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Radio Navigation Coordinate Corrections for Excess Phase Accumulation Over Irregular, Inhomogeneous Terrain

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Technical Memorandum ERLTM-ITS 220

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FOREWORD

This work was completed as part of interagency work order F3361567M5010, amendment P002, dated September 13, 1968, for the United States Air Force (AFSC), Loran Programs Office (ASD), Wright-Patterson AF Base, Ohio 45433. It represents part of the theoretical work performed under this order.

It should be emphasized that numerical examples given in this report are cases of extreme roughness over the entire propagation path, intended to give physically possible bounds. These results are not necessarily appropriate to data obtained in the flight test program. In fact, the latter data are to be analyzed in separate reports, based on both the exact approach given in ESSA Technical Report ERL 121-ITS 85 and the approximate methods outlined in ESSA Technical Report ERL 116-ITS 63 and in this report.

TABLE OF CONTENTS

ABSTRACT

Radio navigation systems such as Loran C, D operate on ground waves over distances up to 3000 or 4000 km from the transmitters. If the ground is inhomogeneous and irregular, the wave propagation may be considerably different from the classical smooth, spherical ground behavior. In addition to local perturbations in the field resulting from mountains and ground geological structure, an excess phase accumulation as a function of distance from the transmitter can be theoretically demonstrated. In this paper, the effect of a surface wave, excited by uniform roughness of the ground, on the navigation coordinate calculation is used to calculate large but physically possible excess phase accummulations. A computer program based on simplified and more general rough ground concepts is presented. Time differences, gradients, latitude, longitude, and distances along a geodetic line can be calculated with this program. Various indexes of roughness can be introduced for each propagation path calculated.

Key Words: Ground impedance, ground wave, ground wave propagation, LF ground wave, Loran , Loran C, Loran D, low frequencies, propagation, propagation over rough terrain, radio navigation.

RADIO NAVIGATION COORDINATE CORRECTIONS FOR EXCESS PHASE ACCUMULATION OVER IRREGULAR, INHOMOGENEOUS TERRAIN

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1. INTRODUCTION

In a previous paper (Johler and Berry, 1967),the procedure for calculating the effects of arbitrary two-dimensional rough terrain on the radio navigation signal was presented. More recently (Johler, 1969b), a theory based on simplified and more general impedance concepts was introduced as a computer program for calculating phase corrections. While calculations with this technique ordinarily pertain to uniformly rough surfaces, considerable generalization of the impedance concept to almost any type of geological structure seems to be possible. Calculations of the phase corrections over almost any type of terrain can then be made within the framework of classical theory. This greatly simplifies the computer program, compared with the tedious numerical integration required in the more rigorous integral equation solution (Johler and Berry, 1967).

Previously (Johler, 1969b), it was found that a surface wave could be excited over uniformly rough terrain at 100 kHz. Under such circumstances an excess phase accumulation as a function of distance from the transmitter was noted. Thus, the phase lag was considerably greater than the phase lag possible over smooth, spherical ground. This phase accumulation was also noted by Johler and Berry (1967), since the phase perturbations caused by a single ridge or hill caused an apparent permanent phase offset after the hill was passed. This paper demonstrates the effect of excess phase accumulation on a Loran C,D coordinate calculation.

A radio navigation fix is usually obtained as the intersection of two hyperbolic lines of position. These hyperbolic lines are synthesized (fig. 1) from a set of three transmitters comprising a master (M) and two slaves (S_1 and S_2) separated by convenient baseline lengths, d_{b_1} and d_{b_2}. The radio navigator's line of position is expressed as a constant time difference,

$$\Delta t = \text{constant} , \tag{1}$$

where

$$\Delta t = \frac{\eta_1}{c} [d_b + d_s - d_m] + t_c (d_b) + t_c (d_s) - t_c (d_m) + C_s . \tag{2}$$

In (2),

η_1 = index of refraction of air, $\eta_1 = 1.0001$ to 1.0003.

c = speed of light, $c \sim 2.997925(10^8)$ m/s.

d_b = length of a geodetic line from the master to a slave, i.e., the baseline.

d_m = length of a geodetic line from an observation point to the master transmitter.

d_s = length of a geodetic line from an observation point to a slave transmitter.

C_s = coding delay or the retransmission time of the slave signal.

t_c = phase correction for propagation over a path of length $d = d_m$, d_s , d_b , seconds. This correction is usually expressed in microseconds.

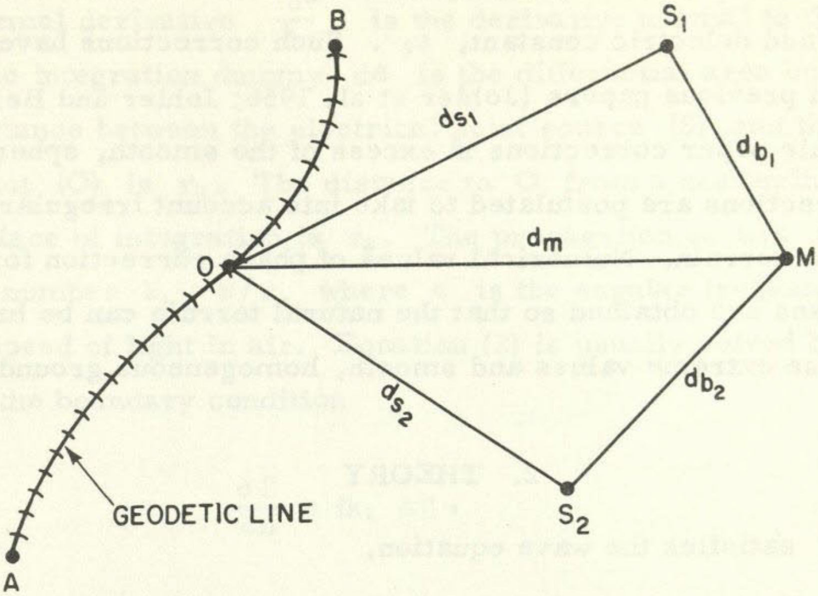


Figure 1. Loran C, D system configuration for calculating time-difference at the point O on a geodetic line AB.

All distances are calculated as the shortest distance on the Clarke spheroid of 1866 (Clarke, 1880). Methods for calculating geodetic lines have been given by Clarke (1880), U. S. Coast and Geodetic Survey (1933), and Lewis (1963). A computer program developed by Crary (1965) is based on the Lewis (1963) method for the geodesic curve. This method was adapted to the analysis presented in this paper.

Two hyperbolic lines of position Δt_1 and Δt_2 defined by (1) determine a radio navigation fix at the intersection point. If the latitude and longitude of the master and slave transmitters are known, the latitude and longitude of the intersection point can be calculated with a computer. The phase corrections t_c given in (2) must be known to accomplish this calculation with the precision required by modern navigation systems. The first order correction involves the classical propagation theory over smooth, spherical ground of finite conductivity, σ mhos/m, and delectric constant, ϵ_2. Such corrections have been presented in previous papers (Johler et al, 1956; Johler and Berry, 1967). In this paper corrections in excess of the smooth, spherical ground corrections are postulated to take into account irregular, inhomogeneous terrain. Numerical values of phase correction for extreme cases are obtained so that the natural terrain can be bracketed between these extreme values and smooth, homogeneous ground values.

2. THEORY

If Π satisfies the wave equation,

$$(\nabla^2 + k^2)\,\Pi = 0 \ , \tag{3}$$

where k is the wave number, we concluded in a previous paper (Johler and Berry, 1967) that inhomogeneous, irregular ground effects at a point O can be found from an evaluation of $\Pi(O)$ and a set of points $\Pi(Q)$ - where the set (Q) exist on the surface S_0 of the irregular, inhomogeneous ground - to satisfy the integral equation

$$\Pi(O) = 2\exp[-ik_1 r_0]/r_0 + \frac{1}{2\pi}\int_{S_0}\left[\Pi(Q)\frac{\partial}{\partial n}\left(\exp[-ik_1 r_2]/r_2\right) - \left(\exp[-ik_1 r_2]/r_2\right) \times \frac{\partial}{\partial n}\Pi(Q)\right] dA \ . \tag{4}$$

The normal derivative $\frac{\partial}{\partial n}$ is the derivative normal to the surface S_0. The integration dummy dA is the differential area on the surface. The distance between the electrical point source (S) and the observation point (O) is r_0. The distance to O from a scattering point on the surface of integration is r_2. The propagation occurs in air with a wave number $k_1 = \omega / c$, where ω is the angular frequency and c is the speed of light in air. Equation (2) is usually solved by introducing the boundary condition

$$\frac{\partial \Pi}{\partial n} = i k_1 \, \Delta \Pi \, , \tag{5}$$

where

$$\Delta = Z / Z_0 \, , \tag{6}$$

the local surface impedance relative to free space (Z_0 = 377 ohms) at the point Q. For vertically polarized waves,

$$\Delta = \frac{k_1}{k_2} \sqrt{1 - \frac{k_1^2}{k_2^2}} \quad , \tag{7}$$

where

$$k_2 = \frac{\omega}{c} \sqrt{\epsilon_2 - i \frac{\sigma}{\epsilon_0 \omega}} \quad , \tag{8}$$

and where ϵ_2 is the dielectric constant, σ the conductivity, mhos/m, and ϵ_0 the permittivity of space. If the medium were homogeneous, except for the boundary S_0 over which the integration is performed, σ would be adequately described by the d-c conductivity measurement of the medium k_2. In general, the natural ground is not homogeneous, and a radio frequency value for σ must be found locally by measurements of the type described by Frishknecht (1967), Johler Lilley (1961), and Johler (1969a). In the presence of such inhomogeneities as ground stratification, σ may be a complex number. If in the measurement of σ, for example, the mutal impedance of loop antennas (Wait, 1953, 1955, 1956) near the ground is used, the impedance measurement in general depends upon the entire surface S_0. However, only local conditions affect the mutual impedance (not to be confused with the ground impedance) of the two loops to any significant extent when the loops consisting of a transmitter and a receiver are close together and close to the ground. The loop technique described in a previous paper (Johler, 1969b) therefore determines the quantity σ or indeed the complex conductivity

$$\sigma_{eff} \approx i\omega \epsilon_0 \left[\frac{\epsilon_1^2}{\Delta^2} - \epsilon_2 \right] , \tag{9}$$

where ϵ_1 and ϵ_2 are the assumed dielectric constants of air and the ground. If the transmitter and receiver are far apart, as is ordinarily the case in Loran C, D phase measurements, the entire surface S_0 determines the effective complex impedance at any point O. This is a consequence of contributions from (Q), the set of local points spread over the surface S_0. Each point Q scatters a field to O. The most important values of Q might be expected to lie on the geodetic line connecting S to O (transmitter to receiver) on a reference sphere with a radius of ~ 6360 km. Such a conclusion can be reached by applying Kelvin's principle of stationary phase. Then the off-path points would be expected to make a contribution that would be expected to diminish as the distance of Q from the geodetic line is increased. Nevertheless, in the case of natural ground, strong off-path scatterers can be found that may contribute to the impedance or a point on the geodetic line.

The question naturally arises: Can we ascribe an impedance Δ to describe the field, $\Pi(O)$ within the framework of classical theory?

In a previous paper (Johler and Berry, 1967) it was established theoretically and numerically that classical theory could be recovered by evaluating (2) for a smooth, homogeneous sphere. In the notation of this paper, $\delta = \Delta$.

In another paper (Johler, 1969b), an impedance $\Delta = \Delta_2$ was described to represent uniformly rough terrain of finite conductivity in the context of classical theory. The transverse magnetic or vertical electric ordinarily dominates as a propagated field because the transverse electric field or the vertical magnetic field is usually attenuated severely over finitely conducting ground. Thus, if we assume $|\Delta_1| >> 1$ and $|\Delta_2| << 1$, where Δ_1 is the impedance for the transverse electric or TE-propagation mode and Δ_2 is the impedance for the transverse magnetic or TM-propagation mode, we can neglect the TE-propagation mode $\Pi^m(O)$. Then the TM-mode, $\Pi^e(O)$ as an attenuation function $W^e(O)$, is given by

$$W^e(O) = \frac{\Pi^e(O)}{2\Pi_{pri}(O)} , \tag{10}$$

or

$$W^e(O) \cong \sqrt{-2\pi i (k_1 a)^{\frac{1}{3}} \frac{d}{a}} \sum_{s=o}^{\infty} \frac{\exp[-i(k_1 a)^{\frac{1}{3}} \frac{d}{a} \tau_s]}{2\tau_s + (k_1 a)^{2/3} \Delta_2^2} , \tag{11}$$

where $\tau = \tau_s$ are the roots of

$$\frac{d\delta_e}{d\tau} - 2\delta_e^2 \tau + 1 = 0 , \tag{12}$$

and

$$\delta_e = \frac{-i}{(k_1 a)^{\frac{1}{3}} \Delta_2} , \tag{13}$$

and

$$\Pi_{pri}(O) = \exp[-ik_1 r_0] / r_0 . \tag{14}$$

The phase correction φ_c is the quantity of importance to Loran C, D navigation:

$$\varphi_c \sim (k_1 a)^{\frac{1}{3}} \tau_0 \frac{d}{a} \quad , \tag{15}$$

where the first and dominant term of the series (11) is used, s = 0.

Suppose the measured value of the phase correction is $\varphi_c{}'$. Over smooth spherical ground, $\varphi_c{}' = \varphi_c$. But as a result of inhomogeneous, irregular ground,

$$\varphi_c{}' = \varphi_c + \xi \;, \tag{16}$$

where ξ is the excess phase accumulation. From Johler et al.(1959) and Johler et al.(1956),

$$\tau_0 \simeq \tau_{0,\infty} - \frac{1}{2\tau_{0,\infty}\,\delta_e} \,, \tag{17}$$

where

$$\tau_{0,\infty} = 0.808 \exp\left[-i\,\frac{\pi}{3}\right] ,$$

provided $\delta_e \to \infty$ or $\sigma \to \infty$. Using (13), (16), and (17), and noticing that

$$\frac{\varphi_c + \xi}{(k_1 a)^{\frac{1}{3}} \frac{d}{a}} - \tau_{0,\infty} = \frac{(k_1 a)^{\frac{1}{3}}}{2 i \tau_{0,\infty}} \; \Delta_2$$

and

$$\frac{\varphi_c}{(k_1 a)^{\frac{1}{3}} \frac{d}{a}} - \tau_{0,\infty} = \frac{(k_1 a)^{\frac{1}{3}}}{2 i \tau_{0,\infty}} \; \Delta \,,$$

we can conclude that

$$\Delta_2 \approx \frac{1 + \dfrac{\xi(d)}{\varphi_c(d)} - \dfrac{\tau_{0,\infty} (k_1 a)^{\frac{1}{3}} \frac{d}{a}}{\varphi_c(d)}}{1 - \dfrac{\tau_{0,\infty} (k_1 a)^{\frac{1}{3}} \frac{d}{a}}{\varphi_c(d)}} \; \Delta \,. \tag{18}$$

Similarly, for $\delta_\circ \rightarrow 0$, $\sigma \rightarrow 0$ or Δ_2 large,

$$\Delta_2 \approx \frac{1 - \dfrac{\tau_{\circ,\circ}\,(k_1 a)^{\frac{1}{3}}\,\dfrac{d}{a}}{\varphi_c(d)}}{1 + \dfrac{\xi(d)}{\varphi_c(d)} - \dfrac{\tau_{\circ,\circ}\,(k_1 a)^{\frac{1}{3}}\,\dfrac{d}{a}}{\varphi_c(d)}}\ \Delta , \tag{19}$$

where Δ (7) is the smooth, homogeneous impedance for average ground and where

$$\tau_{\circ,\circ} = 1.856 \exp\left[-i\frac{\pi}{3}\right] .$$

The time correction in microseconds for the radio navigation system is given by

$$t_c = \frac{\varphi_c}{\omega}\,(10^6) , \tag{20}$$

or, at 100 kHz,

$$t_c = 1.592\,\varphi_c . \tag{21}$$

It is, of course, obvious that this solution can be accomplished in a more exact manner by using (11), which gives

$$\varphi_c'' = \mathrm{Arg}\,\Pi^\circ\,(O) . \tag{22}$$

This implies that Δ_2 is calculated with the approximate formula (17) and iterated until

$$\varphi_c'' = \varphi_c' = \varphi_c + \xi , \tag{23}$$

with inclusion of all the terms, $s = 0, 1, 2, 3 \cdots$ of the series (11) necessary to obtain the required accuracy. This can be accomplished, for example, by using the Miller (1956) iterative procedure to solve (23).

Usually three approximations are required to start the iterations. For this purpose (18), (19), and (7) can be used. Measurement of $\varphi_c'(d)$ uniquely determines an impedance and a field amplitude because the set $\varphi_c'(d_1)$, $\varphi_c'(d_2)$, $\varphi_c'(d_3)$ ... are known, i.e., the phase is known as a function of distance. In effect, then, the $\varphi_c'(d)$ measurement has provided a numerical evaluation of the integral equation (4) for each point O, with account taken of scatter fields arising from the set (Ω), the latter of which is spread over the surface S_o. The impedance Δ_2 is then a generalized impedance and will be different as the point O is moved, which implies that

$$\Delta_2 = \Delta_2(d) \ . \tag{24}$$

This means that we could find a different Δ_2 at each distance d from the transmitter. Only in the case of a smooth, homogeneous spherical ground would Δ_2 be constant and equal to Δ. As pointed out in the previous paper, Δ_2 belongs to the set

$$-\frac{\pi}{2} \le \arg \Delta_2 \le \frac{\pi}{2} \ . \tag{25}$$

Also, the magnitude $|\Delta_2|$ belongs to a set:

$$0 \le |\Delta_2| < M \quad ,$$

where at 100 kHz the upper bound $M \sim 10^{-1}$ can be applied. Clearly, M is bounded at worst by the right half of the complex plane, since negative real Δ_2 are physically impossible. Quite naturally the analysis given above suggests mapping an area by reconnaissance. The maps would be impedance maps instead of topographic maps, showing the amplitude and phase of the impedance Δ_2 or the complex conductivity σ_{eff} (9). Once such data are generated for an area, the behavior of the Loran C, D system can be calculated with the aid of simplified computer programs of the type given in the appendix for arbitrary flight plans over the area.

The loss into the TE-mode can be treated in a more exact mathematical form. In a previous paper (Johler, 1969b), the vertical electric field E_r of a source dipole current moment $I_o \ell$ ampere-meters is given by

$$E_r = \left[\frac{-\pi i \mu_o c I_o \ell}{2 k_1^2 \; r^2 \; b^2} \right] \sum_{s=o}^{\infty} \frac{\nu_s (\nu_s^2 - \frac{1}{4}) P_{\nu_s - \frac{1}{2}}(-\cos\theta) f_s(h_1) f_s(h_2)}{\cos(\nu_s \pi) \left[\frac{\partial}{\partial \nu} D_\nu \right]_{\nu = \nu_s}} , \tag{26}$$

where μ_o is the permeability of space, and

$$D_\nu = \left\{ \left[-\ell n' \left(\zeta_{1r}^{(2)} \right) + i \Delta_1 \right] \left[-\ell n' \left(\zeta_{1r}^{(2)} \right) + i \Delta_2 \right] \right\}_{r=a} , \tag{27}$$

and $\nu = \nu_s$ is a solution of

$$D_\nu = 0 . \tag{28}$$

The abbreviations

$$\zeta_{1a}^{(1,2)} = \zeta_n^{(1,2)}(k_2 a) = \sqrt{\frac{\pi k_1 a}{2}} \; H_{n+\frac{1}{2}}^{(1,2)}(k_1 a) \tag{29}$$

are used with $n = \nu - \frac{1}{2}$. The well-known Hankel functions $H_n^{(1,2)}(z)$ are of order n, argument z, and may be of the first or second kind. The logarithmic derivative $\ell n'$ is defined at r=a:

$$\ell n' \left(\zeta_{1r}^{(1,2)} \right) = \left. \frac{\zeta_{1r}^{(1,2)\prime}}{\zeta_{1r}^{(1,2)}} \right]_{r=a} , \tag{30}$$

where

$$\zeta_{1r}^{(1,2)\prime} = \frac{\partial}{\partial z} \; \zeta_n^{(1,2)}(z = k_1 r) . \tag{31}$$

The function $P_n(z)$ is a Legendre function of order n and argument (z). The height gain functions are given by

$$f_s(h_1)\, f_s(h_2) = \frac{\zeta^{(1)}_{1_b}\ \zeta^{(2)}_{1_r}}{\zeta^{(1)}_{1a}\ \zeta^{(2)}_{1a}}, \quad (r > b) \tag{32}$$

where $b = a + h_1$, $r = a + h_2$, and h_1 and h_2 are the altitude of the transmitter and receiver above the ground level, $r = a$.

After making the usual approximations to (26), one can deduce an attenuation function similar to (11),

$$W^e(O) \cong \sqrt{-2\pi i\,(k_1 a)^{\frac{1}{3}}\,\frac{d}{a}}\ \sum_{s=o}^{\infty} \frac{\exp\left[-i\,(k_1 a)^{\frac{1}{3}}\,\frac{d}{a}\,\tau_s^{e}\right]}{2\tau_s^{e} + (k_1 a)^{2/3}\,\Delta_2^2}\, F_e\,, \tag{33}$$

where $F_e = F_e(s)$ and can be written

$$F_e = \frac{-\ell n'\,(\zeta^{(1)}_{1a}) + i\Delta_1}{-\ell n'\,(\zeta^{(2)}_{1a}) + i\Delta_1}\ . \tag{34}$$

If $|\Delta_1| >> 1$, $F_e \sim 1$. This, of course, was assumed in (11).

The TE - mode does not propagate as readily as the TM-mode, but a similar attenuation function, $W^m(O)$, can be written for the TE-mode:

$$W^m(O) \cong \sqrt{-2\pi i\,(k_1 a)^{\frac{1}{3}}\,\frac{d}{a}}\ \sum_{s=o}^{\infty} \frac{\exp\left[-i\,(k_1 a)^{\frac{1}{3}}\,\frac{d}{a}\,\tau_s^{m}\right]}{2\tau_s^{m} + (k_1 a)^{2/3}\,\Delta_1^2}\, F_m\,, \tag{35}$$

where $F_m = F_m(s)$ and can be written

$$F_m = \frac{-\ell n'\,(\zeta^{(1)}_{1a}) + i\Delta_2}{-\ell n'\,(\zeta^{(2)}_{1a}) + i\Delta_2}\ . \tag{36}$$

The order of the spherical wave functions ν has been approximated by

$$\nu_s \cong k_1 a + (k_1 a)^{\frac{1}{3}} \tau_s^{e,m} \quad , \tag{37}$$

where $\tau_s^{e,m}$ is evaluated as the root $\tau^{e,m} = \tau_s^{e,m}$ of

$$\frac{d\delta_{e,m}}{d\tau} - 2\,\delta_{e,m}^2\,\tau + 1 = 0 \quad , \tag{38}$$

and

$$\delta_{e,m} = \frac{-i}{(k_1 a)^{\frac{1}{3}}\,\Delta_{2,1}} \quad . \tag{39}$$

The following are typical values of F_e and F_m together with Δ_1 and Δ_2 at f = 100 kHz for various modes, s = 0, 1, 2, 3..., (26):

s	$\lvert F_e \rvert$	$\operatorname{Arg} F_e$	$\lvert F_m \rvert$	$\operatorname{Arg} F_m$	$R_e\,\Delta_1$	$\operatorname{Im} \Delta_1$	$R_e\,\Delta_2$	$\operatorname{Im} \Delta_2$
0	0.9996	$-3.08(10^{-4})$	222.4	$-2.18(10^{-2})$	-0.216	-9.107	$8.19(10^{-3})$	$-6.20(10^{-2})$
1	0.9980	$-4.17(10^{-4})$	456.0	$3.03(10^{-1})$	-0.216	-9.107	$8.19(10^{-3})$	$-6.20(10^{-2})$
2	0.9960	$-5.59(10^{-4})$	236.3	$4.44(10^{-1})$	-0.216	-9.107	$8.19(10^{-3})$	$-6.20(10^{-2})$
3	0.9946	$-6.54(10^{-4})$	143.7	$5.12(10^{-1})$	-0.216	-9.107	$8.19(10^{-3})$	$-6.20(10^{-2})$

Here Δ_1 and Δ_2 are impedances for a bossy surface of the type described by Johler (1969b); uniform roughness of 300-m bosses with $3(10^{-7})$ bosses per square meter are used. This is a highly reactive impedance surface that excites a surface wave. It is apparent that the assumptions $F_e = 1$ and $\Delta_1 \gg \Delta_2$ are excellent assumptions at 100 kHz.

Of course, the vertical electric field E_r is of primary concern; hence (33) should be used for Loran C, D, unless the equipment is not measuring a strictly vertically polarized field (vertical transmitting and receiving antenna).

3. EXCESS PHASE ACCUMULATION

The application of the concepts of section 2 to field measurements of Loran C, D signals is complicated,and this task is reserved for future work. In this section we shall demonstrate the principle of excess phase accumulation (positive or negative) by introducing uniform roughness, and we shall describe the effect of such uniform roughness as though the actual ground wave over natural terrain gave the characteristic behavior to be discussed. We shall describe a hypothetical case that will give physically possible numerical values for natural ground that are not necessarily appropriate to the region described by the geographical coordinates. Extreme or very high values of roughness were selected, so that ultimately natural roughness could be bracketed between these values of roughness and smooth ground. Thus, the natural terrain values of impedance and phase correction will be bracketed between such extremes when data become available.

Consider navigating along the geodetic line AB, i.e., the shortest distance from A to B in figure 1. Suppose the area of concern could be represented by a rough surface that included departures from the sea-level spheroid for all propagation paths to the arbitrary point O on the geodetic line. It is a comparatively simple matter with the aid of the computer program presented in the appendix to calculate the Loran C, D time differences when the geodetic line AB corresponds to a radial from the transmitter (M) in figure 1, for example. Instead of calculating the time difference between the master (M) and slave ($S_{1,2}$) signals, the time difference between the master (M) and a stable oscillator carried by the observer can be made. This will give the phase accumulation as a function of distance along the geodesic over a single propagation path. In the presence of smooth, spherical ground an impedance Δ given in (7) is used. The phase accumulation as a function of distance along the geodesic is obtained if the impedance for rough terrain, Δ_2, is used. The corresponding calculated phase correction would be φ_c and φ_c'. The excess phase accumulation ξ caused by the rough terrain would then be $\xi = \varphi_c' - \varphi_c$. If we represent the surface with bosses of radii $a_e = 300$ m and number density $N = 3(10^{-7})\text{m}^{-2}$, we can excite a surface wave on the ground and cause considerable excess phase accumulation (Johler, 1969b). Thus, in the computer programs (see appendix) we use numbers N = ANN, a_e = BORA.

If the conductivity of the ground $\sigma = 0.005$ and the dielectric constant $\epsilon_2 = 15$, the impedance $|\Delta| = 0.03336$ and $\text{Arg}\,\Delta = 0.7765$ over smooth ground, while over rough terrain $|\Delta_2| = 0.06258$ and $\text{Arg}\,\Delta = 1.440$. The roughness has caused the surface impedance to become more reactive, i.e., the phase angle of Δ_2 is closer to $\frac{\pi}{2}$. Figure 2 illustrates the excess phase accumulation ξ as a function of distance. The direction of increasing distance is toward the transmitter (located at 662 km or 77° 54' W longitude). Thus ξ goes to zero at the transmitter. The computer graphical presentation is specific, and the actual geographical path in the North Carolina - Tennessee area displayed by the computer is also shown. In the absence of measured data we have of course made no attempt to simulate an actual measurement over this area, since this task is reserved for future work.

To improve our quantitative physical understanding of this matter, the conductivity is increased to very highly conducting ground, $\sigma = 5$. In the presence of identical roughness and identical geodetic line, the excess phase accumulation has increased (fig. 2). Thus at 662 km from the transmitter the phase ξ has increased from 3.2 to 4.5 μs. Note that we have expressed ξ in microseconds in (19) and (20), instead of radians. Figures 2, 3, and 4 show the excess phase accumulation for other geodetic lines with similar results, as might be

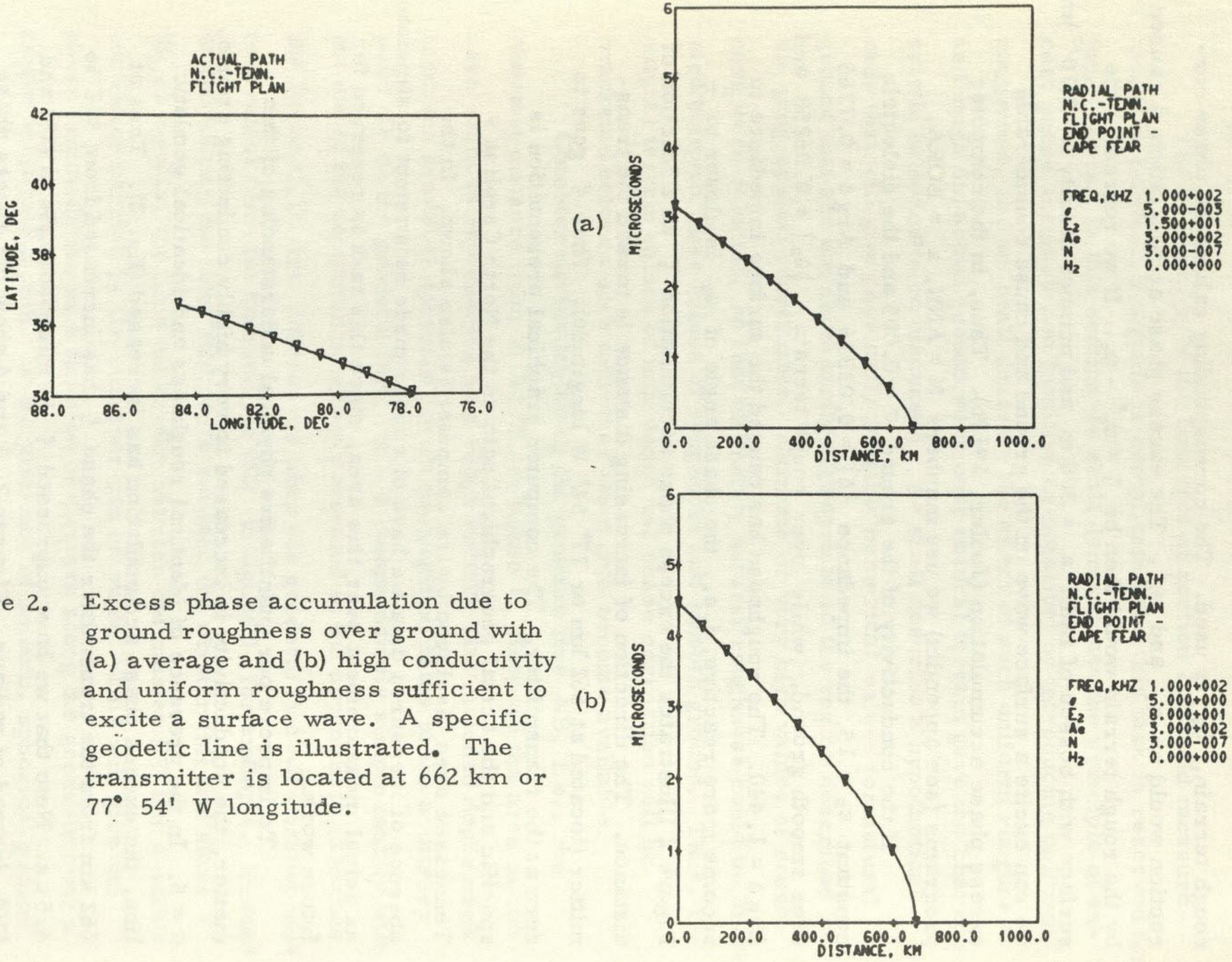
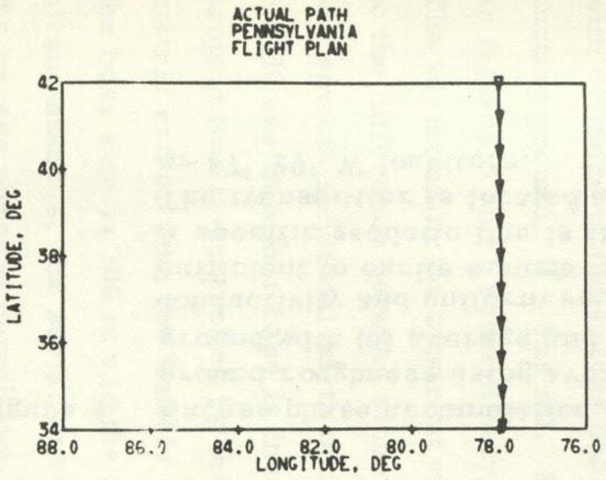


Figure 2. Excess phase accumulation due to ground roughness over ground with (a) average and (b) high conductivity and uniform roughness sufficient to excite a surface wave. A specific geodetic line is illustrated. The transmitter is located at 662 km or 77° 54' W longitude.



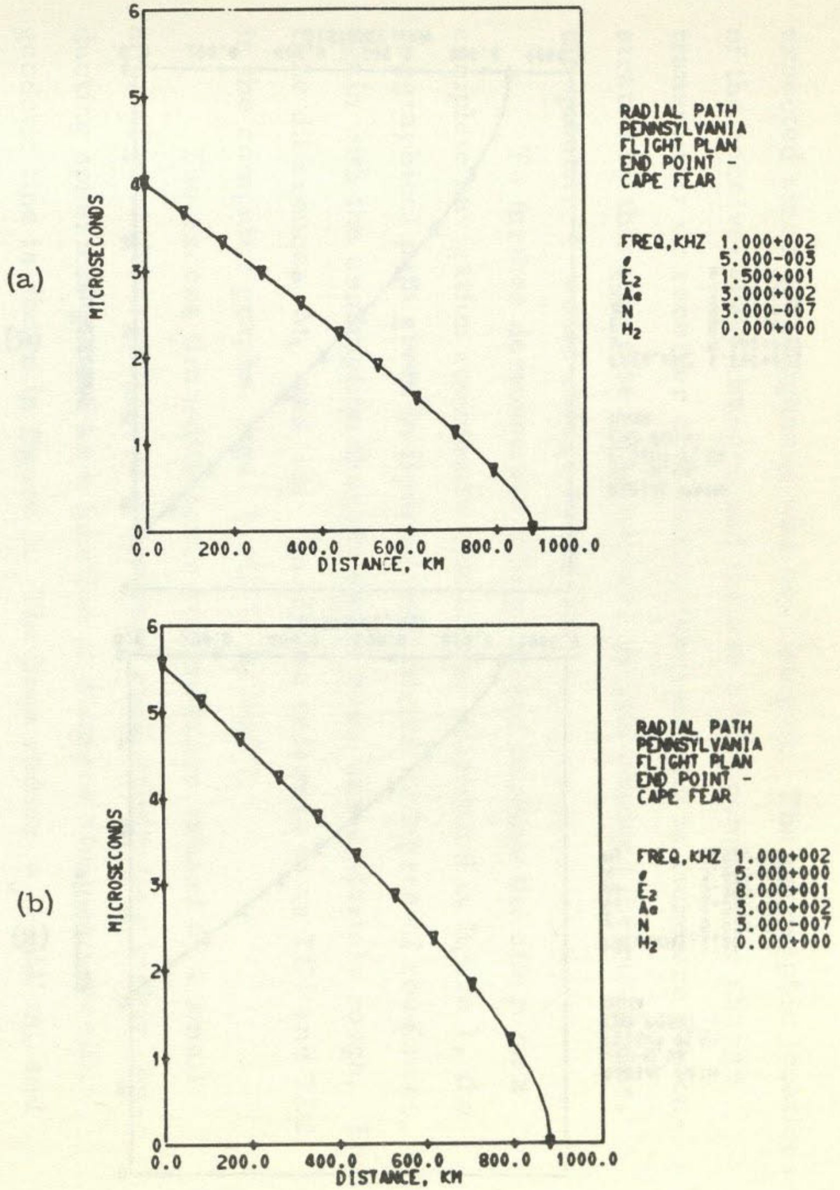
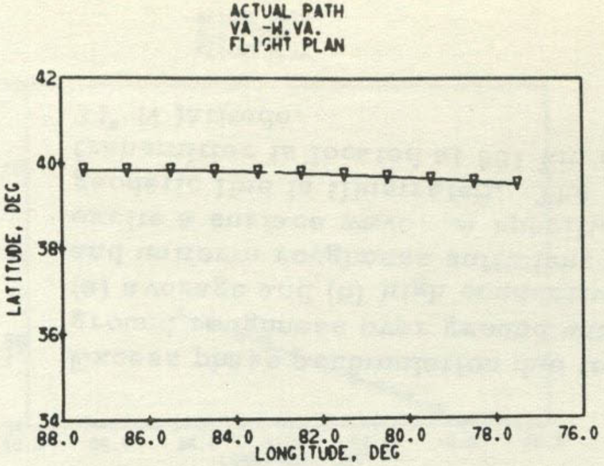
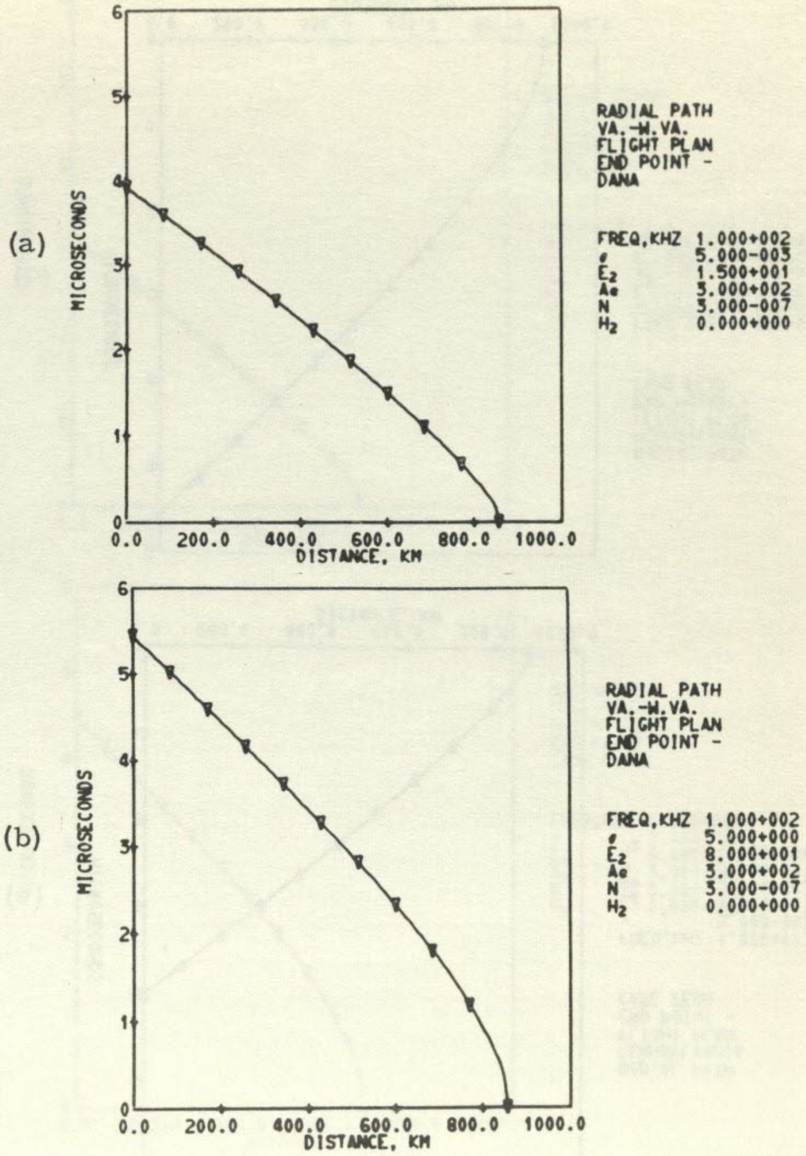


Figure 3. Excess phase accumulation due to ground roughness over ground with (a) average and (b) high conductivity and uniform roughness sufficient to excite a surface wave. A specific geodetic line is illustrated. The transmitter is located at 881 km or 34° N latitude.





(a)

(b)

Figure 4. Excess phase accumulation due to ground roughness using average ground with (a) average and (b) high conductivity and uniform roughness sufficient to excite a surface wave. A specific geodetic line is illustrated. The transmitter is located at 857 km or 87° 29' W longitude.

expected since the roughness was not changed. The geographic locations of the receiver were changed, and the use of the computer to change transmitter or receiver coordinates theoretically is therefore demonstrated by this exercise. If however, we had changed the roughness, the quantity ξ would change accordingly.

To further demonstrate this point and to show the effect on a complete navigation coordinate calculation illustrated in figure 1, the geographical path given in figure 2 was varied in degree of roughness, again with the assumption that the entire area was uniformly rough. The time differences Δt_1 and Δt_2 in (2) are referred to as TD1 and TD2 in the computer graphs, figs. 5, 6, 7, 8, and 9.

The excess time-difference accumulation caused by a small amount of uniform roughness of average conductivity on a highly conducting spherical ground as a function of distance along the specific geodetic line is shown in figure 5. The boss radius $a_e = 300$ m, and the number density $N = 3(10^{-8})\ m^{-2}$. Only a small variation with distance exists relative to a smooth, spherical earth of conductivity $\sigma = 5$. If the boss size is reduced (fig. 9) so that $a_e = 0.01$ m, the variation with distance in the excess phase accumulation relative to highly conducting ground, $\sigma = 5$, is nil. Figures 7 and 8 illustrate the same cases as figures 5 and 6 respectively, normalized to average ground, $\sigma = 0.005$. The variation in the apparent excess with distance is almost entirely due to the difference between smooth spherical earth of infinite conductivity and smooth spherical earth of finite conductivity, since the degree of roughness in either case is insufficient to excite a surface wave and the propagation is controlled by the assumed highly conducting background matrix rather than the finitely conducting bosses. In figure 9, however, the boss size is 300 m and the number density is $3(10^{-7})$. Under these circumstances, the surface wave is launched, and a drastic change in the excess phase accumulation with distance exists. This produces the large corrections in TD1 and TD2 shown in figure 9.

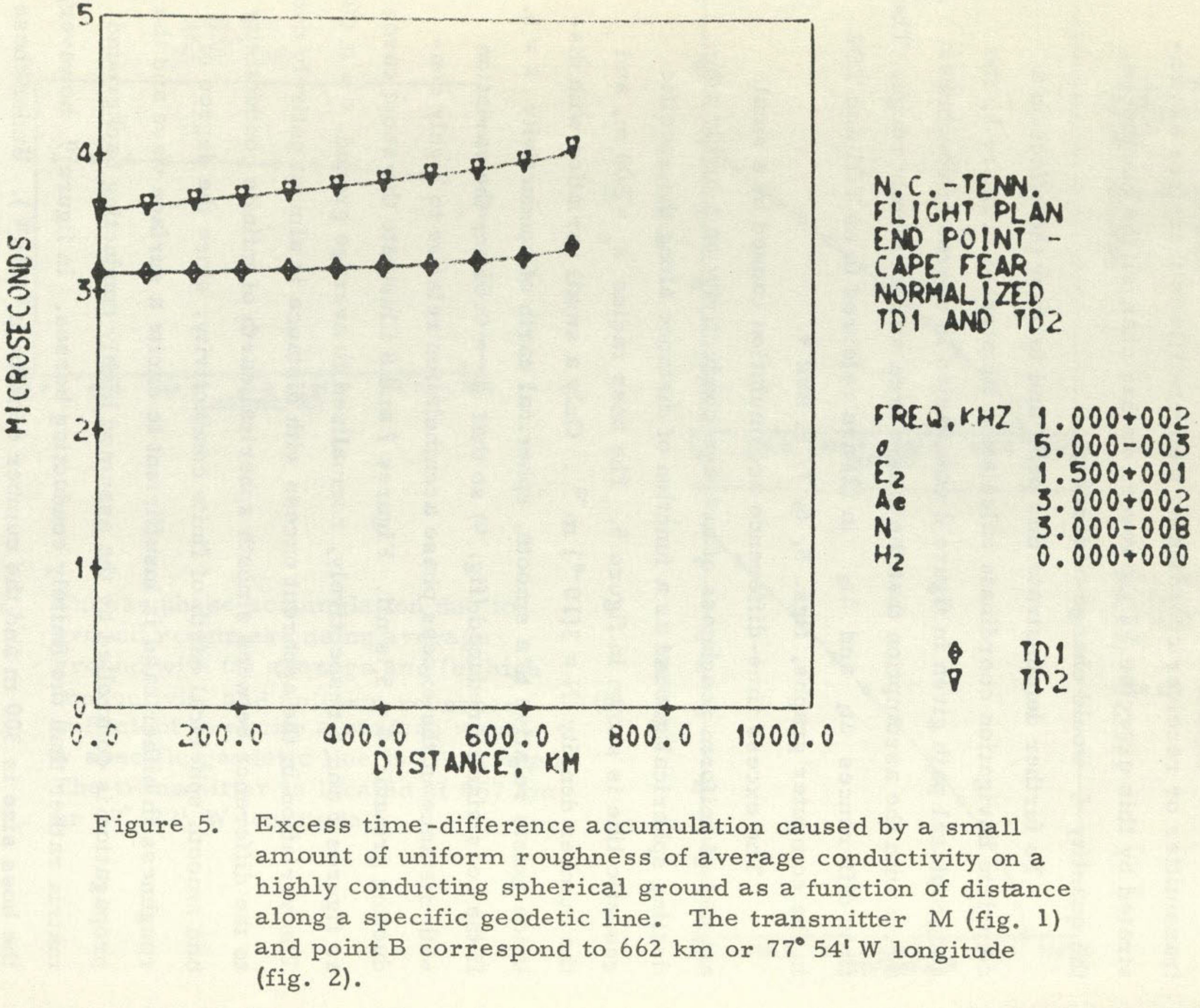


Figure 5. Excess time-difference accumulation caused by a small amount of uniform roughness of average conductivity on a highly conducting spherical ground as a function of distance along a specific geodetic line. The transmitter M (fig. 1) and point B correspond to 662 km or 77° 54' W longitude (fig. 2).

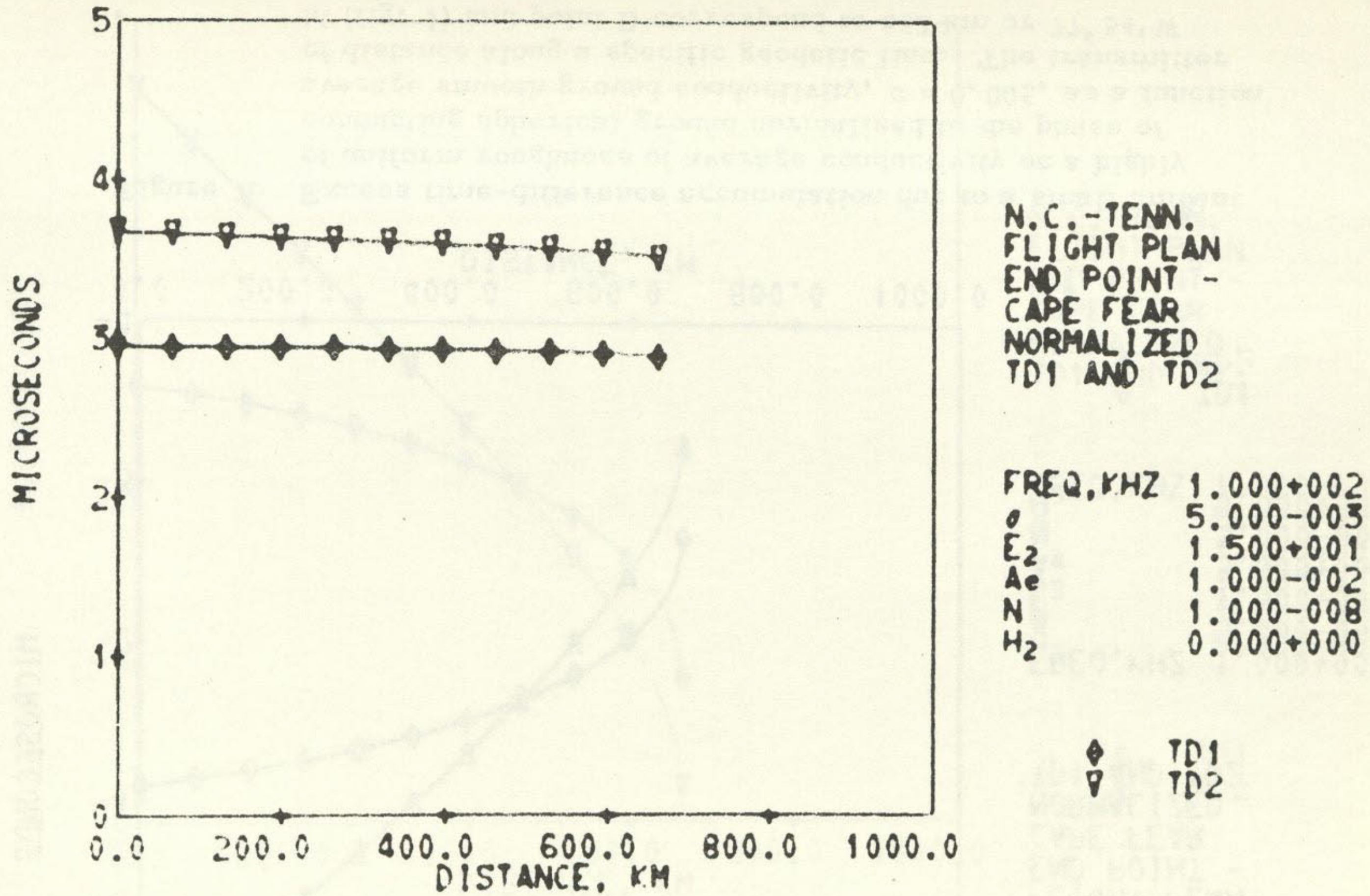


Figure 6. Excess time-difference accumulation due to a very small amount of uniform roughness of average conductivity on a highly conducting spherical ground as a function of distance along a specific geodetic line. The transmitter M (fig. 1) and point B correspond to 662 km or 77° 54' W longitude (fig. 2).

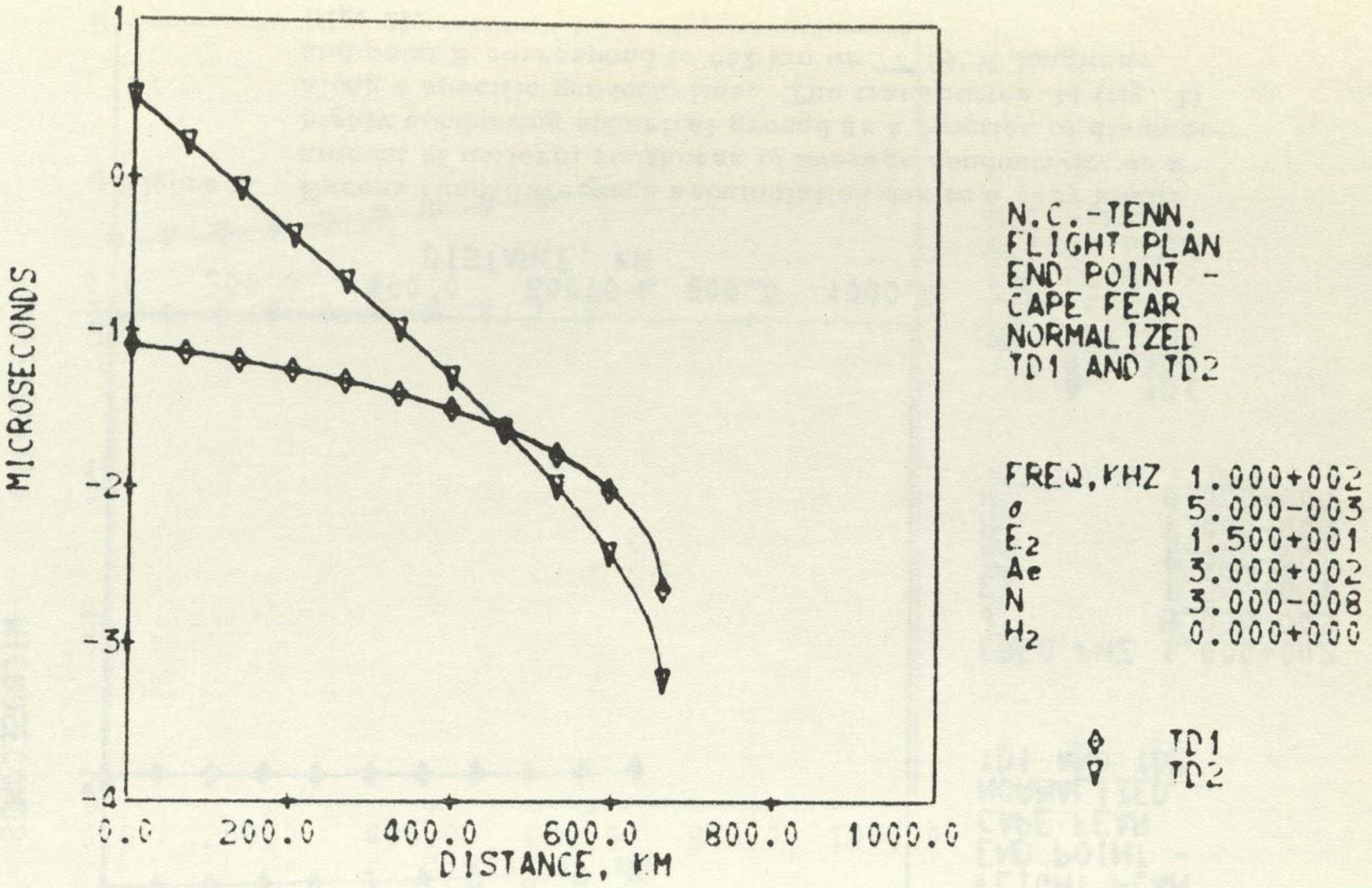


Figure 7. Excess time-difference accumulation due to a small amount of uniform roughness of average conductivity on a highly conducting spherical ground normalized to the phase of average smooth ground conductivity, σ = 0.005, as a function of distance along a specific geodetic line. The transmitter M (fig. 1) and point B correspond to 662 km or 77° 54' W longitude (fig. 2).

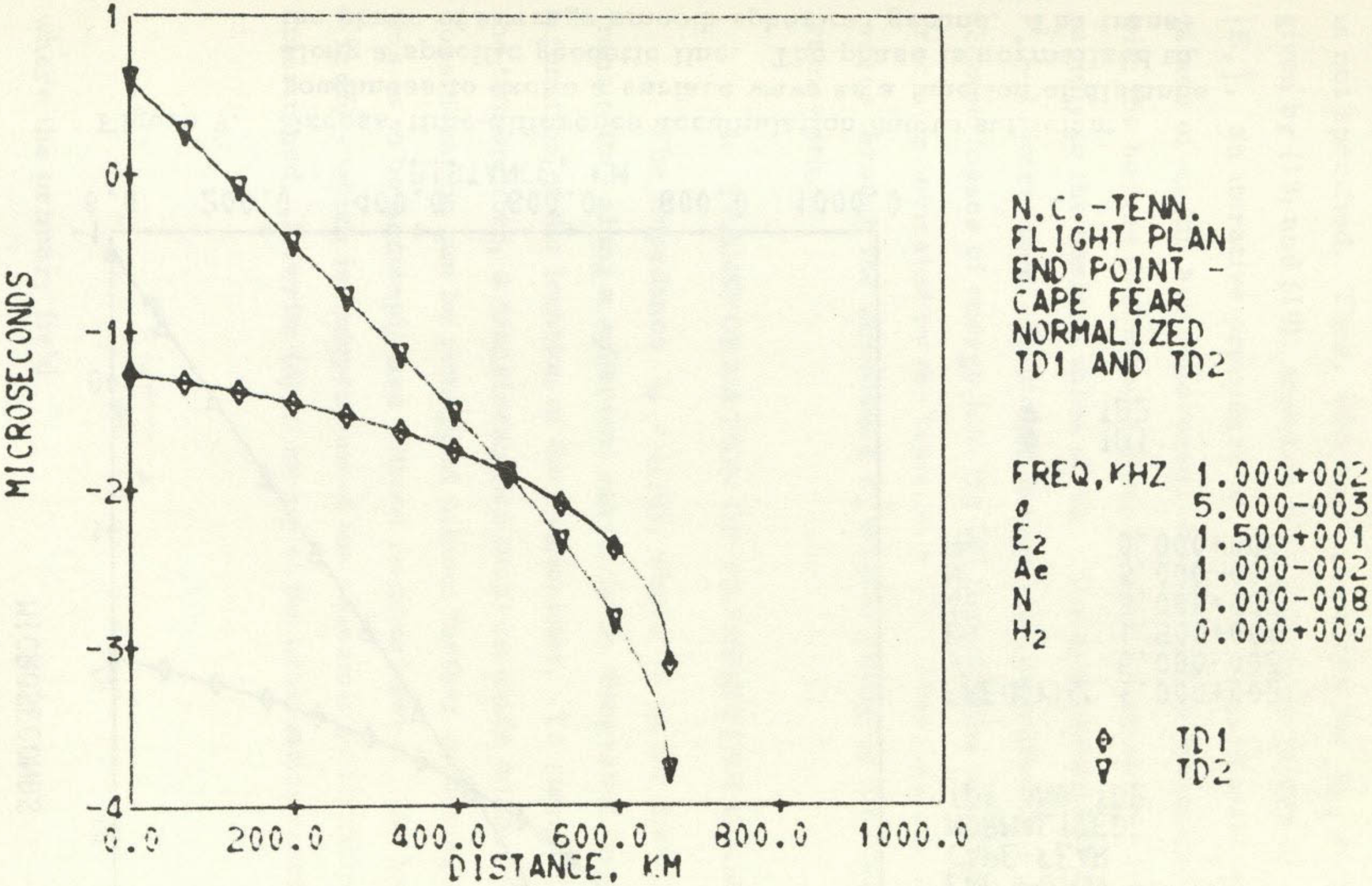


Figure 8. Excess time-difference accumulation due to a very small amount of uniform roughness of average conductivity on a highly conducting spherical ground normalized to the phase of average, smooth ground conductivity as a function of distance along a specific geodetic line. The transmitter M (fig. 1) and point B correspond to 662 km or 77° 54' W longitude.

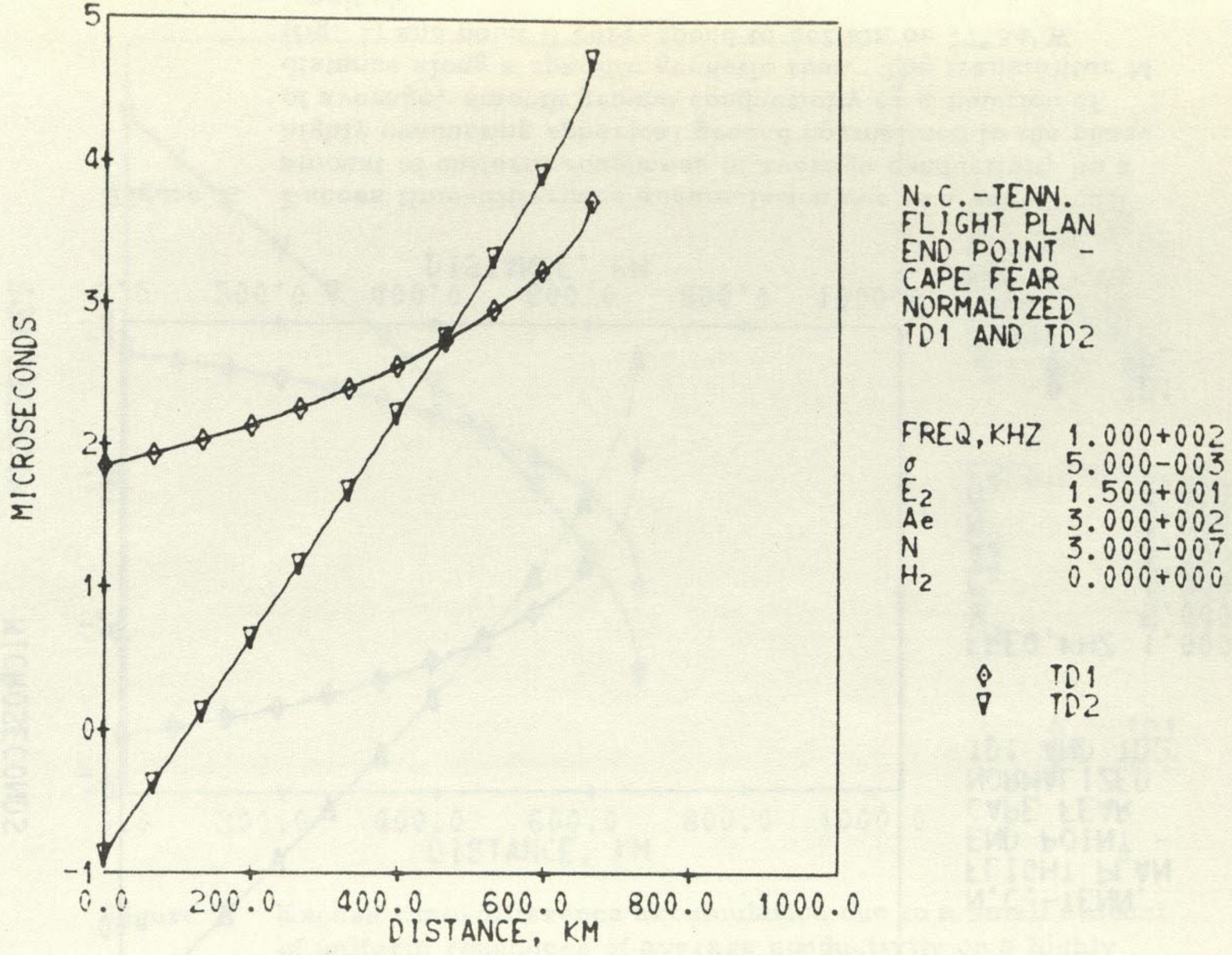


Figure 9. Excess time-difference accumulation due to sufficient roughness to excite a surface wave as a function of distance along a specific geodetic line. The phase is normalized to the phase of average smooth spherical ground. The transmitter M (fig. 1) and point B correspond to 662 km or 77° 54' W longitude.

In view of the generalization of Δ_2, (26) can be used to evaluate the field over irregular, inhomogeneous terrain in which the roughness is not specified. Thus, with approximations for Δ_2, such as those given by (18) and (19), together with measured values of $\varphi_c(d)$ and/or $|E_r|$, an iterative procedure on Δ_2 can be used until the measured values of $\varphi_c(d)$ are recovered. A test of this procedure was made with the bosses described above, and the iteration was found to converge rapidly to the desired value of Δ_2. The approximation $\Delta_2 << \Delta_1$ and $F_\bullet \sim 1$ were used. Note that the general impedance Δ_2 takes into account losses of energy into the TE propagation mode to a degree of precision indicated by the table on p. 13. Thus, we can account for such losses through the impedance Δ_2 without changing the classical analytical framework.

4. TRANSFORMATION OF TRANSMITTER COORDINATES

The impedance $\Delta_2 = \Delta_2(d)$, where d is the distance from the transmitter along a spherical earth, is an integrated impedance that is a function of the location of the transmitter. To change the location of the transmitter, a transformation must be made so that the area under consideration can be remapped without further gathering of data. If this is to be accomplished without reconnaissance, the local impedance, Δ in (6) - which is independent of the transmitter location - must be determined. Rewrite (4) in terms of the attenuation function:

$$W = \frac{\Pi}{2\Pi_{pri}} \quad , \tag{40}$$

where the primary field

$$\Pi_{pri} = \exp\left[-ik_1 r_o\right]/r_o \quad , \tag{41}$$

and r_o is the direct distance between transmitter and receiver. Then,

$$W[\Delta_2(O)] = \left\{ 1 + \frac{-ik_1}{2\pi} \int_{S_o} W[\Delta_2(Q)] \exp[-ik_1(r_1 + r_2 - r_o)] \right.$$
$$\left. \times \left[\Delta(Q) + \left(1 + \frac{1}{ik_1 r_2}\right) \frac{\partial r_2}{\partial n} \right] \frac{r_o \, dS}{r_1 r_2} \right\} A \,, \tag{42}$$

where

$$A = \begin{cases} 1 \text{ if } Q \text{ is off } S_o \,, \\ \frac{1}{2} \text{ if } Q \text{ is on } S_o \,, \end{cases}$$

r_1 is the distance from the transmitter to the scatterpoint, and r_2 is the distance from the scatterpoint to the receiver. Since $\Delta_2(Q)$ and $\Delta_2(O)$ are known from reconnaissance and analysis of the phase data described in sections 2 and 3, $W[\Delta_2(Q)]$ and $W[\Delta_2(O)]$ can be calculated from (11). Hence, (42) can be solved for the set $[\Delta(Q)]$ instead of the set $[W(Q), W(O)]$. Suppose $\Delta_2(d)$ were determined by reconnaissance along a geodetic line or a radial from the transmitter. Then a numerical integration of the two-dimensional form of (41) can be used, i.e.,

$$W[\Delta_2(O)] = \left\{ 1 - \exp\left(i \frac{\pi}{4}\right) \frac{r_o}{x} \sqrt{\frac{k_1}{2\pi}} \int_0^x W[\Delta_2(s)] \exp[-ik_1(r_1 + r_2 - r_o)] \right.$$
$$\left. \times \left[\Delta(s) + \left(1 + \frac{1}{ik_1 r_2}\right) \frac{\partial r_2}{\partial n} \right] \sqrt{\frac{x}{s(x-s)}} \, ds \right\} A \,, \tag{43}$$

where x is the integration surface total distance, and the integration procedure outlined in a previous paper (Johler and Berry, 1967) can be followed with some modifications.

Thus, at the surface, $A = 1$, and

$$W[\Delta_2(O)] = 1 - B \int_o^x W[\Delta_2(s)] \Big[F_1(s)\,\Delta(s) + F_2(s) \Big]\, ds, \qquad (44)$$

where

$$B = \exp\left(i\frac{\pi}{4} \right) \frac{r_o}{x} \sqrt{\frac{k_1}{4\pi}} \;,$$

$$F_1 = \sqrt{\frac{x}{s(x-s)}} \;,$$

$$F_2 = \left(1 + \frac{1}{i k_1 r_2} \right) \frac{\partial r_2}{\partial n} F_1 .$$

If we suppose $\Delta(x_k)$ is known for $k = 1$ through $i-1$, then

$$W[\Delta_2(x_i)] = 1 - B \sum_{k=1}^{i-1} p_k\, W[\Delta_2(x_k)] \Big[F_1(x_i\,,\, x_k)\,\Delta(x_k) + F_2(x_i\,,\, x_k) \Big]$$

$$- B\, p_i\, W[\Delta_2(x_i)] \Big[F_1(x_i\,,\, x_i)\,\Delta(x_i) + F_2(x_i\,,\, x_i) \Big] \;, \qquad (45)$$

where p_k is the weight assigned to the Gaussian quadrature formula. Upon solving for the only unknown, $\Delta(x_i)$, we find

$$\Delta(x_i) = \Big\{ 1 - B \sum_{k=1}^{i-1} p_k\, W[\Delta_2(x_k)] \Big[F_1(x_i\,,\, x_k)\,\Delta(x_k) + F_2(x_i\,,\, x_k) \Big]$$

$$- B p_i\, W[\Delta_2(x_i)]\, F_2(x_i\,,\, x_i) - W[\Delta_2(x_i)] \Big\}$$

$$\times \Big\{ B p_i\, W[\Delta_2(x_i)]\, F_1(x_i\,,\, x_i) \Big\}^{-1} . \qquad (46)$$

Thus, if the first few values of $\Delta(x_1)$ are known, the solution can be extended step by step. By assuming an initial smooth, average ground as in (7), the first few points can be calculated near the transmitter. Otherwise the iteration procedure is identical to the earlier method (Johler and Berry, 1967).

The physical meaning of the set of points $\Delta(d)$ is an important consideration. This is the local impedance relative to free space (6). By "local" we mean an infinitesimal or small segment of distance along the propagation path over which the wave impedance $\Delta_2(d)$ is changing. To solve for this point, the set of field measurements along the entire path $W[\Delta_2(Q)]$ is employed. This set yields greater computation precision than a set of, say, only two points and indeed yields a large number of local impedances over the propagation path between transmitter and receiver. Since $W[\Delta_2(Q)]$ is measured and is in effect a function of Δ_2, we concluded that Δ_2 is a measured impedance, the numerical value of which takes into account losses into the TE-propagation mode and the effect of off-path irregularities and inhomogeneities. The local impedance, $\Delta(d)$, calculated from such data by means of (46) therefore implies such losses into the TE-propagation mode and off-path effects due to irregularities and inhomogeneities, notwithstanding the fact that we have interpreted this impedance within the context of two-dimensional theory, since it must by definition recover the original measured fields $W[\Delta_2(Q)]$, $W[\Delta_2(O)]$ when substituted into (42). Exploration of the full theoretical consequences of this assumption is reserved for future work.

We therefore conclude that the available data on $\Delta(d)$ can be used to calculate W-functions for $W[\Delta_2(O)]$ and $W[\Delta_2(Q)]$ after the transmitter has been moved along the radial to a new position. Obviously, with the aid of reconnaissance data over a large number of radials, the transmitter could be relocated to any desired location in the area for which data are available, and in this manner we can sidestep the evaluation of the three-dimensional integral equation (42). Thus, once measurements have been made in an area, the transmitter can be relocated, and the hyperbolic grid (1) can be recalculated without further reconnaissance.

The set $[\Delta(x_1)]$ in (46) is interesting, since each member of this set is the local impedance relative to free space (6). The equivalent complex conductivity can now be calculated from (9). Equation (46) thus determines a new value of complex conductivity, i.e., it replaces the homogeneous impedance calculation (7), so that inhomogeneities and irregularities in the ground are taken into account. Another implication of (46) is that irregular terrain can be modeled with smooth terrain, in which the impedance is variable with location.

5. CONCLUSIONS

The presence of irregular, inhomogeneous terrain in the vicinity of a Loran C,D navigation system may cause phase accumulation as a function of distance in excess of the phase accumulation of classical theory. A generalization of inhomogeneous, irregular terrain to an impedance surface permits the use of the framework of classical theory to predict excess phase accumulation. The surface impedance can be mapped with reconnaissance over an area, and once such maps are obtained, the Loran C,D navigation over an arbitrary path can be calculated by simplified computer methods. The transmitter coordinates can be transformed, if necessary, by retrieving numerically from the data the local or nonintegrated impedance.

6. REFERENCES

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APPENDIX

Computer Programs

Program LORANCD calculates the time difference (2) for two pairs shown in figure 1, Δt_1 and Δt_2. These are called TD1 and TD2 in the program. Equation numbers in the computer program refer to Johler (1969b). The program LORANR calculates the phase accumulation over the radial from the transmitter discussed in section 3. Subroutines necessary for the operation of these programs are also given. The sample data with each program listing gave the computer printout listed with each program. Several complete computer runs discussed in section 3 are also given. The calculations shown use the actual geographic coordinates of operational LORAN C transmitters. Field strengths (dB relative to $1 \mu v/m$) as a function of distance are given for an assumed radiated power of 400 kw. The decay of the field with distance, however, is appropriate for the models discussed in section 3. These models do not necessarily represent the geographical area indicated by the geographical coordinates.

Some applications of the computer techniques based on the basic ground wave theory have been discussed in this report. The numerical output data used in the figures 2 through 9 is given in tables 1 through 15 for reference. Considerably more information is given by these computer outputs than was used in the discussion in this report. Each set of computer data is preceded by a listing of the basic parameter of interest. Thus, for example, in table 1, KDEL 0 refers to the smooth ground mode of operation of LORAN CD program. The parameters for DB1 refer to the Cape Fear-Jupiter pair. The parameters for DB2 refer to the Cape Fear-Dana pair. The parameters for DB refer to baseline d_b (fig. 1) for the Cape Fear-Jupiter pair, with time difference TD1 = DELTA (T1). The parameters for DB2 refer to the baseline d_b (fig. 1) for Cape Fear-Dana pair with time difference TD2 = DELTA (T2). F = frequency, kHz = 100 kHz. The conductivity of the ground σ = SIGMA = 0.005 mhos/m. The dielectric constant ϵ_2 = E2 = 15. The vertical lapse of the permittivity factor α = ALFA = 1. The index of refraction of air η = ETA = 1.0001. The roughness criterion is a_e = BORA = 0, and N = ANN = 0. means the ground is assumed to be smooth. Finite values for BORA and ANN would introduce roughness, provided KDEL = 1. The height (altitude) of the receiver above the ground h_2 = H2 = 0. A finite value of H2 (kilometers) would cause the calculation to account for elevated receivers. The set of data labeled "PARAMETERS FOR HOMOGENEOUS CASE" gives the corresponding data for the propagation paths other than the baselines. Since in this report we considered only the uniformly inhomogeneous case, these propagation paths were not sorted out to assign different impedances for the paths, ds_1, ds_2, dm_1, and dm_2. However, the program can be used to obtain this flexibility with minor modification.

The beginning point of the propagation path A (fig. 1) is specified as "NEW VA-WVA END POINT." The end point B is specified as "DANA." The latitude and longitude of these points are then given. Next, the location of the master "CAPE FEAR" is given. This is the point M in figure 1. The locations of the Slave 1 "JUPITER," point S_1, and the slave 2 "DANA," point S_2 (fig. 1), are then given. An assumed coding delay for each of these slaves is also given. The radiated power and dipole current moment for the determination of the absolute field amplitude in DB relative to 1 μV/m, columns 6, 7 and 8, on the second page of table 1, are given. The path A, B under consideration is divided into a specified number of segments, and the distance to each such point and to the destination are calculated. These numbers are tabulated in columns 1 and 2 on the second page of table 1. The azimuth at each point to the destination is given in column 3. The latitude and longitude of each point is given in columns 4 and 5 respectively. The solution of the time differences in (2) for each pair Δt_1 and Δt_2 are given in columns 9 and 10. The gradients along the geodetic line in μs/km are also given in columns 11 and 12. Table 1 therefore gives the average smooth ground time difference and amplitude time differences for the path A to B (fig. 1), together with other pertinent information. Table 2 gives time differences, etc., for another geodetic line, AB (fig. 1), over smooth, homogeneous ground. Finally, the third geodetic line is given in table 3. These geodetic lines are plotted as latitude vs. longitude in figures 2, 3, and 4.

Data from program LORANR are given tables 4 though 15. These data have been presented in figures 2 through 4. Thus, the column marked "time difference, microseconds", table 4 for BORA = $3(10^2)$, ANN = $3(10^{-7})$, contains data that were normalized to smooth, homogeneous terrain cases, BORA = 0., ANN = 0, to give the curves shown in figure 4. The first 5 columns of these data are the same as previous data in table 1. Since the observer is assumed to be moving on a radial from or toward the transmitter, only the total phase accumulation to each point on such a radial is given in column 7 and the corresponding absolute amplitude in column 6. Since the line is a geodetic line through the transmitter, the gradient along this line is almost constant because the phase correction is almost, but not exactly, a linear function of distance from the transmitter at large distances.

```
      PROGRAM LORANCD
C
C     PROGRAM TO CALCULATE THE TIME DIFFERENCES FOR A LORAN C OR D PATH
C
      DIMENSION LATBEG(3),LONBEG(3),START(4),LATEND(3),LONEND(3),
     1 FINISH(4),LATXMT(3),LONXMT(3),LOCXMT(4),LATSL1(3),LONSL1(3),
     2 LOCSL1(4),LATSL2(3),LONSL2(3),LOCSL2(4)
      DIMENSION XLAT(105),XLON(105),D(105),BERXMT(105),X(105),RD(105),
     1 BEREND(105)
      DIMENSION DENTIF(4)
      DIMENSION IDENT(2)
      COMMON DIS,SIGMA,E2,ALFA,ETA
      TYPE INTEGER DSTNCE,REG,START,FINISH,TYPATH
      DSTNCE=6HDSTNCE
      REG=4HNORM
      C=2.997925E8
      TWOPI=6.283185307
      PI=3.141592654
      CON=1.E9/C
      CONST=1.E3/TWOPI
    1 FORMAT (2(2(2A8,A1,1X),4A8/),I3,10X,A5)
    2 FORMAT    (2(2A8,A1,1X),4A8)
    3 FORMAT (8E10.0)
    4 FORMAT (I10/8E10.0)
    5 FORMAT (I10)
    6 FORMAT (4A8)
    7 FORMAT (1H1,39X,4A8)
    8 FORMAT (30X,4A8,*  TO  *,4A8)
    9 FORMAT (  114X,14HGRADIENT ALONG/
     1         8X,11HDISTANCE IN,7X,10HAZIMUTH TO, 2X,
     2 19HCOORDINATES OF PATH,6X,20HFIELD STRENGTH IN DB,7X,
     3 15HTIME DIFFERENCE,7X,17HTHE GEODETIC LINE/
     4 7X,13HKILOMETERS TO,5X,11HDESTINATION, 2X,8HLATITUDE, 2X,
     5 9HLONGITUDE,3X,25HRELATIVE TO 1 MICROVOLT/M,7X,
     6              12HMICROSECONDS,9X,15HMICROSECONDS/KM/
     7 5X,6HORIGIN,2X,11HDESTINATION,3X,7HDEGREES,
     8 2(4X,7HDEGREES),5X,6HMASTER,2X,7HSLAVE 1,2X,7HSLAVE 2,3X,
     9 9HDELTA(T1),3X,9HDELTA(T2),2X,9HDELTA(T1),1X,9HDELTA(T2))
   11 FORMAT (1X,2F11.4,F12.4,2F11.5,   3F9.2 ,1X,2F12.4,1X,2F10.5)
   12 FORMAT (18X,4HLAT=2A8,A2,4HLON=2A8,A2,*  TO  *,4HLAT=2A8,A2,4HLON=
     1 2A8,A2/)
   13 FORMAT (28X,4HLAT=2A8,A2,4HLON=2A8,A2,12HLOCATION OF ,4A8)
   14 FORMAT (/)
   16 FORMAT (64X,6HMASTER,7X,7HSLAVE 1,6X,7HSLAVE 2/
     1 22X,27HCODING DELAY (MICROSECONDS),22X,2F13.2/
     2 22X,26HRADIATED POWER (KILOWATTS),10X,3F13.3/
     3 22X,37HDIPOLE CURRENT MOMENT (AMPERE-METERS),3E13.4/)
   17 FORMAT (1H0,*PARAMETERS FOR *,2A8//2X,5HKDEL=I10/5X,2HF=E16.9,
     14H KHZ/1X,6HSIGMA=E16.9/4X,3HE2=E16.9/2X,5HALFA=E16.9/3X,4HETA=
     2 E16.9/2X,5HBORA=E16.9/3X,4HANN=E16.9/4X,3HH2=E16.9)
   18 FORMAT (F10.4,3F10.2,2F10.4,2F10.5)
   19 FORMAT (I10/F10.2,F10.4,F10.1,F10.2,F10.6,2E10.2,F10.1)
   21 FORMAT (1H1,2HJ=I5,5X,5HDIFF=E15.6,5X,4HDST=E15.6/
     1 1X,7HSDELT1=E15.6,5X,6HDELT1=E15.6,5X,7HSDELT2=E15.6,5X,
```

```
     2 6HDELT2=E15.6/
     3 1X,7HPGRAD1=E15.6,5X,6HGRAD1=E15.6,5X,7HPGRAD2=E15.6,5X,
     4 6HGRAD2=E15.6)
C
C     READ THE COORDINATES OF A GIVEN PATH
C
C     LATBEG = LATITUDE OF BEGINNING POINT
C     LONBEG = LONGITUDE OF BEGINNING POINT
C     START = IDENTIFICATION OF BEGINNING POINT
C     LATEND = LATITUDE OF END POINT
C     LONEND = LONGITUDE OF END POINT
C     FINISH = IDENTIFICATION OF END POINT
C     NOSEG = NUMBER OF SEGMENTS TO BREAK THE PATH INTO -- MAX OF 100
C
   10 READ    1, LATBEG,LONBEG,START,LATEND,LONEND,FINISH,NOSEG,TYPATH
      IF (EOF,60) 200,20
C
C     READ IDENTIFICATION
   20 READ    6, DENTIF
C
C     READ THE COORDINATES OF THE MASTER, SLAVE 1, AND SLAVE 2
C
C     LATXMT = LATITUDE OF MASTER
C     LONXMT = LONGITUDE OF MASTER
C     LOCXMT = IDENTIFICATION OF MASTER
C     LATSL1 = LATITUDE OF SLAVE 1
C     LONSL1 = LONGITUDE OF SLAVE 1
C     LOCSL1 = IDENTIFICATION OF SLAVE 1
C     LATSL2 = LATITUDE OF SLAVE 2
C     LONSL2 = LONGITUDE OF SLAVE 2
C     LOCSL2 = IDENTIFICATION OF SLAVE 2
C
      READ    2, LATXMT,LONXMT,LOCXMT,LATSL1,LONSL1,LOCSL1,LATSL2,
     1 LONSL2,LOCSL2
C
C     READ CODING DELAYS (TIME DELAY) IN MICROSECONDS FOR SLAVE 1 AND
C     SLAVE 2
   30 READ    3, CS1,CS2
C
C     READ RADIATED POWER IN KILOWATTS OF MASTER, SLAVE 1, AND SLAVE 2
      READ    3, PRMAS,PRSL1,PRSL2
C
C     CHANGE COORDINATES (DEGREES,MINUTES,SECONDS) TO DEGREES
      BEGLAT=CORDCONV(LATBEG,17)
      BEGLON=CORDCONV(LONBEG,17)
      ENDLAT=CORDCONV(LATEND,17)
      ENDLON=CORDCONV(LONEND,17)
      XMTLAT=CORDCONV(LATXMT,17)
      XMTLON=CORDCONV(LONXMT,17)
      SL1LAT=CORDCONV(LATSL1,17)
      SL1LON=CORDCONV(LONSL1,17)
      SL2LAT=CORDCONV(LATSL2,17)
      SL2LON=CORDCONV(LONSL2,17)
C
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```
C     CALCULATES THE DISTANCE BETWEEN TWO POINTS
C
C     BETWEEN THE MASTER AND SLAVE 1  (DB1)
      CALL PATH (XMTLAT,XMTLON,SL1LAT,SL1LON,DSTNCE,XINT,DB1,XLAT,XLON,
     1 D,BERATX,BERATR,BERXMT,NMAX,TYPATH)
C     BETWEEN THE MASTER AND SLAVE 2  (DB2)
      CALL PATH (XMTLAT,XMTLON,SL2LAT,SL2LON,DSTNCE,XINT,DB2,XLAT,XLON,
     1 D,BERATX,BERATR,BERXMT,NMAX,TYPATH)
C     BETWEEN THE TWO END POINTS OF A GIVEN PATH  (DIST)
      CALL PATH (BEGLAT,BEGLON,ENDLAT,ENDLON,DSTNCE,XINT,DIST,XLAT,XLON,
     1 D,BERATX,BERATR,BERXMT,NMAX,TYPATH)
      SEG=NOSEG
      XINT=DIST/SEG
C
C     CALCULATES THE LATITUDE, LONGITUDE, AND DISTANCE OF (NOSEG+1)
C     POINTS ALONG THE GIVEN PATH
      CALL PATH (ENDLAT,ENDLON,BEGLAT,BEGLON,REG,XINT,DIST,XLAT,XLON,RD,
     1 BERATX,BERATR,BEREND,NMAX,TYPATH)
      CALL PATH (BEGLAT,BEGLON,ENDLAT,ENDLON,REG,XINT,DIST,XLAT,XLON,D,
     1 BERATX,BERATR,BERXMT,NMAX,TYPATH)
C
C     READ NECESSARY PARAMETERS AND CALCULATE THE PHASE CORRECTION FOR
C     THE PATH BETWEEN THE MASTER AND SLAVE 1
C
C   EXPLANATION OF INPUT DATA TO CALCULATE THE PHASE CORRECTION
C
C   KDEL = KDEL NOT EQUAL TO ZERO PUTS PROGRAM IN ROUGH GROUND MODE
C      OF OPERATION
C          KDEL EQUAL TO ZERO OPERATES PROGRAM IN CLASSICAL GROUND WAVE
C          MODE OF OPERATION -- SMOOTH SPHERICAL GROUND
C   F = FREQUENCY IN KHZ
C   SIGMA = CONDUCTIVITY IN MHOS/METER
C   E2 = DIELECTRIC CONSTANT
C   ALFA = VERTICAL LAPSE FACTOR OF THE ATMOSPHERE ACCORDING TO NBS
C          CIRCULAR 573.
C   ETA = INDEX OF REFRACTION OF AIR AT THE GROUND LEVEL
C   BORA = RADIUS OF HEMISPHERICAL SURFACE PROTUBERANCE.
C   ANN = NUMBER OF HEMISPHERICAL BOSSES PER SQUARE METER.
C   H2 = ALTITUDE OF RECEIVER IN KILOMETERS
C
   60 READ    4, KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
      IDENT(1)=8HDB1
      IDENT(2)=8H
      PRINT 17,     IDENT,KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
   65 DIS=DB1
      FAZCOR=PI
      IF (DIS.LE.0.)   GO TO 66
      CALL GROUND (F*1000.,AMP,FAZCOR,KDEL,BORA,ANN,H2)
   66 CONTINUE
C     RESOLUTION OF TWO PI AMBIGUITY OF THE GROUND WAVE PHASE
C     GOOD ONLY FOR 100 KHZ -- MUST BE MODIFIED FOR ANY OTHER FREQUENCY
C     THE SAME TEST IS USED AFTER EVERY CALL TO GROUND WAVE SUBROUTINE
C     THE DISTANCE SHOULD NOT BE MUCH GREATER THAN 2000 KM
      IF (FAZCOR.GE.0.)    GO TO 70
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```
      FAZCOR=FAZCOR+TWOPI
   70 IF (DIS.LE.1000.)    GO TO 75
      IF (SIGMA.GT..0051)    GO TO 75
      IF (FAZCOR.GT.PI)    GO TO 75
      FAZCOR=FAZCOR+TWOPI
   75 TCDB1=FAZCOR*CONST/F
C
C     READ NECESSARY PARAMETERS AND CALCULATE THE PHASE CORRECTION FOR
C     THE PATH BETWEEN THE MASTER AND SLAVE 2
   80 READ     4, KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
      IDENT(1)=8HDB2
      IDENT(2)=8H
      PRINT 17,     IDENT,KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
   83 DIS=DB2
      FAZCOR=PI
      IF (DIS.LE.0.)    GO TO 84
      CALL GROUND (F*1000.,AMP,FAZCOR,KDEL,BORA,ANN,H2)
   84 CONTINUE
C     RESOLUTION OF TWO PI AMBIGUITY OF THE GROUND WAVE PHASE
      IF (FAZCOR.GE.0.)    GO TO 85
      FAZCOR=FAZCOR+TWOPI
   85 IF (DIS.LE.1000.)    GO TO 88
      IF (SIGMA.GT..0051)    GO TO 88
      IF (FAZCOR.GT.PI)    GO TO 88
      FAZCOR=FAZCOR+TWOPI
   88 TCDB2=FAZCOR*CONST/F
      CONS=1.E6/(2.*TWOPI*F)*SQRTF(37.67304)
      IF (PRMAS.EQ.0.)    GO TO 880
      DIPMAS=CONS*SQRTF(PRMAS)
      DBMAS=20.*ALOG10(DIPMAS)
      GO TO 881
  880 DIPMAS=1.0
      DBMAS=0.
  881 IF (PRSL1.EQ.0.)    GO TO 882
      DIPSL1=CONS*SQRTF(PRSL1)
      DBSL1=20.*ALOG10(DIPSL1)
      GO TO 883
  882 DIPSL1=1.0
      DBSL1=0.
  883 IF (PRSL2.EQ.0.)    GO TO 884
      DIPSL2=CONS*SQRTF(PRSL2)
      DBSL2=20.*ALOG10(DIPSL2)
      GO TO 885
  884 DIPSL2=1.0
      DBSL2=0.
  885 CONTINUE
C
C     IHOM NOT EQUAL TO ZERO GIVES INHOMOGENEOUS CASE
   40 READ     5, IHOM
      IF (IHOM.NE.0)    GO TO 886
C
C     READ NECESSARY PARAMETERS TO CALCULATE THE PHASE CORRECTION FOR
C     THE HOMOGENEOUS CASE
   50 READ     4, KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
```

```
      IDENT(1)=8HHOMOGENE
      IDENT(2)=8HOUS CASE
      PRINT 17,   IDENT,KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
      PUNCH 19,KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
  886 CONTINUE
      PRINT 7,    DENTIF
      PRINT 8,    START,FINISH
      PRINT 12,   LATBEG,LONBEG,LATEND,LONEND
      PRINT 13,   LATXMT,LONXMT,LOCXMT,LATSL1,LONSL1,LOCSL1,LATSL2,
     1 LONSL2,LOCSL2
      PRINT 16,   CS1,CS2,PRMAS,PRSL1,PRSL2,DIPMAS,DIPSL1,DIPSL2
      PRINT 9
      PRINT 14
      NS=NOSEG+1
      PUNCH 6,DENTIF
      PUNCH 2,LATBEG,LONBEG,START,LATEND,LONEND,FINISH,LATXMT,LONXMT,
     1 LOCXMT,LATSL1,LONSL1,LOCSL1,LATSL2,LONSL2,LOCSL2
      PUNCH 5,NS
      NP=0
      NNP=0
      GRAD1=0.
      GRAD2=0.
C
C     CALCULATE DISTANCES AND PHASE CORRECTIONS FOR EACH POINT ON THE
C     GIVEN PATH
C
      DO 150 I=1,NS
C     CALCULATE DISTANCE FROM GIVEN POINT TO MASTER  (DM)
      CALL PATH (XLAT(I),XLON(I),XMTLAT,XMTLON,DSTNCE,XINT,DM,X,X,X,Y,Y,
     1 X,NMAX,TYPATH)
      IF (IHOM.EQ.0)   GO TO 90
C
C     READ NECESSARY PARAMETERS AND CALCULATE THE PHASE CORRECTION FOR
C     THE ABOVE PATH
      READ  3, KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
   90 DIS=DM
      AMP=1.0
      FAZCOR=PI
      IF (DIS.LE.0.)   GO TO 901
      CALL GROUND (F*1000.,AMP,FAZCOR,KDEL,BORA,ANN,H2)
  901 FSMAS=20.*ALOG10(AMP)+DBMAS+120.
C     RESOLUTION OF TWO PI AMBIGUITY OF THE GROUND WAVE PHASE
      IF (FAZCOR.GE.0.)   GO TO 91
      FAZCOR=FAZCOR+TWOPI
   91 IF (DIS.LE.1000.)   GO TO 95
      IF (SIGMA.GT..0051)   GO TO 95
      IF (FAZCOR.GT.PI)   GO TO 95
      FAZCOR=FAZCOR+TWOPI
   95 TCDM=FAZCOR*CONST/F
C     CALCULATE DISTANCE FROM GIVEN POINT TO SLAVE 1  (DS1)
      CALL PATH (XLAT(I),XLON(I),SL1LAT,SL1LON,DSTNCE,XINT,DS1,X,X,X,Y,
     1 Y,X,NMAX,TYPATH)
      IF (IHOM.EQ.0)   GO TO 100
C
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```
C     READ NECESSARY PARAMETERS AND CALCULATE THE PHASE CORRECTION FOR
C     THE ABOVE PATH
      READ    3, KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
  100 DIS=DS1
      AMP=1.0
      FAZCOR=PI
      IF (DIS.LE.0.)   GO TO 1001
      CALL GROUND (F*1000.,AMP,FAZCOR,KDEL,BORA,ANN,H2)
 1001 FSSL1=20.*ALOG10(AMP)+DBSL1+120.
C     RESOLUTION OF TWO PI AMBIGUITY OF THE GROUND WAVE PHASE
      IF (FAZCOR.GE.0.)   GO TO 101
      FAZCOR=FAZCOR+TWOPI
  101 IF (DIS.LE.1000.)   GO TO 105
      IF (SIGMA.GT..0051)   GO TO 105
      IF (FAZCOR.GT.PI)   GO TO 105
      FAZCOR=FAZCOR+TWOPI
  105 TCDS1=FAZCOR*CONST/F
C
C     CALCULATE THE TIME DIFFERENCE FOR SLAVE 1  (TDX)
      DELT1=ETA*CON*(DB1+DS1-DM)+TCDB1+TCDS1-TCDM+CS1
C     CALCULATE DISTANCE FROM GIVEN POINT TO SLAVE 2   (DS2)
      CALL PATH (XLAT(I),XLON(I),SL2LAT,SL2LON,DSTNCE,XINT,DS2,X,X,X,Y,
     1 Y,X,NMAX,TYPATH)
      IF (IHOM.EQ.0)   GO TO 110
C
C     READ NECESSARY PARAMETERS AND CALCULATE THE PHASE CORRECTION FOR
C     THE ABOVE PATH
      READ    3, KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
  110 DIS=DS2
      AMP=1.0
      FAZCOR=PI
      IF (DIS.LE.0.)   GO TO 1101
      CALL GROUND (F*1000.,AMP,FAZCOR,KDEL,BORA,ANN,H2)
 1101 FSSL2=20.*ALOG10(AMP)+DBSL2+120.
C     RESOLUTION OF TWO PI AMBIGUITY OF THE GROUND WAVE PHASE
      IF (FAZCOR.GE.0.)   GO TO 111
      FAZCOR=FAZCOR+TWOPI
  111 IF (DIS.LE.1000.)   GO TO 115
      IF (SIGMA.GT..0051)   GO TO 115
      IF (FAZCOR.GT.PI)   GO TO 115
      FAZCOR=FAZCOR+TWOPI
  115 TCDS2=FAZCOR*CONST/F
C
C     CALCULATE THE TIME DIFFERENCE FOR SLAVE 2  (TDY)
      DELT2=ETA*CON*(DB2+DS2-DM)+TCDB2+TCDS2-TCDM+CS2
      IF (I.EQ.1)   GO TO 140
      DST=D(I)-D(I-1)
      GRAD1=(DELT1-SDELT1)/DST
      GRAD2=(DELT2-SDELT2)/DST
      IF (NNP.NE.30)   GO TO 120
      PRINT 7,     DENTIF
      PRINT 8,     START,FINISH
      PRINT 12,     LATBEG,LONBEG,LATEND,LONEND
      PRINT 13,     LATXMT,LONXMT,LOCXMT,LATSL1,LONSL1,LOCSL1,LATSL2,
```

```
   1 LONSL2,LOCSL2
     PRINT 16,     CS1,CS2,PRMAS,PRSL1,PRSL2,DIPMAS,DIPSL1,DIPSL2
     PRINT 9
     NNP=0
 120 NNP=NNP+1
     IF (NP.NE.10)   GO TO 130
     PRINT 14
     NP=0
 130 NP=NP+1
     II=I-1
     N=NS+1-II
     IF (II.LE.2)   GO TO 139
     IF (N.LE.2)   GO TO 139
     J=0
 131 DIFF=PGRAD1-GRAD1
     IF (ABS(DIFF).LE..2)   GO TO 135
     IF (J.GT.3)   GO TO 190
     IF (PGRAD1.GT.GRAD1)   GO TO 132
     J=J+1
     DELT1=DELT1-1.E3/F
     GO TO 133
 132 J=J+1
     DELT1=DELT1+1.E3/F
 133 GRAD1=(DELT1-SDELT1)/DST
     GO TO 131
 135 J=0
 136 DIFF=PGRAD2-GRAD2
     IF (ABS(DIFF).LE..2)   GO TO 139
     IF (J.GT.3)   GO TO 190
     IF (PGRAD2.GT.GRAD2)   GO TO 137
     J=J+1
     DELT2=DELT2-1.E3/F
     GO TO 138
 137 J=J+1
     DELT2=DELT2+1.E3/F
 138 GRAD2=(DELT2-SDELT2)/DST
     GO TO 136
 139 CONTINUE
     PRINT 11,     D(II),RD(N),BEREND(N),XLAT(II),XLON(II),SFSMAS,
   1 SFSSL1,SFSSL2,SDELT1,SDELT2,GRAD1,GRAD2
     PUNCH 18,D(II),SFSMAS,SFSSL1,SFSSL2,SDELT1,SDELT2,GRAD1,GRAD2
 140 XLON(I)=-XLON(I)
     SFSMAS=FSMAS
     SFSSL1=FSSL1
     SFSSL2=FSSL2
     SDELT1=DELT1
     SDELT2=DELT2
     PGRAD1=GRAD1
     PGRAD2=GRAD2
     IF (I.LT.NS)   GO TO 150
     IF (NP.NE.10)   GO TO 145
     PRINT 14
 145 GRAD1=0.
     GRAD2=0.
```

```
      PRINT 11,     D(I),RD(1),BEREND(1),XLAT(I),XLON(I),SFSMAS,
     1 SFSSL1,SFSSL2,SDELT1,SDELT2,GRAD1,GRAD2
      PUNCH 18,D(I) ,SFSMAS,SFSSL1,SFSSL2,SDELT1,SDELT2,GRAD1,GRAD2
  150 CONTINUE
      GO TO 10
  190 CONTINUE
      PRINT 21,J,DIFF,DST,SDELT1,DELT1,SDELT2,DELT2,PGRAD1,GRAD1,
     1 PGRAD2,GRAD2
  200 CALL EXIT
      END

      SUBROUTINE GROUND (F,AMP,PHASE,KDEL,BORA,ANN,H2)
C    GROUND CALCULATES AMPLITUDE AND PHASE CORRECTION OF THE GROUND WAVE
C     A NEGATIVE TIME FUNCTION IS ASSUMED
C     DIST=KM, F=CYCLES
      COMMON DIST,SIGMA,E2,ALFA,ETA
      COMMON /INFO/ DELT2A,DELT2P,D1A,D1P
      A=6.36739E6
      C=2.997925E8
      PI=3.141592654
      E1=ETA*ETA
  300 ERROR=4.E-6
      OMEGA=2.*PI*F
C     CONVERTS DISTANCE TO STATUTE MILES
      DST=DIST/1.6093472
      AK1=A*OMEGA/C*ETA
      AK1SQ=AK1*AK1
      AK13R=CUBERT(AK1)
      AK16R=SQRTF(AK13R)
      ALF13=CUBERT(ALFA)
      ALF23=ALF13*ALF13
      ALF56=ALF13*SQRTF(ALFA)
      THETA=1.E3*DIST/A
      DK1=AK1*THETA
      IF (KDEL.NE.0)   GO TO 50
C
C     OLD DELTA SUB E
      X1=(SIGMA*4.E-7*PI*C*C)/OMEGA
      X2=CUBERT((C*ALFA)/(A*OMEGA*E1*E1))
      CALL ZSQRT (E2-E1,X1,CE,D)
      CALL ZDIV (-X1*X2,E2*X2,CE,D,DR,DI)
      DR2=DR*DR-DI*DI
      DI2=2.*DR*DI
      CALL ZDIV (0.,ALF13/AK13R,DR,DI,DELT2R,DELT2I)
      CALL POLR (DELT2R,DELT2I,DELT2A,DELT2P)
      CALL POLR (DR,DI,D1A,D1P)
      IF (DST-30.)   350,310,310
C
C     NEW DELTA SUB E
   50 EPS0=8.85419E-12
      FR=E2
      FI=SIGMA/(EPS0*OMEGA)
      CALL ZSQRT(-FR,-FI,FX,FY)
      GR=(FX*OMEGA/C)*BORA
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      GI=(FY*OMEGA/C)*BORA
      VB=2.*PI*ANN*(BORA**3)/3.
      CALL ZEXP(GR,GI,FX,FY,MAGT1)
      CALL ZEXP(-GR,-GI,GX,GY,MAGT2)
      EMAG=MAGT2-MAGT1
      CALL ZDIV (FX+GX*EXPF(EMAG        ),FY+GY*EXPF(EMAG        ),
     1 FX-GX*EXPF(EMAG        ),FY-GY*EXPF(EMAG        ),COTR,COTI)
      CALL ZMPY (GR,GI,GR,GI,FX,FY)
      CALL ZMPY (GR,GI,COTR,COTI,GX,GY)
      CALL ZDIV (FX,FY,1.-GX,-GY,FX,FY)
C     SEE EQUATION (2.6)
      AGR=FX+1.
      AGI=FY
C     SEE EQUATION (2.4)
      CALL ZDIV (FR+0.5*AGR,FI+0.5*AGI,FR-AGR,FI-AGI,GAMR,GAMI)
C     SEE EQUATION (2.2)
      ALPBR=3.*VB*GAMR
      ALPBI=3.*VB*GAMI
      CALL ZDIV (1.+0.5*AGR,0.5*AGI,1.-      AGR,-      AGI,FX,FY)
C     SEE EQUATION (2.5)
      GGGR=-2.*FX
      GGGI=-2.*FY
C     SEE EQUATION (2.3)
      AAAR=3.*VB*GGGR
      AAAI=3.*VB*GGGI
      CALL ZDIV (AAAR,AAAI,ALPBR*2.,ALPBI*2.,FX,FY)
      GX=(OMEGA/C)*ALPBR*2.
      GY=(OMEGA/C)*ALPBI*2.
      CALL ZMPY (GX,GY,GX,GY,GX,GY)
      CALL ZMPY (FX,FY,GX,GY,FX,FY)
      FX=GX-FX
      FY=GY-FY
      CALL ZSQRT (1.-FX,-FY,FX,FY)
      FXX=-FY   $   FY=-1.+FX   $   FX=FXX
      CALL ZMPY (2.*OMEGA/C,0.,ALPBR,ALPBI,GX,GY)
C     SEE EQUATION (2.19)
      CALL ZDIV (FX,FY,GX,GY,DELT2R,DELT2I)
      CALL POLR(DELT2R,DELT2I,DELT2A,DELT2P)
      X2=CUBERT((C*ALFA)/(A*OMEGA*ETA))
C     SEE EQUATION (2.28)
      CALL ZDIV (0.,X2,DELT2R,DELT2I,DR ,DI )
      CALL POLR(DR,DI,D1A,D1P)
      CALL ZMPY (DR,DI,DR,DI,DR2,DI2)
      IF(DST-30.)   350,310,310
  310 IF(1./CUBERT(F/1000.)-DST/100.) 400,400,350
C
C     PLANE EARTH THEORY
C     NBS CIRCULAR 573
  350 AA = -AK13R*THETA*ALF23
      DENOM= 2.*(DI2*DI2+DR2*DR2)
      RHOR=AA*DI2/DENOM
      RHOI= AA*DR2/DENOM
      CALL POLR(RHOR,RHOI,RHO,PHIRHO)
      IF(RHO-12.) 355,355,365
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C
C     PLANE EARTH THEORY -- CONVERGENT SERIES
  355 AA=SQRTF(RHO)
      BB=EXPF(-RHOR)
      CALL ZMPY(AA*COSF(PHIRHO/2.),AA*SINF(PHIRHO/2.),1.7724539*BB*SINF(
     1RHOI),1.7724539*BB*COSF(RHOI),SUMR,SUMI)
      SUMR=SUMR+1.
      S=-1.
      DEN=1.
      PTHR=-2.*RHOR/DEN
      PTHI=-2.*RHOI/DEN
  370 CALL POLR(SUMR,SUMI,FSUBR,SUMPHI)
      CALL POLR(PTHR,PTHI,PTH,PHIPTH)
      IF (PTH/FSUBR-ERROR) 380,380,360
  380 ESUBR=FSUBR*12.5663706E-10*F/DIST
      GO TO 900
  360 SUMR=SUMR+PTHR
      SUMI=SUMI+PTHI
      DEN=DEN+2.
      CALL ZMPY (PTHR,PTHI,-2.*RHOR/DEN,-2.*RHOI/DEN,PTHR,PTHI)
      GO TO 370
C
C     PLANE EARTH THEORY -- ASYMPTOTIC SERIES
  365 CALL ZDIV(1.,0.,2.*RHOR,2.*RHOI,RHOR,RHOI)
      PTHR=RHOR
      PTHI=RHOI
      PTH=.5/RHO
      S=-2.
      SUMR=0.
      SUMI=0.
      ENUM=3.
  352 SUMR=SUMR+PTHR
      SUMI=SUMI+PTHI
      CALL POLR(-SUMR,-SUMI,FSUBR,SUMPHI)
      CALL ZMPY(ENUM,0.,RHOR,RHOI,PPOR,PPOI)
      CALL ZMPY(PTHR,PTHI,PPOR,PPOI,PPOR,PPOI)
      CALL POLR(PPOR,PPOI,PPOMOD,PHIPPO)
      IF(PPOMOD-PTH) 353,654,654
  654 S=-3.
      GO TO 380
  353 IF(PPOMOD/FSUBR-ERROR) 380,380,354
  354 PTH=PPOMOD
      PTHR=PPOR
      PTHI=PPOI
      ENUM=ENUM+2.
      GO TO 352
C
C     RESIDUE SERIES
C     FOR RESIDUE SERIES SEE EQUATIONS (2.25)
  400 CONST=(4.5027258E10*AK16R*AK1SQ*ALF56)/(OMEGA*A*A*A*SQRTF(SINF(
     1ALFA*THETA)))
      CON=2.0*AK13R**2*H2*ALF13/A
      SUMR=0.
      SUMI=0.
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      SUMMOD=0.
      S=0.
      ZERO=0
  500 CALL TAU(S,DR,DI,TR,TI)
C CORRECTION FOR TAUS - ADDED TO GROUND
      N=0
  718 CONTINUE
      XT=-2.*TR
      YT=-2.*TI
      CALL ZMPY(XT,YT,XT,YT,XXT,YYT)
      CALL ZMPY(XT,YT,XXT,YYT,XTT,YTT)
      CALL ZSQRT(XTT,YTT,XXX,YYY)
      CALL HANK(1,1./3.,-1.,-XXX/3.,-YYY/3.,XHAN,YHAN,MAG1)
      EMAG1=MAG1
      CALL HANK(1,2./3.,-1.,-XXX/3.,-YYY/3.,XXHAN,YYHAN,MAG2)
      EMAG2=MAG2
      CALL ZDIV(XHAN,YHAN,XXHAN,YYHAN,HANX,HANY)
      CALL ZSQRT(XT,YT,TTX,TTY)
      EXX=MAG1-MAG2
      XR=COSF(1.0471976)*EXPF(EXX)
      YR=SINF(1.0471976)*EXPF(EXX)
      CALL ZDIV(XR,YR,TTX,TTY,TTXX,TTYY)
      CALL ZMPY(HANX,HANY,TTXX,TTYY,XREAL,YIMAG)
      CORX=-XREAL-DR
      CORY=-YIMAG-DI
      CALL ZMPY(DR2,DI2,XT,YT,DXT,DYT)
      DEMRE=-1.-DXT
      DEMIM=-DYT
      CALL ZDIV(CORX,CORY,DEMRE,DEMIM,SOUP,SALAD)
      TRR=TR-SOUP
      TII=TI-SALAD
      CALL ZDIV(TRR-TR,TII-TI,TR,TI,SPNR,SPNI)
      IF(SQRTF(SPNR*SPNR+SPNI*SPNI)-ERROR)  716,716, 714
  714 N=N+1
      TR=TRR
      TI=TII
      IF(N-30)  718,720,720
  720 CONTINUE
      XT=-2.*TR
      YT=-2.*TI
      CALL ZMPY (XT,YT,XT,YT,XXT,YYT)
      CALL ZMPY (XT,YT,XXT,YYT,XTT,YTT)
      CALL ZSQRT (XTT,YTT,XXX,YYY)
      CALL HANK (1,1./3.,-1.,-XXX/3.,-YYY/3.,XHAN,YHAN,MAG1)
  716 CONTINUE
C
C     HEIGHT GAIN FACTOR
C     FOR HEIGHT GAIN FACTOR SEE EQUATION (2.30)
      CONR=CON+XT
      CONI=YT
      CALL ZMPY (CONR,CONI,CONR,CONI,CONR2,CONI2)
      CALL ZMPY (CONR,CONI,CONR2,CONI2,CONR3,CONI3)
      CALL ZSQRT (CONR3,CONI3,CONR32,CONI32)
      IF (CONI32.GE.0.)  GO TO 730
```

```
      CALL HANK (1,1./3.,-1.,-CONR32/3.,-CONI32/3.,XXHAN,YYHAN,MAG2)
      GO TO 731
  730 CONTINUE
      CALL HANK (1,1./3., 0.,-CONR32/3.,-CONI32/3.,XXHAN,YYHAN,MAG2)
  731 CONTINUE
      CALL ZDIV (CONR,CONI,XT,YT,CONX,CONY)
      CALL ZSQRT (CONX,CONY,CONX12,CONY12)
      CALL ZDIV (XXHAN,YYHAN,XHAN,YHAN,HANX,HANY)
      EXX=MAG2-MAG1
      EXF=EXP(EXX)
C     SEE EQUATION (2.30)
      CALL ZMPY (HANX*EXF,HANY*EXF,CONX12,CONY12,FSH2R,FSH2I)
C
      SSS=N
      ANGLE=AK13R*ALF23*THETA*TR+PI/4.
      ARG=-AK13R*ALF23*THETA*TI
      IF(ARG+300.)  700,700,600
  600 EX=EXPF(ARG)
      ZR=EX*COSF(ANGLE)
      ZI=EX*SINF(ANGLE)
      AA=2.*TR-DR2/(DR2*DR2+DI2*DI2)
      B=2.*TI+DI2/(DR2*DR2+DI2*DI2)
      CALL ZDIV(ZR,ZI,AA,B,PPOR,PPOI)
      CALL ZDIV(2.5*TR,2.5*TI,CUBERT(AK1*AK1),0.,FBX,FBY)
      CALL ZMPY(PPOR,PPOI,1.+FBX,FBY,PPOR,PPOI)
      CALL ZMPY (PPOR,PPOI,FSH2R,FSH2I,PPOR,PPOI)
      CALL POLR(PPOR,PPOI,PPOMOD,PHIPPO)
      IF(SUMMOD) 13,13,12
   12 IF(PPOMOD/SUMMOD-ERROR)  700,700,13
   13 SUMR=SUMR+PPOR
      SUMI=SUMI+PPOI
      CALL POLR(SUMR,SUMI,SUMMOD,SUMPHI)
      S=S+1.
      IF(S-500.)  500,500,15
   15 ERROR=4.E-4
      GO TO 500
  700 ESUBR=SUMMOD*CONST
      FSUBR=ESUBR*DIST/(12.5663706E-10*F)
  900 CALL POLR(((DK1*DK1)-1.)/(DK1*DK1),1./DK1,FPRIZ,PHIFZ)
      AMP = ESUBR*FPRIZ
      PHASE=SUMPHI+PHIFZ
      RETURN
      END

 4000 SUBROUTINE TAU (S,DR,DI,TR,TI)
      DIMENSION TZERO(5), TIN(5)
      DATA (ITM=0)
      IF(ITM) 16,15,16
   15 TZERO(1)=1.8557571
      TZERO(2)=3.2446076
      TZERO(3)=4.3816712
      TZERO(4)=5.3866138
      TZERO(5)=6.3052630
      TIN(1)=.80861652
```

```
      TIN(2)=2.5780961
      TIN(3)=3.8257153
      TIN(4)=4.8918203
      TIN(5)=5.8513010
      ITM=1
      SINT=.86602540
      COST=.5
   16 IF(S-5.) 1,2,2
    1 IC=S+1.
      TSO=TZERO(IC)
      TSIN=TIN(IC)
      GO TO 3
    2 Y1=1.1780972*(4.*S+3.)
      Y12=Y1*Y1
      Y14=Y12*Y12
      Y13RT=CUBERT(Y1)
      TSO=Y13RT*Y13RT/1.2599211
      TSO=TSO+TSO/(9.6*Y12)-TSO/(7.2*Y14)+.92928404*TSO/(Y14*Y12)
      Y2=1.1780972*(4.*S+1.)
      Y22=Y2*Y2
      Y24=Y22*Y22
      Y23RT=CUBERT(Y2)
      TSIN=Y23RT*Y23RT/1.259921
      TSIN=TSIN-.14583333*TSIN/Y22+.12152778*TSIN/Y24-.87395351*TSIN/(Y2
     12*Y24)
    3 DELTA2=DR*DR+DI*DI
      IF (2.*DELTA2*TSO-1.)  5,10,10
   10 ASSIGN 1001 TO N
C
C     ASYMPTOTIC SERIES (1/DELTA SUB E = DEL)
   11 TS1=TSIN
      DELR=DR/DELTA2
      DELI=-DI/DELTA2
      ASSIGN 30 TO J
   20 SUMR=COST*TS1
      SUMI=SINT*TS1
      TS2=TS1*TS1
      TS3=TS2*TS1
      TS4=TS2*TS2
      TS5=TS2*TS3
      TS6=TS3*TS3
      TS7=TS3*TS4
      TS9=TS4*TS5
      TS12=TS6*TS6
      TS15=TS9*TS6
      CALL ZMPY (DELR,DELI,DELR,DELI,DEL2R,DEL2I)
      CALL ZMPY (DELR,DELI,DEL2R,DEL2I,DEL3R,DEL3I)
      CALL ZMPY (DEL2R,DEL2I,DEL2R,DEL2I,DEL4R,DEL4I)
      CALL ZMPY (DEL2R,DEL2I,DEL3R,DEL3I,DEL5R,DEL5I)
      CALL ZMPY (DEL3R,DEL3I,DEL3R,DEL3I,DEL6R,DEL6I)
      CALL ZMPY (DEL3R,DEL3I,DEL4R,DEL4I,DEL7R,DEL7I)
      CALL ZMPY (DEL4R,DEL4I,DEL4R,DEL4I,DEL8R,DEL8I)
      CALL ZMPY (DEL4R,DEL4I,DEL5R,DEL5I,DEL9R,DEL9I)
      CALL ZMPY (DEL5R,DEL5I,DEL5R,DEL5I,DEL10R,DEL10I)
```

```
      CALL ZMPY (DEL5R,DEL5I,DEL6R,DEL6I,DEL11R,DEL11I)
      GO TO J,  (30, 60)
   30 TSR=-COST/(2.*TS1)
      TSI=SINT/(2.*TS1)
      CALL ZMPY (TSR,TSI,DELR,DELI,PP1R,PP1I)
      CALL POLR(PP1R,PP1I,PP1MOD,PP1PHI)
      K=1
      TSA=TS1
   40 IF (PP1MOD/TSA - 4.E-7)  50,50,41
   41 GO TO (101,102,103,104,105,106,107,108,109,50), K
  101 PP2R=.125/TS3*DEL2R
      PP2I=.125/TS3*DEL2I
  110 CALL POLR(PP2R,PP2I,PP2MOD,PP2PHI)
      IF (PP2MOD - PP1MOD)  42,50,50
   42 SUMR=SUMR+PP1R
      SUMI=SUMI+PP1I
      CALL POLR(SUMR,SUMI,TSA,TSPHIA)
      PP1MOD=PP2MOD
      PP1R=PP2R
      PP1I=PP2I
      K=K+1
      GO TO 40
  102 TSR=-COST/TS2
      TSI=-SINT/TS2
      CALL ZMPY (TSR,TSI,DEL3R,DEL3I,PP2R,PP2I)
      CONST=-(.83333333E-1-.0625/TS3)
  120 PP2R=PP2R*CONST
      PP2I=PP2I*CONST
      GO TO 110
  103 TSR=-COST/TS4
      TSI=SINT/TS4
      CALL ZMPY (TSR,TSI,DEL4R,DEL4I,PP2R,PP2I)
      CONST=-(.72916667E-1-.0390625/TS3)
      GO TO 120
  104 PP2R=DEL5R
      PP2I=DEL5I
      CONST=-(-.025/TS3+.065625/TS6-.02734375/TS9)
      GO TO 120
  105 TSR=COST/TS5
      TSI=SINT/TS5
      CALL ZMPY (TSR,TSI,DEL6R,DEL6I,PP2R,PP2I)
      CONST=-(.40277778E-1-.06015625/TS3+.20507812E-1/TS6)
      GO TO 120
  106 TSR=-COST/TS4
      TSI=SINT/TS4
      CALL ZMPY (TSR,TSI,DEL7R,DEL7I,PP2R,PP2I)
      CONST=-(.89285714E-2-.52777778E-1/TS3+.55859375E-1/TS6-.16113281E-
     11/TS9)
      GO TO 120
  107 PP2R=DEL8R
      PP2I=DEL8I
      CONST=-(.21651786E-1/TS6-.63671875E-1/TS9+.52368164E-1/TS12-
     1.13092041E-1/TS15)
      GO TO 120
```

```
  108 TSR=COST/TS5
      TSI=SINT/TS5
      CALL ZMPY (TSR,TSI,DEL9R,DEL9I,PP2R,PP2I)
      CONST=-(.34722222E-2-.37646054E-1/TS3+.73448351E-1/TS6-.49458822E-
     11/TS9+.10910034E-1/TS12)
      GO TO 120
  109 TSR=COST/TS7
      TSI=-SINT/TS7
      CALL ZMPY (TSR,TSI,DEL10R,DEL10I,PP2R,PP2I)
      CONST=-(.11453373E-1-.56531980E-1/TS3+.82380642E-1/TS6-.46985881E-
     11/TS9+.92735291E-2/TS12)
      GO TO 120
   50 ERRA=PP1MOD
      TRA=SUMR
      TIA=SUMI
  200 GO TO N,  (1001,1002,1003)
 1001 IF (2.*DELTA2*TSA-1.)  45,500,500
   45 ASSIGN 1003 TO N
      GO TO 7
 1002 IF (2.*DELTA2*TSC-.6)  501,501,46
   46 ASSIGN 1003 TO N
      GO TO 11
 1003 IF (ERRA-ERRC)  500,500,501
C
C     CONVERGENT SERIES
    5 IF (2.*DELTA2*TS0-.6)  6,6,10
    6 ASSIGN 1002 TO N
    7 TS1=TS0
      DELR=DR
      DELI=DI
      ASSIGN 60 TO J
      GO TO 20
   60 SUMR=SUMR-DELR
      SUMI=SUMI-DELI
      TS1R=COST*TS1
      TS1I=SINT*TS1
      CALL ZMPY (TS1R,TS1I,DEL3R,DEL3I,PP1R,PP1I)
      SUMR=SUMR-.66666667*PP1R+COST*DEL4R
      SUMI=SUMI-.66666667*PP1I+COST*DEL4I
      TS2R=-COST*TS2
      TS2I=SINT*TS2
      CALL ZMPY (TS2R,TS2I,DEL5R,DEL5I,PP1R,PP1I)
      SUMR=SUMR-.8*PP1R
      SUMI=SUMI-.8*PP1I
      CALL ZMPY (TS1R,TS1I,DEL6R,DEL6I,PP1R,PP1I)
      CONST=.71428571-1.1428571*TS3
      SUMR=SUMR+1.5555556*PP1R-CONST*DEL7R
      SUMI=SUMI+1.5555556*PP1I-CONST*DEL7I
      CALL ZMPY (TS2R,TS2I,DEL8R,DEL8I,PP1R,PP1I)
      SUMR=SUMR+3.8666667*PP1R
      SUMI=SUMI+3.8666667*PP1I
      CALL ZMPY (TS1R,TS1I,DEL9R,DEL9I,PP1R,PP1I)
      CONST=4.0493827-1.7777778*TS3
      CONST1=1.3428571-8.8685714*TS3
```

```
      TRC=SUMR-CONST*PP1R+CONST1*DEL10R
      TIC=SUMI-CONST*PP1I+CONST1*DEL10I
      CALL POLR(TRC,TIC,TSC,TSPHIC)
      CALL ZMPY (TS2R,TS2I,DEL11R,DEL11I,PP1R,PP1I)
      CONST=15.305051-2.9090909*TS3
      PP1R=-CONST*PP1R
      PP1I=-CONST*PP1I
      CALL POLR(PP1R,PP1I,ERRC,ERPHIC)
      GO TO 200
  500 ERR=ERRA
      TR=TRA
      TI=TIA
      TS=TSA
      TSPHI=TSPHIA
      TSZ=TSIN
      GO TO 550
  501 ERR=ERRC
      TR=TRC
      TI=TIC
      TS=TSC
      TSPHI=TSPHIC
      TSZ=TSO
  550 DEL2T=DELTA2*TS
      RETURN
      END

      SUBROUTINE HANK(KIND,ORDER,BRANCH,A,B,X,Y,MAGTUD)
      DIMENSION BR(2),BI(2),GAM(4)
      IF(A*A+B*B) 300,400,300
  300 MAGTUD=0
      SIGN=3-2*KIND
      SO=3.-6.*ORDER
      V=ORDER
      IF(B) 1,2,3
    1 SIY=-1.
      GO TO 4
    2 SIY=0.
      GO TO 4
    3 SIY=1.
    4 IF(SIY*SIGN)  5,5,6
    5 RB=5.5
      GO TO 7
    6 RB=2.3
    7 CALL POLR  (A,B,R,THETA )
      THETA=THETA+BRANCH*6.2831853
      IF(R-RB) 10,100,100
   10 KO=3.*ORDER+.1
      GAM(1)=-4.06235381
      GAM(2)=2.6789385
   35 GAM(3)=-4.0184078
      GAM(4)=1.3541179
      DO 90 L=1,2
      KI=2*KO+1-L
   50 GR=(.5*R)**V*COSF(V*THETA)/GAM(KI)
```

```
      GI=(.5*R)**V*SINF(V*THETA)/GAM(KI)
      CALL SERIES(A,B,V    ,SUMR,SUMI)
      CALL ZMPY(SUMR,SUMI,GR,GI,BR(L),BI(L))
   90 V=-V
      CALLZMPY(0.,1.1547005      ,SO*.5*BR(1)-BR(2),SO*.5*BI(1)-BI(2),GR,GI)
      X=BR(1)+SIGN*GR
      Y=BI(1)+SIGN*GI
      RETURN
  100 IGO=1
      C=A
   28 D=B
      SR=1.2533141  *SQRTF(R)
      TR=SR*COSF(.5*THETA)
      TI=SR*SINF(.5*THETA)
      IF(ABSF(THETA)-4.7123890   ) 103,103,115
  103 IF(SIGN*(THETA+SIGN*1.5707963   )) 105,113,113
  105 C=-A
      D=-B
      CALLZMPY(TR,TI,0.,SIGN,TR,TI)
      IGO=2
      GO TO 113
  115 IGO =3
      TR=-TR
      TI=-TI
  113 CALLZEXP(-SIGN*D,SIGN*(C-1.5707963   *(V+.5)),SR,SI,MAGTUD)
      CALLSP(V,2.*SIGN*D,-2.*SIGN*C,RTR,RTI)
      CALL ZMPY(SR,SI,RTR,RTI,X,Y)
      GO TO (135,192,192),IGO
  192 CALLSP(V,-2.*SIGN*D,2.*SIGN*C,RTR,RTI)
      CALLZDIV(RTR,RTI,SR,SI,SR,SI)
      CALLZMPY(SR,SI,SO*.5,-SIGN*.86602540   ,SR,SI)
      EX1=1.
      EX2=1.
      IF(MAGTUD) 195,200,197
  195  EMA=2*MAGTUD
      EX1=EXPF(EMA)
      MAGTUD=-MAGTUD
      GO TO 200
  197  EMA=-2*MAGTUD
      EX2=EXPF(EMA)
  200 GO TO (135,205,210),IGO
  205 X=SO*EX1*X+SR*EX2
      Y=SO*EX1*Y+SI*EX2
      GO TO 135
  210 X=-EX1*X-SO*SR*EX2
      Y=-EX1*Y-SO*SI*EX2
  135 CALLZDIV(X,Y,TR,TI,X,Y)
  136 RETURN
  400 WRITE OUTPUT TAPE61,401
  401 FORMAT(35H ZERO ARGUMENT NOT DEFINED IN HANK.)
      CALL EXIT
      END

      SUBROUTINE SERIES (A,B,V,SUMR,SUMI)
```

```
      CALL ZMPY(.25*A,.25*B,A,B,SQR,SQI)
      TERMR=1./V
      TERMI=0.
      SUMR=TERMR
      SUMI=TERMI
      EN=0.
   10 EN=EN+1.
      CALLZMPY(TERMR,TERMI,-SQR/(EN*(V+EN)),-SQI/(EN*(V+EN)),
     1TERMR,TERMI)
      SUMR=SUMR+TERMR
      SUMI=SUMI+TERMI
      IF((TERMR*TERMR+TERMI*TERMI)/(SUMR*SUMR+SUMI*SUMI)-1.E-22)20,20,10
   20 RETURN
      END

      FUNCTION GAMMA(X)
   75 FORMAT(66H GAMMA FUNCTION OF A NEGATIVE INTEGER, OR OF ZERO, IS NO
     1T DEFINED.)
    5 IF(X) 10,80,15
   10 N=-X
      EN=-N-1
      V=X-EN
      IF(V-1.) 5, 80, 20
   15 N=X
      EN=N
      V=X-EN
   20 GAMMA=1.+V*(.422784337+V*(.4118402518+V*(.08157821878+V*
     1(.07423790761+V*(-.0002109074673+V*(.01097369584+V*(-.002466747981
     2+V*(.001539768105-V*(.0003442342046-V*.00006771057117)))))))))
      IF(EN-2.) 37,25,30
   25 RETURN
   30 N=N-1
      DO 35 I=2,N
      FI=I
   35 GAMMA=GAMMA*(FI+V)
      RETURN
   37 N=2.-EN
      DO 40 I=1,N
      FI=2-I
   40 GAMMA=GAMMA/(FI+V)
      RETURN
   80 WRITE OUTPUT TAPE 6,75
      CALL EXIT
      END

      SUBROUTINE SP(P,C,B,RTR,RTI)
      DIMENSION CVR(4),CVI(4) ,A( 8),H( 8)
      T=1.
      REAL1=1.
      AM1=0.
      RTR=1.
      RTI=0.
      CALL ZDIV(1.,0.,C,B,X,Y)
      PP=4.*P*P
```

```
 20 PRELIM=(PP-(2.*T-1.)*(2.*T-1.))/(4.*T)
    U=PRELIM*X
    V=PRELIM*Y
    CALL ZMPY(REAL1,AM1,U,V,REAL2,AM2)
    IF((REAL2*REAL2+AM2*AM2)-(REAL1*REAL1+AM1*AM1))110,110,200
110 RTR=RTR+REAL2
    RTI=RTI+AM2
    CALL ZDIV(REAL2,AM2,RTR,RTI,QTR,QTI)
    REAL1=REAL2
    AM1=AM2
 10 T=T+1.
    IF((QTR*QTR+QTI*QTI)-1.E-16) 30, 30,20
200 S=T-P-.5
    IF(S-25.)  201,201, 30
201 A(1)=1.7878605
    A(2)=3.5882389
    A(3)=5.9200900
    A(4)=8.8668464
    A(5)=1.2543589  E+1
    A(6)=1.7140529  E+1
    A(7)=2.3023343  E+1
    A(8)=3.1129504     E+1
    H(1)=4.7828652
    H(2)=3.3761327  E+1
    H(3)=5.1231373  E+1
    H(4)=2.5408127E+1
    H(5)=4.5375890
    H(6)=2.7433832  E-1
    H(7)=4.3728310  E-3
    H(8)=8.8275945  E-6
    CVR(1)=0.
    CVI(1)=0.
    DO 205 I=1,8
    XS=A(I)**(S-5.)
    CALLZDIV(XS*C,XS*B,C+A(I),B,ADR,ADI)
    CVR(1)=CVR(1)+ADR*H(I)
205 CVI(1)=CVI(1)+ADI*H(I)
    GA=GAMMA(S+1.)
    CVR(1)=CVR(1)/GA
    CVI(1)=CVI(1)/GA
    TERMR=   C*(P- .5)/(T+P- .5)
    TERMI=   B*(P- .5)/(T+P- .5)
    CALLZMPY(S+1.+C,B,CVR(1),CVI(1),CVR(2),CVI(2))
    CALLZDIV(CVR(2)-C,CVI(2)-B,C,B,CVR(2),CVI(2))
    CALL ZMPY(TERMR,TERMI,CVR(2),CVI(2),TR,TI)
    SUMR=CVR(1)-TR
    SUMI=CVI(1)-TI
202 ADD=1.
    SIGN=-1.
    DO 211 N=2,3
    EN=N
    SIGN=-SIGN
    ZIP=(P-EN+.5) /(T+P-EN+.5)
    CALLZMPY(   ZIP*C,   ZIP*B,TERMR,TERMI,TERMR,TERMI)
```

```
      CALLZMPY(S+C+2.-EN,B,CVR(N),CVI(N),CVR(N+1),CVI(N+1))
        CALLZDIV(CVR(N+1)+CVR(N-1)-ADD,CVI(N+1)+CVI(N-1),EN*C,EN*B ,
     1 CVR(N+1),CVI(N+1))
      CALLZMPY(TERMR,TERMI,CVR(N+1),CVI(N+1),TPR,TPI)
      IF(TPR*TPR+TPI*TPI-TR*TR-TI*TI) 206,212,212
  206 TR=TPR
      TI=TPI
      SUMR=SUMR+SIGN*TR
      SUMI=SUMI+SIGN*TI
  211 ADD=0.
  212 CALLZMPY(SUMR,SUMI,REAL2,AM2,REAL2,AM2)
      RTR=RTR+REAL2
      RTI=RTI+AM2
   30 RETURN
      END

      FUNCTION CUBERT (X)
      S=1.
      IF (X) 1,3,2
    1 S=-1.
      X=-X
    2 X0=1.
      B=X
      IF (X-1.) 4,3,6
    3 CUBERT=X
      GO TO 30
    4 B=B*1000.
      X0=0.1*X0
      IF (B-1.) 4,10,10
    6 B=B*.001
      IF (B-1.) 10,7,7
    7 X0=10.*X0
      GO TO 6
   10 CUBERT=X/(3.*X0*X0)+.66666667*X0
      IF (ABSF((CUBERT-X0)/CUBERT)-4.E-8) 30,30,20
   20 X0=CUBERT
      GO TO 10
   30 CUBERT=CUBERT*S
      X=S*X
      RETURN
      END

      SUBROUTINE ZEXP(A,B,X,Y,MAGTUD)
      MAGTUD=A
      SCALE=MAGTUD
      E=EXPF(A-SCALE)
      X=E*COSF(B)
      Y=E*SINF(B)
      RETURN
      END

      SUBROUTINE ZMPY(A,B,C,D,X,Y)
C     CALCULATES THE PRODUCT OF TWO COMPLEX NUMBERS.
C     INPUT.
```

```
C         (A,B) = THE MULTIPLICAND.
C         (C,D) = THE MULTIPLIER.
C       OUTPUT.
C         (X,Y) = THE PRODUCT, (X+IY)=(A+IB)*(C+ID)
        EX=(A*C-B*D)
        Y=A*D+C*B
        X=EX
        RETURN
        END

        SUBROUTINE ZSQRT(AA,BB,X,Y)
C       CALCULATION OF THE PRINCIPLE SQUARE ROOT OF A COMPLEX NUMBER.
C       INPUT.
C         (AA,BB) = THE GIVEN COMPLEX NUMBER.
C       OUTPUT.
C         (X,Y) = THE PRINCIPLE SQUARE ROOT OF AA + I BB.
        A=AA
        B=BB
        S=1.
        IF(B) 1,5,5
    1   S=-1.
    5   IF(A) 2,4,2
    2   IF(ABSF(A)-ABSF(B))20,25,25
   20   X=ABSF(B)*SQRTF(1.+(A/B)**2)
        GO TO 30
   25   X=ABSF(A)*SQRTF(1.+(B/A)**2)
   30   X=SQRTF(.5*(X+ABSF(A)))
        D=B/(2.*X)
        Y=D
        IF(A) 3,10,10
    3   Y=S*X
        X=S*D
        GO TO 10
    4   X=SQRTF(S*B*.5)
        Y=S*X
   10   RETURN
        END

        SUBROUTINE POLR(EX,EY,R,THETA)
C       CALCULATION OF THE AMPLITUDE AND PHASE OF A COMPLEX NUMBER.
C       INPUT.
C         (EX,EY) = THE GIVEN COMPLEX NUMBER.
C       OUTPUT.
C         R = THE AMPLITUDE OF EX + I EY.
C         THETA = PHASE IN RADIANS OF EX + I EY.
        X=EX
        Y=EY
        IF(ABSF(X)-ABSF(Y)) 20,25,25
   20   R=ABSF(Y)*SQRTF(1.+(X/Y)**2)
        GO TO 30
   25   R=ABSF(X)*SQRTF(1.+(Y/X)**2)
   30   S=1.
        IF(Y) 2, 3, 3
    2   S=-1.
```

```
    3 IF(X) 10,5,15
    5 THETA=S*1.570796327
      RETURN
   10 THETA=S*3.141592654     +ATANF(Y/X)
      RETURN
   15 THETA=ATANF(Y/X)
      RETURN
      END

      SUBROUTINE ZDIV(A,B,C,D,X,Y)
C     CALCULATES THE QUOTIENT OF TWO COMPLEX NUMBERS.
C     INPUT.
C        (A,B) = THE DIVIDEND.
C        (C,D) = THE DIVISOR.
C     OUTPUT.
C        (X,Y) = THE QUOTIENT, (X+IY)=(A+IB)/(C+ID)
      IF(C) 20,5,20
    5 IF(D) 6,12,6
    6 EX=B/D
      Y=-A/D
      GO TO 40
   20 IF(D) 30,10,30
   10 EX=A/C
      Y=B/C
      GO TO 40
   12 PRINT 13
   13 FORMAT(21H ZERO DIVISOR IN ZDIV)
      CALL EXIT
   30 IF(ABSF(C)-ABSF(D))35,35,31
   31 AOVC= A/C
      BOVC= B/C
      DOVC= D/C
      DEN= 1.+(DOVC*DOVC)
      X= (AOVC+(BOVC*DOVC))/DEN
      Y=(BOVC-(AOVC*DOVC))/DEN
      RETURN
   35 AOVD= A/D
      BOVD= B/D
      COVD= C/D
      DEN= 1.+(COVD*COVD)
      X=((AOVD*COVD)+BOVD)/DEN
      Y=((BOVD*COVD)-AOVD)/DEN
      RETURN
   40 X=EX
   65 RETURN
      END

      SUBROUTINE PATH (TMTRLA, TMTRLO, RCVLAT, RCVLON, FUNCT,XINT,DKM,
     2   PATHLA, PATHLO, DIST, BERATX, BERATR,BERXMT,NMAX,TYPATH)
CPATH  SUBR. TO CALC. DIST, , LAT., AND LONG. ALONG PATH. FUNCTIONS ARE
C      (1)  REG---CALC. LAT. AND LONG. ALONG PATH AT DIST. SPEC. AS INT
C      (2) MID--TREAT COORD. GIVEN AS MID-POINT OF PATH, FIND END POINT
C      (3) HOP-- FIND REFLECTION POINTS FOR RAY ORDER SPEC. AS INT
C      (4)  DSTNCE--FIND DISTANCE BETWEEN SPECIFIED POINTS
```

```
      DIMENSION  DIST (1000),PATHLA (1000),PATHLO (1000),BERXMT (1000)
      DIMENSION DELTLIM (4),SIGNT (2)
      TYPE INTEGER REG,XMID,HOP,DSTNCE,SHORT,XLONG,TYPATH,FUNCT,QFLAG
       TYPE INTEGER ORDER, Q, QUADRANT, QR,RETADRES,QP,ORDRFLAG
      TYPE INTEGER ZETAFLAG,TYPEPATH,FUNCTION
      TYPE REAL MAXLAT,MAXLONG
      EQUIVALENCE (Q, QUADRANT),(PRECISON,MAXERR),(JDELT1,DELTPHI1),
     2 (JDELTC,DELTPHIC),(INDTP,NOTPIND)
      COMMON/PATHSTOR/ MAXLAT (2),MAXLONG (2),DISTP (2),NUMTP,Q,QR,QP,
     2COFUNC, ZETAFLAG,A,AOVERB,U,DELTPHI1,   CTAB (3), DLTPHTAB (3),
     3         C,C1,CMAX,PRESERR,PREVERR,ERROR,ZETAXMTR,ZETARCVR,RADDEG
      DATA                      (RADDEG=57.29577951),
     2 (DEGRAD=1.745329252E-2),    (NLIM=20)
      DATA (REG = 4HNORM),(XMID=3HMID),(HOP=3HHOP),(DSTNCE=6HDSTNCE),
     2 (SHORT = 5HSHORT),(XLONG=4HLONG),(PI=3.141592654)
C     CONSTANT A/B IS FOR B=6356.5838
      DATA (A = 6378.2064),
     2                 (AOVERB =1.0034016),
     3                 (U = 0.0033900),(PIOVER2 = 1.570796327),
     4(CTAB = 0.), (DLTPHTAB = 0.)
      COMMON/IPATHEQ/IPATHEQ,IPATHEQ1
      DATA (IPATHEQ=3),(IPATHEQ1=4)
      COF (C)= SQRTF (1.-C*C)
      QFLAG=ORDRFLAG=MERIDFLG= 0
       N =        1
      CALL Q9OVER
      IF (FUNCT .EQ. 3HREG .OR. FUNCT .EQ. 4HSTEP.OR. FUNCT .EQ. 4HNORM)
     2 IFUNCT = 1
      IF (FUNCT .EQ. 3HMID) IFUNCT = 2
      IF (FUNCT .EQ. 3HHOP) IFUNCT = 3
      IF (FUNCT .EQ. 4HDIST .OR. FUNCT .EQ. 6HDSTNCE) IFUNCT = 4
      IF (TMTRLA .NE. XMTRLAT .OR. TMTRLO .NE. XMTRLON .OR.
     2 RCVLAT .NE. RCVRLAT .OR. RCVLON .NE. RCVRLON .OR.
     3 TYPEPATH .NE. TYPATH  ) GO TO 110
      IF ((FUNCTION .EQ. 4HDIST .OR. FUNCTION .EQ. 6HDSTNCE) .AND.
     2 (FUNCT .EQ. 4HSTEP .OR. FUNCT .EQ. 3HREG .OR. FUNCT .EQ. 4HNORM))
     3 GO TO 810
      IF ((FUNCTION .EQ.4HSTEP.OR.FUNCTION.EQ.3HREG .OR. FUNCT .EQ.
     2 4HNORM) .AND.
     3 (FUNCT .EQ. 4HDIST .OR. FUNCT .EQ. 6HDSTNCE)) GO TO 8990
      IF (FUNCT .EQ. FUNCTION .AND. DISTEP .EQ.XINT) GO TO 8990
      GO TO (110,8980,8980,110),IFUNCT
  110 XMTRLAT= TMTRLA
      XMTRLON= TMTRLO
      RCVRLAT= RCVLAT
      RCVRLON= RCVLON
      TYPEPATH = TYPATH
      FUNCTION = FUNCT
      DISTEP = XINT
      NUMTP =0
  220 IF (      TYPEPATH-XLONG ) 223, 221, 223
  221 IPATH = 1
      GO TO 290
  223 IPATH = 2
```

```
      TYPATH = TYPEPATH = 5HSHORT
  290 CALL R9OVER
      DELTPHI1= RCVRLON-XMTRLON
      DELTLAT = RCVRLAT-XMTRLAT
      IF (ABSF (DELTPHI1) .LE. 180.)  GO TO  300
C             LONG SHORT   PATH
      GO TO (330, 310), IPATH
  300 GO TO (310, 330), IPATH
  310 IF (DELTPHI1 .LT. 0) GO  TO 320
      DELTPHI1 = DELTPHI1 -360.
      GO TO 330
  320 DELTPHI1 = 360 + DELTPHI1
  330 ERROR = ABS (1.0 E-08*DELTPHI1)
      IF (ERROR .EQ. 0.) ERROR = 1.0E-08
      IF (DELTPHI1 .LT. 0)  GO TO 365
  340 IF (DELTLAT   .LT.0 )  GO TO 350
      Q = 3 -IPATH
      GO TO 370
  350 Q = IPATH
      GO TO 370
  365 Q = 5 -IPATH
  370 IF (ABSF (RCVRLAT) .NE. 90. .AND. ABSF (XMTRLAT) .NE. 90.
     1   .AND. DELTPHI1 .NE. 0.) GO TO 375
      COFUNC = 1.
      C1= C = 0.
      MERIDFLG = 1
  375 IF (ABS (RCVRLAT) .NE. 90.) GO TO 376
      IF (RCVRLAT .EQ. 90.) ZETARCVR = 0.
      IF (RCVRLAT .EQ. -90.) ZETARCVR = PI
      GO TO 380
  376 TANRCLAT = TANF(RCVRLAT*DEGRAD)
      IF (TANRCLAT .NE. 0.) GO TO  378
      ZETARCVR = PIOVER2
      GO TO 380
  378 ZETARCVR = ATANF (AOVERB/TANRCLAT)
  380 IF (ABS (XMTRLAT) .NE. 90.) GO TO 382
      IF (XMTRLAT .EQ. 90.) ZETAXMTR = 0.
      IF (XMTRLAT .EQ.-90.) ZETAXMTR = PI
      GO TO 401
  382 TANXMLAT = TANF (XMTRLAT*DEGRAD)
      IF (TANXMLAT .NE. 0.)  GO TO 390
      ZETAXMTR = PIOVER2
      GO TO 400
  390 ZETAXMTR = ATANF (AOVERB/TANXMLAT)
      IF (ZETAXMTR .LT. 0.) ZETAXMTR =ZETAXMTR +PI
  400 IF (ZETARCVR .LT. 0.) ZETARCVR =ZETARCVR +PI
  401 IF (ABSF (RCVRLAT).GE. ABSF (XMTRLAT)) GO TO 402
      IF (DELTPHI1 .NE. 0.)
     2C =         SIN (ZETAXMTR)
      ZETAFLAG = 1
      GO TO 404
  402 IF (DELTPHI1 .NE. 0.)
     2C =         SIN (ZETARCVR)
      ZETAFLAG = 2
```

```
 404 CMAX = C
     IF (MERIDFLG) 600, 410
 406 C = CMAX
 410 C = SIGNF (C, FLOATF ((-1)**(Q+1)))
     COFUNC = COF (C)
     IF (ZETAFLAG .EQ. 2 .AND. COFUNC .NE. 0.) GO TO 416
     ARG12 = SIGN (1.,C*COTF(ZETAXMTR))
     ARG22 = SIGN (1.,COS (ZETAXMTR))
     IF (COFUNC .EQ. 0.) 416, 420
 416 ARG11 = SIGN (1.,C*COTF(ZETARCVR))
     ARG21 = SIGN (1.,COS (ZETARCVR))
 418 IF (COFUNC .EQ. 0.) GO TO  424
 420 IF (ZETAFLAG .EQ. 1) ARG11 = ARG1 (ZETARCVR,C)
     IF (ZETAFLAG .EQ.2) ARG12 = ARG1 (ZETAXMTR,C)
     IF (ZETAFLAG .EQ. 1) ARG21 = ARG2 (ZETARCVR)
     IF (ZETAFLAG .EQ. 2) ARG22 = ARG2 (ZETAXMTR)
 424 PHIARG11 =  PHI1F (  ARG11,     NUMTP)
     PHIARG12 = PHI1F (  ARG12,    0)
     PHIARG21 = PHI2F (ARG21,   NUMTP)
     PHIARG22 = PHI2F (ARG22,      0)
 425 DELTPHIC = PHIARG11 -PHIARG12 -C* U * (PHIARG21-PHIARG22)
     DELTPHI0 =  NUMTP          *180 *(-1)**((Q-1)/2)
     DELTLIM (NUMTP+1) = DELTPHIC
 440 IF ((DELTPHI1 .GE. DELTPHIC .AND. DELTPHI1 .LE. DELTPHI0) .OR.
    1 (DELTPHI1 .GE. DELTPHI0 .AND . DELTPHI1 .LE. DELTPHIC)) GO TO 470
 441 IF (NUMTP .GE. 2) GO TO 452
 442 NUMTP =NUMTP +1
     GO TO 406
 452 IF (QFLAG .LT. 1) GO TO 453
     KEYER = 452
     GO TO 9900
 453 IF (Q .GT. 2) GO TO 454
     Q = 3 -Q
     GO TO 456
 454 Q = 7 -Q
 456 QFLAG = QFLAG +1
     NUMTP = 0
     GO TO 406
 470 IF (DELTPHIC .GT. DELTPHI0) GO TO 472
     I1 = 2 $ I2 = 1
     GO TO 474
 472 I1 = 1 $ I2 = 2
 474 DLTPHTAB (I1)= DELTPHI0
     CTAB (I1) = 0.
     DLTPHTAB (I2) =       DELTLIM (NUMTP +1)
     CTAB (I2) = C
     NORDER = 1
     NPOINTS = 2
     PREVERR = 1.0 E+10
 475 IF (CTAB .GT. CTAB (2)) GO TO 478
     I1 = 1
     I2 = 2
     GO TO 479
 478 I1 = 2
```

```
      I2 = 1
  479 C1 = ROOT(CTAB (I1), CTAB (I2), IERROR)
      IF(IERROR .EQ. 0) GO TO 480
      KEYER = 475
      GO TO 9900
  480 IF (C1*C .GE. 0. .AND.
     2     ABSF (C1) .LE. ABSF (CMAX)) GO TO 490
      KEYER = 480
      GO TO 9900
  490 COFUNC = COF (C1)
  600 C = C1
      COFUNC = COF (C)
      IF (COFUNC .NE. 0.) GO TO 610
      DKM = ABSF (A*DELTPHI1*DEGRAD)
      GO TO 620
  610 DKM=ABSF (DISTF (C,ARG2 (ZETARCVR),ARG2 (ZETAXMTR),ZETARCVR,
     1  ARGD2 (ZETARCVR,C),NUMTP))
  620 QR = 4 -Q +XMODF (NUMTP +1,2)  *XMODF (Q+1,2)*2+XMODF (NUMTP,2)
      BERATX = SIGN (ASIN (ABS (C/SIN (ZETAXMTR)))*RADDEG,(-1)**(Q-1))
     2                               +(Q/2)*180.
      BERATR = SIGN (ASIN (ABS (C/SIN (ZETARCVR)))*RADDEG,(-1)**(QR-1))
     2                                +(QR/2)*180.
      ARG12 = ARG1 (ZETAXMTR,C)
      ARG22 = ARG2 (ZETAXMTR)
  640 IF (Q .EQ. 2 .OR. Q .EQ. 3) GO TO 650
      SIGNT (1) = +1.
      SIGNT(2) = -1.
      GO TO 660
  650 SIGNT(1) = -1.
      SIGNT(2) = +1.
  660 DO 800 I = 1, 2
      ARG11 = SIGNF (1.,C*SIGNT(I))
      ARG21 = SIGNF (1.,SIGNT (I))
  690 ZETA     = ASINF (ABS (C)*SIGNT (I))
  700 IF (ZETA .LT. 0.) ZETA = PI+ZETA
      TANZETA = TANF(ZETA)
      IF (TANZETA .NE. 0.)GO TO 710
      IF (ZETA .EQ. 0.)MAXLAT (I) = +90.
      IF (ZETA .EQ. PI      ) MAXLAT (I) = -90.
      GO TO 720
  710 MAXLAT (I) = ATANF (AOVERB/TANZETA)      *RADDEG
  720 MAXLONG (I) = XMTRLON +PHI1F (ARG11,I-1)-PHI1F (ARG12,0)
     1 -C*U*(PHI2F (ARG21,I-1)-PHI2F (ARG22,0))
  730 IF (ABS (MAXLONG (I)) .LT. 360.) GO TO 735
      MAXLONG (I) = MAXLONG (I) -SIGNF (1.,MAXLONG (I))*360.
      GO TO 730
  735 IF (ABSF (MAXLONG (I)).LT. 180.) GO TO 750
      IF (MAXLONG (I) .LE.180.)MAXLONG (I) = 360.+MAXLONG (I)
  740 IF (MAXLONG (I) .GT.180.)MAXLONG (I) = MAXLONG (I) -360.
  750 DISTP (I) = ABSF (DISTF (C,ARG21, ARG22,ZETA,0.,I-1))
  800 CONTINUE
  810 CALL R9OVER
      GO TO (820,8980,8980,8990), IFUNCT
  820 FUNCTION = FUNCT
```

```
      DISTEP = XINT
      INDTP = INDTP1 = INDTP2 = 0
      DIST (1) = 0.
      PATHLA (1) = XMTRLAT
      PATHLO (1) = XMTRLON
      PREVERR = 1.0 E+10
      IF (BERATX .GE. 180.) BERXMT (1) = BERATX -180.
      IF (BERATX .LT. 180.) BERXMT (1) = BERATX +180.
  830 DO 840 I = 1, NUMTP
      DIST (I+1) = DISTP (I)
  840 PATHLA (I+1) = MAXLAT (I)
  850 DIST (NUMTP+2) = DKM
      PATHLA (NUMTP+2) = RCVRLAT
      NOTPIND = INDTP1 = INDTP2 = 0
      IF (NUMTP .EQ. 0) GO TO 860
      IF (NUMTP .GE. 1) INDTP1 = 2
      IF (NUMTP .EQ. 2) INDTP2 = 3
  860 IF (DKM .GT. 0. .AND. DISTEP .GT. 0.) GO TO 865
      KEYER = 865
      GO TO 9900
  865 NMAX = DKM/DISTEP +2
      IF (ABS (DISTEP* (NMAX -2) -DKM) -DISTEP/10. .LT. 0.)
     2 NMAX = NMAX - 1
      NMAX1 = NMAX -1
  870 DO 985 IND = 2, NMAX1
      N = 1
      ORDRFLAG = 0
      NPOINTS = IND +NUMTP
      IF (NPOINTS .LT. 7) NORDER   = NPOINTS -1
      IF (NPOINTS .GE. 7) NORDER = 5
      DREQ = DISTEP*(IND-1)
  880 IF (DREQ .LE.  DISTP (NOTPIND+1) .OR.NOTPIND .EQ. NUMTP) GO TO 890
      IF (NOTPIND .GE. NUMTP)  GO TO 885
      NOTPIND = NOTPIND +1
      GO TO 880
  885 KEYER = 885
      GO TO 9900
  890 IERROR = 1
      CALL  MONTONCK (DIST,NPOINTS,IERROR)
      IF (IERROR .EQ. 1) GO TO 900
      KEYER = 890
      GO TO 9900
  900 IERROR = 0
      CALL INTRPOLT  (NORDER,NPOINTS,DIST,PATHLA,DREQ,REQLAT,IERROR)
      IF (IERROR .EQ. 0) GO TO 910
      KEYER = 900
      GO TO 9900
  910 IF (ABS (REQLAT) .GT. ABS (MAXLAT (1))) GO TO 946
      IF (NUMTP .EQ. 0) GO TO 918
      IF (NOTPIND .GT. 0) GO TO 915
      IF ((REQLAT.GE. PATHLA (1) .AND. REQLAT .LE. MAXLAT (1))
     2.OR. (REQLAT .LE. PATHLA (1) .AND. REQLAT .GE. MAXLAT (1)))
     3 919,946
  915 GO TO (916,917),NOTPIND
```

```
916 IF ((REQLAT .GE. MAXLAT (1) .AND. REQLAT .LE. MAXLAT (2)).OR.
   2(REQLAT .LE. MAXLAT (1) .AND. REQLAT .GE. MAXLAT (2))) 919,946
917 IF ((REQLAT .GE. MAXLAT (2) .AND. REQLAT .LE. RCVRLAT) .OR.
   2 (REQLAT .LE. MAXLAT (2) .AND. REQLAT .GE. RCVRLAT)) 919,946
918 IF ((REQLAT .GE. PATHLA (1) .AND. REQLAT .LE. RCVRLAT) .OR.
   2 (REQLAT .LE. PATHLA  (1) .AND. REQLAT .GE. RCVRLAT)) 919,946
919 TANLAT = TANF(REQLAT*DEGRAD)
    IF (TANLAT .NE. 0.) GO TO 920
    ZETA = PIOVER2
    GO TO 940
920 ZETA = ATAN (AOVERB/TANLAT)
930 IF (ZETA .LT. 0.) ZETA = ZETA +PI
940 DCALC = ABS (DISTF (C,ARG2 (ZETA),ARG22,ZETA,ARGD2 (ZETA,C),
   1 NOTPIND))
945 PRESERR = DREQ-DCALC
    IF ( ABS ( DREQ - DCALC) .LT. 0.0005 .OR. PRESERR .EQ. PREVERR)
   2 GO TO 960
    IF (DCALC .LT. DKM ) GO TO 948
946 NORDER = NORDER -1
    N = N +1
    ORDRFLAG = ORDRFLAG +1
    IF (NORDER .GT. 0 ) GO TO 890
    KEYER = 945
    GO TO 9900
948 IF (N .LT. NLIM) GO TO 950
    KEYER = 948
    GO TO 9900
950 PREVERR = PRESERR
    CALL ORDER (DIST,PATHLA, NPOINTS,DCALC,REQLAT,INDX,IERROR)
    IF (IERROR .NE. 0) GO TO 946
    N = N +1
    IF (ORDRFLAG .GT. 1) GO TO 890
    IF (NORDER .LT. 5) NORDER = NORDER +1
    IF (NORDER+1 .GT. NPOINTS) NORDER = NPOINTS -1
    GO TO 890
960 IF (NUMTP .EQ. 0) GO TO 980
    IF (IND  .LE.INDTP1.AND. NOTPIND .LT. 1) INDTP1 = INDTP1 +1
970 IF (IND  .LE. INDTP2.AND.NOTPIND .LT. 2) INDTP2 = INDTP2 +1
980 DIST (IND +NOTPIND) = DCALC
    PATHLA (IND +NOTPIND) = REQLAT
    BERXMT  (IND +NOTPIND) = ZETA
    IF (INDTP1 .LE. 0 .OR. IND .GT. INDTP1 +1) GO TO 981
    DIST (INDTP1) = DISTP (1)
    PATHLA (INDTP1) = MAXLAT (1)
981 IF (INDTP2 .LE. 0 .OR. IND .GT. INDTP2 +1) GO TO 982
    DIST (INDTP2) = DISTP (2)
    PATHLA (INDTP2) = MAXLAT (2)
982 DIST (IND +NUMTP +1) = DKM
    PATHLA (IND +NUMTP  +1) = RCVRLAT
985 CONTINUE
990 NOTPIND = 0
    DO 1100 IND = 2, NMAX1
1000 IF (IND+INDTP .EQ. INDTP1 .OR. IND+INDTP .EQ. INDTP2)
   1 INDTP = INDTP +1
```

```
1020 IF (NOTPIND .EQ. 0) GO TO 1025
     DIST (IND) = DIST (IND +INDTP)
1025 ZETA = BERXMT  (IND +INDTP)
1030 XLAT = PATHLA (IND +INDTP)
     PATHLA (IND) = XLAT
1040 PATHLONG = XMTRLON +PHI1F (ARG1 (ZETA,C),NOTPIND)-PHI1F (ARG12,0)
    1 -C*U*(PHI2F (ARG2 (ZETA),NOTPIND)-PHI2F (ARG22,0))
1050 IF (ABS (PATHLONG) .LT. 360.) GO TO 1055
     PATHLONG = PATHLONG -SIGNF (1.,PATHLONG)*360.
     GO TO 1050
1055 IF (ABS (PATHLONG) .LT. 180.) GO TO 1060
     IF (PATHLONG .GT. 180.) PATHLONG =-360.+PATHLONG
     IF (PATHLONG .LE. -180.) PATHLONG = 360. +PATHLONG
1060 PATHLO (IND) = PATHLONG
     QP = 4 -Q +XMODF (NOTPIND+1,2)*XMODF (Q+1,2)*2 +XMODF (NOTPIND,2)
1070 BERXMT (IND)= SIGN (ASIN (ABS (C/SIN (ZETA)))*RADDEG,(-1)**(QP-1))
    1 + (QP/2)*180.
1100 CONTINUE
     PATHLA (NMAX) = RCVRLAT
     PATHLO (NMAX) = RCVRLON
     BERXMT (NMAX) = BERATR
     DIST (NMAX) = DKM
1200 RETURN
8980 CALL R9OVER
     CALL Q8QERROR (0,41H1MID AND HOP FUNCTIONS NOT YET OPERATING.   )
8990 RETURN
9900 WRITE (61, 9000) KEYER
9000 FORMAT (*1STATEMENT NO. * I6)
     CALL Q8QERROR (0,14HERROR IN PATG.)
     END

     FUNCTION ROOT (TI,TF,IERROR)
     COMMON/PATHSTOR/ MAXLAT (2),MAXLONG (2),DISTP (2),NUMTP,Q,QR,QP,
    2COFUNC, ZETAFLAG,A,AOVERB,U,DELTPHI1,   CTAB (3), DLTPHTAB (3),
    3        C,C1,CMAX,PRESERR,PREVERR,E,ZETAXMTR,ZETARCVR,RADDEG
     INTEGER Q,QR,QP,ZETAFLAG
     DIMENSION FACTOR (4)
     DATA (FACTOR = 0.5,0.7,0.8,0.9)
 100 FORMAT(* UPPER LIMIT OF ITERATION EXCEEDED  N=*,I4,3X,*T=*,E12.5,
    13X,*F(T)=*,E12.5)
  10 IERROR = ITRFLAG = ITLFLAG = 0
     PREVERR = 1. E+05
     N=1
  20    TL= TI
     FL = F (TL)
        TR=TF
     FR = F (TR)
  30 IF (MOD (N-1,25).EQ. 0)
    2SLOPE=(FL   -FR)   /(TL-TR)
     IF(N.LT.50) 40, 50
  40 T = (TR*FL-TL*FR)/(FL-FR)
     GO TO 60
  50 T=(TL+TR)/2.
  60 FT=F(T)
```

```
      PRESERR= ABS (FT)
      IF (PRESERR.LT. E) GO TO 150
      IF (N .GT. 1 .AND. PRESERR .EQ. PREVERR) GO TO 150
      PREVERR = PRESERR
      N=N+1
   70 IF(N.GE.200)GO TO 120
      IF(SLOPE.LT.0.)GO TO 90
      IF(FT.LT.0.) 110, 100
   90 IF(FT.GE.0.)GO TO 110
  100 TR=T
      FR = FT
      ITRFLAG = ITRFLAG +1
      IF (ITRFLAG .LE. 2) GO TO 30
      ITRFLAG = ITLFLAG = 0
      I = 1
  105 TX = TL +(T-TL)*(1.-FACTOR (I))
      FX = F (TX)
      IF (SIGN (1., FX)       .EQ. SIGN (1., FL))    GO TO 107
      I = I+1
      IF (I .LT. 5) 105, 30
  107 TL = TX
      FL = FX
      GO TO 30
  110 TL=T
      FL = FT
      ITLFLAG = ITLFLAG +1
      IF (ITLFLAG .LE. 2) GO TO 30
      ITRFLAG = ITLFLAG = 0
      I = 1
  115 TX = T+(TR-T)*FACTOR (I)
      FX = F (TX)
      IF (SIGN (1.,FX)       .EQ. SIGN (1.,FR))    GO TO 117
      I = I+1
      IF (I .LT. 5) 115,30
  117 TR = TX
      FR = FX
      GO TO 30
  120 WRITE(61,100)N,T,FT
      ROOT=(TL+TR)/2.
  130 IERROR = 1
      RETURN
  150 ROOT=T
      END

      FUNCTION PHI1F (ARG10,N)
      COMMON/PATHSTOR/ MAXLAT (2),MAXLONG (2),DISTP (2),NUMTP,Q,QR,QP,
     2COFUNC, ZETAFLAG,A,AOVERB,U,DELTPHI1,   CTAB (3), DLTPHTAB (3),
     3         C,C1,CMAX,PRESERR,PREVERR,E,ZETAXMTR,ZETARCVR,RADDEG
      INTEGER Q,QR,QP,ZETAFLAG
      IF (ABS (ARG10) .GT. 1. .AND. ABS (ARG10) .LE. 1.0000001)
     2                           ARG10 = SIGN (1.,ARG10)
      PHI1F              = ASIN (     ARG10                    )*RADDEG*
     2 (-1)**N +N*180.*(-1)**((Q-1)/2)
      RETURN
```

```
       END

       FUNCTION PHI2F (ARG20,N)
       COMMON/PATHSTOR/ MAXLAT (2),MAXLONG (2),DISTP (2),NUMTP,Q,QR,QP,
      2COFUNC, ZETAFLAG,A,AOVERB,U,DELTPHI1,   CTAB (3), DLTPHTAB (3),
      3         C,C1,CMAX,PRESERR,PREVERR,E,ZETAXMTR,ZETARCVR,RADDEG
       INTEGER Q,QR,QP,ZETAFLAG
       IF (ABS (ARG20) .GT. 1. .AND. ABS (ARG20) .LE. 1.00000001)
      2                            ARG20 = SIGN (1.,ARG20)
       PHI2F        = ASIN (          ARG20              )*RADDEG*(-1)**N
      2 +N*180.*(-1)**(Q/2)
       RETURN
       END

       FUNCTION DISTF (C,ARGZ,ARGXMTR,ZETA,ARG3,N)
       COMMON/PATHSTOR/ MAXLAT (2),MAXLONG (2),DISTP (2),NUMTP,Q,QR,QP,
      2COFUNC, ZETAFLAG,A,AOVERB,U,DELTPHI1,   CTAB (3), DLTPHTAB (3),
      3       CVAL,C1,CMAX,PRESERR,PREVERR,E,ZETAXMTR,ZETARCVR,RADDEG
       INTEGER Q,QR,QP,ZETAFLAG
       DATA (PI=3.141592654)
       DISTF                                    =
      2                    A*((1.-U/2.*(1.+C*C))*(ASIN (ARGZ        )
      3      *(-1)**N +N* PI *(-1)**(Q/2) -ASIN (   ARGXMTR  )
      4      ) -U/2.*(COSF (ZETA)          *SQRTF ( ARG3)
      5   *(-1)**       N -COSF (ZETAXMTR)      * SQRTF(SINF (ZETAXMTR)
      6      **2 -C*C)                   ))
       RETURN
       END

       FUNCTION F (C)
       COMMON/PATHSTOR/ MAXLAT (2),MAXLONG (2),DISTP (2),NUMTP,Q,QR,QP,
      2COFUNC, ZETAFLAG,A,AOVERB,U,DELTPHI1,   CTAB (3), DLTPHTAB (3),
      3       CVAL,C1,CMAX,PRESERR,PREVERR,E,ZETAXMTR,ZETARCVR,RADDEG
       INTEGER Q,QR,QP,ZETAFLAG
       COF (C)= SQRTF (1.-C*C)
       COFUNC = COF (C)
       F      = DELTPHI1-(PHI1F (ARG1 (ZETARCVR, C),NUMTP)
      2 -PHI1F (ARG1 (ZETAXMTR, C),0)-C*U*(PHI2F(ARG2(ZETARCVR)  ,NUMTP)
      3 -PHI2F (ARG2 (ZETAXMTR)  , 0)))
       RETURN
       END

       FUNCTION ARG1 (ZETA,C)
       COMMON/PATHSTOR/ MAXLAT (2),MAXLONG (2),DISTP (2),NUMTP,Q,QR,QP,
      2COFUNC, ZETAFLAG,A,AOVERB,U,DELTPHI1,   CTAB (3), DLTPHTAB (3),
      3       CVAL,C1,CMAX,PRESERR,PREVERR,ERROR,ZETAXMTR,ZETARCVR,RADDEG
       ARG1       = C*COTF (ZETA)/COFUNC
       RETURN
       END

       FUNCTION ARG2 (ZETA)
       COMMON/PATHSTOR/ MAXLAT (2),MAXLONG (2),DISTP (2),NUMTP,Q,QR,QP,
      2COFUNC, ZETAFLAG,A,AOVERB,U,DELTPHI1,   CTAB (3), DLTPHTAB (3),
      3       CVAL,C1,CMAX,PRESERR,PREVERR,ERROR,ZETAXMTR,ZETARCVR,RADDEG
```

```
      ARG2          =COS (ZETA)/COFUNC
      RETURN
      END

      FUNCTION ARGD2 (ZETA,C)
      ARGD2           = SINF (ZETA)**2 -C*C
      RETURN
      END

      SUBROUTINE ORDER (XTAB,YTAB,NPOINTS,X,Y,IND,IERROR)
      DIMENSION XTAB (1000), YTAB (1000)
      IERROR = 0
      NUM = NPOINTS -1
 9000 DO 9010 IND = 1, NUM
      IF (      X     .GT.    XTAB (IND) .AND.   X     .LT.   XTAB
     2 (IND +1)) GO TO 9030
 9010 CONTINUE
      KEYER = 9010
      GO TO 9900
 9030 DO 9040 IND1 = IND, NUM
      YTAB (NPOINTS-IND1+IND+1) = YTAB (NPOINTS-IND1+IND)
 9040    XTAB (NPOINTS-IND1+IND+1) =    XTAB (NPOINTS-IND1+IND)
      YTAB (IND+1) = Y
         XTAB (IND+1) = X
      NPOINTS = NPOINTS +1
      RETURN
 9900 IERROR = 1
      RETURN
      END

      SUBROUTINE MONTONCK (XARRAY,NPOINTS,IOK)
C***** THIS ROUTINE TESTS AN ARRAY FOR STRICT MONOTONICITY AND SETS
C        IOK = 1 IF THE ARRAY IS STRICKLY MONOTONIC.--IOK = 0 OTHERWISE.
      DIMENSION XARRAY (2)
      IOK = 0
      IF (XARRAY(1) - XARRAY(NPOINTS)) 10,30,40
   10 DO 20 I = 2,NPOINTS
      IF (XARRAY(I-1).GE.XARRAY(I)) RETURN
   20 CONTINUE
      IOK = 1
   30 RETURN
   40 DO 50 I = 2,NPOINTS
      IF (XARRAY(I-1).LE.XARRAY(I)) RETURN
   50 CONTINUE
      IOK = 1
      RETURN
      END

      SUBROUTINE INTRPOLT (IORDER,IPOINTS,XARRAY,YARRAY,X,Y,IERR)
C        IORDER = ORDER OF THE POLYNOMIAL USED FOR INTERPOLATION
C        IPOINTS = NUMBER OF POINTS IN THE ARRAYS
C        XARRAY = ARRAY OF X VALUES. MUST BE STRICTLY MONTONIC
C        YARRAY = ARRAY OF Y VALUES
C        X = ARGUMENT FOR WHICH VALUE IS REQUESTED
```

```
C        Y = COMPUTED VALUE
C        IERR = 1 IF N+1 GT IPOINTS. N SET = IPOINTS-1. RUN CONTINUES.
C        IERR = 2 IF X(1) = X(IPOINTS) . RETURNS TO PROGRAM
      DIMENSION XARRAY(2),YARRAY(2),XTEMP(6),YTEMP(6)
C***** XARRAY AND YARRAY HAVE DUMMY DIMENSIONS
      IERR = 0
      IF (IORDER + 1.LE.IPOINTS) GO TO 10
      IERR = 1
      IORDER = IPOINTS - 1
      GO TO 48
   10 IBOT = 1
      ITOP = IPOINTS
      I = IPOINTS / 2
      IF (XARRAY(IPOINTS) - XARRAY(1)) 28,12,16
C***** X VALUES NOT MONTONIC
   12 IERR = 2
      RETURN
C***** X MONTONIC INCREASING
   14 I = ( ITOP + IBOT ) / 2
   16 IF ( X - XARRAY(I) )  18,24,20
   18 ITOP = I
      GO TO 22
   20 IBOT = I
   22 IF ( ITOP - IBOT .GT. 1 ) GO TO 14
      GO TO 36
   24 IBOT = I
      ITOP = I + 1
      GO TO 36
C***** X MONTONIC DECREASING
   26 I = ( ITOP + IBOT ) / 2
   28 IF ( X - XARRAY(I) )  30,24,32
   30 IBOT = I
      GO TO 34
   32 ITOP = I
   34 IF ( ITOP - IBOT .GT. 1 ) GO TO 26
   36 IF ( XMODF (IORDER,2).EQ.1) GO TO 42
C***** IORDER IS EVEN THEREFORE THE NUMBER OF POINTS IS ODD
      IF ((XARRAY(ITOP)-X)/(XARRAY(ITOP)-XARRAY(IBOT)).GE.0.5) GO TO 38
      IBOT = ITOP
      GO TO 42
   38 ITOP = IBOT
   42 IBOT = IBOT - IORDER/2
      ITOP = ITOP + IORDER/2
      IF ( ITOP .LE. IPOINTS ) GO TO 46
      ITOP = IPOINTS
      IBOT = IPOINTS - IORDER
      GO TO 100
   46 IF ( IBOT .GT. 1 ) GO TO 100
   48 IBOT = 1
      ITOP = 1 + IORDER
  100 ISTOP = IORDER + 1
      DO 104 I = 1,ISTOP
      XTEMP(I) = XARRAY(IBOT+I-1)
  104 YTEMP(I) = YARRAY(IBOT+I-1)
```

```
      DO 110 J= 1,IORDER
      ISTART = J + 1
      DO 110 I = ISTART,ISTOP
 110   YTEMP(I)= ((X-XTEMP(J))*YTEMP(I)-(X-XTEMP(I))*YTEMP(J))
    1 / (XTEMP(I)-XTEMP(J))
      Y = YTEMP(ISTOP)
      RETURN
      END

      FUNCTION CORDCONV (COORD,NUMCHAR)
C     NUMWDS=TOTAL NUMBER OF WORDS USED.
C     NUMWORD=SUBSCRIPT (INDEX) OF CURRENT WORD.
C     INDCHAR=POSITION OF CURRENT CHARACTER IN CURRENT WORD.
C     INDSTART= NO. OF BLANK CHAR. POSITIONS TO BE DROPPED  INITIALLY.
C     INDSTORE= CURRENT WORD TO BE DECODED.
C     DECINDX= NO. OF DECIMAL PLACES BEFORE (TO RIGHT OF) DECIMAL PT.
C     CHAR    = CURRENT CHARACTER TO BE DECODED.
C     IDNTCHAR=IDENTIFICATION OF UNITS OF CURRENT NUMBER = 0-NO IDENT.
C                                                        = 1 DEGREES
C                                                        = 2 MINUTES
C                                                        = 3 SECONDS
      TYPE INTEGER COORD,DECINDX,CHAR
      DIMENSION COORD (10)
      DATA (INDSEC=3),(MASK=0000000000000077B)
      CALL Q9OVER
      INDVAL =IDNTCHAR =INDIGIT=NUMBER=DECINDX = 0
      VALUE = 0.
      INDUNIT=1
      ALSIGN = +1.
C     FIND NO. OF WORDS USED AND POSITION OF FIRST CHARACTER IN WORD.
  100 NUMWDS = (NUMCHAR+7)/8
  101 NUMWORD = NUMWDS
      INDCHAR = XMODF (NUMCHAR-1,8) +1
      INDSTART =  8-INDCHAR
  120 IF (INDSTART .EQ. 0)  GO TO 135
      INDSTORE = COORD (NUMWORD)/64**INDSTART
      GO TO 140
  135 INDSTORE = COORD (NUMWORD)
  140 DO 380 I = 1,NUMCHAR
      CHAR = MASK .AND. INDSTORE
      INDSTORE = INDSTORE/64
      IF (CHAR .GT. 1R9) GO TO 205
      IF (IDNTCHAR  .EQ. 0) GO TO 151
  150 NUMBER = CHAR*10**INDIGIT +NUMBER
  151 INDIGIT = INDIGIT +1
  160 INDCHAR = INDCHAR -1
      IF (INDCHAR .GT. 0) GO TO 380
  190 INDCHAR = 8
      NUMWORD = NUMWORD-1
      INDSTORE = COORD (NUMWORD)
      GO TO 380
  205 IF (CHAR .EQ. 1RN .OR. CHAR .EQ. 1RE .OR. CHAR .EQ. 1R+) GO TO 330
      IF (CHAR .EQ. 1RW.OR. CHAR .EQ.        1R- .OR.(CHAR.EQ. 1RS.AND.
    2(IDNTCHAR .EQ. 1 .OR. IDNTCHAR .EQ. 2))) GO TO 340
```

```
  210 IF (CHAR .EQ. 1RS .AND. IDNTCHAR .EQ. 0) GO TO 250
      IF (CHAR .EQ. 1RM) GO TO 270
      IF (CHAR .EQ. 1RD) GO TO 300
  220 IF (CHAR .EQ. 1R.)  GO TO 320
  225 IF (CHAR .EQ.  1R   ) GO TO 160
  230 KEYER = 230
      GO TO 600
  250 IDNTCHAR = 3
  255 DECINDX = NUMBER = INDIGIT = 0
      GO TO 160
  270 IF (IDNTCHAR .EQ. 0 .OR. IDNTCHAR .EQ. 3)GO TO 290
      KEYER = 270
      GO TO 600
  290 IF (IDNTCHAR .EQ. 0) GO TO 291
      VALUE = VALUE +NUMBER/(3600.*10.**DECINDX)
  291 IDNTCHAR = 2
      GO TO 255
  300 IF (IDNTCHAR .EQ. 2 .OR. IDNTCHAR .EQ. 0) GO TO 310
      KEYER = 300
      GO TO 600
  310 IF (IDNTCHAR .EQ. 0) GO TO 311
      VALUE = VALUE +NUMBER/(60.*10.**DECINDX)
  311 IDNTCHAR = 1
      GO TO 255
  320 DECINDX = INDIGIT
      GO TO 160
  330 ALSIGN = +1.
      GO TO 160
  340 ALSIGN = -1.
      GO TO 160
  380 CONTINUE
  400 IF (IDNTCHAR .EQ. 1) GO TO 410
      KEYER = 400
      GO TO 600
  410 CORDCONV = VALUE+NUMBER/(10.**DECINDX)
      CORDCONV = SIGN (CORDCONV,ALSIGN)
      CALL R9OVER
      RETURN
  600 WRITE (61,10) KEYER
   10 FORMAT (*1CORDCONV ERROR AT STATEMENT  * I6)
      CALL Q8QERROR (0,11H COORDCONV. )
      END
C     SAMPLE DATA DECK
C
N39D 30M          W77D 30M          NEW VA-WVA END POINT
N39D 51.125M      W87D 29.192M      DANA
100 SEGMENTS
 NEW VA-WVA FLIGHT PLAN
N34D 3.76M        W77D 54.787M      MASTER (CAPE FEAR)
N27D 1M 57.32S    W80D 6M 53.71S    SLAVE 1 (JUPITER)
N39D 51M 7.48S    W87D 29M 11.51S   SLAVE 2 (DANA)
  11000.    65000.
  400.      400.      400.
```

```
          0
100.         .005        15.         1.0        1.0001     0.        0.         0.
          0
100.         .005        15.         1.0        1.0001     0.        0.         0.
          0
          0
100.         .005        15.         1.0        1.0001     0.        0.         0.
```

```
      PROGRAM LORANR
C
C     PROGRAM TO CALCULATE THE TIME DIFFERENCES FOR A RADIAL LORAN PATH
C
      DIMENSION LATBEG(3),LONBEG(3),START(4),LATEND(3),LONEND(3),
     1 FINISH(4),LATXMT(3),LONXMT(3),LOCXMT(4)
      DIMENSION XLAT(105),XLON(105),D(105),BERXMT(105),X(105),RD(105),
     1 BEREND(105)
      DIMENSION DENTIF(4)
      COMMON DIS,SIGMA,E2,ALFA,ETA
      TYPE INTEGER DSTNCE,REG,START,FINISH,TYPATH
      DSTNCE=6HDSTNCE
      REG=4HNORM
      C=2.997925E8
      TWOPI=6.283185307
      PI=3.141592654
      CON=1.E9/C
      CONST=1.E3/TWOPI
    1 FORMAT (2(2(2A8,A1,1X),4A8/),I3,10X,A5)
    2 FORMAT   (2(2A8,A1,1X),4A8)
    3 FORMAT (8E10.0)
    4 FORMAT (I10/8E10.0)
    5 FORMAT (I10)
    6 FORMAT (4A8)
    7 FORMAT (1H1,39X,4A8)
    8 FORMAT (30X,4A8,*  TO  *,4A8)
    9 FORMAT (   8X,11HDISTANCE IN,7X,10HAZIMUTH TO, 2X,
     2 19HCOORDINATES OF PATH,2X,17HFIELD STRENGTH IN,5X,
     3 4HTIME,7X,14HGRADIENT ALONG/
     4 7X,13HKILOMETERS TO,5X,11HDESTINATION, 2X,8HLATITUDE, 2X,
     5 9HLONGITUDE,3X,14HDB RELATIVE TO,4X,10HDIFFERENCE,3X,
     6                             17HTHE GEODETIC LINE/
     7 5X,6HORIGIN,2X,11HDESTINATION,3X,7HDEGREES,
     8 2(4X,7HDEGREES),5X,13H1 MICROVOLT/M,3X,
     9                     12HMICROSECONDS,3X,15HMICROSECONDS/KM)
   11 FORMAT (1X,2F11.4,F12.4,2F11.5,4X, F9.2 ,6X, F12.4,5X, F10.5)
   12 FORMAT (18X,4HLAT=2A8,A2,4HLON=2A8,A2,*  TO  *,4HLAT=2A8,A2,4HLON=
     1 2A8,A2/)
   13 FORMAT (28X,4HLAT=2A8,A2,4HLON=2A8,A2,12HLOCATION OF ,4A8)
   14 FORMAT (/)
   16 FORMAT (64X,6HMASTER/
     2 22X,26HRADIATED POWER (KILOWATTS),10X, F13.3/
     3 22X,37HDIPOLE CURRENT MOMENT (AMPERE-METERS), E13.4/)
   17 FORMAT (1H1,3X,*HOMOGENEOUS CASE*//2X,5HKDEL=I10/5X,2HF=E16.9,
     14H KHZ/1X,6HSIGMA=E16.9/4X,3HE2=E16.9/2X,5HALFA=E16.9/3X,4HETA=
     2 E16.9/2X,5HBORA=E16.9/3X,4HANN=E16.9/4X,3HH2=E16.9)
   18 FORMAT (2F10.4,2F10.5,F10.2,F10.4,F10.5)
   19 FORMAT (I10/F10.2,F10.4,F10.1,F10.2,F10.6,2E10.2,F10.1)
C
C     READ THE COORDINATES OF A GIVEN PATH
C
C     LATBEG = LATITUDE OF BEGINNING POINT
C     LONBEG = LONGITUDE OF BEGINNING POINT
C     START  = IDENTIFICATION OF BEGINNING POINT
```

```
C     LATEND = LATITUDE OF END POINT
C     LONEND = LONGITUDE OF END POINT
C     FINISH = IDENTIFICATION OF END POINT
C     NOSEG = NUMBER OF SEGMENTS TO BREAK THE PATH INTO -- MAX OF 100
C
   10 READ   1, LATBEG,LONBEG,START,LATEND,LONEND,FINISH,NOSEG,TYPATH
      IF (EOF,60)  200,20
C
C     READ IDENTIFICATION
   20 READ    6, DENTIF
C
C     READ THE COORDINATES OF THE TRANSMITTER
C
C     LATXMT = LATITUDE OF MASTER
C     LONXMT = LONGITUDE OF MASTER
C     LOCXMT = IDENTIFICATION OF MASTER
C
      READ    2, LATXMT,LONXMT,LOCXMT
C
C     READ RADIATED POWER IN KILOWATTS OF TRANSMITTER
C
      READ    3, PRMAS
C
C     CHANGE COORDINATES (DEGREES,MINUTES,SECONDS) TO DEGREES
      BEGLAT=CORDCONV(LATBEG,17)
      BEGLON=CORDCONV(LONBEG,17)
      ENDLAT=CORDCONV(LATEND,17)
      ENDLON=CORDCONV(LONEND,17)
      XMTLAT=CORDCONV(LATXMT,17)
      XMTLON=CORDCONV(LONXMT,17)
C
C     CALCULATES THE DISTANCE BETWEEN THE TWO END POINTS OF THE PATH
C
      CALL PATH (BEGLAT,BEGLON,ENDLAT,ENDLON,DSTNCE,XINT,DIST,XLAT,XLON,
     1 D,BERATX,BERATR,BERXMT,NMAX,TYPATH)
      SEG=NOSEG
      XINT=DIST/SEG
C
C     CALCULATES THE LATITUDE, LONGITUDE, AND DISTANCE OF (NOSEG+1)
C     POINTS ALONG THE GIVEN PATH
      CALL PATH (ENDLAT,ENDLON,BEGLAT,BEGLON,REG,XINT,DIST,XLAT,XLON,RD,
     1 BERATX,BERATR,BEREND,NMAX,TYPATH)
      CALL PATH (BEGLAT,BEGLON,ENDLAT,ENDLON,REG,XINT,DIST,XLAT,XLON,D,
     1 BERATX,BERATR,BERXMT,NMAX,TYPATH)
C
C     IHOM NOT EQUAL TO ZERO GIVES INHOMOGENEOUS CASE
   40 READ    5, IHOM
C
C     READ NECESSARY PARAMETERS TO CALCULATE THE PHASE CORRECTION FOR
C     THE HOMOGENEOUS CASE
C
C  EXPLANATION OF INPUT DATA TO CALCULATE THE PHASE CORRECTION
C
C  KDEL = KDEL NOT EQUAL TO ZERO PUTS PROGRAM IN ROUGH GROUND MODE
```

```
C        OF OPERATION
C             KDEL EQUAL TO ZERO OPERATES PROGRAM IN CLASSICAL GROUND WAVE
C             MODE OF OPERATION -- SMOOTH SPHERICAL GROUND
C     F = FREQUENCY IN KHZ
C     SIGMA = CONDUCTIVITY IN MHOS/METER
C     E2 = DIELECTRIC CONSTANT
C     ALFA = VERTICAL LAPSE FACTOR OF THE ATMOSPHERE ACCORDING TO NBS
C             CIRCULAR 573.
C     ETA = INDEX OF REFRACTION OF AIR AT THE GROUND LEVEL
C     BORA = RADIUS OF HEMISPHERICAL SURFACE PROTUBERANCE.
C     ANN = NUMBER OF HEMISPHERICAL BOSSES PER SQUARE METER.
C     H2 = ALTITUDE OF RECEIVER IN METERS
C
   50 READ    4, KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
      PRINT 17,     KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
      PUNCH 19,KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
      CONS=1.E6/(2.*TWOPI*F)*SQRTF(37.67304)
      IF (PRMAS.EQ.0.)   GO TO 880
      DIPMAS=CONS*SQRTF(PRMAS)
      DBMAS=20.*ALOG10(DIPMAS)
      GO TO 885
  880 DIPMAS=1.0
      DBMAS=0.
  885 CONTINUE
      PRINT 7,     DENTIF
      PRINT 8,     START,FINISH
      PRINT 12,     LATBEG,LONBEG,LATEND,LONEND
      PRINT 13,     LATXMT,LONXMT,LOCXMT
      PRINT 16,PRMAS,DIPMAS
      PRINT 9
      PRINT 14
      NS=NOSEG+1
      PUNCH 6,DENTIF
      PUNCH 1,LATBEG,LONBEG,START,LATEND,LONEND,FINISH
      PUNCH 2,LATXMT,LONXMT,LOCXMT
      PUNCH 5,NS
      NP=0
      NNP=0
C
C     CALCULATE DISTANCES AND PHASE CORRECTIONS FOR EACH POINT ON THE
C     GIVEN PATH
C
      DO 150 I=1,NS
C
C     CALCULATE DISTANCE FROM GIVEN POINT TO MASTER  (DM)
      CALL PATH (XLAT(I),XLON(I),XMTLAT,XMTLON,DSTNCE,XINT,DM,X,X,X,Y,Y,
     1 X,NMAX,TYPATH)
      IF (IHOM.EQ.0)   GO TO 90
C
C     READ NECESSARY PARAMETERS AND CALCULATE THE PHASE CORRECTION FOR
C     THE ABOVE PATH
      READ    4, KDEL,F,SIGMA,E2,ALFA,ETA,BORA,ANN,H2
   90 DIS=DM
      AMP=1.0
```

```
      FAZCOR=PI
      IF (DIS.LE.0.)   GO TO 901
      CALL GROUND (F*1000.,AMP,FAZCOR,KDEL,BORA,ANN,H2)
  901 FSMAS=20.*ALOG10(AMP)+DBMAS+120.
C
C     RESOLUTION OF TWO PI AMBIGUITY OF THE GROUND WAVE PHASE
C     GOOD ONLY FOR 100 KHZ -- MUST BE MODIFIED FOR ANY OTHER FREQUENCY
C     THE SAME TEST IS USED AFTER EVERY CALL TO GROUND WAVE SUBROUTINE
C     THE DISTANCE SHOULD NOT BE MUCH GREATER THAN 2000 KM
      IF (FAZCOR.GE.0.)   GO TO 91
      FAZCOR=FAZCOR+TWOPI
   91 IF (DIS.LE.1000.)   GO TO 95
      IF (SIGMA.GT..0051)   GO TO 95
      IF (FAZCOR.GT.PI)   GO TO 95
      FAZCOR=FAZCOR+TWOPI
   95 TCDM=FAZCOR*CONST/F
C
C     CALCULATE THE TIME DIFFERENCE
      DELT=ETA*CON*DM+TCDM
      IF (I.EQ.1)   GO TO 140
      DST=D(I)-D(I-1)
      GRAD =(DELT -SDELT )/DST
      IF (NNP.NE.30)   GO TO 120
      PRINT 7,    DENTIF
      PRINT 8,    START,FINISH
      PRINT 12,    LATBEG,LONBEG,LATEND,LONEND
      PRINT 13,    LATXMT,LONXMT,LOCXMT
      PRINT 16,PRMAS,DIPMAS
      PRINT 9
      NNP=0
  120 NNP=NNP+1
      IF (NP.NE.10)   GO TO 130
      PRINT 14
      NP=0
  130 NP=NP+1
      II=I-1
      N=NS+1-II
      PRINT 11,    D(II),RD(N),BEREND(N),XLAT(II),XLON(II),SFSMAS,
     1 SDELT,GRAD
      PUNCH 18,D(II),BEREND(N),XLAT(II),XLON(II),SFSMAS,SDELT,GRAD
  140 XLON(I)=-XLON(I)
      SFSMAS=FSMAS
      SDELT =DELT
      IF (I.LT.NS)   GO TO 150
      IF (NP.NE.10)   GO TO 145
      PRINT 14
  145 GRAD =0.
      PRINT 11,    D(I),RD(1),BEREND(1),XLAT(I),XLON(I),SFSMAS,
     1 SDELT,GRAD
      PUNCH 18,D(I),BEREND(1),XLAT(I),XLON(I),SFSMAS,SDELT,GRAD
  150 CONTINUE
      GO TO 10
  200 CALL EXIT
      END
```

```
C     SAMPLE DATA DECK
C
N39D 30M          W77D 30M          NEW VA-WVA END POINT
N39D 51.125M      W87D 29.192M      DANA
100 SEGMENTS
 NEW VA-WVA FLIGHT PLAN
N39D 51.125M      W87D 29.192M      MASTER (DANA)
   400.
         0
         0
   100.     .005      15.       1.0       1.0001    0.        0.        0.
```

TABLE INDEX

Table Number	Page	Figure or other Reference	Conductivity
1	77	*Va-W Va.	.005
2	82	*NC-Tenn.	.005
3	87	*Penn.	.005
4	92	4(a)**	.005
5	97	4(a)***	.005
6	102	4(b)**	5.
7	107	4(b)***	5.
8	112	2(a)**	.005
9	117	2(a)***	.005
10	122	2(b)**	5.
11	127	2(b)***	5.
12	132	3(a)**	.005
13	137	3(a)***	.005
14	142	3(b)**	5.
15	147	3(b)***	5.

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*Smooth, homogeneous terrain only, normal time differences.

**Smooth, homogeneous terrain, cumulative phase along a radial.

***Rough terrain, cumulative phase along a radial.

Table 1.

```
PARAMETERS FOR DB1

  KDEL=          0
     F= 1.000000000+002 KHZ
 SIGMA= 5.000000000-003
    E2= 1.500000000+001
  ALFA= 1.000000000+000
   ETA= 1.000100000+000
  BORA= 0.000000000+000
   ANN= 0.000000000+000
    H2= 0.000000000+000

PARAMETERS FOR DB2

  KDEL=          0
     F= 1.000000000+002 KHZ
 SIGMA= 5.000000000-003
    E2= 1.500000000+001
  ALFA= 1.000000000+000
   ETA= 1.000100000+000
  BORA= 0.000000000+000
   ANN= 0.000000000+000
    H2= 0.000000000+000

PARAMETERS FOR HOMOGENEOUS CASE

  KDEL=          0
     F= 1.000000000+002 KHZ
 SIGMA= 5.000000000-003
    E2= 1.500000000+001
  ALFA= 1.000000000+000
   ETA= 1.000100000+000
  BORA= 0.000000000+000
   ANN= 0.000000000+000
    H2= 0.000000000+000
```

Table 1. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)
LAT=N27D 1M 57.32S LON=W80D 6M 53.71S LOCATION OF SLAVE 1 (JUPITER)
LAT=N39D 51M 7.48S LON=W87D 29M 11.51S LOCATION OF SLAVE 2 (DANA)

	MASTER	SLAVE 1	SLAVE 2
CODING DELAY (MICROSECONDS)		11000.00	65000.00
RADIATED POWER (KILOWATTS)	400.000	400.000	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004	9.7687+004	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M MASTER	SLAVE 1	SLAVE 2	TIME DIFFERENCE MICROSECONDS DELTA(T1)	DELTA(T2)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T1)	DELTA(T2)
0.0000	857.2720	275.7983	39.50000	77.50000	78.21	55.96	70.76	16368.6451	69408.3195	-0.42797	-3.49139
8.5727	848.6993	275.7352	39.50776	77.59917	78.19	55.98	71.00	16364.9762	69378.3889	-0.45509	-3.53846
17.1450	840.1266	275.6721	39.51543	77.69835	78.18	55.99	71.25	16361.0751	69348.0560	-0.48207	-3.58543
25.7182	831.5538	275.6090	39.52302	77.79756	78.16	56.01	71.49	16356.9423	69317.3178	-0.50887	-3.63223
34.2909	822.9811	275.5458	39.53053	77.89679	78.14	56.02	71.74	16352.5798	69286.1797	-0.53548	-3.67887
42.8636	814.4084	275.4826	39.53795	77.99605	78.11	56.04	71.98	16347.9893	69254.6418	-0.56187	-3.72530
51.4363	805.8357	275.4194	39.54528	78.09532	78.08	56.05	72.23	16343.1726	69222.7058	-0.58801	-3.77152
60.0090	797.2630	275.3562	39.55253	78.19461	78.05	56.06	72.47	16338.1317	69190.3737	-0.61389	-3.81749
68.5818	788.6902	275.2930	39.55970	78.29393	78.01	56.07	72.72	16332.8690	69157.6472	-0.63947	-3.86317
77.1545	780.1175	275.2297	39.56678	78.39326	77.97	56.08	72.97	16327.3871	69124.5294	-0.66474	-3.90856
85.7272	771.5448	275.1664	39.57377	78.49262	77.92	56.08	73.22	16321.6884	69091.0224	-0.68968	-3.95362
94.2999	762.9721	275.1031	39.58068	78.59199	77.87	56.09	73.46	16315.7760	69057.1292	-0.71427	-3.99835
102.8727	754.3994	275.0398	39.58751	78.69139	77.82	56.09	73.71	16309.6528	69022.8523	-0.73848	-4.04271
111.4454	745.8266	274.9764	39.59425	78.79080	77.77	56.09	73.96	16303.3220	68988.1953	-0.76230	-4.08666
120.0181	737.2540	274.9130	39.60091	78.89023	77.71	56.10	74.22	16296.7870	68953.1616	-0.78572	-4.13024
128.5908	728.6812	274.8496	39.60748	78.98968	77.64	56.10	74.47	16290.0513	68917.7541	-0.80871	-4.17337
137.1635	720.1085	274.7862	39.61396	79.08916	77.58	56.09	74.72	16283.1184	68881.9770	-0.83127	-4.21608
145.7363	711.5358	274.7228	39.62036	79.18864	77.51	56.09	74.97	16275.9921	68845.8336	-0.85337	-4.25832
154.3090	702.9630	274.6593	39.62668	79.28815	77.44	56.09	75.23	16268.6764	68809.3282	-0.87501	-4.30009
162.8817	694.3903	274.5958	39.63290	79.38768	77.36	56.08	75.48	16261.1753	68772.4649	-0.89617	-4.34137
171.4544	685.8176	274.5323	39.63905	79.48722	77.28	56.07	75.74	16253.4926	68735.2474	-0.91684	-4.38217
180.0271	677.2449	274.4688	39.64511	79.58678	77.20	56.07	75.99	16245.6328	68697.6804	-0.93702	-4.42244
188.5998	668.6721	274.4053	39.65108	79.68636	77.12	56.06	76.25	16237.5999	68659.7681	-0.95669	-4.46218
197.1726	660.0994	274.3417	39.65697	79.78595	77.03	56.04	76.51	16229.3985	68621.5149	-0.97585	-4.50141
205.7453	651.5267	274.2781	39.66277	79.88556	76.94	56.03	76.77	16221.0327	68582.9255	-0.99449	-4.54009
214.3180	642.9540	274.2145	39.66849	79.98519	76.85	56.02	77.03	16212.5073	68544.0047	-1.01260	-4.57823
222.8907	634.3813	274.1509	39.67412	80.08484	76.75	56.00	77.29	16203.8265	68504.7567	-1.03019	-4.61581
231.4634	625.8086	274.0873	39.67967	80.18450	76.65	55.99	77.55	16194.9950	68465.1867	-1.04724	-4.65283
240.0362	617.2358	274.0237	39.68513	80.28417	76.55	55.97	77.81	16186.0173	68425.2992	-1.06375	-4.68929
248.6089	608.6632	273.9600	39.69050	80.38386	76.45	55.95	78.08	16176.8981	68385.0993	-1.07973	-4.72517

Table 1. (Continued)

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                             NEW VA-WVA FLIGHT PLAN
                     NEW VA-WVA END POINT                    TO  DANA
        LAT=N39D 30M            LON=W77D 30M                 TO  LAT=N39D 51.125M          LON=W87D 29.192M

                  LAT=N34D 3.76M        LON=W77D 54.787M      LOCATION OF MASTER (CAPE FEAR)
                  LAT=N27D 1M 57.32S    LON=W80D 6M 53.71S    LOCATION OF SLAVE 1 (JUPITER)
                  LAT=N39D 51M 7.48S    LON=W87D 29M 11.51S   LOCATION OF SLAVE 2 (DANA)
                                                   MASTER          SLAVE 1         SLAVE 2
              CODING DELAY (MICROSECONDS)                          11000.00        65000.00
              RADIATED POWER (KILOWATTS)           400.000         400.000         400.000
              DIPOLE CURRENT MOMENT (AMPERE-METERS)  9.7687+004    9.7687+004      9.7687+004

                                                                                                                GRADIENT ALONG
     DISTANCE IN         AZIMUTH TO    COORDINATES OF PATH     FIELD STRENGTH IN DB          TIME DIFFERENCE            THE GEODETIC LINE
   KILOMETERS TO        DESTINATION    LATITUDE  LONGITUDE   RELATIVE TO 1 MICROVOLT/M         MICROSECONDS             MICROSECONDS/KM
ORIGIN   DESTINATION      DEGREES      DEGREES    DEGREES     MASTER  SLAVE 1  SLAVE 2     DELTA(T1)    DELTA(T2)     DELTA(T1) DELTA(T2)

257.1816   600.0904     273.8963     39.69579   80.48357     76.34    55.93    78.34     16167.6419   68344.5919     -1.09517  -4.76048
265.7543   591.5177     273.8326     39.70100   80.58329     76.23    55.91    78.61     16158.2533   68303.7817     -1.11007  -4.79524
274.3270   582.9450     273.7689     39.70612   80.68303     76.12    55.88    78.88     16148.7369   68262.6734     -1.12444  -4.82940
282.8998   574.3723     273.7052     39.71115   80.78278     76.00    55.86    79.15     16139.0974   68221.2723     -1.13827  -4.86299
291.4724   565.7995     273.6414     39.71609   80.88255     75.89    55.83    79.42     16129.3394   68179.5834     -1.15156  -4.89600
300.0452   557.2268     273.5777     39.72096   80.98233     75.77    55.81    79.69     16119.4674   68137.6111     -1.16433  -4.92846
308.6179   548.6541     273.5139     39.72573   81.08212     75.64    55.78    79.97     16109.4859   68095.3609     -1.17657  -4.96032
317.1906   540.0813     273.4501     39.73042   81.18193     75.52    55.75    80.24     16099.3995   68052.8374     -1.18828  -4.99162
325.7634   531.5087     273.3863     39.73502   81.28175     75.39    55.72    80.52     16089.2127   68010.0453     -1.19948  -5.02237
334.3361   522.9359     273.3225     39.73954   81.38158     75.27    55.69    80.80     16078.9300   67966.9903     -1.21017  -5.05253

342.9088   514.3632     273.2586     39.74397   81.48143     75.14    55.65    81.08     16068.5555   67923.6762     -1.22035  -5.08216
351.4815   505.7905     273.1948     39.74832   81.58129     75.00    55.62    81.36     16058.0939   67880.1086     -1.23003  -5.11120
360.0543   497.2178     273.1309     39.75258   81.68116     74.87    55.58    81.64     16047.5491   67836.2915     -1.23921  -5.13972
368.6269   488.6450     273.0670     39.75675   81.78105     74.73    55.54    81.93     16036.9258   67792.2304     -1.24791  -5.16768
377.1997   480.0724     273.0032     39.76084   81.88094     74.60    55.50    82.22     16026.2277   67747.9291     -1.25613  -5.19510
385.7723   471.4996     272.9393     39.76484   81.98085     74.46    55.46    82.50     16015.4593   67703.3932     -1.26388  -5.22199
394.3451   462.9269     272.8753     39.76876   82.08077     74.31    55.42    82.80     16004.6244   67658.6264     -1.27117  -5.24835
402.9178   454.3541     272.8114     39.77259   82.18070     74.17    55.38    83.09     15993.7270   67613.6338     -1.27800  -5.27420
411.4905   445.7815     272.7475     39.77634   82.28064     74.03    55.34    83.39     15982.7711   67568.4196     -1.28438  -5.29952
420.0633   437.2087     272.6835     39.77999   82.38060     73.88    55.29    83.69     15971.7604   67522.9882     -1.29033  -5.32435

428.6360   428.6360     272.6196     39.78357   82.48056     73.73    55.24    83.99     15960.6987   67477.3439     -1.29585  -5.34867
437.2087   420.0632     272.5556     39.78705   82.58053     73.58    55.20    84.29     15949.5898   67431.4913     -1.30095  -5.37251
445.7814   411.4906     272.4916     39.79045   82.68052     73.43    55.15    84.60     15938.4372   67385.4343     -1.30563  -5.39584
454.3541   402.9178     272.4276     39.79376   82.78051     73.28    55.10    84.91     15927.2444   67339.1774     -1.30992  -5.41873
462.9268   394.3452     272.3636     39.79699   82.88051     73.12    55.04    85.23     15916.0148   67292.7242     -1.31381  -5.44113
471.4996   385.7724     272.2996     39.80013   82.98052     72.97    54.99    85.54     15904.7519   67246.0787     -1.31732  -5.46307
480.0723   377.1997     272.2356     39.80319   83.08054     72.81    54.94    85.86     15893.4589   67199.2455     -1.32045  -5.48457
488.6451   368.6269     272.1715     39.80616   83.18057     72.65    54.88    86.19     15882.1390   67152.2276     -1.32322  -5.50560
497.2177   360.0544     272.1075     39.80904   83.28061     72.49    54.83    86.52     15870.7954   67105.0298     -1.32564  -5.52621
505.7905   351.4814     272.0434     39.81184   83.38065     72.33    54.77    86.85     15859.4311   67057.6551     -1.32771  -5.54640
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Table 1. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)
LAT=N27D 1M 57.32S LON=W80D 6M 53.71S LOCATION OF SLAVE 1 (JUPITER)
LAT=N39D 51M 7.48S LON=W87D 29M 11.51S LOCATION OF SLAVE 2 (DANA)

	MASTER	SLAVE 1	SLAVE 2
CODING DELAY (MICROSECONDS)		11000.00	65000.00
RADIATED POWER (KILOWATTS)	400.000	400.000	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004	9.7687+004	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M MASTER	FIELD STRENGTH SLAVE 1	FIELD STRENGTH SLAVE 2	TIME DIFFERENCE MICROSECONDS DELTA(T1)	TIME DIFFERENCE DELTA(T2)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T1)	GRADIENT DELTA(T2)
514.3632	342.9088	271.9794	39.81455	83.48071	72.17	54.71	87.19	15848.0490	67010.1075	-1.32944	-5.56616
522.9359	334.3361	271.9153	39.81717	83.58077	72.00	54.65	87.53	15836.6521	66962.3903	-1.33084	-5.58550
531.5086	325.7633	271.8512	39.81971	83.68084	71.84	54.59	87.87	15825.2432	66914.5075	-1.33193	-5.60443
540.0813	317.1907	271.7871	39.82216	83.78091	71.67	54.53	88.22	15813.8249	66866.4622	-1.33271	-5.62300
548.6540	308.6179	271.7230	39.82452	83.88100	71.50	54.46	88.58	15802.4001	66818.2582	-1.33318	-5.64116
557.2268	300.0452	271.6589	39.82680	83.98109	71.34	54.40	88.94	15790.9710	66769.8976	-1.33337	-5.65892
565.7995	291.4726	271.5948	39.82899	84.08118	71.17	54.33	89.31	15779.5404	66721.3855	-1.33327	-5.67634
574.3723	282.8997	271.5307	39.83110	84.18129	71.00	54.26	89.69	15768.1106	66672.7235	-1.33290	-5.69337
582.9449	274.3271	271.4666	39.83312	84.28140	70.83	54.20	90.07	15756.6842	66623.9163	-1.33226	-5.71007
591.5177	265.7543	271.4024	39.83505	84.38151	70.65	54.13	90.46	15745.2630	66574.9651	-1.33137	-5.72640
600.0904	257.1816	271.3383	39.83690	84.48163	70.48	54.06	90.86	15733.8496	66525.8746	-1.33022	-5.74238
608.6632	248.6089	271.2742	39.83866	84.58176	70.31	53.98	91.27	15722.4459	66476.6462	-1.32884	-5.75804
617.2358	240.0362	271.2100	39.84033	84.68188	70.13	53.91	91.68	15711.0543	66427.2847	-1.32722	-5.77339
625.8086	231.4634	271.1459	39.84192	84.78202	69.96	53.84	92.11	15699.6762	66377.7904	-1.32538	-5.78838
634.3812	222.8909	271.0817	39.84342	84.88216	69.78	53.76	92.54	15688.3142	66328.1689	-1.32332	-5.80309
642.9540	214.3178	271.0175	39.84483	84.98230	69.60	53.69	92.99	15676.9697	66278.4204	-1.32106	-5.81749
651.5266	205.7455	270.9534	39.84616	85.08245	69.42	53.61	93.45	15665.6447	66228.5489	-1.31859	-5.83159
660.0995	197.1724	270.8892	39.84740	85.18260	69.25	53.53	93.93	15654.3406	66178.5553	-1.31592	-5.84539
668.6721	188.5999	270.8250	39.84856	85.28276	69.07	53.45	94.42	15643.0598	66128.4453	-1.31307	-5.85892
677.2448	180.0271	270.7608	39.84963	85.38291	68.89	53.37	94.93	15631.8032	66078.2186	-1.31004	-5.87215
685.8175	171.4542	270.6967	39.85061	85.48307	68.70	53.29	95.45	15620.5727	66027.8786	-1.30684	-5.88515
694.3903	162.8821	270.6325	39.85150	85.58324	68.52	53.21	96.00	15609.3694	65977.4261	-1.30347	-5.89785
702.9629	154.3087	270.5683	39.85231	85.68340	68.34	53.12	96.57	15598.1953	65926.8664	-1.29994	-5.91032
711.5360	145.7367	270.5041	39.85304	85.78358	68.16	53.04	97.17	15587.0508	65876.1965	-1.29625	-5.92252
720.1083	137.1633	270.4399	39.85367	85.88374	67.97	52.95	97.79	15575.9389	65825.4268	-1.29242	-5.93446
728.6812	128.5908	270.3757	39.85422	85.98392	67.79	52.87	98.44	15564.8592	65774.5512	-1.28844	-5.94621
737.2539	120.0179	270.3115	39.85468	86.08409	67.60	52.78	99.14	15553.8138	65723.5764	-1.28433	-5.95769
745.8264	111.4453	270.2473	39.85506	86.18426	67.42	52.69	99.87	15542.8039	65672.5042	-1.28009	-5.96898
754.3995	102.8725	270.1831	39.85535	86.28444	67.23	52.60	100.66	15531.8295	65621.3313	-1.27572	-5.98004
762.9720	94.3000	270.1189	39.85555	86.38461	67.05	52.51	101.51	15520.8934	65570.0675	-1.27125	-5.99095

Table 1. (Continued)

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                               NEW VA-WVA FLIGHT PLAN
                     NEW VA-WVA END POINT                     TO   DANA
        LAT=N39D 30M            LON=W77D 30M                  TO   LAT=N39D 51.125M        LON=W87D 29.192M

                     LAT=N34D 3.76M          LON=W77D 54.787M        LOCATION OF MASTER (CAPE FEAR)
                     LAT=N27D 1M 57.32S      LON=W80D 6M 53.71S      LOCATION OF SLAVE 1 (JUPITER)
                     LAT=N39D 51M 7.48S      LON=W87D 29M 11.51S     LOCATION OF SLAVE 2 (DANA)
                                                         MASTER          SLAVE 1         SLAVE 2
              CODING DELAY (MICROSECONDS)                                11000.00        65000.00
              RADIATED POWER (KILOWATTS)                 400.000         400.000         400.000
              DIPOLE CURRENT MOMENT (AMPERE-METERS)      9.7687+004      9.7687+004      9.7687+004

                                                                                                                       GRADIENT ALONG
     DISTANCE IN           AZIMUTH TO     COORDINATES OF PATH       FIELD STRENGTH IN DB          TIME DIFFERENCE          THE GEODETIC LINE
   KILOMETERS TO          DESTINATION    LATITUDE    LONGITUDE    RELATIVE TO 1 MICROVOLT/M          MICROSECONDS           MICROSECONDS/KM
  ORIGIN   DESTINATION      DEGREES       DEGREES     DEGREES      MASTER   SLAVE 1   SLAVE 2    DELTA(T1)     DELTA(T2)    DELTA(T1)  DELTA(T2)

  771.5443    85.7272      270.0547      39.85567    86.48479      66.86    52.42     102.42    15509.9958    65518.7111    -1.26680   -6.00202
  780.1177    77.1524      269.9905      39.85570    86.58498      66.67    52.32     103.42    15499.1350    65467.2532    -1.26179   -6.01155
  788.6907    68.5821      269.9263      39.85565    86.68515      66.48    52.23     104.53    15488.3178    65415.7165    -1.25715   -6.02238
  797.2631    60.0087      269.8621      39.85550    86.78533      66.29    52.14     105.77    15477.5409    65364.0899    -1.25225   -6.03249
  805.8357    51.4364      269.7979      39.85527    86.88550      66.10    52.04     107.19    15466.8059    65312.3763    -1.24723   -6.04797
  814.4084    42.8636      269.7337      39.85496    86.98568      65.91    51.94     108.92    15456.1138    65260.5285    -1.24215   -6.05202
  822.9811    34.2908      269.6695      39.85456    87.08585      65.72    51.85     110.90    15445.4652    65208.6463    -1.23697   -6.06201
  831.5543    25.7182      269.6053      39.85407    87.18603      65.53    51.75     113.44    15434.8603    65156.6754    -1.23173   -6.07195
  840.1264    17.1451      269.5412      39.85349    87.28619      65.34    51.65     117.00    15424.3018    65104.6260    -1.22640   -6.08060
  848.6994     8.5727      269.4770      39.85283    87.38637      65.15    51.55     123.05    15413.7879    65052.4971    -1.22100   -5.54052


  857.2720     0.0000      269.4128      39.85208    87.48653      64.96    51.45     319.70    15403.3208    65005.0007     0.00000    0.00000
```

Table 2.

```
PARAMETERS FOR DB1

 KDEL=          0
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000-003
   E2= 1.500000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 0.000000000+000
  ANN= 0.000000000+000
   H2= 0.000000000+000

PARAMETERS FOR DB2

 KDEL=          0
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000-003
   E2= 1.500000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 0.000000000+000
  ANN= 0.000000000+000
   H2= 0.000000000+000

PARAMETERS FOR HOMOGENEOUS CASE

 KDEL=          0
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000-003
   E2= 1.500000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 0.000000000+000
  ANN= 0.000000000+000
   H2= 0.000000000+000
```

Table 2. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)
LAT=N27D 1M 57.32S LON=W80D 6M 53.71S LOCATION OF SLAVE 1 (JUPITER)
LAT=N39D 51M 7.48S LON=W87D 29M 11.51S LOCATION OF SLAVE 2 (DANA)

	MASTER	SLAVE 1	SLAVE 2
CODING DELAY (MICROSECONDS)		11000.00	65000.00
RADIATED POWER (KILOWATTS)	400.000	400.000	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004	9.7687+004	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M MASTER	SLAVE 1	SLAVE 2	TIME DIFFERENCE MICROSECONDS DELTA(T1)	DELTA(T2)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T1)	DELTA(T2)
0.0000	662.1918	113.3747	36.61500	84.50000	76.44	62.96	83.44	15295.6073	67835.9625	0.94597	6.19639
6.6219	655.5699	113.4152	36.59131	84.43207	76.64	63.09	83.24	15301.8715	67876.9946	0.95538	6.20946
13.2438	648.9480	113.4557	36.56757	84.36419	76.85	63.21	83.05	15308.1979	67918.1130	0.96490	6.22203
19.8658	642.3261	113.4961	36.54380	84.29635	77.05	63.34	82.85	15314.5874	67959.3148	0.97455	6.23415
26.4877	635.7042	113.5365	36.51999	84.22855	77.25	63.47	82.65	15321.0408	68000.5969	0.98432	6.24583
33.1096	629.0823	113.5768	36.49614	84.16079	77.45	63.59	82.46	15327.5589	68041.9563	0.99421	6.25709
39.7315	622.4603	113.6170	36.47225	84.09307	77.65	63.72	82.26	15334.1425	68083.3902	1.00423	6.26794
46.3534	615.8384	113.6573	36.44832	84.02540	77.86	63.85	82.07	15340.7923	68124.8959	1.01437	6.27841
52.9754	609.2165	113.6974	36.42436	83.95776	78.06	63.97	81.87	15347.5094	68166.4711	1.02464	6.28851
59.5973	602.5946	113.7375	36.40036	83.89017	78.27	64.09	81.68	15354.2945	68208.1131	1.03504	6.29825
66.2192	595.9727	113.7776	36.37631	83.82262	78.47	64.22	81.48	15361.1484	68249.8196	1.04557	6.30766
72.8411	589.3507	113.8176	36.35223	83.75511	78.68	64.34	81.29	15368.0721	68291.5885	1.05623	6.31675
79.4630	582.7288	113.8576	36.32812	83.68765	78.89	64.47	81.10	15375.0663	68333.4174	1.06703	6.32553
86.0849	576.1069	113.8976	36.30396	83.62022	79.09	64.59	80.90	15382.1321	68375.3046	1.07796	6.33401
92.7069	569.4850	113.9374	36.27976	83.55284	79.30	64.71	80.71	15389.2703	68417.2479	1.08903	6.34220
99.3288	562.8631	113.9773	36.25553	83.48549	79.51	64.83	80.52	15396.4817	68459.2453	1.10024	6.35013
105.9507	556.2412	114.0171	36.23126	83.41819	79.72	64.95	80.32	15403.7674	68501.2955	1.11159	6.35779
112.5726	549.6192	114.0568	36.20695	83.35093	79.93	65.07	80.13	15411.1282	68543.3962	1.12308	6.36521
119.1945	542.9973	114.0965	36.18261	83.28371	80.15	65.19	79.94	15418.5652	68585.5461	1.13471	6.37238
125.8165	536.3754	114.1362	36.15822	83.21654	80.36	65.31	79.75	15426.0792	68627.7435	1.14650	6.37932
132.4384	529.7535	114.1758	36.13380	83.14940	80.57	65.43	79.55	15433.6711	68669.9868	1.15842	6.38605
139.0603	523.1316	114.2153	36.10934	83.08231	80.79	65.55	79.36	15441.3421	68712.2747	1.17050	6.39256
145.6822	516.5096	114.2548	36.08484	83.01526	81.01	65.67	79.17	15449.0931	68754.6058	1.18273	6.39886
152.3041	509.8877	114.2943	36.06031	82.94825	81.22	65.78	78.98	15456.9250	68796.9785	1.19511	6.40497
158.9260	503.2658	114.3337	36.03574	82.88128	81.44	65.90	78.79	15464.8389	68839.3917	1.20764	6.41090
165.5480	496.6439	114.3730	36.01113	82.81435	81.66	66.02	78.60	15472.8358	68881.8442	1.22033	6.41664
172.1699	490.0220	114.4123	35.98648	82.74747	81.88	66.13	78.41	15480.9167	68924.3345	1.23318	6.42221
178.7918	483.4001	114.4516	35.96179	82.68063	82.10	66.25	78.22	15489.0827	68966.8620	1.24618	6.42761
185.4137	476.7781	114.4908	35.93707	82.61382	82.33	66.36	78.03	15497.3348	69009.4250	1.25934	6.43285
192.0356	470.1562	114.5300	35.91231	82.54706	82.55	66.47	77.84	15505.6741	69052.0229	1.27267	6.43793

Table 2. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)
LAT=N27D 1M 57.32S LON=W80D 6M 53.71S LOCATION OF SLAVE 1 (JUPITER)
LAT=N39D 51M 7.48S LON=W87D 29M 11.51S LOCATION OF SLAVE 2 (DANA)

	MASTER	SLAVE 1	SLAVE 2
CODING DELAY (MICROSECONDS)		11000.00	65000.00
RADIATED POWER (KILOWATTS)	400.000	400.000	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004	9.7687+004	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M MASTER	FIELD STRENGTH SLAVE 1	FIELD STRENGTH SLAVE 2	TIME DIFFERENCE MICROSECONDS DELTA(T1)	TIME DIFFERENCE MICROSECONDS DELTA(T2)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T1)	GRADIENT DELTA(T2)
198.6576	463.5343	114.5691	35.88752	82.48035	82.78	66.58	77.65	15514.1016	69094.6543	1.28616	6.44287
205.2795	456.9124	114.6082	35.86268	82.41367	83.00	66.70	77.47	15522.6185	69137.3185	1.29982	6.44766
211.9014	450.2905	114.6472	35.83781	82.34703	83.23	66.81	77.28	15531.2258	69180.0144	1.31364	6.45232
218.5233	443.6685	114.6862	35.81290	82.28044	83.46	66.92	77.09	15539.9246	69222.7411	1.32763	6.45684
225.1452	437.0466	114.7251	35.78796	82.21389	83.69	67.03	76.90	15548.7160	69265.4978	1.34179	6.46124
231.7671	430.4247	114.7640	35.76298	82.14738	83.93	67.14	76.71	15557.6013	69308.2836	1.35612	6.46551
238.3891	423.8028	114.8028	35.73796	82.08091	84.16	67.25	76.53	15566.5814	69351.0977	1.37063	6.46966
245.0110	417.1809	114.8416	35.71290	82.01448	84.40	67.35	76.34	15575.6575	69393.9392	1.38530	6.47370
251.6329	410.5590	114.8804	35.68781	81.94810	84.64	67.46	76.15	15584.8309	69436.8075	1.40016	6.47762
258.2548	403.9370	114.9191	35.66268	81.88175	84.88	67.57	75.97	15594.1026	69479.7019	1.41519	6.48144
264.8767	397.3151	114.9577	35.63752	81.81545	85.12	67.67	75.78	15603.4739	69522.6212	1.43040	6.48516
271.4987	390.6932	114.9963	35.61231	81.74919	85.36	67.78	75.60	15612.9459	69565.5656	1.44579	6.48877
278.1206	384.0713	115.0349	35.58708	81.68297	85.61	67.88	75.41	15622.5198	69608.5336	1.46136	6.49230
284.7425	377.4493	115.0734	35.56180	81.61679	85.85	67.99	75.22	15632.1968	69651.5251	1.47712	6.49572
291.3644	370.8274	115.1118	35.53649	81.55066	86.10	68.09	75.04	15641.9782	69694.5393	1.49306	6.49906
297.9863	364.2055	115.1502	35.51114	81.48456	86.36	68.19	74.85	15651.8651	69737.5756	1.50918	6.50231
304.6083	357.5836	115.1886	35.48576	81.41851	86.61	68.29	74.67	15661.8587	69780.6334	1.52549	6.50548
311.2302	350.9617	115.2269	35.46034	81.35250	86.87	68.39	74.48	15671.9604	69823.7121	1.54199	6.50857
317.8521	344.3398	115.2651	35.43488	81.28653	87.13	68.49	74.30	15682.1714	69866.8114	1.55868	6.51158
324.4740	337.7178	115.3033	35.40939	81.22060	87.39	68.59	74.12	15692.4929	69909.9305	1.57556	6.51451
331.0959	331.0959	115.3415	35.38386	81.15471	87.66	68.69	73.93	15702.9261	69953.0691	1.59263	6.51738
337.7178	324.4740	115.3796	35.35830	81.08887	87.93	68.78	73.75	15713.4724	69996.2267	1.60989	6.52017
344.3398	317.8521	115.4177	35.33270	81.02306	88.20	68.88	73.57	15724.1330	70039.4026	1.62735	6.52289
350.9617	311.2302	115.4557	35.30706	80.95730	88.47	68.97	73.38	15734.9091	70082.5966	1.64500	6.52554
357.5836	304.6083	115.4937	35.28139	80.89158	88.75	69.07	73.20	15745.8022	70125.8083	1.66285	6.52814
364.2055	297.9863	115.5316	35.25568	80.82590	89.03	69.16	73.02	15756.8134	70169.0370	1.68089	6.53067
370.8274	291.3644	115.5695	35.22993	80.76026	89.32	69.25	72.83	15767.9441	70212.2826	1.69913	6.53314
377.4494	284.7425	115.6073	35.20415	80.69467	89.61	69.34	72.65	15779.1956	70255.5445	1.71756	6.53555
384.0713	278.1206	115.6451	35.17834	80.62911	89.90	69.43	72.47	15790.5692	70298.8224	1.73620	6.53790
390.6932	271.4986	115.6828	35.15249	80.56360	90.20	69.52	72.29	15802.0661	70342.1158	1.75503	6.54021

Table 2. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M	LON=W77D 54.787M	LOCATION OF MASTER (CAPE FEAR)
LAT=N27D 1M 57.32S	LON=W80D 6M 53.71S	LOCATION OF SLAVE 1 (JUPITER)
LAT=N39D 51M 7.48S	LON=W87D 29M 11.51S	LOCATION OF SLAVE 2 (DANA)

	MASTER	SLAVE 1	SLAVE 2
CODING DELAY (MICROSECONDS)		11000.00	65000.00
RADIATED POWER (KILOWATTS)	400.000	400.000	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004	9.7687+004	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M MASTER	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M SLAVE 1	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M SLAVE 2	TIME DIFFERENCE MICROSECONDS DELTA(T1)	TIME DIFFERENCE MICROSECONDS DELTA(T2)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T1)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T2)
397.3151	264.8767	115.7205	35.12660	80.49813	90.50	69.61	72.10	15813.6878	70385.4246	1.77406	6.54246
403.9370	258.2548	115.7581	35.10068	80.43270	90.81	69.70	71.92	15825.4354	70428.7481	1.79329	6.54465
410.5589	251.6329	115.7957	35.07472	80.36731	91.12	69.78	71.74	15837.3105	70472.0863	1.81272	6.54680
417.1809	245.0110	115.8333	35.04873	80.30196	91.44	69.87	71.56	15849.3142	70515.4387	1.83235	6.54890
423.8028	238.3891	115.8708	35.02270	80.23666	91.76	69.95	71.38	15861.4479	70558.8050	1.85219	6.55096
430.4247	231.7671	115.9082	34.99664	80.17139	92.09	70.04	71.20	15873.7129	70602.1850	1.87222	6.55297
437.0466	225.1452	115.9456	34.97054	80.10617	92.43	70.12	71.02	15886.1106	70645.5781	1.89245	6.55494
443.6685	218.5233	115.9829	34.94441	80.04099	92.77	70.20	70.84	15898.6423	70688.9844	1.91289	6.55686
450.2905	211.9014	116.0202	34.91824	79.97585	93.12	70.28	70.66	15911.3092	70732.4034	1.93352	6.55875
456.9124	205.2795	116.0575	34.89204	79.91075	93.48	70.36	70.48	15924.1128	70775.8349	1.95435	6.56059
463.5343	198.6576	116.0947	34.86580	79.84569	93.85	70.43	70.30	15937.0544	70819.2786	1.97539	6.56240
470.1562	192.0356	116.1319	34.83952	79.78067	94.22	70.51	70.12	15950.1353	70862.7343	1.99662	6.56417
476.7781	185.4137	116.1690	34.81322	79.71570	94.61	70.59	69.94	15963.3568	70906.2017	2.01806	6.56591
483.4000	178.7918	116.2060	34.78687	79.65076	95.00	70.66	69.76	15976.7202	70949.6806	2.03969	6.56761
490.0220	172.1699	116.2430	34.76050	79.58587	95.41	70.73	69.58	15990.2268	70993.1708	2.06152	6.56928
496.6439	165.5480	116.2800	34.73408	79.52102	95.83	70.81	69.40	16003.8781	71036.6720	2.08355	6.57092
503.2658	158.9260	116.3169	34.70764	79.45621	96.26	70.88	69.22	16017.6751	71080.1840	2.10577	6.57252
509.8877	152.3041	116.3538	34.68116	79.39144	96.71	70.95	69.04	16031.6194	71123.7067	2.12819	6.57410
516.5096	145.6822	116.3906	34.65464	79.32671	97.17	71.01	68.86	16045.7121	71167.2400	2.15081	6.57565
523.1316	139.0603	116.4274	34.62809	79.26203	97.65	71.08	68.68	16059.9546	71210.7834	2.17362	6.57718
529.7535	132.4384	116.4641	34.60150	79.19738	98.15	71.15	68.50	16074.3481	71254.3369	2.19662	6.57868
536.3754	125.8164	116.5008	34.57488	79.13278	98.67	71.21	68.32	16088.8939	71297.9004	2.21981	6.58015
542.9973	119.1945	116.5374	34.54823	79.06822	99.21	71.27	68.15	16103.5933	71341.4736	2.24320	6.58161
549.6192	112.5726	116.5740	34.52154	79.00369	99.78	71.34	67.97	16118.4476	71385.0566	2.26677	6.58304
556.2412	105.9507	116.6105	34.49482	78.93921	100.37	71.40	67.79	16133.4580	71428.6489	2.29054	6.58446
562.8631	99.3288	116.6470	34.46807	78.87478	101.00	71.46	67.61	16148.6257	71472.2507	2.31449	6.58586
569.4850	92.7069	116.6834	34.44127	78.81038	101.67	71.51	67.43	16163.9520	71515.8617	2.33862	6.58724
576.1069	86.0849	116.7198	34.41445	78.74602	102.38	71.57	67.26	16179.4382	71559.4819	2.36295	6.58861
582.7288	79.4630	116.7561	34.38759	78.68170	103.14	71.63	67.08	16195.0855	71603.1112	2.38746	6.58998
589.3507	72.8411	116.7924	34.36070	78.61743	103.97	71.68	66.90	16210.8950	71646.7494	2.41215	6.59133

Table 2. (Continued)

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                         NO.CAROLINA-TENN. FLIGHT PLAN
               N.CAROLINA-TENNESSEE END POINT     TO  CAROLINA BEACH
LAT=N36.615D           LON=W84.5000D              TO  LAT=N34D 3.76M          LON=W77D 54.787M

        LAT=N34D 3.76M       LON=W77D 54.787M    LOCATION OF MASTER (CAPE FEAR)
        LAT=N27D 1M 57.32S   LON=W80D 6M 53.71S  LOCATION OF SLAVE 1 (JUPITER)
        LAT=N39D 51M 7.48S   LON=W87D 29M 11.51S LOCATION OF SLAVE 2 (DANA)
                                        MASTER        SLAVE 1       SLAVE 2
    CODING DELAY (MICROSECONDS)                       11000.00      65000.00
    RADIATED POWER (KILOWATTS)          400.000       400.000       400.000
    DIPOLE CURRENT MOMENT (AMPERE-METERS)  9.7687+004  9.7687+004  9.7687+004
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DISTANCE IN KILOMETERS TO ORIGIN	DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M MASTER	SLAVE 1	SLAVE 2	TIME DIFFERENCE MICROSECONDS DELTA(T1)	DELTA(T2)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T1)	DELTA(T2)
595.9727	66.2192	116.8287	34.33377	78.55320	104.86	71.73	66.72	16226.8680	71690.3967	2.43702	6.59268
602.5946	59.5973	116.8648	34.30682	78.48900	105.84	71.78	66.55	16243.0058	71734.0528	2.46208	6.59402
609.2165	52.9753	116.9010	34.27982	78.42485	106.92	71.83	66.37	16259.3095	71777.7179	2.49475	6.60280
615.8384	46.3534	116.9371	34.25279	78.36074	108.23	71.88	66.19	16275.8295	71821.4411	2.51237	6.59635
622.4603	39.7315	116.9731	34.22573	78.29667	109.60	71.93	66.02	16292.4662	71865.1216	2.53820	6.59793
629.0823	33.1096	117.0091	34.19864	78.23264	111.21	71.98	65.84	16309.2740	71908.8125	2.56425	6.59957
635.7042	26.4877	117.0451	34.17151	78.16866	113.18	72.02	65.66	16326.2542	71952.5143	2.59051	6.60124
642.3261	19.8658	117.0810	34.14435	78.10471	115.71	72.06	65.49	16343.4083	71996.2272	2.61671	6.60271
648.9480	13.2434	117.1169	34.11716	78.04081	119.26	72.10	65.31	16360.7360	72039.9498	2.64042	6.60152
655.5699	6.6219	117.1527	34.08993	77.97694	125.30	72.14	65.13	16378.2206	72083.6645	1.95943	5.89547
662.1918	0.0000	117.1884	34.06267	77.91312	550.91	72.18	64.96	16391.1958	72122.7039	0.00000	0.00000

Table 3.

```
HOMOGENEOUS CASE

KDEL=          0
   F= 1.000000000+002 KHZ
SIGMA= 5.000000000-003
  E2= 1.500000000+001
ALFA= 1.000000000+000
 ETA= 1.000100000+000
BORA= 0.000000000+000
 ANN= 0.000000000+000
  H2= 0.000000000+000
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Table 3. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)
LAT=N27D 1M 57.32S LON=W80D 6M 53.71S LOCATION OF SLAVE 1 (JUPITER)
LAT=N39D 51M 7.48S LON=W87D 29M 11.51S LOCATION OF SLAVE 2 (DANA)

	MASTER	SLAVE 1	SLAVE 2
CODING DELAY (MICROSECONDS)		11000.00	65000.00
RADIATED POWER (KILOWATTS)	400.000	400.000	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004	9.7687+004	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M MASTER	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M SLAVE 1	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M SLAVE 2	TIME DIFFERENCE MICROSECONDS DELTA(T1)	TIME DIFFERENCE MICROSECONDS DELTA(T2)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T1)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T2)
0.0000	881.0159	179.6875	42.00000	77.96500	70.09	49.00	71.36	16340.3867	68414.1382	0.03047	2.60095
8.8102	872.2058	179.6879	41.92068	77.96442	70.34	49.22	71.41	16340.6551	68437.0530	0.03078	2.63438
17.6203	863.3956	179.6883	41.84136	77.96384	70.59	49.45	71.47	16340.9263	68460.2623	0.03110	2.66804
26.4305	854.5855	179.6887	41.76204	77.96327	70.84	49.67	71.52	16341.2003	68483.7681	0.03143	2.70192
35.2406	845.7753	179.6890	41.68272	77.96269	71.09	49.90	71.57	16341.4772	68507.5724	0.03176	2.73600
44.0508	836.9651	179.6894	41.60339	77.96212	71.34	50.12	71.61	16341.7569	68531.6770	0.03209	2.77028
52.8610	828.1550	179.6898	41.52407	77.96155	71.59	50.35	71.66	16342.0397	68556.0836	0.03243	2.80474
61.6711	819.3448	179.6902	41.44474	77.96098	71.84	50.57	71.70	16342.3254	68580.7939	0.03278	2.83939
70.4813	810.5347	179.6906	41.36542	77.96041	72.09	50.80	71.73	16342.6142	68605.8093	0.03313	2.87421
79.2914	801.7245	179.6909	41.28609	77.95984	72.35	51.02	71.77	16342.9060	68631.1316	0.03349	2.90917
88.1016	792.9143	179.6913	41.20676	77.95927	72.60	51.25	71.80	16343.2011	68656.7619	0.03385	2.94429
96.9118	784.1042	179.6917	41.12743	77.95871	72.85	51.47	71.83	16343.4993	68682.7015	0.03422	2.97954
105.7219	775.2940	179.6921	41.04810	77.95814	73.11	51.70	71.86	16343.8008	68708.9517	0.03460	3.01491
114.5321	766.4839	179.6924	40.96877	77.95758	73.36	51.92	71.88	16344.1056	68735.5136	0.03498	3.05040
123.3422	757.6737	179.6928	40.88943	77.95702	73.62	52.15	71.90	16344.4138	68762.3881	0.03537	3.08598
132.1524	748.8635	179.6932	40.81010	77.95646	73.88	52.38	71.92	16344.7254	68789.5761	0.03576	3.12165
140.9625	740.0534	179.6935	40.73076	77.95590	74.13	52.60	71.94	16345.0405	68817.0783	0.03617	3.15740
149.7727	731.2432	179.6939	40.65143	77.95534	74.39	52.83	71.95	16345.3592	68844.8955	0.03658	3.19322
158.5829	722.4331	179.6942	40.57209	77.95479	74.65	53.06	71.97	16345.6814	68873.0283	0.03699	3.22908
167.3930	713.6229	179.6946	40.49275	77.95423	74.91	53.28	71.97	16346.0073	68901.4770	0.03742	3.26498
176.2032	704.8128	179.6950	40.41341	77.95368	75.17	53.51	71.98	16346.3370	68930.2420	0.03785	3.30091
185.0133	696.0026	179.6953	40.33407	77.95313	75.43	53.74	71.98	16346.6704	68959.3235	0.03829	3.33684
193.8235	687.1924	179.6957	40.25472	77.95258	75.69	53.96	71.98	16347.0077	68988.7216	0.03873	3.37279
202.6337	678.3823	179.6960	40.17538	77.95203	75.96	54.19	71.98	16347.3489	69018.4364	0.03919	3.40874
211.4438	669.5721	179.6964	40.09604	77.95148	76.22	54.42	71.98	16347.6942	69048.4679	0.03965	3.44464
220.2540	660.7620	179.6967	40.01669	77.95093	76.49	54.65	71.97	16348.0435	69078.8157	0.04012	3.48051
229.0641	651.9518	179.6971	39.93734	77.95039	76.75	54.87	71.96	16348.3970	69109.4796	0.04060	3.51633
237.8743	643.1416	179.6974	39.85800	77.94984	77.02	55.10	71.94	16348.7547	69140.4590	0.04109	3.55210
246.6845	634.3315	179.6978	39.77865	77.94930	77.29	55.33	71.93	16349.1167	69171.7536	0.04159	3.58779
255.4946	625.5213	179.6981	39.69930	77.94876	77.56	55.56	71.91	16349.4831	69203.3626	0.04209	3.62339

Table 3. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)
LAT=N27D 1M 57.32S LON=W80D 6M 53.71S LOCATION OF SLAVE 1 (JUPITER)
LAT=N39D 51M 7.48S LON=W87D 29M 11.51S LOCATION OF SLAVE 2 (DANA)

	MASTER	SLAVE 1	SLAVE 2
CODING DELAY (MICROSECONDS)		11000.00	65000.00
RADIATED POWER (KILOWATTS)	400.000	400.000	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004	9.7687+004	9.7687+004

DISTANCE IN KILOMETERS TO		AZIMUTH TO DESTINATION	COORDINATES OF PATH		FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M			TIME DIFFERENCE MICROSECONDS		GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM	
ORIGIN	DESTINATION	DEGREES	LATITUDE DEGREES	LONGITUDE DEGREES	MASTER	SLAVE 1	SLAVE 2	DELTA(T1)	DELTA(T2)	DELTA(T1)	DELTA(T2)
264.3048	616.7112	179.6985	39.61995	77.94822	77.83	55.78	71.89	16349.8539	69235.2852	0.04261	3.65890
273.1149	607.9010	179.6988	39.54059	77.94768	78.10	56.01	71.86	16350.2293	69267.5207	0.04314	3.69417
281.9251	599.0908	179.6992	39.46124	77.94714	78.37	56.24	71.84	16350.6093	69300.0670	0.04367	3.72971
290.7353	590.2807	179.6995	39.38189	77.94660	78.65	56.47	71.81	16350.9941	69332.9263	0.04422	3.76472
299.5454	581.4705	179.6998	39.30253	77.94607	78.93	56.70	71.78	16351.3837	69366.0942	0.04477	3.79973
308.3556	572.6604	179.7002	39.22317	77.94553	79.20	56.93	71.74	16351.7781	69399.5704	0.04534	3.83457
317.1657	563.8502	179.7005	39.14382	77.94500	79.48	57.16	71.70	16352.1776	69433.3536	0.04592	3.86926
325.9759	555.0400	179.7009	39.06446	77.94447	79.76	57.38	71.66	16352.5821	69467.4424	0.04651	3.90377
334.7861	546.2299	179.7012	38.98510	77.94394	80.04	57.61	71.62	16352.9919	69501.8352	0.04711	3.93809
343.5962	537.4197	179.7015	38.90574	77.94341	80.33	57.84	71.58	16353.4069	69536.5304	0.04772	3.97222
352.4064	528.6095	179.7019	38.82637	77.94288	80.61	58.07	71.53	16353.8274	69571.5263	0.04835	4.00615
361.2165	519.7994	179.7022	38.74701	77.94235	80.90	58.30	71.48	16354.2533	69606.8211	0.04899	4.03985
370.0267	510.9892	179.7025	38.66765	77.94182	81.19	58.53	71.43	16354.6849	69642.4129	0.04964	4.07334
378.8369	502.1791	179.7028	38.58828	77.94130	81.48	58.76	71.37	16355.1222	69678.2996	0.05030	4.10659
387.6470	493.3689	179.7032	38.50891	77.94078	81.77	58.99	71.31	16355.5654	69714.4794	0.05098	4.13961
396.4572	484.5588	179.7035	38.42955	77.94025	82.06	59.22	71.25	16356.0145	69750.9500	0.05167	4.17238
405.2673	475.7486	179.7038	38.35018	77.93973	82.36	59.45	71.19	16356.4697	69787.7093	0.05238	4.20489
414.0775	466.9384	179.7041	38.27081	77.93921	82.66	59.68	71.13	16356.9312	69824.7551	0.05310	4.23714
422.8877	458.1283	179.7045	38.19144	77.93869	82.96	59.91	71.06	16357.3990	69862.0850	0.05383	4.26912
431.6978	449.3181	179.7048	38.11206	77.93817	83.27	60.14	70.99	16357.8732	69899.6966	0.05459	4.30082
440.5080	440.5080	179.7051	38.03269	77.93766	83.57	60.37	70.92	16358.3542	69937.5876	0.05535	4.33225
449.3181	431.6978	179.7054	37.95332	77.93714	83.88	60.61	70.85	16358.8418	69975.7553	0.05614	4.36339
458.1283	422.8877	179.7057	37.87394	77.93663	84.19	60.84	70.77	16359.3364	70014.1975	0.05694	4.39423
466.9384	414.0775	179.7060	37.79457	77.93611	84.51	61.07	70.69	16359.8381	70052.9113	0.05776	4.42478
475.7486	405.2673	179.7064	37.71519	77.93560	84.83	61.30	70.61	16360.3470	70091.8943	0.05860	4.45502
484.5588	396.4572	179.7067	37.63581	77.93509	85.15	61.53	70.53	16360.8632	70131.1437	0.05945	4.48496
493.3689	387.6470	179.7070	37.55643	77.93458	85.47	61.76	70.44	16361.3870	70170.6569	0.06033	4.51458
502.1791	378.8368	179.7073	37.47705	77.93407	85.80	62.00	70.35	16361.9185	70210.4311	0.06122	4.54390
510.9892	370.0267	179.7076	37.39767	77.93356	86.13	62.23	70.26	16362.4579	70250.4635	0.06214	4.57289
519.7994	361.2165	179.7079	37.31828	77.93305	86.47	62.46	70.17	16363.0054	70290.7514	0.06308	4.60157

Table 3. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)
LAT=N27D 1M 57.32S LON=W80D 6M 53.71S LOCATION OF SLAVE 1 (JUPITER)
LAT=N39D 51M 7.48S LON=W87D 29M 11.51S LOCATION OF SLAVE 2 (DANA)

	MASTER	SLAVE 1	SLAVE 2
CODING DELAY (MICROSECONDS)		11000.00	65000.00
RADIATED POWER (KILOWATTS)	400.000	400.000	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004	9.7687+004	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M MASTER	FIELD STRENGTH SLAVE 1	FIELD STRENGTH SLAVE 2	TIME DIFFERENCE MICROSECONDS DELTA(T1)	TIME DIFFERENCE DELTA(T2)	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM DELTA(T1)	GRADIENT DELTA(T2)
528.6096	352.4064	179.7082	37.23890	77.93255	86.81	62.69	70.08	16363.5611	70331.2920	0.06404	4.62992
537.4197	343.5962	179.7085	37.15952	77.93204	87.16	62.93	69.98	16364.1253	70372.0823	0.06502	4.65795
546.2299	334.7861	179.7088	37.08013	77.93154	87.51	63.16	69.89	16364.6981	70413.1195	0.06602	4.68565
555.0400	325.9759	179.7091	37.00074	77.93103	87.86	63.39	69.79	16365.2797	70454.4008	0.06705	4.71302
563.8502	317.1657	179.7094	36.92135	77.93053	88.23	63.63	69.68	16365.8705	70495.9233	0.06810	4.74006
572.6604	308.3556	179.7097	36.84197	77.93003	88.59	63.86	69.58	16366.4704	70537.6840	0.06918	4.76678
581.4705	299.5454	179.7100	36.76257	77.92953	88.96	64.09	69.48	16367.0799	70579.6800	0.07029	4.79316
590.2807	290.7353	179.7103	36.68318	77.92903	89.34	64.33	69.37	16367.6992	70621.9085	0.07142	4.81921
599.0908	281.9251	179.7106	36.60379	77.92853	89.73	64.56	69.26	16368.3284	70664.3665	0.07258	4.84492
607.9010	273.1149	179.7109	36.52440	77.92804	90.13	64.79	69.15	16368.9678	70707.0511	0.07377	4.87031
616.7112	264.3048	179.7112	36.44500	77.92754	90.53	65.03	69.04	16369.6178	70749.9593	0.07499	4.89537
625.5213	255.4946	179.7115	36.36561	77.92705	90.94	65.26	68.92	16370.2784	70793.0883	0.07624	4.92009
634.3315	246.6845	179.7118	36.28621	77.92655	91.36	65.50	68.80	16370.9501	70836.4351	0.07753	4.94448
643.1416	237.8743	179.7121	36.20681	77.92606	91.79	65.73	68.69	16371.6331	70879.9968	0.07884	4.96856
651.9518	229.0641	179.7124	36.12741	77.92557	92.23	65.97	68.57	16372.3278	70923.7705	0.08020	4.99229
660.7620	220.2540	179.7127	36.04801	77.92508	92.68	66.21	68.45	16373.0343	70967.7534	0.08159	5.01570
669.5721	211.4438	179.7130	35.96861	77.92459	93.15	66.44	68.32	16373.7531	71011.9426	0.08301	5.03879
678.3823	202.6337	179.7132	35.88921	77.92410	93.63	66.68	68.20	16374.4845	71056.3351	0.08448	5.06156
687.1924	193.8235	179.7135	35.80981	77.92361	94.12	66.91	68.07	16375.2288	71100.9283	0.08599	5.08401
696.0026	185.0133	179.7138	35.73040	77.92313	94.63	67.15	67.95	16375.9864	71145.7193	0.08754	5.10614
704.8128	176.2032	179.7141	35.65100	77.92264	95.16	67.39	67.82	16376.7576	71190.7052	0.08914	5.12796
713.6229	167.3930	179.7144	35.57159	77.92215	95.71	67.62	67.69	16377.5429	71235.8833	0.09078	5.14946
722.4331	158.5829	179.7147	35.49218	77.92167	96.28	67.86	67.55	16378.3427	71281.2508	0.09247	5.17066
731.2432	149.7727	179.7149	35.41277	77.92119	96.88	68.10	67.42	16379.1573	71326.8052	0.09421	5.19155
740.0534	140.9626	179.7152	35.33336	77.92071	97.51	68.34	67.29	16379.9873	71372.5435	0.09601	5.21214
748.8636	132.1524	179.7155	35.25395	77.92022	98.17	68.58	67.15	16380.8332	71418.4633	0.09786	5.23243
757.6737	123.3422	179.7158	35.17454	77.91974	98.86	68.81	67.01	16381.6953	71464.5618	0.09978	5.25243
766.4839	114.5321	179.7161	35.09513	77.91926	99.60	69.05	66.87	16382.5744	71510.8366	0.10175	5.27214
775.2940	105.7219	179.7163	35.01572	77.91879	100.39	69.29	66.73	16383.4708	71557.2850	0.10380	5.29157
784.1042	96.9118	179.7166	34.93630	77.91831	101.24	69.53	66.59	16384.3853	71603.9046	0.10592	5.31072

Table 3. (Continued)

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                              PENNSYLVANIA FLIGHT PLAN
                   PENNSYLVANIA END POINT              TO  CAROLINA BEACH
        LAT=N42.000D          LON=W77.965D             TO  LAT=N34D 3.76M          LON=W77D 54.787M

                    LAT=N34D 3M 45.61S    LON=W77D 54M 47.20S   LOCATION OF MASTER (CAPE FEAR)
                    LAT=N27D 1M 57.32S    LON=W80D 6M 53.71S    LOCATION OF SLAVE 1 (JUPITER)
                    LAT=N39D 51M 7.48S    LON=W87D 29M 11.51S   LOCATION OF SLAVE 2 (DANA)
                                                       MASTER /      SLAVE 1       SLAVE 2
                CODING DELAY (MICROSECONDS)                          11000.00      65000.00
                RADIATED POWER (KILOWATTS)                400.000     400.000       400.000
                DIPOLE CURRENT MOMENT (AMPERE-METERS)  9.7687+004  9.7687+004    9.7687+004

                                                                                                             GRADIENT ALONG
     DISTANCE IN        AZIMUTH TO    COORDINATES OF PATH       FIELD STRENGTH IN DB        TIME DIFFERENCE       THE GEODETIC LINE
   KILOMETERS TO       DESTINATION   LATITUDE   LONGITUDE    RELATIVE TO 1 MICROVOLT/M       MICROSECONDS         MICROSECONDS/KM
 ORIGIN  DESTINATION     DEGREES     DEGREES     DEGREES     MASTER   SLAVE 1   SLAVE 2   DELTA(T1)   DELTA(T2)   DELTA(T1)  DELTA(T2)

792.9143   88.1016     179.7169    34.85688    77.91783    102.16    69.77     66.45   16385.3184  71650.6928    0.10811    5.32960
801.7245   79.2914     179.7171    34.77747    77.91736    103.16    70.01     66.31   16386.2709  71697.6475    0.11039    5.34822
810.5347   70.4813     179.7174    34.69805    77.91688    104.28    70.25     66.16   16387.2435  71744.7661    0.11276    5.36658
819.3448   61.6711     179.7177    34.61863    77.91641    105.52    70.49     66.01   16388.2370  71792.0465    0.11523    5.38469
828.1550   52.8610     179.7180    34.53921    77.91594    106.94    70.73     65.87   16389.2522  71839.4865    0.12328    5.40804
836.9651   44.0508     179.7182    34.45979    77.91546    108.68    70.97     65.72   16390.3383  71887.1322    0.12024    5.41995
845.7753   35.2406     179.7185    34.38037    77.91499    110.66    71.21     65.57   16391.3977  71934.8828    0.12340    5.43772
854.5855   26.4305     179.7188    34.30094    77.91452    113.20    71.46     65.42   16392.4848  71982.7900    0.12672    5.45531
863.3956   17.6203     179.7190    34.22152    77.91405    116.76    71.70     65.27   16393.6013  72030.8522    0.12918    5.47169
872.2058    8.8102     179.7193    34.14209    77.91358    122.82    71.94     65.11   16394.7394  72079.0586   -0.40232    4.95378


881.0159    0.0000     179.7195    34.06267    77.91312    322.32    72.18     64.96   16391.1949  72122.7022    0.00000    0.00000
```

Table 4.

```
     HOMOGENEOUS CASE

    KDEL=          0
       F= 1.000000000+002 KHZ
   SIGMA= 5.000000000-003
      E2= 1.500000000+001
    ALFA= 1.000000000+000
     ETA= 1.000100000+000
    BORA= 0.000000000+000
     ANN= 0.000000000+000
      H2= 0.000000000+000
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Table 4. (Continued)

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                              NEW VA-WVA FLIGHT PLAN
                    NEW VA-WVA END POINT                      TO  DANA
   LAT=N39D 30M            LON=W77D 30M                       TO  LAT=N39D 51.125M        LON=W87D 29.192M

                 LAT=N39D 51.125M        LON=W87D 29.192M        LOCATION OF MASTER (DANA)
                                                              MASTER
              RADIATED POWER (KILOWATTS)                     400.000
              DIPOLE CURRENT MOMENT (AMPERE-METERS)       9.7687+004

    DISTANCE IN         AZIMUTH TO   COORDINATES OF PATH   FIELD STRENGTH IN      TIME          GRADIENT ALONG
  KILOMETERS TO        DESTINATION   LATITUDE   LONGITUDE  DB RELATIVE TO      DIFFERENCE     THE GEODETIC LINE
 ORIGIN  DESTINATION     DEGREES     DEGREES     DEGREES    1 MICROVOLT/M     MICROSECONDS     MICROSECONDS/KM

   0.0000   857.2720    275.7983    39.50000    77.50000        70.76          2864.7173          -3.34098
   8.5727   848.6993    275.7352    39.50776    77.59917        71.00          2836.0759          -3.34098
  17.1450   840.1266    275.6721    39.51543    77.69835        71.25          2807.4360          -3.34098
  25.7182   831.5538    275.6090    39.52302    77.79756        71.49          2778.7934          -3.34098
  34.2909   822.9811    275.5458    39.53053    77.89679        71.74          2750.1520          -3.34098
  42.8636   814.4084    275.4826    39.53795    77.99605        71.98          2721.5109          -3.34098
  51.4363   805.8357    275.4194    39.54528    78.09532        72.23          2692.8695          -3.34098
  60.0090   797.2630    275.3562    39.55253    78.19461        72.47          2664.2284          -3.34097
  68.5818   788.6902    275.2930    39.55970    78.29393        72.72          2635.5869          -3.34097
  77.1545   780.1175    275.2297    39.56678    78.39326        72.97          2606.9458          -3.34097

  85.7272   771.5448    275.1664    39.57377    78.49262        73.22          2578.3046          -3.34097
  94.2999   762.9721    275.1031    39.58068    78.59199        73.46          2549.6635          -3.34097
 102.8727   754.3994    275.0398    39.58751    78.69139        73.71          2521.0221          -3.34097
 111.4454   745.8266    274.9764    39.59425    78.79080        73.96          2492.3810          -3.34097
 120.0181   737.2540    274.9130    39.60091    78.89023        74.22          2463.7398          -3.34096
 128.5908   728.6812    274.8496    39.60748    78.98968        74.47          2435.0987          -3.34096
 137.1635   720.1085    274.7862    39.61396    79.08916        74.72          2406.4576          -3.34096
 145.7363   711.5358    274.7228    39.62036    79.18864        74.97          2377.8163          -3.34096
 154.3090   702.9630    274.6593    39.62668    79.28815        75.23          2349.1752          -3.34096
 162.8817   694.3903    274.5958    39.63290    79.38768        75.48          2320.5343          -3.34096

 171.4544   685.8176    274.5323    39.63905    79.48722        75.74          2291.8931          -3.34095
 180.0271   677.2449    274.4688    39.64511    79.58678        75.99          2263.2521          -3.34095
 188.5998   668.6721    274.4053    39.65108    79.68636        76.25          2234.6110          -3.34095
 197.1726   660.0994    274.3417    39.65697    79.78595        76.51          2205.9699          -3.34095
 205.7453   651.5267    274.2781    39.66277    79.88556        76.77          2177.3289          -3.34095
 214.3180   642.9540    274.2145    39.66849    79.98519        77.03          2148.6880          -3.34095
 222.8907   634.3813    274.1509    39.67412    80.08484        77.29          2120.0469          -3.34094
 231.4634   625.8086    274.0873    39.67967    80.18450        77.55          2091.4060          -3.34094
 240.0362   617.2358    274.0237    39.68513    80.28417        77.81          2062.7649          -3.34094
 248.6089   608.6632    273.9600    39.69050    80.38386        78.08          2034.1240          -3.34094
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Table 4. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)
MASTER
RADIATED POWER (KILOWATTS) 400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS) 9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
257.1816	600.0904	273.8963	39.69579	80.48357	78.34	2005.4832	-3.34094
265.7543	591.5177	273.8326	39.70100	80.58329	78.61	1976.8423	-3.34093
274.3270	582.9450	273.7689	39.70612	80.68303	78.88	1948.2014	-3.34093
282.8998	574.3723	273.7052	39.71115	80.78278	79.15	1919.5604	-3.34093
291.4724	565.7995	273.6414	39.71609	80.88255	79.42	1890.9197	-3.34093
300.0452	557.2268	273.5777	39.72096	80.98233	79.69	1862.2787	-3.34093
308.6179	548.6541	273.5139	39.72573	81.08212	79.97	1833.6380	-3.34092
317.1906	540.0813	273.4501	39.73042	81.18193	80.24	1804.9971	-3.34092
325.7634	531.5087	273.3863	39.73502	81.28175	80.52	1776.3561	-3.34092
334.3361	522.9359	273.3225	39.73954	81.38158	80.80	1747.7156	-3.34092
342.9088	514.3632	273.2586	39.74397	81.48143	81.08	1719.0747	-3.34092
351.4815	505.7905	273.1948	39.74832	81.58129	81.36	1690.4342	-3.34092
360.0543	497.2178	273.1309	39.75258	81.68116	81.64	1661.7932	-3.34092
368.6269	488.6450	273.0670	39.75675	81.78105	81.93	1633.1527	-3.34091
377.1997	480.0724	273.0032	39.76084	81.88094	82.22	1604.5118	-3.34091
385.7723	471.4996	272.9393	39.76484	81.98085	82.50	1575.8713	-3.34091
394.3451	462.9269	272.8753	39.76876	82.08077	82.80	1547.2305	-3.34091
402.9178	454.3541	272.8114	39.77259	82.18070	83.09	1518.5898	-3.34091
411.4905	445.7815	272.7475	39.77634	82.28064	83.39	1489.9491	-3.34091
420.0633	437.2087	272.6835	39.77999	82.38060	83.69	1461.3084	-3.34091
428.6360	428.6360	272.6196	39.78357	82.48056	83.99	1432.6676	-3.34091
437.2087	420.0632	272.5556	39.78705	82.58053	84.29	1404.0270	-3.34091
445.7814	411.4906	272.4916	39.79045	82.68052	84.60	1375.3863	-3.34091
454.3541	402.9178	272.4276	39.79376	82.78051	84.91	1346.7457	-3.34091
462.9268	394.3452	272.3636	39.79699	82.88051	85.23	1318.1050	-3.34091
471.4996	385.7724	272.2996	39.80013	82.98052	85.54	1289.4642	-3.34091
480.0723	377.1997	272.2356	39.80319	83.08054	85.86	1260.8236	-3.34091
488.6451	368.6269	272.1715	39.80616	83.18057	86.19	1232.1828	-3.34092
497.2177	360.0544	272.1075	39.80904	83.28061	86.52	1203.5421	-3.34092
505.7905	351.4814	272.0434	39.81184	83.38065	86.85	1174.9013	-3.34092

Table 4. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
514.3632	342.9088	271.9794	39.81455	83.48071	87.19	1146.2606	-3.34093
522.9359	334.3361	271.9153	39.81717	83.58077	87.53	1117.6197	-3.34093
531.5086	325.7633	271.8512	39.81971	83.68084	87.87	1088.9789	-3.34094
540.0813	317.1907	271.7871	39.82216	83.78091	88.22	1060.3379	-3.34094
548.6540	308.6179	271.7230	39.82452	83.88100	88.58	1031.6972	-3.34095
557.2268	300.0452	271.6589	39.82680	83.98109	88.94	1003.0559	-3.34096
565.7995	291.4726	271.5948	39.82899	84.08118	89.31	974.4150	-3.34096
574.3723	282.8997	271.5307	39.83110	84.18129	89.69	945.7736	-3.34097
582.9449	274.3271	271.4666	39.83312	84.28140	90.07	917.1327	-3.34098
591.5177	265.7543	271.4024	39.83505	84.38151	90.46	888.4911	-3.34100
600.0904	257.1816	271.3383	39.83690	84.48163	90.86	859.8498	-3.34101
608.6632	248.6089	271.2742	39.83866	84.58176	91.27	831.2080	-3.34103
617.2358	240.0362	271.2100	39.84033	84.68188	91.68	802.5667	-3.34104
625.8086	231.4634	271.1459	39.84192	84.78202	92.11	773.9245	-3.34106
634.3812	222.8909	271.0817	39.84342	84.88216	92.54	745.2828	-3.34108
642.9540	214.3178	271.0175	39.84483	84.98230	92.99	716.6405	-3.34111
651.5266	205.7455	270.9534	39.84616	85.08245	93.45	687.9983	-3.34114
660.0995	197.1724	270.8892	39.84740	85.18260	93.93	659.3551	-3.34117
668.6721	188.5999	270.8250	39.84856	85.28276	94.42	630.7127	-3.34120
677.2448	180.0271	270.7608	39.84963	85.38291	94.93	602.0696	-3.34124
685.8175	171.4542	270.6967	39.85061	85.48307	95.45	573.4263	-3.34128
694.3903	162.8821	270.6325	39.85150	85.58324	96.00	544.7821	-3.34133
702.9629	154.3087	270.5683	39.85231	85.68340	96.57	516.1383	-3.34138
711.5360	145.7367	270.5041	39.85304	85.78358	97.17	487.4923	-3.34144
720.1083	137.1633	270.4399	39.85367	85.88374	97.79	458.8484	-3.34151
728.6812	128.5908	270.3757	39.85422	85.98392	98.44	430.2020	-3.34158
737.2539	120.0179	270.3115	39.85468	86.08409	99.14	401.5557	-3.34167
745.8264	111.4453	270.2473	39.85506	86.18426	99.87	372.9093	-3.34177
754.3995	102.8725	270.1831	39.85535	86.28444	100.66	344.2598	-3.34189
762.9720	94.3000	270.1189	39.85555	86.38461	101.51	315.6115	-3.34202

Table 4. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
771.5443	85.7272	270.0547	39.85567	86.48479	102.42	286.9627	-3.34253
780.1177	77.1524	269.9905	39.85570	86.58498	103.42	258.3057	-3.34199
788.6907	68.5821	269.9263	39.85565	86.68515	104.53	229.6550	-3.34255
797.2631	60.0087	269.8621	39.85550	86.78533	105.77	201.0012	-3.34279
805.8357	51.4364	269.7979	39.85527	86.88550	107.19	172.3451	-3.34863
814.4084	42.8636	269.7337	39.85496	86.98568	108.92	143.6381	-3.34316
822.9811	34.2908	269.6695	39.85456	87.08585	110.90	114.9781	-3.34386
831.5543	25.7182	269.6053	39.85407	87.18603	113.44	86.3105	-3.34466
840.1264	17.1451	269.5412	39.85349	87.28619	117.00	57.6396	-3.34438
848.6994	8.5727	269.4770	39.85283	87.38637	123.05	28.9684	-2.79594
857.2720	0.0000	269.4128	39.85208	87.48653	219.80	5.0000	0.00000

Table 5.

```
   HOMOGENEOUS CASE

 KDEL=          1
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000-003
   E2= 1.500000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 3.000000000+002
  ANN= 3.000000000-007
   H2= 0.000000000+000
```

Table 5. (Continued0

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)
MASTER
RADIATED POWER (KILOWATTS) 400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS) 9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	857.2720	275.7983	39.50000	77.50000	89.08	2868.6460	-3.34487
8.5727	848.6993	275.7352	39.50776	77.59917	89.21	2839.9713	-3.34487
17.1450	840.1266	275.6721	39.51543	77.69835	89.34	2811.2981	-3.34487
25.7182	831.5538	275.6090	39.52302	77.79756	89.46	2782.6221	-3.34487
34.2909	822.9811	275.5458	39.53053	77.89679	89.59	2753.9475	-3.34487
42.8636	814.4084	275.4826	39.53795	77.99605	89.72	2725.2729	-3.34487
51.4363	805.8357	275.4194	39.54528	78.09532	89.85	2696.5982	-3.34487
60.0090	797.2630	275.3562	39.55253	78.19461	89.98	2667.9237	-3.34487
68.5818	788.6902	275.2930	39.55970	78.29393	90.11	2639.2488	-3.34487
77.1545	780.1175	275.2297	39.56678	78.39326	90.24	2610.5743	-3.34487
85.7272	771.5448	275.1664	39.57377	78.49262	90.37	2581.8996	-3.34488
94.2999	762.9721	275.1031	39.58068	78.59199	90.51	2553.2250	-3.34488
102.8727	754.3994	275.0398	39.58751	78.69139	90.64	2524.5501	-3.34488
111.4454	745.8266	274.9764	39.59425	78.79080	90.77	2495.8755	-3.34488
120.0181	737.2540	274.9130	39.60091	78.89023	90.91	2467.2008	-3.34488
128.5908	728.6812	274.8496	39.60748	78.98968	91.04	2438.5261	-3.34488
137.1635	720.1085	274.7862	39.61396	79.08916	91.17	2409.8514	-3.34488
145.7363	711.5358	274.7228	39.62036	79.18864	91.31	2381.1765	-3.34488
154.3090	702.9630	274.6593	39.62668	79.28815	91.45	2352.5018	-3.34489
162.8817	694.3903	274.5958	39.63290	79.38768	91.58	2323.8271	-3.34489
171.4544	685.8176	274.5323	39.63905	79.48722	91.72	2295.1523	-3.34489
180.0271	677.2449	274.4688	39.64511	79.58678	91.86	2266.4775	-3.34489
188.5998	668.6721	274.4053	39.65108	79.68636	92.00	2237.8027	-3.34489
197.1726	660.0994	274.3417	39.65697	79.78595	92.14	2209.1278	-3.34490
205.7453	651.5267	274.2781	39.66277	79.88556	92.28	2180.4529	-3.34490
214.3180	642.9540	274.2145	39.66849	79.98519	92.42	2151.7781	-3.34490
222.8907	634.3813	274.1509	39.67412	80.08484	92.56	2123.1031	-3.34490
231.4634	625.8086	274.0873	39.67967	80.18450	92.71	2094.4282	-3.34491
240.0362	617.2358	274.0237	39.68513	80.28417	92.85	2065.7532	-3.34491
248.6089	608.6632	273.9600	39.69050	80.38386	93.00	2037.0783	-3.34491

Table 5. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)
MASTER
RADIATED POWER (KILOWATTS) 400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS) 9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
257.1816	600.0904	273.8963	39.69579	80.48357	93.14	2008.4034	-3.34491
265.7543	591.5177	273.8326	39.70100	80.58329	93.29	1979.7284	-3.34492
274.3270	582.9450	273.7689	39.70612	80.68303	93.44	1951.0533	-3.34492
282.8998	574.3723	273.7052	39.71115	80.78278	93.59	1922.3782	-3.34493
291.4724	565.7995	273.6414	39.71609	80.88255	93.74	1893.7032	-3.34493
300.0452	557.2268	273.5777	39.72096	80.98233	93.89	1865.0279	-3.34493
308.6179	548.6541	273.5139	39.72573	81.08212	94.04	1836.3528	-3.34494
317.1906	540.0813	273.4501	39.73042	81.18193	94.19	1807.6775	-3.34494
325.7634	531.5087	273.3863	39.73502	81.28175	94.35	1779.0021	-3.34495
334.3361	522.9359	273.3225	39.73954	81.38158	94.50	1750.3271	-3.34495
342.9088	514.3632	273.2586	39.74397	81.48143	94.66	1721.6516	-3.34496
351.4815	505.7905	273.1948	39.74832	81.58129	94.82	1692.9764	-3.34496
360.0543	497.2178	273.1309	39.75258	81.68116	94.98	1664.3008	-3.34497
368.6269	488.6450	273.0670	39.75675	81.78105	95.14	1635.6255	-3.34498
377.1997	480.0724	273.0032	39.76084	81.88094	95.30	1606.9497	-3.34498
385.7723	471.4996	272.9393	39.76484	81.98085	95.46	1578.2743	-3.34499
394.3451	462.9269	272.8753	39.76876	82.08077	95.63	1549.5986	-3.34500
402.9178	454.3541	272.8114	39.77259	82.18070	95.80	1520.9229	-3.34501
411.4905	445.7815	272.7475	39.77634	82.28064	95.97	1492.2471	-3.34502
420.0633	437.2087	272.6835	39.77999	82.38060	96.14	1463.5711	-3.34503
428.6360	428.6360	272.6196	39.78357	82.48056	96.31	1434.8950	-3.34503
437.2087	420.0632	272.5556	39.78705	82.58053	96.49	1406.2191	-3.34505
445.7814	411.4906	272.4916	39.79045	82.68052	96.66	1377.5429	-3.34506
454.3541	402.9178	272.4276	39.79376	82.78051	96.84	1348.8667	-3.34507
462.9268	394.3452	272.3636	39.79699	82.88051	97.02	1320.1904	-3.34508
471.4996	385.7724	272.2996	39.80013	82.98052	97.21	1291.5139	-3.34509
480.0723	377.1997	272.2356	39.80319	83.08054	97.39	1262.8374	-3.34511
488.6451	368.6269	272.1715	39.80616	83.18057	97.58	1234.1606	-3.34512
497.2177	360.0544	272.1075	39.80904	83.28061	97.77	1205.4839	-3.34514
505.7905	351.4814	272.0434	39.81184	83.38065	97.97	1176.8069	-3.34516

Table 5. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)

MASTER
RADIATED POWER (KILOWATTS) 400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS) 9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
514.3632	342.9088	271.9794	39.81455	83.48071	98.17	1148.1299	-3.34518
522.9359	334.3361	271.9153	39.81717	83.58077	98.37	1119.4525	-3.34520
531.5086	325.7633	271.8512	39.81971	83.68084	98.57	1090.7752	-3.34522
540.0813	317.1907	271.7871	39.82216	83.78091	98.78	1062.0975	-3.34524
548.6540	308.6179	271.7230	39.82452	83.88100	98.99	1033.4200	-3.34526
557.2268	300.0452	271.6589	39.82680	83.98109	99.21	1004.7417	-3.34529
565.7995	291.4726	271.5948	39.82899	84.08118	99.43	976.0636	-3.34532
574.3723	282.8997	271.5307	39.83110	84.18129	99.66	947.3849	-3.34535
582.9449	274.3271	271.4666	39.83312	84.28140	99.89	918.7065	-3.34538
591.5177	265.7543	271.4024	39.83505	84.38151	100.13	890.0272	-3.34541
600.0904	257.1816	271.3383	39.83690	84.48163	100.37	861.3481	-3.34545
608.6632	248.6089	271.2742	39.83866	84.58176	100.62	832.6682	-3.34549
617.2358	240.0362	271.2100	39.84033	84.68188	100.87	803.9886	-3.34553
625.8086	231.4634	271.1459	39.84192	84.78202	101.14	775.3079	-3.34558
634.3812	222.8909	271.0817	39.84342	84.88216	101.41	746.6275	-3.34563
642.9540	214.3178	271.0175	39.84483	84.98230	101.69	717.9462	-3.34569
651.5266	205.7455	270.9534	39.84616	85.08245	101.98	689.2648	-3.34575
660.0995	197.1724	270.8892	39.84740	85.18260	102.28	660.5820	-3.34581
668.6721	188.5999	270.8250	39.84856	85.28276	102.59	631.8998	-3.34588
677.2448	180.0271	270.7608	39.84963	85.38291	102.91	603.2166	-3.34596
685.8175	171.4542	270.6967	39.85061	85.48307	103.25	574.5328	-3.34605
694.3903	162.8821	270.6325	39.85150	85.58324	103.61	545.8476	-3.34614
702.9629	154.3087	270.5683	39.85231	85.68340	103.98	517.1626	-3.34625
711.5360	145.7367	270.5041	39.85304	85.78358	104.37	488.4748	-3.34636
720.1083	137.1633	270.4399	39.85367	85.88374	104.79	459.7888	-3.34649
728.6812	128.5908	270.3757	39.85422	85.98392	105.23	431.0996	-3.34664
737.2539	120.0179	270.3115	39.85468	86.08409	105.70	402.4100	-3.34680
745.8264	111.4453	270.2473	39.85506	86.18426	106.20	373.7196	-3.34699
754.3995	102.8725	270.1831	39.85535	86.28444	106.75	345.0254	-3.34720
762.9720	94.3000	270.1189	39.85555	86.38461	107.34	316.3316	-3.34744

Table 5. (Continued)

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                              NEW VA-WVA FLIGHT PLAN
                  NEW VA-WVA END POINT                      TO  DANA
       LAT=N39D 30M           LON=W77D 30M                  TO  LAT=N39D 51.125M       LON=W87D 29.192M

                     LAT=N39D 51.125M      LON=W87D 29.192M      LOCATION OF MASTER (DANA)
                                                             MASTER
                  RADIATED POWER (KILOWATTS)                 400.000
                  DIPOLE CURRENT MOMENT (AMPERE-METERS)    9.7687+004

   DISTANCE IN         AZIMUTH TO  COORDINATES OF PATH   FIELD STRENGTH IN      TIME         GRADIENT ALONG
  KILOMETERS TO       DESTINATION  LATITUDE  LONGITUDE   DB RELATIVE TO      DIFFERENCE    THE GEODETIC LINE
 ORIGIN  DESTINATION    DEGREES    DEGREES    DEGREES     1 MICROVOLT/M     MICROSECONDS   MICROSECONDS/KM

 771.5443   85.7272    270.0547   39.85567   86.48470       107.99            287.6363        -3.34808
 780.1177   77.1524    269.9905   39.85570   86.58498       108.72            258.9317        -3.34769
 788.6907   68.5821    269.9263   39.85565   86.68515       109.53            230.2321        -3.34844
 797.2631   60.0087    269.8621   39.85550   86.78533       110.46            201.5278        -3.34890
 805.8357   51.4364    269.7979   39.85527   86.88550       111.54            172.8193        -3.35378
 814.4084   42.8636    269.7337   39.85496   86.98568       112.85            144.0682        -3.34985
 822.9811   34.2908    269.6695   39.85456   87.08585       114.42            115.3509        -3.35105
 831.5543   25.7182    269.6053   39.85407   87.18603       116.49             86.6217        -3.35262
 840.1264   17.1451    269.5412   39.85349   87.28619       119.50             57.8826        -3.35386
 848.6994    8.5727    269.4770   39.85283   87.38637       124.82             29.1301        -2.81480

 857.2720    0.0000    269.4128   39.85208   87.48653       219.80              5.0000         0.00000
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Table 6.

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HOMOGENEOUS CASE

KDEL=          0
   F= 1.000000000+002 KHZ
SIGMA= 5.000000000+000
  E2= 8.000000000+001
ALFA= 1.000000000+000
 ETA= 1.000100000+000
BORA= 0.000000000+000
 ANN= 0.000000000+000
  H2= 0.000000000+000
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Table 6. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	857.2720	275.7983	39.50000	77.50000	72.61	2861.5879	-3.33844
8.5727	848.6993	275.7352	39.50776	77.59917	72.85	2832.9684	-3.33844
17.1450	840.1266	275.6721	39.51543	77.69835	73.08	2804.3502	-3.33844
25.7182	831.5538	275.6090	39.52302	77.79756	73.32	2775.7294	-3.33844
34.2909	822.9811	275.5458	39.53053	77.89679	73.56	2747.1099	-3.33843
42.8636	814.4084	275.4826	39.53795	77.99605	73.80	2718.4905	-3.33843
51.4363	805.8357	275.4194	39.54528	78.09532	74.03	2689.8710	-3.33843
60.0090	797.2630	275.3562	39.55253	78.19461	74.27	2661.2517	-3.33843
68.5818	788.6902	275.2930	39.55970	78.29393	74.51	2632.6321	-3.33843
77.1545	780.1175	275.2297	39.56678	78.39326	74.75	2604.0128	-3.33842
85.7272	771.5448	275.1664	39.57377	78.49262	74.99	2575.3934	-3.33842
94.2999	762.9721	275.1031	39.58068	78.59199	75.23	2546.7741	-3.33842
102.8727	754.3994	275.0398	39.58751	78.69139	75.47	2518.1546	-3.33842
111.4454	745.8266	274.9764	39.59425	78.79080	75.72	2489.5354	-3.33841
120.0181	737.2540	274.9130	39.60091	78.89023	75.96	2460.9161	-3.33841
128.5908	728.6812	274.8496	39.60748	78.98968	76.20	2432.2969	-3.33841
137.1635	720.1085	274.7862	39.61396	79.08916	76.44	2403.6776	-3.33841
145.7363	711.5358	274.7228	39.62036	79.18864	76.69	2375.0583	-3.33840
154.3090	702.9630	274.6593	39.62668	79.28815	76.93	2346.4391	-3.33840
162.8817	694.3903	274.5958	39.63290	79.38768	77.18	2317.8201	-3.33840
171.4544	685.8176	274.5323	39.63905	79.48722	77.43	2289.2009	-3.33839
180.0271	677.2449	274.4688	39.64511	79.58678	77.67	2260.5818	-3.33839
188.5998	668.6721	274.4053	39.65108	79.68636	77.92	2231.9628	-3.33838
197.1726	660.0994	274.3417	39.65697	79.78595	78.17	2203.3437	-3.33838
205.7453	651.5267	274.2781	39.66277	79.88556	78.42	2174.7246	-3.33838
214.3180	642.9540	274.2145	39.66849	79.98519	78.67	2146.1058	-3.33837
222.8907	634.3813	274.1509	39.67412	80.08484	78.92	2117.4867	-3.33837
231.4634	625.8086	274.0873	39.67967	80.18450	79.17	2088.8679	-3.33836
240.0362	617.2358	274.0237	39.68513	80.28417	79.42	2060.2490	-3.33836
248.6089	608.6632	273.9600	39.69050	80.38386	79.68	2031.6302	-3.33835

Table 6. (Continued)

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                              NEW VA-WVA FLIGHT PLAN
                       NEW VA-WVA END POINT                  TO  DANA
       LAT=N39D 30M              LON=W77D 30M                TO  LAT=N39D 51.125M         LON=W87D 29.192M

                LAT=N39D 51.125M       LON=W87D 29.192M         LOCATION OF MASTER (DANA)
                                                         MASTER
              RADIATED POWER (KILOWATTS)                 400.000
              DIPOLE CURRENT MOMENT (AMPERE-METERS)     9.7687+004

     DISTANCE IN           AZIMUTH TO   COORDINATES OF PATH   FIELD STRENGTH IN      TIME          GRADIENT ALONG
   KILOMETERS TO          DESTINATION   LATITUDE  LONGITUDE   DB RELATIVE TO      DIFFERENCE     THE GEODETIC LINE
 ORIGIN   DESTINATION       DEGREES     DEGREES    DEGREES    1 MICROVOLT/M      MICROSECONDS     MICROSECONDS/KM

257.1816   600.0904       273.8963    39.69579   80.48357        79.93           2003.0116          -3.33835
265.7543   591.5177       273.8326    39.70100   80.58329        80.19           1974.3929          -3.33834
274.3270   582.9450       273.7689    39.70612   80.68303        80.44           1945.7742          -3.33833
282.8998   574.3723       273.7052    39.71115   80.78278        80.70           1917.1555          -3.33833
291.4724   565.7995       273.6414    39.71609   80.88255        80.96           1888.5371          -3.33832
300.0452   557.2268       273.5777    39.72096   80.98233        81.22           1859.9184          -3.33832
308.6179   548.6541       273.5139    39.72573   81.08212        81.48           1831.3001          -3.33831
317.1906   540.0813       273.4501    39.73042   81.18193        81.75           1802.6816          -3.33830
325.7634   531.5087       273.3863    39.73502   81.28175        82.01           1774.0632          -3.33829
334.3361   522.9359       273.3225    39.73954   81.38158        82.28           1745.4452          -3.33829

342.9088   514.3632       273.2586    39.74397   81.48143        82.54           1716.8268          -3.33828
351.4815   505.7905       273.1948    39.74832   81.58129        82.81           1688.2089          -3.33827
360.0543   497.2178       273.1309    39.75258   81.68116        83.08           1659.5907          -3.33826
368.6269   488.6450       273.0670    39.75675   81.78105        83.35           1630.9729          -3.33825
377.1997   480.0724       273.0032    39.76084   81.88094        83.63           1602.3548          -3.33824
385.7723   471.4996       272.9393    39.76484   81.98085        83.90           1573.7372          -3.33823
394.3451   462.9269       272.8753    39.76876   82.08077        84.18           1545.1194          -3.33822
402.9178   454.3541       272.8114    39.77259   82.18070        84.46           1516.5018          -3.33821
411.4905   445.7915       272.7475    39.77634   82.28064        84.74           1487.8843          -3.33820
420.0633   437.2087       272.6835    39.77999   82.38060        85.03           1459.2667          -3.33819

428.6360   428.6360       272.6196    39.78357   82.48056        85.31           1430.6492          -3.33818
437.2087   420.0632       272.5556    39.78705   82.58053        85.60           1402.0321          -3.33817
445.7814   411.4906       272.4916    39.79045   82.68052        85.89           1373.4149          -3.33815
454.3541   402.9178       272.4276    39.79376   82.78051        86.19           1344.7979          -3.33814
462.9268   394.3452       272.3636    39.79699   82.88051        86.48           1316.1810          -3.33813
471.4996   385.7724       272.2996    39.80013   82.98052        86.78           1287.5641          -3.33811
480.0723   377.1997       272.2356    39.80319   83.08054        87.08           1258.9474          -3.33810
488.6451   368.6269       272.1715    39.80616   83.18057        87.39           1230.3307          -3.33808
497.2177   360.0544       272.1075    39.80904   83.28061        87.70           1201.7144          -3.33807
505.7905   351.4814       272.0434    39.81184   83.38065        88.01           1173.0980          -3.33805
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Table 6. (Continued)

NEW VA-WVA FLIGHT PLAN

NEW VA-WVA END POINT TO DANA

LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)

MASTER

RADIATED POWER (KILOWATTS) 400.000

DIPOLE CURRENT MOMENT (AMPERE-METERS) 9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
514.3632	342.9088	271.9794	39.81455	83.48071	88.33	1144.4819	-3.33804
522.9359	334.3361	271.9153	39.81717	83.58077	88.65	1115.8658	-3.33802
531.5096	325.7633	271.8512	39.81971	83.68084	88.98	1087.2500	-3.33800
540.0813	317.1907	271.7871	39.82216	83.78091	89.31	1058.6342	-3.33798
548.6540	308.6179	271.7230	39.82452	83.88100	89.65	1030.0189	-3.33796
557.2268	300.0452	271.6589	39.82680	83.98109	89.99	1001.4031	-3.33794
565.7995	291.4726	271.5948	39.82899	84.08118	90.34	972.7880	-3.33792
574.3723	282.8997	271.5307	39.83110	84.18129	90.69	944.1727	-3.33790
582.9449	274.3271	271.4666	39.83312	84.28140	91.05	915.5581	-3.33788
591.5177	265.7543	271.4024	39.83505	84.38151	91.42	886.9432	-3.33786
600.0904	257.1816	271.3383	39.83690	84.48163	91.79	858.3288	-3.33783
608.6632	248.6089	271.2742	39.83866	84.58176	92.17	829.7142	-3.33781
617.2358	240.0362	271.2100	39.84033	84.68188	92.56	801.1005	-3.33778
625.8086	231.4634	271.1459	39.84192	84.78202	92.97	772.4862	-3.33776
634.3812	222.8909	271.0817	39.84342	84.88216	93.38	743.8729	-3.33773
642.9540	214.3178	271.0175	39.84483	84.98230	93.80	715.2594	-3.33770
651.5266	205.7455	270.9534	39.84616	85.08245	94.24	686.6463	-3.33767
660.0995	197.1724	270.8892	39.84740	85.18260	94.69	658.0328	-3.33764
668.6721	188.5999	270.8250	39.84856	85.28276	95.15	629.4206	-3.33761
677.2448	180.0271	270.7608	39.84963	85.38291	95.63	600.8084	-3.33757
685.8175	171.4542	270.6967	39.85061	85.48307	96.13	572.1965	-3.33754
694.3903	162.8821	270.6325	39.85150	85.58324	96.64	543.5843	-3.33750
702.9629	154.3097	270.5683	39.85231	85.68340	97.18	514.9734	-3.33746
711.5360	145.7367	270.5041	39.85304	85.78358	97.75	486.3609	-3.33742
720.1083	137.1633	270.4399	39.85367	85.88374	98.34	457.7516	-3.33737
728.6812	128.5908	270.3757	39.85422	85.98392	98.97	429.1407	-3.33732
737.2539	120.0179	270.3115	39.85468	86.08409	99.63	400.5310	-3.33726
745.8264	111.4453	270.2473	39.85506	86.18426	100.33	371.9223	-3.33720
754.3995	102.8725	270.1831	39.85535	86.28444	101.08	343.3120	-3.33713
762.9720	94.3000	270.1189	39.85555	86.38461	101.90	314.7045	-3.33706

Table 6. (Continued)

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                          NEW VA-WVA FLIGHT PLAN
                    NEW VA-WVA END POINT                 TO  DANA
       LAT=N39D 30M          LON=W77D 30M                TO  LAT=N39D 51.125M        LON=W87D 29.192M

             LAT=N39D 51.125M        LON=W87D 29.192M       LOCATION OF MASTER (DANA)
                                                       MASTER
                 RADIATED POWER (KILOWATTS)            400.000
                 DIPOLE CURRENT MOMENT (AMPERE-METERS)  9.7687+004

     DISTANCE IN       AZIMUTH TO   COORDINATES OF PATH   FIELD STRENGTH IN     TIME        GRADIENT ALONG
    KILOMETERS TO      DESTINATION  LATITUDE  LONGITUDE   DB RELATIVE TO     DIFFERENCE   THE GEODETIC LINE
  ORIGIN  DESTINATION   DEGREES     DEGREES   DEGREES     1 MICROVOLT/M     MICROSECONDS  MICROSECONDS/KM

 771.5443   85.7272    270.0547    39.85567   86.48479       102.78          286.0982        -3.33732
 780.1177   77.1524    269.9905    39.85570   86.58498       103.74          257.4858        -3.33650
 788.6907   68.5821    269.9263    39.85565   86.68515       104.81          228.9822        -3.33671
 797.2631   60.0087    269.8621    39.85550   86.78533       106.02          200.2784        -3.33653
 805.8357   51.4364    269.7979    39.85527   86.88550       107.40          171.6760        -3.34158
 814.4084   42.8636    269.7337    39.85496   86.98568       109.14          143.0295        -3.33570
 822.9811   34.2908    269.6695    39.85456   87.08585       111.08          114.4334        -3.33539
 831.5543   25.7182    269.6053    39.85407   87.18603       113.57           85.8385        -3.33459
 840.1264   17.1451    269.5412    39.85349   87.28619       117.09           57.2540        -3.33122
 848.6994    8.5727    269.4770    39.85283   87.38637       123.11           28.6955        -2.76411

 857.2720    0.0000    269.4128    39.85208   87.48653       219.80            5.0000         0.00000
```

Table 7.

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   HOMOGENEOUS CASE

 KDEL=           1
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000+000
   E2= 8.000000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 3.000000000+002
  ANN= 3.000000000-007
   H2= 0.000000000+000
```

Table 7. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	857.2720	275.7983	39.50000	77.50000	93.69	2867.0310	-3.34339
8.5727	848.6993	275.7352	39.50776	77.59917	93.77	2838.3690	-3.34339
17.1450	840.1266	275.6721	39.51543	77.69835	93.85	2809.7083	-3.34339
25.7182	831.5538	275.6090	39.52302	77.79756	93.93	2781.0450	-3.34340
34.2909	822.9811	275.5458	39.53053	77.89679	94.01	2752.3830	-3.34340
42.8636	814.4084	275.4826	39.53795	77.99605	94.09	2723.7211	-3.34340
51.4363	805.8357	275.4194	39.54528	78.09532	94.17	2695.0591	-3.34340
60.0090	797.2630	275.3562	39.55253	78.19461	94.25	2666.3972	-3.34340
68.5818	788.6902	275.2930	39.55970	78.29393	94.33	2637.7350	-3.34340
77.1545	780.1175	275.2297	39.56678	78.39326	94.41	2609.0731	-3.34340
85.7272	771.5448	275.1664	39.57377	78.49262	94.49	2580.4110	-3.34340
94.2999	762.9721	275.1031	39.58068	78.59199	94.58	2551.7491	-3.34340
102.8727	754.3994	275.0398	39.58751	78.69139	94.66	2523.0869	-3.34340
111.4454	745.8266	274.9764	39.59425	78.79080	94.75	2494.4250	-3.34340
120.0181	737.2540	274.9130	39.60091	78.89023	94.83	2465.7630	-3.34340
128.5908	728.6812	274.8496	39.60748	78.98968	94.92	2437.1010	-3.34340
137.1635	720.1085	274.7862	39.61396	79.08916	95.00	2408.4389	-3.34340
145.7363	711.5358	274.7228	39.62036	79.18864	95.09	2379.7768	-3.34340
154.3090	702.9630	274.6593	39.62668	79.28815	95.18	2351.1148	-3.34340
162.8817	694.3903	274.5958	39.63290	79.38768	95.27	2322.4529	-3.34340
171.4544	685.8176	274.5323	39.63905	79.48722	95.35	2293.7907	-3.34340
180.0271	677.2449	274.4688	39.64511	79.58678	95.44	2265.1287	-3.34340
188.5998	668.6721	274.4053	39.65108	79.68636	95.53	2236.4667	-3.34340
197.1726	660.0994	274.3417	39.65697	79.78595	95.63	2207.8045	-3.34341
205.7453	651.5267	274.2781	39.66277	79.88556	95.72	2179.1424	-3.34341
214.3180	642.9540	274.2145	39.66849	79.98519	95.81	2150.4804	-3.34341
222.8907	634.3813	274.1509	39.67412	80.08494	95.90	2121.8182	-3.34341
231.4634	625.8086	274.0873	39.67967	80.18450	96.00	2093.1562	-3.34341
240.0362	617.2358	274.0237	39.68513	80.28417	96.09	2064.4940	-3.34341
248.6089	608.6632	273.9600	39.69050	80.38386	96.19	2035.8319	-3.34341

Table 7. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
257.1816	600.0904	273.8963	39.69579	80.48357	96.29	2007.1698	-3.34341
265.7543	591.5177	273.8326	39.70100	80.58329	96.39	1978.5077	-3.34342
274.3270	582.9450	273.7689	39.70612	80.68303	96.49	1949.8455	-3.34342
282.8998	574.3723	273.7052	39.71115	80.78278	96.59	1921.1833	-3.34342
291.4724	565.7995	273.6414	39.71609	80.88255	96.69	1892.5212	-3.34342
300.0452	557.2268	273.5777	39.72096	80.98233	96.79	1863.8589	-3.34342
308.6179	548.6541	273.5139	39.72573	81.08212	96.89	1835.1967	-3.34342
317.1906	540.0813	273.4501	39.73042	81.18193	97.00	1806.5344	-3.34343
325.7634	531.5087	273.3863	39.73502	81.28175	97.10	1777.8720	-3.34343
334.3361	522.9359	273.3225	39.73954	81.38158	97.21	1749.2099	-3.34343
342.9088	514.3632	273.2586	39.74397	81.48143	97.32	1720.5475	-3.34343
351.4815	505.7905	273.1948	39.74832	81.58129	97.43	1691.8854	-3.34344
360.0543	497.2178	273.1309	39.75258	81.68116	97.54	1663.2228	-3.34344
368.6269	488.6450	273.0670	39.75675	81.78105	97.65	1634.5607	-3.34344
377.1997	480.0724	273.0032	39.76084	81.88094	97.77	1605.8980	-3.34345
385.7723	471.4996	272.9393	39.76484	81.98085	97.88	1577.2358	-3.34345
394.3451	462.9269	272.8753	39.76876	82.08077	98.00	1548.5732	-3.34346
402.9178	454.3541	272.8114	39.77259	82.18070	98.12	1519.9107	-3.34346
411.4905	445.7815	272.7475	39.77634	82.28064	98.24	1491.2482	-3.34347
420.0633	437.2087	272.6835	39.77999	82.38060	98.37	1462.5855	-3.34347
428.6360	428.6360	272.6196	39.78357	82.48056	98.49	1433.9228	-3.34348
437.2087	420.0632	272.5556	39.78705	82.58053	98.62	1405.2602	-3.34348
445.7814	411.4906	272.4916	39.79045	82.68052	98.75	1376.5975	-3.34349
454.3541	402.9178	272.4276	39.79376	82.78051	98.88	1347.9347	-3.34349
462.9268	394.3452	272.3636	39.79699	82.88051	99.01	1319.2719	-3.34350
471.4996	385.7724	272.2996	39.80013	82.98052	99.15	1290.6089	-3.34351
480.0723	377.1997	272.2356	39.80319	83.08054	99.29	1261.9460	-3.34352
488.6451	368.6269	272.1715	39.80616	83.18057	99.43	1233.2829	-3.34353
497.2177	360.0544	272.1075	39.80904	83.28061	99.57	1204.6198	-3.34354
505.7905	351.4814	272.0434	39.81184	83.38065	99.72	1175.9566	-3.34355

Table 7. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
514.3632	342.9088	271.9794	39.81455	83.48071	99.87	1147.2934	-3.34356
522.9359	334.3361	271.9153	39.81717	83.58077	100.03	1118.6300	-3.34357
531.5086	325.7633	271.8512	39.81971	83.68084	100.18	1089.9666	-3.34358
540.0813	317.1907	271.7871	39.82216	83.78091	100.35	1061.3029	-3.34359
548.6540	308.6179	271.7230	39.82452	83.88100	100.51	1032.6395	-3.34361
557.2268	300.0452	271.6589	39.82680	83.98109	100.68	1003.9754	-3.34363
565.7995	291.4726	271.5948	39.82899	84.08118	100.86	975.3116	-3.34364
574.3723	282.8997	271.5307	39.83110	84.18129	101.04	946.6472	-3.34366
582.9449	274.3271	271.4666	39.83312	84.28140	101.22	917.9832	-3.34368
591.5177	265.7543	271.4024	39.83505	84.38151	101.41	889.3186	-3.34370
600.0904	257.1816	271.3383	39.83690	84.48163	101.61	860.6541	-3.34373
608.6632	248.6089	271.2742	39.83866	84.58176	101.81	831.9890	-3.34375
617.2358	240.0362	271.2100	39.84033	84.68188	102.02	803.3243	-3.34378
625.8086	231.4634	271.1459	39.84192	84.78202	102.24	774.6586	-3.34381
634.3812	222.8909	271.0817	39.84342	84.88216	102.46	745.9934	-3.34384
642.9540	214.3178	271.0175	39.84483	84.98230	102.70	717.3275	-3.34388
651.5266	205.7455	270.9534	39.84616	85.08245	102.94	688.6615	-3.34392
660.0995	197.1724	270.8892	39.84740	85.18260	103.20	659.9944	-3.34396
668.6721	188.5999	270.8250	39.84856	85.28276	103.47	631.3281	-3.34401
677.2448	180.0271	270.7608	39.84963	85.38291	103.75	602.6609	-3.34406
685.8175	171.4542	270.6967	39.85061	85.48307	104.04	573.9934	-3.34412
694.3903	162.8821	270.6325	39.85150	85.58324	104.35	545.3248	-3.34418
702.9629	154.3087	270.5683	39.85231	85.68340	104.68	516.6566	-3.34425
711.5360	145.7367	270.5041	39.85304	85.78358	105.03	487.0859	-3.34433
720.1083	137.1633	270.4399	39.85367	85.88374	105.40	459.3172	-3.34442
728.6812	128.5908	270.3757	39.85422	85.98392	105.79	430.6458	-3.34452
737.2539	120.0179	270.3115	39.85468	86.08409	106.22	401.9744	-3.34464
745.8264	111.4453	270.2473	39.85506	86.18426	106.68	373.3025	-3.34476
754.3995	102.8725	270.1831	39.85535	86.28444	107.19	344.6274	-3.34491
762.9720	94.3000	270.1189	39.85555	86.38461	107.74	315.9532	-3.34508

Table 7. (Continued)

NEW VA-WVA FLIGHT PLAN
NEW VA-WVA END POINT TO DANA
LAT=N39D 30M LON=W77D 30M TO LAT=N39D 51.125M LON=W87D 29.192M

LAT=N39D 51.125M LON=W87D 29.192M LOCATION OF MASTER (DANA)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
771.5443	85.7272	270.0547	39.85567	86.48479	108.35	287.2782	-3.34563
780.1177	77.1524	269.9905	39.85570	86.58498	109.03	258.5946	-3.34514
788.6907	68.5821	269.9263	39.85565	86.68515	109.80	229.9169	-3.34576
797.2631	60.0087	269.8621	39.85550	85.78533	110.69	201.2355	-3.34608
805.8357	51.4364	269.7979	39.85527	86.88550	111.73	172.5512	-3.35060
814.4084	42.8636	269.7337	39.85496	86.98568	113.02	143.8274	-3.34660
822.9811	34.2908	269.6695	39.85456	87.08585	114.55	115.1379	-3.34744
831.5543	25.7182	269.6053	39.85407	87.18603	116.59	86.4396	-3.34845
840.1264	17.1451	269.5412	39.85349	87.28619	119.56	57.7363	-3.34860
848.6994	8.5727	269.4770	39.85283	87.38637	124.85	29.0287	-2.80298
857.2720	0.0000	269.4128	39.85208	87.48653	219.80	5.0000	0.00000

Table 8.

```
HOMOGENEOUS CASE

 KDEL=       0
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000-003
   E2= 1.500000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 0.000000000+000
  ANN= 0.000000000+000
   H2= 0.000000000+000
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Table 8. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	662.1918	113.3747	36.61500	84.50000	76.44	2212.9606	-3.34095
6.6219	655.5699	113.4152	36.59131	84.43207	76.64	2190.8371	-3.34095
13.2438	648.9480	113.4557	36.56757	84.36419	76.85	2168.7136	-3.34095
19.8658	642.3261	113.4961	36.54380	84.29635	77.05	2146.5901	-3.34095
26.4877	635.7042	113.5365	36.51999	84.22855	77.25	2124.4667	-3.34094
33.1096	629.0823	113.5768	36.49614	84.16079	77.45	2102.3432	-3.34094
39.7315	622.4603	113.6170	36.47225	84.09307	77.65	2080.2198	-3.34094
46.3534	615.8384	113.6573	36.44832	84.02540	77.86	2058.0964	-3.34094
52.9754	609.2165	113.6974	36.42436	83.95776	78.06	2035.9729	-3.34094
59.5973	602.5946	113.7375	36.40036	63.89017	78.27	2013.8495	-3.34094
66.2192	595.9727	113.7776	36.37631	83.82262	78.47	1991.7261	-3.34094
72.8411	589.3507	113.8176	36.35223	83.75511	78.68	1969.6026	-3.34093
79.4630	582.7288	113.8576	36.32812	83.68765	78.89	1947.4793	-3.34093
86.0849	576.1069	113.8976	36.30396	83.62022	79.09	1925.3559	-3.34093
92.7069	569.4850	113.9374	36.27976	83.55284	79.30	1903.2325	-3.34093
99.3288	562.8631	113.9773	36.25553	83.48549	79.51	1881.1092	-3.34093
105.9507	556.2412	114.0171	36.23126	83.41819	79.72	1858.9858	-3.34093
112.5726	549.6192	114.0568	36.20695	83.35093	79.93	1836.8625	-3.34093
119.1945	542.9973	114.0965	36.18261	83.28371	80.15	1814.7391	-3.34092
125.8165	536.3754	114.1362	36.15822	83.21654	80.36	1792.6158	-3.34092
132.4384	529.7535	114.1758	36.13380	83.14940	80.57	1770.4925	-3.34092
139.0603	523.1316	114.2153	36.10934	83.08231	80.79	1748.3692	-3.34092
145.6822	516.5096	114.2548	36.08484	83.01526	81.01	1726.2459	-3.34092
152.3041	509.8877	114.2943	36.06031	82.94825	81.22	1704.1226	-3.34092
158.9260	503.2658	114.3337	36.03574	82.88128	81.44	1681.9993	-3.34092
165.5480	496.6439	114.3730	36.01113	82.81435	81.66	1659.8760	-3.34092
172.1699	490.0220	114.4123	35.98648	82.74747	81.88	1637.7528	-3.34091
178.7918	483.4001	114.4516	35.96179	82.68063	82.10	1615.6295	-3.34091
185.4137	476.7781	114.4908	35.93707	82.61382	82.33	1593.5063	-3.34091
192.0356	470.1562	114.5300	35.91231	82.54706	82.55	1571.3830	-3.34091

Table 8. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

MASTER
RADIATED POWER (KILOWATTS) 400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS) 9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
198.6576	463.5343	114.5691	35.88752	82.48035	82.78	1549.2597	-3.34091
205.2795	456.9124	114.6082	35.86268	82.41367	83.00	1527.1365	-3.34091
211.9014	450.2905	114.6472	35.83781	82.34703	83.23	1505.0133	-3.34091
218.5233	443.6685	114.6862	35.81290	82.28044	83.46	1482.8901	-3.34091
225.1452	437.0466	114.7251	35.78796	82.21389	83.69	1460.7668	-3.34091
231.7671	430.4247	114.7640	35.76298	82.14738	83.93	1438.6436	-3.34091
238.3891	423.8028	114.8028	35.73796	82.08091	84.16	1416.5203	-3.34091
245.0110	417.1809	114.8416	35.71290	82.01448	84.40	1394.3971	-3.34091
251.6329	410.5590	114.8804	35.68781	81.94810	84.64	1372.2739	-3.34091
258.2548	403.9370	114.9191	35.66268	81.88175	84.88	1350.1506	-3.34091
264.8767	397.3151	114.9577	35.63752	81.81545	85.12	1328.0275	-3.34091
271.4987	390.6932	114.9963	35.61231	81.74919	85.36	1305.9041	-3.34091
278.1206	384.0713	115.0349	35.58708	81.68297	85.61	1283.7810	-3.34091
284.7425	377.4493	115.0734	35.56180	81.61679	85.85	1261.6577	-3.34092
291.3644	370.8274	115.1118	35.53649	81.55066	86.10	1239.5344	-3.34092
297.9863	364.2055	115.1502	35.51114	81.48456	86.36	1217.4111	-3.34092
304.6083	357.5836	115.1886	35.48576	81.41851	86.61	1195.2879	-3.34092
311.2302	350.9617	115.2269	35.46034	81.35250	86.87	1173.1646	-3.34092
317.8521	344.3398	115.2651	35.43488	81.28653	87.13	1151.0412	-3.34093
324.4740	337.7178	115.3033	35.40939	81.22060	87.39	1128.9179	-3.34093
331.0959	331.0959	115.3415	35.38386	81.15471	87.66	1106.7946	-3.34093
337.7178	324.4740	115.3796	35.35830	81.08887	87.93	1084.6712	-3.34094
344.3398	317.8521	115.4177	35.33270	81.02306	88.20	1062.5478	-3.34094
350.9617	311.2302	115.4557	35.30706	80.95730	88.47	1040.4243	-3.34094
357.5836	304.6083	115.4937	35.28139	80.89158	88.75	1018.3009	-3.34095
364.2055	297.9863	115.5316	35.25568	80.82590	89.03	996.1774	-3.34096
370.8274	291.3644	115.5695	35.22993	80.76026	89.32	974.0538	-3.34096
377.4494	284.7425	115.6073	35.20415	80.69467	89.61	951.9302	-3.34097
384.0713	278.1206	115.6451	35.17834	80.62911	89.90	929.8066	-3.34098
390.6932	271.4986	115.6828	35.15249	80.56360	90.20	907.6829	-3.34099

Table 8. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
397.3151	264.8767	115.7205	35.12660	80.49813	90.50	885.5591	-3.34100
403.9370	258.2548	115.7581	35.10068	80.43270	90.81	863.4354	-3.34101
410.5589	251.6329	115.7957	35.07472	80.36731	91.12	841.3115	-3.34102
417.1809	245.0110	115.8333	35.04873	80.30196	91.44	819.1875	-3.34103
423.8028	238.3891	115.8708	35.02270	80.23666	91.76	797.0635	-3.34105
430.4247	231.7671	115.9082	34.99664	80.17139	92.09	774.9393	-3.34106
437.0466	225.1452	115.9456	34.97054	80.10617	92.43	752.8152	-3.34108
443.6685	218.5233	115.9829	34.94441	80.04099	92.77	730.6908	-3.34109
450.2905	211.9014	116.0202	34.91824	79.97585	93.12	708.5663	-3.34111
456.9124	205.2795	116.0575	34.89204	79.91075	93.48	686.4418	-3.34113
463.5343	198.6576	116.0947	34.86580	79.84569	93.85	664.3171	-3.34116
470.1562	192.0356	116.1319	34.83952	79.78067	94.22	642.1922	-3.34118
476.7781	185.4137	116.1690	34.81322	79.71570	94.61	620.0671	-3.34121
483.4000	178.7918	116.2060	34.78687	79.65076	95.00	597.9420	-3.34124
490.0220	172.1699	116.2430	34.76050	79.58587	95.41	575.8165	-3.34127
496.6439	165.5480	116.2800	34.73408	79.52102	95.83	553.6909	-3.34131
503.2658	158.9260	116.3169	34.70764	79.45621	96.26	531.5651	-3.34134
509.8877	152.3041	116.3538	34.68116	79.39144	96.71	509.4390	-3.34139
516.5096	145.6822	116.3906	34.65464	79.32671	97.17	487.3125	-3.34143
523.1316	139.0603	116.4274	34.62809	79.26203	97.65	465.1859	-3.34148
529.7535	132.4384	116.4641	34.60150	79.19738	98.15	443.0588	-3.34154
536.3754	125.8164	116.5008	34.57488	79.13278	98.67	420.9314	-3.34160
542.9973	119.1945	116.5374	34.54823	79.06822	99.21	398.8036	-3.34167
549.6192	112.5726	116.5740	34.52154	79.00369	99.78	376.6753	-3.34175
556.2412	105.9507	116.6105	34.49482	78.93921	100.37	354.5466	-3.34183
562.8631	99.3288	116.6470	34.46807	78.87478	101.00	332.4172	-3.34192
569.4850	92.7069	116.6834	34.44127	78.81038	101.67	310.2873	-3.34203
576.1069	86.0849	116.7198	34.41445	78.74602	102.38	288.1566	-3.34214
582.7288	79.4630	116.7561	34.38759	78.68170	103.14	266.0252	-3.34228
589.3507	72.8411	116.7924	34.36070	78.61743	103.97	243.8930	-3.34242

Table 8. (Continued)

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                                NO.CAROLINA-TENN. FLIGHT PLAN
                       N.CAROLINA-TENNESSEE END POINT       TO  CAROLINA BEACH
          LAT=N36.615D            LON=W84.5000D             TO  LAT=N34D 3.76M        LON=W77D 54.787M

                     LAT=N34D 3.76M        LON=W77D 54.787M          LOCATION OF MASTER (CAPE FEAR)
                                                              MASTER
               RADIATED POWER (KILOWATTS)                     400.000
               DIPOLE CURRENT MOMENT (AMPERE-METERS)        9.7687+004

    DISTANCE IN        AZIMUTH TO   COORDINATES OF PATH   FIELD STRENGTH IN     TIME         GRADIENT ALONG
   KILOMETERS TO      DESTINATION   LATITUDE  LONGITUDE    DB RELATIVE TO    DIFFERENCE    THE GEODETIC LINE
 ORIGIN  DESTINATION    DEGREES     DEGREES    DEGREES      1 MICROVOLT/M   MICROSECONDS   MICROSECONDS/KM

595.9727   66.2192    116.8287    34.33377   78.55320        104.86          221.7597        -3.34259
602.5946   59.5973    116.8648    34.30682   78.48900        105.84          199.6254        -3.34277
609.2165   52.9753    116.9010    34.27982   78.42485        106.92          177.4898        -3.35041
615.8384   46.3534    116.9371    34.25279   78.36074        108.23          155.3037        -3.34284
622.4603   39.7315    116.9731    34.22573   78.29667        109.60          133.1677        -3.34332
629.0823   33.1096    117.0091    34.19864   78.23264        111.21          111.0285        -3.34389
635.7042   26.4877    117.0451    34.17151   78.16866        113.18           88.8855        -3.34451
642.3261   19.8658    117.0810    34.14435   78.10471        115.71           66.7385        -3.34493
648.9480   13.2434    117.1169    34.11716   78.04081        119.26           44.5886        -3.34273
655.5699    6.6219    117.1527    34.08993   77.97694        125.30           22.4533        -2.63568

662.1918    0.0000    117.1884    34.06267   77.91312        550.91            5.0000         0.00000
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Table 9.

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HOMOGENEOUS CASE

KDEL=        1
   F= 1.000000000+002 KHZ
SIGMA= 5.000000000-003
  E2= 1.500000000+001
ALFA= 1.000000000+000
 ETA= 1.000100000+000
BORA= 3.000000000+002
 ANN= 3.000000000-007
  H2= 0.000000000+000
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Table 9. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	662.1918	113.3747	36.61500	84.50000	92.11	2216.1267	-3.34490
6.6219	655.5699	113.4152	36.59131	84.43207	92.21	2193.9770	-3.34490
13.2438	648.9480	113.4557	36.56757	84.36419	92.32	2171.8274	-3.34490
19.8658	642.3261	113.4961	36.54380	84.29635	92.43	2149.6778	-3.34490
26.4877	635.7042	113.5365	36.51999	84.22855	92.54	2127.5281	-3.34490
33.1096	629.0823	113.5768	36.49614	84.16079	92.65	2105.3785	-3.34490
39.7315	622.4603	113.6170	36.47225	84.09307	92.76	2083.2288	-3.34491
46.3534	615.8384	113.6573	36.44832	84.02540	92.87	2061.0791	-3.34491
52.9754	609.2165	113.6974	36.42436	83.95776	92.99	2038.9293	-3.34491
59.5973	602.5946	113.7375	36.40036	83.89017	93.10	2016.7796	-3.34491
66.2192	595.9727	113.7776	36.37631	83.82262	93.21	1994.6299	-3.34492
72.8411	589.3507	113.8176	36.35223	83.75511	93.33	1972.4801	-3.34492
79.4630	582.7288	113.8576	36.32812	83.68765	93.44	1950.3304	-3.34492
86.0849	576.1069	113.8976	36.30396	83.62022	93.56	1928.1806	-3.34492
92.7069	569.4850	113.9374	36.27976	83.55284	93.67	1906.0307	-3.34493
99.3288	562.8631	113.9773	36.25553	83.48549	93.79	1883.8809	-3.34493
105.9507	556.2412	114.0171	36.23126	83.41819	93.90	1861.7310	-3.34493
112.5726	549.6192	114.0568	36.20695	83.35093	94.02	1839.5812	-3.34494
119.1945	542.9973	114.0965	36.18261	83.28371	94.14	1817.4313	-3.34494
125.8165	536.3754	114.1362	36.15822	83.21654	94.26	1795.2813	-3.34494
132.4384	529.7535	114.1758	36.13380	83.14940	94.38	1773.1314	-3.34495
139.0603	523.1316	114.2153	36.10934	83.08231	94.50	1750.9814	-3.34495
145.6822	516.5096	114.2548	36.08484	83.01526	94.62	1728.8314	-3.34496
152.3041	509.8877	114.2943	36.06031	82.94825	94.74	1706.6814	-3.34496
158.9260	503.2658	114.3337	36.03574	82.88128	94.86	1684.5314	-3.34497
165.5480	496.6439	114.3730	36.01113	82.81435	94.99	1662.3812	-3.34497
172.1699	490.0220	114.4123	35.98648	82.74747	95.11	1640.2312	-3.34497
178.7918	483.4001	114.4516	35.96179	82.68063	95.24	1618.0810	-3.34498
185.4137	476.7781	114.4908	35.93707	82.61382	95.36	1595.9308	-3.34499
192.0356	470.1562	114.5300	35.91231	82.54706	95.49	1573.7806	-3.34499

Table 9. (Continued)

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                              NO.CAROLINA-TENN. FLIGHT PLAN
                    N.CAROLINA-TENNESSEE END POINT     TO  CAROLINA BEACH
           LAT=N36.615D          LON=W84.5000D          TO  LAT=N34D 3.76M           LON=W77D 54.787M

                 LAT=N34D 3.76M        LON=W77D 54.787M     LOCATION OF MASTER (CAPE FEAR)
                                                      MASTER
               RADIATED POWER (KILOWATTS)             400.000
               DIPOLE CURRENT MOMENT (AMPERE-METERS)  9.7687+004

   DISTANCE IN         AZIMUTH TO  COORDINATES OF PATH  FIELD STRENGTH IN     TIME        GRADIENT ALONG
  KILOMETERS TO       DESTINATION  LATITUDE  LONGITUDE  DB RELATIVE TO     DIFFERENCE   THE GEODETIC LINE
ORIGIN  DESTINATION    DEGREES     DEGREES   DEGREES    1 MICROVOLT/M     MICROSECONDS  MICROSECONDS/KM


198.6576  463.5343    114.5691   35.88752  82.48035       95.62          1551.6303      -3.34500
205.2795  456.9124    114.6082   35.86268  82.41367       95.75          1529.4800      -3.34500
211.9014  450.2905    114.6472   35.83781  82.34703       95.88          1507.3297      -3.34501
218.5233  443.6685    114.6862   35.81290  82.28044       96.01          1485.1793      -3.34502
225.1452  437.0466    114.7251   35.78796  82.21389       96.14          1463.0289      -3.34502
231.7671  430.4247    114.7640   35.76298  82.14738       96.27          1440.8784      -3.34503
238.3891  423.8028    114.8028   35.73796  82.08091       96.41          1418.7278      -3.34504
245.0110  417.1809    114.8416   35.71290  82.01448       96.54          1396.5773      -3.34505
251.6329  410.5590    114.8804   35.68781  81.94810       96.68          1374.4267      -3.34506
258.2548  403.9370    114.9191   35.66268  81.88175       96.82          1352.2759      -3.34506

264.8767  397.3151    114.9577   35.63752  81.81545       96.96          1330.1253      -3.34508
271.4987  390.6932    114.9963   35.61231  81.74919       97.10          1307.9743      -3.34509
278.1206  384.0713    115.0349   35.58708  81.68297       97.24          1285.8235      -3.34510
284.7425  377.4493    115.0734   35.56180  81.61679       97.39          1263.6725      -3.34511
291.3644  370.8274    115.1118   35.53649  81.55066       97.53          1241.5215      -3.34512
297.9863  364.2055    115.1502   35.51114  81.48456       97.68          1219.3704      -3.34513
304.6083  357.5836    115.1886   35.48576  81.41851       97.83          1197.2192      -3.34514
311.2302  350.9617    115.2269   35.46034  81.35250       97.98          1175.0680      -3.34516
317.8521  344.3398    115.2651   35.43488  81.28653       98.13          1152.9166      -3.34517
324.4740  337.7178    115.3033   35.40939  81.22060       98.29          1130.7651      -3.34519

331.0959  331.0959    115.3415   35.38386  81.15471       98.45          1108.6136      -3.34520
337.7178  324.4740    115.3796   35.35830  81.08887       98.60          1086.4619      -3.34522
344.3398  317.8521    115.4177   35.33270  81.02306       98.77          1064.3102      -3.34524
350.9617  311.2302    115.4557   35.30706  80.95730       98.93          1042.1583      -3.34525
357.5836  304.6083    115.4937   35.28139  80.89158       99.09          1020.0063      -3.34527
364.2055  297.9863    115.5316   35.25568  80.82590       99.26           997.8542      -3.34529
370.8274  291.3644    115.5695   35.22993  80.76026       99.43           975.7020      -3.34531
377.4494  284.7425    115.6073   35.20415  80.69467       99.61           953.5495      -3.34534
384.0713  278.1206    115.6451   35.17834  80.62911       99.79           931.3970      -3.34536
390.6932  271.4986    115.6828   35.15249  80.56360       99.97           909.2443      -3.34539
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Table 9. (Continued)

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                                NO.CAROLINA-TENN. FLIGHT PLAN
                       N.CAROLINA-TENNESSEE END POINT     TO  CAROLINA BEACH
          LAT=N36.615D         LON=W84.5000D              TO  LAT=N34D 3.76M        LON=W77D 54.787M

                    LAT=N34D 3.76M        LON=W77D 54.787M     LOCATION OF MASTER (CAPE FEAR)
                                                         MASTER
                 RADIATED POWER (KILOWATTS)              400.000
                 DIPOLE CURRENT MOMENT (AMPERE-METERS)  9.7687+004

    DISTANCE IN        AZIMUTH TO   COORDINATES OF PATH   FIELD STRENGTH IN      TIME        GRADIENT ALONG
  KILOMETERS TO       DESTINATION   LATITUDE  LONGITUDE    DB RELATIVE TO     DIFFERENCE   THE GEODETIC LINE
ORIGIN  DESTINATION     DEGREES     DEGREES    DEGREES      1 MICROVOLT/M    MICROSECONDS  MICROSECONDS/KM

397.3151  264.8767     115.7205     35.12660   80.49813        100.15          887.0914       -3.34541
403.9370  258.2548     115.7581     35.10068   80.43270        100.34          864.9384       -3.34544
410.5589  251.6329     115.7957     35.07472   80.36731        100.53          842.7851       -3.34547
417.1809  245.0110     115.8333     35.04873   80.30196        100.72          820.6316       -3.34550
423.8028  238.3891     115.8708     35.02270   80.23666        100.92          798.4780       -3.34554
430.4247  231.7671     115.9082     34.99664   80.17139        101.13          776.3241       -3.34557
437.0466  225.1452     115.9456     34.97054   80.10617        101.34          754.1701       -3.34561
443.6685  218.5233     115.9829     34.94441   80.04099        101.55          732.0156       -3.34565
450.2905  211.9014     116.0202     34.91824   79.97585        101.77          709.8610       -3.34570
456.9124  205.2795     116.0575     34.89204   79.91075        101.99          687.7061       -3.34574

463.5343  198.6576     116.0947     34.86580   79.84569        102.22          665.5509       -3.34579
470.1562  192.0356     116.1319     34.83952   79.78067        102.46          643.3953       -3.34585
476.7781  185.4137     116.1690     34.81322   79.71570        102.71          621.2394       -3.34590
483.4000  178.7918     116.2060     34.78687   79.65076        102.96          599.0831       -3.34596
490.0220  172.1699     116.2430     34.76050   79.58587        103.22          576.9264       -3.34603
496.6439  165.5480     116.2800     34.73408   79.52102        103.49          554.7692       -3.34610
503.2658  158.9260     116.3169     34.70764   79.45621        103.78          532.6116       -3.34618
509.8877  152.3041     116.3538     34.68116   79.39144        104.07          510.4535       -3.34626
516.5096  145.6822     116.3906     34.65464   79.32671        104.37          488.2948       -3.34635
523.1316  139.0603     116.4274     34.62809   79.26203        104.69          466.1356       -3.34645

529.7535  132.4384     116.4641     34.60150   79.19738        105.03          443.9757       -3.34655
536.3754  125.8164     116.5008     34.57488   79.13278        105.37          421.8151       -3.34667
542.9973  119.1945     116.5374     34.54823   79.06822        105.74          399.6537       -3.34680
549.6192  112.5726     116.5740     34.52154   79.00369        106.13          377.4915       -3.34694
556.2412  105.9507     116.6105     34.49482   78.93921        106.55          355.3283       -3.34709
562.8631   99.3288     116.6470     34.46807   78.87478        106.99          333.1641       -3.34727
569.4850   92.7069     116.6834     34.44127   78.81038        107.46          310.9988       -3.34746
576.1069   86.0849     116.7198     34.41445   78.74602        107.96          288.8322       -3.34767
582.7288   79.4630     116.7561     34.38759   78.68170        108.51          266.6642       -3.34792
589.3507   72.8411     116.7924     34.36070   78.61743        109.11          244.4946       -3.34819
```

Table 9. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPULE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
595.9727	66.2192	116.8287	34.33377	78.55320	109.77	222.3231	-3.34851
602.5946	59.5973	116.8648	34.30682	78.48900	110.51	200.1496	-3.34887
609.2165	52.9753	116.9010	34.27982	78.42485	111.33	177.9737	-3.35513
615.8384	46.3534	116.9371	34.25279	78.36074	112.30	155.7563	-3.34933
622.4603	39.7315	116.9731	34.22573	78.29667	113.38	133.5772	-3.35011
629.0823	33.1096	117.0091	34.19864	78.23264	114.67	111.3931	-3.35108
635.7042	26.4877	117.0451	34.17151	78.16866	116.28	89.2025	-3.35226
642.3261	19.8658	117.0810	34.14435	78.10471	118.40	67.0041	-3.35358
648.9480	13.2434	117.1169	34.11716	78.04081	121.46	44.7969	-3.35312
655.5699	6.6219	117.1527	34.08993	77.97694	126.85	22.5928	-2.65675
662.1918	0.0000	117.1884	34.06267	77.91312	550.91	5.0000	0.00000

Table 10.

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   HOMOGENEOUS CASE

 KDEL=          0
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000+000
   E2= 8.000000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 0.000000000+000
  ANN= 0.000000000+000
   H2= 0.000000000+000
```

Table 10. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.6150 LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	662.1918	113.3747	36.61500	84.50000	78.11	2210.3290	-3.33838
6.6219	655.5699	113.4152	36.59131	84.43207	78.30	2188.2224	-3.33838
13.2438	648.9480	113.4557	36.56757	84.36419	78.49	2166.1160	-3.33838
19.8658	642.3261	113.4961	36.54380	84.29635	78.69	2144.0096	-3.33837
26.4877	635.7042	113.5365	36.51999	84.22855	78.88	2121.9031	-3.33837
33.1096	629.0823	113.5768	36.49614	84.16079	79.07	2099.7967	-3.33836
39.7315	622.4603	113.6170	36.47225	84.09307	79.27	2077.6903	-3.33836
46.3534	615.8384	113.6573	36.44832	84.02540	79.46	2055.5840	-3.33836
52.9754	609.2165	113.6974	36.42436	83.95776	79.66	2033.4777	-3.33835
59.5973	602.5946	113.7375	36.40036	83.89017	79.86	2011.3714	-3.33835
66.2192	595.9727	113.7776	36.37631	83.82262	80.05	1989.2651	-3.33834
72.8411	589.3507	113.8176	36.35223	83.75511	80.25	1967.1588	-3.33834
79.4630	582.7288	113.8576	36.32812	83.68765	80.45	1945.0527	-3.33834
86.0849	576.1069	113.8976	36.30396	83.62022	80.65	1922.9465	-3.33833
92.7069	569.4850	113.9374	36.27976	83.55284	80.85	1900.8403	-3.33833
99.3288	562.8631	113.9773	36.25553	83.48549	81.05	1878.7342	-3.33832
105.9507	556.2412	114.0171	36.23126	83.41819	81.25	1856.6281	-3.33832
112.5726	549.6192	114.0568	36.20695	83.35093	81.45	1834.5221	-3.33831
119.1945	542.9973	114.0965	36.18261	83.28371	81.66	1812.4160	-3.33830
125.8165	536.3754	114.1362	36.15822	83.21654	81.86	1790.3101	-3.33830
132.4384	529.7535	114.1758	36.13380	83.14940	82.07	1768.2041	-3.33829
139.0603	523.1316	114.2153	36.10934	83.08231	82.27	1746.0982	-3.33829
145.6822	516.5096	114.2548	36.08484	83.01526	82.48	1723.9923	-3.33828
152.3041	509.8877	114.2943	36.06031	82.94825	82.68	1701.8865	-3.33827
158.9260	503.2658	114.3337	36.03574	82.88128	82.89	1679.7808	-3.33827
165.5480	496.6439	114.3730	36.01113	82.81435	83.10	1657.6750	-3.33826
172.1699	490.0220	114.4123	35.98648	82.74747	83.31	1635.5694	-3.33825
178.7918	483.4001	114.4516	35.96179	82.68063	83.52	1613.4637	-3.33825
185.4137	476.7781	114.4908	35.93707	82.61382	83.73	1591.3581	-3.33824
192.0356	470.1562	114.5300	35.91231	82.54706	83.95	1569.2525	-3.33823

Table 10. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
198.6576	463.5343	114.5691	35.88752	82.48035	84.16	1547.1470	-3.33822
205.2795	456.9124	114.6082	35.86268	82.41367	84.38	1525.0416	-3.33822
211.9014	450.2905	114.6472	35.83781	82.34703	84.59	1502.9362	-3.33821
218.5233	443.6685	114.6862	35.81290	82.28044	84.81	1480.8309	-3.33820
225.1452	437.0466	114.7251	35.78796	82.21389	85.03	1458.7256	-3.33819
231.7671	430.4247	114.7640	35.76298	82.14738	85.25	1436.6204	-3.33818
238.3891	423.8028	114.8028	35.73796	82.08091	85.47	1414.5152	-3.33817
245.0110	417.1809	114.8416	35.71290	82.01448	85.70	1392.4101	-3.33816
251.6329	410.5590	114.8804	35.68781	81.94810	85.92	1370.3051	-3.33815
258.2548	403.9370	114.9191	35.66268	81.88175	86.15	1348.2000	-3.33814
264.8767	397.3151	114.9577	35.63752	81.81545	86.38	1326.0952	-3.33813
271.4987	390.6932	114.9963	35.61231	81.74919	86.61	1303.9903	-3.33812
278.1206	384.0713	115.0349	35.58708	81.68297	86.84	1281.8856	-3.33811
284.7425	377.4493	115.0734	35.56180	81.61679	87.08	1259.7808	-3.33810
291.3644	370.8274	115.1118	35.53649	81.55066	87.31	1237.6762	-3.33809
297.9863	364.2055	115.1502	35.51114	81.48456	87.55	1215.5716	-3.33808
304.6083	357.5836	115.1886	35.48576	81.41851	87.79	1193.4672	-3.33806
311.2302	350.9617	115.2269	35.46034	81.35250	88.03	1171.3628	-3.33805
317.8521	344.3398	115.2651	35.43488	81.28653	88.28	1149.2585	-3.33804
324.4740	337.7178	115.3033	35.40939	81.22060	88.53	1127.1542	-3.33803
331.0959	331.0959	115.3415	35.38386	81.15471	88.78	1105.0501	-3.33801
337.7178	324.4740	115.3796	35.35830	81.08887	89.03	1082.9460	-3.33800
344.3398	317.8521	115.4177	35.33270	81.02306	89.28	1060.8421	-3.33799
350.9617	311.2302	115.4557	35.30706	80.95730	89.54	1038.7382	-3.33797
357.5836	304.6083	115.4937	35.28139	80.89158	89.81	1016.6344	-3.33796
364.2055	297.9863	115.5316	35.25568	80.82590	90.07	994.5308	-3.33794
370.8274	291.3644	115.5695	35.22993	80.76026	90.34	972.4272	-3.33793
377.4494	284.7425	115.6073	35.20415	80.69467	90.61	950.3237	-3.33791
384.0713	278.1206	115.6451	35.17834	80.62911	90.89	928.2203	-3.33789
390.6932	271.4986	115.6828	35.15249	80.56360	91.17	906.1171	-3.33788

Table 10. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
397.3151	264.8767	115.7205	35.12660	80.49813	91.45	884.0139	-3.33786
403.9370	258.2548	115.7581	35.10068	80.43270	91.74	861.9110	-3.33784
410.5589	251.6329	115.7957	35.07472	80.36731	92.04	839.8080	-3.33782
417.1809	245.0110	115.8333	35.04873	80.30196	92.34	817.7052	-3.33780
423.8028	238.3891	115.8708	35.02270	80.23666	92.64	795.6026	-3.33778
430.4247	231.7671	115.9082	34.99664	80.17139	92.95	773.5000	-3.33776
437.0466	225.1452	115.9456	34.97054	80.10617	93.27	751.3977	-3.33774
443.6685	218.5233	115.9829	34.94441	80.04099	93.59	729.2954	-3.33772
450.2905	211.9014	116.0202	34.91824	79.97585	93.92	707.1933	-3.33770
456.9124	205.2795	116.0575	34.89204	79.91075	94.26	685.0914	-3.33767
463.5343	198.6576	116.0947	34.86580	79.84569	94.61	662.9896	-3.33765
470.1562	192.0356	116.1319	34.83952	79.78067	94.96	640.8879	-3.33762
476.7781	185.4137	116.1690	34.81322	79.71570	95.32	618.7865	-3.33760
483.4000	178.7918	116.2060	34.78687	79.65076	95.70	596.6852	-3.33757
490.0220	172.1699	116.2430	34.76050	79.58587	96.08	574.5840	-3.33754
496.6439	165.5480	116.2800	34.73408	79.52102	96.48	552.4831	-3.33752
503.2658	158.9260	116.3169	34.70764	79.45621	96.89	530.3823	-3.33748
509.8877	152.3041	116.3538	34.68116	79.39144	97.31	508.2818	-3.33745
516.5096	145.6822	116.3906	34.65464	79.32671	97.75	486.1814	-3.33742
523.1316	139.0603	116.4274	34.62809	79.26203	98.21	464.0813	-3.33738
529.7535	132.4384	116.4641	34.60150	79.19738	98.68	441.9814	-3.33735
536.3754	125.8164	116.5008	34.57488	79.13278	99.18	419.8818	-3.33731
542.9973	119.1945	116.5374	34.54823	79.06822	99.69	397.7824	-3.33726
549.6192	112.5726	116.5740	34.52154	79.00369	100.24	375.6833	-3.33722
556.2412	105.9507	116.6105	34.49482	78.93921	100.81	353.5845	-3.33717
562.8631	99.3288	116.6470	34.46807	78.87478	101.41	331.4861	-3.33711
569.4850	92.7069	116.6834	34.44127	78.81038	102.05	309.3880	-3.33705
576.1069	86.0849	116.7198	34.41445	78.74602	102.74	287.2903	-3.33698
582.7288	79.4630	116.7561	34.38759	78.68170	103.47	265.1931	-3.33690
589.3507	72.8411	116.7924	34.36070	78.61743	104.27	243.0964	-3.33680

Table 10. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLF CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	LONGITUDF DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THF GEODETIC LINF MICROSECONDS/KM
595.9727	66.2192	116.8287	34.33377	78.55320	105.13	221.0004	-3.33669
602.5946	59.5973	116.8648	34.30682	78.48900	106.08	198.9051	-3.33654
609.2165	52.9753	116.9010	34.27982	78.42485	107.13	176.8108	-3.34342
615.8384	46.3534	116.9371	34.25279	78.36074	108.46	154.6710	-3.33579
622.4603	39.7315	116.9731	34.22573	78.29667	109.80	132.5816	-3.33565
629.0823	33.1096	117.0091	34.19864	78.23264	111.38	110.4932	-3.33539
635.7042	26.4877	117.0451	34.17151	78.16866	113.32	88.4065	-3.33485
642.3261	19.8658	117.0810	34.14435	78.10471	115.82	66.3235	-3.33346
648.9480	13.2434	117.1169	34.11716	78.04081	119.33	44.2496	-3.32775
655.5699	6.6219	117.1527	34.08993	77.97694	125.34	22.2134	-2.59947
662.1918	0.0000	117.1884	34.06267	77.91312	550.91	5.0000	0.00000

Table 11.

```
HOMOGENEOUS CASE

 KDEL=           1
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000+000
   E2= 8.000000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 3.000000000+002
  ANN= 3.000000000-007
   H2= 0.000000000+000
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Table 11. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.6150 LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	652.1918	113.3747	36.61500	84.50000	95.60	2214.8004	-3.34341
6.6219	655.5699	113.4152	36.59131	84.43207	95.67	2192.6605	-3.34341
13.2438	648.9480	113.4557	36.56757	84.36419	95.75	2170.5208	-3.34341
19.8658	642.3261	113.4961	36.54380	84.29635	95.82	2148.3811	-3.34341
26.4877	635.7042	113.5365	36.51999	84.22855	95.89	2126.2413	-3.34341
33.1096	629.0823	113.5768	36.49614	84.16079	95.96	2104.1015	-3.34341
39.7315	622.4603	113.6170	36.47225	84.09307	96.04	2081.9617	-3.34341
46.3534	615.8384	113.6573	36.44832	84.02540	96.11	2059.8220	-3.34341
52.9754	609.2165	113.6974	36.42436	83.95776	96.18	2037.6821	-3.34341
59.5973	602.5946	113.7375	36.40036	83.89017	96.26	2015.5423	-3.34341
66.2192	595.9727	113.7776	36.37631	83.82262	96.33	1993.4025	-3.34341
72.8411	589.3507	113.8176	36.35223	83.75511	96.41	1971.2627	-3.34342
79.4630	582.7288	113.8576	36.32812	83.68765	96.49	1949.1229	-3.34342
86.0849	576.1069	113.8976	36.30396	83.62022	96.57	1926.9830	-3.34342
92.7069	569.4850	113.9374	36.27976	83.55284	96.64	1904.8432	-3.34342
99.3288	562.8631	113.9773	36.25553	83.48549	96.72	1882.7034	-3.34342
105.9507	556.2412	114.0171	36.23126	83.41819	96.80	1860.5635	-3.34342
112.5726	549.6192	114.0568	36.20695	83.35093	96.88	1838.4236	-3.34342
119.1945	542.9973	114.0965	36.18261	83.28371	96.96	1816.2837	-3.34343
125.8165	536.3754	114.1362	36.15822	83.21654	97.04	1794.1438	-3.34343
132.4384	529.7535	114.1758	36.13380	83.14940	97.13	1772.0040	-3.34343
139.0603	523.1316	114.2153	36.10934	83.08231	97.21	1749.8640	-3.34343
145.6822	516.5096	114.2548	36.08484	83.01526	97.29	1727.7241	-3.34343
152.3041	509.8877	114.2943	36.06031	82.94825	97.38	1705.5841	-3.34344
158.9260	503.2658	114.3337	36.03574	82.88128	97.46	1683.4442	-3.34344
165.5480	496.6439	114.3730	36.01113	82.81435	97.55	1661.3042	-3.34344
172.1699	490.0220	114.4123	35.98648	82.74747	97.64	1639.1642	-3.34344
178.7918	483.4001	114.4516	35.96179	82.68063	97.72	1617.0242	-3.34345
185.4137	476.7781	114.4908	35.93707	82.61382	97.81	1594.8842	-3.34345
192.0356	470.1562	114.5300	35.91231	82.54706	97.90	1572.7441	-3.34345

Table II. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO		AZIMUTH TO DESTINATION	COORDINATES OF PATH		FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
ORIGIN	DESTINATION	DEGREES	LATITUDE DEGREES	LONGITUDE DEGREES			
198.6576	463.5343	114.5691	35.88752	82.48035	97.99	1550.6040	-3,34346
205.2795	456.9124	114.6082	35.86268	82.41367	98.09	1528.4640	-3,34346
211.9014	450.2905	114.6472	35.83781	82.34703	98.18	1506.3238	-3,34346
218.5233	443.6685	114.6862	35.81290	82.28044	98.27	1484.1837	-3,34347
225.1452	437.0466	114.7251	35.78796	82.21389	98.37	1462.0436	-3,34347
231.7671	430.4247	114.7640	35.76298	82.14738	98.46	1439.9034	-3,34347
238.3891	423.8028	114.8028	35.73796	82.08091	98.56	1417.7631	-3,34348
245.0110	417.1809	114.8416	35.71290	82.01448	98.66	1395.6229	-3,34348
251.6329	410.5590	114.8804	35.68781	81.94810	98.76	1373.4827	-3,34349
258.2548	403.9370	114.9191	35.56268	81.88175	98.86	1351.3423	-3,34349
264.8767	397.3151	114.9577	35.63752	81.81545	98.97	1329.2021	-3,34350
271.4987	390.6932	114.9963	35.61231	81.74919	99.07	1307.0616	-3,34350
278.1206	384.0713	115.0349	35.58708	81.68297	99.18	1284.9213	-3,34351
284.7425	377.4493	115.0734	35.56180	81.61679	99.28	1262.7808	-3,34352
291.3644	370.8274	115.1118	35.53649	81.55066	99.39	1240.6403	-3,34352
297.9863	364.2055	115.1502	35.51114	81.48456	99.50	1218.4997	-3,34353
304.6083	357.5836	115.1886	35.48576	81.41851	99.62	1196.3592	-3,34354
311.2302	350.9617	115.2269	35.46034	81.35250	99.73	1174.2185	-3,34354
317.8521	344.3398	115.2651	35.43488	81.28653	99.85	1152.0778	-3,34355
324.4740	337.7178	115.3033	35.40939	81.22060	99.97	1129.9371	-3,34356
331.0959	331.0959	115.3415	35.38386	81.15471	100.09	1107.7963	-3,34357
337.7178	324.4740	115.3796	35.35830	81.08887	100.21	1085.6554	-3,34358
344.3398	317.8521	115.4177	35.33270	81.02306	100.33	1063.5145	-3,34359
350.9617	311.2302	115.4557	35.30706	80.95730	100.46	1041.3735	-3,34360
357.5836	304.6083	115.4937	35.28139	80.89158	100.59	1019.2325	-3,34362
364.2055	297.9863	115.5316	35.25568	80.82590	100.72	997.0913	-3,34363
370.8274	291.3644	115.5695	35.22993	80.76026	100.86	974.9501	-3,34364
377.4494	284.7425	115.6073	35.20415	80.69467	101.00	952.8088	-3,34366
384.0713	278.1206	115.6451	35.17834	80.62911	101.14	930.6673	-3,34367
390.6932	271.4986	115.6828	35.15249	80.56360	101.28	908.5259	-3,34369

Table 11. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
397.3151	264.8767	115.7205	35.12660	80.49813	101.43	886.3842	-3.34370
403.9370	258.2548	115.7581	35.10068	80.43270	101.58	864.2425	-3.34372
410.5589	251.6329	115.7957	35.07472	80.36731	101.74	842.1007	-3.34374
417.1809	245.0110	115.8333	35.04873	80.30196	101.90	819.9587	-3.34376
423.8028	238.3891	115.8708	35.02270	80.23666	102.06	797.8166	-3.34378
430.4247	231.7671	115.9082	34.99664	80.17139	102.23	775.6743	-3.34381
437.0466	225.1452	115.9456	34.97054	80.10617	102.40	753.5320	-3.34383
443.6685	218.5233	115.9829	34.94441	80.04099	102.58	731.3894	-3.34386
450.2905	211.9014	116.0202	34.91824	79.97585	102.77	709.2466	-3.34389
456.9124	205.2795	116.0575	34.89204	79.91075	102.96	687.1037	-3.34392
463.5343	198.6576	116.0947	34.86580	79.84569	103.15	664.9605	-3.34395
470.1562	192.0356	116.1319	34.83952	79.78067	103.36	642.8172	-3.34398
476.7781	185.4137	116.1690	34.81322	79.71570	103.57	620.6736	-3.34402
483.4000	178.7918	116.2060	34.78687	79.65076	103.79	598.5298	-3.34406
490.0220	172.1699	116.2430	34.76050	79.58587	104.01	576.3856	-3.34411
496.6439	165.5480	116.2800	34.73408	79.52102	104.25	554.2412	-3.34415
503.2658	158.9260	116.3169	34.70764	79.45621	104.50	532.0965	-3.34421
509.8877	152.3041	116.3538	34.68116	79.39144	104.76	509.9515	-3.34426
516.5096	145.6822	116.3906	34.65464	79.32671	105.03	487.8060	-3.34432
523.1316	139.0603	116.4274	34.62809	79.26203	105.31	465.6602	-3.34439
529.7535	132.4384	116.4641	34.60150	79.19738	105.61	443.5139	-3.34446
536.3754	125.8164	116.5008	34.57488	79.13278	105.93	421.3671	-3.34454
542.9973	119.1945	116.5374	34.54823	79.06822	106.26	399.2198	-3.34463
549.6192	112.5726	116.5740	34.52154	79.00369	106.62	377.0719	-3.34473
556.2412	105.9507	116.6105	34.49482	78.93921	107.00	354.9234	-3.34484
562.8631	99.3288	116.6470	34.46807	78.87478	107.41	332.7741	-3.34496
569.4850	92.7069	116.6834	34.44127	78.81038	107.85	310.6241	-3.34509
576.1069	86.0849	116.7198	34.41445	78.74602	108.32	288.4732	-3.34524
582.7288	79.4630	116.7561	34.38759	78.68170	108.84	266.3213	-3.34541
589.3507	72.8411	116.7924	34.36070	78.61743	109.41	244.1683	-3.34559

Table 11. (Continued)

NO.CAROLINA-TENN. FLIGHT PLAN
N.CAROLINA-TENNESSEE END POINT TO CAROLINA BEACH
LAT=N36.615D LON=W84.5000D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
595.9727	66.2192	116.8287	34.33377	78.55320	110.04	222.0141	-3.34581
602.5946	59.5973	116.8648	34.30682	78.48900	110.74	199.8584	-3.34605
609.2165	52.9753	116.9010	34.27982	78.42485	111.53	177.7011	-3.35195
615.8384	46.3534	116.9371	34.25279	78.36074	112.49	155.5048	-3.34623
622.4603	39.7315	116.9731	34.22573	78.29667	113.54	133.3463	-3.34679
629.0823	33.1096	117.0091	34.19864	78.23264	114.80	111.1841	-3.34746
635.7042	26.4877	117.0451	34.17151	78.16866	116.38	89.0175	-3.34824
642.3261	19.8658	117.0810	34.14435	78.10471	118.47	66.8457	-3.34892
648.9480	13.2434	117.1169	34.11716	78.04081	121.50	44.6694	-3.34722
655.5699	6.6219	117.1527	34.08993	77.97694	126.87	22.5043	-2.64339
662.1918	0.0000	117.1884	34.06267	77.91312	550.91	5.0000	0.00000

Table 12.

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 HOMOGENEOUS CASE

KDEL=          0
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000-003
   E2= 1.500000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 0.000000000+000
  ANN= 0.000000000+000
   H2= 0.000000000+000
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Table 12. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)
MASTER
RADIATED POWER (KILOWATTS) 400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS) 9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	881.0159	179.6875	42.00000	77.96500	70.09	2944.0444	-3.34099
8.8102	872.2058	179.6879	41.92068	77.96442	70.34	2914.6098	-3.34099
17.6203	863.3956	179.6883	41.84136	77.96384	70.59	2885.1752	-3.34098
26.4305	854.5855	179.6887	41.76204	77.96327	70.84	2855.7406	-3.34098
35.2406	845.7753	179.6890	41.68272	77.96269	71.09	2826.3060	-3.34098
44.0508	836.9651	179.6894	41.60339	77.96212	71.34	2796.8714	-3.34098
52.8610	828.1550	179.6898	41.52407	77.96155	71.59	2767.4368	-3.34098
61.6711	819.3448	179.6902	41.44474	77.96098	71.84	2738.0023	-3.34098
70.4813	810.5347	179.6906	41.36542	77.96041	72.09	2708.5677	-3.34098
79.2914	801.7245	179.6909	41.28609	77.95984	72.35	2679.1332	-3.34098
88.1016	792.9143	179.6913	41.20676	77.95927	72.60	2649.6987	-3.34097
96.9118	784.1042	179.6917	41.12743	77.95871	72.85	2620.2641	-3.34097
105.7219	775.2940	179.6921	41.04810	77.95814	73.11	2590.8296	-3.34097
114.5321	766.4839	179.6924	40.96877	77.95758	73.36	2561.3951	-3.34097
123.3422	757.6737	179.6928	40.88943	77.95702	73.62	2531.9607	-3.34097
132.1524	748.8635	179.6932	40.81010	77.95646	73.88	2502.5262	-3.34097
140.9625	740.0534	179.6935	40.73076	77.95590	74.13	2473.0918	-3.34096
149.7727	731.2432	179.6939	40.65143	77.95534	74.39	2443.6573	-3.34096
158.5829	722.4331	179.6942	40.57209	77.95479	74.65	2414.2229	-3.34096
167.3930	713.6229	179.6946	40.49275	77.95423	74.91	2384.7885	-3.34096
176.2032	704.8128	179.6950	40.41341	77.95368	75.17	2355.3541	-3.34096
185.0133	696.0026	179.6953	40.33407	77.95313	75.43	2325.9197	-3.34096
193.8235	687.1924	179.6957	40.25472	77.95258	75.69	2296.4854	-3.34095
202.6337	678.3823	179.6960	40.17538	77.95203	75.96	2267.0510	-3.34095
211.4438	669.5721	179.6964	40.09604	77.95148	76.22	2237.6167	-3.34095
220.2540	660.7620	179.6967	40.01669	77.95093	76.49	2208.1824	-3.34095
229.0641	651.9518	179.6971	39.93734	77.95039	76.75	2178.7481	-3.34095
237.8743	643.1416	179.6974	39.85800	77.94984	77.02	2149.3138	-3.34095
246.6845	634.3315	179.6978	39.77865	77.94930	77.29	2119.8796	-3.34094
255.4946	625.5213	179.6981	39.69930	77.94876	77.56	2090.4453	-3.34094

Table 12. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)

MASTER
RADIATED POWER (KILOWATTS) 400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS) 9.7687+004

DISTANCE IN KILOMETERS TO		AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH		FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
ORIGIN	DESTINATION		LATITUDE DEGREES	LONGITUDE DEGREES			
264.3048	616.7112	179.6985	39.61995	77.94822	77.83	2061.0111	-3.34094
273.1149	607.9010	179.6988	39.54059	77.94768	78.10	2031.5769	-3.34094
281.9251	599.0908	179.6992	39.46124	77.94714	78.37	2002.1427	-3.34094
290.7353	590.2807	179.6995	39.38189	77.94660	78.65	1972.7085	-3.34093
299.5454	581.4705	179.6998	39.30253	77.94607	78.93	1943.2744	-3.34093
308.3556	572.6604	179.7002	39.22317	77.94553	79.20	1913.8402	-3.34093
317.1657	563.8502	179.7005	39.14382	77.94500	79.48	1884.4061	-3.34093
325.9759	555.0400	179.7009	39.06446	77.94447	79.76	1854.9720	-3.34093
334.7861	546.2299	179.7012	38.98510	77.94394	80.04	1825.5379	-3.34092
343.5962	537.4197	179.7015	38.90574	77.94341	80.33	1796.1038	-3.34092
352.4064	528.6096	179.7019	38.82637	77.94288	80.61	1766.6698	-3.34092
361.2165	519.7994	179.7022	38.74701	77.94235	80.90	1737.2357	-3.34092
370.0267	510.9892	179.7025	38.66765	77.94182	81.19	1707.8017	-3.34092
378.8369	502.1791	179.7028	38.58828	77.94130	81.48	1678.3677	-3.34092
387.6470	493.3689	179.7032	38.50891	77.94078	81.77	1648.9336	-3.34091
396.4572	484.5588	179.7035	38.42955	77.94025	82.06	1619.4997	-3.34091
405.2673	475.7486	179.7038	38.35018	77.93973	82.36	1590.0657	-3.34091
414.0775	466.9384	179.7041	38.27081	77.93921	82.66	1560.6317	-3.34091
422.8877	458.1283	179.7045	38.19144	77.93869	82.96	1531.1977	-3.34091
431.6978	449.3181	179.7048	38.11206	77.93817	83.27	1501.7638	-3.34091
440.5080	440.5080	179.7051	38.03269	77.93766	83.57	1472.3298	-3.34091
449.3181	431.6978	179.7054	37.95332	77.93714	83.88	1442.8959	-3.34091
458.1283	422.8877	179.7057	37.87394	77.93663	84.19	1413.4619	-3.34091
466.9384	414.0775	179.7060	37.79457	77.93611	84.51	1384.0280	-3.34091
475.7486	405.2673	179.7064	37.71519	77.93560	84.83	1354.5941	-3.34091
484.5588	396.4572	179.7067	37.63581	77.93509	85.15	1325.1601	-3.34091
493.3689	387.6470	179.7070	37.55643	77.93458	85.47	1295.7261	-3.34091
502.1791	378.8368	179.7073	37.47705	77.93407	85.80	1266.2922	-3.34091
510.9892	370.0267	179.7076	37.39767	77.93356	86.13	1236.8582	-3.34092
519.7994	361.2165	179.7079	37.31828	77.93305	86.47	1207.4242	-3.34092

Table 12. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
528.6096	352.4064	179.7082	37.23890	77.93255	86.81	1177.9902	-3.34092
537.4197	343.5962	179.7085	37.15952	77.93204	87.16	1148.5561	-3.34093
546.2299	334.7861	179.7088	37.08013	77.93154	87.51	1119.1220	-3.34093
555.0400	325.9759	179.7091	37.00074	77.93103	87.86	1089.6879	-3.34094
563.8502	317.1657	179.7094	36.92135	77.93053	88.23	1060.2537	-3.34094
572.6604	308.3556	179.7097	36.84197	77.93003	88.59	1030.8195	-3.34095
581.4705	299.5454	179.7100	36.76257	77.92953	88.96	1001.3852	-3.34096
590.2807	290.7353	179.7103	36.68318	77.92903	89.34	971.9508	-3.34096
599.0908	281.9251	179.7106	36.60379	77.92853	89.73	942.5164	-3.34098
607.9010	273.1149	179.7109	36.52440	77.92804	90.13	913.0819	-3.34099
616.7112	264.3048	179.7112	36.44500	77.92754	90.53	883.6473	-3.34100
625.5213	255.4946	179.7115	36.36561	77.92705	90.94	854.2125	-3.34101
634.3315	246.6845	179.7118	36.28621	77.92655	91.36	824.7776	-3.34103
643.1416	237.8743	179.7121	36.20681	77.92606	91.79	795.3426	-3.34105
651.9518	229.0641	179.7124	36.12741	77.92557	92.23	765.9075	-3.34107
660.7620	220.2540	179.7127	36.04801	77.92508	92.68	736.4721	-3.34109
669.5721	211.4438	179.7130	35.96861	77.92459	93.15	707.0365	-3.34112
678.3823	202.6337	179.7132	35.88921	77.92410	93.63	677.6008	-3.34115
687.1924	193.8235	179.7135	35.80981	77.92361	94.12	648.1647	-3.34118
696.0026	185.0133	179.7138	35.73040	77.92313	94.63	618.7284	-3.34121
704.8128	176.2032	179.7141	35.65100	77.92264	95.16	589.2918	-3.34126
713.6229	167.3930	179.7144	35.57159	77.92215	95.71	559.8548	-3.34130
722.4331	158.5829	179.7147	35.49218	77.92167	96.28	530.4174	-3.34135
731.2432	149.7727	179.7149	35.41277	77.92119	96.88	500.9795	-3.34141
740.0534	140.9626	179.7152	35.33336	77.92071	97.51	471.5412	-3.34148
748.8636	132.1524	179.7155	35.25395	77.92022	98.17	442.1022	-3.34155
757.6737	123.3422	179.7158	35.17454	77.91974	98.86	412.6626	-3.34164
766.4839	114.5321	179.7161	35.09513	77.91926	99.60	383.2222	-3.34174
775.2940	105.7219	179.7163	35.01572	77.91879	100.39	353.7810	-3.34185
784.1042	96.9118	179.7166	34.93630	77.91831	101.24	324.3388	-3.34198

Table 12. (Continued)

PENNSYLVANIA FLIGHT PLAN

PENNSYLVANIA END POINT TO CAROLINA BEACH

LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
792.9143	88.1016	179.7169	34.85688	77.91783	102.16	294.8954	-3.34213
801.7245	79.2914	179.7171	34.77747	77.91736	103.16	265.4507	-3.34230
810.5347	70.4813	179.7174	34.69805	77.91688	104.28	236.0045	-3.34251
819.3448	61.6711	179.7177	34.61863	77.91641	105.52	206.5565	-3.34274
828.1550	52.8610	179.7180	34.53921	77.91594	106.94	177.1064	-3.34849
836.9651	44.0508	179.7182	34.45979	77.91546	108.68	147.6057	-3.34308
845.7753	35.2406	179.7185	34.38037	77.91499	110.66	118.1526	-3.34380
854.5855	26.4305	179.7188	34.30094	77.91452	113.20	88.6932	-3.34461
863.3956	17.6203	179.7190	34.22152	77.91405	116.76	59.2267	-3.34447
872.2058	8.8102	179.7193	34.14209	77.91358	122.82	29.7615	-2.81029
881.0159	0.0000	179.7195	34.06267	77.91312	322.32	5.0024	0.00000

Table 13.

```
  HOMOGENEOUS CASE

 KDEL=         1
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000-003
   E2= 1.500000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 3.000000000+002
  ANN= 3.000000000-007
   H2= 0.000000000+000
```

Table 13. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	881.0159	179.6875	42.00000	77.96500	88.73	2948.0653	-3.34487
8.8102	872.2058	179.6879	41.92068	77.96442	88.86	2918.5965	-3.34487
17.6203	863.3956	179.6883	41.84136	77.96384	88.99	2889.1277	-3.34487
26.4305	854.5855	179.6887	41.76204	77.96327	89.12	2859.6589	-3.34487
35.2406	845.7753	179.6890	41.68272	77.96269	89.25	2830.1900	-3.34487
44.0508	836.9651	179.6894	41.60339	77.96212	89.38	2800.7212	-3.34487
52.8610	828.1550	179.6898	41.52407	77.96155	89.51	2771.2524	-3.34487
61.6711	819.3448	179.6902	41.44474	77.96098	89.65	2741.7836	-3.34487
70.4813	810.5347	179.6906	41.36542	77.96041	89.78	2712.3147	-3.34487
79.2914	801.7245	179.6909	41.28609	77.95984	89.91	2682.8459	-3.34487
88.1016	792.9143	179.6913	41.20676	77.95927	90.05	2653.3770	-3.34487
96.9118	784.1042	179.6917	41.12743	77.95871	90.18	2623.9082	-3.34487
105.7219	775.2940	179.6921	41.04810	77.95814	90.32	2594.4393	-3.34488
114.5321	766.4839	179.6924	40.96877	77.95758	90.45	2564.9704	-3.34488
123.3422	757.6737	179.6928	40.88943	77.95702	90.59	2535.5015	-3.34488
132.1524	748.8635	179.6932	40.81010	77.95646	90.72	2506.0326	-3.34488
140.9625	740.0534	179.6935	40.73076	77.95590	90.86	2476.5637	-3.34488
149.7727	731.2432	179.6939	40.65143	77.95534	91.00	2447.0948	-3.34488
158.5829	722.4331	179.6942	40.57209	77.95479	91.14	2417.6258	-3.34488
167.3930	713.6229	179.6946	40.49275	77.95423	91.28	2388.1569	-3.34488
176.2032	704.8128	179.6950	40.41341	77.95368	91.42	2358.6879	-3.34489
185.0133	696.0026	179.6953	40.33407	77.95313	91.56	2329.2189	-3.34489
193.8235	687.1924	179.6957	40.25472	77.95258	91.70	2299.7499	-3.34489
202.6337	678.3823	179.6960	40.17538	77.95203	91.84	2270.2809	-3.34489
211.4438	669.5721	179.6964	40.09604	77.95148	91.98	2240.8119	-3.34489
220.2540	660.7620	179.6967	40.01669	77.95093	92.13	2211.3429	-3.34490
229.0641	651.9518	179.6971	39.93734	77.95039	92.27	2181.8738	-3.34490
237.8743	643.1416	179.6974	39.85800	77.94984	92.42	2152.4047	-3.34490
246.6845	634.3315	179.6978	39.77865	77.94930	92.56	2122.9356	-3.34490
255.4946	625.5213	179.6981	39.69930	77.94876	92.71	2093.4664	-3.34491

Table 13. (Continued)

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                              PENNSYLVANIA FLIGHT PLAN
                      PENNSYLVANIA END POINT                 TO  CAROLINA BEACH
       LAT=N42.000D            LON=W77.965D                  TO  LAT=N34D 3.76M           LON=W77D 54.787M

                   LAT=N34D 3M 45.61S    LON=W77D 54M 47.20S   LOCATION OF MASTER (CAPE FEAR)
                                                        MASTER
               RADIATED POWER (KILOWATTS)                400.000
               DIPOLE CURRENT MOMENT (AMPERE-METERS)   9.7687+004

   DISTANCE IN          AZIMUTH TO   COORDINATES OF PATH   FIELD STRENGTH IN      TIME        GRADIENT ALONG
  KILOMETERS TO        DESTINATION   LATITUDE  LONGITUDE    DB RELATIVE TO     DIFFERENCE   THE GEODETIC LINE
ORIGIN  DESTINATION      DEGREES     DEGREES    DEGREES     1 MICROVOLT/M     MICROSECONDS  MICROSECONDS/KM


264.3048   616.7112     179.6985    39.61905   77.94822         92.86          2063.9973        -3.34491
273.1149   607.9010     179.6988    39.54059   77.94768         93.01          2034.5281        -3.34491
281.9251   599.0908     179.6992    39.46124   77.94714         93.16          2005.0589        -3.34492
290.7353   590.2807     179.6995    39.38189   77.94660         93.31          1975.5897        -3.34492
299.5454   581.4705     179.6998    39.30253   77.94607         93.46          1946.1204        -3.34492
308.3556   572.6604     179.7002    39.22317   77.94553         93.62          1916.6511        -3.34493
317.1657   563.8502     179.7005    39.14382   77.94500         93.77          1887.1818        -3.34493
325.9759   555.0400     179.7009    39.06446   77.94447         93.92          1857.7124        -3.34493
334.7861   546.2299     179.7012    38.98510   77.94394         94.08          1828.2430        -3.34494
343.5962   537.4197     179.7015    38.90574   77.94341         94.24          1799.7735        -3.34494

352.4064   528.6096     179.7019    38.82637   77.94288         94.40          1769.3041        -3.34495
361.2165   519.7994     179.7022    38.74701   77.94235         94.56          1739.8345        -3.34495
370.0267   510.9892     179.7025    38.66765   77.94182         94.72          1710.3649        -3.34496
378.8369   502.1791     179.7028    38.58828   77.94130         94.88          1680.8953        -3.34497
387.6470   493.3689     179.7032    38.50891   77.94078         95.05          1651.4256        -3.34497
396.4572   484.5588     179.7035    38.42955   77.94025         95.21          1621.9559        -3.34498
405.2673   475.7486     179.7038    38.35018   77.93973         95.38          1592.4861        -3.34499
414.0775   466.9384     179.7041    38.27081   77.93921         95.55          1563.0162        -3.34500
422.8877   458.1283     179.7045    38.19144   77.93869         95.72          1533.5462        -3.34500
431.6978   449.3181     179.7048    38.11206   77.93817         95.90          1504.0762        -3.34501

440.5080   440.5080     179.7051    38.03269   77.93766         96.07          1474.6061        -3.34502
449.3181   431.6978     179.7054    37.95332   77.93714         96.25          1445.1360        -3.34503
458.1283   422.8877     179.7057    37.87394   77.93663         96.43          1415.6657        -3.34504
466.9384   414.0775     179.7060    37.79457   77.93611         96.61          1386.1953        -3.34505
475.7486   405.2673     179.7064    37.71519   77.93560         96.79          1356.7249        -3.34507
484.5588   396.4572     179.7067    37.63581   77.93509         96.98          1327.2543        -3.34508
493.3689   387.6470     179.7070    37.55643   77.93458         97.17          1297.7836        -3.34509
502.1791   378.8368     179.7073    37.47705   77.93407         97.36          1268.3129        -3.34511
510.9892   370.0267     179.7076    37.39767   77.93356         97.55          1239.8419        -3.34512
519.7994   361.2165     179.7079    37.31828   77.93305         97.75          1209.3709        -3.34514
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Table 13. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)
MASTER
RADIATED POWER (KILOWATTS) 400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS) 9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
528.6096	352.4064	179.7082	37.23890	77.93255	97.95	1179.8997	-3.34516
537.4197	343.5962	179.7085	37.15952	77.93204	98.15	1150.4283	-3.34517
546.2299	334.7861	179.7088	37.08013	77.93154	98.36	1120.9568	-3.34520
555.0400	325.9759	179.7091	37.00074	77.93103	98.57	1091.4851	-3.34522
563.8502	317.1657	179.7094	36.92135	77.93053	98.78	1062.0132	-3.34524
572.6604	308.3556	179.7097	36.84197	77.93003	99.00	1032.5411	-3.34526
581.4705	299.5454	179.7100	36.76257	77.92953	99.22	1003.0688	-3.34529
590.2807	290.7353	179.7103	36.68318	77.92903	99.45	973.5962	-3.34532
599.0908	281.9251	179.7106	36.60379	77.92853	99.68	944.1234	-3.34535
607.9010	273.1149	179.7109	36.52440	77.92804	99.92	914.6503	-3.34538
616.7112	264.3049	179.7112	36.44500	77.92754	100.17	885.1770	-3.34542
625.5213	255.4946	179.7115	36.36561	77.92705	100.42	855.7033	-3.34546
634.3315	246.6845	179.7118	36.28621	77.92655	100.67	826.2293	-3.34550
643.1416	237.8743	179.7121	36.20681	77.92606	100.94	796.7549	-3.34555
651.9518	229.0641	179.7124	36.12741	77.92557	101.21	767.2801	-3.34560
660.7620	220.2540	179.7127	36.04801	77.92508	101.49	737.8048	-3.34565
669.5721	211.4438	179.7130	35.96861	77.92459	101.78	708.3291	-3.34571
678.3823	202.6337	179.7132	35.88921	77.92410	102.08	678.8529	-3.34577
687.1924	193.8235	179.7135	35.80981	77.92361	102.40	649.3761	-3.34584
696.0026	185.0133	179.7138	35.73040	77.92313	102.72	619.8988	-3.34592
704.8128	176.2032	179.7141	35.65100	77.92264	103.06	590.4207	-3.34600
713.6229	167.3930	179.7144	35.57159	77.92215	103.42	560.9419	-3.34609
722.4331	158.5829	179.7147	35.49218	77.92167	103.79	531.4623	-3.34619
731.2432	149.7727	179.7149	35.41277	77.92119	104.18	501.9818	-3.34631
740.0534	140.9626	179.7152	35.33336	77.92071	104.60	472.5003	-3.34644
748.8636	132.1524	179.7155	35.25395	77.92022	105.04	443.0176	-3.34658
757.6737	123.3422	179.7158	35.17454	77.91974	105.51	413.5338	-3.34674
766.4839	114.5321	179.7161	35.09513	77.91926	106.02	384.0485	-3.34692
775.2940	105.7219	179.7163	35.01572	77.91879	106.56	354.5616	-3.34713
784.1042	96.9118	179.7166	34.93630	77.91831	107.15	325.0728	-3.34737

Table 13. (Continued)

PENNSYLVANIA FLIGHT PLAN

PENNSYLVANIA END POINT TO CAROLINA BEACH

LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3M 45.61S LON=W77D 54M 47.20S LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
792.9143	88.1016	179.7169	34.85688	77.91783	107.81	295.5820	-3.34764
801.7245	79.2914	179.7171	34.77747	77.91736	108.53	264.0887	-3.34797
810.5347	70.4813	179.7174	34.69805	77.91688	109.34	236.5926	-3.34835
819.3448	61.6711	179.7177	34.61863	77.91641	110.27	207.0931	-3.34881
828.1550	52.8610	179.7180	34.53921	77.91594	111.35	177.5895	-3.35363
836.9651	44.0508	179.7182	34.45979	77.91546	112.66	148.0435	-3.34972
845.7753	35.2406	179.7185	34.38037	77.91499	114.22	118.5319	-3.35092
854.5855	26.4305	179.7188	34.30094	77.91452	116.29	89.0098	-3.35250
863.3956	17.6203	179.7190	34.22152	77.91405	119.29	59.4737	-3.35386
872.2058	8.8102	179.7193	34.14209	77.91358	124.61	29.9257	-2.82880
881.0159	0.0000	179.7195	34.06267	77.91312	322.34	5.0035	0.00000

Table 14.

```
  HOMOGENEOUS CASE

 KDEL=          0
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000+000
   E2= 8.000000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 0.000000000+000
  ANN= 0.000000000+000
   H2= 0.000000000+000
```

Table 14. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	881.0159	179.6875	42.00000	77.96500	71.96	2940.8557	-3.33844
8.8102	872.2058	179.6879	41.92068	77.96442	72.20	2911.4435	-3.33844
17.6203	863.3956	179.6883	41.84136	77.96384	72.44	2882.0313	-3.33844
26.4305	854.5855	179.6887	41.76204	77.96327	72.69	2852.6191	-3.33844
35.2406	845.7753	179.6890	41.68272	77.96269	72.93	2823.2069	-3.33844
44.0508	836.9651	179.6894	41.60339	77.96212	73.17	2793.7947	-3.33844
52.8610	828.1550	179.6898	41.52407	77.96155	73.42	2764.3825	-3.33843
61.6711	819.3448	179.6902	41.44474	77.96098	73.66	2734.9704	-3.33843
70.4813	810.5347	179.6906	41.36542	77.96041	73.90	2705.5583	-3.33843
79.2914	801.7245	179.6909	41.28609	77.95984	74.15	2676.1462	-3.33843
88.1016	792.9143	179.6913	41.20676	77.95927	74.39	2646.7341	-3.33843
96.9118	784.1042	179.6917	41.12743	77.95871	74.64	2617.3220	-3.33842
105.7219	775.2940	179.6921	41.04810	77.95814	74.89	2587.9099	-3.33842
114.5321	766.4839	179.6924	40.96877	77.95758	75.13	2558.4979	-3.33842
123.3422	757.6737	179.6928	40.88943	77.95702	75.38	2529.0859	-3.33842
132.1524	748.8635	179.6932	40.81010	77.95646	75.63	2499.6739	-3.33842
140.9625	740.0534	179.6935	40.73076	77.95590	75.88	2470.2619	-3.33841
149.7727	731.2432	179.6939	40.65143	77.95534	76.13	2440.8500	-3.33841
158.5829	722.4331	179.6942	40.57209	77.95479	76.38	2411.4381	-3.33841
167.3930	713.6229	179.6946	40.49275	77.95423	76.63	2382.0262	-3.33840
176.2032	704.8128	179.6950	40.41341	77.95368	76.88	2352.6143	-3.33840
185.0133	696.0026	179.6953	40.33407	77.95313	77.13	2323.2025	-3.33840
193.8235	687.1924	179.6957	40.25472	77.95258	77.39	2293.7907	-3.33839
202.6337	678.3823	179.6960	40.17538	77.95203	77.64	2264.3789	-3.33839
211.4438	669.5721	179.6964	40.09604	77.95148	77.89	2234.9671	-3.33838
220.2540	660.7620	179.6967	40.01669	77.95093	78.15	2205.5555	-3.33838
229.0641	651.9518	179.6971	39.93734	77.95039	78.41	2176.1438	-3.33838
237.8743	643.1416	179.6974	39.85800	77.94984	78.66	2146.7322	-3.33837
246.6845	634.3315	179.6978	39.77865	77.94930	78.92	2117.3206	-3.33837
255.4946	625.5213	179.6981	39.69930	77.94876	79.18	2087.9090	-3.33836

Table 14. (Continued)

PENNSYLVANIA FLIGHT PLAN

PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
264.3048	616.7112	179.6985	39.61995	77.94822	79.44	2058.4975	-3.33836
273.1149	607.9010	179.6988	39.54059	77.94768	79.70	2029.0861	-3.33835
281.9251	599.0908	179.6992	39.46124	77.94714	79.96	1999.6747	-3.33835
290.7353	590.2807	179.6995	39.38189	77.94660	80.23	1970.2633	-3.33834
299.5454	581.4705	179.6998	39.30253	77.94607	80.49	1940.8520	-3.33833
308.3556	572.6604	179.7002	39.22317	77.94553	80.75	1911.4407	-3.33833
317.1657	563.8502	179.7005	39.14382	77.94500	81.02	1882.0296	-3.33832
325.9759	555.0400	179.7009	39.06446	77.94447	81.29	1852.6184	-3.33831
334.7861	546.2299	179.7012	38.98510	77.94394	81.56	1823.2074	-3.33831
343.5962	537.4197	179.7015	38.90574	77.94341	81.83	1793.7963	-3.33830
352.4064	528.6096	179.7019	38.82637	77.94288	82.10	1764.3854	-3.33829
361.2165	519.7994	179.7022	38.74701	77.94235	82.37	1734.9745	-3.33828
370.0267	510.9892	179.7025	38.66765	77.94182	82.65	1705.5637	-3.33827
378.8369	502.1791	179.7028	38.58828	77.94130	82.93	1676.1530	-3.33827
387.6470	493.3689	179.7032	38.50891	77.94078	83.20	1646.7423	-3.33826
396.4572	484.5588	179.7035	38.42955	77.94025	83.48	1617.3318	-3.33825
405.2673	475.7486	179.7038	38.35018	77.93973	83.77	1587.9213	-3.33824
414.0775	466.9384	179.7041	38.27081	77.93921	84.05	1558.5109	-3.33823
422.8877	458.1283	179.7045	38.19144	77.93869	84.34	1529.1006	-3.33822
431.6978	449.3181	179.7048	38.11206	77.93817	84.63	1499.6904	-3.33820
440.5080	440.5080	179.7051	38.03269	77.93766	84.92	1470.2802	-3.33819
449.3181	431.6978	179.7054	37.95332	77.93714	85.21	1440.8702	-3.33818
458.1283	422.8877	179.7057	37.87394	77.93663	85.51	1411.4603	-3.33817
466.9384	414.0775	179.7060	37.79457	77.93611	85.80	1382.0505	-3.33816
475.7486	405.2673	179.7064	37.71519	77.93560	86.10	1352.6408	-3.33814
484.5588	396.4572	179.7067	37.63581	77.93509	86.41	1323.2312	-3.33813
493.3689	387.6470	179.7070	37.55643	77.93458	86.72	1293.8218	-3.33812
502.1791	378.8368	179.7073	37.47705	77.93407	87.03	1264.4125	-3.33810
510.9892	370.0267	179.7076	37.39767	77.93356	87.34	1235.0033	-3.33809
519.7994	361.2165	179.7079	37.31828	77.93305	87.66	1205.5942	-3.33807

Table 14. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO		AZIMUTH TO DESTINATION	COORDINATES OF PATH		FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
ORIGIN	DESTINATION	DEGREES	LATITUDE DEGREES	LONGITUDE DEGREES			
528.6096	352.4064	179.7082	37.23890	77.93255	87.98	1176.1853	-3.33805
537.4197	343.5962	179.7085	37.15952	77.93204	88.31	1146.7765	-3.33804
546.2299	334.7861	179.7088	37.08013	77.93154	88.64	1117.3678	-3.33802
555.0400	325.9759	179.7091	37.00074	77.93103	88.97	1087.9594	-3.33800
563.8502	317.1657	179.7094	36.92135	77.93053	89.31	1058.5510	-3.33798
572.6604	308.3556	179.7097	36.84197	77.93003	89.66	1029.1429	-3.33796
581.4705	299.5454	179.7100	36.76257	77.92953	90.01	999.7349	-3.33794
590.2807	290.7353	179.7103	36.68318	77.92903	90.37	970.3271	-3.33792
599.0908	281.9251	179.7106	36.60379	77.92853	90.73	940.9195	-3.33790
607.9010	273.1149	179.7109	36.52440	77.92804	91.10	911.5121	-3.33788
616.7112	264.3048	179.7112	36.44500	77.92754	91.48	882.1048	-3.33785
625.5213	255.4946	179.7115	36.36561	77.92705	91.86	852.6978	-3.33783
634.3315	246.6845	179.7118	36.28621	77.92655	92.26	823.2910	-3.33780
643.1416	237.8743	179.7121	36.20681	77.92606	92.67	793.8844	-3.33778
651.9518	229.0641	179.7124	36.12741	77.92557	93.08	764.4781	-3.33775
660.7620	220.2540	179.7127	36.04801	77.92508	93.51	735.0720	-3.33772
669.5721	211.4438	179.7130	35.96861	77.92459	93.95	705.6661	-3.33769
678.3823	202.6337	179.7132	35.88921	77.92410	94.40	676.2605	-3.33766
687.1924	193.8235	179.7135	35.80981	77.92361	94.86	646.8552	-3.33763
696.0026	185.0133	179.7138	35.73040	77.92313	95.35	617.4502	-3.33759
704.8128	176.2032	179.7141	35.65100	77.92264	95.85	588.0455	-3.33756
713.6229	167.3930	179.7144	35.57159	77.92215	96.37	558.6411	-3.33752
722.4331	158.5829	179.7147	35.49218	77.92167	96.91	529.2370	-3.33748
731.2432	149.7727	179.7149	35.41277	77.92119	97.48	499.8333	-3.33744
740.0534	140.9626	179.7152	35.33336	77.92071	98.07	470.4300	-3.33739
748.8636	132.1524	179.7155	35.25395	77.92022	98.70	441.0270	-3.33734
757.6737	123.3422	179.7158	35.17454	77.91974	99.37	411.6245	-3.33728
766.4839	114.5321	179.7161	35.09513	77.91926	100.07	382.2225	-3.33722
775.2940	105.7219	179.7163	35.01572	77.91879	100.83	352.8211	-3.33716
784.1042	96.9118	179.7166	34.93630	77.91831	101.64	323.4202	-3.33708

Table 14. (Continued)

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                                  PENNSYLVANIA FLIGHT PLAN
                      PENNSYLVANIA END POINT               TO  CAROLINA BEACH
          LAT=N42.000D          LON=W77.965D               TO  LAT=N34D 3.76M          LON=W77D 54.787M

                     LAT=N34D 3.76M        LON=W77D 54.787M       LOCATION OF MASTER (CAPE FEAR)
                                                        MASTER
                RADIATED POWER (KILOWATTS)              400.000
                DIPOLE CURRENT MOMENT (AMPERE-METERS)  9.7687+004

   DISTANCE IN         AZIMUTH TO   COORDINATES OF PATH   FIELD STRENGTH IN       TIME        GRADIENT ALONG
  KILOMETERS TO       DESTINATION  LATITUDE   LONGITUDE   DB RELATIVE TO      DIFFERENCE    THE GEODETIC LINE
ORIGIN  DESTINATION     DEGREES     DEGREES    DEGREES     1 MICROVOLT/M     MICROSECONDS    MICROSECONDS/KM

792.9143   88.1016     179.7169    34.85688   77.91783       102.52           294.0200          -3.33699
801.7245   79.2914     179.7171    34.77747   77.91736       103.49           264.6205          -3.33688
810.5347   70.4813     179.7174    34.69805   77.91688       104.56           235.2220          -3.33675
819.3448   61.6711     179.7177    34.61863   77.91641       105.77           205.8248          -3.33656
828.1550   52.8610     179.7180    34.53921   77.91594       107.15           176.4291          -3.34152
836.9651   44.0508     179.7182    34.45979   77.91546       108.90           146.9898          -3.33573
845.7753   35.2406     179.7185    34.38037   77.91499       110.84           117.6015          -3.33543
854.5855   26.4305     179.7188    34.30094   77.91452       113.34            88.2158          -3.33467
863.3956   17.6203     179.7190    34.22152   77.91405       116.86            58.8368          -3.33149
872.2058    8.8102     179.7193    34.14209   77.91358       122.87            29.4859          -2.77928

881.0159    0.0000     179.7195    34.06267   77.91312       550.91             5.0000           0.00000
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Table 15.

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HOMOGENEOUS CASE

 KDEL=          1
    F= 1.000000000+002 KHZ
SIGMA= 5.000000000+000
   E2= R.000000000+001
 ALFA= 1.000000000+000
  ETA= 1.000100000+000
 BORA= 3.000000000+002
  ANN= 3.000000000-007
   H2= 0.000000000+000
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Table 15. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M

LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
RADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
0.0000	881.0159	179.6875	42.00000	77.96500	93.48	2946.4164	-3.34339
8.8102	872.2058	179.6879	41.92068	77.96442	93.56	2916.9605	-3.34339
17.6203	863.3956	179.6883	41.84136	77.96384	93.64	2887.5047	-3.34339
26.4305	854.5855	179.6887	41.76204	77.96327	93.72	2858.0489	-3.34339
35.2406	845.7753	179.6890	41.68272	77.96269	93.80	2828.5930	-3.34339
44.0508	836.9651	179.6894	41.60339	77.96212	93.88	2799.1372	-3.34339
52.8610	828.1550	179.6898	41.52407	77.96155	93.96	2769.6813	-3.34340
61.6711	819.3448	179.6902	41.44474	77.96098	94.04	2740.2255	-3.34340
70.4813	810.5347	179.6906	41.36542	77.96041	94.12	2710.7697	-3.34340
79.2914	801.7245	179.6909	41.28609	77.95984	94.21	2681.3138	-3.34340
88.1016	792.9143	179.6913	41.20676	77.95927	94.29	2651.8579	-3.34340
96.9118	784.1042	179.6917	41.12743	77.95871	94.37	2622.4021	-3.34340
105.7219	775.2940	179.6921	41.04810	77.95814	94.46	2592.9462	-3.34340
114.5321	766.4839	179.6924	40.96877	77.95758	94.54	2563.4904	-3.34340
123.3422	757.6737	179.6928	40.88943	77.95702	94.63	2534.0345	-3.34340
132.1524	748.8635	179.6932	40.81010	77.95646	94.72	2504.5786	-3.34340
140.9625	740.0534	179.6935	40.73076	77.95590	94.80	2475.1228	-3.34340
149.7727	731.2432	179.6939	40.65143	77.95534	94.89	2445.6669	-3.34340
158.5829	722.4331	179.6942	40.57209	77.95479	94.98	2416.2110	-3.34340
167.3930	713.6229	179.6946	40.49275	77.95423	95.07	2386.7551	-3.34340
176.2032	704.9128	179.6950	40.41341	77.95368	95.16	2357.2992	-3.34340
185.0133	696.0026	179.6953	40.33407	77.95313	95.25	2327.8433	-3.34340
193.8235	687.1924	179.6957	40.25472	77.95258	95.34	2298.3874	-3.34340
202.6337	678.3823	179.6960	40.17538	77.95203	95.43	2268.9315	-3.34340
211.4438	669.5721	179.6964	40.09604	77.95148	95.52	2239.4756	-3.34340
220.2540	660.7620	179.6967	40.01669	77.95093	95.62	2210.0196	-3.34341
229.0641	651.9518	179.6971	39.93734	77.95039	95.71	2180.5637	-3.34341
237.8743	643.1416	179.6974	39.85800	77.94984	95.81	2151.1078	-3.34341
246.6845	634.3315	179.6978	39.77865	77.94930	95.90	2121.6518	-3.34341
255.4946	625.5213	179.6981	39.69930	77.94876	96.00	2092.1958	-3.34341

Table 15. (Continued)

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                                  PENNSYLVANIA FLIGHT PLAN
                         PENNSYLVANIA END POINT              TO  CAROLINA BEACH
         LAT=N42.000D           LON=W77.965D                 TO  LAT=N34D 3.76M            LON=W77D 54.787M

                  LAT=N34D 3.76M          LON=W77D 54.787M         LOCATION OF MASTER (CAPE FEAR)
                                                          MASTER
                  RADIATED POWER (KILOWATTS)              400.000
                  DIPOLE CURRENT MOMENT (AMPERE-METERS)  9.7687+004

   DISTANCE IN          AZIMUTH TO    COORDINATES OF PATH   FIELD STRENGTH IN       TIME          GRADIENT ALONG
  KILOMETERS TO        DESTINATION    LATITUDE  LONGITUDE   DB RELATIVE TO       DIFFERENCE     THE GEODETIC LINE
ORIGIN  DESTINATION      DEGREES      DEGREES    DEGREES    1 MICROVOLT/M      MICROSECONDS    MICROSECONDS/KM

264.3048   616.7112    179.6985     39.61995   77.94822        96.10          2062.7399          -3.34341
273.1149   607.9010    179.6988     39.54059   77.94768        96.20          2033.2839          -3.34341
281.9251   599.0908    179.6992     39.46124   77.94714        96.30          2003.8279          -3.34341
290.7353   590.2807    179.6995     39.38189   77.94660        96.40          1974.3719          -3.34342
299.5454   581.4705    179.6998     39.30253   77.94607        96.50          1944.9158          -3.34342
308.3556   572.6604    179.7002     39.22317   77.94553        96.61          1915.4598          -3.34342
317.1657   563.8502    179.7005     39.14382   77.94500        96.71          1886.0038          -3.34342
325.9759   555.0400    179.7009     39.06446   77.94447        96.82          1856.5477          -3.34342
334.7861   546.2299    179.7012     38.98510   77.94394        96.92          1827.0916          -3.34343
343.5962   537.4197    179.7015     38.90574   77.94341        97.03          1797.6355          -3.34343

352.4064   528.6096    179.7019     38.82637   77.94288        97.14          1768.1794          -3.34343
361.2165   519.7994    179.7022     38.74701   77.94235        97.25          1738.7232          -3.34343
370.0267   510.9892    179.7025     38.66765   77.94182        97.36          1709.2670          -3.34344
378.8369   502.1791    179.7028     38.58828   77.94130        97.48          1679.8108          -3.34344
387.6470   493.3689    179.7032     38.50891   77.94078        97.59          1650.3546          -3.34344
396.4572   484.5588    179.7035     38.42955   77.94025        97.71          1620.8983          -3.34345
405.2673   475.7486    179.7038     38.35018   77.93973        97.83          1591.4420          -3.34345
414.0775   466.9384    179.7041     38.27081   77.93921        97.95          1561.9857          -3.34345
422.8877   458.1283    179.7045     38.19144   77.93869        98.07          1532.5293          -3.34346
431.6978   449.3181    179.7048     38.11206   77.93817        98.19          1503.0729          -3.34346

440.5080   440.5080    179.7051     38.03269   77.93766        98.32          1473.6164          -3.34347
449.3181   431.6978    179.7054     37.95332   77.93714        98.45          1444.1600          -3.34347
458.1283   422.8877    179.7057     37.87394   77.93663        98.58          1414.7034          -3.34348
466.9384   414.0775    179.7060     37.79457   77.93611        98.71          1385.2469          -3.34349
475.7486   405.2673    179.7064     37.71519   77.93560        98.84          1355.7902          -3.34349
484.5588   396.4572    179.7067     37.63581   77.93509        98.98          1326.3335          -3.34350
493.3689   387.6470    179.7070     37.55643   77.93458        99.12          1296.8767          -3.34351
502.1791   378.8368    179.7073     37.47705   77.93407        99.26          1267.4199          -3.34352
510.9892   370.0267    179.7076     37.39767   77.93356        99.41          1237.9630          -3.34352
519.7994   361.2165    179.7079     37.31828   77.93305        99.55          1208.5060          -3.34353
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Table 15. (Continued)

PENNSYLVANIA FLIGHT PLAN
PENNSYLVANIA END POINT TO CAROLINA BEACH
LAT=N42.000D LON=W77.965D TO LAT=N34D 3.76M LON=W77D 54.787M
LAT=N34D 3.76M LON=W77D 54.787M LOCATION OF MASTER (CAPE FEAR)

	MASTER
ADIATED POWER (KILOWATTS)	400.000
DIPOLE CURRENT MOMENT (AMPERE-METERS)	9.7687+004

DISTANCE IN KILOMETERS TO ORIGIN	DISTANCE IN KILOMETERS TO DESTINATION	AZIMUTH TO DESTINATION DEGREES	COORDINATES OF PATH LATITUDE DEGREES	COORDINATES OF PATH LONGITUDE DEGREES	FIELD STRENGTH IN DB RELATIVE TO 1 MICROVOLT/M	TIME DIFFERENCE MICROSECONDS	GRADIENT ALONG THE GEODETIC LINE MICROSECONDS/KM
528.6096	352.4064	179.7082	37.23890	77.93255	99.71	1179.0489	-3.34354
537.4197	343.5962	179.7085	37.15952	77.93204	99.86	1149.5918	-3.34356
546.2299	334.7861	179.7088	37.08013	77.93154	100.02	1120.1345	-3.34357
555.0400	325.9759	179.7091	37.00074	77.93103	100.18	1090.6772	-3.34358
563.8502	317.1657	179.7094	36.92135	77.93053	100.35	1061.2197	-3.34360
572.6604	308.3556	179.7097	36.84197	77.93003	100.52	1031.7621	-3.34361
581.4705	299.5454	179.7100	36.76257	77.92953	100.69	1002.3043	-3.34363
590.2807	290.7353	179.7103	36.68318	77.92903	100.87	972.8464	-3.34364
599.0908	281.9251	179.7106	36.60379	77.92853	101.06	943.3884	-3.34366
607.9010	273.1149	179.7109	36.52440	77.92804	101.25	913.9302	-3.34368
616.7112	264.3048	179.7112	36.44500	77.92754	101.44	884.4718	-3.34371
625.5213	255.4946	179.7115	36.36561	77.92705	101.65	855.0132	-3.34373
634.3315	246.6845	179.7118	36.28621	77.92655	101.86	825.5544	-3.34376
643.1416	237.8743	179.7121	36.20681	77.92606	102.07	796.0953	-3.34379
651.9519	229.0641	179.7124	36.12741	77.92557	102.30	766.6360	-3.34382
660.7620	220.2540	179.7127	36.04801	77.92508	102.54	737.1765	-3.34385
669.5721	211.4438	179.7130	35.96861	77.92459	102.78	707.7166	-3.34389
678.3823	202.6337	179.7132	35.88921	77.92410	103.03	678.2564	-3.34393
687.1924	193.8235	179.7135	35.80981	77.92361	103.30	648.7958	-3.34398
696.0026	185.0133	179.7138	35.73040	77.92313	103.58	619.3348	-3.34403
704.8128	176.2032	179.7141	35.65100	77.92264	103.87	589.8733	-3.34409
713.6229	167.3930	179.7144	35.57159	77.92215	104.18	560.4114	-3.34415
722.4331	158.5829	179.7147	35.49218	77.92167	104.51	530.9489	-3.34422
731.2432	149.7727	179.7149	35.41277	77.92119	104.86	501.4858	-3.34430
740.0534	140.9626	179.7152	35.33336	77.92071	105.23	472.0220	-3.34438
748.8636	132.1524	179.7155	35.25395	77.92022	105.63	442.5574	-3.34448
757.6737	123.3422	179.7158	35.17454	77.91974	106.05	413.0920	-3.34459
766.4839	114.5321	179.7161	35.09513	77.91926	106.51	383.6256	-3.34472
775.2940	105.7219	179.7163	35.01572	77.91879	107.01	354.1582	-3.34486
784.1042	96.9118	179.7166	34.93630	77.91831	107.56	324.6894	-3.34503