TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

June 10, 1983

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

By my letter to you dated June 3, 1983 TVA provided responses to informal NRC questions received during a telephone conference call with NRC seismic qualification review team (SQRT) reviewers for Watts Bar Nuclear Plant. We have discovered that page 11 of the enclosure was inadvertently omitted. Enclosed is a complete copy of the enclosure which includes the missing page.

If you have any questions concerning this matter, please get in touch with D. P. Ormsby at FTS 858-2682.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L M Mills

L. M. Mills, Manager
Nuclear Licensing

Sworn to and subscribed before me
this 10th day of June 1983
Paulette H. White
Notary Public
My Commission Expires 9-5-84

Enclosure
cc: U.S. Nuclear Regulatory Commission
Region II
Attn: Mr. James P. O'Reilly, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

3001 1/1

ENCLOSURE
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
ANSWERS TO NRC CONCERNS WITH TVA's RESPONSE TO SQRT FINDINGS

6 - Charging/Safety Injection Pumps

Question

Provide information used in evaluation of the charging/safety injection pumps suction nozzle and manner in which maximum nozzle loads are determined.

Response

The Watts Bar Charging/Safety Injection Pumps were evaluated in Pacific Pumps Report K-318-1 Revision 5 for the loading conditions including seismic, deadweight, operating and nozzle loads. Seismic accelerations used for the faulted condition were 3g horizontal and 2g vertical. Operational loads included the effects of maximum design pressure and torque due to power transmission. The nozzle loads used are:

Suction

Axial Load	5,500 lb
Shear Resultant Load	5,500 lb
Torsional Moment	80,200 in-lb
Resultant Bending Moment	80,200 in-lb

Discharge

Axial Load	4,300 lb
Shear Resultant Load	4,300 lb
Torsional Moment	38,700 in-lb
Resultant Bending Moment	38,700 in-lb

The nozzle loads were determined from the following:

Axial Load = (.04)(S)(A)
Shear Resultant Load = (.04)(S)(A)
Torsional Moment = .4(S)(I/do/2)
Resultant Bending Moment = (.4)(S)(I/do/2)

Where:

S = Allowable stress for the attached piping material at metal temperature as given in ASME Section III.
A = Cross sectional area of the metal of the attached piping.
I = Moment of inertia of the attached piping.
do = Outside diameter of the attached piping.

These maximum allowable nozzle loads were developed such that when the piping designer limits loads transmitted to the pump nozzles at or below these levels, the integrity and pressure boundary capability on the nozzles is assured.

A static analysis was performed using standard mechanics and strength of materials techniques. Most of the calculations were performed by hand. The following areas were evaluated.

- Pump/case nozzle junction
- Pump head flange and bolts
- Nozzles
- Flanges
- Supports
- Case alignment lug
- Anchor bolts
- Shaft
- Bearings

The results obtained from the evaluation were compared to the allowable limits per ASME Section III. All results were relatively low except for the suction nozzle stress which was 15,935 lb/in² for the faulted condition. This was compared to a normal condition allowable stress intensity of 16,600 lb/in². Comparing faulted condition stresses to normal allowables is very conservative. A faulted condition allowable of 33,200 lb/in² (2.0 S) is justifiable using the ASME code. There exists a considerable amount of margin when the faulted allowables are used.

9 - Control Rod Drive Mechanism (CRDM)

Question

Provide information on the qualification method of the CRDM. This includes information on the ratio used in the calculation.

Response

Vibration tests were performed in the Westinghouse Model L-105 full length CRDM (Ref. 1. and 2). Reported first mode frequencies for the L-105 ranged from 6.51 Hz to 10.08 Hz depending on head adapter lengths (the lower frequency corresponding to longer adapters). These frequencies were higher than those calculated for the L-106A since the L-105 is shorter by about two feet. The calculated first natural frequency was 4.26 Hz. Taking into account the differences between the L-105 and L-106 the correlation between available test results and calculations are reasonable.

In addition, to account for the WAT specific spectra, Westinghouse evaluated peak acceleration in the 4.26 Hz-10.8 Hz range. The peak acceleration in this range is 2.0g which can be obtained from the WAT specific horizontal SSE spectra. The CRDMs were qualified for this peak acceleration. The ratio technique described in a previous submittal was merely a technique to ensure that all natural frequencies experienced, at a minimum, the peak acceleration of 2.0g. Specifically, the accelerations were multiplied by a factor of 1.14 at all frequencies in the range. This value is obtained by dividing the peak acceleration of 2.0g by the acceleration at 4.26 Hz (1.76g).

Thus, this ratioing ensures that at least the peak acceleration was considered for the entire range.

Resultant loadings from analyses were shown to be acceptable.

10 - Main Control Board

Question

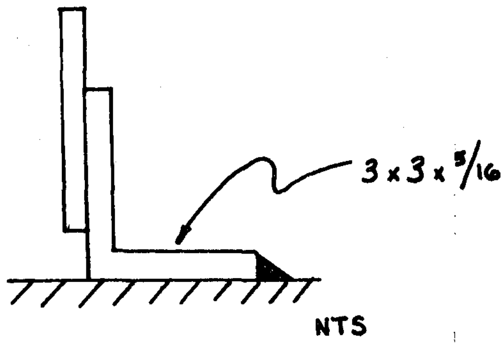
Provide calculations for the panel frequency shift from 21.1 Hz to 19.7 Hz due to base sill attachment difference between qualification and installed configuration.

Response

The requested calculations are provided.

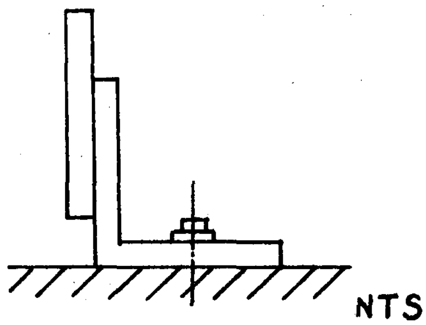
WBN Main Control Room Panel
"As-Qualified" Versus "As Installed"
Anchorage Flexibility

Installed Configuration



Intermittent Weld
2" on 12" Centers

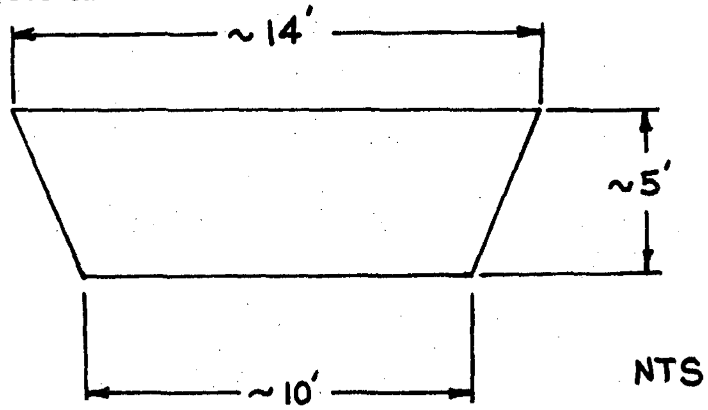
Qualified Configuration



Bolted
Approximately 2 Ft Centers

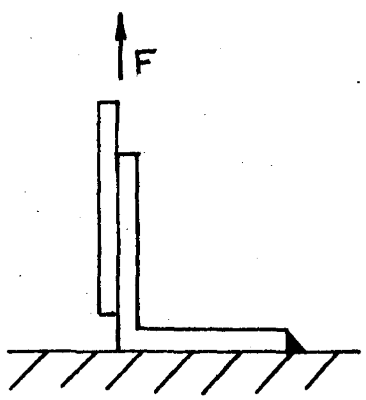
Assume no support from floor other than at weld or bolt locations as the conservative basis for comparison (i.e., effectively cantilevered from weld and bolt respectively.)

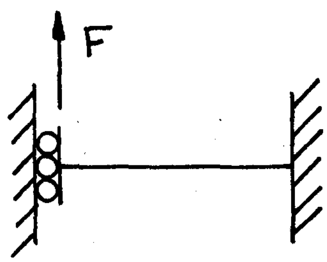
Panel Plan Section



For simplification, assume equivalent 12' x 5' rectangular plan section.

Base angle stiffness of installed configuration - for front/back motion.





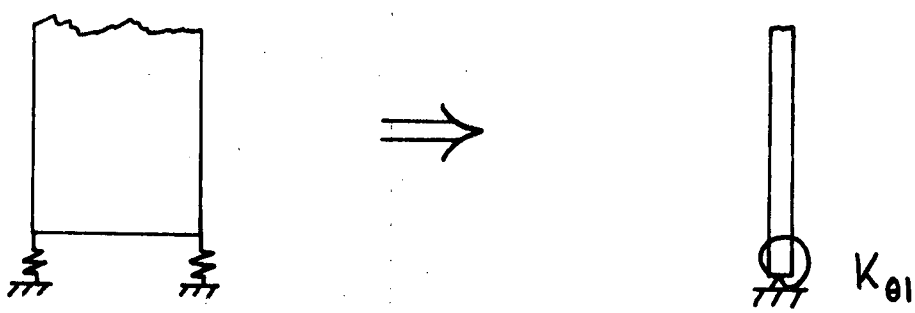
$$K = \frac{12EI}{L^3}$$

$I = 1/12\ bh^3$; b = 24"--12 segments of 2" weld each (Cons. Flexible)

$$k = \frac{(12)(30 \times 10^6)\ (1/12)(24)(5/16)^3}{(3)^3}$$

$$= .814 \times 10^6 \text{ lb/in}$$

Equivalent Base Rotational spring for panel



$$k_{\theta 1} = 1/2\ kd^2$$

$$k_{\theta 1\ inst} = (1/2)(.814 \times 10^6)(60)^2$$

$$= 1465 \times 10^6\ \frac{\text{in lb}}{\text{RAD}}\quad \text{Installed}$$

Comparison of 'as qualified' configuration with 'as installed:'

- Base angle effective bending length:

  Qualified (bolted) configuration bending length is approximately 1/2 the installed (welded) bending length. Stiffness of qualified configuration is therefore 8 times as stiff as the installed configuration.

- Effective width of base collection for equivalent rectangular plan section:

  Effectively, 6 bolts per side with fixity width of 1 inch per bolt. (Conservatively stiff)-- b = 6 inches

  Welded configuration has 12 segments of 2 inches weld on each side -- b = 24. Stiffness of qualified configuration is therefore 1/4 times as stiff as the installed configuration.

Total Effect: Effective base angle stiffness of bolted configuration is equal to twice that of welded configuration

$$k_{01} = 2930 \times 10^6 \ \frac{\text{in lb}}{\text{RAD}}$$

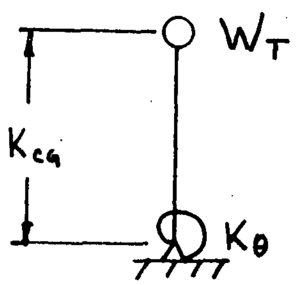
Assembly stiffness:

The stiffness of the total panel assembly (k_θ) can be thought of as two springs i.e.

1) Base Angle Stiffness ($k_{\theta 1}$) and
2) Panel Structural stiffness with total base fixity ($k_{\theta 2}$) which add together as springs in series, $1/k_\theta = 1/k_{\theta 1} + 1/k_{\theta 2}$.

The front/back natural frequency of the as qualified assembly configuration was 21.1 HZ.

For this comparative exercise, it is appropriate to use the simplified frequency analysis model:



$$f = \frac{1}{2\pi}\sqrt{\frac{K_\theta\, g}{(W_T)(K_{cg})^2}}$$

PANEL DATA:

$W_T \approx 4200$ lb.

$K_{cg} \approx 48$ in.

The total assembly stiffness of the as qualified configuration is:

$$21.1 = 1/2\pi \sqrt{\frac{K_\theta \quad (386)}{(4200)(48)^2}}$$

$$K_{\theta \text{ QUAL}} = 441 \times 10^6 \quad \frac{\text{in lb}}{\text{RAD}}$$

Combining this with the base angle stiffness of $2930 \times 10^6 \; \frac{\text{in lb}}{\text{RAD}}$,

yields an effective panel structural stiffness of:

$$\frac{1}{K_{\theta \text{ QUAL}}} = \frac{1}{k_{\theta 1 \text{ QUAL}}} + \frac{1}{k_{\theta 2}}$$

$$\frac{1}{441 \times 10^6} = \frac{1}{2930 \times 10^6} + \frac{1}{k_{\theta 2}}$$

$$k_{\theta 2} = 519 \times 10^6 \quad \frac{\text{in lb}}{\text{RAD}}$$

This same degree of panel structural stiffness would of course exist in the as installed configuration. The "as installed" (welded base) assembly stiffness and natural frequency can now be determined.

$$K_{\theta \text{ INSTL}} = \frac{k_{\theta 1 \text{ INST}} \, k_{\theta 2}}{k_{\theta 1 \text{ INST}} \, k_{\theta 2}}$$

$$= \frac{(1465)(519)}{1465 + 519} \times 10^6$$

$$= 383 \times 10^6 \quad \frac{\text{in lb}}{\text{RAD}}$$

$$f_{\text{INST}} = 1/2\pi \sqrt{\frac{(383 \times 10^6)(386)}{(4200)(48)^2}}$$

$$= 19.7 \text{ HZ}$$

11 - Electrical Penetrations

Question

The NRC requested that TVA determine if nitrogen under pressure was required during operation to prevent moisture ingress.

Response

We have confirmed that no penetrations at Watts Bar are of the pressurized nitrogen type.

17 - Main Steam Isolation Valves (MSIV)

Question

Provide additional nozzle loads information related to maximum shear and/or torsional loading test conditions.

Response

The qualification program for the Atwood and Morrill MSIV's included the pipe end load/static bend test. This test consisted of the application of valve actuator seismic loads, internal pressure, and attached piping nozzle loads. Two sets of maximum nozzle load conditions were applied; maximum bending moment for normal stress at the nozzle, and maximum torsional moment for shear stress. Load data from both tests is tabulated below.

	Bending Test	Torsion Test
Internal Pressure (PSIG)	1244	1146
Moment (ft lb)	1.967×10^6	2.278×10^6
Axial Force (lb)	1.0×10^6	9.21×10^5
Actuator Load (lb)	29,900	31,200

19 - Diesel Combustion Air Intake Filter

Question

Previous information described the filter body angle stiffeners as 4x4x3/8" and also as 2x3x3/8"; either is acceptable. What is angle stiffener size for the installed configuration? Define the filter assembly material.

Response

Field inspection has verified the angle stiffeners as 2 x 3 x 3/8. The filter body is constructed from commercial grade rolled steel; the angle stiffeners (added for structural strength and rigidity) are ASTM A-36 steel.

21 - Barksdale Pressure Switch/Square D Relay

Question

Illustrate the comparison of the test response spectra (TRS) with the required response spectra (RRS) for the Barksdale pressure switch.

Response

As discussed in detail in the previous submittal, the switch was subjected to a series of single frequency tests at observed natural frequencies. The attached plot (fig. 21.2-1) represents typical comparison of TRS and RRS. Note that at the most critical frequencies (observed natural frequencies), the TRS exceeds the RRS.

GC-3

Question

Provide statement regarding seismic response spectra peak broadening for Watts Bar equipment. Provide additional examples.

Response

The seismic qualification of all Watts Bar safety-related equipment (BOP and NSSS) includes the consideration of response spectra peak broadening. In all cases, the applicable required response spectra is broadened, with respect to frequency, by at least ± 10 percent throughout the critical frequency range.

Qualification tests enveloping the broadened required response spectra is illustrated in the attached figures GC-3-1 through GC-3-8.

GC-4

Question

Provide further discussion regarding the apparent differences between the equipment installed mounting configuration and the corresponding seismic qualification configuration.

Response

TVA's electrical panels at Watts Bar are typically supplied and installed with base sill subassemblies. By inspection, these base sills are judged to be stiff relative to typical electrical panel natural frequencies and the critical frequency range of the seismic motion. With the effectively rigid base sill as an integral component of the qualified and installed equipment assembly, the dynamic characteristics will be dictated by the mass and stiffness of the equipment (above the sill) and the attachment configuration of the equipment to the sill subassembly. Consistency is appropriately maintained in the equipment to sill attachment between the qualified configuration and installation. Differences in the attachment details of the typically stiff base sill subassembly to the building floor as observed during the site audit (i.e., welded versus bolted) would have a very small effect on the equipments seismic response. The small differences in response characteristics would most certainly be within the accuracy of state of the art qualification test simulation or analysis.

The evaluation of the bolted-for-qualification vs. welded installation of the main control room panel (equipment item No. 10) provides an excellent analytical verification of the negligible difference in dynamic response (natural frequency) attributable to the bolted vs welded anchorage consideration for a representative Watts Bar electrical panel. In this case, a natural frequency shift from 21.1 HZ to 19.7 HZ can be assigned directly to the bolted-qualification/welded-installation configuration difference. This degree of frequency shift would have no real impact on the validity of the equipment qualification program.

For rigidity consideration, data evaluation has been conducted by Westinghouse over the years on test results, analytical modeling, and correlation between the predicted and tested results for the equipment with base sill assembly. The results of this data evaluation have indicated that the bolted sill-to-floor mounting can be substituted with the welded installation with rather insignificant change of 6 percent or less for equipment resonant frequencies. The engineering analysis and test data can be made available for review at Westinghouse facilities upon request.

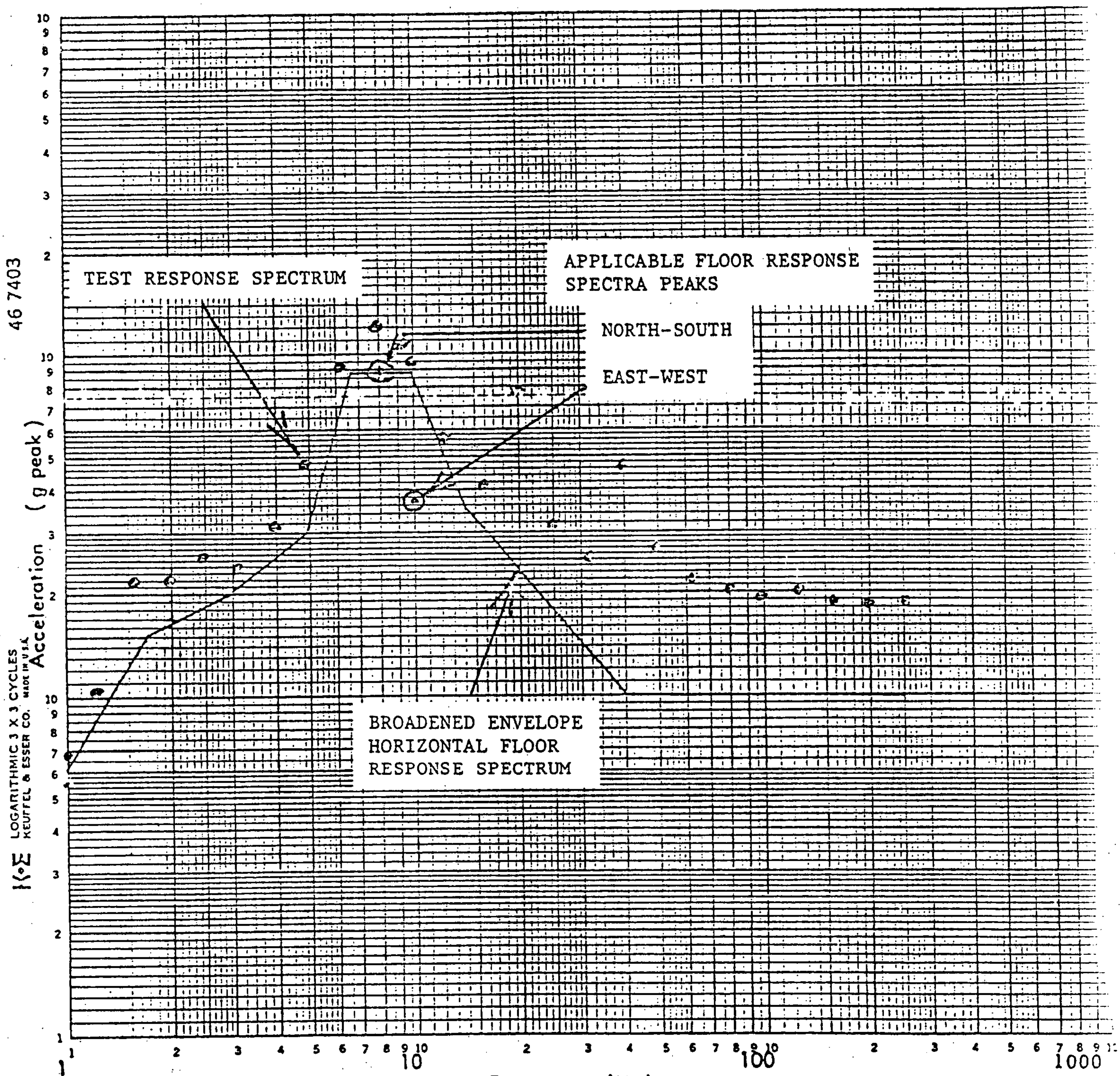
Report No. 43137-1

FIGGC-3-1

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING [1 %]



6900 VOLT SHUTDOWN BOARD LOGIC PANELS

AXIS S-S&V

LOCATION NO. HCA

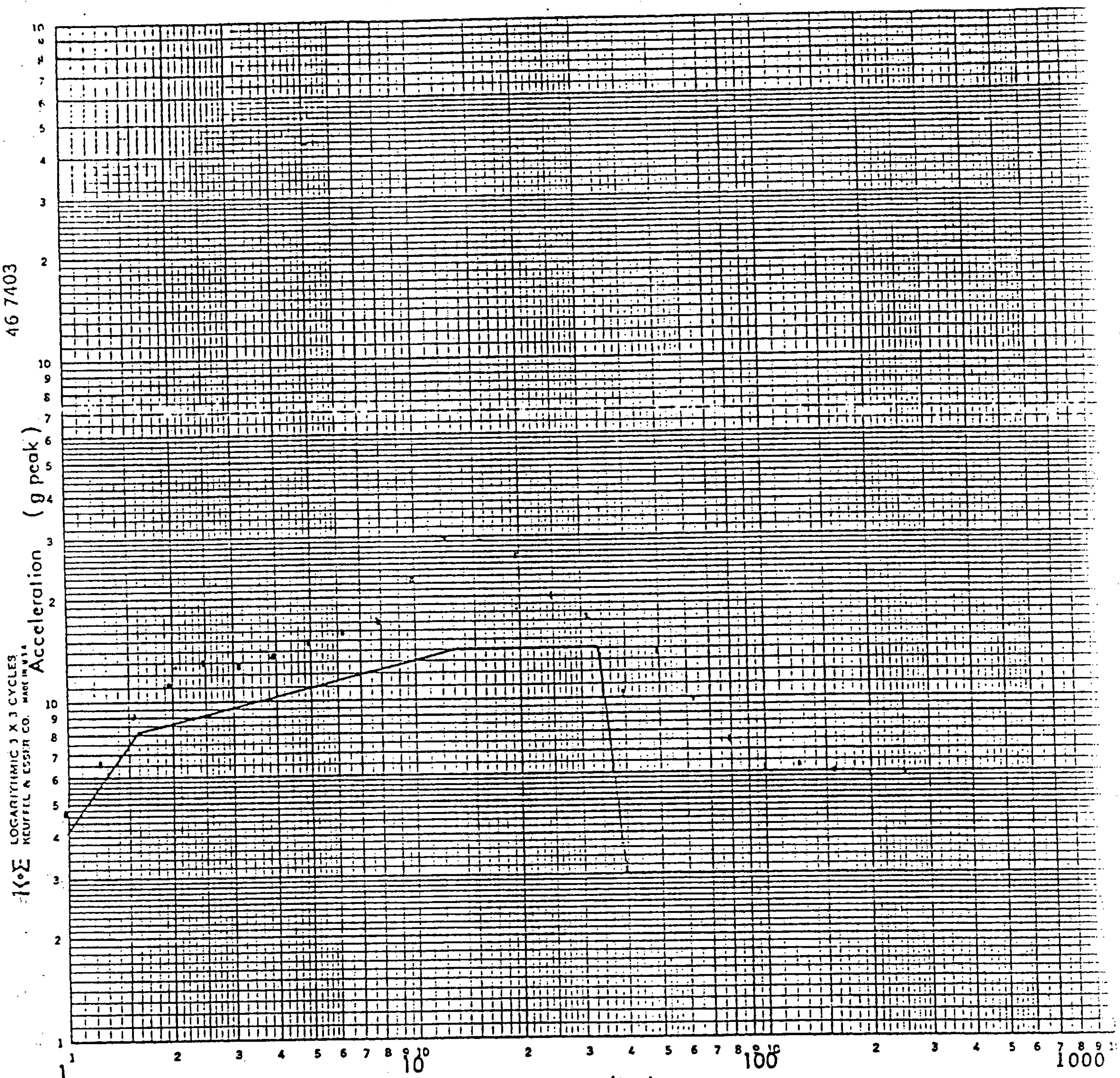
TEST RUN NO. 13

FIGG¢-3-2

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING [1 %]



AXIS S-S & V

LOCATION NO. VCB

TEST RUN NO. 13

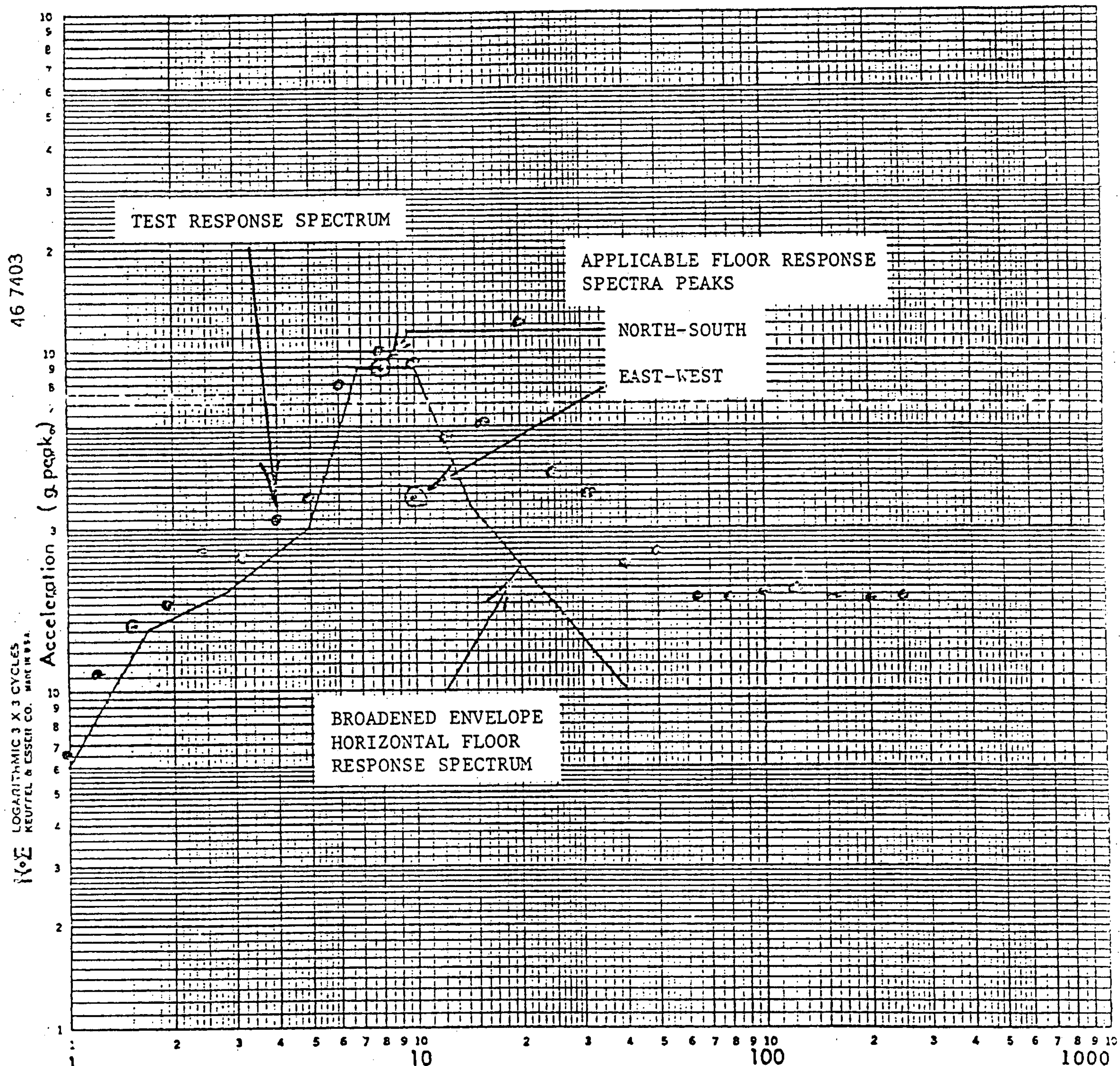
Report No. 43137-1

FIG EC3-3

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING [1 %]



6900 VOLT SHUTDOWN BOARD LOGIC PANELS

AXIS F-B & V

LOCATION NO. HCA

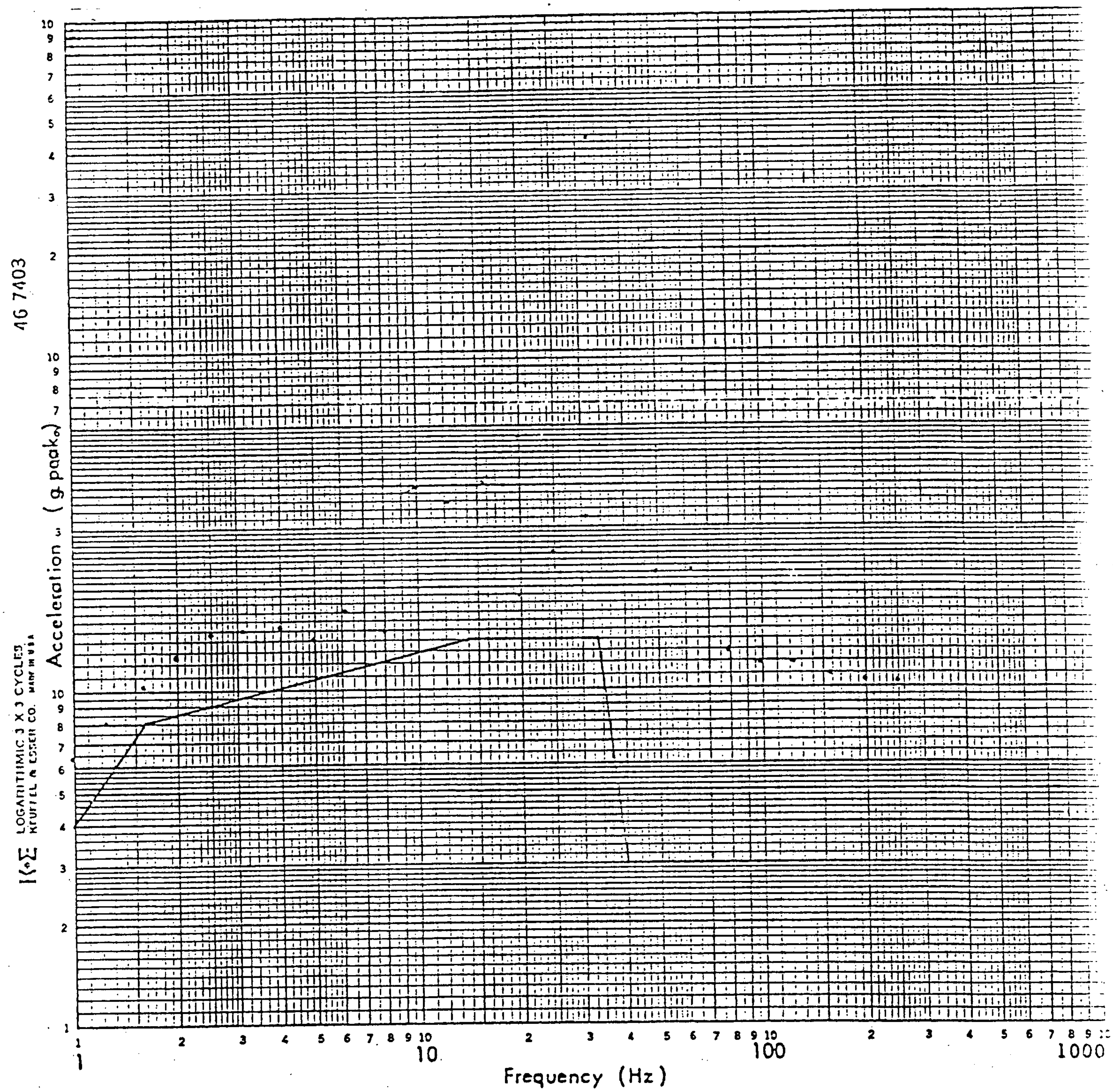
TEST RUN NO. 2a

FIG GC-3-4

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING | 1 % |



AXIS ____________

LOCATION NO. VCA

TEST RUN NO. 26

FIG GC-3-5 X $\frac{\cos 26}{\sqrt{2}}$

TITLE DS LOW VOLTAGE SWITCHGEAR

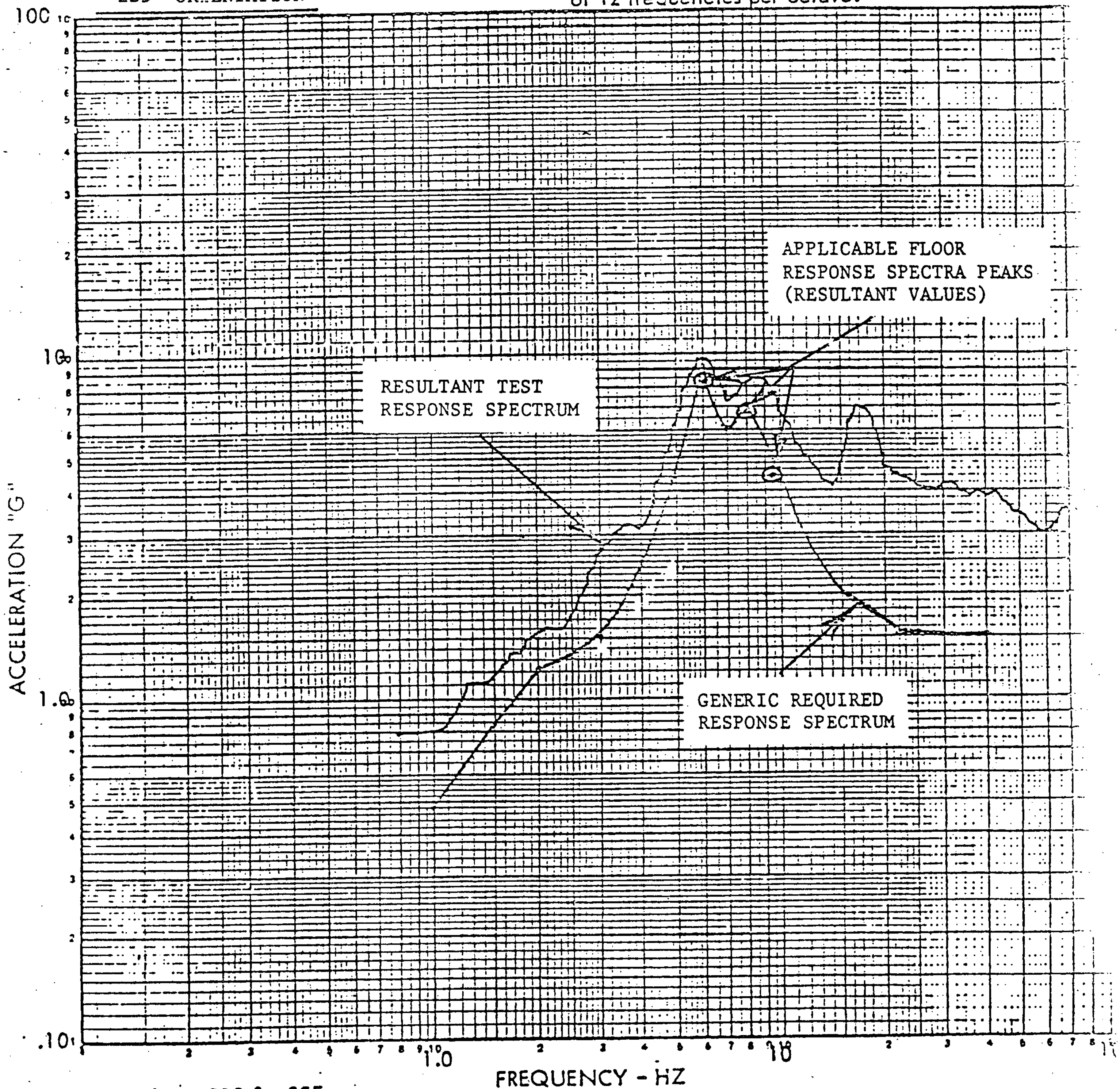
CUSTOMER WESTINGHOUSE EAST PITTSBURGH

SERIES I TEST I RUN 2M

OPERATOR ACCELEROMETER A2

CONTRACT NO. XAL 71706 ANALYSIS METHOD Seismic Shock Response Spec analysis at 5% of critical damping with a resolution of 12 frequencies per octave.

225° ORIENTATION

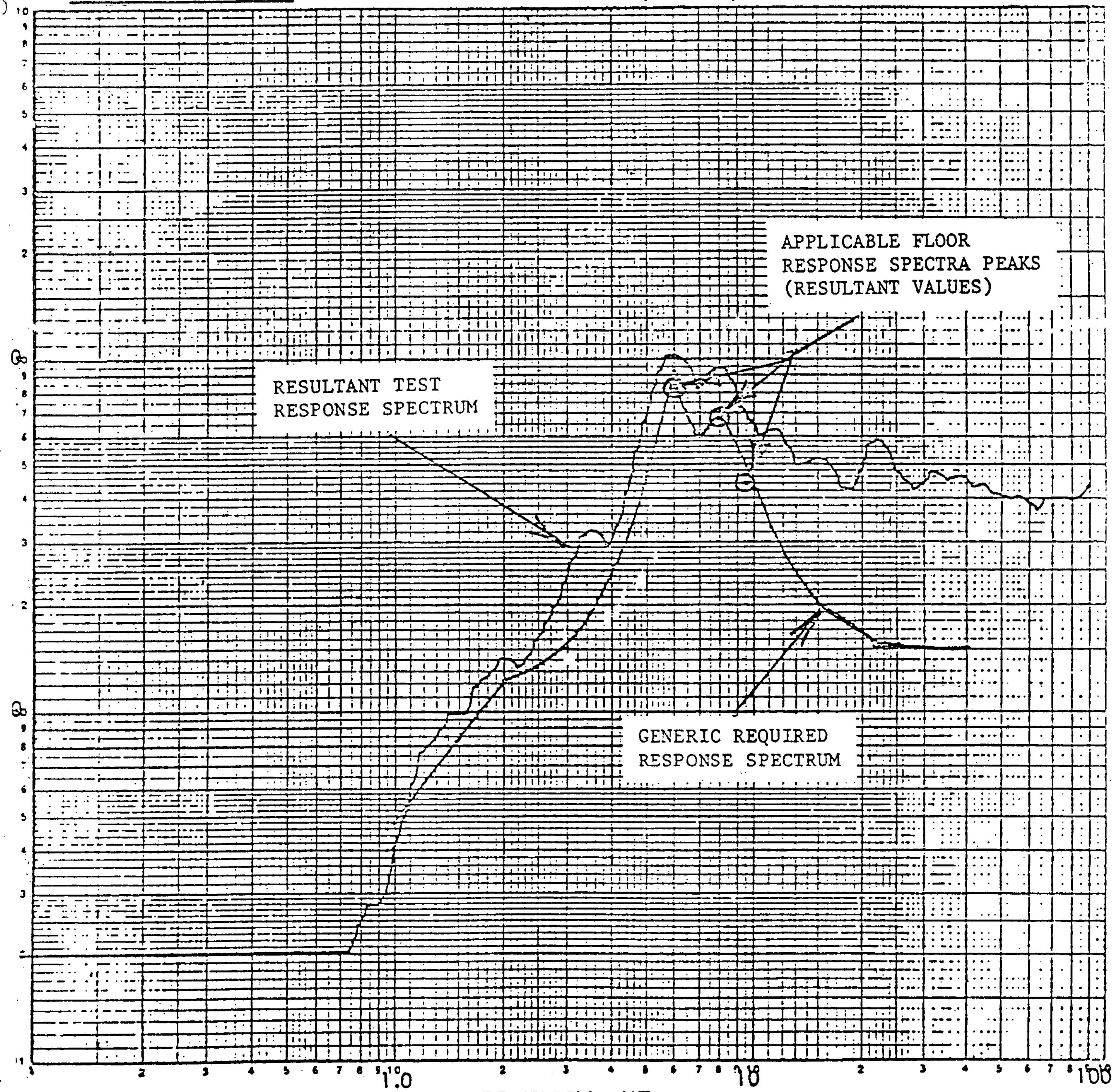


TRS envelope RRS for SSE

Figure 36

FIG GC-3-6. SSE

TITLE TYPE DS LOW VOLTAGE SWITCHGEAR
CUSTOMER WESTINGHOUSE EAST PITTSBURGH
SERIES 1 TEST 11 RUN 9
OPERATOR J. Sinwell, J. Zummo ACCELEROMETER A1
CONTRACT NO. XAL 71706 ANALYSIS METHOD Seismic Shock Response Spectrum analysis at 5% of critical damping with a resolution of 12 frequencies per octave.
315° ORIENTATION



FREQUENCY - HZ

TRS envelopes RRS for SSE

Figure 47

FIG GC-3-7

1-21-1

SSL

TITLE TYPE DS LOW VOLTAGE SWITCHGEAR

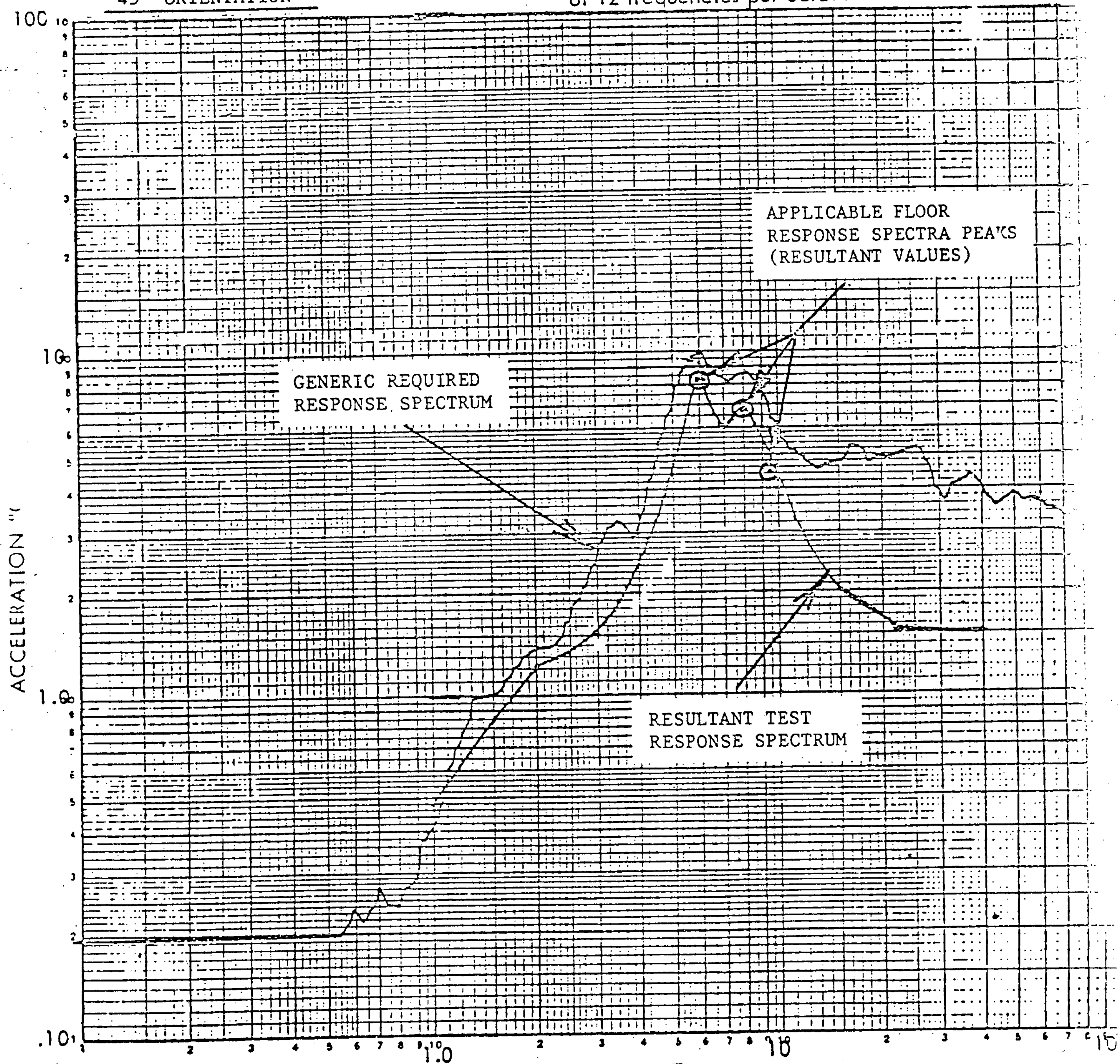
CUSTOMER WESTINGHOUSE EAST PITTSBURGH

SERIES I TEST III RUN 1

OPERATOR J. Sinwell, J. Zummo, G. Barna ACCELEROMETER A1

CONTRACT NO. XAL 71706 ANALYSIS METHOD Seismic Shock Response Spectr analysis at 5% of critical damping with a resolution of 12 frequencies per octave.

45° ORIENTATION



TRS envelopes RRS for SSE

Figure 48

FIG GC3-8

SSE

TITLE TYPE DS LOW VOLTAGE SWITCHGEAR

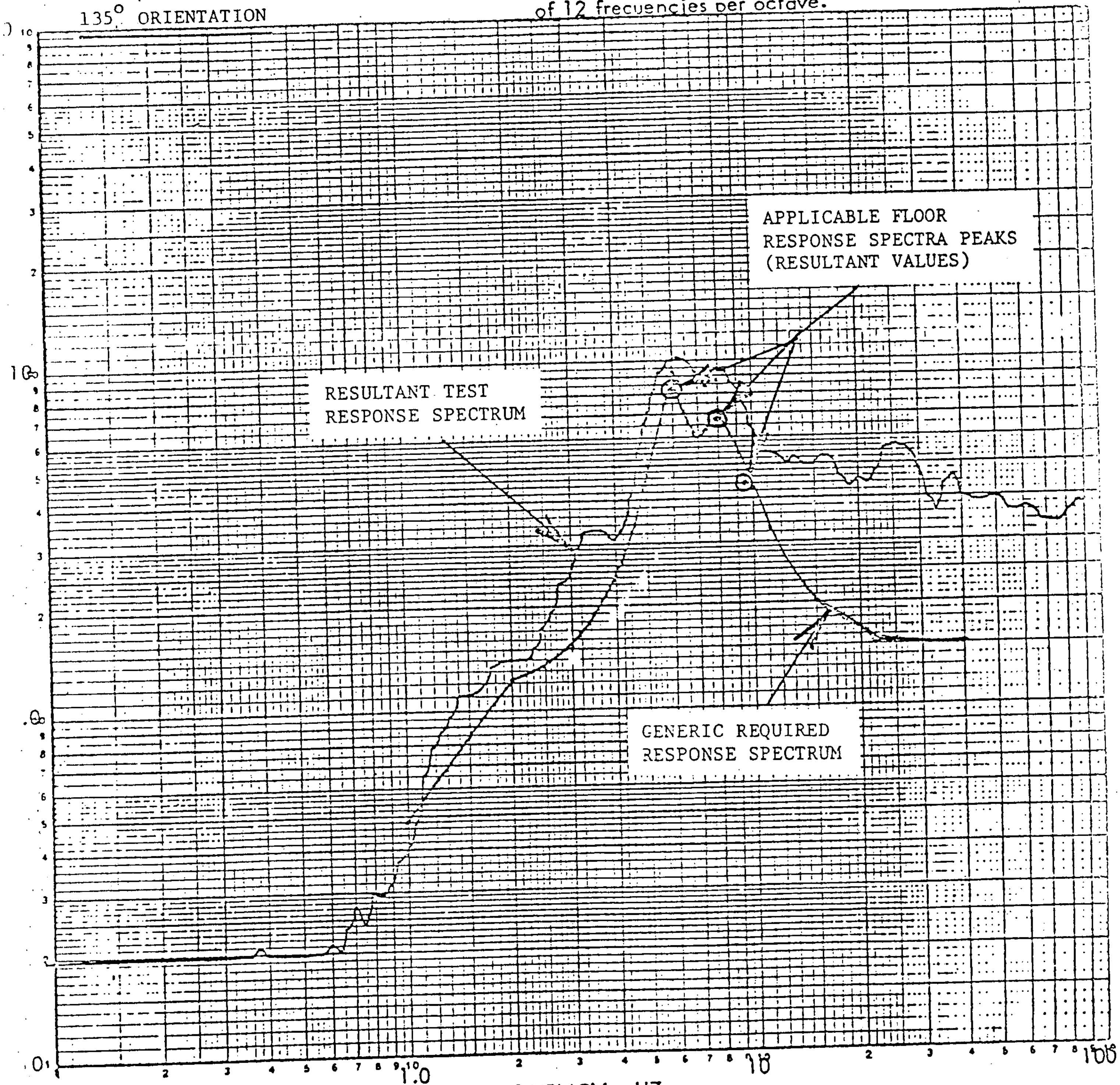
CUSTOMER WESTINGHOUSE EAST PITTSBURGH

SERIES 1 TEST IV RUN 3

OPERATOR ACCELEROMETER A1

CONTRACT NO. XAL 71706 ANALYSIS METHOD Seismic Shock Response Sepctrum analysis at 5% of critical damping with a resolution of 12 frecuencies per octave.

135° ORIENTATION

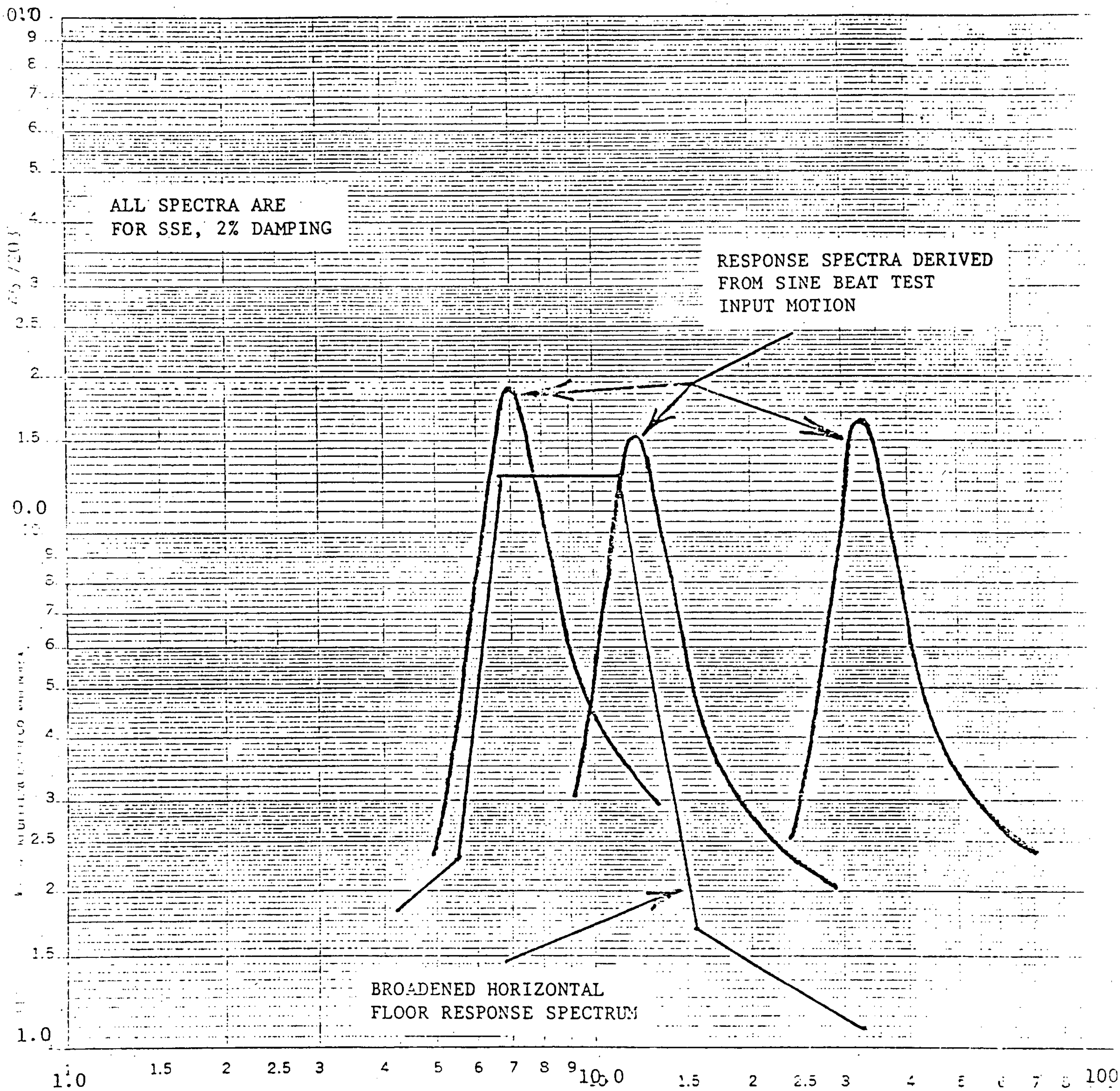


TRS envelopes RRS for SSE.

Figure 59

FIG 21.2-1

TRS/RRS COMPARISON
BARKSDALE PRESSURE SWITCH
LATERAL (FRONT/BACK) AXIS



FREQUENCY - HZ