SECOND SUPPLEMENT

TO

JUSTIFICATION OF MARK II LEAD PLANT

SRV LOAD DEFINITION

- EQUIPMENT EVALUATION -

September 28, 1979

STONE & WEBSTER

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1. INTRODUCTION

The report entitled "Justification of Mark II Lead Plant SRV Load Definition" submitted to the NRC on March 30, 1979 (SNRS-374) contains a demonstration of the conservatism present in the Ramshead Load Definition. That report along with additional information subsequently submitted (SNRC-396 May 30, 1979) clearly demonstrates that piping system response resulting from the Ramshead Load Definition is greater than response resulting from a conservatively constructed T-Quencher load definition. This supplemental report has been prepared in response to the NRC request for a similar demonstration specifically addressing reactor building equipment.

Before presenting the detailed results for equipment it is important to review briefly the primary conservatisms contained in the T-Quencher load definition used as the basis of comparison with the Ramshead Load Definition. They can be summarized briefly as follows:

1. Bubbles are assumed to enter the pool simultaneously.
2. Bubbles are assumed to oscillate in phase.
3. The predominant oscillation frequency is swept through a frequency range of 3 to 9 Hz with results throughout the range enveloped.
4. A pressure amplitude multiplier of 1.1 is applied to the actual test measured pressure traces.
5. Four discharge cases - all valves, ADS, asymmetric (3 adjacent valves), and single valve - are independently analyzed and results are enveloped.

The first four of these features have been emphasized previously while the importance of the fifth may not have been stressed. It causes the greatest symmetric and asymmetric results to be applied simultaneously. This conservatism is used as a design convenience for both piping and equipment such that results may be used in any SRV load combination.

On this basis a detailed study of equipment has been performed. Since the original report demonstrated that the only potential for the T-Quencher results to exceed Ramshead results is for components with low (less than

about 7 Hz) fundamental frequencies, this will be the area concentrated on herein. Equipment qualified both by analysis and by test is addressed in the following sections.

2. FLOOR MOUNTED EQUIPMENT

Before presenting details of the equipment evaluation, one important aspect of the qualification of equipment in the Shoreham plant should be pointed out. The original seismic qualification was based on equipment damping values lower (more conservative) than that required by NRC Regulatory Guide 1.61. Damping values of 1/2% and 1% were used for UPSET and FAULTED conditions respectively. This has resulted in a margin of safety in the low frequency range which is sufficient to cover the combined seismic and hydrodynamic results independent of the SRV discharge device.

For Mark II load evaluations the controlling UPSET and FAULTED condition load combinations used are N + SRV + OBE and N + SRV + LOCA + SSE respectively where N refers to normal operating loads and SRV is the envelope of all SRV discharge cases as stated previously. LOCA is also the envelope of all LOCA subevents - vent clearing, condensation oscillations, and chugging. Regulatory Guide 1.61 damping values of 2% and 4% respectively are used for all loads in each combination.

2.1 Qualification by Analysis

Mechanical equipment is requalified for Mark II loads by static analysis to equivalent dynamic loads (static coefficients) obtained from enveloping the dynamic responses of several representative equipment models. A static coefficient curve resulting from the dynamic analyses relates the equivalent static load on a component to the fundamental frequency of the component. The effects of the higher modes are thereby simply accounted for in subsequent evaluations. This method as applied to seismic analysis has been described in the Shoreham FSAR (section 3.7.3.5.1A) and as extended for Mark II loads in the Shoreham DAR (section 9.1.2.3.3).

Static coefficient curves for UPSET and FAULTED conditions have been redeveloped using the T-Quencher load definition and are presented in Figures 1 and 2 for the primary containment and in Figures 3 and 4 for the secondary containment. The T-Quencher based static coefficients exceed the Ramshead based coefficients only for primary containment equipment with a fundamental frequency below about 3 Hz. The reason that the exceedance does not occur through the range of approximately 2 to 7 Hz where T-Quencher ARS exceed Ramshead ARS is the same reason that applies for piping systems. That is, the fundamental mode is not the sole contributor to the total stress in any component. Higher modes where the Ramshead response exceeds the T-Quencher response also contribute, thereby offsetting the effect of the fundamental mode. The reason that there can be some net exceedance for equipment is that typical pieces of equipment are less complex dynamic systems than piping systems are. Therefore, the fundamental mode may be relatively more important than it is for piping.

A review of Shoreham reactor building (primary and secondary containment) equipment indicates that there are no components which fall into this special situation where T-Quencher results could exceed those from the Ramshead. There is no floor mounted equipment with a fundamental frequency less than 3 Hz located in the primary containment and qualified by analysis. Equipment in the primary containment includes cable tray, conduit, and duct systems as well as excess flow check valves. All of these components have fundamental frequencies greater than 10 Hz. For floor mounted equipment in the secondary containment, the Ramshead results bound T-Quencher results for all frequencies.

Furthermore, as stated earlier, any reactor building equipment in this low frequency range would be designed to higher static coefficients corresponding to lower seismic damping values. The level of the original design curves in this frequency range is shown in

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Figures 5 and 6 for the primary containment. The same relationship is true in the secondary containment. As can be seen in Figures 5 and 6 there is a sufficient margin of safety in the low frequency range of the original design curve to cover the effects of either the Ramshead or T-Quencher discharge device.

2.2 Qualification by Test

Class 1E floor-mounted electrical equipment in the secondary containment is qualified by test at the assembly level (rack, panel, etc.) if possible or by a combination of device (relay, switch, etc.) testing with analysis to obtain the loads acting in the device mounting base. The very small amount of 1E floor-mounted electrical equipment in the primary containment is qualified by single frequency testing.

Input loading for testing is quantified from the required response spectrum (RRS) corresponding to the location of the equipment. For single frequency testing, the peak input acceleration must be equal to or greater than the acceleration at the high frequency end of the spectra, that is, the zero period acceleration (ZPA). Inspection shows the ZPA of the ramshead spectra always to be larger than that of the T-Quencher spectra. For multifrequency testing, the input acceleration time history must be shaped so that its response spectra, the test response spectra (TRS), envelopes the RRS between the equipment fundamental frequency and the ZPA asymptote. The means of developing the TRS is such that its magnitude over the entire frequency range is governed by the low frequency peaks.

This is demonstrated in Figures 7 and 8 for the lowest frequency (4 Hz) component in the secondary containment by multifrequency testing. As can be seen, the TRS developed to encompass the original seismic peaks provides ample conservatism to cover all Mark II loads above 4 Hz, independent of the SRV discharge device.

It is thus shown that the ramshead spectra is bounding for the qualification by test of Class 1E floor-mounted electric equipment in the reactor building.

3. PIPE MOUNTED EQUIPMENT

The response of pipe mounted equipment to seismic and hydrodynamic loads is determined by the dynamic response of the piping system (which includes the equipment component). This has been addressed in detail in the original report and in the additional information submitted specifically addressing low frequency piping systems. The conclusions reached there for the piping systems are inherently true for pipe mounted equipment as for any component of the piping system. Specifically, since the piping system response is contributed to by a large number of modes, the higher T-Quencher response at a few low frequency modes is not sufficient to cause the total stress from the T-Quencher loads to exceed the total stress from the Ramshead loads.

4. CONCLUSION

This supplement to the original SRV Ramshead Load Definition Justification report has specifically addressed the relative effects of Ramshead versus T-Quencher loads on reactor building equipment. The same trends that were found in the piping evaluation are also found for equipment. The predominant effect on both is an increasing relative importance of T-Quencher loads with decreasing fundamental frequency of the component. For piping it was shown that for low frequency systems even though the T-Quencher became relatively more important, the Ramshead was still bounding. For equipment it has been shown herein that for the special situation of floor mounted equipment with a fundamental frequency less than 3 Hz located in the primary containment and qualified by analysis the T-Quencher results could exceed Ramshead results. However, Shoreham has no equipment components in this situation and furthermore, low frequency equipment in general has been designed to conservative seismic loads which bound both Ramshead and T-Quencher results.

On this basis it is considered to be evident that all reactor building equipment requalified to Mark II loads including the SRV Ramshead Load Definition will be able to sustain the effects resulting from SRV discharge with a T-Quencher device. This has been demonstrated herein using several conservative assumptions on the nature of the T-Quencher load.

POOR ORIGINAL

K•E SEMI-LOGARITHMIC • 2 CYCLES X 70 DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A. 46 4976

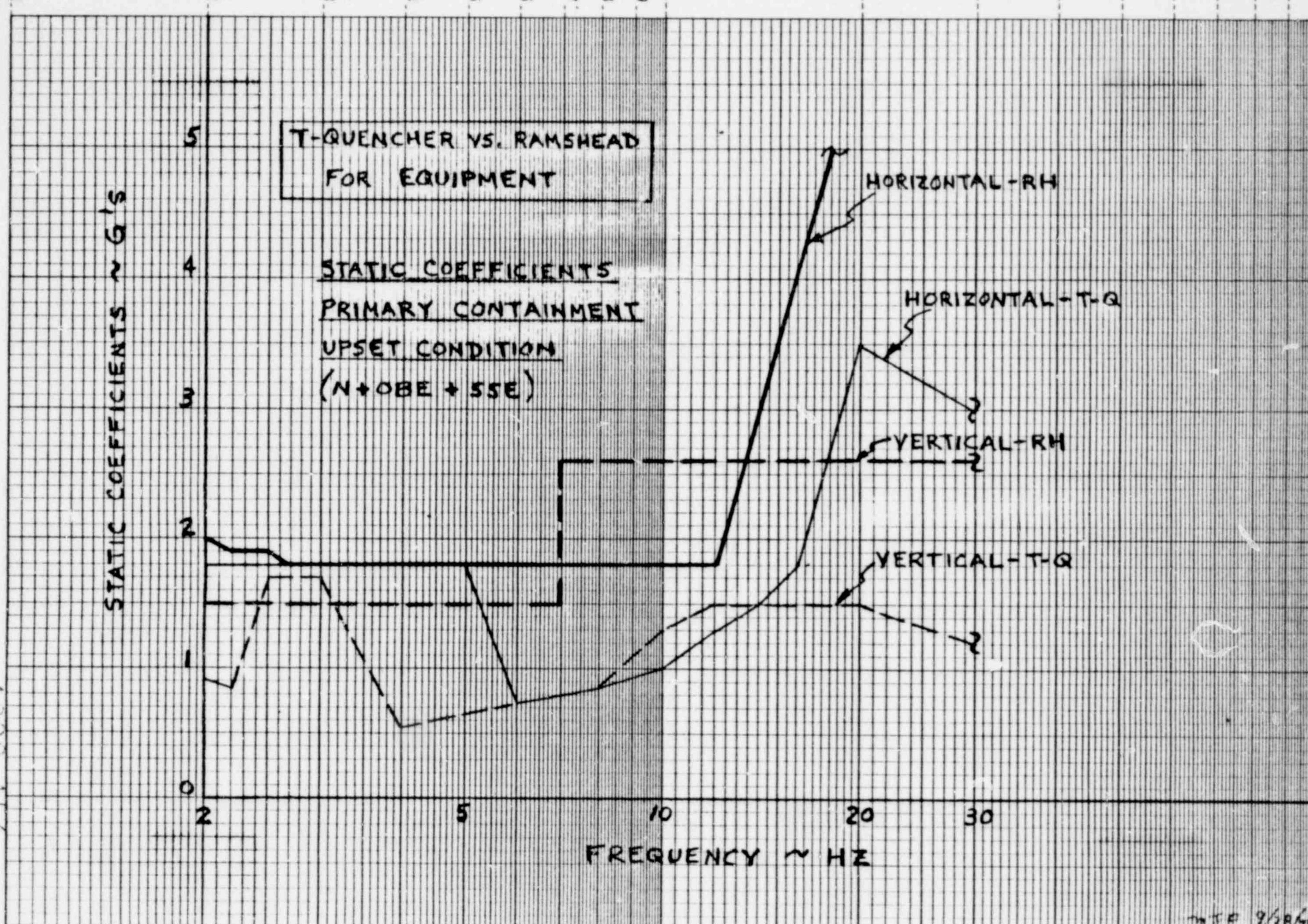

FIGURE 1

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K•E SEMI-LOGARITHMIC • 2 CYCLES X 70 DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A.

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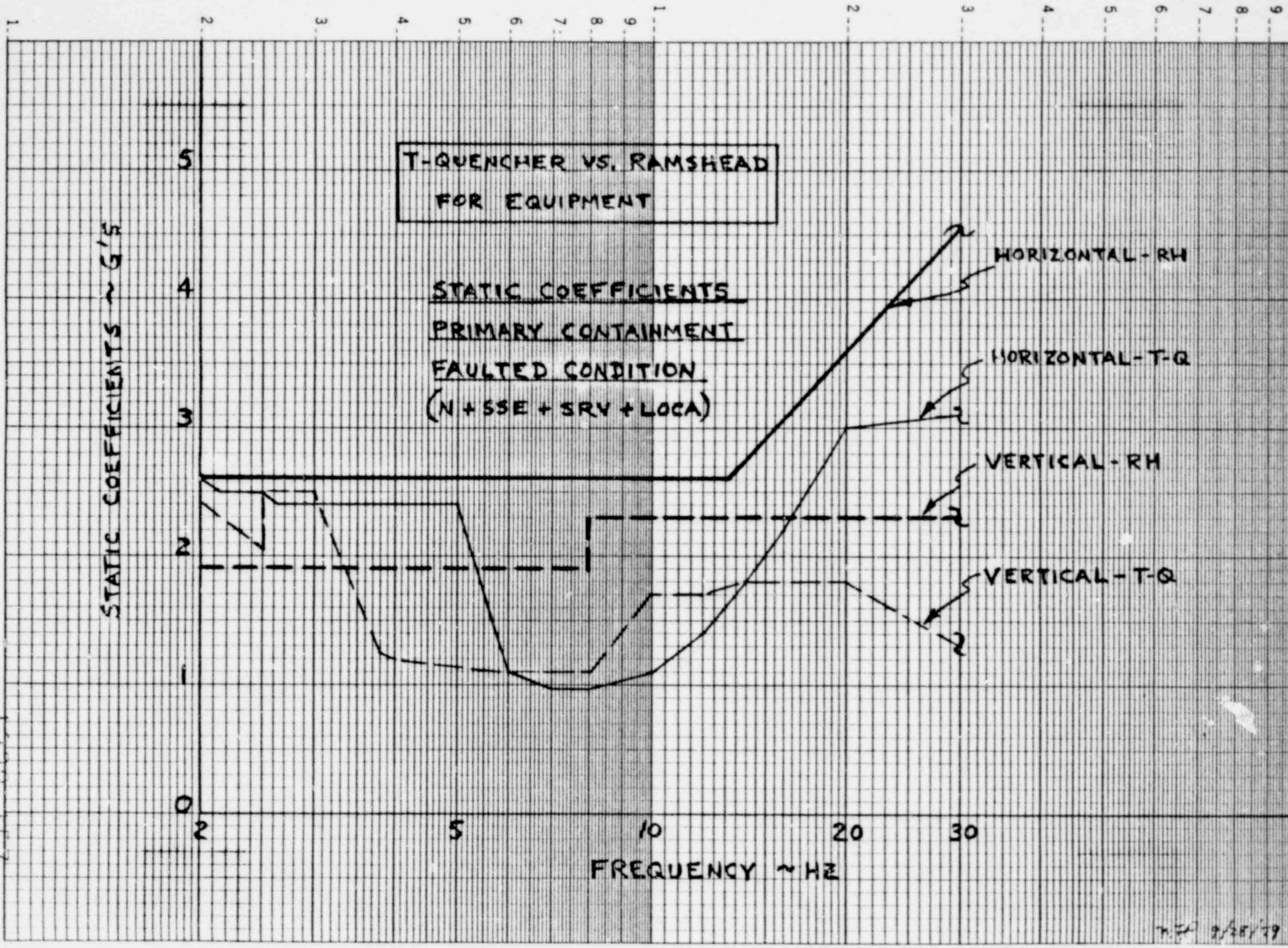

FIGURE 2

K·E SEMI-LOGARITHMIC • 2 CYCLES X 70 DIVISIONS
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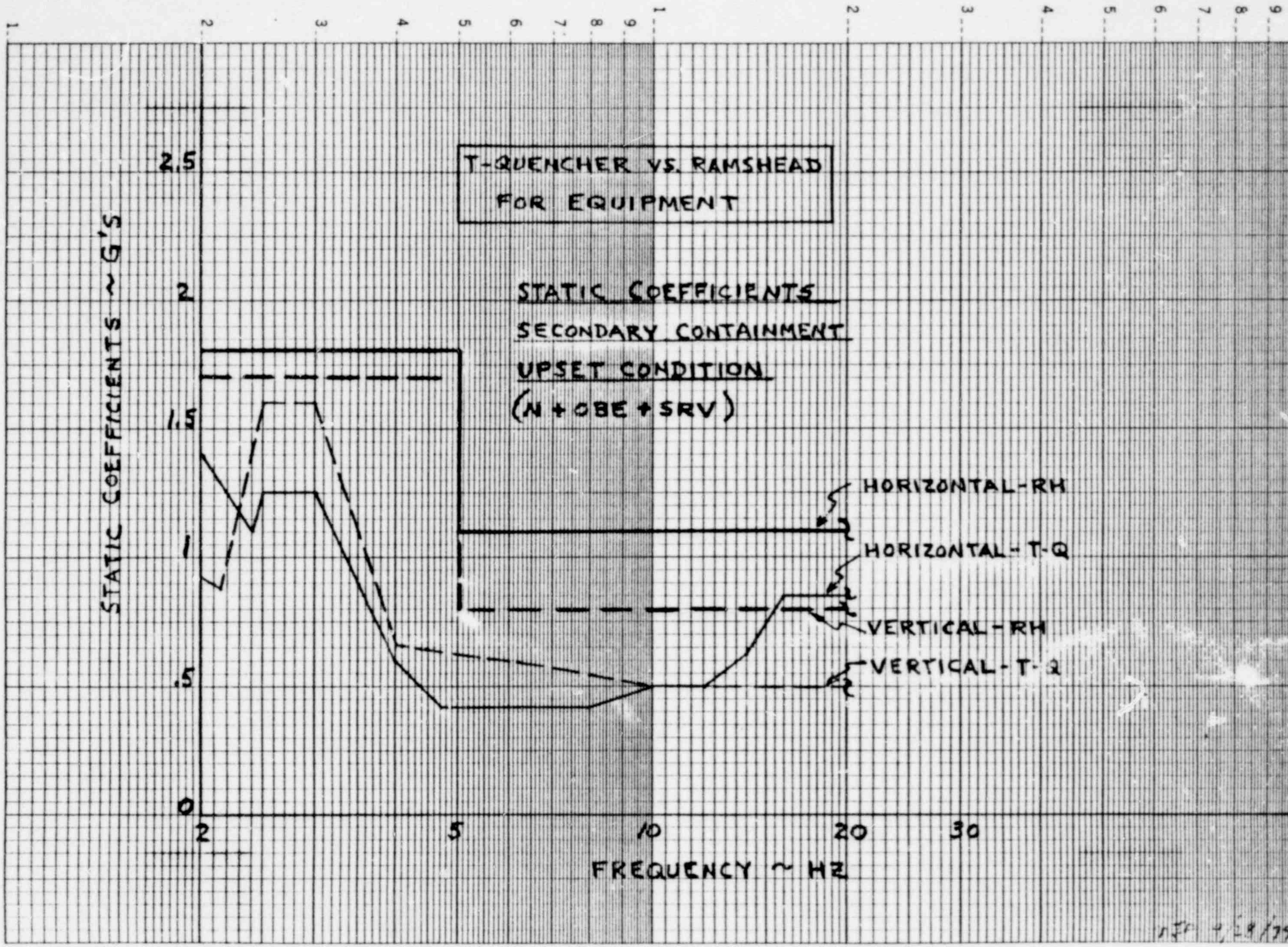

FIGURE 3

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K•E SEMI-LOGARITHMIC • 2 CYCLES X 70 DIVISIONS
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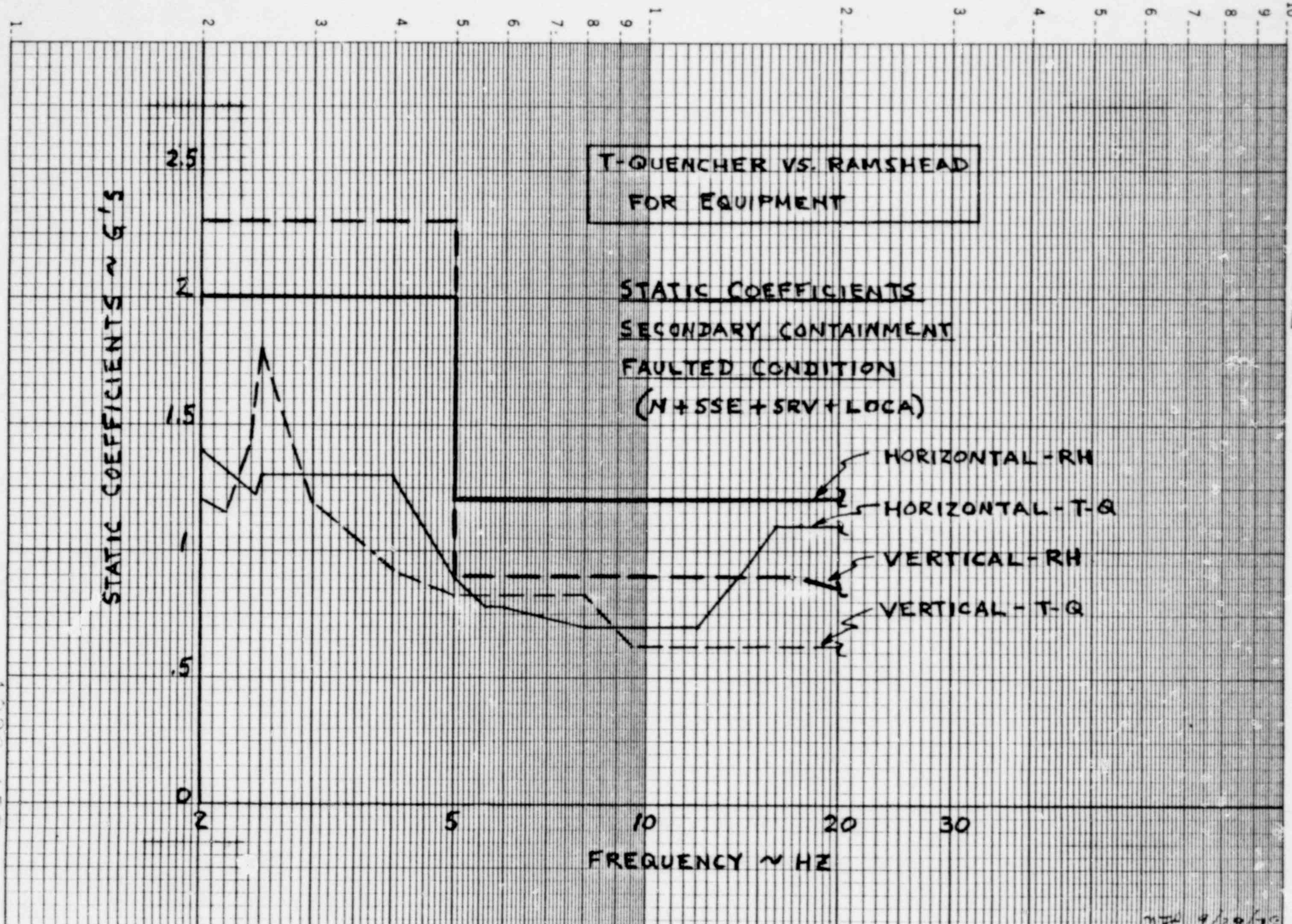

FIGURE 4

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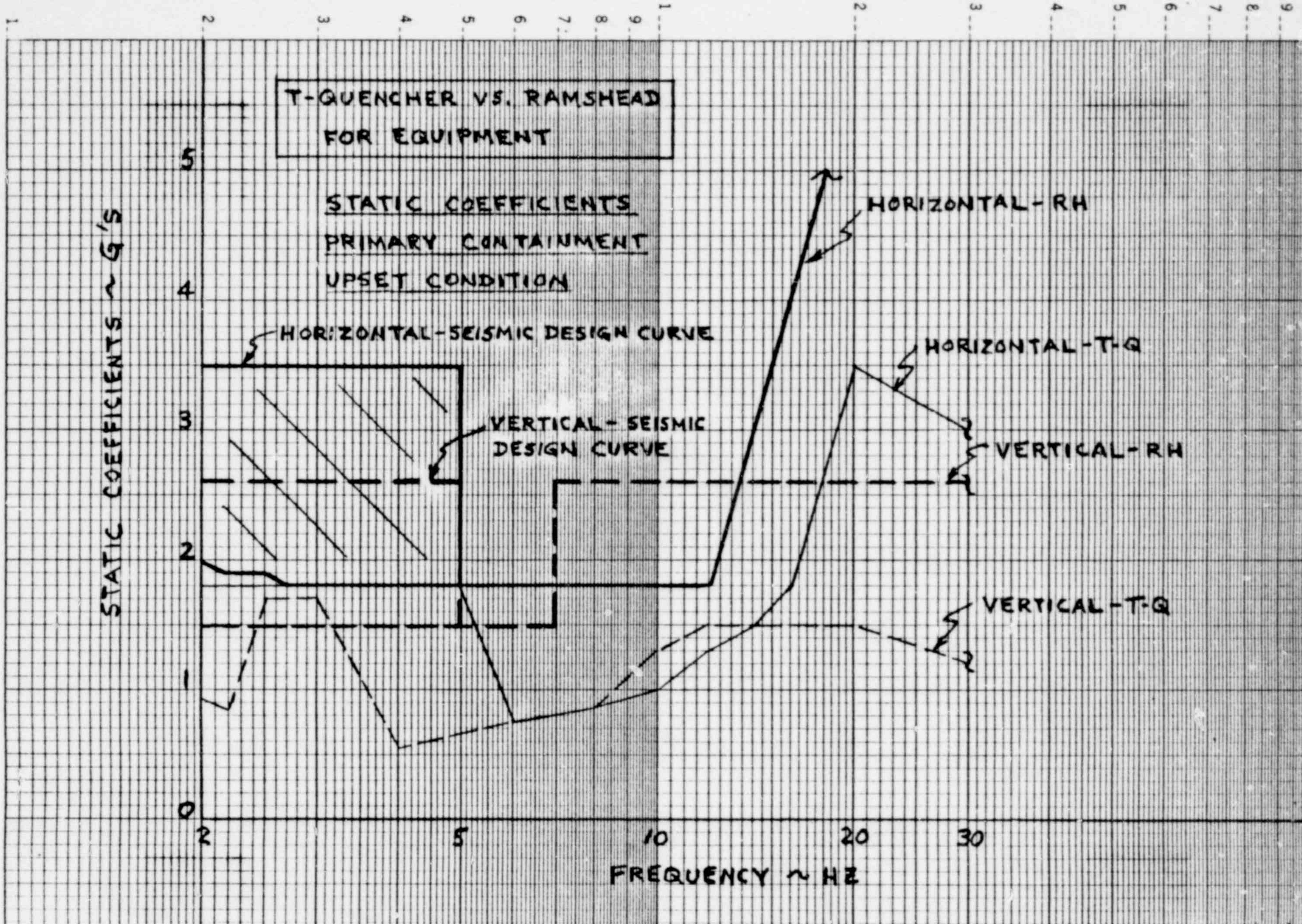

FIGURE 5

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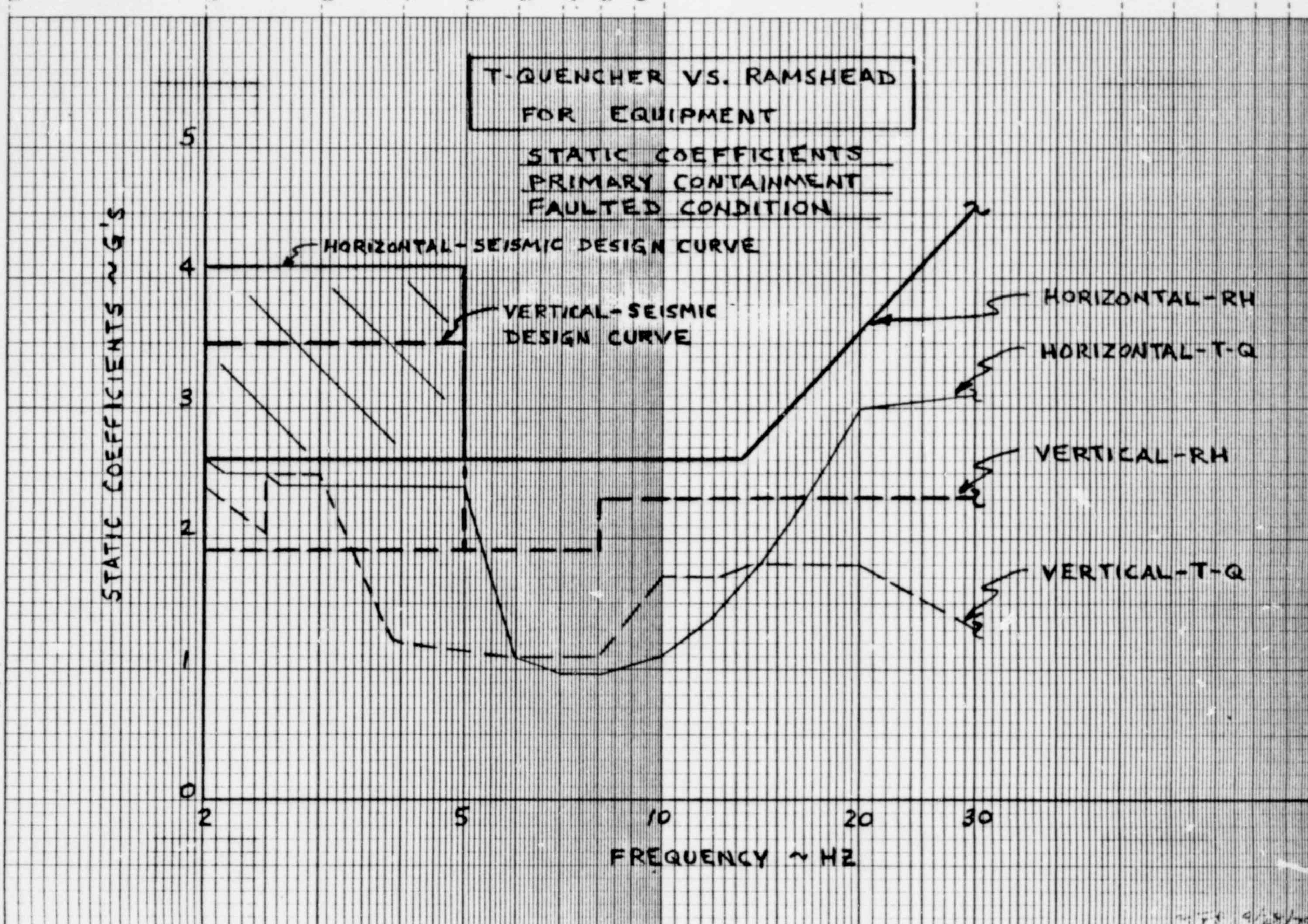

FIGURE 6

K·E LOGARITHMIC 2 X 3 CYCLES KEUFFEL & ESSER CO. MADE IN U.S.A.   46 7320

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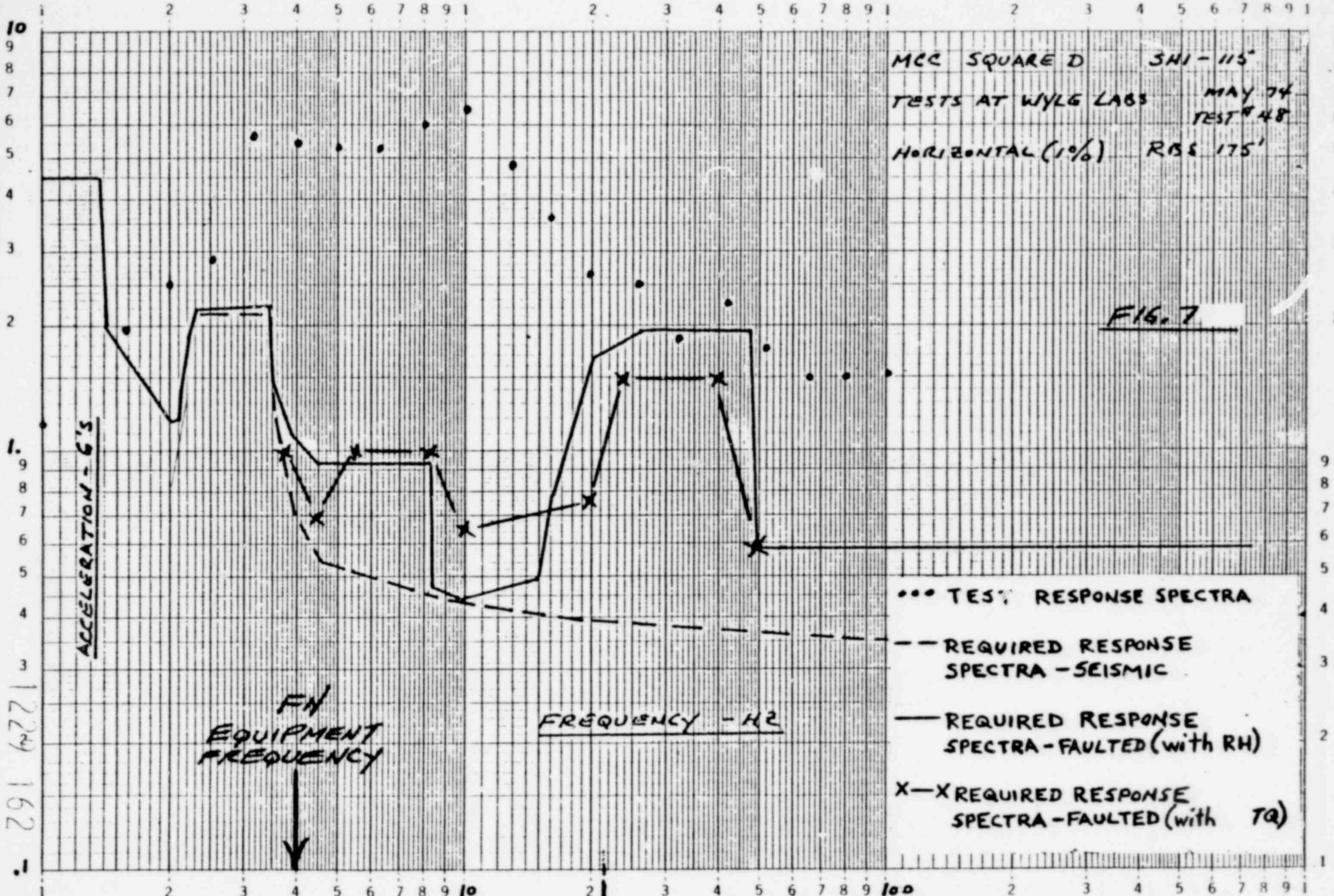

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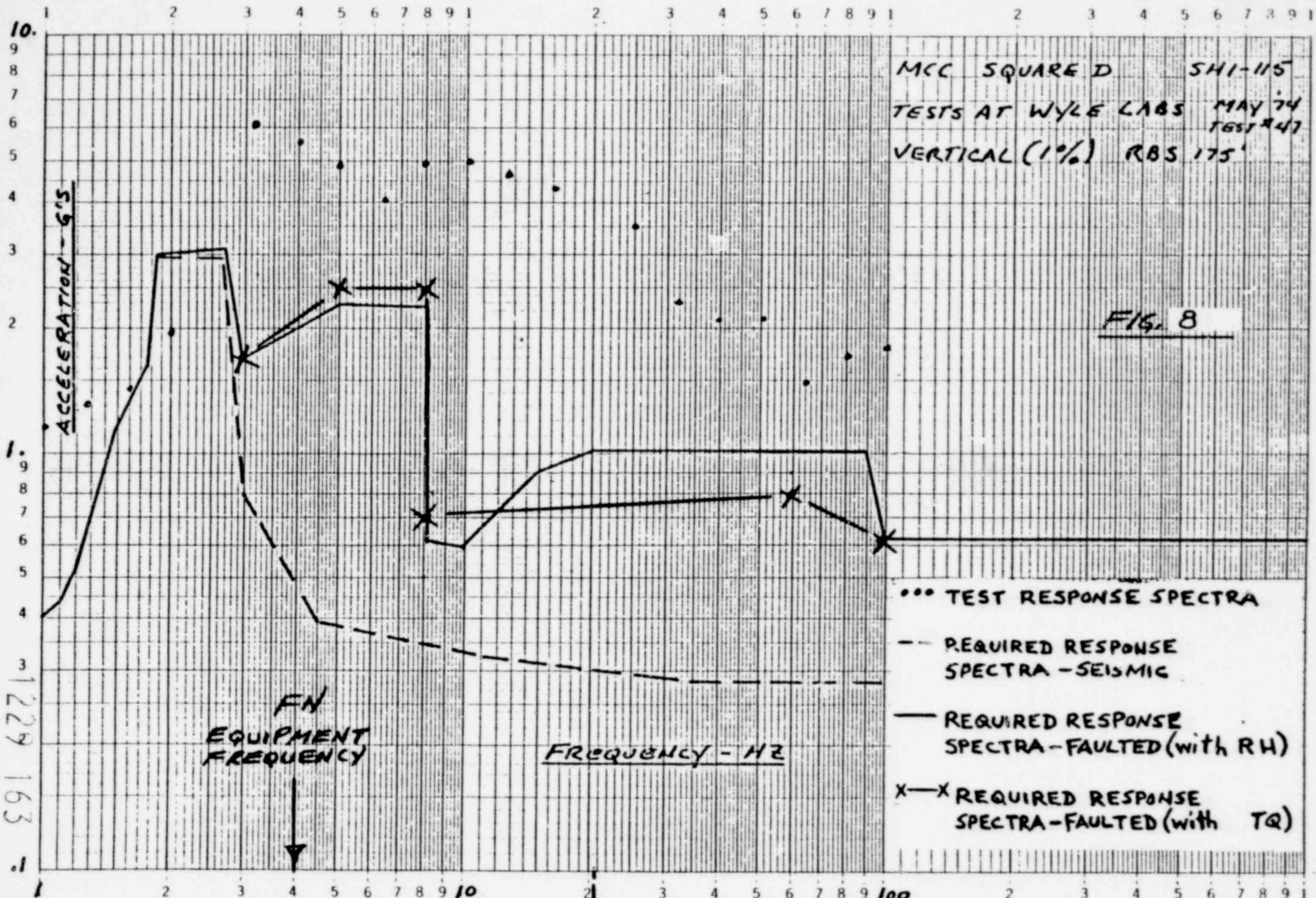

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