A MODEL FOR PREDICTING AIR QUALITY ALONG HIGHWAYS

by

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ABSTRACT

The subject of this report is an air quality prediction model for highways, AIRPOL — Version 2, July 1973. AIRPOL has been developed by modifying the basic Gaussian approach to gaseous dispersion. The resultant model is smooth and continuous throughout its entire range, which adds mathematical credence to its applicability.

AIRPOL has the capability to model a wide variety of real-world highway pollution problems. It can handle elevated, depressed, and at-grade roadways. It can be used to analyze any number of lanes for divided or undivided highways as well as ramps and service roads. AIRPOL is even capable of making an analysis of concentrations upwind from a pollution source.

Field studies have been initiated to verify AIRPOL — Version 2 and to provide empirical information should future modifications be necessary. The limited test data available so far indicate a satisfactory correlation between observed and predicted CO levels.

The computer program AIRPOL has been structured such that it can easily be modified to accept upgraded data on emission factors for CO, HC, and NO_x as they become available. Furthermore, should future modifications to the model be necessary, the modular design of AIRPOL will simplify the transition from Version 2 to Version 3.

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HISTORY

1.0 The Federal Highway Act of 1970 requires an environmental impact statement for each federally funded highway project. The statement must include a quantitative analysis of the impact of the highway on the air quality in the area of the proposed project.

1.1 In the fall of 1971, the Council was requested by the Department to initiate the development of a dispersion model to comply with the requirements of the 1970 act. The result of this initial attempt was a method essentially similar to, but without the refinement and sophistication of, the APRAC Model, which was then still under active development by the Stanford Research Institute. This method was abandoned in favor of AIRPOL — Version 1, which was prepared by the Research Council and submitted to the Department in September, 1972. Since that time, research has continued on the AIRPOL project and an upgraded model, AIRPOL — Version 2, July 1973, has been developed and submitted. This report explains the development and application of AIRPOL — Version 2, July 1973.

MATHEMATICAL DEVELOPMENT

2.0 A survey of the literature and inquiries to other highway departments revealed that the classical Gaussian dispersion process was considered to be the most promising basis for a general highway dispersion model. [1, 2, 3, 4] The Gaussian process was initially conceived as a model of downwind concentrations from a point source. Since modeling of emissions from a highway requires some sort of line source model, it was felt an integration of the Gaussian process should be suitable. However, the equations for the Gaussian point source model are not directly integrable in the general case. Furthermore, because of the interdependence of the variables in the Gaussian model and the complexity of the integration, numerical techniques were considered too inefficient an approach to solving the line source problem. Therefore, AIRPOL employes the simplified technique of finding a point source equivalent to a given highway line source and then using a Gaussian point source process to determine concentrations.

The remainder of this section outlines the mathematical philosophy in progressing from the basic Gaussian technique to the final AIRPOL model. Article 2.1 describes the fundamental Gaussian process for point source emissions.

Articles 2.2 and 2.3 discuss the method of establishing the source strength and location of a point source equivalent to a given highway source. In articles 2.4 and 2.5 the geometric arguments for finding downwind travel distances and vertical and horizontal offsets to enable calculation of concentration profiles are presented. Article 2.6 develops the extension of the basic model to the stage necessary to model the depressed roadway situation. In article 2.7 the model is further extrapolated to encompass upwind as well as downwind concentration profiles. Article 2.8 concludes the mathematical development with the presentation of the terminal AIRPOL equations in their complete form.

2.1 The basic Gaussian model for point source emissions assumes (see Figures 1 and 2) that gaseous concentrations will be normally distributed about the centerline of a plume in both the vertical and horizontal directions and that the standard deviations of these distributions, SZ* and SH*, will be functions of travel distance and atmospheric stability (see Figures 3 and 4). Furthermore (see Figure 5), the model assumes that the ground acts as a perfect reflector of gaseous pollutants, thus producing a concentration increase due to the summation of actual and virtual source emissions. Thus, the concentration, CO, at any observer point (X_o, Y_o, Z_o) from a source point (X_s, Y_s, Z_s) with the wind parallel to the X axis will be

$$CO \propto \left(\frac{Q_p}{WS}\right) \cdot \left(\frac{e^{-\frac{1}{2}\left(\frac{Y_s-Y_o}{SH}\right)^2}}{SH}\right) \cdot \left(\frac{e^{-\frac{1}{2}\left(\frac{Z_s-Z_o}{SZ}\right)^2} + e^{-\frac{1}{2}\left(\frac{Z_s+Z_o}{SZ}\right)^2}}{SZ}\right) \quad \ldots\ldots (1)$$

where:

Q_p is the point source emission strength (mass/time)
WS is the wind speed (length/time)
SH and SZ are the dispersion parameters (length), and are functions of $|X_s - X_o|$ and atmospheric stability (see sections 2.4 and 2.5)
CO is the observed concentration (mass/length^3)

Now, suppose a technique could be established for determining the location and emission strength of a point source equivalent to a given highway line source, then one would be able to apply the basic Gaussian model to predict highway proximity concentrations. The California Division of Highways, Department of Materials Research has provided curves (approved by the EPA) for determining Q, the line-source emission strength, (mass/length · time) as a function of vehicle mix, vehicle speed, traffic volume, and roadway type (see Figures 6 through 21). (These curves have been computerized for use in the AIRPOL model.) Now, if Q is multiplied by some appropriate roadway length, LFACTR, then the product would be equivalent to a point source, Q_p (units of mass/time).

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*Throughout the text of this report, variable names given in all capitals refer directly to the variables in the program, AIRPOL — Version 2, July 1973. (See Appendix A-1.)

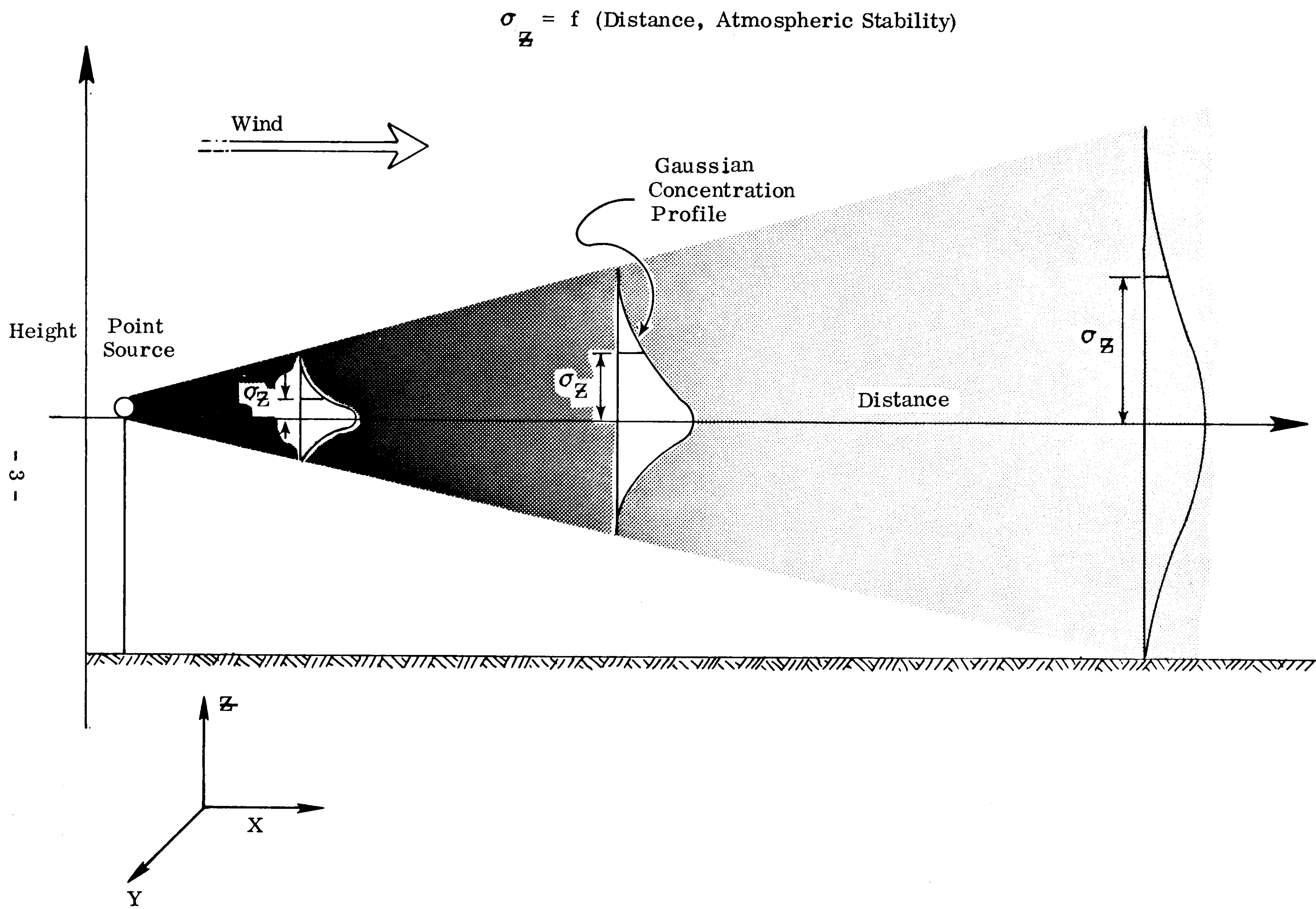

Figure 1. Verticle dispersion according to Gaussian formulation.

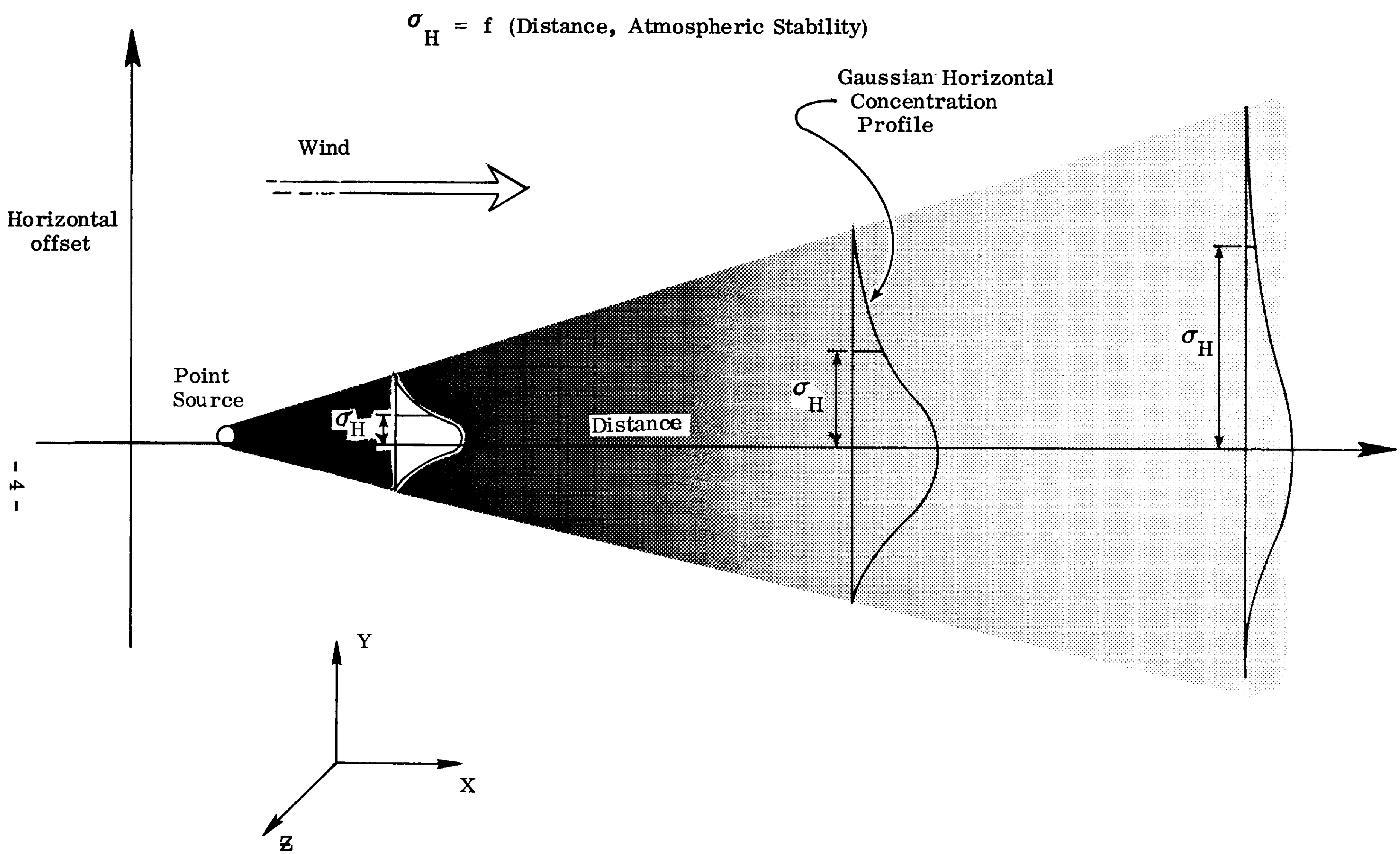

Figure 2. Horizontal dispersion according to Gaussian formulation.

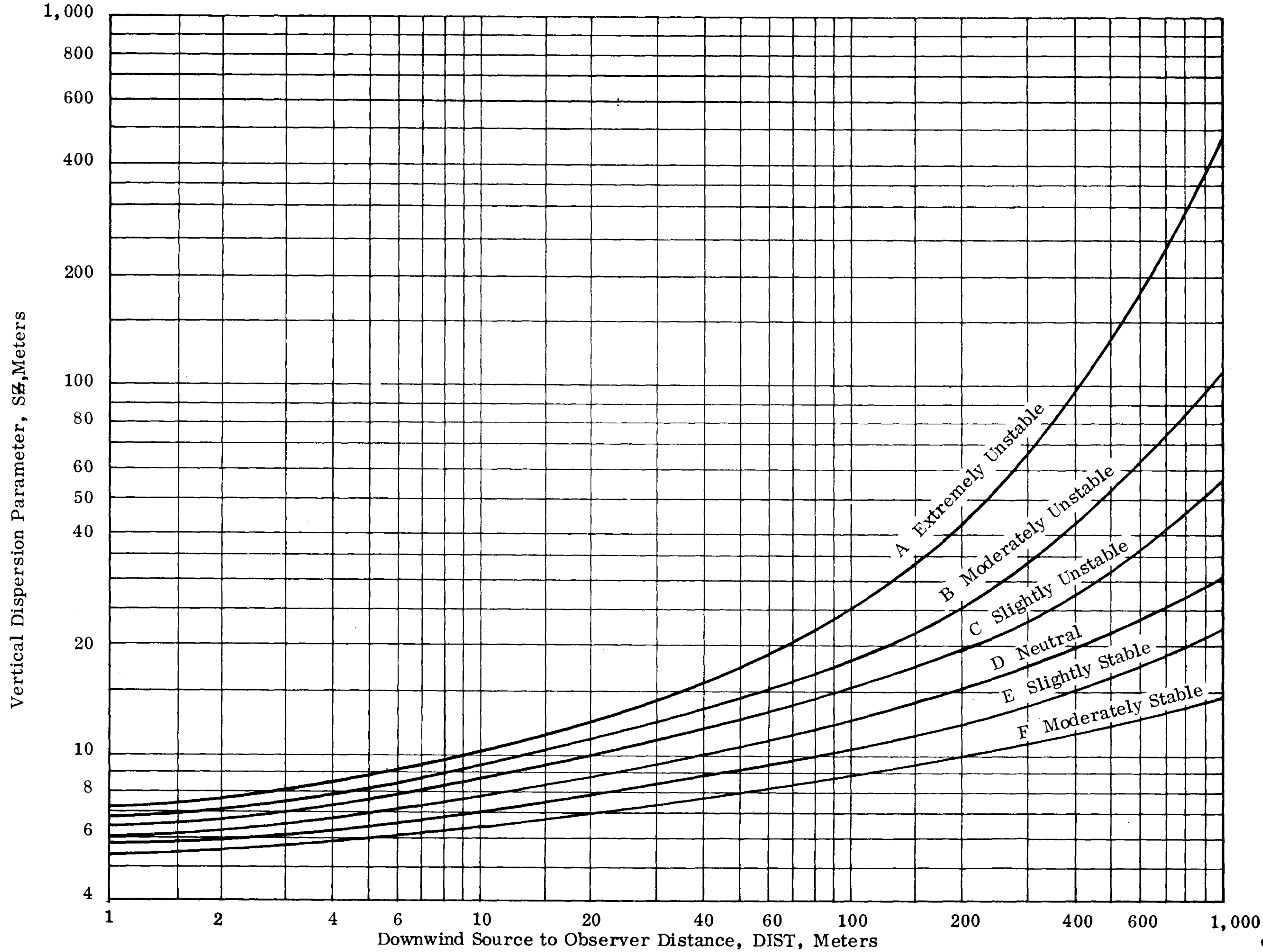

Figure 3. Vertical dispersion parameters.

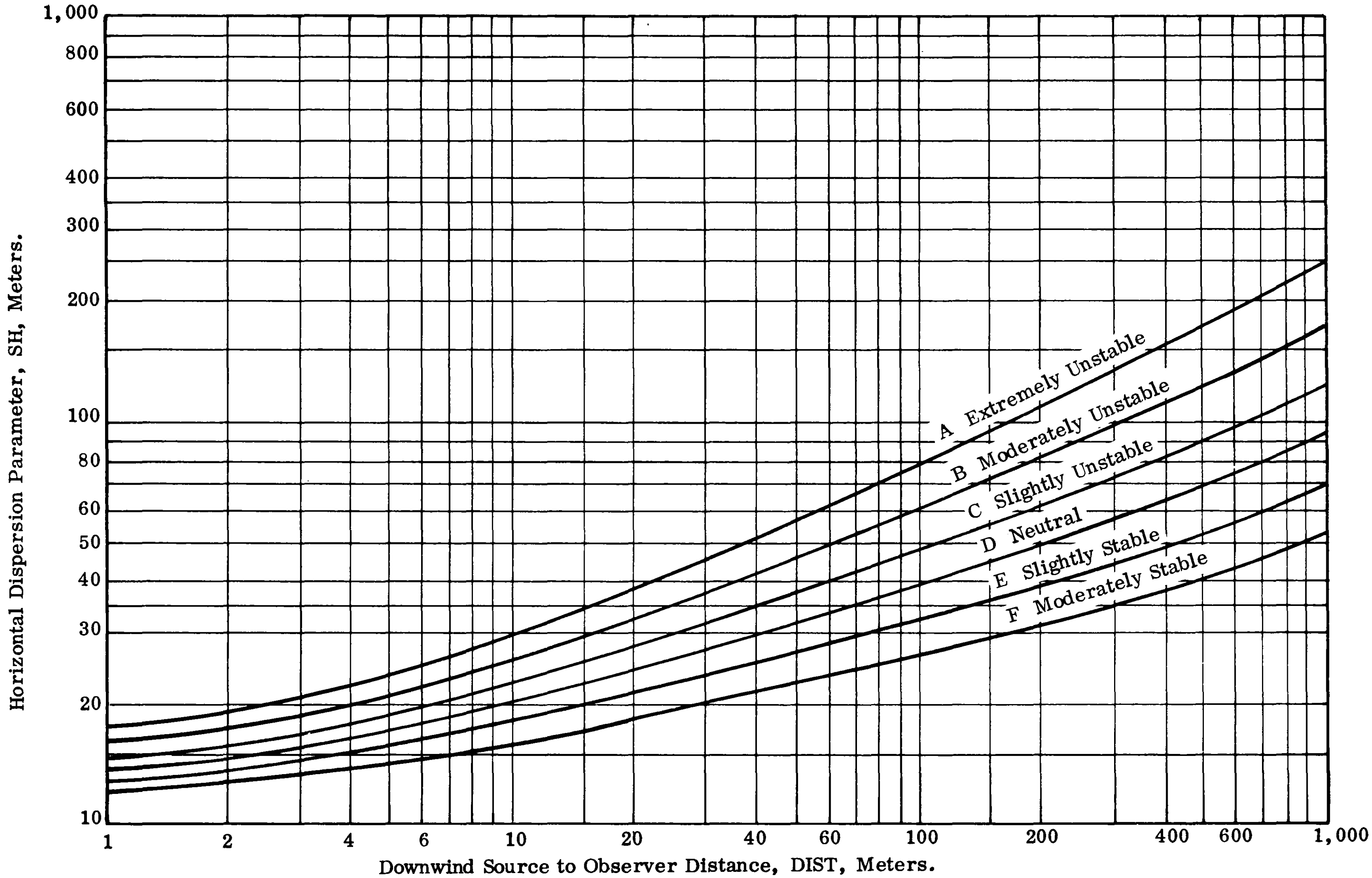

Figure 4. Horizontal dispersion parameters.

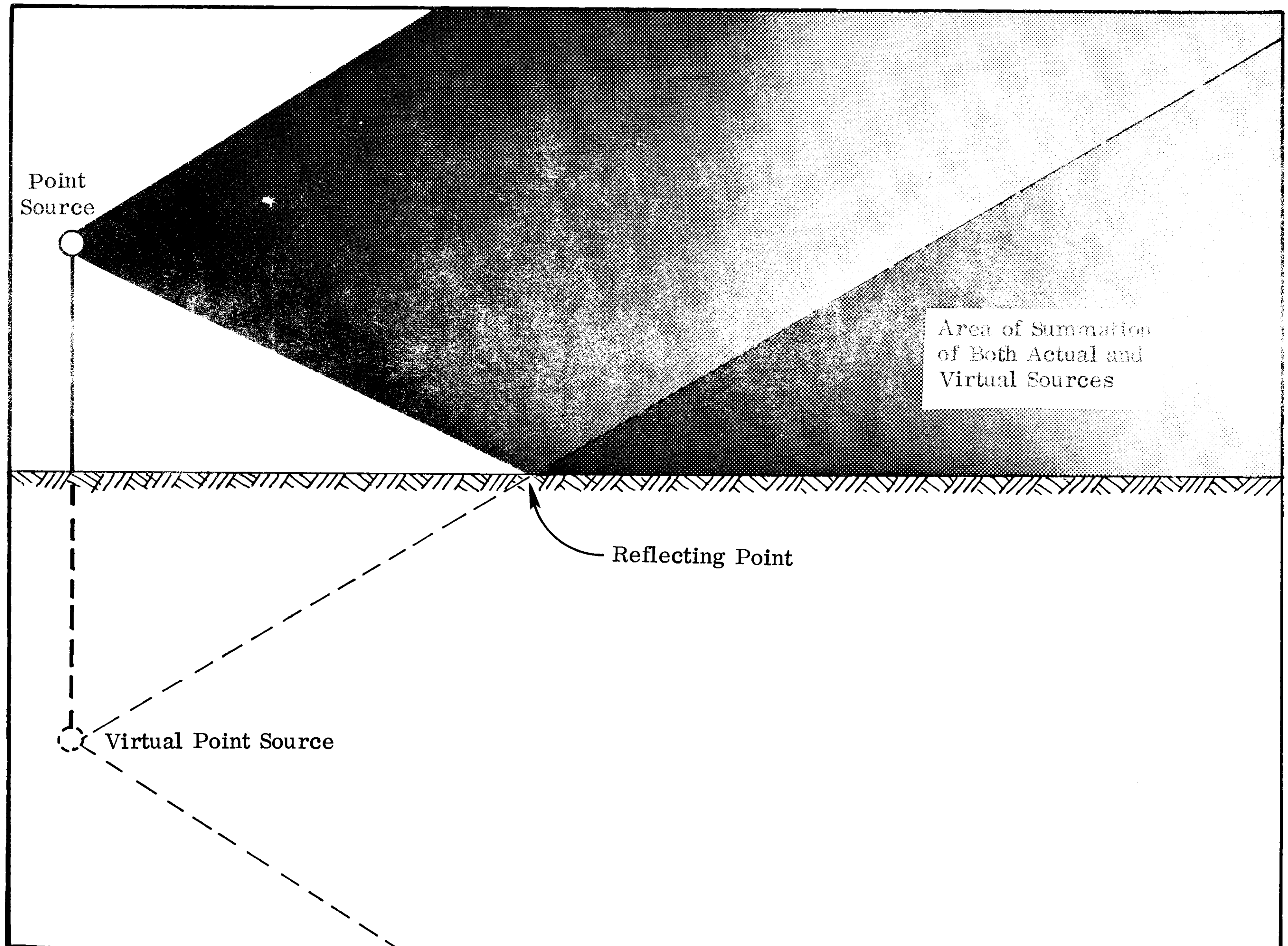

Figure 5. Influence of a virtual point source due to reflection.

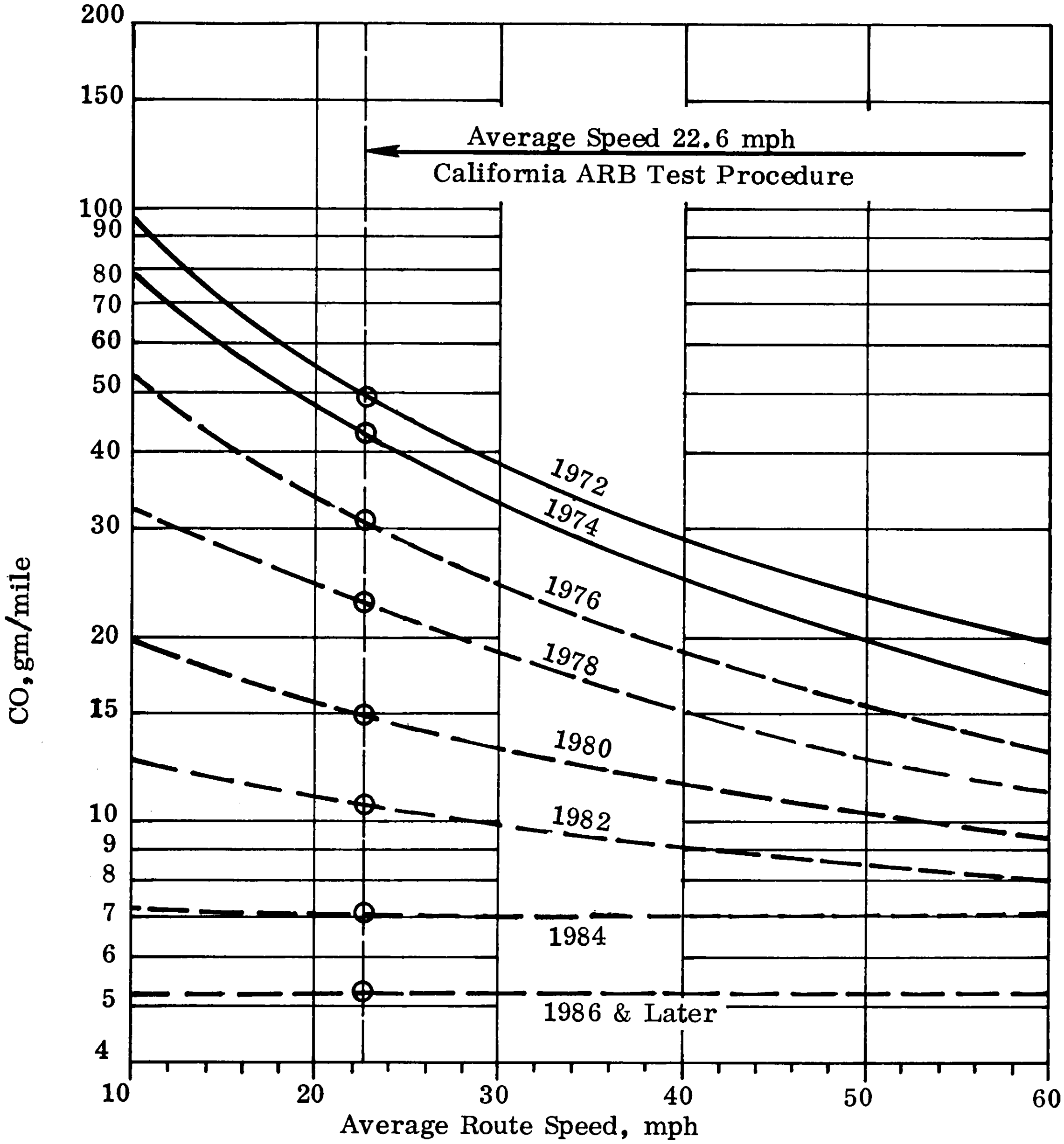

Figure 6. Emission factors for carbon monoxide vs. average route speed on freeways — 5% heavy duty vehicles.

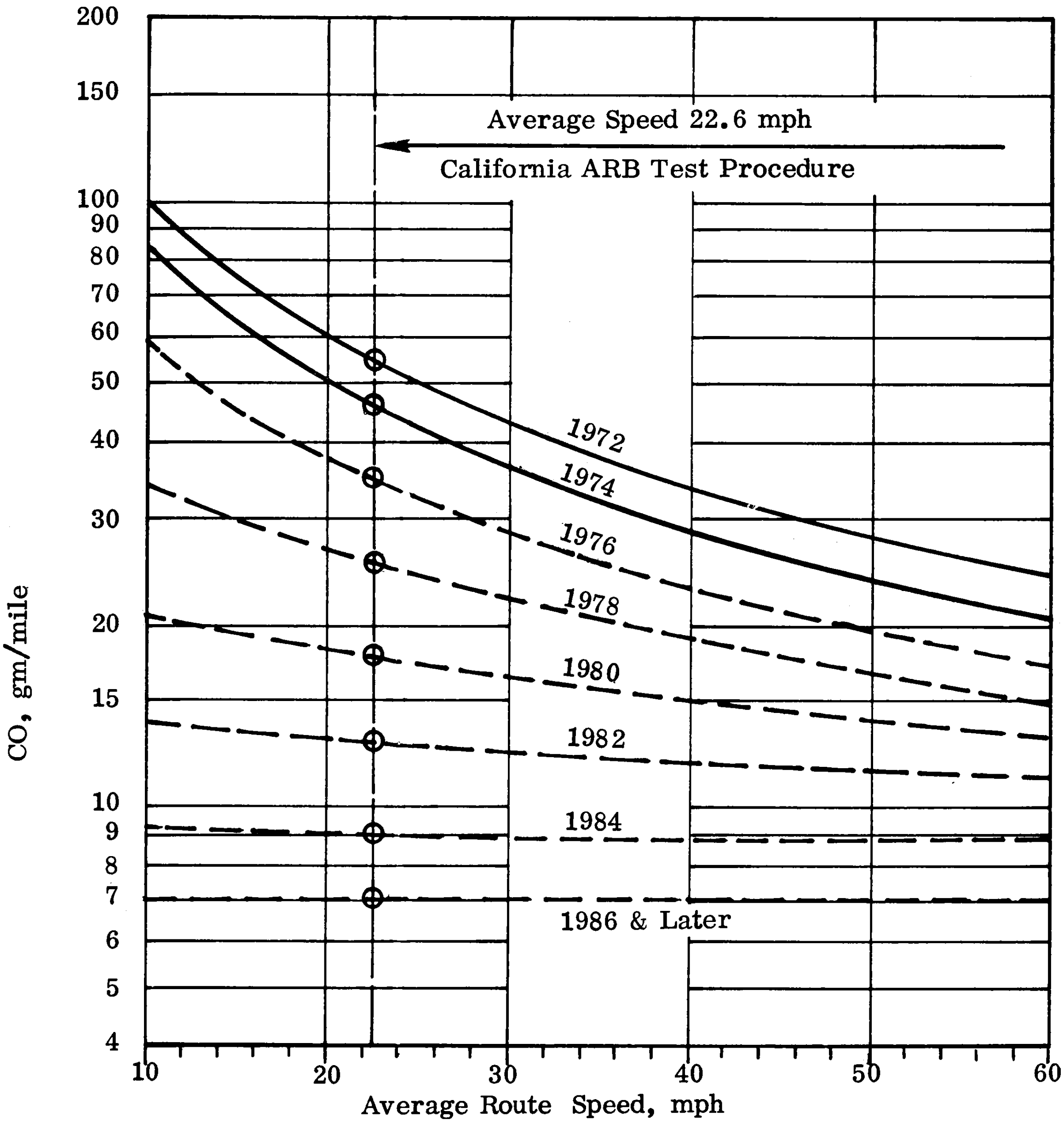

Figure 7. Emission factors for carbon monoxide vs. average route speed on freeways — 10% heavy duty vehicles.

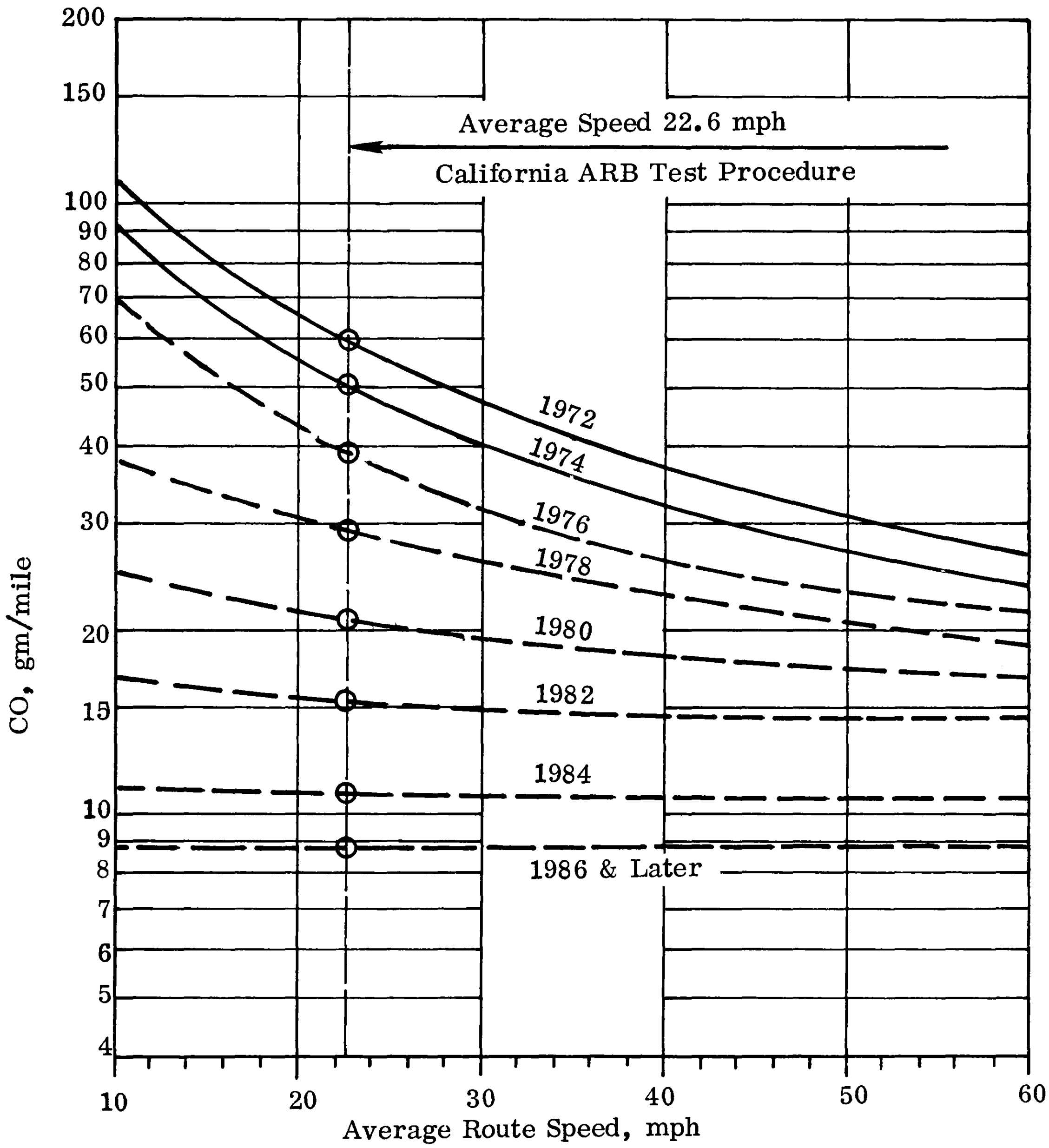

Figure 8. Emission factors for carbon monoxide vs. average route speed on freeways — 15% heavy duty vehicles.

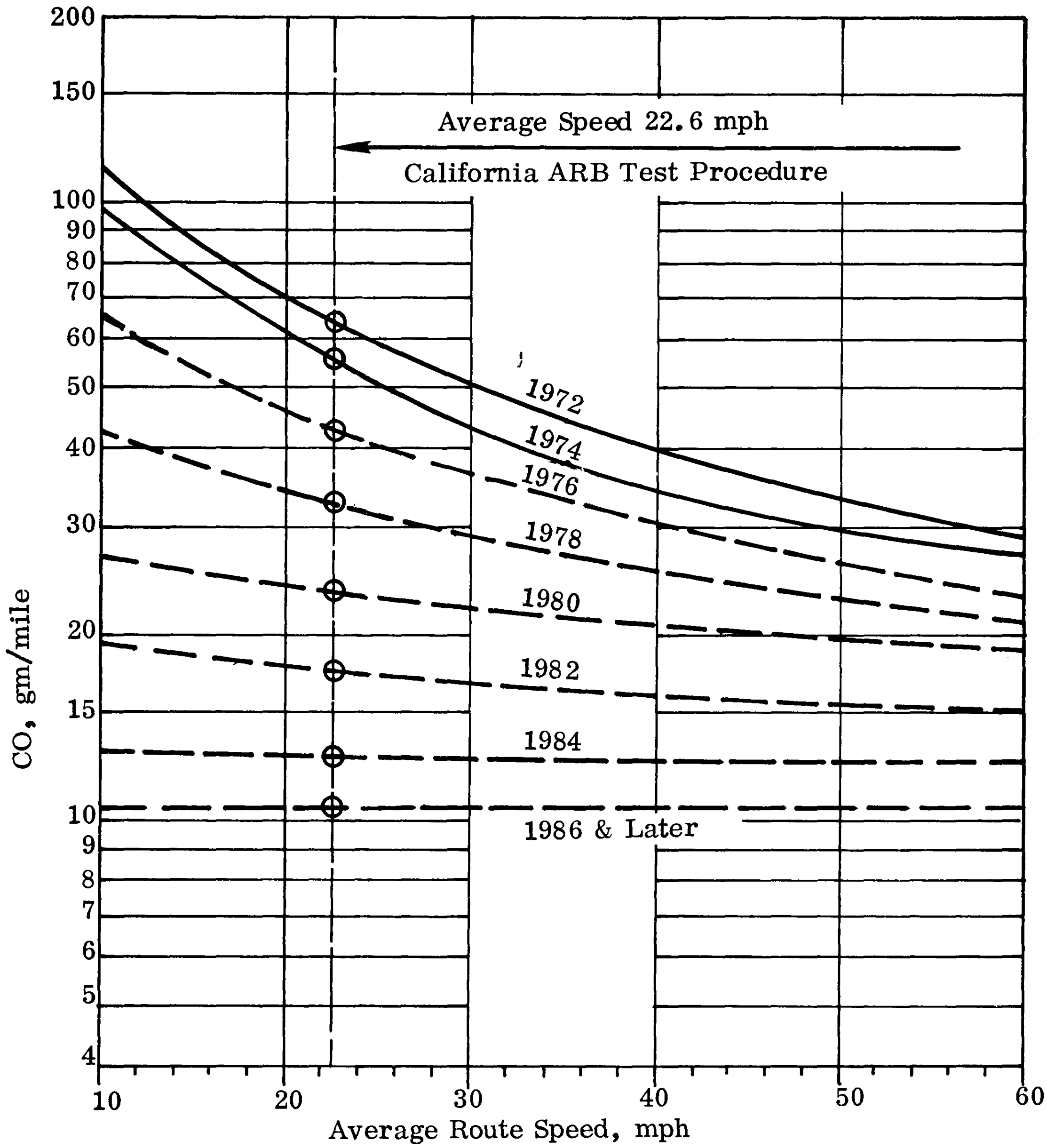

Figure 9. Emission factors for carbon monoxide vs. average route speed on freeways — 20% heavy duty vehicles.

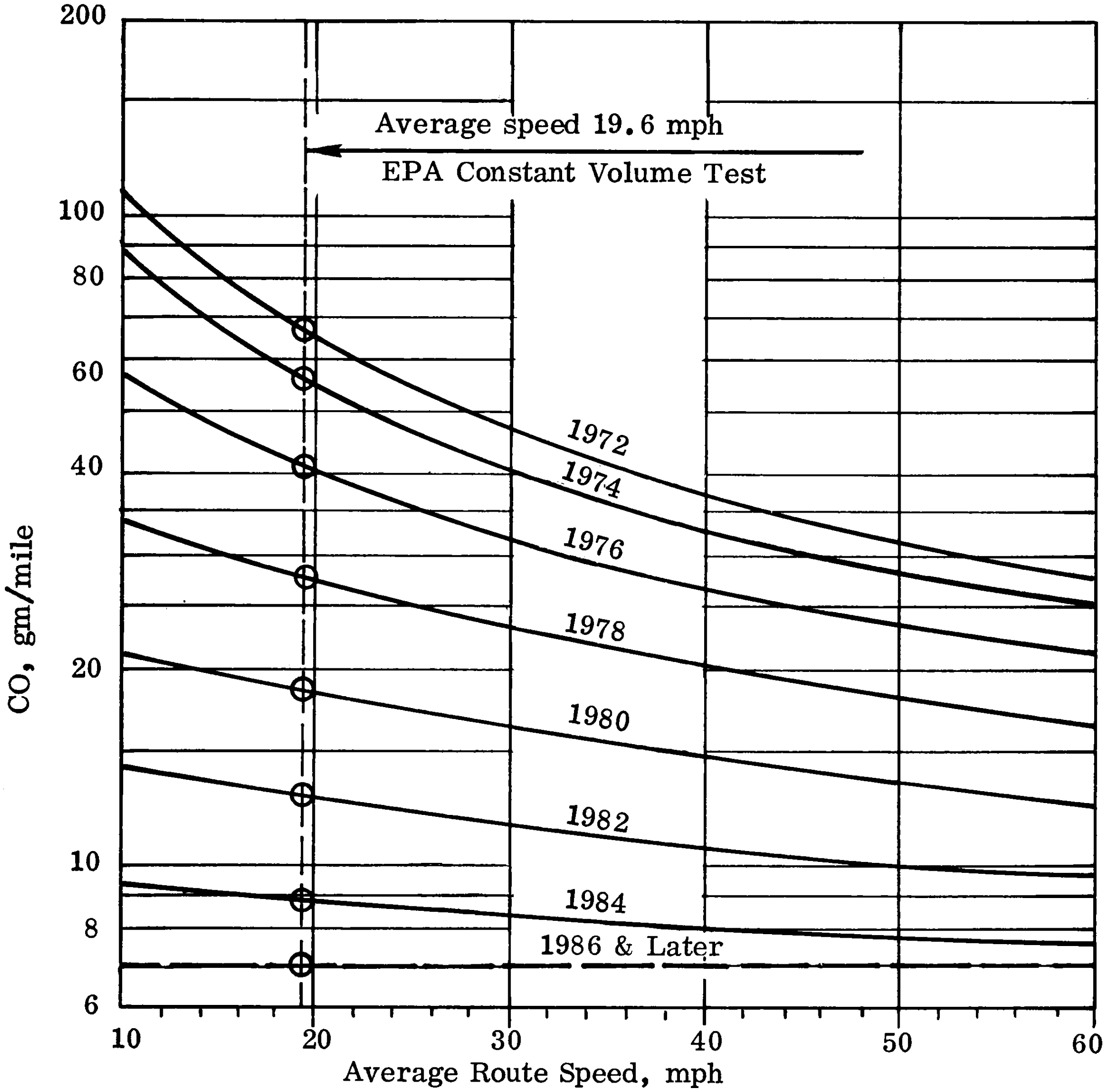

Figure 10. Emission factors for carbon monoxide vs. average route speed on city streets — 5% heavy duty vehicles.

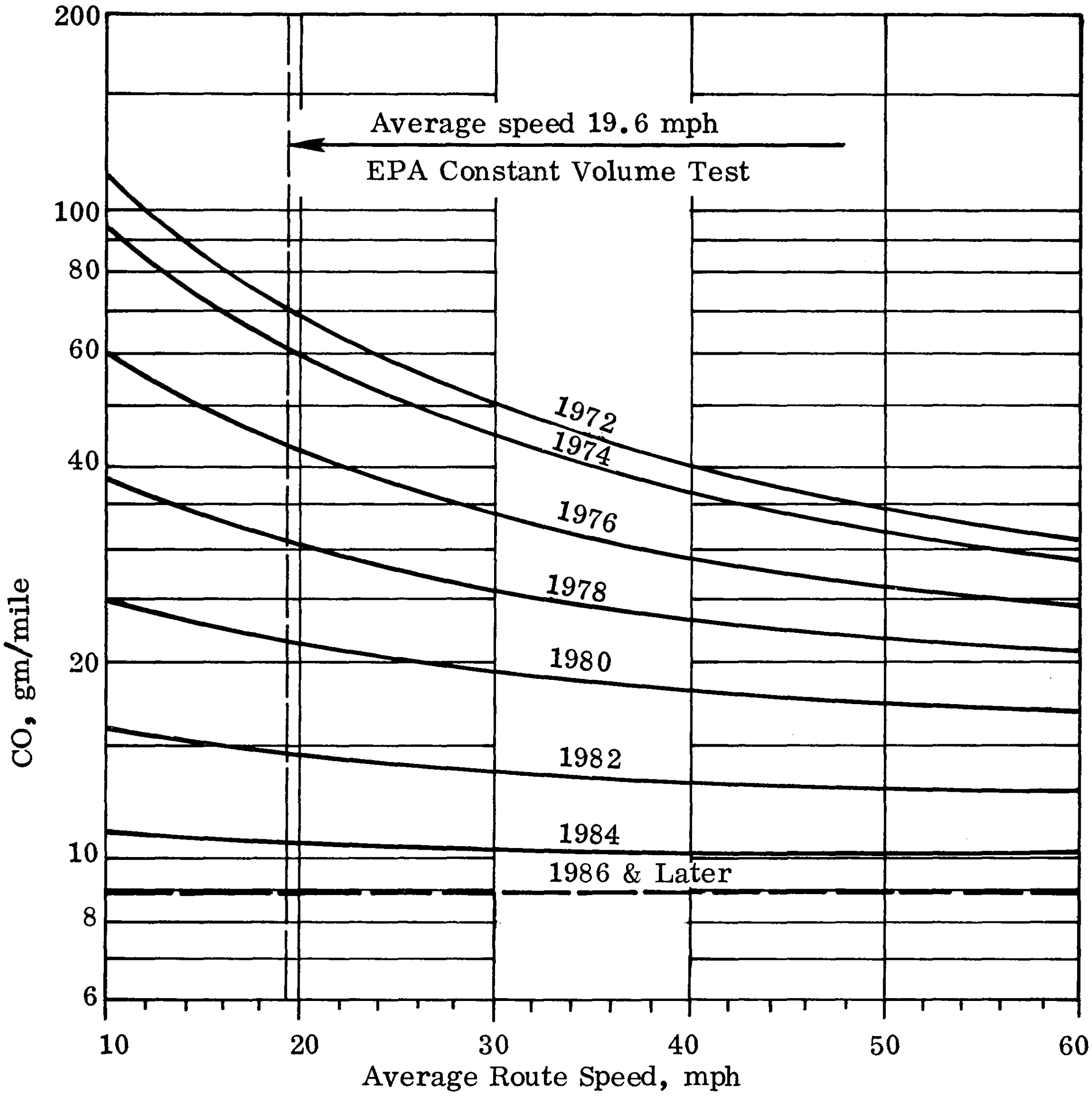

Figure 11. Emission factors for carbon monoxide vs. average route speed on city streets — 10% heavy duty vehicles.

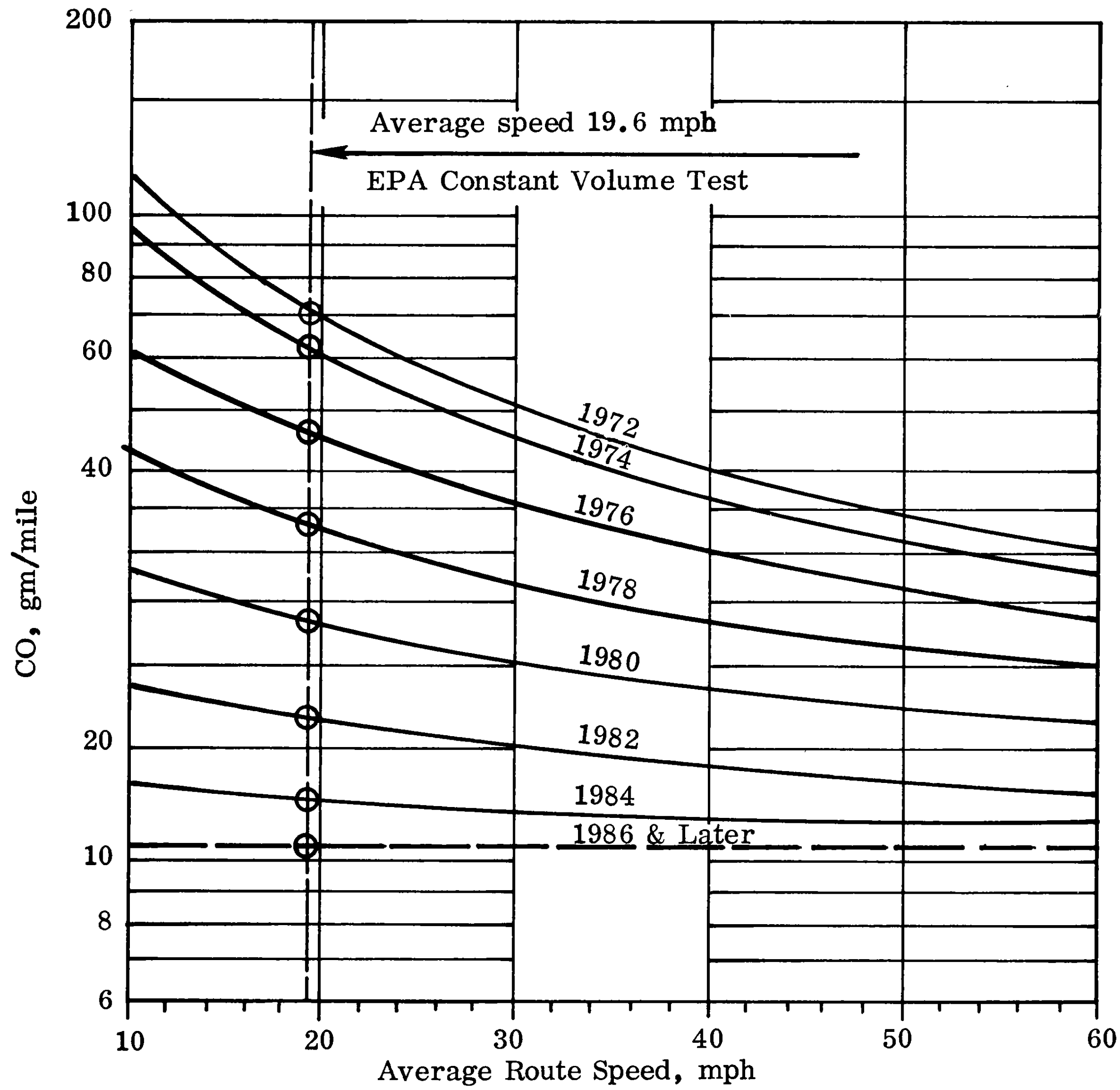

Figure 12. Emission factors for carbon monoxide vs. average route speed on city streets — 15% heavy duty vehicles.

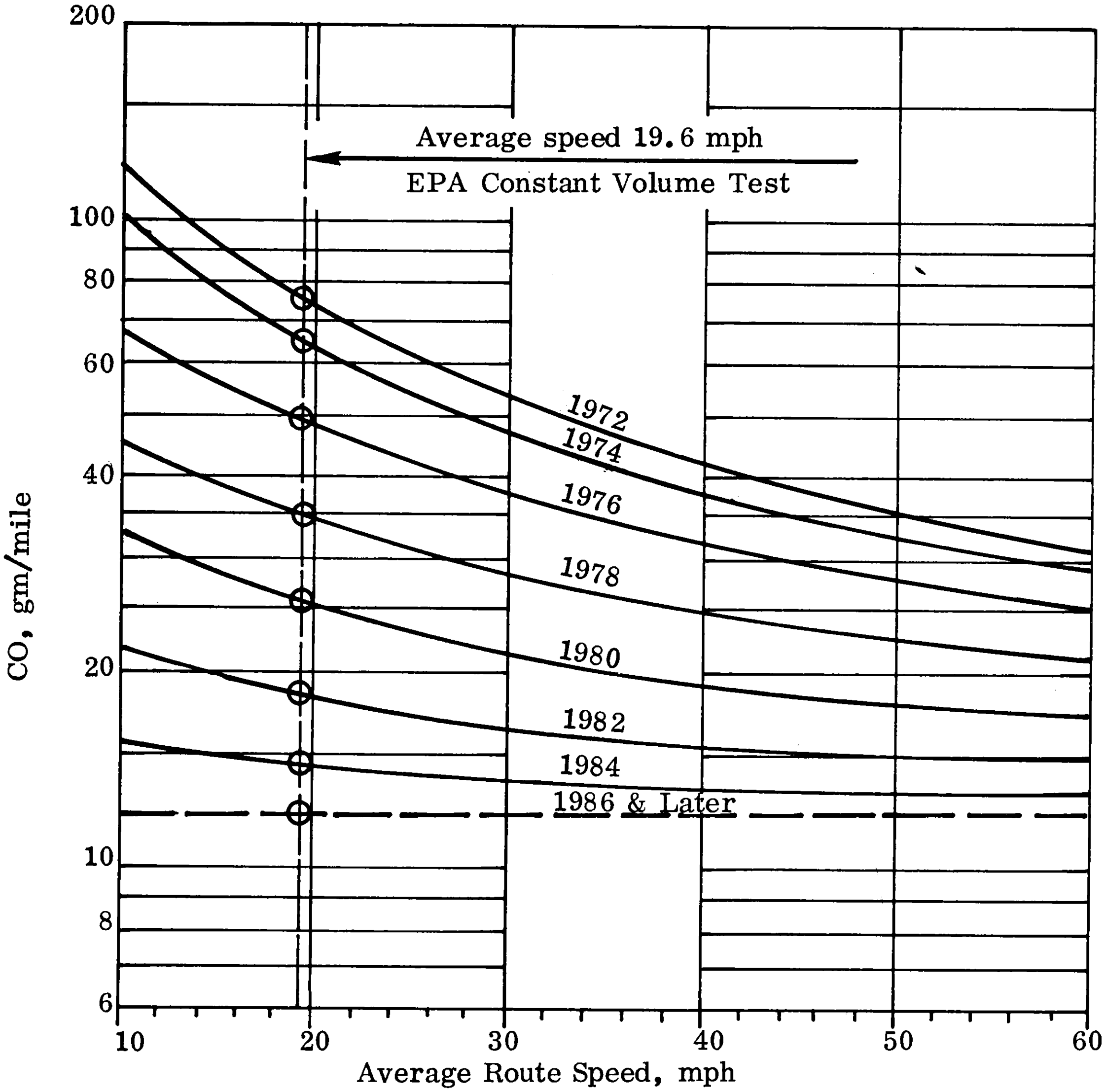

Figure 13. Emission factors for carbon monoxide vs. average route speed on city streets — 20% heavy duty vehicles.

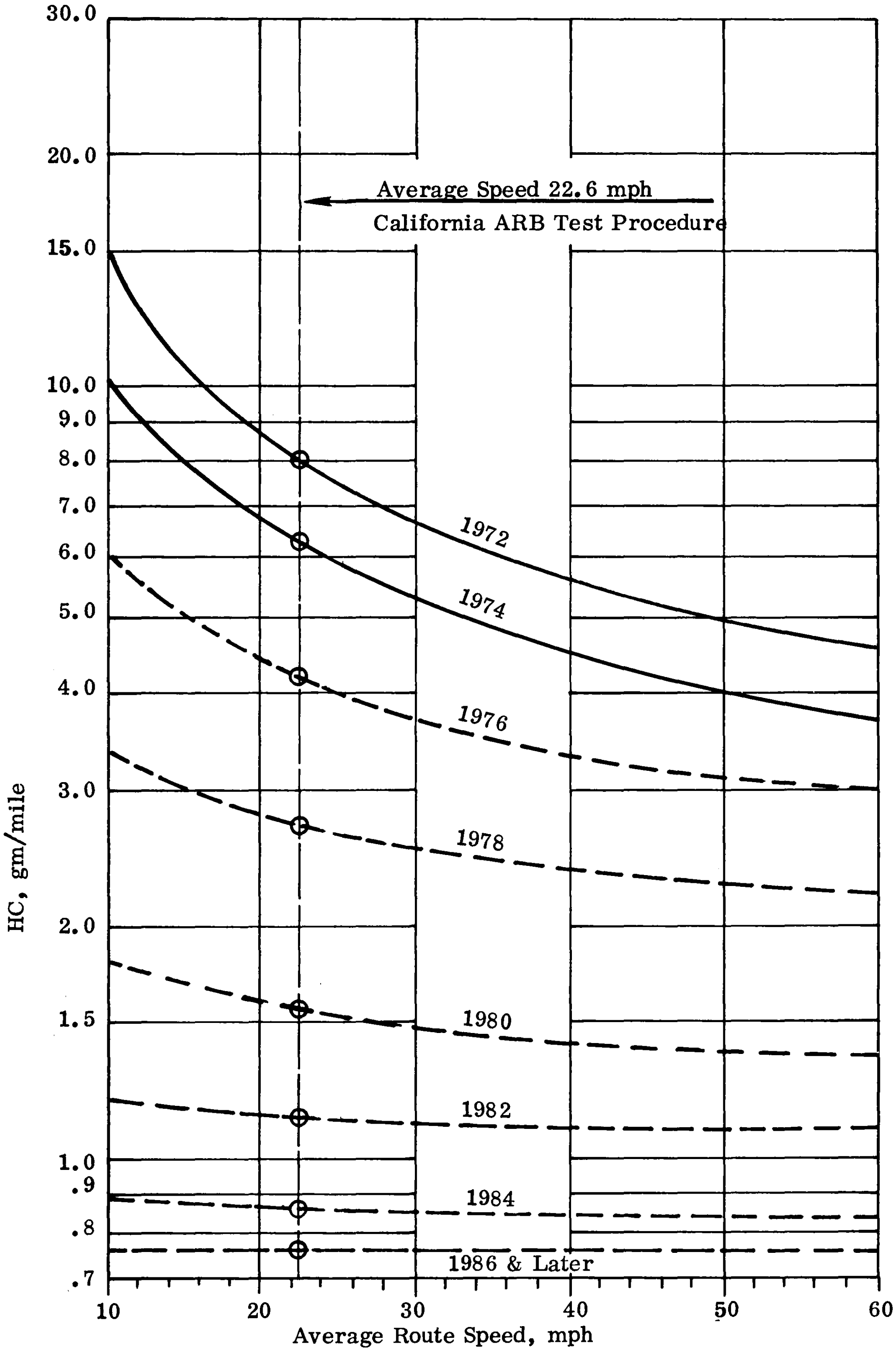

Figure 14. Emission factors for hydrocarbons vs. average route speed on freeways — 5% heavy duty vehicles.

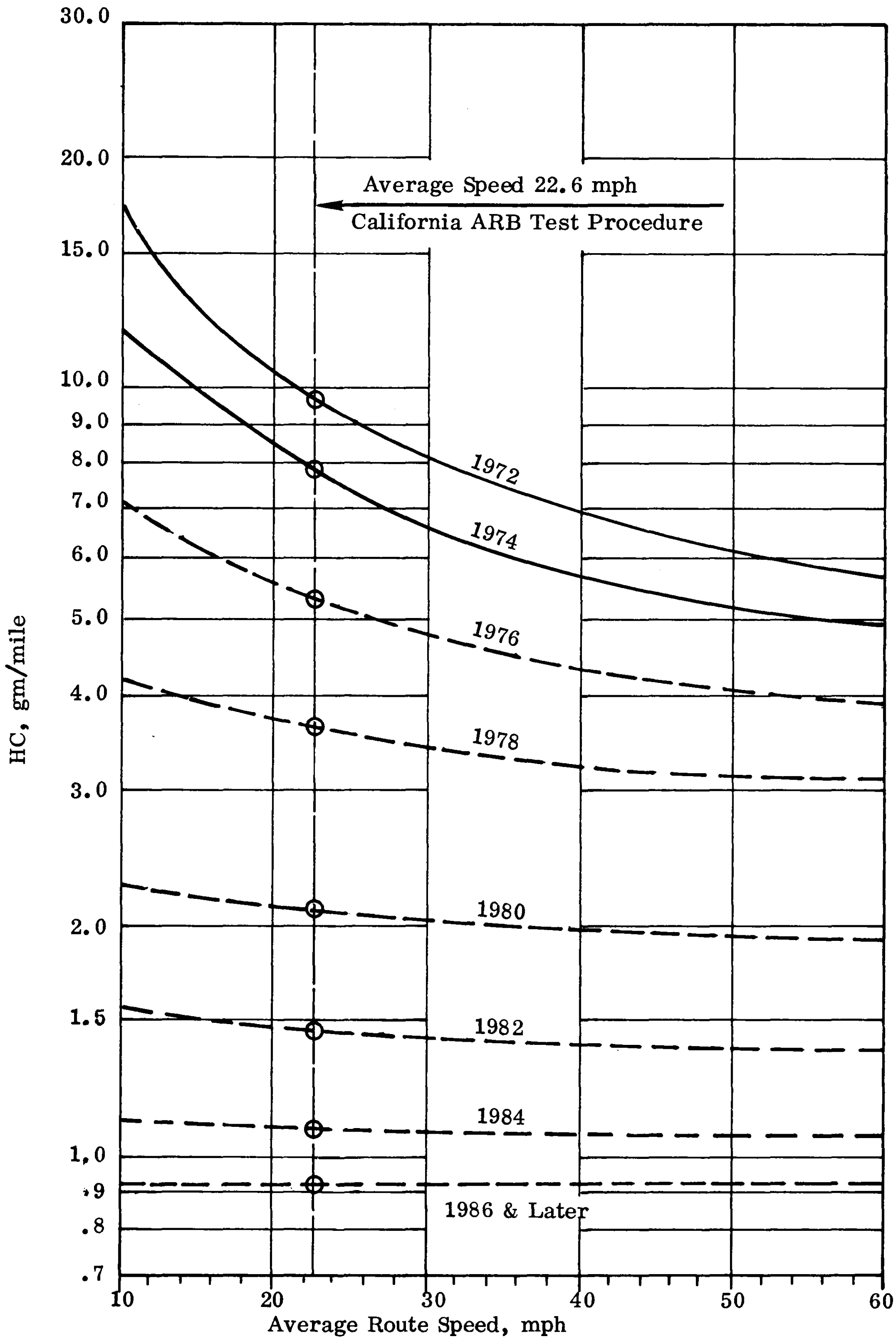

Figure 15. Emission factors for hydrocarbons vs. average route speed on freeways — 10% heavy duty vehicles.

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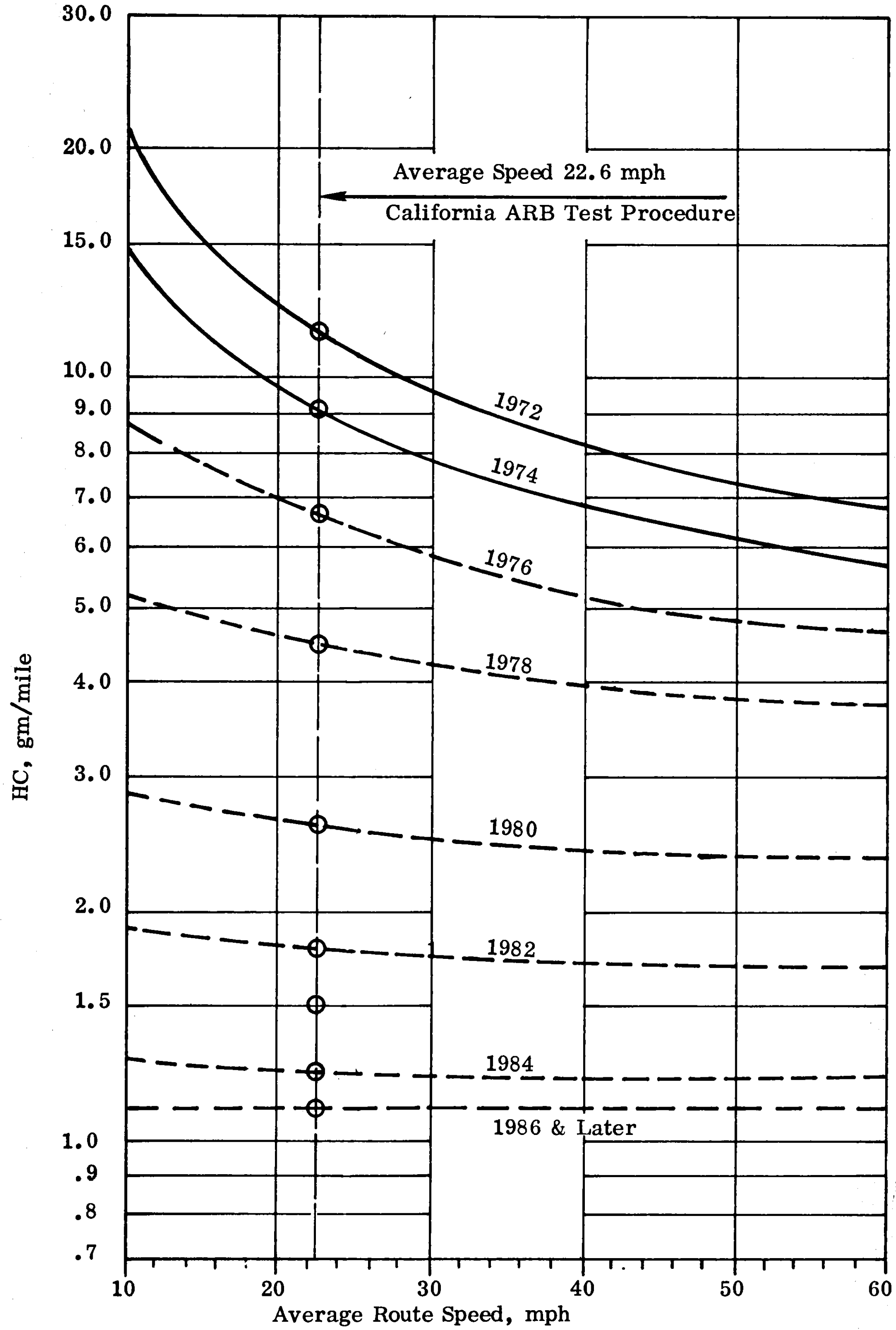

Figure 16. Emission factors for hydrocarbons vs. average route speed on freeways — 15% heavy duty vehicles.

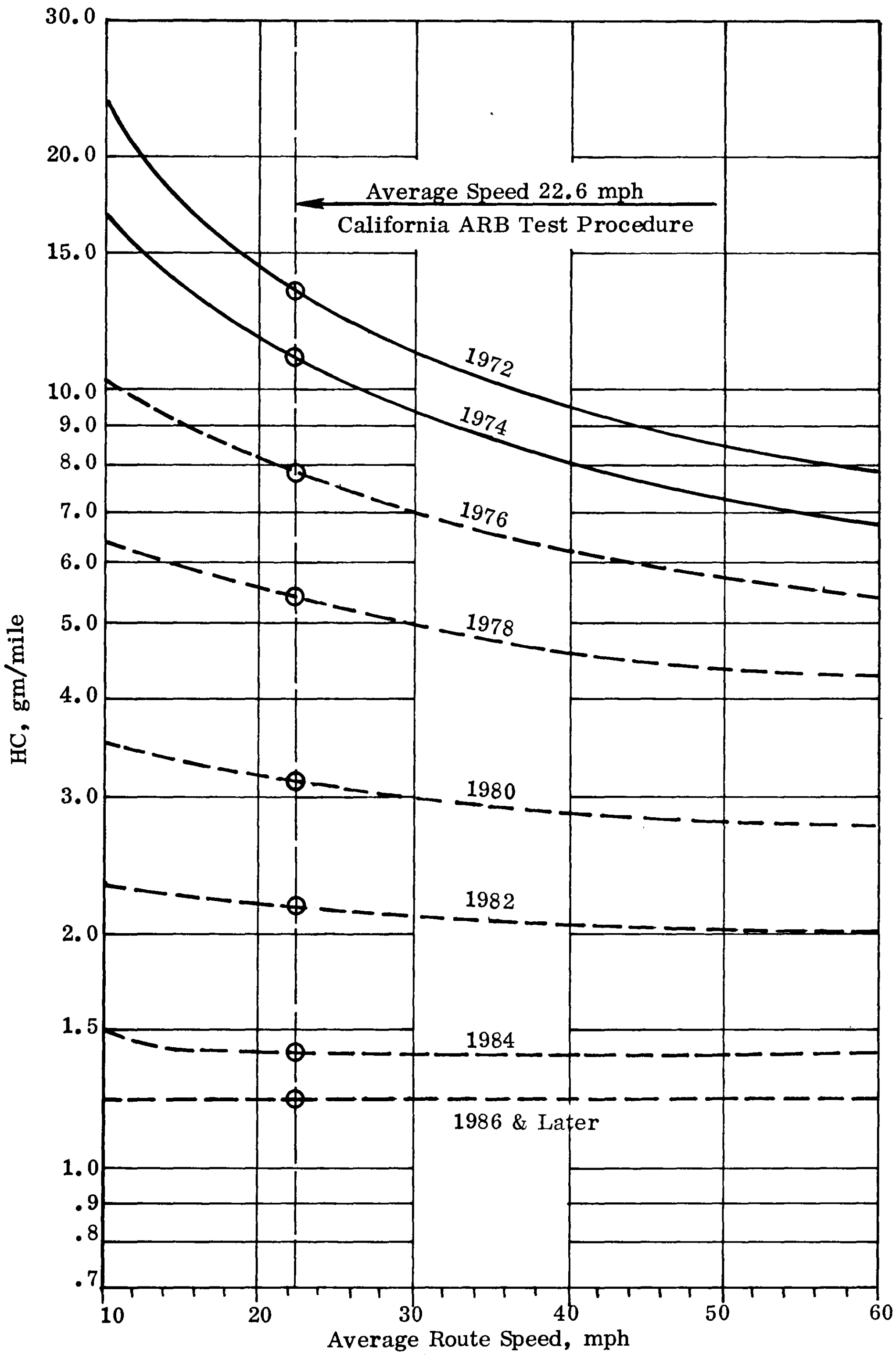

Figure 17. Emission factors for hydrocarbons vs. average route speed on freeways — 20% heavy duty vehicles.

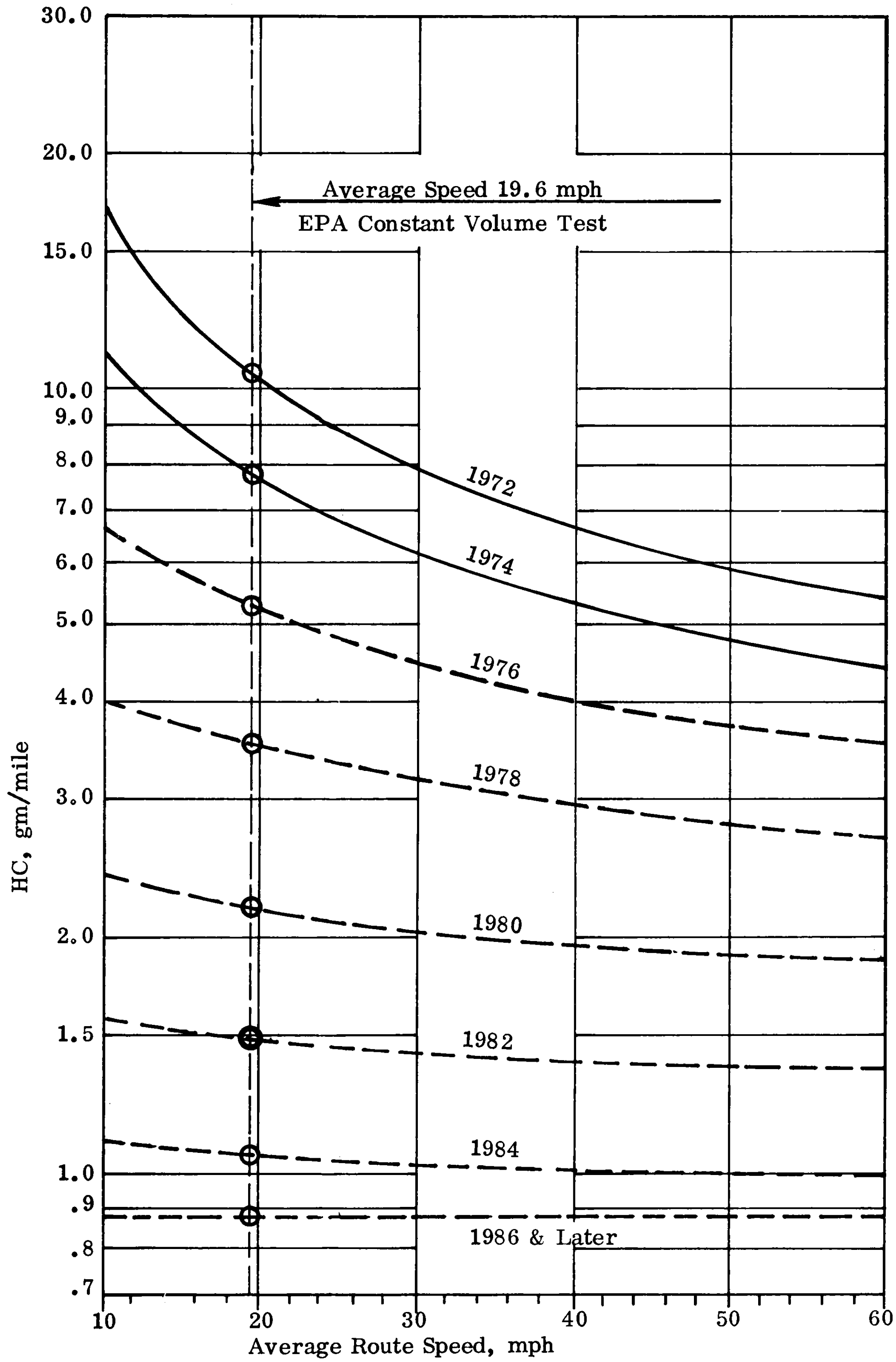

Figure 18. Emission factors for hydrocarbons vs. average route speed on city streets — 5% heavy duty vehicles.

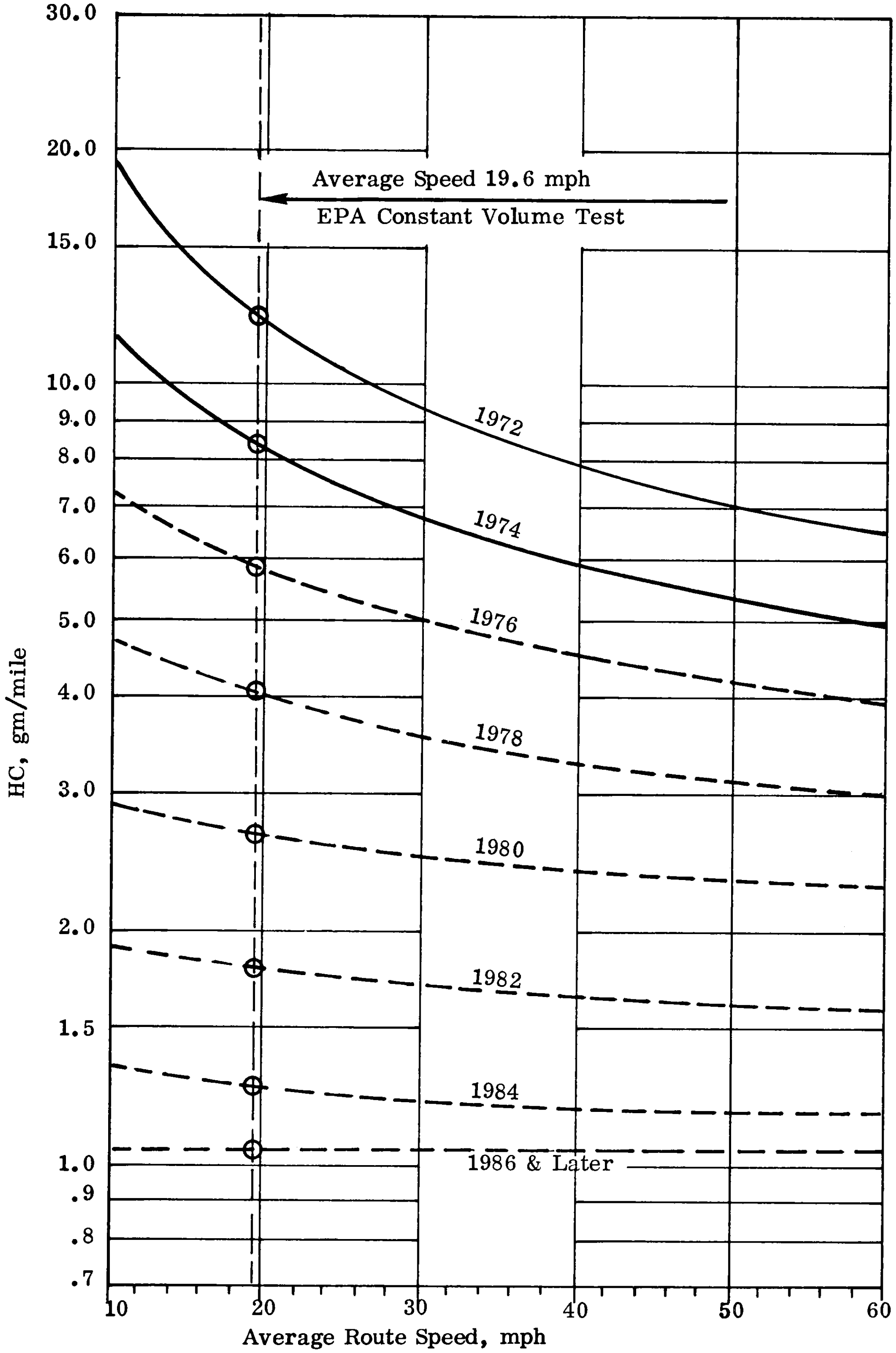

Figure 19. Emission factors for hydrocarbons vs. average route speed on city streets — 10% heavy duty vehicles.

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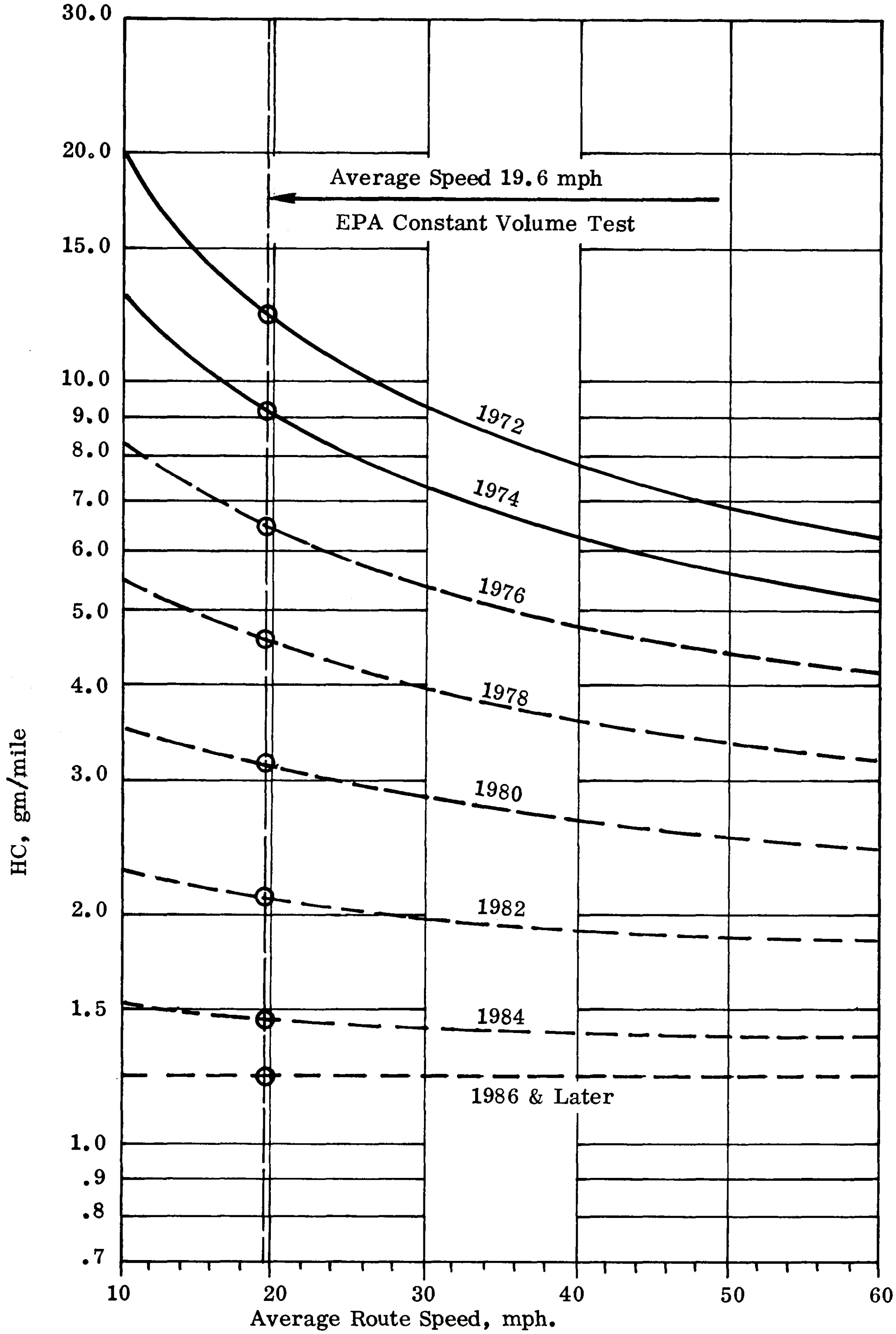

Figure 20. Emission factors for hydrocarbons vs. average route speed on city streets — 15% heavy duty vehicles.

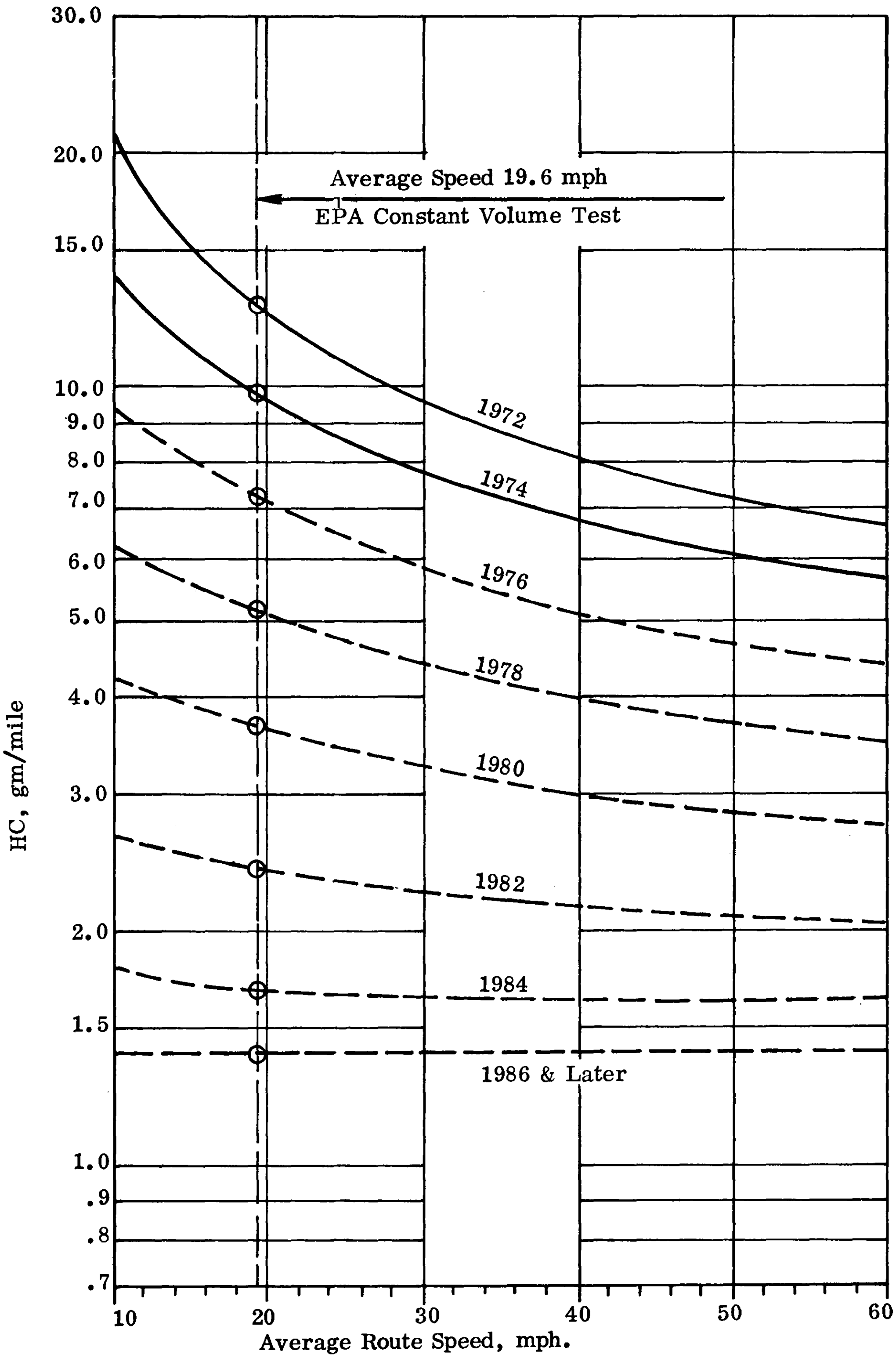

Figure 21. Emission factors for hydrocarbons vs. average route speed on city streets — 20% heavy duty vehicles.

2.2 To determine LFACTR, consider that it must be a function of two factors, LENGTH (see Section A 2.7.10), the upwind roadway length, and ALPHA (see Section A 2.7.7), the acute angle of intersection between the roadway and the wind direction. (LENGTH and ALPHA are data inputs to the program AIRPOL.) LFACTR should obviously be a monotone increasing and continuous function of LENGTH and should be a monotone decreasing and continuous function of ALPHA, since larger angles imply smaller effective upwind roadway lengths. Furthermore, the functional dependence of LFACTR on LENGTH should be such that the rate of change of LFACTR with LENGTH is inversely proportional to LENGTH. An illustrative example of the need for this type of dependence is:

> Suppose LENGTH = 400 feet and is increased by 400 feet. Then intuitively one would expect a substantial increase in LFACTR; however, if LENGTH = 4,000 feet and is increased by 400 feet, one would expect only a small change in LFACTR and consequently in CO.

This required functional dependence on LENGTH can be achieved by taking the geometric mean of 1 meter and LENGTH; i.e., $\sqrt{\text{LENGTH} \cdot 1}$.

The dependence of LFACTR on ALPHA should be such that LENGTH is an important parameter when winds are parallel to the roadway but negligible when the winds are perpendicular. The reason for this dependence is that in the parallel case the winds are capable of carrying emissions from a long stretch of roadway to the observer whereas in the perpendicular case the length of roadway is unimportant (as long as it is greater than 400 feet). The dependence on ALPHA should obviously be triginometric in nature, should vary between 0 and 1 and should have a small derivative near 90^{o} but a large derivative near 0^{o}. The function 1-sin (ALPHA) satisfies all of these criteria. Thus, we have

$$\text{LFACTR} = K_1 + (\sqrt{\text{LENGTH} \cdot 1}) \cdot (1-\text{Sin}(\text{ALPHA}))/K_2 \qquad \text{..........(2)}$$

The constant K_1 is used to account for the case ALPHA = 90^{o}, in which case the wind blows across the road. The value assumed by K_1 is 24 meters, the approximate width of the mechanical mixing cell [4] (see Figure 22). The constant K_2 = 2 and has been assigned empirically to produce a well behaved function in agreement with the limited data available.

When LENGTH is given in feet, as in the AIRPOL program, the complete expression for LFACTR becomes (see Figure 23).

$$\text{LFACTR} = 24 + .552088 \cdot \sqrt{\text{LENGTH} \cdot 1} \cdot (1-\text{Sin}(\text{ALPHA}))/2 \qquad \text{........(3)}$$

where:

$.552088 = \sqrt{.304801 \text{ meters/foot}}$ is used to convert feet to meters.

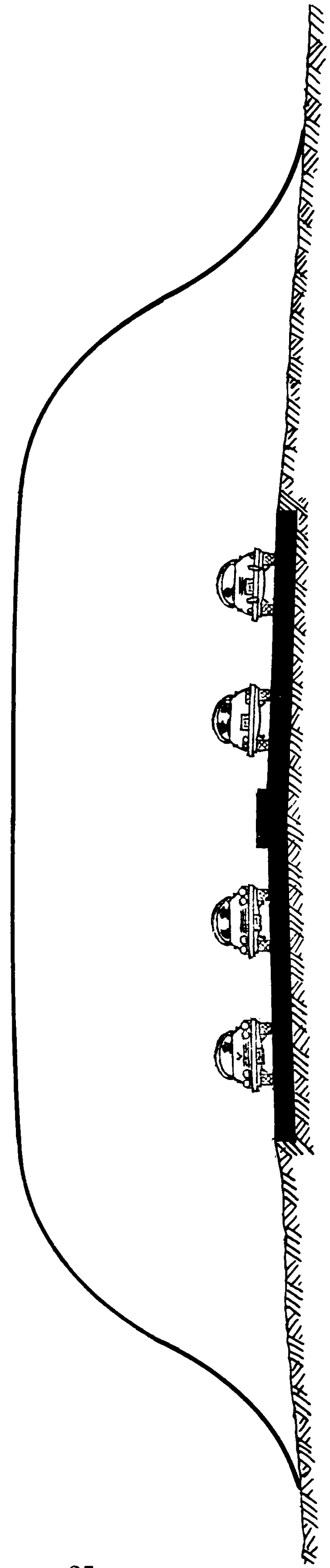

Figure 22. The mechanical mixing cell.

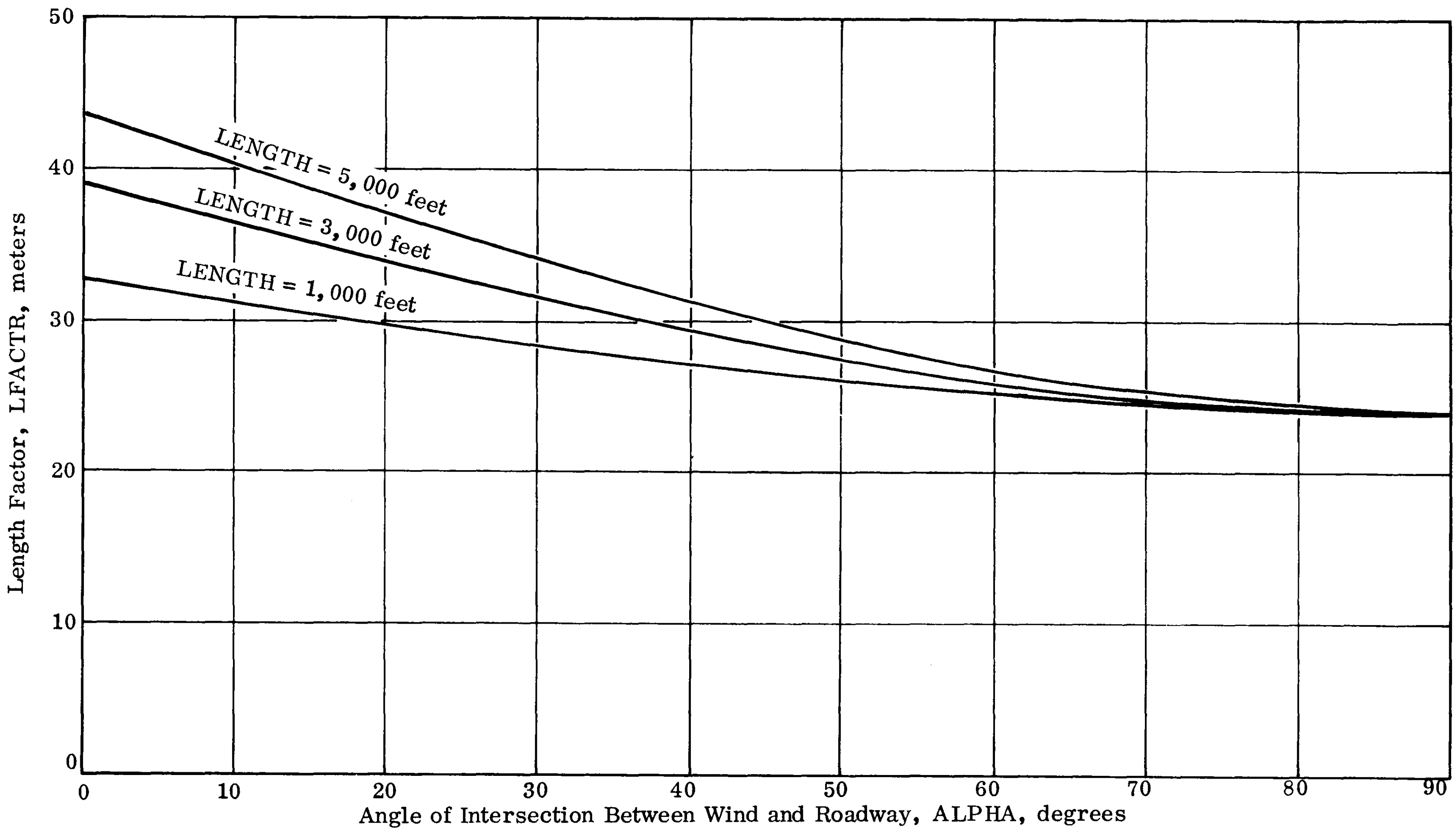

Figure 23. LFACTR vs. ALPHA and LENGTH.

2.3 Thus, an equivalent point source has been established which has an emission strength $Q_p = Q \cdot$ LFACTR. To determine the effective source point location, EFSP, one simply reasons that it must be offset upwind from the observer point in such a manner that the change in offset with LENGTH is inversely proportional to LENGTH, which, as was explained above, can be accomplished with a square foot function. Furthermore, the location of the effective source point must move closer to the observer point on the roadway as the winds approach the perpendicular, ALPHA = 90°, to produce results consistent with the premise that LFACTR was a montone decreasing function of ALPHA. Furthermore the derivative near 90° should be relatively large. Thus, the upwind offset, in feet, along the roadway when LENGTH is in feet and the geometric mean is taken with respect to 1 foot is (see Figure 24):

$$\text{EFSP} = \sqrt{\cos(\text{ALPHA}) \cdot \text{LENGTH} \cdot 1} \qquad \text{.........................} (4)$$

2.4 Knowing EFSP, D (see Section A 2.7.17), the observer distance off the roadway which is an AIRPOL data input, and ALPHA, a simple geometric argument produces the parameters necessary to find SZ and SH. These in turn allow calculation of the vertical and horizontal concentration profiles (see Figures 1 and 2). SZ and SH, as stated earlier, are functions of atmospheric stability, and DIST, the downwind travel distance. DIST is defined to be that distance, measured along a wind vector, W, from the effective source point to the intersection of W with a line through the observer and perpendicular to W. Referring to Figure 25, it is obvious that

$$\text{GAMMA} = \arctan(\text{D}/\text{EFSP}) - \text{ALPHA} \qquad \text{.........................} (5)$$

and that

$$\text{DIST} = \cos(\text{GAMMA}) \cdot \sqrt{\text{D}^2 + \text{EFSP}^2} \qquad \text{.........................} (6)$$

(see Figure 26)

The program AIRPOL contains two subprograms, SIGMAZ (DIST, ICLASS) and SIGMAH (DIST, ICLASS), which determine SZ and SH in meters based on (4) and (5) when given DIST, in feet, and ICLASS (see Section A2.7.5), the Turner modified Pasquil - Guifford atmospheric stability class (ICLASS is an AIRPOL program data input.)

2.5 To determine the actual concentration profiles, one furthermore needs to know the vertical and horizontal offsets of the observer from the centerline of the plume (see Section 2.1). Referring again to Figure 25, one sees that P, the horizontal offset, is simply

$$\text{P} = \tan(\text{GAMMA}) \cdot \text{DIST} \qquad \text{.....................................} (7)$$

(see Figure 27)

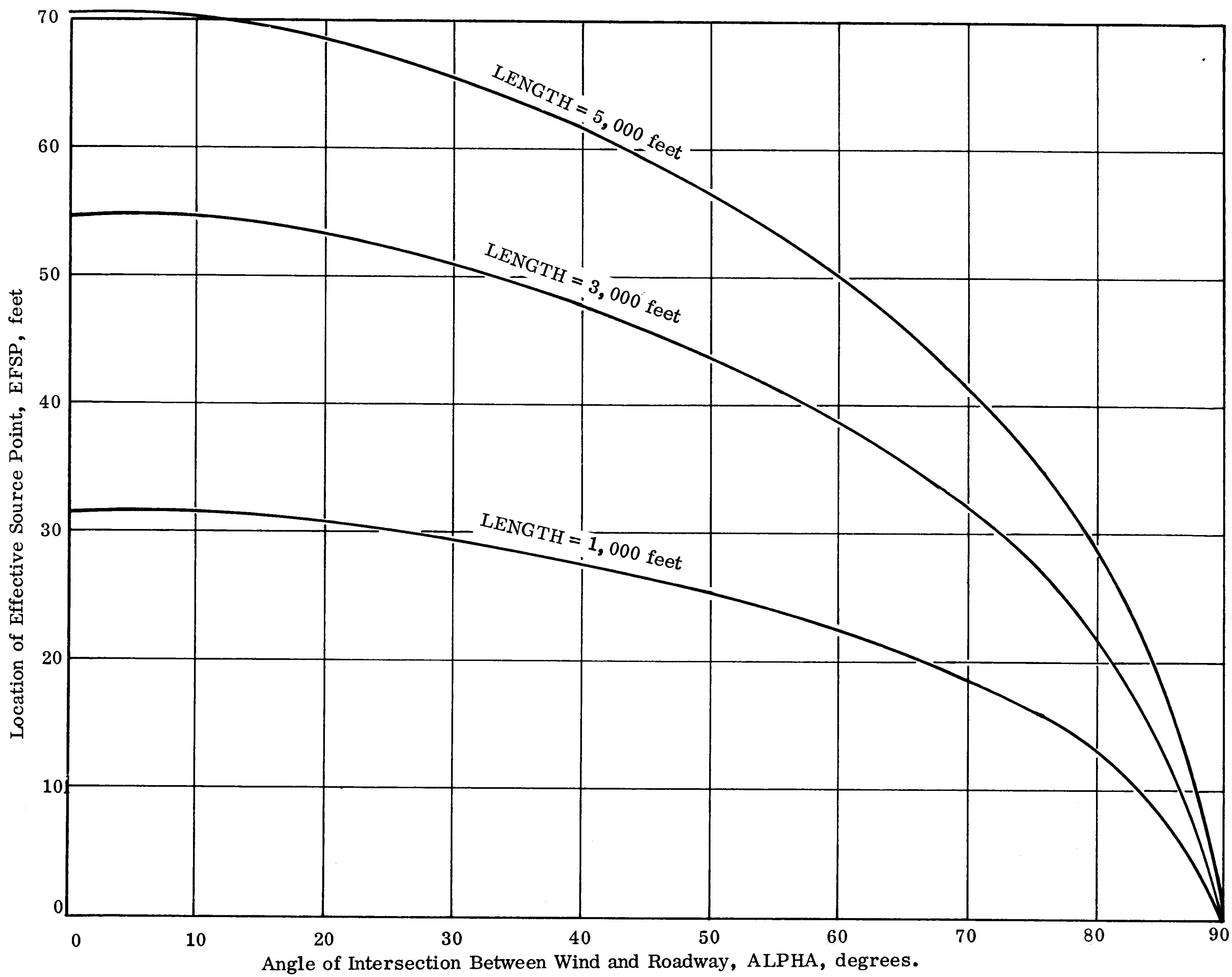

Figure 24. EFSP vs. ALPHA and LENGTH.

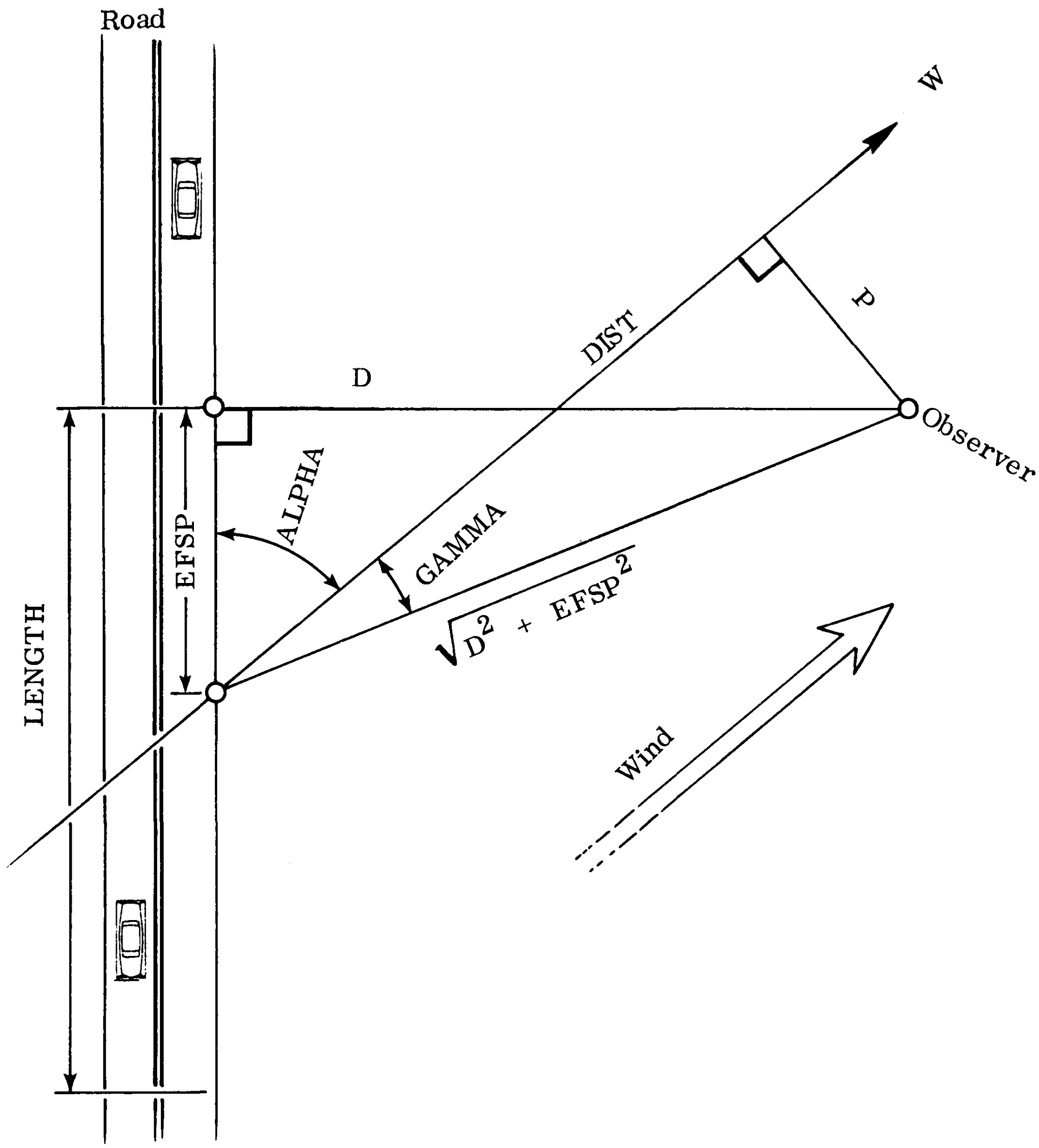

Figure 25. Determination of downwind travel distance, DIST, and horizontal offset, P.

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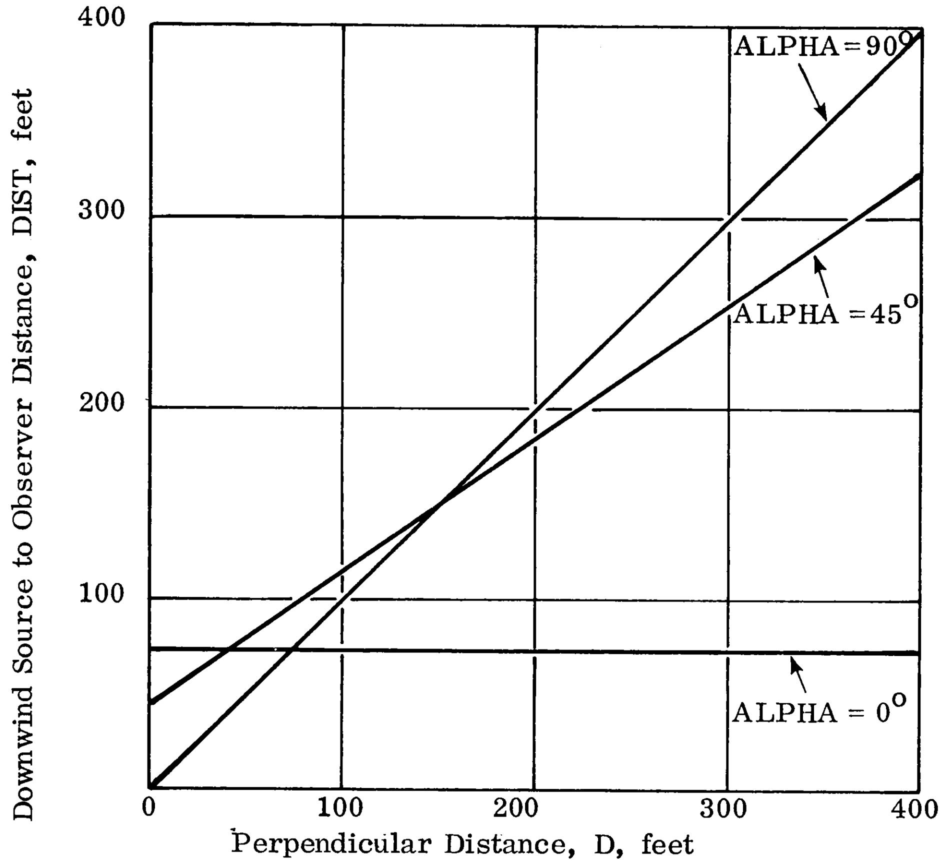

Figure 26. DIST vs. D and ALPHA.

Note: Curves were calculated with LENGTH = 5,000 feet.

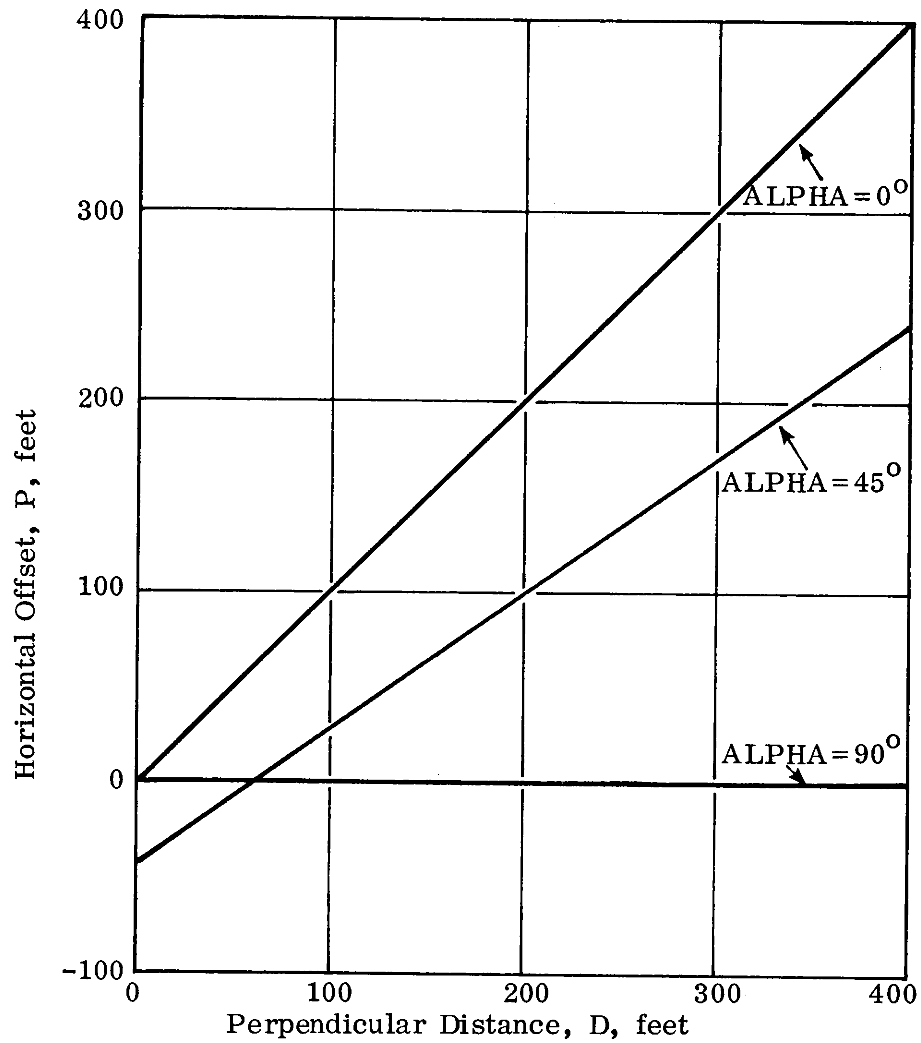

Figure 27. P vs. D and ALPHA

Note: Curves were calculated with LENGTH = 5,000 feet.

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The vertical offset is found by taking the relative difference $|H - Z|$ where H = HEIGHT when HEIGHT ≥ 0 and H = 0 when HEIGHT < 0. HEIGHT (see Section A 2.7.9) and Z (see Section A 2.7.8) are AIRPOL program data inputs. HEIGHT is the elevation (+ or -) of the roadbed relative to the surrounding terrain and Z is the elevation (+ only) of the observer relative to the surrounding terrain. HEIGHT ≥ 0 is used whenever the roadbed is at or above grade. HEIGHT < 0 is used only when the road and the observer are both in a cut, in which case Z must be input as the elevation of the observer relative to the roadbed. Whenever the roadway is in a cut but the observer is not, AIRPOL requires that HEIGHT = 0 (see Figure 28). The rationale behind this convention is that in the equilibrium case the cut will be "full" of gaseous emissions. Thus, a mass balance indicates that the amount of gaseous matter "generated" at the top of the cut will be identical to that actually generated on the road at the bottom of the cut. Therefore, the observer will be cognizant of only a virtual source at the "overflow" point, the top of the cut.

Equation 1 can now be rewritten in the following manner (see Figures 29 through 32):

$$\mathrm{YFACTR} = \exp\left(-\tfrac{1}{2}\left(\frac{P}{SH}\right)^2\right) \qquad (8)$$

$$\mathrm{ZFACTR} = \exp\left(-\tfrac{1}{2}\left(\frac{Z-H}{SZ}\right)^2\right) + \exp\left(-\tfrac{1}{2}\left(\frac{Z+H}{SZ}\right)^2\right) \qquad (9)$$

$$\mathrm{CO} \propto \frac{Q \cdot \mathrm{LFACTR} \cdot \mathrm{YFACTR} \cdot \mathrm{ZFACTR}}{WS \cdot SH \cdot SZ} \qquad (10)$$

2.6 Equation 10 will suffice for most cases but does not yet fully explain the cut situation; i.e., the case with the road and the observer both in a cut. For this situation, it must be noted that gaseous concentrations within a cut are substantially higher due to the confining properties of a valley. The concentration increase observed within a cut must obviously be a function of the cut geometry, i.e., CWIDTH (see Section A 2.7.14), the width of the cut, CHT, the depth of the cut, and CLENGH (see Section A 2.7.15), the upwind length of the cut. The variables CLENGH and CWIDTH are data inputs to the program AIRPOL and CHT is determined from HEIGHT such that CHT = |HEIGHT| when HEIGHT < 0, i.e., in the cut case, and CHT = 0 when HEIGHT ≥ 0. Examination of the limiting conditions will give valuable insight into the influence of cut geometry on concentration.

When CWIDTH is very large, it is obvious that the cut will have little influence. In fact, when CWIDTH $\rightarrow \infty$, the cut situation reverts to an at-grade situation. When CHT = 0 or is close to 0, the cut situation will again revert to the at-grade case. Also, when CLENGH = 0 or is small, the cut case will be identical to the level case. In fact, preliminary data indicate that CLENGH $<$ 200 feet produces a relatively small effect on the cut concentration. Furthermore, as was the case with LFACTR and EFSP, the incremental influence of CLENGH should diminish as CLENGH increases. Also, there should be an interdependence between the effects produced by the cut geometry. The concentration within the cut should increase as the ratio of CHT to CWIDTH increases and as the ratio of (CHT · CLENGH) to CWIDTH increases.

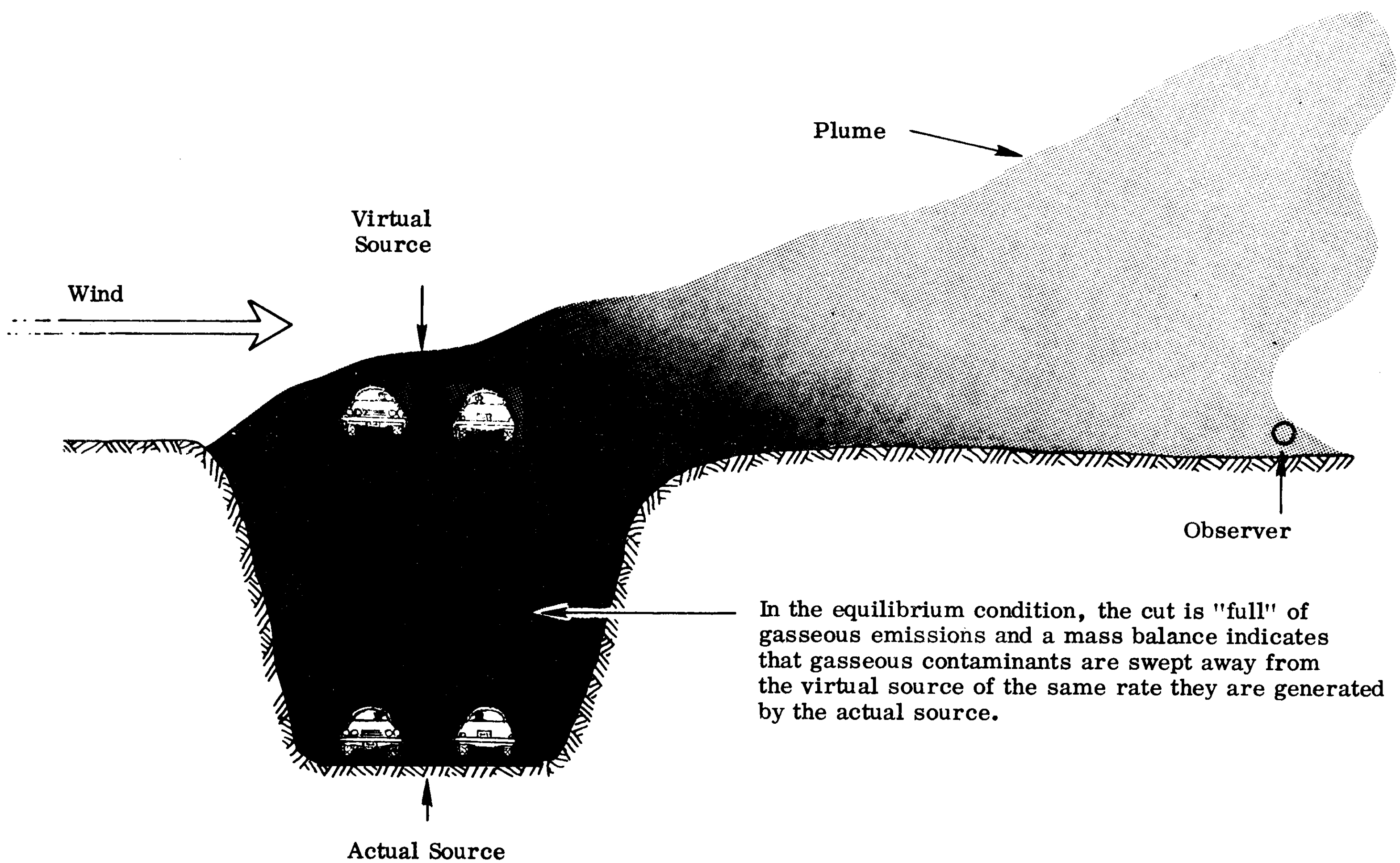

Figure 28. Road in a cut, but observer outside cut.

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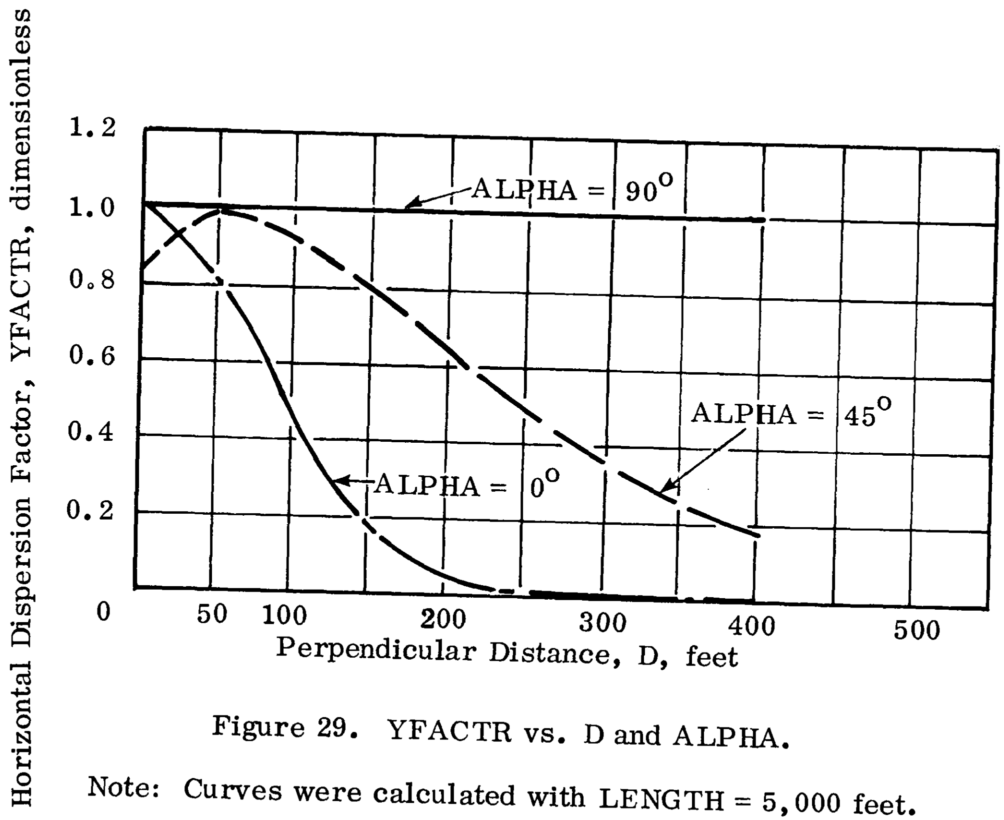

Figure 29. YFACTR vs. D and ALPHA.

Note: Curves were calculated with LENGTH = 5,000 feet.

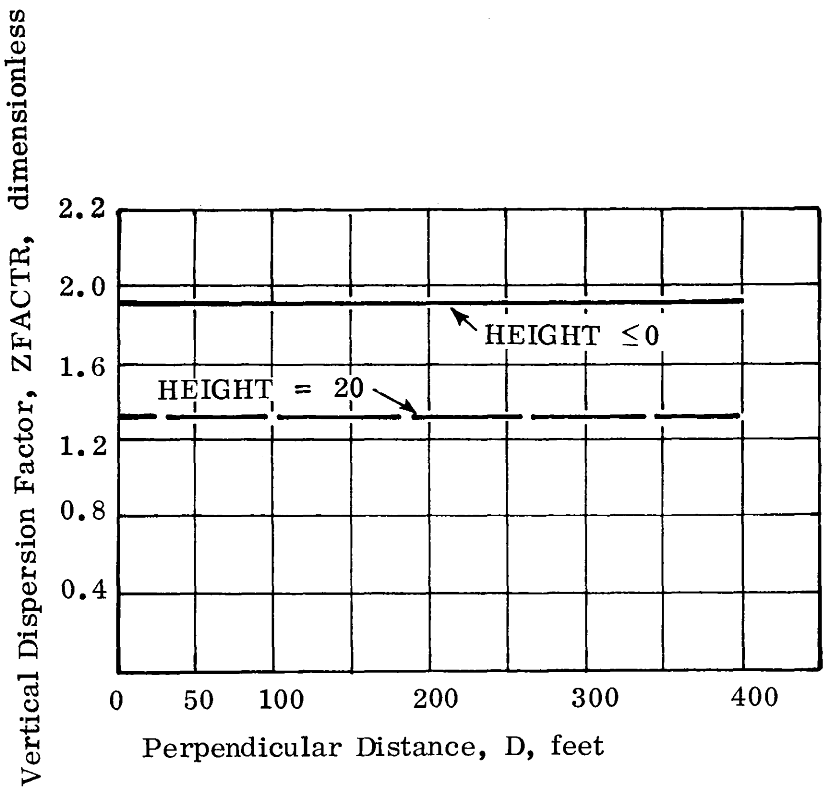

Figure 30. ZFACTR vs. D and HEIGHT for ALPHA = 0^{o}.

Note: Curves were calculated with LENGTH = 5,000 feet and Z = 5 feet.

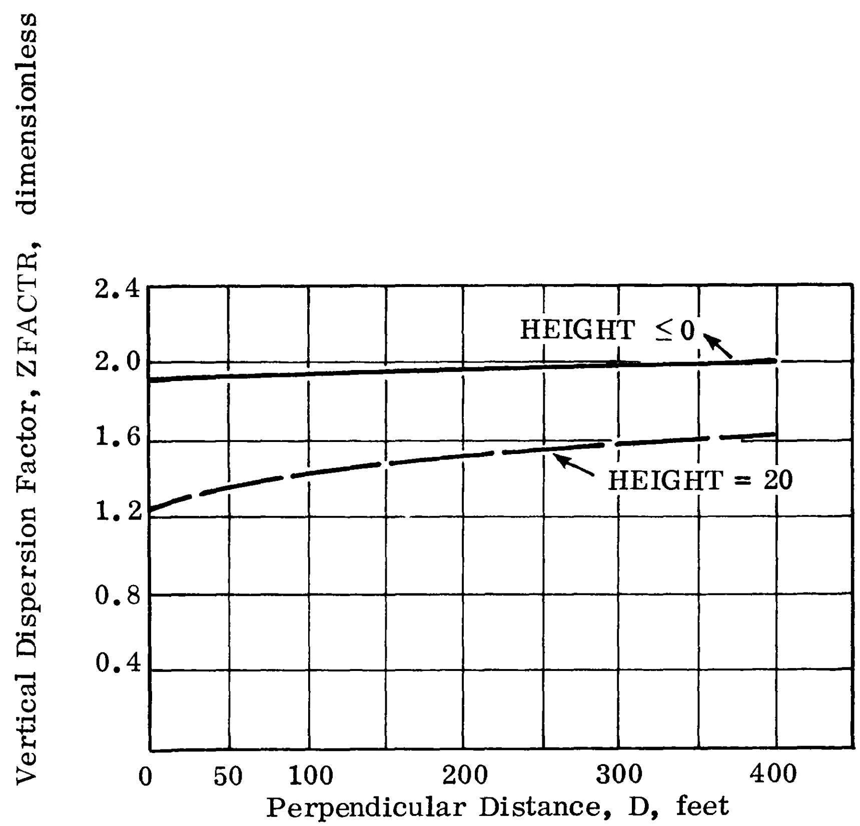

Figure 31. ZFACTR vs. D and HEIGHT for ALPHA = 45^{o}.

Note: Curves were calculated with LENGTH = 5,000 feet and Z = 5 feet.

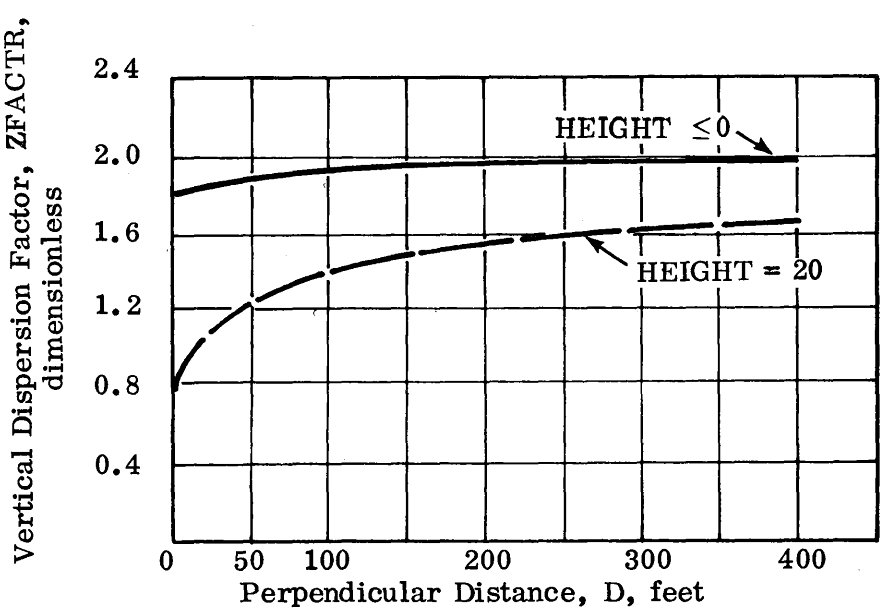

Figure 32. ZFACTR vs. D and HEIGHT for ALPHA = 90°.

Note: Curves were calculated with LENGTH = 5,000 feet and Z = 5 feet.

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Thus, if the geometry factor

$$GFACTR = (2-\exp(-CHT \cdot CLENGH/(200 \cdot CWIDTH))) \cdot \exp(2 \cdot CHT/CWIDTH), \quad \ldots(11)$$

(see Figure 33)

then all of the above limiting conditions will be realized and will provide for the increased concentrations in a cut.

Notice that the restrictions on CHT are such that GFACTR = 1 for an at-grade or elevated roadway and GFACTR ≥ 1 when the roadway and the observer are both in a cut.

2.7 One final aspect of the prediction problem must now be considered. An observer may be either downwind, CASE = 1, or upwind, CASE = 2 (see Section A 2.7.6), from a highway (see Figure 34). (The variable CASE is received by AIRPOL as data input.) Intuitively, the concentration at any distance, D, off the roadway for CASE = 2, $(CO)_2$, should be less than or equal to the concentration at D for CASE = 1, $(CO)_1$. Consideration of the mechanical mixing cell concept (see Figure 22) will show that at D = 0, i.e., at the edge of pavement, $(CO)_1 = (CO)_2$, since the concentration in the mechanical mixing cell is approximately uniform across the roadway. Furthermore, it should be noted that at ALPHA = 0^o, i.e., in a parallel wind condition, that $(CO)_1 = (CO)_2$, since either side of the roadway may be considered as the upwind side. Thus, the case factor, CFACTR, appears to be a function of only D and ALPHA. The assumption has been made that the decrease in $(CO)_2$ with respect to $(CO)_1$ should be a negative exponential in D and ALPHA. The limited data available suggest that the actual dependence on D should be such that $\sqrt{D/K_3}$ controls CFACTR where D is in feet and K_3 = 10 feet. Thus, the function CFACTR is given as:

$$CFACTR = \exp\left(-\tfrac{1}{2} \cdot \sin(ALPHA) \cdot \left(\sqrt{(CASE-1) \cdot D/10} + CASE-1\right)\right) \quad \ldots\ldots(12)$$

(see Figure 35)

2.8 Equation 1 can now be rewritten to include all of the above considerations and thus produce the final model.

$$CO \propto \frac{Q \cdot LFACTR \cdot YFACTR \cdot ZFACTR \cdot GFACTR \cdot CFACTR}{WS \cdot SH \cdot SZ} \quad \ldots\ldots(13)$$

The AIRPOL program further contains two empirical variables used to scale CO to agree with the available data. The constant multiplier, KFACTR, has been set equal to 4.5, and the angle correction factor, AFACTR, has been set equal to 0.4. Thus, the final equations in the AIRPOL model are as follows (see Figures 36, 37, and 38):

$$CO = \frac{2.23693 \cdot 0.155159 \cdot 870 \cdot QCO \cdot LFACTR \cdot YFACTR \cdot ZFACTR \cdot GFACTR \cdot CFACTR \cdot KFACTR}{WS \cdot SHM \cdot SZM \cdot AFACTR} \quad \ldots\ldots(14)$$

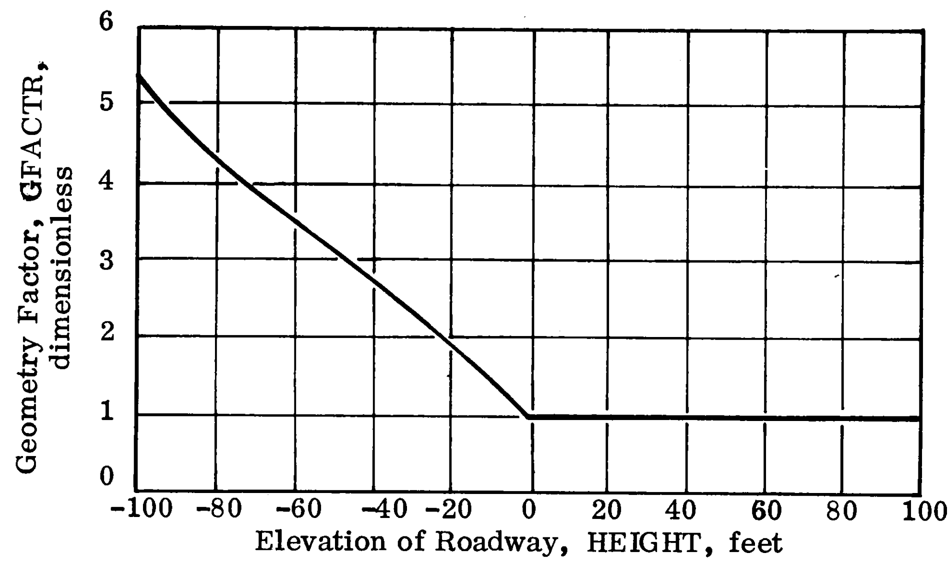

Figure 33. GFACTR vs. HEIGHT.

Note: Curve was calculated with LENGTH = 5,000 feet,
= 200 feet, and = 1,800 feet.

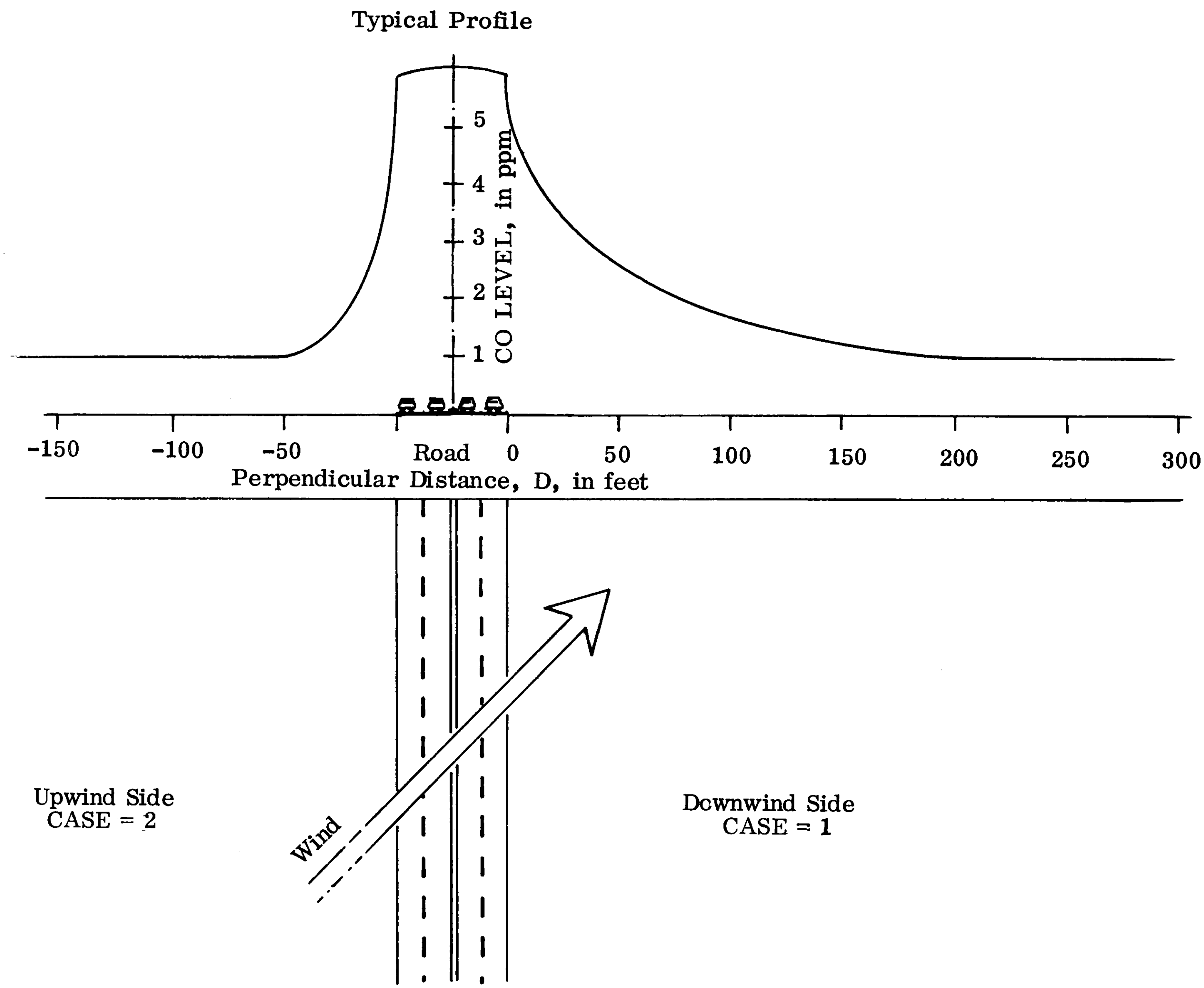

Figure 34. Distinction between CASE = 1 and CASE = 2.

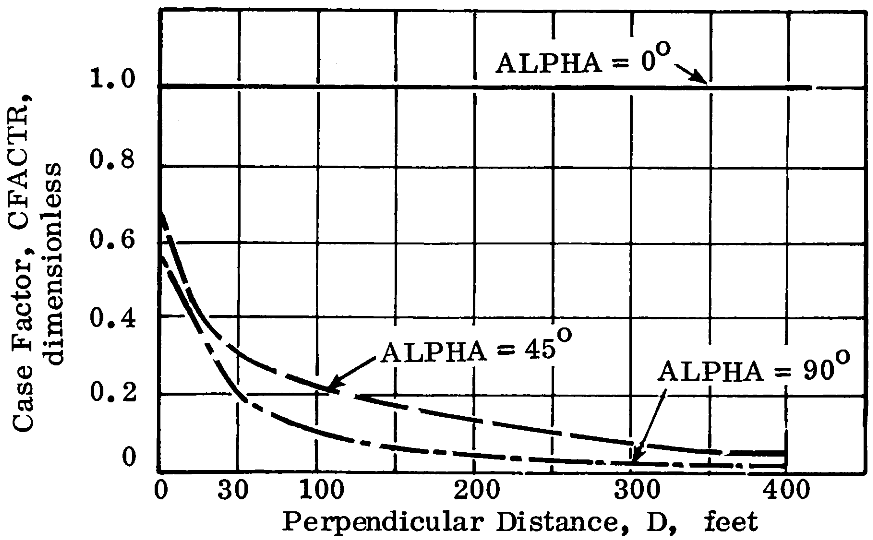

Figure 35. CFACTR vs. D and ALPHA.

00726

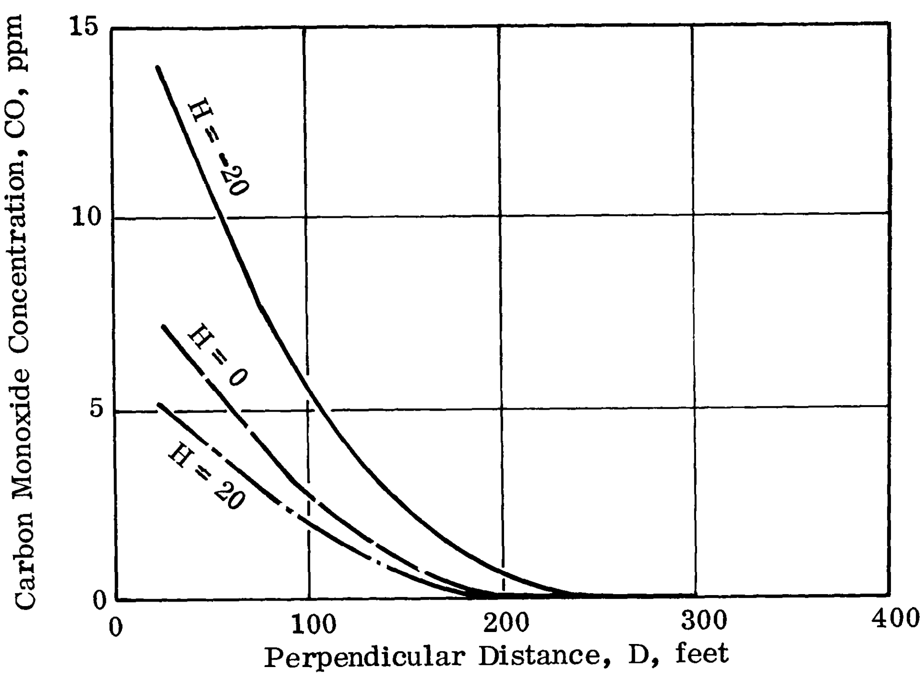

Figure 36. CO vs. D and H for ALPHA = 0^o.

Note: Curves were calculated with the following parameters:

Source Type	= Freeway	TFSPD	= 60 mph
Prediction Year	= 1975	TFMIX	= 5% hdv
Stability Class	= D	CWIDTH	= 200 feet
Z	= 5 feet	CLENGTH	= 1,800 feet
LENGTH	= 5,000 feet	WS	= 5 mph
TFVOL	= 5,000 vph		

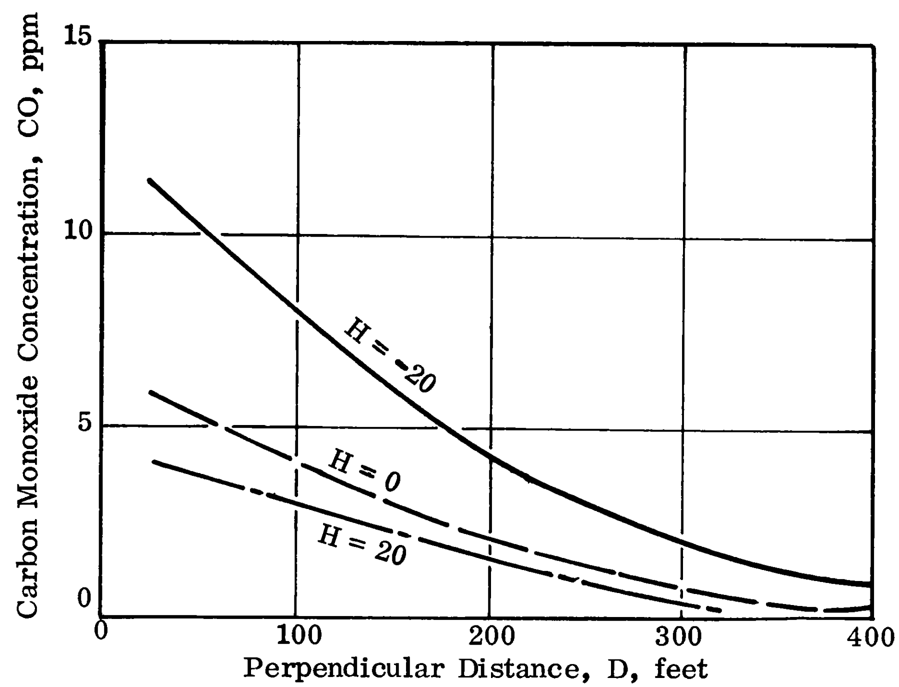

Figure 37. CO vs. D and H for ALPHA = 45°.

Note: Curves were calculated with the following parameters:

Source Type	=	Freeway	TFSPD	=	60 mph
Prediction Year	=	1975	TFMIX	=	5% hdv
Stability Class	=	D	CWIDTH	=	200 feet
Z	=	5 feet	CLENGTH	=	1,800 feet
LENGTH	=	5,000 feet	WS	=	5 mph
TFVOL	=	5,000 vph			

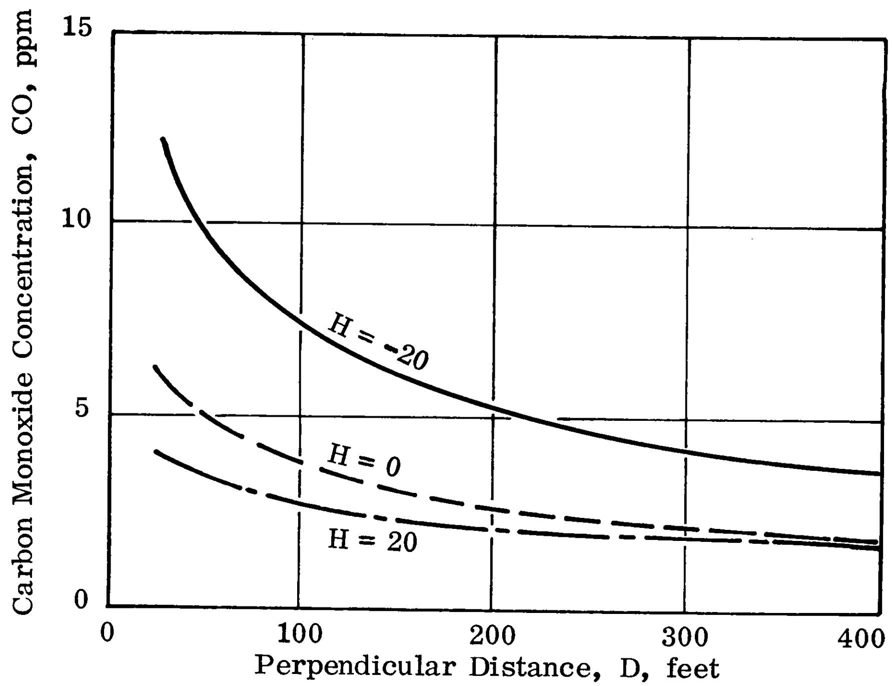

Figure 38. CO vs. D and H for ALPHA = 90^{o}.

Note: Curves were calculated with the following parameters:

Source Type	= Freeway	TFSPD	= 60 mph
Prediction Year	= 1975	TFMIX	= 5% hdv
Stability Class	= D	CWIDTH	= 200 feet
Z	= 5 feet	CLENGTH	= 1,800 feet
LENGTH	= 5,000 feet	WS	= 5 mph
TFVOL	= 5,000 vph		

and

$$HC = \frac{2.23693 \cdot 0.155159 \cdot 1530 \cdot QHC \cdot LFACTR \cdot YFACTR \cdot ZFACTR \cdot GFACTR \cdot CFACTR \cdot KFACTR}{WS \cdot SHM \cdot SZM \cdot AFACTR} \quad \ldots.(15)$$

where:

2.23693 mile/hour = 1 meter/sec.
1 ppm (carbon monoxide) = 870 gm (CO)/m^3.
1 ppm (hydrocarbon methane equivalents) = 1530 gm (HC)/m^3.
0.155159 = $1/(2\pi)$.
QCO is the source emission strength (gm (CO)/m-sec).
QHC is the source emission strength (gm (HC)/m-sec).
LFACTR has units of meters.
YFACTR, ZFACTR, GFACTR, CFACTR, KFACTR, and AFACTR are dimensionless.
WS (see Section A 2.6.4) is the wind speed (mile/hour).
SHM and SZM are SH and SZ respectively converted to meters.

Thus, CO has the units of ppm (CO) and HC has the units of ppm (HC).

ASSUMPTIONS AND LIMITATIONS

3.0 The AIRPOL model has been developed from theoretical, idealized considerations. It is dependent on (1) the assumption of steady state conditions, (2) the reliability of the stability class and mixing cell concepts, (3) the quality of emission factor data, and (4) the validity of the basic Gaussian model.

3.1 The steady state assumptions manifest themselves in several ways.

3.1.1 Assume that vehicular traffic on the roadway under consideration constitutes a continuous, uniform line-source for the time period of interest.

> This assumption is valid for relatively heavy traffic conditions where the time period is short (on the order of one hour). As the traffic volume decreases, the assumption deteriorates because the inter-vehicular gaps enhance the discrete nature of the pollutant sources, and localized turbulences are more able to effect dispersion. Thus, the model will tend to over-predict pollutant concentrations as the traffic diverges from the steady state. When longer time intervals

(greater than one hour) are used, the steady state assumption will most likely be violated since traffic volumes are generally not uniform over long time spans. Thus, it is recommended that for long time analyses the higher traffic volumes for the time interval be used to make predictions. This will, in general, cause the concentration estimates to be greater than actual conditions, but it is felt that this conservative estimate will be in the best interest of the public.

3.1.2 Assume that wind speed and direction are uniform over the time of interest.

This assumption is, in general, valid only for time spans on the order of minutes. Employment of this assumption will cause concentration estimtes to be on the conservative side since it neglects concentration decreases due to unsteady state conditions. However, since this assumption is necessary to produce an efficient model and since it is a conservative assumption, it has been incorporated in AIRPOL.

3.1.3 Assume that localized turbulence and wind shear may be neglected.

This is a simplifying assumption which is rarely realized in actual observations. However, it is a conservative assumption since it neglects concentration decreases which would be caused by these wind conditions.

3.2 References 4 and 5 discuss the techniques for determining atmospheric stability classes and the inherent variabilities that may be noticed. Incorrect determination of stability class can easily cause errors of estimation on the order of 20%. Furthermore, the Turner modified Pasquill - Guifford stability curves are empirically defined only for downwind distances greater than 0.1 km (about 328 feet). This is very significant in light of the fact that pollutant concentrations in the neighborhood of a highway drop off to background levels within about 200 to 400 feet off the roadway. Reference 4 discusses the extrapolation of these curves down to 1 meter by employing the mixing cell concept. Application of these extended curves and the mixing cell concept produces very reasonable results in the AIRPOL model but it must be remembered that they have not had extensive empirical vertification.

3.3 The AIRPOL model is directly dependent on the vehicle emission factors used in determining concentrations. These factors have been provided by the California Division of Highways [4] and are recognized as only approximations. However, they are hopefully conservative estimates which will thus lead to conservative predictions.

3.4 The Gaussian model itself has several inherent shortcomings which affect the predictions made by AIRPOL.

3.4.1 The model assumes that dispersion, not diffusion, is the predominant gaseous transport mechanism.

At wind speeds in excess of 1.5 meter/sec. (about 3 mph), this assumption is reasonable and its validity increases with wind speed. However at calm or near calm wind conditions gaseous diffusion and thermal convection are the predominant transport mechanisms. Under these conditions, the model will seriously overpredict concentration levels because it considers only the dispersion mechanism. Therefore, AIRPOL is not recommended for wind speeds less than 3 mph and preferably not less than 4 mph.

3.4.2 The basic Gaussian approach assumes that concentrations are normally distributed in the vertical and horizontal directions about the centerline of the plume.

This assumption is really valid only for neutral atmospheric conditions (stability Class D).[5] For unstable atmospheric conditions (stability Class A),[5] where the unsteady state predominates, this assumption can be responsible for either under-or overprediction of instantaneous concentrations, depending on the time variation of the plume. However, over a period of about one hour, the time average concentrations predicted should be relatively reliable. For stable atmospheric conditions (stability Class F), this assumption can be responsible for slight underpredictions due to the tendency of the pollutants to concentrate near ground level. However, this problem is not very serious since the model tends to be conservative in other respects.

3.4.3 The Gaussian model is limited by the assumption that pollutants are completely free to disperse in the vertical direction. (Note: AIRPOL does consider the "canyon" effect in which pollutants are constrained in the horizontal direction.)

This assumption is valid for most conditions, but fails when an atmospheric inversion exists close enough to ground level to trap pollutants. Under such circumstances, AIRPOL will underestimate pollutant concentrations. However, such situations are relatively rare in Virginia. If it is necessary to make an analysis under inversion conditions (or, for instance, an anlyais of concentrations in a tunnel), a "box" model and mass balance equations for a steady state environment can be employed to predict concentration levels.

3.5 What is perhaps the most serious limitation associated with AIRPOL is the inability of the model to yield a prediction of the expected or average CO level. The problem here is not with AIRPOL per se but rather is a result of not being able to define those weather conditions which produce the expected or average CO level. The current state of the art allows one to define the most likely or prevailing weather type which will in turn yield a most likely or prevailing CO level. However, the probability of occurrence of this most likely weather condition is generally on the order of 1%. Therefore, even though AIRPOL does predict the most likely CO concentration, it cannot, without exhaustive examination of all weather conditions, forecast the expected CO level. This matter is further considered in Section 4.3.

RECOMMENDATIONS AND FUTURE WORK

4.1 Neither AIRPOL — Version 1 nor Version 2 has had extensive field verification. However, Version 2 offers more user flexibility and ease of operation, as well as a substantially sounder mathematical basis, than Version 1. Therefore, it is recommended that the Department employ the upgraded model, AIRPOL — Version 2, July 1973, until further field data can be collected.

4.2 AIRPOL, Phase II, the field verification of the AIRPOL model, was initiated in June 1973. It is anticipated that at least one year will be required to obtain enough field data to warrant any further alterations to AIRPOL. When sufficient data are available, a reevaluation and possible upgrading of AIRPOL will be made. At that time a report covering the findings of the field study and recommendations for either continued use or modification of the AIRPOL model will be issued.

4.3 AIRPOL, Phase III, a project to develop a technique for finding expected concentrations and concentration probability distributions for short-term and long-term analysis periods, will begin in September 1973. The findings of Phase III should allow removal of a great deal of uncertainty and enable AIRPOL to make accurate predictions of expected concentration levels.

ACKNOWLEDGEMENTS

The author and the Virginia Department of Highways wish to thank the Materials and Research Department of the California Division of Highways and, in particular, Andrew Ranzieri and Marco Farrockhrooz, for their very significant assistance in this endeavor. The author also wishes to express his appreciation to J. L. Korf and H. R. Sherry, highway research assistants, who did a great deal of work on the AIRPOL computer program, and Dr. G. G. Clemena, highway materials and research analyst, who provided assistance on the theory of gaseous dispersion.

REFERENCE

1. TRW Systems Group, Washington, D. C., Air Quality Display Model, U. S. Department of Commerce publication PB 189 194, November 1969.

2. F. L. Ludwig, et al., A Practical Multipurpose Urban Diffusion Model for Carbon Monoxide, U. S. Department of Commerce publication PB 196 003, September 1970.

3. W. B. Johnson, et al., Field Study for Initial Evaluation of an Urban Diffusion Model for Carbon Monoxide, Stanford Research Institute, Menlo Park, California, SRI project 8563, June 1971.

4. J. L. Beaton, et al., Air Quality Manual, Volumes 1 through 8, Federal Highway Administration report No. FHWA-RD-72-33, April 1972.

5. D. Bruce Turner, "A Diffusion Model for an Urban Area", Journal of Applied Meterology, Volume 3, February 1964, pages 83-92.

APPENDIX 1

A1.0 AIRPOL Program Listing

A1.1 This Appendix contains a listing and sample output of the computer program AIRPOL — Version 2, July 1973, in a Fortran 2.3 configuration for use on a CDC 6400 computer under the control of a SCOPE 3.3 operating system. AIRPOL is used in this form at the Virginia Highway Research Council on the University of Virginia's CDC 6400 computer. It requires approximately 8 k words of main memory to process.

There is also an IBM configuration of AIRPOL for general use within the Virginia Department of Highways. It is written in Fortran IV (level G or H) for an IBM 370/155, running under an OS 21.7 operating system with HASP.

The IBM configuration requires approximately 15 k bytes of main memory to process.

```
*****************************************************************************
*****************************************************************************

      PROGRAM AIRPOL (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE9)      AIRP  00
C                                                                      C
C                ****   ***   *****   *****    ****    *               C
C               *    *   *    *    *  *    *  *    *   *               C
C               *    *   *    *    *  *    *  *    *   *               C
C               ******   *    *****   *****   *    *   *               C
C               *    *   *    *    *  *       *    *   *               C
C               *    *  ***   *    *  *        ****    ******          C
C                                                                      C
C                        VERSION 2 -- JULY 1973                        C
C                                                                      C
C**********************************************************************C
C**********************************************************************C
C**                                                                  **C
C**   AIRPOL PROVIDES AN ESTIMATE **AND ONLY AN ESTIMATE** OF THE    **C
C**   AIR QUALITY, IN TERMS OF CO AND HC CONCENTRATIONS IN PPM, IN   **C
C**   THE REGION OF AN EXISTING OR PROPOSED HIGHWAY FACILITY.        **C
C**                                                                  **C
C**   AIRPOL IS THE PROPERTY OF AND WAS DEVELOPED FOR THE VIRGINIA   **C
C**   DEPARTMENT OF HIGHWAYS BY:                                     **C
C**                                                                  **C
C**                       WILLIAM A. CARPENTER                       **C
C**                     HIGHWAY RESEARCH ENGINEER                    **C
C**                                                                  **C
C**                          JERRY L. KORF                           **C
C**                        RESEARCH ASSISTANT                        **C
C**                                                                  **C
C**                         HAROLD R. SHERRY                         **C
C**                        RESEARCH ASSISTANT                        **C
C**                               AND                                **C
C**                         GERRY G. CLEMENA                         **C
C**                HIGHWAY MATERIALS RESEARCH ANALYST                **C
C**                                                                  **C
C**   OF THE DATA SYSTEMS AND ANALYSIS SECTION OF THE VIRGINIA       **C
C**   HIGHWAY RESEARCH COUNCIL, P.O. BOX 3817, UNIVERSITY STATION,   **C
C**   CHARLOTTESVILLE, VIRGINIA  22903.                              **C
C**                                                                  **C
C**   THE AUTHORS AND THE STATE OF VIRGINIA WISH TO ACKNOWLEDGE      **C
C**   THE VERY SIGNIFICANT ASSISTANCE, BOTH THEORETICAL AND          **C
C**   EMPIRICAL, OF THE MATERIALS AND RESEARCH DEPARTMENT OF THE     **C
C**   CALIFORNIA DIVISION OF HIGHWAYS, SACRAMENTO, CALIFORNIA, AND   **C
C**   IN PARTICULAR THE ASSISTANCE OF ANDREW RANZIERI AND MARCO      **C
C**   FARROCKHROOZ (CDH).                                            **C
C**                                                                  **C
C**   AIRPOL IS BASED ON A MODIFIED VERSION OF THE STANDARD          **C
C**   GAUSSIAN DISPERSION MODEL FOR POINT SOURCE EMISSIONS,          **C
C**   QUASI-INTEGRATED TO OBTAIN A LINE-SOURCE MODEL, WHICH          **C
C**   IS A STANDARD APPROACH.  HOWEVER, IN THIS PROGRAM, THE         **C
C**   GAUSSIAN MODEL HAS BEEN FURTHER MODIFIED.  IT IS HOPED THE     **C
C**   RESULT, WHICH IS ONLY A BEGINNING, WILL SERVE AS A VIABLE      **C
C**   RESEARCH TOOL, **AIRPOL**.                                     **C
C**                                                                  **C
C**********************************************************************C
C**********************************************************************C
```

```
C                    ****  DESCRIPTION OF VARIABLES  ****
C
C
C
C     NDATA -- INTEGER -- INPUT (I2) -- COLUMNS 6 - 7
C     THE NUMBER OF DATA CARDS IN THIS DATA SET.
C
C     ALF(5) -- ALPHA -- INPUT (5A10) -- COLUMNS 8 - 57
C     DESCRIPTIVE INFORMATION TO BE USED AS A HEADDING FOR THE OUTPUT.
C
C     WSIN(6) -- REAL -- INPUT (F3.1, 5(1X, F3.1)) -- COLUMNS 58 - 80
C     THE WIND SPEEDS, IN MPH, TO BE USED IN THIS ANALYSIS.  AS MANY AS
C     SIX OR AS FEW AS ONE WIND SPEED MAY BE USED.  IF ALL WSIN(I) ARE
C     .LE. 0 OR BLANK THEN THE PROGRAM WILL ANALYZE THE DATA USING WIND
C     SPEEDS OF 4.0, 7.0, AND 10.0 MPH.
C     NOTE:  AIRPOL IS NOT VALID FOR WIND SPEEDS .LT. 3 MPH.
C
C     SITEID -- ALPHA -- INPUT (A4) -- COLUMNS 6 - 9
C     A FOUR CHARACTER DESIGNATION FOR THE SITE BEING ANALYZED.
C
C     SOURCE -- ALPHA -- INPUT (A1) -- COLUMN 11
C            = C IF SOURCE IS A CITY STREET.
C            = F IF SOURCE IS A FREEWAY.
C     NOTE:  CITY STREET / FREEWAY IS DETERMINED BY THE EXTENT OF STOP
C     AND GO TRAFFIC WITHIN ABOUT 400 FEET OF THE OBSERVER.
C
C     YEAR -- INTEGER -- INPUT (I2) -- COLUMNS 13 - 14
C     THE YEAR FOR WHICH THE PREDICTION IS BEING MADE, YEAR SHOULD BE
C     .GE. 72 AND .LE. 99.
C
C     CLASS -- ALPHA -- INPUT (A1) -- COLUMN 16
C     THE PASQUILL - GIFFORD ATMOSPHERIC STABILITY CLASS (A, B, C, D, E,
C     OR F).  STABILITY CLASS A IS THE LEAST STABLE ATMOSPHERIC
C     CONDITION, AND CLASS F IS THE MOST STABLE.
C
C     CASE -- INTEGER -- INPUT (I1) -- COLUMN 18
C          = 1 IF WIND REACHES ROADWAY BEFORE REACHING THE OBSERVER.
C          = 2 IF WIND REACHES ROADWAY AFTER REACHING THE OBSERVER.
C
C     ALPHA -- REAL -- INPUT (F2.0) -- COLUMNS 20 - 21
C     THE ACUTE ANGLE, IN DEGREES, BETWEEN THE SOURCE ROADWAY AND
C     THE WIND DIRECTION.
C
C     NOTE:  CLASS, CASE, ALPHA, AND WIND SPEED SHOULD BE OBTAINED FROM
C     THE OUTPUT OF EITHER PROGRAM WNDROS OR PROGRAM STAR2 AS DEVELOPED
C     BY MARCO FARROCKHROOZ (CDH) WHEN ANALYZING THE MOST PROBABLE
C     METEOROLOGICAL CONDITION.  FOR AN ANALYSIS OF THE WORST CASE
C     CONDITION, THE CONSTRUCTION PLANS MUST BE CONSULTED.
C
C     Z -- REAL -- INPUT (F3.0) -- COLUMNS 23 - 25
C     VERTICAL DISPLACEMENT, IN FEET, OF THE OBSERVER ABOVE THE
C     SURROUNDING TERRAIN.  IN THE CASE OF A DEPRESSED ROADWAY, Z IS
C     TO BE TAKEN AS THE HEIGHT OF THE OBSERVER ABOVE THE ROAD SURFACE.
C
C     HEIGHT -- REAL -- INPUT (F4.0) -- COLUMNS 27 - 30
C     VERTICAL DISPLACEMENT, IN FEET, OF THE ROADWAY RELATIVE TO THE
C     SURROUNDING TERRAIN.  IF THE ROADWAY IS ELEVATED, THEN HEIGHT MUST
C     BE .GE. 0.  IF THE ROADWAY IS DEPRESSED, HEIGHT MUST BE .LE. 0.
```

```
C     IF THE ROADWAY IS AT GRADE, HEIGHT MUST BE EITHER BLANK OR .EQ. 0.
C     NOTE:  THE DEPRESSED ROADWAY CONDITION IS TO BE USED **ONLY** WHEN
C     THE THE OBSERVER **AND** THE ROADWAY ARE **BOTH** IN A CUT.
C
C     LENGTH -- REAL -- INPUT (F5.0) -- COLUMNS 32 - 36
C     THE MAXIMUM STRAIGHT LINE DISTANCE, IN FEET, THAT THE ROADWAY
C     EXTENDS IN THE UPWIND DIRECTION.  FOR ALPHA .EQ. 90 DEGREES,
C     EITHER DIRECTION MAY BE CONSIDERED AS THE UPWIND DIRECTION.
C
C     TFVOL -- REAL -- INPUT (F5.0) -- COLUMNS 38 - 42
C     TOTAL TRAFFIC VOLUME FOR THE ROADWAY ELEMENT BEING ANALYZED, IN
C     VEHICLES PER HOUR.
C
C     TFSPD -- REAL -- INPUT (F2.0) -- COLUMNS 44 - 45
C     AVERAGE ROUTE SPEED, IN MPH.
C
C     TFMIX -- INTEGER -- INPUT (I2) -- COLUMNS 47 - 48
C     PERCENT OF HEAVY VEHICLE TRAFFIC (5, 10, 15, OR 20)
C
C     NOTE:  FOR DUAL DIVIDED HIGHWAYS, THE TWO TRAFFIC DIRECTIONS
C     **MUST** BE ANALYZED AS SEPERATE SOURCES AND THE RESULTS
C     SUPERIMPOSED TO OBTAIN THE TOTAL EFFECT OF THE FACILITY.  ENTRANCE
C     AND EXIT RAMPS MUST ALSO BE TREATED AS INDEPENDENT SOURCES WITH
C     SUPERPOSITION EMPLOYED TO FIND TOTAL CONCENTRATIONS.  A GIVEN
C     SOURCE MAY **NEVER** CONTAIN MORE THAN THREE TRAFFIC LANES.
C     THEREFORE, IT MAY EVEN BE NECESSARY TO DIVIDE A SINGLE TRAFFIC
C     DIRECTION INTO TWO OR MORE INDEPENDENT SOURCES.  TO TREAT TWO OR
C     MORE ROADWAY ELEMENTS INDEPENDENTLY,  TRAFFIC AND GEOMETRIC DATA
C     FOR THE VARIOUS ELEMENTS MUST BE AVAILABLE.
C
C     CWIDTH -- REAL -- INPUT (F4.0) -- COLUMNS 50 - 53
C     THE AVERAGE CUT WIDTH, IN FEET, MEASURED AT A HEIGHT OF 1/2 THE
C     DEPTH OF THE CUT.  IF THE CUT SITUATION IS NOT APPLICABLE, THEN
C     CWIDTH SHOULD BE LEFT BLANK.
C
C     CLENGH -- REAL -- INPUT (F4.0) -- COLUMNS 55 - 58
C     THE DISTANCE, IN FEET, MEASURED ALONG THE ROADWAY IN THE UPWIND
C     DIRECTION, TO THE POINT WHERE THE CUT DEPTH .EQ. 1/2 THE DEPTH AT
C     THE OBSERVER.  IF THE CUT SITUATION IS NOT APPLIABLE, THEN LEAVE
C     CLENGH BLANK.
C
C     SHOWIT -- LOGICAL -- INPUT (L1) COLUMN 60
C     AN OUTPUT CONTROL PARAMETER.
C     IF SHOWIT = .T. THEN THE FACTORS IN THE CALCULATIONS OF THE CO
C     AND HC LEVELS ARE DISPLAYED ALONG WITH THE RESULTS.
C     IF SHOWIT = .F. OR BLANK THEN ONLY THE RESULTS ARE DISPLAYED.
C     NOTE:  FOR NORMAL OPERATION, SHOWIT SHOULD BE LEFT BLANK.
C
C     DIN(5) -- REAL -- INPUT (5(1X, F3.0)) -- COLUMNS 61 - 80
C     THE PERPENDICULAR DISTANCES, IN FEET, FROM THE OBSERVER TO THE
C     SOURCE (NEAREST EDGE OF NEAREST TRAFFIC LANE OF ROADWAY ELEMENT
C     UNDER CONSIDERATION).  AS MANY AS FIVE OR AS FEW AS ONE DISTANCE
C     MAY BE USED.  IF ALL DIN(I) ARE .LE. 0 OR BLANK THEN THE PROGRAM
C     WILL ANALYZE THE DATA USING A DISTANCE OF 50 FT.
C
C     KFACTR -- REAL -- CONSTANT
C     AN EMPIRICAL FACTOR, DIMENSIONLESS, CURRENTLY = 4.5
C
```

```
C       AFACTR -- REAL -- CONSTANT
C       AN EMPERICAL ANGLE FACTOR, DIMENSIONLESS, CURRENTLY = 0.4
C
C       CFACTR -- REAL -- CALCULATED
C       THE CASE FACTOR, DIMENSIONLESS.  MONOTONE DECREASING FROM 0 TO 90
C       DEGREES.
C
C       LFACTR -- REAL -- CALCULATED
C       THE LENGTH FACTOR TO REFLECT THE EFFECTIVE LENGTH OF THE
C       UPWIND ROADWAY, IN METERS.  MONOTONE DECREASING FROM 0 TO 90
C       DEGREES.
C
C       ZFACTR -- REAL -- CALCULATED
C       THE VERTICAL DISPERSION FACTOR, DIMENSIONLESS.  (ZFACTR / SZM IS
C       THE COMPLETE VERTICAL DISPERSION FACTOR AND HAS DIMENSION 1 / M).
C
C       YFACTR -- REAL -- CALCULATED
C       THE LATERAL DISPERSION FACTOR, DIMENSIONLESS.  (YFACTR / SHM IS
C       THE COMPLETE LATERAL DISPERSION FACTOR AND HAS DIMENSION 1 / M).
C       MONOTONE INCREASING FROM 0 TO 90 DEGREES.
C
C       CA -- REAL -- CALCULATED
C       CA = COSINE (ALPHA).
C
C       SA -- REAL -- CALCULATED
C       SA = SINE (ALPHA).
C
C       EFCO -- REAL -- CALCULATED
C       THE EMISSION FACTOR, IN GM / MILE, FOR CARBON MONOXIDE.
C
C       EFHC -- REAL -- CALCULATED
C       THE EMISSION FACTOR, IN GM / MILE, FOR HYDROCARBONS (BASED ON CH4
C       EQUIVALENT UNITS).
C
C       QCO -- REAL -- CALCULATED
C       SOURCE EMISSION STRENGTH, IN GM (CO) / M-SEC.
C
C       QHC -- REAL -- CALCULATED
C       SOURCE EMISSION STRENGTH, IN GM (HC) / M-SEC.
C
C       DIST -- REAL -- CALCULATED
C       THE DISTANCE, IN FEET, AT WHICH SIGMA-Z AND SIGMA-H ARE COMPUTED.
C       DIST CHANGES FUNCTIONALLY FROM DIST = F(LENGTH, ALPHA, DIN) AT 0
C       DEGREES TO DIST = DIN AT 90 DEGREES.
C
C       H -- REAL -- CALCULATED
C       THE HEIGHT, IN FEET, OF THE EFFECTIVE SOURCE = 6 FT. ABOVE ROAD.
C
C       CHT -- REAL -- CALCULATED
C       THE DEPTH, IN FEET, OF THE CUT BEING ANALYZED.
C
C       EFSP -- REAL -- CALCULATED
C       THE DISTANCE, IN FEET, TAKEN ALONG THE ROADWAY IN THE UPWIND
C       DIRECTION, TO THE EFFECTIVE SOURCE POINT LOCATION.
C
C       SZ -- REAL -- CALCULATED
C       HEIGHT OF THE DISPERSION CURVE, IN FEET.
C
```

```
C     SZM -- REAL -- CALCULATED
C     HEIGHT OF THE DISPERSION CURVE, IN METERS.
C
C     SH -- REAL -- CALCULATED
C     WIDTH OF THE DISPERSION CURVE, IN FEET.
C
C     SHM -- REAL -- CALCULATED
C     WIDTH OF THE DISPERSION CURVE, IN METERS.
C
C     CO -- REAL -- CALCULATED
C     THE CARBON MONOXIDE CONCENTRATION, IN PPM.
C
C     HC -- REAL -- CALCULATED
C     THE HYDROCARBON CONCENTRATION, IN PPM.
C
C
C
C     FORMATS -- FILE 5 = CARD READER.
C
 5000 FORMAT (5X,I2,5A10,5(F3.1,1X),F3.1)
 5010 FORMAT (5X,A4,1X,A1,1X,I2,1X,A1,1X,I1,1X,F2,1X,F3,1X,F4,1X,F5,
     -1X,F5,1X,F2,1X,I2,1X,2(F4,1X),L1,5(1X,F3))
C
C
C
C     FORMATS -- FILE 6 = LINE PRINTER.
C
 6000 FORMAT (*1*10X*SITEID*25X,5A10,25X*SITEID*/
     -12X,A4,102X,A4//64X*UPWIND*43X*DIST*/*  WS *3X*SOURCE*4X*YR*4X   *
     -CLASS*4X*CASE*3X*ALPHA*4X*OBS.*3X*SOURCE*2X*SOURCE*2X*IFVOL*3X*TFS
     -PD*3X*TFMIX*3X*CWIDTH*2X*CLENGTH*2X*FROM*5X*CO*6X*HC*/
     -*  (MPH)*3X*TYPE*
     -28X*DEG.*5X*HT*6X*HT*4X*LENGTH*2X*(VPH)*3X*(MPH)*4X*(PC)*4X*(FT)*
     -4X*(FT)*3X*SOURCE*3X*(PPM)*2X*(PPM)*/49X,3(*(FT)*4X),40X*(FT)*//)
 6010 FORMAT (1X,F4.1,5X,A1,7X,I2,6X,A1,7X,I1,7X,F2,5X,F3,5X,F4,3X,F5,3X
     -,F5,5X,F2,6X,I2,5X*NONE*4X*NONE*5X,F3,2(3X,F5.1))
 6020 FORMAT (1X,F4.1,5X,A1,7X,I2,6X,A1,7X,I1,7X,F2,5X,F3,5X,F4,3X,F5,3X
     -,F5,5X,F2,6X,I2,5X,F4,4X,F4,5X,F3,2(3X,F5.1))
 6030 FORMAT (///)
 6040 FORMAT (16X  *P*12X*GAMMA*11X*QCO*12X*QHC*11X*ZFACTR*9X*YFACTR*9X*
     -KFACTR*/10X,7(E13.6,2X)/14X*LFACTR*9X*CFACTR*9X*GFACTR*10X*SZM*
     -11X*AFACTR*10X*SHM*12X*DIST*/10X,7(E13.6,2X))
 6050 FORMAT (*1 ALL AVAILABLE DATA HAS BEEN PROCESSED -- END OF AIRPOL
     -ANALYSIS.*)
C
C
C
C
C
C                   ****  END OF PRELIMINARY INFORMATION  ****
C
C
C                        ****  START OF AIRPOL CODE  ****
C
C
C
C
C
```

```
C*******************************************************************C
C*******************************************************************C
C**                                                               **C
C**                          NOTICE                               **C
C**                          ******                               **C
C**                                                               **C
C**   THE REMAINDER OF THIS PROGRAM IS PRIVILAGED INFORMATION.    **C
C**   IT SHOULD NOT BE RELEASED OR SHOWN TO PERSONNEL OUTSIDE THE **C
C**   DEPARTMENT WITHOUT APPROPRIATE AUTHORIZATION.               **C
C**                                                               **C
C**                                                               **C
C*******************************************************************C
C*******************************************************************C
C
C
      LOGICAL SHOWIT, DTEST, WSTEST                                     AIRP 210
      REAL KFACTR, LENGTH, LFACTR, DIN(5), WSIN(6)                      AIRP 220
      INTEGER SITEID, CLASS, CASE, TFMIX, YEAR, SOURCE, ALF (5)         AIRP 230
      DATA KFACTR, AFACTR /4.5, 0.4/                                    AIRP 240
C
C
C     READ NDATA, HEADDING INFORMATION, AND WIND SPEEDS.
C     CHECK FOR END OF FILE.
C
 1    READ (5, 5000) NDATA, ALF, WSIN                                   AIRP 250
      IF (EOF,5) 98,2                                                   AIRP 260
C
C
C     DO VALIDITY CHECK-CORRECT ON WSIN.
C
 2    WSTEST = .F.                                                      AIRP 270
      DO 3 J = 1, 6                                                     AIRP 280
      IF (WSIN(J) .GT. 0.0) WSTEST = .T.                                AIRP 290
 3    CONTINUE                                                          AIRP 300
      IF (WSTEST) GO TO 4                                               AIRP 310
      WSIN(1) = 4.0                                                     AIRP 320
      WSIN(2) = 7.0                                                     AIRP 330
      WSIN(3) = 10.0                                                    AIRP 340
C
C
 4    DO 90 I = 1, NDATA                                                AIRP 350
C
C     PROCESS THE NDATA DATA CARDS IN THIS DATA SET.
C
C
C     READ A DATA CARD, CHECK FOR END OF FILE, AND VERIFY THE DATA.
C
      READ (5, 5010) SITEID, SOURCE, YEAR, CLASS, CASE, ALPHA, Z,       AIRP 360
     -HEIGHT, LENGTH, TFVOL, TFSPD, TFMIX, CWIDTH, CLENGH, SHOWIT, DIN   AIRP 370
      IF (EOF, 5) 98, 7                                                 AIRP 380
C
C     WRITE THE HEADDING FOR THE PRINTER OUTPUT.
C
 7    WRITE (6, 6000) ALF, SITEID, SITEID                               AIRP 390
C
C
C     DO VALIDITY CHECK-CORRECT ON SOURCE.
C
```

```
      IF (SOURCE .EQ. 1HC) GO TO 10
      SOURCE = 1HF
C
C
C     DO VALIDITY CHECK-CORRECT ON YEAR.
C
   10 IF (YEAR .LT. 72) YEAR = 72
C
C
C     DO VALIDITY CHECK-CORRECT ON CLASS.
C
      IF (CLASS .EQ. 1HA .OR. CLASS .EQ. 1HB .OR. CLASS .EQ. 1HC .OR.
     -CLASS .EQ. 1HD .OR. CLASS .EQ. 1HE .OR. CLASS .EQ. 1HF) GO TO 20
      CLASS = 1HD
C
C
C     DO VALIDITY CHECK-CORRECT ON CASE.
C
   20 IF (CASE .EQ. 2) GO TO 30
      CASE = 1
C
C
C     DO VALIDITY CHECK-CORRECT ON ALPHA.
C
   30 ALPHA = ABS(ALPHA)
      XALPHA = ALPHA
C
C
C     DO VALIDITY CHECK-CORRECT ON Z.
C
      Z = ABS(Z)
C
C
C     DO VALIDITY CHECK-CORRECT ON HEIGHT.
C
      H = 6.0
      CHT = ABS(HEIGHT)
      IF (HEIGHT .LE. 0.0) GO TO 40
      H = H + CHT
      CHT = 0.0
C
C
C     DO VALIDITY CHECK-CORRECT ON LENGTH.
C
   40 LENGTH = ABS(LENGTH)
      IF (LENGTH .LT. 400.0) LENGTH = 400.0
      XLEN = LENGTH
C
C
C     DO VALIDITY CHECK-CORRECT ON TFVOL.
C
      TFVOL = ABS(TFVOL)
C
C
C     DO VALIDITY CHECK-CORRECT ON TFSPD.
C
      TFSPD = ABS(TFSPD)
      IF (TFSPD .LT. 10.0) TFSPD = 10.0
```

```
      IF (TFSPD .GT. 60.0) TFSPD = 60.0                                 AIRP 620
C
C
C     DO VALIDITY CHECK-CORRECT ON TFMIX.
C
      TFMIX = ((IABS(TFMIX) + 4) / 5) * 5                               AIRP 630
      IF (TFMIX .GT. 20) TFMIX = 20                                     AIRP 640
      IF (TFMIX .LT. 5) TFMIX = 5                                       AIRP 650
C
C
C     DO VALIDITY CHECK-CORRECT ON CWIDTH.
C
      IF (CWIDTH * CHT .LE. 0.0) CWIDTH = 1E300                         AIRP 660
C
C
C     DO VALIDITY CHECK-CORRECT ON CLENGH.
C
      IF (CLENGH * CHT .LE. 0.0) CLENGH = 0.0                           AIRP 670
C
C
C     DO VALIDITY CHECK-CORRECT ON DIN.
C
      DTEST = .T.                                                       AIRP 680
      DO 50 J = 1, 5                                                    AIRP 690
      IF (DIN(J) .GT. 0.0) DTEST = .F.                                  AIRP 700
   50 CONTINUE                                                          AIRP 710
      IF (DTEST) DIN(1) = 50.0                                          AIRP 720
C
C
C     CALCULATE PRELIMINARY VARIABLES AND PERFORM NECESSARY CONVERSIONS.
C
   60 ICLASS = ICNVRT(CLASS)                                            AIRP 730
C
C     0.0174533 CONVERTS DEGREES TO RADIANS
C
      ALPHA = .0174533 * ALPHA                                          AIRP 740
      CA = COS(ALPHA)                                                   AIRP 750
      SA = SIN(ALPHA)                                                   AIRP 760
C
C     0.304801 CONVERTS FEET TO METERS.
C
C     0.552088 = (0.304801)**.5 AND CONVERTS EFFECTIVE LENGTH IN FEET
C     TO EFFECTIVE LENGTH IN METERS.
C
      LFACTR = 24.0 + 0.552088 * SQRT(LENGTH * 1.0) * (1.0 - SA) / 2.0  AIRP 770
      EFSP = SQRT(ABS(CA * LENGTH) * 1.0)                               AIRP 780
      EFCO = EFCRVC(YEAR, TFMIX, TFSPD, SOURCE)                         AIRP 790
      EFHC = EFCRVH(YEAR, TFMIX, TFSPD, SOURCE)                         AIRP 800
C
C
C     CALCULATE FACTORS FOR FINAL EQUATIONS.
C
C     1.726025E-7 CONVERTS GM / MILE-HOUR TO GM / M-SEC.
C
      QCO = (1.726025E-7) * TFVOL * EFCO                                AIRP 810
      QHC = (1.726025E-7) * TFVOL * EFHC                                AIRP 820
      GFACTR = (2.0 - EXP(-CHT * CLENGH / (CWIDTH * 200.0))) *          AIRP 830
     -EXP(2.0 * CHT / CWIDTH)                                           AIRP 840
```

```
      DO 80 J = 1, 5
C
C     PERFORM THE ANALYSIS FOR UP TO FIVE OFF THE ROAD DISTANCES.
C
      D = DIN(J)
      IF (D .LE. 0.0) GO TO 80
      DIST = D
      P = 0.0
      IF (XALPHA .GT. 89.0) GO TO 70
      GAMMA = ATAN (D / EFSP) - ALPHA
      XGAMMA = GAMMA / .0174533
      DIST = COS(GAMMA) * SQRT(D**2 + EFSP**2)
      P = TAN(GAMMA) * DIST
   70 SZM = SIGMAZ(DIST, ICLASS)
      SHM = SIGMAH(DIST, ICLASS)
C
C     3.28083 CONVERTS METERS TO FEET.
C
      SZ = 3.28083 * SZM
      SH = 3.28083 * SHM
      CFACTR = EXP(-0.5 * SA * (SQRT(ABS((CASE-1) * D / 10.0)) +
     -CASE - 1))
      ZFACTR = EXP(-0.5 * ((Z - H) / SZ)**2) + EXP(-0.5 * ((Z - H) /
     -SZ)**2)
      YFACTR = EXP(-0.5 * (P / SH)**2)
C
C     2.23693 CONVERTS HOUR / MILE TO SEC / M.
C     0.159155 = 1 / (2 * PIE)
C
      R = 2.23693 * 0.159155 * ZFACTR * YFACTR * KFACTR * LFACTR *
     -CFACTR * GFACTR / (SZM * AFACTR * SHM)
C
C     870.0 CONVERTS GM (CO) / M**3 TO PPM (CO).
C     1530.0 CONVERTS GM (HC) / M**3 TO PPM (HC).
C
      COWS = 870.0 * QCO * R
      HCWS = 1530.0 * QHC * R
C
C
C     CALCULATE THE CARBON MONOXIDE AND HYDROCARBON LEVELS.
C     PRINT OUT THE RESULTS AND THE INPUT DATA.
C
      DO 71 K = 1, 6
C
C     PERFORM THE ANALYSIS FOR UP TO SIX WIND SPEEDS.
C
      WS = WSIN(K)
      IF (WS .LE. 0.0) GO TO 71
      CO = COWS / WS
      HC = HCWS / WS
      IF (HEIGHT .GE. 0.0) WRITE (6, 6010) WS, SOURCE, YEAR, CLASS,
     -CASE, XALPHA, Z, HEIGHT, XLEN, TFVOL, TFSPD, TFMIX, D, CO, HC
C
      IF (HEIGHT .LT. 0.0) WRITE (6, 6020) WS, SOURCE, YEAR, CLASS,
     -CASE, XALPHA, Z, HEIGHT, XLEN, TFVOL, TFSPD, TFMIX, CWIDTH,
     -CLENGH, D, CO, HC
C
C     END OF WIND SPEED LOOP.
```

```
C
 71    CONTINUE                                                          AIRP1180
C
C
       IF (SHOWIT) GO TO 78                                              AIRP1190
       WRITE (6, 6030)                                                   AIRP1200
       GO TO 80                                                          AIRP1210
C
C
C      PRINT OUT THE FACTORS USED IN THE CONCENTRATION EQUATIONS.
C
 78    WRITE (6, 6040)  P, XGAMMA, QCO, QHC, ZFACTR, YFACTR, KFACTR,     AIRP1220
      -LFACTR, CFACTR, GFACTR, SZM, AFACTR, SHM, DIST                    AIRP1230
C
C      END OF OFF THE ROAD DISTANCE LOOP.
C
 80    CONTINUE                                                          AIRP1240
C
C
C      END OF NDATA LOOP.
C
 90    CONTINUE                                                          AIRP1250
C
C
C      RETURN FOR THE NEXT DATA SET.
C
       GO TO 1                                                           AIRP1260
C
C
C      TERMINATION OF AIRPOL ANALYSIS
C
 98    WRITE (6, 6050)                                                   AIRP1270
       STOP                                                              AIRP1280
       END                                                               AIRP1290
```

```
      INTEGER FUNCTION ICNVRT(CLASS)                                    ICNV   0
C
C     ICNVRT CONVERTS STABILITY CLASSES FROM ALPHA TO INTEGER BY TAKING
C
C         A  TO  1
C         B  TO  2
C         C  TO  3
C         D  TO  4
C         E  TO  5
C         F  TO  6
C
C     DESCRIPTION OF PARAMETER
C
C
C     CLASS -- INTEGER
C     THE HOLLERITH CODED STABILITY CLASS.
C
C     NOTE -- THE MAIN PROGRAM ALLOWS ONLY VALID CLASSES TO ENTER ICNVRT
C
C
      INTEGER CLASS                                                     ICNV  10
      IF (CLASS .NE. 1HA) GO TO 1                                       ICNV  20
      ICNVRT = 1                                                        ICNV  30
      RETURN                                                            ICNV  40
    1 IF (CLASS .NE. 1HB) GO TO 2                                       ICNV  50
      ICNVRT = 2                                                        ICNV  60
      RETURN                                                            ICNV  70
    2 IF (CLASS .NE. 1HC) GO TO 3                                       ICNV  80
      ICNVRT = 3                                                        ICNV  90
      RETURN                                                            ICNV 100
    3 IF (CLASS .NE. 1HD) GO TO 4                                       ICNV 110
      ICNVRT = 4                                                        ICNV 120
      RETURN                                                            ICNV 130
    4 IF (CLASS .NE. 1HE) GO TO 5                                       ICNV 140
      ICNVRT = 5                                                        ICNV 150
      RETURN                                                            ICNV 160
    5 ICNVRT = 6                                                        ICNV 170
      RETURN                                                            ICNV 180
      END                                                               ICNV 190
```

```
      REAL FUNCTION EFCRVC(IYEAR,MIX,SPEED,IAREA)
C
C     EFCRVC CALCULATES THE EMISSION FACTOR FOR CARBON MONOXIDE IN
C     GM/MILE.  EFCRVC IS BASED ON INFORMATION SUPPLIED BY CALIFORNIA
C     AND THE EPA.
C
C     DESCRIPTION OF PARAMETERS
C
C
C     IYEAR -- INTEGER
C     THE PREDICTION YEAR (72 TO 99).
C
C     MIX -- INTEGER
C     THE PERCENT OF HEAVY DUTY VEHICLES (5 TO 20).
C
C     SPEED -- REAL
C     THE AVERAGE ROUTE SPEED IN MPH (10.0 TO 60.0).
C
C     IAREA -- INTEGER
C           = 1HC FOR CITY STREETS.
C           = 1HF FOR FREEWAYS.
C
C     NOTE -- THE MAIN PROGRAM ALLOWS ONLY VALID PARAMETERS TO ENTER
C     EFCRVC.
C
C
      DIMENSION FACTOR(64,3),LOOP(2,4,8)
      DATA LOOP /
     -    1, 3, 3*1, 3, 2*1, 2*3, 3*1, 3, 4*1, 3, 2*1, 3, 2*1, 3, 2*1,
     -    3, 1, 3, 2*2, 3, 1, 5*3, 2*2, 3, 1, 2, 3, 2, 3, 7*2, 1, 2,
     -    8*1 /
      DATA (FACTOR(I),I=1,32)/
     -     5.65752E02,    1.44214E02,    2.02540E02,    3.60333E01,
     -     1.32453E01,    2.71779E-5,    1.08973E-5,    0.00000E00,
     -     5.79521E02,    5.39790E02,    9.83709E01,    3.21637E02,
     -     1.48568E01,    1.48118E01,    1.00008E-5,    0.00000E00,
     -     5.29352E02,    4.50980E02,    2.39046E02,    2.65299E02,
     -     1.34966E01,    4.55117E00,    1.19887E-5,    0.00000E00,
     -     5.87595E02,    3.87147E02,    2.27269E02,    8.56307E-5,
     -     1.74364E01,    7.78920E00,    4.89085E03,    0.00000E00/
      DATA  (FACTOR(I),I=33,64)/
     -     1.95818E02,    1.41506E02,    2.17730E02,    1.17670E02,
     -     9.65348E01,    1.44070E01,    4.43688E-5,    0.00000E00,
     -     6.24130E02,    4.37954E02,    1.85211E02,    4.17487E01,
     -     2.06270E01,    4.01187E-5,    2.50182E-5,    0.00000E00,
     -     1.60159E02,    1.30365E02,    6.34737E01,    3.13966E01,
     -     1.51934E01,    4.94393E-5,    1.68292E-5,    0.00000E00,
     -     5.72436E02,    4.21772E02,    1.73348E02,    5.81926E-5,
     -     2.16513E-5,    3.91489E-5,    1.04089E-5,    0.00000E00/
      DATA (FACTOR(I),I=65,96)/
     -    -6.53565E-1,   -6.74530E-2,   -3.49186E-1,   -3.85910E-2,
     -    -2.91528E-2,   -4.04148E-3,   -1.10431E-3,    0.00000E00,
     -    -6.93394E-1,   -7.53674E-1,   -7.22738E-2,   -3.80191E-2,
     -    -5.04023E-2,   -5.76866E-1,   -1.01110E-3,    0.00000E00,
     -    -6.95107E-1,   -6.96526E-1,   -5.75480E-1,   -4.69673E-2,
     -    -2.42488E-2,   -2.70245E-2,   -1.21267E-3,    0.00000E00,
     -    -7.39486E-1,   -6.01641E-1,   -5.31573E-1,   -1.54058E-2,
```

```
     -    -3.93008E-2,    -3.06201E-2,    -4.30624E00,     0.00000E00/
      DATA  (FACTOR(I),I=97,128)/
     -    -7.20767E-2,    -6.61371E-2,    -4.66178E-1,    -3.81762E-1,
     -    -5.95946E-1,    -5.91702E-2,    -4.57976E-3,     0.00000E00,
     -    -7.27895E-1,    -6.47426E-1,    -3.42860E-1,    -5.38272E-2,
     -    -4.99514E-2,    -6.03031E-3,    -2.87828E-3,     0.00000E00,
     -    -6.87518E-2,    -6.87243E-2,    -5.92993E-2,    -5.58030E-2,
     -    -5.81366E-2,    -5.23564E-3,    -1.84937E-3,     0.00000E00,
     -    -7.14979E-1,    -6.76193E-1,    -3.99664E-1,    -1.01025E-2,
     -    -6.11127E-3,    -5.96172E-3,    -2.48989E-3,     0.00000E00/
      DATA (FACTOR(I),I=129,160)/
     -    -1.05638E01,     2.43131E01,    -2.55637E01,     1.74736E01,
     -     1.65955E01,     1.32091E00,     1.12417E00,     1.05000E01,
     -    -7.32925E00,    -1.15817E00,     2.01528E01,    -2.56637E02,
     -     1.60387E01,     1.28750E01,     1.05024E00,     8.80000E00,
     -    -6.77248E00,    -5.66273E00,    -5.49700E00,    -2.04077E02,
     -     9.89953E00,     1.02718E01,     9.74405E-1,     7.00000E00,
     -    -9.01798E00,    -1.68359E01,    -1.28138E01,     1.65925E00,
     -     7.78475E00,     6.77010E00,     6.99970E00,     5.20000E00/
      DATA  (FACTOR(I),I=161,192)/
     -     2.95037E01,     2.69009E01,    -7.13429E00,    -3.80564E00,
     -     8.54834E00,     1.40436E01,     1.23041E00,     1.20000E01,
     -    -1.73067E00,    -3.58023E00,    -2.20577E01,     1.85445E01,
     -     1.54590E01,     1.32264E00,     1.14029E00,     1.05000E01,
     -     2.92566E01,     2.73362E01,     2.28356E01,     1.99599E01,
     -     1.65533E01,     1.24425E00,     1.05046E00,     8.80000E00,
     -    -3.27971E00,    -1.85205E00,    -1.25300E01,     1.61996E00,
     -     1.38115E00,     1.20506E00,     9.91989E-1,     7.00000E00/
      I1 = 1
      IF (IAREA.EQ.1HC) I1 = 2
      I2 = (25-MIX)/5
      I3 = (IYEAR-70)/2
      IF (I3 .GT. 8) I3 = 8
      I4 = 32*I1+8*I2+I3-40
      A = FACTOR(I4,1)
      B = FACTOR(I4,2)
      C = FACTOR(I4,3)
      L = LOOP(I1,I2,I3)
      GO TO (1,2,3), L
    1 EFCRVC = A*SPEED**B+C
      RETURN
    2 EFCRVC = 10.**(A*SPEED*SPEED+B*SPEED+C)
      RETURN
    3 EFCRVC = A*EXP(B*SPEED)+C
      RETURN
      END
```

```
      REAL FUNCTION EFCRVH(IYEAR,MIX,SPEED,IAREA)
C
C     EFCRVH CALCULATES THE EMISSION FACTOR FOR HYDROCARBONS IN GM/MILE.
C     EFCRVH IS BASED ON INFORMATION SUPPLIED BY CALIFORNIA AND THE EPA.
C
C     DESCRIPTION OF PARAMETERS
C
C
C     IYEAR -- INTEGER
C     THE PREDICTION YEAR (72 TO 99).
C
C     MIX -- INTEGER
C     THE PERCENT OF HEAVY DUTY VEHICLES (5 TO 20).
C
C     SPEED -- REAL
C     THE AVERAGE ROUTE SPEED IN MPH (10.0 TO 60.0).
C
C     IAREA -- INTEGER
C           = 1HC FOR CITY STREETS.
C           = 1HF FOR FREEWAYS.
C
C     NOTE -- THE MAIN PROGRAM ALLOWS ONLY VALID PARAMETERS TO ENTER
C     EFCRVH.
C
C
      DIMENSION FACTOR(64,3),LOOP(2,4,8)
      DATA LOOP /
     -    12*1, 3, 3*1, 2*3, 2, 2*3, 1, 2*3, 2, 3, 2, 3, 2, 3, 1, 3,
     -    4*2, 1, 3, 2, 3, 2, 1, 2*2, 1, 2*2, 3, 4*1, 2*2, 10*1 /
      DATA  (FACTOR(I),I=1,32)/
     -     1.50162E02,    6.39940E01,    8.61310E00,    6.42102E-5,
     -     4.25668E-5,    2.32362E-5,    4.23919E02,    0.00000E00,
     -     1.58421E02,    7.05582E01,    1.05499E-4,    5.34104E-5,
     -     3.97580E-5,    2.50334E-5,    1.79543E00,    0.00000E00,
     -     1.13877E02,    1.40835E01,    6.02771E00,    5.94810E-5,
     -     1.84650E00,    1.44452E00,    9.20128E-6,    0.00000E00,
     -     1.05965E02,    4.58494E01,    6.13075E00,    7.01075E00,
     -     5.62009E-5,    3.09698E-5,    3.78380E-1,    0.00000E00/
      DATA (FACTOR(I),I=33,64)/
     -     1.51138E02,    5.35004E01,    8.98436E00,    4.69481E00,
     -     5.86606E-5,    3.25151E00,    7.89525E00,    0.00000E00,
     -     1.25860E02,    4.70564E01,    7.31735E00,    4.05274E00,
     -     4.45306E-5,    3.99596E-5,    2.63064E00,    0.00000E00,
     -     1.27860E02,    3.92126E01,    1.64742E01,    2.97939E00,
     -     1.06608E00,    2.73313E-5,    3.64307E-5,    0.00000E00,
     -     1.14499E02,    4.23883E01,    5.55750E00,    2.26058E00,
     -     9.61940E-1,    4.10527E-1,    5.46212E-1,    0.00000E00/
      DATA  (FACTOR(I),I=65,96)/
     -    -8.79538E-1,   -6.16078E-1,   -4.83220E-2,   -7.95623E-3,
     -    -5.05007E-3,   -2.84130E-3,   -3.67339E00,    0.00000E00,
     -    -9.58843E-1,   -7.61681E-1,   -1.28116E-2,   -6.63754E-3,
     -    -4.47777E-3,   -2.70661E-3,   -1.30047E00,    0.00000E00,
     -    -8.98129E-1,   -6.53162E-2,   -5.76682E-2,   -6.70283E-3,
     -    -2.19467E-1,   -7.09649E-1,   -9.86269E-4,    0.00000E00,
     -    -9.39551E-1,   -7.02790E-1,   -6.90627E-2,   -5.86071E-1,
     -    -6.25507E-3,   -2.84068E-3,   -7.71442E-1,    0.00000E00/
      DATA (FACTOR(I),I=97,128)/
```

```
     -    -9.36764E-1,   -6.38365E-1,   -5.36549E-2,   -4.36695E-2,
     -    -7.83860E-3,   -2.12653E-1,   -1.64584E00,    0.00000E00,
     -    -8.76247E-1,   -5.91357E-1,   -5.18047E-2,   -4.77457E-2,
     -    -6.24072E-3,   -4.47006E-3,   -1.17976E00,    0.00000E00,
     -    -8.94419E-1,   -5.67329E-1,   -3.45940E-1,   -4.68316E-2,
     -    -4.25428E-2,   -3.46216E-3,   -3.61439E-3,    0.00000E00,
     -    -8.97727E-1,   -6.20300E-1,   -5.20706E-2,   -3.73075E-2,
     -    -5.35122E-2,   -5.86501E-2,   -2.35268E-1,    0.00000E00/
      DATA  (FACTOR(I),I=129,160)/
     -     3.68365E00,    1.51557E00,    4.90833E00,    8.77041E-1,
     -     5.89877E-1,    3.88288E-1,    1.39970E00,    1.22000E00,
     -     3.58287E00,    2.55537E00,    1.05719E00,    7.75740E-1,
     -     4.96152E-1,    3.02329E-1,    1.19908E00,    1.10000E00,
     -     2.78890E00,    4.65367E00,    3.71103E00,    6.81801E-1,
     -     1.16289E00,    1.29847E00,    5.52793E-2,    9.20000E-1,
     -     2.31976E00,    1.11239E00,    2.91433E00,    1.58217E00,
     -     3.10573E-1,    1.02729E-1,    8.25721E-1,    7.60000E-1/
      DATA (FACTOR(I),I=161,192)/
     -     3.31365E00,    1.69508E00,    4.04226E00,    3.15840E00,
     -     6.95542E-1,    6.78304E-1,    1.61718E00,    1.40000E00,
     -     2.76034E00,    9.46851E-1,    3.84516E00,    2.97917E00,
     -     6.01738E-1,    3.94201E-1,    1.36425E00,    1.23000E00,
     -     3.18944E00,    1.08558E00,   -7.22235E-2,    2.83371E00,
     -     2.20101E00,    3.11847E-1,    1.58901E-1,    1.05000E00,
     -     2.50732E00,    1.04220E00,    3.29389E00,    2.43898E00,
     -     1.83758E00,    1.35177E00,    7.81921E-1,    8.80000E-1/
      I1 = 1
      IF (IAREA.EQ.1HC) I1 = 2
      I2 = (25-MIX)/5
      I3 = (IYEAR-70)/2
      IF (I3 .GT. 8) I3 = 8
      I4 = 32*I1+8*I2+I3-40
      A = FACTOR(I4,1)
      B = FACTOR(I4,2)
      C = FACTOR(I4,3)
      L = LOOP(I1,I2,I3)
      GO TO (1,2,3), L
    1 EFCRVH = A*SPEED**B+C
      RETURN
    2 EFCRVH = 10.**(A*SPEED*SPEED+B*SPEED+C)
      RETURN
    3 EFCRVH = A*EXP(B*SPEED)+C
      RETURN
      END
```

```
      REAL FUNCTION SIGMAZ (DIST, IGRAPH)
C
C     SIGMAZ CALCULATES THE STANDARD DEVIATION OF THE GAUSSIAN CURVE
C     FOR VERTICAL DISPERSION, IN METERS.  SIGMAZ IS BASED ON EMPIRICAL
C     RESULTS OF CALIFORNIAS WORK.
C
C     DESCRIPTION OF PARAMETERS
C
C
C     DIST -- REAL
C     THE EFFECTIVE DOWNWIND DISTANCE, IN FEET.
C
C     IGRAPH -- INTEGER
C     THE PREVAILING STABILITY CLASS (FROM ICNVRT).
C
C     NOTE -- THE MAIN PROGRAM ALLOWS ONLY VALID PARAMETERS TO ENTER
C     SIGMAZ.
C
C
      XMETER = .304801 * DIST + 4.0
      GO TO (1, 2, 3, 4, 5, 6), IGRAPH
    1 IF (XMETER .LT. 40.) GO TO 18
      IF (XMETER .LE. 170.) GO TO 19
      IF (XMETER .LT. 420.) GO TO 20
      A = 1.78963
      B = -2.68404
      GO TO 9
   18 A = .35374
      B = .60937
      GO TO 9
   19 A = .655
      B = .09249
      GO TO 9
   20 A = 1.0683
      B = -.81474
      GO TO 9
    2 IF (XMETER .LE. 100.) GO TO 10
      IF (XMETER .GE. 500.) GO TO 11
      A = .62506
      B = -.00061
      GO TO 9
   10 A = .33099
      B = .58754
      GO TO 9
   11 A = 1.15870
      B = -1.44088
      GO TO 9
    3 IF (XMETER .LE. 150.) GO TO 13
      IF (XMETER .GE. 600.) GO TO 14
      A = .52998
      B = .07328
      GO TO 9
   13 A = .2866
      B = .6029
      GO TO 9
   14 A = .89825
      B = -.94982
```

vt0752

```
      GO TO 9                                                           SIGZ 390
    4 IF (XMETER .LE. 200.) GO TO 7                                     SIGZ 400
      IF (XMETER .GE. 700.) GO TO 8                                     SIGZ 410
      A = .39114                                                        SIGZ 420
      B = .27167                                                        SIGZ 430
      GO TO 9                                                           SIGZ 440
    7 A = .24566                                                        SIGZ 450
      B = .60644                                                        SIGZ 460
      GO TO 9                                                           SIGZ 470
    8 A = .65722                                                        SIGZ 480
      B = -.48534                                                       SIGZ 490
      GO TO 9                                                           SIGZ 500
    5 IF (XMETER .LE. 300.) GO TO 15                                    SIGZ 510
      IF (XMETER .GE. 700.) GO TO 16                                    SIGZ 520
      A = .32309                                                        SIGZ 530
      B = .32004                                                        SIGZ 540
      GO TO 9                                                           SIGZ 550
   15 A = .20969                                                        SIGZ 560
      B = .60094                                                        SIGZ 570
      GO TO 9                                                           SIGZ 580
   16 A = .57403                                                        SIGZ 590
      B = -.39391                                                       SIGZ 600
      GO TO 9                                                           SIGZ 610
    6 IF (XMETER .LE. 600.) GO TO 17                                    SIGZ 620
      IF (XMETER .GE. 2000.) GO TO 21                                   SIGZ 630
      A = .35366                                                        SIGZ 640
      B = .09885                                                        SIGZ 650
      GO TO 9                                                           SIGZ 660
   17 A = .17052                                                        SIGZ 670
      B = .60763                                                        SIGZ 680
      GO TO 9                                                           SIGZ 690
   21 A = .58496                                                        SIGZ 700
      B = -.66469                                                       SIGZ 710
    9 SIGMAZ = 10.**(A*ALOG10(XMETER)+B)                                SIGZ 720
      RETURN                                                            SIGZ 730
      END                                                               SIGZ 740
```

```
      REAL FUNCTION SIGMAH (DIST, IGRAPH)                               SIGH  00
C
C     SIGMAH CALCULATES THE STANDARD DEVIATION OF THE GAUSSIAN CURVE
C     FOR HORIZONTAL DISPERSION, IN METERS.  SIGMAH IS BASED ON
C     EMPIRICAL RESULTS OF CALIFORNIAS WORK.
C
C     DESCRIPTION OF PARAMETERS
C
C
C     DIST -- REAL
C     THE EFFECTIVE DOWNWIND DISTANCE, IN FEET.
C
C     IGRAPH -- INTEGER
C     THE PREVAILING STABILITY CLASS (FROM ICNVRT).
C
C     NOTE -- THE MAIN PROGRAM ALLOWS ONLY VALID PARAMETERS TO ENTER
C     SIGMAH.
C
C
      XMETER = .304801 * DIST + 4.0                                     SIGH  10
      GO TO (1, 2, 3, 4, 5, 6), IGRAPH                                  SIGH  20
1     IF (XMETER .LE. 800.) GO TO 10                                    SIGH  30
      IF (XMETER .GE. 3000.) GO TO 11                                   SIGH  40
      A = .72897                                                        SIGH  50
      B = .21321                                                        SIGH  60
      GO TO 9                                                           SIGH  70
10    A = .49024                                                        SIGH  80
      B = .90626                                                        SIGH  90
      GO TO 9                                                           SIGH 100
11    A = .92995                                                        SIGH 110
      B = -.48563                                                       SIGH 120
      GO TO 9                                                           SIGH 130
2     IF (XMETER .LE. 700.) GO TO 12                                    SIGH 140
      IF (XMETER .GE.2000.) GO TO 13                                    SIGH 150
      A = .62374                                                        SIGH 160
      B = .389                                                          SIGH 170
      GO TO 9                                                           SIGH 180
12    A = .44459                                                        SIGH 190
      B = .89869                                                        SIGH 200
      GO TO 9                                                           SIGH 210
13    A = .87506                                                        SIGH 220
      B = -.44063                                                       SIGH 230
      GO TO 9                                                           SIGH 240
3     IF (XMETER .LE. 600.) GO TO 14                                    SIGH 250
      IF (XMETER .GE. 1500.) GO TO 15                                   SIGH 260
      A = .59454                                                        SIGH 270
      B = .33345                                                        SIGH 280
      GO TO 9                                                           SIGH 290
14    A = .39049                                                        SIGH 300
      B = .90032                                                        SIGH 310
      GO TO 9                                                           SIGH 320
15    A = .84836                                                        SIGH 330
      B = -.47272                                                       SIGH 340
      GO TO 9                                                           SIGH 350
    4 IF (XMETER .LE. 700.) GO TO 7                                     SIGH 360
      IF (XMETER .GE. 1500.) GO TO 8                                    SIGH 370
      A = .61908                                                        SIGH 380
```

```
      B = .12580                                                        SIGH 390
      GO TO 9                                                           SIGH 400
    7 A = .34588                                                        SIGH 410
      B = .90309                                                        SIGH 420
      GO TO 9                                                           SIGH 430
    8 A = .81104                                                        SIGH 440
      B = -.48388                                                       SIGH 450
      GO TO 9                                                           SIGH 460
5     IF (XMETER .LE. 500.) GO TO 16                                    SIGH 470
      IF (XMETER .GE. 2000.) GO TO 17                                   SIGH 480
      A = .50445                                                        SIGH 490
      B = .36181                                                        SIGH 500
      GO TO 9                                                           SIGH 510
16    A = .30471                                                        SIGH 520
      B = .90091                                                        SIGH 530
      GO TO 9                                                           SIGH 540
17    A = .82732                                                        SIGH 550
      B = -.70399                                                       SIGH 560
      GO TO 9                                                           SIGH 570
6     IF (XMETER .LE. 500.) GO TO 18                                    SIGH 580
      IF (XMETER .GE. 5000.) GO TO 19                                   SIGH 590
      A = .57675                                                        SIGH 600
      B = .04271                                                        SIGH 610
      GO TO 9                                                           SIGH 620
18    A = .24912                                                        SIGH 630
      B = .92697                                                        SIGH 640
      GO TO 9                                                           SIGH 650
19    A = .89701                                                        SIGH 660
      B = -1.14191                                                      SIGH 670
9     SIGMAH = 10.**(A*ALOG10(XMETER)+B)                                SIGH 680
      RETURN                                                            SIGH 690
      END                                                               SIGH 700
```

SITEID 1A+W

ANALYSIS OF AIRPOL TEST SITE 1

SITEID 1A W

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
5.6	F	73	B	1	60	5	-0	3960	3580	57	10	NONE	NONE	88	1.1	.4
5.6	F	73	B	1	60	5	-0	3960	3580	57	10	NONE	NONE	138	.8	.3
5.6	F	73	B	1	60	5	-0	3960	3580	57	10	NONE	NONE	188	.6	.3
5.6	F	73	B	1	60	5	-0	3960	3580	57	10	NONE	NONE	288	.4	.2
5.6	F	73	B	1	60	5	-0	3960	3580	57	10	NONE	NONE	388	.3	.1

0755

SITEID 1A+E — ANALYSIS OF AIRPOL TEST SITE 1 — SITEID 1A E

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
5.6	F	73	B	1	60	5	-0	3960	2580	60	10	NONE	NONE	12	1.3	.6
5.6	F	73	B	1	60	5	-0	3960	2580	60	10	NONE	NONE	62	.9	.4
5.6	F	73	B	1	60	5	-0	3960	2580	60	10	NONE	NONE	112	.6	.3
5.6	F	73	B	1	60	5	-0	3960	2580	60	10	NONE	NONE	212	.4	.2
5.6	F	73	B	1	60	5	-0	3960	2580	60	10	NONE	NONE	312	.3	.1

SITEID 1A-W

ANALYSIS OF AIRPOL TEST SITE 1

SITEID 1A-W

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
5.6	F	73	B	2	60	5	-0	3960	3580	57	10	NONE	NONE	18	.7	.3
5.6	F	73	B	2	60	5	-0	3960	3580	57	10	NONE	NONE	68	.3	.1
5.6	F	73	B	2	60	5	-0	3960	3580	57	10	NONE	NONE	118	.1	.1
5.6	F	73	B	2	60	5	-0	3960	3580	57	10	NONE	NONE	200	.1	.0
5.6	F	73	B	2	60	5	-0	3960	3580	57	10	NONE	NONE	300	.0	.0

000057

SITEID 1A-E ANALYSIS OF AIRPOL TEST SITE 1 SITEID 1A-E

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
5.6	F	73	B	2	60	5	-0	3960	2580	60	10	NONE	NONE	94	.1	.1
5.6	F	73	B	2	60	5	-0	3960	2580	60	10	NONE	NONE	144	.1	.0
5.6	F	73	B	2	60	5	-0	3960	2580	60	10	NONE	NONE	194	.0	.0
5.6	F	73	B	2	60	5	-0	3960	2580	60	10	NONE	NONE	276	.0	.0
5.6	F	73	B	2	60	5	-0	3960	2580	60	10	NONE	NONE	376	.0	.0

vv0759

SITEID TST1			ANALYSIS OF AIRPOL TEST SITE 1											SITEID TST1	
WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	88	1.3	.6
7.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	88	.8	.4
8.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	88	.7	.3
12.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	88	.4	.2
13.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	88	.4	.2
18.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	88	.3	.1
4.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	138	1.[illegible]	.5
7.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	138	.6	.3
8.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	138	.5	.2
12.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	138	.3	.2
13.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	138	.3	.1
18.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	138	.2	.1
4.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	188	.8	.4
7.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	188	.4	.2
8.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	188	.4	.2
12.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	188	.3	.1
13.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	188	.2	.1
18.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	188	.2	.1
4.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	288	.5	.2
7.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	288	.3	.1
8.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	288	.2	.1
12.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	288	.2	.1
13.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	288	.1	.1
18.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	288	.1	.1
4.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	388	.3	.1
7.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	388	.2	.1
8.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	388	.2	.1
12.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	388	.1	.0
13.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	388	.1	.0
18.0	F	73	B	1	45	5	-0	3960	2600	58	20	NONE	NONE	388	.1	.0

SITEID TSI2					ANALYSIS OF AIRPOL TEST SITE 1										SITEID TSI2
WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	12	4.9	2.1
7.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	12	2.8	1.2
8.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	12	2.4	1.1
12.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	12	1.6	.7
13.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	12	1.5	.7
18.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	12	1.1	.5

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
-2.893226E+01	-3.222297E+01	2.985639E-02	7.429855E-03	1.945603E+00	9.536398E-01	4.500000E-00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908786E+01	1.000000E+00	1.000000E+00	1.006822E+01	4.000000E-01	2.862051E-01	4.590279E-01

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	62	3.6	1.6
7.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	62	2.0	.9
8.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	62	1.8	.8
12.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	62	1.2	.5
13.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	62	1.1	.5
18.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	62	.8	.3

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
6.423071E+00	4.519560E+00	2.985639E-02	7.429855E-03	1.959840E+00	9.984599E-01	4.500000E 00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908786E+01	1.000000E+00	1.000000E+00	1.176041E+01	4.000000E-01	3.526174E+01	8.125814E+01

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	112	2.7	1.2
7.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	112	1.5	.7
8.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	112	1.3	.6
12.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	112	.9	.4
13.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	112	.8	.4
18.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	112	.6	.3

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
4.177840E+01	1.971076E+01	2.985639E-02	7.429855E-03	1.967343E 00	9.520479E-01	4.500000E-00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908786E+01	1.000000E+00	1.000000E+00	1.306644E+01	4.000000E-01	4.061960E+01	1.166135E+02

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	212	1.6	.7
7.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	212	.9	.4
8.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	212	.8	.3
12.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	212	.5	.2
13.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	212	.5	.2
18.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	212	.4	.2

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
1.124891E+02	3.098500E+01	2.985639E-02	7.429855E-03	1.975415E 00	7.850837E-01	4.500000E+00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908786E+01	1.000000E+00	1.000000E+00	1.509016E+01	4.000000E-01	4.928733E+01	1.873242E+02

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	312	1.0	.4
7.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	312	.6	.2
8.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	312	.5	.2
12.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	312	.3	.1
13.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	312	.3	.1
18.0	F	73	B	1	45	5	-0	3960	6320	58	15	NONE	NONE	312	.2	.1

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
1.831997E+02	3.537399E+01	2.985639E-02	7.429855E-03	1.979827E+00	6.122770E-01	4.500000E 00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908786E+01	1.000000E+00	1.000000E+00	1.667735E+01	4.000000E-01	5.637355E+01	2.580349E-02

SITEID TSI3 — ANALYSIS OF AIRPOL TEST SITE 1 — SITEID TSI3

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	12	3.7	1.6
7.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	12	2.1	.9
8.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	12	1.8	.8
12.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	12	1.2	.5
13.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	12	1.1	.5
18.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	12	.8	.4

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
-2.893226E+01	-3.222297E+01	2.985639E-02	7.429855E-03	1.460821E 00	9.536398E-01	4.500000E+00
LFACTR	**CFACTR**	**GFACTR**	**SZM**	**AFACTR**	**SHM**	**DIST**
2.908786E+01	1.000000E+00	1.000000E+00	1.006822E+01	4.000000E-01	2.862051E+01	4.590279E 01

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	62	2.9	1.3
7.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	62	1.7	.7
8.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	62	1.4	.6
12.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	62	1.0	.4
13.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	62	.9	.4
18.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	62	.6	.3

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
6.423071E+00	4.519560E+00	2.985639E-02	7.429855E-03	1.586479E-00	9.984599E-01	4.500000E 00
LFACTR	**CFACTR**	**GFACTR**	**SZM**	**AFACTR**	**SHM**	**DIST**
2.908786E+01	1.000000E+00	1.000000E+00	1.176041E+01	4.000000E-01	3.526174E+01	8.125814E+01

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	112	2.2	1.0
7.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	112	1.3	.6
8.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	112	1.1	.5
12.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	112	.7	.3
13.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	112	.7	.3
18.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	112	.5	.2

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
4.177840E+01	1.971076E+01	2.985639E-02	7.429855E-03	1.656858E+00	9.520479E-01	4.5[illegible]
LFACTR	**CFACTR**	**GFACTR**	**SZM**	**AFACTR**	**SHM**	**DIST**
2.908786E+01	1.000000E+00	1.000000E+00	1.306644E+01	4.000000E-01	4.061960E+01	1.166135E+02

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	212	1.4	.6
7.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	212	.8	.3
8.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	212	.7	.3
12.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	212	.5	.2
13.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	212	.4	.2
18.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	212	.3	.1

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
1.124891E+02	3.098500E+01	2.985639E-02	7.429855E-03	1.735949E+00	7.850837E-01	4.500000E-00
LFACTR	**CFACTR**	**GFACTR**	**SZM**	**AFACTR**	**SHM**	**DIST**
2.908786E+01	1.000000E+00	1.000000E+00	1.509016E+01	4.000000E-01	4.928733E+01	1.873242E 02

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	312	.9	.4
7.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	312	.5	.2
8.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	312	.4	.2
12.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	312	.3	.1
13.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	312	.3	.1
18.0	F	73	B	1	45	5	20	3960	6320	58	15	NONE	NONE	312	.2	.1

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
1.831997E+02	3.537399E+01	2.985639E-02	7.429855E-03	1.780713E+00	6.122770E-01	4.500000E+00
LFACTR	**CFACTR**	**GFACTR**	**SZM**	**AFACTR**	**SHM**	**DIST**
2.908786E+01	1.000000E+00	1.000000E+00	1.667735E+01	4.000000E-01	5.637355E+01	2.580349E+02

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SITEID TST4 — ANALYSIS OF AIRPOL TEST SITE 1 — SITEID TST4

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	12	9.5	4.1
7.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	12	5.4	2.4
8.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	12	4.7	2.1
12.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	12	3.2	1.4
13.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	12	2.9	1.3
18.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	12	2.1	.9

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
-2.893226E+01	-3.222297E+01	2.985639E-02	7.429855E-03	1.945603E+00	9.536398E-01	4.500000E+00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908786E+01	1.000000E+00	1.946220E+00	1.006822E+01	4.000000E-01	2.862051E+01	4.590279E+01

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	62	6.9	3.0
7.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	62	4.0	1.7
8.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	62	3.5	1.5
12.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	62	2.3	1.0
13.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	62	2.1	.9
18.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	62	1.5	.7

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
6.423071E+00	4.519560E+00	2.985639E-02	7.429855E-03	1.959840E+00	9.984599E-01	4.500000E+00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908786E+01	1.000000E+00	1.946220E+00	1.176041E+01	4.000000E-01	3.526174E+01	8.125814E+01

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	112	5.2	2.3
7.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	112	3.0	1.3
8.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	112	2.6	1.1
12.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	112	1.7	.8
13.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	112	1.6	.7
18.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	112	1.2	.5

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
4.177840E+01	1.971076E+01	2.985639E-02	7.429855E-03	1.967343E+00	9.520479E-01	4.500000E+00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908786E+01	1.000000E+00	1.946220E+00	1.306644E+01	4.000000E-01	4.061960E+01	1.166135E+02

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	212	3.1	1.3
7.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	212	1.8	.8
8.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	212	1.5	.7
12.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	212	1.0	.4
13.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	212	.9	.4
18.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	212	.7	.3

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
1.124891E+02	3.098500E+01	2.985639E-02	7.429855E-03	1.975415E+00	7.850837E-01	4.500000E+00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908786E+01	1.000000E+00	1.946220E+00	1.509016E+01	4.000000E-01	4.928733E+01	1.873242E+02

WS (MPH)	SOURCE TYPE	YR	CLASS	CASE	ALPHA DEG.	OBS. HT (FT)	SOURCE HT (FT)	UPWIND SOURCE LENGTH (FT)	TFVOL (VPH)	TFSPD (MPH)	TFMIX (PC)	CWIDTH (FT)	CLENGTH (FT)	DIST FROM SOURCE (FT)	CO (PPM)	HC (PPM)
4.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	312	1.9	.8
7.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	312	1.1	.5
8.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	312	.9	.4
12.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	312	.6	.3
13.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	312	.6	.3
18.0	F	73	B	1	45	5	-20	3960	6320	58	15	200	1800	312	.4	.2

P	GAMMA	QCO	QHC	ZFACTR	YFACTR	KFACTR
1.831997E+02	3.537399E+01	2.985639E-02	7.429855E-03	1.979827E+00	6.122770E-01	4.500000E+00
LFACTR	CFACTR	GFACTR	SZM	AFACTR	SHM	DIST
2.908785E+01	1.000000E+00	1.946220E+00	1.667735E+01	4.000000E-01	5.637355E+01	2.580349E+02

ALL AVAILABLE DATA HAS BEEN PROCESSED -- END OF AIRPOL ANALYSIS.

APPENDIX 2

A2.0 A User's Guide to AIRPOL

A2.1 This Appendix contains a detailed description of the philosophy and techniques employed in using AIRPOL. Figure A2-1 shows a data input sheet for AIRPOL and should be referred to throughout the following discussion.

A2.2 AIRPOL has been designed to minimize the influence of subjective judgements on the part of the user in order to obtain defensible predictions. However, some decisions must necessarily be made when employing any predictive scheme.

As a general guide in the use of AIRPOL, the conservative decision should be made whenever there is question about application of the model. This approach should not be considered a liability, but rather an exercise in responsible judgement with the additional benefit of allowing the user to state, with a high degree of confidence, that actual levels should be less than or equal to the predicted levels.

A2.3 AIRPOL has been designed to analyze the impact on air quality of a roadway consisting of three or fewer lanes. If an anlysis of a larger facility is desired, the highway must be broken into two or more lane groups, each consisting of three or fewer lanes. Furthermore, entrance ramps, exit ramps, and service roads must all be treated as distinct lane groups and not part of a lane group which includes travel lanes. Each lane group should then be analyzed as a separate roadway having its own geometric and traffic data. (Weather data will be the same for all lane groups constituting a given highway.) The total effect of the facility on the environment is then found by superimposing the effects of the several lane groups.

For instance, a dual, divided, four-lane highway having a 50-foot median, 12-foot traffic lanes, and 8-foot safety lanes (no ramps or service roads nearby) would be divided into two lane groups of two lanes each. Then, to get an analysis for the entire facility at 100 feet from the downwind guardrail, one would analyze the near lane group for a distance of 108 (100 + 8 = 108) feet from the nearest edge of the nearest traffic lane and the far lane group for a distance of 198 (100 + 8 + 12 + 12 +8 +50 + 8 = 198) feet, using directional traffic and geometric data. The two CO levels thus found are then added together to get the total CO level at 100 feet from the downwind guardrail.

A2.4 AIRPOL is designed to accept two types of input cards—header cards and data cards. (See Figure A2-1.) A header card followed by from one to ninety-nine data cards constitute a data set. AIRPOL will accept any number of data sets as input. Multiple data sets are simply placed one after the other to make up an input data deck for an AIRPOL run.

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VIRGINIA DEPARTMENT OF HIGHWAYS

AIRPOL--VERSION 2
DATA PROCESSING INPUT
JULY 1973

COMPUTER JOB NUMBER | COMMENT NO.

INPUT SUBMITTED BY: ________________ PHONE EXT: ________ ROOM NO. ________

DATE SUBMITTED: ________________ PROJECT CHARGE NO:

CO.	ROUTE	CITY/CO.	SECT.	TYPE	ACT.

1 - 3	4-5	6-7	COMMENTS (Note: Information should be centered in these 50 columns) 8-57	WS-1 (mph) 58 - 60	WS-2 (mph) 62 - 64	WS-3 (mph) 66 - 68	WS-4 (mph) 70 - 72	WS-5 (mph) 74 - 76	WS-6 (mph) 78 - 80

↑ NO. OF DATA CARDS

Columns 58–80 for research use only

DATA CARDS

(NOTE: AS A GENERAL GUIDE, USE NO DECIMAL FRACTIONS.)

NOTE: KEYPUNCH COMPUTER JOB NO. AND COMMENT NO. IN ALL CARDS

SITE ID	SOURCE	YR.	CLASS	CASE	ALPHA (degrees)	OBS HT (ft.)	SOURCE HT (ft.)	UPWIND SOURCE LENGTH (ft.)	TFVOL (vph)	TS (mph)	TM (%)	CWIDTH (ft.)	CLENGTH (ft.)	SHOW +	D-1 (ft.)	D-2 (ft.)	D-3 (ft.)	D-4 (ft.)	D-5 (ft.)
6-9	11	13-14	16	18	20-21	23-25	27-30	32-36	38-42	44-45	47-48	50-53	55-58	60	62-64	66-68	70-72	74-76	78-80

Figure A2.1

A2.5 The first five columns of every card in an AIRPOL data deck contain special information for use by the Data Processing Division (DPD). This information is not integral to the AIRPOL model. Columns 1-3 of each card must contain a three digit number assigned by the DPD for accounting purposes. This number will remain unchanged for a given AIRPOL run and must appear on every card in the input data deck. Columns 4-5 of each card must contain a two digit number identifying a data set. These numbers are assigned by the user. Each data set should have a unique number assigned to it and that number should appear on every card in the data set. Typically a user will number the data sets sequentially starting with 01.

A2.6 <u>The Header Card</u>

The first card of every data set is a header (or comment) card. It contains information relevant to all the data cards in the set. This common information will remain unchanged until a new data set is encountered. A header card is structured as follows:

A2.6.1 Accounting Information:

Columns 1-5 (see Section A2.4), Format (I3, I2).

A2.6.2 Number of Data Cards:

Columns 6-7, Format (I2).

This data field contains the number of data cards constituting this data set. The number of data cards following this header card must correspond to the number in this field.

Only right-justified* positive integers may appear in this data field.

A2.6.3 Descriptive Information (Comments):

Columns 8-57, Format (5A10).

This data field is used for descriptive information about the data set. This information is displayed as a heading on the printer output. It is suggested that the descriptive information be centered in this field to achieve report-quality output. For instance, the heading "ANALYSIS OF I99, WILLIAM COUNTY, VA.", which contains 36 characters, should begin in Column #15.

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*For the reader who is unfamiliar with data processing terminology, right justification signifies that the rightmost character must appear in the rightmost column of a data field and there may be no blanks between non-blank characters.

Any combination of letters, digits, symbols, blanks, or punctuation may appear in this data field.

A2.6.4 Wind Speeds:

Columns 58-80, Format (F3.1).

These six data fields contain the wind speeds to be used in analyzing each data point (data card) in the data set. From one to six wind speeds may be input. If fewer than six wind speeds are desired, the excess data fields should be left blank. If all six fields are blank (or equal to zero, or negative), the program will analyze the data set using wind speeds of 4.0, 7.0, and 10.0 mph.

The user may sometimes find it advantageous to use wind speeds of 4.0, 7.0, 8.0, 12.0, 13.0, and 18.0 mph. These are the ranges the Virginia Department of Highways generally uses when preparing impact statements, since they are the ranges contained in the weather data used by the Department.

The prevailing CO level is predicted by using the prevailing stability class (see Section A2.7.5), the prevailing wind direction within that class (see Section A2.7.7), and the prevailing wind speed (or range) within that direction. To predict the worst case CO levels, use class E or F, parallel winds and the prevailing wind speed within that class and direction. Prevailing weather data may be obtained from the output of either program WNDROS or program STAROS (4).

Only right-justified, positive decimal fractions or blanks are allowed in these fields. If no decimal point is punched in a field, the program will insert one between the second and third digits of the field. If a decimal point is punched, the decimal fraction so designated will be input. Thus one may input twelve mph as either 120 (implied decimal point will be inserted by the program) or 12. (actual decimal point noted and used by the program). Wind speeds less than 3.0 mph should not be used (see Section 3.4.1).

A2.7 The Data Cards

Each data set has from one to ninety-nine data cards following the header card. Each data card constitutes a data point (more accurately, a data matrix) to be analyzed. The information on a data card, together with the common data set information on the header card, provides all the necessary inputs to analyze a data point. The structure of a data card is:

A2.7.1 Accounting Information:

Columns 1-5 (see Section A2.4), Format (I3, I2).

A2.7.2 Site Identification:

Columns 6-9, Format (A4).

This field contains a four character designation for the site and lane groups being analyzed. This identifier may be assigned in any systematic manner deemed appropriate by the user. For example, one method which can be employed is to use columns 6, 7, and 8 to identify the site and to use column 9 to identify the source lane group. (See Section A2.3.)

Any combination of letters, digits, symbols, blanks, or punctuation may appear in this data field.

A2.7.3 Source Roadway Type:

Column 11, Format (A1).

This column contains a code to identify the type of roadway (lane group) being analyzed.

The codes are:

C = city street
F = freeway

If anything other than a C or an F appears in this field, the program assumes the analysis is for a freeway.

Whenever there is a stop sign, signal light, or other traffic obstruction within about 400 feet up or down the roadway from the observer, the roadway should be designated as a city street. In all other cases, i.e., quasi-free-flow traffic, the roadway should be designated as a freeway.

Only a C or an F should appear in this data field.

A2.7.4 Prediction Year:

Columns 13-14, Format (I2).

This field contains the last two digits of the year for which the prediction is to be made. The program will perform an analysis for any year from 1972 to 1999 inclusive. If the year input is less than 72 the program will default to an analysis for 1972. For any analysis beyond 1999, use 99 for year. This will give consistent results since the program assumes that emission levels will be constant from 1986 on. (4)

Only right-justified, positive integers are allowed in this field.

A2.7.5 Stability Class:

Column 16, Format (A1).

This data field contains the Turner modified, Pasquill-Guifford atmospheric stability class (4,5) for which this analysis is to be performed. The classes are A, B, C, D, E, and F, where A is the least stable condition, D is neutral, and F is the most stable. If an invalid symbol appears in this field, the program will default to an analysis for stability class D.

When AIRPOL is used to predict CO levels at prevailing weather conditions, the output of either program WNDROS or program STAROS (4) should be consulted to find the prevailing stability class. When AIRPOL is being used to estimate the "worst-case" conditions, current thinking is to use stability class F for rural areas and stability class E for urban areas.

Only an A, B, C, D, E, or F should appear in this column.

A2.7.6 Case:

Column 18, Format (I1).

This field contains a code indicating whether the analysis should be performed for an observer downwind (wind reaches road before reaching observer) or upwind (wind reaches road after reaching observer) of the source lane groups. (See Section 2.7.)

The codes are:

1 = downwind
2 = upwind

If an invalid code appears in this column the program will default to an analysis of the downwind case.

Only a 1 or a 2 should appear in this data field.

A2.7.7 Wind Angle (Alpha):

Columns 20-21, Format (F2.0).

This data field is used to specify the acute (between 0^{o} and 90^{o}) angle, in degrees, between the wind direction and road direction. This angle should be determined by passing a wind vector through the point where a line through the observer perpendicular to the roadway intersects the road and measuring the acute angle between this vector and the lane group being analyzed. (See Figure A2-2.)

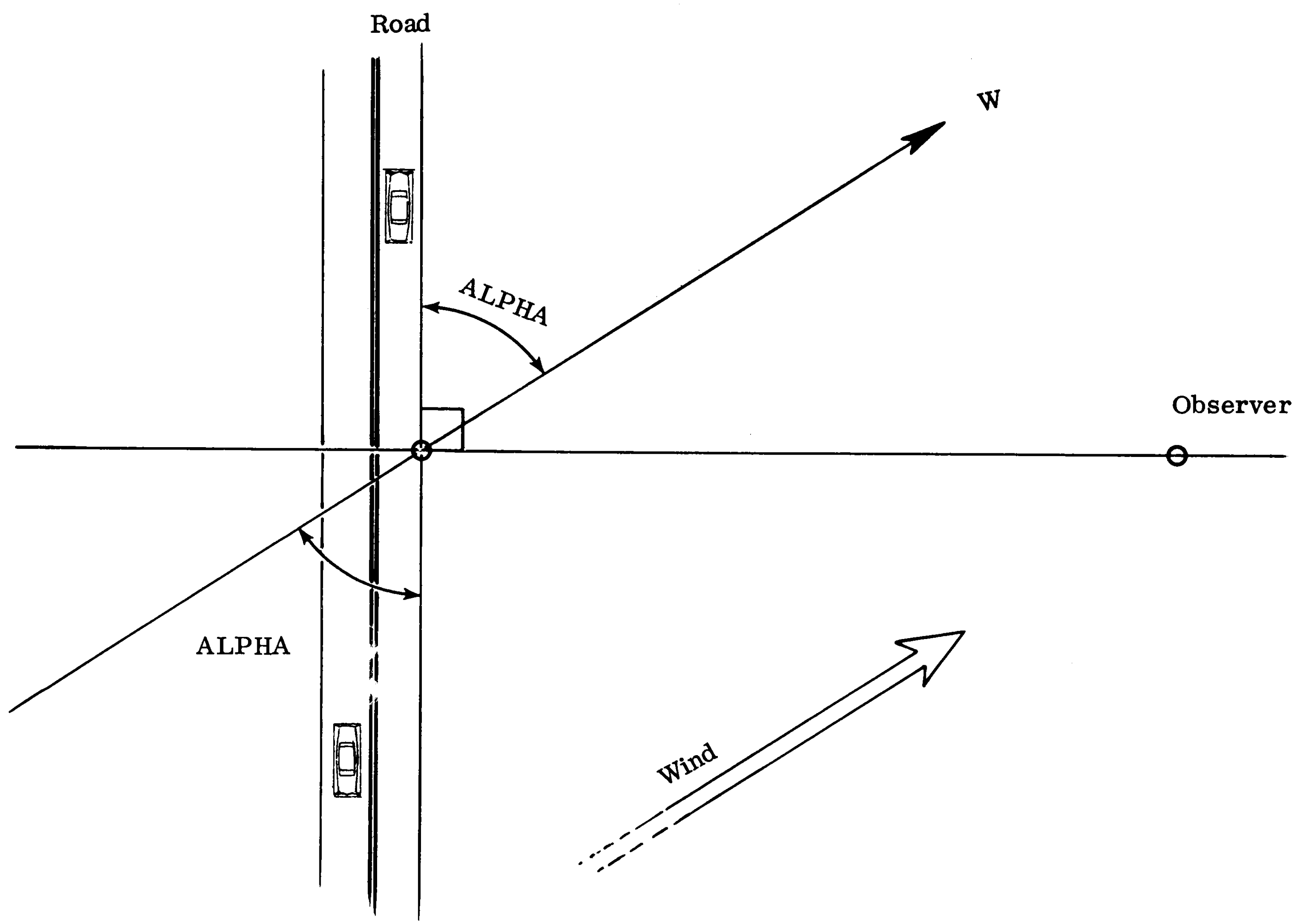


Figure A2. 2. Measurement of ALPHA.

To obtain an estimate of the expected or prevailing CO levels, use the prevailing wind direction and wind speed for the prevailing stability class. This information is contained in the outputs of either program WNDROS or program STAROS.(4) To obtain an estimate for the "worst" case, use stability class E or F and parallel (0^{o}) wind with its prevailing wind speed.

Only right-justified, positive integers should appear in this data field.

A2.7.8 Observer Height:

Columns 23-25, Format (F3.0).

This data field is used to specify the observer height, in feet, above the surrounding terrain. In the special case of a depressed* roadway, this height must be given as the elevation of the observer above the road surface. (See Section 2.5.)

Only right-justified, positive integers should appear in this field.

A2.7.9 Source Height:

Columns 27-30, Format (F4.0).

This field is used to specify the elevation, in feet, of the road surface relative to the surrounding terrain. This value should be negative for a depressed* roadway, positive for an elevated roadway, and zero for an at-grade roadway. (See Section 2.5.)

Only right-justified integers (positive, negative, or zero) should appear in this field.

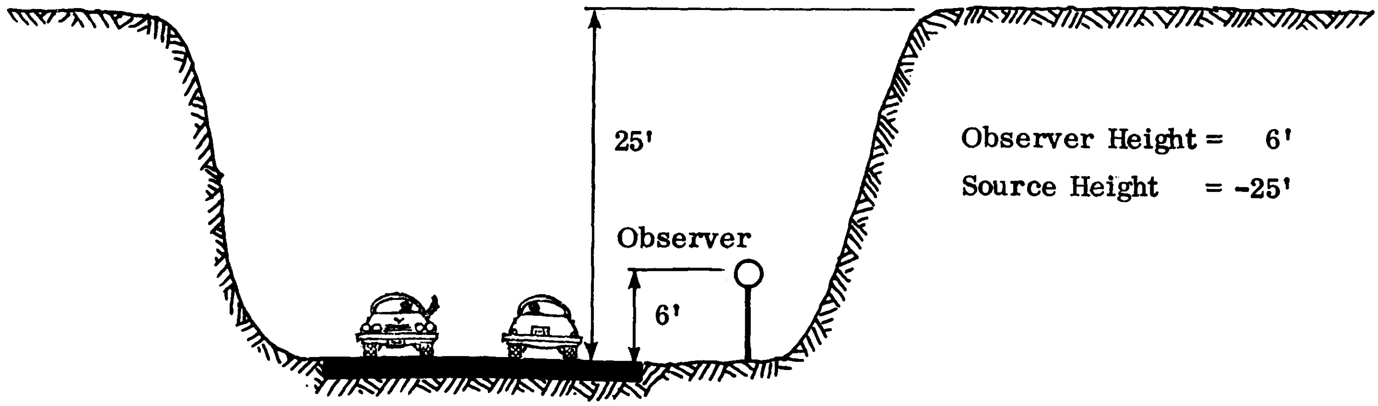
A2.7.10 Upwind Source Length:

Columns 32-36, Format (F5.0).

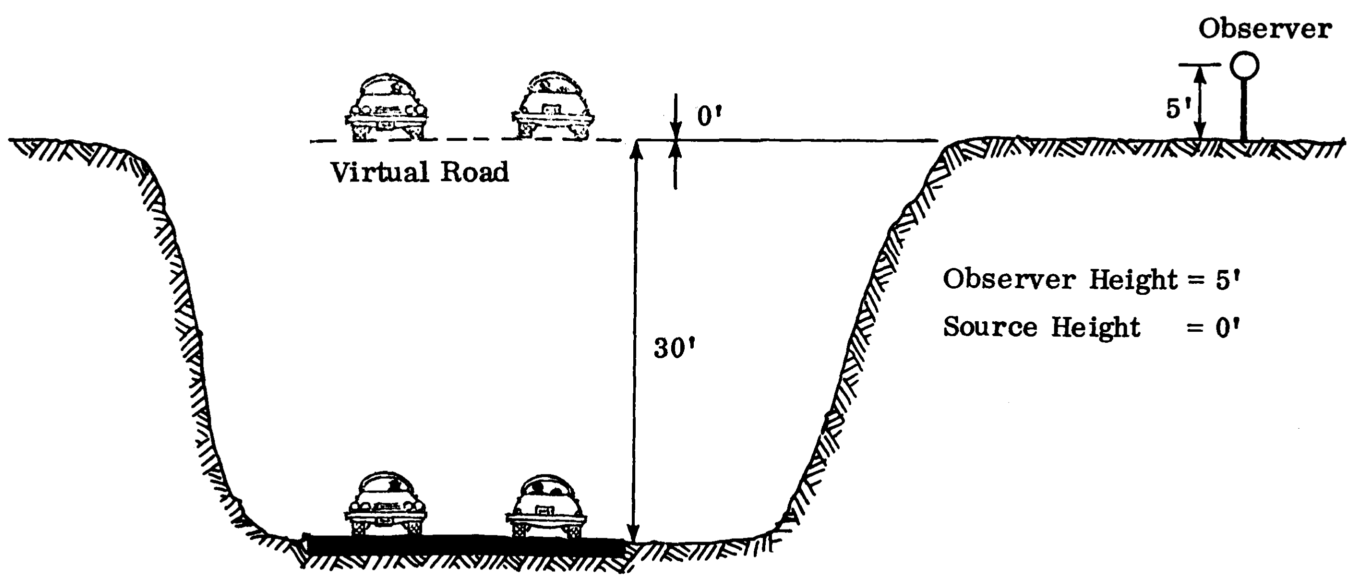
This data field is used to specify the length, in feet, of the source lane group in the upwind direction. This length is measured by taking the maximum distance that the roadway extends in a straight line from the point where a line through the observer perpendicular to the roadway intersects the roadway (see Figure A2-4). This distance will rarely exceed 5000 feet. When the wind intersects the roadway at exactly 90^{o}, the "upwind" direction may be taken as either roadway direction since both (or neither, depending on your point of view) directions are "upwind".

Only right-justified, positive integers should appear in this field.

*The depressed roadway condition may be used only when the observer and the lane group are both in the cut. Otherwise the at-grade condition must be employed. (See Figure A2-3.)



Observer and roadway both in a cut



Roadway in a cut but observer outside the cut

Figure A2.3. Comparison of an observer in a cut to an observer outside a cut.

A2.7.11 Traffic Volume:

Columns 38-42, Format (F5.0).

This field is used to specify, in vehicles per hour, the total traffic volume for the lane group being analyzed.

Only right-justified, positive integers should appear in this data field.

A2.7.12 Traffic Speed:

Columns 44-45, Format (F2.0).

This data field is used to specify the average traffic speed, in mph, for the lane group being analyzed.

Only right-justified, positive integers should appear in this field.

A2.7.13 Traffic Mix:

Columns 47-48, Format (I2).

These columns are used to specify the traffic mix, in percent of heavy duty vehicles, for the lane group being analyzed. Busses, trucks, etc. are considered heavy duty vehicles.

Only right-justified, positive integers may appear in this data field.

A2.7.14 Cut Width:

Columns 50-53, Format (F4.0).

This field is used to specify the width, in feet, of the cut in which both the lane group being analyzed and the observer are located. This width should be measured as the average cut width at one-half of the cut depth. If the cut situation is not applicable, this field should be left blank.

Only right-justified, positive integers should be used in this data field.

A2.7.15 Cut Length:

Columns 55-58, Format (F4.0).

This field is used to specify the upwind length, in feet, of the cut in which both the lane group being analyzed and the observer are located. This distance should be measured in the upwind direction (see Section A2.7.10) along the roadway from the point where a line through the observer perpendicular to the roadway intersects the road to that point at which the cut depth equals one-half the depth at the observer. If the cut situation is not applicable, this field should be left blank. (See Figure A2-4.)

Only right-justified, positive integers should appear in this field.

A2.7.16 Showit:

Column 60, Format (L1).

The contents of this field are used to signal the program to display intermediate calculations. A "T" in this column turns on the display control for the current data point only. This feature is intended for research purposes only and offers the general user no pertinent information. In the default mode the display control is always off.

For normal operation, this field should be left blank.

A2.7.17 Observer Distances:

Columns 61-80, Format (F3.0).

These five fields contain the perpendicular distances, in feet, from the observer to the nearest edge of the nearest lane of the lane group being analyzed. These distances should be measured perpendicular to the roadway and horizontal to the earth. They should not follow the contour of the ground.

From one to five distances may be specified. If fewer than five distances are desired, the excess fields should be left blank. If all five fields are either negative, zero, or blank, the program will default to a single analysis at 50 feet.

Only right-justified, positive integers should appear in these data fields.

A2.8 The use of superposition with AIRPOL was introduced in Section A2.3 to illustrate how a roadway of more than three lanes should be analyzed. Superposition also has other applications with respect to AIRPOL. Concentration levels near an intersection can be found by using this technique. Short segments of roadway, such as ramps, can be analyzed by judicious application of this principle to an imaginary 5000 foot long segment appended to the existing one. Superposition may, in fact, be used with CO concentration levels under any circumstances since CO levels are directly additive. Thus this principle may be applied whenever necessary.

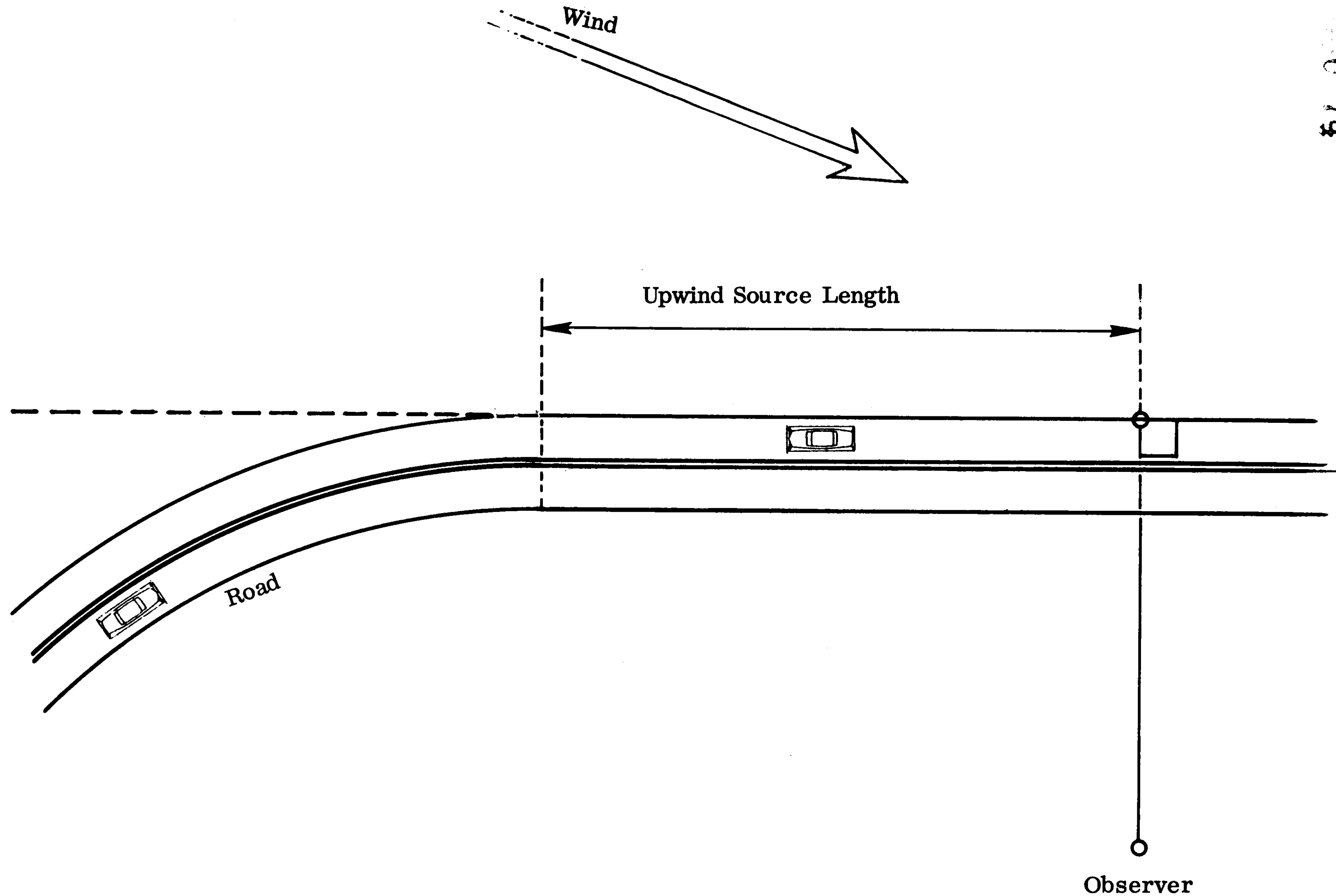


Figure A2.4. Determination of LENGTH.