ATTACHMENT

ANALYTICAL JUSTIFICATION OF THE
SEISMIC TEST ADEQUACY OF THE
ST. LUCIE UNIT 2 CPC AND NI MODULES
IN THE RPS CABINET

(SUPPLEMENT NO. 1)

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DISCUSSION

The original analytical justification of the CPC and NI modules used a frequency-dependent derating method to correct the in-cabinet (RPS) response spectra (RRS for subject modules) for overtesting of the RPS cabinet. The procedure was found not to be acceptable. A second procedure was recommended, which is to derate the module RRS by a single factor (in each direction). This single factor would be determined by comparing the RPS cabinet's RRS and TRS in the frequency of 5Hz and higher. This range is sufficient due to the fact that all natural or resonant frequencies of the RPS cabinet are 7Hz and higher, as determined by testing. Also, the use of the 2nd procedure incorporates a 10% penalty to account for possible non-linear behavior of the cabinet.

Included herein is the derivation of the governing equation, data processing and the results of using the 2nd procedure.

Only the NI module is discussed herein because the CPC module results, while based on the first justification, were acceptable from the significant margin shown.

The results herein show that the NI module is indeed qualified for seismic based upon the testing of this module and the RPS cabinet.

The original analytical justification contains addition detail such as descriptions of abbreviations, references, etc., which may be helpful in the review of this (herein) document.

GOVERNING EQUATION

This equation is used to evaluate the degree of overtesting experienced by the RPS cabinet. 90% of this overtesting is used to correct the in-cabinet response spectra. A 10% penalty is taken to account for possible non-linear behavior of the cabinet.

$$\text{Cabinet overtest} = TRS_c = RRS_c + (TRS_c - RRS_c)$$

$$\text{Cabinet overtest factor} = \frac{RRS_c + (TRS_c - RRS_c)}{RRS_c}$$

$$90\% \text{ of cabinet overtest factor} = \frac{RRS_c + 0.9\,(TRS_c - RRS_c)}{RRS_c}$$

$$= \frac{RRS_c + 0.9\,TRS_c - 0.9\,RRS_c}{RRS_c}$$

$$= \frac{0.9\,TRS_c + 0.1\,RRS_c}{RRS_c}$$

$$= \boxed{0.9\,\frac{(TRS_c)}{(RRS_c)} + 0.1}$$

$$RRS_{mc} = RRS_m \div \left[0.9\,\frac{(TRS_c)}{(RRS_c)} + 0.1\right]$$

PROCEDURE

1) Find minimum value of $\frac{(TRS)}{(RRS)}$ cabinet for all frequencies $5H_2$ and higher.

   Do this for each of the four test axes.

   Horizontal of F/B test

   Vertical of F/B test

   Horizontal of S/S test

   Vertical of S/S test

2) Use the governing equation $(0.9 \frac{(TRS_c)}{(RRS_c)} + 0.1)$ for each of the above axes to determine overtest factors (90%).

3) Divide NI RRS_m by the 90% overtest factors (appropriate factors with appropriate axes) to obtain the corrected RRS (RRS_{mc}) for the NI.

4) Plot RRS_{mc} (obtained in Step 3) against the NI RRS (RRS_m) to evaluate adequacy of NI seismic qualification.

Minimum overtesting of
RPS Cabinet at frequencies of
5Hz and higher

(data circled)

- step 1 of procedure -

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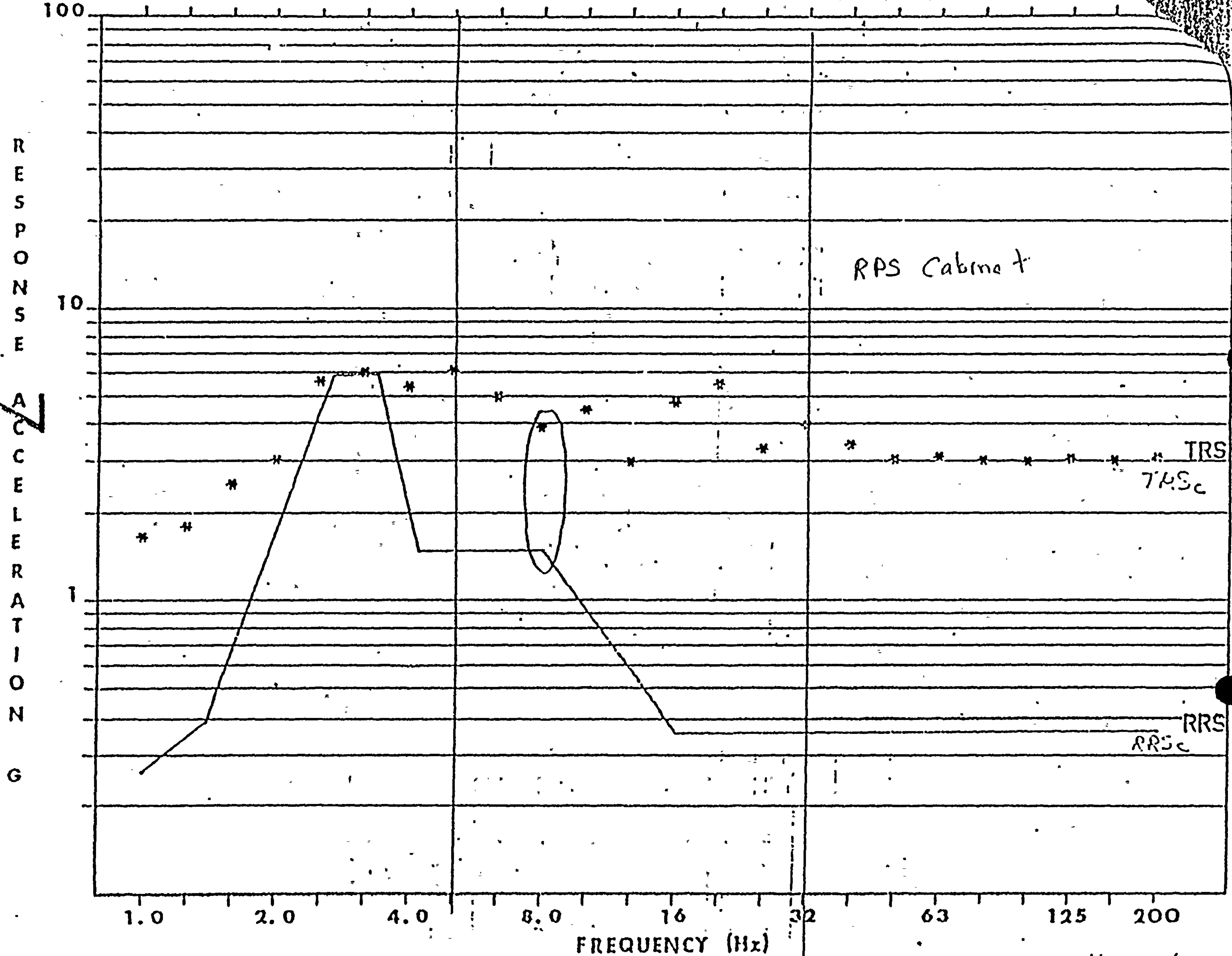
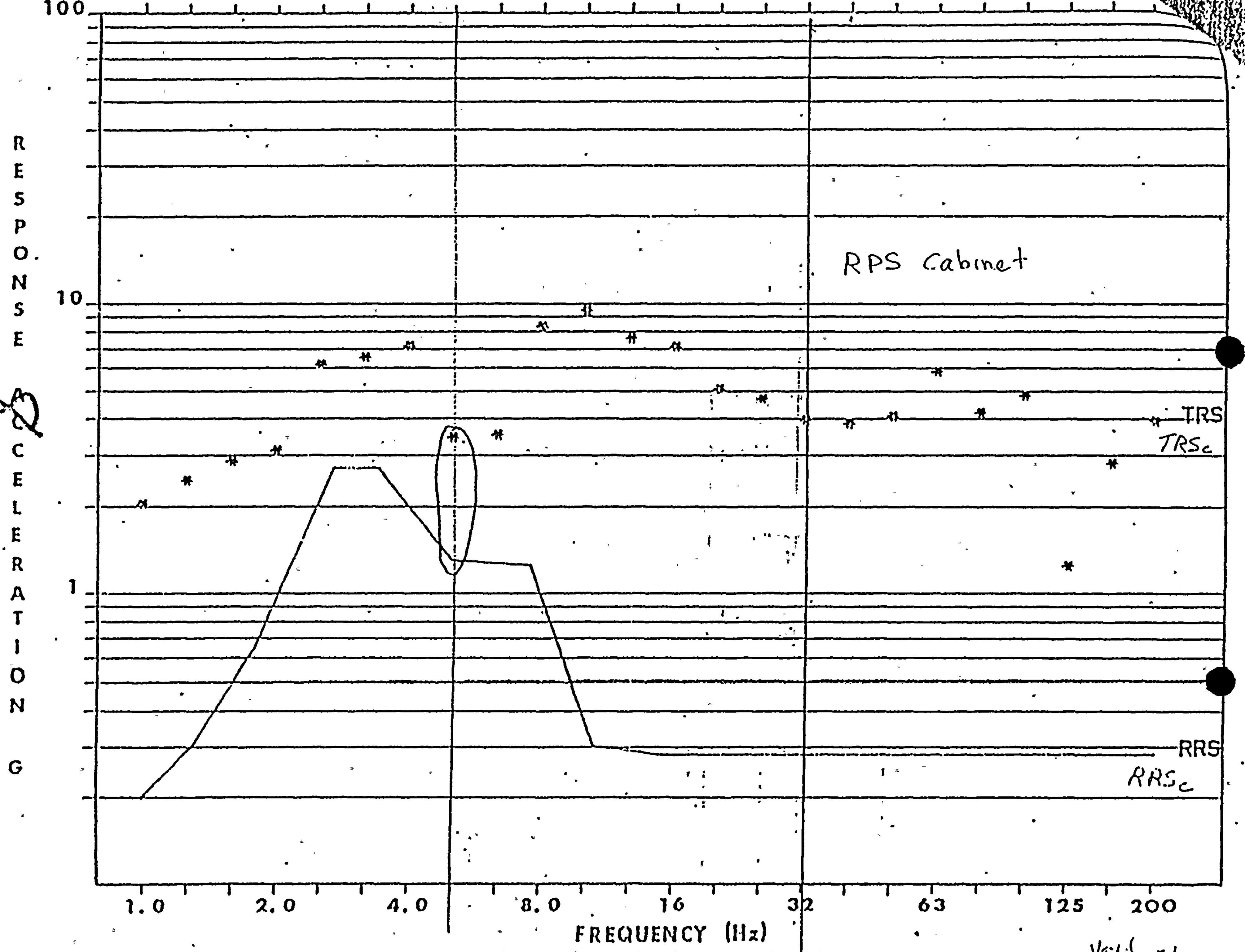
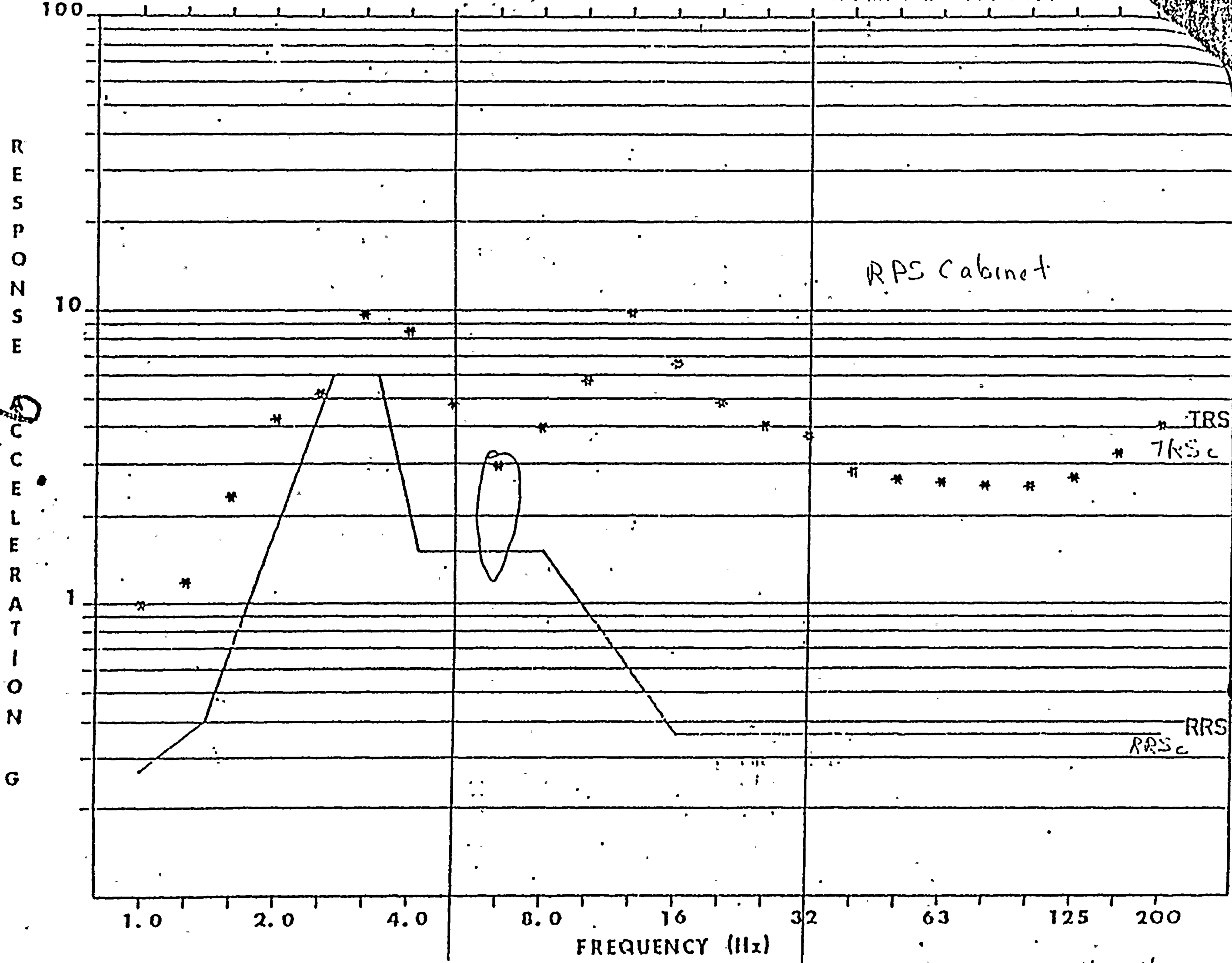


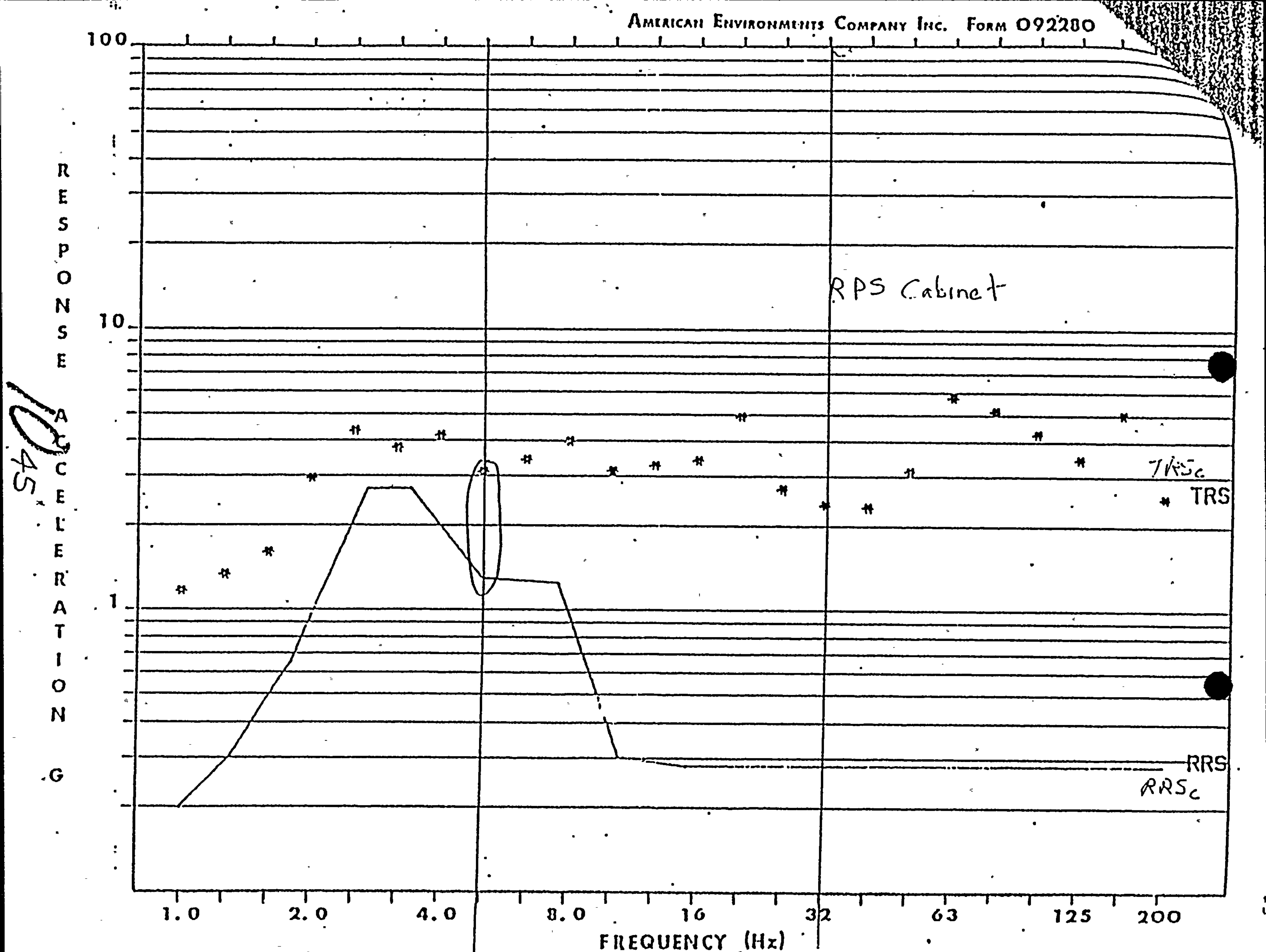
RUN NUMBER 12 TRS - HORIZONTAL FRONT TO BACK - SSE #12 Hor F/B



RUN NUMBER.. 12 TRS - VERTICAL - SSE #12



RUN NUMBER.. 6 TRS - HORIZONTAL SIDE TO SIDE - SSE #6



RUN NUMBER.. 6 TRS - VERTICAL - SSE #6

CALCULATION OF MINIMUM OVERTEST FACTORS (90%) FOR RPS CABINET

- step 2 of procedure -

1) Minimum $\frac{(TRS)}{(RRS)}$ of cabinet.

Hor (F/B) = $\frac{3.9}{1.5}$ = 2.60 at $8H_2$

Vert (F/B) = $\frac{3.5}{1.3}$ = 2.69 at $5H_2$

Hor (S/S) = $\frac{3.0}{1.5}$ = 2.0 at $6.3H_2$

Vert (S/S) = $\frac{3.1}{1.3}$ = 2.4 at $5H_2$

2) 90% Overtest Factors $(0.9 \frac{(TRS_c)}{(RRS_c)} + 0.1)$

Hor (F/B) = 0.9 (2.60) + 0.1 = **2.44**

Vert (F/B) = 0.9 (2.69) + 0.1 = **2.52**

Hor (S/S) = 0.9 (2.0) + 0.1 = **1.90**

Vert (S/S) = 0.9 (2.4) + 0.1 = **2.25**

$NIRRS_{mc}$

(Tabulated and Plotted with NI TRS_m)

- steps 3 & 4 of procedure -

TABULATED

NI RRS (RRS_m)

[Recalculated Data under arrows (RRS_{mc})]

Freq (Hz)	Note 1 H - F/B ( ) ÷ 2.44 =		Note 2 V - F/B ( ) ÷ 2.52 =		Note 3 H - S/S ( ) ÷ 1.90 =		Note 4 V - S/S ( ) ÷ 2.25 =	
1.0	2.7	1.1	2.9	1.2	2.9	1.5	2.4	1.1
1.28	3.3	1.4	3.1	1.2	3.1	1.6	2.8	1.2
1.6	4.9	2.0	4.0	1.6	3.2	1.7	3.7	1.6
2.0	4.0	1.6	4.2	1.7	6.0	3.2	4.2	1.9
2.5	7.7	3.2	6.7	2.7	6.2	3.3	9.2	4.1
3.2	7.9	3.2	7.4	2.9	10.7	5.6	8.4	3.7
4.0	8.3	3.4	8.7	3.5	11.0	5.8	7.0	3.1
5.0	7.9	3.2	6.9	2.7	8.4	4.4	5.6	2.5
6.3	7.7	3.2	8.4	3.3	8.2	4.3	7.5	3.3
8.0	8.0	3.3	8.2	3.3	8.5	4.5	9.0	4.0
10.0	8.0	3.3	11.0	4.4	6.3	3.3	11.0	4.9
12.5	8.0	3.3	9.2	3.7	6.0	3.2	11.0	4.9
16.0	5.7	2.3	7.5	3.0	5.0	2.6	8.0	3.6
20.0	4.6	1.9	5.8	2.3	6.0	3.2	8.0	3.6
25.0	5.2	2.1	6.2	2.5	5.9	3.1	5.9	2.6
32.0	4.6	1.9	5.0	2.0	4.5	2.4	5.8	2.6
40.0	3.7	1.5	4.2	1.7	4.4	2.3	4.8	2.1

NOTES:
(1) RRS composite of Run #12, channels 4, 14, 16, 23
(2) RRS composite of Run #12, channels 3, 15, 17, 24
(3) RRS composite of Run #6, channels 2, 14, 16, 23
(4) RRS composite of Run #6, channels 3, 15, 17, 24

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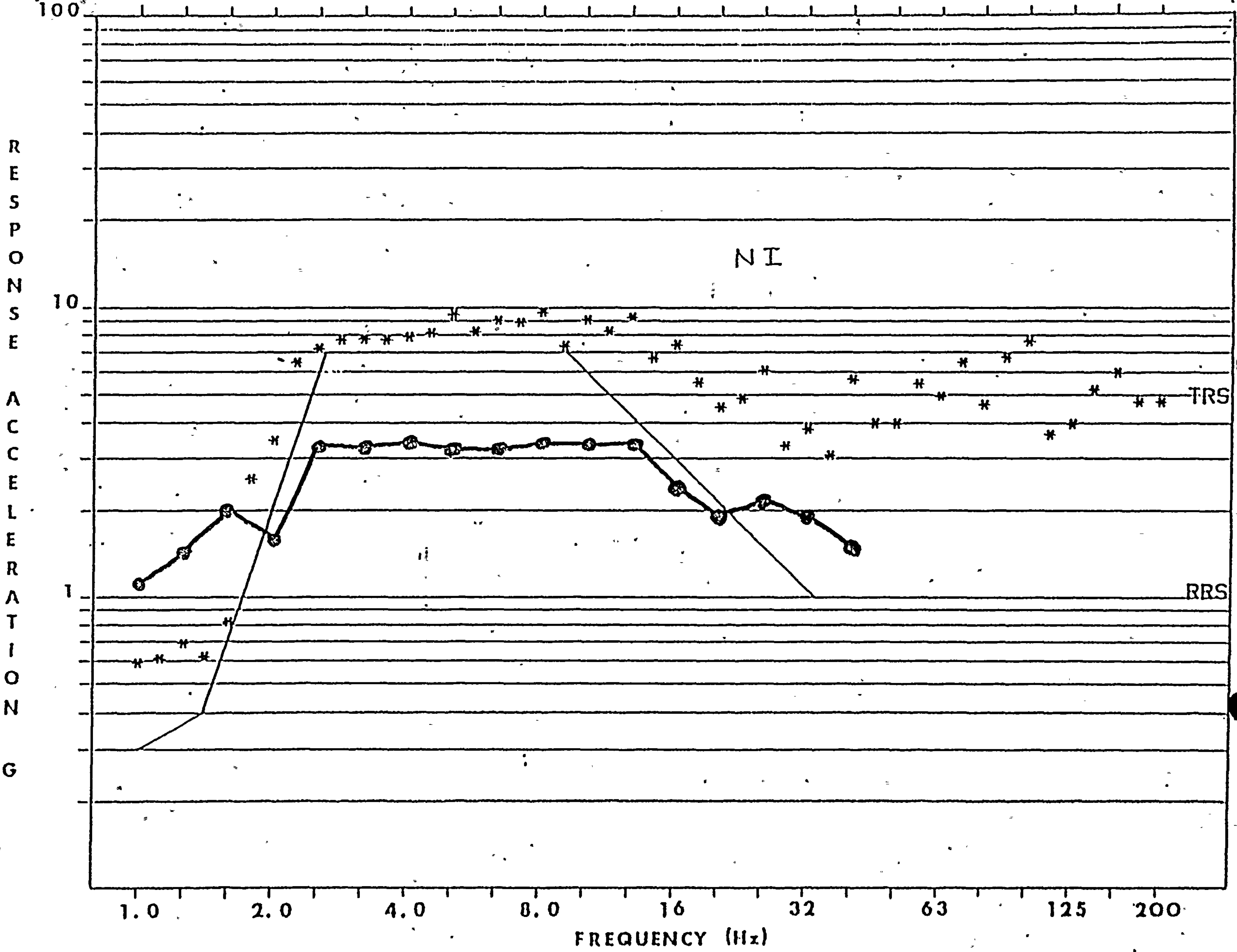

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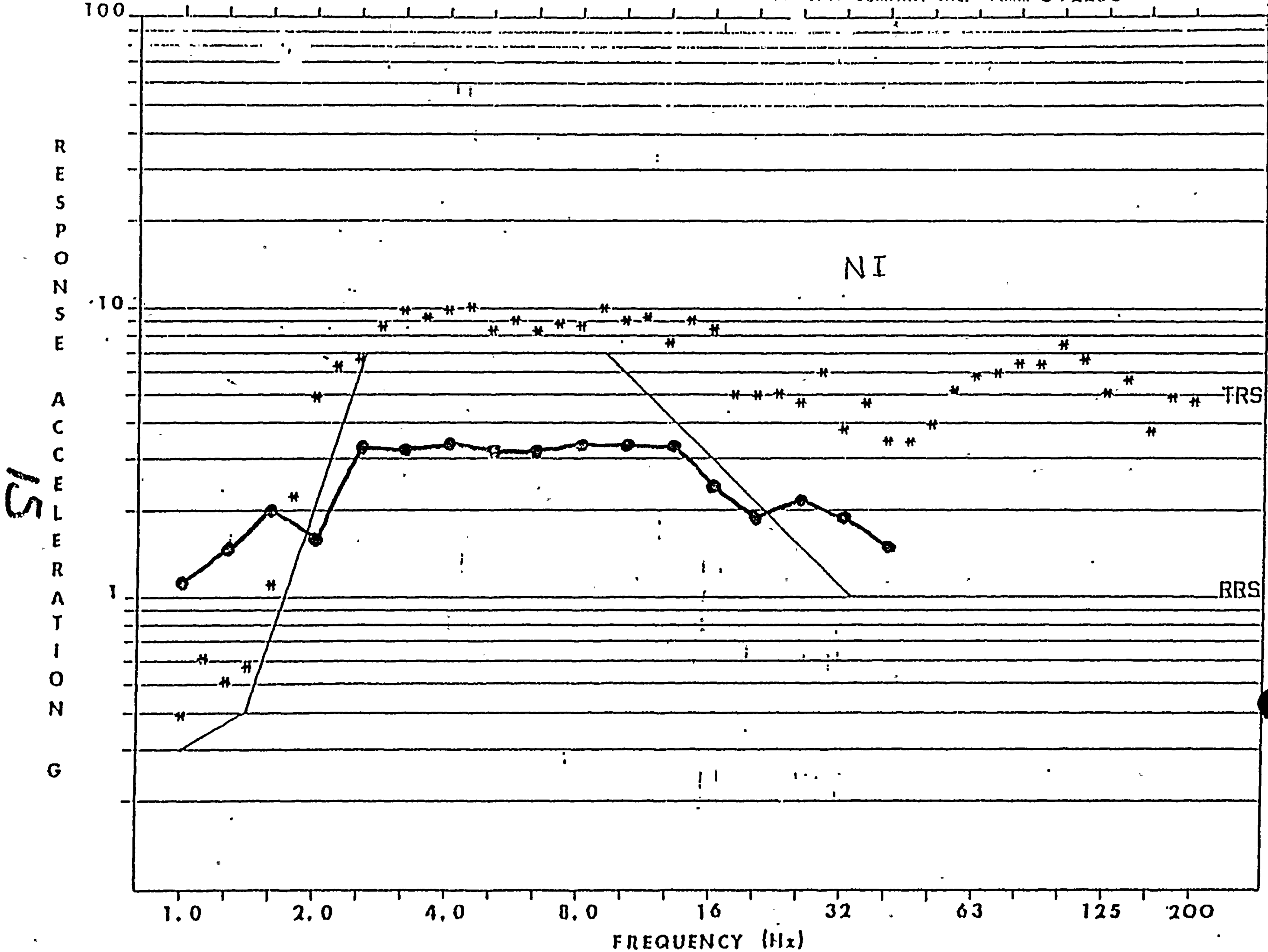
RUN NUMBER.. 6 TRS - HORIZONTAL (BIAXIAL PAIR NO. 1 IN-PHASE) SSE

CHANNEL NUMBER.. 1 1.0 % OF CRITICAL DAMPING

H1+
Hor F/B



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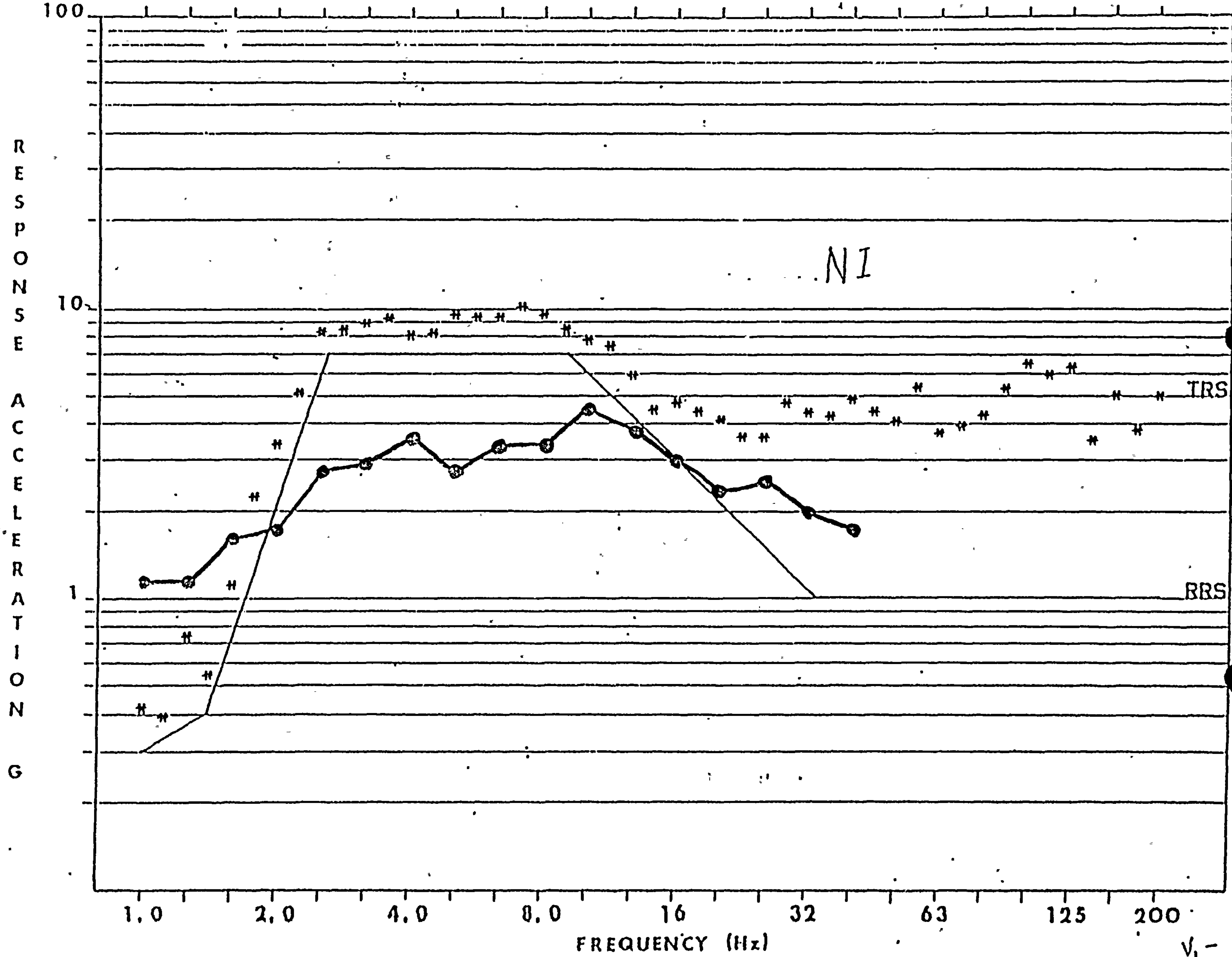
RUN N''MBER.. 12 TRS - HORIZONTAL (BIAXIAL..PAIR NO. 1 OUT-OF-PHASE) SSE

CHANL NUMBER 1 1.0 % OF [illegible]TICAL DAMPING

H₁- Hor F/B



RUN NUMBER.. 12   TRS - VERTICAL (BIAXIAL PAIR NO. 1 OUT-OF-PHASE) SSE

CHANNEL NUMBER.. 2   1.0 % OF CRITICAL DAMPING

V1 - Vert F/B

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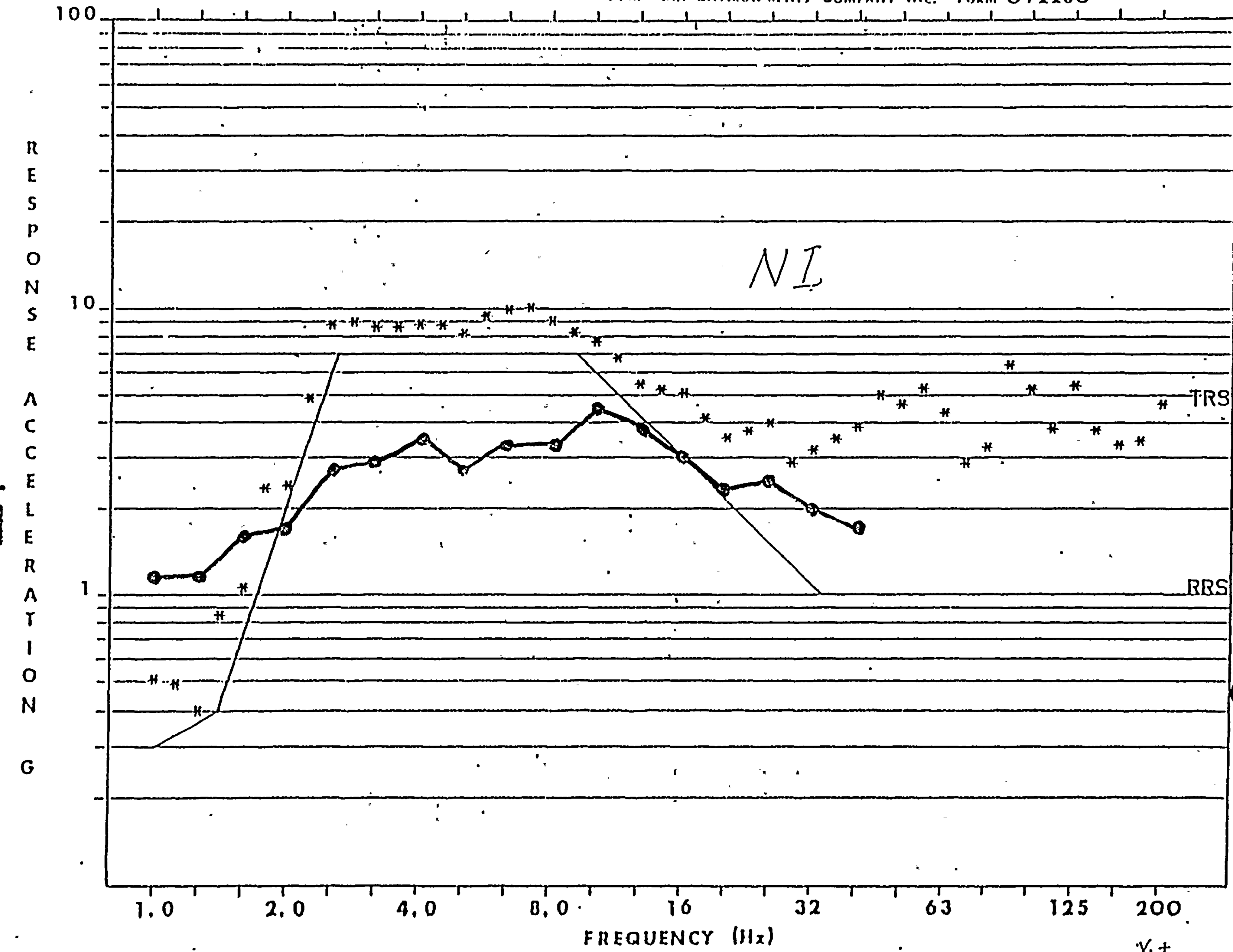

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RUN NUMBER.. 6 TRS - VERTICAL (BIAXIAL PAIR NO. 1 IN-PHASE) SSE

CHANNEL NUMBER 2 1.0 % OF CRITICAL DAMPING

Y1+

Vert F/B

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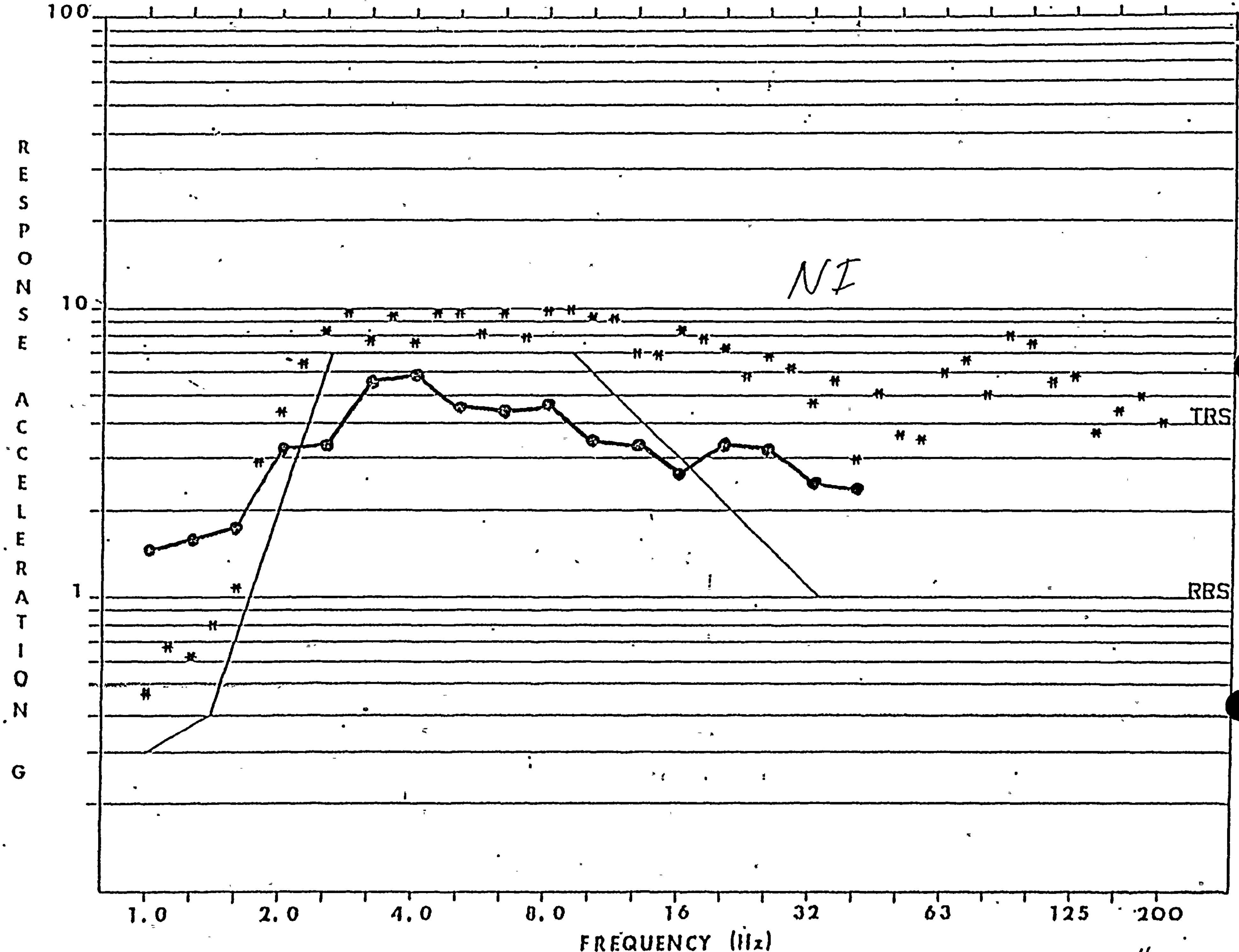

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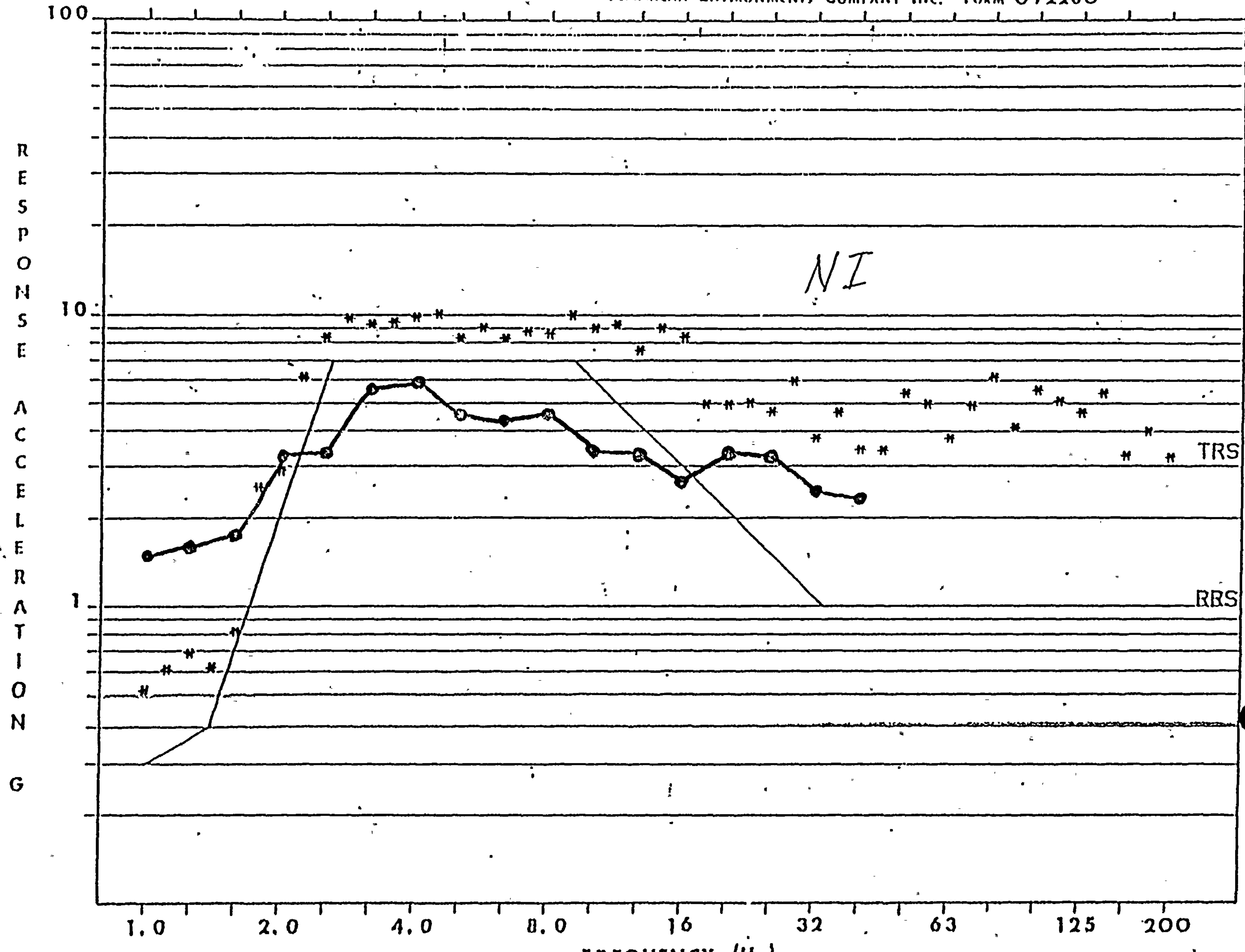
RUN NUMBER... 24 TRS - HORIZONTAL (BIAXIAL PAIR NO. 2 OUT-OF-PHASE) SSE

CHAN' NUMBER.. 1 1.0 % OF 'TICAL DAMPING

H_2 - Hor S/S



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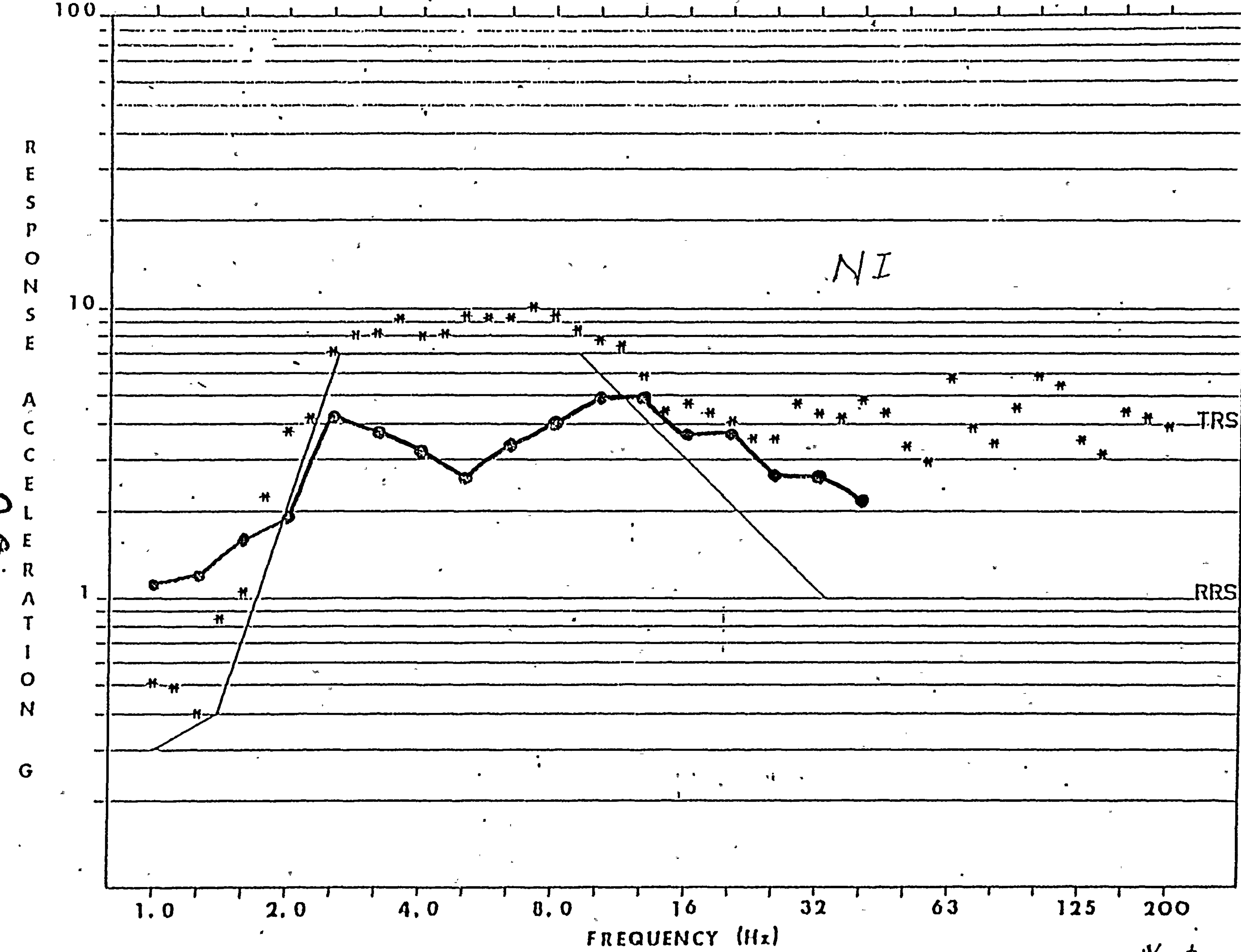
RUN NUMBER.. 18 TRS - HORIZONTAL (BIAXIAL PAIR NO. 2 IN-PHASE) SSE

CHANL NUMBER.. 1 1.0 % OF CRITICAL DAMPING

H_2+ Hor S/S



RUN NUMBER.. 18
CHANNEL NUMBER.. 2

TRS - VERTICAL (BIAXIAL PAIR NO. 2 IN-PHASE) SSE
1.0 % OF CRITICAL DAMPING

20

1/2 +
Vert S/S

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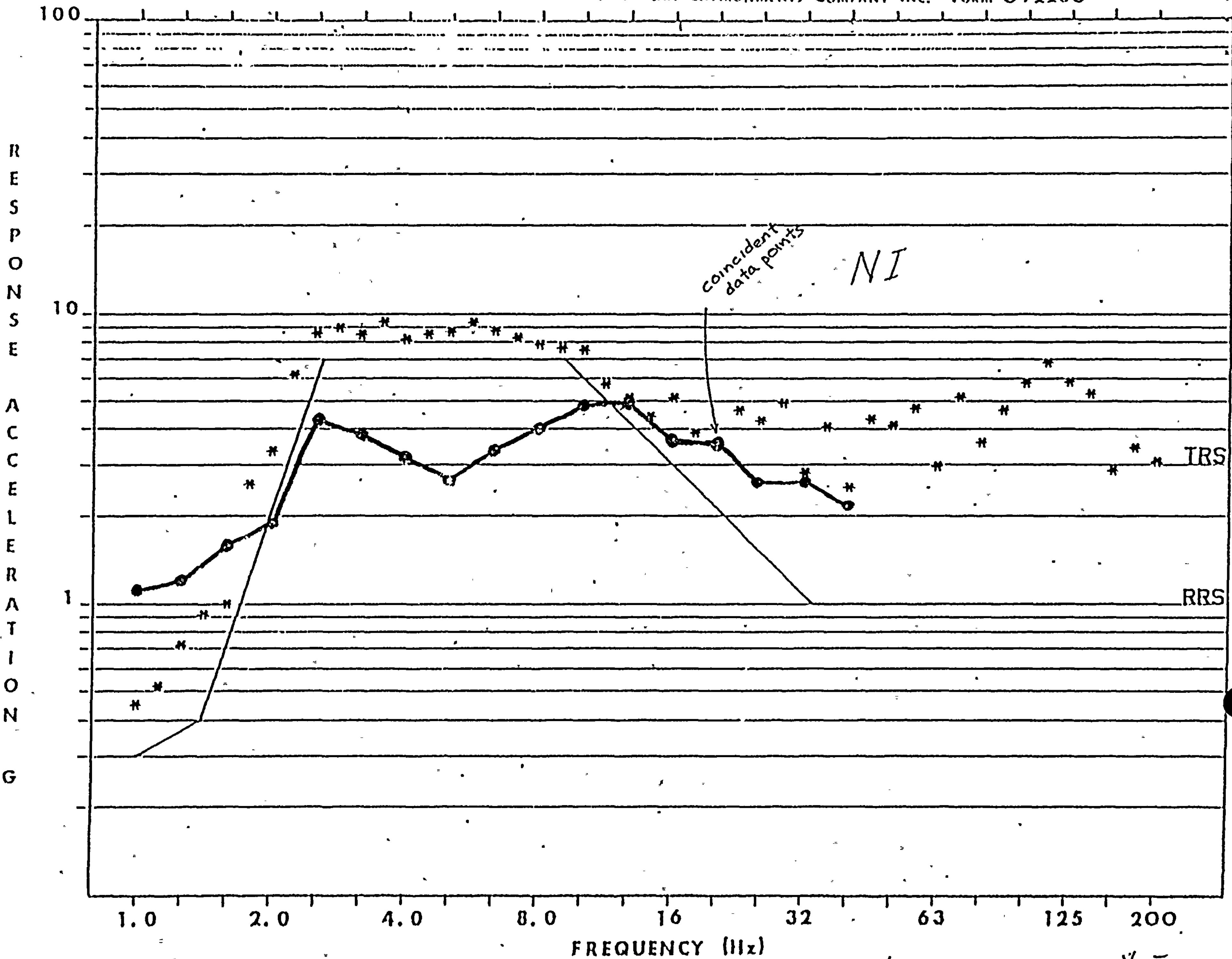

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RUN NUMBER.. 24 TRS - VERTICAL (BIAXIAL PAIR NO. 2 OUT-OF-PHASE) SSE

CHANNEL NUMBER.. 2 1.0 % OF CRITICAL DAMPING

V_2 - Vert S/S