AIR QUALITY MANUAL

APPENDIX

MATHEMATICAL APPROACH TO ESTIMATING HIGHWAY IMPACT ON AIR QUALITY

72-12
appendix
DND

STATE OF CALIFORNIA

BUSINESS AND TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

AIR QUALITY MANUAL

CA-HWY-MR6570825-4-72-12

Prepared in Cooperation with the U.S. Department of Transportation, Federal Highway Administration July, 1972

72-12 appendix DND

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State of California

Department of Public Works

Division of Highways

Materials and Research Department

APPENDIX

MATHEMATICAL APPROACH TO ESTIMATING HIGHWAY IMPACT ON AIR QUALITY

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Figure 1

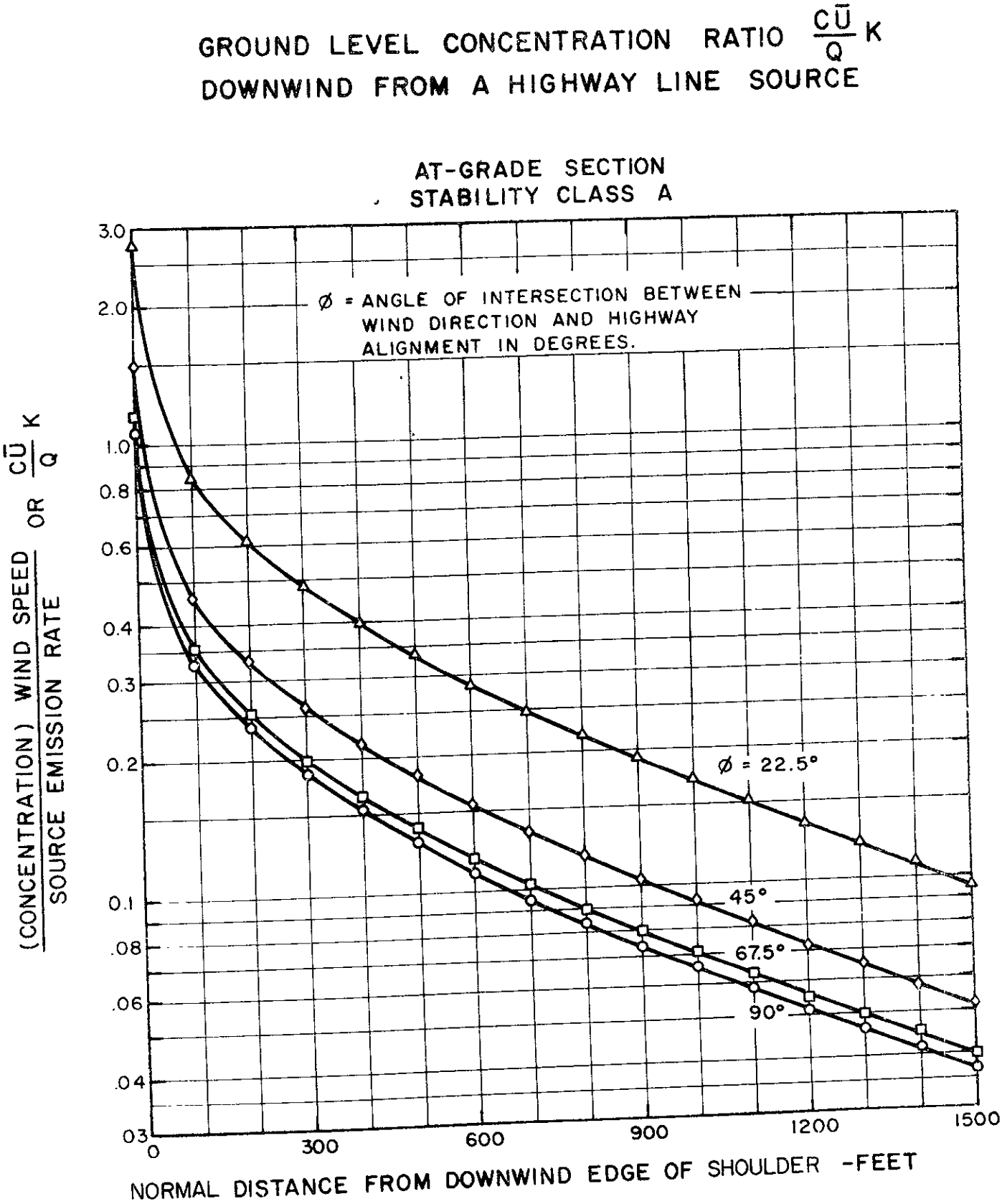

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Figure 2

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

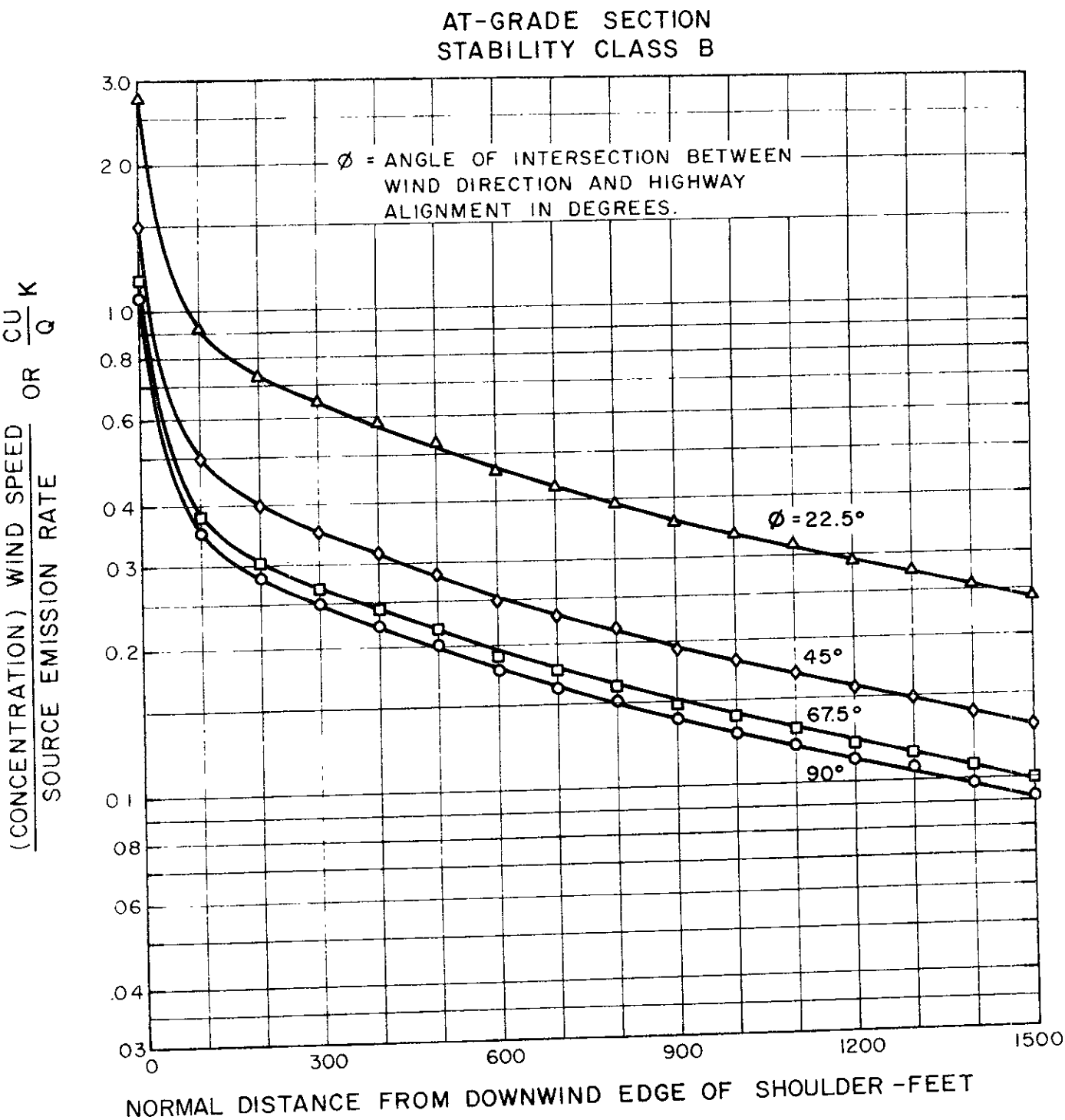

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Figure 3

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

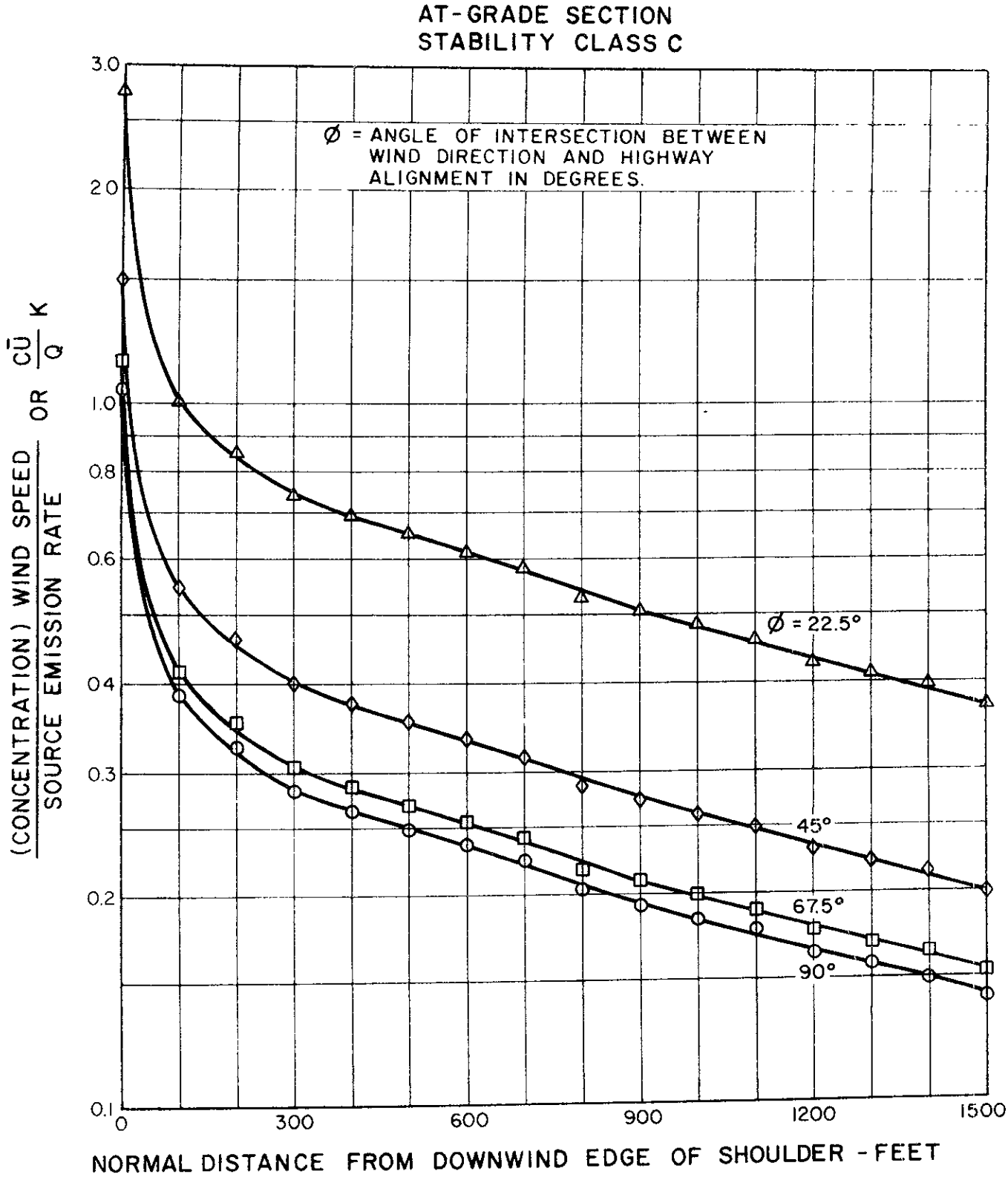

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Figure 4

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

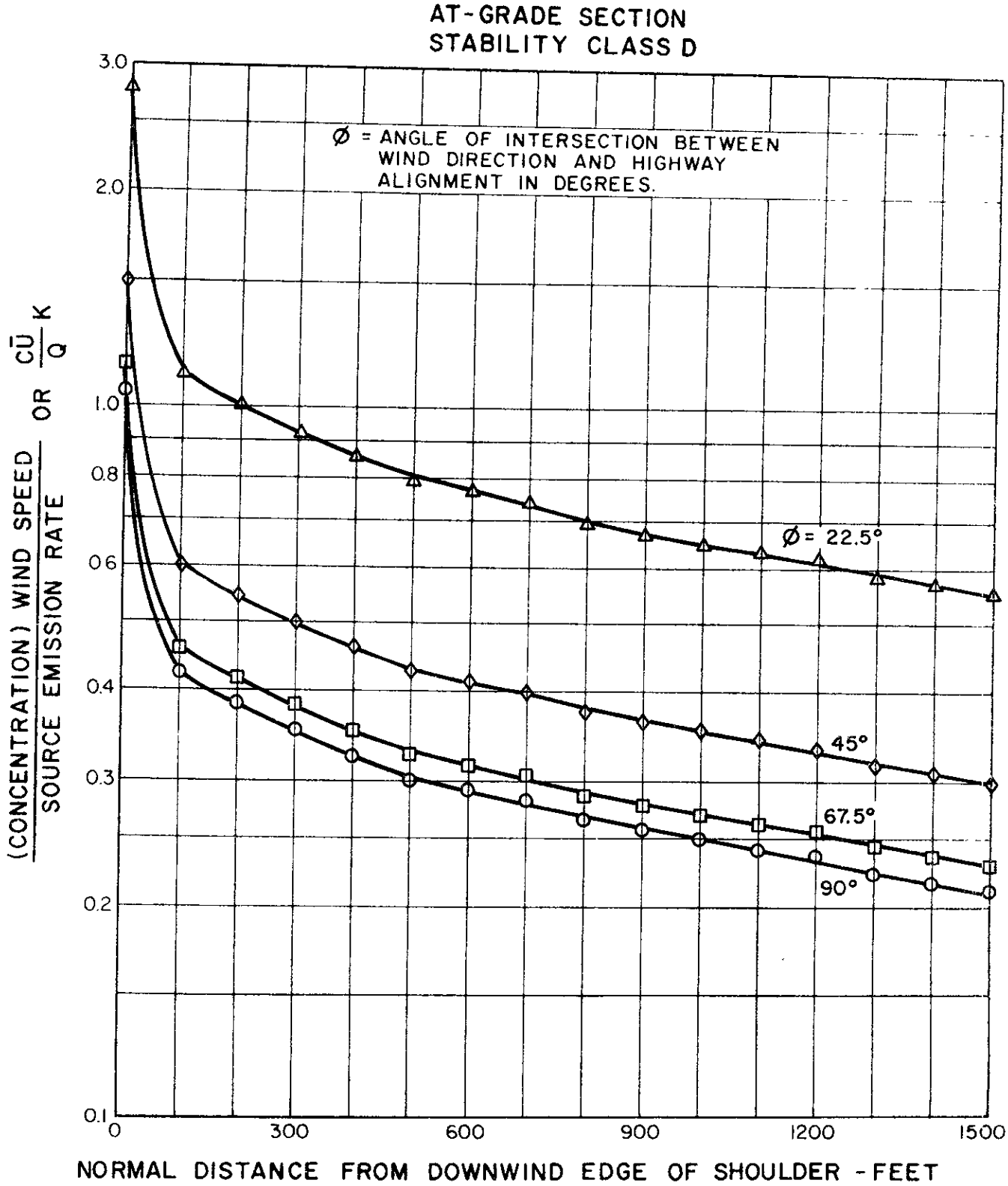

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Figure 5

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

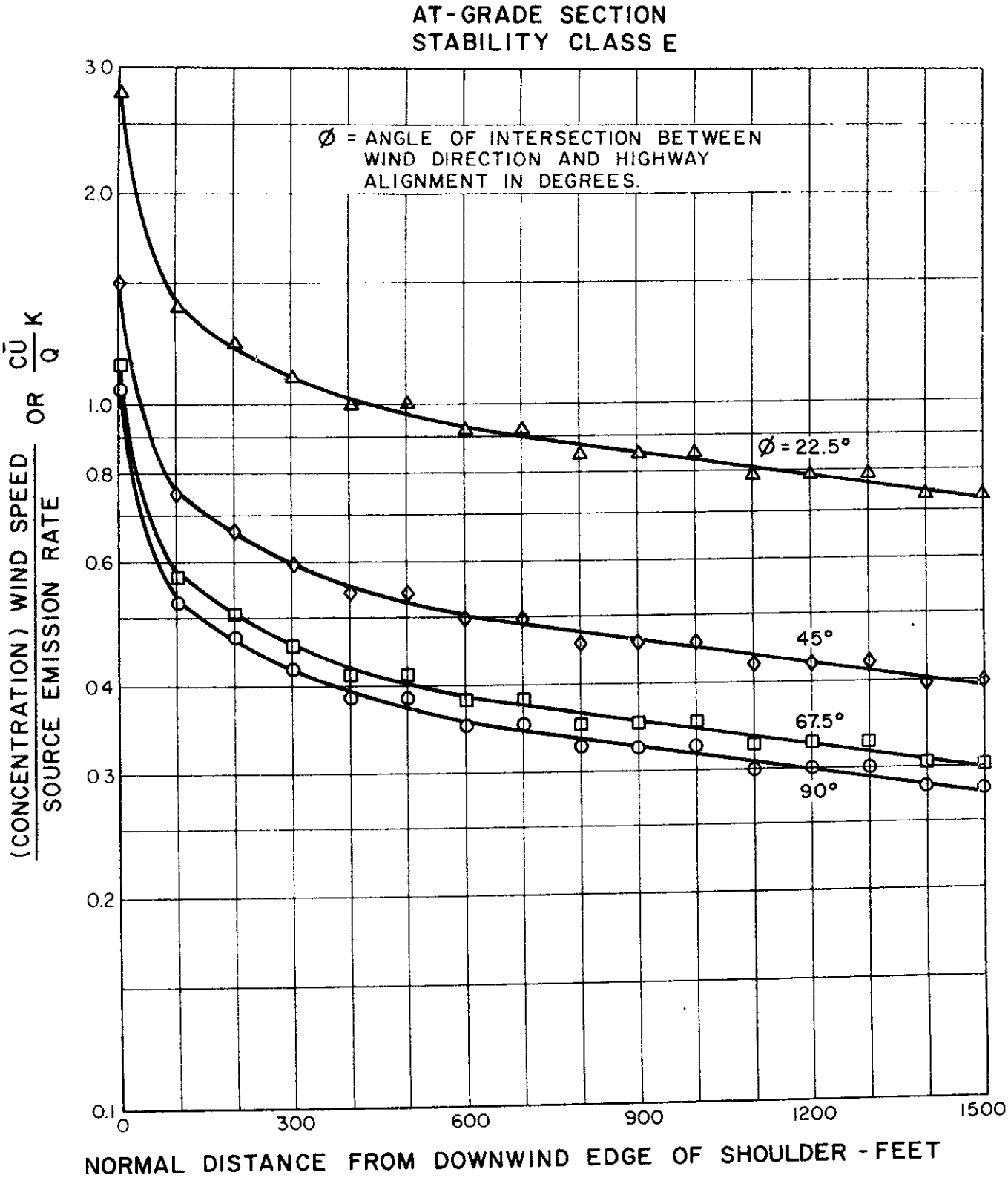

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Figure 6

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

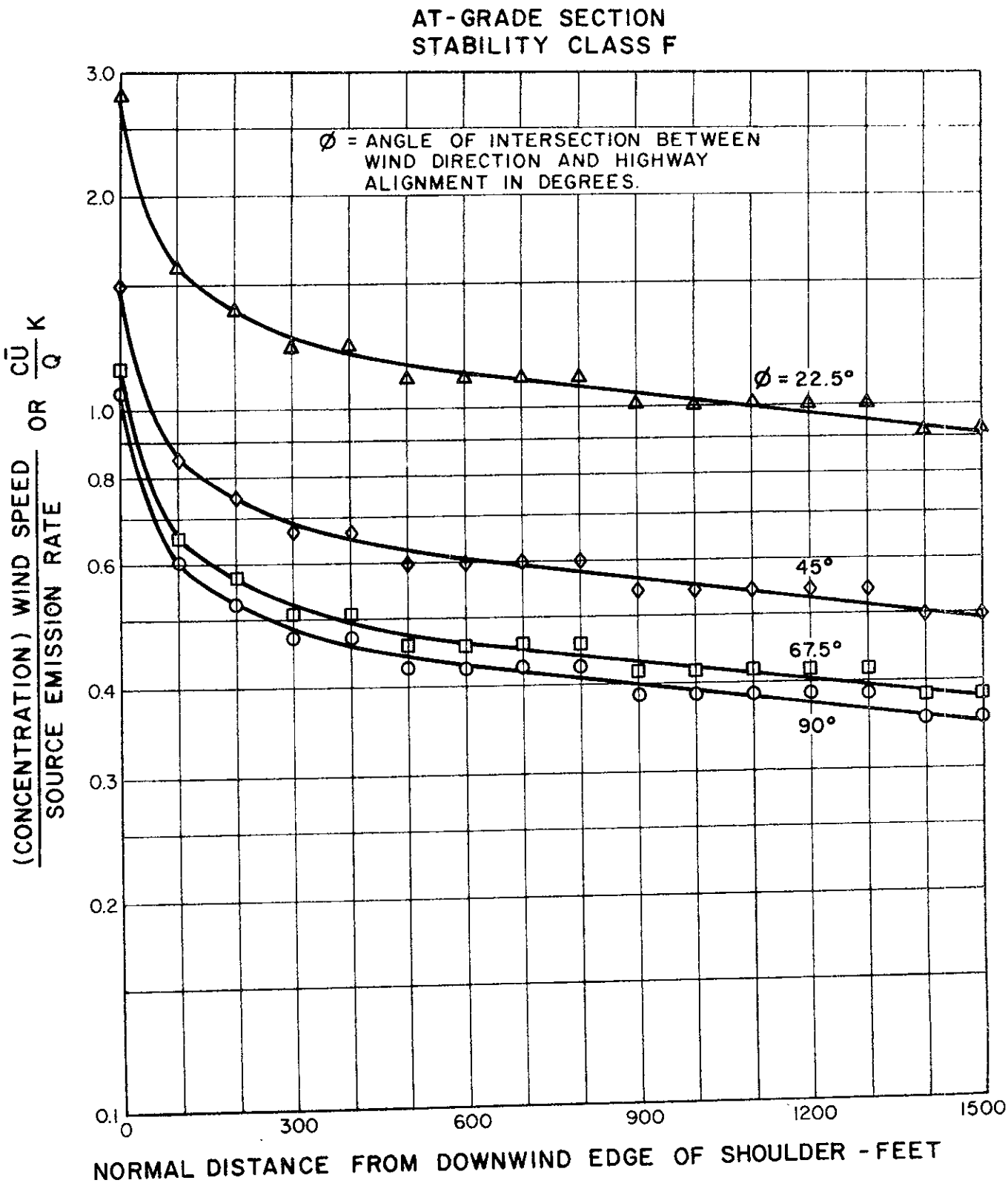

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Figure 7

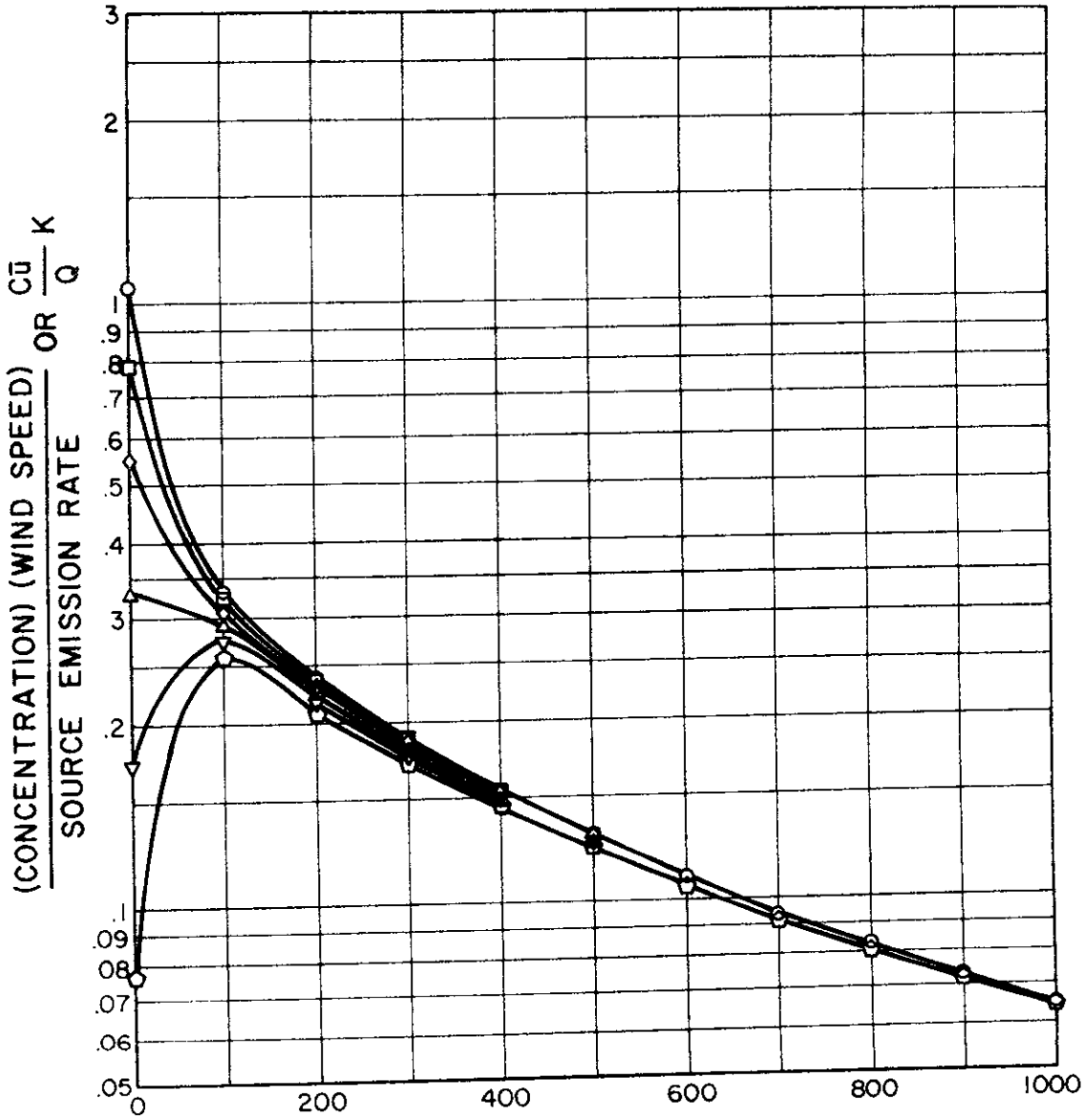
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS A

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=90° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 8

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS B

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=90° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)

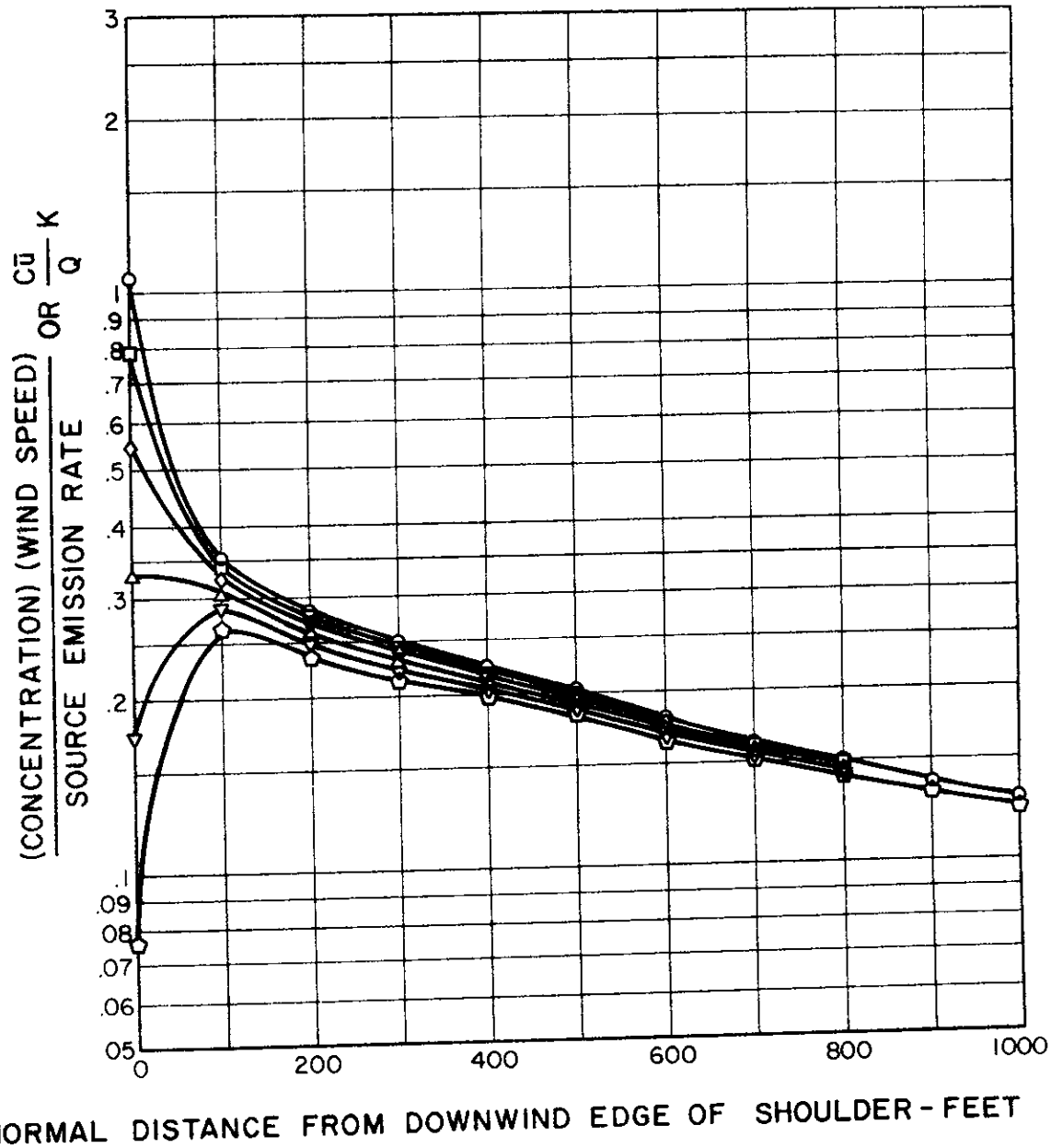

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Figure 9

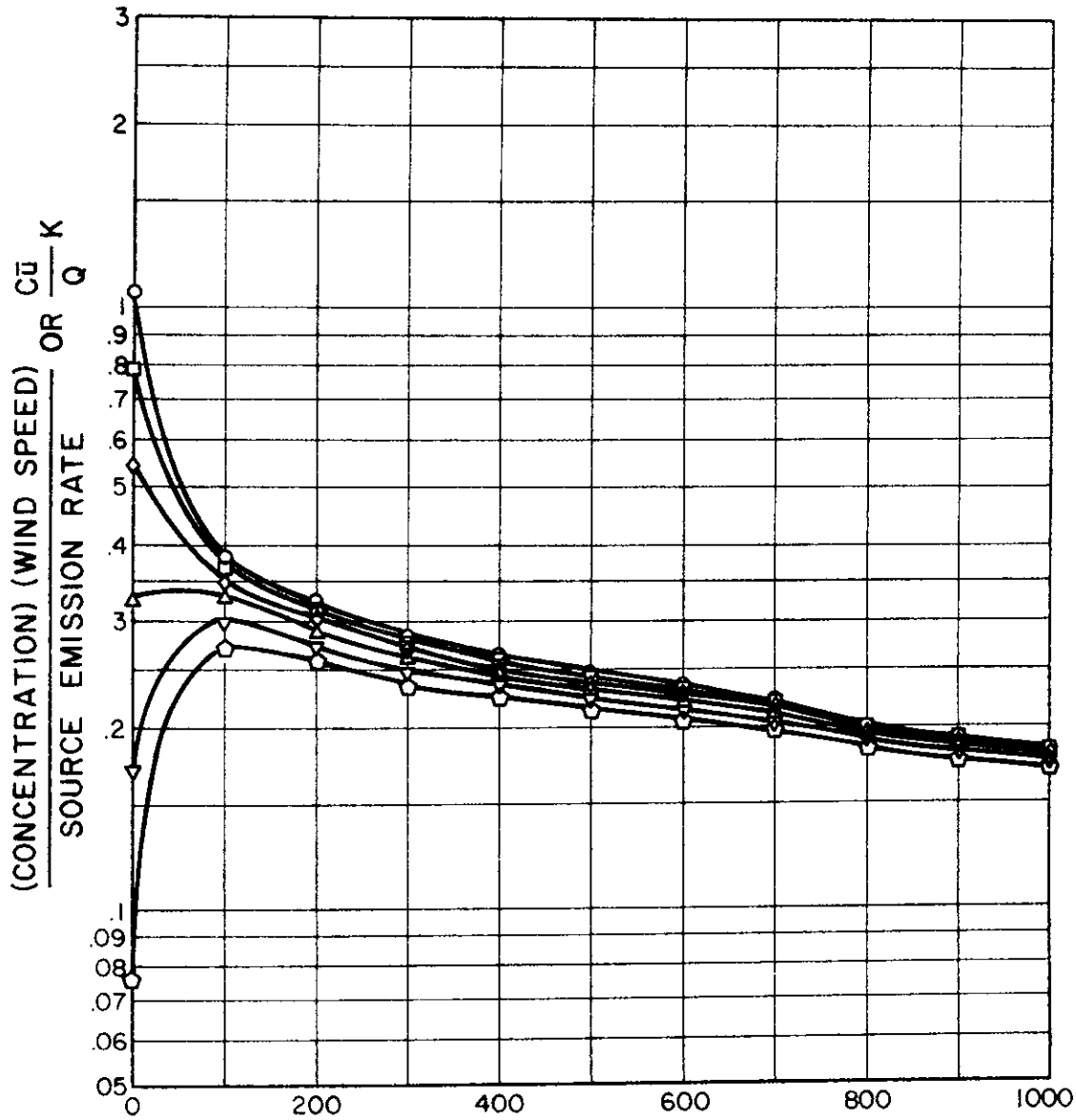
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS C

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=90° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 10

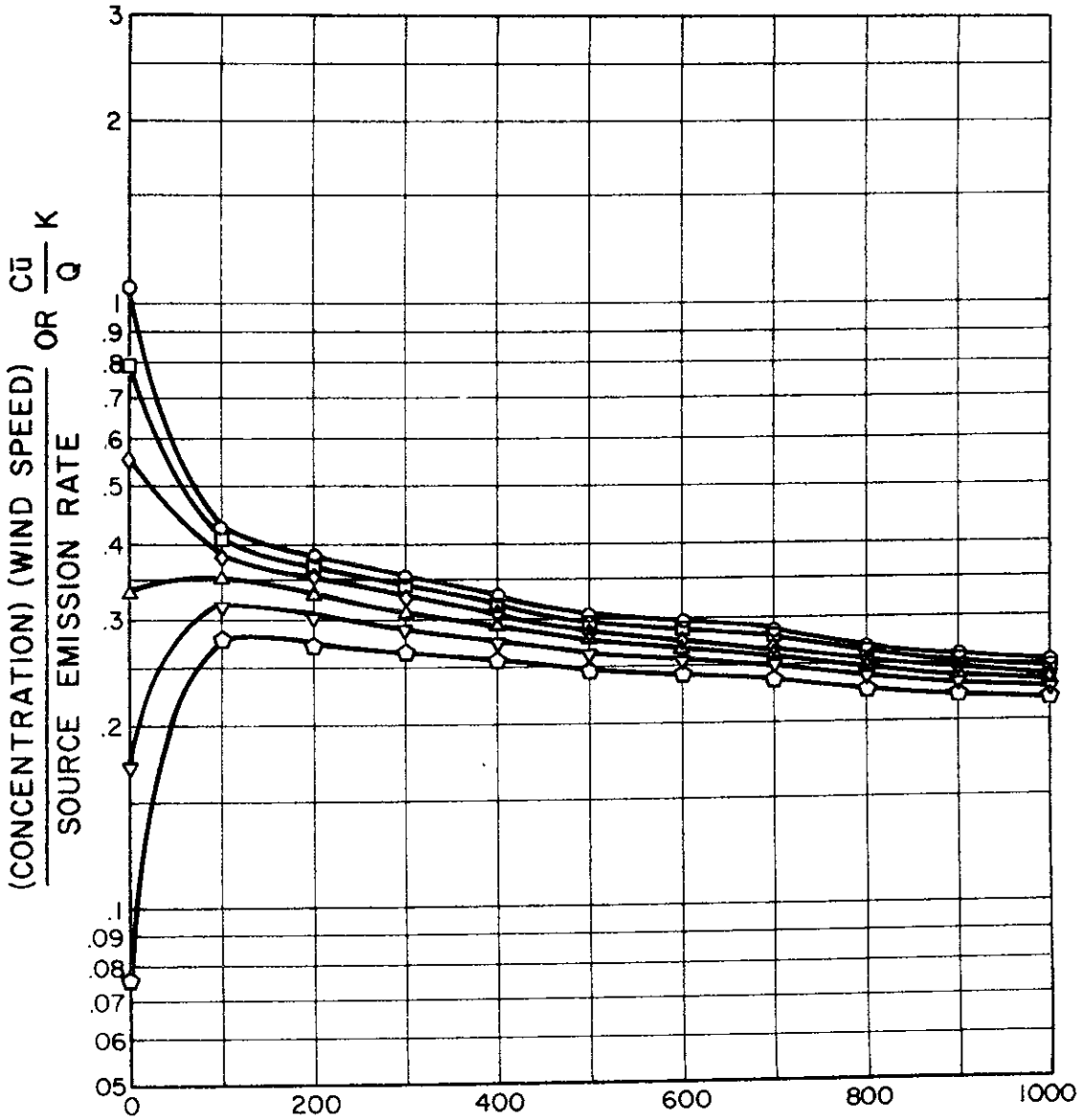
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS D

H = Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø = 90° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 11

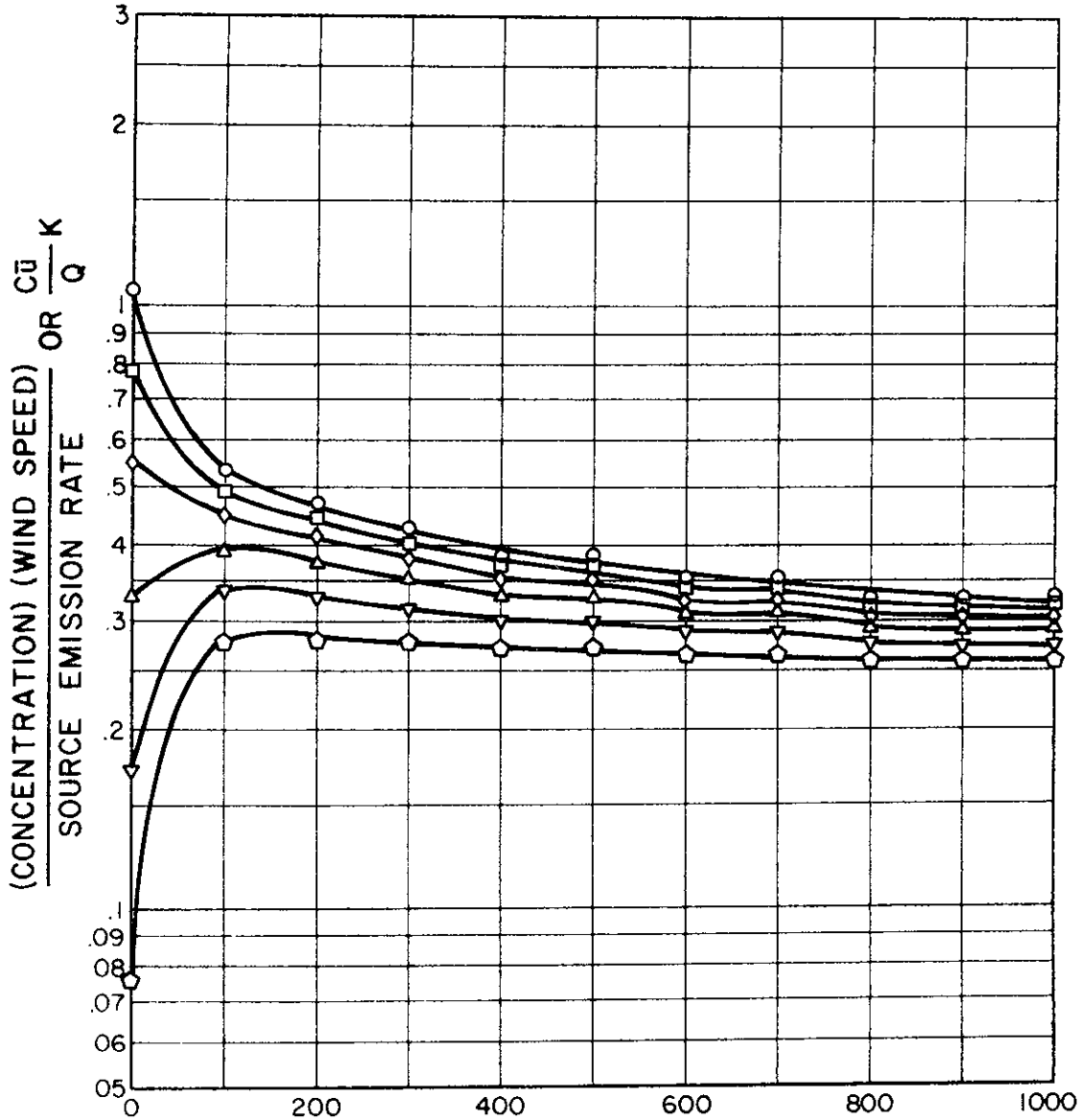
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS E

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=90° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 12

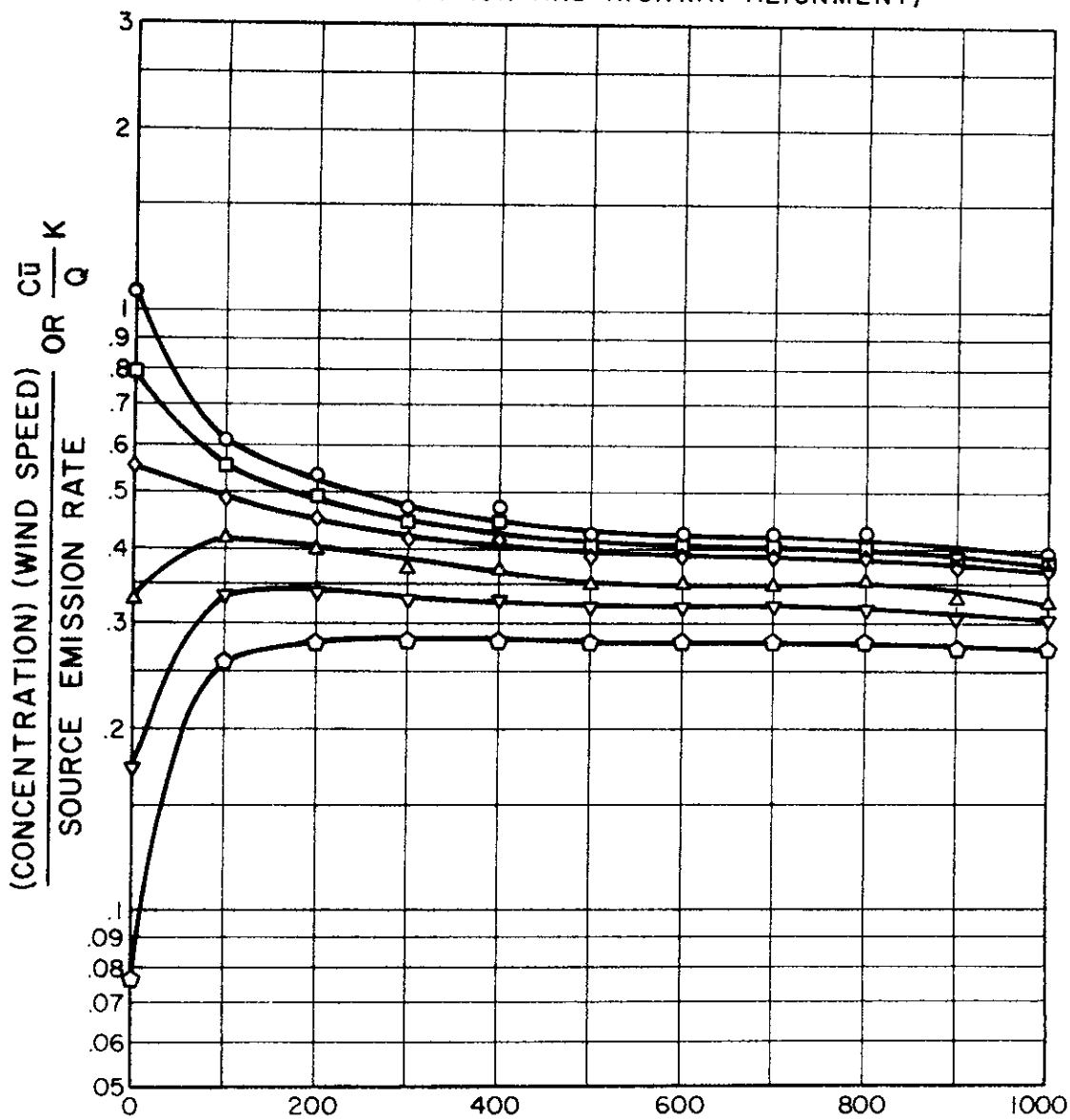
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS F

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø = 90° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 13

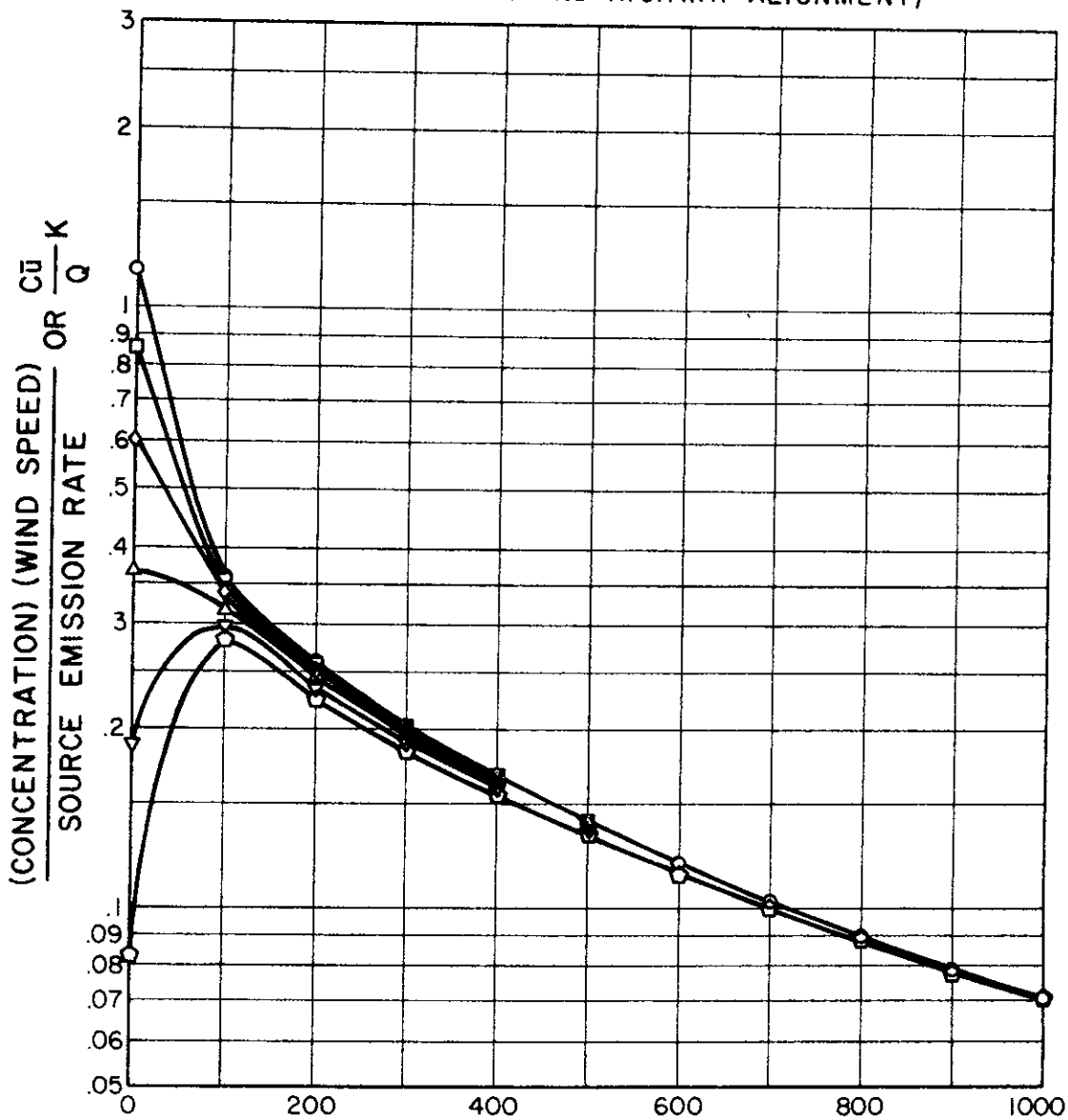
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS A

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=67.5° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 14

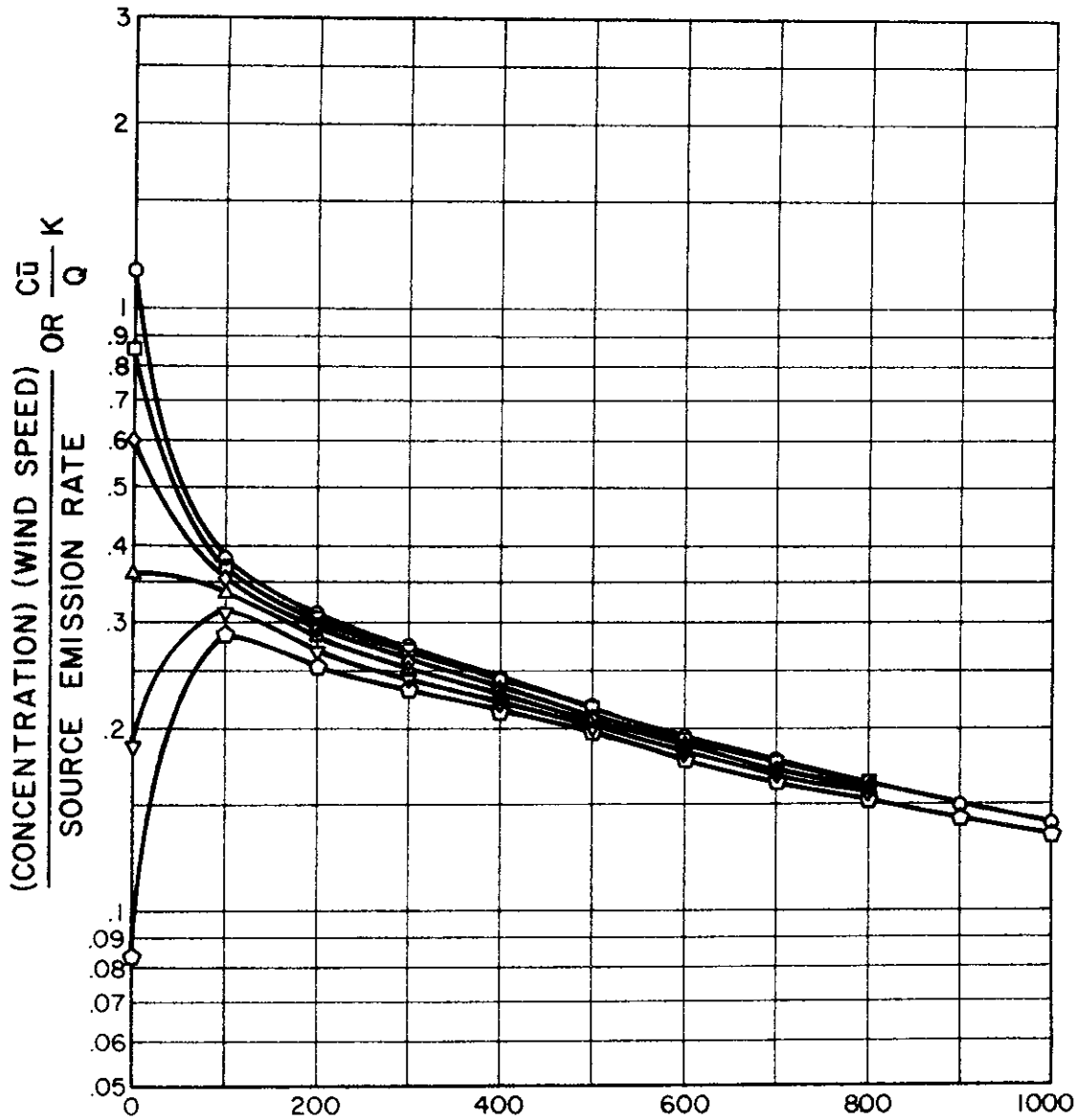
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS B

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=67.5°(ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 15

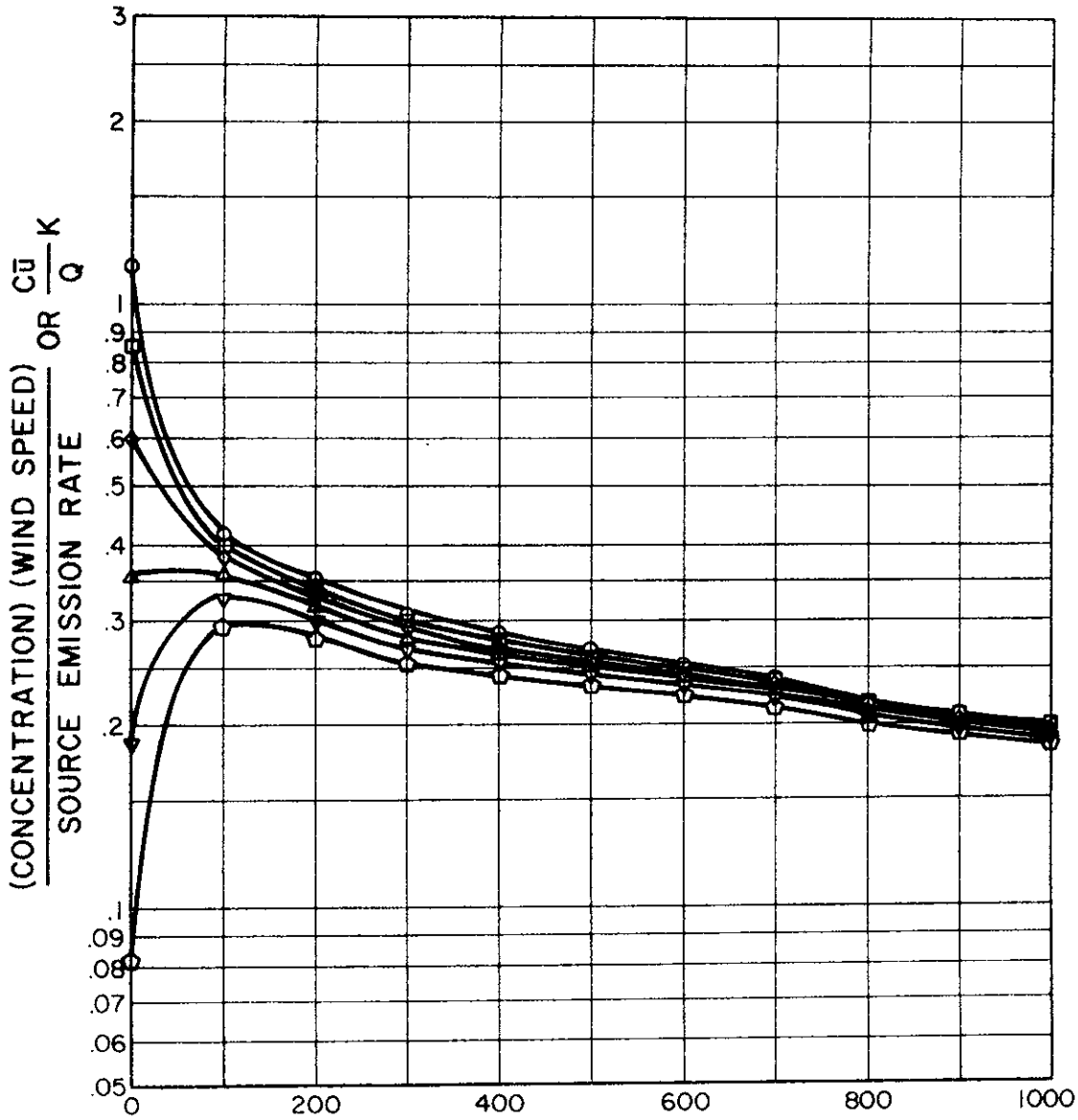
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS C

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=67.5°(ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 16

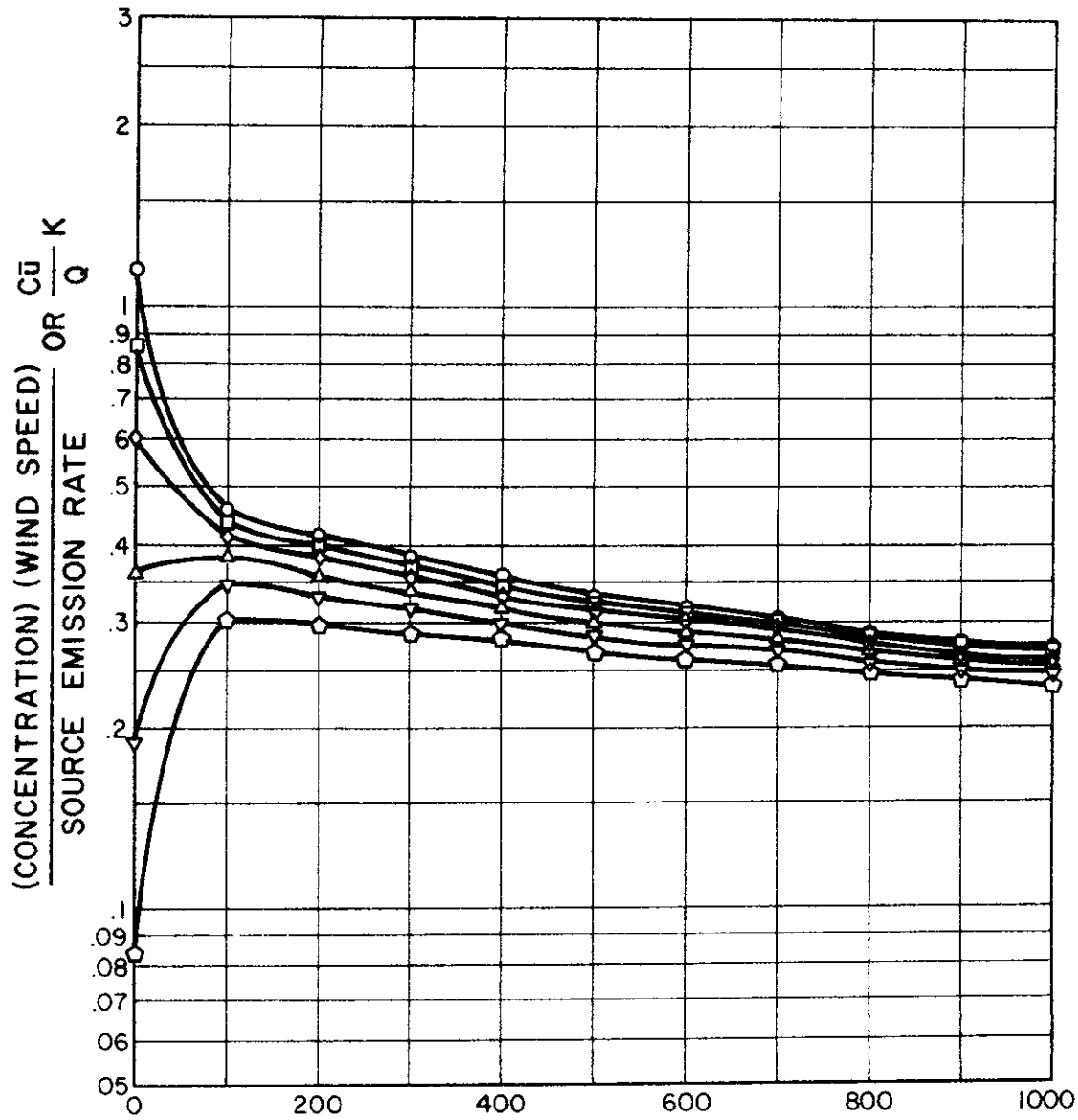
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS D

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=67.5°(ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 17

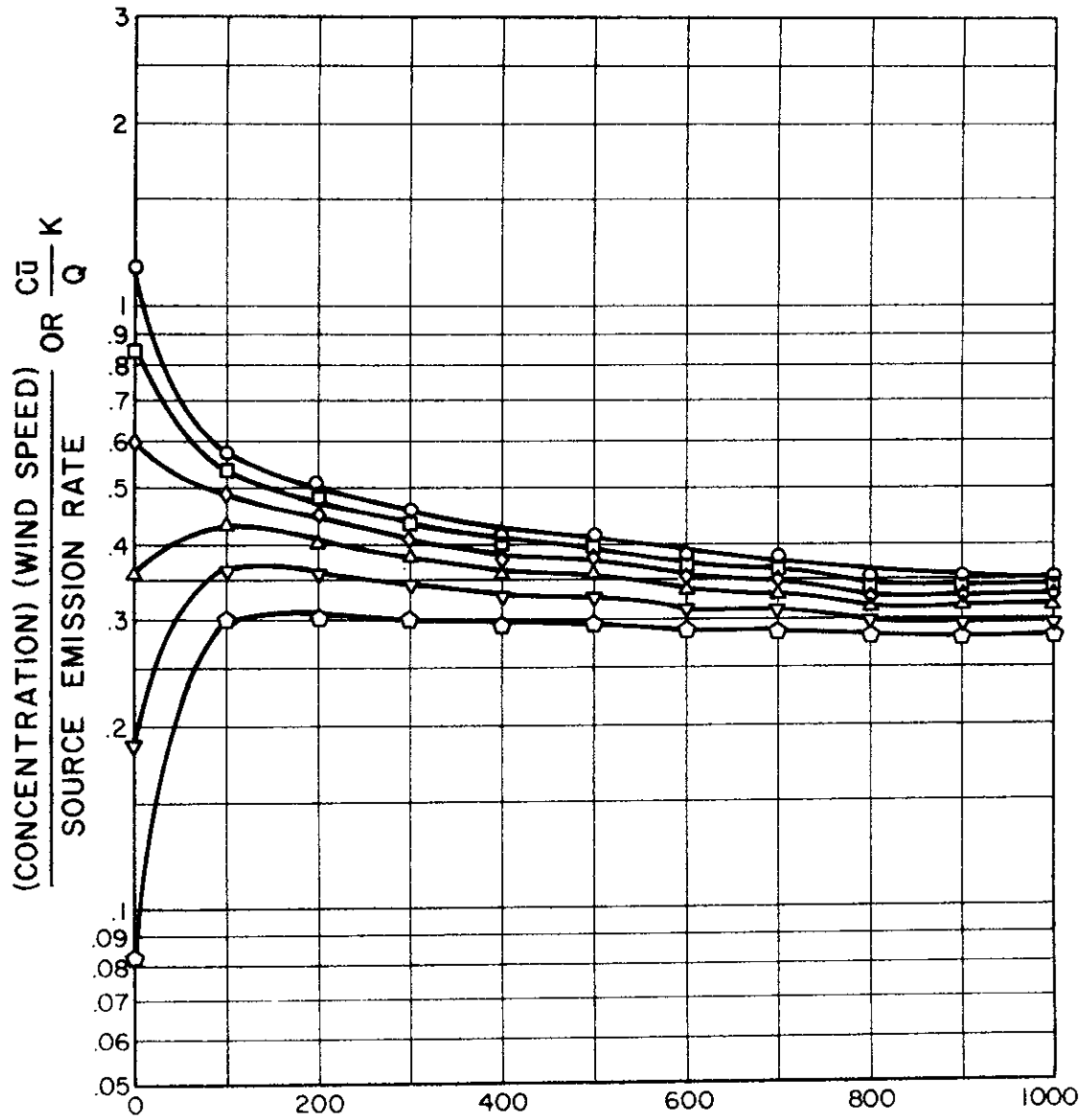
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS E

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=67.5° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 18

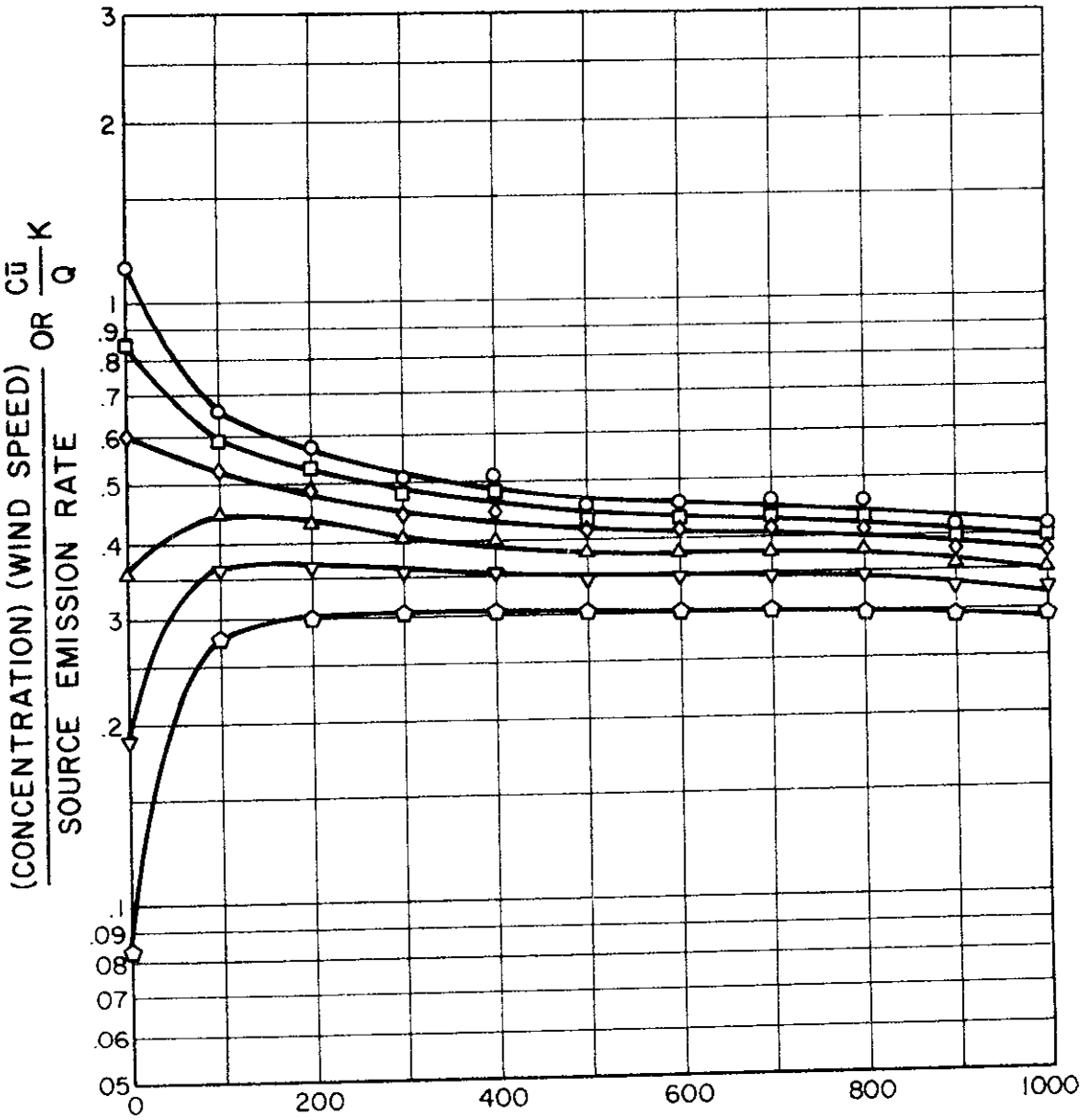
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS F

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=67.5° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 19

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS A

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=45° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)

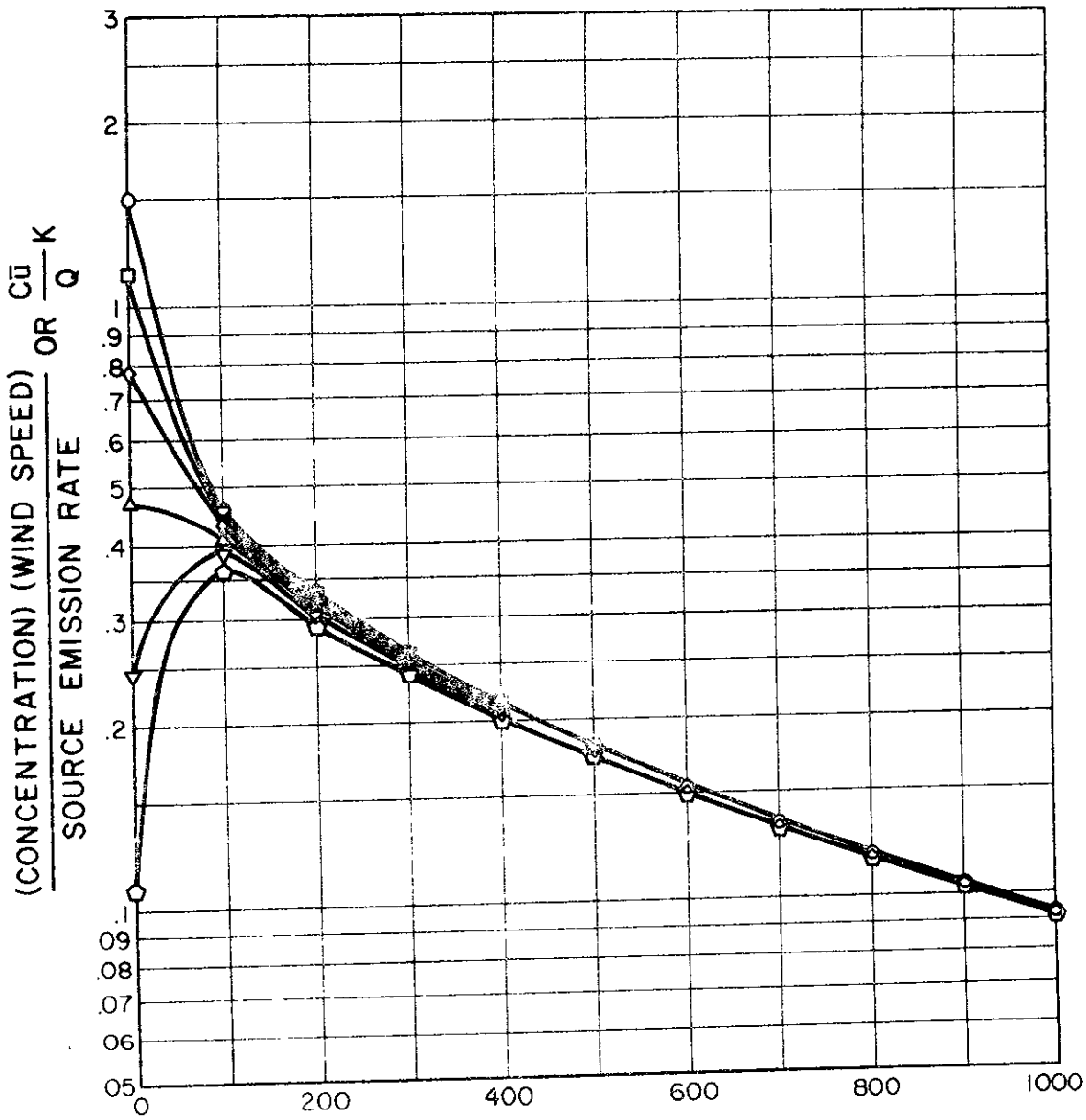

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Figure 20

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS B

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø = 45° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)

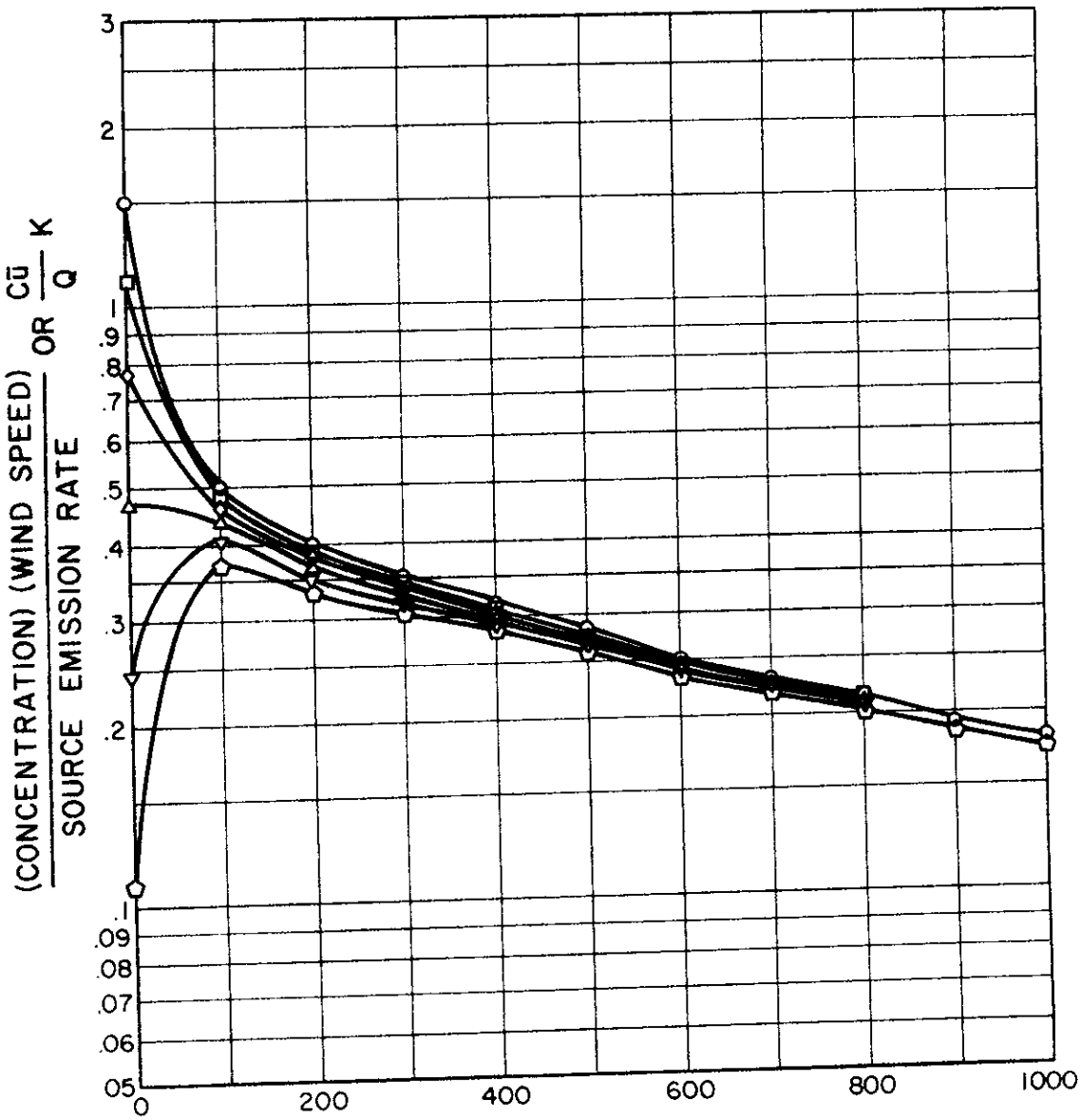

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Figure 21

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS C

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø = 45° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)

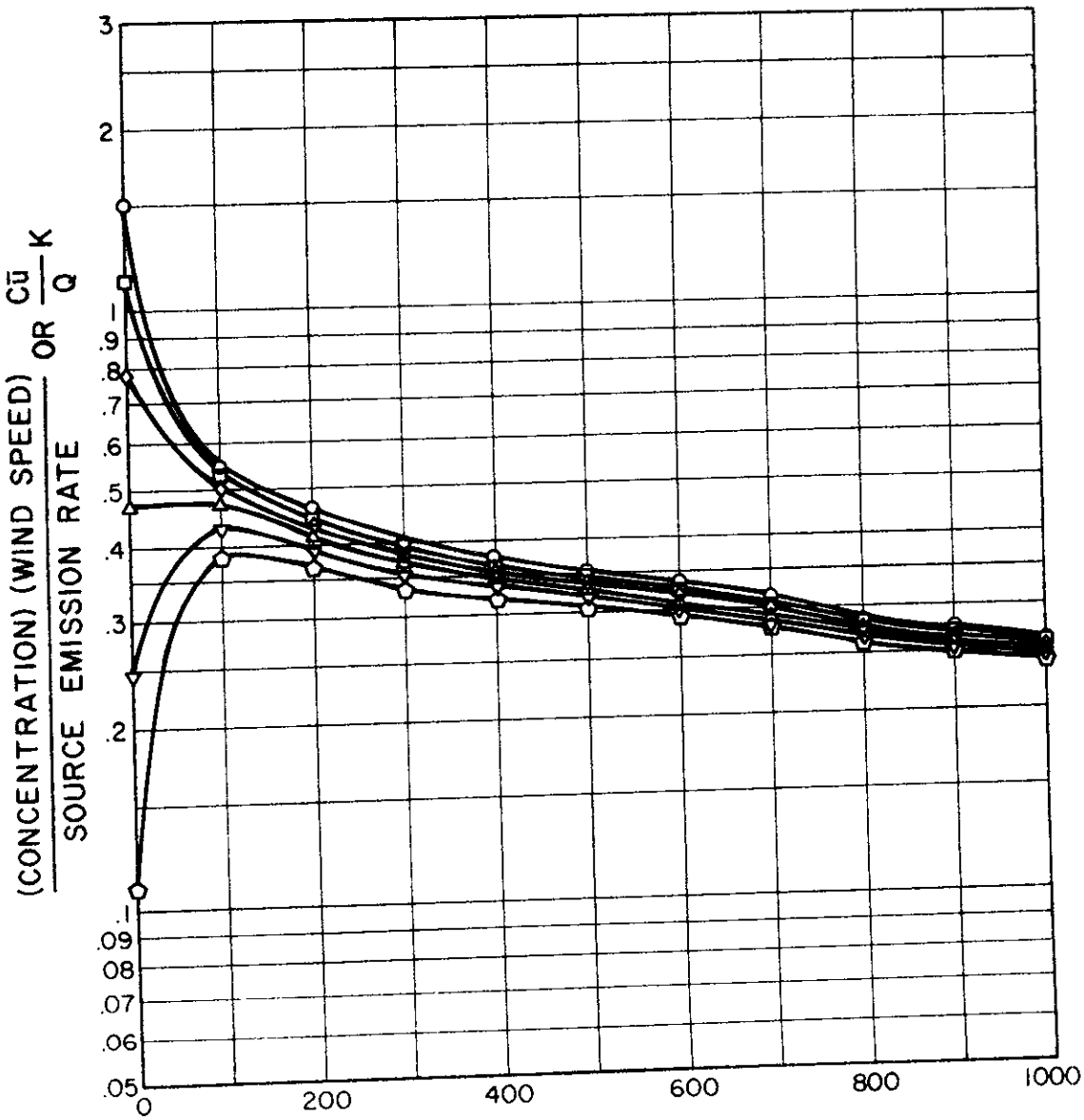

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Figure 22

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS D

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø = 45° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)

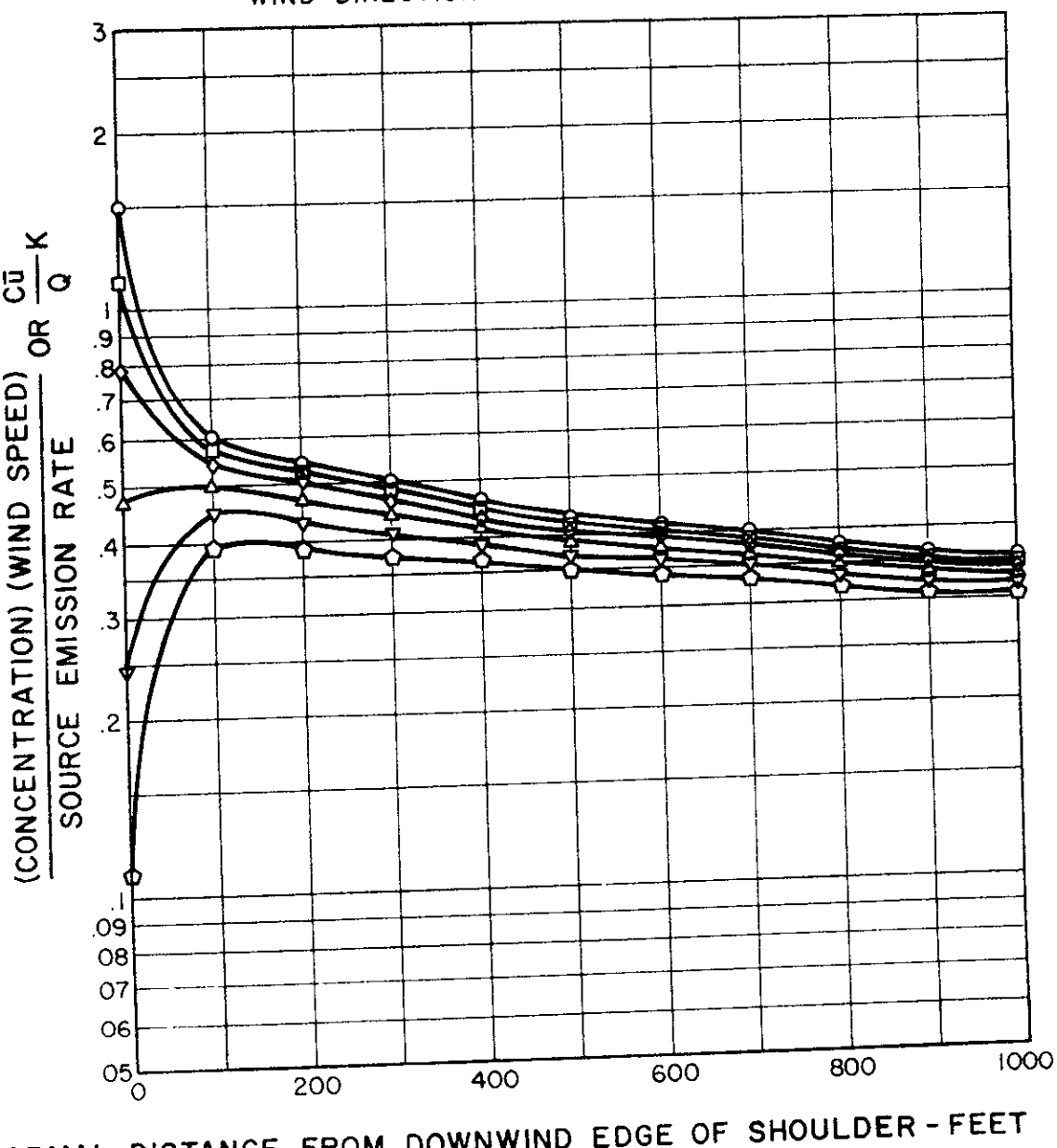

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Figure 23

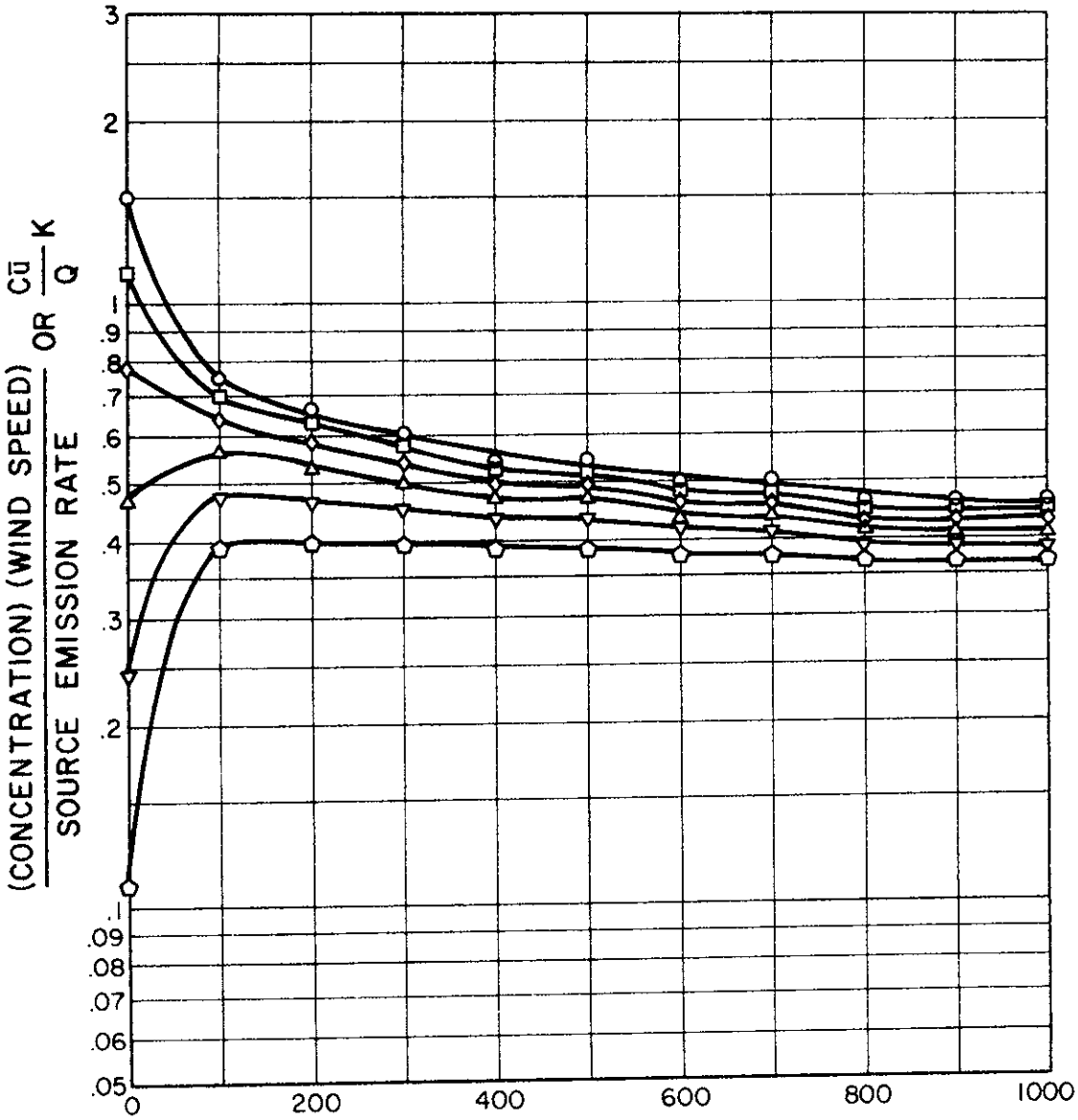
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS E

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=45° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 24

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS F

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=45° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)

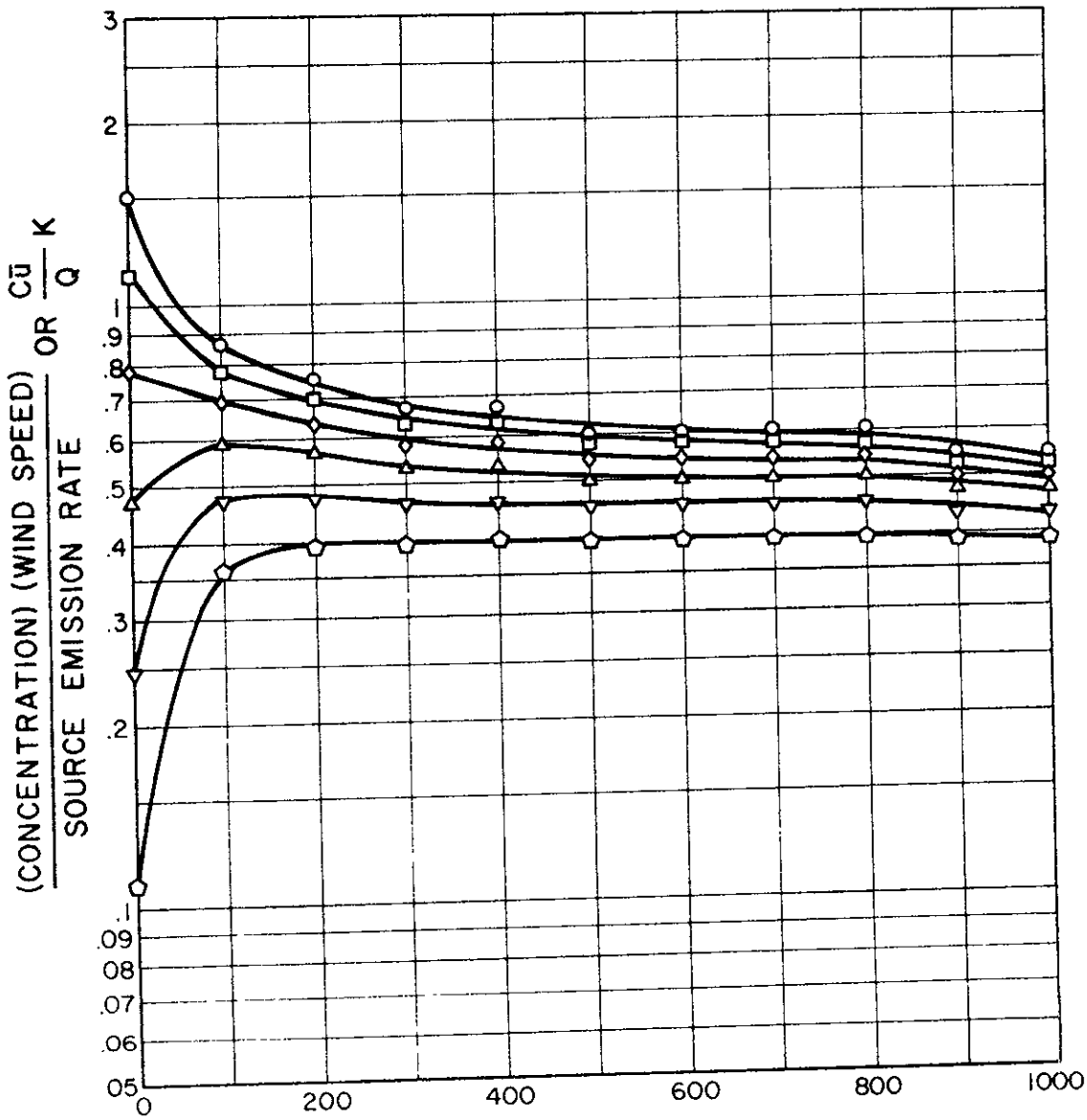

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Figure 25

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS A

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=22.5° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)

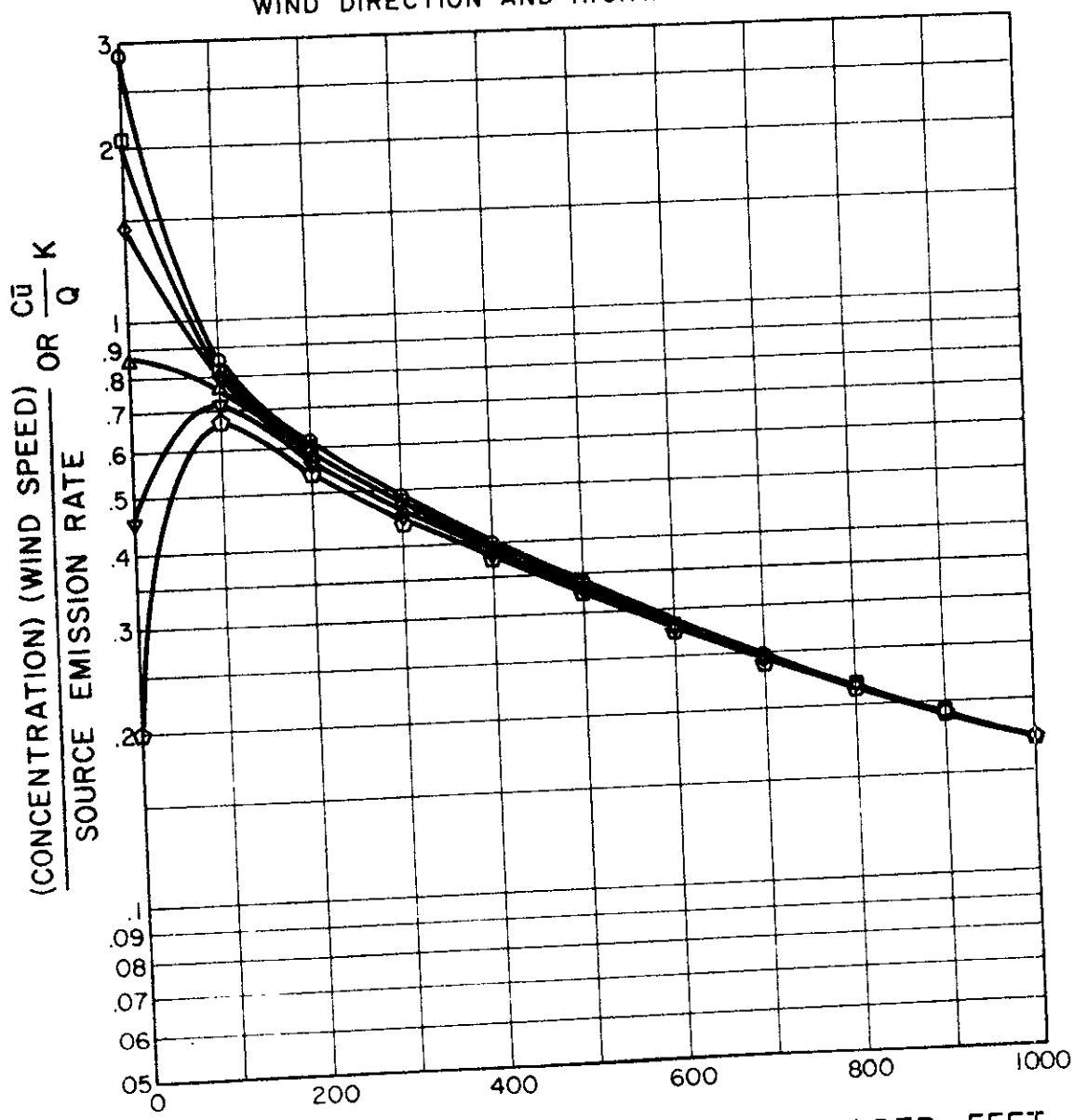

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Figure 26

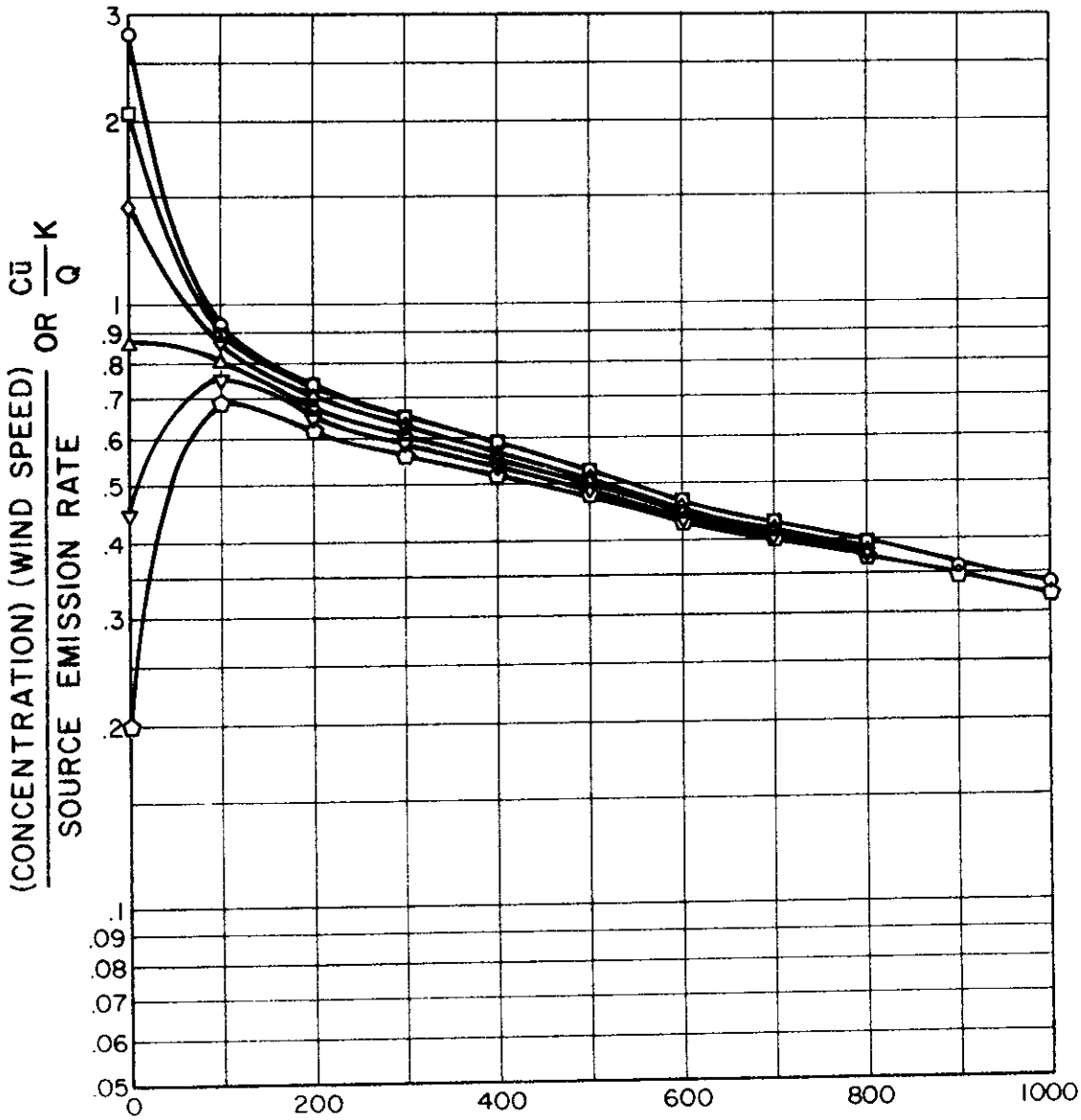
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS B

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=22.5° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 27

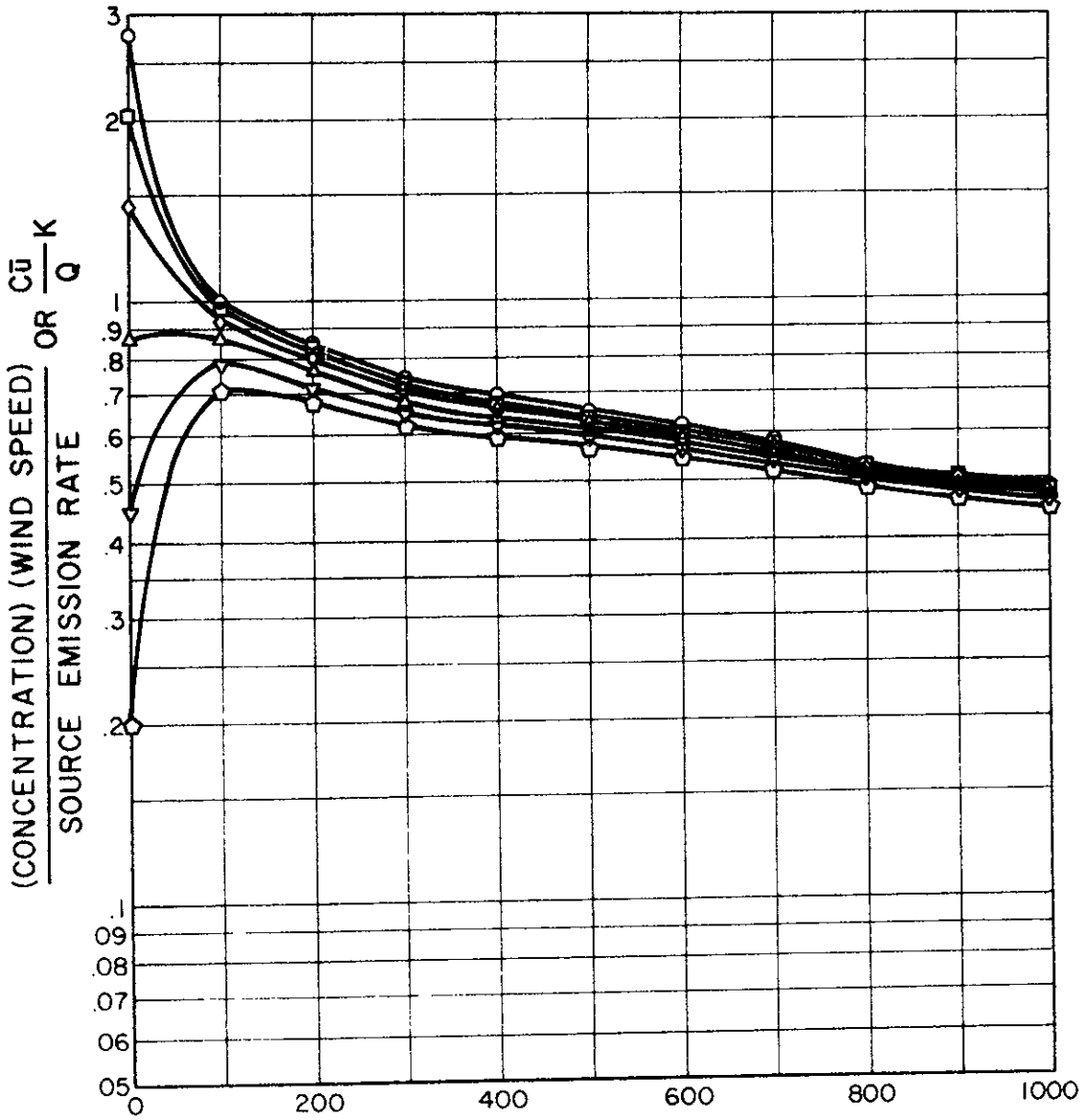
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS C

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=22.5°(ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 28

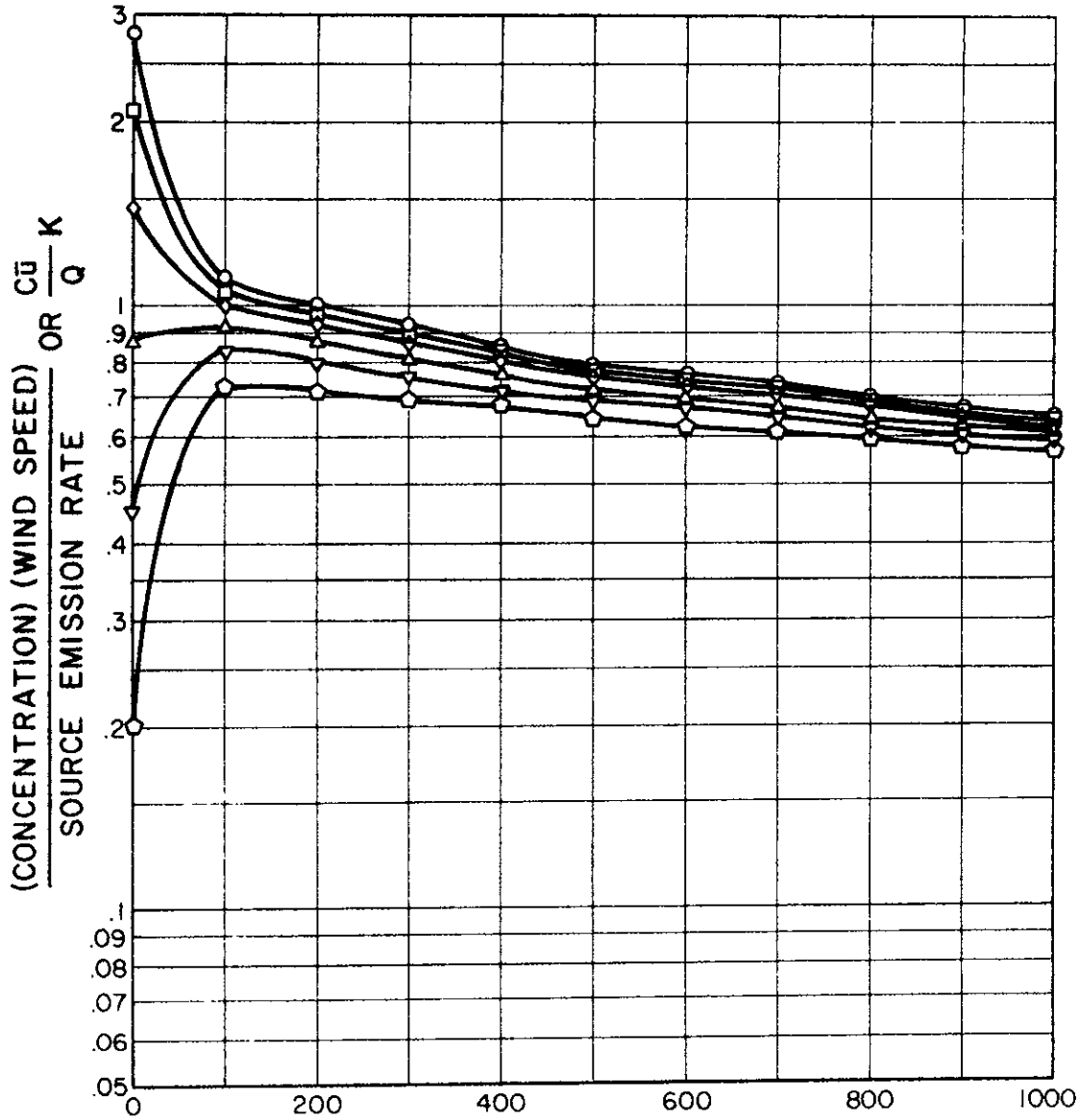
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS D

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=22.5° (ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 29

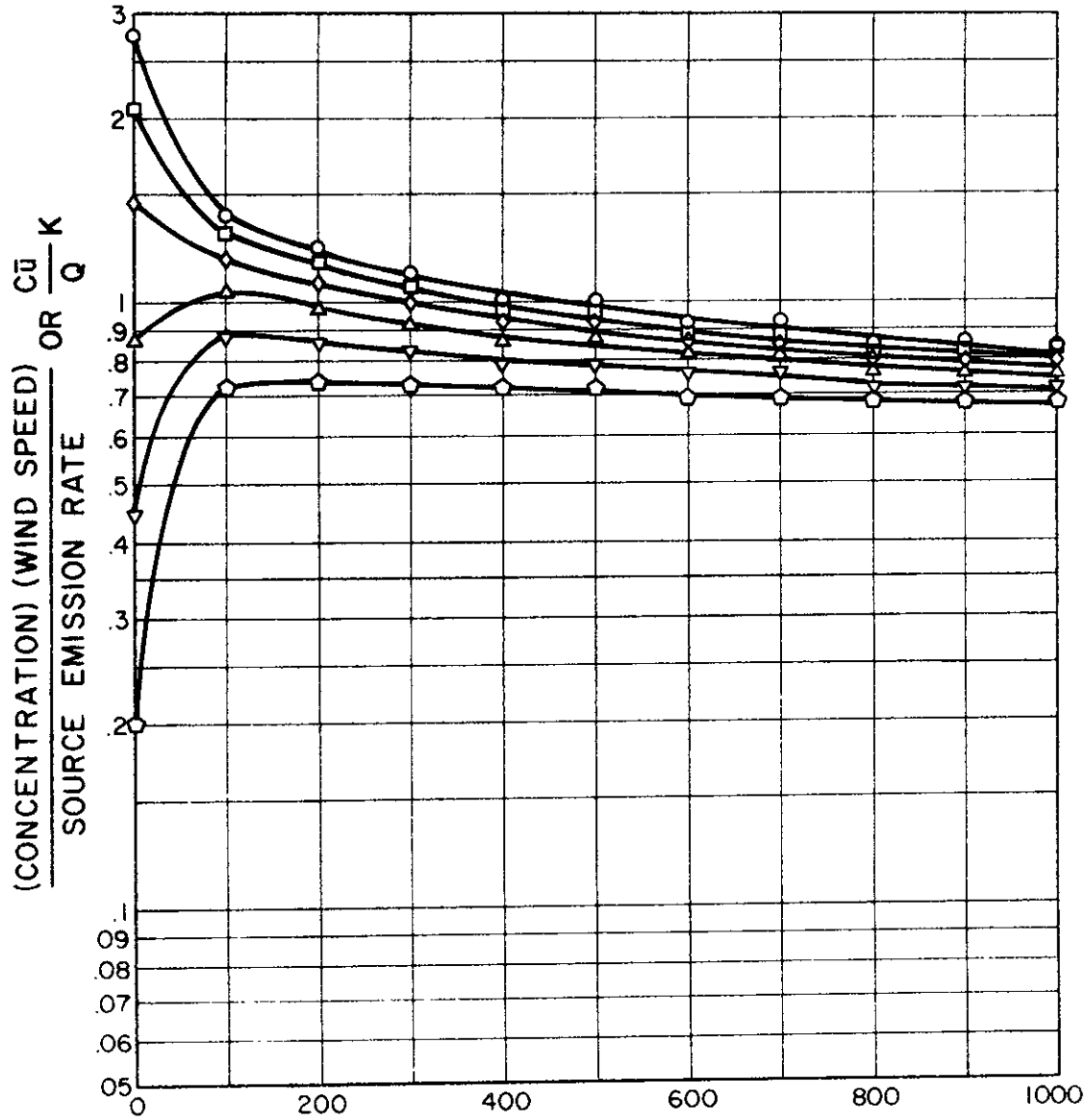
GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS E

H= Height of pavement above surrounding terrain in feet.

○ H = 0
□ = 10
◇ = 15
△ = 20
▽ = 25
⬠ = 30

Ø=22.5°(ANGLE OF INTERSECTION BETWEEN WIND DIRECTION AND HIGHWAY ALIGNMENT)



NORMAL DISTANCE FROM DOWNWIND EDGE OF SHOULDER - FEET

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Figure 30

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS F

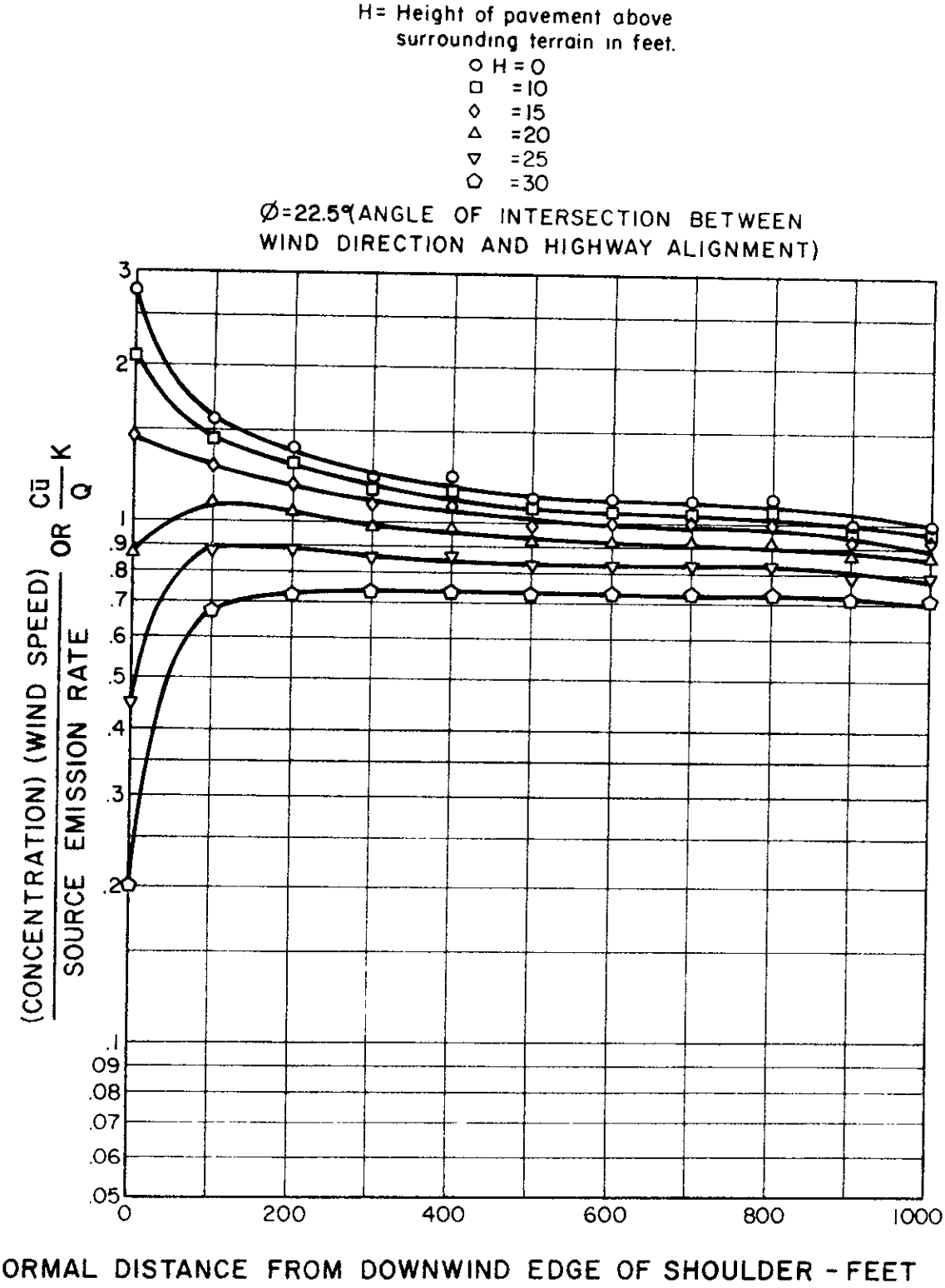

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Figure 31

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS A

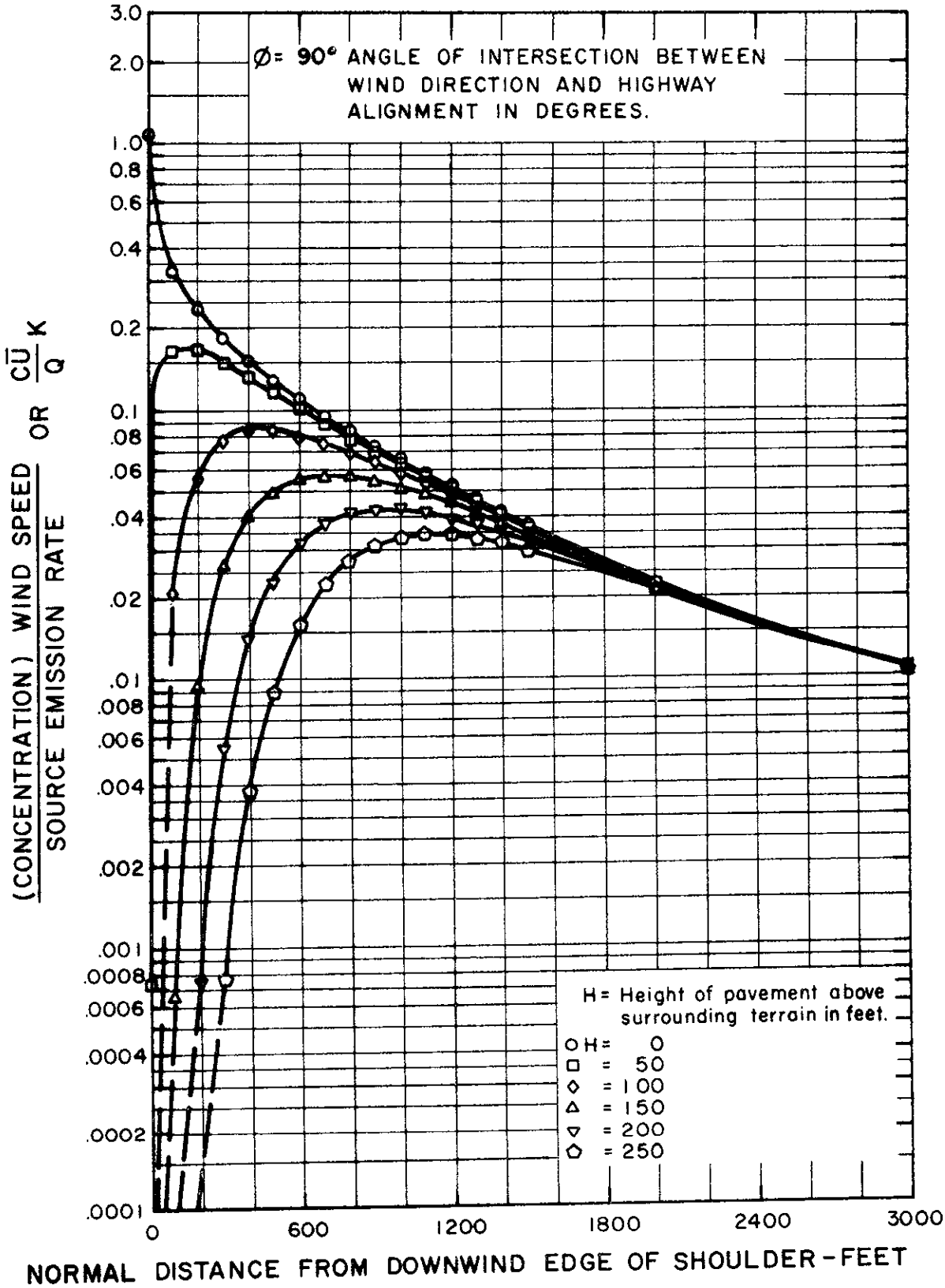

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Figure 32

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS B

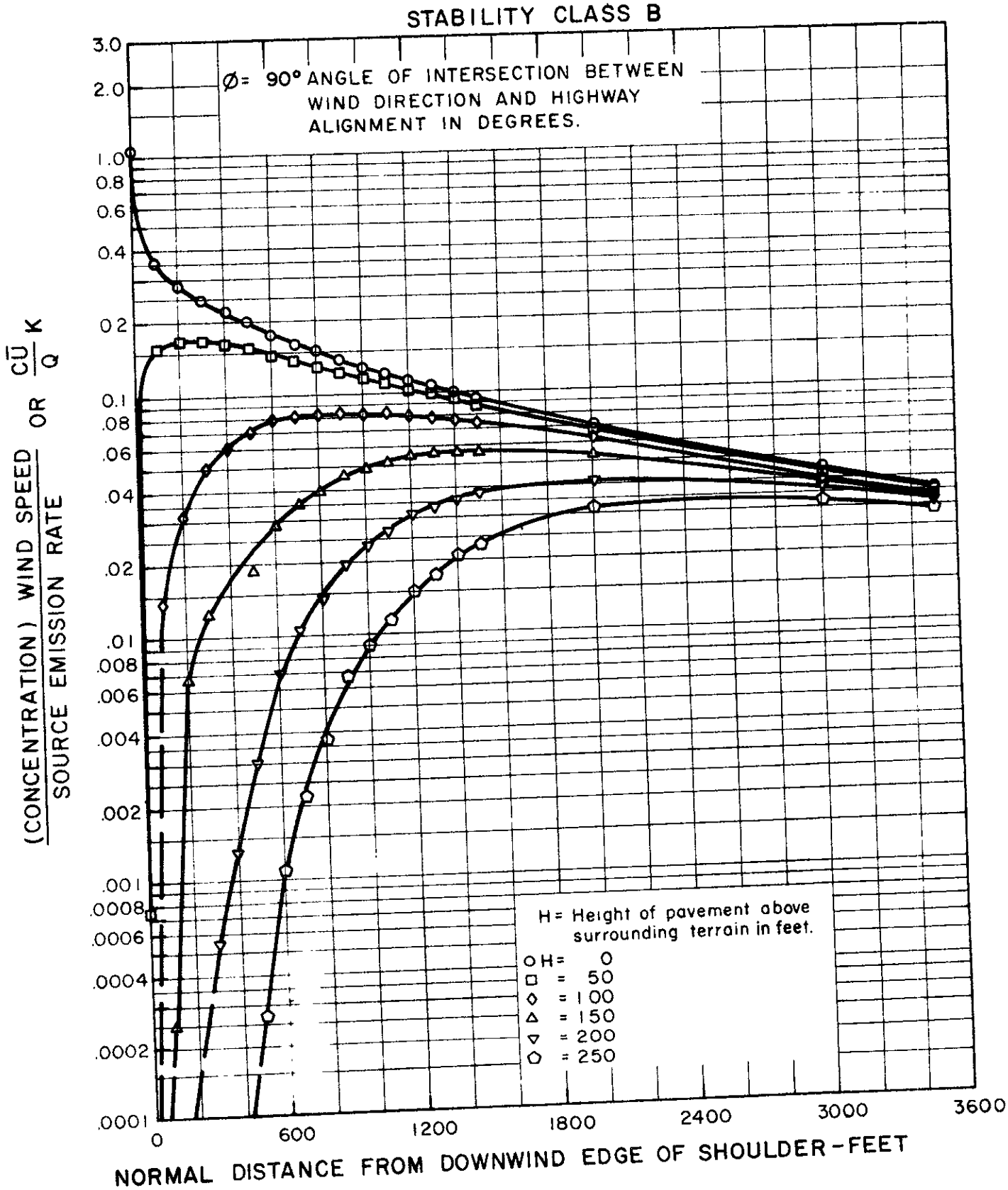

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Figure 37

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS A

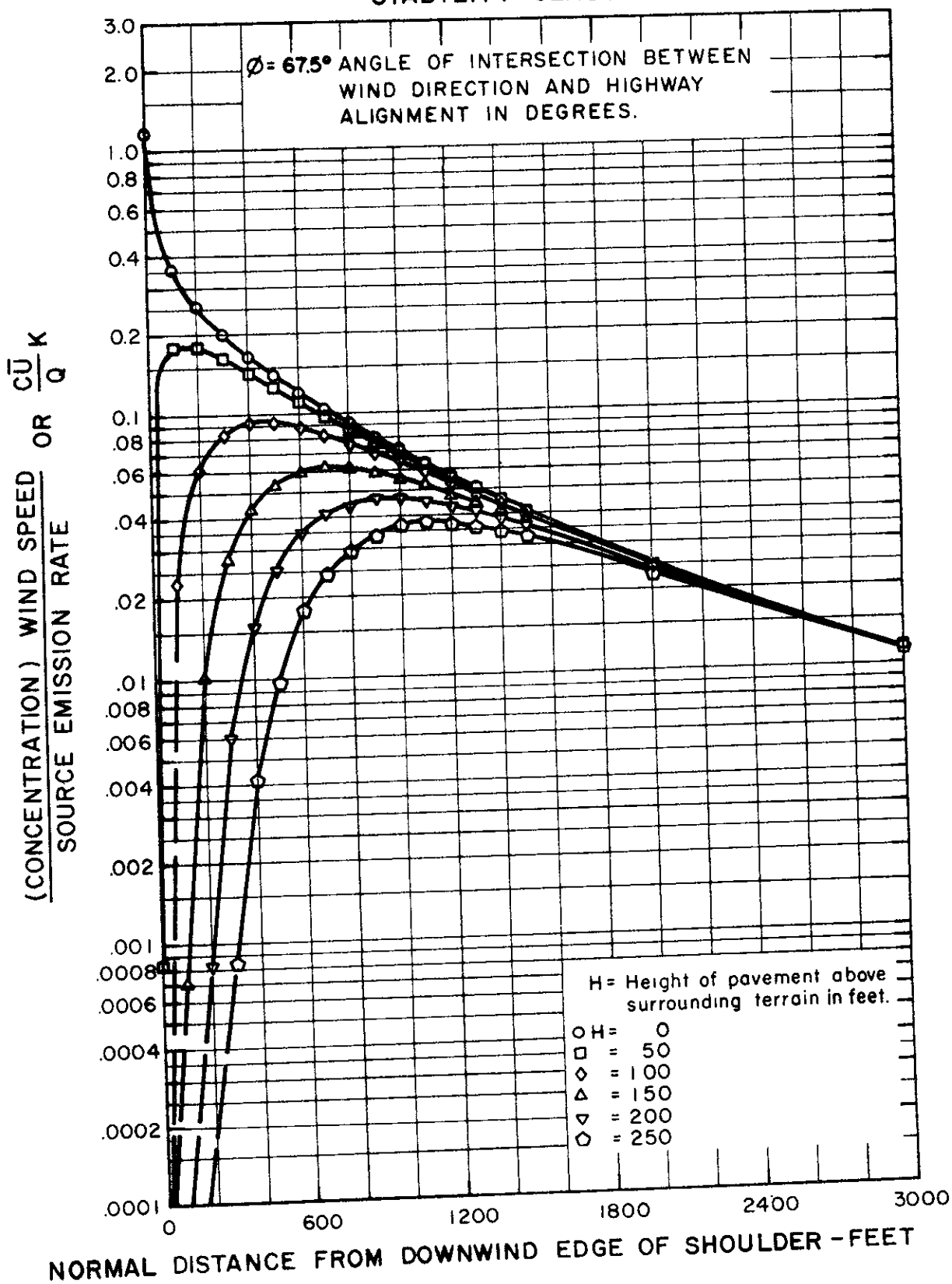

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Figure 38

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS B

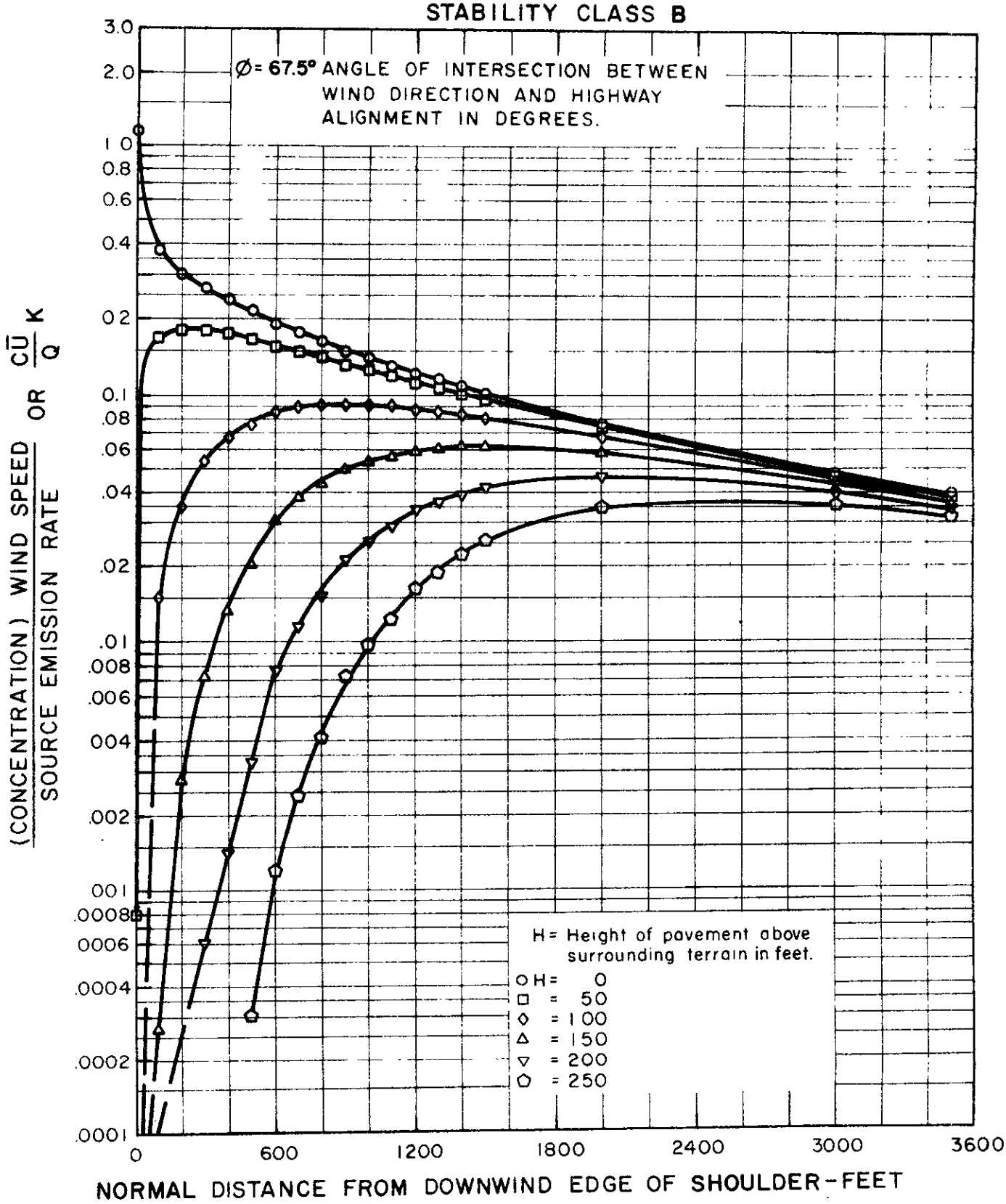

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Figure 50

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{U}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

ELEVATED SECTION
STABILITY CLASS B

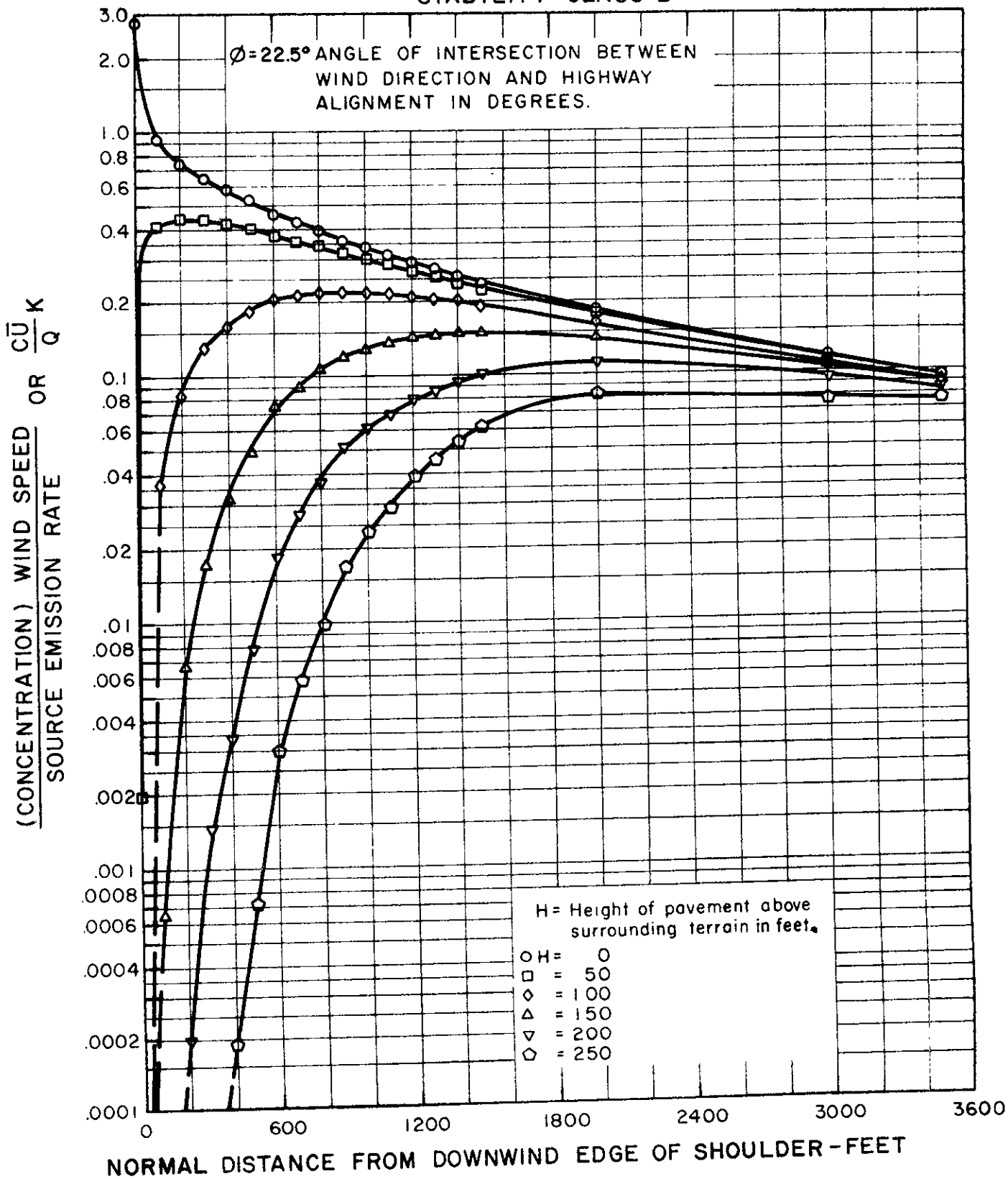

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Figure 55

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

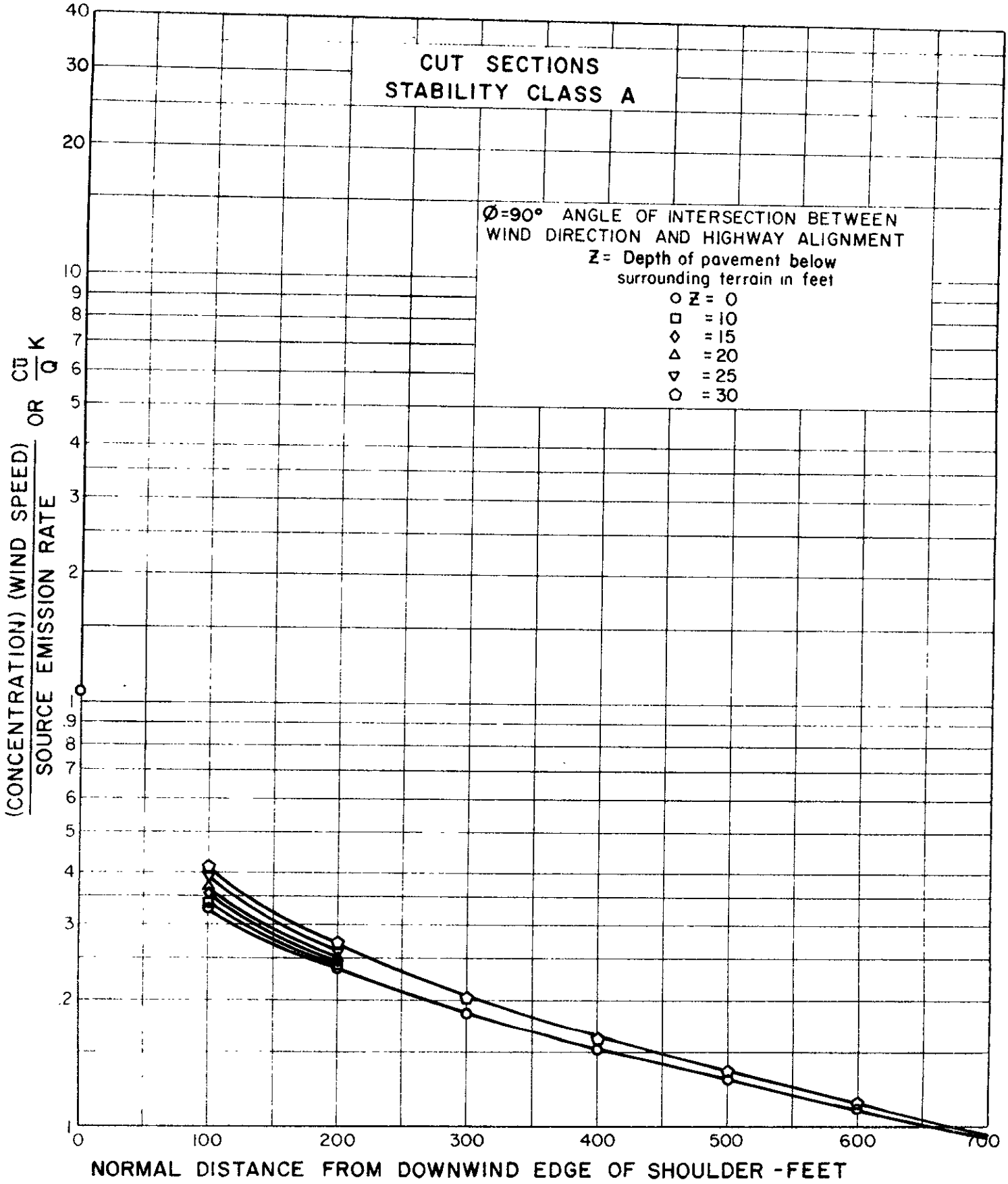

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Figure 56

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

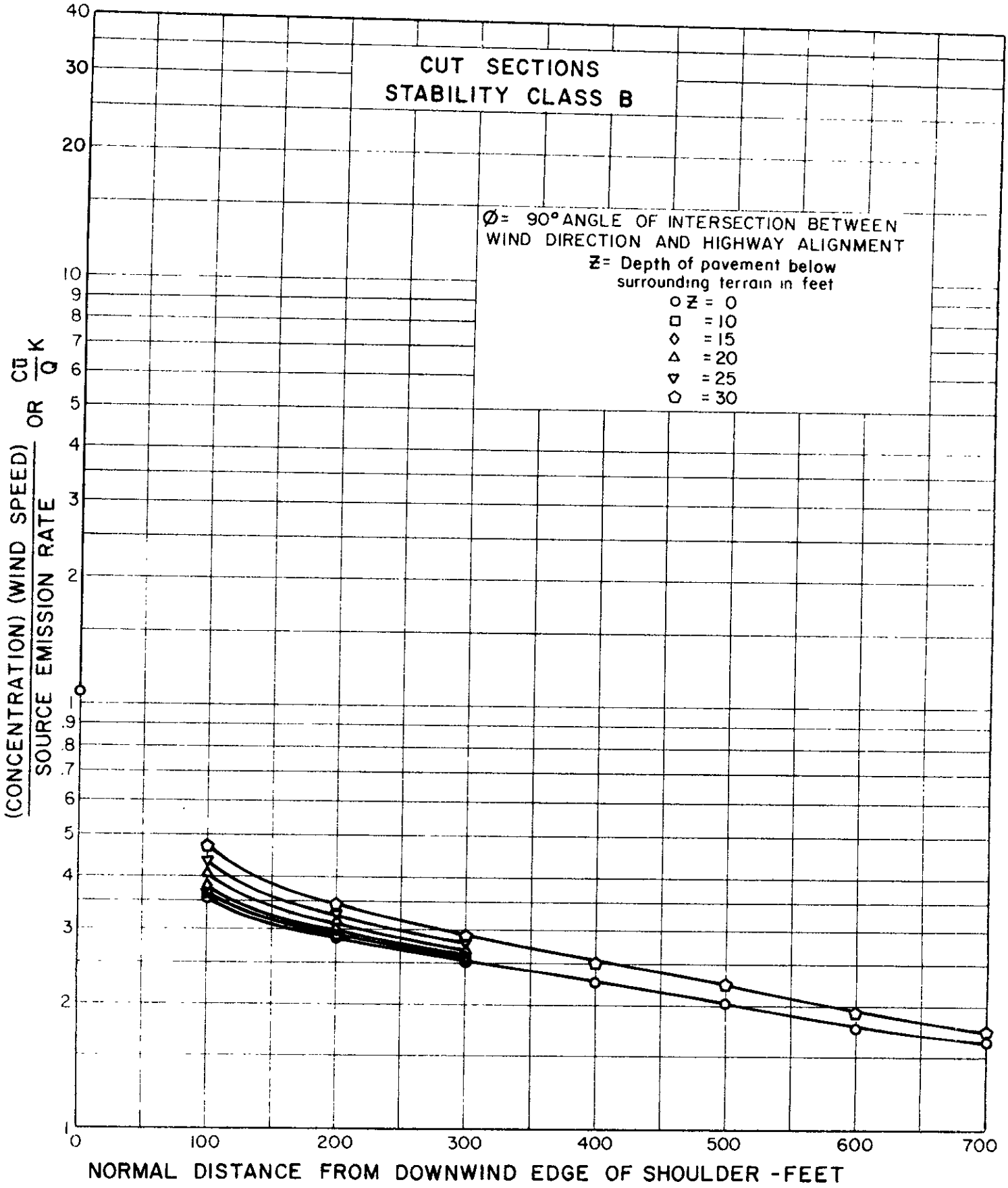

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Figure 57

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

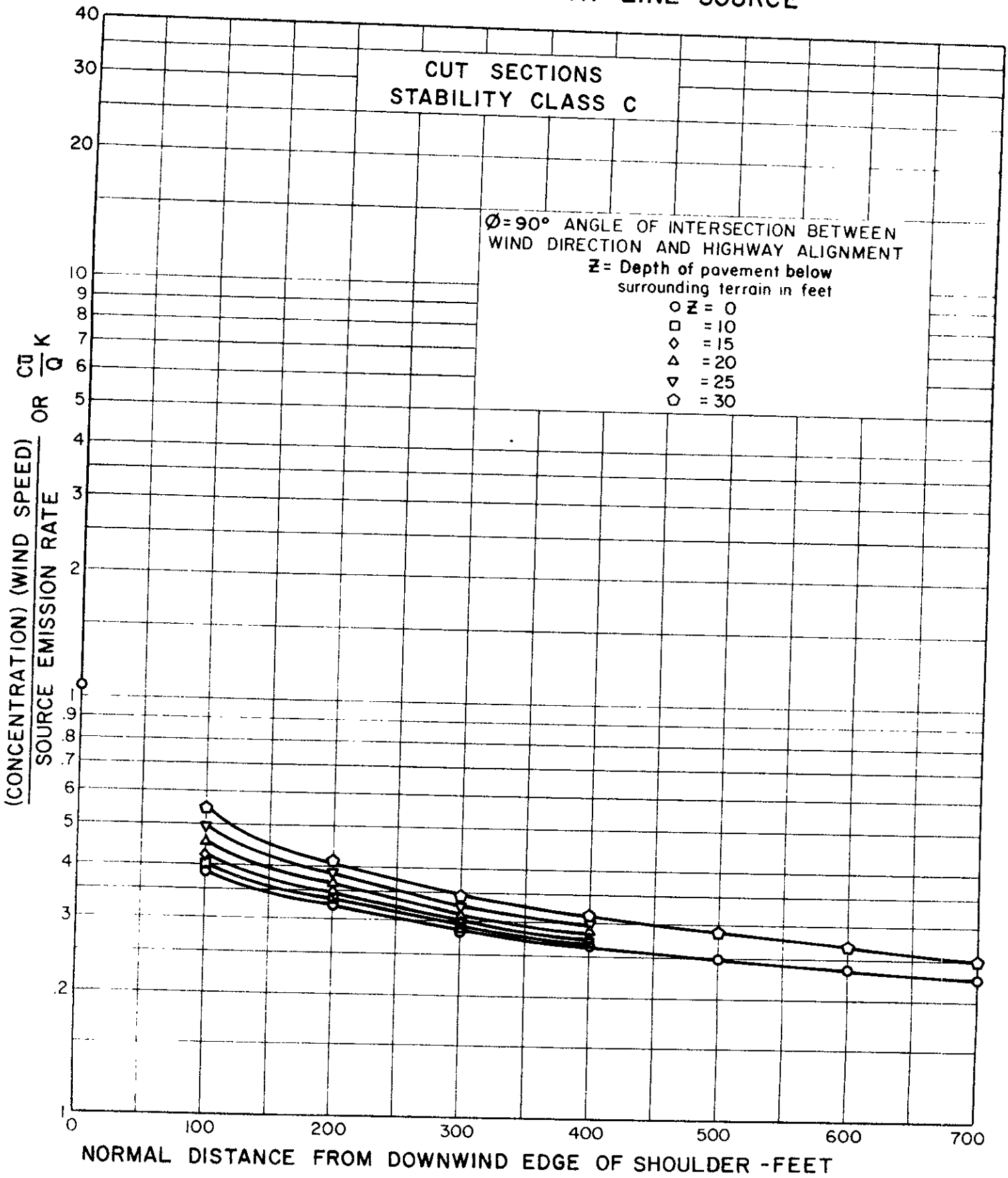

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Figure 58

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

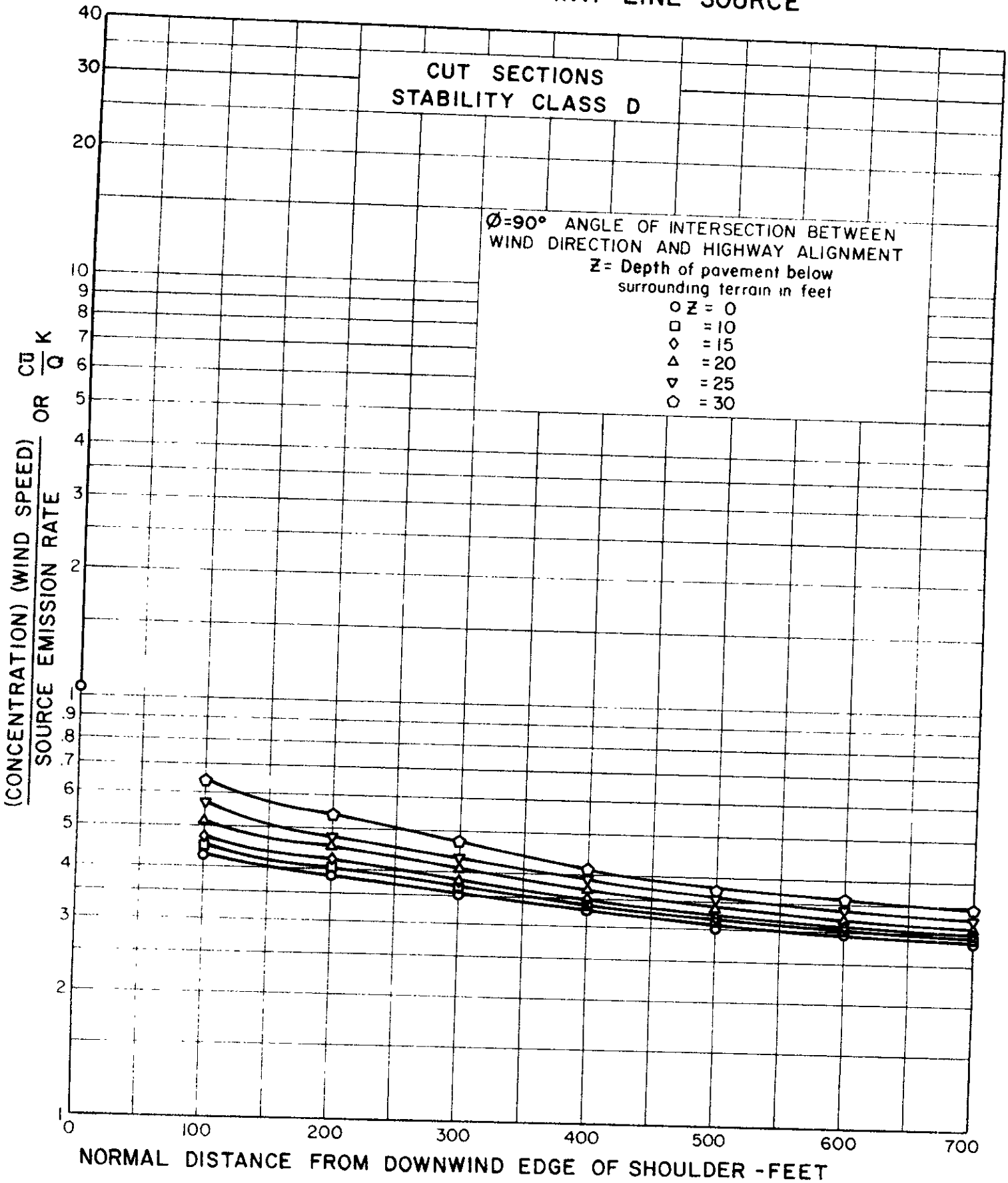

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Figure 59

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

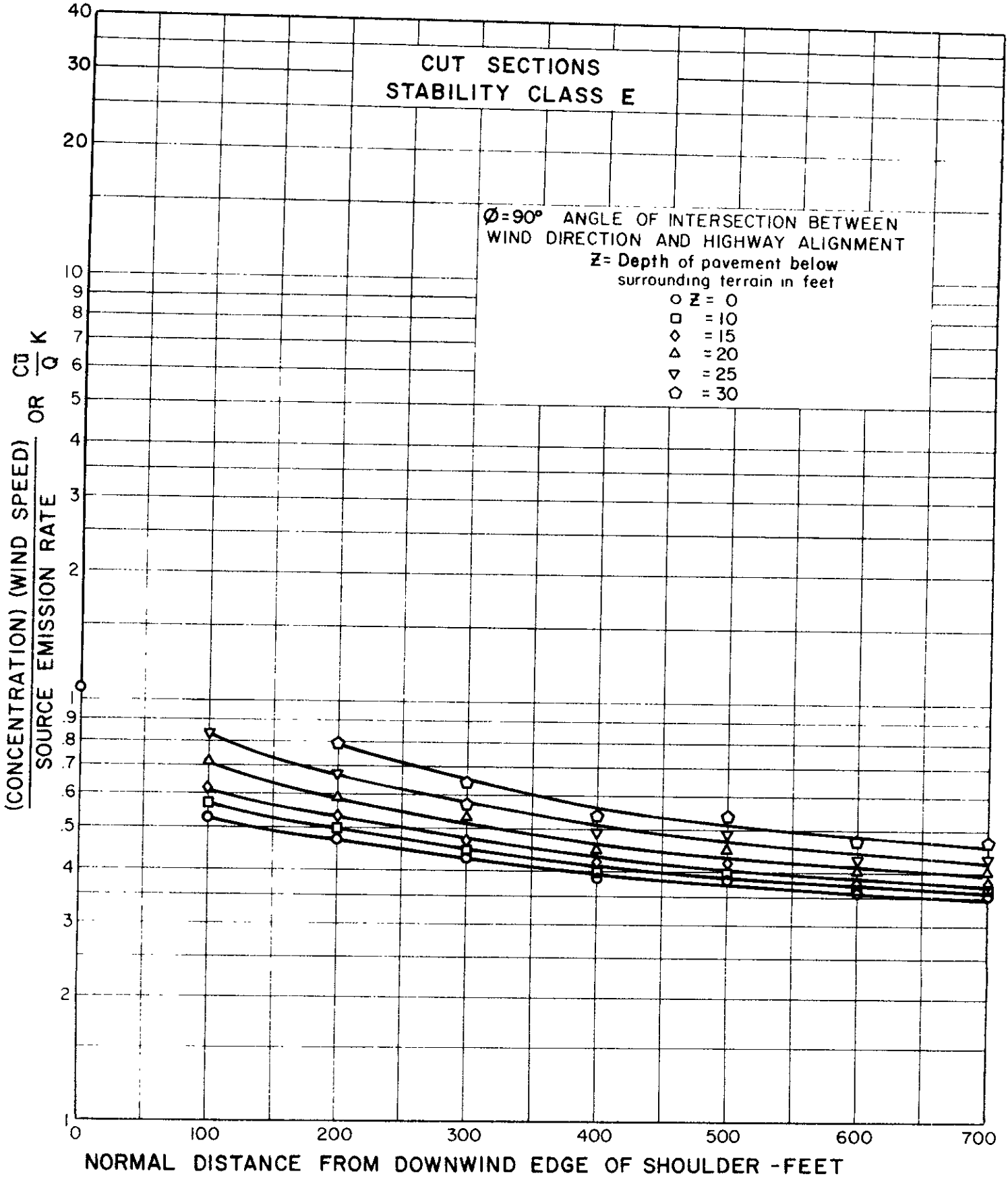

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Figure 60

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

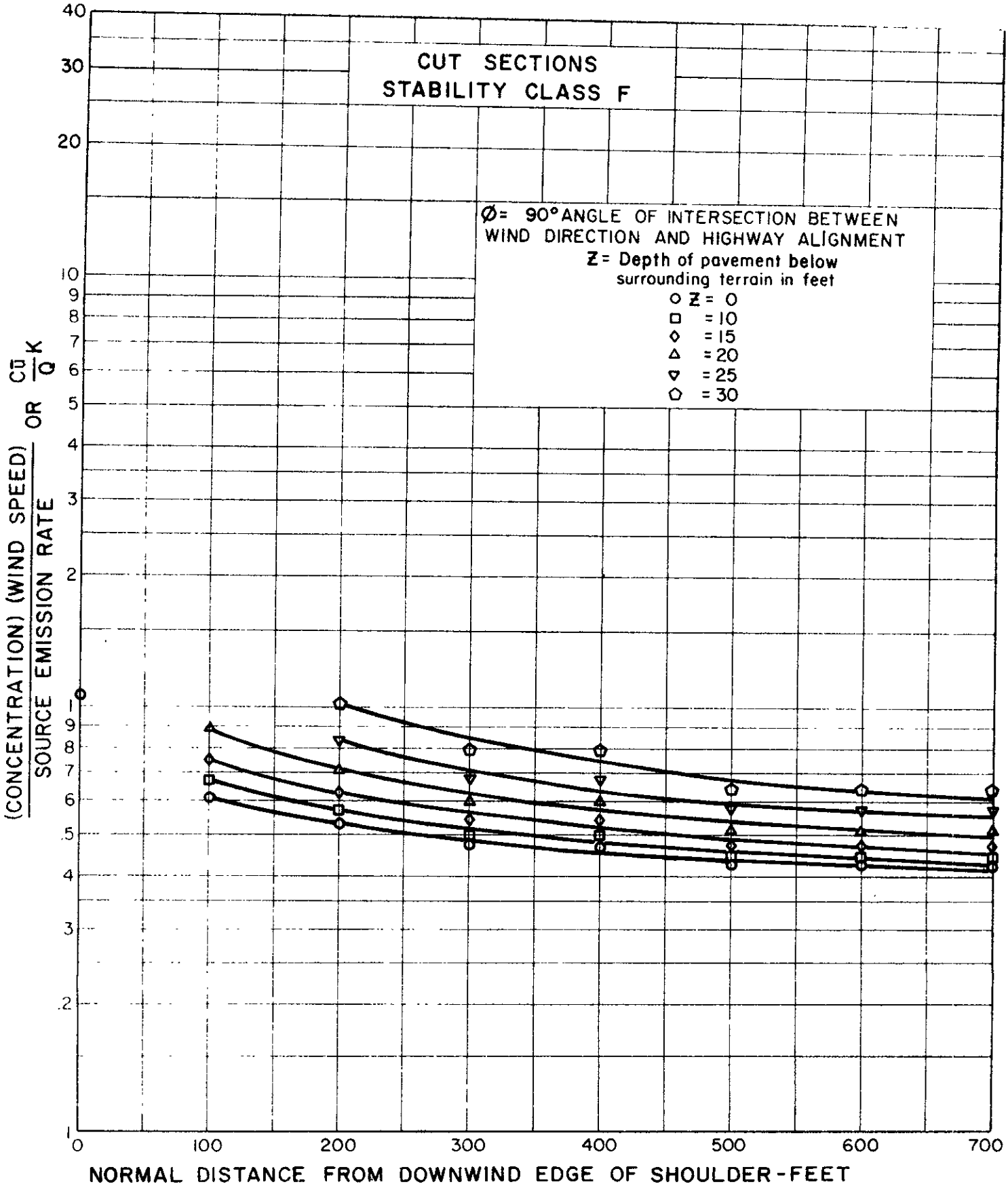

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Figure 61

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

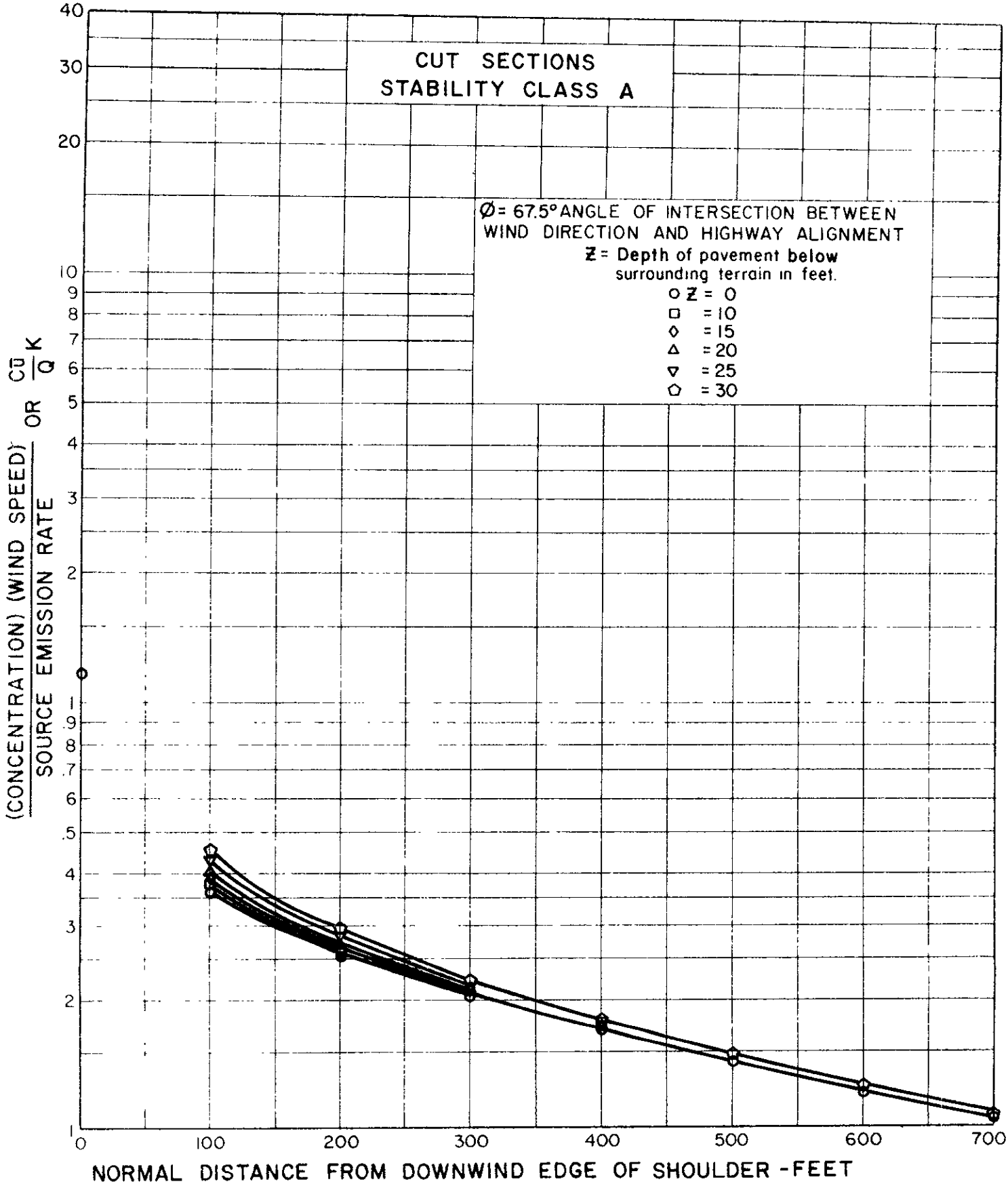

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Figure 62

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

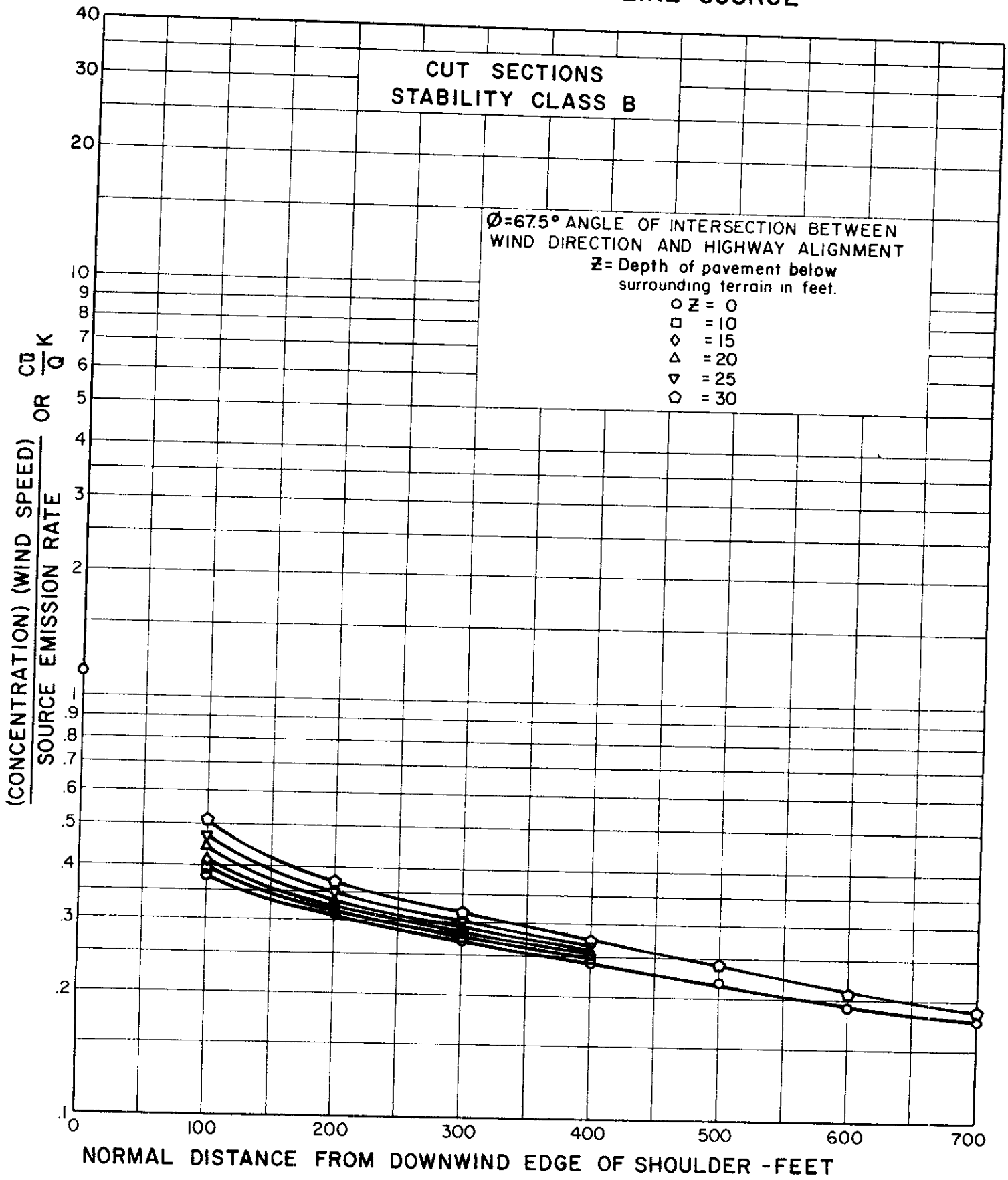

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Figure 63

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

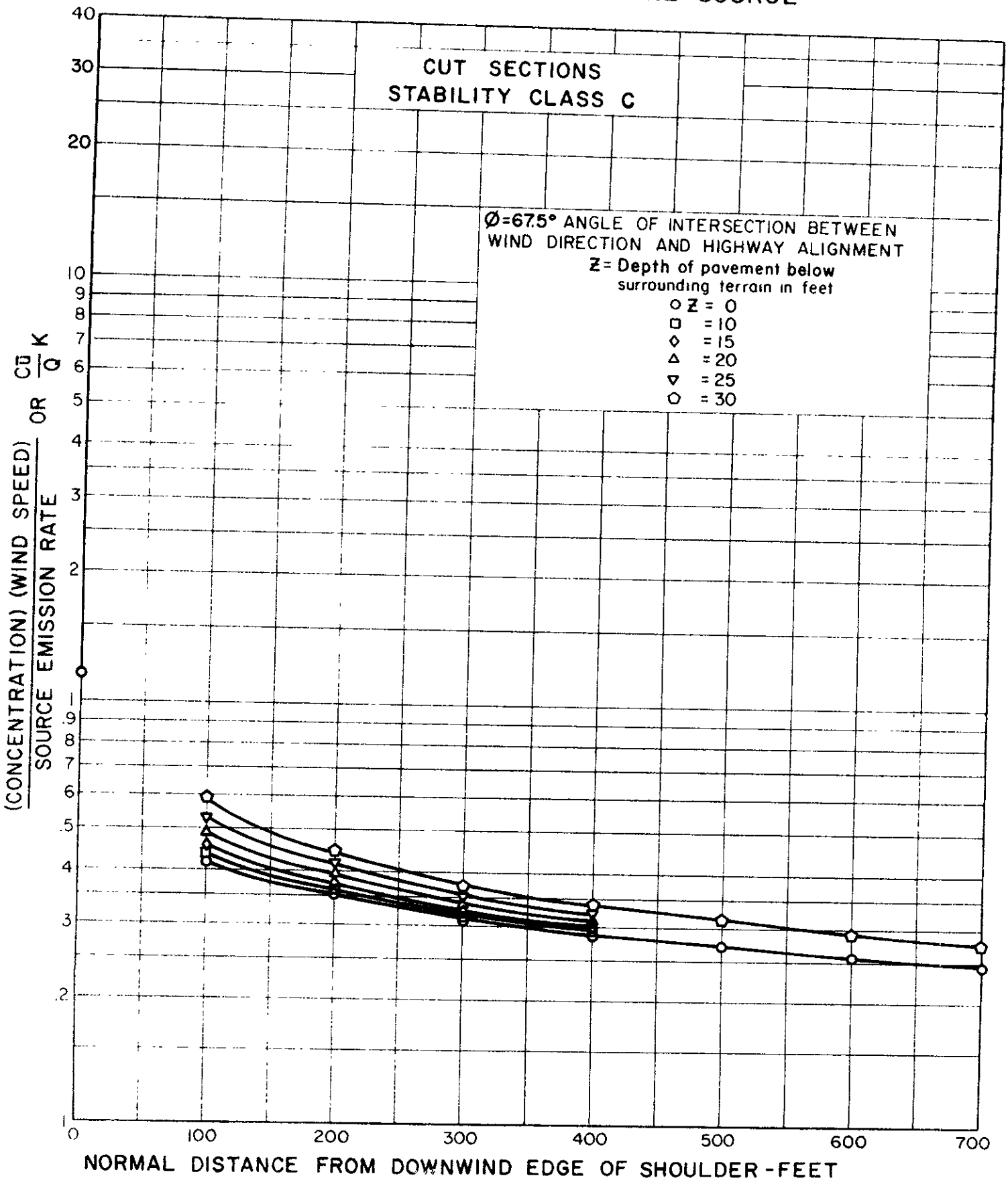

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Figure 64

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

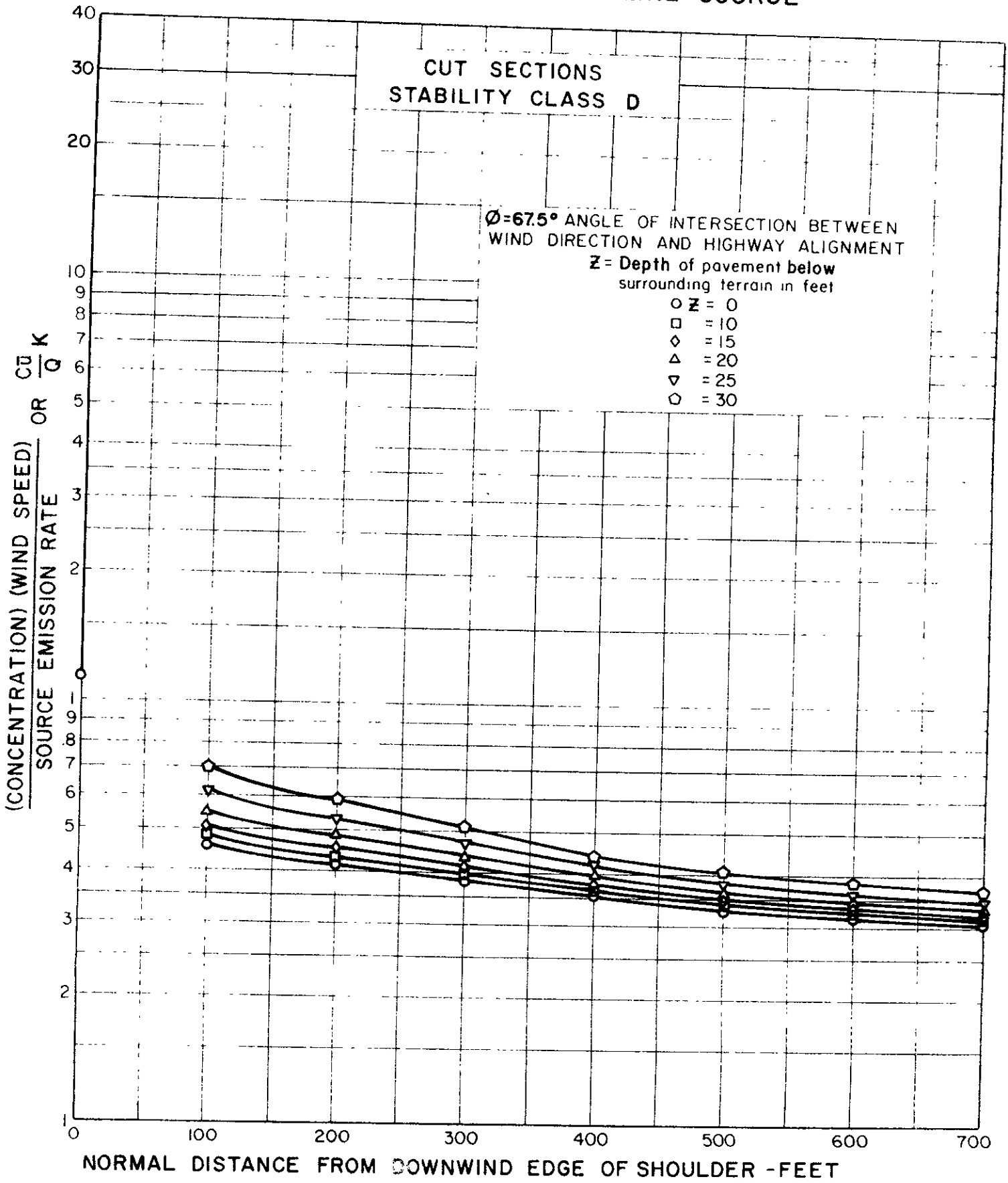

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Figure 65

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

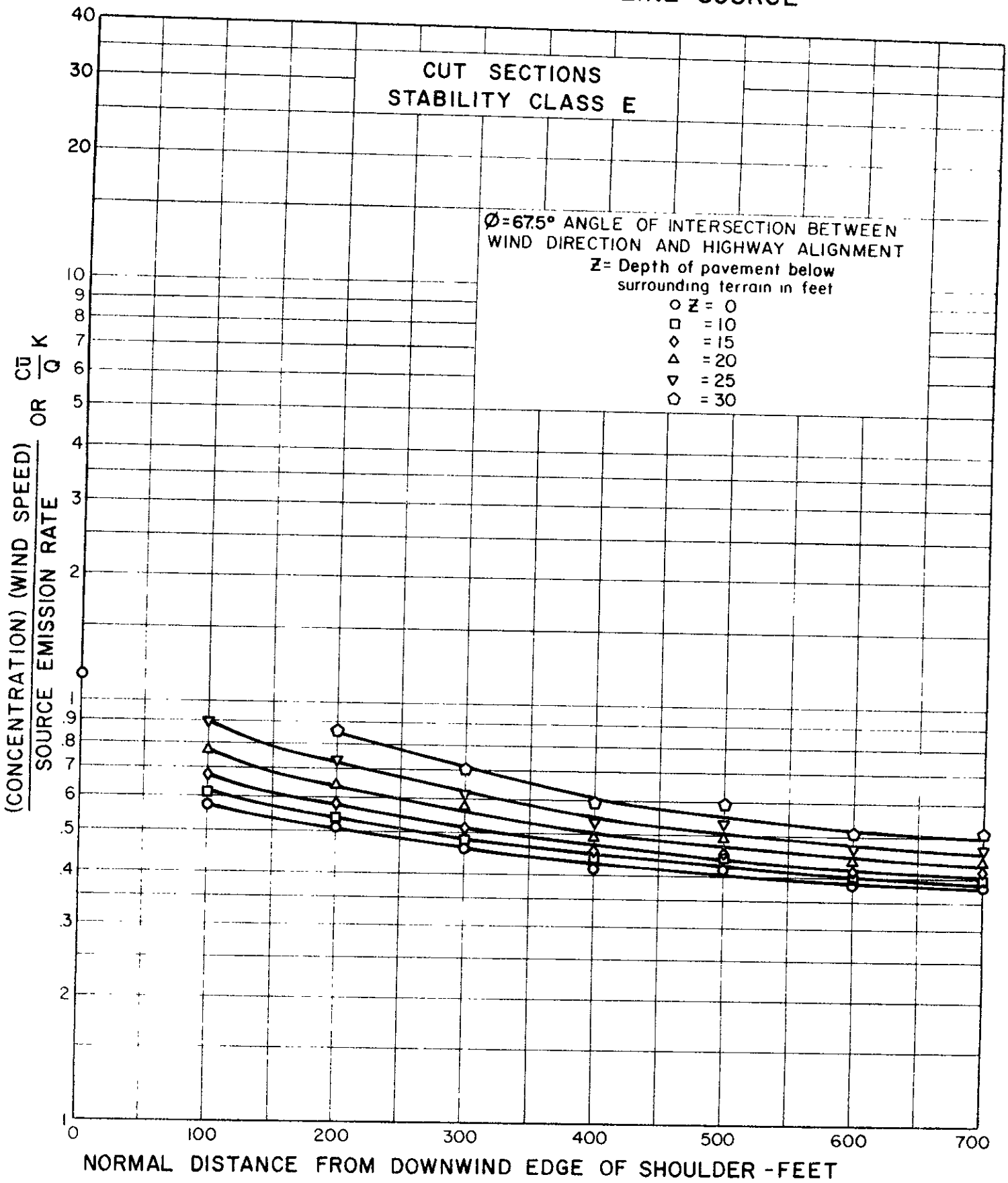

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Figure 66

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

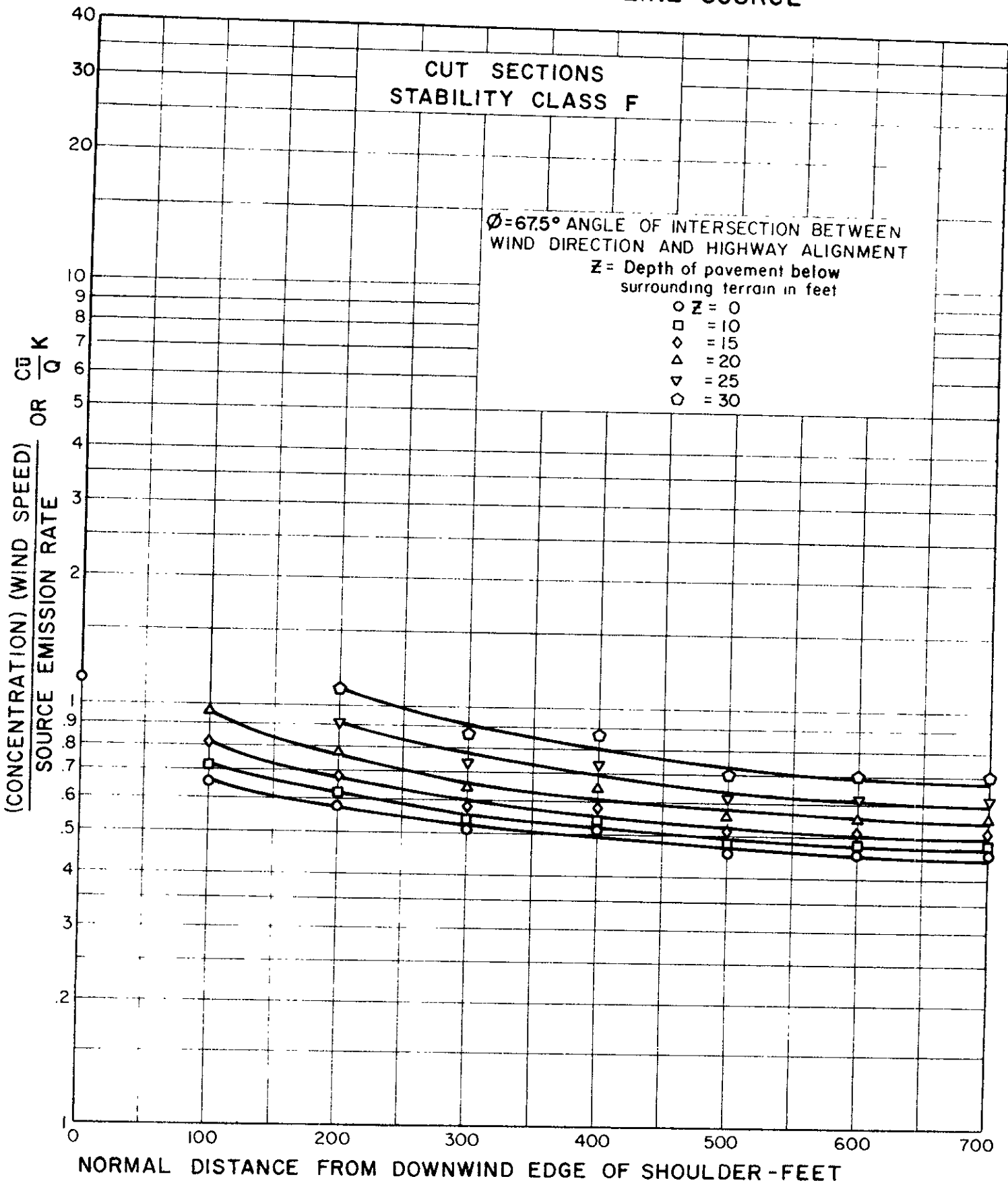

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Figure 67

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

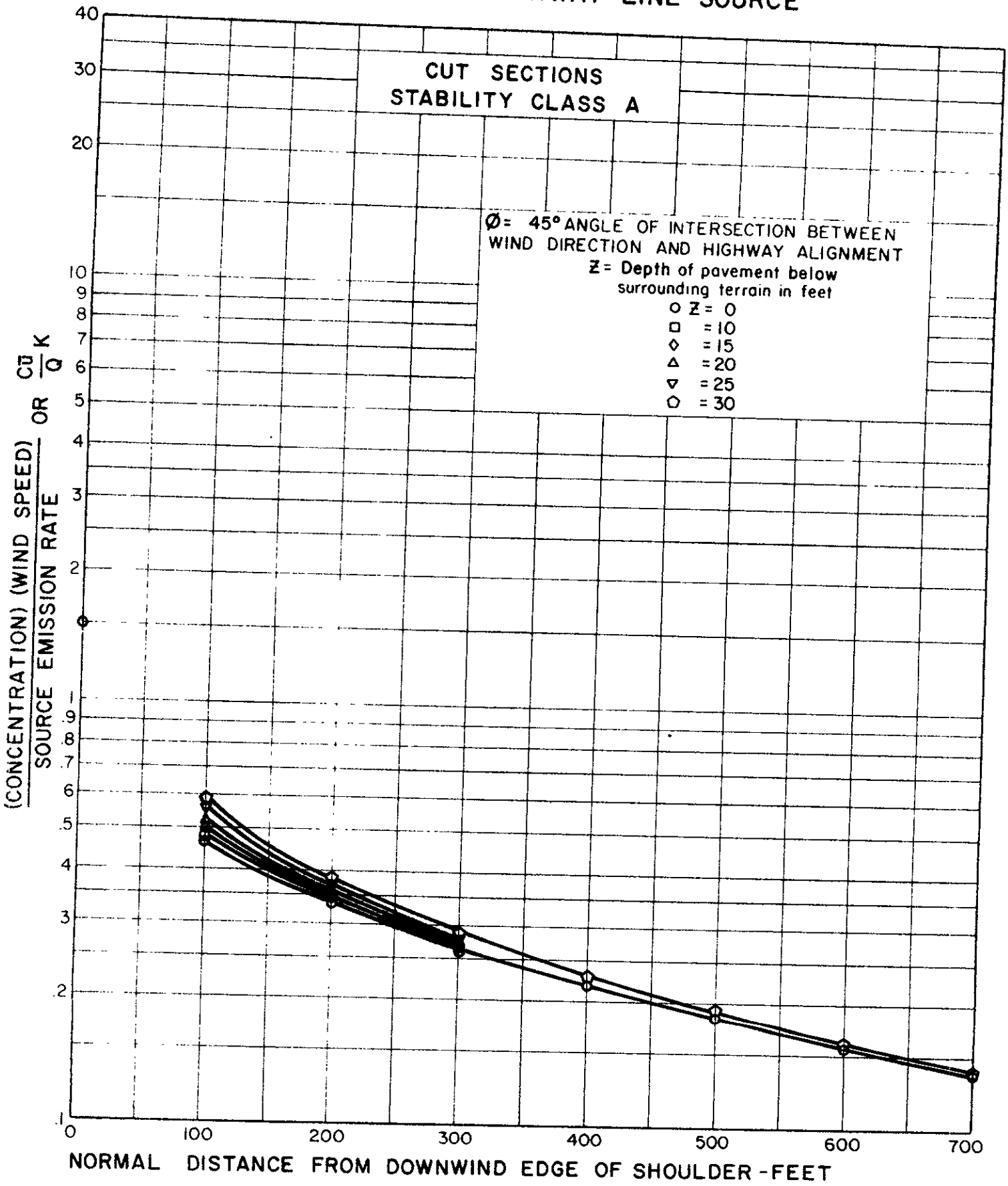

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Figure 68

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

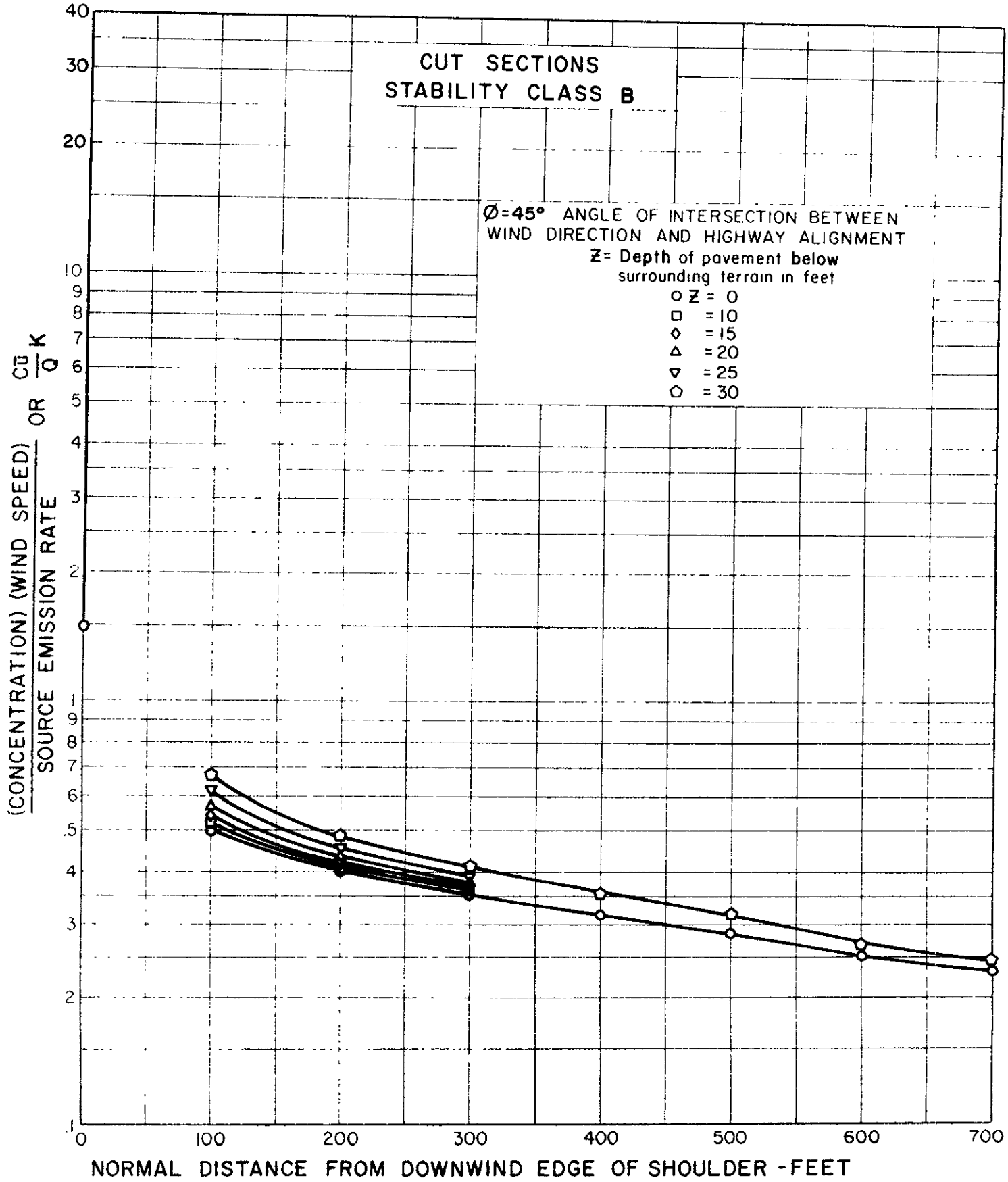

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Figure 69

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

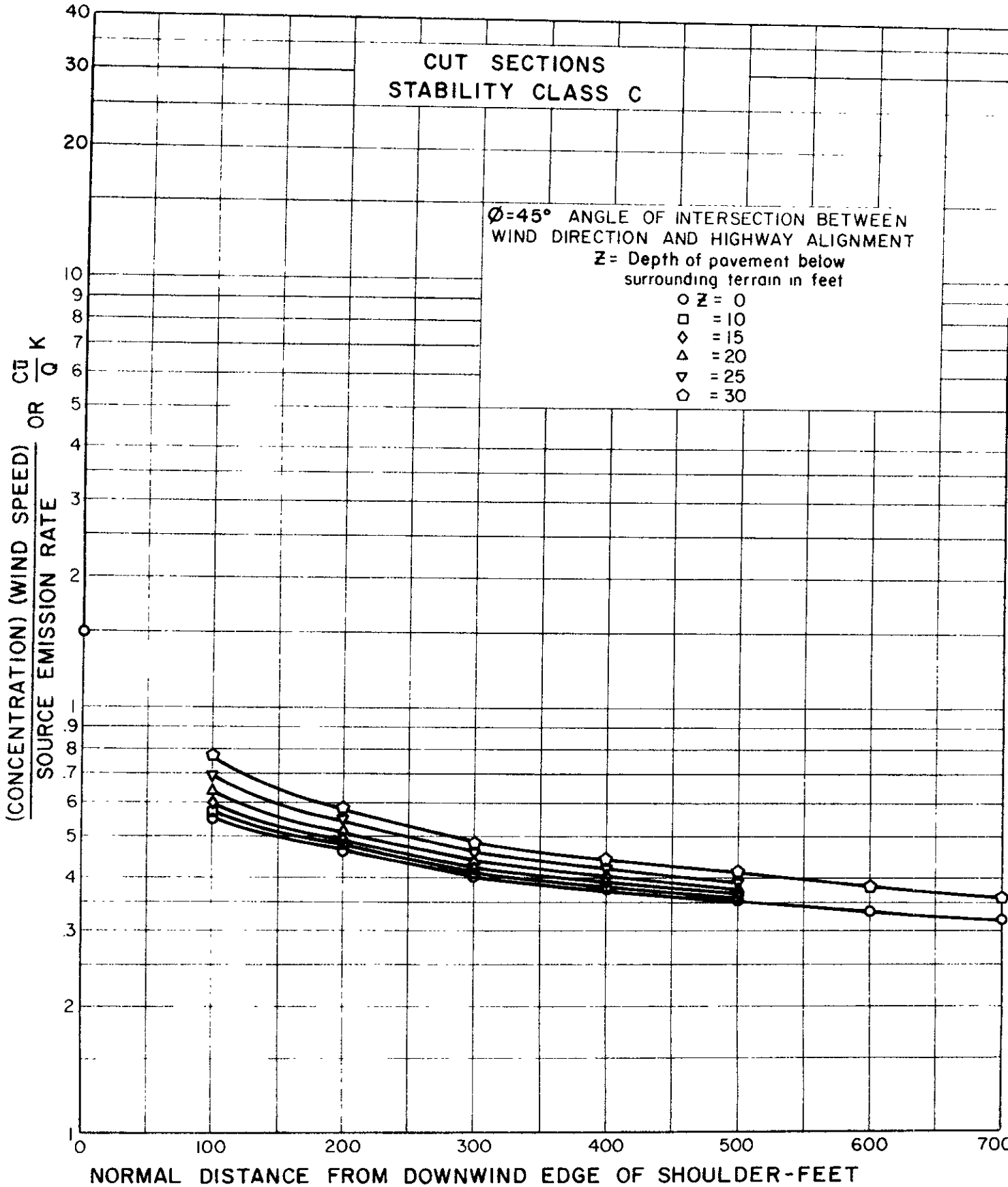

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Figure 70

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

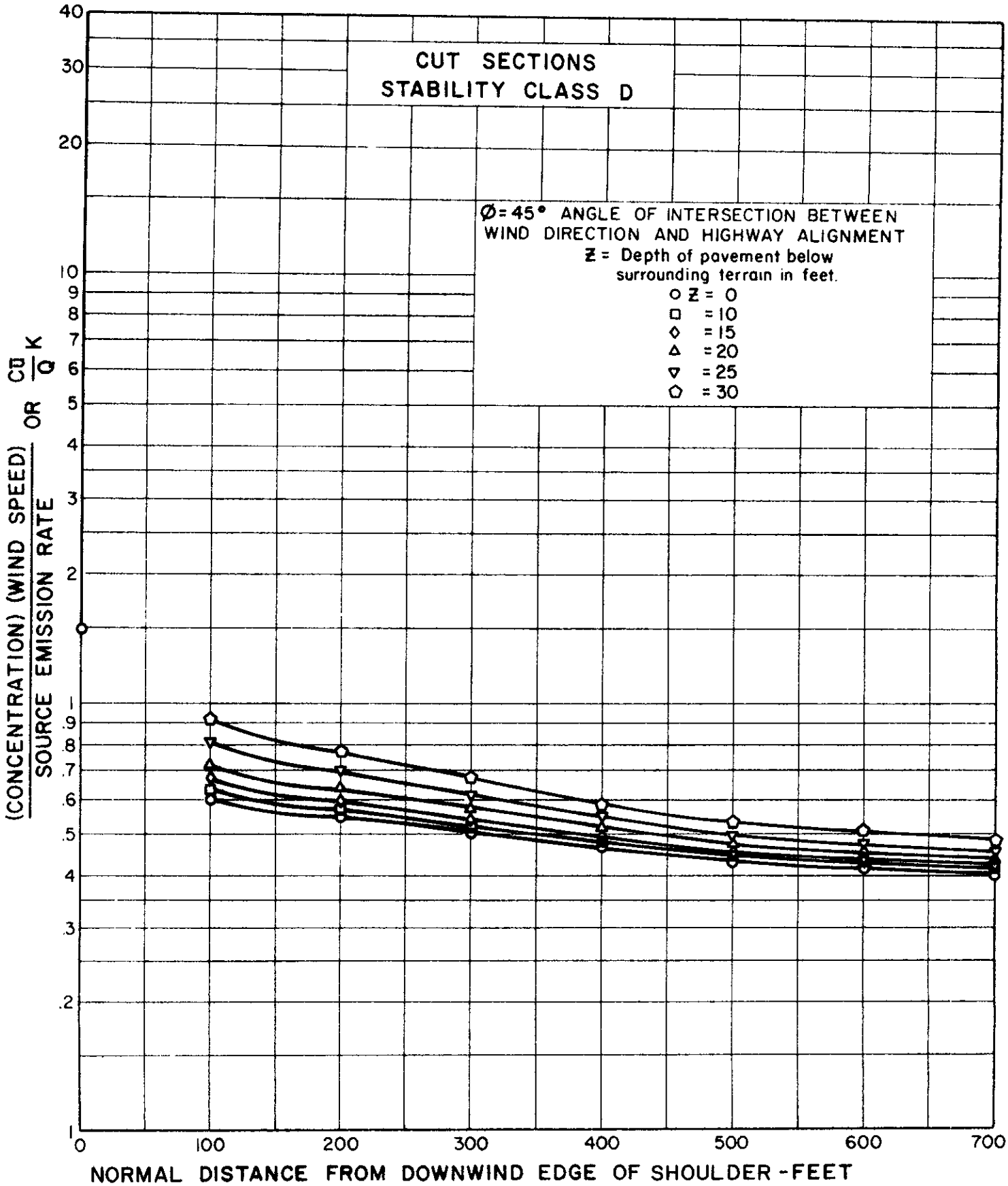

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Figure 71

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

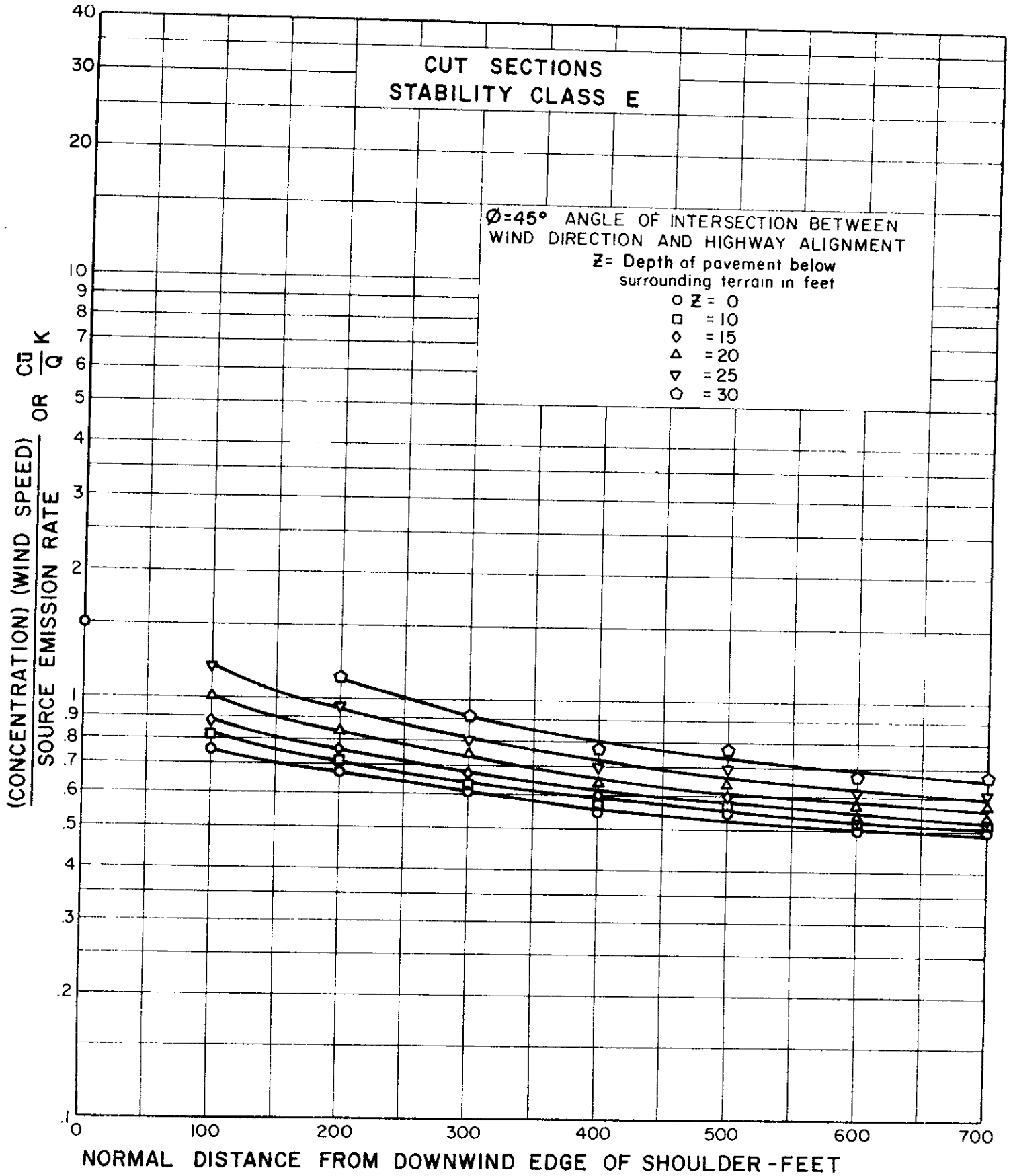

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Figure 72

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

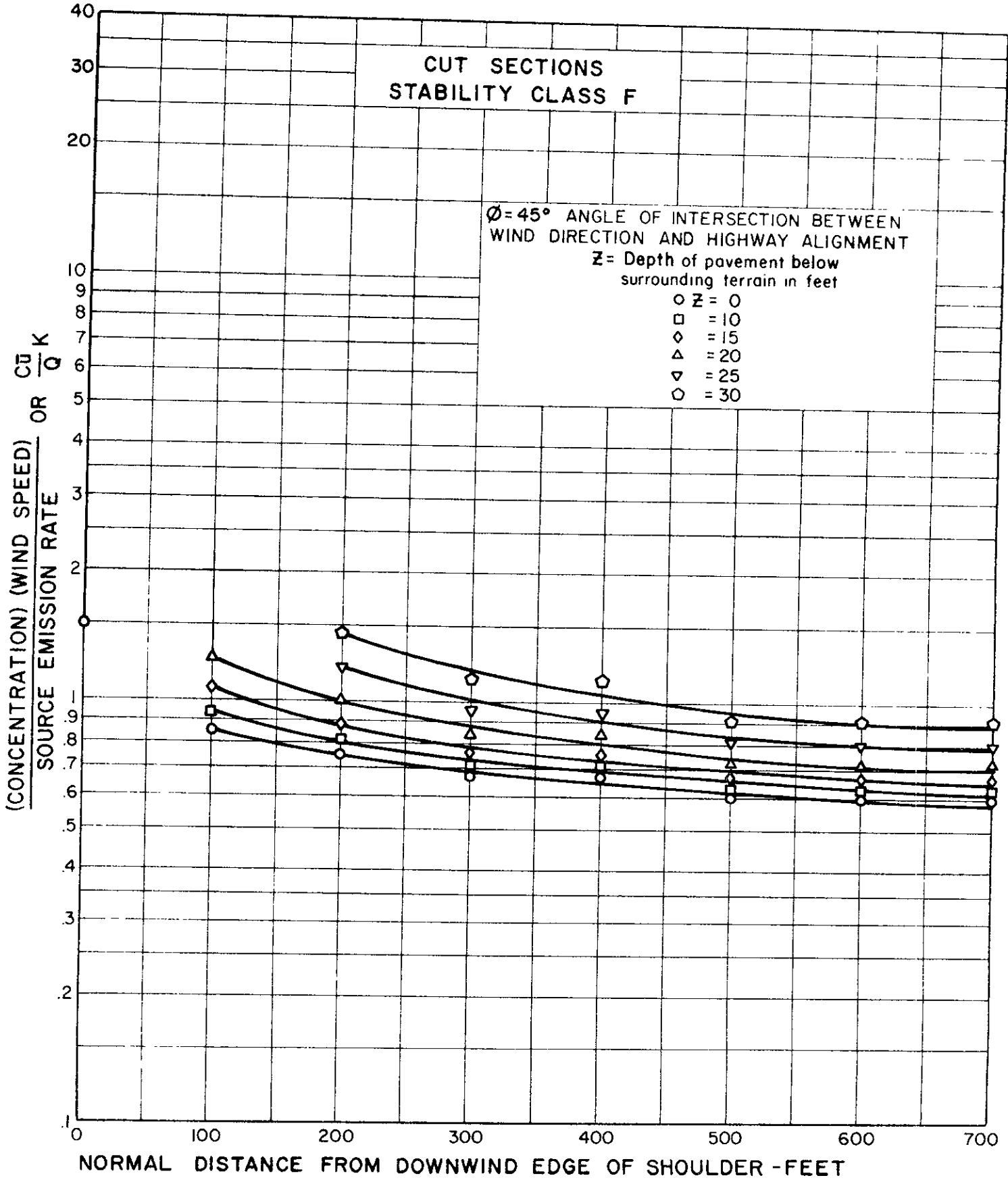

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Figure 73

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

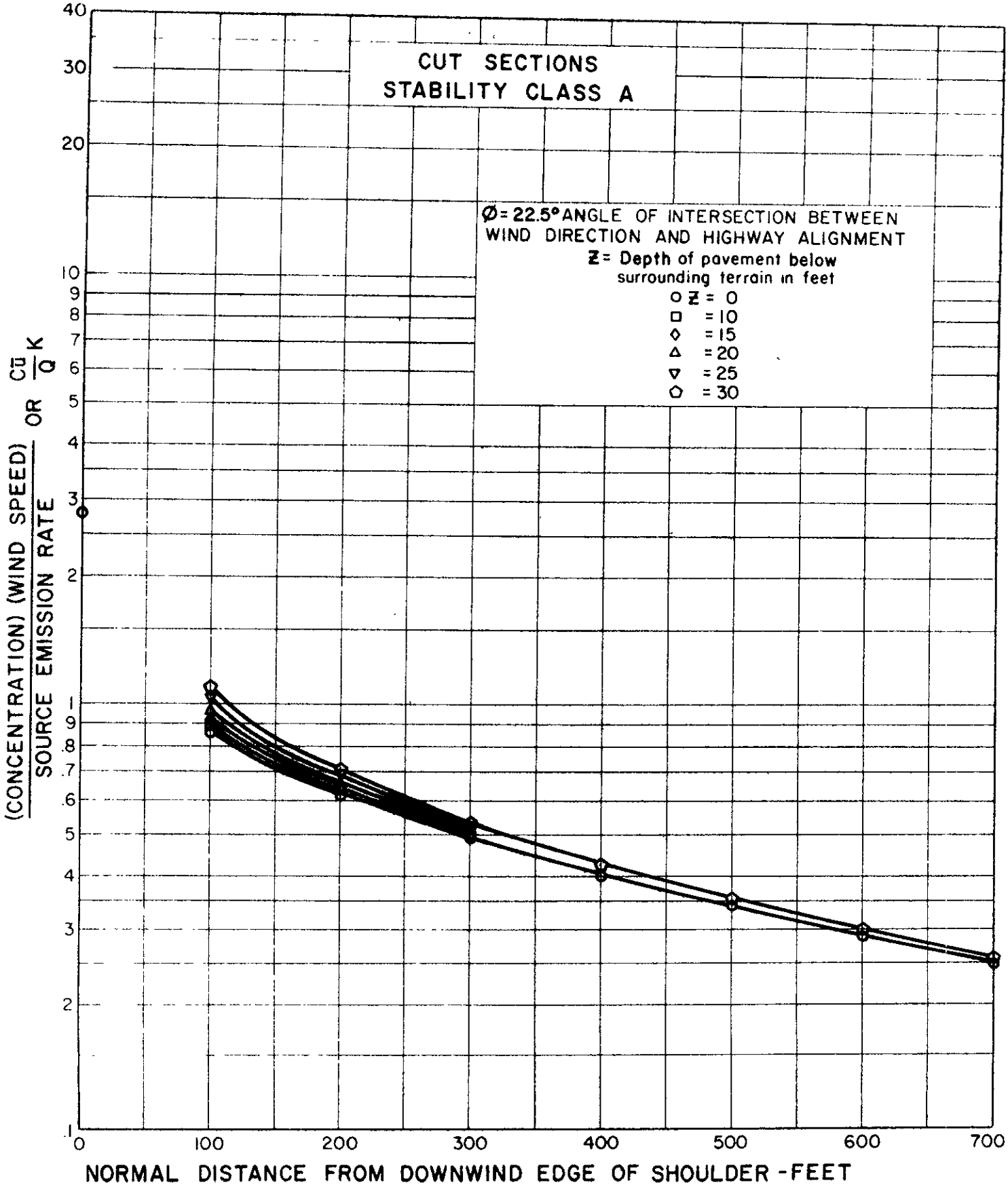

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Figure 74

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

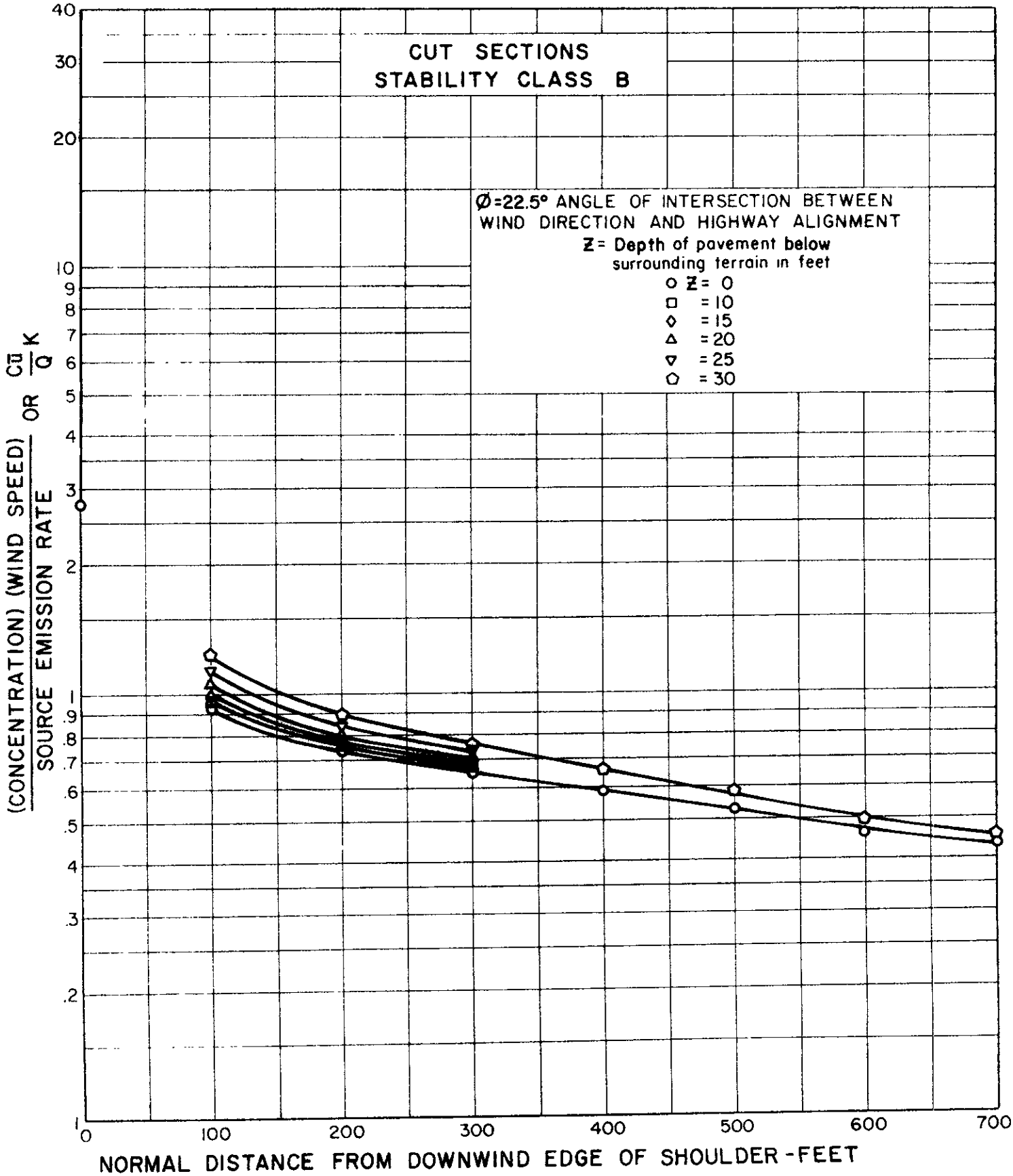

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Figure 75

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

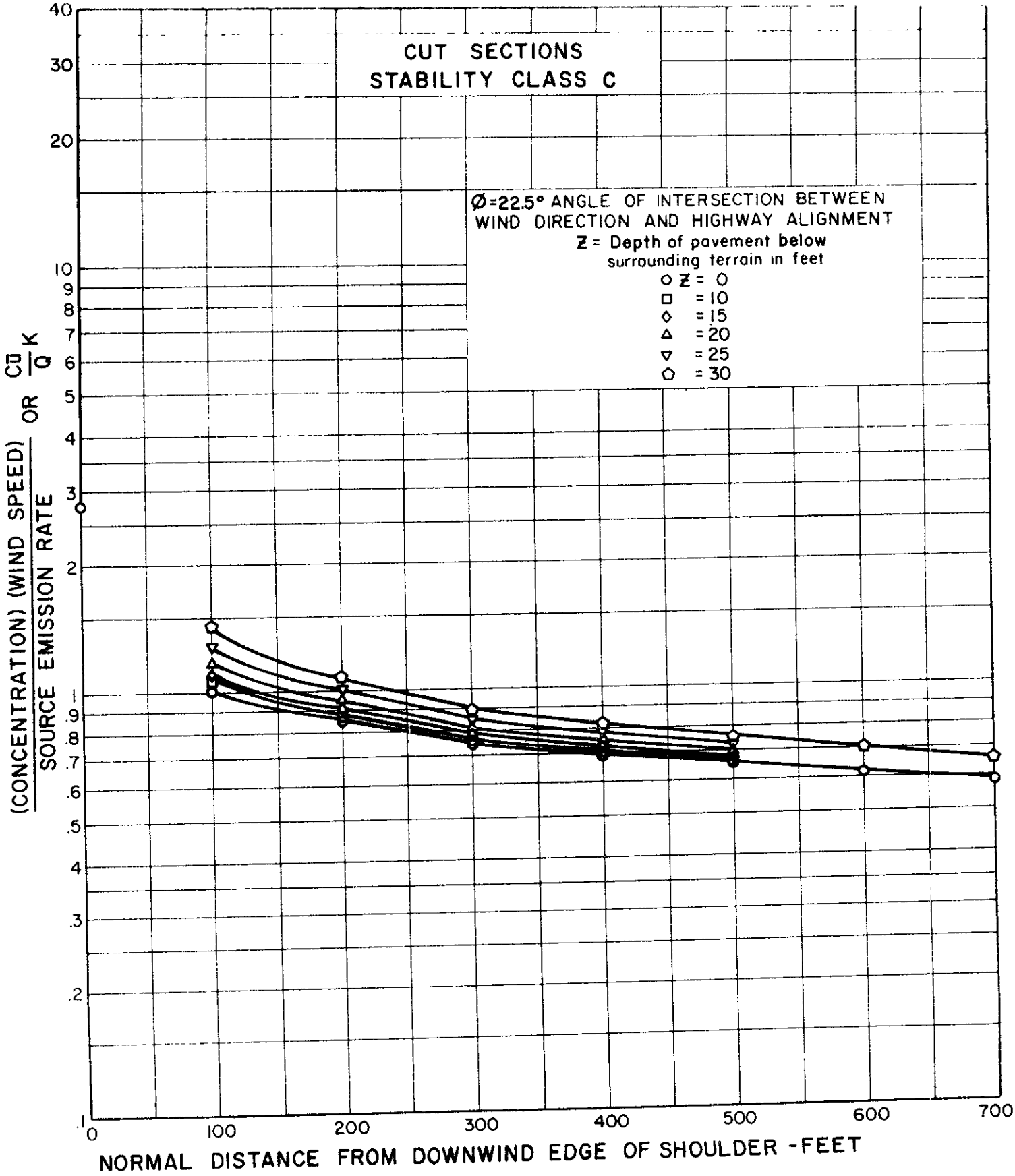

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Figure 76

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

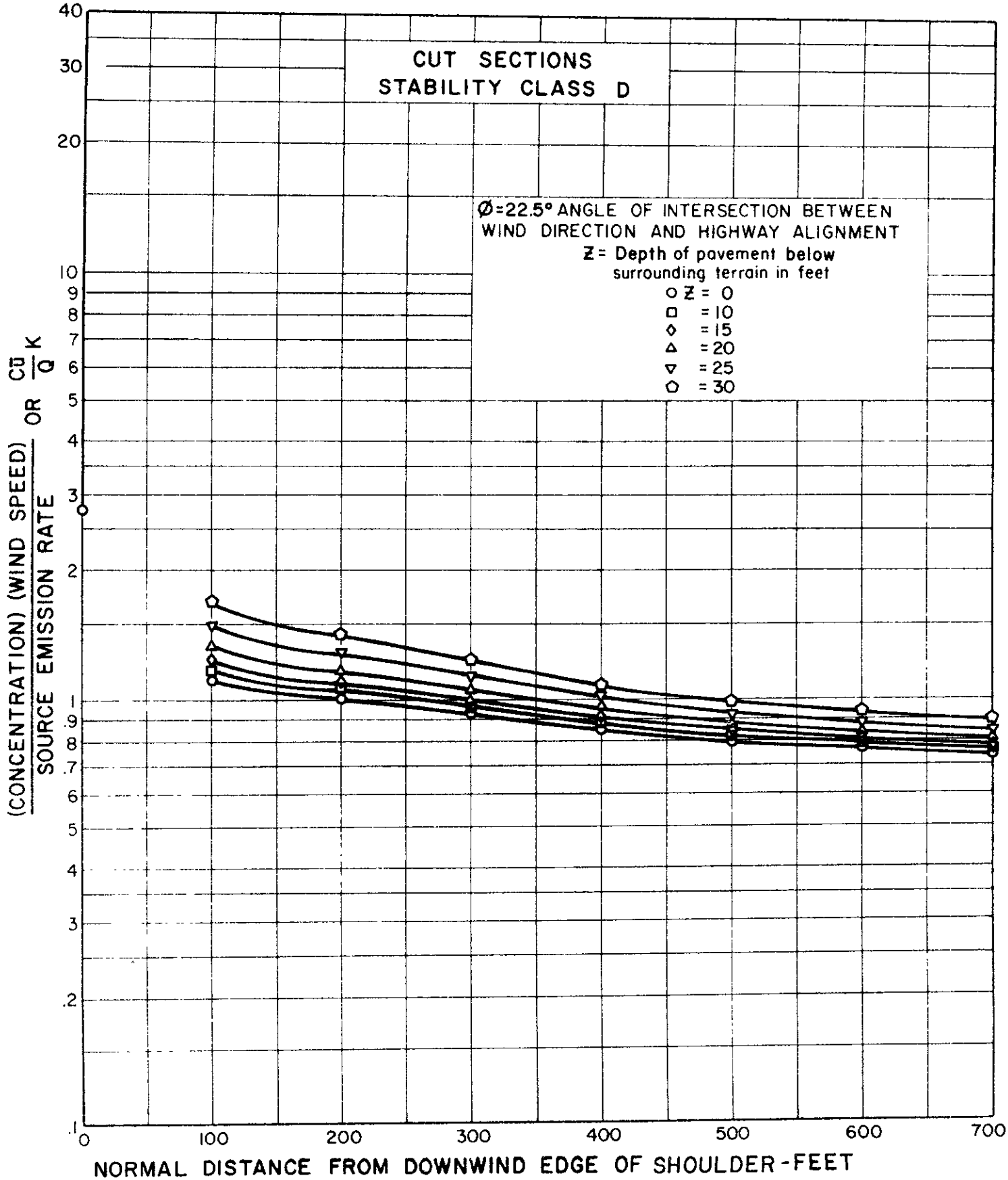

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Figure 77

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$
DOWNWIND FROM A HIGHWAY LINE SOURCE

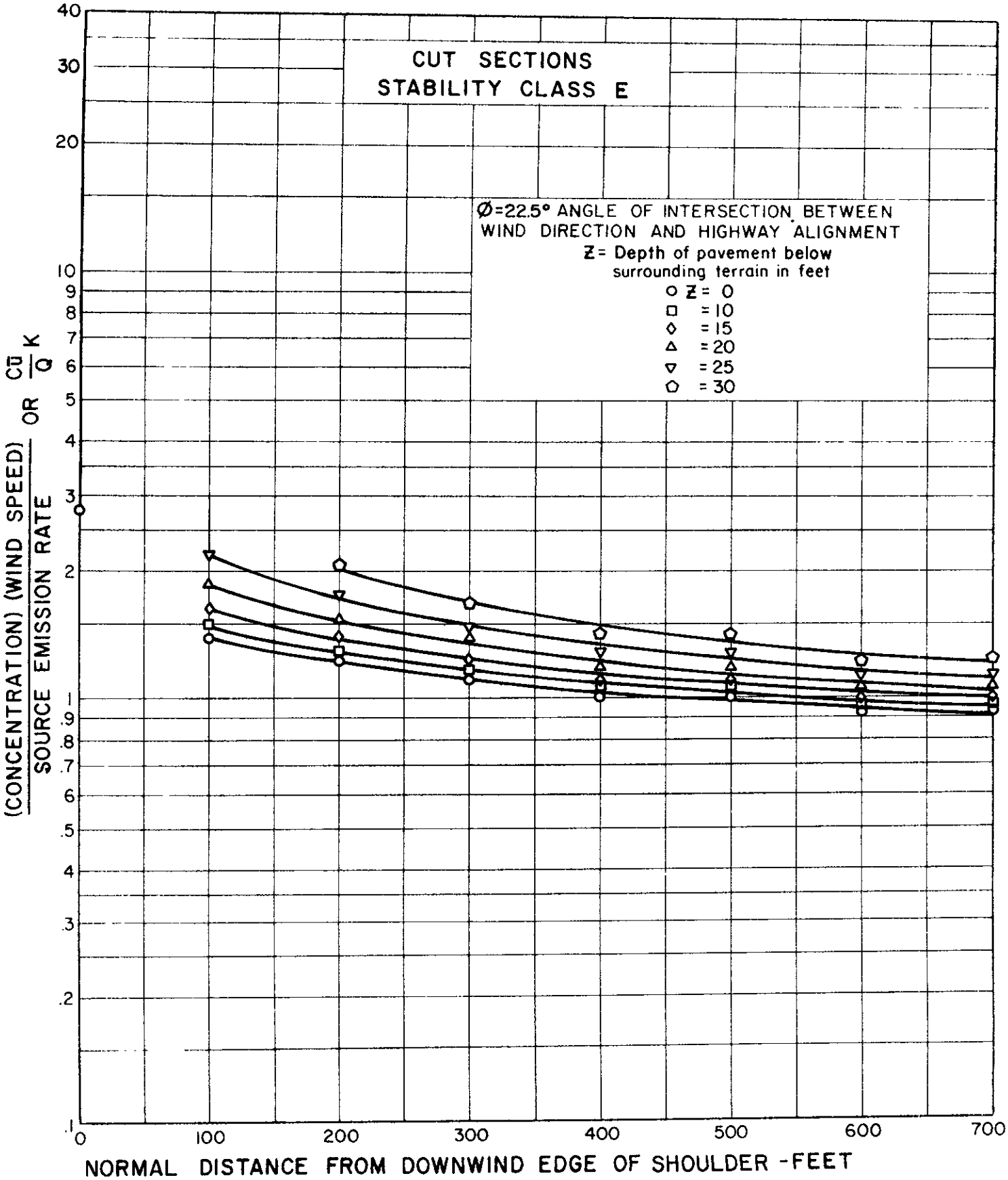

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Figure 78

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K$ DOWNWIND FROM A HIGHWAY LINE SOURCE

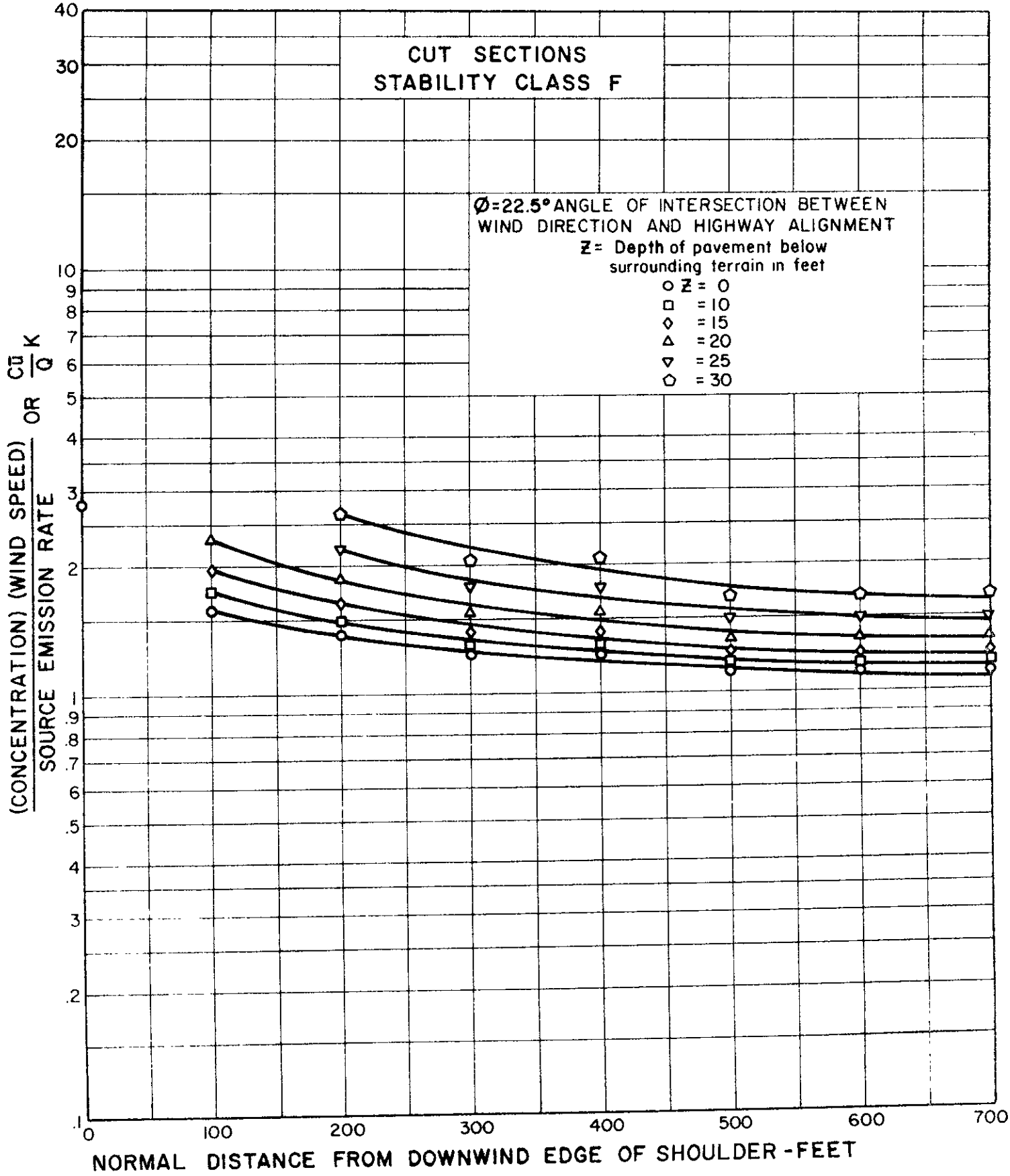

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Figure 81

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q}K\left(\frac{W}{30.5}\right)$ DOWNWIND FROM HIGHWAY LINE SOURCE PARALLEL WIND (CUT SECTIONS) STABILITY CLASS B

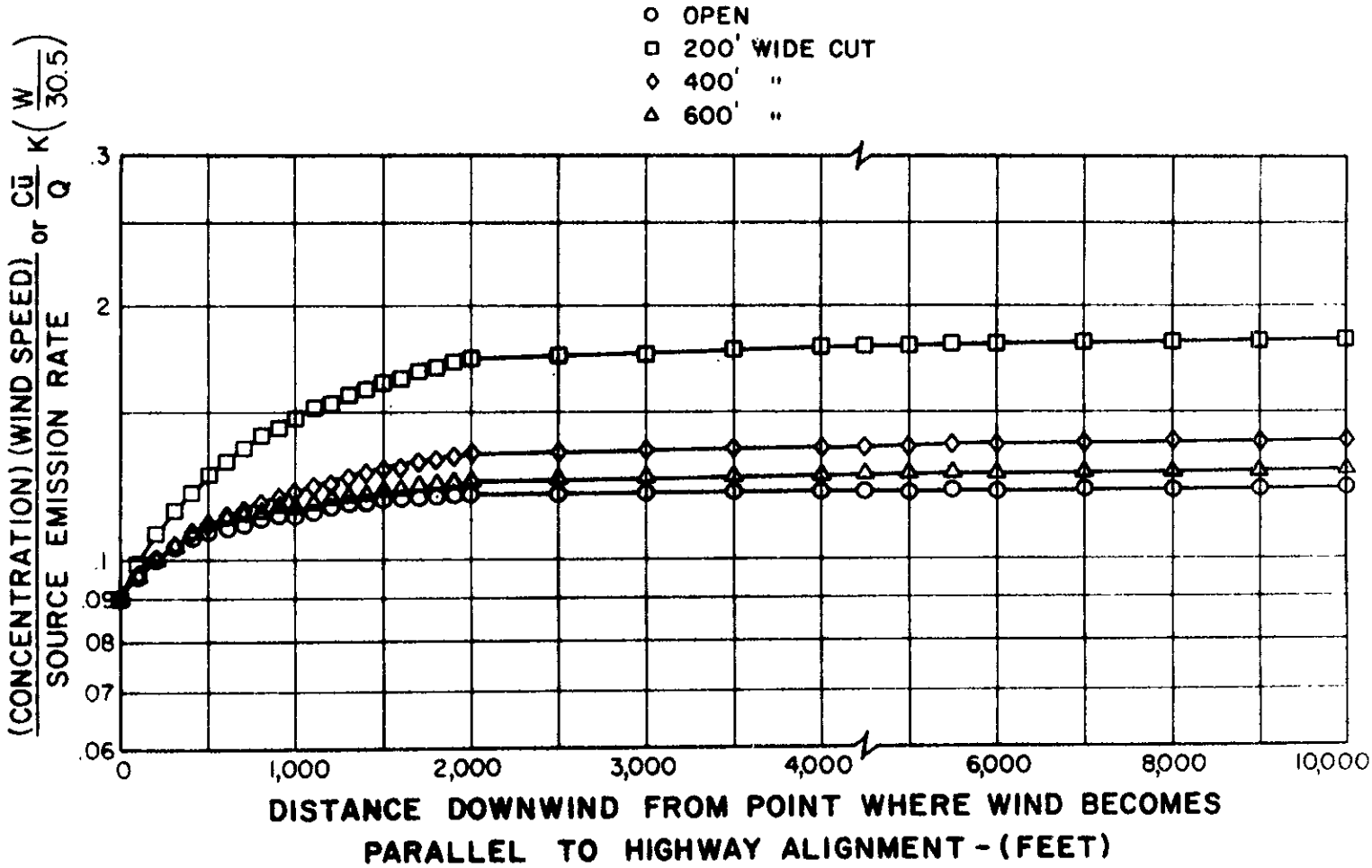

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Figure 82

GROUND LEVEL CONCENTRATION RATIO $\frac{C\bar{u}}{Q} K\left(\frac{W}{30.5}\right)$ DOWNWIND FROM HIGHWAY LINE SOURCE PARALLEL WIND (CUT SECTIONS) STABILITY CLASS C

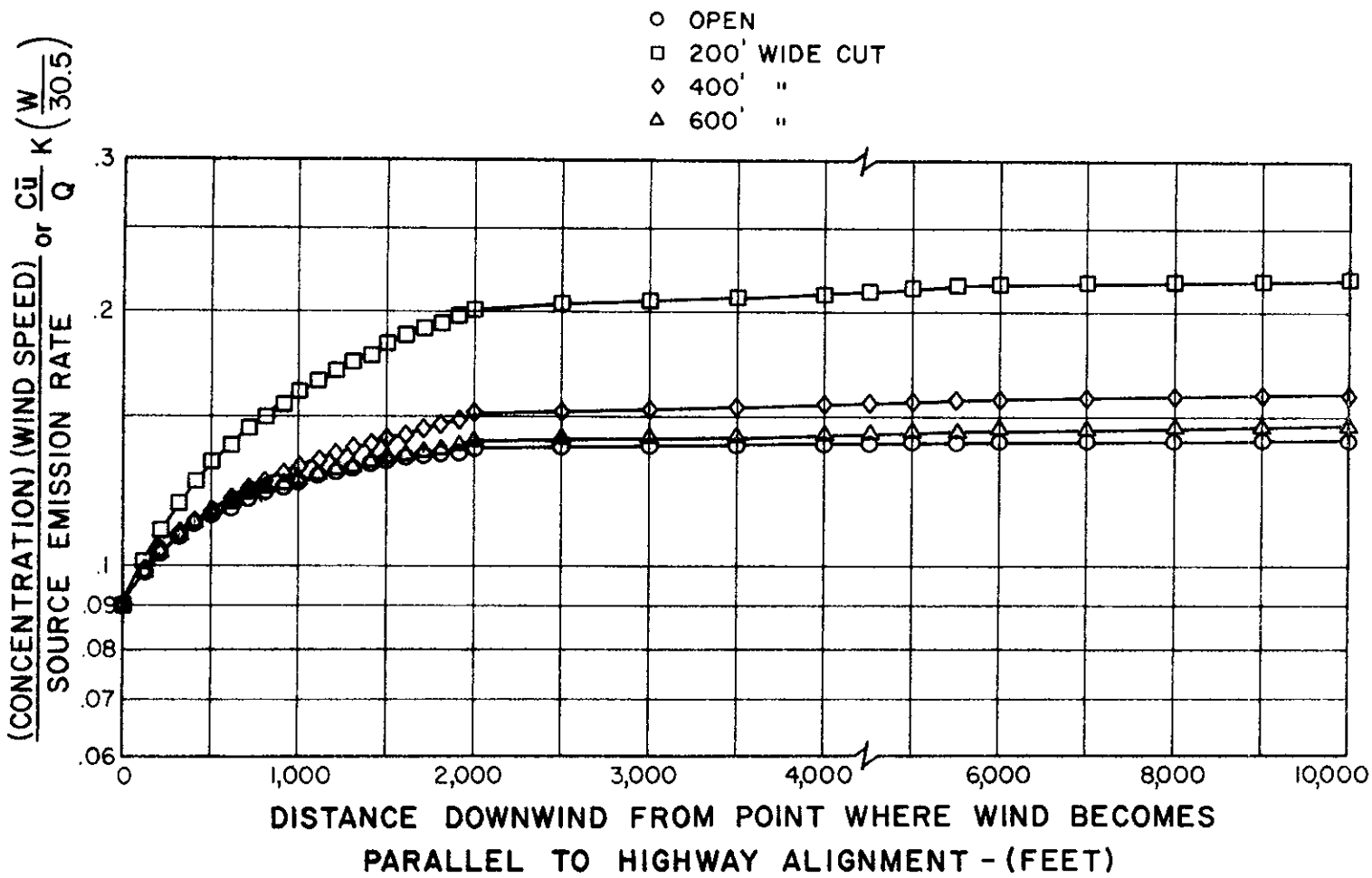

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Figure 89

EMISSION FACTORS FOR CARBON MONOXIDE VS AVERAGE ROUTE SPEED ON FREEWAYS 5% HDV

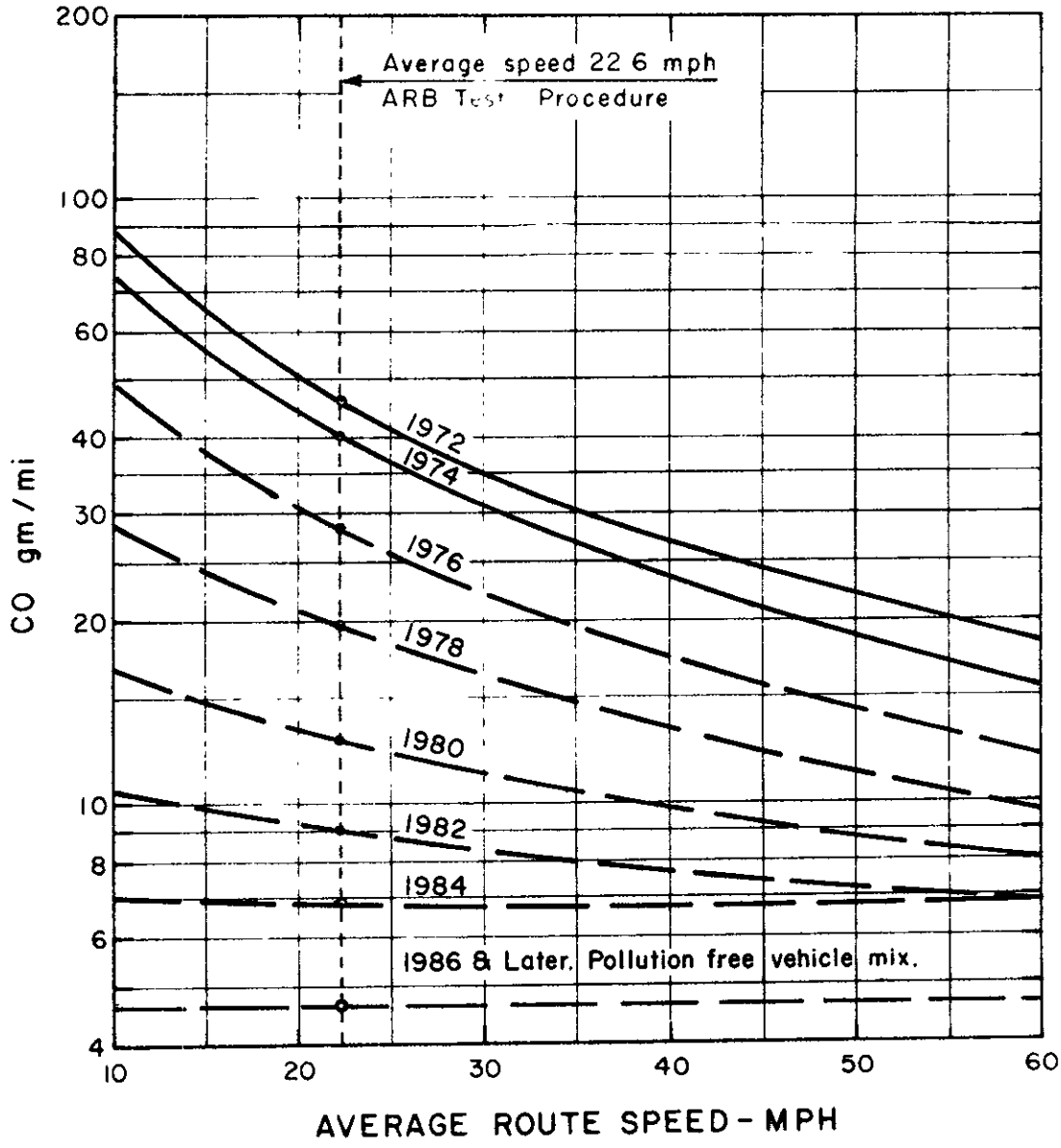

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Figure 90

EMISSION FACTORS FOR CARBON MONOXIDE VS AVERAGE ROUTE SPEED ON FREEWAYS 10% HDV

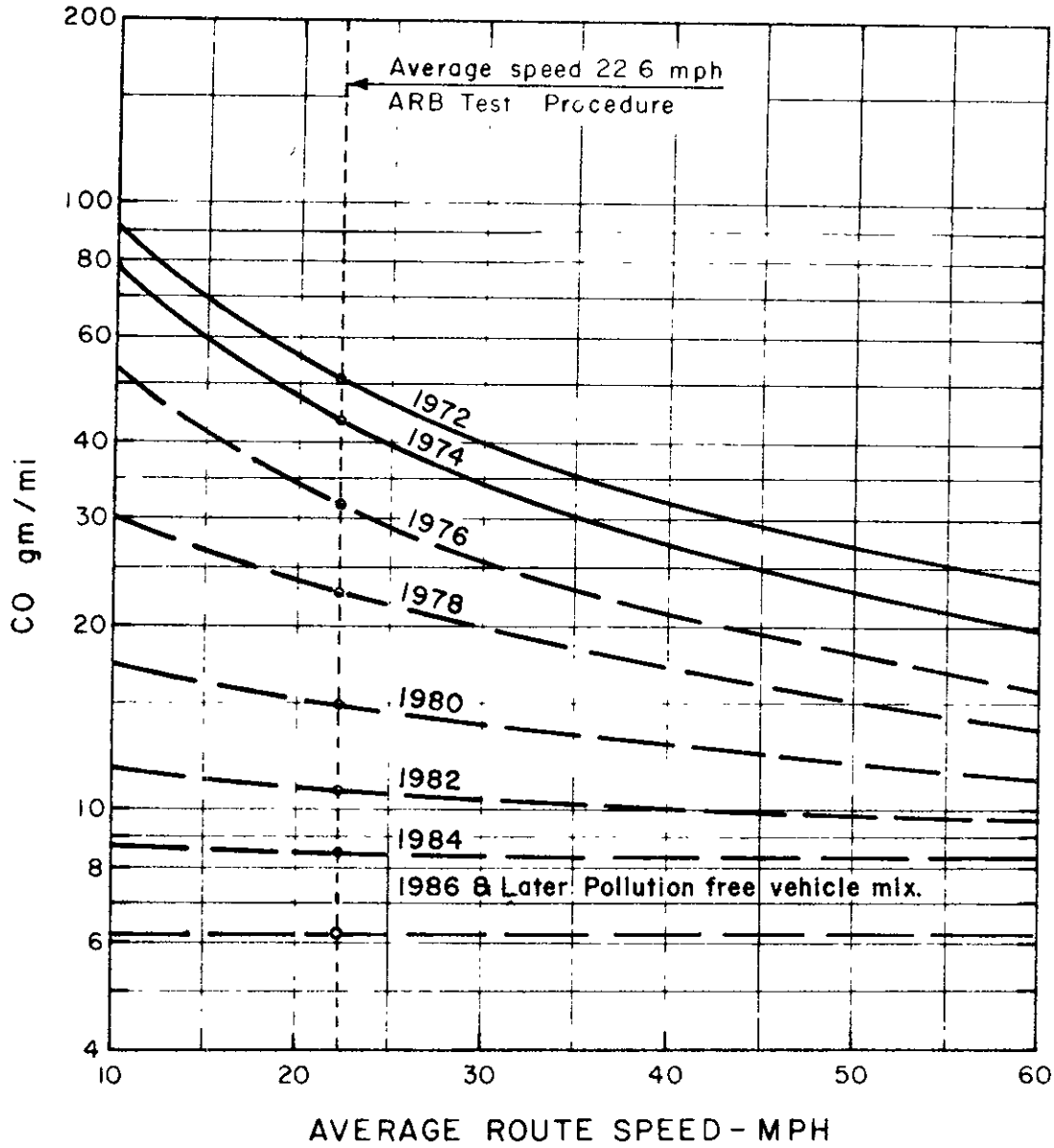

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Figure 91

EMISSION FACTORS FOR CARBON MONOXIDE VS AVERAGE ROUTE SPEED ON FREEWAYS 15% HDV

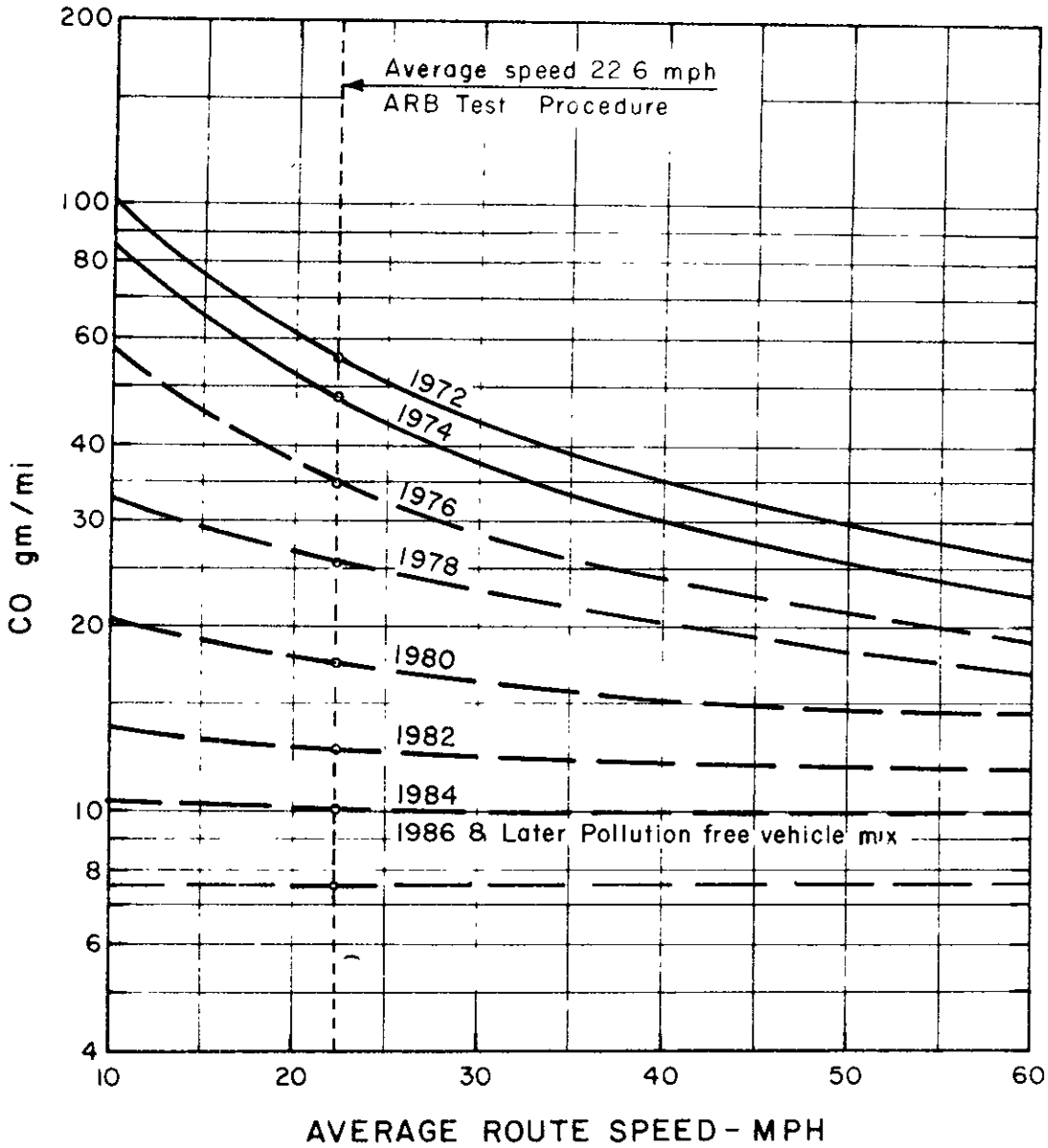

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Figure 92

EMISSION FACTORS FOR CARBON MONOXIDE
VS AVERAGE ROUTE SPEED
ON FREEWAYS
20% HDV

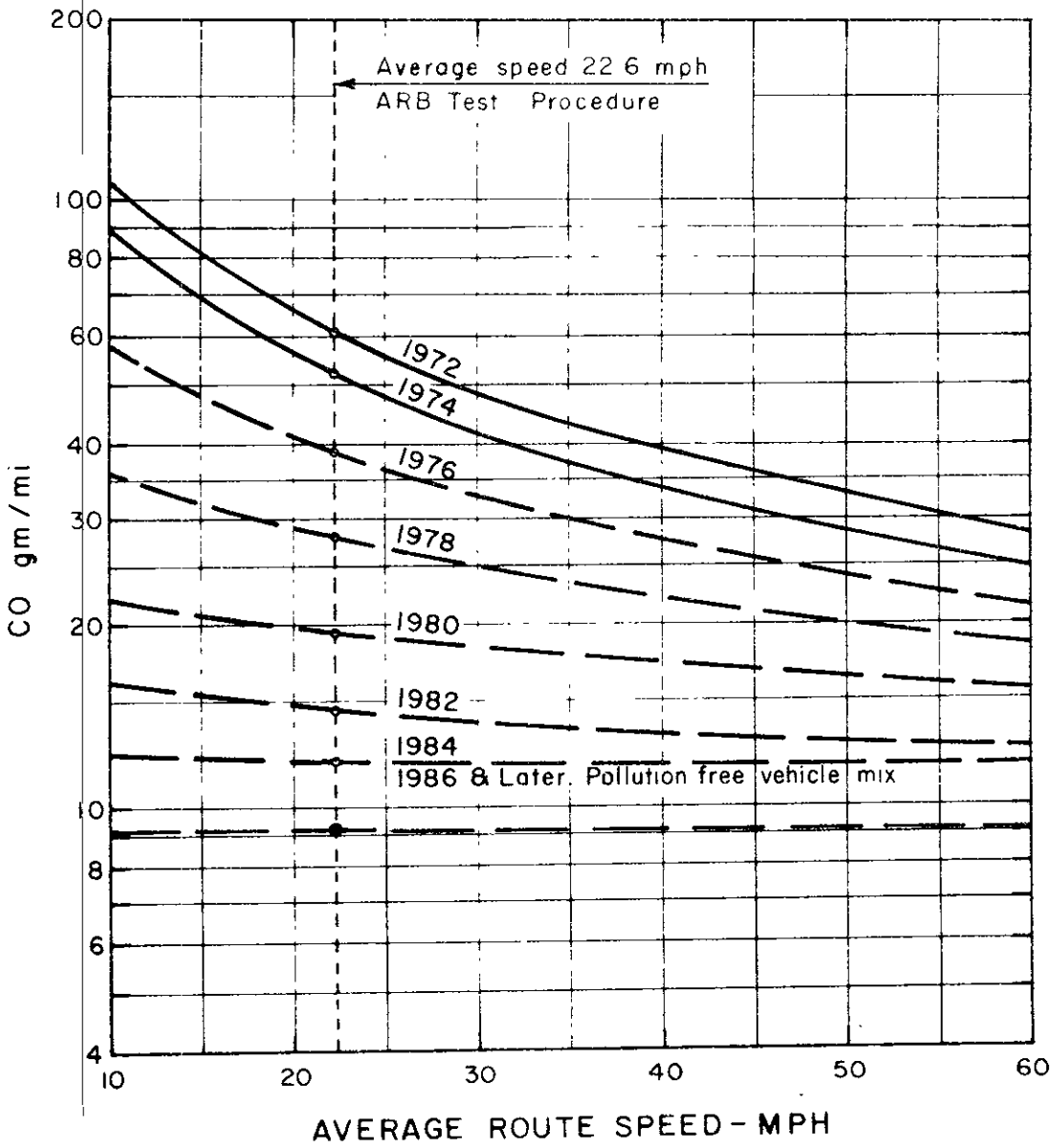

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Figure 93

EMISSION FACTORS FOR CARBON MONOXIDE VS AVERAGE ROUTE SPEED ON CITY STREETS 0 % HDV

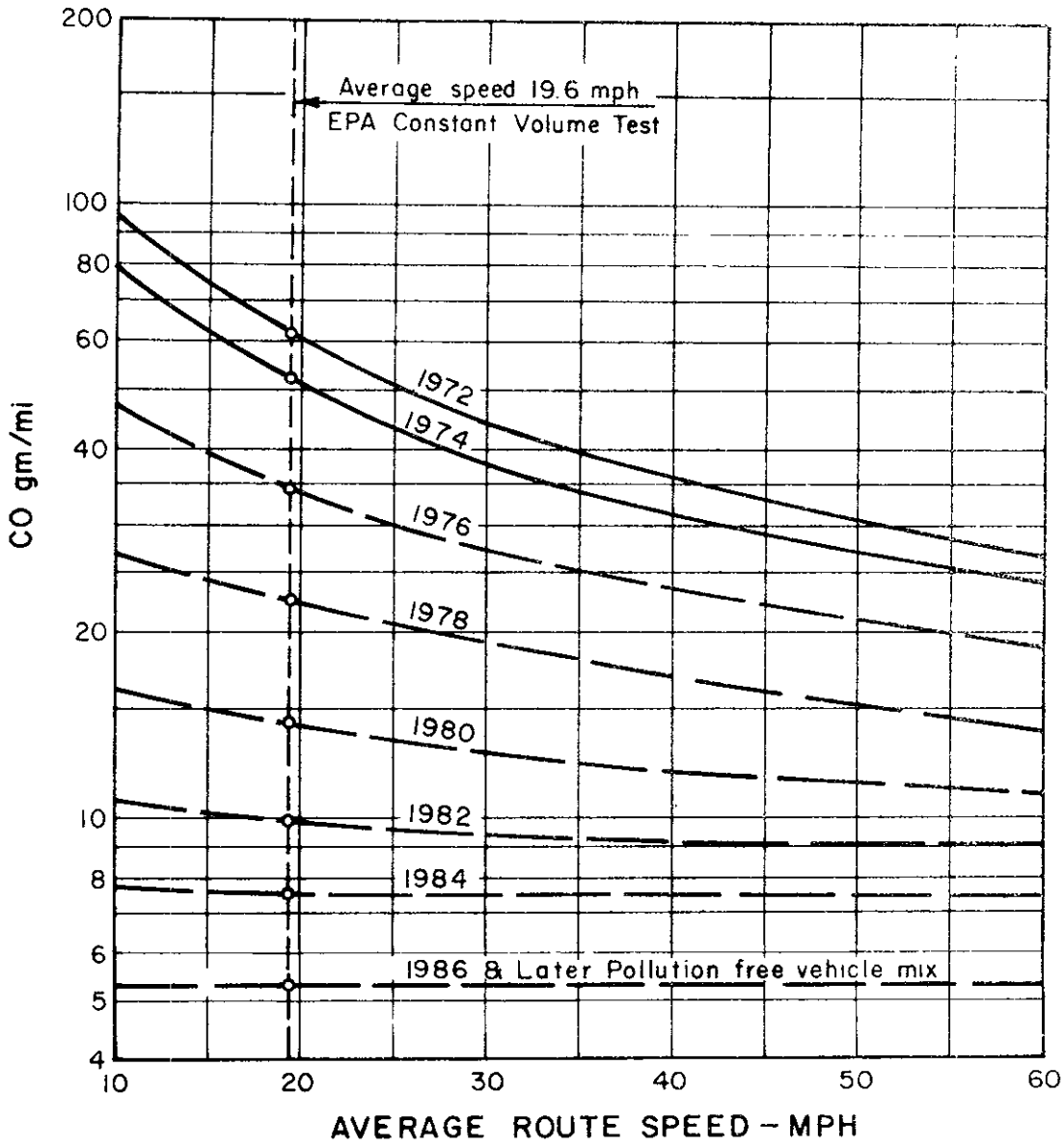

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Figure 94

EMISSION FACTORS FOR CARBON MONOXIDE VS AVERAGE ROUTE SPEED ON CITY STREETS 5% HDV

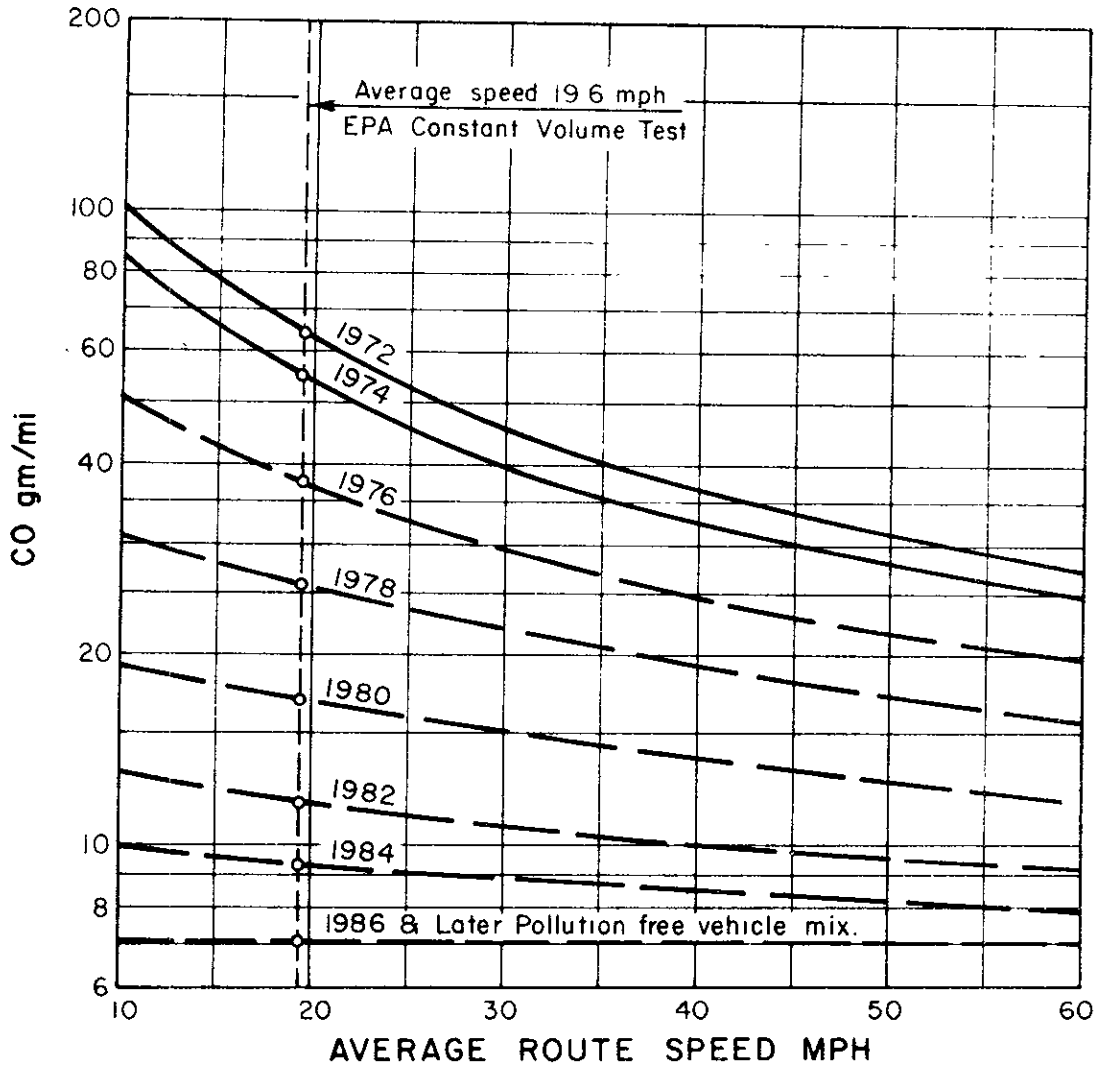

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Figure 95

EMISSION FACTORS FOR CARBON MONOXIDE VS AVERAGE ROUTE SPEED ON CITY STREETS 10 % HDV

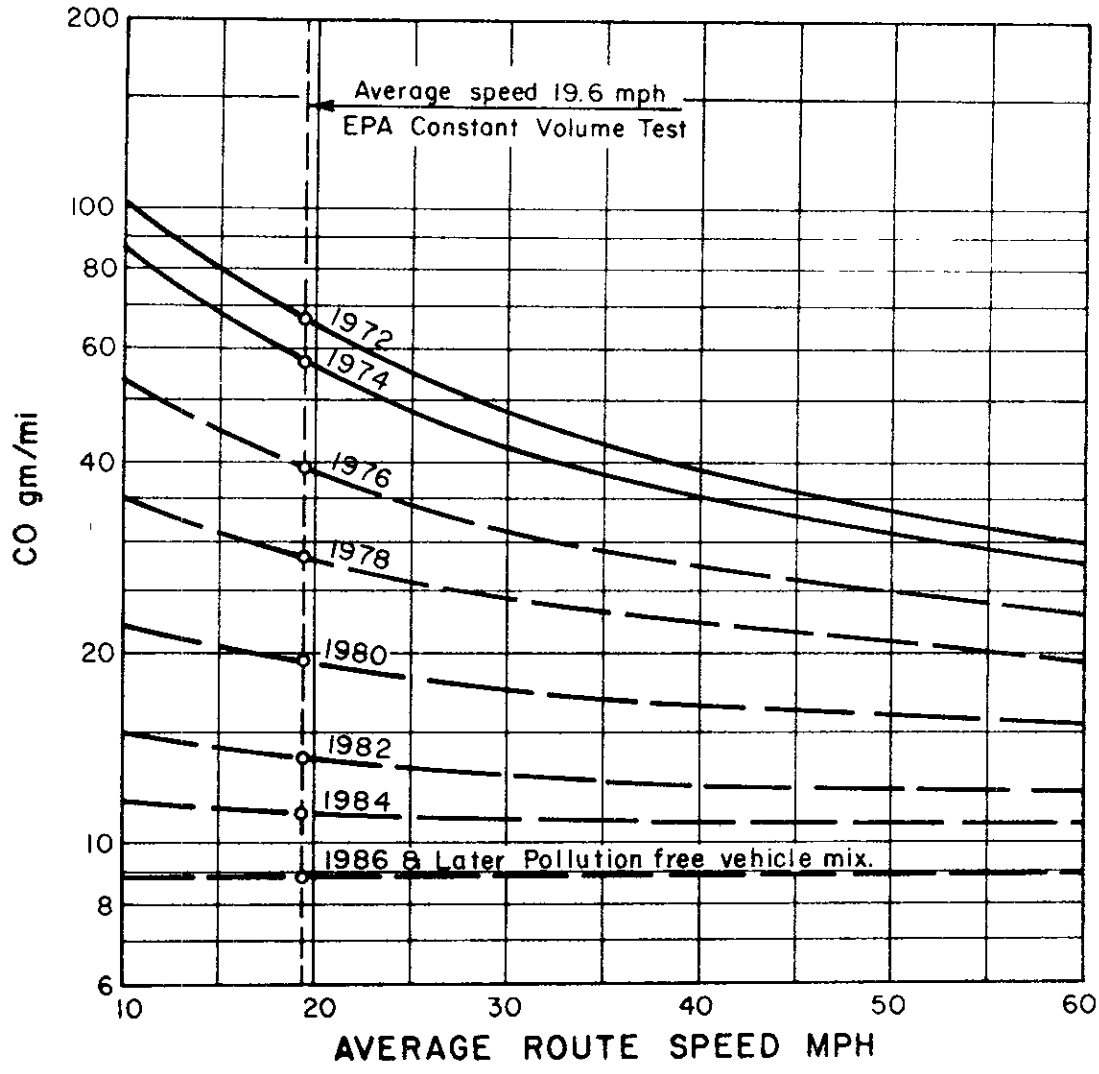

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Figure 96

EMISSION FACTORS FOR CARBON MONOXIDE VS AVERAGE ROUTE SPEED ON CITY STREETS 15 % HDV

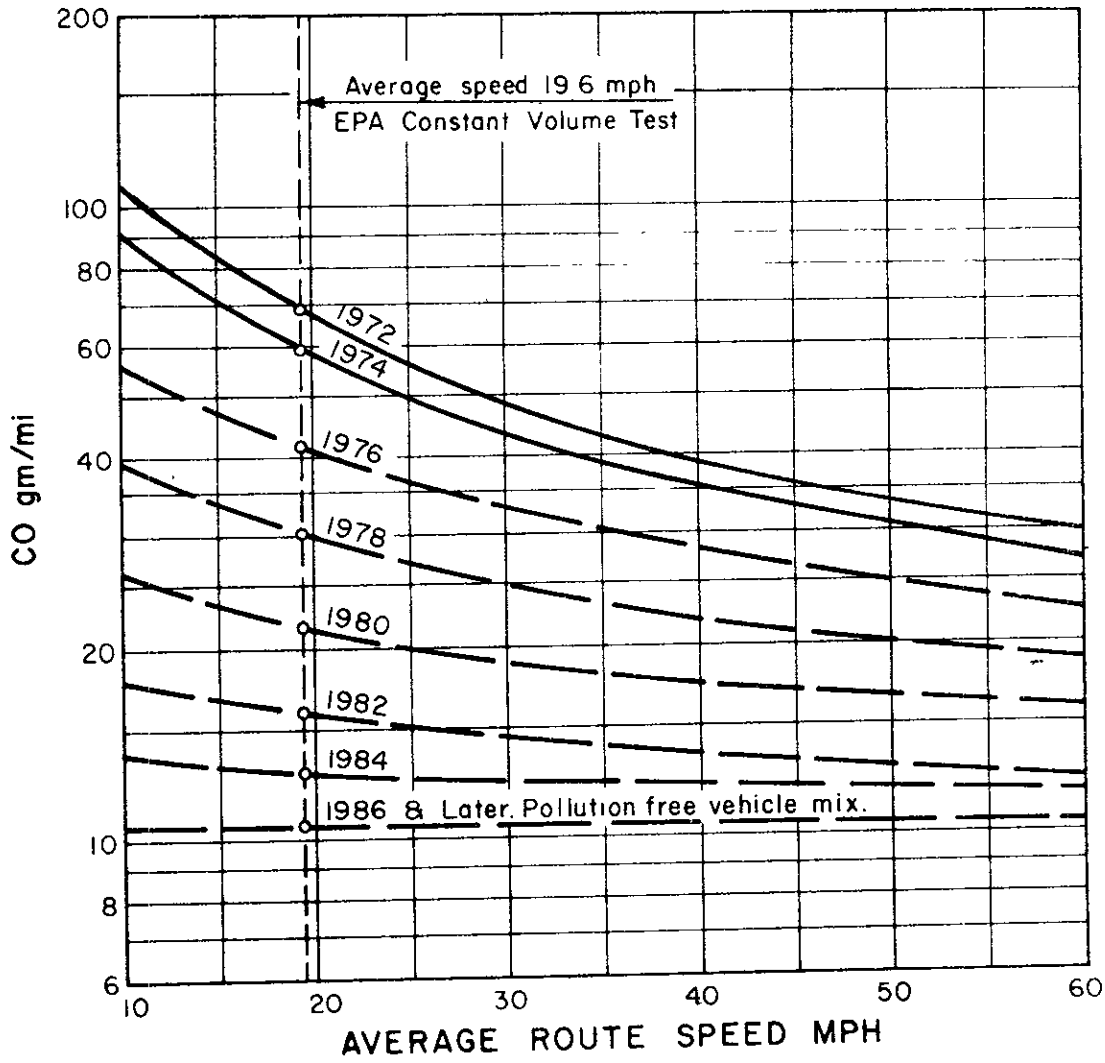

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Figure 97

EMISSION FACTORS FOR CARBON MONOXIDE VS AVERAGE ROUTE SPEED ON CITY STREETS 20 % HDV

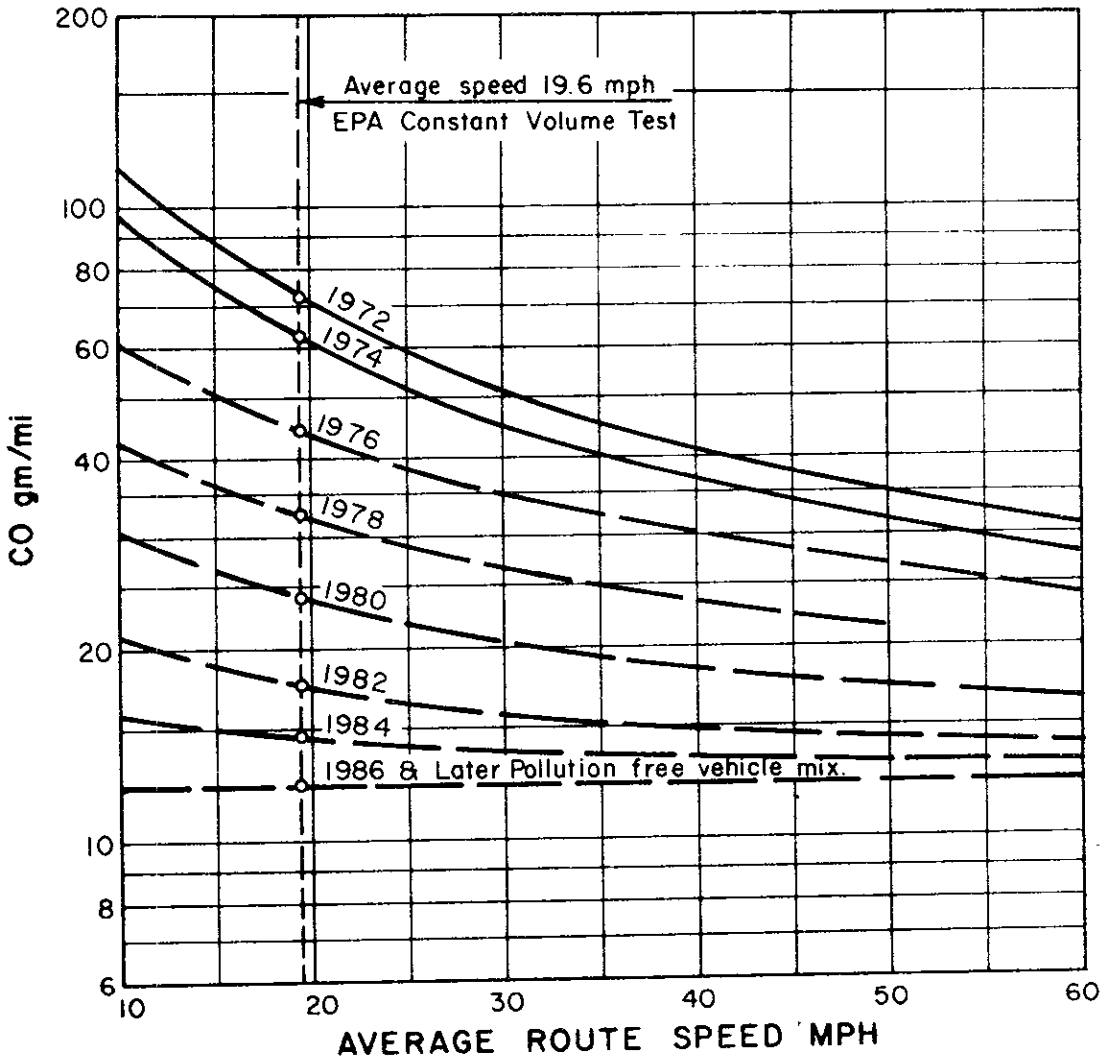

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Figure 98

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON FREEWAYS 0% HDV

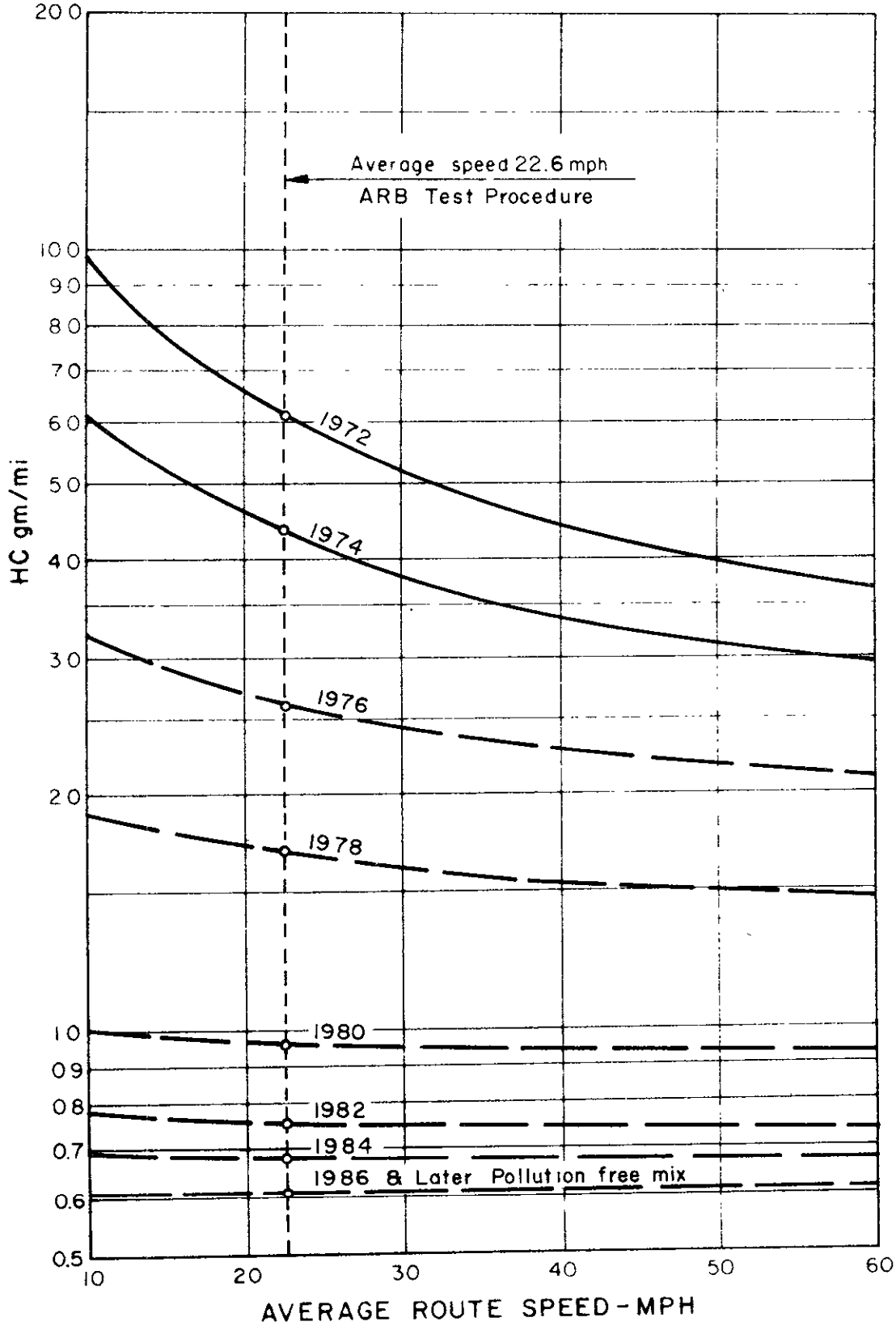

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Figure 99

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON FREEWAYS 5% HDV

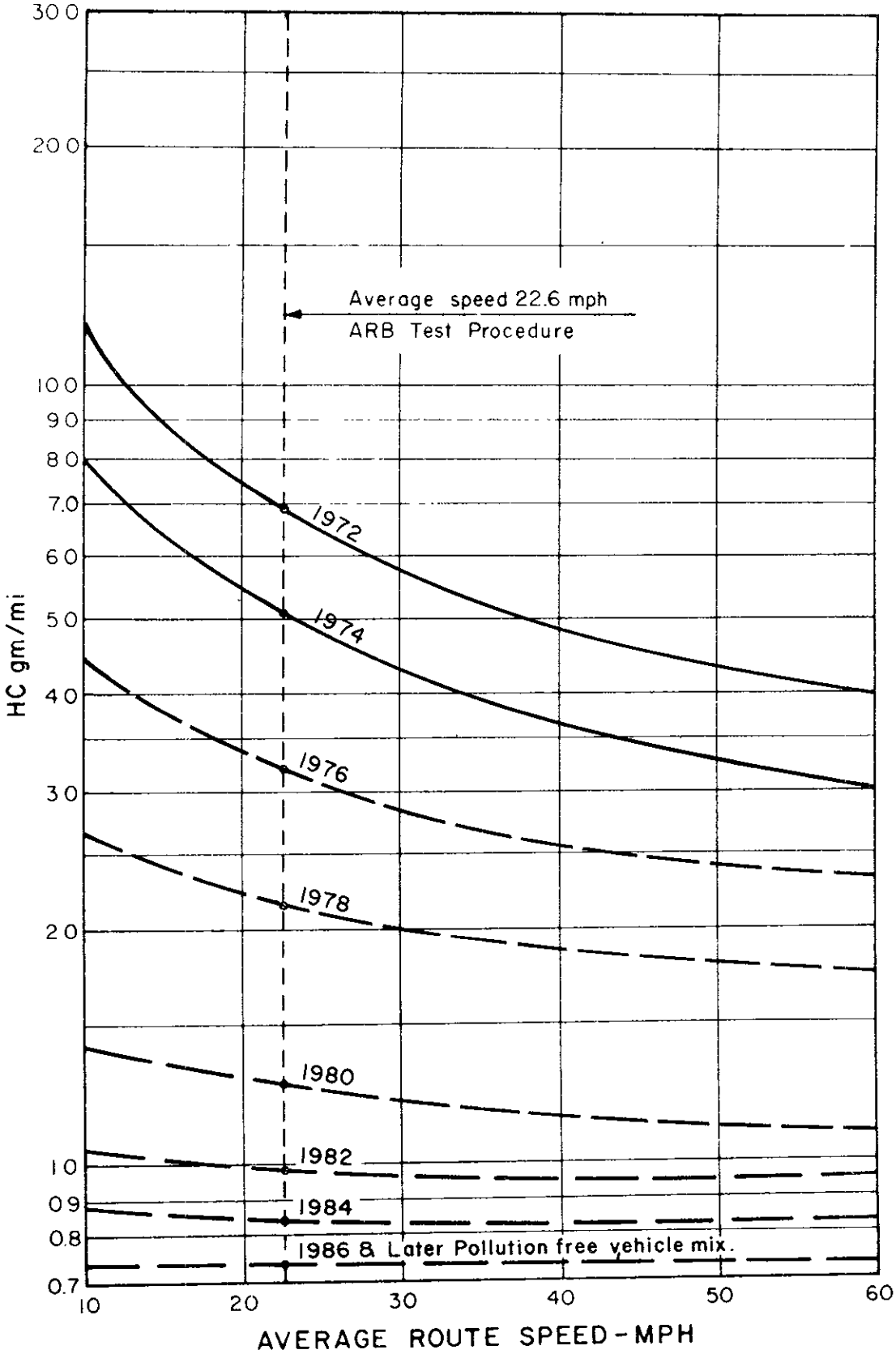

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Figure 100

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON FREEWAYS 10% HDV

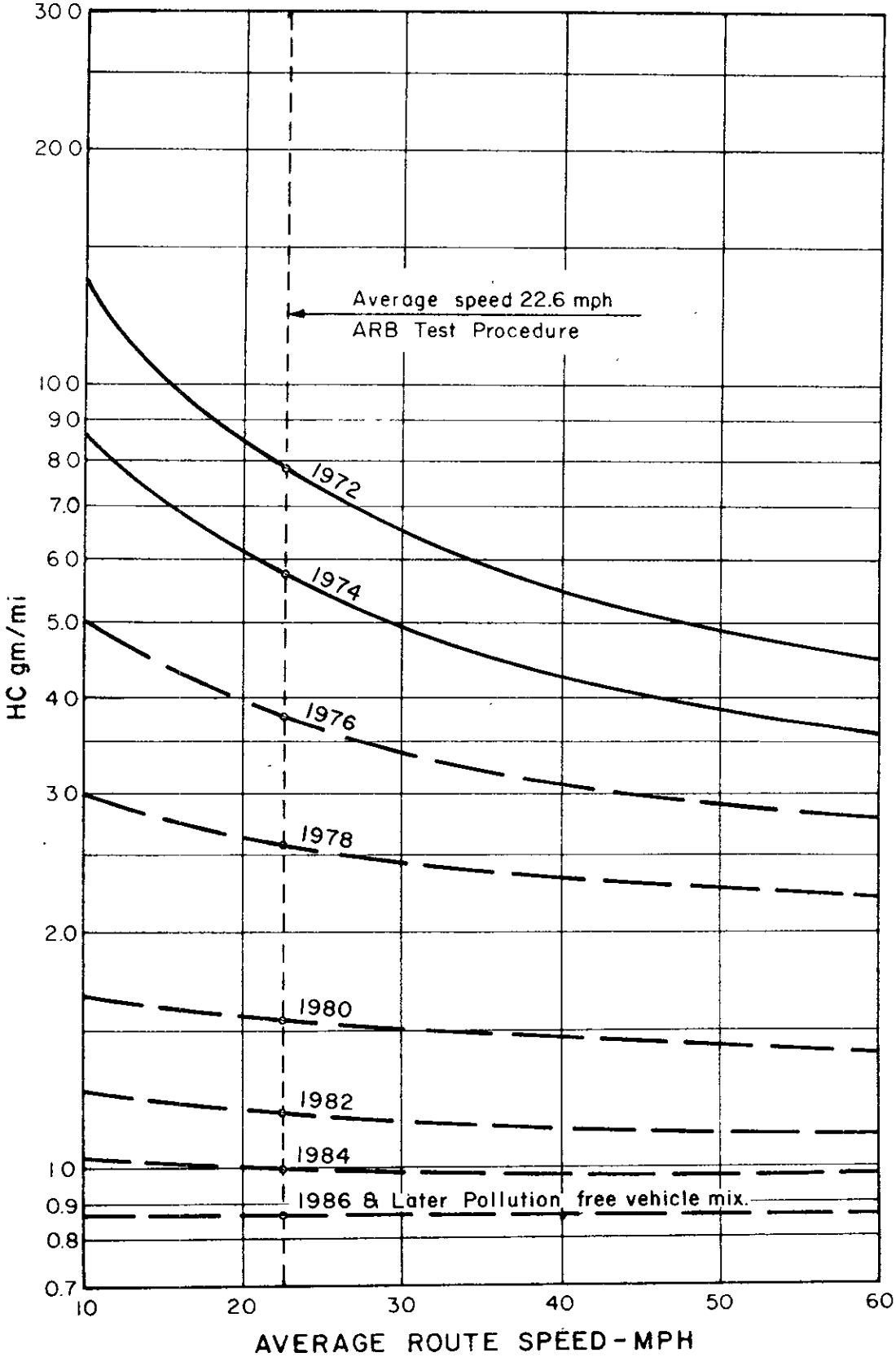

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Figure

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON FREEWAYS 15% HDV

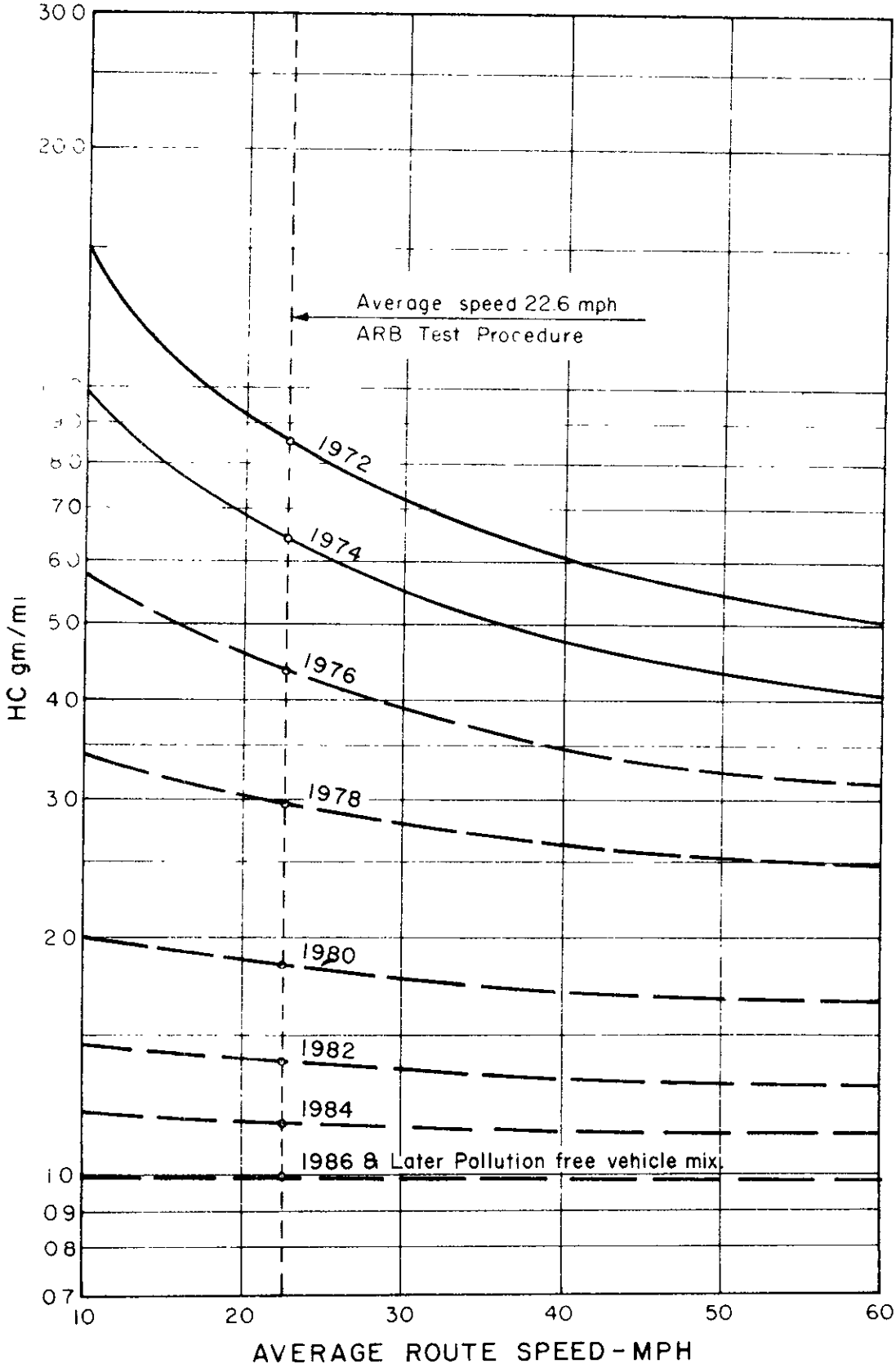

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Figure 102

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON FREEWAYS 20% HDV

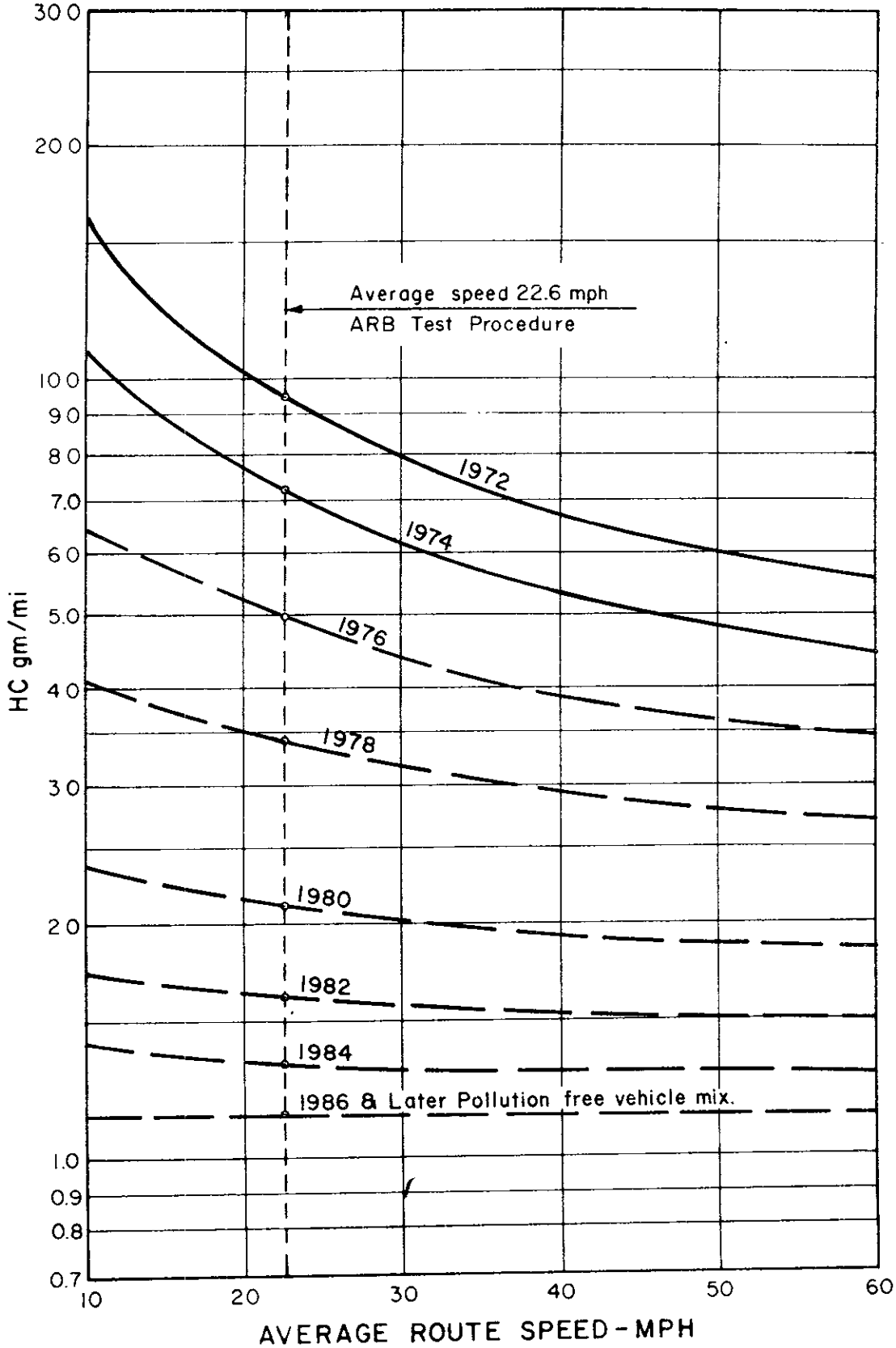

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Figure 103

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON CITY STREETS 0% HDV

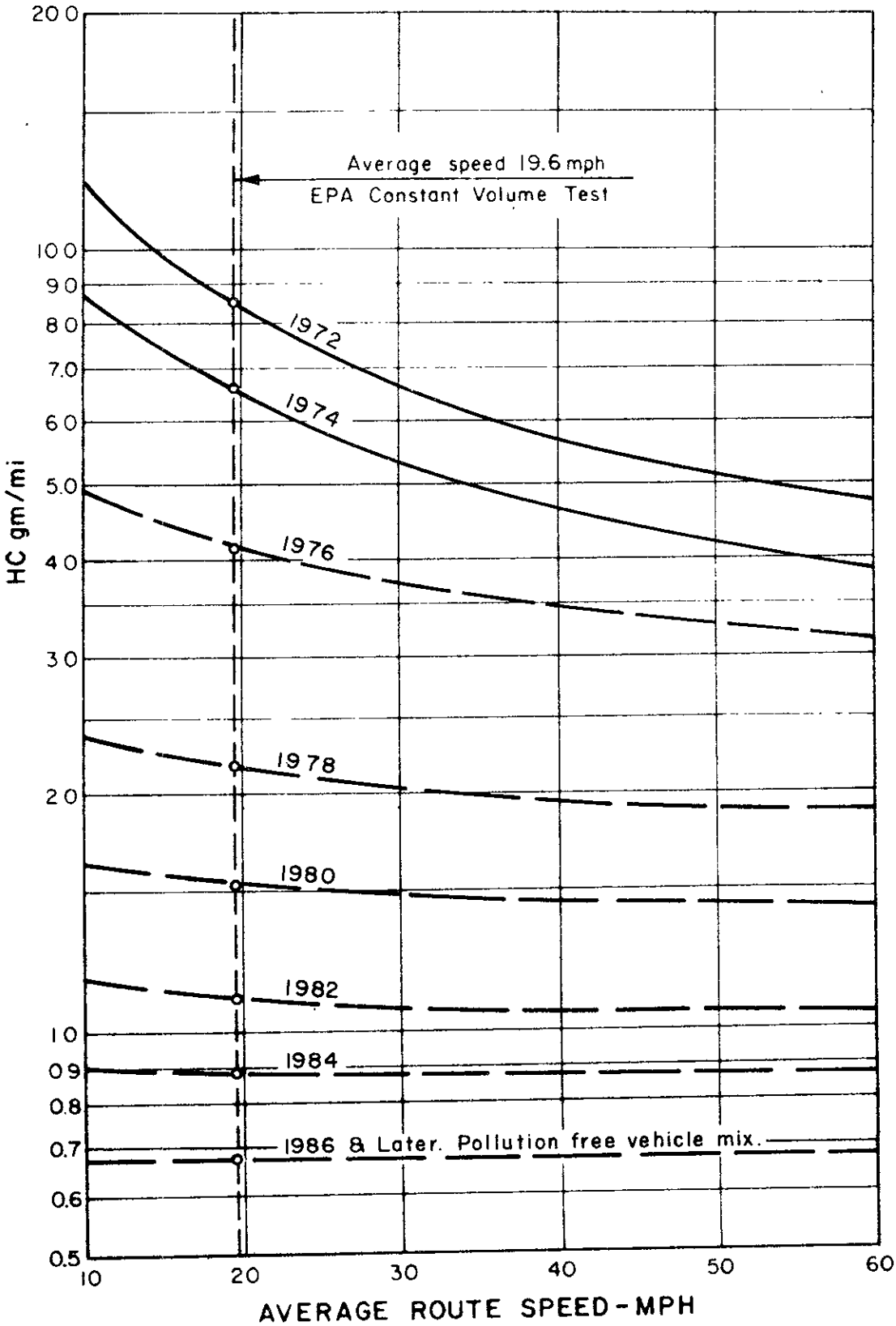

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Figure 104

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON CITY STREETS 5% HDV

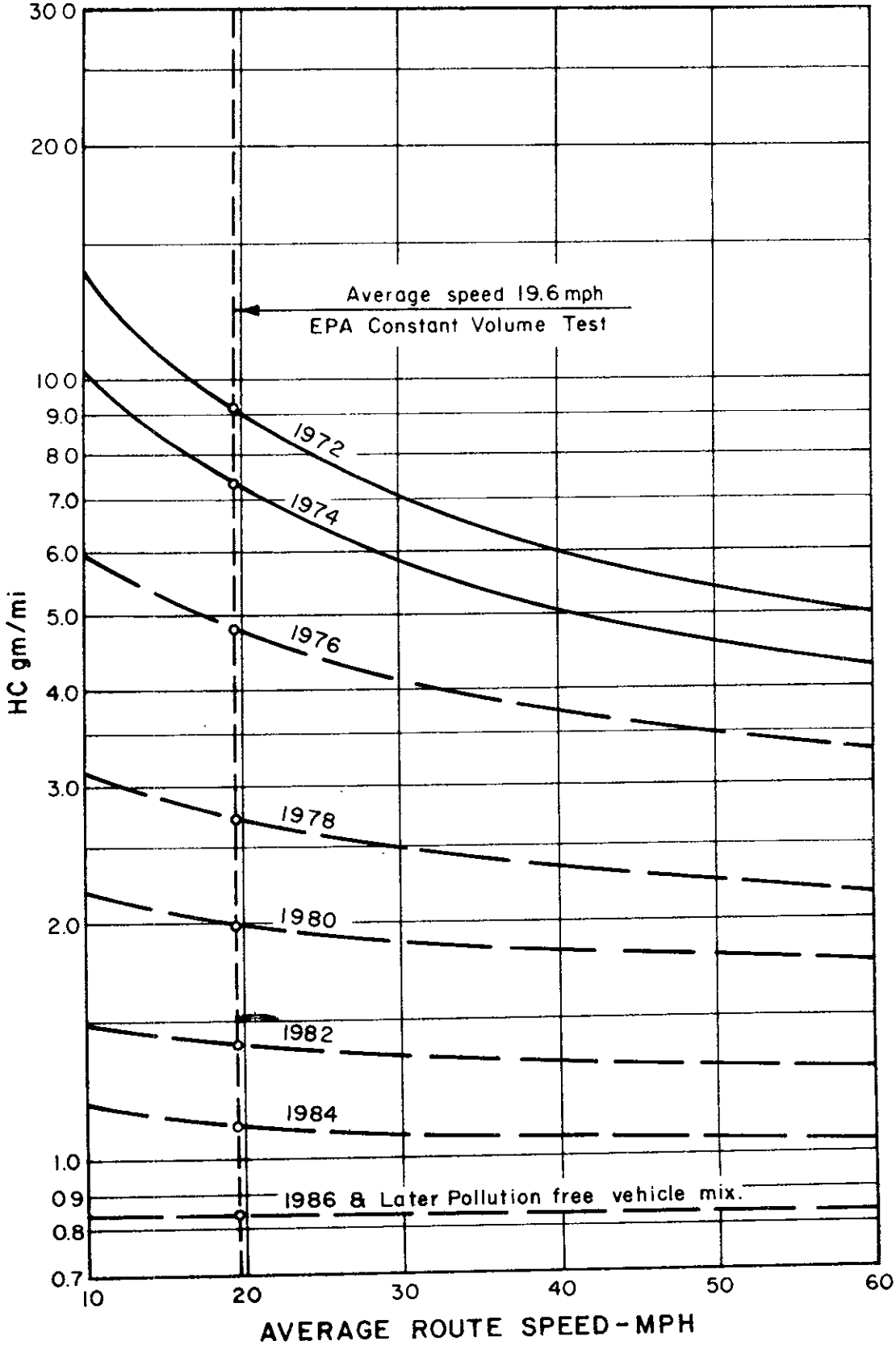

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Figure 105

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON CITY STREETS 10% HDV

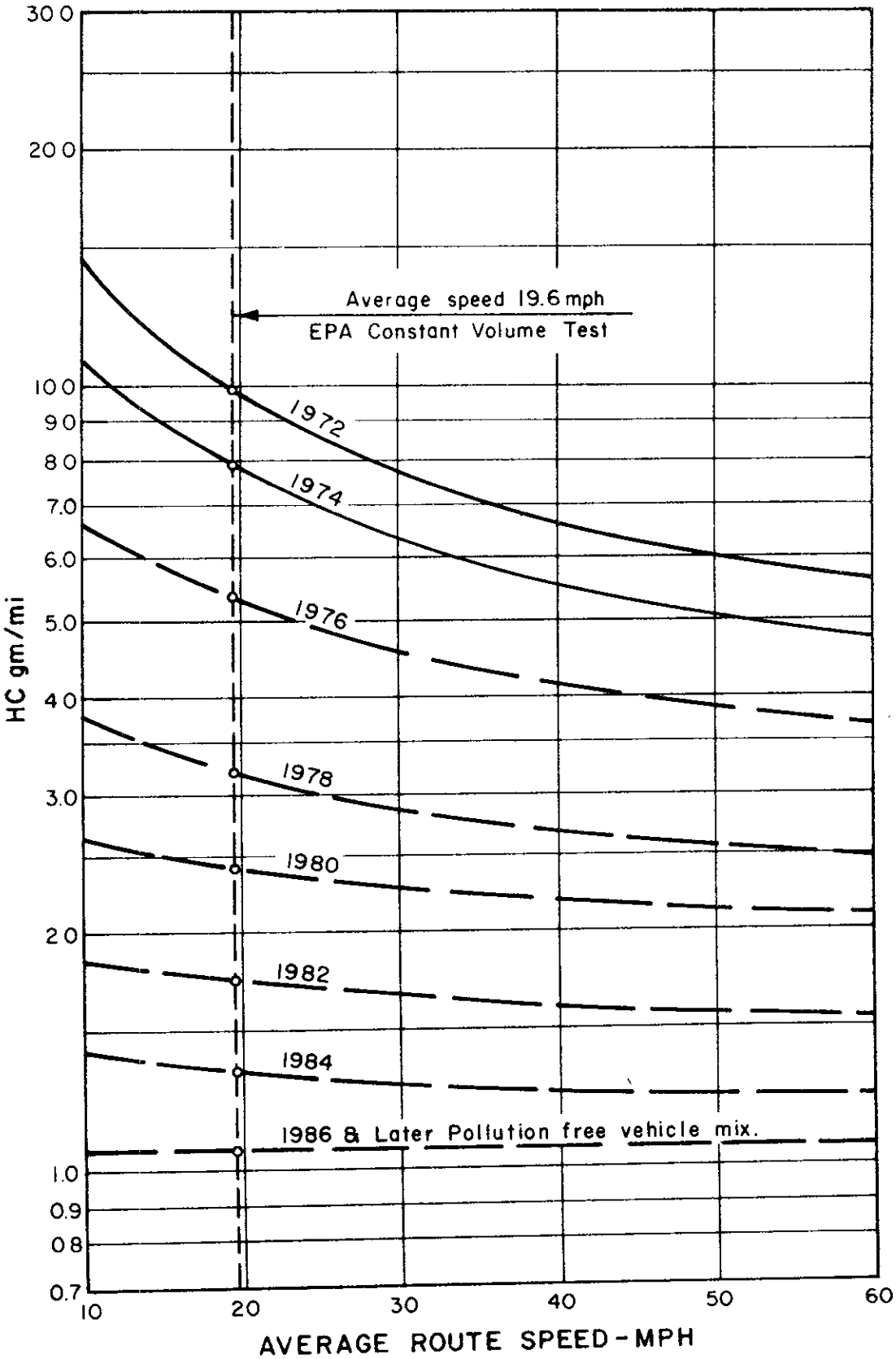

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Figure 106

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON CITY STREETS 15% HDV

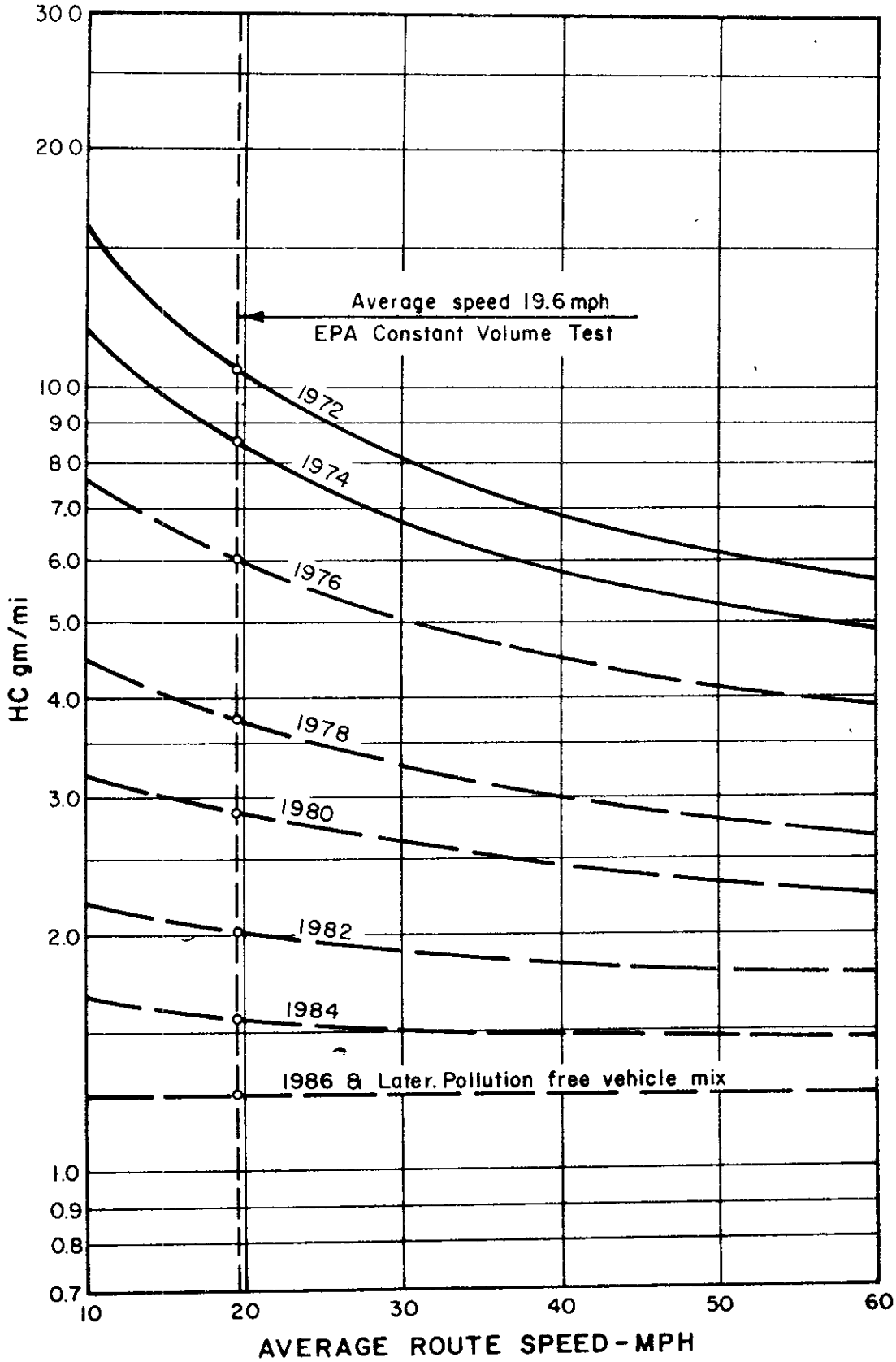

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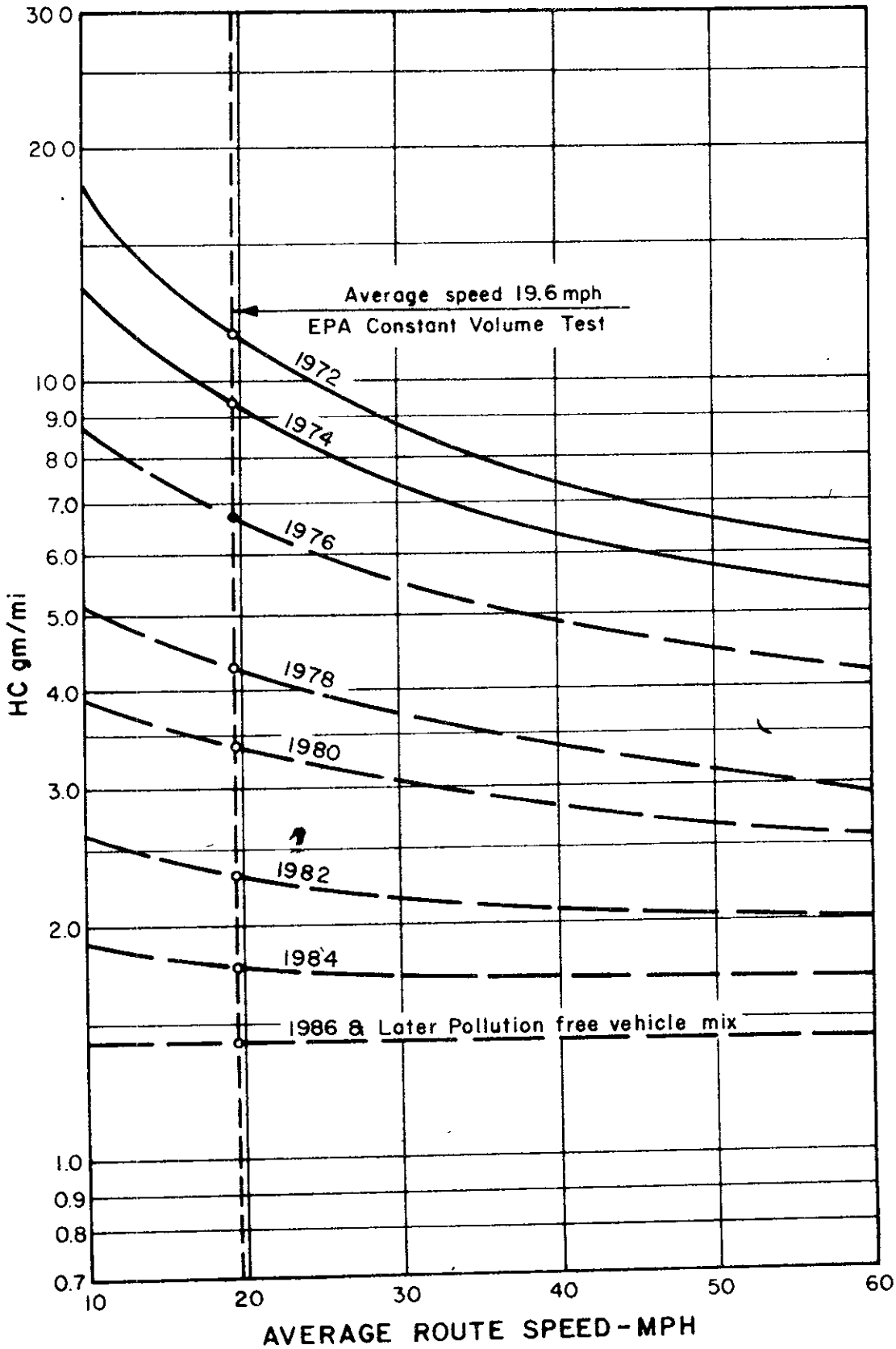
Figure 107

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON CITY STREETS 20 % HDV



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