AD-754 144

SEER II: A NEW DAMAGE ASSESSMENT FALL-OUT MODEL

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Prepared for:

Defense Nuclear Agency

May 1972

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May 1972

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CONTRACT DASA01-71-C-0121

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MENLO PARK, CALIFORNIA 94025

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138

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*

Stanford Research Institute
Menlo Park, California 94025

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP

3. REPORT TITLE

SEER II: A NEW DAMAGE ASSESSMENT FALLOUT MODEL

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Draft Report

5. AUTHOR(S) *(First name, middle initial, last name)*

Hong Lee Paul W. Wong Stephen L. Brown

6. REPORT DATE
May 1972

7a. TOTAL NO. OF PAGES
~~130~~ 138

7b. NO. OF REFS
6

8a. CONTRACT OR GRANT NO.
DASA01-71-C-0121

b. PROJECT NO. NWE R Code: P

c. Task and Subtask Code: D071

d. Work Unit Code: 02

9a. ORIGINATOR'S REPORT NUMBER(S)
EGU 1206

9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. DISTRIBUTION STATEMENT

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
Director
Defense Nuclear Agency
Washington, D.C. 20305

13. ABSTRACT

The purposes of this research are to develop a simplified fallout computational system for use in damage-assessment studies where very large numbers of weapons are used, and to develop a statistical procedure to relate wind variability to fallout pattern variability. The basic requirements of the simplified fallout computational system are that it simulate DELFIC fallout exposure rate contours and DELFIC accumulated exposure doses anywhere within the areas of significant fallout for identical input winds and weapon yield, and that the computer time for exercising the simplified fallout computational system be minimal. The wind variability to be considered was limited to the statistical probability of observing a given vertical wind profile over a given geographical location of any instant in time.

Because the original simplified fallout computational system that was developed, Simplified Estimation of Exposure to Radiation (SEER), could not simulate DELFIC output for severely sheared winds, a new model, SEER II, was developed with this capability. The computer computation time required by SEER II on the CDC 6400 computer is approximately 3 seconds for weapon yields in the low kiloton range and 8 seconds for weapon yields in the 10 megaton range per 1200 grid points, which is approximately one-fiftieth to one one-hundredth of the computation time required by DELFIC. The SEER II output simulates DELFIC output reasonably well over a wide range of yields (1 kiloton to 30 megatons), and diverse wind structures.

The procedure for statistically relating wind variability to fallout pattern variability appears to be successful. The procedure was tested with wind data obtained for Peoria, Illinois, i.e. wind directions and speeds at various altitudes measured four times daily over Peoria for several years. A result of major importance from this test of the procedure is that statistical features of fallout patterns can be predicted reasonably well from patterns produced by the mean and standard deviation wind parameters. Another important result is that variability of angular displacement in the wind (wind shear) appears to be responsible for the greater part of variability in the pattern, whereas variability of wind speed is less effective.

DD FORM 1 NOV 65 1473 (PAGE 1)
S/N 0101-807-6801

Ia

UNCLASSIFIED
Security Classification

UNCLASSIFIED
Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Fallout						
Nuclear War						
Damage Assessment						
Radiation						
DELFIC						

DD FORM 1 NOV 65 1473 (BACK)
(PAGE

I-b

UNCLASSIFIED
Security Classification

DNA 3008F

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THIS EFFORT WAS SUPPORTED BY
THE DEFENSE NUCLEAR AGENCY UNDER
NWER SUBTASK PD071, WORK UNIT 02

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CONTRACT DASA01-71-C-0121

SRI Project EGU-1206

Copy No. 14

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ACKNOWLEDGMENTS

The authors acknowledge with gratitude the assistance of Mr. Roy M. Endlich of SRI who provided his expertise on meteorology and who selected representative meteorological stations, and of Lt. Dennis Trout, USAF, of USAF Environmental Technical Applications Center who supplied the wind data tapes. The advice and direction of Major George H. Connor Jr., Captain John C. Phillips, and Major Joseph Cote, of DNA, are acknowledged with appreciation.

I INTRODUCTION

A. Background

The Department of Defense Land Fallout Prediction System is a research tool designed to utilize a Modular Computer Program called DELFIC (for Defense Land Fallout Interpretive Code), to implement a highly sophisticated and physical fallout model.[1]* As a research tool, DELFIC typically requires a relatively large amount of computer time and yields a great variety of output data. Much of the output is not needed for damage assessment, and the long computer time is inconsistent with the necessity for generating a large number of fallout patterns to assess the damage from a strategic nuclear attack. A derivative of the DELFIC program called PROFET (for Prediction of Fallout at Early Times) has been developed to provide an operational capability to make rapid-access fallout predictions with a minimal amount of input data and an easily interpretable output.[2] It simplifies the input requirements for the program, replaces the less-sensitive portions of the program with empirical formulas, and reduces the output to a few essential parameters. However, it remains principally a physical model, and its running time is still suitable for handling only a few detonations in a reasonable period. A need exists for a simplified model with much reduced computing time and restricted input and output requirements for large-scale damage-assessment studies. To this end research was initiated and the SEER model was developed.[3]

The development criteria for SEER were that it simulate DELFIC output and that it produce the simulated output at a fraction of the

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* References are listed at the end of the report.

computer time needed for DELFIC. The computerized SEER program requires about 2.5 seconds of CDC 6400 computer execution time for each 1200-grid-point run. Preliminary exposure rate comparisons of SEER output with DELFIC output indicated fair agreement of exposure rate contour shape, size, and pattern directionality for moderately sheared winds for yields between one kiloton and 10 megatons. Additional equations were formulated to improve the accuracy of SEER, but these were not integrated into the original SEER, nor were they tested.

The problems remaining at the termination of the above SEER development research were:

(1) Uncertainty as to whether the developed simplified system would match DELFIC output adequately under all reasonable inputs to DELFIC (e.g., wind structure and atmosphere).

(2) Uncertainty as to what criteria should be used for measuring the adequacy of match (e.g., H + 1 exposure rate at a point, area of exposure dose contours, intensity-area integral, or fraction down).

(3) Uncertainty as to whether or not statistical wind data can be used to predict fallout effects.

These remaining problems required resolution before the simplified system could be recommended without reservations to predict fallout effects in damage assessment studies.

B. Objectives

The objectives of this research were to formulate criteria and conduct validation tests of the developed simplified fallout computational system with respect to DELFIC under a wide variety of conditions, and to make the necessary corrections or improvements on the simplified computational system where validation is inadequate so as to satisfy the validation criteria. The SEER II computational model will incorporate these corrections and improvements.

An additional objective is to develop a procedure to incorporate statistical variabilities of wind structures into expected fallout patterns with measures of variations.

C. Scope

The long-term goal of the research program that includes the research effort reported here is to implement a better fallout model for damage assessment. It is believed that models in current use cannot adequately predict fallout for the likely range of yield and wind conditions under which an attack could occur, and that the operational consequences of this inadequacy are significant.* The new model must 1) produce fallout information at given resource location from a large number of detonations at given target locations, and 2) do so without substantially increasing the computer costs associated with the model. As an intermediate objective, a model capable of predicting fallout on a specified resource point from a single specified detonation must be developed. This objective has been substantially met by the SEER II model, with the following limitations in scope:

- It is a single shot model.
- Its range of validity is 1 KT to 30 MT.
- It does not currently provide for fission fractions less than unity.
- It does not currently provide for height or depth of burst corrections.
- It assumes that a single vertical wind profile obtains for the entire time and spatial extent of significant fallout.

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*This contention is being investigated under a contract entitled "Demonstration of the Utility of the SEER Fallout Model."

- It is calibrated to DELFIC fallout patterns with the following data inputs
  - Siliceous soil substrate
  - U.S. standard atmosphere 30° North, January
  - Log-normal particle size distribution with mass mean 130 microns.
  - U-235 fission spectrum or U-238 8 MeV, depending on yield.

Most of these limitations will be alleviated during the Demonstration phase currently under way. In particular, SEER II will be incorporated in a system that provides for addition of the fallout at a resource point from all the detonations affecting it, and the prediction will take into account spatial variation of wind fields for large-yield weapons. Providing for fission fraction and height of burst corrections should require a minimal effort. Although the validity of the model for very low or very high yields is certainly in doubt, provision will be made to extrapolate the results to all reasonable values of yield.

The validity of the research results reported here is also subject to the limitation that no standardized technique has been established for judging the agreement between two fallout patterns. Therefore, subjective judgments on their similarities in directionality, shape, and size have been used to assess the success of SEER II in simulating DELFIC.

Finally, the study of statistical wind variability was limited to the question of what the historical variability of the instantaneous vertical wind profile over a particular point had on the statistical variability of fallout patterns generated from these instantaneous winds. The question of correlations between winds at different locations and different times is being investigated elsewhere.

II FALLOUT MODELING

A. Problem Discussion

Depending on the geographical location and the time of year, the wind structure can vary greatly with altitude; both wind direction and wind velocity are subject to large changes. Fallout particles falling from various cloud altitudes and subjected to shearing winds are moved about at varying velocities and directions during their descent. The resulting deposition patterns are irregular and difficult to reproduce by the use of simplified empirical equations. Normalized wind inputs are too simple to adequately characterize the actual winds. For this reason, and because good simulation of DELFIC output for all naturally occurring wind structures was deemed necessary for the simplified fallout model to be generally useful, it was decided that SEER should be modified to handle complex as well as simple wind structures.

Typical of the wind structures for which the modified model is required to accept and produce good simulation of DELFIC output are the summer winds over Fort Worth, Texas, and Lake Charles, Louisiana.[4] Representations of the winds that may be expected at these two locations in the summer are shown in Figures 1 and 2, where the wind vectors (directions and velocities) at altitude intervals of 1000 meters are placed end to end. A straight line drawn from the zero point to any altitude point on the curve is an approximation of the fallout pattern direction for particles falling from that altitude, with the larger particles landing closer to the zero point and the smaller particles landing farther away. The general shapes of the fallout pattern limits (e.g., the 1 r/hr exposure rates) resulting from these winds, for a weapon yield

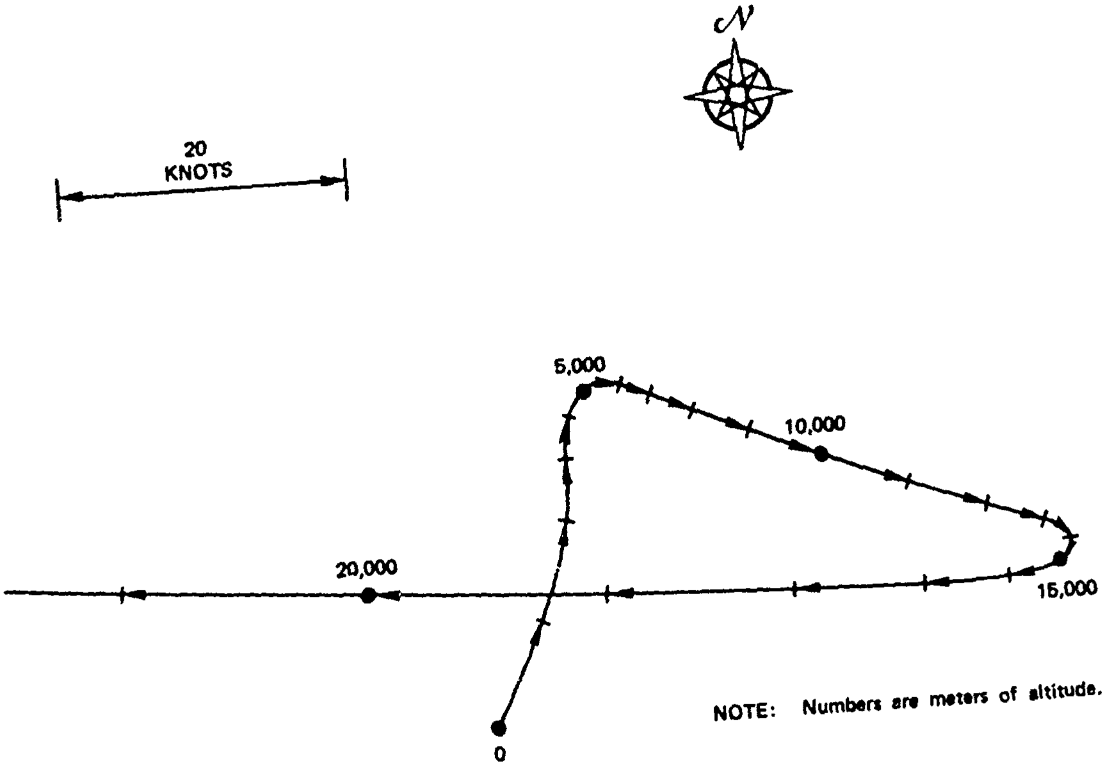
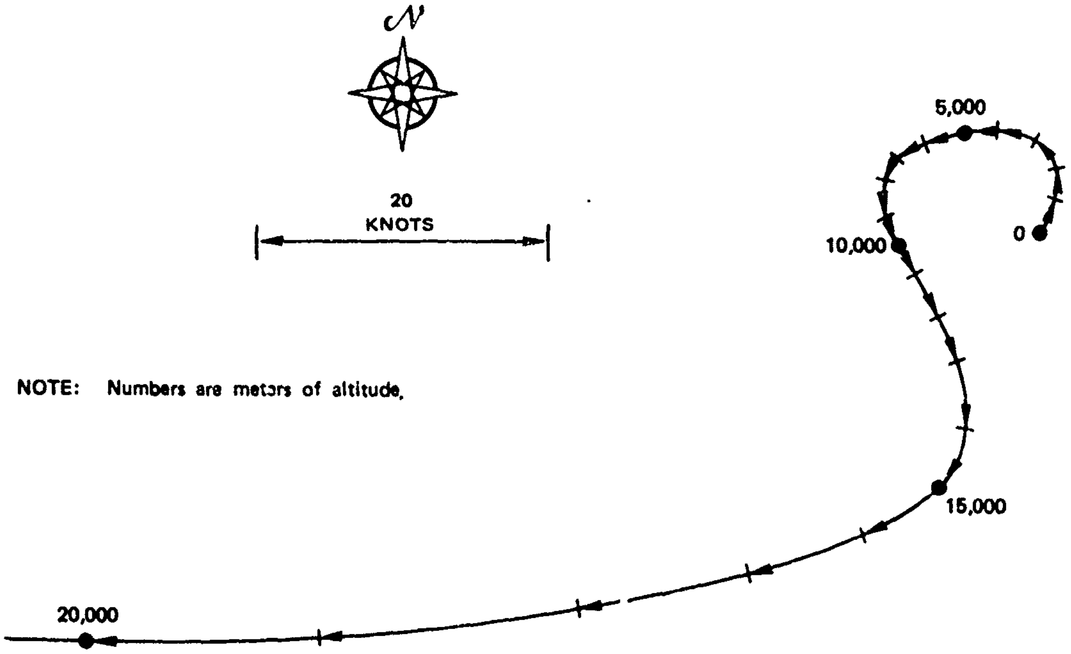


FIGURE 1 FORT WORTH SUMMER WIND



NOTE: Numbers are meters of altitude.

FIGURE 2 LAKE CHARLES SUMMER WIND

that will produce a maximum cloud height of 20 kilometers, are shown in Figures 3 and 4.* As can be seen, the shapes are irregular (especially with respect to the relative location of ground zero) rather than symmetrical about a hotline axis. The higher exposure rate contours are also expected to be irregular. The reproduction of these irregular contours therefore is beyond the capabilities of the simplified SEER model.

The use of mock winds for input into fallout models can serve two purposes: 1) it is a means of providing information on the manner in which selected inputs affect the model's output, and 2) it is a means of generating pattern extremes for model output comparisons. For the mock winds shown in Figure 5, SEER produces the fallout contour pattern shown in Figure 6 while DELFIC produces the pattern shown in Figure 7. The SEER contours do not adequately simulate the DELFIC contours in shape or size, although the bearing is similar. The mock wind is simple in structure (only one direction of rotation) but is highly sheared. Its total change of direction is 225°.

B. Method of Approach

In order to obtain a closer approximation of DELFIC fallout exposure rate contours for any wind structure, it was necessary to expand the modeling of the physical characteristics of particle transport. The following major tasks were carried out:

(1) Improving the accuracy of those empirical equations previously developed which were retained for SEER II.

(2) Including particle transport modeling.

(3) Formulating new empirical equations that were necessary for the new model.

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* See also Figure 20 and Table C-1.

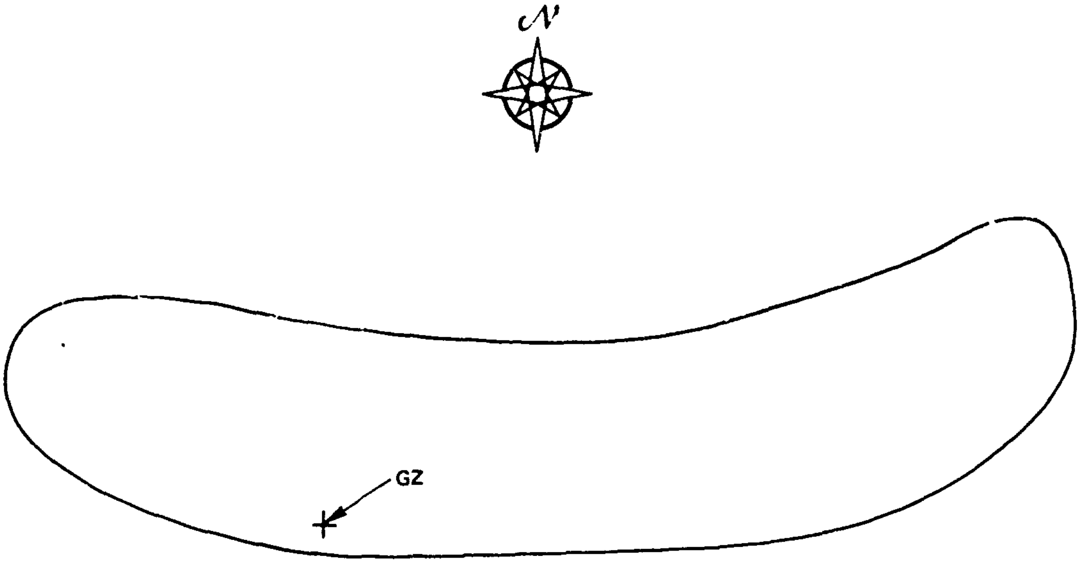


FIGURE 3 EXPECTED SHAPE OF FALLOUT PATTERN LIMITS FOR FIGURE 1 WINDS

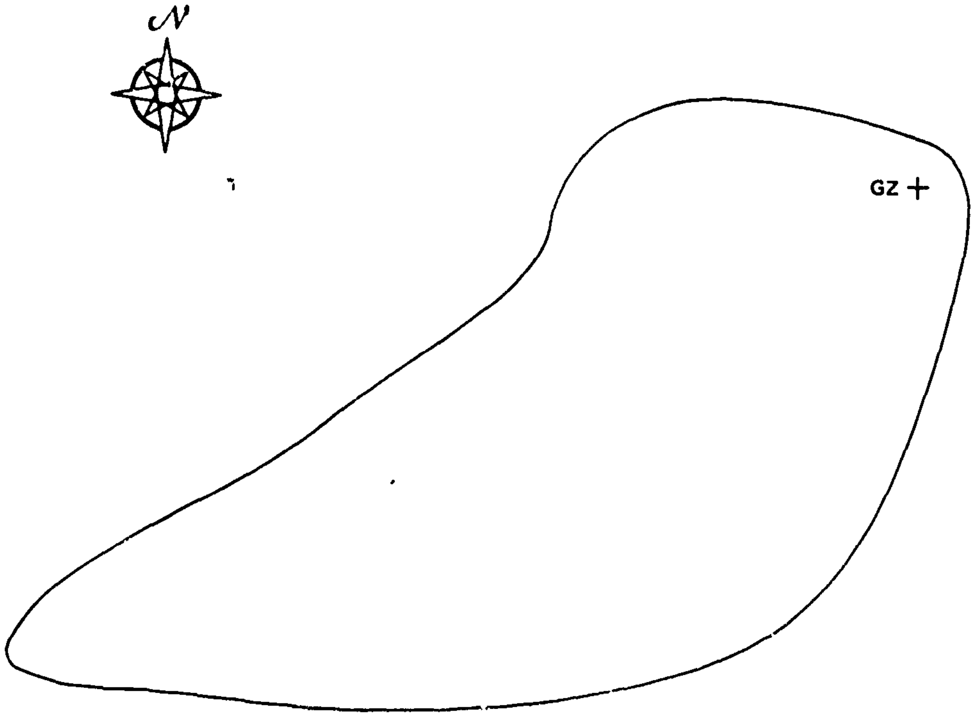
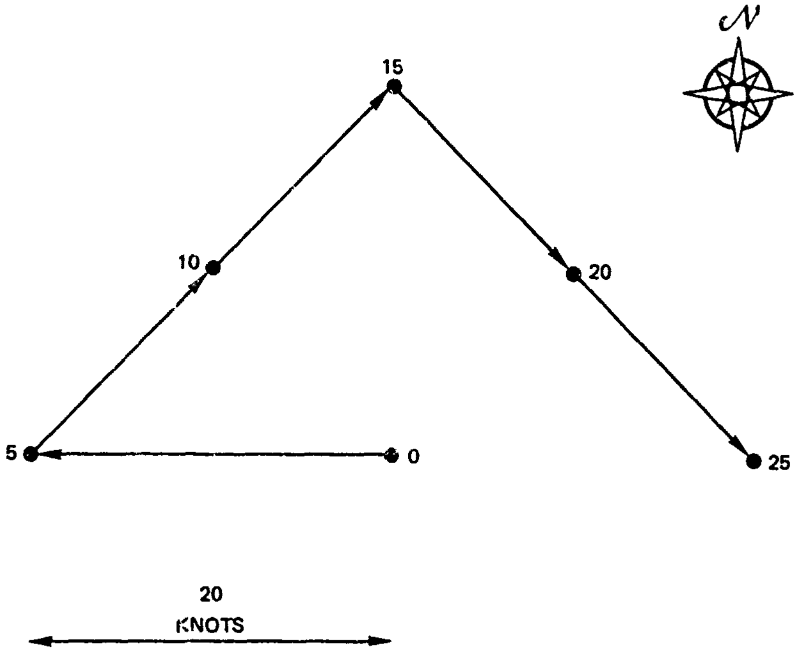
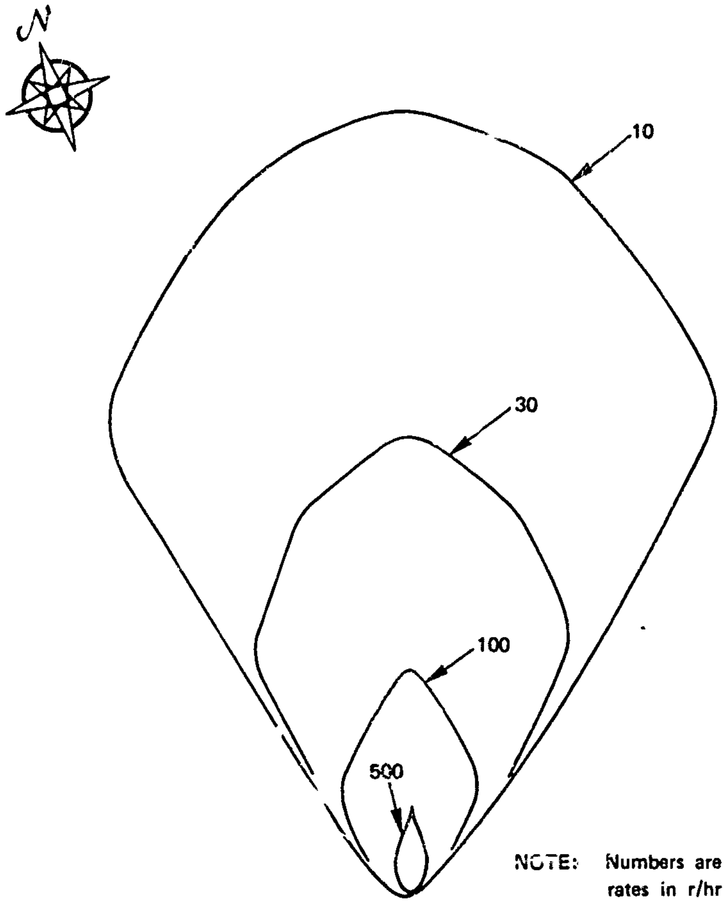


FIGURE 4 EXPECTED SHAPE OF FALLOUT PATTERN LIMITS FOR FIGURE 2 WINDS



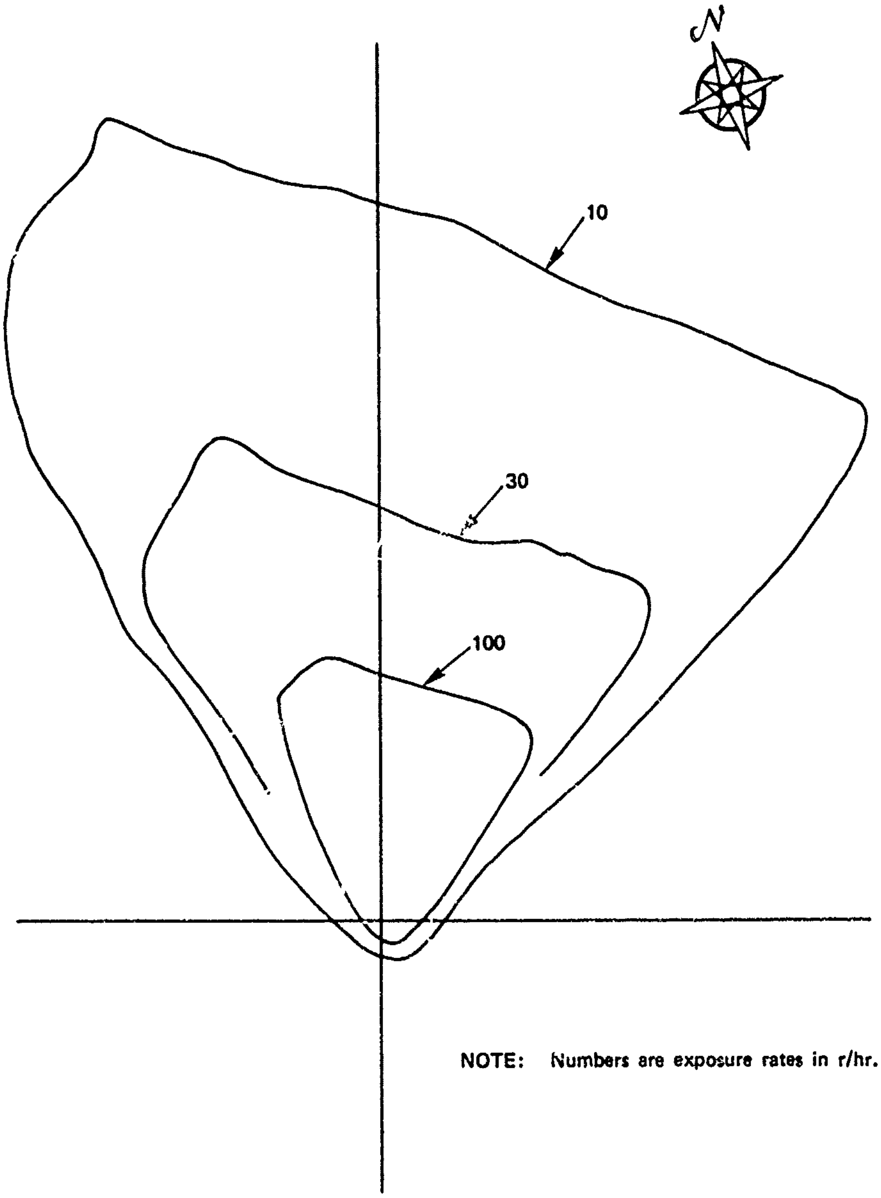
NOTE: Vectors lengths are average velocities for each 5 kilometers of altitude.

FIGURE 5 MOCK WIND STRUCTURE



NOTE: Numbers are exposure rates in r/hr.

FIGURE 6 SEER FALLOUT PATTERN WITH MOCK WIND — 2 MT



NOTE: Numbers are exposure rates in r/hr.

FIGURE 7 DELFIC FALLOUT PATTERN WITH MOCK WIND — 2 MT

(4) Translating the model into computer programs and subroutines.

(5) Analyzing computer output and adjusting the model and the associated programming.

C. Model Development

1. Empirical Equations Derived from DELFIC

The modeling starting point for SEER II is the DELFIC cloud at stabilization. The important parameters at cloud stabilization are:

a) the cloud stabilization times, (t_s)
b) the cloud top altitude, (A_t)
c) the cloud base altitude, (A_b)
d) the cloud radius, (r_{min})

These values can be directly obtained for various yields from the DELFIC cloud history table. Empirical equations written to approximate these parameters as a function of yield are included in Appendix B along with figures demonstrating their accuracy. At the cloud stabilization time, the cloud radius is at a reference minimum. From the minimum radius, the cloud expands radially, first at one rate and then at another rate, until the cloud radial expansion termination time is reached. Since SEER II is a cloud disk transport and deposition model, the rate of cloud radial expansion is an important modeling parameter. The rate of cloud radial expansion with time, the expansion termination time, the maximum radius, and the deposition radius (which may be less than or equal to the maximum) are derived from analyses of DELFIC constant wind fallout patterns, DELFIC cloud stabilization parameters, and particle fall velocities. Empirical equations written to approximate these parameters as functions of yield are also included in Appendix B. Since there is no direct DELFIC printout of these parameters, no comparison of accuracy is made, and the adequacy of the approximations can be judged only as they affect the final results.

2. Analytical Theory

The total potential fallout deposition (intensity integrated over area) from a weapon of fission yield W can be expressed by

$$I_k = KW \tag{1}$$

where K depends on the weapon type k and W is in kilotons. For example, Miller[5] gives a K value of 3610 r/hr at 1 hour per kiloton per square mile for fission of U-238 by 8 MeV neutrons, and this converts to 9350 r/hr at 1 hour per kiloton per square kilometer. If f_c is the fraction of the fallout falling locally from the cloud, then

$$I_k^c = f_c\ KW \tag{2}$$

is the deposition of cloud fallout.

If the fallout cloud is separated into L equal layers of equal total fallout radioactivity, then for each layer, ℓ,

$$I_{k\ell}^c = f_c\ KW/L \tag{3}$$

is the fallout deposition from that layer. If the particles in each layer are separated into particle size groups, and if each particle size group, g, represents a fraction of the total activity of all particle sizes, then for each particle size group in each layer,

$$I_{k\ell g}^c = f_c f_g\ KW/L \tag{4}$$

where f_g is the fraction of the activity in size group g.

For each layer of cloud deposition, the area covered by fallout is approximated by

$$A_\ell = 2r_d(d_n - d_1) \qquad (5)$$

where d_n is the deposition distance of the largest particles, and where r_d is the radius of the cloud at the time of deposition. The increment in area of deposition between adjacent particle sizes g and g+1 is

$$\Delta A_{\ell g} = 2r_d \Delta d_g \qquad (6)$$

where Δd_g is the increment in deposition distance.

The fallout intensity (exposure rate) is inversely proportional to $\Delta A_{\ell g}$. Thus, for each layer of deposition, the average exposure rate within each $\Delta A_{\ell g}$ is

$$I_a = I^c_{k\ell g}/\Delta A_{\ell g} = f_c f_g KW/2Lr_d \Delta d_g \qquad (7)$$

where the deposition distance for particle group g is

$$d_g = \bar{V}_\ell t_d = \bar{V}_\ell (t_s + t_{fg}) \qquad (8)$$

and where $\bar{V}_\ell$ is the effective fallout wind velocity from the altitude of cloud layer ℓ to the ground surface, t_d is the time of deposition, t_s is the elapsed time from the time of detonation to the time of cloud cap stabilization, and t_{fg} is the time of fall for particle size g.

The particle falling times depend on the particle size and its altitude of origin. Instead of providing approximating equations to calculate the particle falling times for various sizes and from various altitudes, falling times were precalculated for specific particle size groupings and stored in the program.

If the cloud is divided into L equally thick layers, each layer will have a thickness of $(A_t - A_b)/L$, and the midpoint altitude of each layer is

$$A_\ell = A_b + \frac{(2\ell - 1)\ (A_t - A_b)}{2L} \qquad (9)$$

where ℓ is the number of the layer counting from the bottom layer ($\ell = 1$) to the top layer ($\ell = L$). The cloud is assumed to be uniform along any vertical section.

The direction of fallout deposition, with respect to the weapon burst point, of fallout particles from each cloud layer is determined by the effective fallout wind direction for the altitude of each cloud layer. The effective fallout wind direction for an altitude is the net result of the directional transport of particles falling from that altitude. From each cloud layer, the fallout will land in the direction of a line extending radially from the ground burst point, with the larger particles landing closer to the burst point and the smaller particles landing further away. The exposure rate of the deposited fallout from each layer not only varies with distance in the effective fallout layer direction, but also varies with distance, r_x, perpendicular to the effective fallout layer direction. The exposure rate is at a peak value at $r_x = 0$ (measured from the radial line) and diminishes to a minimum value at $r_x = \pm r_d$.

The peak exposure rate at a downwind distance Y for a cloud layer is approximated by

$$I_y = I_a \left(\frac{10^4\ W^{1/3}}{t_s + t_f} \right)^{.36} \qquad (10)$$

where I_a is given by Equation 8 and is the average exposure rate between $-r_d$ and r_d at any downwind distance. The exposure rate decreases from its peak value ("hotline" value) in a fashion that is approximated by a normal distribution:

$$I_{rx} = I_y \, e^{-1/2 \, \frac{\pi I_y r_x}{3 I_a r_d}^{2}} \qquad (11)$$

where $-r_d \leq r_x \leq r_d$.

However, the DELFIC exposure rates near the pattern edge exhibit more of a shoulder and then drop off relatively sharply; this necessitates modifying Equation (11) to simulate the sharper drop. The revised expression is

$$I_{rx} = 0.75 \, I_y \, DR + 0.25 \left(\frac{r_{min} - r_x}{r_{min}} \right)^{DR/6} \qquad (12)$$

where

$$DR = e^{-1/2 \left(\frac{\pi \, I_y r_x}{3 \, I_a \, r} \right)^{2}} \quad . \qquad (13)$$

The procedure as reported thus far provides the mechanics for the determination of the exposure rates within the area of deposition for fallout from each cloud layer. Where the deposition areas of fallout from the various cloud layers overlap, the exposure rates are then summed to give total cloud exposure rates.

In the development of the above procedure, many of the inputs, such as the value of $f_c K$ in Equation (2) and the relationship of I_y to I_a in Equation (10) are empirically determined by comparative analysis of DELFIC data (the results of DELFIC runs) with the results obtained from partially developed computerized runs based on the above rationale.

In the region near the detonation point, the radioactivity on the ground arises from detonation ejecta as well as fallout from the stabilized cloud and fallout originating from the developing cloud prior to stabilization. The resulting exposure rates are not presently adequately modeled by DELFIC nor by any other fallout model. For the reasons given above, the exposure rates near ground zero are separately modeled as a smooth extension to the upwind boundary of the results obtained from the cloud deposition.

Once the hotlines for each boundary of the pattern have been established (usually from the bottommost and topmost cloud layers), the edge regions are defined to a distance of r_d from these hotlines by using Equation 12. The largest particle size group, landing closest to ground zero, is then used to define the shoulder of the pattern on each side, by rotating the radius r_d to the upwind direction. The upwind portion of the pattern is then smoothly fitted between these two upwind radii. Details of this computation can be obtained by inspecting computer subroutines GRNDZ, EGDOSE, and SHLDR, described below.

3. Computer Implementation

This section is the formal documentation of the SEER II computer program. The reader is assumed to possess a knowledge of the FORTRAN computer programming language and an understanding of general computer terminologies. The subsection on the preparation of input data and run procedures, however, is directed toward the users of the SEER II program, and is written so that users and analysts can prepare input data and use the program without the assistance of a professional computer programmer. The source statements for all routines in the SEER II program are listed in Appendix A.

a. Program Storage Requirements

The SEER II computer program is written in FORTRAN IV for the Control Data 6000 Series Computer Systems. The program is developed in such a way that, with minimal modifications, it can be implemented on any computer system with a FORTRAN compiler and 40K available central memory storage. Except for normal card-data input and printed output, the program requires neither peripheral storage nor peripheral equipment.

b. Computer Running Time

The program is composed of two distinct segments, both controlled by the SEER II Main Program. The first segment computes all the values of key parameters of the fallout pattern and prints these values in tabular form. The computer running time of this segment varies from approximately 1.3 seconds for a one kiloton weapon to approximately 6 seconds for a ten megaton weapon. This segment of the program is called only once for each weapon and wind specification.

The second segment performs the mapping functions of the program. This segment utilizes the results of the first segment to compute exposure rates for all grid points as specified by the user. The user specifies the range of the values and the scale for each axis. The computer running time of this segment depends on the number of grid-point values that must be computed. For a 1200-grid-point map in which the specified scale is sufficiently large so that the output map includes the 1 r/hr contour line, the running time is about 1 or 2 seconds; however, for the same size map but with a smaller scale, the mapping segment may require up to 5 seconds of computer time. The second segment of the SEER II program is called once for each map requested by the user.*

c. SEER II Main Program

The SEER II computer program consists of a Main Program and twelve subroutines. The Main Program performs the following functions:

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*It should be noted that maps, per se, will be of little interest in a damage assessment system.

(1) reads the input data deck; (2) assigns default values where the user has not specified any value; (3) calls the computational subroutines to compute values for various key parameters of the fallout pattern; (4) prints the computed values in tabular form; and (5) calls the mapping control subroutine, TMAP, to generate the maps requested by the user. The flowchart for the SEER II Main Program is shown in Figure 8.

d. The Computational Subroutines

There are five computational subroutines in the SEER II program. They are FEATUR, PARTLP, INTENS, LFTRT, and EDGE. These routines are all called from the SEER II Main Program and their primary functions are to compute values for key parameters of the model:

Subroutine FEATUR. This subroutine computes values for the following parameters: (1) altitudes of the cloud top and cloud base at stabilization time; (2) time of cloud formation or stabilization; (3) time of termination of radial expansion of the cloud; (4) time of change in radial expansion rate of the cloud; (5) the minimum and maximum cloud radius; and (6) the rates of cloud radial expansion immediately after stabilization and at later times. The equations for these parameters are presented in Appendix B, and were empirically derived from DELFIC print-outs. Subroutine FEATUR is quite straightforward and no flowchart is necessary to show the computational processes.

Subroutine PARTLP. This subroutine divides the nuclear cloud into various layers and then computes the landing points, the horizontal distances traversed, and the times

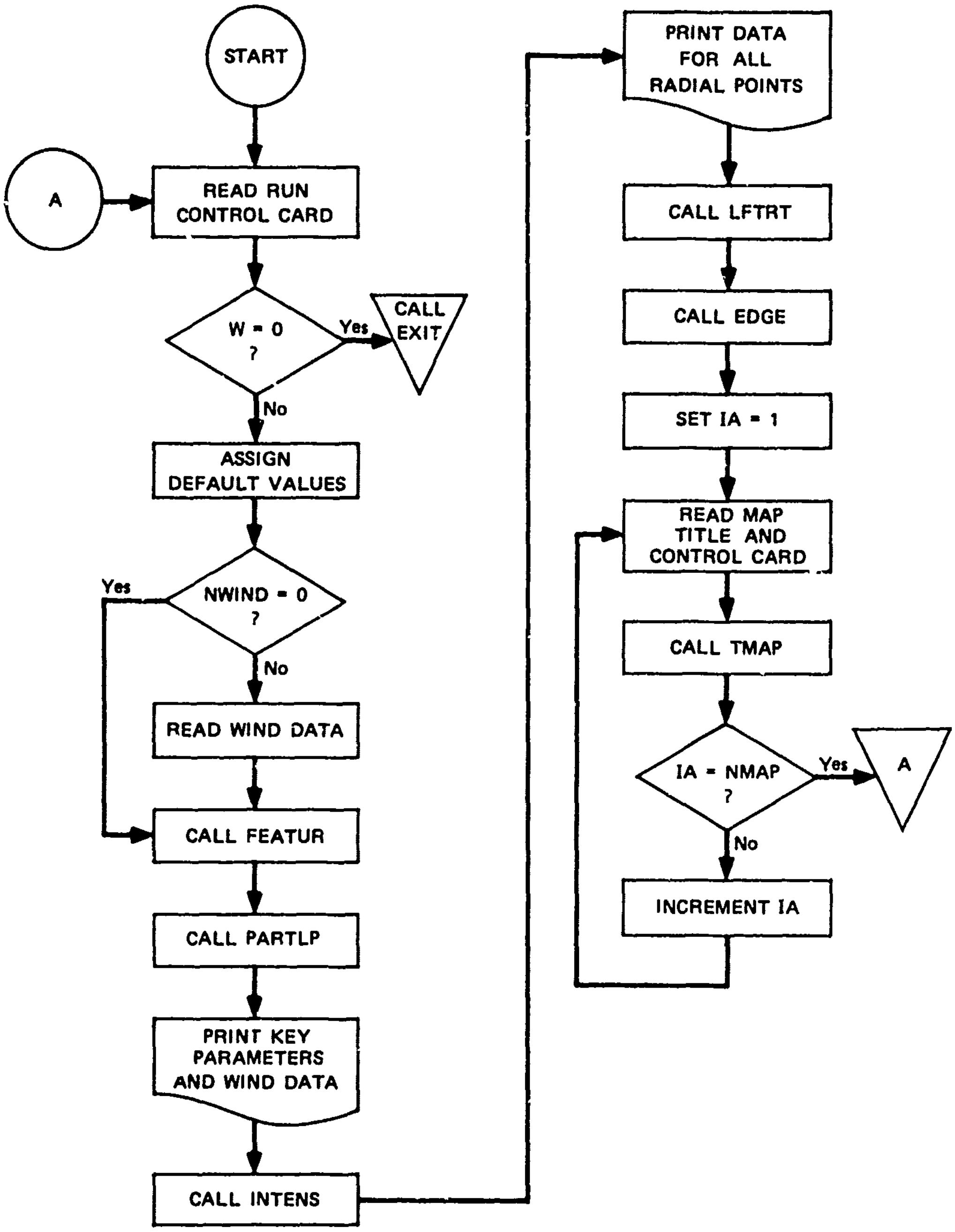

FIGURE 8 FLOWCHART FOR SEER II MAIN PROGRAM

of fall for up to 25 particle groups falling from each altitude layer to the ground. This procedure traces the path of the hotline for each cloud layer. A precalculated table of falling times for the particle groups for 80 altitudes is stored within the subroutine. The calculation for this table follows that of subroutine FALRAT in DELFIC. Subroutine PARTLP takes into account the wind specified by the user and the falling rates of each particle group at various altitudes to determine the landing point as well as the horizontal distances traversed during the descent to the surface. The routine also calculates the 1 r/hr exposure rate radii at the particle group landing points. The flowchart of this subroutine is shown in Figure 9.

Subroutine INTENS. The primary function of Subroutine INTENS is to determine the exposure rates at various internally established key points. The locations of these key points are selected so that an appropriate network of exposure-rate values would be available for the mapping routines. The routine first computes the fallout intensities along the hotline for each cloud layer at the particle-group landing points. Then, after establishing the radial distances from ground zero to the key positions on each hotline, the routine calculates the exposure rates at each key point, taking into account contributions from all cloud layers. Upon return from this routine, array DRAY contains the intensities at the radial points; arrays XRAY and YRAY contain the x and y coordinates of the radial points; array GDRAY contains the horizontal distances traversed

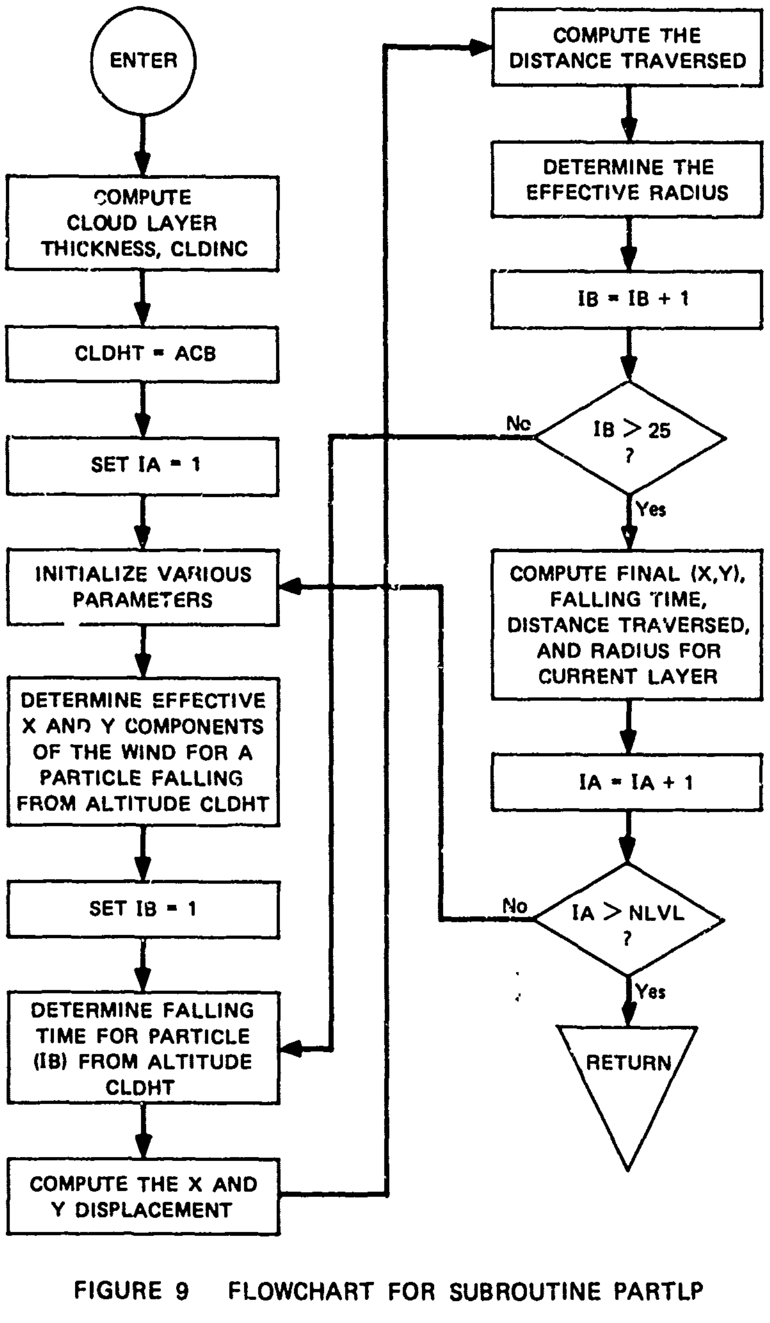

FIGURE 9 FLOWCHART FOR SUBROUTINE PARTLP

by particles descending from the cloud to the radial points; array FTRAY contains the corresponding falling times; array RDRAY contains the effective radii of the particle groups; and array DRATSA contains the ratios of the hotline exposure-rate values to the average rates at the established radial distances. The flowchart for Subroutine INTENS is shown in Figure 10.

Subroutine LFTRT. This routine determines which cloud layer lands on the leftmost side of the fallout pattern and which lands on the rightmost side. The results of this routine are used by Subroutines EDGE and EDGED. For runs in which the wind is constant, the first cloud layer deposited will be both the leftmost and the rightmost sides, since all layers land on a line. The routine is straightforward so that no flowchart is needed to show the computational process.

Subroutine EDGE. This routine determines the locations of pivotal points along the left and right edges of the fallout pattern. For each of the radial points on the left and right crests of the pattern, the routine calculates the location of a corresponding point a distance of 1.1 times the effective radius away. The two sets of points thus calculated define the left and right edges of the pattern. A multiplier of 1.1 is used because it corrects the very sharp dropoff of the DELFIC patterns. The flowchart for Subroutine EDGE is shown in Figure 11.

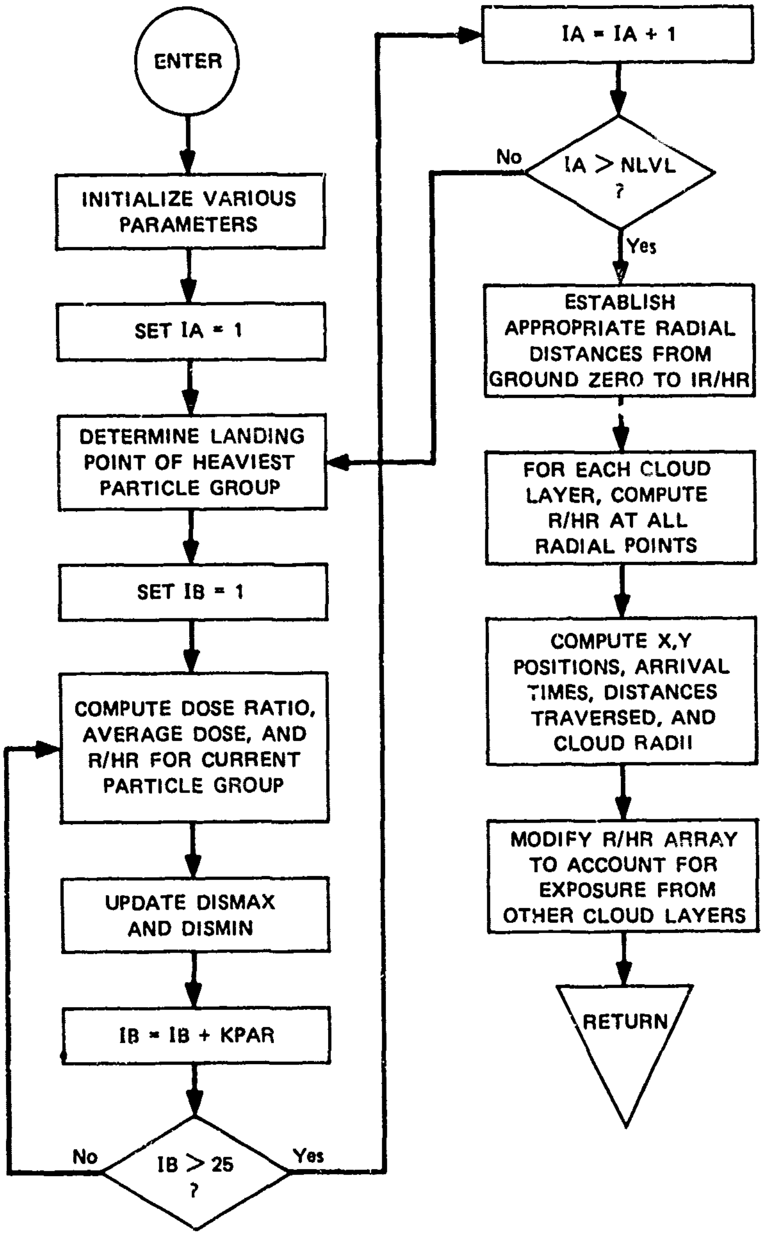

FIGURE 10 FLOWCHART FOR SUBROUTINE INTENS

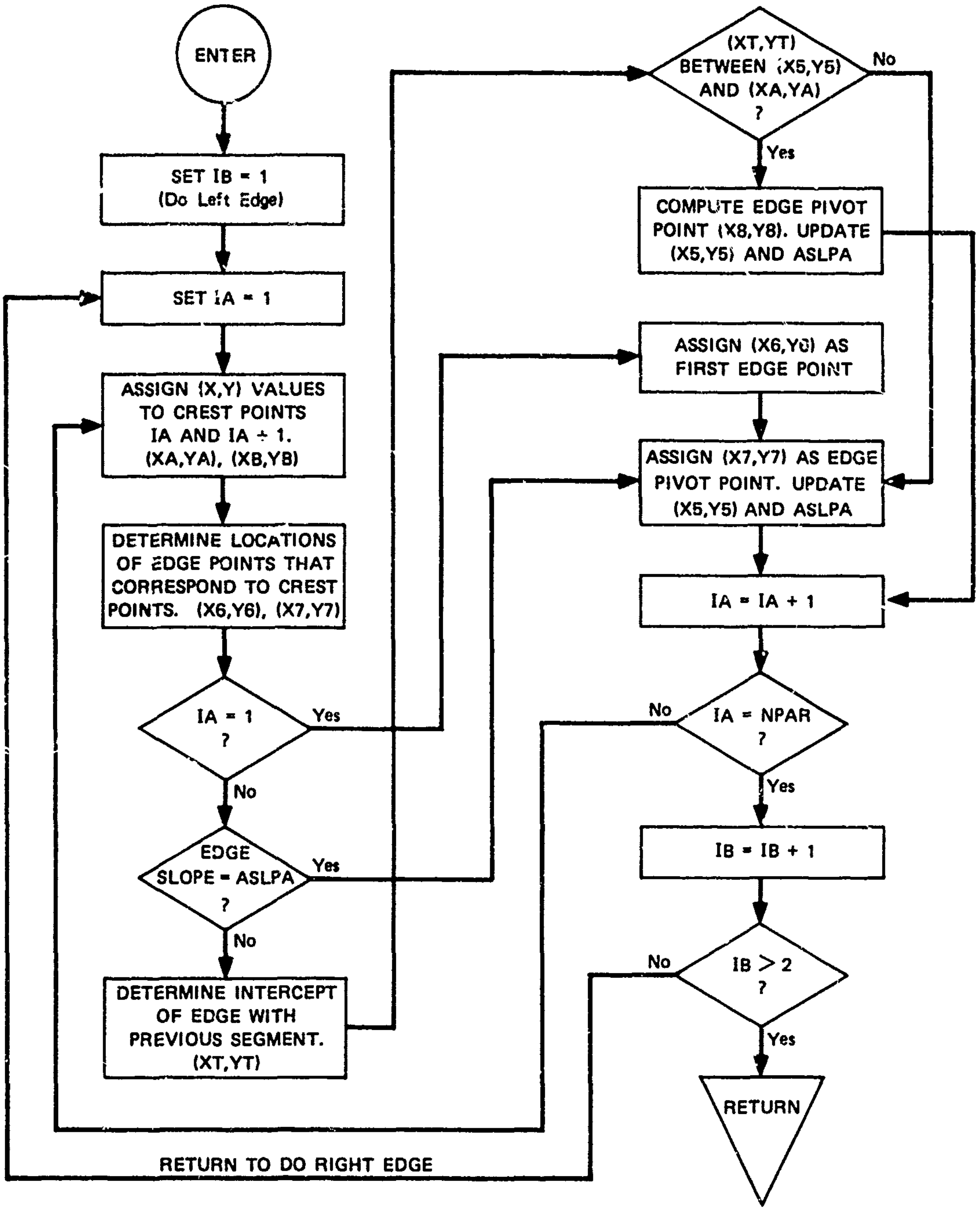

FIGURE 11 FLOWCHART FOR SUBROUTINE EDGE

e. The Mapping Subroutines

There are seven subroutines in the mapping segment of the SEER II program. They are TMAP, EDGED, INTERP, GRNDZ, EGDOSE, QUAD, and SHLDR:

Subroutine TMAP. This routine is the driver for the mapping segment of the program. It is the only one of the seven routines in this segment that is called directly from the SEER II Main Program. TMAP performs the following functions: (1) determines the number of strips of map output for the current map request; (2) clears the map storage areas; (3) sets up the range of x values for each strip of map; (4) sets up the values of the coordinates for the x and y axes; (5) calls Subroutines EDGED, INTERP, and GRNDZ to compute the exposure rates for all map points; (6) examines the computed values at each map point and converts the values to the output mode specified by the user; and (7) prints the output map in the format specified. Subroutine TMAP is called once for each map requested. The flowchart for this subroutine is shown in Figure 12.

Subroutine EDGED. This routine sets up the sequential segments of the left and right edges of the pattern for mapping. This subroutine performs no computations, but merely sets up the segments and then calls subroutine EGDOSE to perform the computations related to the mapping within each segment. The routine is quite simple and no flowchart is needed to show the procedure.

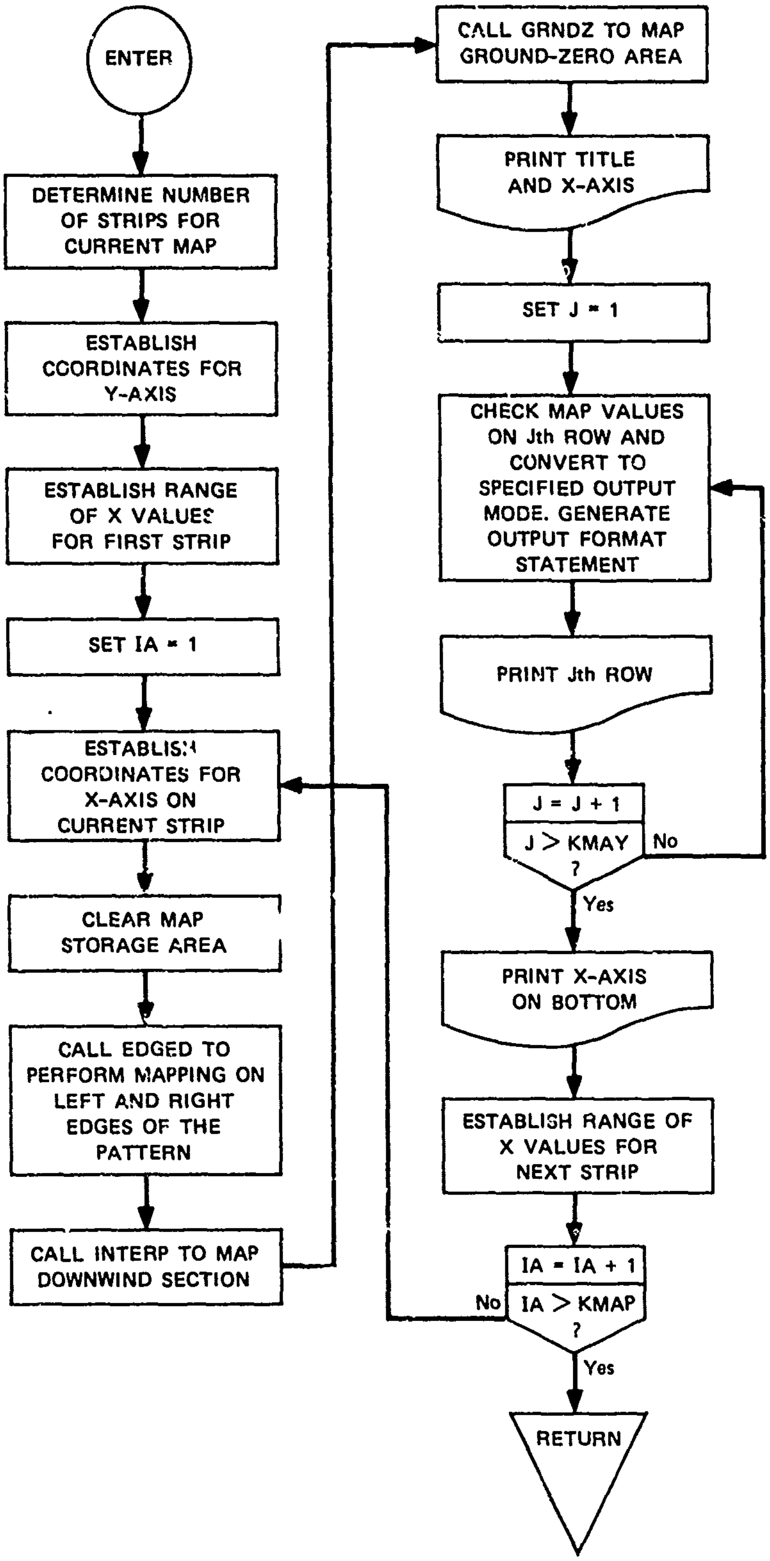

FIGURE 12 FLOWCHART FOR SUBROUTINE TMAP

Subroutine INTERP. This routine computes the exposure rates for all map points in the downwind section of the fallout pattern. The routine divides the downwind section into segments bounded by two pairs of adjacent radial points from two adjacent cloud layer hotlines. The routine then checks each segment to determine the map points that fall within its boundaries. Exposure rates at those points are computed using the weighted values of exposure rates at the four radial points. The flowchart for Subroutine INTERP is presented in Figure 13.

Subroutine GRNDZ. This routine sets up various parameters in COMMON block /QUADRB/ for the computations of exposure rates around the ground zero area. The routine then calls Subroutine SHLDR to perform the mapping for the left and right shoulders of the fallout pattern, and calls Subroutine EGDOSE o perform the mapping in the upwind section of the pattern. The flowchart for the routine is shown in Figure 14. Subroutine GRNDZ is called by TMAP and is called once for each map requested.

Subroutine EGDOSE. This routine computes exposure rates for all map points on the left and right edges of the pattern, or on the upwind section of the pattern. For a run in which the user has not specified the use of fewer than 25 particle groups, the routine will be called fifty times by Subroutine EDGED and once by Subroutine GRNDZ. The flowchart for Subroutine EGDOSE is shown in Figure 15.

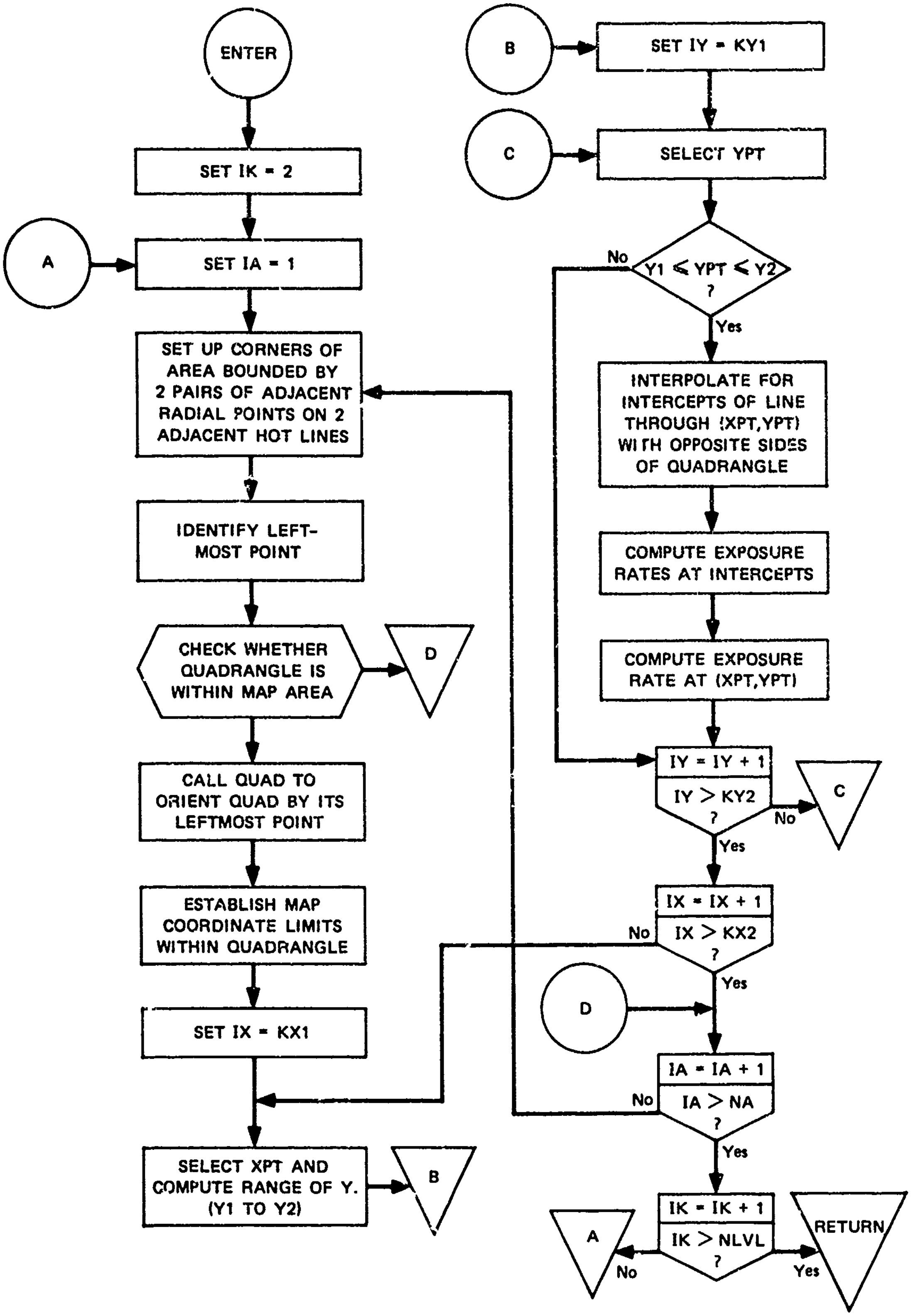

FIGURE 13 FLOWCHART FOR SUBROUTINE INTERP

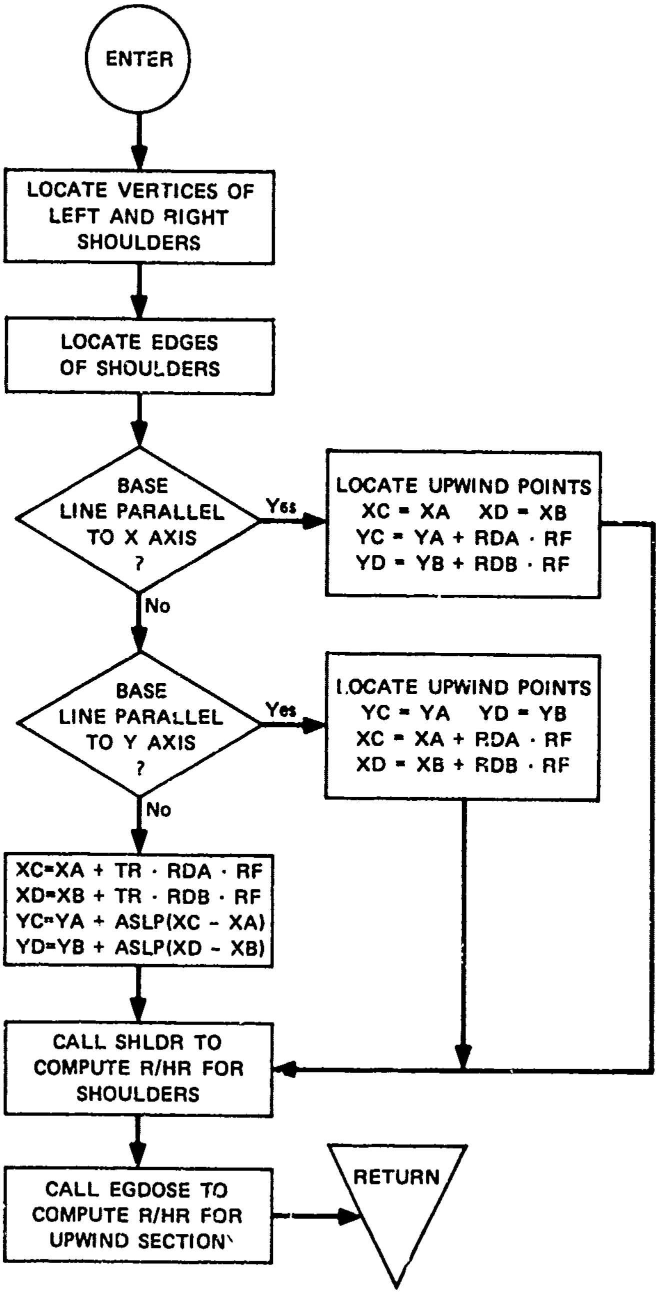

FIGURE 14 FLOWCHART FOR SUBROUTINE GRNDZ

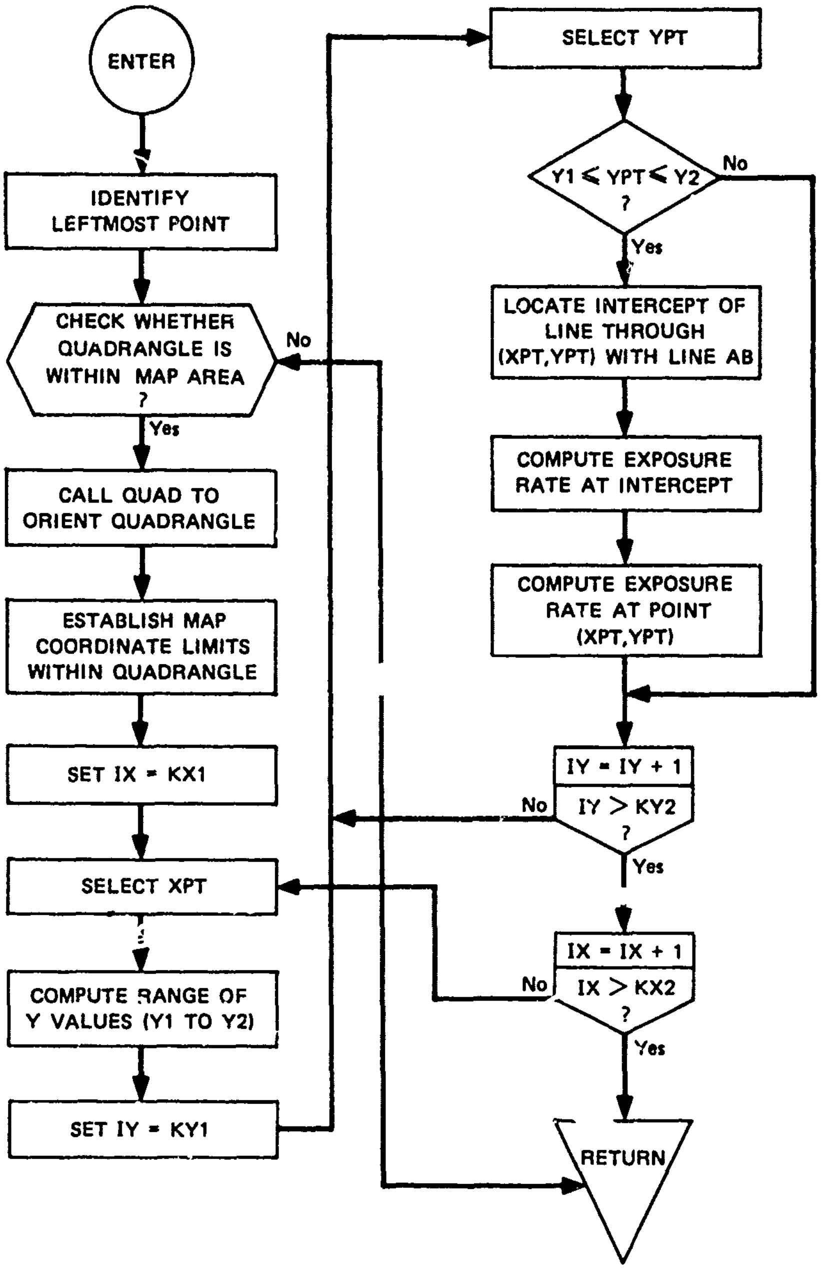

FIGURE 15 FLOWCHART FOR SUBROUTINE EGDOSE

Subroutine QUAD. This routine determines the orientation of a quadrangle and orders the four corners of the quadrangle so that subsequent mapping of the area can be done in an orderly way. The mapping processes in Subroutines INTERP, EGDOSE, and SHLDR require the leftmost point of the quadrangle to be stored in (AX, AY) of COMMON block /QUADRA/; the point diagonally opposite it must be stored in (DX, DY) and the point with the greater slope from (AX, AY) must be stored in (BX, BY); the fourth point is stored in (CX, CY). The routine also calculates the slopes of the lines connecting the four points. Subroutine QUAD is a simple routine and no flowchart is needed to show the computational process.

Subroutine SHLDR. This routine computes the exposure rates for all points on the left and right shoulders of the fallout pattern. Each shoulder is defined as the area enclosed by four points: the vertex point, the edge point, the upwind point, and the bisector point. On the left shoulder, the vertex is the first radial point on the leftmost side of the pattern. The edge point is the first point of the left edge of the pattern. The upwind point is a point located a distance of 1.1 times the effective radius away from the vertex on a line perpendicular to the line connecting the left and right vertices. The bisector point is located on the bisector of the angle formed by the edge point, the vertex, and the upwind point. The point is located a distance of 1.2 times the effective radius away from the vertex. The right shoulder is defined in a similar way. The flowchart for the routine is shown in Figure 16.

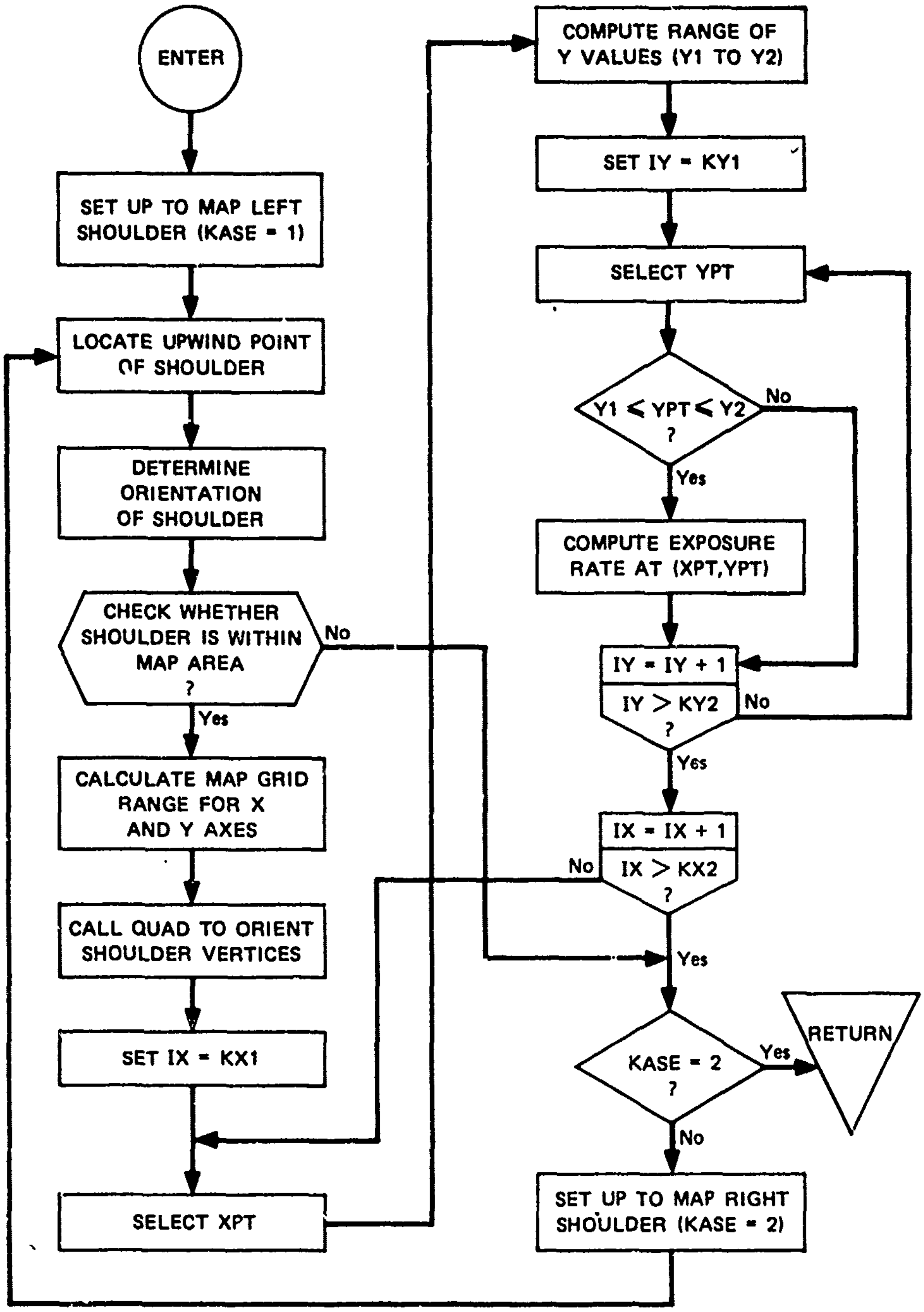

FIGURE 16 FLOWCHART FOR SUBROUTINE SHLDR

4. Users Instructions

The input data for the SEER II computer program are specified on five logical[*] cards. These logical cards are problem identification, problem specification, wind data specification, map identification, and map specification cards. The program is designed so that any number of problems can be run in one computer run. If more than one problem is to be executed in one computer run, the wind data need not be respecified for the second or subsequent problems unless the wind data are to be changed.

a. Problem Identification Card

The problem identification card is used to provide a title or heading for the output data. The user may enter any comment in columns 1 to 80 of this card. There are no column restrictions except that the comment or title must be on one card only. There must be a problem identification card for each problem. A blank car may be used if no comment is desired for a particular problem.

b. Problem Specification Card

A problem specification card must be used for each problem. This card contains the following data:

---

[*] A logical card may consist of any number of physical cards needed to contain the data to be specified by that logical card. For example, wind data specification may require from 1 to 14 cards, depending on the amount of data to be specified. The other four logic input cards, however, require only one physical card each.

Mnemonic	Columns	Format	Restrictions
W	1-10	F10.0	Value must be between 1. and 30000.
TLIMIT	11-20	F10.0	None.
NWIND	24-25	I2	If entered, value must be between 0 and 40.
KDAT	30	I1	If entered, value must be between 0 and 4.
NMAP	31-35	I5	None.
NLVL	39-40	I2	If entered, value must be between 0 and 23.
KPAR	45	I1	If entered, value must be between 0 and 3.

W	is the weapon yield in kilotons. This value must be specified.
TLIMIT	is the transport time limit in seconds. If no value is entered, a default value of 200000 seconds will be assigned.
NWIND	is the number of input wind levels. Leave blank or enter zero if wind conditions of the previous problem are to be used. (See 4-c, Wind Data Specification, for maximum value of NWIND).
KDAT	is the wind data format code. If the entry is blank or zero, a default value of one is assigned. (See 4-c, Wind Data Specification, for an explanation of the wind data formats.)
NMAP	is the number of output maps requested for this problem.
NLVL	is the number of cloud subdivisions to use in the current problem. If a blank or zero is entered, the program will compute an appropriate value based upon the weapon yield. Values larger than 15 may result in excessive computer time. Generally, it would be better to allow the program to compute this value.
KPAR	is the particle gradient code. If a blank or zero is entered, the program will assign a value of one. A 1 requests the program to trace the fallout pattern with 25 particle groups. A 2 requests the program to trace the pattern with 13 groups. A 3

requests the program to use only 9 groups. The latter value should be used only if computer running time is an important factor.

c. Wind Data Specification

Wind data may be specified in one of four formats. The KDAT entry in Column 30 of the problem specification card indicates the format that is used. If KDAT is a blank or zero, Format 1 is used. When Format 1, 3, or 4 is used, the maximum number of wind levels (NWIND) is 40; when Format 2 is used, the maximum number is 15. The wind data specified for the last wind level is considered constant for altitudes above that level. For Format 1, the wind components are in the direction that the wind blows. For the remaining formats, the direction shown is that from which the wind blows.

Wind Format 1--Wind data are specified by altitude and by x and y components. The data for three altitude levels are entered on one card. Use as many cards as needed to specify all data:

Columns	Format	Data
1-8	F8.0	Altitude level in meters.
9-16	F8.0	x component of wind in meters/second.
17-24	F8.0	y component of wind in meters/second.
25-48	3F8.0	Data for next altitude level.
49-72	3F8.0	Data for next altitude level.

Wind Format 2--This format is used by the U.S. Weather Bureau; in it the wind data, at specific atmospheric levels, are specified by compass direction codes and speeds in meters per second. The compass direction codes are:

01 = NNE
02 = NE
03 = ENE
04 = E
05 = ESE
06 = SE
07 = SSE
08 = S
09 = SSW
10 = SW
11 = WSW
12 = W
13 = WNW
14 = NW
15 = NNW
16 = N
20 = calm

The data are for 15 atmospheric levels:

(1) 950 millibars or 500 meters
(2) 850 mb or 1500 m
(3) 700 mb or 3000 m
(4) 500 mb or 5000 m
(5) 400 mb or 7000 m
(6) 300 mb or 9000 m
(7) 250 mb or 10000 m
(8) 200 mb or 12000 m
(9) 150 mb or 14000 m
(10) 100 mb or 16000 m
(11) 80 mb or 18000 m
(12) 50 mb or 20000 m
(13) 30 mb or 24000 m
(14) 20 mb or 26000 m
(15) 10 mb or 31000 m

The data are entered on two cards with the following format:

Columns	Format	Data
1-7	7x	Identification (not read by program).
8-9	F2.0	Direction code for Level 1.
10-12	F3.0	Speed in meters/second for Level 1.
13-17	F2.0,F3.0	Direction and speed for Level 2.
.	.	.
.	.	.
68-72	F2.0,F3.0	Direction and speed for Level 13.

The second card has the same format; data for Level 14 are entered in columns 8-12; Level 15 in columns 13-17.

Wind Format 3--Wind data are specified by altitude, speed, and direction. Data for three altitude levels are entered on one card. Use as many cards as needed to specify all data:

Columns	Format	Data
1-8	F8.0	Altitude level in feet.
9-16	F8.0	Speed in feet/second.
17-24	F8.0	Direction in degrees clockwise from North.
25-48	3F8.0	Data for next altitude level.
49-72	3F8.0	Data for next altitude level.

Wind Format 4--Wind data are specified in a second format used by the U.S. Weather Bureau. Data are given by direction and speed at specific altitude levels. The altitude levels are: surface, 150 meters, 300, 500, 1000, 1500, 2000, 2500, 3000,... increments of 1000..., 34,000 meters. Eleven sets of data are entered on one card. A maximum of four cards may be used to enter the data:

Columns	Format	Data
1-14	14X	Identification (not read by program).
15-17	F3.0	Direction in degrees from North (surface).
18-20	F3.0	Speed in meters/seconds (surface).
21-26	2F3.0	Direction and speed (150 meters altitude).
.		.
.		.
.		.
75-80	2F3.0	Direction and speed (5,000 meters altitude).

Second card--data for altitudes 6,000 to 16,000 meters.

Third card--data for altitudes 17,000 to 27,000 meters.

Fourth card--data for altitudes 28,000 to 34,000 meters.

d. Map Identification Card

The map identification card is used to provide an identifying title for each map requested. The user may enter any comment in Columns 1 to 80 of this card. There are no column restrictions except that the comment or title must be on one card only. There must be one map identification card for each map requested. A blank card may be used if no comment is desired for a particular map output.

e. Map Specification Card

The map specification card is used to define the area and the size of the output map. The user specifies the x and y ranges, the incremental values of the grid coordinates, and the format of the output map. If the user wants the map grid coordinates to have the same linear scales in the x and y directions, he must specify the incremental values in the same ratio as indicated in the format description below. For example, the ratio for Format 4 is 6 to 5; therefore, if the x increment has been specified as 6000 meters, the y increment must be specified as 5000 meters if the user wants the scales to be equal. The grid points in the x (East-West) direction are 0.6 inch apart. The grid points in the y (North-South) direction are 0.333 inch apart for Formats 1 and 3, and 0.5 inch apart for Formats 2 and 4. One map specification card must be used for each map requested:

Columns	Format	Data
1-10	F10.0	Minimum grid value on the x axis.
11-20	F10.0	Maximum grid value on the x axis.
21-30	F10.0	Minimum grid value on the y axis.
31-40	F10.0	Maximum grid value on the y axis.
41-50	F10.0	x increment, in meters.
51-60	F10.0	y increment, in meters.
65	I1	Map output format code. If specified, the value must be between 0 and 4. If a blank or zero is entered, Format 4 will be used.

Map Format 1--Double-space between grid points in the y direction. Map values are in decimal format. Values below 1 are not printed, while values of 100,000 or above are indicated by 99999. The x and y ratio is 9 to 5.

Map Format 2--Triple space, decimal format, 6 to 5 ratio.

Map Format 3--Double space, exponential format. Map values must be multipled by the power of ten indicated above each value. For example, $\overset{3}{3.565}$ means 3,565. The x to y ratio is 9 to 5.

Map Format 4--Triple space, exponential format, 6 to 5 ratio.

f. Data Deck Setup

The following is the order of the input data deck for a SEER II run:

(First problem)	RUN IDENTIFICATION RUN SPECIFICATION WIND SPECIFICATION (1 to 14 cards) MAP IDENTIFICATION MAP SPECIFICATION (Repeat map identification and map specification cards NMAP times.)
(Subsequent Problems)	RUN IDENTIFICATION RUN SPECIFICATION WIND SPECIFICATION (Omit if wind data are the same as the previous problem; i.e., NWIND = 0.) MAP IDENTIFICATION MAP SPECIFICATION (Repeat last 2 cards NMAP times.) . . . . . BLANK CARD (Follows last problem set to indicate end of the input data deck.)

III MODEL VALIDATION

A. Technical Aspects of the Model

The SEER II model is designed to simulate DELFIC-produced fallout patterns at greatly reduced computer computation times. The outputs of the SEER II model are print-out maps and tabularized data which provide the following information:

(1) Map coordinates

(2) Normalized H + 1 exposure rates

(3) Fallout arrival times

(4) Cloud base at cloud stabilization time

(5) Cloud top at cloud stabilization time

(6) Minimum cloud radius

(7) Maximum cloud radius

(8) Cloud formation or stabilization time

(9) Radial expansion termination time.

The computer* computation time for weapon yields in the 10-megaton range is approximately 6 seconds per 1200 grid point run and approximately 3 seconds for weapon yields in the low kiloton range. The computer time could also be further reduced by decreasing the number of integration operations, e.g., by increasing the incremental particle size ranges, by increasing the incremental cloud layer thicknesses, or both. The results of these changes are point values of less accuracy.

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* CDC 6400.

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In its present state of development the model is limited in application to 100-percent-fission surface bursts for weapon yields between 1 kiloton and 30 megatons. (An adjustment factor for less than 100 percent fission could readily be inserted.) The model is also limited to a static wind structure; that is, the model cannot handle wind inputs that include wind vector changes with time or horizontal displacement. The wind inputs are therefore restricted to wind vectors at various altitudes.

B. Comparison of Results

A criterion for the SEER II model is that it simulate DELFIC fallout patterns. Good simulation requires the SEER II fallout pattern exposure rate contours to be similar to those of DELFIC in shape, size and orientation. Since DELFIC produces irregular exposure rate contours with highly diverse wind structures, it is necessary that SEER II also produce exposure rate contours that are similarly irregular with the same input winds. With a diverse wind structure input, the DELFIC fallout pattern no longer exhibits a hotline as a prominent pattern feature; consequently the usual hotline comparisons, e.g., hotline direction and hotline exposure rates vs. distance from ground zero are omitted.

The first pattern comparison is for a yield of 10 megatons and for a 40-knot uniform wind. As can be expected for a uniform wind, (same velocity and direction at all altitudes) the fallout pattern is long and narrow; the pattern is symmetrical, and a readily distinguishable hotline exists through the axis of the pattern. The fallout patterns for this constant wind case are shown in Figure 17. The length to width ratios of these exposure rate contours are so large that it was necessary to foreshorten the patterns in order to display them, by applying one scale for the length and another scale for the width. As can be seen, the lengths and widths of the exposure rate contours and the areas within the exposure contours agree reasonably well. The difference in

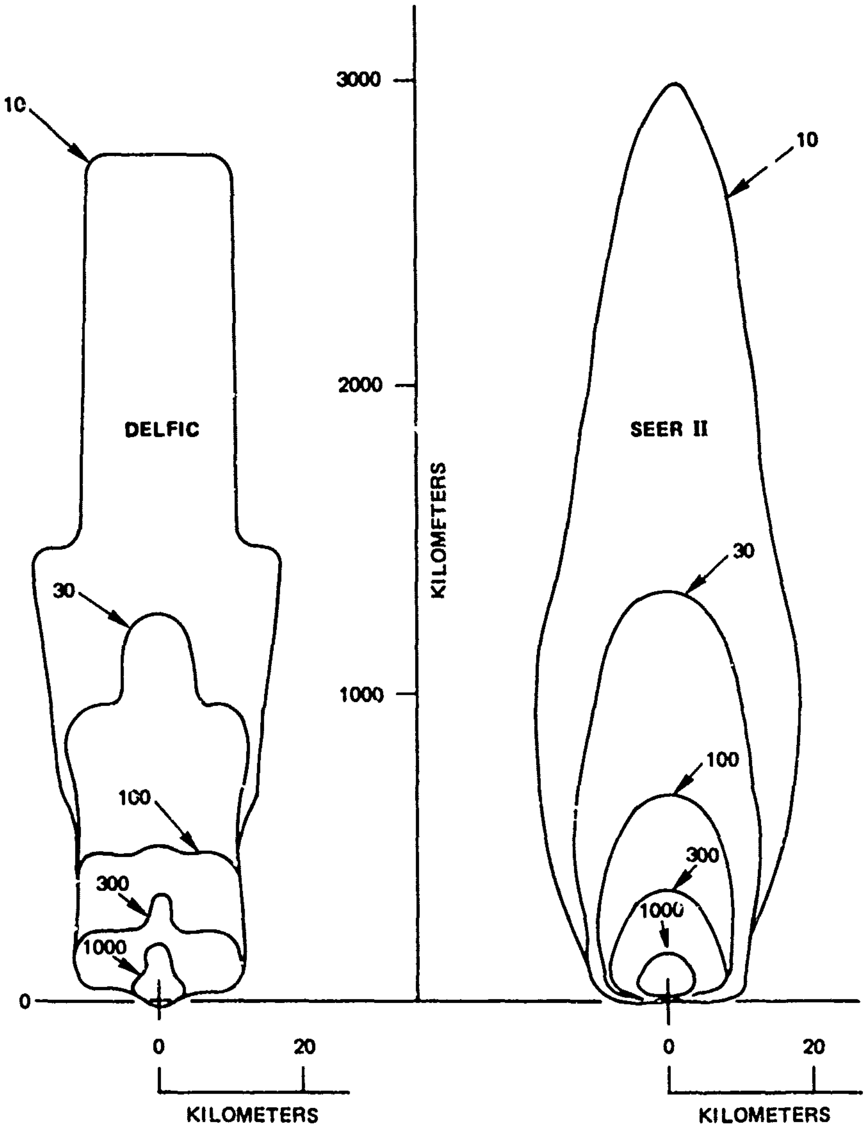


FIGURE 17 FALLOUT PATTERNS FOR 10 MT-40 KNOT CONSTANT WIND

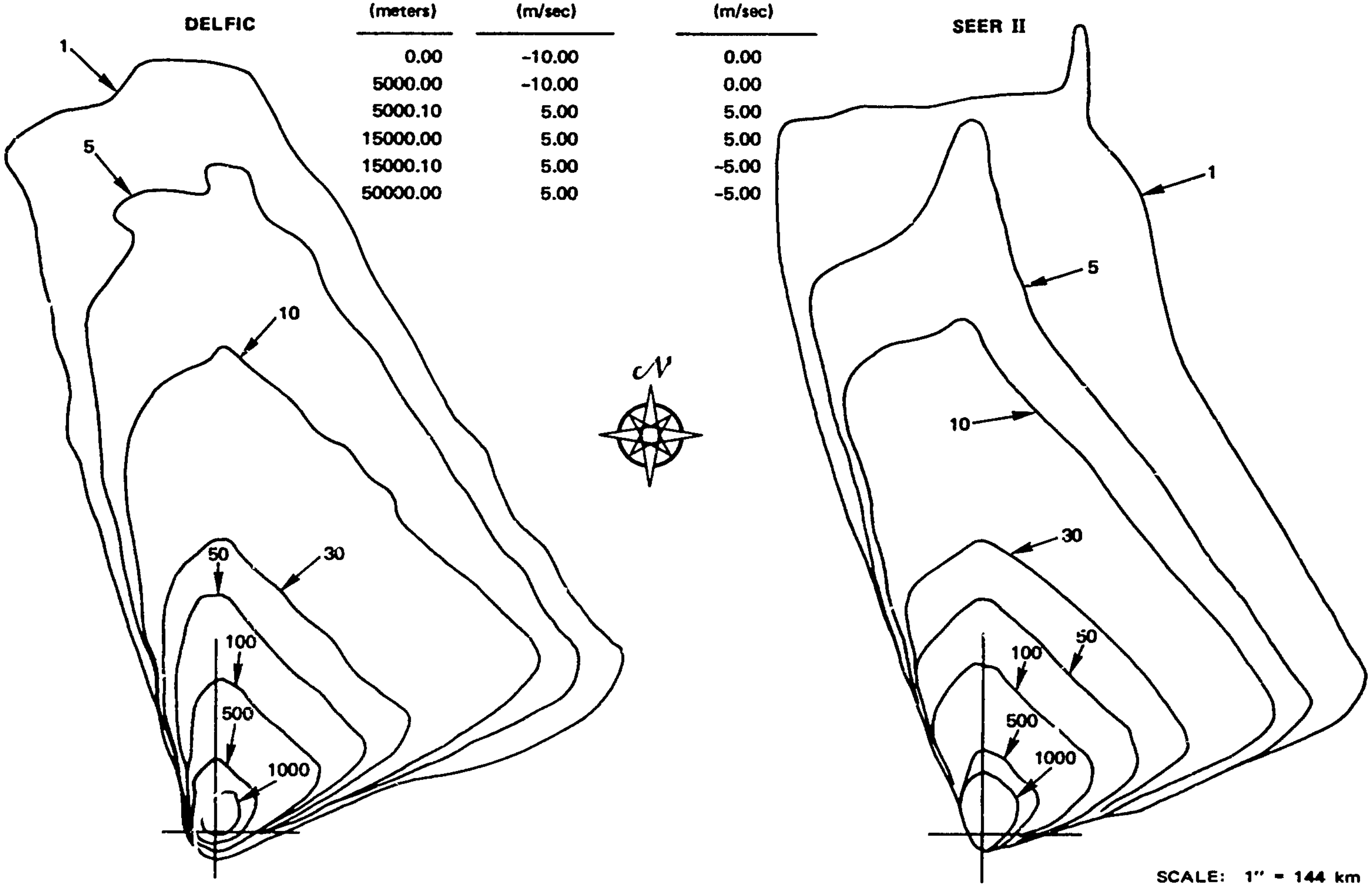
shape is obvious. However, if the DELFIC pattern were smoothed of its apparent large-increment square-wafer effects, the shapes would also be reasonably similar.

The fallout patterns that follow will be generated with wind structures that are variable in velocity and direction with altitude. Consequently, they will not be symmetrical about an axis. In the fallout patterns that follow, the important features of comparison are: exposure rate contour area size; exposure rate contour configuration; and pattern orientation (i.e., the exposure rate contour area should not only be similar in size, but the ground coordinates covered by the exposure rate contour areas should be similar).

The second and third comparisons of fallout patterns are for more severely sheared wind for a 2-megaton and a 30-megaton burst, respectively. These fallout pattern comparisons are shown in Figures 18 and 19. Included in each figure are the input winds. As can be seen in both comparisons, the fallout patterns are considerably wider than in the uniform wind case. The exposure rate contour area sizes and configurations and the pattern orientation are remarkably similar.

The fourth comparison is for a 2-megaton burst using a typical Fort Worth summer wind.[4] The fallout patterns for this case are shown in Figure 20. As can be seen, the fallout deposited in both easterly and westerly directions and the patterns are not at all typical of those normally presented in fallout research literature. Nevertheless, the SEER II exposure rate contours are remarkably similar to those of DELFIC in size, configuration, and orientation.

The final comparison includes a DELFIC, a SEER II, and a WSEG[5] fallout pattern. The weapon yield is 1 megaton and the wind structure is as listed on page 7 of Seery and Polan.[6] These fallout patterns are shown in Figure 21. The WSEG model pattern in this figure is an approximation

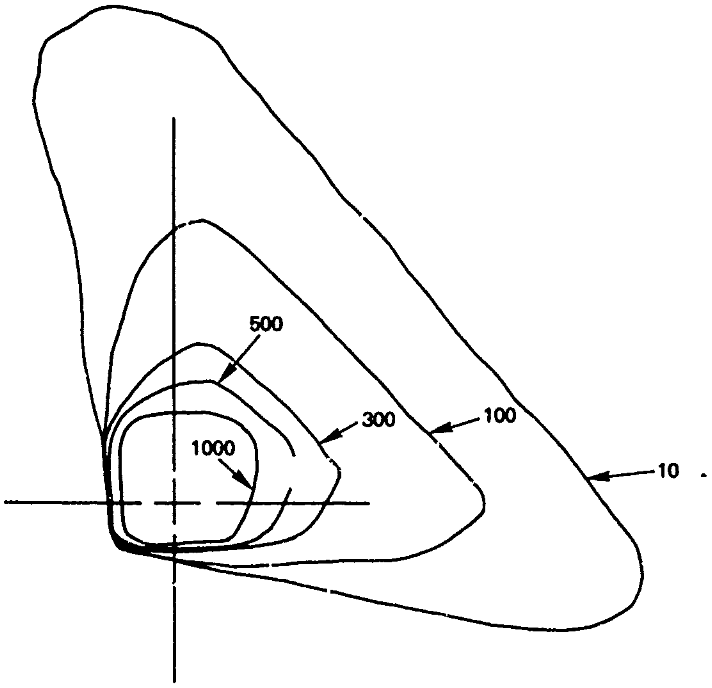


WIND HODOGRAPH AT GROUND ZERO

ALTITUDE (meters)	X COMPONENT (m/sec)	Y COMPONENT (m/sec)
0.00	-10.00	0.00
5000.00	-10.00	0.00
5000.10	5.00	5.00
15000.00	5.00	5.00
15000.10	5.00	-5.00
50000.00	5.00	-5.00

FIGURE 18 FALLOUT PATTERNS FOR 2 MT-SHEARED WINDS I

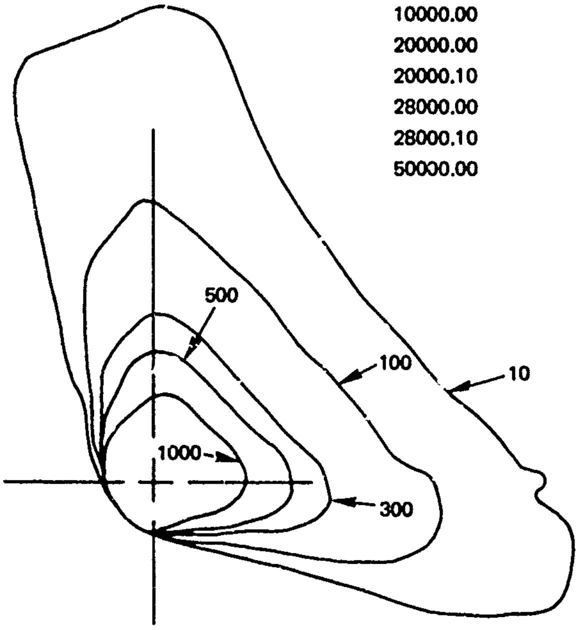
DELFIC



WIND HODOGRAPH AT GROUND ZERO

ALTITUDE (meters)	X COMPONENT (m/sec)	Y COMPONENT (m/sec)
10000.00	-5.82	0.00
20000.00	-5.82	0.00
20000.10	14.55	14.55
28000.00	14.55	14.55
28000.10	14.55	-14.55
50000.00	14.55	-14.55

SEER II



SCALE: 1" = 285 km

FIGURE 19 FALLOUT PATTERNS FOR 30 MT-SHEARED WINDS II

WIND HODOGRAPH AT GROUND ZERO

ALTITUDE (meters)	X COMPONENT (m/sec)	Y COMPONENT (m/sec)	ALTITUDE (meters)	X COMPONENT (m/sec)	Y COMPONENT (m/sec)
500.00	2.04	4.04	12000.00	3.27	-1.25
1500.00	1.56	3.68	14000.00	1.88	-0.68
3000.00	-0.51	1.41	16000.00	-1.36	-0.63
5000.00	0.77	0.64	18000.00	-4.00	0.00
7000.00	1.00	-0.05	20000.00	-8.48	0.59
9000.00	1.78	-0.91	24000.00	-11.93	1.25
10000.00	2.82	-1.03			

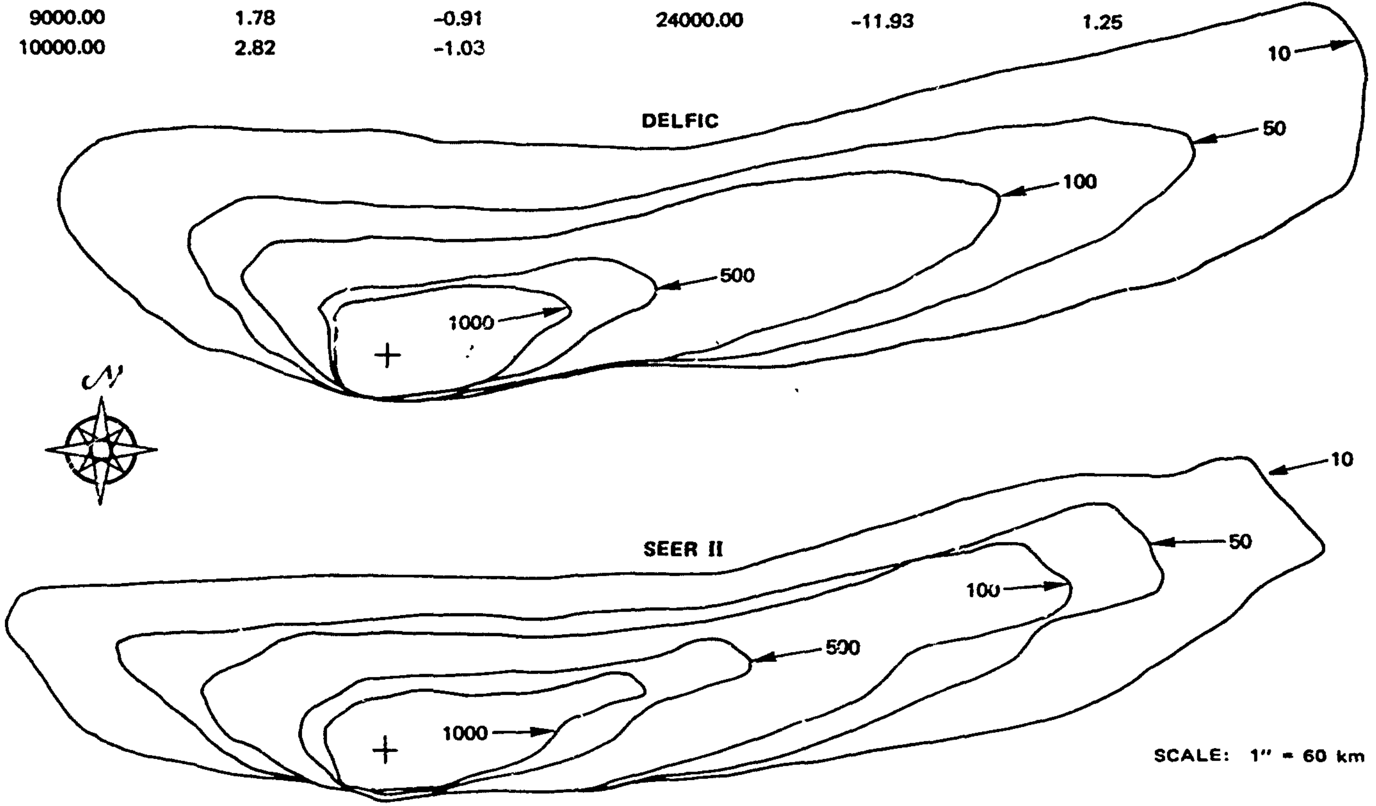
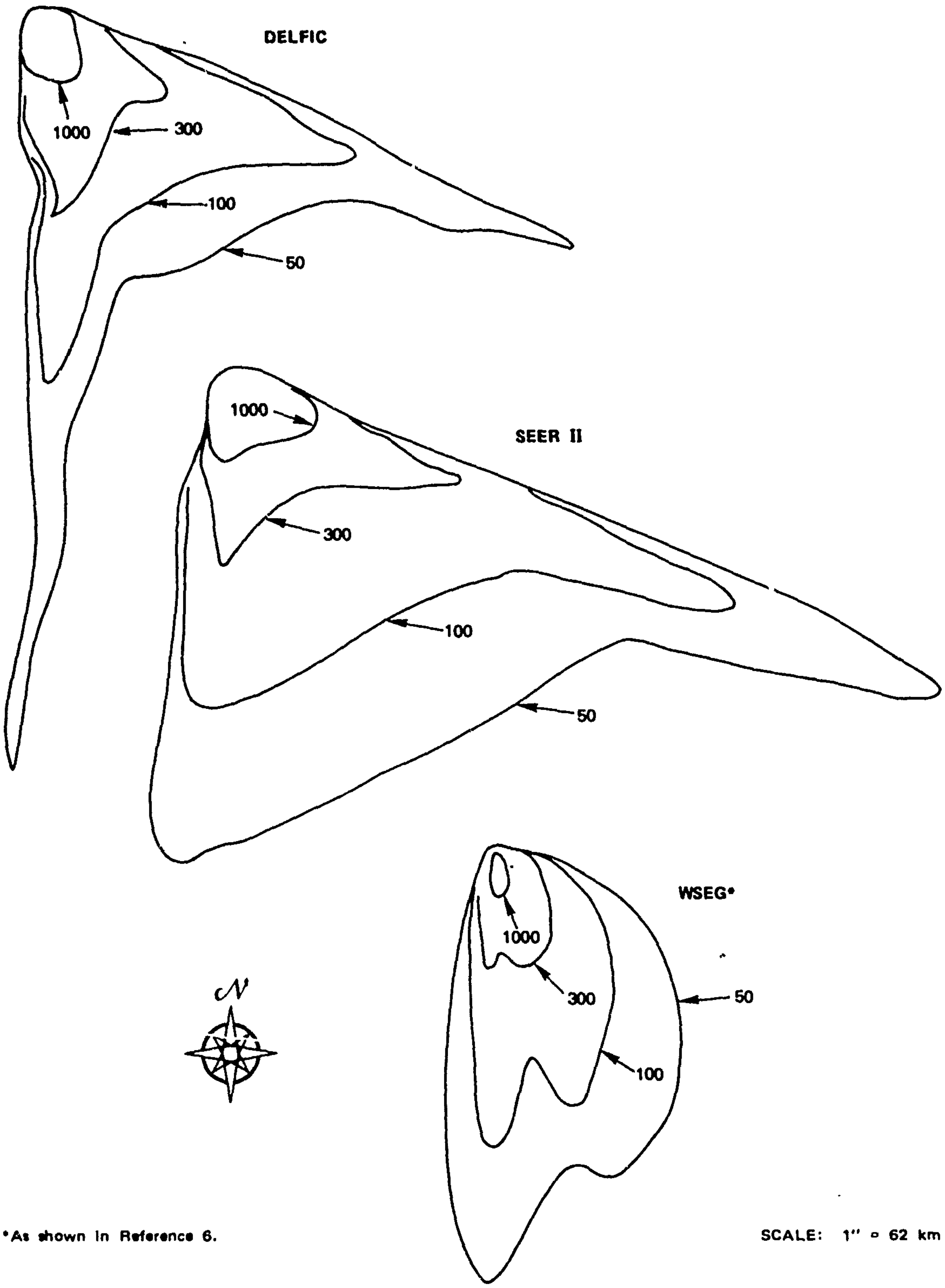


FIGURE 20 FALLOUT PATTERNS FOR 2 MT-FORT WORTH SUMMER WIND



*As shown in Reference 6.

SCALE: 1" = 62 km

FIGURE 21 FALLOUT PATTERN COMPARISONS FOR 1 MT-REFERENCE 6, CASE V WINDS of that shown in Figure 3.5 on page 25 of Seery and Polan.[6] The similarities and differences in the three fallout patterns are obvious. In this case, although the SEER II and DELFIC patterns were similar in orientation, the areas within the 100 r/hr and the 50 r/hr contours are significantly different,as are their configurations.

In general, the comparison of other SEER II fallout patterns with DELFIC fallout patterns, as well as those shown here, indicate that the SEER II fallout patterns will simulate DELFIC fallout patterns reasonably well for weapon yields between 1 kiloton and 30 megatons for any common wind structure.

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In general, the comparison of other SEER II fallout patterns with DELFIC fallout patterns, as well as those shown here, indicate that the SEER II fallout patterns will simulate DELFIC fallout patterns reasonably well for weapon yields between 1 kiloton and 30 megatons for any common wind structure.

IV STATISTICAL WIND VARIATIONS VS. FALLOUT PATTERN VARIATIONS

A. Purpose

Predictions of fallout from nuclear detonations are sensitive to at least two inputs: the fallout model used and the meteorological conditions postulated. The possible errors introduced into the prediction by a faulty fallout model, even when information on winds is perfect, have already been discussed. But it is also well known that the most detailed fallout model in use (DELFIC) will fail to yield good fallout predictions if it is given inaccurate or incomplete wind predictions.

There are two essentially different problems in wind predictions. One type applies when it is known that a nuclear detonation is going to occur at or near a specified time, as in weapon tests or in simulating actual nuclear warfare. In this situation, it is important to be able to predict winds for a few hours or days in the future given meteorological data now and in the immediate past. The essential questions concern meteorological theory and observations about persistence and change of wind fields. The other type of problem is peculiar to damage assessment studies of the kind that SEER is designed for. Here, one in general does not know the most likely time of detonation (although it is sometimes postulated). For a given set of detonations and targets, the damage assessor is most interested in what is the most likely fallout pattern and what degree of variation from this mean condition is possible. The answers to these questions possibly can be found by examining the statistics of wind data for the geographical locations of interest. The purpose of this section is to investigate how the variability of winds

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affects the variability of fallout patterns, and whether relatively simple rules can be generated for relating the two kinds of statistics.

B. Discussion of Procedure

Winds vary in direction and speed at different altitudes, geographical locations, and time. Because the winds at any time and at any location can vary significantly with altitude, the number of distinctive sets of wind structures is so large as to make the available wind frequency data difficult to interpret. The variations in fallout patterns, on the other hand, can be described by the distribution of activity deposited within the pattern, by pattern size, by pattern shape, and by the location of the pattern. Both the size and shape of the fallout pattern and the fallout deposition within the pattern can be described by specifying the sizes and the shapes of the areas within normalized exposure rate contours.

If the manifold ways in which a wind structure can vary could be converted to only a few parameters to which fallout deposition is sensitive, then the problem of relating statistical wind variations to statistical fallout pattern variations would become manageable. By this means, wind variations that do not significantly affect the fallout deposition pattern need not be evaluated statistically.

The primary wind characteristics that affect the size, shape, and location of various fallout exposure rate contours can be reduced to three parameters: the maximum effective wind speed; the effective wind angular displacement;* and the direction of the maximum effective wind vector. These parameters are illustrated in Figure 22 and defined in the next paragraph. However, variations in fallout patterns will occur even among winds defined by the same maximum effective wind speed and effective wind angular displacement.

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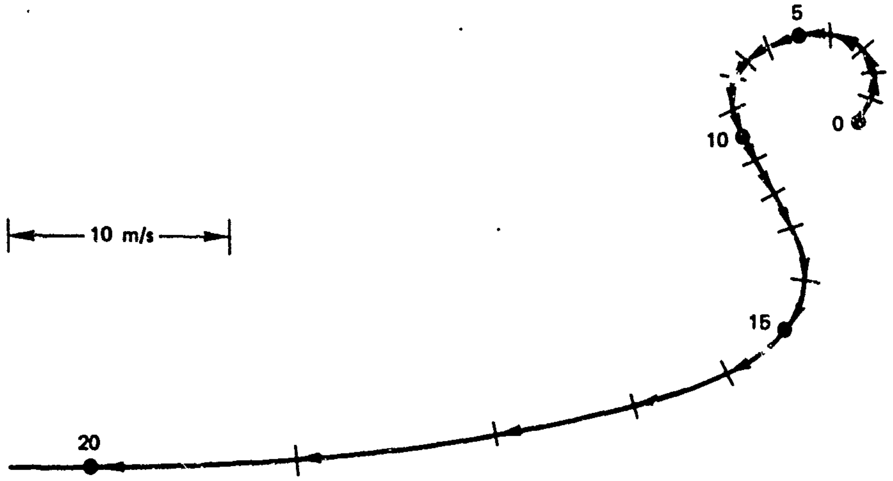
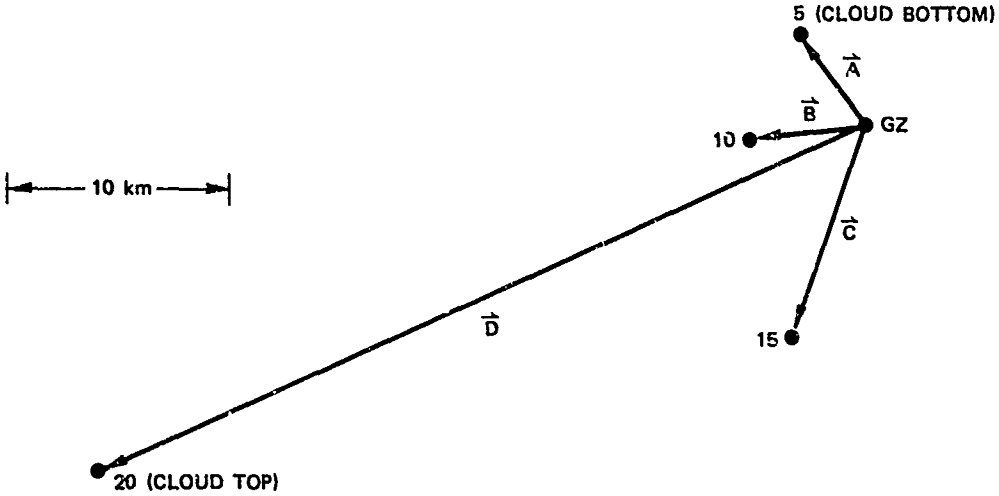
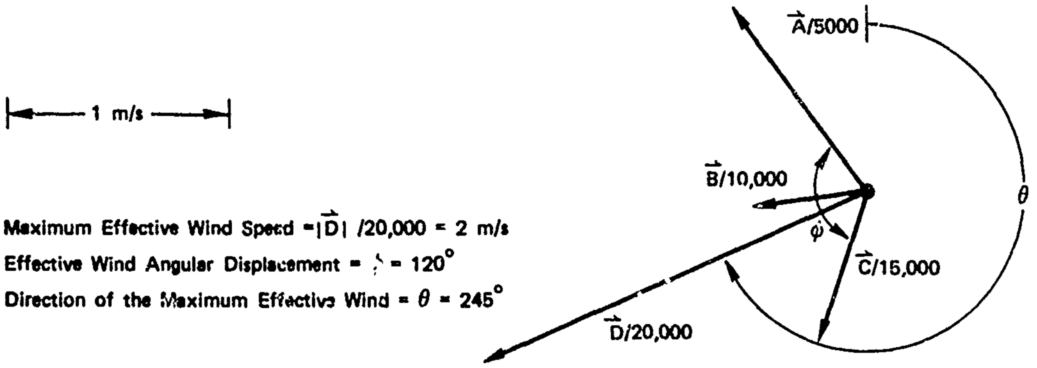
*This parameter is related to what is often termed wind shear.



(a) LAKE CHARLES SUMMER WIND (ALTITUDE IN km)



(b) DISPLACEMENT VECTORS FOR PARTICLES FALLING AT CONSTANT 1 m/s FROM ALTITUDE TO SURFACE



Maximum Effective Wind Speed $= |\vec{D}| / 20{,}000 = 2$ m/s

Effective Wind Angular Displacement $= \varphi = 120°$

Direction of the Maximum Effective Wind $= \theta = 245°$

(c) AVERAGE HORIZONTAL VELOCITY VECTORS DURING FALL

FIGURE 22 WIND PARAMETERS FOR STATISTICAL ANALYSIS

Although many fallout models use an effective wind speed as a modeling parameter, our studies indicate that fallout pattern characteristics correlate best with the maximum effective wind velocity. The effective wind velocity vector is commonly defined as the vector sum of the wind vector velocities at each altitude layer divided by the number of altitude layers from the weapon cloud altitude, e.g., cloud center altitude, to the ground surface. The maximum effective wind velocity is defined as the maximum effective velocity vector that is obtained from any altitude within the weapon cloud base and weapon cloud top to the ground surface. The effective wind angular displacement is defined as the maximum angle between any two effective wind vectors for altitudes within the weapon cloud. It is equivalent to the enclosed angle within which would land all falling particles originating from any point vertically above ground zero within the weapon cloud. These parameters obviously depend on the postulated weapon yield.

The fallout pattern response to an increase in the maximum effective wind speed is an increase in pattern length, and the fallout pattern response to an increase in the wind's angular displacement is an increase in pattern width. Increases in both speed and angular displacement are reflected in a decrease of the areas within the higher exposure rate contours together with an increase of the areas within the lower exposure rate contours.

The number of descriptive shapes ascribable to fallout patterns is limited only by imagination. One quantitative measure of pattern shape that can usually be easily defined, however, is the width to length ratio. Our primary measure of shape shall therefore be the ratio of width to length. Other descriptive indicators of shape, such as elongated ellipse, a fan shape, or a teardrop, could also be included if useful. The maximum effective wind vector direction is the general indicator of the direction of the fallout cloud movement from ground zero. The maximum effective wind vector is also near the bisector of the fallout mass, even though it may not geometrically bisect all of the exposure rate contour areas. For these reasons, exposure rate contour lengths are measured parallel to the direction of the maximum effective wind vector, and widths are measured perpendicular to this vector. The length is defined as the distance between the extreme upwind and extreme downwind extents of the contour, whereas the width is defined as the maximum of the crosswind distances between the contour edges (see Figure 23). The width to length ratio is expected to decrease with increasing maximum effective wind speed or decreasing wind angular displacement.

For a specific weapon yield, each wind structure--as defined by a range of maximum effective speeds and a range of effective angular displacements--will produce a fallout pattern with a range of exposure rate contour areas and a range of width to length ratios. The application of statistics to maximum effective wind speeds and effective angular displacements, both of which incorporate variations with altitude, will supply the statistics on exposure rate contour area sizes and exposure rate contour width to length ratios. Additional statistical breakdowns by descriptive shapes could also be made if useful. If the statistical distribution of exposure rate contour sizes and shapes is known, wind direction frequency can then be used to determine the frequency of fallout patterns by direction.

It is acknowledged that only the effects of static wind structures at fixed times and geographical locations are included in the general analytical procedure suggested above, and that the effects of variations of dynamic wind changes as a function of time and space are not included. There are several reasons for excluding the latter type of analysis. Perhaps the most important is that data are rarely collected in such a way that they describe the varying winds seen by a moving fallout cloud

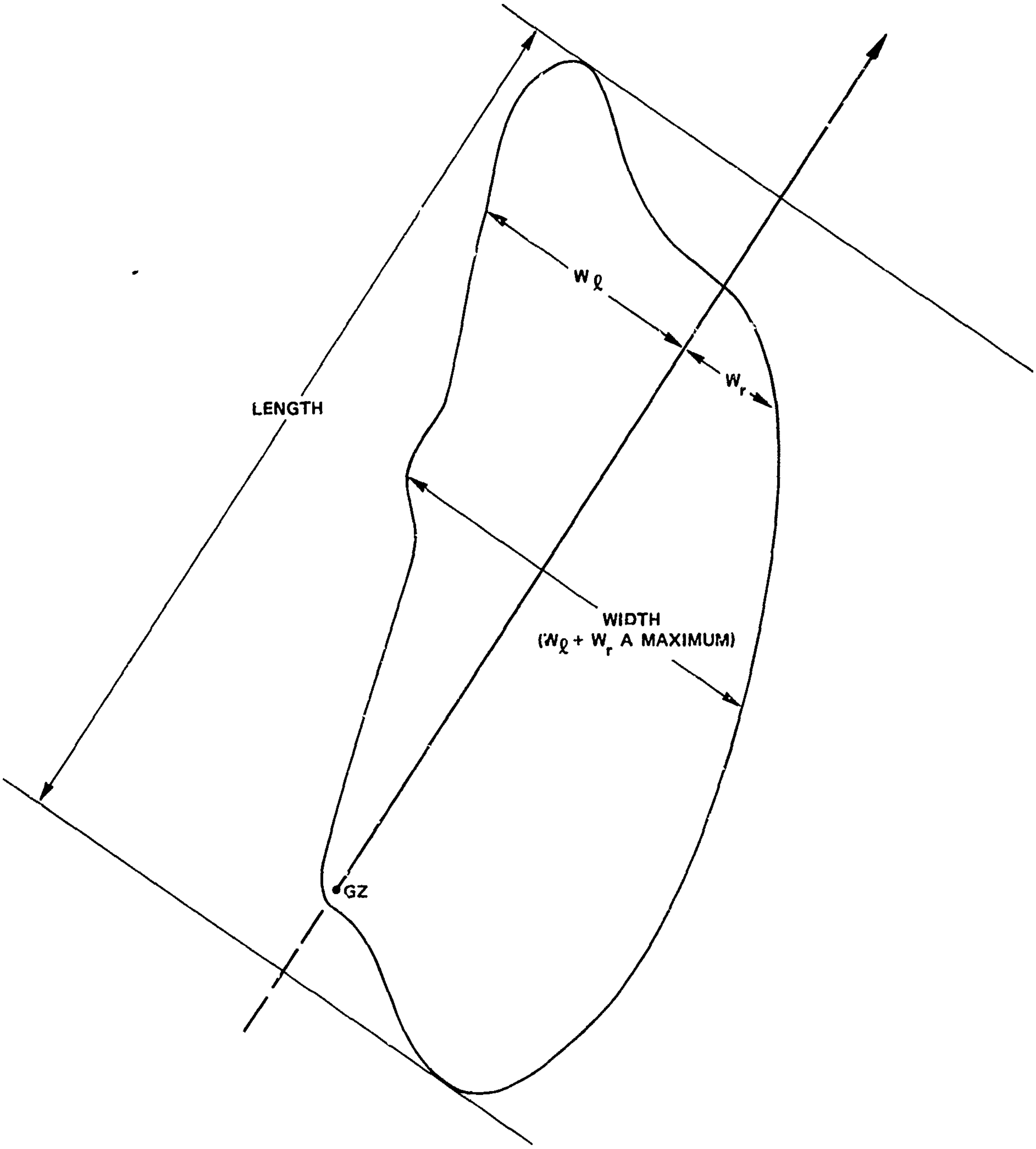


FIGURE 23 EXPOSURE RATE CONTOUR WIDTH AND LENGTH

Even if this type of data were available, however, its resolution into quantitative relationships between wind variability and pattern variability would require a sophisticated model to handle this data and extensive analysis.

C. Procedure

The following steps appear to constitute a reasonable procedure for investigating the relationship of wind variability and fallout pattern variability:

(1) Obtain wind data for a location (meteorological station). The data are in the form of wind speeds and wind directions, at various altitudes at various times of measurement.

(2) Convert the data to effective speeds and effective directions as functions of altitude. The altitudes of interest depend on the weapon yields of interest. For example, if the pattern variability for a 1 megaton weapon is desired, the altitudes of interest are between 0 and 20 kilometers. The primary converted data of this effort are the maximum effective speed, the effective direction, and the effective angular displacement for each set of wind data. Supplementary data from this effort could include the following:

(a) Sum of clockwise directional changes

(b) Sum of counterclockwise directional changes

(c) Total directional change

(d) Net directional change

(e) Maximum rate of directional change and corresponding altitude

(f) Maximum speed and corresponding altitude and direction

(g) Minimum speed and corresponding altitude and direction

(h) Sum of velocities

(i) Average effective speed

(j) Minimum effective speed and corresponding altitude.

Variability in the supplementary data could create variability in fallout patterns. The supplementary data are for determining the significance of this variability.

(3) Group the winds according to:

(a) Effective angular displacement (degrees)

a-1	0-10
a-2	10-25
a-3	25-50
a-4	50-90
a-5	> 90

(b) Maximum effective speed (meters/second)

b-1	0- 8
b-2	8-16
b-3	16-24
b-4	24-32
b-5	> 32

(c) Combination of (a) and (b) above (i.e., 25 subgroups where a-1, b-1 and a-1, b-2 are two subgroups.

(d) Supplementary groupings

d-1 Sum of clockwise directional changes (degrees)

d-1-1	0-10
d-1-2	10-25
d-1-3	25-50 (etc.)

d-2 Sum of counterclockwise directional changes

d-3 Average effective speed (m/s)

d-3-1	0- 8
d-3-2	8-16
d-3-3	16-24 (etc.)

(4) Find frequency distributions in Groups a, b, a and b in combination, and a, b, and d in combination.

(5) Select wind structures that are most closely approximated by Table 1.

(6) Run SEER II for all selected basic wind structures (maximum of 25 runs). Additional runs can be made for winds that fit the same subgroup but nevertheless are significantly different--e.g., Subgroups (a-3, b-3, d-1-1) and (a-3, b-3, d-1-3) are both in Subgroup (a-3, b-3)--to ascertain the effects of these differences.

(7) Measure, from the SEER II computer run printouts, area sizes and width to length ratios of a set of exposure rate contours, e.g., 5000 r/hr, 1000 r/hr, 500 r/hr, 100 r/hr, and 50 r/hr. Record supplementary comparative shape descriptions.

Table 1

MATRIX SHELL FOR COMPUTER RUNS OF MAXIMUM EFFECTIVE SPEEDS FOR SELECTED ANGULAR DISPLACEMENTS

For a Maximum Effective Speed of	For an Effective Angular Displacement of				
	5°	17°	37°	70°	130°
5 meters/second					
12 meters/second					
20 meters/second					
28 meters/second					
36 meters/second					

(8) Apply the wind frequency in each subgroup as a weight for the area sizes and width to length ratios.

(9) Determine the following for each exposure rate contour:

- (a) Mean area size
- (b) Area size range for $\mu \pm 0.5\sigma$[*]
- (c) Area size range for $\mu \pm 1\sigma$[*]
- (d) Area size range for $\mu \pm 2\sigma$[*]
- (e) Mean width to length ratio
- (f) Width to length ratio range for $\mu \pm 0.5\sigma$[*]
- (g) Width to length ratio range for $\mu \pm 1.\sigma$[*]
- (h) Width to length ratio range for $\mu \pm 2.\sigma$[*]

(10) Determine corresponding ranges of wind variability for the ranges of fallout pattern variability.

(11) Using supplementary data on Subgroupings d-1, and d-2, provide pertinent supplementary statistical breakdowns.

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[*] μ = mean, σ = standard deviation.

(12) Using supplementary data from Step (2a), determine directional frequency distribution.

(13) Formulate empirical relationships equating wind variations to fallout pattern variations.

Wind Statistics:

(1) Frequency vs. effective speed

(2) Frequency vs. effective angular change

(3) Frequency vs. direction

(4) Mean effective speed

(5) Mean effective angular change

(6) Mean direction

(7) Frequency between speed and angular change ranges

(8) Frequency of speed in directional range

(9) Frequency of angular change in directional range

(10) Frequency in speed and angular change ranges in directional range

Pattern Statistics:

(1) Exposure contour size distributions

(2) Exposure contour width to length ratio distributions

(3) Pattern direction distribution

(4) Mean contour sizes

(5) Mean width to length ratios

(6) Mean pattern direction

(7) Frequency of contour sizes and width to length ratio combinations

(8) Frequency of contour sizes in directional range

(9) Frequency of width to length ratios in directional range

(10) Frequency in size and width to length ranges in directional range.

D. Procedure Test

1. Conditions

The above suggested procedure for relating wind variations to fallout pattern variations was tested with the wind data obtained for Peoria, Illinois and a 1 megaton surface burst. The test was limited to the following wind calculations and pattern measurements:

Wind

(1) Maximum effective speeds

(2) Directions of maximum effective velocity vectors

(3) Effective angular displacements

Pattern

(1) Exposure rate contour areas
    (a) 1000 r/hr contours
    (b) 100 r/hr contours

(2) Width to length ratios

(3) Directions.

The available Peoria wind data consisted of wind speeds and directions at various altitudes taken at 6-hour intervals over a period of 6 years. It was therefore possible to examine fallout pattern variations statistically for time of day and seasonal wind variations. However, since specification of the time and season are not always done in damage assessment, the following analysis was performed only for the overall annual statistics.

2. Results

Shown in Figure 24 are the daily wind variations over Peoria in 1962 in terms of direction, effective angular displacement and maximum effective speed. On most days, four observations were made 6 hours apart; however, the number of observations on any day could range from none (no mark indicated in the figure) to four. The wind direction was separated into sixteen sectors, and thus the shortest lines indicate one-day direction variations of only 22.5 degrees. The ranges of effective angular displacement and maximum effective speed on any day are as indicated. In most cases a single value (a dot) indicates only one observation on that day rather than no variation within that day.

Table 2 gives the wind frequencies within the maximum effective speed--effective angular displacement ranges indicated for 6 years of data. Figure 25 shows the directional frequencies. The mean wind direction is very nearly west-to-east (275°), and the standard deviation is 44°. The speed-angular displacement relationship is shown in Figure 26. As can be seen (and as can be expected) winds with small angular displacements occur more often with high speed and winds with large angular displacements occur more often with low speeds.

The exposure rate contour areas of SEER II fallout patterns for a 1 megaton surface burst and for selected winds--ones that closely approximate the mid-value of the parameters in Table 1--are shown in

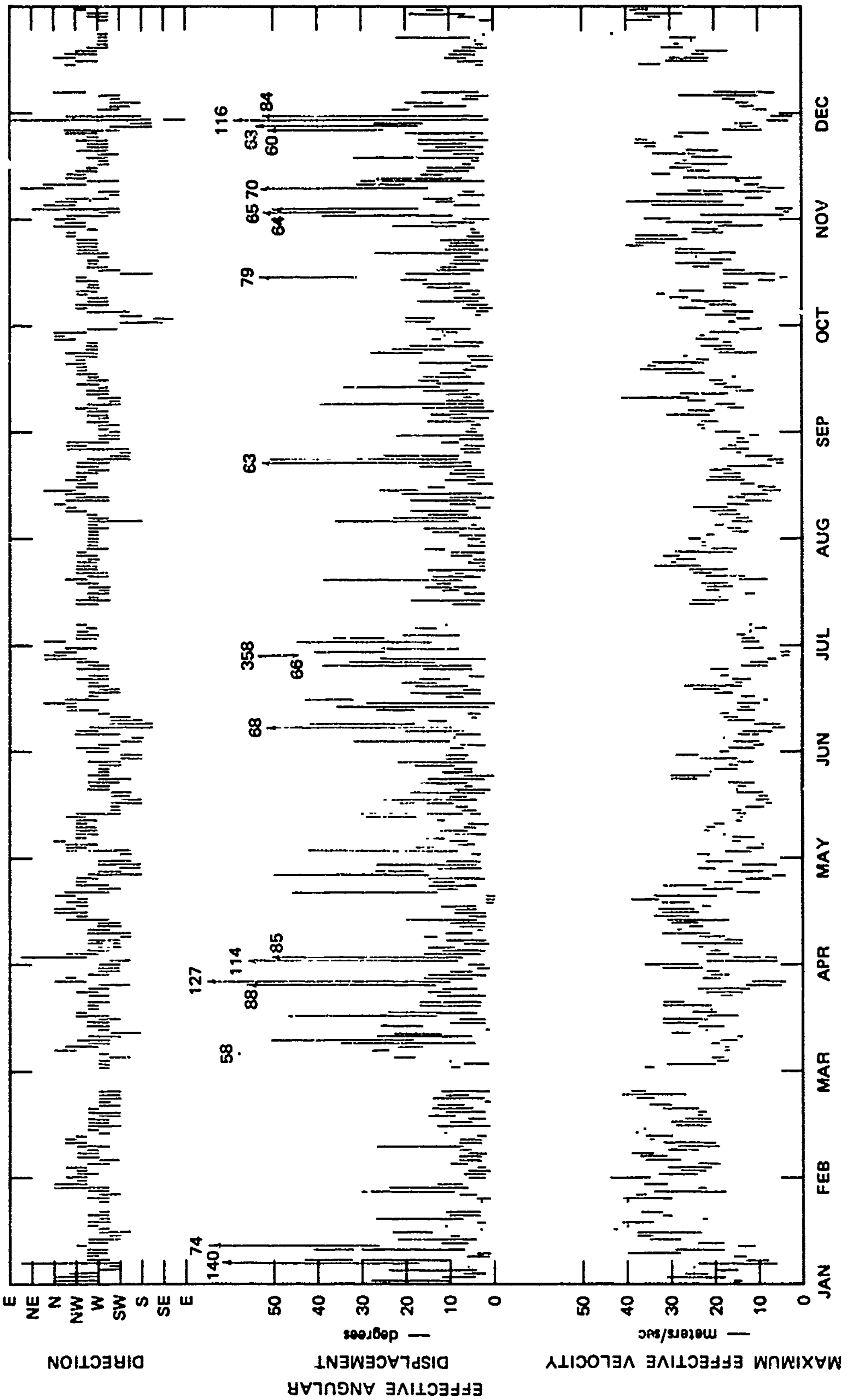

FIGURE 24 WINDS OVER PEORIA IN 1962

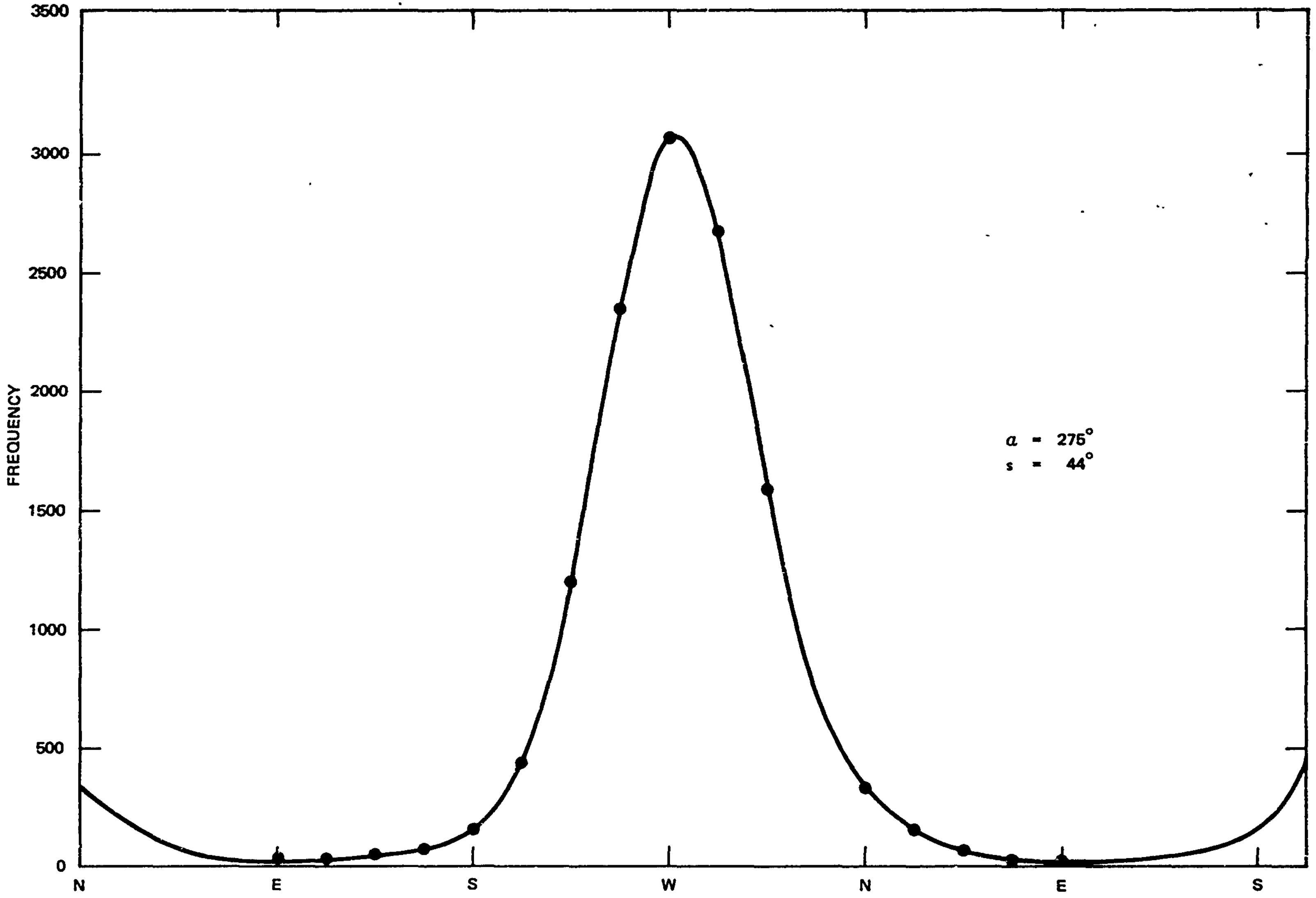

FIGURE 2[illegible] DISTRIBUTION OF WIND DIRECTIONS OVER PEORIA

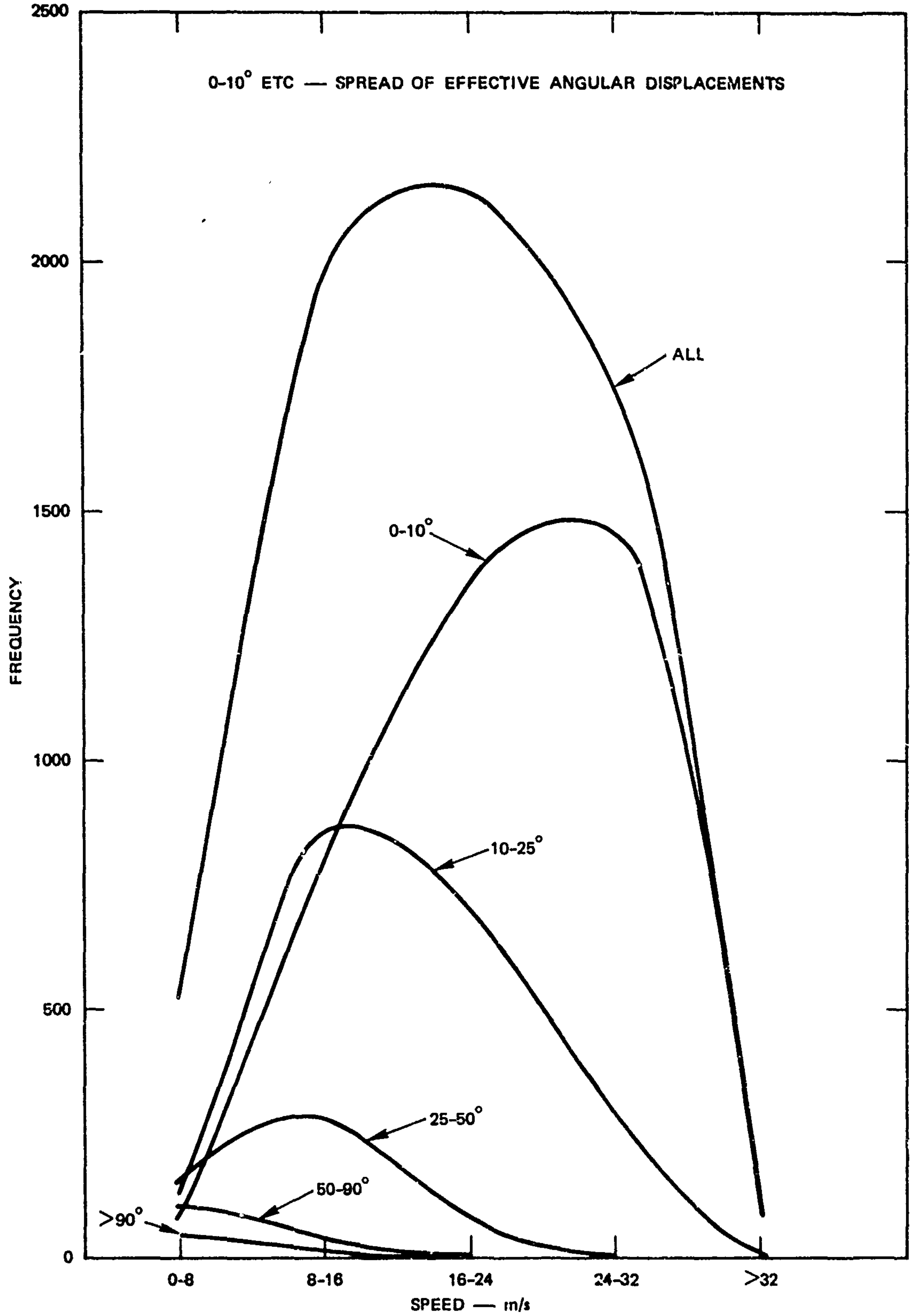

FIGURE 26 DISTRIBUTION OF WIND SPEEDS OVER PEORIA

Table 2

OVERALL WIND FREQUENCIES

Maximum Effective Speed	For an Effective Angular Displacement of					
	0-10°	10-25°	25-50°	50-90°	90°	All Angles
0-8 meters/second						
Frequency	85	143	154	102	44	528
Percent	1.31%	2.21%	2.38%	1.57%	0.68%	8.14%
8-16 meters/second						
Frequency	789	859	281	36	11	1976
Percent	12.17	13.25	4.33	0.56	0.17	30.48
16-24 meters/second						
Frequency	1358	703	81	2	0	2144
Percent	20.95	10.84	1.25	0.03	0	33.07
24-32 meters/second						
Frequency	1455	287	2	0	0	1744
Percent	22.44	4.43	0.03	0	0	26.90
> 32 meters/second						
Frequency	81	9	0	1	0	91
Percent	1.25	0.14	0	0.015	0	1.40
All speeds						
Frequency	3768	2001	518	141	55	6483
Percent	58.12	30.87	7.99	2.17	0.85	100%

Table 3. The ratios of the 1000 r/hr contour areas to the 100 r/hr contour areas are shown in Table 4. The contour lengths, widths, and width to length ratios for the 1000 r/hr contours are shown in Table 5, and contour lengths, widths, and width to length ratios for the 100 r/hr contours are shown in Table 6.

The trend in area changes is stronger with maximum effective speed changes than with effective angular displacement changes. The former relationship is shown in Figure 27. Conversely, length, width, and width to length ratios of the 1000 r/hr contour and the 100 r/hr

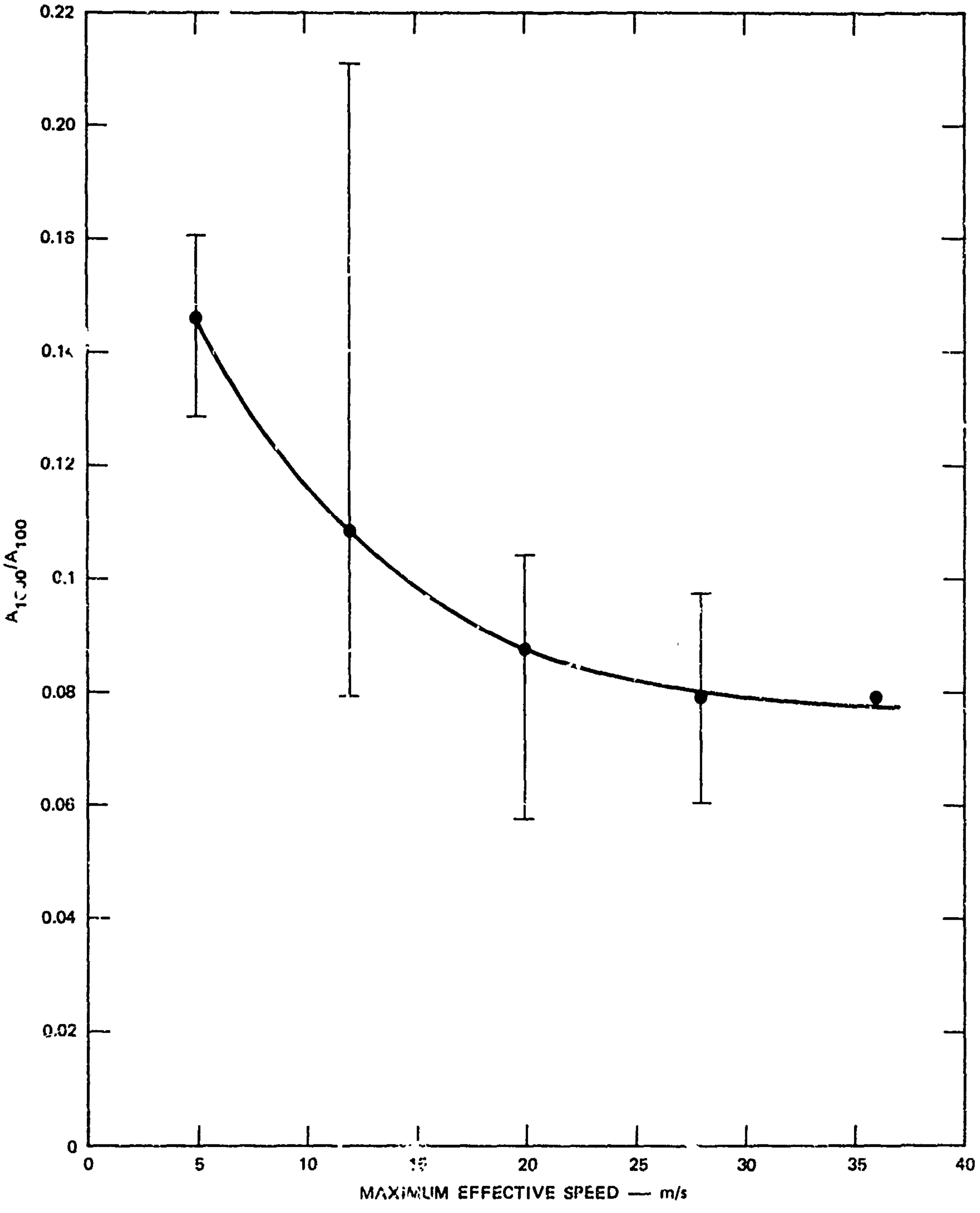

FIGURE 27 A_{1000}/A_{100} RATIOS VERSUS MAXIMUM EFFECTIVE SPEED

Table 3

EXPOSURE RATE CONTOUR AREAS
(square kilometers)

Maximum Effective Speed	For an Effective Angular Displacement of				
	0-10°	10-25°	25-50°	50-90°	> 90°
0-8 meters/second					
Exposure rate 1000 r/hr	2,000	1,150	1,250	1,200	1,200
Exposure rate 100 r/hr	12,500	8,930	8,370	7,460	9,120
8-16 meters/second					
Exposure rate 1000 r/hr	1,900	990	790	[illegible]	
Exposure rate 100 r/hr	9,940	9,770	11,200	13,000	
16-24 meters/second					
Exposure rate 1000 r/hr	1,400	1,150	690		
Exposure rate 100 r/hr	13,400	11,300	11,900		
24-32 meters/second					
Exposure rate 1000 r/hr	1,250	720			
Exposure rate 100 r/hr	12,800	11,800			
> 32 meters/second					
Exposure rate 1000 r/hr	1,080				
Exposure rate 100 r/hr	13,600				

Table 4

RATIO OF 1000 r/hr CONTOUR AREA TO 100 r/hr CONTOUR AREA

Maximum Effective Speed	For an Effective Angular Displacement of				
	0-10°	10-25°	25-50°	50-90°	> 90°
0-8 meters/second	[illegible]	0.1288	0.1493	0.1609	0.1316
8-16 meters/second	0.191[illegible]	0.1013	0.0705	0.0723	
16-24 meters/second	0.1045	0.1018	0.0580		
24-32 meters/second	0.0977	0.0610			
> 32 meters/second	0.0794				

Table 5

1000 r/hr CONTOUR AREA LENGTHS AND WIDTHS
(kilometers)

Maximum Effective Speed	For Effective Angular Displacements of				
	0-10°	10-25°	25-50°	50-90°	> 90°
0-8 meters/second					
Length	188.3	69.2	61.5	44.0	25.5
Width	20.7	22.2	26.4	38.0	77.7
Width/Length	0.11	0.32	0.43	0.86	3.05
8-16 meters/second					
Length	190.4	116.0	58.0	50.0	
Width	20.0	17.5	18.0	38.0	
Width/Length	0.11	0.15	0.31	0.76	
16-24 meters/second					
Length	116.0	82.0	47.2		
Width	14.6	17.2	19.2		
Width/Length	0.13	0.21	0.41		
24-32 meters/second					
Length	123.0	69.6			
Width	11.6	12.1			
Width/Length	0.094	0.22			
> 32 meters/second					
Length	116.0				
Width	10.0				
Width/Length	0.086				

contour are more readily related to the effective angular displacement parameter. These relationships are shown in Figures 28, 29, and 30. The statistics of fallout pattern characteristics can be determined by weighting the pattern features from Tables 3-6 by the wind statistics from Table 2. The contour pattern statistics are shown in Table 7.

The wind statistics in Table 2 also lead to the following wind statistics:

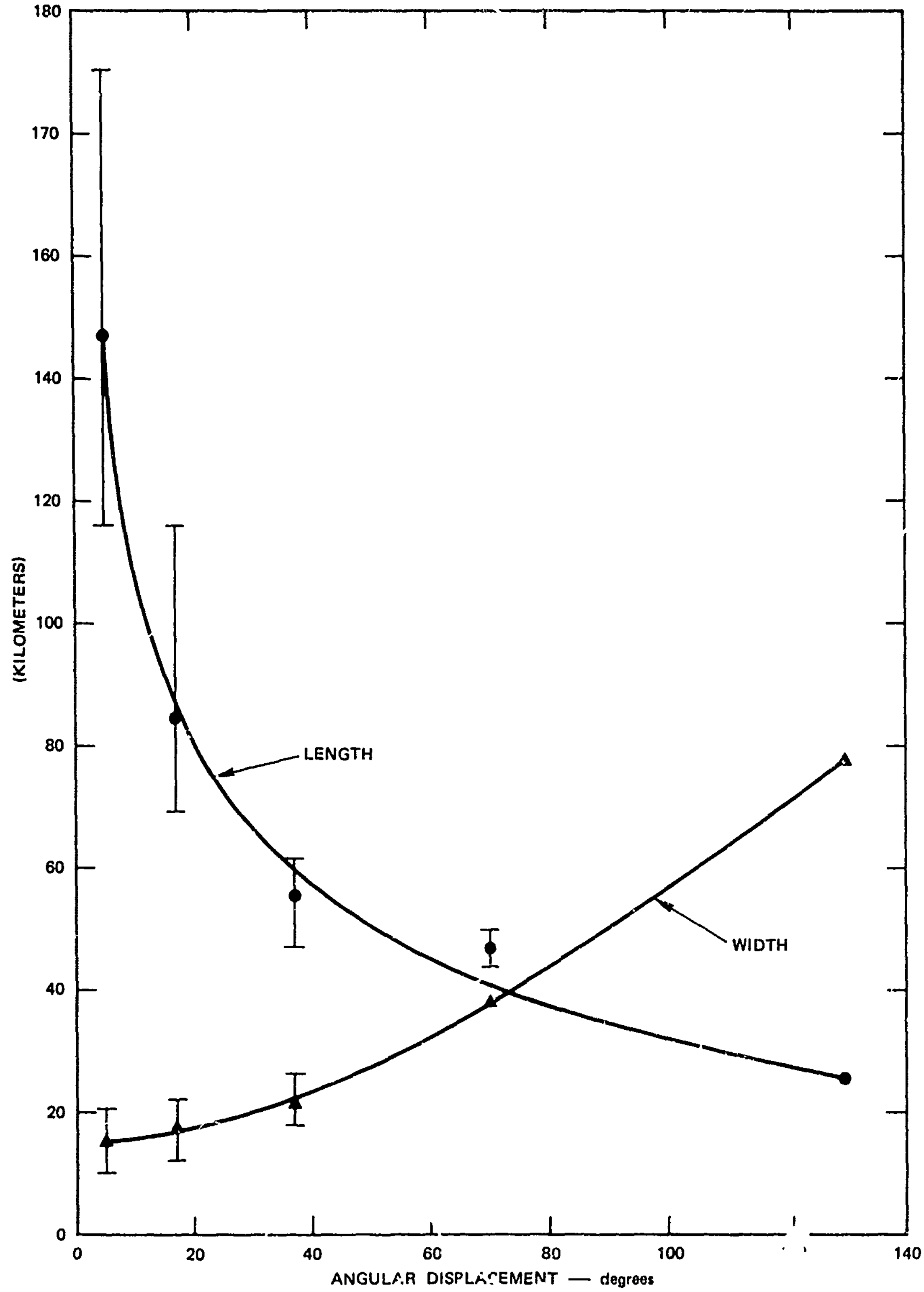

FIGURE 28 1000 r/hr CONTOUR LENGTH AND WIDTH VERSUS EFFECTIVE WIND ANGULAR DISPLACEMENT

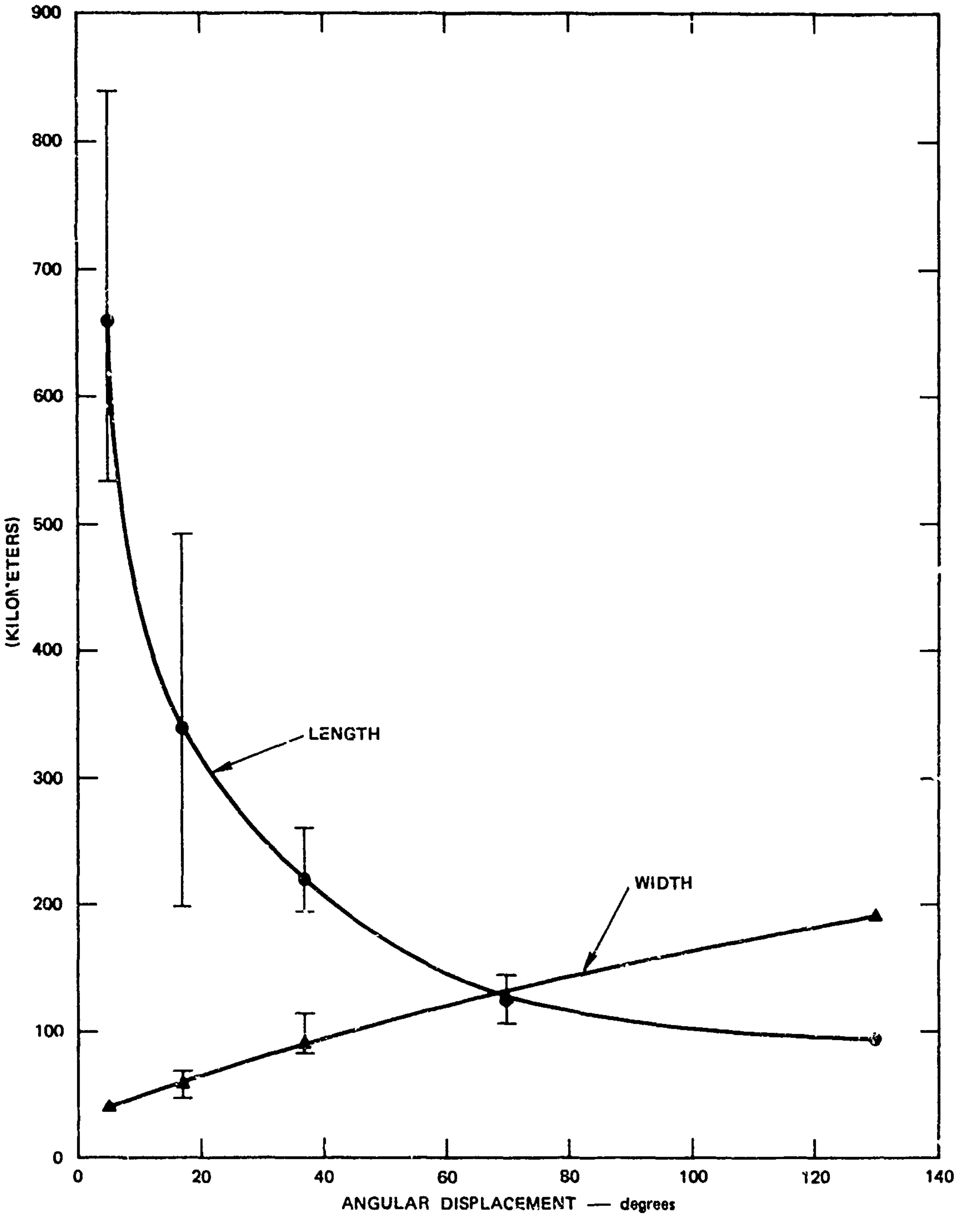

FIGURE 29 100 r/hr CONTOUR LENGTH AND WIDTH VERSUS EFFECTIVE WIND ANGULAR DISPLACEMENT

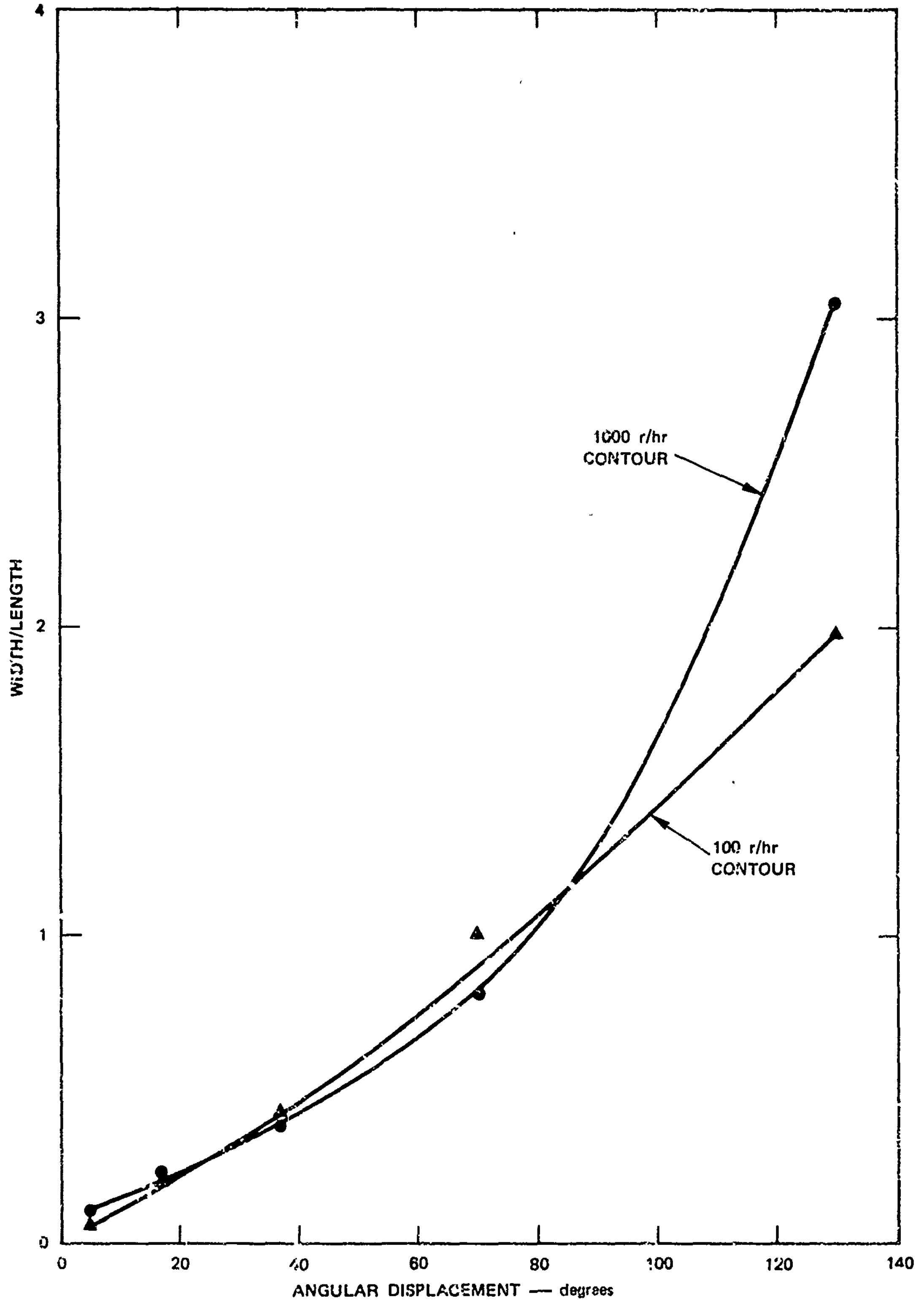

FIGURE 30 WIDTH/LENGTH RATIOS VERSUS EFFECTIVE WIND ANGULAR DISPLACEMENT

Table 6

100 r/hr CONTOUR AREA LENGTHS AND WIDTHS (kilometers)

Maximum Effective Speed	For Effective Angular Displacements of				
	0-10°	10-25°	25-50°	50-90°	> 90°
0-8 meters/second					
Length	649.4	196.6	200.0	106.0	96.2
Width	37.4	68.6	84.9	106.0	190.0
Width/Length	0.058	0.35	0.42	1.00	1.98
8-16 meters/second					
Length	571.1	492.0	260.0	142.0	
Width	36.0	48.8	82.0	148.0	
Width/Length	0.063	0.099	0.32	1.04	
16-24 meters/second					
Length	700.0	300.0	194.0		
Width	34.0	55.0	114.0		
Width/Length	0.049	0.18	0.57		
24-32 meters/second					
Length	532.0	360.5			
Width	37.0	62.3			
Width/Length	0.070	0.17			
> 32 meters/second					
Length	837.0				
Width	47.4				
Width/Length	0.057				

Wind Parameter	Mean	Standard Deviation
Maximum effective speed, meters/second	18.75	7.21
Effective angular displacement, degrees	14.09	16.30
Effective direction, degrees	275	44

By the definitions used in this analysis, the effective direction of the fallout pattern is identical to the effective wind direction, so that the

Table 7

FALLOUT PATTERN STATISTICS

Parameter	Units	Mean	Standard Deviation
1000 r/hr area	km^2	1267	318
1000 r/hr length	km	114	38
1000 r/hr width	km	16.8	6.9
1000 r/hr W/L ratio	--	0.193	0.267
100 r/hr area	km^2	11,590	1631
100 r/hr length	km	496	168
100 r/hr width	km	48.6	22.7
100 r/hr W/L ratio	--	0.150	0.224
$\frac{\text{1000 r/hr area}}{\text{100 r/hr area}}$	--	0.112	0.035

statistics of the pattern direction coincide with those of the wind direction. Thus, the mean pattern direction is the same as the mean wind direction, and the distribution of directions is the same.

It is interesting to see whether the same argument applies to the other fallout pattern characteristics. The values shown above were used to generate a fallout pattern for the mean wind and for given extreme winds. (Although a specific wind could have been selected to reproduce these parameters, the pattern features were instead obtained by interpolation in Tables 3-6.) The results are shown in Table 8.

Comparison of Tables 7 and 8 shows that the fallout pattern derived from the mean wind field closely approximates the mean fallout pattern. Furthermore, the deviations predicted from deviations in the winds are often good approximations to the observed fallout pattern deviations. The only exceptions are in the pattern widths and width to

Table 8

FALLOUT PATTERN FEATURES OF SELECTED WINDS

Parameter	Units	Mean	Deviation*
1000 r/hr area	km^2	1200	325
1000 r/hr length	km	98	37.
1000 r/hr width	km	17	2.3
1000 r/hr W/L ratio	--	.18	.08
100 r/hr area	km^2	11,500	1560
100 r/hr length	km	420	215
100 r/hr width	km	48	20
100 r/hr W/L ratio	--	.13	.14
$\frac{\text{1000 r/hr area}}{\text{100 r/hr area}}$	--	.105	.028

*Root mean square of deviations obtained from using mean wind speed with plus and minus 1 σ angular displacements and mean angular displacement with plus and minus 1 σ wind speeds.

length ratios, particularly for the 1000 r/hr contour. Finally, it was determined that much more of the variability in pattern features was accounted for by variability in the effective singular displacement than by variability in the maximum effective speed.

3. Discussion of Results

The results of the test of the procedure to relate wind variability to fallout pattern variability show that the procedure appears to be effective. Even though the test was only exploratory by nature (in that it lacked the detail and refinement of a complete test), it did reveal the more prominent relationships between wind variability and fallout pattern variability. These relationships were previously shown in Figures 27-30, and in Tables 7 and 8. A more complete test will undoubtedly reveal other more subtle correlations as well as the relationships for the entire fallout pattern.

To date, wind speed has been generally used as the predominant variable in modeling fallout. It is therefore a revelation that the effective angular displacement has a greater effect on fallout deposition patterns than speed. On the other hand, if the winds do not exhibit significant variations in effective angular displacement, then the effects of this relationship would be suppressed. Table 2 indicates that about 60 percent of the winds over Peoria, Illinois have effective angular displacements, with reference to a 1 megaton surface burst, within the 0 to 10 degree range. Whereas most of the winds of Peoria will produce long narrow patterns, i.e., 1000 r/hr contour width to length ratios of about 0.1 and 100 r/hr contour width to length ratios of about 0.06, the percentage of Peoria winds that will produce wider and shorter exposure rate contour patterns are not insignificant. Because fallout, especially for the lower exposure rate contours, takes many hours to descend, it is also necessary to consider the stability or persistence of the wind structure with time. By scanning the daily wind direction variations in conjunction with the variations in the daily effective angular displacement variations in Figure 24, it can be concluded that where the time element is included, the occurrence of small effective angular displacement winds over Peoria would be significantly reduced. The relationship of the variability of the wind's effective angular displacement to fallout pattern variability is therefore of major importance.

E. Conclusions and Recommendations

The limited test of the procedure for relating pattern variability to wind variability appears to be successful.

A result of major importance is that statistical features of fallout patterns (means and standard deviations of area, length, and so on) can be predicted reasonably well from the patterns produced by the mean and standard deviation wind parameters. This feature suggests that statistical measures of fallout pattern variability can be produced for any geographical location by using the wind statistics with SEER II or other fallout models, rather than by applying the model repeatedly to the observed winds to produce the statistics.

Another important result is that variability of angular displacement in the wind (wind shear) appears to be responsible for the greater part of variability in the pattern, whereas variability in wind speed is less effective.

It is recognized that these results are based on wind statistics for only one meteorological station and are valid for only one weapon yield. Although it is currently believed that the conclusions will be strengthened with a greater variety of test cases, it is recommended that the test be extended to several other geographical locations* and several other yields before great reliance is put on these conclusions. It is also recommended that the effect of the other possible variations mentioned in Part B be tested for significance.

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* Wind data for hundreds of other U.S. and foreign locations are available from the USAF ETAC; of these, the data have already been converted into the correct format for analysis for six other U.S. locations.

V SUMMARY

The originally developed SEER simplified fallout computation model provided symmetrical fallout patterns that simulated DELFIC fallout patterns for moderately sheared winds. For highly sheared winds, however, DELFIC produced irregular patterns that could not be adequately simulated by the original SEER model. Because of this inadequacy, a new model, SEER II, was developed that would simulate DELFIC fallout patterns for any wind structure.

SEER II and DELFIC fallout patterns for various yields and wind structures were compared, and it was found that in general the SEER II exposure rate contours simulated the DELFIC exposure rate contours in size, shape, and orientation reasonably well. SEER II requires about 3 seconds of CDC 6400 computer execution time per 1200-grid-point run for weapon yields in the low kiloton range increasing to 6 seconds of computer time for weapons in the 10 megaton range. These computer execution times can be compared to about 2.5 seconds for the original SEER model and a few hundred seconds for DELFIC.

A procedure to relate wind variability statistically to fallout pattern variability was developed and tested. From the limited test conducted, the developed procedure appeared to be successful. A result of major importance is that statistical features of fallout patterns can be predicted reasonably well from patterns produced by the mean and standard deviation wind parameters. Another important result is that variability of angular displacement in the wind (wind shear) appears to be responsible for the greater part of variability in the pattern, whereas variability in wind speed is less effective.

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Appendix A

SEER II PROGRAM AND SUBROUTINE LISTING

Table A-1

SEER II MAIN PROGRAM

```
PROGRAM     SEER        TRACE                          CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.

                PROGRAM SEER (INPUT, OUTPUT)
          C
          C     SEER II MODEL--REVISED SIMPLIFIED ESTIMATION OF EXPOSURE TO
          C                    RADIATION MODEL
          C
          C     TLABEL     CURRENT PROBLEM IDENTIFICATION
          C     W          WEAPON YIELD (KT).  THIS VALUE MUST BE SPECIFIED.
          C     TLIMIT     TRANSPORT TIME LIMIT (SECONDS).  IF NO VALUE IS
          C                SPECIFIED, DEFAULT VALUE OF 200,000 SECONDS WILL BE
          C                ASSIGNED.
          C     NWIND      NUMBER OF INPUT WIND LEVELS.  ENTER BLANK OR 0 (ZERO)
          C                IF WIND DATA OF PREVIOUS PROBLEM ARE TO BE USED.
          C     KDAT       INPUT WIND DATA FORMAT CONTROL INTEGER.
          C          = 1   WIND DATA ARE ENTERED BY ALTITUDE (METERS) AND X AND Y
          C                COMPONENTS (M/SEC).
          C          = 2   WIND DATA ARE ENTERED IN WEATHER BUREAU FORMAT--COMPASS
          C                DIRECTION CODE AND SPEED (M/SEC) AT SPECIFIC ELEVATIONS
          C          = 3   DATA ARE ENTERED BY ALTITUDE (FEET), SPEED (FT/SEC),
          C                AND DIRECTION (DEGREES CLOCKWISE FROM NORTH)
          C          = 4   DATA ARE ENTERED IN SECOND WEATHER BUREAU FORMAT--
          C                DIRECTION IN DEGREES CLOCKWISE FROM NORTH AND SPEED
          C                IN M/SEC AT SPECIFIC ELEVATIONS
          C     NMAP       NUMBER OF OUTPUT MAP REQUESTS
          C     NLVL       NUMBER OF CLOUD LEVELS TO USE IN CURRENT PROBLEM.  IF A
          C                BLANK OR 0 (ZERO) IS ENTERED, PROGRAM WILL COMPUTE AN
          C                APPROPRIATE VALUE.  IF NLVL IS SPECIFIED, VALUE MUST BE
          C                BETWEEN 3 AND 23.  VALUES LARGER THAN 15 MAY RESULT IN
          C                EXCESSIVE COMPUTER TIME.  IN GENERAL, LET THE PROGRAM
          C                COMPUTE THIS VALUE.
          C     KPAR       PARTICLE GRADIENT CODE.
          C          = 1   TRACE HOTLINES WITH 25 PARTICLE GROUPS.  WHEN A BLANK
          C                OR 0 (ZERO) HAS BEEN SPECIFIED, A DEFAULT VALUE OF 1
          C                WILL BE ASSIGNED.
          C          = 2   USE 13 PARTICLE GROUPS FOR THE TRACE
          C          = 3   USE 9 PARTICLE GROUPS FOR THE TRACE.  USE THIS VALUE
          C                ONLY IS SHORT COMPUTER TIME IS IMPORTANT
          C     TITLE      CURRENT MAP TITLE OR IDENTIFICATION
          C     XMIN,XMAX  SPECIFIED RANGE OF X VALUES FOR CURRENT MAP
          C     YMIN,YMAX  SPECIFIED RANGE OF Y VALUES FOR CURRENT MAP
          C     DELX,DELY  SPECIFIED DISTANCES BETWEEN GRID POINTS ALONG THE X AND
          C                Y AXES FOR THE CURRENT MAP REQUEST
          C     LMAP       MAP FORMAT CONTROL INTEGER
          C          = 1   DOUBLE SPACE, DECIMAL FORMAT, 9 TO 5 RATIO ON AXES.
          C          = 2   TRIPLE SPACE, DECIMAL FORMAT, 6 TO 5 RATIO ON AXES.
          C          = 3   DOUBLE SPACE, EXPONENTIAL FORMAT, 9 TO 5 RATIO ON AXES.
          C          = 4   TRIPLE SPACE, EXPONENTIAL FORMAT, 6 TO 5 RATIO ON AXES.
          C
                COMMON /INDAT/ W,ALW,TITLE(8),TLIMIT
               1       /ARRAY/ DRAY(26,23),XRAY(26,23),YRAY(26,23),GDRAY(26,23),
               2               FIRAY(26,23),RDRAY(26,23),DRATSA(26,23),
               3               NLVL,DISMAX,DISMIN,KPAR,KA,KB,NPAR
               4       /EDGRAY/ XLR(26,2),YLR(26,2),ILR(26,2)
               5       /WNDATA/ ALT(40), DX(40), DY(40), NWIND, KDAT
               6       /CLDATA/ ACB,ACT,RMIN,RMAX,TSR,TRMAX,RATIO,TRA,RATA
               7       /MAP/    XMIN,XMAX,YMIN,YMAX,DELX,DELY,LMAP,TXMIN,TXMAX,
               8               YAXIS(500),XAXIS(20)
                DIMENSION TLABEL(8)
                DATA ASTAR / 9H* * * * *  /
          C
             10 READ 930, (TLABEL(I), I=1,8)
            930 FORMAT (8A10)
                READ 900, W, TLIMIT, NWIND, KDAT, NMAP, NLVL, KPAR
            900 FORMAT (2F10.0, 14I5)
                IF (W .EQ. 0.) CALL EXIT
                IF (TLIMIT .EQ. 0.) TLIMIT = 200000.
                IF (KDAT .EQ. 0) KDAT = 1
                IF (KPAR .LT. 1) KPAR = 1    $    IF (KPAR .GT. 3) KPAR = 3
                KA = 2    $    KB = 20    $    NPAR = 20
                IF (KPAR .EQ. 1) GO TO 12
```

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Table A-1 (Concluded)

```
PROGRAM    SEER    TRACE                    CDC 6600 FTN V3.0-P271 OPT=0  05/09/72  15.13.21.
      KA = 3   $   KB = 27   $   NPAR = 14
      IF (KPAR .EQ. 2) GO TO 12
      KA = 4   $   KB = 28   $   NPAR = 40
   12 IF (NLVL .EQ. 0) NLVL = ALOG(W) + 3.0
      IF (NLVL .LT. 3) NLVL = 3   $   IF (NLVL .GT. 23) NLVL = 23
      IF (NWIND .EQ. 0) GO TO 30
      NWD = NWIND
      GO TO (2   15, 20, 25), KDAT
C
C     WEATHER BUREAU FORMAT
   15 READ 910, (DX(I), DY(I), I=1,NWIND)   $   GO TO 40
  910 FORMAT (7X, 13(F2.0, F3.0))
C
C     ALTITUDE AND X, Y COMPONENTS OR ALTITUDE, SPEED, AND DIRECTION
   20 READ 920, (ALT(I), DX(I), DY(I), I=1,NWIND)   $   GO TO 40
  920 FORMAT (9F8.0, 8X)
C
C     SECOND WEATHER BUREAU FORMAT
   25 READ 925, (DX(I), DY(I), I=1,NWIND)   $   GO TO 40
  925 FORMAT (14X, 22F3.0)
   30 NWIND = NWD
   40 CALL FEATUR   $   CALL PARTLP
      PRINT 950, ASTAR,ASTAR,ASTAR,ASTAR,(TLABEL(I),I=1,8),W,TLIMIT,
     1             ACB,ACT,RMIN,RMAX,TSR,TRMAX,ASTAR,ASTAR
      GO TO (42, 44, 46, 43), KDAT
   42 PRINT 970, (ALT(I), DX(I), DY(I), I=1,NWD)   $   GO TO 48
   43 PRINT 976, (ALT(I), DX(I), DY(I), I=1,NWD)   $   GO TO 48
   44 PRINT 972, (ALT(I), DX(I), DY(I), I=1,NWD)   $   GO TO 48
   46 PRINT 974, (ALT(I), DX(I), DY(I), I=1,NWD)
   48 CALL INTENS
      PRINT 960
      DO 50 IA = 1, NLVL
      PRINT 955, (IA,I,DRAY(I,IA),XRAY(I,IA),YRAY(I,IA),GDRAY(I,IA),
     1             FTRAY(I,IA),RDRAY(I,IA),DRATSA(I,IA), I=1,NPAR)
   50 CONTINUE
      IF (NMAP .EQ. 0) GO TO 10
      CALL LPINT   $   CALL EDGE
      DO 60 IA = 1, NMAP
      READ 930, (TITLE(I), I=1,8)
      READ 935, XMIN,XMAX,YMIN,YMAX,DELX,DELY,LMAP
  935 FORMAT (6F10.0, I5)
      CALL TMAP
      IF (LMAP .EQ. 0) LMAP = 4
   60 CONTINUE
      GO TO 10
  950 FORMAT (1H1 // 57X, 2A10// 38X, *SIMPLIFIED ESTIMATION OF EXPOSURE
     1 TO RADIATION (SEER) MODEL * // 57X, 2A10 //// 19X, *RUN IDENTIFIC
     2ATION--* 8A10  //  39X, *WEAPON YIELD* T77, F10.1, * KILOTONS* //
     3 39X, *TRANSPORT TIME LIMIT* T77, F10.1, * SECONDS* // 39X, *CLOUD
     4 BASE* T77, F10.1, * METERS* // 39X, *CLOUD TOP* T77, F10.1, * MET
     5ERS* // 39X, *MINIMUM CLOUD RADIUS* T77, F10.1, * METERS* // 39X,
     6 *MAXIMUM CLOUD RADIUS* T77, F10.1, * METERS* // 39X, *CLOUD FORMA
     7TION TIME* T77, F10.1, * SECONDS* // 39X, *RADIAL EXPANSION TERMIN
     8ATION TIME* T77, F10.1, * SECONDS* /// 42X, A10, *WIND HODOGRAPH A
     9T GROUND ZERO *, A10 //)
  955 FORMAT(//1H0 *   IA* T11, *I* T15, *EXPOSURE RATE* T35, *X METERS*
     1 T50, *Y METERS* T62, *GROUND DIST* T79, *FALL TIME* T97, *RADIUS*
     2 T108, *DOSE RATIO* // (2I6, 1P7E15.4))
  960 FORMAT (1H1)
  970 FORMAT (45X, *ALTITUDE         X COMPONENT      Y COMPONENT* / 45X,
     1  *(METERS)            (M/SEC)          (M/SEC)* // (37X, 3F16.2))
  972 FORMAT (T49, *ALTITUDE*, T64, *COMPASS*, T78, *SPEED* / T49,
     1  *(METERS)*, T63, *DIRECTION*, T77, *(M/SEC)* // (40X, F16.2,
     2  F12.0, F13.0))
  974 FORMAT (48X, *ALTITUDE          SPEED    DIRECTION* / 49X, *(FEET)
     1       (FT/SEC)  (DEGREES)* // (40X, F16.0, F13.0, F11.0))
  976 FORMAT (T49, *ALTITUDE*, T63,*DIRECTION*, T78, *SPEED* / T49,
     1  *(METERS)*, T63, *(DEGREES)*, T77, *(M/SEC)* // (40X, F16.2,
     2  F12.0, F13.0))
      END
```

Table A-2

SUBROUTINE FEATUR

```
SUBROUTINE  FEATUR    TRACE                    CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.

              SUBROUTINE FEATUR
        C
        C     SUBROUTINE TO COMPUTE VARIOUS FEATURES OF THE CLOUD
        C
              COMMON /CLDATA/ ACB,ACT,RMIN,RMAX,TSR,TRMAX,RATIO,TRA,RATA
             1       /INDAT/ W, ALW, TITLE(8), TLIMIT
        C
        C     COMPUTE ALTITUDES OF CLOUD TOP AND CLOUD BOTTOM
              ALW = ALOG10(W)
              IF (W .GT. 10.0) GO TO 10
              ACT = 3500. * W**0.271 - (11.0-W)**2.87   $   GO TO 35
           10 IF (W .GT. 100.0) GO TO 20
              ACT = 4000. * W**0.2362 - (100.-W)**1.3   $   GO TO 35
           20 IF (W .GT. 1000.) GO TO 30
              ACT = 4200. * W**0.225
           35 ACB = 1700.*W**0.2634 - 333.0*W**(-0.5)   $   GO TO 100
           30 IF (W .GT. 2000.) GO TO 40
              ACB = 1350. * W**0.2961   $   GO TO 45
           40 IF (W .GT. 10000.) GO TO 50
              ACB = 1880. * W**0.2525
           45 ACT = 5800. * W**0.1759   $   GO TO 100
           50 ACT = 3100. * W**0.2439
              ACB = 1330. * W**0.2901
        C
        C     COMPUTE CLOUD FORMATION TIME, EXPANSION TERMINATION TIME, AND
        C       EXPANSION-RATE CHANGE TIME
          100 TSR = 20.0 * (16.0+6.0*ALW-W**0.27)
              TRMAX = 2000.0*W**0.554
              IF (W .GE. 10.) GO TO 110
              TRMAX = (1.44444-.044444*W) * TRMAX   $   GO TO 130
          110 IF (W .LE. 100.) GO TO 130
              IF (W .GT. 1000.) GO TO 115
              TRMAX = (1.665-.333*ALW)*TRMAX   $   GO TO 130
          115 IF (W .GT. 10000.) GO TO 120
              TRMAX = (.418+.093*ALW) * TRMAX   $   GO TO 130
          120 TRMAX = .75 * TRMAX
          130 TRA = (TRMAX-TSR+1000.) / 3.3
        C
        C     COMPUTE MINIMUM AND MAXIMUM CLOUD RADII
              RMIN = 350.*W**0.544 + (350.0-100.*ALW**2.4)*(1.0+ALW)
              IF (W .LE. 10. .OR. W .GE. 10000.) GO TO 150
              IF (W .LE. 100.) GO TO 140
              RMIN = (.9+.03155*ALW**3) * RMIN   $   GO TO 150
          140 RMIN = (1.0086-.00096*W) * RMIN
          150 RMAX = 2200.0*W**0.301+ W**1.18
              IF (W .GE. 1000.) GO TO 170
              IF (W .LE. 10.) GO TO 160
              RMAX = (.81235+.02085*ALW*ALW) * RMAX   $   GO TO 170
          160 RMAX = (.6587+.1745*ALW) * RMAX
        C
        C     COMPUTE RATES OF RADIAL EXPANSION
          170 RATIO = (RMAX-1.1*RMIN) / (TRMAX-TSR)
              RATA = 0.1 * RMIN / (TRA-TSR)
              RETURN
              END
```

Table A-3

SUBROUTINE PARTLP

```
SUBROUTINE  PARTLP    TRACE                        CDC 6600 FTN V3.0-P281 OPT=0  05/10/72  17.36.24.

                  SUBROUTINE PARTLP
            C
            C     SUBROUTINE TO COMPUTE LANDING POINTS (XRAY,YRAY), HORIZONTAL
            C       DISTANCES TRAVERSED (GDRAY), RADII (RDRAY), TIMES OF FALL
            C       (FTRAY) OF PARTICLE GROUPS DESCENDING FROM VARIOUS CLOUD LEVELS
            C
                  COMMON /WNDATA/ ALT(40), DX(40), DY(40), NWIND, KDAT
                 1         /SCHTCH/ XTAY(26,23),YTAY(26,23),GDTAY(26,23),FTTAY(26,23),
                 2                  RDTAY(26,23),PARX(80,26),PARY(80,26),DUMA(2852)
                 3         /ARRAY/ DRAY(26,23),XRAY(26,23),YRAY(26,23),GDRAY(26,23),
                 4                 FTRAY(26,23),RDRAY(26,23),DRATSA(26,23),
                 5                 NLVL,DISMAX,DISMIN,KPAR,KA,KB,NPAR
                 6         /CLDATA/ ACB,ACT,RMIN,RMAX,TSR,TRMAX,RATIO,TRA,RATA
                  DIMENSION FTIME(80,25), ELEV(20), ELEV2(47)
                  DATA RAD / .3926991/
                  DATA ELEV/  500.,  1500.,  3000.,  5000.,  7000.,  9000., 10000.,
                 1         12000., 14000., 16000., 18000., 20000., 24000., 26000.,
                 2         31000., 36000., 41000., 46000., 51000., 56000./
                  DATA ELEV2/   0.,  150.,  300.,  500., 1000., 1500., 2000., 2500.,
                 1         3000., 4000., 5000., 6000., 7000., 8000., 9000.,10000.,
                 2         11000.,12000.,13000.,14000.,15000.,16000.,17000.,18000.,
                 3         19000.,20000.,21000.,22000.,23000.,24000.,25000.,26000.,
                 4         27000.,28000.,29000.,30000.,31000.,32000.,33000.,34000.,
                 5         35000.,36000.,37000.,38000.,39000.,40000.,41000. /
            C
                  DATA (FTIME(I, 1), I=1,80) /      32.,      63.,      93.,     123.,
                 1      151.,     179.,     207.,     233.,     259.,     285.,     310.,
                 1      334.,     357.,     380.,     402.,     424.,     445.,     465.,
                 1      485.,     505.,     523.,     542.,     559.,     577.,     593.,
                 1      609.,     625.,     640.,     654.,     668.,     682.,     695.,
                 1      707.,     720.,     731.,     743.,     753.,     764.,     774.,
                 1      783.,     793.,     802.,     810.,     819.,     827.,     834.,
                 1      842.,     849.,     856.,     863.,     869.,     875.,     882.,
                 1      887.,     893.,     899.,     904.,     909.,     914.,     919.,
                 1      924.,     928.,     933.,     937.,     941.,     945.,     949.,
                 1      953.,     957.,     960.,     964.,     967.,     971.,     974.,
                 1      977.,     980.,     983.,     986.,     989.,     991./
                  DATA (FTIME(I, 2), I=1,80) /      47.,      93.,     138.,     182.,
                 1      225.,     267.,     308.,     348.,     387.,     425.,     462.,
                 1      498.,     534.,     568.,     602.,     635.,     667.,     698.,
                 1      728.,     757.,     786.,     814.,     841.,     868.,     893.,
                 1      918.,     942.,     965.,     988.,    1010.,    1031.,    1051.,
                 1     1071.,    1090.,    1109.,    1127.,    1144.,    1161.,    1177.,
                 1     1193.,    1208.,    1223.,    1237.,    1250.,    1264.,    1277.,
                 1     1289.,    1301.,    1313.,    1324.,    1335.,    1346.,    1357.,
                 1     1367.,    1377.,    1386.,    1395.,    1405.,    1413.,    1422.,
                 1     1430.,    1439.,    1446.,    1454.,    1462.,    1469.,    1476.,
                 1     1483.,    1490.,    1497.,    1503.,    1510.,    1516.,    1522.,
                 1     1528.,    1534.,    1539.,    1545.,    1550.,    1556./
                  DATA (FTIME(I, 3), I=1,80) /      60.,     118.,     174.,     230.,
                 1      284.,     337.,     389.,     439.,     489.,     537.,     585.,
                 1      631.,     676.,     720.,     763.,     805.,     846.,     885.,
                 1      924.,     962.,     999.,    1035.,    1070.,    1103.,    1136.,
                 1     1168.,    1199.,    1229.,    1259.,    1287.,    1315.,    1341.,
                 1     1367.,    1392.,    1416.,    1440.,    1463.,    1485.,    1506.,
                 1     1527.,    1547.,    1566.,    1585.,    1604.,    1621.,    1639.,
                 1     1656.,    1672.,    1688.,    1703.,    1718.,    1733.,    1747.,
                 1     1761.,    1775.,    1788.,    1801.,    1813.,    1825.,    1837.,
                 1     1849.,    1860.,    1872.,    1882.,    1893.,    1903.,    1914.,
                 1     1923.,    1933.,    1943.,    1952.,    1961.,    1970.,    1978.,
                 1     1987.,    1995.,    2003.,    2011.,    2019.,    2027./
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Table A-3 (Continued)

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  SUBROUTINE  PARILP    TRACE                          CDC 6600 FTN V3.0-P261 OPT=0  05/10/72  17.36.24.
                  DATA (FTIME(I, 4), I=1,80) /      73.,     144.,     213.,     281.,
                 1     348.,     413.,     476.,     538.,     599.,     659.,     717.,
                 1     774.,     830.,     884.,     937.,     988.,    1039.,    1088.,
                 1    1136.,    1183.,    1229.,    1273.,    1316.,    1358.,    1399.,
                 1    1439.,    1478.,    1515.,    1552.,    1587.,    1622.,    1655.,
                 1    1688.,    1719.,    1750.,    1780.,    1808.,    1836.,    1864.,
                 1    1890.,    1915.,    1940.,    1965.,    1988.,    2011.,    2033.,
                 1    2055.,    2076.,    2097.,    2117.,    2136.,    2155.,    2174.,
                 1    2192.,    2210.,    2227.,    2244.,    2261.,    2277.,    2293.,
                 1    2308.,    2323.,    2338.,    2352.,    2367.,    2380.,    2394.,
                 1    2407.,    2420.,    2433.,    2446.,    2458.,    2470.,    2482.,
                 1    2493.,    2504.,    2516.,    2526.,    2537.,    2548./
                  DATA (FTIME(I, 5), I=1,80) /      88.,     173.,     257.,     338.,
                 1     419.,     497.,     574.,     649.,     723.,     795.,     865.,
                 1     934.,    1001.,    1067.,    1131.,    1194.,    1255.,    1315.,
                 1    1373.,    1430.,    1486.,    1540.,    1593.,    1644.,    1694.,
                 1    1743.,    1790.,    1836.,    1881.,    1925.,    1967.,    2008.,
                 1    2048.,    2087.,    2125.,    2162.,    2197.,    2232.,    2266.,
                 1    2299.,    2331.,    2362.,    2392.,    2422.,    2450.,    2478.,
                 1    2506.,    2533.,    2559.,    2584.,    2609.,    2633.,    2657.,
                 1    2680.,    2703.,    2725.,    2747.,    2768.,    2789.,    2809.,
                 1    2829.,    2849.,    2868.,    2887.,    2905.,    2923.,    2941.,
                 1    2958.,    2975.,    2992.,    3008.,    3024.,    3040.,    3055.,
                 1    3071.,    3085.,    3100.,    3114.,    3128.,    3142./
                  DATA (FTIME(I, 6), I=1,80) /     103.,     203.,     302.,     398.,
                 1     492.,     585.,     675.,     764.,     851.,     936.,    1019.,
                 1    1100.,    1180.,    1258.,    1334.,    1408.,    1481.,    1552.,
                 1    1621.,    1688.,    1754.,    1819.,    1882.,    1943.,    2002.,
                 1    2060.,    2117.,    2172.,    2225.,    2277.,    2328.,    2377.,
                 1    2425.,    2472.,    2517.,    2562.,    2605.,    2647.,    2688.,
                 1    2727.,    2766.,    2804.,    2841.,    2877.,    2912.,    2946.,
                 1    2980.,    3012.,    3045.,    3076.,    3107.,    3136.,    3166.,
                 1    3194.,    3223.,    3250.,    3277.,    3303.,    3329.,    3355.,
                 1    3380.,    3404.,    3428.,    3451.,    3474.,    3497.,    3519.,
                 1    3541.,    3562.,    3583.,    3604.,    3624.,    3644.,    3664.,
                 1    3683.,    3702.,    3720.,    3739.,    3757.,    3774./
                  DATA (FTIME(I, 7), I=1,80) /     121.,     238.,     354.,     467.,
                 1     579.,     687.,     794.,     898.,    1001.,    1101.,    1199.,
                 1    1295.,    1389.,    1481.,    1571.,    1659.,    1745.,    1828.,
                 1    1911.,    1991.,    2069.,    2145.,    2220.,    2292.,    2363.,
                 1    2432.,    2499.,    2565.,    2629.,    2691.,    2751.,    2810.,
                 1    2868.,    2924.,    2978.,    3032.,    3083.,    3134.,    3183.,
                 1    3231.,    3278.,    3324.,    3369.,    3413.,    3455.,    3497.,
                 1    3538.,    3578.,    3617.,    3656.,    3693.,    3730.,    3766.,
                 1    3802.,    3836.,    3870.,    3904.,    3936.,    3968.,    4000.,
                 1    4031.,    4061.,    4091.,    4120.,    4149.,    4177.,    4205.,
                 1    4232.,    4259.,    4285.,    4311.,    4337.,    4362.,    4386.,
                 1    4411.,    4434.,    4457.,    4480.,    4503.,    4525./
                  DATA (FTIME(I, 8), I=1,80) /     142.,     280.,     414.,     549.,
                 1     680.,     808.,     934.,    1057.,    1178.,    1296.,    1412.,
                 1    1525.,    1637.,    1745.,    1852.,    1956.,    2057.,    2157.,
                 1    2254.,    2349.,    2442.,    2532.,    2621.,    2707.,    2791.,
                 1    2873.,    2954.,    3032.,    3108.,    3182.,    3255.,    3325.,
                 1    3394.,    3461.,    3527.,    3591.,    3653.,    3714.,    3774.,
                 1    3832.,    3889.,    3944.,    3999.,    4052.,    4104.,    4155.,
                 1    4205.,    4254.,    4302.,    4349.,    4395.,    4440.,    4484.,
                 1    4528.,    4571.,    4613.,    4654.,    4694.,    4734.,    4773.,
                 1    4812.,    4849.,    4887.,    4923.,    4959.,    4994.,    5029.,
                 1    5063.,    5096.,    5129.,    5161.,    5193.,    5225.,    5256.,
                 1    5287.,    5318.,    5348.,    5378.,    5407.,    5436./
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Table A-3 (Continued)

```
      DATA (FTIME(I, 9), I=1,80) /      165.,    326.,    485.,    640.,
     1     792.,    941.,   1088.,   1232.,   1373.,   1511.,   1647.,
     1    1779.,   1909.,   2036.,   2161.,   2282.,   2402.,   2518.,
     1    2632.,   2743.,   2852.,   2959.,   3063.,   3164.,   3263.,
     1    3360.,   3454.,   3546.,   3636.,   3724.,   3810.,   3893.,
     1    3975.,   4055.,   4132.,   4209.,   4283.,   4355.,   4426.,
     1    4495.,   4563.,   4630.,   4695.,   4759.,   4822.,   4883.,
     1    4943.,   5002.,   5060.,   5117.,   5173.,   5228.,   5281.,
     1    5334.,   5386.,   5437.,   5488.,   5537.,   5586.,   5633.,
     1    5680.,   5726.,   5772.,   5816.,   5860.,   5903.,   5946.,
     1    5988.,   6030.,   6072.,   6113.,   6153.,   6194.,   6233.,
     1    6272.,   6311.,   6349.,   6387.,   6424.,   6461./
      DATA (FTIME(I,10), I=1,80) /      193.,    381.,    557.,    748.,
     1     927.,   1102.,   1274.,   1442.,   1608.,   1770.,   1929.,
     1    2084.,   2237.,   2387.,   2533.,   2676.,   2817.,   2954.,
     1    3089.,   3220.,   3348.,   3474.,   3597.,   3716.,   3834.,
     1    3948.,   4060.,   4169.,   4276.,   4380.,   4482.,   4581.,
     1    4678.,   4773.,   4866.,   4956.,   5045.,   5132.,   5217.,
     1    5300.,   5382.,   5462.,   5541.,   5618.,   5693.,   5767.,
     1    5840.,   5912.,   5982.,   6051.,   6119.,   6186.,   6252.,
     1    6316.,   6380.,   6442.,   6504.,   6564.,   6623.,   6682.,
     1    6739.,   6796.,   6853.,   6909.,   6964.,   7019.,   7073.,
     1    7127.,   7180.,   7233.,   7285.,   7336.,   7387.,   7437.,
     1    7486.,   7535.,   7583.,   7631.,   7678.,   7724./
      DATA (FTIME(I,11), I=1,80) /      226.,    448.,    666.,    880.,
     1    1091.,   1297.,   1500.,   1698.,   1894.,   2085.,   2273.,
     1    2457.,   2637.,   2814.,   2987.,   3157.,   3323.,   3486.,
     1    3645.,   3801.,   3953.,   4102.,   4248.,   4390.,   4530.,
     1    4666.,   4799.,   4929.,   5057.,   5181.,   5303.,   5422.,
     1    5538.,   5652.,   5763.,   5872.,   5979.,   6083.,   6186.,
     1    6286.,   6385.,   6482.,   6577.,   6670.,   6762.,   6853.,
     1    6942.,   7029.,   7115.,   7199.,   7282.,   7364.,   7444.,
     1    7523.,   7601.,   7677.,   7753.,   7829.,   7904.,   7978.,
     1    8051.,   8124.,   8195.,   8267.,   8337.,   8407.,   8476.,
     1    8544.,   8611.,   8677.,   8743.,   8808.,   8872.,   8936.,
     1    8998.,   9060.,   9122.,   9182.,   9242.,   9301./
      DATA (FTIME(I,12), I=1,80) /      265.,    524.,    780.,   1031.,
     1    1278.,   1520.,   1758.,   1991.,   2221.,   2445.,   2667.,
     1    2883.,   3095.,   3303.,   3507.,   3707.,   3903.,   4095.,
     1    4283.,   4467.,   4647.,   4823.,   4996.,   5164.,   5329.,
     1    5490.,   5648.,   5802.,   5954.,   6102.,   6246.,   6388.,
     1    6526.,   6662.,   6795.,   6925.,   7052.,   7177.,   7301.,
     1    7421.,   7540.,   7656.,   7771.,   7884.,   7995.,   8104.,
     1    8212.,   8317.,   8421.,   8523.,   8624.,   8724.,   8823.,
     1    8921.,   9018.,   9115.,   9211.,   9305.,   9399.,   9492.,
     1    9584.,   9675.,   9765.,   9853.,   9941.,  10028.,  10114.,
     1   10200.,  10284.,  10367.,  10450.,  10531.,  10612.,  10692.,
     1   10771.,  10849.,  10927.,  11003.,  11079.,  11153./
      DATA (FTIME(I,13), I=1,80) /      313.,    619.,    922.,   1218.,
     1    1510.,   1797.,   2079.,   2355.,   2627.,   2893.,   3156.,
     1    3412.,   3665.,   3911.,   4154.,   4391.,   4625.,   4853.,
     1    5077.,   5296.,   5511.,   5720.,   5926.,   6127.,   6324.,
     1    6516.,   6706.,   6890.,   7072.,   7249.,   7423.,   7592.,
     1    7759.,   7922.,   8082.,   8239.,   8393.,   8544.,   8693.,
     1    8840.,   8984.,   9125.,   9265.,   9402.,   9536.,   9669.,
     1    9801.,   9931.,  10061.,  10189.,  10317.,  10443.,  10568.,
     1   10692.,  10815.,  10936.,  11057.,  11176.,  11294.,  11410.,
     1   11526.,  11640.,  11753.,  11865.,  11977.,  12087.,  12196.,
     1   12304.,  12411.,  12517.,  12622.,  12726.,  12829.,  12931.,
     1   13032.,  13132.,  13230.,  13328.,  13424.,  13519./
      DATA (FTIME(I,14), I=1,80) /      373.,    739.,   1100.,   1454.,
     1    1803.,   2145.,   2483.,   2813.,   3139.,   3458.,   3773.,
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Table A-3 (Continued)

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SUBROUTINE  PARTLP    TRACE                          CDC 6600 FTN V3.0-P261 OPT=0  05/10/72  17.36.24.

                 1     4090.,   4393.,   4679.,   4970.,   5255.,   5536.,   5810.,
                 1     6080.,   6343.,   6602.,   6854.,   7102.,   7344.,   7582.,
                 1     7815.,   8043.,   8267.,   8486.,   8701.,   8912.,   9118.,
                 1     9321.,   9519.,   9714.,   9905.,  10093.,  10278.,  10460.,
                 1    10638.,  10814.,  10988.,  11161.,  11332.,  11503.,  11671.,
                 1    11839.,  12005.,  12171.,  12333.,  12494.,  12654.,  12813.,
                 1    12969.,  13125.,  13279.,  13432.,  13583.,  13733.,  13881.,
                 1    14029.,  14175.,  14320.,  14463.,  14606.,  14747.,  14888.,
                 1    15027.,  15165.,  15301.,  15437.,  15571.,  15704.,  15835.,
                 1    15965.,  16094.,  16221.,  16348.,  16470.,  16592./
                  DATA (FTIME(I,15), I=1,80) /    449.,    882.,   1313.,   1736.,
                 1     2154.,   2564.,   2968.,   3363.,   3754.,   4136.,   4513.,
                 1     4882.,   5245.,   5601.,   5951.,   6293.,   6631.,   6960.,
                 1     7285.,   7602.,   7914.,   8219.,   8517.,   8809.,   9096.,
                 1     9377.,   9654.,   9924.,  10190.,  10450.,  10707.,  10957.,
                 1    11204.,  11444.,  11680.,  11911.,  12140.,  12366.,  12591.,
                 1    12815.,  13037.,  13257.,  13475.,  13692.,  13907.,  14120.,
                 1    14331.,  14539.,  14747.,  14952.,  15155.,  15357.,  15557.,
                 1    15755.,  15952.,  16148.,  16342.,  16534.,  16725.,  16915.,
                 1    17104.,  17291.,  17475.,  17661.,  17844.,  18025.,  18205.,
                 1    18384.,  18551.,  18737.,  18911.,  19083.,  19254.,  19422.,
                 1    19589.,  19754.,  19917.,  20077.,  20235.,  20391./
                  DATA (FTIME(I,16), I=1,80) /    539.,   1047.,   1590.,   2103.,
                 1     2610.,   3107.,   3597.,   4079.,   4552.,   5017.,   5475.,
                 1     5924.,   6367.,   6800.,   7227.,   7644.,   8056.,   8458.,
                 1     8854.,   9241.,   9622.,   9995.,  10361.,  10719.,  11070.,
                 1    11415.,  11754.,  12084.,  12409.,  12727.,  13041.,  13350.,
                 1    13656.,  13956.,  14254.,  14548.,  14841.,  15130.,  15418.,
                 1    15702.,  15985.,  16265.,  16543.,  16819.,  17092.,  17363.,
                 1    17632.,  17899.,  18164.,  18427.,  18688.,  18948.,  19206.,
                 1    19462.,  19717.,  19970.,  20221.,  20471.,  20720.,  20967.,
                 1    21212.,  21456.,  21698.,  21939.,  22177.,  22414.,  22649.,
                 1    22882.,  23113.,  23341.,  23568.,  23792.,  24014.,  24233.,
                 1    24450.,  24663.,  24873.,  25080.,  25285.,  25485./
                  DATA (FTIME(I,17), I=1,80) /    662.,   1313.,   1957.,   2589.,
                 1     3214.,   3828.,   4433.,   5027.,   5613.,   6187.,   6754.,
                 1     7309.,   7857.,   8394.,   8923.,   9440.,   9948.,  10444.,
                 1    10932.,  11410.,  11880.,  12341.,  12795.,  13239.,  13678.,
                 1    14110.,  14538.,  14960.,  15377.,  15788.,  16195.,  16595.,
                 1    16991.,  17379.,  17764.,  18144.,  18520.,  18891.,  19263.,
                 1    19630.,  19995.,  20356.,  20716.,  21073.,  21429.,  21782.,
                 1    22133.,  22481.,  22829.,  23174.,  23517.,  23859.,  24199.,
                 1    24537.,  24874.,  25209.,  25542.,  25873.,  26203.,  26531.,
                 1    26856.,  27180.,  27501.,  27819.,  28136.,  28450.,  28761.,
                 1    29069.,  29375.,  29677.,  29976.,  30271.,  30563.,  30850.,
                 1    31135.,  31414.,  31689.,  31959.,  32225.,  32485./
                  DATA (FTIME(I,18), I=1,80) /    821.,   1630.,   2426.,   3207.,
                 1     3973.,   4736.,   5484.,   6219.,   6946.,   7660.,   8367.,
                 1     9061.,   9747.,  10421.,  11088.,  11743.,  12390.,  13026.,
                 1    13653.,  14270.,  14878.,  15474.,  16063.,  16639.,  17209.,
                 1    17767.,  18324.,  18870.,  19409.,  19940.,  20465.,  20981.,
                 1    21491.,  21993.,  22490.,  22980.,  23467.,  23951.,  24432.,
                 1    24910.,  25386.,  25859.,  26331.,  26800.,  27268.,  27733.,
                 1    28197.,  28659.,  29119.,  29577.,  30034.,  30489.,  30941.,
                 1    31392.,  31841.,  32287.,  32731.,  33173.,  33613.,  34050.,
                 1    34486.,  34914.,  35342.,  35766.,  36187.,  36604.,  37017.,
                 1    37425.,  37829.,  38228.,  38629.,  39012.,  39396.,  39773.,
                 1    40146.,  40511.,  40870.,  41222.,  41567.,  41904./
                  DATA (FTIME(I,19), I=1,80) /   1054.,   2096.,   3131.,   4153.,
                 1     5166.,   6164.,   7151.,   8123.,   9084.,  10029.,  10954.,
                 1    11882.,  12790.,  13683.,  14564.,  15430.,  16285.,  17124.,
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Table A-3 (Continued)

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SUBROUTINE  PARTLP   TRACE                          CDC 6600 FTN V3.0-P261 OPT=0  05/10/72  17.36.24.

          1     17952.,  18765.,  19567.,  20353.,  21128.,  21887.,  22637.,
          1     23375.,  24106.,  24825.,  25537.,  26238.,  26932.,  27615.,
          1     28292.,  28959.,  29620.,  30274.,  30925.,  31573.,  32219.,
          1     32863.,  33505.,  34146.,  34785.,  35423.,  36059.,  36693.,
          1     37325.,  37955.,  38584.,  39210.,  39835.,  40456.,  41076.,
          1     41693.,  42307.,  42917.,  43525.,  44129.,  44730.,  45326.,
          1     45918.,  46505.,  47088.,  47664.,  48236.,  48800.,  49360.,
          1     49912.,  50458.,  50995.,  51526.,  52047.,  52561.,  53065.,
          1     53561.,  54046.,  54522.,  54987.,  55443.,  55886./
           DATA (FTIME(I,20), I=1,80) /    1430.,   2843.,   4244.,   5628.,
          1      6999.,   8349.,   9684.,  10997.,  12297.,  13574.,  14838.,
          1     16080.,  17308.,  18515.,  19707.,  20879.,  22037.,  23174.,
          1     24297.,  25399.,  26483.,  27556.,  28611.,  29644.,  30566.,
          1     31674.,  32673.,  33659.,  34637.,  35601.,  36557.,  37501.,
          1     38437.,  39361.,  40279.,  41189.,  42097.,  43002.,  43907.,
          1     44810.,  45712.,  46613.,  47514.,  48413.,  49311.,  50206.,
          1     51100.,  51990.,  52879.,  53764.,  54647.,  55526.,  56402.,
          1     57272.,  58139.,  59000.,  59857.,  60707.,  61552.,  62389.,
          1     63220.,  64041.,  64856.,  65660.,  66457.,  67242.,  68018.,
          1     68782.,  69536.,  70276.,  71006.,  71720.,  72424.,  73110.,
          1     73785.,  74442.,  75086.,  75712.,  76324.,  76918./
           DATA (FTIME(I,21), I=1,80) /    1973.,   3923.,   5860.,   7775.,
          1      9673.,  11543.,  13395.,  15218.,  17023.,  18801.,  20559.,
          1     22290.,  24002.,  25688.,  27355.,  28994.,  30616.,  32211.,
          1     33787.,  35337.,  36869.,  38375.,  39861.,  41321.,  42766.,
          1     44194.,  45612.,  47014.,  48405.,  49781.,  51146.,  52497.,
          1     53837.,  55162.,  56479.,  57789.,  59095.,  60401.,  61706.,
          1     63011.,  64316.,  65620.,  66923.,  68225.,  69525.,  70822.,
          1     72116.,  73405.,  74691.,  75972.,  77248.,  78517.,  79781.,
          1     81035.,  82284.,  83522.,  84752.,  85971.,  87181.,  88377.,
          1     89562.,  90731.,  91882.,  93029.,  94156.,  95263.,  96356.,
          1     97426.,  98482.,  99514., 100530., 101520., 102493., 103439.,
          1    104366., 105265., 106144., 106995., 107825., 108626./
           DATA (FTIME(I,22), I=1,80) /    2850.,   5675.,   8482.,  11263.,
          1     14023.,  16746.,  19443.,  22103.,  24738.,  27336.,  29909.,
          1     32463.,  34953.,  37427.,  39875.,  42287.,  44673.,  47022.,
          1     49347.,  51635.,  53898.,  56123.,  58323.,  60485.,  62627.,
          1     64747.,  66853.,  68939.,  71011.,  73062.,  75100.,  77116.,
          1     79119.,  81101.,  83072.,  85033.,  86990.,  88947.,  90904.,
          1     92862.,  94819.,  96774.,  98729., 100681., 102629., 104571.,
          1    106509., 108436., 110358., 112268., 114171., 116060., 117938.,
          1    119800., 121650., 123481., 125297., 127092., 128870., 130623.,
          1    132358., 134063., 135748., 137408., 139031., 140627., 142199.,
          1    143733., 145241., 146709., 148150., 149548., 150918., 152244.,
          1    153540., 154791., 156011., 157186., 158329., 159426./
           DATA (FTIME(I,23), I=1,80) /    4417.,   8801.,  13162.,  17491.,
          1     21789.,  26033.,  30240.,  34393.,  38509.,  42570.,  46594.,
          1     50563.,  54495.,  58372.,  62212.,  65997.,  69745.,  73437.,
          1     77091.,  80690.,  84252.,  87756.,  91221.,  94628.,  98005.,
          1    101350., 104676., 107971., 111245., 114488., 117710., 120900.,
          1    124069., 127204., 130323., 133425., 136522., 139618., 142714.,
          1    145807., 148899., 151987., 155070., 158146., 161214., 164267.,
          1    167309., 170332., 173340., 176326., 179294., 182234., 185154.,
          1    188039., 190900., 193722., 196517., 199269., 201989., 204661.,
          1    207298., 209879., 212423., 214908., 217352., 219732., 222070.,
          1    224340., 226564., 228719., 230827., 232862., 234848., 236761.,
          1    238624., 240413., 242152., 243817., 245433., 246976./
           DATA (FTIME(I,24), I=1,80) /    7567.,  15084.,  22567.,  30000.,
          1     37386.,  44691.,  51916.,  59059.,  66142.,  73134.,  80065.,
          1     86901.,  93677., 100360., 106982., 113510., 119975., 126345.,
          1    132652., 138864., 145012., 151062., 157045., 162927., 168758.,
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Table A-3 (Continued)

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SUBROUTINE  PARTLP    TRACE                       CDC 6600 FTN V3.0-P261 OPT=0  05/10/72  17.36.24.
      1   174536., 180279., 185970., 191629., 197223., 202784., 208289.,
      1   213756., 219161., 224536., 229878., 235208., 240530., 245847.,
      1   251154., 256452., 261733., 267000., 272243., 277465., 282649.,
      1   287805., 292914., 297990., 303010., 307989., 312905., 317773.,
      1   322564., 327303., 331957., 336553., 341055., 345492., 349827.,
      1   354091., 358262., 362317., 366276., 370154., 373910., 377581.,
      1   381126., 384595., 387915., 391158., 394270., 397294., 400189.,
      1   402998., 405677., 408272., 410741., 413128., 415395./
       DATA (FTIME(I,25), I=1,80) /  14555.,  29019.,  43421.,  57730.,
      1    71952.,  86000.,  99932., 113691., 127334., 140802., 154152.,
      1   167322., 180372., 193247., 206001., 218573., 231022., 243288.,
      1   255430., 267396., 279216., 290854., 302361., 313669., 324875.,
      1   335973., 346799., 357917., 368761., 379487., 390135., 400664.,
      1   411110., 421426., 431673., 441840., 451970., 462065., 472133.,
      1   482156., 492143., 502069., 511947., 521747., 531483., 541111.,
      1   550660., 560093., 569414., 578599., 587681., 596597., 605395.,
      1   614006., 622487., 630767., 638907., 646830., 654603., 662145.,
      1   669527., 676664., 683636., 690358., 696912., 703210., 709337.,
      1   715206., 720905., 726350., 731628., 736652., 741513., 746132.,
      1   750593., 754820., 758894., 762747., 766455., 769954./
C
       CLDINC = (ACT-ACB) / FLOAT(NLVL-1)
       CLDHT = ACB
       DO 190 IA = 1, NLVL
       ALTA = 0.0   $   XDX = 0.0   $   YDY = 0.0
       GO TO (20, 50, 120, 100), KDAT
C
C      WIND DATA ARE GIVEN BY ALTITUDE (METERS) AND X AND Y (METERS/SEC)
C        COMPONENTS
    20 DXA = DX(1)   $   DYA = DY(1)
       DO 30 IB = 1, NWIND
       ALTB = ALT(IB)   $   DXB = DX(IB)   $   DYB = DY(IB)
       IF (CLDHT .LT. ALTB) GO TO 140
       XDX = XDX + .5*(ALTB-ALTA)*(DXA+DXB)
       YDY = YDY + .5*(ALTB-ALTA)*(DYA+DYB)
       ALTA = ALTB   $   DXA = DXB   $   DYA = DYB
    30 CONTINUE
       GO TO 150
C
C      WIND DATA ARE GIVEN IN WEATHER BUREAU FORMAT--COMPASS DIRECTION
C        (DX) AND SPEED (DY IN M/SEC) AT SPECIFIC ELEVATIONS
    50 DXA = 0.0   $   DYA = 0.0
       IF (DX(1) .EQ. 20.) GO TO 70
       TANG = RAD * (DX(1)+8.0)
       DXA = SIN(TANG) * DY(1)   $   DYA = COS(TANG) * DY(1)
    70 DO 90 IB = 1, NWIND
       ALT(IB) = ELEV(IB)
       ALTB = ELEV(IB)   $   DXB = 0.0   $   DYB = 0.0
       IF (DX(IB) .EQ. 20.) GO TO 80
       TANG = RAD * (DX(IB)+8.0)
       DXB = SIN(TANG) * DY(IB)   $   DYB = COS(TANG) * DY(IB)
    80 IF (CLDHT .LT. ALTB) GO TO 140
       XDX = XDX + .5*(ALTB-ALTA)*(DXA+DXB)
       YDY = YDY + .5*(ALTB-ALTA)*(DYA+DYB)
       ALTA = ALTB   $   DXA = DXB   $   DYA = DYB
    90 CONTINUE
       GO TO 150
C
C      WIND DATA ARE GIVEN IN SECOND WEATHER BUREAU FORMAT--DIRECTION IN
C        DEGREES CLOCKWISE FROM NORTH (DX) AND SPEED IN M/SEC (DY) AT
C        SPECIFIC ELEVATIONS
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Table A-3 (Concluded)

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SUBROUTINE  PARTLP    TRACE                          CDC 6600 FTN V3.0-P261 OPT=0  05/10/72  17.36.24.

  100 ALT(1) = 0.0    $    RDN = 0.174533 * (DX(1)+180.)
      DXA = SIN(RDN) * DY(1)    $    DYA = COS(RDN) * DY(1)
      DO 110 IB = 2, NWIND
      ALT(IB) = ELEV2(IB)    $    ALTB = ELEV2(IB)
      RDN = .0174533 * (DX(IB)+180.)
      DXB = SIN(RDN) * DY(IB)    $    DYB = COS(RDN) * DY(IB)
      IF (CLDHT .LT. ALTB) GO TO 140
      XDX = XDX + 0.5*(ALTB-ALTA)*(DXA+DXB)
      YDY = YDY + 0.5*(ALTB-ALTA)*(DYA+DYB)
      ALTA = ALTB    $    DXA = DXB    $    DYA = DYB
  110 CONTINUE
      GO TO 150
C
C     WIND DATA ARE GIVEN BY ALTITUDE (FEET), SPEED (FT/SEC), AND
C       DIRECTION (DEGREES CLOCKWISE FROM NORTH)
  120 RDN = .0174533 * (DY(1)+180.)
      DXA = .3048 * SIN(RDN) * DX(1)
      DYA = .3048 * COS(RDN) * DX(1)
      DO 130 IB = 1, NWIND
      ALTB = .3048 * ALT(IB)    $    RDN = .0174533 * (DY(IB)+180.)
      DXB = .3048 * SIN(RDN) * DX(IB)
      DYB = .3048 * COS(RDN) * DX(IB)
      IF (CLDHT .LT. ALTB) GO TO 140
      XDX = XDX + .5*(ALTB-ALTA)*(DXA+DXB)
      YDY = YDY + .5*(ALTB-ALTA)*(DYA+DYB)
      ALTA = ALTB    $    DXA = DXB    $    DYA = DYB
  130 CONTINUE
      GO TO 150
  140 FRAC = (CLDHT-ALTA) / (ALTB-ALTA)
      DXB = DXA + FRAC*(DXB-DXA)    $    DYB = DYA + FRAC*(DYB-DYA)
  150 XDX = XDX + .5*(CLDHT-ALTA)*(DXA+DXB)
      YDY = YDY + .5*(CLDHT-ALTA)*(DYA+DYB)
      KD = CLDHT / 500.
      FRAC = (CLDHT-FLOAT(KD)*500.) / 500.
      XDX = XDX / CLDHT    $    YDY = YDY / CLDHT
      DO 180 IB = 1, 25, KPAR
      FTTAY(IB,IA) = FTIME(KD,IB) + FRAC*(FTIME(KD+1,IB)-FTIME(KD,IB))
      XTAY(IB,IA) = XDX * FTTAY(IB,IA)
      YTAY(IB,IA) = YDY * FTTAY(IB,IA)
      GDTAY(IB,IA) = SQRT(XTAY(IB,IA)**2 + YTAY(IB,IA)**2)
      IF (FTTAY(IB,IA) + TSR .GE. TRMAX) GO TO 160
      IF (FTTAY(IB,IA) .GE. TRA) GO TO 155
      RT = RMIN + RATA*FTTAY(IB,IA)
      GO TO 170
  155 RT = RMIN + RATIO*FTTAY(IB,IA)
      GO TO 170
  160 RT = RMAX
  170 RDTAY(IB,IA) = RT
  180 CONTINUE
      CLDHT = CLDHT + CLDINC
      KC = 25 - KPAR
      XTAY(26,IA) = 2.0*XTAY(25,IA) - XTAY(KC,IA)
      YTAY(26,IA) = 2.0*YTAY(25,IA) - YTAY(KC,IA)
      GDTAY(26,IA) = 2.0*GDTAY(25,IA) - GDTAY(KC,IA)
      FTTAY(26,IA) = FTTAY(25,IA)
      RDTAY(26,IA) = RT
  190 CONTINUE
      RETURN
      END
```

Table A-4

SUBROUTINE INTENS

```
 SUBROUTINE  INTENS    TRACE                             CDC 6600 FTN V3.0-P261 OPT=0  05/10/72  17.36.24.
                  SUBROUTINE INTENS
            C
            C     SUBROUTINE TO COMPUTE THE FALLOUT INTENSITIES (DRAY) AT KEY POINTS
            C
                  COMMON /ARRAY/ DRAY(26,23),XRAY(26,23),YRAY(26,23),GDRAY(26,23),
                 1               FTRAY(26,23),RDRAY(26,23),DRATSA(26,23),
                 2               NLVL,DISMAX,DISMIN,KPAR,KA,KB,NPAR
                 3       /SCRTCH/ XTAY(26,23),YTAY(26,23),GDTAY(26,23),FTTAY(26,23),
                 4                RDTAY(26,23),DTAY(26,23),UDRAY(26,23),
                 5                DRATSB(26,23),RD(26),DUM(5192)
                 6       /INDAT/ W, ALW, TITLE(8), TLIMIT
                 7       /CLDATA/ ACB,ACT,RMIN,RMAX,TSR,TRMAX,RATIO,TRA,RATA
                 8       /EDGRAY/ XLR(26,2),YLR(26,2),ILR(26,2)
                  DIMENSION PERCNT(26)
                  DATA (PERCNT(I),I=1,26) / 3*.02, 3*.025, 3*.03, 3*.035, 3*.04,
                 1                          3*.045, 7*.05, .065 /
            C
            C     COMPUTE FALLOUT INTENSITY AT KEY POINTS WITH NO CONSIDERATION
            C     FOR OVERLAPPING CLOUD LAYERS.
                  ALVL = 1.0 / FLOAT(NLVL)    $   DMI = 1.5 * ALVL
                  DLAYER = 6.0775E+09 * W * FLOAT(KPAR) * ALVL
                  DCON = 10000. * W**.333333   $   DSTP = DCON - TSR
                  DISMIN = 10.0E+12    $   DISMAX = 0.
                  DO 50 IA = 1, NLVL
                  IF (ALW .GT. 3.3) GO TO 10
                  GD = (0.85 - .03*ALW) * GDTAY(1,IA)    $   GO TO 20
               10 GD = (1.03-.094746*ALW) * GDTAY(1,IA)
               20 FAC = 0.5    $   ITIME = 0
                  DO 40 IB = 1, 25, KPAR
                  DRAT = 1.5    $   IF (ITIME .EQ. 1) GO TO 30
                  IF (IB .EQ. 25) FAC = 0.5 / FLOAT(KPAR)
                  AVEDOS = DLAYER*PERCNT(IB)*FAC/(RDTAY(IB,IA)*(GDTAY(IB,IA)-GD))
                  IF (FTTAY(IB,IA) .GE. DSTP) GO TO 25
                  DRAT = (DCON/(TSR+FTTAY(IB,IA)))**0.36
                  IF (DRAT .LT. 2.0) DRAT = 1.0 + 0.5*DRAT
               25 IF (FTTAY(IB,IA)+TSR .LT. TLIMIT) GO TO 35    $   ITIME = 1
                  SASXY = (TLIMIT - FTTAY(IB-KPAR,IA) - TSR) /
                 1        (FTTAY(IB,IA) - FTTAY(IB-KPAR,IA))
                  TDOS = DTAY(IB-KPAR,IA)**((SASXY-1.0)/SASXY)
                  IF (AVEDOS .GT. TDOS) AVEDOS = TDOS
                  XTEMP = XTAY(IB-KPAR,IA) + SASXY*(XTAY(IB,IA)-XTAY(IB-KPAR,IA))
                  YTEMP = YTAY(IB-KPAR,IA) + SASXY*(YTAY(IB,IA)-YTAY(IB-KPAR,IA))
                  DISQ = XTEMP*XTEMP + YTEMP*YTEMP
                  IF (DISMAX .LT. DISQ) DISMAX = DISQ
                  IF (DISMIN .GT. DISQ) DISMIN = DISQ
                  GO TO 35
               30 AVEDOS = .5 * DTAY(IB-KPAR,IA)
               35 DTAY(IB,IA) = AVEDOS * DRAT
                  IF (DTAY(IB,IA) .LT. DMI) GO TO 38
                  DISQ = XTAY(IB,IA)*XTAY(IB,IA) + YTAY(IB,IA)*YTAY(IB,IA)
               37 IF (DISMAX .LT. DISQ) DISMAX = DISQ
                  IF (DISMIN .GT. DISQ) DISMIN = DISQ
               38 DRATSB(IB,IA) = DRAT    $   GD = GDTAY(IB,IA)
               40 CONTINUE
                  DTAY(26,IA) = 1.0
```

Table A-4 (Continued)

```
          IF (DTAY(25,IA) .LT.2.0) DTAY(26,IA) = .5*DTAY(25,IA)
   50  CONTINUE
C
C      ESTABLISH RADIAL DISTANCES
       DISMAX = SQRT(DISMAX) + RMAX   $   DISMIN = SQRT(DISMIN)
       DISMP = DISMAX - DISMIN   $   RD(1) = DISMIN
       CON = -.137543*FLOAT(KPAR)
       DO 60 IA = 2, NPAR
       RD(IA) = DISMIN + DISMP*10.0**(CON*FLOAT(NPAR-IA))
   60  CONTINUE
C
C      COMPUTE VALUES FOR ALL RADIAL POINTS
       DO 260 IA = 1, NLVL
       IF (RD(1) .GT. .333*GDTAY(1,IA)) GO TO 70
       DRAY(1,IA) = 2.0 * DTAY(1,IA) * RD(1) / GDTAY(1,IA)
       GO TO 80
   70  DRAY(1,IA) = (.666 + ((.5*RD(1)-.1666*GDTAY(1,IA))/GDTAY(1,IA))) *
     1                DTAY(1,IA)
   80  UDRAY(1,IA) = DRAY(1,IA)   $   PRO = RD(1) / GDTAY(1,IA)
       XRAY(1,IA) = XTAY(1,IA) * PRO   $   DRATSA(1,IA) = DRATSB(1,IA)
       YRAY(1,IA) = YTAY(1,IA) * PRO   $   GDRAY(1,IA) = RD(1)
       RDRAY(1,IA) = RMIN + PRO*(RDTAY(1,IA)-RMIN)
       FTRAY(1,IA) = FTTAY(1,IA) * PRO
       XA = XRAY(1,IA)   $   YA = YRAY(1,IA)   $   IT = 1
       DTDA = DRAY(1,IA)   $   RTA = RDRAY(1,IA)   $   FTA = FTRAY(1,IA)
       DRTA = DRATSA(1,IA)   $   GDA = GDRAY(1,IA)   $   IEND = 0
C
C      DETERMINE VALUES AT RADIAL POINTS 2 THRU 26
       DO 250 IB = 2, NPAR
       RDSQ = RD(IB) * RD(IB)   $   IF (IEND .EQ. 1) GO TO 190
  100  XYSQ = XTAY(IT,IA)*XTAY(IT,IA) + YTAY(IT,IA)*YTAY(IT,IA)
       IF (XYSQ .LT. RDSQ) GO TO 150   $   DTDB = DTAY(IT,IA)
       IF (XA .EQ. XTAY(IT,IA)) GO TO 130
       IF (YA .EQ. YTAY(IT,IA)) GO TO 140
       S = (YTAY(IT,IA) - YA) / (XTAY(IT,IA) - XA)
       Y0 = YA - S*XA   $   S1 = S*S + 1.0   $   SY0 = S * Y0 / S1
       XT = SQRT(SY0*SY0 - (Y0*Y0-RDSQ)/S1)   $   X1 = -SY0 + XT
       IF (XA .GT. XTAY(IT,IA)) GO TO 110
       IF (X1 .LT. XA) X1 = -SY0 - XT   $   GO TO 120
  110  IF (X1 .GT. XA) X1 = -SY0 - XT
  120  Y1 = Y0 + S*X1
       SASXY = SQRT(((X1-XA)**2 + (Y1-YA)**2) / ((XTAY(IT,IA)-XA)**2 +
     1                (YTAY(IT,IA)-YA)**2))
       GO TO 160
C
C      LINE IS PARALLEL TO Y AXIS
  130  X1 = XA   $   Y1 = SQRT(RDSQ-X1*X1)
       IF (YA .GT. YTAY(IT,IA)) Y1 = -Y1
       SASXY = (Y1-YA) / (YTAY(IT,IA)-YA)   $   GO TO 160
C
C      LINE IS PARALLEL TO X AXIS
  140  Y1 = YA   $   X1 = SQRT(RDSQ-Y1*Y1)
       IF (XA .GT. XTAY(IT,IA)) X1 = -X1
       SASXY = (X1-XA) / (XTAY(IT,IA)-XA)   $   GO TO 160
C
```

Table A-4 (Concluded)

```
SUBROUTINE  INTENS    TRACE                            CDC 6600 FTN V3.0-P261 OPT=0  05/10/72  17.36.24.
      C     RADIAL POINT IS FARTHER THAN CURRENT PARTICLE POINT.  INCREMENT
      C       PARTICLE POINT AND UPDATE VARIABLES
        150 IF (IT .EQ. 25) GO TO 180
            XA = XTAY(IT,IA)    $   YA = YTAY(IT,IA)
            DTDA = DTAY(IT,IA)    $   RTA = RDTAY(IT,IA)
            DRTA = DRATSB(IT,IA)    $   GDA = GDTAY(IT,IA)
            FTA = FTTAY(IT,IA)    $   IT = IT + KPAR    $   GO TO 100
      C
      C     X1 AND Y1 HAVE BEEN DETERMINED, COMPUTE OTHER PARAMETERS.
        160 DRAY(IB,IA) = DTDA**(1.0-SASXY) * DTDB**(SASXY)
            XRAY(IB,IA) = X1    $   YRAY(IB,IA) = Y1
            DRATSA(IB,IA) = DRTA + SASXY*(DRATSB(IT,IA)-DRTA)
            RDRAY(IB,IA) = RTA + SASXY*(RDTAY(IT,IA)-RTA)
            FTRAY(IB,IA) = FTA + SASXY*(FTTAY(IT,IA)-FTA)
            GDRAY(IB,IA) = GDA + SASXY*(GDTAY(IT,IA)-GDA)
            UDRAY(IB,IA) = DRAY(IB,IA)
            XA = X1    $   YA = Y1    $   DTDA = DRAY(IB,IA)
            RTA = RDRAY(IB,IA)    $   DRTA = DRATSA(IB,IA)
            GDA = GDRAY(IB,IA)    $   FTA = FTRAY(IB,IA)    $   GO TO 250
      C
      C     PARTICLE POINTS EXHAUSTED, FINISH UP WITH RADIAL POINTS
        180 IEND = 1    $   DRAY(IB,IA) = 1.0
            IF (DRAY(IB-1,IA) .GT. 2.0) GO TO 195
        190 DRAY(IB,IA) = .5 * DRAY(IB-1,IA)
        195 IF (XA .EQ. XTAY(25,IA)) GO TO 220
            IF (YA .EQ. YTAY(25,IA)) GO TO 230
            XT = SQRT(SY0*SY0 - (Y0*Y0-RDSQ)/S1)    $   X1 = -SY0 + XT
            IF (XA .GT. XTAY(IT,IA)) GO TO 200
            IF (X1 .LT. XA) X1 = -SY0 - XT    $   GO TO 210
        200 IF (X1 .GT. XA) X1 = -SY0 - XT
        210 Y1 = Y0 + S*X1    $   GO TO 240
        220 Y1 = SQRT(RDSQ - X1*X1)
            IF (YA .GT. YTAY(IT,IA)) Y1 = -Y1    $   GO TO 240
        230 X1 = SQRT(RDSQ-Y1*Y1)
            IF (XA .GT. XTAY(IT,IA)) X1 = -X1
        240 XRAY(IB,IA) = X1    $   YRAY(IB,IA) = Y1
            DRATSA(IB,IA) = DRATSB(25,IA)    $   RDRAY(IB,IA) = RDTAY(25,IA)
            FTRAY(IB,IA) = FTTAY(25,IA)    $   UDRAY(IB,IA) = DRAY(IB,IA)
            TEMB = SQRT((X1-XRAY(IB-1,IA))**2 + (Y1-YRAY(IB-1,IA))**2)
            GDRAY(IB,IA) = GDRAY(IB-1,IA) + TEMB
        250 CONTINUE
        260 CONTINUE
      C
      C     MODIFY DRAY TO ACCOUNT FOR OVERLAPPING CLOUD LAYERS
            DO 270 IA = 1, NLVL
            DO 270 IB = 1, NPAR
            X = XRAY(IB,IA)    $   Y = YRAY(IB,IA)
            DO 270 IC = 1, NLVL
            IF (IA .EQ. IC) GO TO 270
            DTSQ=(XRAY(IB,IC)-X)**2+(YRAY(IB,IC)-Y)**2
            DTEM = SQRT((XRAY(IB,IC)-X)**2 + (YRAY(IB,IC)-Y)**2)
            IF (DTEM .GT. 2.0*RDRAY(IB,IA)) GO TO 270
            TEMA = DRATSA(IB,IA) * DTEM / RDRAY(IB,IA)
            TEMB = 0.    $   IF (DTEM .GT. RMIN) GO TO 265
            TEMB = .25 * ((RMIN-DTEM)/RMIN)**(DRATSA(IB,IA)/6.0)
        265 ADDOSE = UDRAY(IB,IA) * (.75*EXP(-.94831*TEMA*TEMA) + TEMB)
            DRAY(IB,IC)=DRAY(IB,IC) + ADDOSE
        270 CONTINUE
            RETURN
            END
```

Table A-5

SUBROUTINE LFTRT

```
SUBROUTINE  LFTRT     TRACE                         CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.

                      SUBROUTINE LFTRT
                C
                C     SUBROUTINE TO ASSIGN CLOUD LEVEL SUBSCRIPTS FOR LEFT AND RIGHT
                C       SIDES OF FALLOUT PATTERN
                C
                      COMMON /ARRAY/ DRAY(26,23),XRAY(26,23),YRAY(26,23),GDRAY(26,23),
                     1               FTRAY(26,23),RDRAY(26,23),DRATSA(26,23),
                     2               NLVL,DISMAX,DISMIN,KPAR,KA,KB,NPAR
                     3        /EDGRAY/ XLR(26,2),YLR(26,2),ILR(26,2)
                      DATA PI2,PI32,PIPI/1.5707963, 4.7123890, 6.2831853/
                C
                C     LOOP FOR EACH PARTICLE GROUP
                      DO 90 IA = 1, NPAR
                      ILA = 1   $   IRA = 1
                      THETAL = ATAN2 (XRAY(IA,1),YRAY(IA,1))
                      IF (THETAL .LT. 0.) THETAL = PIPI+THETAL
                      THETAR = THETAL
                C
                C     LOOP FOR EACH CLOUD LEVEL
                      DO 80 IB = 2, NLVL
                      ALPHA = ATAN2(XRAY(IA,IB),YRAY(IA,IB))
                      IF (ALPHA .LT. 0.) ALPHA = PIPI + ALPHA
                C
                C     TEST ON LEFT SIDE OF PATTERN
                      IF (THETAL .LT. PI2) GO TO 10
                C
                C     LEFT SIDE IS BETWEEN 360 AND 90 DEGREES
                      IF (ALPHA .GT. THETAL-PI2 .AND. ALPHA .LT. THETAL) GO TO 30
                      GO TO 40
                C
                C     LEFT SIDE IS BETWEEN 90 AND 0 DEGREES
                   10 IF (ALPHA .LT. PI2) GO TO 20
                      IF (ALPHA .GT. THETAL+PI32) GO TO 30   $   GO TO 40
                   20 IF (ALPHA .GE. THETAL) GO TO 40
                   30 THETAL = ALPHA   $   ILA = IB   $   GO TO 80
                C
                C     TEST ON RIGHT SIDE OF PATTERN
                   40 IF (THETAR .GT. PI32) GO TO 50
                C
                C     RIGHT SIDE IS BETWEEN 0 AND 270 DEGREES
                      IF (ALPHA .LT. THETAR+PI2 .AND. ALPHA .GT. THETAR) GO TO 70
                      GO TO 80
                C
                C     RIGHT SIDE IS BETWEEN 270 AND 360 DEGREES
                   50 IF (ALPHA .GT. PI32) GO TO 60
                      IF (ALPHA+PI32 .LT. THETAR) GO TO 70   $   GO TO 80
                C
                C     ALPHA AND THETAR ARE BETWEEN 270 AND 360 DEGREES
                   60 IF (ALPHA .LE. THETAR) GO TO 80
                   70 THETAR = ALPHA   $   IRA = IB
                   80 CONTINUE
                      ILR(IA,1) = ILA   $   ILR(IA,2) = IRA
                   90 CONTINUE
                      RETURN
                      END
```

Table A-6

SUBROUTINE EDGE

```
SUBROUTINE  EDGE      TRACE                    CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.
      SUBROUTINE EDGE
C
C     SUBROUTINE TO DETERMINE THE LOCATIONS OF THE PIVOT POINTS ON THE
C       LEFT AND RIGHT EDGES OF THE FALLOUT PATTERN
C
      COMMON /EDGRAY/ XLR(26,2),YLR(26,2),ILR(26,2)
     1        /ARRAY/ DRAY(26,23),XRAY(26,23),YRAY(26,23),SDRAY(26,23),
     2                FTRAY(26,23),RDRAY(26,23),DRATSA(26,23),
     3                NLVL,DISMAX,DISMIN,KPAR,KA,KB,NPAR
      DIMENSION RH(2)
      DATA RH(1),RH(2) / 1.0, -1.0 /
C
      DO 140 IB = 1, 2
      NP = NPAR - 1
      DO 130 IA = 1, NP
      IX = ILR(IA,IB)   $   IY = ILR(IA+1,IB)
      XA = XRAY(IA,IX)   $   YA = YRAY(IA,IX)
      XB = XRAY(IA+1,IY)   $   YB = YRAY(IA+1,IY)
      RDA = RDRAY(IA,IX) * 1.1   $   RDB = RDRAY(IA+1,IY) * 1.1
      XT = 0.   $   YT = 0.
C
C     CHECK IF CURRENT LEG IS PARALLEL TO X AXIS
      IF (YA .NE. YB) GO TO 10
      X6 = XA   $   X7 = XB   $   RF = 1.0
      IF (XA .GT. XB) RF = -1.0
      Y6 = YA + RDA*RH(IB)*RF   $   Y7 = YB + RDB*RH(IB)*RF
      ASLP = 0.   $   KSLP = 0   $   GO TO 60
C
C     CHECK IF CURRENT LEG IS PARALLEL TO Y AXIS
   10 IF (XA .NE. XB) GO TO 20
      Y6 = YA   $   Y7 = YB   $   RF = 1.0
      IF (YA .LT. YB) RF = -1.0
      X6 = XA + RDA*RH(IB)*RF   $   X7 = XB + RDB*RH(IB)*RF
      ASLP = 0.   $   KSLP = 1   $   GO TO 60
C
C     CURRENT LEG IS NOT PARALLEL TO EITHER AXIS
   20 ASLP = (XA-XB) / (YB-YA)   $   KSLP = 1
      TB = (YB-YA)**2   $   TR = SQRT(TB / (TB+(XB-XA)**2))
      RF = 1.0   $   IF (ASLP .LT. 0.) GO TO 30
      IF (XB .LT. XA) RF = -1.0   $   GO TO 40
   30 IF (XB .GT. XA) RF = -1.0
   40 X6 = XA + TR*RDA*RH(IB)*RF   $   Y6 = YA + ASLP*(X6-XA)
      X7 = XB + TR*RDB*RH(IB)*RF   $   Y7 = YB + ASLP*(X7-XB)
   60 CONTINUE
      ASLP = 0.   $   KSLP = 0   $   IF (XB .EQ. X7) GO TO 70
      ASLP = (YB-Y7) / (XB-X7)   $   KSLP = 1
   70 IF (IA .EQ. 1) GO TO 103   $   IF (KSLP .EQ. 0) GO TO 80
      IF (KSLPA .EQ. 0) GO TO 85   $   IF (ASLPA .EQ. ASLP) GO TO 105
      XT = (YB-YA+XA*ASLPA-XB*ASLP) / (ASLPA-ASLP)
      YT = YA + ASLPA*(XT-XA)   $   GO TO 90
   80 IF (KSLPA .EQ. 0) GO TO 105
      XT = XB   $   YT = YA + ASLPA*(XT-XA)   $   GO TO 90
   85 XT = XA   $   YT = YB + ASLP*(XT-XA)
   90 IF (X5 .EQ. XA) GO TO 95
      IF (X5 .GT. XA .AND. (XA .GT. XT .OR. XT .GT. X5)) GO TO 105
      IF (X5 .LT. XA .AND. (XA .LT. XT .OR. XT .LT. X5)) GO TO 105
      GO TO 100
   95 IF (Y5 .GT. YA .AND. (YA .GT. YT .OR. YT .GT. Y5)) GO TO 105
      IF (Y5 .LT. YA .AND. (YA .LT. YT .OR. YT .LT. Y5)) GO TO 105
  100 RR = SQRT((X5-XA)**2 + (Y5-YA)**2)
      X8 = XA + RDA*(X5-XA)/RR   $   Y8 = YA + RDA*(Y5-YA)/RR
      XLR(IA+1,IB) = X8   $   YLR(IA+1,IB) = Y8
      X5 = X8   $   Y5 = Y8   $   ASLPA = 0.   $   KSLPA = 0
      IF (X8 .EQ. XB) GO TO 120
      ASLPA = (YB-Y8) / (XB-X8)   $   KSLPA = 1   $   GO TO 120
  103 XLR(1,IB) = X6   $   YLR(1,IB) = Y6
  105 XLR(IA+1,IB) = X7   $   YLR(IA+1,IB) = Y7
      X5 = X7   $   Y5 = Y7   $   ASLPA = ASLP   $   KSLPA = KSLP
  120 CONTINUE
  130 CONTINUE
  140 CONTINUE
      RETURN
      END
```

Table A-7

SUBROUTINE TMAP

```
SUBROUTINE  TMAP       TRACE                        CDC 6600 FTN V3.0-P261 OPT=2  05/11/72  13.10.45.

                    SUBROUTINE TMAP
              C
              C     SUBROUTINE TO PRINT EXPOSURE DOSE CONTOUR MAPS
              C
                    COMMON /MAP/    XMIN,XMAX,YMIN,YMAX,DELX,DELY,LMAP,TXMIN,TXMAX,
                   1                YAXIS(500),XAXIS(20)
                   2       /INDAT/ N,ALN,TITLE(8),TLIMIT
                   3       /SCRTCH/DR(20,500),KMAX,KMAY
                    DIMENSION NEXPT(20), IFMTEP(23), IFMTRL(23)
                    DATA IFMTEP(23), IFMTRL(23),   IFMTA,   IFMTF,   IFMTI,   IFMTH  /
                   1          1H),        1H),   3H,A6, 5H,F6.0,   3H,I6, 5H,F6.3  /
                    DATA   IBLANK,     DOTA,     DOTB,    IFEX1,   IFEX2A,   IFEX2B  /
                   1          1H ,    3H  ., 6H      .,  4H(10X, 6H(1H0, ,     2H9X  /
                    DATA    IFRLA,    IFRLB,   IFRL1A,   IFRL1B,   IFRL2A,   IFRL2B  /
                   1     6H(F10.0,    3H,4X, 6H(1H0,F, 6H9.0,1X, 6H(//F10, 6H.0, 1X  /
              C
              C     DETERMINE NUMBER OF MAP STRIPS
                    KMAY = (YMAX - YMIN) / DELY + 1.0
                    KNX = (XMAX - XMIN) / DELX + 1.0
                    KMAP = (KNX + 19) / 20   $   KMAX = 20
              C
              C     SET UP Y AXIS AND INITIAL RANGE OF X VALUES
                    DO 10 IA = 1, KMAY
                    YAXIS(IA) = YMAX - FLOAT(IA-1)*DELY
                 10 CONTINUE
                    IF (KNX - 20) 15, 15, 20
                 15 TXMAX = XMAX   $   GO TO 30
                 20 TXMAX = XMIN + 19.0*DELX
                 30 TXMIN = XMIN
                    DO 140 IA = 1, KMAP
                    IF (IA .EQ. KMAP) KMAX = KNX - 20*(IA-1)
                    DO 40 IB = 1,20
                    XAXIS(IB) = TXMIN + (IB-1)*DELX
                 40 CONTINUE
              C
              C     CLEAR MAP STORAGE AREA
                    DO 45 IB = 1, KMAX
                    DO 45 IC = 1, KMAY
                    DR(IB,IC) = 0.
                 45 CONTINUE
              C
              C     CALL EDGED, INTERP, AND GRND7 TO PERFORM MAPPING
                    CALL EDGED   $   CALL INTERP   $   CALL GRND7
              C
              C     PRINT MAP TITLE
                    GO TO (58, 58, 50, 50), LMAP
                 50 PRINT 945, IA, (TITLE(I), I=1,8)   $   GO TO 61
                 58 PRINT 940, IA, (TITLE(I), I=1,8)
                 61 IF (MOD(IFIX(XMIN/DELX), 2) .EQ. 0) GO TO 63
                    PRINT 950, (XAXIS(I), I=1,19,2)
                    IPRINT = 1   $   GO TO 65
                 63 PRINT 955, (XAXIS(I), I=2,20,2)   $   IPRINT = 0
                 65 GO TO (70, 72, 74, 76), LMAP
                 70 IFMTRL(1) = IFRL1A   $   IFMTRL(2) = IFRL1B   $   GO TO 80
                 72 IFMTRL(1) = IFRL2A   $   IFMTRL(2) = IFRL2B   $   GO TO 80
```

Table A-7 (Concluded)

```
SUBROUTINE  TMAP      TRACE                          CDC 6600 FTN V3.0-P261 OPT=0  05/11/72  11.10.45.

   74 IFMTEP(1) = IFFX1    $   IFMTEP(2) = IBLANK   $   GO TO 78
   76 IFMTEP(1) = IFFX2A   $   IFMTEP(2) = IFFX2B
   78 IFMTRL(1) = IFRLA    $   IFMTRL(2) = IFRLB
   80 DO 110 J = 1, KMAY
C
C     CHECK VALUES AND SET UP OUTPUT FORMAT
      GO TO (82, 82, 92, 92), LMAP
   82 DO 86 I = 1, KMAX
      IF (DR(I,J) .GT. 99999.) DR(I,J) = 99999.
      IF (DR(I,J) .LT. 1.0) GO TO 84
      IFMTRL(I+2) = IFMTF   $   GO TO 86
   84 DR(I,J) = DOTA   $   IFMTRL(I+2) = IFMTA
   86 CONTINUE
      IF (KMAX .EQ. 20) GO TO 108
      K = KMAX + 1
      DO 88 I = K, 20
      IFMTRL(I+2) = IBLANK
   88 CONTINUE
      GO TO 108
   92 DO 98 I = 1, KMAX
      NEXPT(I) = IBLANK   $   IFMTEP(I+2) = IFMTA
      IF (DR(I,J) .LT. 0.50) GO TO 94
      IF (DR(I,J) .LT. 10.) GO TO 93
      NEXPT(I) = ALOG10(DR(I,J))   $   IFMTEP(I+2) = IFMTI
      DR(I,J) = DR(I,J) / 10.0**NEXPT(I)
   93 IFMTRL(I+2) = IFMTM   $   GO TO 98
   94 DR(I,J) = DOTA   $   IFMTRL(I+2) = IFMTA
   98 CONTINUE
      IF (KMAX .EQ. 20) GO TO 105
      K = KMAX + 1
      DO 100 I = K, 20
      IFMTRL(I+2) = IBLANK   $   IFMTEP(I+2) = IBLANK
  100 CONTINUE
C
C     PRINT MAP IN REQUESTED FORMAT
  105 PRINT IFMTEP, (NEXPT(I), I=1,KMAX)
  108 PRINT IFMTRL, YAXIS(J), (DR(I,J), I=1,KMAX)
  110 CONTINUE
      IF (IPRINT .EQ. 0) GO TO 115
      PRINT 955, (XAXIS(I), I=2,20,2)   $   GO TO 120
  115 PRINT 950, (XAXIS(I), I=1,19,2)
  120 TXMIN = TXMAX + DELX   $   TXMAX = TXMIN + 19.0*DELX
      IF (TXMAX - XMAX) 140, 140, 130
  130 TXMAX = XMAX
  140 CONTINUE
      RETURN
  940 FORMAT (6H1STRIP  I4,  5X, 8A10, 5X, *MAP OUTPUT IS IN DECIMAL FOR
     1MAT* )
  945 FORMAT (6H1STRIP  I4,  5X, 8A10, 5X, *MAP OUTPUT IS IN EXPONENTIAL
     1 FORMAT*)
  950 FORMAT (1H0, 4X, 10F12.0)
  955 FORMAT (1H0, 10X, 10F12.0)
      END
```

Table A-8

SUBROUTINE EDGED

```
 SUBROUTINE  EDGED     TRACE                        CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.

                       SUBRO       DGED
                 C
                 C       SU          SET UP MAPPING OF PATTERN EDGES
                 C
                       COM      M    / DRAY(26,23),XRAY(26,23),YRAY(26,23),SDRAY(26,23),
                      1                  RAY(26,23),RDRAY(26,23),DRATSA(26,23),
                      2                NLVL,DISMAX,DISMIN,KPAR,KA,KB,NPAR
                      3          /ELGRAY/ XLR(25,2),YLR(26,2),ILR(26,2)
                      4          /QUADRS/ XA,YA,DA,RDA,DRA,XB,YB,DB,RDB,DRB,XC,YC,XD,YD,XE,
                      5                  YE,XF,YF,KEG
                 C
                 C     LOOP FOR LEFT AND RIGHT EDGES OF PATTERN
                       KEA = 1
                       DO 460 IB = 1, 2
                       KEG = KEA
                       NF = NPAR - 1
                       DO 450 IA = 1, NP
                       IC = ILR(IA,IB)
                       ID = ILR(IA+1,IB)
                       IF (DRAY(IA,IC) .LT. 1.0) GO TO 460
                       XA = XRAY(IA,IC)
                       YA = YRAY(IA,IC)
                       DA = DRAY(IA,IC)
                       XB = XRAY(IA+1,ID)
                       YB = YRAY(IA+1,ID)
                       DB = DRAY(IA+1,ID)
                       XC = XLR(IA,IB)
                       YC = YLR(IA,IB)
                       XD = XLR(IA+1,IB)
                       YD = YLR(IA+1,IB)
                       RDA = RDRAY(IA,IC)
                       RDB = RDRAY(IA+1,ID)
                       DRA = DRATSA(IA,IC)
                       DRB = DRATSA(IA+1,ID)
                       CALL EGDOSE
                       KEG = KEA + 1
                   450 CONTINUE
                       KEA = 3
                   460 CONTINUE
                       RETURN
                       END
```

Table A-9

SUBROUTINE INTERP

```
SUBROUTINE  INTERP    TRACE                        CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.50.51.

      SUBROUTINE INTERP
C
C     SUBROUTINE TO PERFORM MAPPING OF THE DOWNWIND SECTION
C
C     DRAY         DOSE RATE AT 26 POINTS ALONG THE GROUND TRAVERSAL
C                  PATH OF UP TO 23 CLOUD LEVELS
C     XRAY,YRAY    X, Y LOCATIONS OF THE POINTS
C     NLVL         NUMBER OF CLOUD LEVELS
C     DR           DOSE RATE OUTPUT MAP
C     KMAX,KMAY    NUMBER OF X,Y VALUE ON CURRENT STRIP OF MAP.  MAXIMUM
C                  IS (20,500)
C     XMIN,XMAX    INPUT VALUES OF MINIMUM AND MAXIMUM X FOR OUTPUT MAP
C     YMIN,YMAX    INPUT VALUES OF MINIMUM AND MAXIMUM Y FOR OUTPUT MAP
C     DELX,DELY    INPUT VALUES OF INCREMENTS IN X AND Y DIRECTIONS
C     TXMIN,TXMAX  MINIMUM AND MAXIMUM VALUES OF X IN CURRENT STRIP OF
C                  MAP
C     XAXIS,YAXIS  X AND Y VALUES ALONG THE AXES
C
      COMMON /ARRAY/ DRAY(26,23),XRAY(26,23),YRAY(26,23),DDRAY(26,23),
     1               FTRAY(26,23),HDRAY(26,23),DRATSA(26,23),
     2               NLVL,DISMAX,DISMIN,KPAR,KA,KB,NPAR
     3       /MAP/   XMIN,XMAX,YMIN,YMAX,DELX,DELY,LMAP,TXMIN,TXMAX,
     4               YAXIS(500),XAXIS(20)
     5       /SCRTCH/DR(20,500),KMAX,KMAY
     6       /QUADRA/ AX,AY,BX,BY,CX,CY,DX,DY,SLPAB,SLPBD,SLPDC,SLPCA,
     7                KAB,KBD,KDC,KCA
C
C     LOOP FOR EACH LAYER BETWEEN 2 CLOUD LEVELS
      DO 500 IK = 2, NLVL
      LA = IK - 1   $   LB = IK
C
C     LOOP FOR EACH AREA BOUNDED BY COORDINATES OF 2 PAIRS OF ADJACENT
C       RADIAL POINTS OF 2 ADJACENT HOTLINES
      NA = NPAR - 1
      DO 550 IA = 1, NA
      XA = XRAY(IA,LA)    $   XB = XRAY(IA+1,LA)
      YA = YRAY(IA,LA)    $   YB = YRAY(IA+1,LA)
      DA = DRAY(IA,LA)    $   DB = DRAY(IA+1,LA)
      XC = XRAY(IA,LB)    $   XD = XRAY(IA+1,LB)
      YC = YRAY(IA,LB)    $   YD = YRAY(IA+1,LB)
      DC = DRAY(IA,LB)    $   DD = DRAY(IA+1,LB)
      DSMAX = AMAX1(DA,DB,DC,DD)    $    IF (DSMAX .LT. 1.0) GO TO 360
C
C     IDENTIFY LEFTMOST POINT
      ICASE = 1    $    PXMIN = XA
      IF (XB .GE. PXMIN) GO TO 10    $    ICASE = 2    $    PXMIN = XB
   10 IF (XC .GE. PXMIN) GO TO 20    $    ICASE = 3    $    PXMIN = XC
   20 IF (XD .GE. PXMIN) GO TO 30    $    ICASE = 4    $    PXMIN = XD
C
C     DETERMINE IF QUADRANGLE IS WITHIN MAP AREA
   30 PXMAX = AMAX1(XA,XB,XC,XD)    $    PYMAX = AMAX1(YA,YB,YC,YD)
      PYMIN = AMIN1(YA,YB,YC,YD)
      IF (PXMAX .LT. TXMIN) GO TO 550
      IF (PXMIN .GT. TXMAX) GO TO 550
      IF (PYMAX .LT.  YMIN) GO TO 550
      IF (PYMIN .GT.  YMAX) GO TO 550
      GO TO (40, 50, 60, 70), ICASE
   40 CALL QUAD (XA,YA,XB,YB,XC,YC,XD,YD)    $    GO TO 130
   50 CALL QUAD (XB,YB,XA,YA,XD,YD,XC,YC)    $    GO TO 130
   60 CALL QUAD (XC,YC,XA,YA,XD,YD,XB,YB)    $    GO TO 130
   70 CALL QUAD (XD,YD,XB,YB,XC,YC,XA,YA)
C
C     ESTABLISH GRID COORDINATE LIMITS WITHIN QUADRANGLE
  130 KX1 = (PXMIN-TXMIN)/DELX + 1.0
      KX2 = (PXMAX-TXMIN) / DELX + 1.0
      KY1 = (YMAX-PYMAX)/DELY + 1.0
      KY2 = (YMAX-PYMIN) / DELY + 1.0
```

Table A-9 (Continued)

```
 SUBROUTINE  INTERP    TRACE                      CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  16.50.51.
                   IF (FLOAT(KX1)*DELX .LT. PXMIN-TXMIN+DELX) KX1 = KX1 + 1
                   IF (FLOAT(KY1)*DELY .LT. YMAX-PYMAX+DELY) KY1 = KY1 + 1
                   IF (KX1 .LT. 1) KX1 = 1
                   IF (KX2 .GT. KMAX) KX2 = KMAX
                   IF (KY1 .LT. 1) KY1 = 1
                   IF (KY2 .GT. KMAY) KY2 = KMAY
                   IF (KX1 .GT. KX2) GO TO 550
                   IF (KY1 .GT. KY2) GO TO 550
                   DEX = XC - XA   $   DEY = YC - YA
                   DFX = XD - XB   $   DFY = YD - YB
                   K12 = 0   $   K13 = 0   $   K24 = 0   $   K34 = 0
                   IF (XA .EQ. XB) GO TO 142
                   SLP12 = (YB-YA) / (XB-XA)   $   K12 = 1
               142 IF (XA .EQ. XC) GO TO 144
                   SLP13 = (YC-YA) / (XC-XA)   $   K13 = 1
               144 IF (XB .EQ. XD) GO TO 146
                   SLP24 = (YD-YB) / (XD-XB)   $   K24 = 1
               146 IF (XC .EQ. XD) GO TO 148
                   SLP34 = (YD-YC) / (XD-XC)   $   K34 = 1
               148 CONTINUE
             C
             C     PERFORM MAPPING BY X COLUMN
                   DO 550 IX = KX1, KX2
             C
             C     SELECT X VALUES (XPT) AND DETERMINE RANGE OF Y VALUES
                   XPT = XAXIS(IX)
                   IF (KAB .NE. 0) GO TO 200
             C
             C     AB IS PARALLEL TO Y AXIS
                   IF (DX - XPT) 160, 152, 150
               150 Y2 = BY + SLPBD*(XPT-BX)   $   GO TO 170
               152 Y2 = DY   $   GO TO 170
               160 Y2 = DY + SLPDC*(XPT-DX)
               170 IF (CX - XPT) 190, 182, 180
               180 Y1 = CY + SLPCA*(XPT-CX)   $   GO TO 320
               182 Y1 = CY   $   GO TO 320
               190 Y1 = DY + SLPDC*(XPT-DX)   $   GO TO 320
               200 IF (KCA .NE. 0) GO TO 260
             C
             C     AC IS PARALLEL TO Y AXIS
                   IF (DX - XPT) 220, 212, 210
               210 Y2 = AY + SLPAB*(XPT-AX)   $   GO TO 230
               212 Y2 = BY   $   GO TO 230
               220 Y2 = BY + SLPBD*(XPT-BX)
               230 IF (DX - XPT) 250, 242, 240
               240 Y1 = DY + SLPDC*(XPT-DX)   $   GO TO 320
               242 Y1 = DY   $   GO TO 320
               250 Y1 = BY + SLPBD*(XPT-BX)   $   GO TO 320
             C
             C     NEITHER AB NOR AC IS PARALLEL TO YAXIS
               260 IF (BX - XPT) 280, 272, 270
               270 Y2 = AY + SLPAB*(XPT-AX)  $   GO TO 290
               272 Y2 = BY   $   GO TO 290
               280 IF (DX - XPT) 281, 282, 285
               281 Y2 = DY + SLPDC*(XPT-DX)   $   GO TO 290
               282 Y2 = DY   $   GO TO 290
               285 Y2 = BY + SLPBD*(XPT-BX)
               290 IF (CX - XPT) 310, 302, 300
               300 Y1 = CY + SLPCA*(XPT-CX)   $   GO TO 320
               302 Y1 = CY   $   GO TO 320
               310 IF (DX - XPT) 311, 312, 315
               311 Y1 = DY + SLPBD*(XPT-DX)   $   GO TO 320
               312 Y1 = DY   $   GO TO 320
               315 Y1 = DY + SLPDC*(XPT-DX)
               320 CONTINUE
             C
             C     PERFORM MAPPING FOR Y POINTS ALONG THE CURRENT X COLUMN
                   DO 530 IY = KY1, KY2
                   YPT = YAXIS(IY)
```

Table A-9 (Concluded)

```
SUBROUTINE  INTERP    TRACE                     CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  16.50.51.

C
C     IF X,Y POINT IS OUTSIDE QUADRANGLE, PROCEED TO NEXT POINT
      IF (YPT .GT. Y2 .OR. YPT .LT. Y1) GO TO 530
C
      IF (XB .EQ. XA) GO TO 340
      IF (YPT .EQ. YA+SLP12*(XPT-XA)) GO TO 530
      GO TO 350
  340 IF (XPT .EQ. XA) GO TO 530
  350 IF (I4 .EQ. 1) GO TO 440
      IF (XA .EQ. XC) GO TO 360
      IF (YPT .EQ. YA+SLP13*(XPT-XA)) GO TO 530
      GO TO 440
  360 IF (XPT .EQ. XA) GO TO 530
C
C     DETERMINE INTERCEPTS OF LINE (XA,YA) TO (XC,YC) AND (XB,YB) TO
C       (XD,YD) WITH LINE THROUGH POINT (XPT,YPT)
  440 TEX = XA + DEX*.5   $   TEY = YA + DEY*.5
      TFX = XB + DFX*.5   $   TFY = YB + DFY*.5   $   RFAC = 0.5
      DO 490 IB = 1, 20
      RFAC = .5 * RFAC
      IF (TEX .NE. TFX) GO TO 450
      IF (ABS(XPT-TEX) .LT. 10.) GO TO 500
      IF (XPT .GT. TEX) GO TO 470
      GO TO 475
  450 SLOPE = (TFY-TEY) / (TFX-TEX)
      YTER = TEY + SLOPE*(XPT-TEX)
      IF (ABS(YTER-YPT) .LT. 10.) GO TO 500
      IF (SLOPE) 460, 475, 465
  460 IF (YTER-YPT) 470, 500, 475
  465 IF (YTER-YPT) 475, 500, 470
  470 FAC = SIGN(RFAC,DEX)   $   GO TO 480
  475 FAC = -SIGN(RFAC,DEX)
  480 TEX = TEX + FAC*DEX   $   TEY = TEY + FAC*DEY
      TFX = TFX + FAC*DFX   $   TFY = TFY + FAC*DFY
  490 CONTINUE
C
C     COMPUTE EXPOSURE RATES AT INTERCEPTS
  500 SXY = (XA-XC)**2 + (YA-YC)**2
      IF (SXY .GT. 100.) GO TO 505
      DRAT1 = .5 * (DA+DC)   $   GO TO 510
  505 DRAT1 = DA*(DC/DA)**(SQRT(((XA-TEX)**2 + (YA-TEY)**2) / SXY))
  510 SXY = (XB-XD)**2 + (YB-YD)**2
      IF (SXY .GT. 100.) GO TO 515
      DRAT2 = .5 * (DB+DD)   $   GO TO 516
  515 DRAT2 = DB*(DD/DB)**(SQRT(((XB-TFX)**2 + (YB-TFY)**2) / SXY))
  516 SXY = (TEX-TFX)**2 + (TEY-TFY)**2
      IF (SXY .GT. 100.) GO TO 518
      DRATE = .5 * (DRAT1+DRAT2)   $   GO TO 520
  518 DRATE = DRAT1*(DRAT2/DRAT1)**(SQRT(((TEX-XPT)**2 + (TEY-YPT)**2) /
     1                                    SXY))
  520 DR(IX,IY) = DR(IX,IY) + DRATE
  530 CONTINUE
C
C     CURRENT X COLUMN IS COMPLETED, PROCEED TO NEXT COLUMN
  540 CONTINUE
C
C     MAPPING IS COMPLETED FOR CURRENT QUADRANGLE, PROCEED TO NEXT SET
C       OF POINTS
  550 CONTINUE
C
C     MAPPING IS COMPLETED FOR CURRENT CLOUD LEVEL
  560 CONTINUE
C
C     MAPPING IS COMPLETED FOR ENTIRE CLOUD
      RETURN
      END
```

Table A-10

SUBROUTINE GRNDZ

```
 SUBROUTINE  GRNDZ      TRACE                         CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.

                   SUBROUTINE GRNDZ
              C
              C     SUBROUTINE TO SET UP MAPPING AROUND GROUND ZERO
              C
                    COMMON /QUADRB/ XA,YA,DA,RDA,DRA,XB,YB,DB,RDB,DRB,XC,YC,XD,YD,XE,
                   1                YE,XF,YF,KEG
                   2      /ARRAY/ DRAY(26,23),XRAY(26,23),YRAY(26,23),GDRAY(26,23),
                   3              FTRAY(26,23),RDRAY(26,23),DRATSA(26,23),
                   4              ILVL,DISMAX,DISMIN,KPAR,KA,KB,NPAR
                   5      /EDGRAY/ XLR(26,2),YLR(26,2),ILR(26,2)
              C
              C     LOCATE UPWIND POINTS FOR LEFT AND RIGHT SHOULDERS OF THE PATTERN
                    IX = ILR(1,1)          $  IY = ILR(1,2)
                    XA = XRAY(1,IX)        $  XB = XRAY(1,IY)
                    YA = YRAY(1,IX)        $  YB = YRAY(1,IY)
                    DA = DRAY(1,IX)        $  DB = DRAY(1,IY)
                    RDA = RDRAY(1,IX)      $  RDB = RDRAY(1,IY)
                    DRA = DRATSA(1,IX)     $  DRB = DRATSA(1,IY)
                    XE = XLR(1,1)          $  XF = XLR(1,2)
                    YE = YLR(1,1)          $  YF = YLR(1,2)
              C
              C     CHECK IF LINE (XA,YA) TO (XB,YB) IS PARALLEL TO X AXIS
                    IF (YA .NE. YB) GO TO 10
                    XC = XA  $  XD = XB  $  RF = 1.1
                    IF (XA-XB) 7, 5, 9
                  5 IF (YA - YRAY(2,IX)) 7, 6, 9
                  6 IF (XA - XRAY(2,IX)) 9, 9, 7
                  7 RF = -1.1
                  9 YC = YA + RDA*RF  $  YD = YB + RDB*RF   $   GO TO 60
              C
              C     CHECK IF LINE IS PARALLEL TO Y AXIS
                 10 IF (XA .NE. XB) GO TO 20
                    YC = YA  $  YD = YB  $  RF = 1.1
                    IF (YA .GT. YB) RF = -1.1
                    XC = XA + RDA*RF  $  XD = XB + RDB*RF   $   GO TO 60
              C
              C     LINE IS NOT PARALLEL TO EITHER AXIS
                 20 ASLP = (XA-XB) / (YB-YA)
                    TR = SQRT(1.0/(1.0+ASLP*ASLP))    $    RF = 1.1
                    IF (ASLP .LT. 0.) GO TO 30
                    IF (XB .GT. XA) RF = -1.1  $  GO TO 40
                 30 IF (XB .LT. XA) RF = -1.1
                 40 XC = XA + TR*RDA*RF      $  XD = XB + TR*RDB*RF
                    YC = YA + ASLP*(XC-XA)   $  YD = YB + ASLP*(XD-XB)
              C
              C     CALL SUBROUTINES SHLDR AND EGDOSE TO MAP SHOULDERS AND UPWIND AREA
                 60 CALL SHLDR   $   KEG = 5   $   CALL EGDOSE
                    RETURN
                    END
```

Table A-11

SUBROUTINE QUAD

```
SUBROUTINE  QUAD       TRACE                        CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.

                   SUBROUTINE QUAD (X1,Y1,X2,Y2,X3,Y3,X4,Y4)
              C
              C    SUBROUTINE TO DETERMINE THE ORIENTATION OF A QUADRANGLE
              C
                   COMMON /QUADRA/ AX,AY,BX,BY,CX,CY,DX,DY,SLPAB,SLPBD,SLPDC,SLPCA,
                  1                KAB,KBD,KDC,KCA
              C
                   KAB = 0  $  KBD = 0  $  KDC = 0  $  KCA = 0
                   KTA = 0  $  KTB = 0
                   AX = X1  $  AY = Y1  $  DX = X4  $  DY = Y4
                   IF (X1 .EQ. X2) GO TO 10
                   TEMA = (Y2-Y1) / (X2-X1)  $  KTA = 1
                10 IF (X1 .EQ. X3) GO TO 20
                   TEMB = (Y3-Y1) / (X3-X1)  $  KTB = 1
                20 IF (KTA .EQ. 0) GO TO 30
                   IF (KTB .EQ. 0) GO TO 50
                   IF (TEMA - TEMB) 70, 60, 60
                30 IF (KTB .EQ. 0) GO TO 40
                   IF (Y1-Y2) 60, 60, 70
                40 IF (Y2 - Y3) 70, 60, 60
                50 IF (Y1 - Y3) 70, 70, 60
                60 BX = X2  $  BY = Y2  $  CX = X3  $  CY = Y3
                   SLPAB = TEMA  $  KAB = KTA
                   SLPCA = TEMB  $  KCA = KTB
                   GO TO 80
                70 BX = X3  $  BY = Y3  $  CX = X2  $  CY = Y2
                   SLPAB = TEMB  $  KAB = KTB
                   SLPCA = TEMA  $  KCA = KTA
                80 IF (BX .EQ. DX) GO TO 90
                   SLPBD = (DY-BY) / (DX-BX)  $  KBD = 1
                90 IF (CX .EQ. DX) GO TO 100
                   SLPDC = (DY-CY) / (DX-CX)  $  KDC = 1
               100 RETURN
                   END
```

Table A-12

SUBROUTINE EGDOSE

```
SUBROUTINE  EGDOSE    TRACE                         CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.

                SUBROUTINE EGDOSE
      C
      C         SUBROUTINE TO COMPUTE EXPOSURE DOSE FOR THE PATTERN EDGES AND
      C           UPWIND SECTION
      C
                COMMON /QUADRA/ AX,AY,BX,BY,CX,CY,DX,DY,SLPAB,SLPBD,SLPDC,SLPCA,
               1                KAB,KBD,KDC,KCA
               2        /SCRTCH/DR(20,500),KMAX,KMAY
               3        /MAP/    XMIN,XMAX,YMIN,YMAX,DELX,DELY,LMAP,TXMIN,TXMAX,
               *                 YAXIS(500),XAXIS(20)
               5        /QUADRB/ XA,YA,DA,RDA,DRA,XB,YB,DB,RDB,DRB,XC,YC,XD,YD,XE,
               6                 YE,XF,YF,KEG
                        /CLDATA/ ACB,ACT,RMIN,RMAX,TSK,TRMAX,RATIO,TRA,RATA
      C
      C         IDENTIFY LEFTMOST POINT
                IF (DA .LT. 1.0 .AND. DB .LT. 1.0) GO TO 450
                SXY = SQRT((XB-XA)**2 + (YB-YA)**2)
                ICASE = 1    $    PXMIN = XA
                IF (XB .GE. PXMIN) GO TO 10
                ICASE = 2    $    PXMIN = XB
             10 IF (XC .GE. PXMIN) GO TO 20
                ICASE = 3    $    PXMIN = XC
             20 IF (XD .GE. PXMIN) GO TO 30
                ICASE = 4    $    PXMIN = XD
      C
      C         DETERMINE IF QUADRANGLE IS WITHIN MAP AREA
             30 PXMAX = AMAX1(XA,XB,XC,XD)    $    PYMAX = AMAX1(YA,YB,YC,YD)
                PYMIN = AMIN1(YA,YB,YC,YD)
                IF (PXMAX .LT. TXMIN) GO TO 450
                IF (PXMIN .GT. TXMAX) GO TO 450
                IF (PYMAX .LT.  YMIN) GO TO 450
                IF (PYMIN .GT.  YMAX) GO TO 450
                GO TO (40, 50, 60, 70), ICASE
             40 CALL QUAD (XA,YA,XB,YB,XC,YC,XD,YD)    $    GO TO 130
             50 CALL QUAD (XB,YB,XA,YA,XD,YD,XC,YC)    $    GO TO 130
             60 CALL QUAD (XC,YC,XA,YA,XD,YD,XB,YB)    $    GO TO 130
             70 CALL QUAD (XD,YD,XB,YB,XC,YC,XA,YA)
      C
      C         ESTABLISH GRID COORDINATE LIMITS WITHIN QUADRANGLE
            130 KX1 = (PXMIN-TXMIN)/DELX + 1.0
                KX2 = (PXMAX-TXMIN) / DELX + 1.0
                KY1 = (YMAX-PYMAX)/DELY + 1.0
                KY2 = (YMAX-PYMIN) / DELY + 1.0
                IF (FLOAT(KX1)*DELX .LT. PXMIN-TXMIN+DELX) KX1 = KX1 + 1
                IF (FLOAT(KY1)*DELY .LT. YMAX-PYMAX+DELY) KY1 = KY1 + 1
            140 IF (KX1 .LT. 1) KX1 = 1
                IF (KX2 .GT. KMAX) KX2 = KMAX
                IF (KY1 .LT. 1) KY1 = 1
                IF (KY2 .GT. KMAY) KY2 = KMAY
                IF (KX1 .GT. KX2) GO TO 450
                IF (KY1 .GT. KY2) GO TO 450
      C
      C         PERFORM MAPPING BY X COLUMN
                DO 440 IX = KX1, KX2
      C
```

Table A-12 (Continued)

```
  SUBROUTINE  EGOOSE    TRACE                     CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.

            C      SELECT X VALUES (XPT) AND DETERMINE RANGE OF Y VALUES
                   XPT = XAXIS(IX)
                   IF (KAB .NE. 0) GO TO 200
            C
            C      AB IS PARALLEL TO Y AXIS
                   IF (AX .EQ. BX .AND. AY .EQ. BY) GO TO 200
                   IF (DX - XPT) 160, 152, 150
               150 Y2 = BY + SLPBD*(XPT-BX)   $   GO TO 170
               152 Y2 = DY   $   GO TO 170
               160 Y2 = DY + SLPDC*(XPT-DX)
               170 IF (CX - XPT) 190, 182, 180
               180 Y1 = CY + SLPCA*(XPT-CX)   $   GO TO 320
               182 Y1 = CY   $   GO TO 320
               190 Y1 = DY + SLPDC*(XPT-DX)   $   GO TO 320
               200 IF (KCA .NE. 0) GO TO 260
            C
            C      AC IS PARALLEL TO Y AXIS
                   IF (BX - XPT) 220, 212, 210
               210 Y2 = AY + SLPAB*(XPT-AX)   $   GO TO 230
               212 Y2 = BY   $   GO TO 230
               220 Y2 = BY + SLPBD*(XPT-BX)
               230 IF (DX - XPT) 250, 242, 240
               240 Y1 = DY + SLPDC*(XPT-DX)   $   GO TO 320
               242 Y1 = DY   $   GO TO 320
               250 Y1 = BY + SLPBD*(XPT-BX)   $   GO TO 320
            C
            C      NEITHER AB NOR AC IS PARALLEL TO Y AXIS
               260 IF (BX - XPT) 280, 272, 270
               270 Y2 = AY + SLPAB*(XPT-AX)   $   GO TO 290
               272 Y2 = BY   $   GO TO 290
               280 IF (DX - XPT) 281, 282, 285
               281 Y2 = DY + SLPDC*(XPT-DX)   $   GO TO 290
               282 Y2 = DY   $   GO TO 290
               285 Y2 = BY + SLPBD*(XPT-BX)
               290 IF (CX - XPT) 310, 302, 300
               300 Y1 = CY + SLPCA*(XPT-CX)   $   GO TO 320
               302 Y1 = CY   $   GO TO 320
               310 IF (DX - XPT) 311, 312, 315
               311 Y1 = DY + SLPBD*(XPT-DX)   $   GO TO 320
               312 Y1 = DY   $   GO TO 320
               315 Y1 = DY + SLPDC*(XPT-DX)
               320 CONTINUE
            C
            C      PERFORM MAPPING FOR Y POINTS ALONG THE CURRENT X COLUMN
                   DO 430 IY = KY1, KY2
                   YPT = YAXIS(IY)
            C
            C      IF X,Y POINT IS OUTSIDE QUADRANGLE, PROCEED TO NEXT POINT
                   IF (YPT .GT. Y2 .OR. YPT .LT. Y1) GO TO 430
                   GO TO (338, 322, 326, 328, 332), KEG
               322 IF (XB .EQ. XD) GO TO 324
                   IF (YPT .EQ. YB+(YD-YB)*(XPT-XB)/(XD-XB)) GO TO 430
                   GO TO 338
               324 IF (XPT .EQ. XB) GO TO 430   $   GO TO 338
               326 IF (XA .EQ. XB) GO TO 324
```

Table A-12 (Concluded)

```
SUBROUTINE  CGOOSE    TRACE                    CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.
          IF (YPT .EQ. YA+(YB-YA)*(XPT-XA)/(XB-XA)) GO TO 430
          GO TO 338
      328 IF (XA .EQ. XC) GO TO 330
          IF (YPT .EQ. YA+(YC-YA)*(XPT-XA)/(XC-XA)) GO TO 430
          GO TO 326
      330 IF (XPT .EQ. XA) GO TO 430    $    GO TO 326
C
C         DOING UPWIND SECTION
      332 CONTINUE
          IF (XPT .EQ. XA .AND. YPT .EQ. YA) GO TO 430
          IF (XPT .EQ. XB .AND. YPT .EQ. YB) GO TO 430
          IF (XA .NE. XB .OR. YA .NE. YB) GO TO 338
          IF (XA .EQ. XC) GO TO 334
          IF (YPT .NE. YA+(YC-YA)*(XPT-XA)/(XC-XA)) GO TO 430
      334 XT = XA    $    YT = YA    $    GO TO 400
C
C         CHECK IF LINE IS PARALLEL TO Y AXIS
      338 IF (XA .NE. XB) GO TO 350
          XT = XA    $    YT = YPT
          IF (YA .LT. YB) GO TO 340    $    IF (YT .GE. YA) GO TO 400
          IF (YT .LE. YB) GO TO 390    $    GO TO 410
      340 IF (YT .GE. YB) GO TO 390    $    IF (YT .LE. YA) GO TO 400
          GO TO 410
C
C         CHECK IF LINE IS PARALLEL TO X AXIS
      350 IF (YA .NE. YB) GO TO 360
          XT = XPT    $    YT = YA    $    GO TO 370
      360 SLP = (YB - YA) / (XB - XA)
          XT = (SLP*(YPT-YA+SLP*XA) + XPT) / (SLP*SLP+1.0)
          YT = YA + SLP*(XT-XA)
      370 IF (XA .LT. XB)  GO TO 380    $    IF (XT .GE. XA) GO TO 400
          IF (XT .LE. XB) GO TO 390    $    GO TO 410
      380 IF (XT .GE. XB) GO TO 390    $    IF (XT .LE. XA) GO TO 400
          GO TO 410
      390 DXYT = DB    $    RADT = ROB    $    DRATIO = DRB
          GO TO 420
      400 DXYT = DA    $    RADT = ROA    $    DRATIO = DRA
          GO TO 420
      410 SXT = SQRT((XT-XA)**2 + (YT-YA)**2) / SXY
          DXYT = DA*(DB/DA)**SXT
          DRATIO = DRA + SXT*(DRB-DRA)
          RADT = ROA + SXT*(ROB-ROA)
      420 RADS = (XT-XPT)**2 + (YT-YPT)**2
          TEMB = 0.    $    IF (RADS .GT. RMIN*RMIN) GO TO 425
          ROOT = SQRT(RADS)
          TEMB = .25 * ((RMIN-ROOT)/RMIN)**(DRATIO/6.0)
      425 DR(IX,IY) = DR(IX,IY) + DXYT*(.75*EXP(-.54831*RADS*
         1                (DRATIO/RADT)**2) + TEMB)
      430 CONTINUE
      440 CONTINUE
      450 RETURN
          END
```

Table A-13

SUBROUTINE SHLDR

```
SUBROUTINE  SHLDR     TRACE                    CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.
            SUBROUTINE SHLDR
      C
      C     SUBROUTINE TO COMPUTE EXPOSURE DOSE FOR THE LEFT AND RIGHT
      C       SHOULDERS OF THE FALLOUT PATTERN
      C
            COMMON /QUADRB/ XA,YA,DA,RDA,DRA,XB,YB,DB,RDB,DRB,XC,YC,XD,YD,XE,
           1                YE,XF,YF,KEG
           2       /SCRTCH/DR(40,500),KMAX,KMAY
           3       /MAP/   XMIN,XMAX,YMIN,YMAX,DELX,DELY,LMAP,TXMIN,TXMAX,
           4               YAXIS(500),XAXIS(20)
           5       /QUADRA/ AX,AY,BX,BY,CX,CY,DX,DY,SLPAB,SLPBD,SLPDC,SLPCA,
           6                KAB,KBD,KDC,KCA
           7       /CLDATA/ ACB,ACT,RMIN,RMAX,TSR,TRMAX,RATIO,TRA,RATA
      C
      C     SET UP TO MAP THE LEFT SHOULDER OF THE FALLOUT PATTERN
            XL = XA    $    XM = XE     $    XN = XC    $   KASE = 1
            YL = YA    $    YM = YE     $    YN = YC
            DD = DA    $    DI = DRA    $    RD = RDA
      C
      C     LOCATE FOURTH POINT OF SHOULDER
         20 RF = 1.2    $    IF (YM .EQ. YN) GO TO 25
            SL = (XN-XM) / (YM-YN)
            IF (XM+XN .LT. 2.*XL) RF = -1.2
            XK = XL + RF*RD*SQRT(1.0/(1.0+SL*SL))
            YK = YL + SL*(XK-XL)    $    GO TO 28
         25 IF (YM .LT. YL) RF = -1.2    $    XK = XL    $    YK = YL + RF*RD
      C
      C     DETERMINE ORIENTATION OF SHOULDER
         28 ICASE = 1   $  PXMIN = XL
            IF (XM .GE. PXMIN) GO TO 30    $    ICASE = 2    $    PXMIN = XM
         30 IF (XN .GE. PXMIN) GO TO 35    $    ICASE = 3    $    PXMIN = XN
         35 IF (XK .GE. PXMIN) GO TO 40    $    ICASE = 4    $    PXMIN = XK
      C
      C     DETERMINE IF SHOULDER IS WITHIN MAP AREA
         40 PXMAX = AMAX1 (XL,XM,XN,XK)    $    PYMAX = AMAX1 (YL,YM,YN,YK)
            PYMIN = AMIN1 (YL,YM,YN,YK)
            IF (PXMAX .LT. TXMIN) GO TO 150
            IF (PXMIN .GT. TXMAX) GO TO 150
            IF (PYMAX .LT. YMIN)  GO TO 150
            IF (PYMIN .GT. YMAX)  GO TO 150
      C
      C     DETERMINE GRID SUBSCRIPTS FOR SHOULDER AREA
            KX1 = (PXMIN-TXMIN) / DELX + 1.0
            KX2 = (PXMAX-TXMIN) / DELX + 1.0
            KY1 = (YMAX - PYMAX)/ DELY + 1.0
            KY2 = (YMAX-PYMIN)  / DELY + 1.0
            IF (FLOAT(KX1)*DELX .LT. PXMIN-TXMIN+DELX) KX1 = KX1 + 1
            IF (FLOAT(KY1)*DELY .LT. YMAX -PYMAX+DELY) KY1 = KY1 + 1
            IF (KX1 .LT. 1) KX1 = 1         $   IF (KX2 .GT. KMAX) KX2 = KMAX
            IF (KY1 .LT. 1) KY1 = 1         $   IF (KY2 .GT. KMAY) KY2 = KMAY
            IF (KX1 .GT. KX2) GO TO 150     $   IF (KY1 .GT. KY2) GO TO 150
      C
      C     RENAME VERTICES BY ORIENTATION OF SHOULDER
            GO TO (50, 60, 70, 75), ICASE
         50 CALL QUAD (XL,YL,XM,YM,XN,YN,XK,YK)    $    GO TO 80
```

Table A-13 (Concluded)

```
SUBROUTINE  SHLDR      TRACE                        CDC 6600 FTN V3.0-P261 OPT=0  05/09/72  15.13.21.
             60 CALL QUAD (XM,YM,XL,YL,XK,YK,XN,YN)   $   GO TO 80
             70 CALL QUAD (XN,YN,XL,YL,XK,YK,XM,YM)   $   GO TO 80
             75 CALL QUAD (XK,YK,XM,YM,XN,YN,XL,YL)
          C
          C     PERFORM MAPPING BY X COLUMNS
             80 IF (XL .EQ. XM) GO TO 81   $   SLPLM = (YL-YM) / (XL-XM)
             81 IF (XL .EQ. XN) GO TO 82   $   SLPLN = (YL-YN) / (XL-XN)
             82 DO 140 IX = KX1, KX2
                XPT = XAXIS(IX)
          C
          C     DETERMINE RANGE OF Y VALUES
                IF (AX .EQ. BX) GO TO 85
                IF (XPT .LT. BX) GO TO 95
             85 IF (XPT .LE. DX) GO TO 90
                Y2 = DY + SLPDC*(XPT-DX)   $   GO TO 100
             90 Y2 = BY + SLPBD*(XPT-BX)   $   GO TO 100
             95 Y2 = AY + SLPAB*(XPT-AX)
            100 IF (AX .EQ. CX) GO TO 105
                IF (XPT .LT. CX) GO TO 115
            105 IF (XPT .LE. DX) GO TO 110
                Y1 = DY + SLPBD*(XPT-DX)   $   GO TO 120
            110 Y1 = CY + SLPDC*(XPT-CX)   $   GO TO 120
            115 Y1 = AY + SLPCA*(XPT-AX)
          C
          C     PERFORM MAPPING FOR Y POINTS ALONG THE CURRENT X COLUMN
            120 CONTINUE
                DO 130 IY = KY1, KY2
                YPT = YAXIS(IY)
                IF (YPT .GT. Y2 .OR. YPT .LT. Y1) GO TO 130
                IF (XL .EQ. XM) GO TO 122
                IF (YPT .EQ. YL+SLPLM*(XPT-XL)) GO TO 130   $   GO TO 124
            122 IF (XPT .EQ. XL) GO TO 130
            124 IF (XL .EQ. XN) GO TO 126
                IF (YPT .EQ. YL+SLPLN*(XPT-XL)) GO TO 130   $   GO TO 128
            126 IF (XPT .EQ. XL) GO TO 130
            128 RADS = (XL-XPT)**2 + (YL-YPT)**2
                TEMB = 0.   $   IF (RADS .GT. RMIN*RMIN) GO TO 129
                ROOT = SQRT(RADS)
                TEMB = .25 * ((RMIN-ROOT)/RMIN)**(DI/5.0)
            129 DR(IX,IY) = DR(IX,IY)+DD*(.75*EXP(-.54831*RADS*(DI/RD)**2) + TEMB)
            130 CONTINUE
            140 CONTINUE
          C
          C     RETURN TO MAP THE RIGHT SHOULDER OF THE FALLOUT PATTERN
            150 IF (KASE .EQ. 2) GO TO 160
                XL = XB   $   XM = XF   $   XN = XD   $   KASE = 2
                YL = YB   $   YM = YF   $   YN = YD
                DD = DB   $   DI = DRB  $   RD = RDB   $   GO TO 20
            160 RETURN
                END
```

Appendix B

SEER II EMPIRICAL EQUATIONS

The following equations are derived from DELFIC numerical printouts, with total yield W in KT. The cloud formation or stabilization time in seconds:

$$t_s = 20.0\left(16.0 - W^{0.27} + 6.0\log_{10} W\right) \quad . \tag{B.1}$$

The cloud top altitude in meters at t_s:

$$A_t = 3500\ W^{0.271} - (11.0-W)^{2.87} \qquad 1.0 \le W \le 10 \tag{B.2}$$

$$A_t = 4000\ W^{0.2362} - (103-W)^{1.3} \qquad 10 < W \le 100 \tag{B.3}$$

$$A_t = 4200\ W^{0.225} \qquad 100 < W \le 1000 \tag{B.4}$$

$$A_t = 5800\ W^{0.1759} \qquad 1000 < W \le 10{,}000 \tag{B.5}$$

$$A_t = 3100\ W^{0.2439} \qquad 10{,}000 < W \quad . \tag{B.6}$$

The cloud base altitude in meters at t_s:

$$A_b = 1700\ W^{0.2634} - 333\ W^{-0.5} \qquad 1.0 \le W \le 1000 \tag{B.7}$$

$$A_b = 1350\ W^{0.2961} \qquad 1000 < W \le 2000 \tag{B.8}$$

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(B.9) $A_b = 1880\ W^{0.2525}$ $2000 < W \le 10,000$

(B.10) $A_b = 1330\ W^{0.2901}$ $10,000 < W$

The cloud radius in meters at t_s:

(B.11) $r_{min} = r_s$ $1.0 \le W \le 10$

(B.12) $r_{min} = (1.0086 - 0.00096W)r_s$ $10 < W \le 100$

(B.13) $r_{min} = (0.9 + 0.00156(\log_{10}W)^3)r_s$ $100 < W \le 10,000$

(B.14) and

$r_{min} = r_s$ $10,000 < W$

where

(B.15) $r_s = 350W^{0.544} + (350-100(\log_{10}W)^{2.4})(1.0 + \log_{10}W)$.

Curves drawn from the above empirical equations are compared with DELFIC printout values in Figures B.1, B.2, and B.3 respectively.

The following equations are derived from Delfic printouts of fallout patterns. From the referenced minimum radii at t_s, the cloud expands radially, first at one rate and then at another rate, until the cloud radial expansion termination time is reached.

The cloud radial expansion termination time in seconds:

(B.16) $t_{rmax} = (1.44444 - 0.0444W)t_{rt}$ $1.0 \le W < 10$

(B.17) $t_{rmax} = t_{rt}$ $10 \le W \le 100$

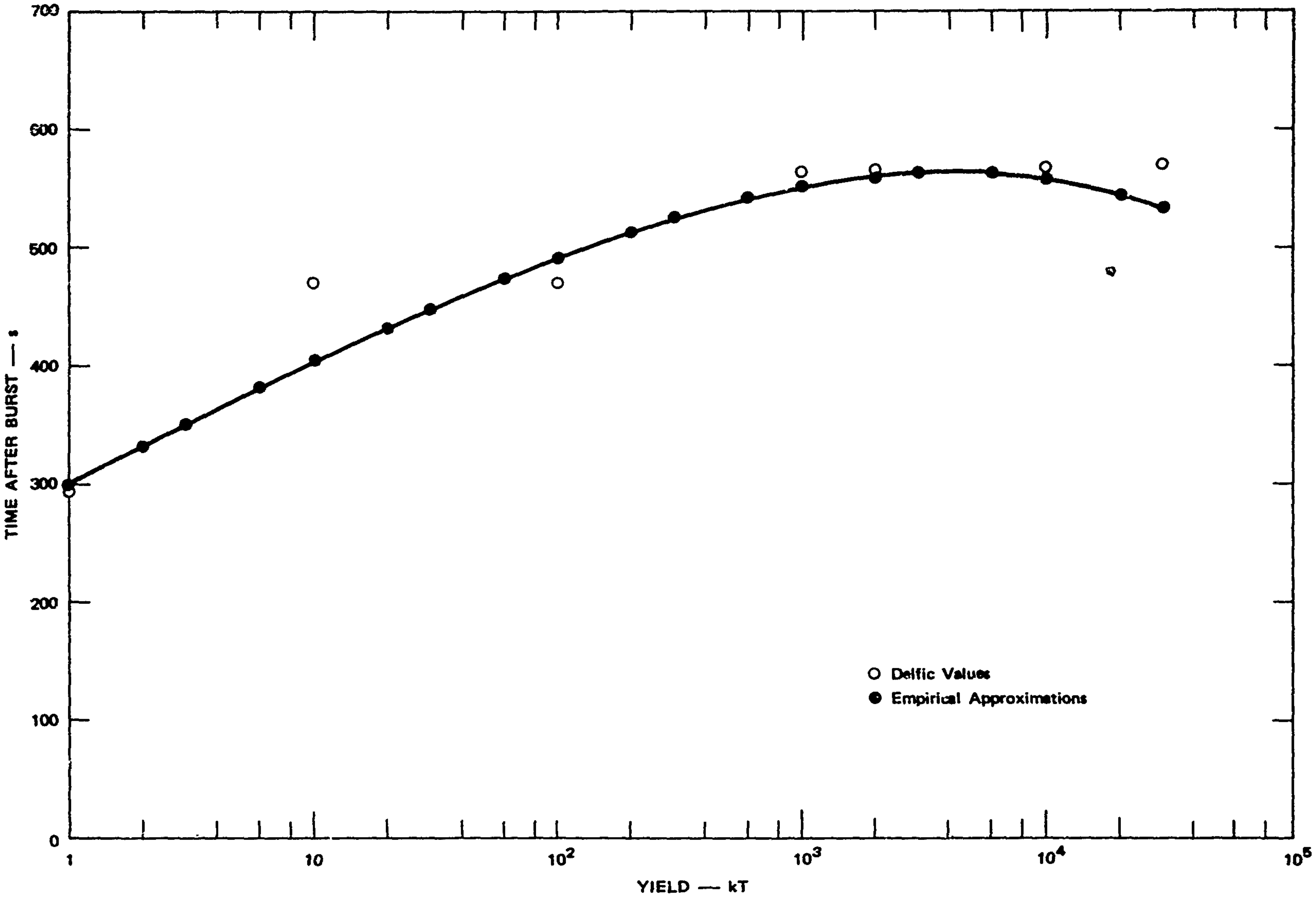


FIGURE B-1 CLOUD STABILIZATION TIME (t_s)

where

$$t_r = (t_{rmax} - t_s + 1000) / 3.3 \qquad \text{(B.28)}$$

and t_d is the time of deposition.

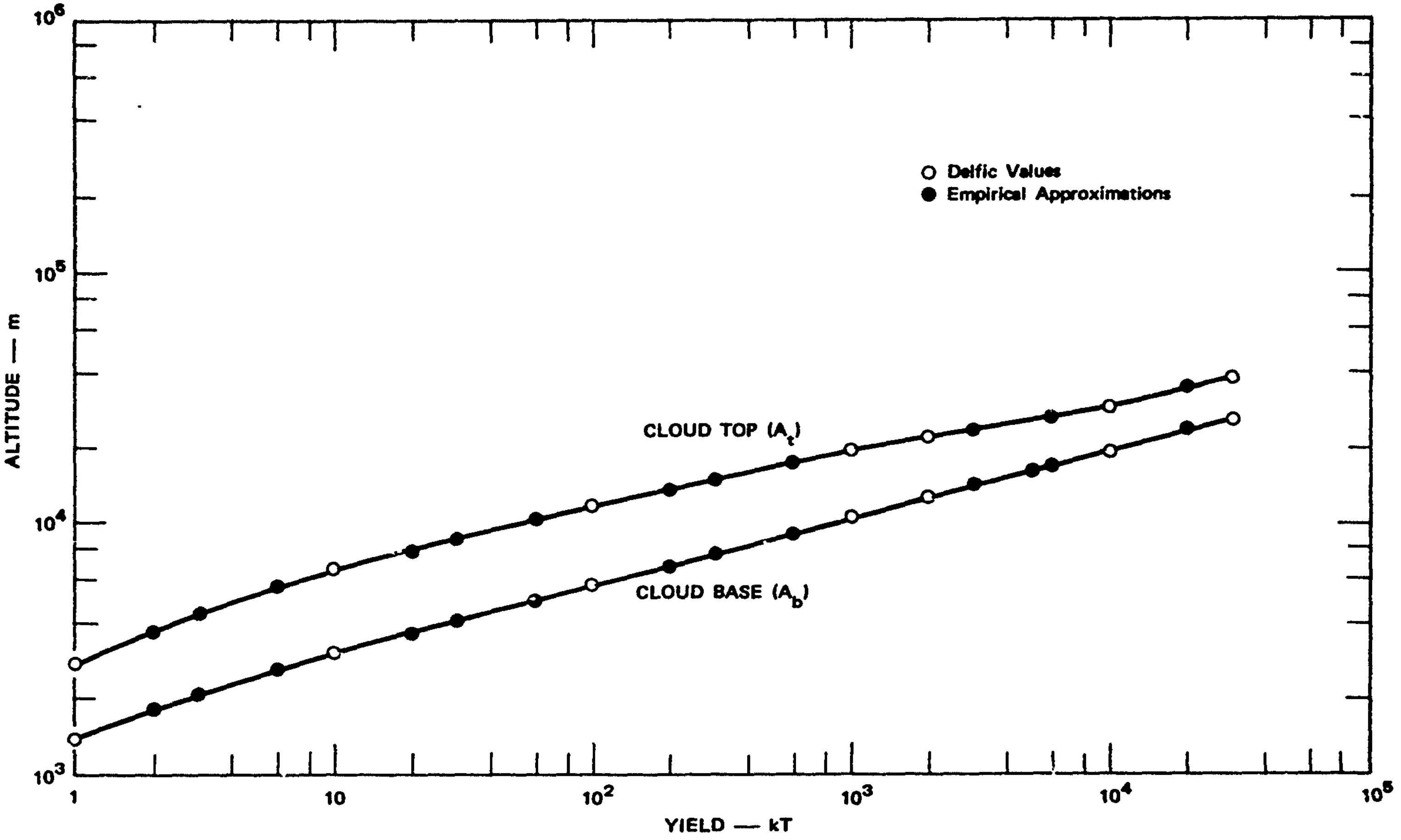


FIGURE B-2 STABILIZED CLOUD ALTITUDES (A_b AND A_t)

(B.18) $t_{rmax} = (1.666 - 0.333 \log_{10} W) t_{rt}$ $100 < W \leq 1000$

(B.19) $t_{rmax} = (0.418 + 0.83 \log_{10} W) t_{rt}$ $1000 < W \leq 10{,}000$

(B.20) $t_{rmax} = 0.75\ t_{rt}$ $10{,}000 < W$

where

(B.21) $t_{rt} = 2000\ W^{0.554}$.

The cloud radius in meters at t_{rmax}:

(B.22) $r_{max} = (0.6587 + 0.1745 \log_{10} W) r_t$ $1.0 \leq W \leq 10$

(B.23) $r_{max} = (0.81235 + 0.02085 (\log_{10} W)^2) r_t$ $10 < W \leq 1000$

(B.24) $r_{max} = r_t$ $1000 < W$

where

(B.25) $r_t = 2200\ W^{0.301} + W^{1.18}$.

The cloud radius in meters at deposition:

(B.26) $r_d = r_{min} + (t_d - t_s)(0.1\ r_{min}) / (t_r - t_s)$ $t_s \leq t_d \leq t_r$

(B.27) and $r_d = r_{min} + (t_d - t_s)(r_{max} - 1.1 r_{min}) / (t_{rmax} - t_s)$

$t_r < t_d < t_{rmax}$

$r_d = r_{max}$ $t_{rmax} \leq t_d$

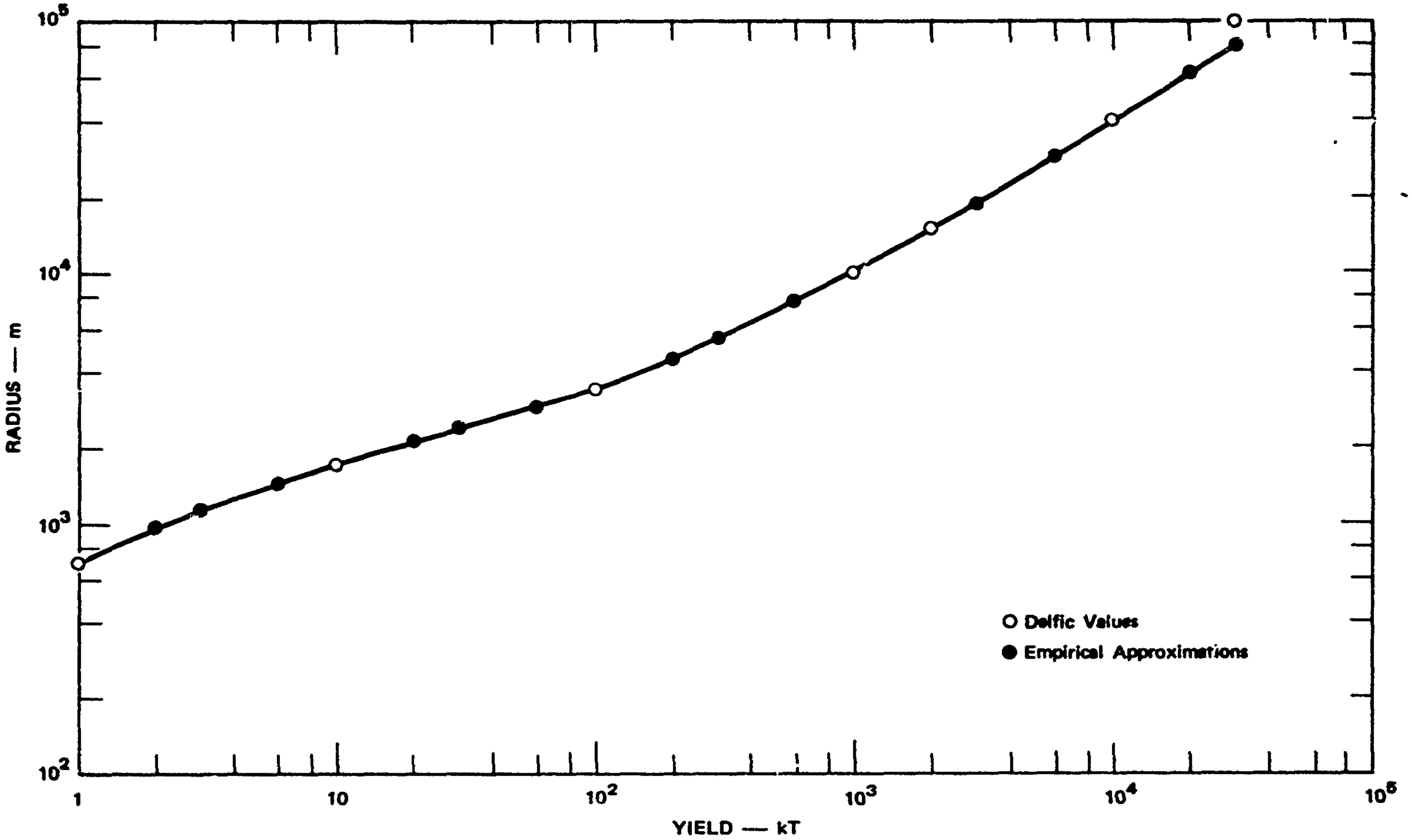
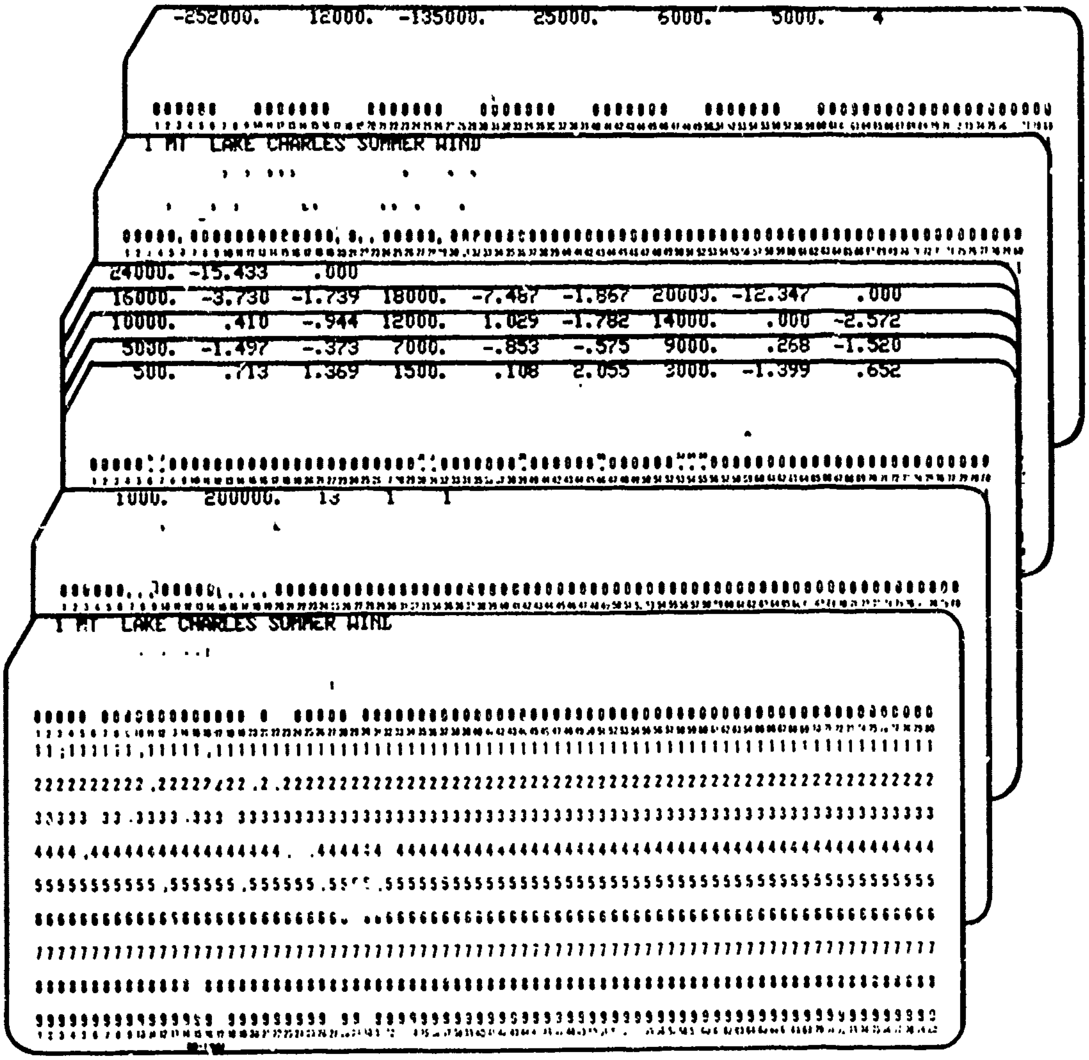


FIGURE B-3 STABILIZED CLOUD RADIUS (r_{min})

Appendix C

SEER II SAMPLE INPUT AND OUTPUT

An example of an input data deck for a SEER II run is shown in Figure C-1. The data specifies a 1 MT weapon burst with the summer wind at Lake Charles, Louisiana. A hodograph of this wind is presented in Figure 2 in the main text. The descriptions of the input data are discussed under "Users Instructions" in Section II-C-4. The computer output for this example is presented in Table C-1.



```
-252000.    12000.  -135000.    25000.     6000.     5000.    4
I MT  LAKE CHARLES SUMMER WIND
24000. -15.433    .000
16000.  -3.730  -1.739  18000.  -7.487  -1.867  20000. -12.347    .000
10000.    .410   -.944  12000.   1.029  -1.782  14000.    .000  -2.572
 5000.  -1.497   -.373   7000.   -.853   -.575   9000.    .268  -1.520
  500.    .713   1.369   1500.    .108   2.055   3000.  -1.399    .652
1000.   200000.   13    1    1
I MT  LAKE CHARLES SUMMER WIND
```

FIGURE C-1 EXAMPLE INPUT DATA DECK FOR A SEER II COMPUTER RUN

Table C-1

SEER II OUTPUT FOR EXAMPLE PROBLEM

```
                           * * * * * * * * * * *
                SIMPLIFIED ESTIMATION OF EXPOSURE TO RADIATION (SEER) MODEL
                           * * * * * * * * * * *


RUN IDENTIFICATION--  1 MT CHARLESTON SUMMER WIND
                     WEAPON YIELD                         1000.0 KILOTONS

                     TRANSPORT TIME LIMIT               200000.0 SECONDS

                     CLOUD BASE                          10476.4 METERS

                     CLOUD TOP                           19872.4 METERS

                     MINIMUM CLOUD RADIUS                10186.7 METERS

                     MAXIMUM CLOUD RADIUS                21063.7 METERS

                     CLOUD FORMATION TIME                  550.9 SECONDS

                     RADIAL EXPANSION TERMINATION TIME   61257.0 SECONDS

                  * * * * * WIND HODOGRAPH AT GROUND ZERO * * * * *

                      ALTITUDE         X COMPONENT      Y COMPONENT
                      (METERS)           (M/SEC)          (M/SEC)

                        500.00              .71             1.37
                       1500.00              .11             2.06
                       3000.00            -1.40              .65
                       5000.00            -1.50             -.37
                       7000.00             -.85             -.57
                       9000.00              .27            -1.52
                      10000.00              .41             -.94
                      12000.00             1.03            -1.78
                      14000.00             0.00            -2.57
                      16000.00            -3.73            -1.74
                      18000.00            -7.49            -1.87
                      20000.00           -12.35             0.00
                      24000.00           -15.43             0.00
```

Table C-1

SEER II OUTPUT FOR EXAMPLE PROBLEM (Continued)

IA	I	EXPOSURE RATE	X METERS	Y METERS	GROUND DIST	FALL TIME	RADIUS	DOSE RATIO
1	1	2.4643E+05	-2.3730E+02	-2.8901E+00	2.3731E+02	4.5508E+02	1.0212E+04	5.1164E+00
1	2	1.6465E+05	-5.9686E+02	-7.2695E+00	5.9691E+02	1.1446E+03	1.0251E+04	4.3442E+00
1	3	1.4930E+05	-7.3084E+02	-8.9012E+00	7.3089E+02	1.4016E+03	1.0263E+04	4.0286E+00
1	4	1.3467E+05	-9.1473E+02	-1.1141E+01	9.1479E+02	1.7542E+03	1.0285E+04	3.8835E+00
1	5	1.1867E+05	-1.1671E+03	-1.4215E+01	1.1672E+03	2.2303E+03	1.0312E+04	3.6316E+00
1	6	9.0230E+04	-1.5136E+03	-1.8435E+01	1.5137E+03	2.9027E+03	1.0350E+04	3.3407E+00
1	7	7.3919E+04	-1.9891E+03	-2.4227E+01	1.9893E+03	3.8147E+03	1.0401E+04	3.0980E+00
1	8	5.4829E+04	-2.6419E+03	-3.2176E+01	2.6421E+03	5.0065E+03	1.0471E+04	2.8236E+00
1	9	3.8282E+04	-3.5378E+03	-4.3090E+01	3.5381E+03	6.7847E+03	1.0568E+04	2.5635E+00
1	10	2.5260E+04	-4.7676E+03	-5.8066E+01	4.7679E+03	9.1431E+03	1.0700E+04	2.3204E+00
1	11	1.5151E+04	-6.4555E+03	-7.8625E+01	6.4560E+03	1.2380E+04	1.0882E+04	2.0953E+00
1	12	8.0357E+03	-8.7724E+03	-1.0684E+02	8.7731E+03	1.6823E+04	1.2088E+04	1.9428E+00
1	13	3.7432E+03	-1.1953E+04	-1.4558E+02	1.1953E+04	2.2922E+04	1.3909E+04	1.8470E+00
1	14	1.6884E+03	-1.6318E+04	-1.9874E+02	1.6319E+04	3.1294E+04	1.5269E+04	1.7598E+00
1	15	7.0770E+02	-2.2309E+04	-2.7171E+02	2.2311E+04	4.2784E+04	1.7135E+04	1.6811E+00
1	16	2.6781E+02	-3.0533E+04	-3.7188E+02	3.0535E+04	5.8555E+04	1.9259E+04	1.6083E+00
1	17	1.3324E+02	-4.1821E+04	-5.0936E+02	4.1824E+04	8.0203E+04	2.0789E+04	1.5427E+00
1	18	7.3011E+01	-5.7315E+04	-6.9807E+02	5.7319E+04	1.0992E+05	2.1064E+04	1.5170E+00
1	19	2.6533E+01	-7.8582E+04	-9.5709E+02	7.8588E+04	1.5070E+05	2.1064E+04	1.5000E+00
1	20	7.4584E-01	-1.0777E+05	-1.3126E+03	1.0778E+05	2.0660E+05	2.1064E+04	1.5000E+00
1	21	3.7286E-01	-1.4784E+05	-1.8006E+03	1.4785E+05	2.7866E+05	2.1064E+04	1.5000E+00
1	22	1.8643E-01	-2.0284E+05	-2.4704E+03	2.0285E+05	2.7866E+05	2.1064E+04	1.5000E+00
1	23	9.3215E-02	-2.7833E+05	-3.3898E+03	2.7835E+05	2.7866E+05	2.1064E+04	1.5000E+00
1	24	4.6607E-02	-3.8194E+05	-4.6518E+03	3.8197E+05	2.7866E+05	2.1064E+04	1.5000E+00
1	25	2.3304E-02	-5.2410E+05	-6.3840E+03	5.2420E+05	2.7866E+05	2.1064E+04	1.5000E+00
1	26	1.1652E-02	-7.1937E+05	-8.7616E+03	7.1943E+05	2.7866E+05	2.1064E+04	1.5000E+00

IA	I	EXPOSURE RATE	X METERS	Y METERS	GROUND DIST	FALL TIME	RADIUS	DOSE RATIO
2	1	2.4781E+05	-2.2259E+02	-8.2294E+01	2.3731E+02	5.6643E+02	1.0218E+04	5.0459E+00
2	2	1.6842E+05	-5.5987E+02	-2.0699E+02	5.9691E+02	1.4197E+03	1.0266E+04	4.1153E+00
2	3	1.5145E+05	-6.8854E+02	-2.5345E+02	7.3089E+02	1.7304E+03	1.0284E+04	3.8988E+00
2	4	1.3933E+05	-8.5803E+02	-3.1723E+02	9.1479E+02	2.1758E+03	1.0309E+04	3.6597E+00
2	5	1.2201E+05	-1.0948E+03	-4.0476E+02	1.1672E+03	2.7762E+03	1.0343E+04	3.4075E+00
2	6	1.0229E+05	-1.4198E+03	-5.2491E+02	1.5137E+03	3.6002E+03	1.0389E+04	3.1447E+00
2	7	7.8513E+04	-1.8658E+03	-6.8983E+02	1.9893E+03	4.7314E+03	1.0452E+04	2.8862E+00
2	8	5.8897E+04	-2.4781E+03	-9.1620E+02	2.6421E+03	6.2840E+03	1.0539E+04	2.6397E+00
2	9	4.3982E+04	-3.3185E+03	-1.2269E+03	3.5381E+03	8.4150E+03	1.0659E+04	[illegible]
2	10	3.0516E+04	-4.4721E+03	-1.6534E+03	4.7679E+03	1.1348E+04	1.0823E+04	2.1573E+00
2	11	1.9947E+04	-6.0554E+03	-2.2388E+03	6.4560E+03	1.5355E+04	1.1049E+04	1.9798E+00
2	12	1.1976E+04	-8.2287E+03	-3.0423E+03	8.7731E+03	2.0866E+04	1.3410E+04	1.8720E+00
2	13	6.9085E+03	-1.1212E+04	-4.1451E+03	1.1953E+04	2.8430E+04	1.4884E+04	1.7810E+00
2	14	3.8435E+03	-1.5306E+04	-5.6589E+03	1.6319E+04	3.8813E+04	1.6498E+04	1.7014E+00
2	15	2.0241E+03	-2.0926E+04	-7.7348E+03	2.2311E+04	5.3065E+04	1.8804E+04	1.6303E+00
2	16	1.0434E+03	-2.8641E+04	-1.0589E+04	3.0535E+04	7.2626E+04	2.0297E+04	1.5661E+00
2	17	5.0155E+02	-3.9229E+04	-1.4504E+04	4.1824E+04	9.9476E+04	2.1064E+04	1.5122E+00
2	18	2.4095E+02	-5.3763E+04	-1.9877E+04	5.7319E+04	1.3633E+05	2.1064E+04	1.5046E+00
2	19	9.5244E+01	-7.3711E+04	-2.7252E+04	7.8588E+04	1.8692E+05	2.1064E+04	1.5000E+00
2	20	4.2681E+01	-1.0109E+05	-3.7376E+04	1.0778E+05	2.5635E+05	2.1064E+04	1.5000E+00
2	21	1.6956E+01	-1.3868E+05	-5.1271E+04	1.4785E+05	3.0577E+05	2.1064E+04	1.5000E+00
2	22	7.9509E+00	-1.9027E+05	-7.0344E+04	2.0285E+05	3.0577E+05	2.1064E+04	1.5000E+00
2	23	3.2551E+00	-2.6107E+05	-9.6523E+04	2.7835E+05	3.0577E+05	2.1064E+04	1.5000E+00
2	24	1.9613E-01	-3.5827E+05	-1.3246E+05	3.8197E+05	3.0577E+05	2.1064E+04	1.5000E+00
2	25	3.2216E-03	-4.9167E+05	-1.8178E+05	5.2420E+05	3.0577E+05	2.1064E+04	1.5000E+00
2	26	1.0561E-04	-6.7479E+05	-2.4948E+05	7.1943E+05	3.0577E+05	2.1064E+04	1.5000E+00

IA	I	EXPOSURE RATE	X METERS	Y METERS	GROUND DIST	FALL TIME	RADIUS	DOSE RATIO
3	1	2.4787E+05	-1.6047E+02	-1.7483E+02	2.3731E+02	5.7486E+02	1.0219E+04	4.9839E+00
3	2	1.6898E+05	-4.0362E+02	-4.3976E+02	5.9691E+02	1.4459E+03	1.0260E+04	4.0920E+00
3	3	1.5205E+05	-4.9422E+02	-5.3846E+02	7.3089E+02	1.7705E+03	1.0286E+04	3.8779E+00
3	4	1.4086E+05	-6.1858E+02	-6.7395E+02	9.1479E+02	2.2160E+03	1.0311E+04	3.6421E+00
3	5	1.2292E+05	-7.8927E+02	-8.5992E+02	1.1672E+03	2.8274E+03	1.0345E+04	3.3864E+00
3	6	1.0344E+05	-1.0236E+03	-1.1152E+03	1.5137E+03	3.6667E+03	1.0393E+04	3.1295E+00
3	7	8.8871E+04	-1.3451E+03	-1.4656E+03	1.9893E+03	4.8187E+03	1.0457E+04	2.8685E+00
3	8	6.1677E+04	-1.7865E+03	-1.9465E+03	2.6421E+03	6.4008E+03	1.0546E+04	2.6121E+00
3	9	4.8373E+04	-2.3924E+03	-2.6066E+03	3.5381E+03	8.5704E+03	1.0668E+04	2.3722E+00
3	10	3.2124E+04	-3.2240E+03	-3.5126E+03	4.7679E+03	1.1550E+04	1.0835E+04	2.1408E+00
3	11	2.1334E+04	-4.3655E+03	-4.7563E+03	6.4560E+03	1.5639E+04	1.1065E+04	1.9649E+00
3	12	1.3140E+04	-5.9323E+03	-6.4633E+03	8.7731E+03	2.1251E+04	1.3009E+04	1.8689E+00
3	13	7.7072E+03	-8.0828E+03	-8.8064E+03	1.1953E+04	2.8955E+04	1.4009E+04	1.7793E+00
3	14	4.3061E+03	-1.1039E+04	-1.2022E+04	1.6319E+04	3.9530E+04	1.6606E+04	1.6989E+00
3	15	2.3117E+03	-1.5086E+04	-1.6437E+04	2.2311E+04	5.4065E+04	1.9209E+04	1.6271E+00
3	16	1.1375E+03	-2.0648E+04	-2.2496E+04	3.0535E+04	7.3967E+04	2.1064E+04	1.5418E+00
3	17	5.4569E+02	-2.8281E+04	-3.0813E+04	4.1824E+04	1.0131E+05	2.1064E+04	1.5000E+00
3	18	2.0353E+02	-3.8759E+04	-4.2229E+04	5.7319E+04	1.3805E+05	2.1064E+04	1.5000E+00
3	19	1.1109E+02	-5.3141E+04	-5.7898E+04	7.8588E+04	1.9037E+05	2.1064E+04	1.5000E+00
3	20	4.5240E+01	-7.2881E+04	-7.9405E+04	1.0778E+05	2.6108E+05	2.1064E+04	1.5000E+00
3	21	1.3191E+01	-9.9976E+04	-1.0893E+05	1.4785E+05	3.3210E+05	2.1064E+04	1.5000E+00
3	22	1.3100E+00	-1.3717E+05	-1.4945E+05	2.0285E+05	3.3210E+05	2.1064E+04	1.5000E+00
3	23	1.1096E-01	-1.8822E+05	-2.0506E+05	2.7835E+05	3.3210E+05	2.1064E+04	1.5000E+00
3	24	5.9835E-02	-2.5828E+05	-2.8141E+05	3.8197E+05	3.3210E+05	2.1064E+04	1.5000E+00
3	25	8.3109E-06	-3.5446E+05	-3.8619E+05	5.2420E+05	3.3210E+05	2.1064E+04	1.5000E+00
3	26	4.1554E-06	-4.8647E+05	-5.3002E+05	7.1943E+05	3.3210E+05	2.1064E+04	1.5000E+00

Table C-1

SEER II OUTPUT FOR EXAMPLE PROBLEM (Continued)

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IA   I  EXPOSURE RATE     X METERS      Y METERS   GROUND DIST    FALL TIME       RADIUS   DOSE RATIO

 4   1    2.4495E+05   -1.0357E+02   -2.1352E+02   2.3731E+02   4.4958E+02   1.0212E+04   4.9282E+00
 4   2    1.6805E+05   -2.6051E+02   -5.3706E+02   5.9691E+02   1.1308E+03   1.0250E+04   4.3588E+00
 4   3    1.5890E+05   -3.1899E+02   -6.5761E+02   7.3089E+02   1.3846E+03   1.0264E+04   4.1432E+00
 4   4    1.3861E+05   -3.9925E+02   -8.2307E+02   9.1479E+02   1.7330E+03   1.0284E+04   3.9026E+00
 4   5    1.2114E+05   -5.0942E+02   -1.0502E+03   1.1672E+03   2.2113E+03   1.0311E+04   3.6419E+00
 4   6    1.0132E+05   -6.6066E+02   -1.3619E+03   1.5137E+03   2.8674E+03   1.0348E+04   3.3751E+00
 4   7    7.7875E+04   -8.6820E+02   -1.7898E+03   1.9893E+03   3.7686E+03   1.0398E+04   3.1027E+00
 4   8    5.9227E+04   -1.1531E+03   -2.3772E+03   2.6421E+03   5.0053E+03   1.0468E+04   2.8319E+00
 4   9    4.2639E+04   -1.5441E+03   -3.1833E+03   3.5381E+03   6.7027E+03   1.0563E+04   2.5738E+00
 4  10    2.9259E+04   -2.0809E+03   -4.2899E+03   4.7679E+03   9.0326E+03   1.0694E+04   2.3304E+00
 4  11    1.8631E+04   -2.8176E+03   -5.8087E+03   6.4560E+03   1.2231E+04   1.0873E+04   2.0994E+00
 4  12    1.0928E+04   -3.8289E+03   -7.8934E+03   8.7731E+03   1.6620E+04   1.1971E+04   1.9457E+00
 4  13    6.0087E+03   -5.2169E+03   -1.0755E+04   1.1953E+04   2.2645E+04   1.3864E+04   1.8495E+00
 4  14    3.0239E+03   -7.1222E+03   -1.4683E+04   1.6319E+04   3.0915E+04   1.5207E+04   1.7616E+00
 4  15    1.4920E+03   -9.7373E+03   -2.0074E+04   2.2311E+04   4.2267E+04   1.7051E+04   1.6826E+00
 4  16    7.4305E+02   -1.3327E+04   -2.7474E+04   3.0535E+04   5.7848E+04   1.9424E+04   1.6122E+00
 4  17    3.8227E+02   -1.8254E+04   -3.7631E+04   4.1824E+04   7.9234E+04   2.1064E+04   1.5515E+00
 4  18    2.0321E+02   -2.5016E+04   -5.1572E+04   5.7319E+04   1.0859E+05   2.1064E+04   1.5000E+00
 4  19    1.0713E+02   -3.4299E+04   -7.0708E+04   7.8588E+04   1.4888E+05   2.1064E+04   1.5000E+00
 4  20    3.8788E+01   -4.7348E+04   -9.6974E+04   1.0778E+05   2.0419E+05   2.1064E+04   1.5000E+00
 4  21    5.6526E-01   -6.4528E+04   -1.3303E+05   1.4785E+05   2.8010E+05   2.1064E+04   1.5000E+00
 4  22    1.9033E-02   -8.8533E+04   -1.8251E+05   2.0285E+05   3.5791E+05   2.1064E+04   1.5000E+00
 4  23    5.3384E-10   -1.2148E+05   -2.5044E+05   2.7835E+05   3.5791E+05   2.1064E+04   1.5000E+00
 4  24    2.6692E-10   -1.6671E+05   -3.4367E+05   3.8197E+05   3.5791E+05   2.1064E+04   1.5000E+00
 4  25    1.3346E-10   -2.2878E+05   -4.7164E+05   5.2420E+05   3.5791E+05   2.1064E+04   1.5000E+00
 4  26    6.6730E-11   -3.1399E+05   -6.4729E+05   7.1943E+05   3.5791E+05   2.1064E+04   1.5000E+00

IA   I  EXPOSURE RATE     X METERS      Y METERS   GROUND DIST    FALL TIME       RADIUS   DOSE RATIO

 5   1    2.4664E+05   -1.0284E+02   -2.1307E+02   2.3731E+02   3.4590E+02   1.0206E+04   4.8801E+00
 5   2    1.6803E+05   -2.5866E+02   -5.3795E+02   5.9691E+02   8.7003E+02   1.0236E+04   4.6415E+00
 5   3    1.5088E+05   -3.1672E+02   -6.5870E+02   7.3089E+02   1.0653E+03   1.0247E+04   4.4194E+00
 5   4    1.3858E+05   -3.9641E+02   -8.2444E+02   9.1479E+02   1.3334E+03   1.0262E+04   4.1804E+00
 5   5    1.2111E+05   -5.0580E+02   -1.0519E+03   1.1672E+03   1.7013E+03   1.0282E+04   3.9224E+00
 5   6    1.0129E+05   -6.5594E+02   -1.3642E+03   1.5137E+03   2.2063E+03   1.0311E+04   3.6457E+00
 5   7    7.7835E+04   -8.6202E+02   -1.7928E+03   1.9893E+03   2.8995E+03   1.0349E+04   3.3641E+00
 5   8    5.9183E+04   -1.1449E+03   -2.3811E+03   2.6421E+03   3.8510E+03   1.0403E+04   3.0801E+00
 5   9    4.2591E+04   -1.5312E+03   -3.1886E+03   3.5381E+03   5.1570E+03   1.0476E+04   2.8045E+00
 5  10    2.9212E+04   -2.0661E+03   -4.2970E+03   4.7679E+03   6.9495E+03   1.0577E+04   2.5441E+00
 5  11    1.8589E+04   -2.7[illegible]E+03   -5.8184E+03   6.4560E+03   9.4100E+03   1.0715E+04   2.2980E+00
 5  12    1.0894E+04   -3.8017E+03   -7.9066E+03   8.7731E+03   1.2787E+04   1.0904E+04   2.0656E+00
 5  13    5.9759E+03   -5.1798E+03   -1.0773E+04   1.1953E+04   1.7423E+04   1.1926E+04   1.9302E+00
 5  14    3.0585E+03   -7.0715E+03   -1.4707E+04   1.6319E+04   2.3786E+04   1.4049E+04   1.8351E+00
 5  15    1.4843E+03   -9.6800E+03   -2.0107E+04   2.2311E+04   3.2519E+04   1.5468E+04   1.7484E+00
 5  16    7.3877E+02   -1.3232E+04   -2.7519E+04   3.0535E+04   4.4507E+04   1.7414E+04   1.6704E+00
 5  17    3.7481E+02   -1.8124E+04   -3.7693E+04   4.1824E+04   6.0961E+04   1.9584E+04   1.6009E+00
 5  18    1.9503E+02   -2.4836E+04   -5.1658E+04   5.7319E+04   8.3547E+04   2.1064E+04   1.5432E+00
 5  19    1.0694E+02   -3.4055E+04   -7.0826E+04   7.8588E+04   1.1455E+05   2.1064E+04   1.5014E+00
 5  20    3.8533E+01   -4.6785E+04   -9.7136E+04   1.0778E+05   1.5710E+05   2.1064E+04   1.5000E+00
 5  21    5.2516E-01   -6.4069E+04   -1.3325E+05   1.4785E+05   2.1550E+05   2.1064E+04   1.5000E+00
 5  22    1.6372E-02   -8.7902E+04   -1.8282E+05   2.0285E+05   2.9567E+05   2.1064E+04   1.5000E+00
 5  23    5.2956E-10   -1.2062E+05   -2.5085E+05   2.7835E+05   3.8320E+05   2.1064E+04   1.5000E+00
 5  24    2.6369E-10   -1.6552E+05   -3.4424E+05   3.8197E+05   3.8320E+05   2.1064E+04   1.5000E+00
 5  25    1.3096E-10   -2.2715E+05   -4.7243E+05   5.2420E+05   3.8320E+05   2.1064E+04   1.5000E+00
 5  26    6.4756E-11   -3.1175E+05   -6.4837E+05   7.1943E+05   3.8320E+05   2.1064E+04   1.5000E+00

IA   I  EXPOSURE RATE     X METERS      Y METERS   GROUND DIST    FALL TIME       RADIUS   DOSE RATIO

 6   1    2.4693E+05   -1.3910E+02   -1.9227E+02   2.3731E+02   2.7167E+02   1.0202E+04   4.8371E+00
 6   2    1.6072E+05   -3.4987E+02   -4.8362E+02   5.9691E+02   6.8332E+02   1.0225E+04   4.8371E+00
 6   3    1.5172E+05   -4.2840E+02   -5.9217E+02   7.3089E+02   8.3670E+02   1.0234E+04   4.6816E+00
 6   4    1.3963E+05   -5.3620E+02   -7.4117E+02   9.1479E+02   1.0472E+03   1.0246E+04   4.4361E+00
 6   5    1.2241E+05   -6.8416E+02   -9.4569E+02   1.1672E+03   1.3362E+03   1.0262E+04   4.1776E+00
 6   6    1.0284E+05   -8.8724E+02   -1.2264E+03   1.5137E+03   1.7328E+03   1.0284E+04   3.9012E+00
 6   7    7.9466E+04   -1.1660E+03   -1.6117E+03   1.9893E+03   2.2773E+03   1.0315E+04   3.6133E+00
 6   8    6.1082E+04   -1.5486E+03   -2.1406E+03   2.6421E+03   3.0246E+03   1.0356E+04   3.3212E+00
 6   9    4.4594E+04   -2.0738E+03   -2.8666E+03   3.5381E+03   4.0503E+03   1.0414E+04   3.0314E+00
 6  10    3.2273E+04   -2.7947E+03   -3.8630E+03   4.7679E+03   5.4582E+03   1.0493E+04   2.7526E+00
 6  11    2.0499E+04   -3.7841E+03   -5.2307E+03   6.4560E+03   7.3907E+03   1.0602E+04   2.4920E+00
 6  12    1.2441E+04   -5.1423E+03   -7.1080E+03   8.7731E+03   1.0043E+04   1.0758E+04   2.2473E+00
 6  13    7.1398E+03   -7.0064E+03   -9.6848E+03   1.1953E+04   1.3684E+04   1.0955E+04   2.0205E+00
 6  14    3.9289E+03   -9.5652E+03   -1.3222E+04   1.6319E+04   1.8681E+04   1.2195E+04   1.9080E+00
 6  15    1.9753E+03   -1.3077E+04   -1.8076E+04   2.2311E+04   2.5541E+04   1.4334E+04   1.8143E+00
 6  16    9.7782E+02   -1.7898E+04   -2.4740E+04   3.0535E+04   3.4956E+04   1.5863E+04   1.7293E+00
 6  17    5.1918E+02   -2.4515E+04   -3.3886E+04   4.1824E+04   4.7879E+04   1.7962E+04   1.6531E+00
 6  18    2.5139E+02   -3.3597E+04   -4.6441E+04   5.7319E+04   6.5618E+04   1.9933E+04   1.5853E+00
 6  19    1.0798E+02   -4.6064E+04   -6.3673E+04   7.8588E+04   8.9965E+04   2.1064E+04   1.5328E+00
 6  20    4.5884E+01   -6.3179E+04   -8.7325E+04   1.0778E+05   1.2339E+05   2.1064E+04   1.5000E+00
 6  21    5.3311E+00   -8.6662E+04   -1.1979E+05   1.4785E+05   1.6926E+05   2.1064E+04   1.5000E+00
 6  22    8.5329E-01   -1.1890E+05   -1.6435E+05   2.0285E+05   2.3222E+05   2.1064E+04   1.5000E+00
 6  23    7.2649E-01   -1.6315E+05   -2.2552E+05   2.7835E+05   3.1864E+05   2.1064E+04   1.5000E+00
 6  24    3.6325E-01   -2.2389E+05   -3.0947E+05   3.8197E+05   4.0795E+05   2.1064E+04   1.5000E+00
 6  25    1.8162E-01   -3.0726E+05   -4.2471E+05   5.2420E+05   4.0795E+05   2.1064E+04   1.5000E+00
 6  26    9.0812E-02   -4.2169E+05   -5.8209E+05   7.1943E+05   4.0795E+05   2.1064E+04   1.5000E+00
```

Table C-1

SEER II OUTPUT FOR EXAMPLE PROBLEM (Continued)

```
IA   I   EXPOSURE RATE    X METERS     Y METERS   GROUND DIST    FALL TIME      RADIUS   DOSE RATIO

 7   1     2.4711E+05  -1.7434E+02  -1.6101E+02  2.3731E+02   2.0618E+02  1.0198E+04  4.7985E+00
 7   2     1.6909E+05  -4.3852E+02  -4.0497E+02  5.9491E+02   5.1861E+02  1.0216E+04  4.7985E+00
 7   3     1.5215E+05  -5.3695E+02  -4.9507E+02  7.3089E+02   6.3502E+02  1.0222E+04  4.7985E+00
 7   4     1.4820E+05  -6.7205E+02  -6.2064E+02  9.1479E+02   7.9400E+02  1.0231E+04  4.7272E+00
 7   5     1.2310E+05  -8.5750E+02  -7.9190E+02  1.1672E+03   1.0141E+03  1.0244E+04  4.4000E+00
 7   6     1.0764E+05  -1.1120E+03  -1.0270E+03  1.5137E+03   1.3151E+03  1.0261E+04  4.1990E+00
 7   7     8.0250E+04  -1.4614E+03  -1.3496E+03  1.9893E+03   1.7283E+03  1.0284E+04  3.9027E+00
 7   8     6.1087E+04  -1.9410E+03  -1.7925E+03  2.6421E+03   2.2955E+03  1.0316E+04  3.6053E+00
 7   9     4.5643E+04  -2.5992E+03  -2.4004E+03  3.5381E+03   3.0740E+03  1.0359E+04  3.3035E+00
 7  10     3.2449E+04  -3.5027E+03  -3.2348E+03  4.7679E+03   4.1425E+03  1.0419E+04  3.0081E+00
 7  11     2.1677E+04  -4.7429E+03  -4.3801E+03  6.4560E+03   5.6091E+03  1.0502E+04  2.7296E+00
 7  12     1.3453E+04  -6.4451E+03  -5.9521E+03  8.7731E+03   7.6223E+03  1.0615E+04  2.4670E+00
 7  13     8.0939E+03  -8.7816E+03  -8.1098E+03  1.1953E+04   1.0385E+04  1.0770E+04  2.2220E+00
 7  14     4.6202E+03  -1.1989E+04  -1.1072E+04  1.6319E+04   1.4178E+04  1.0903E+04  1.9989E+00
 7  15     2.5160E+03  -1.6391E+04  -1.5137E+04  2.2311E+04   1.9384E+04  1.2085E+04  1.8961E+00
 7  16     1.2219E+03  -2.2433E+04  -2.0717E+04  3.0535E+04   2.6530E+04  1.4495E+04  1.8037E+00
 7  17     6.1330E+02  -3.0726E+04  -2.8376E+04  4.1824E+04   3.6338E+04  1.6088E+04  1.7197E+00
 7  18     2.9589E+02  -4.2109E+04  -3.8888E+04  5.7319E+04   4.9801E+04  1.8274E+04  1.6443E+00
 7  19     1.1044E+02  -5.7734E+04  -5.3318E+04  7.8580E+04   6.8279E+04  2.0116E+04  1.5771E+00
 7  20     5.2696E+01  -7.9181E+04  -7.3124E+04  1.0778E+05   9.3643E+04  2.1064E+04  1.5257E+00
 7  21     2.6297E+01  -1.0862E+05  -1.0031E+05  1.4785E+05   1.2844E+05  2.1064E+04  1.5014E+00
 7  22     3.9530E+00  -1.4902E+0   -1.3763E+05  2.0285E+05   1.7624E+05  2.1064E+04  1.5000E+00
 7  23     4.7008E-01  -2.0449E+05  -1.8884E+05  2.7835E+05   2.4183E+05  2.1064E+04  1.5000E+00
 7  24     4.1406E-01  -2.8061E+05  -2.5915E+05  3.8197E+05   3.3186E+05  2.1064E+04  1.5000E+00
 7  25     2.0744E-01  -3.8510E+05  -3.5564E+05  5.2420E+05   4.3215E+05  2.1064E+04  1.5000E+00
 7  26     1.0372E-01  -5.2852E+05  -4.8810E+05  7.1943E+05   4.3215E+05  2.1064E+04  1.5000E+00

IA   I   EXPOSURE RATE    X METERS     Y METERS   GROUND DIST    FALL TIME      RADIUS   DOSE RATIO

 8   1     2.4712E+05  -1.9879E+02  -1.2962E+02  2.3731E+02   1.5494E+02  1.0195E+04  4.7642E+00
 8   2     1.6895E+05  -5.0000E+02  -3.2603E+02  5.9491E+02   3.8972E+02  1.0209E+04  4.7642E+00
 8   3     1.5207E+05  -6.1224E+02  -3.9921E+02  7.3089E+02   4.7725E+02  1.0214E+04  4.7642E+00
 8   4     1.4012E+05  -7.6629E+02  -4.9965E+02  9.1479E+02   5.9727E+02  1.0220E+04  4.7642E+00
 8   5     1.2302E+05  -9.7773E+02  -6.3753E+02  1.1672E+03   7.6209E+02  1.0230E+04  4.7591E+00
 8   6     1.0352E+05  -1.2860E+03  -8.2677E+02  1.5137E+03   9.8830E+02  1.0242E+04  4.5117E+00
 8   7     8.0014E+04  -1.6663E+03  -1.0865E+03  1.9893E+03   1.2988E+03  1.0260E+04  4.2134E+00
 8   8     6.1417E+04  -2.2131E+03  -1.4431E+03  2.6421E+03   1.7250E+03  1.0284E+04  3.9079E+00
 8   9     4.5615E+04  -2.9631E+03  -1.9325E+03  3.5381E+03   2.3100E+03  1.0316E+04  3.5978E+00
 8  10     3.2314E+04  -3.9939E+03  -2.6042E+03  4.7679E+03   3.1130E+03  1.0361E+04  3.2807E+00
 8  11     2.1614E+04  -5.4079E+03  -3.5262E+03  6.4560E+03   4.2152E+03  1.0423E+04  2.9931E+00
 8  12     1.3422E+04  -7.3488E+03  -4.7918E+03  8.7731E+03   5.7280E+03  1.0508E+04  2.7121E+00
 8  13     8.1622E+03  -1.0013E+04  -6.5289E+03  1.1953E+04   7.8045E+03  1.0625E+04  2.4479E+00
 8  14     4.7694E+03  -1.3670E+04  -8.9132E+03  1.6319E+04   1.0655E+04  1.0785E+04  2.2020E+00
 8  15     2.5853E+03  -1.8689E+04  -1.2186E+04  2.2311E+04   1.4567E+04  1.1004E+04  1.9951E+00
 8  16     1.3791E+03  -2.5578E+04  -1.6678E+04  3.0535E+04   1.9937E+04  1.1945E+04  [illegible]
 8  17     6.7939E+02  -3.5034E+04  -2.2844E+04  4.1824E+04   2.7307E+04  1.4821E+04  1.7957E+00
 8  18     3.3498E+02  -4.8014E+04  -3.1307E+04  5.7319E+04   3.7424E+04  1.6264E+04  1.7125E+00
 8  19     1.2724E+02  -6.5830E+04  -4.2924E+04  7.8580E+04   5.1310E+04  1.8519E+04  1.6377E+00
 8  20     6.4037E+01  -9.0284E+04  -5.8869E+04  1.0778E+05   7.0371E+04  2.0325E+04  1.5707E+00
 8  21     3.3079E+01  -1.2385E+05  -8.0755E+04  1.4785E+05   9.6533E+04  2.1064E+04  1.5189E+00
 8  22     1.7695E+01  -1.6992E+05  -1.1080E+05  2.0285E+05   1.3244E+05  2.1064E+04  1.5024E+00
 8  23     2.6375E+00  -2.3316E+05  -1.5203E+05  2.7835E+05   1.8173E+05  2.1064E+04  1.5000E+00
 8  24     2.7242E-01  -3.1996E+05  -2.0863E+05  3.8197E+05   2.4939E+05  2.1064E+04  1.5000E+00
 8  25     2.4180E-01  -4.3910E+05  -2.8631E+05  5.2420E+05   3.4225E+05  2.1064E+04  1.5000E+00
 8  26     1.2854E-01  -6.0263E+05  -3.9295E+05  7.1943E+05   4.5596E+05  2.1064E+04  1.5000E+00

IA   I   EXPOSURE RATE    X METERS     Y METERS   GROUND DIST    FALL TIME      RADIUS   DOSE RATIO

 9   1     2.4704E+05  -2.1636E+02  -9.7499E+01  2.3731E+02   1.1796E+02  1.0193E+04  4.7340E+00
 9   2     1.6863E+05  -5.4420E+02  -2.4524E+02  5.9491E+02   2.9678E+02  1.0203E+04  4.7340E+00
 9   3     1.5170E+05  -6.6636E+02  -3.0028E+02  7.3089E+02   3.6329E+02  1.0207E+04  4.7340E+00
 9   4     1.3966E+05  -8.3402E+02  -3.7584E+02  9.1479E+02   4.5470E+02  1.0212E+04  4.7340E+00
 9   5     1.2242E+05  -1.0642E+03  -4.7955E+02  1.1672E+03   5.8018E+02  1.0219E+04  4.7340E+00
 9   6     1.0281E+05  -1.3801E+03  -6.2190E+02  1.5137E+03   7.5240E+02  1.0229E+04  4.7340E+00
 9   7     7.9120E+04  -1.8136E+03  -8.1729E+02  1.9893E+03   9.8879E+02  1.0242E+04  4.5125E+00
 9   8     6.0537E+04  -2.4088E+03  -1.0855E+03  2.6421E+03   1.3133E+03  1.0260E+04  4.2014E+00
 9   9     4.4330E+04  -3.2257E+03  -1.4536E+03  3.5381E+03   1.7586E+03  1.0285E+04  3.8802E+00
 9  10     3.1201E+04  -4.3469E+03  -1.9589E+03  4.7679E+03   2.3699E+03  1.0320E+04  3.5706E+00
 9  11     2.0650E+04  -5.8860E+03  -2.6524E+03  6.4560E+03   3.2090E+03  1.0367E+04  3.2582E+00
 9  12     1.2587E+04  -7.9984E+03  -3.6044E+03  8.7731E+03   4.3607E+03  1.0431E+04  2.9612E+00
 9  13     7.5101E+03  -1.0898E+04  -4.9110E+03  1.1953E+04   5.9415E+03  1.0520E+04  2.6797E+00
 9  14     4.2161E+03  -1.4878E+04  -6.7045E+03  1.6319E+04   8.1114E+03  1.0642E+04  2.4164E+00
 9  15     2.2986E+03  -2.0341E+04  -9.1663E+03  2.2311E+04   1.1090E+04  1.0809E+04  2.1720E+00
 9  16     1.2298E+03  -2.7839E+04  -1.2545E+04  3.0535E+04   1.5178E+04  1.1039E+04  1.9795E+00
 9  17     5.9460E+02  -3.8131E+04  -1.7183E+04  4.1824E+04   2.0789E+04  1.3563E+04  1.8740E+00
 9  18     3.1509E+02  -5.2258E+04  -2.3549E+04  5.7319E+04   2.8491E+04  1.4813E+04  1.7839E+00
 9  19     1.2552E+02  -7.1649E+04  -3.2288E+04  7.8580E+04   3.9063E+04  1.6539E+04  1.7018E+00
 9  20     6.2015E+01  -9.8262E+04  -4.4281E+04  1.0778E+05   5.3573E+04  1.9234E+04  1.6288E+00
 9  21     3.3048E+01  -1.3480E+05  -6.0744E+04  1.4785E+05   7.3491E+04  2.1064E+04  1.5619E+00
 9  22     1.9313E+01  -1.8494E+05  -8.3341E+04  2.0285E+05   1.0083E+05  2.1064E+04  1.5113E+00
 9  23     1.2210E+01  -2.5377E+05  -1.1436E+05  2.7835E+05   1.3835E+05  2.1064E+04  1.5017E+00
 9  24     1.0240E+00  -3.4876E+05  -1.5693E+05  3.8197E+05   1.8086E+05  2.1064E+04  1.5000E+00
 9  25     1.5647E-01  -4.7792E+05  -2.1537E+05  5.2420E+05   2.6056E+05  2.1064E+04  1.5000E+00
 9  26     1.3850E-01  -6.5590E+05  -2.9557E+05  7.1943E+05   3.5760E+05  2.1064E+04  1.5000E+00
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Table C-1

SEER II OUTPUT FOR EXAMPLE PROBLEM (Continued)

```
STRIP   1         1 MT  LAKE CHARLES SUMMER WIND                                       MAP OUTPUT IS IN EXPONENTIAL FORMAT
              -246000.    -234000.    -222000.    -210000.    -198000.    -186000.    -174000.    -162000.    -150000.    -138000.

    25000.     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .

    20000.     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .

    15000.     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .

    10000.     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .

     5000.     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .

        0.     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .

    -5000.     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .  .509  .576

   -10000.     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .  .533  .590  .655  .739  .853

   -15000.     .     .     .     .     .     .     .     .     .     .     .     .  .531  .592  .660  .740  .830  .935 1.064 1.255

   -20000.     .     .     .     .     .     .     .     .     .  .506  .565  .633  .710  .800  .903 1.023 1.163 1.328 1.526 1.833

   -25000.     .     .     .     .     .     .     .  .538  .593  .656  .740  .836  .947 1.077 1.229 1.409 1.621 1.875 2.182 2.665

   -30000.     .     .     .     .  .508  .560  .619  .686  .763  .850  .965 1.100 1.258 1.446 1.668 1.933 2.252 2.640 3.116 3.842

   -35000.     .     .  .517  .571  .632  .702  .782  .873  .979 1.100 1.256 1.445 1.668 1.934 2.254 2.643 3.117 3.700 4.426 5.516

   -40000.  .517  .572  .634  .705  .787  .879  .986 1.109 1.252 1 419 1.631 1.891 2.204 2.579 3.036 3.600 4.294 5.161 6.262 7.866
                                                                                                                             1
   -45000.  .626  .697  .777  .869  .975 1.098 1.239 1.405 1.598 1.826 2.112 2.469 2.900 3.430 4.079 4.884 5.893 7.177 8.818 1.115
                                                                                                                       1     1
   -50000.  .757  .847  .950 1.070 1.207 1.367 1.554 1.775 2.034 2.343 2.727 3.212 3.810 4.544 5.462 6.608 8.064 9.926 1.237 1.571
                                                                                                           1     1     1     1
   -55000.  .914 1.028 1.162 1.312 1.491 1.694 1.945 2.236 2.583 3.001 3.511 4.172 4.990 6.003 7.284 8.906 1.098 1.369 1.560 1.590
                                                                                                     1     1     1     1     1
   -60000. 1.107 1.246 1.413 1.608 1.837 2  09 2.429 2.813 3.274 3.831 4.512 5.402 6.511 7.915 9.678 1.186 1.243 1.312 1.395 1.495
                                                                                               1     1     1     1     1     1
   -65000. 1.326 1.536 1.718 1.967 2.261 2.610 3.028 3.528 4.136 4.850 5.788 6.982 8.487 9.873 1.027 1.075 1.133 1.202 4.278 4.530
                                                                                                           1     1     1     1
   -70000. 1.593 1.819 2.086 2.401 2.777 3.225 3.765 4.419 5.215 6.198 7.413 8.191 8.469 8.802 9.201 9.677 1.024 3.862 4.087 4.341
                                                                                                     1     1     1     1     1
   -75000. 1.918 2.192 2.528 2.927 3.403 3.977 4.668 5.519 6.560 6.883 7.023 7.199 7.474 7.799 8.186 3.303 3.478 3.676 3.895 4.144
                                                                                         1     1     1     1     1     1     1
   -80000. 2.287 2.634 3.059 3.557 4.162 4.890 5.725 5.811 5.911 6.028 6.164 6.320 6.556 2.835 2.974 3.128 3.299 3.490 3.704 3.947
                                                                             1     1     1     1     1     1     1     1     1
   -85000. 2.736 3.171 3.693 4.319 4.839 4.900 4.971 5.054 5.151 5.263 5.393 2.457 2.552 2.676 2.811 2.960 3.125 3.310 3.518 3.752
                                                                 1     1     1     1     1     1     1     1     1     1     1
   -90000. 3.266 3.844 4.087 4.123 4.177 4.236 4.305 4.386 4.477 2.211 2.248 2.313 2.410 2.525 2.655 2.798 2.959 3.137 3.336 3.561
                                                     1     1     1     1     1     1     1     1     1     1     1     1     1
   -95000. 3.444 3.475 3.510 3.549 3.598 3.654 3.720 2.003 2.085 2.030 2.079 2.157 2.269 2.383 2.508 2.646 2.860 2.970 3.097 3.111
                                               1     1     1     1     1     1     1     1     1     1     1     1     1     1
  -100000. 2.946 2.973 3.007 3.047 3.092 3.144 1.802 1.797 1.812 1.847 1.906 1.993 2.114 2.254 2.369 2.502 2.648 2.679 2.651 2.678
                                   1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
  -105000. 2.513 2.540 2.572 2.609 1.630 1.604 1.593 1.600 1.623 1.667 1.732 1.825 1.951 2.118 2.240 2.365 2.305 2.251 2.239 2.274
                       1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
  -110000. 2.140 2.165 1.483 1.442 1.413 1.394 1.398 1.412 1.442 1.491 1.561 1.656 1.783 1.952 2.093 1.975 1.903 1.867 1.860 1.907
           1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
  -115000. 1.352 1.333 1.262 1.233 1.216 1.211 1.217 1.237 1.271 1.322 1.393 1.489 1.615 1.701 1.677 1.606 1.553 1.532 1.540 1.579
           1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
  -120000. 1.116 1.295 1.087 1.048 1.039 1.048 1.052 1.075 1.111 1.163 1.233 1.326 1.353 1.338 1.319 1.294 1.254 1.243 1.256 1.294
                                                                 1     1     1     1     1     1     1     1           1     1
  -125000. 9.106 9.175 8.964 8.852 8.820 8.875 9.023 9.272 9.643 1.015 1.082 1.078 4.067 1.055 1.041 1.026 1.006 9.993 1.014 1.049

  -130000. 7.445 7.537 '.475 7.428 7.436 7.521 7.685 7.937 8.297 8.647 8.593 8.526 8.445 8.352 8.251 8.137 8.021 7.960 8.113 8.335

  -135000. 6.094 6.168 6.191 6.190 6.228 6.325 6.499 6.767 6.872 6.861 6.819 6.767 6.705 6.635 6.558 6.476 6.391 6.323 6.413 6.552
        -252000.    -240000.    -228000.    -216000.    -204000.    -192000.    -180000.    -168000.    -156000.    -144000.
```

Table C-1

SEER II OUTPUT FOR EXAMPLE PROBLEM (Continued)

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STRIP  2        1 MT  LAKE CHARLES SUMMER WIND                                    MAP OUTPUT IS IN EXPONENTIAL FORMAT
                -126000.    -114000.    -102000.    -90000.     -78000.     -66000.     -54000.     -42000.     -30000.     -18000.

    25000.      .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .     .  
                                                                                1     1     1     1     1     1     1
    20000.      .     .     .     .     .     .    .701 1.474 3.097 6.186 8.126 1.682 1.440 1.836 2.273 2.813 3.479 4.301   .     .  
                                                                    1     1     1     1     1     1     1     1     1     2     2
    15000.      .     .     .     .     .    .556 1.170 2.453 5.144 1.017 1.356 1.807 2.409 3.693 3.868 4.836 6.413 8.649 1.101 2.149
                                                                    1     1     1     1     1     1     1     1     2     2     2
    10000.      .     .     .     .     .    .811 1.698 3.553 7.437 1.475 1.967 2.622 3.497 4.511 5.67- 7.165 9.950 1.429 2.610 5.010
                                                              1     1     1     1     1     1     1     2     2     2     2     3
     5000.      .     .     .     .     .   1.328 2.774 5.797 1.211 2.410 3.213 4.284 5.713 7.389 9.335 1.179 1.692 2.516 5.005 1.102
                                                              1     1     1     1     1     1     2     2     2     2     2     3
        0.      .     .     .     .     .   1.497 3.122 6.511 1.358 2.708 3.605 4.800 6.391 8.264 1.044 1.318 1.904 2.946 5.784 1.316
                                                              1     1     1     1     1     2     2     2     2     2     2     3
    -5000.     .452  .741  .844  .963 1.105 2.050 4.116 8.207 1.621 3.170 4.334 5.885 8.017 1.081 1.435 1.935 2.974 4.821 9.992 2.327
                                                        1     1     1     1     1     2     2     2     2     2     2     3     3
   -10000.     .989 1.150 1.346 1.583 1.875 3.113 5.925 1.112 2.053 3.708 5.347 7.493 1.033 1.444 2.014 2.898 4.701 8.452 1.490 9.384
                                                        1     1     1     1     1     2     2     2     2     2     3     3     3
   -15000.    1.486 1.772 2.128 2.573 3.147 4.809 8.690 1.538 2.058 4.449 6.562 9.253 1.319 1.903 2.780 4.224 5.933 1.078 2.828 4.228
                                                  1     1     1     1     1     2     2     2     2     2     3     3     3     3
   -20000.    2.219 2.795 3.332 4.151 5.233 7.530 1.296 2.171 3.516 5.479 8.009 1.149 1.671 2.469 3.140 8.957 1.167 1.678 2.218 3.029
                                            1     1     1     1     1     1     2     2     2     2     2     3     3     3     3
   -25000.    3.291 4.112 5.181 6.623 8.602 1.199 1.963 3.117 4.757 6.918 9.721 1.365 1.739 5.088 6.494 8.357 1.062 1.347 1.742 1.890
                                1     1     1     1     1     1     1     1     2     2     2     2     2     2     3     3     3
   -30000.    4.843 6.175 7.984 1.049 1.401 1.932 3.029 4.559 6.562 8.280 9.628 2.058 3.633 4.639 5.959 7.613 9.064 1.092 1.264 1.290
                          1     1     1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     2
   -35000.    7.898 9.232 1.221 1.643 2.260 3.183 4.734 5.770 6.686 7.769 2.116 2.582 3.290 4.213 5.182 6.352 7.708 8.839 9.199 9.101
              1     1     1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     2     2     2
   -40000.    1.030 1.371 1.852 2.555 3.583 4.052 4.643 5.277 1.510 1.736 1.998 2.338 2.944 3.617 4.412 5.428 6.433 6.945 6.999 3.444
              1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     2     2     2     2     2
   -45000.    1.498 2.017 2.625 2.959 3.364 3.799 1.078 1.238 1.423 1.637 1.884 2.140 2.526 3.107 3.815 4.420 5.104 5.396 5.439 2.723
              1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     2     2     2     2     2
   -50000.    1.921 2.159 2.432 2.747 8.309 9.206 1.023 1.166 1.341 1.542 1.734 1.943 2.192 2.674 3.273 3.785 4.163 4.269 2.112 2.099
              1     1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     2     2     2     2
   -55000.    1.759 1.992 6.684 7.156 7.915 8.777 9.759 1.099 1.260 1.485 1.571 1.762 1.986 2.309 2.761 3.133 3.496 2.546 1.762 1.576
              1     1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     2     2     2     2
   -60000.    5.980 5.549 6.161 6.803 7.530 8.355 9.298 1.027 1.138 1.270 1.422 1.598 1.813 2.060 2.313 2.623 2.854 3.015 1.474 1.161
              1     1     1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     2     2     1
   -65000.    4.936 5.393 5.848 6.461 7.155 7.944 8.683 9.408 1.028 1.140 1.287 1.451 1.650 1.817 2.009 2.219 2.440 1.287 1.199 7.501
              1     1     1     1     1     1     1     1     1     2     2     2     2     2     2     2     2     2     1     1
   -70000.    4.631 5.027 5.546 6.131 6.792 7.347 7.943 8.611 9.368 1.037 1.164 1.316 1.456 1.597 1.752 1.919 2.118 1.691 9.754 5.648
              1     1     1     1     1     1     1     1     1     1     2     2     2     2     2     2     1     1     1     1
   -75000.    4.424 4.771 5.256 5.766 6.226 6.717 7.264 7.879 8.577 9.379 1.052 1.167 1.275 1.398 1.515 1.655 9.071 8.906 5.844 4.157
              1     1     1     1     1     1     1     1     1     1     1     2     2     2     2     2     1     1     1     1
   -80000.    4.223 4.542 4.916 5.284 5.689 6.134 6.641 7.205 7.763 8.444 9.383 1.021 1.114 1.207 1.305 1.421 7.560 6.917 4.343 2.959
              1     1     1     1     1     1     1     1     1     1     1     1     1     2     2     2     1     1     1     1
   -85000.    4.029 4.219 4.434 4.827 5.198 5.609 6.069 6.479 6.849 7.457 7.882 8.432 9.462 1.037 1.126 1.216 6.198 5.969 3.131 1.990
              1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
   -90000.    3.633 3.792 4.054 4.403 4.748 5.124 5.450 5.606 5.944 6.051 6.233 7.085 7.979 8.884 9.669 5.121 4.863 3.123 2.199 1.315
              1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
   -95000.    3.193 3.352 3.644 3.974 4.336 4.617 4.628 4.785 4.785 4.721 4.892 5.189 5.697 6.770 8.152 4.218 3.603 2.281 1.505   .  
              1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
  -100000.    2.764 2.987 3.152 3.493 3.821 3.858 3.886 3.877 3.633 3.558 3.633 3.818 3.850 4.431 2.748 3.255 2.231 1.623 1.083   .  
              1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1     1
  -105000.    2.390 2.542 2.717 3.023 3.180 3.182 3.285 2.873 2.678 2.684 2.464 2.388 2.477 2.742 1.653 1.825 1.363 1.125   .     .  
              1     1     1     1     1     1     1     1     1     1     1     1     1     1
  -110000.    1.947 2.118 2.309 2.342 2.452 2.364 2.321 2.071 1.921 1.792 1.596 1.511 1.525 1.049 9.707 9.446 7.195 5.546   .     .  
              1     1     1     1     1     1     1     1     1     1
  -115000.    1.654 1.776 1.831 1.879 1.904 1.856 1.663 1.460 1.348 1.137 9.915 9.171 9.025 4.036 5.540 4.293 3.647 2.634   .     .  
              1     1     1     1     1     1     1     1
  -120000.    1.341 1.438 1.442 1.493 1.474 1.313 1.167 1.035 8.559 6.935 5.933 5.447 5.154 2.075 3.027 2.263 1.881   .     .     .  
              1     1     1     1     1
  -125000.    1.483 1.190 1.142 1.160 1.047 9.372 8.370 7.356 5.475 4.128 3.438 3.039 1.887 1.665 1.324 1.162  .867   .     .     .  

  -130000.    8.518 8.759 9.485 8.321 7.491 6.743 6.051 4.746 3.327 2.659 2.021 1.478  .846  .933  .787  .581   .     .     .     .  

  -135000.    6.724 6.949 6.602 5.974 5.411 4.896 4.157 3.047 2.261 1.788 1.293  .995   .     .     .     .     .     .     .     .  
          -132000.    -120000.    -108000.    -96000.     -84000.     -72000.     -60000.     -48000.     -36000.     -24000.
```

Table C-1

SEER II OUTPUT FOR EXAMPLE PROBLEM (Concluded)

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STRIP   1        1 HR  LAKE CHARLES SUMMER WIND                                                 MAP OUTPUT IS IN EXPONENTIAL FORMAT
                 -6000.     6000.     18000.     30000.     42000.     54000.     66000.     78000.     90000.     102000.

   25000.        .    .    .    .    .

   20000.        .    .    .    .    .
                2
   15000.       3.046 .    .    .    .
                3     3     3
   10000.       1.772 2.924 1.962 .    .
                3     4     4     4
    5000.       2.937 1.132 4.045 1.544 .
                3     4     5     4
       0.       3.707 1.730 2.946 5.192 .
                3     4     4     4
   -5000.       6.026 3.142 2.764 1.136 .
                3     4     3     3
  -10000.       9.404 1.357 7.596 2.084 .
                3     3     3     2
  -15000.       5.821 3.052 2.934 5.710 .
                3     3     3     2
  -20000.       3.104 1.657 1.313 3.461 .
                2     2     2     2
  -25000.       9.371 9.641 4.836 1.861 .
                2     2     2
  -30000.       6.461 5.744 2.865  .    .
                2     2     2
  -35000.       4.649 3.531 1.692  .    .
                2     2     2
  -40000.       3.263 1.945 1.199  .    .
                2     2     1
  -45000.       2.336 1.319 7.255  .    .
                2     1     1
  -50000.       1.352 9.091 4.796  .    .
                1     1
  -55000.       9.736 6.238  .     .    .
                1     1
  -60000.       7.963 4.269  .     .    .
                1     1
  -65000.       5.092 2.897  .     .    .
                1
  -70000.       3.680  .     .     .    .
                1
  -75000.       2.492  .     .     .    .

  -80000.        .     .     .     .    .

  -85000.        .     .     .     .    .

  -90000.        .     .     .     .    .

  -95000.        .     .     .     .    .

 -100000.        .     .     .     .    .

 -105000.        .     .     .     .    .

 -110000.        .     .     .     .    .

 -115000.        .     .     .     .    .

 -120000.        .     .     .     .    .

 -125000.        .     .     .     .    .

 -130000.        .     .     .     .    .

 -138000.        .     .     .     .    .
           -12000.        0.    12000.    24000.    36000.    48000.    60000.    72000.    84000.    96000.
```