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SHIELDING EFFECTIVENESS MEASUREMENT OF THE
SCI SHIELDED ENCLOSURE

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Test and Evaluation Directorate
Research, Development, and Engineering Center

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The attenuation of the SCI shielded enclosure used to perform Electromagnetic Interference Tests in plant was measured using the two antenna methods outlined in MIL-STD-285. The measurement frequency band was 100 kHz to 200 MHz.						
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I. INTRODUCTION

SCI Systems is one of the largest manufacturers of electronic and computer systems in Huntsville. They produce everything from electronic subassemblies to complete electronics systems for commercial industry, NASA, and the military. The products produced by SCI frequently must be qualified to perform properly in various electromagnetic environments as specified in MIL-STD-461, NASA specification MSFC-521A, and special system specifications for the particular system being produced. In order to produce these environments without disturbing adjacent sensitive electrical equipment, SCI procured a metallic wall-shielded enclosure. This report provides a measurement of the shielding effectiveness of the enclosure as a function of frequency.

II. OBJECTIVE

The main objective of this test was to characterize the shielding effectiveness of the SCI shielded enclosure as a function of frequency. A related objective was to determine the entry path for unknown signals found during testing.

III. TEST PROCEDURE

Figure 1 shows a block diagram of the instrumentation configuration. Figure 2 contains a list of the equipment used during the test.

The test apparatus was first calibrated by using the following procedure: 1) the source output level was set at 0 dBm, 2) the source output signal was fed to a rf amplifier for the appropriate frequency band, 3) the output of the amplifier was fed to an LP 105 loop antenna, 4) an identical LP 105 was positioned 24 inches away and the antennas were oriented so that the planes of the loops were aligned, 5) the output from the receiving antenna was fed to a Hewlett-Packard 8568 spectrum analyzer, 6) the source was allowed to sweep the frequency band of interest and the output voltage of the receiving antenna as a function of time was recorded using the peak hold function of the spectrum analyzer, and 7) the recorded information was then used as a reference for the attenuation measurements.

The vertical seams of the enclosure were then numbered starting with the seam directly to the right of the northeast corner (to the left of the door), proceeding to the right until all seams were included. The transmitting antenna was placed inside the enclosure 12 inches from the seam under test. The receiving antenna was placed outside the enclosure 12 inches from the seam at the same height as the transmitting antenna. Low noise amplifiers, with a known gain, were installed in the line between the receiving antenna and spectrum analyzer to increase the measurement systems dynamic range. The source was set for an output level of 0 dBm and set to sweep through the measurement band. The analyzer was set to sweep in peak hold mode, and the received emissions were recorded using a desktop computer. The data was then compared to the reference plot recorded during the calibrations and the shielding effectiveness calculated from the difference in the calibrations and measurement data.

This procedure was repeated using biconic dipoles to cover the 30 to 200 MHz frequency band.

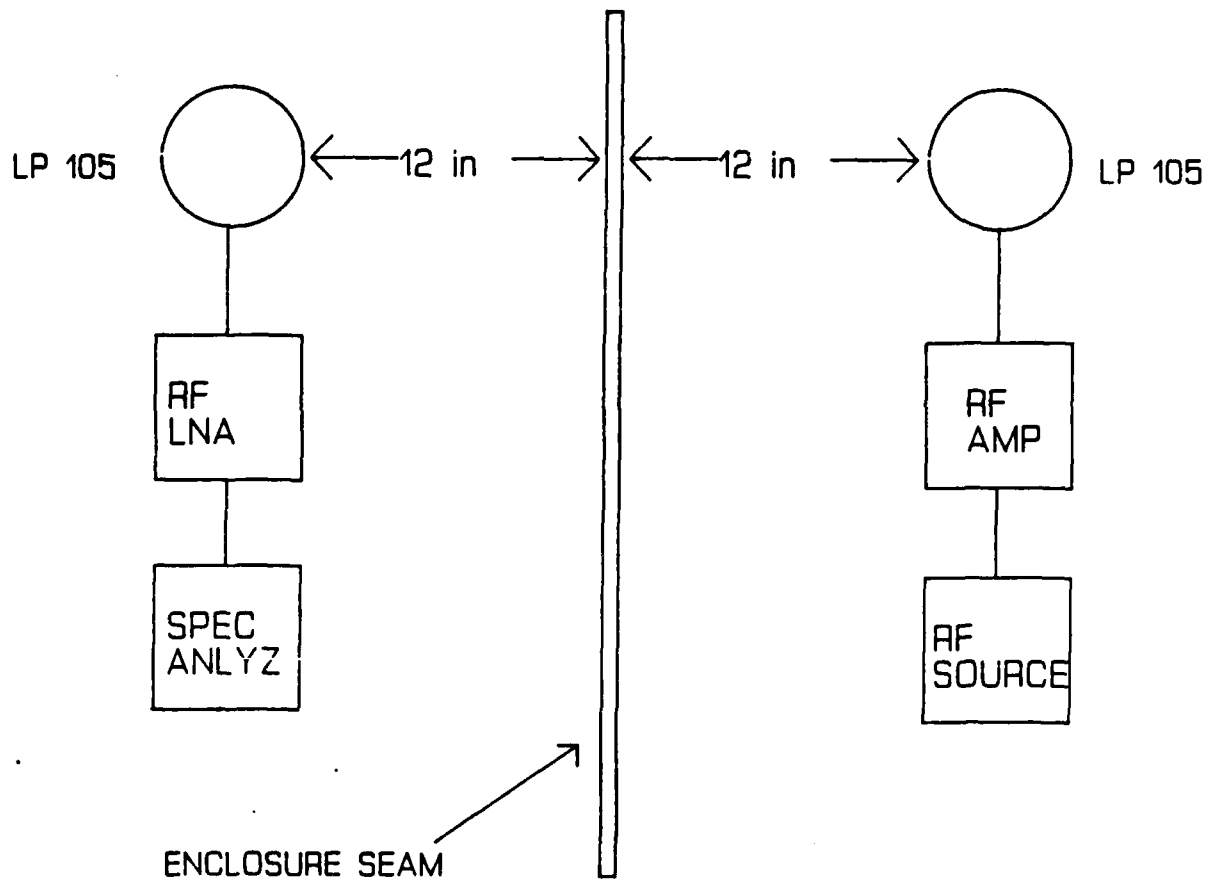


Figure 1. Test equipment configuration.

<u>Nomenclature</u>	<u>Manufacturer/model</u>	<u>Serial Number</u>	<u>Cal Date</u>
Spectrum Analyzer	HP 8566A	2115A00841	16 Feb 87
Computer	HP 9825T	1547A02233	CNR
Plotter	HP 9872A	1810A01764	CNR
Flexible Disk	HP 9885M	1628A08894	CNR
Low Noise Amplifier	HP 8447D	1644A00809	CNR
Low Noise Amplifier	HP 8447E	1644A00574	CNR
RF Amplifier	ENI 320L	105	CNR
RF Amplifier	ENI 502	311	CNR
Synthesizer	HP 8660C	1723A01200	CNR
RF Plug In	HP 86601A	1633A00711	CNR
RF Plug In	HP 86603A	2341A01200	CNR
Loop Antenna	Empire LP 105	NSN	CNR
Loop Antenna	Empire LP 105	NSN	CNR
Biconic Dipole	Emco 3104	2324	CNR
Biconic Dipole	Emco 3108	2068	CNR

Figure 2. Shielding effectiveness test equipment list.

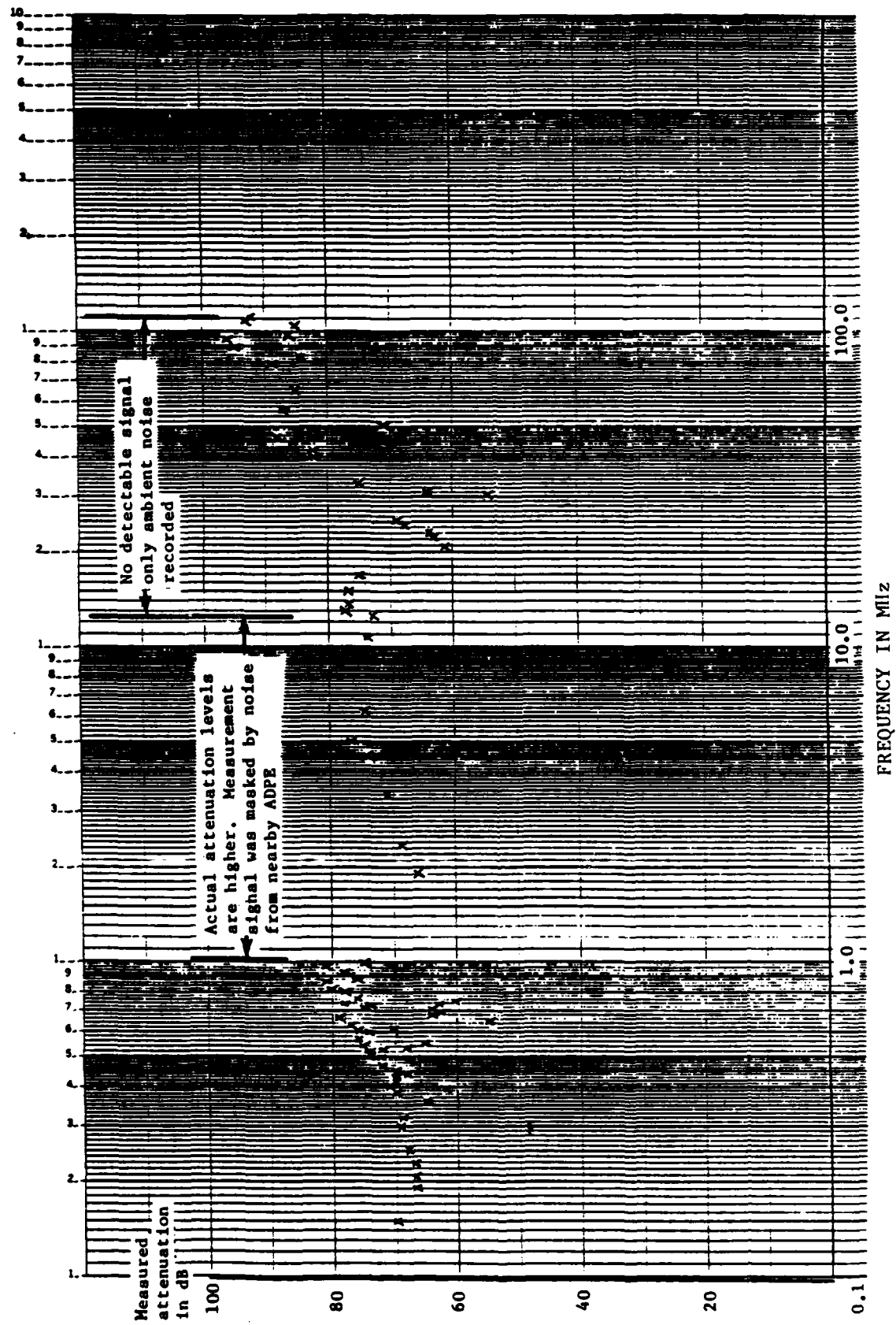


Figure 3. Measured attenuation vs frequency - seam 1.

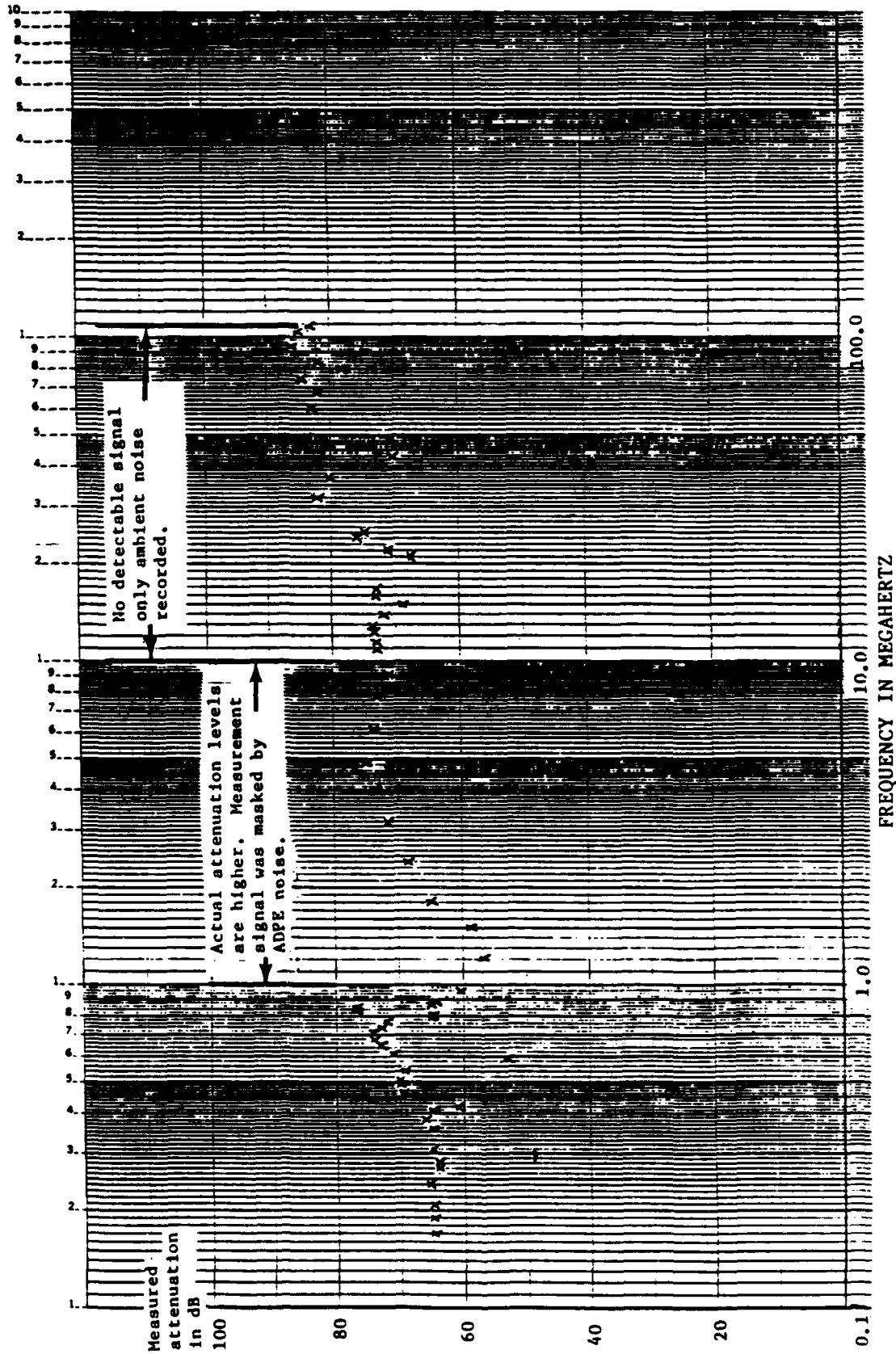


Figure 4. Measured attenuation vs frequency - seam 2.

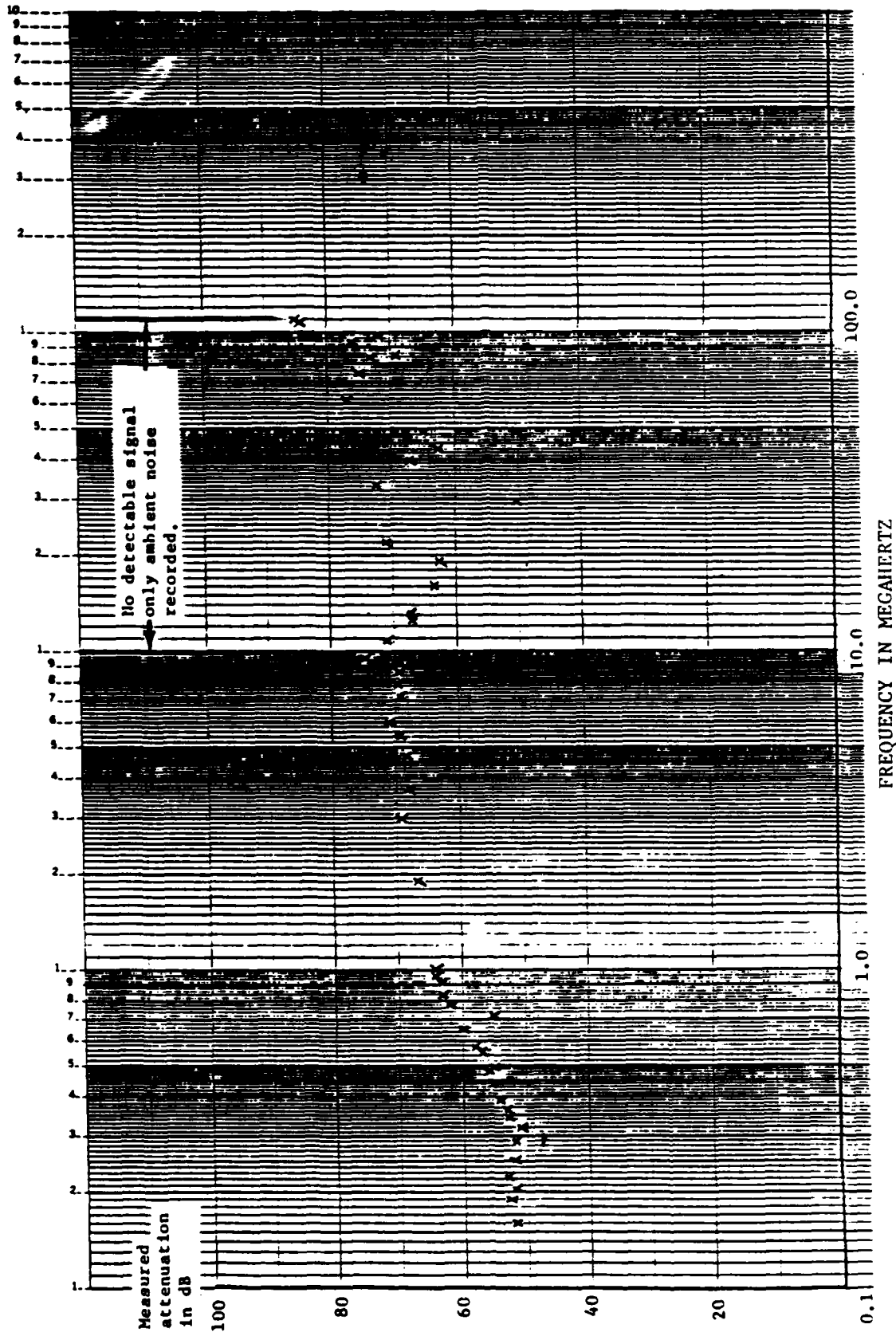


Figure 5. Measured attenuation vs frequency - seam 3.

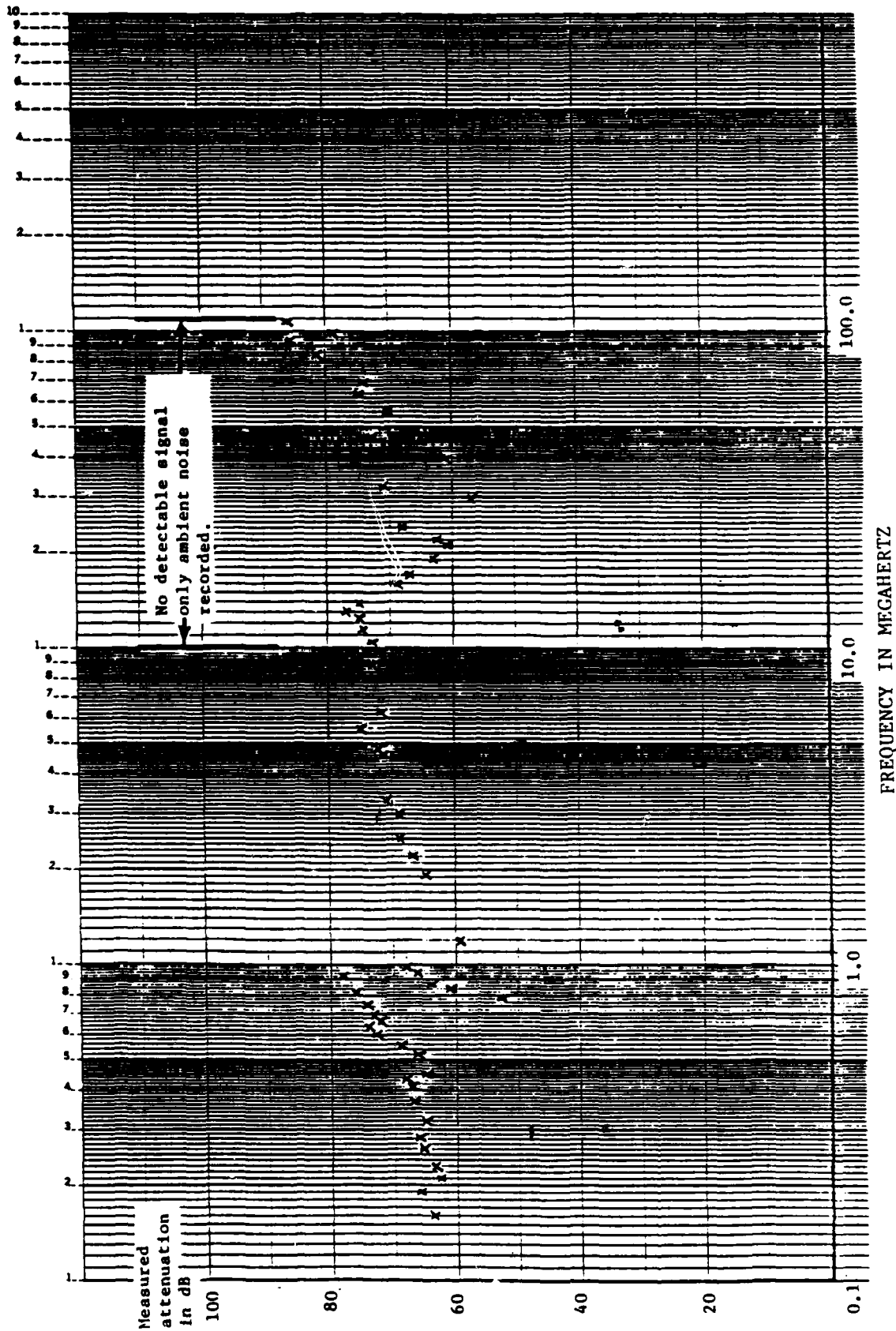


Figure 6. Measured attenuation vs frequency - seam 4.

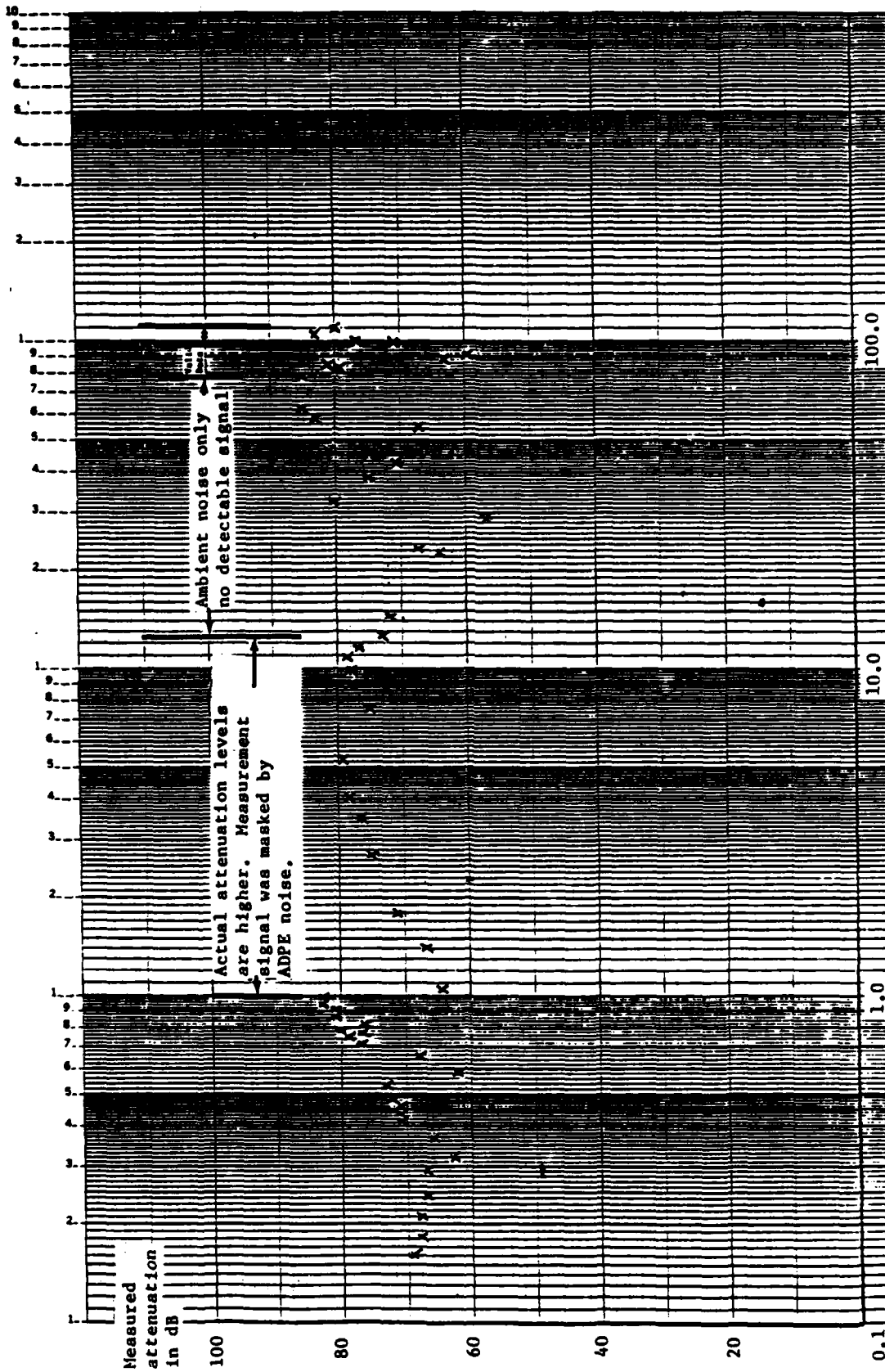


Figure 7. Measured attenuation vs frequency - seam 5.

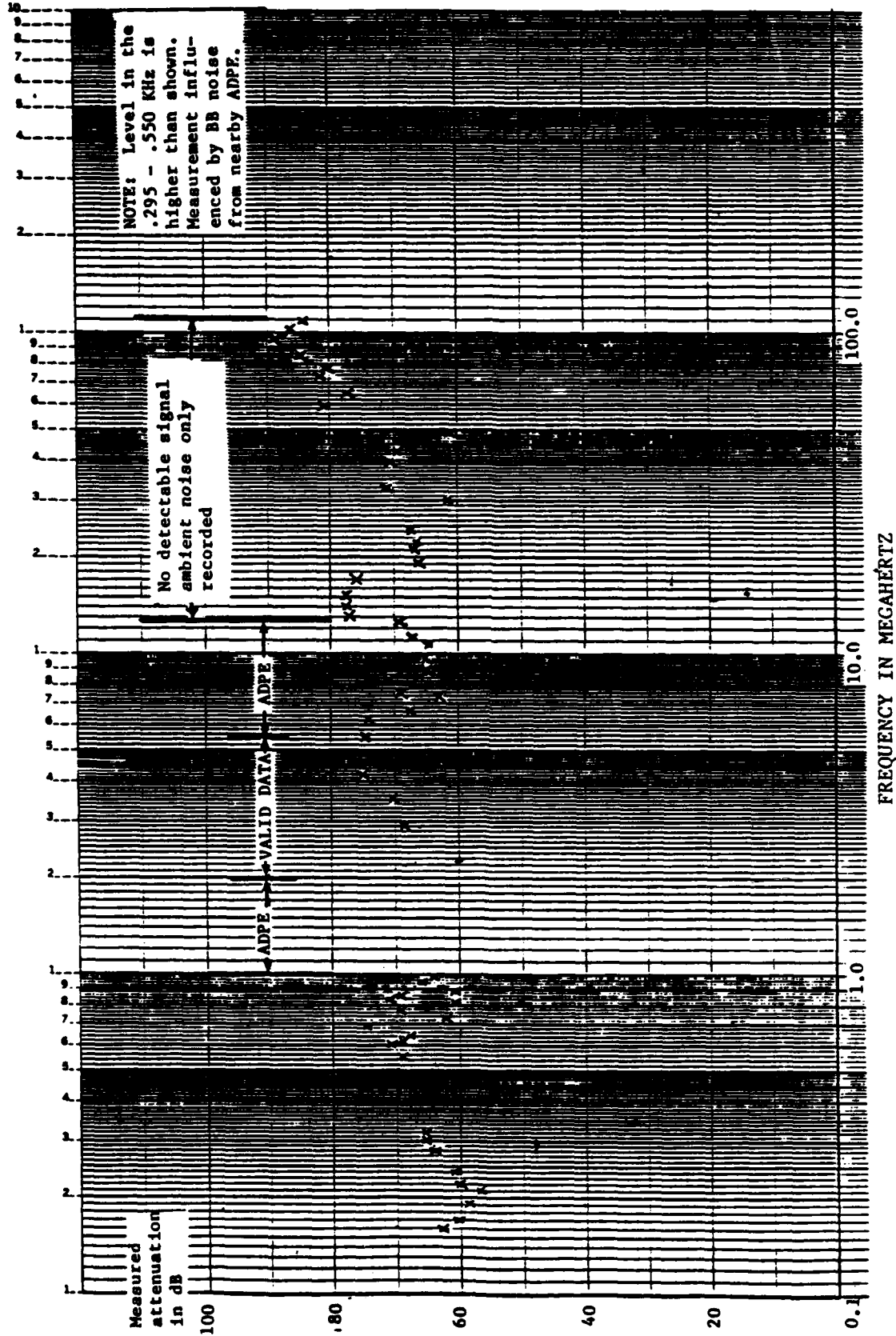
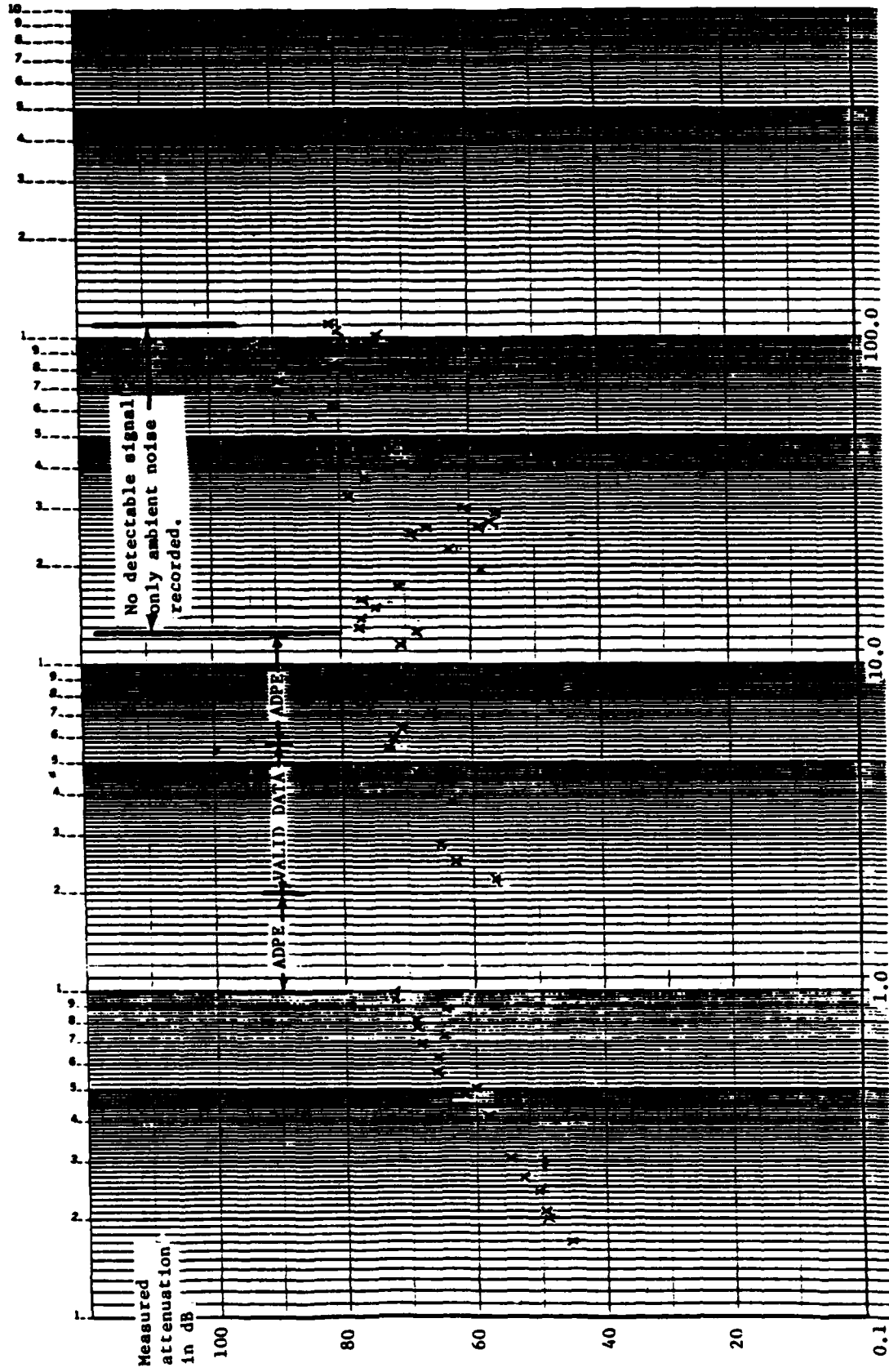
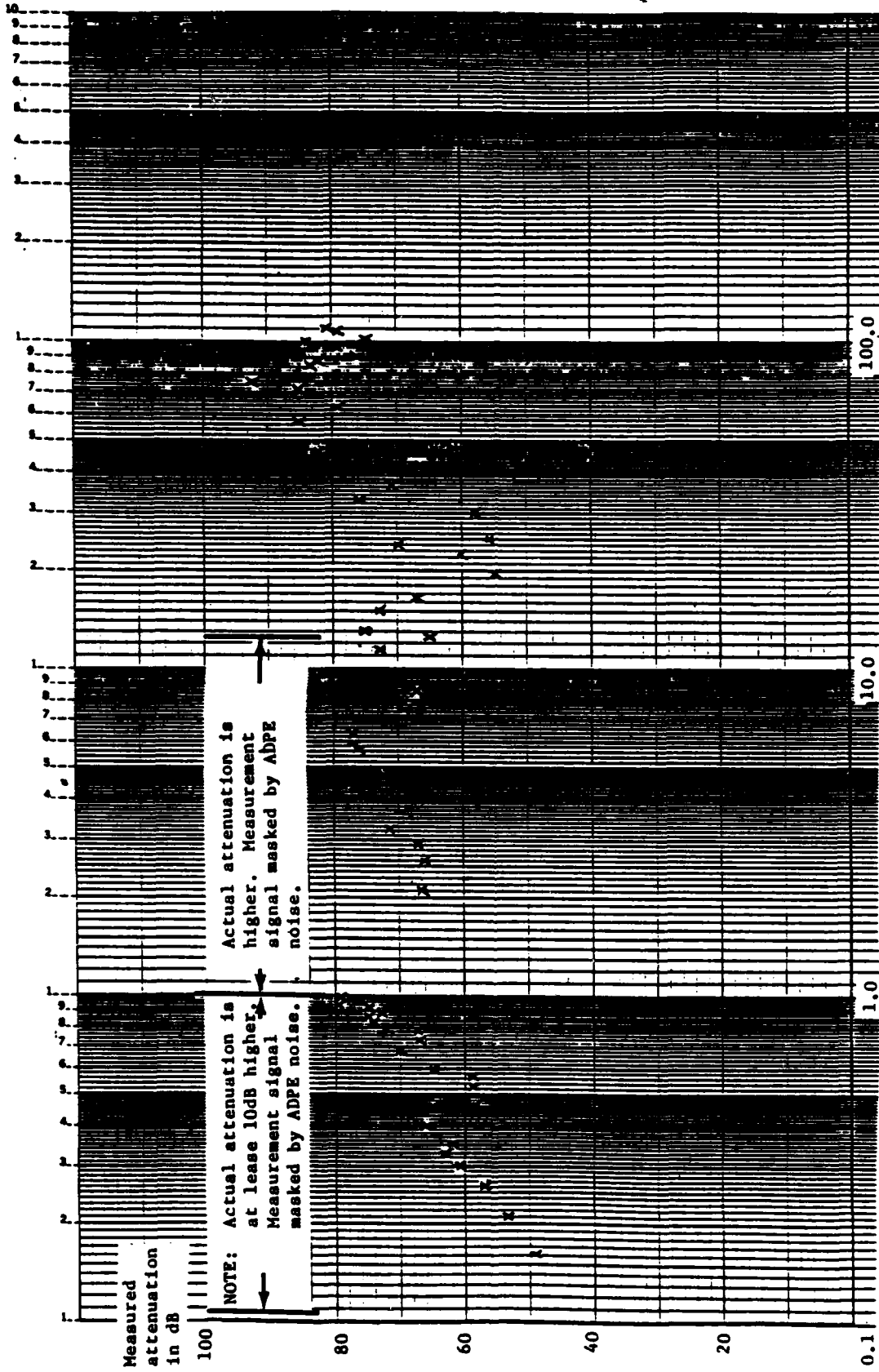


Figure 8. Measured attenuation vs frequency - seam 6.



FREQUENCY IN MEGAHERTZ

Figure 9. Measured attenuation vs frequency - seam 7.



FREQUENCY IN MEGAHERTZ

Figure 10. Measured attenuation vs frequency - seam 8.

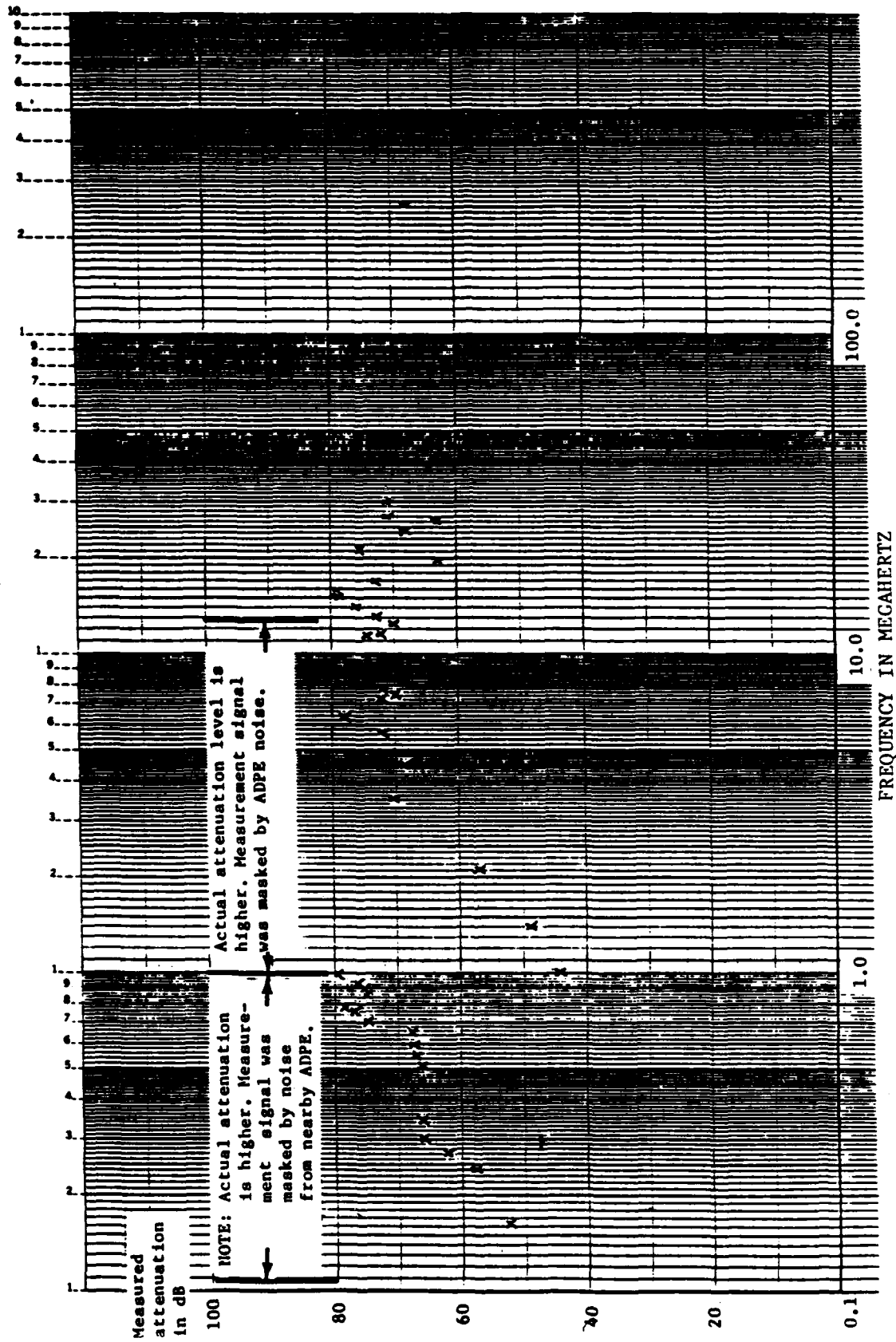


Figure 11. Measured attenuation vs frequency - seam 9.

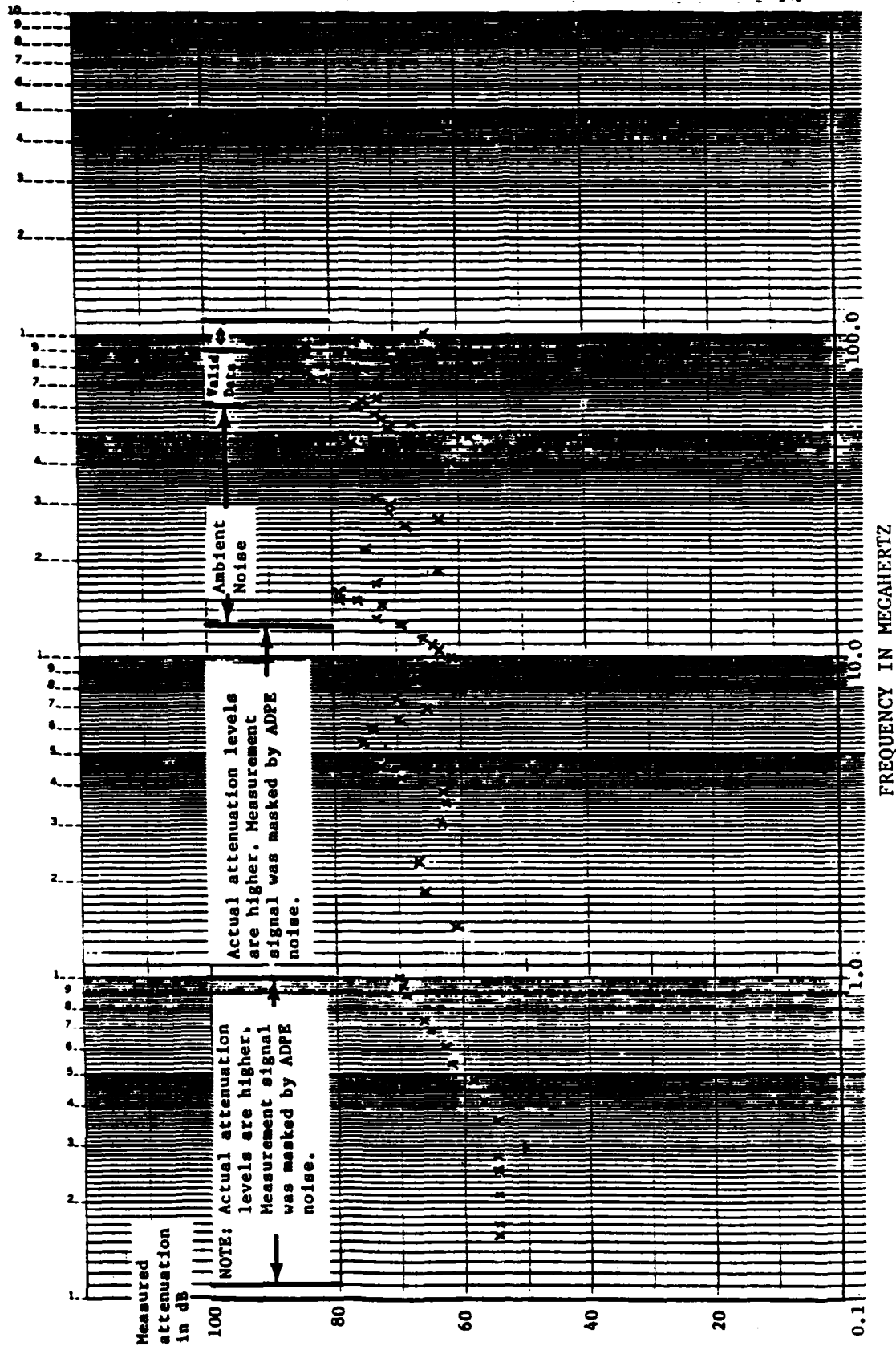


Figure 12. Measured attenuation vs frequency - seam 14.

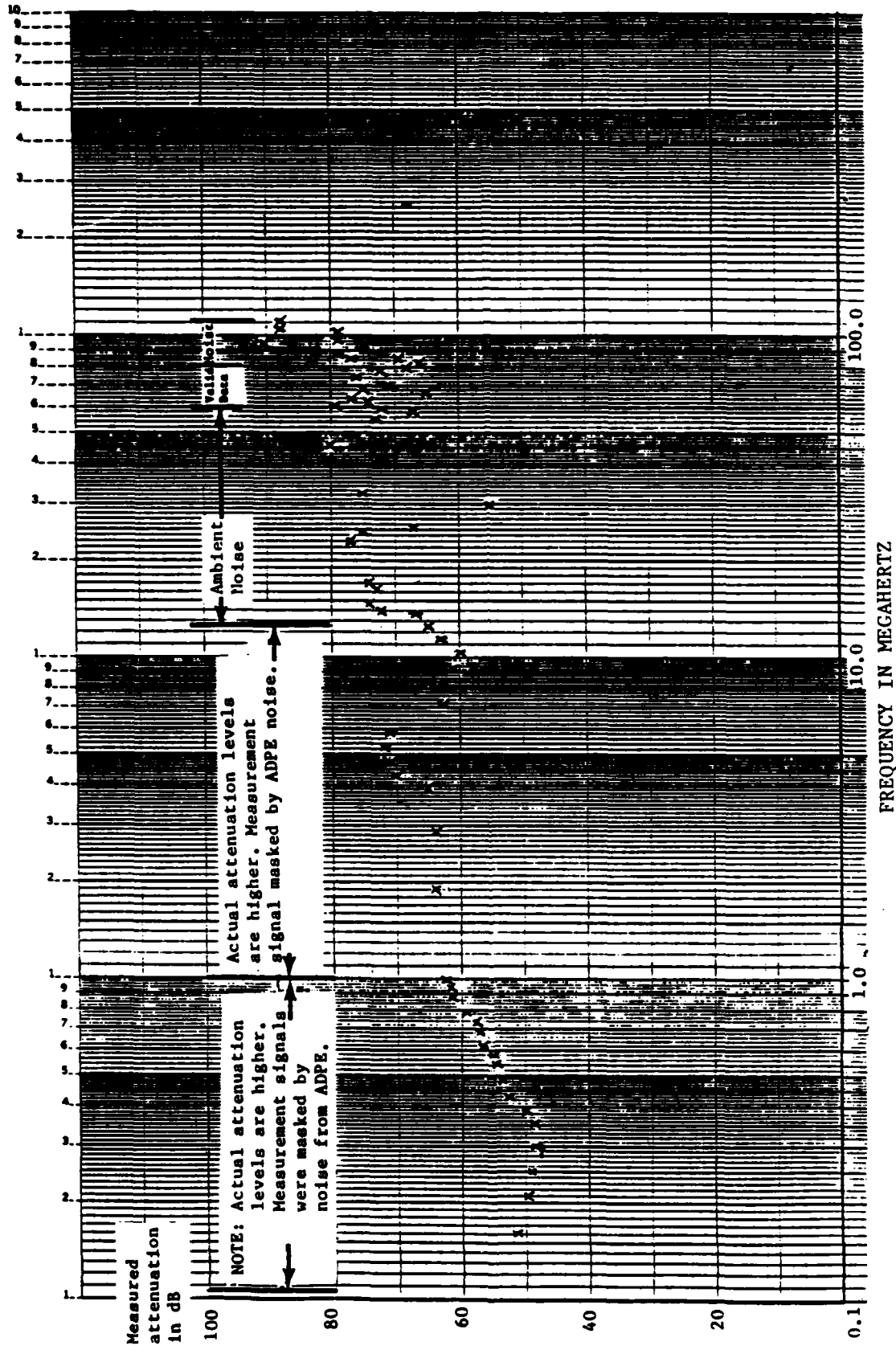


Figure 13. Measured attenuation vs frequency - seam 15.

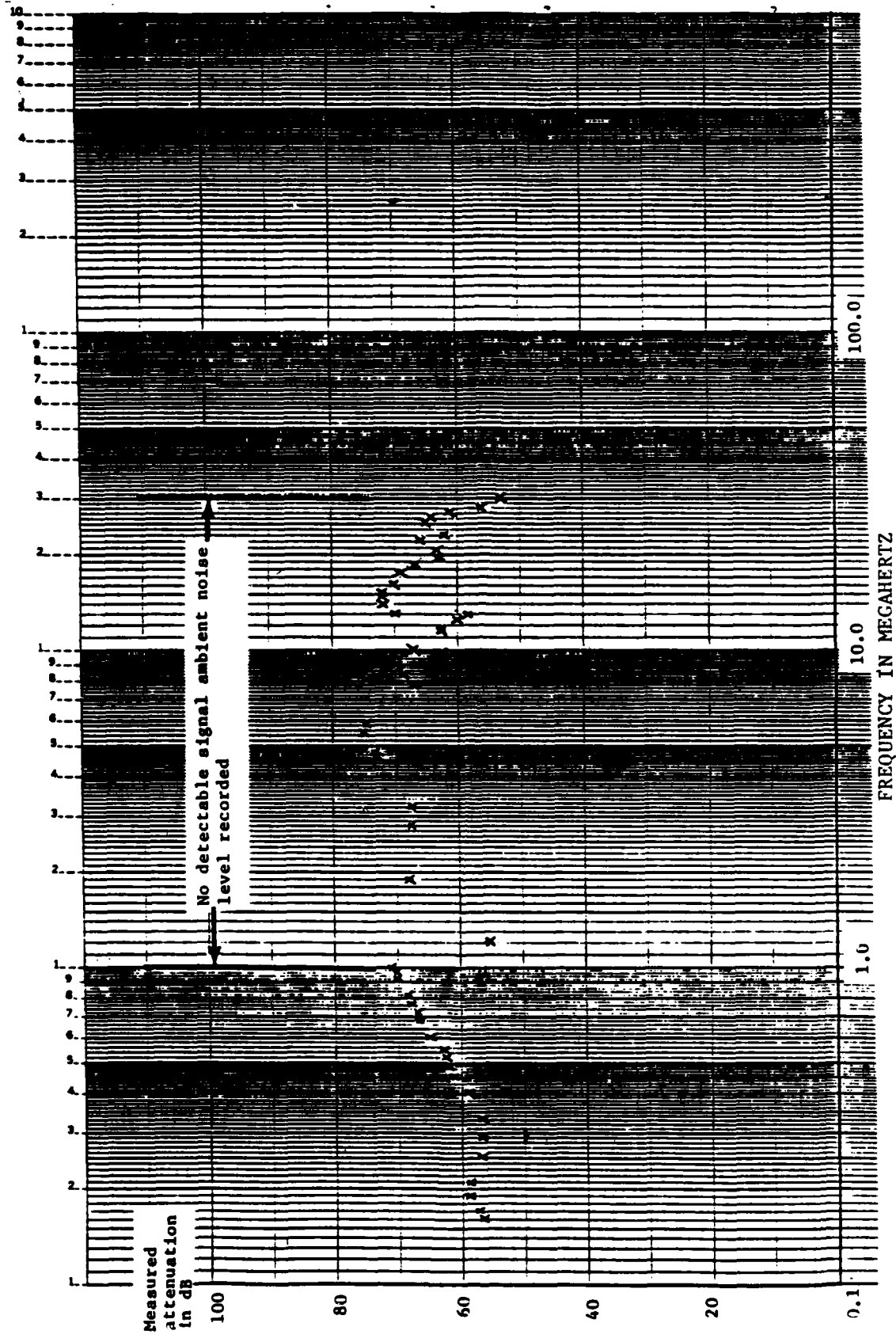


Figure 14. Measured attenuation vs frequency - right side door seam.

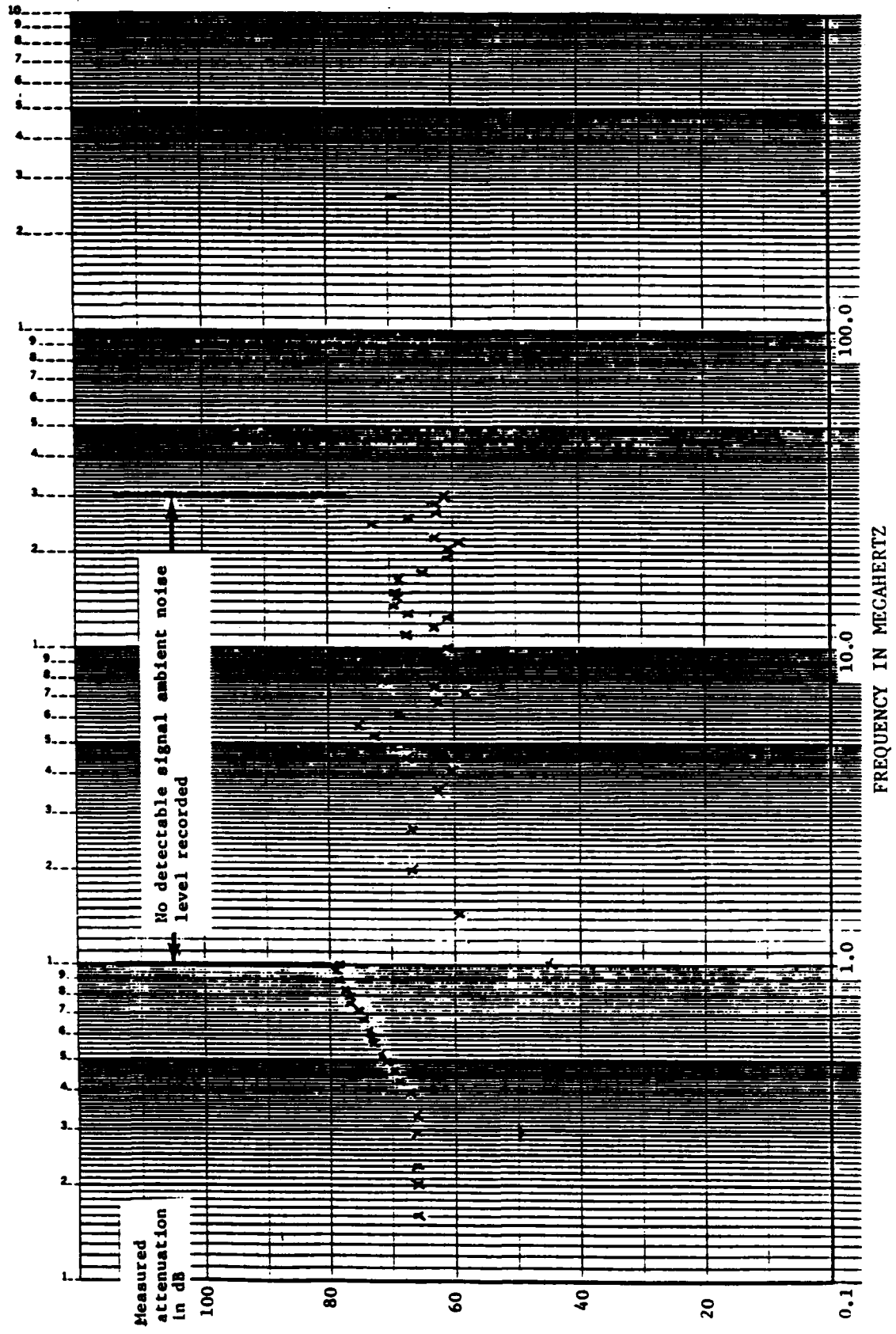


Figure 15. Measured attenuation vs frequency - left side door seam.

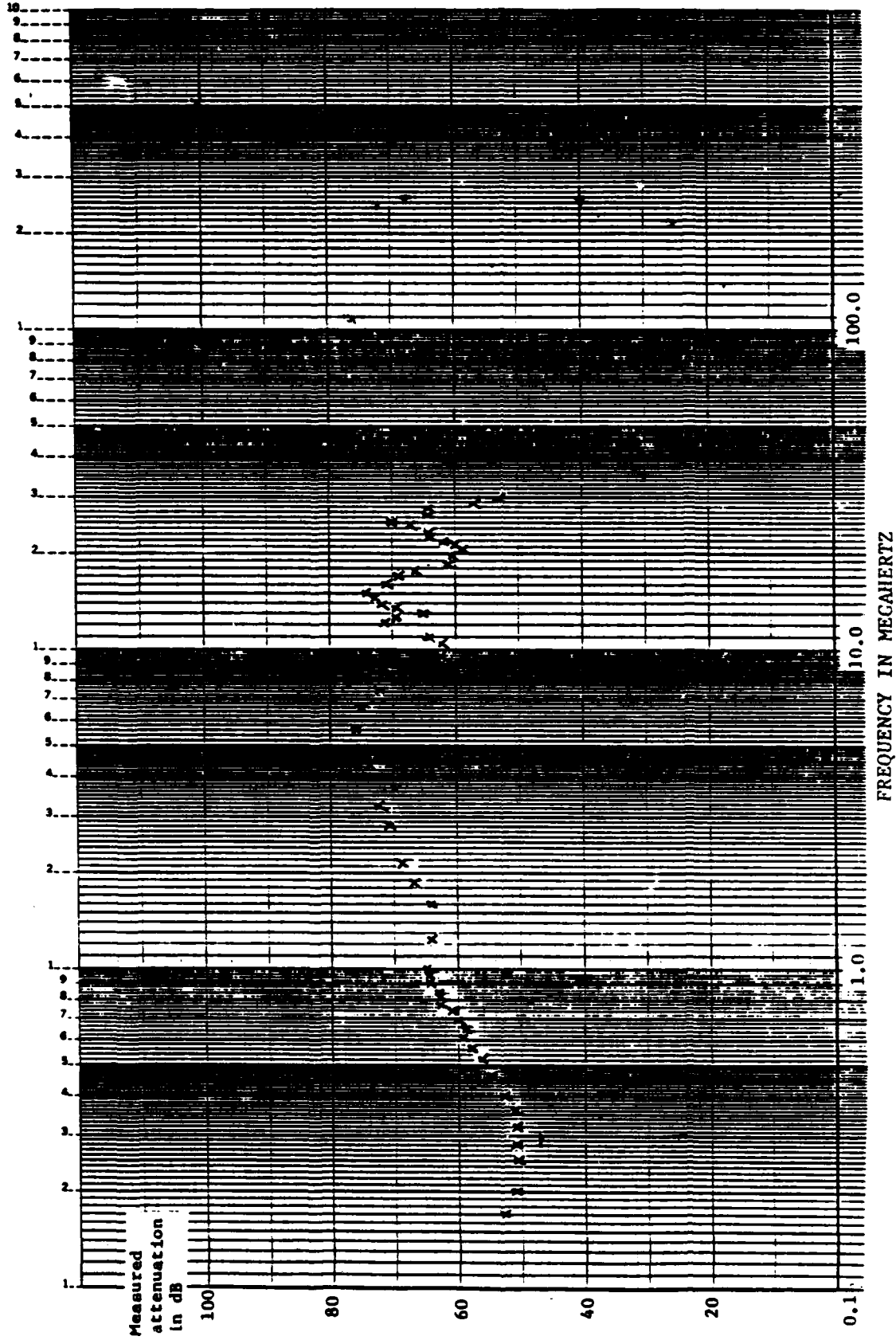


Figure 16. Measured attenuation vs frequency - upper door seam.

IV. TEST RESULTS

The measured attenuation of the enclosure for seams 1 through 9 is shown in Figures 3 through 11. The measured attenuation for seams 14 and 15 is shown in Figures 12 and 13. The measured attenuation at the door gaskets is shown in Figures 14 through 16.

In most cases, the measured attenuation values range from 60 to 80 dB over the frequency range measured. Measured attenuation values near the door indicated no substantial degradation of the finger stock or significant leakage around the door.

Attenuation measurements for seams 10 through 13 could not be obtained since that wall of the enclosure is flush with the partition separating the environmental lab from another physical plant area. In addition, electrical noise from nearby automatic data processing equipment in an adjacent area interfered to some extent with the measurements, particularly for seams 6 through 9. In many cases, the received measurement signal outside the enclosure was below the environmental noise, and the calculated attenuation level is much lower than the actual attenuation. This means that the attenuation of the seam being measured is greater (better) than indicated. The frequencies bands, where this situation is evident, are marked on the figures.

V. CONCLUSIONS

A. The electromagnetic attenuation of the shielded enclosure is close to specification in the region tested (200 MHz and below).

B. Although some physical damage is evident to the enclosure door finger stock, no significant leakage was found.

C. A cursory measurement of the attenuation of the power line filters indicates they are performing properly.

D. Present indications are that the noise problems experienced during previous testing were caused by conduction of rf energy into the enclosure on the shields and cables entering through the access panel at the west end of the enclosure.

VI. RECOMMENDATIONS

A. Repair the broken finger stock on the enclosure door. It does not appear to be a problem yet, but may become one in the future if left uncorrected.

B. Clean the interface between the finger stock and door facing with a good brass cleaner at regular intervals. Contact the enclosure manufacturer for recommendations on products to use for this purpose.

C. Advise personnel using the enclosure to be particularly careful in choosing a termination method for cable shields of the test items keeping elimination of radiated/conducted energy on the cables in mind. This may require the fabrication of special fixtures or cable termination bulkheads for some test items.

D. Give consideration to construction of a shielded anteroom to house test support and measurement equipment during testing. The environment surrounding the enclosure contains high levels of electromagnetic energy, which could lead to severe radiated conducted problems with sensitive test items. It might prove more cost effective to replace the shielded enclosure completely.

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