ANL-76-XX-37

ANL/HIWAY: AN AIR POLLUTION EVALUATION MODEL FOR ROADWAYS

ENVIRONMENTAL POLLUTANTS and the URBAN ECONOMY

Argonne National Laboratory
Energy and Environmental Systems Division

The University of Chicago
Center for Urban Studies

ANL-76-XX-37

ANL/HIWAY: AN AIR POLLUTION EVALUATION MODEL FOR ROADWAYS

by

George A. Concaildi, Alan S. Cohen,
Richard F. King

December 1976

ENVIRONMENTAL POLLUTANTS AND THE URBAN ECONOMY

Argonne National Laboratory
Energy and Environmental Systems Division
9700 South Cass Avenue
Argonne, Illinois 60439

The University of Chicago
Center for Urban Studies
5801 South Ellis Avenue
Chicago, Illinois 60637

This work was partially supported by the National Science Foundation, Research Applied to National Needs (RANN), Contract Nos. AG-352 and GI 32989A2. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the authors and do not necessarily reflect the views of NSF.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

Several frequently used terms have become part of the jargon used by air quality dispersion modelers, and these terms are defined briefly in this section. For a more complete discussion of the concepts implied by these terms, the reader should consult the references cited.

Stability class: Atmospheric stability ranked according to classes, which are given in indexes A through F (or 1 through 6), as shown in Table 3.1 (Pasquill, 1961). Class A is very unstable and is found when skies are clear and sunny, and class F is moderately stable and occurs under calm conditions on clear nights.

Mixing height (or depth): The height to which pollutants are actively mixed. The air close to the earth's surface generally becomes unstable after sunrise, resulting in a zone of vigorous atmospheric mixing in the layer of air at ground level. The height of this layer increases after sunrise and reaches a maximum about 4:00 p.m. (Holzworth, 1972). For most locations close to the pollution source, the mixing height will have very little influence on the calculation of pollution concentration. When the receptor is located at a great distance from the pollution source and the travel time of the pollutant from source to receptor location is long, the mixing height will be the limiting height to which pollution will spread vertically.

Receptor: A location for which it is desired to predict pollutant concentrations. When a model is being validated, it is necessary to obtain model predictions at the receptor locations, where air quality data are measured.

Emission rate of a line source: An estimate of the amount of pollution being generated by a line source (e.g., a lane of automobile traffic).

ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

ANL	Argonne National Laboratory
EPA	U.S. Environmental Protection Agency
g	grams
hr	hours
km	kilometers
m	meters
mi	miles
sec	seconds
veh	vehicles

SYMBOLS

A(X1, Y1)	starting point of line source
a	virtual distance for initial σ_z, km
B(X2, Y2)	end point of line source
b	virtual distance for initial σ_y, km
C(p)	concentration at the perpendicular distance p, g/m^3
c	term to determine Θ_p, dependent upon stability, degrees
d	factor to determine Θ_p, dependent upon stability, degrees
D	line source length, meters
EF	emission factor, g/veh-mi
f	point source dispersion function, 1/m^2
g	factor to determine σ_z (depends upon stability and distance range), meters
H	effective source height, meters
h	exponent to determine σ_z (depends upon stability and distance range), dimensionless
L	mixing height, meters
ℓ	distance from point A to point P, meters
P(XP, YP)	arbitrary point along line source
p	perpendicular distance of receptor from line source, meters
q	emission rate from line source, g/m-sec

ABBREVIATIONS AND SYMBOLS (Contd.)

TV	traffic volume, veh/hr
u	wind speed, m/sec
x	downwind distance, meters or km
x_o	normalizing distance, km
X1	east coordinate of point A, meters
X2	east coordinate of point B, meters
XP	east coordinate of point P, meters
XR	east coordinate of receptor R, meters
y	crosswind distance, meters or km
Y1	north coordinate of point A, meters
Y2	north coordinate of point B, meters
YP	north coordinate of point P, meters
YR	north coordinate of receptor R, meters
z	receptor height above ground, meters
β	direction, relative to north, of line from point A to point B, degrees
γ	angle between wind direction and a perpendicular to the line source, degrees
Θ	wind direction, relative to north, degrees
Θ_p	half angle of horizontal plume spreading, degrees
σ_y	standard deviation of the concentration distribution in the crosswind direction, meters
σ_{yo}	initial σ_y, meters
σ_z	standard deviation of the concentration distribution in the vertical direction, meters
σ_{zo}	initial σ_z, meters
χ	concentration, g/m^3

ANL/HIWAY: AN AIR POLLUTION EVALUATION MODEL FOR ROADWAYS

by

George A. Concaildi, Alan S. Cohen, and Richard F. King

ABSTRACT

This report describes a computer program, called ANL/HIWAY, for estimating air quality levels of nonreactive pollutants produced by vehicular sources. It is valid for receptors at distances of tens to hundreds of meters, at any angle, downwind of a roadway, in relatively uncomplicated terrain. It may be used by planners to analyze the effects of a proposed roadway on adjacent air quality. The ANL/HIWAY model expands the evaluation capabilities of the EPA/HIWAY dispersion model. This report also serves as a user's manual for running the ANL/HIWAY program. All command structures are described in detail, with sample problems exemplifying their use.

1. INTRODUCTION

This report describes a computer program, called ANL/HIWAY, for calculating air quality levels of nonreactive pollutants produced by vehicular sources. It is valid for receptors at distances of tens to hundreds of meters, at any angle, downwind of the highway, in relatively uncomplicated terrain. It may be used by planners to analyze the effects of a proposed roadway on adjacent air quality, e.g., effects to be incorporated into an environmental impact statement as required by the National Environmental Policy Act of 1969 for a Federally funded highway construction project.

The ANL/HIWAY program is basically a driver for the line source subroutine NCEPA, for which it provides flexible input, output, and other options. NCEPA, which does the actual line source integration, is a modification of an early version of the EPA/HIWAY program. We shall refer to ANL/HIWAY (or just HIWAY) as opposed to EPA/HIWAY when the programs differ.

Each lane of traffic is modeled as though it were a straight, continuous, finite line source with a uniform emission rate. There is no internal provision, for example, for the modeling of cars idling at a traffic signal or waiting to turn at an intersection.* Air pollution concentrations downwind

*The last sample problem in Section 7 illustrates how the model can be used to model intersections if emission rates are provided exogenously.

of the line source are found by integration of a simple Gaussian point-source plume along the line source. Source and receptor heights as well as the effects of mixing height are considered by the model.

Each individual lane for an at-grade roadway can be handled by the user as a separate source. If a cut section is to be modeled as a set of individual line sources, each of these sources must be considered separately in a number of ANL/HIWAY runs.

The line source emission rate may be obtained from a separate computation and then input to ANL/HIWAY, or it may be computed by ANL/HIWAY itself from input parameters of average vehicle speed and hourly volume of traffic. The emission rate as calculated by ANL/HIWAY is intended to be representative of 1969-model automobiles; this emission factor, 58.7 g/veh-mi for a speed of 19.6 mph, is also representative of the vehicle mix near the end of 1973.

There are three modes of operation -- GO, COUPLE, and FETCH -- in ANL/HIWAY. In the COUPLE mode, line source integrations are performed with unit emissions and wind speeds. The calculated integrals are called coupling coefficients, and are saved on an external storage unit. In the FETCH model, these coupling coefficients are retrieved and converted, with a minimum of calculation, to air quality concentrations for the input emission strengths, wind speeds, and pollutant types. The GO mode yields a 'one-shot' computation, and no coupling coefficients are saved for future use.

The differences between the ANL/HIWAY and the EPA/HIWAY models lie in their usefulness for conducing policy evaluations or preparing environmental impact statements. The ANL/HIWAY model is generally a more comprehensive planning tool. The differentiating features of the two models are shwon in Table 1.1.

Table 1.1. Differences Between ANL/HIWAY & EPA/HIWAY

Features	ANL/HIWAY	EPA/HIWAY
No. Sources	30	1 Four-lane Roadway
No. Receptors	1000 Maximum	51
Input Characteristic	Flexible	Fixed & Rigid
Input Data	Emission Rate or Volume & Speed	Emission Rate
Models Cutsections of Depressed Roadway	No	Yes
Interactive Capability	No	Yes
Uses Coupling Coefficiency	Yes	No
N-Hour Averaging Capability	Yes	No
Multiple Back-to-Back Runs	Yes	Yes
Selective Report Generator	Yes	No
Multiple Input Devices	Yes	No

2. DESCRIPTION OF THE MODEL*

2.1 Geometry of the Problem

The roadway lane segment to be modeled is construed to be a straight, level line source of finite length extending from the starting point A in Fig. 2.1 to the end point B. For some overlying north-south, west-east Cartesian grid system, coordinates of A(X1,Y1) and B(X2,Y2), and the receptor R(XR,YR), as well as the wind direction Θ east of north, are given. Points A and B are in the middle of the traffic lane, or road as it is called in the model discussion and in the input and output descriptions.

2.2 Calculating Air Quality

The calculation of air quality concentrations is made by a numerical integration of the gaussian plume point source expression over a finite length. If the direction of the line source from A to B is β (input in degrees), then the coordinates (XP,YP) of any point P along the line source at an arbitrary distance ℓ in meters from point A are given by

$$XP = X1 + \ell \sin\beta \qquad (2.1)$$

$$YP = Y1 + \ell \cos\beta \qquad (2.2)$$

For a given receptor R(XR,YR), the downwind distance x in meters and the crosswind distancy y in meters of the receptor from the point P for wind direction Θ is given by

$$x = (YP-YR)\cos\Theta + (XP-XR)\sin\Theta \qquad (2.3)$$

$$y = (YP-YR)\sin\Theta - (XP-XR)\cos\Theta \qquad (2.4)$$

Since the coordinates XP, YP and XR, YR are functions of ℓ, the distances x and y are also functions of ℓ. The resolution of quadrant differences between Θ and β is made within the ANL/HIWAY program.

The concentration χ in grams per cubic meter from emissions along the line source is then given by

---

* Much of the descriptive material for Section 2 is adapted, in part verbatim, from the "User's Guide for HIWAY, a Highway Air Pollution Model,"EPA-650/4-74-008, by John R. Zimmerman and Roger S. Thompson.

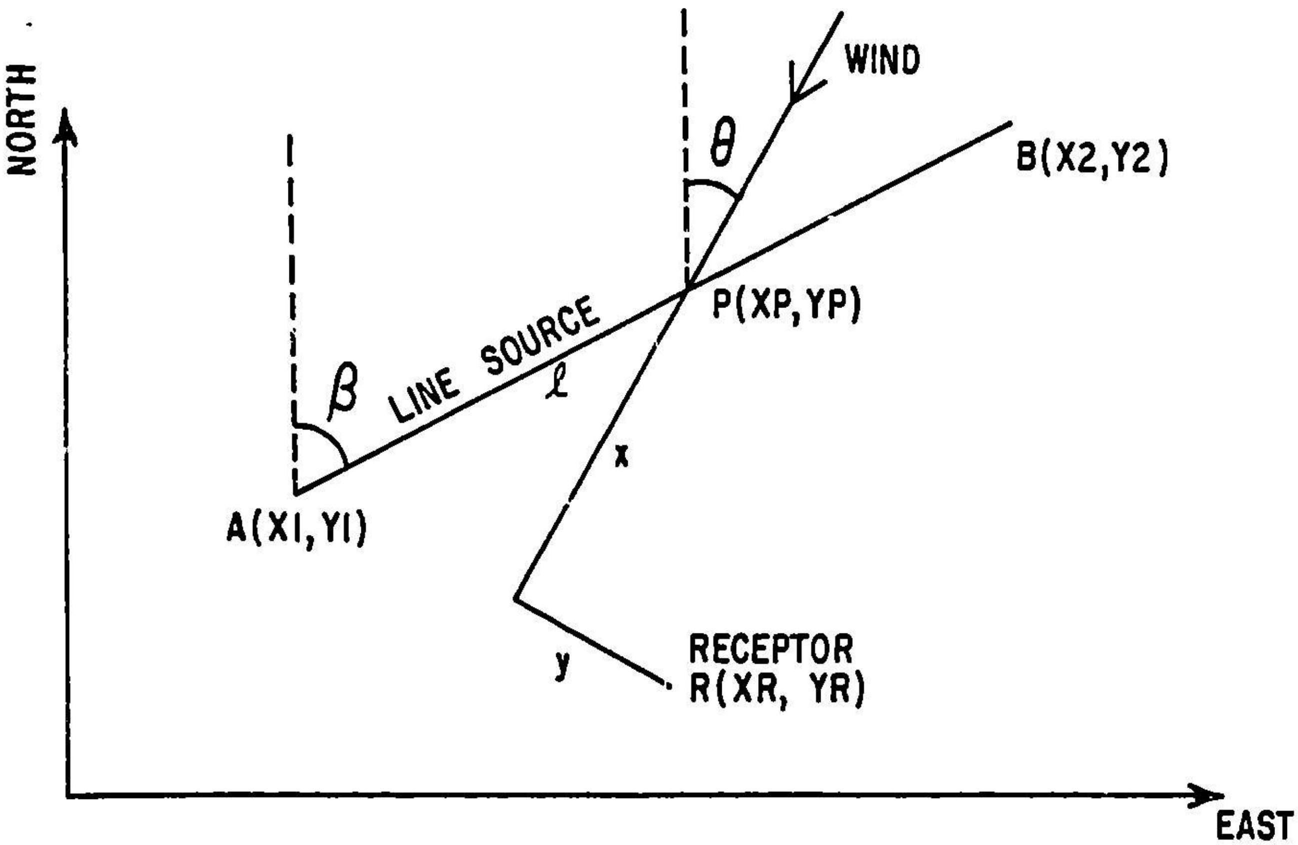


Fig. 2.1. Line Source and Receptor Relationships

$$\chi = \frac{q}{u} \int_{0}^{D} f d\ell \,, \tag{2.5}$$

where

$u \equiv$ the wind speed in m/sec

$D \equiv$ the line source length in meters, and

$f \equiv$ the point source dispersion function in $1/m^2$.

For application of this model to a highway segment in relatively open terrain, an approximation of the wind speed u at a height of two meters above ground is suitable. The integral in Eq. 2.5 is called a coupling coefficient when $q = 1.0$ & $u = 1.0$.

For stable conditions or if the mixing height is no less than 5000 meters, the dispersion is given by:

$$f = \frac{1}{2\pi\sigma_y\sigma_z} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\}, \tag{2.6}$$

where

$\sigma_y \equiv$ the standard deviation of the concentration distribution in the crosswind direction in meters (see Sec. 3),

$\sigma_z \equiv$ the standard deviation of the concentration distribution in the vertical direction in meters (see Sec. 3),

$z \equiv$ the receptor height above ground in meters, and

$H \equiv$ the effective source height in meters.

In unstable or neutral conditions, if σ_z is greater than 1.6 times the mixing height L (in meters), the distribution below the mixing height is uniform with height regardless of source or receptor height, provided both are less than the mixing height:

$$f = \frac{1}{\sqrt{2\pi}\,\sigma_y L} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]. \tag{2.7}$$

In all other unstable or neutral conditions:

$$f = \frac{1}{2\pi\sigma_y\sigma_z} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right]\right. \tag{2.8}$$

$$+ \exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right] + \sum_{N=1}^{N=\infty}\left[\exp -\frac{1}{2}\left(\frac{z-H-2NL}{\sigma_z}\right)^2\right.$$

$$+ \exp -\frac{1}{2}\left(\frac{z+H+2NL}{\sigma_z}\right)^2 + \exp -\frac{1}{2}\left(\frac{z-H+2NL}{\sigma_z}\right)^2$$

$$\left.\left. + \exp -\frac{1}{2}\left(\frac{z+H+2NL}{\sigma_z}\right)^2\right]\right\}.$$

The infinite series in Eq. 2.8 converges rapidly, so that more than four or five sums of the four terms are seldom required.

In each of the three expressions, Eqs. 2-6-2.8, for f, the variables are evaluated for the given stability class and for the distances x + b for σ_y and x + a for σ_z. The virtual distances a and b in kilometers are required to produce the initial σ_z and σ_y, respectively.

If z or H or both are zero, the resulting simpler forms of expressions, Eqs. 2.6 and 2.8, are used by the computer program.

The value of the integral in Eq. 2.5 is approximated by using Simpson's rule. Let $\Delta\ell$ = D/N, with N even. The Simpson approximation gives:

$$\chi = \frac{q\,\Delta\ell}{u}\left[\frac{1}{3}\left(f_o + f_N\right) + \frac{4}{3}\sum_{i=1}^{\frac{N}{2}} f_{2i-1} + \frac{2}{3}\sum_{i=1}^{\frac{N}{2}-1} f_{2i}\right], \tag{2.9}$$

where f_i is evaluated, as appropriate, from Eqs. 2.6, 2.7, and for $\ell = i\,\Delta\ell$.

Interval length $\Delta\ell$ is initially chosen to be D/2. As the calculation proceeds, the interval length is successively halved, to $\Delta\ell/2$, $\Delta\ell/4$, ... , until the concentration estimates converge to within 1/2 percent of the previous estimate. This value is then used as the value of the integral.

2.3 Emission Rate for the Line Source

A uniform emission rate q may be specified as an input variable or computed by ANL/HIWAY from exogenously provided average vehicle speed, S, and volume, V, data. For S in miles per hour and V in thousands of automobiles per hour, the calculation yields q in grams per second per meter as:

$$q = \left[(1.570821)\,\frac{10^{-4}}{S} + (1.0908)\,10^{-6}\right] \cdot V \cdot 1000. \qquad (2.10)$$

2.4 Systems of Units

Although all ANL/HIWAY input and output are in the English system, parameters are converted to MKS units by the program. Consequently, the computations and hence the discussion are all in the MKS system.

3. DISPERSION FUNCTIONS σ_y AND σ_z*

The dispersion functions σ_y and σ_z (in meters) indicate the amount the pollutant plume has spread (dispersed) after leaving its source. The values for these functions are those of Pasquill (if the virtual distance is taken as zero) as given in graphical form in Turner (1970). Pasquill stability classes are given in Table 3.1.

Table 3.1. Pasquill Stability Classes

Stability Class[a]	Description
A (1)	Very unstable
B (2)	Moderately unstable
C (3)	Slightly unstable
D (4)	Neutral
E (5)	Slightly stable
F (6)	Moderately stable

[a]The stability classes are commonly referred to by letter. For input to the computer program, the numbers in parentheses are used.

The horizontal dispersion parameter value is given by

$$\sigma_y = 465.1 \, (x + b) \tan \theta_p \, , \qquad (3.1)$$

where

$x \equiv$ the downwind distance from source to receptor in km,

$b \equiv$ the virtual distance for initial σ_y in km, and

$\Theta_p \equiv$ half the angle of horizontal plume spreading in degrees.

The factor 465.1 is 1000 m/km divided by 2.15, the number of standard deviations of a Gaussian distribution from the centerline to the point where the distribution falls to 10 percent of the centerline value. The angle Θ_p is

*Much of the descriptive material for Section 3 is adapted, in part verbatim, from the "User's Guide for HIWAY, a Highway Air Pollution Model," EPA-650/4-74-008, by John R. Zimmerman and Roger S. Thompson.

given by:

$$\Theta_p = c - d \ln\left[\frac{x + b}{x_o}\right], \qquad (3.2)$$

where c and d (in degrees) are functions of Pasquill stability class, and the normalizing distance x_o is 1 km. Values of the parameters c and d are given in Table 3.2.

Table 3.2. Values of c and d Used to Calculate Θ_p

	Value in Degrees	
Stability	c	d
A (1)	24.167	2.53340
B (2)	18.333	1.80960
C (3)	12.500	1.08570
D (4)	8.333	0.72382
E (5)	6.250	0.54287
F (6)	4.167	0.36191

The vertical dispersion parameter value σ_z (in meters) is given by approximations of the form:

$$\sigma_z = g\left(\frac{x + a}{x_o}\right)^h, \qquad (3.3)$$

where a is the virtual distance (in km) to give the initial σ_z (in meters), and g (in meters) and h (dimensionless) are functions of stability class and also of various ranges of the distance x. When a is zero, the values are the same as those in Fig. 3-3 of Turner (1970). Since the values of σ_z for x at less than 0.1 km are not included in that figure, the values of the parameters g and h for x at less than 0.1 km are given in Table 3.3. The values corresponding to g and h for x at other distances can be determined by examining the program listing for subroutine SIGMA and for BLOCK DATA.

Table 3.3. Values of g and h Used to Determine σ_z for Downwind Distances Less Than 0.1 km

Stability Class	Value g, Meters	Value h, Dimensionless
A (1)	122.800	0.94470
B (2)	90.673	0.93198
C (3)	61.141	0.91465
D (4)	34.459	0.86974
E (5)	24.260	0.83660
F (6)	15.209	0.81558

Turbulence of the air produced by the motion of automobiles results in a rapid mixing of the pollutants near the highway. This mix is modeled by assuming that an initial spreading of the pollutant plume occurs over the highway. To determine an acceptable initial vertical plume spread, data taken near at-grade sections from various highways were used. When the wind direction is less than 75° degrees from the perpendicular to the highway, it has been shown that an approximate expression can be used to determine pollutant concentrations from an infinite line source (Calder, 1973). Solving this expression for σ_z yields:

$$\sigma_z(x) = \sqrt{\frac{2}{\pi}}\ \frac{q}{C(p)\ u\ \cos\gamma}\ , \tag{3.4}$$

where

$\sigma_z(x) \equiv$ the vertical standard deviation of plume distribution at the downwind distance x from the source,

$C(p) \equiv$ the measured concentrations at the perpendicular distance p (meters) from the highway $\left(x = \frac{p}{\cos\gamma}\right)$ in g/m^3, and

$\gamma \equiv$ the angle between the wind direction and a perpendicular to the highway in degrees.

By making estimates of the line-source emission rate, q, and obtaining observed data for air pollution concentrations, a plot of σ_z versus distance has been determined (Fig. 3.1). From this analysis, it may be seen

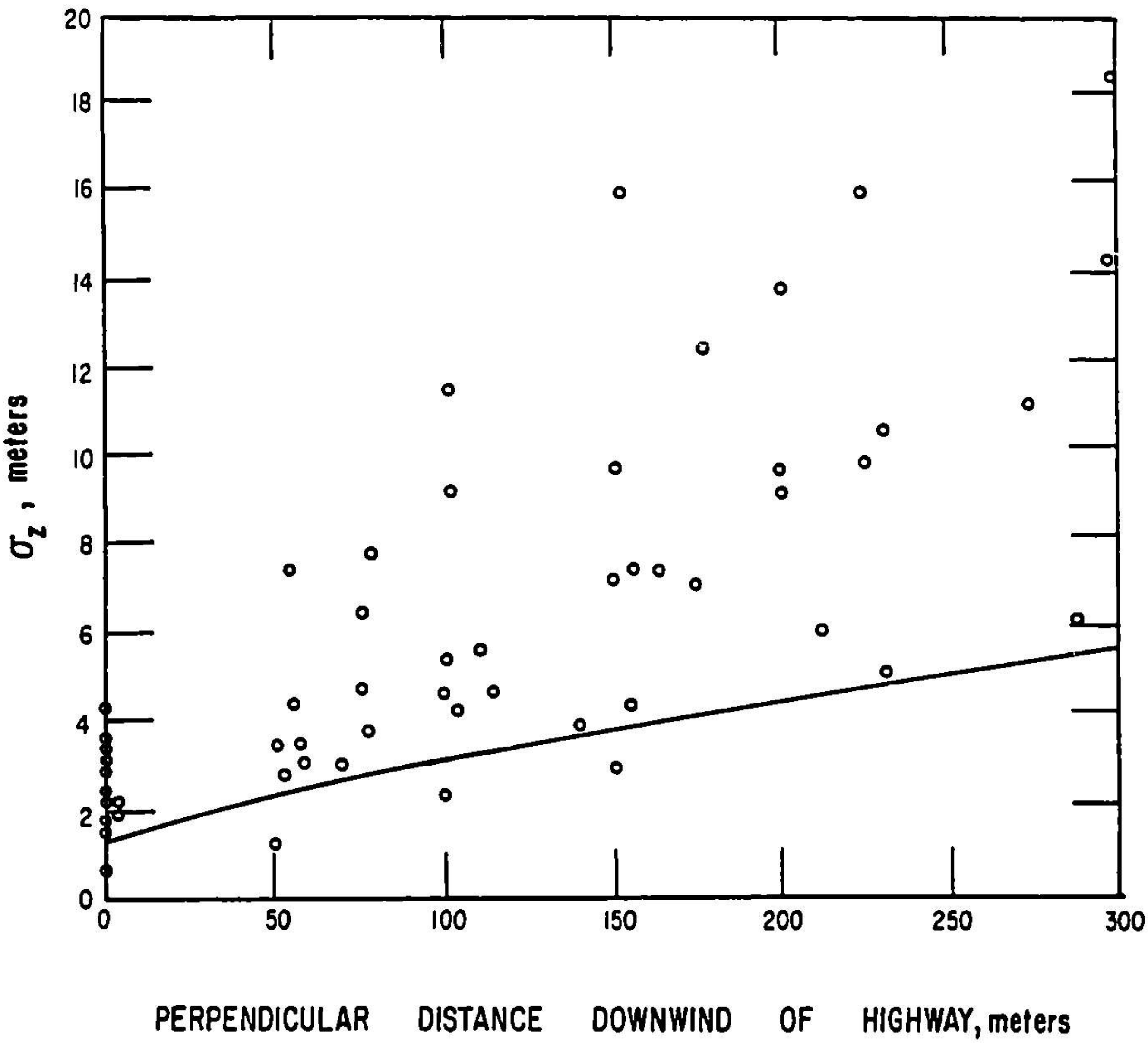


Fig. 3.1. Data Points Used to Determine an Estimate of Initial σ_z

that an initial value σ_{zo} of σ_z equal to 1.5 meters is a conservative approximation to the vertical standard deviation of the plume at the downwind edge of the at-grade highway. This is only a tentative value based on a limited amount of data and may be revised as more data become available. This empirical value of σ_{zo} is applied in the operation of the model to the line source placed along the lane of traffic.

The value given to σ_{yo} has little effect on the computation of air pollution concentrations when the wind direction has a component perpendicular to the highway. An initial σ_y is used to account for a reasonable amount of cross-highway spreading caused by vehicle-generated turbulence when the wind direction is parallel or nearly parallel to the highway.

The virtual distances a corresponding to an initial σ_z of 1.5 meters, and the virtual distances b corresponding to an initial σ_y of 3.0 meters for each stability class are given in Table 3.4.

Table 3.4. Virtual Distances a and b Corresponding to Initial σ_z of 1.5 Meters and Initial σ_y of 3.0 Meters, Respectively

Stability Class	Distance, km	
	a	b
A (1)	0.00944	0.00863
B (2)	0.01226	0.01320
C (3)	0.01736	0.02100
D (4)	0.02722	0.03480
E (5)	0.03590	0.04710
F (6)	0.05842	0.07330

4. INPUT FOR ANL/HIWAY

Input consists of a flexible stream of command cards in almost any order convenient to the user. Since the input structure is modular by command type and by mode of operation, several runs can be made consecutively in the same job. On the other hand, when two successive runs are similar, only the changed conditions need to be indicated in the second run.

4.1 Command Types

Before grouping commands by mode of operation, we first list and describe command types. With the exception of alphanumeric information on cards following DESC and HEADER, all commands and their following cards use a (2A4,12F6.0) format. Commands are listed approximately in the order of the GO, COUPLE, and FETCH modes, followed by input/output commands:

DESC, NSOR, SOURCE, HEADER, VOLUME, RECP, RECPAUTO, ADDS, SUBS, ADDR, SUBR, MET, SYMAP, SYMAPEVL, GO, GOAVE, RESTART, INITIAL, STAB, WIND, COUPLE, FETCH, FETCHAVE, DSN, INPUT, OUTPUT, RESULT, SUPS, SUPR, SELS, SELR, FREESOUR, FREERECP, TERM, VMIX

DESC DNBR

Descriptive Card 1

Descriptive Card 2

.

.

.

Each case may be headed by a DESC command followed by up to 10 comment cards in 20A4 format. Such cards identify the case being modeled both on input and on output. Parameter DNBR is the number of comment cards that will follow the command.

NSOR SNBR

This command sets the number of sources SNBR to be used: $1 \leq \text{SNBR} \leq 30$. It must precede all commands related to sources.

SOURCE	X1	Y1	Z1	X2	Y2	Z2	W	H	Q	for first source
	X1	Y1	Z1	X2	Y2	Z2	W	H	Q	for second source
	.									.
	.									.
	.									.

Each of up to 30 cards identifies one of the line sources (roads). Starting point A of the source has coordinates (X1, Y1, Z1), and ending point B has coordinates (X2, Y2, Z2). The road is W feet wide. Emission height of the source is H feet (Z1 and Z2 are never actually used in this version of HIWAY.) Emission rate is Q, g/m-sec. The SOURCE command must somewhere be preceded by an NSOR command.

HEADER

Source Label 1

Source Label 2

.

.

Each source may be labeled with a 20-character heading (otherwise blanks are output for the source labels). If a HEADER command is used, there must be a card (and hence a label) for each source.

VOLUME V1 S1 V2 S2 . . . V6 S6

. . . . . .

V_i S_i . .

. .

. .

The VOLUME command is used to input traffic volume and speed for each source, to be used in turn by HIWAY for computing emissions. The volumes V are in thousands of cars per hour, and speeds S are in miles per hour; default is 5 mph. CAUTION: VOLUME cards must not precede SOURCE cards nor the NSOR command.

RECP XR_1 YR_1 ZR_1 XR_2 YR_2 ZR_2 XR_3 YR_3 ZR_3 XR_4 YR_4 ZR_4

. . . . . .

XR_i YR_i ZR_i .

Coordinates (XR_i, YR_i, ZR_i), in feet, of receptors are assigned manually by the RECP command. Up to 1000 receptors are permitted, with four sets of receptor coordinates per card.

RECPAUTO XO YO XNBR DELX YNBR DELY

If the user does not desire to input the specific location of each receptor, HIWAY will create a uniform grid of receptors automatically from parameters in the RECPAUTO command. From an origin (XO, YO) there are XNBR receptors with incremental spacing DELX in the x-direction and YNBR receptors with incremental spacing DELY in the y-direction. All units are in feet. The receptor height ZO is automatically set equal to zero.

ADDS X1 Y1 Z1 X2 Y2 Z2 W H Q

This command adds a single source to the end of the list of sources. The source extends from A(X1, Y1, Z1) to B(X2, Y2, Z2) in feet. It is W feet wide, has emission height H, and emission rate Q. A maximum of 30 total sources are allowed in HIWAY.

SUBS SNO

This command simply deletes the source referenced by its position SNO in the source list, and then closes the gap, i.e., all sources are renumbered following the deleted source.

ADDR XR YR ZR

This command adds a receptor at (XR, YR, ZR) in feet to the end of the present list of receptors. A total of one thousand receptors are allowed.

SUBR RNO

This command simply deletes the receptor referenced by its position RNO in the receptor list, and renumbers the remaining receptors.

MET STAB WS WD HLID CONVER

Each run in the GO mode requires a MET command for stability class (STAB), wind speed (WS) in mph, wind angle (WD) in degrees east of north, mixing height (HLID) in feet, and conversion factor (CONVER) to convert emissions for the desired pollutant from g/m^3 to parts per million (ppm).

The following table gives the stability classes and their meanings:

Class	Meaning
1	Very unstable
2	Moderately unstable
3	Slightly unstable
4	Neutral
5	Slightly stable
6	Moderately stable

SYMAP X Y

The user may wish, in addition to printed output, to have SYMAP cards punched so that contour plotting of pollutant concentrations can be made. The SYMAP command establishes (X,Y) as the upper left hand corner of the user's grid, and punches both B-DATA POINTS (receptor locations) and E-VALUES (concentrations), after making the proper coordinate transformations.

SYMAPEVL X Y

This command causes punching of SYMAP E-VALUES (concentrations), only after establishing (X,Y) as the upper left-hand corner of the receptor grid. *B-DATA POINTS are not punched.*

GO

This command signals the start of computation for the user's data, and printing, or punching and printing of computed receptor concentrations.

GOAVE

Relatively short runs that do not require the creation of coupling coefficients but still need to do multi-hour averaging can make use of the GOAVE command. This command replaces the GO command in serial runs. No printing or punching will occur until the RESULT command is issued. Output is the same as that for a COUPLE and then a FETCHAVE run.

RESTART

Command 1

Command 2

.

.

.

The user may want to vary input only slightly on several runs, e.g., adding or deleting sources, receptors, volumes, and speeds. He can do this by a RESTART and GO sequence, either using some new data or changing some of the old. The following list shows the RESTART conditions.

RESTART DEFAULTS (OR OVERRIDES)

1. All receptor concentrations will be printed.
2. All source contributions to each receptor will be printed.
3. Input unit for data deck is unit 5 (reader ANL installation).
4. Output unit for printout is unit 6 (printer ANL installation).
5. Stability class 4 (neutral).
6. Mixing depth 3500 feet.
7. No SYMAP card punched.
8. Number of sources used 1.
9. No averaging.
10. GO mode only.
11. Emissions come from source card.
12. Coupling coefficient external storage unit device #11 (disk ANL installation).

INITIAL

Command 1

Command 2

.

.

.

This is another restarting command, but here all of the original information is cleared from the computer memory. All arrays are cleared and the default values are established. The following list gives the default values.

INITIAL DEFAULTS (OR OVERRIDES)

1. Clears all source arrays.
2. Clears all receptor arrays.
3. Clears all title arrays.
4. Clears all descriptive comments.
5. Clears all volume & speed arrays.
6. Clears all concentration arrays.
7. Clears all print flags.
8. Sets all defaults as specified under RESTART.

STAB C1 C2 C3 C4 C5 C6

This command sets up a series of up to six stability classes C1,..., C6 to be used by COUPLE in generating a set of coupling coefficients for each stability class and each wind direction given in the WIND command.

WIND WD1 D1 D2 . . . D11
WD2 D12 . . D16

A series of up to 16 wind directions D1,...,Di,..., are set up for cycling through each of the stability classes given in STAB. Coupling coefficients for each combination of wind direction and stability class are generated in COUPLE and saved for later use by FETCH. WD1 is the number of wind directions on the first WIND card, WD2 the number on the second. If less than 12 wind directions are desired, then only one card is required.

COUPLE HLID

COUPLE may be thought of as an extended form of the GO command, since it performs all the functions of a GO, and also stores the coupling coefficients (integrals). Coupling coefficients are formed and saved in separate data sets for each wind direction given in the WIND command and each stability class in the STAB command, where the wind directions are being cycled more frequently. Data set numbering starts at zero.

FETCH FILENO WS CONVER

(Q1 Q2 . . .)

The FETCH command retrieves the coupling coefficients saved in COUPLE at the data set numbered FILENO. The coupling coefficients are divided by the wind speed, WS, and multiplied by the emissions for each source, Qi, to obtain air quality estimates in g/m^3. The conversion factor, CONVER, is applied to get receptor concentrations in ppm. FETCH must be either preceded by the VOLUME command, so that emissions (i.e., the Qi's) can be computed from traffic volumes and speeds, or followed by cards containing explicit emissions for each line source. The default for wind speed is 1 m/sec.

FETCHAVE FILENO WS CONVER

This command is the same as FETCH, except that output occurs only following a number of FETCHAVE commands and a RESULT command. Hence concentrations are N-hour averages.

DSN D

This gives the number of the "device" where coupling coefficients are saved. Unit 11 is the default (a disk unit at Argonne). If DSN is to appear it must precede COUPLE in the coupling mode and FETCH in the fetch mode.

INPUT UNITIN

The command cards may be read in from any unit UNITIN instead of the default number 5 (card reader).

OUTPUT UNITOUT

Output may be to any unit number UNITOUT instead of the default unit 6 (line printer).

RESULT VALUE

RESULT averages estimated air quality concentrations for N sets of data input, giving an N-hour (N-period) average. Each period is assumed to be independent. To adjust the output to reflect vehicle mixes other than 1973, when using the GOAVE and FETCHAVE modes, air quality concentrations are multiplied by the VALUE on the RESULT command card.

VMIX VALUE

To adjust the output for automotive mix other then 1973, air quality concentrations are multiplied by the VALUE on the VMIX command card. VALUE is defaulted to 1.0. The command is only used for the GO and FETCH modes.

SUPS S1 S2 . . . S12

. . .

Sk

. . .

This command will suppress printing for the indicated source numbers, for any of the 30 line sources.

SUPR R1 R2 . . . R12

. . .

Rk

. . .

This will suppress printing for the indicated receptor numbers, for any of the 1000 receptors.

SELS S1 . . . S12

. . .

Sk

. . .

Only those sources listed by source number on these cards will be printed, for any of the 30 line sources.

SELR R1 . . . R12

. . .

Rk

. . .

This will force printing of only those receptors indicated on these cards, for any of the 1000 receptors.

FREESOUR

All sources are restored for printing by FREESOUR.

FREERECP

All receptors are restored for printing by FREERECP.

TERM

The final command is TERM. It simply ends the input stream and stops program execution.

4.2. Summary of Command Types

HIWAY command words are summarized in Table 4.1; allowable modes for each type of command are indicated. Table 4.2 outlines commands by input card content and format.

Table 4.1. HIWAY Command Words and Their Modes

Command Word	Modes[a] Where Used	Command Word	Modes[a] Where Used	Command Word	Modes[a] Where Used
DESC	GCF	SYMAP	GCF	DSN	CF
NSOR	GC	SYMAPEVL	GCF	INPUT	GCF
SOURCE	GC	GO	G	OUTPUT	GCF
HEADER	GC	GOAVE	G	RESULT	GF
VOLUME	GF	RESTART	GCF	SUPS	GCF
RECP	GC	INITIAL	GCF	SUPR	GCF
RECPAUTO	GC	STAB	C	SELS	GCF
ADDS	GC	WIND	C	SELR	GCF
SUBS	GC	COUPLE	C	FREESOUR	GCF
ADDR	GC	FETCH	F	FREERECP	GCF
SUBR	GC	FETCHAVE	F	TERM	GCF
MET	G	VMIX	GCF		

[a] G = GO, C = COUPLE, and F = FETCH.

Table 4.2. Input Cards for HIWAY

Mode	Name	Card No.	Columns	Format	Parameter or Variable	Units
GCF	DESC	1	1-4	A4	DESC command card	
	DNBR		9-14	F6.0	Number of cards in description	
		2	1-80	20A4	Alphanumeric description of the current case	
				.	.	
	(up to 10 cards)			.	.	
				.	.	
GC	NSOR	1	1-4	A4	NSOR command card	
	SNBR		9-14	F6.0	Number of sources	
GC	SOURCE	1	1-6	A4	SOURCE command card	
	X1,Y1,Z1		9-26	3F6.0	Coordinates of starting point A for first source	ft.
	X2,Y2,Z2		27-44	3F6.0	Coordinates of end point B for first source	ft.
	W		45-50	F6.0	Width of the first source	ft.
	H		51-56	F6.0	Emission height of the first source	ft.
	Q		57-62	F6.0	Emission strength of first source	g/m
	X1,Y1,Z1	2	9-26	3F6.0	Coordinates of A for second source	ft.
	(up to 30 cards for as many sources as are needed)					
GC	HEADER	1	1-6	2A4	HEADER command card	
		2	1-20	5A4	Name or label for 1st source	
		3	1-20	5A4	Name or label for 2nd source	
		.	.	.	.	
		.	.	.	.	
	(each source requires a label if a HEADER command is used)					

Table 4.2. (Contd.)

Mode	Name	Card No.	Columns	Format	Parameter or Variable	Units
GF	VOLUME	1	1-6	2A4	VOLUME command card	
	V1		9-14	F6.0	Volume of traffic, 1st source	Thousands of cars/hr
	S1		15-20	F6.0	Average speed of traffic, 1st source	mph
	V2		21-26	F6.0	Volume of traffic, 2nd source	Thousands of cars/hr
	.		.	.		
	.		.	.		
	.		.	.		
	S6		75-80	F6.0	Average speed of traffic, 6th source	mph
	V1	2	9-14	F6.0	Volume of traffic, 7th source	Thousands of cars/hr

(a volume & speed must be given for each source if the VOLUME command is used

Mode	Name	Card No.	Columns	Format	Parameter or Variable	Units
GC	RECP	1	1-4	A4	RECP command card	
	XR,YR,ZR		9-26	3F6.0	Coordinates of 1st receptor	ft.
	XR,YR,ZR		27-44	3F6.0	Coordinates of 2nd receptor	ft.
	.					
	.					
	.					
	XR,YR,ZR	2	9-26	3F6.0	Coordinates of 5th receptor	ft.
	.		.	.		
	.		.	.		
	.		.	.		
GC	RECPAUTO	1	1-8	2A4	RECPAUTO command card	
	XO,YO		9-20	2F6.0	Origin of automatic receptor grid	ft.
	XNBR		21-26	F6.0	Number of receptors in x-direction	

Table 4.2. (Contd.)

Mode	Name	Card No.	Columns	Format	Parameter or Variable	Units
	DELX		27-32	F6.0	Distance between receptors, x-direction	ft.
	YNBR		33-38	F6.0	Number of receptors in y-direction	
	DELY		39-44	F6.0	Distance between receptors, y-direction	ft.
GC	ADDS	1	1-4	A4	ADDS command card	
	X1,Y1,Z1,		9-26	3F6.0	Coordinates of point A for added source	ft.
	X2,Y2,Z2,		27-44	3F6.0	Coordinates of point B for added source	ft.
	W		45-50	F6.0	Width of added source	ft.
	H		51-56	F6.0	Emission height of added source	ft.
	Q		57-62	F6.0	Emission strength of added source	g/m-sec
GC	SUBS	1	1-4	A4	SUBS command card	
	SNO		9-14	F6.0	Source number to be deleted	
GC	ADDR	1	1-4	A4	ADDR command card	
	XR,YR,ZR		9-26	3F6.0	Coordinates of added receptor	ft.
GC	SUBR	1	1-4	A4	SUBR command card	
	RNO		9-14	F6.0	Receptor number to be deleted	
G	MET	1	1-3	A4	MET command card	
	STAB		9-14	F6.0	Stability class	
	WS		15-20	F6.0	Wind speed	mph
	WD		21-26	F6.0	Wind direction east of north	deg.

Table 4.2. (Contd.)

Mode	Name	Card No.	Columns	Format	Parameter or Variable	Units
	HLID		27-32	F6.0	Mixing height	ft.
	CONVER		33-38	F6.0	Conversion factor from emission in g/m-sec to ppm	
GCF	SYMAP	1	1-5	2A4	SYMAP command card	
	X,Y		9-20	2F6.0	Coordinates of upper left-hand corner of user's SYMAP grid, for B-DATA POINTS and E-VALUES	ft.
GCF	SYMAPEVL	1	1-8	2A4	SYMAPEVL command card	
	X,Y		9-20	2F6.0	Coordinates of upper left-hand corner of user's SYMAP grid, for E-VALUES only	ft.
G	GO	1	1-2	A4	GO command card	
G	GOAVE	1	1-5	2A4	GOAVE command card	
GCF	RESTART	1	1-7	2A4	RESTART command card	
GCF	INITIAL	1	1-7	2A4	INITIAL command card	
C	STAB	1	1-4	A4	STAB command card	
	C1		9-14	F6.0	First stability class	
	C2		15-20	F6.0	Second stability class	
			(up to six stability classes)			
C	WIND	1	1-4	A4	WIND command card	
	WD1		9-14	F6.0	Number of wind directions on first card	
	D1-D11		15-80	11F6.0	Wind directions (up to 11)	deg.
	WD2	2	9-14	F6.0	Number of wind directions on second card	
	D12-D16		15-44	5F6.0	Wind directions (up to 16 altogether)	deg.
C	COUPLE	1	1-6	2A4	COUPLE command card	
	HLID		9-14	F6.0	Mixing height	ft.
F	FETCH	1	1-5	2A4	FETCH command card	

Table 4.2. (Contd.)

Mode	Name	Card No.	Columns	Format	Parameter or Variable	Units
	FILENO		9-14	F6.0	File number of coupling coefficients	
	WS		15-20	F6.0	Wind speed	mph
	CONVER		21-26	F6.0	Conversion factor from emission in g/m-sec to ppm	
F	FETCHAVE	1	1-8	2A4	FETCHAVE command card	
	FILENO		9-14	F6.0	File number of coupling coefficients	
	WS		15-20	F6.0	Wind speed	mph
	CONVER		21-26	F6.0	Conversion factor from emission in g/m-sec to ppm	
CT	DSN	1	1-3	A4	DSN command card	
	D		9-14	F6.0	Data set device number for coupling coefficients	
GCT	INPUT	1	1-5	2A4	INPUT command card	
	IN		9-14	F6.0	Input device unit number	
GCT	OUTPUT	1	1-6	2A4	OUTPUT command card	
	OUT		9-14	F6.0	Output device unit number	
G	RESULT	1	1-6	2A4	RESULT command card	
GCT	VMIX	1	1-4	A4	VMIX command card	
	VALUE		9-14	F6.0	Automotive mix (Scale factor based upon 1973 automotive mix.)	
GCT	SUPS	1	1-4	A4	SUPS command card	
	S1-S12		9-80	12F6.0	Source numbers to be suppressed for printing	
	S13-S24	2	9-80	12F6.0	Source numbers to be suppressed for printing	

(up to 30 sources)

Table 4.2. (Contd.)

Mode	Name	Card No.	Columns	Format	Parameter or Variable	Units
GCF	SUPR	1	1-4	A4	SUPR command card	
	R1-R12		9-80	12F6.0	Receptor numbers to be suppressed for printing	
	R13-R24	2	9-80	12F6.0	Receptor numbers to be suppressed for printing	
			(up to 1000 receptors)			
GCF	SELS	1	1-4	A4	SELS command card	
	S1-S12		9-80	12F6.0	Source numbers to be printed	
	S13-S24	2	9-80	12F6.0	Source numbers to be printed	
			(up to 30 sources)			
GCF	SELR	1	1-4	A4	SELR command card	
	R1-R12		9-80	12F6.0	Receptor numbers to be printed	
	R13-R24	2	9-80	12F6.0	Receptor numbers to be printed	
			(up to 1000 receptors)			
GCF	FREESOUR	1	1-8	2A4	FREESOUR command card	
GCF	FREERECP	1	1-8	2A4	FREERECP command card	
GCF	TERM	1	1-4	A4	TERM command card	

4.3 Operation Modes

Each of the three operation modes (GO, COUPLE, and FETCH) is invoked by a series of command cards containing parameters relevant to that particular mode. Some 35 different command types are available, and there is a great deal of flexibility as to their arrangement in the input stream. Modes or sub-modes, however, are not to be mixed (e.g., GO & COMVE, etc). For each mode, some commands are required and many are optional, as shown in Fig. 4.1, which also

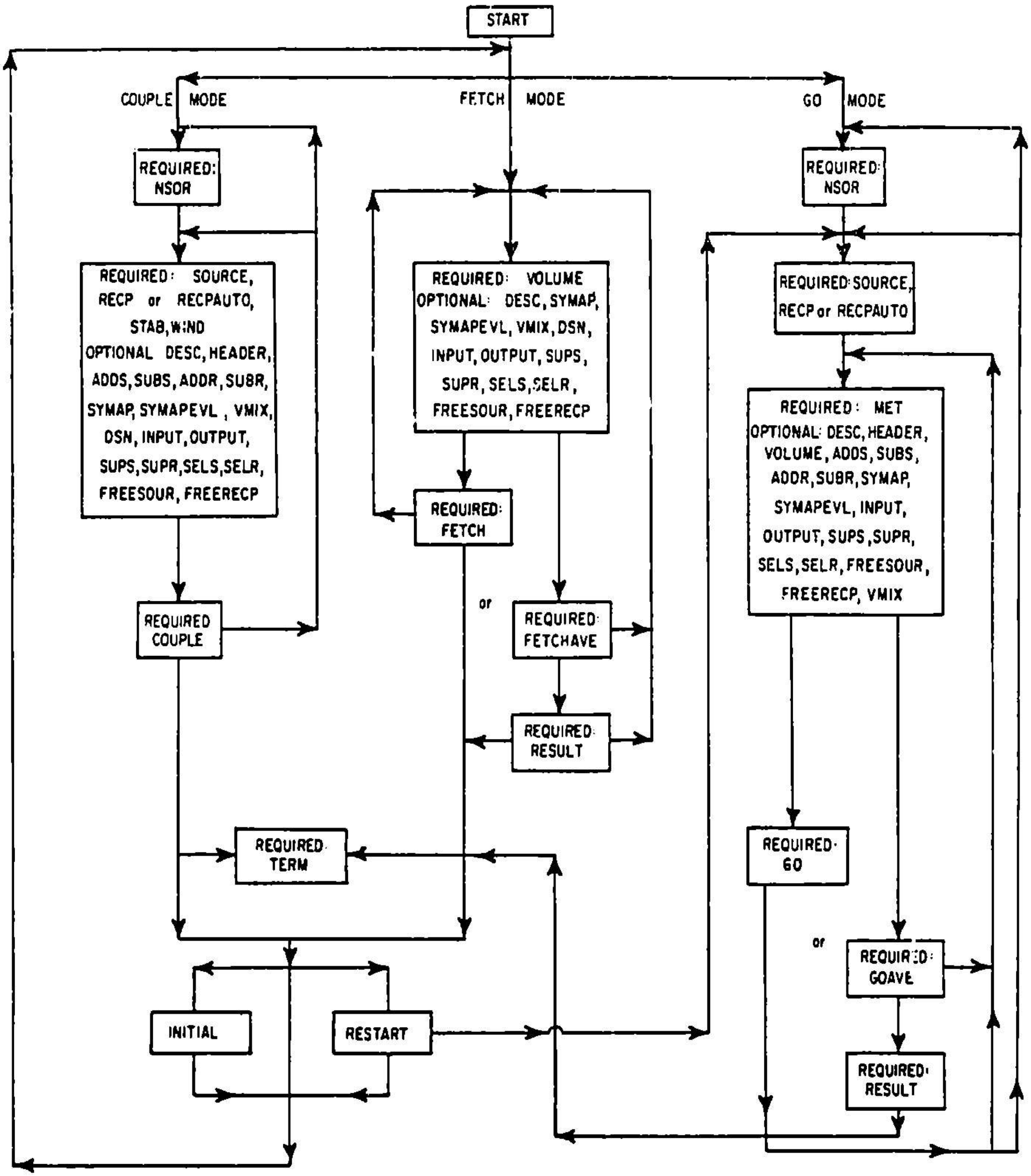


Fig. 4.1 Normal Flow of ANL/HIWAY Commands

gives the normal flow of commands. The number of sources (NSOR) must be input in the GO and COUPLE modes, and must appear before any other commands relating to sources. For the FETCH mode NSOR is read in as part of the coupling coefficient data set.

4.3.1 The GO Mode

In the GO mode, input consists of coordinates for a set of sources and receptors, together with a particular set of meteorological conditions (MET). Integration along the line sources (roads) is performed to get predicted air quality concentrations at each receptor as a result of emissions from each road. Output is selective as to which sources and receptors are printed, whether SYMAP cards for later concentration contour plotting are to be punched, and whether results are for one-hour periods or are averaged (via GOAVE and RESULT) over a number of hours for varying conditions. None of the integrations in the GO mode are preserved.

4.3.2 The COUPLE Mode

When (1) the source-to-receptor geometry is fixed, (2) the only variables are wind speed, emissions, and conversion factor to ppm, and (3) a large number of runs are to be made, then the COUPLE mode is indicated. In this mode, line source integrations are performed for the given sources and receptors but with nominal (unit) values for emission, wind speed, and conversion factor. These computed concentrations, whose relative sizes are the important consideration, are saved on an external storage device (a disk unit at Argonne) as coupling coefficients for later use in the FETCH mode. Since the coupling coefficients are functions of mixing height, stability class, and wind direction, these parameters are part of the COUPLE mode input. In fact coupling coefficients are generated for whole sets of wind directions (WIND) and stability classes (STAB). The MET command should never be used in the COUPLE mode. As in the GO mode, road and receptor coordinates are input for the COUPLE mode; the various output options are also available.

Coupling coefficients are generated for each stability class given in the STAB command and for each wind direction stated on the WIND card(s). The wind directions are cycled more frequently than the stability classes. Coupling coefficient data sets are numbered sequentially starting at zero.

4.3.3 The FETCH Mode

This is the follow up to the COUPLE mode. The FETCH command retrieves the proper coupling coefficient file, multiplies each coefficient by the given emission rate and conversion factor, and divides by the wind speed to get concentrations, with only a minimum of computation. FETCH must be preceded by the VOLUME command so that traffic volumes and speeds can be used to compute emissions for each source, or emissions must be input directly as parameters, 12 per card, following the FETCH command.

As in the GO mode, output is selective, SYMAP cards may be punched, and concentrations may be averaged (by means of FETCHAVE and RESULT) over a number of hours, for varying emissions and wind speeds.

4.3.4 Common Commands

There are a number of commands that may be used in any of the three modes. The list includes commands to describe a HIWAY case (DESC); to provide SYMAP punched card output (SYMAP, SYMAPEVL); to begin subsequent cases of a run with some of the original data (RESTART) or none of it (INITIAL); to designate input or output device numbers (INPUT, OUTPUT); and to suppress printing of sources and receptors selectively (SUPS, SUPR, SELS, SELR, FREESOUR, FREERECP).

In both the GO and the COUPLE modes, sources may be named by means of the HEADER command; an individual source may be added by using the ADDS command or deleted by SUBS; and an individual receptor may be added by ADDR or deleted by SUBR.

5. OUTPUT FOR ANL/HIWAY

Most of the ANL/HIWAY output is self-explanatory. Output -- both printing and card punching -- is triggered by the GO, COUPLE, FETCH, and RESULT commands. RESULT is used only after a sequence of GOAVE commands for varying conditions or after a series of FETCHAVE commands.

5.1 Printing (See examples at the end of Chapter 7)

Before any other output, the entire set of input data cards is printed, line by line, and one card per line.

5.1.1 GO Mode Printing

In the GO mode, meteorological conditions (from the MET command) are printed next: wind direction, wind speed, stability class, mixing depth, and conversion factor. This is followed in sequence by:

Whatever title or descriptive information has been input with the DESC command (if any);

Each road (line source) selected for output, with its starting and end point coordinates, its width, its emission height, its name (if given in the HEAD command), and its traffic volume and speed (if given with the VOLUME command);

Each receptor to be output, with its coordinates in feet and in kilometers;

Air quality concentrations for all receptors selected for output, in ppm and μg/m^3. In addition the percent and absolute (ppm) contribution to these air quality levels from each line source are provided;

Air quality concentrations at all receptors, with concentrations as high as that of the 10 highest concentrations.

5.1.2 COUPLE Mode Printing (See examples at the end of Chapter 7)

COUPLE mode printing includes everything for the GO mode plus the coupling coefficient file number (following the meteorological conditions). In this case, the concentrations calculated and output are for nominal emissions, wind speeds, and conversion factors.

5.1.3 FETCH Mode Printing (See examples at the end of Chapter 7)

Input meteorological conditions are not listed on the output. Refer to the coupling coefficient file for that information.

5.2 Punching

Under the SYMAP command, ANL/HIWAY punches cards (for later plotting via the SYMAP computer program) containing coordinates for all receptors as B-DATA POINTS and corresponding total concentrations at these receptors as E-VALUES. Under SYMAPEVL, only the E-VALUEs are punched.

6. THE ANL/HIWAY COMPUTER PROGRAM

ANL/HIWAY is written in FORTRAN for the IBM 360. It consists of a driver program (MAIN), seven subroutines, a function subprogram, and BLOCK DATA. The MAIN program processes input and output through a command structure, utilizing the REED, OUTPT, and VOCAB subroutines and the KIND function. For integration of the line sources, MAIN calls on a modified EPA subroutine named NCEPA. NCEPA in turn calls subroutine RELCO to calculate concentrations, and RELCO uses subroutine SIGMA to get standard deviations for dispersion. Data (virtual distances, coefficients, and exponents) for RELCO and SIGMA are stored in BLOCK DATA. A complete program listing for ANL/HIWAY may be found in Appendix A.

The following pages list the Fortran Variables and arrays used in ANL/HIWAY. These are followed by three tables listing the ANL/HIWAY commands by command card, switch number, and label number.

FORTRAN VARIABLES AND ARRAYS FOR ANL/HIWAY

SYMBOL	
ABC(12)	Command parameters, varying in number and meaning from command to command
ABS	Absolute value function, a built-in subprogram
ANGH	Angle of road in polar coordinates
ATH	Subroutine for adjusting angles, calling arctangent function routine ATAN2; returns angle in radians and in degrees
BOT	Sign of DY; used in getting proper sign for angle of road
CNTM	Width of highway center strip in ft.; called CNTR in NCEPA subroutine. In labeled COMMON: TRADE.
CONC(1000,30)	Cumulative concentration for each source and receptor over set of stability classes and wind directions (used by GOAVE command)
CONMIN	Minimum concentration; used by GO command for finding all receptors at level of top ten
CONST	Conversion constant (mulitplier .0003048) to change from ft to km
CONST2	Conversion constant (multiplier .3048) to change from ft to meters
CONTOP(50)	Array in GO holding all concentrations at level of top ten receptors (no. of CONTOP $\leq$ 50)
CONVER	Parameter ABC(5) in MET command (default 1.0) for converting from $\mu g/m^3$ to parts per million ppm: not applicable for photochemicals
COS	Built-in function subprogram for cosine, in COUPLE and GO commands
CS	Temporary cosine used in GO for projecting road to N-S and E-W components and finding polar coordinates for receptors
DANG	Output parameter (angle in degrees) from arctangent subroutine ATH. Set to angle of current source (in degrees) for GO command and for COUPLE command
DEG(30)	Angle of current source (in degrees) for GO and COUPLE commands, and in adjustment for wind angle

SYMBOL

DELX	Delta x in RECPAUTO for generating uniform grid of receptors (input parameter #4)
DELY	Delta y in RECPAUTO for generating uniform grid of receptors (input parameter #6)
DELZS (30)	Eighth parameter in SOURCE command: emission height of the line source (road) in meters (equivalent to DH)
DH(30)	Equivalent to DELZS: emission height of road in feet (default 0.0)
DHH	Emission height of current road in feet for output
DW(30)	Seventh parameter of SOURCE command: width of line source (road) in feet (default 0.0) (equivalent to WSS)
DWW	Width of line source (road) in feet for output
DX	Absolute value of difference of x-coordinate of beginning and end of current source, in GO and COUPLE commands
DY	Absolute value of difference of y-coordinate of beginning and end of current source (road), in GO and COUPLE commands
EM1	Concentration in g/m-sec to be printed for current source and left-hand column receptor
EM2	Concentration in g/m-sec to be printed for current source and right-hand receptor
EOF	End of file indicator (-99.9) written on disk at end of coupling coefficent set
EVAL	Name of end of file indicator (EOF) when read during execution of FETCH and FETCHAVE commands; EVAL is -99.9
HLID	Mixing height parameter ABC(4) in ft in MET command and ABC(1) in ft. in COUPLE command; default is 3500 feet
HM	Half of emission height in feet; in labeled COMMON: TRADE
IDSN	Dat set unit number for coupling coefficient storage; parameter ABC(1) in DSN command; default is unit 11, defined at Argonne as a disk unit
IGOFLG	GO flag, set to 100 in GOAVE to bypass printing; set to zero in RESTART to allow printing
IHEAD(20,10)	Description of whole case, up to ten cards with 20 characters each, in DESC command; read in REED subroutine

SYMBOL

IIS	Counter used in restart loop
IJK	Counter to number the receptors; NRECP in RECP and RECPAUTO commands
IKLM	Counter to number the files in writing coupling coef. on disk, in COUPLE
IKZ	Counter to ten, used in finding all receptors at level of top ten
ILM	Counter in SOURCE command
ILP	Counter in printing description of case
INIT	Initialization flag, 0 for no initialization, 1 to initialize all variables; set to 0 by INITIAL command after initialization and to positive quantity in REED subroutine. INITIAL command is seldom used; it redefines total geometry. INIT counts through command array and knows when to stop. (a variable in the program)
INP	Input unit number for parameters and data, parameter ABC(1) in INPUT command; default is 5 (card reader)
IOUT	Output unit number for all output, parameter ABC(1) in OUTPUT command; default is 6 (printer)
IPUSH	Counter to number of sources NSOR in alternate mode of FETCH (direct reading of emissions from cards following FETCH if volumes and speed are not present)
ISAVE	Flag to indicate coupling mode (ISAVE =1) or GO mode (ISAVE = 0)
ISCORE	Counter in FETCH to skip ISKIP-1 sets of coupling coef. (ISKIP is file number ABC(1) in FETCH and FETCHAVE commands
ISKIP	File number of coupling coefficients (ABC(i)) in FETCH and FETCHAVE commands
ISLAP	Flag in FETCH and FETCHAVE; for usual FETCH and FETCHAVE, using VOLUMEs, ISLAP is set to 1; for no VOLUMEs, ISLAP = 0 and emissions are read from cards following FETCH or FETCHAVE card
ISTAB	Number of stability classes to be used in COUPLE mode; number of nonzero classes on STAB card
ISTRT	Receptor number ABC(1) to be deleted in SUBR command; subsequent receptors are renumbered.
ISYMAP	Flag for SYMAP punched card output, 0 for no output, 1 for

	output; set to 1 in SYMAP command, to 0 in RESTART
ITITL(30,5)	Array containing title or name (of 20 characters each) for each of the up to 30 sources; read in under HEADER command
ITT	Constant integer 99999 punched after B-DATA POINTS and after E-VALUES, and used for SYMAP runs
IUP	In RECPAUTO command, counts receptors as they are generated; number of receptors NRECP is set to current IUP when generation is completed
IUPIT	Flag for FETCHAVE: if IUPIT>0, concentrations are totaled for FETCHAVE instead of being printed. If IUPIT≤0, print total concentrations for normal FETCH run. IUPIT is stepped for FETCHAVE
IV	Index used in suppressing or selecting sources or receptors for printing, in SUPR, SUPS, SELR, SELS
JIS	Counter used in clearing concentration array
JFILE	Number of coupling coef. file, in COUPLE command
JJ	Counter and source index in printing loop
JK	Index used in printing receptors at level of ten highest
JKZ	Index used in finding receptors at level of ten highest
JKLM	Counter and index in receptor loop for writing coupling coef.
JLL	Counter through all wind directions listed in WIND command
JLP	Index used in printing case heading
JSTAB	Stability class in MET command (ABC(1)); default is 4 (neutral)
K	Counter in INITIAL command
KILLR(1000)	Mask of 1's to suppress printing of corresponding receptors and of 0's to allow printing, as set by parameters in SUPR command or in SELR command
KILLS(30)	Mask of 1's to suppress printing of corresponding sources and of 0's to allow printing, as set by parameters in SUPS command or in SELS command
KSTABL(6)	Array to hold up to six stability classes entered as parameters in STAB command (for coupling coefficient runs).
LINES	Counter to maximum number of lines (50, or 52 in REED) per page of output

SYMBOL	
LISTOP(50)	Array of receptor numbers in printing of receptors at level of ten highest
LJ	Counter and index in INITIAL
LO	Index in ten top receptor section
LWIND	Counter and index in WIND command that records total number of wind directions
M	Index in suppressing receptor printout
MSS	DESC command parameter ABC(1), the number of description cards for the current case
MT	Index in VOLUME
NAME	First half (four characters) of current command name
NBE	Number of wind directions on current WIND command card
NCEPA	Main EPA HIWAY subroutine for generating concentration at given receptor from given line source (road) for particular stability class, wind speed and direction, mixing height, and emission rate
NIME	Second half (four characters) of current command name
NN	Main switch integer variable for directing program control to various command modules; set from first four characters (NAME) on command card
NRECP	Number of receptors, as determined by input or generated receptor data ($1 \leq NRECP \leq 1000$)
NSOR	Number of sources, as determined by parameter ABC(1) of NSOR command ($1 \leq NSOR \leq 30$)
NX	In automatic receptor generation command RECPAUTO, number ABC(3) of X points in receptor grid
NY	In automatic receptor generation command RECPAUTO, number ABC(5) of Y points in receptor grid
OUTPT	Subroutine that prints wind direction and speed, stability class, mixing height (or depth), and conversion factor at start of receptor printout
PP1	Percentage of total concentration at given receptor due to listed road, for left receptor column on printout

SYMBOL	
PP2	Percentage of total concentration at given receptor due to listed road, for right receptor column on printout
QL(30)	Array of source strengths (emission values in g/m-sec.), input directly as ABC(9) for each source in SOURCE command, or directly as parameters in alternate FETCH mode; computed for each source in VOLUME command
RSIDE	Angle used in adjustment for wind angle
RECP	Number of receptors in coupling coef. file, as written (and read) in old version of HIWAY
REED	Subroutine for reading and listing command cards (INIT=0), and for processing (INIT>0) NSOR, HEADER, and DESC commands
ROAD	Road center parameter in labeled COMMON: TRADE; same as CNTR in NCEPA subroutine; used in determining actual width of line sources in road
SDEG(30)	Variable carrying sign of road angle, for each source, in GO and in COUPLE modes
SIGN	Built-in function to determine sign, SIGN(a,b)=(signum a)x|b|; used in GO and COUPLE to find road angle
SIN	Built-in sine-function for argument in degrees
SOR	Number of sources in coupling coef. file, as written (and read) in this version of HIWAY
SPEED	In VOLUME command, speed of cars in current source (road); default speed is 5 mph.
SS	For each source, sine of road angle; used in projecting road to E-W and N-S components, and in finding polar coord. for receptors
STAB	Stability class for COUPLE and FETCH modes, and as used by subroutine NCEPA for computing concentrations
SUPR	Flag in SELR command: 0 to set KILLR array to all 1's, 100 not to set KILLR
SUPS	Flag in SELR command: 0 to set KILLS array to all 1's, 100 not to set KILLS
T	Concentration for given source, receptor, source emission, wind speed, and conversion factor

SYMBOL	
TCONC(1000,30)	Coupling coefficients: concentrations at each receptor from emissions at each source, with unit or nominal parameters. TCONC is also actual concentrations for given emissions, wind speed, and conversion factor in FETCH and GO modes
TCONCT(1000)	TCONCT(J) is total concentration at receptor J for all sources
TCOS(361)	TCOS is cosine of road angle for each of NSOR sources
TEMP	Variable used in computing emissions for given volumes and speeds
THETA	Angle of wind, in polar coordinates (degrees)
TOP	Sign of DX; used in getting proper sign for angle of road
TSIN(361)	TSIN is sign of road angle for each of NSOR sources
UP	Value of IUPIT used in RESULT to calculate concentration
VEL(30)	In VOLUME command, average speeds in mph for each road source
VOCAB(NN,NAME)	Subroutine that returns name of command for given command number NN
VOL(30)	In VOLUME command, (array of) average volume of traffic in thousands of cars per hour for each road source
WD	Wind direction (direction from which wind blows) in degrees east of north; input parameter ABC(3) in MET command; stored in COUPLE mode and retrieved in FETCH mode in this version of HIWAY
WDK(16)	Array of wind directions in degrees east of north, input in WIND command; used in sequence and with array of stability classes in coupling mode
WDM	Direction of wind from direction of highway
WIDM	Width of current road in km. In labeled COMMON: TRADE (WIDTH in NCEPA subroutine). SOURCE parameter ABC(7) scaled to km from ft
WS	In MET command WS is parameter ABC(2), wind speed in mph. In FETCH command WS is .447*ABC(2) and is wind speed in m/sec
WSM	In MET command, wind speed in m/sec
WSMPH	Wind speed in mph
WSS(30)	In SOURCE command, WSS is ABC(7), the width of the line source (road) in ft.; default is 0.0. WSS is equivalent to DW.

SYMBOL

XA	X-coordinate of start of road rotated to E-W orientation; in labeled COMMON: TRADE. REP1 in NCEPA subroutine
XB	X-coordinate of end of road rotated to E-W orientation; in labeled COMMON: TRADE. REP2 in NCEPA subroutine
XBASE	In RECPAUTO for automatic generation of receptors, XBASE is ABC(1) and is the X-coord. of the grid origin
XCOR	In SYMAP punched card output, X-coordinate of current B-DATA point
XR(1000)	In RECP, RECPAUTO, and ADDR commands, XR is the X-coordinate of the receptor
XRM	X-coordinate of receptor adjusted for wind angle
XTR	In SYMAP command, XTR is parameter ABC(1), the X-coordinate of the upper left hand corner of the user's grid
X1(30)	In SOURCE command, array of X-coordinates of starting points of roads, in km
X2(30)	In SOURCE command, array of X-coordinates of end points of roads, in km
X11	X-coordinate of start of current source, in ft
X21	X-coordinate of end of current source, in ft
YA	Y-coordinate of start of road rotated to E-W orientation; in labeled COMMON: TRADE. SEP1 in NCEPA subroutine
YB	Y-coordinate of end of road rotated to E-W orientation; in labeled COMMON: TRADE. SEP2 in NCEPA subroutine
YBASE	In RECPAUTO for automatic generation of receptors, YBASE is ABC(2) and is the Y-coordinate of the grid origin
YCOR	In SYMAP punched card output, Y-coordinate of current B-DATA point
YR(1000)	In RECP, RECPAUTO, and ADDR commands, YR is the Y-coordinate of the receptor
YRM	Y-coordinate of receptor adjusted for wind angle
YTR	In SYMAP command, YTR is parameter ABC(2), the Y-coordinate of the upper left hand corner of user's grid
Y1(30)	In SOURCE command, array of Y-coordinates of starting points of roads, in km

SYMBOL

Y2(30)	In SOURCE command, array of Y-coordinates of end points of roads, in km
Y11	Y-coordinate of start of current source, in ft
Y21	Y-coordinate of end of current source, in ft
Z	Receptor Z-coordinate, in ft
ZR(1000)	In RECP, RECPAUTO, and ADDR commands, ZR is the Z-coordinate of the receptor
ZRM	Z-coordinate of the receptor in ft, for use by NCEPA subroutine
Z1(30)	In SOURCE command, array of Z-coordinates of starting points of roads, in meters
Z2(30)	In SOURCE command, array of Z-coordinates of end points of roads, in meters
Z11	Z-coordinate of start of current source, in ft
Z21	Z-coordinate of end of current source, in ft

Subroutine Symbols (other than those also in MAIN)

OUTPT	Subroutine
CONV	Conversion factor: same as CONVER in MAIN program
JOUT	Output unit number; same as IOUT in MAIN program (except when punching SYMAP cards)
KODE(5)	Array of characters printed in stability class name
VOCAB	Subroutine
N	Number of command words (different kinds), currently 33
REED	Subroutine REED (NAME, NIME, ABC, INIT, INP, IOUT, ITITL, IHEAD, MSS, NSOR)
KONT	Counter and flag; set to 0 for reading and printing commands, to current count of command cards during execution of commands, and compared with total command cards INIT to terminate run
PARAM(500,12)	Array of twelve parameters for each of INIT command cards, INIT≤500

SYMBOL

KOMAND(500,2)	Two command words of four characters each for each of the INIT (INIT≤500) command cards
ATH	Subroutine
RAD	Constant 57.2958, the number of degrees in a radian
ATAN2	Arctangent function (built in)
BLOCK DATA	Used in NCEPA subroutine
GY(6)	.4, .295, .2, .13, .098
GZ(6,5)	2* .0002539, .0383, 2*2.0886, 1.2812, 2*.04936, .1393. . ., .8155
XVY(6)	.009, .013, .020, .032, .044, .044
XVZ(6)	.012, .012, .017, .027, .035, .058

Subroutine Symbols (NCEPA)

NCEPA	Subroutine
AN	Number of times summation term is evaluated and added in (in RELCO)
CLS	Concentration before conversion factor is applied
CLSS	Coupling coef: concentration of current receptor from current source. Same as TCONC (J,I)
CONT	Conversion factor
COST	Cosine of the wind direction
CURR	Current estimate of concentration integral
CUT	Flag for road cut computation
DELW	Average lane width
DQLS	Cut section source strength
ESTD	Sum of Richardson extrapolations
GS	Measure between coordinates
GY(6)	Constants for sigma Y
GZ(6,5)	Constants for sigma Z

Subroutine Symbols (NCEPA) (Contd.)

H	Effective emission height of line source, in meters
HEAD(20)	Unused heading array
HL	Height of the limiting lid (mixing height)
PP	Projection of line source
PREV	Previous estimate of concentration integral
QLS(30)	Array of source strengths (QL in MAIN)
RAT	Comparison between current and previous estimates of integral (concentration)
RC	Relative concentration in sec/m^3
REP1	X-coordinate of start of line source
REP2	X-coordinate of end of line source
SEP1	Y-coordinate of start of line source
SEP2	Y-coordinate of end of line source
SINT	Sine of the wind direction
S2	Wind direction in radians
WIDTH	Highway width in km (same as STAB in MAIN)
XKST	Stability class
XXRR	X-coord. of receptor
XXSR	Y-coord. of receptor
Y3	SIGN(Y1,Y2)

Subroutine Symbols (RELCO)

RELCO	Subroutine to calculate CHI/Q concentration values by integrating over line source
AN	Number of times summation term is evaluated and added in
A1-A7,CA-CF, C1-C9	Intermediate quantities used in calculating CHI/Q
EXP	Built-in exponential function

Subroutine Symbols (RELCO) (Contd.)

GY(6)	Constants for sigma Y
GZ(6,5)	Constants for sigma Z
HL	Height of limiting lid
IWRI	Control code for output
KST	Stability class
RC	Relative concentration in sec/m^3
SIGMA	Subroutine to calculate std. deviations in Y & Z directions
SUM	Intermediate sum in RELCO calculation
SY	Sigma Y, the standard deviation of concentration in Y direction
SZ	Sigma Z, the standard deviation of concentration in Z direction
THL	Twice the mixing height
XVY(6)	Constant array
XVZ(6)	Constant array
YD	Crosswind distance in meters

SIGMA	Subroutine
AY	Downwind distance in meters for calculating sigma Y
AZ	Downwind distance in meters for calculating sigma Z
GY(6)	Constants used in calculating sigma Y
GZ(6,5)	Constants used in calculating sigma Z
IZ	Flag for different ranges of downwind distance
KST	Stability class
SY	sigma Y, std. deviation of concentration in Y direction
SZ	sigma Z, std. deviation of concentration in Z direction
X	Downwind distance for calculating sigma Z (km)
XY	Downwind distance for calculating sigma Y (km)
Y	Distance receptor is crosswind from source (km)

Table 6.1. ANL/HIWAY Commands by Command Name

COMMAND	NN	LABEL
ADDR (ADDR)	10	3001
ADDS (ADDS)	11	3002
blank	2	800
COUP (COUPLE)	16	3008
DESC (DESC)	27	800
DSN (DSN)	30	4012
FETC (FETCH, FETCHAVE)	15	3009
FREE (FREESOUR, FREERECP)	26	4008
GO (GO)	6	906
GOAVE (GOAVE)	31	4013
HEAD (HEADER)	20	800
INIT (INITIAL)	14	3005
INPU (INPUT)	28	4010
MET (MET)	3	703
NSOR (NSOR)	4	704
OLDV (OLDV)	32	4014
OUTP (OUTPUT)	29	4011
RECP (RECP, RECPAUTO)	1	701
REST (RESTART)	7	811
RESU (RESULT)	21	4003
SELR (SELR)	24	4006
SELS (SELS)	25	4007
SOUR (SOURCE)	5	705
STAB (STAB)	17	3006
SUBR (SUBR)	12	3003
SUBS (SUBS)	13	3004
SUPR (SUPR)	22	4004
SUPS (SUPS)	23	4005
SYMA (SYMAP, SYMAPEVL)	9	3000
TERM (TERM)	8	230
VMIX (VMIX)	33	4015
VOLU (VOLUME)	19	4001
WIND (WIND)	18	3007

Table 6.2. ANL/HIWAY Commands by Switch No. NN

NN	COMMAND	LABEL
1	RECP	701
2	blank	800
3	MET	703
4	NSOR	704
5	SOUR	705
6	GO	906
7	REST	811
8	TERM	230
9	SYMA	3000
10	ADDR	3001
11	ADDS	3002
12	SUBR	3003
13	SUBS	3004
14	INIT	3005
15	FETC	3009
16	COUP	3008
17	STAB	3006
18	WIND	3007
19	VOLU	4001
20	HEAD	800
21	RESU	4003
22	SUPR	4004
23	SUPS	4005
24	SELR	4006
25	SELS	4007
26	FREE	4008
27	DESC	800
28	INPU	4010
29	OUTP	4011
30	DSN	4012
31	GOAV	4013
32	OLDV	4014
33	VMIX	4015

Table 6.3. ANL/HIWAY Commands by Label No.

LABEL	COMMAND	NN
230	TERM	8
701	RECP	1
703	MET	3
704	NSOR	4
705	SOUR	5
800	blank	2
800	HEAD	20
800	DESC	27
811	REST	7
906	GO	6
3000	SYMA	9
3001	ADDR	10
3002	ADDS	11
3003	SUBR	12
3004	SUBS	13
3005	INIT	14
3006	STAB	17
3007	WIND	18
3008	COUP	16
3009	FETC	15
4001	VOLU	19
4003	RESU	21
4004	SUPR	22
4005	SUPS	23
4006	SELR	24
4007	SELS	25
4008	FREE	26
4010	INPU	28
4011	OUTP	29
4012	DSN	30
4013	GOAV	31
4014	OLDV	32
4015	VMIX	33

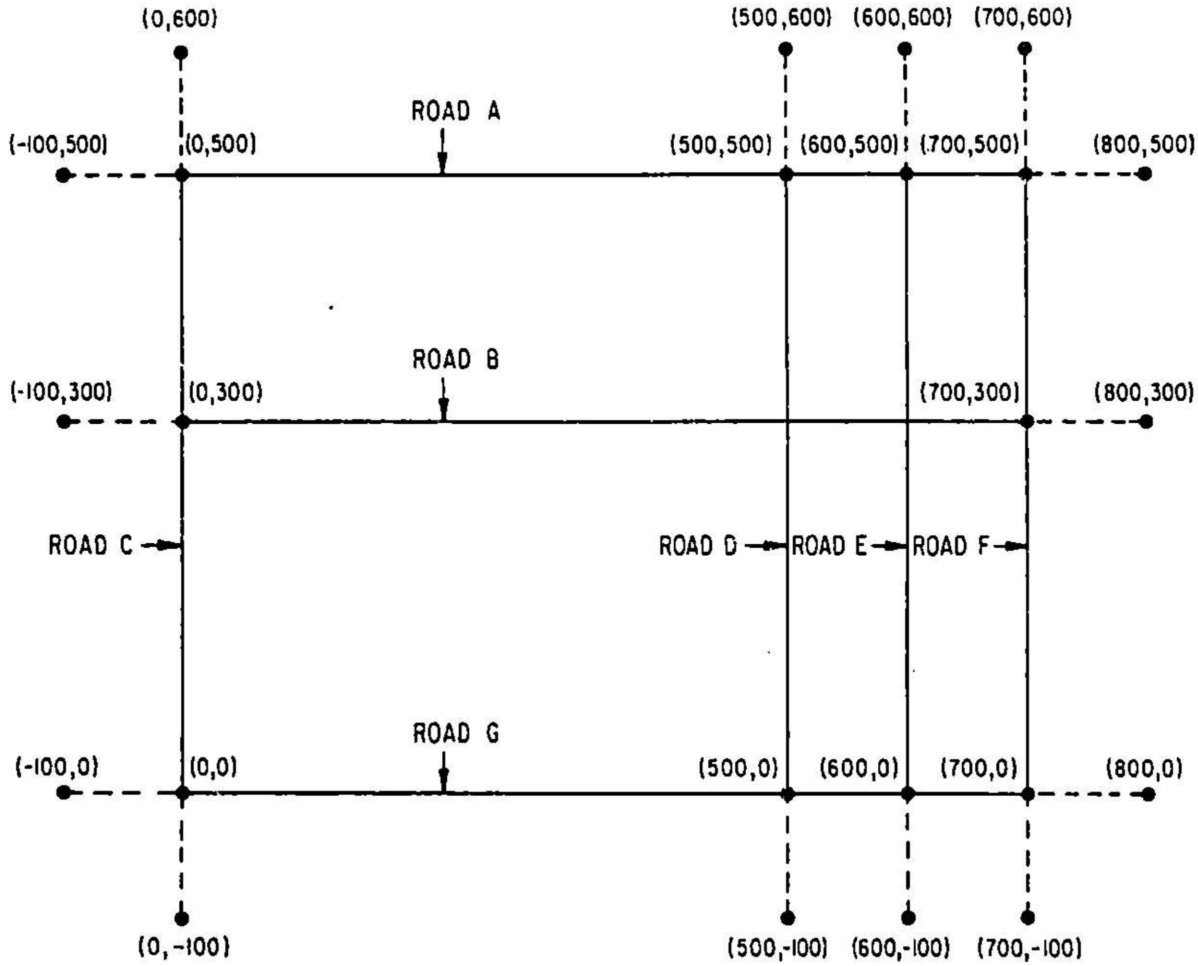
7. SAMPLE PROBLEMS

A series of simple examples should help to clarify how the data deck is structured and how to interpret the output as well as serve as a demonstration of some of the basic commands. Most of the examples use the roadway network shown in Fig. 7.1. All roads are indicated by thick black lines. Dashed lines are extensions of the roadway. It is generally a good practice to extend the roadway beyond the receptor grid in all directions. This will internalize some of the boundary conditions.

The origin of the roadway is in the lower left-hand corner of the network, and is placed there purely for convenience, as the origin may be anywhere. All roads in the system are 40 feet wide and all emissions are assumed to be 5 feet above the road. The emissions will be computed from the speed and volume data supplied. The input data cards are listed in Fig. 7.2.

The first sample problem begins with a descriptor card and the desired comments (DESC command and comments). This comprises the first four cards of the data deck. Next a uniform grid of receptor points is set up as shown in Fig. 7.3 (RECPAUTO command). This command comprises one card. The next 8 cards are used to define the roadway network. The first of these tells how many roadways are in the system. The remaining 7 give the coordinates, width, emission height, and emission rates for each road in the network (NSOR & SOURCE commands). The data cards described thus far are the so-called "constants" of the system; namely, for a given computer run these parameters will be the least likely to change.

The "variables" of the system are input next. For this example, the air quality estimates for only 6 of the 285 receptors (SELR command) and the contribution from all of the roads will be printed. The volume and speed have been set for 15 x 10^3 cars/hr/road and 5 mph, respectively (VOLUME command). In this example two one-hour periods are considered. During the first hour, the meteorological conditions are neutral stability, i.e., 4, with a 5.5 mph wind at 60° east of north and a ceiling of 3500 feet (MET command). The program is then directed to compute the first hour's results and print (GO command). At the second hour, the meteorological conditions are neutral stability with a 6.5 mph wind 30° east of north and a ceiling of 3500 feet (MET command). Again the program is directed to compute that hour's results and print (GO command). Finally the run is terminated (TERM command).



ACTUAL CO-ORDINATES OF ROADS (FEET)

ROAD	FROM	TO
A	(0,500)	(700,500)
B	(0,300)	(700,300)
C	(0,0)	(0,500)
D	(500,0)	(500,500)
E	(600,0)	(600,500)
F	(700,0)	(700,500)
G	(0,0)	(700,0)

Fig. 7.1. Sample Problem Roadway Network Without Receptor Grid

INPUT COMMANDS AND ASSOCIATED PARAMETERS

```
DESC          3.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SEVEN ROADS WITH CONSTANT VOLUME AND SPEED.  A UNIFORM GRID OF RECEPTORS
FOR THE DETERMINATION OF AIR QUALITY IS SUPERIMPOSED UPON THE NETWORK.
MULTIPLE MET CONDITIONS ARE USED IN SERIAL RUNS.
RECPAUTO -100.  -100.    19.    50.    15.    50.     0.     0.     0.     0.     0.     0.
NSOR          7.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SOURCE     -100.   500.     0.   800.   500.     0.    40.     5.     1.     0.     0.     0.
           -100.   300.     0.   800.   300.     0.    40.     5.     1.     0.     0.     0.
           -100.     0.     0.   800.     0.     0.    40.     5.     1.     0.     0.     0.
              0.     0.     0.     0.   600.     0.    40.     5.     1.     0.     0.     0.
            500.  -100.     0.   500.   600.     0.    40.     5.     1.     0.     0.     0.
            600.  -100.     0.   600.   600.     0.    40.     5.     1.     0.     0.     0.
            700.  -100.     0.   700.   600.     0.    40.     5.     1.     0.     0.     0.
HEAD          0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
        ROAD A
        ROAD B
        ROAD C
        ROAD D
        ROAD E
        ROAD F
        ROAD G
SELR         31.    33.    69.    71.    88.    90.     0.     0.     0.     0.     0.     0.
VOLUME        5.    15.     5.    15.     5.    15.     5.    15.     5.    15.     5.    15.
              5.    15.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
MET           4.     6.    60.  3500.     0.     0.     0.     0.     0.     0.     0.     0.
GO            0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
MET           4.     7.    30.  3500.     0.     0.     0.     0.     0.     0.     0.     0.
GO            0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
TERM          0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
```

Fig. 7.2. Sample GO Run With Uniform Receptor Grid -- Sample Problem No. 1

WIND DIRECTION IN DEGREES = 60.0 WIND SPEED = 5.50
STABILITY CLASS = 4 NEUTRAL
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.8800E-03

SEVEN ROADS WITH CONSTANT VOLUME AND SPEED. A UNIFORM GRID OF RECEPTORS
FOR THE DETERMINATION OF AIR QUALITY IS SUPERIMPOSED UPON THE NETWORK.
MULTIPLE MET CONDITIONS ARE USED IN SERIAL RUNS.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	5000.00	15.00
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	5000.00	15.00
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	5000.00	15.00
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	5000.00	15.00
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	5000.00	15.00
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	5000.00	15.00
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	5000.00	15.00

RECEPTOR	XR	YR	ZR (FT)	EPA Y(KM)	X(KM)	Z(KM)
31	450.00	-50.00	0.0	-0.0152	0.1372	0.0
33	550.00	-50.00	0.0	-0.0152	0.1676	0.0
69	450.00	50.00	0.0	0.0152	0.1372	0.0
71	550.00	50.00	0.0	0.0152	0.1676	0.0
88	450.00	100.00	0.0	0.0305	0.1372	0.0
90	550.00	100.00	0.0	0.0305	0.1676	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	0.0578	33	1	0.0	0.0	0.0578
31	2	0.3414E-03	0.8489E-02	0.0578	33	2	0.5358E-06	0.1142E-04	0.0578
31	3	0.4028E 00	0.1001E 02	0.0578	33	3	0.4688E 00	0.9992E 01	0.0578
31	4	0.0	0.0	0.0578	33	4	0.0	0.0	0.0578
31	5	0.2684E 00	0.6674E 01	0.0578	33	5	0.0	0.0	0.0578
31	6	0.1869E 00	0.4648E 01	0.0578	33	6	0.3131E 00	0.6674E 01	0.0578
31	7	0.1416E 00	0.3520E 01	0.0578	33	7	0.2181E 00	0.4648E 01	0.0578
TOTAL CONCENTRATION IS 0.2826E 05			0.2486E 02		TOTAL CONCENTRATION IS 0.2422E 05			0.2131E 02	
69	1	0.1188E-05	0.1844E-04	0.0578	71	1	0.0	0.0	0.0578
69	2	0.4412E-01	0.6851E 00	0.0576	71	2	0.2031E-02	0.2304E-01	0.0578
69	3	0.0	0.0	0.0578	71	3	0.0	0.0	0.0578
69	4	0.0	0.0	0.0578	71	4	0.0	0.0	0.0578
69	5	0.4299E 00	0.6675E 01	0.0578	71	5	0.0	0.0	0.0578
69	6	0.2993E 00	0.4648E 01	0.0578	71	6	0.5883E 00	0.6675E 01	0.0578
69	7	0.2267E 00	0.3520E 01	0.0578	71	7	0.4096E 00	0.4648E 01	0.0578
TOTAL CONCENTRATION IS 0.1764E 05			0.1553E 02		TOTAL CONCENTRATION IS 0.1289E 05			0.1135E 02	
88	1	0.2697E-04	0.4690E-03	0.0578	90	1	0.0	0.0	0.0578
88	2	0.1464E 00	0.2546E 01	0.0578	90	2	0.3299E-01	0.3863E 00	0.0578
88	3	0.0	0.0	0.0578	90	3	0.0	0.0	0.0578
88	4	0.0	0.0	0.0578	90	4	0.0	0.0	0.0578
88	5	0.3839E 00	0.6674E 01	0.0578	90	5	0.0	0.0	0.0578
88	6	0.2673E 00	0.4648E 01	0.0578	90	6	0.5701E 00	0.6674E 01	0.0578
88	7	0.2024E 00	0.3520E 01	0.0578	90	7	0.3970E 00	0.4648E 01	0.0578
TOTAL CONCENTRATION IS 0.1976E 05			0.1739E 02		TOTAL CONCENTRATION IS 0.1330E 05			0.1171E 02	

Fig. 7.2. (Contd.)

THE FOLLOWING 10 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

164	0.2470E 02	135	0.2325E 02	146	0.2343E 02	163	0.2356E 02	40	0.2408E 02
145	0.2554E 02	143	0.2342E 02	144	0.2395E 02	32	0.2348E 02	31	0.2486E 02

Fig. 7.2. (Contd.)

WIND DIRECTION IN DEGREES = 30.0 WIND SPEED = 6.50
STABILITY CLASS = 4 NEUTRAL
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.8800E-03

SEVEN ROADS WITH CONSTANT VOLUME AND SPEED. A UNIFORM GRID OF RECEPTORS
FOR THE DETERMINATION OF AIR QUALITY IS SUPERIMPOSED UPON THE NETWORK.
MULTIPLE MET CONDITIONS ARE USED IN SERIAL RUNS.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	5000.00	15.00
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	5000.00	15.00
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	5000.00	15.00
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	5000.00	15.00
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	5000.00	15.00
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	5000.00	15.00
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	5000.00	15.00

RECEPTOR	XR	YR	ZR (FT)	EPA Y(KM)	X(KM)	Z(KM)
31	450.00	-50.00	0.0	-0.0152	0.1372	0.0
33	550.00	-50.00	0.0	-0.0152	0.1676	0.0
69	450.00	50.00	0.0	0.0152	0.1372	0.0
71	550.00	50.00	0.0	0.0152	0.1676	0.0
88	450.00	100.00	0.0	0.0305	0.1372	0.0
90	550.00	100.00	0.0	0.0305	0.1676	0.0

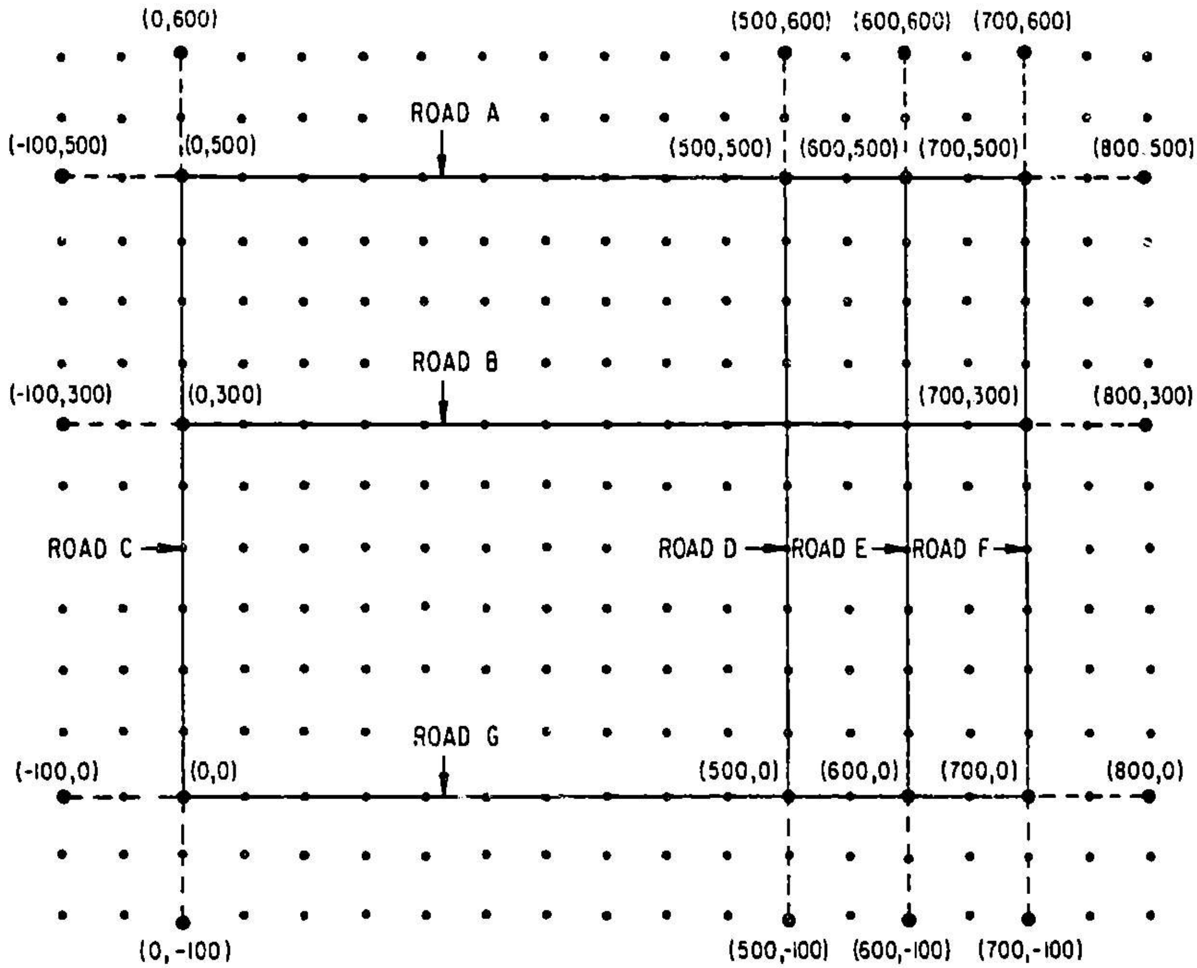
RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.4566E-01	0.1196E 01	0.0578	33	1	0.1152E-01	0.2466E 00	0.0578
31	2	0.9143E-01	0.2396E 01	0.0578	33	2	0.9382E-01	0.2009E 01	0.0578
31	3	0.2155E 00	0.5648E 01	0.0578	33	3	0.2638E 00	0.5648E 01	0.0578
31	4	0.0	0.0	0.0578	33	4	0.0	0.0	0.0578
31	5	0.3234E 00	0.8475E 01	0.0578	33	5	0.0	0.0	0.0578
31	6	0.1920E 00	0.5032E 01	0.0578	33	6	0.3958E 00	0.8475E 01	0.0578
31	7	0.1320E 00	0.3458E 01	0.0578	33	7	0.2350E 00	0.5032E 01	0.0578
TOTAL CONCENTRATION IS 0.2978E 05			0.2621E 02		TOTAL CONCENTRATION IS 0.2433E 05				0.2141E 02
69	1	0.8790E-01	0.1884E 01	0.0578	71	1	0.5006E-01	0.8673E 00	0.0578
69	2	0.1389E 00	0.2978E 01	0.0578	71	2	0.1709E 00	0.2962E 01	0.0578
69	3	0.0	0.0	0.0578	71	3	0.0	0.0	0.0578
69	4	0.0	0.0	0.0578	71	4	0.0	0.0	0.0578
69	5	0.3953E 00	0.8474E 01	0.0578	71	5	0.0	0.0	0.0578
69	6	0.2343E 00	0.5022E 01	0.0578	71	6	0.4891E 00	0.8474E 01	0.0578
69	7	0.1436E 00	0.3078E 01	0.0578	71	7	0.2899E 00	0.5022E 01	0.0578
TOTAL CONCENTRATION IS 0.2436E 05			0.2144E 02		TOTAL CONCENTRATION IS 0.1969E 05				0.1733E 02
88	1	0.9938E-01	0.2154E 01	0.0578	90	1	0.7696E-01	0.1406E 01	0.0578
88	2	0.1563E 00	0.3389E 01	0.0578	90	2	0.1855E 00	0.3389E 01	0.0578
88	3	0.0	0.0	0.0578	90	3	0.0	0.0	0.0578
88	4	0.0	0.0	0.0578	90	4	0.0	0.0	0.0578
88	5	0.3909E 00	0.8474E 01	0.0578	90	5	0.0	0.0	0.0578
88	6	0.2307E 00	0.5002E 01	0.0578	90	6	0.4638E 00	0.8474E 01	0.0578
88	7	0.1226E 00	0.2659E 01	0.0578	90	7	0.2738E 00	0.5002E 01	0.0578
TOTAL CONCENTRATION IS 0.2463E 05			0.2168E 02		TOTAL CONCENTRATION IS 0.2076E 05				0.1827E 02

Fig. 7.2. (Contd.)

THE FOLLOWING 10 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

13	0.2373E 02	31	0.2621E 02	50	0.2438E 02	108	0.2240E 02	127	0.2286E 02
32	0.2535E 02	12	0.2451E 02	30	0.2277E 02	51	0.2371E 02	146	0.2324E 02

Fig. 7.2 (Contd.)



ACTUAL CO-ORDINATES OF ROADS (FEET)

ROAD	FROM	TO
A	(0,500)	(700,500)
B	(0,300)	(700,300)
C	(0,0)	(0,500)
D	(500,0)	(500,500)
E	(600,0)	(600,500)
F	(700,0)	(700,500)
G	(0,0)	(700,0)

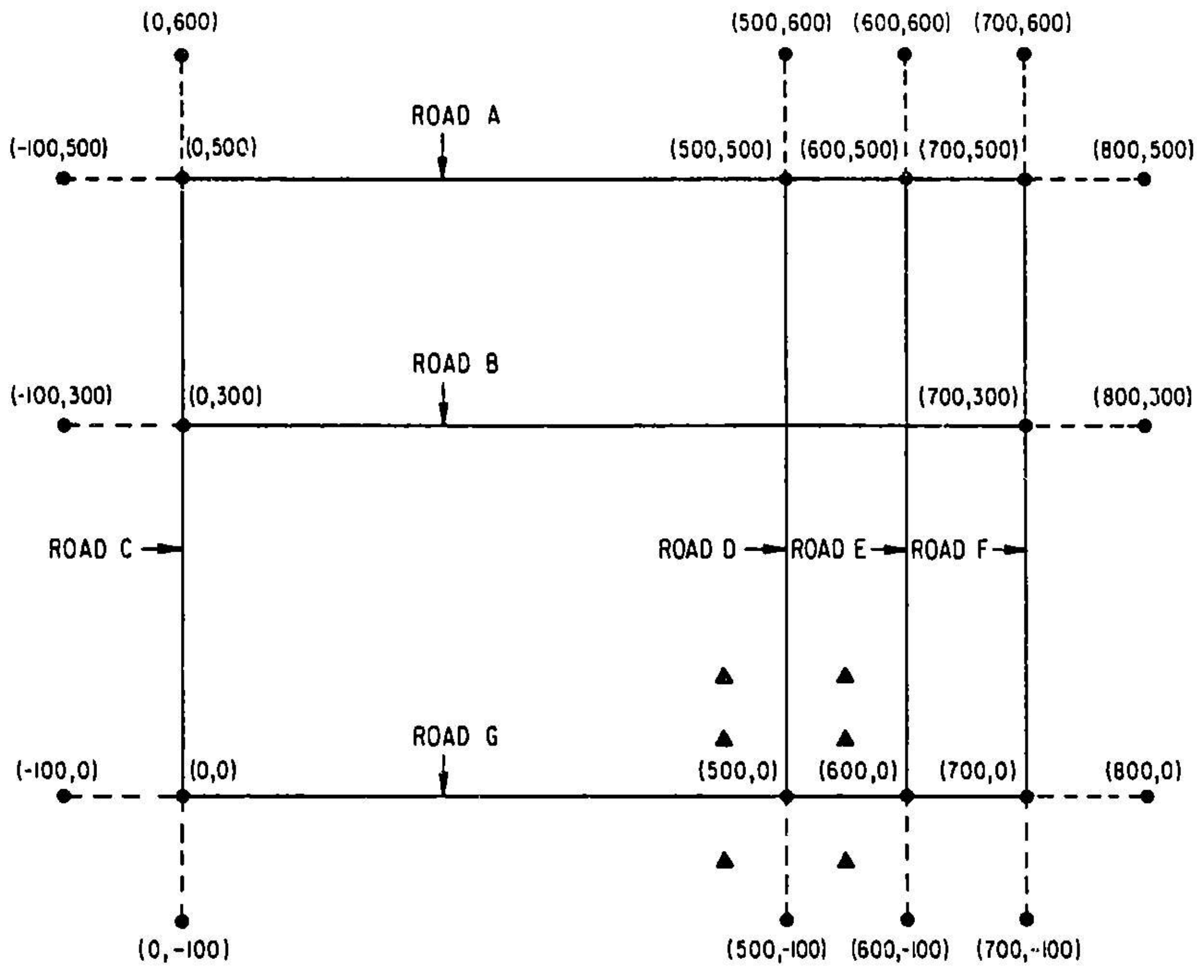
Fig. 7.3. Sample Problem Roadway Network with Uniform Receptor Grid

The printout provides output for each hour separately as shown in Fig. 7.2. Only the first hour is discussed since the same type of output appears for all subsequent hours. All meteorological conditions are printed at the top of the page. The conversion factor used to convert $\mu g/m^3$ to ppm follows the met conditions. A listing of the roads follows along with a listing of the receptors. Note both the roads and receptors have been numbered. It is this number which will be used when referencing the contribution of air quality concentrations from each source to each receptor. The individual contribution of each road to the air quality at a given receptor is expressed in two forms: % of total and ppm. The column labeled EMIS is the speed correction factor used to adjust the emission level for that roadway. Finally all receptors with pollution concentration greater than or equal to the 10 highest estimated concentrations are listed, with the concentration at each of the receptors provided in ppm.

Since the reader has been led through the details of one printout, only the variations in the input data deck and their effect upon the output are discussed in the following examples.

For the second sample problem there are two essential changes in the input deck. First the automatic receptor command that creates a uniform grid, is exchanged for a manual receptor command. Here the actual co-ordinates of the desired receptor locations are specified. These are the only receptors known to the system (See Fig. 7.4). The small triangles in Fig. 7.4 indicate their position relative to the roadway system. Since no other receptors exist, the SELR command card can be removed. For this problem the receptors were chosen and computation begins. The resultant printout, Fig. 7.5, reflects these changes.

So far the examples have been using the simplest of the three modes, the "GO" mode. This mode should be used for one-shot runs or when the number of receptors and sources are small (i.e., receptors $\leq$ 20). For small runs the computation costs for the GO mode are reasonable. However, for larger problems, costs can be minimized by using the COUPLE and FETCH modes. The COUPLE mode is used to generate coupling coefficients and the printed output produces little useful information. Its real function is to store the basic receptor-to-source geometry for future use, thereby minimizing the computations for repeated runs of different hourly parameters.



ACTUAL CO-ORDINATES OF ROADS (FEET)

ROAD	FROM	TO
A	(0,500)	(700,500)
B	(0,300)	(700,300)
C	(0,0)	(0,500)
D	(500,0)	(500,500)
E	(600,0)	(600,500)
F	(700,0)	(700,500)
G	(0,0)	(700,0)

Fig. 7.4. Sample Problem Roadway Network with Special Receptors

INPUT COMMANDS AND ASSOCIATED PARAMETERS

```
DESC          3.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SEVEN ROADS WITH CONSTANT VOLUME AND SPEED.  SPECIFIC RECEPTORS ARE
SUPERIMPOSED UPON THE NETWORK FOR AIR QUALITY DETERMINATION.  MULTIPLE MET
CONDITIONS ARE USED IN SERIAL RUNS.
RECP        450.   -50.     0.   550.   -50.     0.   450.    50.     0.   550.    50.     0.
            450.   100.     0.   550.   110.     0.     0.     0.     0.     0.     0.     0.
NSOR          7.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SOURCE     -100.   500.     0.   800.   500.     0.    40.     5.     1.     0.     0.     0.
           -100.   300.     0.   800.   300.     0.    40.     5.     1.     0.     0.     0.
           -100.     0.     0.   800.     0.     0.    40.     5.     1.     0.     0.     0.
              0.     0.     0.     0.   600.     0.    40.     5.     1.     0.     0.     0.
            500.  -100.     0.   500.   600.     0.    40.     5.     1.     0.     0.     0.
            600.  -100.     0.   600.   600.     0.    40.     5.     1.     0.     0.     0.
            700.  -100.     0.   700.   600.     0.    40.     5.     1.     0.     0.     0.
HEAD          0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
          ROAD A
          ROAD B
          ROAD C
          ROAD D
          ROAD E
          ROAD F
          ROAD G
VOLUME        5.    15.     5.    15.     5.    15.     5.    15.     5.    15.     5.    15.
              5.    15.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
MET           4.     6.    60.  3500.     0.     0.     0.     0.     0.     0.     0.     0.
GO            0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
MET           4.     7.    30.  3500.     0.     0.     0.     0.     0.     0.     0.     0.
GO            0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
TERM          0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
```

Fig. 7.5. Sample CO Run With Special Receptors -- Sample Problem No. 2

WIND DIRECTION IN DEGREES = 60.0 WIND SPEED = 5.50
STABILITY CLASS = 4 NEUTRAL
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.8800E-03

SEVEN ROADS WITH CONSTANT VOLUME AND SPEED. SPECIFIC RECEPTORS ARE SUPERIMPOSED UPON THE NETWORK FOR AIR QUALITY DETERMINATION. MULTIPLE MET CONDITIONS ARE USED IN SERIAL RUNS.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	5000.00	15.00
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	5000.00	15.00
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	5000.00	15.00
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	5000.00	15.00
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	5000.00	15.00
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	5000.00	15.00
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	5000.00	15.00

RECEPTOR	XR	YR	ZR (FT)	EPA Y(KM)	X(KM)	Z(KM)
1	450.00	-50.00	0.0	-0.0152	0.1372	0.0
2	550.00	-50.00	0.0	-0.0152	0.1676	0.0
3	450.00	50.00	0.0	0.0152	0.1372	0.0
4	550.00	50.00	0.0	0.0152	0.1676	0.0
5	450.00	100.00	0.0	0.0305	0.1372	0.0
6	550.00	110.00	0.0	0.0335	0.1676	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
1	1	0.0	0.0	0.0578	2	1	0.0	0.0	0.0578
1	2	0.3414E-03	0.8489E-02	0.0578	2	2	0.5358E-06	0.1142E-04	0.0578
1	3	0.4028E 00	0.1001E 02	0.0578	2	3	0.4688E 00	0.9992E 01	0.0578
1	4	0.0	0.0	0.0578	2	4	0.0	0.0	0.0578
1	5	0.2684E 00	0.6674E 01	0.0578	2	5	0.0	0.0	0.0578
1	6	0.1869E 00	0.4648E 01	0.0578	2	6	0.3131E 00	0.6674E 01	0.0578
1	7	0.1416E 00	0.3520E 01	0.0578	2	7	0.2181E 00	0.4648E 01	0.0578
TOTAL CONCENTRATION IS 0.2826E 05			0.2486E 02		TOTAL CONCENTRATION IS 0.2422E 05				0.2131E 02
3	1	0.1108E-05	0.1844E-04	0.0578	4	1	0.0	0.0	0.0578
3	2	0.4412E-01	0.6851E 00	0.0578	4	2	0.2031E-02	0.2304E-01	0.0578
3	3	0.0	0.0	0.0578	4	3	0.0	0.0	0.0578
3	4	0.0	0.0	0.0578	4	4	0.0	0.0	0.0578
3	5	0.4299E 00	0.6675E 01	0.0578	4	5	0.0	0.0	0.0578
3	6	0.2993E 00	0.4648E 01	0.0578	4	6	0.5883E 00	0.6675E 01	0.0578
3	7	0.2267E 00	0.3520E 01	0.0578	4	7	0.4096E 00	0.4648E 01	0.0578
TOTAL CONCENTRATION IS 0.1764E 05			0.1553E 02		TOTAL CONCENTRATION IS 0.1289E 05				0.1135E 02

Fig. 7.5 (Contd.)

RECP	ROAD	% OF TOTAL	PPM	EMIS
5	1	0.2697E-04	0.4690E-03	0.0578
5	2	0.1464E 00	0.2546E 01	0.0578
5	3	0.0	0.0	0.0578
5	4	0.0	0.0	0.0578
5	5	0.3839E 00	0.6674E 01	0.0578
5	6	0.2673E 00	0.4648E 01	0.0578
5	7	0.2024E 00	0.3520E 01	0.0578

TOTAL CONCENTRATION IS 0.1976E 05 0.1739E 02

RECP	ROAD	% OF TOTAL	PPM	EMIS
6	1	0.0	0.0	0.0578
6	2	0.5124E-01	0.6114E 00	0.0578
6	3	0.0	0.0	0.0578
6	4	0.0	0.0	0.0578
6	5	0.0	0.0	0.0578
6	6	0.5593E 00	0.6674E 01	0.0578
6	7	0.3894E 00	0.4647E 01	0.0578

TOTAL CONCENTRATION IS 0.1356E 05 0.1193E 02

RECP	ROAD	% OF TOTAL	PPM	EMIS
7	1	0.3913E-01	0.8440E 00	0.0578
7	2	0.1683E 00	0.3632E 01	0.0578
7	3	0.3388E 00	0.7309E 01	0.0578
7	4	0.1828E 00	0.3943E 01	0.0578
7	5	0.1025E 00	0.2212E 01	0.0578
7	6	0.8957E-01	0.1932E 01	0.0578
7	7	0.7880E-01	0.1700E 01	0.0578

TOTAL CONCENTRATION IS 0.2451E 05 0.2157E 02

RECP	ROAD	% OF TOTAL	PPM	EMIS
8	1	0.3913E-01	0.8440E 00	0.0578
8	2	0.1683E 00	0.3632E 01	0.0578
8	3	0.3388E 00	0.7309E 01	0.0578
8	4	0.1828E 00	0.3943E 01	0.0578
8	5	0.1025E 00	0.2212E 01	0.0578
8	6	0.8957E-01	0.1932E 01	0.0578
8	7	0.7880E-01	0.1700E 01	0.0578

TOTAL CONCENTRATION IS 0.2451E 05 0.2157E 02

THE FOLLOWING 11 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

1	0.2486E 02	2	0.2131E 02	7	0.2157E 02	8	0.2157E 02	5	0.1739E 02
5	0.1739E 02	7	0.2157E 02	8	0.2157E 02	1	0.2486E 02	2	0.2131E 02
8	0.2157E 02								

Fig. 7.5. (Contd.)

WIND DIRECTION IN DEGREES = 30.0 WIND SPEED = 6.50
STABILITY CLASS = 4 NEUTRAL
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.8800E-03

SEVEN ROADS WITH CONSTANT VOLUME AND SPEED. SPECIFIC RECEPTORS ARE SUPERIMPOSED UPON THE NETWORK FOR AIR QUALITY DETERMINATION. MULTIPLE MET CONDITIONS ARE USED IN SERIAL RUNS.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	5000.00	15.00
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	5000.00	15.00
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	5000.00	15.00
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	5000.00	15.00
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	5000.00	15.00
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	5000.00	15.00
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	5000.00	15.00

RECEPTOR	XR	YR	ZR (FT)	EPA Y (KM)	X (KM)	Z (KM)
1	450.00	-50.00	0.0	-0.0152	0.1372	0.0
2	550.00	-50.00	0.0	-0.0152	0.1676	0.0
3	450.00	50.00	0.0	0.0152	0.1372	0.0
4	550.00	50.00	0.0	0.0152	0.1676	0.0
5	450.00	100.00	0.0	0.0305	0.1372	0.0
6	550.00	110.00	0.0	0.0335	0.1676	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
1	1	0.4566E-01	0.1196E 01	0.0578	2	1	0.1152E-01	0.2466E 00	0.0578
1	2	0.9143E-01	0.2396E 01	0.0578	2	2	0.9382E-01	0.2009E 01	0.0578
1	3	0.2155E 00	0.5648E 01	0.0578	2	3	0.2638E 00	0.5648E 01	0.0578
1	4	0.0	0.0	0.0578	2	4	0.0	0.0	0.0578
1	5	0.3234E 00	0.8475E 01	0.0578	2	5	0.0	0.0	0.0578
1	6	0.1920E 00	0.5032E 01	0.0578	2	6	0.3958E 00	0.8475E 01	0.0578
1	7	0.1320E 00	0.3458E 01	0.0578	2	7	0.2350E 00	0.5032E 01	0.0578
TOTAL CONCENTRATION IS 0.2978E 05			0.2621E 02		TOTAL CONCENTRATION IS 0.2433E 05				0.2141E 02
3	1	0.8790E-01	0.1884E 01	0.0578	4	1	0.5006E-01	0.8673E 00	0.0578
3	2	0.1389E 00	0.2978E 01	0.0578	4	2	0.1709E 00	0.2962E 01	0.0578
3	3	0.0	0.0	0.0578	4	3	0.0	0.0	0.0578
3	4	0.0	0.0	0.0578	4	4	0.0	0.0	0.0578
3	5	0.3953E 00	0.8474E 01	0.0578	4	5	0.0	0.0	0.0578
3	6	0.2343E 00	0.5022E 01	0.0578	4	6	0.4891E 00	0.8474E 01	0.0578
3	7	0.1436E 00	0.3078E 01	0.0578	4	7	0.2899E 00	0.5022E 01	0.0578
TOTAL CONCENTRATION IS 0.2436E 05			0.2144E 02		TOTAL CONCENTRATION IS 0.1969E 05				0.1733E 02

Fig. 7.5. (Contd.)

RECP	ROAD	% OF TOTAL	PPM	EMIS
5	1	0.9938E-01	0.2154E 01	0.0578
5	2	0.1563E 00	0.3389E 01	0.0578
5	3	0.0	0.0	0.0578
5	4	0.0	0.0	0.0578
5	5	0.3909E 00	0.8474E 01	0.0578
5	6	0.2307E 00	0.5002E 01	0.0578
5	7	0.1226E 00	0.2659E 01	0.0578

TOTAL CONCENTRATION IS 0.2463E 05 0.2168E 02

RECP	ROAD	% OF TOTAL	PPM	EMIS
6	1	0.8256E-01	0.1526E 01	0.0578
6	2	0.1886E 00	0.3486E 01	0.0578
6	3	0.0	0.0	0.0578
6	4	0.0	0.0	0.0578
6	5	0.0	0.0	0.0578
6	6	0.4586E 00	0.8474E 01	0.0578
6	7	0.2703E 00	0.4995E 01	0.0578

TOTAL CONCENTRATION IS 0.2100E 05 0.1848E 02

RECP	ROAD	% OF TOTAL	PPM	EMIS
7	1	0.1344E 00	0.1872E 01	0.0578
7	2	0.1783E 00	0.2483E 01	0.0578
7	3	0.2396E 00	0.3337E 01	0.0578
7	4	0.4442E 00	0.6185E 01	0.0578
7	5	0.3357E-02	0.4674E-01	0.0578
7	6	0.1036E-03	0.1443E-02	0.0578
7	7	0.1539E-05	0.2143E-04	0.0578

TOTAL CONCENTRATION IS 0.1582E 05 0.1392E 02

RECP	ROAD	% OF TOTAL	PPM	EMIS
8	1	0.1344E 00	0.1872E 01	0.0578
8	2	0.1783E 00	0.2483E 01	0.0578
8	3	0.2396E 00	0.3337E 01	0.0578
8	4	0.4442E 00	0.6185E 01	0.0578
8	5	0.3357E-02	0.4674E-01	0.0578
8	6	0.1036E-03	0.1443E-02	0.0578
8	7	0.1539E-05	0.2143E-04	0.0578

TOTAL CONCENTRATION IS 0.1582E 05 0.1392E 02

THE FOLLOWING 10 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

1	0.2621E 02	2	0.2141E 02	3	0.2144E 02	5	0.2168E 02	5	0.2168E 02
6	0.1848E 02	3	0.2144E 02	6	0.1848E 02	1	0.2621E 02	2	0.2141E 02

Fig. 7.5. (Contd.)

As in the other sample problems the input for this are (see Fig. 7.6): descriptor cards, receptor cards, source cards, header cards, and a selected receptor print card. The next three cards set this mode apart from the others. The stability card states that two stabilities will be used, neutral and slightly stable. The wind card defines the different wind angles to be used. All angles are measured clockwise from north. The couple card defines the mixing depth and begins the computation of the coupling coefficients. For each stability class, all values of wind angles are used in succession. The following table shows the order of computation and storage.

FILE #	STABILITY CLASS	WIND ANGLE
0	4	60°
1	4	90°
2	4	133°
3	5	60°
4	5	90°
5	5	133°

Each file represents a one-hour period during which the met conditions prevailed. No absolute information about air quality can be ascertained from the output. However, relative concentrations for unit wind speeds and emissions can be determined. The absolute concentrations can be derived from the relative concentrations by multiplying them by an emission rate and conversion factor and dividing by a wind speed. This is the method used in the FETCH mode.

The fourth sample problem incorporates the FETCH mode (see Fig. 7.7). The usual preliminary data is supplied through the select receptor card. Each road in the network is assigned a volume and speed or emission rate. Then the desired coupling coefficient file is fetched. In the example a command to fetch file 3 using a 5-mph wind and a .00088 conversion factor is made. File 3 already has a stability class of 5 and a wind direction 60°, which are the met conditions desired in the example. A printout for each fetch command issued will result. Just as in the "GO" mode each printout is for a one-hour period.

```
                INPUT COMMANDS AND ASSOCIATED PARAMETERS

DESC         3.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED.  COUPLING COEFFICIENTS
ARE CREATED AND STORED.  THREE WIND ANGLES AND TWO STABILITY CLASSES
WILL BE USED.
RECPAUTO -100. -100.    19.    50.    15.    50.     0.     0.     0.     0.     0.     0.
NSOR         7.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SOURCE   -100.   500.     0.   800.   500.     0.    40.     5.     1.     0.     0.     0.
         -100.   300.     0.   800.   300.     0.    40.     5.     1.     0.     0.     0.
         -100.     0.     0.   800.     0.     0.    40.     5.     1.     0.     0.     0.
            0.     0.     0.     0.   600.     0.    40.     5.     1.     0.     0.     0.
          500.  -100.     0.   500.   600.     0.    40.     5.     1.     0.     0.     0.
          600.  -100.     0.   600.   600.     0.    40.     5.     1.     0.     0.     0.
          700.  -100.     0.   700.   600.     0.    40.     5.     1.     0.     0.     0.
HEAD         0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
        ROAD A
        ROAD B
        ROAD C
        ROAD D
        ROAD E
        ROAD F
        ROAD G
SELR        31.    33.    69.    71.    88.    90.     0.     0.     0.     0.     0.     0.
STAB         4.     5.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
WIND         3.    60.    90.   133.     0.     0.     0.     0.     0.     0.     0.     0.
COUPLE    3500.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
TERM         0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
```

Fig. 7.6. Sample COUPLE Run -- Sample Problem No. 3

WIND DIRECTION IN DEGREES = 60.0 WIND SPEED = 2.24
STABILITY CLASS = 4 NEUTRAL
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.1000E 01

COUPLING COEFFICIENT FILE 0

SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED. COUPLING COEFFICIENTS ARE CREATED AND STORED. THREE WIND ANGLES AND TWO STABILITY CLASSES WILL BE USED.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	0.0	0.0
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	0.0	0.0
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	0.0	0.0
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	0.0	0.0
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	0.0	0.0
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	0.0	0.0
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	0.0	0.0

RECEPTOR	XR	YR	ZR (FT)	EPA Y(KM)	X(KM)	Z(KM)
31	450.00	-50.00	0.0	-0.0152	0.1372	0.0
33	550.00	-50.00	0.0	-0.0152	0.1676	0.0
69	450.00	50.00	0.0	0.0152	0.1372	0.0
71	550.00	50.00	0.0	0.0152	0.1676	0.0
88	450.00	100.00	0.0	0.0305	0.1372	0.0
90	550.00	100.00	0.0	0.0305	0.1676	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	1.0000	33	1	0.0	0.0	1.0000
31	2	0.3414E-03	0.4102E 03	1.0000	33	2	0.5358E-06	0.5519E 00	1.0000
31	3	0.4028E 00	0.4839E 06	1.0000	33	3	0.4688E 00	0.4828E 06	1.0000
31	4	0.0	0.0	1.0000	33	4	0.0	0.0	1.0000
31	5	0.2684E 00	0.3225E 06	1.0000	33	5	0.0	0.0	1.0000
31	6	0.1869E 00	0.2246E 06	1.0000	33	6	0.3131E 00	0.3225E 06	1.0000
31	7	0.1416E 00	0.1701E 06	1.0000	33	7	0.2181E 00	0.2246E 06	1.0000
TOTAL CONCENTRATION IS 0.1202E 07			0.1202E 07		TOTAL CONCENTRATION IS 0.1030E 07				0.1030E 07
69	1	0.1188E-05	0.8912E 00	1.0000	71	1	0.0	0.0	1.0000
69	2	0.4412E-01	0.3311E 05	1.0000	71	2	0.2031E-02	0.1114E 04	1.0000
69	3	0.0	0.0	1.0000	71	3	0.0	0.0	1.0000
69	4	0.0	0.0	1.0000	71	4	0.0	0.0	1.0000
69	5	0.4299E 00	0.3225E 06	1.0000	71	5	0.0	0.0	1.0000
69	6	0.2993E 00	0.2246E 06	1.0000	71	6	0.5883E 00	0.3225E 06	1.0000
69	7	0.2267E 00	0.1701E 06	1.0000	71	7	0.4096E 00	0.2246E 06	1.0000
TOTAL CONCENTRATION IS 0.7503E 06			0.7503E 06		TOTAL CONCENTRATION IS 0.5482E 06				0.5482E 06
88	1	0.2697E-04	0.2266E 02	1.0000	90	1	0.0	0.0	1.0000
88	2	0.1464E 00	0.1230E 06	1.0000	90	2	0.3299E-01	0.1867E 05	1.0000
88	3	0.0	0.0	1.0000	90	3	0.0	0.0	1.0000
88	4	0.0	0.0	1.0000	90	4	0.0	0.0	1.0000
88	5	0.3838E 00	0.3225E 06	1.0000	90	5	0.0	0.0	1.0000
88	6	0.2673E 00	0.2246E 06	1.0000	90	6	0.5701E 00	0.3225E 06	1.0000
88	7	0.2024E 00	0.1701E 06	1.0000	90	7	0.3970E 00	0.2246E 06	1.0000
TOTAL CONCENTRATION IS 0.8402E 06			0.8402E 06		TOTAL CONCENTRATION IS 0.5658E 06				0.5658E 06

Fig. 7.6 (Contd.)

WIND DIRECTION IN DEGREES = 90.0 WIND SPEED = 2.24
STABILITY CLASS = 4 NEUTRAL
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.1000E 01

COUPLING COEFFICIENT FILE 1

SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED. COUPLING COEFFICIENTS ARE CREATED AND STORED. THREE WIND ANGLES AND TWO STABILITY CLASSES WILL BE USED.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	0.0	0.0
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	0.0	0.0
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	0.0	0.0
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	0.0	0.0
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	0.0	0.0
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	0.0	0.0
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	0.0	0.0

RECEPTOR	XR	YR	ZR (FT)	EPA	Y (KM)	X (KM)	Z (KM)
31	450.00	-50.00	0.0		-0.0152	0.1372	0.0
33	550.00	-50.00	0.0		-0.0152	0.1676	0.0
69	450.00	50.00	0.0		0.0152	0.1372	0.0
71	550.00	50.00	0.0		0.0152	0.1676	0.0
88	450.00	100.00	0.0		0.0305	0.1372	0.0
90	550.00	100.00	0.0		0.0305	0.1676	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	1.0000	33	1	0.0	0.0	1.0000
31	2	0.0	0.0	1.0000	33	2	0.0	0.0	1.0000
31	3	0.1427E 00	0.1074E 06	1.0000	33	3	0.9684E-01	0.5277E 05	1.0000
31	4	0.0	0.0	1.0000	33	4	0.0	0.0	1.0000
31	5	0.3806E 00	0.2865E 06	1.0000	33	5	0.0	0.0	1.0000
31	6	0.2731E 00	0.2056E 06	1.0000	33	6	0.5258E 00	0.2865E 06	1.0000
31	7	0.2036E 00	0.1533E 06	1.0000	33	7	0.3773E 00	0.2056E 06	1.0000
TOTAL CONCENTRATION IS 0.7528E 06				0.7528E 06	TOTAL CONCENTRATION IS 0.5449E 06				0.5449E 06
69	1	0.0	0.0	1.0000	71	1	0.0	0.0	1.0000
69	2	0.0	0.0	1.0000	71	2	0.0	0.0	1.0000
69	3	0.1409E 00	0.1074E 06	1.0000	71	3	0.9643E-01	0.5277E 05	1.0000
69	4	0.0	0.0	1.0000	71	4	0.0	0.0	1.0000
69	5	0.3760E 00	0.2866E 06	1.0000	71	5	0.0	0.0	1.0000
69	6	0.2727E 00	0.2078E 06	1.0000	71	6	0.5237E 00	0.2866E 06	1.0000
69	7	0.2104E 00	0.1603E 06	1.0000	71	7	0.3798E 00	0.2078E 06	1.0000
TOTAL CONCENTRATION IS 0.7621E 06				0.7621E 06	TOTAL CONCENTRATION IS 0.5472E 06				0.5472E 06
88	1	0.0	0.0	1.0000	90	1	0.0	0.0	1.0000
88	2	0.0	0.0	1.0000	90	2	0.0	0.0	1.0000
88	3	0.3132E-02	0.2057E 04	1.0000	90	3	0.4029E-03	0.1993E 03	1.0000
88	4	0.0	0.0	1.0000	90	4	0.0	0.0	1.0000
88	5	0.4363E 00	0.2866E 06	1.0000	90	5	0.0	0.0	1.0000
88	6	0.3164E 00	0.2078E 06	1.0000	90	6	0.5794E 00	0.2866E 06	1.0000
88	7	0.2441E 00	0.1603E 06	1.0000	90	7	0.4202E 00	0.2078E 06	1.0000
TOTAL CONCENTRATION IS 0.6568E 06				0.6568E 06	TOTAL CONCENTRATION IS 0.4946E 06				0.4946E 06

Fig. 7.6. (Contd.)

```
WIND DIRECTION IN DEGREES =  133.0          WIND SPEED  =        2.24
STABILITY CLASS =     4      NEUTRAL
MIXING DEPTH IN FEET =     3500.00
CONVERSION FACTOR =   0.1000E 01

COUPLING COEFFICIENT FILE      2

                  SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED.  COUPLING COEFFICIENTS
                  ARE CREATED AND STORED.  THREE WIND ANGLES AND TWO STABILITY CLASSES
                  WILL BE USED.
```

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	0.0	0.0
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	0.0	0.0
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	0.0	0.0
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	0.0	0.0
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	0.0	0.0
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	0.0	0.0
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	0.0	0.0

RECEPTOR	XR	YR	ZR (FT)	EPA Y(KM)	X(KM)	Z(KM)
31	450.00	-50.00	0.0	-0.0152	0.1372	0.0
33	550.00	-50.00	0.0	-0.0152	0.1676	0.0
69	450.00	50.00	0.0	0.0152	0.1372	0.0
71	550.00	50.00	0.0	0.0152	0.1676	0.0
88	450.00	100.00	0.0	0.0305	0.1372	0.0
90	550.00	100.00	0.0	0.0305	0.1676	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	1.0000	33	1	0.0	0.0	1.0000
31	2	0.0	0.0	1.0000	33	2	0.0	0.0	1.0000
31	3	0.0	0.0	1.0000	33	3	0.0	0.0	1.0000
31	4	0.0	0.0	1.0000	33	4	0.0	0.0	1.0000
31	5	0.9989E 00	0.2036E 06	1.0000	33	5	0.0	0.0	1.0000
31	6	0.1148E-02	0.2340E 03	1.0000	33	6	0.9989E 00	0.2036E 06	1.0000
31	7	0.0	0.0	1.0000	33	7	0.1148E-02	0.2340E 03	1.0000
TOTAL CONCENTRATION IS 0.2039E 06				0.2039E 06	TOTAL CONCENTRATION IS 0.2039E 06				0.2039E 06
69	1	0.0	0.0	1.0000	71	1	0.0	0.0	1.0000
69	2	0.0	0.0	1.0000	71	2	0.0	0.0	1.0000
69	3	0.4268E 00	0.3885E 06	1.0000	71	3	0.4292E 00	0.3885E 06	1.0000
69	4	0.0	0.0	1.0000	71	4	0.0	0.0	1.0000
69	5	0.4047E 00	0.3683E 06	1.0000	71	5	0.0	0.0	1.0000
69	6	0.1629E 00	0.1483E 06	1.0000	71	6	0.4069E 00	0.3683E 06	1.0000
69	7	0.5574E-02	0.5074E 04	1.0000	71	7	0.1638E 00	0.1483E 06	1.0000
TOTAL CONCENTRATION IS 0.9102E 06				0.9102E 06	TOTAL CONCENTRATION IS 0.9051E 06				0.9051E 06
88	1	0.0	0.0	1.0000	90	1	0.0	0.0	1.0000
88	2	0.0	0.0	1.0000	90	2	0.0	0.0	1.0000
88	3	0.3246E 00	0.3075E 06	1.0000	90	3	0.3400E 00	0.3074E 06	1.0000
88	4	0.0	0.0	1.0000	90	4	0.0	0.0	1.0000
88	5	0.3888E 00	0.3684E 06	1.0000	90	5	0.0	0.0	1.0000
88	6	0.2409E 00	0.2282E 06	1.0000	90	6	0.4075E 00	0.3684E 06	1.0000
88	7	0.4573E-01	0.4333E 05	1.0000	90	7	0.2525E 00	0.2282E 06	1.0000
TOTAL CONCENTRATION IS 0.9474E 06				0.9474E 06	TOTAL CONCENTRATION IS 0.9040E 06				0.9040E 06

Fig. 7.6 (Contd.)

WIND DIRECTION IN DEGREES = 60.0 WIND SPEED = 2.24
STABILITY CLASS = 5 SLIGHTLY STABLE
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.1000E 01

COUPLING COEFFICIENT FILE 3

SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED. COUPLING COEFFICIENTS ARE CREATED AND STORED. THREE WIND ANGLES AND TWO STABILITY CLASSES WILL BE USED.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	0.0	0.0
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	0.0	0.0
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	0.0	0.0
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	0.0	0.0
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	0.0	0.0
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	0.0	0.0
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	0.0	0.0

RECEPTOR	XR	YR	ZR (FT)	EPA Y(KM)	X(KM)	Z(KM)
31	450.00	-50.00	0.0	-0.0152	0.1372	0.0
33	550.00	-50.00	0.0	-0.0152	0.1676	0.0
69	450.00	50.00	0.0	0.0152	0.1372	0.0
71	550.00	50.00	0.0	0.0152	0.1676	0.0
88	450.00	100.00	0.0	0.0305	0.1372	0.0
90	550.00	100.00	0.0	0.0305	0.1676	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	1.0000	33	1	0.0	0.0	1.0000
31	2	0.3652E-04	0.4893E 02	1.0000	33	2	0.0	0.0	1.0000
31	3	0.3972E 00	0.5323E 06	1.0000	33	3	0.4701E 00	0.5321E 06	1.0000
31	4	0.0	0.0	1.0000	33	4	0.0	0.0	1.0000
31	5	0.2532E 00	0.3392E 06	1.0000	33	5	0.0	0.0	1.0000
31	6	0.1944E 00	0.2605E 06	1.0000	33	6	0.2997E 00	0.3392E 06	1.0000
31	7	0.1552E 00	0.2079E 06	1.0000	33	7	0.2301E 00	0.2605E 06	1.0000
TOTAL CONCENTRATION IS 0.1340E 07			0.1340E 07		TOTAL CONCENTRATION IS 0.1132E 07				0.1132E 07
69	1	0.0	0.0	1.0000	71	1	0.0	0.0	1.0000
69	2	0.3482E-01	0.2879E 05	1.0000	71	2	0.3818E-03	0.2291E 03	1.0000
69	3	0.0	0.0	1.0000	71	3	0.0	0.0	1.0000
69	4	0.0	0.0	1.0000	71	4	0.0	0.0	1.0000
69	5	0.4102E 00	0.3393E 06	1.0000	71	5	0.0	0.0	1.0000
69	6	0.3150E 00	0.2605E 06	1.0000	71	6	0.5655E 00	0.3393E 06	1.0000
69	7	0.2400E 00	0.1984E 06	1.0000	71	7	0.4341E 00	0.2605E 06	1.0000
TOTAL CONCENTRATION IS 0.8269E 06			0.8269E 06		TOTAL CONCENTRATION IS 0.5999E 06				0.5999E 06
88	1	0.6233E-06	0.6006E 00	1.0000	90	1	0.0	0.0	1.0000
88	2	0.1619E 00	0.1560E 06	1.0000	90	2	0.2028E-01	0.1241E 05	1.0000
88	3	0.0	0.0	1.0000	90	3	0.0	0.0	1.0000
88	4	0.0	0.0	1.0000	90	4	0.0	0.0	1.0000
88	5	0.3520E 00	0.3393E 06	1.0000	90	5	0.0	0.0	1.0000
88	6	0.2703E 00	0.2605E 06	1.0000	90	6	0.5542E 00	0.3393E 06	1.0000
88	7	0.2158E 00	0.2079E 06	1.0000	90	7	0.4255E 00	0.2605E 06	1.0000
TOTAL CONCENTRATION IS 0.9637E 06			0.9637E 06		TOTAL CONCENTRATION IS 0.6121E 06				0.6121E 06

Fig. 7.6. (Contd.)

WIND DIRECTION IN DEGREES = 90.0 WIND SPEED = 2.24
STABILITY CLASS = 5 SLIGHTLY STABLE
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.1000E 01

COUPLING COEFFICIENT FILE 4

SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED. COUPLING COEFFICIENTS ARE CREATED AND STORED. THREE WIND ANGLES AND TWO STABILITY CLASSES WILL BE USED.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	0.0	0.0
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	0.0	0.0
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	0.0	0.0
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	0.0	0.0
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	0.0	0.0
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	0.0	0.0
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	0.0	0.0

RECEPTOR	XR	YR	ZR (FT)	EPA	Y(KM)	X(KM)	Z(KM)
31	450.00	-50.00	0.0		-0.0152	0.1372	0.0
33	550.00	-50.00	0.0		-0.0152	0.1676	0.0
69	450.00	50.00	0.0		0.0152	0.1372	0.0
71	550.00	50.00	0.0		0.0152	0.1676	0.0
88	450.00	100.00	0.0		0.0305	0.1372	0.0
90	550.00	100.00	0.0		0.0305	0.1676	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	1.0000	33	1	0.0	0.0	1.0000
31	2	0.0	0.0	1.0000	33	2	0.0	0.0	1.0000
31	3	0.9725E-01	0.7806E 05	1.0000	33	3	0.5593E-01	0.3171E 05	1.0000
31	4	0.0	0.0	1.0000	33	4	0.0	0.0	1.0000
31	5	0.3721E 00	0.2987E 06	1.0000	33	5	0.0	0.0	1.0000
31	6	0.2947E 00	0.2366E 06	1.0000	33	6	0.5268E 00	0.2987E 06	1.0000
31	7	0.2359E 00	0.1893E 06	1.0000	33	7	0.4172E 00	0.2366E 06	1.0000
TOTAL CONCENTRATION IS 0.8027E 06				0.8027E 06	TOTAL CONCENTRATION IS 0.5670E 06				0.5670E 06
69	1	0.0	0.0	1.0000	71	1	0.0	0.0	1.0000
69	2	0.0	0.0	1.0000	71	2	0.0	0.0	1.0000
69	3	0.9668E-01	0.7806E 05	1.0000	71	3	0.5584E-01	0.3171E 05	1.0000
69	4	0.0	0.0	1.0000	71	4	0.0	0.0	1.0000
69	5	0.3700E 00	0.2987E 06	1.0000	71	5	0.0	0.0	1.0000
69	6	0.2941E 00	0.2375E 06	1.0000	71	6	0.5260E 00	0.2987E 06	1.0000
69	7	0.2392E 00	0.1932E 06	1.0000	71	7	0.4181E 00	0.2375E 06	1.0000
TOTAL CONCENTRATION IS 0.8074E 06				0.8074E 06	TOTAL CONCENTRATION IS 0.5679E 06				0.5679E 06
88	1	0.0	0.0	1.0000	90	1	0.0	0.0	1.0000
88	2	0.0	0.0	1.0000	90	2	0.0	0.0	1.0000
88	3	0.4714E-03	0.3440E 03	1.0000	90	3	0.2968E-04	0.1591E 02	1.0000
88	4	0.0	0.0	1.0000	90	4	0.0	0.0	1.0000
88	5	0.4094E 00	0.2987E 06	1.0000	90	5	0.0	0.0	1.0000
88	6	0.3254E 00	0.2375E 06	1.0000	90	6	0.5571E 00	0.2987E 06	1.0000
88	7	0.2647E 00	0.1932E 06	1.0000	90	7	0.4428E 00	0.2375E 06	1.0000
TOTAL CONCENTRATION IS 0.7297E 06				0.7297E 06	TOTAL CONCENTRATION IS 0.5362E 06				0.5362E 06

Fig. 7.6 (Contd.)

WIND DIRECTION IN DEGREES = 133.0 WIND SPEED = 2.24
STABILITY CLASS = 5 SLIGHTLY STABLE
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.1000E 01

COUPLING COEFFICIENT FILE 5

SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED. COUPLING COEFFICIENTS ARE CREATED AND STORED. THREE WIND ANGLES AND TWO STABILITY CLASSES WILL BE USED.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	0.0	0.0
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	0.0	0.0
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	0.0	0.0
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	0.0	0.0
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	0.0	0.0
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	0.0	0.0
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	0.0	0.0

RECEPTOR	XR	YR	ZR (FT)	EPA Y(KM)	X(KM)	Z(KM)
31	450.00	-50.00	0.0	-0.0152	0.1372	0.0
33	550.00	-50.00	0.0	-0.0152	0.1676	0.0
69	450.00	50.00	0.0	0.0152	0.1372	0.0
71	550.00	50.00	0.0	0.0152	0.1676	0.0
88	450.00	100.00	0.0	0.0305	0.1372	0.0
90	550.00	100.00	0.0	0.0305	0.1676	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	1.0000	33	1	0.0	0.0	1.0000
31	2	0.0	0.0	1.0000	33	2	0.0	0.0	1.0000
31	3	0.0	0.0	1.0000	33	3	0.0	0.0	1.0000
31	4	0.0	0.0	1.0000	33	4	0.0	0.0	1.0000
31	5	0.9998E 00	0.2195E 06	1.0000	33	5	0.0	0.0	1.0000
31	6	0.2050E-03	0.4501E 02	1.0000	33	6	0.9998E 00	0.2195E 06	1.0000
31	7	0.0	0.0	1.0000	33	7	0.2050E-03	0.4501E 02	1.0000
TOTAL CONCENTRATION IS 0.2196E 06			0.2196E 06		TOTAL CONCENTRATION IS 0.2196E 06				0.2196E 06
69	1	0.0	0.0	1.0000	71	1	0.0	0.0	1.0000
69	2	0.0	0.0	1.0000	71	2	0.0	0.0	1.0000
69	3	0.4196E 00	0.4157E 06	1.0000	71	3	0.4205E 00	0.4158E 06	1.0000
69	4	0.0	0.0	1.0000	71	4	0.0	0.0	1.0000
69	5	0.3958E 00	0.3922E 06	1.0000	71	5	0.0	0.0	1.0000
69	6	0.1824E 00	0.1807E 06	1.0000	71	6	0.3967E 00	0.3922E 06	1.0000
69	7	0.2281E-02	0.2260E 04	1.0000	71	7	0.1828E 00	0.1807E 06	1.0000
TOTAL CONCENTRATION IS 0.9909E 06			0.9909E 06		TOTAL CONCENTRATION IS 0.9886E 06				0.9886E 06
88	1	0.0	0.0	1.0000	90	1	0.0	0.0	1.0000
88	2	0.0	0.0	1.0000	90	2	0.0	0.0	1.0000
88	3	0.3294E 00	0.3507E 06	1.0000	90	3	0.3434E 00	0.3506E 06	1.0000
88	4	0.0	0.0	1.0000	90	4	0.0	0.0	1.0000
88	5	0.3684E 00	0.3922E 06	1.0000	90	5	0.0	0.0	1.0000
88	6	0.2615E 00	0.2784E 06	1.0000	90	6	0.3840E 00	0.3922E 06	1.0000
88	7	0.4070E-01	0.4333E 05	1.0000	90	7	0.2726E 00	0.2784E 06	1.0000
TOTAL CONCENTRATION IS 0.1065E 07			0.1065E 07		TOTAL CONCENTRATION IS 0.1021E 07				0.1021E 07

Fig. 7.6 (Contd.)

THE FOLLOWING 10 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

257	0.1351E 07	277	0.1334E 07	240	0.1413E 07	260	0.1394E 07	259	0.1542E 07
258	0.1428E 07	278	0.1403E 07	183	0.1383E 07	268	0.1383E 07	249	0.1433E 07

Fig. 7.6 (Contd.)

INPUT COMMANDS AND ASSOCIATED PARAMETERS

```
DESC         2.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED.  ONE HOUR AVERAGES VIA.
THE FETCH WILL BE USED.
RECPAUTO -100.  -100.    19.    50.    15.    50.     0.     0.     0.     0.     0.     0.
NSOR         7.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SOURCE    -100.   500.     0.   800.   500.     0.    40.     5.     1.     0.     0.     0.
          -100.   300.     0.   800.   300.     0.    40.     5.     1.     0.     0.     0.
          -100.     0.     0.   800.     0.     0.    40.     5.     1.     0.     0.     0.
             0.     0.     0.     0.   600.     0.    40.     5.     1.     0.     0.     0.
           500.  -100.     0.   500.   600.     0.    40.     5.     1.     0.     0.     0.
           600.  -100.     0.   600.   600.     0.    40.     5.     1.     0.     0.     0.
           700.  -100.     0.   700.   600.     0.    40.     5.     1.     0.     0.     0.
HEAD         0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
        ROAD A
        ROAD B
        ROAD C
        ROAD D
        ROAD E
        ROAD F
        ROAD G
SELR        31.    33.    69.    71.    88.    90.     0.     0.     0.     0.     0.     0.
VOLUME       5.    15.     5.    15.     5.    15.     5.    15.     5.    15.     5.    15.
             5.    15.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
FETCH        3.     5.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
VOLUME      10.    15.    10.    15.    10.    15.     5.    15.     5.    15.     5.    15.
             5.    15.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
FETCH        0.     4.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
VOLUME       5.    15.     5.    15.     5.    15.    10.    15.    10.    15.    10.    15.
            10.    15.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
FETCH        5.     6.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
TERM         0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
```

Fig. 7.7. Sample FETCH Run -- Sample Problem No. 4

SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED. ONE HOUR AVERAGES VIA.
THE FETCH WILL BE USED.

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	0.0578	33	1	0.0	0.0	0.0578
31	2	0.3652E-04	0.1114E-02	0.0578	33	2	0.0	0.0	0.0578
31	3	0.3973E 00	0.1212E 02	0.0578	33	3	0.4701E 00	0.1211E 02	0.0578
31	4	0.0	0.0	0.0578	33	4	0.0	0.0	0.0578
31	5	0.2531E 00	0.7721E 01	0.0578	33	5	0.0	0.0	0.0578
31	6	0.1944E 00	0.5930E 01	0.0578	33	6	0.2997E 00	0.7721E 01	0.0578
31	7	0.1552E 00	0.4733E 01	0.0578	33	7	0.2302E 00	0.5930E 01	0.0578
TOTAL CONCENTRATION IS 0.3466E 05			0.3050E 02		TOTAL CONCENTRATION IS 0.2928E 05				0.2576E 02
69	1	0.0	0.0	0.0578	71	1	0.0	0.0	0.0578
69	2	0.3481E-01	0.6554E 00	0.0578	71	2	0.3818E-03	0.5215E-02	0.0578
69	3	0.0	0.0	0.0578	71	3	0.0	0.0	0.0578
69	4	0.0	0.0	0.0578	71	4	0.0	0.0	0.0578
69	5	0.4103E 00	0.7724E 01	0.0578	71	5	0.0	0.0	0.0578
69	6	0.3150E 00	0.5930E 01	0.0578	71	6	0.5655E 00	0.7724E 01	0.0578
69	7	0.2399E 00	0.4516E 01	0.0578	71	7	0.4341E 00	0.5930E 01	0.0578
TOTAL CONCENTRATION IS 0.2139E 05			0.1883E 02		TOTAL CONCENTRATION IS 0.1552E 05				0.1366E 02
88	1	0.6232E-06	0.1367E-04	0.0578	90	1	0.0	0.0	0.0578
88	2	0.1619E 00	0.3551E 01	0.0578	90	2	0.2027E-01	0.2825E 00	0.0578
88	3	0.0	0.0	0.0578	90	3	0.0	0.0	0.0578
88	4	0.0	0.0	0.0578	90	4	0.0	0.0	0.0578
88	5	0.3521E 00	0.7724E 01	0.0578	90	5	0.0	0.0	0.0578
88	6	0.2703E 00	0.5930E 01	0.0578	90	6	0.5542E 00	0.7724E 01	0.0578
88	7	0.2157E 00	0.4733E 01	0.0578	90	7	0.4255E 00	0.5930E 01	0.0578
TOTAL CONCENTRATION IS 0.2493E 05			0.2194E 02		TOTAL CONCENTRATION IS 0.1584E 05				0.1394E 02

THE FOLLOWING 10 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

20	0.2951E 02	40	0.3047E 02	142	0.3007E 02	144	0.3037E 02	145	0.3116E 02
164	0.2977E 02	143	0.3023E 02	31	0.3050E 02	39	0.2980E 02	141	0.2956E 02

Fig. 7.7. (Contd.)

SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED. ONE HOUR AVERAGES VIA.
THE FETCH WILL BE USED.

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	0.1156	33	1	0.0	0.0	0.1156
31	2	0.4866E-03	0.2334E-01	0.1156	33	2	0.7297E-06	0.3141E-04	0.1156
31	3	0.5741E 00	0.2754E 02	0.1156	33	3	0.6383E 00	0.2748E 02	0.1156
31	4	0.0	0.0	0.0578	33	4	0.0	0.0	0.0578
31	5	0.1913E 00	0.9177E 01	0.0578	33	5	0.0	0.0	0.0578
31	6	0.1332E 00	0.6391E 01	0.0578	33	6	0.2132E 00	0.9177E 01	0.0578
31	7	0.1009E 00	0.4840E 01	0.0578	33	7	0.1485E 00	0.6391E 01	0.0578
TOTAL CONCENTRATION IS 0.5451E 05			0.4797E 02		TOTAL CONCENTRATION IS 0.4891E 05				0.4304E 02
69	1	0.2275E-05	0.5072E-04	0.1156	71	1	0.0	0.0	0.1156
69	2	0.8453E-01	0.1884E 01	0.1156	71	2	0.4056E-02	0.6340E-01	0.1156
69	3	0.0	0.0	0.1156	71	3	0.0	0.0	0.1156
69	4	0.0	0.0	0.0578	71	4	0.0	0.0	0.0578
69	5	0.4117E 00	0.9177E 01	0.0578	71	5	0.0	0.0	0.0578
69	6	0.2867E 00	0.6391E 01	0.0578	71	6	0.5871E 00	0.9177E 01	0.0578
69	7	0.2171E 00	0.4840E 01	0.0578	71	7	0.4089E 00	0.6391E 01	0.0578
TOTAL CONCENTRATION IS 0.2533E 05			0.2229E 02		TOTAL CONCENTRATION IS 0.1776E 05				0.1563E 02
88	1	0.4705E-04	0.1290E-02	0.1156	90	1	0.0	0.0	0.1156
88	2	0.2554E 00	0.7000E 01	0.1156	90	2	0.6389E-01	0.1062E 01	0.1156
88	3	0.0	0.0	0.1156	90	3	0.0	0.0	0.1156
88	4	0.0	0.0	0.0578	90	4	0.0	0.0	0.0578
88	5	0.3348E 00	0.9177E 01	0.0578	90	5	0.0	0.0	0.0578
88	6	0.2332E 00	0.6391E 01	0.0578	90	6	0.5518E 00	0.9177E 01	0.0578
88	7	0.1766E 00	0.4840E 01	0.0578	90	7	0.3843E 00	0.6391E 01	0.0578
TOTAL CONCENTRATION IS 0.3115E 05			0.2741E 02		TOTAL CONCENTRATION IS 0.1890E 05				0.1663E 02

THE FOLLOWING 10 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

40	0.4981E 02	145	0.4983E 02	143	0.4929E 02	136	0.4907E 02	141	0.4934E 02
20	0.5080E 02	142	0.4951E 02	144	0.4879E 02	39	0.4885E 02	135	0.5157E 02

Fig. 7.7. (Contd.)

SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED. ONE HOUR AVERAGES VIA.
THE FETCH WILL BE USED.

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	0.0578	33	1	0.0	0.0	0.0578
31	2	0.0	0.0	0.0578	33	2	0.0	0.0	0.0578
31	3	0.0	0.0	0.0578	33	3	0.0	0.0	0.0578
31	4	0.0	0.0	0.1156	33	4	0.0	0.0	0.1156
31	5	0.9998E 00	0.8328E 01	0.1156	33	5	0.0	0.0	0.1156
31	6	0.2050E-03	0.1708E-02	0.1156	33	6	0.9998E 00	0.8328E 01	0.1156
31	7	0.0	0.0	0.1156	33	7	0.2050E-03	0.1708E-02	0.1156
TOTAL CONCENTRATION IS C.9465E 04			0.8329E 01		TOTAL CONCENTRATION IS 0.9465E 04				0.8329E 01
69	1	0.0	0.0	0.0578	71	1	0.0	0.0	0.0578
69	2	0.0	0.0	0.0578	71	2	0.0	0.0	0.0578
69	3	0.2655E 00	0.7886E 01	0.0578	71	3	0.2663E 00	0.7888E 01	0.0578
69	4	0.0	0.0	0.1156	71	4	0.0	0.0	0.1156
69	5	0.5009E 00	0.1488E 02	0.1156	71	5	0.0	0.0	0.1156
69	6	0.2308F 00	0.6856E 01	0.1156	71	6	0.5023E 00	0.1488E 02	0.1156
69	7	0.2886E-02	0.8574E-01	0.1156	71	7	0.2314E 00	0.6856E 01	0.1156
TOTAL CONCENTRATION IS 0.3376E 05			0.2971E 02		TOTAL CONCENTRATION IS 0.3366E 05				0.2962E 02
88	1	0.0	0.0	0.0578	90	1	0.0	0.0	0.0578
88	2	0.0	0.0	0.0578	90	2	0.0	0.0	0.0578
88	3	0.1972E 00	0.6653E 01	0.0578	90	3	0.2072E 00	0.6651E 01	0.0578
88	4	0.0	0.0	0.1156	90	4	0.0	0.0	0.1156
88	5	0.4410E 00	0.1488E 02	0.1156	90	5	0.0	0.0	0.1156
88	6	0.3131E 00	0.1056E 02	0.1156	90	6	0.4636E 00	0.1488E 02	0.1156
88	7	0.4872E-01	0.1644E 01	0.1156	90	7	0.3291E 00	0.1056E 02	0.1156
TOTAL CONCENTRATION IS 0.3834E 05			0,3374E 02		TOTAL CONCENTRATION IS 0.3647E 05				0.3209E 02

THE FOLLOWING 10 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

277	0.4031E 02	278	0.4378E 02	259	0.4645E 02	260	0.4171E 02	241	0.4039E 02
258	0.4189E 02	164	C.4181E 02	240	0.4399E 02	202	0.4130E 02	183	0.4341E 02

Fig. 7.7. (Contd.)

Thus far examples of all existing modes in ANL/HIWAY have been given. However, each of these examples computed only concentrations on an hourly basis. If the user desires to average concentrations for several hours, a slight modification to the mode command and one additional command are required. The modifications for doing N-hour averaging are as follows: Replace GO by GOAVE or the FETCH by FETCHAVE. Examples 5 and 6 show these changes (see Figs. 7.8 & 7.9). The additional command is the RESULT command. It is placed after the input for the last hour to be included in the average.

To demonstrate the use of ANL/HIWAY for estimating carbon monoxide levels at an intersection, the sample problem presented in Guidelines for Air Quality Maintenance Planning and Analysis, Volume 9: Evaluating Indirect Sources EPA-450/4-75-001, January 1975 (OAQPS No. 1.2-028) was run on ANL/HIWAY. The intersection's shown in Fig. 7.10 and the parameters of the problem in Table 7.1. Table 7.2 shows a comparison of the ANL/HIWAY results and the results reported by the EPA on page H-42 of the Indirect Source Guidelines. Keep in mind that only one ANL/HIWAY run was needed to provide these results.

INPUT COMMANDS AND ASSOCIATED PARAMETERS

```
DESC          3.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SEVEN ROADS WITH CONSTANT VOLUME AND SPEED.  A UNIFORM GRID OF RECEPTORS
FOR THE DETERMINATION OF AIR QUALITY IS SUPERIMPOSED UPON THE NETWORK.
MULTIPLE MET CONDITIONS ARE USED IN SERIAL RUNS.
RECPAUTO -100.  -100.    19.    50.    15.    50.     0.     0.     0.     0.     0.     0.
NSOR          7.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SOURCE     -100.   500.     0.   800.   500.     0.    40.     5.     1.     0.     0.     0.
           -100.   300.     0.   800.   300.     0.    40.     5.     1.     0.     0.     0.
           -100.     0.     0.   800.     0.     0.    40.     5.     1.     0.     0.     0.
              0.     0.     0.     0.   600.     0.    40.     5.     1.     0.     0.     0.
            500.  -100.     0.   500.   600.     0.    40.     5.     1.     0.     0.     0.
            600.  -100.     0.   600.   600.     0.    40.     5.     1.     0.     0.     0.
            700.  -100.     0.   700.   600.     0.    40.     5.     1.     0.     0.     0.
HEAD          0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
          ROAD A
          ROAD B
          ROAD C
          ROAD D
          ROAD E
          ROAD F
          ROAD G
SELR         31.    33.    69.    71.    88.    90.     0.     0.     0.     0.     0.     0.
VOLUME        5.    15.     5.    15.     5.    15.     5.    15.     5.    15.     5.    15.
              5.    15.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
MET           4.     6.    60.  3500.     0.     0.     0.     0.     0.     0.     0.     0.
GOAVE         0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
MET           4.     7.    30.  3500.     0.     0.     0.     0.     0.     0.     0.     0.
GOAVE         0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
MET           4.     6.    45.  3500.     0.     0.     0.     0.     0.     0.     0.     0.
GOAVE         0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
RESULTS       0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
TERM          0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
```

Fig. 7.8. Sample COAVE Run -- Sample Problem No. 5

WIND DIRECTION IN DEGREES = 45.0 WIND SPEED = 6.00
STABILTY CLASS = 4 NEUTRAL
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.8800E-03

SEVEN ROADS WITH CONSTANT VOLUME AND SPEED. A UNIFORM GRID OF RECEPTORS FOR THE DETERMINATION OF AIR QUALITY IS SUPERIMPOSED UPON THE NETWORK. MULTIPLE MET CONDITIONS ARE USED IN SERIAL RUNS.

ROAD	X1	Y1	Z1	X2	Y2	Z2	WIDTH	EMIS HT.	(ALL IN FEET)	VOLUME	SPEED
1	-100.00	500.00	0.0	800.00	500.00	0.0	40.00	5.00	ROAD A	5000.00	15.00
2	-100.00	300.00	0.0	800.00	300.00	0.0	40.00	5.00	ROAD B	5000.00	15.00
3	-100.00	0.0	0.0	800.00	0.0	0.0	40.00	5.00	ROAD C	5000.00	15.00
4	0.0	0.0	0.0	0.0	600.00	0.0	40.00	5.00	ROAD D	5000.00	15.00
5	500.00	-100.00	0.0	500.00	600.00	0.0	40.00	5.00	ROAD E	5000.00	15.00
6	600.00	-100.00	0.0	600.00	600.00	0.0	40.00	5.00	ROAD F	5000.00	15.00
7	700.00	-100.00	0.0	700.00	600.00	0.0	40.00	5.00	ROAD G	5000.00	15.00

RECEPTOR	XR	YR	ZR (FT)	EPA Y (KM)	X (KM)	Z (KM)
31	450.00	-50.00	0.0	-0.0152	0.1372	0.0
33	550.00	-50.00	0.0	-0.0152	0.1676	0.0
69	450.00	50.00	0.0	0.0152	0.1372	0.0
71	550.00	50.00	0.0	0.0152	0.1676	0.0
88	450.00	100.00	0.0	0.0305	0.1372	0.0
90	550.00	100.00	0.0	0.0305	0.1676	0.0

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.1613E-01	0.4031E 00	1.0000	33	1	0.3984E-02	0.8221E-01	1.0000
31	2	0.5049E-01	0.1262E 01	1.0000	33	2	0.3450E-01	0.7118E 00	1.0000
31	3	0.3045E 00	0.7611E 01	1.0000	33	3	0.3685E 00	0.7603E 01	1.0000
31	4	0.0	0.0	1.0000	33	4	0.0	0.0	1.0000
31	5	0.2976E 00	0.7440E 01	1.0000	33	5	0.0	0.0	1.0000
31	6	0.1918E 00	0.4795E 01	1.0000	33	6	0.3606E 00	0.7440E 01	1.0000
31	7	0.1395E 00	0.3486E 01	1.0000	33	7	0.2324E 00	0.4795E 01	1.0000
TOTAL CONCENTRATION IS 0.2841E 05			0.2500E 02		TOTAL CONCENTRATION IS 0.2345E 05			0.2063E 02	
69	1	0.3733E-01	0.6948E 00	1.0000	71	1	0.2058E-01	0.2901E 00	1.0000
69	2	0.1250E 00	0.2327E 01	1.0000	71	2	0.1116E 00	0.1573E 01	1.0000
69	3	0.0	0.0	1.0000	71	3	0.0	0.0	1.0000
69	4	0.0	0.0	1.0000	71	4	0.0	0.0	1.0000
69	5	0.3997E 00	0.7440E 01	1.0000	71	5	0.0	0.0	1.0000
69	6	0.2575E 00	0.4792E 01	1.0000	71	6	0.5278E 00	0.7440E 01	1.0000
69	7	0.1805E 00	0.3359E 01	1.0000	71	7	0.3400E 00	0.4792E 01	1.0000
TOTAL CONCENTRATION IS 0.2115E 05			0.1861E 02		TOTAL CONCENTRATION IS 0.1602E 05			0.1409E 02	
88	1	0.4663E-01	0.9171E 00	1.0000	90	1	0.3154E-01	0.4759E 00	1.0000
88	2	0.1681E 00	0.3306E 01	1.0000	90	2	0.1582E 00	0.2388E 01	1.0000
88	3	0.0	0.0	1.0000	90	3	0.0	0.0	1.0000
88	4	0.0	0.0	1.0000	90	4	0.0	0.0	1.0000
88	5	0.3783E 00	0.7440E 01	1.0000	90	5	0.0	0.0	1.0000
88	6	0.2433E 00	0.4786E 01	1.0000	90	6	0.4931E 00	0.7440E 01	1.0000
88	7	0.1637E 00	0.3219E 01	1.0000	90	7	0.3172E 00	0.4786E 01	1.0000
TOTAL CONCENTRATION IS 0.2235E 05			0.1967E 02		TOTAL CONCENTRATION IS 0.1715E 05			0.1509E 02	

Fig. 7.8. (Contd.)

WIND DIRECTION IN DEGREES = 60.0 WIND SPEED = 5.50
STABILITY CLASS = 4 NEUTRAL
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.8800E-03

WIND DIRECTION IN DEGREES = 30.0 WIND SPEED = 6.50
STABILITY CLASS = 4 NEUTRAL
MIXING DEPTH IN FEET = 3500.00
CONVERSION FACTOR = 0.8800E-03

THE FOLLOWING 10 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

146	0.2364E 02	145	0.2444E 02	30	0.2255E 02	127	0.2170E 02	164	0.2229E 02
32	0.2362E 02	12	0.2274E 02	31	0.2500E 02	50	0.2300E 02	126	0.2250E 02

Fig. 7.8. (Contd.)

INPUT COMMANDS AND ASSOCIATED PARAMETERS

```
DESC         2.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED.  ONE HOUR AVERAGES VIA.
THE FETCH WILL BE USED.
RECPAUTO  -100.  -100.    19.    50.    15.    50.     0.     0.     0.     0.     0.     0.
NSOR         7.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
SOURCE    -100.   500.     0.   800.   500.     0.    40.     5.     1.     0.     0.     0.
          -100.   300.     0.   800.   300.     0.    40.     5.     1.     0.     0.     0.
          -100.     0.     0.   800.     0.     0.    40.     5.     1.     0.     0.     0.
             0.     0.     0.     0.   600.     0.    40.     5.     1.     0.     0.     0.
           500.  -100.     0.   500.   600.     0.    40.     5.     1.     0.     0.     0.
           600.  -100.     0.   600.   600.     0.    40.     5.     1.     0.     0.     0.
           700.  -100.     0.   700.   600.     0.    40.     5.     1.     0.     0.     0.
HEAD         0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
        ROAD A
        ROAD B
        ROAD C
        ROAD D
        ROAD E
        ROAD F
        ROAD G
SELR        31.    33.    69.    71.    88.    90.     0.     0.     0.     0.     0.     0.
VOLUME       5.    15.     5.    15.     5.    15.     5.    15.     5.    15.     5.    15.
             5.    15.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
FETCHAVE     3.     5.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
VOLUME      10.    15.    10.    15.    10.    15.     5.    15.     5.    15.     5.    15.
             5.    15.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
FETCHAVE     0.     4.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
VOLUME       5.    15.     5.    15.     5.    15.    10.    15.    10.    15.    10.    15.
            10.    15.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
FETCHAVE     5.     6.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
RESULTS      0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
TERM         0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.     0.
```

Fig. 7.9. Sample FETCHAVE Run -- Sample Problem No. 6

SEVEN ROADS WITH AVERAGE VOLUME AND AVERAGE SPEED. ONE HOUR AVERAGES VIA.
THE FETCH WILL BE USED.

RECP	ROAD	% OF TOTAL	PPM	EMIS	RECP	ROAD	% OF TOTAL	PPM	EMIS
31	1	0.0	0.0	1.0000	33	1	0.0	0.0	1.0000
31	2	0.2818E-03	0.8153E-02	1.0000	33	2	0.4072E-06	0.1047E-04	1.0000
31	3	0.4569E 00	0.1322E 02	1.0000	33	3	0.5132E 00	0.1320E 02	1.0000
31	4	0.0	0.0	1.0000	33	4	0.0	0.0	1.0000
31	5	0.2906E 00	0.8409E 01	1.0000	33	5	0.0	0.0	1.0000
31	6	0.1420E 00	0.4108E 01	1.0000	33	6	0.3270E 00	0.8409E 01	1.0000
31	7	0.1103E 00	0.3191E 01	1.0000	33	7	0.1597E 00	0.4108E 01	1.0000
TOTAL CONCENTRATION IS 0.3288E 05			0.2893E 02		TOTAL CONCENTRATION IS 0.2922E 05				0.2571E 02
69	1	0.7161E-06	0.1691E-04	1.0000	71	1	0.0	0.0	1.0000
69	2	0.3586E-01	0.8465E 00	1.0000	71	2	0.1165E-02	0.2287E-01	1.0000
69	3	0.1113E 00	0.2629E 01	1.0000	71	3	0.1339E 00	0.2629E 01	1.0000
69	4	0.0	0.0	1.0000	71	4	0.0	0.0	1.0000
69	5	0.4487E 00	0.1059E 02	1.0000	71	5	0.0	0.0	1.0000
69	6	0.2708E 00	0.6392E 01	1.0000	71	6	0.5394E 00	0.1059E 02	1.0000
69	7	0.1333E 00	0.3147E 01	1.0000	71	7	0.3255E 00	0.6392E 01	1.0000
TOTAL CONCENTRATION IS 0.2683E 05			0.2361E 02		TOTAL CONCENTRATION IS 0.2232E 05				0.1964E 02
88	1	0.1569E-04	0.4344E-03	1.0000	90	1	0.0	0.0	1.0000
88	2	0.1270E 00	0.3517E 01	1.0000	90	2	0.2147E-01	0.4483E 00	1.0000
88	3	0.8007E-01	0.2218E 01	1.0000	90	3	0.1061E 00	0.2217E 01	1.0000
88	4	0.0	0.0	1.0000	90	4	0.0	0.0	1.0000
88	5	0.3825E 00	0.1059E 02	1.0000	90	5	0.0	0.0	1.0000
88	6	0.2754E 00	0.7628E 01	1.0000	90	6	0.5072E 00	0.1059E 02	1.0000
88	7	0.1350E 00	0.3739E 01	1.0000	90	7	0.3652E 00	0.7628E 01	1.0000
TOTAL CONCENTRATION IS 0.3147E 05			0.2769E 02		TOTAL CONCENTRATION IS 0.2373E 05				0.2089E 02

THE FOLLOWING 10 RECEPTORS HAVE THE 10 HIGHEST CONCENTRATIONS

162	0.3669E 02	163	0.3837E 02	202	0.3652E 02	145	0.3983E 02	146	0.3633E 02
164	0.3970E 02	143	0.3604E 02	222	0.3655E 02	221	0.3808E 02	144	0.3765E 02

Fig. 7.9. (Contd.)

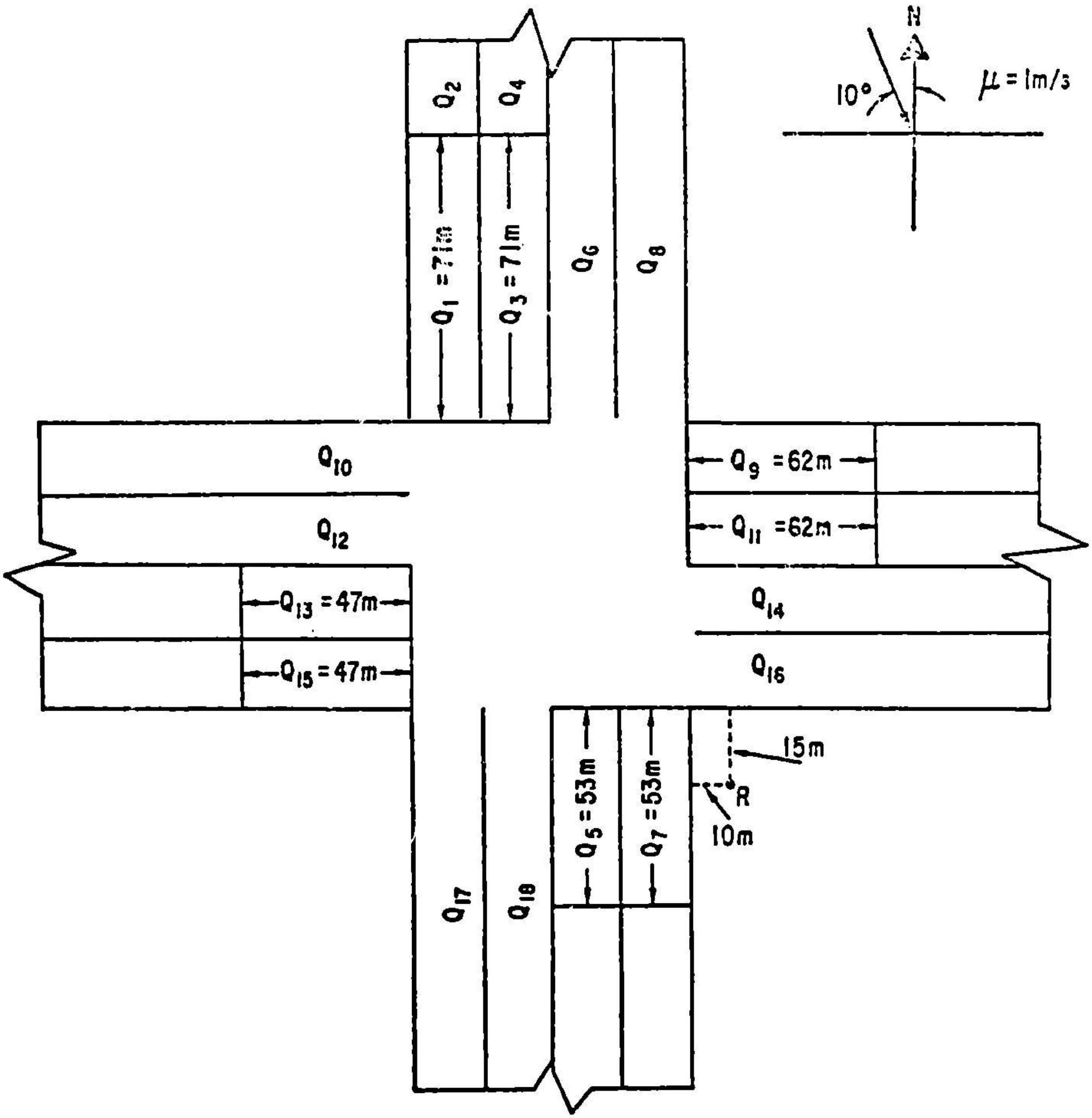


Fig. 7.10. Intersection Analyzed in Sample Problem No. 7

Table 7.1. Parameters Used in Sample Problem 7

Source	West Coordinate (km,km,m)	East Coordinate (km,km,m)	North Coordinate (km,km,m)	South Coordinate (km,km,m)	Emission Intensity (g/s-m)	Volume (VPH)
Q_1	-	-	(.152,.091,0)	(.152,.020,0)	.0116	800
Q_2	-	-	(.152,.191,0)	(.152,.091,0)	.0057	800
Q_3	-	-	(.157,.091,0)	(.157,.020,0)	.0116	800
Q_4	-	-	(.157,.191,0)	(.157,.091,0)	.0057	800
Q_5	-	-	(.162,.000,0)	(.167,-.53,0)	.0110	600
Q_6	-	-	(.162,.191,0)	(.162,.000,0)	.0043	600
Q_7	-	-	(.167,.000,0)	(.167,-.53,0)	.0110	600
Q_8	-	-	(.167,.191,0)	(.167,.000,0)	.0043	600
Q_9	(.167,.015,0)	(.292,.015,0)	-	-	.0161	400
Q_{10}	(.100,.015,0)	(.167,.015,0)	-	-	.0161	400
Q_{11}	(.167,.010,0)	(.229,.010,0)	-	-	.0161	400
Q_{12}	(.100,.010,0)	(.167,.010,0)	-	-	.0029	400
Q_{13}	(.100,.005,0)	(.147,.005,0)	-	-	.0152	300
Q_{14}	(.147,.005,0)	(.229,.005,0)	-	-	.0022	300
Q_{15}	(.100,.000,0)	(.147,.000,0)	-	-	.0152	300
Q_{16}	(.147,.000,0)	(.229,.000,0)	-	-	.0022	300
Q_{17}	-	-	(.152,.020,0)	(.152,-.53,0)	.0057	800
Q_{18}	-	-	(.157,.020,0)	(.157,-.53,0)	.0057	800

Receptor site coordinates: (.1795,0.0175,2) (km,km,m).

Table 7.2. Comparison of ANL/HIWAY and EPA/HIWAY Results for Sample Problem 7

Source	ANL/HIWAY	EPA/HIWAY
Q_1	.9	.9
Q_2	1.2	1.2
Q_3	1.7	1.8
Q_4	1.3	1.3
Q_5	.0	.0
Q_6	2.1	2.1
Q_7	.0	.0
Q_8	2.6	2.6
Q_9	3.2	2.8
Q_{10}	.0	.1
Q_{11}	3.6	3.0
Q_{12}	.0	.0
Q_{13}	.0	.0
Q_{14}	.6	.5
Q_{15}	.0	.0
Q_{16}	.6	.5
Q_{17}	.0	.0
Q_{18}	.0	.0
Total	**17.82**	**16.85**

8. SOME OPERATIONAL DIFFICULTIES

A number of interesting problems arise in using the ANL/HIWAY model to estimate carbon monoxide levels about a roadway network. The first problem involves the modeling of intersections. The program as set up assumes free flow traffic movement when volumes and speeds are used to estimate emission rates. At intersections, however, significant increases of emissions occur due to acceleration, deceleration, and idle operations of motor vehicles. In Section 9 it is suggested that an intersection delay model could be coupled with the ANL/HIWAY model to improve the air quality estimation procedures. In lieu of this modification, the model can be used to estimate air quality levels at intersections as follows:

1. Divide the roadways at the intersection into segments reflecting acceleration/deceleration/idle zones and free flow zones, and

2. Estimate emission rates, i.e., Qi's, for each zone and input these into the program.

An intersection problem of this type is provided as a sample problem in Section 7.

A second problem encountered occurs when a critical wind angle at low wind speeds is used; this causes a drastic peak in the estimated air pollution concentration. Actual hourly average air quality measurements usually do not exhibit this peaking phenomenon, probably because wind directions, especially at low wind speeds, are not constant over an hour-long period. To remedy this problem, the GOAVE or FETCHAVE provisions of the program can be used. For example, an hourly air quality estimate may be generated by averaging four quarter-hour periods, assuming a slight change in the wind direction about the critical angle each quarter-hour.

9. FUTURE MODIFICATIONS OF ANL/HIWAY

The present version of ANL/HIWAY is very versatile, although there is a great deal of room for improvement. Among the desirable modifications are choice of a better algorithm for line-source integration; modeling of diesel vehicles; modeling of vehicles during acceleration, deceleration, and idling, at intersections; curve fitting of observed emisssion vs. computed emisssions; curve plotting and contour mapping of computed air quality concentrations.

First, the choice of a better algorithm for line-source integration is very desirable, since the present version uses the Simpson method. Its popularity stems from its ease in implementation; however, this method is extremely slow. Modifications to this basic method have been developed and comparisons made of its efficiency with respect to time and accuracy. These results have been obtained by J. N. Lyness and J. J. Kaganove of the Applied Mathematics Division of Argonne National Laboratory. Their tests show that for the family of functions represented by the steady state plume model in the HIWAY code, at least three other integration methods are superior to the Simpson method. Among them are AIND (R. Piessens, Report TW17), which is an interval bisection routine using the 21-point Kronrod rule; GAUS8 (R. Jones, Sandia Library), an interval bisection routine using an eight-point Newton-Cotes rule; and ANC4, an interval bisection routine using the five-point Newton-Cotes rule. The results show the ANC4 is excellent, AIND is good, and GAUS8 is average. Since a great deal of the time and cost of running the model is tied to this integration routine, it seems clear that a concentration of effort in making this part of the code efficient is of prime importance.

The modeling of diesel vehicles should be made endogenous to the code, since the present version can handle only CO emissions from automobiles endogenously. The addition of a submodel to account for acceleration, deceleration, and idling will allow the user to model intersections, parking lots, or any congested roadway. This, plus the addition of diesel vehicles, will provide the user with a more general and realistic package to do roadway analysis.

Adding the curve fitting, plotting, and contouring routines would allow the user to produce visual and statistical information. The curve fitting and plotting capability could be used to calibrate the model or to determine the goodness of fit of the computed values to observed data. A routine within the package to produce isopleths of the computed air quality would provide a definite saving in user time and effort, and make unnecessary the use of an external graphics package to get these vital results.

With relatively little effort, these modifications can be made and the analytical capabilities of the model as well as the efficiency of the code could be significantly improved.

REFERENCES

1. Beaton, J. L., A. J. Ranzieri, and J. B. Skog (1972). *Motor Vehicle Emission Factors for Estimates of Highway Impact on Air Quality.* In: Air Quality Manual, Vol. 2. California Department of Public Works, Division of Highways. Sacramento, California. Report No. FHWA-RD-72-34. (April 1972). 58p.

2. Calder, K. L. (1973). *On Estimating Air Pollution Concentrations from a Highway in an Oblique Wind.* Atmos. Environ. 7:863-868 (September 1973).

3. EPA (1973). *Compilation of Air Pollutant Emission Factors*, 2nd Ed. U.S. Environmental Protection Agency. Research Triangle Park, North Carolina. Publication No. AP-42 (April 1973).

4. Holzworth, G. C. (1972). *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution throughout the Contiguous United States.* U. S. Environmental Protection Agency. Research Triangle Park, North Carolina. Publication NO. AP-101. (1972) 118 p.

5. Ludwig, F. L., W. B. Johnson, A. E. Moon, and R. L. Mancuso (1970). *A Practical Multipurpose Diffusion Model for Carbon Monoxide.* Stanford Reasearch Institute. Menlo Park, California. Contracts CAPA-3-68 and CPA 22-69-64. 184 p.

6. Pasquill, F. (1961). *The Estimation of the Dispersion of Windborne Material.* Meteorol. Mag. 90(1063):33-49, (1961).

7. Turner, D. B. (1970). *Workbook of Atmospheric Dispersion Estimates.* U.S. Enrironmental Protection Agency. Research Triangle Park, North Carolina. Publication No. AP-26. (1970) 84 p.

8. Zimmerman, J. R., and R. S. Thompson. *User's Guide for HIWAY, a Highway Air Pollution Model.* U.S. Environmental Protection Agency. Research Triangle Park, North Carolina. Publication No. EPA-650/4-74-008. (1975) 59 p.

APPENDIX A. FORTRAN SOURCE LISTING

```
C
C
C         ANL-HIWAY
C            MODIFIED BY GEORGE A. CONCAILDI
C      NOV. 1974
C
C
      DIMENSION LISTOP(50),CONTOP(50)
      DIMENSION KILLR(1000),KILLS(30)
      DIMENSION CONC(1000,30)
      DIMENSION WDK(16),KSTABL(6)
       DIMENSION DEG(30),SDEG(30)
      DIMENSION VOL(30),VEL(30)
       DIMENSION IHEAD(20,10)
      DIMENSION TSIN(30),TCOS(30)
      DIMENSION ITITL(30,5)
      DIMENSION XR(1000),YR(1000),ZR(1000)
       DIMENSION X1(30  ),X2(30  ),Y1(30  ),Y2(30  ),Z1(30  ),Z2(30  )
      DIMENSION DW(30  ),DH(30  ),QL(30  ),TCONC(1000,30),TCONCT(1000)
      DIMENSION WSS(30  ),DELZS(30  ),ABC(12)
C
      COMMON/TRADE/WIDM,CNTM,XA,YA,XB,YB,ROAD,HM
C
      EQUIVALENCE (WSS(1),DW(1))
      EQUIVALENCE(DELZS(1),DH(1))
C.............................................................................
C
C                                          INIT (NN=14)
C
C         INITALIZE VARIABLES
C
C.............................................................................
 3005 DO 931 I=1,1000
      KILLR(I)=0
      XR(I)=0.0
      YR(I)=0.0
      ZR(I)=0.0
      TCONCT(I)=0.0
      DO 931 J=1,30
      DO 932 K=1,5
932   ITITL(J,K)=KIND('    ')
      KILLS(J)=0
      X1(J)=0.0
```

```
      X2(J)=0.0
       Y1(J)=0.0
      Y2(J)=0.0
      Z1(J)=0.0
       Z2(J)=0.0
      DW(J)=0.0
      DH(J)=0.0
      QL(J)=0.0
      VOL(J)=0.0
      VEL(J)=0.0
      TCONC(I,J)=0.0
      CONC(I,J)=0.0
 931  CONTINUE
C.........................................................................
C
C  DEFAULT INPUT TO 5 (CARD READER)
C DEFAULT OUTPUT TO 6 (PRINTER)
C DEFAULT COUPLING COEFFICIENT DSN TO 11 (DISK,CELL,...)
C
C DEFAULT STABILITY CLASSTO NEUTRAL (JSTAB=4)
C DEFAULT MIXING HEIGHT TO 3500. FEET
C.........................................................................
       INP=5
       IOUT=6
      IDSN=11
      SUPR=0.0
      SUPS=0.0
      JSTAB=4
      HLID=3500.
      NSOR=1
      DO 7373 JL=1,10
      DO 7373 LJ=1,20
 7373  IHEAD(LJ,JL)=KIND('    ')
C.........................................................................
C
C      CONVERSION FROM FEET TO KM
C     DEFAULT HIWAY CODE TO OLD VERSION.
C
C.........................................................................
      CONST=.0003048
      CONST2=CONST*1000.0
      CONVER=1.0
```

```
      IVER=1
      NN=-10
      CALL VOCAB(NN,NAME)
      NN=10
C.............................................................................
C
C READ IN ALL COMMANDS AND STORE FOR FUTURE REFERENCE
C
C.............................................................................
       INIT=0
       CALL REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
C.............................................................................
C
C                                        REST  (NN=7)
C RESTART BY RESETTING I/O FLAGS
C
C.............................................................................
 811  WRITE(6,6060)
 6060 FORMAT(1H1)
      IGOFLG=0
      VMIX=1.0
      ISTAB=0
      DO 1933 IIS=1,1000
       DO 1933 JIS=1,30
 1933  CONC(IIS,JIS)=0.0
       L"IND=0
       ISAVE=0
       ISLAP=0
       IUPIT=0
       ISCORE=-2
        MSS=1
       ISYMAP=0
C.............................................................................
C
C RETRIEVE EACH COMMAND, FOR EXECUTION, IN THE ORDER THAT THEY WERE READ
C                                        HEAD (NN=20)  DESC (NN=27)  BLANKS (NN=2)
C
C.............................................................................
 600   CALL REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
 6000 FORMAT(2A4,12F6.1)
       CALL VOCAB(NN,NAME)
 2310  IF(NN)230,230,231
```

```
 231  GO TO (701,800,703,704,705,906,611,230,3000,3001,3002,3003,3004
     X,3005,3009,3008,3006,3007,4001, 800,4003,4004,4005,4006,4007,4008
     X, 800,4010,4011,4012,4013,4014
     X,4015
     X    ),NN
C.................................................................................
C
C      READ IN THE VALUE FOR THE VECHILE MIX
C
C.................................................................................
 4015     VMIX=ABC(1)
       GO TO 800
C.................................................................................
C
C                                        NEWV  (N=32)
C SET FLAG FOR USING COUPLING COEFFICIENTS UNDER THE NEW VERSION
C
C.................................................................................
 4014  IVER=0
      GO TO 800
C.................................................................................
C
C                                        INPU  (NN=28)
C      INPUT UNIT
C
C.................................................................................
 4010   INP=ABC(1)+.001
      GO TO 800
C.................................................................................
C
C                                        OUTP  (NN=29)
C     OUTPUT UNIT
C
C.................................................................................
 4011  IOUT=ABC(1)+.001
       GO TO 800
C.................................................................................
C
C                                        DSN  (NN=30)
C     COUPLING COEFFICIENT STORAGE
C
C.................................................................................
 4012  IDSN=ABC(1)+.001
       GO TO 800
```

```
C.......................................................................
C
C                                        GOAV (NN=31)
C      SET THE FLAG FOR THE GOAVE AND THEN GO
C
C.......................................................................
 4013    IGOFLG=100
      GO TO 906
C.......................................................................
C
C                                        RECP (NN=1)
C AUTOMATIC FIRST MODULE
C       SET UP AUTOMATIC RECEPTORS
C
C.......................................................................
 701  IF(NIME-KIND('AUTO')) 1701,1702,1701
 1702  XBASE=ABC(1)
      YBASE=ABC(2)
      NX=ABC(3)+.001
      DELX=ABC(4)
      NRECP=0
      IUP=0
      NY=ABC(5)+.001
      DELY=ABC(6)
      DO 5 I=1,NY
      Y=(YBASE+DELY*(I-1))*CONST
      DO 5 J=1,NX
      X=(XBASE+DELX*(J-1))*CONST
      IUP=IUP+1
      XR(IUP)=X
      YR(IUP)=Y
      ZR(IUP)=0.0
 5    CONTINUE
      NRECP=IUP
      GO TO 800
C.......................................................................
C
C                                        RECP (NN=1)
C  MANUAL SECOND MODULE
C        SET UP MANUAL RECEPTORS
C
C.......................................................................
 1701  IJK=0
```

```
 1705     DO 1703 I=1,12,3
       IJK=IJK+1
       XR(IJK)=ABC(I)*CONST
       YR(IJK)=ABC(I+1)*CONST
      ZR(IJK)=ABC(I+2)*CONST2
 1703   CONTINUE
       CALL REED(NAME,NIMF,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
      CALL VOCAB(NN,NAME)
      IF(NN-1)2312,1705,2312
 2312  IF(NN-2)2311,1705,2311
 2311  NRECP=IJK
      GO TO 2310
C.....................................................................
C
C                                          MET  (NN=3)
C         SET UP MET. CONDITIONS
C
C.....................................................................
 703   JSTAB=ABC(1)+.001
      WS=ABC(2)
      WD=ABC(3)
      HLID=ABC(4)
      IF(ABC(5).EQ.0.0) ABC(5)=1.0
      CONVER=ABC(5)
      WSM=WS*.447
       STAB=JSTAB
      HLM=HLID*CONST2
      GO TO 800
C.....................................................................
C
C                                          SYMA  (NN=9)
C         SET UP SYMAP ADJUSTMENT CO-ORDINATES
C
C.....................................................................
 3000 ISYMAP=1
      XTR=ABC(1)
      YTR=ABC(2)
      GO TO 800
```

```
C.......................................................................
C
C                                     NSOR (NN=4)
C        READ IN NUMBER OF SOURCES TO EXPECT
C
C.......................................................................
  704  NSOR=ABC(1)+.001
       GO TO 800
C.......................................................................
C
C                                     SUPR (NN=22)
C      SUPRESS RECEPTORS FOR PRINTING
C
C.......................................................................
 4004   DO 9091  I=1,12
       IV=ABC(I)+.001
       IF(IV)9091,9091,9092
 9092   KILLR(IV)=1
 9091   CONTINUE
        CALL REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
       CALL VOCAB(NN,NAME)
        IF(NN-2)9093,4004,9093
 9093   IF(NN-22) 2310,4004,2310
C.......................................................................
C
C                                     SUPS (NN=23)
C       SUPRESS SOURCES FOR PRINTING
C
C.......................................................................
 4005   DO 9293 I=1,12
       IV=ABC(I)+.001
       IF(IV)9293,9293,9297
 9297   KILLS(IV)=1
 9293   CONTINUE
        CALL REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
       CALL VOCAB(NN,NAME)
       IF(NN-2)9294,4005,9294
 9294   IF(NN-23) 2310,4005,2310
C.......................................................................
C
C                                     SELR (NN=24)
C          SELECT RECEPTORS FOR PRINTING
C
C.......................................................................
```

```
4006  IF(SUPR)9394,9394,9395
9394  DO 9396 I=1,1000
9396  KILLR(I)=1
9395  DO 9397  I=1,12
     IV=ABC(I)+.001
     IF(IV)9397,9397,9398
9398  KILLR(IV)=0
9397   CONTINUE
     SUPR=100.0
      CALL REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
     CALL VOCAB(NN,NAME)
     IF(NN-2)9399,9395,9399
9399  IF(NN-24)2310,9395,2310
C.......................................................................
C
C                                        SELS (NN=25)
C        SELECT SOURCES FOR PRINTING
C
C.......................................................................
4007  IF(SUPS)9594,9594,9595
9594   DO 9596  I=1,30
9596  KILLS(I)=1
9595  DO 95 97 I=1,12
     IV=ABC(I)+.001
      IF(IV)9597,9597,9598
9598  KILLS(IV)=0
9597  CONTINUE
     SUPS=100.0
      CALL REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
     CALL VOCAB(NN,NAME)
     IF(NN-2)9599,9595,9599
9599  IF(NN-25)2310,9595,2310
C.......................................................................
C
C                                        FREE (NN=26)
C       CLEAR FLAGS FOR RECEPTORS OR SOURCES
C
C.......................................................................
4008  IF(NIME-KIND('RECP'))9695,9696,9695
9695  IF(NIME-KIND('SOUR'))9698,9697,9698
9698  IF(NIME-KIND('    '))800,9699,800
9696  DO 9692 I=1,1000
9692   KILLR(I)=0
     SUPR=0.0
```

```
      GO TO 800
 9697  DO 9691  I=1,30
 9691  KILLS(I)=0
      SUPS=0.0
       GO TO 800
 9699  DO 9693  I=1,30
 9693  KILLS(I)=0
      NIME=KIND('RECP')
      GO TO 4008
C.........................................................................
C
C                                  SOUR  (NN=5)
C      READ IN SOURCE PARAMETERS
C
C.........................................................................
 705     QL(1)=ABC(9)
      DELZS(1)=ABC(8)*CONST2
      WSS(1)=ABC(7)*CONST2
       X1(1)=ABC(1)*CONST
      Y1(1)=ABC(2)*CONST
      Z1(1)=ABC(3)*CONST2
      X2(1)=ABC(4)*CONST
      Y2(1)=ABC(5)*CONST
      Z2(1)=ABC(6)*CONST2
      IF(NSOR.LE.1) GO TO 800
      DO 1781 ILM = 2,NSOR
       CALL REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
      CALL VOCAB(NN,NAME)
      IF(NAME-KIND('    ')) 1782,1784,1782
 1782 IF(NAME-KIND('SOUR'))2310,1784,2310
 1784  X1(ILM)=ABC(1)*CONST
      Y1(ILM)=ABC(2)*CONST
      Z1(ILM)=ABC(3)*CONST2
      X2(ILM)=ABC(4)*CONST
      Y2(ILM)=ABC(5)*CONST
      Z2(ILM)=ABC(6)*CONST2
      WSS(ILM)=ABC(7)*CONST2
      DELZS(ILM)=ABC(8)*CONST 2
      QL(ILM)=ABC(9)
 1781  CONTINUE
      GO TO 800
C.........................................................................
C
```

```
C                                            GO (NN=6)
C     COMPUTE SINES AND COSINES FOR ROAD AND RECEPTOR ROTATIONS
C
C.......................................................................
 906   DO 907 I=1,NSOR
       DX=ABS(X2(I)-X1(I))
       DY=ABS(Y2(I)-Y1(I))
        CALL ATH(DX,DY,ANGH,DANG)
       DEG(I)=DANG
       IF(DY*DX)5091,5092,5091
 5092   TOP=1.0
        BOT=1.0
       GO TO 5093
 5091   CONTINUE
       TOP=SIGN(1.0,DX)
       BOT=SIGN(1.0,DY)
 5093    CONTINUE
       SDEG(I)=TOP/BOT
       ANGH=SDEG(I)*ABS(ANGH)
       TSIN(I)=SIN(ANGH)
       TCOS(I)=COS(ANGH)
 907   CONTINUE
       GO TO 706
C.......................................................................
C
C                                            VOLU (NN=19)
C VOLUMES OF VEHICLES IN THOUSANDS OF CARS AND SPEED IN MPH.
C
C.......................................................................
 4001   MT=0
       ISLAP=1
       GO TO 4025
 4030   CALL REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
       CALL VOCAB(NN,NAME)
       IF(NN-2)4031,4025,4031
4031   IF(NN-19)2310,4025,2310
 4025   DO 4026 III=1,12,2
       MT=MT+1
       VOL(MT)=ABC(III)*1000.0
       VEL(MT)=ABC(III&1)
        SPEED=ABC(III+1)
        IF(MT-NSOR)4029,4029,800
 4029   IF(ABC(III+1))4027,4027,4028
```

```
 4027  SPEED=5.0
 4028  TEMP=1.570821E-04/SPEED
       QL(MT)=(TEMP+1.0908E-06)*ABC(III)  * 1000.0
 4026  CONTINUE
      GO TO 4030
C.................................................................................
C
C                                        STAB (NN=17)
C         READ IN THE STABILITY CLASSES FOR A COEF. RUN
C
C.................................................................................
 3006 ISTAB=0
      ISAVE=1
      DO 3016 II=1,6
      IF(ABC(II).EQ.0.0) GO TO 3016
      ISTAB=ISTAB+1
      KSTABL(ISTAB)=ABC(II)+.001
 3016 CONTINUE
      IF(ISTAB.LE.0) GO TO 230
      GO TO 800
C.................................................................................
C
C                                        WIND (NN=18)
C         READ IN THE WIND DIRECTIONS FOR THE COEF. RUN
C
C.................................................................................
 3007 LWIND=0
      ISAVE=1
      GO TO 6073
 6074  CALL REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NFOR)
      CALL VOCAB(NN,NAME)
      IF(NN-18)2321,6073,2321
 2321 IF(NN-2)2310,6073,2310
 6073 NBE=ABC(1)+1.001
      DO 3017 III=2,NBE
      LWIND=LWIND+1
 3017 WDK(LWIND)=ABC(III)
      IF(LWIND.LE.0) GO TO 230
      GO TO 6074
C.................................................................................
C
C                                        RESU (NN=21)
```

```
C       PRODUCE AVERAGED RESULTS
C
C.............................................................................
 4003  IF(ABC(1))9009,9009,9008
 9009  ABC(1)=1.0
 9008  UP=IUPIT
      DO 9007  IWAS=1,NSOR
      QL(IWAS)=1.0
      DO 9007 JWAS=1,NRECP
      TCONC(JWAS,IWAS)=CONC(JWAS,IWAS)/UP*ABC(1)
 9007  CONTINUE
      ISAVE=0
      GO TO 3190
C.............................................................................
C
C                                        FETC  (NN=15)
C        FETCH THE COUPLING COEFFICIENTS AND STORE IN THE TCONC ARRAY
C
C.............................................................................
 3009  IF(NIME KIND('HAVE'))9002,9001,9002
 9001  IUPIT=IUPIT+1
 9002  ISKIP=ABC(1)+.001
      ISCORE=-1
      REWIND IDSN
 3028  CONTINUE
      ISCORE=ISCORE+1
      READ(IDSN,3023) SOR
      READ(IDSN,3023) RECP
      IF(IVER)1946,1945,1946
 1945     READ(IDSN,3023) WD
      READ(IDSN,3023) HLID
       READ(IDSN,3023) STAB
 1946   CONTINUE
      NSOR=SOR+.001
      NRECP=RECP+.001
      DO 3029 IWAS=1,NSOR
      DO 3029 JWAS=1,NRECP
      READ(IDSN,3023) TCONC(JWAS,IWAS)
 3029 CONTINUE
      READ(IDSN,3023) EVAL
      IF(ISCORE.LT.ISKIP)GO TO 3028
      WS=ABC(2)*.447
      IF(WS.LE.0.0)WS=1.0
      CONVER=ABC(3)
```

```
      IF(ISLAP.GT.0) GO TO 8005
 8004  READ(INP,6000) NAME,NIME,(ABC(III),III=1,12)
      CALL VOCAB(NN,NAME)
      IF(NN-2)8888,8882,8888
 8888 IF(NN-15)2310,8882,2310
 8882 IPUSH=0
      DO 8003 III=1,12
      IPUSH=IPUSH+1
      QL(IPUSH)=ABC(III)
 8003  CONTINUE
      IF(IPUSH-NSOR)8004,8005,8005
 8005  CONTINUE
      IF(IUPIT) 9003,9003,9004
 9004  DO 9005 IWAS=1,NSOR
      DO 9005 JWAS=1,NRECP
      T=TCONC(JWAS,IWAS)*QL(IWAS)*CONVER/WS
      CONC(JWAS,IWAS)=CONC(JWAS,IWAS)+T
 9005  CONTINUE
      GO TO 800
 9003  CONTINUE
      ISAVE=0
      DO 3030 IWAS=1,NSOR
      DO 3030 JWAS=1,NRECP
      TCONC(JWAS,IWAS)=(TCONC(JWAS,IWAS)*QL(IWAS)*CONVER)/WS
 3030 CONTINUE
       WRITE(6,6060)
       GO TO 3190
C.........................................................................
C
C
C          BEGIN EXECUTION
C
C
C                                              COUP  (NN=16)
C          CREATE THE COUPLING COEFFICIENTS AND SAVE ON DISK
C
C
C   NOTE *
C          GO COMMAND IS IMBEDDED WITHIN COUPLING COEFFICIENT MODE
C
C.........................................................................
 3008 HLID=ABC(1)
      DO 5907 I=1,NSOR
```

```
      DX=ABS(X2(I)-X1(I))
      DY=ABS(Y2(I)-Y1(I))
      CALL ATH(DX,DY,ANGH,DANG)
      DEG(I)=DANG
      IF(DX*DY)5908,5909,5908
 5909  TOP=1.0
      BOT=1.0
      GO TO 5910
 5908  TOP=SIGN(1.0,DX)
      BOT=SIGN(1.0,DY)
 5910  SDEG(I)=TOP/BOT
      ANGH=SDEG(I)*ABS(ANGH)
      TSIN(I)=SIN(ANGH)
      TCOS(I)=COS(ANGH)
 5907  CONTINUE
      HLM=HLID*CONST2
      JFILE=-1
      XS=2.23714
      DO 3018 JL=1,ISTAB
      ISAVE=1
      DO 3018 JLL=1,LWIND
      JFILE=JFILE+1
      RECP=NRECP
      SOR=NSOR
       WD=WDK(JLL)
      STAB=KSTABL(JL)
      YSM=1.0
       CONVER=1.0
C.......................................................................
C
C BEGIN GO MODE
C
C.......................................................................
 706       CONTINUE
       IUPIT=IUPIT+1
       DO 8001 I=1,NSOR
      IF(ISAVE.GT.0)QL(I)=1.0
C.......................................................................
C
C DETERMINE ADJUSTED WIND ANGLE
C
C.......................................................................
      CS=TCOS(I)
      SS=TSIN(I)
```

```
      WD=ABS(WD)
      IF(DEG(I))5971,5973,5971
 5973 WDM=WD
      GO TO 975
 5971  CONTINUE
      IF(SDEG(I))970,971,971
 971  RSIDE=360.0-ABS(DEG(I))
      IF(WD-RSIDE)972,5972,973
 5972  WDM=0.0
      GO TO 975
 972  WDM=WD+ABS(DEG(I))
      GO TO 975
 973  WDM=WD-RSIDE
      GO TO 975
 970  THETA=ABS(DEG(I))
      IF(WD-THETA)974,5976,976
 5976  WDM=0.0
      GO TO 975
 976  WDM=WD-THETA
      GO TO 975
 974  WDM=360.0-THETA+WD
C.....................................................................
C
C ROTATE ROADS E-W
C
C.....................................................................
 975  CONTINUE
      XA=X1(I)*CS+Y1(I)*SS
      YA=Y1(I)*CS-X1(I)*SS
      XB=X2(I)*CS+Y2(I)*SS
      YB=Y2(I)*CS-X2(I)*SS
      HM=DELZS(I)
        WIDM=WSS(I)*CONST
      ROAD=1.0
      CNTM=0.0
C.....................................................................
C
C ROTATE RECEPTORS SAME AS ROADS
C
C.....................................................................
      DO 8010 J=1,NRECP
      XRM=XR(J)*CS+YR(J)*SS
```

```
      YRM=YR(J)*CS-XR(J)*SS
      ZRM=ZR(J)
      CALL NCEPA(XRM,YRM,ZRM,STAB,WSM,WDM,HLM,QL(I),TCONC(J,I),J,CONVER)
C.............................................................................
C
C PRODUCE CONCENTRATION TOTALS FOR GOAVE COMMAND
C
C.............................................................................
         CONC(J,I)=CONC(J,I)+TCONC(J,I)
 8010  CONTINUE
      WSMPH=WS
      CALL OUTPT(WD,WSMPH,STAB,HLID,CONVER,I,IOUT)
 8001  CONTINUE
         IF(IGOFLG) 3190,3190,800
 3190  DO 95 I=1,NRECP
      TCONCT(I)=0.0
C.............................................................................
C
C PRODUCE CONCENTRATION TOTALS FOR PRINTING
C
C.............................................................................
      DO 95 J=1,NSOR
 95   TCONCT(I)=TCONCT(I)+TCONC(I,J)*VMIX
      IF(ISAVE .LE. 0) GO TO 3020
C.............................................................................
C
C WRITE COUPLING COEFFICIENTS TO IDSN UNIT
C
C.............................................................................
      EOF=-9.99E01
      WRITE(IDSN,3023) SOR
      WRITE(IDSN,3023) RECP
       IF(IVER)1944,1943,1944
 1943     WRITE(IDSN,3023) WD
       WRITE(IDSN,3023) HLID
      WRITE(IDSN,3023) STAB
 1944    CONTINUE
      DO 3021 IKLM=1,NSOR
      DO 3021 JKLM=1,NRECP
      WRITE(IDSN,3023) TCONC(JKLM,IKLM)
 3021 CONTINUE
 3023 FORMAT(E12.4)
      WRITE(IDSN,3023) EOF
      WRITE(IOUT,1776) JFILE
```

```
1776  FORMAT(5X,'COUPLING COEFFICIENT FILE ',2X,I3/)
[illegible] CONTINUE
      IF(ISYMAP) 90,90,91
C.............................................................................
C
C        PUNCH SYMAP CARDS FOR B-DATA POINTS AND E-VALUES
C
C............................................................. ..............
 91   ITT=99999
       CALL OUTPT(WD,WSMPH,STAB,HLID,CONVER,-100,IOUT)
      IF(NIME-KIND('PEVL'))908,909,908
 908  CONTINUE
      WRITE(7,6109)
 6109 FORMAT('B-DATA POINTS')
      DO 92 III=1,NRECP
      XCOR=ABS(XTR-XR(III)/CONST)
      YCOR=ABS(YTR-YR(III)/CONST)
      WRITE(7,6107) YCOR,XCOR
 6107 FORMAT(10X,2F10.2)
 92   CONTINUE
      WRITE(7,6104)  ITT
 6104 FORMAT(I5)
 909  CONTINUE
      WRITE(7,6101)
 6101 FORMAT('E-VALUES')
      DO 97 III=1,NRECP
 97    WRITE(7,6107) TCONCT(III)
      WRITE(7,6104)  ITT
C.............................................................................
C
C       PRINT RESULTS OF THE RUN
C
C.............................................................................
 90   LINES=0
      IF(MSS.LE.0)MSS=1
      WRITE(IOUT,3973)((IHEAD(ILP,JLP),ILP=1,20),JLP=1,MSS)
      LINES=LINES&MSS
3973  FORMAT(25X,20A4)
      IF(ISCORE.GE.0) GO TO 937
      WRITE(IOUT,602)
       DO 190 II=1,NSOR
      IF(KILLS(II)) 190,1111,190
 1111  CONTINUE
      X11=X1(II)/CONST
```

```
      X21=X2(II)/CONST
      Y11=Y1(II)/CONST
      Y21=Y2(II)/CONST
      Z11=Z1(II)/CONST2
      Z21=Z2(II)/CONST2
      DWW=DW(II)/CONST2
      DHH=DH(II)/CONST2
      LINES=LINES+1
      IF(LINES-50)1800,1800,1801
 1801  LINES=1
      WRITE(IOUT,6060)
 1800 CONTINUE
      WRITE(IOUT,606) II,X11,Y11,Z11,X21,Y21,Z21,DWW,DHH
     X ,(ITITL(II,L),L=1,5),VOL(II),VEL(II)
 606   FORMAT(1X,I4,8F10.2,2X,5A4,2X,F10.2,3X,F10.2)
 602  FORMAT(/,' ROAD',8X,'X1',8X,'Y1',8X,'Z1',8X,'X2',8X,'Y2',8X,'Z2',
     X  5X,'WIDTH  EMIS HT.    (ALL IN FEET)',5X,'VOLUME',5X,'SPEED'/)
 190   CONTINUE
C.......................................................................
C
C CHECK FOR SELECTED RECEPTOR PRINTOUT
C
      WRITE(IOUT,607)
       DO 191 II=1,NRECP
      IF(KILLR(II)) 191,1112,191
 1112  CONTINUE
      X=XR(II)/CONST
      Y=YR(II)/CONST
      Z=ZR(II)/CONST2
      LINES=LINES+1
      IF(LINES-50)1802,1802,1803
 1803 LINES=2
      WRITE(IOUT,6060)
      WRITE(IOUT,607)
 1802  CONTINUE
      WRITE(IOUT,601) II,X,Y,Z,YR(II),XR(II),ZR(II)
 601  FORMAT(I10,3F10.2,10X,3F10.4)
 607  FORMAT(/' RECEPTOR',9X,'XR',8X,'YR',8X,'ZR (FT)',5X,'EPA   Y(KM)',
     X  5X,'X(KM)',5X,'Z(KM)'/)
 191   CONTINUE
 937  CONTINUE
      WRITE(IOUT,1696)
      DO 192 II=1,NRECP,2
```

```
      M=II
      L=II+1
 1120   IF(KILLR(M)) 1117,1116,1117
 1117  IF(KILLR(L))  192,1115,192
 1115  M=L
      L=L+1
      GO TO 1120
 1116  IF(KILLR(L)) 1118,1119,1118
 1118  L=L+1
      IF(L-NRECP) 1116,1116,1192
 1192 L=NRECP+1
      IF(L-1000) 1119,1119,1193
 1193 L=1000
 1119   CONTINUE
C.................................................................................
C
C CHECK FOR SELECTED SOURCE PRINTOUT
C
C.................................................................................
      DO 193 JJ=1,NSOR
      IF(KILLS(JJ)) 193,1114,193
 1114   CONTINUE
       EM1=TCONC(L,JJ)
      PP1=0.0
      PP2=0.0
      IF(TCONCT(M)) 1991,1991,1992
 1992  PP1=TCONC(M,JJ)/TCONCT(M)
 1991  IF(TCONCT(L)) 1993,1993,1994
 1994  PP2=TCONC(L,JJ)/TCONCT(L)
 1993  CONTINUE
      LINES=LINES+1
      IF(LINES-50) 1804,1804,1805
 1805 LINES=2
      WRITE(IOUT,6060)
      WRITE(IOUT,1696)
 1804  CONTINUE
      WRITE(IOUT,1695) M,JJ,PP1,TCONC(M,JJ),QL(JJ),L,JJ,PP2,EM1,QL(JJ)
 1695   FORMAT(5X,2(I4,5X,I4,5X,F10.4,3X,F10.4,3X,F9.4,5X))
 1696 FORMAT(/,5X,2('RECP',5X,'ROAD',5X,'% OF TOTAL',3X,'PPM',10X,'EMIS'
     X  ,10X)/)
 193   CONTINUE
      EM1=TCONCT(M)
      EM2=TCONCT(L)
```

```
      PP1=EM1/CONVER
       PP2=EM2/CONVER
       WRITE(IOUT,1697)   PP1,EM1,PP2,EM2
 1697  FORMAT(5X,2('TOTAL CONCENTRATION IS ',E10.4,5X,E10.4,15X)/)
       LINES = LINES +3
      IF(LINES-50) 2013,2013,2014
2014  LINES=1
      WRITE(IOUT,6060)
 2013 CONTINUE
      II=L-1
 192  CONTINUE
      WRITE(IOUT,6060)
      IF(ISAVE.LE.0) GO TO9800
 3018 CONTINUE
C.......................................................................
C
C FIND AND PRINT ALL RECEPTORS WHICH HAVE THE HIGHEST 10 CONCENTRATIONS
C
C.......................................................................
9800  DO 1947  IKZ=1,10
      LISTOP(IKZ)=IKZ
 1947    CONTOP(IKZ)=TCONCT(IKZ)
       DO 1948 IKZ=1,NRECP
      IO=1
      CONMIN=CONTOP(1)
      DO 1949 JKZ=1,10
       IF(CONMIN-CONTOP(JKZ)) 1949,1949,1950
 1950   CONMIN=CONTOP(JKZ)
      LO=JKZ
 1949   CONTINUE
       IF(TCONCT(IKZ)-CONMIN) 1948,1948,1951
 1951   LISTOP(LO)=IKZ
      CONTOP(LO)=TCONCT(IKZ)
 1948   CONTINUE
      WRITE(IOUT,6060)
      L=10
      DO 1952 IKZ=1,NRECP
       DO 1953  JKZ=1,10
       IF(IKZ-LISTOP(JKZ)) 1967,1952,1967
 1967   IF(TCONCT(IKZ)-CONTOP(JKZ)) 1953,1954,1953
 1954   L=L+1
       CONTOP(L)=TCONCT(IKZ)
       LISTOP(L)=IKZ
      GO TO 1952
```

```
 1953   CONTINUE
 1952   CONTINUE
      WRITE(IOUT,1955) L
 1955  FORMAT(25X,'THE FOLLOWING ',I4,' RECEPTORS HAVE THE 10 HIGHEST
     XCONCENTRATIONS',/)
       WRITE(IOUT,1956) (LISTOP(JK),CONTOP(JK),JK=1,L)
 1956 FORMAT(5(3X,I5,3X,E10.4))
       GO TO 800
C.......................................................................
C
C
C                                      ADDR (NN=10)
C         ADD A RECEPTOR TO THE LIST
C
C.......................................................................
 3001 IF(NRECP+1.GT.1000) GO TO 800
      NRECP=NRECP+1
      XR(NRECP)=ABC(1)*CONST
      YR(NRECP)=ABC(2)*CONST

      ZR(NRECP)=ABC(3)*CONST2
       GO TO 800
C.......................................................................
C
C                                      ADDS (NN=11)
C         ADD A SOURCE TO THE LIST
C
C.......................................................................
 3002  IF(NSOR+1.GT.30)GO TO 800
       NSOR=NSOR+1
      X1(NSOR)=ABC(1)*CONST
      Y1(NSOR)=ABC(2)*CONST
      Z1(NSOR)=ABC(3)*CONST2
      X2(NSOR)=ABC(4)*CONST
      Y2(NSOR)=ABC(5)*CONST
       Z2(NSOR)=ABC(6)*CONST2
       VSS(NSOR)=ABC(7)*CONST2
      DELZS(NSOR)=ABC(8)*CONST2
      QL(NSOR)=ABC(9)
      GO TO 800
C.......................................................................
C
C                                      SUBR (NN=12)
```

```
C         DELETE A RECEPTOR FROM THE LIST
C
C.........................................................................
 3003  ISTRT=ABC(1)+1.001
      DO 3090 II=ISTRT,NRECP
      XR(II-1)=XR(II)
      YR(II-1)=YR(II)
 3090  ZR(II-1)=ZR(II)
      NRECP=NRECP-1
      GO TO 800
C.........................................................................
C
C                                                SUBS (NN=13)
C         DELETE A SOURCE FROM THE LIST
C
C.........................................................................
 3004       ISTRT=ABC(1)+1.001
      DO 3091 II=ISTRT,NSOR
      X1(II-1)=X1(II)
      Y1(II-1)=Y1(II)
       Z1(II-1)=Z1(II)
      X2(II-1)=X2(II)
       Y2(II-1)=Y2(II)
      Z2(II-1)=Z2(II)
      NSS(II-1)=NSS(II)
      DELZS(II-1)=DELZS(II)
 3091  QL(II-1)=QL(II)
       NSOR=NSOR-1
       GO TO 800
C.........................................................................
C
C                                                TERM (NN=8)
C
C.........................................................................
 230      CONTINUE
       STOP
        END
```

```
COMPILER OPTIONS - NAME=   MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
C*
      SUBROUTINE REED(NAME,NIME,ABC,INIT,INP,IOUT,ITITL,IHEAD,MSS,NSOR)
      DIMENSION ABC(12),KOMAND(500,2),PARAM(500,12)
       DIMENSION ITITL(30,5),IHEAD(20,10)
      IF(INIT)1,1,2
 1      WRITE(IOUT,6003)
 6003   FORMAT ('1',25X,'INPUT COMMANDS AND ASSOCIATED PARAMETERS',//)
      LINES=3
 11   INIT=INIT+1
      READ(INP,6000,END=1000) (KOMAND(INIT,I),I=1,2),(PARAM(INIT,I),I
     X=1,12)
 6000  FORMAT(2A4,12F6.0)
      WRITE(IOUT,6001) (KOMAND(INIT,I),I=1,2),(PARAM(INIT,I),I=1,12)
 6001     FORMAT(10X,2A4,12F9.3)
       IF(KOMAND(INIT,1)-KIND('NSOR'))4016,4015,4016
 4016    CONTINUE
      IF(KOMAND(INIT,1)-KIND('HEAD')) 7001,4002,7001
 7001  IF(KOMAND(INIT,1)-KIND('DESC'))7003,4009,7003
 4015    NSOR=PARAM(INIT,1)+.01
      GO TO 7003
C
C     TITLES FOR SOURCES  (20 CHARACTERS MAX.)
C
4002  DO 934 J=1,NSOR
      READ(INP,933)  (ITITL(J,L),L=1,5)
 933  FORMAT(5A4)
       WRITE(IOUT,930)  (ITITL(J,L),L=1,5)
 930  FORMAT(10X,5A4)
 934  CONTINUE
      GO TO 7003
C
C     HEADINGS FOR RUNS.  THIS GIVES THE TITLE AND DESCRIPTION OF THE RUN
C
 4009  CONTINUE
      MSS=PARAM(INIT,1)+.001
      IF(MSS.LT.1) MSS=1
      READ(INP,3972)((IHEAD(I,J),I=1,20),J=1,MSS)
      WRITE(IOUT,3973)((IHEAD(I,J),I=1,20),J=1,MSS)
 3973 FORMAT(10X,20A4)
3972  FORMAT(20A4)
 7003  CONTINUE
 6002  FORMAT('1')
```

```
      LINES=LINES+1
      IF(LINES-52)11,11,12
12    LINES=3
      WRITE(IOUT,6330)
6330   FORMAT(1H1)
       GO TO 11
1000   KONT=0
       RETURN
2      KONT=KONT+1
      IF(KONT-INIT)3,3,4
3      DO 5 I=1,12
5      ABC(I)=PARAM(KONT,I)
      NAME=KOM AND(KONT,1)
      NIME=KOM AND(KONT,2)
      IF(NAME.EQ.KIND('DESC')) MSS=ABC(1)+.01
      RETURN
   4  NAME=KIND('TERM')
      RETURN
      END
```

```
COMPILER OPTIONS - NAME=  MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
C*
       SUBROUTINE VOCAB(NN,NAME)
       DIMENSION KODE(50)
C
      IF(NN) 1,1,2
 1    KODE(1)=KIND('RECP')
      KODE(2)=KIND('    ')
      KODE(3)=KIND('MET ')
      KODE(4)=KIND('NSOR')
      KODE(5)=KIND('SOUR')
       KODE(6)=KIND('GO  ')
      KODE(7)=KIND('REST')
      KODE(8)=KIND('TERM')
      KODE(9)=KIND('SYMA')
      KODE(10)=KIND('ADDR')
      KODE(11)=KIND('ADDS')
       KODE(12)=KIND('SUBR')
      KODE(13)=KIND('SUBS')
       KODE(14)=KIND('INIT')
      KODE(15)=KIND('FETC')
      KODE(16)=KIND('COUP')
      KODE(17)=  KIND('STAB')
      KODE(18)=KIND('WIND')
       KODE(19)=KIND('VOLU')
      KODE(20)=KIND('HEAD')
      KODE(21)=KIND('RESU')
      KODE(22)=KIND('SUPR')
      KODE(23)=KIND('SUPS')
      KODE(24)=KIND('SELR')
      KODE(25)=KIND('SELS')
      KODE(26)=KIND('FREE')
      KODE(27)=KIND('DESC')
      KODE(28)=KIND('INPU')
      KODE(29)=KIND('OUTP')
      KODE(30)=KIND('DSN ')
       KODE(31)=KIND('GOAV')
      KODE(32)=KIND('OLDV')
      KODE(33)=KIND('VMIX')
    N=33
      RETURN
C
 2    DO 3 I=1,N
```

```
      IF(NAME-KODE(I))3,4,3
 4    NN=I
       GO TO 5
 3    CONTINUE
      WRITE(6,100) NAME
 100  FORMAT(//,5X,A4,2X,'IS ILLEGAL COMMAND',//)
C
      NN=-10
 5    RETURN
      END
```

```
COMPILER OPTIONS - NAME=   MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                  SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
      C*
            SUBROUTINE OUTPT(WD,WS,STAB,HLID,CONV,I,IOUT)
            DIMENSION KODE(5)
      C
      C
            JOUT=IOUT
            IF(I-1)1,1,2
        2   RETURN
      C
        1   JSTAB=STAB+.001
            GO TO (11,12,13,14,15,16),JSTAB
       11   KODE(1)=KIND('EXTR')
            KODE(2)=KIND('EMEL')
            KODE(3)=KIND('Y UN')
            KODE(4)=KIND('STAB')
            KODE(5)=KIND('LE  ')
            GO TO 20
       12   KODE(1)=KIND('MODE')
            KODE(2)=KIND('RATE')
            KODE(3)=KIND('LY U')
            KODE(4)=KIND('NSTA')
            KODE(5)=KIND('BLE ')
            GO TO 20
       13   KODE(1)=KIND('SLIG')
            KODE(2)=KIND('HTLY')
            KODE(3)=KIND(' UNS')
            KODE(4)=KIND('TABL')
            KODE(5)=KIND('E   ')
            GO TO 20
       14   KODE(1)=KIND('NEUT')
            KODE(2)=KIND('RAL ')
            KODE(3)=KIND('    ')
            KODE(4)=KODE(3)
            KODE(5)=KODE(3)
            GO TO 20
       15   KODE(1)=KIND('SLIG')
            KODE(2)=KIND('HTLY')
            KODE(3)=KIND(' STA')
            KODE(4)=KIND('BLE ')
            KODE(5)=KIND('    ')
            GO TO 20
```

```
16     KODE(1)=KIND('MODE')
       KODE(2)=KIND('RATE')
       KODE(3)=KIND('LY S')
       KODE(4)=KIND('TABL')
       KODE(5)=KIND('E   ')
20     CONTINUE
       WRITE(IOUT,101)
101    FORMAT(1H1)
       IF(I    .LE.0) IOUT=7
       WRITE(IOUT,100)  WD,WS,JSTAB,(KODE(J),J=1,5),HLID,CONV
100    FORMAT(5X,'WIND DIRECTION IN DEGREES = ',F6.1,10X,'WIND SPEED  = '
     X,F10.2,/5X,'STABILITY CLASS = ',I4,5X,5A4,/5X,'MIXING DEPTH IN FEE
     XT = ',F10.2,/5X,'CONVERSION FACTOR = ',E12.4/)
       IOUT=JOUT
       RETURN
       END
```

```
COMPILER OPTIONS - NAME=   MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
    C*
          FUNCTION KIND(J)
          KIND=J
           RETURN
          END
```

```
COMPILER OPTIONS - NAME=   MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
     C*
            SUBROUTINE NCEPA(XXRR,XXSR,Z,XKST,U,THETA,HL,QLS,CLSS,IFLAG,CONT)
     C         THIS PROGRAM CALCULATES THE CONCENTRATION FROM A LINE SOURCE
     C          AT EACH OF A NUMBER OF RECEPTORS. SUBROUTINE RELCO
     C          IS CALLED WHICH IN TURN CALLS SUBROUTINE SIGMA.
            DIMENSION QLS(30  ),HEAD(20)
            COMMON/TRADE/WIDTH,CNTR,REP1,SEP1,REP2,SEP2,XNL,H
            COMMON /A/ GY(6),GZ(6,5)
            COMMON /B/ XVZ(6),XVY(6)
            IRD=5
            IWRI = 6
         12 FORMAT(8F10.0)
         13 FORMAT(8F10.3)
         14 FORMAT(20A4)
         15 FORMAT('0',20A4,//)
         16 FORMAT(' WIDTH OF AT-GRADE HIGHWAY IS',F10.3,' KM',/,
           1' WIDTH OF CENTER STRIP IS',F10.3,' KM')
         17 FORMAT(' EMISSION RATE (GRAMS/SECOND*METER) OF',I4,' LANE(S) ')
         18 FORMAT(' THE SCALE OF THE COORDINATE AXES IS ',F10.4,' KM'//)
         19 FORMAT(' ENDPOINTS OF THE LINE SOURCE',/,
           1F9.3,',',F9.3,' AND',F9.3,',',F9.3)
     C   20 FORMAT (' WIND DIRECTION IS',F7.0,'  DEGREES',/,' WIND SPEED IS',
     C     1F7.1,' METERS/SEC'/' STABILITY CLASS IS',I5,/,' HEIGHT OF LIMITING
     C     2 LID IS',F8.1,' METERS')
         20 FORMAT(' THETA(EPA)= 90+THETA(ANL)'/' STABILITY CLASS SAME'/' LID
           1HEIGHT',5X,F9.3,' METERS'/' X(EPA)=-Y(ANL),Y(EPA)=-X(ANL)')
         23 FORMAT (' EMISSION HEIGHT IS',F8.3,' METERS')
         28 FORMAT(1H0,'  RECEPTOR LOCATION   RECEPTOR     CONCENTRATION',/,
           1 '       RR',10X,'SR    HEIGHT (M)      GM/METER**3     PPM')
         30 FORMAT(1H ,3(F10.4,2X),F10.0,F10.1)
     C         READ HEADER CARD
     C   35 READ(IRD,14)HEAD
     C      WRITE(IWRI,15)HEAD
     CC     IF(IFLAG.EQ.1)PRINT 678
        678 FORMAT(////' NCEPA DATA IN MKS SYSTEM'//)
     C      READ(IRD,12,END=975) REP1,SEP1,REP2,SEP2,H,WIDTH,CNTR,XNL
     C         REP1,SEP1 ARE THE COORDINATES OF AN END POINT OF THE LINE
     C          SOURCE IN SOURCE COORDINATES.
     C         REP2,SEP2 ARE THE COORDINATES OF THE OTHER END POINT OF THE
     C          LINE SOURCE IN SOURCE COORDINATES.
     C         H IS THE EFFECTIVE EMISSION HEIGHT OF THE SOURCE IN METERS.
     C         WIDTH IS THE HIGHWAY WIDTH (KM) FOR AT GRADE
```

```
C           CNTR IS THE WIDTH OF THE CENTER STRIP (KM)                          00000370
C           XNL IS THE NUMBER OF LANES FOR THE AT-GRADE HIGHWAY.                00000380
C       WRITE(IWRI,19) REP1,SEP1,REP2,SEP2
CC      IF(IFLAG.EQ.1) WRITE(IWRI,19) REP1,SEP1,REP2,SEP2
        NL=XNL                                                                  00000390
        DELW=(WIDTH-CNTR)/XNL                                                   00000410
C       WRITE(IWRI,23) H
CC      IF(IFLAG.EQ.1) WRITE(IWRI,23) H
C       WRITE(IWRI,17) NL
CC      IF(IFLAG.EQ.1) WRITE(IWRI,17) NL
C       READ(IRD,12) (QLS(I),I=1,NL)                                            00000450
C           QLS IS THE LINE SURCE STRENGTH (GRAMS/SECOND*METER)                 00000460
C       WRITE(IWRI,13) (QLS(I),I=1,NL)
CC      IF(IFLAG.EQ.1) WRITE(IWRI,13) (QLS(I),I=1,NL)
C       READ(IRD,12)CUT,XNDL,WIDTC                                              00000480
        CUT=0
C           XNDL IS THE NUMBER OF LINE SOURCES REPRESENTING THE TOP OF THE      00000490
C            CUT SECTION.                                                       00000500
C            WIDTC IS THE WIDTH OF THE TOP OF THE CUT SECTION (KM)              00000510
        IF(CUT.EQ.0.)GOTO101                                                    00000520
C           DQLS IS THE CUT SECTION SOURCE STRENGTH                             00000530
        DQLS=0.                                                                 00000540
        DO 40 I=1,NL                                                            00000550
     40 DQLS=DQLS+QLS(I)                                                        00000560
        NL=XNDL                                                                 00000570
        DQLS=DQLS/NL                                                            00000590
        DELW=WIDTC/XNDL                                                         00000600
C       WRITE(IWRI,29)WIDTC                                                     00000610
     29 FORMAT(' WIDTH OF TOP OF CUT SECTION IS',F10.3,' KM')                   00000620
        DO100I=1,NL                                                             00000630
    100 QLS(I)=DQLS                                                             00000640
C       GOTO102                                                                 00000650
    101 CONTINUE
C   101 WRITE(IWRI,16) WIDTH,CNTR
CC      IF(IFLAG.EQ.1) WRITE(IWRI,16) WIDTH,CNTR
C   102 READ(IRD,12) THETA,U,HL,XKST                                            00000670
        KST=XKST                                                                00000680
C           THETA IS THE WIND DIRECTION IN DEGREES.                             00000690
C           U IS THE WIND SPEED IN METERS PER SECOND.                           00000700
C           KST IS THE STABILITY CLASS                                          00000710
C           HL IS THE HEIGHT OF THE LIMITING LID                                00000720
C       WRITE (IWRI,20) THETA,U,KST,HL
CC      IF(IFLAG.EQ.1) PRINT 20,HL
C       READ(IRD,12) GS                                                         00000740
C           GS IS THE MEASURE BETWEEN COORDINATES (KM).                         00000750
        GS=1.0
```

```
C       WRITE(IWRI,18) GS
CC      IF(IFLAG.EQ.1)WRITE(IWRI,18) GS
C       WRITE(IWRI,28)
CC      IF(IFLAG.EQ.1)WRITE(IWRI,28)
C            CONVERT COORDINATE SYSTEM SO THAT HIGHWAY
C              IS ORIENTATED ALONG ZERO DEGREES (MATH SYSTEM)
        X1=REP1
        Y1=SEP1
        X2=REP2
        Y2=SEP2
        DX=X2-X1
        DY=Y2-Y1
        DANG=0.0
        ANGH=0.0
CC      CALL ATH(DX,DY,ANGH,DANG)
CC      REP1=Y1*SIN(ANGH)+X1*COS(ANGH)
CC      SEP1=Y1*COS(ANGH)-X1*SIN(ANGH)
CC      REP2=Y2*SIN(ANGH)+X2*COS(ANGH)
CC      SEP2=Y2*COS(ANGH)-X2*SIN(ANGH)
C           CONVERT WIND DIRECTION WRT HIGHWAY
        THETA=THETA+DANG
        IF(THETA.LT.0.)THETA=THETA+360.
        IF(THETA.GE.360.)THETA=THETA-360.
        T =THETA/57.2958
C           T IS THE WIN DIRECTION IN RADIANS
        SINT=SIN(T)
        COST=COS(T)
C           SINT AND COST ARE THE SINE AND COSINE OF THE WIND DIRECTION
C           P IS THE LENGTH OF THE LINE SOURCE
        P=(((REP2-REP1)*(REP2-REP1)+(SEP2-SEP1)*(SEP2-SEP1))**0.5)*GS
C    75 READ(IRD,12,END=975)XXRR,XXSR,Z
C           XXRR,XXSR ARE THE COORDINATES OF THE RECEPTOR
C           Z IS THE RECEPTOR HEIGHT IN METERS
C       IF(XXRR.EQ.9999.)GOTO35
        CNTS=0.
        CLS=0.
C           CONVERT RECEPTOR COORDINATES WRT HIGHWAY
CC      XRR=XXSR*SIN(ANGH)+XXRR*COS(ANGH)
```

```
CC    XSR=XXSR*COS(ANGH)-XXRR*SIN(ANGH)
        XRR=XXRR
       XSR=XXSR
      RR=XRR
      DO600IL=1,NL
      IF(CUT.NE.0.)GOTO76
      IF(IL.GT.NL/2.AND.IL.NE.1)CNTS=CNTR
   76 IF(THETA.GT.90..AND.THETA.LE.270.)GOTO77
      SR=XSR-DELW*(IL-1)-CNTS
      GOTO78
   77 SR=XSR+DELW*(IL-1)+CNTS
   78 FSTD=0.
C        CALCULATE DOWNWIND AND CROSSWIND DISTANCES OF RECEPTOR IR,IS
C         FOR THE ENDPOINTS OF THE LINE SOURCE
      R1=(REP1-RR)*GS
      S1=(SEP1-SR)*GS
      R2=(REP2-RR)*GS
      S2=(SEP2-SR)*GS
      X1=R1*SINT+S1*COST
      Y1=S1*SINT-R1*COST
      X2=R2*SINT+S2*COST
      Y2=S2*SINT-R2*COST
C        X1,Y1 ARE THE DOWNWIND AND CROSSWIND DISTANCES (KM)
C         OF RECEPTOP IR,IS FROM ENDPOINT REP1,SEP1 OF THE LINE SOURCE
C        X2,Y2 ARE THE DOWNWIND AND CROSSWIND DISTANCES (KM)
C         OF RECEPTOP IR,IS FROM ENDPOINT REP2,SEP2 OF THE LINE SOURCE
C        TEST FOR AT LEAST ONE ENDPOINT UPWIND OF RECEPTOR - OTHERWISE,
C         CONCENTRATION  = 0.
C        CHECK FOR RECEPTOR DOWNWIND OF SOURCE.  IF NOT, SET CONC. = 0.
C         ELIMINATES THAT PORTION OF THE LINE SOURCE
C         WHICH IS DOWNWIND OF THE RECEPTOR
      IF(X1)4402,105,4403
 4403 IF(X2)4404,110,110
 4404 Y2=Y2-(Y2-Y1)/(X2-X1)*X2
      X2=0.
      D=(X1*X1+(Y2-Y1)**2)**.5
      GOTO110
```

```
 4402 IF(X2) 500,500,4405
 4405 Y1=Y1-(Y2-Y1)/(X2-X1)*X1
      X1=0.
      P=(X2*X2+(Y2-Y1)**2)**.5
      GOTO110
  105 IF(X2)  500,110,110
C          CHECK FOR RECEPTOR BETWEEN CENTERLINE OF PLUMES FROM ENDPOINTS.
C            IF IT IS DIVIDE SOURCE INTO TWO SEGMENTS (INDX=2), GO TO 150.
  110 IF(Y1)  112,120,112
  112 IF(Y2)  115,120,115
  115 Y3=SIGN(Y1,Y2)
      IF(Y3-Y1)  150,120,150
  120 XA=X1
      XB=X2
      YA=Y1
      YB=Y2
      PP=P
      INDX=1
      GO TO 210
  150 XA=X1
      YA=Y1
      XP=X1+(X2-X1)*ABS(Y1)/(ABS(Y1)+ABS(Y2))
      XB=XP
      YB=0.
      PP=P*ABS(Y1)/(ABS(Y1)+ABS(Y2))
      INDX=2
  210 M=0
      DX=XB-XA
      DY=YB-YA
      XZA=XA+XVZ(KST)
      XZB=XB+XVZ(KST)
      XYA=XA+XVY(KST)
      XYB=XB+XVY(KST)
      ESTP=0.0
      CALL RELCO(U,Z,H,HL,XZA,XYA,YA,KST,AN,RC1)
      CALL RELCO(U,Z,H,HL,XZB,XYB,YB,KST,AN,RC2)
      CURR=(RC1+RC2)*PP/2.
      IF(CURR)  215,215,220
```

```
  215 ESTC=0.0
      GO TO 300
  220 PREV=CURR
      SUBT=0.0
      M=2*M+1
      DX=DX/2.
      DY=DY/2.
      DO 250 K=1,M,2
      X=XA+K*DX
      Y=YA+K*DY
      XZ=X+XVZ(KST)
      XY=X+XVY(KST)
      CALL RELCO(U,Z,H,HL,XZ,XY,Y,KST,AN,RC)
  250 SUBT=SUBT+RC
      CURR=PREV/2.+SUBT*PP/(M+1)
      ESTC=(4.*CURR-PREV)/3.
      IF(ESTC-1.E-10) 215,215,255
C        ESTC AND ESTP ARE CURRENT AND PREVIOUS RICHARDSON'S
C         EXTRAPOLATIONS.
  255 RAT=ABS((ESTC-ESTP)/ESTC)
C        RAT IS A COMPARISON BETWEEN THE CURRENT AND PREVIOUS VALUES.
C         WHEN RAT BECOMES LESS THAN 0.02 THE CURRENT VALUE IS ACCEPTED
C         FOR THE VALUE OF THE INTEGRAL.
      IF(RAT-0.005) 300,260,260
  260 ESTP=ESTC
      GO TO 220
  300 ESTD=ESTC+ESTD
      IF(INDX-1) 500,500,310
  310 XA=XP
      YA=0.
      XB=X2
      YB=Y2
      PP=P*ABS(Y2)/(ABS(Y1)+ABS(Y2))
      INDX=1
      GO TO 210
  500 CLSS=ESTD*QLS(IL)*1000.
  600 CLS=CLS+CLSS*1000000.
      CLSS=CONT*CLS
C     WRITE(IWRI,30) XXRR,XXSR,Z,CLS,CLSS
C     GO TO 75
C 975 CALL EXIT
      RETURN
      END
```

```
COMPILER OPTIONS - NAME=  MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
C*
      SUBROUTINE RELCO (U,Z,H,HL,X,XY,Y,KST,AN,RC)
      COMMON /A/ GY(6),GZ(6,5)
      COMMON /B/ XVZ(6),XVY(6)
C        SUBROUTINE RELCO CALCULATES CHI/Q CONCENTRATION VALUES, RELCO
C         CALLS UPON SUBROUTINE SIGMA TO OBTAIN STANDARD DEVIATIONS.
C        THE INPUT VARIABLES ARE....
C         U     WIND SPEED (M/SEC)
C         Z     RECEPTOR HEIGHT (M)
C         H     EFFECTIVE STACK HEIGHT (M)
C         HL=L HEIGHT OF LIMITING LID (M)
C         X     DOWNWIND DISTANCE FOR CALCULATING SIGMAZ (KM)
C         XY    DOWNWIND DISTANCE FOR CALCULATING SIGMAY (KM)
C         Y     DISTANCE RECEPTOR IS CROSSWIND FROM SOURCE (KM)
C         KST  STABILITY CLASS
C        THE OUTPUT VARIABLES ARE....
C         AN    THE NUMBER OF TIMES THE SUMMATION TERM IS EVALUATED
C                AND ADDED IN.
C         RC    RELATIVE CONCENTRATION (SEC/M**3)
C        THE FOLLOWING EQUATION IS SOLVED
C           RC = (1/(2*PI*U*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                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        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        IWRI IS CONTROL CODE FOR OUTPUT
      IWRI = 6
C        IF X IS LESS THAN ZERO,    SET RC=0. AND RETURN.  THIS AVOIDS
C         PROBLEMS OF INCORRECT VALUES NEAR THE SOURCE.
      IF(X-XVZ(KST))30,5,5
    5 IF(XY) 30,300,300
C        CALL SIGMA TO OBTAIN VALUES FOR SY AND SZ
  300 CALL SIGMA (X,XY,KST,SY,SZ)
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        INITIAL VALUE OF AN SET = 0.
      AN=0.
```

```
C         IF THE RECEPTOR IS ABOVE THE LID, WRITE THAT OUT, SET RC = 0.
C          AND RETURN.
      IF(Z-HL) 10,10,20
   20 CONTINUE
C  20 WRITE(IWRI,1)
    1 FORMAT(1X,'RECEPTOR HIGHER THAN LID')
   30 RC=0.
      RETURN
C         IF THE SOURCE IS ABOVE THE LID, SET RC = 0., AND RETURN.
   10 IF(H-HL) 40,40,30
C         YD IS CROSSWIND DISTANCE IN METERS.
C         STATEMENTS 40 TO 250 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).  IF 'AN' BECOMES GREATER THAN 45, A LINE OF OUTPUT IS
C          PRINTED INFORMING OF THIS.
   40 YD = 1000.*Y
      C1 = 0.5*(YD/SY)*(YD/SY)
      IF(C1-50.)50,30,30
   50 A1=1./(6.28318*U*SY*SZ*EXP(C1))
      C2=2.*SZ*SZ
      CA = Z-H
      CB = Z+H
      C3 = CA*CA/C2
      C4 = CB*CB/C2
      IF(C3-50.) 60,70,70
   60 A2=1./EXP(C3)
      GO TO 80
   70 A2=0.
   80 IF(C4-50.) 90,100,100
   90 A3=1./EXP(C4)
      GO TO 110
  100 A3=0.
  110 SUM=0.
      THL = 2.* HL
```

```
120 AN=AN+1.
    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(C6-50.) 130,140,140
130 A4=1./EXP(C6)
    GO TO 150
140 A4=0.
150 IF(C7-50.) 160,170,170
160 A5=1./EXP(C7)
    GO TO 180
170 A5=0.
180 IF(C8-50.) 190,200,200
190 A6=1./EXP(C8)
    GO TO 210
200 A6=0.
210 IF(C9-50.) 220,230,230
220 A7=1./EXP(C9)
    GO TO 240
230 A7=0.
240 T=A4+A5+A6+A7

    SUM=SUM+T
    IF(T-0.01) 250,260,260
260 IF(AN-45.) 120,270,270
270 CONTINUE
C 270 WRITE(IWRI,2) X,Y,H,T,SUM
  2 FORMAT(1X,'N GREATER THAN 45',/,6X,'X = ',F7.0,5X,'Y = ',F7.0,5X,
   1'H = ',F5.1,5X,'T = ',F7.2,5X,'SUM = ',F7.3)
250 RC=A1*(A2+A3+SUM)
    RETURN
    END
```

```
COMPILER OPTIONS - NAME=   MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
C*
      SUBROUTINE SIGMA(X,XY,KST,SY,SZ)
      COMMON /A/ GY(6),GZ(6,5)
      AZ=X*1000.
      AY=XY*1000.
      IF(AZ-5000.)641,643,640
  640 IZ=1
      GOTO644
  641 IF(AZ.GE.500.) GOTO643
      IZ=3
      GOTO644
  643 IZ=2
  644 SZ=GZ(IZ,KST)*AZ**GZ(IZ+3,KST)
      SY=GY(KST)*AY**0.903
      RETURN
      END
```

```
COMPILER OPTIONS - NAME=   MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
C*
      SUBROUTINE ATH(DX,DY,ANGH,DANG)
      RAD=57.2958
      IF(DX)5,6,7
    5 IF(DY.EQ.0.)GOTO9
      ANGH=ATAN2(DY,DX)*RAD+180.
      GOTO16
    9 ANGH=180.
      GOTO16
    6 IF(DY) 10,11,12
   10 ANGH=270.
      GOTO16
   11 ANGH=0.
      GOTO16
   12 ANGH=90.
      GOTO16
    7 IF(DY) 13,14,15
 13   ANGH=ATAN2(DY,DX)*RAD+360.
      GOTO16
C  14 ANGH=360.
   14 ANGH=0.
      GOTO16
 15   ANGH=ATAN2(DY,DX)*RAD
   16 DANG=ANGH
      ANGH=ANGH/RAD
      RETURN
      END
COMPILER OPTIONS - NAME=   MAIN,OPT=00,LINECNT=57,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
C*
      BLOCK DATA
      COMMON /A/ GY(6),GZ(6,5)
      DATA GY/0.4,0.295,0.2,0.13,0.098/
      DATA GZ/2*0.0002539,0.0383,2*2.0886,1.2812,2*0.04936,0.1393,
     A2*1.1137,0.9467,0.1154,0.1014,0.112,0.9109,0.926,0.91,0.7368,
     B0.2591,0.0856,0.5642,0.6869,0.865,1.2969,0.2527,0.0818,
     C0.4421,0.6341,0.8155/
      COMMON /B/ XVZ(6),XVY(6)
      DATA XVZ/0.012,0.012,0.017,0.027,0.035,0.058/
      DATA XVY/.009,.013,.020,.032,.044,.044/
      END
```