ARMY RESEARCH LABORATORY

Calibration Data for the Leaky Coaxial Cable as a Transmitting Antenna for HEMP Shielding Effectiveness Testing

by Canh Ly and Thomas Podlesak

ARL-TN-0330 **August 2008**

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Sensors and Electron Devices Directorate, ARL

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

Leaky coaxial cables are coaxial cables with gaps in their shielding, which allows the center conductor to radiate. We will use a new technique for HEMP shielding effectiveness testing in which the cables function as antennas, not transmission lines, replacing the conventional method in which the normal transmitting antennas, which are loops and bi-logical arrays. This report presents the calibration data for the leaky coaxial cable as a transmitting antenna for HEMP shielding effectiveness testing for both low frequency band from 10 KHz to 20 MHz, and high frequency band from 20 MHz to 1 GHz with different orientations.

15. SUBJECT TERMS

HEMP, leaky coaxial cable

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1. Introduction

This paper documents calibration data collected at building 507, ALC/ALC for the leaky coaxial cable used as a transmitting antenna for High-Altitude Electromagnetic Pulse (HEMP) testing. The data includes both low frequency and high frequency measurements.

The procedure for collecting this data is somewhat similar to the method previously used with conventional HEMP testing for two separate phases of capturing data: one phase for low frequency from 10 KHz to 20 MHz, and the other for high frequency from 20 MHz to 1.0 GHz. For each phase, two different sets of antenna (one for transmitting and one for receiving) were used to calibrate and collect data. On the other hand, for this novel approach, we only use one set of leaky coaxial cable as transmitting antenna for both frequency bands.

For low frequency band, we measured two different orientations. One is co-axial direction; the other is called co-planer orientation. The leaky coaxial cable was laid on the top of a wooden rail as shown in figure 1. The 16 in loop antenna was set at three different separations: 6 ft, 8 ft, and 10 ft. These separations were measured from the edge of the cable to the center of the loop antenna.

For high frequency band, we measured, again, for two different orientations. One is for high frequency horizontal direction; and the other for high frequency vertical orientation. A bi-logic antenna was used to collect data at high frequency band. Figure 1 depicts an experimental setup in building 507 with the bi-logic antenna as a receiver antenna.

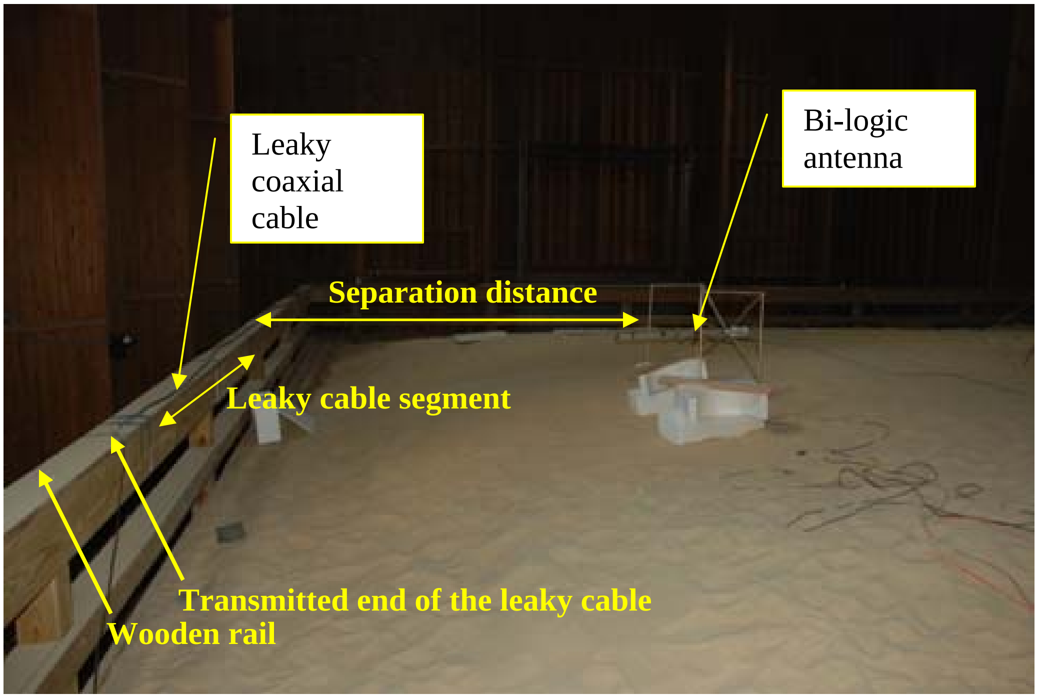


Figure 1. Leaky coaxial cable experimental setup with a bi-logic antenna (high frequency).

2. Data collection

This section consists of descriptions of low frequency and high frequency calibration date. The low frequency graphs are divided into three separate groups, at 6 ft, 8 ft, and 10 ft separations. This data were collected with a HP Network Analyzer (Model 3577B) via IEEE 488 bus to a laptop computer. The high frequency data were collected in a similar manner with a HP Network Analyzer (Model 8357B).

For each separation, we measured at 5 ft, 15 ft, and 25 ft from the transmitter end of the cable. The purpose of these set of data is to use them in the future HEMP testing at confined and small areas that may not accessed very easily.

Figures 2 to 36 show data for three different ranges with three different separations. Figures 2 through 18 present calibration date with measured at the low frequency band. Figures 19 through 36 present calibration date measure at the high frequency band. The numbers of each title indicate as follows: type of measurement Abbreviations: LF (low frequency), HF (high frequency), CA (co-axial), and CP (co-planar); the first number is the separation between the leaky coaxial cable and the loop (for low frequency) or the bi-logic antenna (for high frequency); the second number is the distance along the leaky cable measured from the transmitted end of the cable. For example, the title of figure 2 means: Low frequency measurement, co-axial orientation, 6 ft separation, at 5 ft from the transmitted end of the leaky cable.

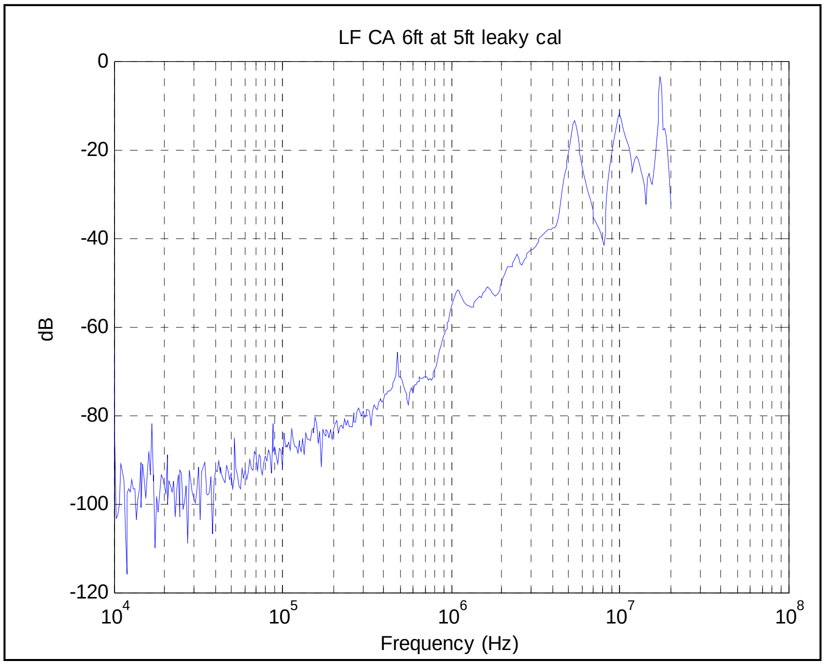


Figure 2. Low frequency, co-axial, 6 ft separation, at 5 ft from the transmitted end of the leaky cable.

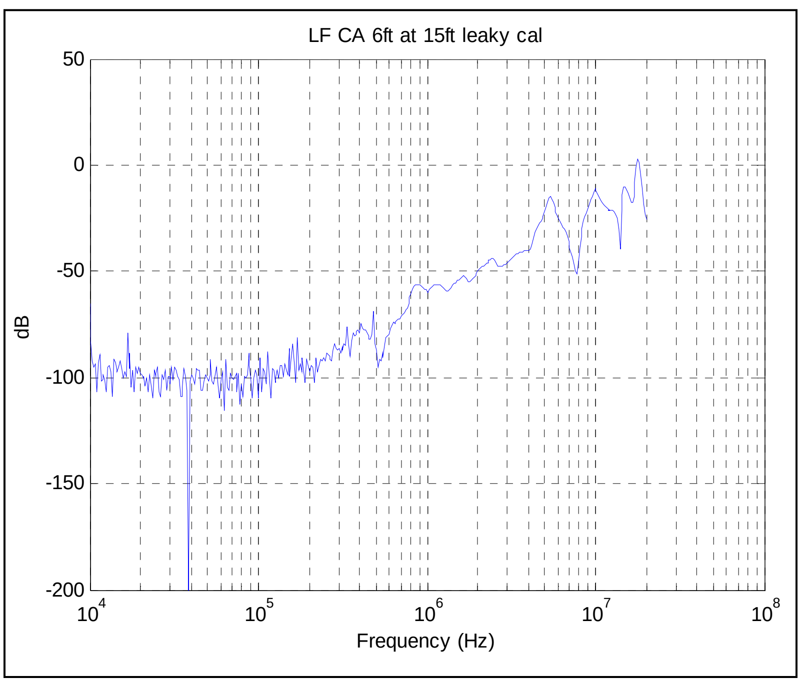
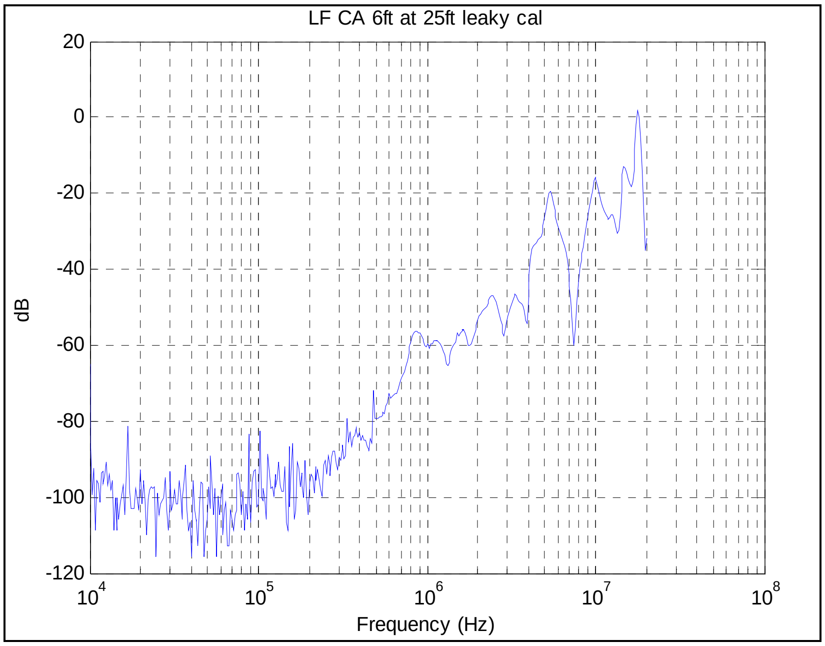


Figure 3. Low frequency, co-axial, 6 ft separation, at 15 ft from the transmitted end of the leaky cable.



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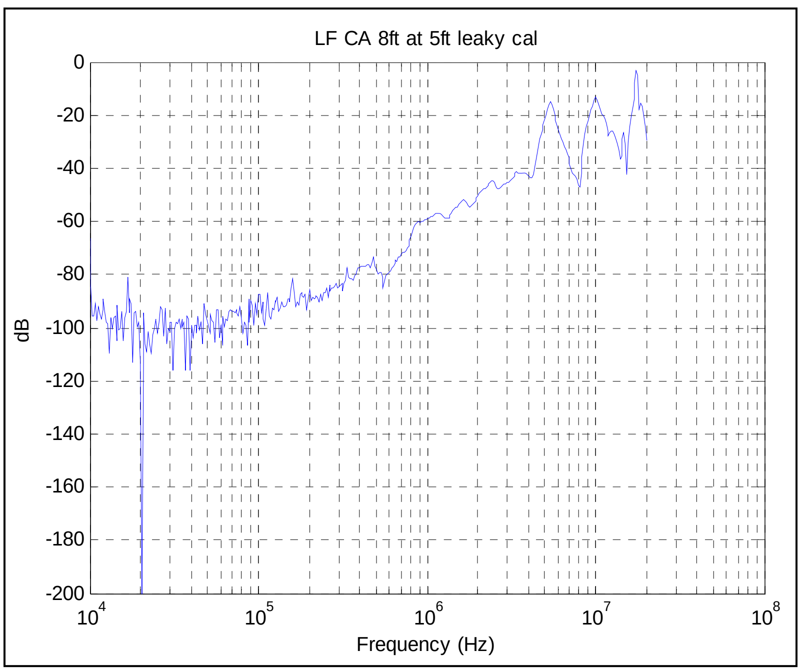

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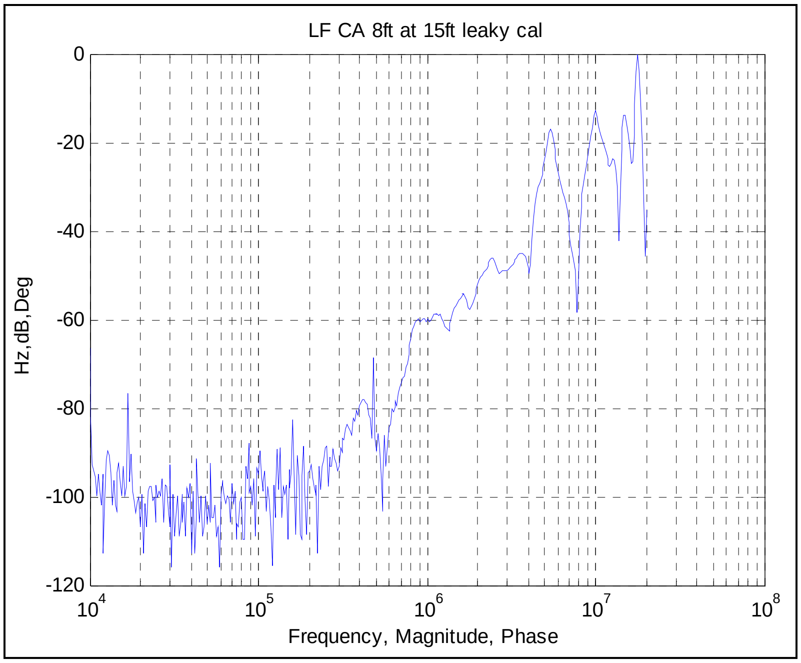

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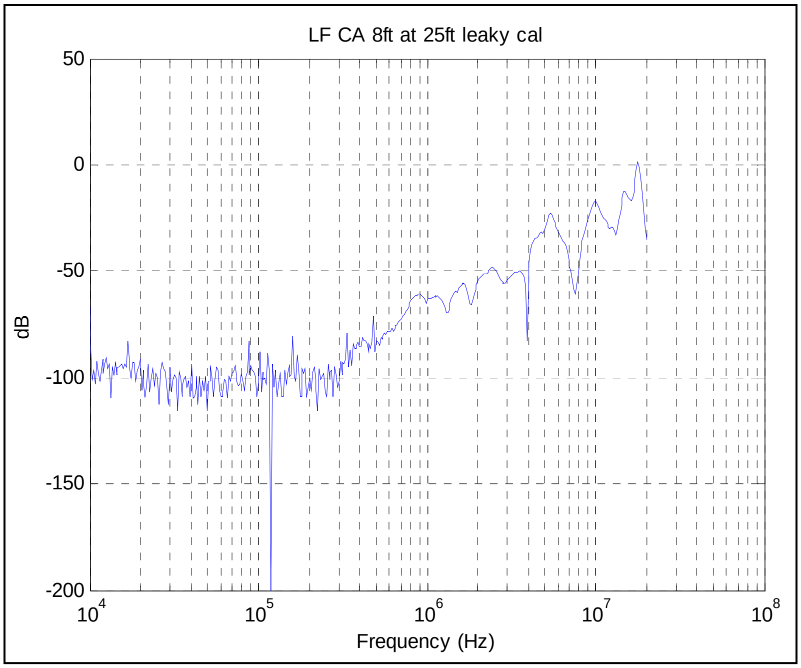

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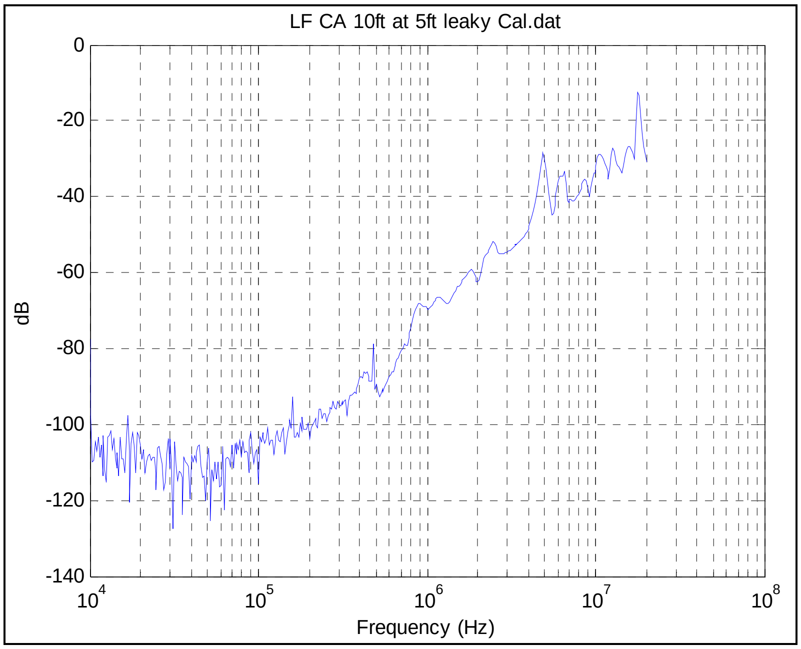

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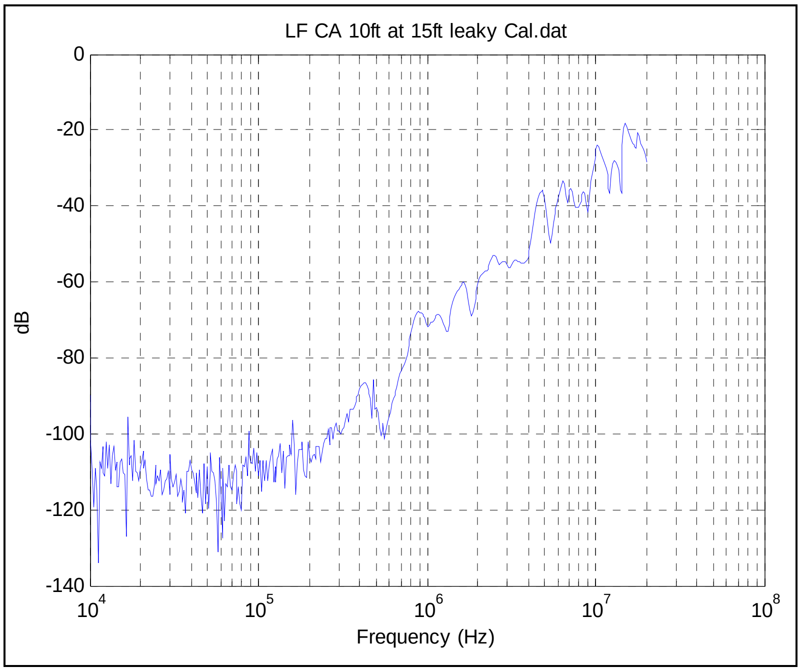

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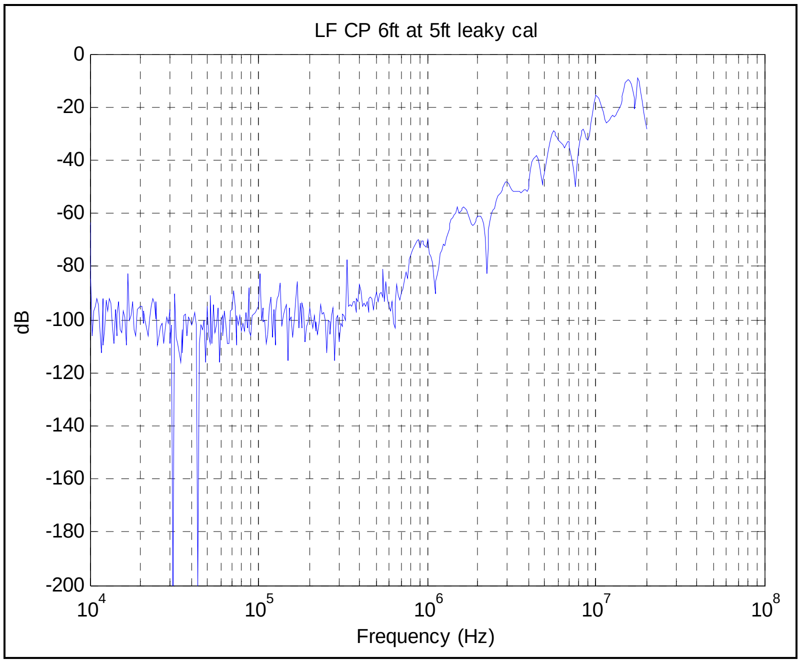

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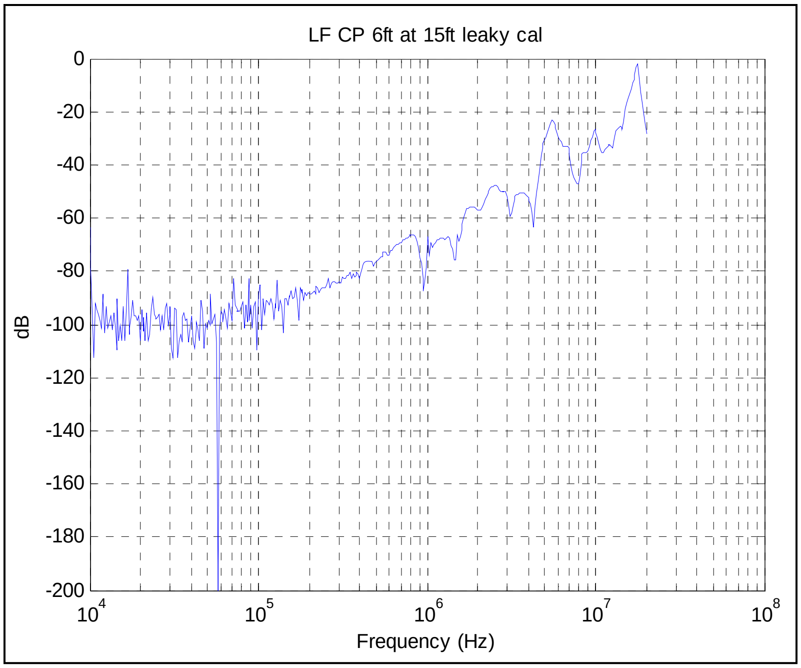

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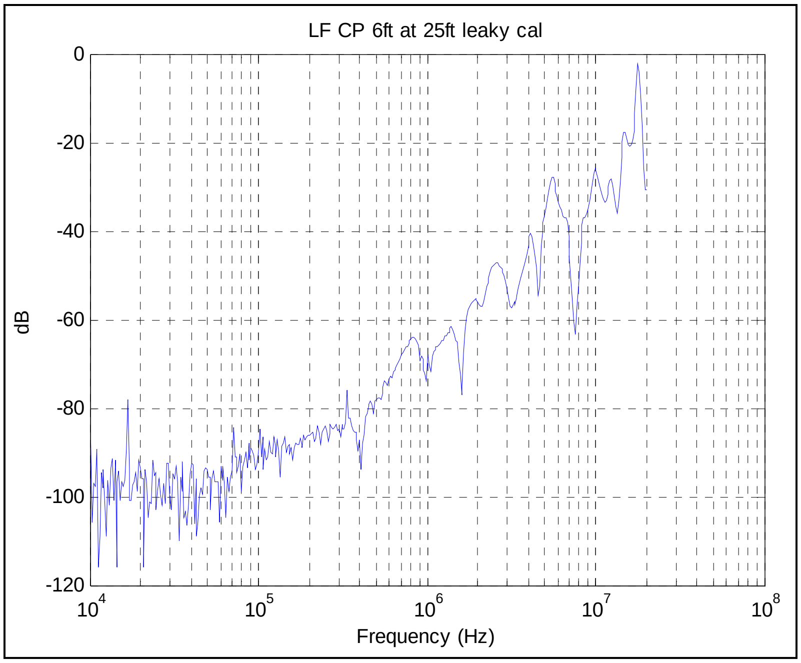

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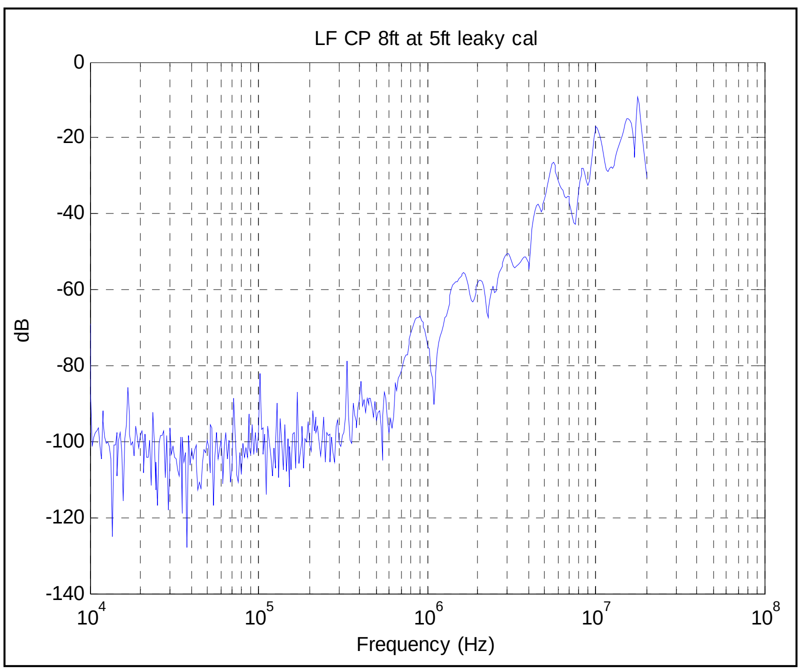

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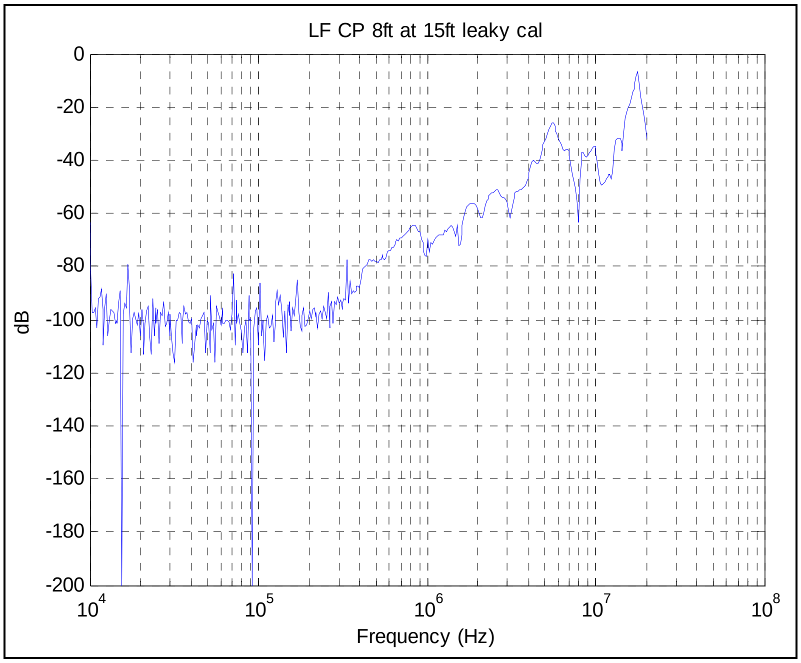

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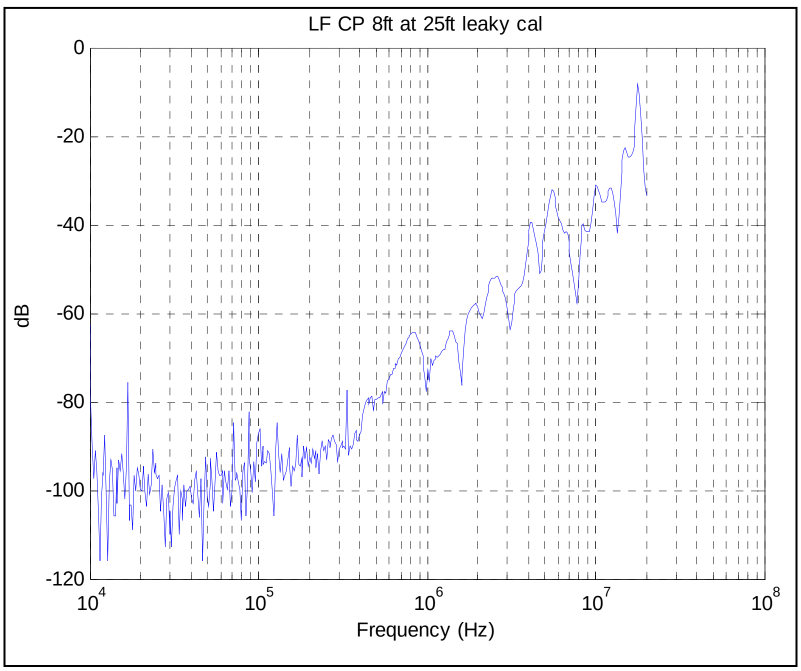

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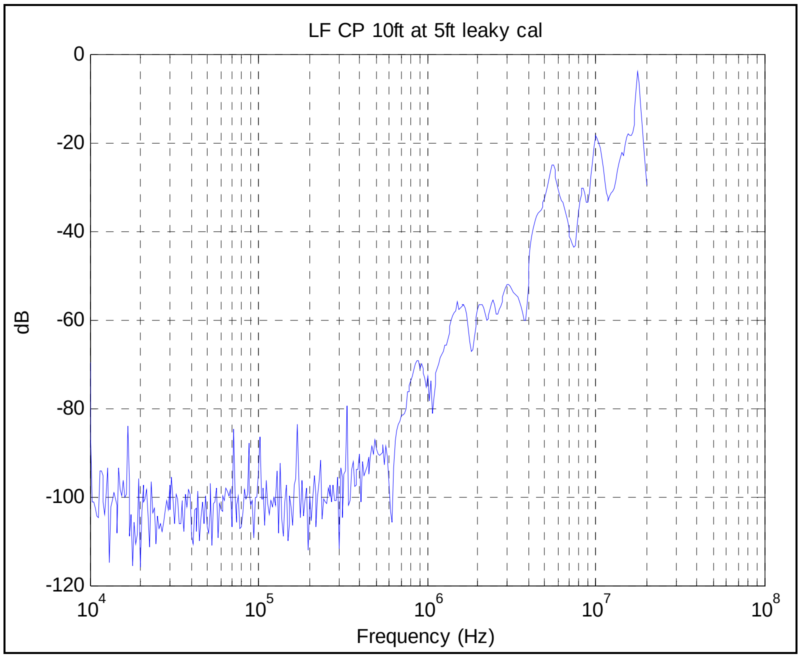

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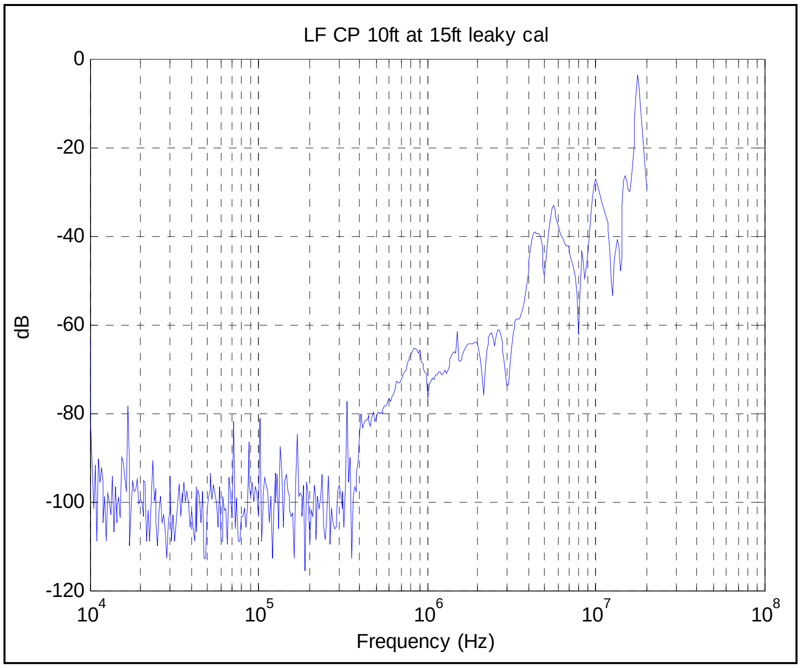

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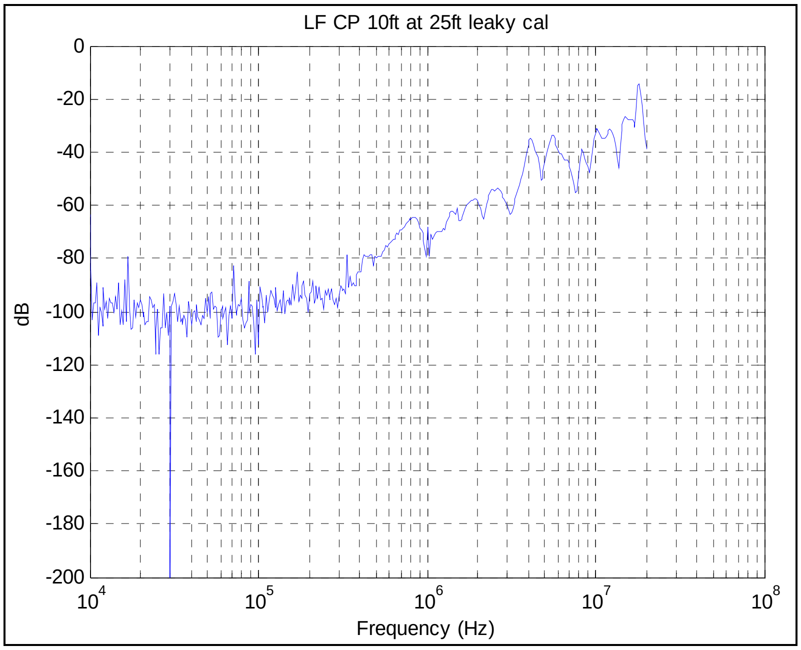

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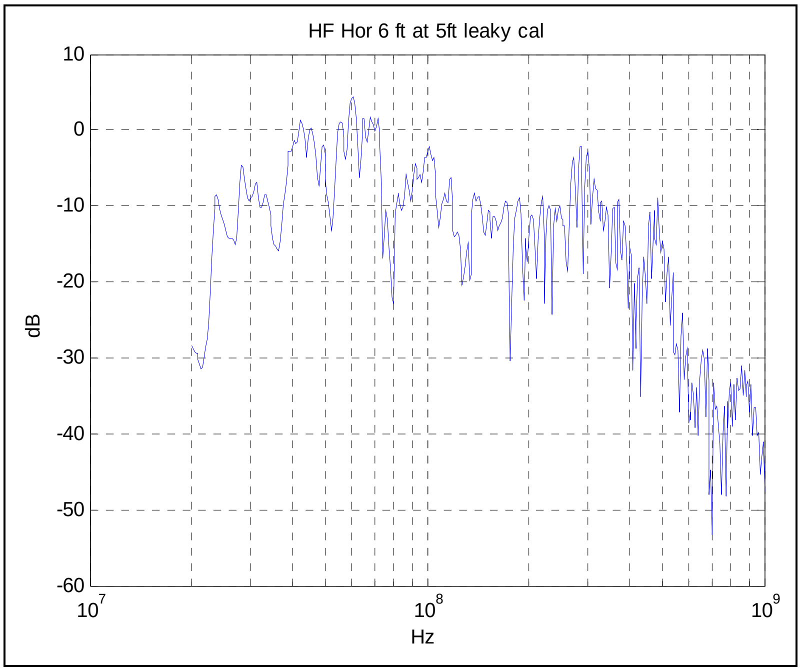

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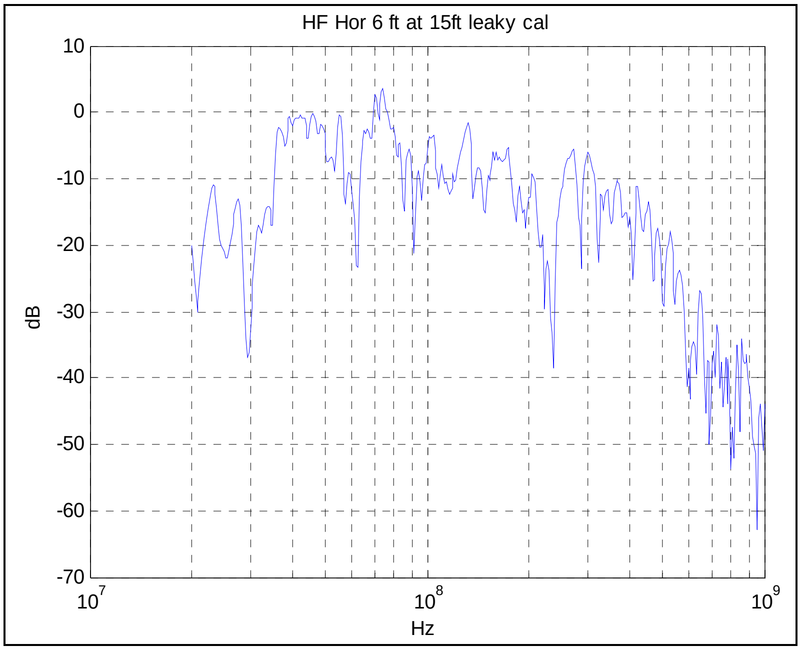

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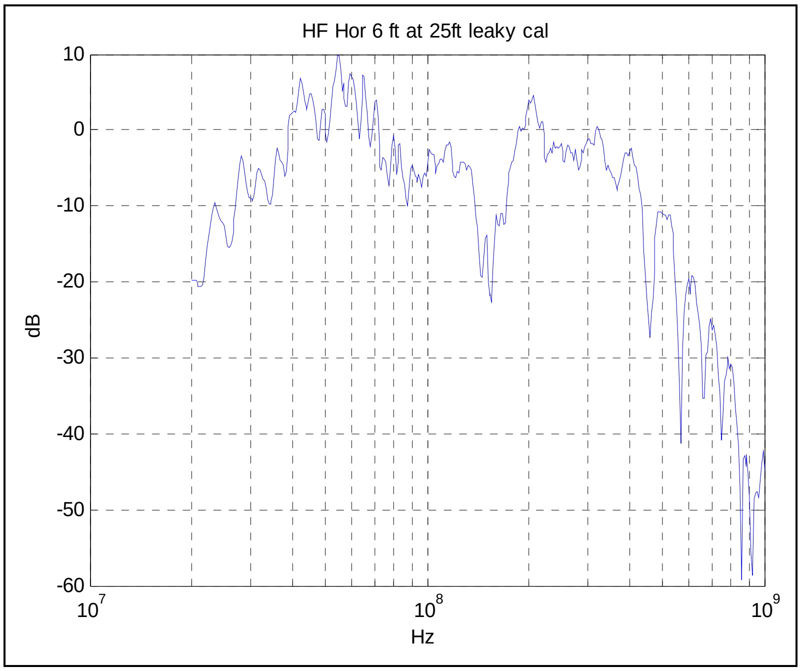

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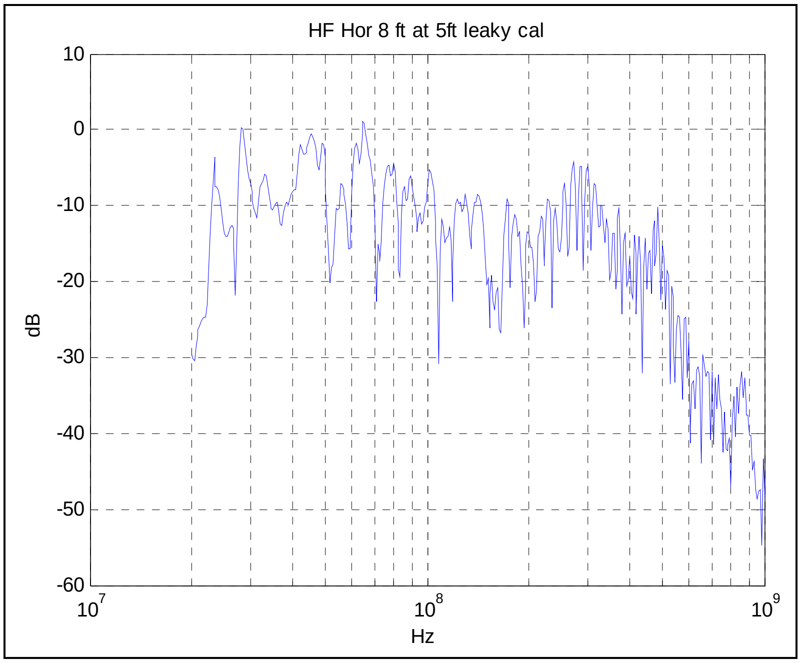

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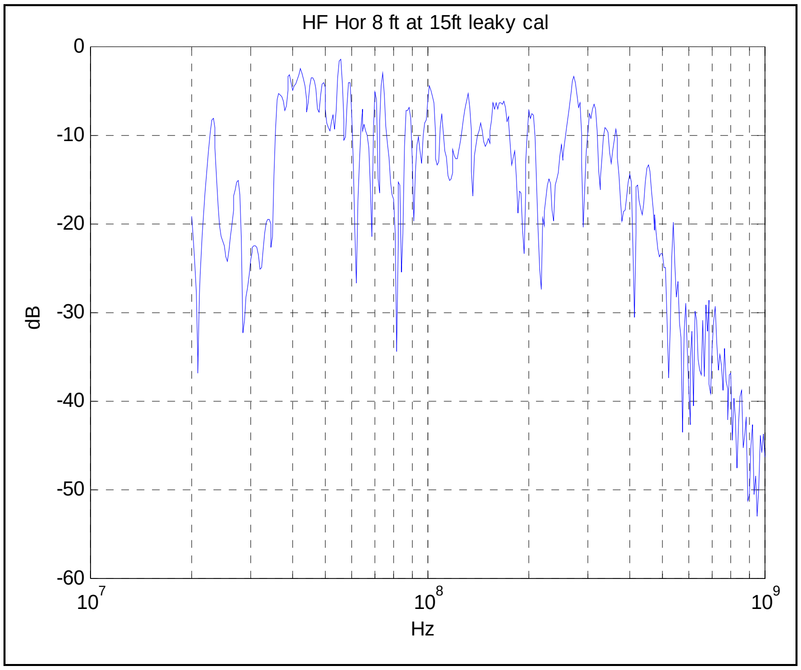

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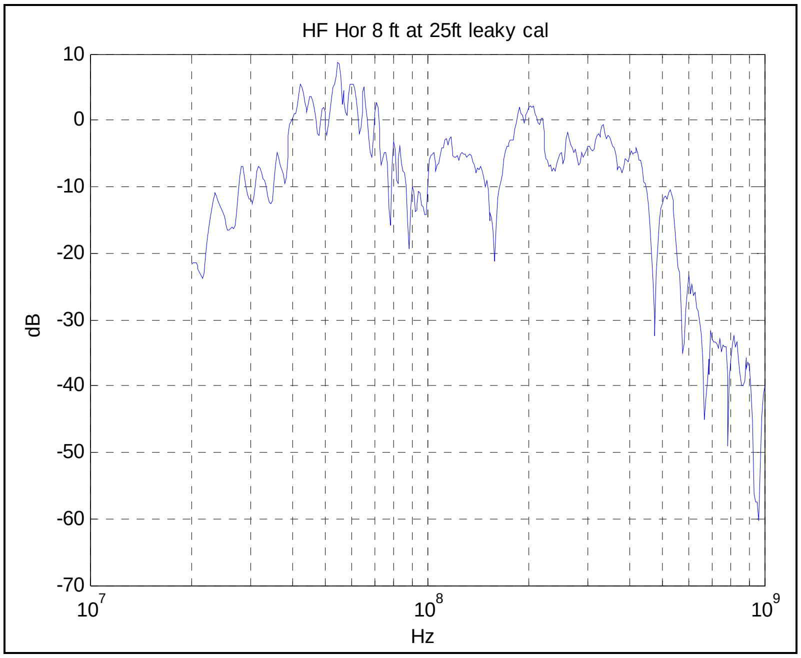

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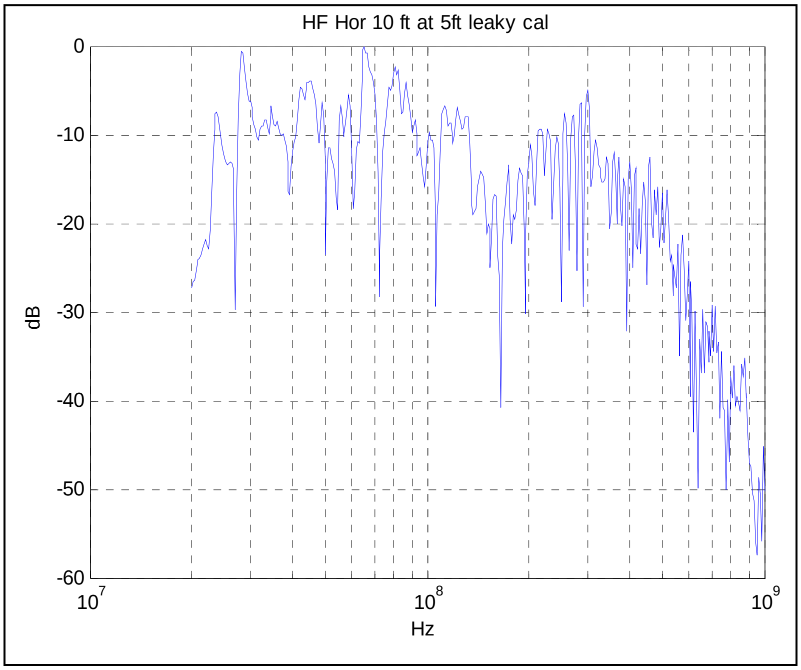

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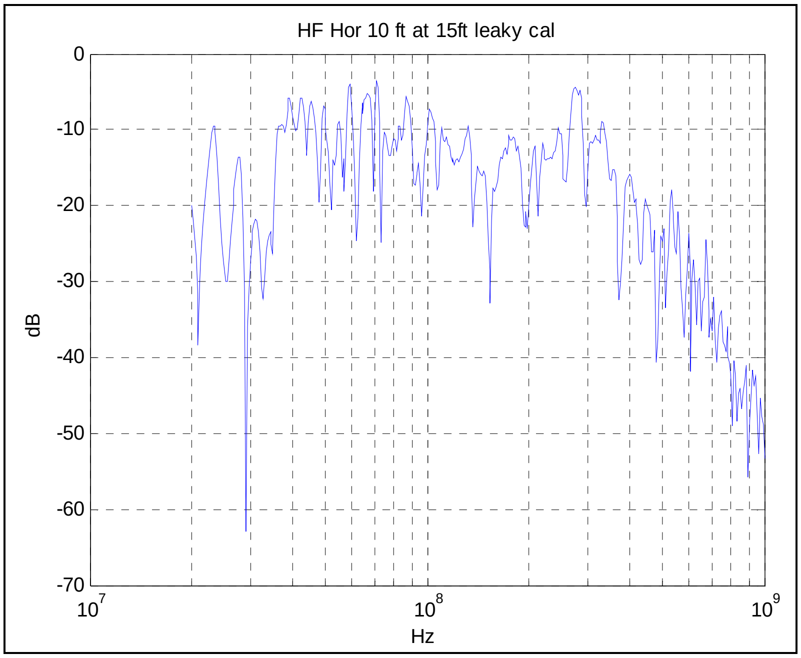

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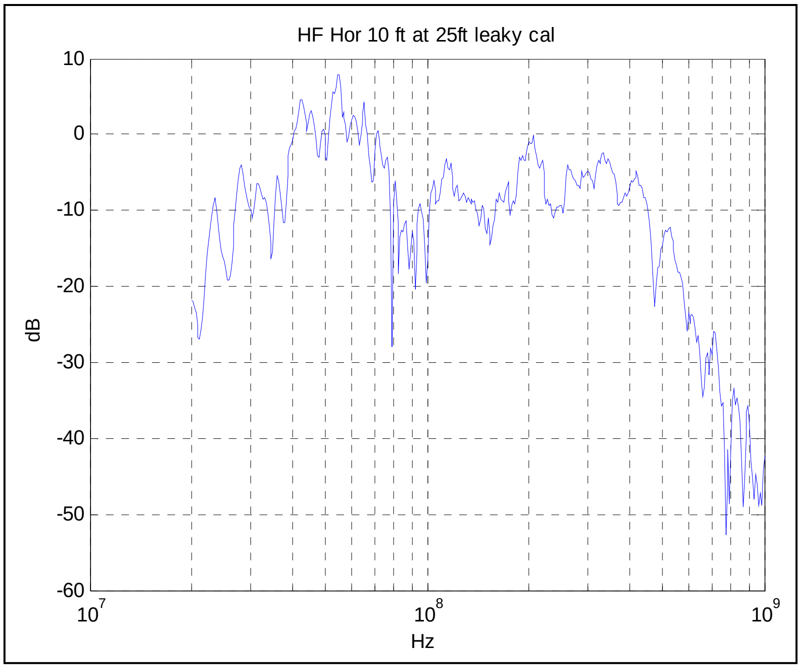

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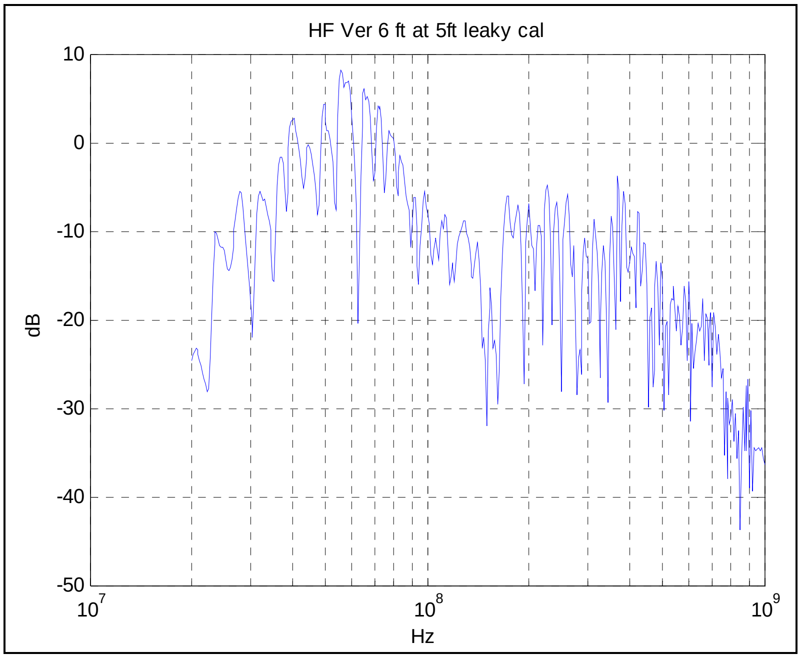

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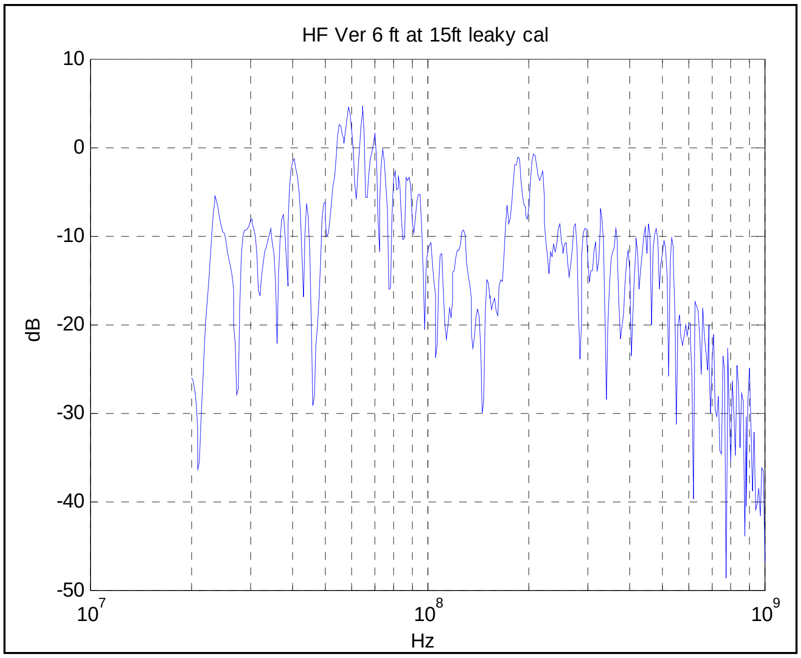

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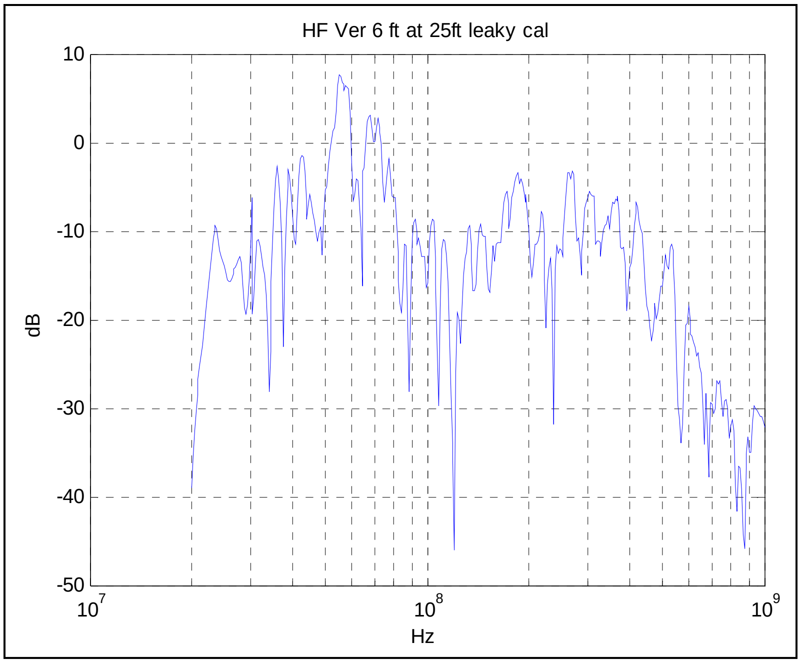

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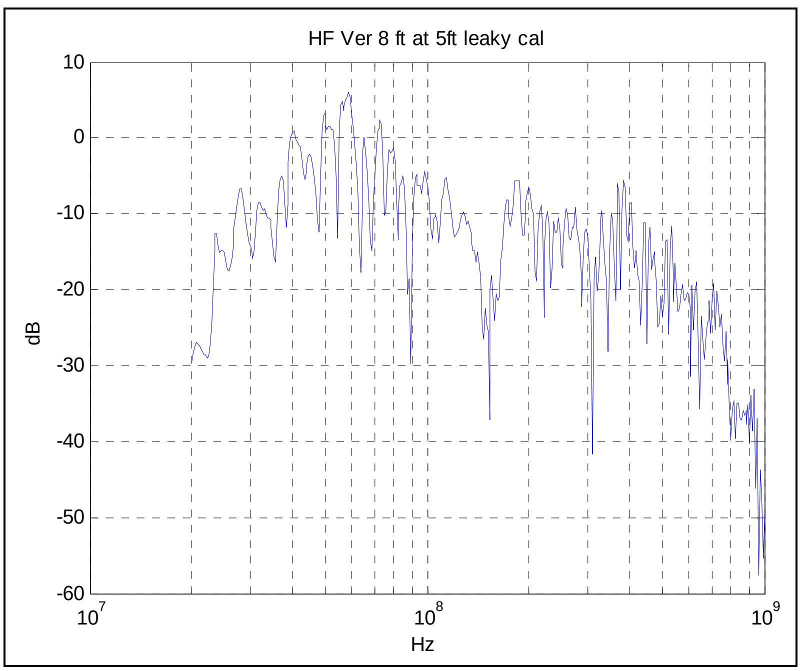

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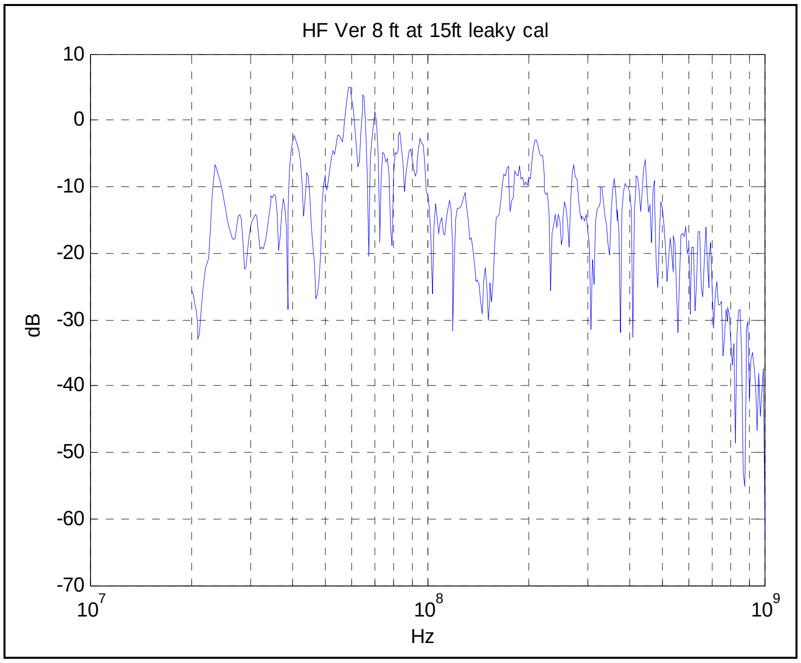

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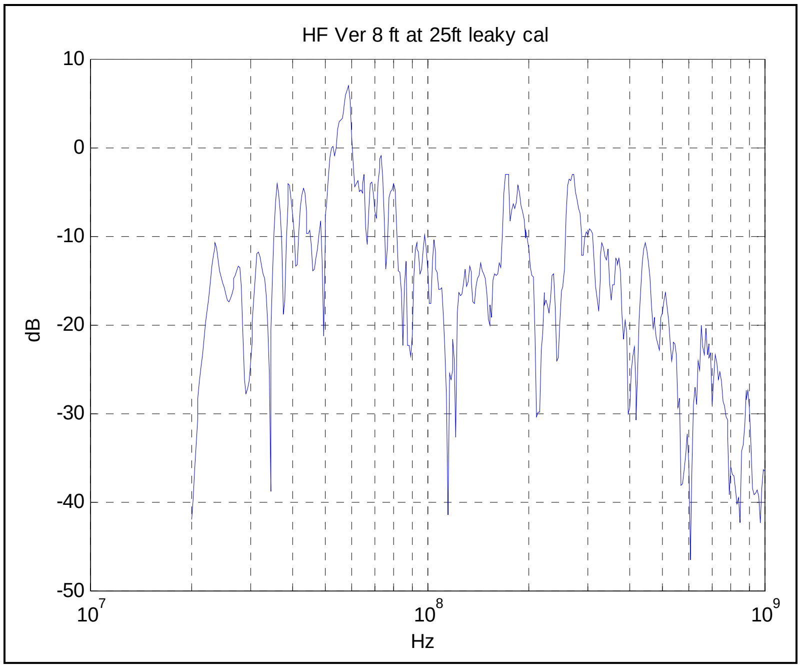

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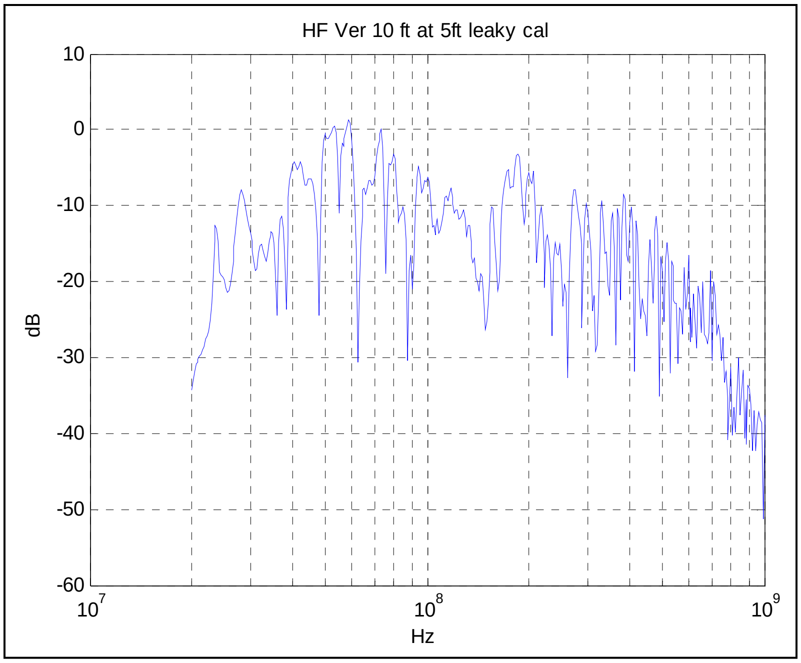

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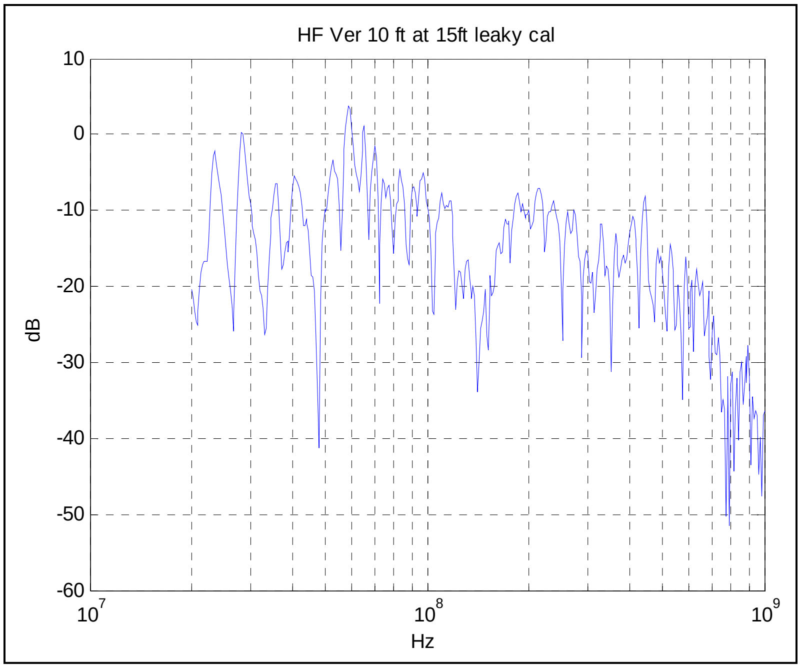

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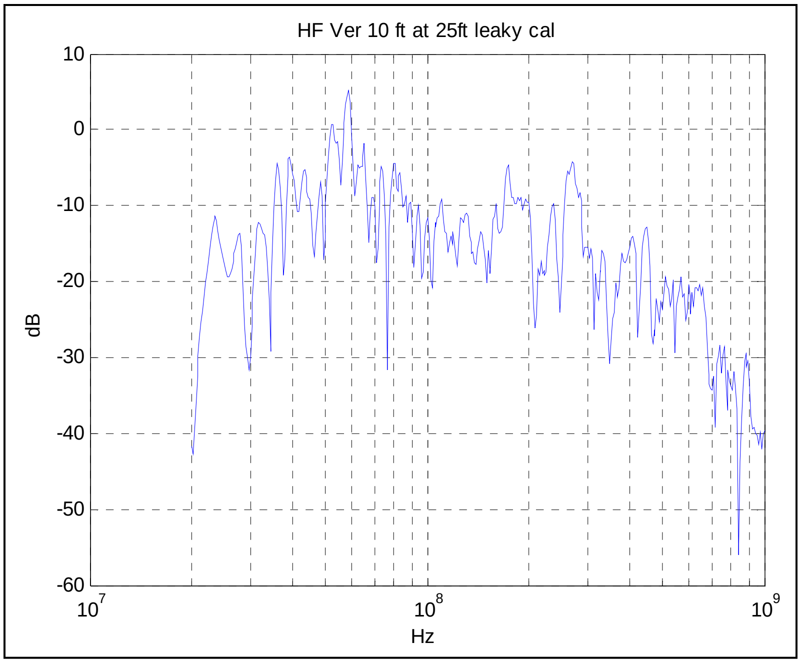

Figure 36. High frequency, vertical orientation, 10 ft separation, at 25 ft from the transmitted end of the leaky cable.

3. Discussions

Conventionally, HEMP testing data processing comprises four sets of data in order to generate a final output. Refer to (*1*) for more information about the processing. In the reference, the first set of data is reference data, the second data set is attenuation data, the third set of data is the noise measurement for a particular setting, and the last data set is the measurement of the particular setting. The data shown in this report are sets of the reference data. The data will be incorporated with other sets of data to generate final outputs for HEMP shield testing. At this point, these data have not been validated, since other sets of data have not yet been collected. The results remain to be evaluated.

4. Summary

The data shown in this report served as a guideline for future HEMP testing. A complete comparison of this data set with previous data that were measured with the conventional HEMP testing will be presented at the Directed Energy Professional Society in July 2008.

5. Reference

1. Atkinson, R.; King, B.; Dilks, L. *FY04 Status Report High-Altitude Electromagnetic Pulse (HEMP) Survivability Support for Critical Command and Control Communications Assets*; ARL-SR-133; U.S. Army Research Laboratory: Adelphi, MD, March 2005.

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