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MARCH 1964

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Downwind From Line Sources

WILLIAM P. ELLIOTT
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Errata

Page 6

Equation (7) for

$$L - L_0 = x^{1-n_y}$$

read

$$L - L_0 = x^{(1-n_y)/2}$$

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
OFFICE OF AEROSPACE RESEARCH
UNITED STATES AIR FORCE
BEDFORD MASSACHUSETTS

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No. 156

Operational Prediction of Diffusion Downwind From Line Sources

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Abstract

Graphs of expected dosage from an infinite line source are presented for various wind speeds, heights of release, and stability conditions. The graphs are based on Sutton's diffusion equation with parameters derived from Project Prairie Grass data by Haugen, Barad, and Antanaitis. A method of estimating the range of validity of these equations for a line source of finite length is also presented.

Contents

Operational Prediction of Diffusion Downwind From Line Sources

1. INTRODUCTION

The Air Force has a requirement for knowledge of the ground-level distribution of various gases and aerosols, released in a quasi-instantaneous fashion, along lines that may either be ground-based or elevated. The purpose of this Survey is to provide a method whereby operations that require such information can be planned. Graphs of the expected ground-level dosage divided by source strength are given as a function of distance downwind from the release line for various heights of release, wind speeds, and the stability of the lower atmosphere.

The equations from which the graphs were constructed are based on those derived by Sutton.[1] While other equations have been presented, Sutton's are the best known and most widely studied and require fewer specialized measurements. In order to appreciate the limitations of the results, presented in Appendix A, a brief review of Sutton's equations is in order. No one should attempt to use the results without first reading the following sections.

2. THE EQUATIONS

Sutton derived his equations from statistical considerations of turbulent diffusion

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from an instantaneous point source. By integrating with respect to time, he obtained an equation for a continuous ground-level point source and this latter equation is the basis for generalizations to other source types.

The equation takes the general form

$$\frac{X}{Q} = \frac{1}{\pi\sigma_y\sigma_z\bar{u}} \exp\left\{-\left[\frac{y^2}{2\sigma_y^2} + \frac{z^2}{2\sigma_z^2}\right]\right\} , \tag{1}$$

where X is the concentration at any point (x, y, z), Q is the source strength, σ_y and σ_z are the standard deviations of the distances traveled by a particle in the crosswind (y) and vertical (z) directions, respectively. The downwind direction (x) is the direction in which the mean wind ($\bar{u}$) is blowing and does not appear explicitly. The values of σ_y and σ_z are, however, both functions of x, reflecting the fact that the cloud spreads both laterally and vertically as it travels away from the source. This equation is presumed valid for sources based at the ground in an atmosphere where the wind does not vary with height. Furthermore, it assumes that any tracer material which hits the surface "bounces" back into the air, that is, there is no deposition on the ground or other surface. It also assumes the crosswind and vertical distributions are Gaussian and that the downwind speed of translation ($\bar{u}$) is much greater than the downwind diffusion.

The problem then is to express σ_y and σ_z as functions of x and of atmospheric stability. Sutton presents some theoretical expressions of the form

$$\begin{aligned} 2\sigma_y^2 &= C_y^2 x^{2-n} \\ 2\sigma_z^2 &= C_z^2 x^{2-n} \end{aligned} \tag{2}$$

where the C's are functions of the gustiness and stability but not of x, and n is presumed related to the wind profile, which is in turn also a function of stability.

Equations (2) state that the downwind variation of σ, as represented by the term x^{2-n}, is the same for both the vertical and crosswind terms. However, Barad and Haugen[2] have presented an analysis of some data for continuous point sources (Project Prairie Grass[3]) which indicated that different values of n (referred to hereafter as n_y and n_z) are more appropriate. This concept was used in constructing the graphs presented here.

Since the problem of direct concern is an instantaneous line source rather than a continuous point source, Eq. (1) has to be transformed. Integration of Eq. (1) in the crosswind plane from $y = -\infty$ to $y = +\infty$ gives the appropriate solution for a continuous line source. Then, if the concentration X is replaced by the total dosage D (units of quantity times time per unit volume), and the source strength Q is taken as quantity per unit length of release, a solution for an instantaneous line source is achieved. Finally, by referring to the method of images,[1] the equation can be made appropriate for a source whose height above ground is h. The final equation is then

$$\frac{D}{Q} = \frac{2}{\sqrt{\pi} C_z \bar{u} x^{(2-n_z)/2}} \exp -\left[\frac{h^2}{C_z^2 x^{2-n_z}}\right] . \quad (3)$$

This equation then gives the value of D/Q, at ground level, as a function of the source height h, the wind speed $\bar{u}$, and the downwind distance x, provided the parameters C_z and n_z can be specified.

3. ESTIMATION OF PARAMETERS

Haugen, Barad, and Antanaitis[4] have presented values of the diffusion parameters C_y, C_z, n_y, and n_z, based upon a careful analysis of the Prairie Grass data. As stated above, these parameters are functions of stability. Haugen et al., chose the Stability Ratio (SR) as the quantitative measure of stability. This parameter is defined as

$$SR = \frac{T_4 - T_{0.5}}{\bar{u}_2^2} \times 10^5 \ {}^{o}C \ sec^2 \ cm^{-2} \quad . \quad (4)$$

The subscripts refer to the height above ground, in meters, at which the temperature (T) and wind speed ($\bar{u}$) were measured. This quantity is negative in lapse situations and positive in inversion situations.

The appropriate values of the parameter for various stability classes as found by Haugen et al. are given in Table 1. (The integration of Eq. (1) with respect to y eliminated C_y and n_y. These values will be needed later in this paper, however, and are presented here for convenience.)

The values appearing in Table 1 are those used in constructing the graphs. Obviously, to use these graphs, one must first be able to ascertain the proper stability category. When measurements of temperature difference and wind speed at the appropriate levels for determining the stability ratio are not available, the following may be useful as a rough guide in estimating the proper stability class.

Based on the experience at Project Prairie Grass, during daylight hours one

TABLE 1.

		C_z	n_z	C_y	n_y
Stability Class	Range of SR	(meters)$^{n_z/2}$		(meters)$^{n_y/2}$	
very unstable	<-0.45	0.002	-1.20	0.38	0.20
moderately unstable	-0.45 to -0.20	0.02	-0.40	0.38	0.30
neutral	0.20 to 0.20	0.07	0.10	0.38	0.50
moderately stable	0.20 to 0.45	0.07	0.20	0.38	0.65
very stable	> 0.45	0.07	0.30	0.38	0.80

would expect to find very unstable conditions with clear skies and surface winds less than 10 knots; neutral conditions would be found with overcast skies and wind speeds in excess of 15 knots. If neither of these conditions is met one would find moderately unstable conditions during the day. At night one would expect very stable conditions with clear skies and wind speeds below 7 knots; neutral conditions with overcast skies and wind speeds greater than 15 knots; otherwise one would expect moderately stable conditions. In addition, near sunrise and sunset one expects a period of neutral conditions, regardless of wind and cloud conditions. It should be emphasized that the terms "very" and "moderately" are based on the conditions during Prairie Grass. Very few trials were made with surface winds less than 3 knots. Therefore one might find that, with very low wind speeds, the graphs for very unstable and very stable are not representative.

A question concerning the wind speed to use in entering the graphs naturally arises. It is well known that the wind is not constant with height as the theoretical development presupposes. Probably, the best wind speed to use would be an average between the surface wind speed and the speed at the release height.

4. ACCURACY OF EQUATIONS

It must be stressed that values of the parameters used in this study have been obtained by a double averaging. They were derived from continuous source data which is, in effect, an average over a large number of instantaneous sources. Also, the values of the parameters represent median values derived from a number of separate continuous source emissions. This means that Eq. (3), with these parameters, represents what would be expected as an average over a number of instantaneous releases in the same stability conditions. Equation (3) cannot be presumed to be more than an educated guess for any particular release.

No data from elevated sources are available in sufficient quantity or quality to determine the accuracy of the graphs in Appendix A; only subjective estimates of their accuracy can be made. One must keep in mind that the parameters were obtained from data in a particularly simple geographic location. Furthermore, the graphs are based on an assumed Gaussian distribution of crosswind and vertical concentration. The assumption of a Gaussian distribution seems to be a good way of representing the crosswind distribution from a point source but there is evidence[5,6] that the vertical distribution may be better represented by some other form. However, neither of these references give sufficient information from which the appropriate diffusion parameters may be calculated. Until more work is available, it is best to use the Gaussian distribution.

In particular applications, one would expect the graphs to be most accurate near the distance of the peak dosage and when the source is close to the ground. At distances greater than a few miles from the source, one would expect deterioration of the results because, at these distances, scales of atmospheric motions larger than those considered in ordinary diffusion equations may become important. Between the elevated source and the maximum dosage the lines of D/Q vs. distance are so steep that a slight shift in the lines could result in a difference of D/Q of several orders of magnitude.

In summary, then, one might expect that, around the maximum value of D/Q, the graphs would provide estimates of D/Q to within a factor of 4 about 2/3 of the time and within an order of magnitude almost all the time. The estimated distance from the source to the maximum D/Q should be accurate to within a factor of 2. These statements are based on subjective judgments and assume an accurate determination of the source height, the wind speed, and the stability class.

Another point which must be stressed is the relation between the wind direction and the direction of the release line. The derivation of Eq. (3) requires that the wind direction must be at right angles to the release line. In practice it appears the results would not differ sufficiently from those predicted here if the wind direction were between 80° and 100° to the release line. Barad, Haugen, and Fuquay[7] have presented the equation necessary to consider all angles between wind and release line as well as finite lengths of the release line. However, this equation can, in general, only be solved by digital methods. Solutions of this equation would be quite valuable and should be undertaken.

5. THE LENGTH OF THE RELEASE LINE

The question of how long a release line must be to be considered effectively infinite is not easy to determine. The farther away from any finite source the more that source appears as a point. Conversely, the closer one is to the center of a finite line source the more it appears as an infinite line source. Thus, one would expect some region down wind of a finite line source to be unaffected by the finite length of the line. This concept is illustrated schematically in Figure 1. The hatched area is the region down wind of release line AB in which the finite length of AB is immaterial for diffusion considerations. The problem is to determine the boundary of this region.

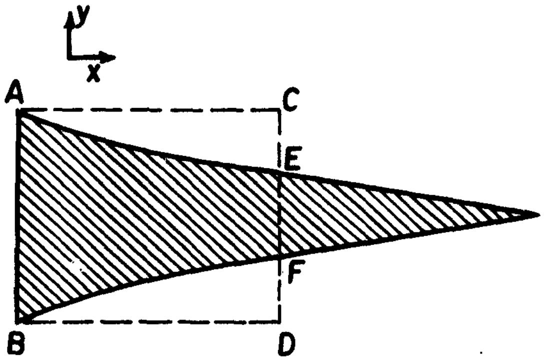


Figure 1

Consider lines AC and BD normal to AB and line CD parallel to AB. A reasonable and probably conservative assumption can be made which should provide sufficient information for planning purposes. This assumption is that CE and FD are equal to twice the crosswind standard deviation σ_y. Then if the length of the release line AB is taken as L and the length of the line EF is taken as L_o, it follows from the geometry of Figure 2 that

$$\frac{L}{2} - \frac{L_o}{2} = 2\sigma_y \quad . \tag{5}$$

Substituting for σ_y from Eq. (2)

$$L - L_o = 2^{3/2} C_y \, x^{(2-n_y)/2} \quad . \tag{6}$$

The value of C_y is not dependent on stability (see Table 1) and is equal to 0.38 $(\text{meters})^{n_y/2}$. Thus with sufficient accuracy Eq. (6) may be written, if L, L_o, and x are measured in meters,

$$L - L_o = x^{1-n_y} \quad , \tag{7}$$

where the n_y values are given in Table 1. Therefore, if two of the three lengths in Eq. (7) can be prescribed, the third can be found. Figure 2 shows graphs of this equation for values of x out to one mile for the five stability conditions used in Appendix A, the lengths having been converted to feet. Appendix B gives an example of the use of this graph in a hypothetical planning problem.

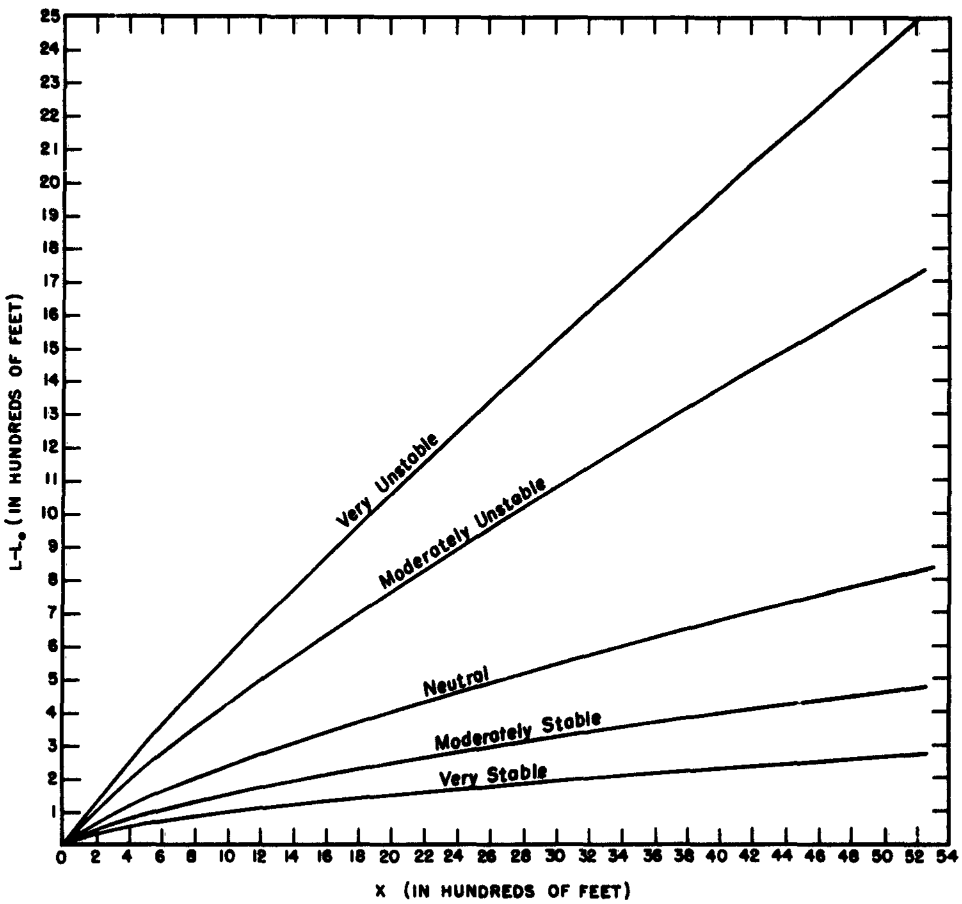


Figure 2

Acknowledgments

We wish to express our appreciation of the efforts of Miss Patricia Kelly of Regis College, who handled the computational work.

References

1. O.G. SUTTON, Micrometeorology, McGraw-Hill (1953).
2. M.L. BARAD, and D.A. HAUGEN, A preliminary evaluation of Sutton's hypothesis for diffusion from a continuous point source, J. Meteorol. 16(No. 1): 16-20 (1957).
3. M.L. BARAD, Ed., Project Prairie Grass, a Field Program in Diffusion, (2 Vol). Geophy. Res. Paper No. 59 (1958).
4. D.A. HAUGEN, M.L. BARAD, and P. ANTANAITIS, Values of parameters appearing in Sutton's diffusion models, J. Meteorol., 18(No. 3):368-372 (1961).
5. W.P. ELLIOTT, The vertical diffusion of gas from a continuous source, Int. J. of Air and Water Poll. 4:33-46 (1961).
6. F. PASQUILL, Atmospheric Diffusion, D. Van Nostrand Co., (1962).
7. M.L. BARAD, D.A. HAUGEN, and J.J. FUQUAY, A Diffusion Deposition Model for In-Flight Release of Fission Fragments, Air Force Surveys in Geophysics No. 123 (1960).

Appendix A

This Appendix contains graphs of dosage divided by line source strength (D/Q) in minutes per square foot vs. distance from the release line (x) in feet. For each of the five stability categories listed in Table 1, graphs of D/Q vs. x are given for assumed release heights of 0, 50, 100, 150, 200, 250, 300, 400, and 500 feet above ground. Thus there are 45 separate graphs. Each graph shows 4 lines corresponding to solutions for transport wind speeds of 5, 10, 20, and 30 knots. Estimates for other wind speeds can be found by multiplying the value of D/Q, at 10 kt, by the ratio 10 kt/actual wind speed. (For further details, consult the test.)

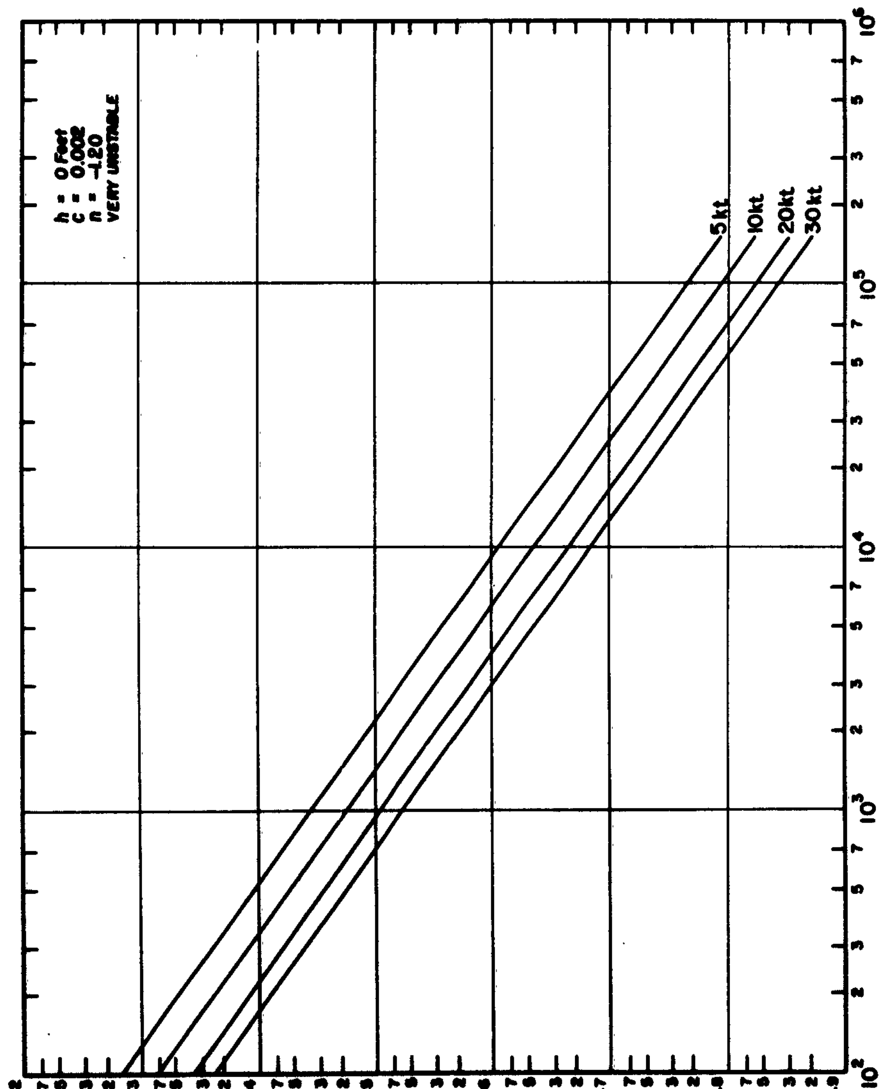
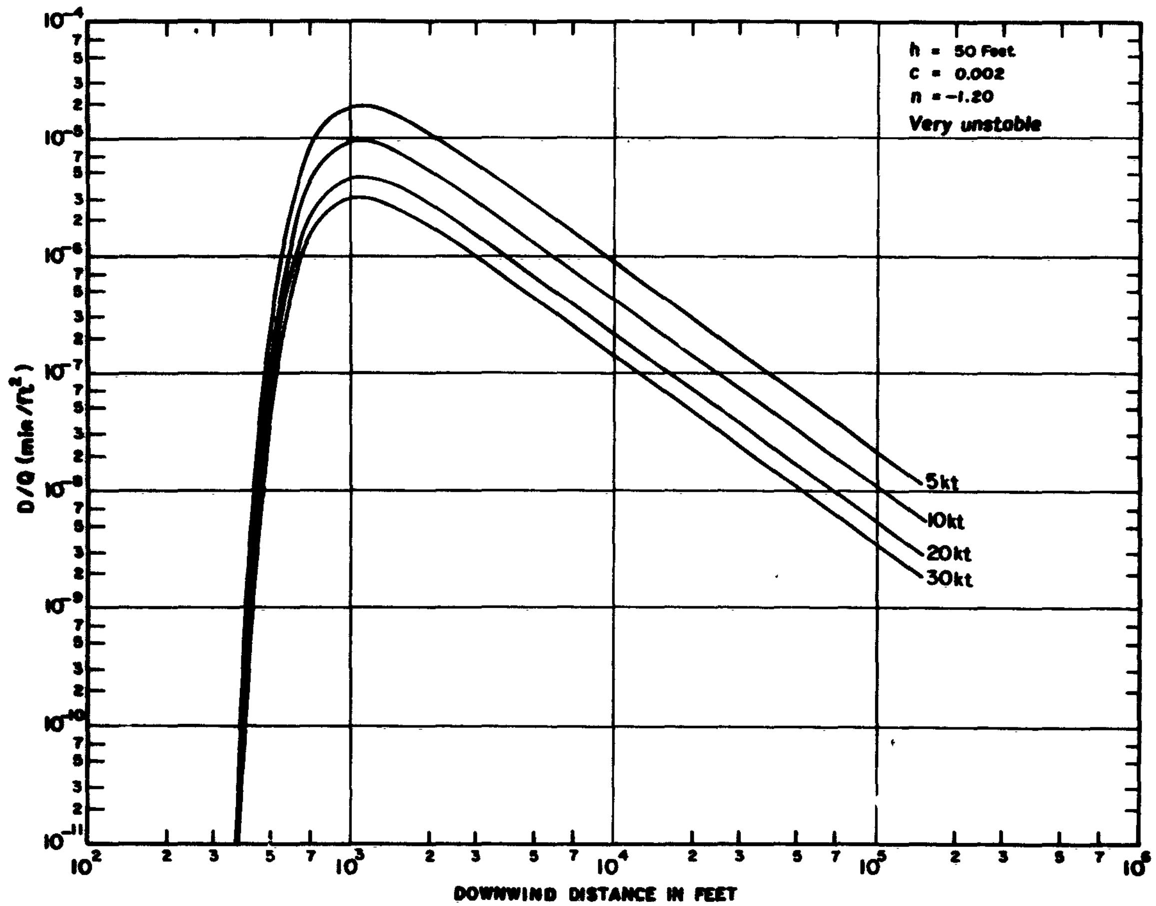

h = 0 Feet
C = 0.002
n = -1.20
VERY UNSTABLE
5kt
10kt
20kt
30kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A1


h = 50 Feet
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Very unstable
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10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A2

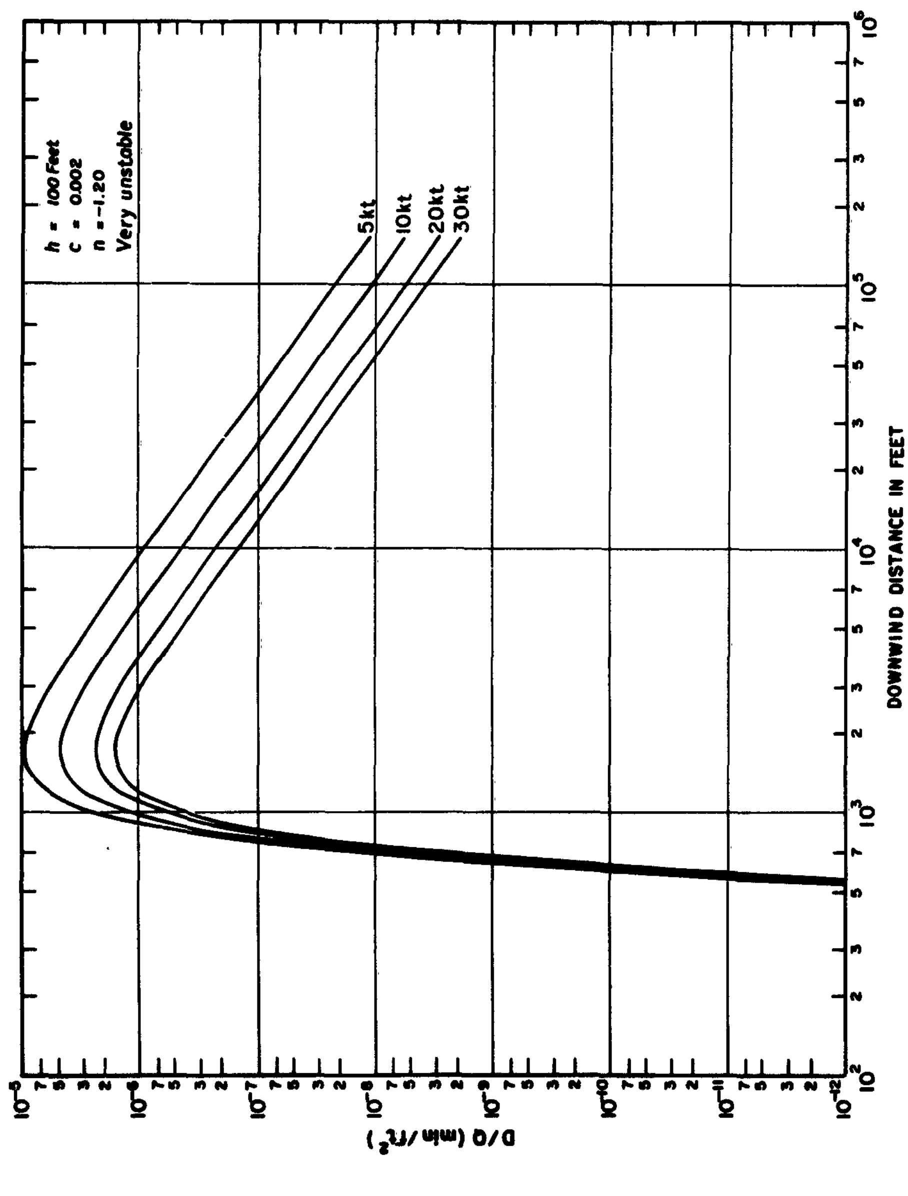

h = 100 Feet
C = 0.002
n = -1.20
Very unstable
5kt
10kt
20kt
30kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A3

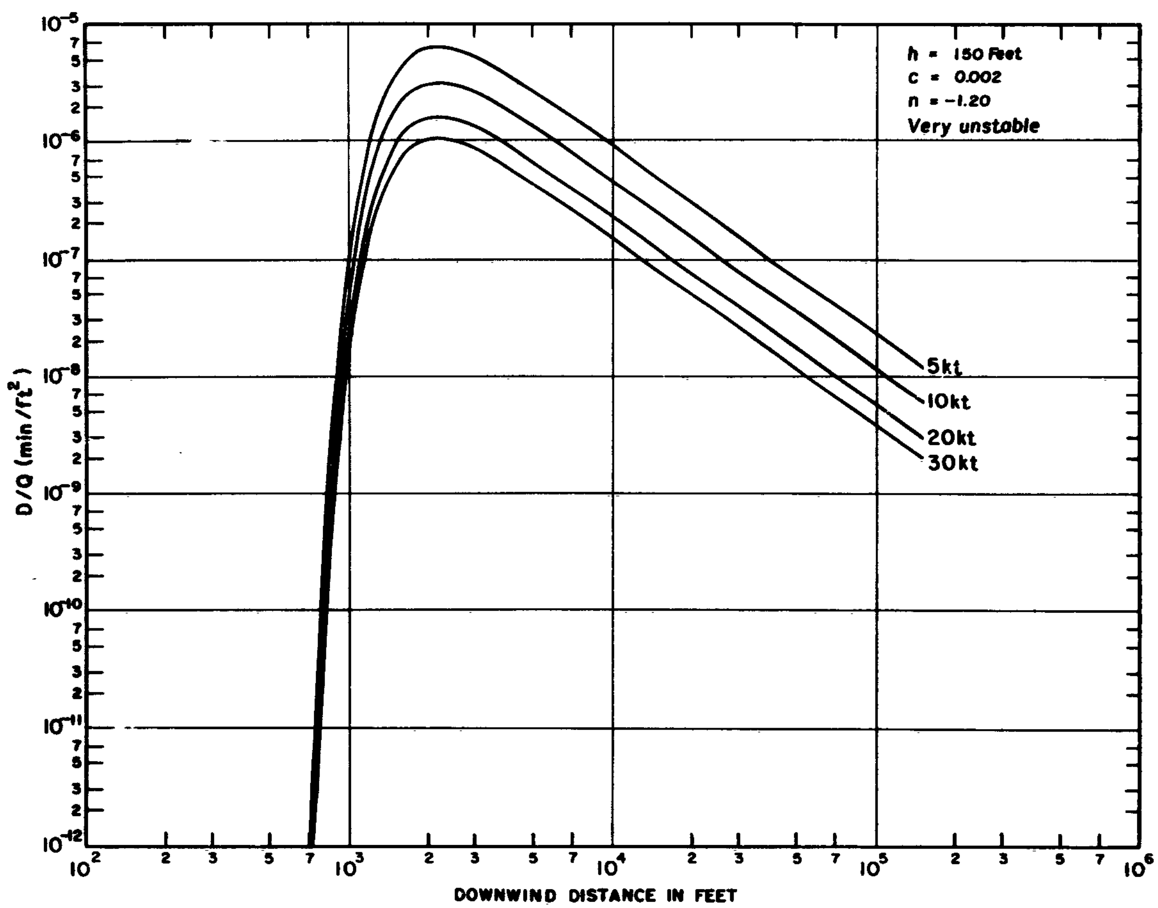

h = 150 Feet
c = 0.002
n = -1.20
Very unstable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A4

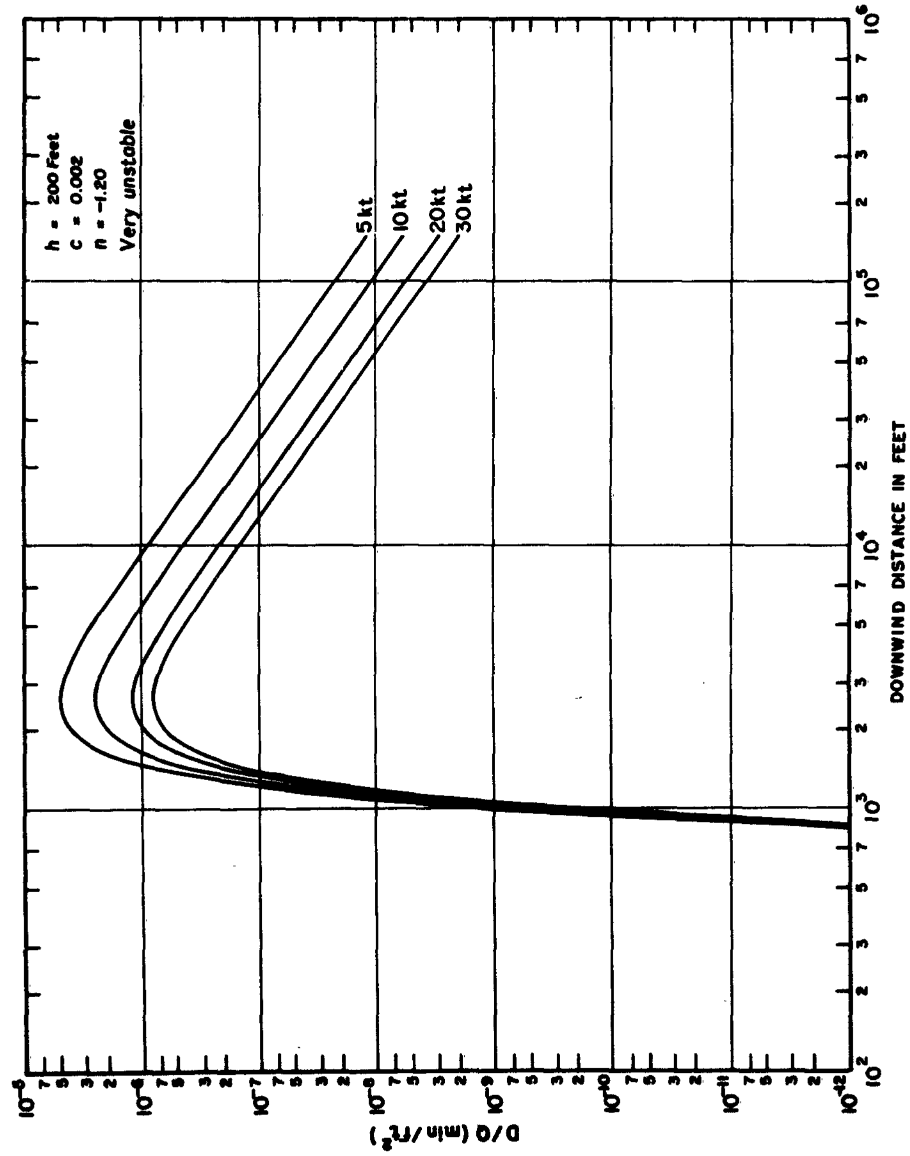
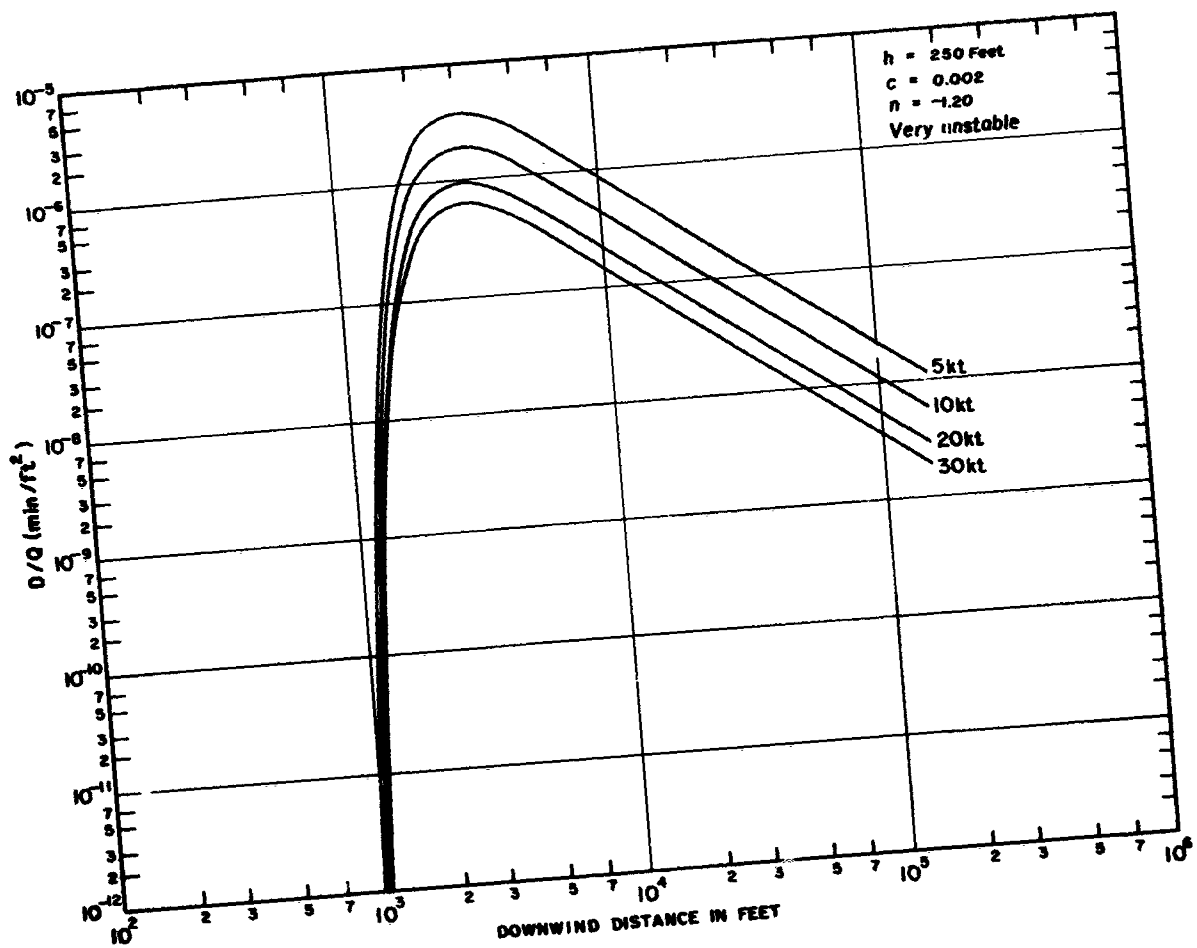

h = 200 Feet
C = 0.002
n = -1.20
Very unstable
5kt
10kt
20kt
30kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A5


h = 250 Feet
c = 0.002
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Very unstable
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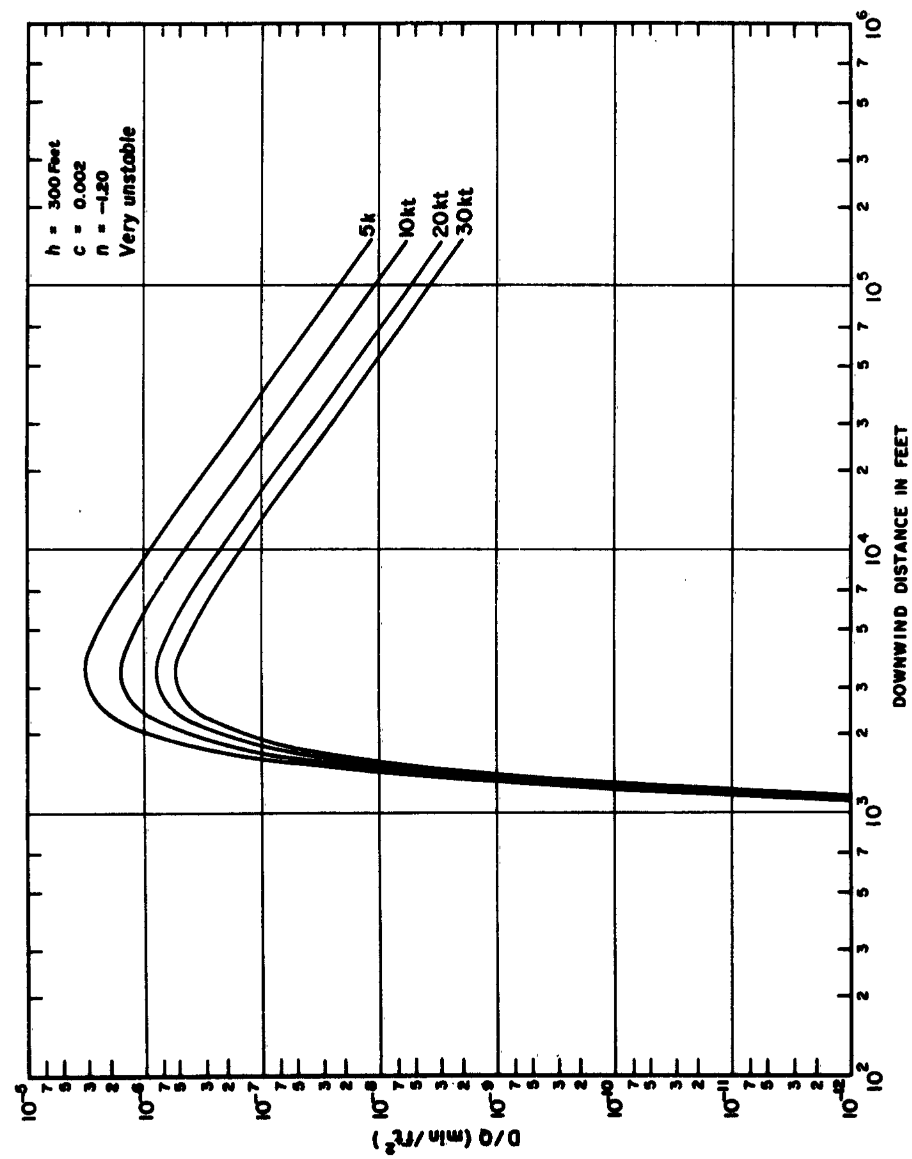
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A6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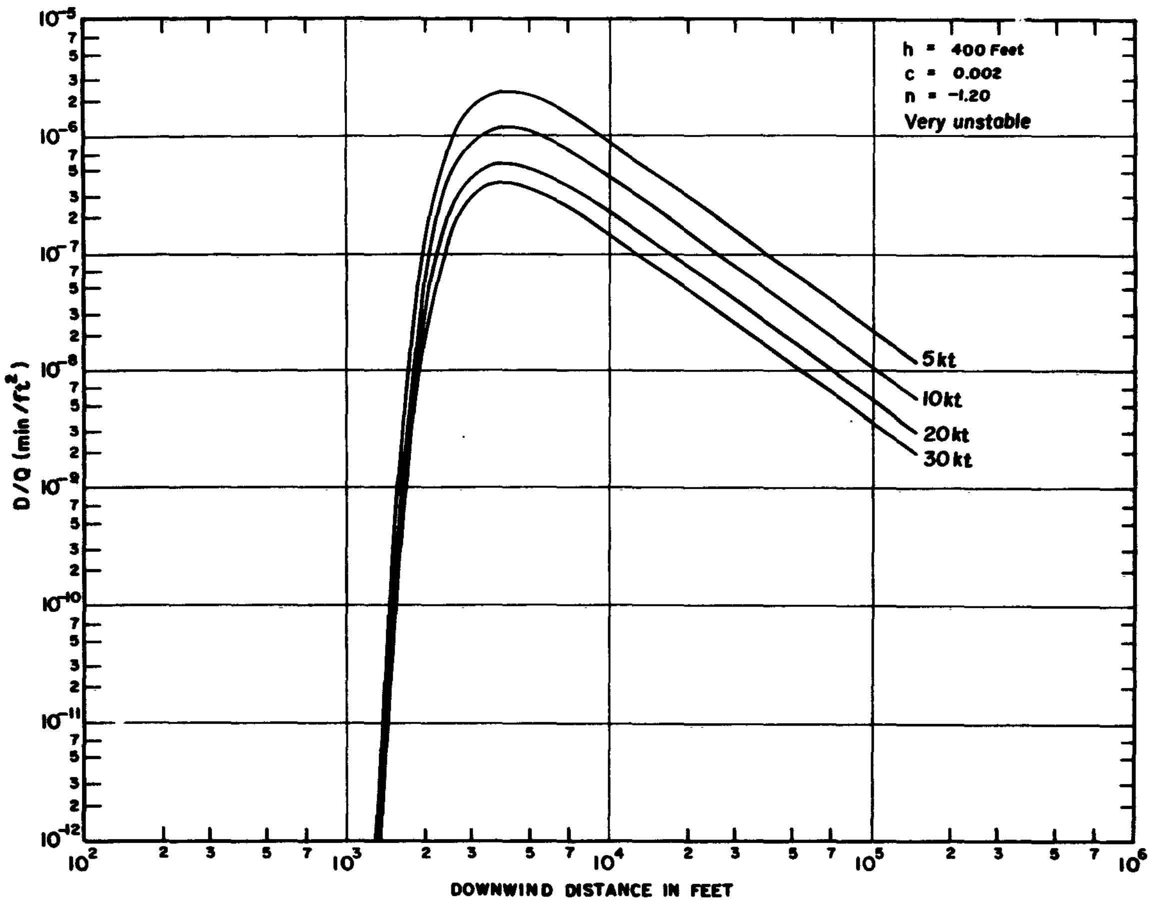
5k
10kt
20kt
30kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A7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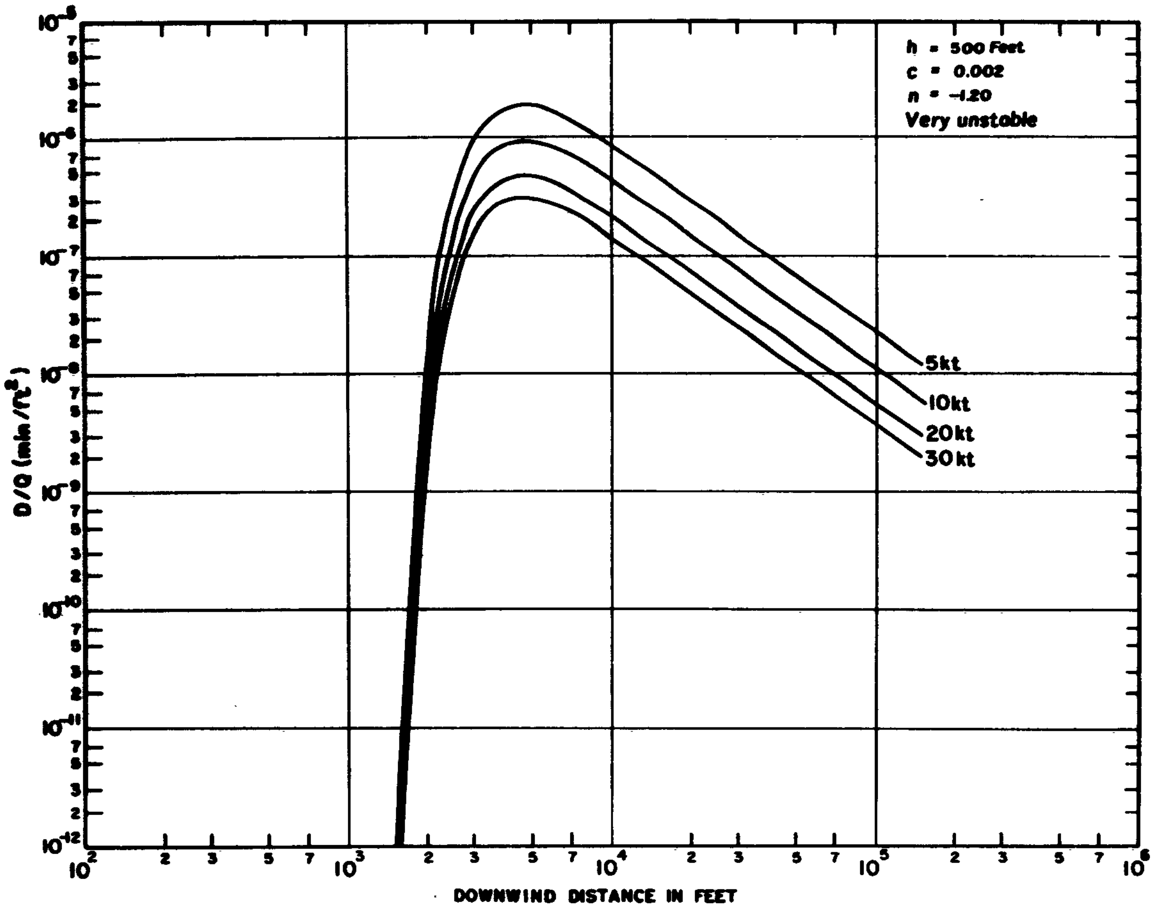
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A8


h = 500 Feet
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Very unstable
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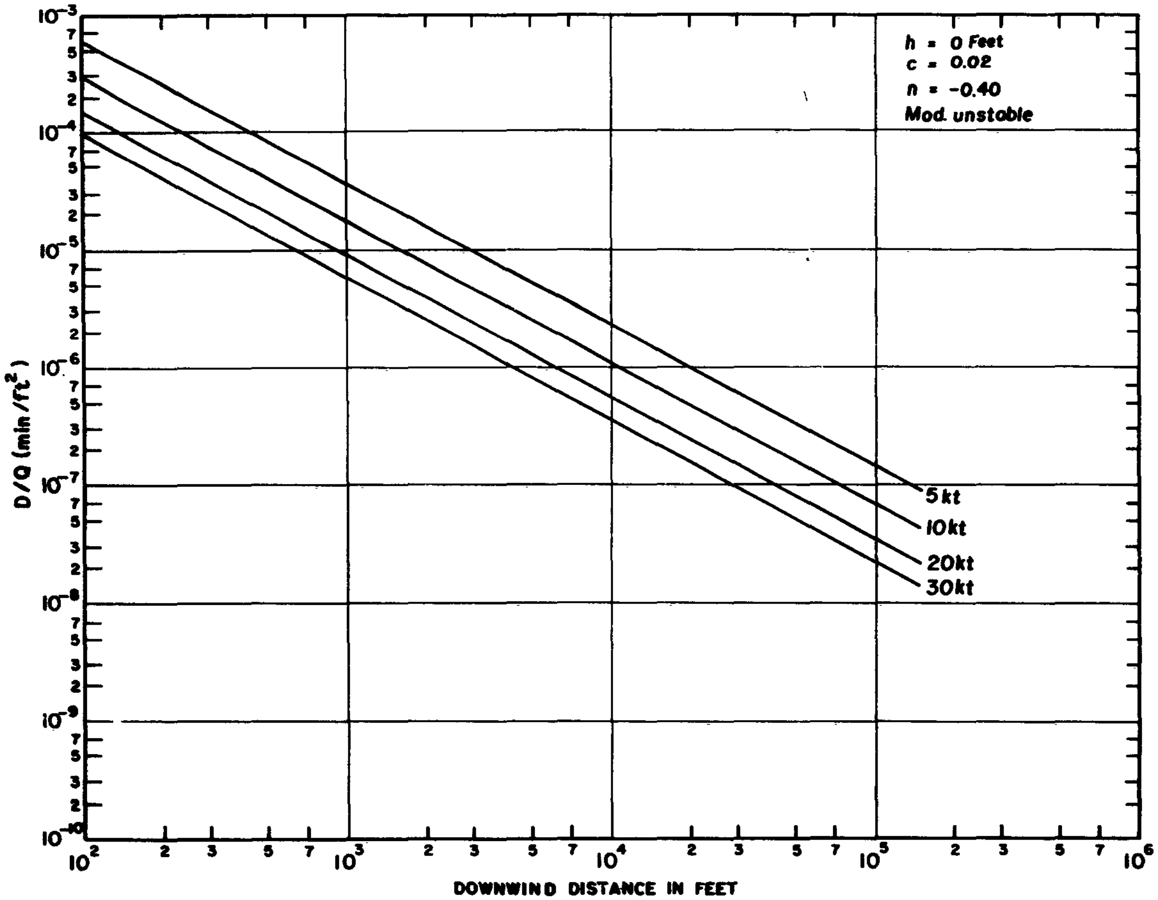
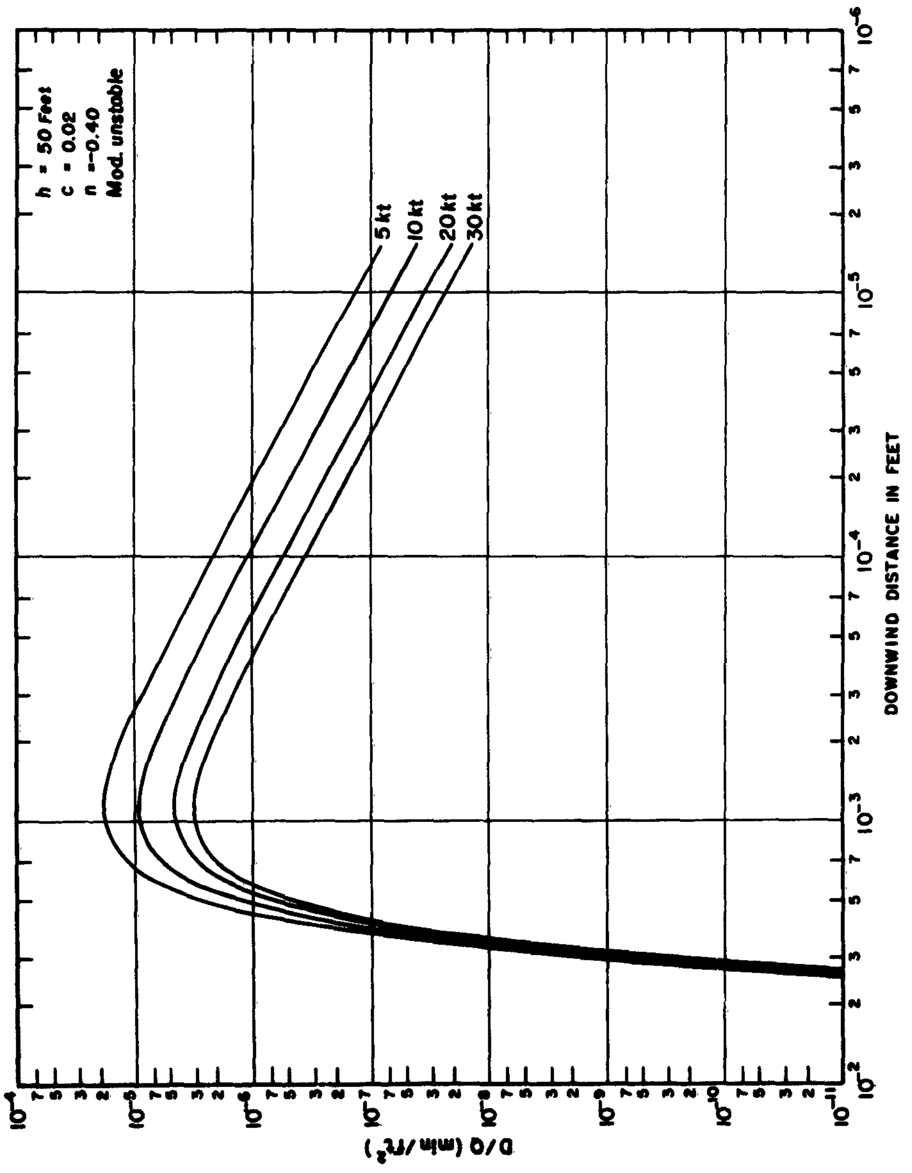
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A9



h = 0 Feet
c = 0.02
n = -0.40
Mod. unstable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A10


h = 50 Feet
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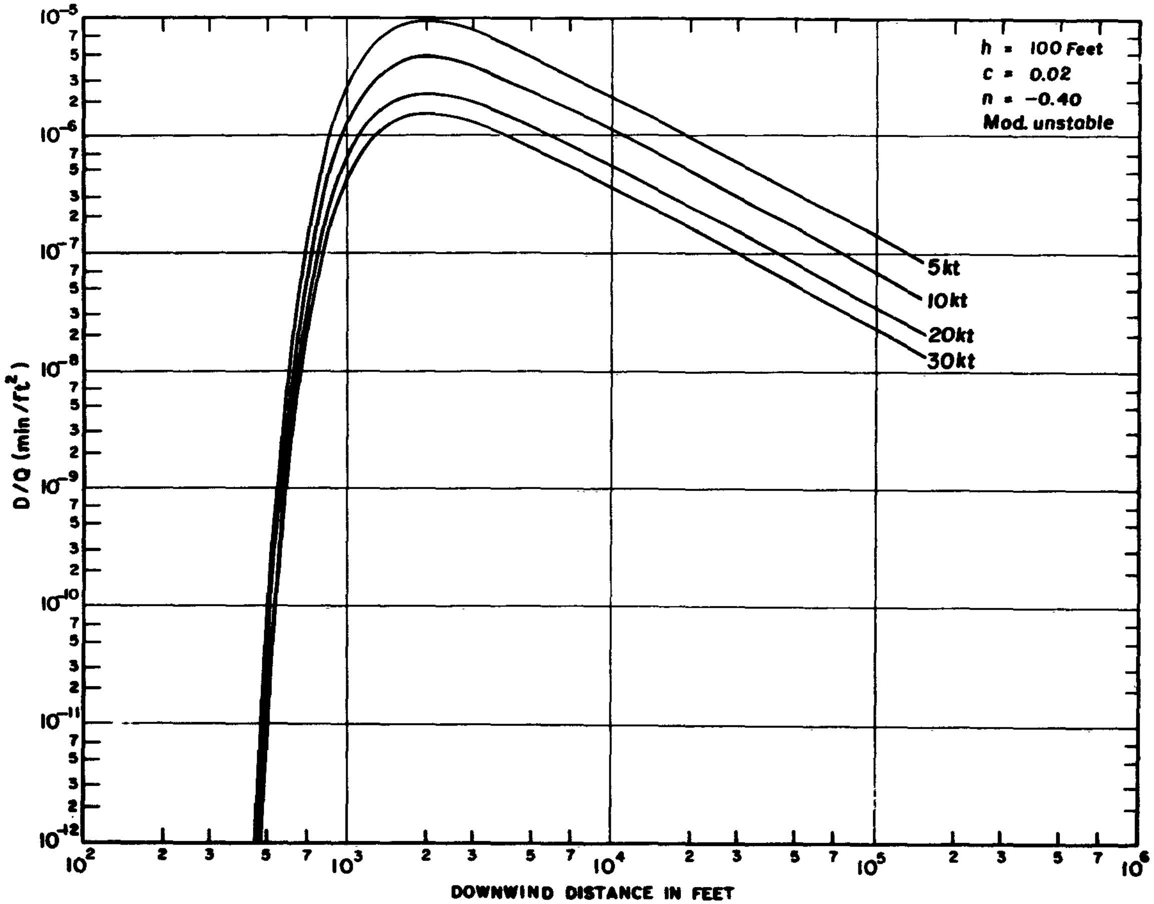
10 kt
20 kt
30 kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A11


h = 100 Feet
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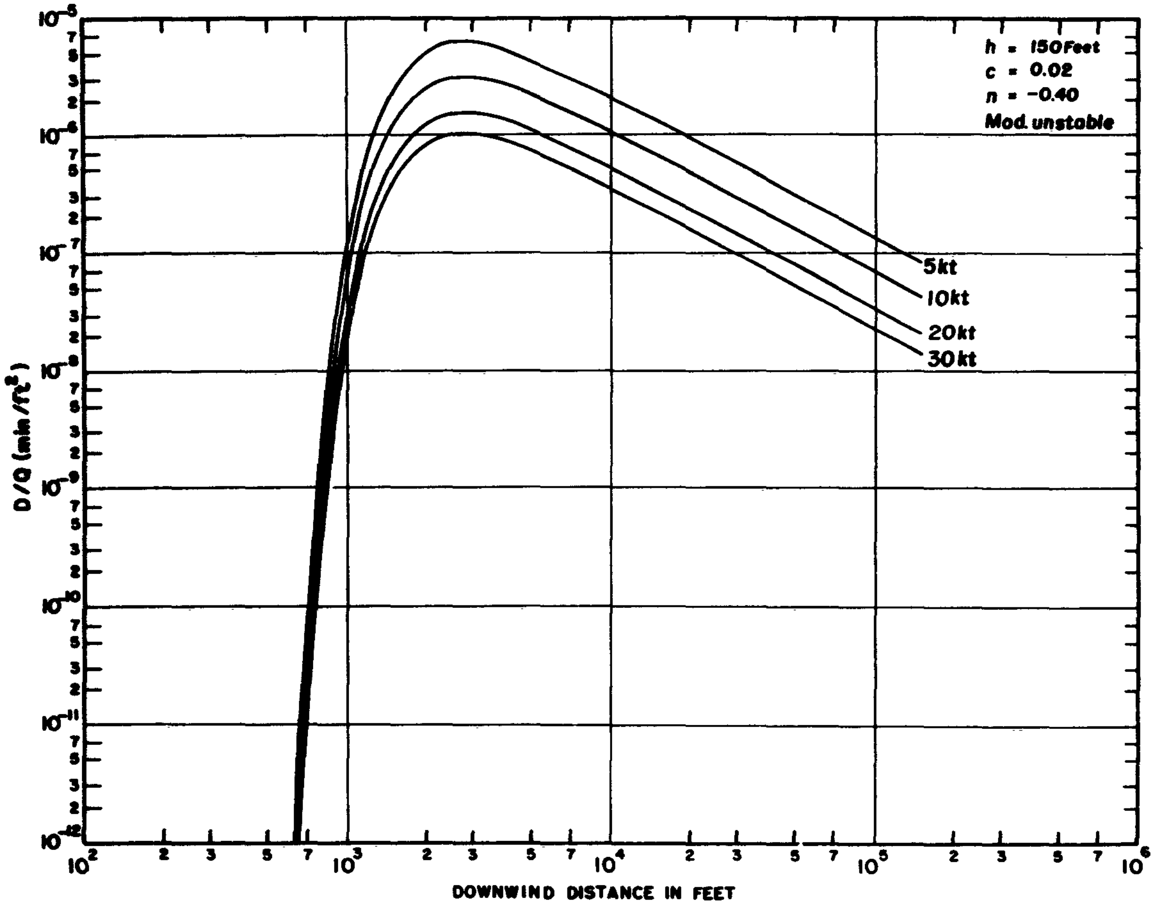
Mod. unstable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A12


h = 150 Feet
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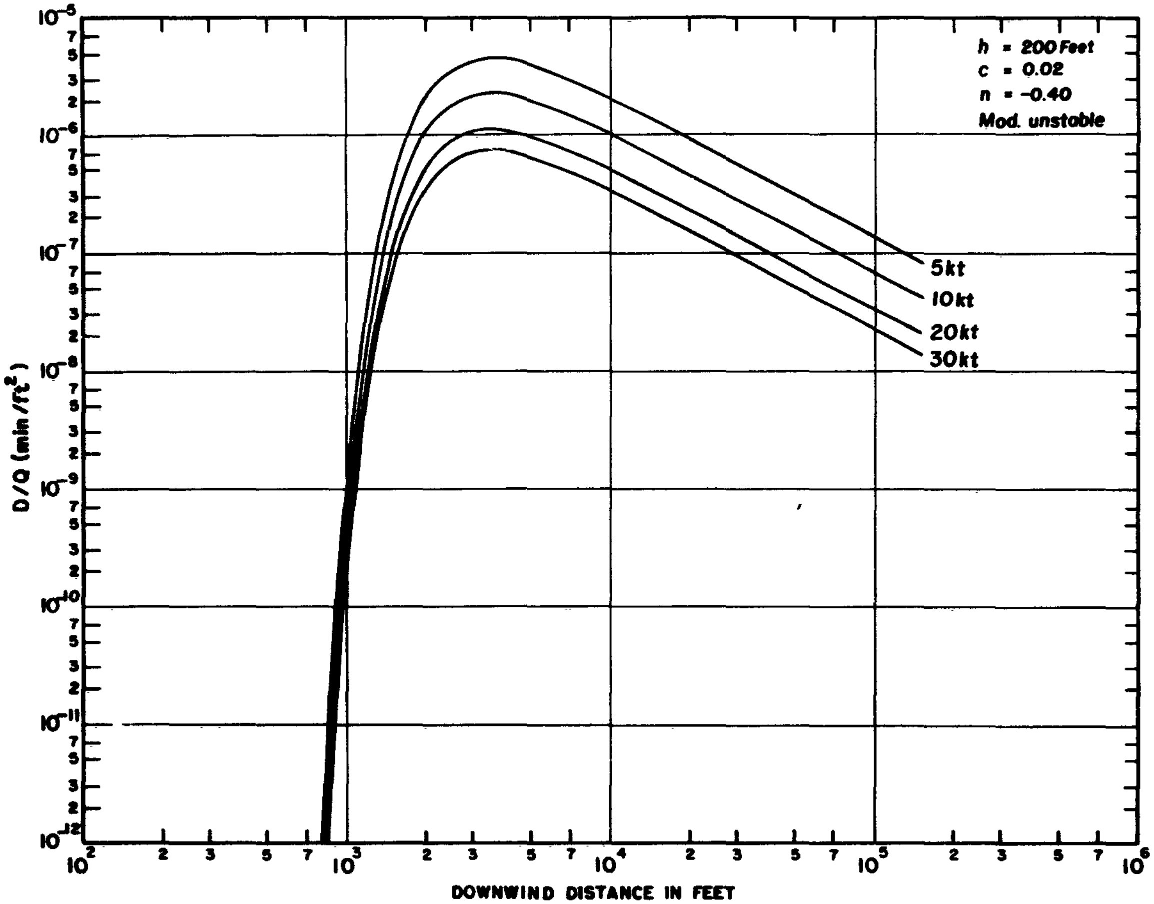
Mod. unstable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A13


h = 200 Feet
c = 0.02
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Mod. unstable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A14

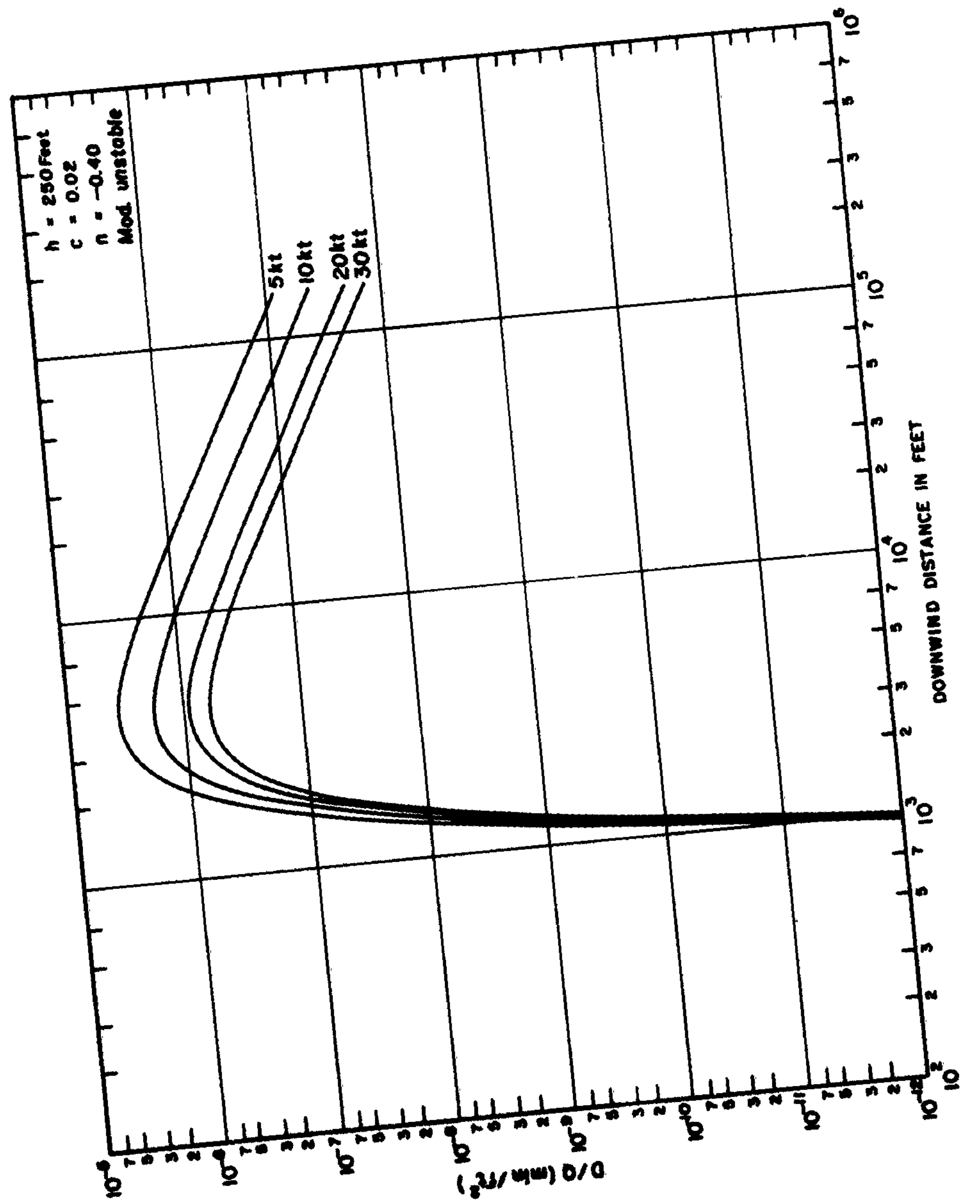

h = 250 Feet
c = 0.02
n = −0.40
Mod. unstable
5kt
10kt
20kt
30kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A15

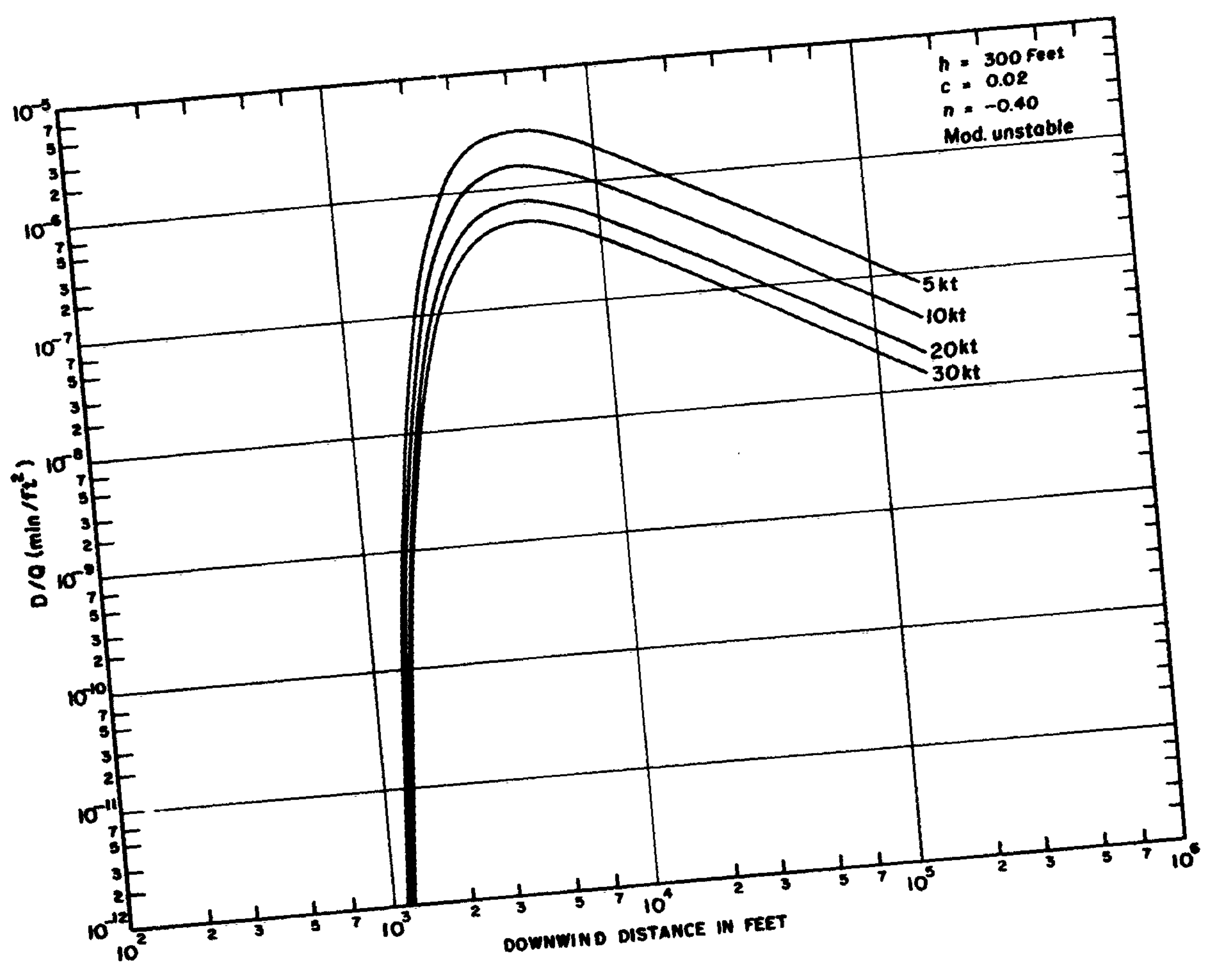

h = 300 Feet
c = 0.02
n = -0.40
Mod. unstable
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A16

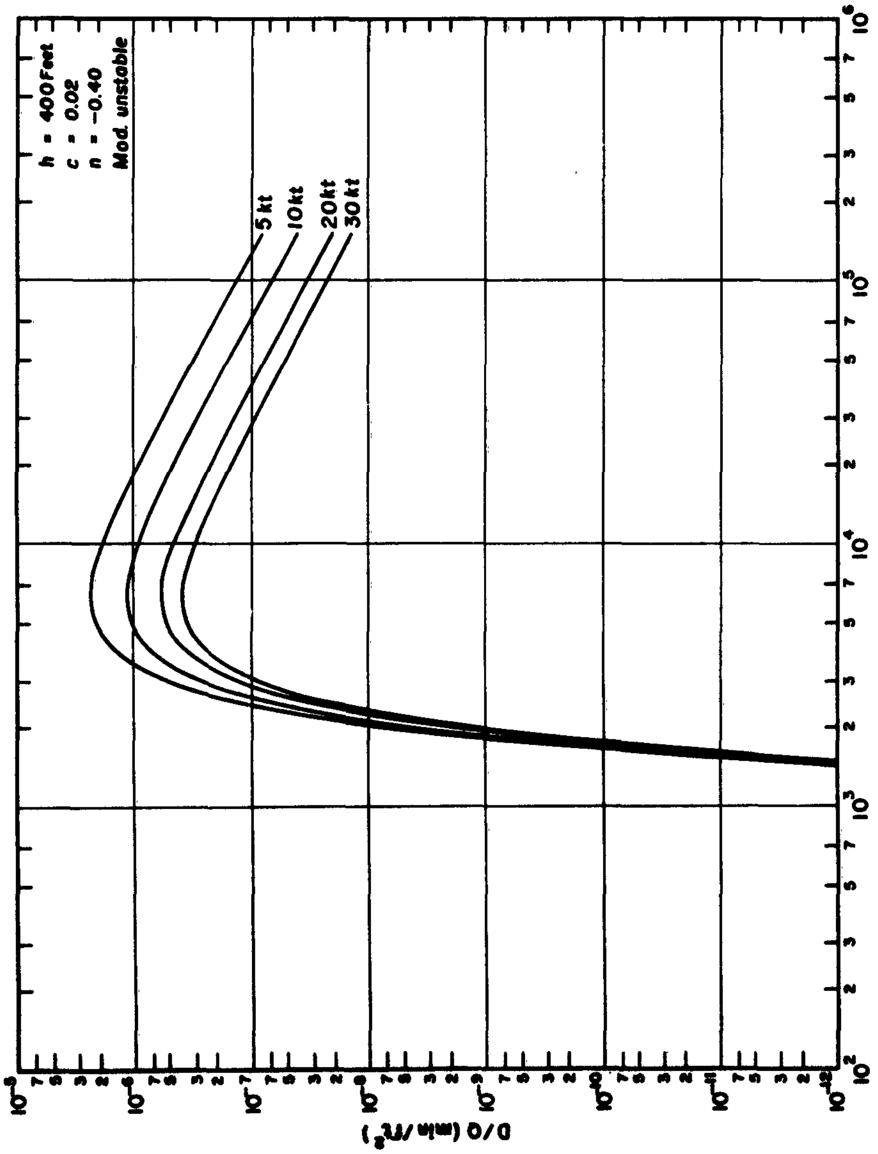
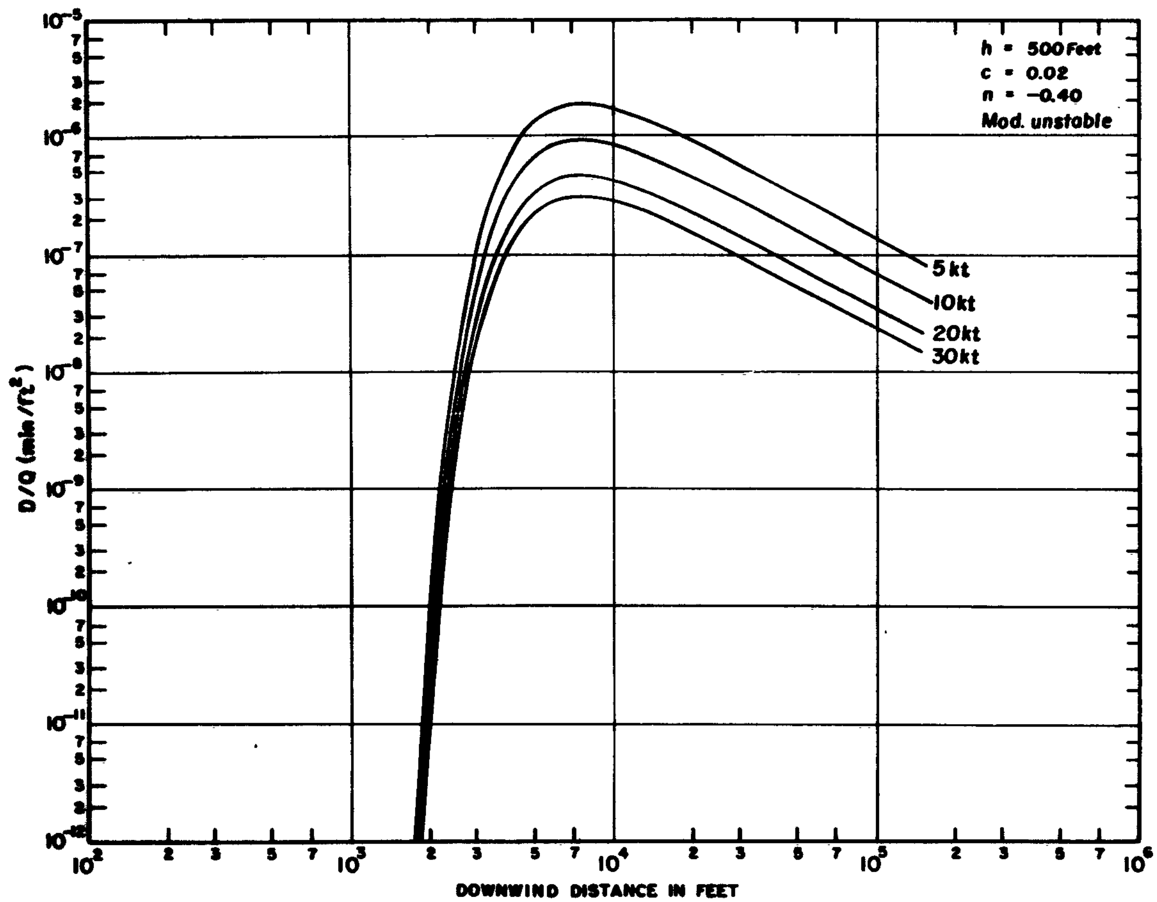

h = 400 Feet
c = 0.02
n = −0.40
Mod. unstable
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A17



h = 500 Feet
c = 0.02
n = −0.40
Mod. unstable
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A18

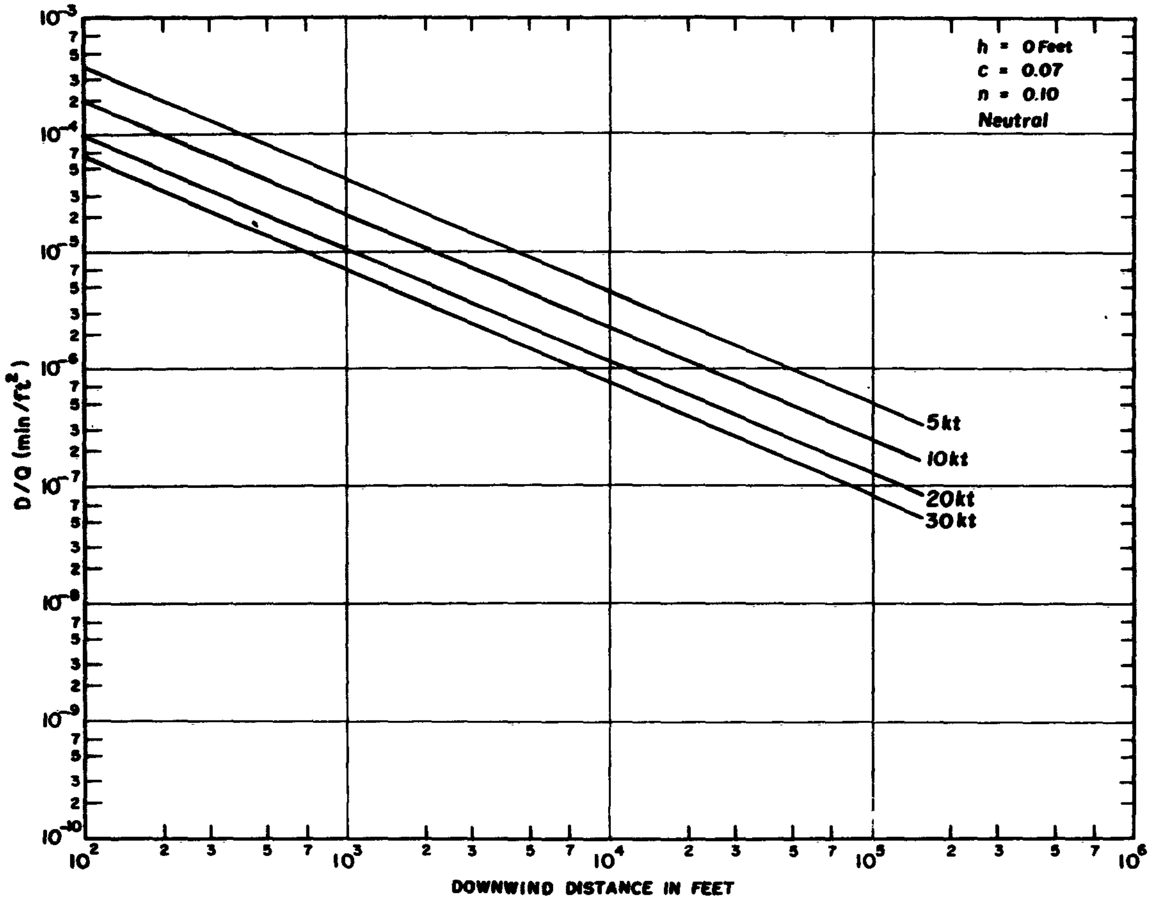
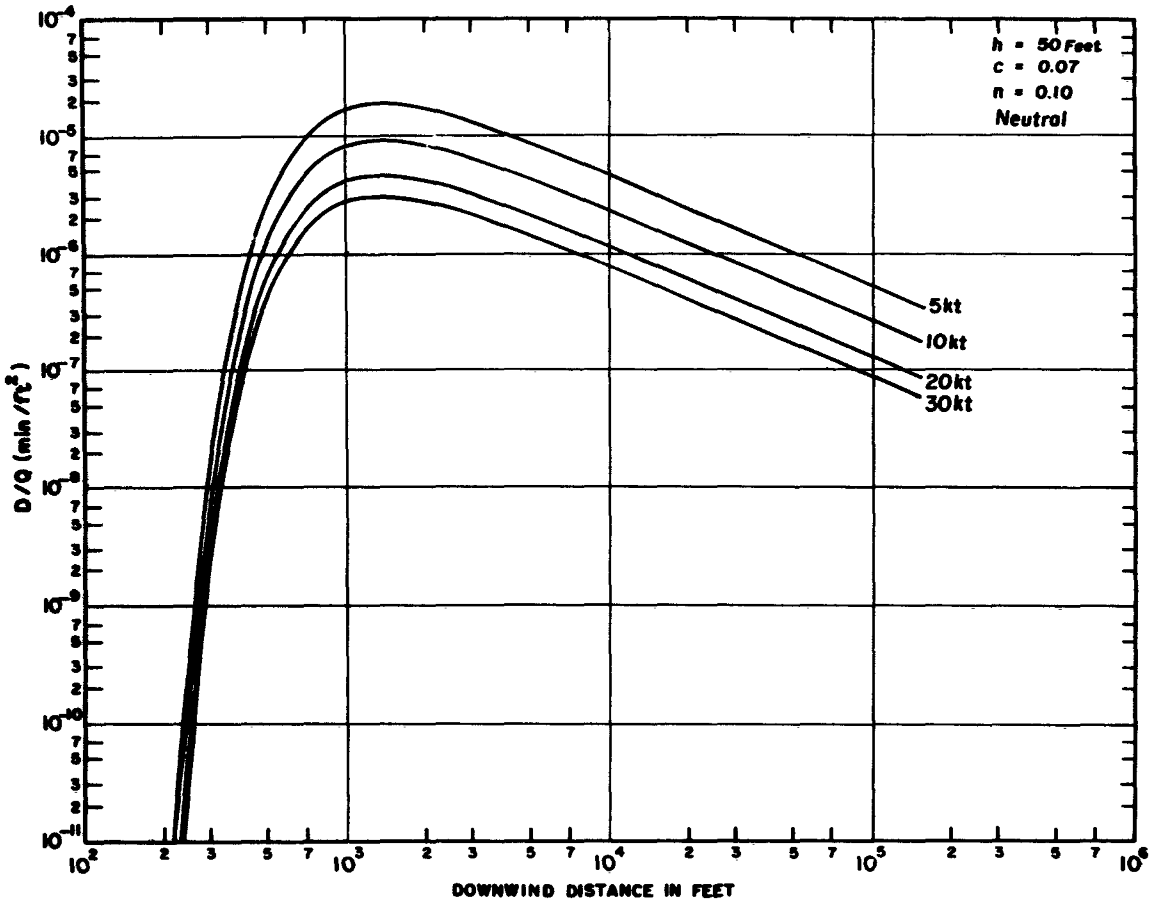

h = 0 Feet
c = 0.07
n = 0.10
Neutral
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A19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Neutral
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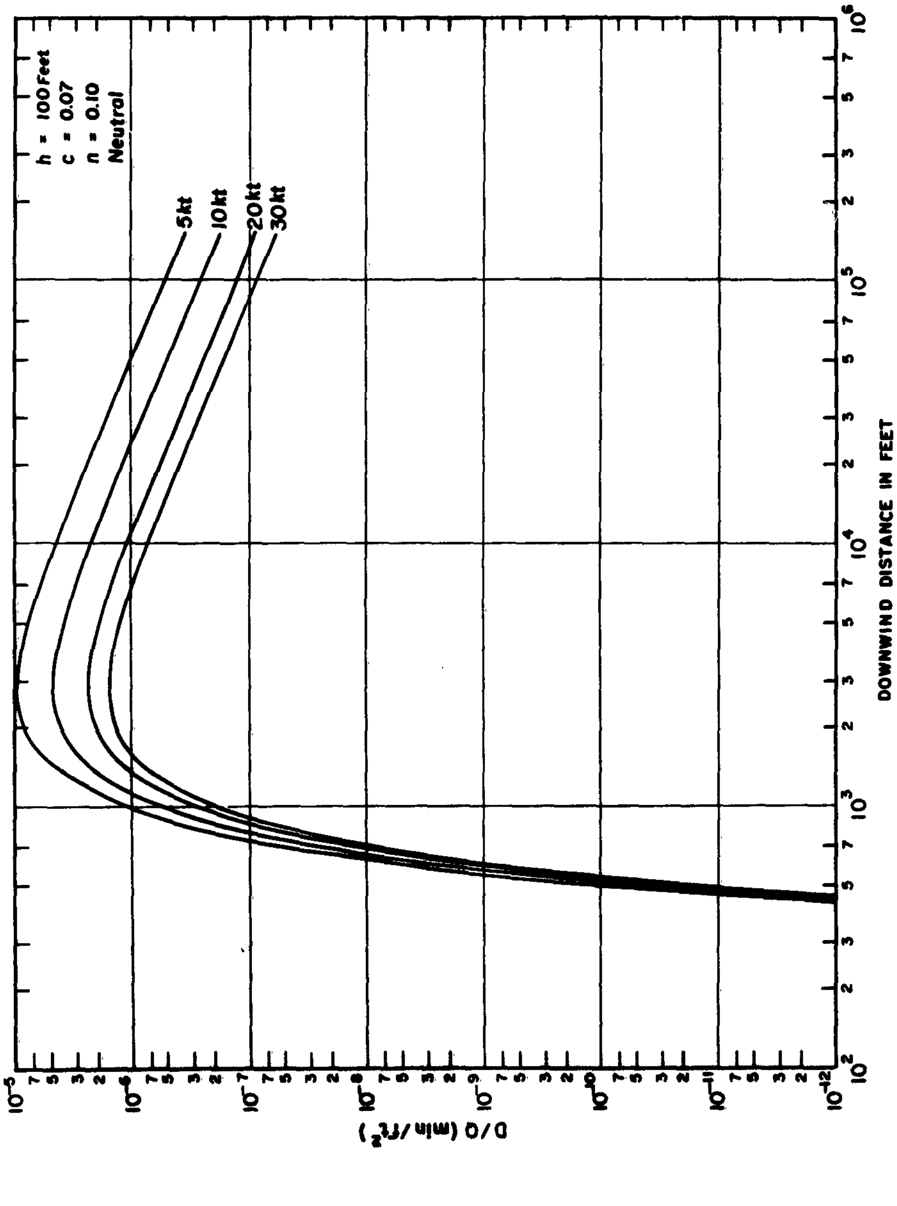
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A20


h = 100 Feet
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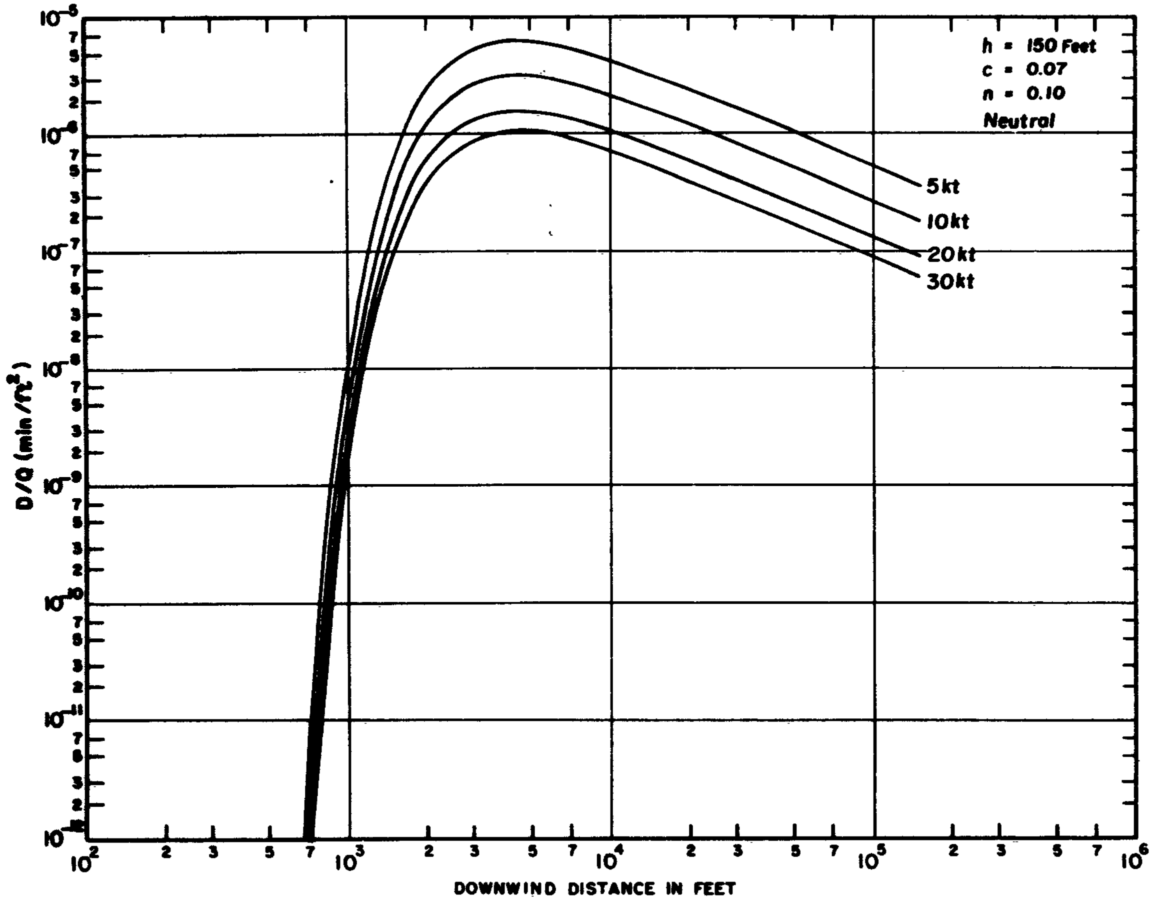
Neutral
5kt
10kt
20kt
30kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A21



h = 150 Feet
c = 0.07
n = 0.10
Neutral
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A22

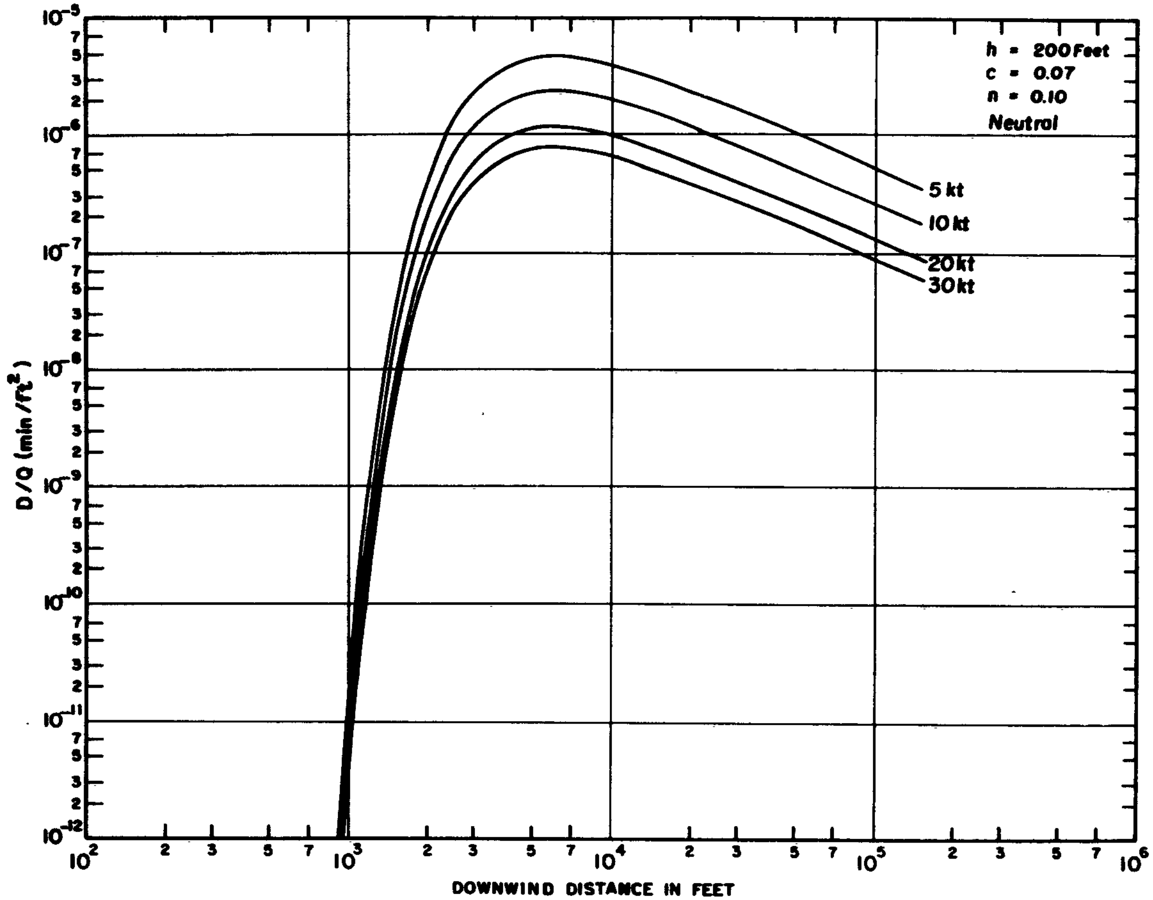

h = 200 Feet
c = 0.07
n = 0.10
Neutral
5 kt
10 kt
20 kt
30 kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A23

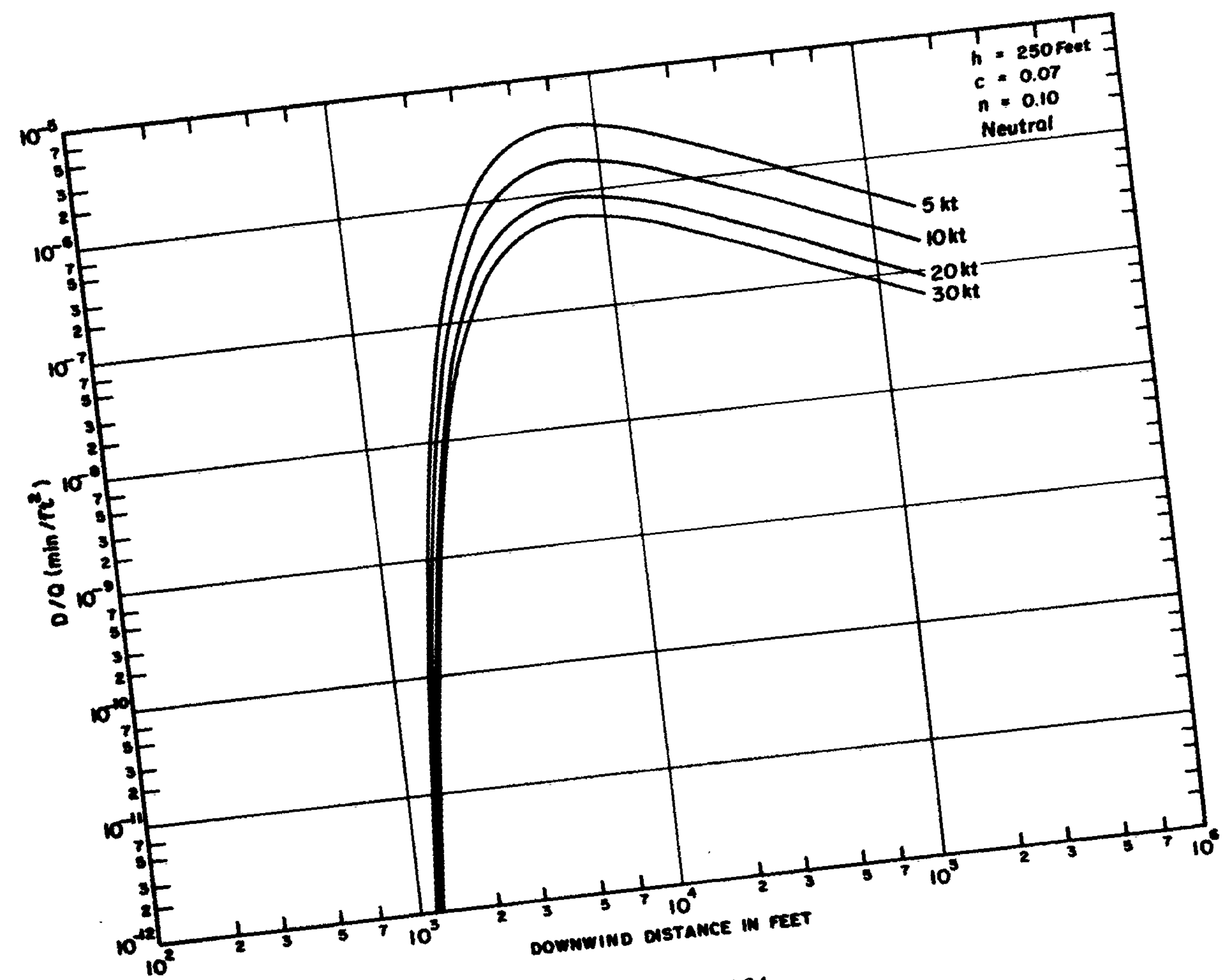

h = 250 Feet
c = 0.07
n = 0.10
Neutral
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A24

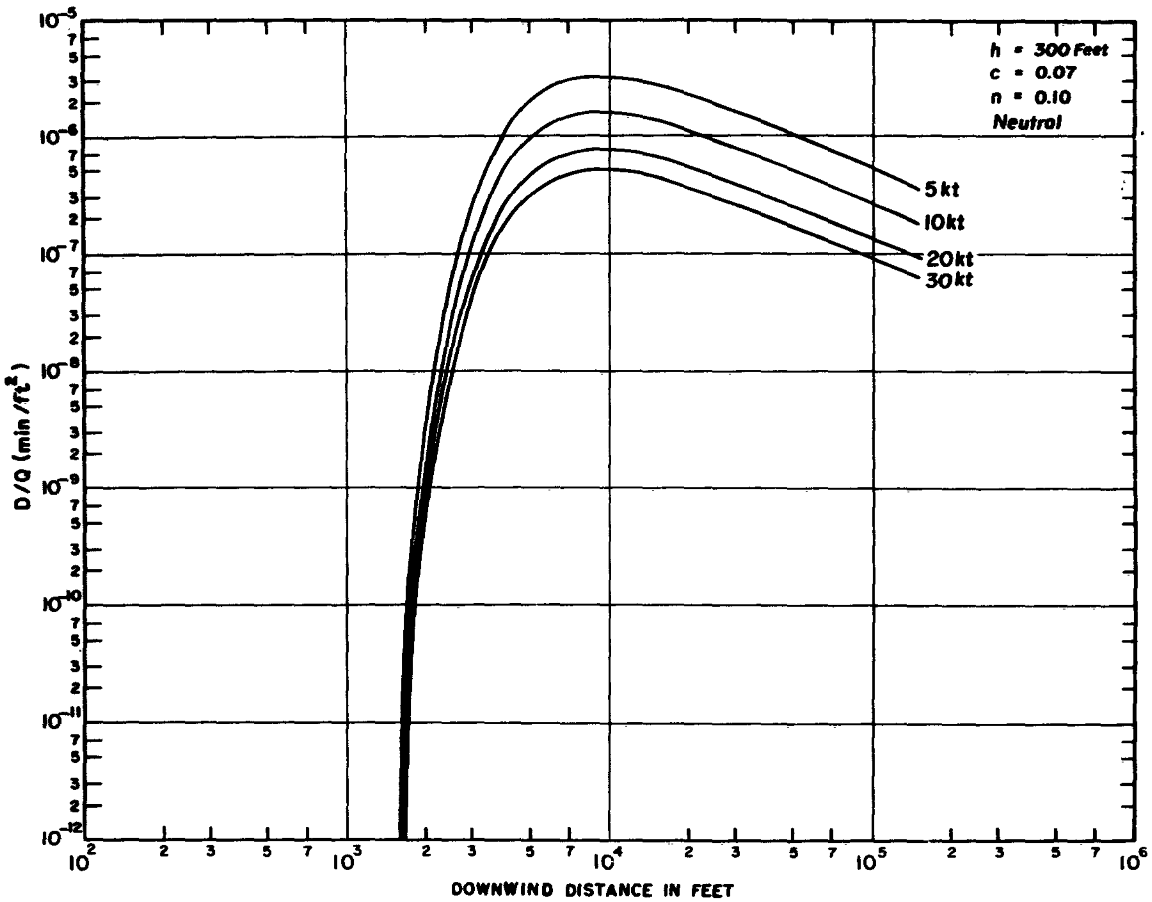

h = 300 Feet
c = 0.07
n = 0.10
Neutral
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A25

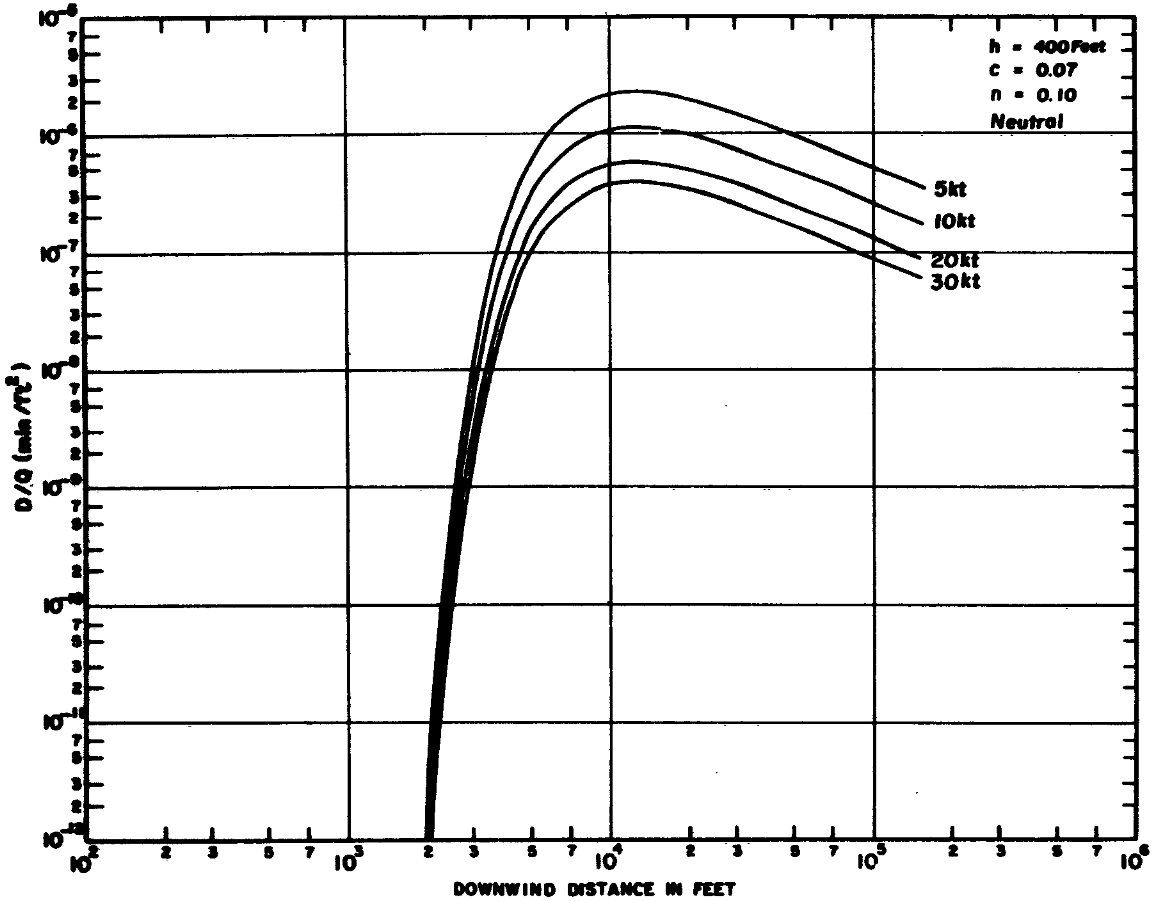

h = 400 Feet
c = 0.07
n = 0.10
Neutral
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A26

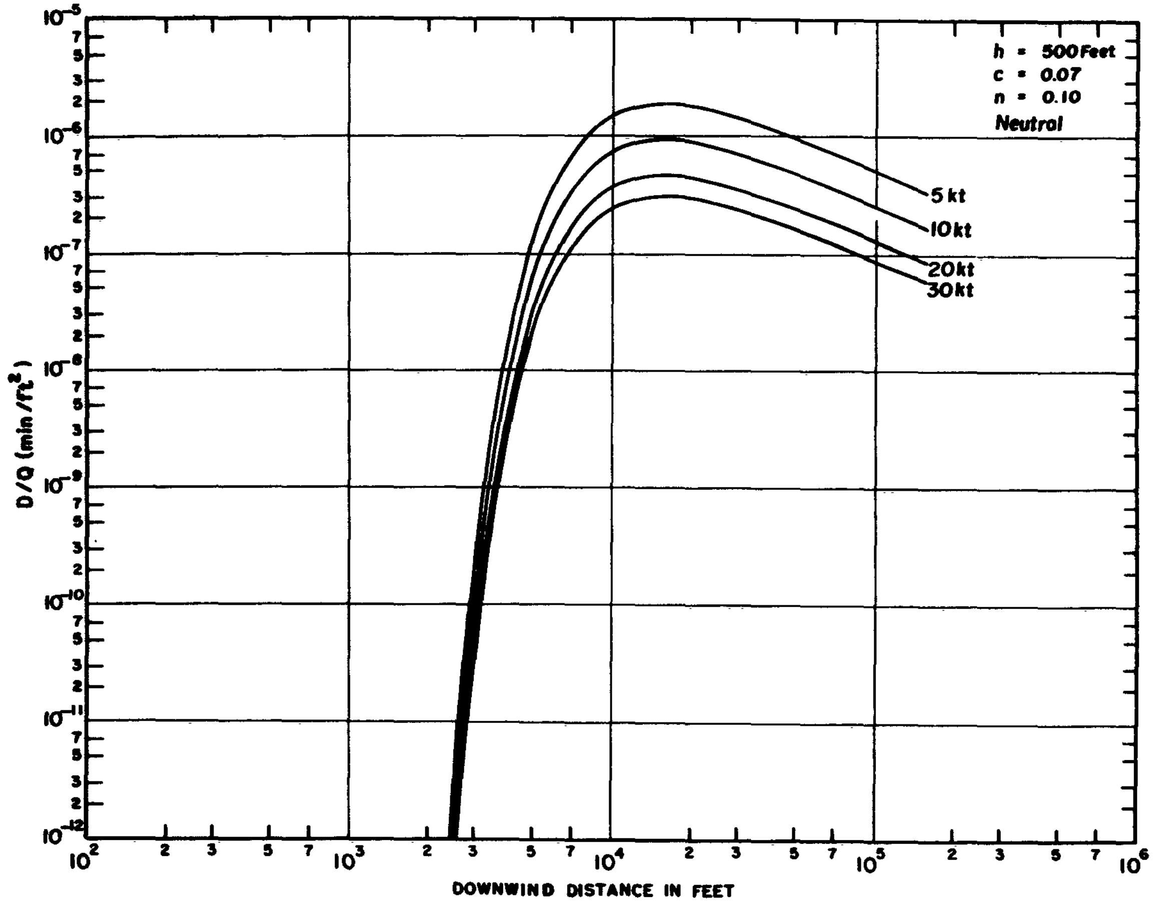

h = 500 Feet
c = 0.07
n = 0.10
Neutral
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A27

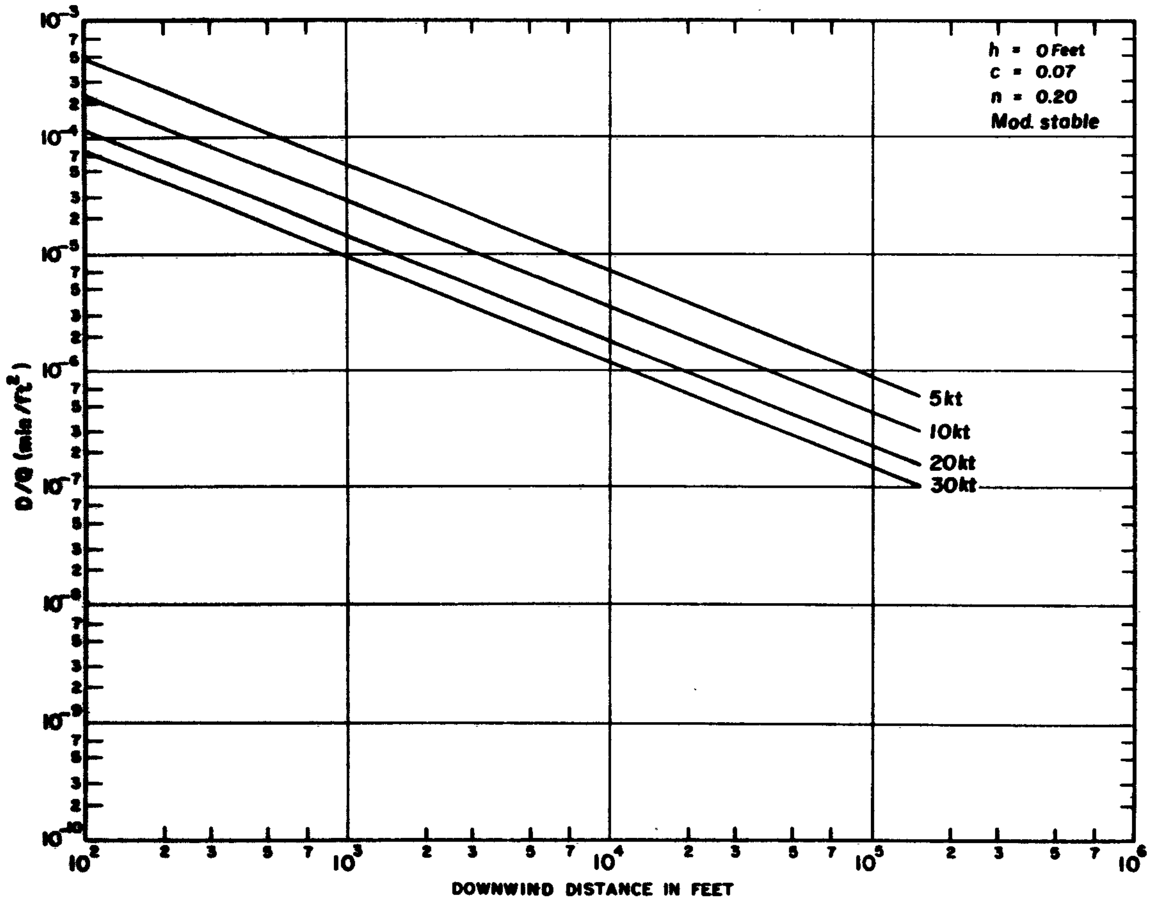

h = 0 Feet
c = 0.07
n = 0.20
Mod. stable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A28

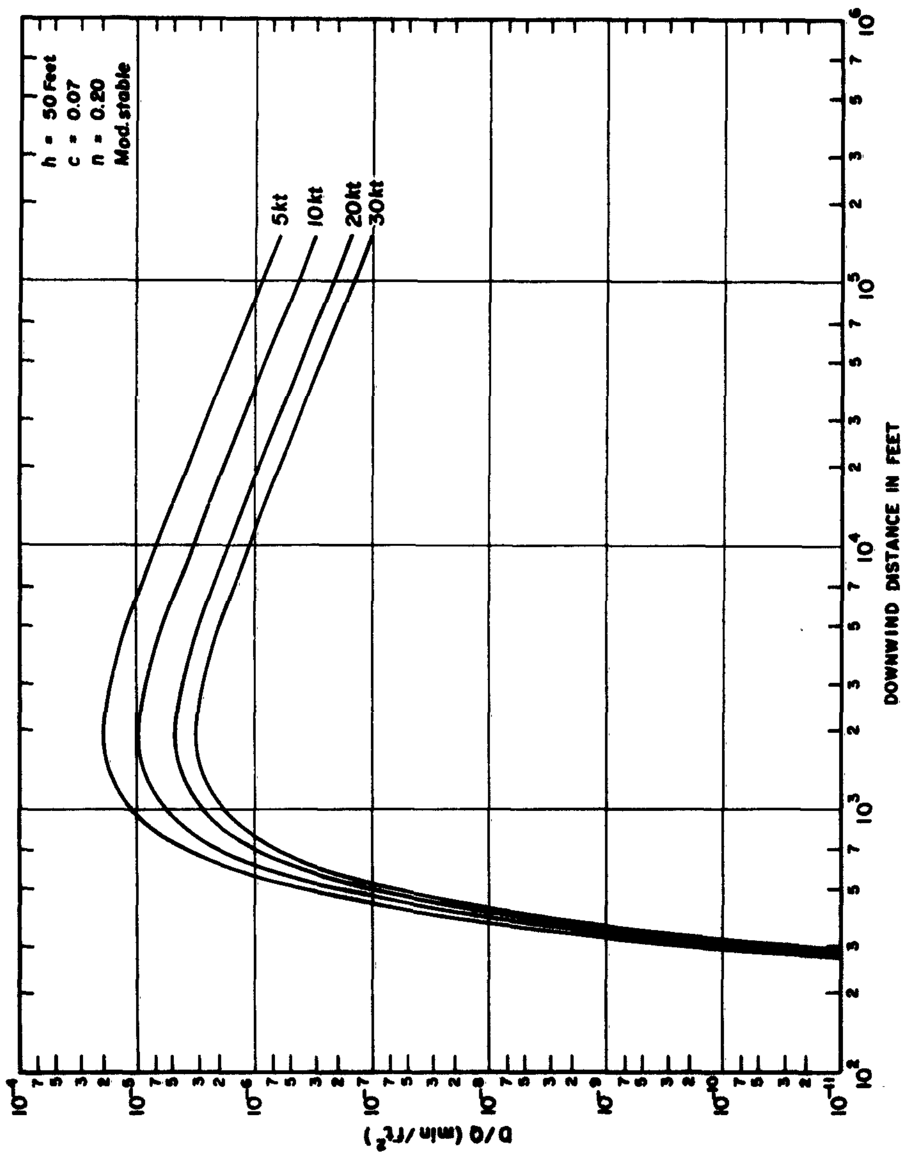

h = 50 Feet
c = 0.07
n = 0.20
Mod. stable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A29

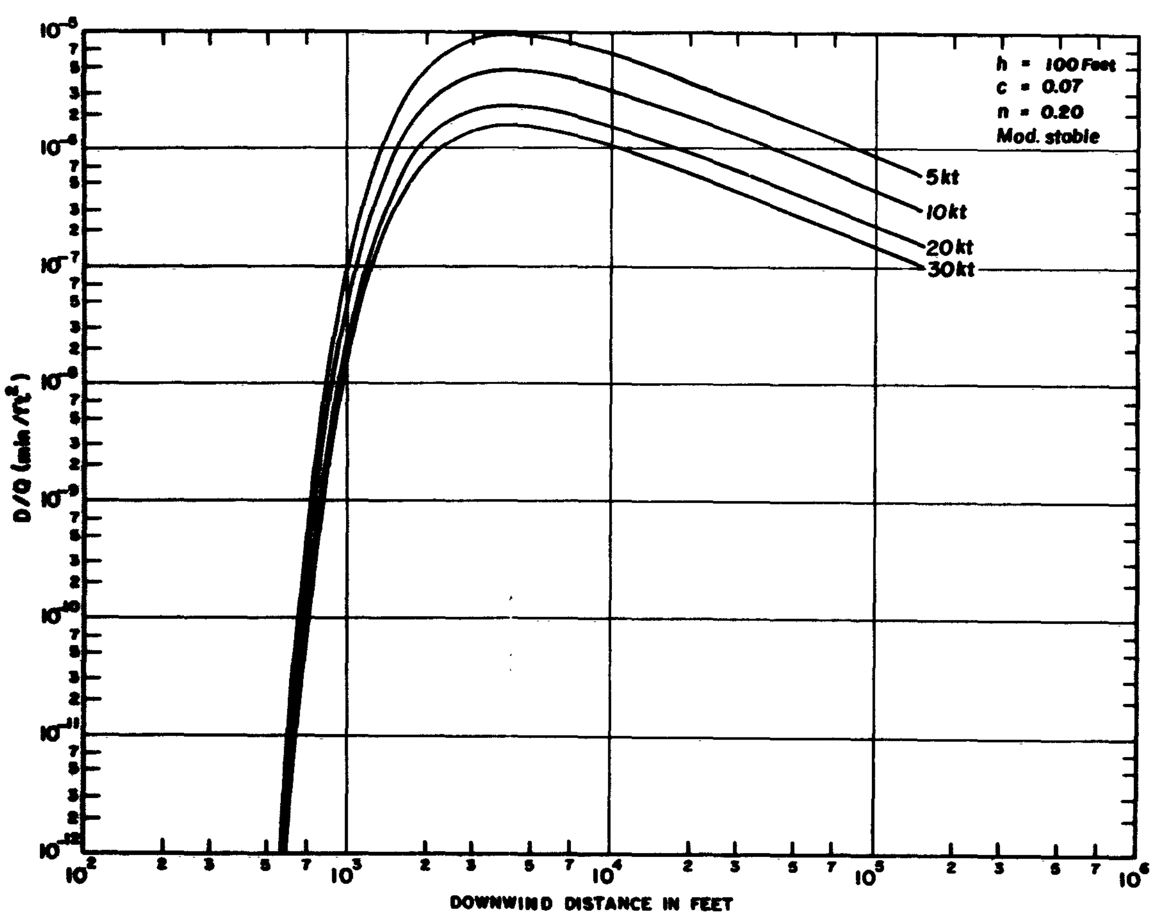

h = 100 Feet
c = 0.07
n = 0.20
Mod. stable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A30

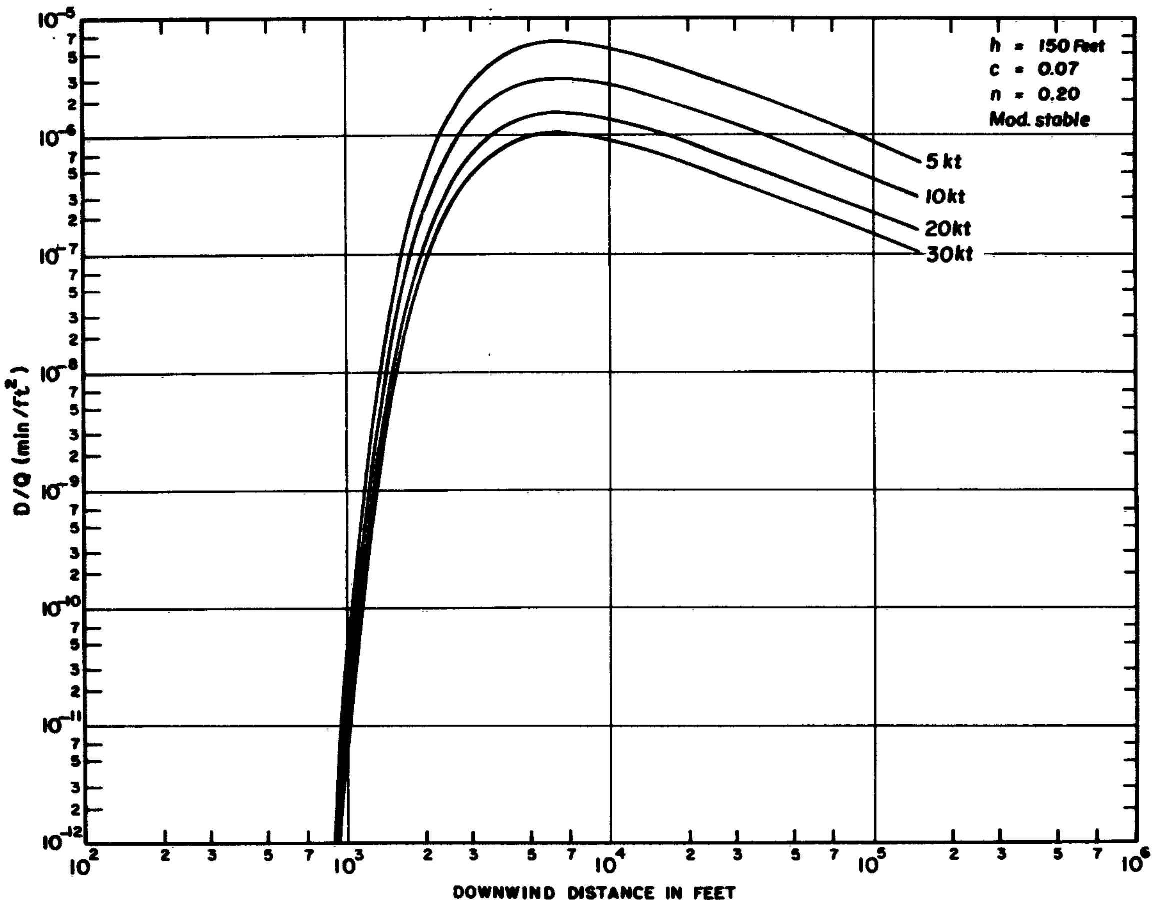

h = 150 Feet
c = 0.07
n = 0.20
Mod. stable
5 kt
10kt
20kt
30kt
D/Q (min/ft^2)
DOWNWIND DISTANCE IN FEET
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{2}
10^{3}
10^{4}
10^{5}
10^{6}

Figure A31

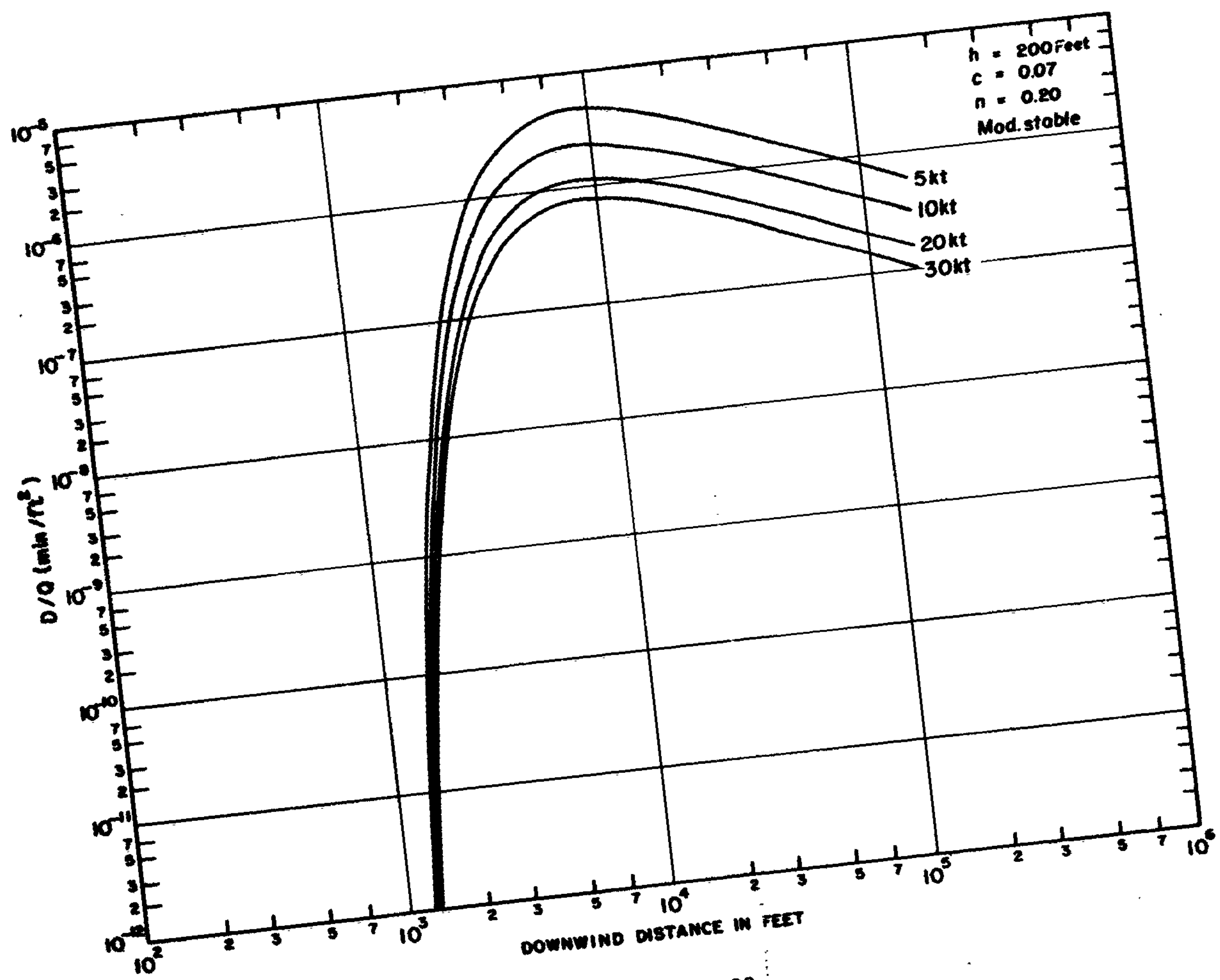

h = 200 Feet
c = 0.07
n = 0.20
Mod. stable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A32

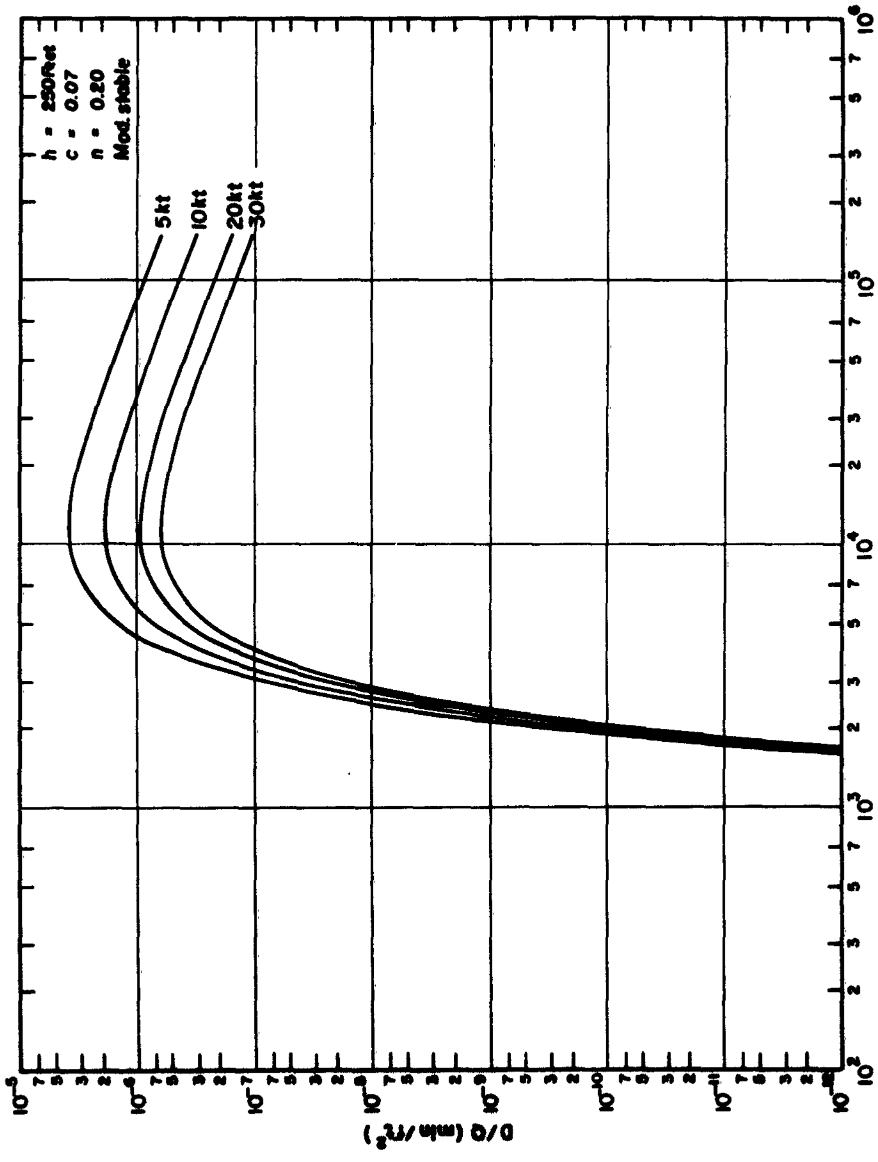
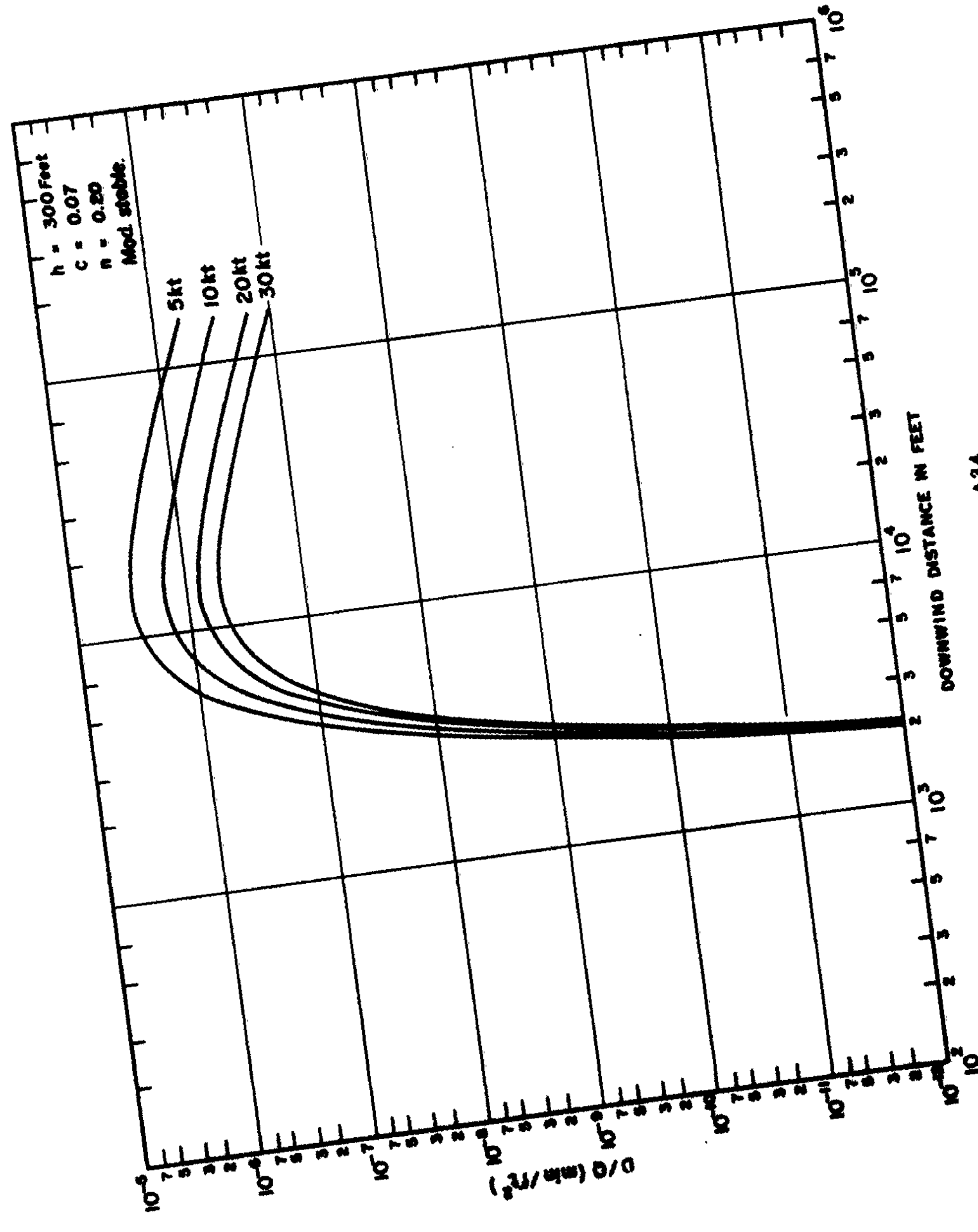

h = 250 feet
c = 0.07
n = 0.20
Mod. stable
5kt
10kt
20kt
30kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A33



h = 300 Feet
c = 0.07
n = 0.20
Mod. stable.
5kt
10kt
20kt
30kt
DOWNWIND DISTANCE IN FEET

Figure A34

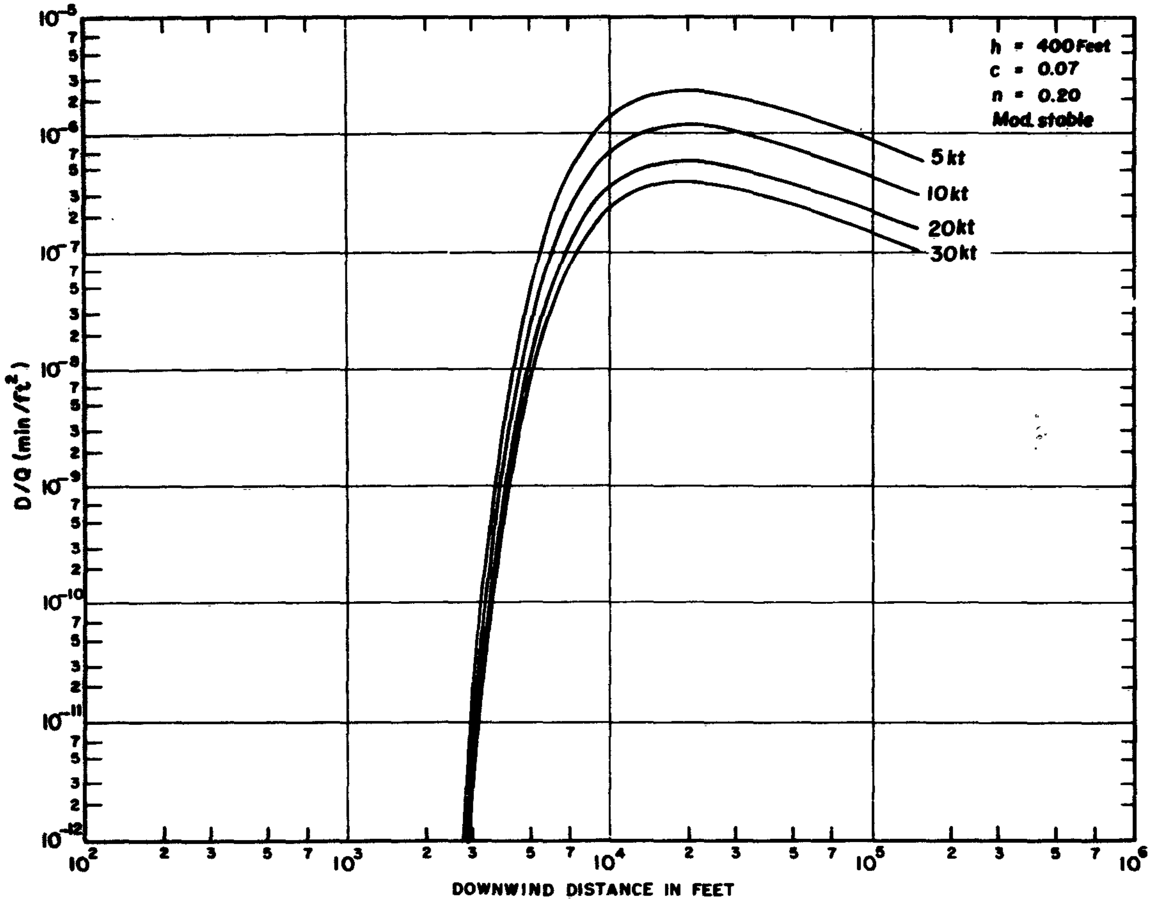

h = 400 Feet
c = 0.07
n = 0.20
Mod. stable
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A35

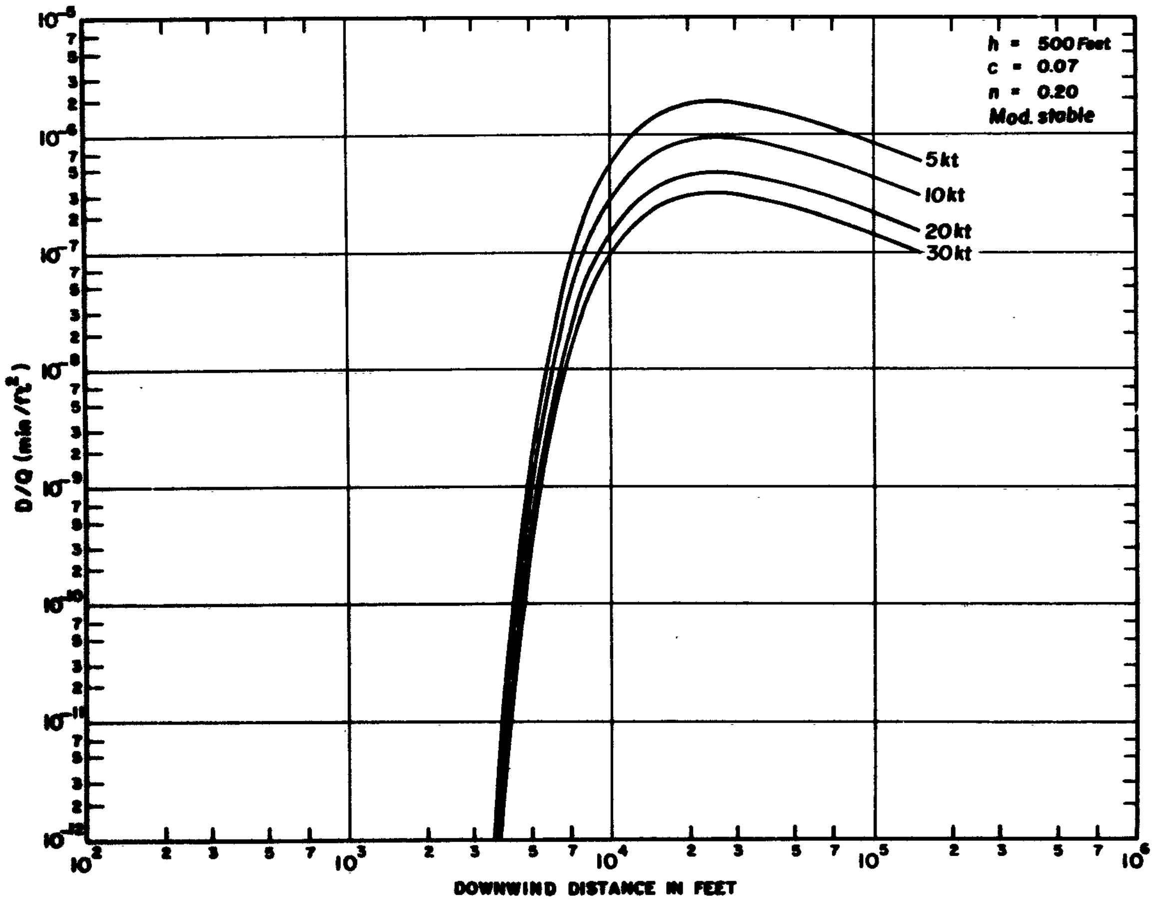

h = 500 Feet
c = 0.07
n = 0.20
Mod. stable
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A36

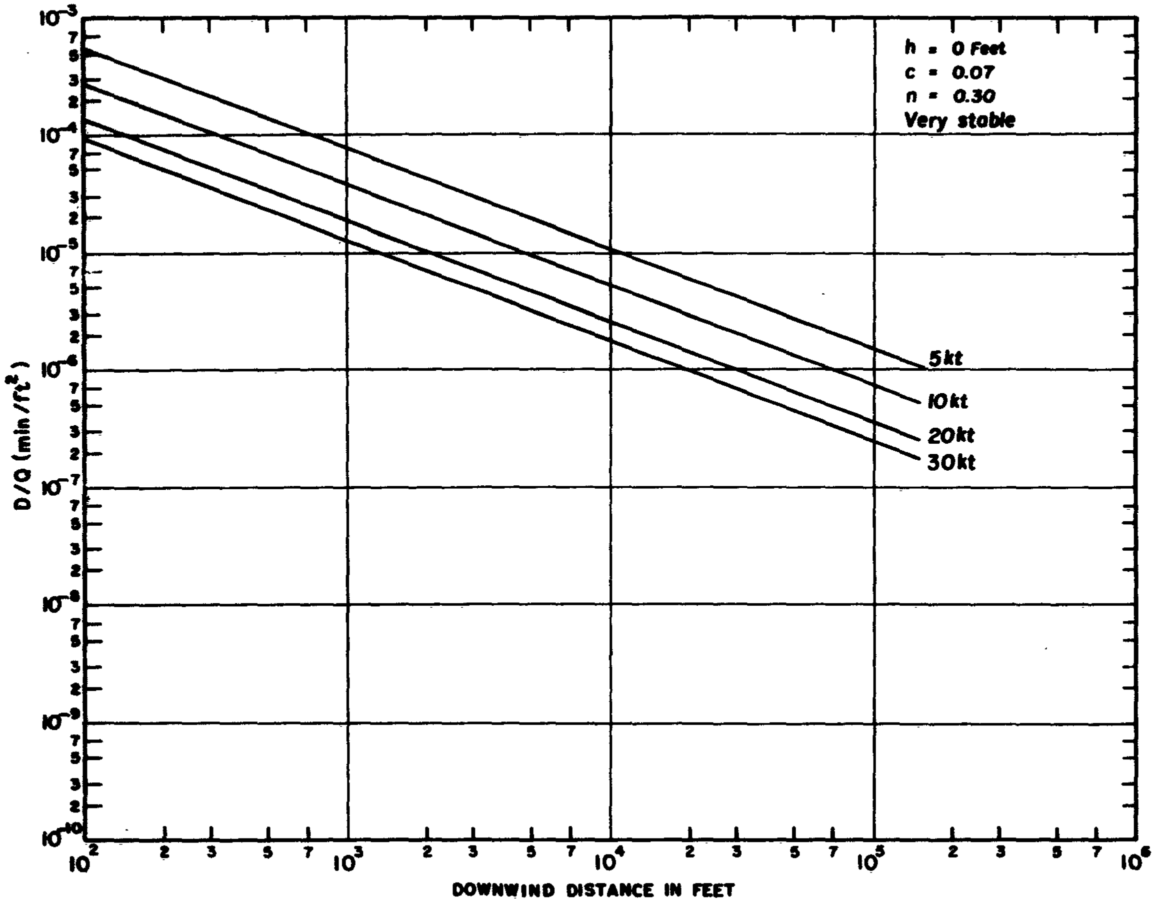

h = 0 Feet
c = 0.07
n = 0.30
Very stable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A37

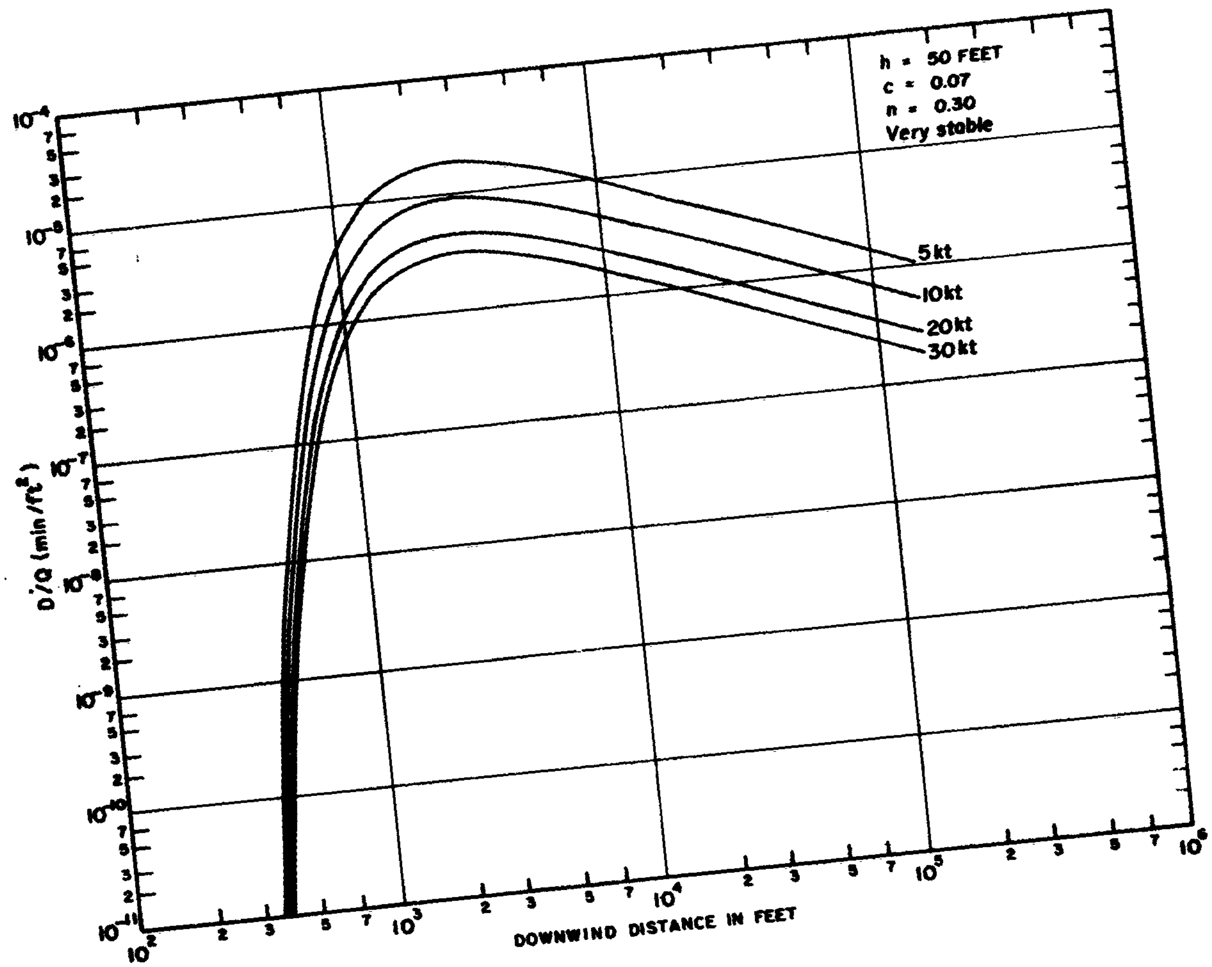

h = 50 FEET
c = 0.07
n = 0.30
Very stable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A38

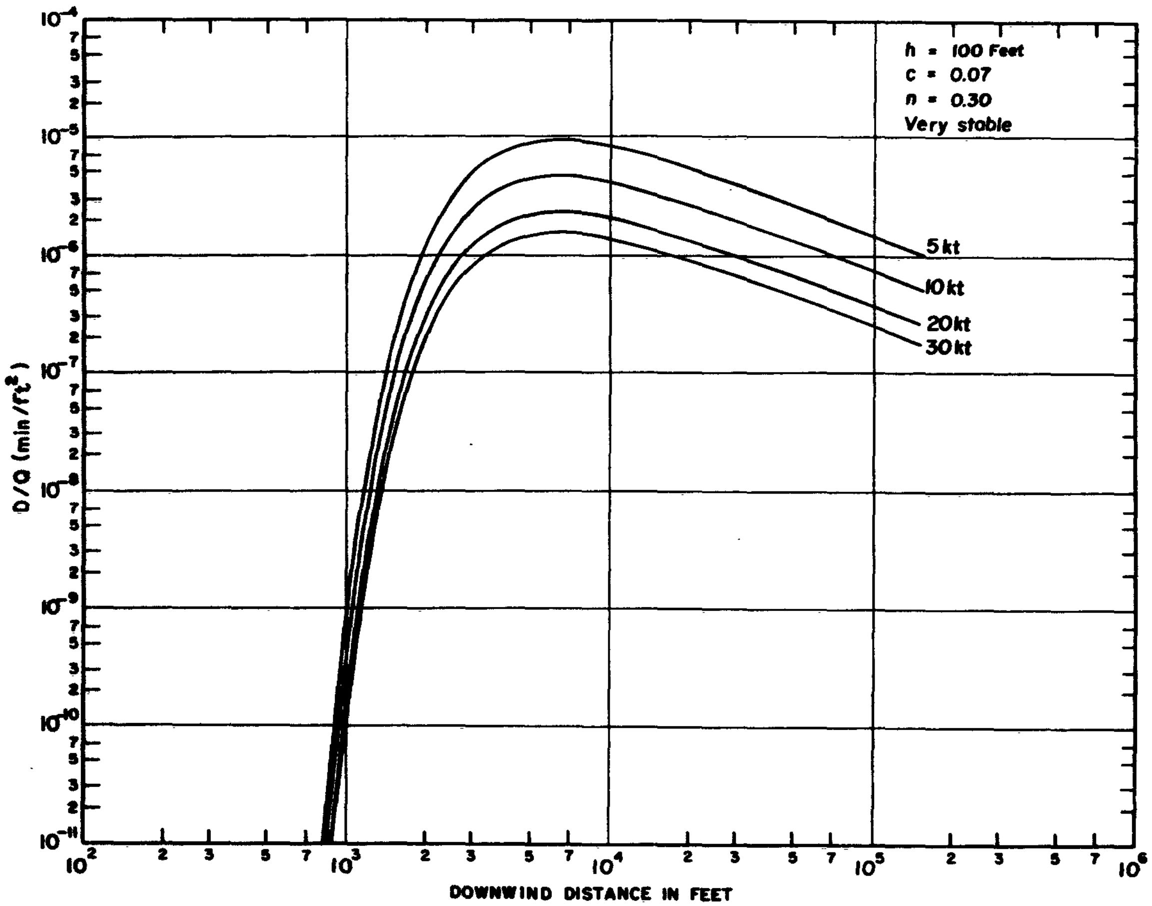

h = 100 Feet
c = 0.07
n = 0.30
Very stable
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A39

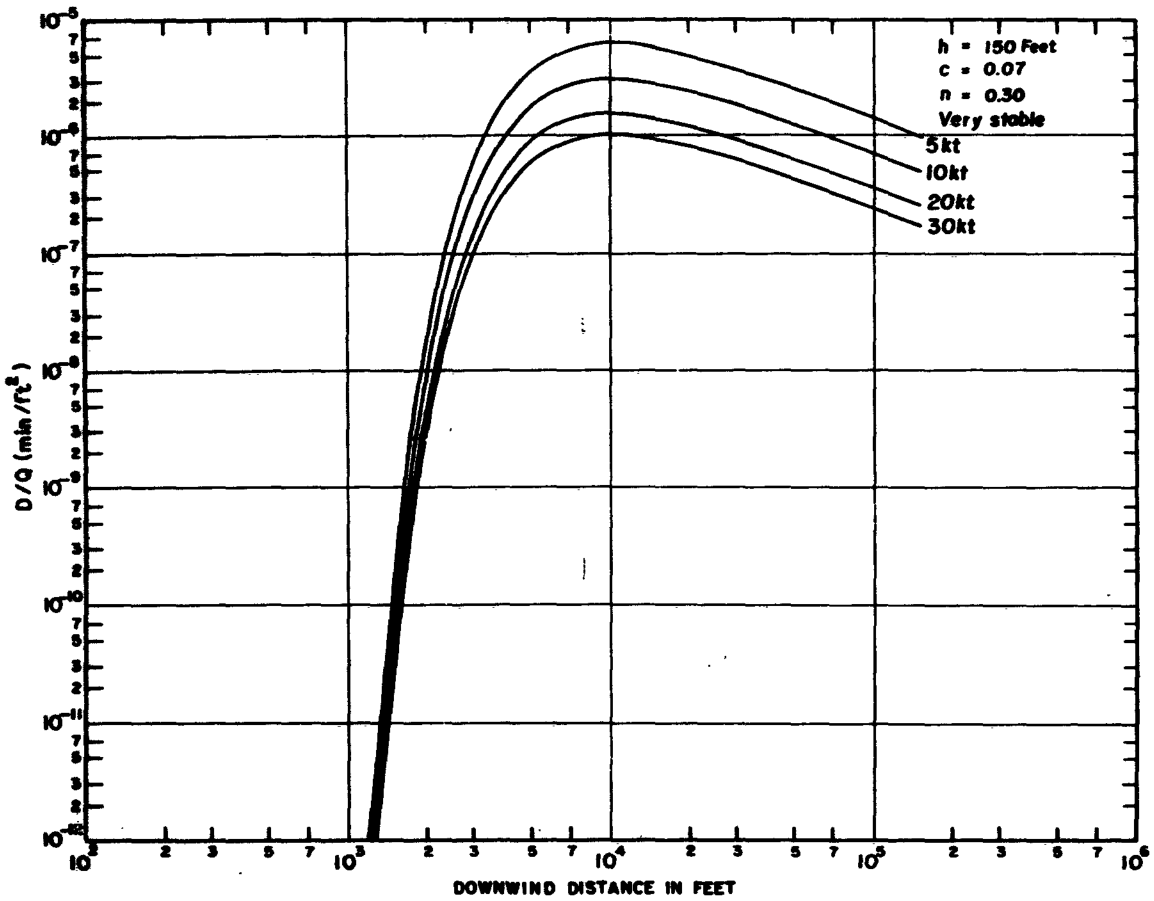

h = 150 Feet
c = 0.07
n = 0.30
Very stable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A40

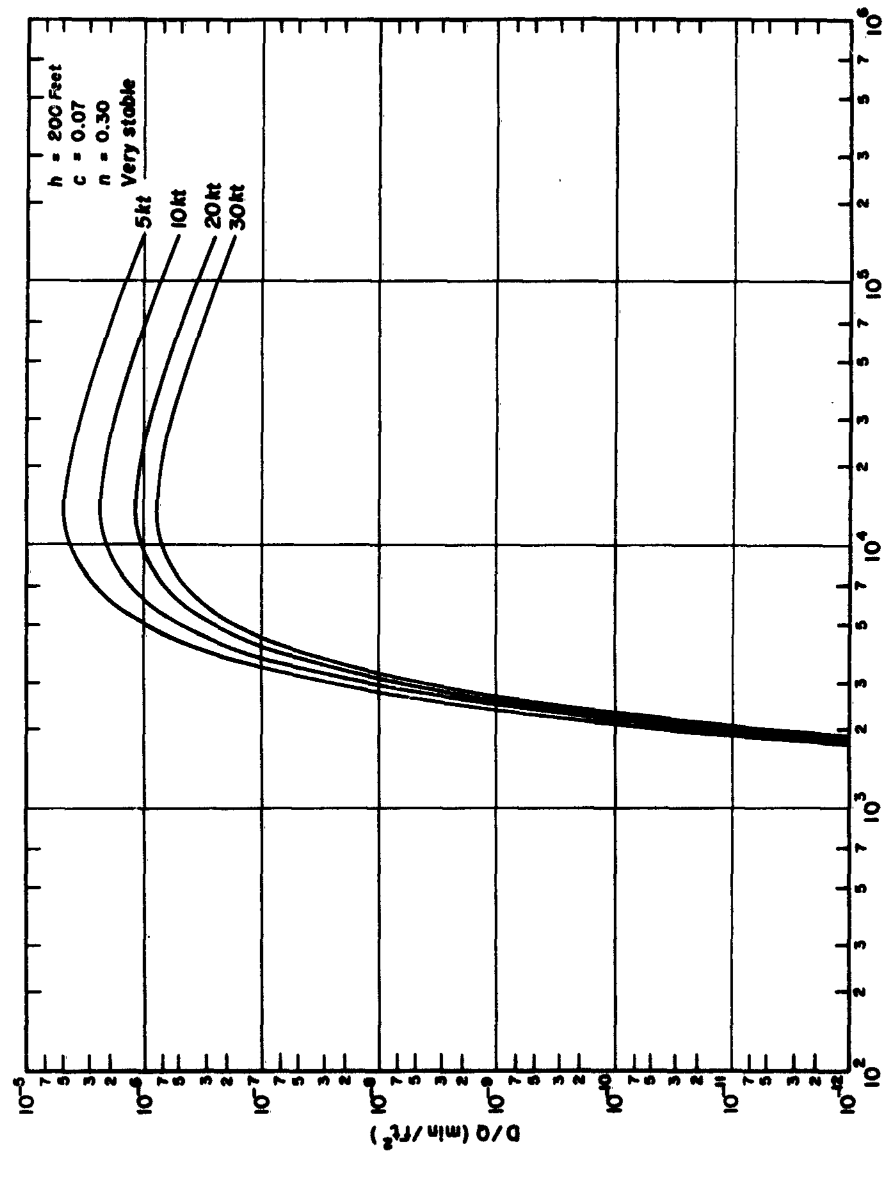

h = 200 Feet
c = 0.07
n = 0.30
Very stable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A41

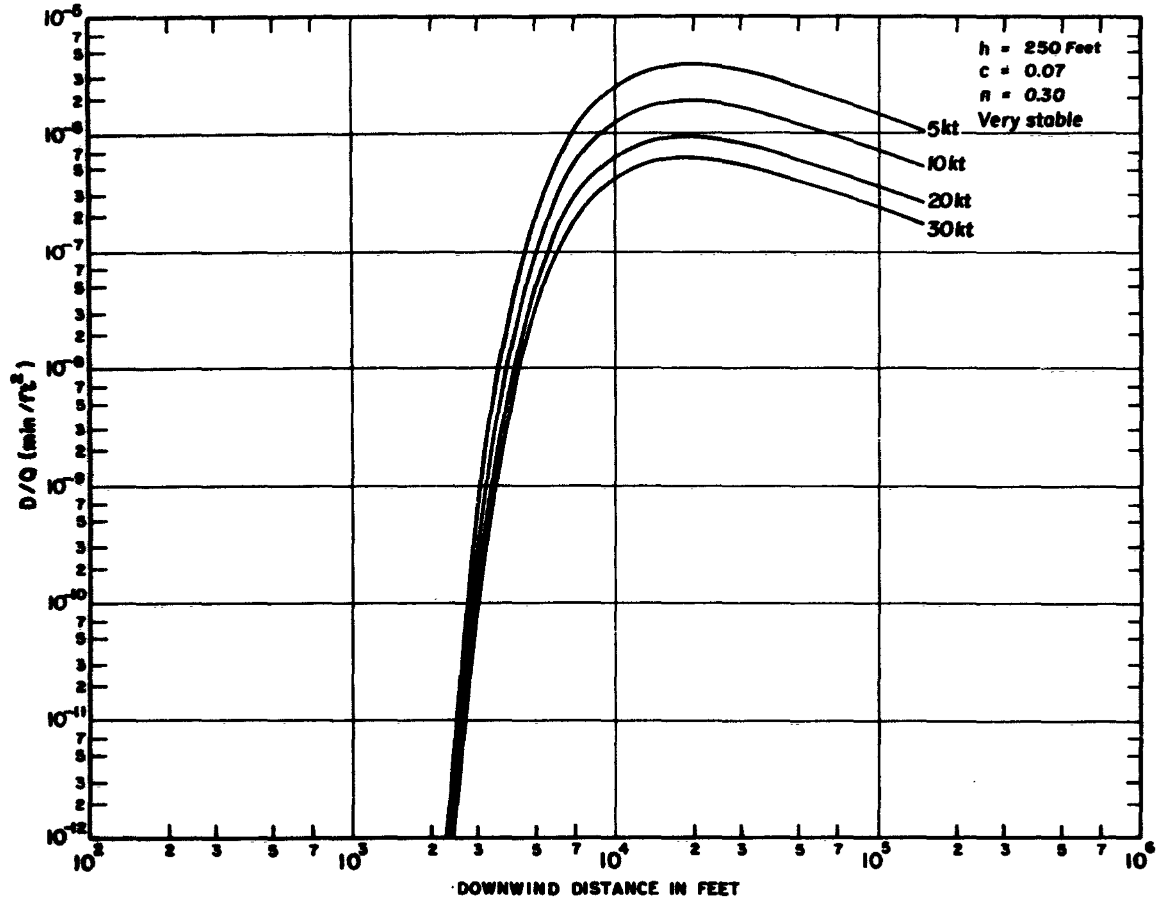

h = 250 Feet
c = 0.07
n = 0.30
Very stable
5kt
10kt
20kt
30kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A42

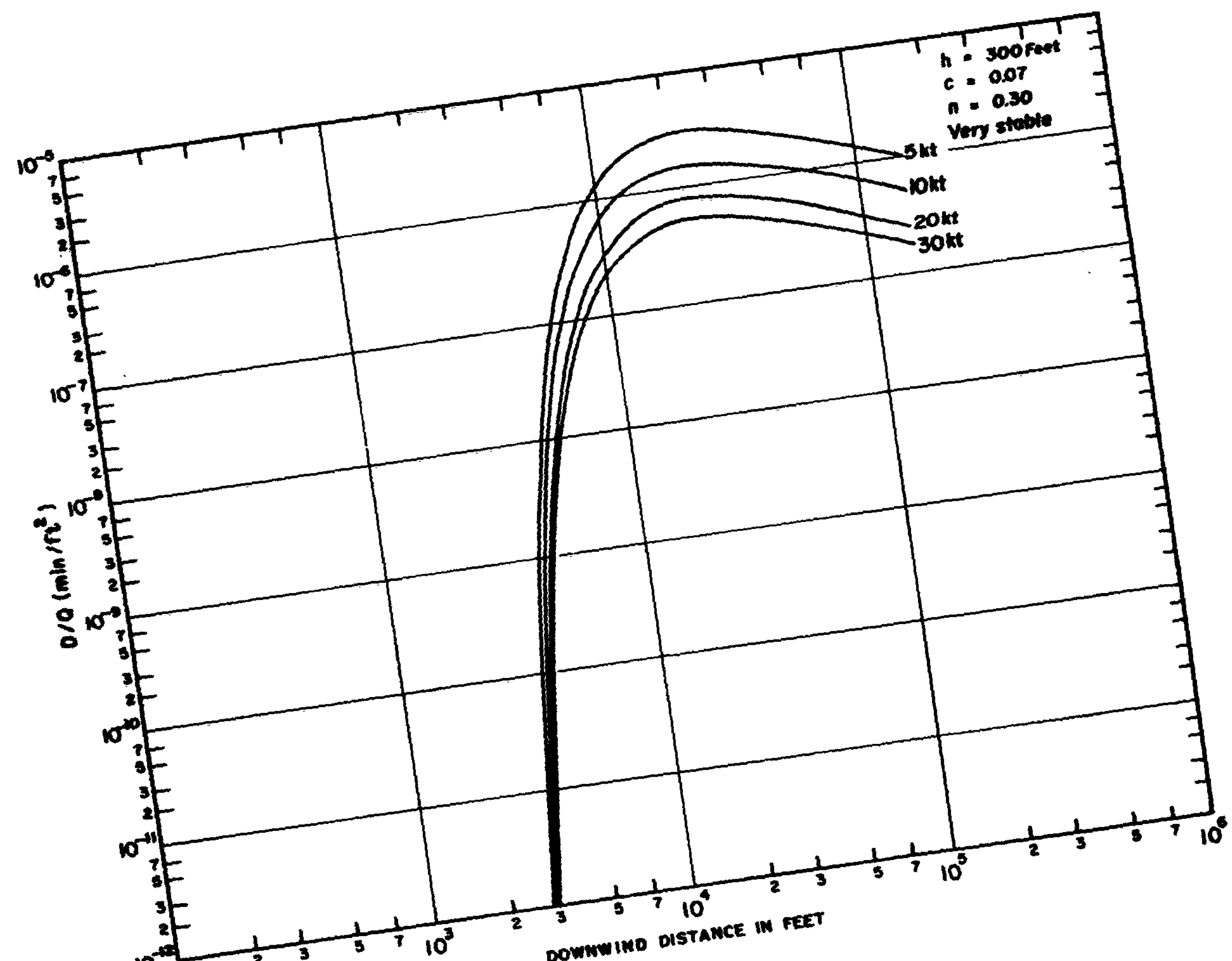

h = 300 Feet
c = 0.07
n = 0.30
Very stable
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A43

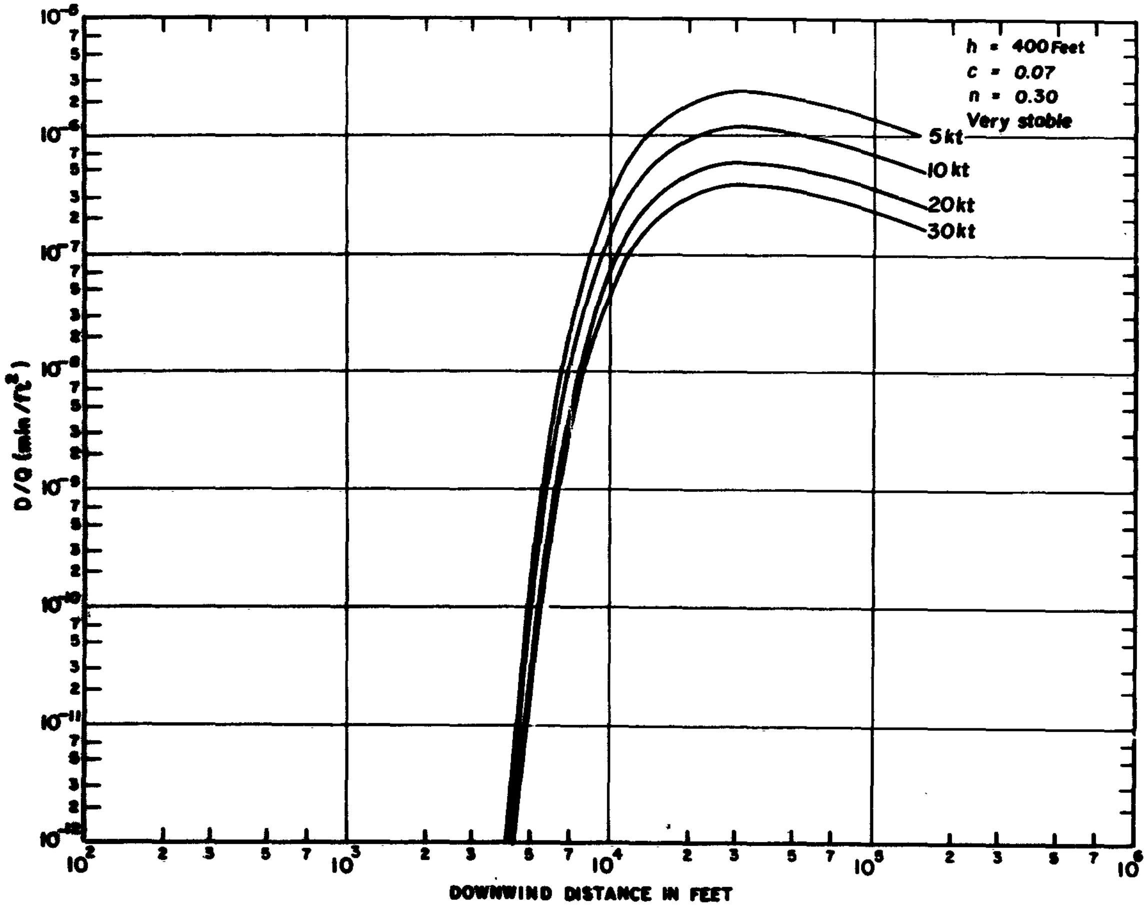

h = 400 Feet
c = 0.07
n = 0.30
Very stable
5 kt
10 kt
20 kt
30 kt
D/Q (min/ft²)
DOWNWIND DISTANCE IN FEET

Figure A44

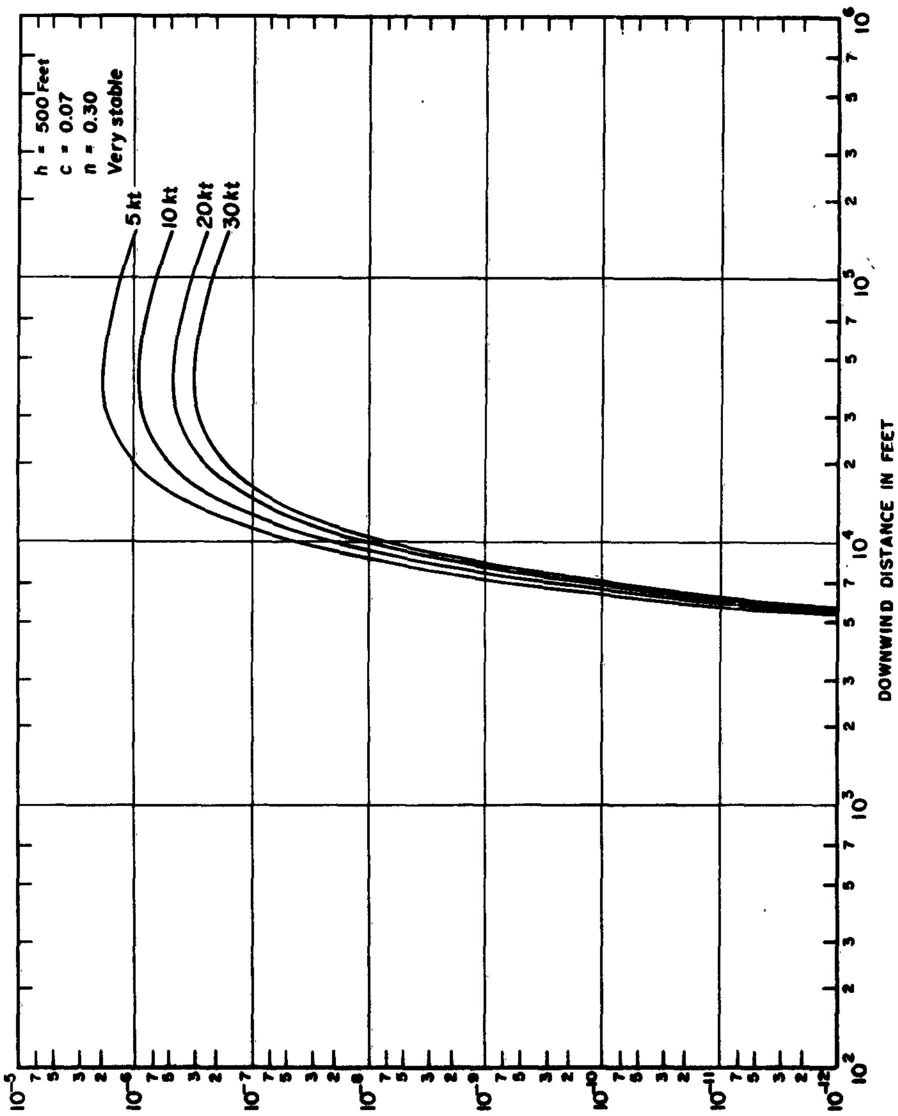

h = 500 Feet
c = 0.07
n = 0.30
Very stable
5 kt
10 kt
20 kt
30 kt
DOWNWIND DISTANCE IN FEET
D/Q (min/ft²)

Figure A45

Appendix B

As an example of how the graphs presented here might be used in planning a particular operation, let us consider the following problem. Assume that a grid of samplers has been laid out in, say, a square area 1 mile on a side. Also assume that a line source 200 feet above the surface is to be emitted in moderately unstable conditions. It is, of course, desired that the maximum dosage be found within the array of samplers. The first problem may be to determine how far from the edge of the grid the line should be laid down so that the maximum will be within the grid. Assuming the wind direction is parallel to one of the sides of the grid, we would first check the appropriate graph in Appendix A. The graph for a moderately unstable condition and a release height of 200 feet gives a maximum about 3500 feet from the release. To be fairly sure we have found the maximum, it appears that we should release even farther back. Therefore, a release about 1 mile from the downwind edge would be indicated.

The next problem would be to determine the length of the release line. The value of x has already been set at 1 mile. Figure 2 indicates that, for moderately unstable conditions, the value of $L-L_o$ should be about 1750 feet. Since we would like to ensure that a significant number of samplers, at the farthest distance from the source, are sampling in conditions that simulate an infinite line source, a value of L_o equal to 1/2 mile or 2600 feet would be appropriate. Therefore L, the length of the release line, should be 1750 + 2600 or 4350 feet.

Now a final check on the feasibility of this operation should be made. Assume an aircrift is to lay out the particular line source whose length should be 4350 feet. Since the tanks from which the tracer will be emitted will have some maximum capacity, say G grams of tracer, then the maximum line source strength, Q', is fixed at a value of G/4350 grams/foot. Also, the samplers will have a minimum dosage, D', below which they will not give representative values. Thus, a value D'/Q' can be found below which the data will be useless. One can then go back to the graph of D/Q vs. x to see if values greater than D'/Q' would be expected to cover a sufficient area of the grid to ensure adequate definition of the distribution of tracer. If adequate definition of the tracer is not possible then alternatives, such as flying lower or flying more than once along the line while the samplers are left running, must be considered.

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