REPLY TO: "A DISCUSSION ON THE THREE-DIMENSIONAL BOUNDARY VALUE PROBLEM FOR ELECTROMAGNETIC FIELDS" BY D. RANKIN

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I do not regard the criticism by Rankin of my work as valid or even meaningful. I strongly reject the assertion by Rankin that my results are invalid.

As stated in my paper, the equation to solve (in e.m.u.) is:

$$\nabla^2 \vec{E} - \nabla (\nabla \cdot \vec{E}) = i\eta^2 \vec{E} \qquad (1)$$

where $\eta^2 = 4\pi\sigma\omega$. This may be rewritten as three scalar equations in Cartesian coordinates, one of which is

$$\frac{\partial^2 E_x}{\partial y^2} + \frac{\partial^2 E_x}{\partial z^2} - \frac{\partial}{\partial x}\left[\frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z}\right] = i\eta^2 E_x \qquad (2)$$

The equation to be solved is the diffusion equation, and it is not appropriate to consider waves in this context.

In the method a point-wise solution to the problem is approximated. As discussed in my paper the approach taken at discontinuities in conductivity is to choose the normal component of $\vec{E}$ at the discontinuity as the average of the normal components on either side of the discontinuity. This is similar to the well-known assumption made in obtaining Fourier series representations for piecewise continuous functions (Pipes, 1958; p. 51). In the geophysical problem this means that the discontinuity is approximated by a transition zone, which is a very good approximation for such cases. By using this approach, both the values of the function and its derivatives give a good estimate for those associated with the physical situation. It is not apparent and Rankin has not shown that "all the field components and the derivatives are grossly distorted in the region about the boundary" for geophysically realistic situations. He has given no evidence to support his assertation that the results are "invalid".

Although Rankin declares that one cannot calculate the electric components from the magnetic, in his discussion he has not stated why this is so. After once calculating the magnetic components the electric components may be calculated, but one must insure that the initial solution is accurate enough to prevent significant round-off errors.

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