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METHODS FOR ESTIMATING ATMOSPHERIC TRANSPORT AND DISPERSION OF GASEOUS EFFLUENTS IN ROUTINE RELEASES FROM LIGHT-WATER-COOLED REACTORS

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A. INTRODUCTION

Section 20.106, "Radioactivity in Effluents to Unrestricted Areas," of 10 CFR Part 20, "Standards for Protection Against Radiation," establishes limits on concentrations of radioactive material in effluents to unrestricted areas. Paragraph 20.1(c) of 10 CFR Part 20 states that licensees should, in addition to complying with the limits set forth in that part, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as far below the limits specified in that part as is reasonably achievable.

Section 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents - Nuclear Power Reactors," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," sets forth design objectives for equipment to control releases of radioactive material in effluents from nuclear power reactors. Section 50.36a, "Technical Specifications on Effluents from Nuclear Power Reactors," of 10 CFR Part 50 further provides that, in order to keep power reactor effluent releases as low as is reasonably achievable, each license authorizing operation of such a facility will include technical specifications that require establishment of operating procedures for effluent control, installation and maintenance of effluent control equipment, and reporting of actual releases.

Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As Is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50 provides numerical guidance for those design objectives and limiting conditions for operation for light-water-cooled nuclear power plants. To implement Appendix I, the NRC staff has developed a series of guides providing acceptable methods for the calculation of effluent releases, dispersion of the effluent in the atmosphere and water bodies, and associated radiation doses to man. This guide describes basic features of calculational models and assumptions for the estimation of atmospheric transport and dispersion of gaseous effluents in routine releases from land-based light-water-cooled reactors.

The procedures and models provided in this guide will be subject to continuing review by the staff with the aim of providing greater flexibility to the applicant in meeting the requirements of Appendix I. As a result of such review, it is expected that alternative acceptable methods for calculation will be made available to applicants and that calculational procedures found to be unnecessary will be eliminated.

This guide supersedes portions of Regulatory Guide 1.42, Revision 1, "Interim Licensing Policy on as Low as Practicable for Gaseous Radioiodine Releases from Light-Water-Cooled Nuclear Power Reactors," which is being withdrawn.

B. DISCUSSION

The transport and dilution of radioactive materials in the form of aerosols, vapors, or gases released into the atmosphere from a nuclear power station are a function of the state of the atmosphere along the plume path, the topography of the region, and the characteristics of the effluents themselves. For a routine airborne release, the concentration of radioactive material in the surrounding region depends on the amount of effluent released; the height of the release; the momentum and buoyancy of the emitted plume; the windspeed, atmospheric stability, and airflow patterns of the site; and various effluent removal mechanisms. Geographic features such as hills, valleys, and large bodies of water greatly influence dispersion and airflow patterns. Surface roughness, including vegetative cover, affects the degree of turbulent mixing. Sites with similar topographical and climatological features can have similar dispersion and airflow patterns, but detailed dispersion patterns are usually unique for each site.

Most gaseous effluents are released from nuclear power plants through tall stacks or vents near the tops of buildings. Certain plant designs can result in other release pathways. For example, auxiliary equipment and major components such as turbines may be housed outside buildings; releases from these components could occur near ground level.

1. Diffusion Models

Atmospheric diffusion modeling has developed along two basic approaches: gradient-transport theory and statistical theory. Gradient-transport theory holds that diffusion at a fixed point in the atmosphere is proportional to the local concentration gradient; this theory attempts to determine momentum or material fluxes at fixed points. The statistical (e.g., Gaussian) approach attempts to determine the histories of individual particles and the statistical properties necessary to represent diffusion. Input data for models based on either approach include windspeed, atmospheric stability, and airflow patterns in the region of interest. Several basic models have been developed using these approaches. These models vary according to their treatment of the spatial changes of input data and the consideration of either a variable or a straight-line trajectory model.

a. Variable Trajectory Models

Variable trajectory models allow conditions to vary spatially over the region of interest; thus, they require regional data. The number of sampling locations needed to approximate the regional airflow depends on the meteorological and topographical characteristics of that region.

The particle-in-cell model is a variable trajectory model based on the gradient-transport approach. In this model, "particles" representing the effluent mass are released in groups over the time period of interest. The particles move at the effective transport velocity of the windflow field into which the effluent is released. The effective velocity is determined by the mean and turbulent windflows within the field. The number of particles located at any given time in each cell (volume) of a fixed coordinate grid determines the effluent concentration. Concentration averages are determined from the total number of particles that pass through a cell during the time of interest.

The puff advection model is another variable trajectory model but is based on the statistical approach to diffusion. This model approximates a continuous release by dividing a plume into a sufficient number of plume segments (puffs). These puffs are released at specified intervals and are tracked over the region of interest. The advective transport of puff centers and the diffusion of effluent puffs about their individual centers cause the dispersion of the plume effluent. Concentration averages are calculated by determining the contribution each puff makes to the grid of points over which it passes.

b. Straight-Line Trajectory Models

Straight-line trajectory models assume that the airflow transports and diffuses effluents along a straight line through the entire region of interest in the airflow direction at the release point. A commonly used version of this model is the Gaussian straight-line trajectory model. In this model, the windspeed and atmospheric stability at the release point are assumed to determine the atmospheric dispersion characteristics in the direction of airflow.

These basic models can be modified to account for various modes of effluent release and for effluent removal mechanisms.

2. Release Mode

At ground-level locations beyond several miles from the plant, the annual average concentrations of effluents are essentially independent of the release mode; however, for ground-level concentrations within a few miles, the release mode is very important.

For a typical nuclear plant, gaseous effluents released from tall stacks generally produce peak ground-level air concentrations near or beyond the site boundary; near-ground-level releases usually produce concentrations that monotonically decrease from the release point to all locations downwind. Some releases tend to produce intermediate concentrations. Under certain conditions, the effluent plume may become entrained in the aerodynamic wake of the building and mix rapidly down to ground level; under other conditions, the full effect of the elevation of the release may be realized.

Methods have been developed to estimate the effective release height for calculations of effluent concentrations at all downwind locations. The important parameters in these methods include the initial release height, the location of the release point in relation to obstructions, size and shape of the release point, the initial vertical velocity of the effluent, the heat content of the effluent, ambient windspeed and temperature, and atmospheric stability.

For those effluents that are entrained into the aerodynamic wake of a building, mixing of the effluent into the wake is usually assumed. This mixing zone can constitute a plume with an initial cross section of one-half or more of the cross-sectional area of the building.

3. Removal Mechanisms

As the effluent travels from its release point, several mechanisms can work to reduce its concentration beyond that achieved by diffusion alone. Such removal mechanisms include radioactive decay and dry and wet deposition.

Radioactive decay is dependent on the half-life and the travel time of the radioactive effluent. All effluents can undergo dry deposition by sorption onto the ground surface; however, the dry deposition rate for noble gases, tritium, carbon-14, and nonelemental radioiodines is so slow that depletion is negligible within 50 miles of the release point. Elemental radioiodines and other particulates are much more readily deposited. The transfer of elemental radioiodines and particulates to a surface can be quantified as a transfer velocity (where concentration x transfer velocity = deposition rate). There is evidence that the transfer velocity is directly proportional to windspeed and, as a consequence, the rate of deposition is independent of windspeed since concentration in air is inversely proportional to windspeed.

At most sites precipitation occurs during a small portion of the year; therefore, for long-term averages, dose calculations considering only dry deposition are not significantly changed by the consideration of wet deposition. However, wet deposition can be an important factor in dose calculations at sites where a well-defined rainy season corresponds to the local grazing season.

Deposition of radionuclides over large bodies of water is not considered in this guide. Such deposition should be analyzed on a case-by-case basis.

C. REGULATORY POSITION

This section identifies types of atmospheric transport and diffusion models, source configuration and removal mechanism modifications, and input data that are acceptable to the NRC staff for use in providing assessments of potential annual radiation doses to the public resulting from routine releases of radioactive materials in gaseous effluents.

Models proposed by the applicant and accepted by the NRC staff will be used by the staff in determining environmental technical specifications.

1. Atmospheric Transport and Diffusion Models

The following types of atmospheric transport and diffusion models can be modified for elevated sources and for effective area sources created when effluent is trapped in the building wake cavity in accordance with the source configuration considerations presented in regulatory position 2. Plume rise due to momentum or buoyancy effects can also be incorporated into the calculations. Radiological decay and dry and wet deposition, consistent with the guidelines presented in regulatory position 3, should also be considered.

a. Particle-in-Cell (PIC) Model

The basic equation for each "particle" group in this variable trajectory model, modified from Sklarew (Ref. 1), is:

$$\delta(\overline{\chi})/\delta t + \nabla \cdot V(\overline{\chi}) = 0 \qquad (1)$$

where

- t is the travel time;
- V is the velocity vector for effective mean wind transport, which includes the mean flow component, $\overline{V}$, and the turbulent flow component, V', such that $V = \overline{V}+V'$; and
- $(\overline{\chi})$ is the average atmospheric concentration produced by a group of particles.

Concentration averages for long time intervals are obtained by summing all "particles" passing through each grid cell during the period of interest.

The PIC model incorporates spatial and temporal variations of wind direction, windspeed, atmospheric stability, and topography to define airflow and atmospheric diffusion rates. The representativeness of the input data determines the accuracy of estimates (i.e., fewer data acquisition locations tend to increase the uncertainty of the estimates); therefore, detailed discussion of the applicability and accuracy of the model and input data used should be provided.

b. Puff Advection Model

In this model, the transport of a puff is determined from a horizontal wind field which can vary in time or in space. The diffusion of each puff can be determined from the Gaussian diffusion model below, according to Start and Wendell (Ref. 2):

$$\chi/Q = 2[(2\pi)^{3/2}\sigma_H^2\sigma_z]^{-1}\exp[-1/2(r^2/\sigma_H^2 + h_e^2/\sigma_H^2)] \qquad (2)$$

where

$r^2 = (x - \bar{u}t)^2 + y^2$ and

$\sigma_H = \sigma_y = \sigma_x$

and where

h_e is the effective release height;

Q is the effluent emission over the time interval;

t is the travel time;

$\bar{u}$ is the mean windspeed at the height of the release point;

x is the distance from center of puff along the direction of flow;

y is the distance from center of puff in the crossflow direction;

σ_x is the plume spread along the direction of flow;

σ_y is the lateral plume spread;

σ_z is the vertical plume spread; and

χ is the atmospheric concentration of effluent in a puff at ground level and at distance x from the puff center.

Concentration averages for long time intervals should be calculated by summing the concentrations of individual puffs for the grid of points over which they pass.

The number of puffs and the plume spread parameters (σ_x, σ_y, and σ_z) should be selected such that the resulting concentration estimate is representative of the concentration from a continuous point source release. Puffs should be followed in the computational scheme until they are beyond the region of interest or until their peak concentration falls below a specified value.

The puff advection model incorporates spatial and temporal variations of wind direction, windspeed, and atmospheric stability to define the transport and diffusion rate of each puff. The effectiveness of the meteorological input data in defining atmospheric transport and diffusion conditions is dependent on the representativeness of these data and the complexity of the topography in the site region; therefore, a detailed discussion of the applicability and accuracy of the model and input data used should be provided.

c. Straight-Line Airflow Model

The equation for this model, as presented by Sagendorf (Ref. 3), is:

$$(\overline{\chi/Q'})_D = 2.032 \sum_{ij} n_{ij}[NX\bar{u}_i\Sigma_{zj}(X)]^{-1} \exp[-h_e^2/2\sigma_{zj}^2(X)] \qquad (3)$$

where

h_e is the effective release height (see regulatory position 2);

n_{ij} is the length of time (hours of valid data) weather conditions are observed to be at a given wind direction, windspeed class, i, and atmospheric stability class, j;

N is the total hours of valid data;

$\bar{u}_i$ is the midpoint of windspeed class, i, at a height representative of release;

$\sigma_{zj}(X)$ is the vertical plume spread without volumetric correction at distance, X, for stability class, j (see Figure 1);

$\Sigma_{zj}(X)$ is the vertical plume spread with a volumetric correction (see regulatory position 2.c) for a release within the building wake cavity, at a distance, X, for stability class, j; otherwise $\Sigma_{zj}(X) = \sigma_{zj}(X)$;

$(\overline{\chi/Q'})_D$ is the average effluent concentration, χ, normalized by source strength, Q', at distance, X, in a given downwind direction, D; and

2.032 is $(2/\pi)^{1/2}$ divided by the width in radians of a 22.5° sector.

Since the straight-line flow model does not consider the effects of spatial and temporal variations in airflow in the region of the site, appropriate adjustments to the calculated $(\chi/Q')_D$ values should be made to account for these effects. There are three basic categories of regional airflow characteristics that are related to topography:

(1) Inland in open terrain, including gently rolling hills, with airflow dominated almost entirely by large-scale weather patterns,

(2) In pronounced river valleys, with airflow patterns largely dominated by terrain, and

(3) Along and near coasts of large bodies of water, with considerable land-water boundary layer effects on airflow patterns.

Adjustments, based on specific data and studies that characterize regional airflow patterns, should be made in Equation (3) to account for these topographical effects. Alternatively, the following adjustments and considerations may be used for open terrain and river valley site locations. These factors are based on a conservative assessment of preliminary comparisons between variables and straight-line trajectory models.

(1) Sites in open terrain. The right side of Equation (3) should be multiplied by the correction factors shown in Figure 2.

(2) Sites in river valleys. For downvalley airflow, the right side of Equation (3) should be multiplied by 5 for distances less than 20 miles. For upvalley airflow, the right side of Equation (3) should be multiplied by 1.5 for all distances. For downvalley airflow beyond 20 miles and crossvalley flow, no correction should be applied. For meandering valleys, additional adjustments should be made on a case-by-case basis to ensure that individual doses and population doses at locations of interest are not underestimated.

For coastal sites, specific correction factors should be developed and applied for each site and release point. Some factors that should be considered are the characteristics of sea or lake breezes, the variation of the mixing layer height with time and distance from shore, and the effects of shoreline bluffs or dunes. These factors should be considered in relation to the locations of the meteorological towers, plant structures, and release points with respect to the land-water boundary layer.

For all sites, a detailed discussion of the applicability and accuracy of the model and input data should be provided.

2. Source Configuration Considerations

The actual height above ground of the gaseous effluent plume should be considered in making estimates of average effluent concentrations downwind from the release points. An acceptable method to determine the effective plume height is described below.

a. Elevated Releases

For effluents exhausted from release points that are higher than twice the height of adjacent solid structures, the effective release height (h_e) is determined (Ref. 3) from:

$$h_e = h_s + h_{pr} - h_t - c \tag{4}$$

where

- c is the correction for low relative exit velocity (see below);
- h_e is the effective release height;
- h_{pr} is the rise of the plume above the release point, according to Sagendorf (Ref. 3), whose treatment is based on Briggs (Ref. 4);
- h_s is the physical height of the release point (the elevation of the stack base should be assumed to be zero); and
- h_t is the maximum terrain height (above the stack base) between the release point and the point for which the calculation is made (h_t must be greater than or equal to zero).

Note that the effective release height is a function of the distance between the release point and the location where the concentration is being calculated.

When the vertical exit velocity is less than 1.5 times the horizontal windspeed, a correction for downwash is subtracted from Equation (4), according to Gifford (Ref. 5):

$$c = 3(1.5 - W_o/\overline{u})d \tag{5}$$

where

- c is the downwash correction;
- d is the inside diameter of the stack or other release point;
- $\overline{u}$ is the mean windspeed at the height of release; and
- W_o is the vertical exit velocity of the plume.

b. Releases Other Than Elevated

For effluents released from points less than or equal to the height of adjacent solid structures, a ground-level release should be assumed ($h_e = 0$).

For effluents released from vents or other points above adjacent solid structures, but lower than elevated release points, the effluent plume should be considered as an elevated release whenever the vertical exit velocity of the plume, W_o, is at least five times the horizontal windspeed, $\overline{u}$, at the height of release; i.e., as modified from Johnson et al. (Ref. 6):

$$W_o/\overline{u} \geq 5.0 \tag{6}$$

In this case, the release should be evaluated as described in regulatory position 2.a.

If $W_o/\overline{u}$ is less than 1.0 or unknown, a ground-level release should be assumed ($h_e = 0$).

For cases where the ratio of plume exit velocity to horizontal windspeed is between one and five, a mixed release mode should be assumed, in which the plume is considered as an elevated release during a part of the time and as a ground-level release ($h_e = 0$) during the remainder of the time. An entrainment coefficient, E_t, modified from Reference 6, is determined for those cases in which $W_o/\bar{u}$ is between one and five:

$$E_t = 2.58 - 1.58(W_o/\bar{u}) \text{ for } 1 < W_o/\bar{u} \leq 1.5 \tag{7}$$

and

$$E_t = 0.3 - 0.06(W_o/\bar{u}) \text{ for } 1.5 < W_o/\bar{u} \leq 5.0 \tag{8}$$

The release should be considered to occur as an elevated release $100(1 - E_t)$ percent of the time and as a ground release $100E_t$ percent of the time. Each of these cases should then be evaluated separately and the concentration calculated according to the fraction of time each type of release occurs. Windspeeds representative of conditions at the actual release heights should be used for the times when the release is considered to be elevated. Windspeeds measured at the 10-meter level should be used for those times when the effluent plume is considered to be a ground release. If Equation (3) is used, the adjustment described in regulatory position 2.c may be made for the ground release portion of the calculation.

c. Building Wake Correction

For ground-level releases only ($h_e = 0$), an adjustment may be made in Equation (3) that takes into consideration initial mixing of the effluent plume within the building wake. This adjustment, according to Yanskey et al. (Ref. 7), should be in the form of:

$$\Sigma_{zj}(X) = (\sigma_{zj}^2(X) + 0.5\, D_z^2/\pi)^{1/2} \leq \sqrt{3}\sigma_{zj}(X) \tag{9}$$

where

D_z is the maximum adjacent building height either up- or downwind from the release point;

X is the distance from the release point to the receptor, measured from the lee edge of the complex of adjacent buildings;

$\sigma_{zj}(X)$ is the vertical standard deviation of the materials in the plume at distance, X, for atmospheric stability class, j; and

$\Sigma_{zj}(X)$ is the vertical standard deviation of plume material as above, with the correction for additional dispersion within the building wake cavity, restricted by the condition that

$$\Sigma_{zj}(X) = \sqrt{3}\sigma_{zj}(X)$$

when

$$(\sigma_{zj}^2(X) + 0.5D_z^2/\pi)^{1/2} > \sqrt{3}\sigma_{zj}(X).$$

3. Removal Mechanism Considerations

Radioactive decay and dry and wet deposition should be considered in radiological impact evaluations. Acceptable methods of considering these removal mechanisms are described below.

a. Radioactive Decay

For conservative estimates of radioactive decay, an overall half-life of 2.26 days is acceptable for short-lived noble gases and of eight days for all iodines released to the atmosphere. Alternatively, the actual half-life of each radionuclide may be used. The decay time used should be the calculated time of travel between the source and receptor based on the airflow model used.

b. Dry Deposition

Dry deposition of elemental radioiodines and other particulates and attendant plume depletion should be considered for all releases.

Acceptable plume depletion correction factors and relative deposition rates are presented in Figures 3 through 10. These figures are based on the discussion of deposition in References 8 and 9.

Figures 3 through 6 illustrate an acceptable method for considering plume depletion effects for all distances from the source and atmospheric stability classes for ground and elevated release modes. After a given concentration is calculated using the models in regulatory position 1, the concentration should be corrected by multiplying by the fraction remaining in the plume, as determined from these figures.

Figures 7 through 10 show acceptable values of relative deposition rate (meters^{-1}) as a function of distance from the source and atmospheric stability for ground and elevated release modes. The relative deposition rate is the deposition rate per unit downwind distance (Ci/sec per meter) divided by the source strength (Ci/sec).

To obtain the relative deposition per unit area (meters^{-2}) at a given point in a given sector, the relative deposition rate must be (1) multiplied by the fraction of the release transported into the sector, determined according to the distribution of wind direction and (2) divided by an appropriate crosswind distance (meters), as discussed below.

Figures 7 through 10 are based on the assumption that the effluent concentration in a given sector is uniform across the sector at a given distance. Therefore, for the straight-line airflow model, or for any model that assumes uniform concentration across the sector at a given distance, the relative deposition rate should be divided by the arc length of the sector at the point being considered. In addition, for the straight-line airflow model, the relative deposition rate should be multiplied by the appropriate correction factor discussed in regulatory position 1.c.

For models where concentration at a given distance is not uniform across the sector, the relative deposition at a given point should be calculated as above, but then multiplied by the ratio of the maximum effluent concentration in the sector at the distance being considered to the average concentration across the sector at the same distance.

c. Wet Deposition

For long-term averages, dose calculations considering dry deposition only are not usually changed significantly by the consideration of wet deposition. However, the effects of wet deposition and attendant plume depletion should be considered for plants with predominantly elevated releases and at sites that have a well-defined rainy season corresponding to the grazing season. Consideration of wet deposition effects should include examination of total precipitation, number of hours of precipitation, rainfall rate distributions, and the precipitation wind rose. If the precipitation data indicate that wet deposition may be significant, washout rates and attendant plume depletion should be calculated in accordance with the relationships identified by Engelmann (Ref. 10).

d. Deposition over Water

For dispersion over small bodies of water, deposition may be assumed to occur at the same rate as over land. For calculations involving radionuclide transport over large bodies of water, deposition should be considered on a case-by-case basis.

4. Meteorological Data for Models

Sufficient meteorological information should be obtained to characterize transport processes (i.e., airflow trajectory, diffusion conditions, deposition characteristics, etc.) out to a distance of 50 miles (approximately 80,000 meters) from the plant. The primary source of meteorological information should be the onsite meteorological program (see Regulatory Guide 1.23, Ref. 11). Other sources should include nearby National Weather Service (NWS) stations, other well-maintained meteorological facilities (e.g., other nuclear facilities, universities, or private meteorological programs), and satellite facilities.

Adequate characterization of transport processes within 50 miles of the plant may include examination of meteorological data from stations further than 50 miles when this information can provide additional clarification of the mesoscale transport processes. To augment the assessment of atmospheric transport to distances of 50 miles from the plant, the following regional meteorological data, based on periods of record specified in Regulatory Guide 4.2 (Ref. 12), from as many relevant stations as practicable should be used:

a. Windspeed

b. Wind direction

c. Atmospheric stability

d. Mixing height

e. Precipitation

For input to variable trajectory atmospheric transport models, measured hourly values of windspeed should be used. Calms (defined as hourly average windspeeds below the starting speed of the anemometer) should be assigned a windspeed of one-half of the starting speed of the anemometer. Hourly wind directions should be classed into at least the 16 compass point sectors (i.e., 22.5-degree sectors, centered on true north, north-northeast, etc.) according to measured values averaged over the time interval.

For input to the straight-line airflow model, windspeed data should be presented as (1) hourly measured values or (2) windspeed classes divided in accordance with the Beaufort wind scale or other suitable class division (e.g., a greater number of light windspeed classes should be used for sites with high frequencies of light winds). Wind directions should be divided into the 16 compass directions (22.5-degree sectors, centered on true north, north-northeast, etc.). If joint frequency distributions of wind direction and speed by atmospheric stability class, rather than hourly values, are used in this model, calms (defined as hourly average windspeeds below the starting speed of the vane or anemometer, whichever is higher) should be assigned to wind directions in proportion to the directional distribution within an atmospheric stability class of the lowest noncalm windspeed class. If hourly data are used, calms should be assigned to the recorded wind direction averaged over the time interval. The windspeed to be assumed for calms is one-half of the starting speed of the vane or anemometer, whichever is higher.

Atmospheric stability should be determined by vertical temperature difference (ΔT) between the release point and the 10-meter level, or by other well-documented parameters that have been substantiated by diffusion data. Acceptable stability classes are given in Reference 11.

Appropriate time periods for meteorological data utilization should be based on constancy of the source term (rate of release) and potential availability of the receptor (i.e., man or cow). If emissions are frequent or continuous, annual data summaries should be used. Other data time periods and atmospheric dispersion models should be used if emissions are infrequent and of short duration. These infrequent releases should be evaluated on a case-by-case basis unless such releases are restricted by technical specifications to periods when atmospheric conditions are more favorable than the average for the site. If such technical specifications are planned or exist, annual average data and annual average dispersion models may be used. For calculation of doses through the milk pathway, meteorological data for the cow grazing season only should be used.

D. IMPLEMENTATION

The purpose of this section is to provide information to license applicants and licensees regarding the NRC staff's plans for implementing this regulatory guide.

This guide reflects current Nuclear Regulatory Commission practice. Therefore, except in those cases in which the license applicant or licensee proposes an acceptable alternative method, the method described herein for complying with specified portions of the Commission's regulations is being and will continue to be used in the evaluation of submittals for operating license or construction permit applications until this guide is revised as a result of suggestions from the public or additional staff review.

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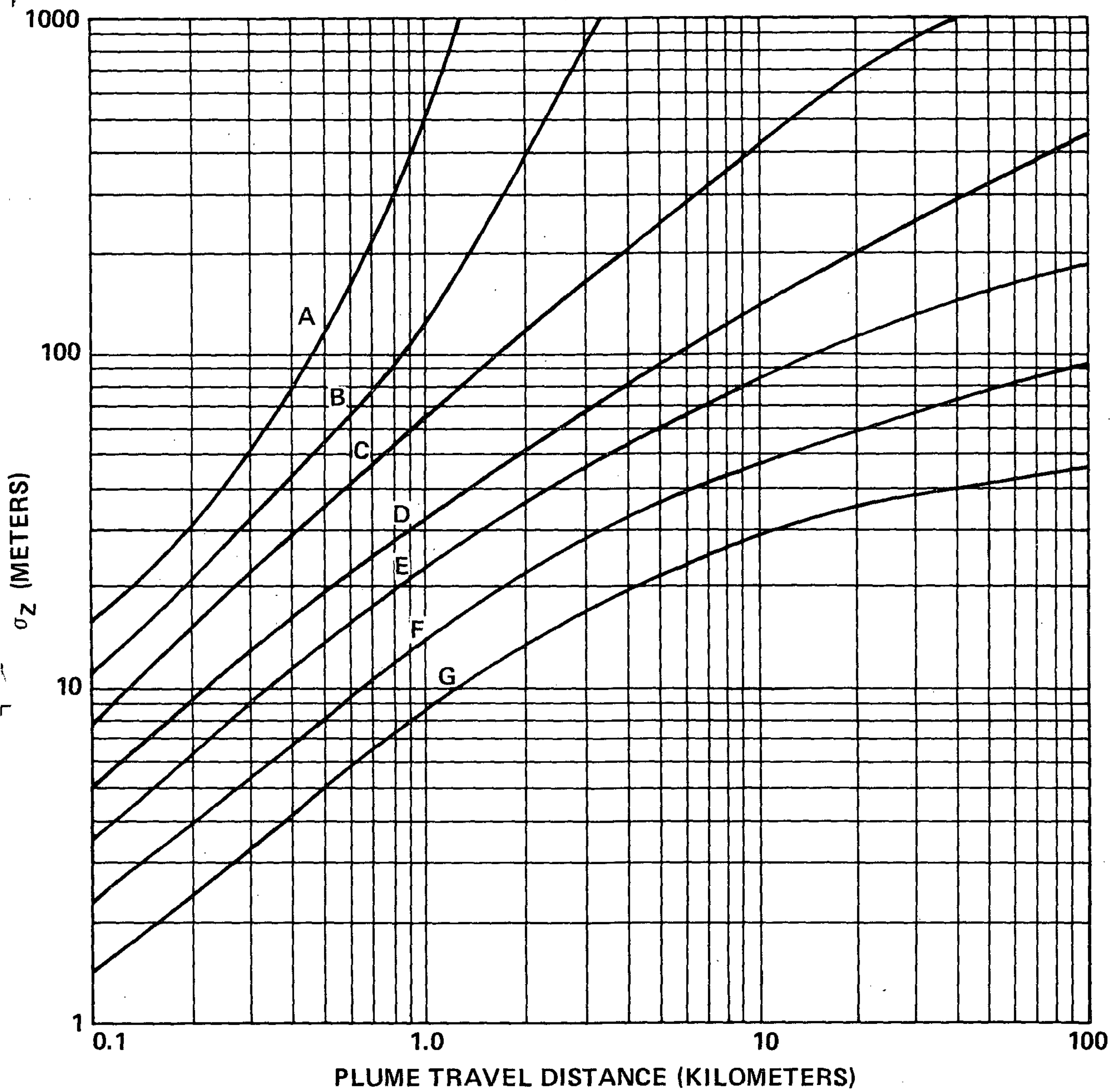

Figure 1. Vertical Standard Deviation of Material in a Plume
(Letters Denote Pasquill Stability Class)

NOTE: THESE ARE STANDARD RELATIONSHIPS AND MAY HAVE TO BE MODIFIED FOR CERTAIN TYPES OF TERRAIN AND/OR CLIMATIC CONDITIONS (E.G., VALLEY, DESERT, OVER WATER).

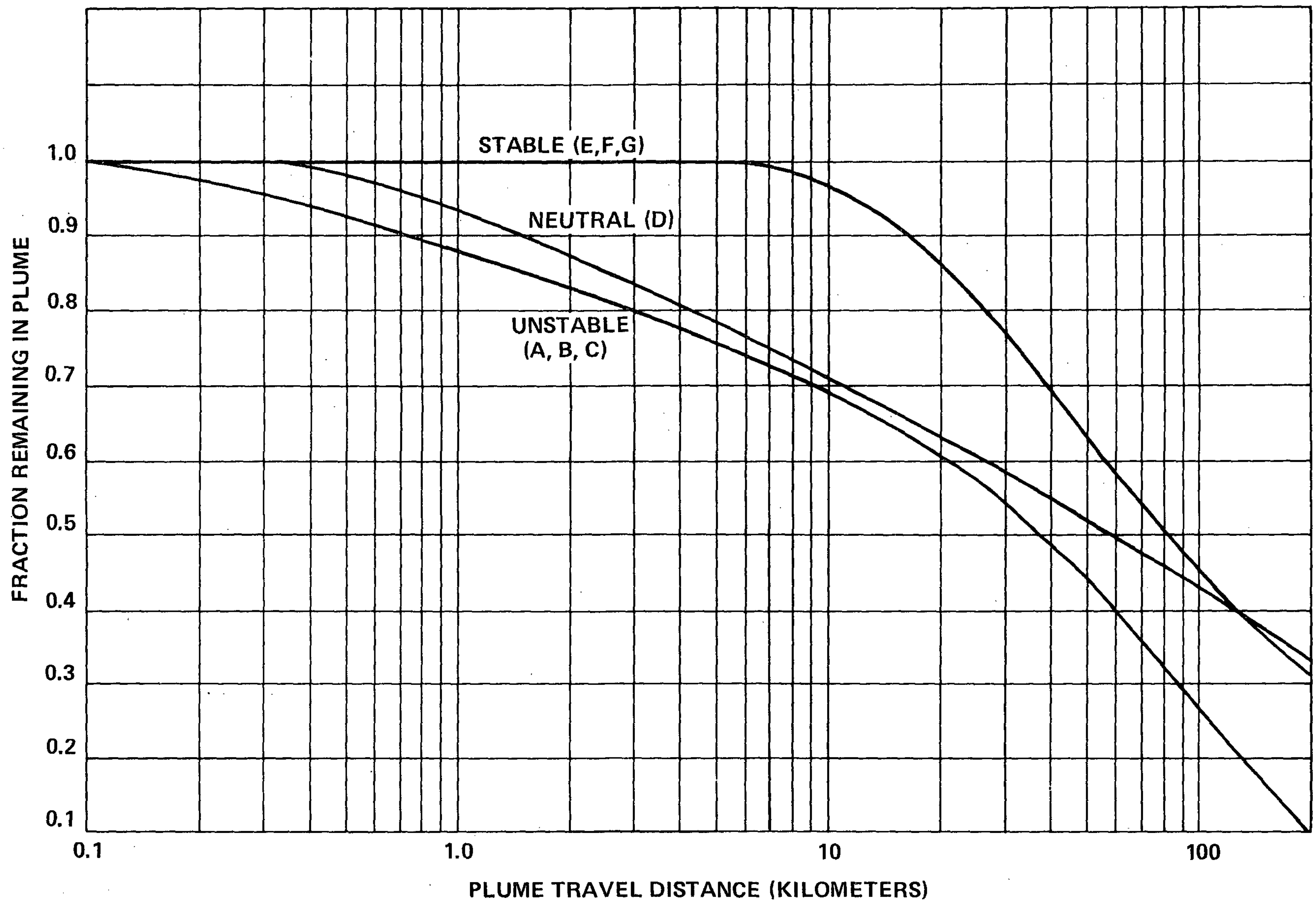

Figure 4. Plume Depletion Effect for 30m Releases (Letters Denote Pasquill Stability Class)

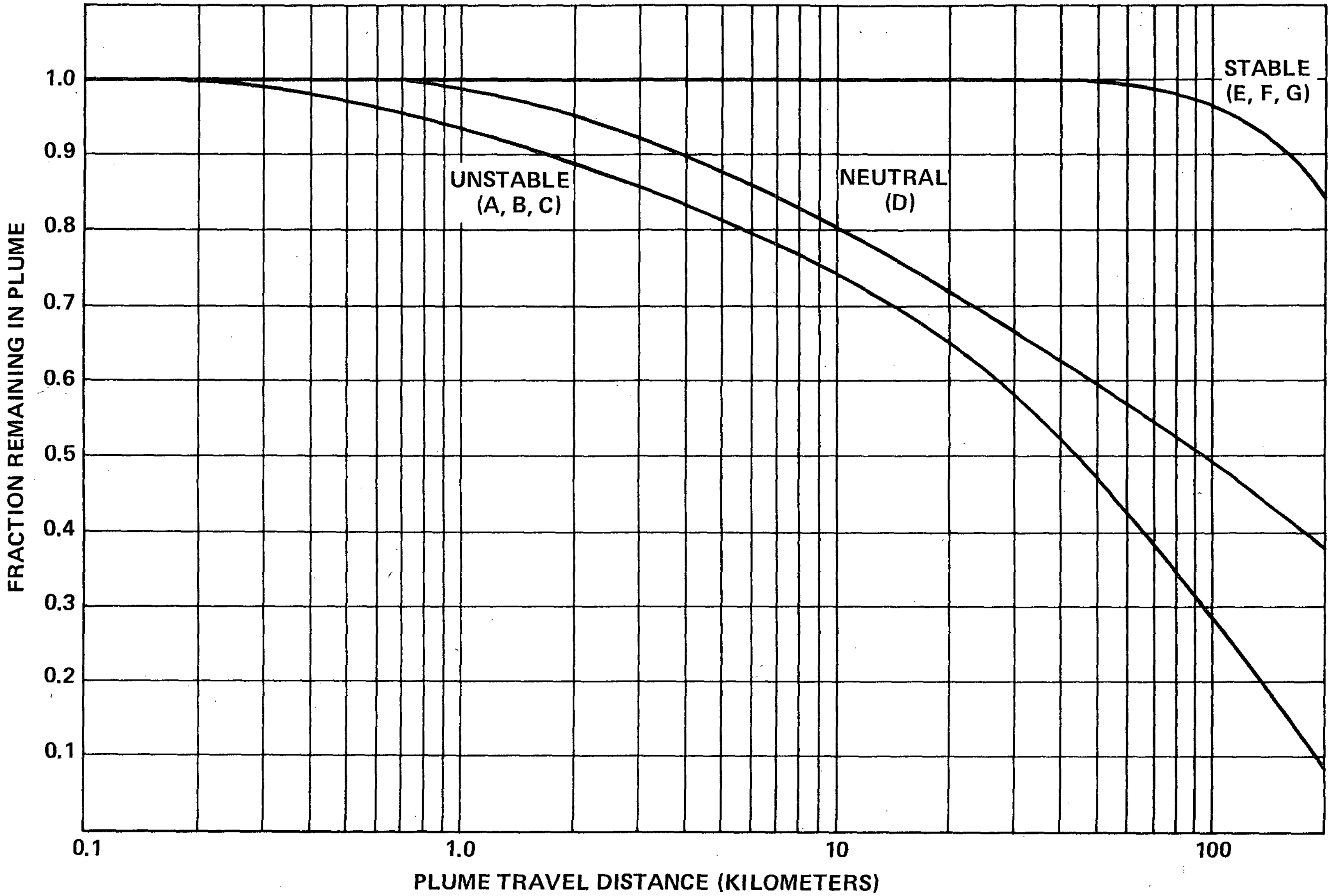

Figure 5. Plume Depletion Effect for 60m Releases (Letters Denote Pasquill Stability Class)

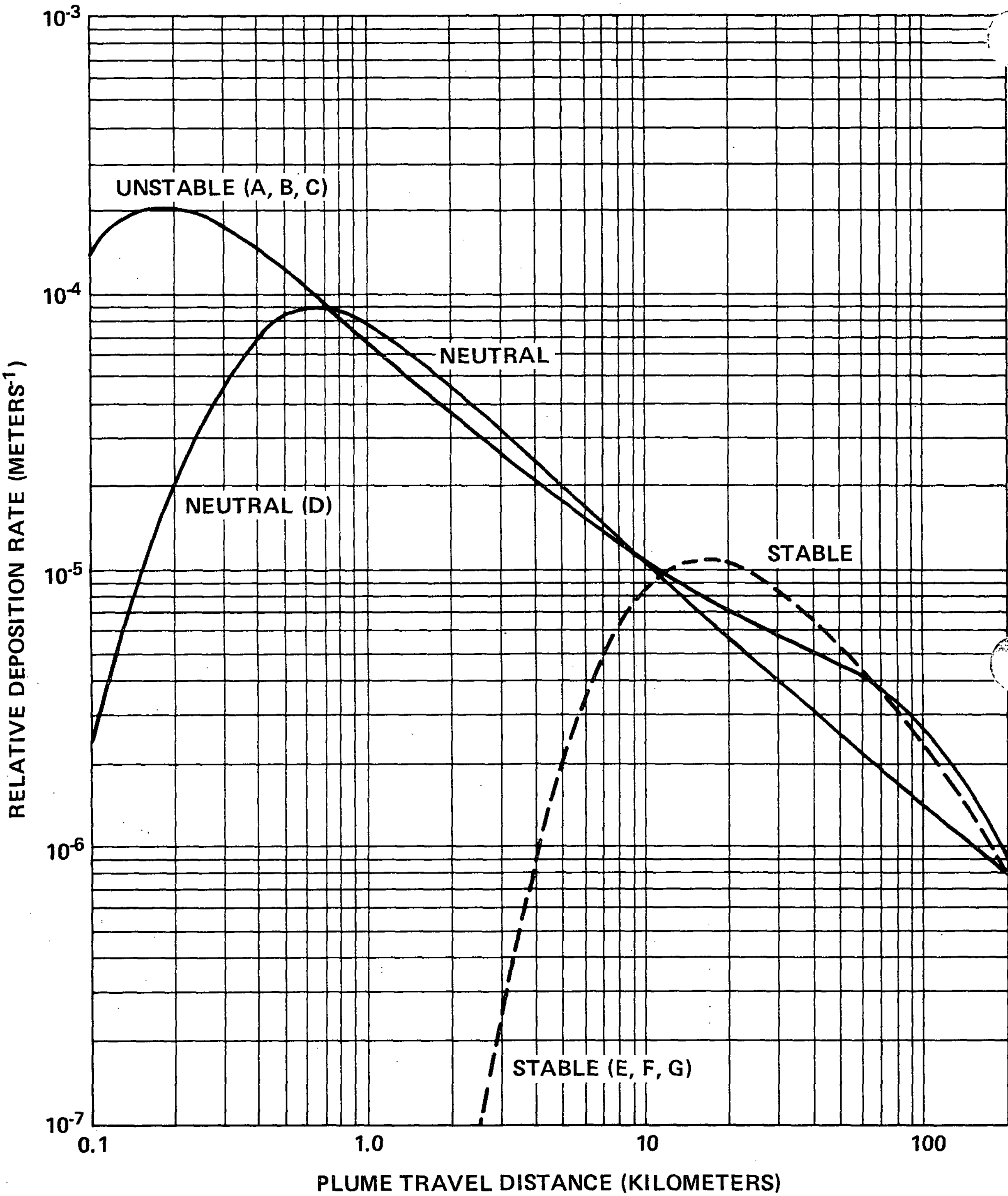

Figure 8. Relative Deposition for 30m Releases (Letters Denote Pasquill Stability Class)

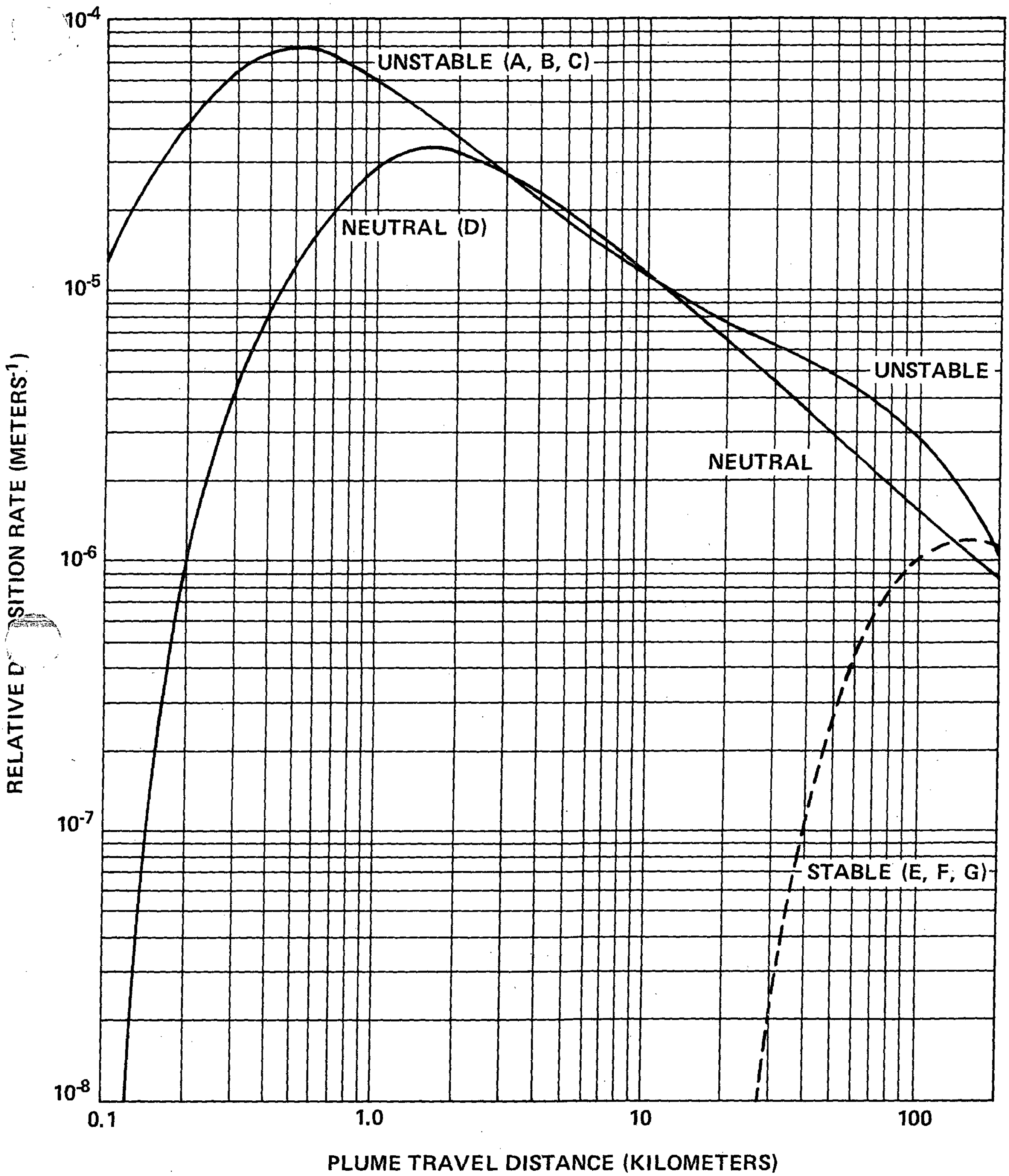

Figure 9. Relative Deposition for 60m Releases (Letters Denote Pasquill Stability Class)

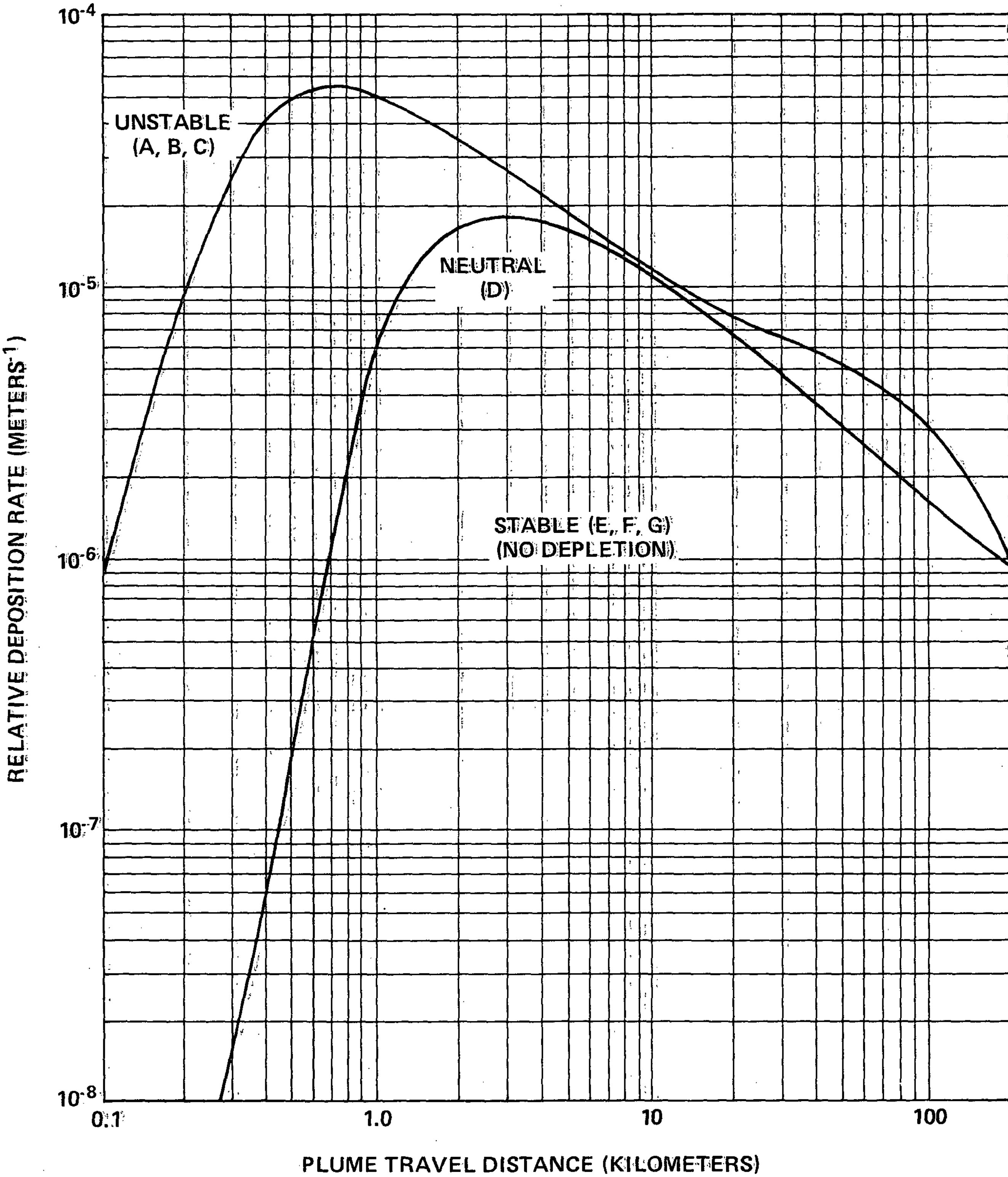

Figure 10. Relative Deposition for 100m Releases (Letters Denote Pasquill Stability Class)