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THE LLL TRANSIENT ELECTROMAGNETIC MEASUREMENT FACILITY: A BRIEF DESCRIPTION

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DISCLAIMER

FOREWORD

This work was performed under the joint auspices of the Atomic Energy Commission and the Defense Nuclear Agency.

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I. INTRODUCTION

Advances in sub-nanosecond pulse generation and sampling technology have provided the electromagnetic engineer the use of pulse techniques for various antenna and scattering measurements. The data is obtained in the time domain and converted to broad band frequency domain information by the use of the Fast Fourier Transform. This report summarizes LLL's transient EM measurement facility which is similar to that described by Bennet et al [1]. A more detailed description is in preparation.

Pulse type systems eliminate the need for an expensive anechoic chamber, a large outside area facility and equipment for measurement of amplitude and phase over a large bandwidth. Also, the ease in which the experimental setup can be changed is enhanced.

In its simplest form, measurements are obtained in the time interval from the time of incident pulse to time of arrival of the first reflection. This time interval is determined by the size of the ground plane and the length of "infinite" radiating source. Further, in frequency domain terms, this time interval determines the low frequency cut off. For the LLL facility the cut off frequency is 50 MHz; however, it can be extended by simple experiment modifications and data processing. The upper frequency cut off is determined by the measuring equipment bandwidth. In this facility the upper frequency cut off is about 3 GHz, which can be extended to 10 GHz by additional data processing.

II. HARDWARE

The range consists of a 28' x 28' aluminum ground plane. The excitation is from an IKOR pulser, which produces an approximate gaussian pulse, with a peak voltage of 1400 V and a half width of 300 ps. (Other pulse sources of the reed switch variety are available.) For transient response and scattering measurements the pulse is applied to a vertical wire approximately 14' in length. The radiated field is produced by the small source region at the ground plane surface where coaxial feed line connects to the vertical wire.

The measurement system consists of a Tektronix sampling scope (bandwidth ≈ 18 GC). The vertical output of the scope is connected to the data processing system (Fig. 1). It should be noted that digitizing the data directly from the vertical amplifiers produces much greater data accuracy and resolution over conventional photograph to film reader type digitizer: i.e., it is not necessary to consider all of the problems associated with determining the center of the trace on a photograph. The horizontal input to the scope is controlled by the data processor and allows convenience and flexibility in the number of samples obtained in a measurement interval. The time base sampling interval is chosen to produce the exact number of samples to input to the Fast Fourier Transform routines, 128, 256, 512, etc.

The data processor consists of a D112 minicomputer, and associated peripheral equipment. It is a 12 bit machine with 12K of core storage. The software is compatible with a DEC PDP 8/I. The 12K of core is adequate to handle the resident data acquisition and control routines plus additional processing routines; FFT, plotting, magnetic tape and high speed punch and reader operation. Fig. 2 shows the overall system. Fig. 3 shows a typical plot of the raw data. These plots are produced on line and simultaneously with the data acquisition.

III. OPERATION

The types of measurements that can be performed are:

a) Response of structures to the pulse incident field. The input pulse can be unfolded numerically to yield the impulse response or the response to any given input.

b) Response of structures to incident pulse, with additional resistive loading applied in series with the structure. This decreases the ring-down time for structures with high Q; also it is a simple matter to unfold the loading from the data.

c) Scattering from a structure obtained by a probe at known geometry from the scatterer.

d) Transmission through a structure, such as a screen, imperfect conductor, etc.

e) Broad band terminal impedance can be obtained from reflectometry techniques. At present the software necessary to compute impedance is not implemented, but can be readily obtained off-line.

f) Short circuit current and open circuit voltage.

In addition to the above measurements that have been made; near future implementation of skin current, and simulated free space instrumentation will be available.

Fig. 4 and 5 show a VEE dipole experiment with the solid line being the measured data and the asterisk the calculated response [2,3]. Fig. 6 shows additional targets that have been analyzed [4]. A comparison between the measured and calculated response is shown in Fig. 7 for the model on the right-hand side of Fig. 6.

ACKNOWLEDGMENTS

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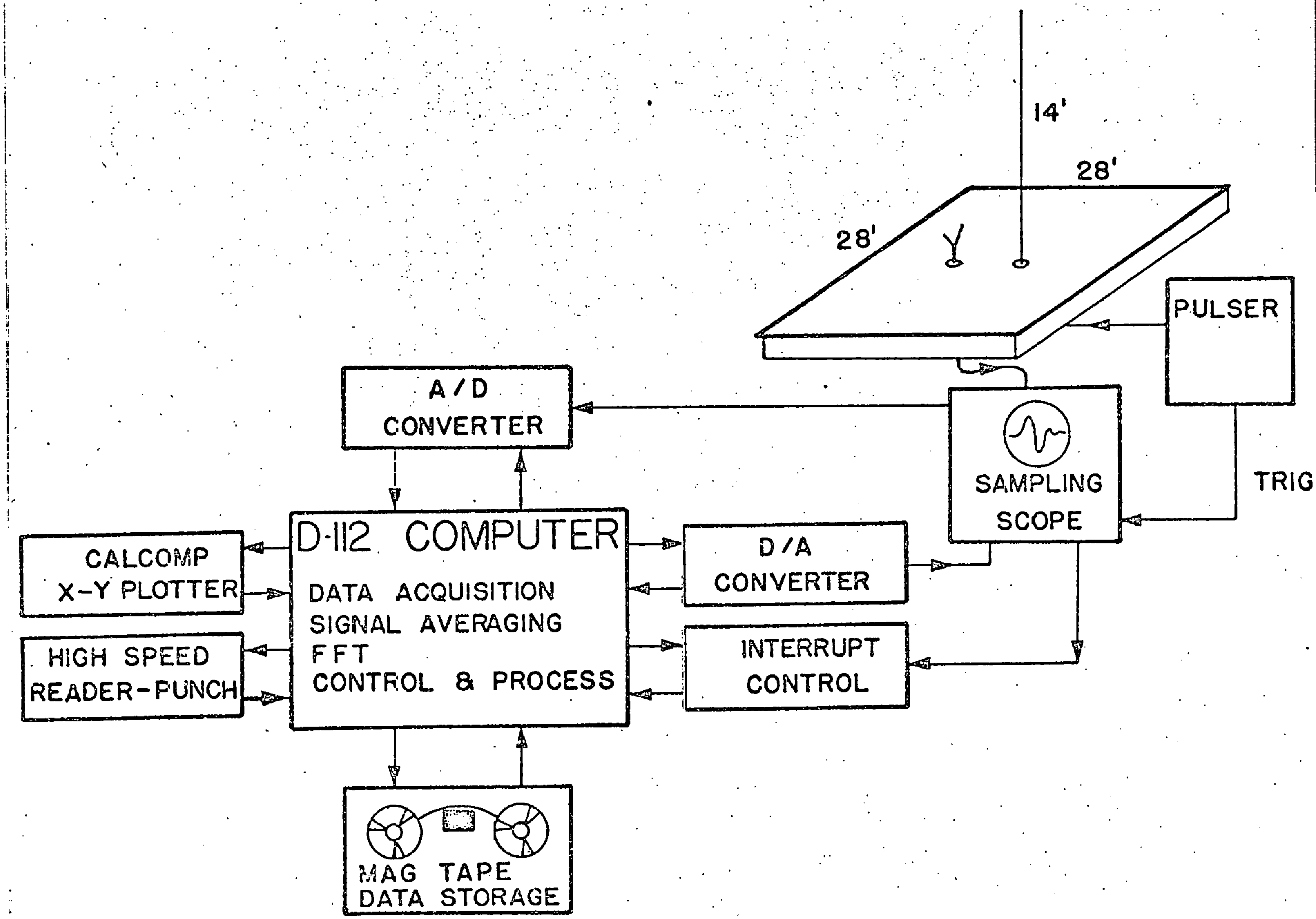

Figure 1. Schematic of LLL transient electromagnetic measurement facility.

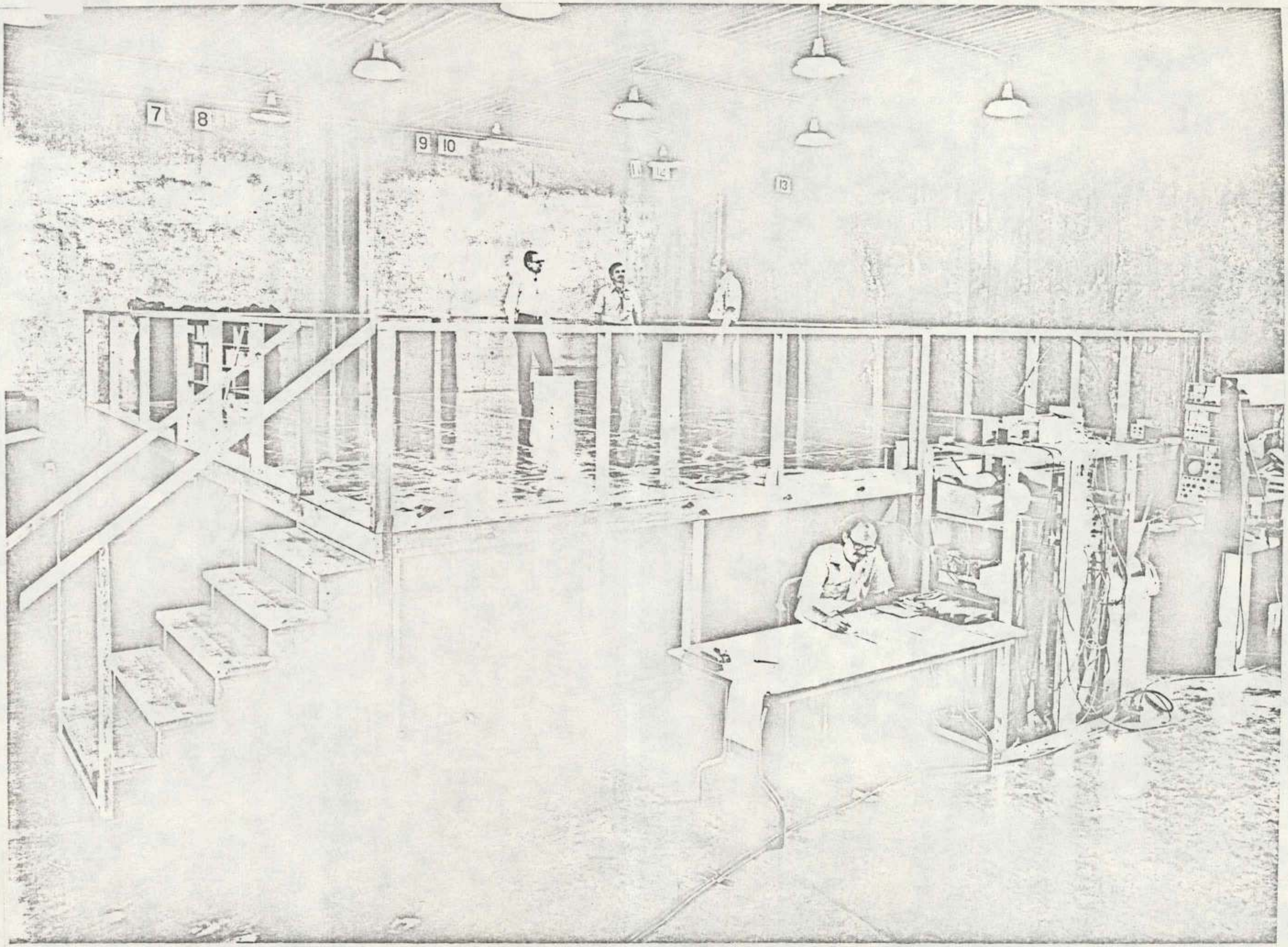

Figure 2. The ground plane and data acquisition equipment.

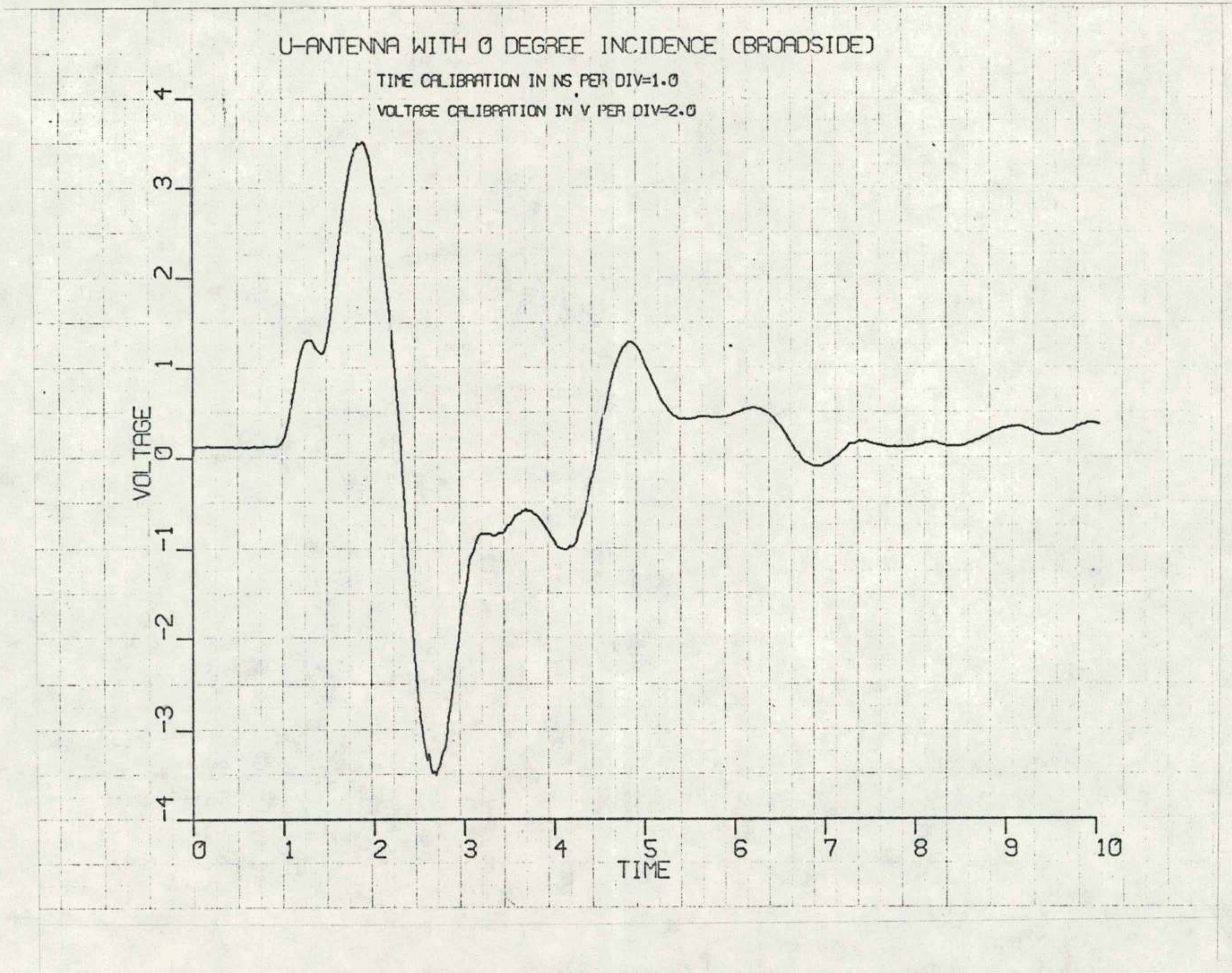

Figure 3. Response of a U-antenna, plotted as the data were acquired.

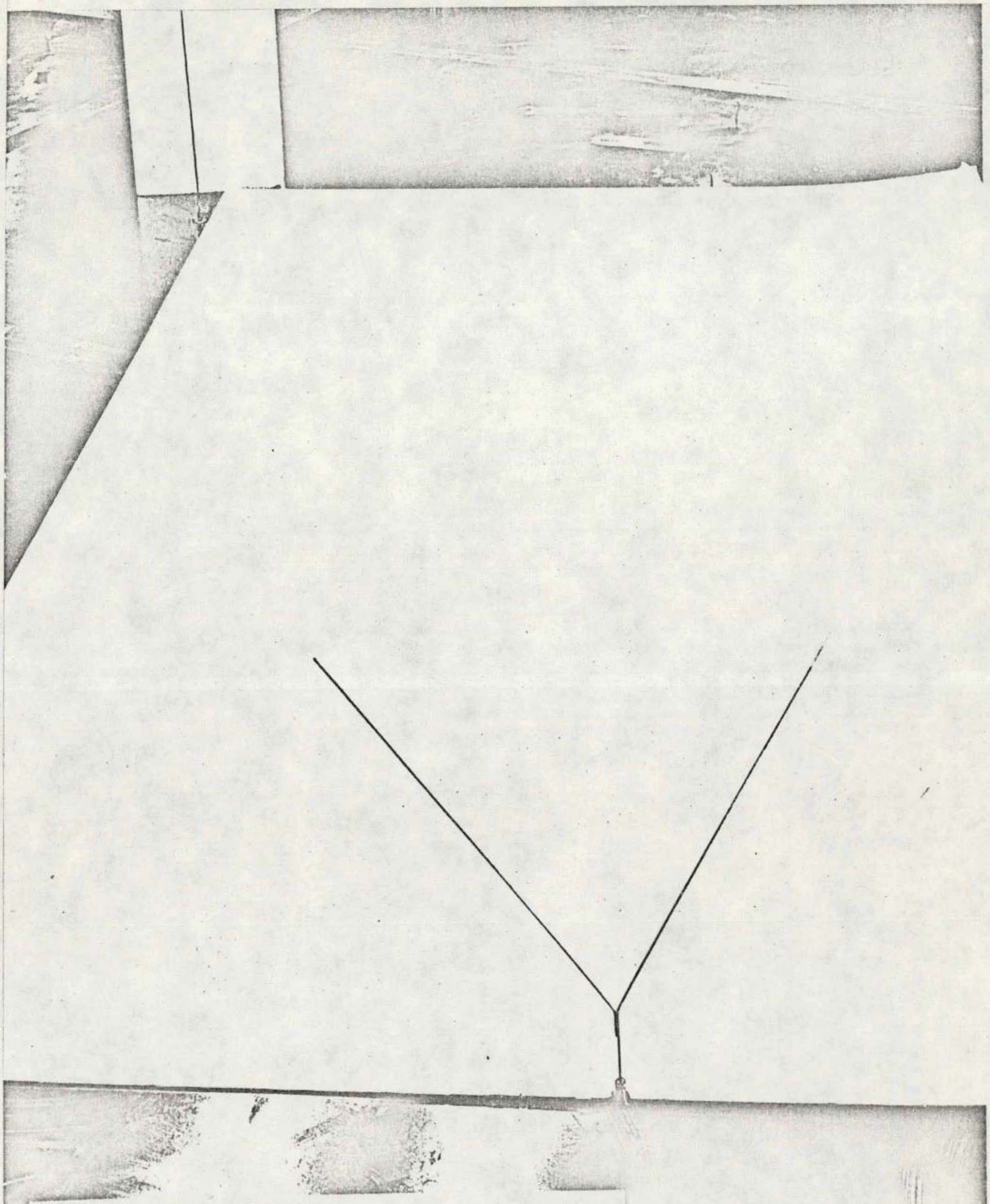

Figure 4. The V-dipole experiment.

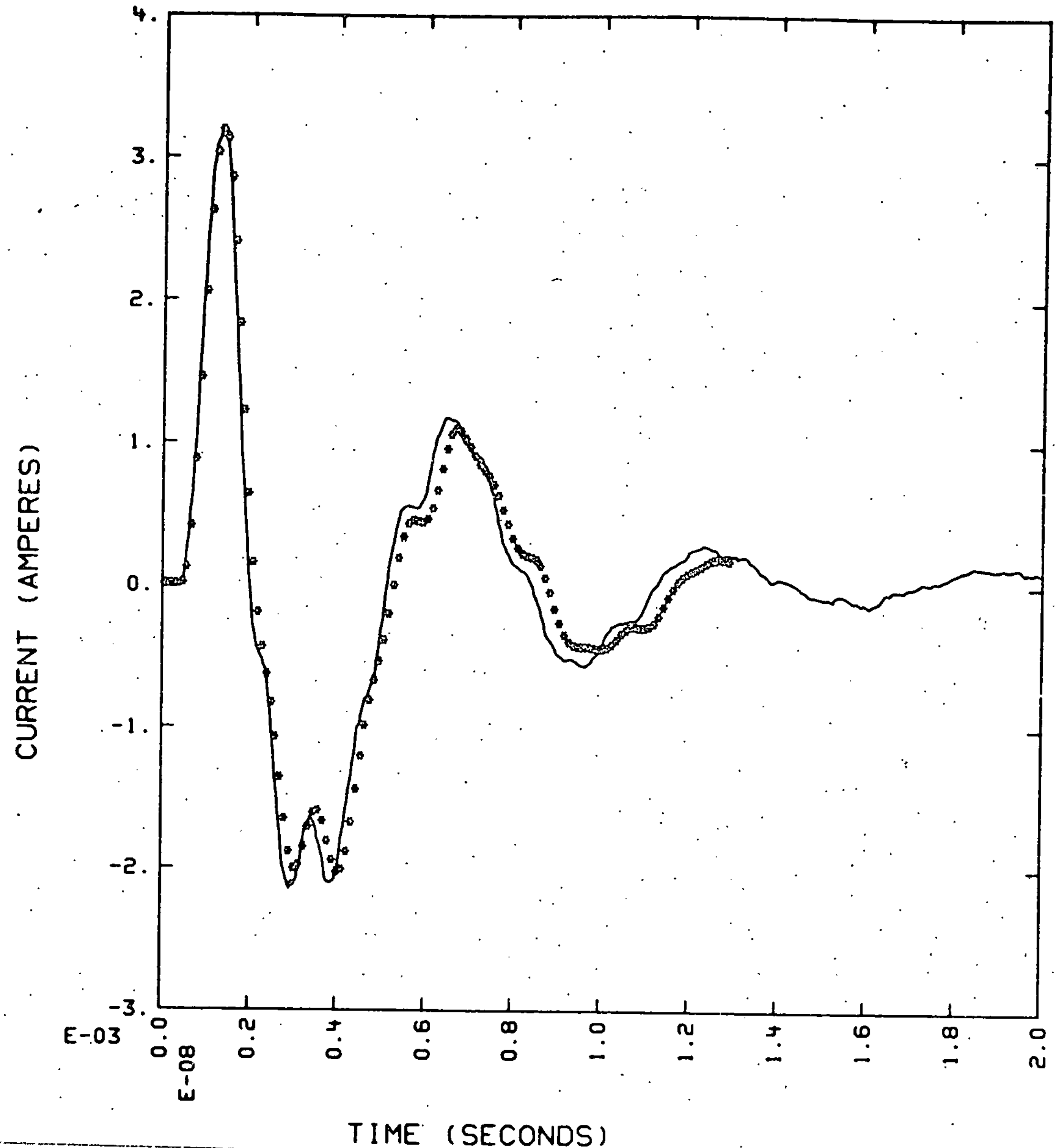

Figure 5. Comparison of measured response (solid line) with calculations for the V-dipole antenna.

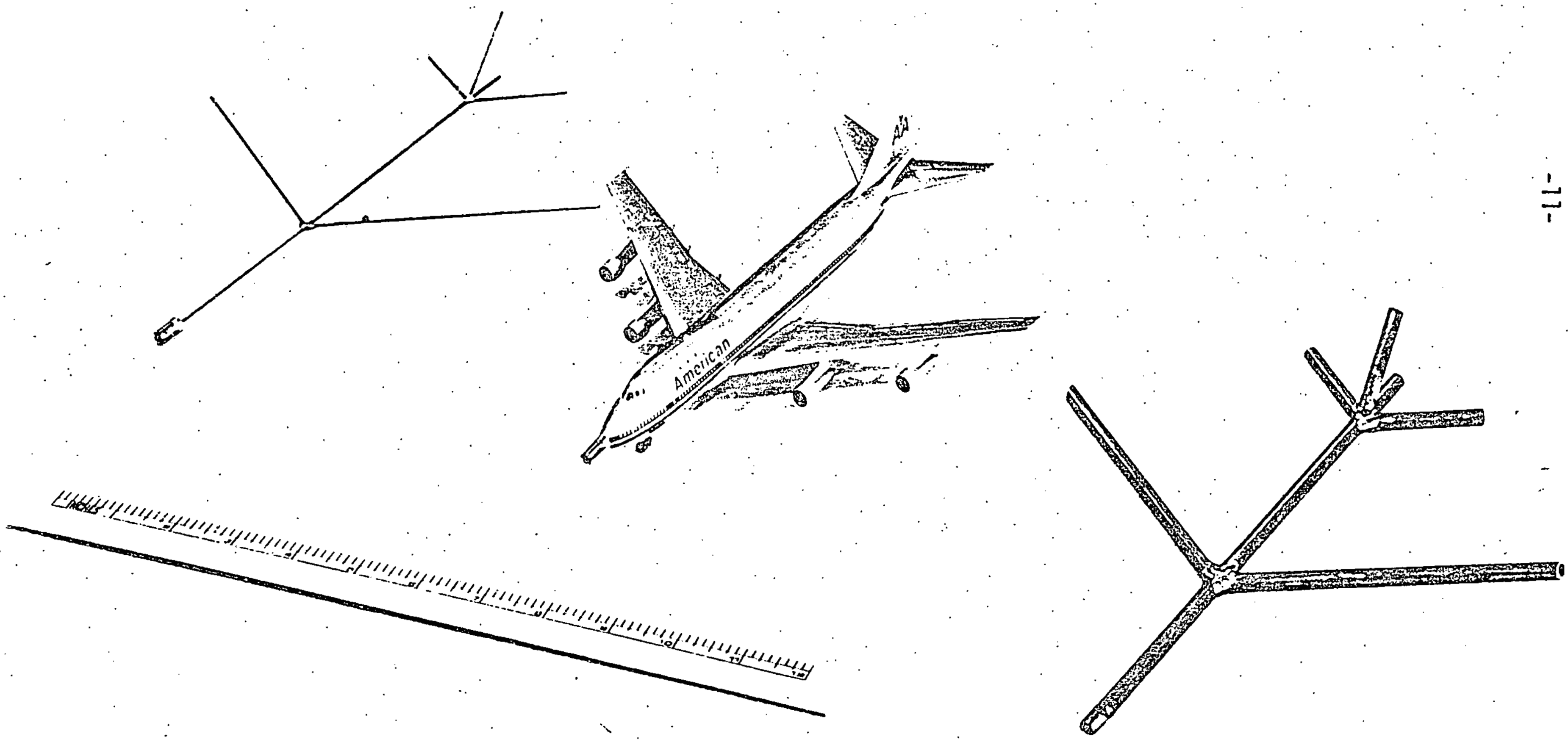

Figure 6   Typical Targets

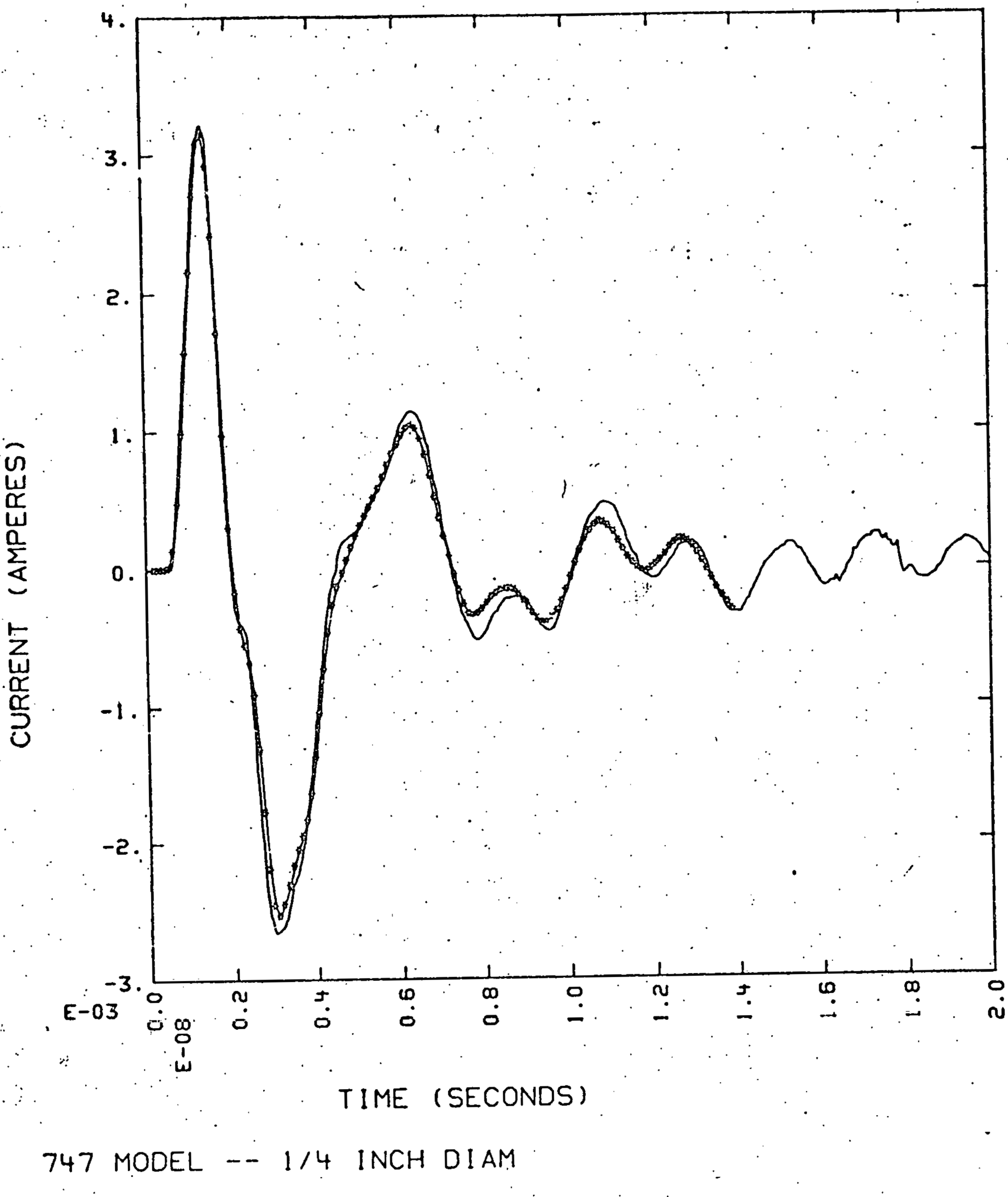

Figure 7. Comparison of measured response (solid line) with calculations for the 1/4" tubins model of a 747 aircraft.

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