C. TIME VARYING AIR CONDUCTIVITY—RESULTS

by
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The theory used in the present research is due to Clayborne D. Taylor of Mississippi State University. A description was published in IEEE Transactions on Antennas and Propagation, Volume AP-18, No. 1, January 1970. This theory has been modified slightly and the direction of propagation of the incident wave can now be specified, whereas previously only longitudinal propagation was considered. Replacement currents are not included. The antenna of interest for the following three cases is a cylindrical reentry vehicle 1.5 m in length and 3 m in diameter.

In case 1, the amplitude of the field was set at 1 v/m with a pulse length of 20 ns. Wave propagation was in a direction parallel to the axis of the cylinder, and the surface current was calculated at the cylinder center. Results for various RV conductivities are given in Figure 1.

Case 2 is identical to case 1 except that the conductivity is assumed to increase linearly for 10 ns (to the peak pulse time) and then remain constant. The results in Figure 2 are approximately the same as those of Figure 1.

Case 3 is identical to case 1 except that the conductivity is assumed to be zero for the first 10 ns (to the peak pulse time), then increases linearly between 10 ns and 20 ns, and finally remains constant. The results in Figure 3 are substantially different from those of Figures 1 and 2.

Case 4 is for a hypothetical pulse and related conductivity, where the field is assumed to be of the form

$$E(t) = 10^3 (e^{-7.6\times10^6 t} - e^{-3.3\times10^8 t}),$$

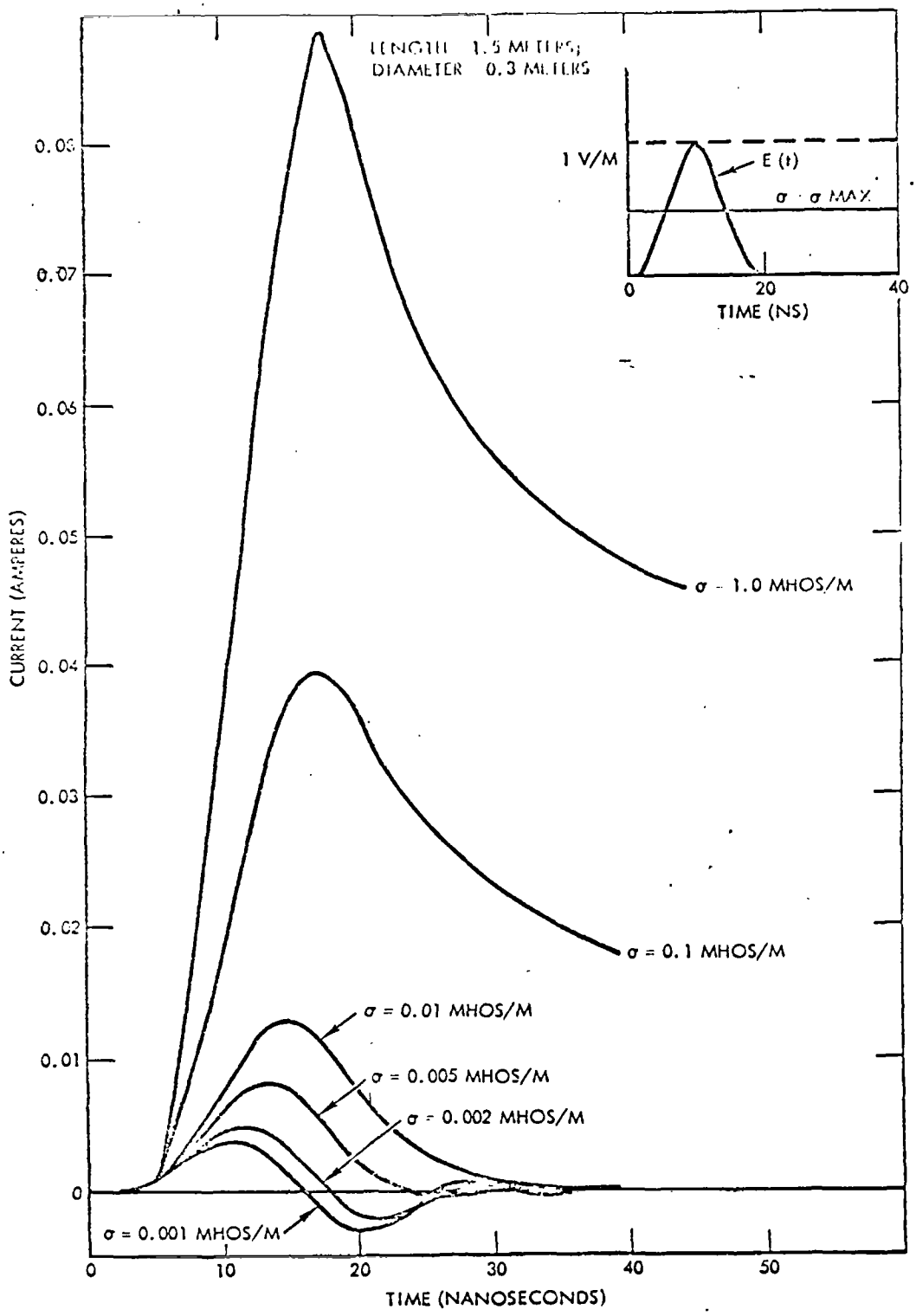


Figure 1. Center current vs. time – case 1.

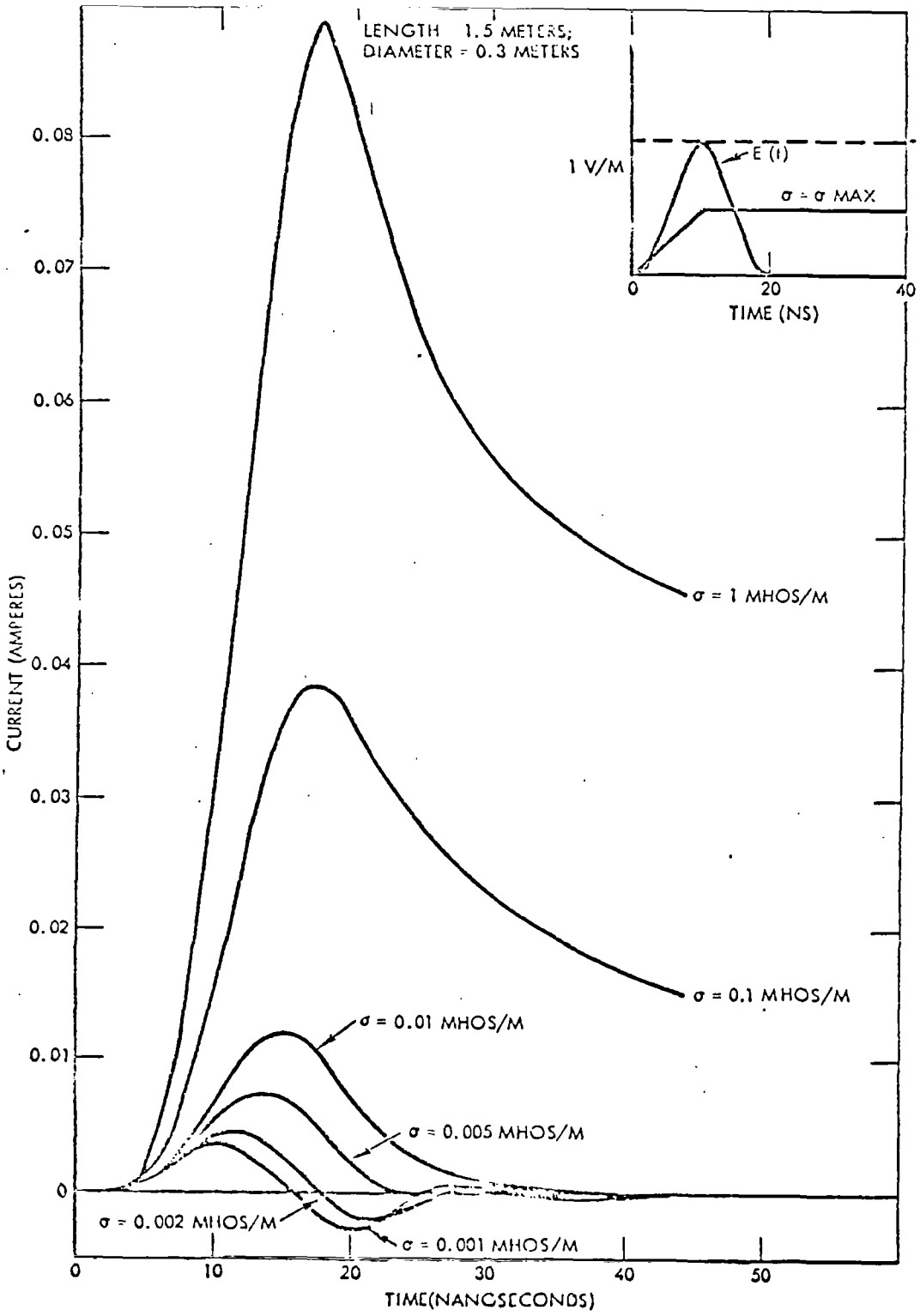


Figure 2. Center current vs. time - case 2.

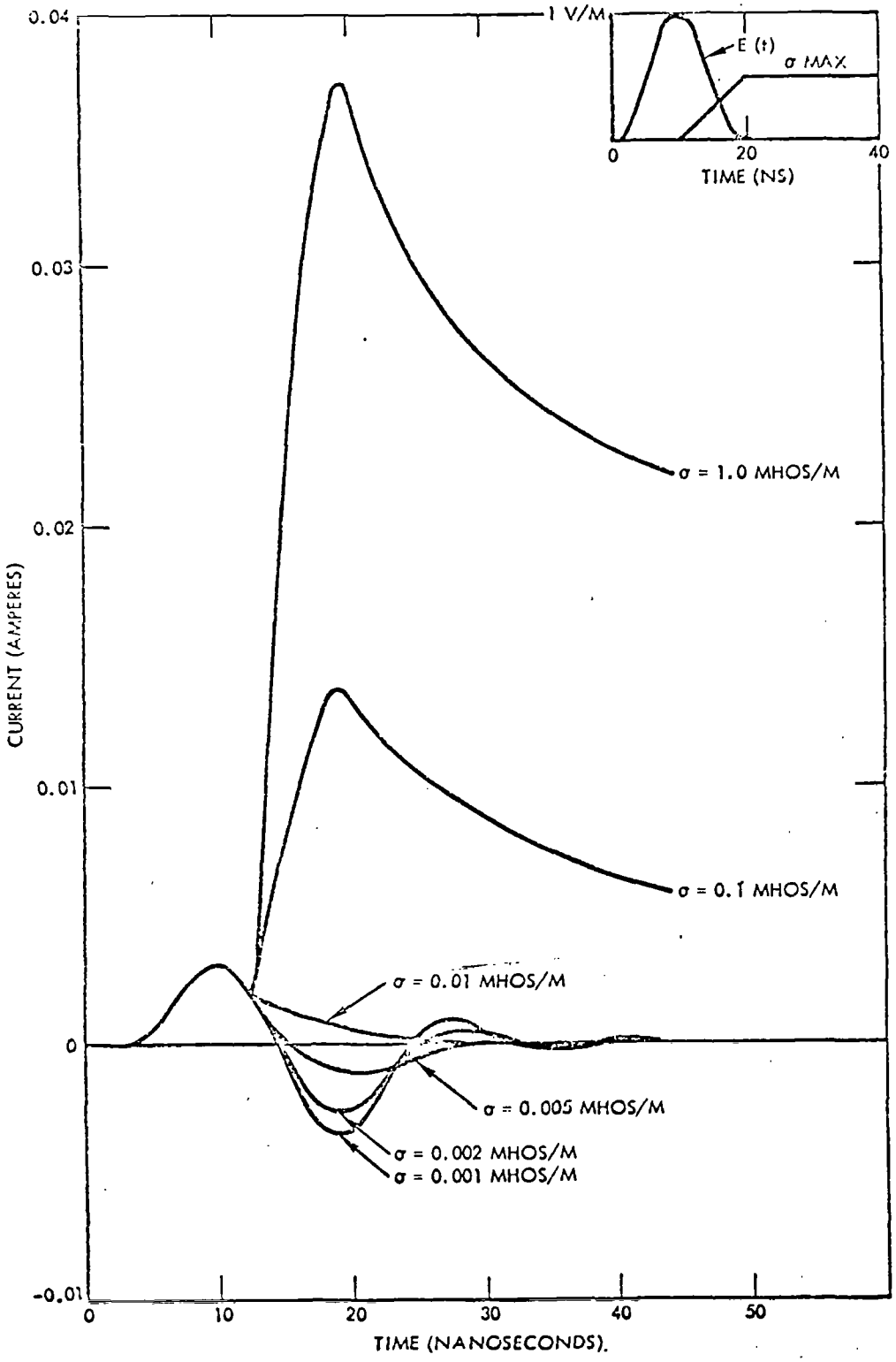
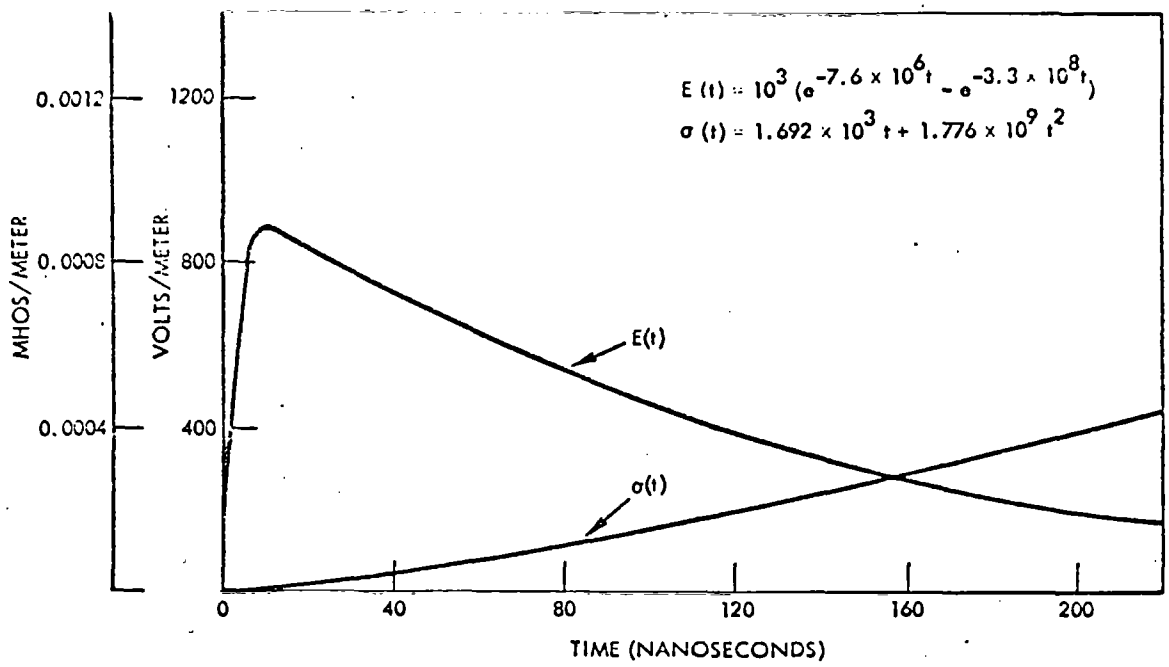


Figure 3. Center current vs. time – case 3.

and the conductivity of the form

- $\sigma(t) = 1.692 \times 10^{3}t + 1.776 \times 10^{9}t^{2}$.

The graph of each function is given in Figure 4, as is a comparison between the case of time-varying conductivity and free-space conductivity, for an antenna of length 12 meters and radius 0.6 meters. Note that the current in the time-varying conductivity showed a damped effect.


E (t) = 10^3 (e^-7.6 x 10^6 t - e^-3.3 x 10^8 t)
σ (t) = 1.692 x 10^3 t + 1.776 x 10^9 t^2
0.0012
0.0008
0.0004
MHOS/METER
1200
800
400
VOLTS/METER
E(t)
σ(t)
0
40
80
120
160
200
TIME (NANOSECONDS)

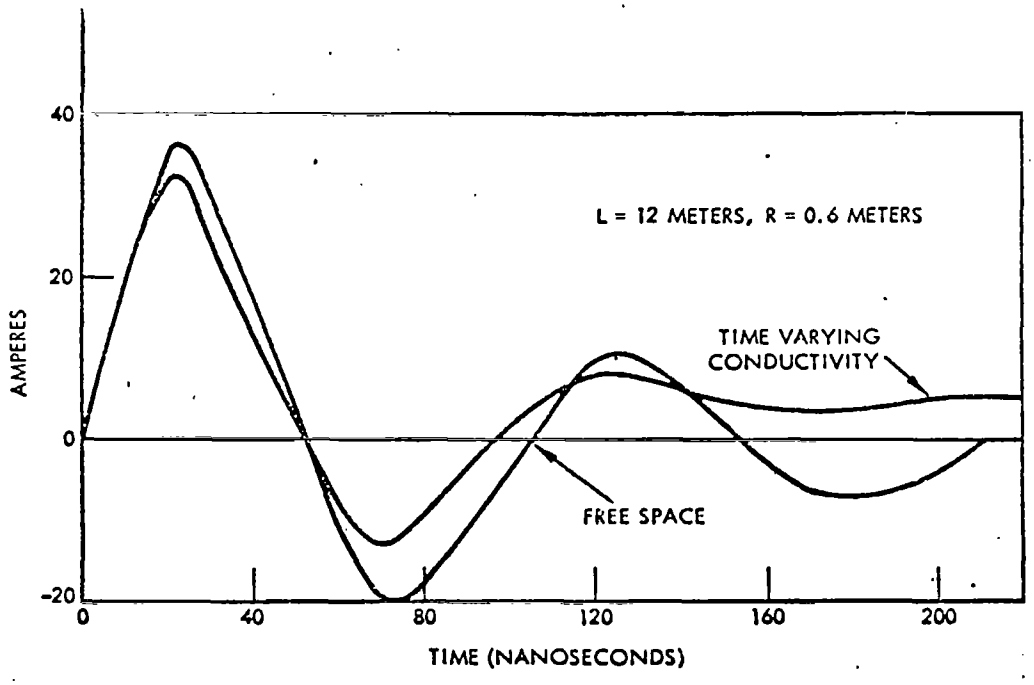

40
20
0
-20
AMPERES
L = 12 METERS, R = 0.6 METERS
TIME VARYING CONDUCTIVITY
FREE SPACE
0
40
80
120
160
200
TIME (NANOSECONDS)

Figure 4.