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VLFACM Program Description and Operational Manual

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VLFACM is a FORTRAN computer program which can compute signal or noise-field strengths and signal-to-noise, signal-to-jam, or signal-to-jam-plus-noise ratios in the 14- to 30-kHz frequency range. Additional postprocessing programs exist which can plot VLFACM results in the form of rectangular or polar contour maps, field strength versus distance plots, or diurnal plots.

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VLFACM PROGRAM DESCRIPTION AND OPERATIONAL MANUAL

INTRODUCTION

The Very Low Frequency Automatic Computation Method (VLFACM) is a computer program designed to evaluate the effectiveness of VLF communication circuits. The propagation and atmospheric noise models cover the 10- to 30-kHz-frequency range. Signal and noise thresholds, signal-to-noise, and signal-to-jam ratios can be computed for specified time availabilities, or conversely, time availabilities may be computed for specified ratios and thresholds. VLFACM is written in FORTRAN and is presently being run on the (NRL's) Texas Instruments Advanced Scientific Computer (TI/ASC), which is a large batch processing machine.

The purpose of this report is to enable someone unfamiliar with VLFACM to operate the computer program effectively. Effective program operation entails the ability to properly select program options and interpret the results as well as the expertise to execute the program on a computer. Therefore, brief but adequate descriptions of VLFACM models and methodologies are given, along with a detailed description of operational procedures.

HISTORY

The VLFACM propagation model, as originally developed by RCA [1], has undergone two successive modifications. The first modification, designated "NRL 1 and W.P. 18," consisted of adjustments in attenuation rates for "poor land," "arctic land," and "ice cap" [2]. The first revision was prompted by gross disagreement between the VLFACM propagation model and data collected over propagation paths having low-ground conductivity. A second revision, designated "NCPP 70" and based on a much larger amount of data, further refined the attenuation rates and excitation factors used in the VLFACM propagation model. The result was very good agreement between the model and data above 14 kHz. However, since no data below 14 kHz were used in the analysis, the model's validity below 14 kHz is questionable. In fact, comparison with data at 10.2 kHz has shown gross inaccuracies in the NCPP 70 propagation model at this frequency. Therefore, it is inadvisable to use the VLFACM program below 14 kHz.

The present model designation for the VLFACM program is NCPP 74. The designation results from a change in the atmospheric noise model used by VLFACM rather than the propagation model, which is the same as the NCPP 70 version. In the NCPP 74 version of VLFACM, the CCIR noise model [3] is replaced by the WGL noise model [4]. The WGL model, as refined by NRL, is more accurate than the CCIR model [5].

The majority of VLFACM communication coverage predictions existent in the user community have been generated with the NCPP 74 model. However, some users still may have predictions computed by the older NRL 1 and WP 18 or NCPP 70 models. Care should be taken when determining consistency of new results with older work to assure that the models are identical.

Manuscript submitted on August 8, 1981.

PROPAGATION MODEL

VLFACM computes the first two moments of a signal distribution, i.e., mean and standard deviation, at a receiver location given the location and power of the transmitter, the universal time, month, and frequency. The mean signal is calculated using a semi-empirical dominant mode propagation model. The mathematical formulation is similar to J. R. Wait's [6] for a single waveguide mode. However, the modal attenuation rates and excitation factors are empirically derived. The following parameters are accounted for in the computation of the mean signal strength: 1. changes in ground conductivity along the propagation path, 2. changes in ionospheric reflection height (day or night), 3. solar zenith angle (for daytime propagation), 4. direction of propagation with respect to the earth's magnetic field (for nighttime propagation), 5. total path length, and 6. frequency. Reference 2 gives a more detailed explanation of how mean signal strength is computed. Also, it is important to note that only the vertical electric (TM) field component at the ground is computed by VLFACM. This limits the program's applicability to TM fields generated and received at or near the ground.

The standard deviation of the signal strength is empirically derived and is based on the following parameters: 1. path length, 2. frequency, 3. season, 4. geomagnetic latitude, and 5. ionospheric condition, i.e., day, night or transition. Further explanation may be found in Ref. 7.

NOISE MODELS

Both the CCIR and the WGL atmospheric noise models are included in the current revision of the VLFACM program. Both models compute the mean and standard deviation of the vertical electric atmospheric radio noise at a receiver located at or near the ground. The WGL model is the one normally used for computing noise in VLFACM. However, an option to select the CCIR noise model is also available to facilitate computing noise at frequencies above 30 kHz. This option is provided to satisfy the requirements of some users who have needed signal-to-jam plus noise (S/J+N) predictions in the 30- to 44-kHz-frequency range. The technique used is to run the propagation model at 30 kHz and degrade the resultant signal and jam fields by a constant number of decibels to simulate the higher frequency, while at the same time using the CCIR noise at the higher frequency. The method is admittedly crude and is viewed as a stop gap measure until an LF program is produced that has the same signal-to-jam capabilities as VLFACM.

STATISTICAL METHODS

Both the propagation and the noise models compute the first and second moments of their respective distributions for each hour of a 24-hour day. Both signal and noise distributions are considered to be log-normally distributed over the span of one hour for any given month. In other words, if the signal or noise were measured each day during the same hour over a one-month period, the 30 measurements obtained would be log-normally distributed. From these moments, i.e., $\bar{S}$, σ_S, $\bar{N}$, σ_N, and, in the case of jam signals, $\bar{J}$ and σ_J, the first and second moments of the ratio distributions are derived in the following manner:

$$\overline{(S/N)} = \bar{S} - \bar{N}$$

$$\sigma_{S/N} = (\sigma_S^2 + \sigma_N^2)^{1/2}$$

$$\overline{(S/J)} = \bar{S} - \bar{J}$$

$$\sigma_{S/J} = (\sigma_S^2 + \sigma_J^2)^{1/2}.$$

These equations are valid only if S, N, and J are uncorrelated; and, this is assumed to be the case in VLFACM. Therefore, the S/N and S/J distributions are likewise log-normally distributed.

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VLFACM also computes S/J+N and S/J+J ratios. The estimates of the first and second moments of these distributions are complicated by the linear addition of J+N and J+J. A technique for estimating the first and second moments of a linearly combined distribution, given the first and second moments of its addends, may be found in Ref. 8.

With the first and second moments of a log-normal distribution, one may calculate the threshold given the time availability or the time availability given the threshold. A threshold is a value of S, N, S/N, S/J, S/J+N, or S/J+J, whereas time availability is the percentage of time that a threshold is either equaled or exceeded at a specified location for a given span of time. VLFACM can compute thresholds or time availabilities on either an hour-by-hour basis or on a 24-hour basis. In the event that a 24-hour basis is chosen, VLFACM performs an iterative technique to find the threshold of the combined 24-hour distribution for a given time availability [9]. If the time availability is being computed for a combined 24-hour distribution for a given threshold, it is computed by averaging the hourly time availabilities.

VLFACM OPERATIONAL OVERVIEW

VLFACM requires two files of data for proper execution. The first file is normally read in via a card reader or entered through a teletype terminal and contains the input specifications for essential parameters such as transmitter, receiver, and jammer coordinates, frequency, radiated power, required time availabilities or thresholds, month, and option flags. The second file contains either the WGL- or the CCIR-noise data, depending on which VLFACM noise option has been selected. It is the user's responsibility to see that the correct noise data file is assigned to the job.

The execution of the VLFACM load module generates two additional files of data. The first is a print file containing the input specification data and either the threshold levels or time availabilities, and the second is a tape or disc file containing the same information, but in a format compatible for input to plotting routines. The plotting routines are run as separate programs and provide a variety of options for graphic presentation of VLFACM data. Figure 1 depicts the processing involved in producing graphic output with the VLFACM computer program.

VLFACM NOMENCLATURE

Several points about VLFACM nomenclature are worth emphasizing. The first is the distinction drawn between "A" and "B" options. "A" options compute thresholds or time availabilities for many points, whereas "B" options compute for only a single point. Therefore, one must specify an "A" option if the final graphic output is to be a contour map or a threshold/time availability versus distance plot. For a diurnal plot, one must begin with a "B" option.

"Time availability" (TA) and "probability" are often used interchangeably. VLFACM can give the time availability as a number in the range 0 to 1 for a single hour of a month or for all hours of a month. For example, a 90-percent (.9) time availability for all hours of the month means that for a given month at a specified location the threshold level is equaled or exceeded 90% of the total time during that month.

The preceding example also illustrates what is meant by the "all hours" option. The other options are "specific hour" or "worst hour." Specific hour means that time availability or threshold is computed for each specified hour rather than for a combined 24-hour distribution. For example, if 1200 GMT were chosen, a 90-percent time availability would mean that the threshold is equaled or exceeded 90% of the time during the 1200 GMT hour over the span of a month. The worst hour option is similar to the specific hour option with the difference that VLFACM determines which GMT hour has the lowest threshold or time availability, and results are given for that hour.

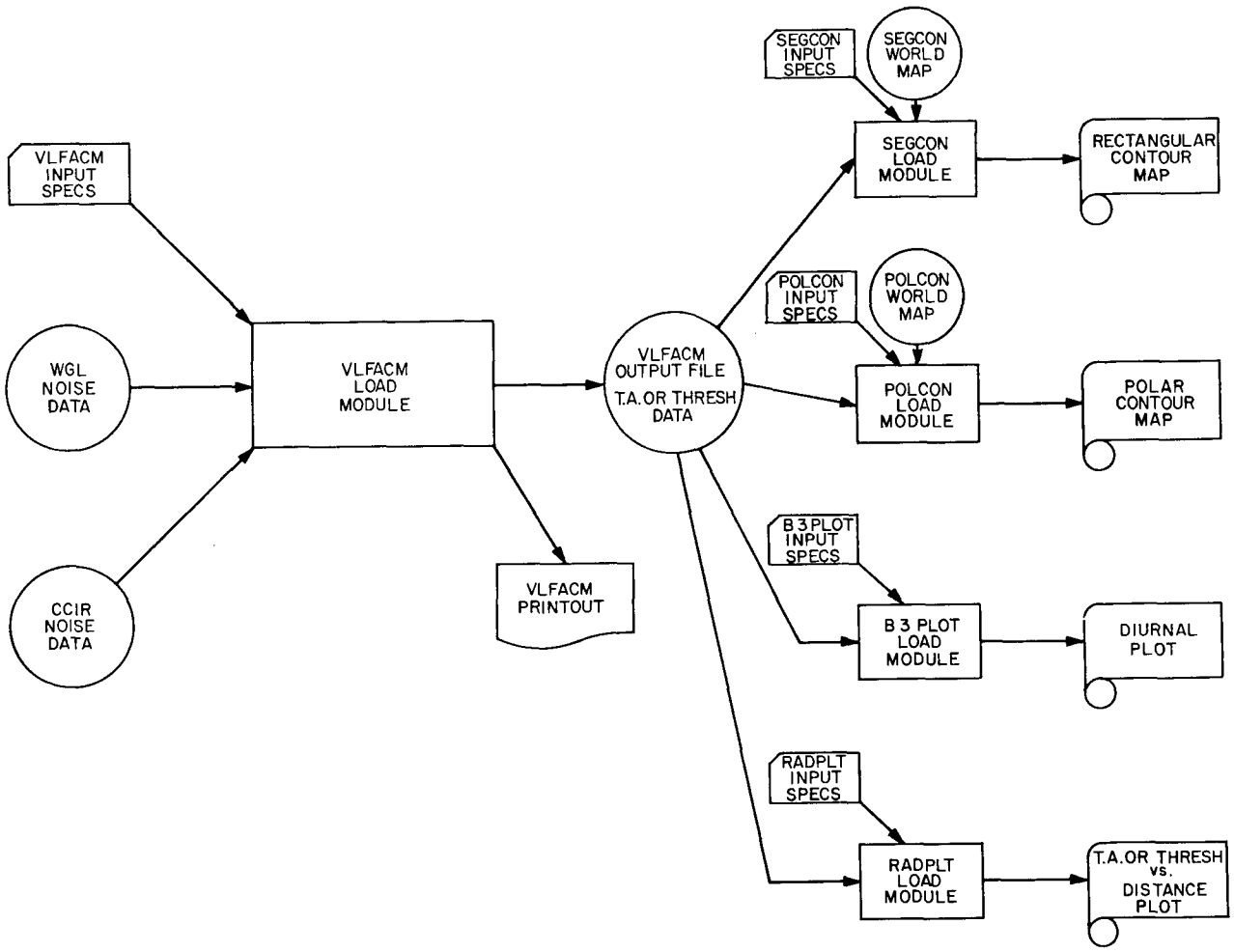

Fig. 1 — Flowchart showing the process required to produce graphic output from VLFACM.

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The term "threshold" denotes either a field strength level or a ratio. Signal (S) and noise (N) field strengths are given in dB > 1 μv/m. Signal-to-noise (S/N), signal-to-jam (S/J) and signal-to-jam plus noise (S/J+N) ratios are given in decibels.

VLFACM INPUT SPECIFICATIONS

The following tables give a card-by-card description of the input specifications required to properly execute VLFACM. Underlined data in the tables are punched on the cards exactly as shown. The "Explanation" portion of each table gives a very detailed explanation of the contents, purpose, interplay, and pitfalls of each data field. A careful reading should give one a good understanding of how to exercise the variety of options VLFACM offers. However, initially understanding a few concepts about setting up a VLFACM-input specification file should prove helpful:

1. A General card is always the first card and a Blank card is always the last card.

2. A General card is always followed by an Options card unless an "Ignore Options" flag is specified on the General card.

3. All cards may be used more than once except the Blank card.

4. The RLOC card initiates VLFACM execution for the B options, the Radial or Sector cards initiate execution for the A options. All options and data must be specified prior to insertion of these cards.

5. VLFACM "remembers" all data and options until a new Options card is encountered. Only the data which needs changing has to be respecified before inserting another Radial or Sector card (A options) or RLOC card (B options) to re-execute VLFACM. However, if a new Options card is encountered, all data, i.e., Station or TLOC, MONTH, SPROB and SNPROB or THRESH, and Radial or Sector or RLOC cards must be respecified even if they have not changed. Data from the General card need not be respecified.

Table 1 — General Card

Columns	Data Description	Explanation
1-7	GENERAL	These columns must be coded as shown. The General card must be the first card.
9-14	Run ID (A6)	The "Run ID" is provided to enable easy identification of VLFACM output. The "Run ID" appears on all printouts and plots. It may be left blank. If the "Run ID" is set to INPUT = then Cols. 16-17 give the file device number. This can only be done on the first General card.
15-16	File Device (I2)	This is a file device or logical unit number of a file containing the remaining VLFACM data cards if they are not on the standard input device. Normally these columns would be left blank. However, this makes it possible to create a long file of VLFACM input cards on another device and automatically read it with VLFACM.
18	Ignore Options (I1)	A 1 in this field sets up a condition whereby the option information on succeeding General cards will be ignored. This facilitates usage of the succeeding General cards to change jammer, distance increment, or noise bandwidth data without necessitating the use of additional Options cards, and hence, respecification of all the other data as well. Once the "Ignore Options" flag is set it remains in force and cannot be changed on a succeeding General card.
41-43	JAM	This is a flag for an S/J option with a fixed receiver, a fixed jammer, and a mobile transmitter. Option B1 must first be run to compute the jammer field strength at the receiver location. Then an A2 option may be run to compute thresholds, or an A4 option may be run to compute time availabilities. Also, B1, B2 or B3 options may be run, in which case the transmitter would be fixed rather than mobile. Selection of the JAM option causes S/J values to be computed in place of S values. Therefore, S/J and S/N values are computed.
41-45	JAM+N	This flag does the same thing as the JAM flag, except S/J+N values are computed rather than S/J values.
41-46	S/SCON	This is a flag for an S/J option with a fixed transmitter, a fixed jammer, and a mobile receiver. Either an A1 option for thresholds or an A3 option for time availabilities may be selected.
41-45	S/S+N	This flag does the same thing as the S/SCON flag, except that S/J+N values are computed rather than S/J values.
41-48	blank	A blank field indicates that no S/J computation will be made. Rather, S and S/N values will be computed.
49-56	Jammer Latitude (F8.2)	If an S/SCON or an S/S+N option has been selected, this field contains the jammer latitude in degrees. Use positive values for north latitudes, negative values for south latitudes. If this field is set to 99., then VLFACM will attempt to read Jammer Info cards containing data for multiple jammers. Multiple jammers may be used with JAM, JAM+N, S/SCON, or S/S+N options. If multiple jammers are used with the JAM or JAM+N options, the Jammer Info cards provide jammer information for the plotting routines. However, the jammer signals are still computed by running B1 options, as stated above in the JAM option flag explanation. One B1 option must be run for each jammer to compute jammer field strengths at the receiver location.
57-64	Jammer Longitude (F8.2)	If an S/SCON or an S/S+N option has been selected, this field contains the jammer longitude in degrees. Use positive value for east longitudes, negative values for west longitude. If multiple jammers are used, this field specifies the number of jammers (maximum of four) to be used. For example, if the field contains a 3., three Jammer Info cards would immediately follow the General card giving the information for each of the three jammers.
65-70	Jammer Power (F6.0)	This field specifies the jammer power in kw if a single jammer is used.
71-72	Distance Increment (I2)	The distance increment gives the spacing in degrees between receiver locations (A1 and A3 options) or transmitter locations (A2 and A4 options) along radials from the transmitter (A1 and A3 options) or the receiver (A2 or A4 options). If left blank, the distance increment will be set to 1°. For S/SCON or S/S+N options increasing the distance increment greatly reduces VLFACM execution time.
73-76	Jammer Name (A4)	This four character field contains a jammer name. It may be left blank. The name appears on all printouts and plots.
77-80	Noise Bandwidth (F4.0)	The noise bandwidth in VLFACM is nominally 1 kHz. However, it may be changed by coding this field. The noise bandwidth is given in hertz (Hz).

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Table 2 — Jammer Information Card

Columns	Data Description	Explanation
		Jammer Info cards are used to specify jammer data for multiple jammer options. The Jammer Info cards must immediately follow the General card on which the multiple jammer option was specified. The number of cards should agree with the number coded in columns 57-64 of the General card.
1-8	Jammer Latitude (F8.3)	This field gives the jammer latitude in degrees. North latitudes are positive, south latitudes are negative.
9-16	Jammer Longitude (F8.3)	This field gives the jammer longitude in degrees. East longitudes are positive, west longitudes are negative.
17-24	Jammer Power (F8.3)	This field gives the jammer radiated power in kW.
25-28	Jammer Name	This four character field contains the jammer name. It may be left blank. The name appears on all printouts and plots.

Table 3 — Options Card

Columns	Data Description	Explanation
1-7	OPTIONS	The Options card must immediately follow the General card, or if multiple jammers are being run, the Jammer Info cards.
10	Noise Option Flags (I1)	Normally this column is left blank. In that case, WGL noise data is read in on file device #49. However, special noise options may be executed in the following manner. Col. 10 = 1 : Noise values punched on two cards by the NOISLAN program may be read in. The first card contains 24 values of median noise field strengths and the second contains 24 values of standard deviation of the noise. This noise option is only appropriate when the receiver is fixed, i.e. (A2, A4, B1, B2 and B3 options). Col. 10 = 2 : The CCIR noise model will be used rather than the WGL noise model. The CCIR noise data is read in on file device #4. Also, a CCIR noise card must immediately follow the Options card specifying noise frequency (kHz) and a delta value (dB) to be added to signal and jammer field strengths. Col. 10 = 3 : This specifies a noise only option. Instead of computing S/N, values of N will be computed.
11-16	A and B Option Flags	The A and B options are selected by putting T punches in this field as follows: A1 (fixed transmitter, specify T.A., calculate thresholds): Col. 11 A2 (fixed receiver, specify T.A., calculate thresholds): Col. 11 and 13 A3 (fixed transmitter, specify thresholds, calculate T.A.): Col. 12 A4 (fixed receiver, specify thresholds, calcualte T.A.): Cols. 12 and 13 B1 (point to point, calculate mean and sigma): Col. 14 B2 (point to point, specify T.A., calculate thresholds): Col. 15 B3 (point to point, specify thresholds, calculate T.A.): Col. 16 The following additional cards are required to run A and B options. A1: STATION MONTH SPROB SNPROB RADIAL A2: STATION MONTH SPROB SNPROB RADIAL A3: STATION MONTH THRESH RADIAL A4: STATION MONTH THRESH RADIAL B1: TLOC MONTH RLOC B2: TLOC MONTH SPROB SNPROB RLOC B3: TLOC MONTH THRESH RLOC
19	TRW Flag	A T in this column punches cards in a special format which was used solely for a project done for TRW. Otherwise, leave blank.
21	B1 Output Flag	A T in this column creates an output file for B1 options on device #10 which contains the data required to run the B3PLOT program.
22	B2 Output Flag	A T in this column creates an output file for B2 options on device #10, which contains the data required to run the B3PLOT program.
24	B3 Output Flag	A T in this column creates an output file for B3 options on device #10, which contains the date required to run the B3 PLOT program.

Table 3 — Options Card (Continued)

25-26	Specific Hour/Worst Hour (I2)	This field is used to select either "specific hour" or "worst hour" options. Such a selection is only appropriate if one has selected one of the A options. If this field is left blank, an all hours option is assumed. Cols. 25-26 = +1 : "Worst hour" calculations will be made for S, S/J, or S/J+N in addition to the "all hour" calculations. No computations of S/N are performed. The SNPROB card specifies time availabilities for the "worst hour" (A1 and A2 options) or the S/N thresholds on the THRESH card specify "worst hour" thresholds (A3 and A4 options). Cols. 25-26 = −1 : "Worst hour" calculations will be made for S/N along with "all hour" calculations for S/N. No calculations of S, S/J or S/J+N will be performed. The SPROB card specifies time availabilities for the "worst hour" (A1 and A2 options) or the S thresholds on the THRESH card specify "worst hour" thresholds for S/N (A3 and A4 options). Col. 25-26 = +2 : "Specific hour" calculations will be made along with "all hour" calculations for S, S/J or S/J+N. No calculations of S/N will be made. The SNPROB card specifies time availabilities for each "specific hour" (A1 and A2 options) or the S/N thresholds on the THRESH card specify "specific hour" thresholds (A3 and A4 options). Cols. 25-26 = −2 : "Specific hour" calculations will be made along with "all hour" calculations for S/N. No calculations of S, S/J, or S/J+N will be performed. The SPROB card specifies time availabilities for the "specific hour" (A1 and A2 options) or the S thresholds on the THRESH card specify "specific hour" thresholds for S/N (A3 and A4 options). If a "specific hour" option has been selected (+2 or −2 in Cols. 25-26), specific hour data must be given on the SPECIFIC HOUR card immediately following the Options card. In the event that CCIR noise in being used (2 in Col. 10), the SPECIFIC HOUR card follows immediately after the CCIR NOISE card.
27-28	Path Increment (I2) for B1 Outputs	This field specifies a great circle path increment in degrees along which B1 outputs will be generated by running an A1 option. If the B1 output flag (T in Col. 21) is set, the B1 data will be written on device #10 and the no A option output flag (T in Col. 31) must be set. Also, the range increment (Cols. 71-72 on the General card) must be left blank. Otherwise, flags and data are specified just as for an A1 option.
29-30	Printout Skip Increment (I2)	Specifying a number in this field will reduce the volume of printout for A options. For example, if Col. 30 = 4 only every fourth bearing which is calculated will actually be printed. The output file on device #10 is unaffected.
31	No A Option Output Flag	A T in Col. 31 will flag VLFACM to not write A option output on device #10. The A option printed data is unaffected.

Table 4 — CCIR Noise Card

Columns	Data Description	Explanation
		This card is needed only if the CCIR noise is being used (2 in Col. 10 of Options card).
1-10	Noise Frequency (F10.2)	This field specifies the frequency in kHz at which CCIR noise will be computed. It does not affect the frequency at which signal or jam fields are computed.
11-20	Delta (F10.2)	This field specifies a delta in dB to add to both signal and jam field strengths to account for a shift in frequency from 30 kHz (VLFACM maximum frequency) to a higher frequency. Merely adding a constant to all signals is extremely crude and is meant to serve as an interim measure until an LF program is produced which has the same capabilities as VLFACM.

Table 5 — Specific Hour Card

Columns	Data Description	Explanation
		This card is needed only if a "specific hour" option has been specified (+2 or −2 in Cols. 25-26 of Options card).
1-2	Number of Hours (I2)	This field gives the number of different "specific hours" to be calculated (# $\leqslant$ 6).
3-20	Specific Hours (6I3)	This field specifies the hours in GMT.

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Table 6 — Station Card

Columns	Data Description	Explanation
1-7	STATION	The Station card is required for all the A options.
9-12	Station Name (A4)	This four character field contains the station name. It may be left blank. For A1 and A3 options it names the transmitter, and for A2 and A4 options it names the receiver. The name appears on all printouts and plots.
14-20	Station Latitude (F7.3)	This field gives the station latitude in degrees. North latitudes are positive and south latitudes are negative. For A1 and A3 options this is the transmitter latitude and for A2 and A4 options this is the receiver latitude.
22-29	Station Longitude (F8.3)	This field gives the station longitude in degrees. East longitudes are positive and west longitudes are negative. For A1 and A3 options this is the transmitter longitude and for A2 and A4 options this is the receiver longitude.
31-35	Frequency (F5.1)	The frequency is given in kHz. This is the frequency at which all signals and noise are computed unless otherwise specified, i.e., the CCIR NOISE card. Care should be taken, however, when running a JAM or JAM+N options to make sure that the jammer frequency on the TLOC card and the transmitter frequency on the Station card agree.
36-45	Power (F10.1)	This field gives the radiated power of the transmitter in kw.

Table 7 — TLOC Card

Columns	Data Description	Explanation
1-4	TLOC	The TLOC card is required for all the B options.
9-12	Transmitter Name (A4)	This four character field contains the transmitter name. It may be left blank.
14-20	Transmitter Latitude (F7.3)	This field gives the transmitter latitude in degrees. North latitudes are positive and south latitudes are negative.
22-29	Transmitter Longitude (F8.3)	This field gives the transmitter longitude in degrees. East longitudes are positive and west longitudes are negative.
31-35	Frequency (F5.1)	The frequency is given in kHz.
36-45	Power (F10.1)	This field gives the radiated power of the transmitter in kw.

Table 8 — Month Card

Columns	Data Description	Explanation
1-5	MONTH	The Month card is required for all A and B options.
9-11	Month Abbrev. (A3)	This field contains the first three letters of the month, i.e., JAN, FEB, MAR, etc.

Table 9 — SPROB Card

Columns	Data Description	Explanation
1-5	SPROB	The SPROB card is required for A1, A2, and B2 options.
9	Number of T.A.'s (I1)	Up to three time availabilities may be specified (Col. 9 = 1, 2, or 3). VLFACM can compute three time availabilities almost as rapidly as it can compute one. Therefore, the practice has been to always specify the maximum number of time availabilities.
10-14	1st T.A. (F5.3)	This field gives the first time availability for S, S/J, or S/J+N "all hour" predictions or S/N "worst hour" or "specific hour" predictions. It is a number between 0 and 1.
15-19	2nd T.A. (F5.3)	This is second time availability ($0 \leqslant$ T.A. $\leqslant 1$).
20-24	3rd T.A (F5.3)	This is the third time availability ($0 \leqslant$ T.A. $\leqslant 1$).

Table 10 — SNPROB Card

Columns	Data Description	Explanation
1-5	SNPROB	The SNPROB card is required for A1, A2, and B2 options.
9	Number of T.A.'s (A3)	Up to three time availabilities may be specified (Col. 9 = 1, 2, or 3). Practice has been to specify the maximum of three time availabilities.
10-14	1st T.A. (F5.3)	This field gives the first time availability for S/N "all hour" predictions or S, S/J, or S/J+N "worst hour" or "specific hour" predictions. It is a number between 0 and 1.
15-19	2nd T.A. (F5.3)	This is the second time availability ($0 \leqslant$ T.A. $\leqslant 1$).
20-24	3rd T.A. (F5.3)	This is the third time availability ($0 \leqslant$ T.A. $\leqslant 1$).

Table 11 — THRESH Card

Columns	Data Description	Explanation
1-6	THRESH	The THRESH card is required for A3, A4, and B3 options.
9	Number of Thresholds (I1)	Up to three thresholds may be specified (Col. 9 = 1, 2, or 3).
10-15	1st Threshold (F6.3)	This field gives the first threshold for S, S/J, or S/J+N "all hour" predictions or S/N "worst hour" or "specific hour" predictions. Signal is given in dB > 1 μv/m and all ratios are given in dB.
16-21	2nd Threshold (F6.3)	Same as Cols. 10-15.
22-27	3rd Threshold (F6.3)	Same as Cols. 10-15.
29	Number of Thresholds (I1)	Up to three thresholds may be specified (Col. 29 = 1, 2, or 3).
30-35	1st Threshold (F6.3)	This field gives the first threshold for S/N "all hour" predictions or S, S/J, or S/J+N "worst hour" or "specific hour" predictions. Signal is given in dB > 1 μv/m and all ratios are given in dB.
36-41	2nd Threshold (F6.3)	Same as Cols. 30-35.
42-47	3rd Threshold (F6.3)	Same as Cols. 30-35.

Table 12 — RLOC Card

Columns	Data Description	Explanation
1-4	RLOC	The RLOC card is required for the B options. It is the card which initiates execution of the VLFACM program and should only be inserted after all other B option data has been specified.
9-12	Receiver Name (A4)	This four character field contains the receiver name. It may be left blank. The receiver name appears on all printouts and plots.
14-20	Receiver Latitude (F7.3)	The receiver latitude is given in degrees. North latitudes are positive and south latitudes are negative.
22-29	Receiver Longitude (F8.3)	The receiver longitude is given in degrees. East longitudes are positive and west longitudes are negative.

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Table 13 — Radial Card

Columns	Data Description	Explanation
1-6	RADIAL	The Radial card is required for the A options. It is the card which initiates execution of the VLFACM program and should only be inserted after all the other A option data has been specified.
9-11	First Bearing (I3)	This is the initial geographic bearing in degrees east-of-north (0°-360°) of a radial starting at the location on the Station card. For A1 and A3 options, receivers will be placed along the radials. For A2 and A4 options, transmitters will be placed along the radials.
13-15	Last Bearing (I3)	This is the final bearing. It is also given in degrees east-of-north. However, it must always be larger in magnitude than the first bearing. For example, if one wished to compute the northly radials from a first bearing of 270° around through the 0° bearing to a last bearing of 90°, one would specify the last bearing as 450, i.e., (90° + 360°).
17-19	First Distance (I3)	This is the initial starting distance in degrees. The distance increment is given in Cols. 71-72 of the General card.
21-23	Last Distance (I3)	This is the final distance in degrees. VLFACM will compute thresholds or time availabilities along each radial at the end point of each successive distance increment until the last distance is exceeded. There is a limit to the number of points along a radial at which computations can be made (# pts. = (first dist.−last dist.)/dist. inc.+1). The normal limit is 133 points. However, if multiple jammers are used, the limit is 30 points.
25-27	Bearing Increment (I3)	The bearing increment gives the spacing in degrees between each successive radial. Since bearings are specified in degrees east-of-north, incrementing the bearing computes successive radials in a clockwise direction until the last bearing is exceeded.

Table 14 — Sector Card

Columns	Data Description	Explanation
1-6	SECTOR	The Sector card provides an alternative to the Radial card. It behaves the same way as the Radial card in that it initiates execution of the VLFACM program for A options. The Sector card defines an area to be entirely covered by radials. It computes the parameters specified on the Radial card and is particularly useful when the area does not contain and is far away from the Station location.
11-20	North Boundary (F10.2)	This field contains the latitude in degrees of the northern boundary of the area.
21-30	East Boundary (F10.2)	This field contains the longitude in degrees of the eastern boundary of the area.
31-40	South Boundary (F10.2)	This field contains the latitude in degrees of the southern boundary of the area.
41-50	West Boundary (F10.2)	This field contains the longitude in degrees of the western boundary of the area.

Table 15 — Blank Card

Columns	Data Description	Explanation
1-80	Blank	The Blank card terminates all VLFACM input. If it is left out, VLFACM will terminate abnormally. It should always be the last card.

VLFACM SAMPLE JOBS

The VLFACM sample jobs presented in this section illustrate the card deck structure for running a few of the most commonly used VLFACM options. The JSL (Job Specification Language) statements are peculiar to the TI/ASC. However, their counterparts would be required to run a job on another machine. The VLFACM input shown here is, of course, valid for any machine assuming the program has been properly converted. A sample job illustrating some of the A options is presented first, followed by notes, and then notes for a sample job illustrating B options are given, followed by the sample job. Printed outputs from these jobs are in Appendix A.

```
    / JOB HAUSER$VLFACM,41099101,HAUSJ1,CAT=22,LOC=RTE8
    / LIMIT BAND=100,MTN=30
    / JSLOPTS OPT=(L)
(1) / ASG SYS.LMOD,USERCAT/D54/B60/HAUSJ1/VLFACM/LMOD,USE=SHR
(2) / ASG FT49F001,USERCAT/D54/B60/HAUSJ1/VLFMCI,USE=SHR
    / FD FT10F001,BAND=2/20/2,FORG=DS
(3) / FD FT10F002,BAND=2/20/2,FORG=DS
    / FD FT10F003,BAND=2/20/2,FORG=DS
    / FD FT10F004,BAND=2/20/2,FORG=DS
(4) / FD VLFPRT,BAND=2/10/2,RCFM=FBA,LREC=133,BKSZ=3990
(5) / EXQT CPTIME=180000,OPT=(A,C,K,I),ADDMEM=3JK,LIST=VLFPRT
    GENERAL SER001
(6) OPTIONS   T                    9
(7) STATION NAA  44.7    -67.3    17.8 1000.
    MONTH   JUL
(8) SPROB   3 .500 .900 .990
(9) SNPROB  3 .500 .900 .990
(10) RADIAL  000 350 010 100 010
(11) GENERAL SER002                          S/SCON  64.     41.     1000. 10ARC
(12) OPTIONS   T                    9
    STATION NAA  44.7    -67.3    17.8 1000.
    MONTH   JUL
(13) SPROB   3 .500 .900 .990
    SNPROB  3 .500 .900 .990
(14) RADIAL  000 350 010 100 010
(15) GENERAL SER003                          JAM
(16) OPTIONS     T
(17) TLOC    MIN  54.     28.      26.1 500.
    MONTH   JUL
(18) RLOC    SSBN 60.     -10.
(19) OPTIONS   T T                  9
(20) STATION SSBN 60.     -10.     26.1 100.
(21) MONTH   JUL
(22) SPROB   3 .500 .900 .990
    SNPROB  3 .500 .900 .990
(23) RADIAL  180 270 001 090 010
(24) GENERAL SER004
(25) OPTIONS    T                   9
(26) STATION NAA  44.7    -67.3    17.8 1000.
    MONTH   JUL
(27) THRESH  3 60.  48.   30.    3 12.  -6.   -24.
(28) RADIAL  330 480 010 120 010
(29)
    / CAT USERCAT/D54/B60/HAUSJ1/VLFACM/RUNS/SER001,ACNM=FT10F001
(30) / CAT USERCAT/D54/B60/HAUSJ1/VLFACM/RUNS/SER002,ACNM=FT10F002
    / CAT USERCAT/D54/B60/HAUSJ1/VLFACM/RUNS/SER003,ACNM=FT10F003
    / CAT USERCAT/D54/B60/HAUSJ1/VLFACM/RUNS/SER004,ACNM=FT10F004
(31) / CAT USERCAT/D54/B60/HAUSJ1/VLFACM/RUNS/VLFPRT,ACNM=VLFPRT
    / FOSYS VLFPRT
    / EOJ
```

Fig. 2 — Sample A Option Job

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Sample A Option Job (see Fig. 2)

Notes

(1) Assign the VLFACM load module file.

(2) Assign the WGL noise data file.

(3) Define the FORTRAN unit #10 files. Four files are written on unit #10, one file for each of the four Radial cards.

(4) Define a file for the VLFACM printed output.

(5) Execute the VLFACM program. All the cards that follow, until the next JSL card ("/" in Col. 1) is encountered, are defaulted to the standard FORTRAN input unit and are read by the Read statements in VLFACM.

(6) The T in Col. 11 selects an A1 option (fixed transmitter, mobile receiver). The 9 in Col. 30 limits the printed output to the data from every *9th* bearing which is computed.

(7) Since this is an A1 option, the Station card specifies the transmitter location as 44.7° North, 67.3° West. The frequency is 17.8 kHz and the radiated power is 1000 kw.

(8) The SPROB card specifies three time availabilities—50%, 90%, and 99%. These are signal time availabilities for "all hours" since no jam, specific hour or worst hour options have been selected.

(9) The SNPROB card gives the signal-to-noise ratio time availabilities.

(10) The Radial card initiates execution of VLFACM. The signal and signal-to-noise ratio thresholds are computed and written to file FT10F001.

(11) The new General card specifies an S/SCON option and gives the jammer location as 64° North, 41° East, with a radiated power of 1000 kW. The 10 in Cols. 71-72 specifies the distance increment to be 10° This decreases the VLFACM computation time for this option by a factor of 10.

(12) An A1 option is again specified. This Options card is required to follow the General card. It interacts with the S/SCON option on the General card to generate a VLFACM run with a fixed transmitter, a fixed jammer, and a mobile receiver.

(13) This SPROB card gives the time availabilities for signal-to-jam ratios since this is an S/SCON option run.

(14) This Radial card initiates execution of VLFACM. Signal-to-jam and signal-to-noise ratio thresholds are now written to file FT10F002.

(15) This General card selects a JAM option, i.e., a fixed receiver, a fixed jammer, and a mobile transmitter.

(16) The T in Col. 14 selects a B1 option which must be run to compute the jam signal at the receiver location.

(17) The TLOC card specifies the jammer location, frequency, and power.

(18) The RLOC card gives the receiver location and executes the B1 option.

(19) The T's in Cols. 11 and 13 specify an A2 option which must immediately follow the B1 option for a JAM run.

(20) The Station card gives the receiver location, since this is an A2 option, and the transmitter frequency and power. Note that the transmitter frequency specified here agrees with the jammer frequency specified on the TLOC card.

(21) Note that the month specified for the A2 option agrees with the month specified for the B1 option.

(22) The SPROB card gives signal-to-jam ratio time availabilities.

(23) This Radial card executes the A2 option. Since this is part of a JAM run, signal-to-jam and signal-to-noise ratio thresholds are computed at the fixed receiver location as the location of the transmitter is moved along radials from the receiver. The computed data are written to file FT10F003.

(24) No jam-type options are called for. All previous options are reset.

(25) The T in Col. 12 selects an A3 option, which computes time availabilities for specified signal and signal-to-noise ratio thresholds.

(26) The Station card gives the transmitter location, frequency, and radiated power.

(27) The THRESH card specifies signal thresholds of 60, 48, and 30 dB $> 1\ \mu$v/m, and signal-to-noise ratio thresholds of 12, -6, and -24 dB.

(28) The Radial card executes the A3 option and writes time availability data to file FT10F004.

(29) A blank card terminates VLFACM input.

(30) The four files written on FORTRAN unit #10 are saved for later processing by plotting programs.

(31) The printed output is both saved and printed out.

Sample B Option Job (see Fig. 3)

Notes

(1) Define a file for FORTRAN unit #10. The B option unformatted data is written to this file. Later it may be plotted using the B3PLOT program.

(2) The T's in Cols. 14 and 21 specify a B1 option with unformatted output written on FORTRAN unit #10.

(3) The RLOC card executes the B1 option and writes one record of data to file FT10F001.

(4) The T's in Cols. 15 and 22 specify a B2 option with unformatted output written on FORTRAN unit #10. Note that a new General card is unnecessary since no jam options are being respecified.

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(5) The RLOC card executes the B2 option and writes a second record to file FT10F001.

(6) The T's in Cols. 16 and 24 specify a B3 option with unformatted output written on FORTRAN unit #10.

(7) The RLOC card executes the B3 option and writes a third record to file FT10F001.

(8) A blank card terminates VLFACM input.

(9) The three records of data written to file FT10F001 are saved for later plotting by the B3PLOT program.

```
    / JOB HAUSER$VLFACM,41099101,HAUSJ1,CAT=5,LOC=RTE8
    / LIMIT BAND=50,MIN=10
    / JSLOPTS OPT=(L)
    / ASG FT49F001,USERCAT/D54/B60/HAUSJ1/VLFNOI,USE=SHR
    / ASG SYS.LMOD,USERCAT/D54/B60/HAUSJ1/VLFACM/LMOD,USE=SHR
    / FD VLFPRT,BAND=2/10/2,RCFM=FBA,LREC=133,BKSZ=3990
①   / FD FT10F001,BAND=2/10/2
    / FXQT OPT=(A,C,K,I),ADDMEM=30K,LIST=VLFPRT
    GENERAL SER005
②   OPTIONS        T        T
    TLOC     NSS  39.0     -76.5     23.4 500.
    MONTH    JUL
③   RLOC     GBAY 53.4     -60.5
④   OPTIONS         T        T
    TLOC     NSS  39.0     -76.5     23.4 500.
    MONTH    JUL
    SPROB    3 .500 .900 .990
    SNPROB   3 .500 .900 .990
⑤   RLOC     GBAY 53.4     -60.5
⑥   OPTIONS          T        T
    TLOC     NSS  39.0     -76.5     23.4 500.
    MONTH    JUL
    THRESH   3 60.  66.    72.     3 18.  24.    30.
⑦   RLOC     GBAY 53.4     -60.5
⑧
⑨   / CATV USERCAT/D54/B60/HAUSJ1/VLFACM/RUNS/SER005,ACNM=FT10F001
    / CATV USERCAT/D54/B60/HAUSJ1/VLFACM/RUNS/SER005/VLFPRT,ACNM=VLFPRT
    / FOSYS VLFPRT
    / EOJ
```

Fig. 3 — Sample B Option Job

PLOTTING PROGRAMS

Four computer programs have been written to produce plots of VLFACM data (see Fig. 1). SEGCON draws a rectangular contour map of A option data computed by VLFACM. The map scale, size, and boundaries may be varied, and land masses are automatically drawn. POLCON draws a polar contour map of A option data computed by VLFACM. The map pole and orientation may be varied. Also, the map scale and size may be changed. Land masses are drawn automatically. B3PLOT generates diurnal plots from any of the B option unformatted output data. Scale and size may be varied. RADPLT draws plots using the A option data along a single radial, the A option data being the ordinate and distance along the radial being the abscissa. Sample maps and plots are in Appendix B.

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8. Lawrence F. Fenton, "The Sum of Log-Normal Probability Distributions in Scatter Transmission Systems," IRE Transactions on Communications Systems, March 1960.

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Appendix A
VLFACM PRINTED OUTPUTS

OPTIONS T 9 ¢¢¢¢¢¢¢¢
OUTPUT A1

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SSP001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 0. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
54.7N	67.3W	10.0	79.0	76.1	73.8	30.4	24.7	20.1
55.7N	67.3W	11.0	78.0	75.1	72.8	30.2	24.5	20.0
56.7N	67.3W	12.0	76.3	73.4	71.1	29.2	23.5	19.1
57.7N	67.3W	13.0	74.5	71.6	69.3	28.2	22.6	18.2
58.7N	67.3W	14.0	73.5	70.6	68.3	27.9	22.3	18.0
59.7N	67.3W	15.0	73.2	70.2	68.0	28.3	22.7	18.4
60.7N	67.3W	16.0	72.9	69.9	67.6	28.4	22.8	18.5
61.7N	67.3W	17.0	72.6	69.6	67.4	28.3	22.7	18.4
62.7N	67.3W	18.0	70.5	67.6	65.0	26.2	20.4	16.1
63.7N	67.3W	19.0	69.3	66.4	63.8	25.1	19.3	15.1
64.7N	67.3W	20.0	67.5	64.6	61.9	23.5	17.6	13.5
65.7N	67.3W	21.0	66.4	63.4	60.8	22.5	16.7	12.5
66.7N	67.3W	22.0	65.2	62.3	59.7	21.6	15.7	11.6
67.7N	67.3W	23.0	63.4	60.5	57.9	20.0	14.1	10.0
68.7N	67.3W	24.0	62.3	59.4	56.8	19.1	13.1	9.0
69.7N	67.3W	25.0	60.6	57.6	55.0	17.5	11.5	7.4
70.7N	67.3W	26.0	60.1	57.2	54.6	17.4	11.5	7.5
71.7N	67.3W	27.0	59.7	56.8	54.2	17.4	11.7	7.7
72.7N	67.3W	28.0	59.3	56.4	53.8	17.3	11.9	8.0
73.7N	67.3W	29.0	58.9	56.0	53.3	17.3	12.1	8.2
74.7N	67.3W	30.0	58.5	55.6	53.0	17.2	12.2	8.4
75.7N	67.3W	31.0	58.2	55.2	52.6	16.4	11.6	7.8
76.7N	67.3W	32.0	56.5	53.5	50.9	15.1	10.4	6.7
77.7N	67.3W	33.0	54.8	51.9	49.2	13.8	9.2	5.5
78.7N	67.3W	34.0	53.2	50.2	47.5	12.5	7.9	4.3
79.7N	67.3W	35.0	52.8	49.8	47.2	12.4	8.0	4.4
80.7N	67.3W	36.0	51.8	48.8	46.2	11.3	6.8	3.2
81.7N	67.3W	37.0	50.1	47.1	44.4	9.2	4.7	1.1
82.7N	67.3W	38.0	48.4	45.4	42.7	7.1	2.6	-1.1
83.7N	67.3W	39.0	48.0	45.0	42.4	6.3	1.8	-1.9
84.7N	67.3W	40.0	47.6	44.7	42.0	5.6	1.0	-2.7
85.7N	67.3W	41.0	47.3	44.3	41.7	4.8	0.2	-3.5
86.7N	67.3W	42.0	46.9	44.0	41.3	4.1	-0.7	-4.4
87.7N	67.3W	43.0	46.6	43.6	41.0	3.4	-1.5	-5.2
88.7N	67.3W	44.0	46.3	43.3	40.6	2.6	-2.4	-6.1
89.7N	67.3W	45.0	45.9	43.0	40.3	1.9	-3.2	-7.0
89.3N	112.7E	46.0	45.6	42.6	40.0	1.5	-3.4	-7.2
88.3N	112.7E	47.0	45.3	42.3	39.6	1.3	-3.4	-7.1
87.3N	112.7E	48.0	44.9	42.0	39.3	1.0	-3.4	-7.2
86.3N	112.7E	49.0	44.6	41.6	39.0	0.8	-3.6	-7.3
85.3N	112.7E	50.0	44.3	41.3	38.7	0.6	-3.8	-7.5
84.3N	112.7E	51.0	43.9	41.0	38.3	0.5	-4.0	-7.9

OPTIONS T 9 ccccccccc
OUTPUT A1 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 0. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
83.3N	112.7E	52.0	43.6	40.7	38.0	0.3	-4.3	-8.3
82.3N	112.7E	53.0	43.3	40.3	37.7	0.1	-4.7	-8.8
81.3N	112.7E	54.0	43.0	40.0	37.4	-0.1	-5.2	-9.3
80.3N	112.7E	55.0	42.6	39.7	37.1	-0.3	-5.6	-9.9
79.3N	112.7E	56.0	42.3	39.4	36.8	-0.8	-6.3	-10.6
78.3N	112.7E	57.0	42.0	39.1	36.5	-1.6	-7.1	-11.4
77.3N	112.7E	58.0	41.7	38.8	36.2	-2.3	-7.9	-12.2
76.3N	112.7E	59.0	41.4	38.4	35.9	-3.0	-8.7	-13.1
75.3N	112.7E	60.0	39.7	36.8	34.2	-5.1	-10.8	-15.2
74.3N	112.7E	61.0	38.7	35.8	33.2	-5.3	-10.9	-15.3
73.3N	112.7E	62.0	37.8	34.8	32.3	-6.7	-12.4	-16.8
72.3N	112.7E	63.0	36.1	33.2	30.6	-8.8	-14.5	-19.0
71.3N	112.7E	64.0	34.5	31.5	29.0	-10.9	-16.7	-21.2
70.3N	112.7E	65.0	32.8	29.9	27.3	-13.0	-18.8	-23.3
69.3N	112.7E	66.0	31.2	28.2	25.7	-15.3	-21.4	-26.0
68.3N	112.7E	67.0	30.0	27.0	24.5	-17.4	-23.6	-28.5
67.3N	112.7E	68.0	29.3	26.3	23.8	-19.0	-25.4	-30.4
66.3N	112.7E	69.0	28.5	25.6	23.1	-20.5	-27.2	-32.4
65.3N	112.7E	70.0	27.8	24.9	22.4	-22.1	-29.0	-34.4
64.3N	112.7E	71.0	27.1	24.2	21.8	-23.7	-30.9	-36.4
63.3N	112.7E	72.0	26.4	23.5	20.9	-25.3	-32.7	-38.5
62.3N	112.7E	73.0	25.7	22.7	20.1	-26.9	-34.5	-40.5
61.3N	112.7E	74.0	25.0	21.9	19.2	-28.4	-36.4	-42.6
60.3N	112.7E	75.0	24.3	21.2	18.5	-30.0	-38.3	-44.6
59.3N	112.7E	76.0	23.6	20.5	17.9	-31.1	-39.4	-45.8
58.3N	112.7E	77.0	22.9	19.8	17.2	-32.0	-40.4	-46.8
57.3N	112.7E	78.0	22.2	19.0	16.3	-32.8	-41.3	-47.8
56.3N	112.7E	79.0	21.5	18.3	15.6	-33.7	-42.3	-48.7
55.3N	112.7E	80.0	20.8	17.6	14.9	-34.6	-43.2	-49.7
54.3N	112.7E	81.0	20.1	16.9	14.2	-35.5	-44.1	-50.6
53.3N	112.7E	82.0	19.4	16.2	13.5	-36.5	-45.1	-51.6
52.3N	112.7E	83.0	18.7	15.5	12.8	-37.4	-46.0	-52.5
51.3N	112.7E	84.0	17.9	14.7	12.1	-38.3	-46.9	-53.5
50.3N	112.7E	85.0	17.2	14.0	11.4	-39.2	-47.9	-54.5
49.3N	112.7E	86.0	16.9	13.5	10.7	-39.6	-48.2	-54.8
48.3N	112.7E	87.0	16.5	13.2	10.3	-39.9	-48.4	-54.9
47.3N	112.7E	88.0	16.1	12.8	9.9	-40.2	-48.6	-55.0
46.3N	112.7E	89.0	15.7	12.4	9.5	-40.5	-48.8	-55.1
45.3N	112.7E	90.0	15.4	12.0	9.1	-40.8	-49.0	-55.2
44.3N	112.7E	91.0	15.0	11.6	8.7	-40.9	-49.0	-55.3
43.3N	112.7E	92.0	14.6	11.2	8.4	-41.2	-49.2	-55.4
42.3N	112.7E	93.0	14.3	10.9	8.0	-41.5	-49.4	-55.5

UNCLASSIFIED

OPTIONS T 9 ZZZZZZZZ
OUTPUT A1 VLF PROPAGATION STUDIES NCPP 74(VLFAC4)SER001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 0. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
41.3N	112.7E	94.0	13.9	10.5	7.6	-41.8	-49.6	-55.7
40.3N	112.7E	95.0	13.5	10.1	7.2	-42.1	-49.8	-55.8
39.3N	112.7E	96.0	13.2	9.7	6.8	-42.4	-50.0	-55.9
38.3N	112.7E	97.0	12.8	9.3	6.4	-42.7	-50.2	-56.0
37.3N	112.7E	98.0	12.4	8.9	6.0	-43.0	-50.4	-56.1
36.3N	112.7E	99.0	12.1	8.5	5.6	-43.3	-50.6	-56.2
35.3N	112.7E	100.0	11.7	8.1	5.2	-43.6	-50.8	-56.3

OPTIONS T 9 ¢¢¢¢¢¢¢¢
OUTPUT A1

VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 90. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
43.8N	53.4W	10.0	81.2	78.3	75.8	30.8	25.6	21.4
43.7N	52.0W	11.0	80.6	77.7	75.3	30.5	25.4	21.1
43.5N	50.7W	12.0	80.1	77.2	74.8	30.3	25.1	20.9
43.3N	49.3W	13.0	79.7	76.8	74.4	30.1	25.0	20.7
43.0N	48.0W	14.0	79.4	76.4	74.1	29.9	24.8	20.6
42.8N	46.6W	15.0	79.0	76.1	73.7	29.7	24.7	20.5
42.5N	45.3W	16.0	78.8	75.8	73.3	29.7	24.5	20.3
42.3N	44.0W	17.0	78.5	75.6	73.1	29.6	24.5	20.3
42.0N	42.7W	18.0	78.0	75.0	72.2	29.3	24.0	19.4
41.7N	41.5W	19.0	77.6	74.5	71.7	29.0	23.7	19.1
41.4N	40.2W	20.0	77.1	74.1	71.2	28.7	23.4	18.8
41.0N	38.9W	21.0	76.7	73.6	70.8	28.4	23.1	18.6
40.7N	37.7W	22.0	76.2	73.1	70.3	28.2	23.0	18.5
40.4N	36.5W	23.0	75.8	72.7	69.9	27.5	22.3	17.8
40.0N	35.2W	24.0	75.3	72.3	69.4	27.3	22.2	17.7
39.6N	34.0W	25.0	74.9	71.8	69.0	27.1	22.1	17.7
39.2N	32.8W	26.0	74.5	71.3	68.4	27.0	21.9	17.5
38.8N	31.7W	27.0	74.1	70.9	68.0	26.8	21.8	17.5
38.4N	30.5W	28.0	73.6	70.5	67.6	26.6	21.7	17.4
38.0N	29.4W	29.0	73.2	70.1	67.2	26.4	21.5	17.2
37.5N	28.2W	30.0	72.8	69.7	66.8	26.1	21.2	17.0
37.1N	27.1W	31.0	72.4	69.3	66.4	25.8	21.0	16.8
36.6N	26.0W	32.0	72.0	68.9	65.9	25.5	20.7	16.5
36.2N	24.9W	33.0	71.6	68.5	65.5	25.2	20.4	16.3
35.7N	23.8W	34.0	71.2	68.1	65.1	24.9	20.2	16.0
35.2N	22.7W	35.0	70.8	67.6	64.7	24.6	19.9	15.7
34.7N	21.7W	36.0	70.5	67.2	64.1	24.3	19.5	15.3
34.2N	20.6W	37.0	70.1	66.8	63.7	24.0	19.2	15.1
33.7N	19.6W	38.0	69.8	66.4	63.3	23.7	18.9	14.7
33.1N	18.6W	39.0	69.4	66.1	63.0	23.2	18.5	14.3
32.6N	17.6W	40.0	69.1	65.7	62.6	22.8	18.0	13.9
32.1N	16.6W	41.0	68.7	65.4	62.3	22.3	17.6	13.5
31.5N	15.6W	42.0	68.4	65.0	61.9	21.9	17.2	13.1
31.0N	14.6W	43.0	68.0	64.6	61.5	21.4	16.7	12.7
30.4N	13.7W	44.0	67.7	64.3	61.1	21.0	16.2	12.2
29.8N	12.7W	45.0	67.4	63.9	60.7	20.5	15.7	11.7
29.2N	11.8W	46.0	67.1	63.6	60.3	19.8	14.9	10.9
28.7N	10.8W	47.0	66.7	63.1	59.7	19.1	14.0	9.7
28.1N	9.9W	48.0	66.3	62.7	59.3	18.3	13.0	8.7
27.5N	9.0W	49.0	65.9	62.3	58.9	17.6	12.1	7.7
25.9N	8.1W	50.0	65.6	61.9	58.4	16.9	11.3	6.7
26.3N	7.2W	51.0	65.2	61.5	58.0	16.2	10.4	5.7

UNCLASSIFIED

OPTIONS T 9 ccccccccc
OUTPUT A1 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 90. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
25.7N	6.3W	52.0	64.8	61.1	57.6	15.5	9.5	4.8
25.0N	5.5W	53.0	64.4	60.7	57.1	14.8	8.7	3.8
24.4N	4.6W	54.0	64.1	60.3	56.7	14.1	7.8	2.9
23.8N	3.8W	55.0	63.7	59.9	56.3	13.4	7.0	2.0
23.2N	2.9W	56.0	63.3	59.5	55.9	12.7	6.2	1.1
22.5N	2.1W	57.0	63.0	59.1	55.5	12.1	5.4	0.2
21.9N	1.2W	58.0	62.6	58.7	55.0	11.4	4.6	-0.7
21.2N	0.4W	59.0	62.2	58.3	54.6	10.7	3.8	-1.6
20.6N	0.4E	60.0	61.9	57.9	54.0	10.1	2.9	-2.6
19.9N	1.2E	61.0	61.6	57.5	53.6	9.4	2.2	-3.4
19.3N	2.0E	62.0	61.2	57.1	53.2	8.9	1.6	-4.0
18.6N	2.8E	63.0	60.8	56.0	51.5	8.3	0.6	-5.4
18.0N	3.6E	64.0	60.4	55.6	51.1	7.7	0.0	-6.0
17.3N	4.4E	65.0	60.1	55.3	50.7	7.2	-0.6	-6.7
16.6N	5.1E	66.0	59.7	54.9	50.3	6.6	-1.2	-7.3
16.0N	5.9E	67.0	59.4	54.5	50.0	6.0	-1.9	-8.0
15.3N	6.7E	68.0	59.0	54.1	49.6	5.3	-2.6	-8.8
14.6N	7.4E	69.0	58.7	53.8	49.2	4.8	-3.3	-9.5
13.9N	8.2E	70.0	58.3	53.4	48.8	4.5	-3.5	-9.8
13.2N	8.9E	71.0	58.0	53.0	48.4	3.8	-4.3	-10.6
12.6N	9.7E	72.0	57.6	52.6	48.0	3.1	-5.1	-11.5
11.9N	10.4E	73.0	57.3	52.2	47.5	2.4	-5.9	-12.5
11.2N	11.2E	74.0	56.9	51.8	47.1	1.8	-6.6	-13.3
10.5N	11.9E	75.0	56.6	51.5	46.7	1.1	-7.3	-14.0
9.8N	12.7E	76.0	56.3	51.1	46.4	0.6	-7.9	-14.6
9.1N	13.4E	77.0	55.9	50.7	46.0	0.4	-8.0	-14.6
8.4N	14.1E	78.0	55.6	50.4	45.5	0.3	-8.1	-14.6
7.7N	14.8E	79.0	55.3	50.0	45.2	0.0	-8.2	-14.7
7.0N	15.6E	80.0	54.9	49.7	44.8	-0.2	-8.4	-14.8
6.3N	16.3E	81.0	54.6	49.3	44.4	-0.4	-8.6	-15.0
5.6N	17.0E	82.0	54.3	48.9	44.0	-0.7	-8.8	-15.2
4.9N	17.7E	83.0	53.9	48.6	43.7	-0.9	-9.1	-15.5
4.2N	18.4E	84.0	53.6	48.2	43.3	-1.2	-9.4	-15.8
3.5N	19.1E	85.0	53.3	47.9	42.9	-1.5	-9.3	-16.2
2.8N	19.9E	86.0	53.0	47.5	42.5	-1.8	-10.1	-16.5
2.1N	20.6E	87.0	52.6	47.1	42.2	-2.0	-10.4	-16.8
1.4N	21.3E	88.0	52.3	46.7	41.7	-2.2	-10.6	-17.1
0.7N	22.0E	89.0	52.0	46.4	41.4	-2.4	-10.8	-17.3
0.0N	22.7E	90.0	51.7	46.0	41.0	-2.6	-11.1	-17.6
0.7S	23.4E	91.0	51.4	45.7	40.6	-2.5	-10.9	-17.3
1.4S	24.1E	92.0	51.1	45.3	40.3	-2.4	-10.7	-17.0
2.1S	24.8E	93.0	50.8	45.0	39.9	-2.3	-10.5	-16.7

OPTIONS T 9 ccccccccc
OUTPUT A1 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 90. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
2.8S	25.5E	94.0	50.5	44.6	39.6	-2.2	-10.3	-16.4
3.5S	26.3E	95.0	50.1	44.3	39.2	-2.1	-10.1	-16.2
4.2S	27.0E	96.0	49.8	44.0	38.8	-2.0	-9.9	-15.9
4.9S	27.7E	97.0	49.5	43.6	38.5	-1.9	-9.7	-15.6
5.6S	28.4E	98.0	49.2	43.3	38.1	-1.8	-9.5	-15.3
6.3S	29.1E	99.0	48.9	42.9	37.8	-1.7	-9.3	-15.0
7.0S	29.8E	100.0	48.5	42.6	37.4	-1.6	-9.1	-14.8

UNCLASSIFIED

OPTIONS T 9 ********
OUTPUT A1

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SER001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 180. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
34.7N	67.3W	10.0	81.0	78.1	75.4	25.3	19.3	14.5
33.7N	67.3W	11.0	80.4	77.4	74.6	24.6	18.6	13.6
32.7N	67.3W	12.0	79.9	76.9	74.1	23.9	17.9	13.0
31.7N	67.3W	13.0	79.5	76.4	73.6	23.3	17.3	12.4
30.7N	67.3W	14.0	79.1	76.0	73.3	22.8	16.8	11.9
29.7N	67.3W	15.0	78.7	75.7	72.9	22.3	16.3	11.4
28.7N	67.3W	16.0	78.4	75.3	72.6	22.0	16.0	11.1
27.7N	67.3W	17.0	78.1	75.0	72.3	21.7	15.7	10.8
26.7N	67.3W	18.0	77.7	74.5	71.5	21.2	15.1	10.0
25.7N	67.3W	19.0	77.2	74.0	70.9	20.7	14.5	9.5
24.7N	67.3W	20.0	76.6	73.4	70.3	20.2	13.9	8.9
23.7N	67.3W	21.0	76.1	72.8	69.7	19.6	13.4	8.3
22.7N	67.3W	22.0	75.6	72.2	69.0	19.0	12.8	7.7
21.7N	67.3W	23.0	75.0	71.6	68.4	18.5	12.2	7.1
20.7N	67.3W	24.0	74.5	71.0	67.8	18.0	11.7	6.5
19.7N	67.3W	25.0	74.0	70.5	67.2	17.4	11.1	5.9
18.7N	67.3W	26.0	73.5	69.9	66.6	16.9	10.5	5.2
17.7N	67.3W	27.0	73.0	69.3	66.0	16.4	9.8	4.6
16.7N	67.3W	28.0	72.6	68.7	65.4	15.9	9.2	3.9
15.7N	67.3W	29.0	72.1	68.2	64.8	15.4	8.6	3.2
14.7N	67.3W	30.0	71.6	67.6	64.2	14.6	7.7	2.1
13.7N	67.3W	31.0	71.1	67.0	63.6	14.1	7.1	1.4
12.7N	67.3W	32.0	70.6	66.4	63.0	13.6	6.5	0.8
11.7N	67.3W	33.0	70.2	65.9	62.4	13.2	5.9	0.1
10.7N	67.3W	34.0	69.7	65.3	61.8	12.7	5.3	-0.6
9.7N	67.3W	35.0	69.2	64.0	59.8	12.2	4.3	-2.0
8.7N	67.3W	36.0	68.6	63.4	59.2	11.8	4.0	-2.3
7.7N	67.3W	37.0	68.1	62.9	58.6	11.5	3.7	-2.5
6.7N	67.3W	38.0	67.7	62.4	58.1	11.2	3.4	-2.7
5.7N	67.3W	39.0	67.2	61.8	57.5	10.9	3.1	-3.0
4.7N	67.3W	40.0	66.8	61.2	56.9	10.6	2.8	-3.3
3.7N	67.3W	41.0	66.3	60.7	56.4	10.3	2.6	-3.5
2.7N	67.3W	42.0	65.8	60.2	55.9	10.0	2.3	-3.7
1.7N	67.3W	43.0	65.3	59.6	55.4	9.7	2.1	-3.9
0.7N	67.3W	44.0	64.9	59.1	54.9	9.4	1.8	-4.1
0.3S	67.3W	45.0	64.4	58.6	54.4	9.1	1.6	-4.3
1.3S	67.3W	46.0	63.9	58.1	53.8	9.0	1.5	-4.3
2.3S	67.3W	47.0	63.5	57.6	53.3	9.0	1.5	-4.3
3.3S	67.3W	48.0	63.0	57.1	52.8	8.9	1.4	-4.4
4.3S	67.3W	49.0	62.6	56.6	52.3	8.8	1.4	-4.4
5.3S	67.3W	50.0	62.1	56.1	51.8	8.7	1.3	-4.5
6.3S	67.3W	51.0	61.6	55.6	51.3	8.7	1.2	-4.5

OPTIONS T 9 ccccccccc
OUTPUT A1 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 180. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
7.3S	67.3W	52.0	61.2	55.1	50.8	8.6	1.2	-4.5
8.3S	67.3W	53.0	60.7	54.6	50.3	8.5	1.1	-4.6
9.3S	67.3W	54.0	60.3	54.1	49.8	8.5	1.0	-4.6
10.3S	67.3W	55.0	59.8	53.6	49.4	8.4	1.0	-4.7
11.3S	67.3W	56.0	59.4	53.1	48.9	8.4	0.9	-4.7
12.3S	67.3W	57.0	58.9	52.7	48.4	8.4	0.9	-4.7
13.3S	67.3W	58.0	58.5	52.2	47.9	8.4	0.8	-4.8
14.3S	67.3W	59.0	58.0	51.7	47.4	8.4	0.8	-4.8
15.3S	67.3W	60.0	57.6	51.2	46.9	8.3	0.8	-4.6
16.3S	67.3W	61.0	57.1	50.7	46.5	8.3	0.7	-4.7
17.3S	67.3W	62.0	56.7	50.3	46.0	8.3	0.7	-4.7
18.3S	67.3W	63.0	56.2	49.8	45.5	8.3	0.6	-4.8
19.3S	67.3W	64.0	55.8	49.3	45.0	8.3	0.5	-4.8
20.3S	67.3W	65.0	55.3	48.9	44.5	8.3	0.4	-4.9
21.3S	67.3W	66.0	54.9	48.4	44.1	8.0	0.1	-5.2
22.3S	67.3W	67.0	54.4	47.9	43.6	7.8	-0.2	-5.5
23.3S	67.3W	68.0	54.0	47.5	43.1	7.6	-0.4	-5.7
24.3S	67.3W	69.0	53.6	47.0	42.7	7.3	-0.7	-6.0
25.3S	67.3W	70.0	53.1	46.6	42.2	7.1	-0.9	-6.3
26.3S	67.3W	71.0	52.7	46.1	41.8	6.9	-1.2	-6.5
27.3S	67.3W	72.0	52.2	45.7	41.3	6.7	-1.5	-6.8
28.3S	67.3W	73.0	51.8	45.2	40.9	6.5	-1.7	-7.0
29.3S	67.3W	74.0	51.3	44.8	40.4	6.2	-2.0	-7.3
30.3S	67.3W	75.0	50.9	44.3	40.0	6.0	-2.2	-7.5
31.3S	67.3W	76.0	50.5	43.8	39.5	5.8	-2.4	-7.8
32.3S	67.3W	77.0	50.1	43.3	39.0	5.6	-2.7	-8.0
33.3S	67.3W	78.0	49.6	42.9	38.6	5.4	-2.9	-8.2
34.3S	67.3W	79.0	49.2	42.4	38.1	5.2	-3.1	-8.4
35.3S	67.3W	80.0	48.7	42.0	37.7	5.1	-3.3	-8.6
36.3S	67.3W	81.0	48.3	41.5	37.3	4.9	-3.5	-8.8
37.3S	67.3W	82.0	47.9	41.1	36.8	4.7	-3.7	-9.0
38.3S	67.3W	83.0	47.4	40.7	36.4	4.5	-4.0	-9.3
39.3S	67.3W	84.0	47.0	40.2	35.9	4.3	-4.2	-9.5
40.3S	67.3W	85.0	46.5	39.8	35.5	4.1	-4.4	-9.7
41.3S	67.3W	86.0	46.1	39.4	35.1	3.9	-4.6	-9.9
42.3S	67.3W	87.0	45.7	38.9	34.6	3.6	-4.8	-10.1
43.3S	67.3W	88.0	45.2	38.5	34.2	3.4	-5.0	-10.3
44.3S	67.3W	89.0	44.8	38.1	33.8	3.2	-5.2	-10.5
45.3S	67.3W	90.0	44.4	37.6	33.3	2.5	-6.0	-11.3
46.3S	67.3W	91.0	44.0	37.3	33.0	2.3	-6.1	-11.4
47.3S	67.3W	92.0	43.6	36.8	32.5	2.1	-6.3	-11.6
48.3S	67.3W	93.0	43.1	36.4	32.1	1.9	-6.5	-11.8

UNCLASSIFIED

OPTIONS T
OUTPUT A1

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SEP001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 180. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
49.3S	67.3W	94.0	42.7	36.0	31.7	1.7	-6.7	-12.0
50.3S	67.3W	95.0	42.3	35.6	31.3	1.5	-6.9	-12.1
51.3S	67.3W	96.0	42.0	35.2	30.9	1.3	-7.1	-12.3
52.3S	67.3W	97.0	41.6	34.9	30.6	1.1	-7.3	-12.5
53.3S	67.3W	98.0	41.2	34.5	30.2	0.9	-7.5	-12.8
54.3S	67.3W	99.0	40.7	34.1	29.8	0.5	-7.8	-13.0
55.3S	67.3W	100.0	40.3	33.7	29.4	0.2	-8.1	-13.3

OPTIONS T
OUTPUT A1

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SFRCC1

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 270. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
43.8N	81.2W	10.0	80.5	77.6	75.1	23.9	16.6	10.6
43.7N	82.6W	11.0	79.9	77.0	74.5	23.1	16.0	10.2
43.5N	83.9W	12.0	79.4	76.4	74.0	22.3	15.1	9.3
43.3N	85.3W	13.0	78.9	75.9	73.5	21.6	14.3	8.4
43.0N	86.6W	14.0	78.4	75.5	73.1	20.9	13.6	7.7
42.8N	88.0W	15.0	78.0	75.1	72.7	20.3	12.9	6.9
42.5N	89.3W	16.0	77.7	74.7	72.2	19.7	12.3	6.2
42.3N	90.6W	17.0	77.4	74.4	71.9	19.2	11.7	5.6
42.0N	91.9W	18.0	76.8	73.7	70.8	18.4	10.8	4.8
41.7N	93.1W	19.0	76.3	73.2	70.3	17.7	10.1	4.0
41.4N	94.4W	20.0	75.7	72.6	69.7	17.0	9.4	3.3
41.0N	95.7W	21.0	75.2	72.1	69.1	16.3	8.6	2.5
40.7N	96.9W	22.0	74.6	71.5	68.6	15.6	7.9	1.7
40.4N	98.1W	23.0	74.1	71.0	68.0	14.9	7.2	1.0
40.0N	99.4W	24.0	73.6	70.5	67.5	14.2	6.5	0.3
39.6N	100.6W	25.0	73.0	69.9	67.0	13.8	6.0	-0.2
39.2N	101.8W	26.0	72.5	69.3	66.3	13.5	5.7	-0.6
38.8N	102.9W	27.0	72.0	68.8	65.8	13.2	5.3	-0.9
38.4N	104.1W	28.0	71.5	68.3	65.3	12.9	5.0	-1.3
38.0N	105.2W	29.0	71.0	67.8	64.8	12.7	4.7	-1.6
37.5N	106.4W	30.0	70.6	67.3	64.2	12.4	4.4	-2.0
37.1N	107.5W	31.0	70.1	66.8	63.7	12.1	4.0	-2.3
36.6N	108.6W	32.0	69.6	66.3	63.2	11.9	3.7	-2.6
36.2N	109.7W	33.0	69.1	65.8	62.7	11.7	3.4	-2.9
35.7N	110.8W	34.0	68.6	65.3	62.1	11.7	3.5	-2.8
35.2N	111.9W	35.0	68.1	64.8	61.6	11.8	3.8	-2.4
34.7N	112.9W	36.0	67.7	64.2	61.0	11.9	4.0	-2.1
34.2N	114.0W	37.0	67.2	63.7	60.5	12.0	4.2	-1.7
33.7N	115.0W	38.0	66.8	63.2	60.0	12.2	4.5	-1.3
33.1N	116.0W	39.0	66.3	62.8	59.5	12.3	4.7	-0.9
32.6N	117.0W	40.0	65.9	62.3	59.0	12.4	5.0	-0.5
32.1N	118.0W	41.0	65.5	61.9	58.6	12.6	5.3	-0.1
31.5N	119.0W	42.0	65.2	61.5	58.2	12.7	5.6	0.3
31.0N	120.0W	43.0	64.8	61.1	57.8	12.9	5.9	0.8
30.4N	120.9W	44.0	64.4	60.7	57.4	13.0	6.2	1.1
29.8N	121.9W	45.0	64.1	60.3	57.0	13.2	6.4	1.5
29.2N	122.8W	46.0	63.7	59.9	56.6	13.3	6.5	1.8
28.7N	123.8W	47.0	63.3	59.5	56.2	13.4	6.9	2.1
28.1N	124.7W	48.0	63.0	59.1	55.7	13.4	7.1	2.3
27.5N	125.6W	49.0	62.7	58.7	55.3	13.5	7.3	2.6
26.9N	126.5W	50.0	62.3	58.3	54.9	13.6	7.5	2.9
26.3N	127.4W	51.0	62.0	57.9	54.5	13.7	7.6	3.1

UNCLASSIFIED

OPTIONS T 9 eeeeeeee
OUTPUT A1 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 270. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
25.7N	128.3W	52.0	61.6	57.6	54.1	13.0	7.0	2.4
25.0N	129.1W	53.0	61.3	57.2	53.7	13.1	7.2	2.6
24.4N	130.0W	54.0	60.9	56.8	53.3	13.2	7.3	2.7
23.8N	130.8W	55.0	60.6	56.4	52.9	13.2	7.4	2.9
23.2N	131.7W	56.0	60.2	56.1	52.6	13.2	7.5	3.0
22.5N	132.5W	57.0	59.9	55.7	52.2	13.2	7.6	3.2
21.9N	133.4W	58.0	59.6	55.3	51.8	13.3	7.7	3.3
21.2N	134.2W	59.0	59.2	54.9	51.4	13.3	7.7	3.4
20.6N	135.0W	60.0	58.9	54.5	51.0	13.3	7.8	3.5
19.9N	135.8W	61.0	58.6	54.1	50.6	13.3	7.9	3.6
19.3N	136.6W	62.0	58.2	53.7	50.2	13.3	7.9	3.7
18.6N	137.4W	63.0	57.9	53.4	49.8	13.4	8.0	3.7
18.0N	138.2W	64.0	57.5	52.3	48.0	13.4	7.4	2.5
17.3N	139.0W	65.0	57.2	51.9	47.6	13.4	7.4	2.5
16.6N	139.7W	66.0	56.8	51.6	47.3	13.4	7.4	2.5
16.0N	140.5W	67.0	56.5	51.2	46.9	13.3	7.3	2.4
15.3N	141.3W	68.0	56.2	50.8	46.5	13.2	7.1	2.2
14.6N	142.0W	69.0	55.8	50.5	46.1	13.0	6.9	2.0
13.9N	142.8W	70.0	55.5	50.1	45.8	12.8	6.7	1.7
13.2N	143.5W	71.0	55.2	49.7	45.4	12.7	6.5	1.5
12.6N	144.3W	72.0	54.8	49.3	45.0	12.5	6.3	1.3
11.9N	145.0W	73.0	54.5	49.0	44.7	12.4	6.1	1.1
11.2N	145.8W	74.0	54.2	48.5	44.2	12.2	5.9	0.8
10.5N	146.5W	75.0	53.8	48.2	43.9	12.0	5.7	0.6
9.8N	147.3W	76.0	53.5	47.8	43.5	11.8	5.4	0.3
9.1N	148.0W	77.0	53.2	47.5	43.1	11.6	5.1	0.0
8.4N	148.7W	78.0	52.9	47.1	42.8	11.4	4.8	-0.3
7.7N	149.4W	79.0	52.5	46.7	42.4	11.2	4.5	-0.6
7.0N	150.2W	80.0	52.2	46.4	42.1	11.0	4.2	-0.9
6.3N	150.9W	81.0	51.9	46.0	41.7	10.7	3.8	-1.3
5.6N	151.6W	82.0	51.6	45.7	41.3	10.4	3.4	-1.8
4.9N	152.3W	83.0	51.2	45.3	41.0	10.1	3.0	-2.2
4.2N	153.0W	84.0	50.9	45.0	40.6	9.8	2.5	-2.6
3.5N	153.7W	85.0	50.6	44.6	40.3	9.4	2.1	-3.1
2.8N	154.5W	86.0	50.3	44.3	39.9	9.1	1.7	-3.5
2.1N	155.2W	87.0	49.9	43.9	39.6	8.8	1.3	-4.0
1.4N	155.9W	88.0	49.6	43.6	39.2	8.4	0.8	-4.4
0.7N	156.6W	89.0	49.3	43.2	38.9	8.1	0.3	-4.9
0.0S	157.3W	90.0	49.0	42.9	38.5	7.8	-0.1	-5.4
0.7S	158.0W	91.0	48.6	42.5	38.2	7.4	-0.6	-5.9
1.4S	158.7W	92.0	48.3	42.2	37.8	7.0	-1.1	-6.4
2.1S	159.4W	93.0	48.0	41.8	37.5	6.6	-1.6	-6.9

OPTIONS T 9 ¢¢¢¢¢¢¢¢
OUTPUT A1

VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER001

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 270. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
2.8S	160.1W	94.0	47.7	41.5	37.1	6.2	-2.1	-7.4
3.5S	160.9W	95.0	47.4	41.2	36.8	5.8	-2.6	-7.9
4.2S	161.6W	96.0	47.0	40.8	36.5	5.3	-3.1	-8.5
4.9S	162.3W	97.0	46.7	40.5	36.1	4.8	-3.6	-9.0
5.6S	163.0W	98.0	46.4	40.1	35.8	4.3	-4.1	-9.5
6.3S	163.7W	99.0	46.1	39.8	35.5	3.8	-4.6	-10.1
7.0S	164.4W	100.0	45.8	39.5	35.1	3.3	-5.1	-10.6

UNCLASSIFIED

OPTIONS T 9 S=S/J
OUTPUT A1

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SER002

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

S/SCON 64. 41. 1000. 10

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 0. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
54.7N	67.3W	10.0	35.2	31.1	27.8	30.4	24.7	20.1
64.7N	67.3W	20.0	17.4	13.5	10.3	23.5	17.6	13.5
74.7N	67.3W	30.0	-0.2	-4.1	-7.4	17.2	12.2	8.4
84.7N	67.3W	40.0	-23.5	-27.5	-30.8	5.6	1.0	-2.7
85.3N	112.7E	50.0	-28.8	-32.8	-36.1	0.6	-3.8	-7.5
75.3N	112.7E	60.0	-25.9	-29.9	-33.3	-5.1	-10.8	-15.2
65.3N	112.7E	70.0	-34.0	-38.0	-41.4	-22.1	-29.0	-34.4
55.3N	112.7E	80.0	-36.2	-40.5	-44.4	-34.6	-43.2	-49.7
45.3N	112.7E	90.0	-41.3	-46.1	-50.6	-40.8	-49.0	-55.2
35.3N	112.7E	100.0	-44.3	-49.5	-54.4	-43.6	-50.8	-56.3

OPTIONS T 9 S=S/J
OUTPUT A1

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SER002

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

S/SCON 64. 41. 1000. 10

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 90. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
43.8N	53.4W	10.0	17.8	13.6	10.2	30.8	25.6	21.4
41.4N	40.2W	20.0	12.6	8.3	4.8	28.7	23.4	18.8
37.5N	28.2W	30.0	8.4	4.1	0.4	26.1	21.2	17.0
32.6N	17.6W	40.0	4.4	0.0	-3.7	22.8	18.0	13.9
26.9N	8.1W	50.0	3.1	-1.5	-5.4	16.9	11.3	6.7
20.6N	0.4E	60.0	0.7	-4.4	-8.5	10.1	2.9	-2.6
13.9N	8.2E	70.0	-1.2	-7.7	-13.2	4.5	-3.5	-9.8
7.0N	15.6E	80.0	-2.2	-9.3	-15.2	-0.2	-8.4	-14.8
0.0N	22.7E	90.0	-3.1	-11.0	-17.2	-2.6	-11.1	-17.6
7.0S	29.8E	100.0	-2.8	-11.6	-18.2	-1.6	-9.1	-14.8

UNCLASSIFIED

OPTIONS T 9 S=S/J
OUTPUT A1

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SER002

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

S/SCON 64. 41. 1000. 10

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 180. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
34.7N	67.3W	10.0	22.7	18.5	15.0	25.3	19.3	14.5
24.7N	67.3W	20.0	21.4	17.0	13.4	20.2	13.9	8.9
14.7N	67.3W	30.0	18.3	13.8	10.1	14.6	7.7	2.1
4.7N	67.3W	40.0	16.6	10.7	5.6	10.6	2.8	-3.3
5.3S	67.3W	50.0	15.3	9.3	4.1	8.7	1.3	-4.5
15.3S	67.3W	60.0	14.2	8.1	2.8	8.3	0.8	-4.6
25.3S	67.3W	70.0	13.5	7.1	1.8	7.1	-0.9	-6.3
35.3S	67.3W	80.0	12.1	5.4	-0.3	5.1	-3.3	-8.6
45.3S	67.3W	90.0	10.4	3.2	-2.8	2.5	-6.0	-11.3
55.3S	67.3W	100.0	7.1	-0.7	-7.3	0.2	-8.1	-13.3

OPTIONS T 9 S=S/J
OUTPUT A1

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SEP002

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

S/SCON 64. 41. 1000. 10

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 270. DEG

RECEIVER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
43.8N	81.2W	10.0	45.5	41.4	37.7	23.9	16.6	10.6
41.4N	94.4W	20.0	41.6	37.4	33.9	17.0	9.4	3.3
37.5N	106.4W	30.0	49.0	43.8	40.1	12.4	4.4	-2.0
32.6N	117.0W	40.0	45.6	41.3	37.6	12.4	5.0	-0.5
26.9N	126.5W	50.0	28.2	23.8	20.0	13.6	7.5	2.9
20.6N	135.0W	60.0	16.3	11.6	7.4	13.3	7.8	3.5
13.9N	142.8W	70.0	14.0	7.6	2.2	12.8	6.7	1.7
7.0N	150.2W	80.0	11.5	4.6	-1.0	11.0	4.2	-0.9
0.0S	157.3W	90.0	10.0	2.5	-3.3	7.8	-0.1	-5.4
7.0S	164.4W	100.0	12.4	4.3	-1.6	3.3	-5.1	-10.6

UNCLASSIFIED

OPTIONS T S=S/J
OUTPUT B1 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER003

TRANSMITTER MIN 54.0N 28.0E
RECEIVER SSBN 60.0N 10.0W
BEARING = 301.7DEG DISTANCE = 21.2DEG

FREQUENCY = 26.1 KHZ
NOISE BW = 1 KHZ
POWER = 500.0KW

MONTH JUL

GMT	S(DB)	N(DB)	S/N(DB)	SIGMA(S)	SIGMA(NU)	SIGMA(SN-L)	NDT
00	76.7	40.5	36.1	3.6	2.4	4.3	N
01	76.7	40.3	36.4	3.6	2.4	4.3	N
02	66.4	39.7	26.6	3.6	2.4	4.3	T
03	64.3	39.1	25.2	2.0	2.4	3.1	D
04	64.5	38.7	25.7	2.0	2.5	3.2	D
05	64.7	37.3	27.4	2.0	2.5	3.2	D
06	64.9	36.9	28.0	2.0	2.6	3.3	D
07	65.1	36.9	28.2	2.0	2.5	3.2	D
08	65.2	37.4	27.8	2.0	2.5	3.2	D
09	65.3	38.1	27.3	2.0	2.5	3.2	D
10	65.4	38.9	26.5	2.0	2.6	3.3	D
11	65.4	39.9	25.5	2.0	2.7	3.4	D
12	65.4	40.2	25.3	2.0	2.6	3.3	D
13	65.4	40.3	25.1	2.0	2.7	3.4	D
14	65.3	40.2	25.1	2.0	2.6	3.3	D
15	65.2	39.9	25.3	2.0	2.7	3.4	D
16	65.0	39.3	25.7	2.0	2.7	3.4	D
17	64.8	38.8	26.0	2.0	2.7	3.3	D
18	64.6	38.3	26.4	2.0	2.6	3.3	D
19	64.4	37.7	26.7	2.0	2.5	3.2	D
20	66.3	38.5	27.8	3.6	2.5	4.4	T
21	68.1	40.2	27.9	3.6	2.4	4.4	T
22	70.4	38.5	31.9	3.6	2.5	4.4	T
23	76.7	39.1	37.5	3.6	2.4	4.3	N

OPTIONS T T 9 S=S/J
OUTPUT A2

VLF PROPAGATION STUDIES

NOPP 74(VLFACM)SER003

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

JAM 54. 28.

MONTH JUL

POWER = 100.0KW
FREQUENCY=26.1 KHZ

RECEIVER LOCATION 60.0N 10.0W

NOISE BW = 1 KHZ
BEARING = 180. DEG

TRANSMITTER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
59.0N	10.0W	1.0	22.5	14.6	5.2	49.6	45.0	41.0
58.0N	10.0W	2.0	16.4	8.8	-0.3	43.5	38.9	35.0
57.0N	10.0W	3.0	12.7	5.5	-3.3	39.9	35.3	31.5
56.0N	10.0W	4.0	10.1	3.2	-5.5	37.4	32.7	28.8
55.0N	10.0W	5.0	8.0	1.4	-7.0	35.4	30.7	26.8
54.0N	10.0W	6.0	6.2	-0.0	-8.2	33.6	28.9	25.1
53.0N	10.0W	7.0	4.8	-1.2	-9.1	32.2	27.4	23.7
52.0N	10.0W	8.0	3.4	-2.4	-9.9	30.9	26.1	22.3
51.0N	10.0W	9.0	2.2	-3.4	-10.5	29.8	24.9	21.0
50.0N	10.0W	10.0	1.2	-4.3	-11.1	28.7	23.8	19.9
49.0N	10.0W	11.0	0.3	-5.0	-11.6	27.8	22.9	19.0
48.0N	10.0W	12.0	-0.6	-5.7	-12.1	27.0	22.0	18.1
47.0N	10.0W	13.0	-1.3	-6.4	-12.8	26.2	21.1	17.0
46.0N	10.0W	14.0	-2.1	-7.1	-13.2	25.4	20.3	16.2
45.0N	10.0W	15.0	-2.8	-7.6	-13.6	24.7	19.6	15.5
44.0N	10.0W	16.0	-3.4	-8.2	-14.0	24.0	18.9	14.8
43.0N	10.0W	17.0	-4.0	-8.7	-14.4	23.4	18.2	14.2
42.0N	10.0W	18.0	-4.4	-8.9	-13.8	23.1	17.9	14.0
41.0N	10.0W	19.0	-4.8	-9.4	-14.2	22.7	17.4	13.5
40.0N	10.0W	20.0	-5.3	-9.9	-14.8	22.2	16.9	13.1
39.0N	10.0W	21.0	-5.8	-10.4	-15.3	21.7	16.4	12.6
38.0N	10.0W	22.0	-6.4	-11.0	-15.8	21.2	15.9	12.1
37.0N	10.0W	23.0	-6.8	-11.5	-16.5	20.8	15.4	11.5
36.0N	10.0W	24.0	-7.3	-12.0	-17.0	20.3	15.0	11.1
35.0N	10.0W	25.0	-7.8	-12.5	-17.5	19.8	14.5	10.6
34.0N	10.0W	26.0	-8.2	-13.0	-18.1	19.4	14.0	10.2
33.0N	10.0W	27.0	-8.7	-13.5	-18.7	18.9	13.6	9.8
32.0N	10.0W	28.0	-9.2	-14.0	-19.3	18.4	13.1	9.2
31.0N	10.0W	29.0	-9.8	-14.6	-20.0	17.9	12.5	8.7
30.0N	10.0W	30.0	-10.2	-15.2	-20.9	17.4	12.0	7.9
29.0N	10.0W	31.0	-10.8	-15.7	-21.4	17.0	11.5	7.5
28.0N	10.0W	32.0	-11.3	-16.2	-21.9	16.5	11.0	7.0
27.0N	10.0W	33.0	-11.8	-16.7	-22.5	16.0	10.5	6.5
26.0N	10.0W	34.0	-12.3	-17.2	-23.0	15.5	10.1	6.1
25.0N	10.0W	35.0	-12.8	-17.8	-23.6	15.0	9.6	5.6
24.0N	10.0W	36.0	-13.2	-18.3	-24.2	14.5	9.1	5.2
23.0N	10.0W	37.0	-13.7	-18.8	-24.5	14.1	8.6	4.7
22.0N	10.0W	38.0	-14.2	-19.2	-24.9	13.6	8.1	4.2
21.0N	10.0W	39.0	-14.6	-19.7	-25.2	13.2	7.7	3.7
20.0N	10.0W	40.0	-15.1	-20.1	-25.6	12.7	7.2	3.3
19.0N	10.0W	41.0	-15.5	-20.6	-26.0	12.3	6.7	2.8
18.0N	10.0W	42.0	-16.0	-21.0	-26.3	11.8	6.2	2.3

UNCLASSIFIED

OPTIONS T T 9 S=S/J
OUTPUT A2

VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER003

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES JAM 54. 28.

MONTH JUL

POWER = 100.0KW
FREQUENCY=26.1 KHZ

RECEIVER LOCATION 60.0N 10.0W

NOISE BW = 1 KHZ
BEARING = 130. DEG

TRANSMITTER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
17.0N	10.0W	43.0	-16.4	-21.5	-26.7	11.4	5.7	1.8
16.0N	10.0W	44.0	-16.7	-23.2	-29.1	11.1	4.2	-0.7
15.0N	10.0W	45.0	-17.2	-23.6	-29.5	10.7	3.8	-1.2
14.0N	10.0W	46.0	-17.6	-24.1	-29.9	10.2	3.3	-1.7
13.0N	10.0W	47.0	-18.0	-24.5	-30.3	9.8	2.8	-2.1
12.0N	10.0W	48.0	-18.4	-25.0	-30.7	9.4	2.4	-2.6
11.0N	10.0W	49.0	-18.8	-25.4	-31.6	9.0	1.9	-3.5
10.0N	10.0W	50.0	-19.2	-25.9	-31.9	8.6	1.4	-3.9
9.0N	10.0W	51.0	-19.6	-26.3	-32.3	8.2	1.0	-4.3
8.0N	10.0W	52.0	-20.1	-26.7	-32.6	7.8	0.5	-4.7
7.0N	10.0W	53.0	-20.5	-27.1	-33.0	7.4	0.1	-5.2
6.0N	10.0W	54.0	-20.9	-27.5	-33.4	7.0	-0.3	-5.6
5.0N	10.0W	55.0	-21.2	-27.9	-33.7	6.7	-0.7	-6.0
4.0N	10.0W	56.0	-21.5	-28.2	-34.0	6.3	-1.1	-6.3
3.0N	10.0W	57.0	-21.8	-28.6	-34.3	6.0	-1.4	-6.7
2.0N	10.0W	58.0	-22.2	-28.9	-34.6	5.7	-1.8	-7.0
1.0N	10.0W	59.0	-22.5	-29.3	-34.9	5.4	-2.1	-7.4
0.0N	10.0W	60.0	-22.8	-29.6	-35.2	5.1	-2.5	-7.8
1.0S	10.0W	61.0	-23.1	-30.0	-36.0	4.8	-2.9	-8.6
2.0S	10.0W	62.0	-23.4	-30.3	-36.3	4.5	-3.2	-8.9
3.0S	10.0W	63.0	-23.7	-30.6	-36.6	4.2	-3.5	-9.2
4.0S	10.0W	64.0	-24.0	-30.9	-36.9	3.9	-3.8	-9.6
5.0S	10.0W	65.0	-24.3	-31.2	-37.1	3.6	-4.2	-9.9
6.0S	10.0W	66.0	-24.6	-31.5	-37.4	3.3	-4.5	-10.2
7.0S	10.0W	67.0	-24.9	-31.9	-37.7	3.0	-4.8	-10.5
8.0S	10.0W	68.0	-25.2	-32.2	-38.0	2.7	-5.2	-10.8
9.0S	10.0W	69.0	-25.5	-32.5	-38.3	2.4	-5.5	-11.1
10.0S	10.0W	70.0	-25.8	-32.8	-38.6	2.1	-5.8	-11.4
11.0S	10.0W	71.0	-26.1	-33.1	-38.9	1.8	-6.2	-11.7
12.0S	10.0W	72.0	-26.4	-33.5	-39.2	1.5	-6.5	-12.0
13.0S	10.0W	73.0	-26.6	-33.8	-39.5	1.2	-6.8	-12.4
14.0S	10.0W	74.0	-26.9	-34.1	-39.8	0.9	-7.2	-12.7
15.0S	10.0W	75.0	-27.2	-34.4	-40.1	0.6	-7.5	-13.1
16.0S	10.0W	76.0	-27.5	-34.8	-40.4	0.3	-7.8	-13.4
17.0S	10.0W	77.0	-27.8	-35.1	-40.7	0.0	-8.2	-13.7
18.0S	10.0W	78.0	-28.1	-35.4	-41.0	-0.3	-8.5	-14.1
19.0S	10.0W	79.0	-28.4	-35.7	-41.4	-0.5	-8.8	-14.4
20.0S	10.0W	80.0	-28.7	-36.1	-41.7	-0.8	-9.2	-14.8
21.0S	10.0W	81.0	-29.0	-36.4	-42.1	-1.1	-9.5	-15.1
22.0S	10.0W	82.0	-29.2	-36.7	-42.4	-1.4	-9.9	-15.5
23.0S	10.0W	83.0	-29.5	-37.0	-42.8	-1.7	-10.2	-15.8
24.0S	10.0W	84.0	-29.8	-37.4	-43.1	-2.0	-10.5	-16.2

OPTIONS T T
OUTPUT A2

S=S/J

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SER003

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

JAM 54. 28.

POWER = 160.0KW
FREQUENCY=26.1 KHZ

RECEIVER LOCATION 60.0N 10.0W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 180. DEG

TRANSMITTER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
25.0S	10.0W	85.0	-30.1	-37.7	-43.5	-2.3	-10.9	-16.6
26.0S	10.0W	86.0	-30.3	-38.0	-44.4	-2.5	-11.2	-17.4
27.0S	10.0W	87.0	-30.6	-38.3	-44.7	-2.8	-11.6	-17.7
28.0S	10.0W	88.0	-30.9	-38.6	-45.0	-3.1	-11.9	-18.0
29.0S	10.0W	89.0	-31.2	-38.9	-45.2	-3.3	-12.2	-18.3
30.0S	10.0W	90.0	-31.4	-39.2	-45.5	-3.6	-12.5	-18.7

UNCLASSIFIED

OPTIONS T T 9 S=S/J
OUTPUT A2

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SER003

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

JAM 54. 28.

MONTH JUL

POWER = 100.0KW
FREQUENCY=26.1 KHZ

RECEIVER LOCATION 60.0N 10.0W

NOISE BW = 1 KHZ
BEARING = 270. DEG

TRANSMITTER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
60.0N	12.0W	1.0	22.5	14.6	5.3	49.6	45.0	41.0
59.9N	14.0W	2.0	16.4	8.9	-0.3	43.5	38.9	35.1
59.9N	16.0W	3.0	12.7	5.5	-3.3	39.9	35.3	31.4
59.8N	18.0W	4.0	10.1	3.2	-5.3	37.3	32.7	28.9
59.6N	19.9W	5.0	8.0	1.5	-6.8	35.3	30.7	26.9
59.5N	21.9W	6.0	6.3	0.0	-7.9	33.7	29.0	25.2
59.3N	23.8W	7.0	4.8	-1.2	-8.9	32.2	27.5	23.8
59.0N	25.7W	8.0	3.5	-2.3	-9.6	31.0	26.3	22.5
58.8N	27.6W	9.0	2.4	-3.4	-10.3	29.9	25.0	21.2
58.5N	29.4W	10.0	1.3	-4.3	-10.9	28.8	24.0	20.1
58.2N	31.2W	11.0	0.4	-5.0	-11.5	27.9	23.0	19.2
57.9N	33.0W	12.0	-0.5	-5.8	-12.0	27.0	22.1	18.3
57.5N	34.8W	13.0	-1.3	-6.4	-12.6	26.2	21.3	17.4
57.2N	36.5W	14.0	-2.0	-7.1	-13.1	25.4	20.5	16.7
56.8N	38.2W	15.0	-2.7	-7.7	-13.6	24.7	19.7	15.8
56.4N	39.8W	16.0	-3.4	-8.4	-14.2	24.0	19.0	15.1
55.9N	41.4W	17.0	-4.0	-9.0	-14.7	23.3	18.3	14.5
55.5N	43.0W	18.0	-4.8	-10.9	-20.2	22.6	17.6	13.7
55.0N	44.6W	19.0	-5.2	-11.4	-20.8	22.1	17.1	13.3
54.5N	46.1W	20.0	-5.7	-12.1	-21.4	21.6	16.6	12.7
54.0N	47.5W	21.0	-6.2	-12.6	-22.0	21.2	16.1	12.2
53.4N	48.9W	22.0	-6.7	-13.1	-22.6	20.7	15.6	11.8
52.9N	50.3W	23.0	-7.1	-13.7	-23.2	20.2	15.2	11.3
52.3N	51.7W	24.0	-7.6	-14.2	-23.7	19.8	14.7	10.8
51.7N	53.0W	25.0	-8.0	-14.7	-24.3	19.3	14.2	10.3
51.1N	54.3W	26.0	-8.5	-15.2	-24.8	18.9	13.8	9.9
50.5N	55.5W	27.0	-8.9	-15.8	-25.3	18.4	13.3	9.4
49.9N	56.8W	28.0	-9.4	-16.3	-25.9	17.9	12.8	8.8
49.2N	57.9W	29.0	-9.9	-16.9	-26.5	17.4	12.3	8.3
48.6N	59.1W	30.0	-10.4	-17.5	-27.1	16.9	11.8	7.8
47.9N	60.2W	31.0	-10.8	-17.9	-27.6	16.5	11.3	7.4
47.3N	61.3W	32.0	-11.2	-18.4	-28.1	16.1	10.9	7.0
46.6N	62.4W	33.0	-11.6	-18.9	-28.5	15.7	10.5	6.6
45.9N	63.5W	34.0	-12.1	-19.5	-29.1	15.2	10.0	5.9
45.2N	64.5W	35.0	-12.5	-20.0	-29.6	14.8	9.5	5.5
44.5N	65.5W	36.0	-13.0	-20.6	-30.2	14.3	9.0	5.0
43.8N	66.4W	37.0	-13.4	-21.0	-30.8	13.8	8.5	4.5
43.0N	67.4W	38.0	-13.8	-21.4	-31.2	13.5	8.1	4.1
42.3N	68.3W	39.0	-14.1	-21.8	-31.7	13.1	7.8	3.7
41.6N	69.2W	40.0	-14.5	-22.2	-32.1	12.8	7.4	3.3
40.8N	70.1W	41.0	-14.9	-22.6	-32.5	12.4	7.0	2.9
40.1N	71.0W	42.0	-15.2	-23.0	-33.0	12.0	6.6	2.6

OPTIONS T T 9 S=S/J
OUTPUT A2

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SER003

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES

JAM 54. 28.

MONTH JUL

POWER = 100.0KW
FREQUENCY=26.1 KHZ

RECEIVER LOCATION 60.0N 10.0W

NOISE BW = 1 KHZ
BEARING = 270. DEG

TRANSMITTER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
39.3N	71.8W	43.0	-15.5	-23.5	-33.4	11.7	6.2	2.0
38.5N	72.6W	44.0	-15.8	-23.9	-33.8	11.4	5.8	1.7
37.8N	73.4W	45.0	-16.2	-24.2	-34.2	11.0	5.5	1.3
37.0N	74.2W	46.0	-16.5	-24.6	-34.6	10.7	5.1	1.0
36.2N	75.0W	47.0	-15.8	-24.9	-35.1	10.4	4.7	0.6
35.4N	75.8W	48.0	-17.2	-25.3	-35.5	10.0	4.4	0.2
34.6N	76.5W	49.0	-17.5	-25.7	-35.9	9.7	4.0	-0.2
33.8N	77.2W	50.0	-17.8	-26.0	-36.3	9.4	3.7	-0.5
33.0N	78.0W	51.0	-18.1	-26.4	-36.7	9.0	3.3	-0.9
32.2N	78.7W	52.0	-18.5	-26.8	-37.2	8.7	2.9	-1.3
31.4N	79.4W	53.0	-18.8	-27.2	-37.6	8.4	2.5	-1.7
30.6N	80.0W	54.0	-19.1	-27.7	-38.1	8.1	2.1	-2.3
29.8N	80.7W	55.0	-19.4	-28.0	-38.5	7.7	1.8	-2.7
29.0N	81.4W	56.0	-19.8	-28.5	-39.1	7.3	1.3	-3.1
28.1N	82.0W	57.0	-20.2	-28.9	-39.6	6.9	0.9	-3.6
27.3N	82.6W	58.0	-20.5	-29.4	-40.1	6.5	0.4	-4.0
26.5N	83.3W	59.0	-20.8	-29.7	-40.6	6.2	0.1	-4.4
25.7N	83.9W	60.0	-21.1	-30.1	-41.0	5.9	-0.3	-4.8
24.8N	84.5W	61.0	-21.5	-30.4	-41.4	5.6	-0.6	-5.2
24.0N	85.1W	62.0	-21.8	-30.8	-41.8	5.3	-1.0	-5.6
23.2N	85.7W	63.0	-22.1	-31.1	-42.3	5.0	-1.3	-5.9
22.3N	86.3W	64.0	-22.4	-31.5	-42.7	4.7	-1.7	-6.3
21.5N	86.9W	65.0	-22.6	-31.8	-43.1	4.4	-2.1	-6.7
20.6N	87.4W	66.0	-23.0	-32.2	-43.6	4.0	-2.5	-7.2
19.8N	88.0W	67.0	-23.4	-32.7	-44.1	3.6	-3.0	-7.7
18.9N	88.6W	68.0	-23.7	-33.3	-44.6	3.3	-3.4	-8.5
18.1N	89.1W	69.0	-24.1	-33.7	-45.1	2.9	-3.8	-8.9
17.2N	89.7W	70.0	-24.4	-34.1	-45.6	2.5	-4.2	-9.3
16.4N	90.2W	71.0	-24.8	-34.5	-46.1	2.2	-4.6	-9.7
15.5N	90.8W	72.0	-25.2	-34.9	-46.6	1.8	-5.1	-10.2
14.7N	91.3W	73.0	-25.5	-35.3	-47.1	1.4	-5.5	-10.6
13.8N	91.8W	74.0	-25.8	-35.6	-47.5	1.2	-5.8	-10.9
13.0N	92.4W	75.0	-26.1	-35.9	-47.9	0.9	-6.1	-11.3
12.1N	92.9W	76.0	-26.4	-36.2	-48.2	0.6	-6.5	-11.6
11.2N	93.4W	77.0	-26.6	-37.3	-49.9	0.6	-7.7	-14.0
10.4N	93.9W	78.0	-26.8	-37.6	-50.3	0.3	-8.0	-14.3
9.5N	94.4W	79.0	-27.1	-37.9	-50.5	0.0	-8.4	-14.7
8.6N	95.0W	80.0	-27.4	-38.2	-51.0	-0.3	-8.7	-15.0
7.8N	95.5W	81.0	-27.6	-38.5	-51.4	-0.5	-9.0	-15.4
5.9N	96.0W	82.0	-27.9	-38.9	-51.8	-0.8	-9.3	-15.7
6.1N	96.5W	83.0	-28.2	-39.2	-52.2	-1.1	-9.7	-16.1
5.2N	97.0W	84.0	-28.4	-39.5	-52.5	-1.3	-10.0	-16.4

UNCLASSIFIED

OPTIONS T T 9 S=S/J
OUTPUT A2

VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER003

DB LEVEL EXCEEDED FOR FIXED PROBABILITIES JAM 54. 28.

MONTH JUL

POWER = 100.0KW
FREQUENCY=26.1 KHZ

RECEIVER LOCATION 60.0N 10.0W

NOISE BW = 1 KHZ
BEARING = 270. DEG

TRANSMITTER LOCATIONS		DISTANCE	S(DB)			S/N(DB)		
LAT(DEG)	LON(DEG)	(DEG)	P=0.500	P=0.900	P=0.990	P=0.500	P=0.900	P=0.990
4.3N	97.5W	85.0	-28.6	-40.0	-52.9	-1.6	-10.3	-17.2
3.5N	98.0W	86.0	-28.9	-40.3	-53.3	-1.8	-10.6	-17.5
2.6N	98.5W	87.0	-29.1	-40.6	-53.6	-2.1	-10.9	-17.8
1.7N	99.0W	88.0	-29.4	-40.9	-54.0	-2.4	-11.2	-18.1
0.9N	99.5W	89.0	-29.7	-41.2	-54.4	-2.6	-11.5	-18.4
0.0S	100.0W	90.0	-30.0	-41.5	-54.7	-2.9	-11.8	-18.7

OPTIONS T 9 ¢¢¢¢¢¢¢¢
OUTPUT A3 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER004

AVERAGE PROBABILITIES FOR FIXED THRESHOLDS

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 330. DEG

RECEIVER LOCATIONS		DISTANCE	S PROBABILITY			S/N PROBABILITY		
LAT(DEG)	LON(DEG)	(DEG)	T= 60.0	T= 48.0	T= 30.0	T= 12.0	T= -6.0	T=-24.0
53.1N	75.6W	10.0	1.000	1.000	1.000	0.999	1.000	1.000
53.9N	76.6W	11.0	1.000	1.000	1.000	0.999	1.000	1.000
54.7N	77.7W	12.0	1.000	1.000	1.000	0.996	1.000	1.000
55.5N	78.7W	13.0	1.000	1.000	1.000	0.995	1.000	1.000
56.2N	79.9W	14.0	1.000	1.000	1.000	0.994	1.000	1.000
57.0N	81.0W	15.0	1.000	1.000	1.000	0.994	1.000	1.000
57.8N	82.3W	16.0	1.000	1.000	1.000	0.994	1.000	1.000
58.5N	83.5W	17.0	1.000	1.000	1.000	0.995	1.000	1.000
59.2N	84.9W	18.0	1.000	1.000	1.000	0.992	1.000	1.000
59.9N	86.3W	19.0	1.000	1.000	1.000	0.991	1.000	1.000
60.6N	87.7W	20.0	1.000	1.000	1.000	0.991	1.000	1.000
61.3N	89.2W	21.0	1.000	1.000	1.000	0.992	1.000	1.000
62.0N	90.8W	22.0	1.000	1.000	1.000	0.993	1.000	1.000
62.6N	92.4W	23.0	1.000	1.000	1.000	0.991	1.000	1.000
63.2N	94.2W	24.0	1.000	1.000	1.000	0.982	1.000	1.000
63.8N	96.0W	25.0	0.998	1.000	1.000	0.967	1.000	1.000
64.4N	97.8W	26.0	0.989	1.000	1.000	0.944	1.000	1.000
65.0N	99.8W	27.0	0.945	1.000	1.000	0.911	1.000	1.000
65.5N	101.8W	28.0	0.806	1.000	1.000	0.852	1.000	1.000
66.0N	103.9W	29.0	0.540	1.000	1.000	0.772	1.000	1.000
66.5N	106.1W	30.0	0.257	1.000	1.000	0.683	1.000	1.000
66.9N	108.4W	31.0	0.085	1.000	1.000	0.571	1.000	1.000
67.3N	110.7W	32.0	0.021	0.997	1.000	0.457	1.000	1.000
67.7N	113.2W	33.0	0.009	0.993	1.000	0.405	1.000	1.000
68.0N	115.7W	34.0	0.002	0.964	1.000	0.297	1.000	1.000
68.3N	118.2W	35.0	0.000	0.862	1.000	0.199	0.999	1.000
68.6N	120.9W	36.0	0.000	0.638	1.000	0.109	0.997	1.000
68.8N	123.5W	37.0	0.000	0.350	1.000	0.040	0.988	1.000
68.9N	126.3W	38.0	0.000	0.135	1.000	0.011	0.956	1.000
69.1N	129.1W	39.0	0.000	0.038	1.000	0.002	0.875	1.000
69.1N	131.9W	40.0	0.000	0.009	1.000	0.001	0.764	1.000
69.2N	134.7W	41.0	0.000	0.002	1.000	0.000	0.641	1.000
69.2N	137.5W	42.0	0.000	0.001	1.000	0.000	0.610	1.000
69.1N	140.3W	43.0	0.000	0.000	0.999	0.000	0.468	1.000
69.0N	143.1W	44.0	0.000	0.000	0.996	0.000	0.343	1.000
68.9N	145.8W	45.0	0.000	0.000	0.978	0.000	0.230	0.999
68.7N	148.5W	46.0	0.000	0.000	0.910	0.000	0.140	0.997
68.4N	151.2W	47.0	0.000	0.000	0.738	0.000	0.080	0.994
68.1N	153.8W	48.0	0.000	0.000	0.470	0.000	0.043	0.990
67.8N	156.3W	49.0	0.000	0.000	0.217	0.000	0.020	0.982
67.5N	158.8W	50.0	0.000	0.000	0.072	0.000	0.008	0.969
67.1N	161.1W	51.0	0.000	0.000	0.018	0.000	0.003	0.943

UNCLASSIFIED

OPTIONS T 9 ccccccccc
OUTPUT A3 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER004

AVERAGE PROBABILITIES FOR FIXED THRESHOLDS

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 330. DEG

RECEIVER LOCATIONS		DISTANCE	S PROBABILITY			S/N PROBABILITY		
LAT(DEG)	LON(DEG)	(DEG)	T= 60.0	T= 48.0	T= 36.0	T= 12.0	T= -6.0	T=-24.0
66.7N	163.4W	52.0	0.000	0.000	0.014	0.000	0.002	0.944
66.2N	165.7W	53.0	0.000	0.000	0.007	0.000	0.001	0.930
65.7N	167.8W	54.0	0.000	0.000	0.004	0.000	0.000	0.913
65.2N	169.9W	55.0	0.000	0.000	0.003	0.000	0.000	0.909
64.6N	171.8W	56.0	0.000	0.000	0.002	0.000	0.000	0.887
64.1N	173.7W	57.0	0.000	0.000	0.001	0.000	0.000	0.858
63.5N	175.6W	58.0	0.000	0.000	0.001	0.000	0.000	0.822
62.9N	177.3W	59.0	0.000	0.000	0.001	0.000	0.000	0.777
62.2N	179.0W	60.0	0.000	0.000	0.001	0.000	0.000	0.726
61.6N	179.4E	61.0	0.000	0.000	0.000	0.000	0.000	0.665
60.9N	177.9E	62.0	0.000	0.000	0.000	0.000	0.000	0.590
60.2N	176.4E	63.0	0.000	0.000	0.000	0.000	0.000	0.513
59.5N	175.0E	64.0	0.000	0.000	0.000	0.000	0.000	0.454
58.8N	173.7E	65.0	0.000	0.000	0.000	0.000	0.000	0.405
58.0N	172.4E	66.0	0.000	0.000	0.000	0.000	0.000	0.360
57.3N	171.1E	67.0	0.000	0.000	0.000	0.000	0.000	0.321
56.5N	169.9E	68.0	0.000	0.000	0.000	0.000	0.000	0.284
55.8N	168.8E	69.0	0.000	0.000	0.000	0.000	0.000	0.246
55.0N	167.7E	70.0	0.000	0.000	0.000	0.000	0.000	0.211
54.2N	166.6E	71.0	0.000	0.000	0.000	0.000	0.000	0.181
53.4N	165.6E	72.0	0.000	0.000	0.000	0.000	0.000	0.156
52.6N	164.6E	73.0	0.000	0.000	0.000	0.000	0.000	0.148
51.8N	163.7E	74.0	0.000	0.000	0.000	0.000	0.000	0.126
51.0N	162.8E	75.0	0.000	0.000	0.000	0.000	0.000	0.108
50.1N	161.9E	76.0	0.000	0.000	0.000	0.000	0.000	0.093
49.3N	161.0E	77.0	0.000	0.000	0.000	0.000	0.000	0.078
48.4N	160.2E	78.0	0.000	0.000	0.000	0.000	0.000	0.065
47.6N	159.4E	79.0	0.000	0.000	0.000	0.000	0.000	0.053
46.7N	158.6E	80.0	0.000	0.000	0.000	0.000	0.000	0.043
45.9N	157.9E	81.0	0.000	0.000	0.000	0.000	0.000	0.034
45.0N	157.2E	82.0	0.000	0.000	0.000	0.000	0.000	0.027
44.2N	156.5E	83.0	0.000	0.000	0.000	0.000	0.000	0.017
43.3N	155.8E	84.0	0.000	0.000	0.000	0.000	0.000	0.014
42.4N	155.1E	85.0	0.000	0.000	0.000	0.000	0.000	0.011
41.5N	154.5E	86.0	0.000	0.000	0.000	0.000	0.000	0.009
40.7N	153.9E	87.0	0.000	0.000	0.000	0.000	0.000	0.007
39.8N	153.3E	88.0	0.000	0.000	0.000	0.000	0.000	0.005
38.9N	152.7E	89.0	0.000	0.000	0.000	0.000	0.000	0.005
38.0N	152.1E	90.0	0.000	0.000	0.000	0.000	0.000	0.004
37.1N	151.5E	91.0	0.000	0.000	0.000	0.000	0.000	0.003
36.2N	151.0E	92.0	0.000	0.000	0.000	0.000	0.000	0.003
35.3N	150.4E	93.0	0.000	0.000	0.000	0.000	0.000	0.002

OPTIONS T 9 ********
OUTPUT A3 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER004

AVERAGE PROBABILITIES FOR FIXED THRESHOLDS

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 330. DEG

RECEIVER LOCATIONS		DISTANCE	S PROBABILITY			S/N PROBABILITY		
LAT(DEG)	LON(DEG)	(DEG)	T= 60.0	T= 48.0	T= 30.0	T= 12.0	T= -6.0	T=-24.0
34.4N	149.9E	94.0	0.000	0.000	0.000	0.000	0.000	0.002
33.5N	149.4E	95.0	0.000	0.000	0.000	0.000	0.000	0.002
32.6N	148.9E	96.0	0.000	0.000	0.000	0.000	0.000	0.001
31.7N	148.4E	97.0	0.000	0.000	0.000	0.000	0.000	0.003
30.8N	147.9E	98.0	0.000	0.000	0.000	0.000	0.000	0.002
29.9N	147.4E	99.0	0.000	0.000	0.000	0.000	0.000	0.002
29.0N	146.9E	100.0	0.000	0.000	0.000	0.000	0.000	0.002
28.0N	146.5E	101.0	0.000	0.000	0.000	0.000	0.000	0.001
27.1N	146.0E	102.0	0.000	0.000	0.000	0.000	0.000	0.001
26.2N	145.6E	103.0	0.000	0.000	0.000	0.000	0.000	0.001
25.3N	145.1E	104.0	0.000	0.000	0.000	0.000	0.000	0.001
24.4N	144.7E	105.0	0.000	0.000	0.000	0.000	0.000	0.001
23.4N	144.3E	106.0	0.000	0.000	0.000	0.000	0.000	0.001
22.5N	143.9E	107.0	0.000	0.000	0.000	0.000	0.000	0.001
21.6N	143.5E	108.0	0.000	0.000	0.000	0.000	0.000	0.001
20.7N	143.1E	109.0	0.000	0.000	0.000	0.000	0.000	0.000
19.7N	142.6E	110.0	0.000	0.000	0.000	0.000	0.000	0.000
18.8N	142.2E	111.0	0.000	0.000	0.000	0.000	0.000	0.000
17.9N	141.9E	112.0	0.000	0.000	0.000	0.000	0.000	0.000
17.0N	141.5E	113.0	0.000	0.000	0.000	0.000	0.000	0.000
16.0N	141.1E	114.0	0.000	0.000	0.000	0.000	0.000	0.000
15.1N	140.7E	115.0	0.000	0.000	0.000	0.000	0.000	0.000
14.2N	140.3E	116.0	0.000	0.000	0.000	0.000	0.000	0.000
13.2N	139.9E	117.0	0.000	0.000	0.000	0.000	0.000	0.000
12.3N	139.6E	118.0	0.000	0.000	0.000	0.000	0.000	0.000
11.4N	139.2E	119.0	0.000	0.000	0.000	0.000	0.000	0.000
10.5N	138.8E	120.0	0.000	0.000	0.000	0.000	0.000	0.000

UNCLASSIFIED

OPTIONS T 9 ********
OUTPUT A3

VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SER004

AVERAGE PROBABILITIES FOR FIXED THRESHOLDS

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 60. DEG

RECEIVER LOCATIONS		DISTANCE	S PROBABILITY			S/N PROBABILITY		
LAT(DEG)	LON(DEG)	(DEG)	T= 60.0	T= 48.0	T= 30.0	T= 12.0	T= -6.0	T=-24.0
49.0N	54.1W	10.0	1.000	1.000	1.000	1.000	1.000	1.000
49.3N	52.6W	11.0	1.000	1.000	1.000	1.000	1.000	1.000
49.6N	51.2W	12.0	1.000	1.000	1.000	1.000	1.000	1.000
49.9N	49.7W	13.0	1.000	1.000	1.000	1.000	1.000	1.000
50.2N	48.2W	14.0	1.000	1.000	1.000	1.000	1.000	1.000
50.5N	46.7W	15.0	1.000	1.000	1.000	1.000	1.000	1.000
50.7N	45.1W	16.0	1.000	1.000	1.000	1.000	1.000	1.000
50.9N	43.6W	17.0	1.000	1.000	1.000	1.000	1.000	1.000
51.2N	42.0W	18.0	1.000	1.000	1.000	1.000	1.000	1.000
51.3N	40.5W	19.0	1.000	1.000	1.000	1.000	1.000	1.000
51.5N	38.9W	20.0	1.000	1.000	1.000	1.000	1.000	1.000
51.6N	37.3W	21.0	1.000	1.000	1.000	1.000	1.000	1.000
51.7N	35.7W	22.0	1.000	1.000	1.000	1.000	1.000	1.000
51.8N	34.1W	23.0	1.000	1.000	1.000	1.000	1.000	1.000
51.9N	32.5W	24.0	1.000	1.000	1.000	1.000	1.000	1.000
52.0N	30.9W	25.0	1.000	1.000	1.000	1.000	1.000	1.000
52.0N	29.2W	26.0	1.000	1.000	1.000	1.000	1.000	1.000
52.0N	27.6W	27.0	1.000	1.000	1.000	1.000	1.000	1.000
52.0N	26.0W	28.0	1.000	1.000	1.000	1.000	1.000	1.000
52.0N	24.4W	29.0	1.000	1.000	1.000	1.000	1.000	1.000
51.9N	22.7W	30.0	1.000	1.000	1.000	1.000	1.000	1.000
51.8N	21.1W	31.0	1.000	1.000	1.000	1.000	1.000	1.000
51.7N	19.5W	32.0	1.000	1.000	1.000	1.000	1.000	1.000
51.6N	17.9W	33.0	1.000	1.000	1.000	1.000	1.000	1.000
51.4N	16.3W	34.0	1.000	1.000	1.000	1.000	1.000	1.000
51.3N	14.8W	35.0	1.000	1.000	1.000	1.000	1.000	1.000
51.1N	13.2W	36.0	1.000	1.000	1.000	1.000	1.000	1.000
50.9N	11.6W	37.0	1.000	1.000	1.000	0.999	1.000	1.000
50.6N	10.1W	38.0	1.000	1.000	1.000	0.998	1.000	1.000
50.4N	8.6W	39.0	0.999	1.000	1.000	0.997	1.000	1.000
50.1N	7.1W	40.0	0.999	1.000	1.000	0.994	1.000	1.000
49.8N	5.6W	41.0	0.999	1.000	1.000	0.990	1.000	1.000
49.5N	4.1W	42.0	0.998	1.000	1.000	0.985	1.000	1.000
49.2N	2.7W	43.0	0.997	1.000	1.000	0.978	1.000	1.000
48.8N	1.2W	44.0	0.996	1.000	1.000	0.967	1.000	1.000
48.5N	0.2E	45.0	0.994	1.000	1.000	0.953	1.000	1.000
48.1N	1.6E	46.0	0.992	1.000	1.000	0.938	1.000	1.000
47.7N	2.9E	47.0	0.989	1.000	1.000	0.919	1.000	1.000
47.3N	4.3E	48.0	0.985	1.000	1.000	0.897	1.000	1.000
46.9N	5.6E	49.0	0.977	1.000	1.000	0.871	1.000	1.000
46.4N	6.9E	50.0	0.969	1.000	1.000	0.844	1.000	1.000
46.0N	8.2E	51.0	0.960	1.000	1.000	0.814	1.000	1.000

OPTIONS T 9 ********
OUTPUT A3 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER004

AVERAGE PROBABILITIES FOR FIXED THRESHOLDS

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 60. DEG

RECEIVER LOCATIONS		DISTANCE	S PROBABILITY			S/N PROBABILITY		
LAT(DEG)	LON(DEG)	(DEG)	T= 60.0	T= 48.0	T= 30.0	T= 12.0	T= -6.0	T=-24.0
45.5N	9.5E	52.0	0.945	1.000	1.000	0.782	1.000	1.000
45.0N	10.7E	53.0	0.932	1.000	1.000	0.753	1.000	1.000
44.5N	11.9E	54.0	0.912	1.000	1.000	0.698	1.000	1.000
44.0N	13.1E	55.0	0.887	1.000	1.000	0.670	1.000	1.000
43.5N	14.3E	56.0	0.863	1.000	1.000	0.648	1.000	1.000
42.9N	15.5E	57.0	0.832	1.000	1.000	0.627	1.000	1.000
42.4N	16.6E	58.0	0.801	1.000	1.000	0.607	1.000	1.000
41.8N	17.7E	59.0	0.766	1.000	1.000	0.587	1.000	1.000
41.3N	18.8E	60.0	0.728	1.000	1.000	0.569	1.000	1.000
40.7N	19.9E	61.0	0.679	1.000	1.000	0.547	1.000	1.000
40.1N	21.0E	62.0	0.625	1.000	1.000	0.528	1.000	1.000
39.5N	22.0E	63.0	0.570	1.000	1.000	0.500	1.000	1.000
38.9N	23.0E	64.0	0.513	1.000	1.000	0.469	1.000	1.000
38.3N	24.0E	65.0	0.456	1.000	1.000	0.438	1.000	1.000
37.6N	25.0E	66.0	0.415	1.000	1.000	0.415	1.000	1.000
37.0N	26.0E	67.0	0.373	1.000	1.000	0.391	1.000	1.000
36.4N	27.0E	68.0	0.332	1.000	1.000	0.368	1.000	1.000
35.7N	27.9E	69.0	0.294	1.000	1.000	0.345	1.000	1.000
35.1N	28.8E	70.0	0.258	1.000	1.000	0.323	1.000	1.000
34.4N	29.7E	71.0	0.226	0.999	1.000	0.302	1.000	1.000
33.7N	30.6E	72.0	0.196	0.999	1.000	0.281	1.000	1.000
33.1N	31.5E	73.0	0.170	0.999	1.000	0.261	1.000	1.000
32.4N	32.4E	74.0	0.146	0.998	1.000	0.244	1.000	1.000
31.7N	33.2E	75.0	0.125	0.998	1.000	0.229	1.000	1.000
31.0N	34.1E	76.0	0.106	0.997	1.000	0.212	1.000	1.000
30.3N	34.9E	77.0	0.085	0.995	1.000	0.197	0.999	1.000
29.6N	35.7E	78.0	0.069	0.993	1.000	0.176	0.999	1.000
28.9N	36.6E	79.0	0.056	0.990	1.000	0.152	0.999	1.000
28.2N	37.3E	80.0	0.046	0.986	1.000	0.131	0.998	1.000
27.5N	38.1E	81.0	0.037	0.982	1.000	0.112	0.997	1.000
26.7N	38.9E	82.0	0.059	0.955	1.000	0.116	0.990	1.000
26.0N	39.7E	83.0	0.050	0.946	1.000	0.103	0.987	1.000
25.3N	40.4E	84.0	0.042	0.935	1.000	0.091	0.982	1.000
24.5N	41.2E	85.0	0.035	0.924	1.000	0.080	0.977	1.000
23.8N	41.9E	86.0	0.029	0.910	1.000	0.072	0.971	1.000
23.1N	42.7E	87.0	0.024	0.895	1.000	0.064	0.964	1.000
22.3N	43.4E	88.0	0.020	0.879	1.000	0.058	0.957	1.000
21.6N	44.1E	89.0	0.017	0.861	1.000	0.052	0.950	1.000
20.8N	44.3E	90.0	0.014	0.839	1.000	0.047	0.941	1.000
20.1N	45.5E	91.0	0.012	0.819	1.000	0.043	0.934	1.000
19.3N	46.2E	92.0	0.010	0.797	1.000	0.039	0.928	1.000
18.5N	46.9E	93.0	0.008	0.773	1.000	0.035	0.922	1.000

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OPTIONS T 9 eeeeeeee
OUTPUT A3 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER004

AVERAGE PROBABILTIES FOR FIXED THRESHOLDS

TRANSMITTER NAA
POWER =1000.0KW
FREQUENCY=17.8 KHZ

TRANSMITTER LOCATION 44.7N 67.3W

MONTH JUL
NOISE BW = 1 KHZ
BEARING = 60. DEG

RECEIVER LOCATIONS		DISTANCE	S PROBABILITY			S/N PROBABILITY		
LAT(DEG)	LON(DEG)	(DEG)	T= 60.0	T= 48.0	T= 30.0	T= 12.0	T= -6.0	T=-24.0
17.8N	47.6E	94.0	0.006	0.748	1.000	0.031	0.917	1.000
17.0N	48.2E	95.0	0.005	0.721	1.000	0.028	0.913	1.000
16.3N	48.9E	96.0	0.004	0.693	1.000	0.026	0.910	1.000
15.5N	49.6E	97.0	0.003	0.663	1.000	0.023	0.908	1.000
14.7N	50.2E	98.0	0.002	0.633	1.000	0.022	0.916	1.000
13.9N	50.9E	99.0	0.002	0.608	1.000	0.020	0.912	1.000
13.2N	51.5E	100.0	0.002	0.582	1.000	0.018	0.907	1.000
12.4N	52.2E	101.0	0.001	0.556	1.000	0.016	0.903	1.000
11.6N	52.8E	102.0	0.001	0.530	1.000	0.013	0.888	1.000
10.8N	53.5E	103.0	0.001	0.504	1.000	0.012	0.883	1.000
10.1N	54.1E	104.0	0.001	0.478	1.000	0.011	0.879	1.000
9.3N	54.7E	105.0	0.001	0.455	1.000	0.010	0.876	1.000
8.5N	55.4E	106.0	0.001	0.430	1.000	0.009	0.874	1.000
7.7N	56.0E	107.0	0.000	0.406	1.000	0.009	0.871	1.000
6.9N	56.6E	108.0	0.000	0.382	1.000	0.008	0.869	1.000
6.1N	57.3E	109.0	0.000	0.359	1.000	0.008	0.866	1.000
5.4N	57.9E	110.0	0.000	0.336	1.000	0.007	0.862	1.000
4.6N	58.5E	111.0	0.000	0.314	1.000	0.007	0.859	1.000
3.8N	59.1E	112.0	0.000	0.293	1.000	0.006	0.855	1.000
3.0N	59.7E	113.0	0.000	0.273	1.000	0.006	0.851	1.000
2.2N	60.4E	114.0	0.000	0.254	1.000	0.005	0.842	1.000
1.4N	61.0E	115.0	0.000	0.235	1.000	0.005	0.831	1.000
0.6N	61.6E	116.0	0.000	0.218	0.999	0.004	0.819	1.000
0.2S	62.2E	117.0	0.000	0.202	0.999	0.004	0.807	1.000
0.9S	62.8E	118.0	0.000	0.187	0.999	0.004	0.799	1.000
1.7S	63.4E	119.0	0.000	0.173	0.999	0.003	0.792	1.000
2.5S	64.0E	120.0	0.000	0.159	0.999	0.003	0.784	1.000

OPTIONS T T

OUTPUT P1

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VLF PROPAGATION STUDIES

NCPP 74(VLFACM)SER005

TRANSMITTER NSS 39.0N 76.5W
RECEIVER GBAY 53.4N 60.5W
BEARING = 32.0DEG DISTANCE = 18.1DEG

FREQUENCY = 23.4 KHZ
NOISE BW = 1 KHZ
POWER = 500.0KW

MONTH JUL

GMT	S(DB)	N(DB)	S/N(DB)	SIGMA(S)	SIGMA(NU)	SIGMA(SN-L)	NDT
00	65.6	46.1	19.5	2.0	3.0	3.6	D
01	77.1	47.4	29.8	3.4	3.0	4.5	N
02	77.1	47.6	29.5	3.4	2.9	4.5	N
03	77.1	47.2	30.0	3.4	2.9	4.5	N
04	77.1	46.7	30.4	3.4	2.9	4.5	N
05	77.1	46.6	30.5	3.4	2.7	4.3	N
06	77.1	46.4	30.7	3.4	2.7	4.3	N
07	77.1	46.2	30.9	3.4	2.8	4.4	N
08	70.4	44.4	26.0	3.4	2.8	4.4	T
09	66.9	42.0	24.9	3.4	3.1	4.6	T
10	65.8	41.3	24.5	2.0	3.1	3.7	D
11	66.0	41.6	24.4	2.0	3.0	3.6	D
12	66.2	41.4	24.8	2.0	3.0	3.6	D
13	65.4	40.9	25.5	2.0	3.0	3.6	D
14	66.6	40.5	26.1	2.0	2.9	3.5	D
15	66.6	40.0	26.6	2.0	2.8	3.5	D
16	66.7	40.0	26.7	2.0	2.9	3.5	D
17	66.7	40.7	26.0	2.0	3.0	3.6	D
18	66.7	41.9	24.7	2.0	3.0	3.6	D
19	65.6	43.4	23.2	2.0	3.2	3.7	D
20	66.4	44.9	21.5	2.0	3.2	3.7	D
21	66.3	45.8	20.4	2.0	3.1	3.7	D
22	65.1	46.2	19.8	2.0	3.1	3.7	D
23	65.8	46.2	19.7	2.0	3.1	3.7	D

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OPTIONS T T ********

OUTPUT B2 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SEP005

DB LEVELS FOR FIXED PROBABILITIES

TRANSMITTER NSS 39.0N 76.5W
RECEIVER GRAY 53.4N 60.5W
MONTH JUL
GREAT CIRCLE PATH = 18.1 DEG

TR POWER = 500.0KW
FREQUENCY = 23.4 KHZ
NOISE BW = 1 KHZ
TR BEARING= 32.0 DEG

GMT	S(DB) P=0.500	S(DB) P=0.900	S(DB) P=0.990	S/N(DB) P=0.500	S/N(DB) P=0.900	S/N(DB) P=0.990	NDT
00	65.6	63.0	60.9	19.5	14.9	11.1	D
01	77.1	72.8	69.3	29.8	24.0	19.2	N
02	77.1	72.8	69.3	29.5	23.8	19.2	N
03	77.1	72.8	69.3	30.0	24.3	19.6	N
04	77.1	72.8	69.3	30.4	24.7	20.0	N
05	77.1	72.8	69.3	30.5	25.0	20.5	N
06	77.1	72.8	69.3	30.7	25.2	20.6	N
07	77.1	72.8	69.3	30.9	25.3	20.8	N
08	70.4	66.1	62.6	26.0	20.4	15.8	T
09	66.9	62.6	59.1	24.9	19.0	14.2	T
10	65.8	63.2	61.1	24.5	19.7	15.8	D
11	66.0	63.5	61.4	24.4	19.8	16.0	D
12	66.2	63.7	61.6	24.8	20.2	16.5	D
13	66.4	63.8	61.8	25.5	20.9	17.1	D
14	66.6	64.0	61.9	26.1	21.6	17.9	D
15	66.6	64.1	62.0	26.6	22.2	18.5	D
16	66.7	64.1	62.0	26.7	22.2	18.5	D
17	66.7	64.1	62.1	26.0	21.4	17.6	D
18	66.7	64.1	62.0	24.7	20.1	16.4	D
19	66.6	64.0	61.9	23.2	18.4	14.5	D
20	66.4	63.9	61.8	21.5	16.8	12.9	D
21	66.3	63.7	61.6	20.4	15.7	11.8	D
22	66.1	63.5	61.4	19.8	15.1	11.3	D
23	65.8	63.3	61.2	19.7	14.9	11.0	D
DB LEVEL EXCEEDED	67.6	64.1	61.7	25.6	18.8	13.8	

OPTIONS T T ********

OUTPUT B3 VLF PROPAGATION STUDIES NCPP 74(VLFACM)SER005

PROBABILITIES FOR FIXED THRESHOLDS

TRANSMITTER NSS 39.0N 76.5W
RECEIVER GBAY 53.4N 60.5W
MONTH JUL
GREAT CIRCLE PATH = 18.1 DEG

TR POWER = 500.0KW
FREQUENCY = 23.4 KHZ
NOISE BW = 1 KHZ
TR BEARING= 32.0 DEG

	S PROBABILITY			S/N PROBABILITY			
GMT	T= 60.0	T= 66.0	T= 72.0	T= 18.0	T= 24.0	T= 30.0	NDT
00	0.997	0.420	0.001	0.664	0.110	0.002	D
01	1.000	0.999	0.937	0.995	0.899	0.481	N
02	1.000	0.999	0.937	0.995	0.893	0.459	N
03	1.000	0.999	0.937	0.996	0.909	0.498	N
04	1.000	0.999	0.937	0.997	0.924	0.534	N
05	1.000	0.999	0.937	0.998	0.934	0.549	N
06	1.000	0.999	0.937	0.998	0.940	0.566	N
07	1.000	0.999	0.937	0.998	0.944	0.585	N
08	0.999	0.905	0.316	0.967	0.675	0.177	T
09	0.980	0.604	0.064	0.934	0.576	0.132	T
10	0.998	0.457	0.001	0.959	0.552	0.070	D
11	0.998	0.504	0.002	0.963	0.543	0.059	D
12	0.999	0.546	0.002	0.971	0.589	0.074	D
13	0.999	0.581	0.003	0.982	0.661	0.105	D
14	0.999	0.608	0.003	0.989	0.723	0.134	D
15	0.999	0.627	0.004	0.993	0.775	0.166	D
16	0.999	0.637	0.004	0.993	0.779	0.177	D
17	0.999	0.638	0.004	0.987	0.707	0.130	D
18	0.999	0.630	0.004	0.970	0.582	0.072	D
19	0.999	0.613	0.004	0.917	0.412	0.033	D
20	0.999	0.588	0.003	0.829	0.256	0.012	D
21	0.999	0.554	0.002	0.745	0.168	0.005	D
22	0.999	0.514	0.002	0.693	0.129	0.003	D
23	0.998	0.466	0.001	0.674	0.123	0.003	D
DAILY AVERAGE	0.998	0.704	0.291	0.925	0.617	0.209	

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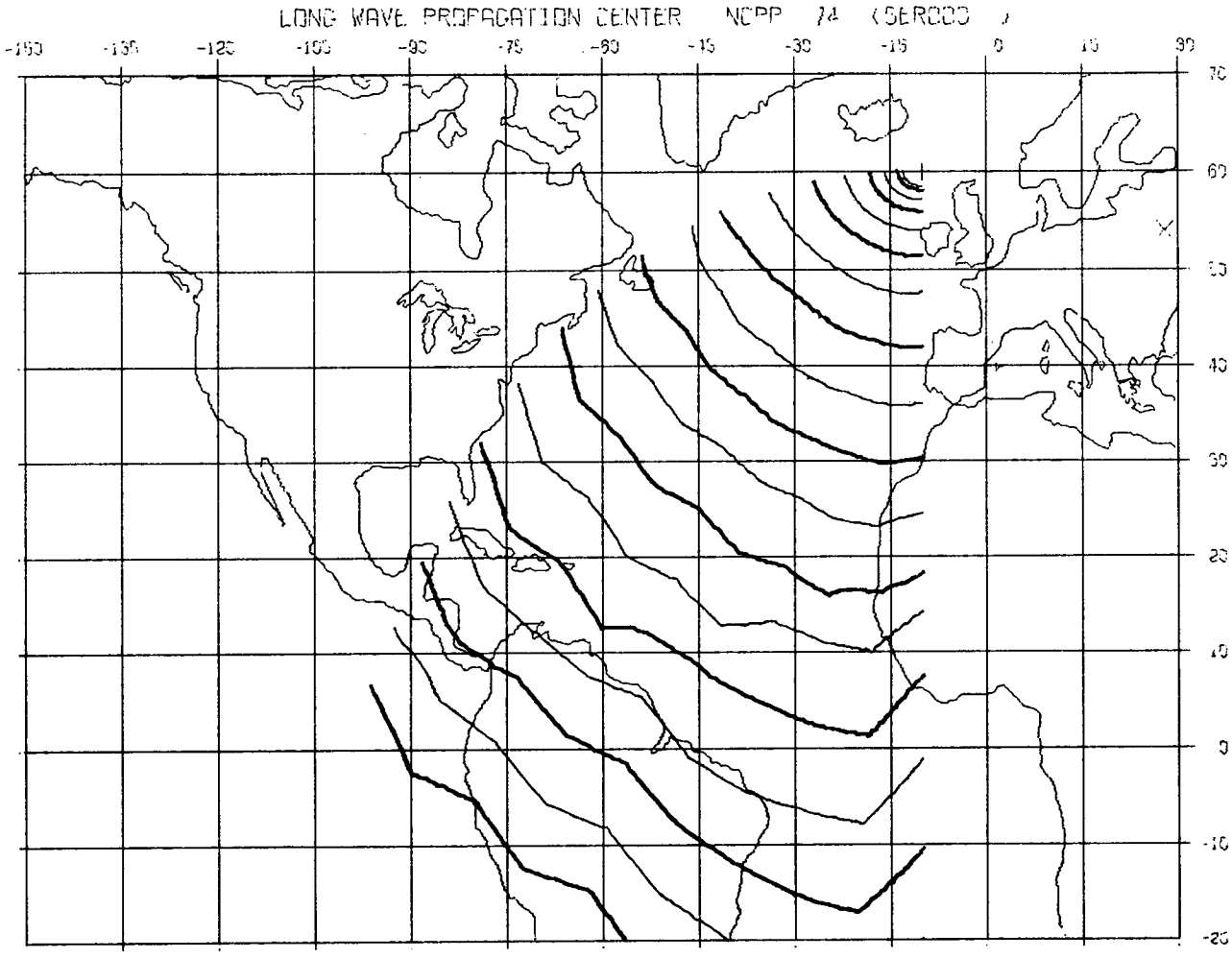

Fig. B2 — Sample plot from the SEGCON Program for Serial No. 003

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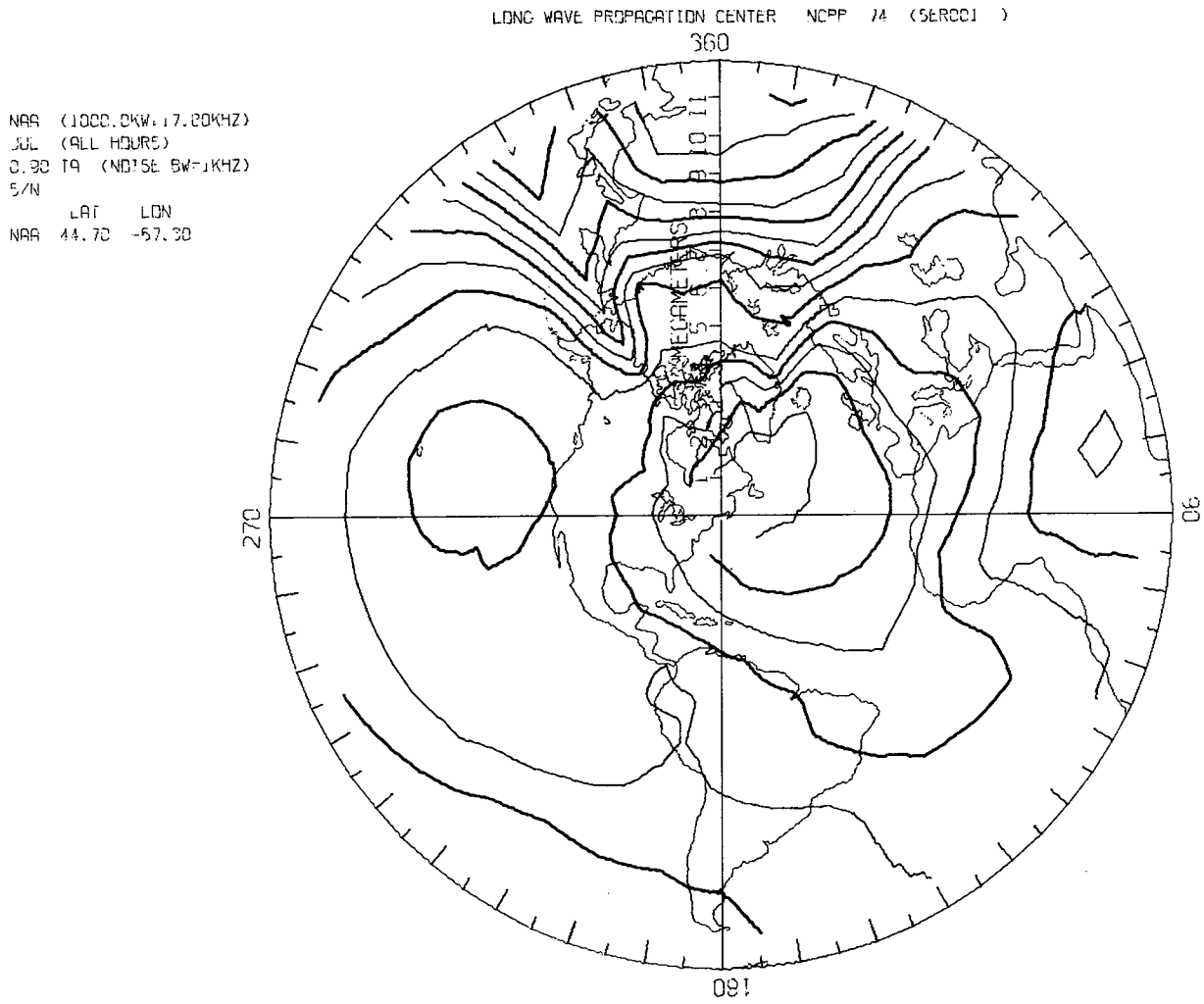

Fig. B3 — Sample plot from the POLCON Program for Serial No. 001

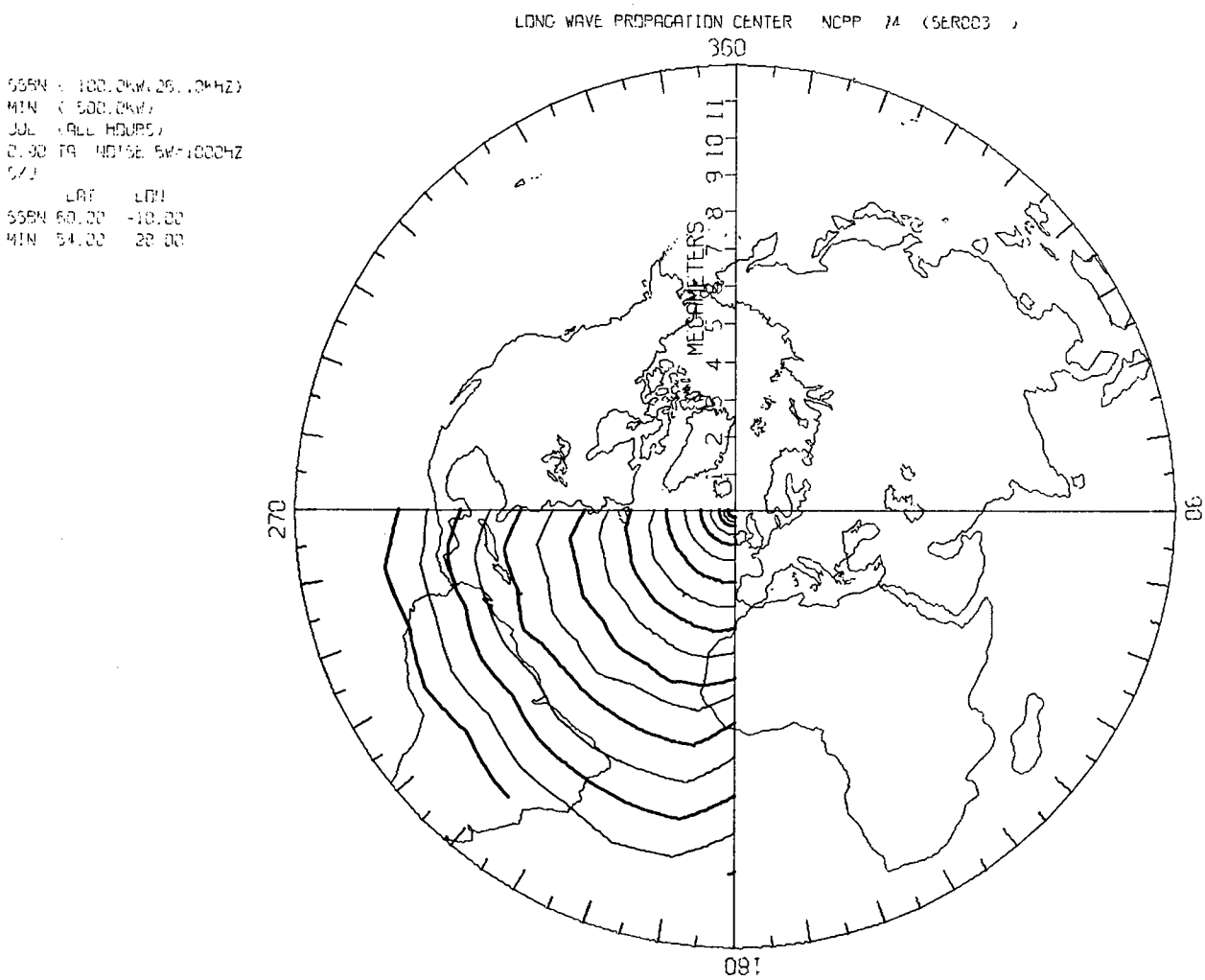

Fig. B4 — Sample plot from the POLCON Program for Serial No. 003

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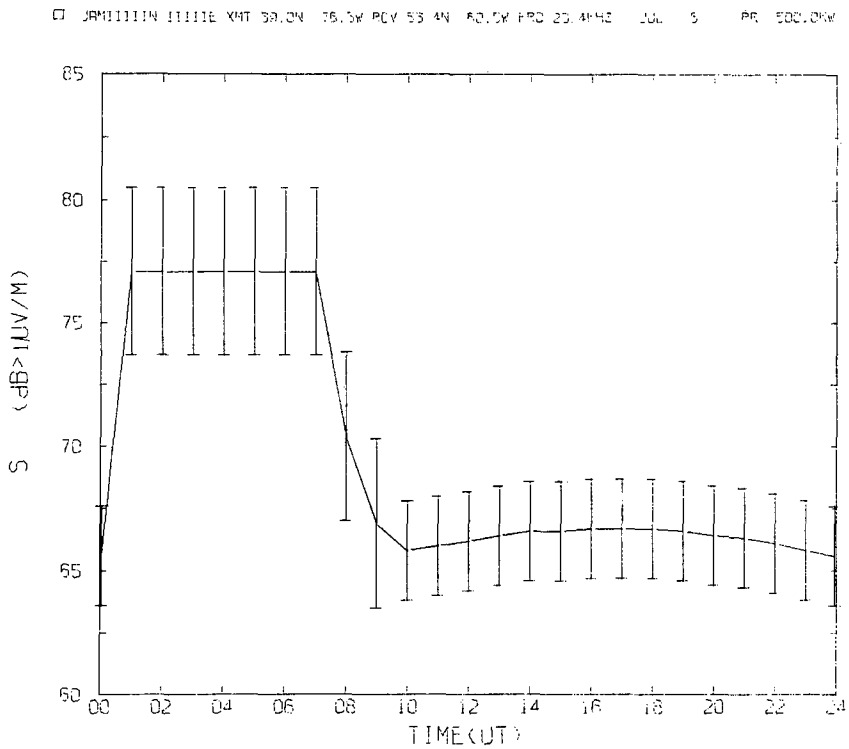

Fig. B5 — Sample plot from the B3PLOT Program for Serial No. 005, B1 Option

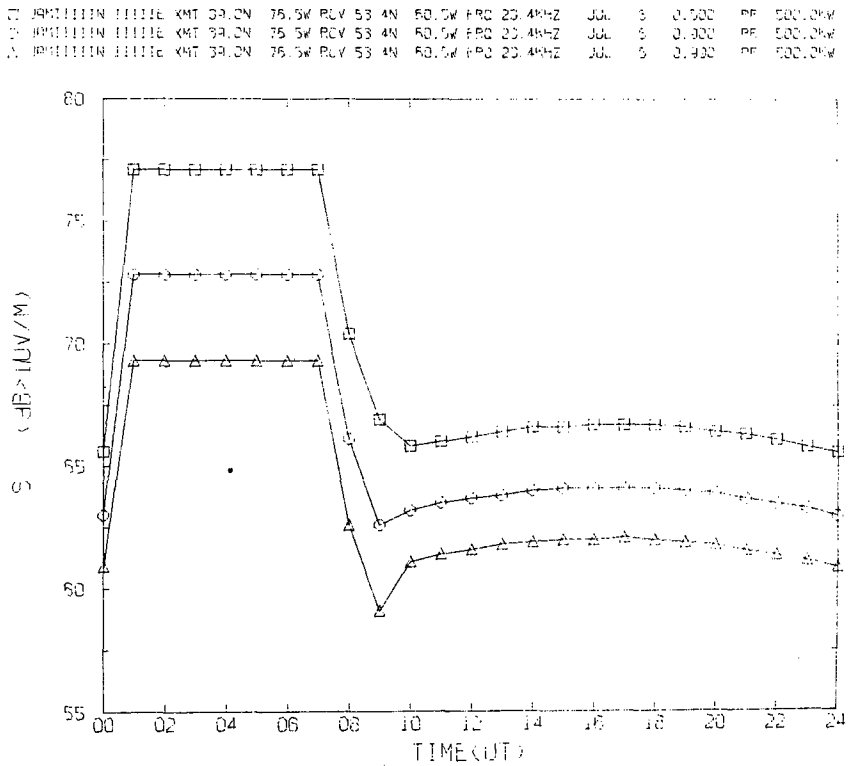

Fig. B6 — Sample plot from the B3PLOT Program for Serial No. 005, B2 Option

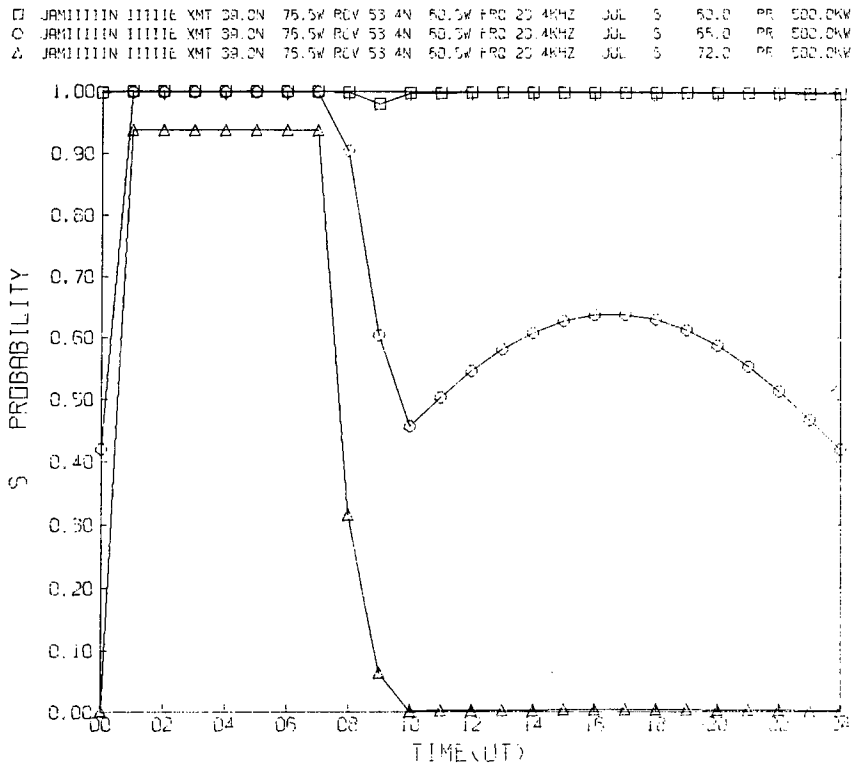

Fig. B7 — Sample plot from the B3PLOT Program for Serial No. 005, B3 Option

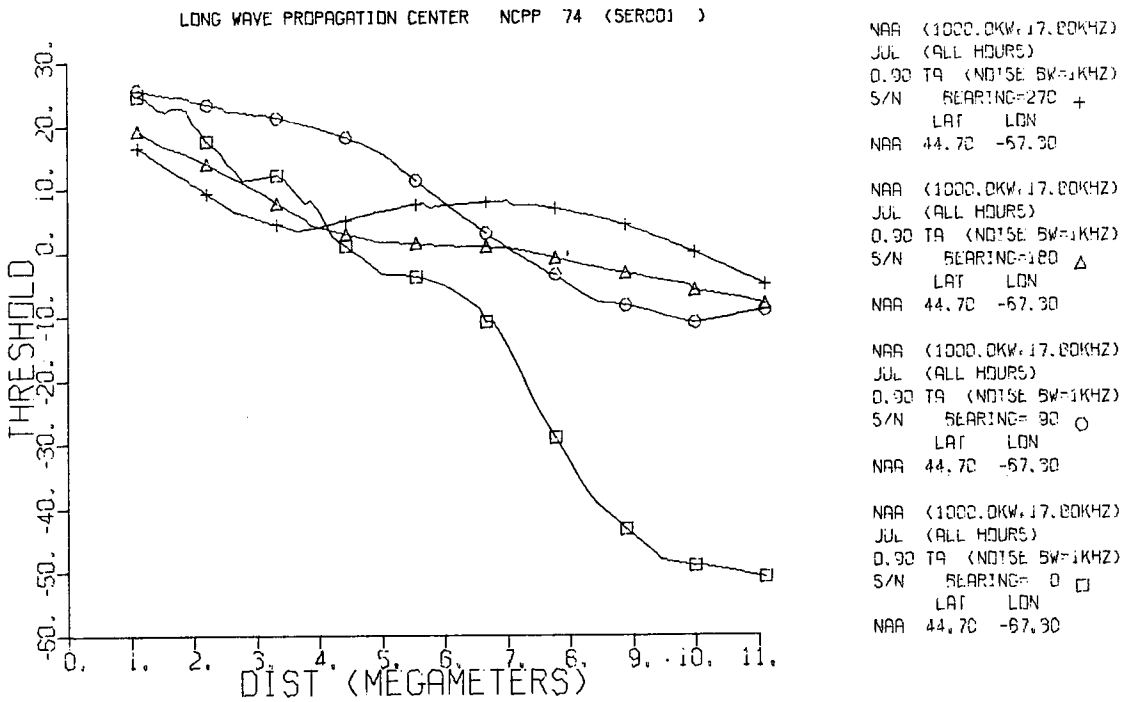

Fig. B8 — Sample plot from the RADPLT Program for Serial No. 001