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User's Guide to SDM—
A Shoreline Dispersion Model

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SECTION 1

INTRODUCTION

The Shoreline Dispersion Model (SDM) is a multipoint Gaussian dispersion model that can be used to determine ground-level concentrations from tall stationary point sources that are influenced by the unique meteorological phenomenon in a shoreline environment. This model provides a realistic approach to the phenomenon of plume fumigation that can affect emissions from tall stacks at a shoreline. Plume fumigation results when a plume emitted from a tall stack and traveling with relatively little diffusion impacts the thermal internal boundary layer (TIBL) at some distance downwind. As long as this situation exists, fumigation may occur continuously and result in a high ground-level concentration. Under these circumstances, current regulatory models are not applicable; therefore, the development of SDM was necessary to allow appropriate treatment of fumigation cases.

The SDM model is a hybrid model that utilizes the Shoreline Fumigation Model, SFM, (see Appendix A) to determine the hours during the year when fumigation events are expected and that uses the MPTER model (UNAMAP Version 6) for the remaining hours. The SFM Model was used because a statistical evaluation of shoreline fumigation models indicated that the SFM Model compares favorably with observations (U.S. EPA 1987). The MPTER model was used because it is an EPA-preferred regulatory model for estimating ground-level concentrations from multiple sources in simple terrain (Pierce 1986).

The advantage of the SDM hybrid model is that it can provide the total impact of a source, i.e., the impact from tall stacks whose plume is being influenced by shoreline fumigation conditions and other nearby sources that may or may not be experiencing this condition but need to be included as nearby background sources. The SDM can model up to 250 sources and 180 receptors coincidently. The user specifies the location of each source by its coordinates and the associated shoreline, and the model computes the distance from the source to the shoreline. Necessary input also includes hourly meteorological data from a tower located on or near the shoreline. The meteorological data used are in both the standard RAMMET preprocessor format and a special format for the shoreline model.

Section 2 includes an overview of the program, its routine, and algorithms. Section 3 provides a brief description of the main program and each subroutine used in the program. Section 4 describes model input requirements for the user. Section 5 shows all output formats. Section 6 describes the execution of the program on a mainframe IBM 3090 system. Section 7 provides an overview and the operating procedures for the specialized tower meteorological data. Section 8 is an example case to be used in testing the model. Appendix A provides more detail concerning the theoretical basis for shoreline fumigation and methods for determining some of the meteorological parameters required for fumigation.

SECTION 2

SUBMODEL OVERVIEW

The SDM is a combination of both the regulatory version of the MPTER model and the SFM model based on algorithms developed by Misra (Appendix A). The combination of these two models permits the analysis of both shoreline fumigation and nonfumigation conditions for sources near a shoreline. When operating, SDM must select the appropriate submodel that is applicable to the particular source, meteorological data, and combination thereof for each hour of analysis. The following subsections review the submodel selection criteria and provide an overview of the individual SFM and MPTER algorithms.

2.1 ALGORITHM SELECTION CRITERIA

The SDM operates on the principle that for each source and each hour of analysis a determination of the existence of a TIBL must be made as well as whether the source height is above or below the TIBL. This determination is made within the SDM and is based on criteria believed to be conducive to the development of a lake breeze condition at some locations. The TIBL develops as a thermal discontinuity interface between the stable onshore air masses and the convective air inland beneath the stable air. The shape of the TIBL is influenced by the sensible heat flux at the ground surface, wind speed, and over-water atmospheric stability.

Table 2-1 gives the submodel selection factors used by SDM for each source and hour of analysis.

TABLE 2-1. MODEL SELECTION

SFM MODEL
Hourly wind direction at the shoreline is onshore Wind speed is greater than or equal to 2 m/s Daytime, with A, B, or C stability over land Heat flux over land is greater than 20 watts/m^2 Stable air over water The stack top is above the TIBL height.
MPTER MODEL
Anytime the above conditions are not met

For a given hour of meteorological data, therefore, the TIBL formation is determined by SDM on the basis of the above criteria and either the SFM or MPTER sub-model is selected to compute ambient concentrations.

2.2 SFM SUBMODEL

The Shoreline Fumigation Model (SFM) estimates ground-level concentrations for user-defined receptor points downwind of an elevated source situated near a simple shoreline. The SFM is described in detail in Appendix A. The model operates under certain inherent assumptions regarding ambient atmospheric conditions and plume behavior. These assumptions are as follows:

- Over-water lapse rate is stable.
- Airflow is on shore.
- Plume is released in the stable air and is Gaussian in nature.
- Mean wind direction in the stable air is the same as the mean wind direction in the TIBL.
- Plume has not begun to meander significantly before impacting the TIBL.
- Plume impacts the top of the TIBL and creates an area source from which pollutants are dispersed downward into the TIBL.
- Mixing downward of the plume upon TIBL impaction is uniform and instantaneous.
- Pollutants corresponding to the elevated area source have horizontal Gaussian and uniform vertical distributions within the TIBL.

- Horizontal dispersion coefficient in the unstable air within the TIBL is a function of the convective velocity, w_*.

2.2.1 Concentration Equation

By summing the contribution of all small area sources dx'dy' along the TIBL interface, the total concentration at a point x,y at ground level (z = 0) can be calculated. The ground-level concentration field inside the TIBL is first thought of in terms of the contribution at (x,y,0) of an elemental source of area dx'dy' located at $[x', y', H_T(x')]$, where H_T is the TIBL height. Integrating over y' between $-\infty$ and ∞ and over x' between 0 and x, the net contribution at (x,y,0) is obtained (Misra 1980, Misra and Onlock 1982):

$$C(x,y) = \frac{Q}{2\pi\, H_T(x)} \int_0^x \frac{1}{U_L \sigma} \exp\left\{ -\frac{1}{2}\left(\frac{H_T(x') - H(x')}{\sigma_{z_s}(x')}\right)^2 - \frac{y^2}{2\sigma^2} \right\} \frac{d}{dx'}\left(\frac{H_T(x') - H(x')}{\sigma_{z_s}(x')}\right) dx' \qquad \text{(Eq. 2-1)}$$

where Q = source strength, g s^{-1}

H_T = TIBL height, m

U_L = mean wind speed within the TIBL, m s^{-1}

$\sigma^2 = \sigma^2_{y_s}(x') + \sigma^2_{y_L}(x,x')$

σ_{y_s} = horizontal dispersion coefficient in the stable air above the TIBL, m

σ_{y_L} = horizontal dispersion coefficient in the unstable air within the TIBL, m

H = plume height, m

σ_{z_s} = vertical dispersion coefficient in stable air, m

x' = point downwind at which the plume begins to intersect the TIBL, m

y = horizontal distance perpendicular to the downwind direction, m

To conceptualize how SFM operates, the user should consider the TIBL interface as a porous, curved surface that a plume impacts from above. Some portion of the plume is thought of as intersecting the TIBL and dispersing downward through it at all times. Initially, only a small portion of the plume will be intersecting; however, with increased distance downwind, more and more of the plume will intersect. One may consider that a source strength exists at each point (x', y') on H_T. The individual terms in Equation 2-1 are described in the remainder of this subsection.

2.2.2 TIBL Height (H_T)

One of the most important variables in shoreline fumigation is the TIBL height, which is defined according to Weisman (1976):

$$H_T = \left(\frac{2H_o X}{\rho c_p (\frac{d\Phi}{dz})_w \; U_L} \right)^{\frac{1}{2}} \qquad \text{(Eq. 2-2)}$$

where H_o = surface, sensible heat flux

X = downwind distance, m

ρ = atmospheric density, kg/m³

c_p = specific heat at constant pressure

$(d\Phi/dz)_w$ = potential temperature gradient over water, K/m

U_L = mean wind speed within the TIBL, m/s

As shown in the equation, the height of the TIBL is directly proportional to the surface turbulent sensible heat flux. Higher wind speeds and greater stability of the over-water air mass tend to dampen the TIBL height. In a shoreline environment, the TIBL height is the actual mixed layer height.

In Equation 2-2, the atmospheric variables are commonly combined and termed the TIBL "A" factor for convenience:

$$H_T = A\, X^{\frac{1}{2}} \qquad \text{(Eq. 2-3)}$$

2.2.3 Plume Rise (H)

While in the transitional phase from the stack to final plume height, the height of the plume is determined by the distance-dependent formula:

$$H = H_{stk} + 1.6\left(\frac{F}{U_s}\right)^{\frac{1}{3}} \left(\frac{X}{U_s}\right)^{\frac{2}{3}} \qquad \text{(Eq. 2-4)}$$

where H_{stk} = stack height, m

F = plume buoyancy, m^4/s^3

U_s = mean wind speed at stack height, m/s

X = distance downwind, m

The equation and value of the coefficient reflect the Briggs (1975) method for estimating gradual plume rise.

Generally, a buoyant plume initially rises in stable air, overshoots, and then settles to some equilibrium height. Neither the gradual plume rise nor the final plume rise equation applies in the transition (overshoot) region. In the model, the equation for gradual plume rise is used up to the point of final plume rise. Based on observations of plume trajectories plotted by Briggs (1975), the distance downwind at which the plume levels off may be given by the quantity (4.5/N) U_s, where N is the Brunt-Vaisala frequency. The expression for N is as follows:

$$N = \left[\frac{g}{\Phi_w}\left(\frac{d\Phi}{dz}\right)_w\right]^{\frac{1}{2}} \qquad \text{(Eq. 2-5)}$$

where g = acceleration due to gravity at the earth's surface, m/s^2

Φ_w = the mean potential temperature over water, K

$(d\Phi/dz)_w$ = the potential temperature gradient over water, K/m

The value of the final plume rise reflects the method of Briggs, where $H = 2.6\,(F/N^2U_s)^{1/3}$.

2.2.4 Dispersion Coefficients for a Buoyant Plume

Vertical--

The dispersion of the plume in the stable air is treated independently of its dispersion within the TIBL. In the stable air, the buoyant plume spreads only because of its internal turbulence; whereas within the TIBL, plume dispersion is dominated by the presence of convective turbulence. The vertical dispersion coefficient in stable air is given by:

$$\sigma_{z_s} = a_1\left(\frac{F}{U_s}\right)^{\frac{1}{3}}\left(\frac{X}{U_s}\right)^{\frac{2}{3}} \qquad \frac{X}{U_s} \leq \frac{4.5}{N} \qquad \text{(Eq. 2-6)}$$

$$= a_2 \qquad \frac{X}{U_s} > \frac{4.5}{N} \qquad \text{(Eq. 2-7)}$$

where F = plume buoyancy, m^4/s^3

U_s = mean wind speed at stack height m/s

X = downwind distance, m

In these equations, 4.5/N represents the time after which the plume has leveled off; it is also the time when the internal turbulence of the plume is completely dissipated (Briggs 1975). At this time, σ_z is believed likely to approach an asymptotically constant value, given by a_2:

$$a_2 = 1.1\left(\frac{F}{U_s N^2}\right)^{\frac{1}{3}} \qquad \text{(Eq. 2-8)}$$

which is obtained by setting Equations 2-6 and 2-7 equal and substituting 4.5/N for X/U_s and 0.4 for a_1.

Horizontal--

The horizontal dispersion coefficient in stable air is given by the equation:

$$\sigma_{y_s} = a_3\left(\frac{F}{U_s}\right)^{\frac{1}{3}}\left(\frac{X}{U_s}\right)^{\frac{2}{3}} \qquad \text{(Eq. 2-9)}$$

where all terms are as defined for Equations 2-6 and 2-7. Once the plume intercepts the TIBL, it fumigates into the unstable air within the TIBL and the horizontal dispersion coefficient is then calculated based on the work of Lamb (1978):

$$\sigma_{y_L} = \frac{1}{3}\left(\frac{w_*}{U_L}\right)(X - X') \qquad (X - X') \leq \frac{(H_T U_L)}{w_*} \qquad \text{(Eq. 2-10)}$$

and

$$\sigma_{y_L} = \frac{1}{3}\left(\frac{w_*}{U_L}\right)H_T^{\frac{1}{3}}(X - X')^{\frac{2}{3}} \qquad (X - X') > \frac{(H_T U_L)}{w_*} \qquad \text{(Eq. 2-11)}$$

In these equations, w_* is the convective velocity and U_L is the mean wind speed within the TIBL. As stated earlier, when the plume impacts the TIBL, it creates an area source on the top surface of the TIBL. As a method of calculating the complete contribution of this area source to the ground-level concentration, the area source is divided into many small area sources. The total concentration is obtained by summing the contributions of all small area sources. The distance (X - X') may be considered the distance affected by a given small area source at a stage in the calculation of the overall concentration. In the development of the model, it was found that using only

Equation 2-10 produced similar results to those obtained by the use of both Equations 2-10 and 2-11; thus, the singular use of Equation 2-10 was adopted.

The convective velocity is defined as follows:

$$w_* = \left(\frac{g\ H_o H_T}{\rho\ c_p \Phi_L}\right)^{\frac{1}{3}} \qquad \text{(Eq. 2-12)}$$

where H_o = surface, sensible heat flux, W/m^2

H_T = TIBL height, m

Φ_L = mean potential temperature over land, k

The other terms are as defined previously. The value of w_* is calculated for each hour of input.

The constants a_1 and a_3 have been determined experimentally from data obtained from the Nanticoke Environmental Management Program (Misra 1980, Portelli 1982, Kerman et al. 1982, Hoff et al. 1982, Anlauf et al. 1982). Use of these constants is retained in the version of the model provided (a_1 = 0.4 and a_3 = 0.67) because the plume observed in the Nanticoke studies is probably representative of the behavior of all plumes under similar circumstances.

Finally, the horizontal dispersion coefficient $\sigma'(x,x')$ is expressed as follows:

$$\sigma' = [\sigma^2_{y_s}\ (x') + \sigma^2_{y_L}\ (x,x')]^{\frac{1}{2}} \qquad \text{(Eq. 2-13)}$$

This equation is a consequence of the integration between $-\infty$ and ∞ over y' in the derivation of Equation 2-1 (Misra and Onlock 1982).

2.2.5 Calculation of Pollutant Concentration

The equation for pollutant concentration at a receptor point (Equation 2-1) is solved by Simpson's Rule, a numerical technique designed to evaluate the definite integral of a continuous function with finite limits of integration. The geometric interpretation of Simpson's Rule is that of replacing the curve of some function f(x) by arcs of parabolas through three adjacent points of the integration interval (Fox 1963). The general expression for Simpson's Rule is as follows:

$$\int_a^b f(x)\,dx = \frac{b-a}{3n}[f(x_0) + 4f(x_1) + 2f(x_2) + 4f(x_3) + \ldots + 2f(x_{n-2}) + 4f(x_{n-1}) + f(x_n)] \qquad \text{(Eq. 2-14)}$$

In this equation, a and b designate the endpoints of the interval over which integration is to be performed, and n is the number of subintervals into which the interval from a to b is divided. In this application, the function f(x) is naturally the concentration equation evaluated over the interval from x equals some small initial value to x equals the downwind distance of the receptor point. (This initial value of x is set at 10, which avoids the problem of singularity presented by x = 0.) In the model, the value of n is equal to 2, which reduces Equation 2-14 to the expression $\frac{b-a}{6}[f(a) + 4f(\frac{a+b}{2}) + f(b)]$.

In the model program, the concentration equation was broken into parts to facilitate computation. The general sequence of steps used is identified in the following paragraphs.

2.3 MPTER SUBMODEL

The following information is provided to give the user background on assumptions made in the MPTER model. Additional information on MPTER is contained in the User's Guide for MPTER (EPA-600/8-80-016, April 1980).

2.3.1 MPTER OVERVIEW

The MPTER Model is based on the steady-state Gaussian algorithm. In MPTER the following assumptions are made: 1) upon release, continuous plumes are diluted by the wind speed at the stack top; 2) dispersion from continuous plumes results in time-averaged Gaussian distributions in both the horizontal and vertical directions through the dispersing plume; 3) concentration estimates may be made for each hourly period by using the mean meteorological conditions appropriate for each hour; 4) the total concentration at a receptor is the sum of the concentrations estimated at the receptor from each source, i.e., concentrations are additive; and 5) concentrations at a receptor for periods longer than an hour can be determined by averaging the hourly concentrations over the period.

The upwind distance x and the crosswind distance y of the source from the receptor is determined as a function of the mean hourly wind direction. Dispersion parameter values are determined as functions of stability class and upwind distance. Selections of equations to estimate concentration depend on stability class and, for neutral or unstable conditions, on the relation of the dispersion parameter value to mixing height. The location of the receptor relative to the plume position is a dominant factor in the magnitude of the concentration.

2.3.2 Dispersion Parameter Values

The dispersion parameter values used in MPTER are the Pasquill-Gifford (P-G) parameters (Pasquill 1961; Gifford 1960) representative for open country (a roughness of approximately 0.03 m). The subroutines used to determine the parameter values are the same as in the UNAMAP programs PTDIS, PTMTP, and RAMR.

Except for stable layers aloft, which inhibit vertical dispersion, the atmosphere is treated as a single vertical layer with the same rate of vertical dispersion throughout. Complete eddy reflection is assumed both from the ground and from the stable layer aloft, which is given by the mixing height.

2.3.3 Plume Rise

Plume rise is calculated by using Briggs (1975) methods. Although the plume rise from point sources is usually dominated by buoyancy, plume rise because of momentum is also considered. (Merging of nearby buoyant plumes is not considered.) Stack-tip downwash is an optional consideration. Building downwash cannot be considered.

2.3.4 Input Data

Input data must be representative of the geographical area and sources being modeled. Consideration of emission variations is possible in MPTER, which allows such variations to be calculated in the concentration estimates because they are directly proportional to emissions. MPTER has the option to use variable hourly emissions. The meteorological data, which consist of wind direction, wind speed, temperature, stability class, and mixing height for each hour, should be representative of the region being modeled.

2.3.5 Mixing Height

The entire plume is assumed to be completely reflected if the effective plume height is below the mixing height. The entire plume is assumed to be within the stable layer aloft if the effective plume height is above the mixing height. For this case, no ground-level concentration is calculated.

MPTER does not include calculations for the transitional phenomenon of shoreline fumigation (which causes mixing of pollutants downward, resulting in uniform concentrations with height beneath the original plume centerline). The SFM submodel accounts for this phenomenon.

2.3.6 Removal or Depletion

Transformations of a pollutant resulting in loss of that pollutant throughout the entire depth of each plume can be approximated by MPTER. If the loss to be simulated is realistic, occurs throughout the whole plume, and does not depend on concentration, this exponential loss may provide a reasonable simulation. If, however, the loss mechanism is selective, the loss mechanism built into the model will not approximate the atmospheric chemistry very well. Examples of selective loss mechanisms include impaction with features on the ground surface, reactions with materials on the ground, or dependence on a given small parcel of air for concentration (requiring consideration of contributions from all sources to this parcel).

2.3.7 Wind Speeds and Wind Directions

Wind speeds and wind directions should be hourly averages. (National Weather Service hourly observations are actually averages of a few minutes at the time of the observation, usually 5 to 10 minutes prior to the hour.) Input wind data should be representative of the entire region being modeled.

Emissions from continuous sources are assumed to be stretched along the direction of the wind by the speed of the wind at the stack top. Thus, the stronger the wind, the greater the dilution of the emitted plume. In MPTER, the input wind speed is assumed to be representative of the input anemometer height above the ground. The wind speed u_h at the physical stack height h is calculated from:

$$u_h = u_z\ (h/z_a)^p$$

where u_z is the input wind speed for this hour, z_a is the anemometer height, and the exponent p is a function of stability. If u_h is determined to be less than 1 m s^{-1}, it is set equal to 1.

The P-G dispersion parameters used in MPTER are most valid for a surface roughness of approximately 0.03 m (Pasquill 1976). Table 2-2 shows wind speed power law exponents for each stability class for rural conditions that correspond best to this surface roughness (U.S. EPA 1980).

TABLE 2-2. WIND PROFILE POWER LAW EXPONENTS CORRESPONDING TO A 0.03-METER ROUGHNESS

Stability	Exponent
A	0.07
B	0.07
C	0.10
D	0.15
E	0.35
F	0.55

As stated earlier, directional shear with height is not included, which means that the direction of flow is assumed to be the same at all heights over the region. The taller the effective height of a source, the larger the expected error in direction of plume transport. Although the effects of surface friction are such that wind direction usually veers (turns clockwise) with height, the thermal effects (in response to the horizontal temperature gradient in the region) can overcome the effect of friction and cause backing (turning counterclockwise with height) instead of veering.

In the program RAMMET, which processes National Weather Service hourly observations, the wind directions (reported to the nearest 10 degrees) are altered by a randomly generated number from 0 to 9 used to add -4 to +5 degrees to the wind vector. An extreme overestimate of concentration is thus prevented at a point downwind of a source during a period of steady wind, when sequential observations are from the same direction. Rather than allow the plume centerline to remain in exactly the same position for several hours, the changing wind allows for some variation of the plume centerline within the 10-degree sector. Although this step can in no way simulate the actual sequence of hourly events (wind direction to 1-degree accuracy cannot be obtained from wind direction reported to the nearest 10 degrees), such variations can be expected to produce more representative concentrations over a period of record than those obtained by the use of winds to only the 10-degree increments. (Sensitivity tests of this alteration for single sources have indicated that, where a few hours of unstable conditions are critical to producing high concentrations, the resulting concentrations are extremely sensitive to the exact sequence of random numbers used. Such a sequence might be two wind directions 1 degree apart versus two wind directions 9 degrees apart. Differences of 40 to 50 percent in 24-hour concentrations from a single source have appeared in the sensitivity tests as a result of the random wind direction variation alone.) Use of the most accurate wind information available for input is therefore necessary.

2.3.8 Gaussian Plume Equations

The upwind distance, x, of the point source from the receptor and the crosswind distance, y, of the point source from the receptor are calculated by Equations 2-15 and 2-16 (presented in the next subsection) for each source-receptor pair per simulated hour. Both dispersion parameter values σ_y and σ_z are determined as functions of this upwind distance x and stability class.

One of three equations (Equations 2-17, 2-18, and 2-19, also presented in the next subsection) is used to estimate concentrations under various conditions of stability and mixing height. Equation 2-17 is used for stable conditions or for unlimited mixing; eddy reflection at the ground is assumed. For unstable or neutral conditions during which vertical dispersion is so great that uniform mixing is assured beneath an elevated inversion, Equation 2-18 is used. Finally, for unstable or neutral conditions in which vertical dispersion is still small compared with the mixing height, Equation 2-19 is used. This equation incorporates multiple eddy reflections from the ground and the base of the stable layer aloft. Simplifications to these equations, valid if the height of the receptor z is assumed at ground level, are incorporated into the appropriate subroutines.

2.3.9 Point Source Computations

Given an east-north coordinate system (R, S), the upwind distance, x, and the crosswind distance, y, of a point source from a receptor are calculated by:

$$x = (S_p - S_r) \cos \theta + (R_p - R_r) \sin \theta \qquad \text{(Eq. 2-15)}$$

$$y = (S_p - S_r) \sin \theta + (R_p - R_r) \cos \theta \qquad \text{(Eq. 2-16)}$$

where R_p, S_p are the coordinates of the point source; R_r, S_r are the coordinates of the receptor; and θ is the wind direction (the direction from which the wind blows). The units of x and y will be the same as those of the coordinate system R, S. To determine plume dispersion parameters, distances must be in kilometers or meters. A conversion may be required to convert x and y in these equations to the appropriate units.

The various forms of the Gaussian equation presented here are based on the coordinate scheme with the origin at the ground, and x upwind from the receptor, y crosswind, and z vertical. The Gaussian equations for continuous releases have four components: 1) concentrations are proportional to the emission rate; 2) the released effluent is diluted by the wind passing the point of release; 3) the effluent is spread horizontally resulting in a

Gaussian or normal (bell-shaped) crosswind distribution at downwind distances; and 4) the effluent is spread vertically. The latter component alsc results in a normal vertical distribution near the source, which at greater downwind distances is modified by eddy reflection at the ground and, if appropriate, by eddy reflection at the mixing height. Equations 2-17 through 2-19 are broken into these four components.

The following are definitions of the individual parameters:

χ_p = concentration, g m^{-3}

Q = emission rate, g s^{-1}

u = wind speed, m s^{-1}

σ_y = standard deviation of plume concentration horizontal distribution (evaluated at the distance x and for appropriate stability), m

σ_z = standard deviation of plume concentration vertical distribution (evaluated at the distance x and for appropriate stability), m

L = mixing height, m

H = effective height of emission, m

z = receptor height above ground, m

y = crosswind distance, m

The contribution to the concentration, χ_p, from a single point source to a receptor is given by one of the three following equations:

Component: (1) (2) (3) (4)

$$\chi_p = Q \cdot \frac{1}{u} \cdot \frac{g_1}{(2\pi)^{\frac{1}{2}}\sigma_y} \cdot \frac{g_2}{(2\pi)^{\frac{1}{2}}\sigma_z} \qquad \text{(Eq. 2-17)}$$

$$\chi_p = Q \cdot \frac{1}{u} \cdot \frac{g_1}{(2\pi)^{\frac{1}{2}}\sigma_y} \cdot \frac{1}{L} \qquad \text{(Eq. 2-18)}$$

$$\chi_p = Q \cdot \frac{1}{u} \cdot \frac{g_1}{(2\pi)^{\frac{1}{2}}\sigma_y} \cdot \frac{g_3}{(2\pi)^{\frac{1}{2}}\sigma_z} \qquad \text{(Eq. 2-19)}$$

Equation 2-17 is used for stable conditions or unlimited mixing.

Equation 2-18 is used for unstable or neutral conditions, where σ_z is equal to or greater than 1.6 L.

Equation 2-19 should be used for unstable or neutral conditions, where σ_z is less than 1.6 L, provided that both H and z are less than L.

Sensitivity tests using Equation 2-19 have indicated that for all H and all z between the ground and the mixing height, the vertical distribution of concentration with height is uniform when σ_z has increased to 1.6 L. Therefore, when σ_z is equal to or greater than 1.6 L for neutral or unstable conditions, Equation 2-18 is used. For special cases such as z = 0, Equation 2-18 may give appropriate concentrations for σ_z that are much less than 1.6 L. The preceding recommendation covers the more general case, however. [Note that this recommendation differs from that of Pasquill (1976) and the Stability Workshop (Hanna 1977), which indicate that σ_z should not be allowed to increase beyond 0.8 L.] For ground-level receptors, z = 0, the use of σ_z = 0.8 L in Equation 2-17 reduces to Equation 2-18. This recommendation allows σ_z to increase beyond the value of L, specifically as large as 1.6 L; it also allows for a smooth transition to a uniform vertical profile for receptors above the ground, $z \neq 0$, and for effective heights of emissions approaching the mixing height.

Definitions for expressions g_1, g_2, and g_3 are as follows:

$$g_1 = \exp(-0.5\, y^2/\sigma_y^2)$$

$$g_2 = \exp[-0.5(z-H)^2/\sigma_z^2] + \exp[-0.5(z+H)^2/\sigma_z^2]$$

$$g_3 = \sum_{N=-\infty}^{\infty} \{\exp[-0.5(z-H+2NL)^2/\sigma_z^2] + \exp[-0.5(z+h+2NL)^2/\sigma_z^2]\}$$

(This infinite series converges rapidly and evaluation with N varying from -4 to +4 is usually sufficient.)

SECTION 3

PROGRAM NARRATIVE

3.1 SDM PROGRAM DESCRIPTION

The SDM program consists of three basic components:

1. SFM program
2. MPTER program (regulatory version)
3. Interface program

The original MAIN and PTR subroutines in MPTER were modified to call external subroutines when necessary to read additional data, calculate TIBL formation, and use the SFM program. This section provides a brief overview of each subroutine in SDM and their function. Also noted for each subroutine is the origin of each, i.e., MPTER, SFM, or interface.

<u>MPTER Routines</u>

MAIN - The MAIN Program reads and checks input parameters, initializes variables, writes out initial information, determines significant sources, calls PTR for point-source concentrations, reads and writes tapes/discs, and calls OUTHR to print concentration contributions and summaries.

PTR - This subroutine is called by MAIN to calculate the point source contribution to each receptor. Briggs (1975) plume rise equations are solved in this routine. It calls INTERF for the SFM applicability and concentrations and writes the SFM concentration card for special output.

RCP - This subroutine is called by PTR; it returns values of relative concentrations.

PGYZ - This subroutine is called by RCP; it calculates σ_y and σ_z for a given downwind distance and stability classification.

EXPOS - This block of data contains coefficients and exponents used in determining ground-level concentrations that are used to rank the significant sources.

ANGARC - This function determines the appropriate arctan of each resultant wind component over the north resultant wind component with the resulting angle between 0 and 360 degrees.

OUTHR - This subroutine arranges and then prints tables of concentration. The number of tables output depends on the option combination specified.

RANK - This subroutine, called by MPTER, ranks concentrations for four or five averaging times so that the highest five concentrations are printed for each receptor.

SFM Subroutines

SFM - This subroutine calls CALC and then returns. It has been modified extensively from the original so it can be used with MPTER but retains all original SFM Model features and capabilities.

CALC - This subroutine calculates plume leveling distances, determines when to use the entire x interval and when to split the interval into level and nonlevel plume segments. It then calls SIMP the appropriate number of times, adds calculated value, and converts to proper units.

SIMP - This subroutine is called by CALC either once or twice. It uses Simpson's 1/3 law to evaluate the concentration integral. It splits the x interval in two and processes the left half until the error is acceptable or number of splits is too great. It also calls the function EVAL to get the value of the integral along the current interval.

EVAL - This function calculates the current value of the function to be integrated.

Interfacing Subroutines

INTERF - This subroutine, which is called by PTR, reads in shoreline meteorological data, tests for shoreline fumigation applicability, and calculates inputs for SDM.

XSHORE - This function calculates distance from source to shoreline.

Figure 3-1 is an abbreviated flow diagram of SDM showing the relationships of the subroutines to each other and to the main program.

The MAIN subroutine in SDM initiates model arrays and subroutines and is used primarily for input and bookkeeping; most technical calculations are performed by subroutine PTR. PTR calls Subroutine RCP, which in turn obtains dispersion parameter values from Subroutine PGYZ and then selects and solves

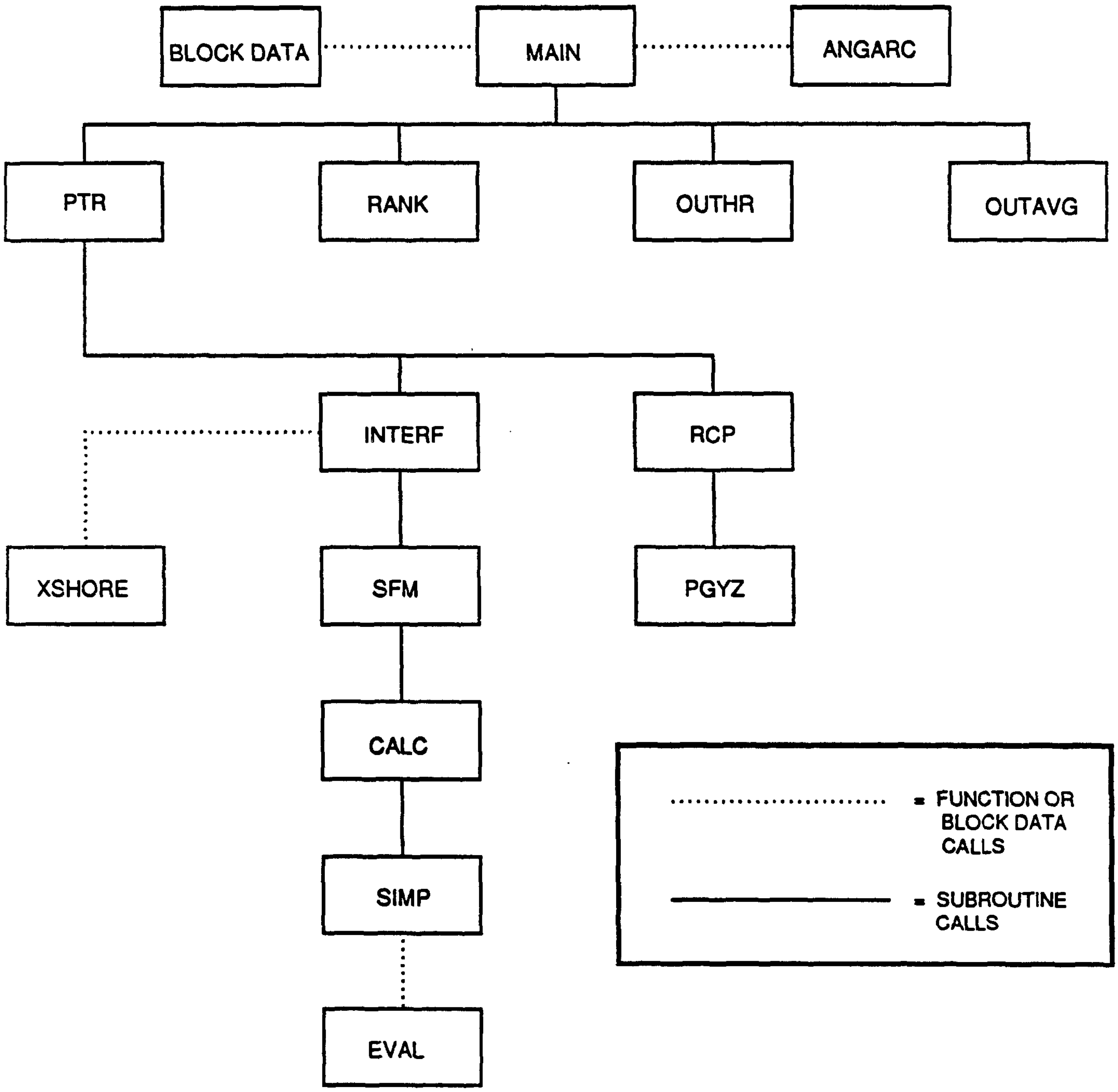

Figure 3-1. SDM subroutines map.

the appropriate Gaussian equation. As shown in Figure 3-1, each case where the TIBL is determined to be a factor involves the subsequent calling of subroutines INTERF, SFM, CALC, and SIMP, and the functions EVAL and XSHORE. Thus, an individual source is modeled using MPTER or SFM if TIBL formation takes place and is applicable to the source. The MPTER/SFM concentrations calculated for each hour are saved in a temporary array and passed to subroutine RANK. Subroutine RANK orders the highest five concentrations for each averaging time for each receptor. Subroutine OUTHR essentially provides the printed output.

3.2 EXTERNAL SUPPORT PROGRAMS

Two sets of meteorological data must be accessed to allow the proper execution of SDM. The first set is the meteorological preprocessor for tower data at two levels and the other is the RAMMET preprocessor, which has had wide use with the RAM, CRSTER, and ISCST Models. The use of these programs is described in the user instructions in Sections 5 and 6. Figure 3-2 describes the generalized input flow by major required input files or programs.

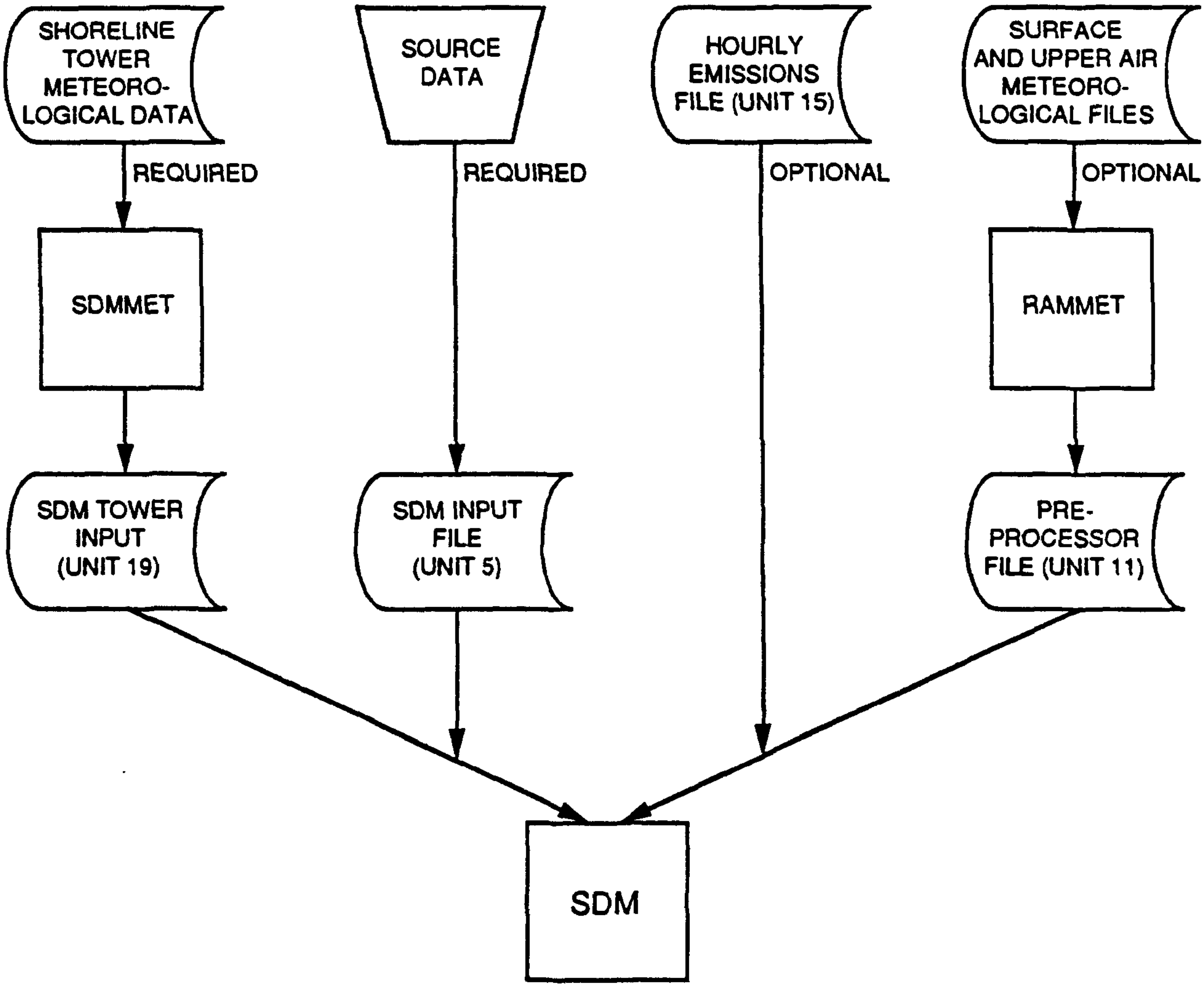

Figure 3-2. Generalized input flow to SDM.

SECTION 4

SDM INPUT

This section describes the SDM input requirements for the user. The section is divided into four parts: 1) input variable formats; 2) input variable definitions and discussion; 3) shoreline definition cards including complex shoreline modeling; and 4) required meteorological data. Figure 4-1 shows all input and output files and their relationship to the SDM program in terms of the appropriate options.

4.1 INPUT FORMAT

Tables 4-1 through 4-13 list the input necessary to execute SDM in an 80 column card format. Because some input types are read in free format, individual values on a card must be separated by either a comma or a space. Other inputs must be entered in the formats indicated. Up to 250 point sources and 180 receptor cards are allowed; more than this number will result in runstream termination. Meteorological data can be input in card image format or through a preprocessed file of the same type as used for RAM and CRSTER. Hourly emissions can also be read in as an input for each source. A description of each input follows the tables in Section 4.2 including cross-referencing.

TABLE 4-1. SDM CARDS 1, 2, AND 3 - TITLE (THREE CARDS)

Variable	Format	Description	Units
LINE1	20A4	80 alphanumeric characters for heading	-
LINE2	20A4	80 alphanumeric characters for heading	-
LINE3	20A4	80 alphanumeric characters for heading	-

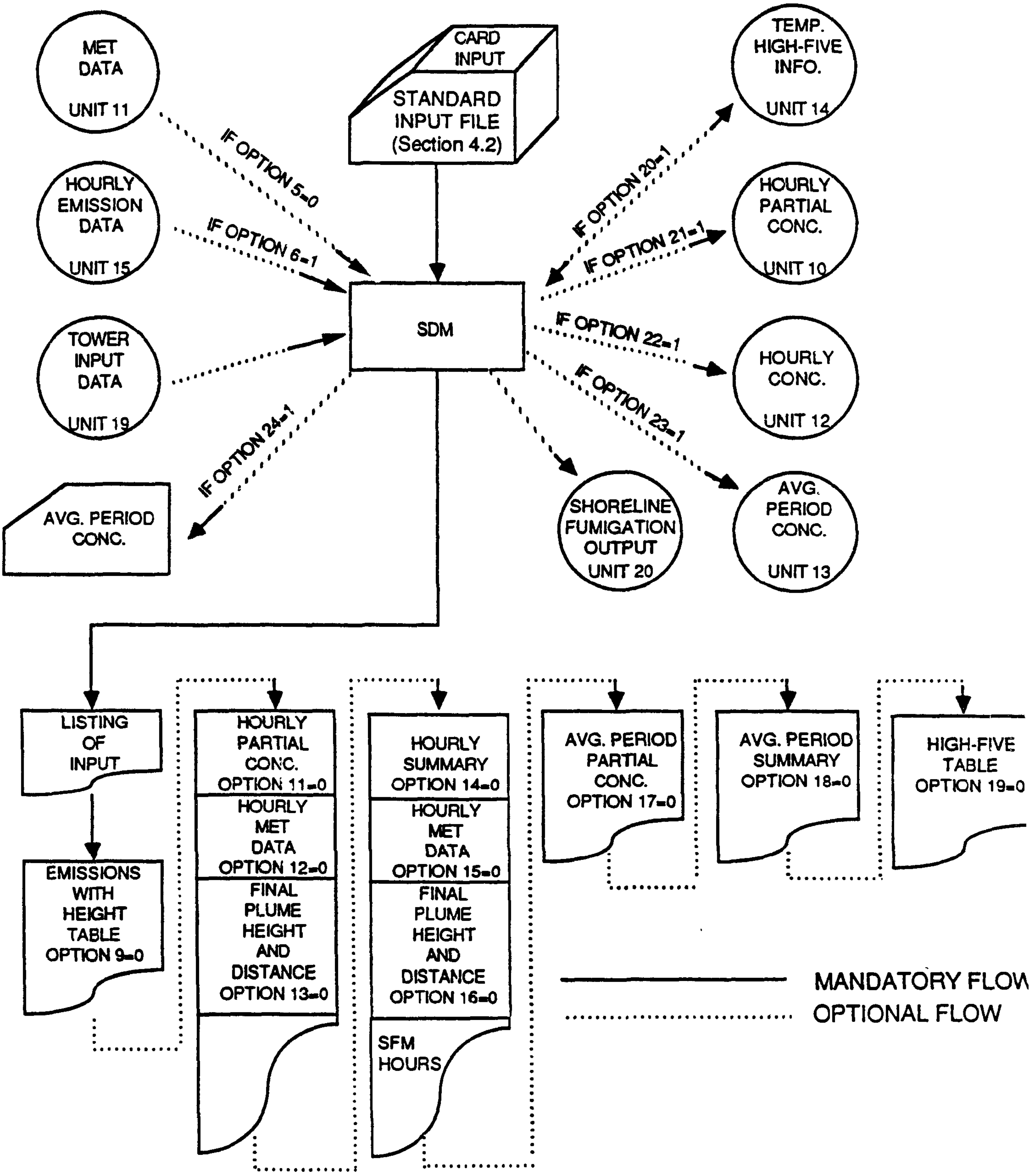

Figure 4-1. System flow for SDM.

TABLE 4-2. SDM CARD 4 - CONTROL AND CONSTANTS (ONE CARD)

Variable[a]	Description	Units
IDATE(1)	2-digit year (see Section 4.2.1.1)	-
IDATE(2)	Starting Julian day for this run (see Section 4.2.1.1)	-
IHSTRT	Starting hour for this run (see Section 4.2.1.1)	-
NPER	Number of averaging periods to be run (see Section 4.2.1.2)	-
NAVG	Number of hours in an averaging period (see Section 4.2.1.2)	-
IPOL	Pollutant indicator: (see Section 4.2.1.3) 3 = SO_2 4 = Suspended particulates	-
MUOR	Urban/rural mode indicator: (see Section 4.2.1.4)) 1 = Urban (should not be selected in SDM) 2 = Rural	-
NSIGP	Number of significant point sources, maximum = 25 (see Section 4.2.1.5)	-
NAV5	Number of hours in the user-specified period for which a high-five concentration table is generated (see Section 4.2.1.6)	-
CONONE	Multiplier constant, user units to km (see Section 4.2.1.7)	-
CELM	Multiplier constant, user height units to m (see Section 4.2.1.8)	-
HAFL	Pollutant half-life (see Section 4.2.1.9)	s

[a] All input variables are free format.

TABLE 4-3. SDM CARD 5--OPTIONS[a] (ONE CARD)

Variable[b,c]	Description
	TECHNICAL OPTIONS (see Section 4.2.2.1)
IOPT(1)[d]	Use terrain adjustments in MPTER submodel
IOPT(2)	No stack downwash
IOPT(3)	No gradual plume rise
IOPT(4)	Include buoyancy-induced dispersion
	INPUT OPTIONS (see Section 4.2.2.2)
IOPT(5)	Meteorological data on cards
IOPT(6)	Read hourly emissions
IOPT(7)	Specify significant sources
IOPT(8)	Input radial distances and generate polar coordinate receptors
	PRINTED OUTPUT OPTIONS (see Section 4.2.2.3)
IOPT(9)	Delete emissions with height table
IOPT(10)	Delete averagine-time meteorological summary
IOPT(11)	Delete hourly contributions
IOPT(12)	Delete meteorological data on hourly contributions
IOPT(13)	Delete final plume height and distance to final rise on hourly contributions
IOPT(14)	Delete hourly summary
IOPT(15)	Delete meteorological data on hourly summary
IOPT(16)	Delete final plume height and distance to final rise on hourly summary
IOPT(17)	Delete averaging-time contributions
IOPT(18)	Delete averaging-time summary
IOPT(19)	Delete average concentrations and high-five table
	OTHER CONTROL AND OUTPUT OPTIONS (see Section 4.2.2.4)
IOPT(20)	Run is part of a segmented run
IOPT(21)	Write partial concentrations to disk or tape
IOPT(22)	Write hourly concentrations to disk or tape
IOPT(23)	Write averaging-time concentrations to disk or tape
IOPT(24)	Punch averaging-time concentrations on cards
IOPT(25)	Set default values (used for regulatory applications of MPTER)

[a] All options are selected as integer values: 0 indicates not to use the option;
1 indicates to use the option.

[b] IOPT = Options are interchangeable.

[c] All options are referred to by their variable name in this table, e.g. Option 1 = IOPT(1).

[d] All options are free format, e.g.: 1,0,1, etc.

TABLE 4-4. SDM CARD 6--WIND AND TERRAIN (ONE CARD)

Variable[a]	Description[b]	Units
HANE	Anemometer height	Meters
PL(I), I = 1, 6	Wind increase with height exponents for each stability class (see "Values of Variables Related to Increase of Wind with Height")	-
CONTER(I), I = 1, 6	Terrain adjustment factors for each stability class (real numbers from 0 to 1)	-

[a] All input variables are free format.

[b] See Section 4.2.3.

TABLE 4-5. SDM CARD 7--POINT SOURCE[a,b] (UP TO 250 SOURCES)

Variable	Format	Description	Units
RNAME	3A4	12 alphanumeric characters for source identification	-
SOURCE(1,NPT)	F8.2	East coordinate of point source	User units
SOURCE(2,NPT)	F8.2	North coordinate of point source	User units
SOURCE(3,NPT)	F8.2	Sulfur dioxide emission rate	g/s
SOURCE(4,NPT)	F8.2	Particulate emission rate	g/s
SOURCE(5,NPT)	F8.2	Physical stack height	meters
SOURCE(6,NPT)	F8.2	Stack gas temperature	Kelvin
SOURCE(7,NPT)	F8.2	Stack inside diameter	meters
SOURCE(8,NPT)	F8.2	Stack gas exit velocity	m/s
ELP(NPT)	F4.0	Source ground-level elevation	User height units

[a] Card with ENDPOINTS in Columns 1 through 9 is read in after the last point source.

[b] See Section 4.2.4.

TABLE 4-6. SDM CARD 7A--SHORELINE DEFINITION (ONE SOURCE)

Variable[a]	Format	Description	Units
SNAME	3A4	12 alphanumeric shoreline descriptors	-
XSL	F8.0	East coordinate of shoreline point	User units
YSL	F8.0	North coordinate of shoreline point	User units
BA	F8.0	Beginning angle of shoreline (0 to 360)	Degrees
EA	F8.0	Ending angle of shoreline (greater than BA, less than 720)	Degrees
FETCH	F8.0	Degrees of acceptable wind fetch for on-shore wind determination	Degrees

[a] See Section 4.4.

TABLE 4-7. SDM CARD 8--METEOROLOGICAL DATA IDENTIFIERS[a]

Variable[b]	Format	Description[c]	Units
ISFCD		SFC meteorological station identifier	5 digits
ISFCYR		Year of SFC meteorological data	2 digits
IMXD		Upper-air station identifier	5 digits
IMXYR		Year of mixing-height data	2 digits

[a] Used with Option 5 = 0; skip if Option 5 = 1.

[b] All input variables are free format.

[c] See Section 4.2.5.

TABLE 4-8. SDM CARD 9--SPECIFIED SIGNIFICANT SOURCES[a] (ONE CARD)

Variable	Format	Description[b]	Units
NPT	I3	Number of user-specified significant point sources	-
MPS	25I3	Point source numbers user wants to be considered significant	-

[a] Used with Option 7 = 1.

[b] See Section 4.2.6.

TABLE 4-9. SDM CARD 10--POLAR COORDINATE RECEPTORS[a] (ONE CARD)

Variable	Format	Description[b]	Units
RADIL(I), I = 1, 5	5F4.0	Up to five radial distances, each of which generates 36 receptors around Points CENTX, CENTY on azimuths to to 360 degrees	User units
CENTX	F8.3	East coordinate, about which radials are centered	User units
CENTY	F8.3	North coordinate, about which radials are centered	User units

[a] Used with Option 8 = 1.

[b] See Section 4.2.7.

TABLE 4-10. SDM CARD 11--POLAR COORDINATE RECEPTOR ELEVATIONS[a] (36 CARDS)

Variable	Format	Description[b]	Units
IDUM	I2	Azimuth indicator (1 to 36)	-
	8X	(8 blank columns)	
ELRDUM	5F10.0	Receptor ground-level elevations for this azimuth for up to five distances	User height units

[a] Used if Options 1 and 8 are both 1; otherwise skip these cards.

[b] See Section 4.2.7.

TABLE 4-11. SDM CARD 12--RECEPTOR[a] (UP TO 180 CARDS)

Variable	Format	Description[b]	Units
RNAME	2A4	8 alphanumeric characters for station identification	-
RREC	F10.3	East coordinate of receptor	User units
SREC	F10.3	North coordinate of receptor	User units
ZR	F10.0	Receptor height above local ground level	Meters
ELR	F10.0	Receptor ground-level elevation	User height units

[a] Card with ENDREC in Columns 1 through 6 should follow the last receptor card (a maximum of 180 receptors is allowed input to MPTER for both those generated by Option 8 and those entered on CARD TYPE 12).

[b] See Section 4.2.7.

TABLE 4-12. SDM CARD 13--SEGMENTED RUN[a] (ONE CARD)

Variable	Description	Units
IDAY	Number of days already processed	-
LDRUN	Last day to be processed in this run	-

[a] Used if Option 20 equals 1; see Section 4.2.2.4.

TABLE 4-13. SDM CARD 14--METEOROLOGICAL DATA[a,b]

Variable[c]	Description	Units
JYR	Year of meteorological data	2 digits
DAY1	Julian day of meteorological data	3 digits
JHR	Hour of meteorological data	2 digits
IKST	Stability class for this hour	-
QU	Windspeed for this hour	m/s
QTEMP	Ambient air temperature for this hour	Kelvin
QTHETA	Wind direction for this hour	degrees azimuth
QHL	Mixing height for this hour	meters

[a] See Section 4.2.9.

[b] Used with Option 5 = 1.

[c] All input variables are free format.

4.2 STANDARD SDM CONTROL AND SOURCE INPUT FILE

A standard input file in the format of Tables 4-1 through 4-13 must be created as input to SDM. Thus, these tables describe all input variables for one input file. Other optional files are described in Section 4.3. The remainder of this section describes the variables listed in Table 4-2 through 4-13.

4.2.1 Control and Constants (Card 4, Table 4-2)

4.2.1.1 Starting Date and Time--IDATE, IHSTRT--

The two-digit year and three-digit Julian day for the start of the run are entered in the two portions of the indexed variable IDATE. The hour for the start of the run (between 1 and 24) is entered in IHSTRT. These data are used somewhat differently, depending upon whether the meteorological data are entered through a file prepared by RAMMET or on hour-by-hour punched cards. If data are entered on cards, all three values are replaced and are relatively unimportant. If data are read from the preprocessed file, these variable values are used to position the file so that the first meteorological data read are for the proper day.

4.2.1.2 Number of Periods, Number of Hours--NPER, NAVG--

Any run of SDM will be for a given simulated length of record, from 1 hour to 1 year. The simulation is done hour-by-hour, with an optional printout of concentration estimates at each receptor for each hour (see "Printed Output Options" later in this section). A printout of concentration estimates for one other averaging period is also available, including the length in hours that the data entry represents, the variables, and the NAVG. The number of these averaging periods in the run is the value entered for NPER.

Example--Simulation is desired of a 3-day (72-hour) length of record, in which 24-hour averages are obtained as part of the run. The NPER will equal 3, and the NAVG will equal 24.

Example--Simulation is desired of a 1-year (not a leap year) length of record, in which 8-hour averages are obtained as part of the run. The NPER will equal 2920 (365 x 8), and the NAVG will equal 8.

4.2.1.3 Pollutant Indicator--IPOL--

The variable IPOL (see Table 4-2) is set on the point source card either to 3 for use of the emission rate in Columns 29 to 36, or to 4 for use of Columns 39 to 44. The IPOL is also used to select the proper headings, "SO_2" or "PART," on output. The SDM was primarily intended for SO_2 modeling but may be used for any pollutant that may be treated as a nonreactive, gaseous emission. The dispersion is treated identically for the two pollutants whose emissions are on the point-source card. Calculations may be made for pollutants other than sulfur dioxide and particulate matter by substituting their emissions in either of these fields. Unless the program is altered, however, all headings will read "SO_2" or "PART". Pollutants whose emissions are substituted should be relatively nonreactive (treat as particulate), or have a loss rate describable by an exponential loss with time similar to SO_2.

4.2.1.4 Urban/Rural Mode Indicator--MUOR--

On the rural setting should be selected through the input variable MUOR. The urban dispersion parameter values do not apply to SDM. For rural conditions when MUOR = 2, the P-G dispersion values are exercised. When the regulatory option is chosen [IOPT(25) = 1], MUOR also determines the set of wind profile power law exponents used for the rural mode.

4.2.1.5 Number of Significant Sources--NSIGP--

The variable NSIGP is specified primarily to obtain printed information on contributions to the concentration at each receptor from up to 25 individual sources. The value entered is the number of sources for which contributions will be printed for each hour and for each averaging time. The output is printed so that the same number of pages is required for 1 to 10 significant sources; twice this number is required for 11 to 20 significant sources; and three times this number, for 21 to 25 sources. Thus, care should be exercised to specify only the number of sources that are actually necessary.

4.2.1.6 Fifth Averaging Time for High-Five Concentration Table--NAV5--

The value of the variable NAV5 is significant only if the run is lengthy (e.g., a simulation of 5 days or more). If the option to produce and write the high-five table is used, this value will be the length in hours of an additional averaging time that will be used to list the five highest concentrations over the period of this run. Because high-five tables are already produced for 1-, 3-, 8-, and 24-hour averaging times, none of these values will be used if entered for NAV5. Also, the value entered should be evenly divisible into 24. Only 2, 4, 6, and 12 meet all these criteria. Therefore, if a need should exist to know the highest five concentrations for any of these averaging times (2, 4, 6, or 12), the proper value should be entered; otherwise, zero should be entered.

4.2.1.7 Multiplier Constant -- CONONE--

The multiplier constant CONONE is used to convert distances in the user units to distances in kilometers. These units are subsequently used to obtain dispersion parameters and to relate receptors to plume locations. If the user coordinate system is in kilometers, CONONE = 1. If the user coordinate system is in miles, CONONE = 1.609344.

4.2.1.8 Multiplier Constant -- CELM--

The multiplier constant CELM will convert the user height units to meters. If the elevations are reported in meters, CELM = 1; if the elevations are in feet, CELM = 0.3048. This constant is used only when terrain adjustments are made with Option 1. In this option, heights are entered for both the source ground-level elevations and the receptor ground-level elevations in height units convenient to the user.

4.2.1.9 Pollutant Half-Life -- HAFL--

An exponential loss of the considered pollutant with travel time is included in the model. At a travel time equal to the half-life, 50 percent of the pollutant will remain. Although this view of chemical or physical depletion processes is overly simplistic, it may be useful under certain circumstances. Note that the half-life is entered in seconds. If the user wants no depletion to be considered, entering zero for the half-life will cause those portions of the code calculating pollutant loss to be skipped.

4.2.2 Options (Card 5, Table 4-3)

There are 4 technical options, 4 input options, 11 print options, and 6 other options, either for control or for output to files. To use a particular option, the user enters 1 as input on Card 5 in the appropriate option location. Otherwise, a zero should be entered for this variable. Values of 0 or 1 are entered for all options on Card 5.

4.2.2.1 Technical Options--IOPT(1) - IOPT(4)--

Option 1: Terrain adjustment--Terrain adjustment is a major feature of the MPTER submodel, but will not be considered by the SFM fumigation submodel. The use of IOPT(1) = 1 will direct the SDM to internally produce a terrain adjustment when the MPTER submodel is used and to produce no adjustment when the SFM submodel is used. The use of this option requires input of source ground-level elevation on Card 7 and receptor ground-level elevation on Card 12. If Option 8 for generation of polar coordinate receptors is used, Card 11 with elevations for the polar coordinate receptors are also read (one card for each of 36 azimuths). This option also requires the entry of six terrain adjustment factors, one for each stability class, on Card 6. These values must be real numbers between 0 and 1. This allows the model to be used for research with various values. The user should note that certain values may be required for these parameters if the run results are to be submitted in response to regulatory requirements. If 0's are entered for all six stabilities, the terrain adjustment will be done in the same manner as it is by CRSTER. If 1's are entered for all six stabilities, the concentration estimates will be the same as if terrain is not considered (the option not employed), as 1's will cause the plumes to rise fully over the terrain, which is equivalent to elevated plumes over a level surface. Therefore, if the use of 1's for all stabilities is contemplated, applying the terrain option is unnecessary.

<u>Option 2: No stack downwash</u>--With IOPT(2) = 0, stack downwash is used (if applicable) in accordance with the procedure given in Appendix B. With IOPT(2) = 1, stack downwash is not estimated.

<u>Option 3: No gradual plume rise</u>--With IOPT(3) = 0, gradual plume rise from stack top to the distance of final rise is determined by using the procedures developed by Briggs (1975). With IOPT(3) = 1, only the final plume height is used for effective height.

<u>Option 4: Use buoyancy-induced dispersion</u>--With IOPT(4) = 0, sources are treated as point sources. With IOPT(4) = 1, buoyancy-induced plume size

is determined in both the horizontal and vertical, dependent on plume rise, by applying the techniques suggested by Pasquill (see Section 2). Even if Option 3 is used, which results in the use of only the final plume height for effective height of emission, the gradual plume rise is determined internally to ascertain the buoyancy-induced plume size. (It would be entirely inappropriate to use the final plume rise to determine the initial size close to the stack.)

4.2.2.2 Input Options--IOPT(5) - IOPT(8)--

For the following four input options, specific action is taken if the value of 1 is entered.

Option 5: Meteorological data on cards--If IOPT(5) = 1, meteorological data are entered on cards, with one card for each simulated hour. If IOPT(5) = 0, meteorological data are entered by using records on Unit 11. (The specification of the records on this input file is given in Section 4.3.)

When the default option [IOPT(25) = 1] is used, IOPT(5) is set equal to 0, which restricts the use of this option. This is done to avoid conflict with the calms processing procedure. If onsite or other than RAMMET data are to be used, they must correspond to the format of the RAMMET file and be read into the model on Unit 11.

Option 6: Read hourly emissions--If IOPT(6) = 1, hourly emissions for each point source are read from Unit 15 in the main program, they are compared with the emissions input on the point source card for scaling the exit velocity. Subroutine PTR performs these tasks; Subsection 4.3 and Table 4-14 specify the records on this input file.

Option 7: Specify significant sources--The number of significant sources, given as NSIGP on Card 4, is ranked when the emissions data are processed according to the expected ground-level impact under B stability, with a wind of 3 m/s at the stack top. This option can be employed if the contribution of a source is sought for a subsequent run that is outside this list or too far down on it to be included among the significant sources, NSIGP on Card 4. When IOPT(7) = 1, an additional input card is read (Card 9) that indicates how many sources will be specified (NPT) and then gives their source numbers (the array MPS) corresponding to the source numbers in the printed output list. Source numbers are assigned according to the order of the source input. For example, consider an application having 30 sources, for which a run is deemed useful that shows contributions from 10 sources (NSIGP on Card 4 will be set to 10). Specifically, the contributions from Sources 7 and 22 are desired. The 12 most significant of the 25 sources, in order, are 3, 8, 23, 11, 2, 15, 4, 27, 1, 5, 28, and 14. Because 7 and 22 are not among these 12 and neither are they in the first 10, Option 7 is set equal to 1, and Card 9 contains 2 for NPT and 7 and 22 for the two entries to MPS. Sources 7 and 22 will occupy the first two columns in the contribution table. The program will fill the other eight positions of the significant source list (to total 10) with the first eight sources of the list of 25 (i.e., 3, 8, 23, 11, 2, 15, 4, and 27).

When the default option [IOPT(25) = 1] is used, IOPT(7) is set equal to 0, which restricts the use of this option. This is done to avoid confusion between estimates of zero concentration and hours with missing data because, except in the high-five tables, flags are not used to identify concentrations calculated for periods of calm winds.

<u>Option 8: Input radial distances and generate polar coordinate receptors</u>--For the user's convenience in making computations at an array of receptors that are positioned about a specific source or some other point, Option 8 provides for reading an additional input card (Card 10) with from one

to five nonzero distances in user units. In addition, the east and north coordinates (also in user units) of a center position are provided. The program generates the east and north coordinates of each receptor in a polar coordinate array, which generates 36 receptors for each nonzero distance (one for each 10 degrees of azimuth). A five-value distance array is read from the card, and distances are entered for the number of distances desired. Zeros are added to fill the array. For example, to produce a receptor array with two distances, one must enter two distances and three zeros. This step will generate 72 receptors (36 for each distance). Putting nonzero values for all five distances will generate 180 receptors, which is the maximum number that MPTER can compute. Thus, using Option 8 in this manner will not allow the input of any additional receptor cards with positions specified by the user.

The user should note that if both Option 8 and Option 1 are used for terrain adjustment, elevations of the polar coordinate receptors must be read when using Card 11. These elevations can best be obtained by drawing 36 radials from the designated center point on a topographical map and drawing circles for each distance. The elevations can then be determined from the map by reading them outward from the center, starting with the 10-degree azimuth radial. If all five distances are used so that 180 receptors are generated, a card with ENDREC in Columns 1 through 6 must be read after Card 10 (or the last card of Card 11, if used).

4.2.2.3 Printed Output Options--IOPT(9) - IOPT(19)--

When used (set equal to 1), the 11 printed output options will cause portions of the computer output to be skipped. A normal run will generally set most of these options equal to 1, and only those set to 0 will give output.

Option 9: Delete emissions with height table--Option 9 will be left at 0 only if it is desirable to look at the distribution of physical stack heights of the sources being modeled. This table is printed at the end of the main program.

Option 10: Delete averaging-time meteorological summary--Option 10 will be left at 0 when the user desires to obtain a listing of the hourly meteorological data for each simulated averaging time and the resultant or average conditions for that period. If the run is for a long period of record (e.g., 1 year), a similar record probably has already been made for the meteorological data. One output page for each averaging time will be required; the main program prints this table.

Option 11: Delete hourly contributions--Option 11 will be left at 0 only when the value of NSIGP on Card 4 is 1 or more and when the user wishes to examine on an hour-by-hour basis the contributions to the receptor concentrations of significant sources.

Option 12: Delete meteorological data on hourly contributions--Option 12 will be left at 0 only when the meteorological data for the hour should be listed with the contribution.

Option 13: Delete final plume height and distance to final rise on hourly contributions--Option 13 will be left at 0 only when the hourly calculated final plume height and the distance to final rise are desired with the hourly contributions. Information on effective plume height of specific sources can be invaluable in determining distance to maximum concentrations, or in arranging receptors vertically.

Option 14: Delete hourly summary--Option 14 will be left at 0 when it is desirable to have the hourly summary printed for each hour in the run. The hourly summary contains the sum of the contributions to the concentration at each receptor. In addition to this sum, two components of the concentration are given: 1) that due to all significant sources, and 2) that due to all other sources (i.e., those not considered in the sources selected as significant for this run).

Option 15: Delete meteorological data on hourly summary--Option 15 will be left at 0 when the meteorological data are required for the hour printed with the hourly summary. This information is the same as discussed under Option 12. The meteorological data should seldom be needed on both of these outputs.

Option 16: Delete final plume height and distance to final rise on hourly summary--Option 16 will be left at 0 when the final plume height and distance to final rise are needed on the hourly summary. This information is the same as on the contributions and should not be needed on both outputs.

Option 17: Delete averaging-time contributions--Option 17 will be left at 0 when examination of the contributions from the significant sources is desired for each averaging time.

Option 18: Delete averaging-time summary--Option 18 will be left at 0 when printout of the averaging-time summary is needed. This table is similar to the hourly summary (see Option 14), except for the simulation period covered. If averaging over these hours would be meaningless because a run is being made for several independent hourly periods, Options 17 and 18 should both be set to 1.

Option 19: Delete average concentrations and high-five table--Option 19 will be left at 0 to produce average concentrations for the duration of the run and to list the five highest concentrations for four or five averaging times. For this table to be useful, at least two periods of the concentration averaging period should be run. Any run less than 5 days will have some

0's in the output table because one output will be the highest five concentrations for the 24-hour averaging time.

4.2.2.4 Other Control and Output Options--IOPT(20) - IOPT(25)--

The five other control and output options cause portions of the code to be executea only if the option is used.

Option 20: Run is part of a segmented run--Option 20 is used to segment a run into several pieces. Card 13 is read, and appropriate input and output files are set to the correct record. Also, data for the average concentration and high-five are read from the previous segment and written for the next segment by using Unit 14.

Properly breaking a large run into segments requires setting the number of averaging periods, NPER on Card 4, to the total number for the sum of the segments. This step will allow the variable LDRUN, from Card 13, to control the program flow and temporarily store the proper data on Unit 14. For example, to break a 1-year run into two segments, let NPER equal 366 and NAVG equal 24 for both segments. On Card 13 for the first segment, IDAY is 0 and LDRUN can be 180; for the second segment, IDAY is 180 and LDRUN is 366 (for a leap year). The proper date and time should be entered on CARD 4 for each run.

Option 21: Write partial concentrations to disk or tape--Option 21 provides for all concentration contributions from each source to each receptor for each hour by using Unit 10. One record is written in Subroutine PTR for each receptor for each hour; thus, a large number of records will be written even for a relatively short length of simulated period. The specifications for these records are given in Section 5. The user should have knowledge of the amount of data generated before using this option.

Option 22: Write hourly concentrations to disk or tape--Option 22 provides for writing a record once each hour (on Unit 12) that contains the concentrations for each receptor. This option is written at the end of the MAIN program. The specifications for these records are given in Section 5.

Option 23: Write averaging-time concentrations to disk or tape--Option 23 provides for writing a record once each averaging period (on Unit 13) that contains the concentration for each receptor. This option is written at the end of Subroutine OUTHR; specifications for these records are given in Section 5.

Option 24: Punch averaging-time concentrations on cards--Option 24 provides for punching cards at the end of each averaging period of the concentration for each receptor for the averaging time (one card per receptor). Unit 1 is used for punching. The format for these output cards is given in Section 5.

Option 25: Set default values (used for regulatory applications)--The default option [IOPT(25) = 1] sets several inputs that override other user-input selections. Currently, the default option sets features required for regulatory applications using MPTER. No regulatory defaults are applicable to the SFM portion of SDM. Exercising this option results in the following:

- Final plume rise is used (gradual or transitional plume rise is not considered); that is, IOPT(3) is set to "1".
- Buoyancy-induced dispersion is used [i.e., IOPT(4) is set to "1"]. For distances less than the distance to final rise, the gradual plume rise is used to determine the buoyancy-induced dispersion, regardless of the setting of IOPT(3).
- Terrain adjustment factors are set to "C" for all stabilities.
- Stack tip downwash (Briggs 1974) is considered [i.e., IOPT(2) is set to "C"].
- Default urban or rural wind profile exponents are used, depending on the value of MUOR; appropriate mixing heights are set.
- Calms are treated according to methods developed by the EPA (EPA 1984), as discussed herein.

- Decay half-life is set to 4.0 hours for SO_2 for the urban option, and infinite half-life (no decay) is set for all other cases.

It is possible to operate in either the urban or rural mode when the default option is selected.

Table 4-14 contains a listing of the subsequent settings for other options and the values for specific variables that will result when the default option is selected.

One result of exercising the default option is that calm conditions are handled according to methods developed by the EPA (EPA 1984). A calm hour can be identified in the model as an hour with a windspeed of 1.0 m/s and a wind direction equal to the previous hour. When a calm is detected in the meteorological data, the concentrations at all receptors are set to 0 and the number of hours being averaged is reduced by 1; however, the divisor used in calculating the average is never less than 75 percent of the averaging time. For any simulation, this results in the following:

- Three-hour averages are determined by always dividing the sum of the hourly contributions by 3.
- Eight-hour averages are calculated by dividing the sum of the hourly contributions by the number of noncalm hours or 6, whichever is greater.
- Twenty-four-hour averages are determined by dividing the sum of the hourly contributions by the number of noncalm hours or 18, whichever is greater.
- Period-of-record averages, regardless of length, are calculated by dividing the sum of all the hourly contributions by the number of noncalm hours during the period of record.

Concentration calculations that are affected by calms are flagged in the printed output by placing the letter C next to the concentration value. This treatment of calm cases is <u>always</u> used when the default option is selected, but <u>cannot</u> be used if the default option is <u>not</u> selected.

TABLE 4-14. DEFAULT OPTION--SUBSEQUENT SETTINGS

Employment of the default option [IOPT(25) = 1] will cause the input option switches and specified variables to be set to the following:

IOPT(2) = 0
IOPT(3) = 1
IOPT(4) = 1
IOPT(5) = 0
IOPT(7) = 0
IOPT(10) = 1
IOPT(11) = 1
IOPT(12) = 1
IOPT(13) = 1
IOPT(14) = 1
IOPT(15) = 1
IOPT(16) = 1
IOPT(17) = 1
IOPT(18) = 1
IOPT(19) = 0
IOPT(20) = 0
IOPT(21) = 0
IOPT(22) = 0
IOPT(23) = 0
IOPT(24) = 0

HAFL = 14,400 seconds (for IPOL = 3, MUOR = 1)

HAFL = 0 (for IPOL ≠3 or MUOR ≠1)

IHSTRT = 1

NAVG = 24

NSIGP = 0

NAV5 = 0

PL = 0.07, 0.07, 0.10, 0.15, 0.35, 0.55 for MUOR = 2 (rural)

CONTER = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 (see Card 6, Section 4.2.3)

This procedure for calms is not available in MPTER outside of the default option. The user can employ this procedure, however, through the use of the CALMPRO postprocessor program (EPA 1984). CALMPRO is available as part of UNAMAP Version 6.

4.2.3 Wind and Terrain (Card 6, Table 4-4)

The anemometer height (HANE) in meters for the meteorological data used is entered on Card 6. Six values (one for each stability class) for the wind profile power law exponent (PL) are also entered on Card 6. Table 2-2 in Section 2 includes appropriate values for the rural mode.

If Option 1 is used to make terrain adjustments, six terrain adjustment factor values (CONTER, one for each stability class) are read from Card 6 and are used in subsequent computations. The values must be real numbers between 0 and 1. These values are set by the regulatory default Option 25 as shown in Table 4-14.

4.2.4 Point Source (Card 7, Table 4-5)

The alphanumeric name (RNAME) and eight variables of point-source information are the same as those used in other dispersion models. Only one of the two emission rates (SO_2 or particulate) will be used in a given run. If only one pollutant is of interest, the other field may be left blank. If the Option 6 hourly emission rate is not used, the emission rate should provide the best estimate of emissions for the length of source operation and simulation. If maximum or design emissions are used, concentration estimates may be somewhat larger than actual concentrations; however, Irwin and Cope (1979) have demonstrated that maximum operating conditions may not necessarily produce the highest modeled concentrations. If the option is exercised to input hourly emissions from a separate file (see Table 4-15 and Section 4.3) the input emission on each source card can either be average (normal) emission or maximum design emission, with the exit velocity appropriate for that condition. In MPTER, the hourly emissions input are compared with the emissions initially input on Card 7, and that comparison is used to scale the exit velocity upward if the hourly emission is greater, or downward if the hourly emission is less. In MPTER, no provision exists for altering the stack gas temperature. The value entered on the point-source card is used throughout, even if hourly emissions are entered.

TABLE 4-15. SDM OPTIONAL INPUT FILE--EMISSION DATA[a] (UNIT 15)

Variable	Dimensions	Description	Units
Record Type 1 (one each for each hour of simulation)			
IDATP	-	Date-time indicator consisting of:	
		Year	2 digits
		Julian day	3 digits
		Hour	2 digits
Source (IPOL, 1)	I = 1, NPT	Emission rate for the pollutant IPOL for each source	g/s

[a] Input if Option 6 = 1.

If Option 1 for terrain adjustments is employed, the ground-level elevation of each point source, ELP (NPT) is input in units chosen as convenient by the user (refer to Section 4.2.1.7).

4.2.5 Meteorological Data Identifiers (Card 8, Table 4-7)

If Option 5 equals 0, the user must specify the meteorological station identifer for both the surface and upper air data. The last two digits of the year of the data must also be specified for each station. The station number is a five-digit code specified by the National Oceanic and Atmospheric Administration.

4.2.6 Specified Significant Sources (Card 9, Table 4-8)

The user may specify up to 25 sources as significant. This specification will direct the SDM program to specify the individual contributions for each period of analysis. The user selects the number of significant sources (NPT) as well as which sources are to be considered by selecting individual source identification numbers (MPS).

4.2.7 Receptor Data (Cards 10, 11, and 12, Tables 4-9, 4-10, and 4-11)

If Option 8 is employed, polar coordinate receptor positions are generated internally in SDM around a specified location (CENTX, CENTY) for one to five radial distances (RADIL). Thirty-six receptors are generated for each distance. If all five distances are used, 180 receptors are generated--the maximum number of receptors allowed in SDM. Note that the distances (and also the center of the polar coordinate grid) are specified in user units. If Option 8 is used to generate the polar coordinate receptors and Option 1 is used to include terrain adjustments, the ground-level elevations of these receptors must be entered with Card 11. A separate card is used for each azimuth, with from one to five elevations per card.

An alternative method of entering receptors into an SDM run is to specify receptor locations (again, in user units) on individual cards for each receptor (Card 12).

The receptor height above local ground level must be in meters. Although in many applications the height will be zero (receptor at the ground), in other situations determining concentrations above the ground may be desirable, such as at plume centerline. Although no restriction exists for this height, careful thought should be given to the assignment of receptor heights far removed from the ground surface. A cautioning statement will be generated if both the effective plume height and the receptor height are above the mixing height.

Values for receptor elevations are required only if Option 1 is used for terrain adjustments in the MPTER submodel. Elevations are entered in the user height units. Estimations in SDM are limited to receptors whose ground-level elevation is lower than the lowest elevation of all the stack tops in the run. A receptor whose elevation is above this lowest stack height will not have a calculated concentration estimate; instead, multiple asterisks will appear on the concentration output for this receptor. Also, two asterisks will appear beside the receptor listing in the initial input section of the SDM printed output for receptors higher than the lowest stack height. Single asterisks will appear beside receptor numbers whose elevations are below the ground-level elevation of the source having the highest ground-level elevation. When two sources are treated independently by the SFM submodel and by the MPTER submodel with terrain, caution should be used in interpreting the concentration estimates for combined source concentrations where elevated receptors were used.

4.2.8 Segmented Run (Card 13, Table 4-12)

See Section 4.2.2.4.

4.2.9 Meteorological Data (Card 14, Table 4-13)

Meteorological data files prepared for the CRSTER, MPTER, and RAMR models are acceptable by SDM. Proper running of the RAMR or CRSTER pre-processor programs results in a 1-year period of record with one record for each calendar year. This record contains 24 values of each of the following parameters: Pasquill-Gifford Stability Class, wind-speed (at anemometer height), ambient air temperature, wind flow vector (wind direction ±180 degrees), and mixing height. The user should keep in mind that the use of these programs to process meteorological data requires the input of a complete set of hourly surface and mixing height data. When these data are used for input to SDM, one record is read for each simulated day. If a run is being made for a period of record of less than a year and starts after Day 001 (January 1), SDM will skip records to arrive at the proper day based on the variable IDATE(2) on Card 4.

If meteorological data from the preprocessed file are used, Option 5 will be zero. Also, the four variables on Card 8 should be read in and checked against the data on the input file.

Alternatively, when Option 5 is equal to 1, meteorological data are read from cards (see Card 14) with one record for each simulated hour in the run. The wind speed on this card is for the anemometer height. The wind direction is the direction from which the wind blows.

Appendix D provides an example input file including cards and inputs listed in the order shown above.

4.3 OTHER INPUT FILES

As shown in Figure 4-1, a number of additional input files are required to run SDM. These are separate from the standard input file in Section 4.2. Input specifications for each additional file are given in Tables 4-15 through 4-17. Table 4-15 shows the formats for specifying the hourly emission rates for individual sources. This file is only required if Option 6 is equal to 1. Table 4-16 shows the input format for the preprocessed meteorology. This format is the standard format from RAMMET. These data are required if Option 5 equals 0. Table 4-17 shows the input format for the shoreline tower meteorological data. These data are required for running the SDM model. A supplemental program, SDMMET, prepares the user's tower data for use as SDM meteorological data input. Use and requirements of this program are given in Section 7.

TABLE 4-16. SDM OPTIONAL INPUT FILE - METEOROLOGICAL DATA (UNIT 11)[a]

Variable	Dimensions	Description	Units
Record Type 1			
ID		SCF station identifier	5 digits
IYEAR		Year of surface data	2 digits
IDM		Mixing height station identifier	5 digits
IYR		Year of mixing height data	2 digits
Record Type 2 (one for each day of year)			
JYR		Year	
IMO		Month	
DAY1		Julian day	
IKST	24	Stability class	
QU	24	Wind speed	m/s
QTEMP	24	Ambient air temperature	Kelvin
DUMR	24	Flow vector to nearest 10 degrees	degrees-azimuth
QTHETA	24	Randomized flow vector	degrees-azimuth
HLH	2, 24	Mixing height	meters

[a] Required if Option 5 equals 0.

TABLE 4-17. SDM MANDATORY SHORELINE TOWER METEOROLOGICAL DATA (UNIT 19)[a]

Variable	Description	Units
IDAY	Julian day	-
IHR	Hour	-
UL	Wind speed in TIBL	m/s
US	Wind speed at stack height	m/s
PTMOL	Mean potential temperature over land	Kelvin
PTMOW	Mean potential temperature over water	Kelvin
DTHDZ	Over-water potential temperature	K/m
HO	Surface, sensible heat flux	W/m^2

[a]One card per hour; see Section 7 for the SDMMET program that generates this file.

4.4 TREATMENT OF SHORELINE ORIENTATION

An important consideration in the modeling of coastal areas is the location and orientation of the shoreline. Of primary concern in SDM is the development of the TIBL with onshore winds. The wind direction for shoreline fumigation, the TIBL height, and the source distance to the shoreline are a function of the location and orientation of the shoreline. The user should specify the shoreline carefully, paying full attention to location of sources, receptors, and irregularities in the land-sea interface.

SDM uses a series of shoreline definition cards to identify the shoreline for each source. Each shoreline definition card uniquely identifies the nearest shoreline for each source. This input allows flexibility in the modeling of a shoreline for different sources.

4.4.1 General Use of Shoreline Definition Card (Card 7A, Table 4-6)

The shoreline definition card is used to define the relationship between a point source and the nearby shoreline. This relationship is specified by selecting a point on the shoreline and drawing two lines away from the location of this point that follow the shoreline. Figure 4-2 gives four examples of shoreline point selection and the accompanying shoreline definition lines. The shore point is selected by examining the shoreline for any place where two straight or near straight shorelines come together. In Figure 4-2, source S1 is on a shoreline with a gradual bend. The shore point is located at the approximate intersection of this bend and two lines are drawn to follow the shore on either side of the bend. Source S2 shows a more acute bend with the corresponding point and lines drawn. Source S3 has an inverted bend and is handled the same way. Source S4 has a virtually straight shoreline. The location of the shore point in this case is arbitrary and is chosen at the source located on the shoreline. In all cases the angle, Θ, as shown in Figure 4-2, is the inclusive angle of the shorelines over water.

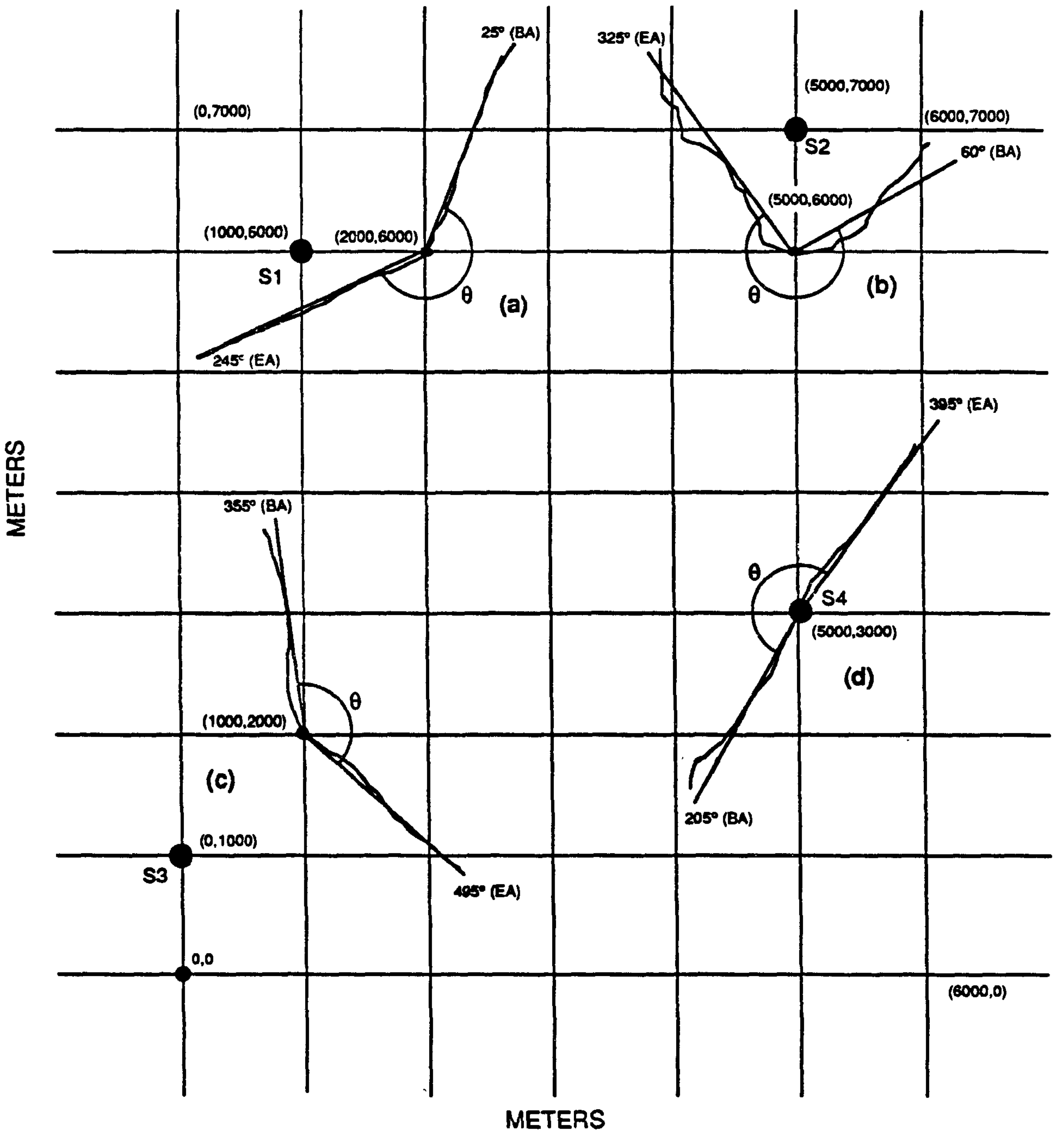

Figure 4-2. Use of the shoreline definition cards.

The remaining angle (360-Θ) represents the wind fetch over land. The wind angles beginning (BA) and ending (EA) and the applicable upwind fetch for onshore flow are determined from the shore point and shorelines as defined above. Figure 4-2 shows various values of BA and EA for different shorelines.

The variable FETCH is generally assigned a value of 20 degrees (this is the default value). FETCH limits the wind angles of consideration for onshore wind flow to within 20 degrees of the actual shoreline. For example, in Case a in Figure 4-2 the shoreline was defined from 25 degrees through 245 degrees. By designating FETCH as 20 degrees, the wind angles that will apply to onshore wind flow are 45 degrees through 225 degrees. Examples of the shoreline definition cards for Figure 4-2 are as follows:

SNAME______:______	XLS______	YSL_______	BA_______	EA____	FETCH
SOURCE S1	2000	6000	25	245	20
SOURCE S2	5000	6000	60	325	20
SOURCE S3	1000	2000	355	495	20
SOURCE S4	5000	3000	205	395	20

See Table 4-6 for specific format of the shoreline definition cards.

4.4.2 Complex Shoreline Modeling

Complex and irregular shorelines represent a unique situation. The fumigation submodel of SDM is generally applicable to a relatively smooth shoreline. Very irregular shoreline configurations may or may not be associated with TIBL formation, e.g., shallow or narrow bays and peninsulas. In these cases, the user should evaluate the entire area being modeled based on the shoreline, source locations, and receptor locations. Examples of complex shoreline models are described and shown in Figure 4-3.

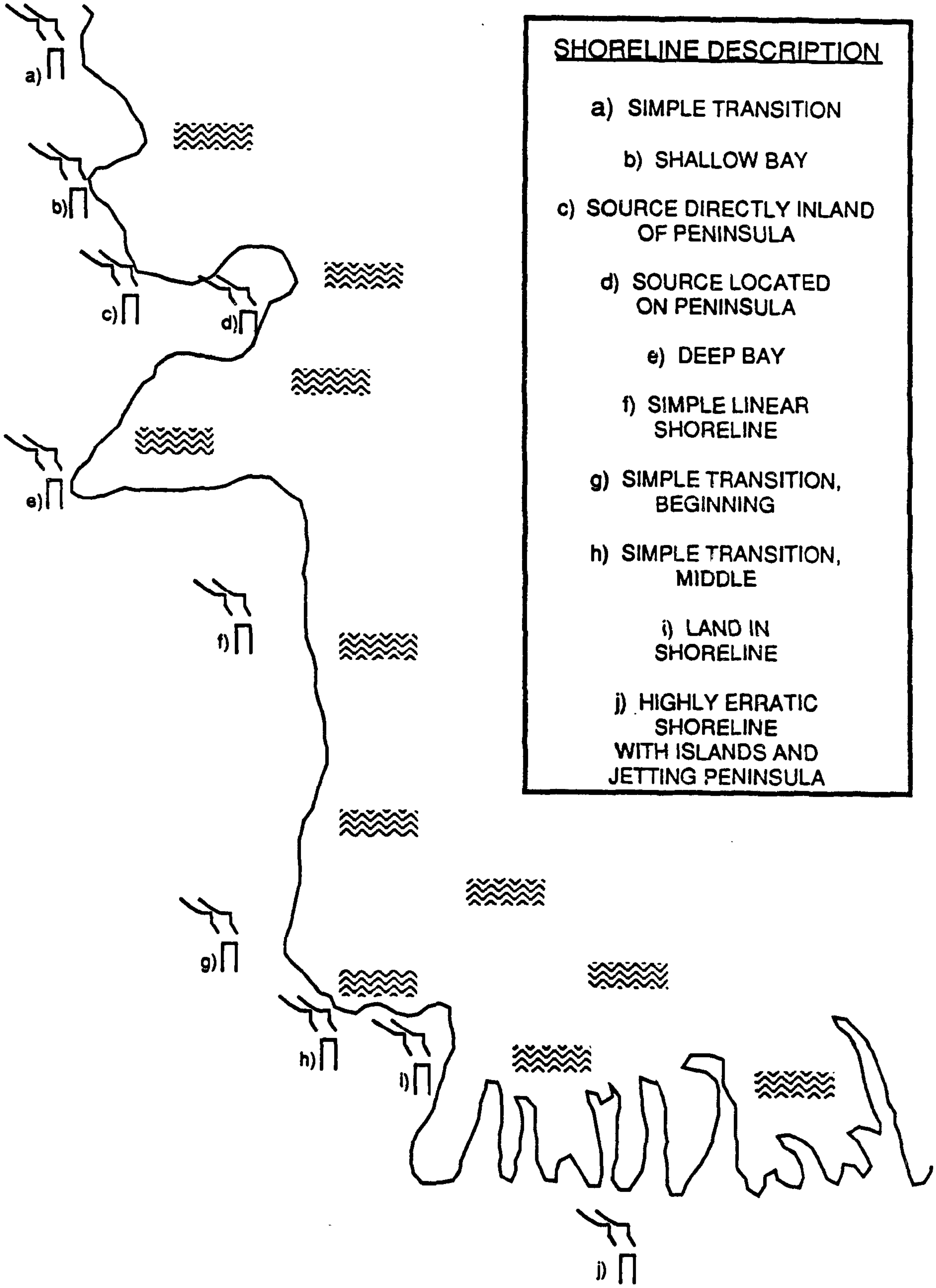

Figure 4-3. Complex shoreline.

SECTION 5

SDM OUTPUT

Output for the SDM program consists of a standard printed output and additional optional output on Units 10, 12, 13, 14, and 20. Table 5-1 describes the type of output obtained from an SDM run on the standard printed output device. The standard output includes the special shoreline fumigation applicability report for each day and source. This portion of the output is arranged by day and source and hour-of-day such that a "1" is printed when shoreline fumigation is applicable and "0" when it is not applicable. Also, the high-five tables on the standard output show an "F" next to the concentration if that averaging period's concentration includes an hour when a shoreline fumigation event developed.

Each of the optional output file formats (Units 10, 12, 13, 14, and 20) is given in Tables 5-2 through 5-7. These external files are a direct function of the original MPTER Model and represent various formats and data combinations that may be obtained. The newest external file is that described in Table 5-7 for Unit 20. Table 5-7 shows the shoreline fumigation output format that contains concentrations and meteorological conditions for all applicable hours when a TIBL developed and a source was subject to fumigation.

TABLE 5-1. SDM STANDARD PRINTED OUTPUT

Output	Number of lines	No. of pages
Mandatory output on all runs		3-6
Fumigation submodel selection report		5-15
Emissions with height table		½
Meteorological data for averaging period		1
Meteorological data on hourly contributions or hourly summaries	5	
Final plume rise and distance to final rise		
Less than 10 sources	3	
250 sources (1 line plus 2 lines for each 10 sources or fraction of 10 sources)	51	
Hourly contributions (for each hour		
For 1 to 10 significant sources		
About 30 receptors		1
About 31 to 83 receptors		2
About 84 to 136 receptors		3
About 137 to 180 receptors		4
For 11 to 20 significant sources	Twice that for 1 to 10	
For 21 to 25 significant sources	Three times that for 1 to 10	
Hourly summaries (for each hour)		
(See above for number of lines to add for meteorological and plume data)		
About 45 receptors		1
About 46 to 98 receptors		2
About 99 to 151 receptors		3
About 152 to 180 receptors		4
Averaging period contributions (for each period)		
For 1 to 10 significant sources		
46 receptors		1
47 to 99 receptors		2
100 to 152 receptors		3
153 to 180 receptors		4
For 11 to 20 significant sources	Twice that for 1 to 10	
For 21 to 25 significant sources	Three times that for 1 to 10	
Averaging period summary (for each period)		
44 receptors		1
45 to 78 receptors		2
99 to 151 receptors		3
152 to 180 receptors		4
Average concentrations and high-five table for 180 receptors (proportionally less for fewer than 180 receptors)		17

TABLE 5-2. SDM OPTIONAL OUTPUT PUNCHED CARDS--AVERAGE CONCENTRATIONS[a]

Variable	Card columns	Description	Units
	1-4	Word CNTL punched	
	5	Blank	
RREC	6-15	East coordinate of receptor	User units
SREC	16-25	North coordinate of receptor	User units
GWU	26-35	Concentration for averaging time	$\mu g/m^3$
	36-45	Blank	
K	46-50	Receptor number	-
ZR	51-60	Receptor height above ground	meters
ELR	61-70	Receptor ground-level elevation	User height units
IDATE(1)	72-73	Year	-
IDATE(2)	75-77	Julian day	-
NB	79-80	Beginning hour of this period	-

[a] Punched if Option 24 = 1; one card for each receptor for each averaging time.

TABLE 5-3. SDM OPTIONAL OUTPUT FILE--PARTIAL CONCENTRATIONS (UNIT 10)[a]

Variable	Dimensions	Description	Units
RECORD 1[b]			
NRECEP		Number of receptors	-
NPT		Number of receptors	-
RREC(I)	I = 1, NRECEP	East coordinate of receptor	User units
SREC(I)	I = 1, NRECEP	North coordinate of receptor	User units
RECORD 2[c]			
IDATE		Year and Julian day	-
LH		Hour	
K		Receptor number	
PARTC(J)	J = 1, NPT	Concentration at Receptor K from Source J	g/m^{-3}

[a] Output if Option 21 = 1.

[b] From main program.

[c] One record for each receptor for each simulated hour, from PTR.

TABLE 5-4. SDM OPTIONAL OUTPUT FILE--HOURLY CONCENTRATIONS (UNIT 12)[a]

Variable	Dimensions	Description	Units
RECORD 1			
NPER		Number of periods	-
NAVG		Number of hours in averaging period	-
LINE1	14	80 alphanumeric characters for title	-
LINE2	14	80 alphanumeric characters for title	-
LINE3	14	80 alphanumeric characters for title	-
RECORD 2			
NRECEP		Number of receptors	-
RREC(I)	I = 1, NRECEP	East coordinate of receptor	User units
SREC(I)	I = 1, NRECEP	North coordinate of receptor	User units
RECORD 3[b]			
IDATE(2)		Julian day	
LH		Hour	
PHCHI(I)	I = 1, NRECEP	Hourly concentration for each receptor	g/m³

[a] Output if Option 22 = 1.

[b] One for each simulated hour.

TABLE 5-5. SDM OPTIONAL OUTPUT FILE--AVERAGING PERIOD CONCENTRATIONS (UNIT 13)[a]

Variable	Dimensions	Description	Units
RECORD 1			
NPER		Number of periods	-
NAVG		Number of hours in averaging period	-
LINE1	14	80 alphanumeric characters for title	-
LINE2	14	80 alphanumeric characters for title	-
LINE3	14	80 alphanumeric characters for title	-
RECORD 2			
NRECEP		Number of receptors	-
RREC(I)	I = 1, NRECEP	East coordinate of receptor	User units
SREC(I)	I = 1, NRECEP	North coordinate of receptor	User units
RECORD 3[b]			
IDATE(2)		Julian day	
NB		Ending hour of period	
PCHI(K)	K = 1, NRECEP	Averaging period concentration for each receptor	g/m³

[a] Output if Option 23 = 1.

[b] One for each simulated averaging period.

TABLE 5-6. SDM OPTIONAL TEMPORARY FILE--VALUES FOR HIGH-FIVE TABLES (UNIT 14)[a]

Variable	Dimensions	Description	Units
ONE RECORD			
IDAY (on write)		Number of days processed	
IDAYS (on read)		Number of days previously processed	-
SUM	180	Cumulation of long-term concentration	
NHR		Number of hours processed	-
DAY1A		Julian day number of start of period of record	
HR1		Start hour of period of record	-
HMAXA	3, 5, 180, 5	Highest five concentrations (g/m^{-3}), and associated day and hour, for each receptor, for five different averaging times	-

[a] Output if Option 20 = 1.

TABLE 5-7. SDM SPECIAL SHORELINE FUMIGATION OUTPUT (UNIT 20)

Variable	Format	Description	Units
RECORD 1			
Identifier	A5	"TIBL:"	-
IDAY	I3	Day of year	
IHR	I2	Hour of day	
HO	F7.2	Sensible heat flux	$1/m^2$
UL	F13.1	TIBL windspeed	m/s
US	F13.1	Stack windspeed	m/s
DTNDZ	F10.4	Over-water potential temperature gradient	Kelvin/m
PTMOL	F8.1	Over-land mean temperature	K
PMTOLV	F8.1	Over-water mean temperature	K
RECORD 2			
Identifier	A5	"CONC"	-
SNAME	3A4	Source identifier	-
SREC	F13.3	East receptor coordinate	User units
RREC	F13.3	North receptor coordinate	User units
CONC	F10.3	Concentration at receptor	$micrograms/m^3$

SECTION 6

MODEL EXECUTION

Execution of the SDM Model may be performed through job control language (JCL) on an IBM-3090 mainframe system. The user must generate the appropriate input files, as described in Section 4, and specify all input and output file names. This section reviews the appropriate JCL for running the model on an IBM-3090 mainframe computer.

Following is a listing of the JCL to execute SDM using catalogued partitioned data sets for all model input and output. Refer to the "IBM VS FORTRAN Programming Guide" for more information on executing FORTRAN programs and run time options. The lower case characters "nnn" and "uuu" should be replaced by an account name and a user ID.

```
//SDM JOB (nnnnSPCLD, Muuu),PRTY=2, TIME=(0,30)
/* ROUTE PRINT HOLD
//*
//* EXECUTE PROGRAM
//*
//STEP1 EXEC PGM=SDM
//STEPLIB DD DSN=VGDTIER.Q.LOAD,DISP=SHR
//*
//* INPUT FILES
//*
//FT05F001 DD DSN=VGDTIER.SDM.INPUT(FILENAME),DISP=SHR
//FT11F001 DD DSN=OAMS.PREPYY.S#####.U#####,DISP=SHR
//FT19F001 DD DSN=VGDTIER.SDM.TOWER(FILENAME),DISP=SHR
//*FT15F001 DD DSN=VGDTIER.SDM.HOURLY(FILENAME),DISP=SHR
//*
```

```
//* OUTPUT FILES
//*
//FT06F001 DD SYSOUT=A
//FT20F001 DD DSN=VGDTIER.SDM.SHORE(FILENAME),DISP=SHR
//*FT10F001 DD DSN=VGDTIER.SDM.PARTIAL(FILENAME),DISP=SHR
//*FT12F001 DD DSN=VGDTIER.SDM.HOURCONC(FILENAME),DISP=SHR
//*FT13F001 DD DSN=VGDTIER.SDM.AVEPER(FILENAME),DISP=SHR
//*FT14F001 DD DSN-VGDTIER.SDM.TEMP(FILENAME),DISP=SHR
//SYSPRINT DD SYSOUT=A
/*
```

The inclusion/exclusion of data files and JCL above is, of course, contingent upon the options selected for the input variables in File FT05F001. For detailed information on executing Fortran programs or possible JCL options see:

'IBM VS FORTRAN Programming Guide'	(publication SC26-4118-1)
'OS/VS2 MVS JCL'	(publication GC28-0692-5)
'Messages and Codes'	(publication GC28-6631-13).

Appendix D provides an SDM input file. The JCL listing for a one-year run and the output for this example are provided in Appendix E. The example case is described in more detail in Section 8.

SECTION 7

SDMMET PROGRAM

SDMMET is an interactive program that creates the tower data meteorology file for the Shoreline Dispersion Model. SDMMET requires two input files and from these files generates an unformatted FORTRAN output file. The program internally calculates sensible heat flux, overwater lapse rate, and mean temperatures. The program can be run on an IBM-3090 mainframe.

The input files required to run the program are the raw tower data file and the data format definition file. The raw file is the hourly values at the tower. Table 7-1 lists all necessary input data. Minimum data requirements are two overland temperature measurements, water temperature, and wind speed. For this case, the 10-meter overland temperature is used as the overwater temperature and the wind speed is used for all wind speed measurements. Full measurements should be made whenever possible.

The data definition file is set up to define the order and format of the raw tower data and to provide important information about the measurements and surrounding terrain. The inputs are given in Table 7-2. The first card provides SDMMET with the tower measurement heights and surface roughness length. Table 7-3 gives example surface roughness lengths for various terrain. Card 2 allows the user to specify the order that the SDMMET input variables occur in the raw tower data file. Variable overlap can be accomplished by using the same position for two or more variables. For example, if the TIBL and stack height windspeeds were measured at the same height, the

TABLE 7-1. SDMMET VARIABLES[a]

Z0	Surface roughness (meters). See Table 7-3.
Z1	Height of 1st tower measurement station. The 10-meter height is recommended for use.
Z2	Height of 2nd tower measurement. The use of 60-meter measurements is recommended.
ZOW	Height of over-water measurement. If no over-water measurements were made, the 10-meter overland measurements are recommended.
TEMP1	The temperature (in Kelvin) at the first measuring height.
U1	The windspeed (m/s) at the first measuring height.
TEMP2	The temperature (in Kelvin) at the second measuring height.
UL	The windspeed (m/s) within the TIBL. The value at 60 meters is recommended.
USTACK	The windspeed (m/s) at stack height. If no measurement is made at stack height, the closest height on the tower is recommended (i.e., 60 meters).
TEMPOW	The over-water temperature (in degrees Kelvin). The overland temperatureat 10 meters is recommended if no over-water measurements are made.
TEMPWT	The water temperature (in degrees Kelvin). This can be from the environmental water monitoring done at the plant or from nearby facilities.

[a] Format specified by user as described in text and Table 7-2.

TABLE 7-2. SDMMET INPUT FILE

Columns	Format	Variable	Descriptor
CARD 1			
1-10	F10.0	Zϕ	Surface roughness length
11-20	F10.0	Z1	1st tower level height
21-30	F10.0	Z2	2nd tower level height
31-40	F10.0	ZOW	Overwater temperature height
CARD 2			
1-4	I4	ORD(1)	Position of 1st tower level temperature
5-8	I4	ORD(2)	Position of 1st tower level windspeed
9-12	I4	ORD(3)	Position of 2nd tower level temperature
13-16	I4	ORD(4)	Position of TIBL windspeed
17-20	I4	ORD(5)	Position of stack height windspeed
21-24	I4	ORD(6)	Position of over-water temperature
25-28	I4	ORD(7)	Position of water temperature
CARD 3			
1-80	ASO	FMT	Format of tower data using fortran format editing characters enclosed in parentheses

TABLE 7-3. SURFACE ROUGHNESS LENGTHS CATEGORIZED BY TERRAIN[a]

Class	Terrain descriptions	z_o, m
1	Open sea, fetch at least 5 km	0.0002
2	Mud flats, snow; no vegetation, no obstacles	0.0050
3	Open flat terrain; grass, fw isolated obstacles	0.030
4	Low crops; occasional large obstacles, $x/h > 20$	0.10
5	High crops; scattered obstacles, $15 < x/h < 20$	0.25
6	Parkland, bushes, numerous obstacles, $x/h \sim 10$	0.50
7	Regular large obstacles coverage (suburb, forest)	1.0
8	City center with high- and low-rise buildings	user defined

NOTE: Here x is a typical upwind obstacle distance and h the height of the corresponding major obstacles. Class 8 is theoretically intractable within the framework of boundary layer meteorology and can better be modeled in a wind tunnel.

[a]Classification is from Davenport (1960) and Wieringa (1980).

position of these data would be the same for the TIBL and the stack height. The final card of this data file is the FORTRAN format statement that will read in the file. This format statement should be enclosed by parentheses. For more information on FORTRAN format statements, consult a FORTRAN users' guide or a FORTRAN textbook.

Following is a listing of the JCL to execute the model using catalogued partitioned data sets for all model inputs and outputs. Refer to the "IBM VS FORTRAN Programming Guide" for more information on executing FORTRAN programs and run time options. The lower case characters 'nnn' and 'uuu' should be replaced by an account name and user ID.

```
//SDMMET JOB (nnnnSPCLD,Muuu),PRTY=2,TIME=0,20)
/* ROUTE PRINT HOLD
//*
//* EXECUTE PROGRAM
//*
//STEP1 EXEC PGM=SDMMET
//STEPLIB DD DSN=VGDTIER.Q.LOAD,DISP=SHR
//*
//* INPUT FILES
//*
//FT03F001 DD DSN=VGDTIER.SDMMET.INPUT(FILENAME),DISP=SHR
//FT04F001 DD DSN=VGDTIER.SDMMET.TOWER(FILENAME),DISP=SHR
//*
//* OUTPUT FILES
//*
//FT11F001 DD DSN=VGDTIER.SDM.TOWER(FILENAME),DISP=SHR
//*
//SYSPRINT DD SYSOUT=A
/*
```

For detailed information on executing FORTRAN programs or possible JCL options see:

'IBM VS FORTRAN Programming Guide'	(publication SC26-4118-1)
'OS/VS2 MVS JCL'	(publication GC28-0692-5)
'Messages And Codes'	(publication GC28-6631-13).

SECTION 8

EXAMPLE CASE

An example case output of the SDM Model has been included in this user's manual to allow the user to insure a good comparison with a test case. The input and output files have been included in Appendixes D and E, respectively.

This example is based on a hypothetical shoreline, randomly-generated tower meteorological data, and surface and mixing height meteorological data (processed in the RAMMET meteorological preprocessor program). This test case was for a one-year analysis.

Nine sources are positioned in three locations along a hypothetical shoreline. To model this scenario, 37 receptors were located south of the nine sources with the shoreline at various distances to the north. Sources 1 through 3 are located 70 meters from the shore, Stacks 2 through 6 are 560 meters from the shore, and Stacks 7 through 9 are 280 meters from the shore.

Appendix D presents the input data file including the option switches, source characteristics, and model specifications. Appendix E presents the output from such a test run and includes the input/output options, the shoreline fumigation applicability indicators, and the 1-h, 3-h, 8-h, and 24-h high-five tables. The appearance of an "F" after a concentration in these high-five tables indicates that at least one hour of the subject averaging period was subject to fumigation and the appropriate SFM portion of SDM was used for this hour. No "F" indicates that the MPTER submodel was used exclusively.

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APPENDIX A

USER'S GUIDE FOR SHORELINE FUMIGATION MODEL (SFM)

USER'S GUIDE FOR
SHORELINE FUMIGATION MODEL
(SFM)

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July 1988

Abstract

This user's guide describes the Shoreline Fumigation Model (SFM) developed by Misra (1980). Also included in this guide is a listing of the model program, sample input and output files and a discussion of how the input data required by the model should be obtained. The information contained herein is intended to facilitate use of the model in conjunction with a multiple point Gaussian dispersion model (e.g., the EPA regulatory model MPTER). The combined model will be applicable to modeling dispersion in shoreline environments during both fumigation and non-fumigation events.

SFM predicts ground level concentrations at user-defined receptor points based on hourly meteorological and source data. The meteorological input required by the model includes: mean wind speed at stack height and within the thermal internal boundary layer; mean potential temperature over land and over water; vertical potential temperature gradient overwater; and surface, sensible heat flux over land. Source data include plume buoyancy, emission rate and stack height. In order to apply the model, the wind must be onshore, the lapse rate overwater must be stable and there must be sufficient surface heating over land to trigger the establishment of a thermal internal boundary layer.

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List of Symbols

A	collective term for atmospheric variables involved in TIBL growth ($m^{1/2}$)
a_1, a_2, a_3	empirically determined constants
c_p	specific heat at constant pressure ($J\ K^{-1}\ kg^{-1}$)
e_s	saturation vapor pressure (mb)
F	plume buoyancy ($m^4\ s^{-3}$)
g	acceleration due to gravity at the earth's surface ($m\ s^{-2}$)
G	ground heat flux ($W\ m^{-2}$)
H	plume height (m)
H_o	surface, sensible heat flux ($W\ m^{-2}$)
H_{stk}	stack height (m)
H_T	TIBL height (m)
k	von Karman's constant (0.4)
L	Monin-Obukhov length (m)
L_e	latent heat of evaporation ($J\ kg^{-1}$)
m_w	mean molecular weight of water vapor ($kg\ mol^{-1}$)
N	Brunt-Vaisala frequency (s^{-1})
P	atmospheric pressure (mb)
Q	source strength ($g\ s^{-1}$)
R_i	gradient Richardson number
R_{i_b}	bulk Richardson number
R_N	net radiation ($W\ m^{-2}$)
R_*	universal gas constant ($8.31432\ J\ K^{-1}\ mol^{-1}$)
T	air temperature (K)
$U(z)$	wind speed at tower level z over land ($m\ s^{-1}$)

List of Symbols, continued.

U_L	mean wind speed within the TIBL (m s^{-1})
U_S	mean wind speed at stack height (m s^{-1})
u_*	friction velocity (m s^{-1})
w_*	convective velocity (m s^{-1})
X, x	downwind distance (m)
x'	downwind distance on the TIBL interface also point downwind at which the plume begins to intersect the TIBL (m)
Y, y	horizontal or off-centerline distance (m)
y'	horizontal distance on the TIBL interface (m)
z	vertical distance (m)
z_1, z_2	vertical distance at levels 1 and 2 (m)
z_o	surface roughness length (m)
Δ	slope of the saturation vapor pressure versus temperature curve (mb K^{-1})
γ	psychrometric constant used in energy balance calculations (mb K^{-1})
ρ	atmospheric density (kg m^{-3})
σ'	effective horizontal dispersion coefficient $\sigma' = \left[\sigma_{y_s}^2(x) + \sigma_{y_L}^2(x, x')\right]^{\frac{1}{2}}$ (m)
σ_{y_L}	horizontal dispersion coefficient in the unstable air within the TIBL (m)
σ_{y_s}	horizontal dispersion coefficient in stable air above the TIBL (m)
σ_{z_s}	vertical dispersion coefficient in stable air above the TIBL (m)
θ (z)	potential temperature over land (K)

List of Symbols, continued.

θ_L	mean potential temperature at tower level z over land (K)
θ_w	mean potential temperature over water (K)
θ_*	friction temperature scale used in similarity theory (K)
Ψ_H	universal function in the diabatic surface layer temperature profile
Ψ_M	universal function in the diabatic surface layer wind profile

1. INTRODUCTION

Coastal environments vary from inland environments in several ways which affect the dispersion of atmospheric pollutants. The occurrence of sea or lake breezes, a more moderate climate and the continuous presence of an internal boundary layer while air flows across the shoreline are some of the noted distinctions (Raynor et al., 1980). The internal boundary layer is of particular importance to understanding the meteorological processes that influence atmospheric dispersion. An internal boundary layer forms whenever the air flow crosses the surface discontinuity between the land and water (Raynor et al., 1980). These two surfaces commonly differ in temperature and nearly always differ in roughness, which leads to the creation of an interface between the air whose properties were determined by passage over the upwind surface and the air modified by passage over the downwind surface (Raynor et al., 1980). The internal boundary layer due to the roughness change is dominated, for the most part, by the affects of the thermal discontinuity and is generally known as the Thermal Internal Boundary Layer, or TIBL (Raynor et al., 1979). The TIBL interface grows parabolically with downwind distance until it reaches an equilibrium height which is the height of the inland mixed layer. The rate of growth depends primarily on the wind speed, the original (upwind) stability of the air and the magnitude of the surface, sensible heat flux over land. An example of internal boundary layer and stack locations for a complex shoreline is shown in Figure 1.

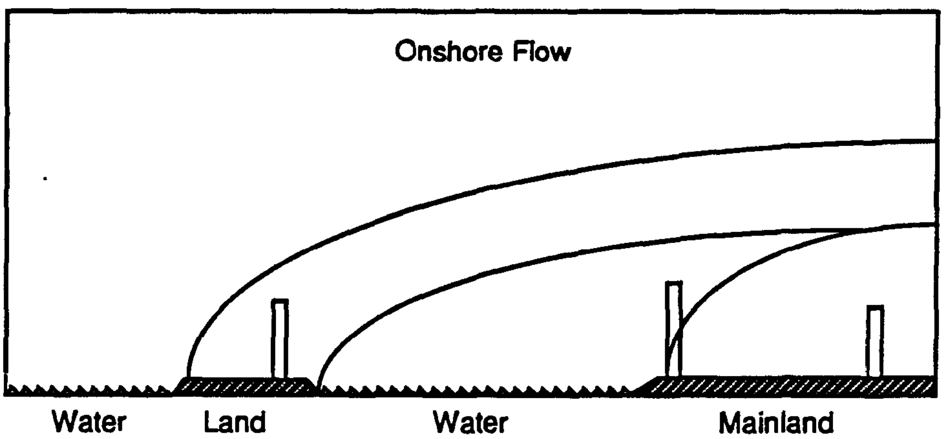


Figure 1. Example of internal boundary layer and stack locations for onshore flow at a complex shoreline (from Raynor et al., 1980).

Basically, two situations may be experienced with onshore flow. Either the land will be warmer and rougher than the water or the land will be colder and rougher than the water. In the former situation, which is the case under consideration here, the air mass cools from below as it crosses the water surface and becomes stable. TIBLs characterized by stable overwater lapse rates initiate growth at the shoreline and reach an equilibrium height at some distance downwind. In the latter situation the flow over land may become more stable. A water surface warmer than the adjacent land may be associated with an overwater stability that is near-neutral or unstable. In this situation the TIBL grows out of the mixed layer overwater and thus begins with some initial height (this case, however, is not considered).

Of interest here and of concern because of the potential for high inland concentrations is the case of onshore flow from colder water to heated land in which a plume, emitted from a tall stack at the shoreline, initially travels in the stable air with relatively little diffusion and impacts the TIBL at some distance downwind. As long as this situation exists, fumigation may occur continuously, resulting in high ground level concentrations. In contrast is the situation inland in which fumigation is usually transitory (Raynor et al., 1980). Given the nocturnal cooling which occurs over land, the conditions for fumigation will rarely continue past the hours of daylight (Raynor et al., 1980). Typically, the land temperature is warmer than the water temperature in the spring and early summer seasons in the temperate climate zones; hence these are periods during which the TIBL is likely to form (Misra, 1980). An illustration of plume behavior in a shoreline environment is given in Figure 2.

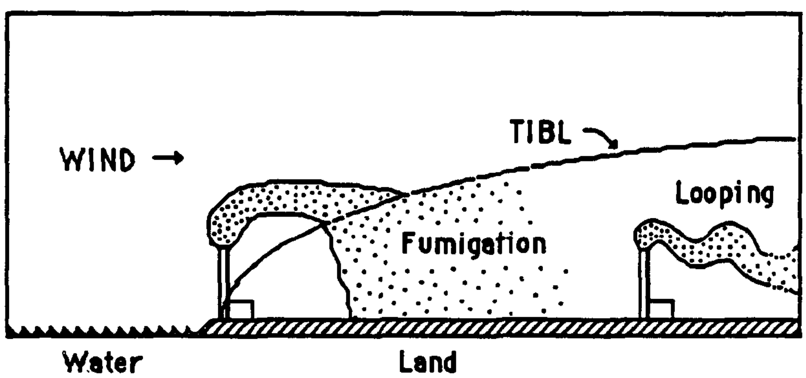


Figure 2. Plume behavior on a sunny, spring day as a function of location relative to the TIBL. The plume emitted at the inland location essentially remains trapped within the TIBL (after Oke, 1978).

Sensitivity studies have shown that the ability to determine the TIBL height is vital to the accuracy of model predictions (Stunder and SethuRaman, 1985). Depth of the TIBL affects both the location and magnitude of ground level concentrations from elevated sources. For onshore flow from a stable overwater air mass, a shallow TIBL will generally lead to lower ground level concentrations which occur at a farther distance downwind. A steep TIBL generally results in relatively higher concentrations which occur closer to the shoreline (EPA, 1987). Figure 3 illustrates the impact of different TIBL shapes on the location of ground level concentration.

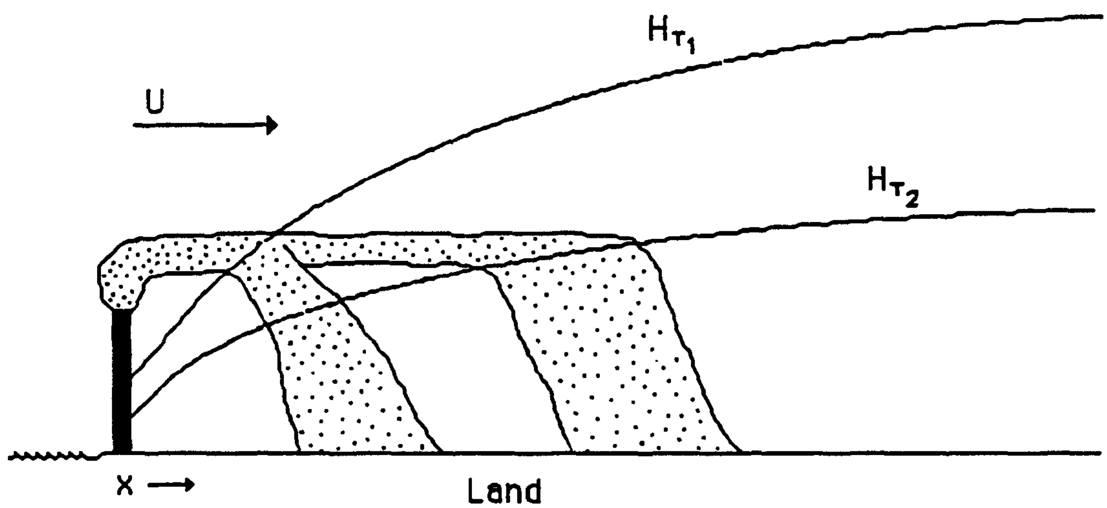


Figure 3. Impact of the variation in TIBL shape upon the location of ground level concentration downwind (after EPA, 1987). Air flow (U) is onshore and the land is warmer than the water surface upwind. The fumigation zone which occurs closest to the stack is associated with TIBL height H_{T_1} while the fumigation zone occurring farthest from the stack corresponds to TIBL height H_{T_2}.

Several models described in the literature address the conditions associated with dispersion in shoreline environments (Lyons and Cole, 1973; Van Dop et al., 1979; Misra, 1980). A statistical evaluation of the shoreline fumigation model developed by Misra, based on two sets of data from a shoreline location, indicates that the output of this model compares favorably with observations (EPA, 1987).

To extend the application of the Shoreline Fumigation Model (SFM) it will be merged with a multiple point Gaussian dispersion model (e.g., the EPA regulatory model

MPTER). The combined model will be applicable to modeling dispersion in shoreline environments during both fumigation and non-fumigation events. The appropriate routine in this combined model will be executed on the basis of the meteorological data for each hour of analysis. Limitations in the application of SFM are identified in Section 3.

2. SHORELINE FUMIGATION MODEL (SFM)

2.1 Description

The Shoreline Fumigation Model estimates ground level concentrations for user-defined receptor points downwind of an elevated source situated near a shoreline. The model operates under certain assumptions of the ambient atmospheric conditions and of plume behavior. Inherent in the development of the model are the assumptions identified below:

<u>Physical assumptions</u>:

onshore gradient or sea breeze flow on warm, sunny days

inland high temperature exceeds mean surface water temperature

stable overwater lapse rate

<u>Model assumptions</u>:

plume is released in the stable air and is Gaussian in nature

mean wind direction in the stable air is the same as the mean wind direction in the TIBL

plume has not begun to meander significantly before impacting the TIBL

plume impacts the top of the TIBL creating an *area* source from which pollutants are dispersed downward into the TIBL

uniform, instantaneous mixing downward of the plume upon TIBL impaction

pollutants corresponding to the elevated area source have horizontal Gaussian and uniform vertical distributions within the TIBL

horizontal dispersion coefficient in the unstable air within the TIBL is parameterized in terms of the convective velocity w_* instead of being characterized by the Pasquill-Gifford curves with Turner's correction factor

receptors are located in flat terrain

shoreline is essentially straight-line

An illustration of the model operating scenario is given in Figure 4. Note that the area shown is divided into two general zones, that of plume behavior in stable and unstable air. By definition, the unstable air corresponds to the air within the TIBL. The area over which the plume impacts the TIBL may be visually thought of as a "window" of dimension dx'dy', where x' and y' denote source locations on the top surface of the TIBL. Distance downwind is represented by the variable x and horizontal (off-centerline) distance by the variable y. As depicted, ground level concentrations are insignificant until the plume impacts the TIBL.

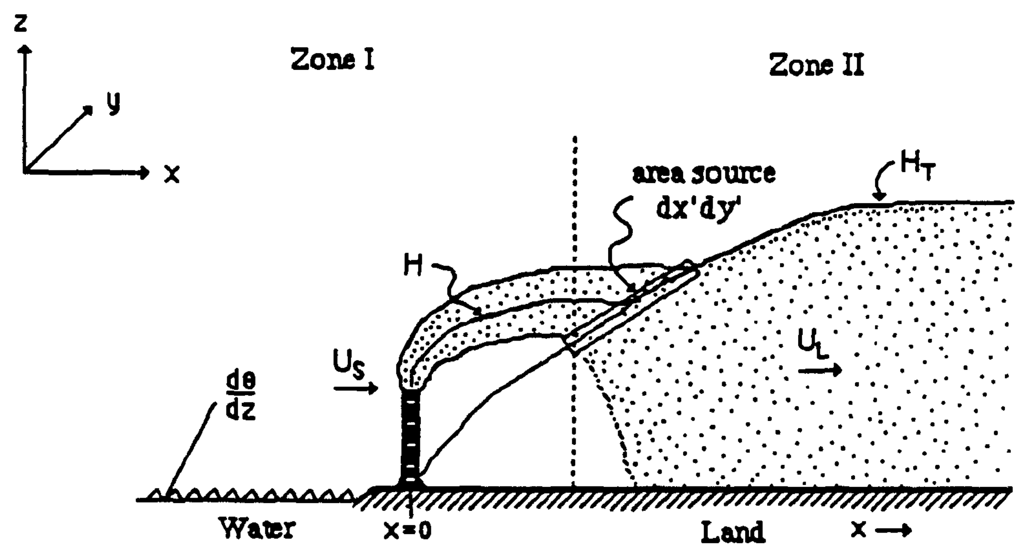


Figure 4. Schematic of shoreline fumigation (after Misra, 1980). Here H is the plume height, H_T is the TIBL height, and U_S and U_L are the mean wind speeds at stack height and within the TIBL, respectively.

The ground level concentration field inside the TIBL is first thought of in terms of the contribution at (x, y, z=0) of an elemental source of area dx'dy' located at [x', y', H_T (x')], where H_T is the TIBL height (Misra, 1980; Misra and Onlock, 1982). Integrating over y' between $-\infty$ and ∞ and over x' between 0 and x, the net contribution at (x, y, 0) is obtained (Misra, 1980; Misra and Onlock, 1982):

$$C(x,y) = \frac{Q}{2\pi H_T(x)} \int_0^x \frac{1}{U_L \sigma'} \exp\left\{ -\frac{1}{2} \left(\frac{H_T(x') - H(x')}{\sigma_{z_s}(x')} \right)^2 - \frac{y^2}{2\sigma'^2} \right\} \frac{d}{dx'} \left(\frac{H_T(x') - H(x')}{\sigma_{z_s}(x')} \right) dx' \quad (1)$$

where Q is the source strength (g s^{-1});

H_T is the TIBL height (m);

U_L is the mean wind speed within the TIBL (m s^{-1});

σ' is the effective horizontal dispersion coefficient;

$\sigma'^2 = \sigma_{y_s}^2 (x') + \sigma_{y_L}^2 (x,x')$;

σ_{ys} is the horizontal dispersion coefficient in the stable air above the TIBL (m);

σ_{y_L} is the horizontal dispersion coefficient in the unstable air within the TIBL (m);

H is the plume height (m);

σ_{zs} is the vertical dispersion coefficient in the stable air above the TIBL (m);

x' is the point downwind at which the plume begins to intersect the TIBL (m); and

y is the horizontal distance perpendicular to the downwind direction (m).

To conceptualize how SFM operates, the following points should be noted. Consider the TIBL interface as a porous, curved surface which a plume impacts from above. In the model plume impaction with this surface is not explicitly defined. Instead it is implicitly expressed in the derivation of Equation 1. Some portion of the plume is thought of as intersecting the TIBL and dispersing downward within it at all times; initially only a small portion of the plume will be intersecting and with increased distance downwind more and more of the plume will intersect. One may consider a source existing at each point (x', y') on H_T. The terms in Equation 1 are described more completely through the remainder of this section.

2.1.1 TIBL Height

The most important variables in shoreline fumigation include the height and shape of the TIBL. Height of the TIBL is defined according to Weisman (1976):

$$H_T = \left(\frac{2\,H_o X}{\rho\, c_p \left(\frac{d\theta}{dz}\right)_w U_L} \right)^{\frac{1}{2}} \tag{2a}$$

where H_o is the surface, sensible heat flux; X is downwind distance; ρ is atmospheric density; c_p is specific heat at constant pressure; $(d\theta/dz)_w$ is the potential temperature gradient over water, which indicates atmospheric stability; and U_L is the mean wind speed within the TIBL (refer also to Gamo et. al., 1983). As is evident by the equation, height of the TIBL is directly proportional to the surface, sensible heat flux. Higher wind speeds and greater stability of the over water air mass serve to dampen the TIBL height. In a shoreline environment as illustrated in Figure 4, the TIBL height is the actual mixed layer height. In Equation 2a the atmospheric variables are commonly combined and termed the TIBL "A" factor for convenience:

$$H_T = A\,X^{1/2} \tag{2b}$$

2.1.2 Plume Rise

Figure 4 illustrates that the plume emitted from a stack initially rises due to its own buoyancy. While rising its height is determined by the distance dependent formula:

$$H = H_{stk} + 1.6\left(\frac{F}{U_s}\right)^{\frac{1}{3}}\left(\frac{X}{U_s}\right)^{\frac{2}{3}} \qquad (3)$$

where H_{stk} is stack height, F is plume buoyancy, U_s is the mean wind speed at stack height and X is distance downwind. The equation and value of the coefficient reflect the method of Briggs (1975) for estimation of gradual plume rise. (Note that the equation does not reflect the contribution of plume momentum.)

A buoyant plume is generally observed to initially rise in stable air, overshoot and then settle to some equilibrium height. Neither the gradual plume rise nor final plume rise equation applies in the transition (overshoot) region. In the model, the equation for gradual plume rise is used up to the point of final plume rise. Based on observations of plume trajectories plotted by Briggs (1975), the distance downwind at which the plume levels off may be given by:

$$X = \frac{4.5\,U_s}{N} \qquad (4)$$

where U_s is the mean wind speed at stack height and N is the Brunt-Vaisala frequency. The expression for N is:

$$N = \left(\frac{g}{\theta_w}\left(\frac{d\theta}{dz}\right)_w\right)^{\frac{1}{2}} \qquad (5)$$

where g is the acceleration due to gravity at the earth's surface, θ_w is the mean potential temperature over water and $(d\theta/dz)_w$ is the potential temperature gradient over water. The value of N serves as an indicator of the stability or buoyancy of the air. The value of final plume rise reflects the method of Briggs, where $H = 2.6\,(F/N^2U_s)^{1/3}$.

2.1.3 Dispersion Coefficients for a Buoyant Plume

Vertical

Dispersion of the plume in the stable air above the TIBL is treated independently of its dispersion in the unstable air within the TIBL. In the stable air the buoyant plume spreads only because of its internal turbulence, while within the TIBL plume dispersion is dominated by the presence of convective turbulence. In the initial stages of the plume the dispersion coefficients are proportional to plume rise (Misra, 1980; Misra and McMillan, 1980). The vertical dispersion coefficient in stable air is given by:

$$\sigma_{z_s} = a_1\left(\frac{F}{U_s}\right)^{\frac{1}{3}}\left(\frac{X}{U_s}\right)^{\frac{2}{3}} \qquad \text{for} \quad \frac{X}{U_s} \leq \frac{4.5}{N} \tag{6}$$

where F is plume buoyancy, U_s is the mean wind speed at stack height, X is downwind distance and a_1 is an empirically determined constant. Here 4.5/N represents the time after which the plume has leveled off and is, then, the time when the internal turbulence of the plume is completely dissipated (Briggs, 1975). Once the plume has leveled off σ_z is considered likely to approach an asymptotically constant value, given by:

$$\sigma_{z_s} = 1.1\left(\frac{F}{U_s N^2}\right)^{\frac{1}{3}} \qquad \text{for} \quad \frac{X}{U_s} > \frac{4.5}{N} \tag{7}$$

which is obtained by substituting 4.5/N for X/U_s and setting a_1 equal to 0.4 in Equation 6.

Horizontal

The horizontal dispersion coefficient in stable air is given by the equation:

$$\sigma_{y_s} = a_3\left(\frac{F}{U_s}\right)^{\frac{1}{3}}\left(\frac{X}{U_s}\right)^{\frac{2}{3}} \tag{8}$$

where a_3 is an empirically determined constant and the other terms are as defined above. Once the plume intercepts the TIBL it fumigates into the unstable air within the TIBL and the horizontal dispersion coefficient is then calculated based on the work of Lamb (1978):

$$\sigma_{y_L} = \frac{1}{3}\left(\frac{w_*}{U_L}\right)(X - X') \qquad \text{for} \quad (X - X') \leq \frac{(H_T U_L)}{w_*} \tag{9a}$$

and

$$\sigma_{y_L} = \frac{1}{3}\left(\frac{w_*}{U_L}\right)H_T^{\frac{1}{3}}(X - X')^{\frac{2}{3}} \qquad \text{for} \quad (X - X') > \frac{(H_T U_L)}{w_*}\,. \tag{9b}$$

Here w_* is the convective velocity and U_L is the mean wind speed within the TIBL. Recall that when the plume impacts the TIBL it creates an area source on the top surface of the TIBL. As a method of calculating the complete contribution of this area source to the ground level concentration, the area source is divided into many small area sources. The total concentration is obtained by summing the contribution of all these small area sources. The distance (X - X') may be thought of as the distance affected by a given small area source at a stage in calculation of the complete concentration. In development of the model it was found that using only Equation 9a produced similar results to employing both Equations 9a and 9b, so singular use of Equation 9a was adopted. The convective velocity is defined as:

$$w_* = \left(\frac{g H_o H_T}{\rho c_p \theta_L} \right)^{\frac{1}{3}} \tag{10}$$

where H_0 is the surface, sensible heat flux, H_T is the TIBL height, θ_L is the mean potential temperature over land and the other terms are as defined previously. The value of w_* is calculated for each hour of input.

The constants a_1 and a_3 have been determined experimentally from data obtained from the Nanticoke Environmental Management Program (Misra, 1980; Portelli, 1982; Kerman et al., 1982; Hoff et al., 1982; Anlauf et al., 1982). Use of these constants is retained in the version of the model provided ($a_1 = 0.4$ and $a_3 = 0.67$, respectively). The reasoning for this is that the plume observed in the Nanticoke studies is likely representative of the behavior of all plumes under similar shoreline fumigation conditions.

Finally, the effective horizontal dispersion coefficient $\sigma'(x,x')$ is expressed:

$$\sigma' = \left[\sigma^2_{y_s}(x') + \sigma^2_{y_L}(x,x') \right]^{\frac{1}{2}} . \tag{11}$$

This equation is a consequence of the integration between $-\infty$ and ∞ over y' in the derivation of Equation 1 (Misra and Onlock, 1982).

2.1.4 Evaluation of Pollutant Concentration

The equation for pollutant concentration at a receptor point (Equation 1) is solved using Simpson's Rule, a numerical technique designed to evaluate the definite integral of a continuous function with finite limits of integration. The geometrical interpretation of Simpson's Rule is that of replacing the curve of some function f(x) by arcs of parabolas through three adjacent points of the integration interval (Fox, 1963). The general expression for Simpson's Rule is (Fox, 1963):

$$\int_a^b f(x)\,dx = \frac{b-a}{3n}[f(x_0) + 4f(x_1) + 2f(x_2) + 4f(x_3) + \ldots + 2f(x_{n-2}) + 4f(x_{n-1}) + f(x_n)] \quad (12)$$

Here a and b designate the endpoints of the interval over which integration is to be performed and n is the number of subintervals into which the interval from a to b is divided. In this application the function f(x) is, naturally, the concentration equation, evaluated over the interval from x equal some small, initial value to x equal the downwind distance of the receptor point. (This initial value of x is set equal to 10 m, which avoids the problem of singularity with x = 0.) In the model the value of n is equal to 2, which reduces Equation 12 to the expression: $\frac{b-a}{6}\left[f(a) + 4f\left(\frac{a+b}{2}\right) + f(b)\right]$.

In the model program the concentration equation is broken into parts to facilitate computation. The general sequence of steps used is identified in the following paragraphs and is labeled in italics in the source code (Appendix A).

Step 1 The model first computes the quantity:

$$\frac{1}{2\pi\, H_T(x)\, U_L} \quad (13)$$

Here the TIBL height (H_T) is evaluated at the x coordinate of the receptor point. The wind speed (U_L) was moved outside the integral since it is constant for any given hour of computation.

Step 2 The model compares the value of X/U_s with the value of 4.5/N. If the plume has not leveled off (i.e., $X/U_s \leq 4.5/N$) then σ_{z_s} is determined by Equation 6 and the value of the derivative in the concentration equation is given by:

$$\frac{d}{dx'}\left(\frac{H_T(x') - H(x')}{\sigma_{z_s}(x')}\right) = -\frac{1}{6}\frac{A\,U_L X^{-\frac{7}{6}}}{a_1 F^{\frac{1}{3}}} + \frac{2}{3}\frac{H_{stk} U_L X^{-\frac{5}{3}}}{a_1 F^{\frac{1}{3}}} \quad . \tag{14}$$

If the plume has leveled off (i.e., $X/U_s > 4.5/N$), then σ_{z_s} is calculated by Equation 7 and the derivative part of the concentration equation takes the much simpler form:

$$\frac{d}{dx'}\left(\frac{H_T(x') - H(x')}{\sigma_{z_s}(x')}\right) = \frac{A}{2\sqrt{x}\,\sigma_{z_s}} \quad . \tag{15}$$

Step 3 The exponential term is now calculated:

$$-\frac{1}{2}\left(\frac{H_T(x') - H(x')}{\sigma_{z_s}(x')}\right)^2 - \frac{y^2}{2\sigma'^2} = -\frac{1}{2}\left(\frac{\left(H_T(x') - H(x')\right)^2}{\sigma_{z_s}^2(x')} + \frac{y^2}{\sigma'^2}\right) . \tag{16}$$

Step 4 Referring here to the right hand sides of Equation 14 or 15 as "DERIV" and to Equation 16 as "C1," respectively, the model continues evaluation of the concentration equation as follows:

$$C = \ln(\mathrm{DERIV}) + C1 - 1/2 \ln(\sigma'^2) \tag{17}$$

and

$$\mathrm{EVAL} = \exp(C) \; . \tag{18}$$

The term $-1/2 \ln(\sigma'^2)$ represents the last term not yet accounted for inside the integral of Equation 1 [$\sigma'^{-1} = (\sigma'^2)^{-1/2}$ and $\ln(\sigma'^2)^{-1/2} = -1/2 \ln(\sigma'^2)$].

Step 5 Finally, the program multiplies Equation 18 by Equation 13, and this product by the source strength Q:

$$C(x,y) = \frac{Q}{2\pi H_T U_L} \text{EVAL} \quad (19)$$

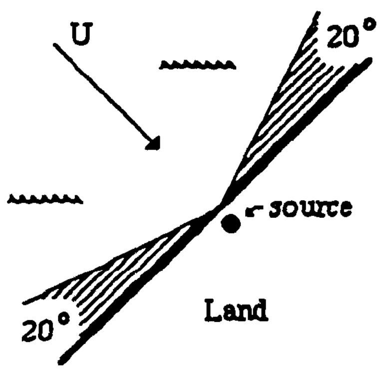
which yields the solution for ground level concentration at a particular receptor point. The units for Equation 19 are g m^{-3}, which are converted to $\mu g\ m^{-3}$.

2.2 Operating Conditions

The operating scenario of the Shoreline Fumigation Model involves that of an elevated plume, released at the shoreline in stable marine air, which impacts a growing TIBL over land at some distance downwind. In order to apply the algorithm for shoreline fumigation, the following conditions must be met:

1) the hourly wind direction at the shoreline source must be onshore.

   Since the accuracy of wind direction measurement is generally ± 10 degrees and wind direction may fluctuate for lower wind speeds, it is recommended that only those measurements outside of 20 degrees from the shoreline be used (i.e., use only those cases with winds from a 140 degree sector centered on a line perpendicular offshore). The diagram below illustrates this situation.



2) the hourly wind speed should be greater than 2 m s^{-1}

3) it must be daytime so that unstable atmospheric conditions exist over land.

   Specifically, the overland, surface, sensible heat flux must be at least +5 W m^{-2} to insure formation of a TIBL.

4) the overwater lapse rate must be stable (i.e., the vertical potential temperature gradient must be greater than zero).

As long as all these conditions are satisfied, then SFM is applicable. Concentrations for the receptor grid will be determined as discussed in the Model Description.

2.3 Input Data Requirements

As with other air quality models, the Shoreline Fumigation Model operates on hourly input of certain meteorological variables and source characteristics. The following are the fundamental input variables required by SFM:

H_o - surface, sensible heat flux ($W\ m^{-2}$)

U_L - mean wind speed within the TIBL ($m\ s^{-1}$)

U_S - mean wind speed at stack height ($m\ s^{-1}$)

θ_L - mean potential temperature over land (K)

θ_w - mean potential temperature over water (K)

$\left(\frac{d\theta}{dz}\right)_w$ - vertical potential temperature gradient overwater ($K\ m^{-1}$)

F - plume buoyancy ($m^4\ s^{-3}$)

Q - source strength ($g\ s^{-1}$)

H_{stk} - stack height (m)

ρ - atmospheric density ($kg\ m^{-3}$)

c_p - specific heat at constant pressure ($J\ K^{-1}\ kg^{-1}$)

These variables are directly input or assigned in the version of the model provided. In the absence of actual measurements, values of H_o, for example, may need to be calculated within the model. Methods of obtaining the meteorological input are explained in the remainder of this section.

2.3.1 Methods for Calculating Surface, Sensible Heat Flux

The surface, sensible heat flux is required for the determination of the TIBL height and is also used in calculating the convective velocity. Three primary methods exist for obtaining sensible heat flux; these methods are described below.

Eddy Correlation

The most reliable and direct way of obtaining H_o is by the *eddy correlation* method, in which $H_o = \rho c_p \overline{w\theta}$ and the covariance $\overline{w\theta}$ is obtained from temperature and vertical velocity fluctuations measured by research grade turbulence instrumentation, such as a vertical-axis sonic anemometer-platinum wire thermometer assembly.

Profile

<u>Needed Input for the Profile Method</u>

Wind speed at one level Surface roughness length Temperature at two levels	or	Wind speed at two levels Temperature at two levels

A commonly used method employed when direct turbulence measurements are not available is the *profile* method. This method for estimating surface, sensible heat flux is based on Monin-Obukhov similarity theory for the surface layer (Berkowicz and Prahm, 1982). Under the assumptions of stationary and horizontally homogeneous conditions, dimensionless vertical gradients of a conservative quantity are only functions of the stability parameter z/L, where L is the Monin-Obukhov length. Under this method, the equation for heat flux is given as:

$$H_o = -\rho\, c_p u_* \theta_* \quad .$$

where

ρ = atmospheric density (kg m^{-3})

c_p = specific heat at constant pressure (J K^{-1} kg^{-1})

u_* = friction velocity (m s^{-1})

$$u_* = \frac{k\,U(z_1)}{[\ln(z_1/z_o) - \psi_M(z_1/L) + \psi_M(z_o/L)]} \quad \text{(wind speed at one level)}$$

or

$$u_* = \frac{k\,[U(z_2) - U(z_1)]}{[\ln(z_2/z_1) - \psi_M(z_2/L) + \psi_M(z_1/L)]} \quad \text{(wind speed at two levels)}$$

k = von Karman's constant (0.4)

$U(z_1)$ = wind speed at z_1 tower level over land (m s^{-1})

$U(z_2)$ = wind speed at z_2 tower level over land (m s^{-1})

z_1 = 10 m

z_2 = 20 m (or next closest level to z_1)

z_o = surface roughness length (m)

z/L = stability parameter

$$\psi_M = 2\ln[(1+\beta)/2] + \ln[(1+\beta^2)/2] - 2\tan^{-1}(\beta) + \pi/2$$

$$\beta = (1 - 16z/L)^{1/4}$$

θ_* = friction temperature scale used in similarity theory (K)

$$\theta_* = \frac{k[\theta(z_2) - \theta(z_1)]}{[\ln(z_2/z_1) - \psi_H(z_2/L) + \psi_H(z_1/L)]}$$

$\theta(z_1)$ = potential temperature at z_1 tower level over land (K)

$\theta(z_2)$ = potential temperature at z_2 tower level over land (K)

$$\psi_H = 2\ln[(1+\beta^2)/2]$$

The above equations apply to the atmospheric surface layer, which is typically the lowest 100 m during daytime conditions. The expression shown for β is that applicable to an unstable atmosphere, since the interest here is in obtaining the surface, sensible heat flux over land during daytime, convective conditions. For an unstable atmosphere the quantity z/L can be determined by the gradient (R_i) or bulk (R_{ib}) Richardson number (Tennekes, 1982):

$$R_i = \frac{g}{\theta_L} \frac{\left(\frac{d\theta}{dz}\right)_L}{\left(\frac{dU}{dz}\right)_L^2}$$

$$R_{i_b} = \frac{g\, z_1 [\theta(z_2) - \theta(z_1)]}{\theta_L U^2(z_1)}$$

$$\approx z/L$$

Here g is the acceleration due to gravity at the earth's surface; θ_L is the mean of the potential temperatures $\theta(z_1)$ and $\theta(z_2)$; $[d\theta/dz]_L$ is the overland, potential temperature gradient between levels z_1 and z_2; and $[dU/dz]_L$ is the overland, horizontal wind speed gradient between levels z_1 and z_2. Suitable heights for z_1 and z_2 are 10 and 20 meters, however other levels may be used provided they are located in the atmospheric surface layer.

To calculate the Ψ functions for estimation of u_* and θ_*, first determine R_i or R_{i_b}. The gradient Richardson number corresponds to the height $(z_2 z_1)^{1/2}$. Using this height for z, solve the expression $R_i = z/L$ for the Monin-Obukhov length, L. Knowing the value of L (which is assumed constant in the surface layer, based on similarity theory), compute the Ψ functions using the appropriate value of z. The surface roughness length (z_o) may be approximated on the basis of a visual terrain description or calculated for each source site using the logarithmic wind speed profile. Values for z_o categorized by terrain are provided in the table in Appendix C.

Energy Balance

Needed Input for the Energy Balance Method

net radiation (e.g., from a net pyrradiometer)
wet and dry bulb temperatures at two levels
atmospheric pressure

The surface energy budget indicates that the net radiation at the surface is balanced by a combination of sensible and latent heat fluxes to the atmosphere and by the heat flux to the soil or subsurface medium. An energy budget equation may be used to calculate the sum of the latent and sensible heat fluxes from measurements and/or estimates of the remaining terms in the equation. If the ratio of sensible to latent heat fluxes (otherwise known as the Bowen ratio) is estimated or measured, then the separate fluxes may be determined. For wet, bare surfaces and vegetative surfaces over which evapotranspiration is near its potential rate and both the evapotranspiration and heat flux are positive (upward), the surface sensible heat flux may be estimated from the equation (Arya, 1988):

$$H_o \approx \frac{\gamma}{(\Delta + \gamma)}(R_N - G)$$

where $\gamma = \dfrac{c_p P}{0.622\, L_e}$ and $\Delta \approx de_s/dT$.

Here R_N is the net radiation, G is the ground heat flux, P is atmospheric pressure, L_e is the latent heat of evaporation, and de_s/dT is the slope of the curve of saturation vapor pressure versus temperature. This slope may be determined by the equation:

$$\frac{de_s}{dT} = \frac{e_s m_w L_e}{R_* T^2}$$

where e_s is the saturation vapor pressure at level T, m_w is the mean molecular weight of water vapor, R_* is the universal gas constant and T is the air temperature.

An alternate form of the equation for sensible heat flux using the energy balance method is given by the following (Holtslag and Van Ulden, 1983; Wilczak and Phillips, 1986):

$$H_o = \frac{(1 - \alpha) + (\varepsilon/s)}{1 + (\varepsilon/s)}(R_N - G) - \zeta$$

where α and ζ are empirical parameters associated with the sensible and latent components of the surface flux; $\varepsilon = c_p/L_e$; $s = \delta q_s/\delta t$, where q_s is the saturation specific humidity and the other terms are as defined previously.

While the energy balance method has been shown to perform at least as well as, if not better than the profile method, accuracy of this method is quite sensitive to the values of α and ζ (i.e., to values of the Bowen ratio; Wilczak and Phillips, 1986). In addition, the input required by this method may be difficult to obtain or approximate. Use of the profile method for calculating the surface sensible heat flux is therefore suggested, keeping in mind that the accuracy of this approach will depend on the quality of the meteorological measurements involved.

2.3.2 Determination of Other Meteorological Input

Mean wind speed within the TIBL (U_L) -

To approximate the mean TIBL wind speed, the highest tower level (e.g., 60 m) wind speed over land may be employed.

Mean wind speed at stack height (U_S) -

Use the wind speed measured at stack height up to 60 m, if available. Otherwise use the wind measured from the nearest comparable height. Wind speed extrapolation using the power law profiles is not recommended.

Mean potential temperature over land (θ_L) -

Use the arithmetic average of the over land potential temperatures θ (z_1) and θ (z_2), where:

$$\theta (z) = T\left(\frac{1000}{P(z)}\right)^{\frac{R}{c_p}} .$$

Here T is the ambient air temperature (K), P is atmospheric pressure (mb), R is the gas constant ($J\ K^{-1}\ kg^{-1}$) and c_p is specific heat at constant pressure ($J\ K^{-1}\ kg^{-1}$). In most applications T can be substituted for θ.

Mean potential temperature over water (θ_w) -

Use the arithmetic average of the over water potential temperatures θ (z_1) and θ (z_2).

Vertical potential temperature gradient overwater $[d\theta/dz]_w$ -

The vertical potential temperature gradient may be defined as:
$[\theta (z_2) - \theta (z_1)]/[z_2 - z_1]$.

For the upper level: use the 10 m potential temperature over water, if possible. If this is not available, use the 10 m potential temperature from a tower situated at the shoreline. If this is not available, use the 10 m potential temperature from an inland tower, provided this tower is within 1 km of the shoreline.

For the lower level: use the water surface temperature as recorded from satellite data (value used should be representative of the offshore water surface temperature, hence values from the shallow, near shore waters should be avoided). An alternative to using satellite data is to employ the water intake temperature measured by the industry. In this case the intake should be within 2 m of the surface, unless it is determined that the vertical water temperature gradient is not significant. The intake should also be made outside of the shallow, near shore waters.

Atmospheric density (ρ) -

A fixed value of atmospheric density reflecting 20 C (293 K) and 1000 mb pressure is currently employed in the model (ρ = 1.188 kg m^{-3}).

Specific heat at constant pressure (c_p) -

A fixed value of c_p reflecting 20 C (293 K), 1000 mb and 50% relative humidity is currently employed in the model (c_p = 1020 J K^{-1} kg^{-1}).

Convective velocity (w_*) -

The convective velocity needs to be calculated for each hour of model operation. Equation 10 identifies the formula for w_*. H_T should first be determined by Equation 2 using x = 5000 m (Misra, 1988). The value for w_* can then be determined by substituting H_T and the values of the other variables for the given hour into Equation 10.

2.3.3 Input Data Format

As presently coded, the model executes in batch mode and draws on input from two separate files, one containing the X and Y coordinates of the receptor points (XY.DAT) and the other containing the hourly meteorological and source data (MET.DAT). Samples of these files are provided in Appendix B. These files are created by the user, with the following formats:

Variable	Column	Format
Mean wind speed within the TIBL - U_L (m s^{-1})	1-5	F5.2
Mean wind speed at stack height - U_s (m s^{-1})	7-11	F5.2
Mean potential temperature over land - θ_L (K)	13-18	F6.2
Mean potential temperature over water - θ_w (K)	20-25	F6.2
Overwater lapse rate - $(d\theta/dz)_w$ (K m^{-1})	27-33	F7.4
Surface, sensible heat flux - H_o (W m^{-2})	35-40	F6.2
Plume buoyancy - F (m^4 s^{-3})	42-48	F7.2
Source strength - Q (g s^{-1})	50-56	F7.2
Stack height - H_{stk} (m)	58-64	F7.2
Number of receptors - NR	66-68	I3

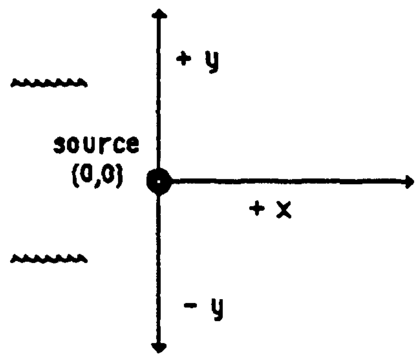
One space separates each of the variables in the input string (as indicated by the column designation). For the sample model run the heat flux and overwater lapse rate are considered known. Means of calculating these variables are commented in the main program.

The format of the X and Y coordinate data is as follows:

Variable	Column	Format
X coordinate (m)	1-9	F9.1
Y coordinate (m)	12-20	F9.1

Two spaces separate the X and Y variables in the input string.

A few points should be made regarding the convention of downwind distance in the model. The X in the plume rise equation represents the distance downwind of the stack (i.e., at the stack X = 0). In the equations for the vertical and horizontal dispersion coefficients X is also the distance downwind of the stack. However, in the TIBL height equation X is the distance downwind of the shoreline (i.e., at the shoreline X = 0). Thus, if the stack is located inland, the TIBL height should be defined as H_T (X + d), where d is the downwind distance of the stack from the shoreline. The following diagram indicates the x and y grid for a source situated at the shoreline.



2.4 Output Data Description

The Shoreline Fumigation Model (SFM) predicts hourly, ground level pollutant concentration for user-defined receptor points. The X coordinate of the receptor may be any value greater than zero, with increasing values representing greater downwind distances from the source. The Y coordinate may be positive or negative in value, signifying the horizontal or off-centerline distance of the receptor. Concentrations are output in $\mu g\ m^{-3}$ and reflect the pollutant identified by the source strength (Q). As coded in Appendix A, the model produces an output table of the X and Y receptor coordinates along with the corresponding pollutant concentration. Input variables are also listed for reference.

While executing SFM, output is written to an external file (SFM.OUT) and to the terminal screen. A sample output file is included in Appendix B. What appears on the screen as the model is running is identical to the output written to the external file. The output to the terminal will scroll on the screen, pausing momentarily after displaying the input variables. The length of this pause will be a function of how many receptor points are being processed (output to the screen occurs only after all receptor points have been processed).

3. FUTURE CONSIDERATIONS

Merging the Shoreline Fumigation Model with a more extensive, multiple point Gaussian dispersion model introduces potential modeling situations which are beyond the realm of continuous fumigation considered here. One such situation involves plume penetration of the TIBL. Buoyant plumes emitted within the TIBL have been observed to partially penetrate the inversion layer existing above it (Manins, 1984). Regardless of the TIBL height, if a stack is located within the TIBL then provision needs to be made within the overall shoreline dispersion model to handle plume penetration (Misra, 1988). Investigation of this phenomenon has been conducted by Briggs (1984) and Manins (1979, 1984) which may provide useful information for the development of an appropriate algorithm.

An additional matter to be resolved is that of the mixed layer height determination for hours of model operation in which a TIBL exists, but fumigation does not occur (i.e., the stack is located far enough inland for the plume to be trapped within the TIBL). This situation would warrant execution of the more extensive model, but the TIBL height expression in SFM would still be appropriate for determining the mixed layer height. If the plume were emitted in the region of rapid TIBL growth, then determining the mixed layer height is not clearly straightforward. Using the TIBL height above a receptor point located downwind would produce results that are optimistic, while using the height of the TIBL above the stack would produce more conservative results. The modeling procedure for this situation requires further development.

SFM computes ground level concentrations with the understanding that pollutants are well mixed within the TIBL; hence it is assumed that no vertical gradient in concentration exists. Ground level concentrations produced apply to receptors situated on level terrain; however if there are only slight terrain perturbations in the receptor grid the model may be executed in its current state. If larger surface features exist then the model would need to be modified in terms of both definition of the TIBL height and calculation of ground level concentration in order to produce acceptable results.

Finally, SFM does not currently address the onshore cases in which the overwater lapse rate is neutral or unstable. In this situation the TIBL would grow out of the mixed layer over water and begin with some initial height at the shoreline. A method of determining this initial height needs to be incorporated.

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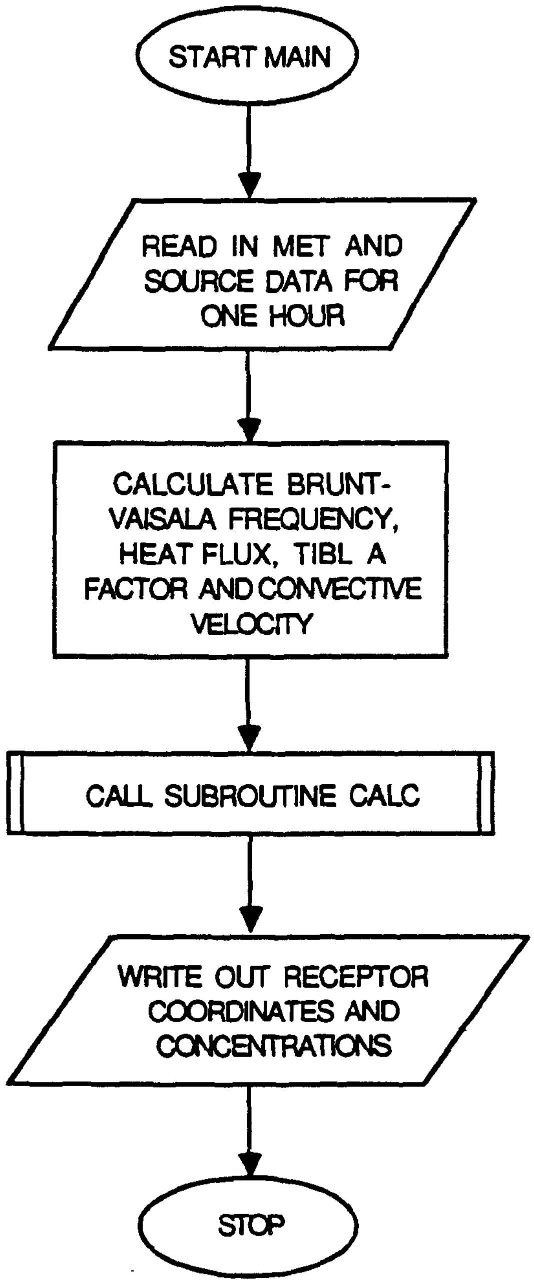
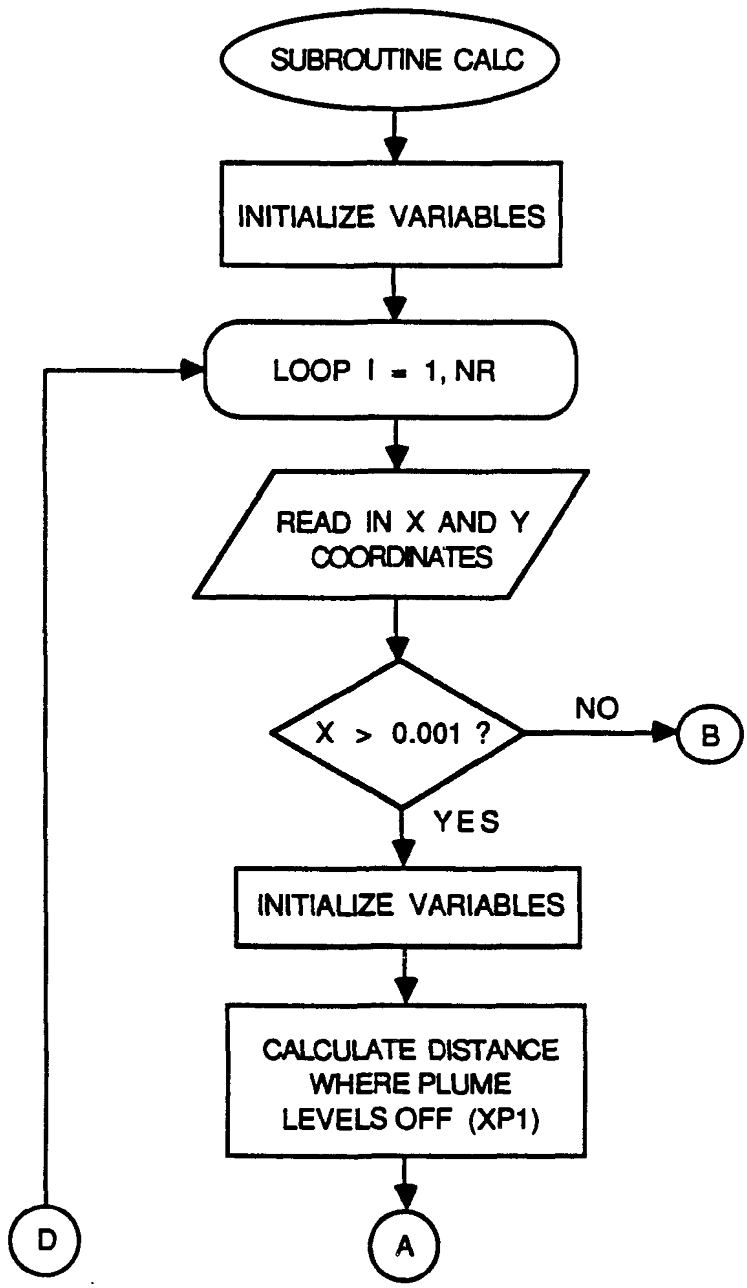
Appendix

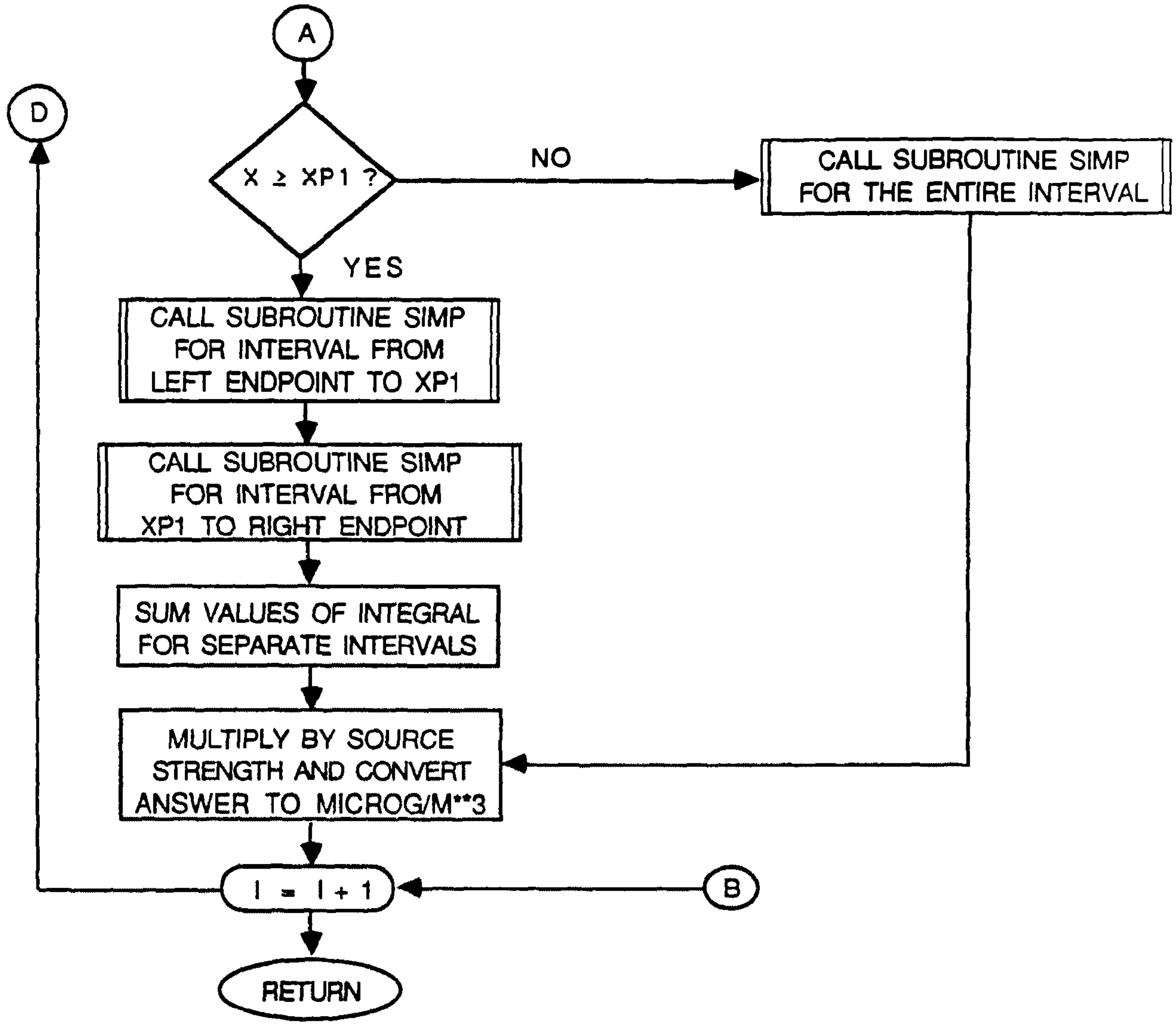
Program Flowchart
and Source Code



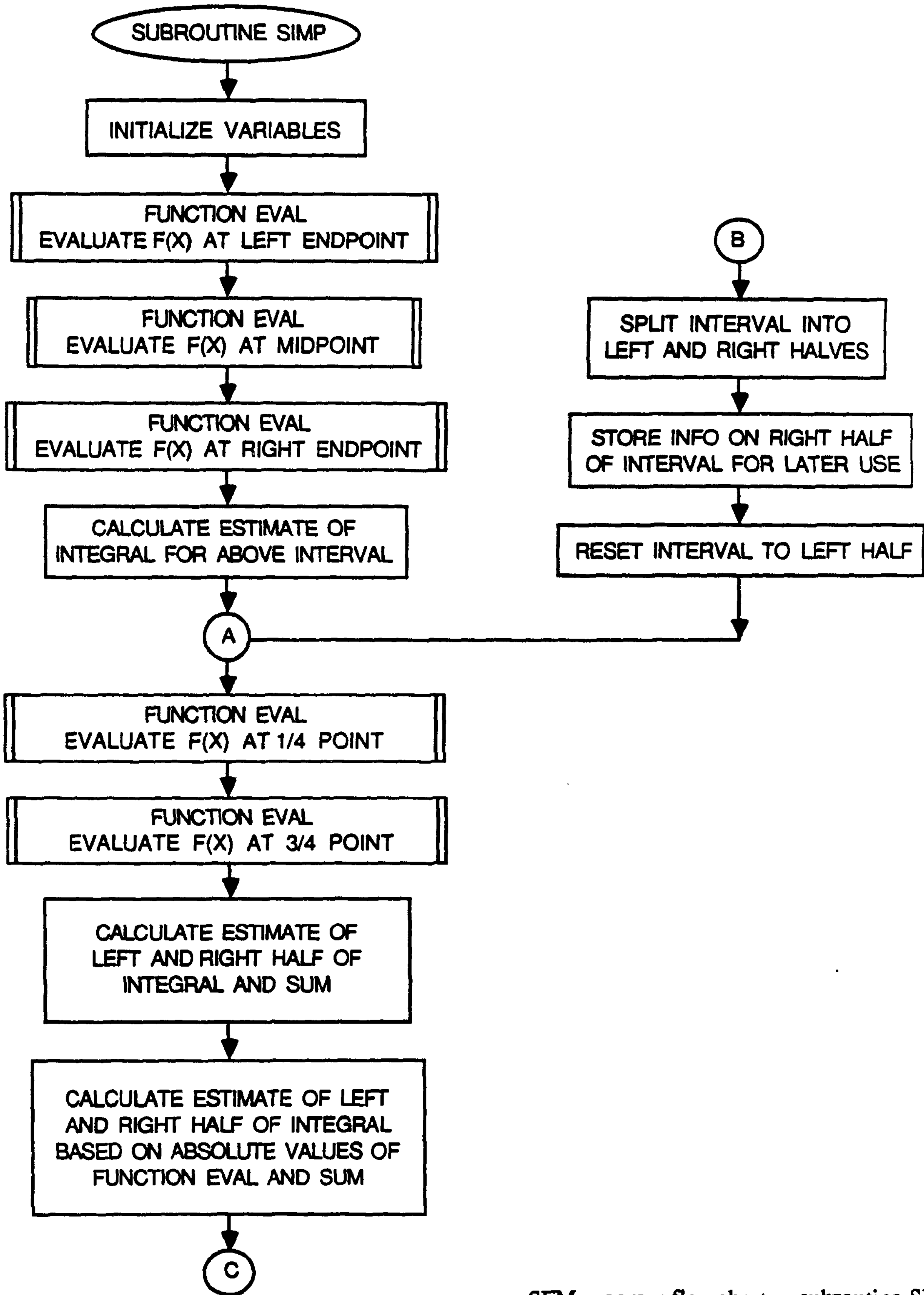
SFM program flowchart - main routine.



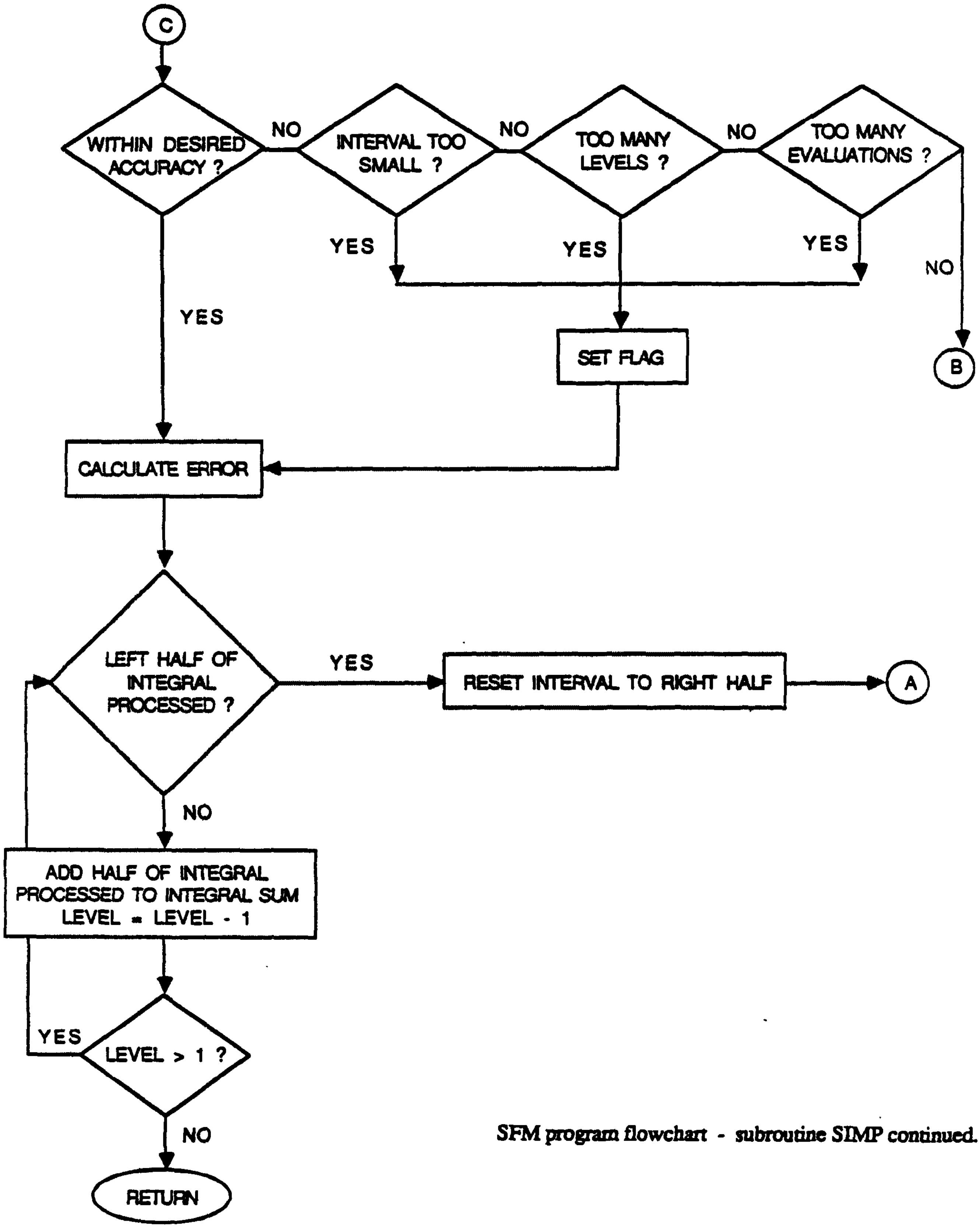
SFM program flowchart - subroutine CALC.



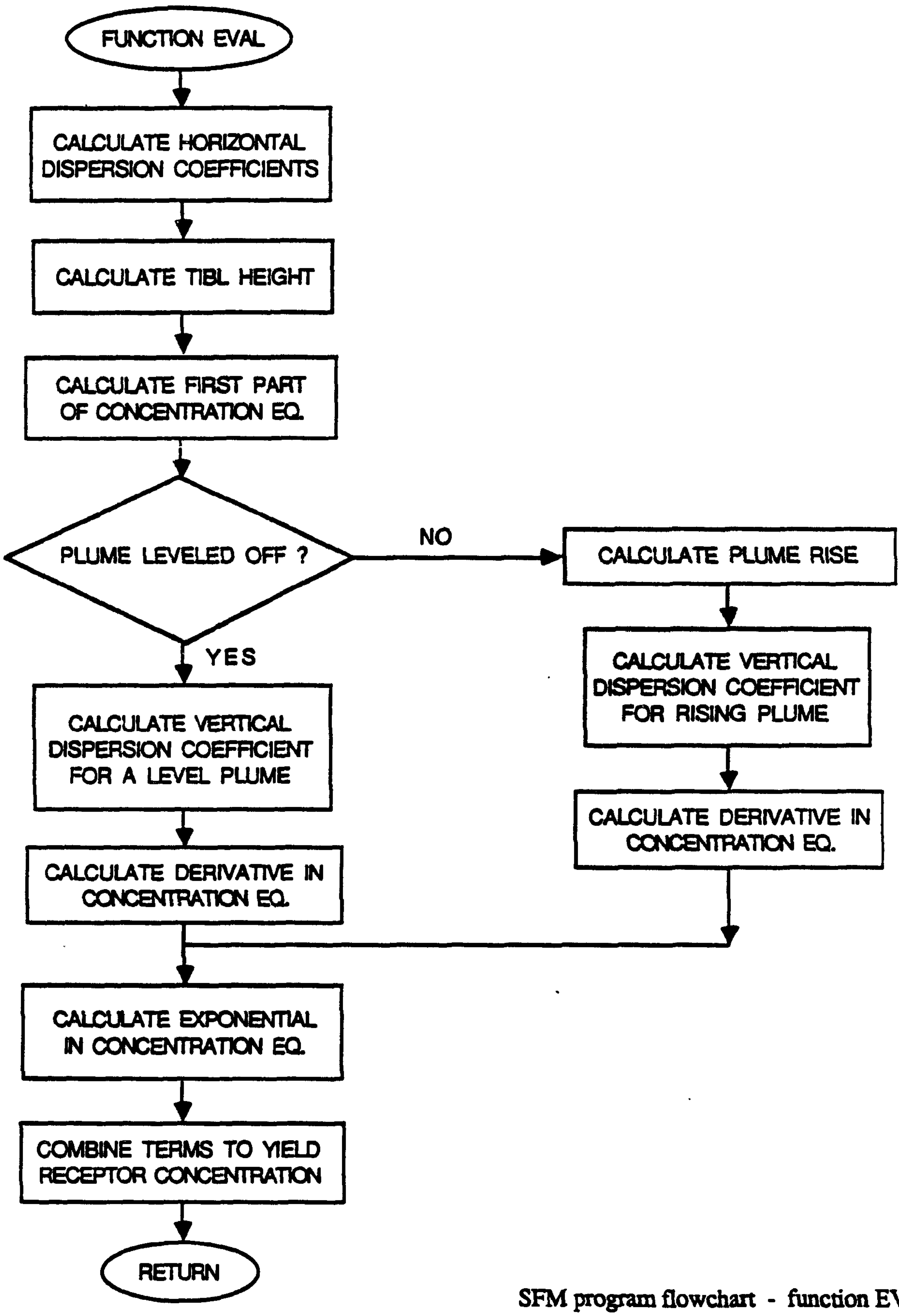
SFM program flowchart - subroutine CALC continued.



SFM program flowchart - subroutine SIMP.



SFM program flowchart - subroutine SIMP continued.



SFM program flowchart - function EVAL.

```
C*****************************************************************
C
C                           SFM
C                SHORELINE FUMIGATION MODEL
C
C   ORIGINAL AUTHOR:  DR. P.K. MISRA
C                     AIR RESOURCES BRANCH
C                     ONTARIO MINISTRY OF ENVIRONMENT
C                     CANADA
C
C   MODIFIED BY:
C            SUZANNE TEMPLEMAN
C            MARINE, EARTH AND ATMOSPHERIC SCIENCES DEPT.
C            NORTH CAROLINA STATE UNIVERSITY
C            RALEIGH, NC  27695-8208
C
C            JUNE 1988
C
C   SFM PROGRAM ABSTRACT:
C
C       SFM IS AN ALGORITHM CODE WHICH PRODUCES ESTIMATES
C   OF GROUND LEVEL POLLUTANT CONCENTRATION FOR USER-DEFINED
C   RECEPTORS LOCATED DOWNWIND OF AN ELEVATED, SINGLE POINT
C   SOURCE SITUATED AT THE SHORELINE.
C
C   HOURLY SOURCE AND METEOROLOGICAL DATA AND RECEPTOR
C   COORDINATES ARE REQUIRED AS INPUT.
C
C   EXECUTION OF THE CODE IS APPROPRIATE PROVIDED THE
C   FOLLOWING CONDITIONS ARE SATISFIED:
C
C   1) WIND DIRECTION AT THE SHORELINE SOURCE IS ONSHORE
C   2) WIND SPEED IS GREATER THAN 2 M/S
C   3) IT IS DAYTIME AND THE SURFACE, SENSIBLE HEAT
C      FLUX OVER LAND IS AT LEAST +5 W/M**2
C   4) LAPSE RATE OVER WATER IS STABLE
C
C   IT IS ALSO UNDERSTOOD THAT THE PLUME IS INITIALLY
C   EMITTED INTO THE STABLE AIR.
C
C   THE USER IS REFERRED TO THE USER'S GUIDE FOR A MORE
C   DETAILED EXPLANATION OF MODEL OPERATING ASSUMPTIONS.
C
C          THE PROGRAM CONSISTS OF FOUR MODULES:
C                1. MAIN MODULE
C                2. SUBROUTINE CALC
C                3. SUBROUTINE SIMP
C                4. FUNCTION EVAL
C
C*****************************************************************
C
C*********************** MAIN MODULE *************************
C  THE MAIN MODULE CONTROLS METEOROLOGICAL AND SOURCE INPUT
C  AND OUTPUT OF THE POLLUTANT CONCENTRATIONS FOR THE
C  DESIGNATED RECEPTORS.  VARIABLES WHICH REMAIN CONSTANT
C  FOR ANY GIVEN HOUR OF INPUT ARE COMPUTED WITHIN THIS MODULE.
C*****************************************************************
C
C  DEFINE VARIABLES:
C
```

```
C    A       =  TIBL A factor, given by:
C               ((2*HO)/(RHO*CSUBP*DTHDZ*UL))**0.5  (M**1/2)
C    B       =  W*/UL
C    RHO     =  atmospheric density  (KG/M**3)
C    CSUBP   =  specific heat at constant pressure (J/K KG)
C    CK      =  von Karman's constant  (0.4)
C    CN      =  Brunt-Vaisala frequency (1/S)
C    DTHDZ   =  potential temperature gradient overwater (K/M)
C    F       =  plume buoyancy (M**4/S**3)
C    G       =  acceleration due to gravity at the surface (M/S**2)
C    HO      =  surface sensible heat flux over land (W/M**2)
C    HSTK    =  stack height (M)
C    NR      =  number of receptors
C    OWZ2,1  =  height over water at levels 2, 1 (M)
C    PTOW2,1 =  potential temperature over water at
C                levels 2, 1 (K)
C    PTMOL   =  mean potential temperature over land
C               between levels 2, 1 (K)
C    PTMOW   =  mean potential temperature over water
C               between levels 2, 1 (K)
C    Q       =  source strength (G/S)
C    UL      =  mean wind speed in the TIBL (M/S)
C    US      =  mean wind speed in the stable layer (M/S)
C    W*      =  convective velocity (M/S)
C    X       =  downwind distance (M)
C*************************************************************
      REAL XP(200),YP(200),MGCM(200)
      REAL A,B,CK,CN,DTHDZ,F,H,HO,HSTK,Q,PTMOL,PTMOW,UL,US
      INTEGER NR
      COMMON /ONE/XP,YP,A,B,UL,US,H,HSTK,CN,F,I,Q,MGCM
C
C->->  OPEN FILES FOR INPUT AND OUTPUT
C
      OPEN(11,FILE='MET.DAT',STATUS='OLD',FORM='FORMATTED')
      OPEN(12,FILE='XY.DAT',STATUS='OLD',FORM='FORMATTED')
      OPEN(15,FILE='SFM.OUT',STATUS='NEW')
C
C     DEFINE CONSTANTS
C
      CK = 0.4
      CSUBP = 1020.
      G = 9.8
      PI = 3.1415927
      RHO = 1.188
C
C->->  READ IN METEOROLOGICAL AND STACK VARIABLES
C
20     READ(11,22) UL,US,PTMOL,PTMOW,DTHDZ,HO,F,Q,HSTK,NR
22     FORMAT(F5.2,1X,F5.2,1X,F6.2,1X,F6.2,1X,F7.4,1X,
     #        F6.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,I3)
C
C->->  CALCULATE BRUNT-VAISALA FREQUENCY
C
C      DTHDZ = (PTOW2 - PTOW1)/(OWZ2 - OWZ1)
C      PTMOW = (PTOW2 - PTOW1)/2.
       CN = ((G/PTMOW)*DTHDZ)**0.5
C
C-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*
C
C    IF THE SURFACE, SENSIBLE HEAT FLUX IS NOT
```

```
C     A KNOWN INPUT, USE THE FOLLOWING STATEMENTS
C     TO GENERATE AN ESTIMATE.  MODIFY THE READ
C     STATEMENT ACCORDINGLY.
C
C*>*>  DETERMINE SURFACE, SENSIBLE HEAT FLUX USING
C      THE PROFILE METHOD
C
C      DEFINE VARIABLES:
C
C      BETA0,1,2 =  function of stability parameter z/L
C                   for an unstable atmosphere
C                   at z levels 0,1,2
C      CL        =  Monin-Obukhov length (M)
C      PTMOL     =  mean potential temperature over land
C                   between levels 2,1 (K)
C      PTOL2,1   =  potential temperature over land at
C                   levels 2, 1 (K)
C      PTOW2,1   =  potential temperature over water at
C                   levels 2, 1 (K)
C      OLU2,1    =  wind speed over land at level 2, 1 (M/S)
C      OLZ2,1    =  height over land at level 2, 1  (M)
C      OWZ2,1    =  height over water at level 2,1  (M)
C      PSIH1,2   =  universal function in the diabatic surface
C                   layer temperature profile
C      PSIM0,1   =  universal function in the diabatic surface
C                   layer wind profile
C      RI        =  Richardson number
C      USTAR     =  friction velocity (M/S)
C      TSTAR     =  temperature scale (K)
C      ZO        =  surface roughness length (M)
C      ZR        =  height associated with RI (M)
C
C*>*>  FIRST CALCULATE THE RICHARDSON NUMBER
C
C      PTMOL = (PTOL2 - PTOL1)/2.
C
C      RI = (G/PTMOL)*
C     # ((PTOL2 - PTOL1)/(OLZ2 - OLZ1))
C     # /((OLU2 - OLU1)/(OLZ2 - OLZ1))**2.
C
C     ZR = (OLZ1*OLZ2)**0.5
C     CL = ZR/RI
C
C     BETA0 = (1 - 16*ZO/CL)**0.25
C     BETA1 = (1 - 16*OLZ1/CL)**0.25
C     BETA2 = (1 - 16*OLZ2/CL)**0.25
C
C     PSIM0 = 2*ALOG((1 + BETA0)/2.) +
C    # ALOG((1 + BETA0*BETA0)/2.) -
C    # 2*ATAN(BETA0) + PI/2.
C
C     PSIM1 = 2*ALOG((1 + BETA1)/2.) +
C    # ALOG((1 + BETA1*BETA1)/2.) -
C    # 2*ATAN(BETA1) + PI/2.
C
C     PSIH1 = 2*ALOG((1 + BETA1*BETA1)/2.)
C     PSIH2 = 2*ALOG((1 + BETA2*BETA2)/2.)
C
C->->  CALCULATE FRICTION VELOCITY
C
```

```
C     USTAR = (CK*U1)/(ALOG(OLZ1/ZO) - PSIM1 + PSIMO)
C
C->->  CALCULATE FRICTION TEMPERATURE SCALE
C
C     TSTAR = (CK*(PTOL2 - PTOL1))/
C    # (ALOG(OLZ2/OLZ1) - PSIH2 + PSIH1)
C
C     HO = -RHO*CSUBP*USTAR*TSTAR
C
C-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*
C
C->->  DETERMINE THE TIBL A FACTOR
C
      A = ((2.*HO)/(CSUBP*RHO*DTHDZ*UL))**0.5
C
C->->  DETERMINE THE TIBL HEIGHT FOR USE IN CALCULATING
C      CONVECTIVE VELOCITY (W*)
C
      HT = A*(5000.**0.5)
C
C->->  DETERMINE PART OF SIGMA Y EQUATION
C      FOR THE CONVECTIVE LAYER (B = W*/UL)
C
      B = (((G*HC*HT)/(RHO*CSUBP*PTMOL))**.333)/UL
C
C->->  WRITE HEADER AND VALUES OF INPUT VARIABLES USED
C
      WRITE(*,25)
      WRITE(15,25)
25    FORMAT(8X,'**  SHORELINE FUMIGATION MODEL  **')
      WRITE(*,35)
35    FORMAT(1X)
      WRITE(*,45)
      WRITE(15,45)
45    FORMAT(/'  ORIGINALLY DEVELOPED BY')
      WRITE(*,55)
      WRITE(15,55)
55    FORMAT(1X,'   P.K. MISRA')
      WRITE(*,65)
      WRITE(15,65)
65    FORMAT(1X,'   ONTARIO MINISTRY OF ENVIRONMENT')
      WRITE(*,75)
      WRITE(15,75)
75    FORMAT(/'  MODIFIED BY')
      WRITE(*,85)
      WRITE(15,85)
85    FORMAT(1X,'   S. TEMPLEMAN')
      WRITE(*,95)
      WRITE(15,95)
95    FORMAT(1X,'   NORTH CAROLINA STATE UNIVERSITY - JUNE 1988')
      WRITE(*,105)
105   FORMAT(1X)
      WRITE(*,115)
      WRITE(15,115)
115    FORMAT(/'  INPUT VARIABLES:')
      WRITE (*,125) A
      WRITE(15,125) A
125   FORMAT(/'  THE TIBL A FACTOR IS:',F5.2,1X,'M**1/2')
      WRITE (*,135) B
      WRITE(15,135) B
```

```
135   FORMAT(1X' THE VARIABLE B = W*/UL IS: ',F4.2)
      WRITE (*,145)  UL
      WRITE (15,145) UL
145   FORMAT (1X' THE MEAN WIND SPEED IN THE TIBL IS:',F5.2,
     #1X,'M/S')
      WRITE (*,155)  US
      WRITE (15,155) US
155   FORMAT (1X' THE MEAN WIND SPEED AT STACK HEIGHT IS:',F5.2,
     #1X,'M/S')
      WRITE (*,165)  PTMOL
      WRITE (15,165) PTMOL
165   FORMAT(1X' THE POTENTIAL TEMPERATURE OVER LAND IS:',
     #1X,F5.1,1X,'K')
      WRITE (*,175)  DTHDZ
      WRITE (15,175) DTHDZ
175   FORMAT(1X' THE OVERWATER LAPSE RATE IS: ',F5.3,1X,'K/M')
      WRITE (*,185)  HO
      WRITE (15,185) HO
185   FORMAT(1X' THE SURFACE, SENSIBLE HEAT FLUX IS:', 1X,
     #F4.0,1X,'W/M**2 ')
      WRITE (*,195) F
      WRITE(15,195)  F
195   FORMAT(1X' THE BUOYANCY PARAMETER IS:',F5.0,1X,'M**4/S**3')
      WRITE (*,205) Q
      WRITE(15,205) Q
205   FORMAT(1X' THE EMISSION RATE IS:',F6.0,1X,'G/S')
      WRITE (*,215)  HSTK
      WRITE (15,215) HSTK
215   FORMAT(1X,' THE STACK HEIGHT IS:',F5.0,1X,'M')
C
C->->  CALL TO CALC SUBROUTINE TO BEGIN CALCULATION
C      OF GROUND LEVEL CONCENTRATIONS
C
      CALL CALC(NR)
C
C->->  WRITE CONCENTRATIONS FOR RECEPTOR LOCATIONS
C
30    WRITE(*,225)
225   FORMAT (1X)
      WRITE(*,235)
      WRITE(15,235)
235   FORMAT(//'  RECEPTOR LOCATIONS AND CONCENTRATIONS',
     #' IN MICROGRAMS/M**3')
      WRITE(*,245)
      WRITE(15,245)
245   FORMAT(/'  X LOCATION',10X,' Y LOCATION',11X,
     #'MICROG/M**3'/)
      WRITE(*,255)
255   FORMAT(1X)
C
      DO 200 I=1,NR
        WRITE(*,265) XP(I),YP(I),MGCM(I)
        WRITE(15,265) XP(I),YP(I),MGCM(I)
265     FORMAT(3X,F6.0,15X,F6.0,13X,F9.3)
200   CONTINUE
40    WRITE (*,275)
      WRITE (15,275)
275   FORMAT (/' END OF MODEL RUN')
      STOP
      END
```

```
ccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
      SUBROUTINE CALC(NR)
C
C   THIS SUBROUTINE ACTS AS AN INTERMEDIARY BETWEEN THE
C   MAIN MODULE AND SUBROUTINE SIMP.  IN THIS ROUTINE
C   RECEPTOR COORDINATES ARE READ IN AND GROUND LEVEL
C   CONCENTRATIONS EVALUATED BY SUBROUTINE SIMP ARE
C   MULTIPLIED BY THE SOURCE STRENGTH AND CONVERTED TO
C   MICROG/M**3.  CONCENTRATIONS ARE STORED IN THE COMMON
C   BLOCK FOR OUTPUT IN MAIN.
C
C   DEFINE VARIABLES:
C
C      ACC    = desired accuracy of answer
C      ANS    = approximate value of the integral of F(X)
C               for interval from left endpoint to XP1
C      ANS1   = approximate value of the integral of F(X)
C               for the interval from XP1 to right endpoint
C      AREA   = approximate, absolute value of the integral of
C               F(X) for the entire interval
C      F(X)   = function whose integral is desired
C      IFLAG  = 1 for normal return
C               2 If it is necessary to go to 30 levels.
C                 Error may be unreliable in this case.
C               3 If more than 2000 function evaluations.
C                 Complete the computations and note that
C                 error is usually unreliable.
C               IFLAG may be used for diagnostics.
C      LB     = left endpoint  (Initial X value near stack)
C      UL     = mean wind speed in the TIBL
C      US     = mean wind speed at stack height in stable air
C      XP     = right endpoint  (Downwind distance of receptor)
C      XP1    = downwind distance at which plume levels off
C      YP     = horizontal distance of receptor
C
ccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
      EXTERNAL EVAL
      REAL XP(200),YP(200),MGCM(200),LB
      INTEGER NR
      COMMON/ONE/XP,YP,A,B,UL,US,H,HSTK,CN,F,I,Q,MGCM
C
C->->  INITIALIZE VARIABLES
C
      ACC = 10.0E-6
      LB = 10.00
      IFLAG = 0.0
C
C->->  LOOP THROUGH RECEPTOR POINTS
C
      DO 100 I=1,NR
C
C->->  READ IN RECEPTOR COORDINATES
C
        READ(12,15) XP(I),YP(I)
15      FORMAT(F9.1,2X,F9.1)
C
C->->  IF X COORDINATE IS TOO SMALL, GO TO
C      NEXT RECEPTOR
C
        IF(XP(I).GT.0.001) GOTO 10
```

```
        GOTO 100
C
C->>->  INITIALIZE VALUES OF THE INTEGRAL FOR LEFT
C       AND RIGHT HALVES OF THE INTERVAL
C
10       ANS = 0.0
         ANS1 = 0.0
C
C->>->  DETERMINE TRAVEL DISTANCE UNTIL PLUME LEVELS OFF
C
          XP1 = (4.50/CN)*US
C
C->>->  DETERMINE WHETHER DISTANCE OF RECEPTOR DOWNWIND OF
C       SOURCE EXCEEDS TRAVEL DISTANCE UNTIL PLUME LEVELS OFF
C
          IF(XP(I).GE.XP1) GOTO 20
C
C->>->  APPLY SIMPSON'S RULE OVER THE INTERVAL FROM LEFT
C       ENDPOINT (LB) TO RIGHT ENDPOINT (XP)
C
          CALL SIMP(EVAL,LB,XP(I),ACC,ANS,ERROR,AREA,IFLAG)
C
          GOTO 30
C
C->>->  RECEPTOR POINT IS IN REGION WHERE PLUME HAS LEVELED
C       OFF.  APPLY SIMPSON'S RULE IN TWO STEPS.  FIRST APPLY
C       OVER THE INTERVAL FROM LEFT ENDPOINT TO XP1.  SECOND
C       APPLY OVER THE INTERVAL FROM XP1 TO RIGHT ENDPOINT.
C       USING TWO CALLS TO SIMP HERE SAVES ON COMPUTATION TIME.
C
20      CALL SIMP(EVAL,LB,XP1,ACC,ANS,ERROR,AREA,IFLAG)
        CALL SIMP(EVAL,XP1,XP(I),ACC,ANS1,ERROR,AREA,IFLAG)
C
C->>->  SUM VALUES OF THE INTEGRAL FOR THE LEFT AND
C       RIGHT HALVES OF THE INTERVAL
C
30        ANS = ANS+ANS1
C
C->>->  MULTIPLY BY SOURCE STRENGTH AND CONVERT ANSWER
C       TO MICROGRAMS PER M**3
C
          MGCM(I) = ANS*Q/1.E-06
C
100   CONTINUE
200   RETURN
      END
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
      SUBROUTINE SIMP(EVAL,EA,EB,ACC,ANS,ERROR,AREA,IFLAG)
C
C   SIMP IS AN ITERATIVE CODE BASED ON SIMPSON'S RULE,
C   A NUMERICAL TECHNIQUE DESIGNED TO EVALUATE THE
C   DEFINITE INTEGRAL OF A CONTINUOUS FUNCTION WITH
C   FINITE LIMITS OF INTEGRATION.
C
C   DEFINE VARIABLES:
C
C     ACC      = desired accuracy of answer
C     ANS      = approximate value of the integral of F(X)
C                from EA to EB
C     AREA     = approximate, absolute value of the integral
```

```
C              F(X) from EA to EB
C       EA,EB   = lower and upper limits of integration
C       ERROR   = estimated error of answer
C       EVAL(X) = value of the integral evaluated at X
C       IFLAG   = 1 for normal return
C                 2 If it is necessary to go to 30 levels or
C                   use length.  Error may be unreliable
C                   in this case.
C                 3 If more than 2000 function evaluations
C                   then complete the computations.  Error
C                   is usually unreliable.
C                 IFLAG may be used for diagnostics.
C       U       = unit round-off
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DIMENSION FV(5),LORR(30),FIT(30),F2T(30),F3T(30),
     #DAT(30),ARESTT(30),ESTT(30),EPST(30),PSUM(30)
      REAL EVAL
C
C->->  SET U TO APPROXIMATELY THE UNIT ROUND-OFF
C
      U = 9.0E-7
C
C->->  INITIALIZE VARIABLES
C
      FOURU = 4.0*U
      IFLAG = 1
      EPS = ACC
      ERROR = 0.0
      AREA = 0.0
      AREST = 0.0
      LVL = 1
      LORR(LVL) = 1
      PSUM(LVL) = 0.0
      ALPHA = EA
      DA = EB-EA
C
C->->   DETERMINE VALUES OF THE FUNCTION AT THE ENDS
C       AND MID-POINT OF THE INTERVAL
C
      FV(1) = EVAL(ALPHA)
      FV(3) = EVAL(ALPHA+0.5*DA)
      FV(5) = EVAL(ALPHA+DA)
C
C->->   START SUMMATION OF NUMBER OF FUNCTION EVALUATIONS
C
      KOUNT = 3
      WT = DA/6.0
C
C->->   DETERMINE ESTIMATE OF THE INTEGRAL FOR THE INTERVAL
C       BETWEEN THE DESIGNATED ENDPOINTS
C
      EST = WT*(FV(1)+4.0*FV(3)+FV(5))
10    DX = 0.5*DA
C
C->->   DETERMINE VALUES OF THE FUNCTION AT THE ONE QUARTER
C       AND THREE QUARTER POINTS OF THE INTERVAL
C
      FV(2) = EVAL(ALPHA+0.5*DX)
      FV(4) = EVAL(ALPHA+1.5*DX)
```

```
      KOUNT = KOUNT+2
      WT = DX/6.0
C
C->->   DETERMINE ESTIMATES OF THE AREA UNDER THE LEFT HALF
C       AND RIGHT HALF OF THE CURVE THEN SUM
C
      ESTL = WT*(FV(1)+4.0*FV(2)+FV(3))
      ESTR = WT*(FV(3)+4.0*FV(4)+FV(5))
      SUM = ESTL+ESTR
      DIFF = EST-SUM
C
C->->   DETERMINE ESTIMATES OF THE AREA UNDER THE CURVE
C       BETWEEN THE DESIGNATED ENDPOINTS BASED ON THE
C       ABSOLUTE VALUES OF THE FUNCTION EVALUATIONS
C
      ARESTL = WT*(ABS(FV(1))+ABS(4.0*FV(2))+ABS(FV(3)))
      ARESTR = WT*(ABS(FV(3))+ABS(4.0*FV(4))+ABS(FV(5)))
      AREA = AREA+((ARESTL+ARESTR)-AREST)
C
C->->  IF WITHIN DESIRED ACCURACY GO TO 20.  IF INTERVAL IS TOO
C      SMALL OR TOO MANY LEVELS OR TOO MANY FUNCTION
C      EVALUATIONS, SET A FLAG AND GO TO 20 ANYWAY.
C
      IF(ABS(DIFF).LE.EPS*ABS(AREA)) GOTO 20
      IF(ABS(DX).LE.FOURU*ABS(ALPHA)) GOTO 50
      IF(LVL.GE.30) GOTO 50
      IF(KOUNT.GE.2000) GOTO 60
C
C->->  STORE INFORMATION TO PROCESS RIGHT HALF OF THE
C      CURVE.  NOW, USING A GREATER NUMBER OF SUB-INTERVALS,
C      RECALCULATE AREA UNDER THE LEFT HALF OF THE CURVE.
C
      LVL = LVL+1
      LORR(LVL) = 0
      F1T(LVL) = FV(3)
      F2T(LVL) = FV(4)
      F3T(LVL) = FV(5)
      DA = DX
      DAT(LVL) = DX
      AREST = ARESTL
      ARESTT(LVL) = ARESTR
      EST = ESTL
      ESTT(LVL) = ESTR
      EPS = EPS/1.4
      EPST(LVL) = EPS
      FV(5) = FV(3)
      FV(3) = FV(2)
      GOTO 10
C
C->->  ACCEPT APPROXIMATE INTEGRAL SUM.  IF LEFT HALF
C      OF CURVE WAS PROCESSED, MOVE TO RIGHT HALF.
C      IF RIGHT HALF OF CURVE WAS PROCESSED, ADD RESULTS
C      TO FINISH.  LORR (A MNEMONIC FOR LEFT OR RIGHT)
C      TELLS WHETHER INTERVAL IS RIGHT OR LEFT AT EACH
C      LEVEL.
C
20    ERROR = ERROR+DIFF/15.0
30    IF(LORR(LVL).EQ. 0) GOTO 40
      SUM = PSUM(LVL)+SUM
      LVL = LVL-1
```

```
      IF(LVL.GT.1) GOTO 30
      ANS = SUM
      RETURN
C
C->>-> MOVE RIGHT.  RESTORE SAVED INFORMATION TO PROCESS
C       RIGHT HALF OF INTERVAL.
C
40    PSUM(LVL) = SUM
      LORR(LVL) = 1
      ALPHA = ALPHA+DA
      DA = DAT(LVL)
      FV(1) = F1T(LVL)
      FV(3) = F2T(LVL)
      FV(5) = F3T(LVL)
      AREST = ARESTT(LVL)
      EST = ESTT(LVL)
      EPS = EPST(LVL)
      GOTO 10
C
C->>-> ACCEPT 'POOR' VALUE.  SET APPROPRIATE FLAGS.
C
50    IFLAG = 2
      GOTO 20
60    IFLAG = 3
      GOTO 20
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      FUNCTION EVAL(X)
C
C   FUNCTION EVAL RETURNS A VALUE OF THE INTEGRAL FOR (X),
C   THE DESIGNATED POINT ON THE INTERVAL OF INTEGRATION.
C   THE FUNCTION RETURNS THE VALUE TO SUBROUTINE SIMP
C   THROUGH THE FUNCTION NAME.
C
C      DEFINE VARIABLES:
C
C      CA    = coefficient in plume rise equation
C      CYS   = constant for SIGMA Y in stable air
C      CZS   = constant for SIGMA Z in stable air
C      FN    = time after which plume has leveled off (4.5/N)
C      D     = travel time = X/US
C      H     = plume height
C      HT    = TIBL height at designated point on
C              interval of integration
C      HT1   = TIBL height at receptor point
C      VARYL = SIGMA Y in convective layer
C      VARYS = SIGMA Y in stable layer
C      VARZ  = SIGMA Z in stable layer
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      REAL XP(200),YP(200),MGCM(200),EVAL,MF
      COMMON/ONE/XP,YP,A,B,UL,US,H,HSTK,CN,F,I,Q,MGCM
C
C->>-> DEFINE CONSTANTS
C
      CA  = 1.6
      CYS = 0.67
      CZS = 0.40
C
C->>-> REEXPRESS FREQUENTLY USED CALCULATIONS
C
```

```
      FU = F/US
      FN = 4.50/CN
      IF(X.LE.0.001) GOTO 100
      D = X/US
C
C->>->  DETERMINE SIGMA Y IN THE STABLE AIR
C
      VARYS = CYS*(D**(2./3.))*(FU**(1./3.))
C
C->>->  DETERMINE SIGMA Y IN THE UNSTABLE AIR
C
      VARYL = B*(XP(I)-X)/3.0
C
C->>->  DETERMINE TIBL HEIGHT AT EVALUATION POINT (X)
C       AND AT RECEPTOR POINT (XP)
C
      HT = A*SQRT(X)
      HT1 = A*SQRT(XP(I))
C
C->>->  DETERMINE FIRST PART OF CONCENTRATION EQUATION
C
      MF = 1./(2.*3.14159*HT1*UL)
C
C->>->  DETERMINE IF TRAVEL TIME IN STABLE AIR EXCEEDS
C       TIME AFTER WHICH PLUME HAS LEVELED OFF.  IF YES,
C       FINAL PLUME RISE CALCULATIONS APPLY.
C
      IF(D.GT.FN) GOTO 10
C
C->>->  DETERMINE PLUME HEIGHT USING GRADUAL PLUME
C       RISE EQUATION
C
       H = (CA*(FU**(1./3.))*(D**(2./3.))) + HSTK
C
C->>->  INSURE THAT FINAL PLUME HEIGHT IS NOT OVERESTIMATED
C       BY TAKING THE LOWEST VALUE OF H.  FINAL, STABLE PLUME
C       RISE, ACCORDING TO BRIGGS, IS:
C       2.6*(FU/(CN*CN))**(1./3.) + HSTK
C
       H = AMIN1(H,2.6*(FU/(CN*CN))**(1./3.) + HSTK)
C
C->>->  DETERMINE SIGMA Z IN STABLE AIR FOR GRADUALLY
C       RISING PLUME
C
      VARZ = CZS*(D**(2./3.))*(FU**(1./3.))
C
C->>->  DETERMINE VALUE OF DERIVATIVE IN
C       CONCENTRATION EQUATION FOR RISING PLUME
C
      DERIV = (-1./6.)*(A*UL)/(CZS*(F**(1./3.)))
     #*(X**(-7./6.)) +
     #(HSTK * UL)/(CZS*(F**(1./3.)))*(2./3.)*(X**(-5./3.))
C
      GO TO 20
C
C->>->  PLUME HAS LEVELED OFF IN STABLE AIR
C
C->>->  DETERMINE SIGMA Z IN STABLE AIR FOR A LEVEL
C       PLUME
C
```

```
10     VARZ = 1.1*(FU/(CN*CN))**(1./3.)
C
C->->   DETERMINE VALUE OF DERIVATIVE IN
C       CONCENTRATION EQUATION FOR LEVEL PLUME
C
       DERIV = A/(2.*SQRT(X)*VARZ)
C
20     VARZS = VARZ*VARZ
       SIGS = (VARYS*VARYS+VARYL*VARYL)
       BLDIFS = (HT-H)*(HT-H)
C
C->->   DETERMINE VALUE OF EXPONENTIAL
C       IN CONCENTRATION EQUATION
C
       C1 = -.5*(BLDIFS/VARZS+YP(I)*YP(I)/SIGS)
C
C->->   TAKE ALOG OF EXPRESSION INSIDE
C       INTEGRAL OF CONCENTRATION EQUATION
C
       C = ALOG(DERIV)+C1-(ALOG(SIGS))/2.0
C
       IF(ABS(C).GT.70.0) GOTO 100
C
C->->   TAKE EXPONENTIAL OF EXPRESSION
C       INSIDE INTEGRAL OF CONCENTRATION EQUATION
C
        EVALL = EXP(C)
C
C->->   DETERMINE VALUE OF THE CONCENTRATION
C       EQUATION (MINUS MULTIPLICATION BY
C       THE SOURCE STRENGTH)
C
        EVAL = EVALL*MF
        GOTO 30
100     EVAL = 0.
30      CONTINUE
        END
```

Appendix

Sample Input and Output Files

A. Sample Input Files

The two input files shown here were used to create the model output which follows. The input in the first file relates to a buoyant plume emitted from a 198 m stack under meteorological conditions in which onshore flow, a stable overwater lapse rate and a moderate upward, surface, sensible heat flux overland exist. The second file contains the x and y coordinate data. The first fifteen points indicated denote centerline receptors while the remaining five points provide some off-centerline locations for comparison. The user is referred to Section 2.3.3 for further explanation of the input data format.

Values of Meteorological and Source Data Used in the Sample Input File:

Mean wind speed within the TIBL - U_L ($m\ s^{-1}$)	4.70
Mean wind speed at stack height - U_s ($m\ s^{-1}$)	4.70
Mean potential temperature over land - θ_L (K)	294.0
Mean potential temperature over water - θ_w (K)	292.0
Overwater lapse rate - $(d\theta/dz)_w$ ($K\ m^{-1}$)	0.008
Surface, sensible heat flux - H_o ($W\ m^{-2}$)	184.0
Plume buoyancy - F ($m^4\ s^{-3}$)	564.0
Source strength - Q ($g\ s^{-1}$)	6550.0
Stack height - H_{stk} (m)	198.0
Number of receptors - NR	20

Meteorological and source data as they appear in the program input file MET.DAT:

4.70 4.70 294.0 292.0 0.008 184.0 564.0 6550.0 198.0 20

X and Y Coordinate Data

Data as they appear in the program input file XY.DAT (the first column contains the X coordinates and the second contains the Y coordinates):

1000.0	0000.0
2000.0	0000.0
3000.0	0000.0
4000.0	0000.0
5000.0	0000.0
10000.0	0000.0
12000.0	0000.0
14000.0	0000.0
16000.0	0000.0
18000.0	0000.0
20000.0	0000.0
25000.0	0000.0
30000.0	0000.0
40000.0	0000.0
50000.0	0000.0
10000.0	500.0
15000.0	-200.0
15000.0	200.0
20000.0	-400.0
20000.0	400.0

B. Sample Output File

The sample output file illustrates the change in ground level concentration with downwind distance from the source.

** SHORELINE FUMIGATION MODEL **

ORIGINALLY DEVELOPED BY
P.K. MISRA
ONTARIO MINISTRY OF ENVIRONMENT

MODIFIED BY
S. TEMPLEMAN
NORTH CAROLINA STATE UNIVERSITY - JUNE 1988

INPUT VARIABLES:

THE TIBL A FACTOR IS: 2.84 M**1/2
THE VARIABLE B = W*/UL IS: .21
THE MEAN WIND SPEED IN THE TIBL IS: 4.70 M/S
THE MEAN WIND SPEED AT STACK HEIGHT IS: 4.70 M/S
THE POTENTIAL TEMPERATURE OVER LAND IS: 294.0 K
THE OVERWATER LAPSE RATE IS: .008 K/M
THE SURFACE, SENSIBLE HEAT FLUX IS: 184. W/M**2
THE BUOYANCY PARAMETER IS: 564. M**4/S**3
THE EMISSION RATE IS: 6550. G/S
THE STACK HEIGHT IS: 198. M

RECEPTOR LOCATIONS AND CONCENTRATIONS IN MICROGRAMS/M**3

X LOCATION	Y LOCATION	MICROG/M**3
1000.	0.	0.164
2000.	0.	14.410
3000.	0.	32.580
4000.	0.	56.945
5000.	0.	88.709
10000.	0.	349.763
12000.	0.	479.400
14000.	0.	604.000
16000.	0.	712.281
18000.	0.	796.722
20000.	0.	853.932
25000.	0.	885.255
30000.	0.	807.289
40000.	0.	568.004
50000.	0.	385.945
10000.	500.	213.982
15000.	-200.	632.572
15000.	200.	632.572
20000.	-400.	763.026
20000.	400.	763.026

END OF MODEL RUN

Appendix

Surface Roughness Lengths

Table 1. Surface roughness lengths categorized by terrain. Classification is from Davenport (1960) and Wieringa (1980).

Class	Terrain Description	z_0 (m)
1	Open sea, fetch at least 5 km	0.0002
2	Mud flats, snow; no vegetation, no obstacles	0.0050
3	Open flat terrain; grass, few isolated obstacles	0.030
4	Low crops; occasional large obstacles, $x/h > 20$	0.10
5	High crops; scattered obstacles, $15 < x/h < 20$	0.25
6	Parkland, bushes; numerous obstacles, $x/h \sim 10$	0.50
7	Regular large obstacles coverage (suburb, forest)	(1.0)
8	City center with high- and low-rise buildings	?

Notes: Here x is a typical upwind obstacle distance and h the height of the corresponding major obstacles. Class 8 is theoretically intractable within the framework of boundary layer meteorology and can better be modeled in a wind tunnel.

APPENDIX B

FLOW CHARTS FOR THE SDM MODEL

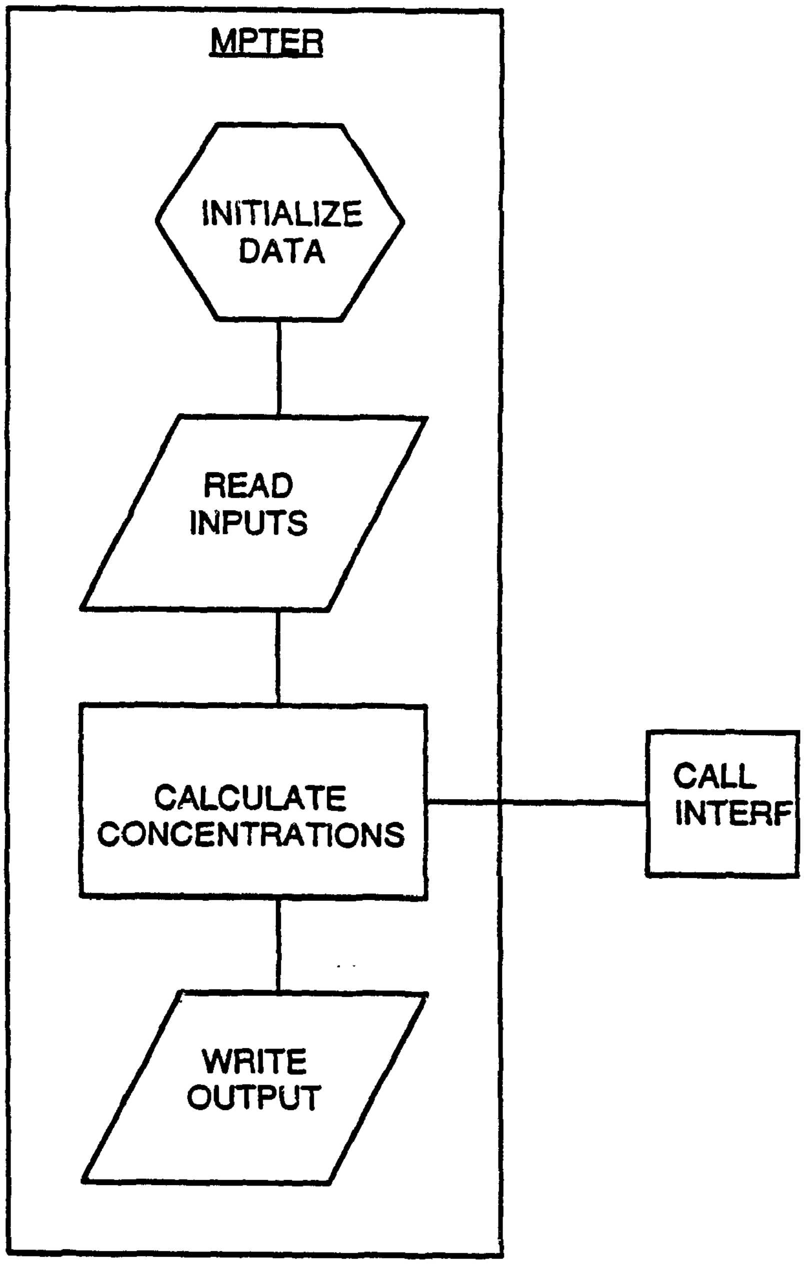
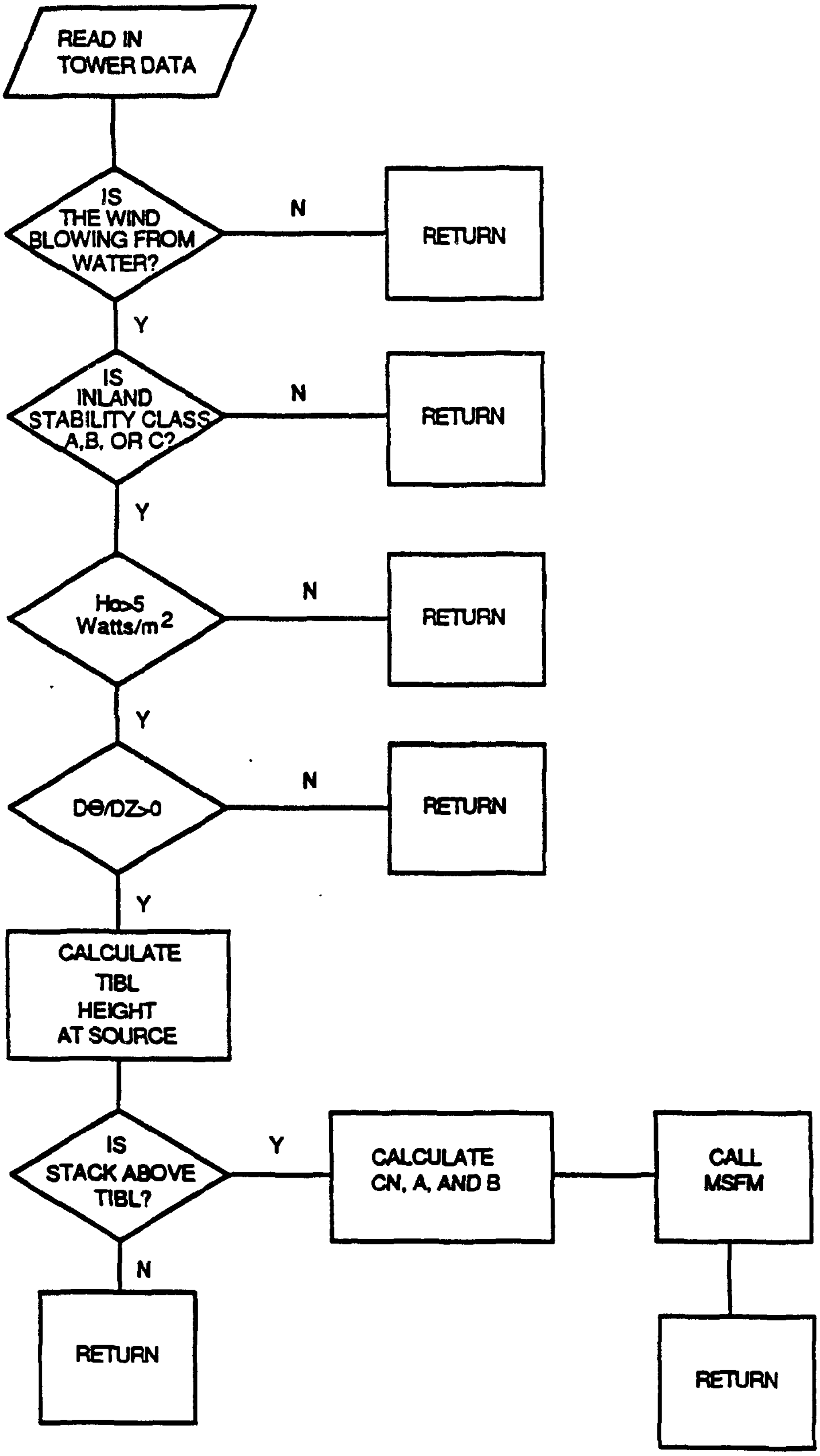


Figure B-1. Modified MPTER flow diagram.

SUBROUTINE INTERF



APPENDIX C

SOURCE CODE FOR SDM

```
IKJ52827I  Q.FORT(SDM)
C
C->>->>-> SECTION C -  COMMON, DIMENSION, AND DATA STATEMENTS.
C
C         /EXPOS/  BETWEEN MAIN PROGRAM AND BLOCK DATA
      COMMON /EXPOS/ PXUCOF(6,9),PXUEXP(6,9),HC1(10),BXUCOF(6,9),BXUEXP(
     *6,9)
C         /MPOR/ BETWEEN MAIN, PTR, OUTHR, AND RCP
      COMMON /MPOR/ IOPT(26)
C         /MPO/ BETWEEN MAIN, PTR, AND OUTHR
      COMMON /MPO/ NRECEP,NAVG,NB,LH,NPT,IDATE(2),RREC(180),SREC(180),ZR
     1(180),ELR(180),PHCHI(180),PHSIGS(180,26),HSAV(250),DSAV(250),PCHI(
     2180),PSIGS(180,26),IPOL
C         /MPR/  BETWEEN MAIN, PTR, AND RCP
      COMMON /MPR/ UPL,Z,H,HL,X,Y,KST,DELH,SY,SZ,RC,MUOR
C         /MP/  BETWEEN MAIN PROGRAM AND PTR
      COMMON /MP/ SOURCE(9,250),CONTWO,PSAV(250),IPSIGS(250),U,TEMP,SINT
     1,COST,PL(6),ELP(250),ELHN,HANE,TLOS,CELM,CTER
C         /MO/  BETWEEN MAIN PROGRAM AND OUTHR
      COMMON /MO/ QTHETA(24),QU(24),IKST(24),QHL(24),QTEMP(24),MPS(25),N
     1SIGP,IO,LINE1(20),LINE2(20),LINE3(20),RNAME(2,180),IRANK(180),STAR
     2(5,180)
C         /MR/  BETWEEN MAIN PROGRAM AND RANK
      COMMON /MR/ HMAXA(5,180,5),NDAY(5,180,5),IHR(5,180,5),CONC(180,5),
     1JDAY,NR
C
C     SHORELINE COMMON - ADDED BY JEFF WINGET (6-88) TO HANDLE SHORE
C     LINE DEFINITION CARDS
C
      COMMON /SHORE/XSL(250),YSL(250),BA(250),EA(250),FETCH(250),
     & INDEX(250),SNAME(3),THETA
      CHARACTER*4 SNAME,ENDS

      COMMON /MSFM/ MSFMFL,MSFMHR
      INTEGER MSFMFL(50,24),MSFMHR(8784)
      CHARACTER*5 CRADIL
      CHARACTER*4 RNAME,PNAME,ANAME,BLNK,ENDP,ENDR,DUM,STAR,STR,CF,C,
     & FUME
      DIMENSION PNAME(3,250), IFREQ(7), DUMR(24), HLH(2,24), IMPS(25), T
     1ITLE(2), TABLE(2,21), CONTER(6), RADIL(5), ANAME(36),PLL(6,2)
      DIMENSION SUM(180), ELRDUM(5), NTIME(5), ATIME(5), MODEL(2,2)
      DIMENSION CF(5),IDUMR(24)
C
      CHARACTER*4 TITLE,MODEL
C
C
      DATA IFREQ /7*0/ ,BLNK /' '/
      DATA TITLE /'S02 ','PART'/
      DATA MODEL /'URBA','N','RURA','L'/
      DATA ENDP /'ENDP'/ ,ENDR /'ENDR'/,ENDS /'ENDS'/
      DATA MAXP /250/ ,STR /'*'/
C        MAXP EQUALS SECOND DIMENSION OF THE ARRAY NAMED: SOURCE.
      DATA ANAME /' 10,',' 20,',' 30,',' 40,',' 50,',' 60,',' 70,',' 80,
     1',' 90,','100,','110,','120,','130,','140,','150,','160,','170,','
     2180,','190,','200,','210,','220,','230,','240,','250,','260,','270
     3,','280,','290,','300,','310,','320,','330,','340,','350,','360,'/
     4
C
      DATA NTIME /1,3,8,24,0/ ...
```

```
      DATA ITMIN1 /9999/,IDIV8 /0/, IDIV24 /0/, ICALM /0/
      DATA C/'C'/,ICFL3/0/,ICFL8/0/,ICFL24/0/,CF/5*' '/
      DATA FUME/'F'/
      DATA L1/1/,L2/2/,L3/3/,L4/4/,L5/5/
C
C      DEFAULT POWER LAW EXPONENTS AND TERRAIN ADJUSTMENT FACTORS.
C
      DATA PLL/.15,.15,.20,.25,.30,.30,.07,.07,.10,.15,.35,.55/
      DATA CONTER/0.,0.,0.,0.,0.,0./
C
C     CALL WSTCLK
C
      WRITE (6,5432)
 5432 FORMAT ('1',34X,'SDM (DATED 88204)'/
     1 29X,'AN AIR QUALITY DISPERSION MODEL '/
     1 32X,'COMBINING MPTER AND SHORELINE FUMIGATION'/
     4 22X,'SOURCE: UNAMAP FILE ON EPA''S IBM 3090, RTP. NC.')
C
C->->->->SECTION D - FLOW DIAGRAM
C
C
C->->->->SECTION E - RUN SET-UP AND READ FIRST 6 INPUT CARDS.
C
C        INITIALIZATIONS............
C        THE FOLLOWING 18 STATEMENTS MAY BE DELETED FOR USE ON
C        COMPUTERS THAT ZERO CORE LOCATIONS USED BY A PROBLEM
C        PRIOR TO EXECUTION.
      NRECEP=0
      NP=0
      NHR=0
      NP3=0
      NP8=0
      NP24=0
      NPX=0
      DO 10 I=1,21
      TABLE(1,I)=0.
10    TABLE(2,I)=0.
      DO 40 I=1,180
      SUM(I)=0.
      DO 30 J=1,5
      CONC(I,J)=0.
      DO 20 K=1,5
20    HMAXA(J,I,K)=0.
30    CONTINUE
40    CONTINUE
C        I/O DEVICE INITIALIZATIONS
      IN=5
      IO=6
C        UNIT 11 - DISK INPUT OF MET DATA--USED WHEN IOPT(5)=1.
C        UNIT 10 - DISK OUPUT OF PARTIAL CONCENTRATIONS
C         AT EACH RECEPTOR--USED WHEN IOPT(21) = 1.
C        UNIT 12 TAPE/DISK OUTPUT OF HRLY CONCENTRATIONS-IF IOPT(22)=1.
C        UNIT 13 TAPE/DISK OUTPUT OF CONCENTRATIONS FOR AVERAGING PERIOD
C           USED IF IOPT(23) = 1.
C        UNIT 14 TAPE/DISK STORAGE FOR SUMMARY INFO, USED IF IOPT(20)=1.
C        UNIT 15 - TAPE/DISK INPUT OF HOURLY POINT SOURCE EMISSIONS
C          -- USED IF IOPT(6) = 1.
C
C        READ CARDS 1-3  (SEE DESCRIPTION, SECTION B).
```

```
      READ (IN,1180) LINE1,LINE2,LINE3
C
C        READ CARD TYPE 4  (SEE DESCRIPTION, SECTION B).
C
      READ (IN,*) IDATE(1),IDATE(2),IHSTRT,NPER,NAVG,IPOL,MUOR,NSIGP,
     1NAV5,CONONE,CELM,HAFL
C        THE ABOVE FORMAT IS IBM'S FREE FIELD INPUT.
C        VARIABLES MUST BE SEPARATED BY COMMAS.
C        THIS IS SIMILAR TO IBM'S LIST DIRECTED IO.
      WRITE (IO,1395)(MODEL(K,MUOR),K=1,2),LINE1,LINE2,LINE3
      IF (NSIGP.LE.25) GO TO 50
      WRITE (IO,1250) NSIGP
C     CALL WAUDIT
      STOP
50    IP=IPOL-2
      CONTWO=CONONE
C        READ CARD TYPE 5  (SEE DESCRIPTION, SECTION B).
C
      READ (IN,*) (IOPT(I),I=1,25)
C
      IF(IOPT(25).NE.1) GO TO 55
C
C        DEFAULT SELECTION RESULTS IN THE FOLLOWING: USE STACK DOWNWASH
C        (2); USE FINAL PLUME RISE (3); USE BUOYANCY-INDUCED DISPERSION
C        (4); WRITE HIGH-5 TABLES (19) BUT DELETE ALL OTHER OUTPUT (10,
C        11,12, 13, 14, 15, 16, 17, 18, 21, 22, 23, AND 24).
C
         IOPT(2)=0
         IOPT(3)=1
         IOPT(4)=1
         IOPT(5)=0
         IOPT(7)=0
         IOPT(10)=1
         IOPT(11)=1
         IOPT(12)=1
         IOPT(13)=1
         IOPT(14)=1
         IOPT(15)=1
         IOPT(16)=1
         IOPT(17)=1
         IOPT(18)=1
         IOPT(19)=0
         IOPT(20)=0
         IOPT(21)=0
         IOPT(22)=0
         IOPT(23)=0
         IOPT(24)=0
C
C        SET HALF-LIFE FOR DEFAULT OPTION
C
         IF(IPOL.EQ.3.AND.MUOR.EQ.1)HAFL=14400.
         IF(IPOL.NE.3.OR.MUOR.NE.1)HAFL=0.
C
C          SET START HOUR AND AVERAGING PERIOD;
C          SET THE NUMBER OF SIGNIFICANT POINT AND
C          AREA SOURCES.
C
         IHSTRT=1
         NAVG=24
         NSIGP=0
```

```
C
55    CONTINUE
C
C          WRITE GENERAL INPUT INFORMATION
      WRITE (IO,1410) TITLE(IP),NPER,NAVG,IHSTRT,IDATE(2),IDATE(1),CONTW
     1O,NSIGP
      DAY1A=IDATE(2)
      HR1=IHSTRT
      IF (HAFL.GT.0.0) GO TO 60
      TLOS=0.
      WRITE (IO,1420)
      GO TO 70
60    WRITE (IO,1430) HAFL
      TLOS=693./HAFL
70    IF (IOPT(19).EQ.1) GO TO 80
      NAVT=5
C        FOR DEFAULT OPTION
C        ADDITIONAL AVERAGING PERIOD SET TO ZERO.
      IF(IOPT(25).EQ.1) NAV5=0
      IF (NAV5.EQ.1.OR.NAV5.EQ.3.OR.NAV5.EQ.8.OR.NAV5.EQ.24.OR.NAV5.EQ.0
     1) NAVT=4
      NTIME(5)=NAV5
      ATIME(5)=NAV5
      WRITE (IO,1440) NAVT
80    IF (IOPT(1).EQ.0) GO TO 90
      WRITE (IO,1450) CELM
      ELHN=99999.
      ELOW=99999.
90    IF (NSIGP.GT.0) GO TO 100
      IOPT(11)=1
      IOPT(17)=1
100   WRITE (IO,1460) (I,IOPT(I),I=1,13)
      WRITE (IO,1470) (I,IOPT(I),I=14,25)
C
C        READ CARD TYPE 6 (SEE DESCRIPTION, SECTION B).
C
C       SWITCH TO SELECT DEFAULT POWER LAW EXPONENTS,
C       TERS.RAIN ADJUSTMENT FACTOR
C
      IF(IOPT(25).NE.0)READ(IN,*)HANE
      IF(IOPT(25).EQ.0)READ(IN,*)HANE,PL,CONTER
      IF(IOPT(25).EQ.0) GO TO 105
      DO 104 I1=1,6
      PL(I1)=PLL(I1,MUOR)
104   CONTINUE
105   CONTINUE
C
      IF (IOPT(1).EQ.1) GO TO 110
      WRITE (IO,1480) HANE,PL
      GO TO 140
110   WRITE (IO,1490) HANE,PL,CONTER
      DO 120 I=1,6
      IF (CONTER(I).LT.0..OR.CONTER(I).GT.1.) GO TO 130
120   CONTINUE
      GO TO 140
130   WRITE (IO,1260)
C     CALL WAUDIT
      STOP
C
```

```
C          RAMQ IN THE RAM SYSTEM. THIS SECTION IS RESPONSIBLE
C          FOR MAKING THE NECESSARY DATA CONVERSIONS ON THE RAW
C          EMISSIONS DATA IN ORDER TO ESTABLISH A STANDARD
C          DATA BANK WHICH WILL BE ACCEPTABLE. A CONVERSION FACTOR
C          FROM USER UNITS TO KILOMETERS IS APPLIED WHEN NECESSARY.
C
C->->->->SECTION F - INPUT AND PROCESS EMISSION INFORMATION.
C
140    WRITE (IO,1500)
       NPT=0
C         BEGIN LOOP TO READ THE POINT SOURCE INFORMATION
150    NPT=NPT+1
       IF (NPT.LE.MAXP) GO TO 160
       READ (IN,1200) DUM
       IF (DUM.EQ.ENDP) GO TO 230
       WRITE (IO,1270) MAXP
C      CALL WAUDIT
       STOP
C
C         READ CARD TYPE 7  (SEE DESCRIPTION, SECTION B).
C
160    READ (IN,1210) (PNAME(I,NPT),I=1,3),(SOURCE(I,NPT),I=1,8),ELP(NPT)
C         CARD WITH     'ENDP'   IN COL 1-10 IS USED TO SIGNIFY END OF
C         POINT SOURCES.
       IF (PNAME(1,NPT).EQ.ENDP) GO TO 230
C         ELHN, ELEVATION OF LOWEST STACK TOP IN INVENTORY, IS DETERMINED
C         IN USER HEIGHT UNITS
       IF (IOPT(1).EQ.0) GO TO 170
       TOM=SOURCE(5,NPT)/CELM+ELP(NPT)
       IF (TOM.LT.ELHN) ELHN=TOM
C         LOWPT, ELEVATION OF LOWEST SOURCE GROUND-LEVEL
C          IN INVENTORY, IN USER HEIGHT UNITS.
       IF (ELP(NPT).LT.ELOW) ELOW=ELP(NPT)
C         CALCULATE BUOYANCY FACTOR
170    D=SOURCE(7,NPT)
C          FOLLOWING VARIABLE IS BRIGGS' F WITHOUT TEMPERATURE FACTOR.
       SOURCE(9,NPT)=2.45153*SOURCE(8,NPT)*D*D
C         2.45153 IS GRAVITY OVER FOUR.
       TS=SOURCE(6,NPT)
       IF (TS.GT.293.) GO TO 180
       HF=SOURCE(5,NPT)
       GO TO 200
180    F=SOURCE(9,NPT)*(TS-293.)/TS
       IF (F.GE.55.) GO TO 190
C         ONLY BUOYANCY PLUME RISE IS CONSIDERED HERE.
       HF=SOURCE(5,NPT)+21.425*F**0.75/3.
       GO TO 200
190    HF=SOURCE(5,NPT)+38.71*F**0.6/3.
C         HSAV, DSAV, AND PSAV ARE USED FOR TEMPORARY STORAGE
C         (OR AS DUMMIES) FOR THE NEXT 60 STATEMENTS.
200    HSAV(NPT)=HF
C         DETERMINE HEIGHT INDEX.
       DO 210 IH=2,9
       IF (HF.LT.(HC1(IH)-.01)) GO TO 220
210    CONTINUE
       IH=10
220    IS=IH-1
       IF(MUOR.EQ.1)GO TO 221
       A=PXUCOF(2,IS)
```

```
      GO TO 222
221   A=BXUCOF(2,IS)
      B=BXUEXP(2,IS)
222   DSAV(NPT)=(A*HF**B)*SOURCE(IPOL,NPT)/3.
C        AN ESTIMATE OF THE POTENTIAL IMPACT OF EACH SOURCE IS
C         DETERMINED AND STORED IN DSAV. MAX CONCENTRATION IS
C         DETERMINED BY CHI(MAX)=(A*H**B)*Q/U WHERE
C         A IS THE COEFFICIENT AND B IS THE EXPONENT, OF
C         MAXIMUM CHI*U/Q VALUES PREDETERMINED FOR B STABILITY
C         AND A SPECIFIC EFFECTIVE HEIGHT RANGE. PLUME RISE
C         IS CALCULATED FOR B STABILITY AND 3 M/SEC WIND SPEED.
C
C        GO BACK AND READ DATA FOR ANOTHER POINT SOURCE.
      IPSIGS(NPT)=0
C        LIST POINT SOURCE INFORMATION.
      WRITE (IO,1510) NPT,(PNAME(J,NPT),J=1,3),(SOURCE(K,NPT),K=1,8),DSA
     1V(NPT),HSAV(NPT),ELP(NPT),F
      GO TO 150
230   NPT=NPT-1
C         CHECK FOR NPT < OR = 0
      IF (NPT.GT.0) GO TO 240
      WRITE (IO,1280) NPT
C     CALL WAUDIT
      STOP
C
C->->->->SECTION G - RANK SIGNIFICANT SOURCES.
C
240   IF (NSIGP.EQ.0) GO TO 280
C        RANK NSIGP HIGHEST POINT SOURCES.
      IF (NPT.LT.NSIGP) NSIGP=NPT
      DO 260 I=1,NSIGP
      SIGMAX=-1.0
      DO 250 J=1,NPT
      IF (DSAV(J).LE.SIGMAX) GO TO 250
      SIGMAX=DSAV(J)
      LMAX=J
250   CONTINUE
C        IMPS IS THE SOURCE NUMBER IN ORDER OF SIGNIFICANCE.
      IMPS(I)=LMAX
C        PSAV IS THE CALC. CONC. IN ORDER OF SIGNIFICANCE.
      PSAV(I)=SIGMAX
260   DSAV(LMAX)=-1.0
C        OUTPUT TABLE OF RANKED SOURCES.
      WRITE (IO,1520) TITLE(IP)
      DO 270 I=1,NSIGP
      WRITE (IO,1530) I,PSAV(I),IMPS(I)
270   CONTINUE
C
C->->->->SECTION H - EMISSIONS WITH HEIGHT TABLE.
C
280   IF (IOPT(9).EQ.1) GO TO 340
      DO 320 I=1,NPT
      DO 290 J=1,20
      HC=J*5.
      IF (SOURCE(5,I).LE.HC) GO TO 300
290   CONTINUE
C        POINT SOURCES WITH PHYSICAL HEIGHTS GT 100 METERS ARE LISTED
C        SEPARATELY.
      WRITE (IO,1540) I,SOURCE(5,I),SOURCE(IPOL,I)
```

```
C        ADD EMISSION RATE INTO TABLE AND TOTAL.
300   TABLE(1,J)=TABLE(1,J)+SOURCE(IPOL,I)
310   TABLE(1,21)=TABLE(1,21)+SOURCE(IPOL,I)
320   CONTINUE
C        OUTPUT SOURCE-STRENGTH-HEIGHT TABLE
C        THIS TABLE DISPLAYS THE TOTAL EMISSIONS FOR POINT
C        SOURCES AND THE CUMULATIVE FREQUENCY ACCORDING TO
C        HEIGHT CLASS
      WRITE (IO,1550) TITLE(IP)
C        HEIGHT CLASS EMISSIONS ARE IN 1
C        DETERMINE CUMULATIVE PERCENT IN 2
      IH1=0
      IH2=5
      IM1=1
      TABLE(2,1)=TABLE(1,1)/TABLE(1,21)
      WRITE (IO,1560) IH1,IH2,(TABLE(J,1),J=1,2)
      DO 330 I=2,20
      IH2=I*5
      IH1=IH2-4
      IM1=I-1
      TABLE(2,I)=TABLE(1,I)/TABLE(1,21)+TABLE(2,IM1)
      WRITE (IO,1560) IH1,IH2,(TABLE(J,I),J=1,2)
330   CONTINUE
      WRITE (IO,1570) TABLE(1,21)
 340  NSL=1
3010  READ (IN,3000) (SNAME(I),I=1,3),XSL(NSL),YSL(NSL),
     & BA(NSL),EA(NSL),FETCH(NSL)
      IF (SNAME(1).EQ.ENDS) GO TO 3020
3000  FORMAT (3A4,5F8.0)
      NSL=NSL+1
      GO TO 3010
3020  CONTINUE
C
C->->->->SECTION I - EXECUTE FOR INPUT OF SIGNIFICANT SOURCE NUMBERS.
C
      WRITE (IO,1580)
      IF (IOPT(7).EQ.0) GO TO 370
C
C        READ CARD TYPE 8 (SEE DESCRIPTION, SECTION B).
C
      READ (IN,1220) INPT,(MPS(I),I=1,INPT)
      WRITE (IO,1590) INPT,(MPS(I),I=1,INPT)
      IF (INPT.LE.NSIGP) GO TO 350
      WRITE (IO,1290) INPT,NSIGP
C     CALL WAUDIT
      STOP
350   IF (INPT.EQ.0) GO TO 370
      IF (MPS(INPT).EQ.0) WRITE (IO,1300)
      J=INPT+1
      K=1
C        ADD SIGNIFICANT SOURCES DETERMINED FROM RANKED SOURCE LIST
C        IF NSIGP GREATER THAN INPT.
      IF (J.GT.NSIGP) GO TO 390
      DO 360 I=J,NSIGP
      MPS(I)=IMPS(K)
360   K=K+1
      GO TO 390
370   DO 380 I=1,NSIGP
380   MPS(I)=IMPS(I)
```

```
      IF (IOPT(6).EQ.0) GO TO 410
C        SAVE AVERAGE EMISSION RATE
      DO 400 I=1,NPT
400   PSAV(I)=SOURCE(IPOL,I)
C        FILL IN SIGNIFICANT POINT SOURCE ARRAY
410   DO 420 I=1,NSIGP
      J=MPS(I)
420   IPSIGS(J)=I
C
C->->->->SECTION J - CHECK MET DATA IF FROM FILE OF ONE YEAR'S DATA.
C
      IF (IOPT(5).EQ.1) GO TO 450
C
C        READ CARD TYPE 9 (SEE DESCRIPTION, SECTION B).
C
      READ (IN,*) ISFCD,ISFCYR,IMXD,IMXYR
C        READ ID RECORD FROM PREPROCESSED MET DISK OR TAPE FILE.
      READ (11) ID,IYEAR,IDM,IYM
      IF (ISFCD.EQ.ID.AND.ISFCYR.EQ.IYEAR) GO TO 430
      WRITE (IO,1310) ISFCD,ISFCYR,ID,IYEAR
C     CALL WAUDIT
      STOP
430   IF (IMXD.EQ.IDM.AND.IMXYR.EQ.IYM) GO TO 440
      WRITE (IO,1320) IMXD,IMXYR,IDM,IYM
C     CALL WAUDIT
      STOP
440   WRITE (IO,1610) ISFCD,ISFCYR,IMXD,IMXYR
C
C->->->->SECTION K - GENERATE POLAR COORDINATE RECEPTORS.
C
450   NRECEP=0
      WRITE (IO,1620)
      IF (IOPT(8).NE.1) GO TO 520
C
C        READ CARD TYPE 10 (SEE DESCRIPTION, SECTION B).
C
      READ (IN,*) RADIL,CENTX,CENTY
      JA=0
      DO 460 J=1,5
      IF (RADIL(J).EQ.0) GO TO 460
      JA=JA+1
460   CONTINUE
      WRITE (IO,1630) CENTX,CENTY,RADIL
      DO 480 I=1,36
C          CALCULATE THE ANGLE IN RADIANS
      RADIK=FLOAT(I)*0.1745329
C        0.1745329 IS 2*PI/36
      SINRAD=SIN(RADIK)
      COSRAD=COS(RADIK)
      DO 470 J=1,JA
      NRECEP=I+36*(J-1)
      RREC(NRECEP)=(RADIL(J)*SINRAD)+CENTX
C          CALCULATE THE EAST-COORDINATE
      SREC(NRECEP)=(RADIL(J)*COSRAD)+CENTY
C          CALCULATE THE NORTH-COORDINATE
      RNAME(1,NRECEP)=ANAME(I)
C          ALPHANUMERIC INFORMATION WHICH INDICATES DEGREES AZIMUTH
C     ENCODE (4,1640,RNAME(2,NRECEP)) RADIL(J)
C          ENCODE THE FLOATING POINT VARIABLE OF RADIAL DISTANCE
```

```
C
C  THE IBM3090 DOES NOT SUPPORT ENCODE SO WRITE THE RADIL DISTANCE
C  TO AN INTERNAL FILE TO CONVERT IT TO A CHARACTER VALUE
C
      ASSIGN 2531 TO NUMF
      IF (RADIL(J) .LT. 100.) ASSIGN 2532 TO NUMF
      IF (RADIL(J) .LT. 0.1) ASSIGN 2533 TO NUMF
      WRITE(CRADIL,NUMF) RADIL(J)
      RNAME(2,NRECEP)=CRADIL
C
      ZR(NRECEP)=0.
      ELR(NRECEP)=0.
470   CONTINUE
480   CONTINUE
      NRECEP=36*JA
C
C->->->->SECTION L - READ POLAR COORDINATE ELEVATIONS.
C
      IF (IOPT(1).EQ.0) GO TO 520
C
C        READ 36 CARDS, TYPE 11 (SEE DESCRIPTION, SECTION 8).
C
      DO 510 I=1,36
      READ (IN,1230) IDUM,(ELRDUM(J),J=1,JA)
      IF (IDUM.EQ.I) GO TO 490
      WRITE (IO,1330) I,IDUM
C     CALL WAUDIT
      STOP
490   DO 500 J=1,JA
      K=J-1
      L=K*36+I
500   ELR(L)=ELRDUM(J)
510   CONTINUE
C
C->->->->SECTION M - READ AND PROCESS RECEPTOR INFORMATION.
C
C          NOW READ CARD TYPE 12 IF NECESSARY. MUST HAVE A CARD WITH
C          'ENDR'IN COLS 1-4 TO INDICATE END OF RECEPTOR CARDS.
C          NO MORE THAN 180 RECEPTORS CAN BE INPUT TO MPTER.
C        START LOOP TO ENTER RECEPTORS.
520   NRECEP=NRECEP+1
      IF (NRECEP.LE.180) GO TO 540
      READ (IN,1200,END=530) DUM
      IF (DUM.EQ.ENDR) GO TO 550
530   WRITE (IO,1340)
C     CALL WAUDIT
      STOP
C
C        READ CARD TYPE 12 (SEE DESCRIPTION, SECTION B).
C
540   READ (IN,1240) (RNAME(J,NRECEP),J=1,2),RREC(NRECEP),SREC(NRECEP),Z
     1R(NRECEP),ELR(NRECEP)
C        PLACE 'ENDR' IN COLS 1 TO 4 ON CARD FOLLOWING LAST RECEPTOR
C        TO END READING TYPE 12 CARDS.
      IF (RNAME(1,NRECEP).EQ.ENDR) GO TO 550
      GO TO 520
550   NRECEP=NRECEP-1
      IF (IOPT(1).EQ.0) GO TO 570
C        IF TERRAIN OPTION IS EMPLOYED, DETERMINE IF
```

```
C         FOR ADDITIONAL REMARKS.
      DO 560 J=1,NRECEP
      IF (ELR(J).GT.ELHN.OR.ELR(J).LT.ELOW) STAR(2,J)=STR
      IF (ELR(J).GT.ELHN) STAR(1,J)=STR
560   CONTINUE
570   IF (NRECEP.GT.0) GO TO 580
      WRITE (IO,1350) NRECEP
C     CALL WAUDIT
      STOP
C        PRINT OUT TABLE OF RECEPTORS. ***
580   WRITE (IO,1650)
      DO 590 K=1,NRECEP
590   WRITE (IO,1660) K,STAR(1,K),STAR(2,K),(RNAME(J,K),J=1,2),RREC(K),S
     1REC(K),ZR(K),ELR(K)
      IF (IOPT(1).EQ.0) GO TO 600
      WRITE (IO,1670)
C
C->->->->SECTION N - POSITION FILES AS REQUIRED.
C
600   IF (IOPT(20).EQ.0) GO TO 610
C
C        READ CARD TYPE 13 (SEE DESCRIPTION, SECTION B).
C
      READ (IN,*) IDAY,LDRUN
      WRITE (IO,1680) IDAY,LDRUN
      IF (IDAY.EQ.0) GO TO 610
C        READ INFO FOR HIGH-FIVE TABLE FROM LAST SEGMENT.
      READ (14) IDAYS,SUM,NHR,DAY1A,HR1,HMAXA,NDAY,IHR
      REWIND 14
      IF (IDAY.EQ.IDAYS) GO TO 610
      WRITE (IO,1360) IDAY,IDAYS
C     CALL WAUDIT
      STOP
610   NP=IDAY*(24/NAVG)
C        IF OPTION 21 = 1, WRITE INITIAL INFO TO UNIT 10
      IF (IOPT(21).EQ.1) WRITE (10) NPER,NAVG,LINE1,LINE2,LINE3
      IF (IOPT(22).EQ.0) GO TO 640
      IF (IDAY.LE.0) GO TO 630
C        SKIP PREVIOUSLY GENERATED HOURLY RECORDS.
      ISKIP=IDAY*24+2
      DO 620 I=1,ISKIP
620   READ (12)
      GO TO 640
C        WRITE LEAD TWO RECORDS ON HOURLY FILE.
630   WRITE (12) NPER,NAVG,LINE1,LINE2,LINE3
      WRITE (12) NRECEP,(RREC(I),I=1,NRECEP),(SREC(J),J=1,NRECEP)
640   IF (IOPT(23).EQ.0) GO TO 670
      IF (IDAY.LE.0) GO TO 660
C        SKIP PREVIOUSLY GENERATED AVERAGING-PERIOD FILE.
      ISKIP=NP+2
      DO 650 I=1,ISKIP
650   READ (13)
      GO TO 670
C        WRITE LEAD TWO RECORDS ON AVERAGING PERIOD FILE.
660   WRITE (13) NPER,NAVG,LINE1,LINE2,LINE3
      WRITE (13) NRECEP,(RREC(I),I=1,NRECEP),(SREC(J),J=1,NRECEP)
670   IF (IOPT(6).EQ.0) GO TO 690
      IF (IDAY.LE.0) GO TO 690
      ISKIP=IDAY*24
```

```
680     READ (15)
690     IDAY=IDATE(2)-1
        IF (IDAY.LE.0.OR.IOPT(5).EQ.1) GO TO 710
C          SKIP PREVIOUSLY USED HOURLY EMISSION RECORDS.
        DO 700 I=1,IDAY
700     READ (11)
710     CONTINUE
C
C->->->->SECTION O - START LOOPS FOR DAY AND AVG TIME; READ MET DATA.
C
720     IDAY=IDAY+1
        DAY=IDAY
        NHRS=0
        IF (IOPT(5).EQ.1) GO TO 760
C          IF OPTION 5 EQUALS ZERO, INPUT MET DATA OFF DISK (UNIT 11)
        READ (11) JYR,IMO,DAY1,IKST,QU,QTEMP,DUMR,QTHETA,HLH
        DO 781 JM1=1,24
        IDUMR(JM1)=DUMR(JM1)+0.5
 781    CONTINUE
        IF (JYR.NE.IDATE(1)) GO TO 730
        IF (DAY1.EQ.DAY) GO TO 740
C          DATE ON MET TAPE DOES NOT MATCH INTERNAL DATE
730     WRITE (IO,1370) JYR,IDATE(2),IDATE(1),IDAY
C       CALL WAUDIT
        STOP
C          MODIFY WIND VECTOR BY 180 DEGREES. SINCE FLOW VECTORS WERE
C          OUTPUT FROM RAMMET. THIS CONVERTS BACK TO WIND DIRECTIONS.
740     IDATE(2)=DAY1
        DO 750 IQ=1,24
        IF (IKST(IQ).EQ.7) IKST(IQ)=6
        QTHETA(IQ)=QTHETA(IQ)+180.
        IF (QTHETA(IQ).GT.360.) QTHETA(IQ)=QTHETA(IQ)-360.
C         SELECT URBAN OR RURAL MIXING HEIGHTS AS APPROPRIATE.
        IF(MUOR.EQ.1)IMX=2
        IF(MUOR.EQ.2)IMX=1
750     QHL(IQ)=HLH(IMX,IQ)
760     NB=IHSTRT
        NE=NB+NAVG-1
        IF (NB.GT.0) GO TO 770
        WRITE (IO,1380) IHSTRT
C       CALL WAUDIT
        STOP
C          START LOOP FOR AVERAGING PERIOD.
770     U=0.0
        TEMP=0.0
        DELN=0.0
        DELM=0.0
        DO 780 I=1,7
780     IFREQ(I)=0.0
        DO 800 I=NB,NE
        JHR=I
        DAY2=IDATE(2)
        IF (IOPT(5).EQ.0) GO TO 790
C
C          READ CARD TYPE 14 IF IOPT
C            (SEE DESCRIPTION, SECTION B).
C
        READ (IN,*) JYR,DAY1,JHR,IKST(JHR),QU(JHR),QTEMP(JHR),QTHETA(JH
       1R),QHL(JHR)
```

```
C          REDEFINE START HOURS AND DATES AT FIRST HOUR OF EACH
C            AVERAGING PERIOD IF READING HOURLY MET DATA.
      IDATE(1)=JYR
      IHSTRT=JHR
      ISTDAY=DAY1
      IDATE(2)=ISTDAY
      DAY2=IDATE(2)
790   IF (IKST(JHR).EQ.7) IKST(JHR)=6
      IF (IOPT(10).EQ.1) GO TO 800
C
C->->->->SECTION P - CALCULATE AND STORE FOR HIGH-FIVE TABLE.
C
      IF (I.EQ.NB) WRITE (IO,1690) IDATE
      TRAD=QTHETA(JHR)*0.01745329
      WRITE (IO,1700) JHR,QTHETA(JHR),QU(JHR),QHL(JHR),QTEMP(JHR),IKST(J
     1HR)
      SINT=SIN(TRAD)
      COST=COS(TRAD)
C          CALCULATE WIND COMPONENTS
      URES=QU(JHR)
      UR=URES*SINT
      VR=URES*COST
      DELM=DELM+UR
      DELN=DELN+VR
      TEMP=TEMP+QTEMP(JHR)
      U=U+URES
      KST=IKST(JHR)
      IFREQ(KST)=IFREQ(KST)+1
C          END LOOP TO READ ALL MET DATA FOR AVERAGING PERIOD.
800   CONTINUE
      IF (IOPT(10).EQ.1) GO TO 860
C          CALCULATE RESULTANT  WIND DIRECTION THETA
      DELN=DELN/NAVG
      DELM=DELM/NAVG
      THETA=ANGARC(DELM,DELN)
C          CALCULATE AVERAGE AND RESULTANT SPEED AND PERSISTENCE.
      U=U/NAVG
      TEMP=TEMP/NAVG
      URES=SQRT(DELN*DELN+DELM*DELM)
      PERSIS=URES/U
C          DETERMINE MODAL AND AVERAGE STABILITY
      LSMAX=0
      DO 810 I=1,7
      LST=IFREQ(I)
      IF (LST.LE.LSMAX) GO TO 810
      LSMAX=LST
      LSTAB=I
810   CONTINUE
      IP1=LSTAB+1
      KST=LSTAB
      DO 820 I=IP1,7
      IF (LSMAX.EQ.IFREQ(I)) GO TO 830
820   CONTINUE
      GO TO 850
C          IF TIE FOR MAX MODAL STABILITY CALCULATE AVERAGE STABILITY
830   KSUM=0
      DO 840 J=1,7
840   KSUM=KSUM+IFREQ(J)*J
      KST=FLOAT(KSUM)/FLOAT(NAVG)+0.5
```

```
850    WRITE (IO,1710)
       WRITE (IO,1720) THETA,URES,U,TEMP,PERSIS,KST
C         REDEFINE NB AND NE IN CASE NON-CONSECUTIVE DAYS ARE BEING RUN
860    IF (IOPT(5).EQ.0) GO TO 870
       NB=IHSTRT
       NE=IHSTRT+NAVG-1
C
C->->->->SECTION Q - INITIALIZE FOR HOURLY LOOP.
C
C         INITIALIZE SUMS FOR CONC AND PARTIAL CONC FOR AVG PERIOD.
870    DO 890 K=1,NRECEP
       PCHI(K)=0.0
       DO 880 I=1,26
880    PSIGS(K,I)=0.0
890    CONTINUE
C         IF SAVING PARTIAL CONCENTRATIONS, WRITE INITIAL RECEPTOR INFO.
       IF (IOPT(21).EQ.0) GO TO 900
       WRITE (10) NRECEP,NPT,(RREC(I),I=1,NRECEP),(SREC(I),I=1,NRECEP)
C
C->->->->SECTION R - BEGIN HOURLY LOOP.
C
900    DO 1020 ILH=NB,NE
       LH=ILH
       IF (LH.LE.24) GO TO 910
       LH=MOD(ILH,24)
       IF (LH.EQ.1) IDATE(2)=DAY1
C         INITIALIZE SUMS FOR CONC AND PARTIAL CONC FOR HOURLY PERIODS.
910    DO 930 K=1,NRECEP
       PHCHI(K)=0.0
       DO 920 I=1,26
920    PHSIGS(K,I)=0.0
930    CONTINUE
C         SET MET CONDITIONS FOR THIS HOUR
       THETA=QTHETA(LH)
       U=QU(LH)
       HL=QHL(LH)
       TEMP=QTEMP(LH)
       KST=IKST(LH)
       TRAD=THETA*0.01745329
       SINT=SIN(TRAD)
       COST=COS(TRAD)
       CTER=CONTER(KST)
C         IF OPTION 6 IS 1, READ HOURLY EMISSIONS.
       IF (IOPT(6).EQ.0) GO TO 940
       IDCK=IDATE(1)*100000+IDATE(2)*100+LH
       READ (15) IDATP,(SOURCE(IPOL,I),I=1,NPT)
C         CHECK DATE
       IF (IDCK.EQ.IDATP) GO TO 940
       WRITE (IO,1390) IDCK,IDATP
C      CALL WAUDIT
       STOP
C         CALCULATE POINT SOURCE CONTRIBUTIONS
940    CALL PTR(IDAY,PNAME)
       IF (IOPT(22).EQ.0) GO TO 950
C         WRITE HOURLY CONCENTRATIONS TO TAPE
       WRITE (12) IDATE(2),LH,(PHCHI(I),I=1,NRECEP)
C
C->->->->SECTION S - CALCULATE AND STORE FOR HIGH-FIVE TABLE.
C
950    NHR=NHR+1
```

```
C        IF OPTION 19 IS 1, DELETE COMPUTATIONS FOR AVG CONC.
C         FOR LENGTH OF RECORD AND HIGH-FIVE TABLE.
      IF (IOPT(19).EQ.1) GO TO 1010
C        CUMULATE CONCENTRATIONS FOR AVG TIMES AND LENGTH OF RECORD.
C
C         FOR DEFAULT OPTION DETERMINE CALM HOURS.
C         FOR CALM HOURS, CONCENTRATIONS AT EACH RECEPTOR ARE
C          SET EQUAL TO ZERO.
C         --- A CALM HOUR IS AN HOUR WITH A WIND SPEED
C             OF 1.00 M/S AND A WIND DIRECTION THE SAME
C              AS THE PREVIOUS HOUR.
      IF(IOPT(25).EQ.1.AND.QU(LH).LT.1.009.AND.ITMIN1.EQ.
     *IDUMR(LH))THEN
      ICALM=ICALM+1
      DO 955 K=1,NRECEP
      PHCHI(K)=0.0
955   CONTINUE
      GO TO 971
      END IF
      DO 970 K=1,NRECEP
      DO 960 L=1,NAVT
960   CONC(K,L)=CONC(K,L)+PHCHI(K)
970   SUM(K)=SUM(K)+PHCHI(K)
C          STORE DATE FOR WHICH CONCS. HAVE BEEN CALCULATED.

  971 JDAY=IDATE(2)
C        SUBROUTINE RANK IS CALLED WHENEVER A COUNTER
C        INDICATES THAT ENOUGH END TO END HOURLY CONCENTRATIONS
C        HAVE BEEN STORED OFF TO COMPLETE AN AVG TIME.
C        NP3, NP8, NP24, NPX ARE USED AS COUNTERS FOR EACH
C        AVG TIME AND ARE ZEROED AFTER EACH CALL TO RANK.
C
C        FOR THE DEFAULT OPTION CALCULATE AVERAGE
C        CONCENTRATION FOR APPROPRIATE AVERAGING PERIOD.
C        SET UP CALM FLAG FOR ENTRY INTO SUBROUTINE RANK.
C
      IF(IOPT(25).EQ.0) GOTO 979
      LL1=1
      IF (MSFMHR(JDAY*24+LH).EQ.1) LL1=111
      CALL RANK(LL1)
      LL1=1
      NP3=NP3+1
      IF(QU(LH).LT.1.009.AND.IDUMR(LH).EQ.ITMIN1)ICFL3=1
      IF (MSFMHR(JDAY*24+LH).EQ.1) IMFL3=1
      IF(NP3.NE.3) GO TO 974
C        FOR 3 HOUR AVERAGING PERIOD DIVIDE SUM BY 3.0.
      DO 972 LQ=1,NRECEP
972   CONC(LQ,2)=CONC(LQ,2)/3.0
      LL2=2
      IF(ICFL3.EQ.1)LL2=22
      IF (IMFL3.EQ.1)LL2=222
      CALL RANK(LL2)
      NP3=0
      ICFL3=0
      IMFL3=0
974   NP8=NP8+1
      IDIV8=IDIV8+1
      IF(QU(LH).LT.1.009.AND.IDUMR(LH).EQ.ITMIN1) THEN
      IDIV8=IDIV8-1
```

```
      END IF
      IF (MSFMHR(JDAY*24+LH).EQ.1) IMFL8=1
      IF(NP8.NE.8)GO TO 976
      IF(IDIV8.LT.6)IDIV8=6
      DIV8=IDIV8
C        FOR 8 HOUR AVERAGING PERIOD DIVIDE THE SUM OF THE HOURLY
C        CONCENTRATIONS BY THE NUMBER OF NON-CALM HOURS OR 6.0
C        WHICHEVER IS GREATER.
      DO 975 LQ=1,NRECEP
975   CONC(LQ,3)=CONC(LQ,3)/DIV8
      LL3=3
      IF(ICFL8.EQ.1)LL3=33
      IF (IMFL8.EQ.1)LL3=333
      CALL RANK(LL3)
      NP8=0
      IDIV8=0
      ICFL8=0
      IMFL8=0
976   NP24=NP24+1
      IDIV24=IDIV24+1
      IF(QU(LH).LT.1.009.AND.IDUMR(LH).EQ.ITMIN1)THEN
      IDIV24=IDIV24-1
      ICFL24=1
      END IF
      IF (MSFMHR(JDAY*24+LH).EQ.1) IMFL24=1
      IF(NP24.NE.24)GO TO 1011
      IF(IDIV24.LT.18)IDIV24=18
      DIV24=IDIV24
C        FOR 24 HOUR AVERAGING PERIOD DIVIDE THE SUM OF THE HOURLY
C        CONCENTRATIONS BY THE NUMBER OF NON-CALM HOURS OR 18.
C        WHICHEVER IS GREATER.
      DO 977 LQ=1,NRECEP
977   CONC(LQ,4)=CONC(LQ,4)/DIV24
      LL4=4
      IF(ICFL24.EQ.1)LL4=44
      IF (IMFL24.EQ.1) LL4=444
      CALL RANK(LL4)
      NP24=0
      IDIV24=0
      ICFL24=0
      IMFL24=0
1011  ITMIN1=IDUMR(LH)
      GO TO 1010
C
C        WHEN DEFAULT OPTION IS NOT USED, DETERMINE ENTRY INTO
C        SUBROUTINE RANK FOR APPROPRIATE AVERAGING PERIOD.
C        RANKING BASED ON HIGH AVERAGING PERIOD SUM.
C
979   IF (MSFMHR(JDAY*24+LH).EQ.1) L1=111
      CALL RANK (L1)
      L1=1
      NP3=NP3+1
      IF (MSFMHR(JDAY*24+LH).EQ.1) L2=222
      IF (NP3.NE.3) GO TO 980
      CALL RANK (L2)
      L2=2
      NP3=0
980   IF (MSFMHR(JDAY*24+LH).EQ.1) L3=333
      NP8=NP8+1
```

```
      CALL RANK (L3)
      L3=3
      NP8=0
990   IF (MSFMHR(JDAY*24+LH).EQ.1) L4=444
      NP24=NP24+1
      IF (NP24.NE.24) GO TO 1000
      CALL RANK (L4)
      L4=4
      NP24=0
1000  IF (NAVT.EQ.4) GO TO 1010
      IF (MSFMHR(JDAY*24+LH).EQ.1) L5=555
      NPX=NPX+1
      IF (NPX.NE.NAV5) GO TO 1010
      CALL RANK (L5)
      L5=5
      NPX=0
C
C->->->->SECTION T - END HOURLY, AVERAGING TIME, AND DAILY LOOPS.
C
1010  IF (IOPT(11).EQ.1.AND.IOPT(14).EQ.1) GO TO 1020
C        IF BOTH OPTIONS 11 AND 14 CALL FOR OUTPUT DELETIONS,
C         SKIP HOURLY PRINTOUT.
      CALL OUTHR
1020  CONTINUE
C
C        END OF HOURLY LOOP
C
      IF (NE.GT.24) IDATE(2)=ISTDAY
C        OUTPUT FINAL RESULTS
      CALL OUTAVG
      NP=NP+1
      NHRS=NHRS+NAVG
C        NEXT STATEMENT IS BRANCH FOR END OF RUN.
      IF (NP.GE.NPER) GO TO 1050
      IF (NHRS.LT.24) GO TO 1030
C
C     ADDED FOR SHORELINE DISPERSION MODEL
C
      DO 1021 I=1,NPT
         PTEST=0.
         DO 1022 J=1,24
            PTEST=PTEST+MSFMFL(I,J)
 1022    CONTINUE
         IF (PTEST.GT.0.) WRITE (IO,1023) (PNAME(J,I),J=1,3),IDAY,
     &   (MSFMFL(I,J),J=1,24)
         DO 1024 J=1,24
            MSFMFL(I,J)=0
 1024    CONTINUE
 1021 CONTINUE
 1023 FORMAT ('  SOURCE ',3A4,' DAY',I3,'SHORELINE FUMIGATION HOURS',
     &  24(2X,I1))
C
C
C
      IF (IOPT(20).EQ.0) GO TO 720
C        NEXT STATEMENT CHECKS FOR END OF SEGMENTED RUN.
      IF (IDAY.GE.LDRUN) GO TO 1040
      GO TO 720
C
```

```
C
1030  NB=NB+NAVG
      NE=NE+NAVG
      IF (NB.LE.24) GO TO 770
      NB=MOD(NB,24)
      NE=NB+NAVG-1
      GO TO 770
C
C        END OF LOOP FOR AVERAGING PERIOD.
C
C        IF SEGMENTED RUN, TEMPORARILY STORE
C         HIGH-FIVE INFO ON UNIT 14 FILE.
1040  WRITE (14) IDAY,SUM,NHR,DAY1A,HR1,HMAXA,NDAY,IHR
      WRITE (IO,1730) IDAY
      GO TO 1140
1050  IF (IOPT(19).EQ.1) GO TO 1140
C
C->->->->SECTION U - WRITE AVERAGE CONC. AND HIGH-FIVE TABLES.
C
C        IF OPTION 19 = 0, WRITE AVERAGE CONCENTRATION.
C         FOR LENGTH OF RECORD AND HIGH-FIVE TABLE.
      DO 1060 J=1,NRECEP
      STAR(1,J)=BLNK
      STAR(2,J)=BLNK
1060  CONTINUE
      WRITE (IO,1400)(MODEL(K,MUOR),K=1,2), LINE1,LINE2,LINE3
      HR2=NE
C        FOR DEFAULT OPTION CALCULATE AND REPORT THE
C        NUMBER OF CALMS FOR AVERAGING PERIOD.
      IF(IOPT(25).EQ.1)THEN
      NHR=NHR-ICALM
      WRITE(6,1061)ICALM
      END IF
      SUM(1)=SUM(1)/NHR
      HIMAX=SUM(1)
      KMX=1
C        INITIALIZE PERIODIC CONC TO BEGIN RANKING FOR PERIODIC MAX
      DO 1070 K=2,NRECEP
      SUM(K)=SUM(K)/NHR
      IF (SUM(K).LE.HIMAX) GO TO 1070
      KMX=K
      HIMAX=SUM(K)
1070  CONTINUE
      STAR(1,KMX)=STR
C        FIND HIGHEST AVERAGE CONC. AMONG RECEPTORS.
      WRITE (IO,1740) DAY1A,HR1,DAY2,HR2
      DO 1080 K=1,NRECEP
1080  WRITE (IO,1750) K,(RNAME(J,K),J=1,2),RREC(K),SREC(K),ZR(K),ELR(K),
     1STAR(1,K),SUM(K)
      STAR(1,KMX)=BLNK
C        LOOP TO WRITE HIGH-FIVE TABLE FOR 4 OR 5 AVG TIMES.
      DO 1130 L=1,NAVT
C        ASTERISKS DEPICT RECEPTORS WITH HIGHEST AND
C         SECOND HIGHEST CONCENTRATIONS.
      K1=1
      K2=1
      HI1=HMAXA(1,1,L)
      HI2=HMAXA(2,1,L)
      DO 1100 K=2,NRECEP
```

```
      HI1=HMAXA(1,K,L)
      K1=K
1090  IF (HMAXA(2,K,L).LE.HI2) GO TO 1100
      HI2=HMAXA(2,K,L)
      K2=K
1100  CONTINUE
      STAR(1,K1)=STR
      STAR(2,K2)=STR
      IF((IOPT(25).EQ.1.AND.L.EQ.1).OR.(IOPT(25).NE.1))THEN
      WRITE (IO,1760) NTIME(L),TITLE(IP),(I,I=1,5)
      END IF
      IF(IOPT(25).EQ.1.AND.L.NE.1)THEN
      WRITE (IO,1761) NTIME(L),TITLE(IP),(I,I=1,5)
      END IF
      ZDUM=ATIME(L)
      DO 1120 K=1,NRECEP
C        SET CALM FLAG FOR PRINTING.
C        RESET HOUR VARIABLE FOR CALM HOURS.
      IF(IOPT(25).EQ.1)THEN
         DO 1112 J=1,5
            IF(IHR(J,K,L).GT.24)THEN
               IHR(J,K,L)=IHR(J,K,L)-100
               CF(J)=C
            END IF
1112     CONTINUE
      END IF
      DO 10000 J=1,5
            CF(J)=BLNK
            IF (IHR(J,K,L).GT.124) THEN
               IHR(J,K,L)=IHR(J,K,L)-200
               CF(J)=FUME
            ENDIF
10000 CONTINUE
      IF(IOPT(25).EQ.1)GO TO 1111
C        CALCULATE AVERAGE CONCENTRATIONS WHEN
C        DEFAULT OPTION IS NOT ON.
      DO 1110 J=1,5
1110  HMAXA(J,K,L)=HMAXA(J,K,L)/ZDUM
 1111 WRITE (IO,1770) K,RREC(K),SREC(K),(STAR(J,K),HMAXA(J,K,L),CF(J),
     1NDAY(J,K,L),IHR(J,K,L),J=1,2),(HMAXA(J,K,L),CF(J),NDAY(J,K,L),
     2IHR(J,K,L),J=3,5)
1120  CONTINUE
C        INITIALIZE ASTERISK STORAGE TO BLANKS.
      STAR(1,K1)=BLNK
      STAR(2,K2)=BLNK
1130  CONTINUE
C
C->->->->SECTION V - CLOSE OUT FILES.
C
1140  IF (IOPT(21).EQ.0) GO TO 1150
      END FILE 10
C     END FILE 10
1150  IF (IOPT(22).EQ.0) GO TO 1160
      END FILE 12
C     END FILE 12
1160  IF (IOPT(23).EQ.0) GO TO 1170
      END FILE 13
C     END FILE 13
C     CALL WAUDIT
```

```
C
C->->->->SECTION X - OUTLINE OF PROGRAM SECTIONS
C
C         SECTION A - GENERAL REMARKS
C         SECTION B - DATA INPUT LISTS.
C         SECTION C - COMMON, DIMENSION, AND DATA STATEMENTS.
C         SECTION D - FLOW DIAGRAM.
C         SECTION E - RUN SET-UP AND READ FIRST 6 INPUT CARDS.
C         SECTION F - INPUT AND PROCESS EMISSION INFORMATION.
C         SECTION G - RANK SIGNIFICANT SOURCES.
C         SECTION H - EMISSIONS WITH HEIGHT TABLE.
C         SECTION I - EXECUTE FOR INPUT OF SIGNIFICANT SOURCE NUMBERS.
C         SECTION J - CHECK MET. DATA IF FROM FILE OF ONE YEARS'S DATA.
C         SECTION K - GENERATE POLAR COORDINATE RECEPTORS.
C         SECTION L - READ POLAR COORDINATE ELEVATIONS.
C         SECTION M - READ AND PROCESS RECEPTOR INFORMATION.
C         SECTION N - POSITION FILES AS REQUIRED.
C         SECTION O - START LOOPS FOR DAY AND AVERAGING TIME; READ
C                        MET. DATA.
C         SECTION P - CALCULATE AND WRITE MET. SUMMARY INFORMATION.
C         SECTION Q - INITIALIZE FOR HOURLY LOOP.
C         SECTION R - BEGIN HOURLY LOOP.
C         SECTION S - CALCULATE AND STORE FOR HIGH-FIVE TABLE.
C         SECTION T - END HOURLY, AVERAGING TIME, AND DAILY LOOPS.
C         SECTION U - WRITE AVERAGE CONC. AND HIGH-FIVE TABLES.
C         SECTION V - CLOSE OUT FILES.
C         SECTION W - FORMAT STATEMENTS.
C         SECTION X - OUTLINE OF PROGRAM SECTIONS.
C         SECTION Y - INPUT AND OUTPUT FILE DESCRIPTIONS.
C         SECTION Z - INDEX AND GLOSSARY.
C
C
C->->->-> SECTION Y -  INPUT AND OUTPUT FILE DESCRIPTIONS.
C
C***      INPUT AND OUTPUT FILE DESCRIPTIONS.
C
C***  INPUT FILE (UNIT 11) METEOROLOGICAL DATA (USED IF IOPT(5)=0)
C
C      RECORD 1
C
C        ID            SFC STATION IDENTIFIER, 5 DIGITS
C        IYEAR         YEAR OF SURFACE DATA, 2 DIGITS
C        IDM           MIX HT STATION IDENTIFIER, 5 DIGITS
C        IYR           YEAR OF MIX HT DATA, 2 DIGITS
C
C      RECORD TYPE 2 (ONE FOR EACH DAY OF YEAR)
C
C        JYR           YEAR
C        IMO           MONTH
C        DAY1          JULIAN DAY
C        IKST(24)      STABILITY CLASS
C        QU(24)        WIND SPEED, METERS PER SECOND
C        QTEMP(24)     AMBIENT AIR TEMPERATURE, KELVIN
C        DUMR(24)      FLOW VECTOR TO 10 DEG, DEGREES AZIMUTH
C        QTHETA(24)    RANDOMIZED FLOW VECTOR, DEGREES AZIMUTH
C        HLH(2,24)     MIXING HEIGHT, METERS
C
C***  INPUT FILE(UNIT 15) EMISSION DATA (USED IF IOPT(6)=1)
C
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C
C        IDATP        DATE-TIME INDICATOR CONSISTING OF YEAR, JULIAN DAY,
C                      AND HOUR: YYDDDHH.
C        SOURCE(IPOL,I),I=1,NPT  EMISSION RATE FOR THE POLLUTANT IPOL
C                                 FOR EACH SOURCE, GRAMS PER SECOND.
C
C***  OUTPUT PUNCHED CARDS (UNIT 1) AVERAGE CONCENTRATIONS (PUNCHED IF
C                                         IOPT(24)=1)
C
C      CARD TYPE 1 (ONE FOR EACH RECEPTOR FOR EACH AVERAGING TIME)
C
C        CC:1-4       WORD'CNTL' PUNCHED
C        CC:5         BLANK
C        CC:6-15      RREC  EAST COORDINATE OF RECEPTOR, USER UNITS
C        CC:16-25     SREC  NORTH COORDINATE OF RECEPTOR, USER UNITS
C        CC:26-35     GWU   CONCENTRATION FOR AVERAGING TIME, MICROG/M**3
C        CC:36-55     BLANK
C        CC:56-59     K     RECEPTOR NUMBER
C        CC:60-69     ZR    RECEPTOR HEIGHT ABOVE GROUND, METERS
C        CC:70-79     ELR  RECEPTOR GROUND-LEVEL ELEVATION, USER HT UNITS
C
C***  OUTPUT FILE (UNIT 10) PARTIAL CONCENTRATIONS (USED IF IOPT(21)=1)
C
C     RECORD TYPE 1
C
C        NPER         NUMBER OF PERIODS
C        NAVG         NUMBER OF HOURS IN AVERAGING PERIOD.
C        LINE1(14)    80 ALPHANUMERIC CHARACTERS FOR TITLE.
C        LINE2(14)    80 ALPHANUMERIC CHARACTERS FOR TITLE.
C        LINE3(14)    80 ALPHANUMERIC CHARACTERS FOR TITLE.
C
C     RECORD TYPE 2 (FROM MPTER) (ONE FOR EACH AVERAGING PERIOD)
C
C        NRECEP       NUMBER OF RECEPTORS
C        NPT          NUMBER OF SOURCES
C        RREC(I),I=1,NRECEP  EAST COORDINATE OF RECEPTOR, USER UNITS
C        SREC(I),I=1,NRECEP  NORTH COORDINATE OF RECEPTOR, USER UNITS
C
C      RECORD TYPE 3 (ONE FOR EACH RECEPTOR FOR EACH SIMULATED HOUR,
C                      FROM PTR)
C
C        IDATE        YEAR AND JULIAN DAY
C        LH           HOUR
C        K            RECEPTOR NUMBER
C        PARTC(J),J=1,NPT  CONCENTRATION AT RECEPTOR K FROM SOURCE J,
C                            G/M**3.
C
C***  OUTPUT FILE (UNIT 12) HOURLY CONCENTRATIONS (USED IF IOPT(22)=1)
C
C     RECORD 1
C
C        NPER         NUMBER OF PERIODS
C        NAVG         NUMBER OF HOURS IN AVERAGING PERIOD.
C        LINE1(14)    80 ALPHANUMERIC CHARACTERS FOR TITLE.
C        LINE2(14)    80 ALPHANUMERIC CHARACTERS FOR TITLE.
C        LINE3(14)    80 ALPHANUMERIC CHARACTERS FOR TITLE.
C
C      RECORD 2
C
```

```
C         RREC(I),I=1,NRECEP  EAST COORDINATE OF RECEPTOR, USER UNITS
C         SREC(I),I=1,NRECEP  NORTH COORDINATE OF RECEPTOR, USER UNITS
C
C       RECORD TYPE 3 (ONE FOR EACH SIMULATED HOUR)
C
C         IDATE(2)     JULIAN DAY
C         LH           HOUR
C         PHCHI(I),I=1,NRECEP  HOURLY CONCENTRATION FOR EACH RECEPTOR,
C                               G/M**3.
C
C***  OUTPUT FILE (UNIT 13) AVERAGING-PERIOD CONCENTRATIONS (USED IF
C                              IOPT(23)=1)
C
C       RECORD 1
C
C         NPER         NUMBER OF PERIODS
C         NAVG         NUMBER OF HOURS IN AVERAGING PERIOD.
C         LINE1(14)    80 ALPHANUMERIC CHARACTERS FOR TITLE.
C         LINE2(14)    80 ALPHANUMERIC CHARACTERS FOR TITLE.
C         LINE3(14)    80 ALPHANUMERIC CHARACTERS FOR TITLE.
C
C       RECORD 2
C
C         NRECEP       NUMBER OF RECEPTORS.
C         RREC(I),I=1,NRECEP  EAST COORDINATE OF RECEPTOR, USER UNITS
C         SREC(I),I=1,NRECEP  NORTH COORDINATE OF RECEPTOR, USER UNITS
C
C       RECORD TYPE 3 (ONE FOR EACH SIMULATED AVERAGING PERIOD)
C
C         IDATE(2)     JULIAN DAY
C         NB           ENDING HOUR OF PERIOD
C         PCHI(K),K=1,NRECEP  AVERAGING PERIOD CONCENTRATION FOR EACH
C                              RECEPTOR, G/M**3.
C
C***  TEMPORARY FILE (UNIT 14) VALUES FOR HIGH-FIVE TABLES (USED IF
C                                  IOPT(20)=1)
C
C       ONLY RECORD
C
C         NDAY(ON WRITE)    NUMBER OF DAYS PROCESSED
C         IDAYS(ON READ     NUMBER OF DAYS PREVIOUSLY PROCESSED
C         SUM(180)          CUMULATION OF LONG-TERM CONCENTRATION,(G/M**3
C         NHR               NUMBER OF HOURS PROCESSED
C         DAY1A             JULIAN DAY OF START OF LENGTH OF RECORD.
C         HR1               START HOUR OF LENGTH OF RECORD
C         HMAXA(3,5,180,5)  HIGHEST FIVE CONCENTRATIONS (G/M**3), AND
C                            ASSOCIATED DAY AND HOUR, FOR EACH RECEPTOR,
C                            FOR FIVE DIFFERENT AVERAGING TIMES.
C
C->->->->SECTION W - FORMAT STATEMENTS.
C
C          INPUT FORMATS
C
1061  FORMAT(5X,T98,'# CALMS FOR PERIOD: ',I4)
1180  FORMAT (20A4/20A4/20A4)
1200  FORMAT (A4)
1210  FORMAT (3A4,8F8.2,F4.0)
1220  FORMAT (26I3)
1230  FORMAT (I2,8X,5F10.0)
```

```
C
C        ERROR STATEMENT FORMATS
C
1250  FORMAT (1X,' NSIGP (THE NO. OF SIGNF POINT SOURCES) WAS FOUND',' T
     1O EXCEED THE LIMIT (25).  USER TRIED TO INPUT ',I3,' SOURCES'/'
     2 *********EXECUTION TERMINATED**********')
1260  FORMAT (1H0,'CONTER VALUE IS OUTSIDE OF RANGE: ','ZERO TO ONE. EXE
     1CUTION TERMINATED.')
1270  FORMAT (' USER TRIED TO INPUT MORE THAN ',I4,' POINT SOURCES. THIS
     1 GOES BEYOND THE CURRENT PROGRAM DIMENSIONS.')
1280  FORMAT (1X,'NPT =  ',I3,'I.E., EQUAL OR LESS THAN ZERO'/' RUN TERM
     1INATED----CHECK INPUT DATA')
1290  FORMAT (1H1,'***ERROR---USER TRIED TO SPECIFY ',I4,' SIGNIFICANT S
     1OURCES, BUT IS ONLY ALLOWING ',I3,' TOTAL SIGNIFICANT SOURCES IN T
     2HIS RUN.',/2X,'***RUN TERMINATED-CHECK INPUT DATA]***')
1300  FORMAT (' (MPS) THE INPUT SIGNIFICANT SOURCE NUMBER ','WAS FOUND T
     1O EQUAL ZERO - USER CHECK INPUT DATA.')
1310  FORMAT (' SURFACE DATA IDENTIFIERS READ INTO MODEL (STATION=',I5,'
     1 ,YEAR=',I2,') DO NOT AGREE WITH THE PREPROCESSOR OUTPUT FILE',/1X
     2,' (STATION=',I5,' ,YEAR=',I2)
1320  FORMAT (' MIXING HEIGHT IDENTIFIERS READ INTO MODEL (STATION=',I5,
     1' ,YEAR=',I2,') DO NOT AGREE WITH THE PREPROCESSOR OUTPUT FILE',/1
     2X,' (STATION=',I5,' ,YEAR=',I2)
1330  FORMAT (1H0,' WRONG RECEPTOR ELEVATION CARD READ.','READ CARD FOR
     1AZIMUTH ',I3,' SHOULD HAVE BEEN ',I3,'.')
1340  FORMAT (1X,'****USER EITHER TRIED TO INPUT MORE THAN 180 ','RECEPT
     1ORS OR ENDREC WAS NOT PLACED AFTER THE LAST RECEPTOR ','CARD****'/
     2'********EXECUTION TERMINATED*******')
1350  FORMAT (1X,'NO RECEPTORS HAVE BEEN CHOSEN')
1360  FORMAT (1H0,'***DAYS DO NOT MATCH, IDAY = ',I4,', IDAYS = ',I4)
1370  FORMAT (' DATE ON MET. TAPE, ',I2,I3,' ,DOES NOT MATCH INTERNAL DA
     1TE, ',I2,I3)
1380  FORMAT (' HOUR ',I3,' IS NOT PERMITTED. HOURS MUST BE DEFINED BETW
     1EEN 1 AND 24')
1390  FORMAT (' DATE BEING PROCESSED IS= ',I8/1X,'DATE OF HOURLY POINT E
     1MISSION RECORD IS =',I8/1X,'***PLEASE CHECK EMISSION RECORDS***')
C
C        OUTPUT FORMATS
C
 1395 FORMAT ('0',T35,A4,A1,1X,'SDM - VERSION 88204'/1X,20A4/1X,20A4/
     *1X,20A4)
 1400 FORMAT ('1',T40,A4,A1,1X,'SDM - VERSION 88204'/1X,20A4/1X,20A4/
     *1X,20A4)
1410  FORMAT (1H0,T30,'GENERAL INPUT INFORMATION'//2X,'THIS RUN OF SDM
     1-VERSION 88204 IS FOR ','THE POLLUTANT ',A4,' FOR ',I3,1X,I3,'-HOU
     2R PERIODS.'/2X,'CONCENTRATION ESTIMATES BEGIN ON HOUR-',I2,', JULI
     3AN DAY-',I3,', YEAR-19',I2,'.'/1X,' A FACTOR OF ',F14.7,' HAS BEEN
     4 SPECIFIED TO ','CONVERT USER LENGTH UNITS TO KILOMETERS.'/1X,I3,'
     5 SIGNIFICANT SOURCES ARE TO BE CONSIDERED.')
1420  FORMAT (1H ,'THIS RUN WILL NOT CONSIDER ANY POLLUTANT LOSS.')
1430  FORMAT (1H ,2X,'A HALF-LIFE OF ',F10.2,' (SECONDS) HAS BEEN ASSUME
     1D BY THE USER.')
1440  FORMAT (1X,' HIGH-FIVE SUMMARY CONCENTRATION TABLES ','WILL BE OUT
     1PUT FOR ',I3,' AVERAGING PERIODS.'/'  AVG TIMES ','OF 1,3,8, AND 2
     24 HOURS ARE AUTOMATICALLY DISPLAYED.')
1450  FORMAT (1H ,2X,'A FACTOR OF ',F14.7,' HAS BEEN SPECIFIED TO CONVER
     1T USER HEIGHT UNITS TO METERS.')
1460  FORMAT (1H0,T3,'OPTION  ',T16,'OPTION LIST',T46,'OPTION SPECIFICAT
     1ION : 0= IGNORE OPTION'/1X,T68,' 1= USE OPTION'/T25,'TECHNICAL OPT
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     3OT INCLUDE STACK DOWNWASH CALCULATIONS',T70,I1/1X,T7,I2,T16,'DO NO
     4T INCLUDE GRADUAL PLUME RISE CALCULATIONS',T70,I1/1X,T7,I2,T16,'CA
     5LCULATE INITIAL PLUME SIZE',T70,I1/1X,T25,'INPUT OPTIONS'/1X,T7,I2
     6,T16,'READ MET DATA FROM CARDS',T70,I1/1X,T7,I2,T16,'READ HOURLY E
     7MISSIONS',T70,I1/1X,T7,I2,T16,'SPECIFY SIGNIFICANT SOURCES',T70,I1
     8/1X,T7,I2,T16,'READ RADIAL DISTANCES TO GENERATE RECEPTOR',T70,I1
     9/T25,'PRINTED OUTPUT OPTIONS'/1X,T7,I2,T16,'DELETE EMISSIONS WITH
     AHEIGHT TABLE',T70,I1/1X,T7,I2,T16,'DELETE MET DATA SUMMARY FOR AVG
     B PERIOD',T70,I1/1X,T7,I2,T16,'DELETE HOURLY CONTRIBUTIONS',T70,I1/
     C1X,T7,I2,T16,'DELETE MET DATA ON HOURLY CONTRIBUTIONS',T70,I1/1X,T
     D7,I2,T16,'DELETE FINAL PLUME RISE CALC ON HRLY CONTRIBUTIONS',T70,
     EI1)
1470  FORMAT (1X,T7,I2,T16,'DELETE HOURLY SUMMARY',T70,I1/1X,T7,I2,T16,'
     1DELETE MET DATA ON HRLY SUMMARY',T70,I1/1X,T7,I2,T16,'DELETE FINAL
     2 PLUME RISE CALC ON HRLY SUMMARY',T70,I1/1X,T7,I2,T16,'DELETE AVG-
     3PERIOD CONTRIBUTIONS',T70,I1/1X,T7,I2,T16,'DELETE AVERAGING PERIOD
     4 SUMMARY',T70,I1/1X,T7,I2,T16,'DELETE AVG CONCENTRATIONS AND HI-5
     5TABLES',T70,I1/T25,'OTHER CONTROL AND OUTPUT OPTIONS'/1X,T7,I2,T16
     6,'RUN IS PART OF A SEGMENTED RUN',T70,I1/1X,T7,I2,T16,'WRITE PARTI
     7AL CONC TO DISK OR TAPE',T70,I1/1X,T7,I2,T16,'WRITE HOURLY CONC TO
     8 DISK OR TAPE',T70,I1/1X,T7,I2,T16,'WRITE AVG-PERIOD CONC TO DISK
     9OR TAPE',T70,I1/1X,T7,I2,T16,'PUNCH AVG-PERIOD CONC ONTO CARDS',T7
     A0,I1/T25,'DEFAULT  OPTION '/1X,T7,I2,T16,
     B'USE DEFAULT OPTION',T70,I1)
1480  FORMAT (1H0,2X,'ANEMOMETER HEIGHT= ',F10.2/3X,'WIND PROFILE WITH '
     1,'HEIGHT EXPONENTS CORRESPONDING TO STABILITY ARE AS FOLLOWS:'/8X,
     2'FOR STABILITY A: ',F4.2/12X,'STABILITY B: ',F4.2/12X,'STABILITY C
     3: ',F4.2,/12X,'STABILITY D: ',F4.2,/12X,'STABILITY E: ',F4.2/12X,'
     4STABILITY F: ',F4.2)
1490  FORMAT (1H0,'ANEMOMETER HEIGHT IS:',F10.2/1X,'EXPONENTS FOR POWER-
     1 LAW WIND INCREASE WITH HEIGHT ARE:',F4.2,5(',',F4.2)/' TERRAIN AD
     2JUSTMENTS ARE: ',F5.3,5(',',F5.3)//)
1500  FORMAT ('1',T40,'POINT SOURCE INFORMATION'//1X,T5,'SOURCE',T23,'EA
     1ST',T31,'NORTH',T39,'SO2(G/SEC)  PART(G/SEC)  STACK  STACK   STACK
     2   STACK',3X,'PCTEN. IMPACT',2X,'EFF',3X,'GRD-LVL BUOY FLUX'/1X,T2
     33,'COORD',T31,'COORD',' EMISSIONS  EMISSIONS   HT(M) TEMP(K) D
     4IAM(M)','VEL(M/SEC)(MICRO G/M**3) HT(M)',3X,'ELEV',6X,'F'/1X,T24,'
     5(USER UNITS)',T116,'USER HT M**4/S**3'/1X,T117,'UNITS'/)
1510  FORMAT (1X,I3,1X,3A4,1X,2F9.2,2F12.2,4F8.2,6PF13.2,0PF9.2,2F9.2)
1520  FORMAT ('0',T3,'SIGNIFICANT ',A4,' POINT SOURCES'//1X,T8,'RANK',T2
     12,'CHI-MAX',T33,'SOURCE NO.'/1X,T17,'(MICROGRAMS/M**3)'/1X)
1530  FORMAT (1X,T9,I3,T18,6PF12.2,T35,I3)
1540  FORMAT (1X,'HEIGHT ABOVE 100M FOR POINT SOURCE',I4,3X,' HEIGHT=',F
     16.2,' (METERS)','  EMISSIONS=',F10.2,' (G/SEC)')
1550  FORMAT ('0',4X,'TOTAL ',A4,' EMISSION AND CUMULATIVE FRACTION ACCO
     1RDING TO HEIGHT'//1X,T12,'TOTAL POINT   CUMULATIVE '/1X,'HEIGHT(M)
     2 EMISSIONS(G/S)  FRACTION'/1X)
1560  FORMAT (1X,T2,I2,' -',I3,T11,F8.2,T26,F7.3,T41,F8.2,T56,F7.3)
1570  FORMAT ('0',T2,'TOTAL',2X,F10.2)
1580  FORMAT (1H0,21X,'ADDITIONAL INFORMATION ON SOURCES.')
1590  FORMAT (1H0,' USER SPECIFIED ',I3,' (NPT) SIGNIFICANT POINT ','SO
     1URCES AS LISTED BY POINT SOURCE NUMBER:'/2X,25I5)
1600  FORMAT ('0',2X,'EMISSION INFORMATION FOR ',I4,' (NPT) POINT SOUR',
     1'CES HAS BEEN INPUT'/2X,I2,' SIGNIFICANT POINT SOURCES(NSIGP) ','A
     2RE TO BE',' USED FOR THIS RUN'/2X,'THE ORDER OF SIGNIFICANCE(IMPS)
     3 FOR 25 OR LESS POINT SOURCES USED IN THIS RUN AS LISTED BY POINT
     4SOURCE NUMBER:'/2X,25I5)
1610  FORMAT (2X,'SURFACE MET DATA FROM STATION(ISFCD) ',I6,', YEAR(ISFC
     1YR) 19',I2/2X,'MIXING HEIGHT DATA FROM STATION(IMXD) ',I6,', YEAR(
     2IMXYR) 19',I2)
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1620  FORMAT (1H0,T21,'RECEPTOR INFORMATION')
1630  FORMAT (1H0,' SDM INTERNALLY GENERATES 36 RECEPTORS ','ON A CIRCLE
     1 CORRESPONDING TO EACH NON-ZERO ','RADIAL DISTANCE FROM A CENTERP
     2OINT '/1X,T10,'COORDINATES ARE (USER UNITS): (',F8.3,',',F8.3,')'
     3/1X,T10,'RADIAL DISTANCE(S) USER SPECIFIED (USER UNITS): ',5(F11.3
     4,'  '))
1640  FORMAT (F4.1)
1650  FORMAT ('0',' RECEPTOR    IDENTIFICATION  EAST     NORTH     RECEP
     1TOR HT     RECEPTOR GROUND LEVEL'/1X,T30,'COORD',T39,'COORD  ABV L
     2OCAL GRD LVL         ELEVATION'/1X,T31,'(USER UNITS)          (METER
     3S)          (USER HT UNITS)'/1X)
1660  FORMAT (1X,T3,I3,2A1,8X,2A4,F13.3,F10.3,F10.1,F20.1)
1670  FORMAT (1H0,T3,'* ONE ASTERISK INDICATES THAT THE ASSOCIATED ','RE
     1CEPTOR(S) HAVE A GROUND LEVEL ELEVATION LOWER ','THAN THE LOWEST S
     2OURCE BASE ELEVATION.'/' CAUTION SHOULD ','BE USED IN INTERPRETING
     3 CONCENTRATIONS FOR THESE RECEPTORS.'/' **  TWO ASTERISKS ','INDIC
     4ATE THAT THE ASSOCIATED RECEPTOR(S) HAVE GROUND LEVEL ','ELEVATION
     5S ABOVE THE LOWEST STACK TOP.'/'    CONSEQUENTLY',' NO CALCULATION
     6S WILL BE PERFORMED WITH THIS RECEPTOR.A ','SERIES OF ASTERISKS WI
     7LL INSTEAD APPEAR IN THE OUTPUT.')
1680  FORMAT (//1X,' THE NUMBER OF   DAYS  PREVIOUSLY COMPLETED EQUAL ',
     1I3,' AND THE LAST   DAY  TO BE COMPLETED IN THIS RUN IS ',I3)
1690  FORMAT ('1INPUT MET DATA  ',I2,'/',I4/1X,T2,'HOUR   THETA    SPEED
     1   MIXING   TEMP     STABILITY'/1X,T9,'(DEG)     (M/S)  HEIGHT(M) (
     2DEG-K)  CLASS'/1X)
1700  FORMAT (1X,T3,I2,4F9.2,6X,I1)
1710  FORMAT ('0','RESULTANT MET CONDITIONS'/1X)
1720  FORMAT (2X,'WIND DIRECTION=',F7.2,T36,'RESULTANT WIND SPEED=',F7.2
     1/2X,'AVERAGE WIND SPEED=',F7.2,T36,'AVERAGE TEMP=',F7.2/2X,'WIND P
     2ERSISTENCE=',F6.3,T36,'MODAL STABILITY=',I2)
1730  FORMAT (1H0,' THIS SEGMENT OF A SEGMENTED RUN HAS COMPLETED',I5,'
     1(IDAY) DAYS.')
1740  FORMAT ('0',T9,'       RECEPTORS'//1X,'RECEPTOR    IDENTIFICATION
     1EAST      NORTH     RECEPTOR HT      RECEPTOR GROUND LEVEL',T99,'AVG
     2 CONC FOR PERIOD'/1X,T30,'COORD',T39,'COORD  ABV LOCAL GRD LVL
     3   ELEVATION',T94,'DAY',F4.0,'HR',F3.0,' TO DAY',F4.0,'HR',F3.0/1X
     4,T31,'(USER UNITS)         (METERS)          (USER HT UNITS)',T100,'
     5(MICROGRAMS/M**3)'/1X)
1750  FORMAT (1X,T3,I3,10X,2A4,5X,F8.2,2X,F8.2,F10.1,F20.1,T110,A1,6PF7.
     12)
1760  FORMAT (1H1,T29,'FIVE HIGHEST ',I2,'-HOUR ',A4,' CONCENTRATIONS((E
     1NDING ON JULIAN DAY, HOUR)'/1X,T55,'(MICROGRAMS/M**3)'//2X,'RECEPT
     2OR ',T38,4(I1,20X),I1,/1X)
1761  FORMAT (1H1,T29,'FIVE HIGHEST ',I2,'-HOUR ',A4,' CONCENTRATIONS((E
     1NDING ON JULIAN DAY, HOUR)'/1X,T55,'(MICROGRAMS/M**3)'/
     21X,T36,'C-FLAG IDENTIFIES CONCENTRATIONS AFFECTED BY CALM HOURS'//
     32X,'RECEPTOR ',T38,4(I1,20X),I1,/1X)
1770  FORMAT (1H ,2X,I3,'(',F7.2,',',F7.2,')',2(1X,A1,6PF9.2,A1,1X,'(',I
     13,',',I2,')'),3(2X,6PF9.2,A1,1X,'(',I3,',',I2,')'))
 2531 FORMAT(F5.1)
 2532 FORMAT(F5.2)
 2533 FORMAT(F5.3)
C
      END

C
      BLOCK DATA
C                    BLOCK DATA        (VERSION 79365), PART OF MPTER.
      COMMON /EXPOS/ PXUCOF(6,9),PXUEXP(6,9),HC1(10),BXUCOF(6,9),BXUEXP(
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C***COEFFICIENTS GENERATED WITH RURAL SIGMAS USING PGYZ
C***   IH=9 FOR H GREATER THAN 500 METERS.
      DATA PXUCOF /.10401E+00,.12133E+00,.14273E+00,.15351E+00,.18855E+0
     10,.18668E+00,.77533E-01,.11728E+00,.14120E+00,.18239E+00,.20458E+0
     20,.34326E+00,.67228E-01,.10013E+00,.13963E+00,.19162E+00,.38998E+0
     30,.76271E+00,.40484E-01,.75308E-01,.13784E+00,.54357E+00,.72550E+0
     40,.22936E+01,.28539E-01,.66936E-01,.13615E+00,.52790E+00,.12908E+0
     51,.56943E+01,.14792E-01,.65799E-01,.13315E+00,.74832E+00,.28818E+0
     61,.40940E+03,.12403E-01,.64321E-01,.12927E+00,.10826E+01,.77020E+0
     72,.23011E+05,.12340E-01,.62874E-01,.12546E+00,.15580E+01,.68810E+0
     83,.46522E+06,.12245E-01,.60615E-01,.11952E+00,.22517E+01,.42842E+0
     93,.00000E+00/
      DATA PXUEXP /-.19460E+01,-.19774E+01,-.20086E+01,-.20742E+01,-.218
     122E+01,-.22176E+01,-.18479E+01,-.19661E+01,-.20050E+01,-.21317E+01
     2,-.22094E+01,-.24209E+01,-.18060E+01,-.19196E+01,-.20017E+01,-.214
     362E+01,-.23991E+01,-.26556E+01,-.16763E+01,-.18468E+01,-.19984E+01
     4,-.24128E+01,-.25578E+01,-.29371E+01,-.15940E+01,-.18191E+01,-.199
     555E+01,-.24059E+01,-.26934E+01,-.31511E+01,-.14513E+01,-.18153E+01
     6,-.19907E+01,-.24817E+01,-.28678E+01,-.40795E+01,-.14181E+01,-.181
     711E+01,-.19851E+01,-.25514E+01,-.34879E+01,-.48399E+01,-.14172E+01
     8,-.18071E+01,-.19799E+01,-.26152E+01,-.38719E+01,-.53670E+01,-.141
     960E+01,-.18012E+01,-.19721E+01,-.26744E+01,-.37956E+01,-.17020E+02
     A/
C***COEFFICIENTS GENUERATED WITH URBAN SIGMAS USING BRSYSZ & BRSZ
C***  FROM RAM MODEL.
C***RELATIVE CONCENTRATIONS NORMALIZED FOR WIND SPEED FROM POINT
C***  SOURCE, CHI*U/Q, =BXUCOF(KST,IH)*H**BXUEXP(KST,IH)
C***   IH=1 FOR H LESS THAN 20 METERS.
C***   IH=2 FOR H FROM 20 TO 30 METERS.
C***   IH=3 FOR H FROM 30 TO 50 METERS.
C***   IH=4 FOR H FROM 50 TO 70 METERS.
C***   IH=5 FOR H FROM 70 TO 100 METERS.
C***   IH=6 FOR H FROM 100 TO 200 METERS.
C***   IH=7 FOR H FROM 200 TO 300 METERS.
C***   IH=8 FOR H FROM 300 TO 500 METERS.
C***   IH=9 FOR H GREATER THAN 500 METERS.
C
      DATA BXUCOF /.16808E+00,.16808E+00,.20927E+00,.20378E+00,.18861E+0
     10,.18861E+00,.15945E+00,.15945E+00,.20527E+00,.20229E+00,.21253E+0
     20,.21253E+00,.14777E+00,.14777E+00,.19871E+00,.20011E+00,.24888E+0
     30,.24888E+00,.13262E+00,.13262E+00,.18908E+00,.19685E+00,.30041E+0
     40,.30041E+00,.11745E+00,.11745E+00,.17767E+00,.19301E+00,.34521E+0
     50,.34521E+00,.91943E-01,.91943E-01,.15327E+00,.18499E+00,.34368E+0
     60,.34368E+00,.65533E-01,.65533E-01,.11984E+00,.17445E+00,.23640E+0
     70,.23640E+00,.47345E-01,.47345E-01,.89821E-01,.16720E+00,.15537E+0
     80,.15537E+00,.29993E-01,.29993E-01,.56100E-01,.16747E+00,.11009E+0
     90,.11009E+00/
      DATA BXUEXP /-.19722E+01,-.19722E+01,-.19896E+01,-.19965E+01,-.206
     149E+01,-.20649E+01,-.19546E+01,-.19546E+01,-.19831E+01,-.19940E+01
     2,-.21047E+01,-.21047E+01,-.19322E+01,-.19322E+01,-.19736E+01,-.199
     308E+01,-.21512E+01,-.21512E+01,-.19045E+01,-.19045E+01,-.19609E+01
     4,-.19867E+01,-.21993E+01,-.21993E+01,-.18759E+01,-.18759E+01,-.194
     562E+01,-.19820E+01,-.22320E+01,-.22320E+01,-.18228E+01,-.18228E+01
     6,-.19142E+01,-.19728E+01,-.22310E+01,-.22310E+01,-.17589E+01,-.175
     789E+01,-.18677E+01,-.19617E+01,-.21604E+01,-.21604E+01,-.17019E+01
     8,-.17019E+01,-.18172E+01,-.19543E+01,-.20868E+01,-.20868E+01,-.162
     984E+01,-.16284E+01,-.17414E+01,-.19545E+01,-.20314E+01,-.20314E+01
     A/
      DATA HC1 /10.,20.,30.,50.,70.,100.,200.,300.,500.,1000./
```

```
      END
C
      BLOCK DATA ONE
C
      COMMON /MO/ QTHETA(24),QU(24),IKST(24),QHL(24),QTEMP(24),MPS(25),N
     1SIGP,IO,LINE1(20),LINE2(20),LINE3(20),RNAME(2,180),IRANK(180),STAR
     2(5,180)
C
      DATA STAR /900*' '/
C
        END
C

C
      FUNCTION ANGARC (DELM,DELN)
C                    FUNCTION ANGARC   (VERSION 79365), PART OF MPTER.
C        DETERMINES APPROPRIATE ANGLE OF TAN(ANG) = DELM/DELN
C        WHICH IS REQUIRED FOR CALCULATION OF RESULTANT WIND DIRECTION.
C        DELM IS THE AVERAGE WIND COMPONENT IN THE EAST DIRECTION.
C        DELN IS THE AVERAGE WIND COMPONENT IN THE NORTH DIRECTION.
C        NO COMMON REQUIREMENT, NO ARRAYS, USES LIBRARY FUNCTION ATAN
      IF (DELN) 10,40,80
10    IF (DELM) 20,30,20
20    ANGARC=57.29578*ATAN(DELM/DELN)+180.
      RETURN
30    ANGARC=180.
      RETURN
40    IF (DELM) 50,60,70
50    ANGARC=270.
      RETURN
60    ANGARC=0.
C     ANGARC=0. INDICATES INDETERMINATE ANGLE
      RETURN
70    ANGARC=090.
      RETURN
80    IF (DELM) 90,100,110
90    ANGARC=57.29578*ATAN(DELM/DELN)+360.
      RETURN
100   ANGARC=360.
      RETURN
110   ANGARC=57.29578*ATAN(DELM/DELN)
      RETURN
C
      END

       SUBROUTINE PTR(IDAY,PNAME)
C                    SUBROUTINE PTR    (VERSION 81350), PART OF MPTER.
C      THE PURPOSE OF THIS ROUTINE IS TO CALCULATE CONCENTRATIONS FROM
C      POINT SOURCES.
C
C->->->->SECTION PTR.A - COMMON AND DIMENSION.
C
      COMMON /MPOR/ IOPT(25)
      COMMON /MPO/ NRECEP,NAVG,NB,LH,NPT,IDATE(2),RREC(180),SREC(180),ZR
     1(180),ELR(180),PHCHI(180),PHSIGS(180,26),HSAV(250),DSAV(250),PCHI(
     2180),PSIGS(180,26),IPOL
      COMMON /MPR/ UPL,Z,H,HL,X,Y,KST,DELH,SY,SZ,RC,MUOR
      COMMON /MP/ SOURCE(9,250),CONTWO,PSAV(250),IPSIGS(250),U,TEMP,SINT
     1,COST,PL(6),ELP(250),ELHN,HANE,TLOS,CELM,CTER
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```
      CHARACTER*4 PNAME(3,250)
C
C     FLAG - ADDED FOR SDM (6-88)
C
      INTEGER FLAG
C
C->->->->SECTION PTR.B - INITIALIZE AND START RECEPTOR LOOP.
C
C        ZERO EFFECTIVE STACK HEIGHT FOR EACH SOURCE
C
C          NPT - THE NUMBER OF POINT SOURCES
      FLAG=0
      DO 10 J=1,NPT
C        HSAV WILL BE USED TO STORE THE SOURCE PLUME HEIGHTS.
10    HSAV(J)=0.0
C        LOOP ON RECEPTORS
C          NRECEP - THE NUMBER OF RECEPTORS
C
C->->->->SECTION PTR.C - START SOURCES LOOP, CALCULATE
C                        UPWIND AND CROSSWIND DISTANCES.
C
      DO 170 J=1,NPT
      IF (FLAG.EQ.1.OR.FLAG.EQ.3) FLAG=4
      DO 180 K=1,NRECEP
C        IF IOPT(1)=1, TERRAIN ADJUSTMENTS ARE MADE.
      IF (IOPT(1).EQ.0) GO TO 20
C          ELR - RECEPTOR GROUND LEVEL ELEVATION
      ER=ELR(K)
C          ELHN - LOWEST SOURCE STACK-TOP ELEVATION?
      IF (ER.LE.ELHN) GO TO 20
      PCHI(K)=99999.E+26
      PHCHI(K)=99999.E+26
      GO TO 180
20    CONTINUE
C          ZR - RECEPOR HEIGHT ABOVE GROUND
      Z=ZR(K)
      PARTC(J)=0.0
C          RQ - EAST COORDINATE OF THE SOURCE
      RQ=SOURCE(1,J)
C          SQ - NORTH COORDINATE OF THE SOURCE
      SQ=SOURCE(2,J)
C          ELP - SOURCE GROUND LEVEL ELEVATION
      EP=ELP(J)
C        DETERMINE UPWIND DISTANCE
C        XDUM,YDUM IN USER UNITS. X,Y IN KM.
C          RREC - EAST COORDINATE OF THE RECEPTOR
      XDUM=RQ-RREC(K)
C          SREC - NORTH COORDINATE OF THE RECEPTOR
      YDUM=SQ-SREC(K)
C        SINT AND COST ARE THE SIN AND COS OF THE WIND DIRECTION
C        CONTWO - MULTIPLIER CONSTANT TO CONVERT USER UNITS TO KM
      X=(YDUM*COST+XDUM*SINT)*CONTWO
C         X IS THE UPWIND DISTANCE  OF THE SOURCE FROM THE RECEPTOR.
C        IF X IS NEGATIVE, INDICATING THAT THE SOURCE IS DOWNWIND OF
C        THE RECEPTOR, THE CALCULATION IS TERMINATED ASSUMING NO
C        CONTRIBUTION FROM THAT SOURCE.
      IF (X.LE.0.0) GO TO 180
C
C        DETERMINE CROSSWIND DISTANCE
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```
      Y=(YDUM*SINT-XDUM*COST)*CONTWO
      H=HSAV(J)
C        SKIP PLUME RISE CALCULATION IF EFFECTIVE HT. HAS ALREADY BEEN
C           CALCULATED FOR THIS SOURCE
      IF (H.EQ.0.0) GO TO 30
      DELH=DH(J)
C
C->->->->SECTION PTR.D - EXTRAPOLATE WIND SPEED TO STACK TOP
C                        CALCULATE PLUME RISE.
C
      GO TO 110
C         MODIFY WIND SPEED BY POWER LAW PROFILE IN ORDER TO TAKE INTO
C        ACCOUNT THE INCREASE OF WIND SPEED WITH HEIGHT.
C        ASSUME WIND MEASUREMENTS ARE REPRESENTATIVE FOR HEIGHT = HANE.
C         THT IS THE PHYSICAL STACK HEIGHT
30    THT=SOURCE(5,J)
C        POINT SOURCE HEIGHT NOT ALLOWED TO BE LESS THAN 1 METER.
      IF (THT.LT.1.) THT=1.
C          U - WIND SPEED AT HEIGHT 'HANE'
C          PL - POWER FOR THE WIND PROFILE
C          UPL - WIND AT THE PHYSICAL STACK HEIGHT
      UPL=U*(THT/HANE)**PL(KST)
C        WIND SPEED NOT ALLOWED TO BE LESS THAN 1 METER/SEC.
      IF (UPL.LT.1.) UPL=1.
C        STORE THE STACK TOP WIND FOR THE JTH SOURCE FOR THIS HOUR
      UPH(J)=UPL
      VS=SOURCE(8,J)
      BUOY=SOURCE(9,J)
      TS=SOURCE(6,J)
C        TEMP- THE AMBIENT AIR TEMPERATURE FOR THIS HOUR
      DELT=TS-TEMP
      F=BUOY*DELT/TS
C         IOPT(6) HOURLY EMISSION INPUT FROM TAPE/DISK?  0=NO, 1=YES.
      IF (IOPT(6).EQ.0) GO TO 40
C        MODIFY EXIT VELOCITY AND BUOYANCY BY RATIO OF HOURLY EMISSIONS
C        TO AVERAGE EMISSIONS
      SCALE = SOURCE(IPOL,J)/PSAV(J)
      VS = VS*SCALE
      F = F*SCALE
40    D=SOURCE(7,J)
C
C*****PLUME RISE AND STACK TIP DOWNWASH CALCULATIONS
C
C        CALCULATE  H PRIME WHICH TAKES INTO ACCOUNT STACK DOWNWASH
C        BRIGGS(1973) PAGE 4
      HPRM=THT
C        IF IOPT(2)=1, THEN NO STACK DOWNWASH COMPUTATION
      IF (IOPT(2).EQ.1) GO TO 50
      DUM=VS/UPL
      IF (DUM.LT.1.5) HPRM=THT+2.*D*(DUM-1.5)
C        'HPRM' IS BRIGGS' H-PRIME
      IF (HPRM.LT.0.) HPRM=0.
C
C        CALCULATE PLUME RISE
C         MOMENTUM RISE EQUATION
C
50    DELHM=3.*VS*D/UPL
      IF(KST.GT.4)GO TO 70
C
```

```
C
      IF(TS.LT.TEMP)GO TO 80
      IF(F.GE.55.)GO TO 60
C
C        COMBINATION OF BRIGG'S(1971) EQNS. 6&7, PAGE 1031, FOR F<55.
C
      DELH=21.425*F**0.75/UPL
      IF(DELHM.GT.DELH)GO TO 80
      DISTF=0.049*F**0.625
      GO TO 100
C
C        COMBINATION OF BRIGG'S(1971) EQNS. 6&7, PAGE 1031, FOR F>=55.
C
60    DELH=38.71*F**0.6/UPL
      IF(DELHM.GT.DELH)GO TO 80
      DISTF=0.119*F**0.4
      GO TO 100
C
C        PLUME RISE FOR STABLE CONDITIONS
C
70    DTHDZ=0.02
      IF(KST.GT.5)DTHDZ=0.035
      S=9.80616*DTHDZ/TEMP
C
C        MOMENTUM RISE EQUATION
C        BRIGG'S(1969) EQUATION 4.28, PAGE 59
C
      DHA=1.5*(VS*VS*D*D*TEMP/(4.*TS*UPL))**0.333333/S**0.166667
      IF(DHA.LT.DELHM)DELHM=DHA
      IF(TS.LT.TEMP)GO TO 80
C
C        STABLE, BUOYANT RISE (WITH WIND)
C
      DELH=2.6*(F/(UPL*S))**0.333333
      IF(DELHM.GT.DELH)GO TO 80
      DISTF=0.0020715*UPL/SQRT(S)
      GO TO 100
80    DELH=DELHM
      DISTF=0.
100   H=HPRM+DELH
105   HSAV(J)=H
      DH(J)=DELH
      DSAV(J)=DISTF
      UPH(J)=UPL
      HPR(J)=HPRM
      FP(J)=F
C        IF SOURCE-RECEPTOR DISTANCE IS GREATER OR EQUAL TO DISTANCE TO
C        FINAL RISE, SKIP PLUME RISE CALCULATION AND USE FINAL RISE.
110   IF (X.GE.DSAV(J)) GO TO 120
      IF (IOPT(4).EQ.0.AND.IOPT(3).EQ.1) GO TO 120
C        CALCULATE GRADUAL PLUME RISE IF (1) THE USER SPECIFIES SO,
C        OR (2) USER EMPLOYS CALCULATION OF INITIAL DISPERSION.....
C        IN THIS CASE, USE OF FINAL EFFECTIVE HEIGHT IN THE CALCULATION
C       OF DISPERSION COEFFICIENTS COULD LEAD TO MISLEADING VALUES SINCE
C          SIGMA-Y,-Z =  DELTA-H/3.5
      DELH=160.*FP(J)**0.333333*X**0.666667/UPH(J)
C        PLUME RISE FOR DISTANCE X(160 IS 1.6*1000**.67 BECAUSE X IN KM)
      IF (DELH.GT.DH(J)) DELH=DH(J)
      IF (IOPT(3).EQ.1) GO TO 120
```

```
C        SPECIFYING CALCULATION OF GRADUAL PLUME RISE, THEN DO NOT
C        ADD THE NEW GRADUAL DELTA-H TO THE EFFECTIVE HEIGHT. OTHERWISE,
C        CHECK THE GRADUAL RISE PLUME HEIGHT WITH FINAL EFFECTIVE HEIGHT
C        AND SET THE PLUME HEIGHT TO THE SMALLER OF THE TWO VALUES.
        H=HPR(J)+DELH
C        ADD PLUME RISE TO STACK HEIGHT FOR TOTAL EFFECTIVE STACK HT.
C        END PLUME RISE CALCULATION
120   UPL=UPH(J)
C
C->->->->SECTION PTR.E - CALCULATE THE CONTRIBUTION OF
C                        ONE SOURCE TO ONE RECEPTOR.
C
      IF(KST.GT.4)GOTO130
      IF (H.LT.HL) GO TO 130
      PROD=0.
      GO TO 150
C        IF IOPT(1) = 1, TERRAIN ADJUSTMENTS ARE MADE
130   IF (IOPT(1).EQ.0) GO TO 140
      DUM=ER-EP
      H=H+CELM*(CTER*DUM-DUM)
C         RCP RETURNS THE DISPERSION PARAMETERS, SY AND SZ (METERS)
C        AND THE RELATIVE CONCENTRATION VALUES CHI/Q (SEC/M**3)

140   CALL INTERF(FLAG,IDAY,LH,J,F)
      IF (FLAG.NE.1)  CALL RCP
C        CALCULATE TRAVEL TIME IN KM-SEC/M TO INCLUDE DECAY RATE OF
C        POLLUTANT.
      TT=X/UPL
C        TLOS IN METERS/KM-SEC, SO TT*TLOS IS DIMENSIONLESS
C        INCLUDE THE POLLUTANT LOSS
      PROD=RC*SOURCE(IPOL,J)/EXP(TT*TLOS)
C
C     SHORELINE DISPERSION MODEL SPECIAL OUTPUT
C
      IF (FLAG.EQ.1.AND.PROD.GT.5.0E-10) WRITE (20,1000)
     & (PNAME(I,J),I=1,3),RREC(K),SREC(K),PROD*1E6
C
C        IF HAFL IS ZERO, TLOS WILL START AS ZERO AND
C        RESULT IN NO COMPUTATION OF POLLUTANT LOSS.
C        INCREMENT CONCENTRATION AT K-TH RECEPTOR(G/M**3)
C          PCHI - SUM FOR THE AVERAGING TIME AT RECEPTOR K
150   PCHI(K)=PCHI(K)+PROD
C          PHCHI - CONCENTRATION FOR THIS HOUR AT RECEPTOR K
      PHCHI(K)=PHCHI(K)+PROD
      KSIG=IPSIGS(J)
      IF (KSIG.EQ.0) GO TO 160
C        STORE CONCENTRATIONS FROM SIGNIFICANT SOURCES.(G/M**3)
      PSIGS(K,KSIG)=PSIGS(K,KSIG)+PROD
      PHSIGS(K,KSIG)=PHSIGS(K,KSIG)+PROD
      PSIGS(K,26)=PSIGS(K,26)+PROD
      PHSIGS(K,26)=PHSIGS(K,26)+PROD
160   PARTC(J)=PROD
C
C->->->->SECTION PTR.F - END SOURCE AND RECEPTOR LOOPS.
C
180   CONTINUE
C        END OF LOOP FOR SOURCES
C        WRITE PARTIAL CONCENTRATIONS ON DISK(G/M**3)  IF IOPT(21) = 1.
C       IF (IOPT(21).EQ.0) GO TO 180
```

```
C      WRITE (10) IDATE,LH,K,(PARTC(J),J=1,NPT)
170    CONTINUE
C
C
C
       IF (FLAG.NE.1.AND.FLAG.NE.3) GO TO 200
       DO 190 K=1,NRECEP
       IF (PHCHI(K).GT.5.E-10) WRITE (20,1000) 'ALL ','SOUR','CES ',
     & RREC(K),SREC(K),PHCHI(K)*1E6
 1000 FORMAT (' CONC:',3A4,F13.3,F13.3,F10.3)
  190 CONTINUE
  200 CONTINUE
C         END OF LOOP FOR RECEPTORS
       RETURN
C
C***    SECTIONS OF SUBROUTINE PTR.
C           SECTION PTR.A -  COMMON AND DIMENSION.
C           SECTION PTR.B -  INITIALIZE AND START RECEPTOR LOOP.
C           SECTION PTR.C -  START SOURCES LOOP; CALCULATE UPWIND AND
C                             CROSSWIND DISTANCES.
C           SECTION PTR.D -  EXTRAPOLATE WIND SPEED TO STACK TOP;
C                             CALCULATE PLUME RISE.
C           SECTION PTR.E -  CALCULATE CONTRIBUTION FROM A SOURCE TO ONE
C                             RECEPTOR.
C           SECTION PTR.F -  END SOURCE AND RECEPTOR LOOPS.
C
       END
C

       SUBROUTINE RCP
C                       SUBROUTINE RCP    (VERSION 86329), PART OF MPTER.
C
C->->->->SECTION RCP.A - COMMON.
       COMMON /MPOR/ IOPT(25)
       COMMON /MPR/ UPL,Z,H,HL,X,Y,KST,DELH,SY,SZ,RC,MUOR
C
C***    MODIFICATIONS:
C          11/27/79 BY K.W.BALDRIDGE, C.S.C., CONVERTED CODE FROM FIELDATA
C                   TO ASCII FORTRAN AND MADE CODE MORE STANDARD
C
C->->->->SECTION RCP.B - EXPLANATIONS AND COMPUTATIONS
C                         COMMON TO ALL CONDITIONS.
C
C  RCP DETERMINES RELATIVE CONCENTRATIONS, CHI/Q, FROM POINT SOURCES.
C           IT CALLS UPON  PGYZ TO OBTAIN STANDARD DEVIATIONS.
C          THE INPUT VARIABLES ARE....
C           UPL  WIND SPEED (M/SEC)
C           Z    RECEPTOR HEIGHT (M)
C           H    EFFECTIVE STACK HEIGHT (M)
C           HL   MIXING HEIGHT- TOP OF NEUTRAL OR UNSTABLE LAYER(M).
C           X    DISTANCE RECEPTOR IS DOWNWIND OF SOURCE (KM)
C           Y    DISTANCE RECEPTOR IS CROSSWIND FROM SOURCE (KM)
C           KST  STABILITY CLASS
C           DELH PLUME RISE(METERS)
C          THE OUTPUT VARIABLES ARE....
C            SY HORIZONTAL DISPERSION PARAMETER
C            SZ VERTICAL DISPERSION PARAMETER
C           RC   RELATIVE CONCENTRATION (SEC/M**3) ,CHI/Q
C          IO IS CONTROL CODE FOR WARNING OUTPUT.
       IO=6
```

```
C         THE FOLLOWING EQUATION IS SOLVED --
C         RC = (1/(2*PI*UPL*SIGMA Y*SIGMA Z))* (EXP(-0.5*(Y/SIGMA Y)**2))
C            (EXP(-0.5*((Z-H)/SIGMA Z)**2) + EXP(-0.5*((Z+H)/SIGMA Z)**2)
C              PLUS THE SUM OF THE FOLLOWING 4 TERMS K TIMES (N=1,K) --
C                   FOR NEUTRAL OR UNSTABLE CASES:
C               TERM 1- EXP(-0.5*((Z-H-2NL)/SIGMA Z)**2)
C               TERM 2- EXP(-0.5*((Z+H-2NL)/SIGMA Z)**2)
C               TERM 3- EXP(-0.5*((Z-H+2NL)/SIGMA Z)**2)
C               TERM 4- EXP(-0.5*((Z+H+2NL)/SIGMA Z)**2)
C NOTE THAT MIXING HEIGHT- THE TOP OF THE NEUTRAL OR UNSTABLE LAYER-
C HAS A VALUE ONLY FOR STABILITIES 1-4, THAT IS, MIXING HEIGHT,
C THE HEIGHT OF THE NEUTRAL OR UNSTABLE LAYER, DOES NOT EXIST FOR STABLE
C LAYERS AT THE GROUND SURFACE- STABILITY 5 OR 6.
C         THE ABOVE EQUATION IS SIMILAR TO EQUATION (5.8) P 36 IN
C          WORKBOOK OF ATMOSPHERIC DISPERSION ESTIMATES WITH THE ADDITION
C          OF THE EXPONENTIAL INVOLVING Y.
C        IF STABLE, SKIP CONSIDERATION OF MIXING HEIGHT.
      IF (KST.GE.5) GO TO 50
      IF (Z-HL) 50,50,40
40    RC=0.
      RETURN
C         IF X IS LESS THAN 1 METER, SET RC=0. AND RETURN.  THIS AVOIDS
C          PROBLEMS OF INCORRECT VALUES NEAR THE SOURCE.
50    IF (X.LT.0.001) GO TO 40
C         CALL PGYZ TO OBTAIN VALUES FOR SY AND SZ
      CALL PGYZ
C          SY = SIGMA Y, THE STANDARD DEVIATION OF CONCENTRATION IN THE
C          Y-DIRECTION (M)
C          SZ = SIGMA Z, THE STANDARD DEVIATION OF CONCENTRATION IN THE
C          Z-DIRECTION (M)
C        IF IOPT(4)=1, CONSIDER BUOYANCY INDUCED DISPERSION OF PLUME DUE
C          TO TURBULENCE DURING BUOYANT RISE.
      IF (IOPT(4).EQ.0) GO TO 70
      DUM=DELH/3.5
      DUM=DUM*DUM
      SY=SQRT(SY*SY+DUM)
      SZ=SQRT(SZ*SZ+DUM)
70    C1=1.
      IF (Y.EQ.0.0) GO TO 100
      YD=1000.*Y
C         YD IS CROSSWIND DISTANCE IN METERS.
      DUM=YD/SY
      TEMP=0.5*DUM*DUM
      IF (TEMP.GE.50.) GO TO 40
      C1=EXP(TEMP)
100   IF (KST.GT.4) GO TO 120
      IF (HL.LT.5000.) GO TO 200
C         IF STABLE CONDITION OR UNLIMITED MIXING HEIGHT,
C          USE EQUATION 3.2 IF Z = 0, OR EQ 3.1 FOR NON-ZERO Z.
C          (EQUATION NUMBERS REFER TO WORKBOOK OF ATMOSPHERIC DISPERSION
C          ESTIMATES.)
120   C2=2.*SZ*SZ
      IF (Z) 40,130,150
C        NOTE: AN ERRONEOUS NEGATIVE Z WILL RESULT IN ZERO CONCENTRATIONS
C
C->->->->SECTION RCP.C - STABLE OR UNLIMITED MIXING, Z IS ZERO.
C
130   C3=H*H/C2
      IF (C3.GE.50.) GO TO 40
```

```
C          WADE EQUATION 3.2.
      RC=A2/(3.14159*UPL*SY*SZ*C1)
      RETURN
C
C->->->->SECTION RCP.D - STABLE OR UNLIMITED MIXING, Z IS NON-ZERO.
C
150   A2=0.
      A3=0.
      CA=Z-H
      CB=Z+H
      C3=CA*CA/C2
      C4=CB*CB/C2
      IF (C3.GE.50.) GO TO 170
      A2=1./EXP(C3)
170   IF (C4.GE.50.) GO TO 190
      A3=1./EXP(C4)
C          WADE EQUATION 3.1.
190   RC=(A2+A3)/(6.28318*UPL*SY*SZ*C1)
      RETURN
C
C->->->->SECTION RCP.E - UNSTABLE, ASSURED OF UNIFORM MIXING.
C
C          IF SIGMA-Z IS GREATER THAN 1.6 TIMES THE MIXING HEIGHT,
C           THE DISTRIBUTION BELOW THE MIXING HEIGHT IS UNIFORM WITH
C           HEIGHT REGARDLESS OF SOURCE HEIGHT OR RECEPTOR HEIGHT BECAUSE
C           OF REPEATED EDDY REFLECTIONS FROM THE GROUND AND THE MIXING HT
200   IF (SZ/HL.LE.1.6) GO TO 220
C          WADE EQUATION 3.5.
      RC=1./(2.5066*UPL*SY*HL*C1)
      RETURN
C          INITIAL VALUE OF AN SET = 0.
C           AN - THE NUMBER OF TIMES THE SUMMATION TERM IS EVALUATED
C                 AND ADDED IN.
220   AN=0.
      IF (Z) 40,380,230
C
C->->->->SECTION RCP.F - UNSTABLE, CALCULATE MULTIPLE EDDY
C                         REFLECTIONS, Z IS NON-ZERO.
C
C         STATEMENTS 220-260 CALCULATE RC, THE RELATIVE CONCENTRATION,
C           USING THE EQUATION DISCUSSED ABOVE.  SEVERAL INTERMEDIATE
C           VARIABLES ARE USED TO AVOID REPEATING CALCULATIONS.
C           CHECKS ARE MADE TO BE SURE THAT THE ARGUMENT OF THE
C           EXPONENTIAL FUNCTION IS NEVER GREATER THAN 50 (OR LESS THAN
C           -50).
C          CALCULATE MULTIPLE EDDY REFLECTIONS FOR RECEPTOR HEIGHT Z.
230   A1=1./(6.28318*UPL*SY*SZ*C1)
      C2=2.*SZ*SZ
      A2=0.
      A3=0.
      CA=Z-H
      CB=Z+H
      C3=CA*CA/C2
      C4=CB*CB/C2
      IF (C3.GE.50.) GO TO 250
      A2=1./EXP(C3)
250   IF (C4.GE.50.) GO TO 270
      A3=1./EXP(C4)
270   SUM=0.
      THL=2.*HL
```

```
280   AN=AN+1.
      A4=0.
      A5=0.
      A6=0.
      A7=0.
      C5=AN*THL
      CC=CA-C5
      CD=CB-C5
      CE=CA+C5
      CF=CB+C5
      C6=CC*CC/C2
      C7=CD*CD/C2
      C8=CE*CE/C2
      C9=CF*CF/C2
      IF (C6.GE.50.) GO TO 300
      A4=1./EXP(C6)
300   IF (C7.GE.50.) GO TO 320
      A5=1./EXP(C7)
320   IF (C8.GE.50.) GO TO 340
      A6=1./EXP(C8)
340   IF (C9.GE.50.) GO TO 360
      A7=1./EXP(C9)
360   T=A4+A5+A6+A7
      SUM=SUM+T
      IF (T.GE.0.01) GO TO 280
      RC=A1*(A2+A3+SUM)
      RETURN
C
C->->->->SECTION RCP.G - UNSTABLE, CALCULATE MULTIPLE EDDY
C                         REFLECTIONS, Z IS ZERO.
C
C        CALCULATE MULTIPLE EDDY REFLECTIONS FOR GROUND LEVEL RECEPTOR
C        HEIGHT.
380   A1=1./(6.28318*UPL*SY*SZ*C1)
      A2=0.
      C2=2.*SZ*SZ
      C3=H*H/C2
      IF (C3.GE.50.) GO TO 400
      A2=2./EXP(C3)
400   SUM=0.
      THL=2.*HL
410   AN=AN+1.
      A4=0.
      A6=0.
      C5=AN*THL
      CC=H-C5
      CE=H+C5
      C6=CC*CC/C2
      C8=CE*CE/C2
      IF (C6.GE.50.) GO TO 430
      A4=2./EXP(C6)
430   IF (C8.GE.50.) GO TO 450
      A6=2./EXP(C8)
450   T=A4+A6
      SUM=SUM+T
      IF (T.GE.0.01) GO TO 410
      RC=A1*(A2+SUM)
      RETURN
C
```

```
C
C***   SECTIONS OF SUBROUTINE RCP.
C         SECTION RCP.A -  COMMON.
C         SECTION RCP.B -  EXPLANATIONS AND COMPUTATIONS COMMON TO ALL
C                           CONDITIONS.
C         SECTION RCP.C -  STABLE OR UNLIMITED MIXING, Z IS ZERO.
C         SECTION RCP.D -  STABLE OR UNLIMITED MIXING, Z IS NON-ZERO.
C         SECTION RCP.E -  UNSTABLE, ASSURED OF UNIFORM MIXING.
C         SECTION RCP.F -  UNSTABLE, CALCULATE MULTIPLE EDDY
C                           REFLECTIONS; Z IS NON-ZERO.
C         SECTION RCP.G -  UNSTABLE, CALCULATE MULTIPLE EDDY
C                           REFLECTIONS; Z IS ZERO.
C         SECTION RCP.H -  FORMAT.
C
      END

C
      SUBROUTINE PGYZ
C                    SUBROUTINE PGYZ   (VERSION 79365), PART OF MPTER.
C        VERTICAL DISPERSION PARAMETER VALUE, SZ DETERMINED BY
C         SZ = A * X ** B WHERE A AND B ARE FUNCTIONS OF BOTH STABILITY
C         AND RANGE OF X.
C        HORIZONTAL DISPERSION PARAMETER VALUE, SY DETERMINED BY
C         LOGARITHMIC INTERPOLATION OF PLUME HALF-ANGLE ACCORDING TO
C         DISTANCE AND CALCULATION OF 1/2.15 TIMES HALF-ARC LENGTH.
      COMMON /MPR/ UPL,Z,H,HL,X,Y,KST,DELH,SY,SZ,RC,MUOR
      DIMENSION XA(7), XB(2), XD(5), XE(8), XF(9), AA(8), BA(8), AB(3),
     1BB(3), AD(6), BD(6), AE(9), BE(9), AF(10), BF(10)
      DATA XA /.5,.4,.3,.25,.2,.15,.1/
      DATA XB /.4,.2/
      DATA XD /30.,10.,3.,1.,.3/
      DATA XE /40.,20.,10.,4.,2.,1.,.3,.1/
      DATA XF /60.,30.,15.,7.,3.,2.,1.,.7,.2/
      DATA AA /453.85,346.75,258.89,217.41,179.52,170.22,158.08,122.8/
      DATA BA /2.1166,1.7283,1.4094,1.2644,1.1262,1.0932,1.0542,.9447/
      DATA AB /109.30,98.483,90.673/
      DATA BB /1.0971,0.98332,0.93198/
      DATA AD /44.053,36.650,33.504,32.093,32.093,34.459/
      DATA BD /0.51179,0.56589,0.60486,0.64403,0.81066,0.86974/
      DATA AE /47.618,35.420,26.970,24.703,22.534,21.628,21.628,23.331,2
     14.26/
      DATA BE /0.29592,0.37615,0.46713,0.50527,0.57154,0.63077,0.75660,0
     1.81956,0.8366/
      DATA AF /34.219,27.074,22.651,17.836,16.187,14.823,13.953,13.953,1
     14.457,15.209/
      DATA BF /0.21716,0.27436,0.32681,0.41507,0.46490,0.54503,0.63227,0
     1.68465,0.78407,0.81558/
C
      IF (MUOR.EQ.2)  GO TO 9
C
C           MCELROY-POOLER URBAN DISPERSION PARAMETERS FROM ST. LOUIS
C             EXPERIMENT AS PUT IN EQUATION FORM BY BRIGGS.
C              X IS DISTANCE IN KM.
C              KST IS PASQUILL STABILITY CLASS.
C              SY AND SZ ARE IN METERS.
      GO TO(2,2,3,4,5,5), KST
2     SY=320.*X/SQRT(1.+0.4*X)
      SZ=240.*X*SQRT(1.+X)
      GO TO 6
```

```
      SZ=200.*X
      GO TO 6
4     SY=160.*X/SQRT(1.+0.4*X)
      SZ=140.*X/SQRT(1.+0.3*X)
      GO TO 6
5     SY=110.*X/SQRT(1.+0.4*X)
      SZ=80.*X/SQRT(1.+1.5*X)
6     IF (SZ.GT.5000.) SZ=5000.
      RETURN
C
    9 XY=X
      GO TO (10,40,70,80,110,140), KST
C        STABILITY A
10    TH=(24.167-2.5334*ALOG(XY))/57.2958
      IF (X.GT.3.11) GO TO 170
      DO 20 ID=1,7
      IF (X.GE.XA(ID)) GO TO 30
20    CONTINUE
      ID=8
30    SZ=AA(ID)*X**BA(ID)
      GO TO 190
C        STABILITY B
40    TH=(18.333-1.8096*ALOG(XY))/57.2958
      IF (X.GT.35.) GO TO 170
      DO 50 ID=1,2
      IF (X.GE.XB(ID)) GO TO 60
50    CONTINUE
      ID=3
60    SZ=AB(ID)*X**BB(ID)
      GO TO 180
C        STABILITY C
70    TH=(12.5-1.0857*ALOG(XY))/57.2958
      SZ=61.141*X**0.91465
      GO TO 180
C        STABILITY D
80    TH=(8.3333-0.72382*ALOG(XY))/57.2958
      DO 90 ID=1,5
      IF (X.GE.XD(ID)) GO TO 100
90    CONTINUE
      ID=6
100   SZ=AD(ID)*X**BD(ID)
      GO TO 180
C        STABILITY E
110   TH=(6.25-0.54287*ALOG(XY))/57.2958
      DO 120 ID=1,8
      IF (X.GE.XE(ID)) GO TO 130
120   CONTINUE
      ID=9
130   SZ=AE(ID)*X**BE(ID)
      GO TO 180
C        STABILITY F
140   TH=(4.1667-0.36191*ALOG(XY))/57.2958
      DO 150 ID=1,9
      IF (X.GE.XF(ID)) GO TO 160
150   CONTINUE
      ID=10
160   SZ=AF(ID)*X**BF(ID)
      GO TO 180
170   SZ=5000.
```

```
180    IF (SZ.GT.5000.) SZ=5000.
190    SY=465.116*XY*SIN(TH)/COS(TH)
C         465.116 = 1000. (M/KM) /2.15
       RETURN
C
       END

C
       SUBROUTINE RANK (L)
C                     SUBROUTINE RANK   (VERSION 79365), PART OF MPTER.
C         CALLED BY MPTER TO ARRANGE CONCENTRATIONS OF VARIOUS AVG
C         TIMES INTO HIGH-FIVE TABLES...THAT IS, ARRAYS STORING
C         THE HIGHEST FIVE CONCENTRATIONS FOR EACH RECEPTOR FOR
C         EACH AVG TIME.
C         VARIABLES OUTPUT:
C              HMAXA(J,K,L)  CONCENTRATIONS ACCORDING TO
C                    J : RANK OF CONC. (1-5)
C                    K : RECEPTOR NUMBER
C                    L : AVG TIME
C              NDAY(J,K,L) : ASSOCIATED DAY OF CONC.
C              IHR(J,K,L) : ENDING HOUR OF CONC.
       COMMON /MSFM/ MSFMFL,MSFMHR
       INTEGER MSFMFL(50,24),MSFMHR(8784)
       COMMON/MR/HMAXA(5,180,5),NDAY(5,180,5),IHR(5,180,5),CONC(180,5),
      1          JDAY,NR
       COMMON /MPO/ NRECEP,NAVG,NB,LH,NPT,IDATE(2),RREC(180),SREC(180),ZR
      1(180),ELR(180),PHCHI(180),PHSIGS(180,26),HSAV(250),DSAV(250),PCHI(
      2180),PSIGS(180,26),IPOL
       IO=6
C         RESET AVERAGING PERIOD FLAG AND SET CALM FLAG, LL.
C         CALMS ACCOUNTED FOR ONLY WHEN DEFAULT OPTION ON.
       LL=0
       IF(L.GT.4)LL=1
       IF (L.GT.100) LL=2
       IF (L.EQ.111) L=1
       IF(L.EQ.22.OR.L.EQ.222)L=2
       IF(L.EQ.33.OR.L.EQ.333)L=3
       IF(L.EQ.44.OR.L.EQ.444)L=4
       DO 50 K=1,NRECEP
       IF (CONC(K,L).LE.HMAXA(5,K,L)) GO TO 50
       DO 10 J=1,5
       IF (CONC(K,L).GT.HMAXA(J,K,L)) GO TO 20
C            CONCENTRATION IS ONE OF THE TOP FIVE
10     CONTINUE
       WRITE (IO,70)
       GO TO 50
C         THE FOLLOWING DO-LOOP HAS THE EFFECT OF INSERTING A NEW
C         CONCENTRATION ENTRY INTO ITS PROPER POSITION WHILE SHIFTING
C         DOWN THE 'OLD' LOWER CONCENTRATIONS THUS ESTABLISHING THE
C         'HIGH-FIVE' CONCENTRATION TABLE.
20     IF (J.EQ.5) GO TO 40
       DO 30 IJ=4,J,-1
       IJP1=IJ+1
       HMAXA(IJP1,K,L)=HMAXA(IJ,K,L)
       NDAY(IJP1,K,L) = NDAY(IJ,K,L)
30     IHR(IJP1,K,L) = IHR(IJ,K,L)
C            INSERT LATEST CONC, DAY AND ENDING HR INTO THE
C            PROPER RANK IN THE HIGH-FIVE TABLE
40     HMAXA(J,K,L)=CONC(K,L)
```

```
      IHR(J,K,L) = LH
C        ADD 100 TO HOUR TO SET CALM FLAG FOR MAIN.
      IF(LL.EQ.1.AND.L.NE.1)IHR(J,K,L)=IHR(J,K,L)+100
      IF (LL.EQ.2) IHR(J,K,L)=IHR(J,K,L)+200
50    CONTINUE
      DO 60 K=1,NRECEP
      CONC(K,L)=0.
60    CONTINUE
      RETURN
C
70    FORMAT (1X,'   ****ERROR IN FINDING THE MAX CONCENTRATION***')
C
      END

C
      SUBROUTINE OUTHR
C                    SUBROUTINE OUTHR  (VERSION 79365), PART OF MPTER.
C        THIS SUBROUTINE PROVIDES OUTPUT CONCENTRATIONS IN
C        MICROGRAMS PER CUBIC METER FOR EACH HOUR IN TWO WAYS:
C           1) CONTRIBUTIONS FROM SIGNIFICANT SOURCES, AND
C           2) SUMMARIES.
C        BEYOND ENTRY POINT OUTAVG THE SUBROUTINE PROVIDES
C        CONCENTRATION OUTPUT FOR EACH AVERAGING PERIOD AGAIN
C        IN THE ABOVE MANNER.
C
C->->->->SECTION OUTHR.A - COMMON, DIMENSION, AND DATA.
C
      COMMON /MPOR/ IOPT(25)
      COMMON /MPO/ NRECEP,NAVG,NB,LH,NPT,IDATE(2),RREC(180),SREC(180),ZR
     1(180),ELR(180),PHCHI(180),PHSIGS(180,26),HSAV(250),DSAV(250),PCHI(
     2180),PSIGS(180,26),IPOL
      COMMON /MO/ QTHETA(24),QU(24),IKST(24),QHL(24),QTEMP(24),MPS(25),N
     1SIGP,IO,LINE1(20),LINE2(20),LINE3(20),RNAME(2,180),IRANK(180),STAR
     2(5,180)
      CHARACTER*4 RNAME,STAR
C
C
      DIMENSION IPOLT(2)
      DATA IPOLT /'SO2 ','PART'/
      IPOLU=IPOLT(1)
      IF (IPOL.EQ.4) IPOLU=IPOLT(2)
C        OPTION(11): PRINT ONLY THE HOURLY SUMMARIES.
      IF (IOPT(11).EQ.1) GO TO 100
C
C->->->->SECTION OUTHR.B - WRITE HOURLY CONTRIBUTION TITLE.
C
      WRITE (IO,350) LINE1,LINE2,LINE3
      WRITE (IO,360)IPOLU,IDATE,LH
C
C->->->->SECTION OUTHR.C - WRITE HOURLY MET DATA.
C
      IF (IOPT(12).EQ.1) GO TO 10
      WRITE (IO,450)
      WRITE (IO,460) LH,QTHETA(LH),QU(LH),QHL(LH),QTEMP(LH),IKST(LH)
C
C->->->->SECTION OUTHR.D - WRITE FINAL PLUME HEIGHT AND DISTANCE
C                          FINAL RISE.
C
10    IF (IOPT(13).EQ.1) GO TO 20
```

```
C         HSAV ARE THE CALCULATED PLUME HEIGHTS FOR THIS HOUR
      WRITE (IO,480) (HSAV(I),I=1,NPT)
      WRITE (IO,490) (DSAV(I),I=1,NPT)
C
C->->->->SECTION OUTHR.E - WRITE HRLY SIGNIFICANT SOURCE CONTRIB.
C
20    IF (NSIGP.GT.10) GO TO 40
C         PRINT FIRST PAGE OF OUTPUT AND TOTALS FOR 10 OR LESS SIGNIF SOU
      WRITE (IO,370)
      WRITE (IO,380) (I,I=1,NSIGP)
      WRITE (IO,390)
      WRITE (IO,380) (MPS(I),I=1,NSIGP)
      WRITE (IO,400)
      DO 30 K=1,NRECEP
      WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PHSIGS(K,I),I=1,NSIGP)
C         PRINT TOTALS
      WRITE (IO,420) PHSIGS(K,26),PHCHI(K)
30    CONTINUE
      GO TO 100
C         PRINT FIRST PAGE FOR MORE THAN 10 SIGNIFICANT SOURCES.
40    WRITE (IO,370)
      WRITE (IO,380) (I,I=1,10)
      WRITE (IO,430) (MPS(I),I=1,10)
      WRITE (IO,400)
      DO 50 K=1,NRECEP
50    WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PHSIGS(K,I),I=1,10)
      IF (NSIGP.GT.20) GO TO 70
C         PRINT SECOND PAGE AND TOTALS FOR 11 TO 20 SIGNIFICANT SOURCES
      WRITE (IO,350) LINE1,LINE2,LINE3
      WRITE (IO,360)IPOLU,IDATE,LH
      WRITE (IO,370)
      WRITE (IO,380) (I,I=11,NSIGP)
      WRITE (IO,390)
      WRITE (IO,380) (MPS(I),I=11,NSIGP)
      WRITE (IO,400)
      DO 60 K=1,NRECEP
      WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PHSIGS(K,I),I=11,NSIGP)
60    WRITE (IO,420) PHSIGS(K,26),PHCHI(K)
      GO TO 100
C         WRITE SECOND PAGE FOR MORE THAN 20 SIGNIFICANT SOURCES.
70    WRITE (IO,350) LINE1,LINE2,LINE3
      WRITE (IO,360)IPOLU,IDATE,LH
      WRITE (IO,370)
      WRITE (IO,380) (I,I=11,20)
      WRITE (IO,430) (MPS(I),I=11,20)
      WRITE (IO,400)
      DO 80 K=1,NRECEP
80    WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PHSIGS(K,I),I=11,20)
      WRITE (IO,350) LINE1,LINE2,LINE3
      WRITE (IO,360)IPOLU,IDATE,LH
      WRITE (IO,370)
C         WRITE LAST PAGE AND TOTALS FOR MORE THAN 20 SIGNIF. SOURCES.
      WRITE (IO,380) (I,I=21,NSIGP)
      WRITE (IO,390)
      WRITE (IO,380) (MPS(I),I=21,NSIGP)
      WRITE (IO,400)
      DO 90 K=1,NRECEP
      WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PHSIGS(K,I),I=21,NSIGP)
90    WRITE (IO,420) PHSIGS(K,26),PHCHI(K)
```

```
100   IF (IOPT(14).EQ.1) GO TO 170
C
C->->->->SECTION OUTHR.F - WRITE HOURLY SUMMARY TITLE.
C
      WRITE (IO,350) LINE1,LINE2,LINE3
      WRITE (IO,440)IPOLU,IDATE,LH
C
C->->->->SECTION OUTHR.G - WRITE HOURLY MET DATA.
C
      IF (IOPT(15).EQ.1) GO TO 110
      WRITE (IO,450)
      WRITE (IO,460) LH,QTHETA(LH),QU(LH),QHL(LH),QTEMP(LH),IKST(LH)
C
C->->->->SECTION OUTHR.H - WRITE FINAL PLUME HEIGHT AND
C         DISTANCE TO FINAL RISE.
C
110   IF (IOPT(16).EQ.1) GO TO 120
      WRITE (IO,470) (I,I=1,10)
C        HSAV ARE THE CALCULATED PLUME HEIGHTS FOR THIS HOUR
      WRITE (IO,480) (HSAV(I),I=1,NPT)
      WRITE (IO,490) (DSAV(I),I=1,NPT)
C
C->->->->SECTION OUTHR.I - WRITE HOURLY SUMMARY TABLE.
C
120   WRITE (IO,500)
C        CALCULATE GRAND TOTALS AND RANK CONCENTRATIONS
      DO 130 K=1,NRECEP
C        HSAV IS USED AS A DUMMY VARIABLE FOR THE REMAINDER OF THIS
C        SUBROUTINE. IT IS ZEROED AGAIN IN PTR BEFORE ITS NORMAL USE.
130   HSAV(K)=PHCHI(K)
C        DETERMINE RANKING ACCORDING TO CONCENTRATION
      DO 150 I=1,NRECEP
      CMAX=-1.0
      DO 140 K=1,NRECEP
      IF (HSAV(K).LE.CMAX) GO TO 140
      CMAX=HSAV(K)
      LMAX=K
140   CONTINUE
      IRANK(LMAX)=I
      HSAV(LMAX)=-1.0
150   CONTINUE
      DO 160 K=1,NRECEP
      WRITE (IO,510) K,STAR(1,K),STAR(2,K),(RNAME(J,K),J=1,2),RREC(K),SR
     1EC(K),ZR(K),ELR(K),PHSIGS(K,26),PHCHI(K),IRANK(K)
160   CONTINUE
170   RETURN

350   FORMAT ('1',20A4/1X,20A4/1X,20A4)
360   FORMAT('0',T30,A4,' CONTRIBUTION(MICROGRAMS/M**3) FROM SIGNIFICANT
     1 POINT SOURCES ',5X,I2,'/',I4,' : HOUR ',I2//)
370   FORMAT (1H0,T5,'RANK')
380   FORMAT ('+',T12,10(I3,7X))
390   FORMAT ('+',T113,'TOTAL      TOTAL'/1X,T113,'SIGNIF    ALL POINT'/1
     1X,T113,'POINT     SOURCES'/1X,'SOURCE #')
400   FORMAT (1X,'RECEP #')
410   FORMAT (1X,I3,2A1,6P,10F10.3)
420   FORMAT ('+',T109,6P,2F10.3)
430   FORMAT (1X,'SOURCE #',T12,10(I3,7X))
440   FORMAT('0',T25,A4,' SUMMARY CONCENTRATION TABLE(MICROGRAMS/M**3) '
```

```
450    FORMAT (1X,T2,'HOUR   THETA    SPEED   MIXING   TEMP   STABILITY'/
      11X,T9,'(DEG)     (M/S) HEIGHT(M)   (K)      CLASS'/1X)
460    FORMAT (1X,T3,I2,4F9.2,6X,I1//)
470    FORMAT (13X,10I11)
480    FORMAT (' FINAL HT (M) ',10F11.2)
490    FORMAT (' DIST FIN HT (KM)',10F11.3)
500    FORMAT ('0',T7,'RECEPTOR',T23,'EAST',T33,'NORTH',T43,'RECEPTOR HT'
      1,T61,'RECEPTOR',T78,'TOTAL FROM',T93,'TOTAL FROM',T106,'CONCENTRAT
      2ION'/' ',T7,'NO. NAME',T22,'COORD',T33,'COORD',T44,'ABV GRD (M)',T
      359,'GRD-LVL ELEV',T77,'SIGNIF POINT',T93,'ALL SOURCES',T111,'RANK'
      4/' ',T58,'(USER HT UNITS)',T80,'SOURCES'//)
510    FORMAT (1H ,I8,2A1,2X,2A4,2F10.2,F12.1,F20.1,6P,2F15.4,I15)
520    FORMAT ('0',T22,I2,'-HOUR AVERAGE ',A4,' CONTRIBUTION(MICROGRAMS/M
      1**3) FROM SIGNIFICANT POINT SOURCES',5X,I2,'/',I3,'  START HOUR: '
      2,I2//1X,T5,'RANK')
530    FORMAT ('0',T25,I2,'-HOUR AVERAGE ',A4,' SUMMARY CONCENTRATION TAB
      1LE(MICROGRAMS/M**3)',5X,I2,'/',I3,'  START HOUR: ',I2//1X)
540    FORMAT ('CNTL',1X,3F10.3,20X,I4,2F10.1)

       END

       SUBROUTINE INTERF(FLAG,IDAY,LH,J,F)
C
C      INTERF - PROGRAM TO INTERFACE MPTER AND MSFM.  PROGRAM TESTS
C      FOR APPLICABILITY OF MSFM AND COMPUTES INPUT VALUES.
C
       COMMON /SHORE/XSL(250),YSL(250),BA(250),EA(250),FETCH(250),
      & INDEX(250),SNAME(3),THETA
       CHARACTER*4 SNAME,ENDS

       COMMON /MSFM/ MSFMFL,MSFMHR
       INTEGER MSFMFL(50,24),MSFMHR(8784)

       COMMON /SDMONE/XP,YP,A,B,UL,US,HPLUME,HSTK,CN,F1,I,Q,MGCM
       REAL MGCM

       COMMON /MPR/UPL,Z,H,HL,X,Y,KST,DELH,SY,SZ,RC,MUOR

C          /MP/  BETWEEN MAIN PROGRAM AND PTR
       COMMON /MP/ SOURCE(9,250),CONTWO,PSAV(250),IPSIGS(250),U,TEMP,SINT
      1,COST,PL(6),ELP(250),ELHN,HANE,TLOS,CELM,CTER

C          /MO/  BETWEEN MAIN PROGRAM AND OUTHR
       COMMON /MO/ QTHETA(24),QU(24),IKST(24),QHL(24),QTEMP(24),MPS(25),N
      1SIGP,IO,LINE1(20),LINE2(20),LINE3(20),RNAME(2,180),IRANK(180),STAR
      2(5,180)

       INTEGER FLAG

C       PSIM(X)=2*LOG((1+X)/2)+LOG((1+X**2)/2)-2*ATAN(X)+3.14159/2
C       PSIH(X)=2*LOG((1+X**2)/2)
       G=9.81
       K=.4
       CSUBP=1020.
       RHO=1.188

       IF (FLAG.EQ.1) GO TO 1000
       IF (FLAG.EQ.4) GO TO 100
       IF (FLAG.EQ.2.OR.FLAG.EQ.3) GO TO 9999
```

```
    5  READ (19) IDAT,IHOUR,UL,US,PTMOL,PTMOW,DTHDZ,HO
       IF (IDAT.LT.IDAY) GO TO 5
       IF (IHOUR.LT.LH) GO TO 5
       IF (IHOUR.GT.LH.OR.IDAT.GT.IDAY) THEN
          WRITE (6,*) 'FAULTY TOWER DATA AT DAY',IDAY
          STOP
       ENDIF
C
C      BA=BEGINNING ANGLE, EA=ENDING ANGLE
C      TRAD=WIND DIRECTION
C
       TRAD=QTHETA(LH)

       IF (EA(J).LT.360.) THEN
          IF (TRAD.LT.BA(J)+FETCH(J).OR.TRAD.GT.EA(J)-FETCH(J)) THEN
             FLAG=2
             RETURN
          ENDIF
        ELSE
          IF (TRAD.GT.BA(J)+FETCH(J)) GO TO 20
          IF (TRAD+360.LT.EA(J)-FETCH(J)) GO TO 20
          FLAG=2
          RETURN
       ENDIF
C
C      KST = STABILITY CLASS
C
   20   IF (KST.GT.3) THEN
          FLAG=2
          RETURN
       ENDIF

       IF (DTHDZ.LE.0) THEN
          FLAG=2
          RETURN
       ENDIF
C
C      TEMP1,TEMP2 = POTENTIAL TEMPERATURE AT LEVELS 1 AND 2
C      WS1,WS2 = WIND SPEED AT LEVELS 1 AND 2
C      Z0,Z1,Z2 = SURFACE ROUGHNESS, LEVEL 1 HEIGHT, LEVEL 2 HEIGHT
C      HO = SENSIBLE HEAT FLUX
C
C
C       RI=G*2/(TEMP1+TEMP2)*(TEMP1-TEMP2)/(Z1-Z2)*((Z1-Z2)/(WS1-WS2))**2
C       L=(Z2*Z1)**.5/RI
C       BETA1=(1-16*Z0/L)**.25
C       BETA2=(1-16*Z1/L)**.25
C       LAMB1=BETA2
C       LAMB2=(1-16*Z2/L)**.25
C       UST=K*WS1/(LOG(Z1/Z0)-PSIM(BETA2)+PSIM(BETA1))
C       THEST=K*(TEMP2-TEMP1)/(LOG(Z2/Z1)-PSIH(LAMB2)+PSIH(LAMB1))
C       HO=-RHO*CSUBP*UST*THEST
C
       IF (HO.LT.20) THEN
          FLAG=2
          RETURN
       ENDIF
C
C      TBLHGT = TIBL HEIGHT
C      XSHORE = DISTANCE FROM SHORE TO STACK
```

```
C      TEMP3 = TEMPERATURE AT 10 FEET ABOVE WATER
C      TEMP4 = WATER TEMPERATURE
C
C       DTHDZ=(TEMP3-TEMP4)/10
C
C
C
       WRITE (20,2000) IDAY,LH,HO,UL,US,DTHDZ,PTMOL,PTMOW
 2000  FORMAT (' TIBL:',I3,I2,F7.2,F13.2,F13.2,F10.4,F8.1,F8.1)
C
C
  100  X1=SOURCE(1,J)*CONTWO
       Y1=SOURCE(2,J)*CONTWO
       X2=XSL(J)*CONTWO
       Y2=YSL(J)*CONTWO
       DIST=XSHORE(X1,Y1,TRAD,X2,Y2,BA(J),EA(J),FETCH(J))
       TBLHGT=(((2*HO)/(CSUBP*RHO*DTHDZ*UL))**.5)*SQRT(DIST)
       HSTK=SOURCE(5,J)
C
C      THT = STACK HEIGHT
C
       IF (HSTK.LT.TBLHGT) THEN
          FLAG=3
          RETURN
       ENDIF
       Q=1
       F1=F
       CN = ((G/PTMOW)*DTHDZ)**0.5
C
C->->   DETERMINE THE TIBL A FACTOR
C
       A = ((2.*HO)/(CSUBP*RHO*DTHDZ*UL))**0.5
C
C->->   DETERMINE THE TIBL HEIGHT FOR USE IN CALCULATING
C       CONVECTIVE VELOCITY (W*)
C
       HT = A*(5000.**0.5)
C
C->->   DETERMINE PART OF SIGMA Y EQUATION
C       FOR THE CONVECTIVE LAYER (B = W*/UL)
C
       B = (((G*HO*HT)/(RHO*CSUBP*PTMOL))**.333)/UL

       FLAG=1
1000   CONTINUE
       XP=X*1000.
       YP=Y*1000.
       CALL SFM(DIST)
       MSFMHR(IDAY*24+LH)=1
       MSFMFL(J,LH)=1
       RC=MGCM/1.E6
9999   CONTINUE
       RETURN
       END
C
C->->->->SECTION OUTHR.J - ENTRY POINT FOR AVERAGING TIME
C
       SUBROUTINE OUTAVG

       COMMON /MPOR/ IOPT(25)
```

```
      COMMON /MPO/ NRECEP,NAVG,NB,LH,NPT,IDATE(2),RREC(180),SREC(180),ZR
     1(180),ELR(180),PHCHI(180),PHSIGS(180,26),HSAV(250),DSAV(250),PCHI(
     2180),PSIGS(180,26),IPOL
      COMMON /MO/ QTHETA(24),QU(24),IKST(24),QHL(24),QTEMP(24),MPS(25),N
     1SIGP,IO,LINE1(20),LINE2(20),LINE3(20),RNAME(2,180),IRANK(180),STAR
     2(5,180)
      CHARACTER*4 RNAME,STAR
C
C
      DIMENSION IPOLT(2)
      CHARACTER*4 IPOLT
      DATA IPOLT /'SO2 ','PART'/

C            AT THIS ENTRY POINT, CONCENTRATION OUTPUT
C         IN MICROGRAMS PER CUBIC METER ARE PRINTED FOR THE
C         AVERAGING PERIOD. CONTRIBUTIONS AND/OR SUMMARY
C         INFORMATION IS AVAILABLE.
C         AVERAGE CONCENTRATIONS OVER SPECIFIED TIME PERIOD
      DO 190 K=1,NRECEP
      PCHI(K)=PCHI(K)/NAVG
      HSAV(K)=PCHI(K)
      DO 180 I=1,26
180   PSIGS(K,I)=PSIGS(K,I)/NAVG
190   CONTINUE
C         OPTION(17): SKIP OUTPUT OF THE AVERAGED CONTRIBUTIONS.
      IF (IOPT(17).EQ.1) GO TO 270
C->->->->SECTION OUTHR.K - WRITE AVERAGING-TIME SIGNIFICANT
C                  SOURCE CONTRIBUTIONS.
      WRITE (IO,350) LINE1,LINE2,LINE3
      WRITE (IO,520) NAVG,IPOLU,IDATE,NB
      IF (NSIGP.GT.10) GO TO 210
C         PRINT FIRST PAGE OF OUTPUT AND TOTALS FOR 10 OR LESS SIGNIF SOU
      WRITE (IO,380) (I,I=1,NSIGP)
      WRITE (IO,390)
      WRITE (IO,380) (MPS(I),I=1,NSIGP)
      WRITE (IO,400)
      DO 200 K=1,NRECEP
      WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PSIGS(K,I),I=1,NSIGP)
C         PRINT TOTALS
      WRITE (IO,420) PSIGS(K,26),PCHI(K)
200   CONTINUE
      GO TO 270
C         PRINT FIRST PAGE FOR MORE THAN 10 SIGNIF SOURCES
210   WRITE (IO,380) (I,I=1,10)
      WRITE (IO,430) (MPS(I),I=1,10)
      WRITE (IO,400)
      DO 220 K=1,NRECEP
220   WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PSIGS(K,I),I=1,10)
      IF (NSIGP.GT.20) GO TO 240
C         PRINT SECOND PAGE AND TOTALS FOR 11 TO 20 SIGNIF SOURCES
      WRITE (IO,350) LINE1,LINE2,LINE3
      WRITE (IO,520) NAVG,IPOLU,IDATE,NB
      WRITE (IO,380) (I,I=11,NSIGP)
      WRITE (IO,390)
      WRITE (IO,380) (MPS(I),I=11,NSIGP)
      WRITE (IO,400)
      DO 230 K=1,NRECEP
      WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PSIGS(K,I),I=11,NSIGP)
230   WRITE (IO,420) PSIGS(K,26),PCHI(K)
      GO TO 270
```

```
C          WRITE SECOND PAGE FOR MORE THAN 20 SIGNIF SOURCES
240     WRITE (IO,350) LINE1,LINE2,LINE3
        WRITE (IO,520) NAVG,IPOLU,IDATE,NB
        WRITE (IO,380) (I,I=11,20)
        WRITE (IO,430) (MPS(I),I=11,20)
        WRITE (IO,400)
        DO 250 K=1,NRECEP
250     WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PSIGS(K,I),I=11,20)
        WRITE (IO,350) LINE1,LINE2,LINE3
        WRITE (IO,520) NAVG,IPOLU,IDATE,NB
C          WRITE LAST PAGE AND TOTALS FOR MORE THAN 20 SIGNIF SOURCES
        WRITE (IO,380) (I,I=21,NSIGP)
        WRITE (IO,390)
        WRITE (IO,380) (MPS(I),I=21,NSIGP)
        WRITE (IO,400)
        DO 260 K=1,NRECEP
        WRITE (IO,410) K,STAR(1,K),STAR(2,K),(PSIGS(K,I),I=21,NSIGP)
260     WRITE (IO,420) PSIGS(K,26),PCHI(K)
C
C->->->->SECTION OUTHR.L - WRITE AVERAGING-TIME SUMMARY.
C
C          OPTION(18): SKIP OUTPUT OF THE AVERAGED SUMMARIES.
270     IF (IOPT(18).EQ.1) GO TO 310
        WRITE (IO,350) LINE1,LINE2,LINE3
        WRITE (IO,530) NAVG,IPOLU,IDATE,NB
        WRITE (IO,500)
C          CALCULATE GRAND TOTALS AND RANK CONCENTRATIONS
        DO 290 I=1,NRECEP
        CMAX=-1.0
        DO 280 K=1,NRECEP
        IF (HSAV(K).LE.CMAX) GO TO 280
        CMAX=HSAV(K)
        LMAX=K
280     CONTINUE
        IRANK(LMAX)=I
        HSAV(LMAX)=-1.0
290     CONTINUE
        DO 300 K=1,NRECEP
        WRITE (IO,510) K,STAR(1,K),STAR(2,K),(RNAME(J,K),J=1,2),RREC(K),SR
       1EC(K),ZR(K),ELR(K),PSIGS(K,26),PCHI(K),IRANK(K)
300     CONTINUE
310     IF (IOPT(24).EQ.0) GO TO 330
C          PUNCH CONCENTRATIONS FOR CONTOURING(MICROGRAMS/CUBIC METER)
C          RECEPTOR COORDINATES IN USER UNITS.
        DO 320 K=1,NRECEP
        GWU=PCHI(K)*1.0E+06
        WRITE (IO,540) RREC(K),SREC(K),GWU,K,ZR(K),ELR(K)
        WRITE (1,540) RREC(K),SREC(K),GWU,K,ZR(K),ELR(K)
320     CONTINUE
330     IF (IOPT(23).EQ.0) GO TO 340
C          WRITE PERIODIC CONC. TO DISK/TAPE - FOR LONG-TERM APPLICATION
C          FOR EACH RUN, THIS WRITE STATEMENT WILL GENERATE
C          'NPER' RECORDS.
        WRITE (13) IDATE(2),NB,(PCHI(K),K=1,NRECEP)
340     RETURN
C
C->->->->SECTION OUTHR.M - FORMATS.
C
C***    SECTIONS OF SUBROUTINE OUTHR.
C            SECTION OUTHR.A -  COMMON, DIMENSION, AND DATA.
```

```
C         SECTION OUTHR.B -  WRITE HOURLY CONTRIBUTION TITLE.
C         SECTION OUTHR.C -  WRITE HOURLY MET. DATA.
C         SECTION OUTHR.D -  WRITE FINAL PLUME HEIGHT AND DISTANCE TO
C                             FINAL RISE.
C         SECTION OUTHR.E -  WRITE HOURLY SIGNIFICANT SOURCE CONTRIB.
C         SECTION OUTHR.F -  WRITE HOURLY SUMMARY TITLE.
C         SECTION OUTHR.G -  WRITE HOURLY MET. DATA.
C         SECTION OUTHR.H -  WRITE FINAL PLUME HEIGHT AND DISTANCE TO
C                             FINAL RISE.
C         SECTION OUTHR.I -  WRITE HOURLY SUMMARY TABLE.
C         SECTION OUTHR.J -  ENTRY POINT FOR AVERAGING TIME.
C         SECTION OUTHR.K -  WRITE AVERAGING-TIME SIGNIFICANT SOURCE
C                             CONTRIBUTIONS.
C         SECTION OUTHR.L -  WRITE AVERAGING-TIME SUMMARY.
C         SECTION OUTHR.M -  FORMATS.
C
350    FORMAT ('1',20A4/1X,20A4/1X,20A4)
360    FORMAT('0',T30,A4,' CONTRIBUTION(MICROGRAMS/M**3) FROM SIGNIFICANT
      1 POINT SOURCES ',5X,I2,'/',I4,' : HOUR ',I2//)
370    FORMAT (1H0,T5,'RANK')
380    FORMAT ('+',T12,10(I3,7X))
390    FORMAT ('+',T113,'TOTAL     TOTAL'/1X,T113,'SIGNIF    ALL POINT'/1
      1X,T113,'POINT     SOURCES'/1X,'SOURCE #')
400    FORMAT (1X,'RECEP #')
410    FORMAT (1X,I3,2A1,6P,10F10.3)
420    FORMAT ('+',T109,6P,2F10.3)
430    FORMAT (1X,'SOURCE #',T12,10(I3,7X))
440    FORMAT('0',T25,A4,' SUMMARY CONCENTRATION TABLE(MICROGRAMS/M**3) '
      1,5X,I2,'/',I4,' : HOUR ',I2/1X)
450    FORMAT (1X,T2,'HOUR   THETA    SPEED   MIXING   TEMP   STABILITY'/
      11X,T9,'(DEG)    (M/S) HEIGHT(M)    (K)      CLASS'/1X)
460    FORMAT (1X,T3,I2,4F9.2,6X,I1//)
470    FORMAT (13X,10I11)
480    FORMAT (' FINAL HT (M) ',10F11.2)
490    FORMAT (' DIST FIN HT (KM)',10F11.3)
500    FORMAT ('0',T7,'RECEPTOR',T23,'EAST',T33,'NORTH',T43,'RECEPTOR HT'
      1,T61,'RECEPTOR',T78,'TOTAL FROM',T93,'TOTAL FROM',T106,'CONCENTRAT
      2ION'/' ',T7,'NO. NAME',T22,'COORD',T33,'COORD',T44,'ABV GRD (M)',T
      359,'GRD-LVL ELEV',T77,'SIGNIF POINT',T93,'ALL SOURCES',T111,'RANK'
      4/' ',T58,'(USER HT UNITS)',T80,'SOURCES'//)
510    FORMAT (1H ,I8,2A1,2X,2A4,2F10.2,F12.1,F20.1,6P,2F15.4,I15)
520    FORMAT ('0',T22,I2,'-HOUR AVERAGE ',A4,' CONTRIBUTION(MICROGRAMS/M
      1**3) FROM SIGNIFICANT POINT SOURCES',5X,I2,'/',I3,'  START HOUR: '
      2,I2//1X,T5,'RANK')
530    FORMAT ('0',T25,I2,'-HOUR AVERAGE ',A4,' SUMMARY CONCENTRATION TAB
      1LE(MICROGRAMS/M**3)',5X,I2,'/',I3,'  START HOUR: ',I2//1X)
540    FORMAT ('CNTL',1X,3F10.3,20X,I4,2F10.1)
C
       END
       FUNCTION XSHORE(X0,Y0,TRAD,X1,Y1,BA,EA,FETCH)
       RADCON=0.017453293
       IF ((X1-X0).NE.0.) THEN
          TSTANG=ATAN((Y1-Y0)/(X1-X0))/RADCON
         ELSE
          IF (Y1.GT.Y0) TSTANG=90
          IF (Y1.LT.Y0) TSTANG=270
          IF (Y1.EQ.Y0) THEN
             XSHORE=0.
             RETURN
          ENDIF
```

```
      ENDIF
      IF (X1.LT.X0) TSTANG=TSTANG+180
      IF (TSTANG.LE.0) TSTANG=TSTANG+360
      TSTANG=360-TSTANG+90
      IF (TSTANG.LT.BA+FETCH) TSTANG=TSTANG+360
      IF (TRAD.LT.BA) TRAD=TRAD+360
      IF (TRAD.GT.EA) TRAD=TRAD-360
      IF (TSTANG.GT.EA-FETCH) THEN
         IF (TSTANG.GT.EA+180-FETCH) THEN
            ANG=BA
          ELSE
            ANG=EA
         ENDIF
         GO TO 100
      ENDIF
      IF (TSTANG.GT.TRAD) ANG=BA
      IF (TSTANG.LT.TRAD) ANG=EA
      IF (TSTANG.EQ.TRAD) THEN
         XSHORE=SQRT((X1-X0)**2+(Y1-Y0)**2)
         RETURN
      ENDIF
  100 CONTINUE
      ANG=360-ANG+90
      WD=360-TRAD+90

      IF (WD/180.EQ.INT(WD/180.)) THEN
         V=Y0
         IF (ANG/90..EQ.INT(ANG/90.).AND.ANG/180..NE.INT(ANG/180.)) THEN
            U=X1
            GO TO 10
         ENDIF
         U=X1+(Y0-Y1)*COTAN(ANG*RADCON)
         GO TO 10
      ENDIF

      IF (WD/90.EQ.INT(WD/90.)) THEN
         U=X0
         IF (ANG/180..EQ.INT(ANG/180.)) THEN
            V=Y1
            GO TO 10
         ENDIF
         V=Y1+(X0-X1)*TAN(ANG*RADCON)
         GO TO 10
      ENDIF

      IF (ANG/180..EQ.INT(ANG/180.)) THEN
         V=Y1
         U=X0+(Y1-Y0)*COTAN(WD*RADCON)
         GO TO 10
      ENDIF

      IF (ANG/90..EQ.INT(ANG/90.)) THEN
         U=X1
         V=Y0+(X1-X0)*TAN(WD*RADCON)
         GO TO 10
      ENDIF

      U=(Y1-Y0+X0*TAN(WD*RADCON)-X1*TAN(ANG*RADCON))/
     &     (TAN(WD*RADCON)-TAN(ANG*RADCON))
      V=Y1+(U-X1)*TAN(ANG*RADCON)
```

```
   10 XSHORE=SQRT((U-XO)**2+(V-YO)**2)
      RETURN
      END

      SUBROUTINE SFM(DIST)
C*****************************************************************
C
C                          SFM
C            A SHORELINE FUMIGATION MODEL
C
C   ORIGINAL AUTHOR:  DR. P.K. MISRA
C                     AIR RESOURCES BRANCH
C                     ONTARIO MINISTRY OF ENVIRONMENT
C                     CANADA
C
C   MODIFIED FOR INCORPORATION IN MPTER BY:
C            SUZANNE TEMPLEMAN
C            MARINE, EARTH AND ATMOSPHERIC SCIENCES DEPT.
C            NORTH CAROLINA STATE UNIVERSITY
C            RALEIGH, NC  27695-8208
C
C            JUNE 1988
C
C   SFM PROGRAM ABSTRACT:
C
C       SFM IS AN ALGORITHM CODE WHICH PRODUCES ESTIMATES
C   OF GROUND LEVEL POLLUTANT CONCENTRATION FOR USER-DEFINED
C   RECEPTORS LOCATED DOWNWIND OF AN ELEVATED, SINGLE POINT
C   SOURCE SITUATED AT THE SHORELINE.
C
C   HOURLY SOURCE AND METEOROLOGICAL DATA AND RECEPTOR
C   COORDINATES ARE REQUIRED AS INPUT.
C
C   EXECUTION OF THE CODE IS APPROPRIATE PROVIDED THE
C   FOLLOWING CONDITIONS ARE SATISFIED:
C
C   1) WIND DIRECTION AT THE SHORELINE SOURCE IS ONSHORE
C   2) IT IS DAYTIME AND THE SURFACE, SENSIBLE HEAT
C      FLUX OVER LAND IS AT LEAST +5 W M[-2
C   3) LAPSE RATE OVER WATER IS STABLE
C
C   THE USER IS REFERRED TO THE USER'S GUIDE FOR A MORE
C   DETAILED EXPLANATION OF WHEN THE MODEL SHOULD BE APPLIED.
C
C          THE PROGRAM CONSISTS OF FOUR MODULES:
C                1. MAIN MODULE
C                2. SUBROUTINE CALC
C                3. SUBROUTINE SIMP
C                4. FUNCTION EVAL
C
C*****************************************************************
C
C*********************** MAIN MODULE *************************
C  THE MAIN MODULE CONTROLS METEOROLOGICAL AND SOURCE INPUT
C  AND OUTPUT OF THE POLLUTANT CONCENTRATIONS FOR THE
C  DESIGNATED RECEPTORS.  VARIABLES WHICH REMAIN CONSTANT
C  FOR ANY GIVEN HOUR OF INPUT ARE COMPUTED WITHIN THIS MODULE.
C*****************************************************************
C
```

```
C  DEFINE VARIABLES:
C
C   A      =  TIBL A FACTOR, GIVEN BY:
C             ((2*HO)/(RHO*CSUBP*DTHDZ*UL))**0.5   (M[1/2)
C   B      =  W*/UL
C   RHO    =  ATMOSPHERIC DENSITY  (KG M[-3)
C   CSUBP =  SPECIFIC HEAT AT CONSTANT PRESSURE (J K[-1 KG[-1)
C   CK     =  VON KARMAN'S CONSTANT  (0.4)
C   CN     =  BRUNT-VAISALA FREQUENCY (S[-1)
C   DTHDZ =  POTENTIAL TEMPERATURE GRADIENT OVERWATER (K M[-1)
C   F      =  PLUME BUOYANCY (M4 S[-3)
C   G      =  ACCELERATION DUE TO GRAVITY AT THE SURFACE (M S[-2)
C   HO     =  SURFACE SENSIBLE HEAT FLUX OVER LAND (W M[-2)
C   HSTK   =  STACK HEIGHT (M)
C   NR     =  NUMBER OF RECEPTORS
C   OWZ2,1  = HEIGHT OVER WATER AT LEVELS 2, 1 (M)
C   PTOW2,1 = POTENTIAL TEMPERATURE OVER WATER AT
C              LEVELS 2, 1 (K)
C   PTMOL =  MEAN POTENTIAL TEMPERATURE OVER LAND
C             BETWEEN LEVELS 2, 1 (K)
C   PTMOW =  MEAN POTENTIAL TEMPERATURE OVER WATER
C             BETWEEN LEVELS 2, 1 (K)
C   Q      =  SOURCE STRENGTH (G S[-1)
C   UL     =  MEAN WIND SPEED IN THE TIBL (M S[-1)
C   US     =  MEAN WIND SPEED IN THE STABLE LAYER (M S[-1)
C   W*     =  CONVECTIVE VELOCITY (M S[-1)
C   X      =  DOWNWIND DISTANCE (M)
C*****************************************************
      REAL XP,YP,MGCM
      REAL A,B,CK,CN,DTHDZ,F,H,HO,HSTK,Q,PTMOL,PTMOW,UL,US
      INTEGER NR
      COMMON /SDMONE/XP,YP,A,B,UL,US,H,HSTK,CN,F,I,Q,MGCM
C
C->->  OPEN FILES FOR INPUT AND OUTPUT
C
C      OPEN(11,FILE='MET.DAT',STATUS='OLD',FORM='FORMATTED')
C      OPEN(12,FILE='XY.DAT',STATUS='OLD',FORM='FORMATTED')
C      OPEN(15,FILE='MSFM.OUT',STATUS='NEW')
C
C     DEFINE CONSTANTS
C
      CK = 0.4
      CSUBP = 1020.
      G = 9.8
      PI = 3.1415927
      RHO = 1.188
C
C->->  READ IN METEOROLOGICAL AND STACK VARIABLES
C
C20     READ(11,22) UL,US,PTMOL,PTMOW,DTHDZ,HO,F,Q,HSTK,NR
C22     FORMAT(F5.2,1X,F5.2,1X,F6.2,1X,F6.2,1X,F7.4,1X,
C     #        F6.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,I3)
C
C->->  CALCULATE BRUNT-VAISALA FREQUENCY
C
C      DTHDZ = (PTOW2 - PTOW1)/(OWZ2 - OWZ1)
C      PTMOW = (PTOW2 - PTOW1)/2.
C       CN = ((G/PTMOW)*DTHDZ)**0.5
C
C-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*
```

```
C
C     IF THE SURFACE, SENSIBLE HEAT FLUX IS NOT
C     A KNOWN INPUT, USE THE FOLLOWING STATEMENTS
C     TO GENERATE AN ESTIMATE.  MODIFY THE READ
C     STATEMENT ACCORDINGLY.
C
C*>*>   DETERMINE SURFACE, SENSIBLE HEAT FLUX USING
C       THE PROFILE METHOD
C
C       DEFINE VARIABLES:
C
C       BETA0,1,2 =  FUNCTION OF STABILITY PARAMETER Z/L
C                    FOR AN UNSTABLE ATMOSPHERE
C                    AT Z LEVELS 0,1,2
C       CL        =  MONIN-OBUKHOV LENGTH (M)
C       PTMOL     =  MEAN POTENTIAL TEMPERATURE OVER LAND
C                    BETWEEN LEVELS 2,1 (K)
C       PTOL2,1   =  POTENTIAL TEMPERATURE OVER LAND AT
C                    LEVELS 2, 1 (K)
C       PTOW2,1   =  POTENTIAL TEMPERATURE OVER WATER AT
C                    LEVELS 2, 1 (K)
C       OLU2,1    =  WIND SPEED OVER LAND AT LEVEL 2, 1 (M S[-1)
C       OLZ2,1    =  HEIGHT OVER LAND AT LEVEL 2, 1  (M)
C       OWZ2,1    =  HEIGHT OVER WATER AT LEVEL 2,1  (M)
C       PSIH1,2   =  UNIVERSAL FUNCTION IN THE DIABATIC SURFACE
C                    LAYER TEMPERATURE PROFILE
C       PSIM0,1   =  UNIVERSAL FUNCTION IN THE DIABATIC SURFACE
C                    LAYER WIND PROFILE
C       RI        =  RICHARDSON NUMBER
C       USTAR     =  FRICTION VELOCITY (M S[-1)
C       TSTAR     =  TEMPERATURE SCALE (K)
C       ZO        =  SURFACE ROUGHNESS LENGTH (M)
C       ZR        =  HEIGHT ASSOCIATED WITH RI (M)
C
C*>*>   FIRST CALCULATE THE RICHARDSON NUMBER
C
C       PTMOL = (PTOL2 - PTOL1)/2.
C
C       RI = (G/PTMOL)*
C      # ((PTOL2 - PTOL1)/(OLZ2 - OLZ1))
C      # /((OLU2 - OLU1)/(OLZ2 - OLZ1))**2.
C
C      ZR = (OLZ1*OLZ2)**0.5
C      CL = ZR/RI
C
C      BETA0 = (1 - 16*ZO/CL)**0.25
C      BETA1 = (1 - 16*OLZ1/CL)**0.25
C      BETA2 = (1 - 16*OLZ2/CL)**0.25
C
C      PSIM0 = 2*ALOG((1 + BETA0)/2.) +
C     # ALOG((1 + BETA0*BETA0)/2.) -
C     # 2ATAN(BETA0) + PI/2.
C
C      PSIM1 = 2*ALOG((1 + BETA1)/2.) +
C     # ALOG((1 + BETA1*BETA1)/2.) -
C     # 2ATAN(BETA1) + PI/2.
C
C      PSIH1 = 2*ALOG((1 + BETA1*BETA1)/2.)
C      PSIH2 = 2*ALOG((1 + BETA2*BETA2)/2.)
C
```

```
C->->  CALCULATE FRICTION VELOCITY
C
C      USTAR = (CK*U1)/(ALOG(OLZ1/ZO) - PSIM1 + PSIM0)
C
C->->  CALCULATE TEMPERATURE SCALE
C
C      TSTAR = (CK*(PTOL2 - PTOL1))/
C     # (ALOG(OLZ2/OLZ1) - PSIH2 + PSIH1)
C
C      HO = - RHO*CSUBP*USTAR*TSTAR
C
C-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*
C
C->->  DETERMINE THE TIBL A FACTOR
C
C       A = ((2.*HO)/(CSUBP*RHO*DTHDZ*UL))**0.5
C
C->->  DETERMINE THE TIBL HEIGHT FOR USE IN CALCULATING
C       CONVECTIVE VELOCITY (W*)
C
C       HT = A*(5000.**0.5)
C
C->->  DETERMINE PART OF SIGMA Y EQUATION
C       FOR THE CONVECTIVE LAYER (B = W*/UL)
C
C       B = (((G*HO*HT)/(RHO*CSUBP*PTMOL))**.333)/UL
C
C->->  WRITE HEADER AND VALUES OF INPUT VARIABLES USED
C
C       WRITE(*,25)
C       WRITE(15,27)
C25     FORMAT(7X,' **  SHORELINE FUMIGATION MODEL  **')
C27     FORMAT(8X,'**  SHORELINE FUMIGATION MODEL  **')
C       WRITE(*,35)
C       WRITE(15,37)
C35     FORMAT('0 ORIGINALLY DEVELOPED BY')
C37     FORMAT(/'  ORIGINALLY DEVELOPED BY')
C       WRITE(*,45)
C       WRITE(15,47)
C45     FORMAT(1X,'   P.K. MISRA')
C47     FORMAT(1X,'   P.K. MISRA')
C       WRITE(*,55)
C       WRITE(15,57)
C55     FORMAT(1X,'   ONTARIO MINISTRY OF ENVIRONMENT')
C57     FORMAT(1X,'   ONTARIO MINISTRY OF ENVIRONMENT')
C       WRITE(*,65)
C       WRITE(15,67)
C65     FORMAT('0 MODIFIED FOR INCORPORATION IN MPTER BY')
C67     FORMAT(/'  MODIFIED FOR INCORPORATION IN MPTER BY')
C       WRITE(*,75)
C       WRITE(15,77)
C75     FORMAT(1X,'   S. TEMPLEMAN')
C77     FORMAT(1X,'   S. TEMPLEMAN')
C       WRITE(*,85)
C       WRITE(15,87)
C85     FORMAT(1X,'   NORTH CAROLINA STATE UNIVERSITY - JUNE 1988')
C87     FORMAT(1X,'   NORTH CAROLINA STATE UNIVERSITY - JUNE 1988')
C       WRITE(*,95)
C       WRITE(15,97)
C95     FORMAT('0 INPUT VARIABLES:')
```

```
C97    FORMAT(/'  INPUT VARIABLES:')
C      WRITE (*,105) A
C      WRITE(15,107) A
C105   FORMAT('0 THE TIBL A FACTOR IS:',F5.2,1X,'M[1/2')
C107   FORMAT(/'  THE TIBL A FACTOR IS:',F5.2,1X,'M[1/2')
C      WRITE (*,115) B
C      WRITE(15,115) B
C115   FORMAT(1X' THE VARIABLE B = W*/UL IS: ',F4.2)
C      WRITE (*,125)  UL
C      WRITE (15,125) UL
C125   FORMAT (1X' THE MEAN WIND SPEED IN THE TIBL IS:',F5.2,
C     #1X,'M S[-1')
C      WRITE (*,135)  US
C      WRITE (15,135) US
C135   FORMAT (1X' THE MEAN WIND SPEED AT STACK HEIGHT IS:',F5.2,
C     #1X,'M S[-1')
C      WRITE (*,145)  PTMOL
C      WRITE (15,145) PTMOL
C145   FORMAT(1X' THE POTENTIAL TEMPERATURE OVER LAND IS:',
C     #1X,F5.1,1X,'K')
C      WRITE (*,155)  DTHDZ
C      WRITE (15,155) DTHDZ
C155   FORMAT(1X' THE OVERWATER LAPSE RATE IS: ',F5.3,1X,'K M[-1')
C      WRITE (*,165)  HO
C      WRITE (15,165) HO
C165   FORMAT(1X' THE SURFACE, SENSIBLE HEAT FLUX IS:', 1X,
C     #F4.0,1X,'W M[-2 ')
C      WRITE (*,175) F
C      WRITE(15,175)  F
C175   FORMAT(1X' THE BUOYANCY PARAMETER IS:',F5.0,1X,'M4 S[-3')
C      WRITE (*,185) Q
C      WRITE(15,185) Q
C185   FORMAT(1X' THE EMISSION RATE IS:',F6.0,1X,'G S[-1')
C      WRITE (*,195)  HSTK
C      WRITE (15,195) HSTK
C195   FORMAT(1X,' THE STACK HEIGHT IS:',F5.0,1X,'M')
C
C->->  CALL TO CALC SUBROUTINE TO BEGIN CALCULATION
C      OF GROUND LEVEL CONCENTRATIONS
C
      CALL CALC(DIST)
C
C->->  WRITE CONCENTRATIONS FOR RECEPTOR LOCATIONS
C
C30    WRITE(*,205)
C      WRITE(15,207)
C205   FORMAT('0',/'  RECEPTOR LOCATIONS AND CONCENTRATIONS',
C     #' IN MICROGRAMS M[-3')
C207   FORMAT(//'  RECEPTOR LOCATIONS AND CONCENTRATIONS',
C     #' IN MICROGRAMS M[-3')
C      WRITE(*,215)
C      WRITE(15,217)
C215   FORMAT('0 X LOCATION',10X,' Y LOCATION',11X,
C     #'MICROG M[-3')
C217   FORMAT(/'  X LOCATION',10X,' Y LOCATION',11X,
C     #'MICROG M[-3'/)
C      WRITE(*,219)
C219   FORMAT(1X)
C
C      DO 200 I=1,NR
```

```
C        WRITE(*,225) XP(I),YP(I),MGCM(I)
C        WRITE(15,227) XP(I),YP(I),MGCM(I)
C225     FORMAT(3X,F6.0,15X,F6.0,13X,F9.3)
C227     FORMAT(3X,F6.0,15X,F6.0,13X,F9.3)
C200   CONTINUE
C40    WRITE (*,235)
C      WRITE (15,237)
C235   FORMAT ('0 END OF MODEL RUN')
C237   FORMAT (/' END OF MODEL RUN')
C      STOP
C   DEBUG UNIT(6),INIT,SUBCHK,SUBTRACE
      RETURN
      END

ccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
      SUBROUTINE CALC(DIST)
C
C   THIS SUBROUTINE ACTS AS AN INTERMEDIARY BETWEEN THE
C   MAIN MODULE AND SUBROUTINE SIMP.  IN THIS ROUTINE
C   RECEPTOR COORDINATES ARE READ IN AND GROUND LEVEL
C   CONCENTRATIONS EVALUATED BY SUBROUTINE SIMP ARE
C   MULTIPLIED BY THE SOURCE STRENGTH AND CONVERTED TO
C   MICROG M[-3.  CONCENTRATIONS ARE STORED IN THE COMMON
C   BLOCK FOR OUTPUT IN MAIN.
C
C   DEFINE VARIABLES:
C
C     ACC     = DESIRED ACCURACY OF ANSWER
C     ANS     = APPROXIMATE VALUE OF THE INTEGRAL OF F(X)
C               FOR INTERVAL FROM LB TO XP1
C     ANS1    = APPROXIMATE VALUE OF THE INTEGRAL OF F(X)
C               FOR THE INTERVAL FROM XP1 TO XP.
C     AREA    = APPROXIMATE, ABSOLUTE VALUE OF THE INTEGRAL OF
C               F(X) FOR THE INTERVAL FROM LB TO XP
C     F(X)    = FUNCTION WHOSE INTEGRAL IS DESIRED
C     IFLAG   = 1 FOR NORMAL RETURN
C               2 IF IT IS NECESSARY TO GO TO 30 LEVELS.
C                 ERROR MAY BE UNRELIABLE IN THIS CASE.
C               3 IF MORE THAN 2000 FUNCTION EVALUATIONS.
C                 COMPLETE THE COMPUTATIONS AND NOTE THAT
C                 ERROR IS USUALLY UNRELIABLE.
C               IFLAG MAY BE USED FOR DIAGNOSTICS.
C     LB      = INITIAL X VALUE NEAR STACK
C     UL      = MEAN WIND SPEED IN THE TIBL
C     US      = MEAN WIND SPEED AT STACK HEIGHT IN STABLE AIR
C     XP      = DOWNWIND DISTANCE FROM SOURCE
C     XP1     = DOWNWIND DISTANCE AT WHICH PLUME LEVELS OFF
C     YP      = HORIZONTAL DISTANCE
C
ccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
      EXTERNAL EVAL
      REAL XP,YP,MGCM,LB
      INTEGER NR
      COMMON/SDMONE/XP,YP,A,B,UL,US,H,HSTK,CN,F,I,Q,MGCM
C
C->->  INITIALIZE VARIABLES
C
      ACC = 10.0E-6
      LB = 10.00 + DIST
      IFLAG = 0.0
```

```
C
C->->   LOOP THROUGH RECEPTOR POINTS
C
C       DO 100 I=1,NR
C
C->->   READ IN RECEPTOR COORDINATES
C
C         READ(12,15) XP(I),YP(I)
C15       FORMAT(F9.1,2X,F9.1)
C
C->->   IF X COORDINATE IS TOO SMALL, GO TO
C       NEXT RECEPTOR
C
         IF(XP.GT.0.001) GOTO 10
         GOTO 100
C
C->->   INITIALIZE VALUES OF THE INTEGRAL
C
10       ANS = 0.0
         ANS1 = 0.0
C
C->->   DETERMINE TRAVEL DISTANCE UNTIL PLUME LEVELS OFF
C
          XP1 = DIST+(4.50/CN)*US
          XP=XP+DIST
C
C->->   DETERMINE WHETHER DISTANCE OF RECEPTOR DOWNWIND OF
C       SOURCE EXCEEDS TRAVEL DISTANCE UNTIL PLUME LEVELS OFF
C
          IF(XP.GE.XP1) GOTO 20
C
C->->   APPLY SIMPSON'S RULE OVER THE INTERVAL FROM INITIAL
C       POINT (LB) TO RECEPTOR POINT (XP)
C
          CALL SIMP(EVAL,LB,XP,ACC,ANS,ERROR,AREA,IFLAG)
C
          GOTO 30
C
C->->   RECEPTOR POINT IS IN REGION WHERE PLUME HAS LEVELED
C       OFF.  APPLY SIMPSON'S RULE IN TWO STEPS.  FIRST APPLY
C       OVER THE INTERVAL FROM INITIAL POINT (LB) TO XP1.
C       SECOND APPLY OVER THE X DISTANCE FROM XP1 TO RECEPTOR
C       POINT (XP).  USING TWO CALLS TO SIMP HERE SAVES
C       ON COMPUTATION TIME.
C
20      CALL SIMP(EVAL,LB,XP1,ACC,ANS,ERROR,AREA,IFLAG)
        CALL SIMP(EVAL,XP1,XP,ACC,ANS1,ERROR,AREA,IFLAG)
C
C->->   SUM VALUES OF THE INTEGRAL FOR THE LEFT (ANS) AND
C       RIGHT (ANS1) HALVES OF THE INTERVAL
C
30        ANS = ANS+ANS1
C
C->->   MULTIPLY BY SOURCE STRENGTH AND CONVERT ANSWER
C       TO MICROGRAMS PER M3
C
          MGCM = ANS*Q/1.E-06
C
100    CONTINUE
200    RETURN
```

```
C       DEBUG UNIT (6),SUBCHK,INIT,SUBTRACE
      END

CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE SIMP(EVAL,EA,EB,ACC,ANS,ERROR,AREA,IFLAG)
C
C    SIMP IS AN ITERATIVE CODE BASED ON SIMPSON'S RULE,
C    A NUMERICAL TECHNIQUE DESIGNED TO EVALUATE THE
C    DEFINITE INTEGRAL OF A CONTINUOUS FUNCTION WITH
C    FINITE LIMITS OF INTEGRATION.
C
C    DEFINE VARIABLES:
C
C      ACC      = DESIRED ACCURACY OF ANS.
C      ANS      = APPROXIMATE VALUE OF THE INTEGRAL OF F(X)
C                 FROM EA TO EB
C      AREA     = APPROXIMATE, ABSOLUTE VALUE OF THE INTEGRAL
C                 F(X) FROM EA TO EB
C      EA,EB    = LOWER AND UPPER LIMITS OF INTEGRATION
C      ERROR    = ESTIMATED ERROR OF ANSWER
C      EVAL(X)  = VALUE OF THE INTEGRAL EVALUATED AT X
C      IFLAG    = 1 FOR NORMAL RETURN
C                 2 IF IT IS NECESSARY TO GO TO 30 LEVELS OR
C                   USE LENGTH.  ERROR MAY BE UNRELIABLE
C                   IN THIS CASE.
C                 3 IF MORE THAN 2000 FUNCTION EVALUATIONS
C                   THEN COMPLETE THE COMPUTATIONS.  ERROR
C                   IS USUALLY UNRELIABLE.
C                 IFLAG MAY BE USED FOR DIAGNOSTICS.
C      U        = UNIT ROUND-OFF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DIMENSION FV(5),LORR(30),FIT(30),F2T(30),F3T(30),
     #DAT(30),ARESTT(30),ESTT(30),EPST(30),PSUM(30)
      REAL EVAL
C
C->->  SET U TO APPROXIMATELY THE UNIT ROUND-OFF
C
      U = 9.0E-7
C
C->->  INITIALIZE VARIABLES
C
      FOURU = 4.0*U
      IFLAG = 1
      EPS = ACC
      ERROR=0.0
      AREA = 0.0
      AREST = 0.0
      LVL = 1
      LORR(LVL) = 1
      PSUM(LVL) = 0.0
      ALPHA = EA
      DA = EB-EA
C
C->->   DETERMINE VALUES OF THE FUNCTION AT THE ENDS
C        AND MID-POINT OF THE INTERVAL
C
      FV(1) = EVAL(ALPHA)
      FV(3) = EVAL(ALPHA+0.5*DA)
      FV(5) = EVAL(ALPHA+DA)
```

```
C
C->>->   START SUMMATION OF NUMBER OF FUNCTION EVALUATIONS
C
      KOUNT = 3
      WT = DA/6.0
C
C->>->   DETERMINE ESTIMATE OF THE INTEGRAL FOR THE INTERVAL
C        BETWEEN THE DESIGNATED ENDPOINTS
C
      EST = WT*(FV(1)+4.0*FV(3)+FV(5))
10    DX = 0.5*DA
C
C->>->   DETERMINE VALUES OF THE FUNCTION AT THE ONE QUARTER
C        AND THREE QUARTER POINTS OF THE INTERVAL
C
      FV(2) = EVAL(ALPHA+0.5*DX)
      FV(4) = EVAL(ALPHA+1.5*DX)
      KOUNT = KOUNT+2
      WT = DX/6.0
C
C->>->   DETERMINE ESTIMATES OF THE AREA UNDER THE LEFT HALF
C        AND RIGHT HALF OF THE CURVE THEN SUM
C
      ESTL = WT*(FV(1)+4.0*FV(2)+FV(3))
      ESTR = WT*(FV(3)+4.0*FV(4)+FV(5))
      SUM = ESTL+ESTR
C
C->>->   DETERMINE ESTIMATES OF THE AREA UNDER THE CURVE
C        BETWEEN THE DESIGNATED ENDPOINTS BASED ON THE
C        ABSOLUTE VALUES OF THE FUNCTION EVALUATIONS
C
      ARESTL = WT*(ABS(FV(1))+ABS(4.0*FV(2))+ABS(FV(3)))
      ARESTR = WT*(ABS(FV(3))+ABS(4.0*FV(4))+ABS(FV(5)))
      AREA = AREA+((ARESTL+ARESTR)-AREST)
      DIFF = EST-SUM
C
C->>->  IF ERROR IS ACCEPTABLE GO TO 20.  IF INTERVAL IS TOO
C       SMALL OR TOO MANY LEVELS OR TOO MANY FUNCTION
C       EVALUATIONS, SET A FLAG AND GO TO 20 ANYWAY.
C
      IF(ABS(DIFF).LE.EPS*ABS(AREA)) GOTO 20
      IF(ABS(DX).LE.FOURU*ABS(ALPHA)) GOTO 50
      IF(LVL.GE.30) GOTO 50
      IF(KOUNT.GE.2000) GOTO 60
C
C->>->  STORE INFORMATION TO PROCESS RIGHT HALF OF THE
C       CURVE.  NOW, USING A GREATER NUMBER OF SUB-INTERVALS,
C       RECALCULATE AREA UNDER THE LEFT HALF OF THE CURVE.
C
      LVL = LVL+1
      LORR(LVL) = 0
      FIT(LVL) = FV(3)
      F2T(LVL) = FV(4)
      F3T(LVL) = FV(5)
      DA = DX
      DAT(LVL) = DX
      AREST = ARESTL
      ARESTT(LVL) = ARESTR
      EST = ESTL
      ESTT(LVL) = ESTR
```

```
      EPS = EPS/1.4
      EPST(LVL) = EPS
      FV(5) = FV(3)
      FV(3) = FV(2)
      GOTO 10
C
C->->  ACCEPT APPROXIMATE INTEGRAL SUM.  IF LEFT HALF
C      OF CURVE WAS PROCESSED, MOVE TO RIGHT HALF.
C      IF RIGHT HALF OF CURVE WAS PROCESSED, ADD RESULTS
C      TO FINISH.  LORR (A MNEMONIC FOR LEFT OR RIGHT)
C      TELLS WHETHER INTERVAL IS RIGHT OR LEFT AT EACH
C      LEVEL.
C
20    ERROR = ERROR+DIFF/15.0
30    IF(LORR(LVL).EQ. 0) GOTO 40
      SUM = PSUM(LVL)+SUM
      LVL = LVL-1
      IF(LVL.GT.1) GOTO 30
      ANS = SUM
      RETURN
C
C->->  MOVE RIGHT.  RESTORE SAVED INFORMATION TO PROCESS
C      RIGHT HALF OF INTERVAL.
C
40    PSUM(LVL) = SUM
      LORR(LVL) = 1
      ALPHA = ALPHA+DA
      DA = DAT(LVL)
      FV(1) = FIT(LVL)
      FV(3) = F2T(LVL)
      FV(5) = F3T(LVL)
      AREST = ARESTT(LVL)
      EST = ESTT(LVL)
      EPS = EPST(LVL)
      GOTO 10
C
C->->  ACCEPT 'POOR' VALUE.  SET APPROPRIATE FLAGS.
C
50    IFLAG = 2
      GOTO 20
60    IFLAG = 3
      GOTO 20
C      DEBUG UNIT (6),SUBCHK,INIT,SUBTRACE
      END

CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      FUNCTION EVAL(X)
C
C   FUNCTION EVAL RETURNS A VALUE OF THE INTEGRAL FOR (X),
C   THE DESIGNATED POINT ON THE INTERVAL OF INTEGRATION.
C   THE FUNCTION RETURNS THE VALUE TO SUBROUTINE SIMP
C   THROUGH THE FUNCTION NAME.
C
C     DEFINE VARIABLES:
C
C     CA    = COEFFICIENT IN PLUME RISE EQUATION
C     CYS   = CONSTANT FOR SIGMA Y IN STABLE AIR
C     CZS   = CONSTANT FOR SIGMA Z IN STABLE
C     BL    = TIBL HEIGHT AT DESIGNATED POINT ON
C             INTERVAL OF INTEGRATION
```

```
C      BL1    = TIBL HEIGHT AT RECEPTOR POINT
C      FN     = TIME AFTER WHICH PLUME HAS LEVELED OFF
C      D      = TRAVEL TIME = X/US
C      H      = PLUME HEIGHT
C      VARYL = SIGMA Y IN CONVECTIVE LAYER
C      VARYS = SIGMA Y IN STABLE LAYER
C      VARZ  = SIGMA Z IN STABLE LAYER
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      REAL XP,YP,MGCM,EVAL,MF
      COMMON/SDMONE/XP,YP,A,B,UL,US,H,HSTK,CN,F,I,Q,MGCM
C
C->->  DEFINE CONSTANTS
C
      CA  = 1.6
      CYS = 0.67
      CZS = 0.40
C
C->->  REEXPRESS FREQUENTLY USED CALCULATIONS
C
      FU = F/US
      FN = 4.50/CN
      IF(X.LE.0.001) GOTO 100
      D = X/US
C
C->->  DETERMINE SIGMA Y IN STABLE AIR
C
      VARYS = CYS*(D**(2./3.))*(FU**(1./3.))
C
C->->  DETERMINE SIGMA Y IN THE UNSTABLE AIR
C
      VARYL = B*(XP-X)/3.0
C
C->->  DETERMINE TIBL HEIGHT AT EVALUATION POINT (X)
C      AND AT RECEPTOR POINT (XP)
C
      BL = A*SQRT(X)
      BL1 = A*SQRT(XP)
C
C->->  DETERMINE FIRST PART OF CONCENTRATION EQUATION
C
      MF = 1./(2.*3.14159*BL1*UL)
C
C->->  DETERMINE IF TRAVEL TIME IN STABLE AIR EXCEEDS
C      TIME AFTER WHICH PLUME HAS LEVELED OFF.  IF YES,
C      FINAL PLUME RISE CALCULATIONS APPLY.
C
      IF(D.GT.FN) GOTO 10
C
C->->  DETERMINE PLUME HEIGHT USING GRADUAL PLUME
C      RISE EQUATION
C
       H = (CA*(FU**(1./3.))*(D**(2./3.))) + HSTK
C
C      ADDED 9-6-88 TO ACCOUNT FOR MPTER/MISRA PLUME RISE DIFFERNCES
C
       H = AMIN1(H,2.6*(FU/CN**2.)**.3333+HSTK)
C
C->->  DETERMINE SIGMA Z IN STABLE AIR FOR GRADUALLY
C      RISING PLUME
C
```

```
      VARZ = CZS*(D**(2./3.))*(FU**(1./3.))
C
C->->  DETERMINE VALUE OF DERIVATIVE IN
C      CONCENTRATION EQUATION FOR RISING PLUME
C
      DERIV = (-1./6.)*(A*UL)/(CZS*(F**(1./3.)))
     #*(X**(-7./6.)) +
     #(HSTK * UL)/(CZS*(F**(1./3.)))*(2./3.)*(X**(-5./3.))
C
C     IF DISTANCE IS LARGE, TREAT AS LEVEL PLUME
C
      IF (DERIV.LE.0.) GO TO 10
C
      GO TO 20
C
C->->  PLUME HAS LEVELED OFF IN STABLE AIR
C
C->->  DETERMINE SIGMA Z IN STABLE AIR FOR A LEVEL
C      PLUME
C
10    VARZ = 1.1*(FU/(CN*CN))**(1./3.)
C
C->->  DETERMINE VALUE OF DERIVATIVE IN
C      CONCENTRATION EQUATION FOR LEVEL PLUME
C
      DERIV = A/(2.*SQRT(X)*VARZ)
C
20    VARZS = VARZ*VARZ
      SIGS = (VARYS*VARYS+VARYL*VARYL)
      BLDIFS = (BL-H)*(BL-H)
C
C->->  DETERMINE VALUE OF EXPONENTIAL
C      IN CONCENTRATION EQUATION
C
      C1 = -.5*(BLDIFS/VARZS+YP*YP/SIGS)
C
C->->  TAKE ALOG OF EXPRESSION INSIDE
C      INTEGRAL OF CONCENTRATION EQUATION
C
      C = ALOG(DERIV)+C1-(ALOG(SIGS))/2.0
C
      IF(ABS(C).GT.70.0) GOTO 100
C
C->->  TAKE EXPONENTIAL OF EXPRESSION
C      INSIDE INTEGRAL OF CONCENTRATION EQUATION
C
       EVALL = EXP(C)
C
C->->  DETERMINE VALUE OF THE CONCENTRATION
C      EQUATION (MINUS MULTIPLICATION BY
C      THE SOURCE STRENGTH)
C
       EVAL = EVALL*MF
       GOTO 30
100    EVAL = 0.
30     CONTINUE
C      DEBUG UNIT(6),SUBCHK,INIT,SUBTRACE
       END

READY
```

APPENDIX D
SDM EXAMPLE CASE
INPUT FILE

Each line shown below represents a card image as presented in Section 4, Tables 4-1 through 4-11. See the text for an explanation.

```
IKJ52827I  SDM.INPUT(CLEVTEST)
********************************************************************************
                    SHORELINE DISPERSION TEST CASE #3
********************* CLEVELAND MET DATA - 1973 ******************************
73,001,01,8760,1,3,1,9,0,1,.3048,0
1,0,1,1,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0
10.,0.07,0.07,0.1,0.15,0.35,0.55,0.5,0.5,0.5,0.5,0.0,0.0,10
1             444 69 4604.38    1.00     0.0   30.00   394.0    1.83    0.62 600
2             444.69 4604.38    1 00     0.0   50.00   394.0    1.83    0.62 600
3             444.69 4604.38    1.00     0.0  100.00   394.0    1.83    0.62 600
4             451.88 4604.38    1.00     0.0   30.00   394.0    1.83    0.62 600
5             451.88 4604.38    1.00     0.0   50.00   394.0    1.83    0.62 600
6             451.88 4604.38    1.00     0.0  100.00   394.0    1.83    0.62 600
7             453 75 4610.94    1.00     0.0   30 00   394.0    1.83    0.62 600
8             453 75 4610.94    1.00     0.0   50.00   394.0    1.83    0 62 600
9             453.75 4610.94    1.00     0.0  100.00   394.0    1.83    0.62 600
ENDP
1              452.5  4612.5     223     407      20
2              452.5  4612.5     223     407      20
3              452.5  4612.5     223     407      20
4              452.5  4612.5     223     407      20
5              452.5  4612.5     223     407      20
6              452.2  4612.5     223     407      20
7              452.5  4612.5     223     407      20
8              452.5  4612.5     223     407      20
9              452.5  4612.5     223     407      20
ENDS
14620,73,14733,73
          435.000   4570.000                  650
          435.000   4580.000                  640
          435.000   4590.000                  610
          435.000   4600 000                  600
          445.000   4570.000                  670
          445.000   4580.000                  650
          445.000   4590.000                  640
          445.000   4600.000                  620
          450.000   4570.000                  690
          450.000   4580.000                  656
          450.000   4590.000                  620
          450.000   4600.000                  630
          450.000   4605.000                  610
          450.000   4610.000                  600
          455.000   4570.000                  690
          455.000   4580.000                  690
          455.000   4590.000                  640
          455.000   4600.000                  630
          455.000   4605.000                  620
          455.000   4610.000                  600
          455.000   4615.000                  600
          465.000   4570.000                  690
          465.000   4580.000                  680
          465.000   4590.000                  670
          465.000   4600.000                  650
          465.000   4605.000                  630
          465.000   4610.000                  650
```

465.000	4615.000	620
465.000	4620.000	600
475.000	4570.000	690
475.000	4580.000	690
475.000	4590.000	660
475.000	4600.000	650
475.000	4605.000	640
475.000	4610.000	650
475.000	4615.000	630
475.000	4620.000	620

ENDREC

APPENDIX E
EXAMPLE SDM CASE OUTPUT

```
                J E S 2   J O B   L O G  --  S Y S T E M   E P A 2  --  N O D E   N C C I B M 1
-------- JOB 5063  IEF097I XXXXX - USER XXX   ASSIGNED
17.34.10 JOB 5063  ICH70001I XXX    LAST ACCESS AT 15:18:00 ON TUESDAY, DECEMBER 13, 1988
17.34.10 JOB 5063  $HASP373 XXXXX  STARTED - INIT 90 - CLASS F - SYS EPA2
18.19.45 JOB 5063  NCC005I * JOB XXXXX ENDED 12/13/88 AT 18:19:45, PRTY=02, CC=0000
18.19.45 JOB 5063  $HASP395 XXXXX  ENDED
------ JES2 JOB STATISTICS ------
    13 DEC 88 JOB EXECUTION DATE
           25 CARDS READ
          970 SYSOUT PRINT RECORDS
            0 SYSOUT PUNCH RECORDS
          108 SYSOUT SPOOL KBYTES
        45.58 MINUTES EXECUTION TIME
    1      //XXXXXJOB (TIERSPCLD,M045),'PEI',PRTY=2,TIME=(15,30),NOTIFY= XXX      JOB 5063
           ***ROUTE PRINT HOLD
           ***
           *** EXECUTE PROGRAM
           ***
    2      //STEP1 EXEC PGM=SDM
    3      //STEPLIB DD DSN=VGDTIER.X.LOAD,DISP=SHR
           ***
           *** INPUT FILES
           ***
    4      //FT05F001 DD DSN=VGDTIER.SDM.INPUT(CLEVTEST),DISP=SHR
    5      //FT11F001 DD DSN=OAMS.PREP73.S14820.U14733,DISP=SHR
    6      //FT19F001 DD DSN=VGDTIER.SDM.TOWER(CLEVTEST),DISP=SHR
           ***FT15F001 DD DSN=VGDTIER.SDM.HOURLY(FILENAME),DISP=SHR
           ***
           *** OUTPUT FILES
           ***
    7      //FT06F001 DD SYSOUT=A
    8      //FT20F001 DD DSN=VGDTIER.SDM.SHORE(CLEVTEST),DISP=SHR
           ***FT10F001 DD DSN=VGDTIER.SDM.PARTIAL(FILENAME),DISP=SHR
           ***FT12F001 DD DSN=VGDTIER.SDM.HOURCONC(FILENAME),DISP=SHR
           ***FT13F001 DD DSN=VGDTIER.SDM.AVEPER(FILENAME),DISP=SHR
           ***FT14F001 DD DSN=VGDTIER.SDM.TEMP(FILENAME),DISP=SHR
    9      //SYSPRINT DD SYSOUT=A
ICH70001I XXX    LAST ACCESS AT 15:18:00 ON TUESDAY, DECEMBER 13, 1988
IEF236I ALLOC. FOR XXXXXSTEP1
IEF237I 985  ALLOCATED TO STEPLIB
IEF237I 91A  ALLOCATED TO SYS00044
IEF237I 980  ALLOCATED TO FT05F001
IEF237I 863  ALLOCATED TO FT11F001
IEF237I 881  ALLOCATED TO SYS00046
IEF237I 843  ALLOCATED TO FT19F001
IEF237I JES2 ALLOCATED TO FT06F001
IEF237I 852  ALLOCATED TO FT20F001
IEF237I JES2 ALLOCATED TO SYSPRINT
IEF142I XXXXXSTEP1 - STEP WAS EXECUTED - COND CODE 0000
IEF285I   VGDTIER.X.LOAD                              KEPT
IEF285I   VOL SER NOS= USR088.
IEF285I   CATALOG.VUCAT04B                            KEPT
IEF285I   VOL SER NOS= UCAT40.
IEF285I   VGDTIER.SDM.INPUT                           KEPT
IEF285I   VOL SER NOS= USR096.
IEF285I   OAMS.PREP73.S14820.U14733                   KEPT
IEF285I   VOL SER NOS= USR065.
IEF285I   CATALOG.VUCAT01B                            KEPT
```

```
IEF285I   VGDTIER.SDM.TOWER                              KEPT
IEF285I   VOL SER NOS= USR051.
IEF285I   JES2.JOB05063.S0000101                         SYSOUT
IEF285I   VGDTIER.SDM.SHORE                              KEPT
IEF285I   VOL SER NOS= USR058.
IEF285I   JES2.JOB05063.S0000102                         SYSOUT
NCC950I ***************** U.S.EPA  SYSTEM EPA2 - STEP SUMMARY ****************
NCC949I *                                                                     *
NCC950I * JOB XXXXX    STEP STEP1                               CC:  0000    *
NCC949I *                                                                     *
NCC950I *  START TUESDAY   12/13/88 AT 17:34:10   STOP 12/13/88 AT 18:19:45   *
NCC950I *    45:34.80 ELAPSED    6:58.95 TCB    0:00.05 SRB    6:59.00 TOT CPU *
NCC949I *                                                                     *
NCC949I *                                                                     *
NCC950I *  MEMORY:       0K VIRTUAL ADDRESS SPACE,        9648K              *
NCC950I *  EXCPS:       161 DA,         0 MT,        0 OTHER,       161 TOTAL  *
NCC950I *  EXCPS BY UNIT:  985:        18   91A:          0   98D:         4   *
NCC950I *  863:        28   881:         0   843:        90   000:         0   *
NCC950I *  852:        21   000:         0   91A:         0   881:         0   *
NCC950I *                                                                     *
NCC950I *  PAGES IN:             0 VIO            0 SWAP           0 OTHER     *
NCC950I *  PAGES OUT:            0 VIO            0 SWAP           0 OTHER     *
NCC950I *            51100 PAGE SECONDS           2604.01 RESIDENT SECONDS    *
NCC949I *                                                                     *
NCC950I *  CPU  :-    6:59.00  AT $775/HR                          $90.20     *
NCC950I *  EXCPS:-        161  AT $.45/1000                         $ .07     *
NCC950I *  TOTAL COST FOR STEP STEP1    AT PRTY=2   (1.0) =         $90.27     *
NCC949I ***********************************************************************
IEF373I STEP /STEP1   / START 88348.1734
IEF374I STEP /STEP1   / STOP  88348.1819 CPU    6MIN 58.95SEC SRB    0MIN 00.05SEC VIRT    88K SYS   264K EXT     452K SYS
NCC951I ***************** U.S.EPA  SYSTEM EPA2 - JOB SUMMARY *****************
NCC949I *                                                                     *
NCC951I * JOB XXXXX  0001 STEPS                                 CC:  0000    *
NCC949I *                                                                     *
NCC951I *  SUBMIT TUESDAY   12/13/88 AT 15:13:31          140:39.18 ON QUEUE *
NCC951I *  START 12/13/88 AT 17:34:10             STOP 12/13/88 AT 18:19:45   *
NCC951I *    45:34.81 ELAPSED    6:58.95 TCB    0:00.05 SRB    6:59.00 TOT CPU *
NCC949I *                                                                     *
NCC949I *                                                                     *
NCC951I *  CPU  :-    6:59.00  AT $775/HR                          $90.20     *
NCC951I *  EXCPS:-        161  AT $.45/1000                         $ .07     *
NCC951I *  TOTAL COST FOR JOB XXXXX  AT PRTY=2   (1.0) =            $90.27     *
NCC949I ***********************************************************************
IEF375I  JOB /XXXXX/ START 88348.1734
IEF376I  JOB /XXXXX/ STOP  88348.1819 CPU    6MIN 58.95SEC SRB    0MIN 00.05SEC
                               SDM (DATED 88204)
                         AN AIR QUALITY DISPERSION MODEL
                            COMBINING MPTER AND SHORELINE FUMIGATION
                   SOURCE: UNAMAP FILE ON EPA'S IBM 3090, RTP. NC.
                              URBAN SDM - VERSION 88204
***********************************************************************
                  SHORELINE DISPERSION TEST CASE
********************** CLEVELAND MET DATA - 1973 **********************
```

THIS RUN OF SDM -VERSION 88204 IS FOR THE POLLUTANT SO2 FOR *** 1-HOUR PERIODS.
CONCENTRATION ESTIMATES BEGIN ON HOUR- 1, JULIAN DAY- 1, YEAR-1973.
A FACTOR OF 1.0000000 HAS BEEN SPECIFIED TO CONVERT USER LENGTH UNITS TO KILOMETERS.
9 SIGNIFICANT SOURCES ARE TO BE CONSIDERED.
THIS RUN WILL NOT CONSIDER ANY POLLUTANT LOSS.

HIGH-FIVE SUMMARY CONCENTRATION TABLES WILL BE OUTPUT FOR 4 AVERAGING PERIODS.
AVG TIMES OF 1,3,8, AND 24 HOURS ARE AUTOMATICALLY DISPLAYED.
A FACTOR OF 0.3048000 HAS BEEN SPECIFIED TO CONVERT USER HEIGHT UNITS TO METERS.

OPTION	OPTION LIST	OPTION SPECIFICATION : 0= IGNORE OPTION 1= USE OPTION
	TECHNICAL OPTIONS	
1	TERRAIN ADJUSTMENTS	1
2	DO NOT INCLUDE STACK DOWNWASH CALCULATIONS	0
3	DO NOT INCLUDE GRADUAL PLUME RISE CALCULATIONS	1
4	CALCULATE INITIAL PLUME SIZE	1
	INPUT OPTIONS	
5	READ MET DATA FROM CARDS	0
6	READ HOURLY EMISSIONS	0
7	SPECIFY SIGNIFICANT SOURCES	0
8	READ RADIAL DISTANCES TO GENERATE RECEPTOR	0
	PRINTED OUTPUT OPTIONS	
9	DELETE EMISSIONS WITH HEIGHT TABLE	1
10	DELETE MET DATA SUMMARY FOR AVG PERIOD	1
11	DELETE HOURLY CONTRIBUTIONS	1
12	DELETE MET DATA ON HOURLY CONTRIBUTIONS	1
13	DELETE FINAL PLUME RISE CALC ON HRLY CONTRIBUTIONS	1
14	DELETE HOURLY SUMMARY	1
15	DELETE MET DATA ON HRLY SUMMARY	1
16	DELETE FINAL PLUME RISE CALC ON HRLY SUMMARY	1
17	DELETE AVG-PERIOD CONTRIBUTIONS	1
18	DELETE AVERAGING PERIOD SUMMARY	1
19	DELETE AVG CONCENTRATIONS AND HI-5 TABLES	0
	OTHER CONTROL AND OUTPUT OPTIONS	
20	RUN IS PART OF A SEGMENTED RUN	0
21	WRITE PARTIAL CONC TO DISK OR TAPE	0
22	WRITE HOURLY CONC TO DISK OR TAPE	0
23	WRITE AVG-PERIOD CONC TO DISK OR TAPE	0
24	PUNCH AVG-PERIOD CONC ONTO CARDS	0
	DEFAULT OPTION	
25	USE DEFAULT OPTION	0

ANEMOMETER HEIGHT IS: 10.00
EXPONENTS FOR POWER- LAW WIND INCREASE WITH HEIGHT ARE:0.07,0.07,0.10,0.15,0.35,0.55
TERRAIN ADJUSTMENTS ARE: 0.500,0.500,0.500,0.500,0.000,0.000

POINT SOURCE INFORMATION

SOURCE	EAST COORD (USER UNITS)	NORTH COORD	SO2(G/SEC) EMISSIONS	PART(G/SEC) EMISSIONS	STACK HT(M)	STACK TEMP(K)	STACK DIAM(M)	STACK VEL(M/SEC)	POTEN. IMPACT (MICRO G/M**3)	EFF HT(M)	GRD-LVL ELEV USER HT UNITS	BUC M**

2	2	444.69	4604.38	1.00	0.00	50.00	394.00	1.83	0.62	18.92	58.72	600.00
3	3	444.69	4604.38	1.00	0.00	100.00	394.00	1.83	0.62	5.95	108.72	600.00
4	4	451.88	4604.38	1.00	0.00	30.00	394.00	1.83	0.62	42.10	38.72	600.00
5	5	451.88	4604.38	1.00	0.00	50.00	394.00	1.83	0.62	18.92	58.72	600.00
6	6	451.88	4604.38	1.00	0.00	100.00	394.00	1.83	0.62	5.95	108.72	600.00
7	7	453.75	4610.94	1.00	0.00	30.00	394.00	1.83	0.62	42.10	38.72	600.00
8	8	453.75	4610.94	1.00	0.00	50.00	394.00	1.83	0.62	18.92	58.72	600.00
9	9	453.75	4610.94	1.00	0.00	100.00	394.00	1.83	0.62	5.95	108.72	600.00

SIGNIFICANT SO2 POINT SOURCES

RANK	CHI-MAX (MICROGRAMS/M**3)	SOURCE NO.
1	42.10	1
2	42.10	4
3	42.10	7
4	18.92	2
5	18.92	5
6	18.92	8
7	5.95	3
8	5.95	6
9	5.95	9

ADDITIONAL INFORMATION ON SOURCES.

EMISSION INFORMATION FOR 9 (NPT) POINT SOURCES HAS BEEN INPUT

9 SIGNIFICANT POINT SOURCES(NSIGP) ARE TO BE USED FOR THIS RUN

THE ORDER OF SIGNIFICANCE(IMPS) FOR 25 OR LESS POINT SOURCES USED IN THIS RUN AS LISTED BY POINT SOURCE NUMBER:

1 4 7 2 5 8 3 6 9

SURFACE MET DATA FROM STATION(ISFCD) 14820, YEAR(ISFCYR) 1973

MIXING HEIGHT DATA FROM STATION(IMXD) 14733, YEAR(IMXYR) 1973

RECEPTOR INFORMATION

RECEPTOR	IDENTIFICATION	EAST COORD (USER UNITS)	NORTH COORD (USER UNITS)	RECEPTOR HT ABV LOCAL GRD LVL (METERS)	RECEPTOR GROUND LEVEL ELEVATION (USER HT UNITS)
1		435.000	4570.000	0.0	650.0
2		435.000	4580.000	0.0	640.0
3		435.000	4590.000	0.0	610.0
4		435.000	4600.000	0.0	600.0
5		445.000	4570.000	0.0	670.0
6		445.000	4580.000	0.0	650.0
7		445.000	4590.000	0.0	640.0
8		445.000	4600.000	0.0	620.0
9		450.000	4570.000	0.0	690.0
10		450.000	4580.000	0.0	656.0
11		450.000	4590.000	0.0	620.0
12		450.000	4600.000	0.0	630.0
13		450.000	4605.000	0.0	610.0
14		450.000	4610.000	0.0	600.0
15		455.000	4570.000	0.0	690.0
16		455.000	4580.000	0.0	690.0
17		455.000	4590.000	0.0	640.0
18		455.000	4600.000	0.0	630.0
19		455.000	4605.000	0.0	620.0

21	455.000	4615.000	0.0	600.0
22	465.000	4570.000	0.0	690.0
23	465.000	4580.000	0.0	680.0
24	465.000	4590.000	0.0	670.0
25	465.000	4600.000	0.0	650.0
26	465.000	4605.000	0.0	630.0
27	465.000	4610.000	0.0	630.0
28	465.000	4615.000	0.0	620.0
29	465.000	4620.000	0.0	600.0
30	475.000	4570.000	0.0	690.0
31	475.000	4580.000	0.0	690.0
32	475.000	4590.000	0.0	660.0
33	475.000	4600.000	0.0	650.0
34	475.000	4605.000	0.0	640.0
35	475.000	4610.000	0.0	650.0
36	475.000	4615.000	0.0	630.0
37	475.000	4620.000	0.0	620.0

* ONE ASTERISK INDICATES THAT THE ASSOCIATED RECEPTOR(S) HAVE A GROUND LEVEL ELEVATION LOWER THAN THE LOWEST SOURCE BASE EL

CAUTION SHOULD BE USED IN INTERPRETING CONCENTRATIONS FOR THESE RECEPTORS.

** TWO ASTERISKS INDICATE THAT THE ASSOCIATED RECEPTOR(S) HAVE GROUND LEVEL ELEVATIONS ABOVE THE LOWEST STACK TOP.

CONSEQUENTLY NO CALCULATIONS WILL BE PERFORMED WITH THIS RECEPTOR.A SERIES OF ASTERISKS WILL INSTEAD APPEAR IN THE OUTPUT

SOURCE 1	DAY 68SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY 68SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY 68SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY 68SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY 68SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY 68SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY 68SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY 68SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY 68SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY 97SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY 97SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY 97SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY 97SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY 97SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY 97SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY 97SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY 97SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY 97SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY104SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY104SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY104SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY104SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY104SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY104SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY104SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY104SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY104SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY114SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY114SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY114SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY114SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY114SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

SOURCE 7	DAY114SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY114SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY114SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY129SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY129SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY129SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY129SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY129SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY129SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY129SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY129SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY129SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY138SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY138SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY138SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY138SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY138SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY138SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY138SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY138SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY138SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 1	DAY141SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY141SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY141SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0

SOURCE 4	DAY141SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY141SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY141SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY141SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY141SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY141SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0
SOURCE 1	DAY153SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY153SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY153SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY153SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY153SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY153SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY153SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY153SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY153SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY161SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY161SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY161SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY161SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY161SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY161SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY161SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY161SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY161SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY162SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY162SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY162SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY162SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY162SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

SOURCE 7	DAY162SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY162SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY162SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY163SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY163SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY163SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY163SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY163SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY163SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY163SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY163SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY163SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY164SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY164SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY164SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY164SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY164SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY164SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY164SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY164SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY164SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
SOURCE 1	DAY165SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0
SOURCE 2	DAY165SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0
SOURCE 3	DAY165SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0
SOURCE 4	DAY165SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0
SOURCE 5	DAY165SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0
SOURCE 6	DAY165SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0
SOURCE 7	DAY165SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0
SOURCE 8	DAY165SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0
SOURCE 9	DAY165SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0

SOURCE 1	DAY166SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY166SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY166SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY166SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY166SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY166SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY166SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY166SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY166SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 1	DAY172SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY172SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY172SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY172SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY172SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY172SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY172SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY172SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY172SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY173SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0
SOURCE 2	DAY173SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0
SOURCE 3	DAY173SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0
SOURCE 4	DAY173SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0
SOURCE 5	DAY173SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0
SOURCE 6	DAY173SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0

SOURCE 7	DAY173SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0	0
SOURCE 8	DAY173SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0	0
SOURCE 9	DAY173SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0	0
SOURCE 1	DAY174SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY174SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY174SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY174SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY174SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY174SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY174SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY174SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY174SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY175SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY175SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY175SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY175SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY175SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY175SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY175SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY175SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY175SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY176SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY176SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY176SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY176SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY176SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY176SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY176SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY176SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY176SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY182SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY182SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY182SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY182SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY182SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY182SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

SOURCE 7	DAY182SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY182SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY182SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY184SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY184SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY184SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY184SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY184SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY184SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY184SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY184SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY184SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY186SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY186SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY186SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY186SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY186SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY186SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0

SOURCE 7	DAY186SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0
SOURCE 8	DAY186SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0
SOURCE 9	DAY186SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0
SOURCE 1	DAY187SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY187SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY187SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY187SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY187SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY187SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY187SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY187SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY187SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY189SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY189SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY189SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY189SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY189SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY189SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY189SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY189SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY189SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY190SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0
SOURCE 2	DAY190SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0
SOURCE 3	DAY190SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0
SOURCE 4	DAY190SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0
SOURCE 5	DAY190SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0
SOURCE 6	DAY190SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0
SOURCE 7	DAY190SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0
SOURCE 8	DAY190SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0
SOURCE 9	DAY190SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0
SOURCE 1	DAY191SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
SOURCE 2	DAY191SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
SOURCE 3	DAY191SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
SOURCE 4	DAY191SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
SOURCE 5	DAY191SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
SOURCE 6	DAY191SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
SOURCE 7	DAY191SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
SOURCE 8	DAY191SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
SOURCE 9	DAY191SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
SOURCE 1	DAY196SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY196SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY196SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY196SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY196SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY196SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY196SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY196SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY196SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY198SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY198SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY198SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY198SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY198SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0

SOURCE 7	DAY198SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY198SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY198SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY199SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY199SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY199SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY199SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY199SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY199SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY199SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY199SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY199SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY200SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY200SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY200SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY200SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY200SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY200SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY200SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY200SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY200SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 1	DAY210SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY210SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY210SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY210SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY210SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY210SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY210SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	.0	0	0	0	0	0	0
SOURCE 8	DAY210SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY210SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY214SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY214SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY214SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY214SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY214SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY214SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY214SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY214SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY214SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY215SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY215SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY215SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY215SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY215SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY215SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY215SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY215SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY215SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

SOURCE 1	DAY216SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY216SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY216SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY216SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY216SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY216SHORELINE FUMIGATION HOURS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SOURCE 7	DAY216SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0
SOURCE 8	DAY216SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0
SOURCE 9	DAY216SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0
SOURCE 1	DAY217SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY217SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY217SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY217SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY217SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY217SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY217SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY217SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY217SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 1	DAY218SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY218SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY218SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY218SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY218SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY218SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY218SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY218SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY218SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SOURCE 1	DAY224SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
SOURCE 2	DAY224SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
SOURCE 3	DAY224SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
SOURCE 4	DAY224SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
SOURCE 5	DAY224SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
SOURCE 6	DAY224SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
SOURCE 7	DAY224SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
SOURCE 8	DAY224SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
SOURCE 9	DAY224SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
SOURCE 1	DAY228SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY228SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY228SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY228SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY228SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY228SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY228SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY228SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY228SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY229SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
SOURCE 2	DAY229SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
SOURCE 3	DAY229SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
SOURCE 4	DAY229SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
SOURCE 5	DAY229SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
SOURCE 6	DAY229SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
SOURCE 7	DAY229SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
SOURCE 8	DAY229SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
SOURCE 9	DAY229SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
SOURCE 1	DAY230SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY230SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY230SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY230SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY230SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY230SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

SOURCE 7	DAY230SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY230SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY230SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY231SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY231SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY231SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY231SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY231SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY231SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY231SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY231SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY231SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY235SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY235SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY235SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY235SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY235SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY235SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY235SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY235SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY235SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY236SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY236SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY236SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY236SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY236SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY236SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY236SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY236SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY236SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY240SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY240SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY240SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY240SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY240SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY240SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY240SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY240SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY240SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY241SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY241SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY241SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY241SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY241SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY241SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY241SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY241SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY241SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY242SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY242SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY242SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY242SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY242SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY242SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY242SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY242SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY242SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY243SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY243SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY243SHORELINE FUMIGATION HOURS	[illegible]																							

SOURCE 4	DAY243SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY243SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY243SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY243SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY243SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY243SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY244SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY244SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY244SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY244SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY244SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY244SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY244SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY244SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY244SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY245SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY245SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY245SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY245SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY245SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY245SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY245SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY245SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY245SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY246SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY246SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 3	DAY246SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 4	DAY246SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 5	DAY246SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 6	DAY246SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 7	DAY246SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 8	DAY246SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 9	DAY246SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SOURCE 1	DAY247SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY247SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY247SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY247SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY247SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY247SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY247SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY247SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY247SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 1	DAY258SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 2	DAY258SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 3	DAY258SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 4	DAY258SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 5	DAY258SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 6	DAY258SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 7	DAY258SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 8	DAY258SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 9	DAY258SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
SOURCE 1	DAY267SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SOURCE 2	DAY267SHORELINE FUMIGATION HOURS	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

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SOURCE 4            DAY267SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 5            DAY267SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 6            DAY267SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 7            DAY267SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 8            DAY267SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 9            DAY267SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0




SOURCE 1            DAY282SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 2            DAY282SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 3            DAY282SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 4            DAY282SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 5            DAY282SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 6            DAY282SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 7            DAY282SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 8            DAY282SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 9            DAY282SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 1            DAY283SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
SOURCE 2            DAY283SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
SOURCE 3            DAY283SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
SOURCE 4            DAY283SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
SOURCE 5            DAY283SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
SOURCE 6            DAY283SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
SOURCE 7            DAY283SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
SOURCE 8            DAY283SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
SOURCE 9            DAY283SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
SOURCE 1            DAY295SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 2            DAY295SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 3            DAY295SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 4            DAY295SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 5            DAY295SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 6            DAY295SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 7            DAY295SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 8            DAY295SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 9            DAY295SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
SOURCE 1            DAY296SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
SOURCE 2            DAY296SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
SOURCE 3            DAY296SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
SOURCE 4            DAY296SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
SOURCE 5            DAY296SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
SOURCE 6            DAY296SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
SOURCE 7            DAY296SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
SOURCE 8            DAY296SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
SOURCE 9            DAY296SHORELINE FUMIGATION HOURS 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
                                         URBAN SDM - VERSION 88204
*******************************************************************************
                         SHORELINE DISPERSION TEST CASE #3
********************** CLEVELAND MET DATA - 1973 ******************************
                  RECEPTORS

RECEPTOR   IDENTIFICATION  EAST      NORTH      RECEPTOR HT      RECEPTOR GROUND LEVEL              AVG CONC FOR PERIOD
                           COORD     COORD   ABV LOCAL GRD LVL        ELEVATION            DAY  1.HR 1. TO DAY365.HR24.
                           (USER UNITS)           (METERS)         (USER HT UNITS)               (MICROGRAMS/M**3)

   1                       435.00   4570.00       0.0                 650.0                              0.02
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3	435.00	4590.00	0.0	610.0	0.02
4	435.00	4600.00	0.0	600.0	0.02
5	445.00	4570.00	0.0	670.0	0.02
6	445.00	4580.00	0.0	650.0	0.03
7	445.00	4590.00	0.0	640.0	0.04
8	445.00	4600.00	0.0	620.0	0.09
9	450.00	4570.00	0.0	690.0	0.02
10	450.00	4580.00	0.0	656.0	0.02
11	450.00	4590.00	0.0	620.0	0.03
12	450.00	4600.00	0.0	630.0	0.12
13	450.00	4605.00	0.0	610.0	0.15
14	450.00	4610.00	0.0	600.0	0.15
15	455.00	4570.00	0.0	690.0	0.02
16	455.00	4580.00	0.0	690.0	0.02
17	455.00	4590.00	0.0	640.0	0.03
18	455.00	4600.00	0.0	630.0	0.07
19	455.00	4605.00	0.0	620.0	0.11
20	455.00	4610.00	0.0	600.0	* 0.31
21	455.00	4615.00	0.0	600.0	0.17
22	465.00	4570.00	0.0	690.0	0.01
23	465.00	4580.00	0.0	680.0	0.01
24	465.00	4590.00	0.0	670.0	0.02
25	465.00	4600.00	0.0	650.0	0.02
26	465.00	4605.00	0.0	630.0	0.03
27	465.00	4610.00	0.0	630.0	0.04
28	465.00	4615.00	0.0	620.0	0.06
29	465.00	4620.00	0.0	600.0	0.07
30	475.00	4570.00	0.0	690.0	0.01
31	475.00	4580.00	0.0	690.0	0.01
32	475.00	4590.00	0.0	660.0	0.01
33	475.00	4600.00	0.0	650.0	0.01
34	475.00	4605.00	0.0	640.0	0.01
35	475.00	4610.00	0.0	650.0	0.02
36	475.00	4615.00	0.0	630.0	0.03
37	475.00	4620.00	0.0	620.0	0.03

FIVE HIGHEST 1-HOUR SO2 CONCENTRATIONS((ENDING ON JULIAN DAY, HOUR)
(MICROGRAMS/M**3)

RECEPTOR	1	2	3	4	5
1(435.00,4570.00)	6.06F (176,11)	5.08F (247,15)	4.98F (186,16)	4.02F (295,14)	3.89F (173,
2(435.00,4580.00)	8.20F (198, 9)	4.57F (182,15)	4.24F (198,10)	3.69F (196,11)	3.58F (236,
3(435.00,4590.00)	2.24 (63,19)	2.11 (190,22)	2.11 (190,24)	1.90 (191, 1)	1.90 (283,
4(435.00,4600.00)	5.04 (302,23)	3.79 (75, 9)	3.51 (175,23)	3.51 (104,22)	3.47 (272,
5(445.00,4570.00)	10.14F (231,15)	9.25F (242,14)	8.01F (229,16)	6.64F (104,14)	4.40 (140,
6(445.00,4580.00)	8.80F (210,13)	7.90F (173,15)	7.89F (295,14)	6.01 (140,19)	5.83F (176,
7(445.00,4590.00)	10.72F (97,10)	10.48F (210,13)	9.04F (186,16)	6.53F (173,18)	6.17F (229,
8(445.00,4600.00)	21.87F (138,16)	7.11 (103, 2)	6.97 (327,17)	6.95 (187,20)	6.95 (172,
9(450.00,4570.00)	8.46F (216,15)	7.40F (231,12)	5.55F (200,15)	4.37F (165,12)	3.71F (97,
10(450.00,4580.00)	7.13F (224,17)	4.30F (267,14)	3.64 (51,22)	3.43 (51,23)	3.17F (245,
11(450.00,4590.00)	4.79 (224,20)	4.53 (140,19)	3.57 (51,22)	3.47 (164,21)	3.47 (296,
12(450.00,4600.00)	12.66 (103, 4)	11.65F (258,13)	10.45 (197, 7)	9.71F (236,15)	8.94 (236,
13(450.00,4605.00)	25.48 (83, 7)	21.51 (204, 3)	20.77 (204, 4)	20.20 (225,22)	20.18 (203,
14(450.00,4610.00)	9.31 (341,18)	7.96 (175,24)	6.61 (55,22)	6.55 (198, 6)	6.40 (267,

15(455.00,4570.00)	5.10F (173,18)	4.24F (231,11)	4.17F (97,10)	4.15F (215,16)	4.05F (210,1
16(455.00,4580.00)	6.66F (282,14)	6.13F (173,18)	5.62F (97,10)	5.24F (141, 9)	2.81F (164,1
17(455.00,4590.00)	10.47F (173,18)	8.08F (97,10)	6.96F (224,15)	5.78F (231,11)	5.18F (196,1
18(455.00,4600.00)	12.23F (175,14)	7.83 (215,21)	7.80 (63, 8)	7.44 (160,23)	6.90 (186,2
19(455.00,4605.00)	26.37F (242,10)	19.24 (63, 5)	14.83 (27,22)	11.43F (235,13)	11.03 (63,
20(455.00,4610.00) *	30.68 (298,23) *	23.09 (63, 6)	18.38 (213,13)	17.93 (293, 5)	16.40 (258,1
21(455.00,4615.00)	12.69 (295, 6)	12.36 (295, 7)	12.00 (196, 3)	11.98 (292, 4)	11.07 (182,
22(465.00,4570.00)	4.46F (164,11)	3.48 (63, 8)	2.98F (164,14)	2.92F (186,15)	1.91 (318,1
23(465.00,4580.00)	2.66F (224,14)	2.55 (63, 8)	1.98 (318,18)	1.65 (2,18)	1.58 (63,
24(465.00,4590.00)	9.13F (283,11)	7.72F (187,12)	7.49F (214,15)	4.66 (63, 7)	3.69 (63,
25(465.00,4600.00)	13.83F (216,10)	9.99F (174,10)	7.58F (174,11)	3.90F (258,12)	3.83 (63,
26(465.00,4605.00)	18.20 (63, 5)	14.43F (235,13)	7.16 (63, 4)	6.69F (247,13)	5.67F (242,1
27(465.00,4610.00)	15.39F (245,10)	7.54F (296,12)	3.68F (242,10)	3.21F (242,11)	3.07 (343,
28(465.00,4615.00)	6.71F (245,10)	3.73 (343, 9)	3.16 (63, 3)	2.98 (103,21)	2.96 (62,2
29(465.00,4620.00)	6.53 (63, 3)	5.71 (62,21)	5.30 (283, 7)	5.10 (236, 6)	4.62 (283,
30(475.00,4570.00)	3.24F (283,12)	2.58F (224,14)	2.23 (63, 7)	2.18 (63, 8)	1.47 (45,2
31(475.00,4580.00)	4.88F (187,12)	3.47 (63, 7)	2.43F (258,13)	2.38 (168, 1)	2.30F (114,1
32(475.00,4590.00)	4.98F (216,10)	4.37F (247,13)	3.28 (93,20)	2.40 (63, 7)	2.21 (168,
33(475.00,4600.00)	4.16F (258,15)	4.09F (174,12)	3.90 (93,20)	3.04F (174,10)	2.15F (247,1
34(475.00,4605.00)	13.58 (63, 5)	8.38F (235,13)	7.12F (199,11)	4.45 (28, 9)	3.92 (63,
35(475.00,4610.00)	8.07F (296,12)	6.30F (242,11)	5.81F (242,10)	4.70 (27,21)	3.76 (27,2
36(475.00,4615.00)	9.00F (245,10)	8.25F (187,11)	6.63F (296,12)	6.57F (242,11)	5.03F (218,15
37(475.00,4620.00)	10.19F (245,10)	2.79 (27,20)	2.30 (27,24)	2.12 (239,19)	2.11F (218,15

FIVE HIGHEST 3-HOUR SO2 CONCENTRATIONS((ENDING ON JULIAN DAY, HOUR)

(MICROGRAMS/M**3)

RECEPTOR	1	2	3	4	5
1(435.00,4570.00)	2.03F (176,12)	1.70F (247,15)	1.66F (186,18)	1.40F (295,15)	1.30F (173,15
2(435.00,4580.00)	2.73F (198, 9)	1.52F (182,15)	1.41F (198,12)	1.25F (236,15)	1.23F (196,12
3(435.00,4590.00)	1.88 (63,21)	1.55 (190,24)	1.33 (360,15)	1.13 (27, 6)	1.12 (282,21
4(435.00,4600.00)	2.41 (175,24)	2.00 (63,24)	1.98 (75, 9)	1.91 (302,24)	1.81 (272,21
5(445.00,4570.00)	3.44F (231,15)	3.08F (242,15)	2.67F (229,18)	2.21F (104,15)	1.71 (327,18
6(445.00,4580.00)	3.00F (210,15)	2.77F (295,15)	2.63F (173,15)	2.00 (140,21)	1.94F (176,12
7(445.00,4590.00)	3.57F (97,12)	3.54F (210,15)	3.01F (186,18)	2.20F (173,18)	2.18 (236, 3
8(445.00,4600.00)	7.39F (138,18)	4.66 (103, 3)	4.59 (327,18)	3.71 (59, 6)	3.59 (258, 3
9(450.00,4570.00)	2.82F (216,15)	2.50F (231,12)	1.85F (200,15)	1.57 (51,24)	1.46F (165,12
10(450.00,4580.00)	2.39F (224,18)	2.36 (51,24)	1.75 (28,15)	1.43F (267,15)	1.13 (191,21
11(450.00,4590.00)	2.31 (51,24)	1.93 (28,15)	1.80 (224,21)	1.60 (241,21)	1.57 (164,21
12(450.00,4600.00)	8.19 (236, 3)	7.35 (235,24)	6.95 (197, 6)	5.05 (82, 3)	4.98 (180,21
13(450.00,4605.00)	12.25 (204, 6)	10.78 (204, 3)	9.81 (203, 6)	8.49 (83, 9)	7.61F (296,12
14(450.00,4610.00)	5.35 (267, 3)	4.12 (62,24)	3.69 (225, 6)	3.61 (299,24)	3.27 (175,24
15(455.00,4570.00)	2.93F (173,18)	1.48F (215,18)	1.41F (231,12)	1.39F (97,12)	1.37F (210,12)
16(455.00,4580.00)	2.25F (173,18)	2.22F (282,15)	1.87F (97,12)	1.76F (141, 9)	1.13 (103, 3)
17(455.00,4590.00)	3.62F (173,18)	2.69F (97,12)	2.39F (224,15)	1.96 (210,21)	1.93F (231,12)
18(455.00,4600.00)	4.67 (186,24)	4.08F (175,15)	3.91 (63, 9)	3.21 (291,24)	3.04 (160,24)
19(455.00,4605.00)	10.21F (242,12)	10.09 (63, 6)	5.35 (210,21)	5.17 (27,24)	3.91F (235,15)
20(455.00,4610.00) *	13.06 (113, 6) *	11.52 (298,24)	7.70 (63, 6)	6.89 (323, 9)	6.44 (323, 6)
21(455.00,4615.00)	6.85 (182, 3)	5.49 (292, 6)	4.99 (295, 9)	4.83 (295, 6)	4.62 (196, 3)
22(465.00,4570.00)	1.85F (164,12)	1.68 (63, 9)	1.10 (241,21)	1.00F (164,15)	0.97F (186,15)
23(465.00,4580.00)	1.88 (63, 9)	0.95 (186,21)	0.89F (224,15)	0.86 (24,21)	0.77 (161, 3)
24(465.00,4590.00)	3.04F (283,12)	2.70 (63, 9)	2.57F (187,12)	2.50F (214,15)	1.23 (63, 6)
25(465.00,4600.00)	5.86F (174,12)	4.67F (216,12)	1.43F (258,12)	1.28 (63, 9)	1.15 (160,21)
26(465.00,4605.00)	[illegible]	[illegible]	[illegible]		

27(465.00,4610.00)	5.15F (245,12)	3.34F (296,12)	2.47F (242,12)	1.96 (252, 3)	1.50 (27,
28(465.00,4615.00)	2.65 (252, 3)	2.34F (245,12)	2.02 (283, 9)	1.74 (28, 3)	1.46 (28,
29(465.00,4620.00)	4.10 (283, 9)	2.77 (28, 6)	2.47 (62,24)	2.19 (236, 6)	2.18 (63,
30(475.00,4570.00)	1.54 (63, 9)	1.08F (283,12)	0.86F (224,15)	0.74 (45,24)	0.73 (186,
31(475.00,4580.00)	1.63F (187,12)	1.54 (63, 9)	1.05F (283,12)	0.82 (303,18)	0.81F (114
32(475.00,4590.00)	1.66F (216,12)	1.46 (93,21)	1.46F (247,15)	0.80 (63, 9)	0.74 (168
33(475.00,4600.00)	2.93F (174,12)	1.68 (93,21)	1.39F (258,15)	0.81 (76, 6)	0.72F (247
34(475.00,4605.00)	5.83 (63, 6)	2.79F (235,15)	2.40F (199,12)	2.23 (28, 9)	1.58F (242
35(475.00,4610.00)	4.40F (296,12)	4.14F (242,12)	1.57 (27,21)	1.25 (27,24)	1.07F (235
36(475.00,4615.00)	3.61F (296,12)	3.48F (242,12)	3.01F (245,12)	2.94F (187,12)	1.75 (27
37(475.00,4620.00)	3.47F (245,12)	1.26 (28, 6)	1.16 (247, 9)	1.13 (93, 3)	1.05 (252

FIVE HIGHEST 8-HOUR SO2 CONCENTRATIONS((ENDING ON JULIAN DAY, HOUR)

(MICROGRAMS/M**3)

RECEPTOR	1	2	3	4	5
1(435.00,4570.00)	0.77F (176,16)	0.68F (186,16)	0.66F (247,16)	0.56 (140,24)	0.53F (295
2(435.00,4580.00)	1.56F (198,16)	0.70 (190,24)	0.60 (169,16)	0.58 (283,24)	0.58F (182
3(435.00,4590.00)	0.85 (190,24)	0.71 (63,24)	0.68 (360,16)	0.67 (283,24)	0.54 (323
4(435.00,4600.00)	1.25 (272,24)	1.14 (302,24)	0.95 (175,24)	0.84 (140,24)	0.75 (63
5(445.00,4570.00)	1.35F (231,16)	1.16F (242,16)	1.01F (229,16)	0.83F (104,16)	0.82 (140
6(445.00,4580.00)	1.29 (140,24)	1.16F (210,16)	1.04F (295,16)	0.99F (173,16)	0.79F (97
7(445.00,4590.00)	1.51F (97,16)	1.35F (210,16)	1.14F (186,16)	1.14 (197, 8)	1.12 (327
8(445.00,4600.00)	3.44 (327,24)	2.82F (138,16)	2.41 (103, 8)	1.49 (197,24)	1.46 (272
9(450.00,4570.00)	1.09F (231,16)	1.08F (216,16)	0.74F (165,16)	0.69F (200,16)	0.59 (51
10(450.00,4580.00)	1.06F (224,24)	0.88 (51,24)	0.68 (28,16)	0.55F (165,16)	0.54F (267
11(450.00,4590.00)	1.01 (164,24)	0.90 (51,24)	0.86 (28,16)	0.85 (140,24)	0.82 (24
12(450.00,4600.00)	5.37 (197, 8)	3.66 (235,24)	3.12 (82, 8)	3.07 (236, 8)	2.20 (27
13(450.00,4605.00) *	9.23 (204, 8)	4.39 (203, 8)	4.28 (83, 8)	3.30F (296,16)	3.26 (22
14(450.00,4610.00)	2.56 (267, 8)	2.20 (62,24)	1.96 (341,24)	1.85 (225, 8)	1.70 (13
15(455.00,4570.00)	0.83F (210,16)	0.68F (97,16)	0.66F (173,24)	0.55F (231,16)	0.55F (21
16(455.00,4580.00)	0.85F (97,16)	0.83F (282,16)	0.81F (173,24)	0.69F (141,16)	0.61F (16
17(455.00,4590.00)	1.38F (173,24)	1.18F (97,16)	0.92F (224,16)	0.77 (210,24)	0.75F (23
18(455.00,4600.00)	2.18 (186,24)	1.91 (215,24)	1.56F (175,16)	1.55 (331,24)	1.46 (29
19(455.00,4605.00)	4.17F (242,16)	3.78 (63, 8)	3.40 (27,24)	2.05 (210,24)	1.84 (10
20(455.00,4610.00)	6.44 (113, 8) *	5.31 (63, 8)	4.40 (298,24)	3.89 (323, 8)	3.48 (25
21(455.00,4615.00)	3.35 (295, 8)	3.14 (292, 8)	3.10 (196, 8)	2.89 (294, 8)	2.66 (5
22(465.00,4570.00)	1.08F (164,16)	0.61 (241,24)	0.43 (63, 8)	0.38F (186,16)	0.31 (24
23(465.00,4580.00)	0.52 (63, 8)	0.45 (186,24)	0.40 (24,24)	0.39 (241,24)	0.38 (
24(465.00,4590.00)	1.41 (63, 8)	1.15F (283,16)	0.97F (187,16)	0.94F (214,16)	0.60 (16
25(465.00,4600.00)	2.22F (174,16)	1.75F (216,16)	0.68 (160,24)	0.66 (131,16)	0.57F (25
26(465.00,4605.00)	3.23 (63, 8)	1.89F (235,16)	1.17F (242,16)	1.08 (93,24)	0.84F (24
27(465.00,4610.00)	2.06F (245,16)	1.25F (296,16)	1.11F (242,16)	1.06 (252, 8)	0.90 (2
28(465.00,4615.00)	1.39 (28, 8)	1.20 (252, 8)	1.06 (93, 8)	1.02 (231, 8)	0.98F (24
29(465.00,4620.00)	1.72 (199, 8)	1.64 (62,24)	1.64 (231, 8)	1.34 (283, 8)	1.32 (2
30(475.00,4570.00)	0.56F (283,16)	0.55 (63, 8)	0.49 (186,24)	0.34 (240,24)	0.34 (33
31(475.00,4580.00)	0.75 (63, 8)	0.62F (187,16)	0.49F (283,16)	0.46 (160,24)	0.38 (18
32(475.00,4590.00)	0.66 (93,24)	0.62F (216,16)	0.55F (247,16)	0.44 (63, 8)	0.42 (
33(475.00,4600.00)	1.14F (174,16)	0.75 (93,24)	0.60F (258,16)	0.32 (131,16)	0.30 (7
34(475.00,4605.00)	2.19 (63, 8)	1.11F (235,16)	0.90F (199,16)	0.59F (242,16)	0.56 (2
35(475.00,4610.00)	1.65F (296,16)	1.62F (242,16)	1.06 (27,24)	0.42F (235,16)	0.36 (6
36(475.00,4615.00)	1.44F (242,16)	1.35F (296,16)	1.31 (27,24)	1.22F (245,16)	1.12F (18
37(475.00,4620.00)	1.32F (245,16)	1.02 (28, 8)	0.92 (93, 8)	0.73 (92,24)	0.64 (13

(MICROGRAMS/M**3)

RECEPTOR	1	2	3	4	5
1(435.00,4570.00)	0.33F (176,24)	0.28 (197,24)	0.23F (247,24)	0.23F (186,24)	0.22 (140,2
2(435.00,4580.00)	0.54F (198,24)	0.26 (169,24)	0.25F (190,24)	0.23F (236,24)	0.21 (360,2
3(435.00,4590.00)	0.30 (360,24)	0.29 (63,24)	0.29F (190,24)	0.27 (169,24)	0.23F (283,2
4(435.00,4600.00)	0.51 (302,24)	0.42 (272,24)	0.36 (140,24)	0.32F (175,24)	0.25 (63,2
5(445.00,4570.00)	0.46F (231,24)	0.39F (242,24)	0.34F (229,24)	0.32 (140,24)	0.30 (327,2
6(445.00,4580.00)	0.50 (140,24)	0.49F (173,24)	0.41F (295,24)	0.39F (210,24)	0.38 (82,2
7(445.00,4590.00)	0.71 (197,24)	0.51F (97,24)	0.46F (210,24)	0.45F (236,24)	0.43 (327,2
8(445.00,4600.00)	1.25 (327,24)	0.95F (138,24)	0.88 (103,24)	0.76F (258,24)	0.73 (360,2
9(450.00,4570.00)	0.49F (216,24)	0.37F (231,24)	0.25F (165,24)	0.24F (200,24)	0.20 (28,2
10(450.00,4580.00)	0.36F (224,24)	0.29 (51,24)	0.27 (28,24)	0.21 (303,24)	0.19 (58,2
11(450.00,4590.00)	0.48F (164,24)	0.36 (140,24)	0.34 (28,24)	0.32 (58,24)	0.32 (257,2
12(450.00,4600.00)	2.29 (197,24)	1.62F (236,24)	1.41 (82,24)	1.24F (235,24)	1.07 (271,2
13(450.00,4605.00) *	3.36 (204,24)	1.74 (342,24)	1.55 (203,24)	1.49 (226,24)	1.46 (83,2
14(450.00,4610.00)	0.97F (267,24)	0.85 (62,24)	0.76 (225,24)	0.67 (139,24)	0.65 (341,2
15(455.00,4570.00)	0.37F (173,24)	0.29F (210,24)	0.23F (97,24)	0.20F (231,24)	0.20F (215,2
16(455.00,4580.00)	0.29F (173,24)	0.28F (97,24)	0.28F (282,24)	0.26F (164,24)	0.26 (323,2
17(455.00,4590.00)	0.46F (173,24)	0.43 (323,24)	0.39F (97,24)	0.33F (224,24)	0.30F (210,2
18(455.00,4600.00)	0.97F (186,24)	0.65F (215,24)	0.57F (175,24)	0.57 (213,24)	0.57 (323,2
19(455.00,4605.00)	1.41F (242,24)	1.28 (63,24)	1.16 (27,24)	1.00F (210,24)	0.97 (103,2
20(455.00,4610.00)	2.30 (113,24) *	2.08 (6,24)	1.95 (323,24)	1.77 (63,24)	1.68 (40,2
21(455.00,4615.00)	1.29 (292,24)	1.23F (295,24)	1.03F (196,24)	1.01 (54,24)	0.96 (294,2
22(465.00,4570.00)	0.39F (164,24)	0.21 (63,24)	0.20F (241,24)	0.17F (186,24)	0.16 (144,2
23(465.00,4580.00)	0.24 (63,24)	0.23F (186,24)	0.14F (241,24)	0.14 (144,24)	0.14 (331,2
24(465.00,4590.00)	0.49 (63,24)	0.40F (187,24)	0.38F (283,24)	0.36F (186,24)	0.31F (214,2
25(465.00,4600.00)	0.74F (174,24)	0.58F (216,24)	0.25 (160,24)	0.24F (258,24)	0.23 (131,2
26(465.00,4605.00)	1.08 (63,24)	0.63F (235,24)	0.42 (93,24)	0.39F (242,24)	0.28F (247,2
27(465.00,4610.00)	0.69F (245,24)	0.51 (93,24)	0.45F (296,24)	0.41 (92,24)	0.39 (131,24
28(465.00,4615.00)	0.81 (93,24)	0.69 (92,24)	0.46 (28,24)	0.43 (252,24)	0.40F (283,24
29(465.00,4620.00)	0.58F (199,24)	0.55F (283,24)	0.55 (62,24)	0.55F (231,24)	0.46F (236,24
30(475.00,4570.00)	0.23F (186,24)	0.19 (63,24)	0.19F (283,24)	0.14 (331,24)	0.13F (240,24
31(475.00,4580.00)	0.25 (63,24)	0.21F (186,24)	0.21F (187,24)	0.21 (323,24)	0.17 (303,24
32(475.00,4590.00)	0.22 (6,24)	0.22 (93,24)	0.21F (216,24)	0.18F (247,24)	0.15 (63,24
33(475.00,4600.00)	0.38F (174,24)	0.25 (93,24)	0.20F (258,24)	0.17 (131,24)	0.13 (76,24
34(475.00,4605.00)	0.73 (63,24)	0.37F (235,24)	0.30F (199,24)	0.28 (28,24)	0.20F (242,24
35(475.00,4610.00)	0.55F (296,24)	0.54F (242,24)	0.35 (27,24)	0.23 (92,24)	0.14F (235,24
36(475.00,4615.00)	0.49F (242,24)	0.48F (296,24)	0.44 (27,24)	0.41F (245,24)	0.40 (92,24
37(475.00,4620.00)	0.56 (93,24)	0.48 (92,24)	0.44F (245,24)	0.34 (28,24)	0.28 (239,24

QUEUE

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(Please read Instructions on the reverse before completing)

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16. ABSTRACT

The Shoreline Dispersion Model (SDM) is a multipoint Guassian dispersion model that can be used to determine ground-level concentrations from tall stationary point sources that are influenced by the unique meteorological phenomenon in a shoreline environment. The SDM model is a hybrid model that utilizes a shoreline fumigation model to determine the hours during the year when fumigation events are expected and that uses the EPA MPTER model to determine the remaining hours. The advantage of the SDM hybrid model is that it can provide the total impact of a source, i.e., the source itself and other nearby sources. This user's guide provides an overview of the program, its routines, and algorithms and describes the model input/output.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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