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AIRPORT VICINITY AIR POLLUTION MODEL ABBREVIATED VERSION USER'S--ETC(U)

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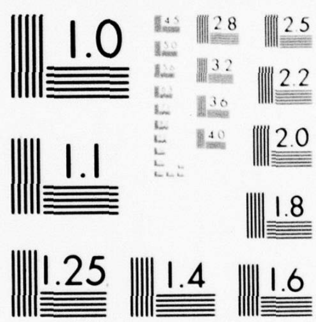

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Report No. FAA-RD-78-111

AIRPORT VICINITY AIR POLLUTION MODEL ABBREVIATED VERSION USER'S GUIDE

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16. Abstract

This document describes the Airport Vicinity Air Pollution (AVAP) Model modified by the Energy and Environmental Systems Division of Argonne National Laboratory for the Federal Aviation Administration under Inter-Agency Agreement DOT-FA71WA1-223. This version of the model, Airport Vicinity Air Pollution Model Abbreviated Version, provides a "first-guess" estimate of an airport air pollution distribution based on more general input information than is described in Report No. FAA-RD-75-230, the model's primary form.

The user must establish a right-handed Cartesian coordinate system as a basis for describing an airport layout, then decide whether to use supplied default values applicable to the types of aircraft and airport facilities.

The estimate of pollutant concentrations are computed for selected individual receptor locations based on the dispersion of pollutant emissions from area and line type sources. Pollutant emission levels due to each member of a source type are tabulated. The results of a one one-hour modeling period of aircraft arrival-departure activities, airport ground-support services, and airport access vehicle roadways are tabulated for each receptor location and pollutant species.

The document presents a discussion of the theoretical considerations fundamental to the AVAP Model Abbreviated Version as well as program flow diagrams essential to understanding the theory. Required sequential card data input to the program is illustrated along with substitution options for program constants. Additionally, an example problem and a program listing are provided.

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METRIC CONVERSION FACTORS

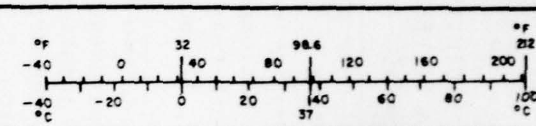
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1 INTRODUCTION

The Airport Air Pollution Model, Abbreviated Version was developed at Argonne National Laboratory and executed on the IBM 360 Model 195 within a core region of 250K bytes while utilizing less than one minute of computer time. The FORTRAN coded program is yet another version of the Airport Air Pollution (AVAP) Model[1] modified to provide a first-guess estimate of an airport air pollution distribution.

This document discusses the theoretical considerations fundamental to the model, describes data input requirements for using the program, and illustrates the use of model by presenting an example problem. Therefore, users of the document should be technical personnel concerned with using the computer code for assessing air pollution impacts of commercial and general aviation airports. For more comprehensive studies, the model's primary form should be used.

In Section 2, the collection of formulas that form the basis of the computer program are presented. Detailed descriptions are to be found for area source and line source dispersion formulas. Although they are not used in this abbreviated version of AVAP, the Gaussian plume formula for a point source, the Carson-Moses plume rise formula, and the Briggs formula for estimating stack downwash effects are presented.

Section 3 provides guidelines for preparation of the input data. The formats and meanings of the input parameters are given along with their relative card position in the input sequence. Almost all of the input parameters that appear in this section havedefault values. Those that do not have default values are marked in Table 3.1. with the asterisk (*) character.

Section 4 provides a description and a table of the default values of the input parameters. All of the default values appear in the BLOCK DATA subprogram of the computer program; all or some of them can be changed by the appropriate data-card insertion.

Section 5 presents a complete example problem that details the resultant output from the model. Appendix A illustrates the conversion of pollutant concentration units and Appendix B gives the program flow diagrams of selected computational modules.

A complete listing of the FORTRAN coded program is found in Appendix C.

2 FORMULAS FOR CONCENTRATION CALCULATIONS

The formulas presented in this section will apply to both forms of the AVAP Model except that Point Source calculations are not required when using the abbreviated version. They form an outline of the most basic set of equations for concentration calculations but are not to be regarded as the complete set that covers all practical conditions of application. The user of the AVAP Model should consult the references quoted in this document for more complete descriptions.

2.1 DISPERSION COEFFICIENTS σ_y and σ_z

The dispersion coefficients σ_y and σ_z (miles) indicate the amount the pollutant plume has spread (dispersed) after leaving its source. To avoid unrealistic behavior of the σ functions at very high and very low wind speeds, the following formulas are used:

$$\sigma_y \equiv \sigma_y(T) = \text{Max}\left[\sigma_{yT}(T), \sigma_{yx}(x)\right], \quad (1)$$

$$\text{and } \sigma_z \equiv \sigma_z(T) = \text{Max}\left[\sigma_{zT}(T), \sigma_{zx}(x)\right], \quad (2)$$

where x is the downwind distance and $T = x/u$ is the travel time. In Eqs. (1) and (2), $\sigma_{yT}(T)$ and $\sigma_{zT}(T)$ denote the travel-time-dependent dispersion coefficients. Curves of $\sigma_{yT}(T)$ for different Turner stability classes are displayed in Figure 2.1. Turner's original values for two-hour sampling time have been converted to one-hour sampling time by multiplication with the factor $(1/2)^{0.2} = 0.87$. No conversion factor for sampling time is applied to the $\sigma_{zT}(T)$ values which are plotted in Figure 2.2. Figures 2.3 and 2.4 show the downwind-distance-dependent dispersion coefficients $\sigma_{yx}(x)$ and $\sigma_{zx}(x)$ derived from curves in Turner's Workbook for 10-minute sampling time, by multiplying the original $\sigma_{yx}(x)$ values by $(60/10)^{.2}$ and the original $\sigma_{zx}(x)$ values by $(20/10)^{.2}$. In doing so we have assumed that the vertical dispersion coefficient is insensitive to sampling times beyond 20 minutes, as suggested by Slade.

2.2 POINT SOURCE DISPERSION EQUATIONS

The short-term average concentration χ_p at the recptor point (x,y,z) due to a point source at

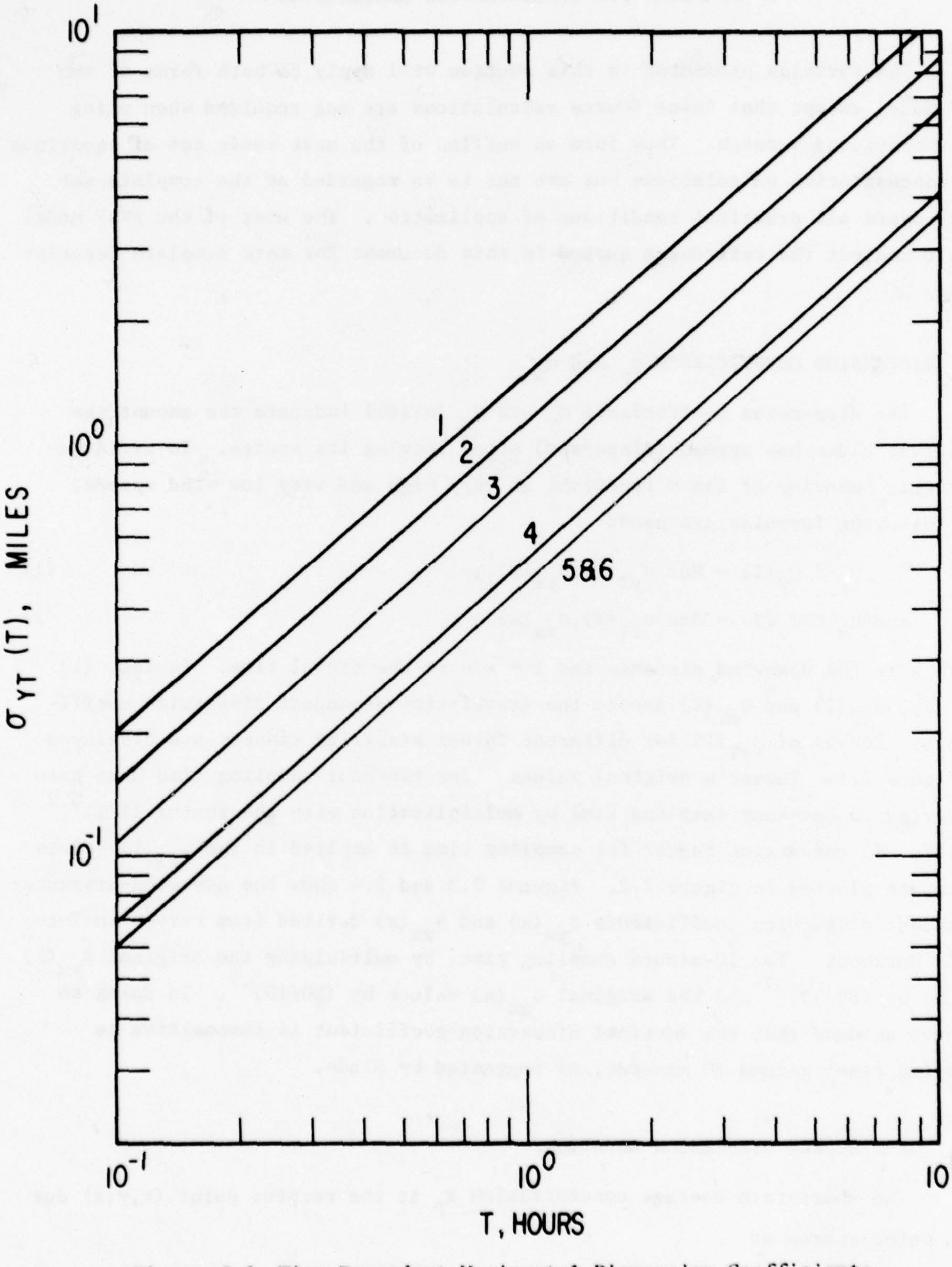

Figure 2.1. Time-Dependent Horizontal Dispersion Coefficients for 1-Hour Sampling Time.

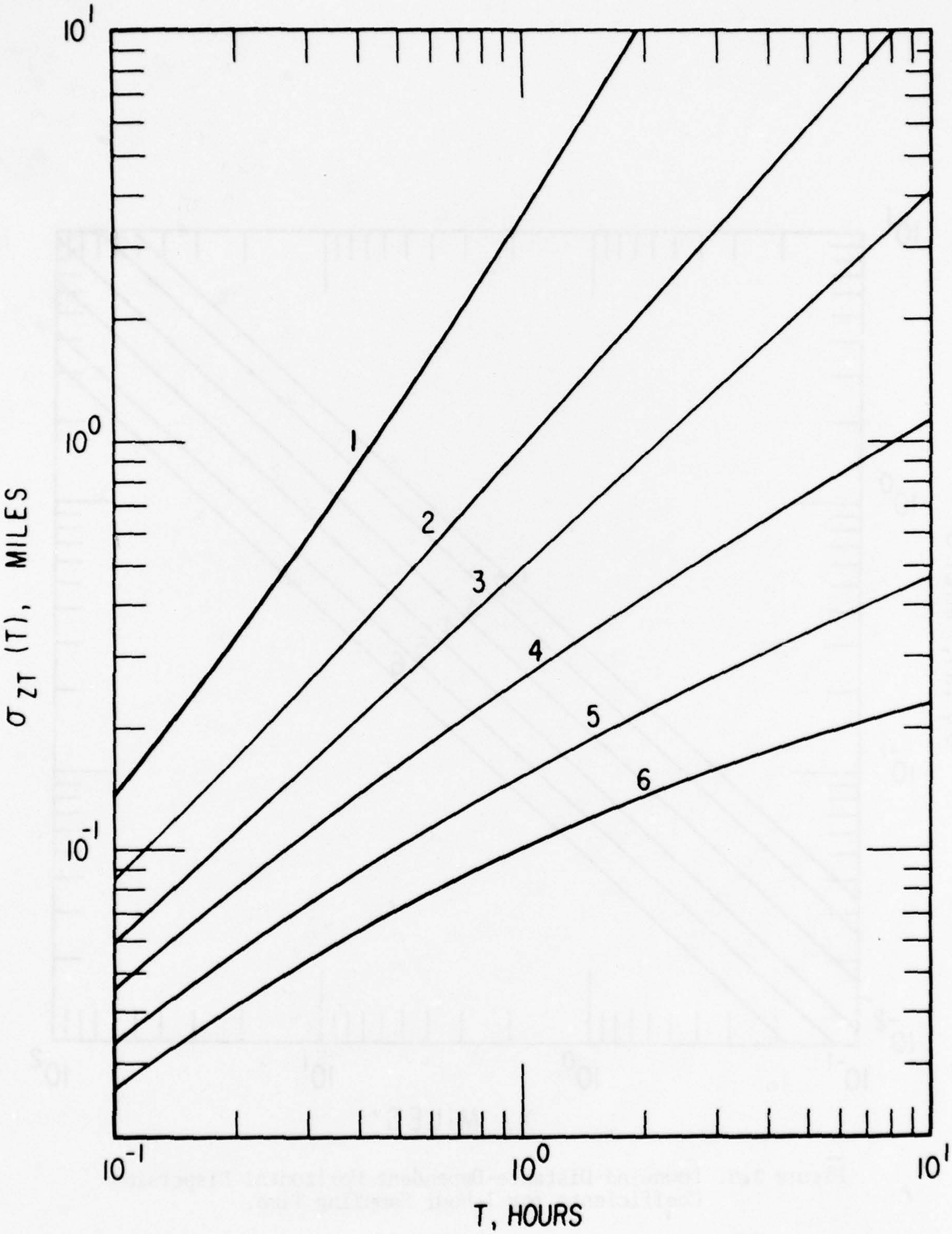

Figure 2.2. Time-Dependent Vertical Dispersion Coefficients for 1-Hour Sampling Time.

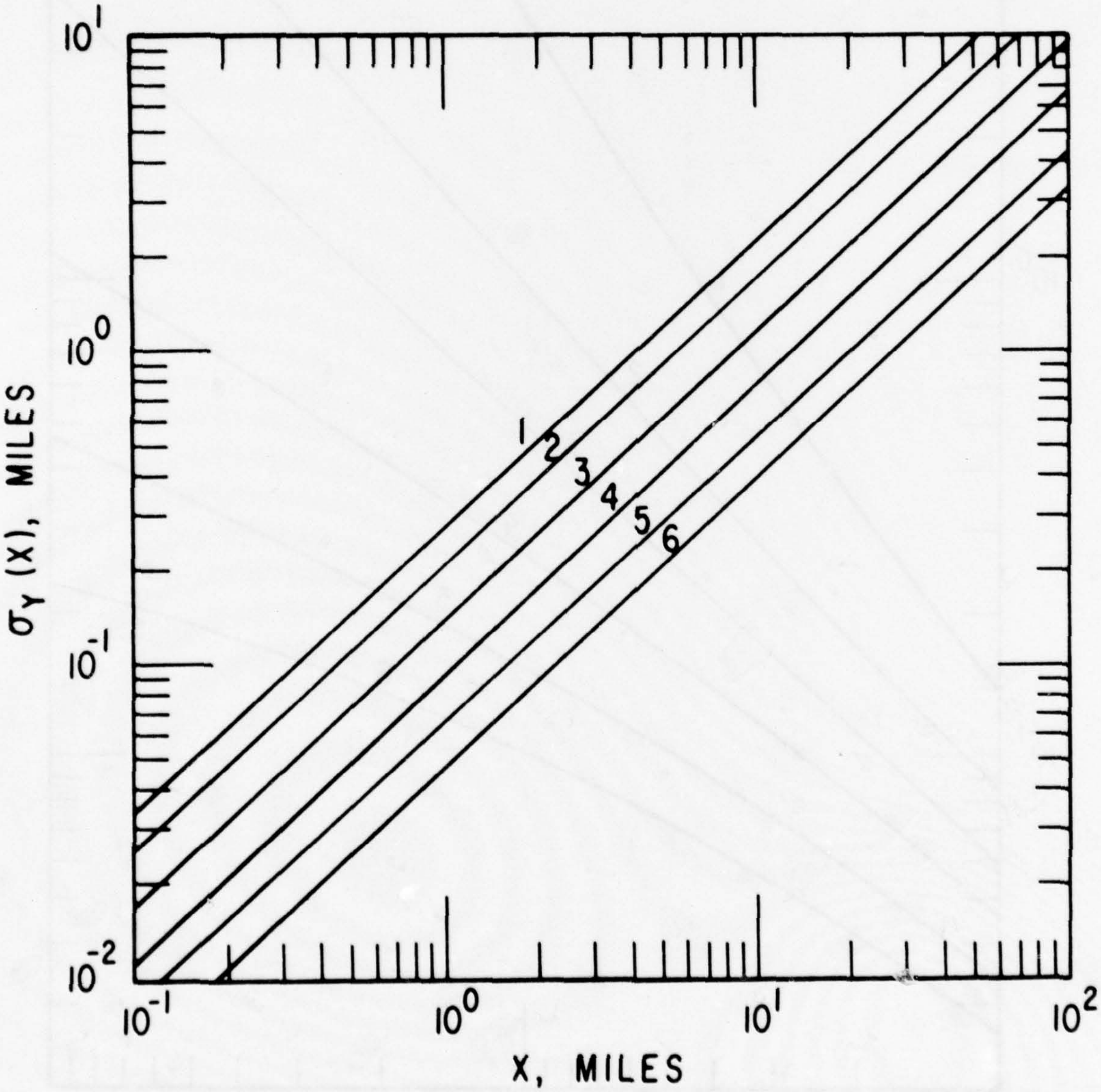

Figure 2.3. Downwind-Distance-Dependent Horizontal Dispersion Coefficients for 1-Hour Sampling Time.

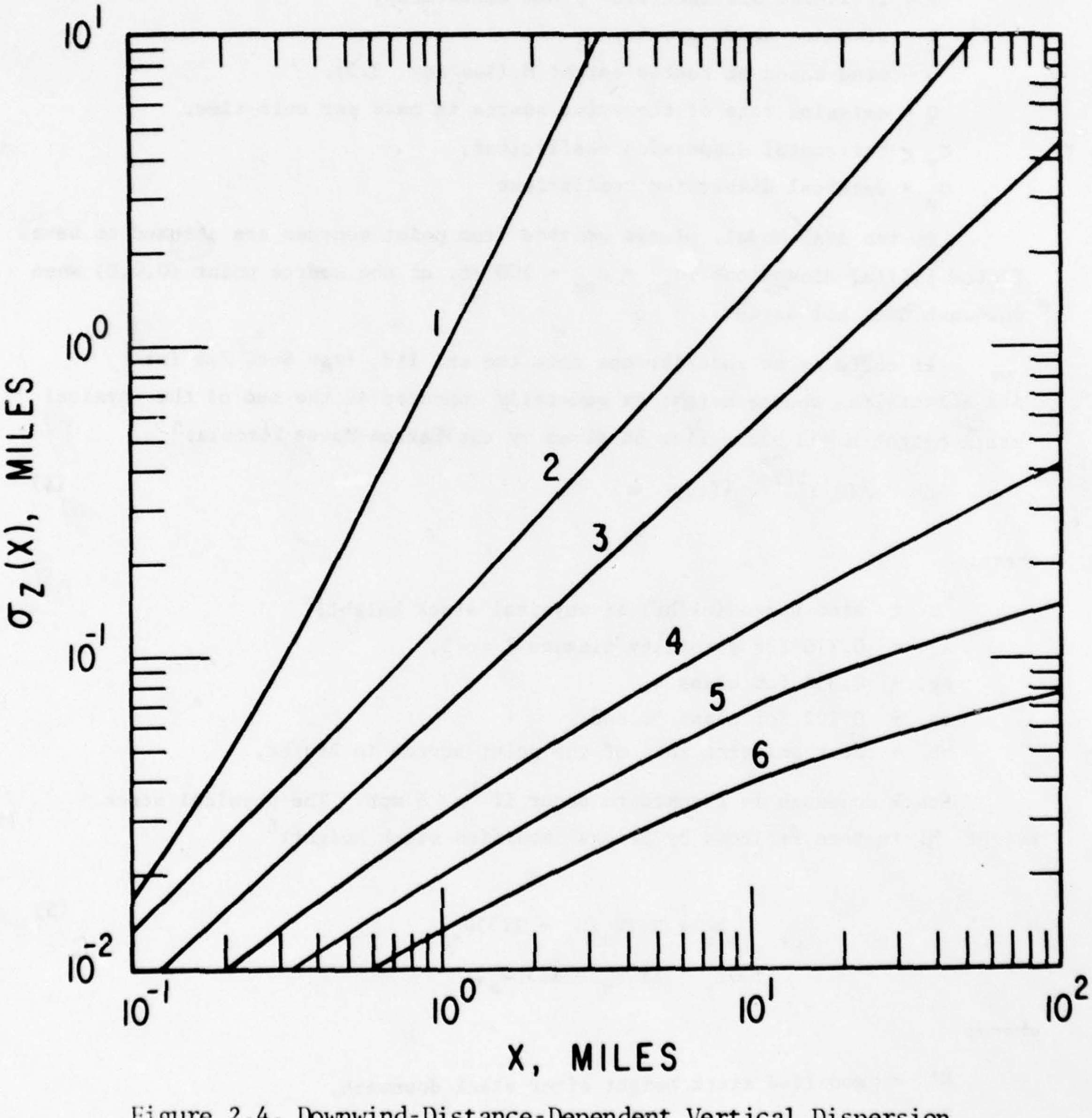

Figure 2.4. Downwind-Distance-Dependent Vertical Dispersion Coefficients for 1-Hour Sampling Time.

$$\chi_p = \frac{Q}{2\pi u\sigma_y\sigma_z} \exp\left[-\frac{1}{2}\left(\frac{Y}{\sigma_y}\right)^2\right] \cdot \left\{\exp\left[-\frac{1}{2}\left(\frac{Z-H}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{Z+H}{\sigma_z}\right)^2\right]\right\}. \quad (3)$$

where

- y = crosswind distance from plume centerline,
- Z = distance above ground,
- u = wind speed at source height H (See Sec. 2.5).
- Q = emission rate of the point source in mass per unit time,
- σ_y = horizontal dispersion coefficient,
- σ_z = vertical dispersion coefficient

In the AVAP Model, plumes emitted from point sources are assumed to have finite initial dimensions ($\sigma_{yo} = \sigma_{zo}$ = 100 ft. at the source point (0,0,H) when downwash does not appear).

If there is no interference from the ski lid, (see Sec. 2.6 for its effects)the source height is generally computed as the sum of the physical stack height h and plume rise Δh given by the Carson-Moses formula:[5]

$$\Delta h = A(Q_h)^{1/2}/U_s \text{(ft)}, \quad (4)$$

where:

- U_s = wind speed (mi/hr) at physical stack height,
- A = 0.870 for stability classes 1 to 3,
- sgl = 0.354 for class 4,
- sp = 0.222 for class 5, and
- Q_h = heat emission rate of the point source in Btu/hr.

Stack downwash is assumed to occur if $U_s > 6$ mph. The physical stack height h is then replaced by Briggs' modified stack height:[6]

$$h' = \begin{cases} Z_s + 2\,(V_s/U_s - 1.5)D_s, \\ Z_s \quad \text{if } V_s > 1.5\,U_s, \end{cases} \quad (5)$$

where:

- h' = modified stack height after stack downwash,
- V_s = stack effluent velocity, and
- D_s = stack diameter.

Also, with stack downwash the initial plume dimensions are reassigned in the AVAP Model to simulate average city block size and building height (σ_{yo} = 250 ft; σ_{zo} = 40 ft).

For point sources with poor aerodynamic characteristics, such as vents or very short stacks on buildings, σ_{yo} is automatically assumed to be 250 ft and the building height h is used to compute σ_{zo} ($\sigma_{zo} = h/1.2$). If h is not supplied by the user the default value of 40 ft is used for σ_{zo}.

2.3 AREA SOURCE DISPERSION EQUATIONS

In the AVAP Model, two sets of dispersion equations are used for area sources. For convenience, area sources are classified as "near" sources and "far" sources depending on the relative location of the receptor and the area source.

First, the critical distance for mixing, x_c, is computed from the mixing height value L by the equation

$$\sigma_z(T = x_c/u) = 0.47\ L. \qquad (6)$$

If the critical distance measured upwind from the receptor is downwind of the downwind edge of the area source, the area source is defined as a "far" source. If the critical distance measured upwind from the receptor extends beyond the upwind edge of the source, the entire area source is treated as "near." There will be cases in which an area source is partitioned into a "near" and a "far" source relative to the receptor. The detailed logic for area source classification is presented in Appendix B on p. B-14.

The far area sources are treated conventionally, with the horizontal and vertical dispersions represented separately, each by an upwind virtual point source, so that at the downwind edge of the area source $\sigma_y = \sigma_{yo}$ and at the center $\sigma_z = \sigma_{zo}$. For an area source of side length d and vertical spread h, the initial Gaussian widths are given by $\sigma_{yo} = d/2.4$ and $\sigma_{zo} = h/1.2$.

For a complete discussion of the treatment of near area sources, the reader is referred to a separate report.[7] Briefly, it is to treat the area source in such a manner that the z component is represented by an upwind virtual line segment along the wind direction instead of a single point, with the simplifying assumption that σ_y is held constant over the area source. The z - component is analytically integrated over the line segment. Therefore, for receptor locations immediately downwind of the area source, the model is expected to give more realistic concentration profiles than the conventional area source model.

The short-term average concentration χ_a at the receptor point (x,y,z), due to an area source having its geometrical center at $(0,0,Z_a)$, is given by

$$\chi_a = \frac{Q_a \cdot F}{2\pi\,\sigma_y d(1-b)} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \cdot$$
$$\cdot \left\{\exp\left[-\frac{1}{2}\left(\frac{Z - Z_a}{\sigma_z(T_2)}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{Z + Z_a}{\sigma_z(T_2)}\right)^2\right]\right\}, \quad (7)$$

where, $F = \frac{T_2}{\sigma_z(T_2)} - \frac{T_1}{\sigma_z(T_1)}$,

$$b = \frac{\ell n(\sigma_z(T_1)/\sigma_z(T_2))}{\ell_n(T_1/T_2)}$$

If b = 1, the factor F/(1-b) in Eq. 7 should be replaced by $T_1\ \ell n(T_2/T_1)/\sigma_z(T_1)$.

In the above equations, T_1 denotes the sum of T_z (pseudo travel time corresponding to σ_{zo}) and the travel time from the downwind edge of the area source to the receptor, and T_2 denotes the sum of T_z and the travel time from the upwind edge of the area source to the receptor. If the receptor is inside the area source, $T_1 = 0$. σ_y is computed with a travel time so that $\sigma_y = d/2.4$ at the downwind edge of the source, or if the receptor is inside the source it is assumed to be d/2.4 at the receptor.

2.4 FINITE LINE SOURCE DISPERSION EQUATIONS

The short-term average concentration χ_ℓ at the receptor point (x,y,z) due to a finite line source with inclination angle θ relative to ground, aximuthal angle ϕ relative to the wind vector and its end points at (0,0,0) and (Lcos θ cos ϕ, Lcos θ sin ϕ, Lsin θ) is given by

$$\chi_\ell = \frac{q_\ell}{2\pi\ u\bar{\sigma}_y\bar{\sigma}_z} \cdot J, \quad (8)$$

with

$$J = (\sqrt{\pi}/2) \cdot A \cdot \sum_{i=1}^{2} \left\{\exp\left(B_i^2 - C_i^2\right)\left[\operatorname{erf}\left(B_i + L/A\right) - \operatorname{erf}(B_i)\right]\right\}$$

where

$$A = \sqrt{2}\ \bar{\sigma}_y\ \bar{\sigma}_z\ \left(\cos^2\theta\ \sin^2\phi\ \bar{\sigma}_z^{\,2} + \sin^2\theta\ \bar{\sigma}_y^{\,2}\right)^{-1/2}$$

$$B_1 = -2\left(\bar{\sigma}_y\,\bar{\sigma}_z\right)^{-2}\ .A.\left[y\cos\theta\ \sin\phi\ \bar{\sigma}_z^{\ 2} + (Z-H)\ \sin\theta\ \bar{\sigma}_y^{\ 2}\right],$$

$$B_2 = -2\left(\bar{\sigma}_y\,\bar{\sigma}_z\right)^{-2}\ .A.\left[y\cos\theta\ \sin\phi\ \bar{\sigma}_z^{\ 2} + (Z+H)\ \sin\theta\ \bar{\sigma}_y^{\ 2}\right],$$

$$C_1 = \left[\frac{y^2}{2\bar{\sigma}_y^{\ 2}} + \frac{(Z-H)^2}{2\bar{\sigma}_z^{\ 2}}\right]^{1/2},$$

$$C_2 = \left[\frac{y^2}{2\bar{\sigma}_y^{\ 2}} + \frac{(Z+H)^2}{2\bar{\sigma}_z^{\ 2}}\right]^{1/2}.$$

The above formula is applicable only under certain conditions. For a complete discussion of the various criteria and the reasons behind them, the user is referred to Refs. 8 and 9. Normally, when the line source subtends a sufficiently large angle relative to the wind vector, for example, a uniform, horizontal line with ϕ greater than 45°, the formula is used without the segmentation scheme discussed in the references mentioned above. The dispersion coefficients $\bar{\sigma}_y$ and $\bar{\sigma}_z$ are evaluated with an effective downwind distance corresponding to a point on the line that is directly upwind of the receptor. When the relative angle is very small ($\leq 10°$), the following approximation formula is used:

$$\chi_{\ell o} = \frac{1}{2\sqrt{2\pi}}\left(\frac{q_{\ell L}}{u}\right)\left(\bar{\sigma}_y\,\bar{\sigma}_z\right)^{-1}\ \exp\left[-\frac{y^2}{2\bar{\sigma}_y^{\ 2}} - \frac{z^2}{2\bar{\sigma}_y^{\ 2}}\right]. \qquad (9)$$

Again, for a long line source, the line is divided into shorter segments, and an effective $\bar{\sigma}_y$ and $\bar{\sigma}_z$ for each segment is evaluated for the downwind distance corresponding to the midpoint of the segment. For angles between 10° and 45° Eq. 8 is used with the segmentation scheme.

2.5 WIND PROFILE LAW

To convert the wind speed measured by anemometer at a local airport (typically 30 ft above ground) to that at the physical stack height h or to that at the effective source height H we use a power law relation of the form:

$$u(Z) = u(Z_o)\ (Z/Z_o)^P. \qquad (10)$$

The exponent P, as determined by DeMarrais[10], depends on the stability class and is given in Table 2.1.

Table 2.1 Exponents for Wind Profile

Stability Class		P
Unstable	(≤ 3)	0.2
Neutral	(4)	0.3
Stable	(5)	0.4
Very Stable	(6)	0.5

2.6 EFFECTS OF SKY LID

The lower surface of an elevated inversion layer is referred to as the sky lid, and as a rough approximation it is assumed to act as a perfect reflector. Thus the plume would generally be reflected repeatedly from two parallel surfaces, the ground and the sky lid. If the reflected plumes from a point source are represented by multiple image sources (see Fig. 2.5), then the net concentration at the receptor can be expressed in terms of a multiple image series:

$$\chi_p = \sum_{i=0}^{N} \chi_{pi} , \tag{11}$$

where χ_{po} = concentration due to original source, and

χ_{pi} = concentration due to i^{th} image source.

The above formula is used with N = 6 (i.e., three image sources below ground and three above the sky lid) when the downwind distance x of the receptor from the source is less than 2 x_c as calculated from Eq.(6). For downwind distances $x \geq 2 x_c$, the net concentration is calculated with the assumption of full mixing in the mixing layer, and

$$\chi_p = \frac{Q}{\sqrt{2\pi}\ Lu\ \sigma_y} \exp\left[- 1/2 \left(\frac{y}{\sigma_y}\right)^2 \right] . \tag{12}$$

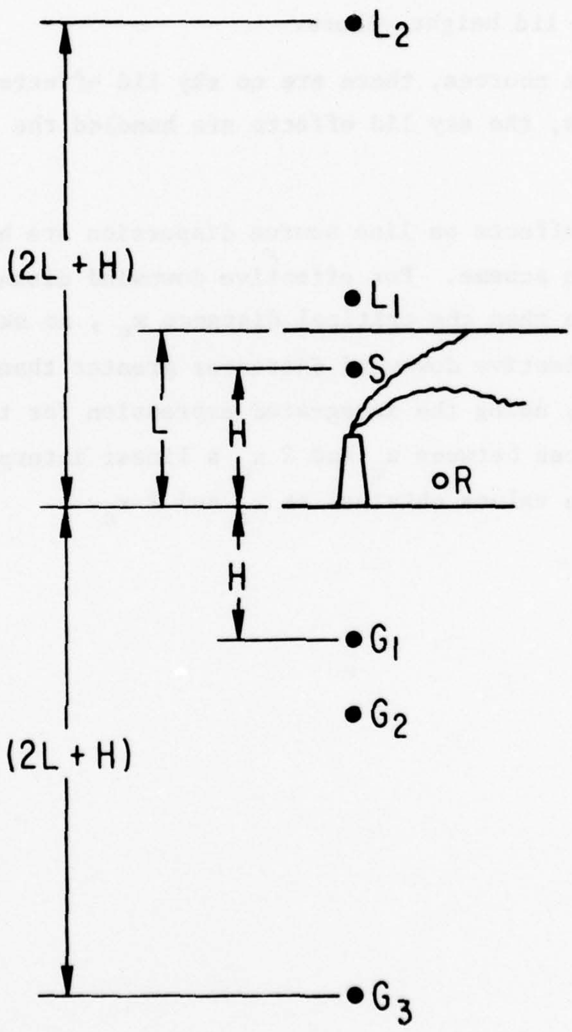

Figure 2.5. Multiple Reflections Between a Stable Layer and Ground Represented by Two Sets of Image Sources.

For some point sources (e.g., power plants with tall stacks), the calculated effective emission height H may be greater than the lid height, especially when the latter is small. These cases are not eliminated from consideration in the AVAP Model, but are simulated by using dispersion coefficients and plume rise for stably stratified air (stability class 5). Depending on the relative position of the lid, the physical stack height, and the computed effective stack height, the model will in some cases reassign the effective stack height or the lid height values.

For near area sources, there are no sky lid effects by definition. For far area sources, the sky lid effects are handled the same way as the point sources.

The sky lid effects on line source dispersion are handled by a simple linear interpolation scheme. For effective downwind distances (see Section 2.4 for definition) less than the critical distance x_c, no sky lid effects are assumed; and for effective downwind distances greater than 2 x_c, uniform vertical mixing is assumed by using the integrated expression for the Z-component. For downwind distances between x_c and 2 x_c a linear interpolation is applied to the concentration values obtained at x_c and 2 x_c.

3 DESCRIPTION OF INPUT

The first six (6) cards in the data deck (see Table 3.1) are the problem title and program parameter input cards required for every application of the model.

Card 1 is a single card of input having no computational value internal to the code. It may be punched or left blank. If punched, the same will appear as the first line of printed output.

Card 2 provides at least one identifying symbol chosen from the following set:

CO - Carbon Monoxide
THC - Total Hydrocarbons
NOX - Nitrogen Oxides
PART - Total Suspended Particulate

If the card is multiply punched, the program will calculate in turn the estimates of pollutant concentrations corresponding to the specified species.

Card 3 will provide the necessary meteorological data. Of the entries made on this card, the atmospheric stability index (JSTAB) should be deduced on the basis of wind speed, cloud cover, time of the day and other isolation parameters according to the scheme outlined by Turner[13]. Then lid height (NLID), if not obtainable by processing local sounding data, is estimated on the basis of JSTAB and the monthly average afternoon maximum mixing depths (meters above surface) tabulated by Holzworth[11]. The twelve (12) average values that are directly coded into the program (FUNCTION HMIX) apply to the Washington, D.C., region and are ordered by month (NMONTH) as follows: 400, 570, 1000, 930, 1120, 1310, 1180, 990, 980, 570, 680, and 480 (meters).

Card 4 provides an accounting of the receptors (points at which the model must estimate the pollutant concentration), the aircraft and aircraft-engine types, and the airport-access vehicle roadways. The aircraft area source comprises four emission sources: (1) ground service vehicles, (2) auxiliary poweruunits, (3) aircraft taxi within the area, and (4) aircraft-engine idle within the area. Therefore, an entry should exclude the aircraft area source (NACA=0) whenever the effects of all the above emission sources are suppressed. The non-aircraft area source is assigned pollutant emission levels later in the input stream, but may be excluded by setting NANA to zero (0).

Card 5 provides the indicators for user selected input. All of the punched card columns require that all corresponding card numbers, punched with all associated data, appear in the appropriate order of the input stream. For example, columns 18 and 21 are punched in order to indicate that card number 10 and card number 11 will appear in the input stream (see Table 3.1). Both of these bears entries for the number of engines with which each aircraft type is equipped, and the second bears entries that indicate the engine types.

Card 6 provides the location of specific receptor points.

The remainder of the input data deck is described in a list form in order to identify clearly those cards that are required for every application of the model and those cards that are used to over-ride program default values.

Card 7 thru Card 11	Refer to default values on page 27.
Card 12	Refer to default values on page 28.
Card 13	Refer to default values on page 30.
Card 14	Airport runway coordinates are always present.
Card 15	Refer to default values on page 30.
Card 16 thru Card 18	Refer to default values on page 29.
Card 19	Refer to default values on page 30.
Card 20 and Card 21	Airport taxiway coordinates are always present.
Card 22	Refer to default values on page 30.
Card 23 and 24	Runway apron coordinates are always present.
Card 25 thru Card 27	Refer to default values on page 30.
Card 28	Is required for access vehicle roadway coordinates.
Card 29	Is required for airport terminal area coordinates.
Card 30 and Card 31	Refer to default values on page 30.
Card 32	Refer to default values on page 31.
Card 33	Refer to default values on page 29.
Card 34	Refer to default values on page 31.
Card 35 and Card 36	Refer to default values on page 29.
Card 37	Is required for airport non-aircraft area coordinates.
Card 38	Is required for airport non-aircraft area pollutant emission level.

Note that, for the hour of interest, the user specifies the number of arriving aircraft of each type in Card 7. The number of aircraft departing during that same hour is assumed equal to the number of arrivals.

Table 3.1. Card Input Sequence

Card Type	Columns	Format	Comment
1 (1 card)* TITLE	1-80	(20A4)	Title card may be punched or left blank.
2 (1 card)*			
CO	1-2	(A4)	Four fields having four columns each are provided
THC	5-7	(A4)	so that one or more pollutant species may be
NOx	9-11	(A4)	chosen for the model run.
PART	13-16	(A4)	
3 (1 card)*			
HTAERO	1-8	F8.0	Height (feet) at which wind speed and direction are measured.
WSP	9-16	F8.0	Wind speed (knots).
DIR	17-24	F8.0	Wind direction (degrees).
TEMP	25-32	F8.0	Ambient temperature (degrees F).
JSTAB	33-40	I8	Atmospheric stability index.
NLID	41-48	I8	Lid height (tens of feet).
MONTH	49-50	I2	Month of year (required whenever NLID=0).
NR	51-52	I2	Hour of day (required whenever NLID=0 and JSTAB=4).
4 (1 card)*		I5	
NSR	16-20	I5	The total number (≤20) of receptor locations at which the model must estimate pollutant levels
NACT	21-25	I5	The number (≤10) of different aircraft types (B727, TØ, etc.) using airport facilities.
NENT	26-30	I5	The number (≤5) of different aircraft engine types (JT8D,TPE331) with which the above aircraft are equipped.
NAVR	31-35	I5	The number (≤60) of motor vehicle roadways leading into the airport.
NACA	36-40	I5	1 if aircraft area source is included. 0 otherwise.
NANA	41-45	I5	1 if non-aircraft area source is included. 0 otherwise.
5 (1 card)+			**If a blank or zero appears in any column the default value is used.**
DFAULT = 1	9	I3	**Card 7 data -- user defined.**
2	12	I3	**Card 8 data -- user defined.**
3	15	I3	**Card 9 data -- user defined.**
4	18	I3	**Card 10 data -- user defined.**
5	21	I3	**Card 11 data -- user defined.**
6	24	I3	**Card 12 data -- user defined.**
7	27	I3	**Card 13 data -- user defined.**
8	30	I3	**Card 15 data -- user defined.**
9	33	I3	**Card 16 data -- user defined.**
10	35-36	I3	**Card 17 data -- user defined.**
11	38-39	I3	**Card 18 data -- user defined.**
12	41-42	I3	**Card 19 data -- user defined.**
13	44-45	I3	**Card 22 data -- user defined.**
14	47-48	I3	**Card 25 data -- user defined.**
15	50-51	I3	**Card 26 data -- user defined.**
16	53-54	I3	**Card 27 data -- user defined.**

Table 3.1. Card Input Sequence (contd.)

ard Type	Columns	Format	Comment
17	56-57		Card 30 data -- user defined.
18	59-60		Card 31 data -- user defined.
19	62-63		Card 32 data -- user defined.
20	65-66		Card 33 data -- user defined.
21	68-69		Card 34 data -- user defined.
22	71-72		Card 35 data -- user defined.
23	74-75		Card 36 data -- user defined.
6 (NSR cards)*			
NRUSED	1-2	I2	Any reference number.
XRECP	3-10	F8.0	X coordinate of receptor (mi
YRECP	11-18	F8.0	Y coordinate of receptor (mi
ZRECP	17-26	F8.0	Height of receptor (ft
7 (1 card)			
NAC(K)	6-55	(5X, 10I5)	NACT entries of the number of arriving aircraft of each type K. (Number of departures assumed to be the same as the *number of arrivals).*
8 (1 card)			
FLNDG(K)	6-55	(5X, 10F5.0)	NACT entries of time (hours) in landing mode for aircraft type K.
9 (1 card)			
FTKOF(K)	6-55	(5X, 10F5.0)	NACT entries of time (hours) in take-off mode for aircraft type K.
0 (1 card)			
NGIN(K)	6-55	(5X,10I5)	NACT entries for the number of engines with which aircraft type K is equipped.
1 (1 card)			
INGN(K)	6-55	(5X,10I5)	NACT entries for the engine type with which aircraft type K is equipped.
2 (NENT x 4 cards)			
EMI (I,J,K)	16-55	(15X, 5F10.0)	For each of the above engine types, enter an emission rate (lbs/hr) for each pollutant K (specified on card type 2). Cards 1 thru 4 for each engine type throttle setting will correspond to taxi, idle, landing and take-off modes, respectively.
3 (1 card)			
DSRW	16-25	F10.0	Width (mi) of initial dispersion on runway.
HRW	26-35	F10.0	Height (mi) of initial dispersion on runway.

Table 3.1. Card Input Sequence (contd.)

Card Type		Columns	Format	Comment
	17	56-57		Card 30 data -- user defined.
	18	59-60		Card 31 data -- user defined.
	19	62-63		Card 32 data -- user defined.
	20	65-66		Card 33 data -- user defined.
	21	68-69		Card 34 data -- user defined.
	22	71-72		Card 35 data -- user defined.
	23	74-75		Card 36 data -- user defined.
6 (NSR cards)*				
NRUSED		1-2	I2	Any reference number.
XRECP		3-10	F8.0	X coordinate of receptor (mi
YRECP		11-18	F8.0	Y coordinate of receptor (mi
ZRECP		17-26	F8.0	Height of receptor (ft
7 (1 card)				
NAC(K)		6-55	(5X, 10I5)	NACT entries of the number of arriving aircraft of each type K. (Number of departures assumed to be the same as the number of arrivals).
8 (1 card)				
FLNDG(K)		6-55	(5X, 10F5.0)	NACT entries of time (hours) in landing mode for aircraft type K.
9 (1 card)				
FTKOF(K)		6-55	(5X, 10F5.0)	NACT entries of time (hours) in take-off mode for aircraft type K.
10 (1 card)				
NGIN(K)		6-55	(5X,10I5)	NACT entries for the number of engines with which aircraft type K is equipped.
11 (1 card)				
INGN(K)		6-55	(5X,10I5)	NACT entries for the engine type with which aircraft type K is equipped.
12 (NENT x 4 cards)				
EMI (I,J,K)		16-55	(15X, 5F10.0)	For each of the above engine types, enter an emission rate (lbs/hr) for each pollutant K (specified on card type 2). Cards 1 thru 4 for each engine type throttle setting will correspond to taxi, idle, landing and take-off modes, respectively.
13 (1 card)				
DSRW		16-25	F10.0	Width (mi) of initial dispersion on runway.
HRW		26-35	F10.0	Height (mi) of initial dispersion on runway.

Table 3.1. Card Input Sequence (contd.)

Card Type	Columns	Format	Comment
14 (1 card)*			
X1	16-25	F10.0	X coordinate of runway (mi) (Aircraft touch-down end)
Y1	26-35	F10.0	Y coordinate of runway (mi) (Aircraft touch-down end)
Z1	36-45	F10.0	Z height (ft) of runway. (Aircraft touch-down end)
X2	46-55	F10.0	X2 coordinate of opposite end point (mi)
Y2	56-65	F10.0	Y2 coordinate of opposite end point (mi)
Z2	66-75	F10.0	Z2 height of opposite end point (ft)
15 (1 card)			
VA1	16-25	F10.0	Initial velocity of arriving aircraft (mi/hr)
VA2	26-35	F10.0	Final velocity of arriving aircraft (mi/hr)
VD1	36-45	F10.0	Initial velocity of departing aircraft (mi/hr)
VD2	46-55	F10.0	Final velocity of departing aircraft (mi/hr)
TIME	56-65	F10.0	Aircraft take-off roll-time (hrs)
TAIL	66-75	F10.0	Exhaust tail length (mi)
16 (1 card)			
FTAXI(K)	6-55	(5X, 10F5.0)	NACT entries of aircraft taxi speed (mi/hr) while in the gate area for each aircraft type K.
17 (1 card)			
FTXII(K)	6-55	(5X, 10F5.0)	NACT entries of aircraft inbound taxi speed (mi/hr)
18 (1 card)			
FTXIO(K)	6-55	(5X, 10F5.0)	NACT entries of aircraft outbound taxi speed (mi/hr)
19 (1 card)			
DSTW	16-25	F10.1	Width (mi) of initial dispersion on taxiway.
HTW	26-35	F10.1	Height (mi) of initial dispersion on taxiway.
20 (1 card)*			
X1	16-25	F10.0	X coordinate of inbound taxiway (mi)
Y1	26-35		Y coordinate of inbound taxiway (mi)
Z1	36-45		Z height of inbound taxiway (ft)
X2	46-55		X2 coordinate of inbound taxiway (mi) (Airport terminal end)
Y2	56-65		Y2 coordinate of inbound taxiway (mi) (Airport terminal end)
Z2	66-75		Z2 height of inbound taxiway (ft) (Airport terminal end)

Table 3.1. Card Input Sequence, (contd.)

Card Type	Columns	Format	Comment
21 (1 card)*			
X1	16-25	F10.0	X coordinate of outbound taxiway (mi)
Y1	26-35	F10.0	Y coordinate of outbound taxiway (mi)
Z1	36-45	F10.0	Z height of outbound taxiway (ft)
X2	46-55	F10.0	X2 coordinate of outbound taxiway (mi) (apron end)
Y2	56-65	F10.0	Y2 coordinate of outbound taxiway (mi) (apron end)
Z2	66-75	F10.0	Z2 height of outbound taxiway (ft) (apron end)
22 (1 card)			
DSRA	16-25	F10.0	Width (mi) of initial dispersion on apron.
HRA	26-35	F10.0	Height (mi) of initial dispersion on apron.
23 (1 card)*			
X1	16-25	F10.0	X coordinate of inbound apron (mi)
Y1	26-35	F10.0	Y coordinate of inbound apron (mi)
Z1	36-45	F10.0	Z height of inbound apron (ft)
X2	46-55	F10.0	X2 coordinate of inbound apron (mi) (from here we start the inbound taxiway)
Y2			Y2 coordinate of inbound apron (mi) (from here we start the inbound taxiway)
Z2			Z2 height of inbound taxiway (ft)
24 (1 card)*			
X1	16-25	F10.0	X coordinate of outbound apron (mi)
Y1	26-35	F10.0	Y coordinate of outbound apron (mi)
Z1	36-45	F10.0	Z height of outbound apron (ft)
X2	46-55	F10.0	X2 coordinate of outbound apron (mi)
Y2	56-65	F10.0	Y2 coordinate of outbound apron (mi)
Z2	66-75	F10.0	Z2 height of outbound apron (ft)
25 (1 card) Omit if NAVR = 0.			
EFUH(J)	16-65	(15X, 5F10.0)	For each of the pollutants specified on card type 2, enter the urban automobile emission factor (gm/km) based on 25 mi/hr traffic speed.
26 (1 card) Omit if NAVR =0.			
EFUL(J)	16-65	(15X, 5F10.0)	For each of the pollutants specified on card type 2, enter the urban automobile emission factor (gm/km) based on 10 mi/hr traffic speed.
27 (1 card) Omit if NAVR = 0.			
DSAR	16-25	F10.0	Width (mi) of initial dispersion on access roadways.
HAR	26-35	F10.0	Height (mi) of initial dispersion on access roadways.

Also, with stack downwash the initial plume dimensions are reassigned in the AVAP Model to simulate average city block size and building height (σ_{yo} = 250 ft; σ_{zo} = 40 ft).

Table 3.1. Card Input Sequence (contd.)

Card Type	Columns	Format	Comment
28 (NAVR cards)*			Access vehicle roadways:
X1	11-20	F10.0	X coordinate of first end point (mi)
Y1	21-30	F10.0	Y coordinate of first end point (mi)
Z1	31-40	F10.0	Z coordinate of first end point (ft)
X2	41-50	F10.0	X coordinate of second end point (mi)
Y2	51-60	F10.0	Y coordinate of second end point (mi)
Z2	61-70	F10.0	Z coordinate of second end point (ft)
VNOON	71-78	F8.0	Average traffic volume
IFS	79-80	I2	Roadway classification: 1=congested, 0=non-congested
29 (1 card)*	Omit if NACA = 0.		
XS	16-25	F10.0	X coordinate of terminal area center (mi)
YS	26-35	F10.0	Y coordinate of terminal area center (mi)
STKH	36-45	F10.0	Height of terminal (ft)
WIT	46-55	F10.0	Side length of terminal (mi)
30 (1 card)	Omit if NACA = 0.		Pollutant emission rate of diesel engine powered service vehicles.
EFD(1)	16-25	F10.0	CO (gm/gal)
EFD(2)	26-35	F10.0	HC (gm/gal)
EFD(3)	36-45	F10.0	NOx (gm/gal)
EFD(4)	46-55	F10.0	PART (gm/gal)
EFD(5)	56-65	F10.0	SOx (gm/gal)
31 (1 card)	Omit if NACA = 0.		Pollutant emission rate of gasoline engine powered service vehicles.
EFG(1)	16-25	F10.0	CO (gm/mi)
EFG(2)	26-35	F10.0	HC (gm/mi)
EFG(3)	36-45	F10.0	NOx (gm/mi)
EFG(4)	46-55	F10.0	PART (gm/mi)
EFG(5)	56-65	F10.0	SOx (gm/mi)
32 (14 cards)	Omit if NACA = 0.		
SRVTIM(1,K)	6-55		NACT entries of service vehicle operation time (min) during the aircraft service operation in the terminal area. See Page 31 for a list of 14 modeled service vehicles.
33 (1 card)	Omit if NACA = 0.		
KAPU(K)	6-55	(5X, 10I5)	NACT entries denoting 1=the use of an auxiliary power unit: 0=no auxiliary power unit used for aircraft type K.
34 (1 card)	Omit if NACA = 0.		
APU(J)	16-65	(15X, 5F10.0)	For each of the pollutants specified on card type 2, enter the emission factors (lb/hr) for auxiliary power units.

expected to give more realistic concentration profiles than the conventional area source model.

Table 3.1. Card Input Sequence (contd.)

Card Type	Columns	Format	Comment
35 (1 card)	Omit if NACA = 0.		
FIDLE(K)	6-55	(5X, 10F5.0)	NACT entries of time (hr) for aircraft K engine idle.
36 (1 card)	Omit if NACA = 0.		
TGND(K)	6-55	(5X, 10F5.0)	NACT entries of time (min) for aircraft K gate occupancy.
37 (1 card)*	Omit if NANA = 0.		
XS	16-25	F10.0	X coordinate of non-aircraft area source center (mi)
YS	26-35	F10.0	Y coordinate of non-aircraft area source center (mi)
STKH	36-45	F10.0	Height of non-aircraft area source (ft)
WIT	46-55	F10.0	Side length of non-aircraft area source (mi)
38 (1 card)*	Omit if NANA = 0.		
EMIT(J)	16-65	(15X, 5F10.0)	For each of the pollutants specified on card type 2, enter the non-aircraft area source emission rate (lbs/hr)

*Default values for these data are not available.

+See Table 4.1, Program Default Values by Card Input Sequence Number.

4 DESCRIPTION OF DEFAULT DATA

This section describes for the user what is required as input data should the option to over-ride program constants be exericsed. Also, it lists the values of program constants (Table 4.1) as they appear in the BLOCK DATA subprogram of the computer code. All or some of the values will change whenever the appropriate card is inserted into the input stream.

The computer program is designed to model activity of ten (10) different aircraft types. These are listed in the first column of Table 4.1 (page 27) and may be replaced with types having identical, or nearly identical operational parameters, engine configurations, and ground service requirements. ments.

Operational parameters include time period values during which the aircraft-engine throttle setting is adjusted to one of the following operational modes:

1 Landing - Aircraft touch-down to beginning of taxi on the inbound apron.

2 Take-off - After alignment of aircraft with runway to liftoff.

3 Idle - Arriving aircraft awaiting gate position.

These operating times are shown in Table 4.1, page 27, columns 3 and 4, and page 29, column 6, respectively. Other operational parameters presented on page 29, columns 2, 3 and 4 consider the speed of aircraft while they are in the gate area, on the inbound taxiway and on the outbound taxiway, respectively. Those that detail the average performance characteristics of all aircraft types during flight modes of operation are shown on page 30 (Card 15).

Engine configuration and their emission characteristics are assigned integer values to denote for each aircraft type, and each engine type the number of engines per aircraft and their pollutant emission rates during 4 modes of operation (Taxi, Idle, Landing and Take-off). These values are shown in Table 4.1, page 27, columns 5 and 6 respectively, with corresponding pollutant emission rate shown on page 28.

The ground serivce requirements of each aircraft type are fulfilled using fourteen (14) different pieces of motorized equipment (page 31, Card 32), all of which operate within the gate area to load and unload cargo and otherwise prepare the airplane for its next departure. It can be seen by the service times entered into the table that the equipment in use is dependent upon the type of aircraft being serviced. The pollutant emission rates (page 30, Cards 30, 31) are presented for both diesel and gasoline engine powered equipment. Note that an auxiliary power unit will provide electrical power, whenever used (Page 29, Column 5), for the entire gate time (Page 29, Column 7) of the aircraft. Its emissions rates are shown on Page 31, Card 34.

Table 4.1. Program Default Values by Card Input Sequence

Aircraft Type	Card 7 Hourly Arrivals	Card 8 Time (hr) Landing	Card 9 Time (hr) Take-off	Card 10 Number of Engines	Card 11 Engine Type
1 (Boeing 727)	10	0.0153	0.0111	3	1 (JT8D)
2 (Douglas DC9)	10	0.0153	0.0111	2	1 (JT8D)
3 (Boeing 737)	10	0.0153	0.0111	2	1 (JT8D)
4 (Convair 580)	10	0.0153	0.0111	2	3 (A-501-D13)
5 (BAC 111)	10	0.0153	0.0111	2	4 (SPEY-511)
6 (NAMC YS11)	10	0.0153	0.0111	2	3 (A-501-D13)
7 (Beech 99)	10	0.0110	0.0111	2	2 (TPE 331)
8 (Fairchild FH-227)	10	0.0153	0.0111	2	3 (A-501-D13)
9 (Twin Otter)	10	0.0110	0.0111	2	2 (TPE 331)
10 (Piston Engine)	10	0.0110	0.0111	2	5 (320)

Table 4.1. Program Default Values by Card Input Sequence (Contd)

Card 12 Pollutant Emission Rate for Each Engine Type During 4 Modes of Operation (lbs/hr)

		CO	HC	NO_x	PART	SO_2
Engine Type 1 (JT8D)	Taxi	37.0	9.0	2.0	0.5	0.9
	Idle	37.0	9.0	2.0	0.5	0.9
	Landing	25.6	5.6	36.3	6.8	3.2
	Take-off	6.0	0.4	133.3	21.0	8.6
Engine Type 2 (TPE 331)	Taxi	3.53	0.88	0.96	0.10	0.5
	Idle	3.53	0.88	0.96	0.10	0.5
	Landing	2.58	0.24	1.69	0.38	0.9
	Take-off	0.39	0.05	3.64	0.62	1.9
Engine Type 3 (All. 501-D13)	Taxi	15.0	6.0	2.0	0.10	0.5
	Idle	15.0	6.0	2.0	0.10	0.5
	Landing	10.1	3.8	8.0	0.30	0.9
	Take-off	2.0	0.4	23.0	0.60	1.9
Engine Type 4 (Spey 511)	Taxi	60.0	66.0	1.0	0.04	0.6
	Idle	60.0	66.0	1.0	0.04	0.6
	Landing	45.6	40.3	42.1	0.30	2.2
	Take-off	14.0	0.0	153.0	0.80	6.2
Engine Type 5 (Ø-320)	Taxi	11.41	0.38	0.01	0.06	0.01
	Idle	11.41	0.38	0.01	0.06	0.01
	Landing	11.41	0.38	0.01	0.06	0.01
	Take-off	72.52	1.66	0.23	0.12	0.07

Table 4.1 (Cont'd)

Card 13	Initial dimensions of dispersion on runway. Width = DSRW = 0.030 miles Height = HRW = 0.002 miles
Card 15	Runway parameters for arrival and departure aircraft. VA1 = Runway - arrival initial velocity = 145 (mi/hr) VA2 = Runway - arrival final velocity = 25 (mi/hr) VD1 = Runway - departure initial velocity = 0.0 (mi/hr) VD2 = Runway - departure final velocity = 180 (mi/hr) TIME = Take-off roll time = .0111 (hrs) TAIL = Exhaust tail length = .8523 (mi)
Card 19	Initial dimensions of dispersion on taxiway. Width = DSTW = 0.030 (mi) Height = HTW = 0.002 (mi)
Card 22	Initial dimensions of dispersion on runway apron. Width = DSRA = 0.095 (mi) Height = HRA = 0.002 (mi)
Card 25	Urban automobile pollutant emission factors (gm/km) based on 25 (mi/hr) traffic speed. CO = 32.36, HC = 4.75, NO_x = 3.46, PART = 0.19, SO_x = 0.11
Card 26	Urban automobile pollutant emission factors (gm/km) based on 10 (mi/hr) traffic speed. CO = 70.18, HC = 8.62, NO_x = 2.86, PART = 0.19, SO_x = 0.11
Card 27	Initial dimensions of dispersion on access roadway. Width = DSAR = 0.0095 (mi) Height = HAR = 0.001 (mi)
Card 30	Pollutant emission factor for diesel engine powered service vehicles in (gm/gal). CO = 126.6, HC = 21.9, NO_x = 185.82, PART = 5.9, SO_x = 0.0
Card 31	Pollutant emission factor for gasoline engine powered service vehicles in (gm/mi). CO = 138.81, HC = 21.35, NO_x = 9.32, PART = 0.85, SO_x = 0.0

Table 4.1 (Cont'd)

Aircraft Type	Card 16 Speed (mi/hr) Gate area taxi	Card 17 Speed (mi/hr) Inbound taxi	Card 18 Speed (mi/hr) Outbound taxi	Card 33 APU use flags	Card 35 Time (hr) Engine idle	Card 36 Time (min) Gate occupancy
1 (Boeing 727)	10	15	12	1	.033	52.
2 (Douglas DC9)	10	15	12	1	.033	52.
3 (Boeing 737)	10	15	12	1	.033	52.
4 (Conviar 580)	10	15	12	1	.033	52.
5 (BAC 111)	10	15	12	0	.033	52.
6 (NAMCO YS 11)	10	15	12	0	.033	52.
7 (Beech 99)	10	15	12	0	.033	52.
8 (Fairchild FH 227)	10	15	12	0	.033	52.
9 (Twin Otter)	10	15	12	0	.033	52.
10 (Piston Engine)	10	15	12	0	.033	52.

Table 4.1 (Cont'd)

Card 34 Pollutant emission factors for auxiliary power units in (lbs/hr).

$CO = 2.82$, $HC = 0.11$, $NO_x = 1.24$, $PART = 0.0$, $SO_x = 0.0$

Card 32. Minutes of Service Vehicle Operation While Servicing Aircraft Type I

Vehicle Type	Aircraft Type 1* 727	 2* DC9	 3* 737	 4* C5	 5 BAC	 6 YS	 7 B9	 8 FH	 9 TO	 10 GA
1 Tractor	66	48	85	55	50	50	0	0	0	0
2 Belt Loader	28	15	30	0	25	25	0	0	0	0
3 Container Loader	6	0	0	0	0	0	0	0	0	0
4 Cabin Service	12	0	15	0	0	0	0	0	0	0
5 Lavatory Truck	15	15	15	10	10	10	5	5	5	0
6 Water Truck	0	10	0	10	10	10	5	5	5	0
7 Food Truck	17	17	20	10	10	10	0	0	0	0
8 Fuel Truck	20	15	15	10	20	20	10	10	10	0
9 Tow Tractor	10	5	5	5	5	5	0	0	0	0
10 Conditioner	0	0	0	0	0	0	0	0	0	0
11 Airstart Transporting and Diesel Engines	0	0	0	0	0	0	0	0	0	0
12 Ground Power Transporting and Gasoline Engines	0	0	0	0	0	0	0	0	0	0
13 Ground Power Unit Diesel Engine	0	0	0	0	0	0	0	0	0	0
14 Transporter	3	0	0	0	0	0	0	0	0	0

*Also serviced by an Auxiliary Power Unit (APU)

5 EXAMPLE PROBLEM

5.1 INTRODUCTION

In order to clarify the procedure for using the AVAP Model Abbreviated Version, a "first-guess" estimate of pollutant concentration is presented for the example airport-layout shown in Figure 5.1 . It is instructive to state that the locations of line type sources (runway, taxiway, apron, access roadway) are specified by the coordinates at their edge (from end to end), but the locations of airport terminal and non-aircraft area sources are specified by the coordinates at their center. Since aircraft movement on the runway is almost always into the wind (given as 180 degrees) the pattern of runway-apron-taxiway usage emerges. The pattern, for the airport-layout shown, is clockwise starting from the northern most point of the runway (landing aircraft touch-down). The input coordinates must be ordered to preserve this pattern. Therefore, all aircraft prepared for departure are queued before take-off on Apron 2 (outbound).

In this example, of the ten different aircraft types for which the Abbreviated Version is internally coded, seven are considered. They are listed with their associated engine type as follows:

(Boeing 727 & 737, Douglas DC9) JT8D turbofan engine
(Beech 99) TPE 331 turboprop engine
(Convair 580, NAMC YS11) All. 501-D13 turboprop engine
(Small Piston Engine aircraft) Ø320 small piston engine

5.2 STATEMENT OF THE PROBLEM

GIVEN: Two pollutant species: Carbon Monoxide and Oxides of Nitrogen

Height of aerovane	10 ft
Wind speed	13 knots
Wind direction	180 degrees
Ambient temperature	36 degrees F
Stability index	4
Lid height	0 (Uses coded table from Holzworth)

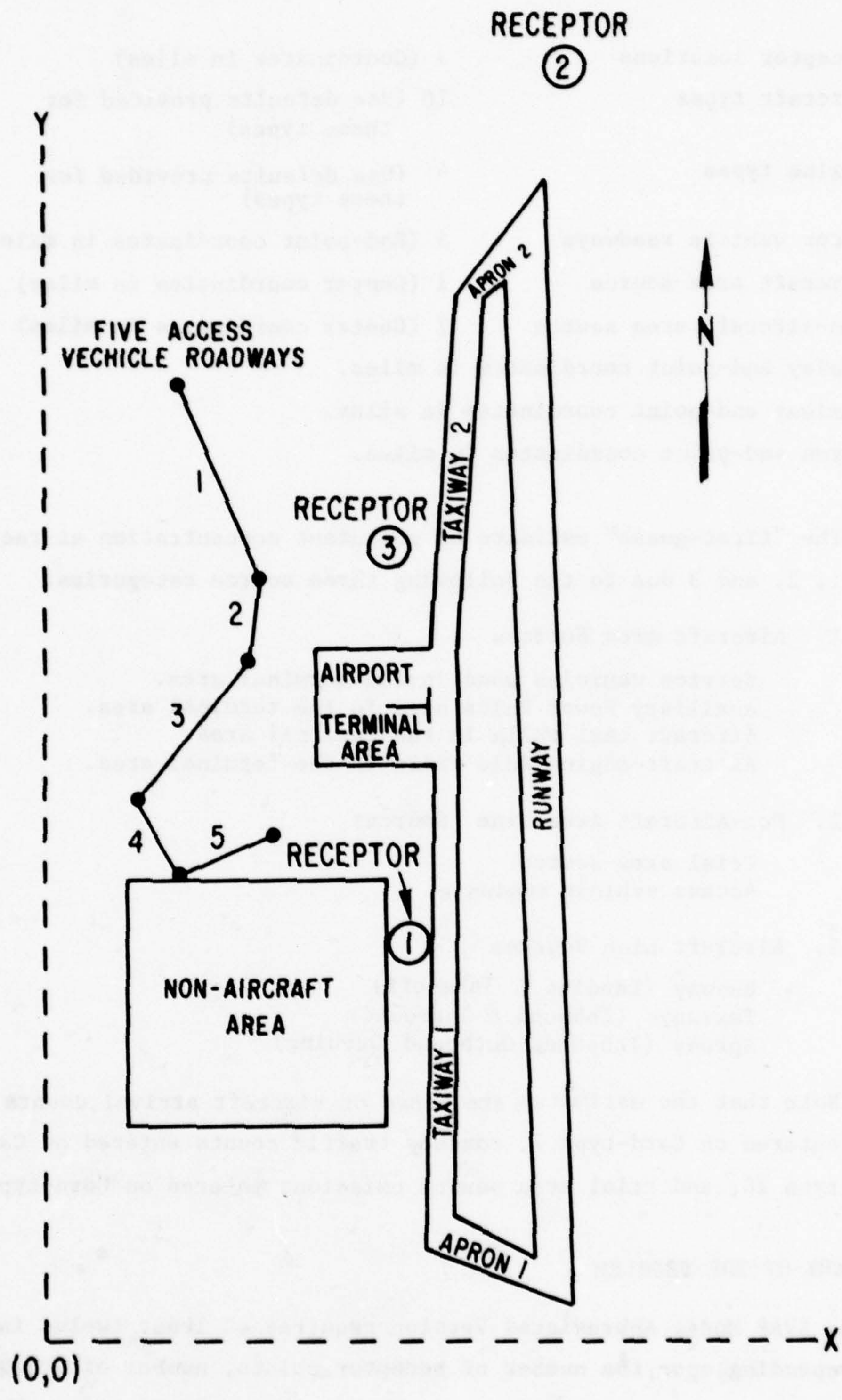

Figure 5.1 Example Airport-Layout

Receptor locations	3 (Coordinates in miles)
Aircraft types	10 (Use defaults provided for these types)
Engine types	4 (Use defaults provided for these types)
Motor vehicle roadways	5 (End-point coordinates in miles)
Aircraft area source	1 (Center coordinates in miles)
Non-aircraft area source	1 (Center coordinates in miles)

Runway end-point coordinates in miles.

Taxiway end-point coordinates in miles.

Apron end-point coordinates in miles.

FIND: The "first-guess" estimate of pollutant concentration at receptors 1, 2, and 3 due to the following three source categories:

1. Aircraft Area Sources

    Service vehicles used in the terminal area.
    Auxiliary Power Units used in the terminal area.
    Aircraft taxi while in the terminal area.
    Aircraft-engine idle while in the terminal area.

2. Non-Aircraft Area-Line Sources

    Trial area source
    Access vehicle roadways

3. Aircraft Line Sources

    Runway (Landing & Take-off)
    Taxiways (Inbound & Outbound)
    Aprons (Inbound, Outbound Queuing)

Note that the estimates are based on aircraft arrival counts entered on Card-type 7, roadway traffic counts entered on Card-type 28, and trial area source emissions entered on Card-type 38.

5.3 SUMMARY OF THE PROBLEM

The AVAP Model Abbreviated Version requires at least twelve input cards. Depending upon the number of receptor points, number of access vehicle roadways and choice of default values, there may be more. The format for each card is given in Table 3.1. Table 5.1 lists the input for the sample problem; Table 5.2 lists the results. Note that a descriptive list of program values starts the table of results. Also note that a tabulation of pollutant emission levels for each area and line type source is provided. The micrograms-per-cubic-meter notation, as seen in the concentrations tabulation, is used for Total Suspended Particulates (PART) if it is one of the pollutants being modeled.

Table 5.1 Input for Example Problem

```
 SHORT MODEL TEST JAN. 1977     EXAMPLE 1
CO      NOX
    10.      13.      180.      36.        4          0 315         MET DATA
CONTROL CARD          3  10     4     5     1     1
CRAULT  1
 1  .447     .452    6.562
 2  .590     1.51    6.562
 3  .375     .925    6.562
A/C       7    8    2     1     0     2     1     0     0    11
RUNWAY COORD.             .524        1.338          10.       .616       .063          10.
TAXIWAY COORD 1           .473         .091          10.       .376       .724          10.
TAXIWAY COORD 2           .376         .801          10.       .438      1.240          10.
APRON COORD 1             .616         .063          10.       .473       .091          10.
APRON COORD 2             .524        1.338          10.       .438      1.240          10.
ROADWAY  1      .0730      1.0853       5.           .1938      1.0675       5.            500. 0
ROADWAY  2      .1938      1.0675       5.           .1781       .7353       5.            400. 0
ROADWAY  3      .1781       .7353       5.           .0406       .5343       5.            300. 0
ROADWAY  4      .0406       .5343       5.           .0938       .4376       5.            425. 0
ROADWAY  5      .094      .438          5.           .281       .528         5.            550. 0
A/C AREA                  .399         .753          11.       .077
NON-A/C AREA              .166         .288          16.        .3
NON-A/C EMIS             793.8         0.0           0.0        0.0        0.0
```

Table 5.2 Results of Example Problem

```
SHORT MODEL TEST JAN. 1977     EXAMPLE 1
POLLUTANT CHOICE          CO         NOX
AIRPORT PARAMETERS:
                              NUMBER OF RECEPTORS________________________________  3
                              NUMBER OF RUNWAYS__________________________________  1
                              NUMBER OF TAXIWAYS_________________________________  2
                              NUMBER OF APRONS___________________________________  2
                              NUMBER OF TERMINAL AREAS___________________________  1
                              NUMBER OF AIRCRAFT TYPES___________________________ 10
                              NUMBER OF AIRCRAFT ENGINE TYPES____________________  4
                              NUMBER OF SERVICE VEHICLE TYPES____________________ 14
                              NUMBER OF ACCESS VEHICLE ROADWAYS__________________  5
                              NUMBER OF AIRPORT NON-AIRCRAFT AREA SOURCES--------  1
   3 RECEPTOR COORDINATES (X,Y,Z):
     0.4440  0.4520  6.5620
     0.5900  1.5100  6.5620
     0.3750  0.9250  6.5620
IRU  1  2  3
 AEROVANE HEIGHT =  10.0 FT.    WIND SPEED = 14.95 MPH    WIND DIRECTION= 180. DEGREES
AMBIENT TEMPERATURE =36.0 F DEGREES  STABILITY CLASS INDEX =4  LID HEIGHT =3281.0 FT.
ARRIVAL ACTIVITY FOR AIRCRAFT TYPES 1 THROUGH 10      7  6  2  1  0  2  1  0  0 11
LANDING TIME       0.015300.015300.015300.015300.015300.015300.011000.015300.011000.0110
TAKE-OFF TIME       0.011100.011100.011100.011100.011100.011100.011100.011100.011100.0111
                1 37.00     2.00
                2 37.00     2.00
                3 25.60    36.30
                4  6.00   123.30
                1  3.53     0.96
                2  3.53     0.96
                3  2.58     1.69
                4  0.39     3.64
                1 15.00     2.00
                2 15.00     2.00
                3 10.10     8.00
                4  2.00    23.00
                1 60.00     1.00
                2 60.00     1.00
                3 45.60    42.10
                4 14.00   153.00
                1 11.41     0.01
                2 11.41     0.01
                3 11.41     0.01
                4 72.52     0.23
END-POINT COORDINATES OF RUNWAYS
      0.52400   1.53500  10.00000    0.61600    0.06300  10.00000
RUNWAY PARAMETERS:
    145.00000  25.00000   0.0       180.00000    0.01110    0.08523
TAXI SPEED           10.0  10.0  10.0  10.0  10.0  10.0  10.0  10.0  10.0  1..
INBOUND SPEED        15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  1..
OUTBOUND SPEED       12.0  12.0  12.0  12.0  12.0  12.0  12.0  12.0  12.0  1..
```

Table 5.2 Results of Example Problem (contd.)

```
END-POINT COORDINATES OF TAXIWAYS
     0.47300   0.09100  10.00000    0.37600   0.72400  10.00000
END-POINT COORDINATES OF TAXIWAYS
     0.37600   0.80100  10.00000    0.43800   1.24000  10.00000
HORIZONTAL AND VERTICAL SPREAD:
   RUNWAYS      0.01250    0.00167
   TAXIWAYS     0.01250    0.00167
   APRONS       0.09500    0.00200
END-POINT COORDINATES OF APRONS
     0.61600    0.06300    0.00189    0.47300    0.09100    0.00189
END-POINT COORDINATES OF APRONS

     0.52400    1.33800    0.00189    0.43800    1.24000    0.00189
   POLLUTANT EMISSION FACTORS-- 25MPH URBAN AUTOMOBILE TRAFFIC:
    32.36   3.46
   POLLUTANT EMISSION FACTORS-- 10 MPH URBAN AUTOMOBILE TRAFFIC:
    [illegible]   2.85
END-POINT COORDINATES, TRAFFIC INTENSITIES, AND INDICATORS OF ACCESS VEHICLE ROADWAYS
          0.07        1.09        5.00        0.19        1.07        5.00      500.00      0
          0.19        1.07        5.00        0.18        0.74        5.00      400.00      0
          0.19        0.74        5.00        0.04        0.53        5.00      300.00      0
          0.04        0.53        5.00        0.09        0.44        5.00      425.00      0
          [illegible] 0.44        5.00        0.28        0.53        5.00      550.00      0
   POLLUTANT EMISSION FACTORS(DIESEL ENGINE) GM/GAL
   CO  =       12[illegible]
   NOX =       13[illegible]
   POLLUTANT EMISSION FACTORS(GASOLINE ENGINE) GM/MI
   CO  =       138.81
   HC  =         9.[illegible]
   [illegible] VEHICLE OPERATION TIME(MIN.):
[illegible]      66.0 48.0 65.0 55.0 50.0 50.0  0.0  0.0  0.0  0.0
[illegible]      2[illegible] 15.0 30.0  0.0 25.0 25.0  0.0  0.0  0.0  0.0
[illegible]      [illegible]  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
[illegible]      12.0  0.0 15.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
[illegible]      15.0 15.0 15.0 10.0 10.0 10.0  5.0  5.0  5.0  0.0
[illegible]       0.0 10.0  0.0 10.0 10.0 10.0  5.0  5.0  5.0  0.0
[illegible]      17.0 17.0 20.0 10.0 10.0 10.0  0.0  0.0  0.0  0.0
[illegible]      20.0 15.0 15.0 10.0 20.0 20.0 10.0 10.0 10.0  0.0
[illegible]      10.0  5.0  5.0  5.0  5.0  5.0  0.0  0.0  0.0  0.0
[illegible]       0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
[illegible]       0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
[illegible]       0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
[illegible]       0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
[illegible]       0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
[illegible]             0.033000.033000.033000.033000.033000.033000.033000.033000.033000.03300
[illegible] ((X,Y),HEIGHT,WIDTH)
     [illegible]   [illegible].23800  10.00000    0.30000
```

Table 5.2 Results of Example Problem (contd.)

POLLUTANT EMISSION RATE (POUNDS)

		CO	NOX
AIRCRAFT LANDING		19.8	23.5
AIRCRAFT TAKE-OFF		20.6	62.3
INBOUND APRON		18.1	0.9
OUTBOUND QUEUING		198.8	10.3
INBOUND TAXIWAY		79.6	4.1
OUTBOUND TAXIWAY		68.9	3.6
SERVICE VEHICLE		265.0	8.8
AUX. POWER UNIT		44.0	19.3
TERM. AREA TAXI		14.4	0.7
TERM AREA ENG. IDLE		61.5	3.2
AIRCRAFT AREA		384.9	32.0
NON-AIRCRAFT AREA		793.8	0.0
ACCESS VEHICLE			
	1	7.0	0.7
	2	15.3	1.6
	3	8.4	0.9
	4	5.4	0.6
	5	13.1	1.4

Table 5.2 Results of Example Problem (contd.)

```
POLLUTANT CONCENTRATIONS : M/CM=MICROGRAMS PER CUBIC METER

          RECEPTOR   1

          COORDINATES (  0.444,   0.452)

                               CO(PPM)     NOX(PPM)
AIRCRAFT AREA                  0.0         0.0
NON-AIRCRAFT AREA-LINES        0.171       0.0
AIRCRAFT LINE                  0.303       0.010
          TOTAL                0.475       0.010
```

```
POLLUTANT CONCENTRATIONS : M/CM=MICROGRAMS PER CUBIC METER

          RECEPTOR   2

          COORDINATES (  0.590,   1.510)

                               CO(PPM)     NOX(PPM)
AIRCRAFT AREA                  0.039       0.002
NON-AIRCRAFT AREA-LINES        0.030       0.000
AIRCRAFT LINE                  0.075       0.043
          TOTAL                0.144       0.045
```

```
POLLUTANT CONCENTRATIONS : M/CM=MICROGRAMS PER CUBIC METER

          RECEPTOR   3

          COORDINATES (  0.375,   0.925)

                               CO(PPM)     NOX(PPM)
AIRCRAFT AREA                  1.413       0.072
NON-AIRCRAFT AREA-LINES        0.192       0.000
AIRCRAFT LINE                  0.410       0.013
          TOTAL                2.015       0.084
```

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7. D. M. Rote, "Airea Source Modeling," Report being prepared for the U.S. Air Force (1975).

8. D. M. Rote, I. T. Wang, L. E. Wangen, R. W. Hecht, R. R. Cirillo, and J. Pratapas, "Airport Vicinity Air Pollution Study", Report No. FAA-RD-73-113, prepared for U.S. Dept. of Transportation, Federal Aviation Administration (1973).

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10. G. A. DeMarrais, "Wind-Speed Profile at Brookhaven National Laboratory", J. Meteorol., 16, 181-190 (1959).

11. G. C. Holzworth, "Estimates of Mean Maximum Mixing Depths in the Contiguous United States, "Monthly Weather Review", 92, 235-242 (1964).

APPENDIX A

CONCENTRATION CONVERSIONS

Concentration ($\mu g/m^3$) = $1.22 \times 10^4 \frac{P}{T} \cdot MW \cdot$ concentration (ppm) where

P = pressure in atmospheres,

T = absolute temperature (°K)

MW = molecular weight

Example: NO_2

P = 1 atm

T = 77°F ≡ 25°C ≡ 273 + 25 = 298°K

MW = 14 + 32 = 46

Concentration ($\mu g/m^3$) = $1.22 \times 10^4 \times \frac{1}{298} \times 46 \times$ concentration (ppm)

= 1883 x concentration (ppm)

for T = 32°F,

Concentration ($\mu g/m^3$) = 2056 x concentration (ppm)

Note that for a pollutant class like THC or NO_x, it is customary to convert from ppm to $\mu g/m^3$ by representing the class in terms of a single pollutant such as CH_4 or NO_2. Consequently, under the same conditions as given above (T = 32°F),

THC Concentration ($\mu g/m^3$) (treated as CH_4) =

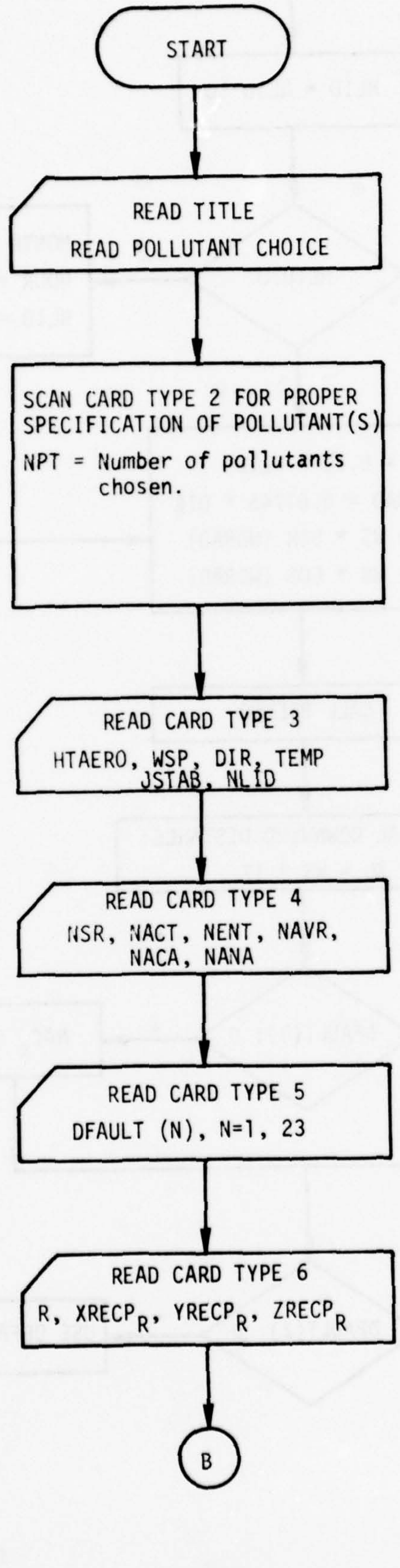
$$\frac{1.22 \times 10^4 \times 1 \times 16}{273} = 715 \times \text{THC conc. (ppm)}$$

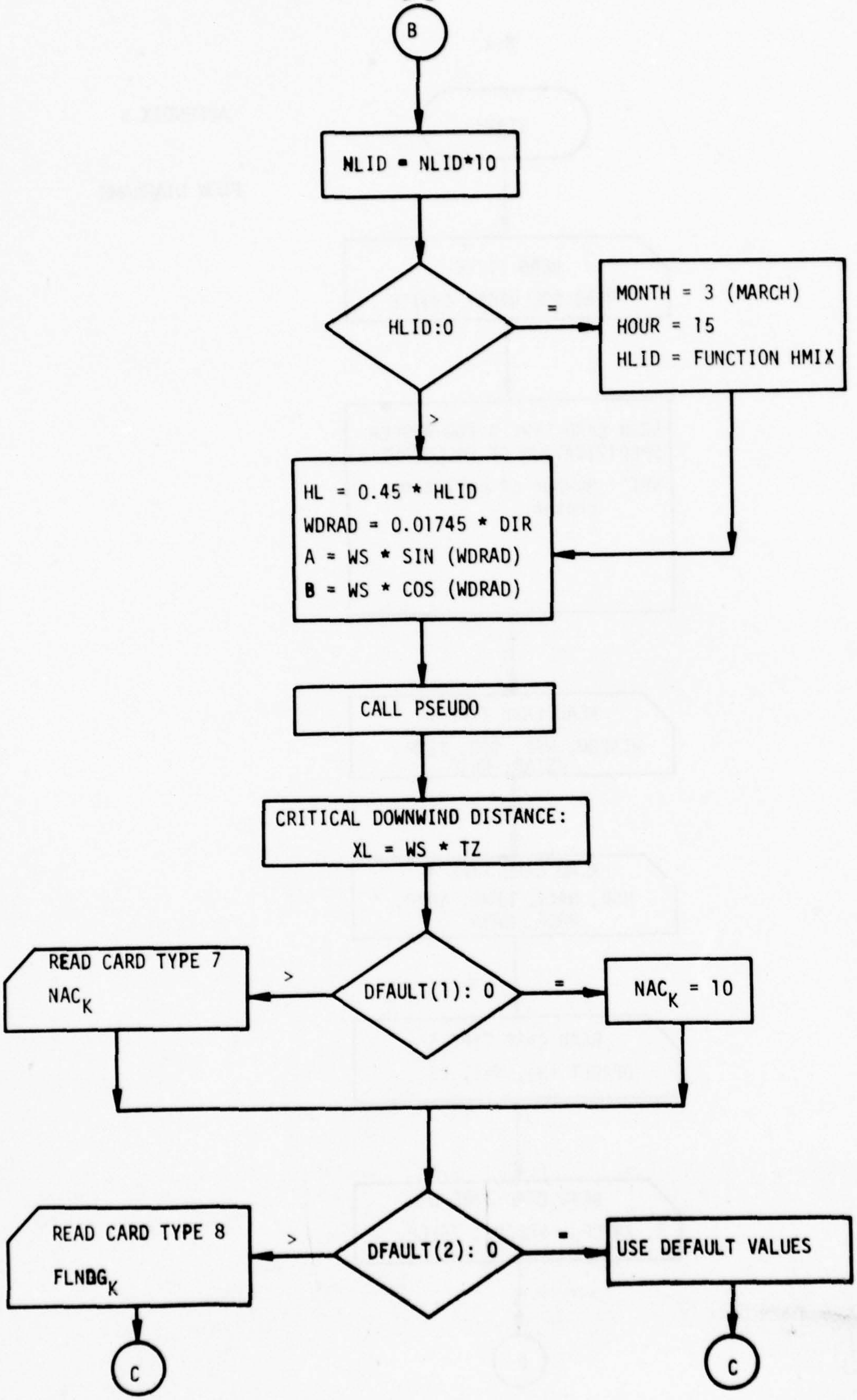
and

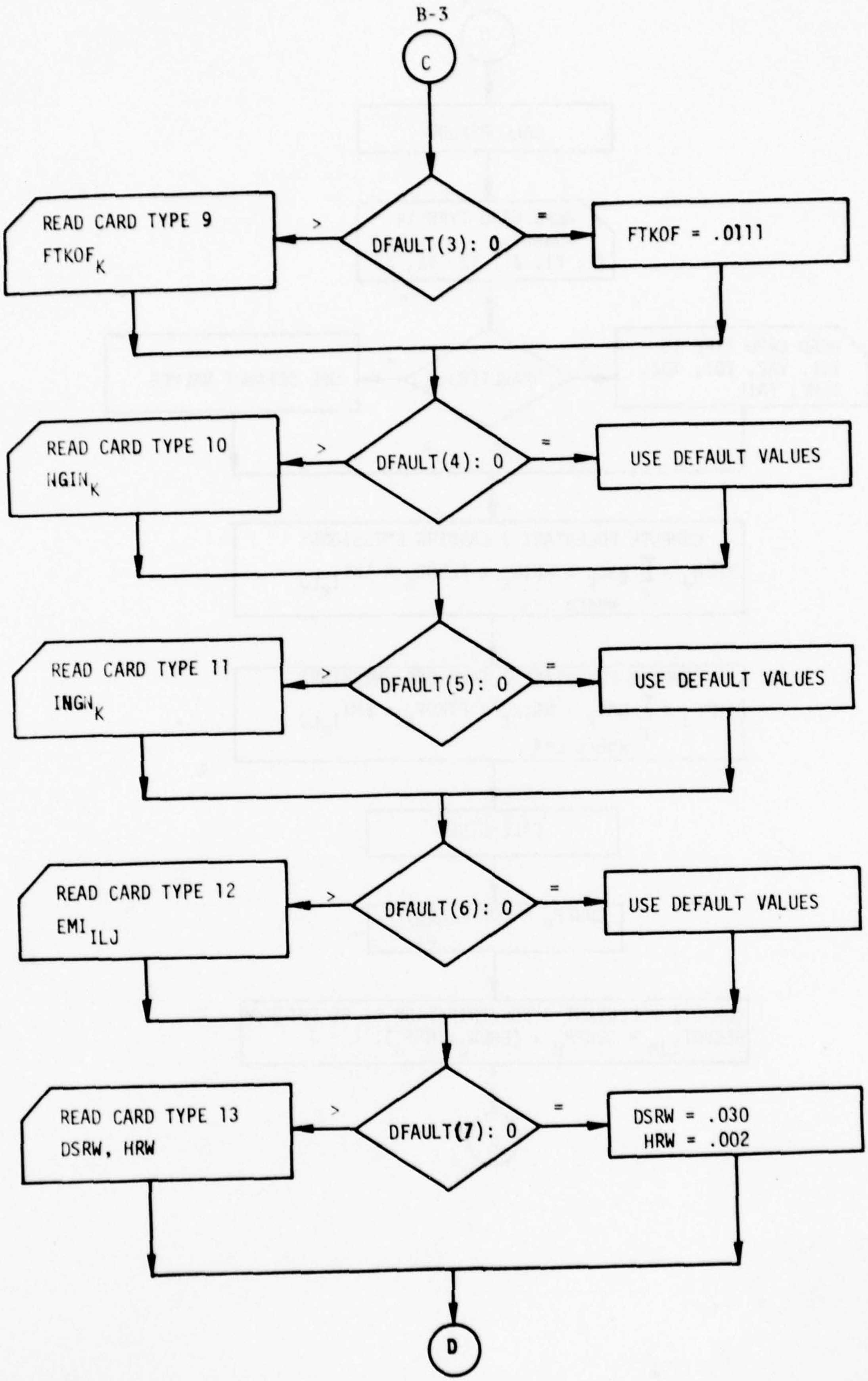
NO_x Concentration ($\mu g/m^3$) (treated as NO_2) = 2056 x NO_x conc. (ppm)

APPENDIX B

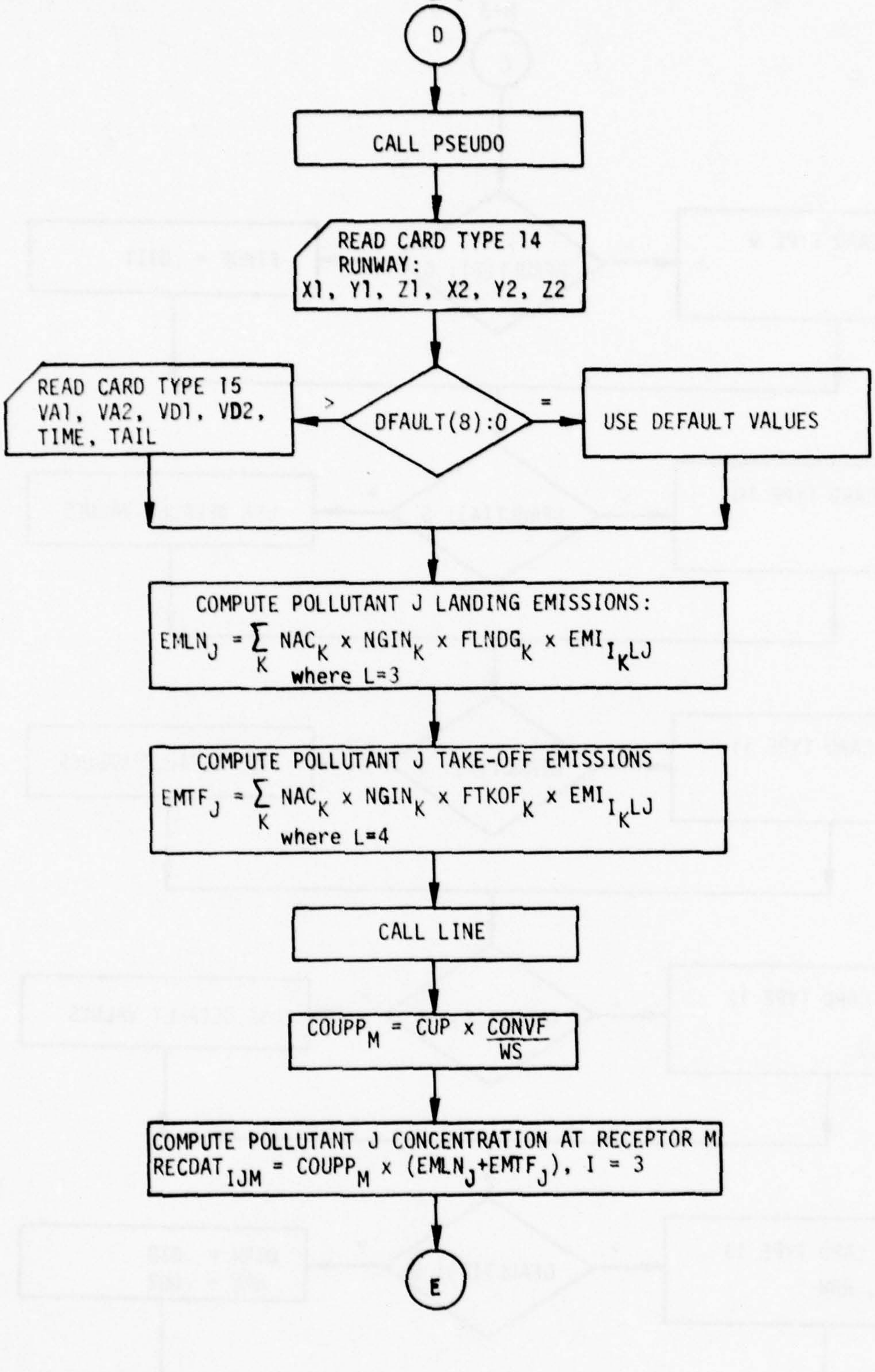
FLOW DIAGRAMS

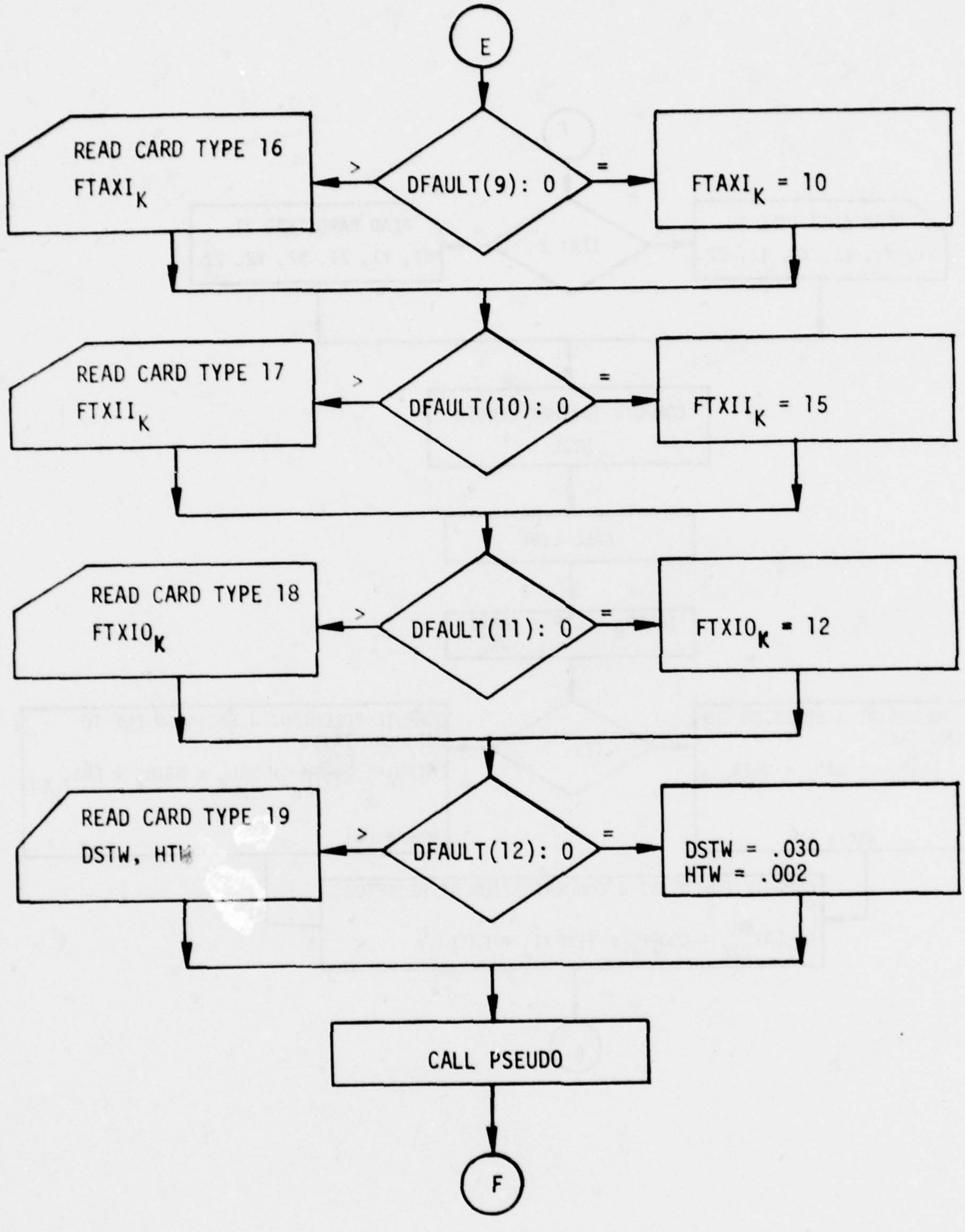


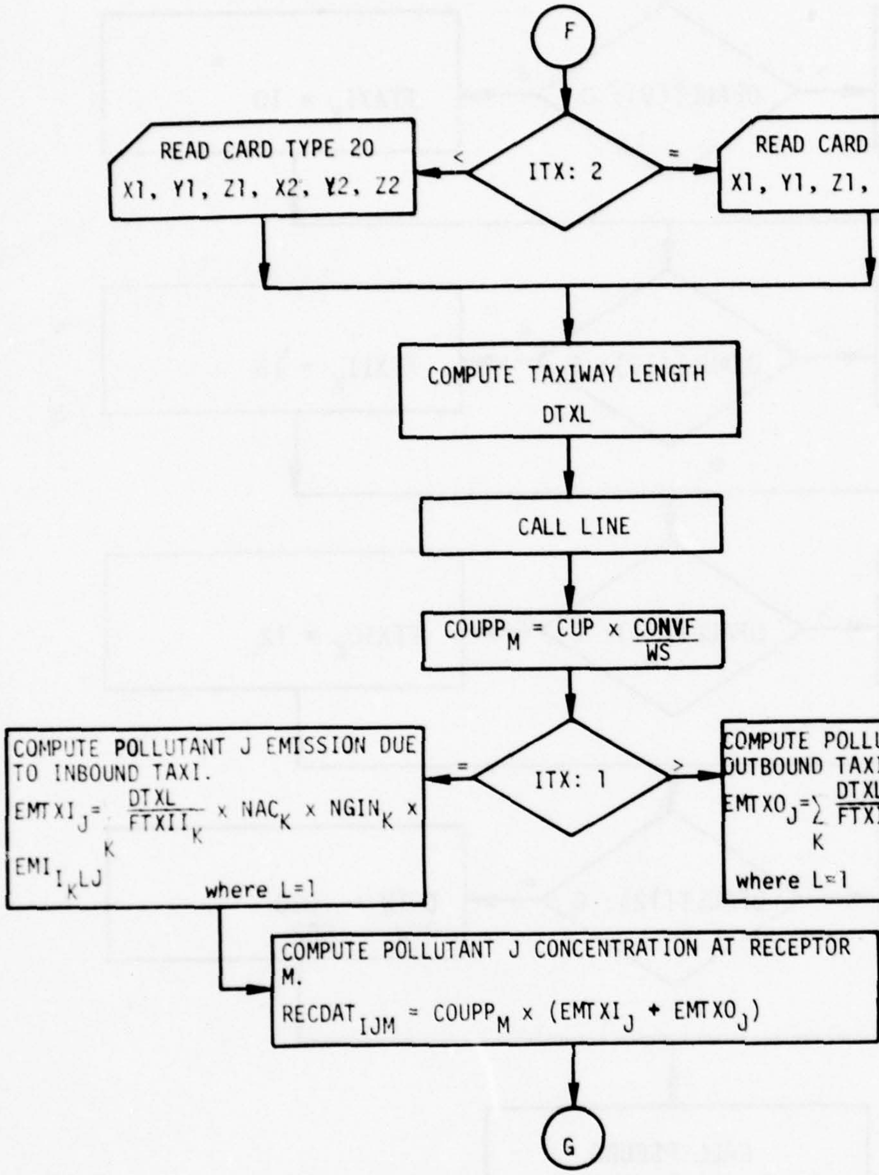

B
NLID = NLID*10
HLID:0
=
>
MONTH = 3 (MARCH)
HOUR = 15
HLID = FUNCTION HMIX
HL = 0.45 * HLID
WDRAD = 0.01745 * DIR
A = WS * SIN (WDRAD)
B = WS * COS (WDRAD)
CALL PSEUDO
CRITICAL DOWNWIND DISTANCE:
XL = WS * TZ
READ CARD TYPE 7
NAC_K
>
DFAULT(1): 0
=
NAC_K = 10
READ CARD TYPE 8
FLNDG_K
>
DFAULT(2): 0
=
USE DEFAULT VALUES
C
C

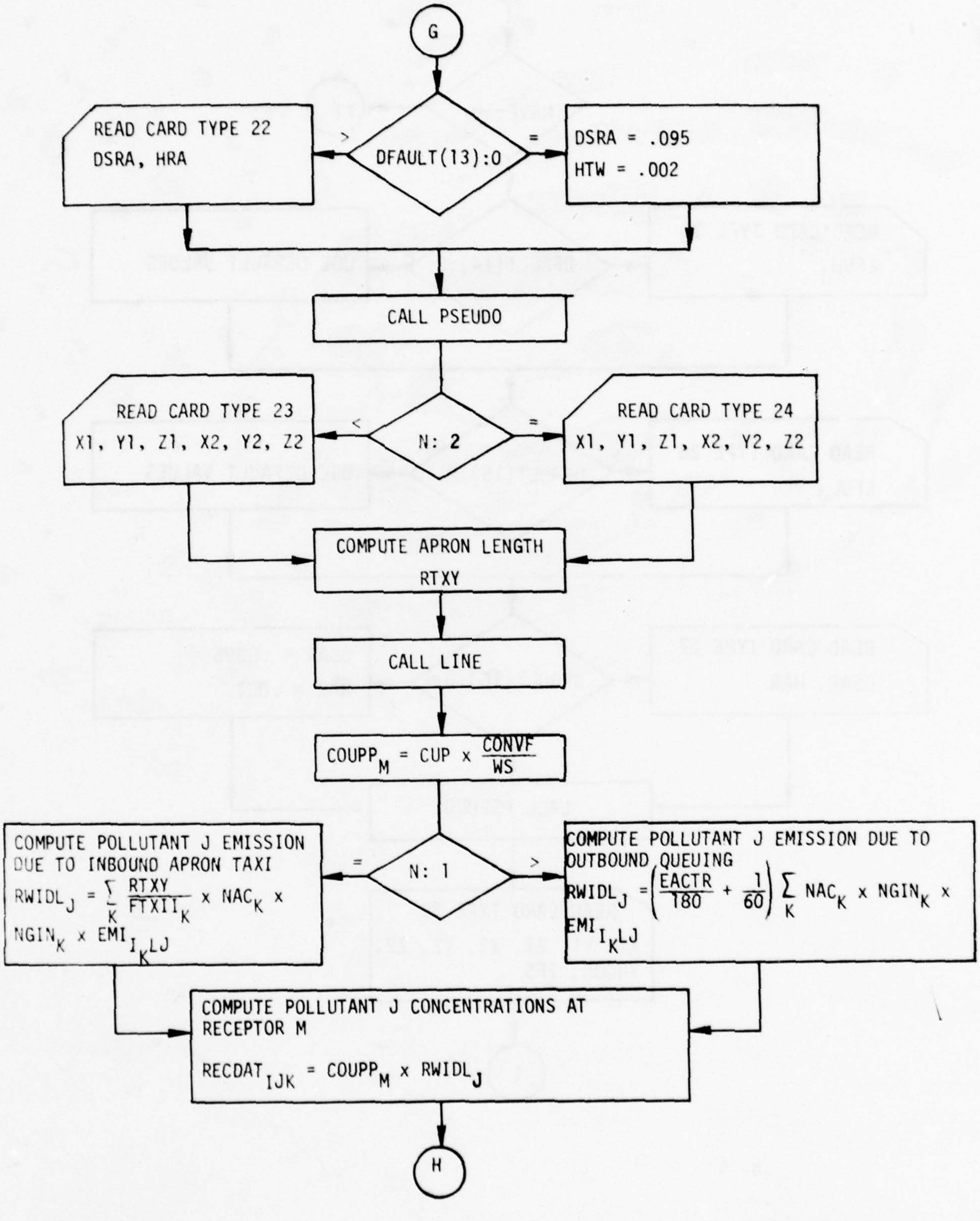


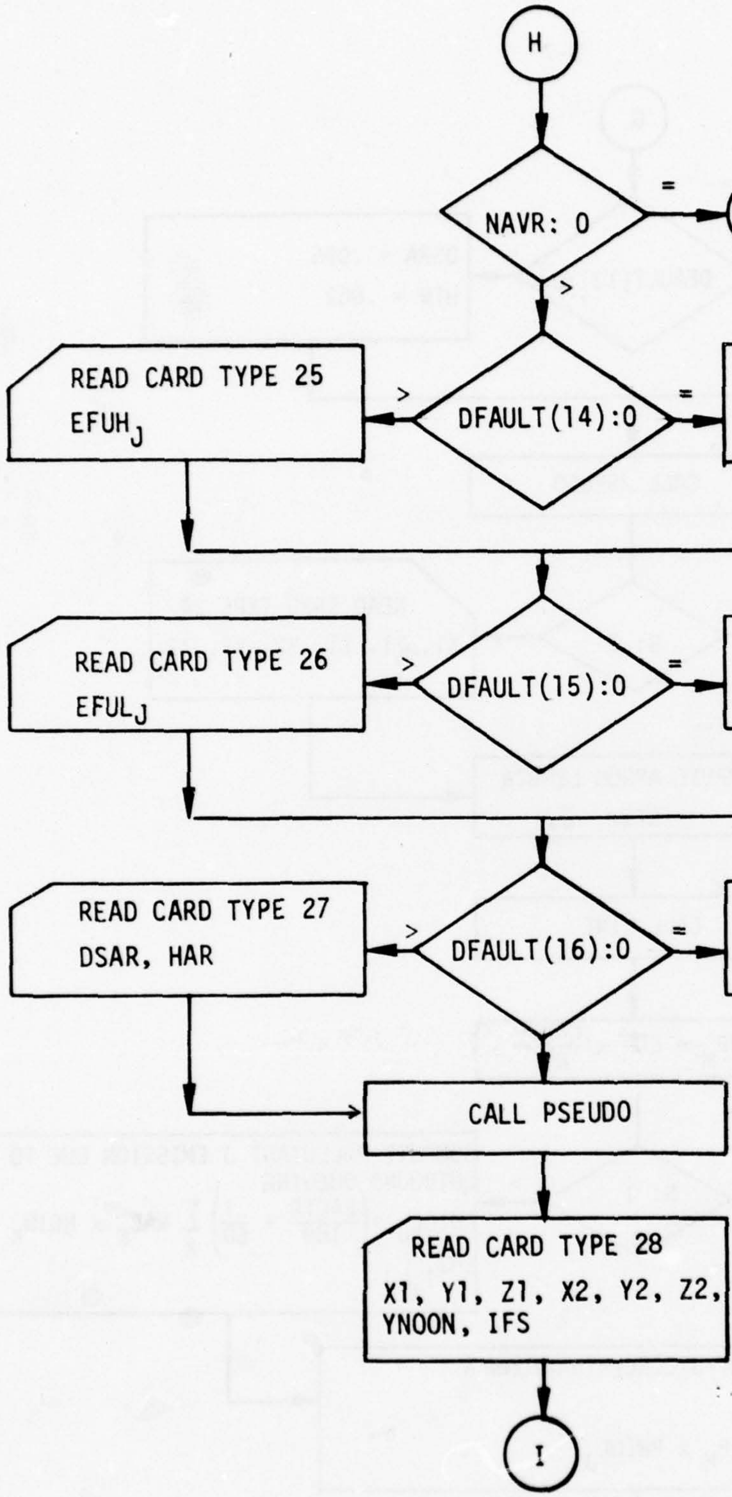
B-3
C
DFAULT(3): 0
>
=
READ CARD TYPE 9
FTKOF_K
FTKOF = .0111
DFAULT(4): 0
READ CARD TYPE 10
NGIN_K
USE DEFAULT VALUES
DFAULT(5): 0
READ CARD TYPE 11
INGN_K
USE DEFAULT VALUES
DFAULT(6): 0
READ CARD TYPE 12
EMI_ILJ
USE DEFAULT VALUES
DFAULT(7): 0
READ CARD TYPE 13
DSRW, HRW
DSRW = .030
HRW = .002
D

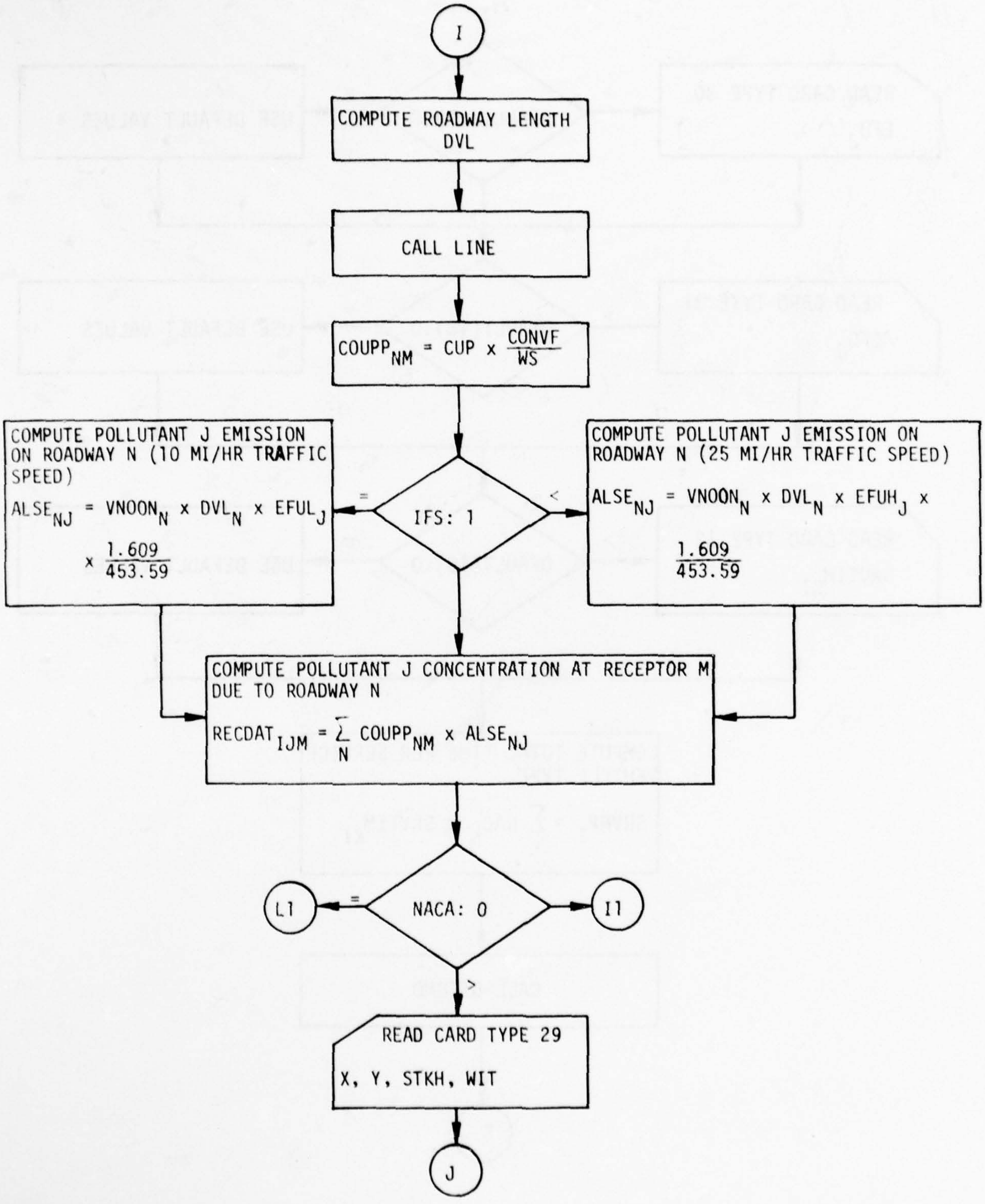

D
CALL PSEUDO
READ CARD TYPE 14 RUNWAY: X1, Y1, Z1, X2, Y2, Z2
READ CARD TYPE 15 VA1, VA2, VD1, VD2, TIME, TAIL
>
DFAULT(8):0
=
USE DEFAULT VALUES
COMPUTE POLLUTANT J LANDING EMISSIONS:
$EMLN_J = \sum_K NAC_K \times NGIN_K \times FLNDG_K \times EMI_{I_K LJ}$
where L=3
COMPUTE POLLUTANT J TAKE-OFF EMISSIONS
$EMTF_J = \sum_K NAC_K \times NGIN_K \times FTKOF_K \times EMI_{I_K LJ}$
where L=4
CALL LINE
$COUPP_M = CUP \times \frac{CONVF}{WS}$
COMPUTE POLLUTANT J CONCENTRATION AT RECEPTOR M
$RECDAT_{IJM} = COUPP_M \times (EMLN_J + EMTF_J)$, I = 3
E

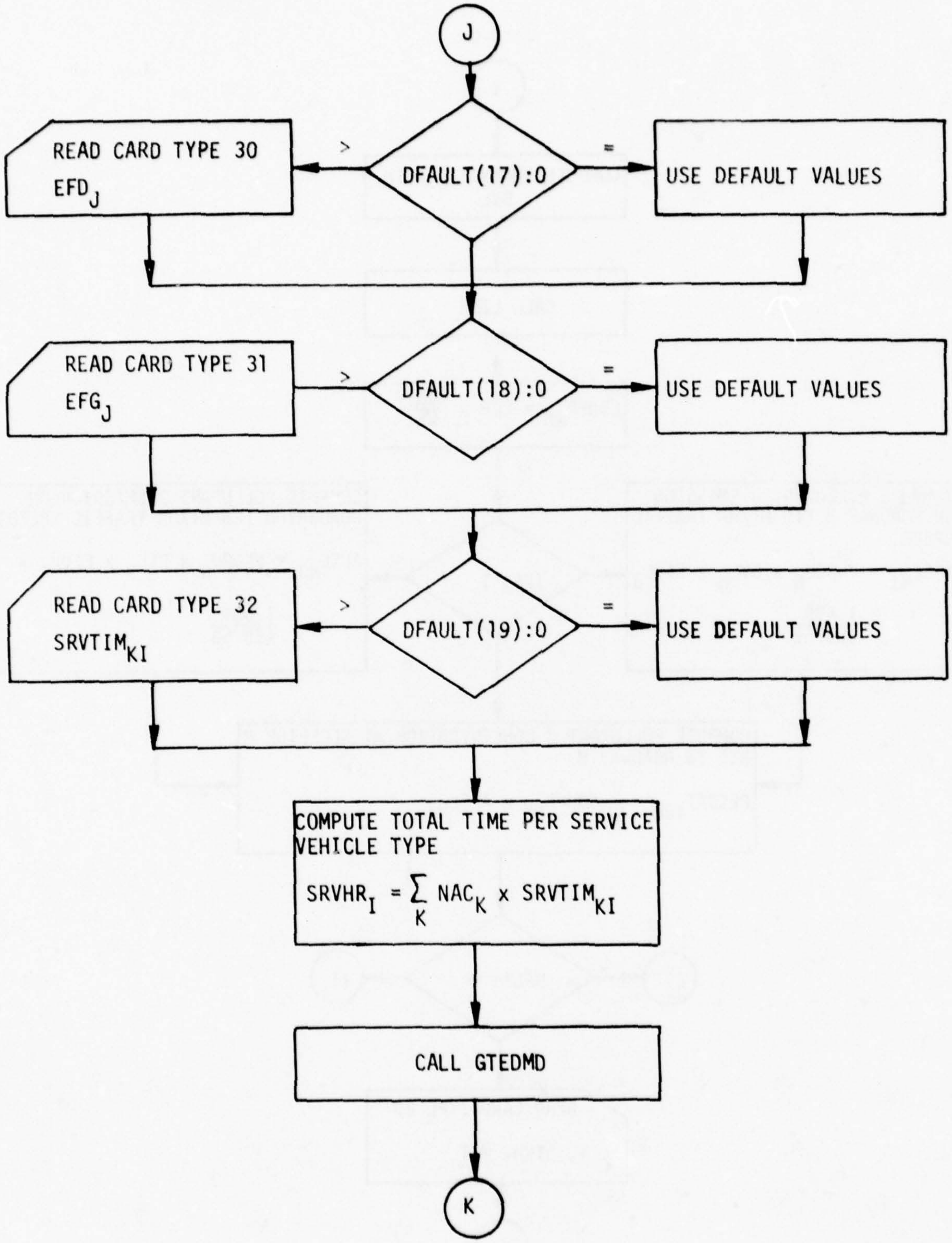

E
READ CARD TYPE 16
FTAXI$_K$
>
DFAULT(9): 0
=
FTAXI$_K$ = 10
READ CARD TYPE 17
FTXII$_K$
>
DFAULT(10): 0
=
FTXII$_K$ = 15
READ CARD TYPE 18
FTXIO$_K$
>
DFAULT(11): 0
=
FTXIO$_K$ = 12
READ CARD TYPE 19
DSTW, HTW
>
DFAULT(12): 0
=
DSTW = .030
HTW = .002
CALL PSEUDO
F

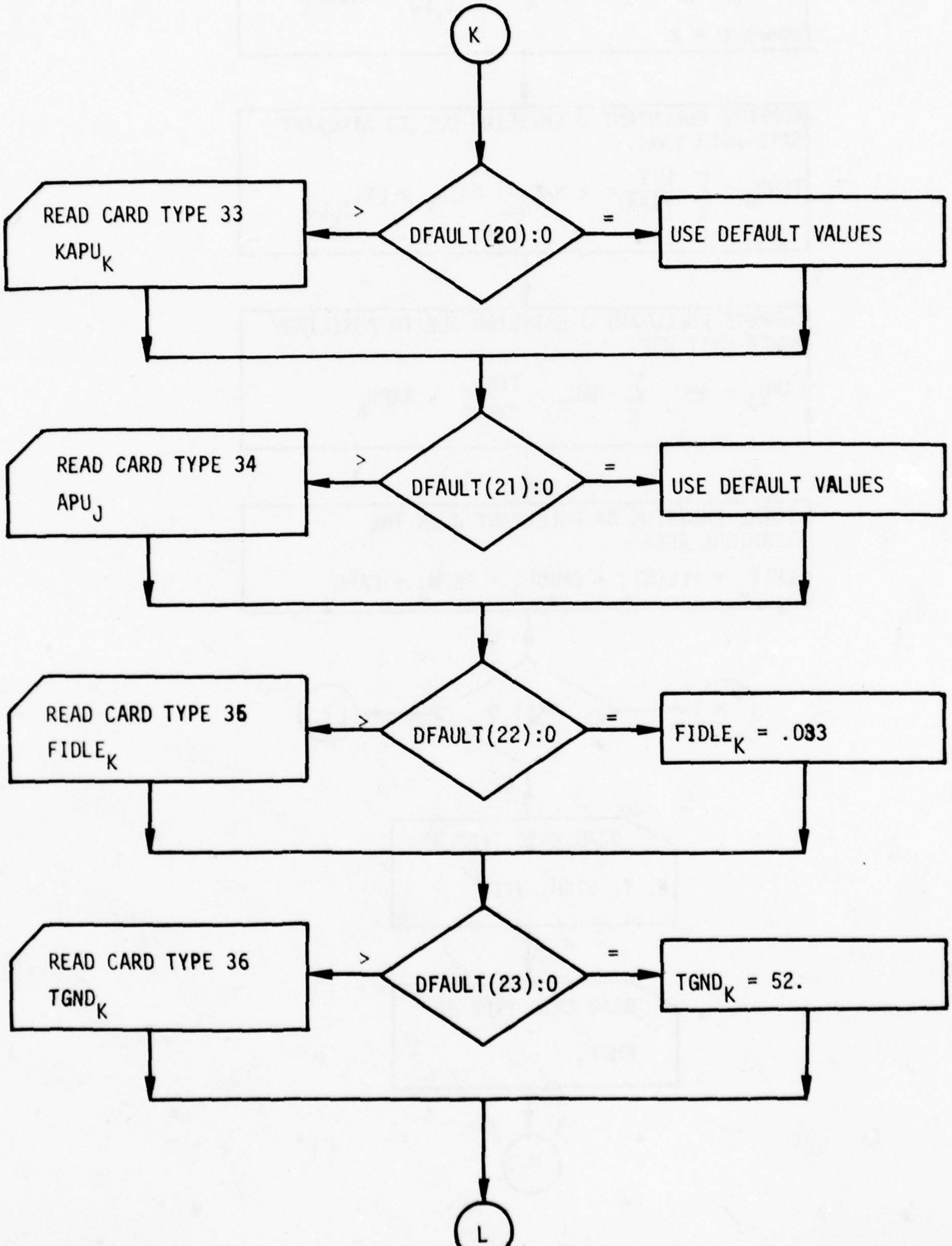

F
ITX: 2
<
=
READ CARD TYPE 20
X1, Y1, Z1, X2, Y2, Z2
READ CARD TYPE 21
X1, Y1, Z1, X2, Y2, Z2
COMPUTE TAXIWAY LENGTH
DTXL
CALL LINE
COUPP_M = CUP x CONVF / WS
ITX: 1
=
>
COMPUTE POLLUTANT J EMISSION DUE TO INBOUND TAXI.
EMTXI_J = Σ_K DTXL / FTXII_K x NAC_K x NGIN_K x EMI_{I_K LJ}
where L=1
COMPUTE POLLUTANT J EMISSION DUE TO OUTBOUND TAXI.
EMTXO_J = Σ_K DTXL / FTXIO_K x NAC_K x NGIN_K x EMI_{I_K LJ}
where L=1
COMPUTE POLLUTANT J CONCENTRATION AT RECEPTOR M.
RECDAT_IJM = COUPP_M x (EMTXI_J + EMTXO_J)
G

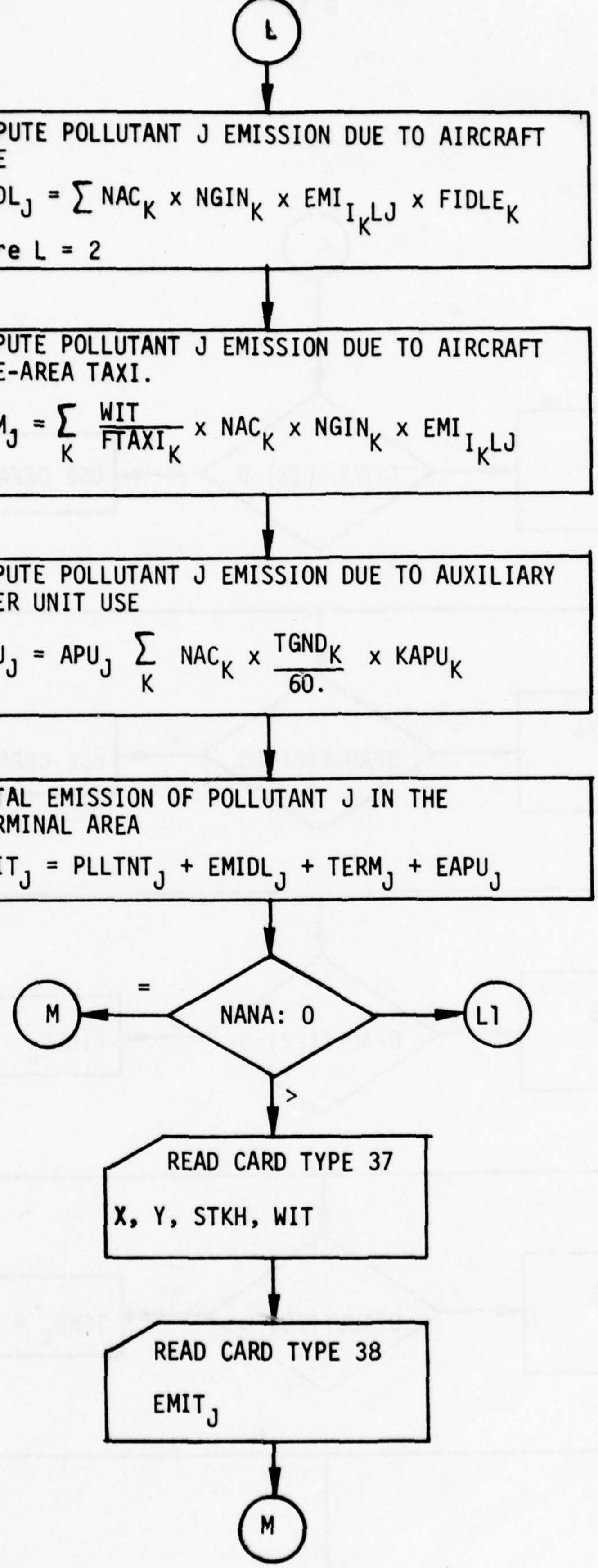

G
DFAULT(13):0
>
=
READ CARD TYPE 22
DSRA, HRA
DSRA = .095
HTW = .002
CALL PSEUDO
N: 2
<
=
READ CARD TYPE 23
X1, Y1, Z1, X2, Y2, Z2
READ CARD TYPE 24
X1, Y1, Z1, X2, Y2, Z2
COMPUTE APRON LENGTH
RTXY
CALL LINE
COUPP_M = CUP x CONVF / WS
N: 1
=
>
COMPUTE POLLUTANT J EMISSION DUE TO INBOUND APRON TAXI
RWIDL_J = Σ_K RTXY / FTXII_K x NAC_K x NGIN_K x EMI_{I_K}LJ
COMPUTE POLLUTANT J EMISSION DUE TO OUTBOUND QUEUING
RWIDL_J = (EACTR/180 + 1/60) Σ_K NAC_K x NGIN_K x EMI_{I_K}LJ
COMPUTE POLLUTANT J CONCENTRATIONS AT RECEPTOR M
RECDAT_IJK = COUPP_M x RWIDL_J
H

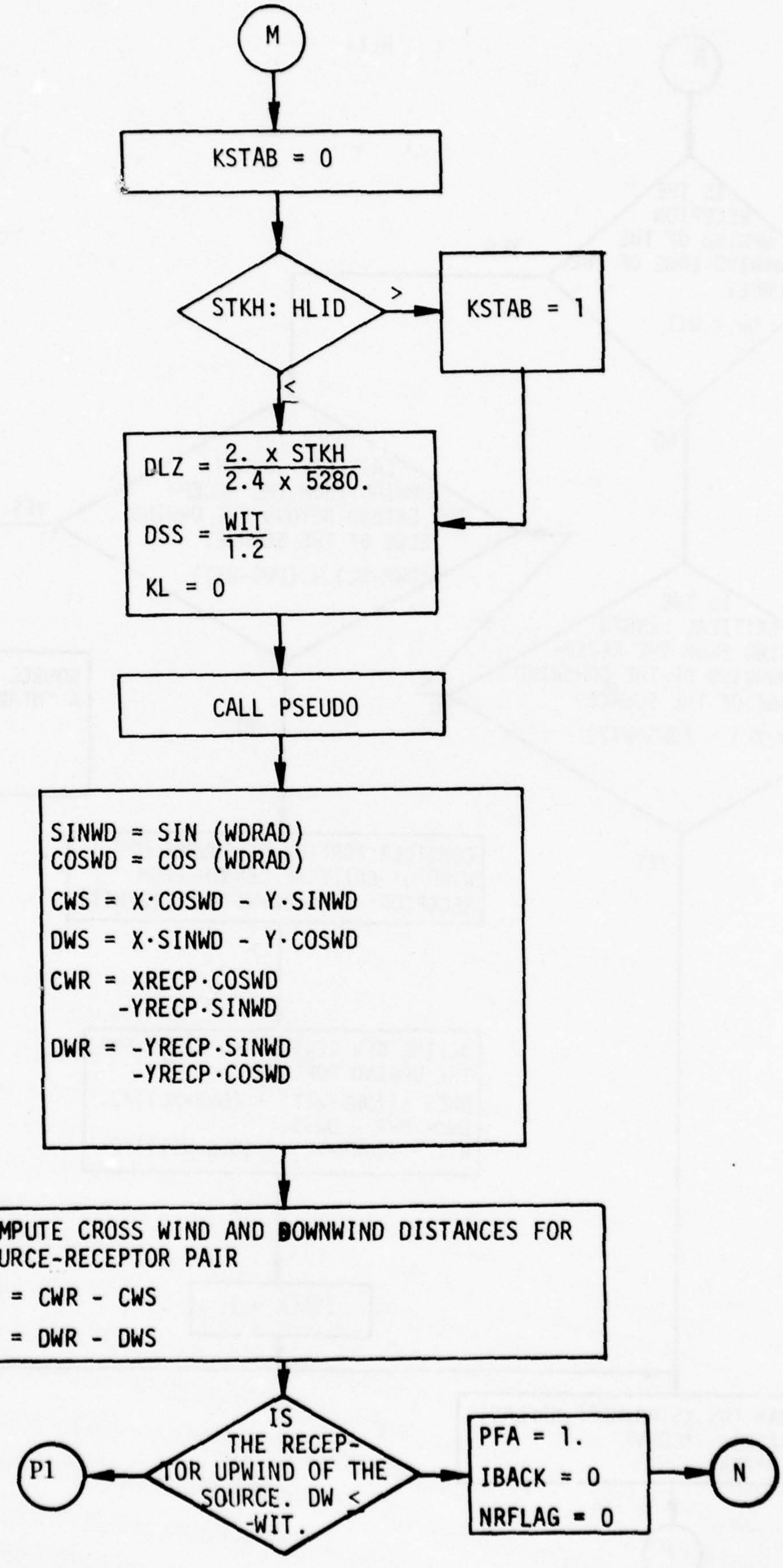

H
NAVR: 0
=
I1
>
READ CARD TYPE 25
EFUH_J
>
DFAULT(14):0
=
USE DEFAULT VALUES
READ CARD TYPE 26
EFUL_J
>
DFAULT(15):0
=
USE DEFAULT VALUES
READ CARD TYPE 27
DSAR, HAR
>
DFAULT(16):0
=
DSAR = .0095
HAR = .001
CALL PSEUDO
READ CARD TYPE 28
X1, Y1, Z1, X2, Y2, Z2,
YNOON, IFS
I

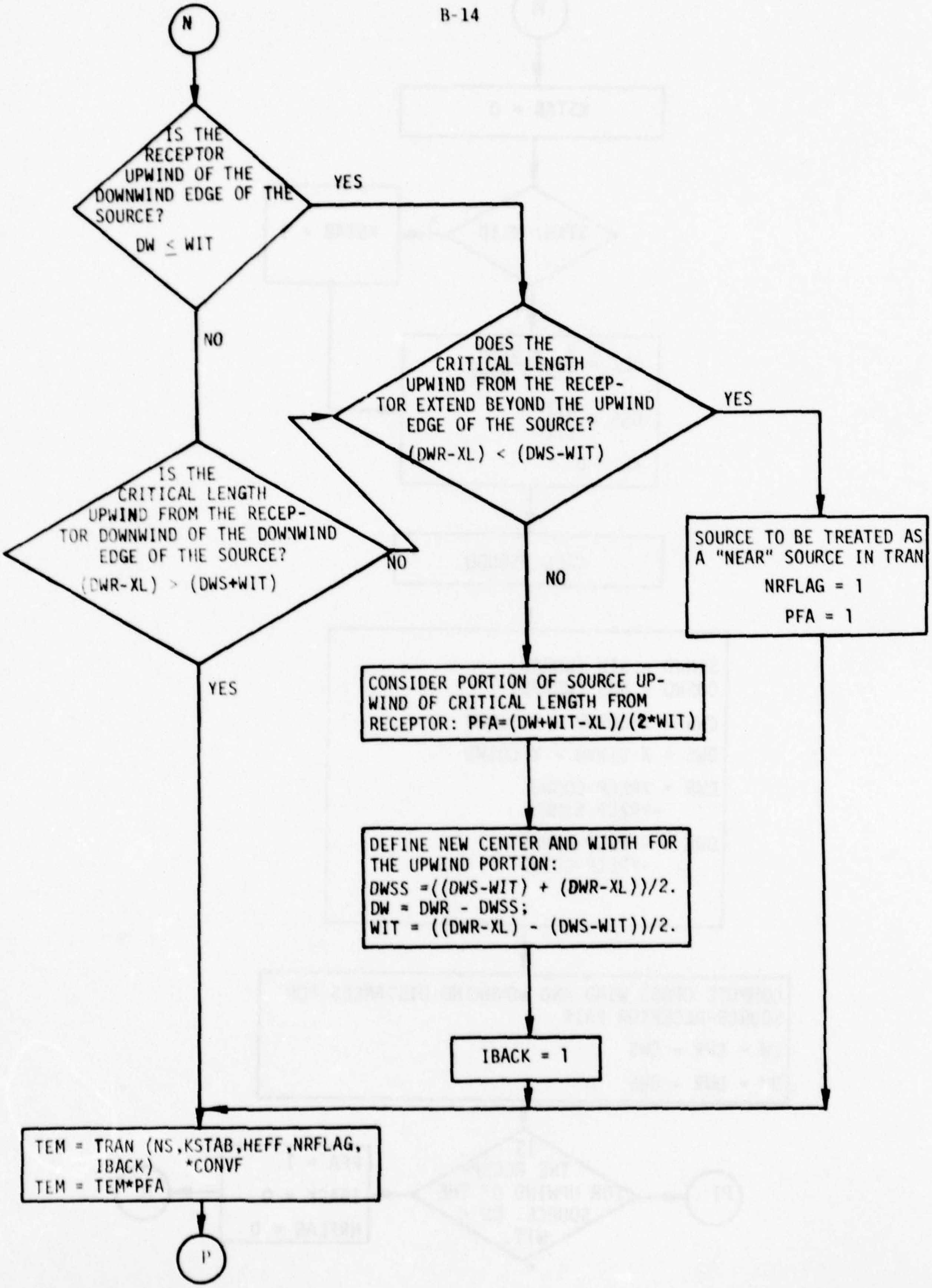

I
COMPUTE ROADWAY LENGTH DVL
CALL LINE
COUPP_NM = CUP x CONVF/WS
IFS: 1
=
<
COMPUTE POLLUTANT J EMISSION ON ROADWAY N (10 MI/HR TRAFFIC SPEED)
ALSE_NJ = VNOON_N x DVL_N x EFUL_J x 1.609/453.59
COMPUTE POLLUTANT J EMISSION ON ROADWAY N (25 MI/HR TRAFFIC SPEED)
ALSE_NJ = VNOON_N x DVL_N x EFUH_J x 1.609/453.59
COMPUTE POLLUTANT J CONCENTRATION AT RECEPTOR M DUE TO ROADWAY N
RECDAT_IJM = Σ_N COUPP_NM x ALSE_NJ
NACA: 0
=
>
L1
I1
READ CARD TYPE 29
X, Y, STKH, WIT
J

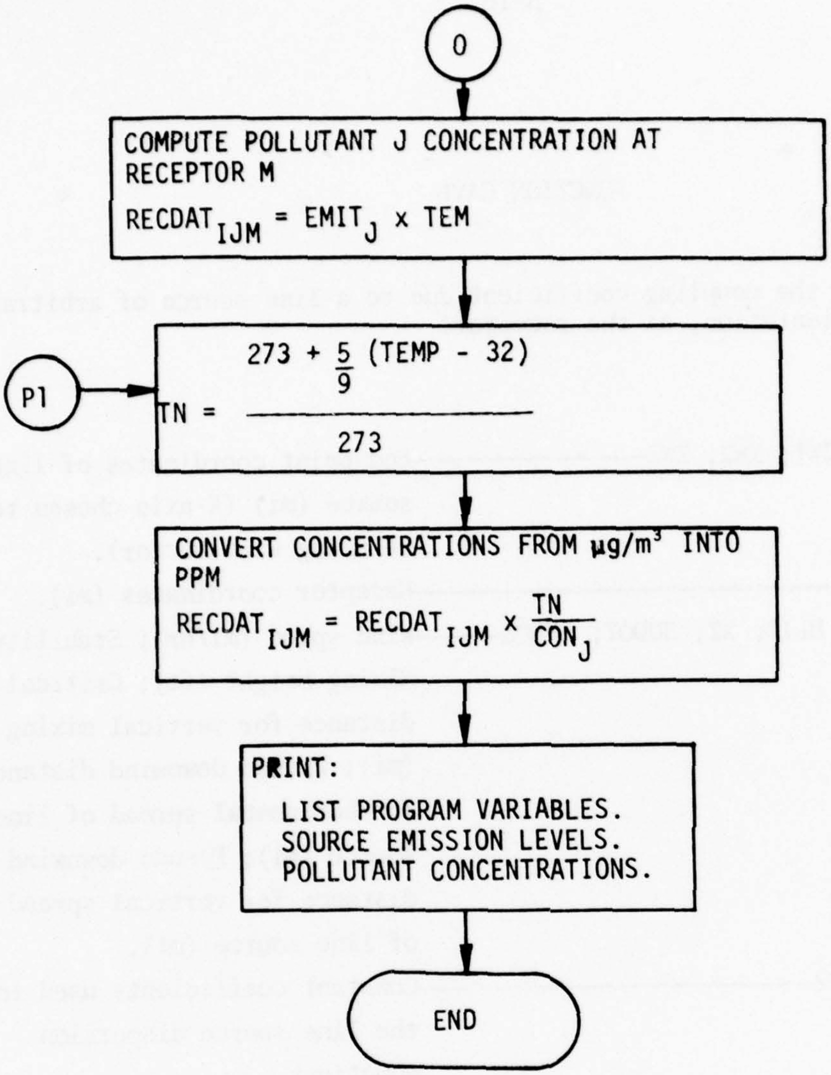

J
READ CARD TYPE 30
EFD_J
>
DFAULT(17):0
=
USE DEFAULT VALUES
READ CARD TYPE 31
EFG_J
>
DFAULT(18):0
=
USE DEFAULT VALUES
READ CARD TYPE 32
SRVTIM_KI
>
DFAULT(19):0
=
USE DEFAULT VALUES
COMPUTE TOTAL TIME PER SERVICE VEHICLE TYPE
$SRVHR_I = \sum_K NAC_K \times SRVTIM_{KI}$
CALL GTEDMD
K


K
DFAULT(20):0
>
READ CARD TYPE 33
KAPU_K
=
USE DEFAULT VALUES
DFAULT(21):0
>
READ CARD TYPE 34
APU_J
=
USE DEFAULT VALUES
DFAULT(22):0
>
READ CARD TYPE 35
FIDLE_K
=
FIDLE_K = .083
DFAULT(23):0
>
READ CARD TYPE 36
TGND_K
=
TGND_K = 52.
L


L
COMPUTE POLLUTANT J EMISSION DUE TO AIRCRAFT IDLE
$EMIDL_J = \sum NAC_K \times NGIN_K \times EMI_{I_K LJ} \times FIDLE_K$
where L = 2
COMPUTE POLLUTANT J EMISSION DUE TO AIRCRAFT GATE-AREA TAXI.
$TERM_J = \sum_K \frac{WIT}{FTAXI_K} \times NAC_K \times NGIN_K \times EMI_{I_K LJ}$
COMPUTE POLLUTANT J EMISSION DUE TO AUXILIARY POWER UNIT USE
$EAPU_J = APU_J \sum_K NAC_K \times \frac{TGND_K}{60.} \times KAPU_K$
TOTAL EMISSION OF POLLUTANT J IN THE TERMINAL AREA
$EMIT_J = PLLTNT_J + EMIDL_J + TERM_J + EAPU_J$
NANA: 0
=
M
L1
>
READ CARD TYPE 37
X, Y, STKH, WIT
READ CARD TYPE 38
$EMIT_J$
M


M
KSTAB = 0
STKH: HLID
>
KSTAB = 1
<
DLZ = 2. x STKH / 2.4 x 5280.
DSS = WIT / 1.2
KL = 0
CALL PSEUDO
SINWD = SIN (WDRAD)
COSWD = COS (WDRAD)
CWS = X·COSWD - Y·SINWD
DWS = X·SINWD - Y·COSWD
CWR = XRECP·COSWD -YRECP·SINWD
DWR = -YRECP·SINWD -YRECP·COSWD
COMPUTE CROSS WIND AND DOWNWIND DISTANCES FOR SOURCE-RECEPTOR PAIR
CW = CWR - CWS
DW = DWR - DWS
IS THE RECEPTOR UPWIND OF THE SOURCE. DW ≤ -WIT.
P1
PFA = 1.
IBACK = 0
NRFLAG = 0
N


N
IS THE RECEPTOR UPWIND OF THE DOWNWIND EDGE OF THE SOURCE?
DW ≤ WIT
YES
NO
DOES THE CRITICAL LENGTH UPWIND FROM THE RECEPTOR EXTEND BEYOND THE UPWIND EDGE OF THE SOURCE?
(DWR-XL) < (DWS-WIT)
YES
IS THE CRITICAL LENGTH UPWIND FROM THE RECEPTOR DOWNWIND OF THE DOWNWIND EDGE OF THE SOURCE?
(DWR-XL) > (DWS+WIT)
NO
NO
SOURCE TO BE TREATED AS A "NEAR" SOURCE IN TRAN
NRFLAG = 1
PFA = 1
YES
CONSIDER PORTION OF SOURCE UPWIND OF CRITICAL LENGTH FROM RECEPTOR: PFA=(DW+WIT-XL)/(2*WIT)
DEFINE NEW CENTER AND WIDTH FOR THE UPWIND PORTION:
DWSS =((DWS-WIT) + (DWR-XL))/2.
DW = DWR - DWSS;
WIT = ((DWR-XL) - (DWS-WIT))/2.
IBACK = 1
TEM = TRAN (NS,KSTAB,HEFF,NRFLAG, IBACK) *CONVF
TEM = TEM*PFA
P


O
COMPUTE POLLUTANT J CONCENTRATION AT RECEPTOR M
$RECDAT_{IJM} = EMIT_J \times TEM$
P1
$TN = \frac{273 + \frac{5}{9}(TEMP - 32)}{273}$
CONVERT CONCENTRATIONS FROM $\mu g/m^3$ INTO PPM
$RECDAT_{IJM} = RECDAT_{IJM} \times \frac{TN}{CON_J}$
PRINT:
LIST PROGRAM VARIABLES.
SOURCE EMISSION LEVELS.
POLLUTANT CONCENTRATIONS.
END

FUNCTION CAVL

Purpose:

To compute the coupling coefficient due to a line source of arbitrary spatial orientation, at the receptor.

Input:

XW1, YW1, ZW1; XW2, ZW2	End-point coordinates of line source (mi) (X-axis chosen to be along wind vector).
XR, YR, ZR	Receptor coordinates (mi).
WS; JSTAB; HLID; XZ; SUDOY; SUDOZ	Wind speed (mi/hr); Stability; Mixing height (ft); Critical distance for vertical mixing (mi); Pseudo downwind distance for horizontal spread of line source (mi); Pseudo downwind distance for vertical spread of line source (mi).
COEF1; COEF2	Constant coefficients used in the line source dispersion equations.

Output:

CAVL (XR, YR, ZR)	Coupling coefficient (mi^{-2}) at the receptor point (XR, YR, ZR).

Procedure:

1. Test whether the receptor is located with respect to the line source such that the concentration is completely negligible.
2. If angle between wind vector and line is sufficiently small, and line source is sufficiently long, a flag is set for the line to be segmented. Each segment is then treated as an individual line.
3. Compute effective downwind distance.
4. Compute horizontal and vertical dispersion coefficients, using external function routines SIGY and SIGZ.
5. Compute the Z-component of the dispersion expression.

6. Test whether the line source has a uniform density. If it is a runway used for aircraft arrival or departure (nonuniform line density), subroutine QMOD is called.

7. Compute and output the concentration for the given receptor.

Functions Called:

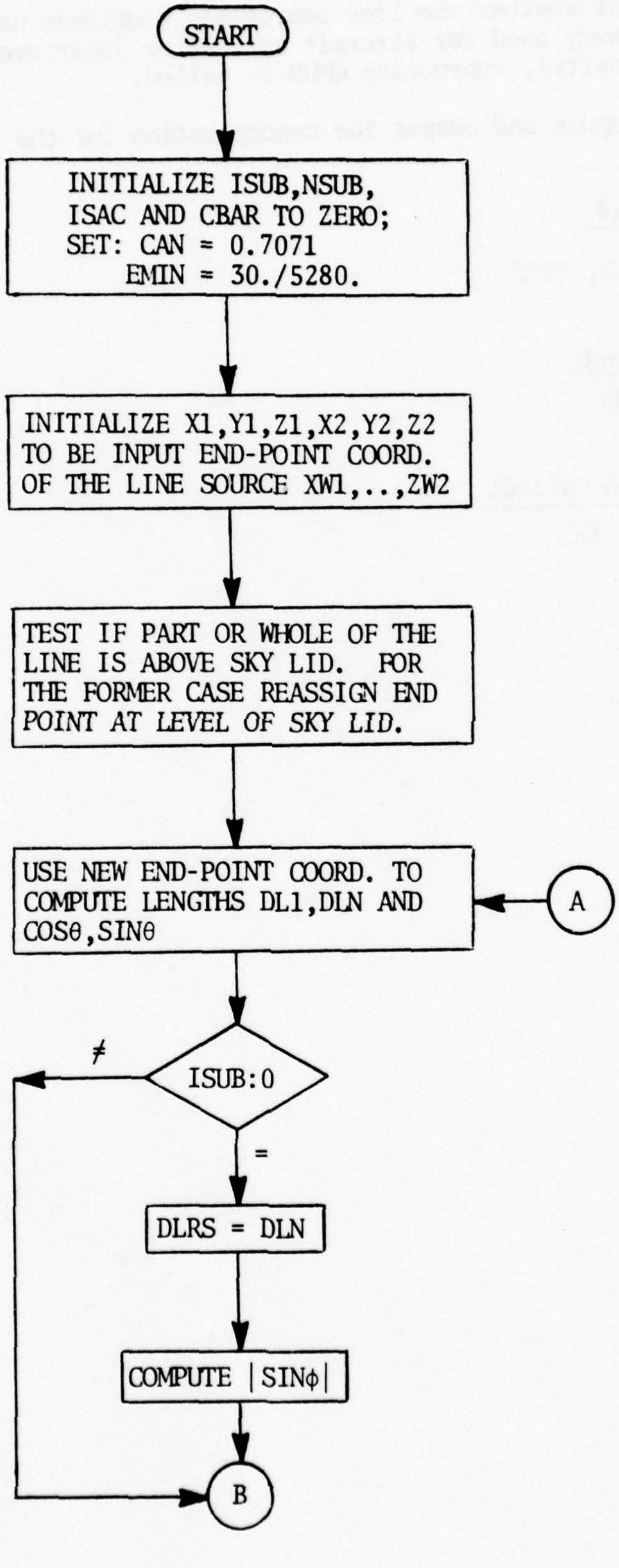
SIGY, SIGZ

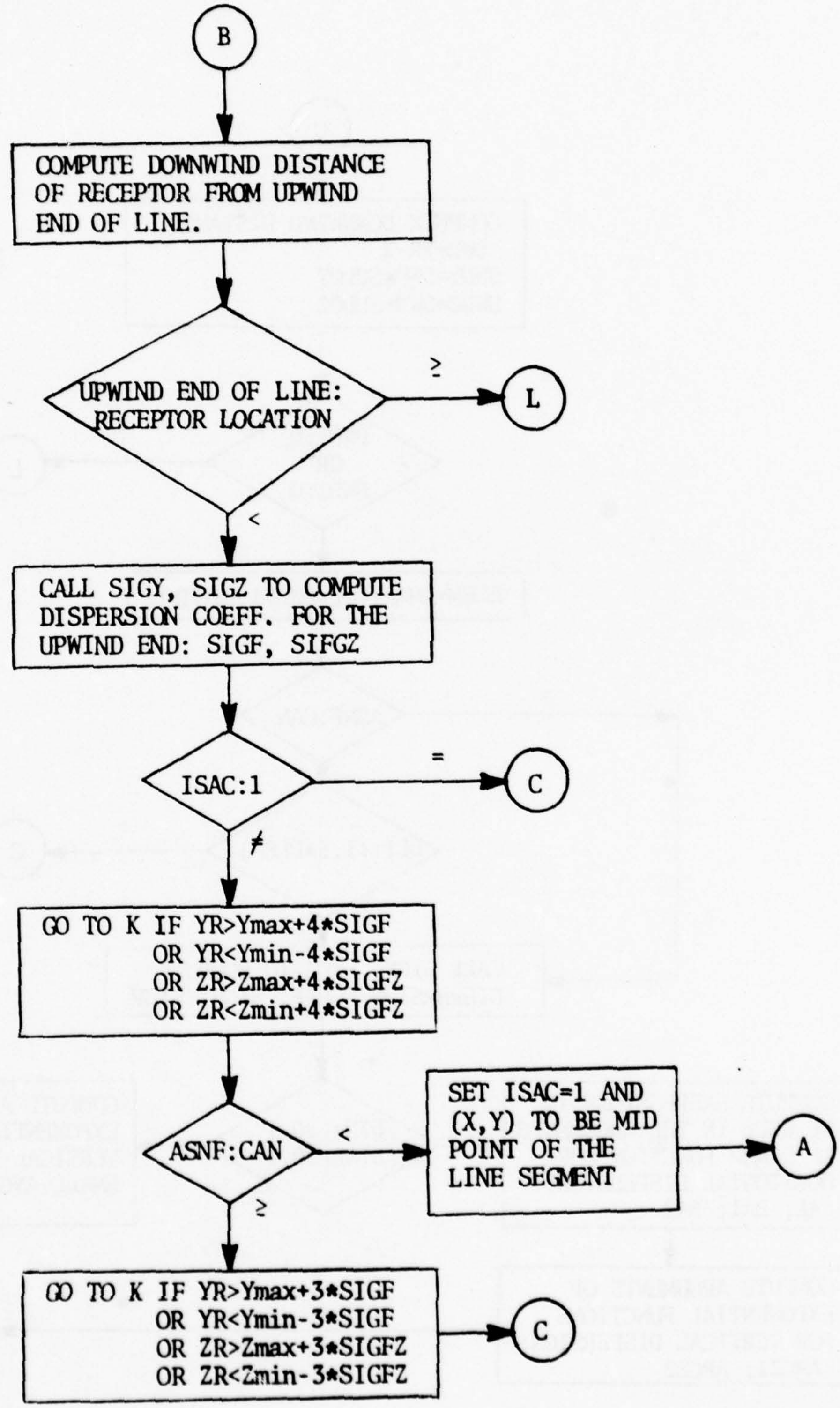
Subroutine Called:

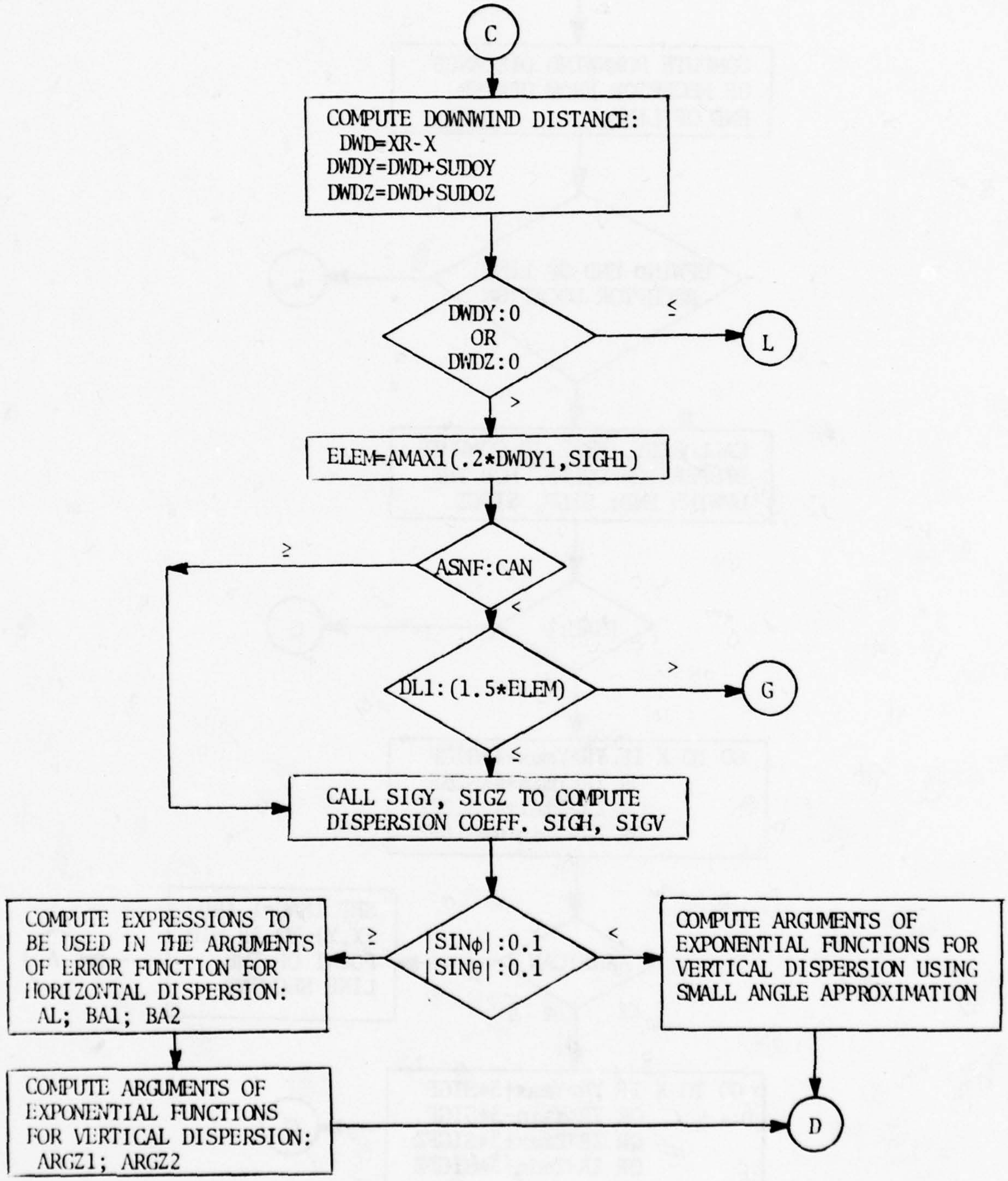
QMOD

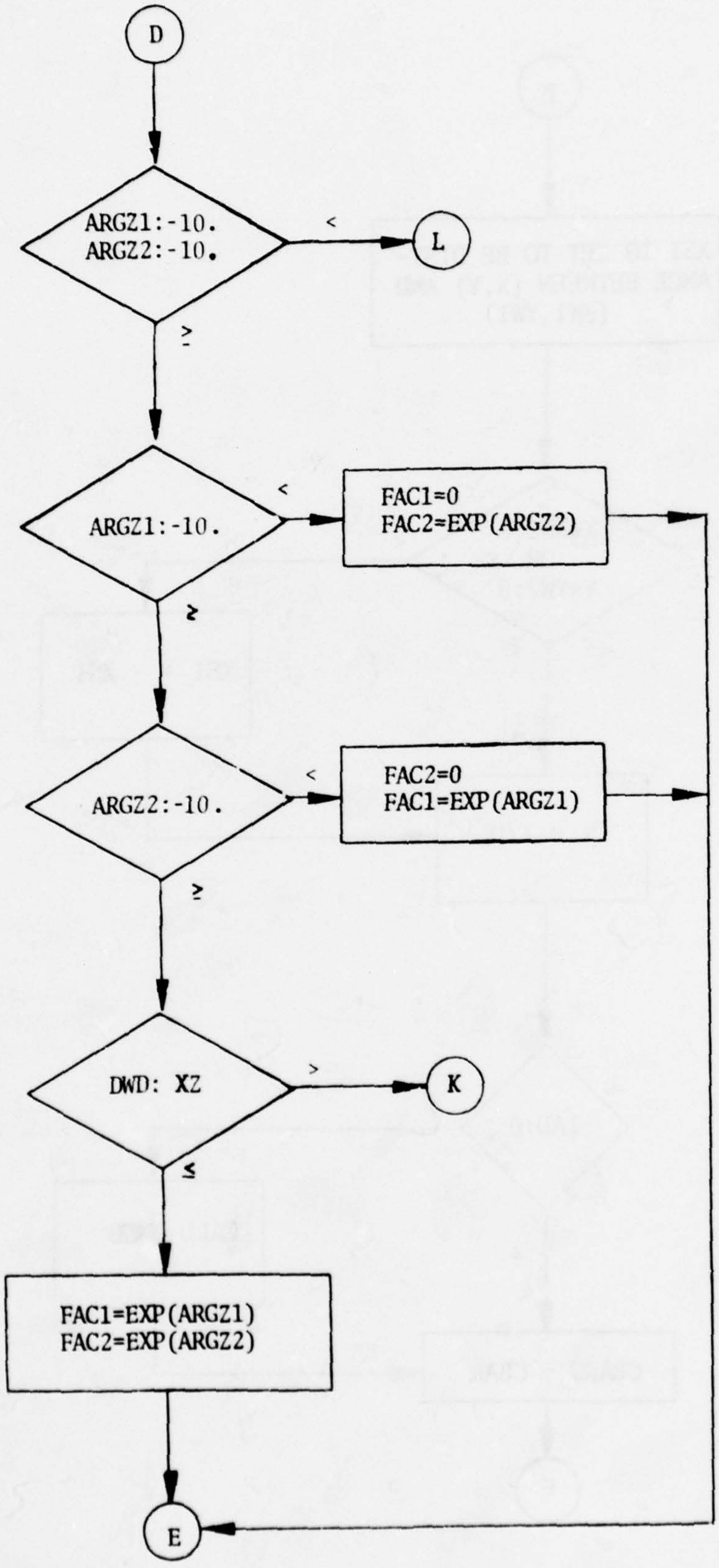
Special Function Called:

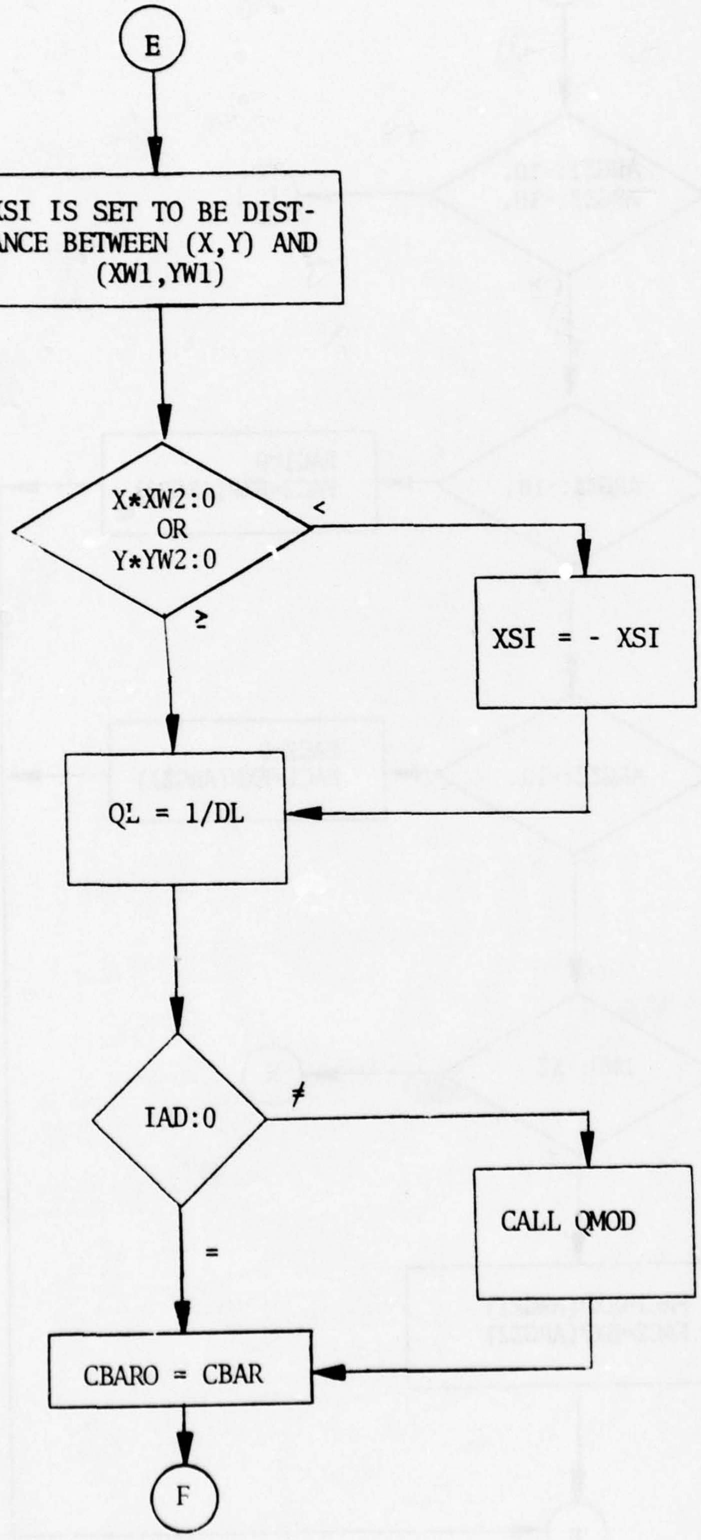
ERF (X)

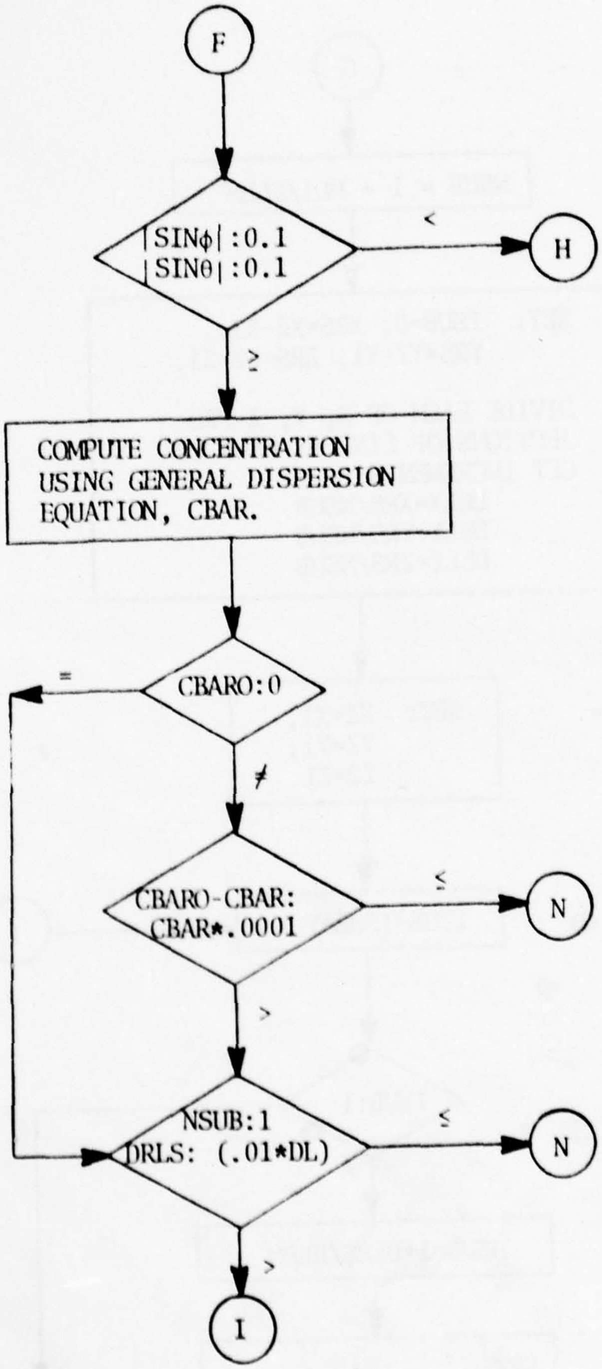

START
INITIALIZE ISUB,NSUB, ISAC AND CBAR TO ZERO; SET: CAN = 0.7071 EMIN = 30./5280.
INITIALIZE X1,Y1,Z1,X2,Y2,Z2 TO BE INPUT END-POINT COORD. OF THE LINE SOURCE XW1,..,ZW2
TEST IF PART OR WHOLE OF THE LINE IS ABOVE SKY LID. FOR THE FORMER CASE REASSIGN END POINT AT LEVEL OF SKY LID.
USE NEW END-POINT COORD. TO COMPUTE LENGTHS DL1,DLN AND COSθ,SINθ
A
ISUB:0
≠
=
DLRS = DLN
COMPUTE |SINϕ|
B

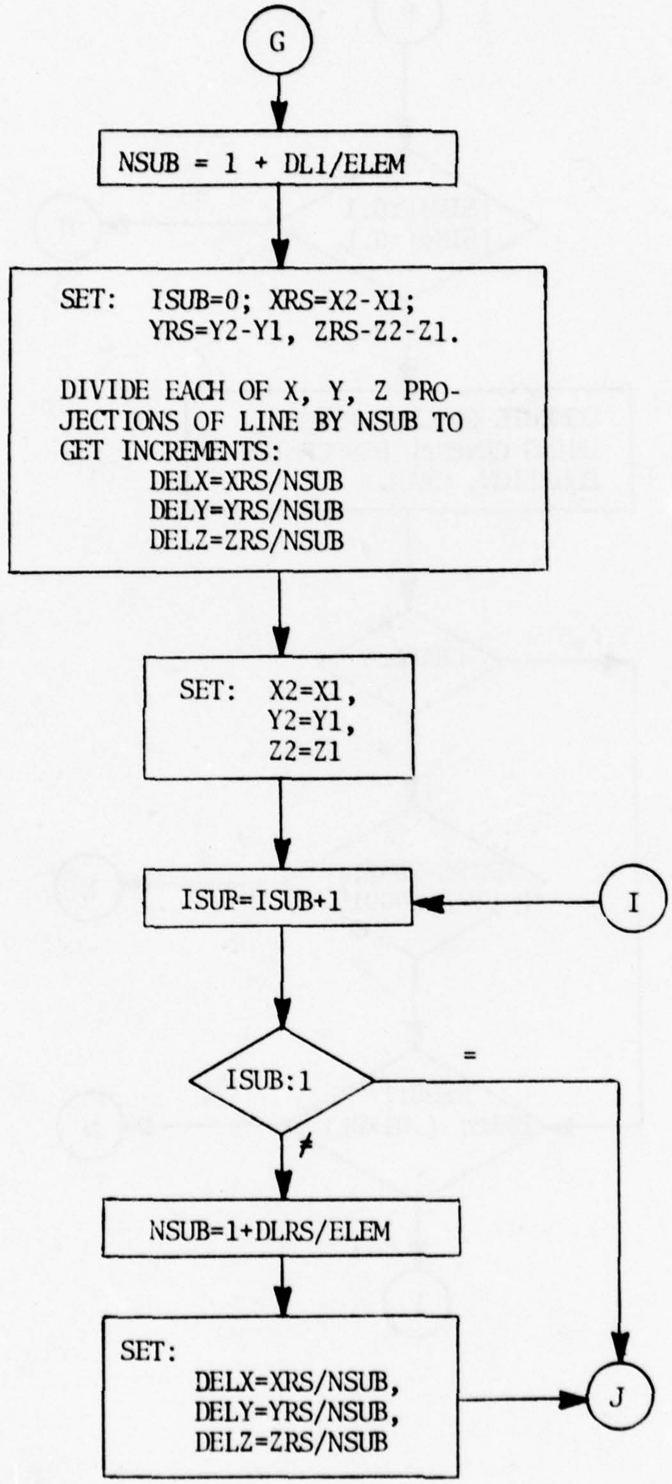

B
COMPUTE DOWNWIND DISTANCE OF RECEPTOR FROM UPWIND END OF LINE.
UPWIND END OF LINE: RECEPTOR LOCATION
≥
L
<
CALL SIGY, SIGZ TO COMPUTE DISPERSION COEFF. FOR THE UPWIND END: SIGF, SIFGZ
ISAC:1
=
C
≠
GO TO K IF YR>Ymax+4*SIGF
OR YR<Ymin-4*SIGF
OR ZR>Zmax+4*SIGFZ
OR ZR<Zmin+4*SIGFZ
ASNF:CAN
<
SET ISAC=1 AND (X,Y) TO BE MID POINT OF THE LINE SEGMENT
A
≥
GO TO K IF YR>Ymax+3*SIGF
OR YR<Ymin-3*SIGF
OR ZR>Zmax+3*SIGFZ
OR ZR<Zmin-3*SIGFZ
C

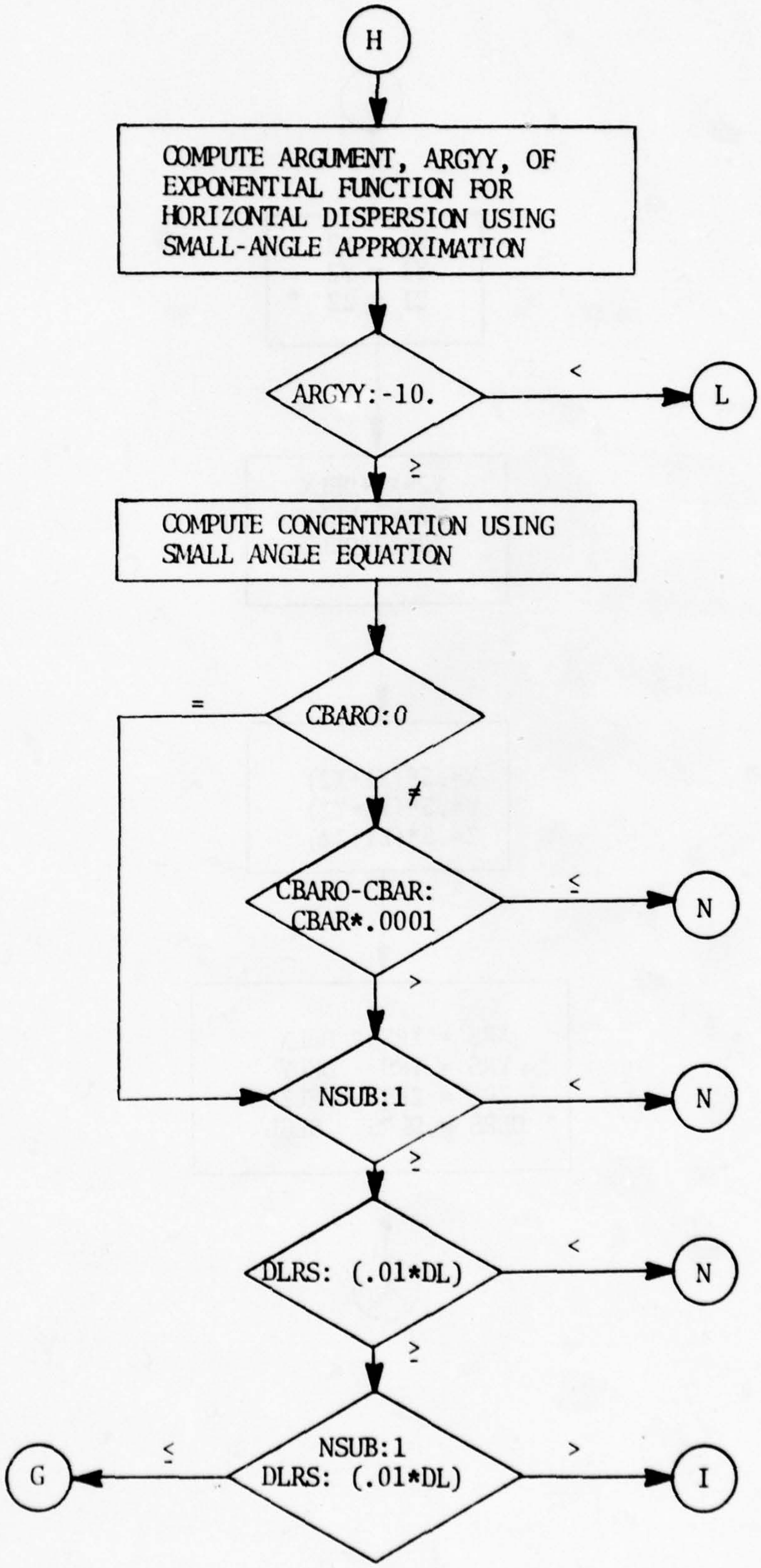

C
COMPUTE DOWNWIND DISTANCE:
DWD=XR-X
DWDY=DWD+SUDOY
DWDZ=DWD+SUDOZ
DWDY:0
OR
DWDZ:0
≤
L
>
ELEM=AMAX1(.2*DWDY1,SIGH1)
ASNF:CAN
≥
<
DL1:(1.5*ELEM)
>
G
≤
CALL SIGY, SIGZ TO COMPUTE
DISPERSION COEFF. SIGH, SIGV
|SINϕ|:0.1
|SINθ|:0.1
≥
<
COMPUTE EXPRESSIONS TO
BE USED IN THE ARGUMENTS
OF ERROR FUNCTION FOR
HORIZONTAL DISPERSION:
AL; BA1; BA2
COMPUTE ARGUMENTS OF
EXPONENTIAL FUNCTIONS FOR
VERTICAL DISPERSION USING
SMALL ANGLE APPROXIMATION
COMPUTE ARGUMENTS OF
EXPONENTIAL FUNCTIONS
FOR VERTICAL DISPERSION:
ARGZ1; ARGZ2
D

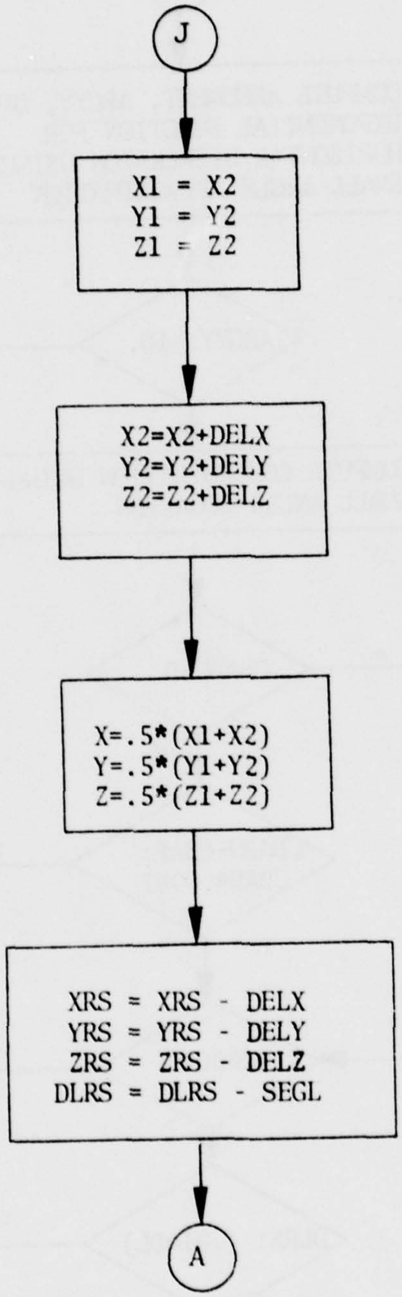

D
ARGZ1:-10.
ARGZ2:-10.
<
L
≥
ARGZ1:-10.
<
FAC1=0
FAC2=EXP(ARGZ2)
≥
ARGZ2:-10.
<
FAC2=0
FAC1=EXP(ARGZ1)
≥
DWD: XZ
>
K
≤
FAC1=EXP(ARGZ1)
FAC2=EXP(ARGZ2)
E

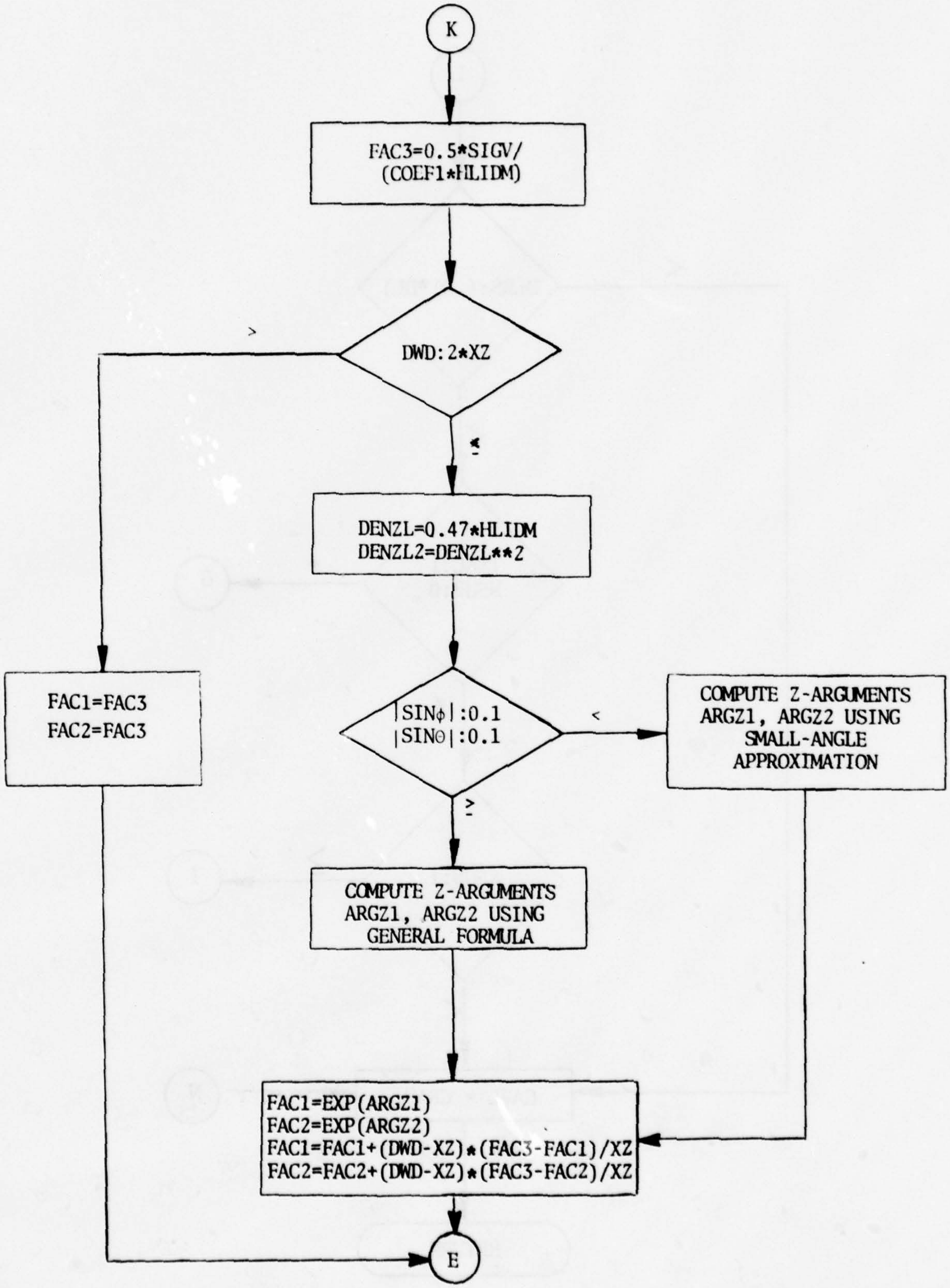

E
XSI IS SET TO BE DIST-
ANCE BETWEEN (X,Y) AND
(XW1,YW1)
X*XW2:0
OR
Y*YW2:0
<
≥
XSI = - XSI
QL = 1/DL
IAD:0
≠
=
CALL QMOD
CBARO = CBAR
F

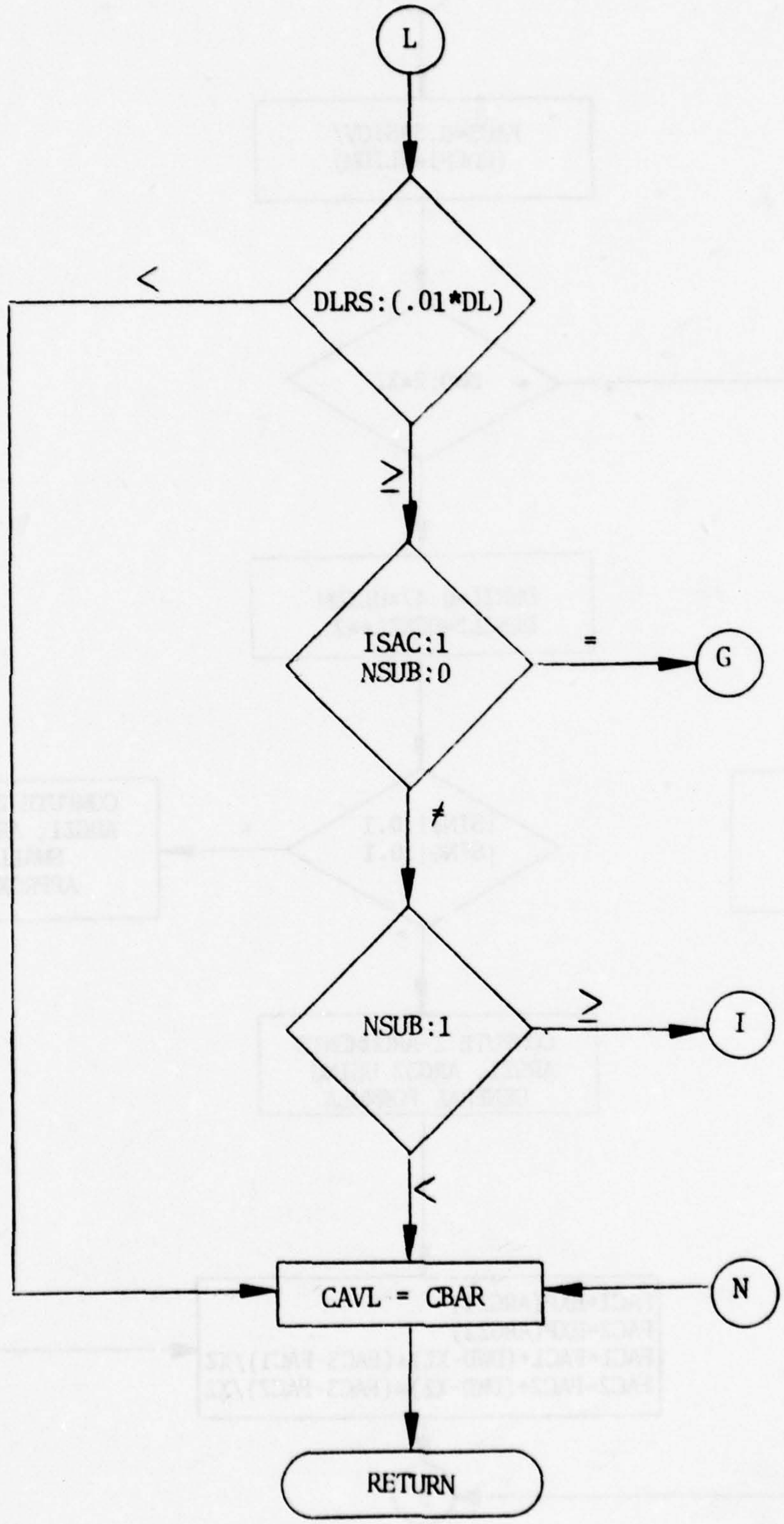

F
|SINϕ|:0.1
|SINθ|:0.1
<
H
≥
COMPUTE CONCENTRATION USING GENERAL DISPERSION EQUATION, CBAR.
CBARO:0
=
≠
CBARO-CBAR:
CBAR*.0001
≤
N
>
NSUB:1
DRLS: (.01*DL)
≤
N
>
I


G
NSUB = 1 + DL1/ELEM
SET: ISUB=0; XRS=X2-X1; YRS=Y2-Y1, ZRS-Z2-Z1.
DIVIDE EACH OF X, Y, Z PROJECTIONS OF LINE BY NSUB TO GET INCREMENTS:
DELX=XRS/NSUB
DELY=YRS/NSUB
DELZ=ZRS/NSUB
SET: X2=X1, Y2=Y1, Z2=Z1
ISUB=ISUB+1
I
ISUB:1
=
≠
NSUB=1+DLRS/ELEM
SET:
DELX=XRS/NSUB,
DELY=YRS/NSUB,
DELZ=ZRS/NSUB
J


H
COMPUTE ARGUMENT, ARGYY, OF EXPONENTIAL FUNCTION FOR HORIZONTAL DISPERSION USING SMALL-ANGLE APPROXIMATION
ARGYY:-10.
<
L
≥
COMPUTE CONCENTRATION USING SMALL ANGLE EQUATION
CBARO:0
=
≠
CBARO-CBAR: CBAR*.0001
≤
N
>
NSUB:1
<
N
≥
DLRS: (.01*DL)
<
N
≥
NSUB:1 DLRS: (.01*DL)
≤
G
>
I


J
X1 = X2
Y1 = Y2
Z1 = Z2
X2=X2+DELX
Y2=Y2+DELY
Z2=Z2+DELZ
X=.5*(X1+X2)
Y=.5*(Y1+Y2)
Z=.5*(Z1+Z2)
XRS = XRS - DELX
YRS = YRS - DELY
ZRS = ZRS - DELZ
DLRS = DLRS - SEGL
A


K
FAC3=0.5*SIGV/
(COEF1*HLIDM)
DWD:2*XZ
>
≤
DENZL=0.47*HLIDM
DENZL2=DENZL**2
FAC1=FAC3
FAC2=FAC3
|SINφ|:0.1
|SINΘ|:0.1
<
≥
COMPUTE Z-ARGUMENTS
ARGZ1, ARGZ2 USING
SMALL-ANGLE
APPROXIMATION
COMPUTE Z-ARGUMENTS
ARGZ1, ARGZ2 USING
GENERAL FORMULA
FAC1=EXP(ARGZ1)
FAC2=EXP(ARGZ2)
FAC1=FAC1+(DWD-XZ)*(FAC3-FAC1)/XZ
FAC2=FAC2+(DWD-XZ)*(FAC3-FAC2)/XZ
E


L
DLRS:(.01*DL)
<
≥
ISAC:1
NSUB:0
=
G
≠
NSUB:1
≥
I
<
CAVL = CBAR
N
RETURN

SUBROUTINE QMOD

Purpose:

To compute the linear distribution (in $(\text{Length})^{-1}$) of pollutant along runway due to aircraft emission during landing or takeoff.

Input:

YS1 ------- Distance along runway measured from the tip of exhaust plume near the starting end of runway.

TAIL ------ Length or penetration of the exhaust plume of aircraft at rest.

DL -------- Total length of the smoke slug on the runway.

A --------- Acceleration (or deceleration) of the aircraft.

V12 ------- Initial Velocity, V1, squared.

VS -------- Average velocity of the exhaust particles relative to the air mass in the tail or exhaust plume.

WS2 ------- Wind speed squared.

WSC ------- 2*(Wind Speed)*(-cosine of angle between runway and wind vector).

RR -------- A/G, where A is the acceleration of the aircraft and G is the normalization constant for line density.

Output:

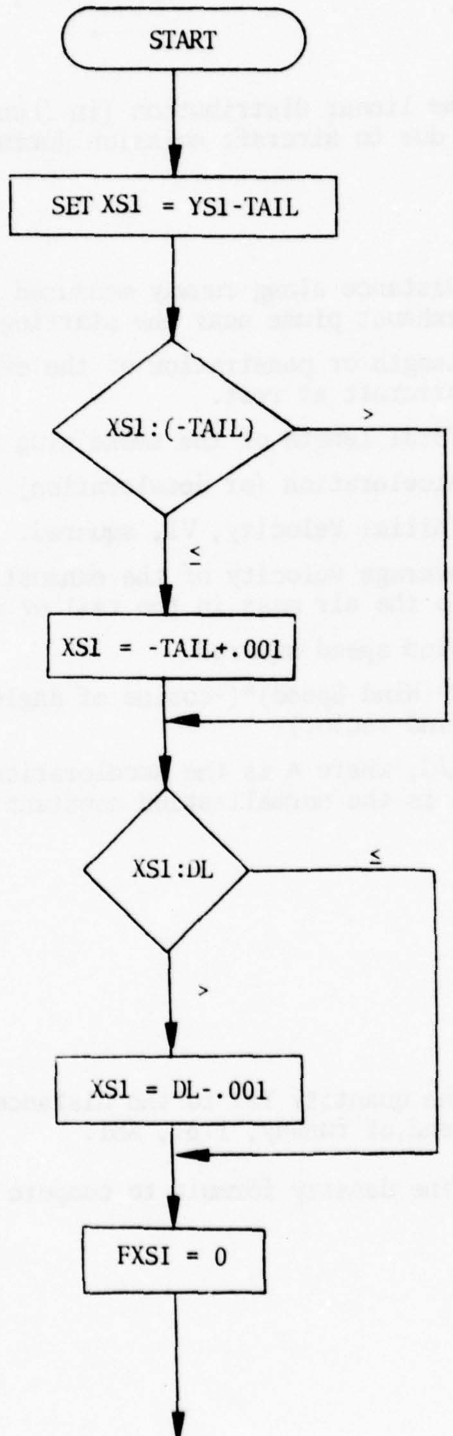
QL

Procedure:

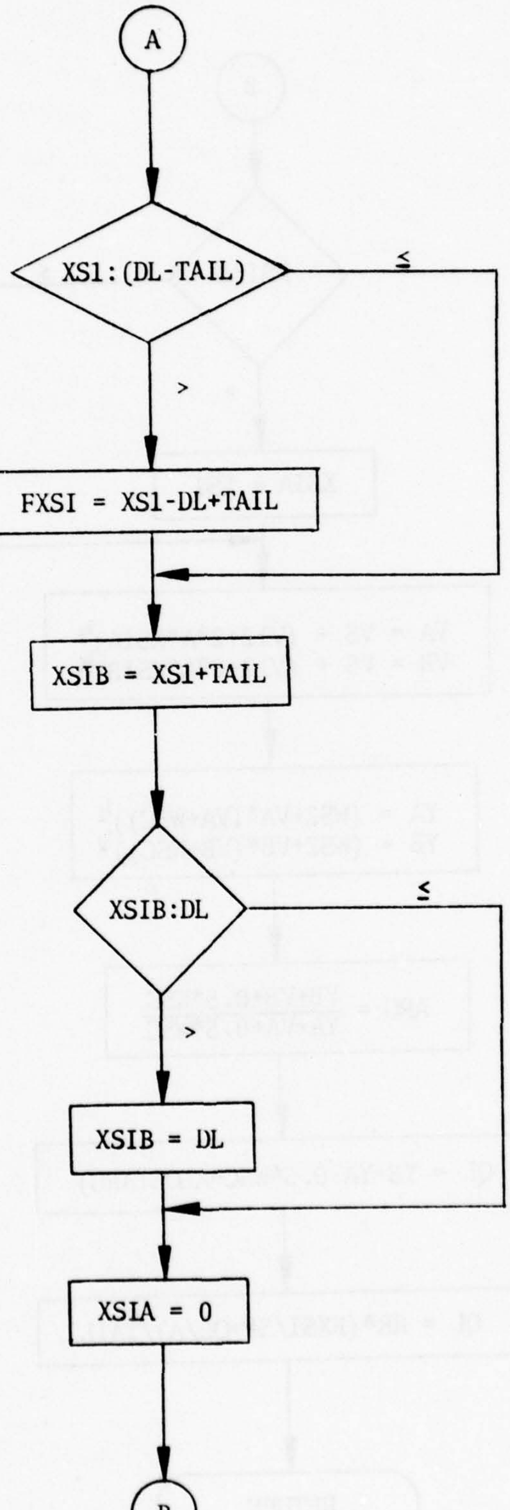
1. Convert the quantity YS1 to the distance measured from the physical end of runway, i.e., XS1.

2. Use the line density formula to compute QL(1/Length).

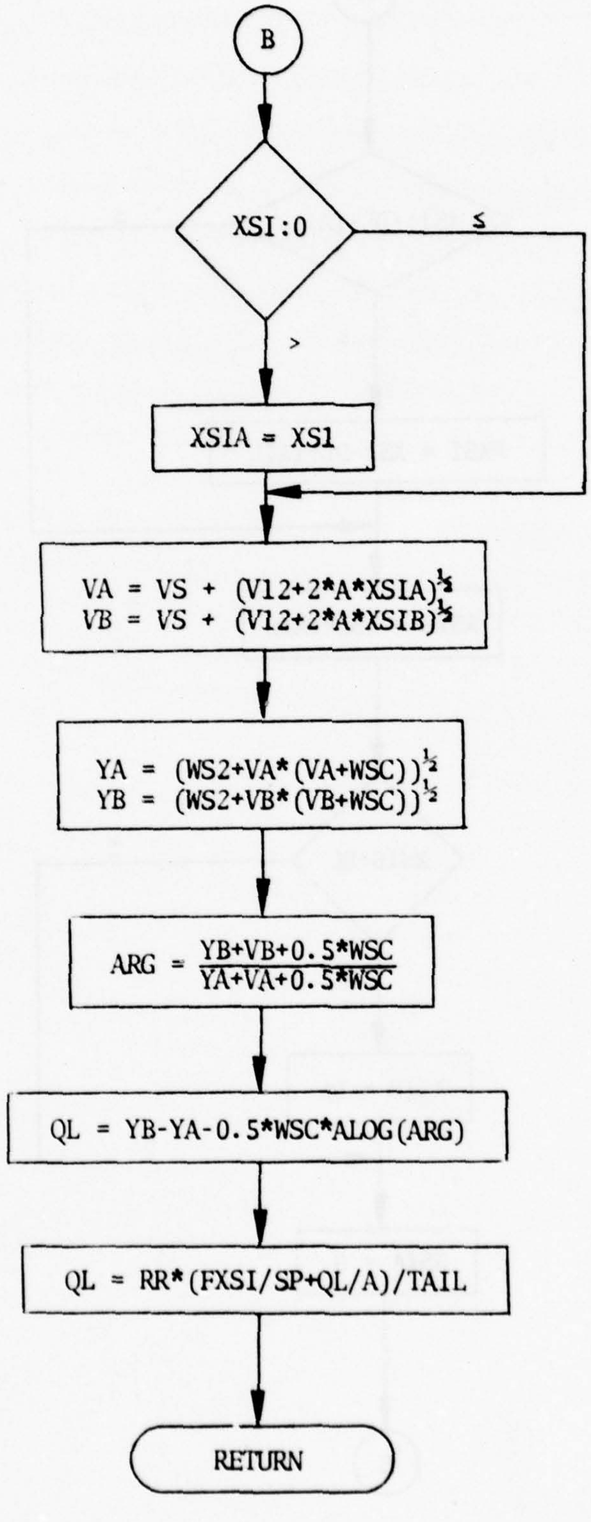
SUBROUTINE QMOD



SUBROUTINE QMOD (Continued)



SUBROUTINE QMOD (Continued)



FUNCTION TRAN

Purpose:

To compute the coupling coefficient at the receptor point due to a point or area source.

Input:

1. Meteorological parameters: wind speed; stability; mixing height; critical distance for mixing.

2. Source parameters: horizontal and vertical spreads; pseudo transport times corresponding to the horizontal and vertical spreads; area source flags: KSTAB, NRFLAG, and IBACK.

3. Receptor parameters: downwind and crosswind distances; receptor height.

Output:

Point or area source coupling coefficient: TRAN.

Procedure:

1. If the effective stack height exceeds the height of the sky lid, then stability index is reassigned according to the current hourly atmospheric stability and the source flag KSTAB computed in PLUME.

2. For point source and area source with source flag NRFLAG = 0, compute the travel time for z dispersion from the center and that for y dispersion from the downwind edge of the source.

3. For sources with NRFLAG = 0 the effects of ground and sky lid are treated by the image method. Up to 6 terms are included in the coupling coefficient.

4. For area source with NRFLAG = 1, the travel times from the downwind and upwind edges of the area sources are determined on the basis of receptor location relative to the area source. These plus the pseudo travel time T_z due to the Z-spread are used to compute the Z-dispersion coefficients $\sigma_z(T_1)$ and $\sigma_z(T_2)$.

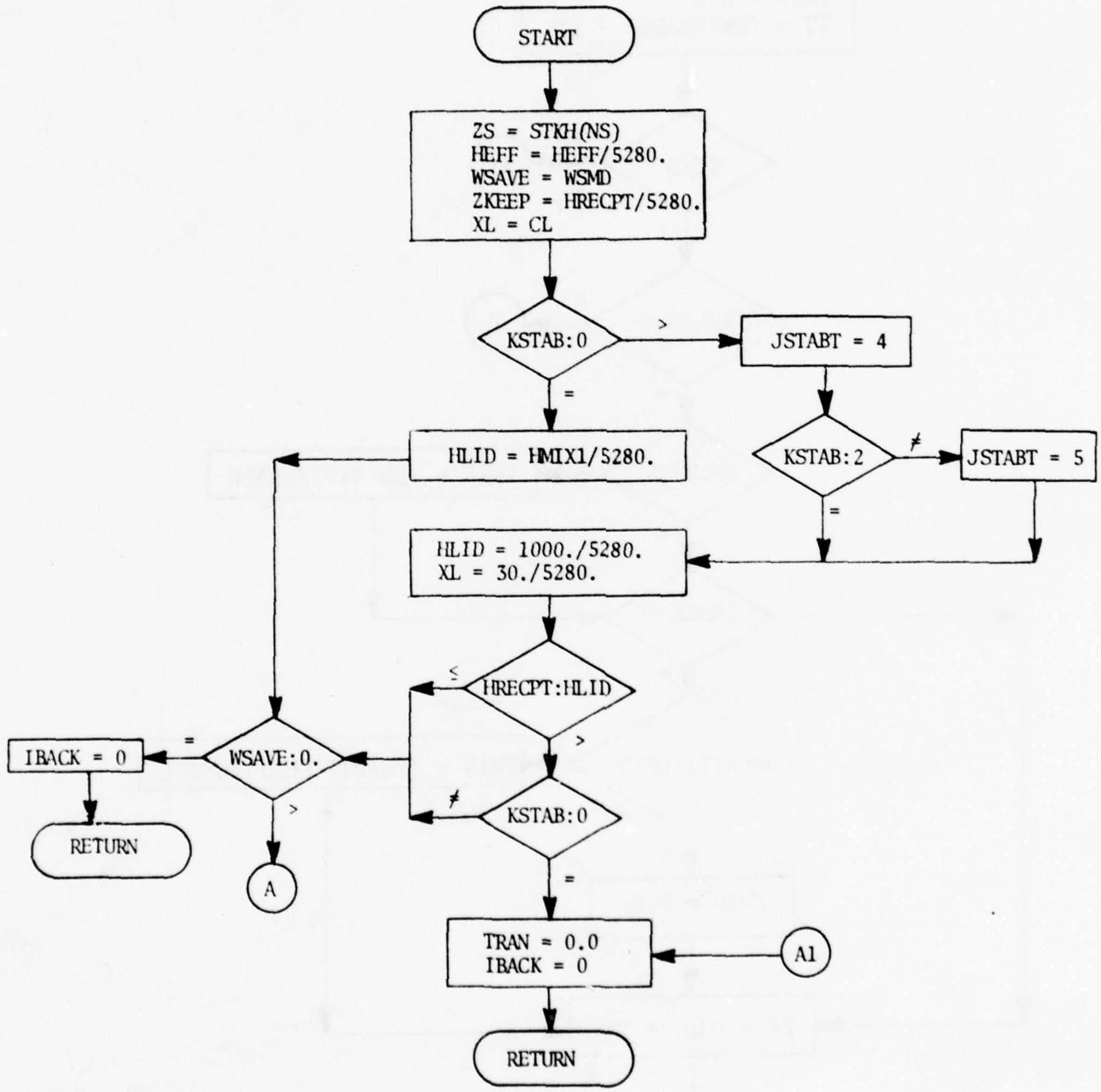
5. For area source with NRFLAG = 1, the y-dispersion coefficient σ_y(TT) is determined on the basis of the pseudo travel time T_y due to the y-spread and the travel time from the downwind edge to the receptor.

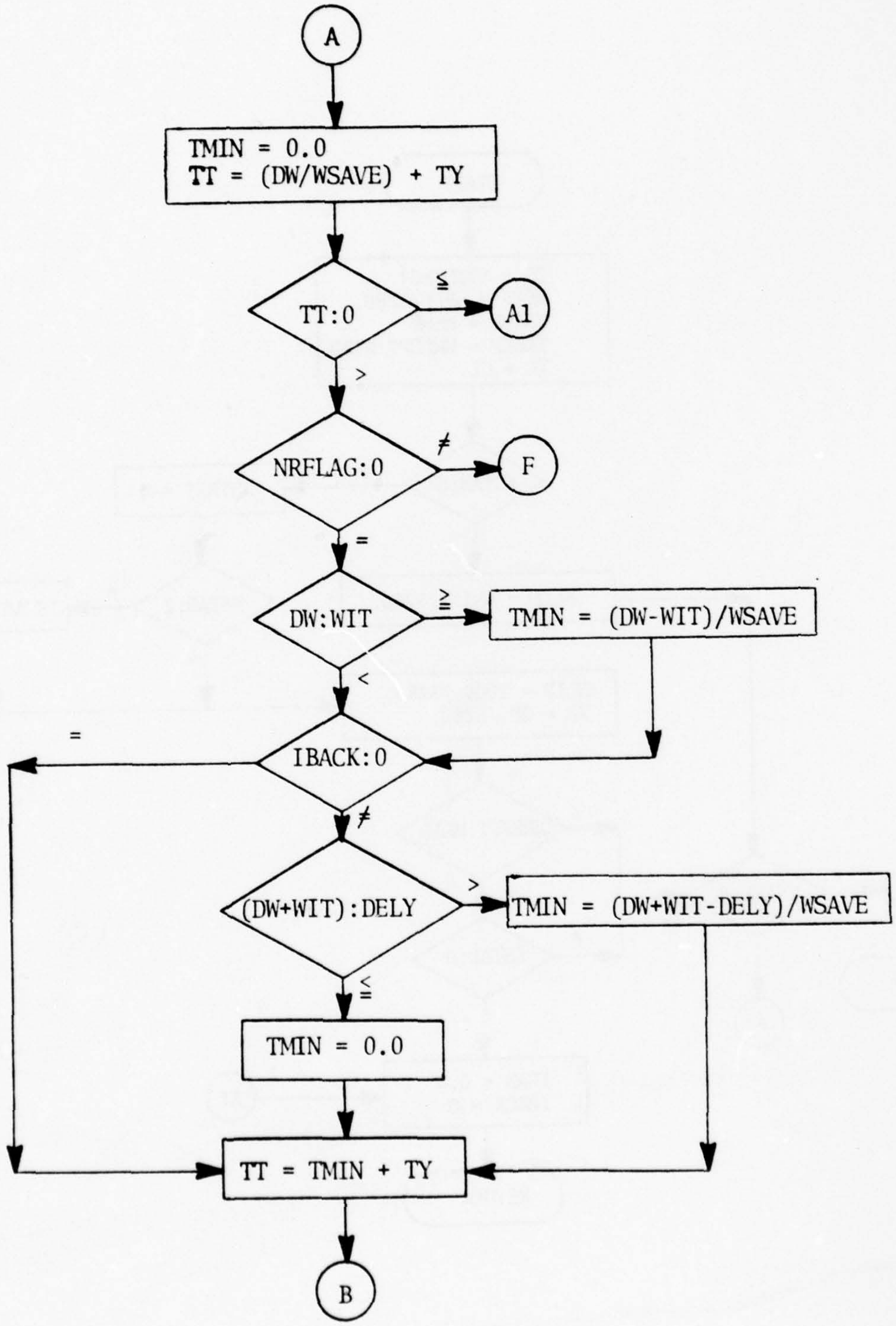
6. The coupling coefficient for area source with NRFLAG = 1 is then computed using the integrated expression for "near" source.

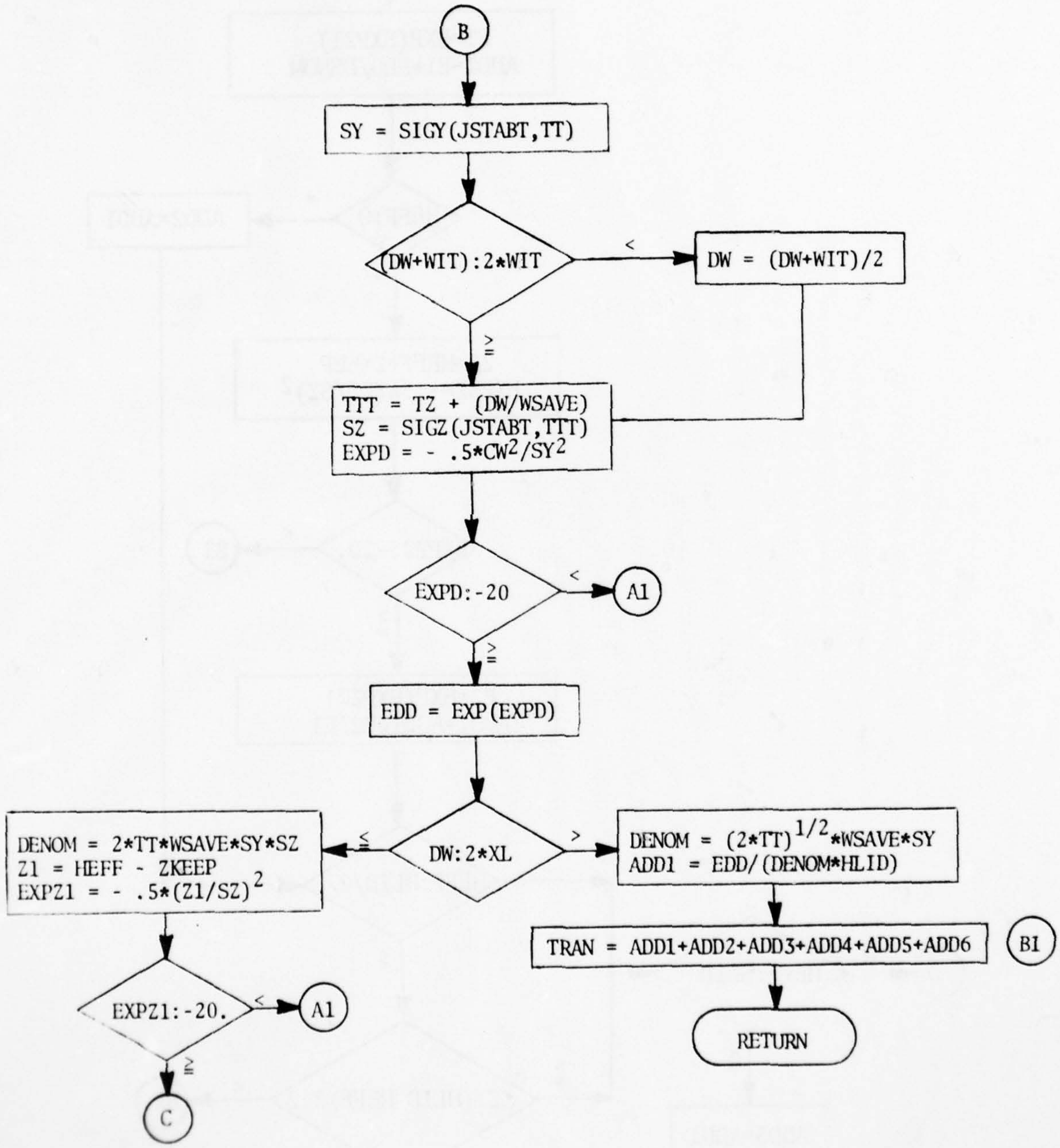
7. If the source flag IBACK is 1, part of the area source is to be treated as "near" and part as "far" area sources. When both contributions to the coupling coefficient are computed and summed, IBACK is then set to 0.

Functions Called:

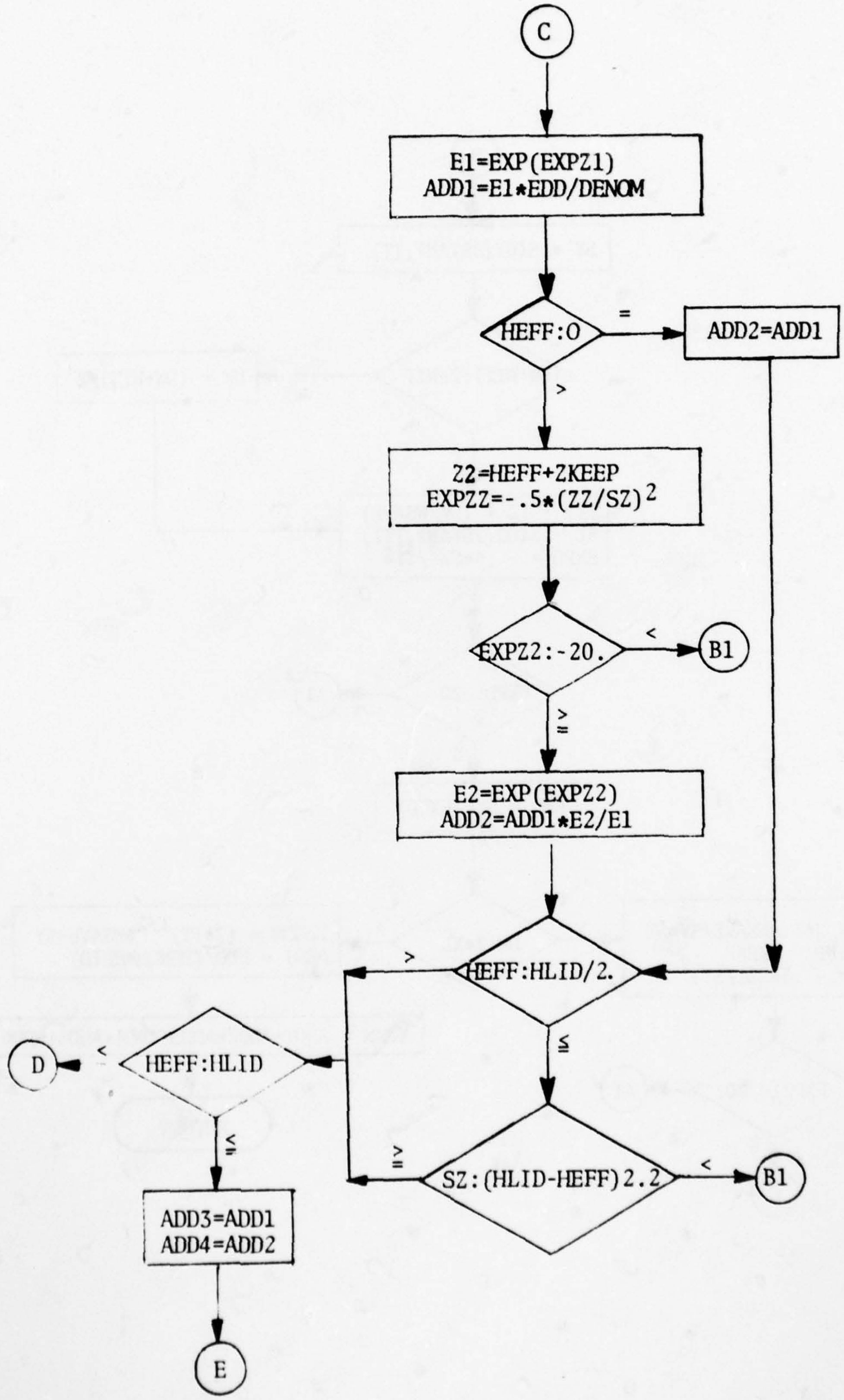
SIGY, SIGZ

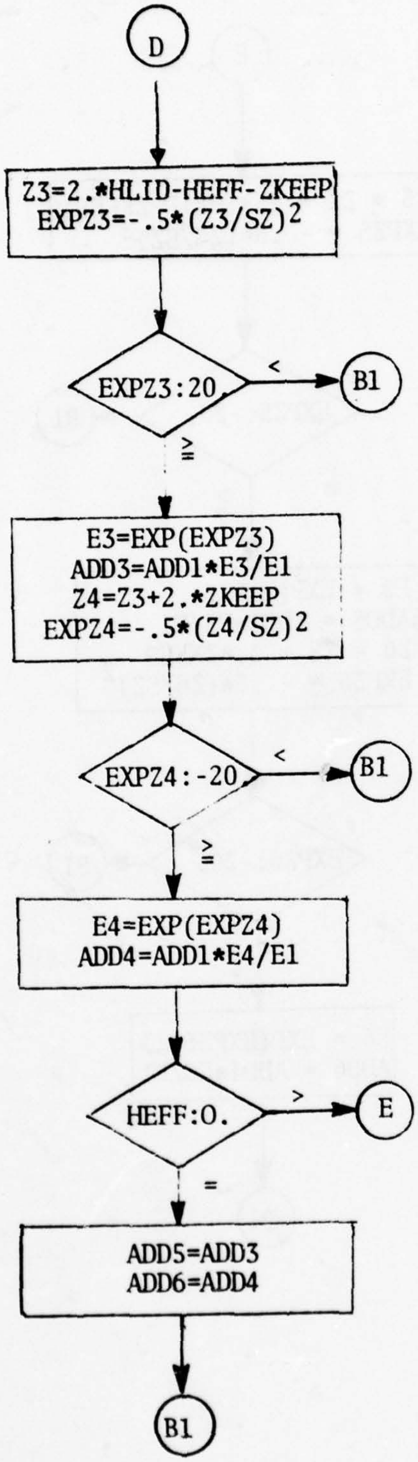

START
ZS = STKH(NS)
HEFF = HEFF/5280.
WSAVE = WSMD
ZKEEP = HRECPT/5280.
XL = CL
KSTAB:0
>
JSTABT = 4
=
HLID = HMIX1/5280.
KSTAB:2
≠
JSTABT = 5
=
HLID = 1000./5280.
XL = 30./5280.
≤
HRECPT:HLID
>
=
IBACK = 0
WSAVE:0.
≠
KSTAB:0
>
RETURN
A
=
TRAN = 0.0
IBACK = 0
A1
RETURN

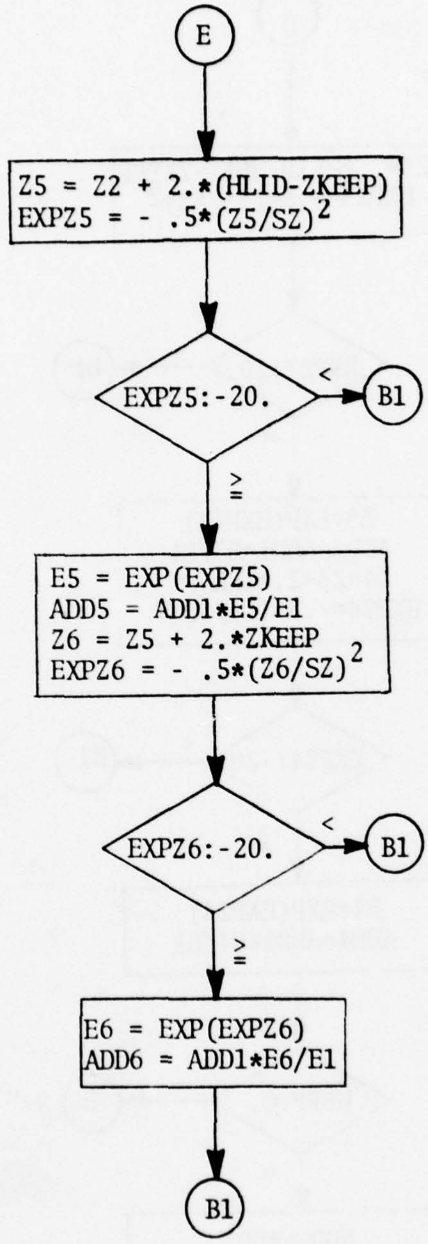

A
TMIN = 0.0
TT = (DW/WSAVE) + TY
TT:0
≦
A1
>
NRFLAG:0
≠
F
=
DW:WIT
≧
TMIN = (DW-WIT)/WSAVE
<
IBACK:0
=
≠
(DW+WIT):DELY
>
TMIN = (DW+WIT-DELY)/WSAVE
≦
TMIN = 0.0
TT = TMIN + TY
B

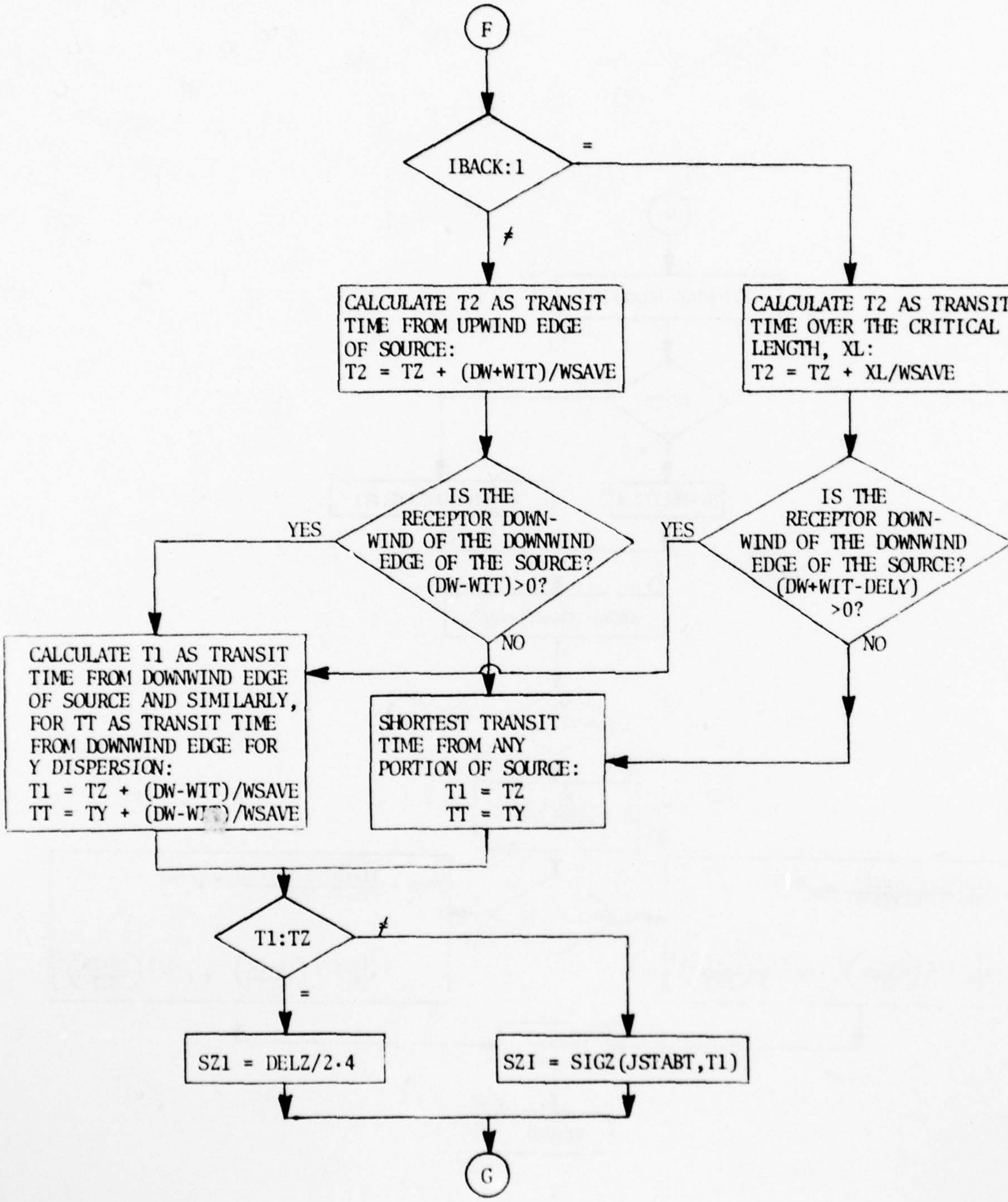


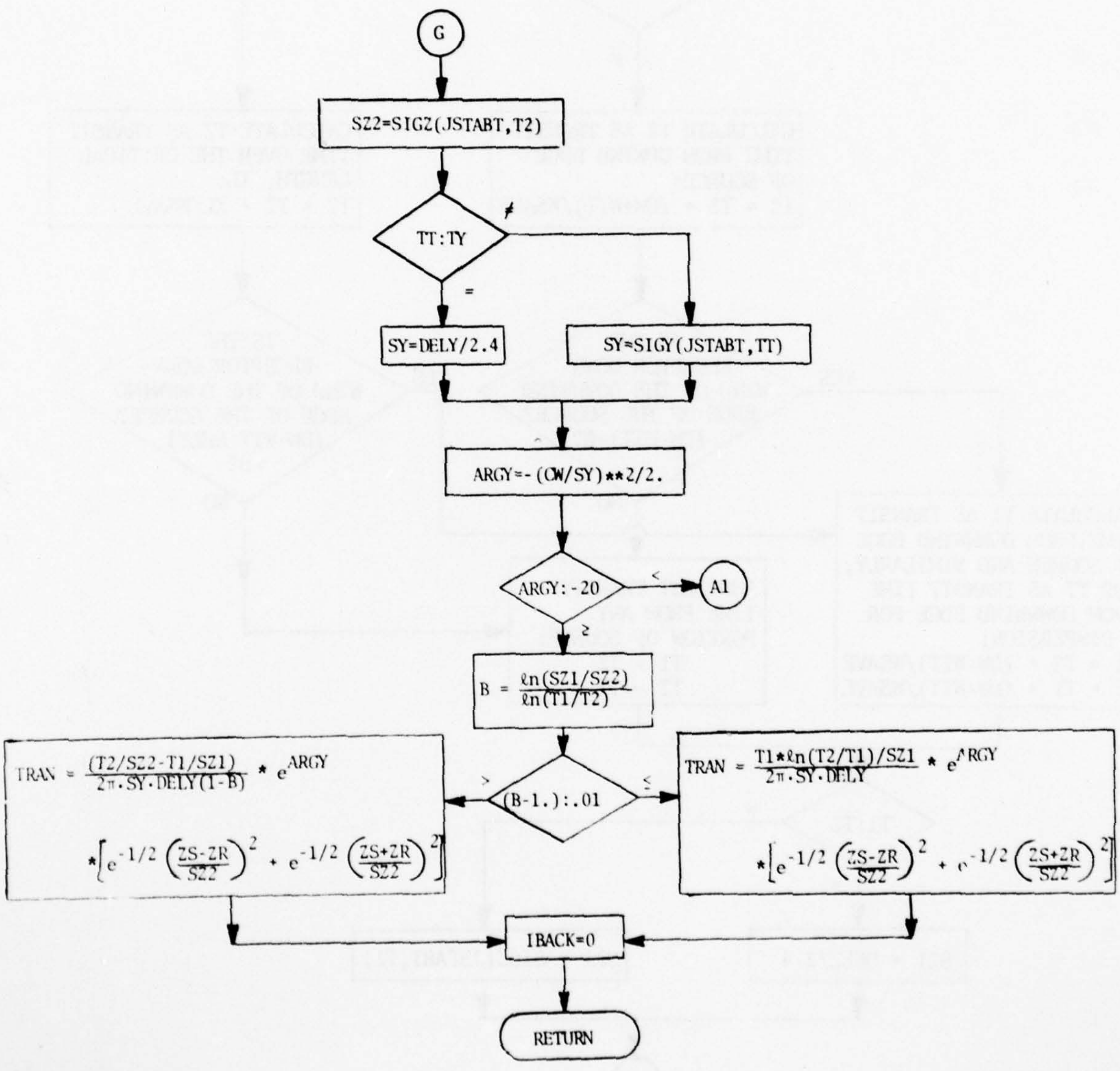
B
SY = SIGY(JSTABT,TT)
(DW+WIT):2*WIT
<
DW = (DW+WIT)/2
≧
TTT = TZ + (DW/WSAVE)
SZ = SIGZ(JSTABT,TTT)
EXPD = - .5*CW2/SY2
EXPD:-20
<
A1
≧
EDD = EXP(EXPD)
DW:2*XL
≦
DENOM = 2*TT*WSAVE*SY*SZ
Z1 = HEFF - ZKEEP
EXPZ1 = - .5*(Z1/SZ)2
EXPZ1:-20.
<
A1
≧
C
>
DENOM = (2*TT)1/2*WSAVE*SY
ADD1 = EDD/(DENOM*HLID)
TRAN = ADD1+ADD2+ADD3+ADD4+ADD5+ADD6
B1
RETURN


C
E1=EXP(EXPZ1)
ADD1=E1*EDD/DENOM
HEFF:0
=
ADD2=ADD1
>
Z2=HEFF+ZKEEP
EXPZZ=-.5*(ZZ/SZ)2
EXPZ2:-20.
<
B1
≥
E2=EXP(EXPZ2)
ADD2=ADD1*E2/E1
HEFF:HLID/2.
>
≤
HEFF:HLID
<
D
≤
ADD3=ADD1
ADD4=ADD2
E
≥
SZ:(HLID-HEFF)2.2
<
B1


D
Z3=2.*HLID-HEFF-ZKEEP
EXPZ3=-.5*(Z3/SZ)2
EXPZ3:20.
<
B1
≥
E3=EXP(EXPZ3)
ADD3=ADD1*E3/E1
Z4=Z3+2.*ZKEEP
EXPZ4=-.5*(Z4/SZ)2
EXPZ4:-20.
<
B1
≥
E4=EXP(EXPZ4)
ADD4=ADD1*E4/E1
HEFF:0.
>
E
=
ADD5=ADD3
ADD6=ADD4
B1


E
Z5 = Z2 + 2.*(HLID-ZKEEP)
EXPZ5 = - .5*(Z5/SZ)2
EXPZ5:-20.
<
B1
≥
E5 = EXP(EXPZ5)
ADD5 = ADD1*E5/E1
Z6 = Z5 + 2.*ZKEEP
EXPZ6 = - .5*(Z6/SZ)2
EXPZ6:-20.
<
B1
≥
E6 = EXP(EXPZ6)
ADD6 = ADD1*E6/E1
B1


F
IBACK:1
=
≠
CALCULATE T2 AS TRANSIT TIME FROM UPWIND EDGE OF SOURCE:
T2 = TZ + (DW+WIT)/WSAVE
CALCULATE T2 AS TRANSIT TIME OVER THE CRITICAL LENGTH, XL:
T2 = TZ + XL/WSAVE
IS THE RECEPTOR DOWN-WIND OF THE DOWNWIND EDGE OF THE SOURCE? (DW-WIT)>0?
YES
NO
IS THE RECEPTOR DOWN-WIND OF THE DOWNWIND EDGE OF THE SOURCE? (DW+WIT-DELY) >0?
YES
NO
CALCULATE T1 AS TRANSIT TIME FROM DOWNWIND EDGE OF SOURCE AND SIMILARLY, FOR TT AS TRANSIT TIME FROM DOWNWIND EDGE FOR Y DISPERSION:
T1 = TZ + (DW-WIT)/WSAVE
TT = TY + (DW-WIT)/WSAVE
SHORTEST TRANSIT TIME FROM ANY PORTION OF SOURCE:
T1 = TZ
TT = TY
T1:TZ
≠
=
SZ1 = DELZ/2·4
SZ1 = SIGZ(JSTABT,T1)
G


G
SZ2=SIGZ(JSTABT,T2)
TT:TY
≠
=
SY=DELY/2.4
SY=SIGY(JSTABT,TT)
ARGY=-(CW/SY)**2/2.
ARGY:-20
<
A1
≥
B = ℓn(SZ1/SZ2) / ℓn(T1/T2)
(B-1.):.01
>
≤
TRAN = (T2/SZ2-T1/SZ1) / 2π·SY·DELY(1-B) * e^ARGY *[e^-1/2 ((ZS-ZR)/SZ2)^2 + e^-1/2 ((ZS+ZR)/SZ2)^2]
TRAN = T1*ℓn(T2/T1)/SZ1 / 2π·SY·DELY * e^ARGY *[e^-1/2 ((ZS-ZR)/SZ2)^2 + e^-1/2 ((ZS+ZR)/SZ2)^2]
IBACK=0
RETURN

APPENDIX C

FORTRAN LISTING OF THE AVAP MODEL ABBREVIATED VERSION

```
C...    AVAP MAIN PGM
        REAL*4 TITLE1(20),TITLE(10)
        REAL*4 NAME(10)
        REAL*8 SRNAME(14),NAUT(5)
        INTEGER OUTPUT,DFAULT(23)
        DIMENSION EMIT(5,2)
        DIMENSION IKA(10),IKB(10)
        DIMENSION SDY(2)
C       EMIT CONTAINS FIVE POLLUTANT EMISSION RATES FOR TWO AREA SOURCES
        DIMENSION XRECP(20),YRECP(20),ZRECP(20),NPUSED(20)
        DIMENSION CON(10)
        DIMENSION XA(7),YA(7),ZA(7),XB(7),YB(7),ZB(7)
        DIMENSION RTXY(2),EMLN(5),EMTF(5)
        DIMENSION CCUP(20),TERM(5),EMTXI(5 ),EMTXO(5 ),
       - RWIDL(5,2),EMID(5),EAPU(5)
        DIMENSION ALSC(60,6)
        DIMENSION ALSE(60,6)
        DIMENSION PLLTNT(5),SRVHR(14)
        DIMENSION CWS(2),DWS(2),CWR(20),DWR(20),RECDAT(4,5,20)
        DIMENSION HEFF(5),KSTAB(5)
        COMMON/DEFLT/NAC(10),FLNDG(10),FTKOF(10),NGIN(10),INGN(10),
       1EMI(5,4,5),DSRW,HRW, FTAXI(10),
       2FTXII(10),FTXIO(10),DSTW,HTW,DSRA,HRA,EFUH(5),EFUL(5),DSAR,HAR,
       3SRVTIM(10,14),KAPU(10),APU(5),FIDLE(10),TGND(10),DFAULT
        COMMON/DELTA/DELY,DELZ
        COMMON/FUEL/EFD(5),EFG(5)
        COMMON/LN/DL,XW1,YW1,ZW1,XW2,YW2,ZW2,COEF1,COEF2,VA1,VA2,VD1,VD2,
       -C,TIME,VA12,VA22,VD12,VD22,WS2,WSC,JAD,SNAN,CSAN,V1,V2,V12,V22,
       -TAIL,VS,RR,SP
        COMMON/LN1/IADC
        COMMON/LOC/DW,CW
        COMMON/MET/WS,WD,JSTAB,HLID,TEMP,XL,SUDOY,SUDOZ
        COMMON/PLM/XS(5),YS(5),STKH(5),WIT(5)
        COMMON/POL/NPT,IJ(5)
        COMMON/RECPT/HRECPT,HTAERO,ZRECPG
        COMMON/RISE/ZSS
        COMMON/SEUDO/TXT,TYT,TZT
        COMMON/SERVHL/SRNAME
        COMMON/XTRAN/WSMO,NCALM,SQTOPI
        DATA NAME/'CO  ','THC ','NOX ','PART','SOX ',5*'    '/
        DATA NAUT/'CO(PPM) ','THC(PPM)','NOX(PPM)','PT(M/CM)','SO2(PPM)'/
        DATA BLANK/'    '/
        DATA SQ2PI /2.5066283  /
C       CONVF CONVERTS LBS/MI**3 INTO MICRO GM/M**3
        DATA CONVF/.10882139/
        DATA CON/1250.,666.,2054.,1.,2854.,5*1./
        INPUT = 5
        OUTPUT = 6
        READ(INPUT,17) TITLE1
        READ(INPUT,19) (TITLE(I),I=1,10)
        WRITE(OUTPUT,17) TITLE1
        WRITE(OUTPUT,31)(TITLE(I),I=1,10)
   17   FORMAT(20A4)
```

```
   19 FORMAT(10A4)
C..   SCAN THE POLLUTANT SPECIFICATION CARD.
      NPT = 0
      I = 1
      L = 1
      IFLAG = 1
  500 IF(NAME(I).EQ.TITLE(L)) GO TO 502
  505 L = L+1
      IF(L.LE.10) GO TO 500
      I = I+1
      IF(I.GT.10) GO TO 501
      L = 1
      GO TO 500
  501 IF(IFLAG.EQ.1) GO TO 503
      GO TO 504
  502 IF(TITLE(L).EQ.BLANK) GO TO 505
      NPT = NPT+1
      IFLAG = 0
  506 IJ(NPT) = I
      IF(NPT.EQ.1) GO TO 510
      IF(IJ(NPT).EQ.IJ(NPT-1)) GO TO 507
  510 CONTINUE
      IF(I.LT.10) GO TO 505
      GO TO 504
  503 WRITE(OUTPUT,508) (TITLE(I),I=1,10)
  508 FORMAT(1H1,'     ERROR----POLLUTANT NAME NOT FOUND        ',10A4)
      GO TO 504
  507 WRITE(OUTPUT,509) TITLE(L)
  509 FORMAT(1H1,'     DUPLICATE POLLUTANT REQUEST     ',A4)
      NPT = NPT-1
      GO TO 506
  504 CONTINUE
      NTXI = 2
      NSVR = 14
      NFWY = 1
      NAPR = 2
C..   READ HEIGHT OF AEROVANE FOR WIND MEASUREMENT
      READ(INPUT,4713) HTAERO,WSP,DIR,TEMP,JSTAB,NLID,NMONTH,NP
 4713 FORMAT(4F8.0,2I8,2I2)
      READ(INPUT,12) NSR,NACT,NENT,NAVR,NACA,NANA
C..   SELECT DEFAULT OPTIONS.
C
      READ(INPUT,1)(DEFAULT(I),I=1,23)
C
C..   READ RECEPTOR COORDINATES X,Y, IN MILES, Z IN FEET.
      READ(INPUT,4711)(NRUSED(N),XRECP(N),YRECP(N),ZRECP(N),N=1,NSR)
      DO 2263 K1=1,4
      DO 2263 LL = 1,NPT
      K2 = IJ(LL)
      DO 2263 K3=1,NSR
 2263 RECDAT(K1,K2,K3)=0.0
      TEM = TEMP
      WD = DIR
      WS = WSP*1.15
      JSTABR = JSTAB
```

```
C.. FUNCTION HMIX WILL RETURN A VALUE FOR MIXING DEPTH
    HLID = NLID*10
    IF(HLID.EQ.0.0) HLID=HMIX(JSTABB,NMONTH,NR,WS)
    WRITE(OUTPUT,34) NSR,NRWY,NTXI,NAPR,NACA,NACT,NENT,NSVP,NAVR,NANA
    WRITE(OUTPUT,9711) NSR,(XRECP(N),YRECP(N),ZRECP(N),N=1,NSR)
    WRITE(OUTPUT,9744)(NPUSED(N),N=1,NSR)
    WRITE(OUTPUT,9734) HTAERO,WS,DIR,TEMP,JSTAB,HLID
C.. COMPUTE SINE AND COSINE OF THE WIND ANGLE
    WDRAD=WD*.01745
    SINWD=SIN(WDRAD)
    COSWD=COS(WDRAD)
    A=WS*SINWD
    B=WS*COSWD
    HL=HLID*0.47/5280.
    DS=0.
    KL=2
    TX=0.
    TY=0.
    TZ=0.
    CALL PSEUDO(DS,A,B,TX,TY,TZ,DX,DY,JSTAB,HL,KL)
    XL=WS*TZ
    WS2 = WS*WS
    WAN = 270.-WD
    WAN = WAN*3.1415927/180.
    CSAN = COS(WAN)
    SNAN= SIN(WAN)
C.. INPUT AIRCRAFT ARRIVAL AND DEPARTURE ACTIVITY BY TYPE .
C..
    IF(DFAULT(1).NE.0)
   1READ(INPUT,5)(NAC(I),I=1,NACT)
    WRITE(OUTPUT,580) NACT,(NAC(K),K=1,NACT)
580 FORMAT(1X,'ARRIVAL ACTIVITY FOR AIRCRAFT TYPES 1 THROUGH',I3
   -,3X,10I3)
C..
C.. INPUT TIME(HOUR) SPENT IN LANDING MODE.
C..
    IF(DFAULT(2).NE.0)
   1READ(INPUT,25)(FLNDG(I),I=1,NACT)
    WRITE(OUTPUT,597)(FLNDG(I),I=1,NACT)
C..
C.. INPUT TIME(HOUR) SPENT IN TAKE-OFF MODE.
C..
    IF(DFAULT(3).NE.0)
   1READ(INPUT,25)(FTKOF(I),I=1,NACT)
    WRITE(OUTPUT,598)(FTKOF(I),I=1,NACT)
C..
C.. INPUT THE NUMBER OF ENGINES USED WITH EACH AIRCRAFT TYPE.
C..
    IF(DFAULT(4).NE.0)
   1READ(INPUT,5)(NGIN(I),I=1,NACT)
C..
C.. INPUT THE ENGINE TYPE INDEX OF THE ABOVE ENGINES.
C..
    IF(DFAULT(5).NE.0)
   1READ(INPUT,5)(INGN(I),I=1,NACT)
```

```
C..
C.. INPUT FOR THE SPECIFIED POLLUTANT(S), THE EMISSION RATE(LB/HR)
C.. OF EACH AIRCRAFT ENGINE TYPE FOR THE FOLLOWING FOUR (4) MODES
C.. OF OPERATION: 1. TAXI, 2. IDLE, 3. LANDING, 4. TAKE-OFF.
      IF(DEFAULT(6).EQ.0) GO TO 446
C..
      DO 445 I=1,NENT
      DO 445 J=1,4
  445 READ(INPUT,3)(EMI(I,J,IJ(K)),K=1,NPT)
  446 CONTINUE
      I5 = 5
C
      IF(DEFAULT(6).EQ.0) GO TO 447
      I5 = NENT
C
  447 DO 448 I = 1,I5
      DO 448 J = 1,4
      WRITE(OUTPUT,150)(J,(EMI(I,J,IJ(K)),K=1,NPT))
  448 CONTINUE
C..
C.. INPUT INITIAL DIMENSIONS OF RUNWAY WIDTH AND HEIGHT.
C..
      IF(DEFAULT(7).NE.0)
     1READ(INPUT,323) DSRW,HRW
      DSRW = DSRW/2.4
      HRW = HRW/1.2
      KL = 0
      CALL PSEUDE(DSRW,A,B,TX1,TY1,TZ1,DX,DY,JSTAB,HRW,KL)
      SUDDY = WS * TX1
      SUDDZ = WS * TZ1
C.. INPUT RUNWAY COORDINATES.
C..
      READ(INPUT,1244) X1,Y1,Z1,X2,Y2,Z2
      WRITE(OUTPUT,9715) X1,Y1,Z1,X2,Y2,Z2
      Z1 = Z1/5280.
      Z2 = Z2/5280.
      RUNX = X2
      RUNY = Y2
C..
C.. INPUT RUNWAY PARAMETERS: INITIAL AND FINAL VELOCITIES DURING
C.. ARRIVAL AND DEPARTURE, TAKE-OFF ROLL TIME, AND EXHAUST TAIL LENGTH.
C.. THESE VALUES WILL DEFAULT AS FOLLOWS*
C..        VA1 = RUNWAY-ARRIVAL INITIAL VELOCITY = 145 MILES/HOUR.
C..        VA2 = RUNWAY-ARRIVAL FINAL VELOCITY   =  25 MILES/HOUR.
C..        VD1 = RUNWAY-DEPARTURE INITIAL VELOCITY=  0 MILES/HOUR.
C..        VD2 = RUNWAY-DEPARTURE FINAL VELOCITY = 180 MILES/HOUR.
C..       TIME = TAKE-OFF ROLL TIME               = .01111 HOURS.
C..       TAIL = EXAUST TAIL LENGTH               = .8523  MILES.
C..
      IF(DEFAULT(8).NE.0)
     1READ(INPUT,1244) VA1,VA2,VD1,VD2,TIME,TAIL
      WRITE(OUTPUT,9721) VA1,VA2,VD1,VD2,TIME,TAIL
      IF(TAIL.LE.0) TAIL = 20./5280.
      VA12 = VA1*VA1
      VA22 = VA2*VA2
```

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```
      VD12 = VD1*VD1
      VD22 = VD2*VD2
C
C                           COMPUTE RUNWAY EMISSIONS
C
      DO 42 L = 1,NPT
      J = IJ(L)
      EMLN(J) = 0.0
      EMTF(J) = 0.0
      TERM(J) = 0.0
      EMTXI(J ) = 0.0
      EMTXO(J ) = 0.0
      EMID(J) = 0.0
      EAPU(J) = 0.0
      DO 42 K = 1,NACT
      TNENG = NAC(K) * NGIN(K)
      EMLN(J) = TNENG*FLNDG(K)*EMI(INGN(K),3,J) + EMLN(J)
   42 EMTF(J) = TNENG*FTKOF(K)*EMI(INGN(K),4,J) + EMTF(J)
C
      DO 8412 IADC = 1,2
      DO 821 M = 1,NSR
      ZR = ZRECP(M)/5280.
      CALL LINE(XRECP(M),YRECP(M),ZR,X1,Y1,Z1,X2,Y2,Z2,CUP)
 5901 FORMAT(1H0,I1,1X,13(E9.3,1X))
      COUPP = CUP*CONVF/WS
      DO  821 LL = 1,NPT
      J = IJ(LL)
      EMSL = EMLN(J)
      IF(IADC.EQ.2) EMSL = EMTF(J)
      RECDAT(3,J,M) = RECDAT(3,J,M) + COUPP*EMSL
      RECDAT(4,J,M) = RECDAT(4,J,M) + COUPP*EMSL
  821 CONTINUE
 8412 CONTINUE
C
C                          TAXIWAYS AS LINE SOURCES.
C
C.. INPUT AIRCRAFT TAXI SPEEDS(MI/HR) IN THE TERMINAL AREA, ON THE
C.. INBOUND TAXIWAY, AND ON THE OUTBOUND TAXIWAY RESPECTIVILY.
       IF(DFAULT(9).NE.0)
      1READ(INPUT,25)(FTAXI(I),I=1,NACT)
       IF(DFAULT(10).NE.0)
      1READ(INPUT,25)(FTXII(I),I=1,NACT)
       IF(DFAULT(11).NE.0)
      1READ(INPUT,25)(FTXIO(I),I=1,NACT)
       WRITE(OUTPUT,592)(FTAXI(I),I=1,NACT)
       WRITE(OUTPUT,593)(FTXII(I),I=1,NACT)
       WRITE(OUTPUT,594)(FTXIO(I),I=1,NACT)
C
C.. INPUT INITIAL DIMENSIONS OF TAXIWAY WIDTH AND HEIGHT.
C
       IF(DFAULT(12).NE.0)
      1READ(INPUT,323) DSTW,HTW
       DSTW = DSTW/2.4
       HTW = HTW/1.2
       KL = 0
```

```
      CALL PSEUDO(DSTW,A,B,TX2,TY2,TZ2,DX,DY,JSTAB,HTW,KL)
      SUDDY = WS*TX2
      SUDDZ = WS*TZ2
      IADC = 0
      DO 826 ITX = 1,NTXI
C.. INPUT TAXIWAY LINE COORDINATES.
C
      READ(INPUT,1244) X1,Y1,Z1,X2,Y2,Z2
      WRITE(OUTPUT,9716) X1,Y1,Z1,X2,Y2,Z2
      Z1 = Z1/5280.
      Z2 = Z2/5280.
      XXSQ = (X1-X2)**2
      YYSQ = (Y1-Y2)**2
      DTXL = SQRT(XXSQ+YYSQ)
C
      EMTAXI = 0.0
C
C                    COMPUTE TAXI EMISSIONS
C
      DO 6413 LL = 1,NPT
      J = IJ(LL)
      DO 41 K = 1,NACT
      TNENG = NAC(K) * NGIN(K)
      EMTX = TNENG * EMI(INGN(K),1,J)
C...
C
      RTI = 1/FTXII(K)
      RTO = 1/FTXIO(K)
      EMTXII = EMTX*DTXL
      IF(ITX.EQ.1) EMTXI(J) = EMTXII*RTI + EMTXI(J)
      IF(ITX.EQ.2) EMTXO(J) = EMTXII*RTO + EMTXO(J)
   41 CONTINUE
      DO 6413 M = 1,NSR
      ZR = ZREC P(M)/5280.
      CALL LINE(XRECP(M),YRECP(M),ZR,X1,Y1,Z1,X2,Y2,Z2,CUP)
      COUPP  = CUP*CONVF/WS
      IF(ITX.EQ.1) EMTAXI = EMTXI(J)
      IF(ITX.EQ.2) EMTAXI = EMTXO(J)
      RECDAT(3,J,M) = RECDAT(3,J,M) + COUPP *EMTAXI
      RECDAT(4,J,M) = RECDAT(4,J,M) + COUPP *EMTAXI
 6413 CONTINUE
  826 CONTINUE
C
C        OUTBOUND APRON QUEUING AS LINE SOURCES
C
C.. INPUT INITIAL DIMENSIONS OF APRON WIDTH AND HEIGHT.
C
      IF(DEFAULT(13).NE.0)
     1READ(INPUT,323) DSRA,HRA
      WRITE(OUTPUT,9719) DSRW,HRW,DSTW,HTW,DSRA,HRA
      DSRA = DSRA/2.4
      HRA = HRA/1.2
      KL = 0
      CALL PSEUDO(DSRA,A,B,TX3,TY3,TZ3,DX,DY,JSTAB,HRA,KL)
      SUDDY = WS*TX3
```

```
      SUDOZ = WS*TZ3
      EACT1 = 0.0
      EACT2 = 0.0
      IADC = 0
      DO 43 I = 1,NACT
      EFACT = NAC(I)
      IKA(I) = .5*EFACT+.5
      IKB(I) = EFACT-IKA(I)
      EACT1 = EACT1 + IKA(I)
   43 EACT2 = EACT2 + IKB(I)
      RCT1 = (EACT1/180. + 1./60.)
      RCT2 = (EACT2/180. + 1./60.)
C..
C.. INPUT AIRPORT APRON COORDINATES.
C
      READ(INPUT,1244)(XA(N),YA(N),ZA(N),XB(N),YB(N),ZB(N),N=1,2)
      DO 124 N=1,2
      SQXY =(XA(N)-XB(N))**2 + (YA(N)-YB(N))**2
      RTXY(N) = SQRT(SQXY)
      ZA(N) = ZA(N)/5280.
      ZB(N) = ZB(N)/5280.
  124 CONTINUE
C
      DO 827 L=1,2
      DISP = 300./5280.
      SN1 = 1.
      SN2 = 1.
      X1 = XA(L)
      Y1 = YA(L)
      Z1 = ZA(L)
      X2 = XB(L)
      Y2 = YB(L)
      Z2 = ZB(L)
      WRITE(OUTPUT,9717) X1,Y1,Z1,X2,Y2,Z2
      IF(L.EQ.1) GO TO 820
      CSI = DISP*(YB(L)-YA(L))/RTXY(L)
      ETA = DISP*(XB(L)-XA(L))/RTXY(L)
      CSI = ABS(CSI)
      ETA = ABS(ETA)
      XC = XB(L)-RUNX
      YC = YB(L)-RUNY
      IF(XC.NE.0) SN1 = XC/ABS(XC)
      IF(YC.NE.0) SN2 = YC/ABS(YC)
      X1 = X1 + SN1*CSI
      Y1 = Y1 + SN2*ETA
      X2 = X2 + SN1*CSI
      Y2 = Y2 + SN2*ETA
  820 CONTINUE
       DO 823 M=1,NSR
      CCUP(M) = 0.0
      ZR = ZRECP(M)/5280.
      CALL LINE(XRECP(M),YRECP(M),ZR,X1,Y1,Z1,X2,Y2,Z2,CUP)
      CCUP(M) = CUP*CONVF/WS
  823 CONTINUE
C
```

```
      DO 8414 LL=1,NPT
      J = IJ(LL)
      RWIDL(J,L) = 0.0
      DO 44 K =1,NACT
      IF(L.EQ.1)
     1 EMRIDL = NAC(K) * NGIN(K) * EMI(INGN(K),1,J) * PTXY(L)/FTXII(K)
      ROT = (IKA(K)*ROT1 + IKB(K)*ROT2)
      IF(L.EQ.2)EMRIDL  =    NGIN(K) * EMI(INGN(K),2,J) * ROT
   44 RWIDL(J,L) = EMRIDL    + RWIDL(J,L)
C
      DO 8414 M=1,NSR
      RECDAT(3,J,M) = RECDAT(3,J,M)  + COUP(M)*RWIDL(J,L)
      RECDAT(4,J,M) = RECDAT(4,J,M)  + COUP(M)*RWIDL(J,L)
 8414 CONTINUE
  827 CONTINUE
C
C                   ACCESS VEHICLE ROADWAYS AS LINE SOURCES
C
      IF(NAVR.EQ.0) GO TO 301
C.. INPUT AUTOMOBILE EMISSION FACTORS(GM/KM)
C
      IF(DFAULT(14).NE.0)
     1READ(INPUT,3)(EFUH(IJ(I)),I=1,NPT)
      IF(DFAULT(15).NE.0)
     1READ(INPUT,3)(EFUL(IJ(I)),I=1,NPT)
      WRITE(OUTPUT,773)(EFUH(IJ(I)),I=1,NPT)
      WRITE(OUTPUT,774)(EFUL(IJ(I)),I=1,NPT)
C
C.. INPUT INITIAL DIMENSIONS OF ROADWAY WIDTH AND HEIGHT.
      IF(DFAULT(16).NE.0)
     1READ(INPUT,323) DSAR,HAR
      DSAR = DSAR/2.4
      HAR = HAR/1.2
      KL = 0
      CALL PSEUDO(DSAR,A,B,TXA,TYA,TZA,DX,DY,JSTAB,HAR,KL)
      SLDDY = WS * TXA
      SLDDZ = WS * TZA
C
C.. INPUT ACCESS VEHICLE ROADWAY COORDINATES.
C
      WRITE(OUTPUT,9735)
      DO 828 N=1,NAVR
      READ(INPUT,311)   X1,Y1,Z1,X2,Y2,Z2,VNOCN,IFS
      WRITE(OUTPUT,9725) X1,Y1,Z1,X2,Y2,Z2,VNOCN,IFS
      Z1 = Z1/5280.
      Z2 = Z2/5280.
      XSQ = (X1-X2)**2
      YSQ = (Y1-Y2)**2
      DVL = SQRT(XSQ+YSQ)
      IANC = 0
C
      DO 824 M=1,NSR
      ZR = ZRECP(M)/5280.
      CALL LINE(XRECP(M),YRECP(M),ZR,X1,Y1,Z1,X2,Y2,Z2,CUP)
      COUP(M) = CUP*CONVF/WS
```

AD-A061 854 ARGONNE NATIONAL LAB ILL F/G 1/5
AIRPORT VICINITY AIR POLLUTION MODEL ABBREVIATED VERSION USER'S--ETC(U)
SEP 78 L A CONLEY, D M ROTE DOT-FA71WA1-223

UNCLASSIFIED FAA-RD-78-111 NL

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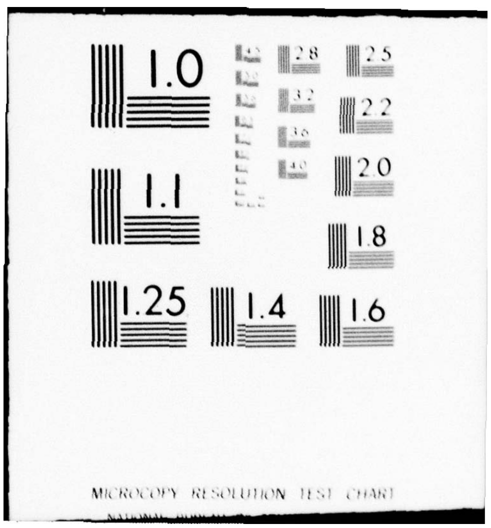
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3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART

```
  824 CONTINUE
C
      DO 8415 LL=1,NPT
      J = IJ(LL)
      EFUEL = EFUH(J)
      IF(IFS.EQ.1) EFUEL = EFUL(J)
      ALSE(N,J) = VNOON*DVL *EFUEL *1.609/453.59
C
      DO 8415 M=1,NSR
      RECDAT(2,J,M) = RECDAT(2,J,M) + COUP(M)*ALSE(N,J)
      RECDAT(4,J,M) = RECDAT(4,J,M) + COUP(M)*ALSE(N,J)
 8415 CONTINUE
  828 CONTINUE
  301 CONTINUE
      IF(NACT.EQ.0) GO TO 3402
C
C                    TERMINAL AREA AS AREA SOURCE
C.. ATTRIBUTABLE EMISSIONS ARE THE FOLLOWING:
C     1. SERVICE VEHICLES (14 TYPES)
C     2. AUXILIARY POWER UNITS
C     3. AIRCRAFT WHILE IN THE INBOUND TAXI MODE
C     4. AIRCRAFT WHILE ENGINE THROTTLE IS SET TO IDLE
C
C
      TK = (273.+5.*(TEMP-32.)/9.)/273.
      NRECPT = NSR
      ZRECPG = HTAERO
      SCTOPI = SO2PI
C
      NSRC = NANA + NACA
      IF(NSRC.EQ.0) GO TO 3402
C
C.. INPUT AREA SOURCE COORDINATES AND THE INITIAL DIMENSIONS OF WIDTH
C.. AND HEIGHT.
C
      IF(NACA.EQ.0) GO TO 116
      READ(INPUT,441) XS(1),YS(1),STKH(1),WIT(1)
      WIT(1) = WIT(1)/2.0
C
C..1. SERVICE VEHICLES IN THE TERMINAL AREA
C
C.. INPUT POLLUTANT EMISSION FACTORS FOR BOTH DIESEL(GM/GAL) AND
C.. GASOLINE(GM/MI) ENGINES.
C
      IF(DFAULT(17).NE.0)
     1READ(INPUT,3)(EFD(IJ(I)),I=1,NPT)
      IF(DFAULT(18).NE.0)
     1READ(INPUT,3)(EFG(IJ(I)),I=1,NPT)
      WRITE(OUTPUT,574)(NAME(IJ(I)),EFD(IJ(I)),I=1,NPT)
      WRITE(OUTPUT,575)(NAME(IJ(I)),EFG(IJ(I)),I=1,NPT)
  574 FORMAT(T5,'POLLUTANT EMISSION FACTORS(DIESEL ENGINE) GM/GAL',/,
     1(T5,A4,'= ',F10.2))
  575 FORMAT(T5,'POLLUTANT EMISSION FACTORS(GASOLINE ENGINE) GM/MI',/,
     1(T5,A4,'= ',F10.2))
      DO 443 I = 1,NSVR
```

```
      SRVHR(I) = 0.0
C
C.. INPUT SERVICE VEHICLE OPERATION TIME (MIN)
C
      IF(DEFAULT(19).NE.0)
     1READ(INPUT,25)(SRVTIM(J,I),J=1,NACT)
C
      DO 410 J=1,NACT
  410 SRVHR(I) = SRVHR(I) + SRVTIM(J,I)*NAC(J)/60.
  443 CONTINUE
      WRITE(OUTPUT,772)
      DO 411 I=1,14
      WRITE(OUTPUT,415) SRNAME(I),(SRVTIM(J,I),J=1,NACT)
  411 CONTINUE
C
C
      DIESEL = 0.0
      GSOLN = 0.0
      IUNIT = 1
      CALL GTFEMC(I,SRVHR,IUNIT,PLLTNT,DIESEL,GSOLN,NPT)
C
C..2. AUXILIARY POWER UNITS IN THE TERMINAL AREA
C
C.. INPUT APU USE FLAGS AND APU POLLUTANT EMISSION RATE.
C
      IF(DEFAULT(20).NE.0)
     1READ(INPUT,5)(KAPU(I),I=1,NACT)
      IF(DEFAULT(21).NE.0)
     1READ(INPUT,3)(APU(IJ(I)),I=1,NPT)
C
C..3. EMISSIONS FROM AIRCRAFT WHILE IN THE INBOUND TAXI MODE
C...
C
C..4. EMISSIONS FROM AIRCRAFT WHILE ENGINE THROTTLE IS SET TO IDLE.
C
C.. INPUT TIME(HOURS) SPENT IN IDLE MODE, AND GATE OCCUPANCY TIME(MIN).
C
      IF(DEFAULT(22).NE.0)
     1READ(INPUT,25)(FIDLE(I),I=1,NACT)
      WRITE(OUTPUT,595)(FIDLE(I),I=1,NACT)
      IF(DEFAULT(23).NE.0)
     1READ(INPUT,25)(TGND(I),I=1,NACT)
C
      DO 111 LL=1,NPT
      J = IJ(LL)
      TMPLNT = 2*WIT(1)
      DO 112 K=1,NACT
      GTOT = TGND(K)/60.
      EMID(J) = NAC(K)*NGIN(K)*FIDLE(K)*EMI(INGN(K),2,J) + EMID(J)
      TERM(J) = NAC(K)*NGIN(K)*EMI(INGN(K),1,J)*TMPLNT/FTAXI(K)+TERM(J)
      EAPU(J) = APU(J)*NAC(K)*GTOT*KAPU(K) + EAPU(J)
  111 CONTINUE
C
C          TOTAL EMISSIONS IN THE TERMINAL AREA.. EMIT(J,1)
C
```

```
  111 EMIT(J,I) =    PLLTNT(J) + TERM(J) + EMID(J) + EAPU(J)
  116 CONTINUE
      IF(NANA.EQ.0) GO TO 115
C
C.. INPUT AIRPORT NON-AIRCRAFT AREA SOURCE COORDINATES, THE INITIAL
C.. DIMENSIONS OF WIDTH AND HEIGHT, AND THE POLLUTANT EMISSION RATE.
C
      N = 2
      IF(NACA.EQ.0) N=1
      READ(INPUT,441) XS(N),YS(N),STKH(N),WIT(N)
      WRITE(OUTPUT,9714) XS(N),YS(N),STKH(N),WIT(N)
      READ(INPUT,3)(EMIT(IJ(J),N),J=1,NPT)
      WIT(N) = WIT(N)/2.0
C
  115 CONTINUE
      DO 211 N=1,NSRC
      CWS(N)=XS(N)*COSWD-YS(N)*SINWD
  211 DWS(N)=-XS(N)*SINWD-YS(N)*COSWD
      DO 212 N=1,NRECPT
      DWR(N)=-XRECP(N)*SINWD-YRECP(N)*COSWD
      CWR(N)=XRECP(N)*COSWD-YRECP(N)*SINWD
  212 CONTINUE
      IF(NSRC.EQ.0) GO TO 3402
      DO  2402 NS=1,NSRC
      HEFF(NS)=STKH(NS)
      KSTAB(NS)=0
      IF(HEFF(NS).GT.HLID)KSTAB(NS)=1
      WSMD=WS
      DLZ=2.*STKH(NS)/(2.4*5280.)
      DSS=2.*WIT(NS)/2.4
      KL=0
      AMOD=A
      BMOD=B
      CALL PSEUDO(DSS,AMOD,BMOD,TX,TY,TZ,DX,DY,JSTAB,DLZ,KL)
      KSTABS=KSTAB(NS)
      HEFFS=HEFF(NS)
      DELY=DSS*2.4
      DELZ=DLZ*2.4
      TXT=TX
      TYT=TY
      TZT=TZ
      HINIT=ZRECPG
      DO 2409 NR=1,NRECPT
      STWIT=WIT(NS)
      DW=DWR(NR)-DWS(NS)
      CW=CWR(NR)-CWS(NS)
      HRECPT = ZRECP(NR)
      PFA=1.
      IF(DW.LE.-WIT(NS)) GO TO 2409
      NRFLAG=0
      IBACK=0
      IF(DW.LE.WIT(NS)) GO TO 231
      IF((DWR(NR)-XL).GE.(DWS(NS)+WIT(NS))) GO TO 241
  231 IF((DWR(NR)-XL).LT.(DWS(NS)-WIT(NS))) GO TO 232
      PFA=(DW-XL+WIT(NS))/(2.*WIT(NS))
```

```
      DWSS=((DWS(NS)-WIT(NS))+(DWR(NR)-XL))/2.
       W=DWR(NR)-DWSS
      WIT(NS)=((DWR(NR)-XL)-(DWS(NS)-WIT(NS)))/2.
      IBACK=1
      GO TO 241
 32   NPFLAG=1
      PFA=1.
C     PERFORM  AREA SOURCE DISPERSION CALCULATIONS BY FUNCTION
C     "TRAN".
 241  TEM=TRAN(NS,KSTABS,HEFFS,NPFLAG,IBACK)*CONVF
      WIT(NS)=STWIT
      TEM=TEM*PFA
      DO 240 LL = 1,NPT
      NR = IJ(LL)
      IXPT = 1
      IF(NACA.EQ.0) IXPT = 2
      IF(NSEC.EQ.2) IXPT = NS
C     FOR EACH RECEPTOR NR, SUM OVER ALL CONTRIBUTIONS FROM
C     AREA SOURCES.
      RECCAT(IXPT,KP,NR)=RECCAT(IXPT,KP,NR)+EMIT(KP,NS)*TEM
 211  RECCAT(4,KP,NR)=RECCAT(4,KP,NR)+EMIT(KP,NS)*TEM
 240  CONTINUE
      IF(IBACK.EQ.1) GO TO 232
 230  CONTINUE
 230  CONTINUE
 230  CONTINUE
 230  CONTINUE
C     CONVERT CONCENTRATIONS FROM MICRO-GRAMS PER CUBIC METER INTO
C     PARTS PER MILLION.
      DO 58 J=1,NSS
      DO 58 LL=1,NPT
      NOP = IJ(LL)
      DO 58 K=1,4
 58   RECCAT(K,NOP,J) = RECCAT(K,NOP,J)* TN/CON(NOP)
C     OUTPUT CALCULATED POLLUTANT CONCENTRATIONS
      WRITE(OUTPUT,20) (NAME(IJ(LL)),LL=1,NPT)
 20   FORMAT(1H1,///,1X,79('*'),/,1X,'*',T80,'*',/,
     11X,'*',19X,'POLLUTANT EMISSION RATE (POUNDS)',T80,'*',/,1X,'*',
     2T80,'*',/,1X,'*' ,31X,5(A4,6X) )
      WRITE(OUTPUT,22) (SMLN(IJ(J)),J=1,NPT)
 22   FORMAT(1H+,T80,'*',/,1X,'* AIRCRAFT LANDING   ',4X,5(F10.1) )
 23   FORMAT(1H+,T80,'*',/,1X,'* OUTBOUND QUEUING   ',4X,5(F10.1))
      WRITE(OUTPUT,24) (EMTF(IJ(J)),J=1,NPT)
 24   FORMAT(1H+,T80,'*',/,1X,'* AIRCRAFT TAKE-OFF ',4X,5(F10.1) )
      WRITE(OUTPUT,26) (RWIDL(IJ(J),1),J=1,NPT)
      WRITE(OUTPUT,22) (RWIDL(IJ(J),2),J=1,NPT)
 26   FORMAT(1H+,T80,'*',/,1X,'* INBOUND APPRN       ',4X,5(F10.1) )
      WRITE(OUTPUT,27) (EMTXI(IJ(J)) ,J=1,NPT)
      WRITE(OUTPUT,45)(EMTXO(IJ(J)) ,J=1,NPT)
 45   FORMAT(1H+,T80,'*',/,1X,'* OUTBOUND TAXIWAY   ',4X,5(F10.1))
 27   FORMAT(1H+,T80,'*',/,1X,'* INBOUND TAXIWAY    ',4X,5(F10.1) )
      WRITE(OUTPUT,32) (PLLINT(IJ(J)),J=1,NPT)
      WRITE(OUTPUT,28) (EAPU(IJ(J)),J=1,NPT)
 28   FORMAT(1H+,T80,'*',/,1X,'* AUX. POWER UNIT',7X,5(F10.1) )
      WRITE(OUTPUT,17)(TEM(IJ(J)),J=1,NPT)
```

```
   13 FORMAT(1H+,T80,'*',/,1X,'* TERM. AREA TAXI    ',4X,5(F10.1))
C
      WRITE(OUTPUT,15)(EMID(IJ(J)),J=1,NPT)
   15 FORMAT(1H+,T80,'*',/,1X,'* TERM AREA ENG. IDLE',3X,5(F10.1))
      WRITE(OUTPUT,29) (EMIT(IJ(J),1),J=1,NPT)
   29 FORMAT(1H+,T80,'*',/,1X,'* AIRCRAFT AREA',9X,5(F10.1) )
      WRITE(OUTPUT,30) (EMIT(IJ(J),2),J=1,NPT)
   30 FORMAT(1H+,T80,'*',/,1X,'* NON-AIRCRAFT AREA',5X,5(F10.1) )
   32 FORMAT(1H+,T80,'*',/,1X,'* SERVICE VEHICLE',7X,5(F10.1) )
      IF(NAVR.EQ.0) GO TO 1001
      WRITE(6,33)
   33 FORMAT(1H+,T80,'*',/,1X,'* ACCESS VEHICLE')
      DO 37 N=1,NAVR
      WRITE(OUTPUT,35) N,(ALSE(N,IJ(J)),J=1,NPT)
   35 FORMAT(1H+,T80,'*',/,1X,'*',16X,I3,4X,5(F10.1) )
   37 CONTINUE
      WRITE(OUTPUT,38)
   38 FORMAT(1H+,T80,'*',/,1X,79('*'),//)
      WRITE(OUTPUT,1000)
 1000 FORMAT(1H1)
 1001 CONTINUE
      DO 16 N=1,NSR
      WRITE(OUTPUT,81) NRUSED(N),XRECP(N),YRECP(N),(NAUT(IJ(J)),J=1,NPT)
   81 FORMAT( 1X,79('*'),/,1X,'*',T80,'*',/,
     11X,'*',9X,'POLLUTANT CONCENTRATIONS : M/CM=MICROGRAMS PER CUBIC ME
     -TER',T80,'*',/,1X,'*'T80,
     2'*',/,1X,'*',19X,'RECEPTOR',I4,T80,'*',/,1X,'*',T80,'*',/,1X
     3 ,'*',19X,'COORDINATES (',F7.3,',',F7.3,')',T80,'*',/,2(1X,'*',T80
     4,'*',/),1X,'*', 31X,5(A8,2X) )
      WRITE(OUTPUT,83) (RECDAT(1,IJ(L),N),L=1,NPT)
   82 FORMAT(1H+,T80,'*',/,1X,'* AIRCRAFT LINE ',11X,5(F10.3) )
      WRITE(OUTPUT,84)(RECDAT(2,IJ(L),N),L=1,NPT)
   83 FORMAT(1H+,T80,'*',/,1X,'* AIRCRAFT AREA ',11X,5(F10.3) )
      WRITE(OUTPUT,82)(RECDAT(3,IJ(L),N),L=1,NPT)
   84 FORMAT(1H+,T80,'*',/,1X,'* NON-AIRCRAFT AREA-LINES',2X,5(F10.3))
      WRITE(OUTPUT,85)(RECDAT(4,IJ(L),N),L=1,NPT)
   85 FORMAT(1H+,T80,'*',/,1X,'*',12X,'TOTAL',9X,5(F10.3))
      WRITE(OUTPUT,38)
   16 CONTINUE
C....... INPUT FORMATS...
C
 4711 FORMAT(I2,3F8.0)
   12 FORMAT(15X,6I5)
    5 FORMAT(5X,15I5)
    1 FORMAT(6X,23I3)
   25 FORMAT(5X,15F5.0)
    3 FORMAT(15X,5F10.0)
  323 FORMAT(15X,2F10.0)
 1244 FORMAT(15X,6F10.0)
  311 FORMAT(10X,6F10.0,F8.0,I2)
  415 FORMAT(1X,A8,5X,10F5.1)
  441 FORMAT(15X,4F10.0)
C
   31 FORMAT(1X,'POLLUTANT CHOICE          ',10A4)
   34 FORMAT(1X,'AIRPORT PARAMETERS:',/,
```

```
     1T24,'NUMBER OF RECEPTORS',
     231('_'),I4,/,T24,'NUMBER OF RUNWAYS',
     333('_'),I4,/,T24,'NUMBER OF TAXIWAYS',
     432('_'),I4,/,T24,'NUMBER OF APRONS',
     534('_'),I4,/,T24,'NUMBER OF TERMINAL AREAS',
     626('_'),I4,/,T24,'NUMBER OF AIRCRAFT TYPES',
     726('_'),I4,/,T24,'NUMBER OF AIRCRAFT ENGINE TYPES',
     419('_'),I4,/,T24,'NUMBER OF SERVICE VEHICLE TYPES',
     919('_'),I4,/,T24,'NUMBER OF ACCESS VEHICLE ROADWAYS',
     717('_'),I4,/,T24,'NUMBER OF AIRPORT NON-AIRCRAFT AREA SOURCES',
     67('-'),I4)
 592 FORMAT(T2,'TAXI SPEED      ',T20,10F6.1)
 593 FORMAT(T2,'INBOUND SPEED   ',T20,10F6.1)
 594 FORMAT(T2,'OUTBOUND SPEED  ',T20,10F6.1)
 595 FORMAT(T2,'IDLE TIME       ',T20,10F7.5)
 597 FORMAT(T2,'LANDING TIME    ',T20,10F7.5)
 598 FORMAT(T2,'TAKE-OFF TIME   ',T20,10F7.5)
 591 FORMAT(T5,'AIRCRAFT OPERATION SPEED(MI/HR), AND TIME(HR)')
 150 FORMAT(12X,I1,5(F6.2,2X))
 571 FORMAT(T5,'NUMBER OF ENGINES PER AIRCRAFT',T40,15I5)
 570 FORMAT(T5,'AIRCRAFT ENGINE TYPES',T40,15I5)
 577 FORMAT(T5,'AUXILIARY POWER UNIT FLAGS',T40,15I5)
 772 FORMAT(T5,'SERVICE VEHICLE OPERATION TIME(MIN.):')
 773 FORMAT(T5,'POLLUTANT EMISSION FACTORS-- 25MPH URBAN AUTOMOBILE TRA
     1FFIC:',/,T5,5F6.2)
 774 FORMAT(T5,'POLLUTANT EMISSION FACTORS-- 10 MPH URBAN AUTOMOBILE TR
     1AFFIC:',/,T5,5F6.2)
 9721 FORMAT(1X,'RUNWAY PARAMETERS:',/,(T5,8F10.5))
 9715 FORMAT(1X,'HORIZONTAL AND VERTICAL SPREAD:',/,T5,'RUNWAYS ',
     12F10.5,/,T5,'TAXIWAYS',2F10.5,/,T5,'APRONS  ',2F10.5)
 9711 FORMAT(1X,I4,' RECEPTOR COORDINATES (X,Y,Z):',/,
     1(T5,3F6.4))
 9744 FORMAT(1X,'ISU',26I3)
 9755 FORMAT(1X,' AEROVANE HEIGHT =',F6.1,' FT.',3X,'WIND SPEED =',F6.2,
     1' MPH',3X,'WIND DIRECTION= ',F4.0,' DEGREES',/,1X,'AMBIENT TEMPERA
     2TURE =',F4.1,' F DEGREES',2X,'STABILITY CLASS INDEX =',I1,,2X,'LID
     3 HEIGHT =',F6.1,' FT.')
 9714 FORMAT(1X, ' AREA SOURCES((X,Y),HEIGHT,WIDTH)',/,(T5,4F10.5))
 417 FORMAT(5F8.0)
 1235 FORMAT(2F8.0)
 9715 FORMAT(1X,'END-POINT COORDINATES OF RUNWAYS',/,(T5,6F10.5))
 9716 FORMAT(1X,'END-POINT COORDINATES OF TAXIWAYS',/,(T5,6F10.5))
 9717 FORMAT(1X,'END-POINT COORDINATES OF APRONS',/,(T5,6F10.5))
 9735 FORMAT(1X,'END-POINT COORDINATES, TRAFFIC INTENSITIES, AND INDICAT
     1ORS OF ACCESS VEHICLE ROADWAYS')
 9725 FORMAT(T5, 7F10.2,I5)
 250 FORMAT(5F8.0)
 450 FORMAT(15F3.0)
     STOP
     END
```

```
      BLOCK DATA
      INTEGER DFAULT(23)
      REAL*8 SRNAME(14)
      COMMON/SERVHL/SRNAME
C
      COMMON/DEFLT/NAC(10),FLNDG(10),FTKOF(10),NGIN(10),INGN(10),
     1EMI(5,4,5),DSRW,HRW, FTAXI(10),
     2FTXII(10),FTXIO(10),DSTW,HTW,DSRA,HRA,EFUH(5),EFUL(5),DSAR,HAR,
     3SRVTIM(10,14),KAPU(10),APU(5),FIDLE(10),TGND(10),DFAULT
      COMMON/FUEL/EFD(5),EFG(5)
      COMMON/LN/DL,XW1,YW1,ZW1,XW2,YW2,ZW2,COFF1,COFF2,VA1,VA2,VD1,VD2,
     -C,TIME,VA12,VA22,VD12,VD22,WS2,WSC,JAD,SNAN,CSAN,V1,V2,V12,V22,
     -TAIL,VS,RR,SP
      DATA NAC/10*10/
      DATA FLNDG/6*.0153,.011,.0153,.011,.011/
      DATA FTKOF/10*.0111/
      DATA NGIN/3,9*2/
      DATA INGN/1,1,1,3,4,3,2,3,2,5/
      DATA EMI/37.,3.53,15.,60.,11.41,37.,3.53,15.,60.,11.41,
     -25.6,2.58,10.1,45.6,11.41,6.,.39,2.,14.,72.52,9.,.88,6.,66.,.38
     -,9.,.88,6.,66.,.38,5.6,.24,3.8,40.3,.38,.4,.05,.4,0.0,1.66,
     -2.,.96,2.0,1.,.01,2.,.96,2.,1.,.01,36.3,1.69,8.,42.1,.01,
     -133.3,3.64,23.,153.,.23,.5,.1,.1,.04,.06,.5,.1,.1,.04,.06,
     -6.8,.38,.3,.3,.06,21.,.62,.6,.8,.12,.9,.5,.5,.6,.01,.9,.5,.5,
     -.6,.01,3.2,.5,.9,2.2,.01,8.6,1.9,1.9,6.2,.07/
      DATA DSRW,HRW/.03,.002/
      DATA VA1,VA2,VD1,VD2,TIME,TAIL/145.,25.,0.0,180.,.0111,.08523/
C
      DATA FTAXI/10*10./
      DATA FTXII/10*15./
      DATA FTXIO/10*12./
      DATA DSTW,HTW/.03,.002/
C
      DATA DSRA,HRA/.095,.002/
C
      DATA EFUH/32.36,4.75,3.46,.19,.11/
      DATA EFUL/70.18,8.62,2.86,.19,.11/
      DATA DSAR,HAR/.0095,.001/
C
      DATA EFD/126.6,21.9,185.82,5.9,0.0/
      DATA EFG/138.81,21.35,9.32,.85,0.0/
C
C
      DATA SRVTIM/66.,48.,85.,55.,50.,50.,4*0.0,28.,15.,30.,0.0,
     -              25.,25.,4*0.0,6.,9*0.0,12.,0.,15.,7*0.0,
     -              15.,15.,15.,10.,10.,10.,5.,5.,5.,0.0,
     -              0.,10.,0.,10.,10.,10.,5.,5.,5.,0.0,
     -              17.,17.,20.,10.,10.,10.,0.,0.,0.,0.,
     -              20.,15.,15.,10.,20.,20.,10.,10.,10.,0.0,
     -              10.,5.,5.,5.,5.,5.,44*0,3.,9*0./
C
C.. NAME THE 14 SERVICE VEHICLE TYPES.
C
```

```
      DATA SRNAME/'TRACTOR ','BELT LDR','CONT LDR','CAB SER ','LAV TRK '
     -,'WAT TRK ','FOOD SRV','FUEL TRK','TOW TCTR','CONDTNR ','AIR STRT'
     -,'GPU FRNT','GPU REAR','TRANSPTR'/

      DATA KAPU/4*1,6*0/
      DATA APU/2.82,.11,1.24,0.,0./
      DATA FIDLE/10*.033/
      DATA TGND/10*52./
      DATA CFAULT/23*0/
      END
```

```
      SUBROUTINE GASOLN(XMIHR,XMIGAL,GAL,XMILE,PLLTNT,NPLTS,IUNIT)
C-----XMIHR=ASSUMED AVERAGE VEHICLE SPEED
C-----XMIGAL=ASSUMED MILES PER GALLON
C-----GAL = GALLONS OF FUEL CONSUMED
C-----IF DATA GIVEN IN VEHICLE MILES, GAL MUST BE SET EQUAL TO 0.0
C-----XMILE=TOTAL MILES; SET EQUAL TO 0.0 IF USING GALLONS
C-----XPT,XCO,ETC. ARE THE EMISSIONS IN UNITS OF POUNDS OR GRAMS FOR
C-----PARTICULATES, CARBON MONOXIDE, HYDROCARBONS, ETC.
C-----IUNIT = 0 MEANS EMISSIONS IN GRAMS ELSE EMISSIONS IN POUNDS.
C
      DIMENSION PLLTNT(5)
      COMMON/PCL/NPT,JJ(5)
      COMMON/FUEL/EFD(5),EF(5)
C**********************************************************************
C      GASOLINE ENGINE POWERED MOTOR VEHICLE EMISSIONS ARE COMPUTED ON
C      THE BASIS OF STANDARD EMISSION FACTORS AND ASSUMED SPEED
C      DEPENDENCE.
C**********************************************************************
C
      SPCO=12.5*(XMIHR)**(-0.845)
      SPHC=7.0*(XMIHR)**(-0.649)
      SPNO=1.0+0.01262*(XMIHR-19.6)
      A=XMIGAL*GAL
      IF(GAL.EQ.0.0) A=XMILE*XMIGAL/12.5
      DO 9 J=1,NPLTS
      I = JJ(J)
      IF(I.EQ.4) FACT = A*EF(4)
      IF(I.EQ.3) FACT = A*EF(3)*SPNO
      IF(I.EQ.1) FACT = A*EF(1)*SPCO
      IF(I.EQ.2) FACT = A*EF(2)*SPHC
      PLLTNT(I) = FACT
      IF(IUNIT.NE.0) PLLTNT(I) = FACT/454.
    9 CONTINUE
      RETURN
      END
```

```
      FUNCTION CAVL(XR,YR,ZR)
      COMMON/LN/DL,XW1,YW1,ZW1,XW2,YW2,ZW2,COEF1,COFF2,VA1,VA2,VD1,VD2,
     -S,TIME,VA12,VA22,VD12,VD22,WS2,WSC,IAD,SNAN,CSAN,V1,V2,V12,V22,
     -TAIL,VS,RR,SP
      COMMON/MET/WS,WD,JSTAB,HLID,TEMP,XZ,SUDDY,SUDDZ
C***********************************************************************
C   CALCULATION OF POLLUTANT CONCENTRATION DUE TO FINITE LINE SOURCE.
C***********************************************************************
      ISUB=0
      NSUB=0
      ISAC=0
      CBAR=0.
      CAN=0.7071
      FMIN=30./5280.
      HLIDM=HLID/5280.
C   INTRODUCE A GENERAL SET OF NOTATION SO THAT SAME DISPERSION CALCULATI
C   CAN BE USED FOR SMALL-ANGLE CASE WHERE LINE IS FURTHER SEGMENTED.
      X1=XW1
      Y1=YW1
      Z1=ZW1
      X2=XW2
      Y2=YW2
      Z2=ZW2
      IF(Z1.GE.HLIDM) GO TO 600
      IF(Z2.GT.HLIDM) GO TO 11
      GO TO 5
   11 X2=X1+(X2-X1)*(HLIDM-Z1)/(Z2-Z1)
      Y2=Y1+(Y2-Y1)*(HLIDM-Z1)/(Z2-Z1)
      Z2=HLIDM
    5 DLXY=(X2-X1)**2+(Y2-Y1)**2
      DL1=SQRT(DLXY)
      IF (DL1.EQ.0.AND.Z1.EQ.Z2)GO TO 600
      DLXYZ=DLXY+(Z2-Z1)**2
      DLN=SQRT(DLXYZ)
      IF(ISUB.NE.0) GO TO 6
      DLPS=DLN
      CSTH=DL1/DLN
      SNTH=(Z2-Z1)/DLN
      PROJL=Y2-Y1
      IF(ABS(PROJL).LT.1.E-20)PROJL=0.
      SNFI=PROJL/DL1
      ASNF=ABS(SNFI)
    6 CONTINUE
      IF(Y1.GT.Y2) GO TO 1
      XH=X2
      YH=Y2
      XL=X1
      YL=Y1
      GO TO 2
    1 XH=X1
      YH=Y1
      XL=X2
      YL=Y2
```

```
    2 CONTINUE
C   TEST RECEPTOR LOCATION RELATIVE TO LINE SOURCE AND BRANCH.
      IF (X1-X2) 27,28,28
   27 XMAX=X2
      XMIN=X1
      GO TO 29
   28 XMAX=X1
      XMIN=X2
   29 IF((XMIN-XR).GE..001) GO TO 500
      XFAR=XR-XMIN
      DWDA=XFAR*SUDDY
      DWDB=XFAR*SUDDZ
      IF(DWDA.LE.0..OR.DWDB.LE.0.) GO TO 500
      TFAR=DWDA/WS
      TFBR=DWDB/WS
      SIGF=SIGY(JSTAB,TFAR)
      SIGFZ=SIGZ(JSTAB,TFBR)
      APRO=ABS(PROJL)
      IF(X1.GT.X2) GO TO 21
      XA=X2
      YA=Y2
      ZA=Z2
      XB=X1
      YB=Y1
      ZB=Z1
      GO TO 22
   21 XA=X1
      YA=Y1
      ZA=Z1
      XB=X2
      YB=Y2
      ZB=Z2
   22 CONTINUE
      IF(ISAC.EQ.1) GO TO 4
      IF(YR.GT.(YH+4.*SIGF)) GO TO 500
      IF(YR.LT.(YL-4.*SIGF)) GO TO 500
      IF(ZR.GT.(Z2+4.*SIGFZ)) GO TO 500
      IF(ZR.LT.(Z1-4.*SIGFZ)) GO TO 500
C     GO TO 3 IF ANGLE IS SMALL
      IF (ASNE .LT.  CAN .AND. ABS(SNTH) .LT. CAN) GO TO 3
      IF(YR.GT.(YH+3.*SIGF)) GO TO 500
      IF(YR.LT.(YL-3.*SIGF)) GO TO 500
      IF(ZR.GT.(Z2+3.*SIGFZ)) GO TO 500
      IF(ZR.LT.(Z1-3.*SIGFZ)) GO TO 500
      X=X1+(YR-Y1)*(X2-X1)/(Y2-Y1)
      IF(X.LT.XB) GO TO 333
      IF(X.GT.XA) GO TO 33
      Y=YR
      GO TO 4
C   SELECT X,Y VALUES ON LINE FOR SMALL ANGLE CASE
    3 X=XR
      IF(XR.GT.XA) X=XA
      Y=Y1+(X-X1)*(Y2-Y1)/(X2-X1)
      ISAC=1
      Z1=Z1+(X-X1)*(Z2-Z1)/(X2-X1)
```

```
      X1=X
      Y1=Y
      X2=XB
      Y2=YB
      Z2=ZB
      X=0.5*(X1+X2)
      Y=0.5*(Y1+Y2)
      GO TO 5
   33 X=XA
      Y=YA
      GO TO 4
  333 X=XB
      Y=YB
    4 DWD=XR-X
      DWD1=DWD
      IF(ISAC.EQ.1) DWD1=XR-X1
      IF(ISAC.EQ.1.AND.NSUB.LE.1) DWD=DWD1
      DWDY1=DWD1+SUBDY
      DWDY=DWD+SUBDY
      DWDZ=DWD+SUBDZ
      IF (DWDY .LE.0. .OR.DWDZ.LE.0..OR.DWDY1.LE.0.)GO TO 500
      IF(X1.EQ.X2) GO TO 44
      Z=Z1+(X-X1)*(Z2-Z1)/(X2-X1)
      GO TO 444
   44 Z=Z1+(Y-Y1)*(Z2-Z1)/(Y2-Y1)
  444 CONTINUE
C     COMPUTE STANDARD DEVIATIONS.
      THRH=DWDY/WS
      THRV=DWDZ/WS
      THRH1=DWDY1/WS
      SIGH1=SIGY(JSTAB,THRH1)
      ELEM=AMAX1(0.2*DWDY1,SIGH1)
      IF (IAE.NE.0) ISAC=1
      IF(ISAC.EQ.1)ELEM=.1*ELEM
      IF(ELEM.LT.EMIN) ELEM=EMIN
C     BRANCH IF ANGLE IS SMALL AND LINE SOURCE IS LONG.
      IF(IAE.NE.0.AND.DL1.GT.(1.5*ELEM))GO TO 55
      IF(ASNF.LT.CAN.AND.DL1.GT.(1.5*ELEM)) GO TO 55
      SIGH=SIGY(JSTAB,THRH)
      SIGV=SIGZ(JSTAB,THRV)
      DENH=1.4142*SIGH
      DENZ=1.4142*SIGV
      IF(ASNF.LT.0.1.AND.(ABS(SNTH)).LT.0.1) GO TO 45
      GO TO 445
   45 ARGZ1=-(ZR-Z1)**2/DENZ**2
      ARGZ2=-(ZR+Z1)**2/DENZ**2
      GO TO 446
  445 CONTINUE
      ARG=CSTH**2*SNFI**2*SIGV**2+SNTH**2*SIGH**2
      RARG=SQRT(ARG)
      A=RARG/(1.4142*SIGH*SIGV)
      AL=DLN*A
      ARG1=(YR-Y1)*CSTH*SNFI*SIGV**2
      ARGZ1=(ZR-Z1)*SNTH*SIGH**2
      ARG22=-(ZR+Z1)*SNTH*SIGH**2
```

```
      BA1=-(ARG1+ARG21)/(1.4142*SIGH*SIGV*RARG)
      BA2=-(ARG1+ARG22)/(1.4142*SIGH*SIGV*RARG)
      ARGY1=AL+BA1
      ARGY2=AL+BA2
      C1=(YR-Y1)**2/DENH**2+(ZR-Z1)**2/DENZ**2
      C2=(YR-Y1)**2/DENH**2+(ZR+Z1)**2/DENZ**2
      ARGZ1=BA1**2-C1
      ARGZ2=BA2**2-C2
  446 IF(ARGZ1.LT.-10..AND.ARGZ2.LT.-10.) GO TO 500
      IF(ARGZ1.LT.-10.)GOTO 2411
      IF(ARGZ2.LT.-10.)GOTO 2412
      IF(DWD.GT.XZ) GO TO 100
      FAC1=EXP(ARGZ1)
      FAC2=EXP(ARGZ2)
      GOTO 2414
 2411 FAC1=0
      FAC2=EXP(ARGZ2)
      GOTO 2414
 2412 FAC2=0
      FAC1=EXP(ARGZ1)
 2414 CONTINUE
  139 CONTINUE
C  GET POLLUTANT DENSITY AND ITS GRADIENT(ID ANY).
C  MODEL ASSUMES CONSTANT ACCELERATION (OR DE-ACCEL.) AND EMISSION ON RU
C  LANDING AND TAKE-OFF.
      XSI2=(X-XW1)**2+(Y-YW1)**2+(Z-ZW1)**2
      XSI=SQRT(XSI2)
      IF(X*XW2.LT.0.OR.Y*YW2.LT.0.OR.Z*ZW2.LT.0) XSI=-XSI
      QL = 1./DL
      IF (IAD .NE. 0) CALL QMOD(XSI,QL)
C  BRANCH IF ANGLE IS SMALL
      IF(ASNE.LT.0.1.AND.(ABS(SNTH)).LT.0.1) GO TO 50
      FJ1=FAC1*(ERF(ARGY1)-ERF(BA1))
      FJ2=FAC2*(ERF(ARGY2)-ERF(BA2))
      CBARO=CBAR
      CBAR=CBAR+0.35355*COEF1*QL*(FJ1+FJ2)/(A*SIGH*SIGV)
      IF (CBARO.EQ.0) GO TO 49
      IF(ABS((CBARO-CBAR)/CBAR).LE..00010) GO TO 600
      IF(IBUG.EQ.0) GO TO 49
   49 CONTINUE
      IF(NSUB.GT.1.AND.DLRS.GT.(.01*DL)) GO TO 60
      GO TO 600
C  SMALL-ANGLE APPROXIMATION
   50 ARGYY=-(YR-Y1)**2/DENH**2
      IF(ARGYY.LT.-10.) GO TO 500
      FAC=0.5*(FAC1+FAC2)
      BRAC=EXP(ARGYY)
 2317 CONTINUE
      CBARO=CBAR
      CBAR=CBAR+COEF2*QL*DLN*FAC*BRAC/(SIGH*SIGV)
      IF (CBARO.EQ.0) GO TO 499
      IF(ABS((CBARO-CBAR)/CBAR).LE..00010) GO TO 600
  499 CONTINUE
      IF(ASNE.LT.0.001) ASNE=0.001
      IF(NSUB.LT.1) GO TO 600
```

```
      IF(DLRS.LT.(.01*DL)) GO TO 600
      IF(NSUB.GT.1.AND.DLRS.GT.(.01*DL)) GO TO 60
   55 NSUB=1.+DL1/ELEM
      RSUB=NSUB
      SEGL=DLN/RSUB
      ISUB=0
      DELX=(X2-X1)/RSUB
      DELY=(Y2-Y1)/RSUB
      DELZ=(Z2-Z1)/RSUB
      XRS=X2-X1
      YRS=Y2-Y1
      ZRS=Z2-Z1
      X2=X1
      Y2=Y1
      Z2=Z1
   60 ISUB=ISUB+1
      IF(ISUB.EQ.1) GO TO 65
      NSUB=1.+DLRS/ELEM
      RSUB=NSUB
      SEGL=DLRS/RSUB
      DELX=XRS/RSUB
      DELY=YRS/RSUB
      DELZ=ZRS/RSUB
   65 CONTINUE
      XRS=XRS-DELX
      YRS=YRS-DELY
      ZRS=ZRS-DELZ
      X1=X2
      Y1=Y2
      Z1=Z2
      X2=X2+DELX
      Y2=Y2+DELY
      Z2=Z2+DELZ
      DLRS=DLRS-SEGL
      X=.5*(X1+X2)
      Y=.5*(Y1+Y2)
      Z=.5*(Z1+Z2)
      GO TO 5
  100 YL = Y1
      ZL = Z1
      IF (Z1 .LE. Z2) GO TO 105
      YL = Y2
      ZL = Z2
  105 FAC3=0.5*SIGV/(COFF1*HLIDM)
      IF(DWC.GT.2.*XZ) GO TO 200
      DENZL=0.47*HLIDM
      DENZL2=DENZL**2
      IF(ASNF.LT.0.1.AND.(ABS(SNTH)).LT.0.1) GO TO 101
      GO TO 102
  101 ARGZ1=-(ZR-ZL)**2/DENZL**2
      ARGZ2=-(ZR+ZL)**2/DENZL**2
      GO TO 103
  102 TL=XZ/WS
      DENHL=1.4142*SIGY(JSTAB,TL)
      DENO=CSTH**2*SNFI**2*DENZL**2+SNTH**2*DENHL**2
```

```
      ARGZ1=-((YR-YL)*SNTH-(ZR-ZL)*CSTH*SNFI)**2/DENO
      ARGZ2=-((YR-YL)*SNTH-(ZR+ZL)*CSTH*SNFI)**2/DENO
  103 FAC1=EXP(ARGZ1)
      FAC2=EXP(ARGZ2)
      FAC1=FAC1+(DWD-XZ)*(FAC3-FAC1)/XZ
      FAC2=FAC2+(DWD-XZ)*(FAC3-FAC2)/XZ
      GO TO 39
  200 FAC1=FAC3
      FAC2=FAC3
      GO TO 39
  500 IF(DLRS.LT.(.01*DL)) GO TO 600
      IF(ISAC.EQ.1.AND.NSUB.EQ.0) GO TO 55
      IF(NSUB.GE.1) GO TO 60
  600 CAVL=CBAR
      RETURN
      END
```

```
      SUBROUTINE DIESEL(GAL,XMIGAL,XMILE,PLLTNT,IUNIT,NPLTS)
C-----GAL = TOTAL GALLONS OF DIESEL FUEL CONSUMED;IF USING MILES, GAL MU
C-----BE SET EQUAL TO 0.0-----------------------------------------------
C-----XMIGAL = MILES PER GALLON; CAN OMIT IF USING GALLONS--------------
C-----XMILE = MILES TRAVELED; NEED NOT BE SPECIFIED IF USING GALLONS----
C-----XPT,XCO,ETC. ARE THE EMISSIONS IN UNITS OF POUNDS OR GRAMS FOR----
C-----PARTICULATES, CARBON MONOXIDE, HYDROCARBONS, ETC.-----------------
C-----IUNIT = 0 MEANS EMISSIONS IN GRAMS ELSE EMISSIONS IN POUNDS-------
      DIMENSION PLLTNT(5)
      COMMON/FUEL/EF(5),EFG(5)
      COMMON/PCL/NPT,JJ(5)
C***********************************************************************
C     COMPUTE DIESEL ENGINE POWERED MOTOR VEHICLE EMISSIONS.
C***********************************************************************
      A=GAL
      IF(A.EQ.0.0) A=XMILE/XMIGAL
      CONFCT=1./454.
      IF(IUNIT.EQ.0) CONFCT=1.0
      DO 10 M=1,NPLTS
      I=JJ(M)
   10 PLLTNT(I)=A*EF(I)*CONFCT
      RETURN
      END
```

```
      SUBROUTINE GTEUMO (IHOUR,SRVHR,IUNIT,PLLTNT,DSL,GSOLN,NPLTS)
      DIMENSION CNSMRT(14),SRVHR(14),PLLTNT(5)
      DIMENSION A(5)
      COMMON/POL/NPT,JJ(5)
      COMMON/FUEL/EFD(5),EFG(5)
      DATA CNSMRT/1.8,0.7,1.75,3*1.5,2.0,1.7,2.35,1.75,1.4,2.0,5.0,1.5/
C***************************************************************************
C-----SUBROUTINE CALCULATES HOURLY EMISSIONS IN PASSENGER GATE AREA RESU
C-----FROM DEMANDS PLACED ON GROUND SERVICE VEHICLES-------------------
C***************************************************************************
C-----CALCULATE GALLONS OF DIESEL USED BY AIRSTART AND GROUND POWER VEHI
      DO 30 I=1,5
30    PLLTNT(I)=0.0
      GAL=0.75*SRVHR(11)*8.2+0.50*SRVHR(13)*7.1
      IF(GAL.EQ.0.0) GO TO 2
      DSL=DSL+GAL
      CALL DIESEL (GAL,0.0,0.0,PLLTNT,IUNIT,NPLTS)
 2    CONTINUE
      GAL=0.5*SRVHR(13)*CNSMRT(13)+SRVHR(14)*CNSMRT(14)
      DO 10 I=1,12
10    GAL=GAL+SRVHR(I)*CNSMRT(I)
      GSOLN=GSOLN+GAL
      IF(GAL.EQ.0.0) GO TO 12
      CALL GASOLN (10.,6.0,GAL,0.0,A,NPLTS,IUNIT)
      DO 20 M=1,NPLTS
      I=JJ(M)
20    PLLTNT(I)=PLLTNT(I)+A(I)
12    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE GUESS2(FCTN,PGGA,PGGB,PZERO,TOL1,
     1 NITMAX,NFLAG1,NFLAG3,NFLAG4)
C
C     CCCCC   MODIFIED FOR PZERO .GT.0.    ONLY
C                         SEE STATEMENT 16
C
C       THIS PROGRAM HAS BEEN TRANSLATED FOR THE        360/50
C       WITH RELEASE 1-A OF THE MOD-50 TRANSDECK
C                                                            JOB
      DIMENSION PGG(50),ERR(50)
C*****************************************************************
C     THIS SUBROUTINE FINDS A ZERO OF THE FUNCTION FCTN(X)
C     FCTN MUST BE DEFINED BY AN EXTERNAL FUNCTION STATEMENT.
C                  PGGA AND PGGB ARE TWO INITIAL GUESSES
C                  TOL1 = ALLOWABLE DEVIATION FROM ZERO IF NFLAG4=1
C                       = ALLOWABLE DIFFERENCE BETWEEN LAST TWO PZERO
C                         VALUES  IF NFLAG4 = -1
C                  NITMAX = MAX NO. OF ITERATIONS
C                  NFLAG3 = 1 IF WANT PRINT OUT  VIA THE SUBROUTINE
C                  NFLAG3 = 0 IF NO PRINT OUT DESIRED
C                INITIALLY CODE SETS NFLAG1=0     .        IF
C     A DIVIDE CHECK  OR EXCESS NO. OF ITERATIONS OCCURS, SETS NFLAG1=1
C*****************************************************************
C
      DELTP=ABS(PGGA-PGGB)
      NFLAG1=0
      NIT=2
      PGG(1)=PGGA
      PGG(2)=PGGB
      I=3
      IA=1
      IB=2
      ERRA=FCTN(PGGA)
      ERR(1)=ERRA
      IF(NFLAG4) 2,2,4
    2 GO TO 5
    4 VALUE=ABS(ERRA)
      IF(VALUE-TOL1)400,400,5
  400 PZERO=PGG(1)
      NIT=1
      ERRB=ERRA
      GO TO 100
    5 ERRB=FCTN(PGGB)
      IF(NFLAG4) 6,6,8
    6 VAL=PGG(IA)-PGG(IB)
      VALUE=ABS(VAL)
      GO TO 9
    8 VALUE = ABS(ERRB)
    9 IF(VALUE-TOL1) 100,100,10
   10 CONTINUE
      VALUE=ABS(ERRA-ERRB)
      IF(VALUE-1.E-28) 75,75,15
   15 PGG(I)=PGG(IB) - ERRB*(PGG(IA)-PGG(IB))/(ERRA-ERRB)
```

```
   16 IF(PGG(I).LE.0.)PGG(I)=.001*DELTP
   20 ERRA=ERRB
      ERR(IB)=ERRB
      PGGB=PGG(I)
      I=I+1
      IA=I-2
      IB=I-1
      NIT=NIT+1
      IF(NIT-NITMAX) 5,5,70
C
   70 PRINT 71,NITMAX
   71 FORMAT(1H1,45H MAX. NO. ITER. FOR PZERO EXCEEDED,NITMAX =    I5 //)
      NFLAG1 = 1
      GO TO 100
C
   75 CONTINUE
      NFLAG1=1
      GO TO 100
C
  100 IF(NFLAG3) 80,80,101
   80 J=I-1
      ERR(J)=ERRB
      PZERO=PGGB
      GO TO 125
C
  101 PZERO=PGGB
      J=I-1
      ERR(J)=ERRB
  104 FORMAT ( ///// )
  105 FORMAT( 22H NO. OF ITERATIONS =       I5     /// )
  115 FORMAT( 4X, 4H NIT ,9X, 6H GUESS , 16X, 6H ERROR          // )
  120 FORMAT(I5,2F20.8)
  125 RETURN
      END
```

```
      FUNCTION HMIX(JSTAB,MON,NHR,WS)
      DIMENSION HMM(12)
      DATA HMM/400.,570.,1000.,930.,1120.,1310.,1180.,990.,980.,570.,
     1660.,480./
C***********************************************************************
C   MIXING DEPTH (IN FEET) IS DETERMINED ON THE BASIS OF STABILITY CLASS
C   AND HOLZWORTH TABLE OF MEAN MONTHLY MAX. MIXING DEPTHS.
C***********************************************************************
      HFT=3.281*HMM(MON)
      GO TO (10,20,20,30,40),JSTAB
   10 HMIX=1.5*HFT
      RETURN
   20 HMIX=HFT
      RETURN
   30 HMIX=HFT
      IF(NHR.GE.7.AND.NHR.LE.11) HMIX=.5*(HFT+328.)
      IF(NHR.GE.17.AND.NHR.LE.21) HMIX=.5*(HFT+328.)
      IF(WS.GE.13.8) HMIX=HFT
      RETURN
   40 HMIX=328.
      RETURN
      END
```

```
      SUBROUTINE LINE(XR,YR,ZR,X1,Y1,Z1,X2,Y2,Z2,CONC)
      COMMON/LN/DL,XW1,YW1,ZW1,XW2,YW2,ZW2,COEF1,COEF2,VA1,VA2,VD1,VD2,
     -A,TIME,VA12,VA22,VD12,VD22,WS2,WSC,IAD,SNAN,CSAN,V1,V2,V12,V22,
     -TAIL,VS,RR,SP
      COMMON/MET/WS,WD,JSTAB,HLID,TEMP,XL,SUDDY,SUDDZ
      COMMON/LN1/IADC
C*********************************************************************
C     PREPARE GEOMETRIC AND KINEMATIC PARAMETERS FOR THE FINITE LINE
C     SOURCE DISPERSION MODEL CAVL.
C*********************************************************************
      IAD=IADC
      AL2=(X2-X1)*(X2-X1)+(Y2-Y1)*(Y2-Y1)+(Z2-Z1)*(Z2-Z1)
      DL=SQRT(AL2)
      IF(IAD.EQ.0) GO TO 20
      GO TO (1,2),IAD
C     FOR ARRIVAL, TIME IS COMPUTED.
    1 V1=VA1
      V2=VA2
      V12=VA12
      V22=VA22
      TYME=2.*DL/(V1+V2)
      GO TO 10
C     FOR DEPARTURE, DL IS COMPUTED.
    2 V1=VD1
      V2=VD2
      V12=VD12
      V22=VD22
      DL1=.5*TIME*(V1+V2)
      X2=X1+(X2-X1)*DL1/DL
      Y2=Y1+(Y2-Y1)*DL1/DL
      DL=DL1
      TYME=TIME
   10 A=(V2-V1)/TYME
   20 XW1=0.
      YW1=0.
      ZW1=Z1
      U=1.
      TAU=1.
      TWOPI=2.*3.1415927
      SQP=SQRT(TWOPI)
      COEF1=1./(SQP*U*TAU)
      COEF2=2./(TWOPI*U*TAU)
      XW2=(X2-X1)*CSAN+(Y2-Y1)*SNAN
      YW2=(X1-X2)*SNAN+(Y2-Y1)*CSAN
      ZW2=Z2
      XRCP=(XR-X1)*CSAN+(YR-Y1)*SNAN
      YRCP=(X1-XR)*SNAN+(YR-Y1)*CSAN
      ZRCP=ZR
      IF(IAD.EQ.0) GO TO 50
      CSA = -XW2 / DL
      WSC = 2 * WS * CSA
      FXT = TAIL / DL
      DX = XW2 * FXT
```

```
      DY = YW2 * EXT
      XW2 = XW2 + DX
      YW2 = YW2 + DY
      XRCP = XRCP + DX
      YRCP = YRCP + DY
      VS = TAIL / TIME
      VT = V2 + VS
      SP2 = WS2 + VT * VT + WSC * VT
      SP =  SQRT (SP2)
      W1 = V1 + VS
      W2 = V2 + VS
      YY1 = SQRT(WS2 + W1 * (W1 + WSC))
      YY2 = SQRT(WS2 + W2 * (W2 + WSC))
      ARG = (YY2+ W2 + WSC/2.) / (YY1+ W1 + WSC/2.)
      G =YY2 -YY1 - WSC/2. * ALOG(ARG)
      RR = A / G
   50 CONC=CAVL(XRCP,YRCP,ZRCP)
      RETURN
      END
```

```
      SUBROUTINE PSEUDO(DS,U,V,TX,TY,TZ,DX,DY,MSTH,HS,NCL)
      EXTERNAL SIGGX,SIGGZ
      COMMON/STABIL/NSTB,SIGXO,SIGZO
      COMMON/WOUN/WSAVE
C*************************************************************************
C     HORIZONTAL AND VERTICAL SOURCE WIDTHS ARE CONVERTED TO PSEUDO
C     TRANSPORT TIMES.
C*************************************************************************
      EPP=.001
      A=1.
      B=.5
      C=.1
      D=.01
      NUL=10
      NP=0
      N4=1
      WSAVE=SQRT(U*U+V*V)
      NSTB=MSTH
      IF(NCL.GE.2)  GO TO 9
      SIGXO=DS
      CALL GUESS2(SIGGX,A,B,TX,EPP,NUL,NF1,NP,N4)
      TY=TX
    9 SIGZO=HS
   10 CALL GUESS2(SIGGZ,C,D,TZ,EPP,NUL,NF1,NP,N4)
   40 DX=U*TX
      DY=V*TY
      RETURN
      END
```

```
      SUBROUTINE QMCD (YS1,QL)
      COMMON/LN/DL,XW1,YW1,ZW1,XW2,YW2,ZW2,COEF1,COEF2,VA1,VA2,VD1,VD2,
     -A,TIME,VA12,VA22,VD12,VD22,WS2,WSC,IAD,SNAN,CSAN,V1,V2,V12,V22,
     -TAIL,VS,RR,SP
      COMMON/MET/WS,WD,JSTAB,HLID,TEMP,XL,SUDDY,SUDDZ
C***********************************************************************
C  A MOBILE SOURCE EMISSION MODEL ASSUMING CONSTANT ACCELERATION
C***********************************************************************
      XS1 = YS1 - TAIL
      IF (XS1 .LE. -TAIL) XS1 = -TAIL + .001
C
      IF (XS1 .GT. DL) XS1 = DL - .001
C
      FXSI = 0.
      IF (XS1 .GT. (DL-TAIL)) FXSI = XS1 - DL + TAIL
C
   30 XSIB = XS1 + TAIL
      IF (XSIB .GT. DL) XSIB = DL
C
      XSIA = 0.
      IF (XS1 .GT. 0) XSIA = XS1
C
      ROOTB = V12 + 2.*A*XSIB
      ROOTA = V12 + 2.*A*XSIA
      VA = SQRT(ROOTA) + VS
      VB = SQRT(ROOTB) + VS
      YA = SQRT(WS2 + VA *(VA + WSC))
      YB = SQRT(WS2 + VB *(VB + WSC))
      ARG = (YB + VB + WSC/2.) / (YA + VA + WSC/2.)
      CL = YB - YA - WSC/2. * ALOG(ARG)
      QL = RR / TAIL * (FXSI / SP + CL / A)
      RETURN
      END
```

```
      FUNCTION SIGGX(THOUR)
      COMMON/STABIL/NSTB,SIGXO,SIGZO
      SIGGX=SIGY(NSTB,THOUR)-SIGXO
      RETURN
      END


      FUNCTION SIGGZ(THOUR)
      COMMON/STABIL/NSTB,SIGXO,SIGZO
      SIGGZ=SIGZ(NSTB,THOUR)-SIGZO
      RETURN
      END


      FUNCTION SIGY(J,THOUR)
      COMMON/WOUN/WSAVE
      DIMENSION A(7),B(7)
      DIMENSION C(5),D(5)
      DATA C/155.,100.,68.,50.,34./,   D/.91,.98,.93,.90,.93/
      DATA A/2.1511,1.5454,1.0606,.68465,.59366,.59366,.59366/
      DATA B/.87326,.88261,.89031,.88866,.89138,.89138,.89138/
      DATA CONV/.000621371/
C**********************************************************************
C     COMPUTE HORIZONTAL DISPERSION COEFFICIENT.
C**********************************************************************
C     J=1,2,3,4,5 ARE CLASSES B,C,D,E,F
C   XX AND SIGXY ARE IN MILES
      TSEC=THOUR*3600.
C
      SIGY=(A(J)*TSEC**B(J))*CONV*.87
C  WSAVE IS MEAN WIND SPEED UP TO TIME T.
       XX=WSAVE*THOUR*1.609
      JJ=MAX0(J-1,1)
       SIGXY=C(JJ)*(XX**D(JJ))*.000889
C     .000889=(1/1609.)*(6**.2)
       SIGY=AMAX1(SIGY,SIGXY)
C
C     DISPERSION COEFFICIENTS BASED ON TURNER WORKBOOK.
C     WHERE THE SIGMAS GIVEN IN THE WORKBOOK FOR
C     TEN MINUTE SAMPLINGS ARE SCALED TO 1 HOUR
C     AVERAGES BY A FACTOR OF 1.43
      RETURN
      END
```

```
      FUNCTION SIGZ(J,THOUR)
      COMMON/WDUN/WSAVE
C     DISPERSION COEF. BASED ON TURNERS WORKBOOK
C     J=1,2,3,4,5 ARE CLASSES B,C,D,E,F
C     X AND SIGZ ARE IN MILES
      DIMENSION C(3,5),D(3,5)
      REAL TIME(7),A(7,6),B(7,6)
C
      DATA TIME/0.,300.,1000.,3000.,10000.,30000.,172000./
      DATA A/.17122,.27668,.41219,.51921,.50963,.47639,.52140,
     1       .11062,.39953,.41219,.57145,.76485,.71936,.88886,
     2       .01338,.16640,.41219,1.0813,1.9467,2.3901,1.8877,
     3       .01338,.16640,.41219,2.2830,2.9850,3.8684,6.7452,
     3       .01338,.16640,.41219,2.3333,5.7990,16.897,20.673,
     3       .01338,.16640,.41219,5.6801,14.599,64.577,54.149/
      DATA B/1.2098,1.0572,.92365,.84130,.79689,.76308,.69839,
     1       1.2864,.99275,.92365,.82449,.72571,.69082,.60486,
     2       1.5922,1.1195,.92365,.73217,.59047,.51700,.49583,
     3       1.5922,1.1195,.92365,.63883,.53706,.45686,.33677,
     4       1.5922,1.1195,.92365,.63646,.46497,.29621,.21517,
     5       1.5922,1.1195,.92365,.55016,.37541,.16667,.12177/
      DATA C/110.,110.,110.,60.,60.,60.,33.,33.,40.,21.5,21.5,36.,14.,
     114.,23.5/
      DATA D/1.,1.09,1.09,.92,.92,.92,.80,.61,.53,.70,.56,.35,.78,.53,
     1.30/
      DATA CONV/.000621371/
C***********************************************************************
C     COMPUTE VERTICAL DISPERSION COEFFICIENT.
C***********************************************************************
      TSEC=THOUR*3600.
      DO 10 N=2,7
      IF(TSEC.LE.TIME(N))GO TO 20
   10 CONTINUE
      IF(N.GT.7)  N=7
C     TIME OF TRAVEL SHOULD BE LESS THAN 172.E03 SEC     APPROX. 2 DAYS
   20 CONTINUE
      N=N-1
      SIGZ=(A(J,N)*TSEC**B(J,N))*CONV
C       TURNER TEST EQUATION
C     SIGZ=(1.17518*TSEC**.72012)*CONV
      XX=WSAVE*THOUR*1.609
      I=1
      IF(XX.GT.1.) I=2
      IF(XX.GT.10.) I=3
      JJ=MAX0(J-1,1)
      SIGTZ=(C(I,JJ)*XX**D(I,JJ))*.000714
C     .000714=(1/1609)*(20/10)**.2, ASSUMING THAT THE VERTICAL DISPER-
C     SION COEFFICIENT IS INSENSITIVE TO SAMPLING TIMES OVER 20 MIN.
      SIGZ=AMAX1(SIGZ,SIGTZ)
      RETURN
      END
```

```
      FUNCTION TRAN (NS,KSTAB,HEFA,NRFLAG,IBACK)
      COMMON/DELTA/DELY,DELZ
      COMMON/LOC/DW,CW
      COMMON/MET/WS,WD,JSTAB,HMIX1,TEMP,CL,SUDDY,SUDDZ
      COMMON/PL4/XS(5),YS(5),STKH(5),WIT1(5)
      COMMON/RECPT/HRECPA,HTAERO,ZRECPC
      COMMON/SEUDC/TX,TY,TZ
      COMMON/XTRAN/WSMD,NCALM,SQ2PI
      COMMON/WDUN/WSAVE
C***********************************************************************
C     COMPUTE COUPLING COEFFICIENT AT RECEPTOR DUE TO POINT AND AREA
C     SOURCE.
C***********************************************************************
C       IF(KSTAB.GT.0)HAVE PLUME INITIALLY ABOVE LID.
      ZS=STKH(NS)/5280.
      HEFF=HEFA/5280.
      WIT=WIT1(NS)
      JSTABT=JSTAB
      WSAVE=WSMD
      HRECPT=HRECPA/5280.
      ZKEEP=HRECPT
      ADD1=0.
      ADD2=0.
      ADD3=0.
      ADD4=0.
      ADD5=0.
      ADD6=0.
      WJWG = 0.
      XL = CL
C
      IF(KSTAB.GT.0)GO TO 121
      HLID=HMIX1/5280.
      GOTO 140
  121 JSTABT=4
      IF(KSTAB.EQ.2) GOTO130
      JSTABT=5
  130   CONTINUE
      HLID=1000./5280.
      XL=30./5280.
  140 CONTINUE
C       IF PLUME BELOW LID AND RECEPTOR ABOVE, TRAN=0.
      IF(HRECPT.GT.HLID.AND.KSTAB.EQ.0)GOTO76
      IF(WSAVE .LE. WJWG) GO TO 9596
      DMIN=ABS(CW)
      TMIN=DW/WSAVE
  305 CONTINUE
      TT=TMIN+TY
      IF(TT.LE.0.)GOTO 76
      IF(NRFLAG.NE.0) GO TO 143
      TMIN = 0.
      IF (DW .GE. WIT) TMIN = (DW    - WIT) / WSAVE
      IF(IBACK.EQ.0) GO TO 131
      IF(DW+WIT-DELY) 132,132,133
```

```
 132 TMIN=0.
     GO TO 131
 133 TMIN=(DW+WIT-DELY)/WSAVE
 131 TT= TMIN + TY
     IF(TT.LE..01)TT=.01
     SY=SIGY(JSTART,TT)
     XRP = WIT + DW
     IF (XRP .GE. 2.*WIT) GO TO 142
     DW = XRP / 2.
 142 TTT = TZ + DW / WSAVE
     SZ=SIGZ(JSTART,TTT)
     ED=DMIN/SY
     EXPD=-.5*ED*ED
     IF(EXPD.LT.-20.)GOTO 76
     EDD=EXP(EXPD)
     IF(DW.GT.2.*XL)GOTO 153
     DENOM=6.2831853*WSAVE*SY*SZ
     Z1 =  HEFF-ZKEEP
     EXPZ1=(-.5*(Z1/SZ)*(Z1/SZ))
     IF(EXPZ1.LT.-20.)GOTO 76
     E1=EXP(EXPZ1)
     ADD1=E1*EDD/DENOM
     IF (HEFF.GT.0.0) GO TO 171
     ADD2=ADD1
     GOTO 172
 171 CONTINUE
     Z2 = HEFF + ZKEEP
     EXPZ2=(-.5*(Z2/SZ)*(Z2/SZ))
     IF(EXPZ2.LT.-20.)GOTO 61
     E2=EXP(EXPZ2)
     ADD2=ADD1*E2/E1
 172 CONTINUE
     IF(HEFF.GT.HLID/2..OR.SZ.GE.(HLID-HEFF)/2.2) GO TO 18
     GO TO 61
 18      CONTINUE
     IF(HEFF.LT.HLID) GO TO 174
     ADD3=ADD1
     ADD4=ADD2
     GOTO 173
 174 CONTINUE
     Z3= (2.*HLID-HEFF)-ZKEEP
     EXPZ3=(-.5*(Z3/SZ)*(Z3/SZ))
     IF(EXPZ3.LT.-20.)GOTO 61
     E3=EXP(EXPZ3)
     ADD3=ADD1*E3/E1
     Z4= Z3+2.*ZKEEP
     EXPZ4=-.5*(Z4/SZ)*(Z4/SZ)
     IF(EXPZ4.LT.-20.)GOTO 61
     E4=EXP(EXPZ4)
     ADD4=ADD1*E4/E1
     IF (HEFF.GT.0.0) GO TO 173
     ADD5=ADD3
     ADD6=ADD4
     GO TO 61
 173 CONTINUE
```

```
      Z5=Z2+2.*(HLID-ZKEEP)
      EXPZ5=-.5*(Z5/SZ)*(Z5/SZ)
      IF(EXPZ5.LT.-20.)GOTO 61
      E5=EXP(EXPZ5)
      ADD5=ADD1*E5/E1
      Z6=Z5+2.*ZKEEP
      EXPZ6=-.5*(Z6/SZ)*(Z6/SZ)
      IF(EXPZ6.LT.-20.)GOTO 61
      E6=EXP(EXPZ6)
      ADD6=ADD1*E6/E1
      GO TO 61
  153 DENOM=SQ2PI*WSAVE*SY
      ADD1=EDD/(DENOM*HLID)
   61 CONTINUE
      TRAN=ADD1+ADD2+ADD3+ADD4+ADD5+ADD6
      RETURN
  143 IF(IBACK.EQ.1) GO TO 144
      T2=(DW+WIT)/ WSAVE+TZ
      IF(DW-WIT) 145,145,146
  145 T1=TZ
      TT=TY
      GO TO 149
  146 T1=(DW-WIT)/ WSAVE+TZ
      TT=(DW-WIT)/ WSAVE+TY
      GO TO 149
  144 T2=XL/ WSAVE+TZ
      IF(DW+WIT-DELY) 147,147,148
  147 T1=TZ
      TT=TY
      GO TO 149
  148 T1=(DW+WIT-DELY)/ WSAVE+TZ
      TT=(DW+WIT-DELY)/ WSAVE+TY
  149 IF(T1.EQ.TZ) GO TO 150
      SZ1=SIGZ(JSTABT,T1)
      GO TO 151
  150 SZ1= DELZ/2.4
  151 SZ2=SIGZ(JSTABT,T2)
      IF(TT.EQ.TY) GO TO 152
      SY=SIGY(JSTABT,TT)
      GO TO 155
  152 SY=DELY/2.4
  155 ARGY=-(DW/SY)**2/2.
      IF(ARGY.LT.-20.) GO TO 76
      H=ALOG(SZ1/SZ2)/ALOG(T1/T2)
  159 EXZ1=0.
      EXZ2=0.
      AGZ1=-((ZS-HRECPT)/SZ2)**2/2.
      AGZ2=-((ZS+HRECPT)/SZ2)**2/2.
      IF(AGZ1.LT.-20) GO TO 157
      EXZ1=EXP(AGZ1)
  157 IF(AGZ2.LT.-20) GO TO 158
      EXZ2=EXP(AGZ2)
  158 CONTINUE
      IF((EXZ1+EXZ2).LE.0.) GO TO 76
      EXY=EXP(ARGY)
```

```
      IF(ABS(B-1.).LE..01) GO TO 2
      FCNX=(T2/SZ2-T1/SZ1)/(1.-B)
      GO TO 3
    2 FCNX=T1*ALOG(T2/T1)/SZ1
    3 TRAN=EXY*(EXZ1+EXZ2)*FCNX/((SQ2PI**2)*SY*DELY)
      IBACK=0
      RETURN
   76 TRAN=0.
      IBACK=0
      RETURN
 9596  CONTINUE
      IBACK=0
      RETURN
      END
```