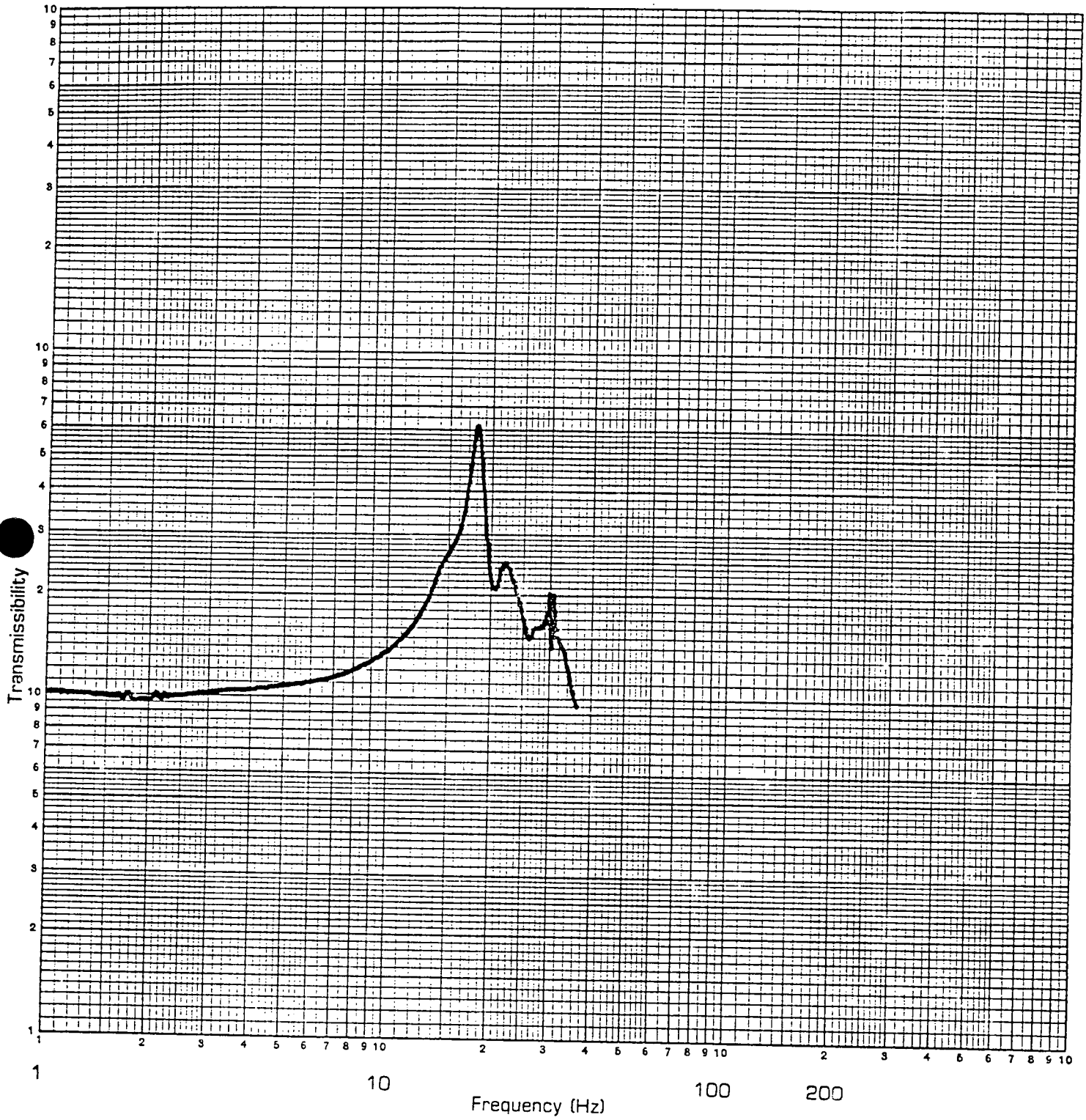
AXIS V

ACCEL. NO. 3V. NO. VCA

TEST RUN NO. 10

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Cable Tray Air Drop

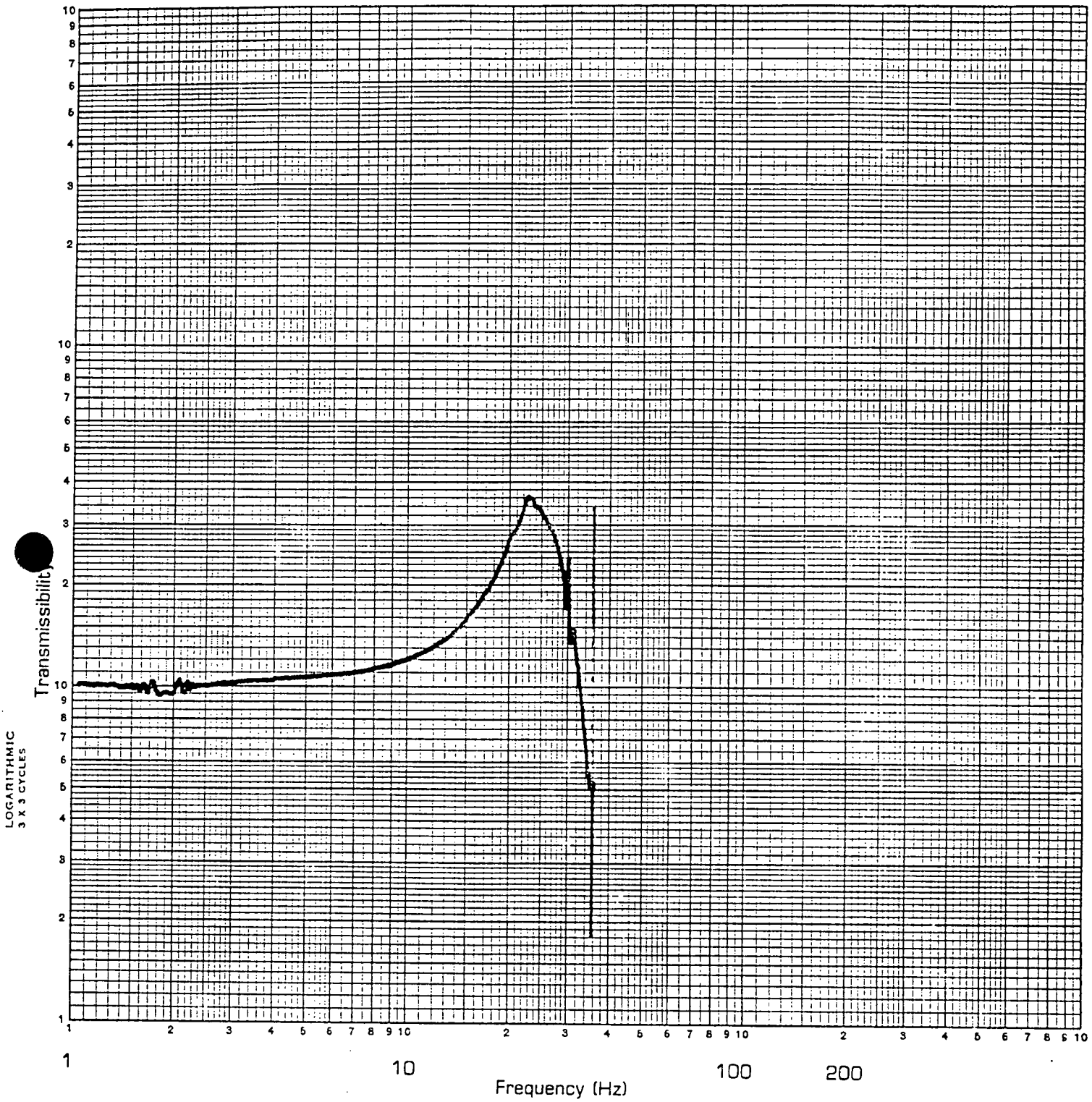
AXIS V

ACCEL. NO. 6V. NO. VCA

TEST RUN NO. 10

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

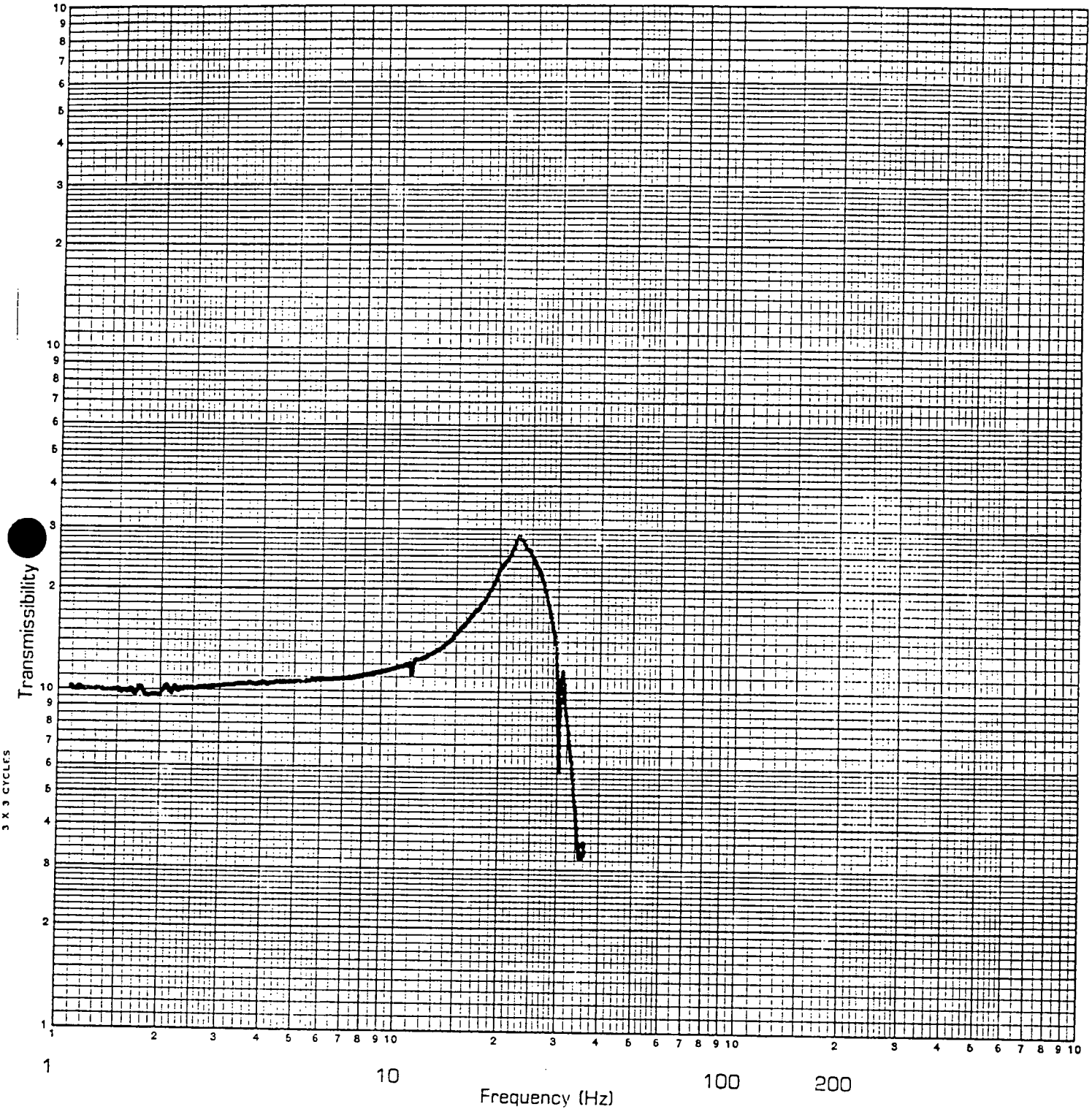
AXIS √

ACCEL. NO. 9V NO. VCA

TEST RUN NO. 10

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Multiple Cable Tray

AXIS V

ACCEL. NO. 12V NO. VLA

TEST RUN NO. 10

APPENDIX V

SERIES 2 RESONANCE SEARCH TRANSMISSIBILITY PLOTS

Test Run	Plots
1	Lateral Response Accelerometer/ Lateral Control Accelerometer
2	Longitudinal Response Accelerometer/ Longitudinal Control Accelerometer
3	Vertical Response Accelerometer/ Vertical Control Accelerometer
7	Lateral Response Accelerometer/ Lateral Control Accelerometer
8	Longitudinal Response Accelerometer/ Longitudinal Control Accelerometer
9	Vertical Response Accelerometer/ Vertical Control Accelerometer

LEGEND:	HCA	=	Horizontal Control Accelerometer
	VCA	=	Vertical Control Accelerometer
	LAT	=	Lateral
	LONG	=	Longitudinal
	V	=	Vertical

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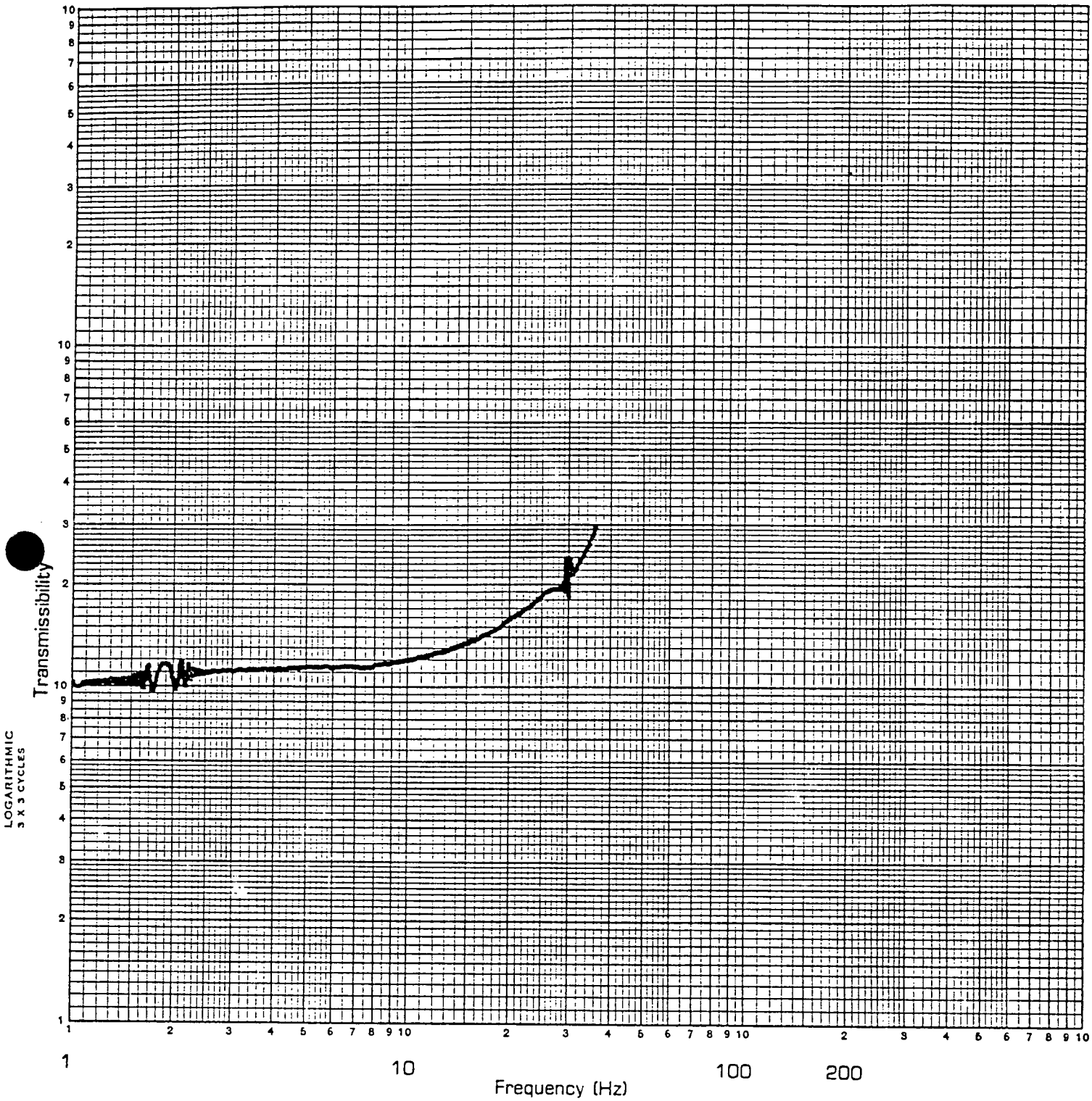
FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Ganged Conduit

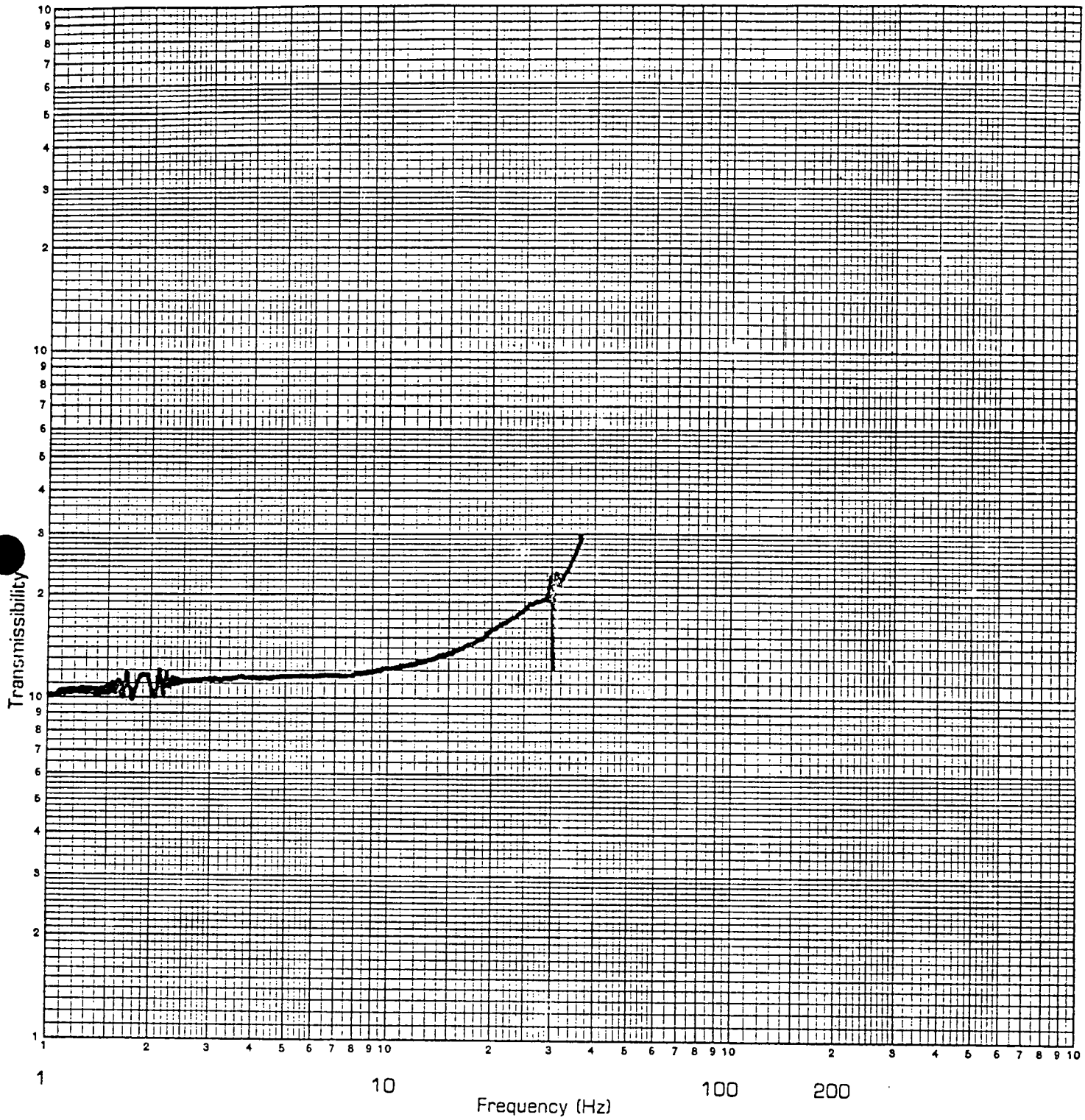
AXIS LAT

ACCEL. NO. 1LAT NO. LAT HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Ganged Conduit

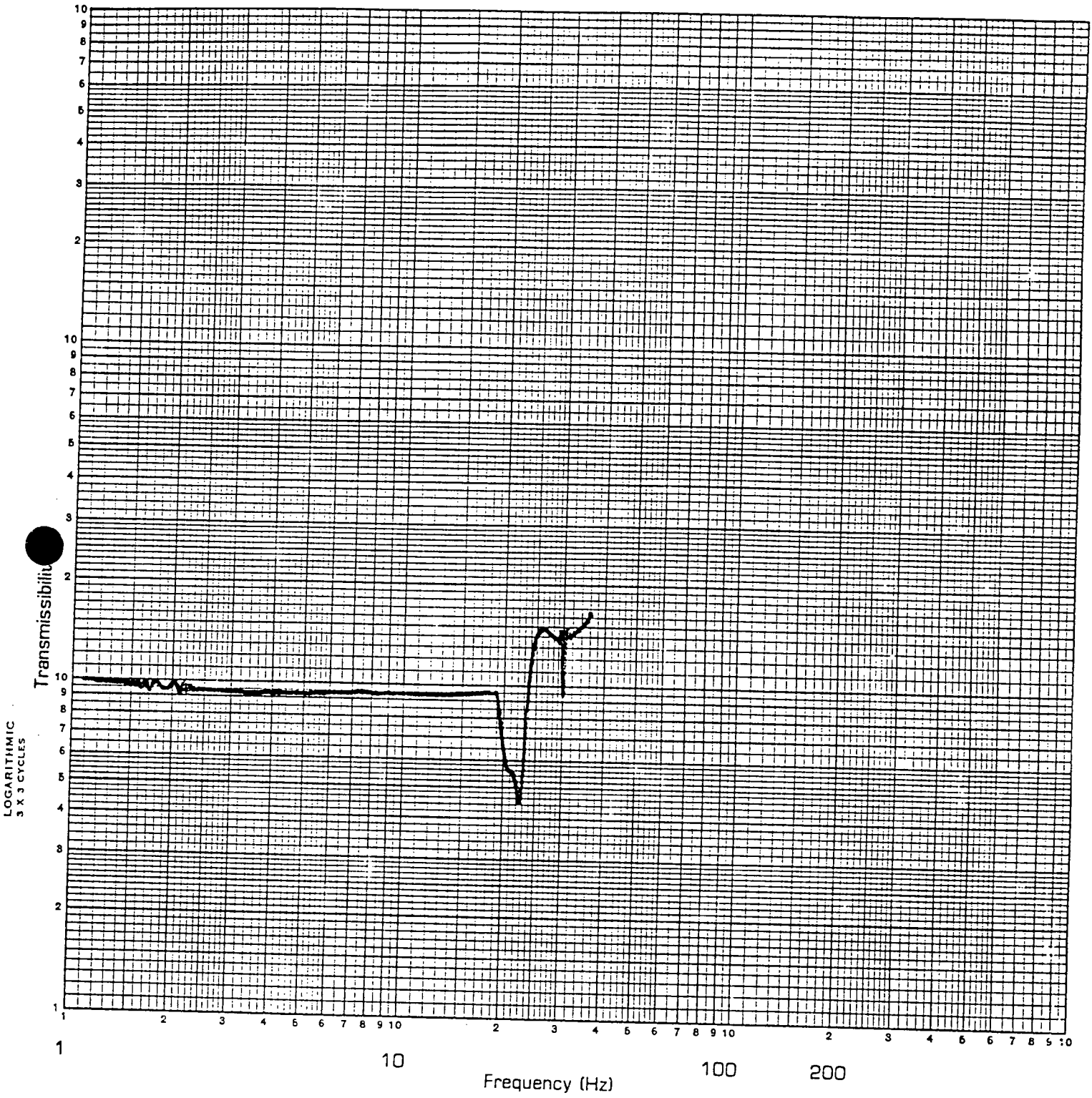
AXIS LAT

ACCEL. NO. 4 LAT NO. LAT HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Conduit

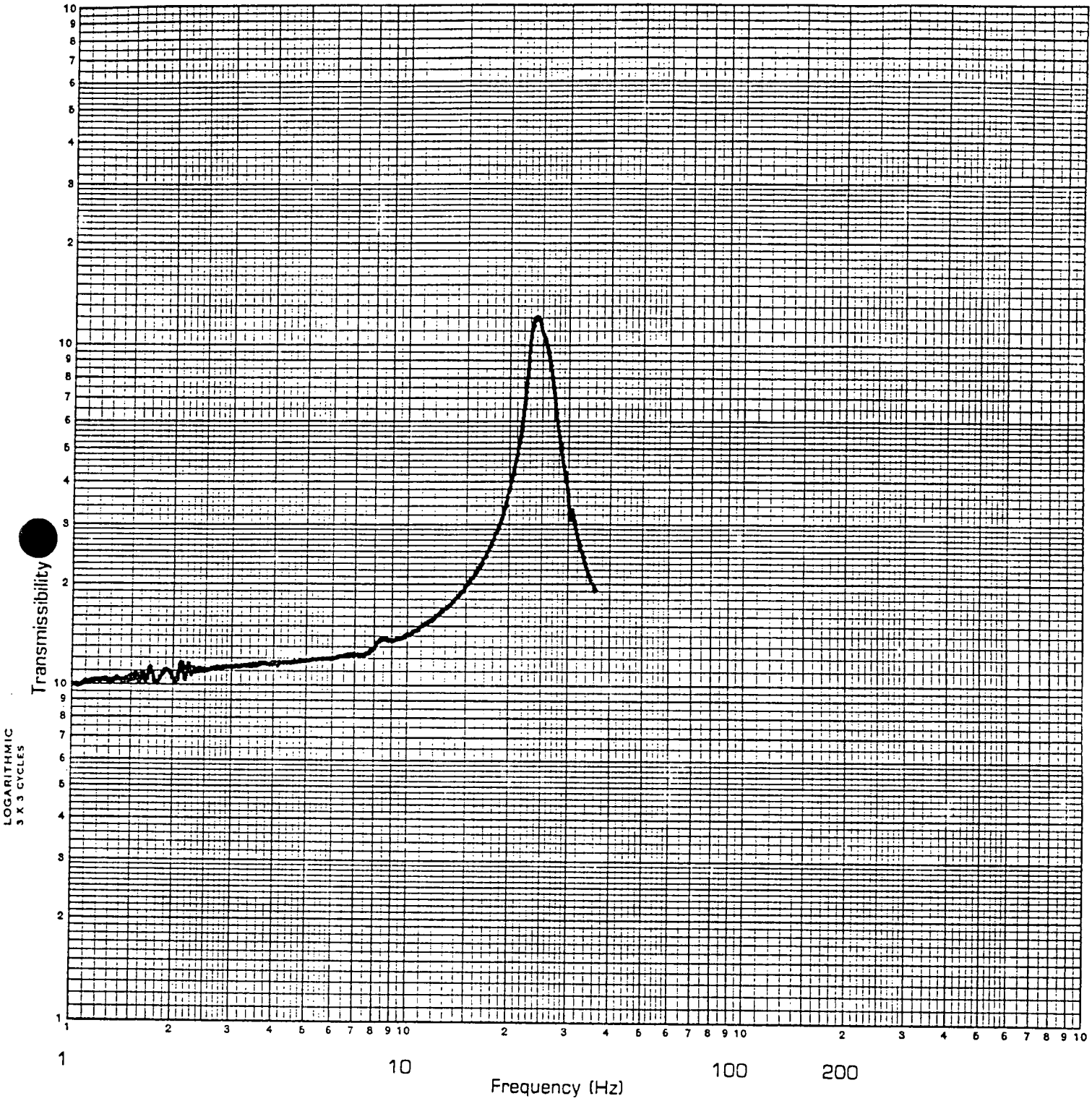
AXIS LAT

ACCEL. NO. 7LAT NO. LATHCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Conduit

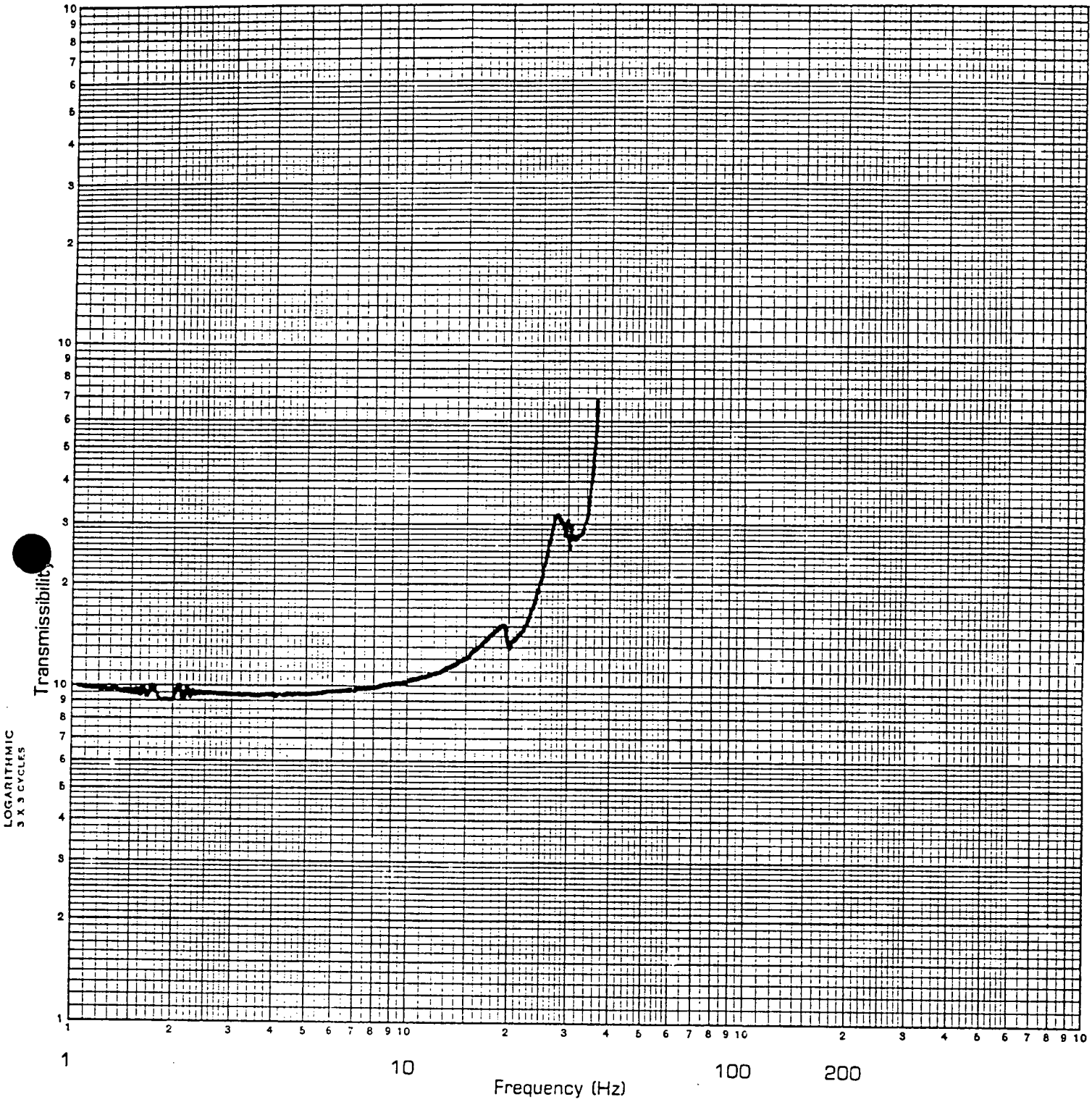
AXIS LAT

ACCEL. NO. 10LAT NO. LAT HCA

TEST RUN NO. 1

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Ganged Conduit

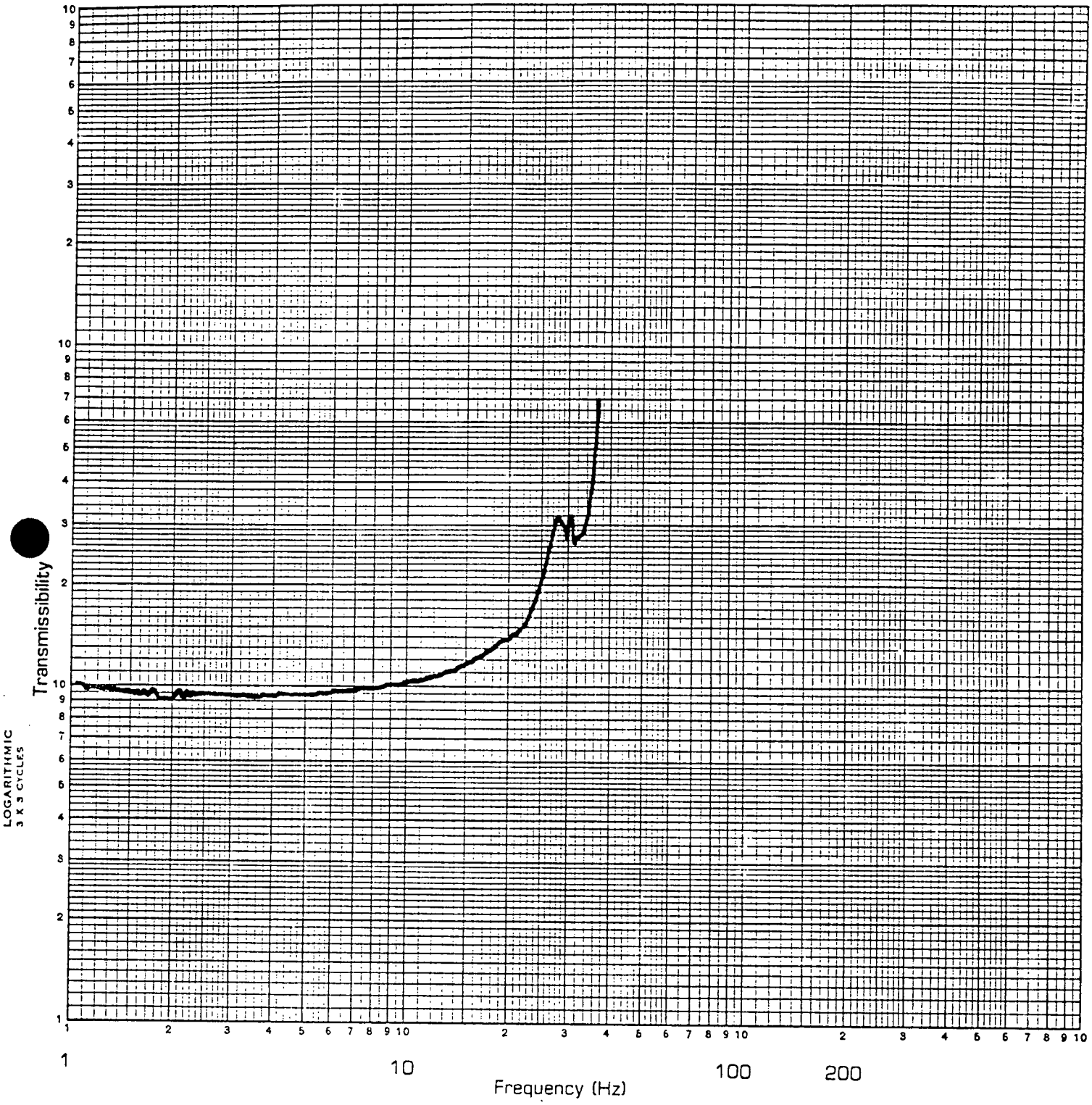
AXIS Long

ACCEL. NO. 2Long NO. LongHCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Ganged Conduit

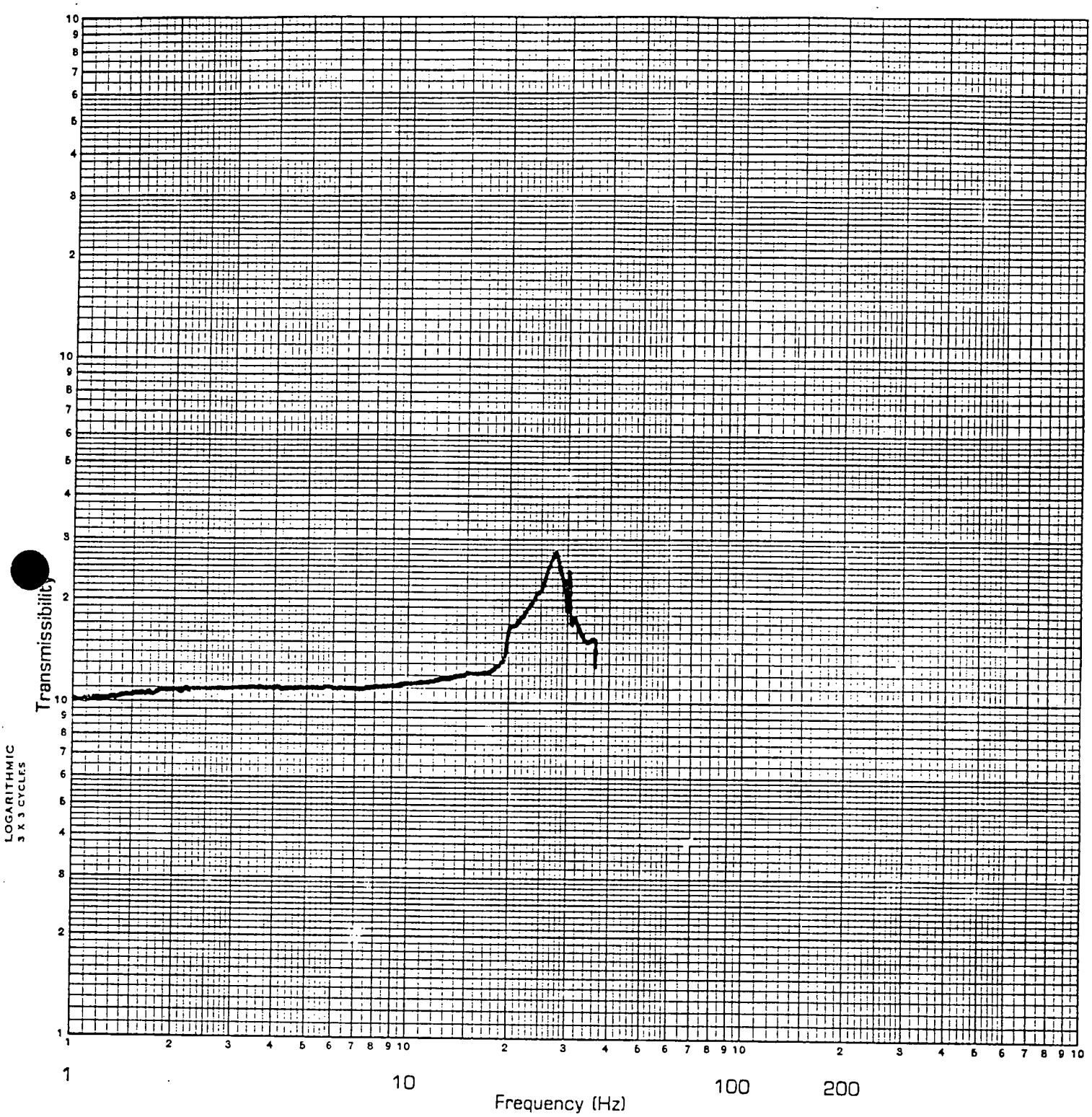
AXIS Long

ACCEL. NO. 5 Long NO. Long HCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Conduit

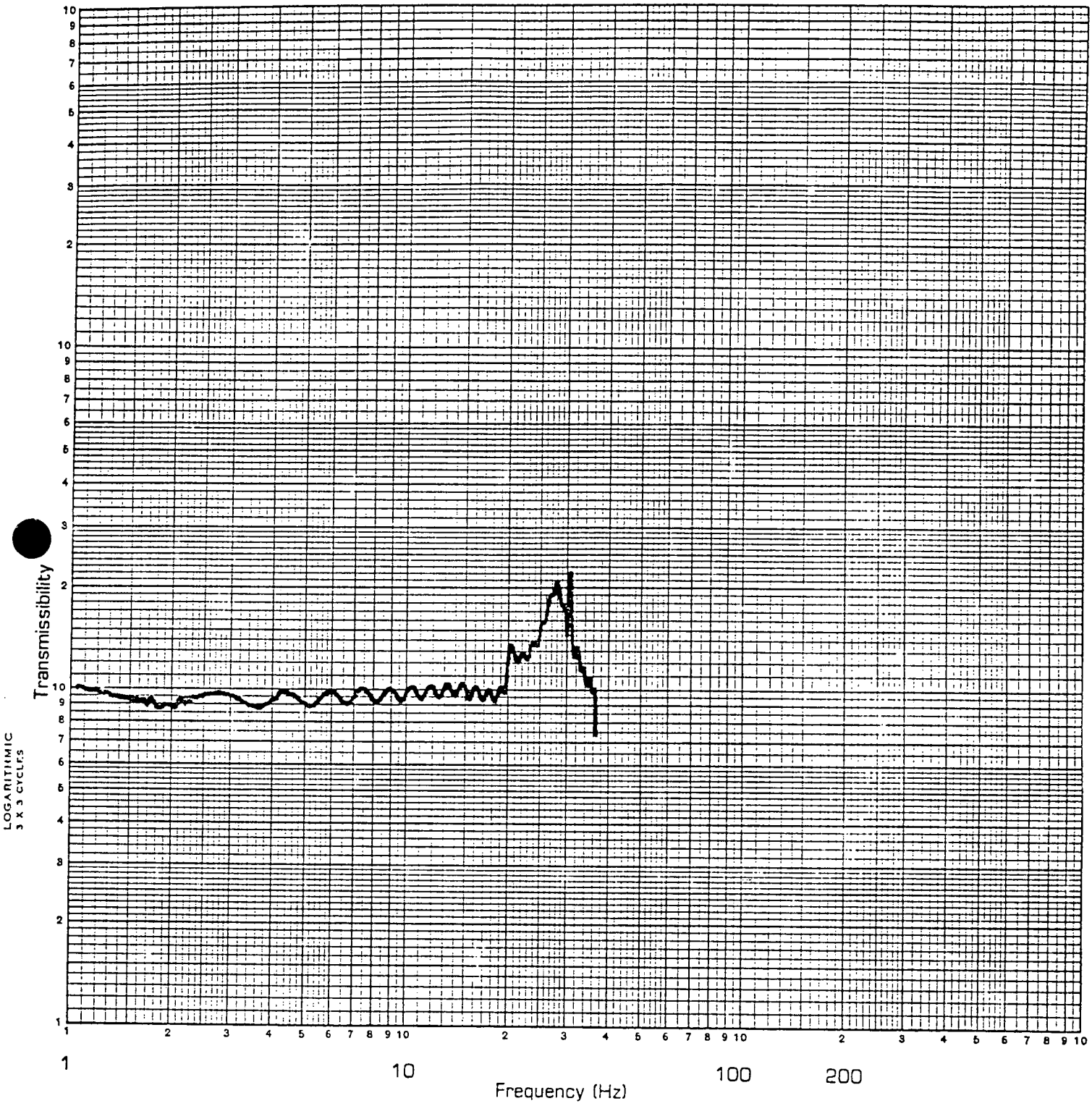
AXIS Long

ACCEL. NO. 8 Long NO. Long HCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Conduit

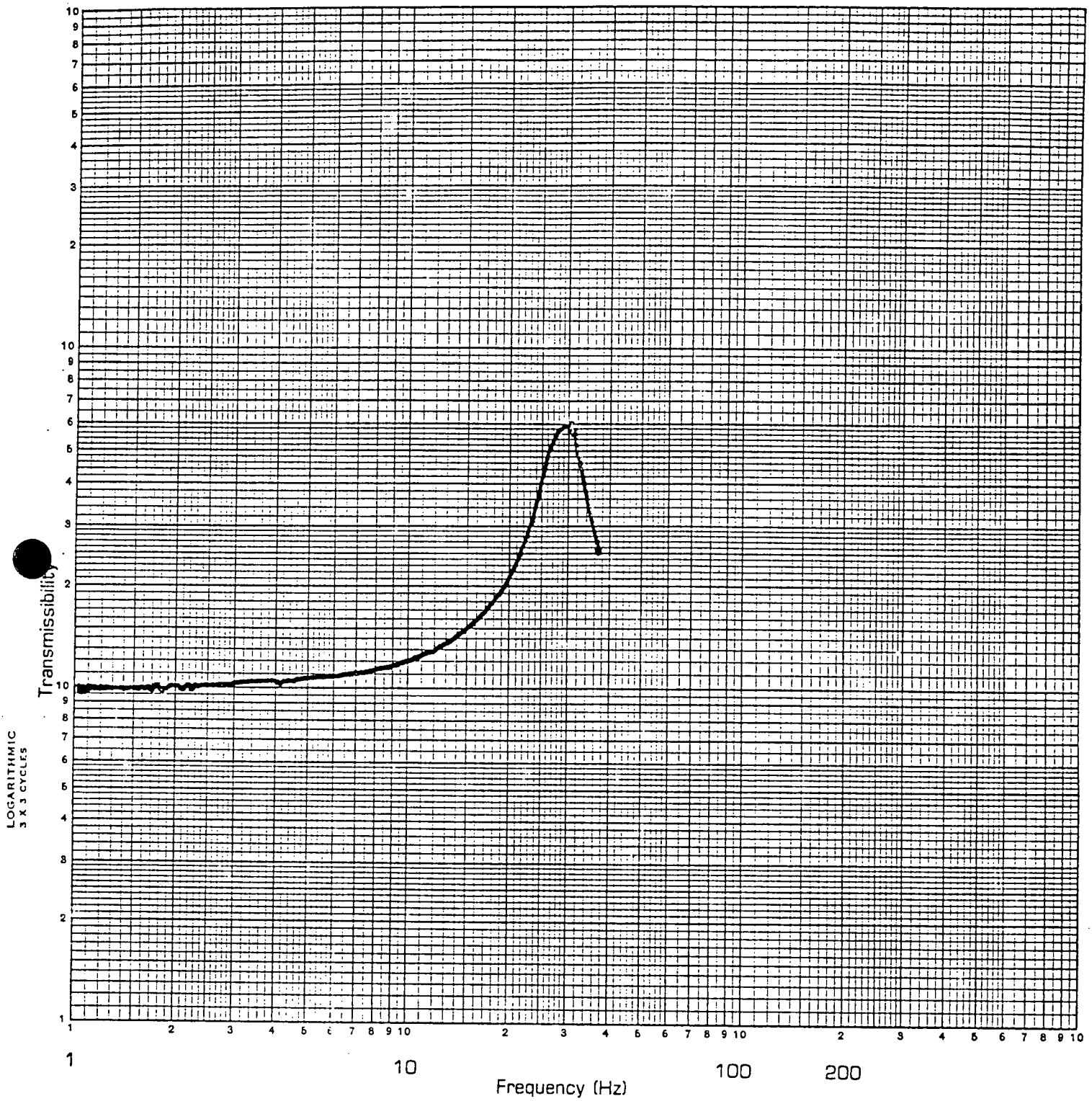
AXIS Long

ACCEL. NO. 11 Long NO. Long HCA

TEST RUN NO. 2

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Ganged Conduit

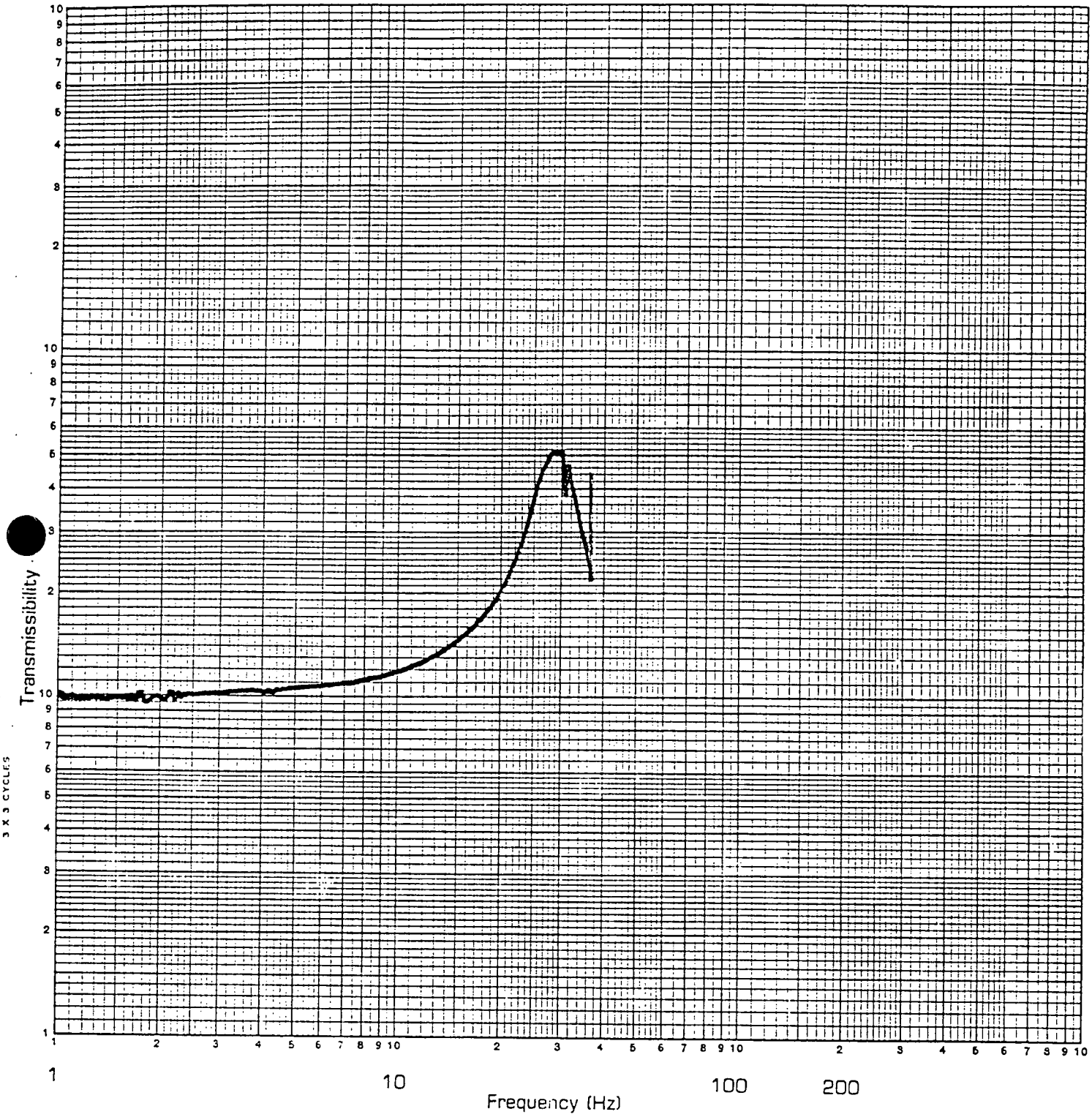
AXIS √

ACCEL. NO. 3V NO. VCA

TEST RUN NO. 3

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Ganged Conduit

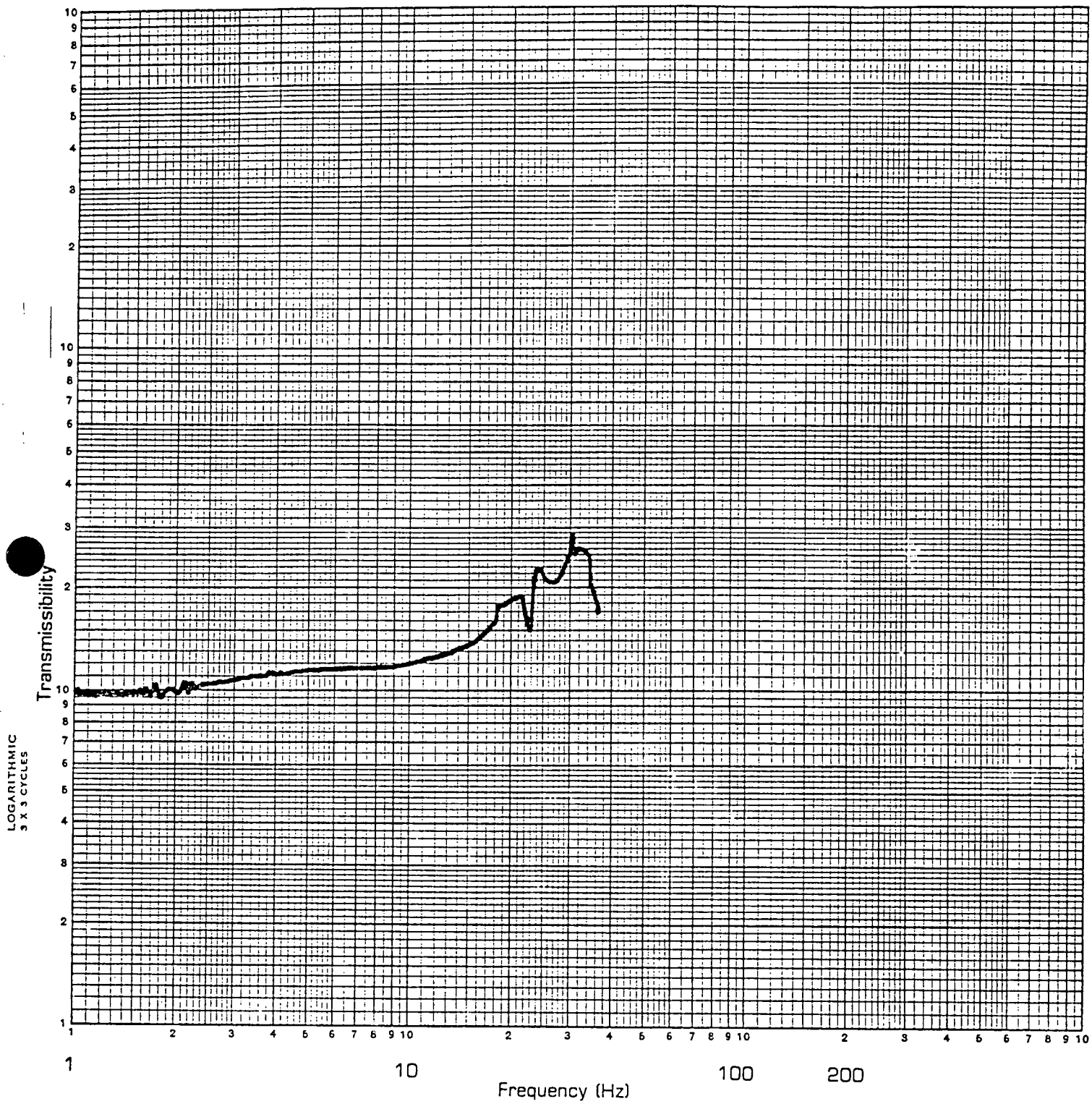
AXIS V

ACCEL. NO. 6V NO. VCA

TEST RUN NO. 3

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Single Conduit

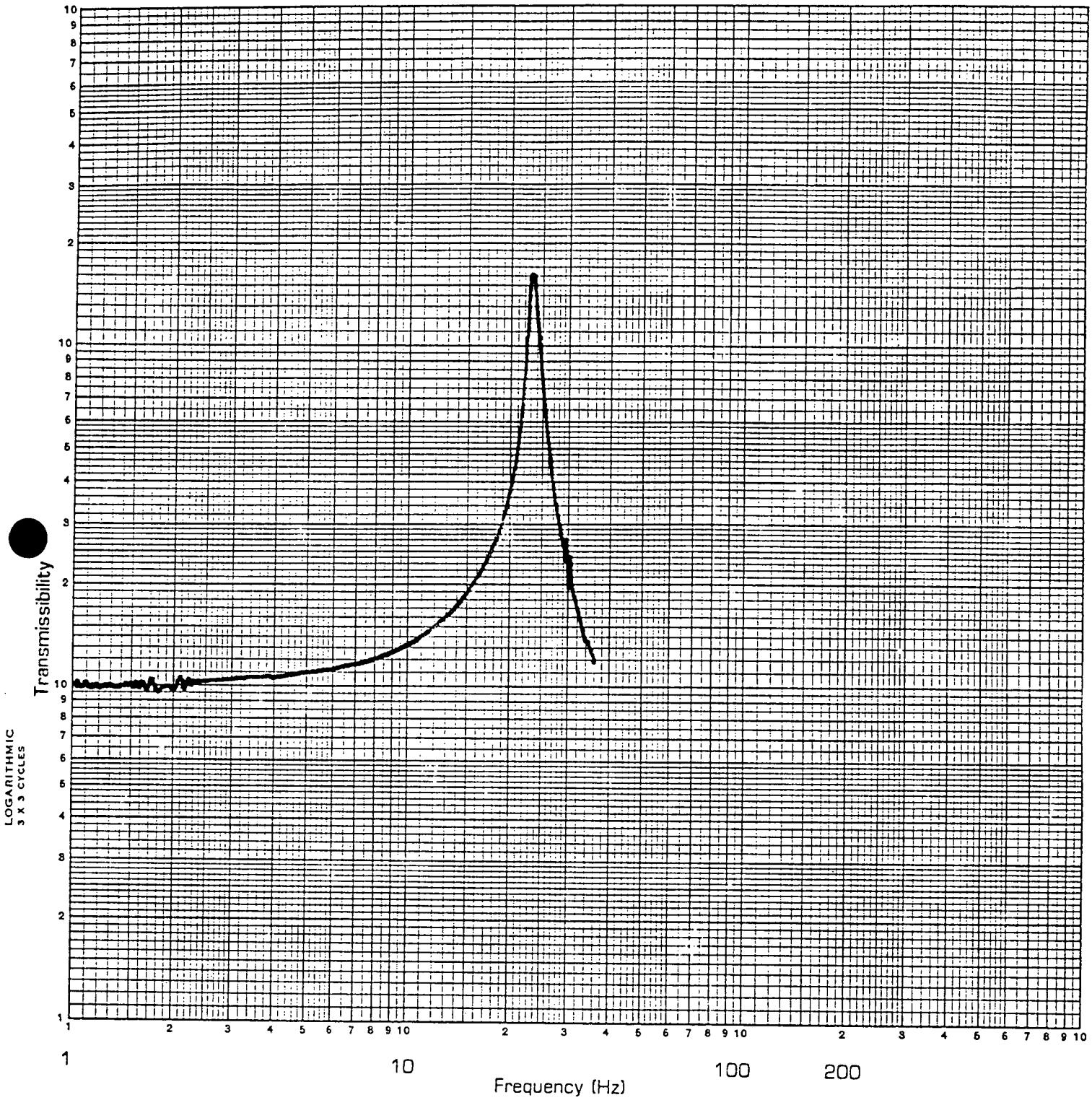
AXIS V

ACCEL. NO. 9V NO. VCA

TEST RUN NO. 3

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Conduit

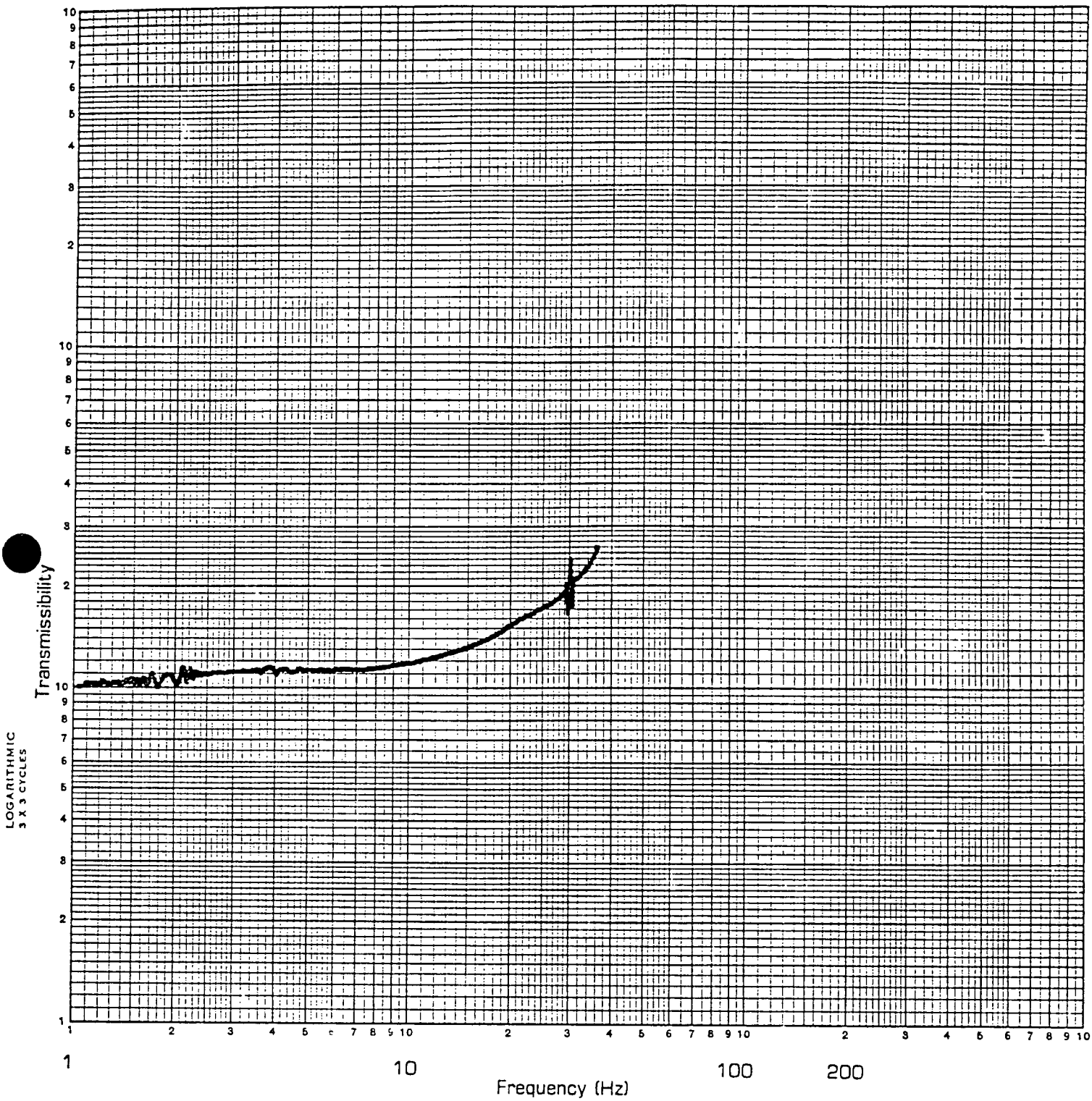
AXIS V

ACCEL. NO. 12V NO. VCA

TEST RUN NO. 3

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Ganged Conduit

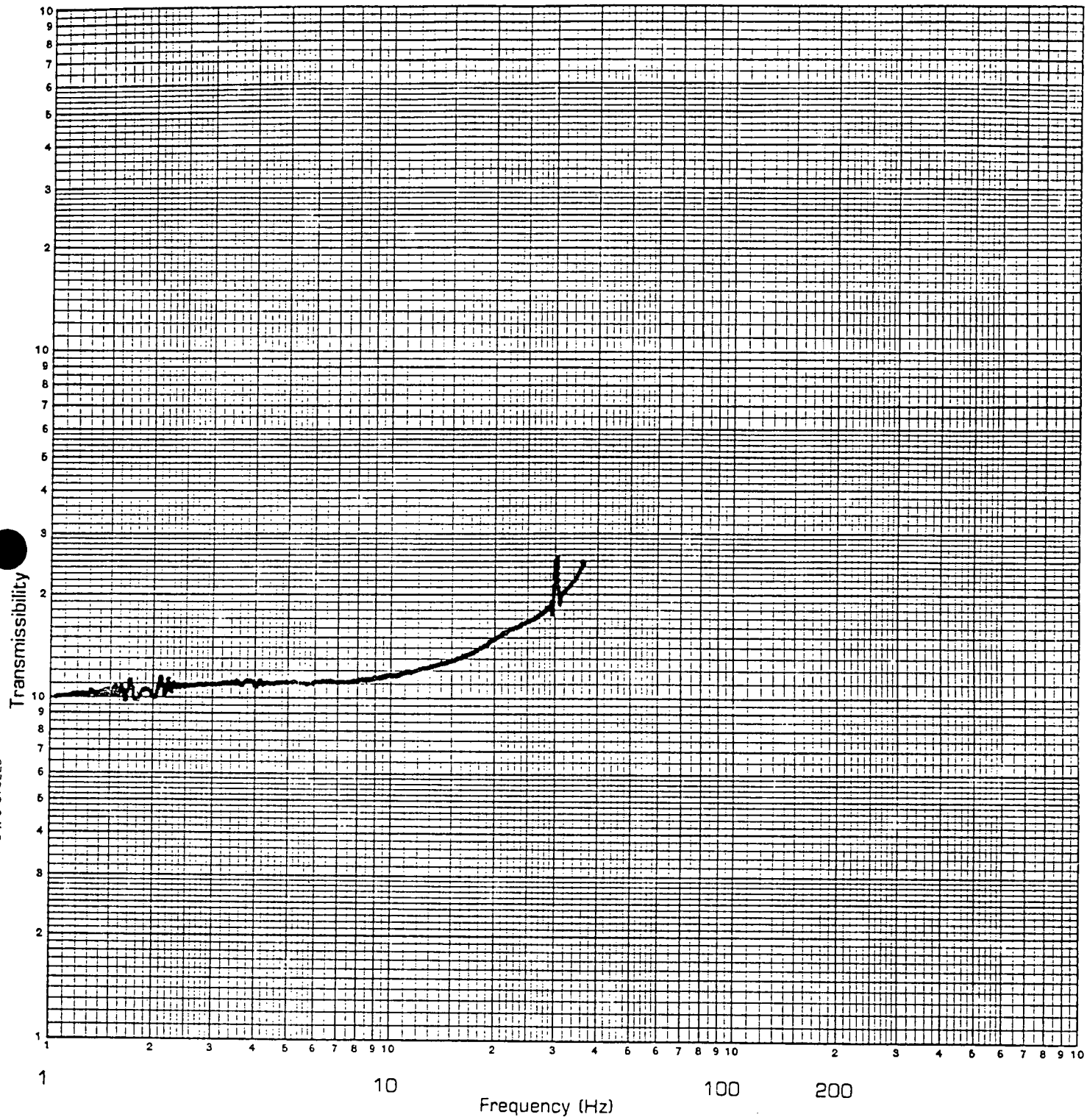
AXIS LAT

ACCEL. NO. 1LAT NO. LAT HCA

TEST RUN NO. 7

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Ganged Conduit

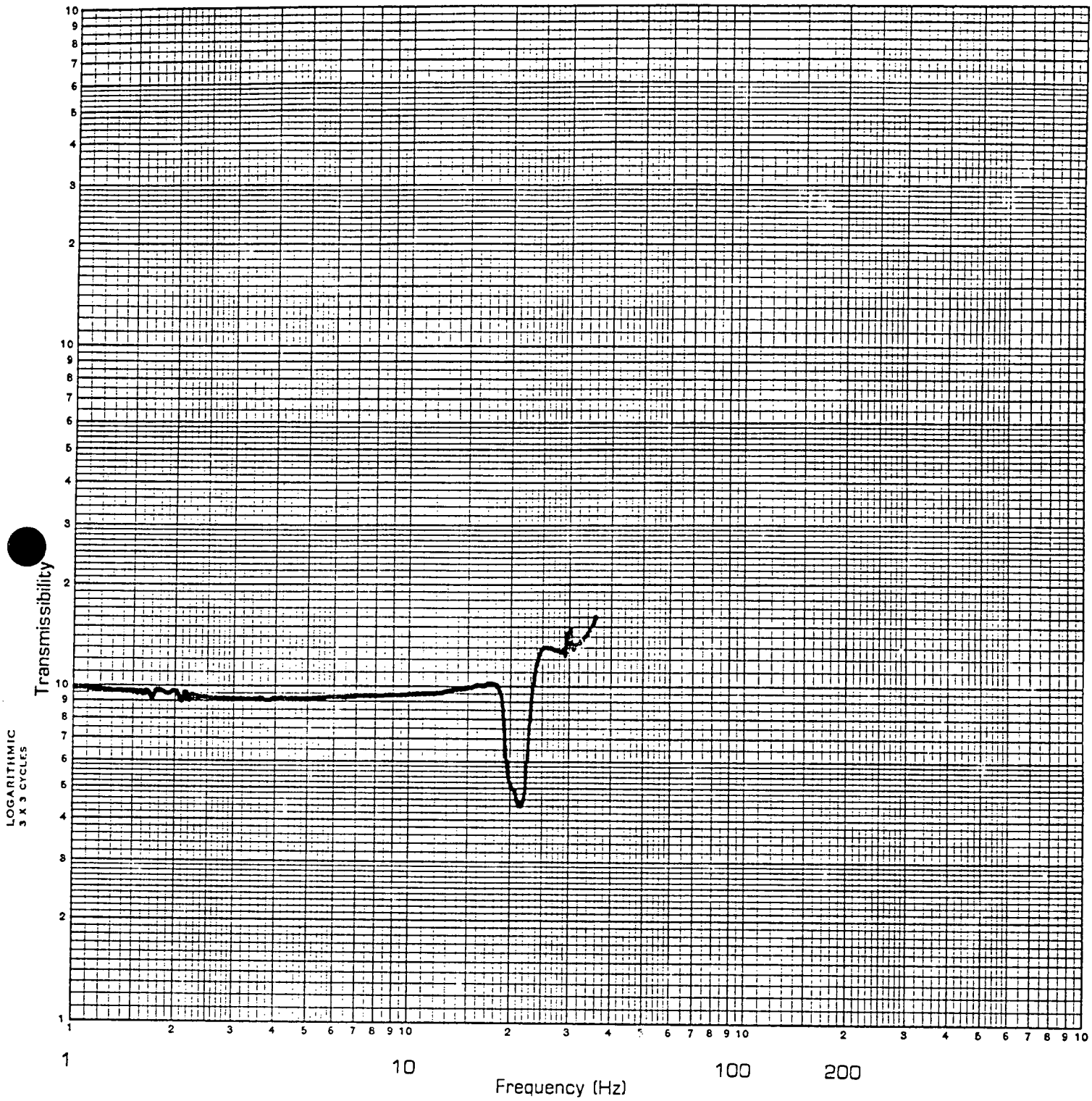
AXIS LAT

ACCEL. NO. 4LAT NO. LAT HCA

TEST RUN NO. 7

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Conduit

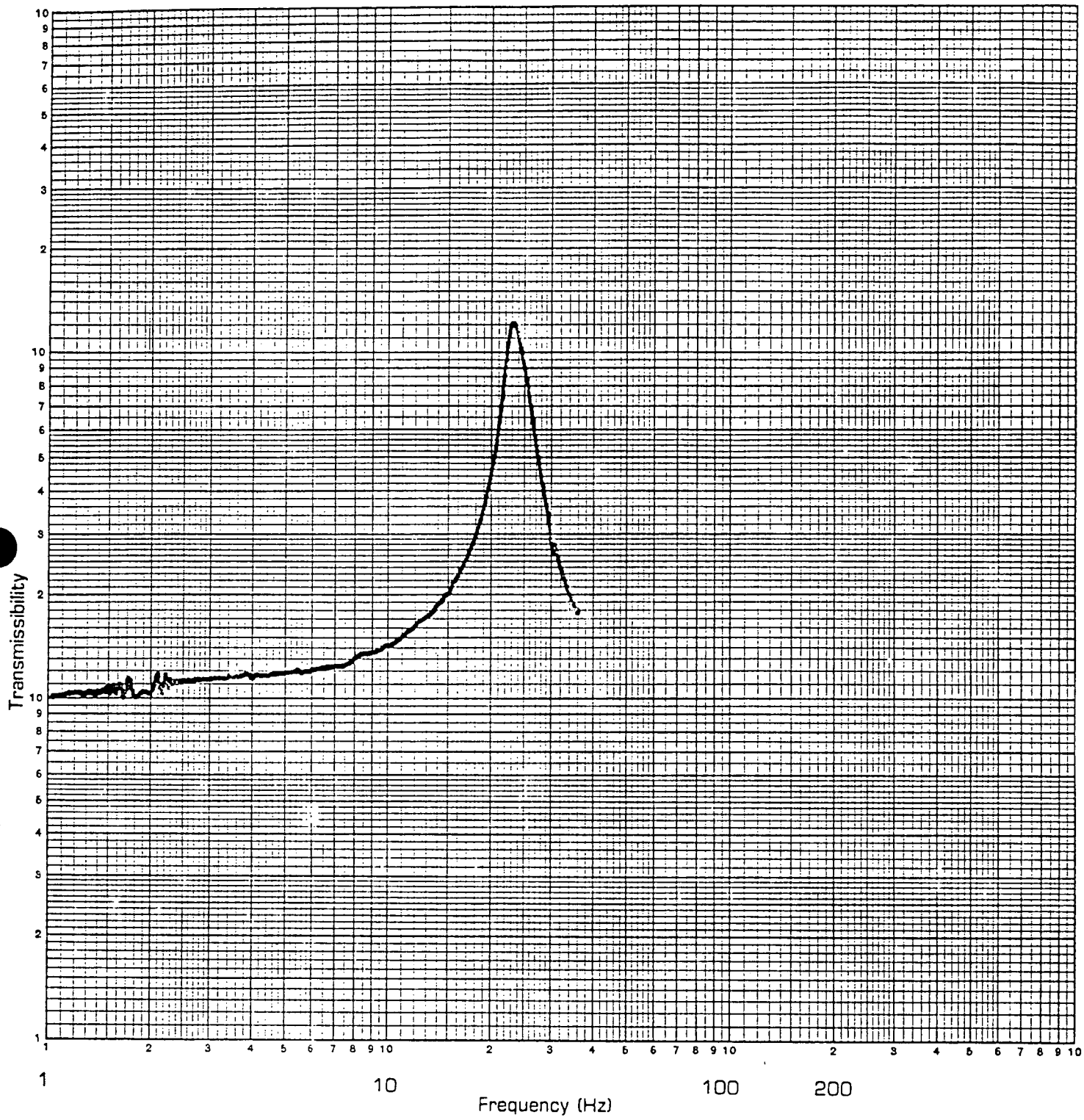
AXIS LAT

ACCEL. NO. 7LAT NO. 2LAT HCA

TEST RUN NO. 7

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Conduit

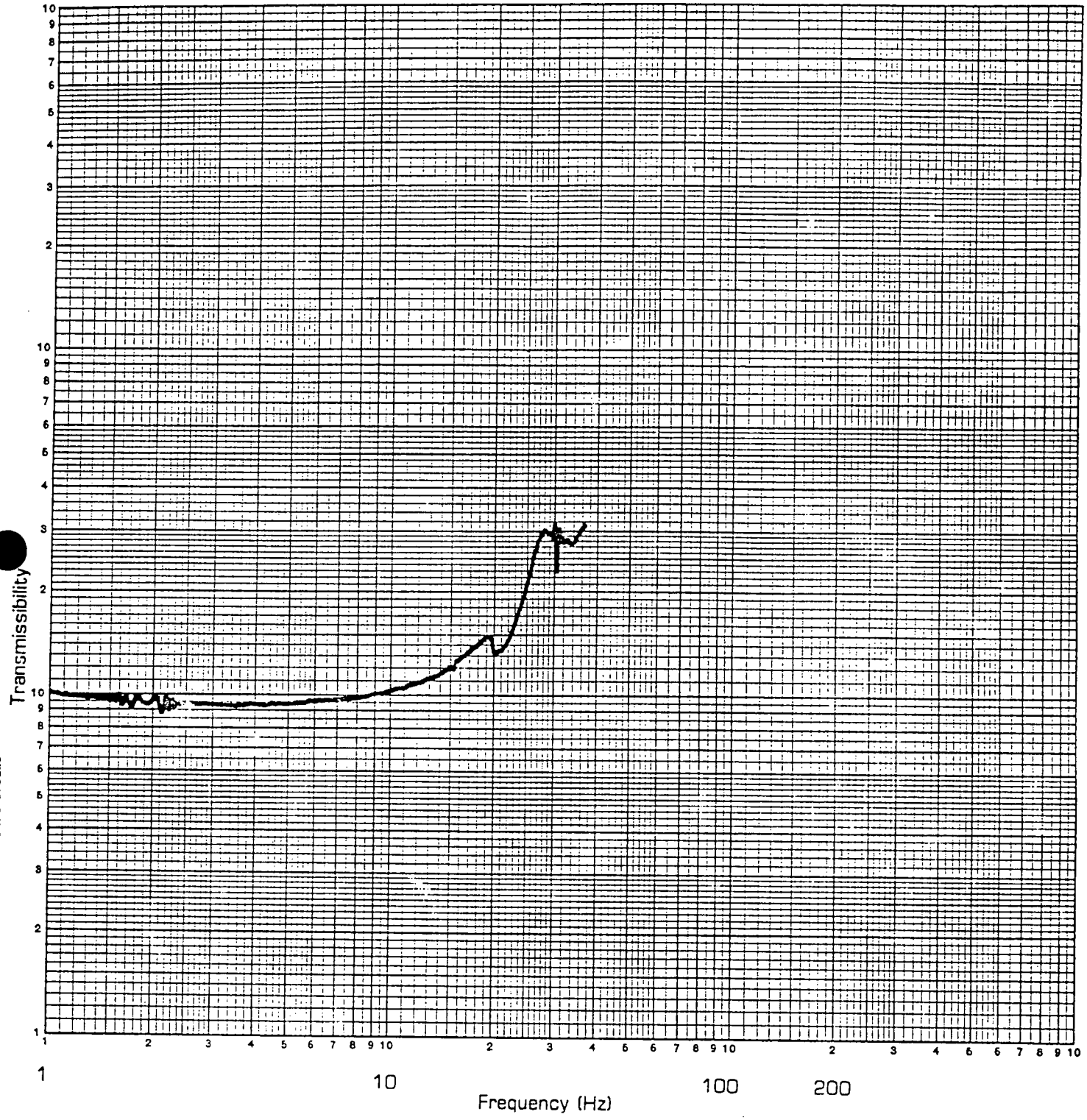
AXIS LAT

ACCEL. NO. 10LAT NO. LAT HEA

TEST RUN NO. 7

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Ganged Conduit

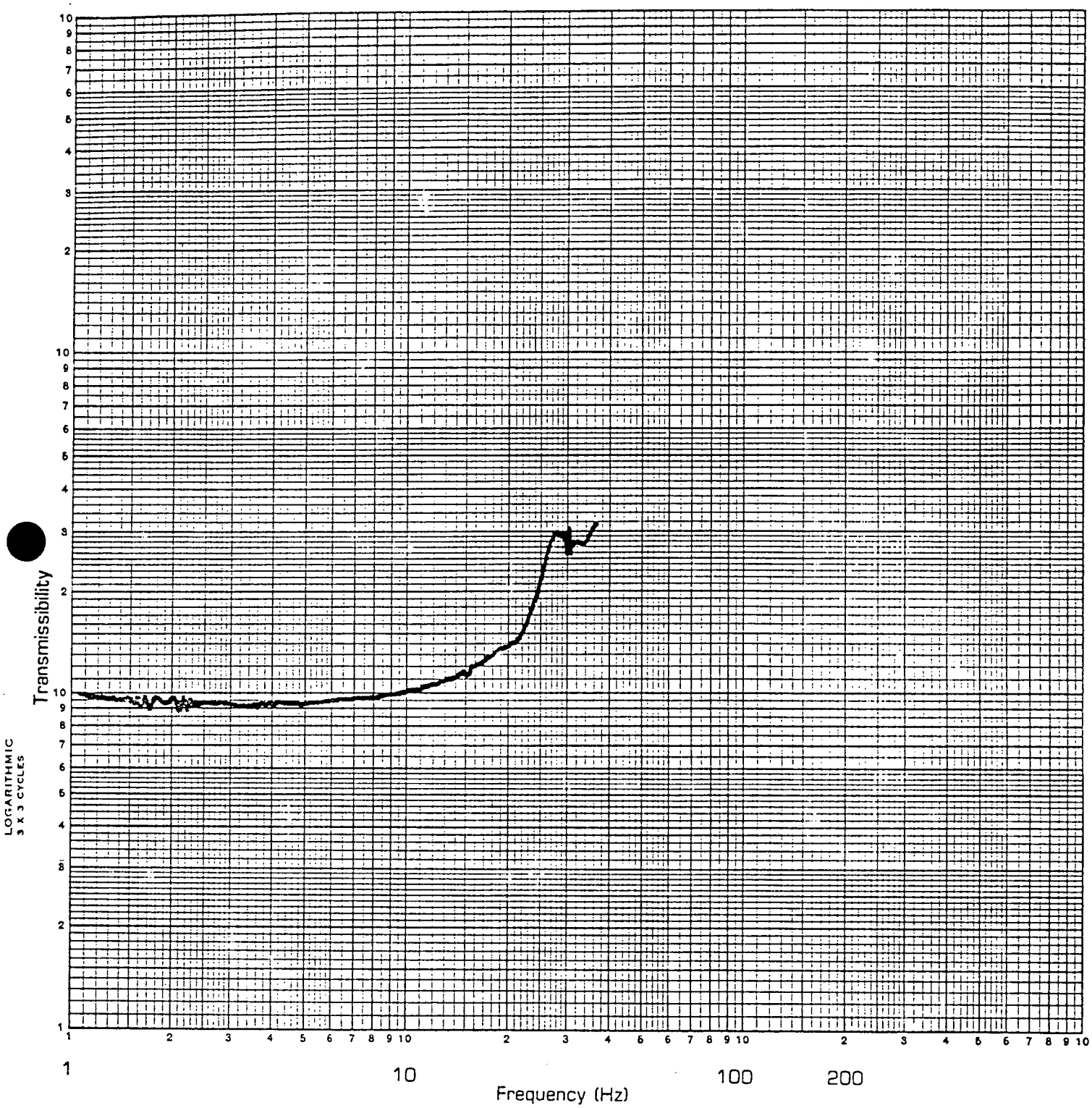
AXIS Long

ACCEL. NO. 2 Long NO. Long HCA

TEST RUN NO. 8

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Ganged Conduit

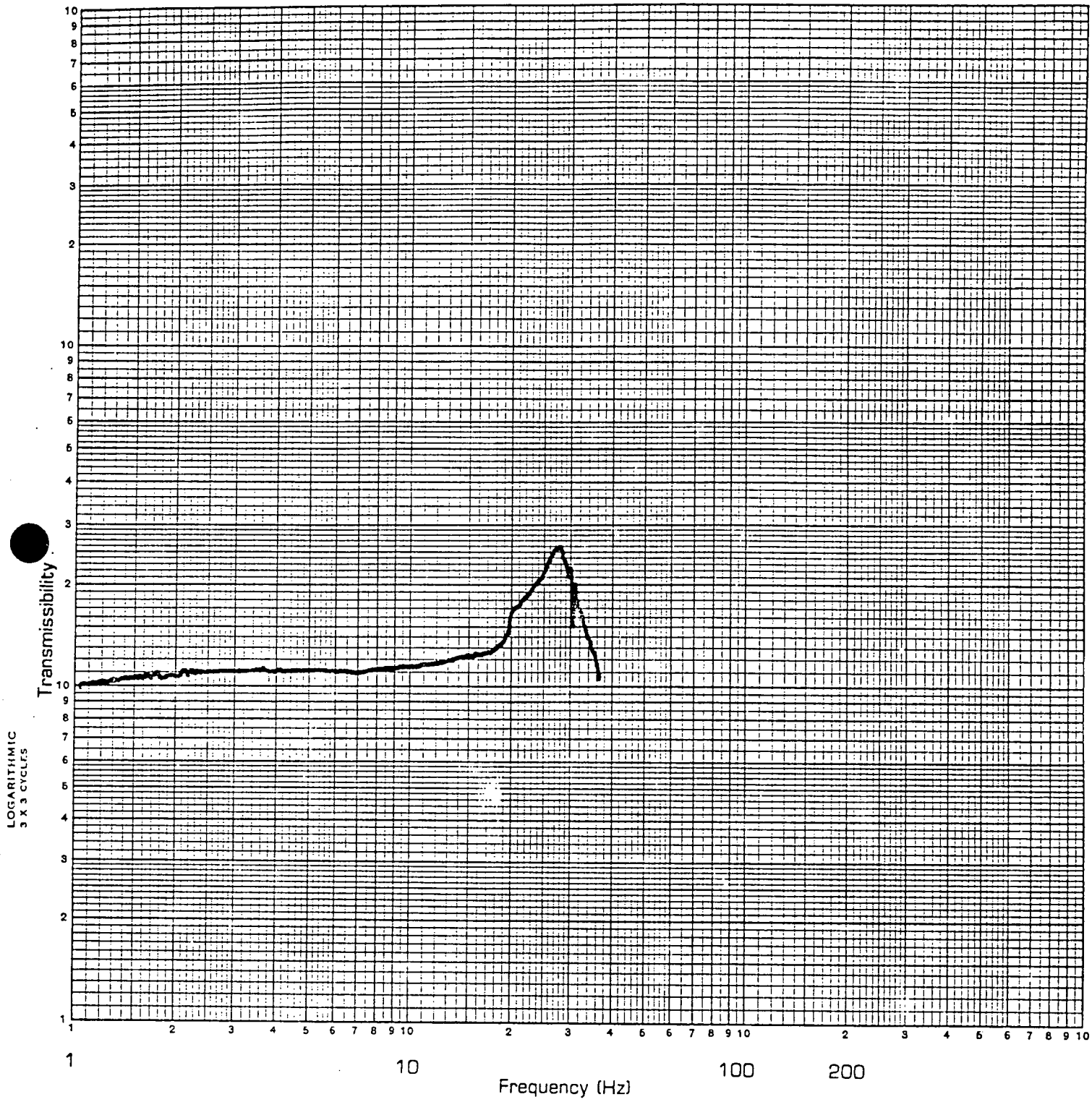
AXIS Long

ACCEL. NO. 5 Long NO. Long HCA

TEST RUN NO. 8

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Single Conduit

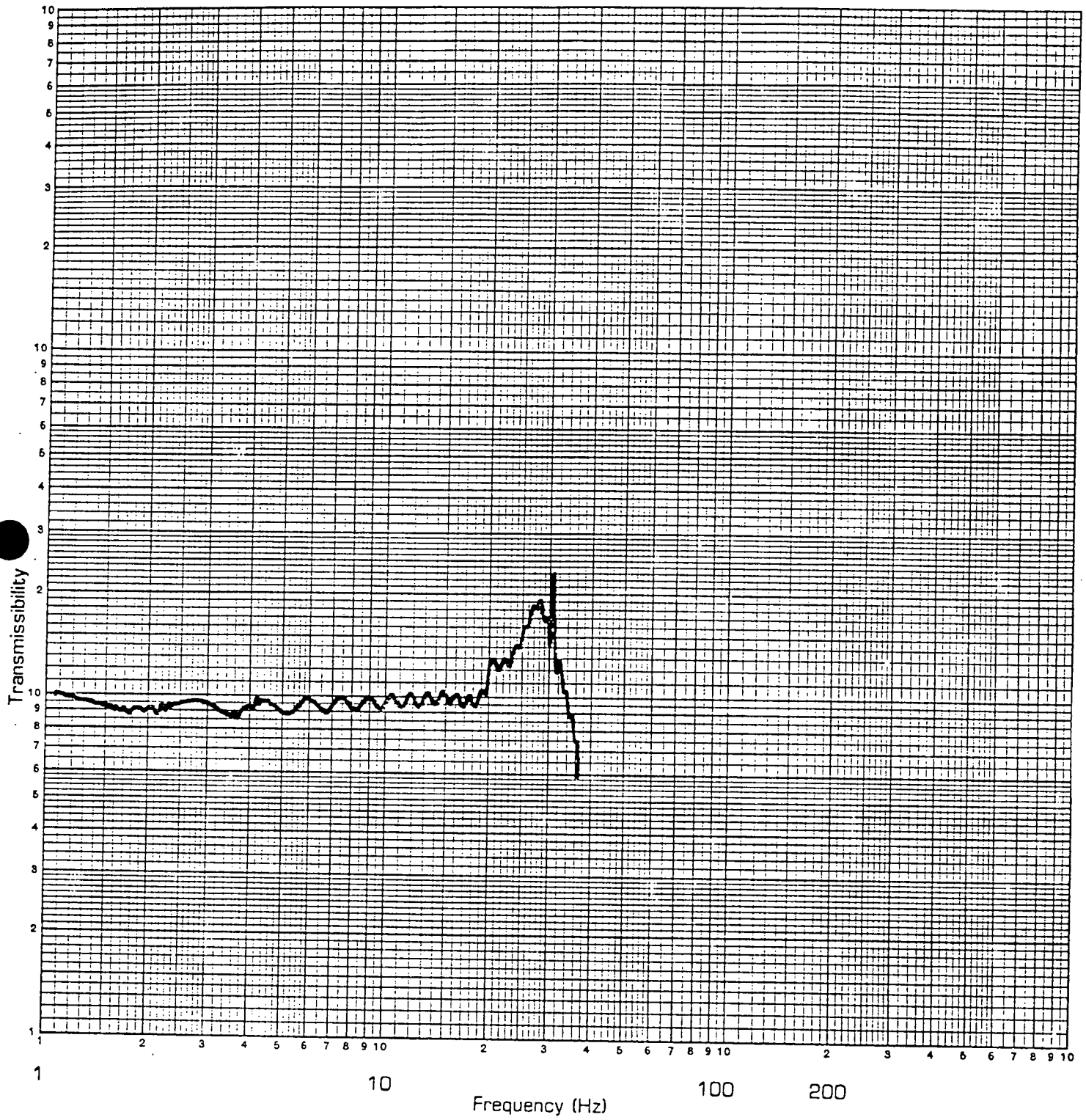
AXIS Long

ACCEL. NO. 8 Long NO. Long HCA

TEST RUN NO. 8

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Conduit

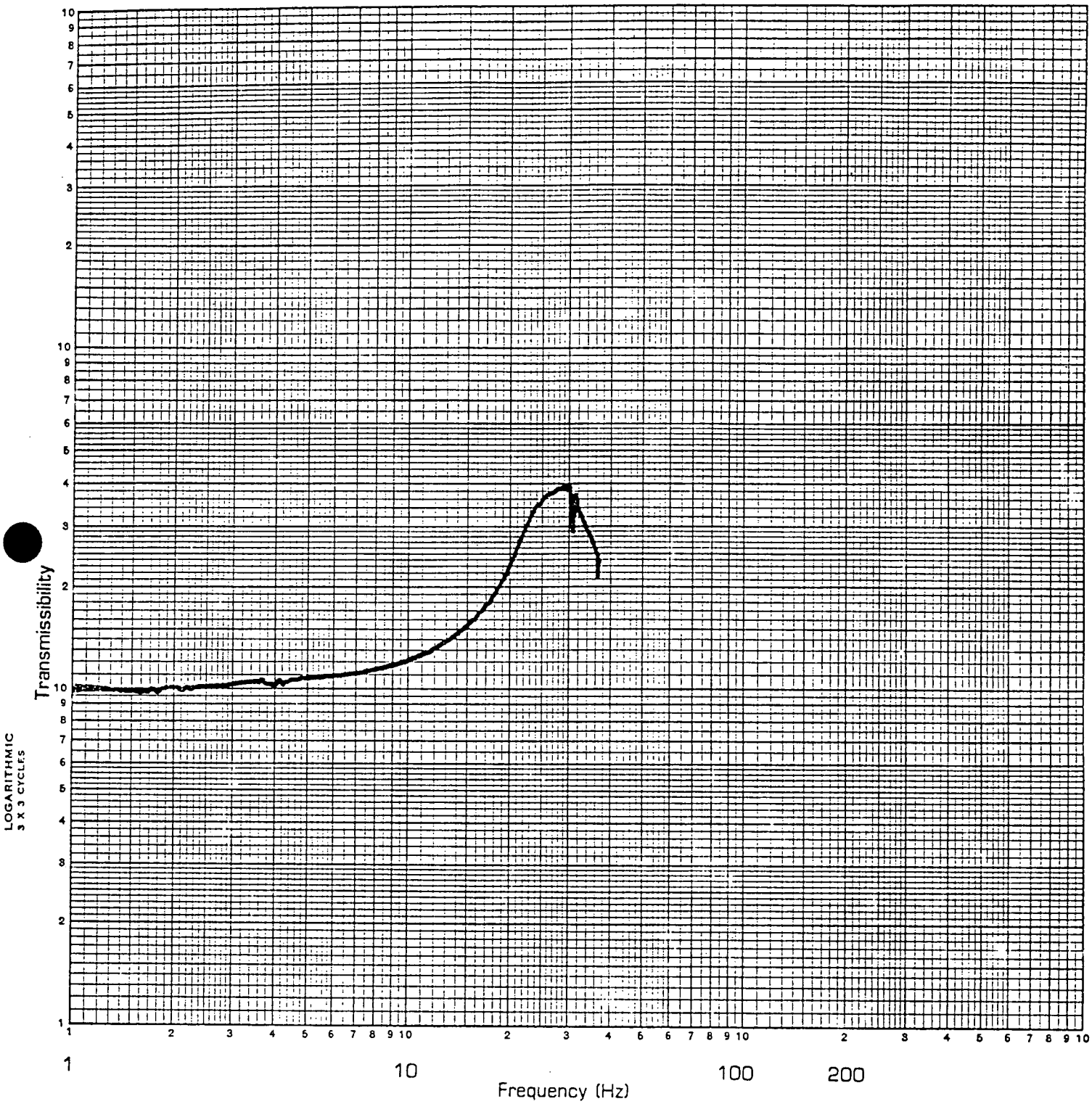
AXIS Long

ACCEL. NO. 11 Long NO. Long HCA

TEST RUN NO. 8

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Ganged Conduit

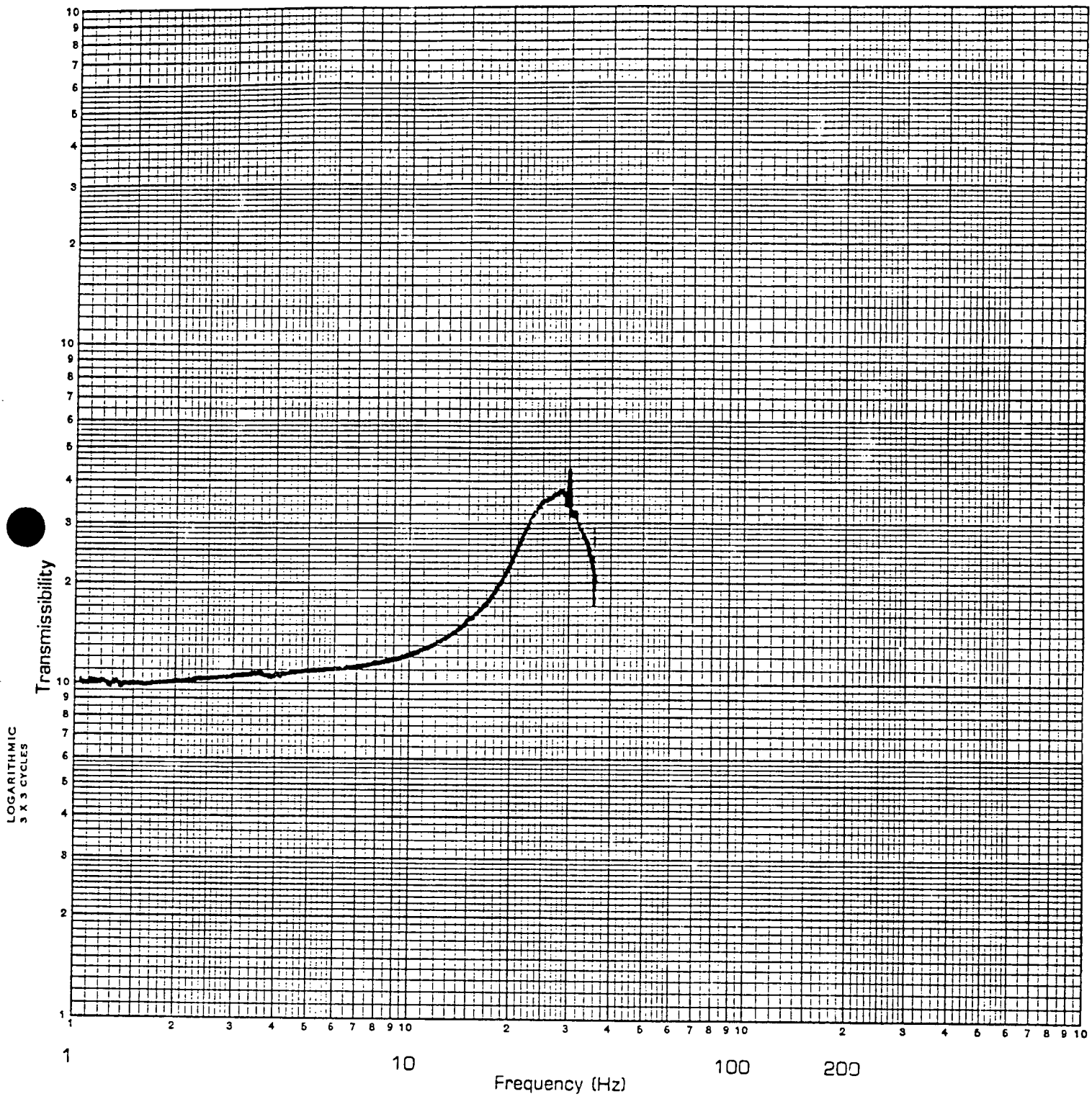
AXIS ✓

ACCEL. NO. 3V NO. VCA

TEST RUN NO. 9

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Ganged Conduit

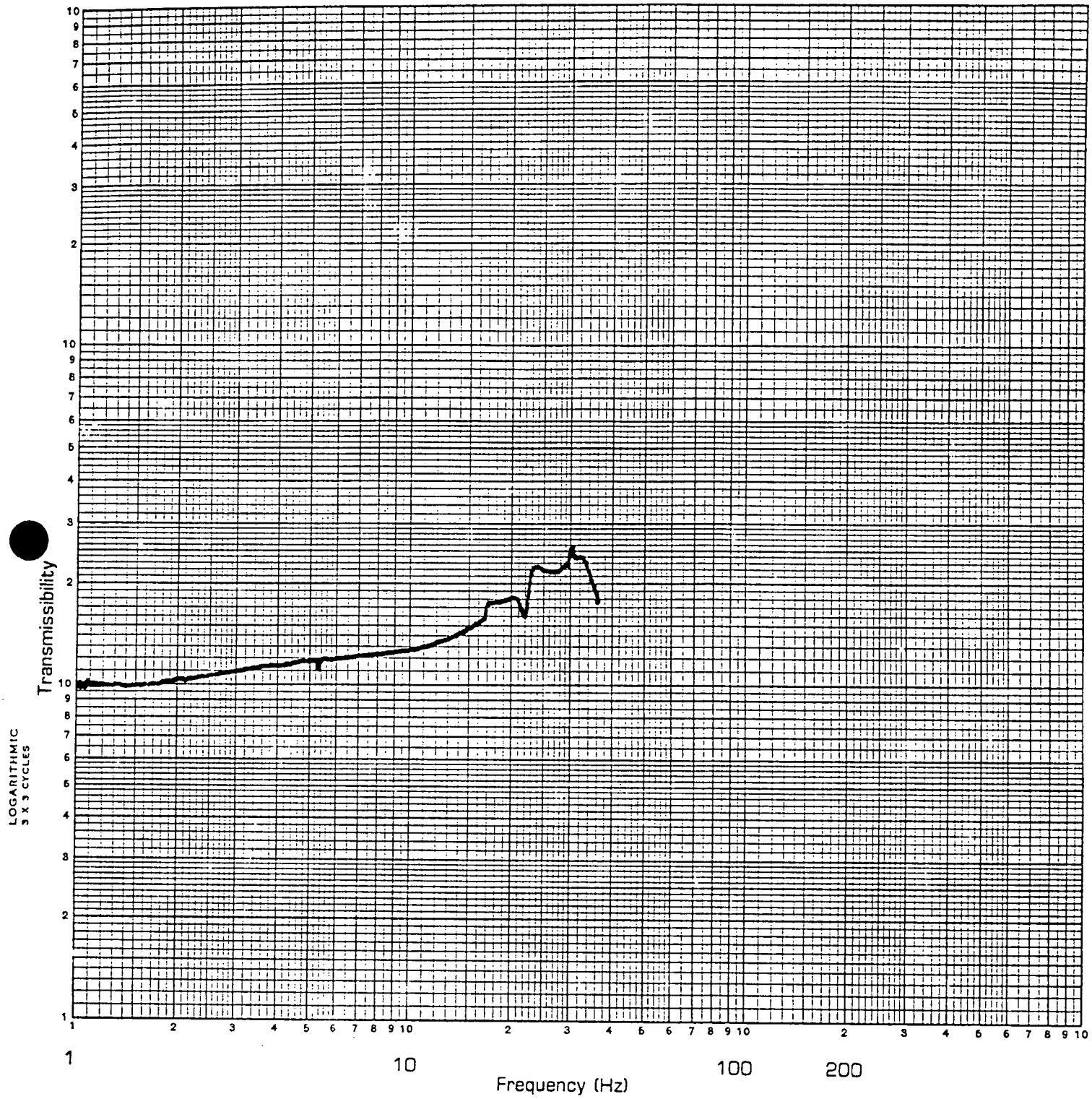
AXIS V

ACCEL. NO. 6V NO. VCA

TEST RUN NO. 9

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☒ 1000 ☐



SPECIMEN Single Conduit

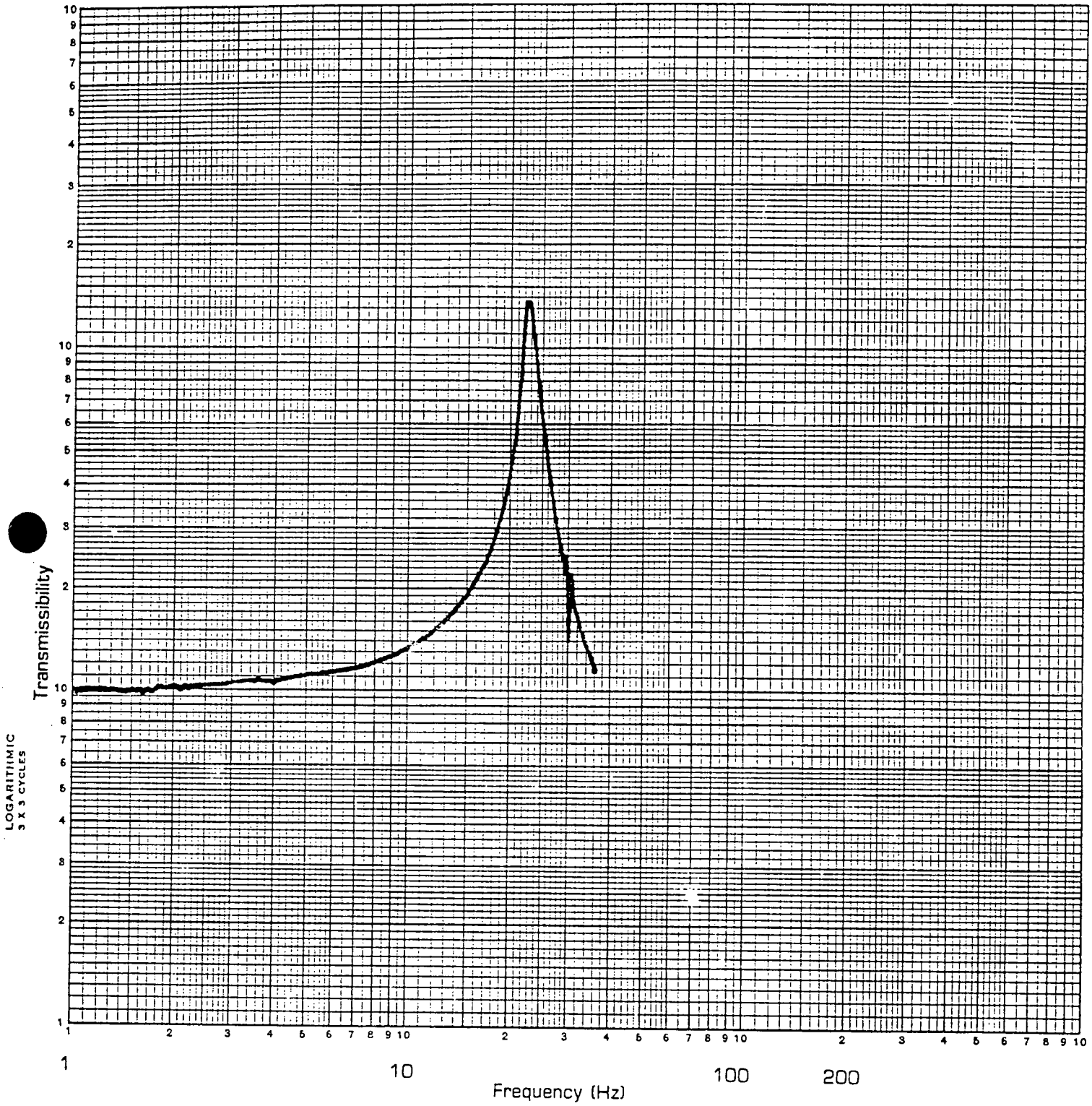
AXIS V

ACCEL. NO. 9V NO. VCA

TEST RUN NO. 9

FULL SCALE TRANSMISSIBILITY

0.1 ☐ 1.0 ☐ 10 ☐ 100 ☑ 1000 ☐



SPECIMEN Single Conduit

AXIS V

ACCEL. NO. 12J NO. VCA

TEST RUN NO. 9

APPENDIX VI

SERIES 1 RANDOM MULTIFREQUENCY TEST RESPONSE SPECTRUM PLOTS

Test Run	Plots
4	Control Accelerometers @ 5% Damping
5	Control Accelerometers @ 5% Damping
6	Control and Response Accelerometers @ 5% Damping
7	Control and Response Accelerometers @ 5% Damping

LEGEND:

HCA	=	Horizontal Control Accelerometer
VCA	=	Vertical Control Accelerometer
LAT	=	Lateral
LONG	=	Longitudinal
V	=	Vertical
OBE	=	Operating Basis Earthquake
SSE	=	Safe Shutdown Earthquake

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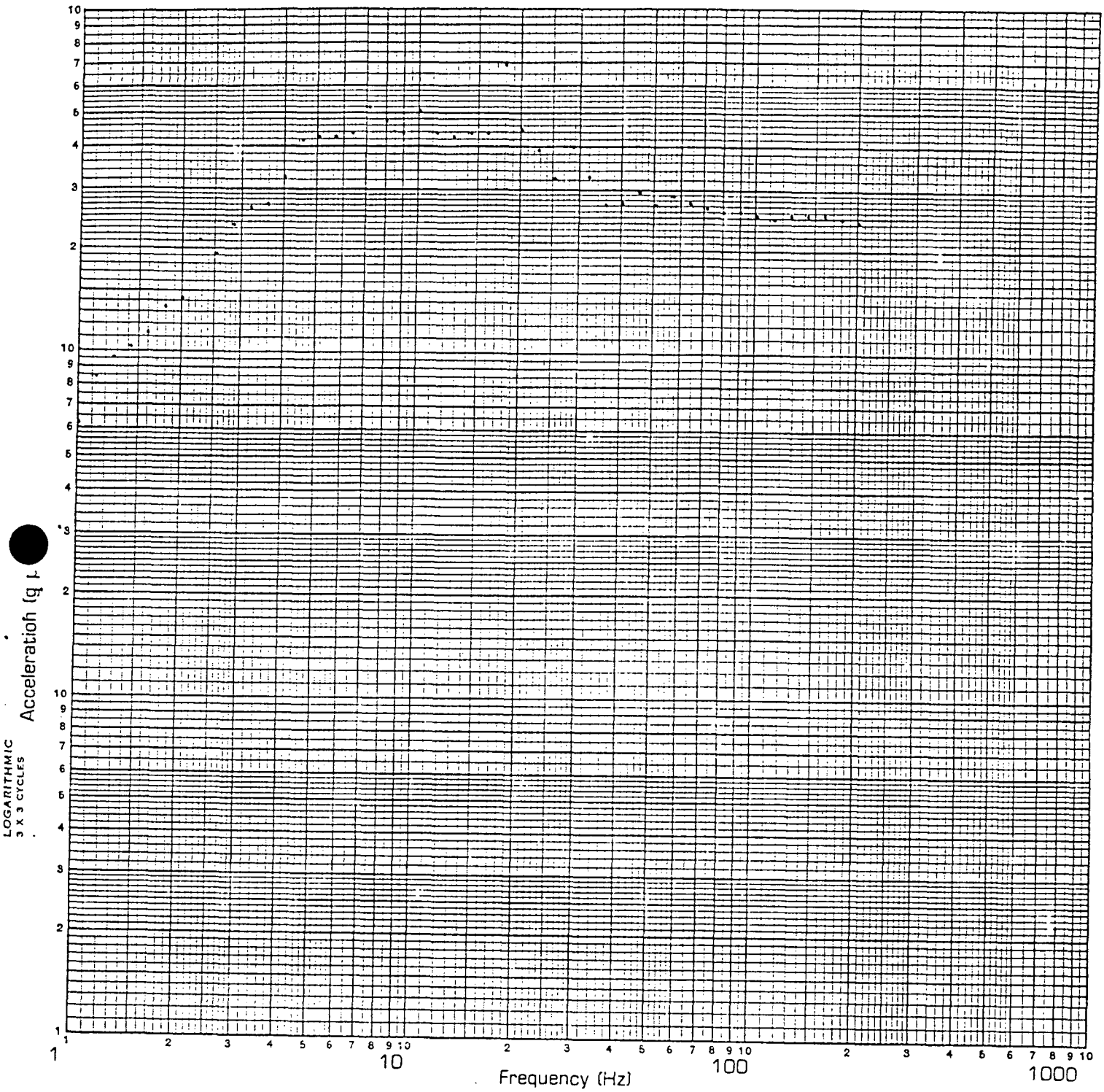
FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

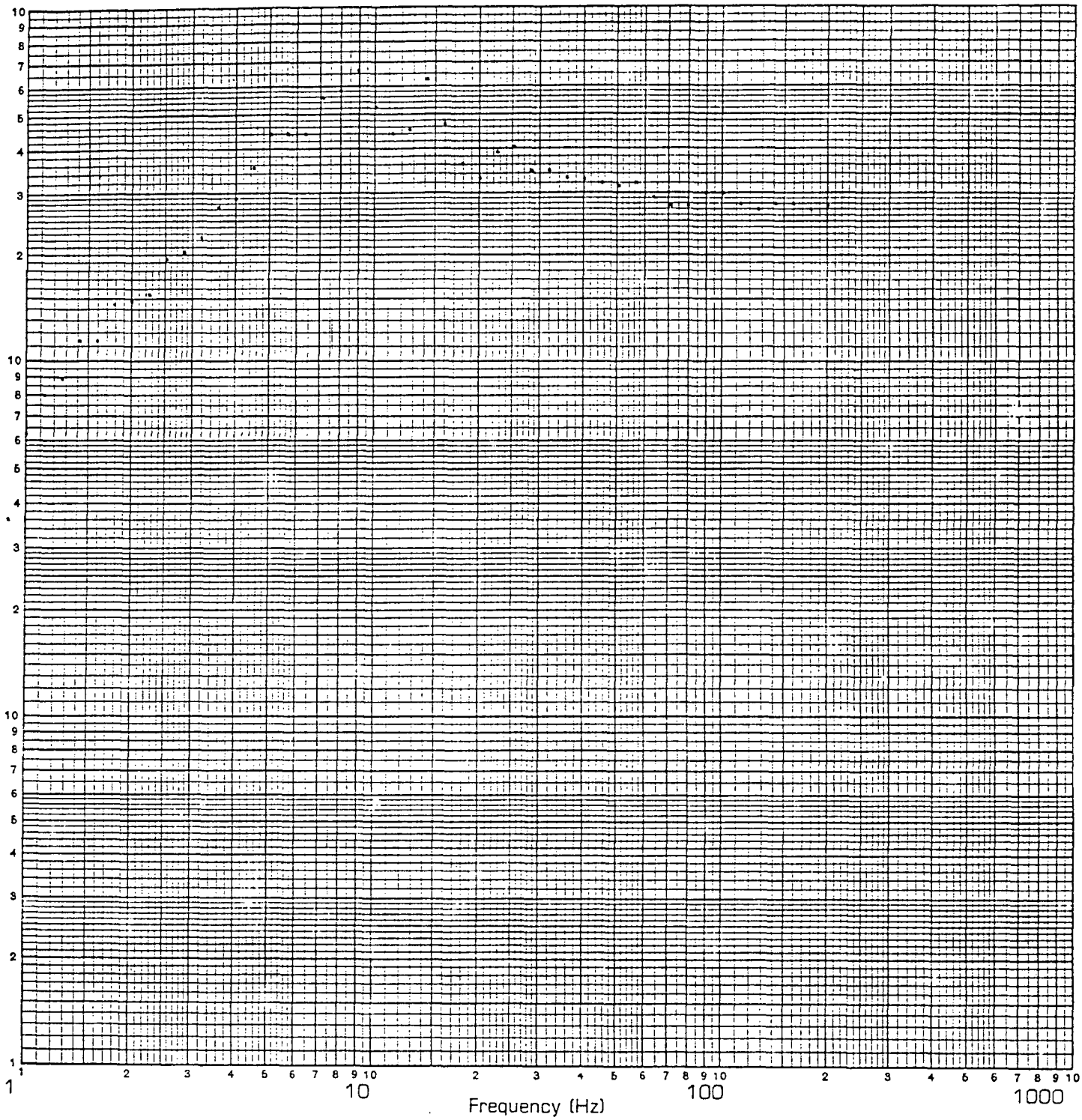
LOCATION NO. LAT HCA

TEST RUN NO. 4

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

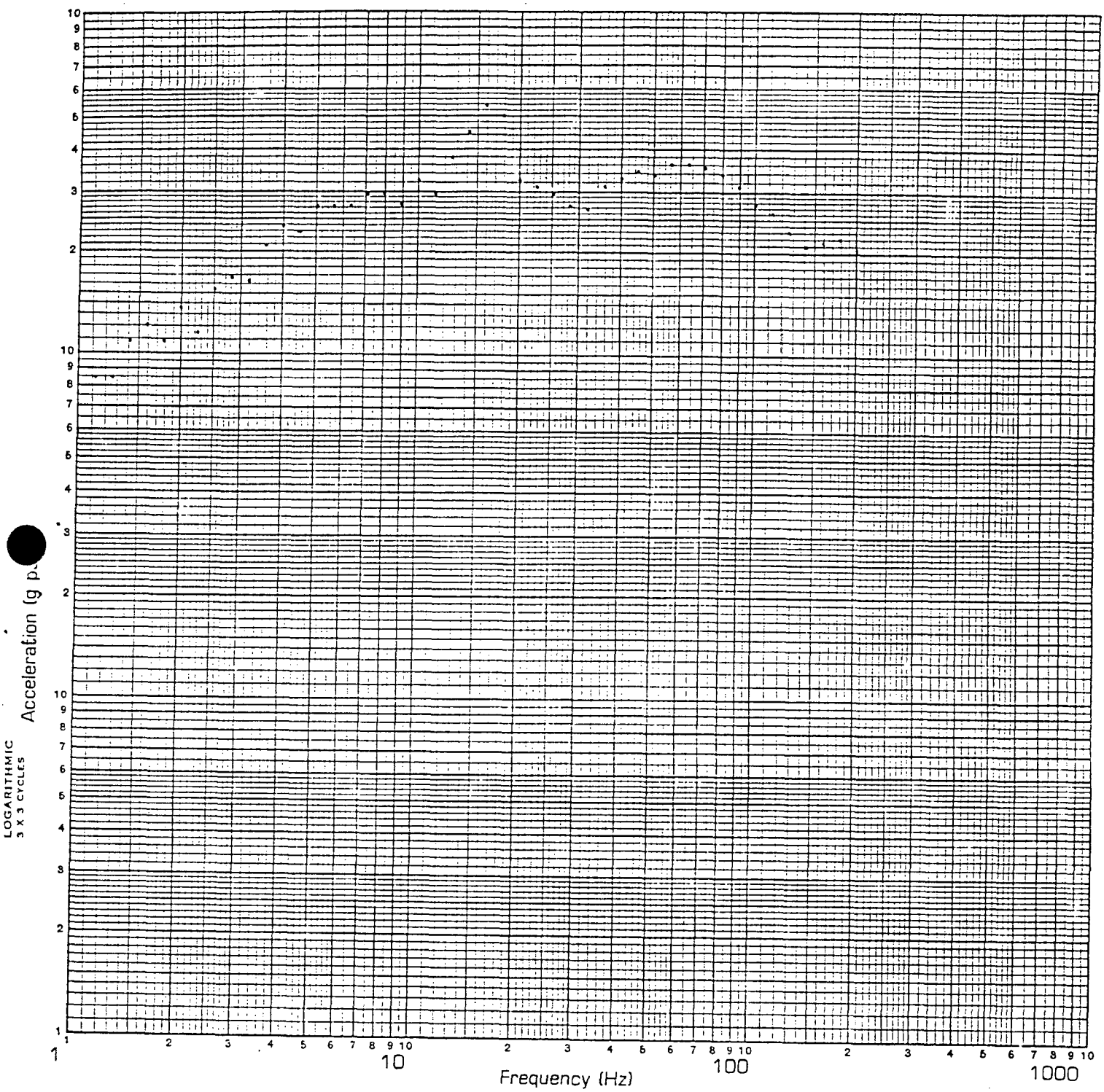
LOCATION NO. LONG HCA

TEST RUN NO. 4

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

LOCATION NO. VCA

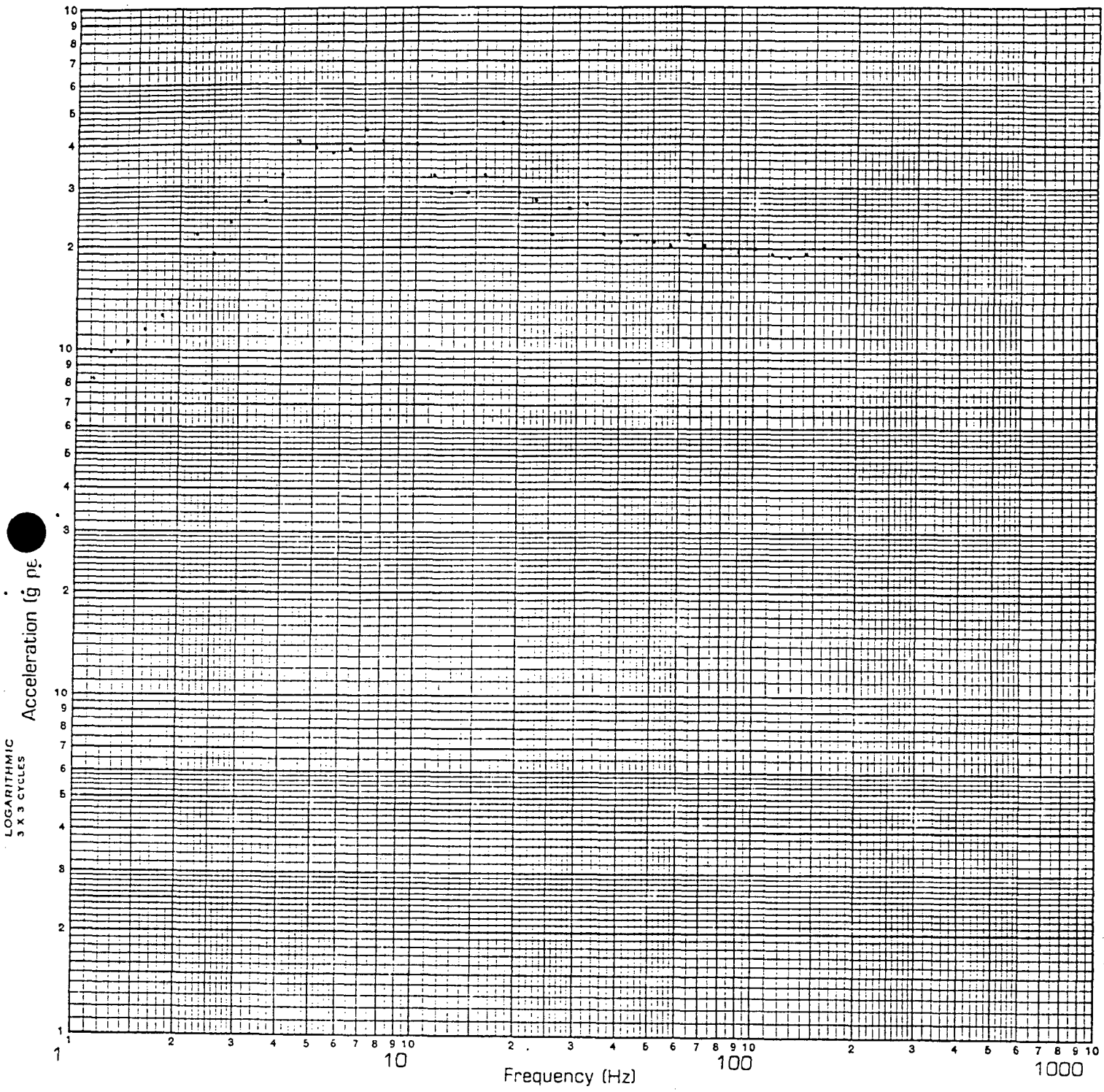
TEST RUN NO. 4

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN ——

AXIS TRI

LOCATION NO. LAT HCA

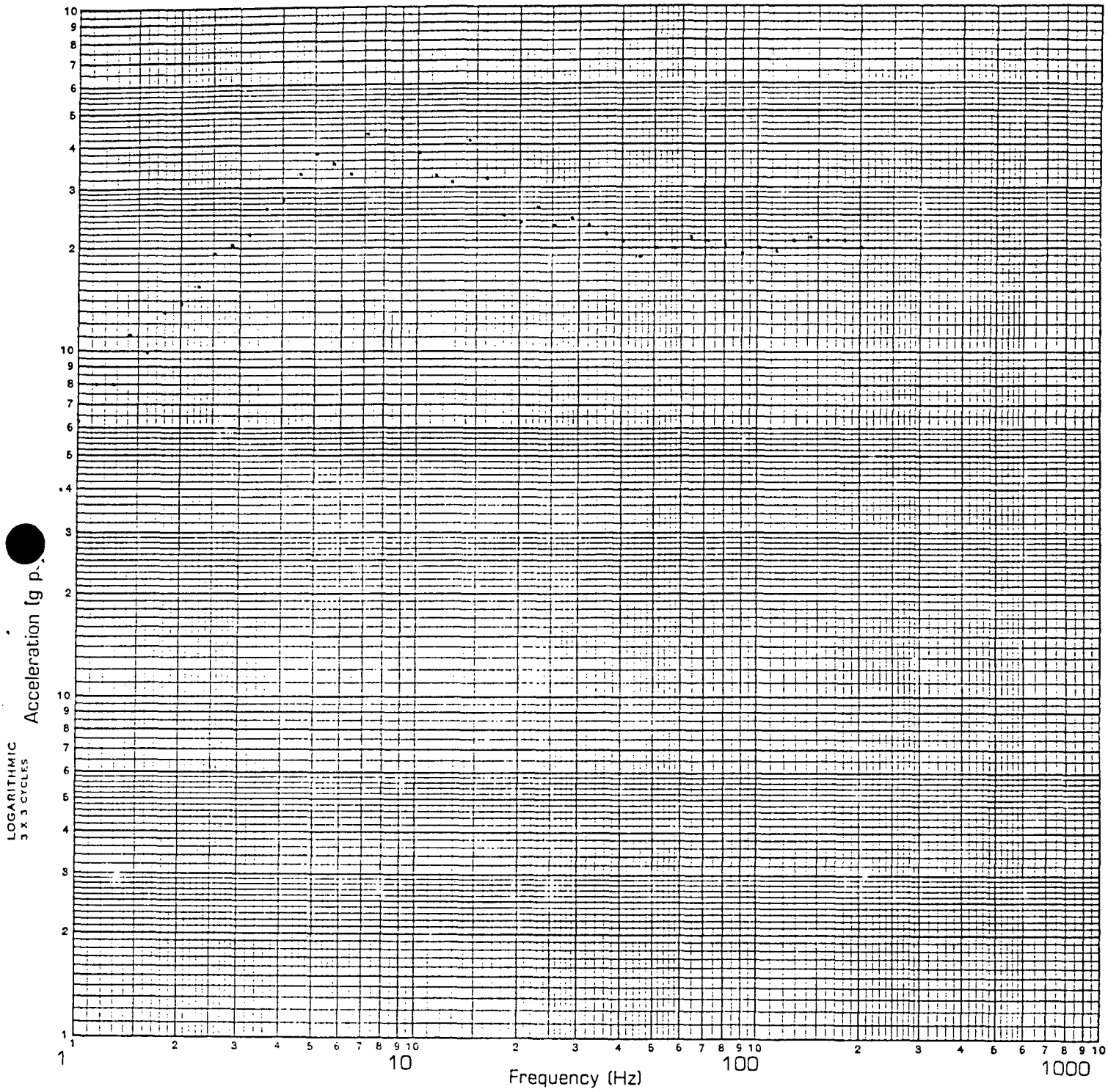
TEST RUN NO. ~~6~~ 5 GRD

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

LOCATION NO. LONG HCA

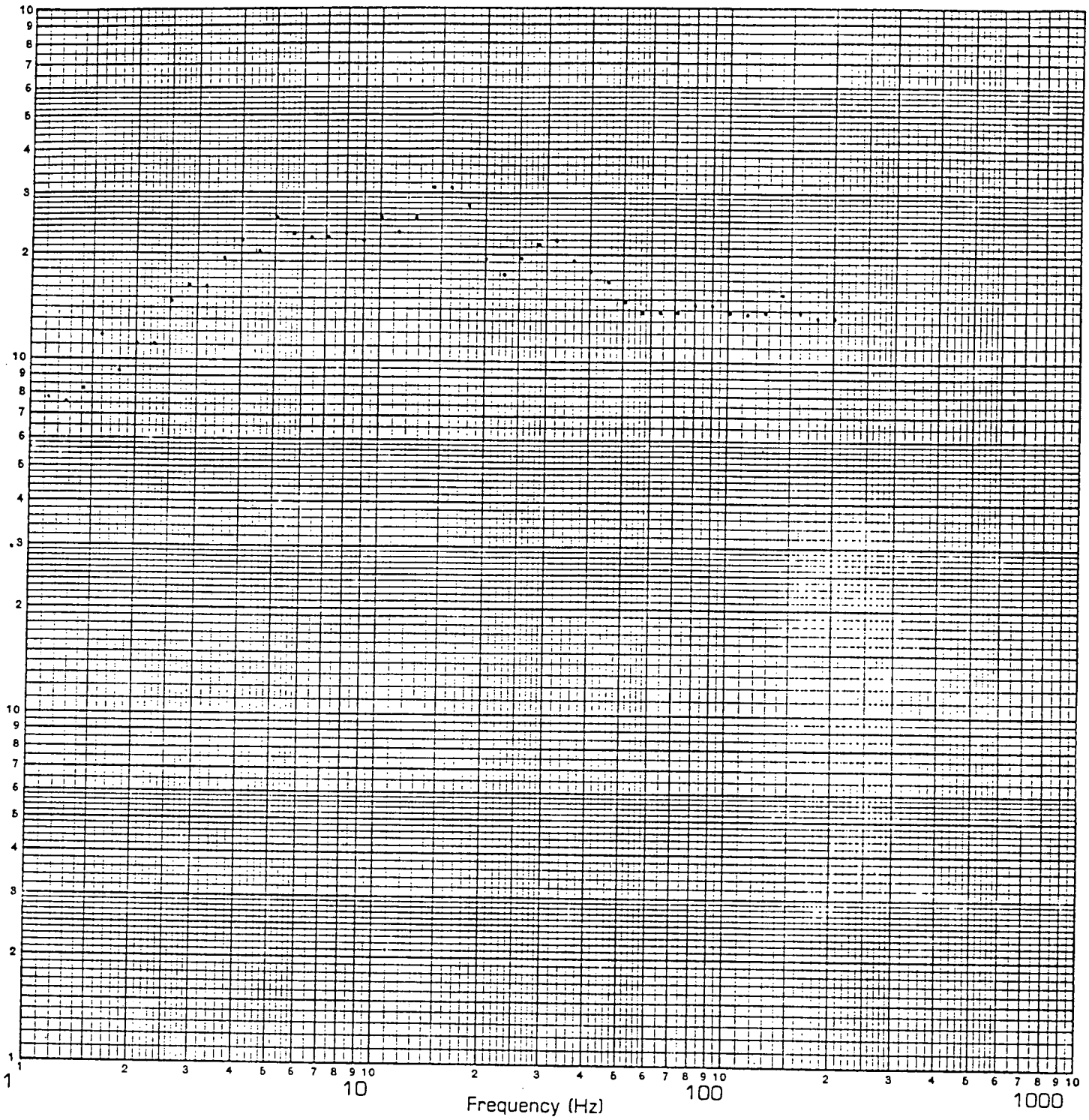
TEST RUN NO. to 5 GRD

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

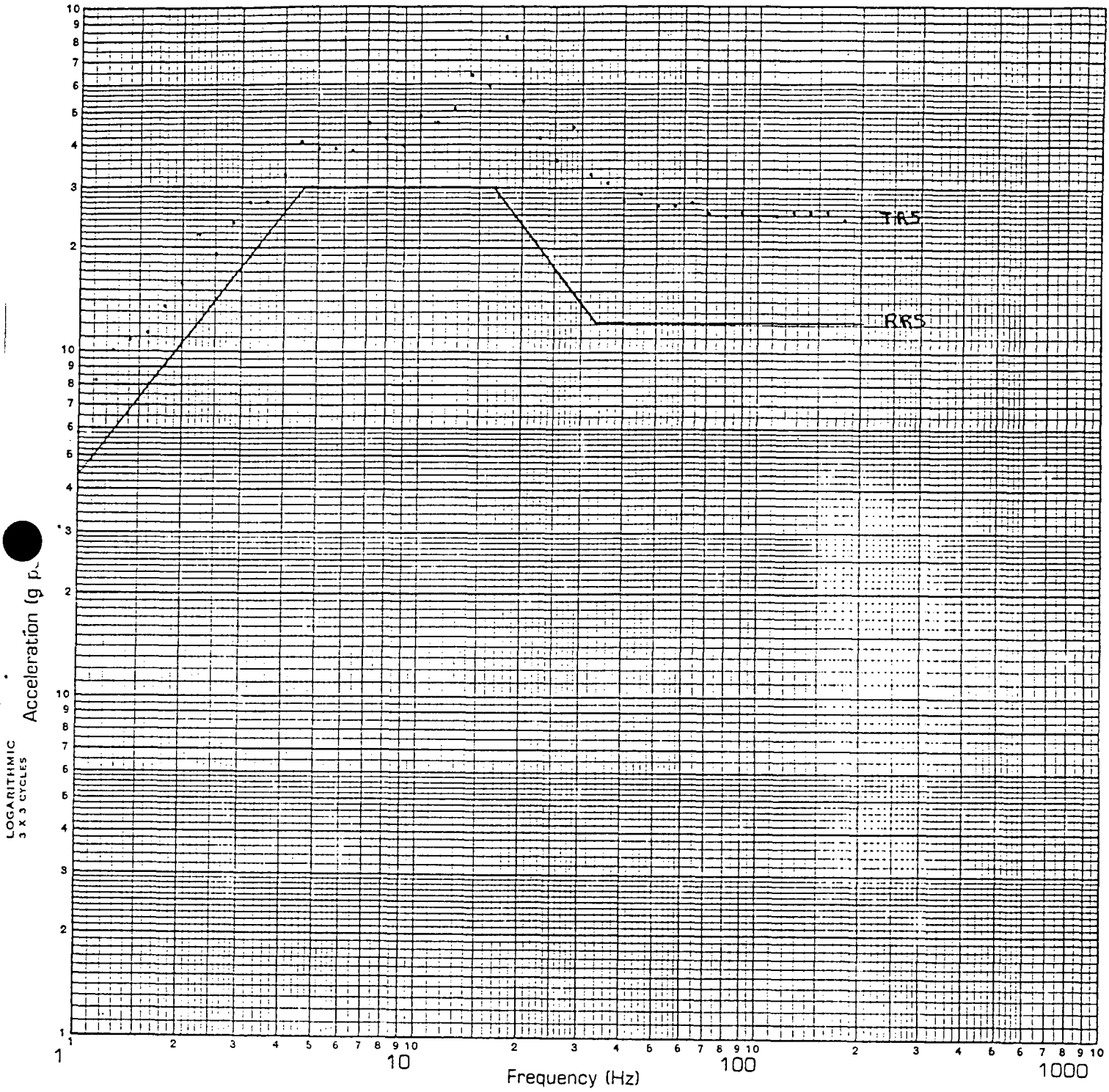
LOCATION NO. VCA

TEST RUN NO. ~~6~~ 5 GRD

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5%



SPECIMEN ——

AXIS TRI

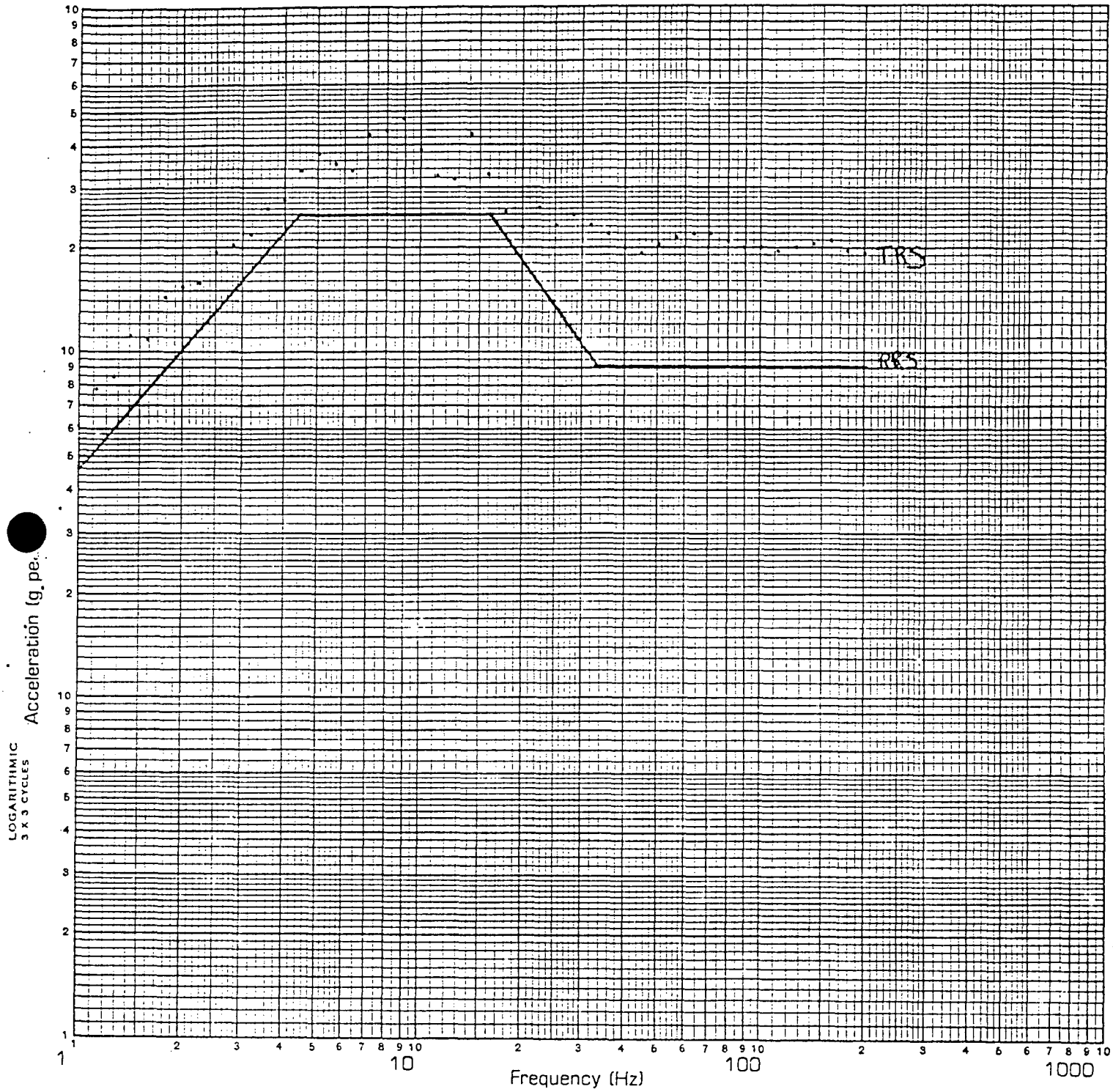
LOCATION NO. LAT HCA

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

LOCATION NO. LONG HCA

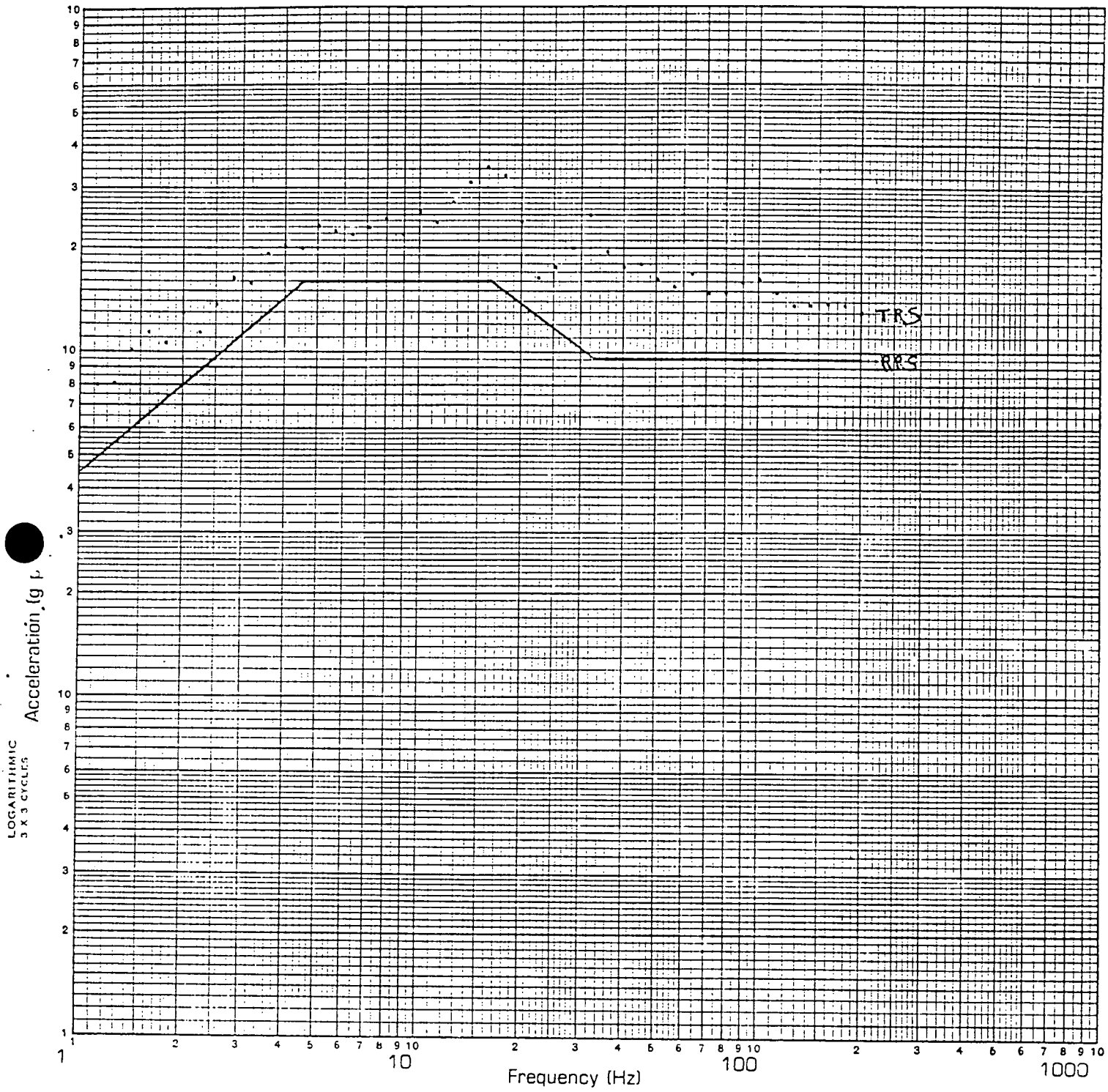
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN —

AXIS TRT

LOCATION NO. VCA

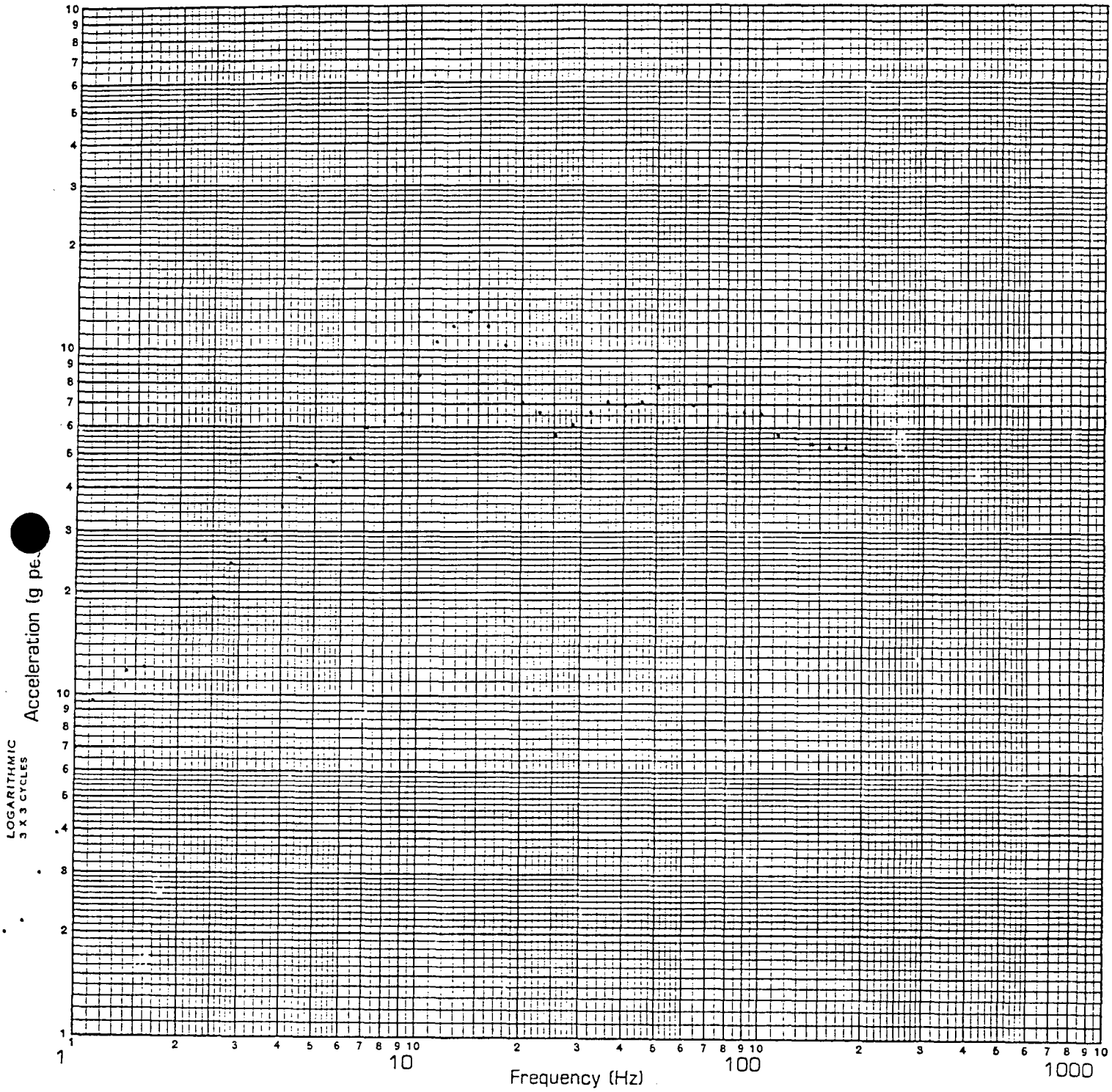
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Cable Tray w/ Air Drop

LOCATION NO. 12AT

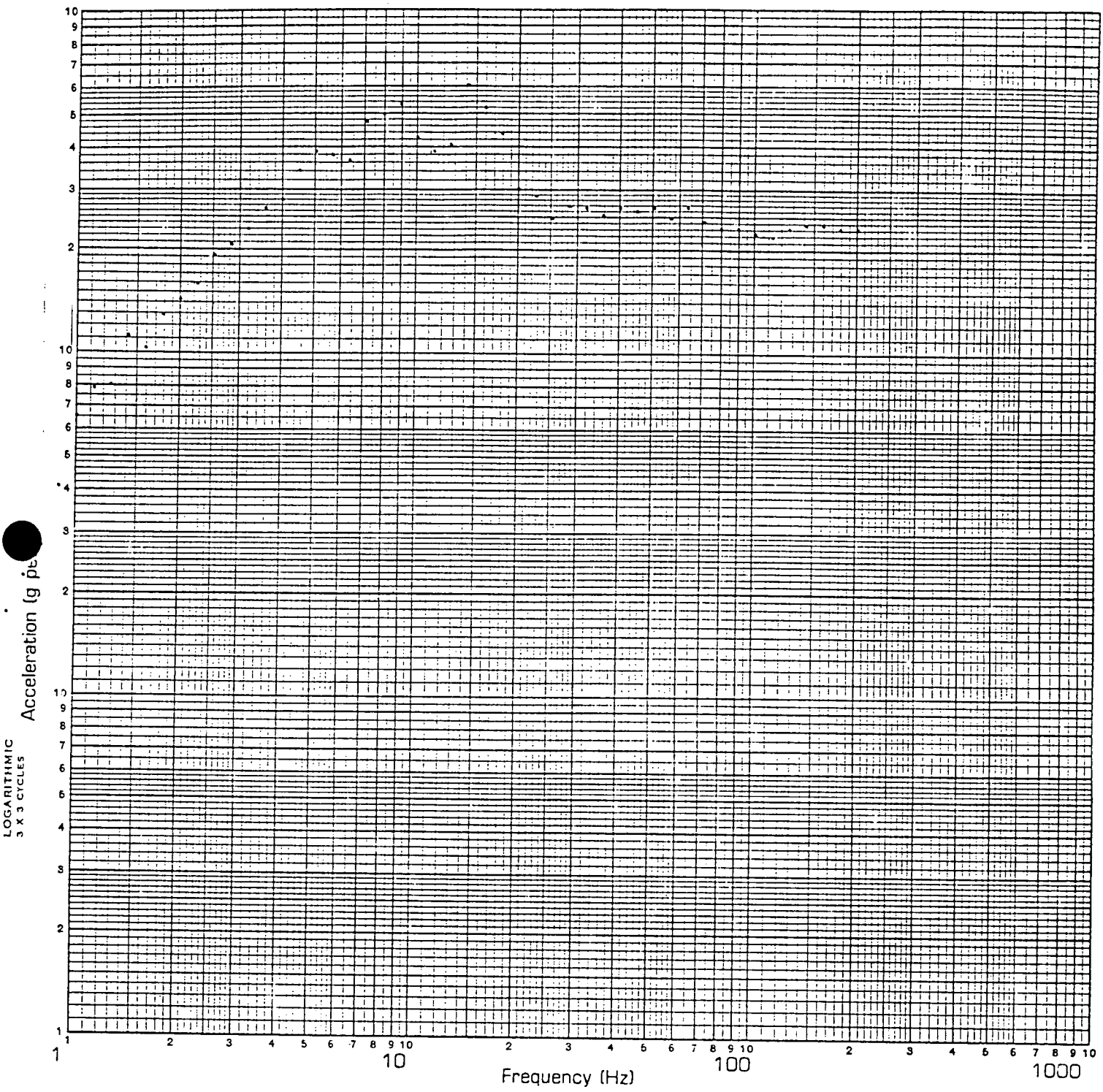
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN Single Cable Tray w/ Air Drop

AXIS TRI

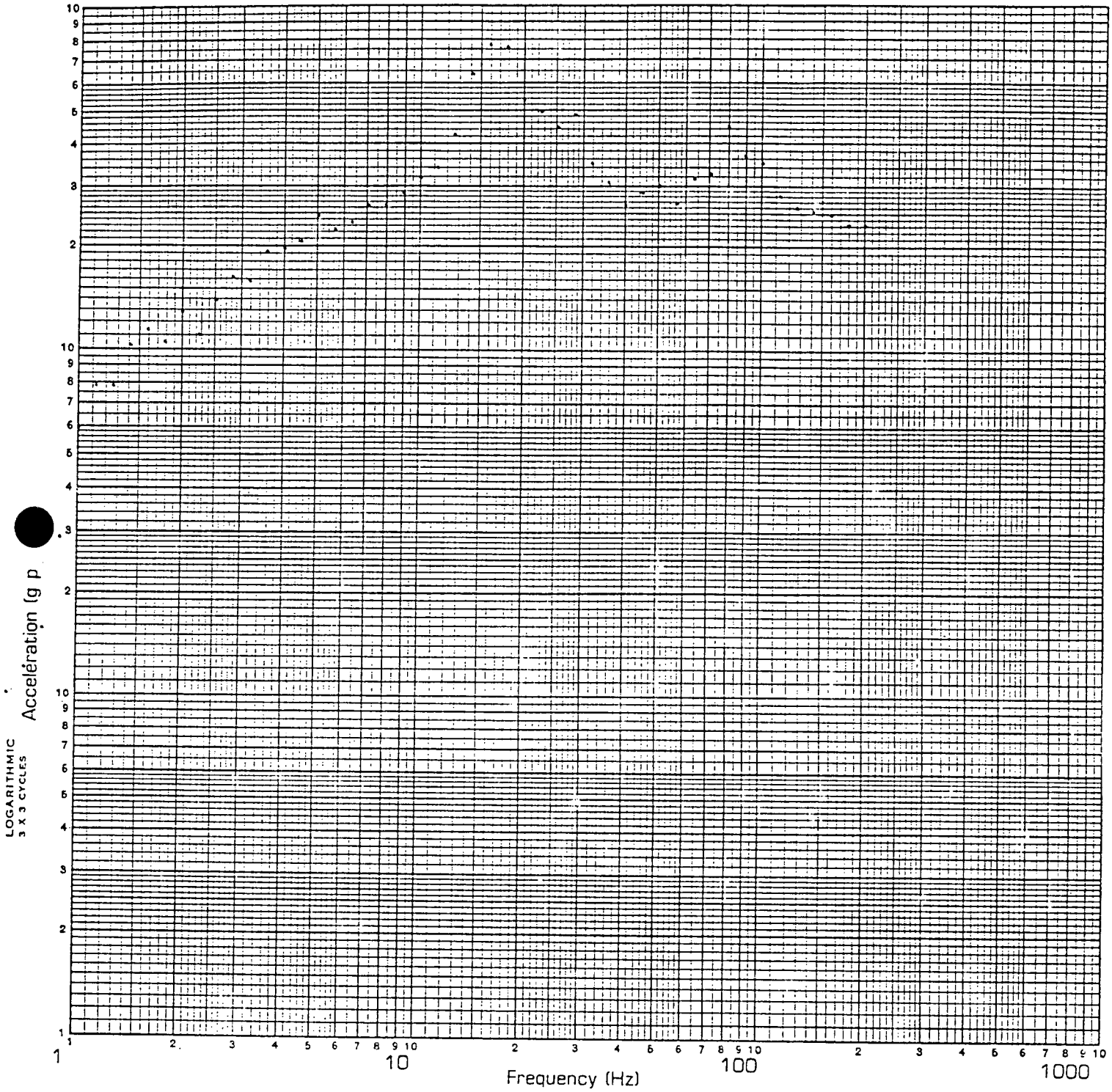
LOCATION NO. 2LONG

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5%



SPECIMEN Single Cable Tray w/ Air Drop

LOCATION NO. 3V

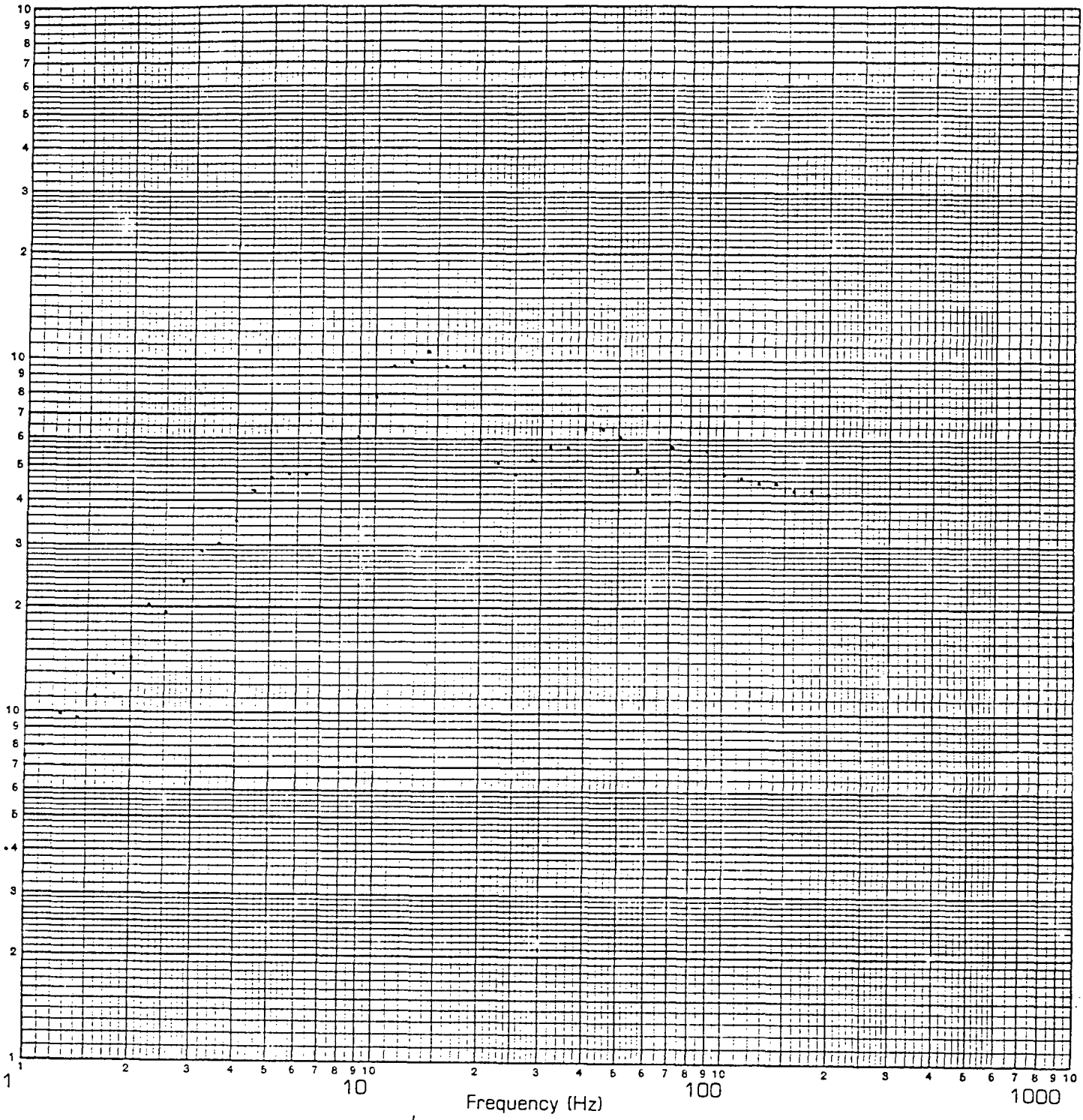
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Cable Tray w/ Air Drop

LOCATION NO. 4LAT

AXIS TRI

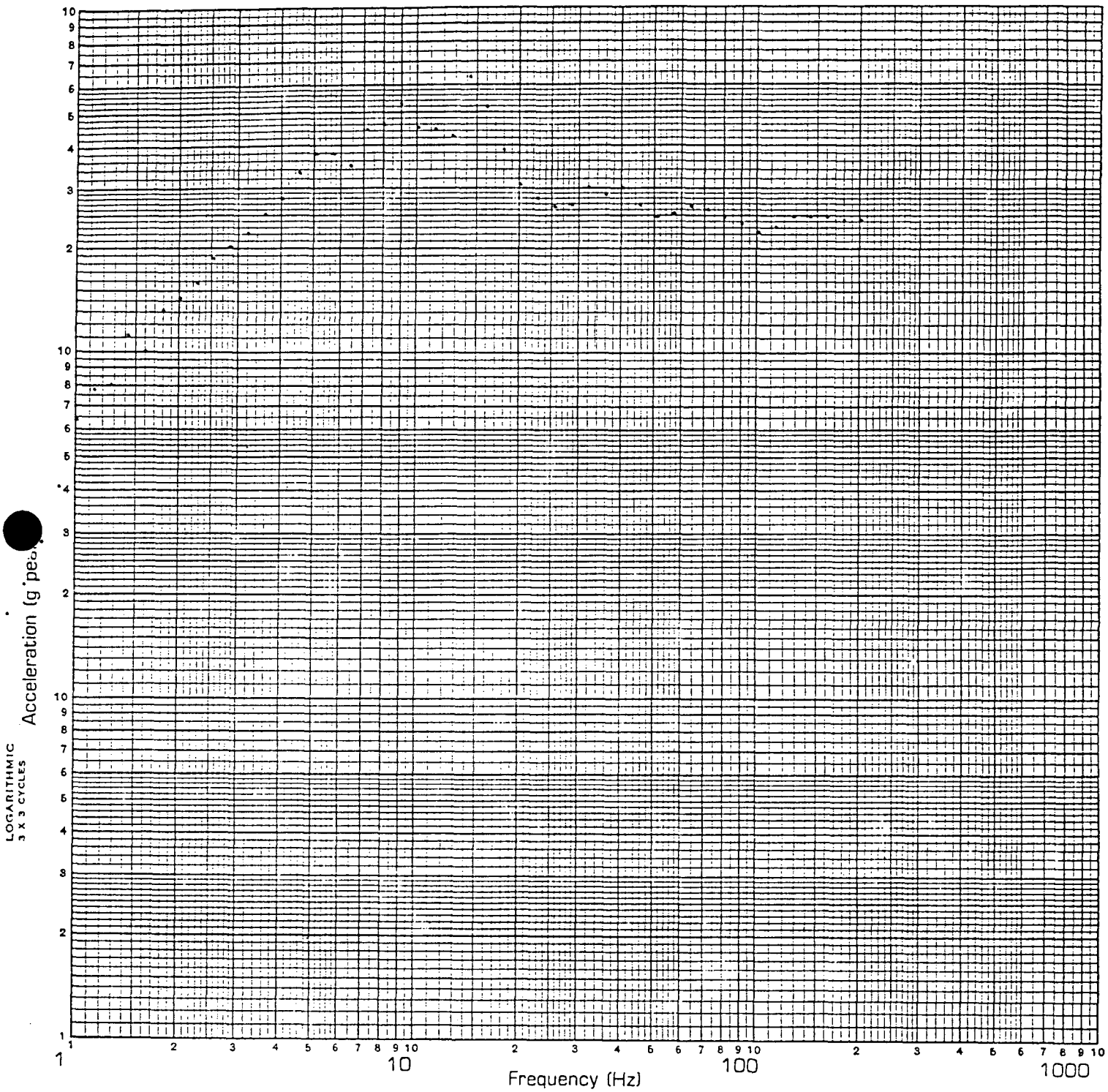
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN Single Cable Tray w/ Air Drop

LOCATION NO. 5LONG

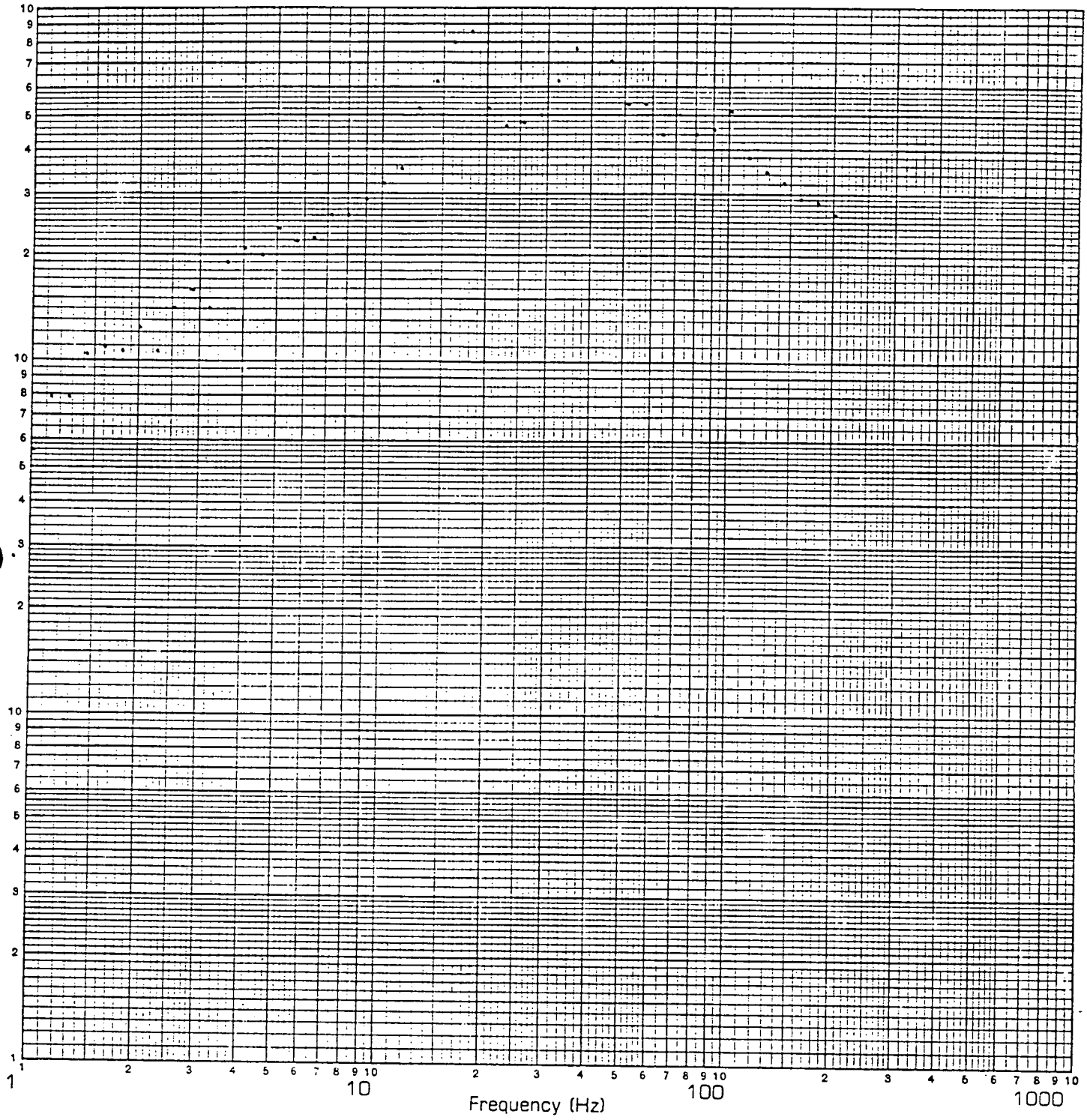
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5%



SPECIMEN Single Cable Tray w/ Air Drop

AXIS TRT

LOCATION NO. 6V

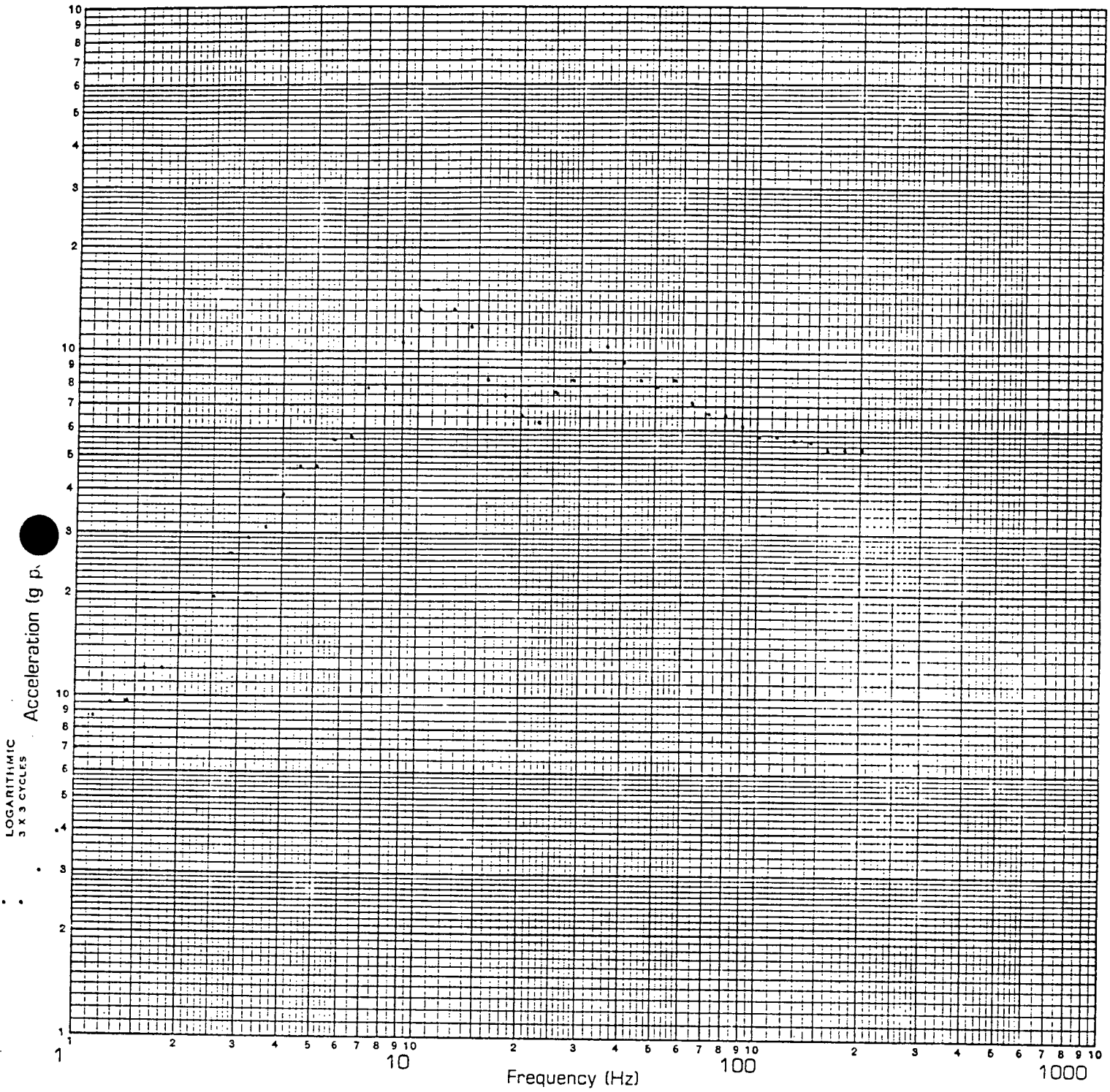
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

LOCATION NO. 7LAT

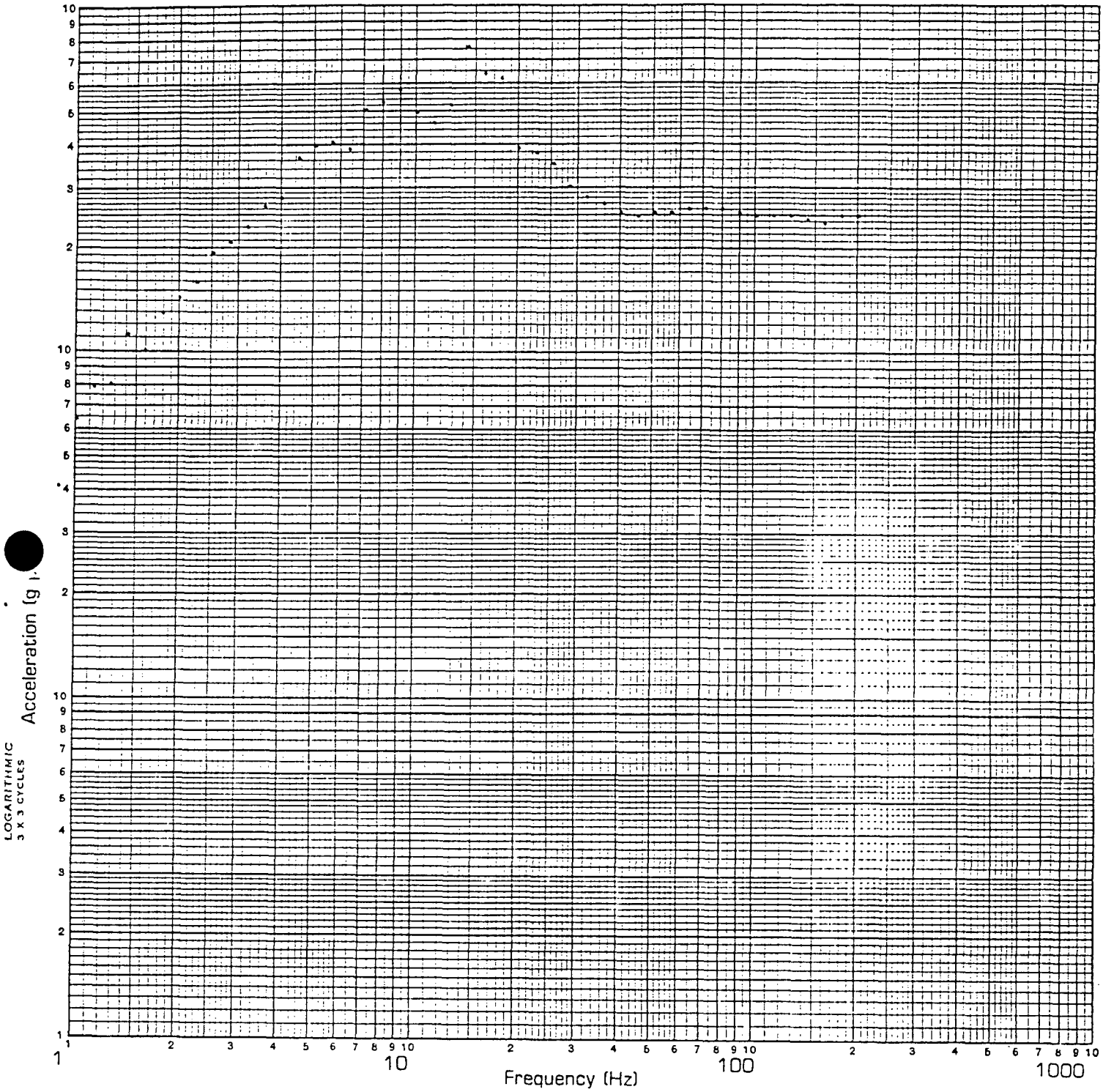
AXIS TRL

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

AXIS TRL

LOCATION NO. 8 LONG

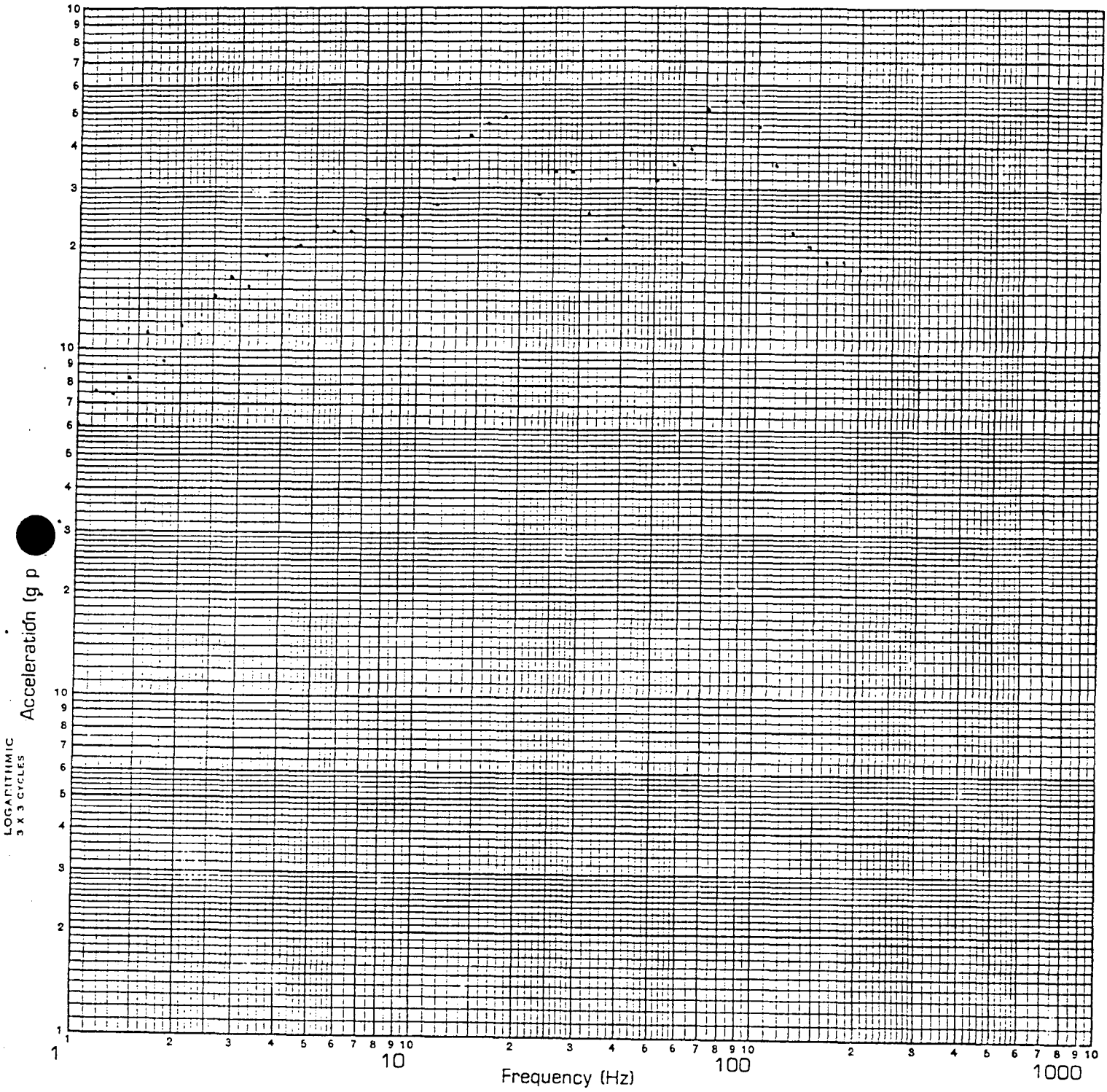
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

LOCATION NO. 9V

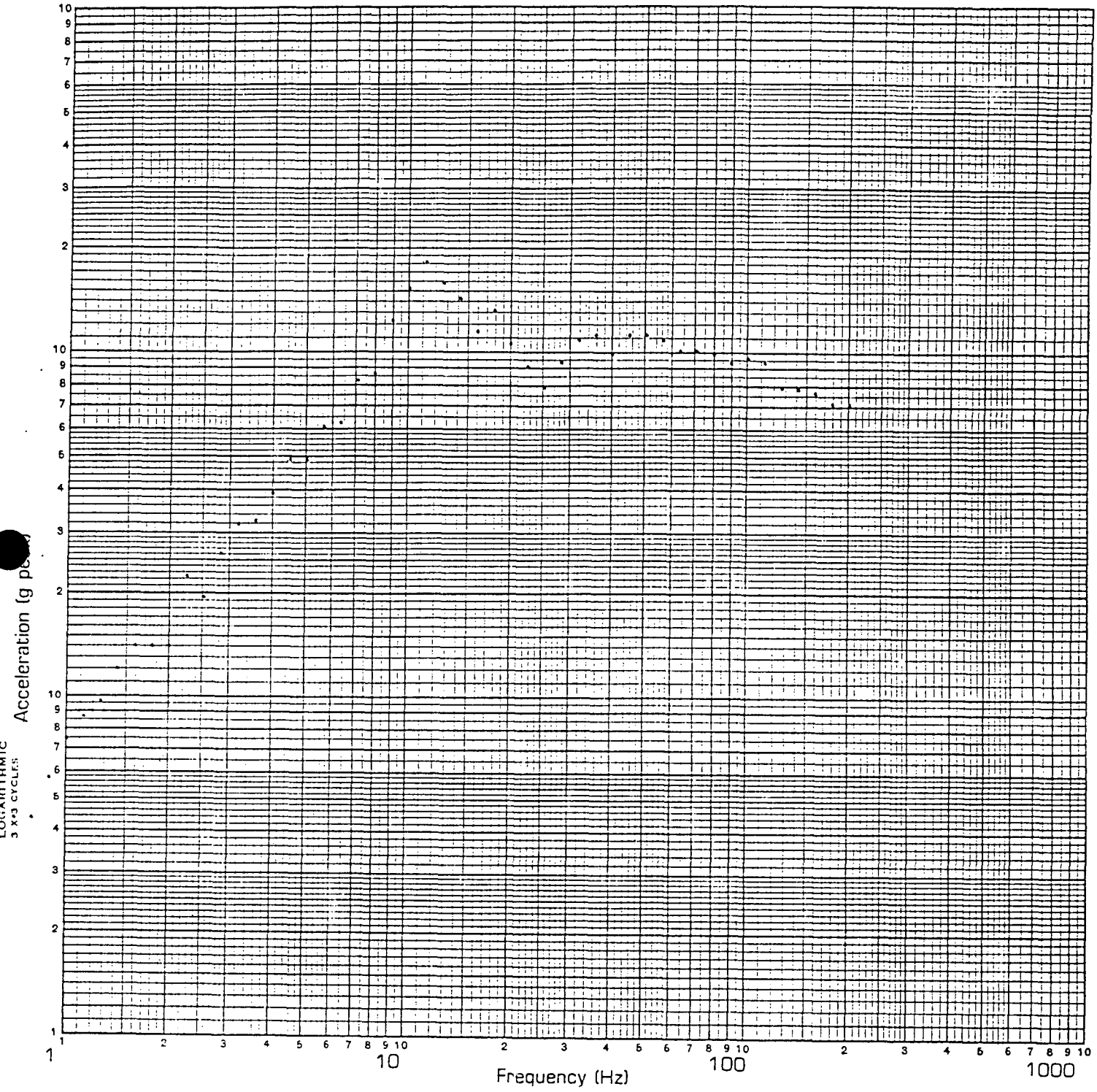
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

LOCATION NO. 10LAT

AXIS TRI

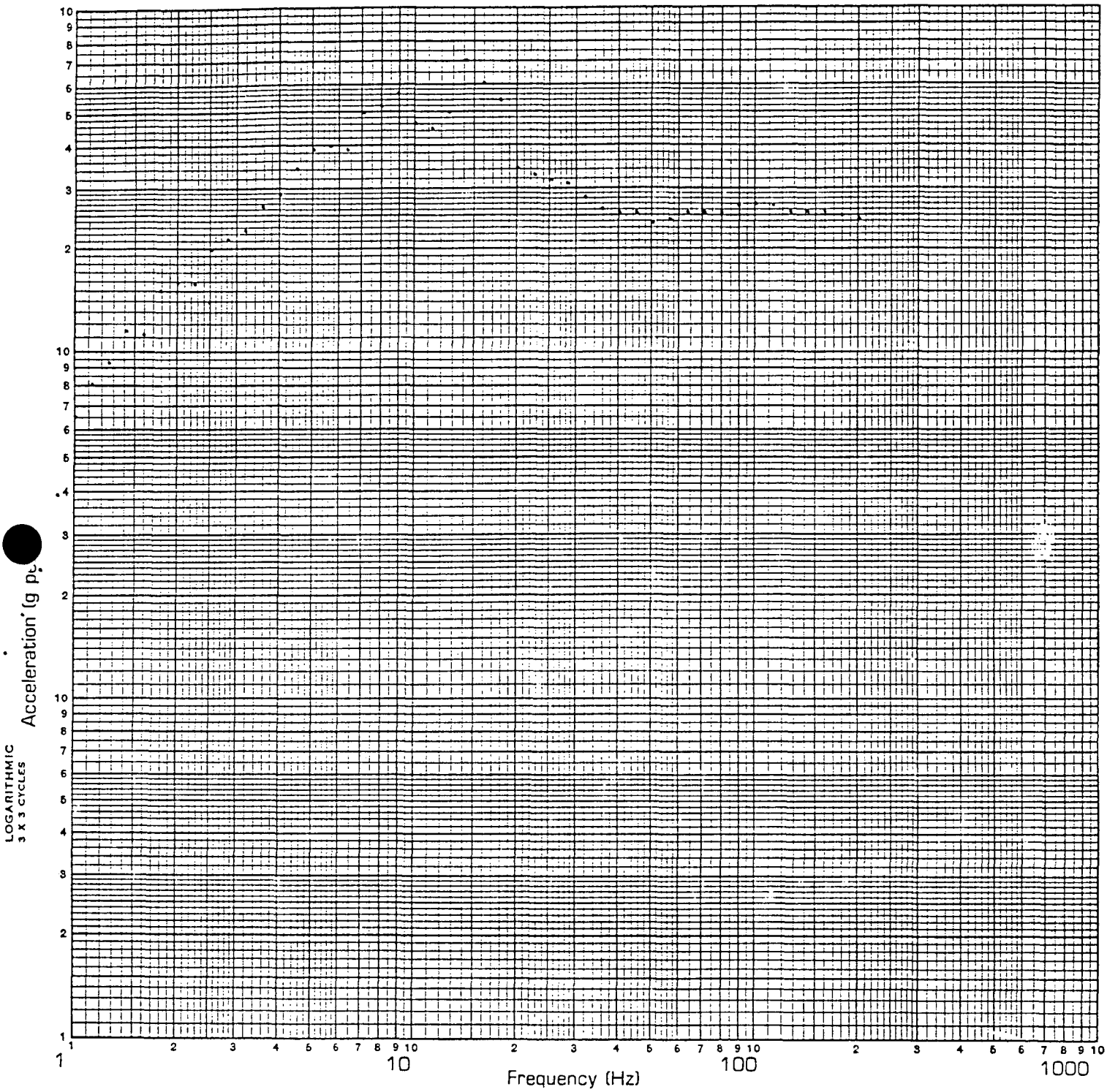
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

LOCATION NO. 11 LONG

AXIS TRI

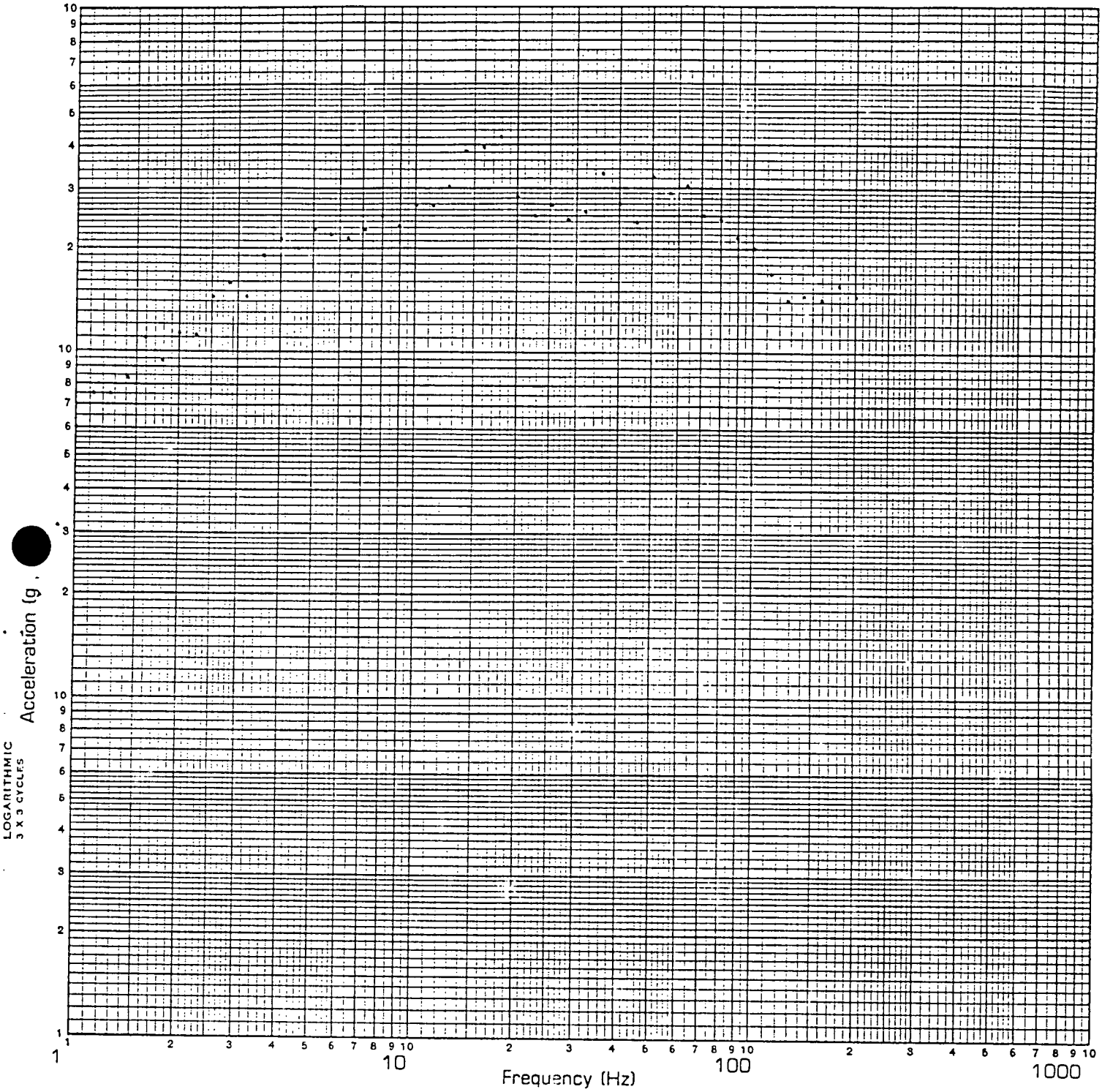
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

AXIS TRI

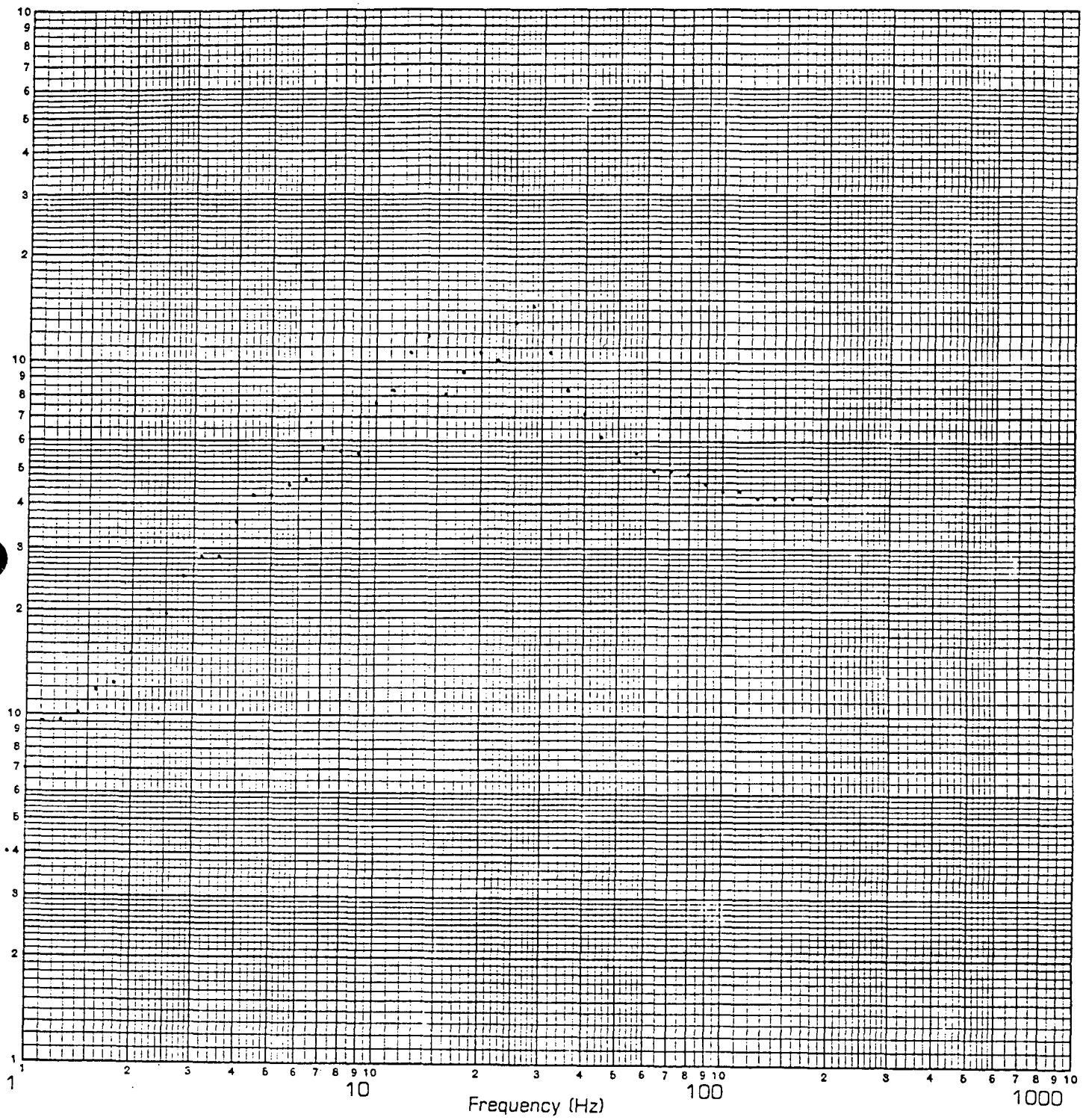
LOCATION NO. 12V

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5 %



SPECIMEN Single Cable Tray w/ Air Drop Support

LOCATION NO. 16LAT

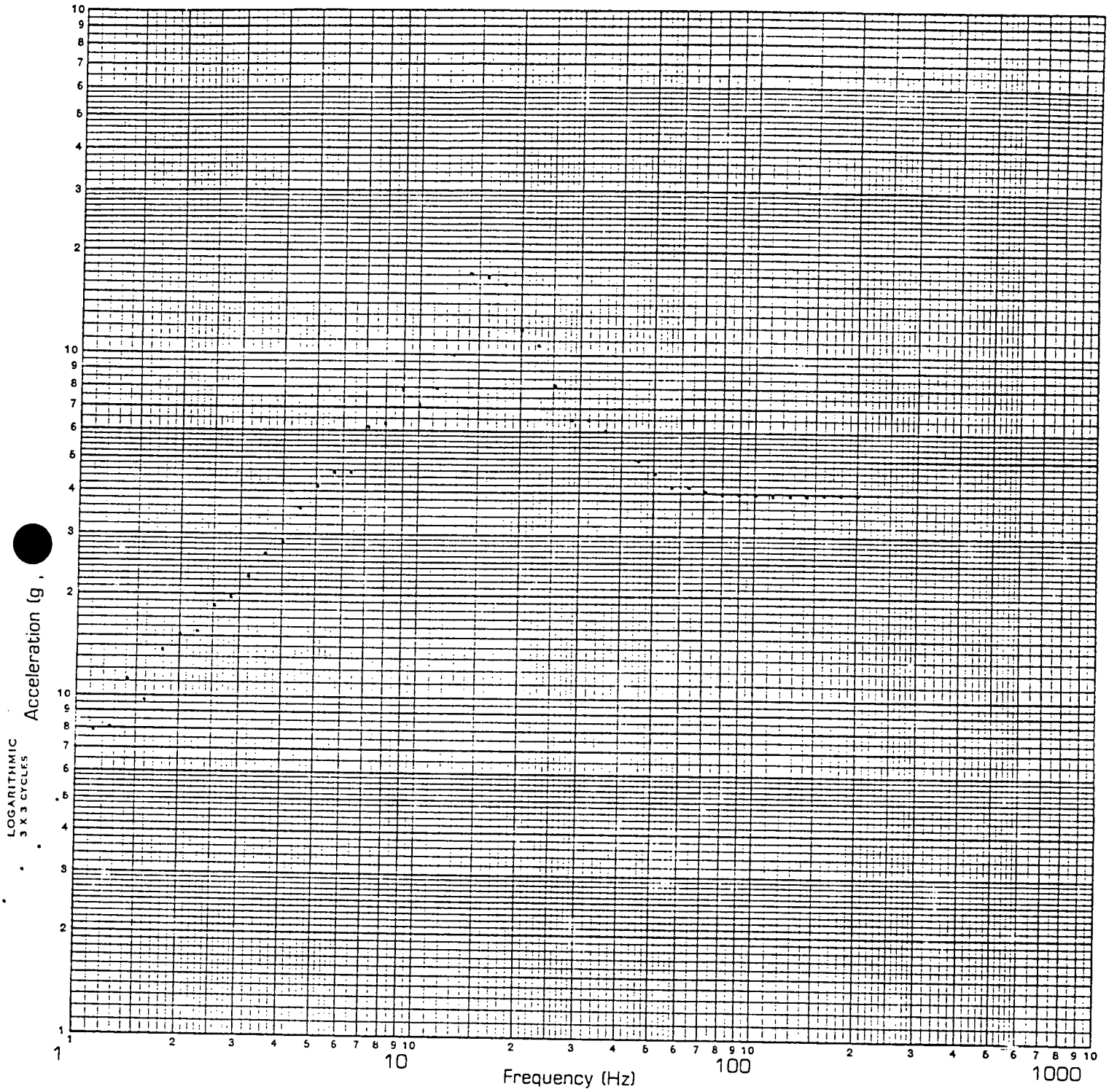
AXIS TRT

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5%



SPECIMEN Single Cable Tray w/ Air Drop Support

AXIS TRI

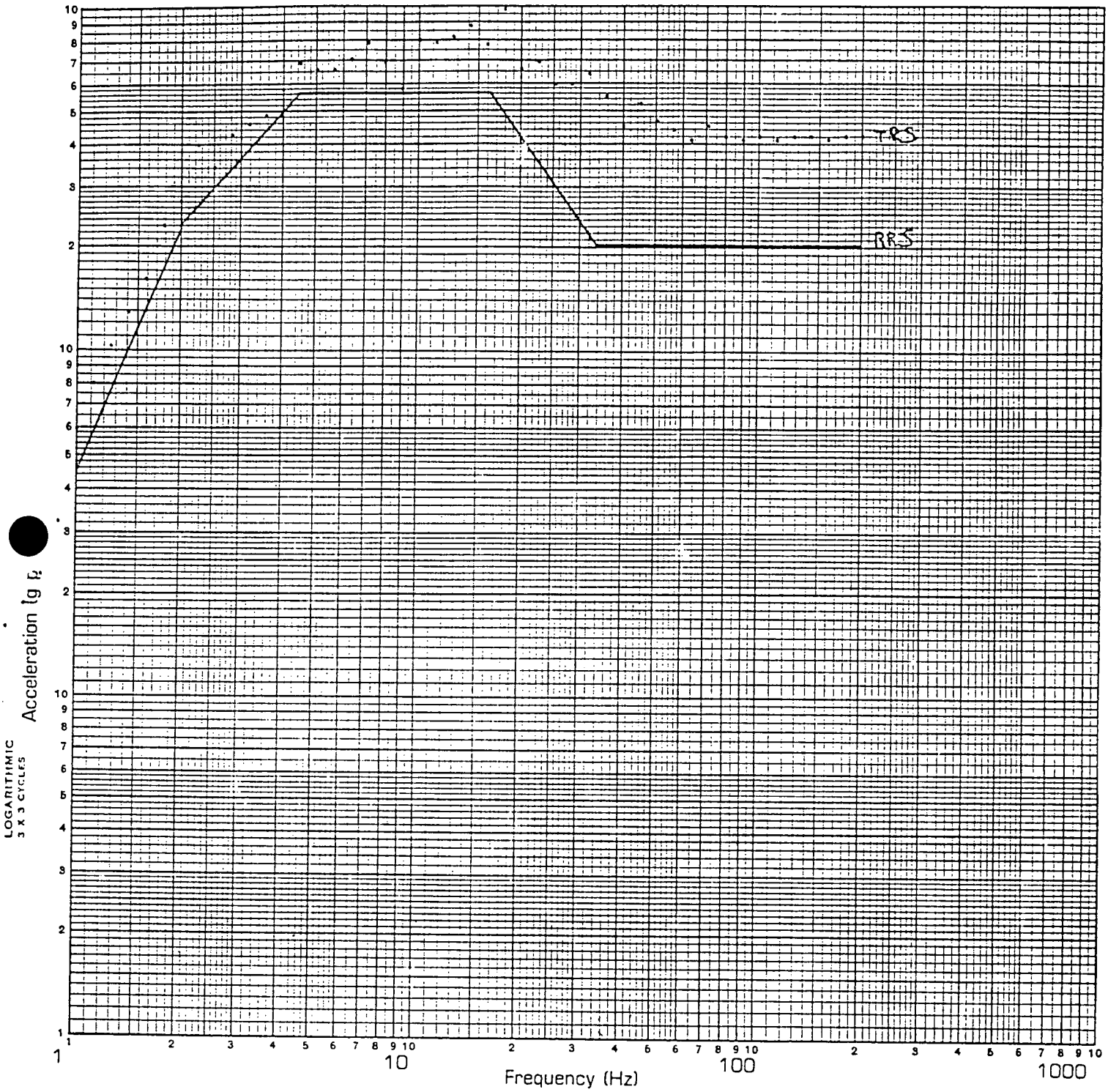
LOCATION NO. 17 LONG

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

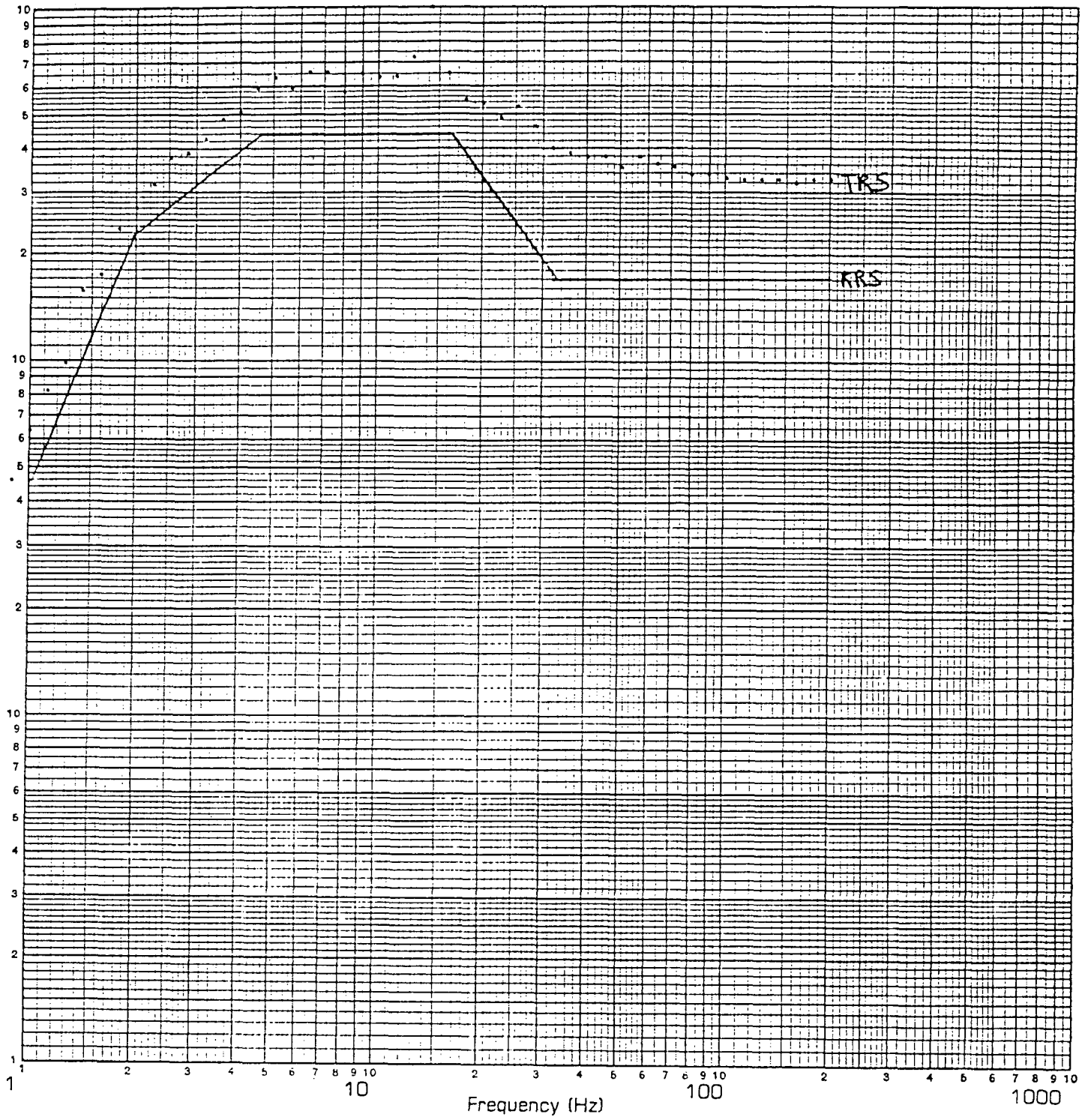
LOCATION NO. LAT HCA

TEST RUN NO. 7

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5%



SPECIMEN

AXIS TRI

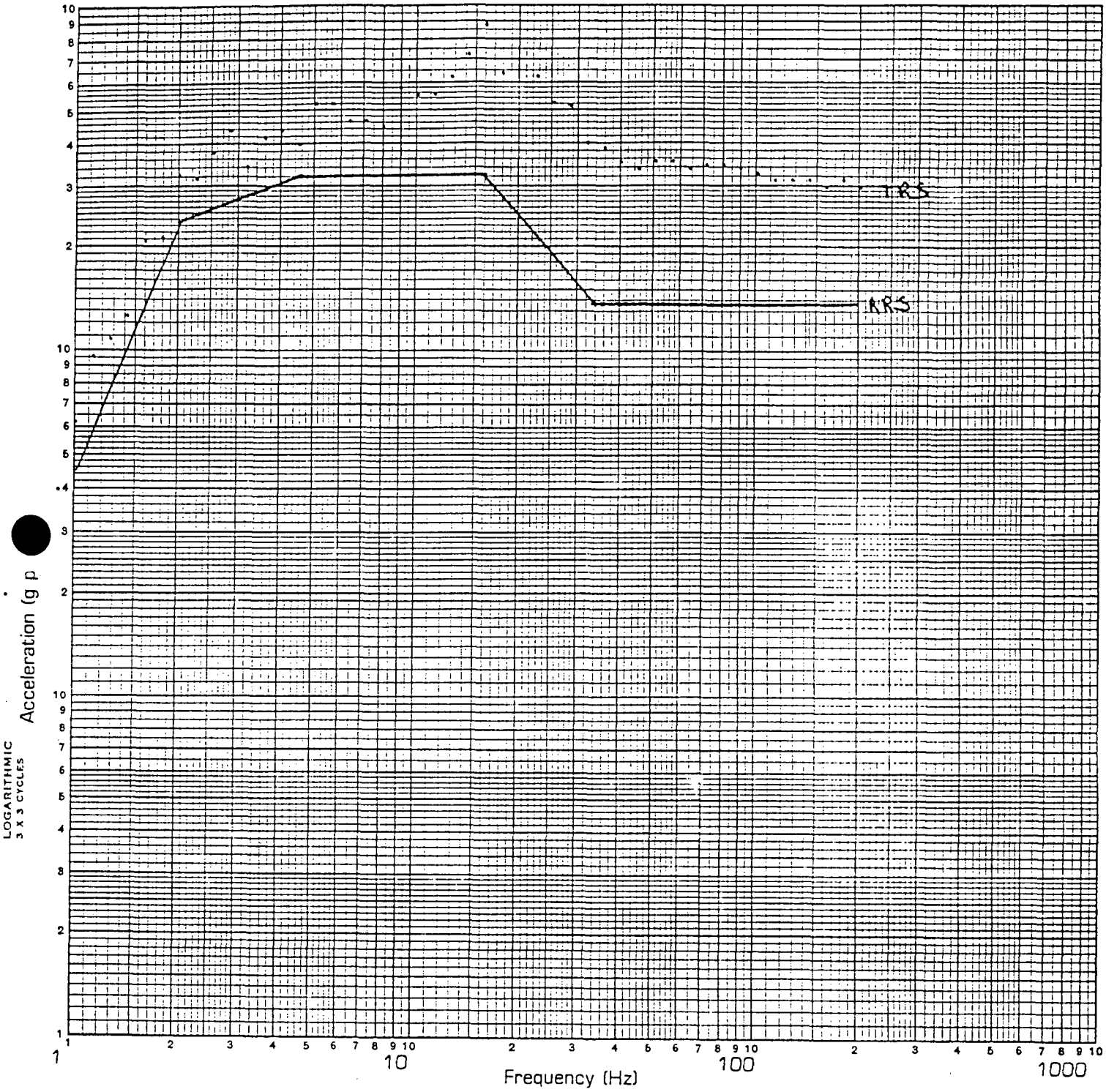
LOCATION NO. LONG HCA

TEST RUN NO. 7

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

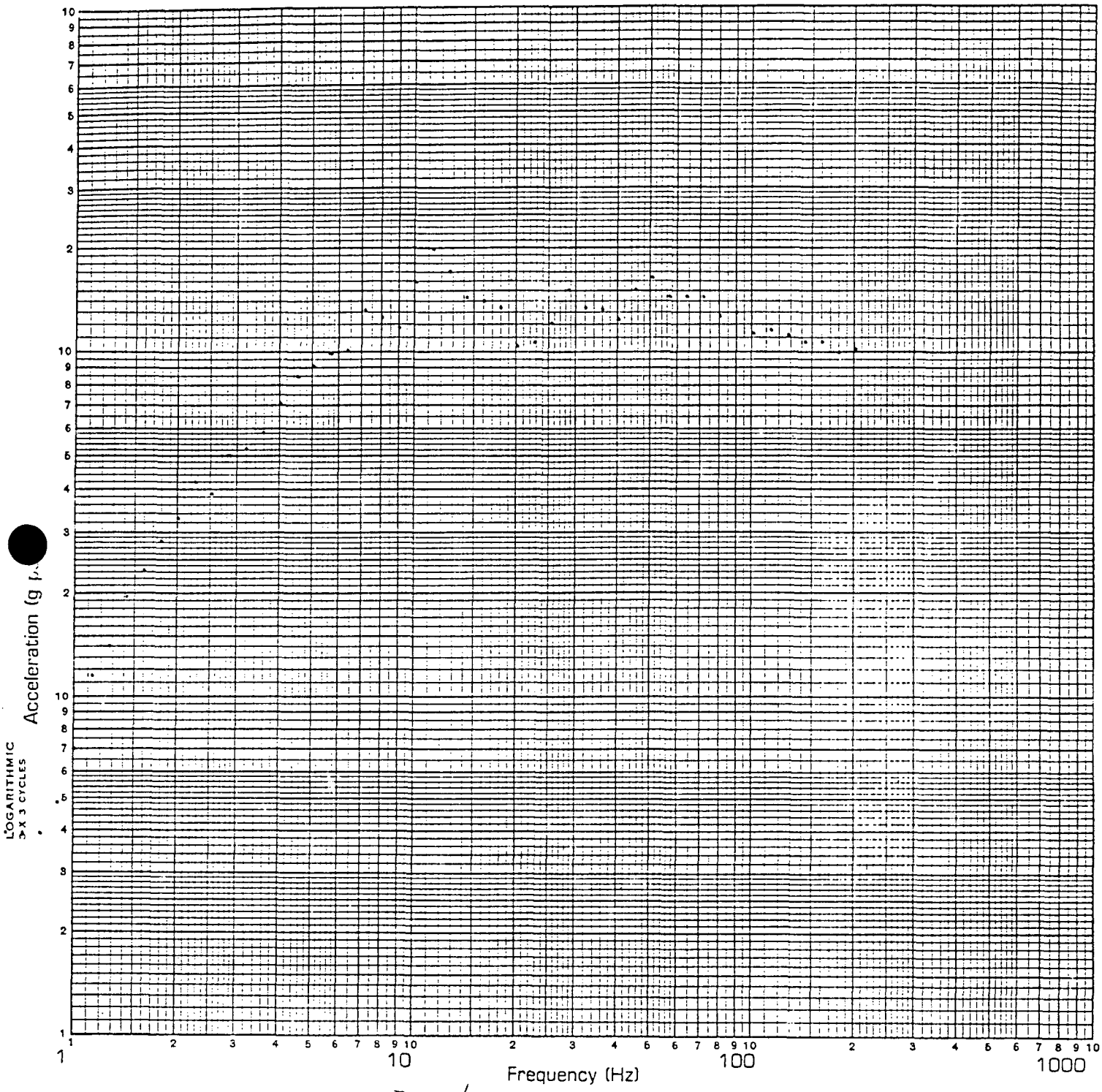
LOCATION NO. VCA

TEST RUN NO. 7

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



Single Cable Tray w/

SPECIMEN Air Drop

LOCATION NO. 1LAT

AXIS TRI

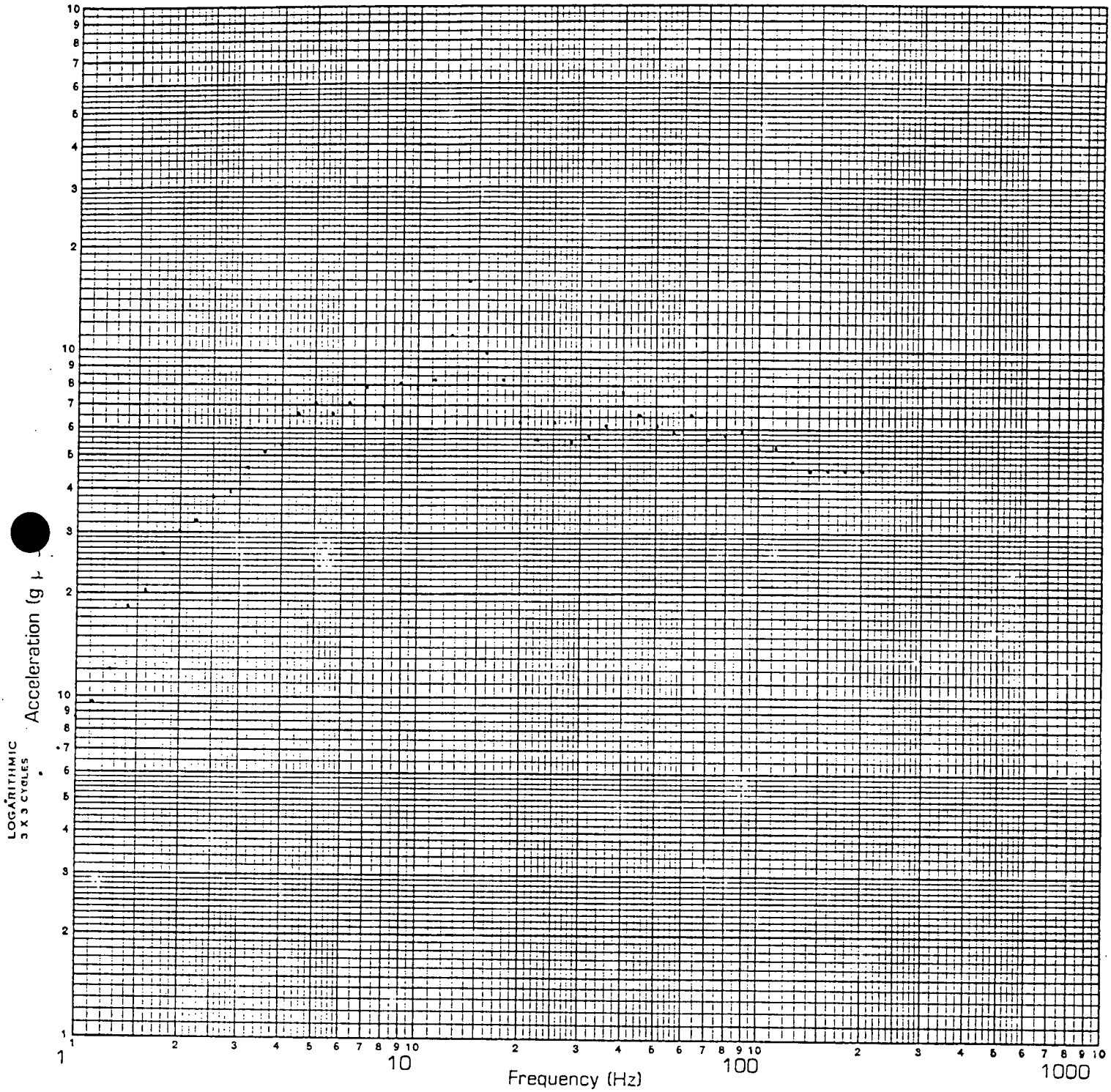
TEST RUN NO. 7

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Cable Tray w/ Air Drop

LOCATION NO. 2 LONG

AXIS TRI

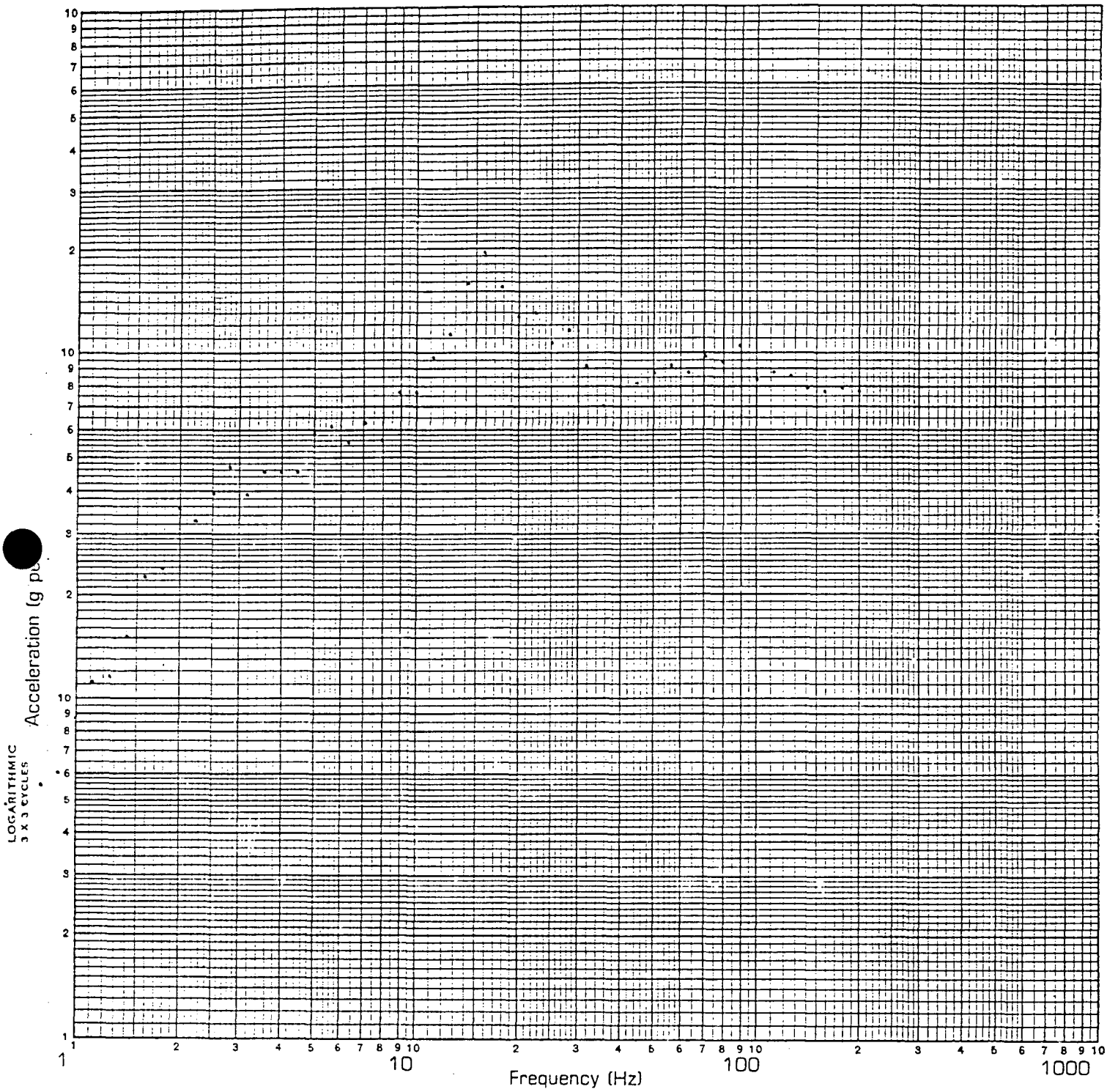
TEST RUN NO. 7

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Cable Tray w/ Air Drop

LOCATION NO. 3V

AXIS TRI

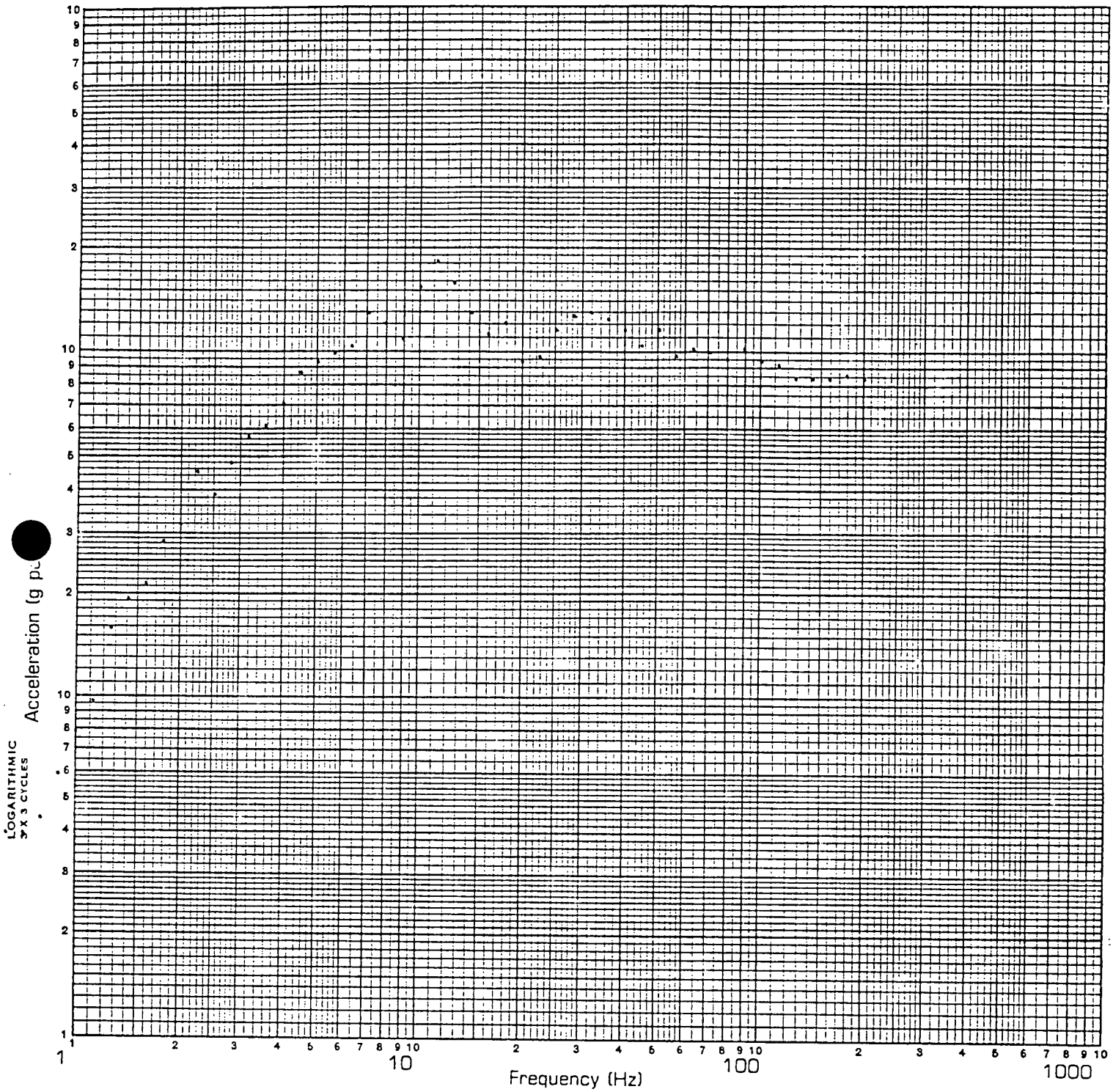
TEST RUN NO. 7

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



Single cable Tray w/

SPECIMEN Air Drop

LOCATION NO. 4 LAT

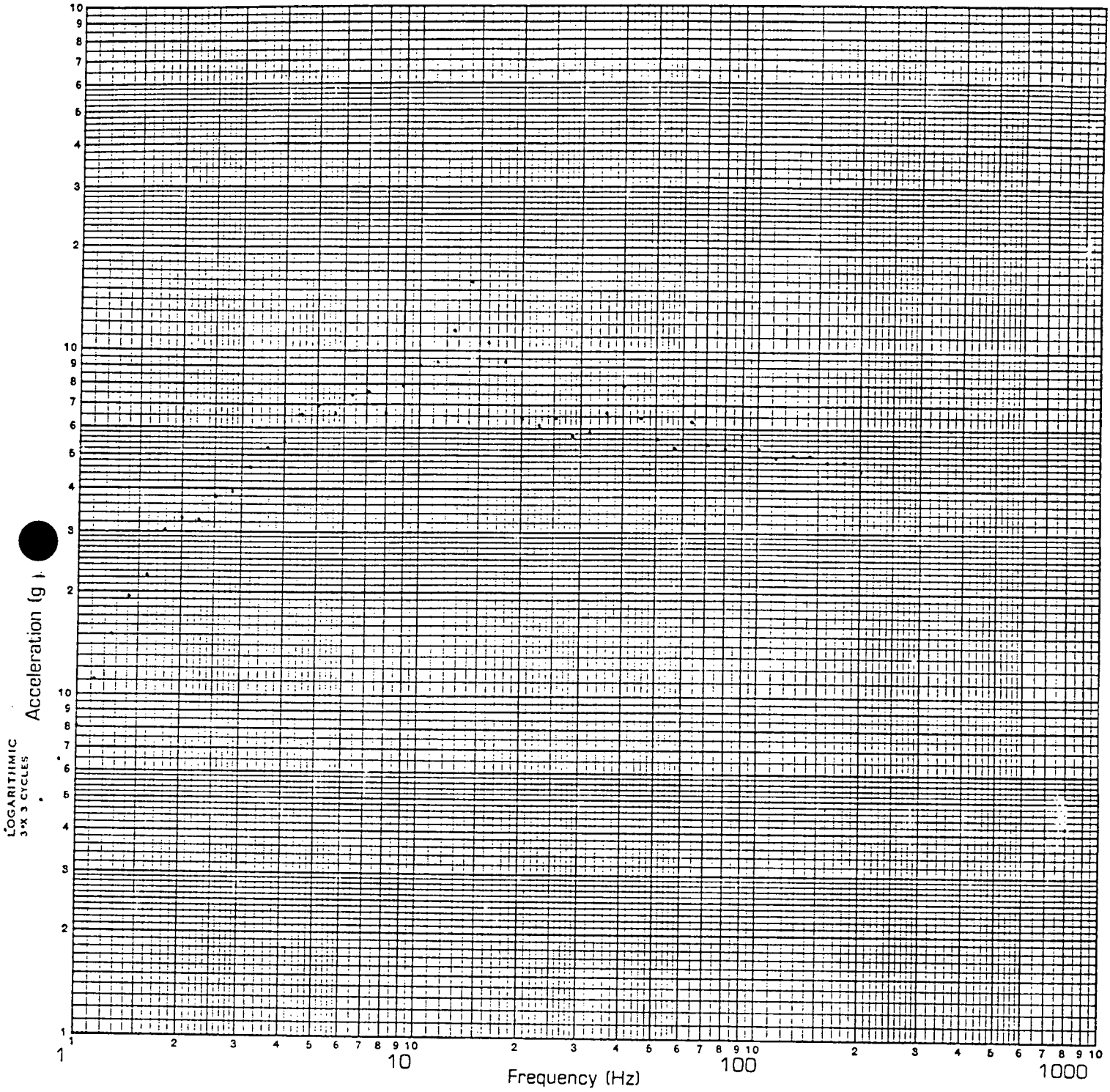
AXIS TRT

TEST RUN NO. 7

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Cable Tray w/ Air Drop

AXIS TRI

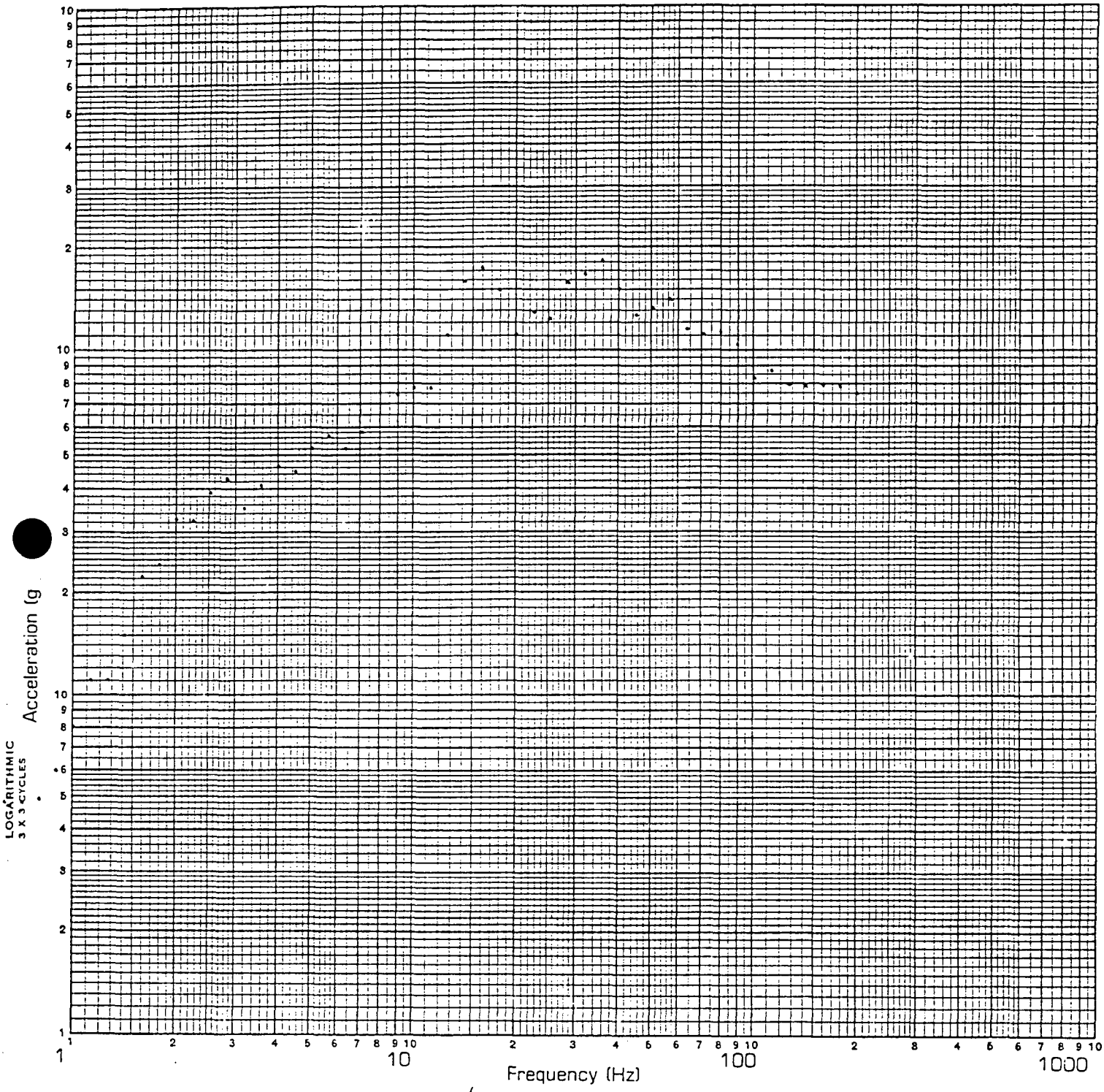
LOCATION NO. 5 LONG

TEST RUN NO. 7

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



Single Cable Tray w/

SPECIMEN Air Drop

LOCATION NO. 6 V

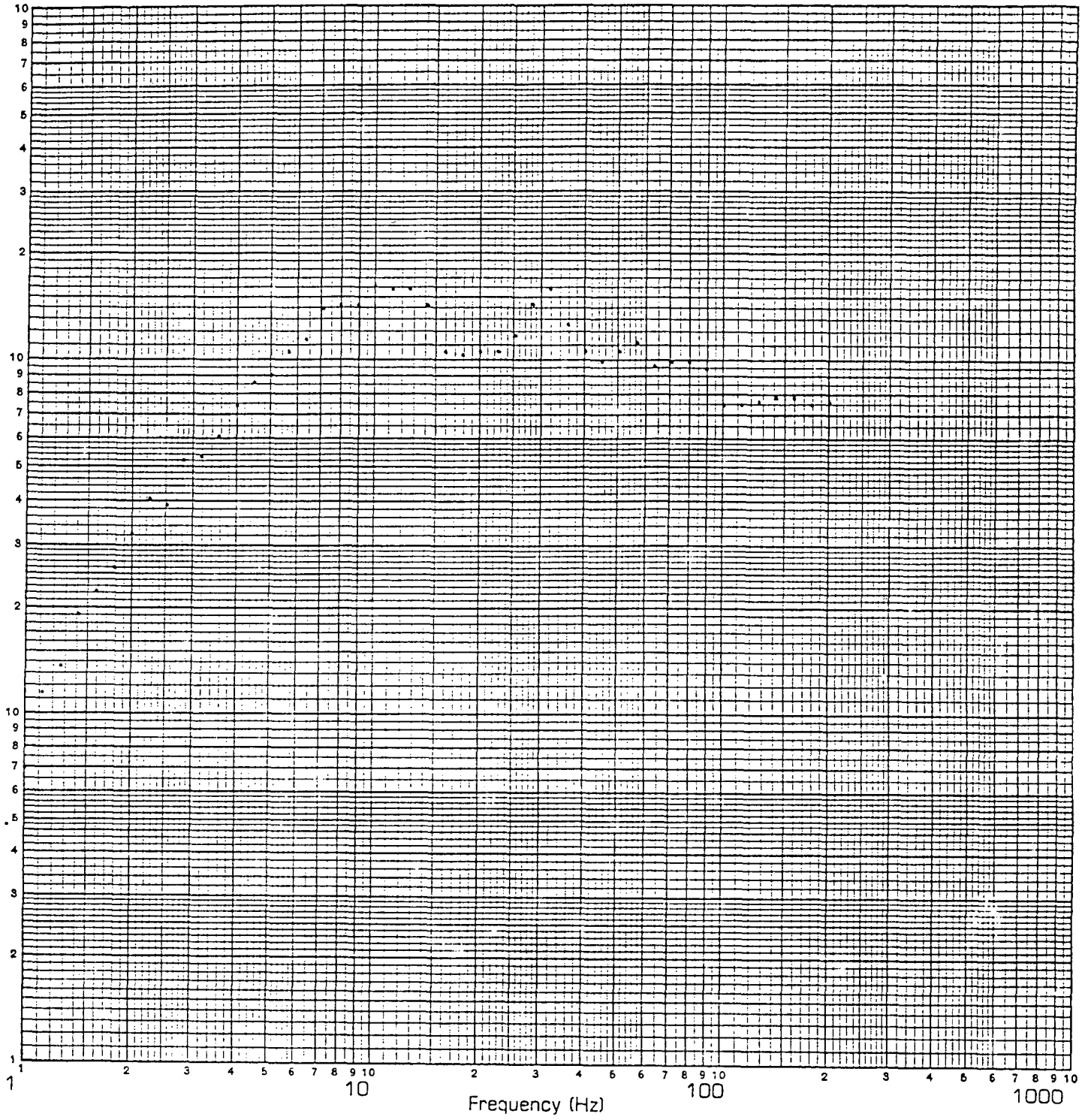
AXIS TRI

TEST RUN NO. 7

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

LOCATION NO. 7LAT

AXIS TRI

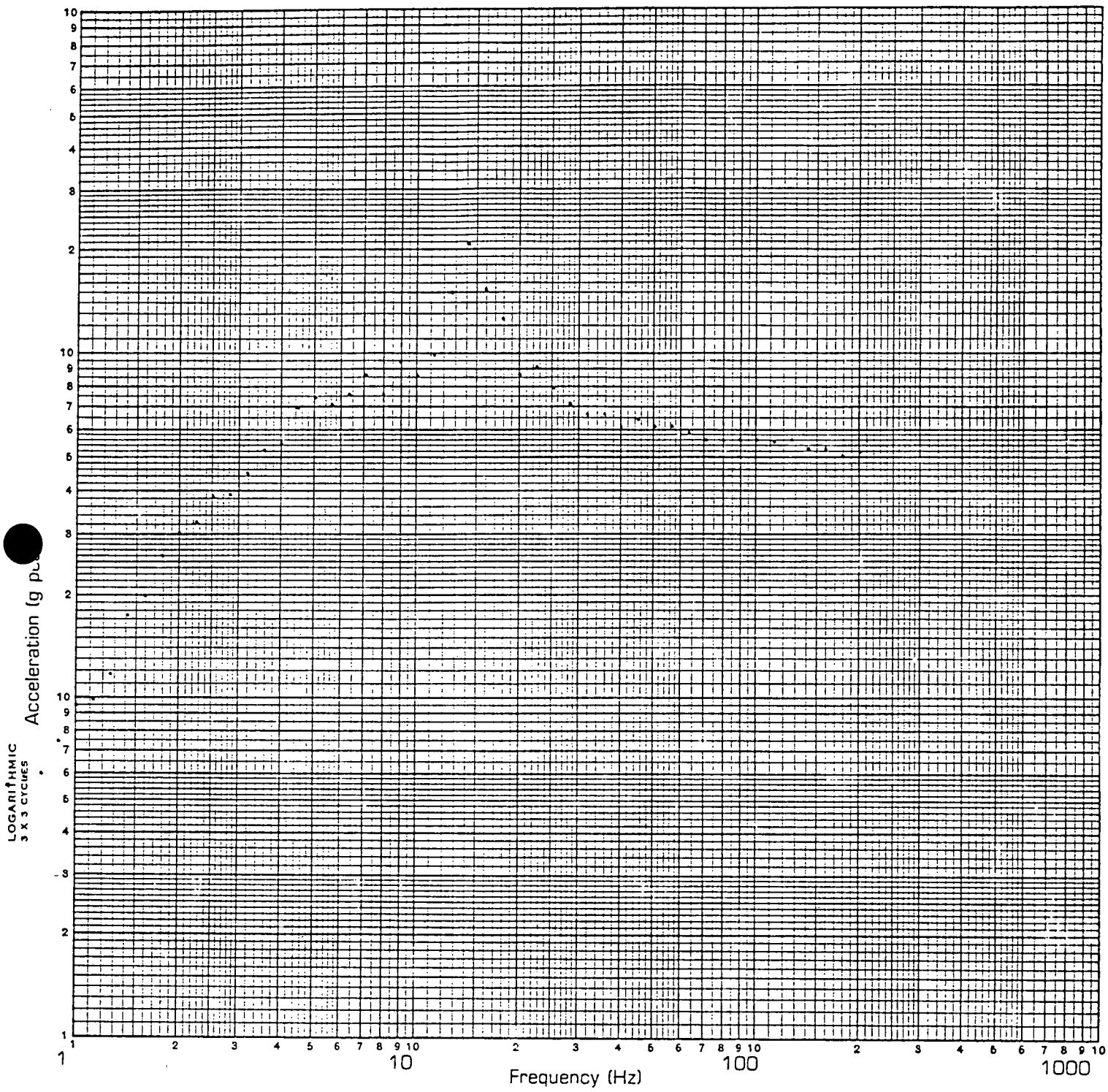
TEST RUN NO. 7

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

LOCATION NO. 8 LONG

AXIS TRI

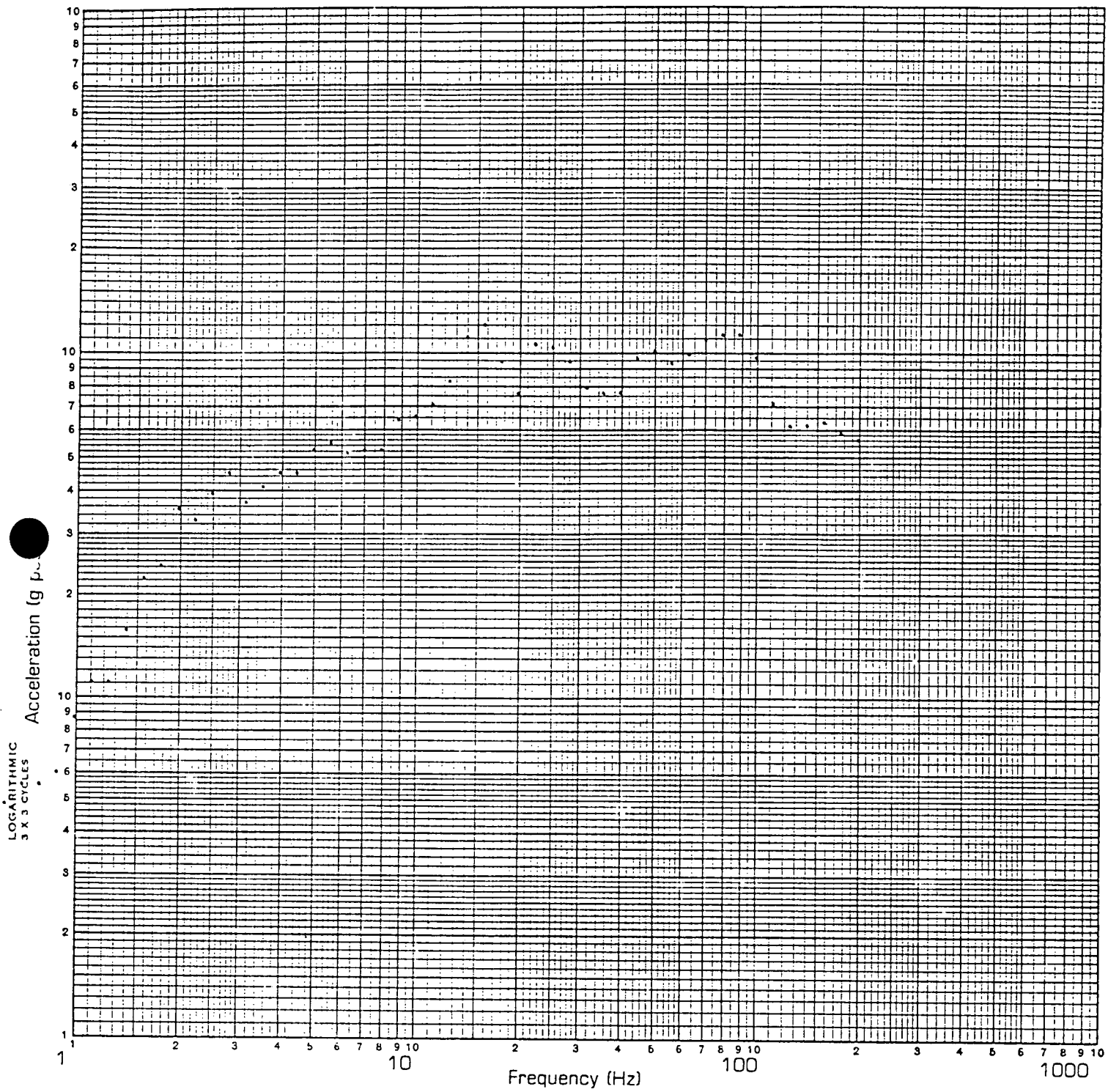
TEST RUN NO. 7

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

LOCATION NO. 9V

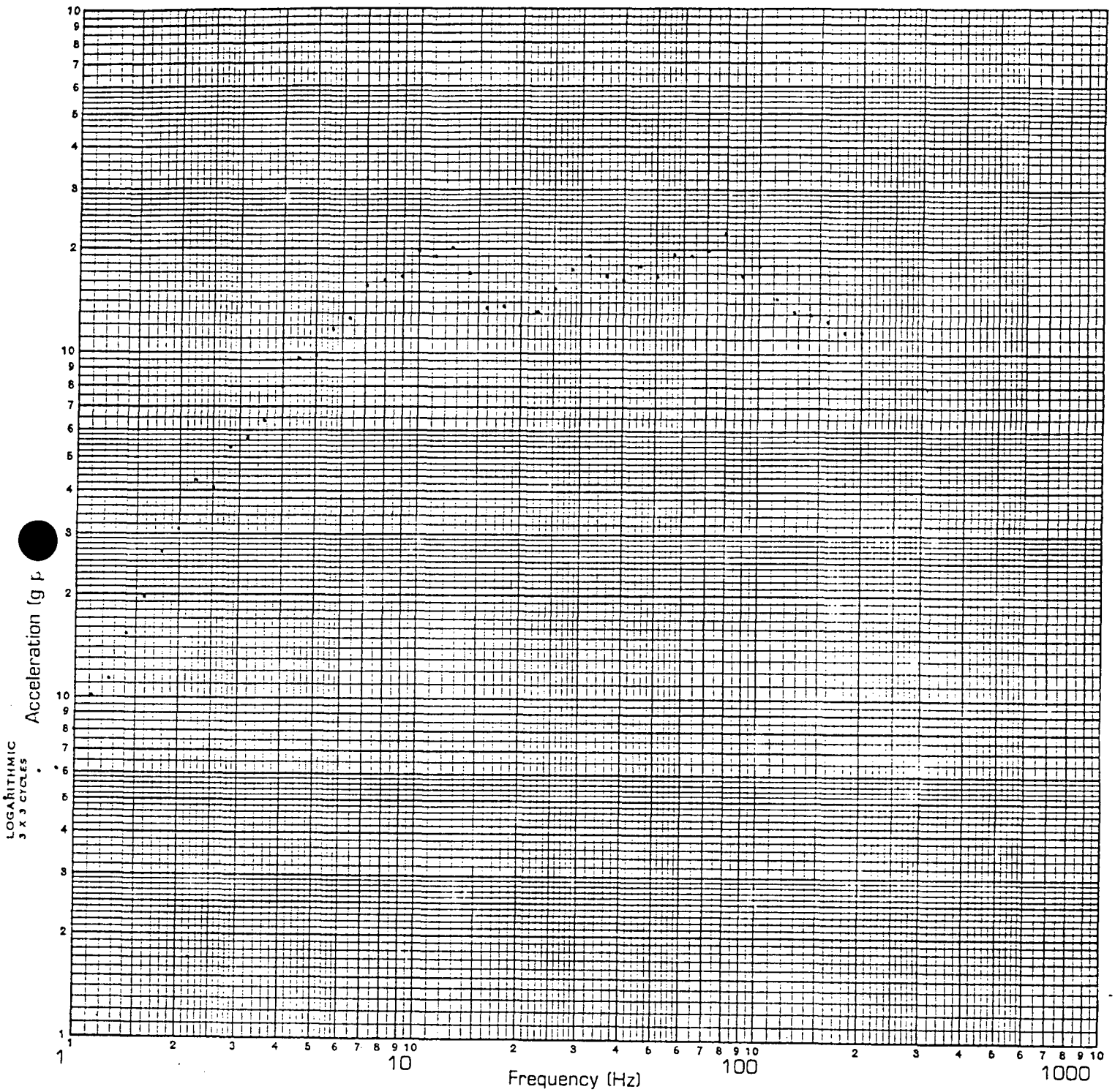
AXIS TRL

TEST RUN NO. 7

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

AXIS TRL

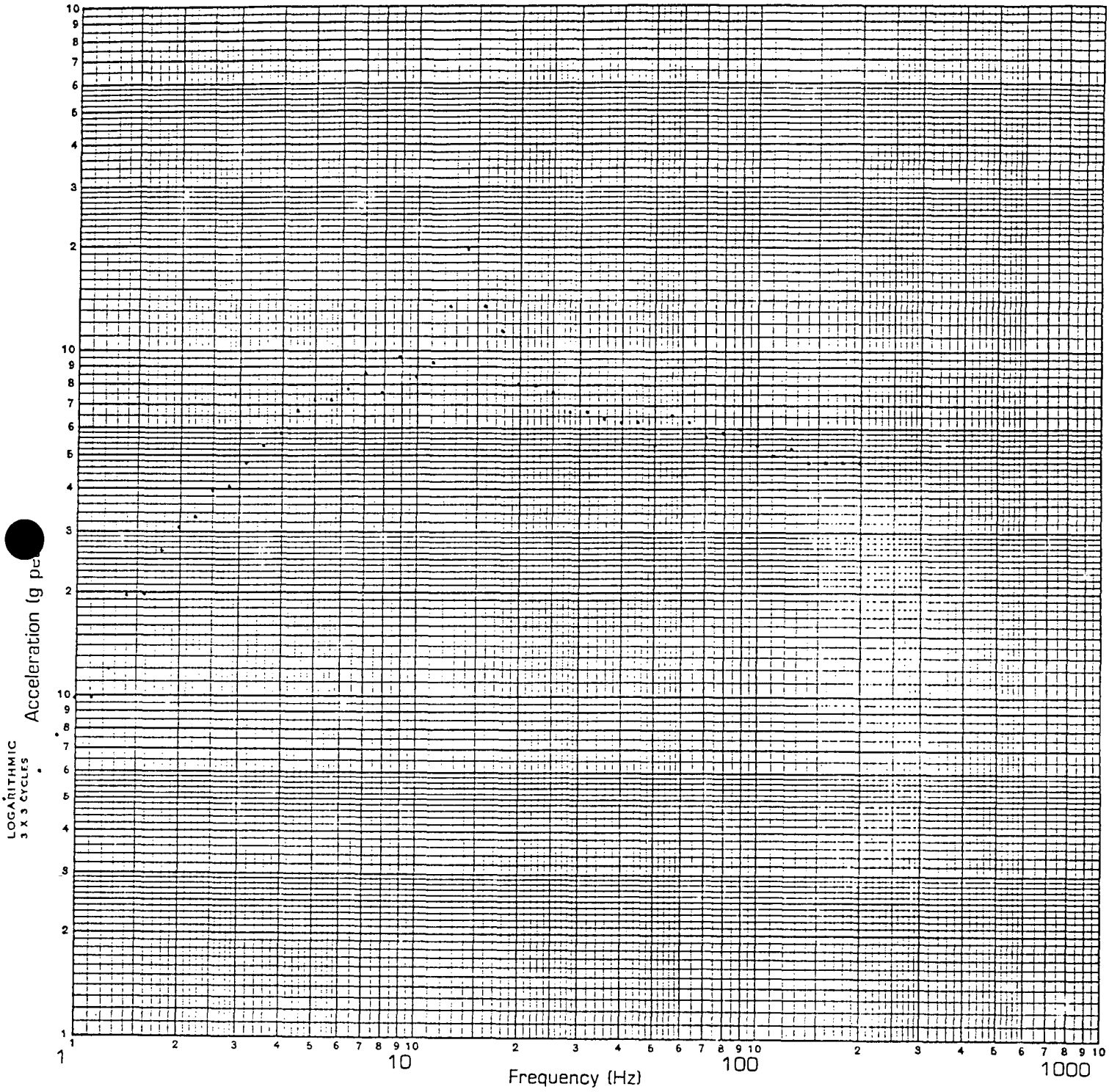
LOCATION NO. 10 LAT

TEST RUN NO. 7

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

LOCATION NO. 11 LONG

AXIS TRI

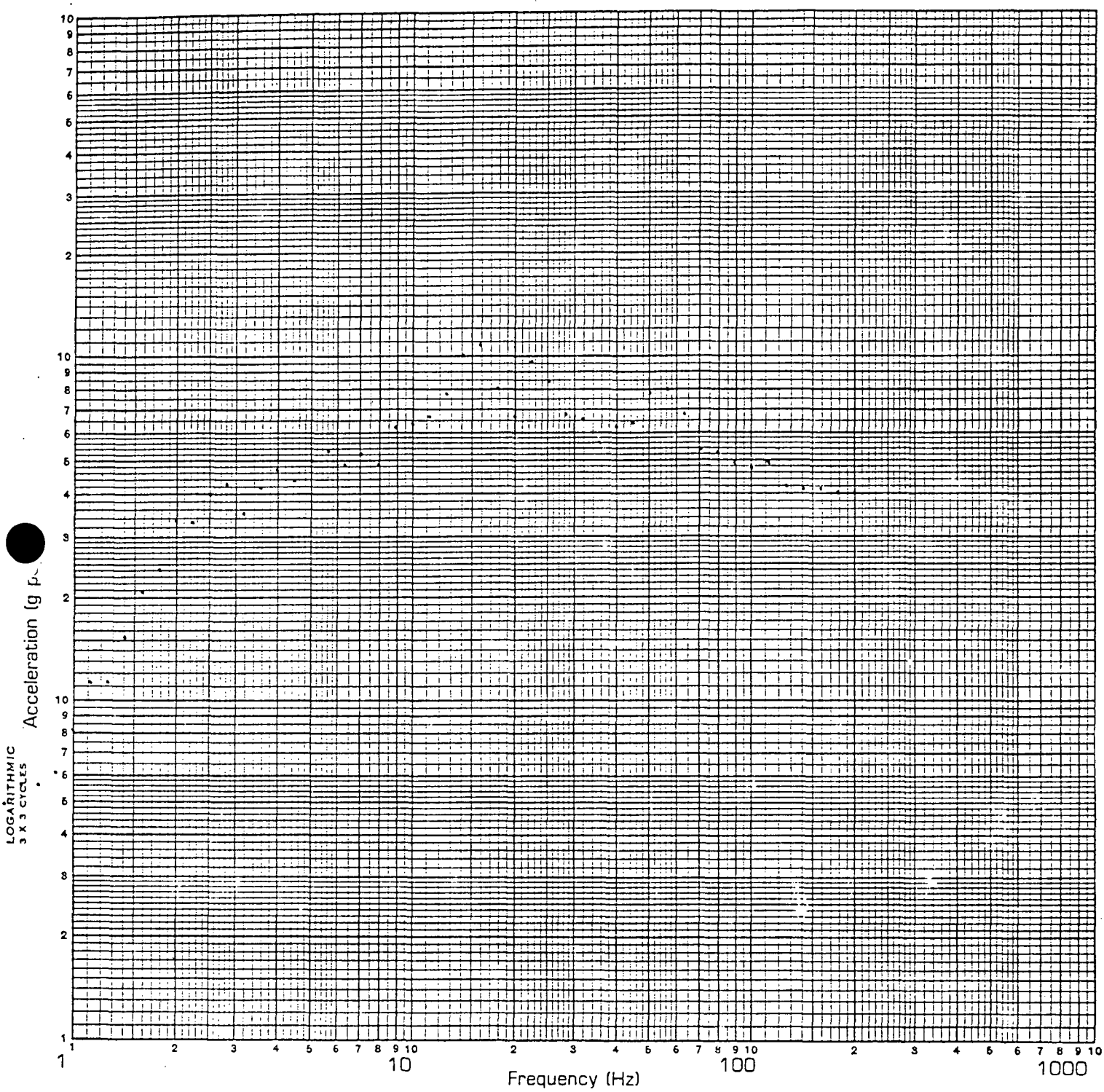
TEST RUN NO. 7

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Multiple Cable Tray

LOCATION NO. 12V

AXIS TRI

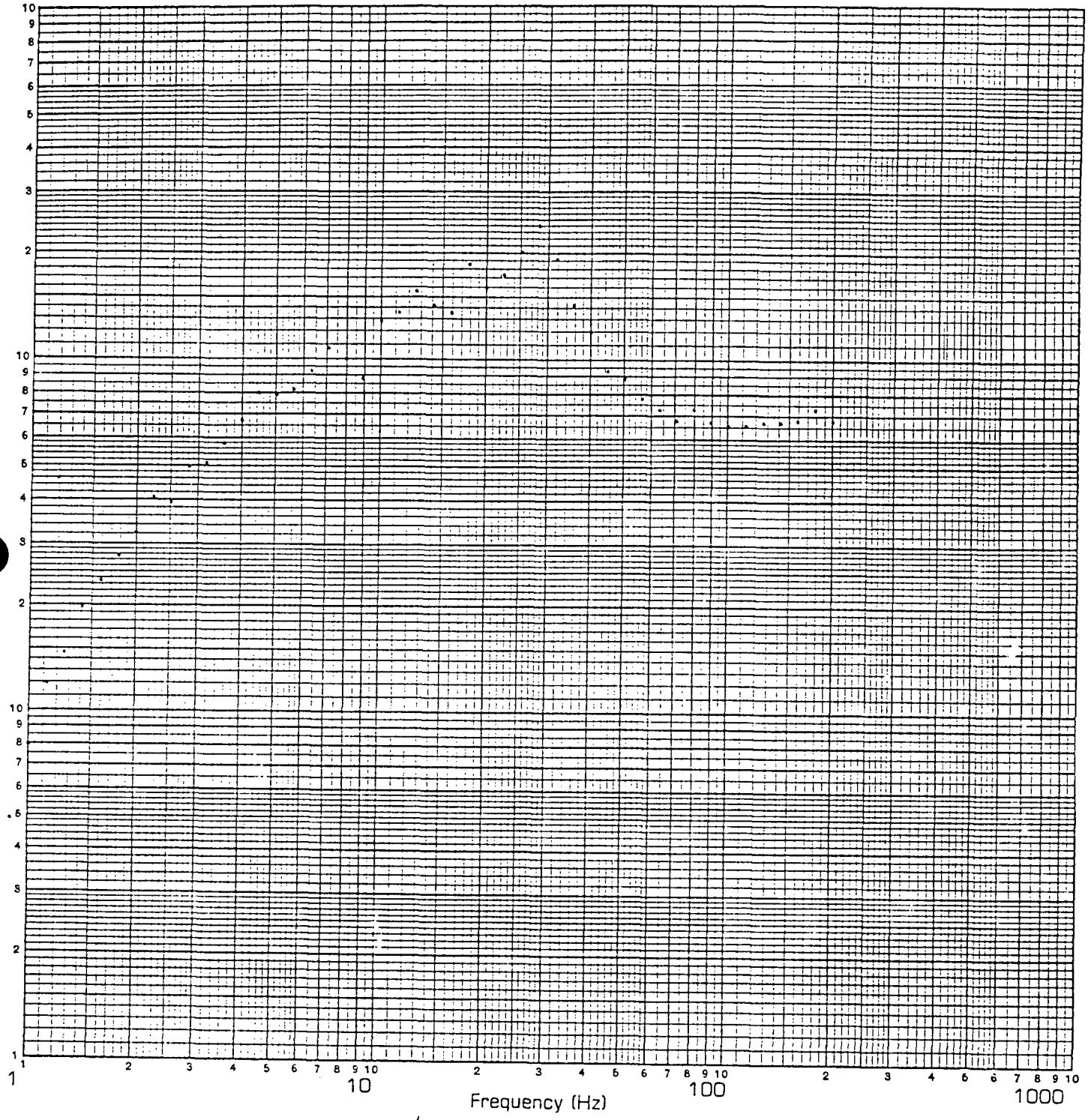
TEST RUN NO. 7

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Cable Tray w/ Air Drop Support

AXIS TRI

LOCATION NO. 16 LAT

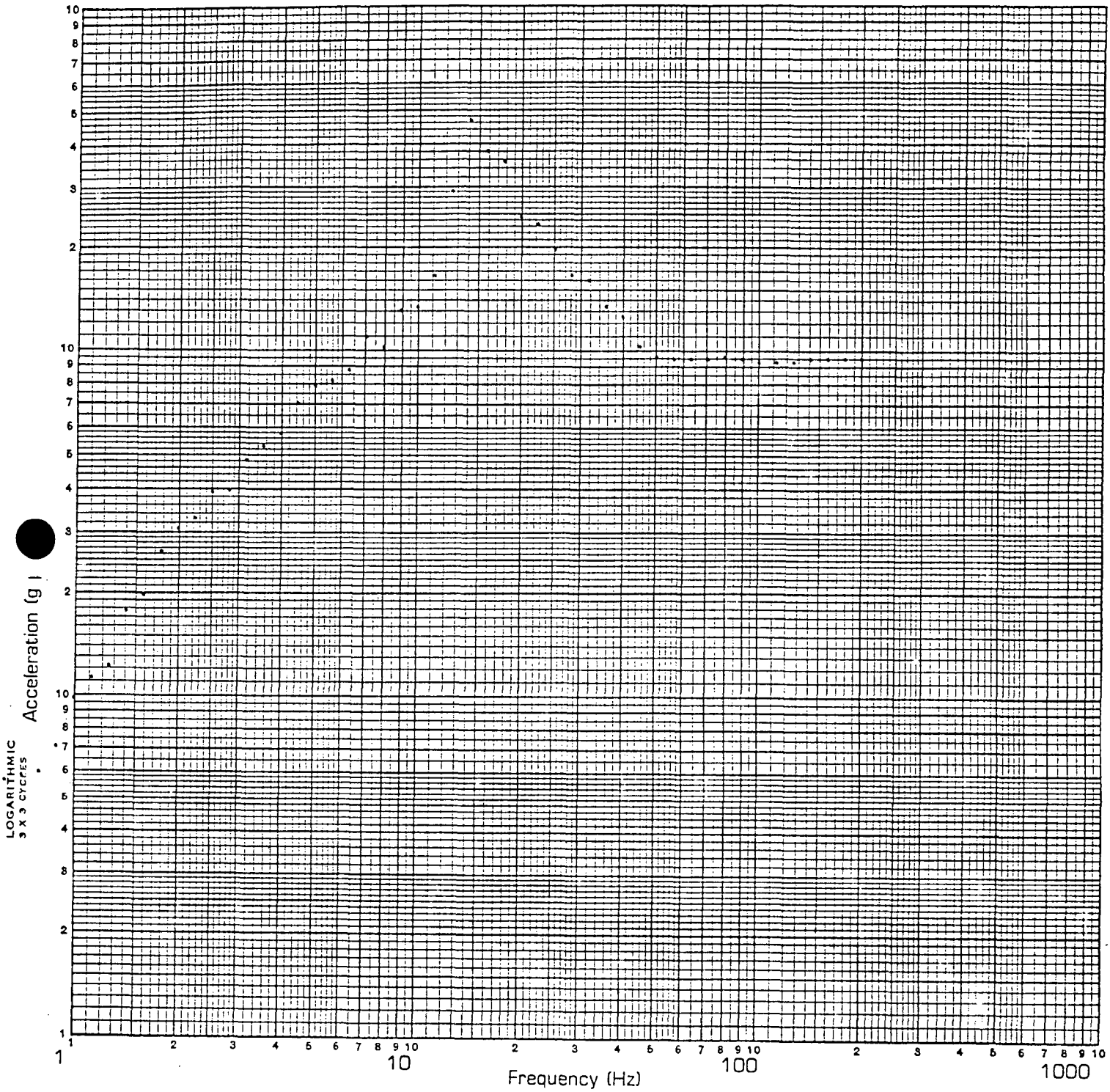
TEST RUN NO. 7

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5%



SPECIMEN Single Cable Tray w/ Air Drop Support

LOCATION NO. 17 LONG

AXIS TRT

TEST RUN NO. 7

APPENDIX VII

SERIES 2 RANDOM MULTIFREQUENCY TEST RESPONSE SPECTRUM PLOTS

Test Run	Plots
4	Control Accelerometers @ 5% Damping
5	Control and Response Accelerometers @ 5% Damping
6	Control and Response Accelerometers @ 5% Damping

LEGEND:

HCA	=	Horizontal Control Accelerometer
VCA	=	Vertical Control Accelerometer
LAT	=	Front to Back
LONG	=	Side to Side
V	=	Vertical
OBE	=	Operating Basis Earthquake
SSE	=	Safe shutdown Earthquake

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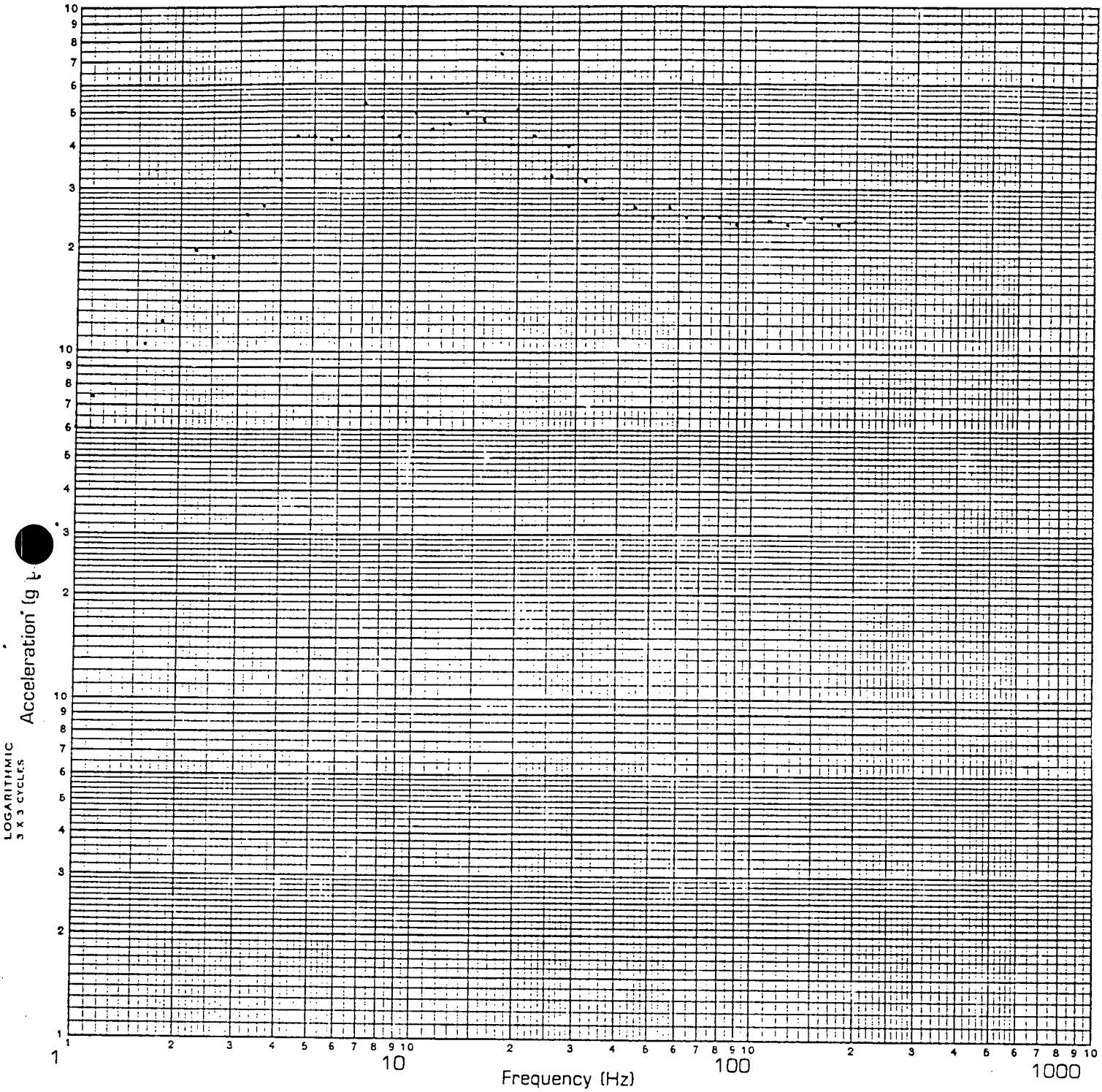
FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5%



SPECIMEN —

AXIS TRI

LOCATION NO. LAT HCA

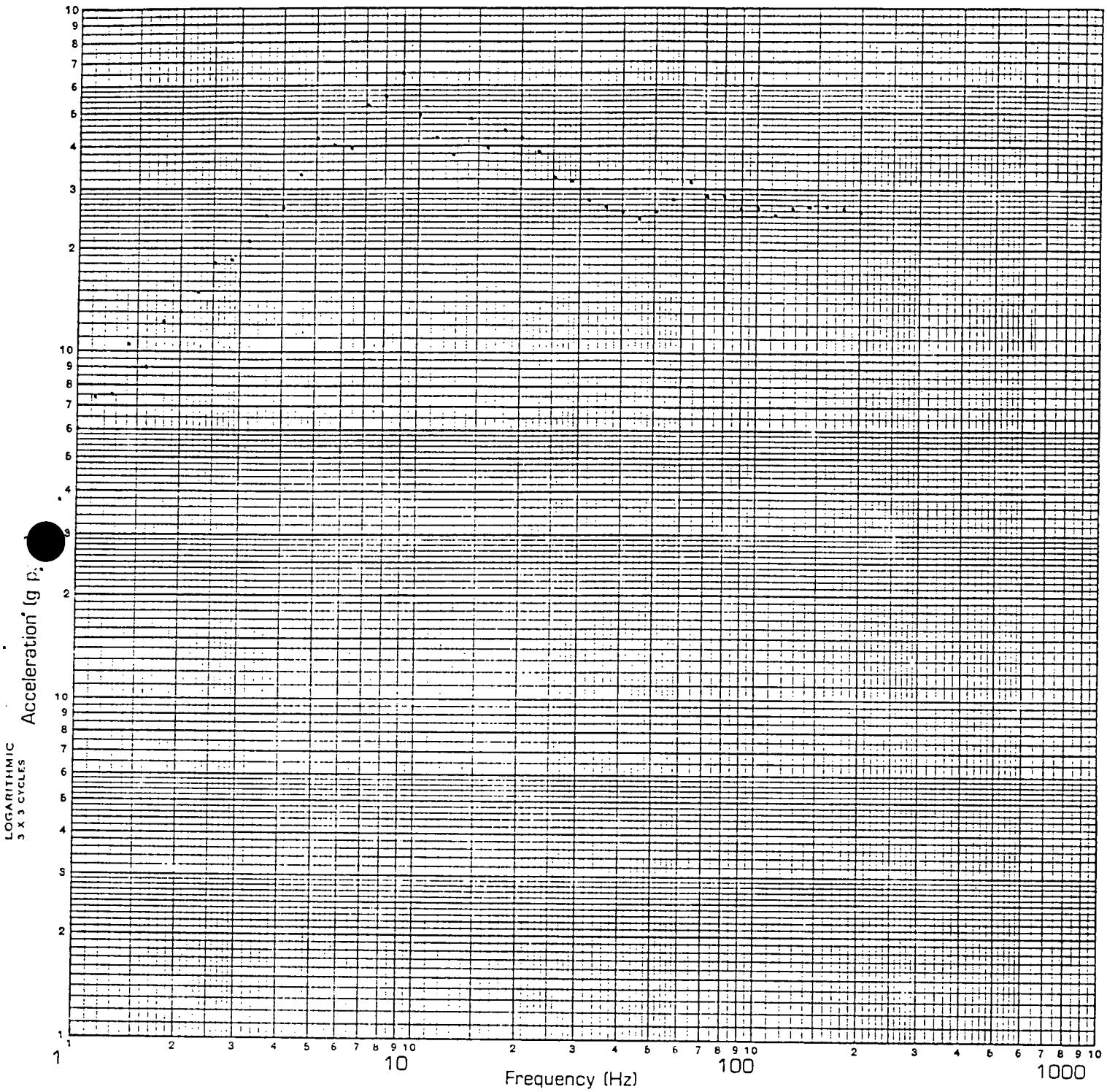
TEST RUN NO. 4

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5%



SPECIMEN ——

AXIS TRT

LOCATION NO. LONG HCA

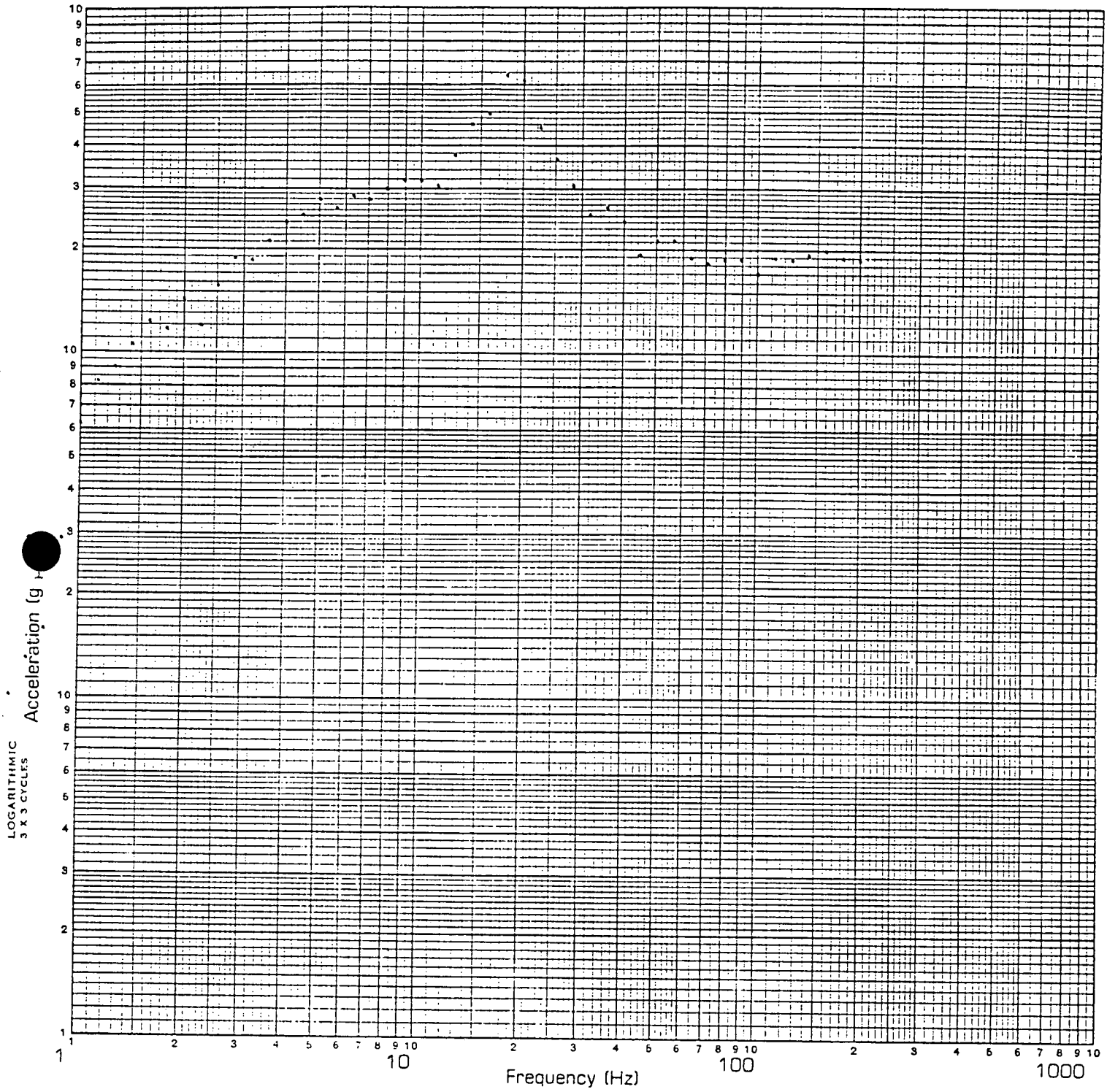
TEST RUN NO. 4

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

LOCATION NO. VCA

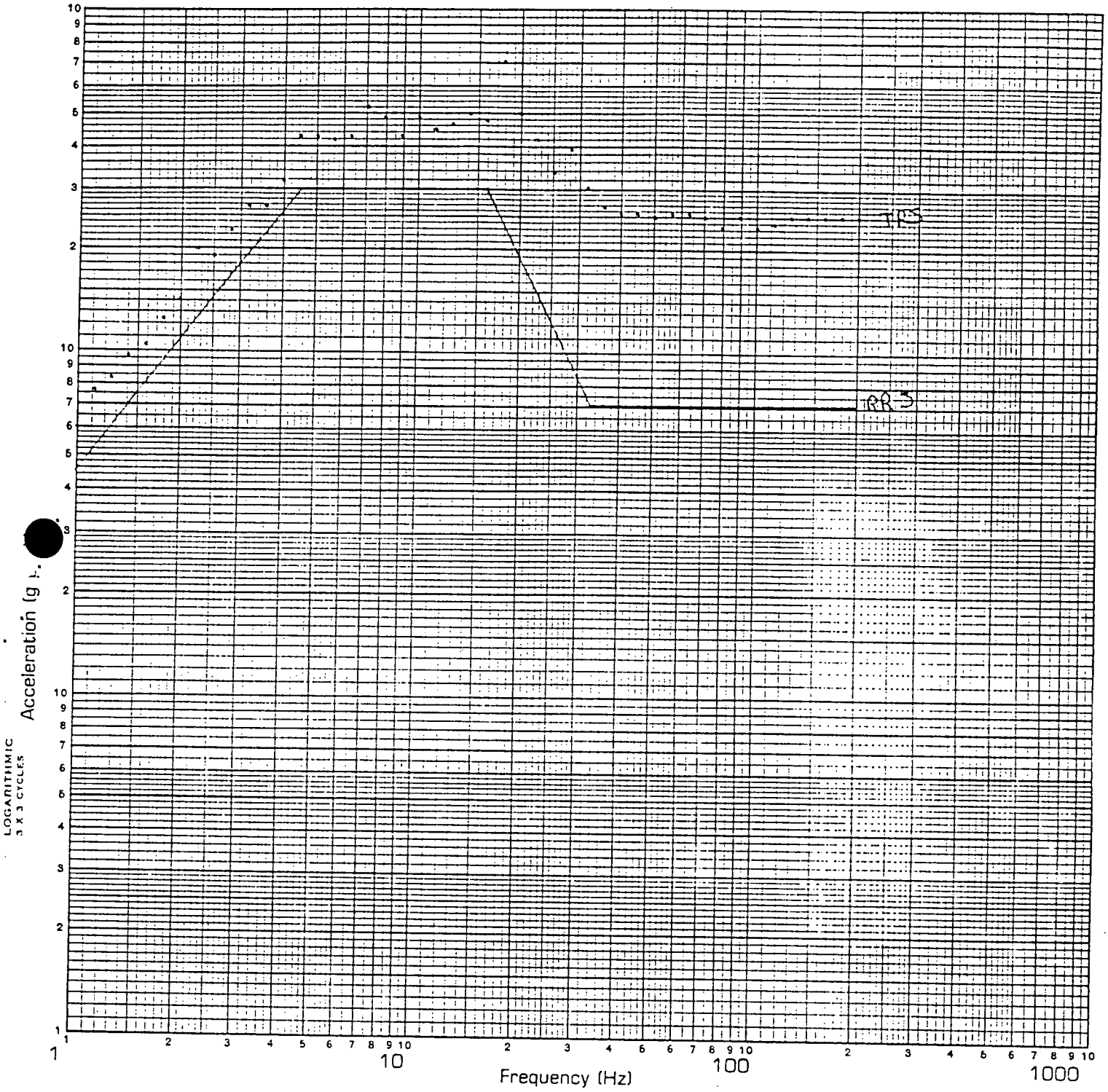
TEST RUN NO. 4

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN _____

AXIS TRI

LOCATION NO. LAT HCA

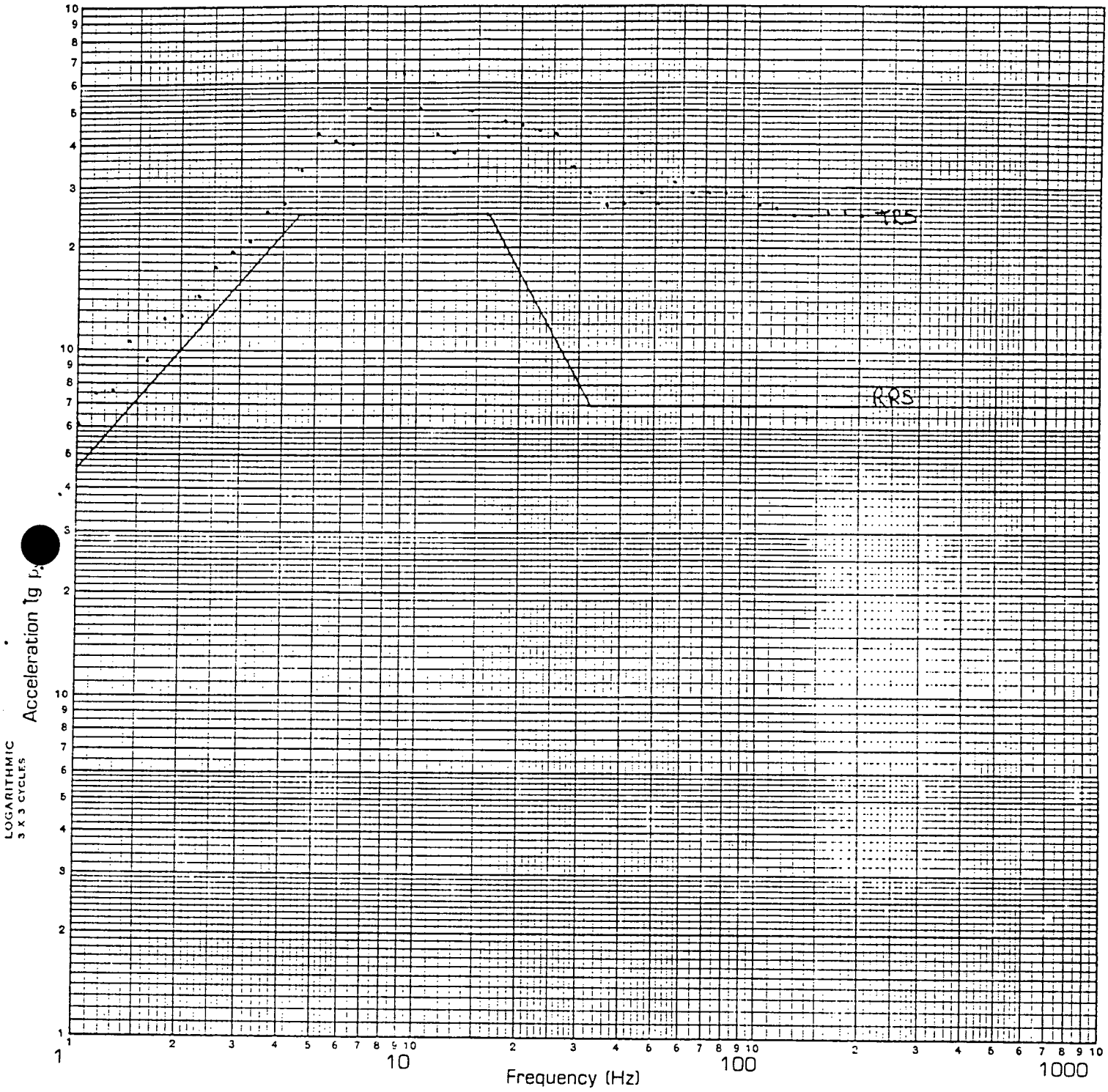
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN —

AXIS TRL

LOCATION NO. LONG HCA

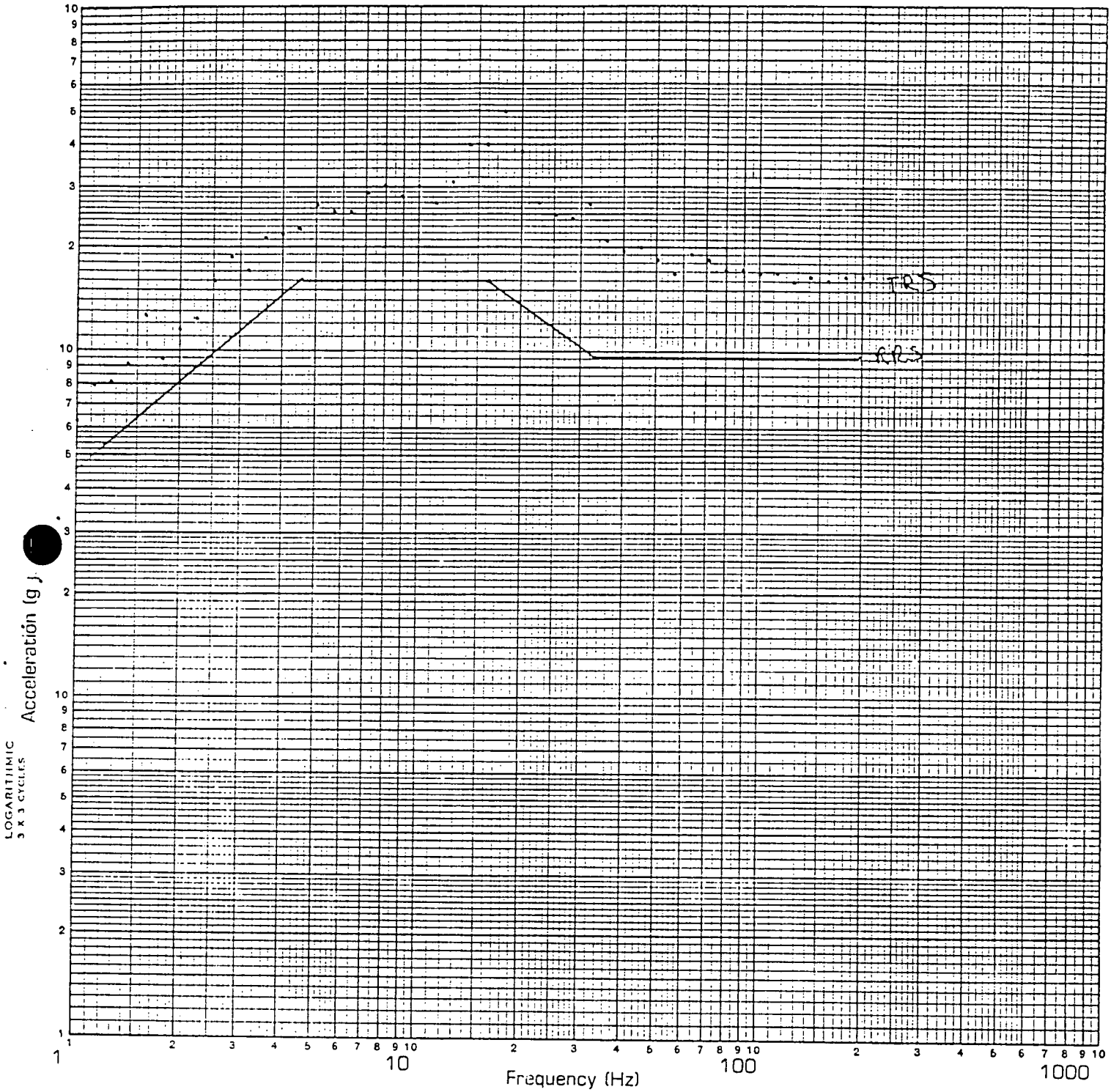
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5%



SPECIMEN —

AXIS TRI

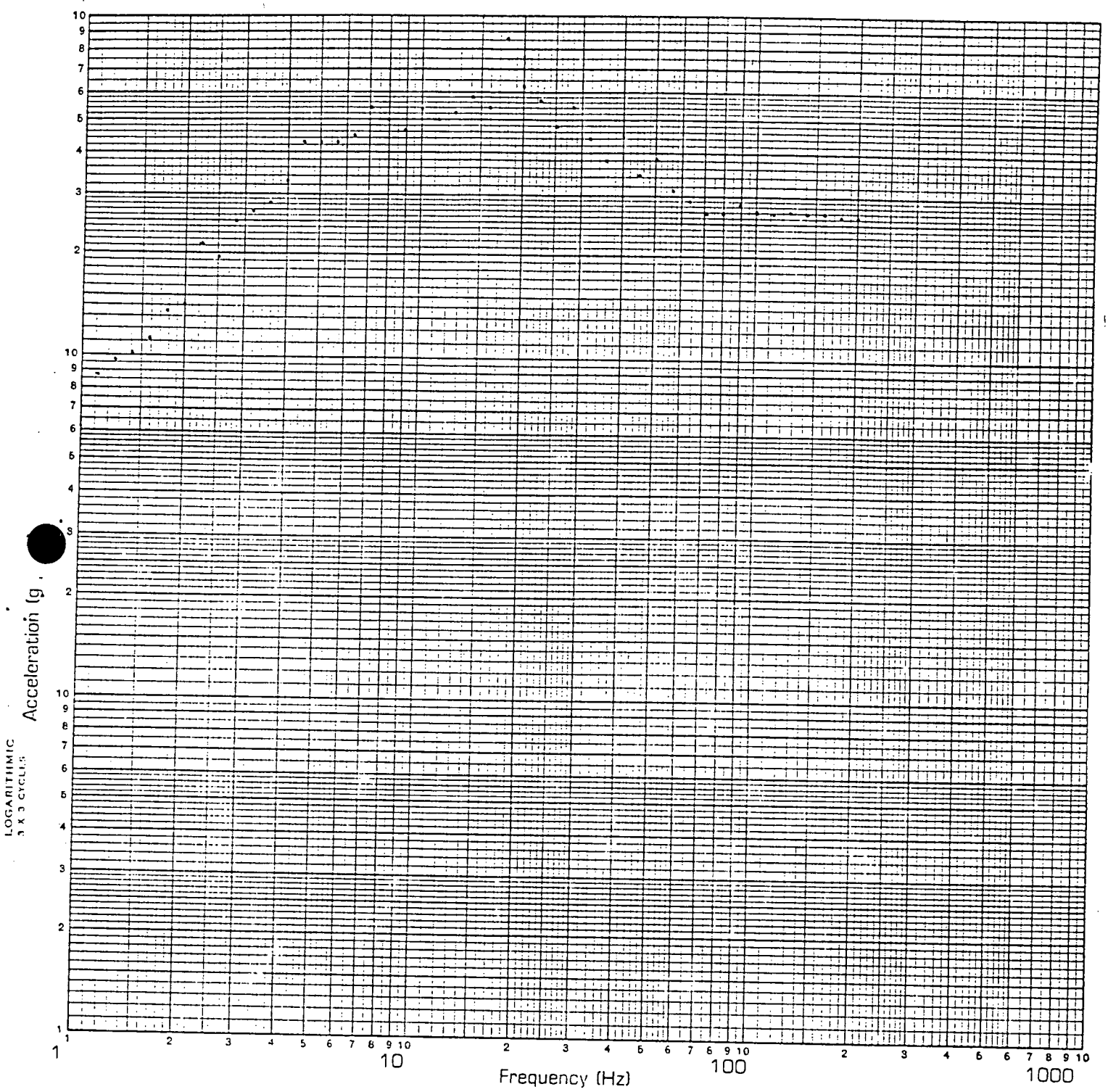
LOCATION NO. VCA

TEST RUN NO. 5

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN Ganged Conduit

AXIS TRI

LOCATION NO. 1LAT

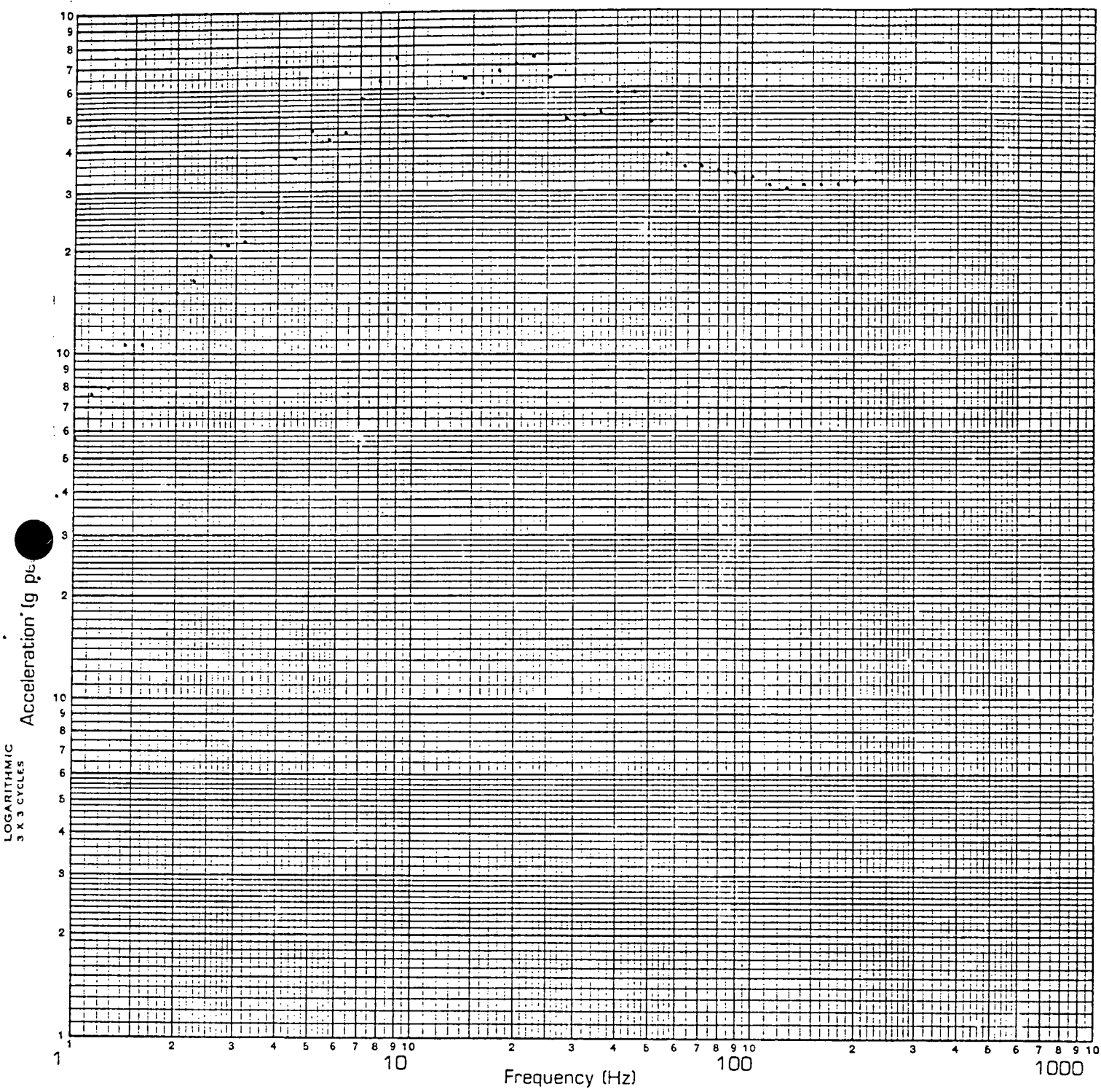
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5%



SPECIMEN Ganged Conduit

LOCATION NO. 2LONG

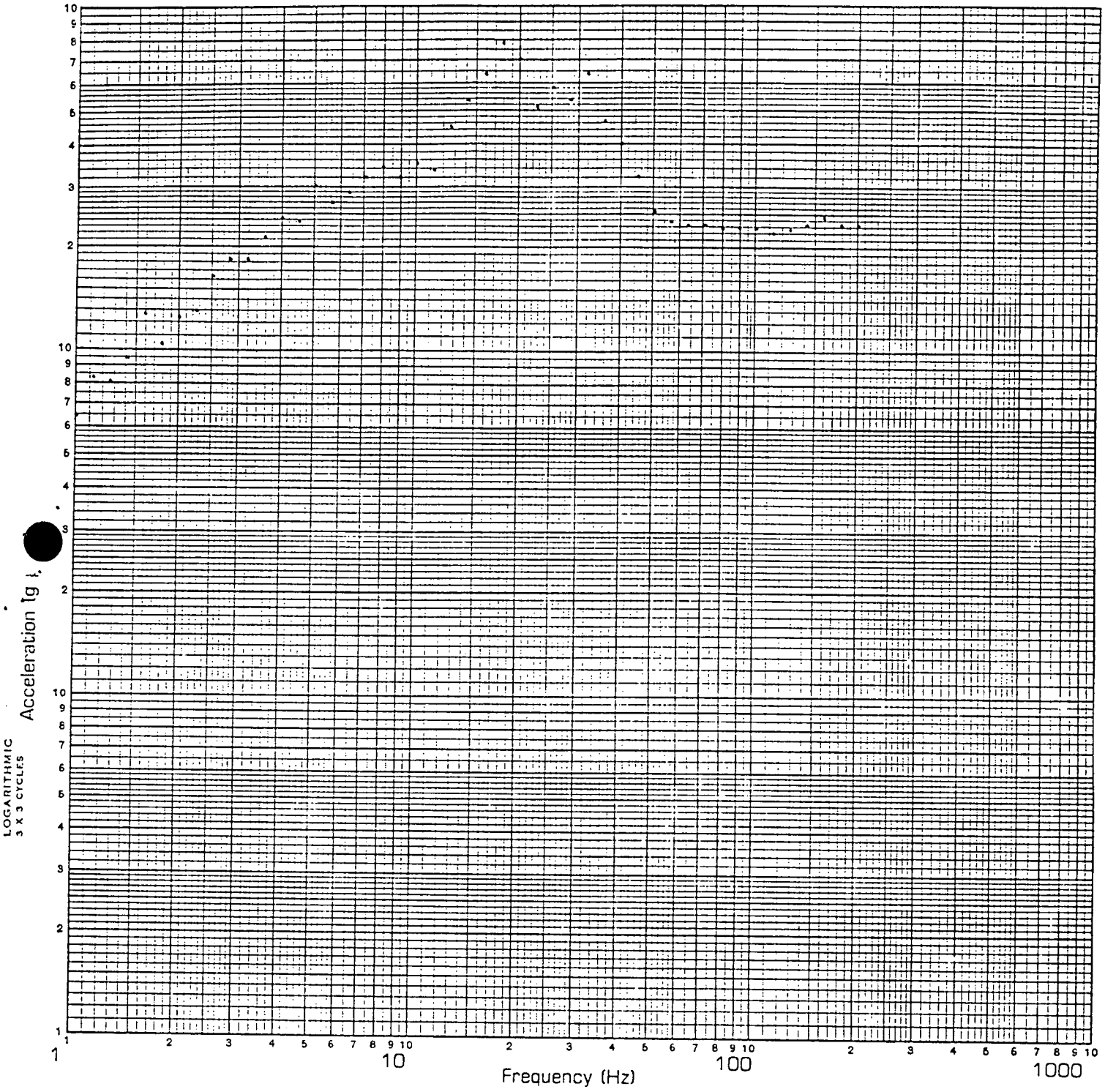
AXIS TRI

TEST RUN NO. 5

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN Ganged Conduit

LOCATION NO. 3V

AXIS TRI

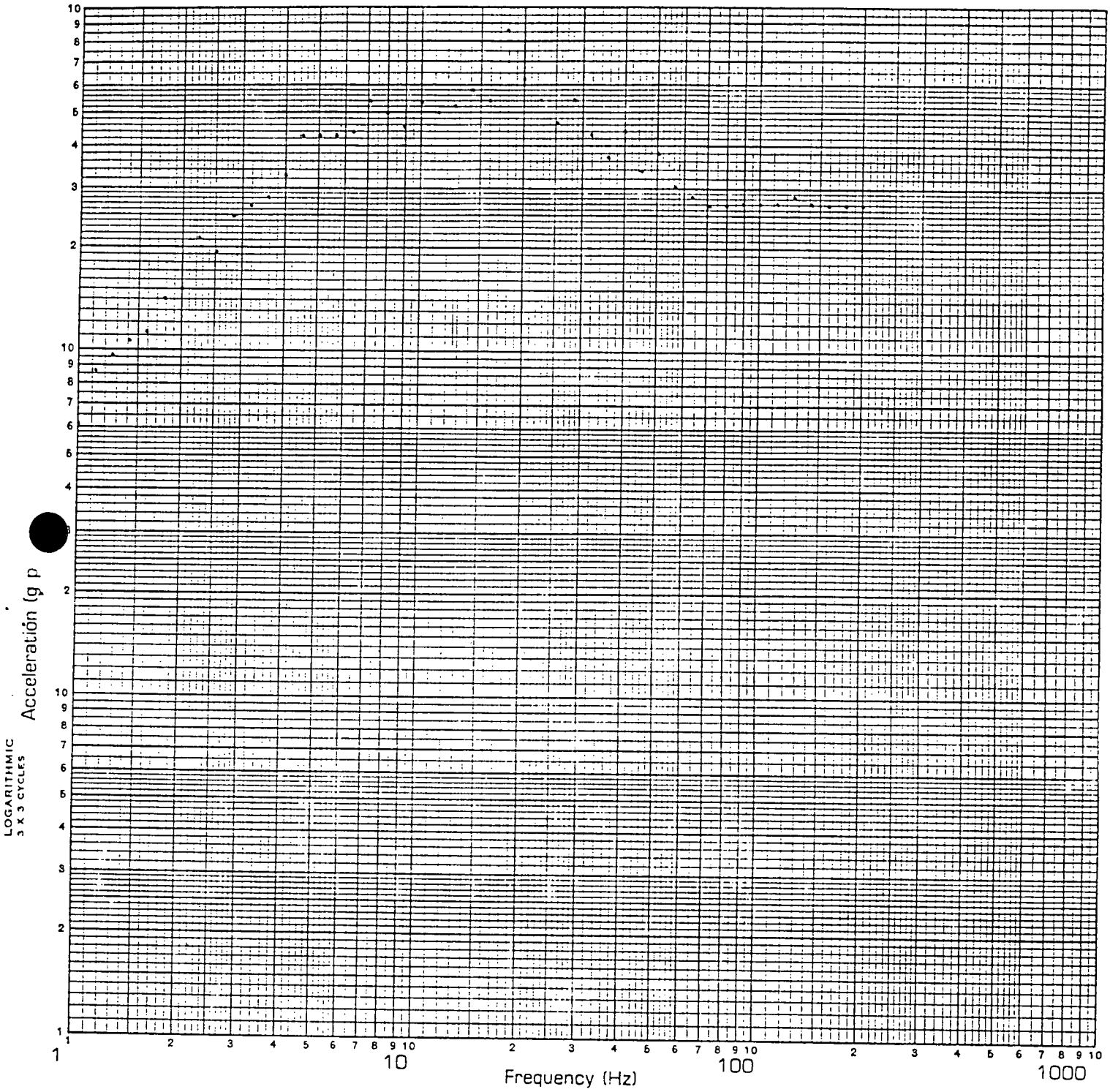
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5%



SPECIMEN Ganged Conduit

LOCATION NO. 4LAT

AXIS TRI

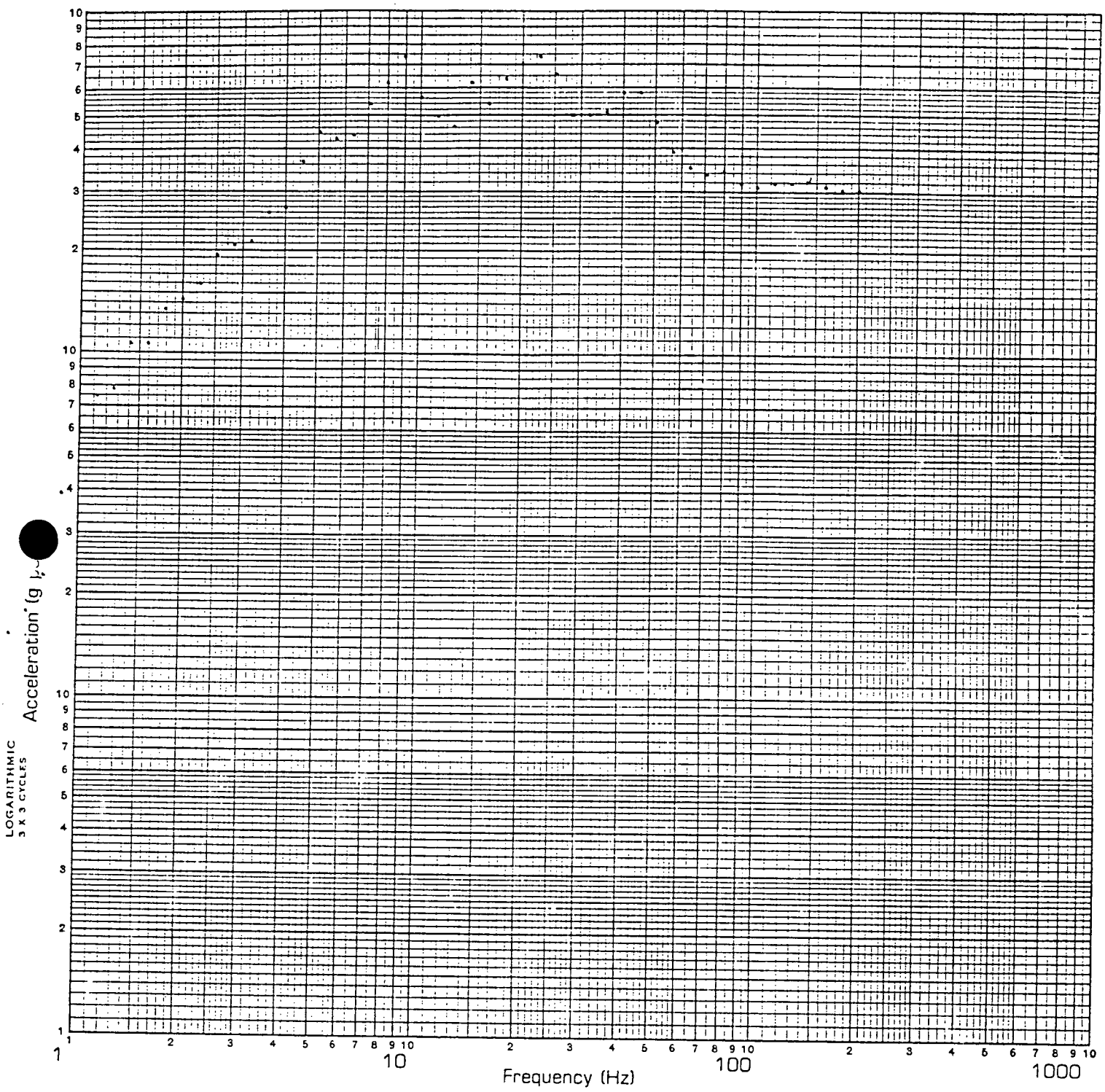
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN Ganged Conduit

AXIS TRI

LOCATION NO. 5 LONG

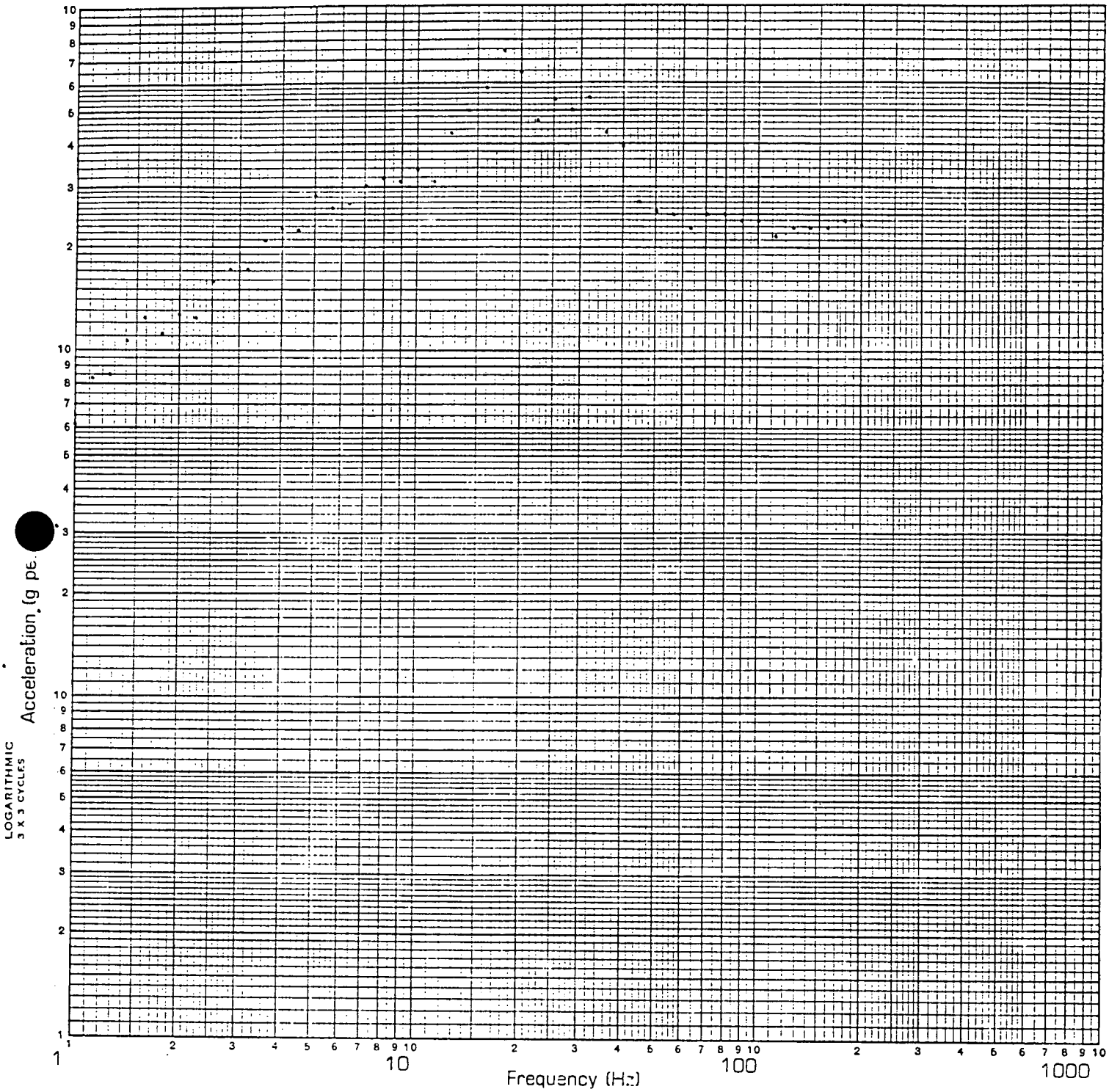
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000☐

DAMPING 5 %



SPECIMEN Ganged Conduit

LOCATION NO. 6V

AXIS TRI

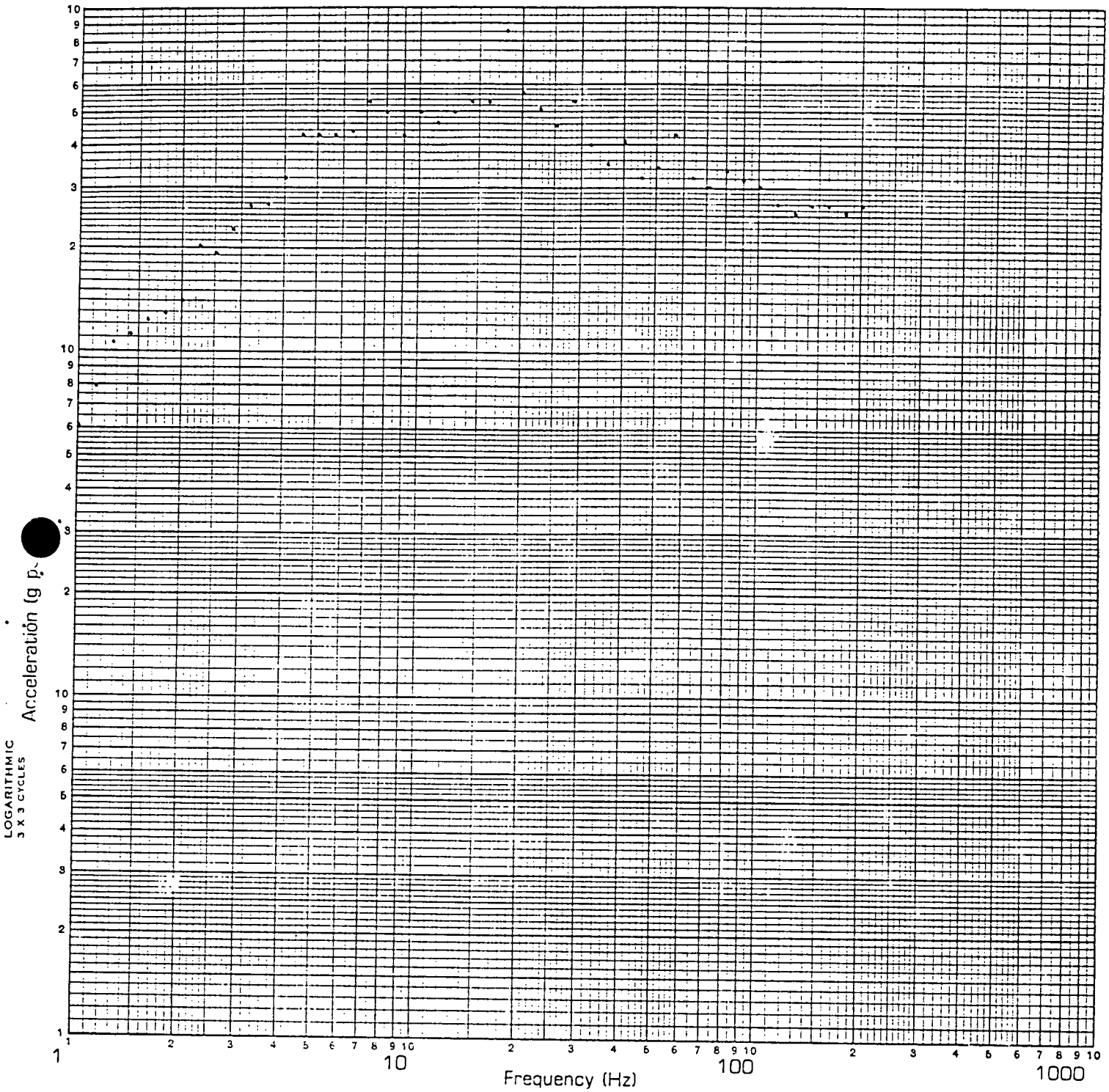
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN Single Conduit

AXIS TRI

LOCATION NO. 7LAT

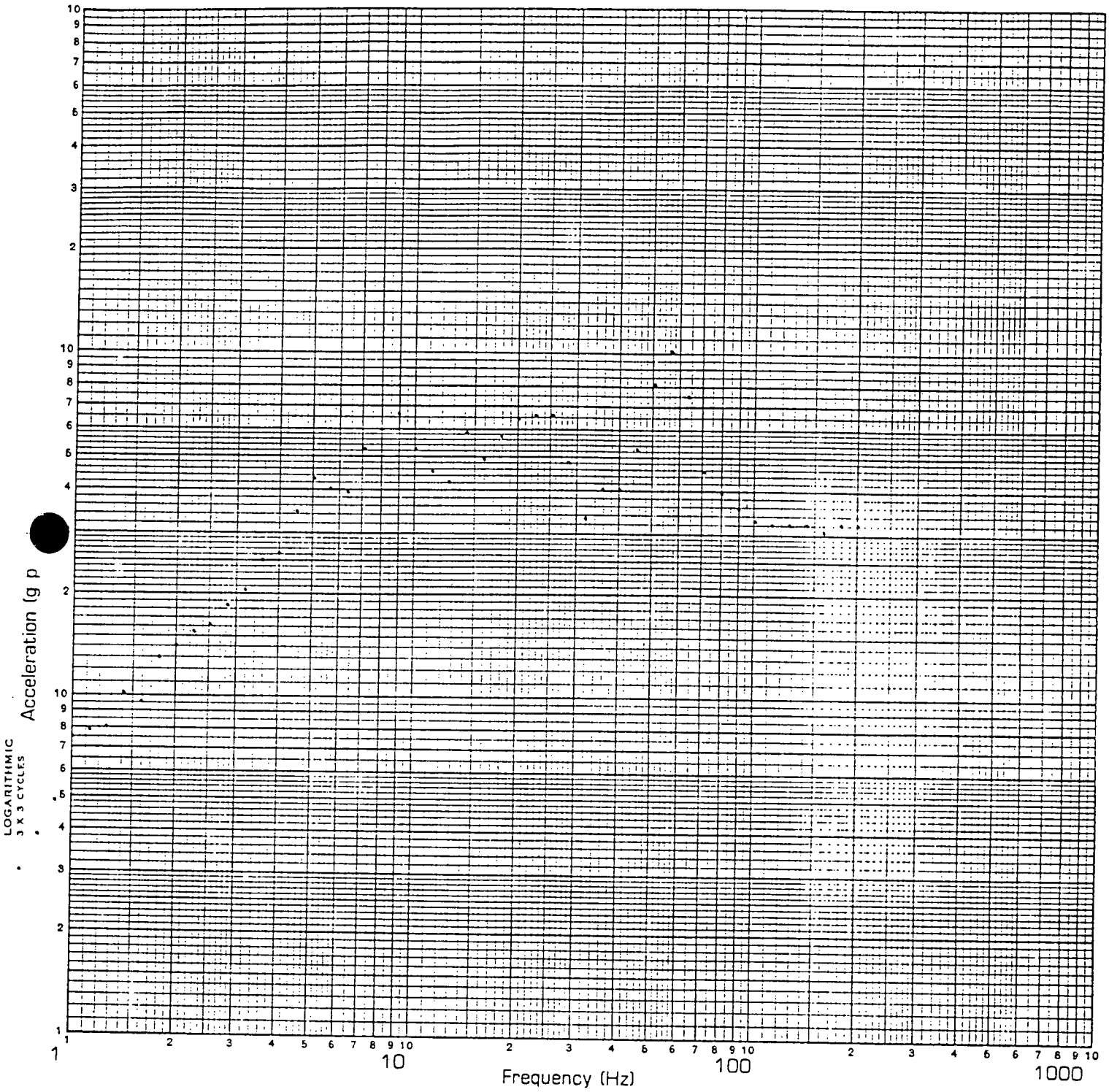
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Conduit

AXIS TRI

LOCATION NO. 8 LONG

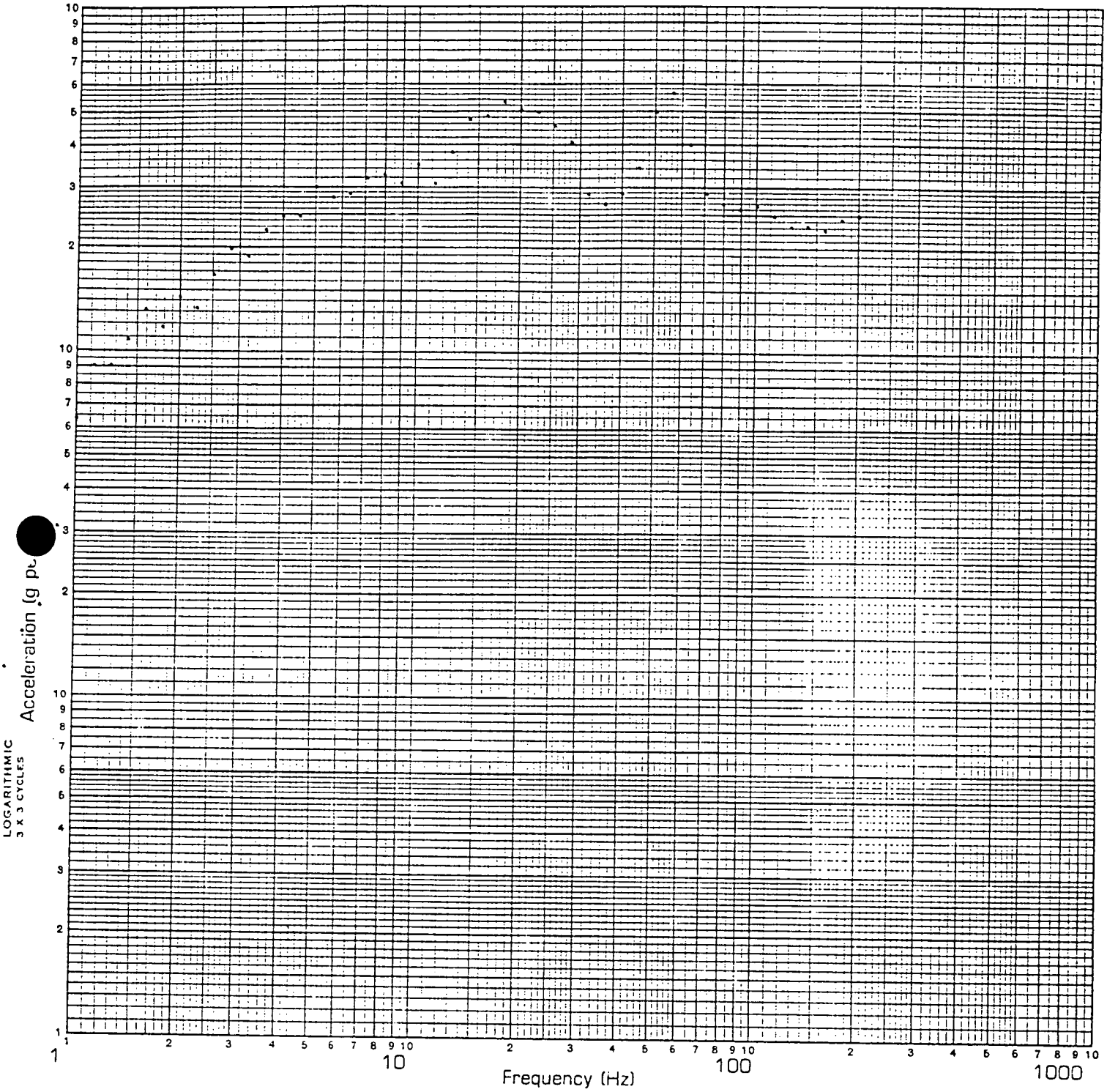
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN Single Conduit

AXIS TRI

LOCATION NO. 9V

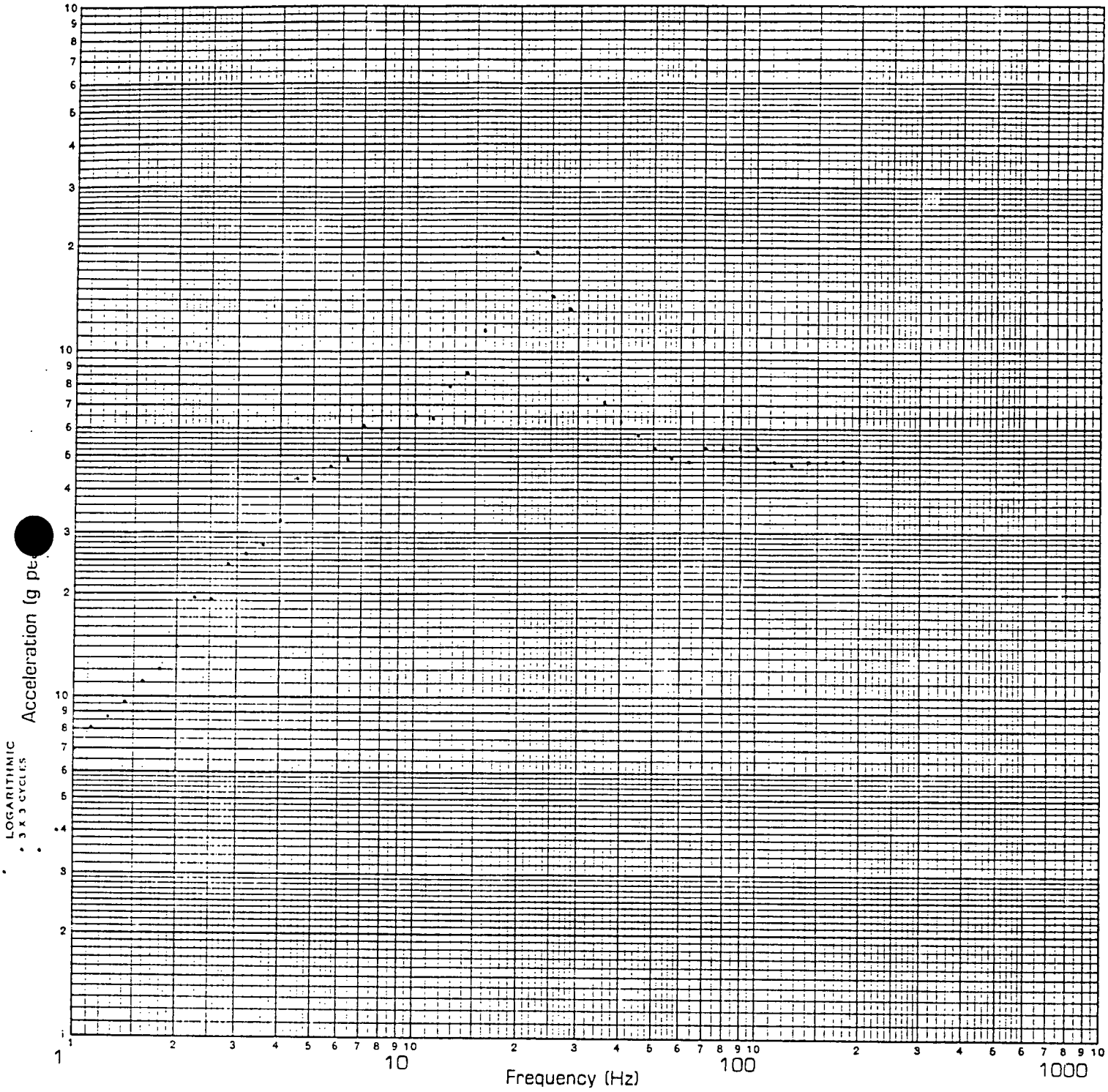
TEST RUN NO. 5

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Conduit

AXIS TRT

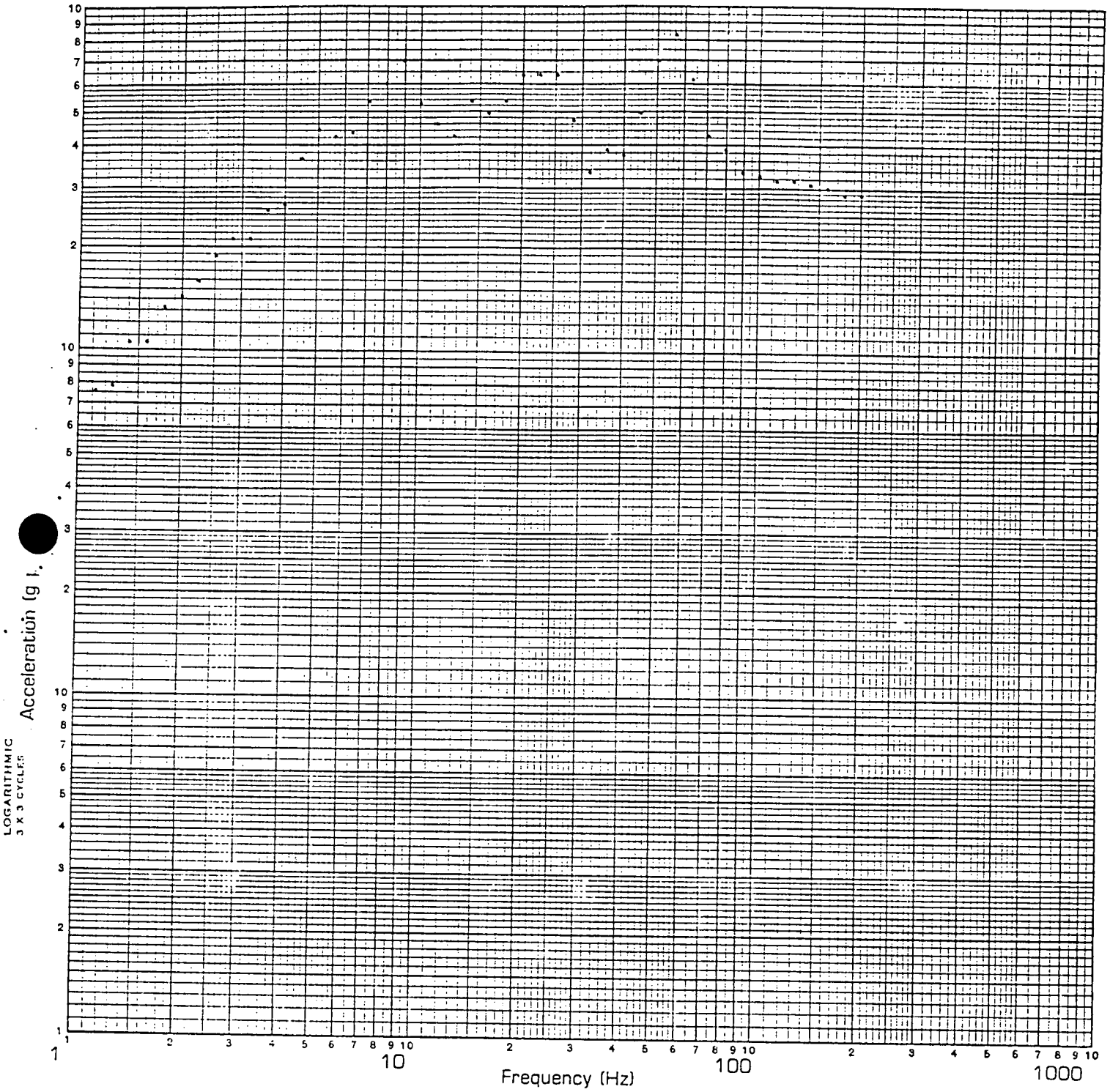
LOCATION NO. 10 LAT

TEST RUN NO. 5

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN Single Conduit

AXIS TRI

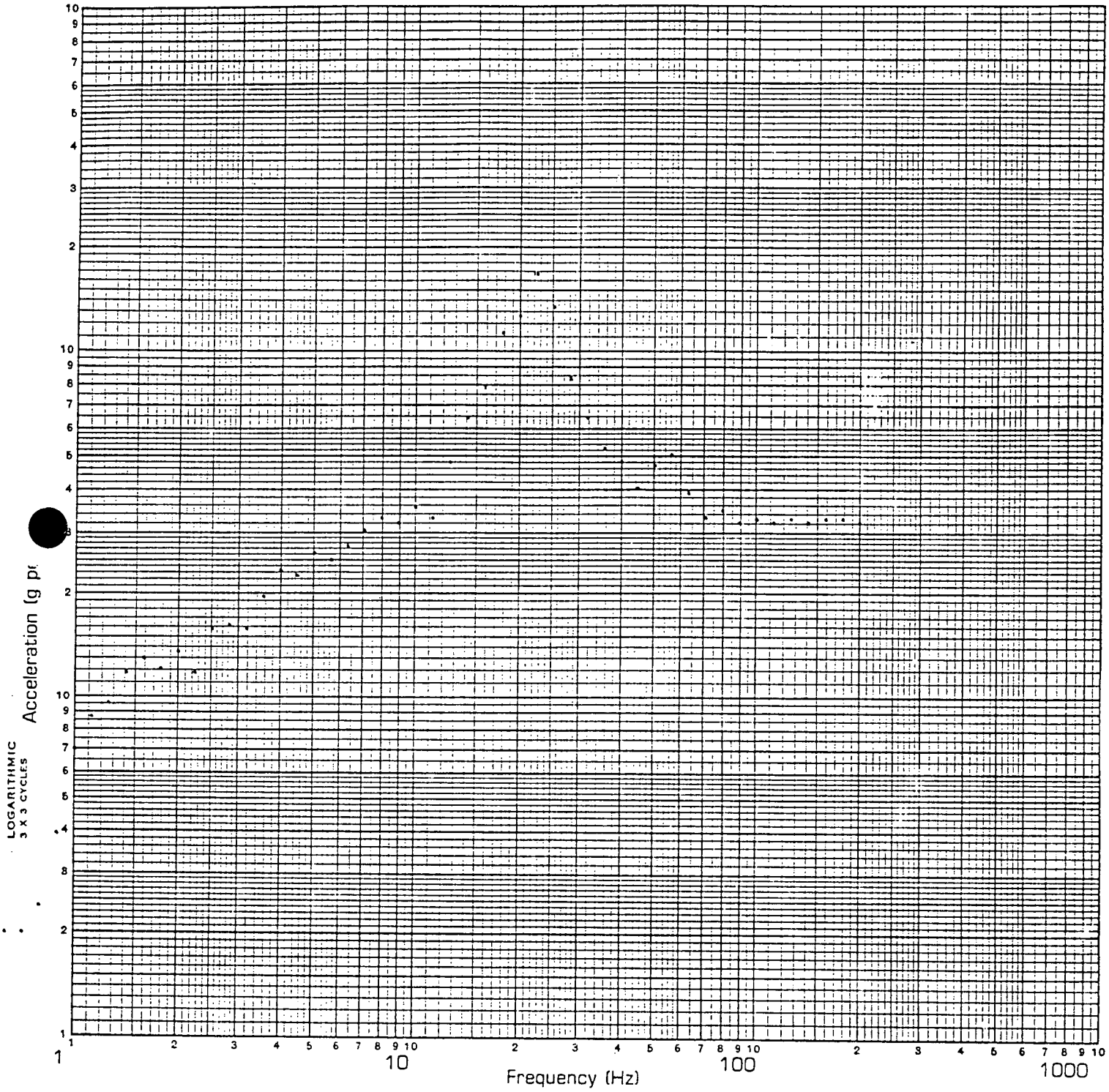
LOCATION NO. 11 LONG

TEST RUN NO. 5

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Conduit

LOCATION NO. 12 V

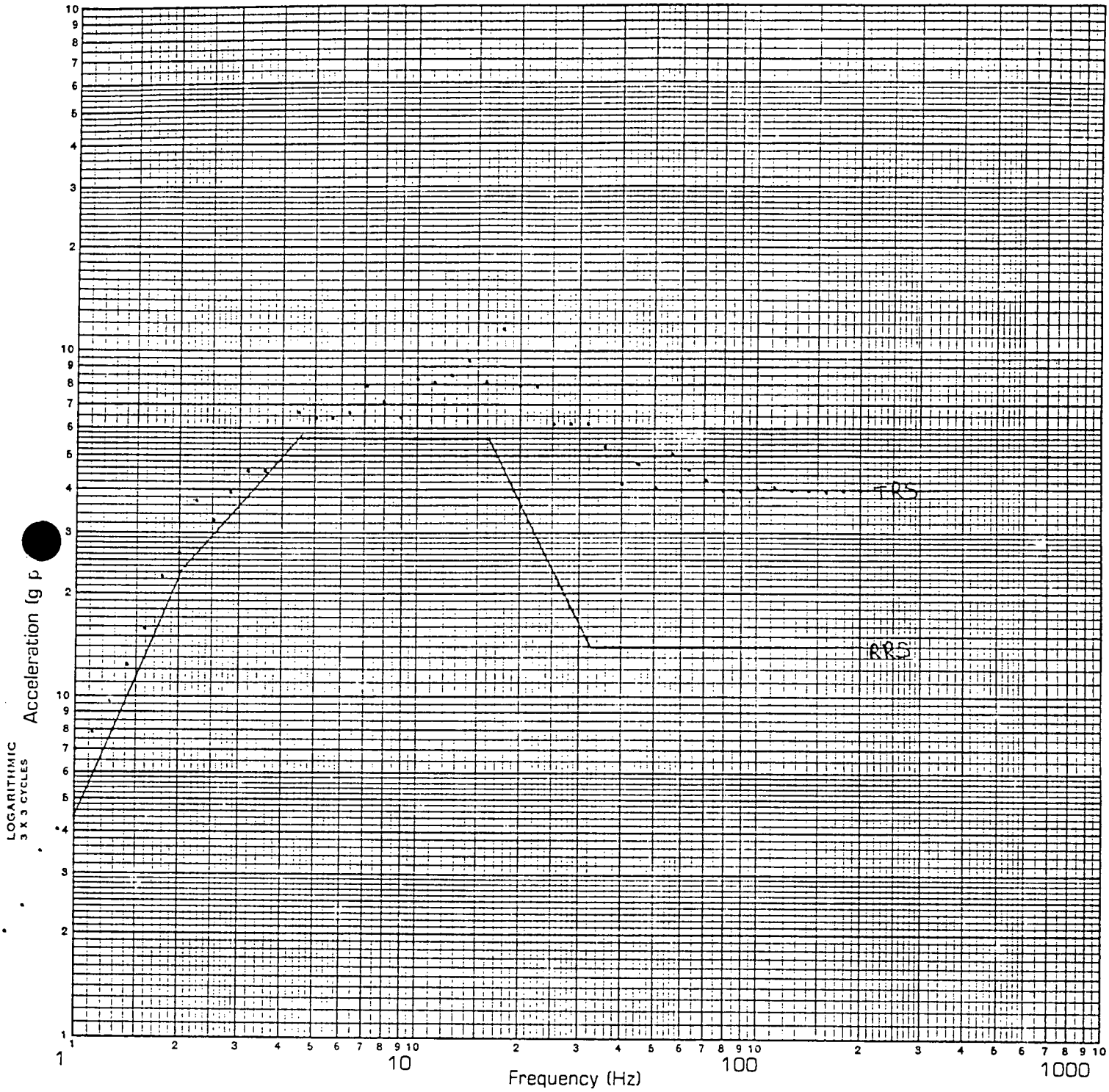
AXIS TRI

TEST RUN NO. 5

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5%



SPECIMEN —

AXIS TRI

LOCATION NO. LAT HCA

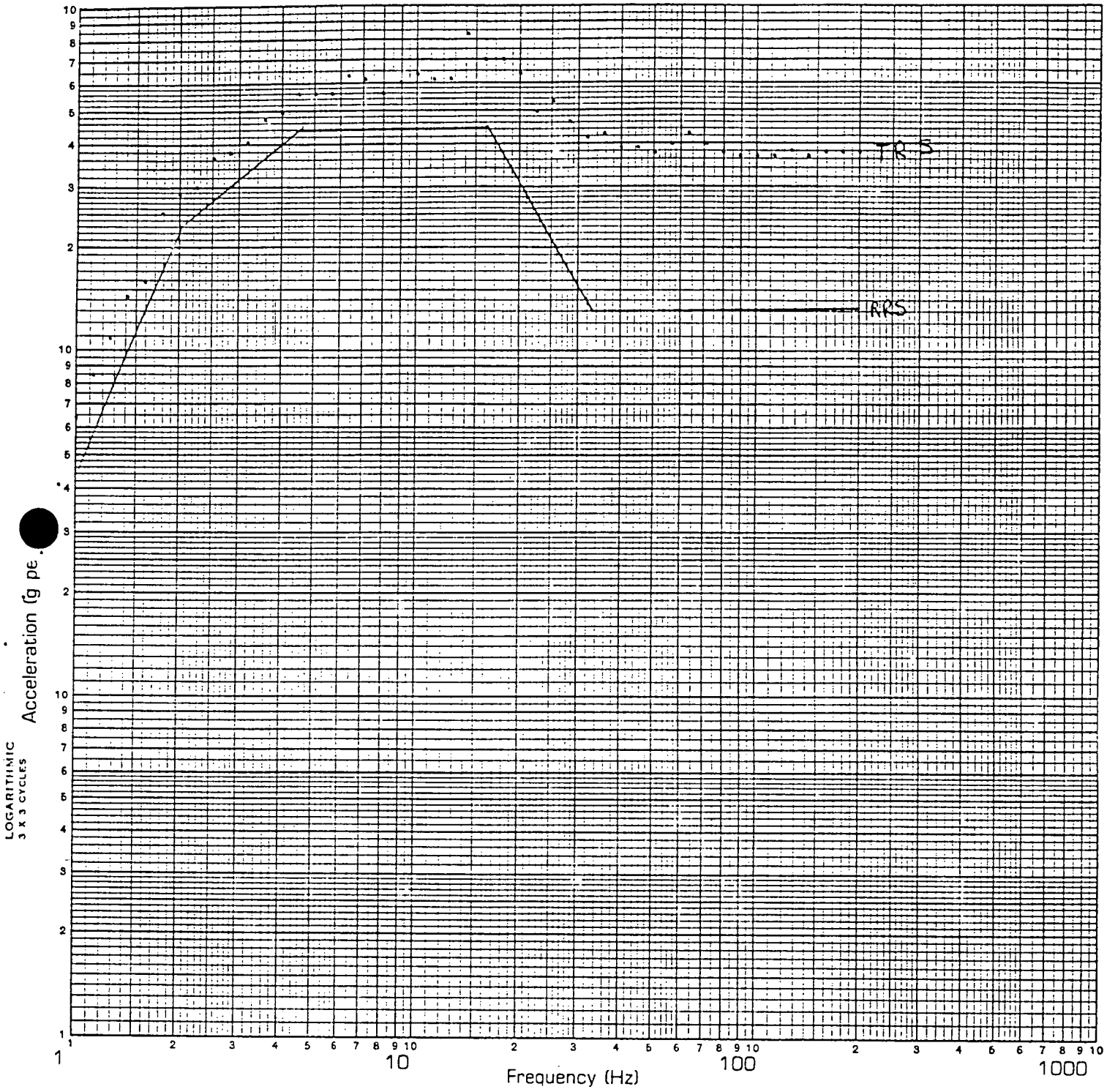
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN —

AXIS TRI

LOCATION NO. LONG HCA

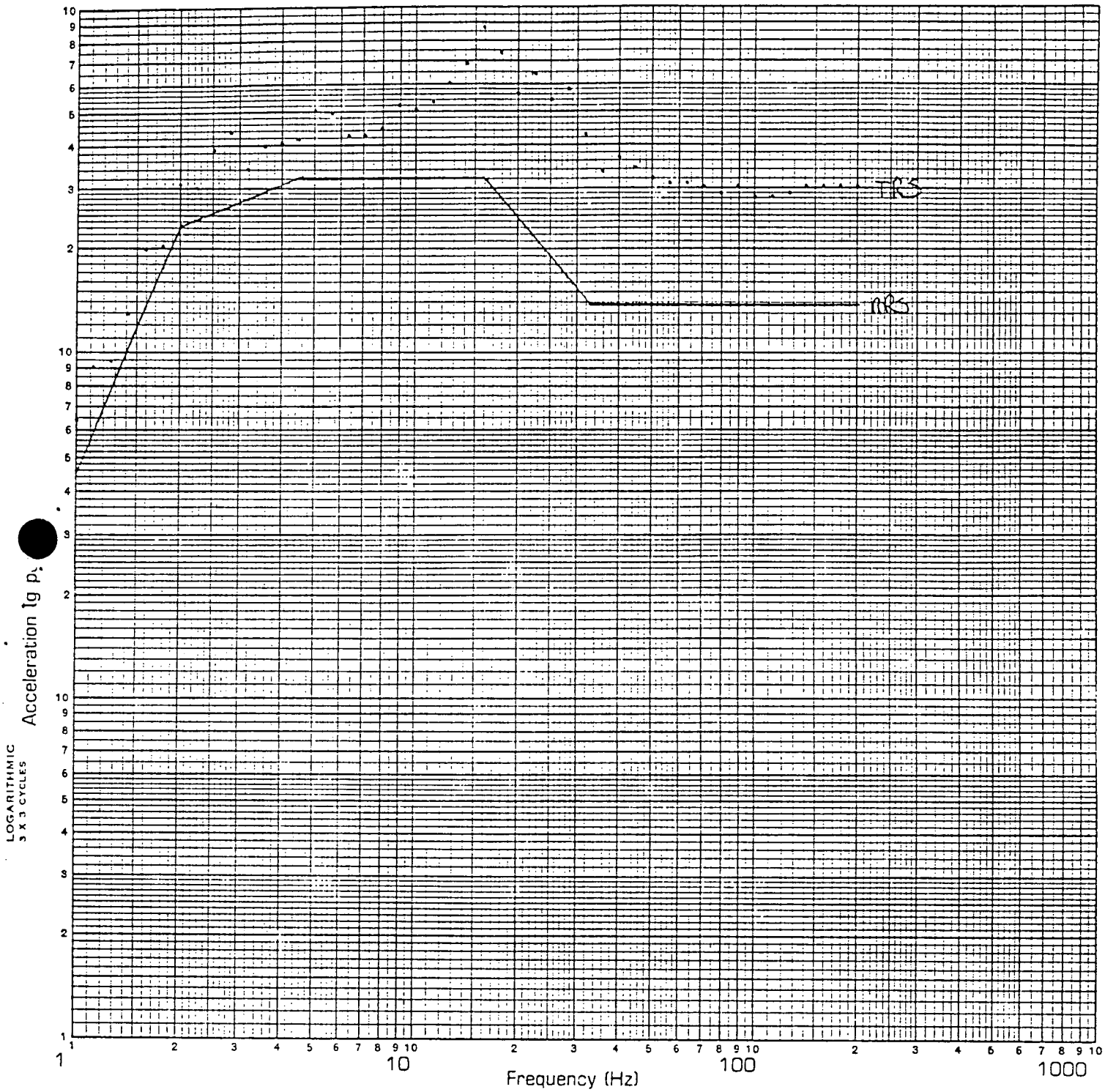
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 5 %



SPECIMEN ——

AXIS TRI

LOCATION NO. VCA

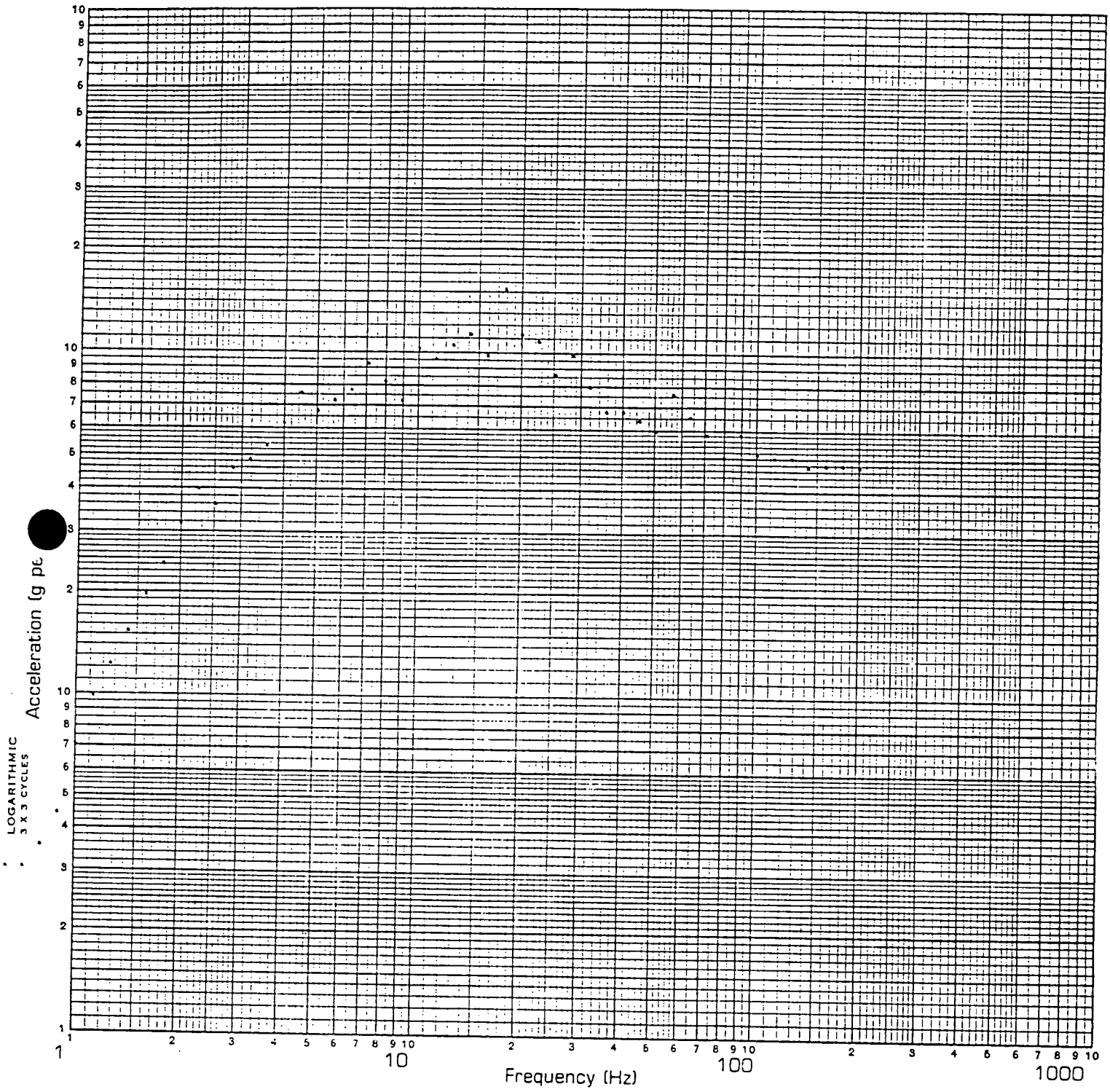
TEST RUN NO. 6

Test Report No. 44213-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Ganged Conduit

AXIS TRI

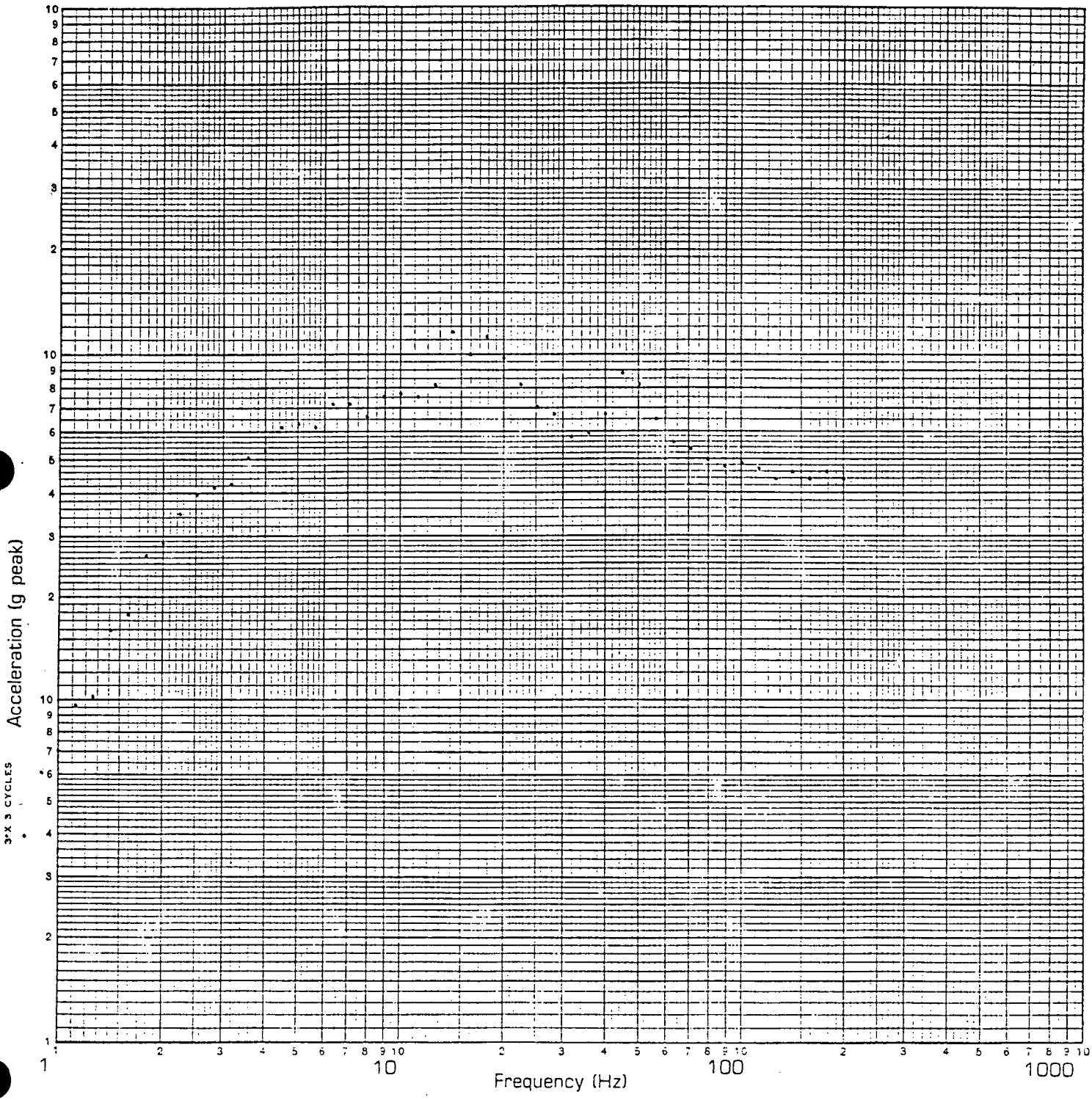
LOCATION NO. 1LAT

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5 %



SPECIMEN Ganged Conduit

LOCATION NO. 2 LONG

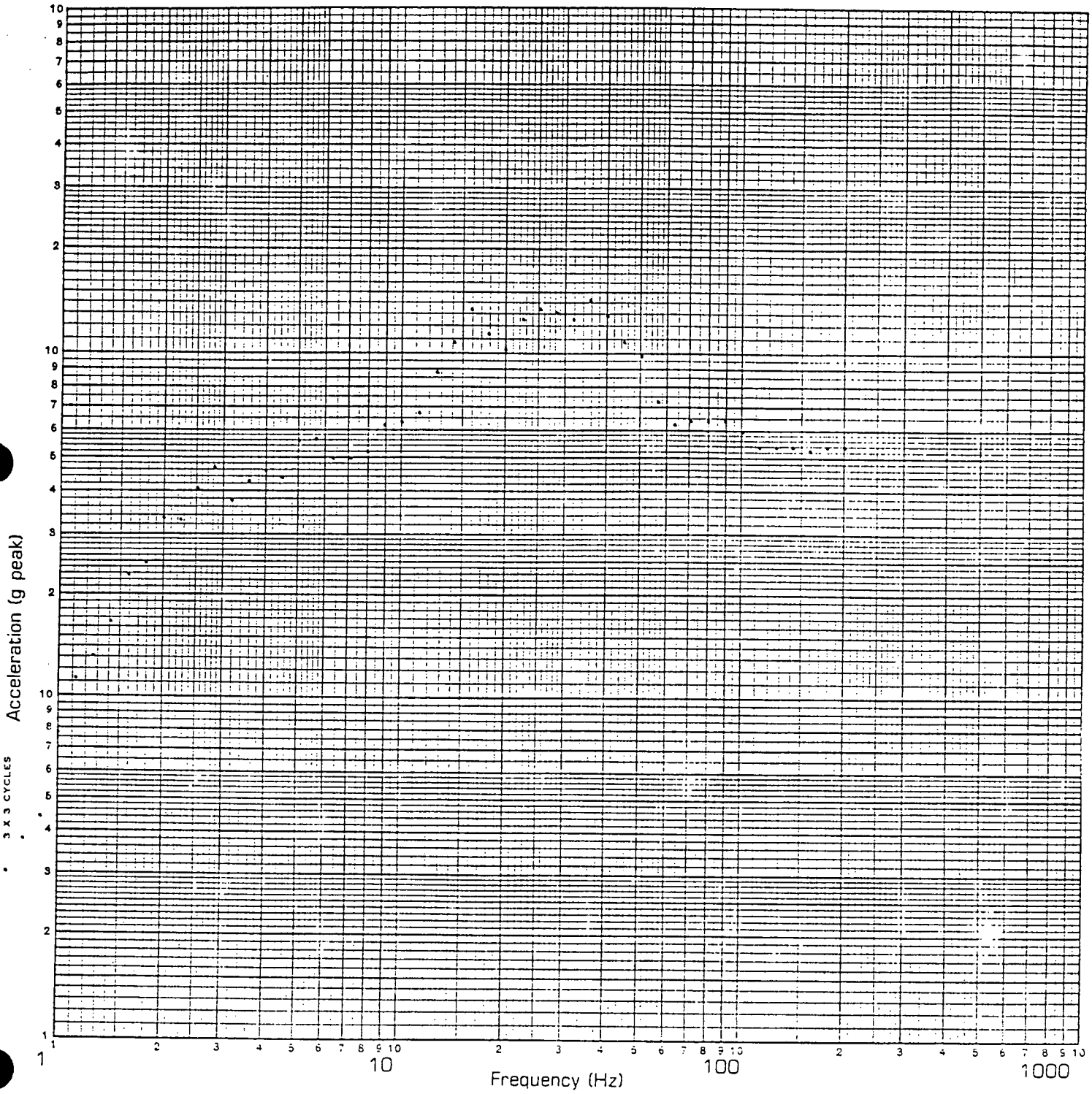
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5 %



SPECIMEN Ganged Conduit

LOCATION NO. 3V

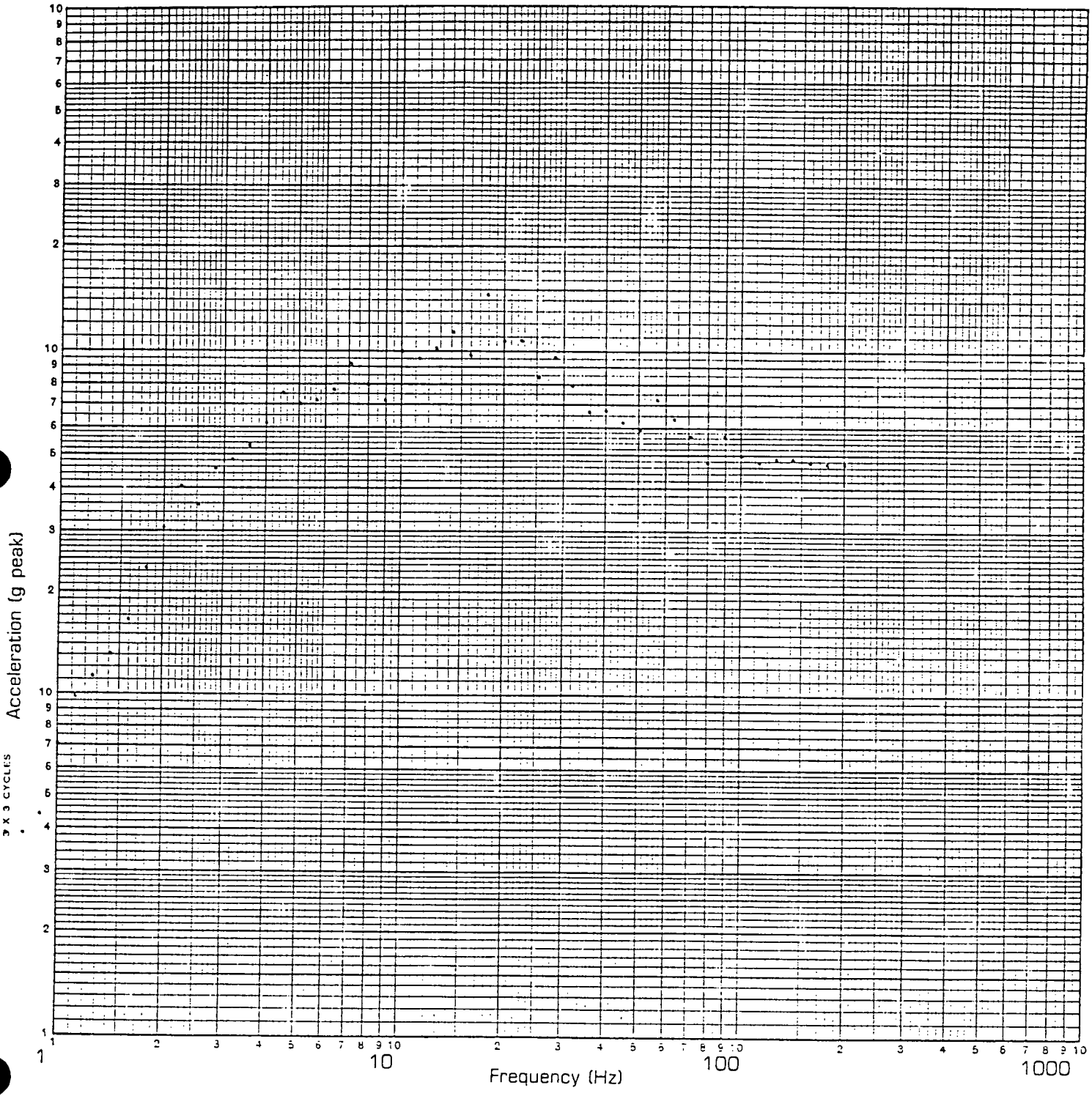
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5 %



SPECIMEN Ganged Conduit

LOCATION NO. 4 LAT

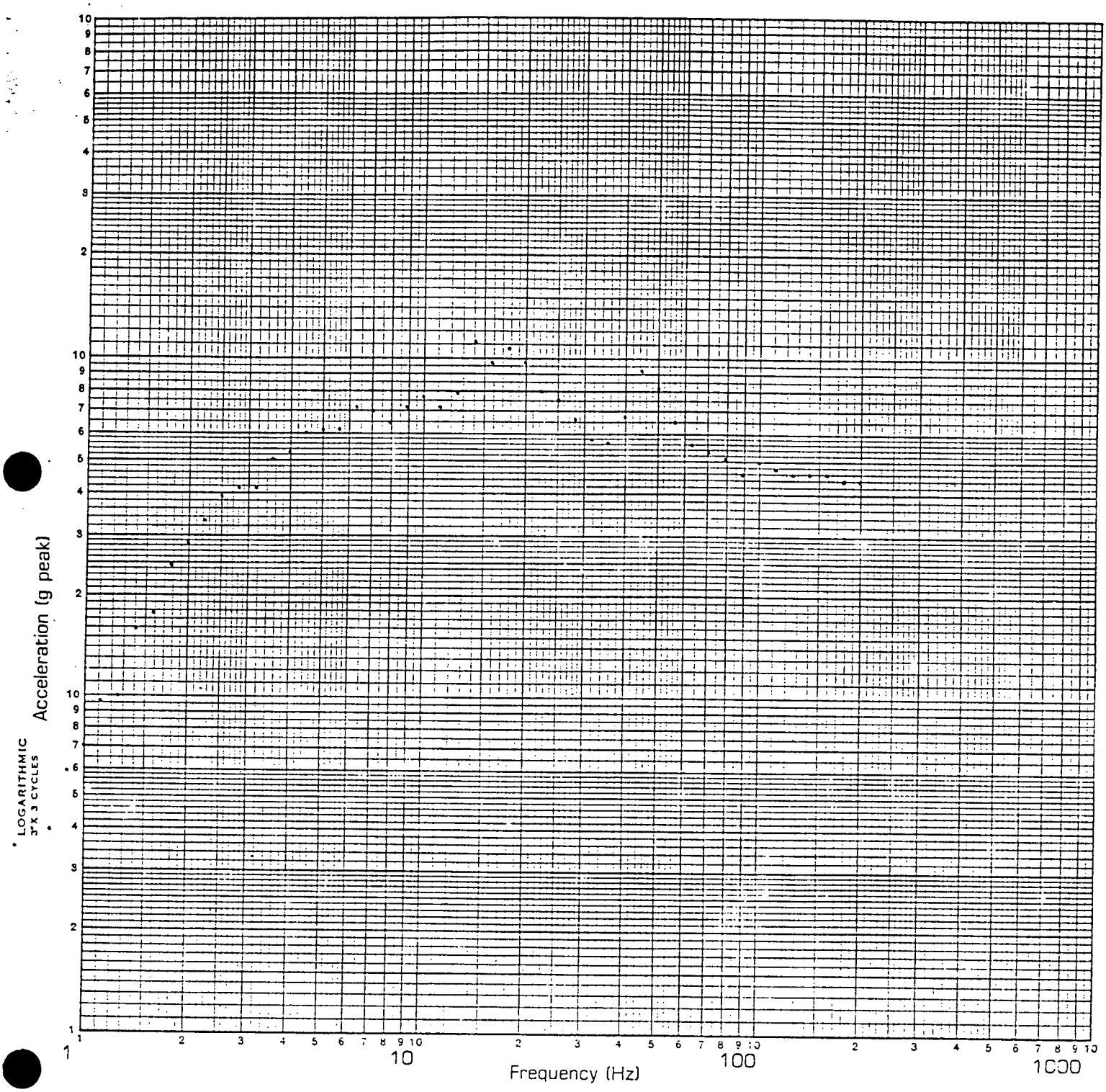
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Damaged Conduit

LOCATION NO. 5 LONG

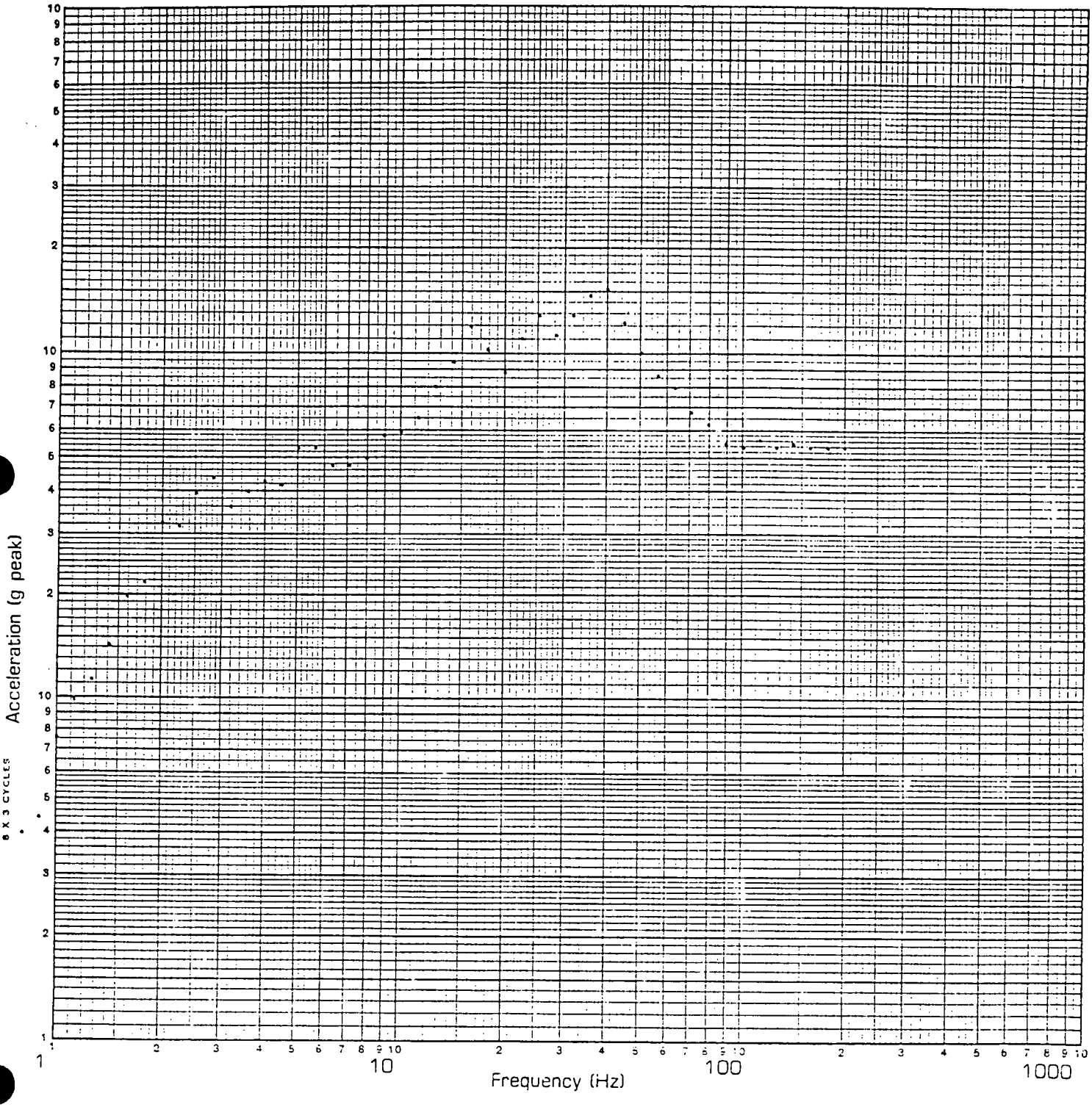
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5 %



SPECIMEN Ganged Conduit

LOCATION NO. 6 V

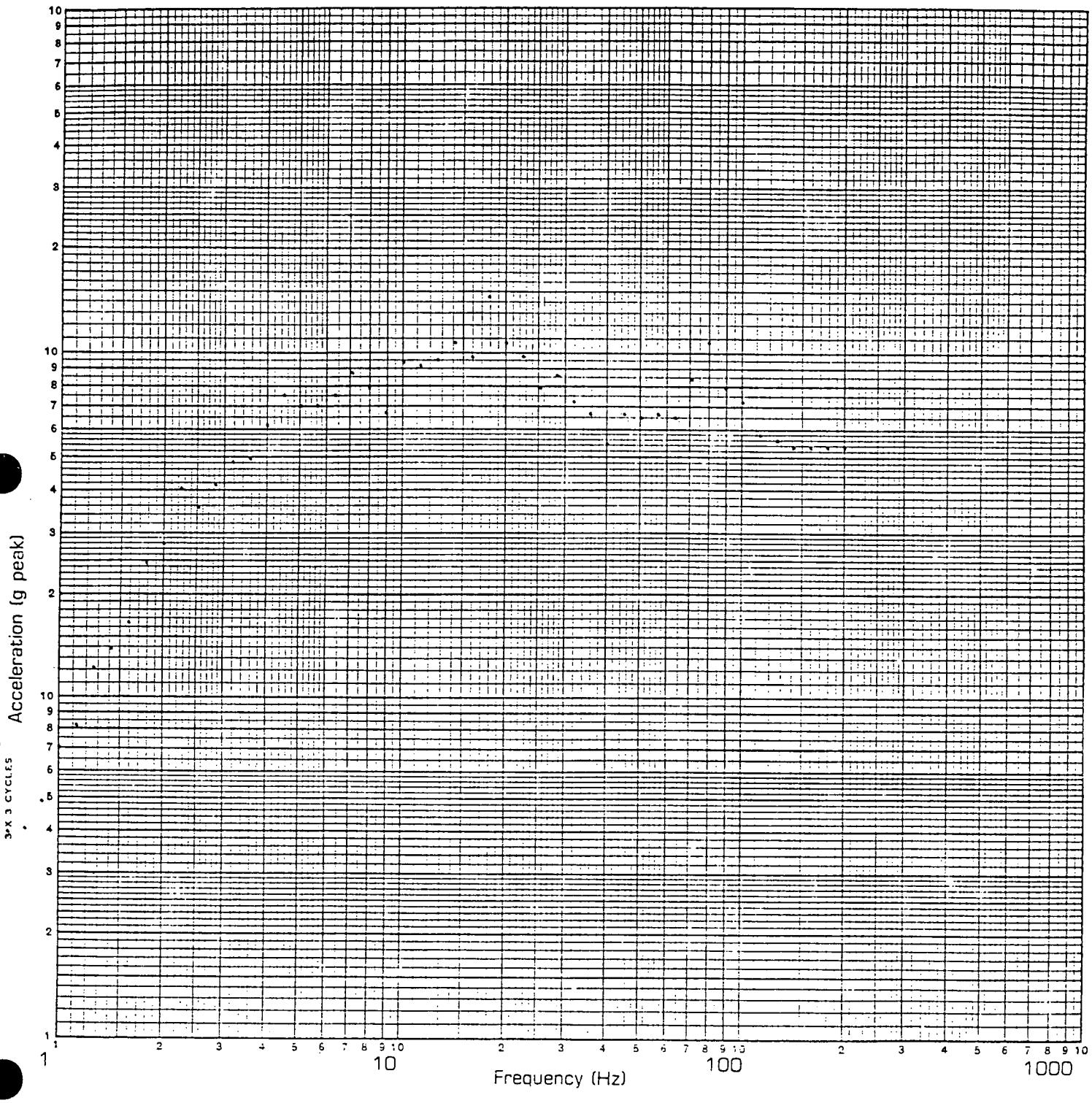
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5 %



SPECIMEN Single Conduit

LOCATION NO. 7LAT

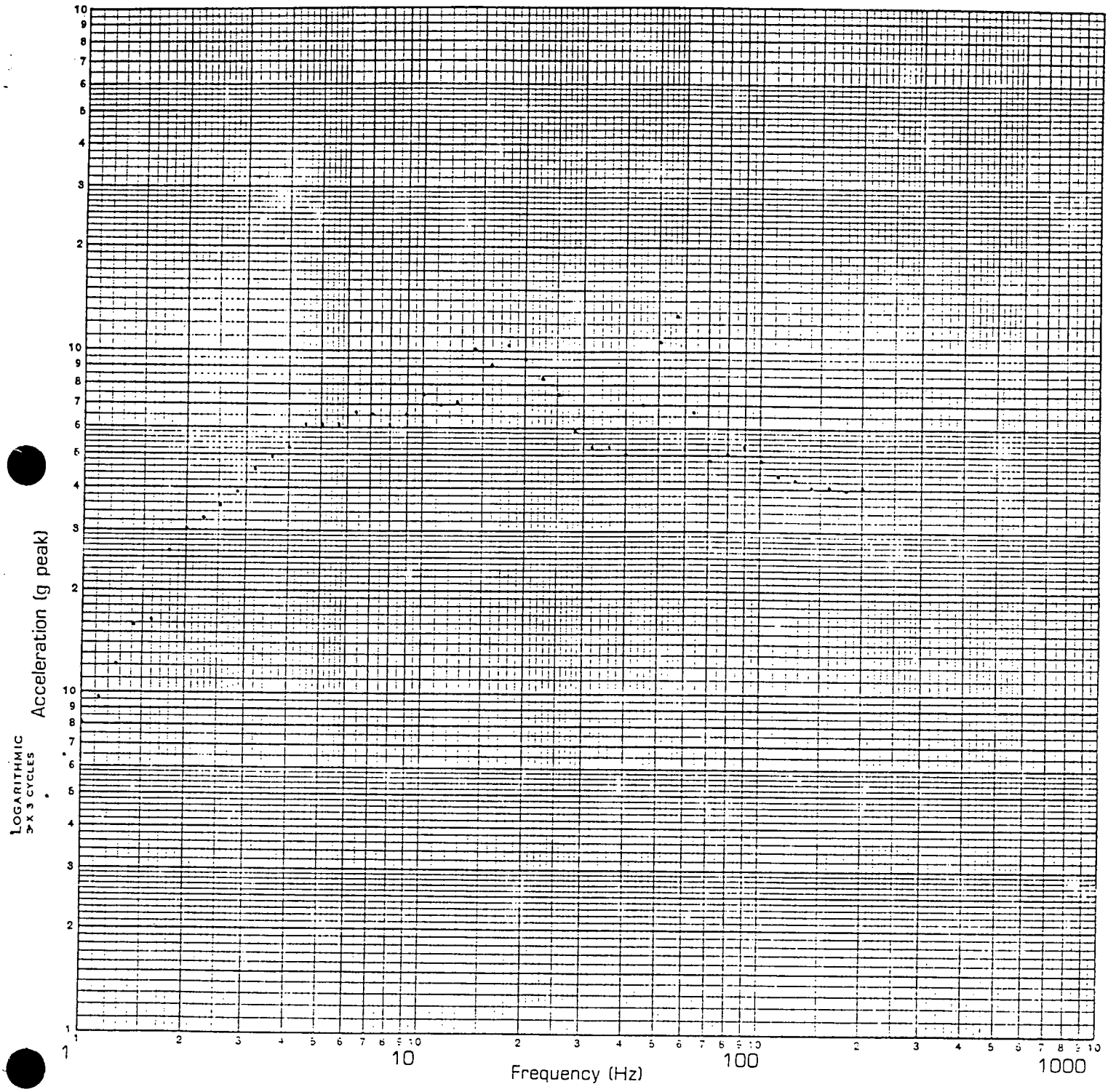
AXIS TRT

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Conduit

AXIS TRI

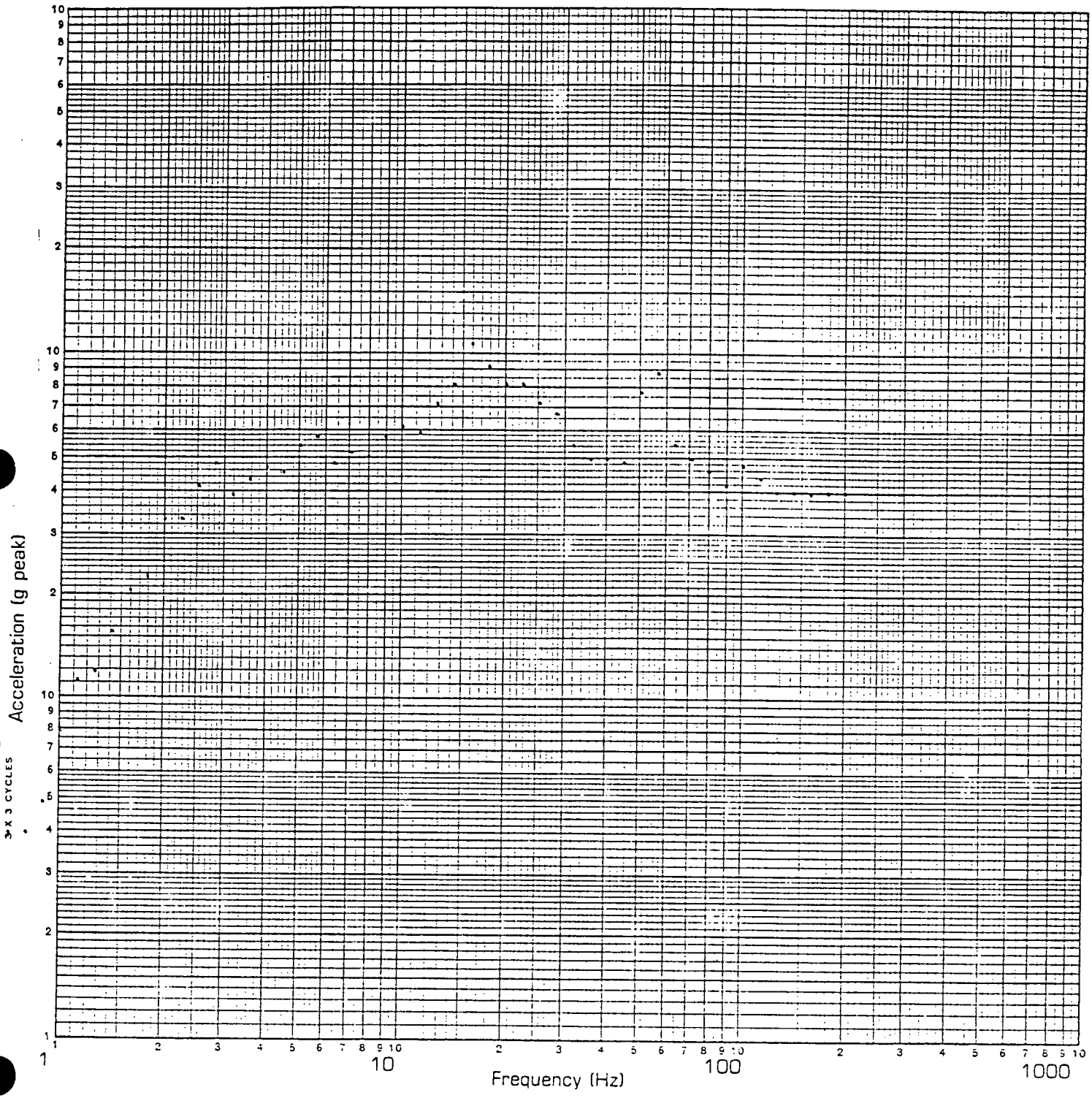
LOCATION NO. 8 LONG

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Conduit

LOCATION NO. 9V

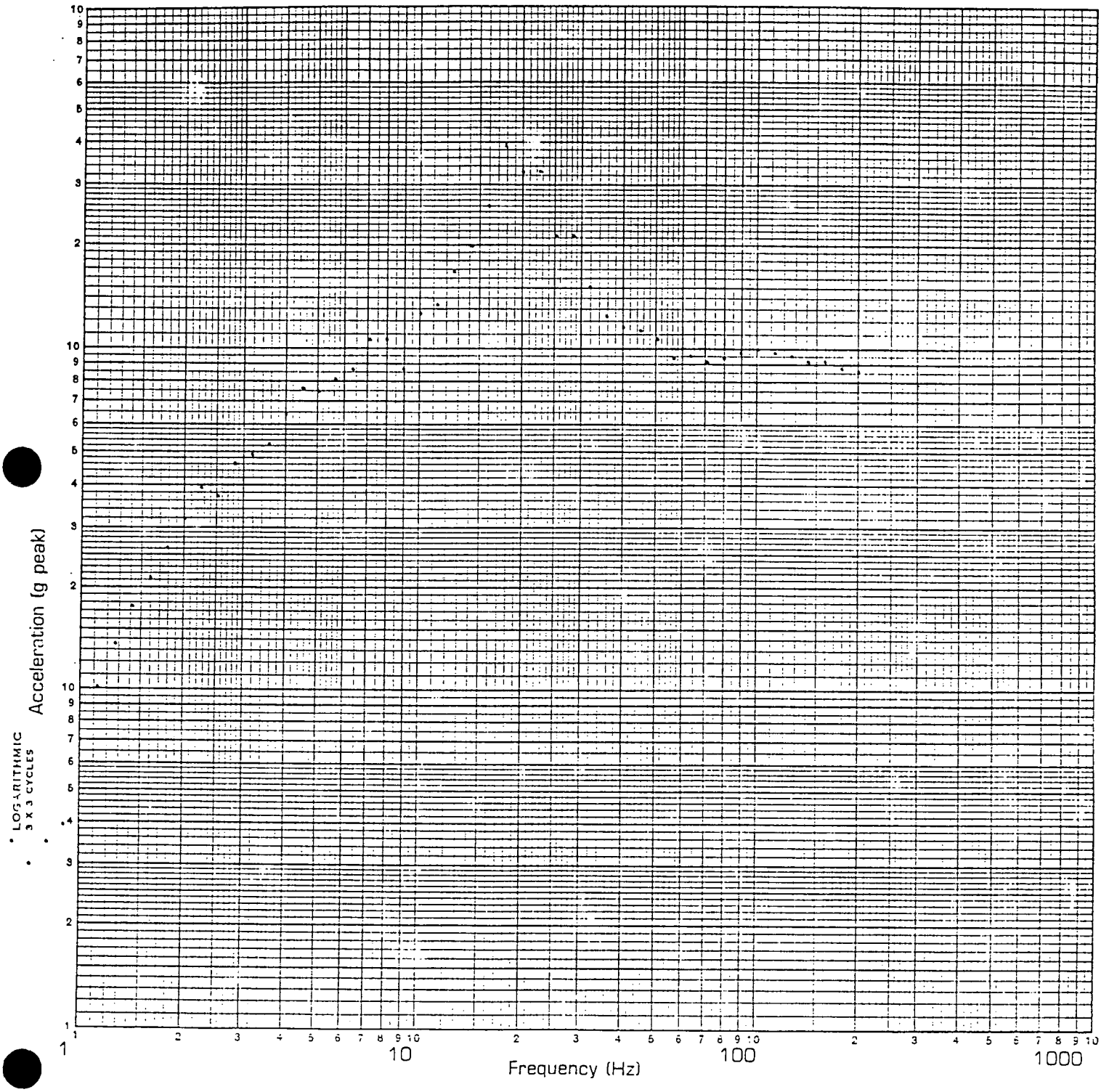
AXIS TRI

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5 %



SPECIMEN Single Conduit

AXIS TRL

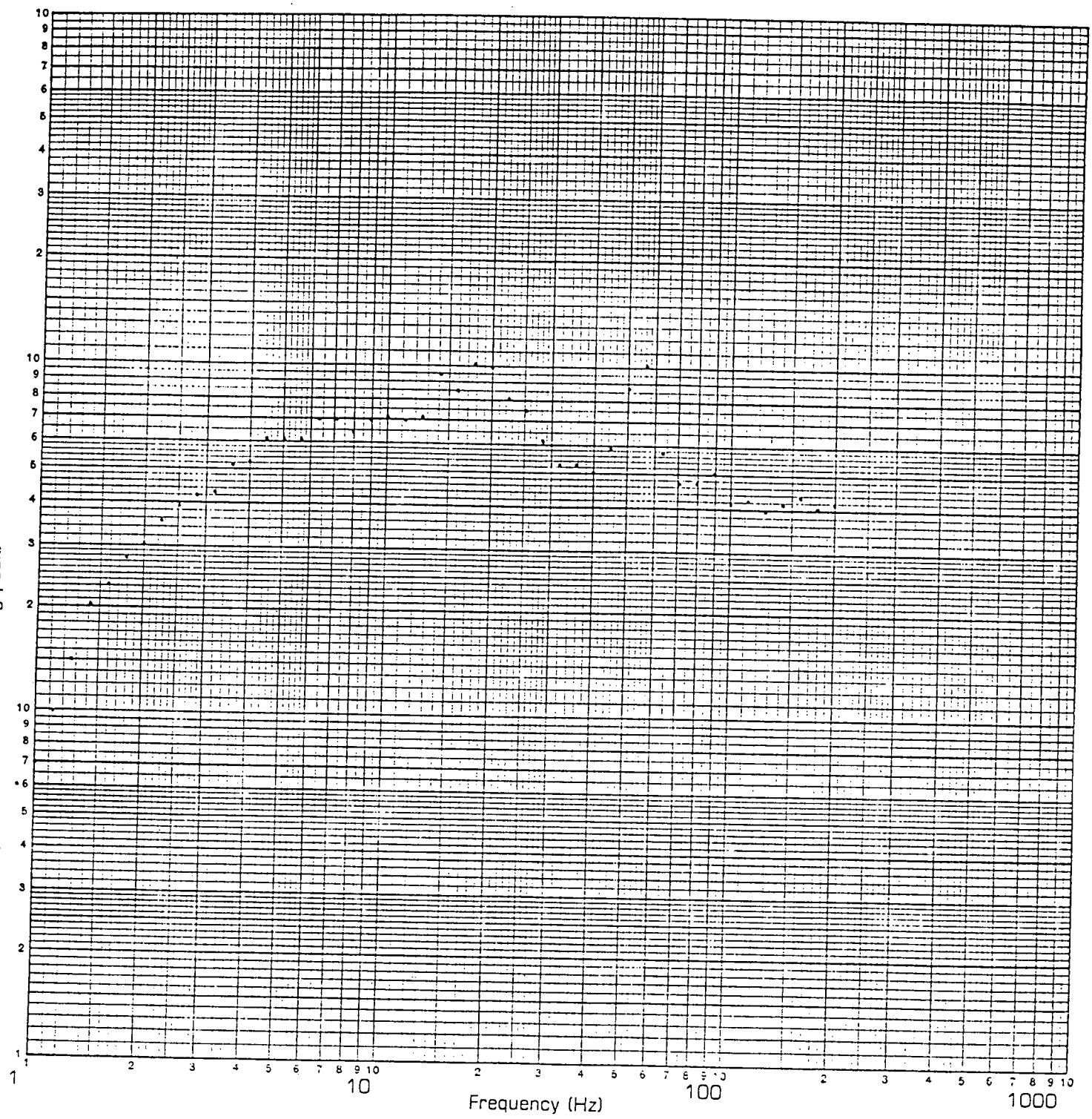
LOCATION NO. 10LAT

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 5 %



SPECIMEN Single Conduit

AXIS TRI

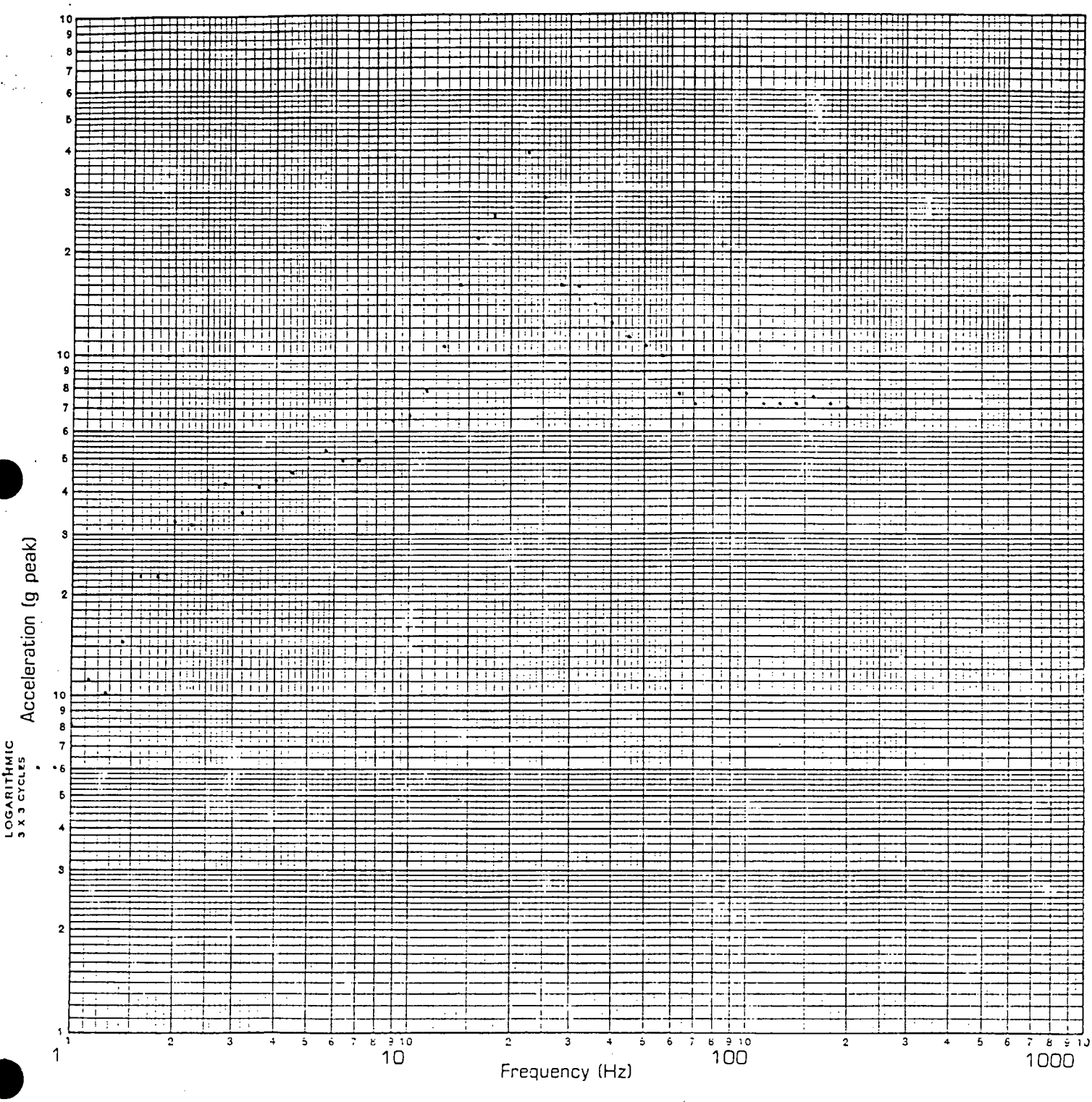
LOCATION NO. 11 LONG

TEST RUN NO. 6

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 5 %



SPECIMEN Single Conduit

LOCATION NO. 12V

AXIS TRT

TEST RUN NO. 6

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APPENDIX VIII

INSTRUMENTATION LOG, EQUIPMENT, AND DATA SHEETS

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W 322

WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44213

CUSTOMER TVA SERIES 1

LOG PAGE NO. 1 OF 2

TEST ENGINEER D. BELL

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)		
9-24-94		SET UP TO RECORD THREE CONTROL AND FOURTEEN RESPONSE		
		ACCELS ON TAPE.		
	0745	RUN #1 SINE SWEEP 1-35HZ 0.2g 1OCT/MIN		LAT (NS)
		START 0050	STOP 0213	
		RUN #2 SINE SWEEP 1-35HZ 0.2g 1OCT/MIN		LONG (EW)
		START 0213	STOP 0378	
		RUN #3 SINE SWEEP 1-35HZ 0.2g 1OCT/MIN		VERT
		START 0378	STOP 0542	
		RUN #4 RMF	OBE	TRI
		START 0542	STOP 0575	
	0840	RUN #5 RMF	<OBE	TRI
		START 0575	STOP 0605	

W 322

WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44213

CUSTOMER TVA SERIES 1

LOG PAGE NO. 2 OF 2

TEST ENGINEER D. BELL

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)		
9-24-94	0850	RUN #6 RMF	OBE	TRI
		START 0605	STOP 0637	
	0915	RUN # 7 RMF	SSE	TRI
		START 0637	STOP 0673	
	0935	RUN #8 SINE SWEEP 1-35 HZ	0.2g 1OCT/MIN	LAT (NS)
		START 0673	STOP 0836	
	0945	RUN #9 SINE SWEEP 1-35 HZ	0.2g 1OCT/MIN	Long (EW)
		START 0836	STOP 1003	
	0955	RUN #10 SINE SWEEP 1-35 HZ	0.2g 1OCT/MIN	VERT
		START 1003	STOP 1165	

W 322

WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44213

CUSTOMER TVA SERIES 2

LOG PAGE NO. 1 OF 2

TEST ENGINEER D. BELL

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)		
9-25-94		SET UP TO RECORD THREE CONTROL AND TWELVE RESPONSE		
		ACCELS ON TAPE.		
	0700	RUN #1 SINE SWEEP 1-35HZ	0.2g 1OCT/MIN	LAT (NS)
		START 0050	STOP 0215	
		RUN #2 SINE SWEEP 1-35HZ	0.2g 1OCT/MIN	LONG (EW)
		START 0215	STOP 0378	
		RUN #3 SINE SWEEP 1-35HZ	0.2g 1OCT/MIN	VERT.
		START 0378	STOP 0538	
		RUN #4 RMF	OBE	TRI
		START 0538	STOP 0569	
	0752	RUN #5 RMF	OBE	TRI
		START 0569	STOP 0605	

W 322

WYLE LABORATORIES
INSTRUMENTATION LOG SHEET

JOB NO. 44213

CUSTOMER TVA SERIES 2

LOG PAGE NO. 2 OF 2

TEST ENGINEER D. BELL

DATE	TIME	REMARKS (Include Run Number, Part Changes, Shift Changes and all other pertinent data)		
9-25-94	0810	RUN #6 RMF	SSE	TRI
		START 0605	STOP 0637	
		RUN #7 SINE SWEEP 1-35HZ 0.2g 1OCT/MIN		LAT (NS)
		START 0637	STOP 0800	
		RUN #8 SINE SWEEP 1-35HZ 0.2g 1OCT/MIN		LONG (EW)
		START 0800	STOP 0965	
	0840	RUN #9 SINE SWEEP 1-35HZ 0.2g 1OCT/MIN		VERT
		START 0965	STOP 1128	

INSTRUMENTATION EQUIPMENT SHEET

DATE: 09/23/94
TECHNICIAN: K. TRACH

JOB NUMBER: 44213-00
CUSTOMER: TVA

TEST AREA: D MACHINE
TYPE TEST: SEISMIC

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	DATALOGGER	FLUKE	2240B	2215029	000831	K&T1.5DEG	.02%RD	08/15/94	02/10/95
2	DIG MTR	FLUKE	87	5639076S	109759	DCV	.1%	10/26/93	10/26/94
3	X-Y PLOTTER	H/P	7044A	2019A03819	101128	MULTI	.2% FS	08/04/94	11/02/94
4	RECORD TAPE	TEAC	XR-7000	772252	108206	H-BAND	40KZ	09/07/94	03/06/95
5	CHARGE PWR	ENDEVCO	4221A	AB41	092934	15VDC	5%	05/26/94	11/22/94
6	CHARGE PWR	ENDEVCO	4331A	AD60	000356	15VDC	5%	05/03/94	10/28/94
7	AMPL CHARGE	ENDEVCO	2721BM	BK13	096749	GAIN	1.5%	05/26/94	11/22/94
8	AMPL CHARGE	ENDEVCO	2721BM	BP62	000385	GAIN	1.5%	05/26/94	11/22/94
9	AMPL CHARGE	ENDEVCO	2721B	BR41	000374	GAIN	1.5%	05/26/94	11/22/94
10	AMPL CHARGE	ENDEVCO	2721B	DR30	000376	GAIN	1.5%	05/26/94	11/22/94
11	AMPL CHARGE	ENDEVCO	2721B	BR09	000372	GAIN	1.5%	05/26/94	11/22/94
12	AMPL CHARGE	ENDEVCO	2721B	BP65	000371	GAIN	1.5%	05/26/94	11/22/94
13	AMPL CHARGE	ENDEVCO	2721BM	BP96	000377	GAIN	1.5%	05/26/94	11/22/94
14	AMPL CHARGE	ENDEVCO	2721BM	BP97	000369	GAIN	1.5%	05/26/94	11/22/94
15	AMPL CHARGE	ENDEVCO	2721BM	BR41	000471	GAIN	1.5%	05/26/94	11/22/94
16	AMPL CHARGE	ENDEVCO	2721BM	BW40	103055	GAIN	1.5%	05/03/94	10/28/94
17	AMPL CHARGE	ENDEVCO	2721BM	BR52	000478	GAIN	1.5%	05/03/94	10/28/94
18	AMPL CHARGE	ENDEVCO	2721BM	BP73	000210	GAIN	1.5%	05/03/94	10/28/94
19	AMPL CHARGE	ENDEVCO	2721B	BR26	000484	GAIN	1.5%	05/03/94	10/28/94
[illegible]	AMPL CHARGE	ENDEVCO	2721B	BR60	000361	GAIN	1.5%	05/03/94	10/28/94
21	AMPL CHARGE	ENDEVCO	2721B	BR45	000360	GAIN	1.5%	05/03/94	10/28/94
22	AMPL CHARGE	ENDEVCO	2721BM	BP-91	000473	GAIN	1.5%	05/03/94	10/28/94
23	AMPL CHARGE	ENDEVCO	2721B	BR01	000375	GAIN	1.5%	05/03/94	10/28/94
24	FILTER TRACK	SPECTRAL DYN	SD-131	431	092683	2HZ-10KHZ	.5 Db	07/28/94	01/24/95
25	FILTER TRACK	SPECTRAL DYN	SD-131	427	092684	2HZ-10KHZ	.5 Db	07/28/94	01/24/95
26	OSC AUDIO SW	SPECTRAL DYN	SD 104A	1430	095295	5HZ-50KHZ	2.5%	08/06/94	11/04/94
27	AMP SERVO MONI	SPECTRAL DYN	SD 105C	757	096142	MULTI	4%	08/08/94	11/04/94
28	X-Y DISPLAY	SPECTRAL DYN	311	435	096767	12INCH SCREEN	1% LIN	05/13/94	11/09/94
29	X-Y RECORDER	H/P	7045B	2164	102373	.5-10V/IN	.2% FS	08/08/94	11/04/94
30	ANALYZER	SPECTRAL DYN	13231	45	096765	.1HZ TO 10KHZ	.5DB	05/13/94	11/09/94
31	XIENT MEMORY	SPECTRAL DYN	13192	43	096766	.1HZ TO 10KHZ	.5DB	05/13/94	11/09/94
32	DUAL HI/LO FIL.	WAVETEK	852	1290722	100710	100KHZ	2%	05/12/94	11/08/94
33	SYNTHESIZER	MRAD	197S	197-17	095477	.5HZ TO 100HZ	4%	05/10/94	11/04/94
34	SYNTHESIZER	MRAD	197S	197-15	095363	.5HZ TO 100HZ	4%	05/11/94	11/07/94
35	SYNTHESIZER	MRAD	197S	197-28	100187	.5HZ TO 100HZ	4%	05/12/94	11/08/94
36	RECORD TAPE	TEAC	R-71	160555	102052	DC-50KC	1%	05/13/94	11/09/94
37	ACCEL	BRUEL & KJAER	4366	1104928	101766	2KGSV/5KGSK	5%	08/02/94	10/31/94
38	ACCEL	BRUEL & KJAER	4366	1104947	101806	2KGSV/5KGSK	5%	08/16/94	11/14/94

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION [signature] 20 Wyle I 9-23-94

CHECKED & RECEIVED BY [signature] 9/23/94

Q.A. Brenda Barnett 9/23/94

INSTRUMENTATION EQUIPMENT SHEET

DATE: 09/23/94
TECHNICIAN: K. TRACH

JOB NUMBER: 44213-00
CUSTOMER: TVA

TEST AREA: D MACHINE
TYPE TEST: SEISMIC

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
39	ACCEL	BRUEL & KJAER	4366	1104819	101745	2KGSV/5KGSK	5%	08/16/94	11/14/94
40	ACCEL	BRUEL & KJAER	4366	1104946	101807	2KGSV/5KGSK	5%	08/16/94	11/14/94
41	ACCEL	BRUEL & KJAER	4366	1104885	101790	2KGSV/5KGSK	5%	08/16/94	11/14/94
42	ACCEL	ENDEVCO	7701-100	AE75	011641	1KGSV/10KGSK	5%	09/09/94	12/08/94
43	ACCEL	BRUEL & KJAER	4366	1104895	101798	2KGSV/5KGSK	5%	08/16/94	11/14/94
44	ACCEL	BRUEL & KJAER	4366	1104886	101789	2KGSV/5KGSK	5%	08/16/94	11/14/94
45	ACCEL	BRUEL & KJAER	4368	1108513	101369	2KGSV/5KGSK	5%	08/16/94	11/14/94
46	ACCEL	BRUEL & KJAER	4383	1579405	108938	2KGSV/5KGSK	5%	08/16/94	11/14/94
47	ACCEL	BRUEL & KJAER	4382	1504972	108681	2KGSV/5KGSK	5%	08/16/94	11/14/94
48	ACCEL	ENDEVCO	7701-100	AE51	011758	1KGSV/10KGSK	5%	09/09/94	12/08/94
49	ACCEL	ENDEVCO	7704-100	BJ75	100852	1KGSV/10KGSK	5%	07/18/94	10/14/94
50	ACCEL	ENDEVCO	7704-100	BG18	100420	1KGSV/10KGSK	5%	08/16/94	11/14/94
51	ACCEL	ENDEVCO	7701-100	BM71	100265	1KGSV/10KGSK	5%	09/09/94	12/08/94
52	ACCEL	BRUEL & KJAER	4383	1599863	109422	2KGSK/5KGSV	5%	07/18/94	10/14/94
53	ACCEL	BRUEL & KJAER	4383	1599575	109418	2KGSV/5KGSK	5%	07/18/94	10/14/94
54	TEMP ALARM	THERMOTRON	12005	263002	094753	-125 TO +375*F	.25%	09/14/94	03/13/95
55	CONTR TEMP	HONEYWELL	R7350	7848 3405	102648	-125 TO 375*F	1%	09/13/94	03/10/95
56	LIMIT ALARM	THERMOTRON	THERM-AL	59	105307	-125 TO 376*F	.8 DG C	09/15/94	03/14/95
[illegible]	CONTR TEMP	HONEYWELL	R7350A	84243396	102085	-125 TO 375*F	1%	09/13/94	03/10/95
[illegible]	SCALES	OHAUS	126	N/A	100145	0-45 LBS	1 GRAM	09/06/94	09/06/95
59	STEEL RULER	STARRETT	36 INCH	N/A	108592	0-36 INCH	*SEE CERT*	04/27/93	04/26/96
60	AMPL CHARGE	ENDEVCO	2721BM	BR-10	000327	GAIN	1.5%	05/03/94	10/28/94

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION Karen Trach (20 Wyle T) 9-23-94

CHECKED & RECEIVED BY David Bell 9/23/94

Q.A. Brenda Bamnister 9/23/94

WYLE LABORATORIES

INSTRUMENTATION DATA SHEET

Recorder No. TEAC XR-7000 Date 9-24-94 Axis TRI Setup TVA SERIES 1 J/N 44213

Accel. S/N	Amp. Ch.	Galvo Tape	Insert q Pk	Volt q Rms	Location	Comp. Ch.	Run # 1-3 mv/g	Run # 1-3 g/in.	Run # 4-6 mv/g	Run # 4-6 g/in.	Remarks
101766	1	1	51.3		1 (LAT)		300		300		
101806	2	2	50.0		2 (LONG)						
101745	3	3	49.6		3 (Vert)						
101807	4	4	50.0		4 (LAT)						
101790	5	5	51.6		5 (Long)						
011641	6	6	97.2		6 (Vert)						
101798	7	7	52.9		7 (LAT)						
101789	8	8	50.4		8 (LONG)						
101369	9	9	50.6		9 (Vert)						
108938	10	10	30.9		10 (LAT)						
108681	11	11	30.6		11 Long						
011758	12	12	94.1		12 (Vert)		300				
100852	13	13	116		HCA (LAT)		1000				
100420	14	14	118		HCA (Long)		1000				
100265	15	15	120		VCA (Vert)		1000				
109422	16	16	30.8		16 (LAT)		300		300		

WH 1026A

WYLE LABORATORIES

INSTRUMENTATION DATA SHEET

Recorder No. TEAC XR-7000 Date 9-24-94 Axis TRI Setup TVA SERIES 1 J/N 44213

Accel. S/N	Amp. Ch.	Galvo Tape	Insert q Pk	Volt q Rms	Location	Comp. Ch.	Run # 1-3 mv/g	Run # 1-3 g/in.	Run # 4-6 mv/g	Run # 4-6 g/in.	Remarks
109418	17	17	30.9		17 (LOW)		300		300		
		18			COLA TRIGGER						

WH 1026A

WYLE LABORATORIES

INSTRUMENTATION DATA SHEET

Recorder No. TEAC XR-7000 Date 9-24-94 Axis TRI Setup TVA SERIES I J/N 44213

Accel. S/N	Amp. Ch.	Galvo Tape	Insert q Pk	Volt q Rms	Location	Comp. Ch.	Run # 7 mv/g	Run # 7 g/in.	Run # 8-10 mv/g	Run # 8-10 g/in.	Remarks
101766	1	1	51.3		1 (LAT)		100		300		
101806	2	2	50.0		2 (LONG)						
101745	3	3	49.6		3 (Vert)						
101807	4	4	50.0		4 (LAT)						
101790	5	5	51.6		5 (Long)						
011641	6	6	97.2		6 (Vert)						
101798	7	7	52.9		7 (LAT)						
101789	8	8	50.4		8 (LONG)						
101369	9	9	50.6		9 (Vert)						
108938	10	10	30.9		10 (LAT)						
108681	11	11	30.6		11 Long						
011758	12	12	94.1		12 (Vert)		100		300		
100852	13	13	116		HCA (LAT)		300		1000		
100420	14	14	118		HCA (Long)		300		1000		
100265	15	15	120		VCA (Vert)		300		1000		
109422	16	16	30.8		16 (LAT)		100		300		

WH 1026A

WYLE LABORATORIES

INSTRUMENTATION DATA SHEET

Recorder No. TEAC XR-7000 Date 9-24-94 Axis TRI Setup TVA SERIES 1 J/N 44213

Accel. S/N	Amp. Ch.	Galvo Tape	Insert q Pk	Volt q Rms	Location	Comp. Ch.	Run # 7 mv/g	Run # 7 g/in.	Run # 8 mv/g	Run # 8 g/in.	Remarks
109418	17	17	30.9		17 (LOW)		100		300		
		18			COLA TRIGGER						

WH 1026A

WYLE LABORATORIES

INSTRUMENTATION DATA SHEET

Recorder No. TEAC XR 7000 Date 9-25-94 Axis TRI Setup TVA SERIES 2 J/N 44213

Accel. S/N	Amp. Ch.	Galvo Tape	Insert q Pk	Volt q Rms	Location	Comp. Ch.	Run # 1-3 mv/g	Run # 1-3 g/in.	Run # 4-5 mv/g	Run # 4-5 g/in.	Remarks
101766	1	1	51.3		1 LAT		300		300		
101806	2	2	50.0		2 LONG						
101745	3	3	49.6		3 V						
101807	4	4	50.0		4 LAT						
101790	5	5	51.6		5 LONG						
11641	6	6	97.2		6 V						
101798	7	7	52.9		7 LAT						
101789	8	8	50.4		8 LONG						
101369	9	9	50.6		9 V						
108938	10	10	30.9		10 LAT						
108681	11	11	30.6		11 LONG						
11758	12	12	94.1		12 V		300				
100852	13	13	116		LAT HCA (NS)		1000				
100420	14	14	118		LONG HCA (EW)		1000				
100265	15	15	120		VCA		1000		300		
		16			COLA / TRIGGER						

WH 1026A

WYLE LABORATORIES

INSTRUMENTATION DATA SHEET

Recorder No. TEAC XR 7000 Date 9-25-94 Axis TRI Setup TVA SERIES 2 J/N 44213

Accel. S/N	Amp. Ch.	Galvo Tape	Insert q Pk	Volt q Rms	Location	Comp. Ch.	Run # 6 mv/g	Run # 6 g/in.	Run # 7-9 mv/g	Run # 7-9 g/in.	Remarks
101766	1	1	51.3		1 LAT		100		300		
101806	2	2	50.0		2 LONG						
101745	3	3	49.6		3 V						
101807	4	4	50.0		4 LAT						
101790	5	5	51.6		5 LONG						
11641	6	6	97.2		6 V						
101798	7	7	52.9		7 LAT						
101789	8	8	50.4		8 LONG						
101369	9	9	50.6		9 V						
108938	10	10	30.9		10 LAT						
108681	11	11	30.6		11 LONG						
11758	12	12	94.1		12 V		100		300		
100852	13	13	116		LAT HCA (NS)		300		1000		
100420	14	14	118		LONG HCA (EW)		300		1000		
102265	15	15	120		VCA		300		1000		
		16			COLA / TRIGGER						

WH 1026A

APPENDIX IX

WYLE LABORATORIES' TEST PROCEDURE 543/7925/DB, REVISION B

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TEST PROCEDURE

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
P. O. Box 077777, Huntsville, AL 35807-7777
Phone (205) 837-4411, Fax (205) 830-2109

TEST PROCEDURE NO. 543/7925/DB

DATE: September 14, 1994

REVISION A September 23,1994
REVISION B October 5, 1994

SEISMIC TEST PROCEDURE FOR VARIOUS THERMO-LAG ENCLOSURE CONFIGURATIONS

For
Tennessee Valley Authority
Watts Bar Nuclear Plant
Spring City, Tennessee

APPROVED BY: _____
FOR: _____

APPROVED BY: _____
FOR: _____

APPROVED BY: _____
FOR: _____

APPROVED BY PROJECT MANAGER: Don Smith 9/16/94
D. Smith, Project Manager

APPROVED BY QUALITY ENGINEER: TR Hamilton 9/19/94
for R. G. Thomas, QA Manager

PREPARED BY PROJECT ENGINEER: Don Bell 9/15/94
D. Bell, Project Engineer

REVISIONS

FORM 1054-1 Rev. 4/74

REV. NO.	DATE	PAGES AFFECTED	BY	APP'L.	DESCRIPTION OF CHANGES
A	9/23/94	2	DB 9/23/94	DB 9/23/94 TRH 9/23/94	Revised para. 3.1
A	9/23/94	3	DB 9/23/94	DB 9/23/94 TRH 9/23/94	Deleted last sentence of para. 3.1
A	9/23/94	13-18	DB 9/23/94	DB 9/23/94 TRH 9/23/94	Revised Figures 8-13
B	10/5/94	2	DB 10/5/94	DB 10/5/94	Revised 1st paragraph of section 3.1

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1.0 SCOPE

The specimens shall be subjected to a Seismic Simulation Test Program as described in the following paragraphs. The specimens shall be tested in accordance with IEEE 344-1975.

1.1 Specimen Description

The Various Thermo-Lag Enclosure Configurations, as shown in Attachment A and hereinafter called the specimens, shall be subjected to seismic testing as described in Paragraph 4.0. The cable tray and air drop configurations shown in Attachment A, Sheets 1 through 5, shall be installed for Series 1. The conduit configurations shown in Attachment A, Sheets 6 through 10, shall be installed for Series 2.

1.2 Acceptance Criteria

- Position retention of the Thermo-Lag material per TVA Seismic Category I(L) acceptance criteria.
- Any failure to maintain position retention, based on visual observations during testing, will be recorded as a test anomaly. Any loose Thermo-Lag material larger than approximately one cubic inch that is found after each OBE, SSE and Resonance Search Test shall be measured, photographed and weighed. TVA will disposition test anomalies based on satisfying the position retention requirements.

1.3 Receipt Inspection

The specimens shall be inspected for obvious physical defects prior to testing.

2.0 MOUNTING

2.1 Specimen Tie-Down and Orientation

The specimens described in Paragraph 1.1 shall be installed on TVA-fabricated test fixtures. The specimens shall be attached to the test fixtures by TVA using TVA procedures, drawings and specifications. The test fixtures shall be welded to the test table.

The specimens shall be installed on the Wyle Triaxial Seismic Simulator Table such that the principal axes of the specimens shall be collinear with the input excitations of the test table.

3.0 TESTING CONDITIONS

3.1 Specimen Temperature

The specimens shall be conditioned at a temperature of between 120° and 140°F in an environmental enclosure installed on the Wyle Triaxial Seismic Simulator Table. The specimens shall be tested when the average temperature of the four specimen thermocouples is between 120° and 140°F for a minimum of six hours. B

3.0 TESTING CONDITIONS (Continued)

3.1 Specimen Temperature (Continued)

The Resonance Search Test described in Paragraph 4.2, prior to the Random Multifrequency Test, shall be performed with the environmental enclosure installed on the test table. During the Random Multifrequency Tests described in Paragraph 4.3, and the second Resonance Search Test, all or part of the enclosure must be removed from the test table to provide a visual observation and video coverage of these tests. Specimen temperature shall be maintained between 120 and 140°F on a best effort basis. A

4.0 EXCITATION

4.1 Simultaneous Triaxial Excitation

Both horizontal axes and the vertical axis shall be excited separately, but simultaneously. The input acceleration level for each of the three axes shall be phase-incoherent during the Multifrequency Tests.

4.2 Resonance Search

A low-level (0.2g horizontally and vertically) single-axis sine sweep shall be performed in each of the three orthogonal axes to determine resonant frequencies prior to and after the Random Multifrequency Tests. The sine sweep shall be performed from 1 to 35 Hz at a sweep rate of one octave per minute. Transmissibility plots of the in-line specimen-mounted accelerometers shall be included in the test report.

4.3 Random Multifrequency Tests

The specimens shall be subjected to 30-second duration triaxial multifrequency random motion which shall be amplitude-controlled in one-third octave bandwidths spaced one-third octave apart over the frequency range of 1 to 100 Hz. Three simultaneous, but independent, random signals shall be used as the excitation to produce phase-incoherent motions in the vertical and two horizontal axes. The amplitude of each one-third octave bandwidth shall be independently adjusted in each of the three axes until the Test Response Spectra (TRS) envelop the Required Response Spectra (RRS) within the limitations of the test machine, as shown in Figure 1. The resulting table motion shall be analyzed by a response spectrum analyzer at the test damping and plotted at one-sixth octave intervals over the frequency range of 1 to 200 Hz.

The specimens shall be subjected to two Operating Basis Earthquake (OBE) Tests prior to the application of a Safe Shutdown Earthquake (SSE) Test. The OBE and SSE RRS shall be as shown in Figures 2 through 13.

5.0 INSTRUMENTATION

All instrumentation, measuring, and test equipment to be used in the performance of this test program shall be calibrated in accordance with Wyle Laboratories' (Eastern Operations) Quality Assurance Program Manual, which complies with the requirements of Military Specification MIL-STD-45662A. Standards used in performing all calibrations are traceable to the National Institute of Standards and Technology (NIST) by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented.

5.1 Excitation Control

Control accelerometers shall be mounted on the test table at a location near the bases of the test fixtures. TRS plots (filtered at 100 Hz) of the accelerometers at the test damping shall be included in the test report.

5.2 Specimen Response

Six uniaxial piezoelectric accelerometers (two triaxial locations) shall be located on each of the cable tray, air drop and conduit specimen configurations. The accelerometers shall be placed on the top and on the side near the mid-span of each specimen. Magnetic tape recorders shall provide a record of each accelerometer's response. TRS plots (filtered at 100 Hz) of the specimen response accelerometers at the test damping for one OBE and the SSE Test shall be provided in the test report.

5.3 Temperature Control

Two thermocouples shall be surface mounted (one on the top and one on the bottom) on each of the cable tray, air drop and ganged conduit specimen configurations. One thermocouple shall be mounted on the top of the single conduit specimen configuration. Thermocouple outputs shall be recorded.

5.4 Post-Test Inspection

The specimens shall be inspected for obvious physical damage.

6.0 IN-PROCESS INSPECTION

The records shall be checked for quality of performance after each test.

The specimens shall be visually examined for possible damage following all violent tests such as at a severe structural resonance.

All important vibration effects shall be logged.

Photographs shall be taken of any noticeable physical damage that may occur.

Video coverage of the dynamic tests with two copies of the video tape shall be provided.

7.0 REPORT

Two copies (one spiral-bound and one unbound reproducible) of a certification-type test report shall be issued subsequent to completion of testing. This report shall be signed by a Registered Professional Engineer. The report shall summarize results and conclusions, details and recommendations concerning deficiencies and repairs, and contain photographs of test setups, failures, etc. The report shall also contain a list of test equipment used, calibrations, and Instrumentation Log Sheets.

In addition, the report shall include an appendix documenting the installation of the Thermo-Lag enclosures on the test fixtures per applicable TVA design documents.

8.0 QUALITY ASSURANCE

All work performed on this test program shall be completed in accordance with Wyle Laboratories' Quality Assurance Program which complies with the applicable requirements of Military Specification MIL-STD-45662A, 10 CFR 50 Appendix B, ANSI N45.2, and Regulatory Guides.

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10.0 ☐ 100.0 ☒ 1000.0 ☐

DAMPING FROM TOP TO BOTTOM: 0.5%, 1.0%, 2.0% & 5.0%

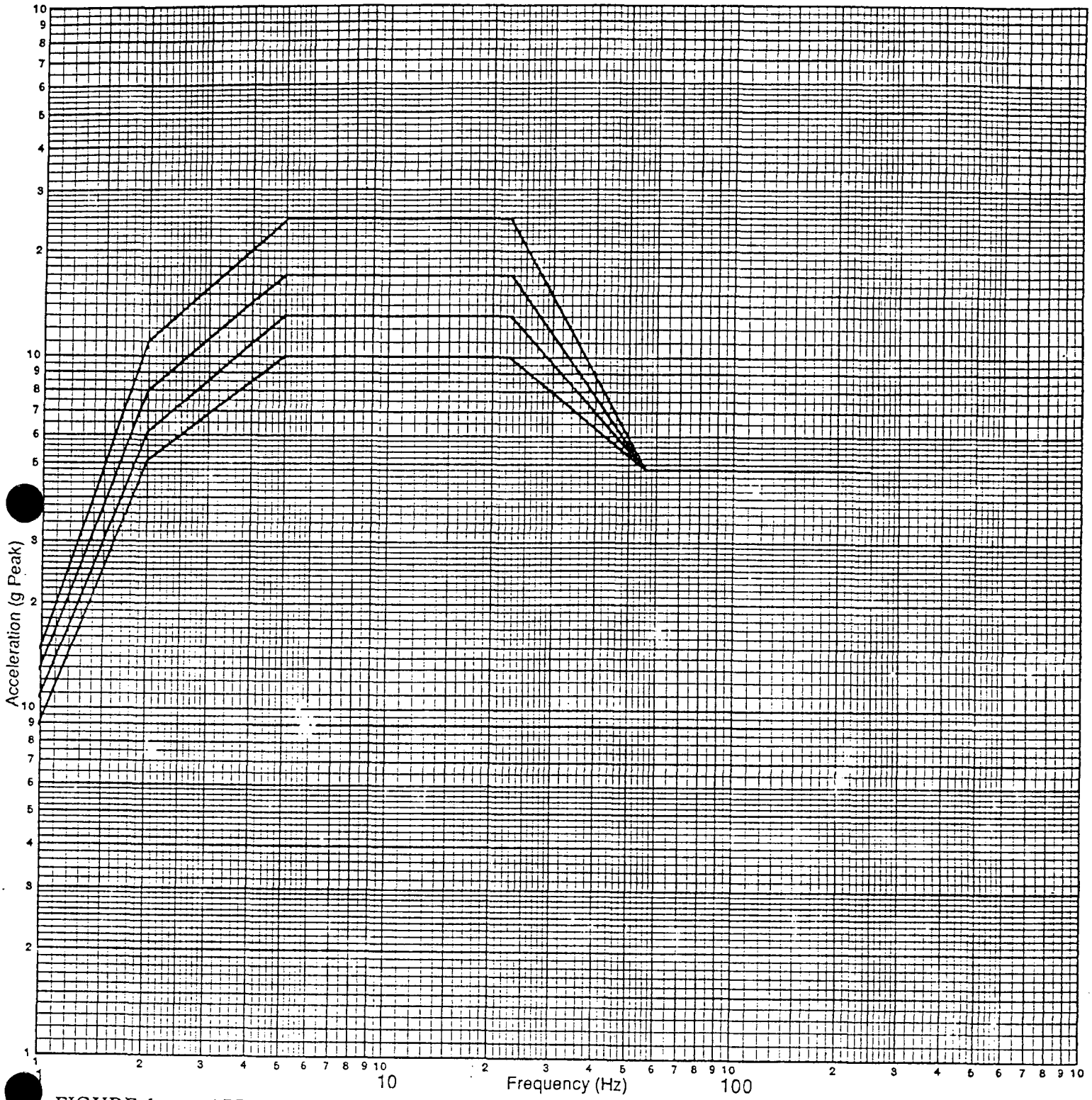


FIGURE 1. APPROXIMATE HORIZONTAL AND VERTICAL BROADBAND LIMITATIONS OF THE WYLE TRIAXIAL SEISMIC SIMULATOR (MACHINE D). RESPONSE ANALYZED AT THE DAMPINGS SHOWN.

Note: The limitations shown were analyzed at 1/3 octave intervals.
Certain frequencies may be lower than this limitations curve when analyzed at 1/6 octave.

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

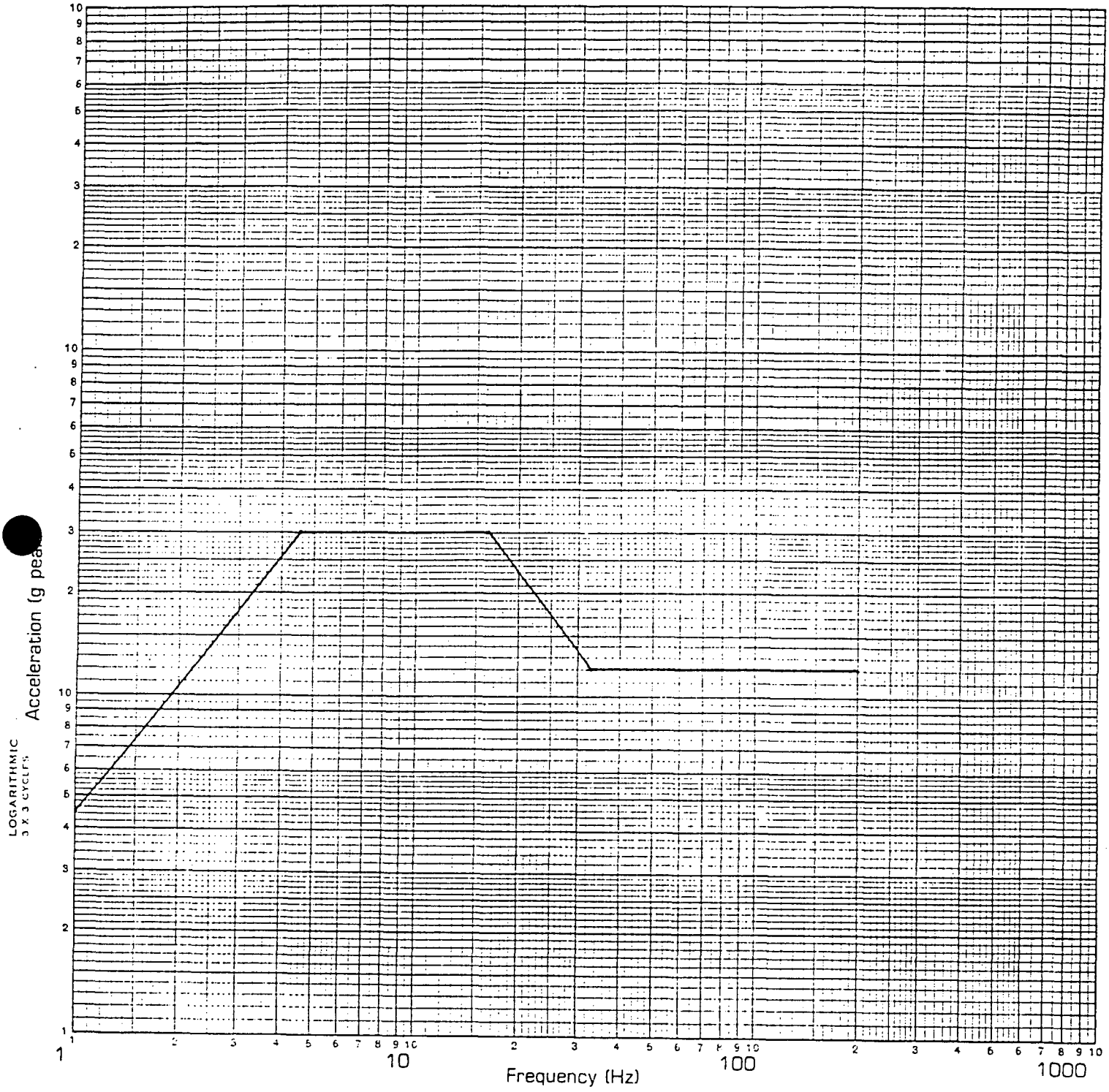


FIGURE 2. SERIES 1 LATERAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

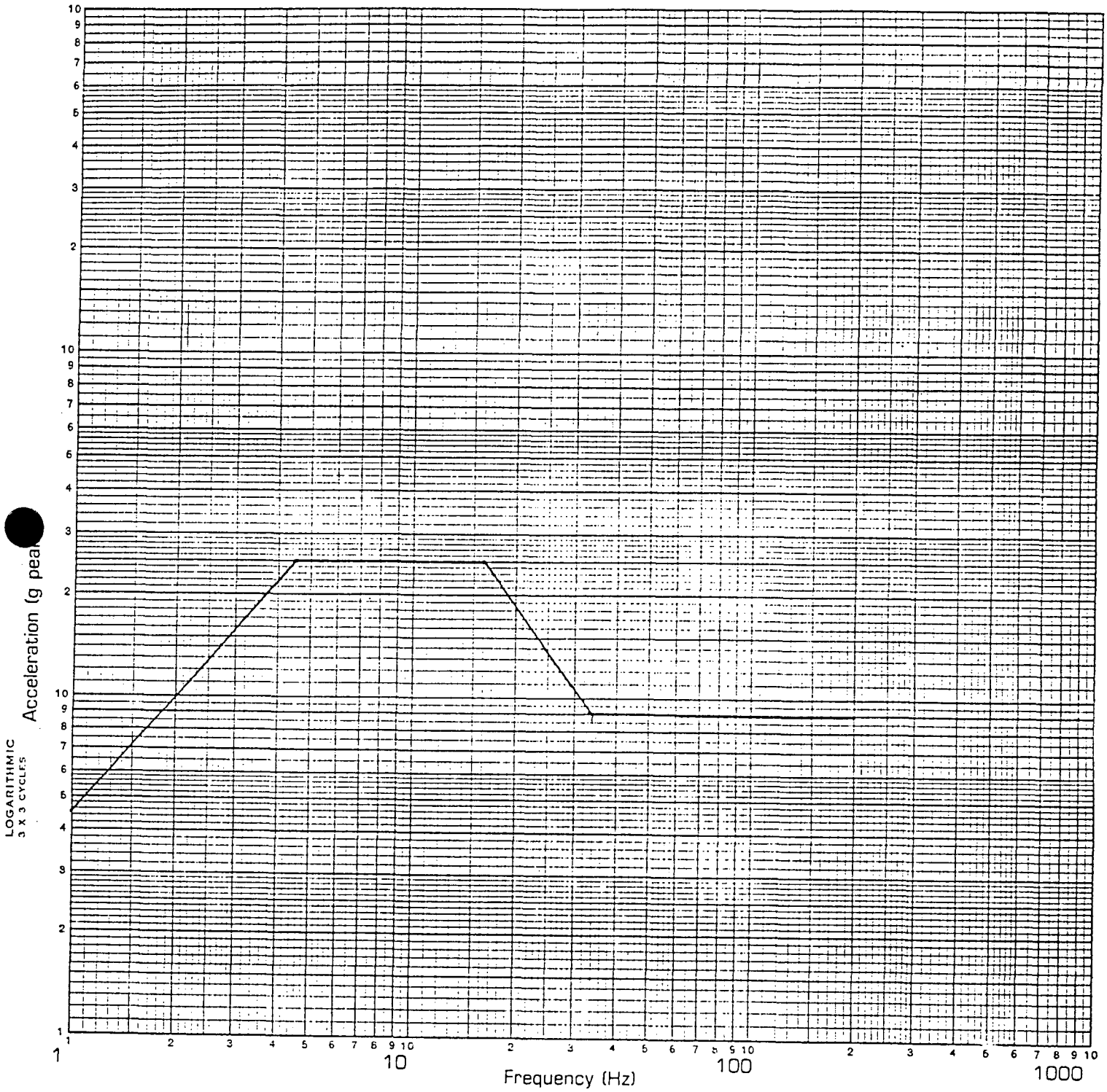


FIGURE 3. SERIES 1 LONGITUDINAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

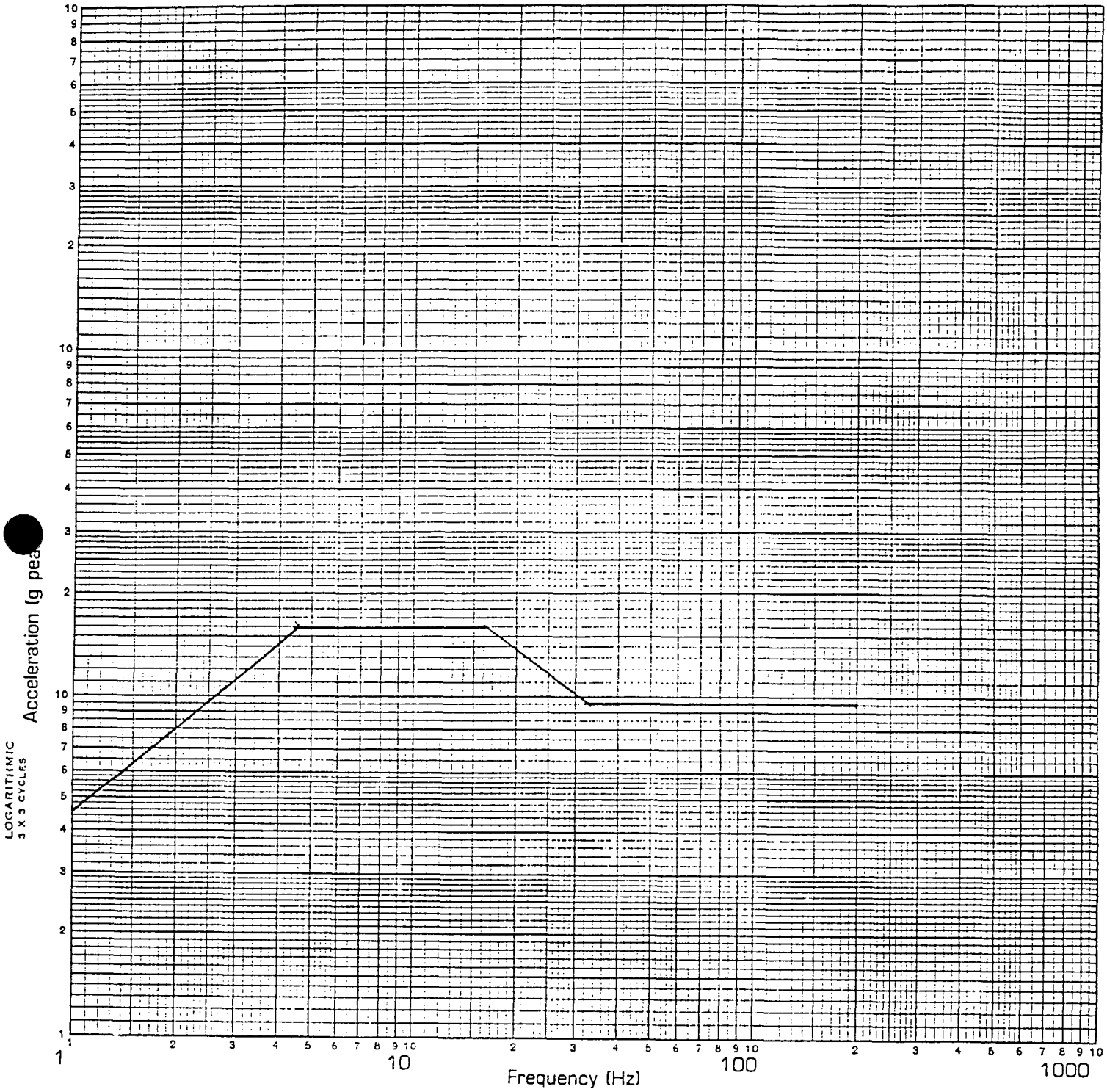


FIGURE 4. SERIES 1 VERTICAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

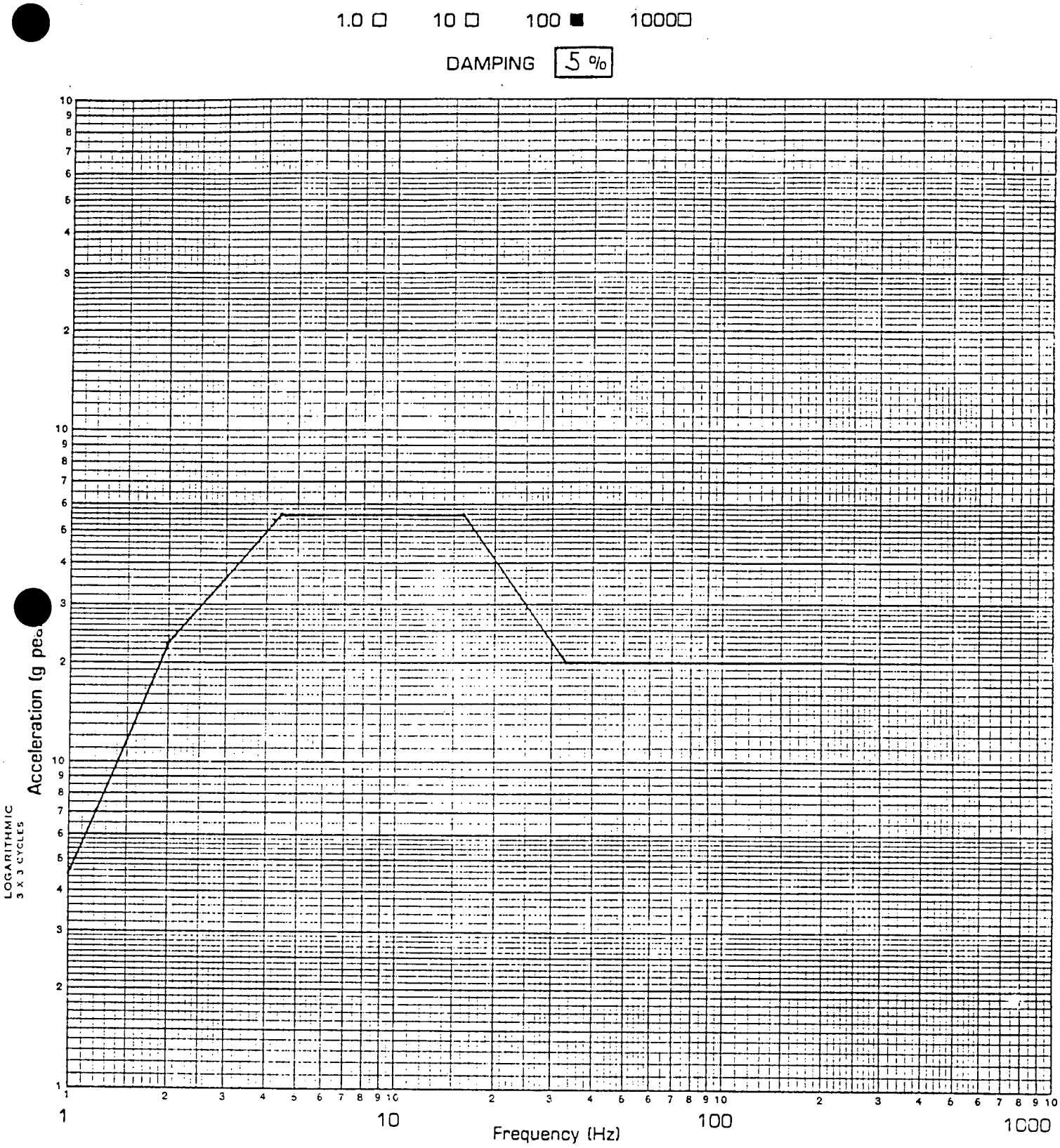


FIGURE 5. SERIES 1 LATERAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

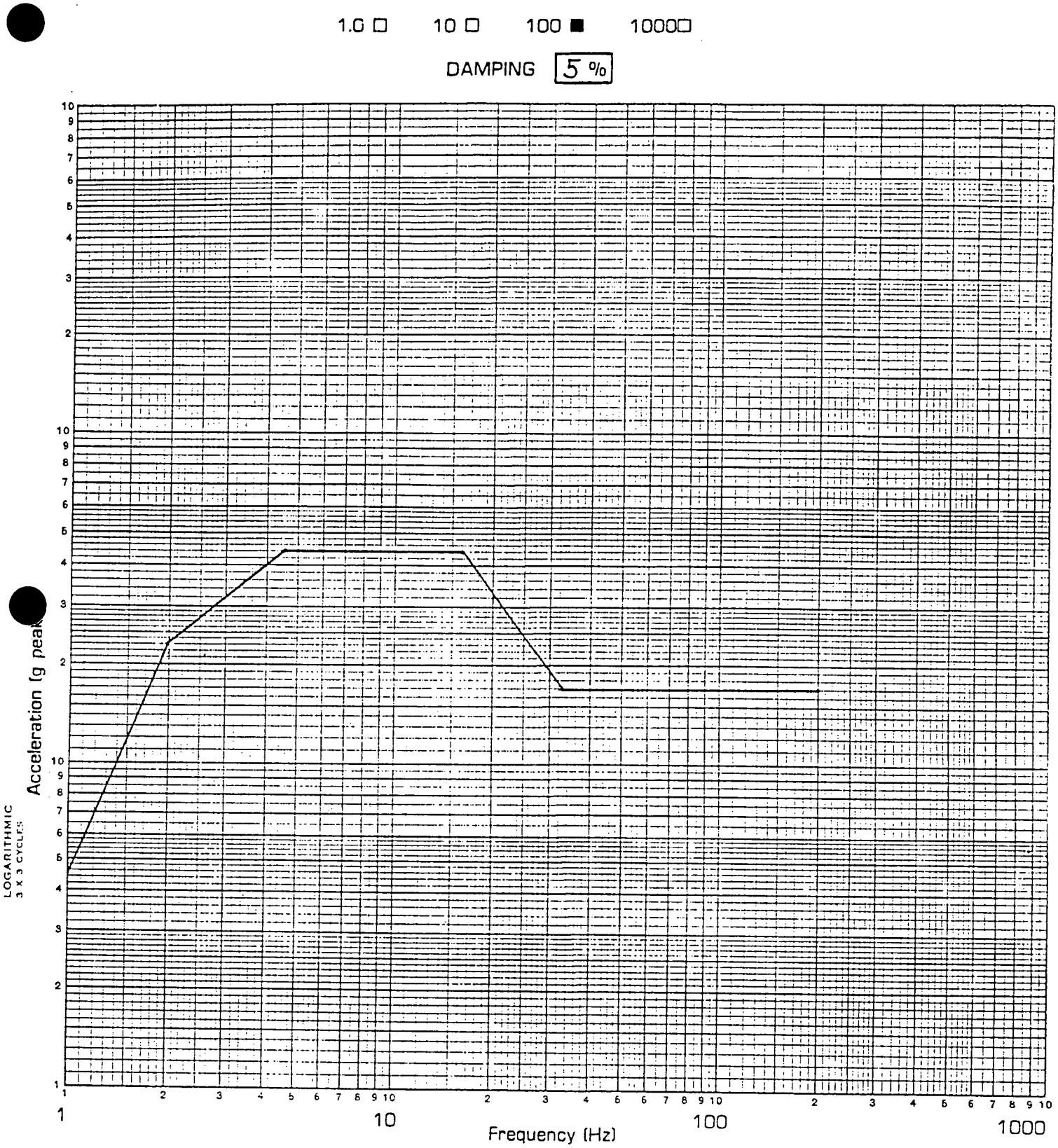


FIGURE 6. SERIES 1 LONGITUDINAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

:ULL SCALE SHOCK SPECTRUM (g Peak)

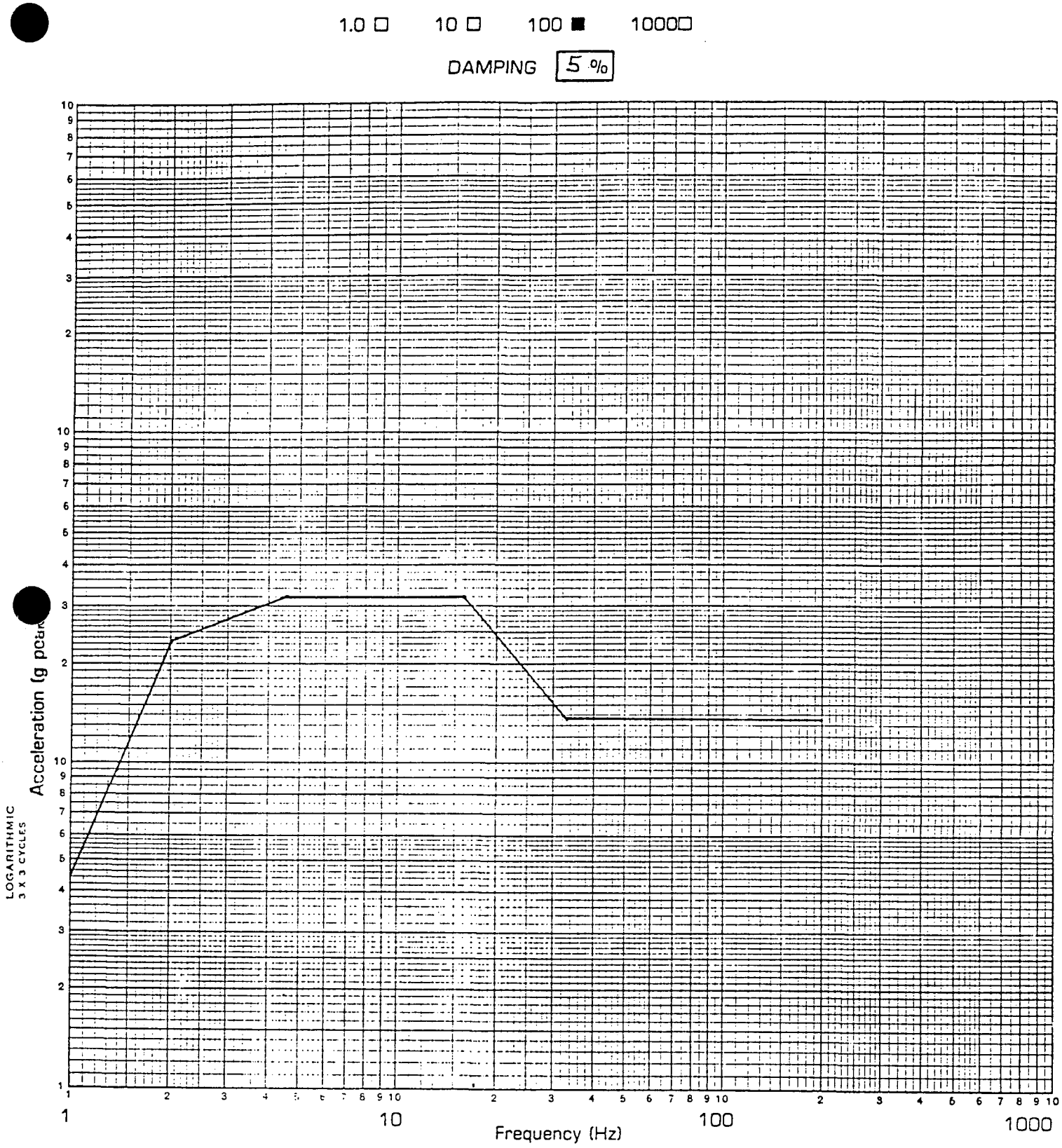


FIGURE 7. SERIES 1 VERTICAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

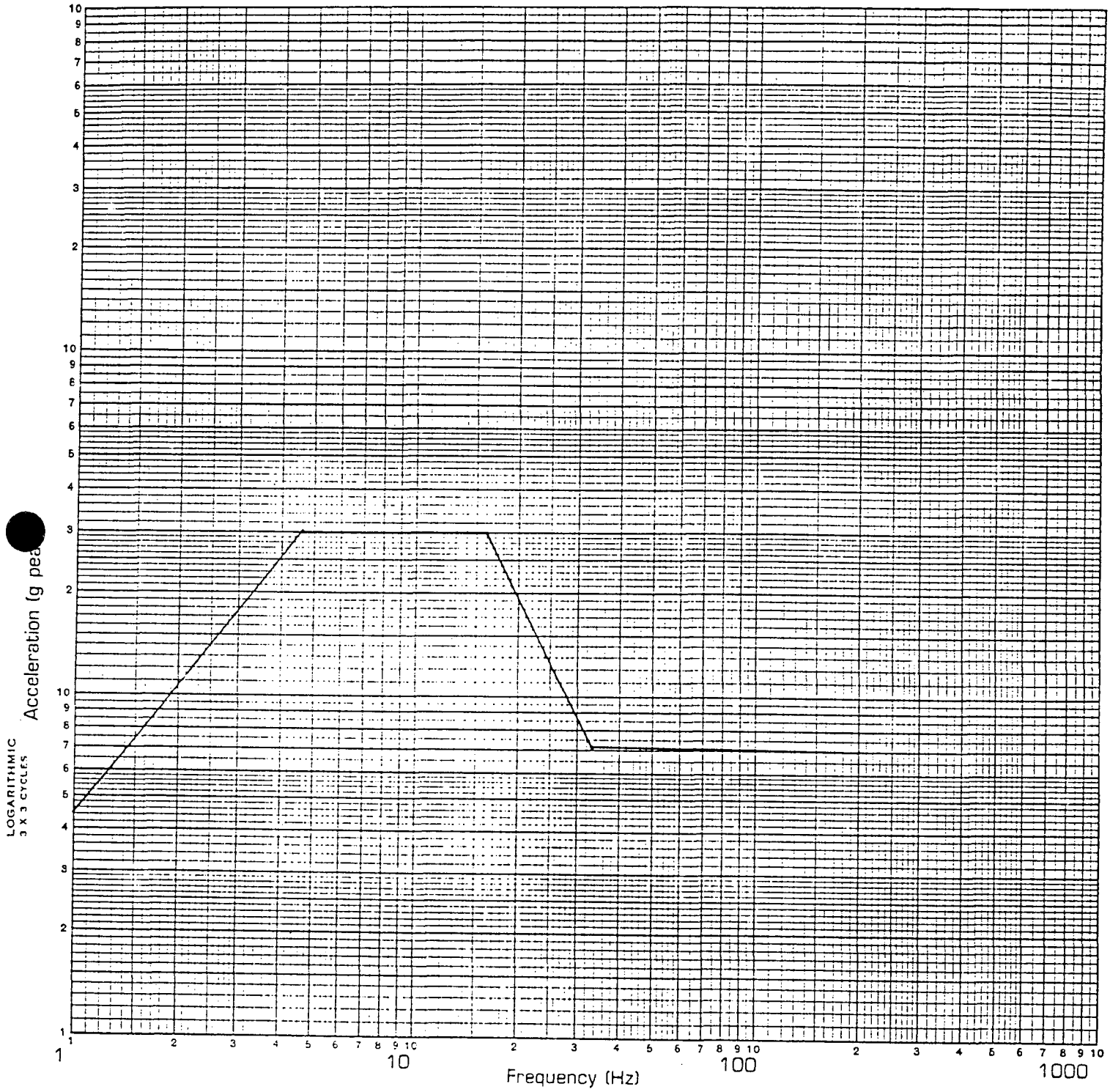


FIGURE 8. SERIES 2 LATERAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

REVISION A

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

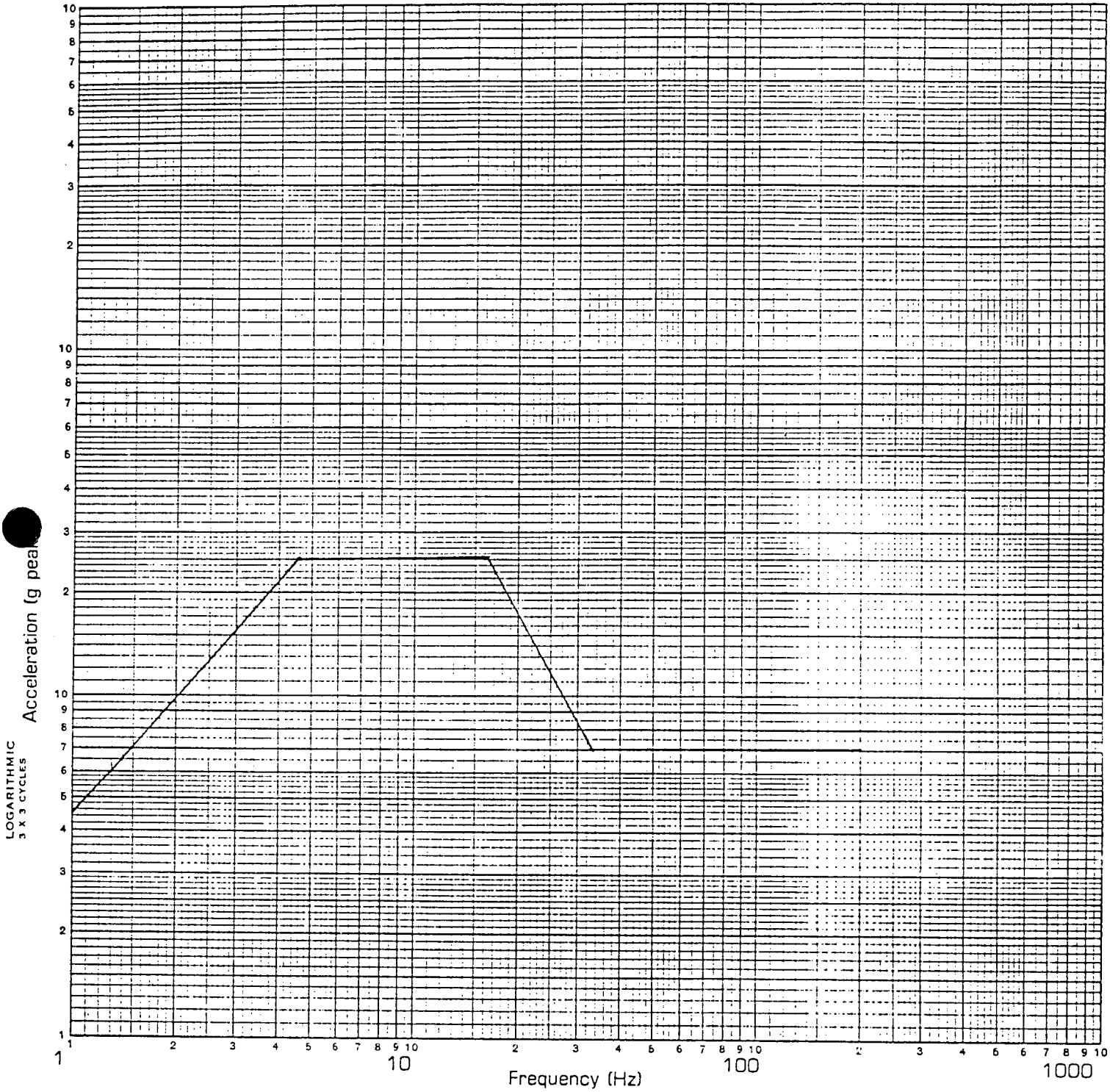


FIGURE 9. SERIES 2 LONGITUDINAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

JLL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

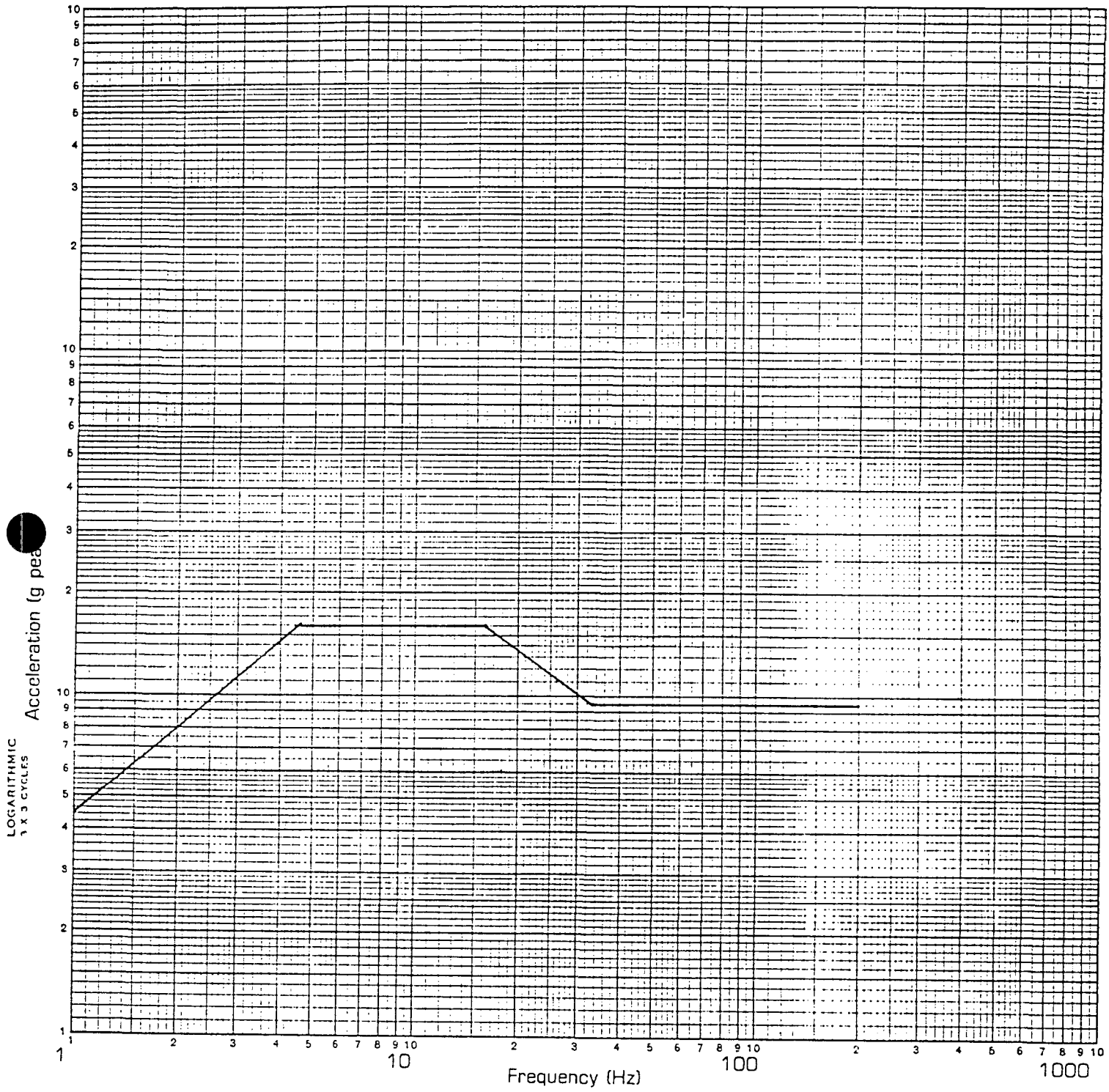


FIGURE 10. SERIES 2 VERTICAL OPERATING BASIS EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

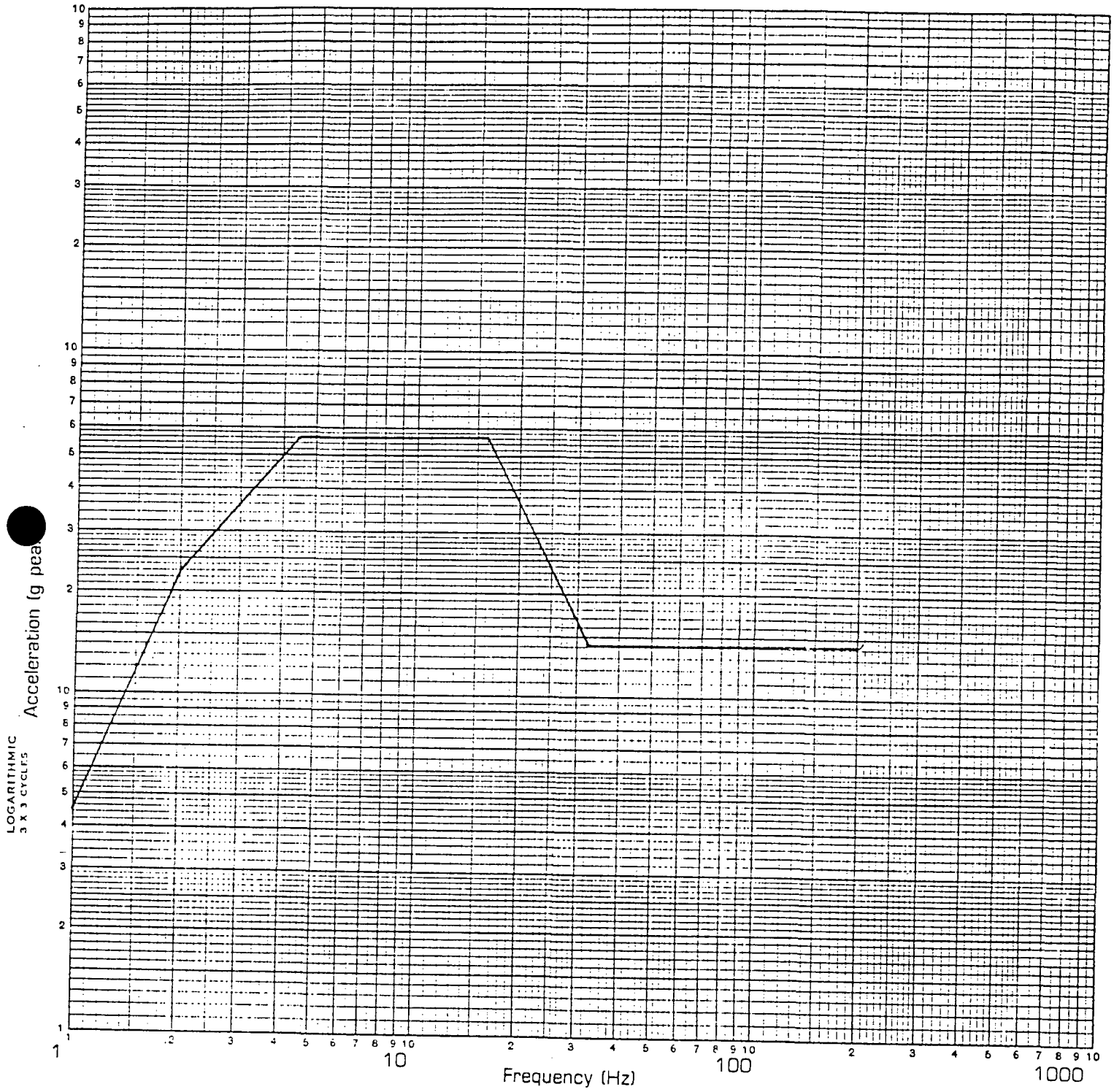


FIGURE 11. SERIES 2 LATERIAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

REVISION A

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5 %

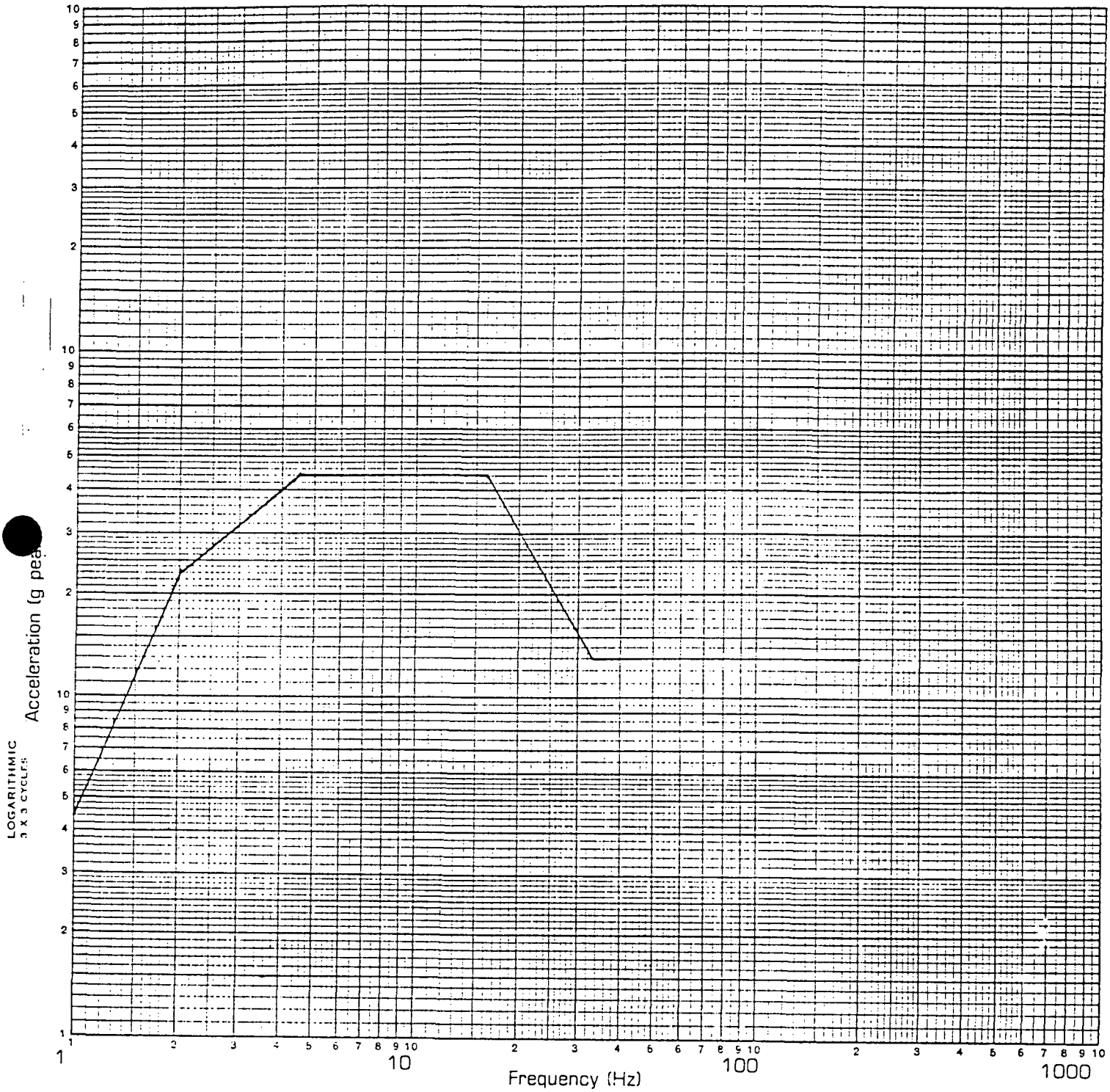


FIGURE 12. SERIES 2 LONGITUDINAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

FULL SCALE SHOCK SPECTRUM (g Peak)

REVISION A

1.0 ☐ 10 ☐ 100 ■ 1000☐

DAMPING 5%

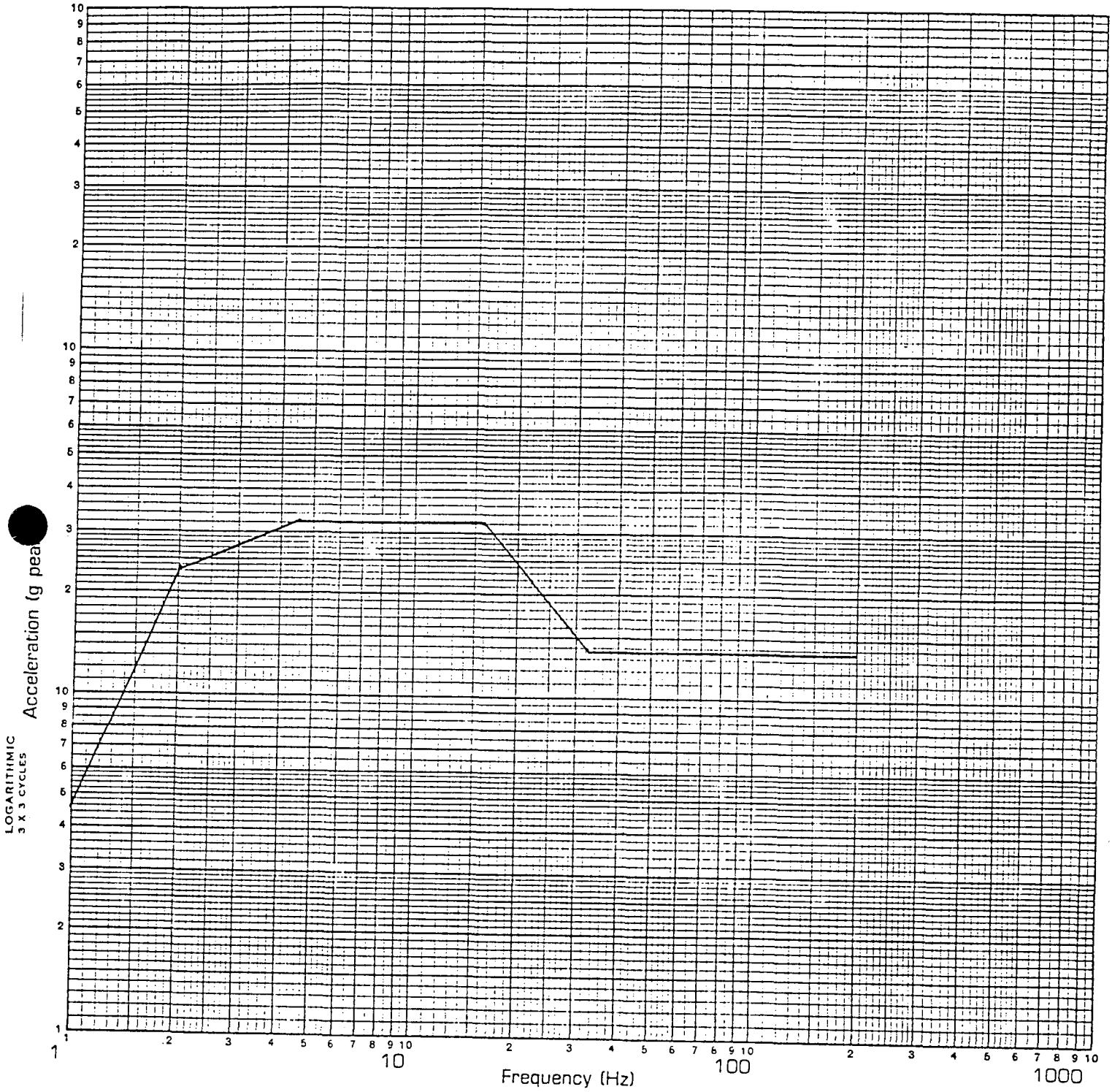


FIGURE 13. SERIES 2 VERTICAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

ATTACHMENT A

TVA 40911 (EN 02-82-91)

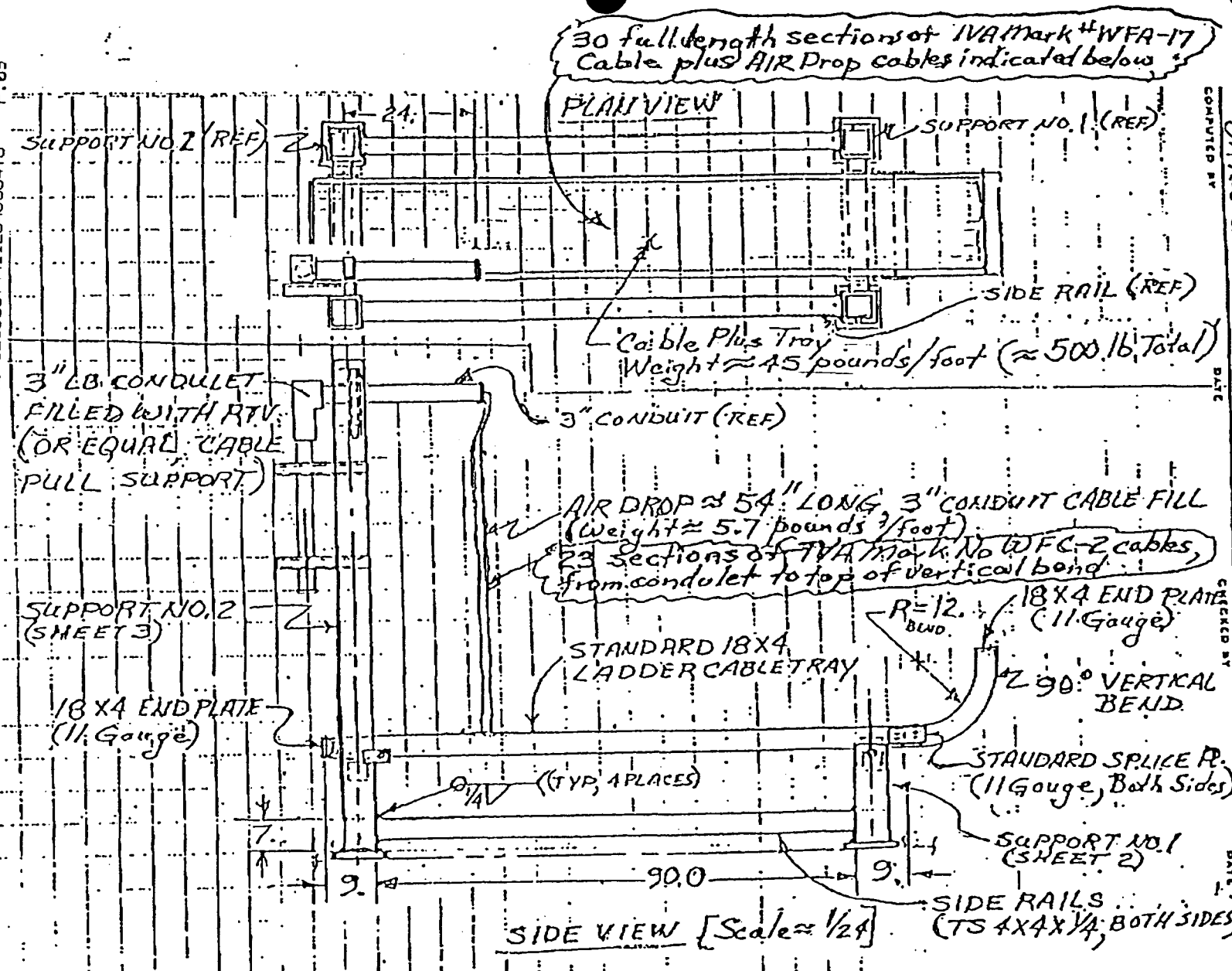
SUBJECT THERMO-LAG SEISMIC TEST-SINGLE CABLE TRAY AND AIR DROP FIXTURES

COMPUTED BY JK Rochello DATE 7/15/94 R1 7/28/94

CHECKED BY AS BUILT 8/11/94 DATE

PROJECT WATTS BAR

SHEET A1 OF 10



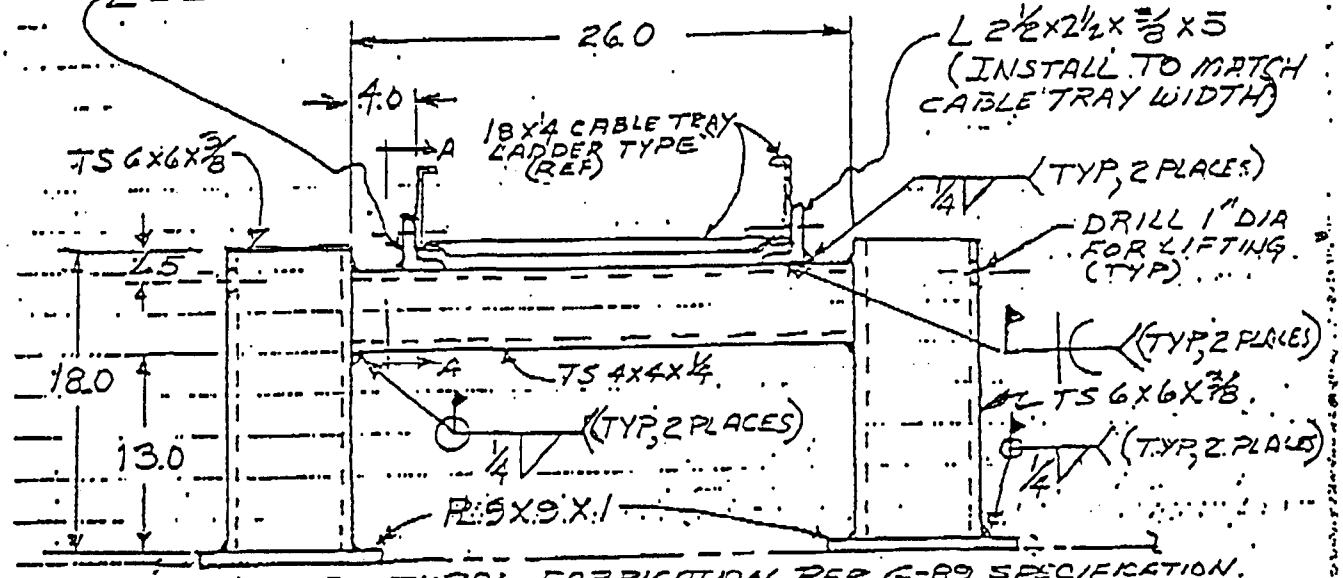
NOTE: THERMO-LAG ENCLOSURES TO BE INSTALLED OVER CABLE TRAY [FIGURES 2(A) AND 2(B)], 3" CONDUIT [FIGURES 1(A) AND 1(B)]; AND AIR DROP [FIGURES 5(A) AND 5(B)] PER 47W243 SERIES DRAWINGS AND G-98 SPECIFICATION.

09-13-1994 06:54AM FROM TO 12058374411284508478 P.09

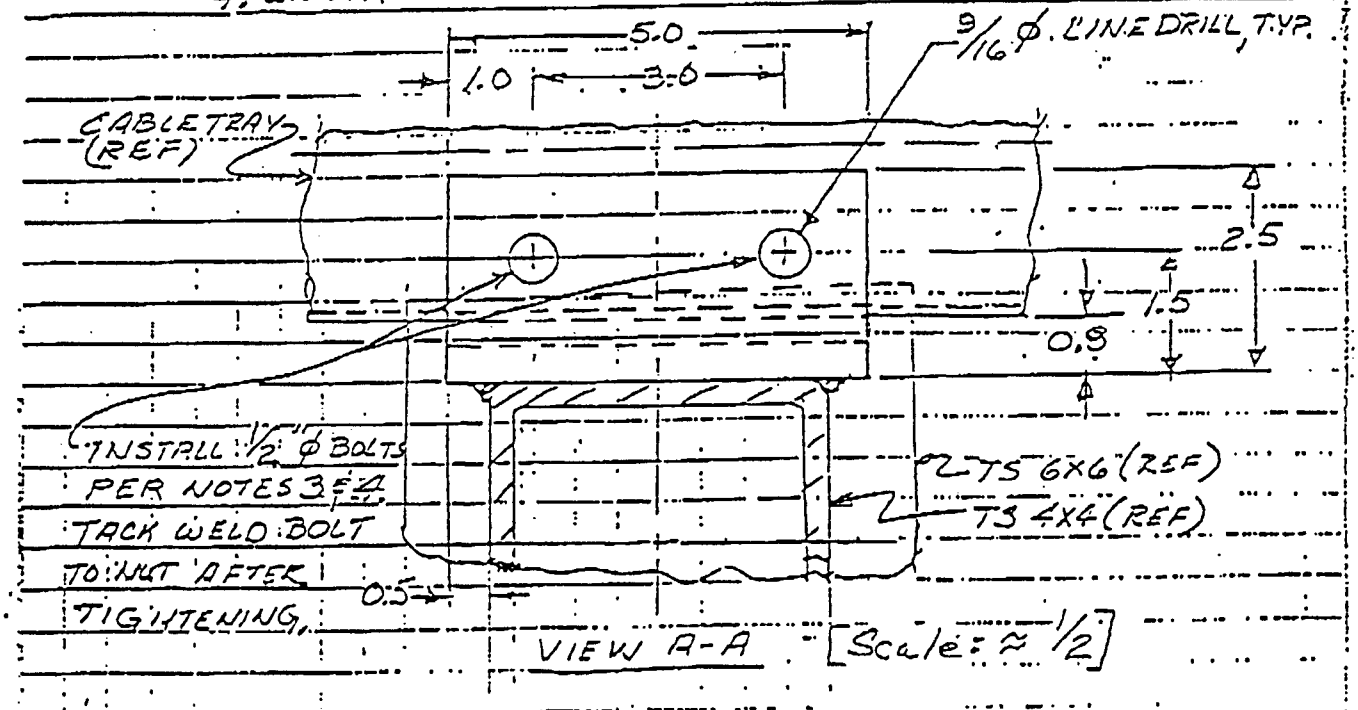
SUBJECT THERMO-LAG SEISMIC TEST - SINGLE CABLE TRAY AND AIR DROP FIXTURES, PROJECT VIATTS BAR

COMPUTED BY J.K. Rochelle DATE 7/15/94 CHECKED BY R1 7/28/94 DATE AS BUILT 8/11/94

SUPPORT NO 1 [Scale ≈ 1/8]



NOTES: 1. STRUCTURAL FABRICATION PER G-89 SPECIFICATION.
2. STRUCTURAL MATERIAL ASTM A500 GRB, A36, OR EQUAL.
3. BOLTS - ROUND PHILLIPS HD, A307, ½"φ - 1¼" LG, WITH MATCHING NUTS.
4. INSTALL BOLTS WITH NUTS ON OUTSIDE, SNUG TIGHT.



VIEW A-A [Scale: ≈ 1/2]

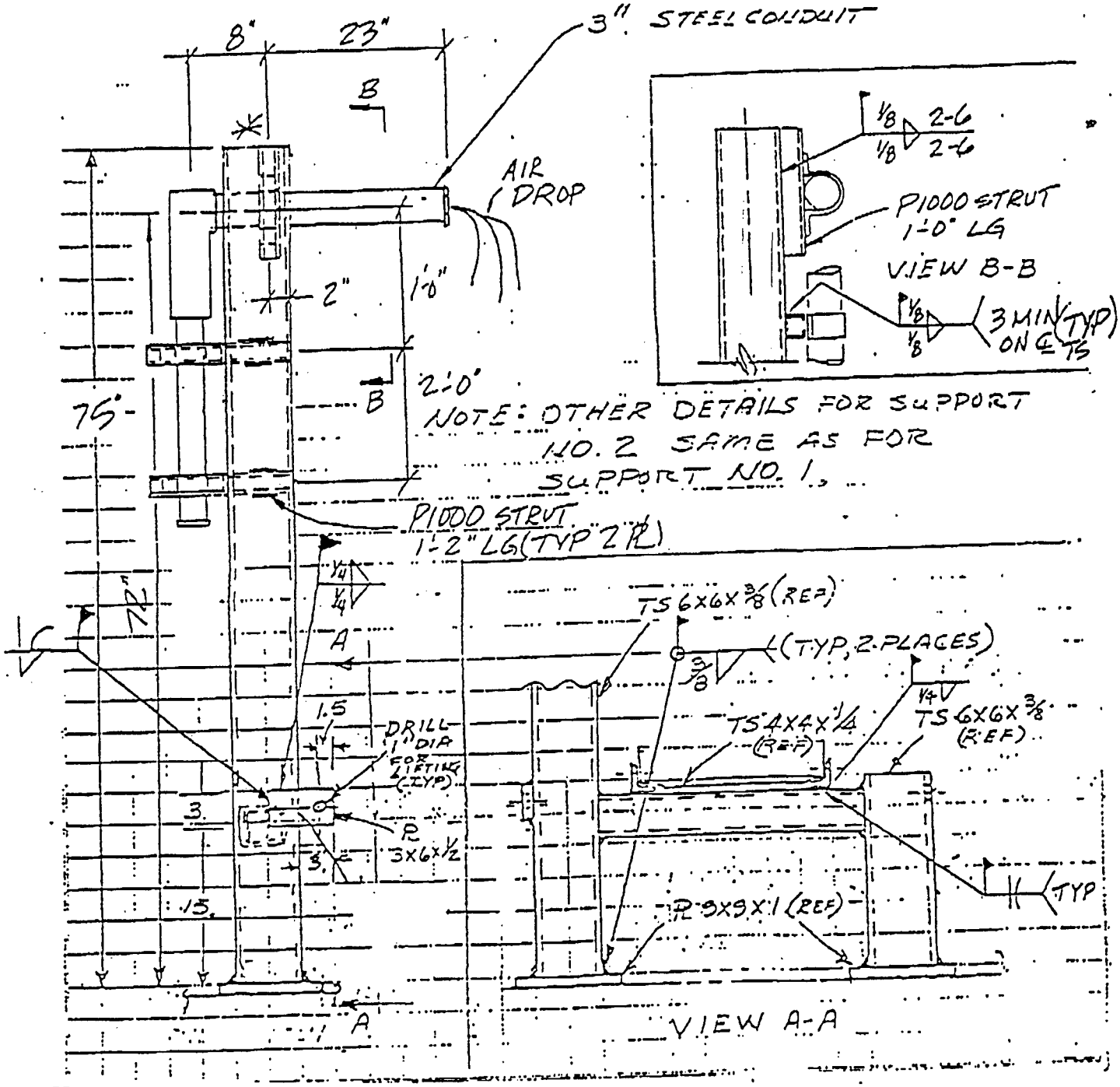
SUBJECT THERMO-LAG SEISMIC TEST-SINGLE CABLE TRAY AND AIR DROP FIXTURES PROJECT WATTS BAR

JK Rochalk 7/15/94 RI 7/28/94 AS BUILT 8/11/94

COMPUTED BY DATE CHECKED BY DATE

*P2558 CLAMP ASSY TYP FOR EACH STRUT

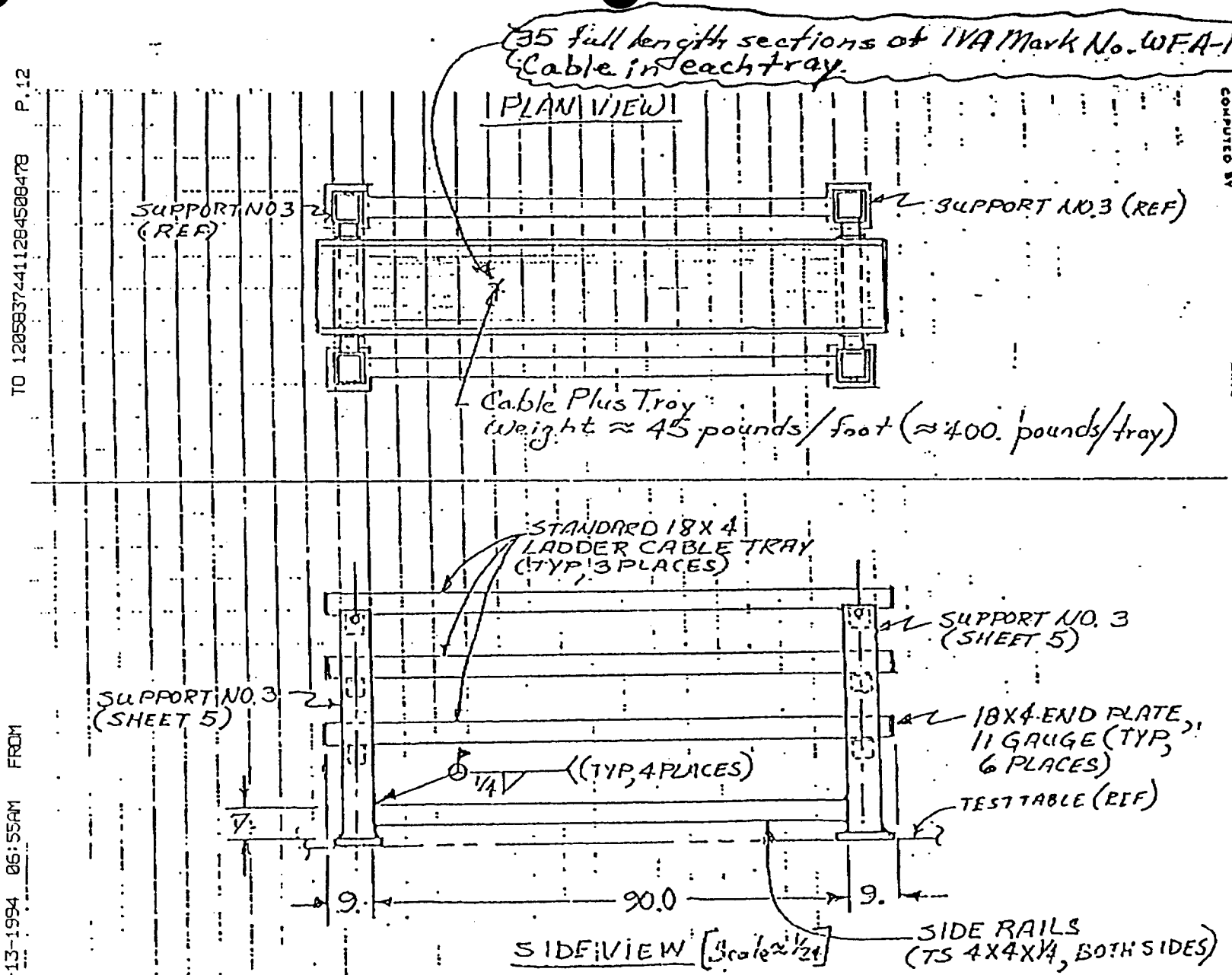
SUPPORT NO. 2 [Scale ≈ 1/12]



SUBJECT CABLE TRAY FIXTURE — THERMO-LAG SEISMIC TEST - MULTIPLE

COMPUTED BY JKBrichella DATE 7/15/94 CHECKED BY AS BUILT DATE 8/11/94 PROJECT WATTS BAR

SHEET 4 OF 10



NOTE: THERMO-LAG ENCLOSURE TO BE INSTALLED OVER 3 CABLE TRAYS [FIGURE 3] PER 47W243 SERIES DRAWINGS AND G-98 SPECIFICATION.

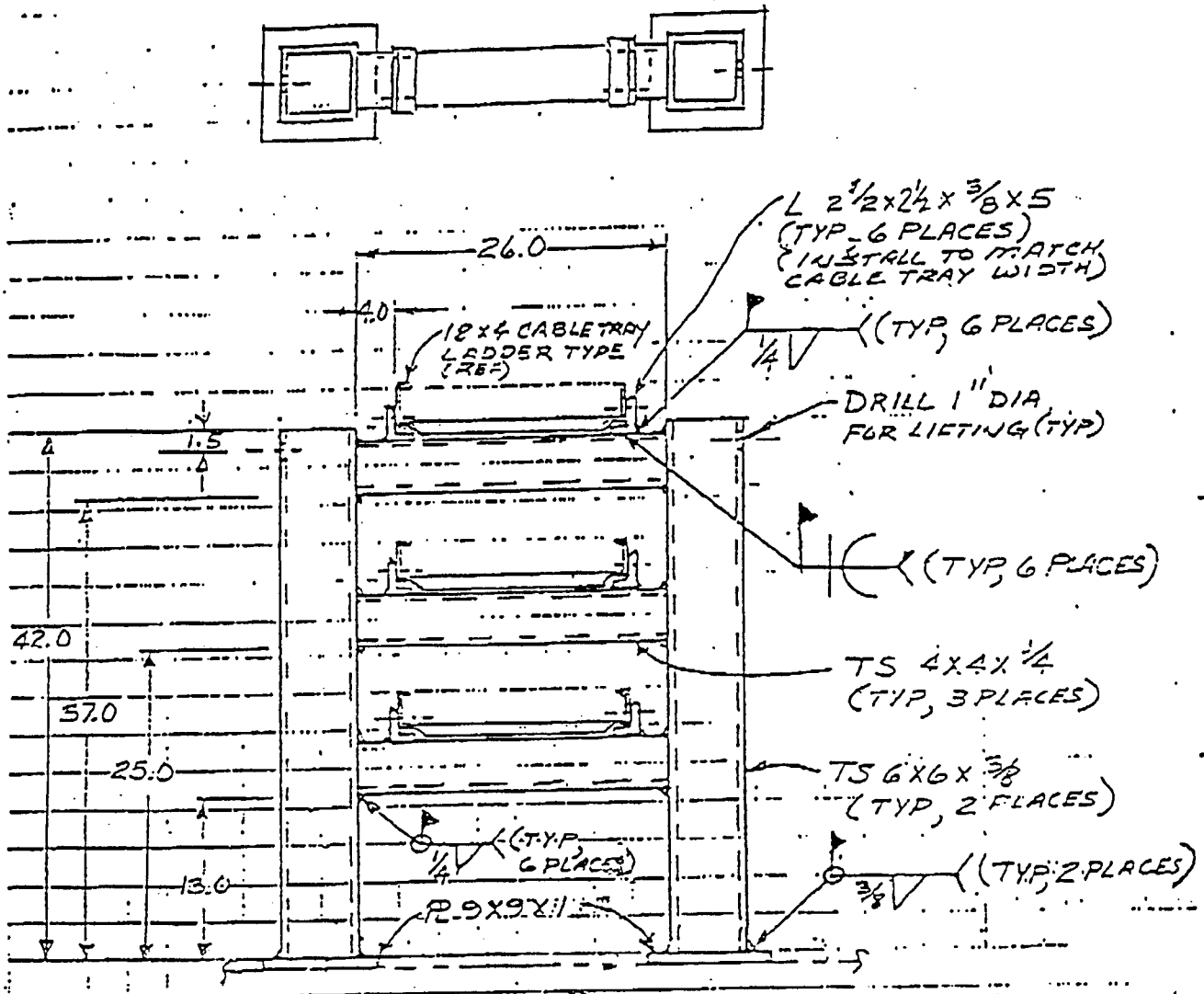
09-13-1994 06:55AM FROM TO 12058374411284508478 P.12

THERMO-LAG SEISMIC TEST-MULTIPLE CABLE TRAY FIXTURE

SUBJECT CABLE TRAY FIXTURE PROJECT ACRITS CHAP

COMPUTED BY J. Rachelle DATE CHECKED BY Robert Blake DATE

SUPPORT NO. 3 (TYP, 2 PLACES) [Scale ≈ 1/12]



NOTES: 1. STRUCTURAL FABRICATION PER G-89 SPECIFICATION.
2. STRUCTURAL MATERIAL ASTM A500 GR B, A36, OR EQUAL.
3. BOLTS, ROUND PHILLIPS HD, A307, ½" ϕ - 1¼ LONG, WITH MATCHING NUTS.
4. INSTALL BOLTS WITH NUTS ON OUTSIDE, SNUG TIGHT. TACK WELD BOLT TO NUT AFTER TIGHTENING.
5. FOR DETAILS OF ATTACHMENT TO CABLE TRAY SEE VIEW A-A FOR SUPPORT NO. 1 (SHEET 2).

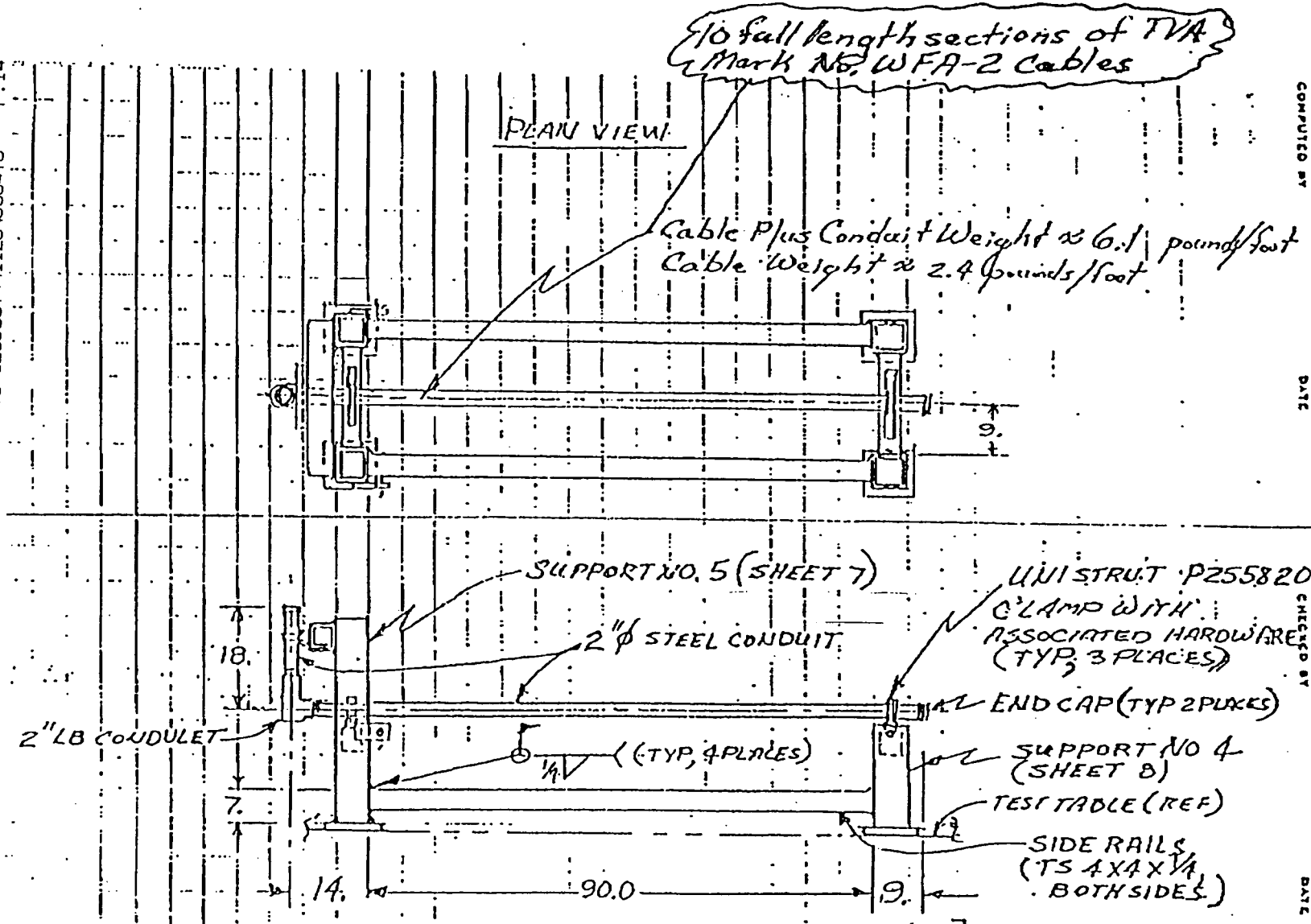
SUBJECT THERMO-LAG SEISMIC TEST-SINGLE CONDUIT FIXTURE

PROJECT WATTS BAR

SHEET A-6 OF 10

COMPUTED BY J.V. Rockalle DATE 7/18/94

CHECKED BY RI 7/28/94 DATE AS BUILT 8/4/94



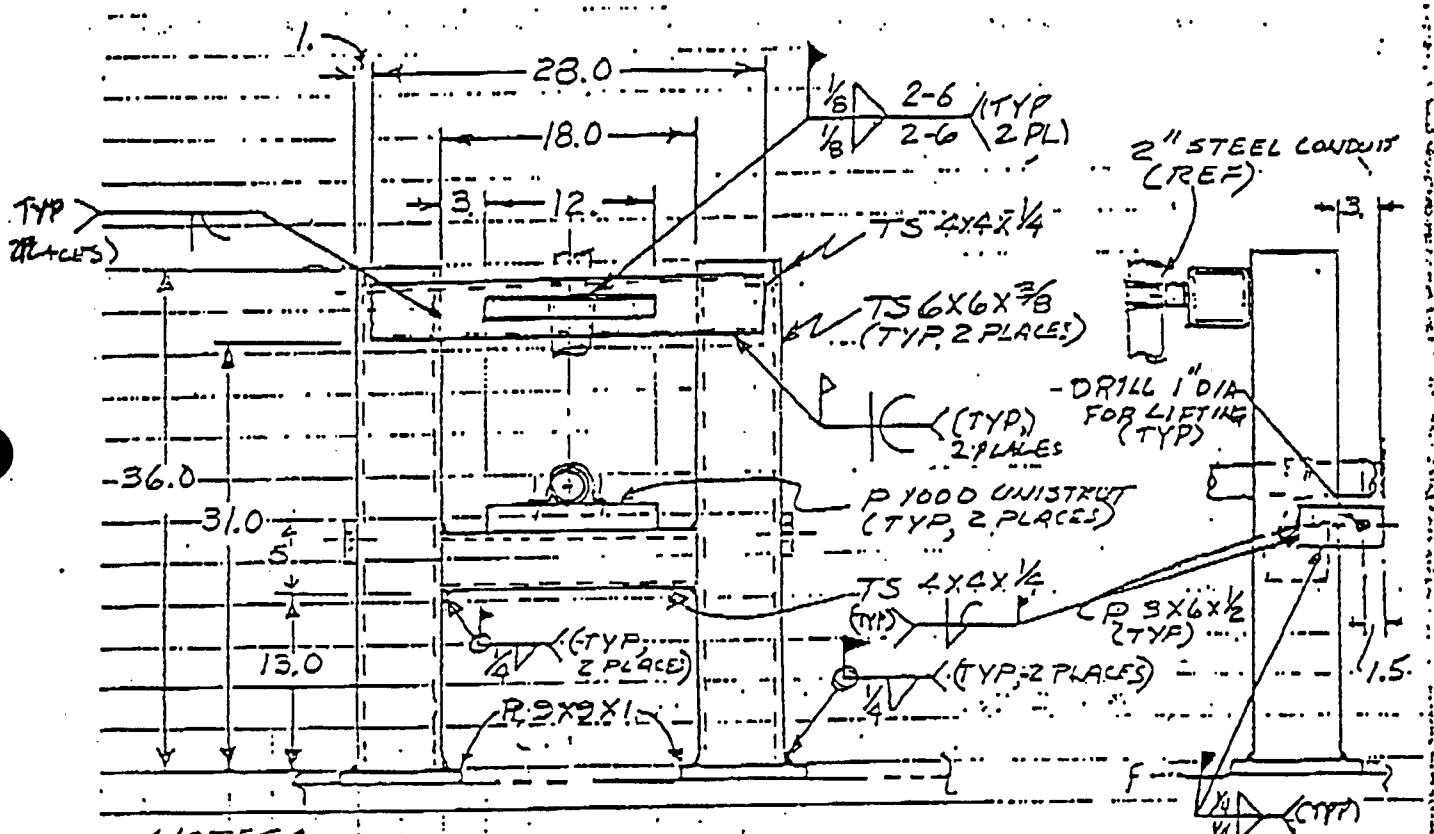
NOTE: 1. CONDUIT AND CONDUIT SUPPORTS TO BE INSTALLED PER N3C-944 SPEC.
2. THERMOLAG ENCLOSURES TO BE INSTALLED OVER CONDUIT (FIGURE 1A) AND LB CONDULET [FIGURE 1(C)] PER 47W243 SERIES DRAWINGS AND G-98 SPECIFICATION.

09-13-1994 06:56AM FROM TO 12058374411284508478 P.14

SUBJECT THERMO-LAG SEISMIC TEST - SINGLE CONDUIT FIXTURE PROJECT WATTS BAR

COMPUTED BY	DATE	CHECKED BY	DATE
J.K. Rochelle	7/19/94	RI 7/28/94	AS BUILT 8/11/94

SUPPORT NO. 5 [Scale ≈ 1/12]



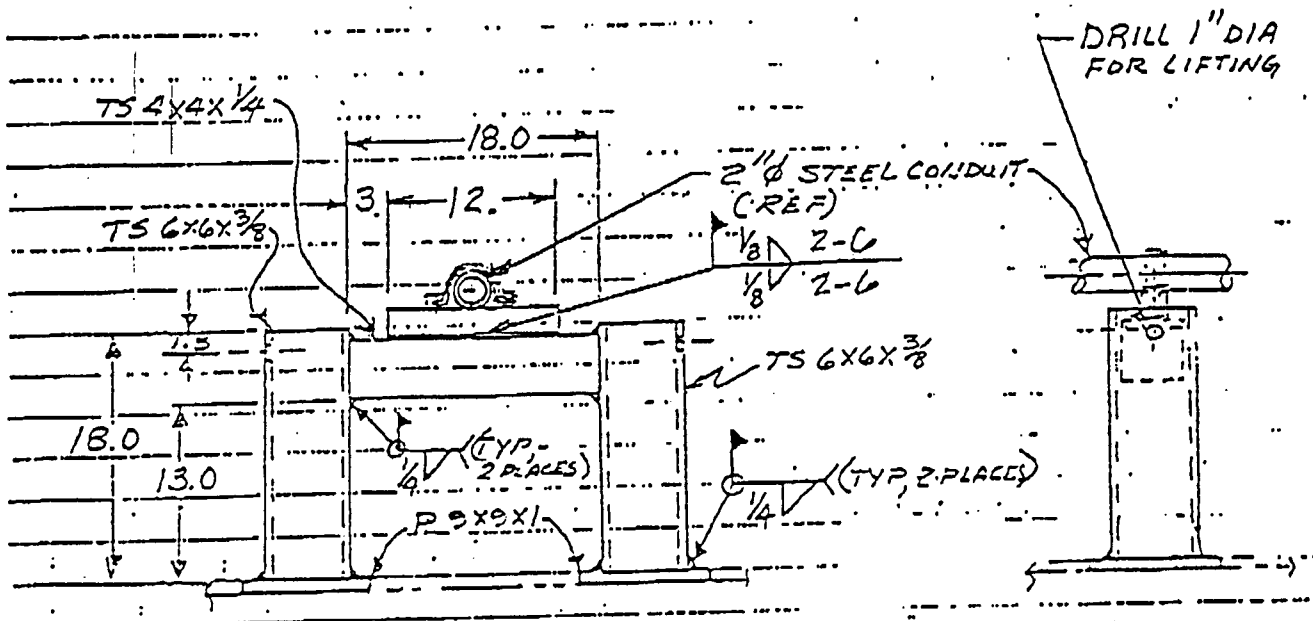
NOTES:

1. STRUCTURAL FABRICATION PER G-89 SPECIFICATION.
2. STRUCTURAL MATERIAL ASTM A500 GRB, A36, OR EQUAL.
3. UNISTRUT MATERIALS PER UNISTRUT GENERAL ENGINEERING CATALOGUE #10 (OR EQUAL).

SUBJECT THERMOLAG SEISMIC TEST - SINGLE CONDUIT FIXTURE
PROJECT WATTS BAR

COMPUTED BY	DATE	CHECKED BY	DATE
JWRichelin	7/19/94	RI 7/28/94	ASBUILT 8/11/94

SUPPORT NO. 4 [Scale ≈ 1/12]

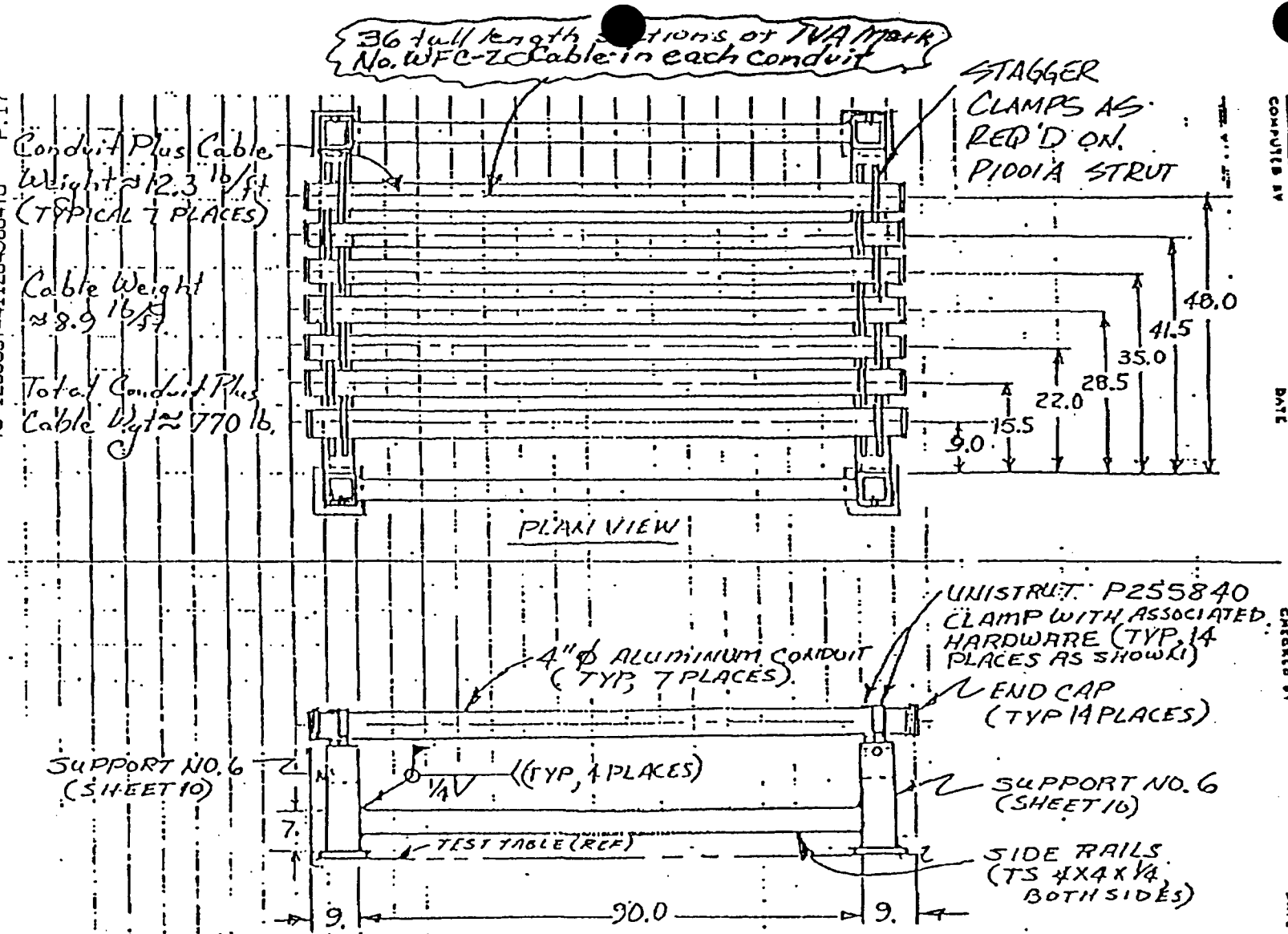


NOTES:
1. STRUCTURAL FABRICATION PER G-89 SPECIFICATION.
2. STRUCTURAL MATERIAL ASTM A500 GRB A36, OR EQUAL.
3. UNISTRUT MATERIALS PER UNISTRUT GENERAL ENGINEERING CATALOGUE #10 (OR EQUAL

SUBJECT THERMO-LAG SEISMIC TEST-MULTIPLE CONDUIT FIXTURE

COMPUTED BY J.W. Rochelle DATE 7/19/94 CHECKED BY RI 7/28/94 PROJECT AS BUILT DATE 8/11/94

SHEET A-9 of 10



SIDE VIEW [Scale ≈ 1/24]

NOTE: 1. CONDUIT AND CONDUIT SUPPORTS TO BE INSTALLED PER N3C-914 SPEC.
2. THERMO-LAG ENCLOSURE TO BE INSTALLED OVER 7 CONDUITS [FIGURE 4] PER 47W243 SERIES DRAWINGS AND G-98 SPECIFICATION.

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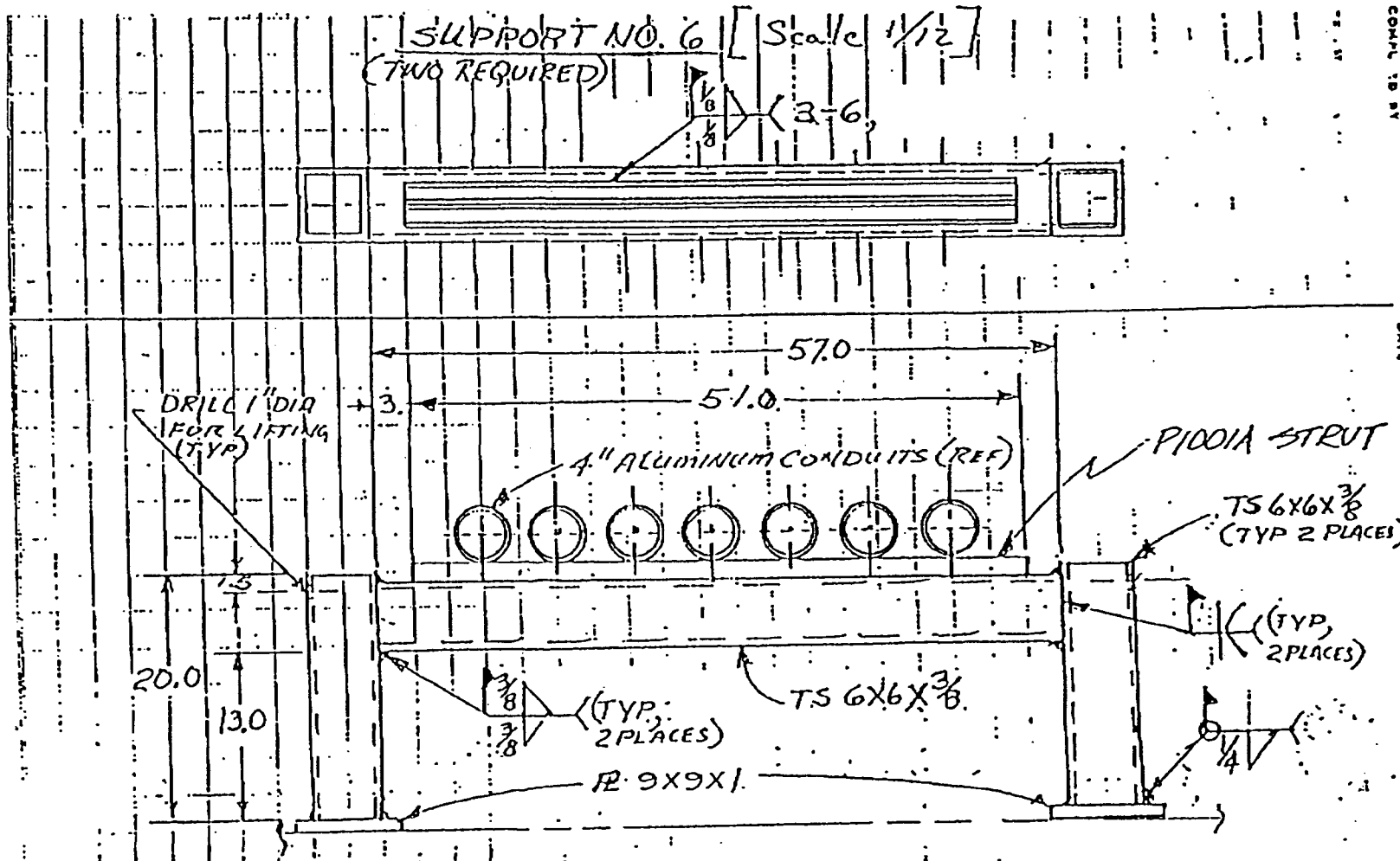
SUBJECT THERMO-LAG SEISMIC TEST - MAKLITE
PROJECT WATTS BAR
COMPL'D BY J.R. Rochelle DATE 7/19/94 REV 7/28/94 CHECKED BY DATE AS BUILT
SHEET 10 OF 10



NOTES:
1. STRUCTURAL FABRICATION PER G-89 SPECIFICATION.
2. STRUCTURAL MATERIAL: ASTM A500 GRB, A36, OR EQUAL.
3. UNISTRUT MATERIALS PER UNISTRUT GENERAL ENGINEERING CATALOGUE. #10 (OR EQUAL)

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APPENDIX X

THERMO-LAG INSTALLATION PROCEDURES, DRAWINGS, DATA SHEETS AND PHOTOGRAPHS

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The TVA procedure, "Special Requirements and Application of Thermo-Lag 330 Electrical Raceway Fire Barrier Systems" Revision 0, presented in this appendix was utilized in the preparation of the specimens for seismic testing at Wyle Laboratories. The installation of the Thermo-Lag on the test specimens was witnessed by Wyle Laboratories' personnel. Comments and exceptions to the procedure are as follows:

Paragraph 7.3	"V" rib orientation was perpendicular to the side rails.
Paragraph 7.9.1	The Thermo-Lag supports need to be a tight fit, not all of them were. The middle three supports on each side were modified to be a tight fit.
Paragraph 9.5	The inside corners between the conduit box and the enclosure were filled in with trowel grade Thermo-Lag instead of Thermo-Lag board.
Paragraph 9.8	The stress skin was applied after the installation of the second layer of Thermo-Lag.
Paragraph 11.3.2	There were four rows of support bolts. Between the first and second conduits there were 7 bolts on 18-inch centers. Between the third and fourth conduits there were 4 bolts on 36-inch centers. Between the fourth and fifth conduits there were three bolts, the first on an 18-inch center and the next two on 36-inch centers. Between the sixth and seventh conduits there were 7 bolts on 18-inch centers.
Paragraph 11.3.3	The surface of the conduit was buttered instead of the inside surface of the Thermo-Lag panels.
Paragraph 7.9.3 and Paragraph 11.3.4	The stress skin was applied to the enclosures then the fender washers and nuts were installed. A thin layer of trowel grade was applied and allowed to dry. The bolts were cut off flush with the head of the nuts and a ball of putty formed from trowel grade was applied to each nut and fender washer. A piece of stress skin was cut to go over each putty ball and to extend a couple of inches on all sides and was stapled to the Thermo-Lag panel. A layer of trowel grade was then applied to cover the stress skin.
Paragraph 11.3.5	Omitted
Paragraph 11.3.6	Omitted
Figure 2(B)	Tie wire was installed on the scored Thermo-Lag panel instead of in the score fold as shown.

Paragraph 12.1

The first and second layer of Thermo-Lag was applied in four sections. The section of the air drop coming out of the cable tray was formed first by cutting the Thermo-Lag conduit sections, applying them to the cables and installing tie wires to each section. The section of the air drop nearest the top was formed second by cutting the Thermo-Lag conduit sections, stapling stress skin to the I.D. to hold the sections together, applying them to the cables and installing tie wires to each section.

The middle section was formed next by cutting the Thermo-Lag conduit sections and applying them to the cables and installing tie wires to each section. The top was formed last by cutting the Thermo-Lag conduit sections, applying them to the cable/conduit and installing tie wires to each section.

Following the application of the second layer of Thermo-Lag, the entire air drop was covered with stress skin held by tie wires, a layer of trowel grade was applied and allowed to dry and tie wires were installed.

Installed second layer to Thermo-Lag panels around the air drop/cable tray intersection.

NOTE: The order of installation for the single cable tray, multiple cable tray and ganged conduit specimen configurations was: Thermo-lag panel, tie wire on 6-inch centers, stress skin, trowel grade, tie wire on 6-inch centers.

NOTE: All stress skin overlap was 4 inches minimum.

NOTE: Small cracks had developed on the surface of trowel grade during curing. These cracks were filled in prior to testing.

SPECIAL REQUIREMENTS AND APPLICATION OF THERMO-LAG 330 ELECTRICAL RACEWAY FIRE BARRIER SYSTEMS

REVISION 0

PREPARED BY J.J. Pierce

SIGNATURE J.J. Pierce

DATE 6/30/94

CHECKED BY Mark.H. Salley

SIGNATURE M.H. Salley

DATE 6/30/94

SPECIAL REQUIREMENTS AND APPLICATION OF THERMO-LAG 330 ELECTRICAL RACEWAY FIRE BARRIER SYSTEMS

1.0 PURPOSE

1.1 The purpose of this appendix is to describe the method for the control, application and quality assurance of Thermo-Lag 330 fire barriers on cable raceways (conduits, cable trays, and junction boxes) and their supports.

2.0 SCOPE

2.1 This appendix provides guidance to personnel involved in the procurement, receiving, application/installation and quality assurance of Thermo-Lag fire barriers.

3.0 REFERENCES

3.1 Design Standard DS-M-17.2.2, Electrical Raceway Fire Barrier Systems.

3.2 General Engineering Specifications G-98, Installation, Modification, and Maintenance of Electrical Raceway Fire Barrier Systems.

3.3 Watts Bar Drawing series 47W243, One-hour Electrical Raceway Fire Barrier Systems.

4.0 DEFINITIONS

4.1 THERMO-LAG 330-1

A water based, subliming, thermally activated fire resistance material which volatilizes at fixed temperatures, exhibits a volume increase through the formation of multi-cellular matrix, and blocks heat to protect the substrate material to which it is applied.

This material is supplied in a trowel grade consistency and in prefabricated shapes (4'x 6½" panels/boards and 36-inch long conduit sections). The term panel and board are used interchangably.

4.2 FASTENING MATERIALS

The following materials are approved for attaching the Thermo-Lag fire barrier system:

4.2.1 Tie Wire - Annealed type 304 stainless steel, 16 gauge (temporary wire may be 18 gauge).

4.2.2 Banding - 0.5" X 0.020" (minimum) stainless steel bands and banding clamps, type 304.

4.2.3 Staples - 0.5" long Arrow or Bostitch T-50.

4.2.4 Bolts - 0.25" (length as required to ensure full thread engagement) hex head bolts, nuts, and fender ~~flat~~ washers, type A-307. All thread rod may be used in lieu of bolts.

4.2.5 Bolts - 0.375" (length as required to ensure full thread engagement) hex head bolts, nuts, and ~~flat~~ finder washers, type A-307. All-thread rod may be used in lieu of bolts.

4.2.5 Anchor Bolts - Sleeve anchors (0.25" X 2.25") type 304 or Hilti Kwik Bolts (0.25" X length required).

4.2.6 T-Lag Supports - 2"x¾", 10 GA angle (cut to fit).

4.3 STRESS SKIN

4.3.1 ASTM E-437 type 304, stainless steel plain weave, 8X8 square mesh wire cloth, 0.017" diameter wire.

4.3.2 ASTM E-437 type 304 stainless steel knitted mesh wire cloth, 60 density, 0.011" diameter wire.

4.3.3 ASTM E-437 type 304 primer coated steel plain weave, 8x8 square mesh wire cloth, 0.017" diameter wire.

4.4 PROTRUDING ITEM

Any metallic item physically attached (bolted, welded, etc.) to the protected item or support and capable of providing a continuous thermally conductive path directly to the inside of a protected envelope. Typical protruding items can include a neighboring raceway (excluding cable trays) sharing a common support and within the 18-inch rule or a nonrequired conduit attached to a junction box.

4.5 18-INCH RULE

The distance which a protruding item must be protected to prevent heat from being conducted along the protruding item and into the protective envelope.

4.6 BUTTER

A term used to describe the application of the trowel grade Thermo-Lag 330-1 to the prefabricated conduit sections and panels.

4.7 CURED

The trowel grade Thermo-Lag 330-1 is considered cured when (1) a minimum of 72 hours has passed following application, or (2) a moisture meter reading of less than 100 when using a meter with a scale of 0-100, such as a Delmhorst D-P Model or equal.

4.8 INTERFERENCE

An interference is an object that is located so close to an item to be protected with Thermo-Lag that it actually occupies the same physical space that would be required for the installation of the Thermo-Lag. An interference is not physically attached to the item being protected.

4.9 MONITOR

Physically observing a task being performed on a periodic or random basis to assure that a specific operation is being performed in accordance with applicable requirements. The Inspector monitoring an operation must determine the extent of physical observation required during the performance of an operation based on variables

associated with the operation. The responsible organization must be notified prior to an operation being performed that has a monitor designation.

4.10 FOREIGN MATERIAL

Dirt, scale, heavy rust, oil, loose impediments and other contaminants.

4.11 PRIMARY ATTACHMENT

A primary attachment is a commodity physically attached to the protected item (e.g., raceway support, junction box support, etc.) by bolting, welding, etc. The entire primary attachments shall be protected with a single layer of nominal ⅝" Thermo-Lag application.

4.12 SECONDARY ATTACHMENT

A secondary attachment is a commodity attached to a primary attachment but not in direct contact with the protected item. Secondary attachments shall be protected in accordance with the 18-inch rule. Only the support of an unprotected cable tray requires protection.

4.13 PUTTY

Trowel grade Thermo-Lag 330-1 material that has been spread out on a piece of plastic and allowed to dry partially until it attains a consistency of putty.

4.14 TYPICAL DETAILS

Drawings issued by Engineering depicting the essential characteristics of a given configuration (e.g., LB condulette fittings, conduits, cable trays, etc.). This does not imply that field configurations must be identical to the associated detail drawings.

5.0 RESPONSIBILITIES

5.1 ENGINEERING

Responsible for the documentation of testing that bounds the installed Thermo-Lag fire barriers, standard drawings and design standards, and for evaluating nonstandard configurations.

5.2 QUALITY ASSURANCE/CONTROL

Responsible for the implementation of this procedure as

it pertains to the QA/QC releases, preplacement and post placement inspection activities for Thermo-Lag fire barrier installation. Responsible for the performance and documentation of the daily surveillance activities.

5.3 INSTALLERS

Responsible for notification of QC prior to each day that Thermo-Lag is to be installed. Responsible for the craftsmanship required for installing the Thermo-Lag in a quality manner in accordance with these instructions.

6.0 GENERAL REQUIREMENTS

6.1 INSPECTIONS (May be done at the source)

6.1.1 The measurements shall be taken along each edge and end at apparent minimum and maximum points. The acceptable tolerances for the thickness of the 4 x 6½ foot panels and the preformed conduit pieces are:

Nominal Thickness	Maximum	Minimum
⅝-inch	½-inch	¼-inch
⅞-inch	¾-inch	½-inch

6.1.2 The acceptable inside circumferences for preformed conduit pieces are:

CONDUIT SIZE (INCHES)	THERMO-LAG DIMENSIONS (INCHES ± ⅛") FIRST LAYER ⅝ AND ⅞	SECOND LAYER ⅝ OVER ⅝	SECOND LAYER ⅞ OVER ⅞
¾	4⅞	11⅛	NA
1	5¾	12	NA
1½	7½	13⅞	12¼
2	9	15⅝	13¾
2½	10⅝	16⅞	15⅝
3	12½	18⅞	17¼
4	15¾	NA	NA
5	19	NA	NA

6.1.3 Each piece is to be visually inspected to ensure:

1. There are no open cracks or delaminations.
2. The stress skin is continuous (no breaks, tears, gaps, etc.)
3. The color of each piece is uniform (no obvious areas of discoloration).

6.2 DATA SHEET

Complete a Data Sheet (Attachment 1) for each electrical raceway (conduit, cable tray, junction box) to be protected.

6.3 QC NOTIFICATION

The monitoring organization shall be notified prior to beginning any work plan that involves the installation or repair of a Thermo-Lag fire barrier system and each day that Thermo-Lag is to be installed. If the fire barrier system requires two layers of Thermo-Lag, the monitoring organization shall be notified prior to the installation of each layer. Do not put a skim coat on the first layer until after QC acceptance.

6.4 ORDER OF INSTALLATION FOR CONDUITS

6.4.1 The Thermo-Lag shall be installed on conduit fittings (e.g., LB, LS, Tee, etc.) and junction boxes before installing on the conduit.

6.4.2 The preformed sections of Thermo-Lag for the conduits shall be installed on any curved sections of conduit (e.g., bends, 45, 90, etc.) and then on the straight sections. The panels shall be installed on curved sections, Tee sections, etc. of trays first and then on the straight sections

6.4.3 The Thermo-Lag shall be installed on supports last.

6.4.4 For assemblies requiring multiple layers of Thermo-Lag, the first layer shall be completed (minimum 12 hour drying time) before starting the second layer. The second layer shall be applied in the same sequence as the first (i.e., fittings and boxes first, curved sections of conduit second, straight sections third, and supports last).

6.4.5 Upon completion of the installation and before the permanent tie wires are applied, the circumference

of the conduit configurations shall be measured t
ensure it is within allowable tolerances (se
Attachment 2).

7.0 CABLE TRAYS

7.1 When installing panels on cable trays, either the score and fold method or individual piece methods may be used. When using the score and fold method to cover tray bottoms and side rails, ensure all corners and joints are sufficiently built up with trowel grade to achieve ½-inch minimum dry thickness (e.g. square the corners with trowel grade).

NOTE: Whenever the score and fold method is used on "V" ribbed panels, localized stress skin damage in the "V" rib is acceptable provided the stress skin between the "V" ribs remain intact.

7.2 For horizontal trays (wider than 18-inches) without covers, stainless steel bands shall be installed around the tray prior to installing the top panel. Bands shall be located no greater than 6-inches from butt joints (both sides) and not greater than 24-inches on center between joints. Vertical runs of cable trays do not require this banding.

7.3 The "V" rib orientation for prefabricated panels installed on cable trays shall be in accordance with the following:

a. For trays wider than 18-inches, ribs on top panels shall be aligned perpendicular to the side rails. Ribs on top panels of cable trays 18-inches wide or less may be aligned either perpendicular or parallel to the side rails.

b. For trays wider than 18-inches, ribs on bottom panels on straight runs and bottom panels on Tee sections shall be aligned perpendicular to the side rails.

c. For trays 18-inches wide or less, ribs on bottom panels at Tee sections shall be aligned perpendicular to the side rails on the "through" direction of Tee. Ribs on bottom panels of

straight sections may be aligned either perpendicular or parallel to the side rails.

d. For parallel trays enclosed within a single enclosure, ribs on top and bottom panels shall be aligned perpendicular to the side rails.

e. For stacked trays enclosed within a single enclosure, ribs on side panels shall be aligned perpendicular to the side rails.

7.4 The "V" ribs may be flattened as needed to ensure a tight fit along seams.

7.5 For parallel or stacked trays within a single enclosure, the Thermo-Lag supports shall be installed prior to installation of the Thermo-Lag.

Not req'd. ly need stitching ere horizontal tem meets vertical ...m. Stitch on ...h centers.

7.6 Butt joints on bottom panels of horizontal tray runs (including bends), butt joints on vertical runs (including bends and side rails) and butt joints on Tee section bottom panels require stainless steel tie wires installed through the stress skin of abutting panels as described below.

7.6.1 Drill holes on 5-inch centers (maximum) through bottom panels (minimum hole size to accommodate the tie wire). The holes should be located between ½-inch and 1½-inch from the edge of the butt joint.

7.6.2 Install tie wires through adjoining panels, butter the joint and install the panels.

7.6.3 Cinch the panel edges together by tightening the tie wires.

7.6.4 Where it is not possible to install tie wires in butt joints due to insufficient work space, clearances, etc., then an acceptable alternative is to tie wire the longitudinal joints as follows:

a. For vertical trays, the two longitudinal joints which intersect the butt joint shall have a minimum of three tie wires on each side of the butt joint. If the score and fold method is used at these longitudinal joints, then tie wires shall be installed at the other two longitudinal joints.

b. For horizontal trays, all four longitudinal joints shall have a minimum of three tie wires on each side of the butt joint. If the score and fold

method is used on the bottom longitudinal joints, then only the top two longitudinal joints require tie wires.

7.7 ~~Following reinforcement of butt joints with tie wires,~~ Install a layer of trowel grade and stress skin around the tray at the joint as follows:

7.7.1 Apply a layer of trowel grade approximately 3/16-inch thick at least 5-inches wide on both sides of the joint. Apply stress skin when trowel grade is dry to the touch, but still pliable enough to penetrate through the stress skin.

7.7.2 Wrap a single piece of stress skin around the joint such that a minimum of 5-inches extends on each side of the joint. The ends of the stress skin should overlap a minimum of 2-inches. Work the stress skin into the trowel grade.

7.7.3 Secure the stress skin to the panels with ½-inch long Arrow or Bostitch T-50 staples as necessary to achieve a snug fit. Staple spacing should be between 1 and 2-inches from the edge of the stress skin and on 3-inch (approximate) centers.

7.7.4 Where the two ends of the stress skin overlap each other, secure with tie wire on 5 to 6-inch (max) spacing. Tie wires should be installed 1 to 2-inches from each edge of the overlap.

7.7.5 Tighten the tie wires and flatten to the panels. Apply a skim coat of trowel grade (approximately 1/16-inch thick) over the entire stress skin surface. The stress skin and fasteners within the stress skin should not be readily distinguishable (visually) following the cure.

Delete 7.8 Thermo-Lag panel pieces installed over splice plates shall be reinforced at the seams by installing a piece of stress skin cut and formed to fit over the splice plate panel.

7.8.1 The stress skin shall cover the entire splice plate piece and lap onto the side rail, top, and bottom panels by 2-inches minimum. Apply a layer of trowel grade approximately 3/16-inch thick over the splice plate piece and 2-inches onto the adjacent panel pieces. Apply the stress skin when the trowel grade is dry to the touch, but still pliable enough to penetrate the stress skin.

7.8.2 Secure the stress skin to the panels using Arrow or Bostitch ½-inch long T-50 staples as necessary to achieve a snug fit. Placement of the staples should be ½-inch maximum from the edge of stress skin and spaced on 3-inch (approximate) centers.

NOTE: THIS PIECE OF STRESS SKIN MUST BE INSTALLED PRIOR TO STRESS SKIN OVERLAY

7.8.3 Apply a skim coat of trowel grade approximately 1/16-inch thick over the entire stress skin area. The stress skin and fasteners should not be readily distinguishable (visually) following cure.

7.9 STACKED OR PARALLEL TRAYS IN A SINGLE ENCLOSURE

7.9.1 Measure the distance between trays and make the Thermo-Lag support. Install the Thermo-Lag supports on 24" maximum spacing.

7.9.2 Use either the score and fold method or cut individual pieces of the Thermo-Lag panel and install on the trays. Drill holes in Thermo-Lag panels to line up with Thermo-Lag support bolts.

7.9.3 Install the fender washers and nuts on the bolts and tighten (just enough to secure the panel to the trays). Cut the bolt off flush with the head of the nut. Form a ball of putty to go over each nut and fender washer (minimum ½" thick over the nut). Cut a piece of stress skin to go over this and extend a couple of inches on all sides. Staple this stress skin to the panel and cover with a layer of trowel grade (approximately ¼" thick).

7.9.4 Complete installation per the instructions in sections 7.1 - 7.8.

7.10 SPECIAL TRAY FITTINGS

7.10.1 Attach tray rung clips or U-bolts to tray rungs on 18" maximum spacing (see Attachment 3). Cut Thermo-Lag panel to fit bottom of tray fitting and drill holes to line up with clips or U-bolts.

7.10.2 Position Thermo-Lag panel so edges are centered on a tray rung and extend past the bottom edge of tray by approximately ⅝".

7.10.3 Install braces across the top of the tray fitting

(see Attachment 3). Cut the top piece of Thermo-Lag to fit so edges are centered on a support and extend past the top edge of the tray by approximately ⅝".

7.10.4 Complete installation per the instructions in sections 7.1 - 7.8.

7.11 Where the bottom panel butts to a support, reinforcing of the interfacing joints with stress skin is required.

7.11.1 Cut the stress skin to fit around the support and tray interface joint (extend at least 3-inches out from the joint), up the side rail and onto the top panel for at least 3-inches. Install a fillet of partially dried trowel grade (putty) to the joint.

7.11.2 Apply an approximate 3/16-inch thick layer of trowel grade over the area to be covered by this stress skin. Apply the stress skin over the trowel grade when the trowel grade is dry to the touch, but still pliable enough to penetrate the stress skin.

7.11.3 Install the stress skin over the trowel grade and use tie wire attached to each side (minimum of ½-inch of stress skin to hold the tie wire) of the stress skin and cinch tight (minimum of two tie wires). The maximum spacing between tie wires should be 5-inches where possible. Work the stress skin into the trowel grade.

7.11.4 Secure the stress skin to the panels with ½-inch long Arrow or Bostitch T-50 staples as necessary. Spacing should be a maximum of ½-inch from the edge of the stress skin and a maximum of 3-inches on centers.

7.11.5 Install tie wires within 1-inch of the joint over the stress skin and around the tray.

7.11.6 Apply a skim coat (approximately 1/16-inch thick) of trowel grade over the stress skin area. The stress skin and fasteners should not be readily distinguishable (visually) following cure.

7.12 Where interferences prevent securing the stress skin to panel surfaces with staples, use of tie wires or ½-inch banding wrapped around the tray is acceptable provided a snug fit of the stress skin to panel surfaces is achieved. Tie wires may be secured to other stress skin

or cross banding on Tees. When securing to stress skin allow for a minimum of ½-inch of stress skin to be engaged.

7.13 Wrap the entire raceway enclosure with stress skin and overlap 1 to 2 inches. Use tie wire, on approximately 6-inch spacing to tie the overlap together. Apply a skim coat of trowel grade approximately 1/16-inch thick over the entire stress skin area. The stress skin and fasteners should not be readily distinguishable (visually) following cure.

7.14 When cable extend above the side rails, the tray must have a cover. The Thermo-Lag side rail pieces must be cut wide enough to extend up to the tray cover.

8.0 CONDUIT BOXES (LB, LS) FOR CONDUITS 4 INCHES AND LARGER

8.1 Use the pattern as shown on 47W243-1 and measure the conduit box to determine the exact dimensions for each cut/score. Allow a minimum of 3-inches for the stress skin overlaps.

8.2 Score the Thermo-Lag (DO NOT CUT THROUGH THE STRESS SKIN) as shown in the detail and remove the excess Thermo-Lag. Hammer the ribs flat.

8.3 Dry fit the box to the conduit box to ensure a firm fit. After fit up, remove the box and butter the entire inside surfaces of the box and attach it to the conduit box with temporary tie wire. Cut the overlapping stress skin as required to make a tight fit around the conduit.

8.4 Fold the bottom piece of the box up. Wrap the stress skin over this piece and tie the stress skin together every 3 to 4 inches (minimum of three places) with tie wire. Wrap temporary tie wire around the box to hold the bottom up.

8.5 Fill in the inside corners between the conduit box and the Thermo-Lag enclosure with Thermo-Lag board (scrap pieces with or without stress skin may be used for this). Cut two pieces of Thermo-Lag to fit around the conduit at the long side of the box. Butter the two pieces and close the box. Pull the overlapping stress skin up over the end of the enclosure and around the conduit. Attach the stress skin to the conduit with permanent tie wire.

8.6 Fill the outside corners of the enclosure with trowel grade to achieve a minimum of ½" dry thickness (e.g., square the corners with trowel grade/putty).

NOTE: TROWEL GRADE THAT HAS BEEN ALLOWED TO DRY AND BECOME PUTTY CAN BE USED JUST LIKE THE WET TROWEL GRADE.

8.7 An acceptable alternative to the above is to cut each side of the enclosure separately and assemble as above (e.g. butter all interior surfaces, fill in the inside corners, etc.). After completing the installation of the enclosure to the conduit box, the whole enclosure shall be wrapped in stress skin. Allow enough overlap of the stress skin to extend at least 3 inches onto the conduit and attach with permanent tie wires.

8.8 Apply a thin coat of trowel grade to cover the stress skin (thick enough such that the stress skin will not be readily distinguishable when dry).

8.9 Install the preformed conduit sections over the stress skin and as close to the conduit box enclosure as possible (See section 10.0 for conduit installation instructions). Use trowel grade (wet or putty) to fill any gaps.

8.10 Allow the installation to dry a minimum of 12 hours. Remove the temporary tie wires and smooth the rough spots (a rasp can be used for this step). Apply a thin coat of trowel grade to fill any low places and indentations caused by the temporary tie wires. The skim coat should only be approximately 1/16-inch dry thickness.

8.11 Allow this skim coat to dry a minimum of 2-hours and smooth out with an abrasive pad (e.g. Scotch-Brite) and water. Allow this to dry a minimum of 12 hours.

8.12 Install permanent tie wires. The spacing between tie wires is to be 6-inches maximum on straight sections and 4-inches on curved sections (NOTE: IT IS NOT POSSIBLE TO ACHIEVE THIS SPACING LIMITATION ON LARGE ENCLOSURES).

9.0 CONDUIT BOXES (LB, LS) FOR CONDUITS SMALLER THAN 4 INCHES

9.1 Use the pattern as shown on 47W243-2 and measure the conduit box to determine the exact dimensions for each cut/score. Allow a minimum of 2 inches for the stress skin overlaps.

9.2 Score the Thermo-Lag (DO NOT CUT THROUGH THE STRESS SKIN) as shown in the detail and remove the excess Thermo-Lag. Hammer the ribs flat.

9.3 Dry fit the enclosure to the conduit box to ensure a firm fit. The edge of the front piece should overlap the edge of the side piece. After fit up, remove the enclosure and butter the entire inside surfaces of the enclosure and attach it to the conduit box with temporary tie wire. Cut the overlapping stress skin as required to make a tight fit around the conduit.

9.4 Fold the bottom piece of the enclosure up and wrap the stress skin over it. Tie the stress skin together with tie wire at each end and in the middle. Miter the FT piece (if used) so it fits snugly. Secure the bottom piece and FT piece to the conduit box with temporary tie wire.

9.5 Fill in the inside corners between the conduit box and the enclosure with Therm-Lag board (scrap pieces with or without stress skin may be used). Cut two pieces of Thermo-Lag board to fit around the conduit at the long end of the conduit box. Butter these pieces and put in place. Pull the overlapping stress skin up over the these pieces and around the conduit. Attach the stress skin to the conduit with permanent tie wire.

9.6 Fill the outside corners of the enclosure with trowel grade to achieve a minimum of ½" dry thickness (e.g., square the corners with trowel grade/putty).

NOTE; TROWEL GRADE THAT HAS BEEN ALLOWED TO DRY AND MADE INTO PUTTY CAN BE USED JUST LIKE THE WET TROWEL GRADE.

9.7 An acceptable alternative to the above is to cut each side of the enclosure separately and assemble as above (e.g. butter all interior surfaces, fill in the inside corners, etc.).

9.8 After completing the installation of the enclosure to the conduit box, wrap the enclosure with either 0.011 diameter stainless steel mesh or 0.017 diameter stress skin held in place with tie wire. Allow enough overlap of the stress skin to extend at least 2 inches onto the conduit and attach with permanent tie wires.

9.9 Apply a thin coat of trowel grade to cover the stress skin (thick enough such that the stress skin will not be readily distinguishable when dry).

9.10 Install the preformed conduit sections over the stress skin and as close to the conduit box enclosure as possible (See section 10.0 for conduit installation instructions). Use trowel grade (wet or putty) to fill any gaps.

9.11 Allow the installation to dry a minimum of 12 hours. Remove the temporary tie wires and smooth the rough spots (a rasp can be used for this step). Apply a thin coat of trowel grade to fill any low places and indentations caused by the temporary tie wires. The skim coat should only be approximately 1/16-inch dry thickness.

9.12 Allow this skim coat to dry a minimum of 2-hours and smooth out with an abrasive pad (e.g. Scotch-Brite) and water. Allow this to dry a minimum of 12 hours.

9.13 Install permanent tie wires. The spacing between tie wires is to be 6-inches maximum on straight sections and 4-inches on curved sections (NOTE: IT IS NOT POSSIBLE TO ACHIEVE THIS SPACING LIMITATION ON ALL ENCLOSURES).

10.0 CONDUITS

10.1 ALWAYS INSTALL THE THERMO-LAG TO THE CONDUIT BEFORE INSTALLING IT TO THE SUPPORTS. STAGGER THE BUTT JOINTS OF EACH HALF SECTION A MINIMUM OF 4-INCHES.

10.2 Conduits 4-inches and larger require only one layer of nominal 5/8-inch thick preformed Thermo-Lag for one hour protection. Conduits smaller than 4 inches and larger than 1-inch require two layers of nominal ⅝-inch thick preformed Thermo-Lag for one hour protection. Conduits 1-inch and smaller require one layer of ⅝-inch and one layer of ⅜-inch thick preformed Thermo-Lag for one hour protection.

10.3 Cut the preformed conduit sections of Thermo-Lag to fit snug around any support and dry fit to check for clearances and proper fit (minimize the gap between pieces of Thermo-Lag). Butter the entire inside surface and edges of the preformed sections and attach to the conduit with temporary tie wire. Smooth the seams and joints where the trowel grade has squeezed out.

NOTE: USE A HAMMER OR MALLET AND THE TIE WIRE TO TAMP AND CINCH THE PREFORMED SECTIONS TIGHTLY TO THE CONDUIT.

10.4 To install preformed sections on curved sections of conduits (45, 90 bends), the Thermo-Lag must be cut down to the stress skin in several places for the outside bend. The inside bend requires wedges to be cut out of the Thermo-Lag. CAUTION - NO NOT CUT THE STRESS SKIN. These pieces are then bent around the curved section of conduit (NOTE: EXPECT THE STRESS SKIN TO TEAR). Where the stress skin tears, cut a piece of stress skin (scrap or 0.017 diameter stress skin) to fit inside the preformed section. Overlap the tear one to two inches. Butter the entire inside surface and edges of the preformed sections with trowel grade and install on the conduit with temporary tie wires. Fill the open cuts with trowel grade and smooth the edges and seams where the trowel grade has squeezed out.

NOTE: USE A HAMMER OR MALLET AND THE TIE WIRE TO TAMP AND CINCH THE PREFORMED SECTIONS TIGHTLY TO THE CONDUIT.

10.5 Allow to dry for a minimum of 12 hours. Wrap the curved sections with either 0.011 diameter stainless steel mesh or 0.017 diameter stress skin and hold in place with permanent tie wire. Apply a thin skim coat of trowel grade over the installation and allow to dry at least two hours. Smooth the installation with an abrasive pad and water. Allow to dry a minimum of 12 hours.

10.6 Attach permanent tie wires. The maximum spacing for the tie wires on curved sections is 4-inches and 6-inches on straight sections.

10.7 For conduits smaller than 4-inches, repeat steps 10.1 through 10.4 for the additional layer of ¾-inch thick preformed sections.

10.8 Apply a skim coat of trowel grade over the installation and allow to dry for a minimum of two hours. Smooth the installation with an abrasive pad and water and allow to dry for a minimum of 12 hours.

10.9 Attach permanent tie wires. The maximum spacing is to be 4-inches on the curved sections and 6-inches on straight section.

11.0 MULTIPLE CONDUITS WITHIN A SINGLE ENCLOSURE

11.1 ALWAYS INSTALL THE THERMO-LAG TO THE CONDUIT BEFORE INSTALLING IT TO THE SUPPORTS.

11.2 Multiple conduits can be protected by configurations shown as ganged conduits enclosure, 4-sided enclosure, 3-sided enclosure, and 2-sided enclosure.

11.3 GANGED CONDUIT ENCLOSURES

11.3.1 Cut the preformed conduit sections and the panel of Thermo-Lag to fit snug to each other, around the conduits and around any support. Dry fit to check for clearances and proper fit (minimize the gap between pieces of Thermo-Lag).

11.3.2 If more than four (4) conduits are parallel, attach the support bolts (or All-Thread) to the panel pieces with fender washers and nuts on approximately 18-inch centers (see 47W243-17).

11.3.3 Butter the entire inside surface and edges of the Thermo-Lag pieces and attach to the conduit with temporary tie wire. Smooth the seams and joints where the trowel grade has squeezed out.

11.3.4 Cut the bolts flush with the nut and cover with putty.

11.3.5 Cut a piece of stress skin 6-inches wide, center over the butt joints and wrap around the enclosure. Overlap the ends approximately 2-inches and tie together with tie wire (three places). Staple the stress skin to the Thermo-Lag (staples to be within 1-inch of the edge of the stress skin and within 1-inch on each side of the butt joint). Install tie wires within 1-inch of the edge of the stress skin and within 1-inch on each side of the butt joint.

11.3.6 Apply a skim coat of trowel grade thick enough such that when dry the stress skin is not readily distinguishable.

11.3.7 Wrap the entire assembly with stress skin. Overlap the ends approximately 2-inches and tie together with tie wire on 6-inch spacing (approximate). Overlap the edges of the stress skin approximately 2-inches and either lace a tie wire through both pieces around the enclosure or wrap two tie wires around the overlap. Install tie wires around the entire assembly on approximate 6-inch spacing for

straight runs and 4-inch spacing on curved or offset sections.

11.3.8 Apply a coat of trowel grade over the entire assembly such that when dry the stress skin will not be readily distinguishable.

11.3.9 Allow the installation to dry a minimum of 12 hours. Smooth any rough spots. Apply a thin skim coat of trowel grade (approximately 1/16-inch dry thickness) to fill in any low spots.

11.3.10 Allow this skim coat to dry a minimum of 2-hours and smooth out with an abrasive pad (e.g., Scotch-Brite) and water. Allow this to dry a minimum of 12 hours.

11.3.11 Install tie wires at required spacing.

11.4 FOUR SIDED ENCLOSURES

11.4.1 Measure and cut the preformed sections and the panels to fit snug to each other, supports and on the conduits. If the score and fold method is used, measure and score the panel to fit snug against the conduits and supports (NOTE: Cut the last fold to overlap the first piece as shown on 47W243-16). Dry fit to conduits to ensure proper fit (minimize gaps and clearances between pieces of Thermo-Lag).

11.4.2 If more than four (4) conduits are parallel, attach the support bolts (or All-Thread) to the panel pieces with fender washers and nuts on approximately 18-inch centers (see 47W243-16).

11.4.3 Butter the entire inside surface and edges of the Thermo-Lag pieces and attach to the conduit with temporary tie wire. Smooth the seams and joints where the trowel grade has squeezed out. If the score and fold method is used, fill in the edges with putty and trowel grade (minimum ½-inch dry thickness).

11.4.4 Cut the bolts flush with the nut and cover with putty.

11.4.5 Cut a piece of stress skin 6-inches wide, center over the butt joints and wrap around the enclosure. Overlap the ends approximately 2-inches and tie together with tie wire (three places). Staple the

stress skin to the Thermo-Lag (staples to be within 1-inch of the edge of the stress skin and within 1-inch on each side of the butt joint). Install tie wires within 1-inch of the edge of the stress skin and within 1-inch on each side of the butt joint.

11.4.6 Apply a skim coat of trowel grade thick enough such that when dry the stress skin is not readily distinguishable.

11.4.7 Wrap the entire assembly with stress skin. Overlap the ends approximately 2-inches and tie together with tie wire spaced approximately 6-inches on center. Overlap the edges of the stress skin approximately 2-inches and either lace a tie wire through both pieces around the enclosure or wrap two tie wires around the overlap. Install tie wires around the entire assembly on approximate 6-inch spacing for straight runs and 4-inch spacing on curved sections.

11.4.8 Apply a coat of trowel grade over the entire assembly thick enough such that when dry the stress skin will not be readily distinguishable.

11.4.9 Allow the installation to dry a minimum of 12 hours. Smooth any rough spots. Apply a thin skim coat of trowel grade to fill in any low spots.

11.4.10 Allow this skim coat to dry a minimum of 2-hours and smooth out with an abrasive pad (e.g., Scotch-Brite) and water. Allow this to dry a minimum of 12 hours.

11.4.11 Install tie wires at required spacing.

11.5 THREE SIDED ENCLOSURES

11.5.1 Measure and cut the preformed sections and the panels to fit snug to each other, supports and on the conduits. If the score and fold method is used, measure and score the panel to fit snug against the conduits and supports (Cut the edge pieces wide enough to allow for 2 to 3 inches of stress skin to lap onto the barrier). See 47W243-15. Dry fit to conduits to ensure proper fit (minimize gaps and clearances between pieces of Thermo-Lag).

11.5.2 Butter the entire inside surface and edges of the Thermo-Lag pieces and attach to the conduit with

temporary tie wire. Smooth the seams and joints where the trowel grade has squeezed out. If the score and fold method is used, fill in the edges with putty and trowel grade.

11.5.3 Cut a piece of stress skin 6-inches wide, center over the butt joints and staple to the Thermo-Lag (staples to be within 1-inch of the edge of the stress skin and within 1-inch on each side of the butt joint).

11.5.4 Apply a coat of trowel grade over this stress skin thick enough such that when dry the stress skin will not be readily distinguishable.

11.5.5 Cover the entire assembly with stress skin and lap the stress skin onto the barrier 2 to 3 inches. Attach the stress skin to the enclosure with either tie wire or staples are required to ensure close fit.

11.5.6 Cut pieces of Thermo-Lag panel to form a border around the enclosure and attach to the barrier with sleeve anchors. Ensure that the sleeve anchors engage the stress skin overlap.

11.5.7 Apply a coat of trowel grade over the entire assembly thick enough such that when dry the stress skin will not be readily distinguishable.

11.5.8 Allow the installation to dry a minimum of 12 hours. Smooth any rough spots. Apply a thin skim coat of trowel grade to fill in any low spots.

11.5.9 Allow this skim coat to dry a minimum of 2-hours and smooth out with an abrasive pad (e.g., Scotch-Brite) and water. Allow this to dry a minimum of 12 hours.

11.5.10 Install tie wires at required spacing if needed.

11.6 TWO SIDED ENCLOSURE

11.6.1 Install the unistrut frame (see 47W243-14).

11.6.2 Measure and cut Thermo-Lag to mount on the frame (use either the individual piece method or the score and fold method). Dry fit to ensure close fit and to mark support stud locations.

11.6.3 Drill the holds for the support studs and backing pieces. Cut the backing pieces and attach the bolts, fender washers and nuts. Prebutter the backing pieces and install on the Thermo-Lag panel.

11.6.4 Prebutter the edges of Thermo-Lag panels and all portions of the panels where they will be against a piece of frame, angle or backing piece. Install the prebutter panels on the studs and secure with fender washers and nuts. Cut the studs off flush with the nut and cover with putty. Cover the putty with a piece of 4-inch square stress skin and staple the stress skin to the panel. Apply a coat of trowel grade over the stress skin thick enough such that when dry the stress skin will not be readily distinguishable.

11.6.5 Fill any gaps between panels and/or barriers with putty or trowel grade. If the score and fold method is used, fill in the edges with putty and trowel grade.

11.6.6 Cover the entire enclosure with stress skin and lap the stress skin onto the barrier 2 to 3 inches. Cut pieces of Thermo-Lag panel to form a border around the enclosure-barrier interface and attach to the barrier with sleeve anchors. Ensure that the sleeve anchors engage the stress skin overlap. Staple the stress skin to the panels as necessary to ensure a close fit. Apply a skim coat of trowel grade over the stress skin thick enough such that when dry the stress skin will not be readily distinguishable.

11.6.7 Allow the assembly to dry a minimum of 12 hours. Smooth out any rough spots and apply a thin skim coat of trowel grade over the entire surface to fill any low spots.

11.6.8 Allow this skim coat to dry a minimum of 2-hours and smooth out with an abrasive pad (e.g., Scotch-Brite) and water. Allow this to dry a minimum of 12 hours.

12.0 AIR DROPS

12.1 Air drops shall consist of a first layer of ⅝-inch preformed conduit sections overlaid with a second layer of ⅝-inch preformed conduit sections.

12.2 The entire volume of the preformed conduit sections shall be filled with trowel grade prior to installing around the air drop cables.

12.3 The chart below shall be used to determine the diameter of the preformed conduit sections to use.

CABLE BUNDLE DIAMETER (IN)	PREFORMED CONDUIT SIZE (IN)
D ≤ 1	1
1 < D ≤ 1½	1½
1½ < D ≤ 2¼	2
2¼ < D ≤ 2¾	2½
2¾ < D ≤ 3¼	3
3¼ < D ≤ 4¼	4
4¼ < D ≤ 5¼	5

12.4 The preformed conduit sections that protect air drops shall be installed in the same manner and sequence as that installed on conduits (see section 10.0).

13.0 JUNCTION BOXES (JB)

13.1 Use the appropriate design as shown on drawing 47W243-3 and measure the JB to determine the exact dimensions for each cut/score. Allow a minimum of 2-inches for the stress skin overlaps.

13.2 Score the Thermo-Lag panel where required and remove the excess from the overlaps. Make the cutouts for the conduits. Hammer the ribs flat.

13.3 Dry fit the enclosure/panels to the JB and around the conduits to ensure a firm fit. After fit up, remove and butter the entire inside surfaces of the enclosure/ pieces and attach to the JB with temporary tie wire.

13.4 For multiple conduits entering a single side of a JB, the panel can be cut down the middle and cutouts provided for each conduit. The two pieces of the panel are to be stitched back together with tie wire (at least two tie wires between each conduit and at the ends). Butter the

entire inside surface of the panel and secure it to the JB with tie wire.

13.5 Fill in the outside corners/seams of folded pieces with trowel grade (minimum ½-inch thick).

NOTE: TROWEL GRADE THAT HAS BEEN ALLOWED TO DRY AND BECOME PUTTY CAN BE USED JUST LIKE WET TROWEL GRADE.

Place stress skin (minimum of 2-inch overlap) on the edges/seams and staple (see 47W243-3).

13.6 Apply a coat of trowel grade over the stress skin and thick enough such that when dry the stress skin will not be readily distinguishable.

13.7 Cut pieces of Thermo-Lag panel to form a border around the enclosure and attach to the barrier with sleeve anchors. Ensure that the sleeve anchors engage the stress skin overlap.

13.8 Install prebuttered Thermo-Lag on the studs (JB with length or width greater than 15-inches) and secure with fender washers and nuts. Cut the stud off flush with the nut and cover with putty. Cover the putty with a piece of 4-inch square stress skin and staple the stress skin to the panel. Apply a coat of trowel grade over the stress skin and thick enough such that when dry the stress skin will not be readily distinguishable.

13.9 Install the preformed conduit sections (see section 10) on the conduits entering the JB (maintain as close a fit as possible). Use trowel grade (wet or putty) to fill any gaps.

13.10 For JBs that require two layers of Thermo-Lag (any dimension 24-inches or greater), the second layer shall be installed in the same sequence as the first layer. If the conduits entering the JB require two layers of Thermo-Lag, the first layer shall be installed on the conduit before the second layer is started on the JB.

13.11 Allow the installation to dry a minimum of 12 hours. Remove the temporary tie wires and smooth the rough spots (a rasp may be used for this step). Apply a thin coat of trowel grade to fill any low places and indentations caused by the temporary tie wire.

13.12 Allow this skim coat to dry a minimum of 2-hours and smooth out with an abrasive pad (e.g. Scotch-Brite) and

water. Allow this to dry a minimum of 12 hours.

13.13 Install permanent tie wires.

14.0 REPAIR

14.1 Remove the damaged Thermo-Lag and at least one inch of undamaged material down to the stress skin.

14.2 From a piece of equal thickness Thermo-Lag, cut a piece to fit tightly into the removed cutout.

14.3 Butter the edges and stress skin side of the plug and install in the cutout such that it is flush with the surrounding Thermo-Lag.

14.4 Cut a piece of stress skin to overlap the cutout at least two inches. Spread a thin layer of trowel grade over the cutout and at least two inches out from the cutout. Place the stress skin over the trowel grade and attach as follows:

Flat Surface - Staple the stress skin down with T-50, ½-inch staples.

Conduit - Tie wire around the conduit if possible. If tie wire cannot be used, then staple the stress skin down with T-50, ½-inch staples.

Cover the stress skin with a layer of trowel grade thick enough such that when dry the stress skin is not visible.

15.0 FINAL QC HOLD POINT

15.1 No openings or cracks in final coat of trowel grade.

15.2 Correct spacing of tie wires (bands on cable trays).

15.3 Thermo-Lag is installed at correct location per NE output drawings.

15.4 Outside dimensions (circumferences) are within acceptable tolerances.

16.0 SPECIAL REQUIREMENTS

16.1 The installation of the Thermo-Lag 330 Fire Barrier System shall be by individuals who have been trained and qualified to this procedure and who have the equipment

and tools to perform the installation.

16.2 Standard industrial safety practices established for the handling of chemical coating and site specific safety rules shall be followed.

16.3 The Thermo-Lag 330 Fire Barrier System materials shall be delivered to the job site on pallets or in original factory sealed containers, which show the product name, color, name of manufacturer, and in the case of trowel grade material, the expiration date.

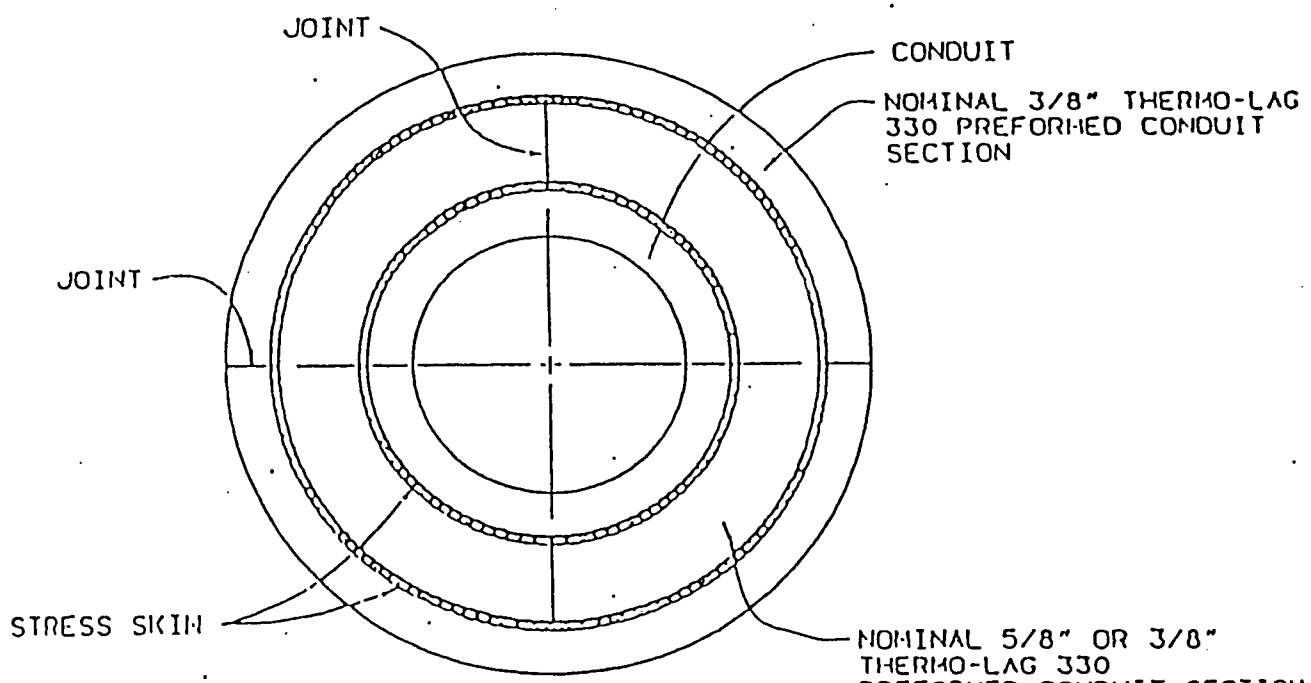
16.4 The Thermo-Lag 330 materials shall be stored off the ground when not in use and in totally enclosed and weather protected areas. The preformed conduit sections and panels do not need any temperature protection. The trowel grade material shall be protected against freezing and from temperatures above 100° F.

16.5 The trowel grade material shall be shipped under "protective" service by truck with an intransit temperature recorder included with each shipment. The chart tape from this recorder shall be inspected and retained upon arrival of the shipment to insure that the temperature conditions have been maintained.

16.6 The preformed conduit sections shall be shipped with two sections fitted together to form a circular tube and bound (taped) together. The binding (tape) shall not be removed until the day the preformed pieces are to be used.

SIZE F
DO NOT PROJECT
CONTROL RECORD

CAD MAINTAINED DRAWING
THIS DRAWING IS NOW PART
OF THE WBN CADAM DATA BASE



DETAIL E
CONDUIT SECTION
5/8" & 3/8" SHOWN

PROJECT FACILITY
MECHANICAL/NUCLEAR
ELECTRICAL RACEWAY FIRE BARRIER SYSTEMS

TITLE
THERMO-LAG 330-1 HOUR
ERFBS
TYPICAL 2 LAYER CONDUIT SECTION

TENNESSEE VALLEY AUTHORITY

DATE 05-M17.2.2-15

FIGURE 1 (A) SINGLE CONDUIT STRAIGHT ENCLOSURE

6(a)

8900625/3

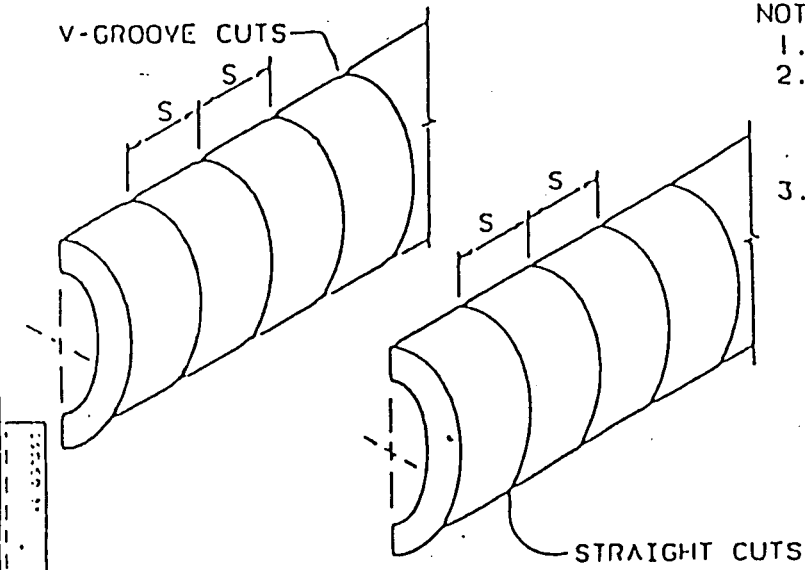
SIZE F

DR OR PROJ
PRINTS REQ'D

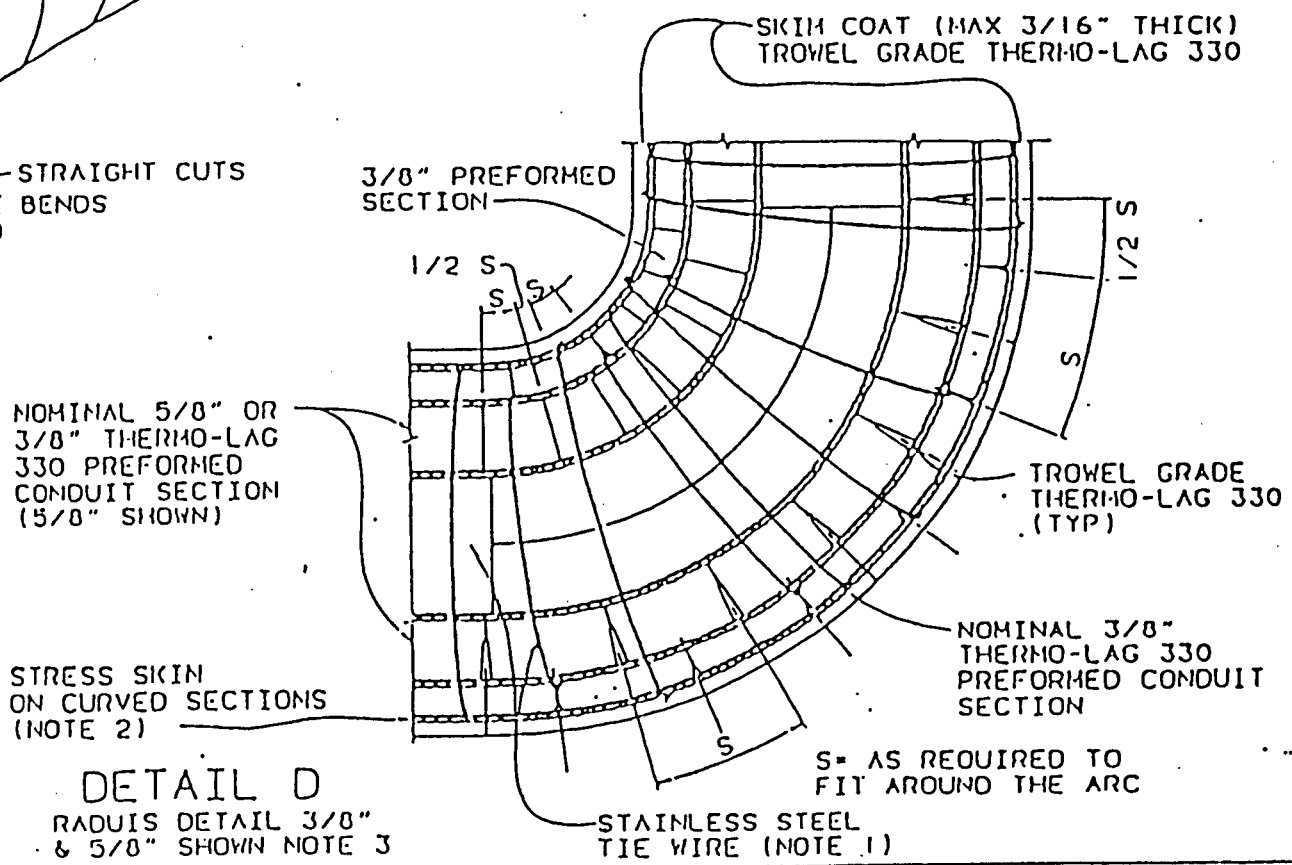
MAINTAINED DRAWING
THIS DRAWING IS NOW PART OF THE WBN CADAM DATA BASE

NOTES:

1. ANNEALED TYPE 304 STAINLESS STEEL TIE WIRE, 16 GAUGE.
2. ASTM E437 TYPE 304 STAINLESS STEEL, PLAIN WEAVE, 8 X 8 SQUARE MESH WIRE CLOTH, 0.017" DIA WIRE OR ASTM E437 TYPE 304 STAINLESS STEEL, KNITTED MESH, 60 DENSITY, 0.011" DIAMETER WIRE.
3. CUTS FOR BENDING AND V-GROOVES SHALL BE DETERMINED DURING INSTALLATION FOR EACH CONDUIT CONFIGURATION (e.g., LB, CONDUIT RADIUS). CARE SHALL BE TAKEN TO NOT DAMAGE THE STRESS SKIN WHEN CUTTING AND BENDING THE ASSEMBLY. BREAKS IN THE STRESS SKIN SHALL BE PATCHED/REINFORCED WITH STRESS SKIN.



CUTS FOR INSIDE OR OUTSIDE BENDS
S= CUT SPACING AS REQUIRED



DETAIL D
RADUIS DETAIL 3/8" & 5/8" SHOWN NOTE 3

TENNESSEE VALLEY AUTHORITY
THERMO-LAG 330-1 HOUR
ERFBS
TYPICAL 2 LAYER RADIUS
MECHANICAL/NUCLEAR
ELECTRICAL BACKEAY FIRE BARRIER SYSTEMS

FIGURE 1.(B) SINGLE CONDUIT BEND ENCLOSURE

8

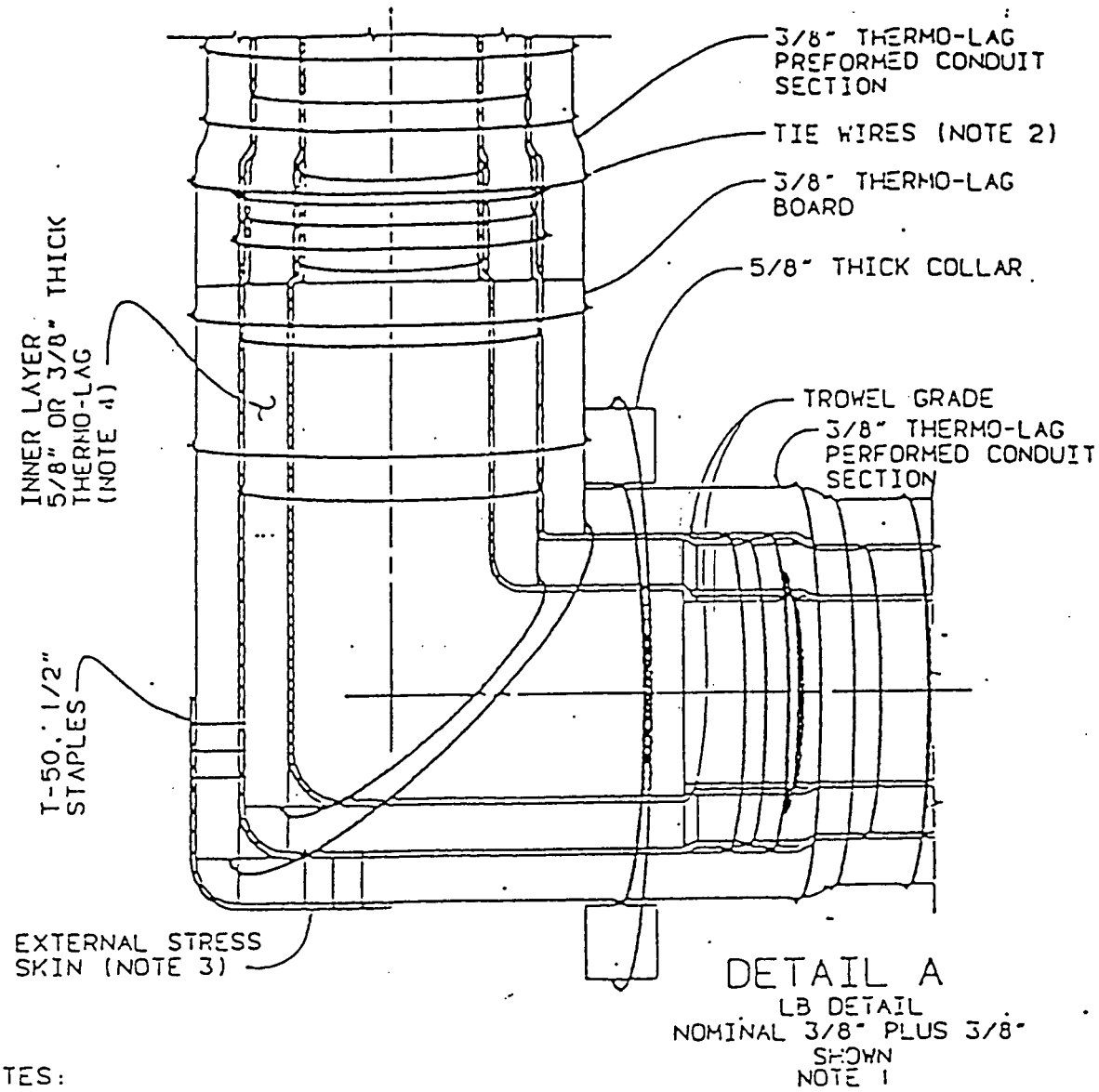


FIGURE 1.(C) SINGLE CONDUIT FITTING ENCLOSURE

NOTES:

1. THE LB/LS FIRE BARRIER SECTION SHALL BE SIZED FOR THE LB/LS BASED ON DETAIL G OR H. CARE SHALL BE TAKEN TO NOT DAMAGE THE STRESS SKIN WHEN SCORING AND FOLDING THE ASSEMBLY.
2. ANNEALED TYPE 304 STAINLESS STEEL TIE WIRE. 16 GAUGE.
3. ASTM E437 TYPE 304 STAINLESS STEEL. PLAIN WEAVE. 8 X 8 SQUARE MESH WIRE CLOTH. 0.017" DIA WIRE. OR TYPE 304 STAINLESS STEEL. KNITTED MESH. 60 DENSITY. 0.011" DIAMETER WIRE.
4. NEW ERFBS TO BE INSTALLED ON CONDUITS REQUIRE THE FOLLOWING APPLICATIONS.

DIAMETER	1ST LAYER	2ND LAYER
1" AND SMALLER	5/8"	3/8"
1/2" THRU 3"	3/8"	3/8"

PROJECT FACILITY
MECHANICAL/NUCLEAR
ELECTRICAL RACEWAY FIRE BARRIER SYSTEMS

TITLE
THERMO-LAG 330-1 HOUR
ERFBS
TYPICAL 2 LAYER LB DETAIL

TENNESSEE VALLEY AUTHORITY

DS-N17.2.2-11

CAD MAINTAINED DRAWING
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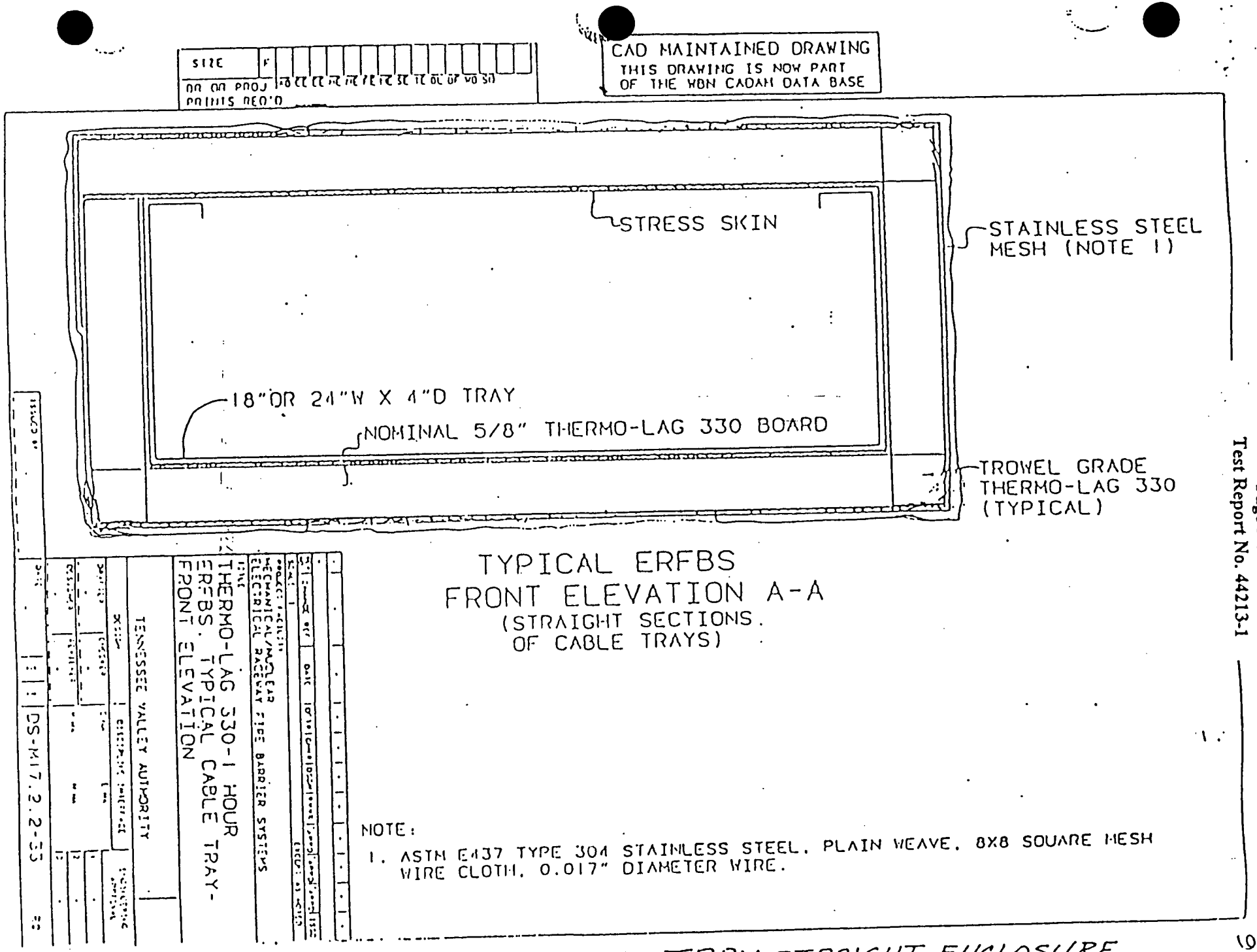
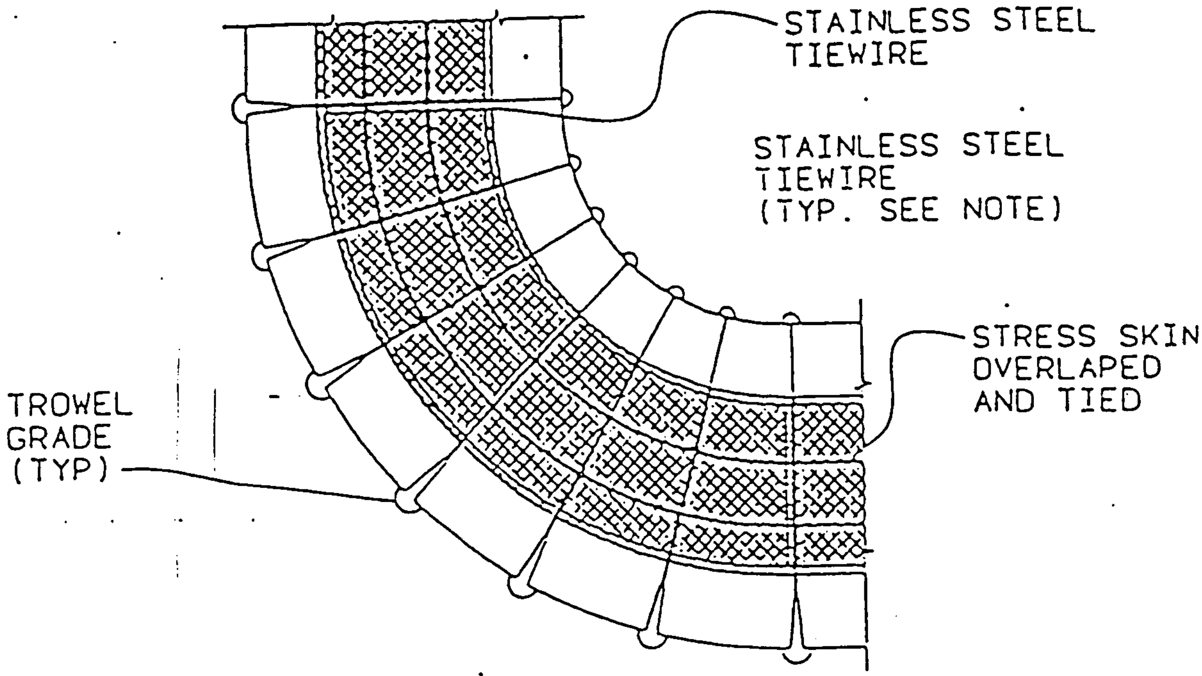


FIGURE 2(A) - SINGLE CABLE TRAY STRAIGHT ENCLOSURE

10



DETAIL A29

12" RADIUS (SIDES REMOVED TO SHOW DETAIL)

NOTE:
ANNEALED TYPE 304 STAINLESS STEEL TIE WIRE 16 GA.

FIGURE 2(B) - SINGLE CABLE TRAY BEND ENCLOSURE

CAD MAINTAINED DRAWING
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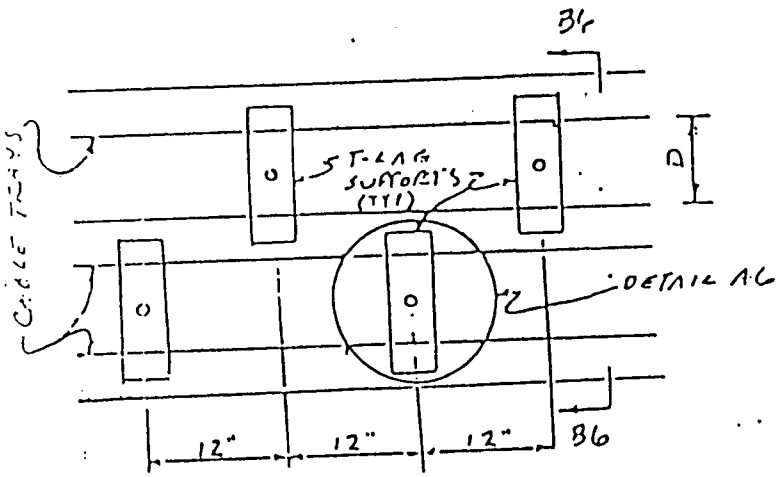
PROJECT FACILITY
MECHANICAL/NUCLEAR
ELECTRICAL RACEWAY FIRE BARRIER SYSTEMS

TITLE
THERMO-LAG 330-1 HOUR ERFBS. TYPICAL CABLE TRAY RADIUS (SIDE REMOVED)

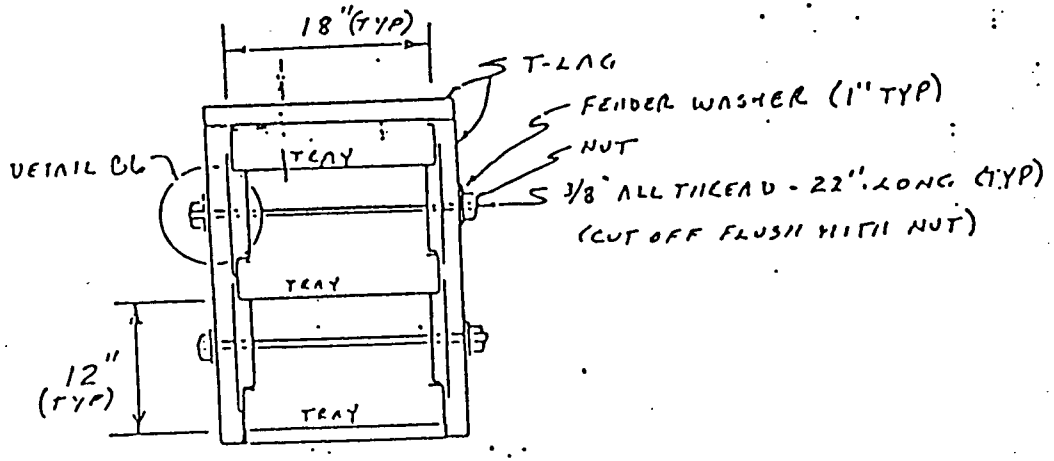
TENNESSEE VALLEY AUTHORITY

DS-M17.2.2-29

9400042573

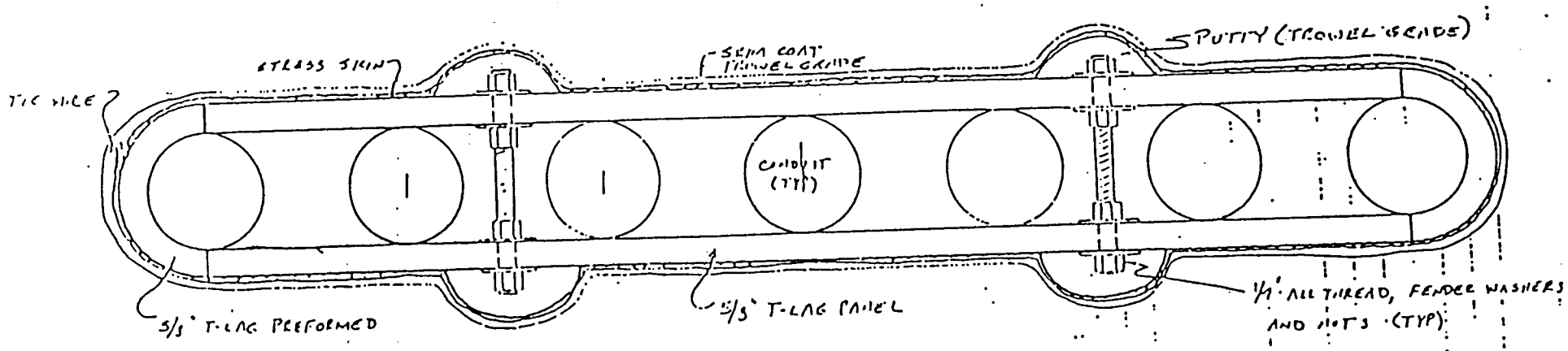


TYPICAL STACK TRAYS
(NTS)

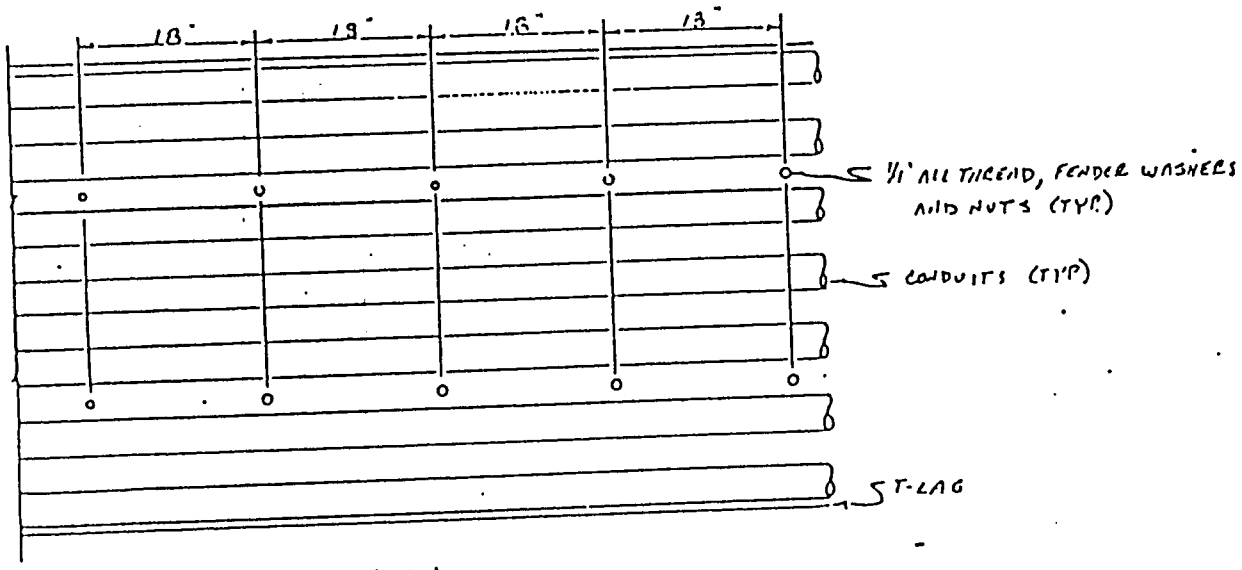


SECTION B6-B6
T-LAG SUPPORT
STACKED TRAYS
(NTS)

FIGURE 3 - MULTIPLE CABLE TRAY ENCLOSURE



MULTIPLE CONDUITS
PREFORMED/PANEL METHOD
(NTS)

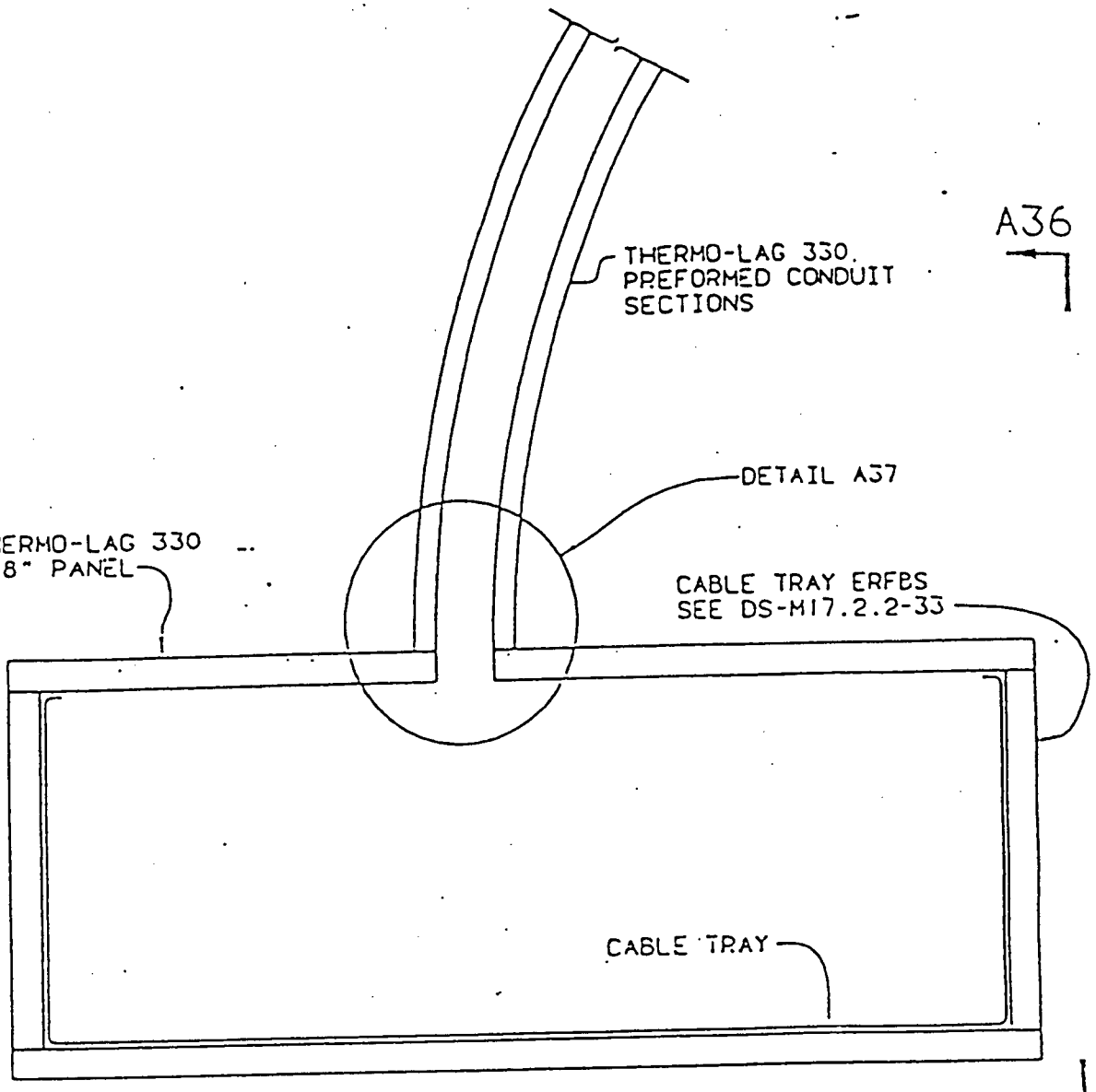


PLAN VIEW
MULTIPLE CONDUITS
(NTS)

MULTIPLE CONDUIT ENCLOSURE

12

13



TYPICAL AIR DROP

FIGURE 5(A) AIR DROP ENCLOSURE

CAD MAINTAINED DRAWING
THIS DRAWING IS NOW PART OF THE NON CADAM DATA BASE

SIZE F

ON ON PROJ
POINTS NEEDED

PROJECT FACILITY
MECHANICAL/NUCLEAR
ELECTRICAL RACEWAY FIRE BARRIER SYSTEMS

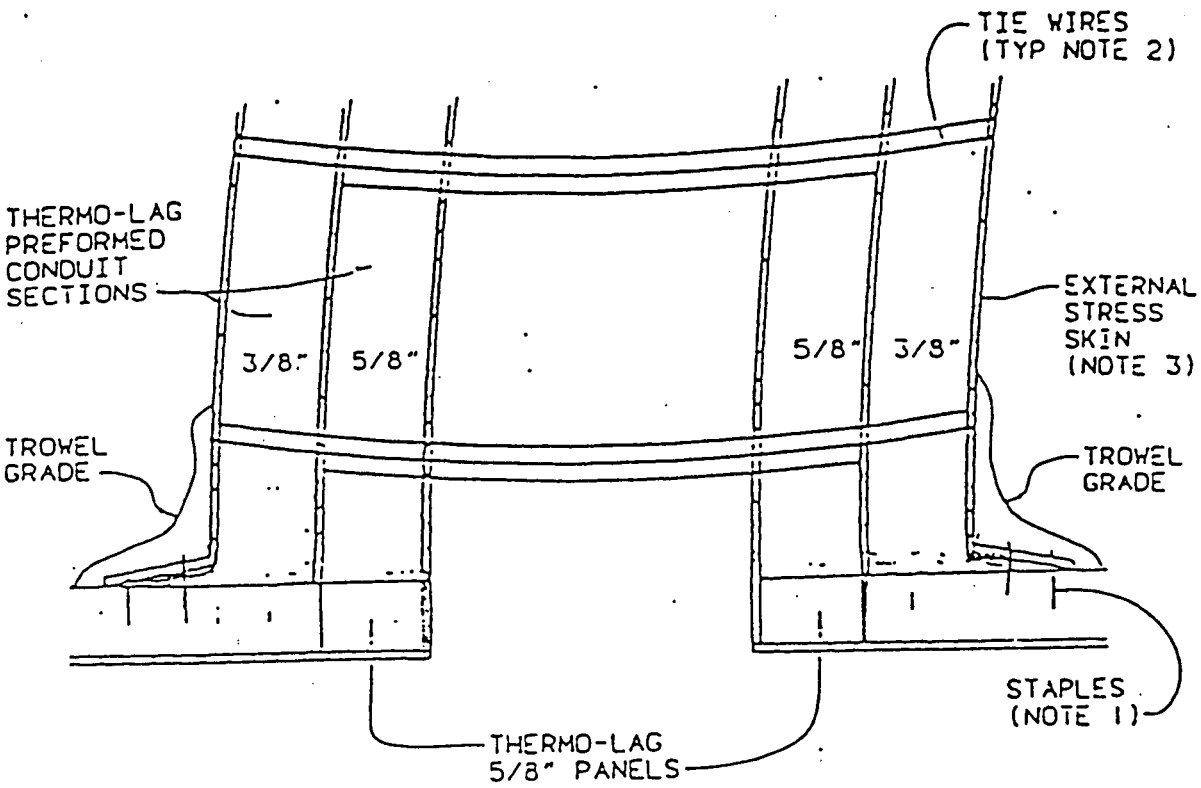
TITLE
THERMO-LAG 330-1 HOUR
ERFBS
TYPICAL AIR DROP

TENNESSEE VALLEY AUTHORITY

DS-M17.2.2-35

9400042513
Page 17 of 29

14



DETAIL A

AIR DROP TO CABLE TRAY
(DS-M17.22-35)

NOTES:

1. STAPLES SHALL BE ARROW OR BOSTITCH T50. 1/2-INCH LONG.
2. TIE WIRE SHALL BE ANNEALED TYPE 304 STAINLESS STEEL. 0.016-INCH DIA.
3. ASTM E437 TYPE 304 STAINLESS STEEL. KNITTED MESH. 60 DENSITY. 0.011" DIAMETER WIRE.

CAD MAINTAINED DRAWING
THIS DRAWING IS NOW PART OF THE NON CADAM DATA BASE

SIZE F

MECHANICAL/NUCLEAR
ELECTRICAL RACEWAY FIRE BARRIER SYSTEMS

THERMO-LAG 330-1 HOUR
ERFBS
TYPICAL AIR DROP-DETAIL

TENNESSEE VALLEY AUTHORITY

DS-M17.2.2-37

FIGURE 5(B) AIR DROP ENCLOSURE DETAIL

9400042513
Page 70 of 229

ATTACHMENT 1

DATA SHEET

RACEWAY ID Air Drop Tray WP/WR NO. 44213

LOT/CONTRACT NO. Trowel 94-05093 EXPIRATION DATE JAN 95

TVA ~~CRAFTSMAN~~ JH Price DATE 8/15/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/15/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	6" max	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE		
CIRCUMFERENCE	JH 8/15/94	
SURFACE APPEARANCE		
MESH OVERLAPS		

REMARKS: 5/8" Panel Lot # 94-07014 (max 3/4" min 1/2")
Use score & fold method. Ribs perpendicular to rails.
5/8" Panel Lot 94-03028 (max 3/4" min 1/2")
Bottom piece attached to tray.

ATTACHMENT 1

DATA SHEET

RACEWAY ID STACKED TRAYS WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

TVA ~~CRAFTSMAN~~ [signature] DATE 8/15/94

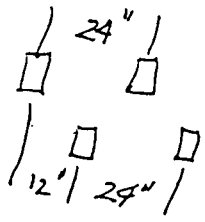
WYLE LABS ~~QC INSPECTOR~~ David Bell DATE 8/15/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	See Remarks	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE		
CIRCUMFERENCE	[signature] 8/15/94	
SURFACE APPEARANCE		
MESH OVERLAPS		

REMARKS: 5/8" Panel Lot #94-07014, 94-04005
T-Lag supports attached. 24" & 12" spacing. →
Bottom piece attached. Extended stress skin up
on side rail (bottom) ~ 3"-4".



ATTACHMENT 1

DATA SHEET

RACEWAY ID GANGED CONDUITS WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

TVA ~~GRAFTSMAN~~ [signature] DATE 8/15/94

WYLE LABS ~~QC INSPECTOR~~ [signature] DATE 8/15/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	6" on Conduit.	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE		
CIRCUMFERENCE	[signature] 8/15/94	
SURFACE APPEARANCE		
MESH OVERLAPS		

REMARKS: 4" PREFORMED LOT # 92-08036, 92-08038, 92-10007, 92-10002, 92-11018, 94-06082. (MAX 5/8", MIN 1/2")
5/8" Panel Lot# 94-02053 (max 3/4", min 1/2")
5/8" " " # 94-02012 (max 3/4", min 1/2")

ATTACHMENT 1

DATA SHEET

RACEWAY ID SINGLE CONDUIT WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

TVA ~~CRAFTSMAN~~ JJ Pierce DATE 8/15/94

WYLE LABS ~~QC INSPECTOR~~ Dave Bell DATE 8/15/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	6" max	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE	N/A	
CIRCUMFERENCE		
SURFACE APPEARANCE	JJP 8/15/94	
MESH OVERLAPS		

REMARKS: 2" PREFORMED (338200) 94-06082 (MAX 7/16" - MIN 3/8")
Panel Lot 94-07023 (MAX , MIN)

ATTACHMENT 1

DATA SHEET

RACEWAY ID AIR DROP TRAY WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN ~~93~~

TVA ~~GRAFTSMAN~~ JJ Pierce DATE 8/16/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/16/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	OK	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE	N/A	
CIRCUMFERENCE	N/A	
SURFACE APPEARANCE	—	
MESH OVERLAPS	—	

REMARKS: PANEL LOT # 94-02012 (MAX 3/4" - MIN 1/2")
Preformed (158300) Lot 94-08045 (MAX 5/8" - MIN 1/2")
92-10012, 92-11024
Preformed (238300) 94-07014 (max 1/2", min 1/4")
Tie wires on radial for tray are not in the (score) cuts, but are on on the T-Lag.

ATTACHMENT 1

DATA SHEET

RACEWAY ID STACKED TRAYS WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

TVA ~~CRAFTSMAN~~ [illegible] DATE 8/16/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/16/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	OK	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE	N/A	
CIRCUMFERENCE	N/A	
SURFACE APPEARANCE	—	
MESH OVERLAPS	—	

REMARKS: PANEL LOT #94-03047 (MAX 3/4" - MIN 1/2")
Panels installed, supports installed. Ready for stress skin.

ATTACHMENT 1

DATA SHEET

RACEWAY ID GANGED CONDUITS WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

TVA ~~CRAFTSMAN~~ [signature] DATE 8/16/94

WYLE LAB ~~QC INSPECTOR~~ [signature] DATE 8/16/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	ok	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE	N/A	
CIRCUMFERENCE	N/A	
SURFACE APPEARANCE	—	
MESH OVERLAPS	—	

REMARKS: Panel Lot # 94-02053 (max 3/4", min 1/2")
Complete - Ready for stress skin.

ATTACHMENT 1

DATA SHEET

RACEWAY ID SINGLE CONDUIT WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

TVA ~~GRAFTSMAN~~ J. Pierce DATE 8/16/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/16/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING		6" max
SEAMS OFFSET	NA	No
JOINTS OFFSET	NA	YES
18" RULE		N/A
CIRCUMFERENCE		OK
SURFACE APPEARANCE		
MESH OVERLAPS		N/A

REMARKS: PREFORMED 2nd Layer (438200) Lot # 94-06082 (max ½", min ¼"). Conduit & LB installation complete except for final "polish". Supports ready for installation.

ATTACHMENT 1

DATA SHEET

RACEWAY ID Air Drop Tray WP/WR NO. 44213

LOT/CONTRACT NO. Trowel 94-05093 EXPIRATION DATE JAN 95

TVA ~~CRAFTSMAN~~ Jeff Prince DATE 8/17/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/17/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	ok	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE	ON ONE SUPPORT ok	8/17/94
CIRCUMFERENCE	ok	
SURFACE APPEARANCE	ok	
MESH OVERLAPS	2" min	

REMARKS: Install preformed pieces on air drop & conduit. Complete tray cover. Air drop was cut into individual pieces to fit curves and then buttered with trowel grade and put back together. Stress skin was buttered into the inside to form a single curved piece (half round) that fits the curved portions of the air drop and extends out the end ~2" to 3". Straight sections go over the extended stress skin.

ATTACHMENT 1

DATA SHEET

RACEWAY ID STACKED TRAYS WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

TVA ~~CRAFTSMAN~~ JJ Pierce DATE 8/17/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/17/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	ok	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE	N/A	JJP 8/17/94
CIRCUMFERENCE	N/A	
SURFACE APPEARANCE	ok	
MESH OVERLAPS	~4"	

REMARKS: Install stress skin and trowel grade skim coat. Cut off threaded rods flush with nuts. Apply dough ball (putty) over nuts and staple stress skin patch over dough balls.

G-98 REV. 0 SRN-98-01

ATTACHMENT 1

DATA SHEET

RACEWAY ID GANGED CONDUITS WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

~~CRAFTSMAN~~ TVA JL Pierce DATE 8/17/94

~~QC INSPECTOR~~ WYLE David Bell DATE 8/17/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING	ok	
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE	N/A	8/17/94
CIRCUMFERENCE	N/A	
SURFACE APPEARANCE	ok	
MESH OVERLAPS	~4"	

REMARKS: Install stress skin and trowel grade skim coat. Cut off threaded rods flush with nuts.

ATTACHMENT 1

DATA SHEET

RACEWAY ID SINGLE CONDUIT WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

TVA ~~GRAFTSMAN~~ JJ Pierce DATE 8/17/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/17/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING		ok
SEAMS OFFSET	NA	No
JOINTS OFFSET	NA	YES
18" RULE	JJP 8/17/94	N/A
CIRCUMFERENCE		ok
SURFACE APPEARANCE		ok
MESH OVERLAPS		N/A

REMARKS: Install supports. Apply skim coat.

ATTACHMENT 1

DATA SHEET

RACEWAY ID Air Drop Tray WP/WR NO. 44213

LOT/CONTRACT NO. Trowel 94-05093 EXPIRATION DATE Jan 95

TVA ~~GRAFTSMAN~~ [signature] DATE 8/18/94

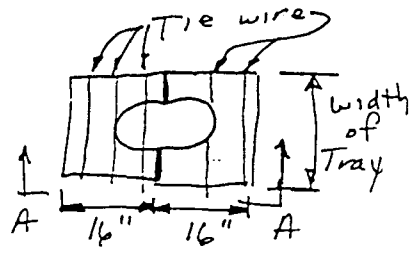
WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/18/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING		ok
SEAMS OFFSET	NA	N/A
JOINTS OFFSET	NA	YES
18" RULE	[signature] 8/18/94	See Remarks
CIRCUMFERENCE		ok
SURFACE APPEARANCE		ok
MESH OVERLAPS		ok

REMARKS: Install T-Lag on Vertical hanger (use 18" rule on upper part from tray). Install second layer on air drop. Install stress skin on assembly.
3/8" Preformed Lot # 94-07014 (max 1/2", min 3/8")
Installed flat panel pieces (see sketch) around air drop at tray intersection.



A-A

ATTACHMENT 1

DATA SHEET

RACEWAY ID Stacked Trays WP/WR NO. 44213

LOT/CONTRACT NO. N/A EXPIRATION DATE N/A

TVA ~~CRAFTSMAN~~ Jeff Pierce DATE 8/18/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/18/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING		
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE		
CIRCUMFERENCE		
SURFACE APPEARANCE		
MESH OVERLAPS		

8/18/94

REMARKS: Finish with Scotch-Brite pads and water. Attach final tie wires on 6" (max) spacing.

ATTACHMENT 1

DATA SHEET

RACEWAY ID GAMGED CONDUITS WP/WR NO. 44213

LOT/CONTRACT NO. TROWEL 94-05093 EXPIRATION DATE JAN 95

~~CRAFTSMAN~~ TVA [illegible] DATE 8/18/94

~~QC INSPECTOR~~ WYLE LAB [illegible] DATE 8/18/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING		
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE		
CIRCUMFERENCE		
SURFACE APPEARANCE		
MESH OVERLAPS		

[illegible] 8/18/94

REMARKS: Applied final coat of trowel (skim coat) and put dough balls over nuts. Installed stress skin patch over dough balls with staples.

ATTACHMENT 1

DATA SHEET

RACEWAY ID Single Conduit WP/WR NO. 44213

LOT/CONTRACT NO. N/A EXPIRATION DATE N/A

TVA ~~GRAFTSMAN~~ JH Pierce DATE 8/18/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/18/94

TYPICAL DRAWING NO.

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING		
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE		
CIRCUMFERENCE		
SURFACE APPEARANCE		
MESH OVERLAPS		

JH 8/18/94

REMARKS: Finish with Scotch-Brite pads and water. Installed final tie wire (6" max spacing).

ATTACHMENT 1

DATA SHEET

RACEWAY ID Air Drop Tray WP/WR NO. 44213

LOT/CONTRACT NO. Trowel 94-05093 EXPIRATION DATE Jan 95

TVA ~~GRAFTSMAN~~ [illegible] DATE 8/19/94

WYLE LAB ~~QC INSPECTOR~~ David Bell DATE 8/19/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING		
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE		
CIRCUMFERENCE		
SURFACE APPEARANCE		
MESH OVERLAPS		

REMARKS: Smooth with Scotch Brite and water. Attach final tie wires on 6" max spacing, except for curved sections which is 4" max spacing.

ATTACHMENT 1

DATA SHEET

RACEWAY ID Ganged Conduits WP/WR NO. 44213

LOT/CONTRACT NO. Trowel 94-05093 EXPIRATION DATE JAN 95

~~CRAFTSMAN~~ TVA [illegible] Pierce DATE 8/19/94

~~QC INSPECTOR~~ WYLE LAB [illegible] DATE 8/19/94

TYPICAL DRAWING NO. _____

MONITORING POINTS

	FIRST LAYER	SECOND LAYER
FASTENER SPACING		
SEAMS OFFSET	NA	
JOINTS OFFSET	NA	
18" RULE		
CIRCUMFERENCE		
SURFACE APPEARANCE		
MESH OVERLAPS		

REMARKS: Attach final tie wires on 6" max spacing

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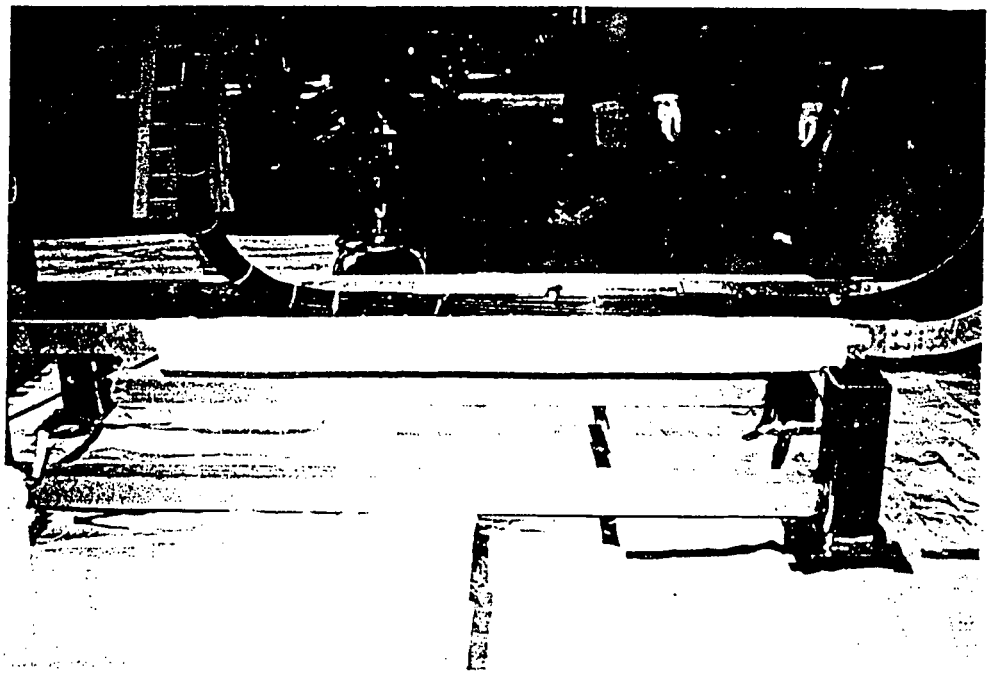
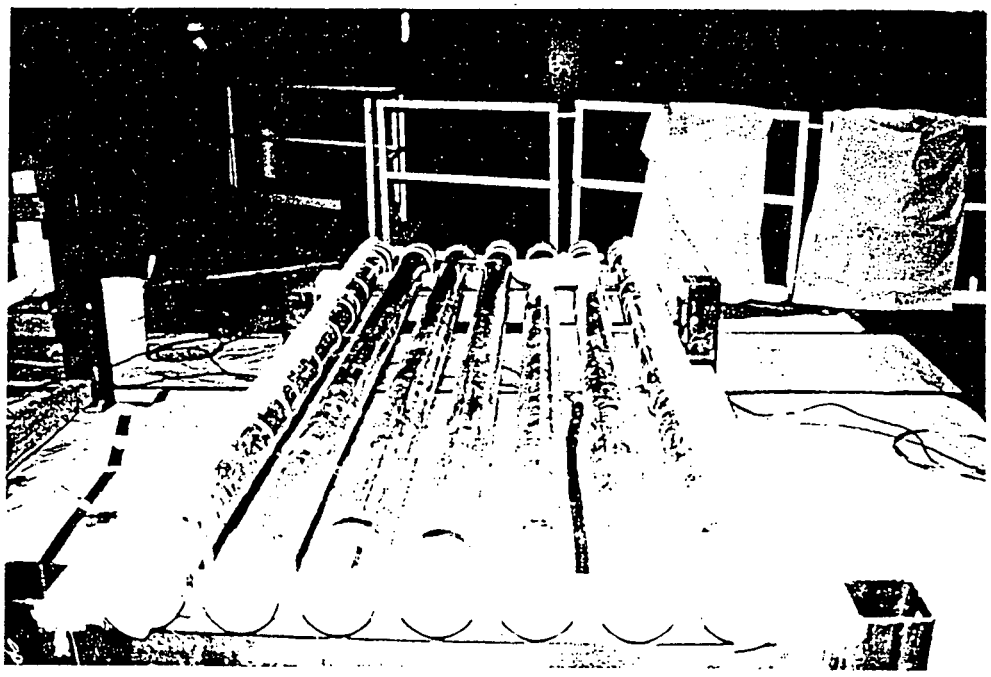


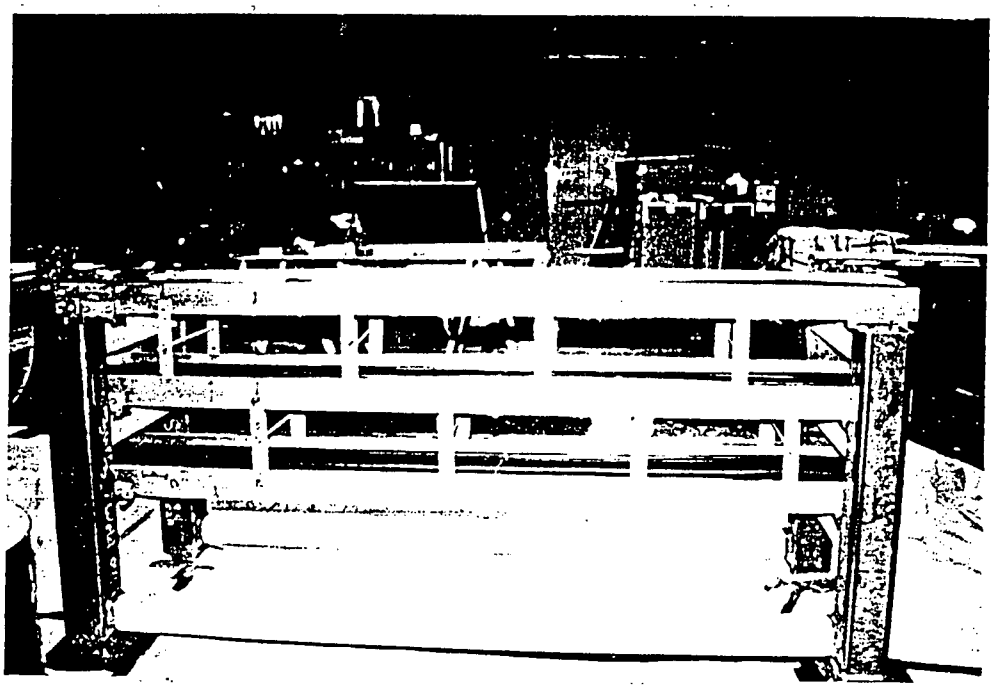
PHOTOGRAPH 1

BOTTOM AND SIDES INSTALLED ON THE SINGLE CABLE TRAY WITH AIR DROP SPECIMEN CONFIGURATION



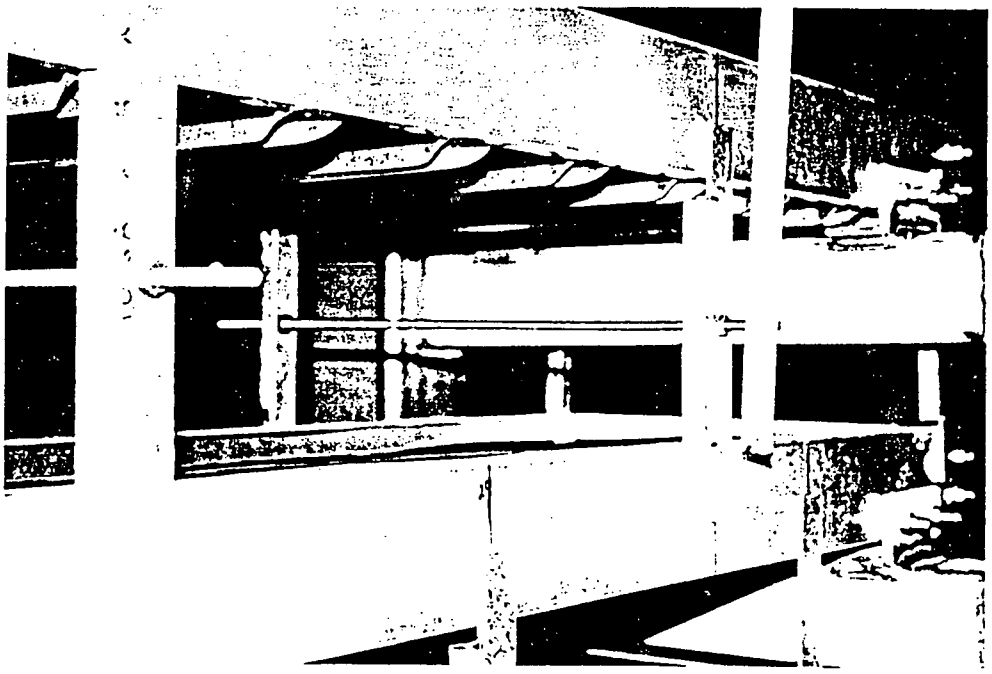
PHOTOGRAPH 2

THERMO-LAG CONDUIT SECTIONS INSTALLED ON THE GANGED CONDUIT SPECIMEN CONFIGURATION



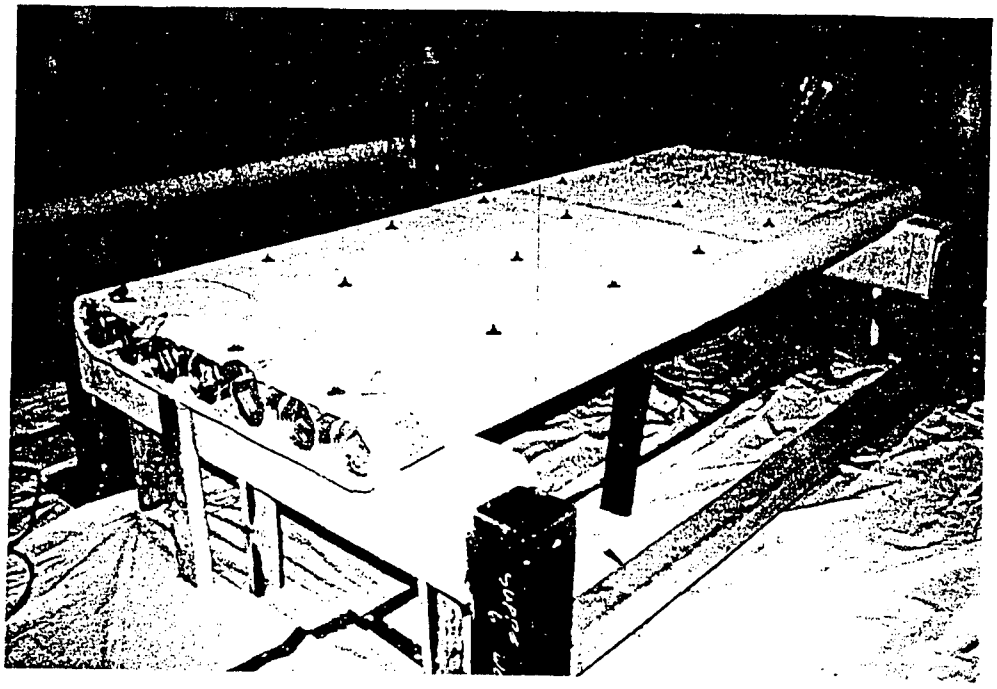
PHOTOGRAPH 3

MULTIPLE CABLE TRAY SPECIMEN CONFIGURATION
WITH THERMO-LAG SUPPORTS INSTALLED



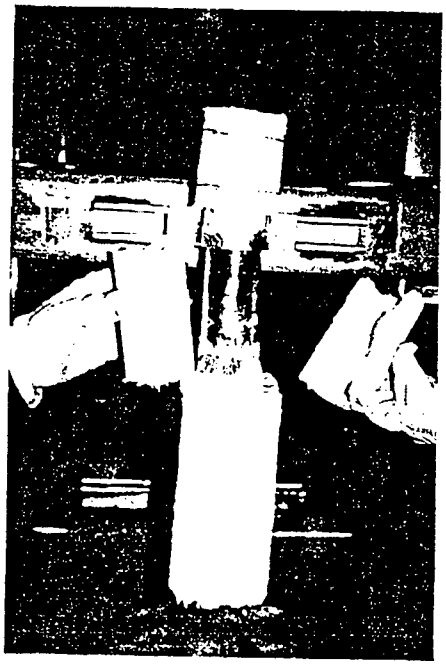
PHOTOGRAPH 4

THERMO-LAG SUPPORT-TIGHT FIT (FOREGROUND)
THERMO-LAG SUPPORT-LOOSE FIT (BACKGROUND)



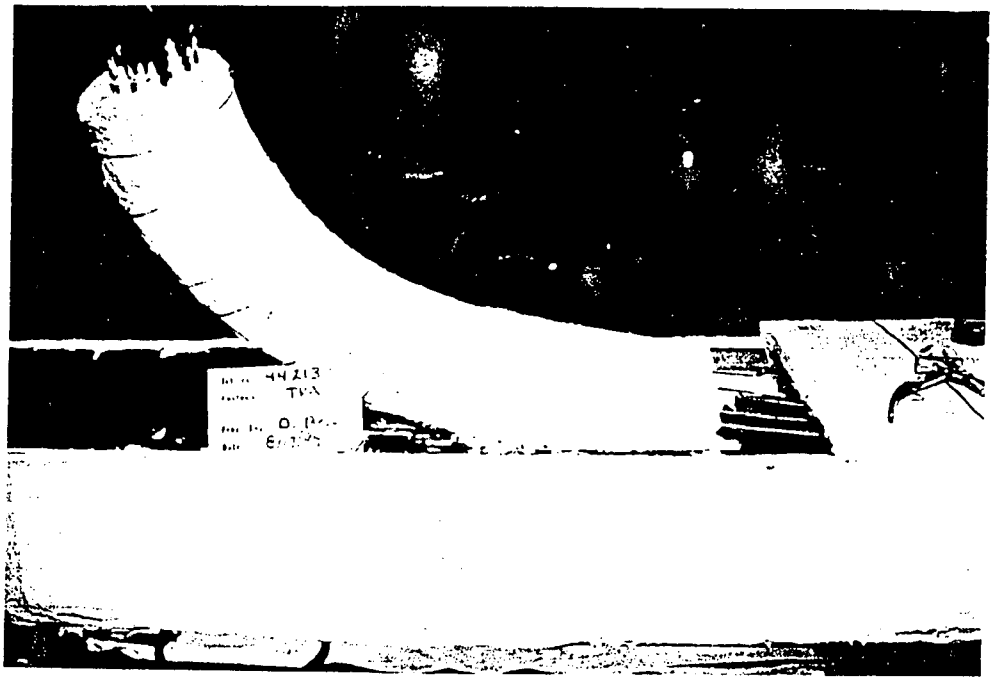
PHOTOGRAPH 5

THERMO-LAG PANELS SHOWING SUPPORT BOLT PATTERN INSTALLED ON THE GANGED CONDUIT SPECIMEN CONFIGURATION



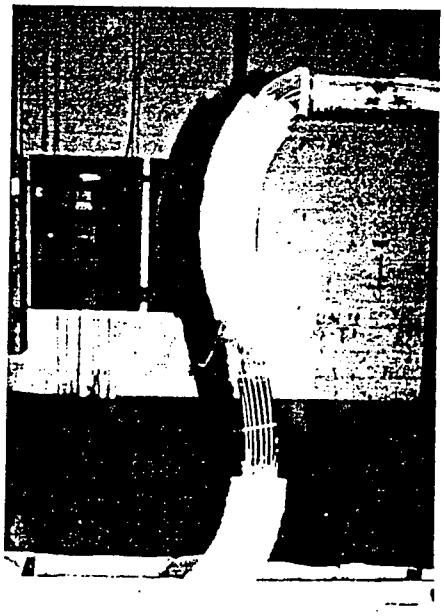
PHOTOGRAPH 6

INSTALLATION OF FIRST LAYER OF THERMO-LAG ON THE CONDUIT BOX OF THE SINGLE CONDUIT SPECIMEN CONFIGURATION



PHOTOGRAPH 7

FIRST LAYER OF THERMO-LAG CONDUIT SECTIONS INSTALLED ON THE AIR DROP PROIR TO THE INSTALLATION OF THE TOP PANEL OF THE SINGLE CABLE TRAY



PHOTOGRAPH 8

INSTALLATION OF THE TOP PANEL OF THE SINGLE CABLE TRAY AND CONTINUATION OF THE FIRST LAYER OF THERMO-LAG ON THE AIR DROP

LAST PAGE

PHOTOGRAPH 9

INSTALLATION OF THE SECOND LAYER OF THERMO-LAG ON THE AIR DROP

PHOTOGRAPH 10

INSTALLATION OF THE FINAL LAYER OF STRESS SKIN ON THE AIR DROP

ENCLOSURE 2

SINGLETON LABORATORIES
TEST REPORT
FOR
STATIC PHYSICAL TESTING OF THERMO-LAG