Technical Report Documentation Page

1. REPORT No.
CA-HWY-MR6570825-4-72-12

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE
Mathematical Approach To Estimating Highway Impact On Air Quality

5. REPORT DATE
July 1972

6. PERFORMING ORGANIZATION

7. AUTHOR(S)
Beaton, John L.; Skog, John B.; Shirley, E.C.; Ranzieri, Andrew

8. PERFORMING ORGANIZATION REPORT No.
CA-HWY-MR6570825-4-72-12

9. PERFORMING ORGANIZATION NAME AND ADDRESS
State of California
Business and Transportation Agency
Department of Public Works
Division of Highways

10. WORK UNIT No.

11. CONTRACT OR GRANT No.

12. SPONSORING AGENCY NAME AND ADDRESS

13. TYPE OF REPORT & PERIOD COVERED

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

17. KEYWORDS

18. No. OF PAGES:
83

19. DRI WEBSITE LINK
http://www.dot.ca.gov/hq/research/researchreports/1972/72-12.pdf

20. FILE NAME
72-12.pdf

This page was created to provide searchable keywords and abstract text for older scanned research reports.
November 2005, Division of Research and Innovation

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

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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

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

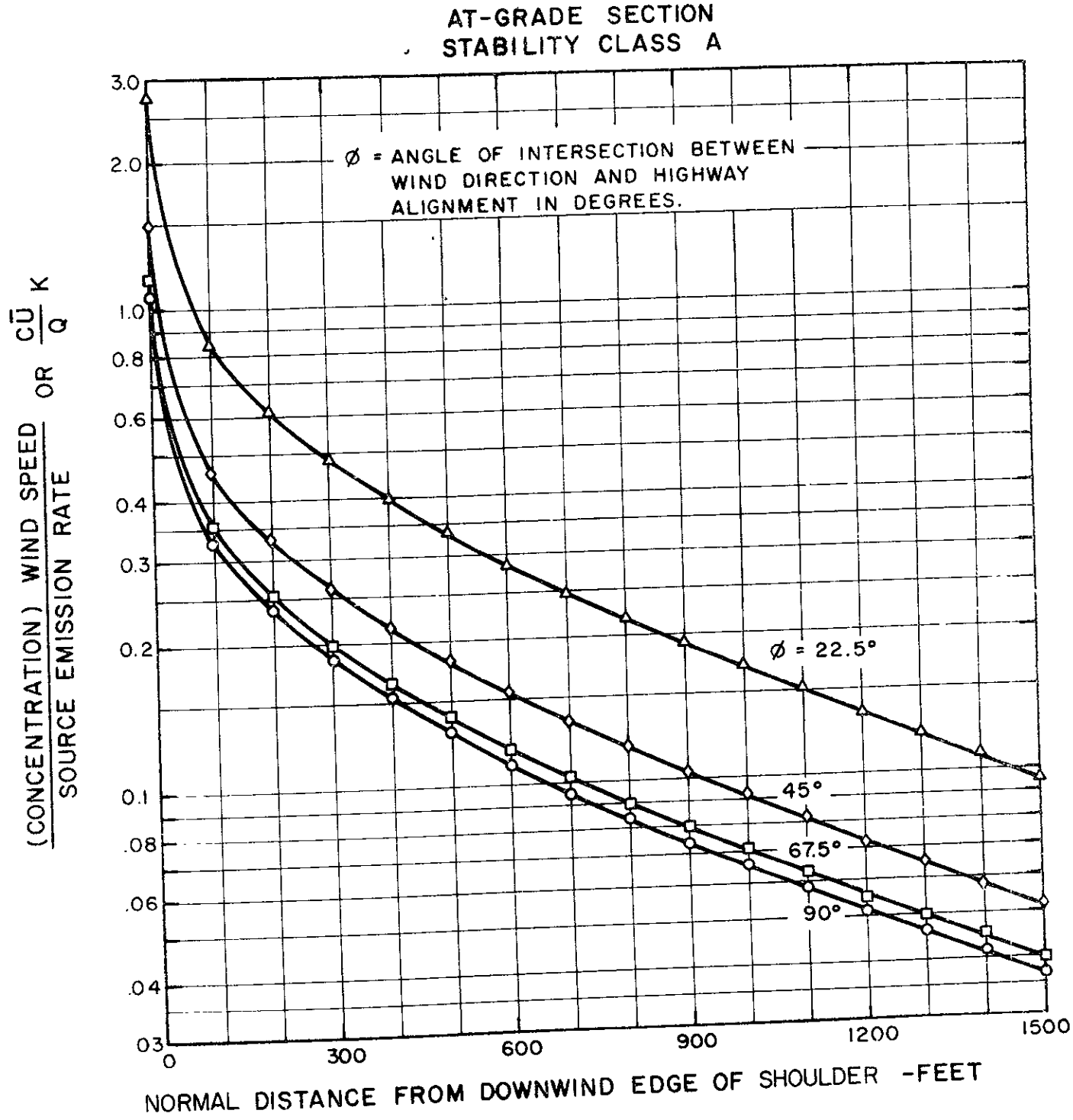

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Figure 2

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

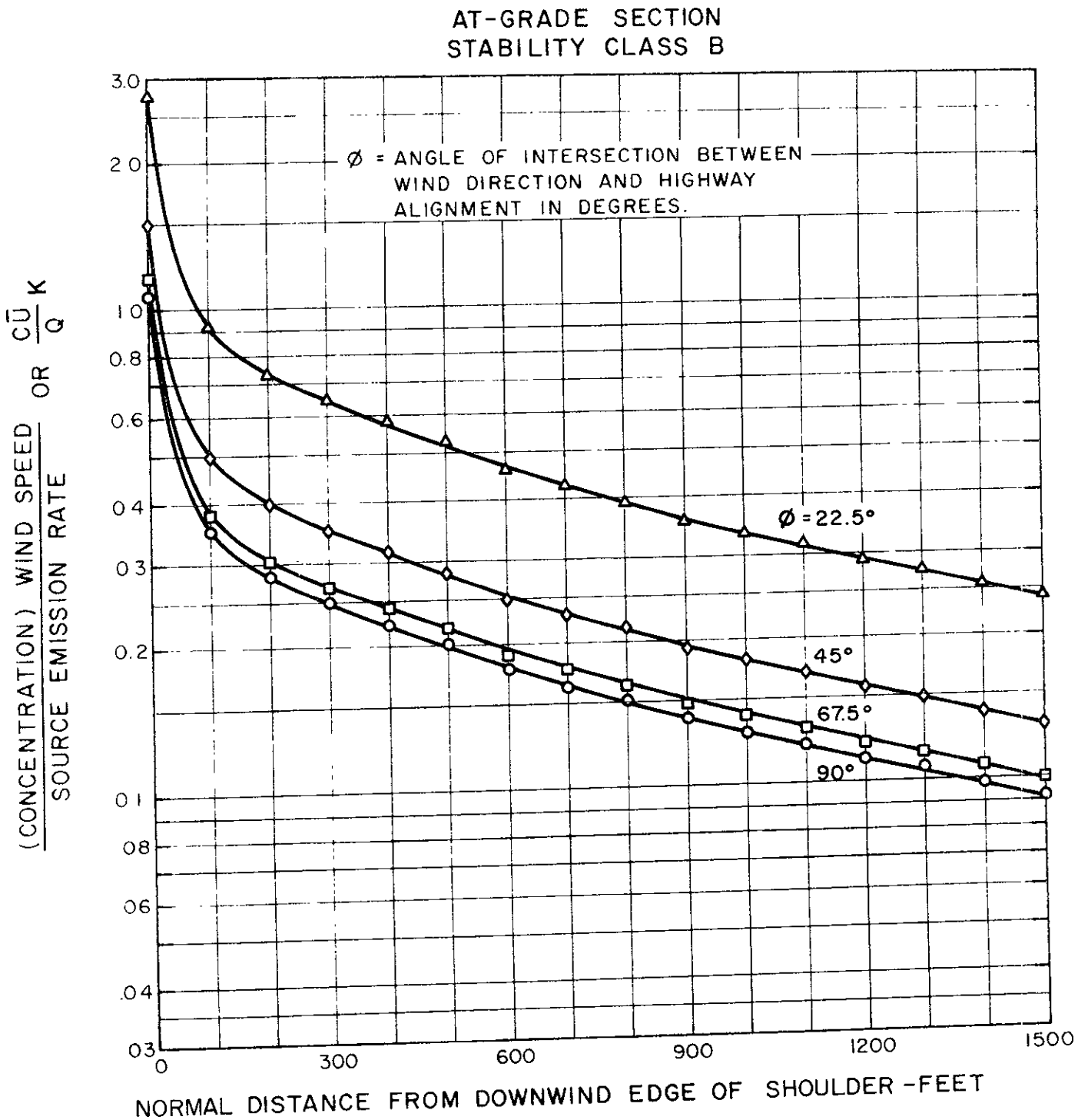

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Figure 3

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

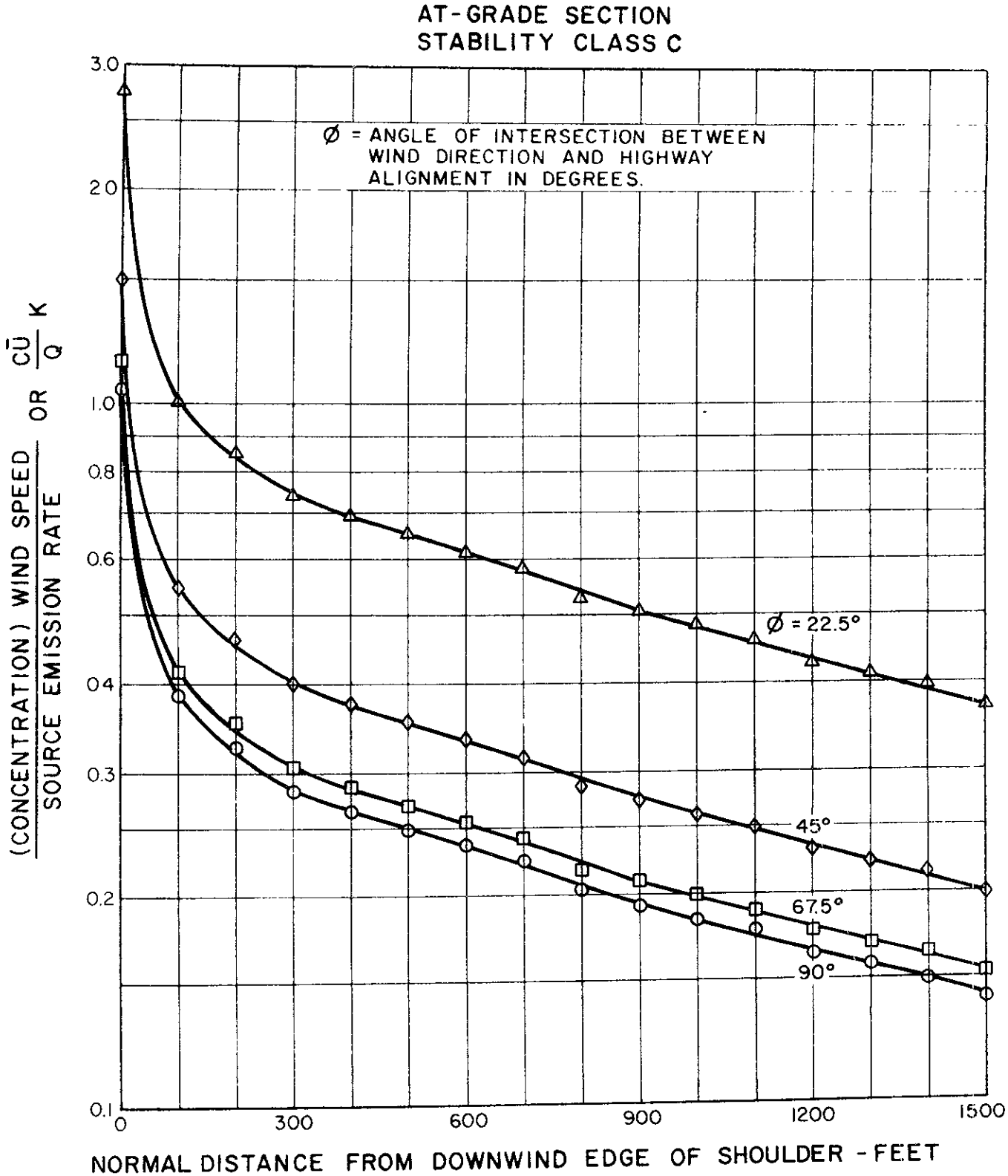

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Figure 4

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

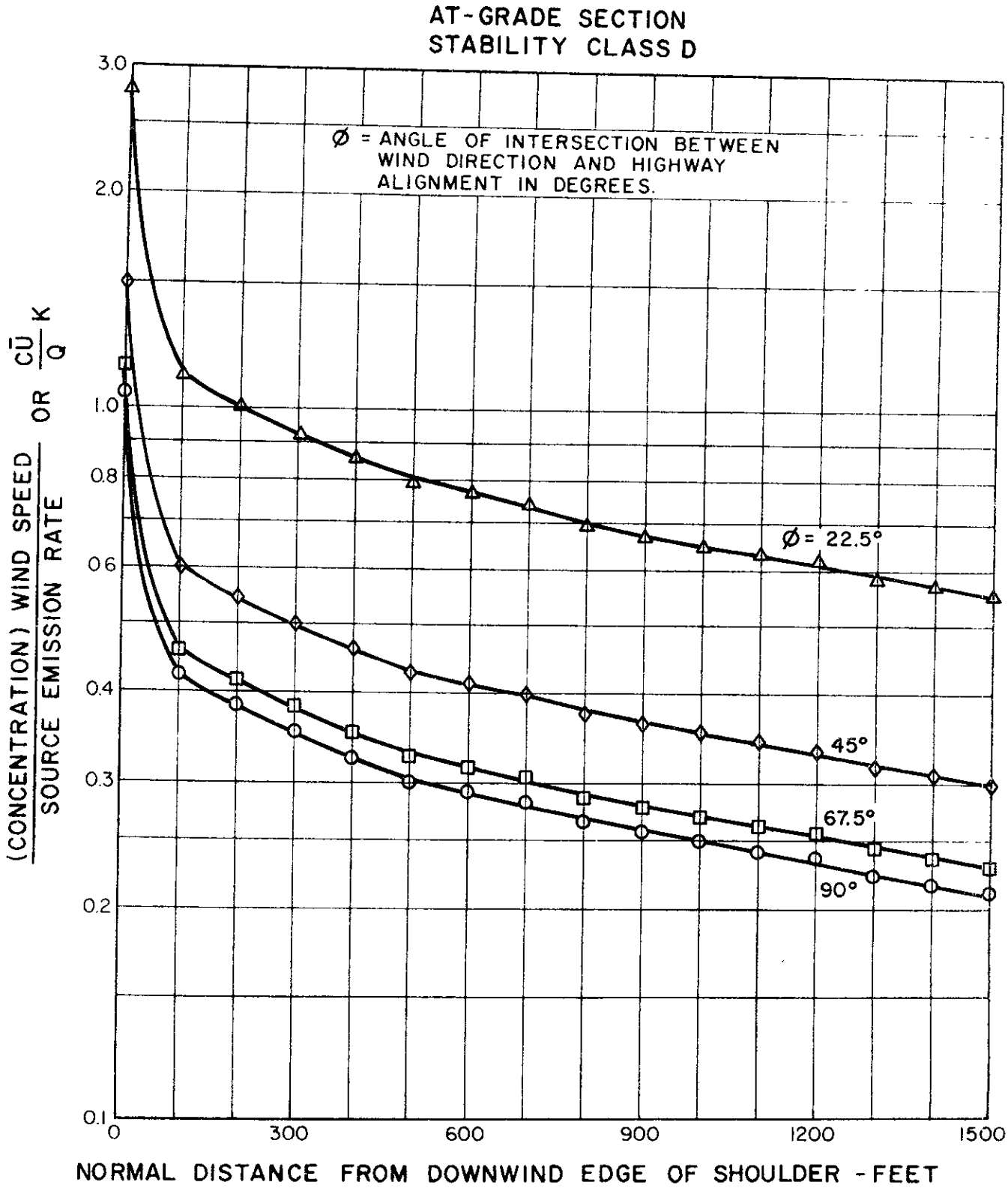

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Figure 5

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

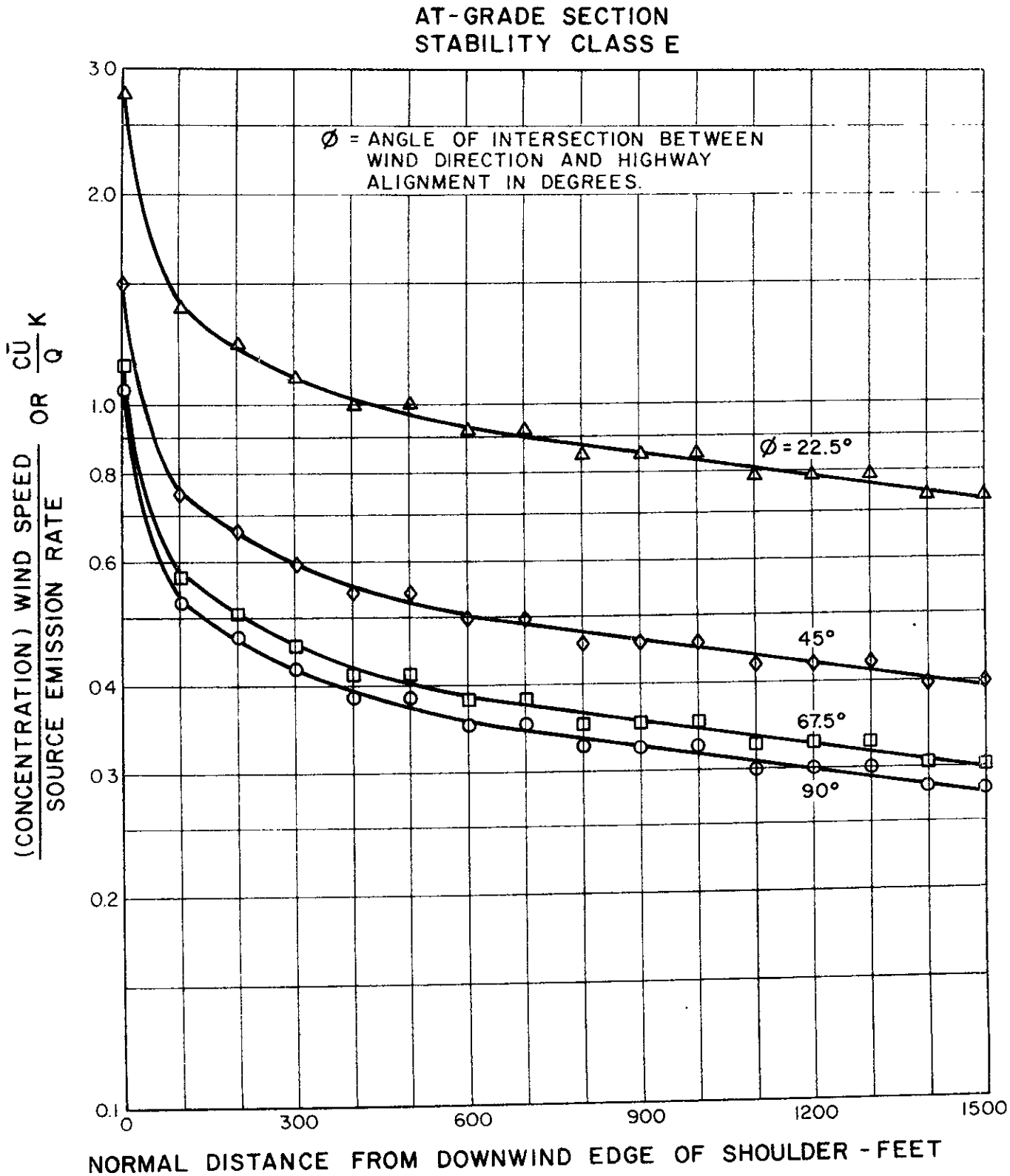

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Figure 6

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

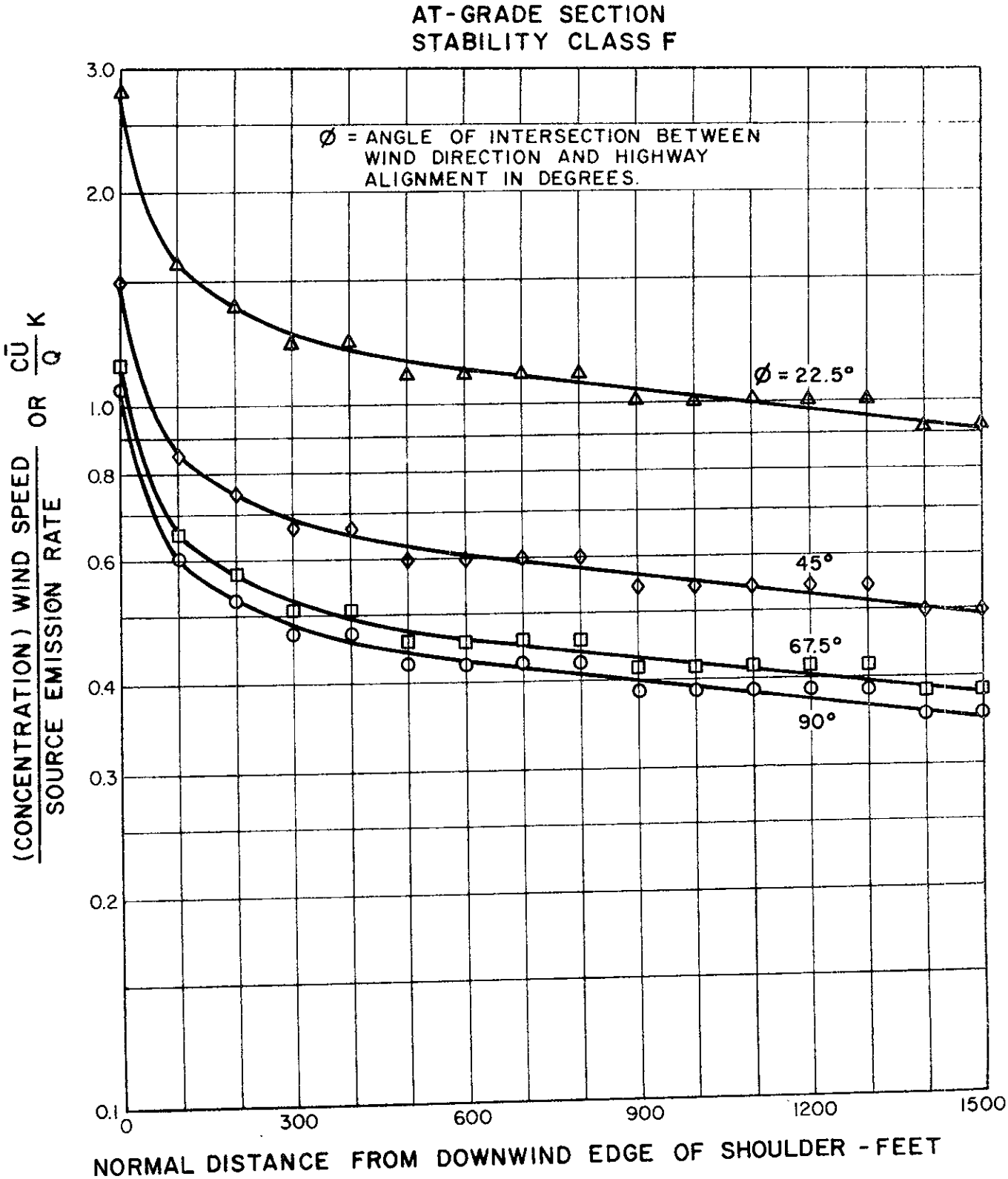

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Figure 7

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)

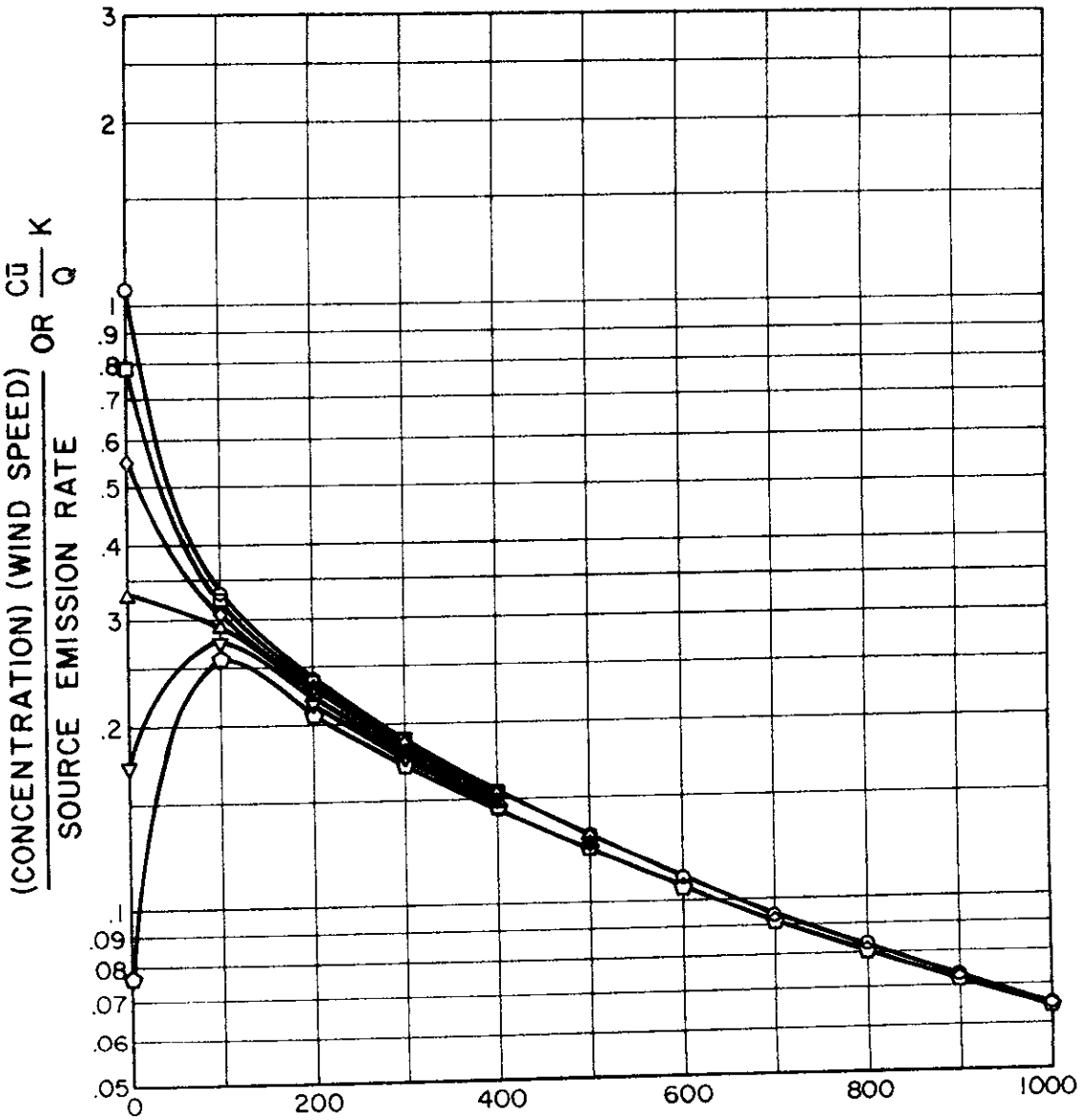

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Figure 8

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)

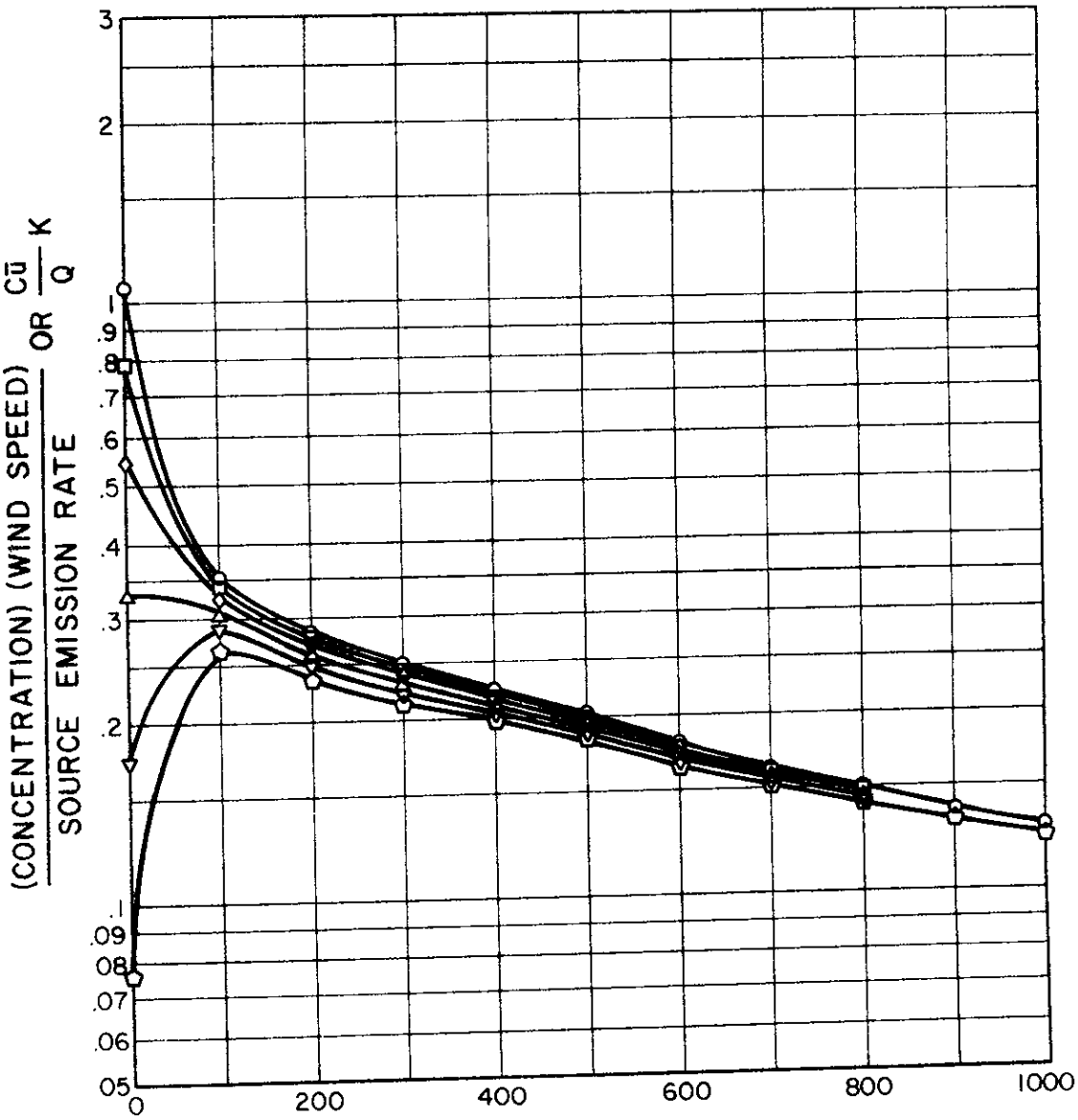

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Figure 9

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)

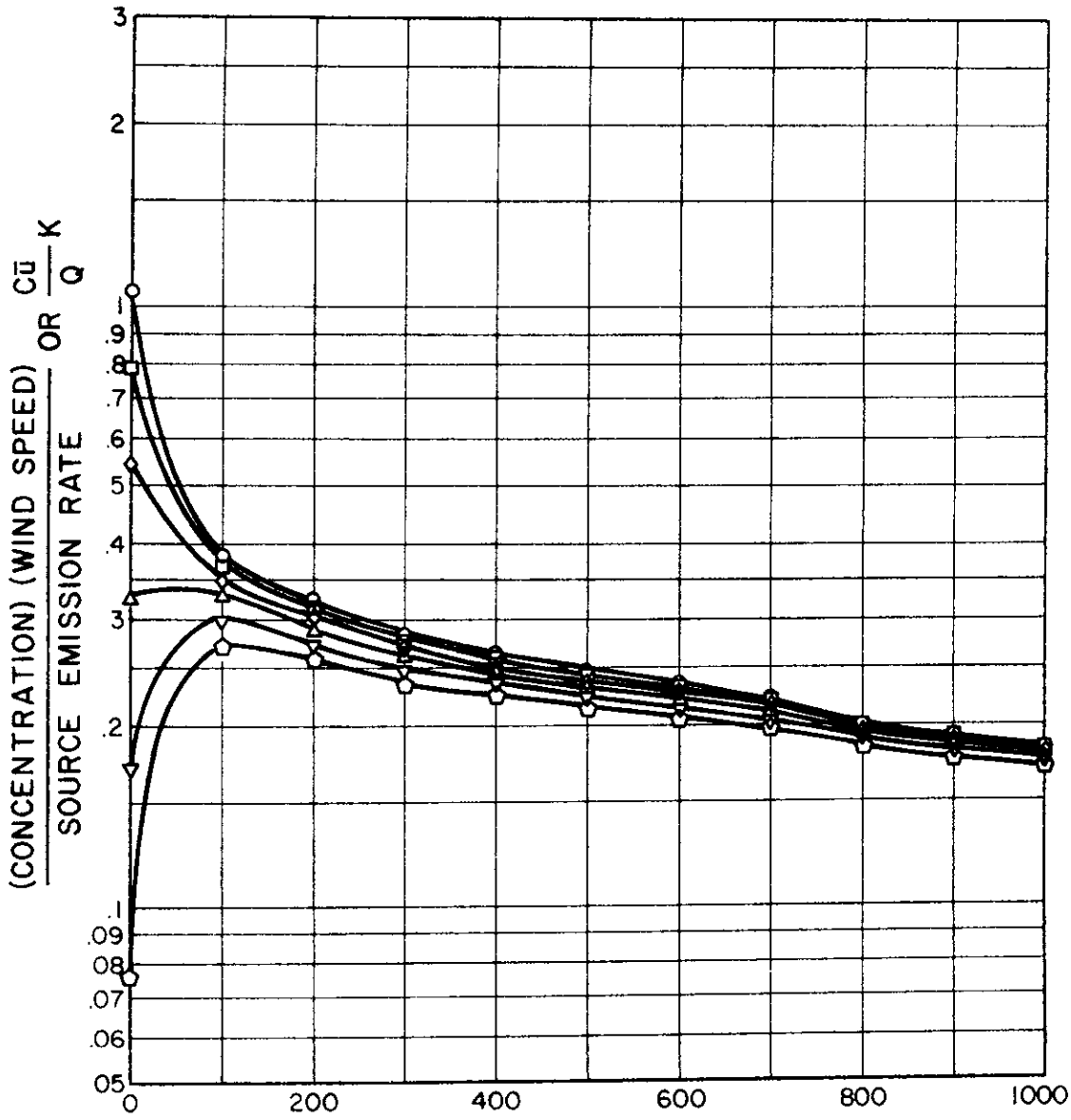

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Figure 10

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)

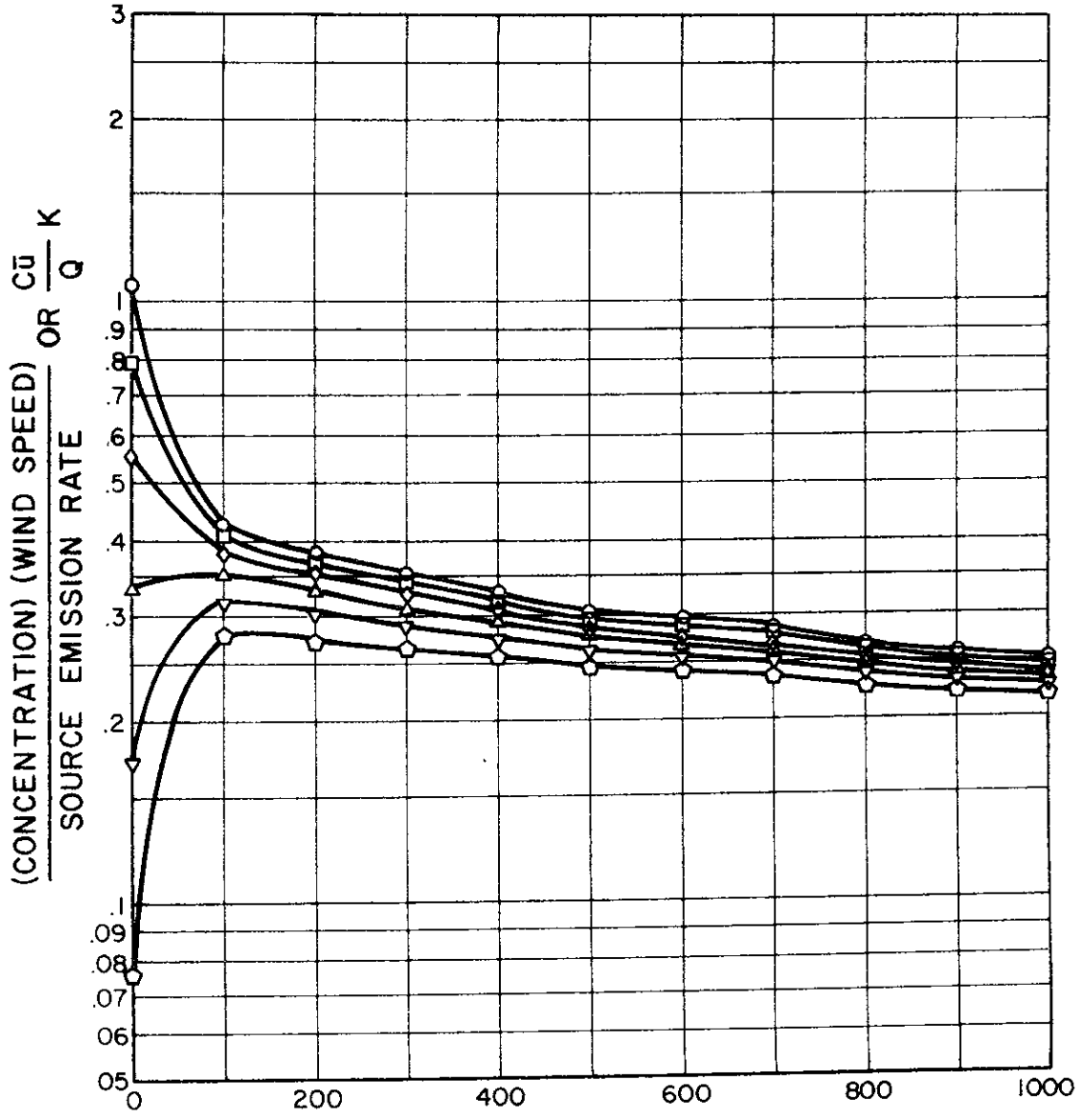

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Figure 11

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)

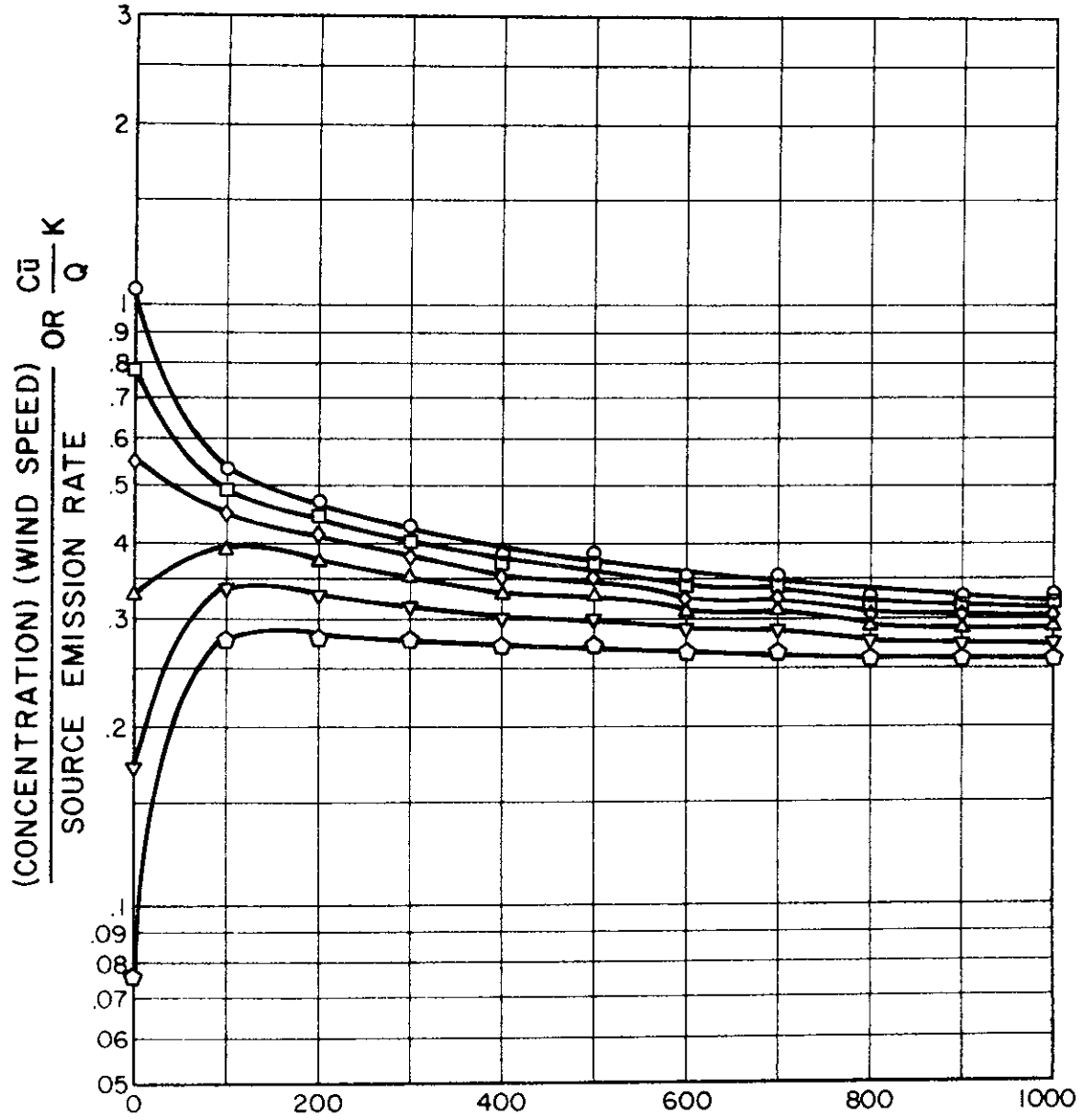

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Figure 12

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)

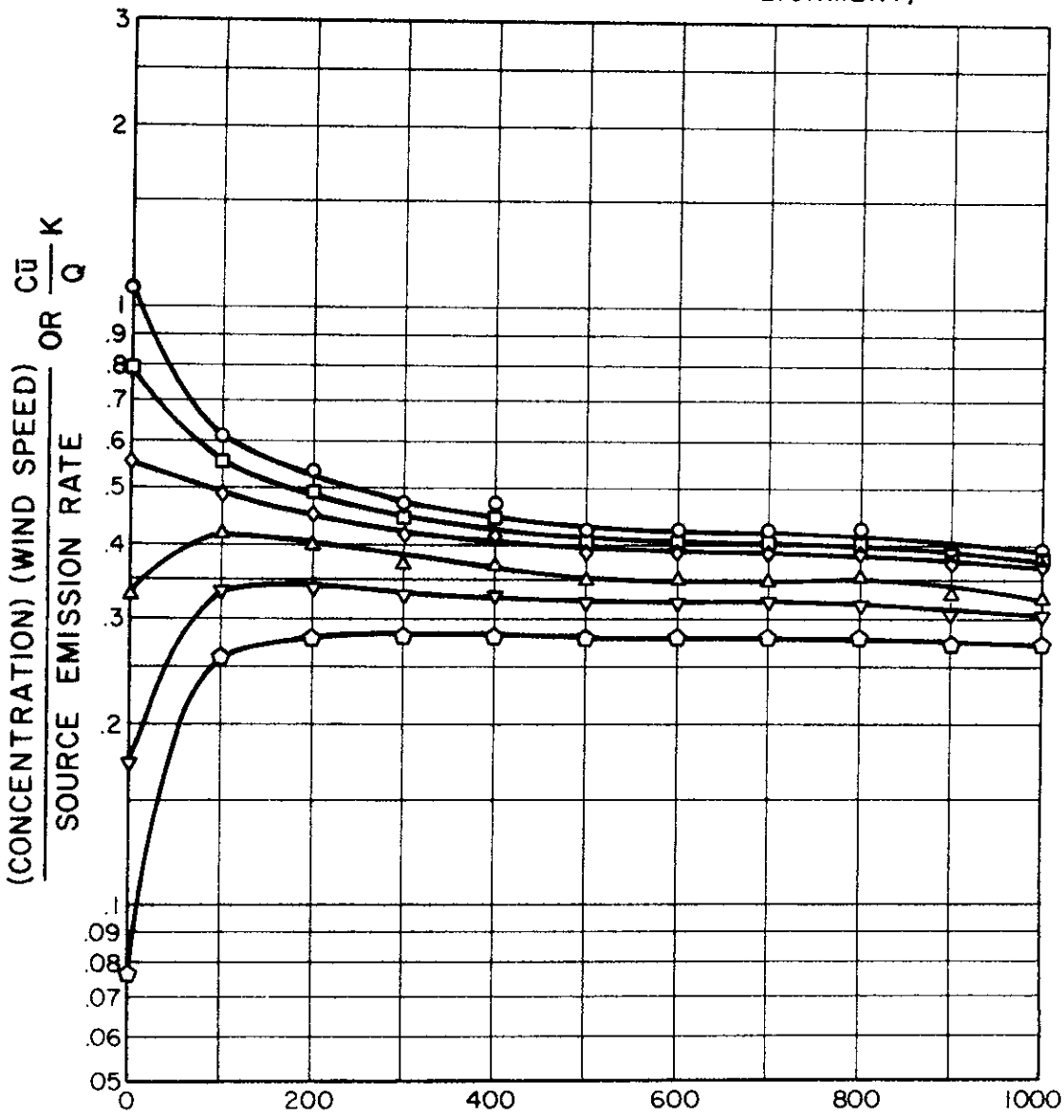

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Figure 13

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)

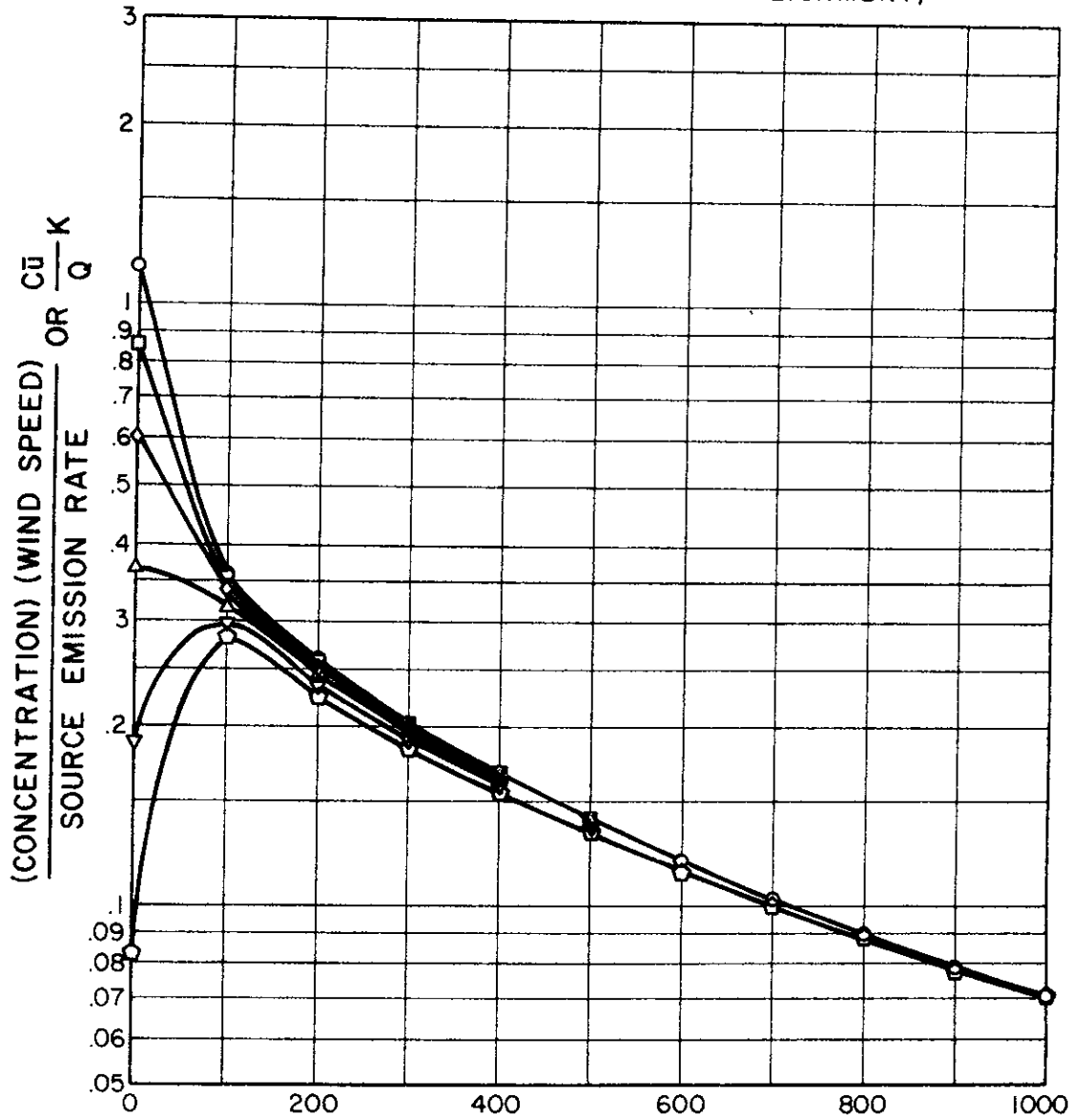

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Figure 14

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)

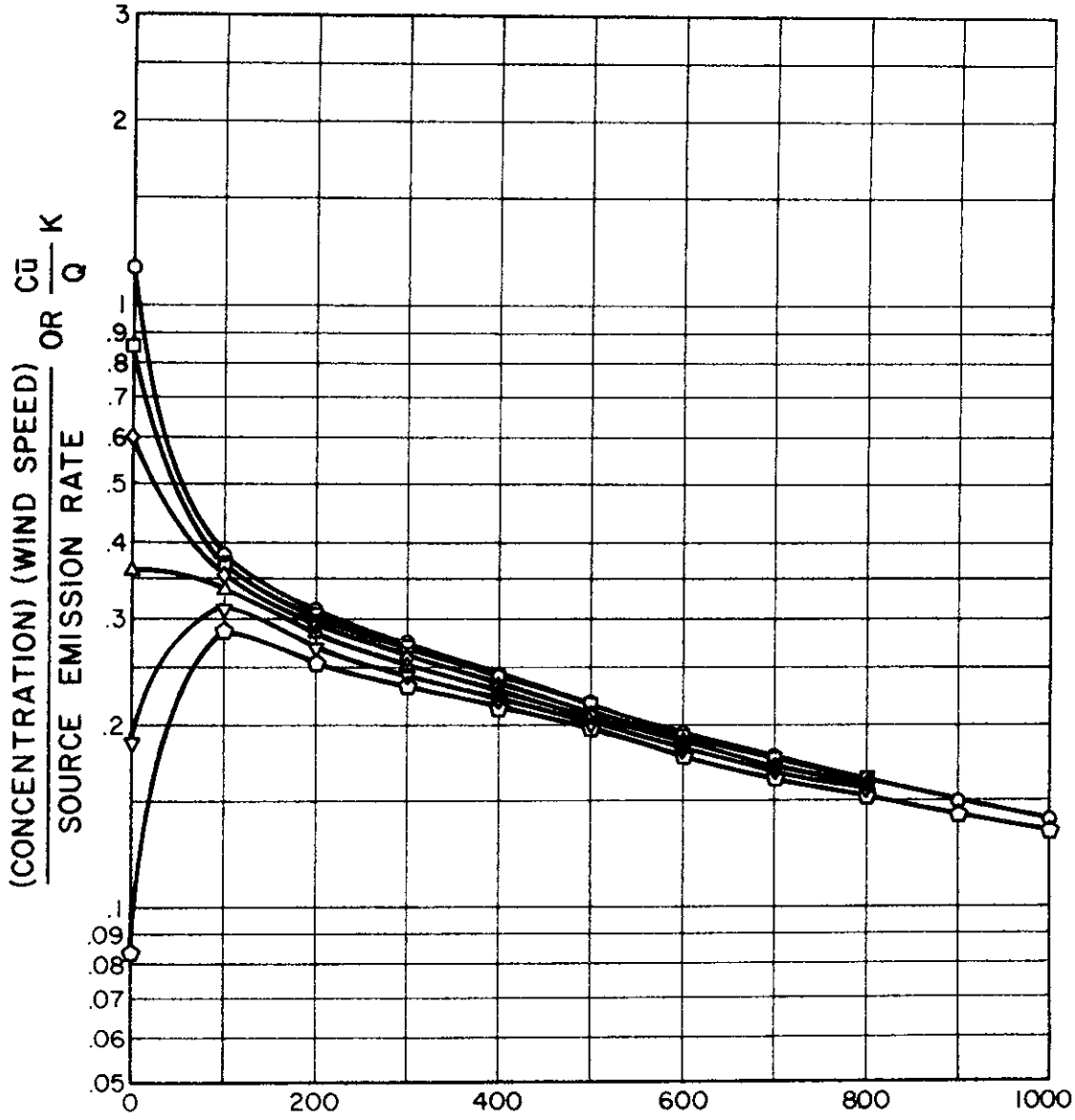

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Figure 15

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)

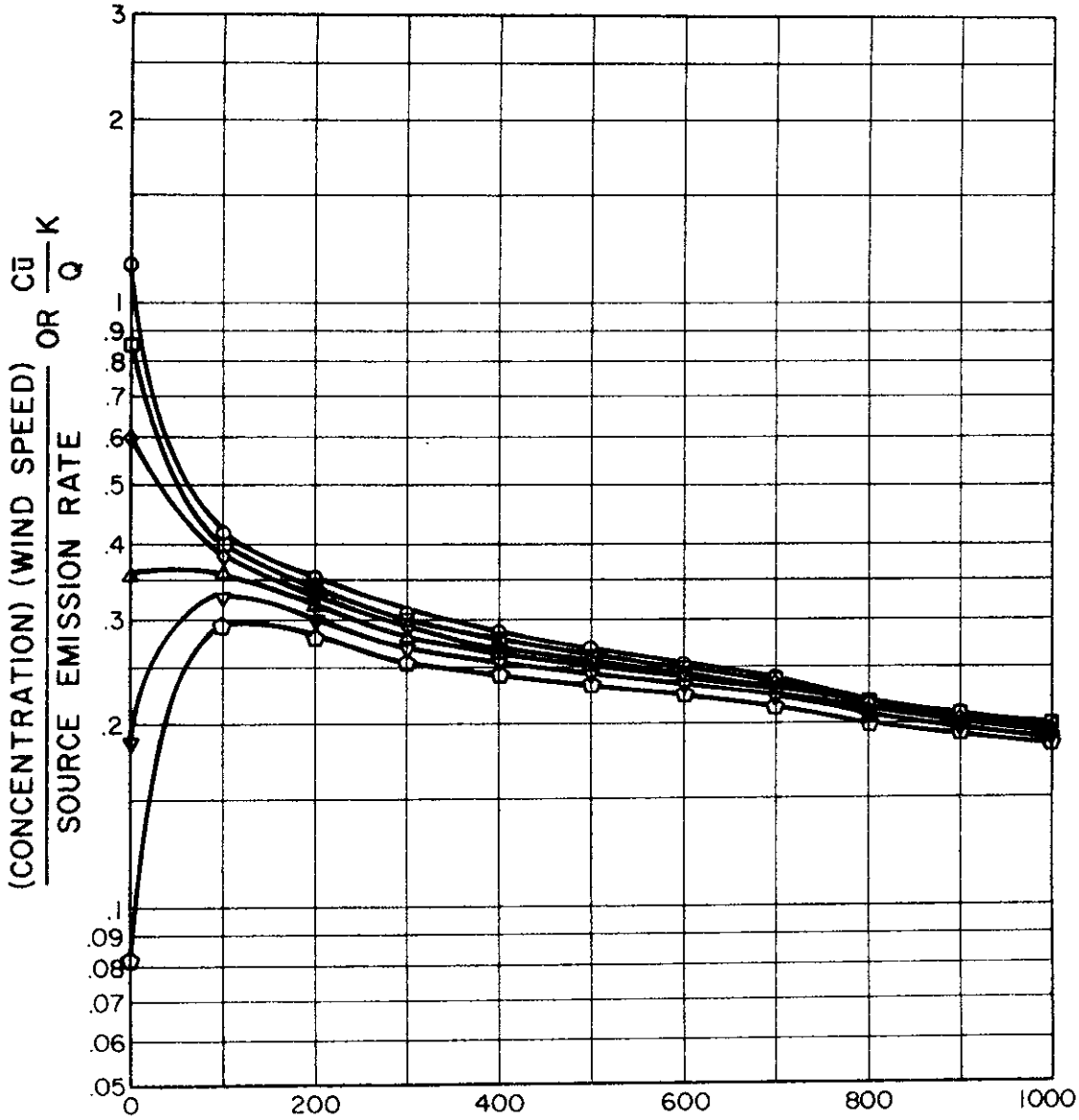

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Figure 16

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)

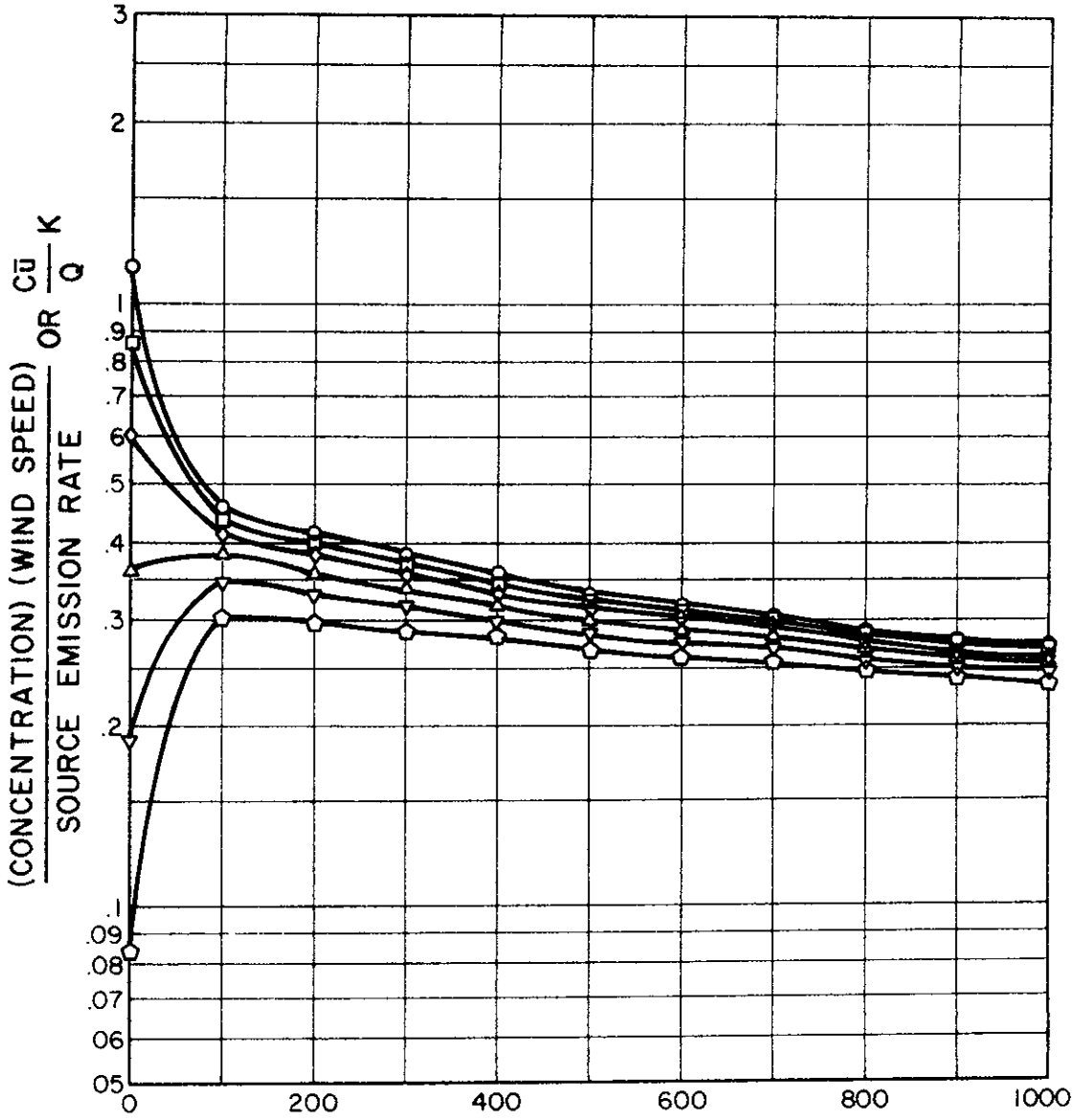

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Figure 17

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)

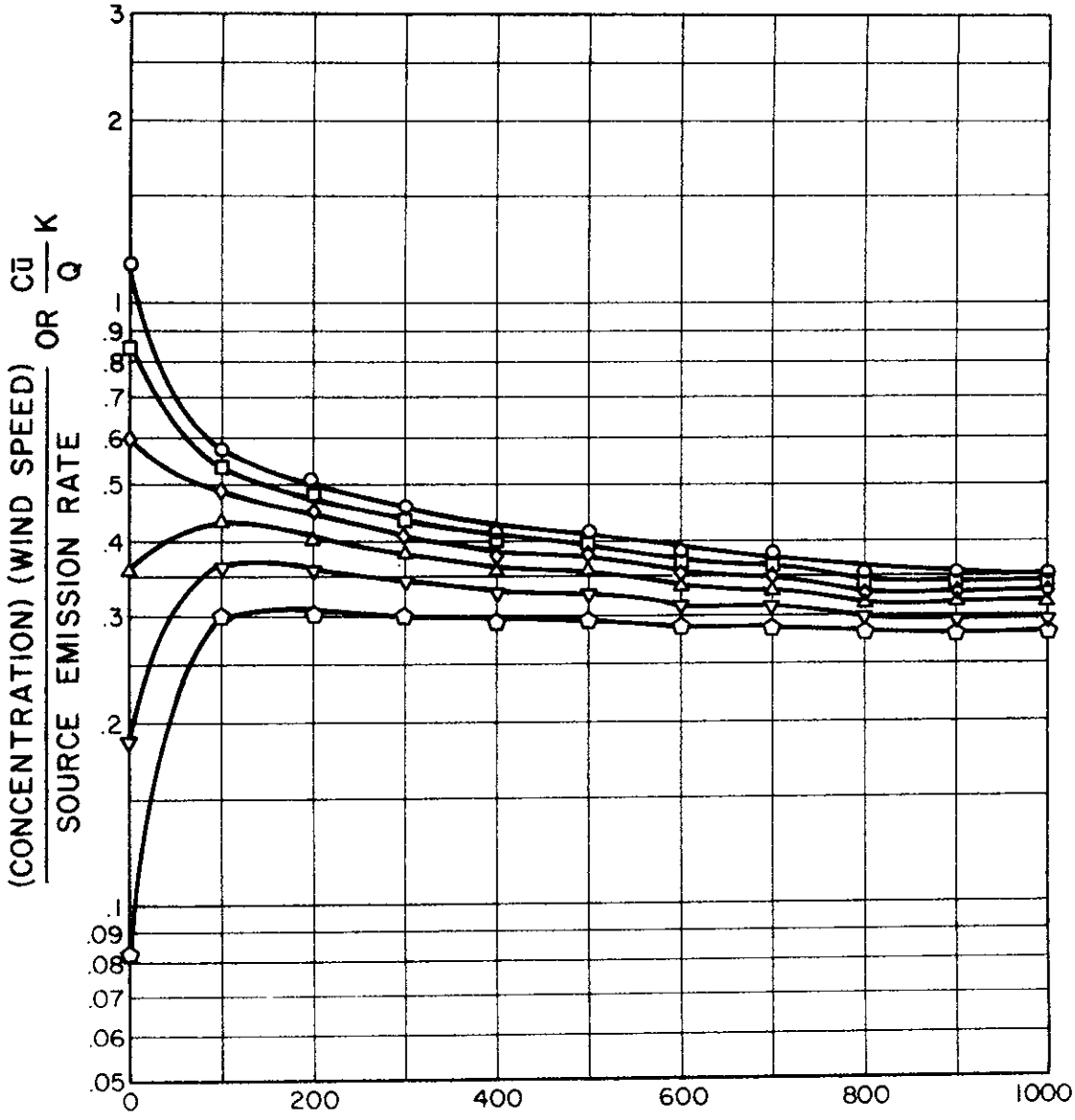

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Figure 18

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)

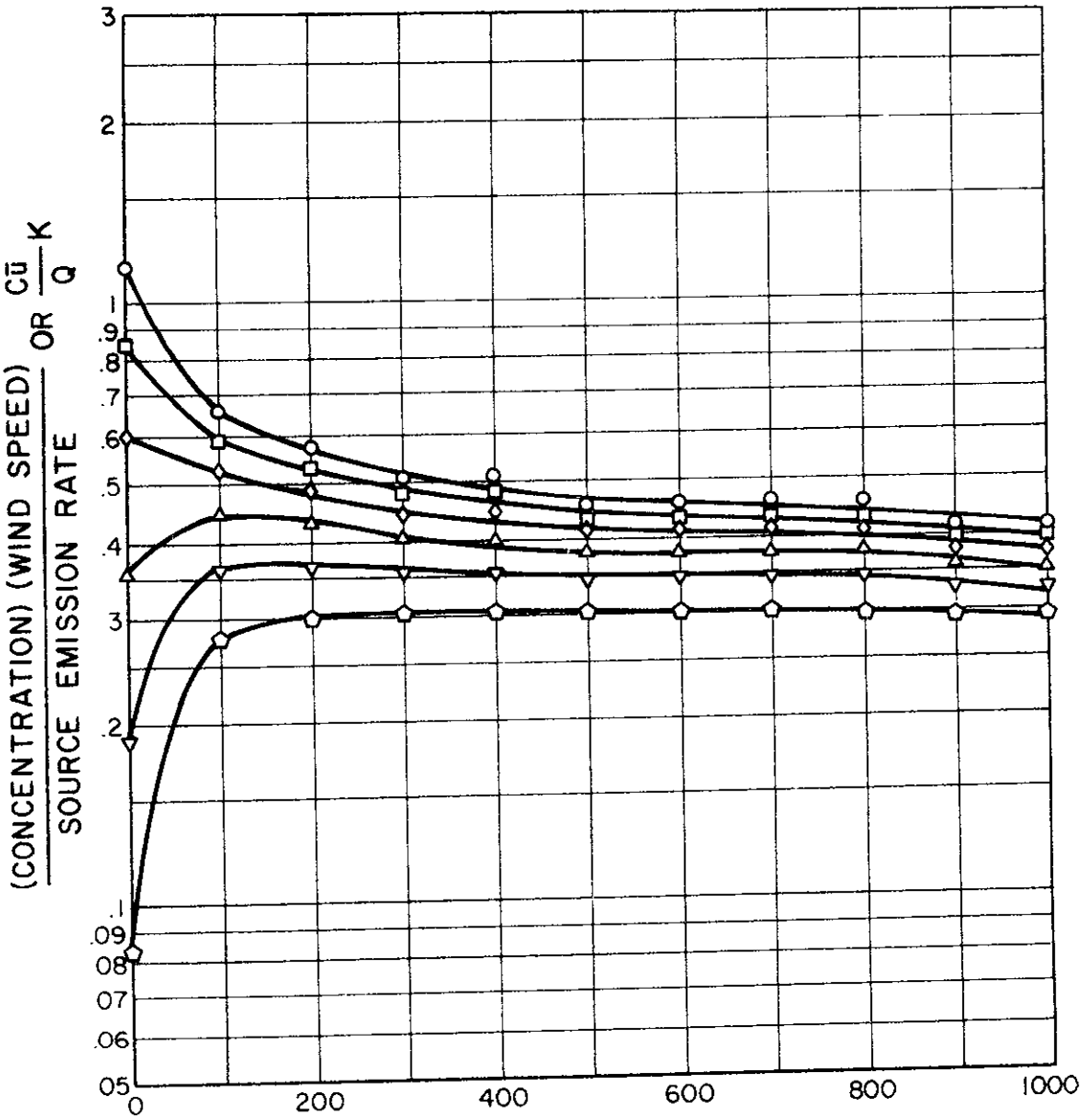

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Figure 19

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)

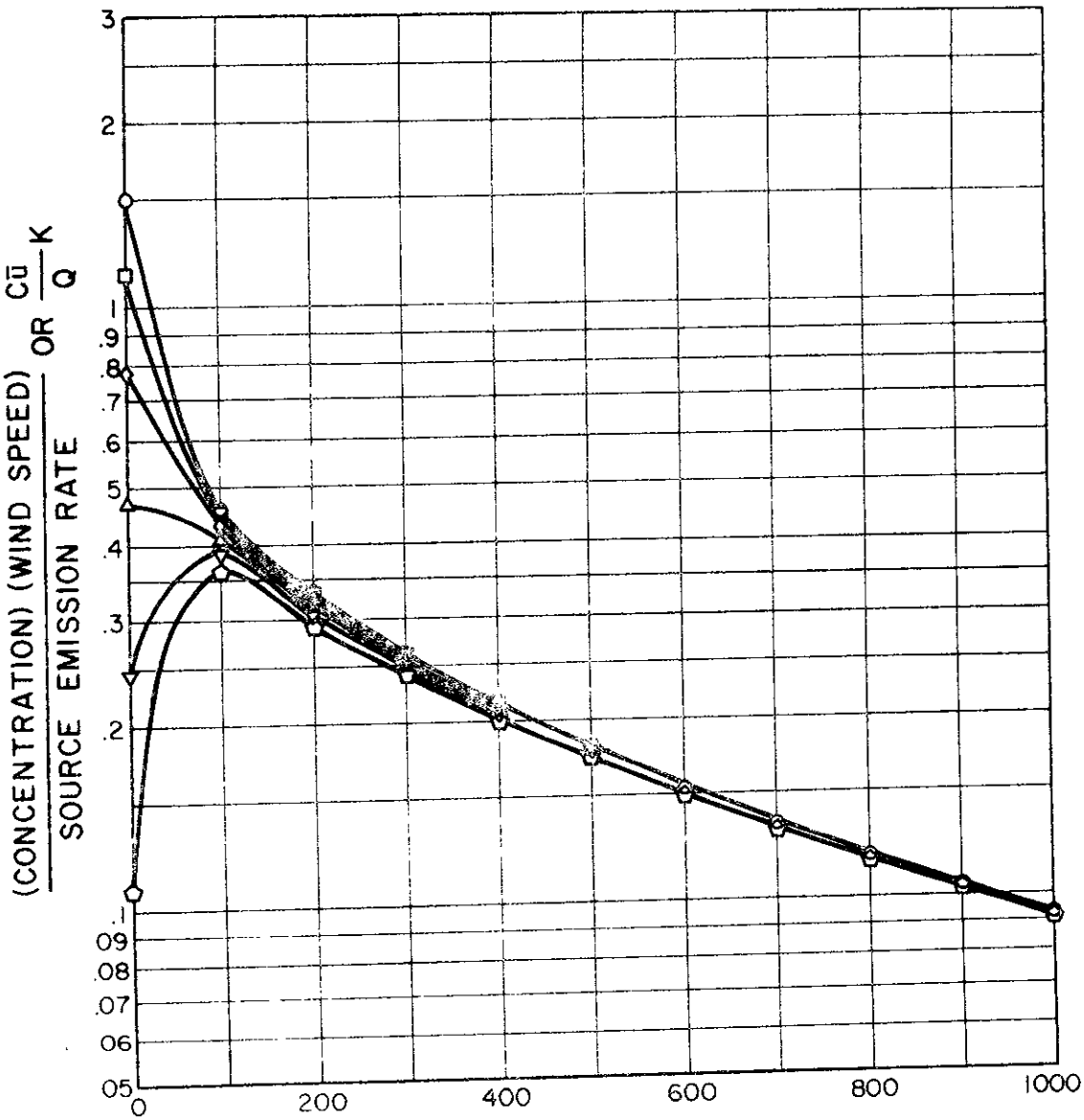

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Figure 20

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)

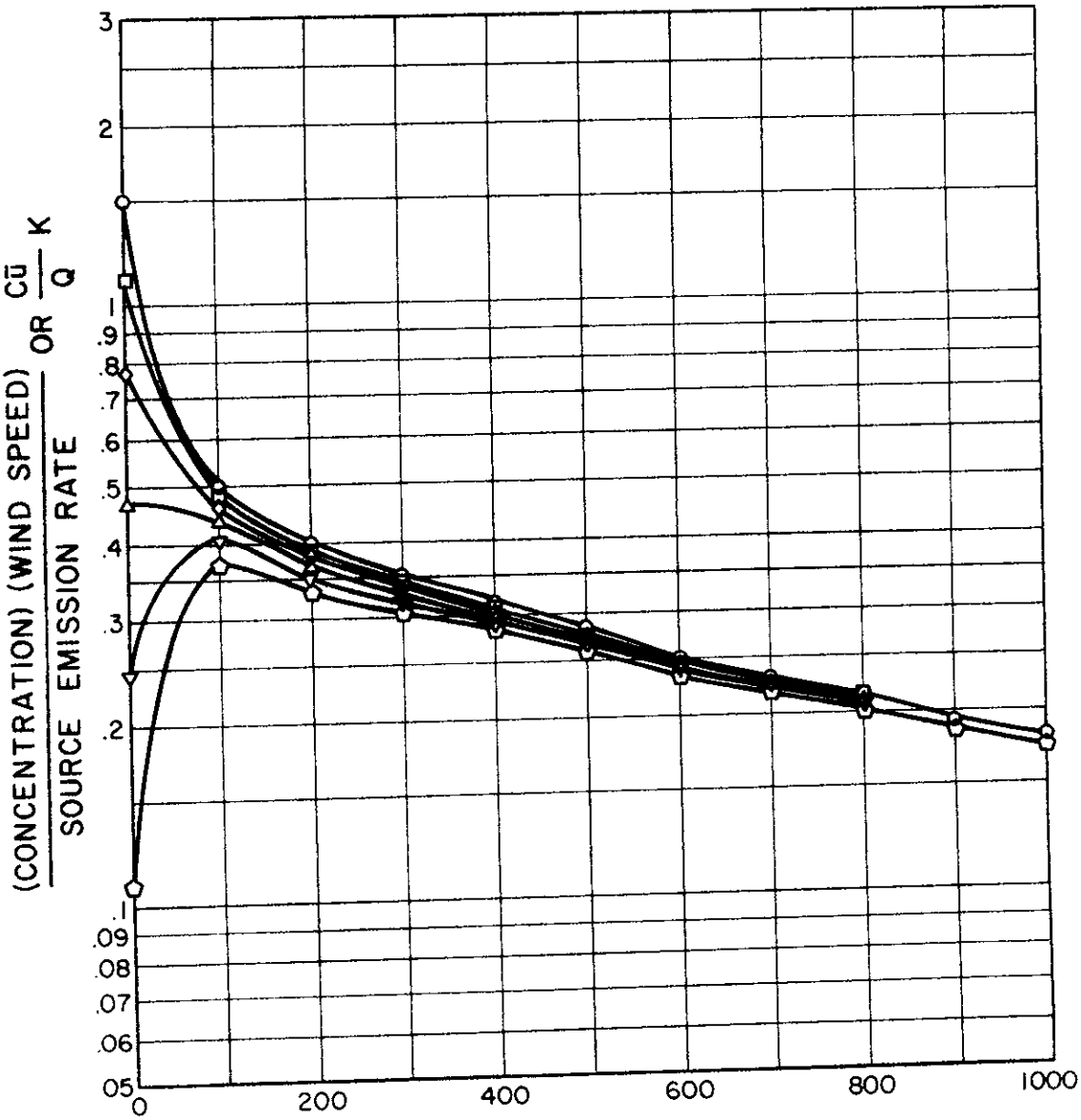

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Figure 21

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)

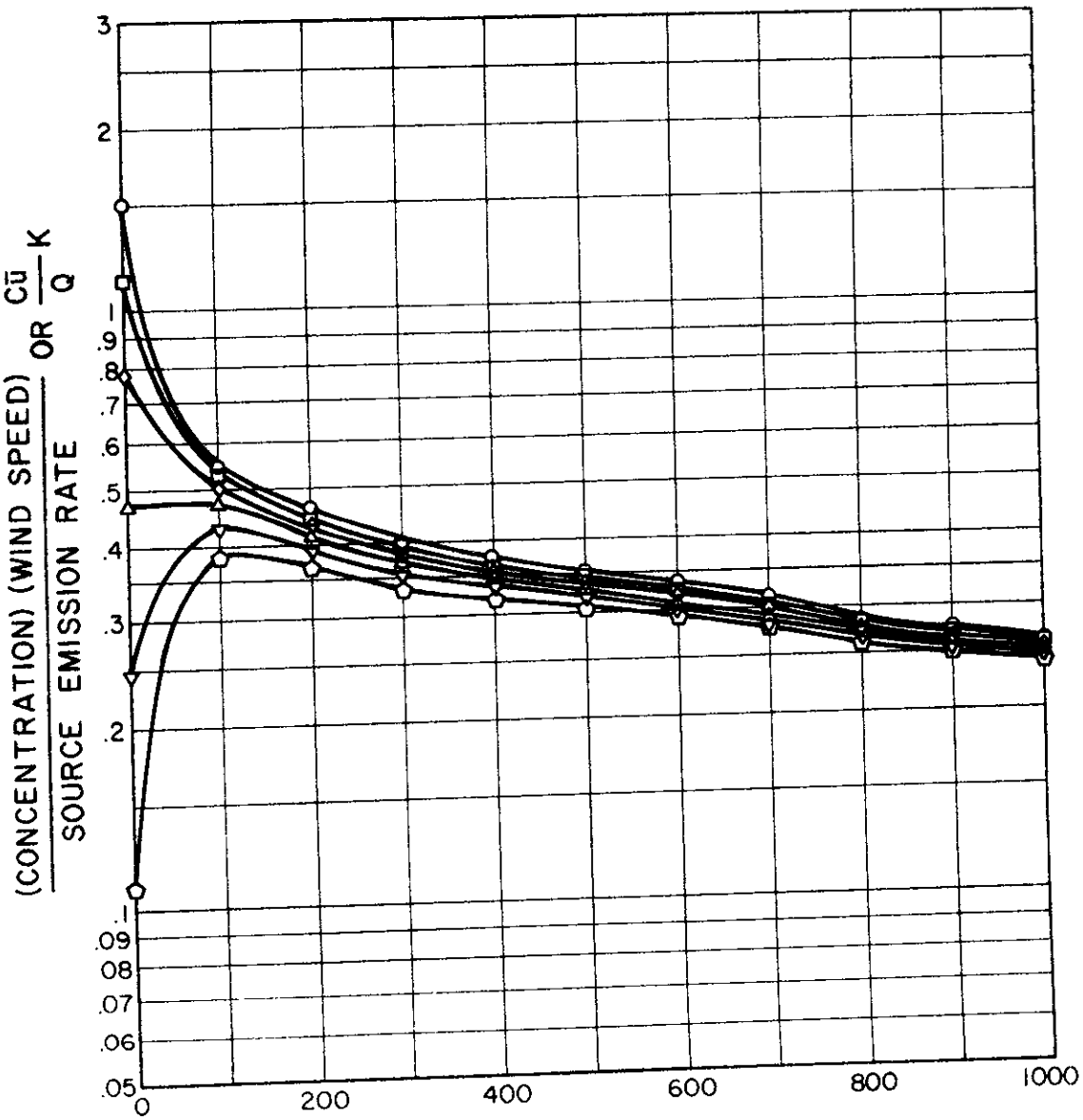

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Figure 22

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)

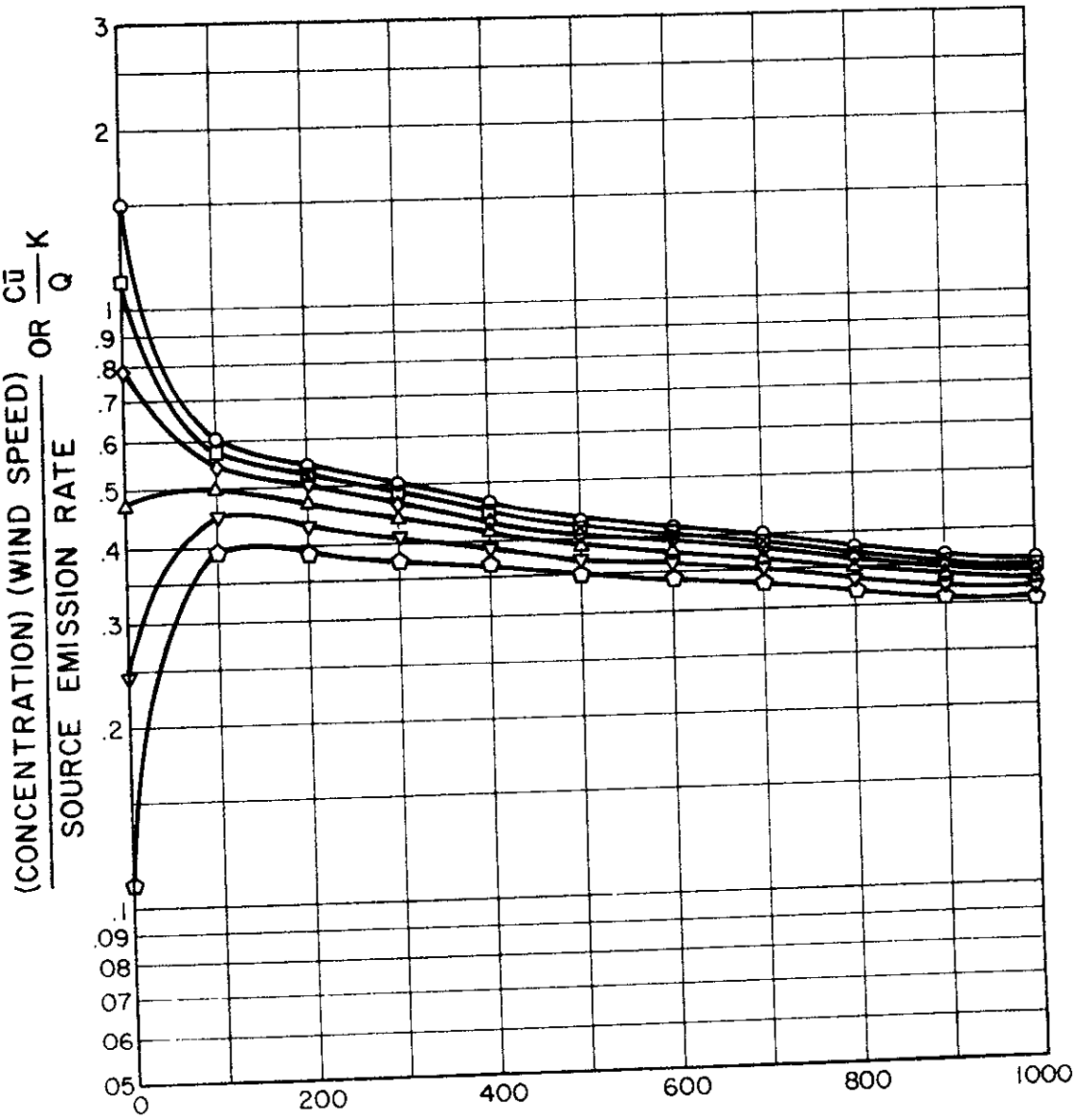

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Figure 23

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)

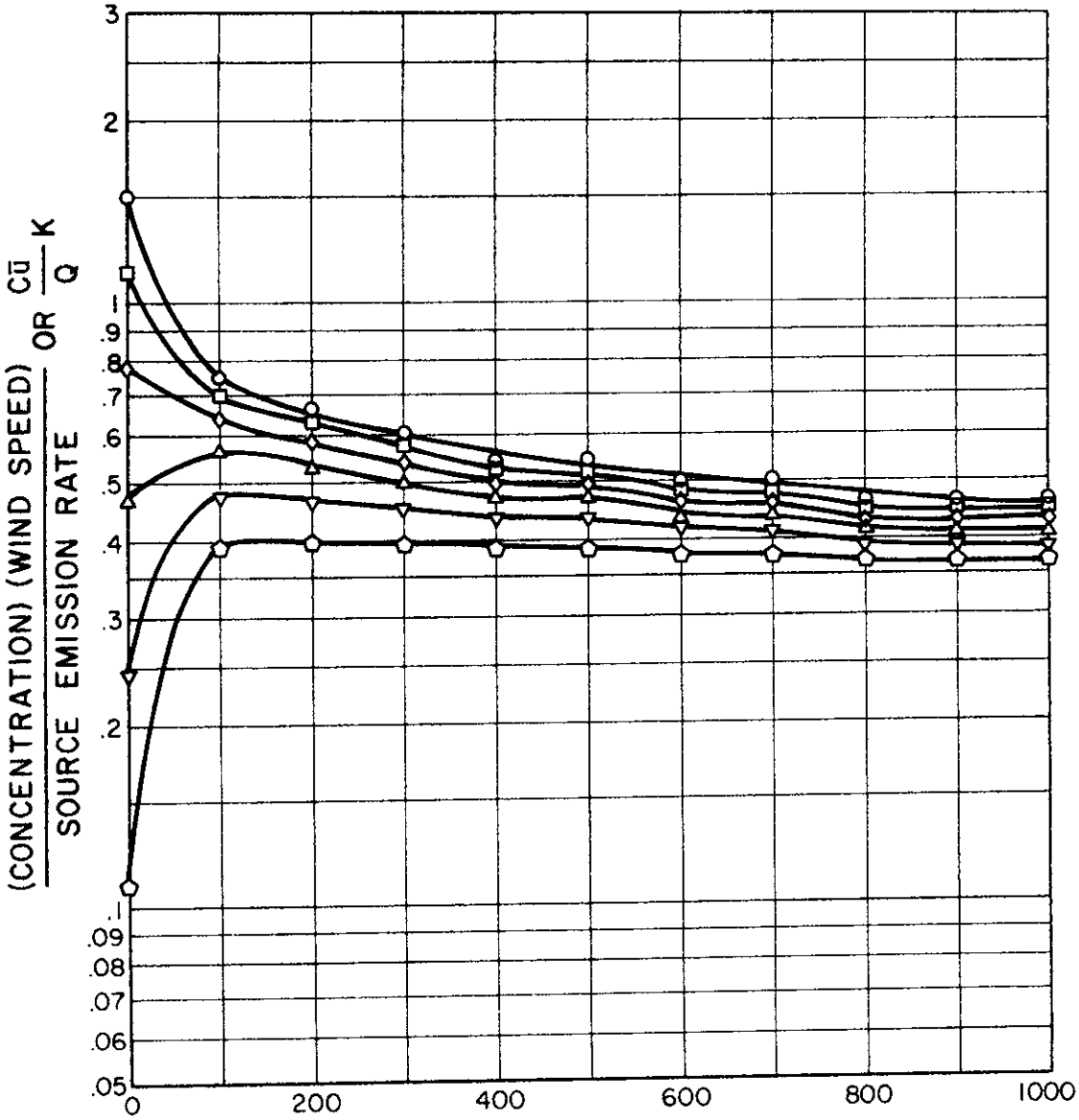

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Figure 24

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)

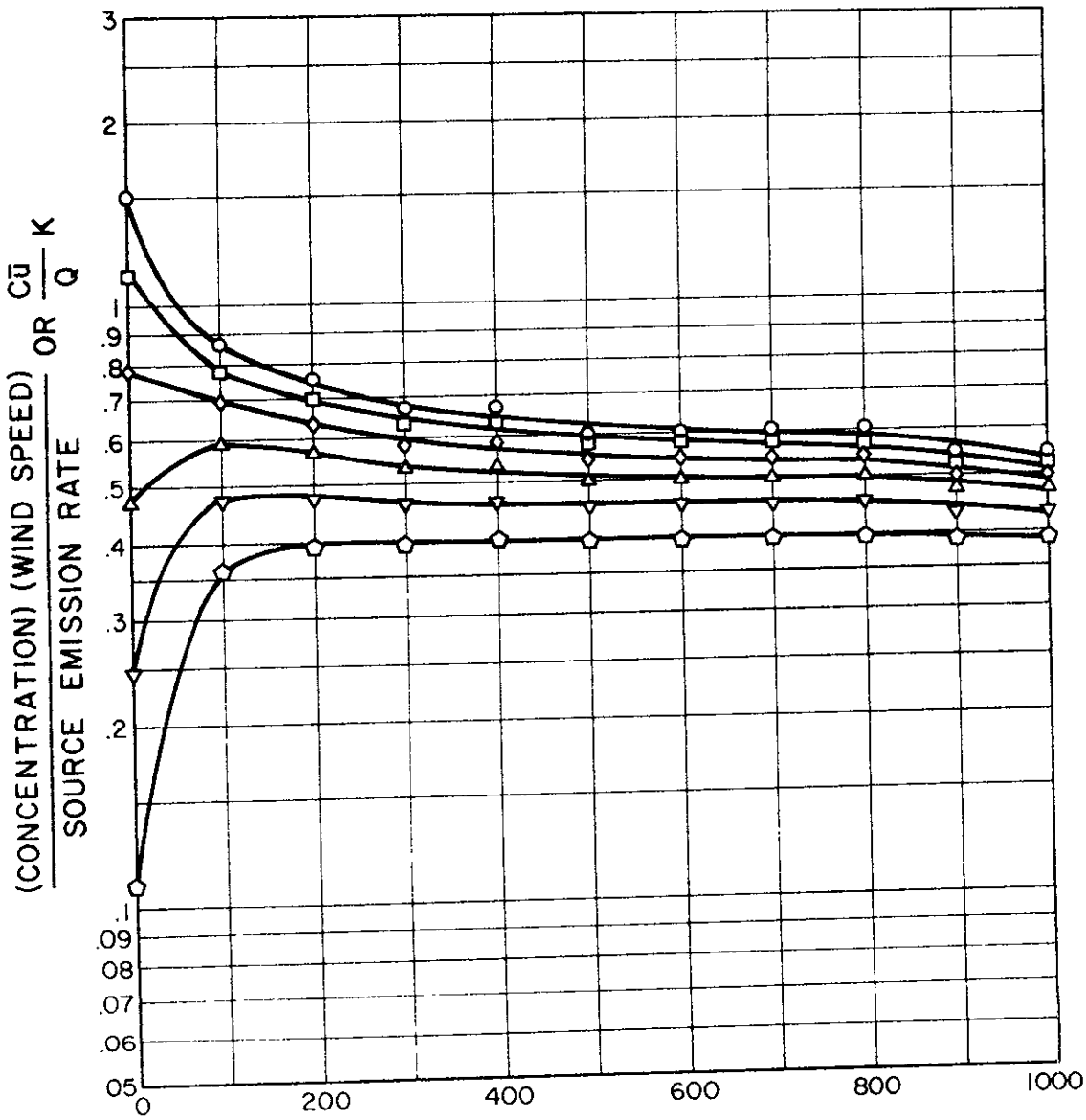

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Figure 25

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)

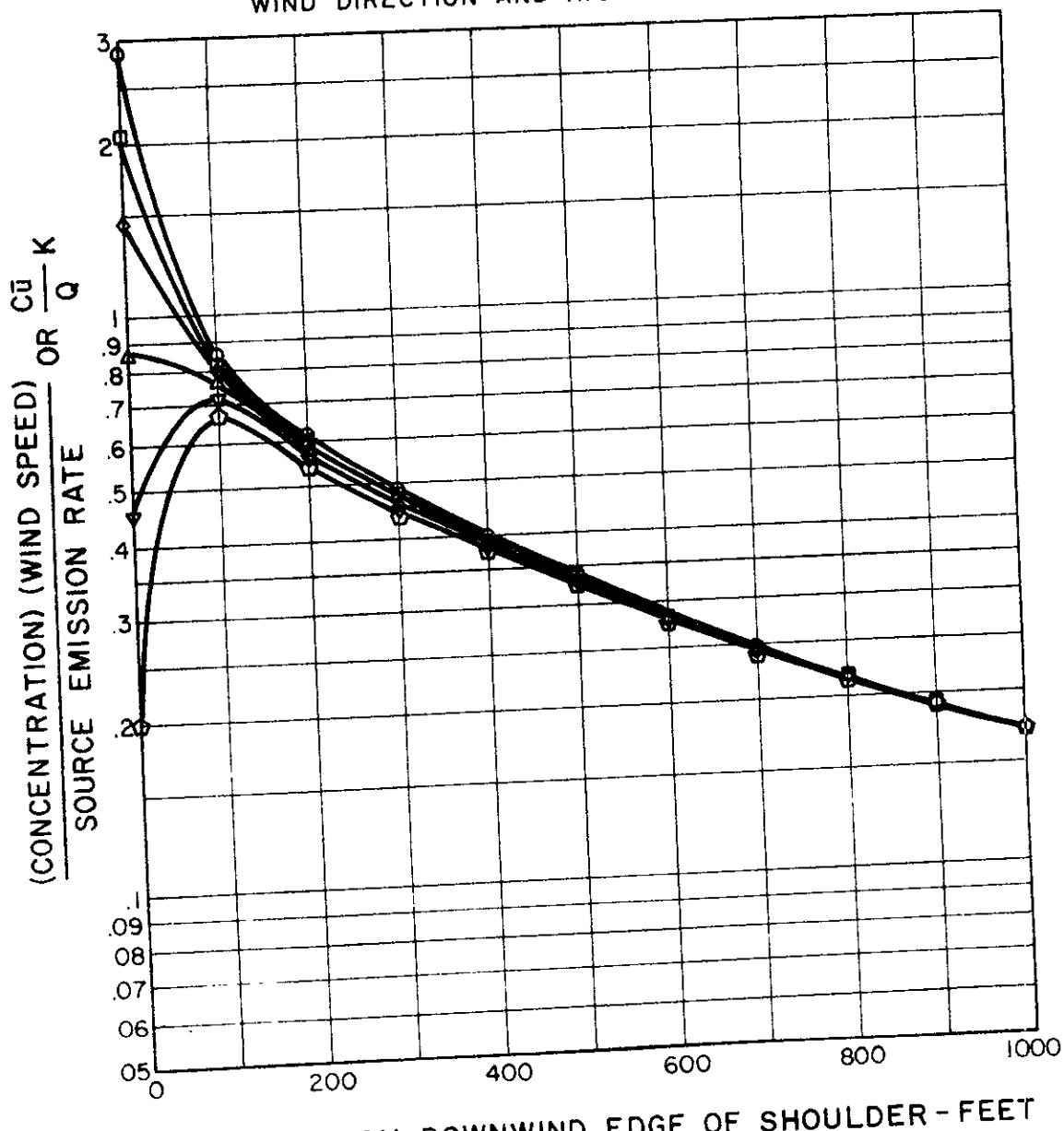

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Figure 26

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)

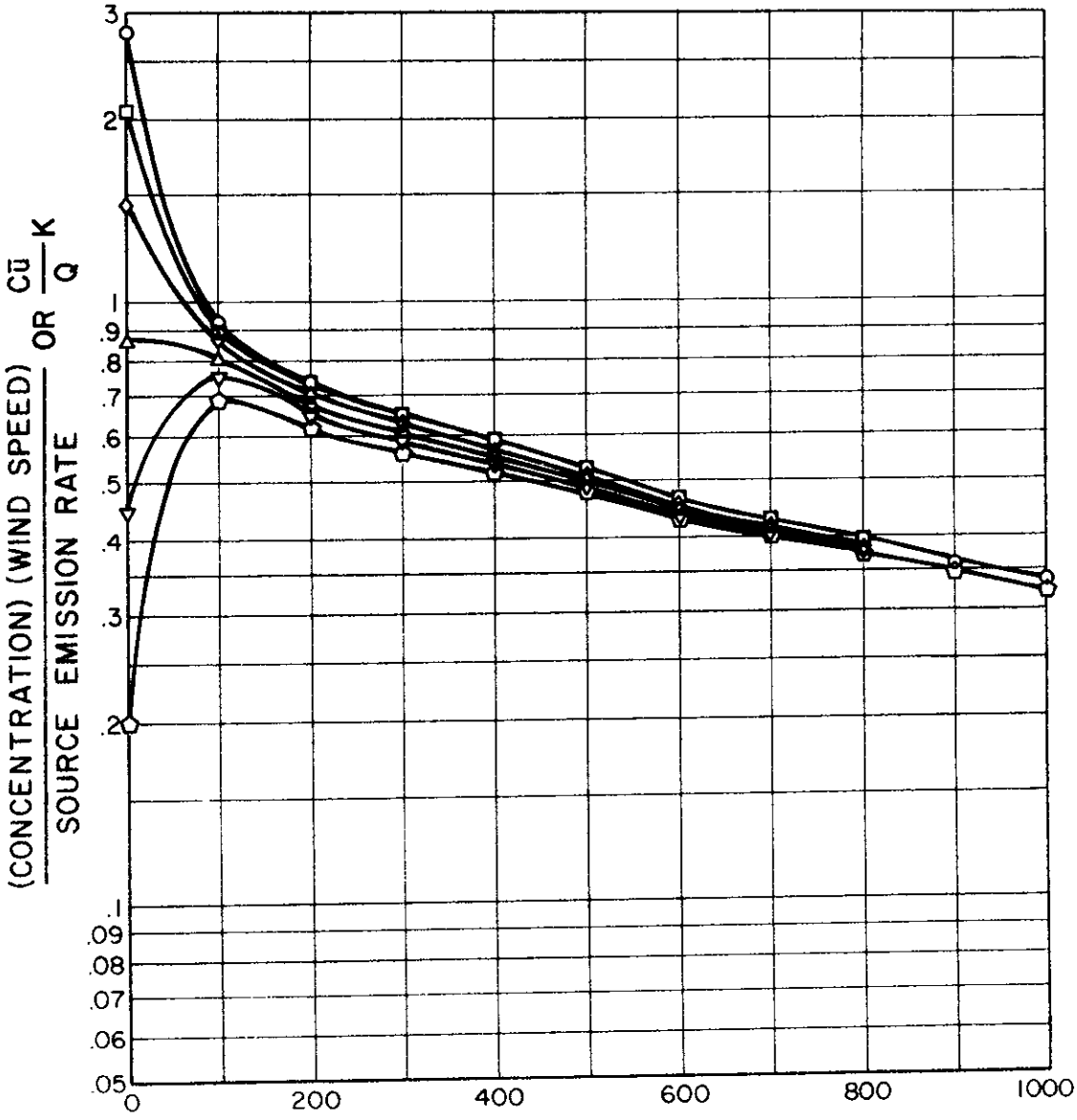

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Figure 27

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)

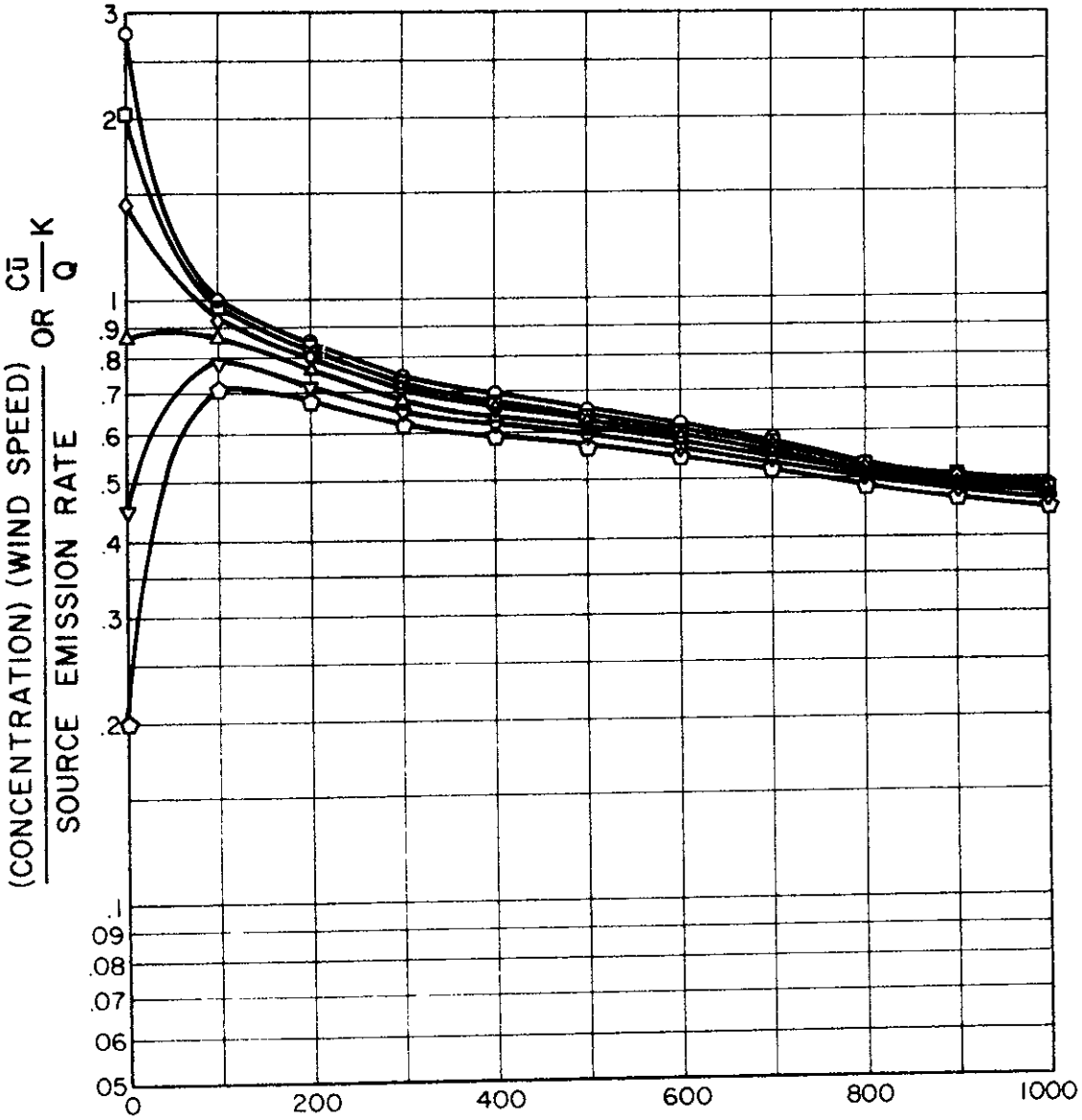

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Figure 28

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)

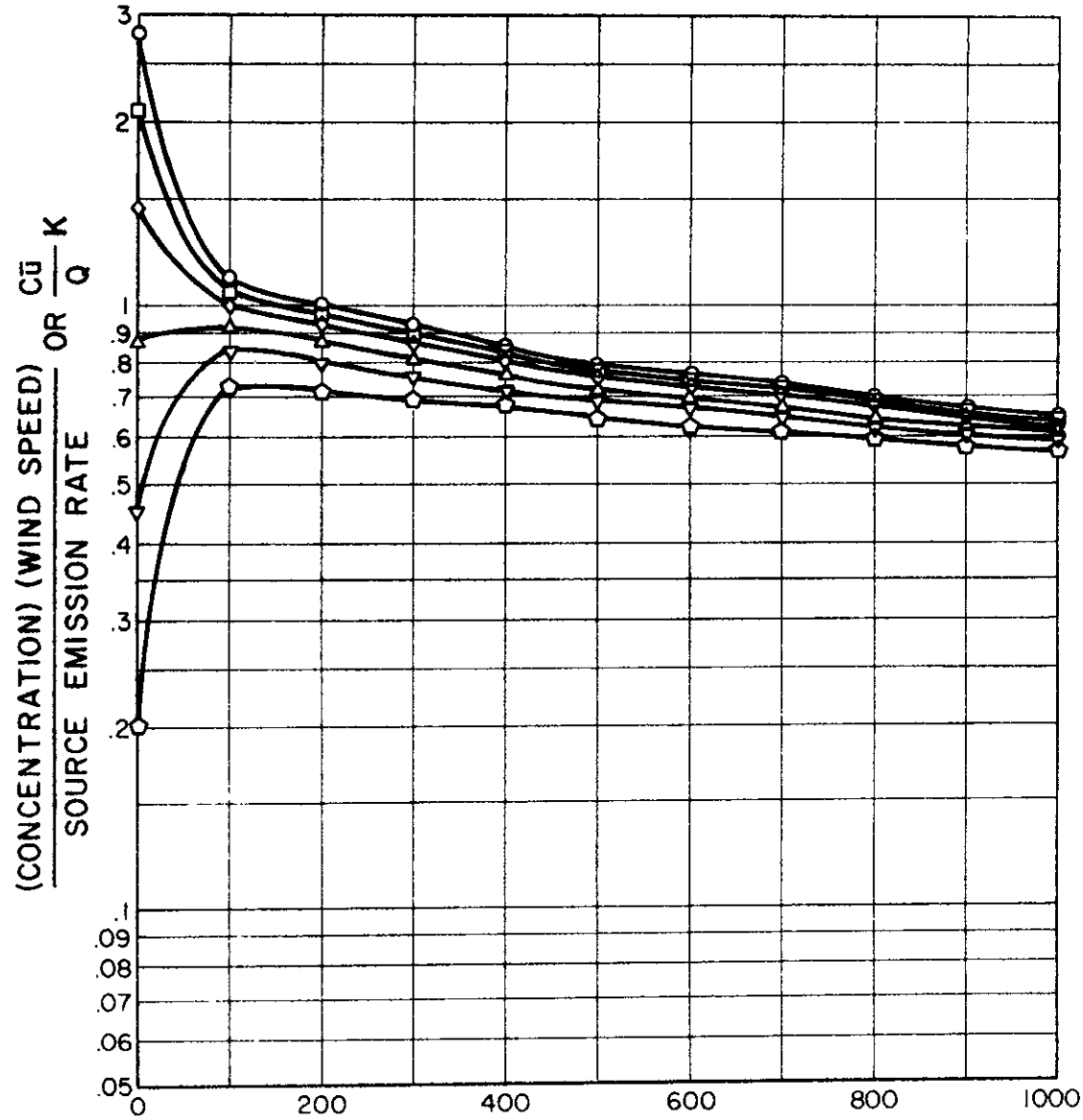

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Figure 29

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)

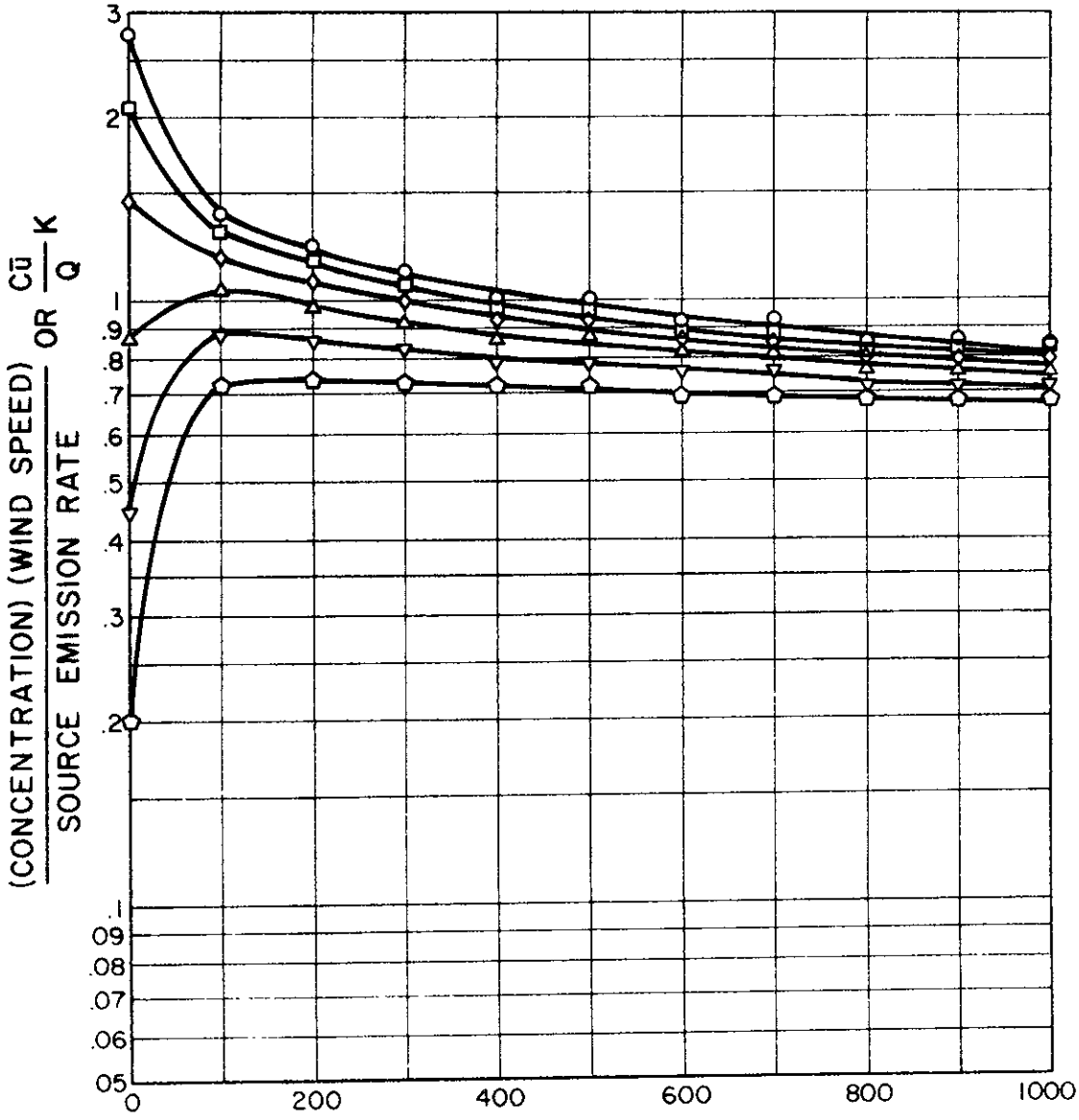

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Figure 30

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

ELEVATED SECTION
STABILITY CLASS F

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)

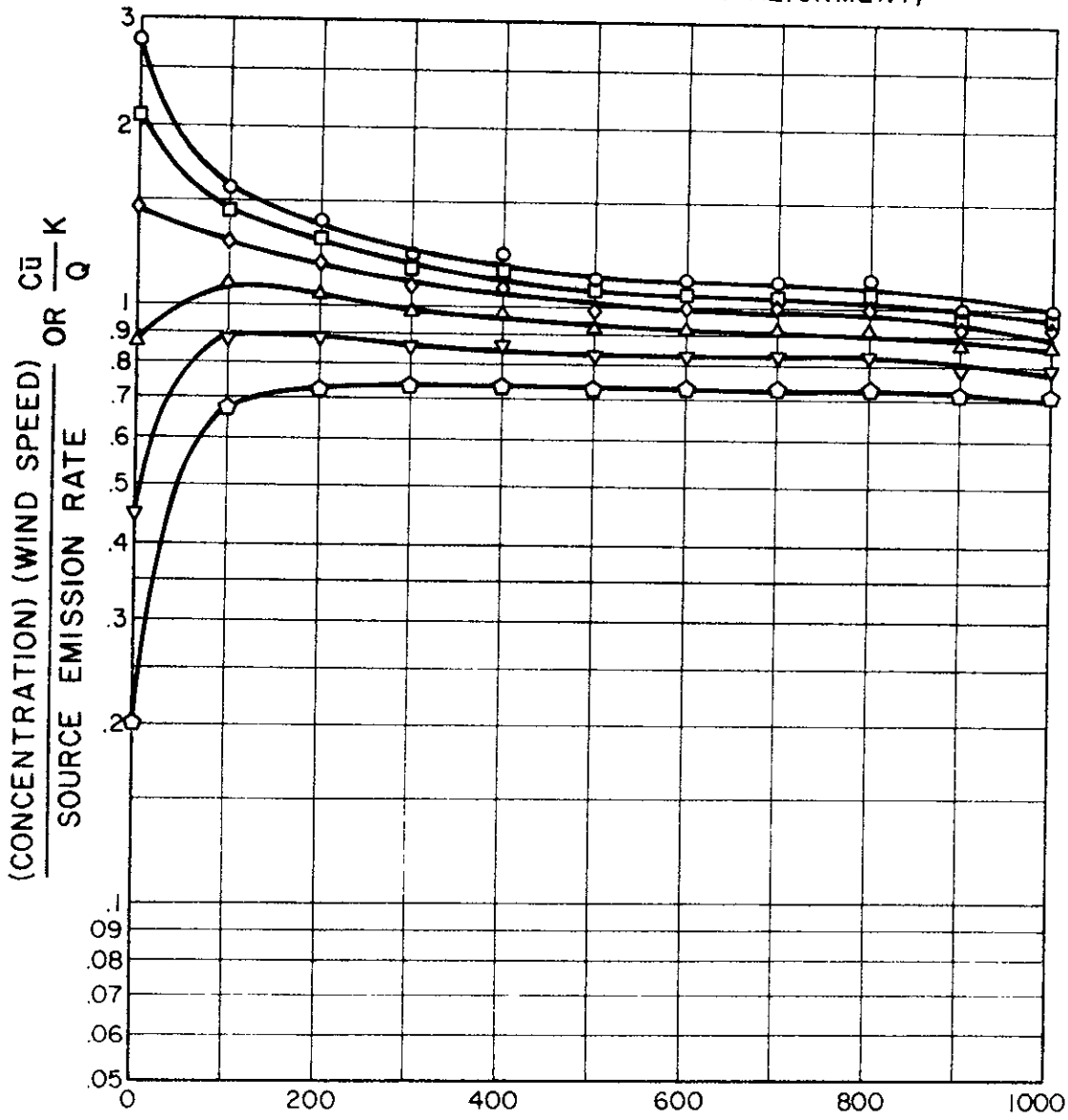

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Figure 31

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

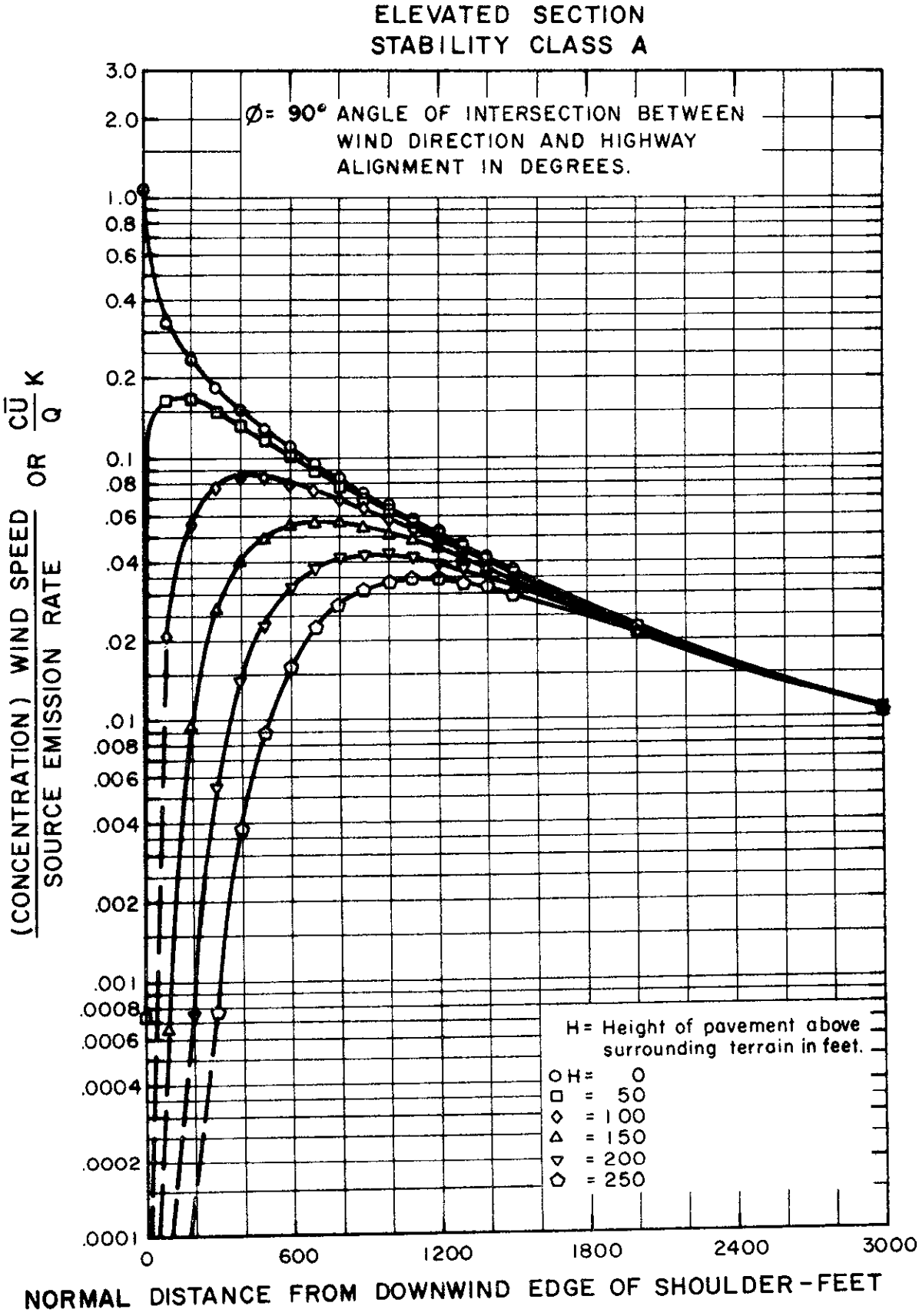

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Figure 32

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

ELEVATED SECTION
STABILITY CLASS B

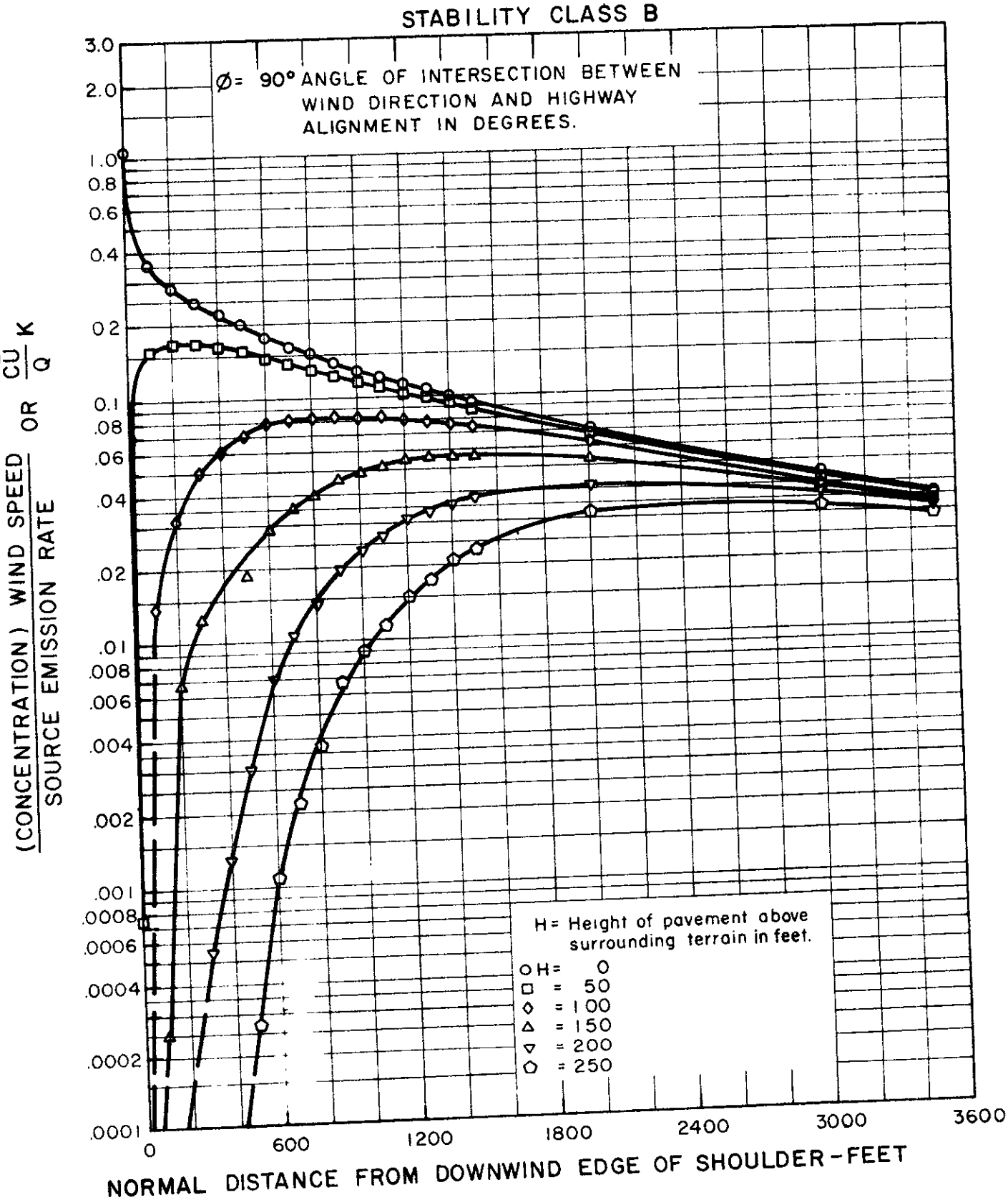

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Figure 37

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

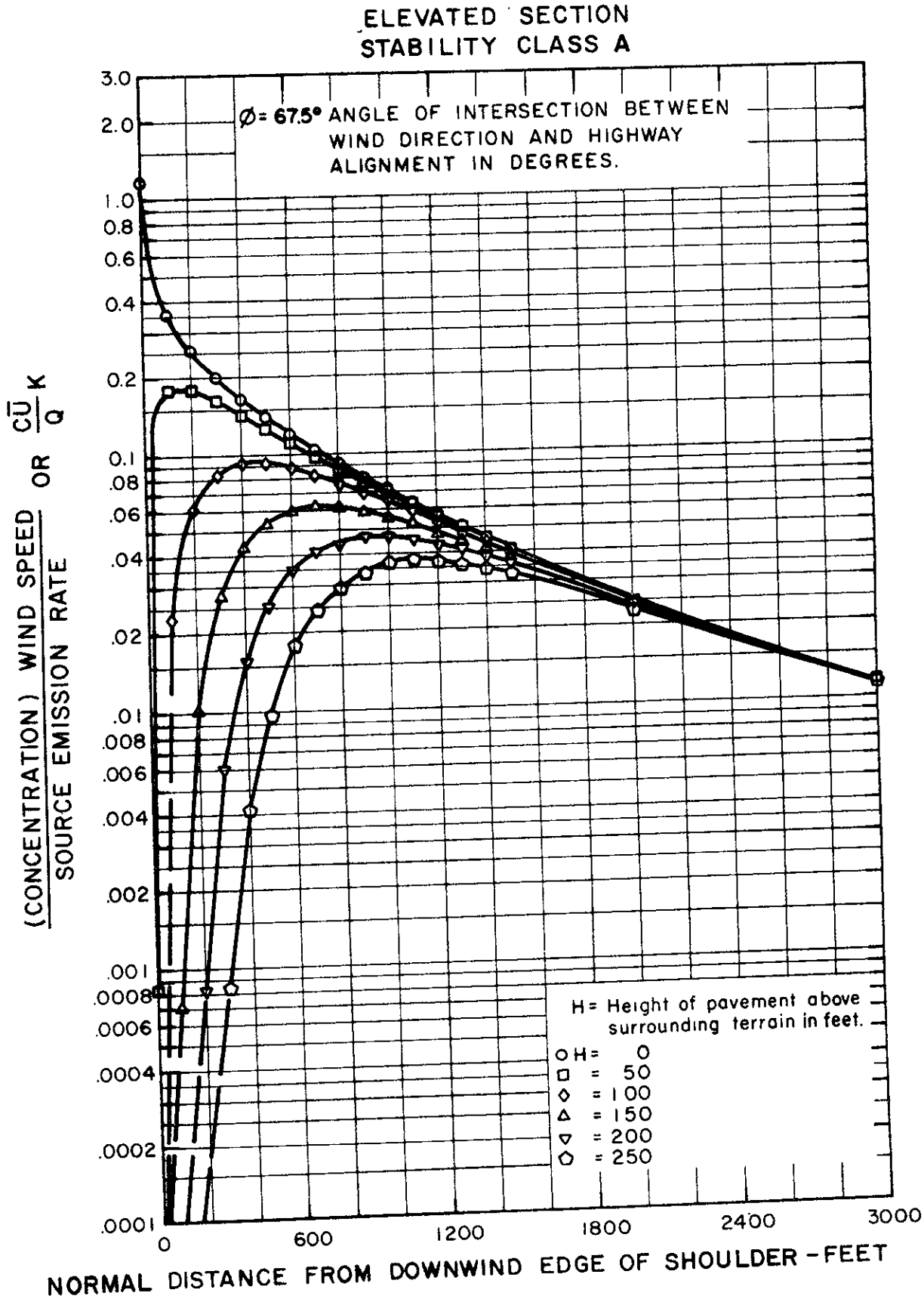

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Figure 38

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

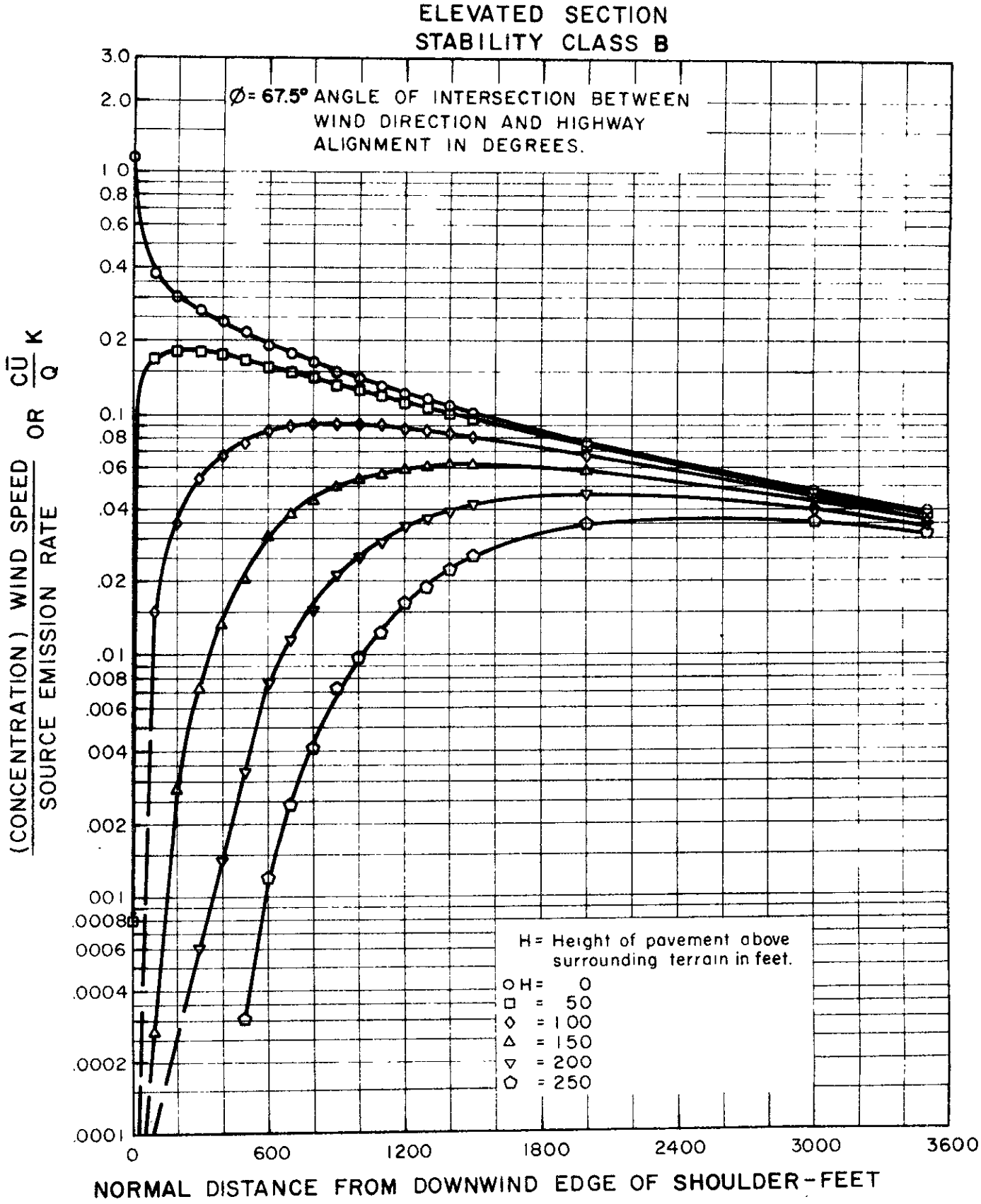

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Figure 50

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

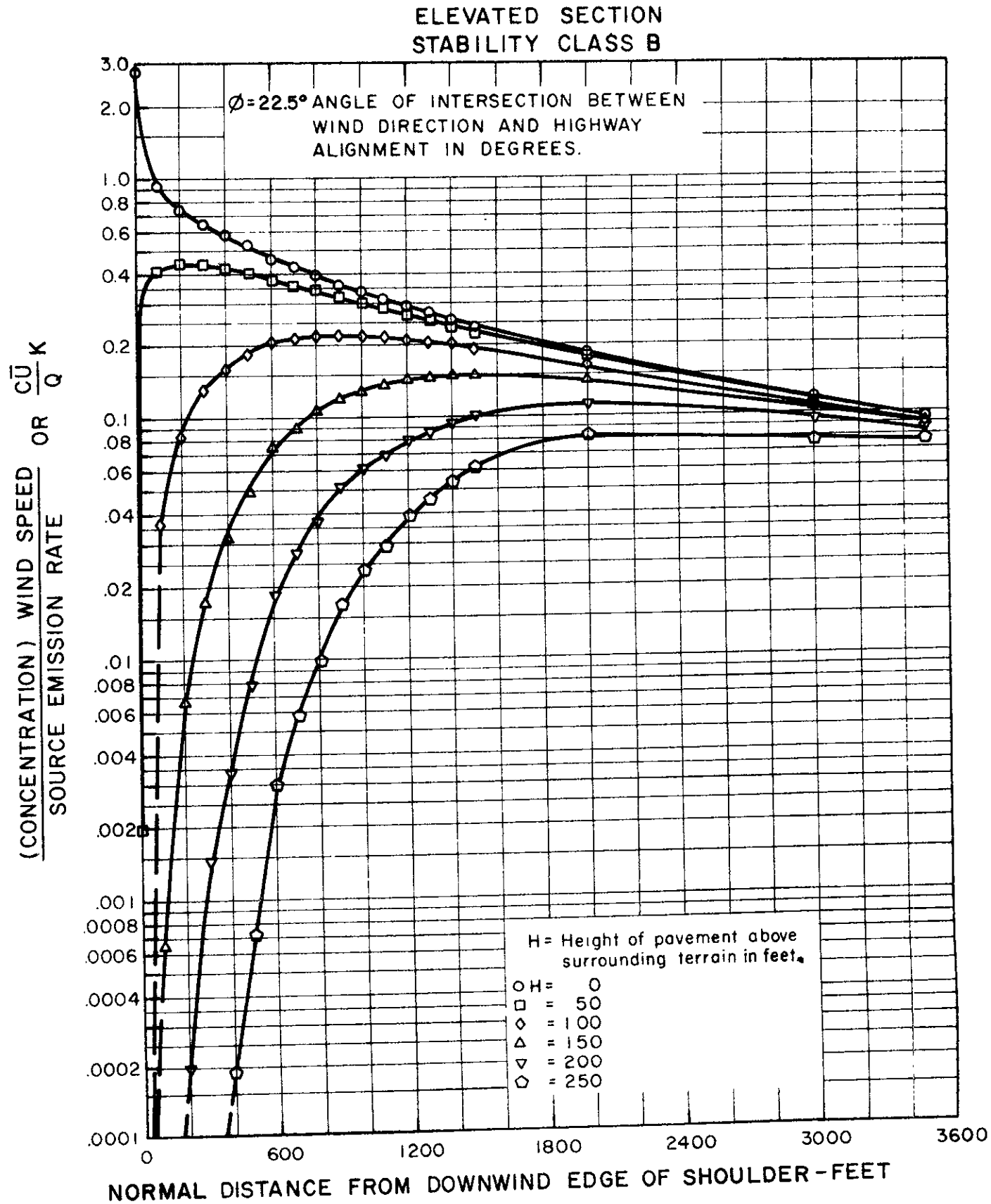

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Figure 55

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

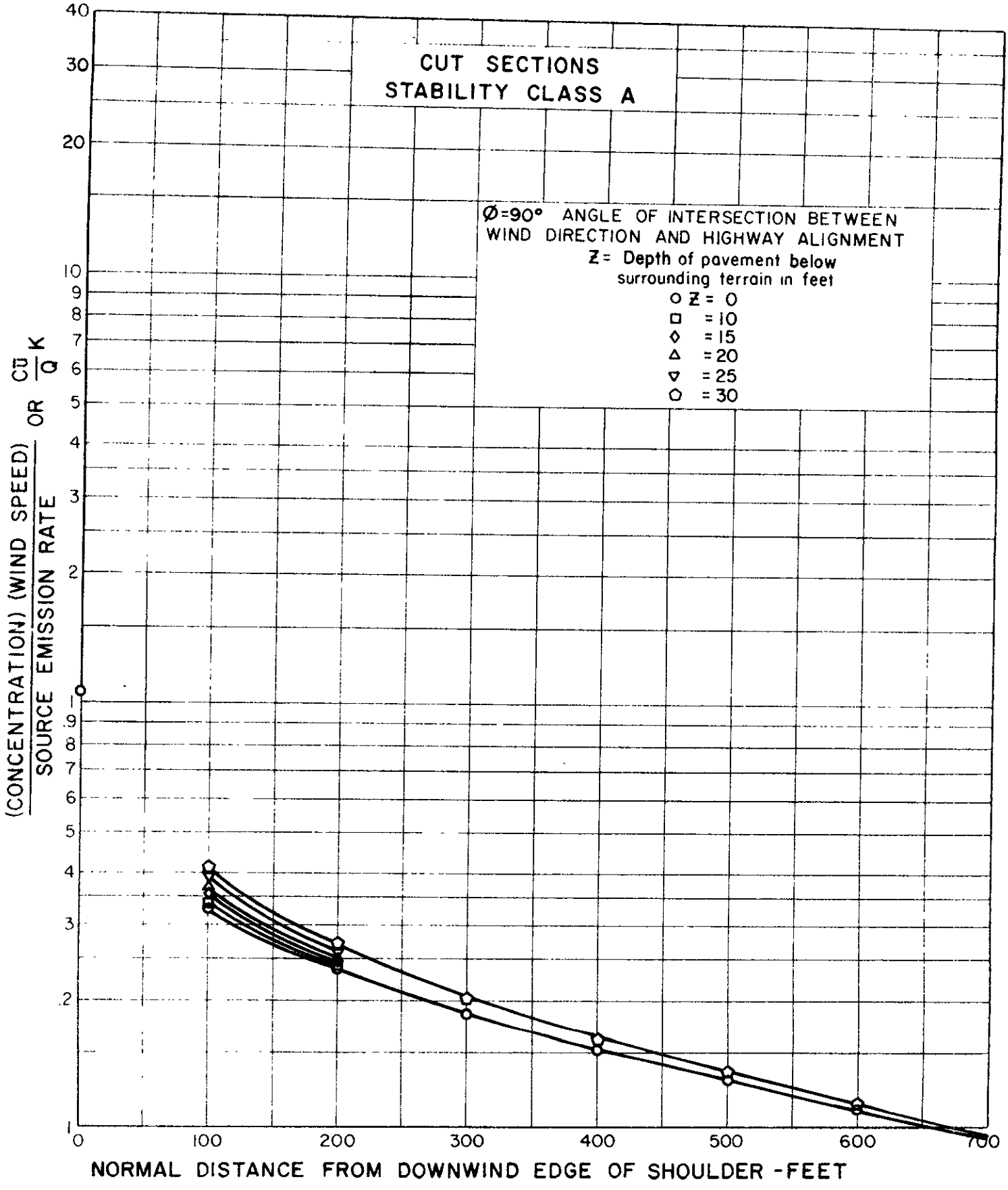

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Figure 56

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

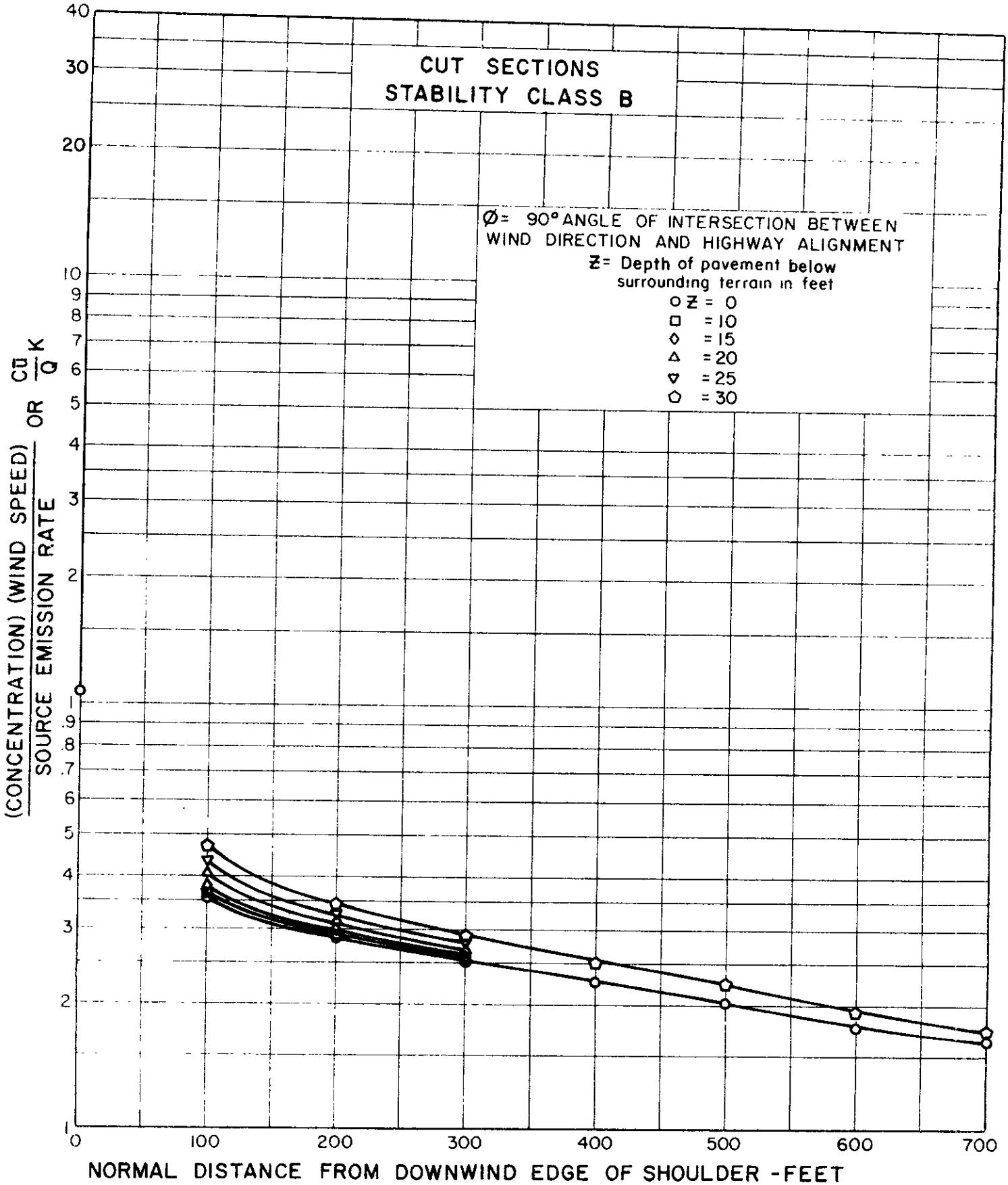

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Figure 57

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

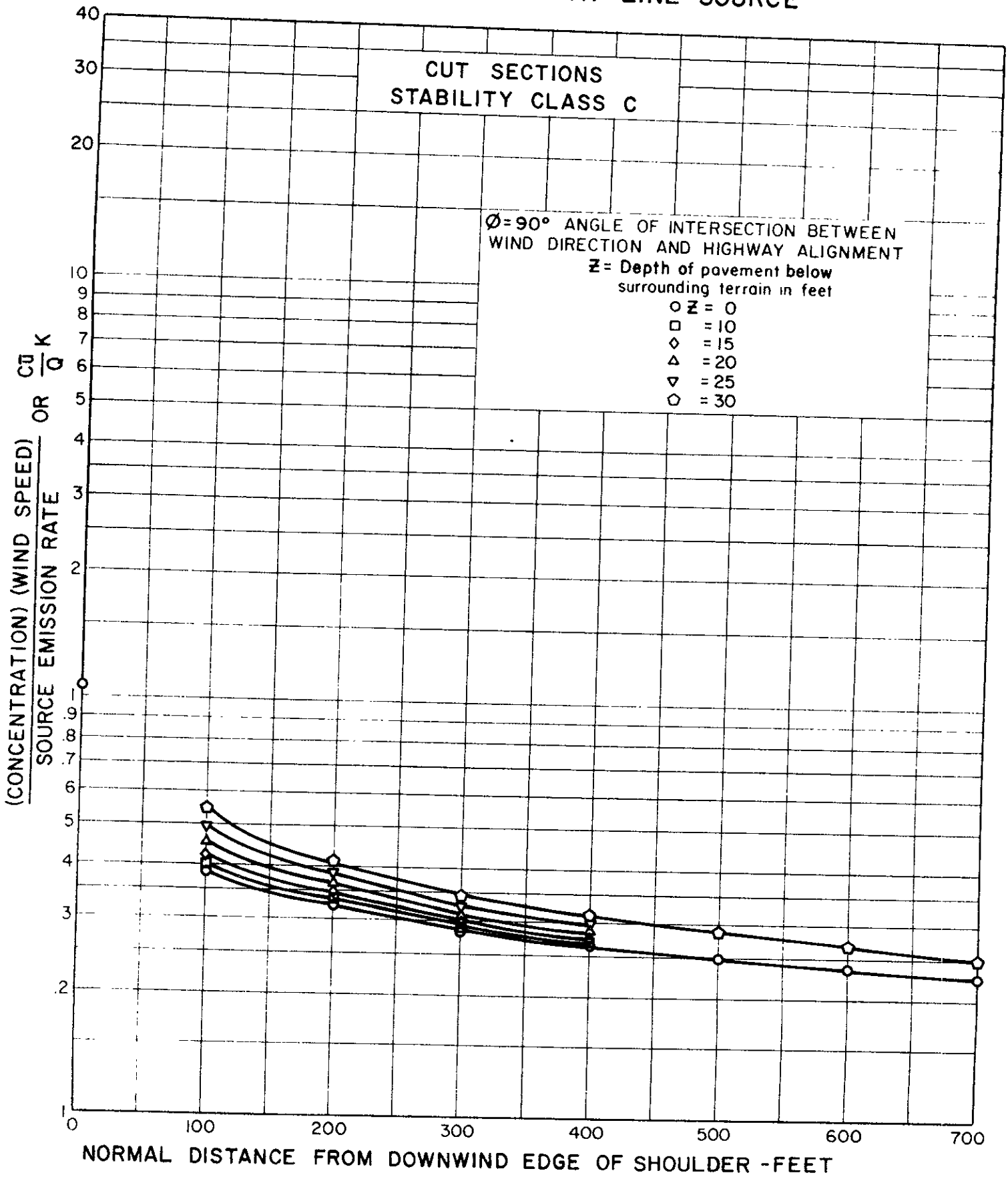

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Figure 58

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

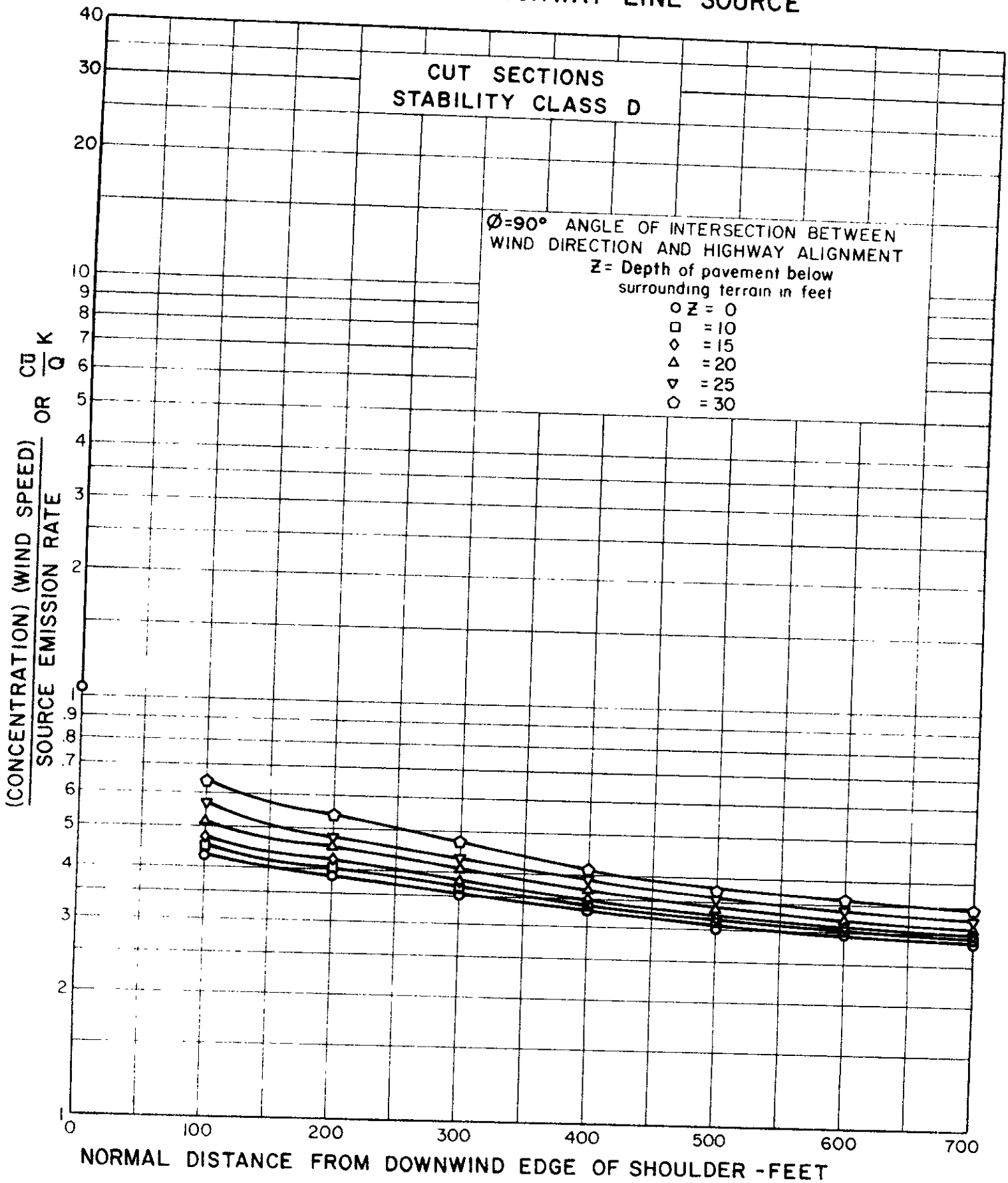

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Figure 59

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

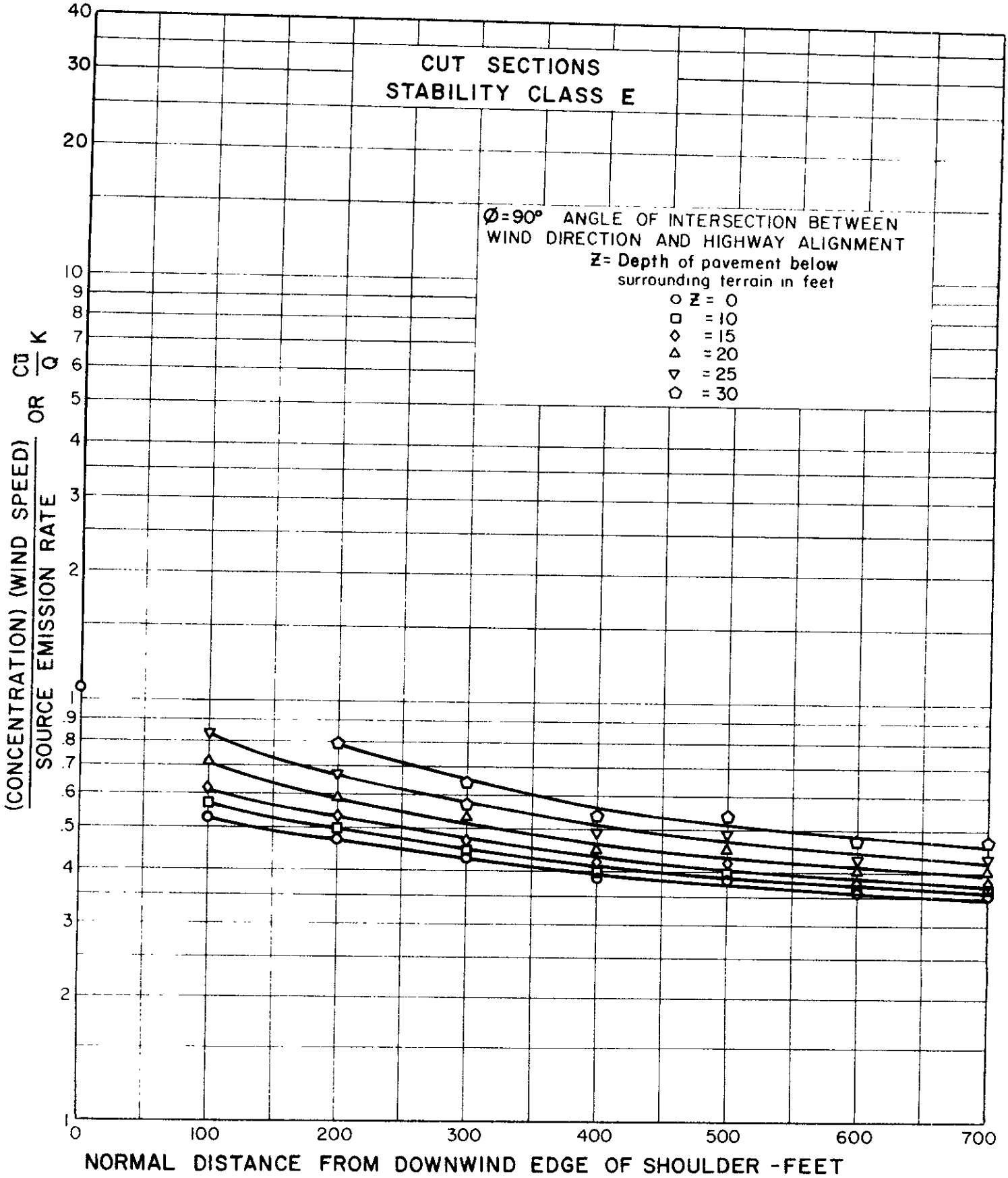

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Figure 60

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

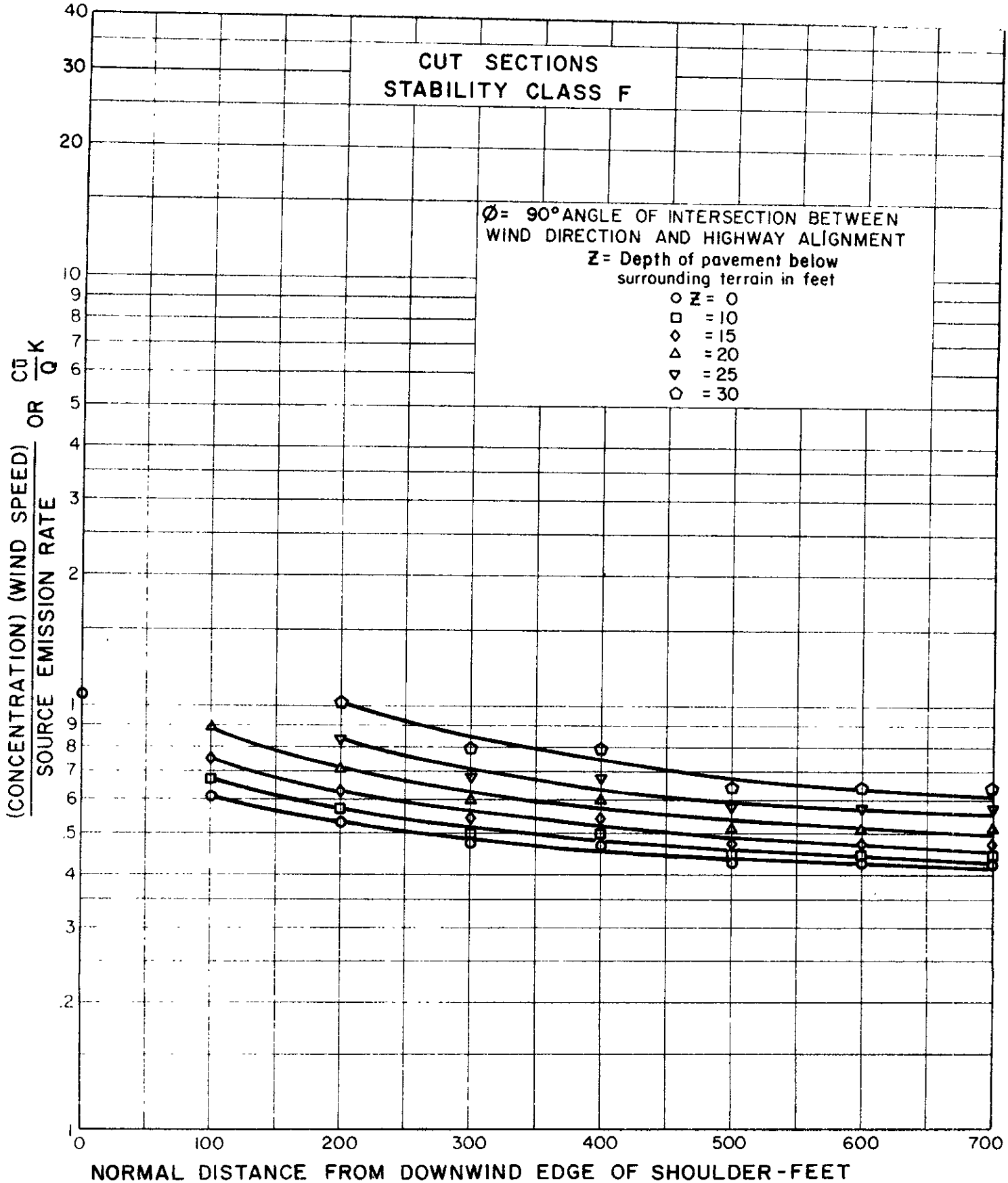

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Figure 61

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

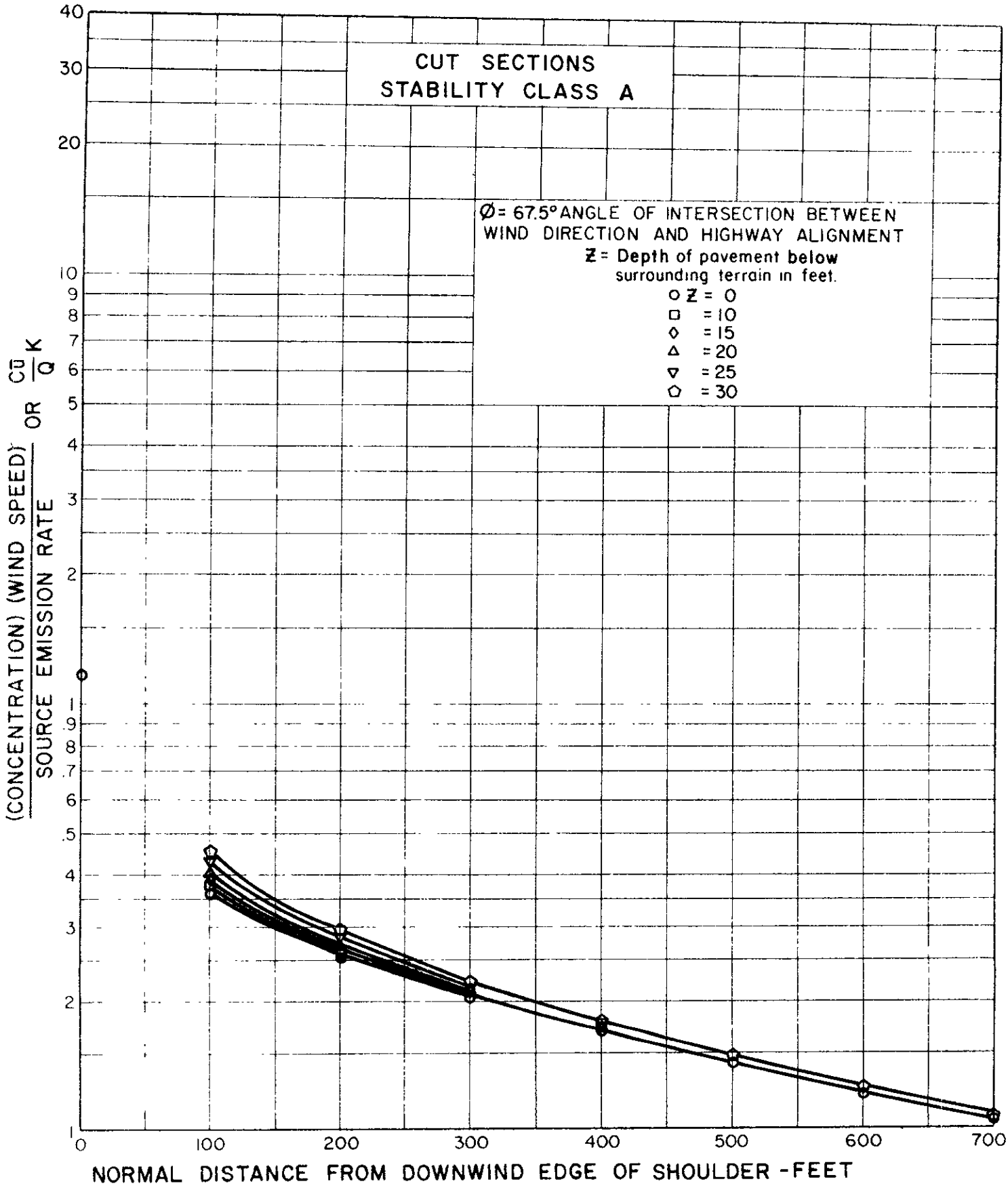

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Figure 62

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

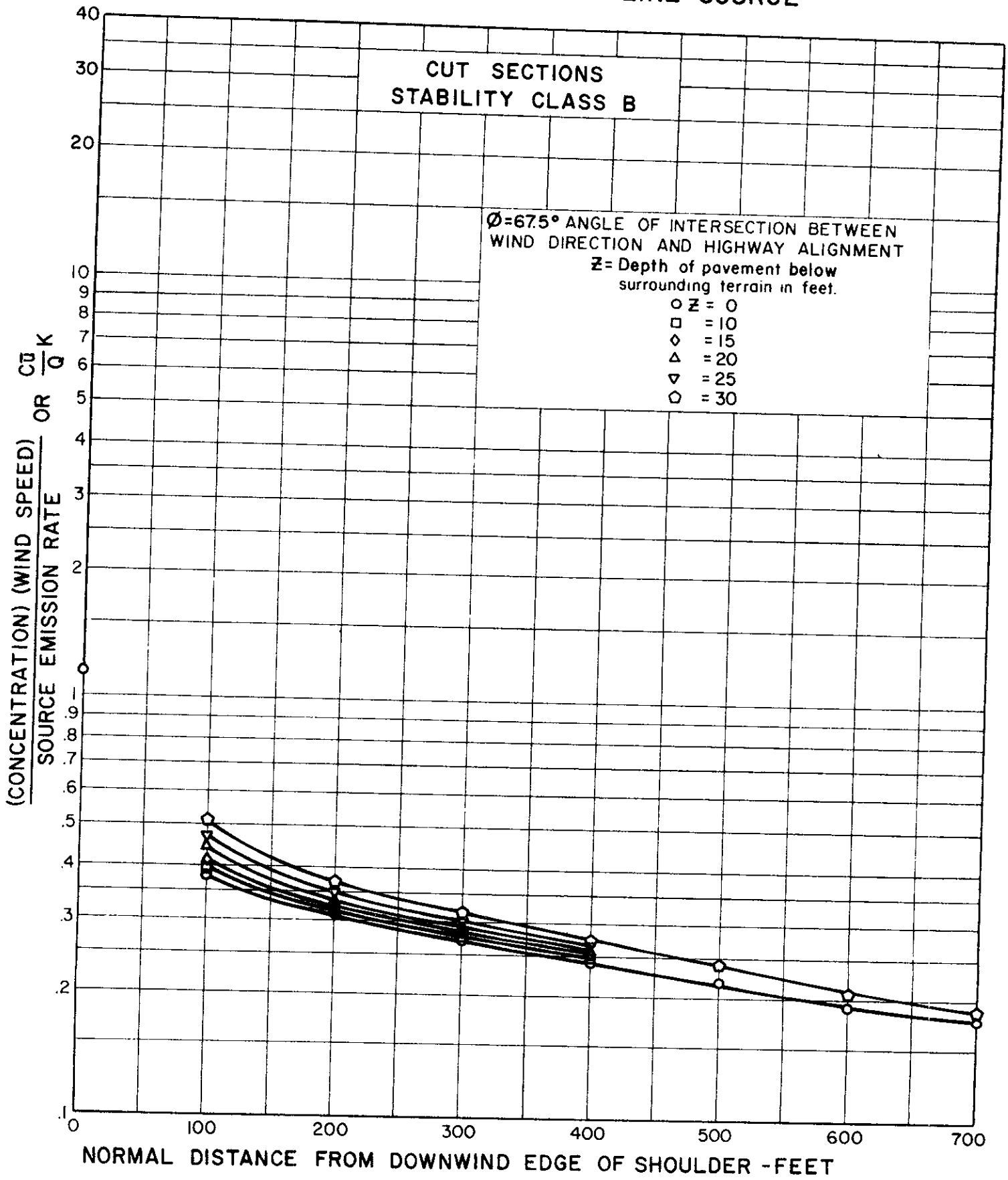

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Figure 63

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

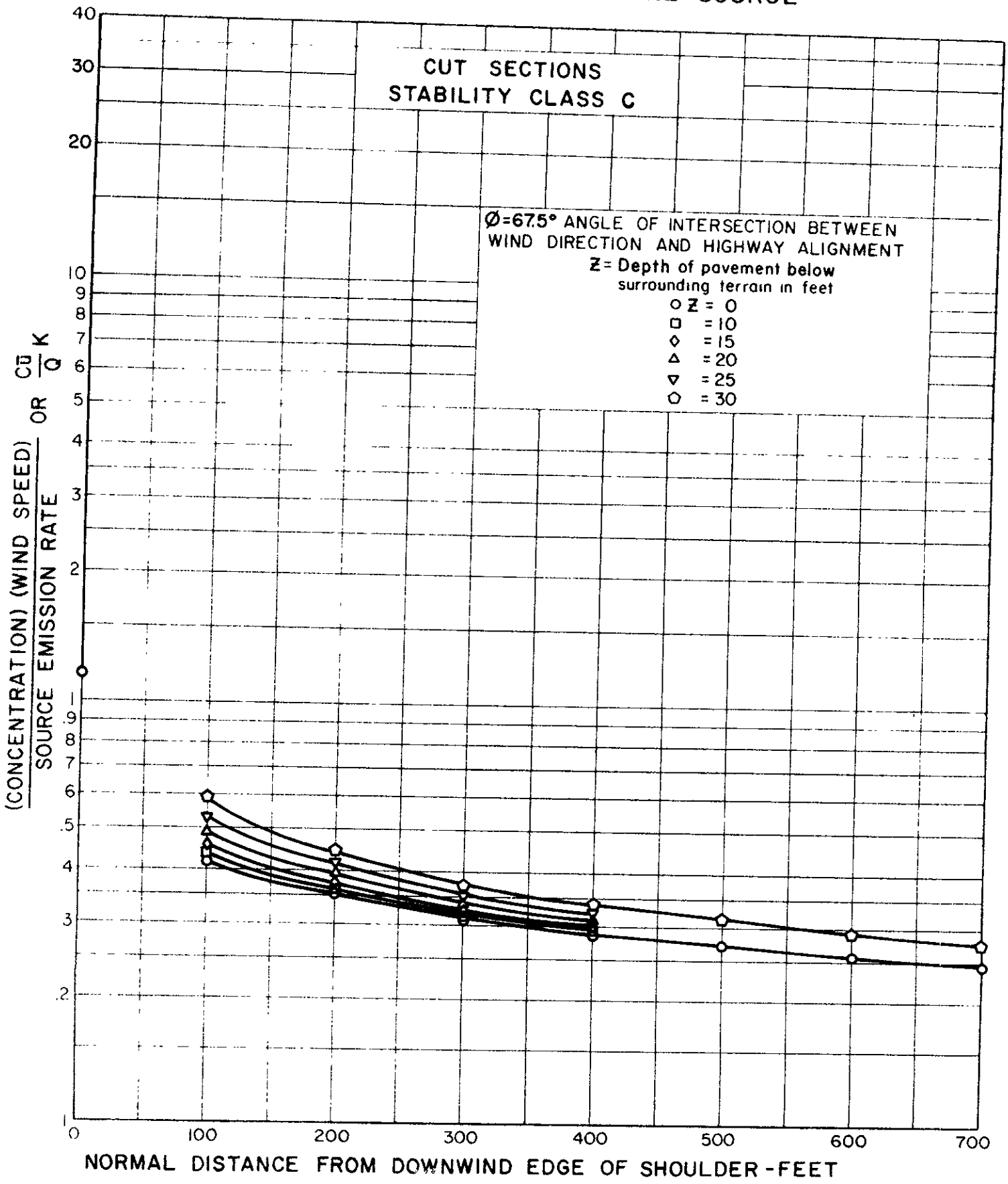

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Figure 64

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

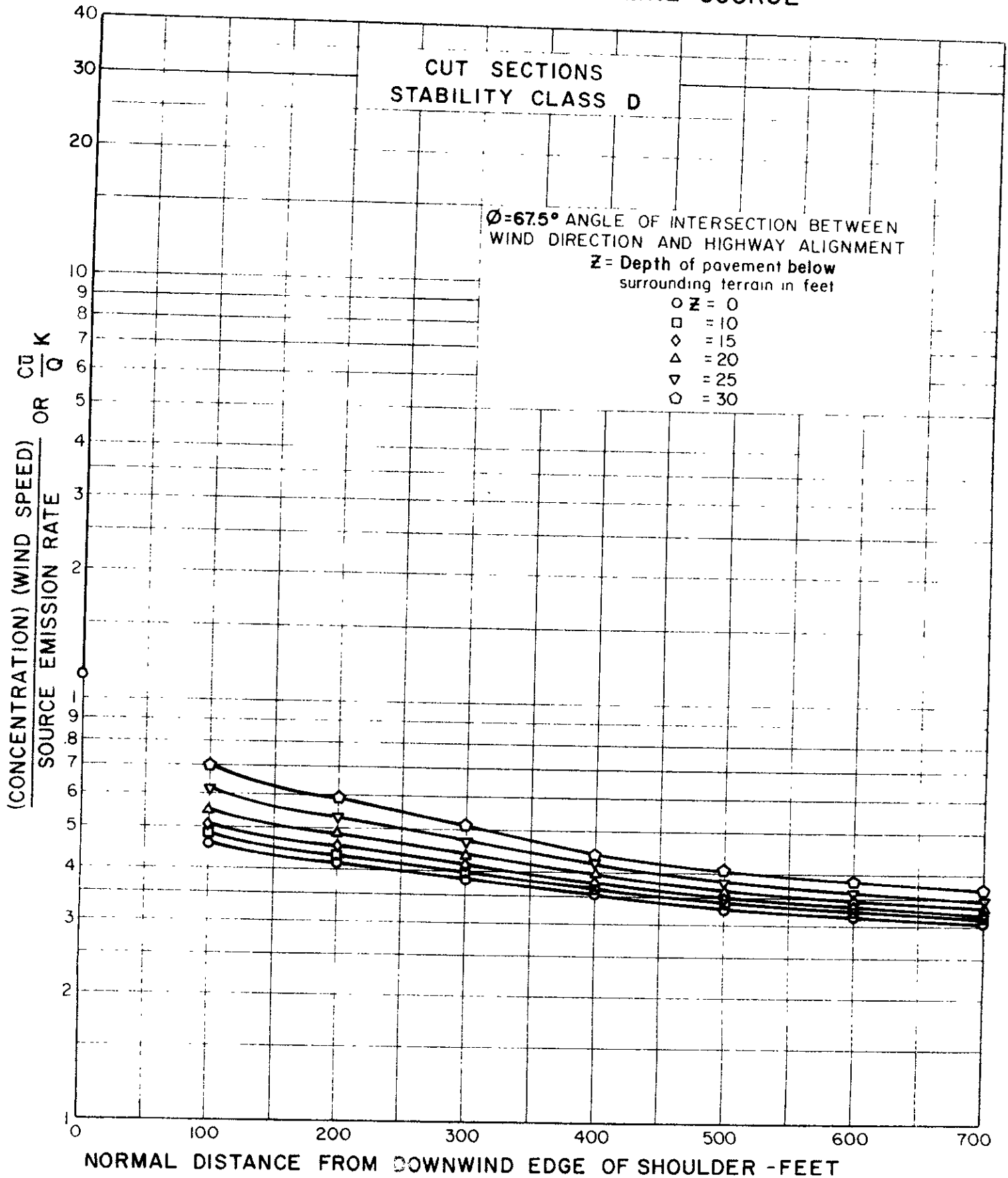

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Figure 65

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

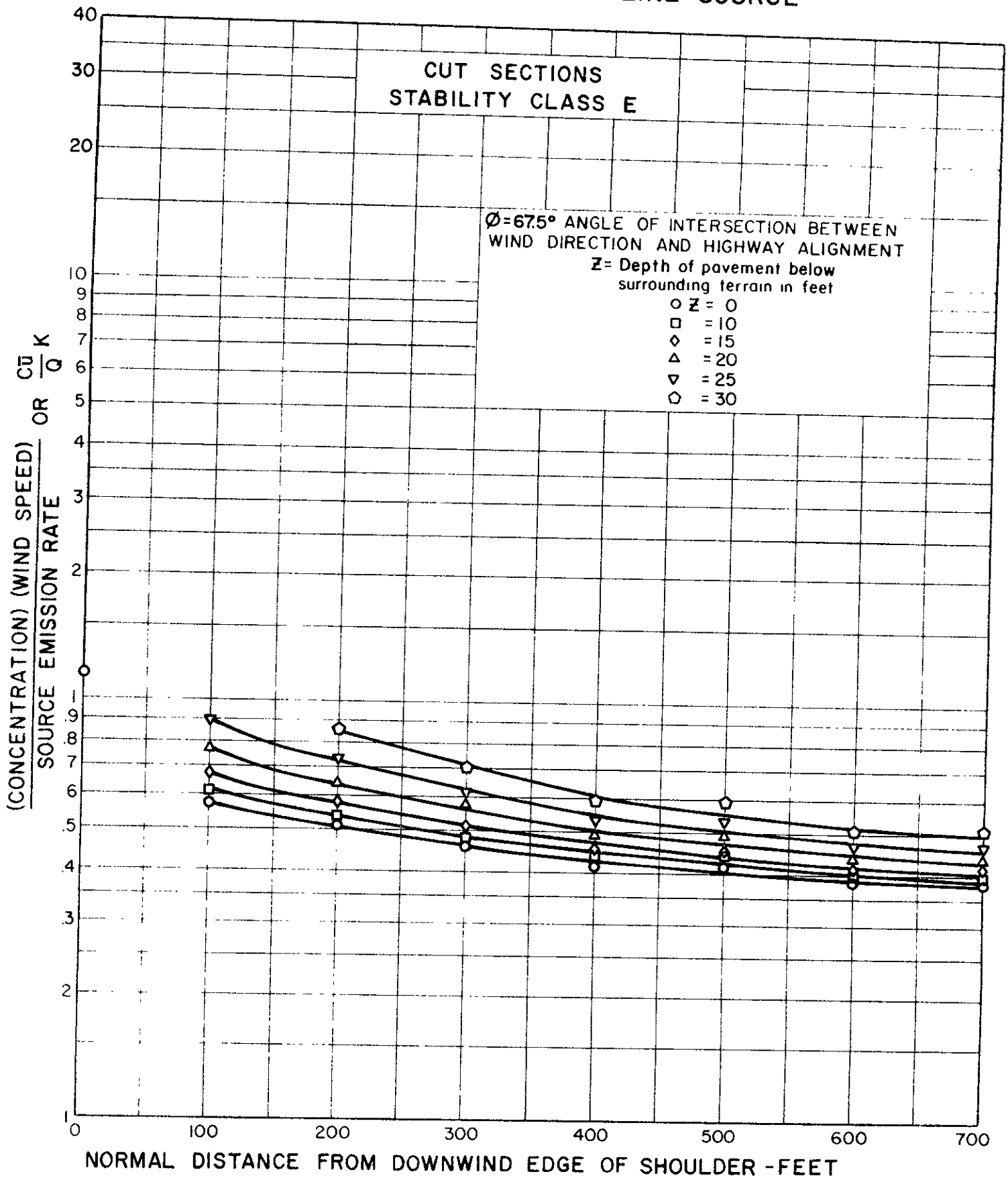

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Figure 66

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

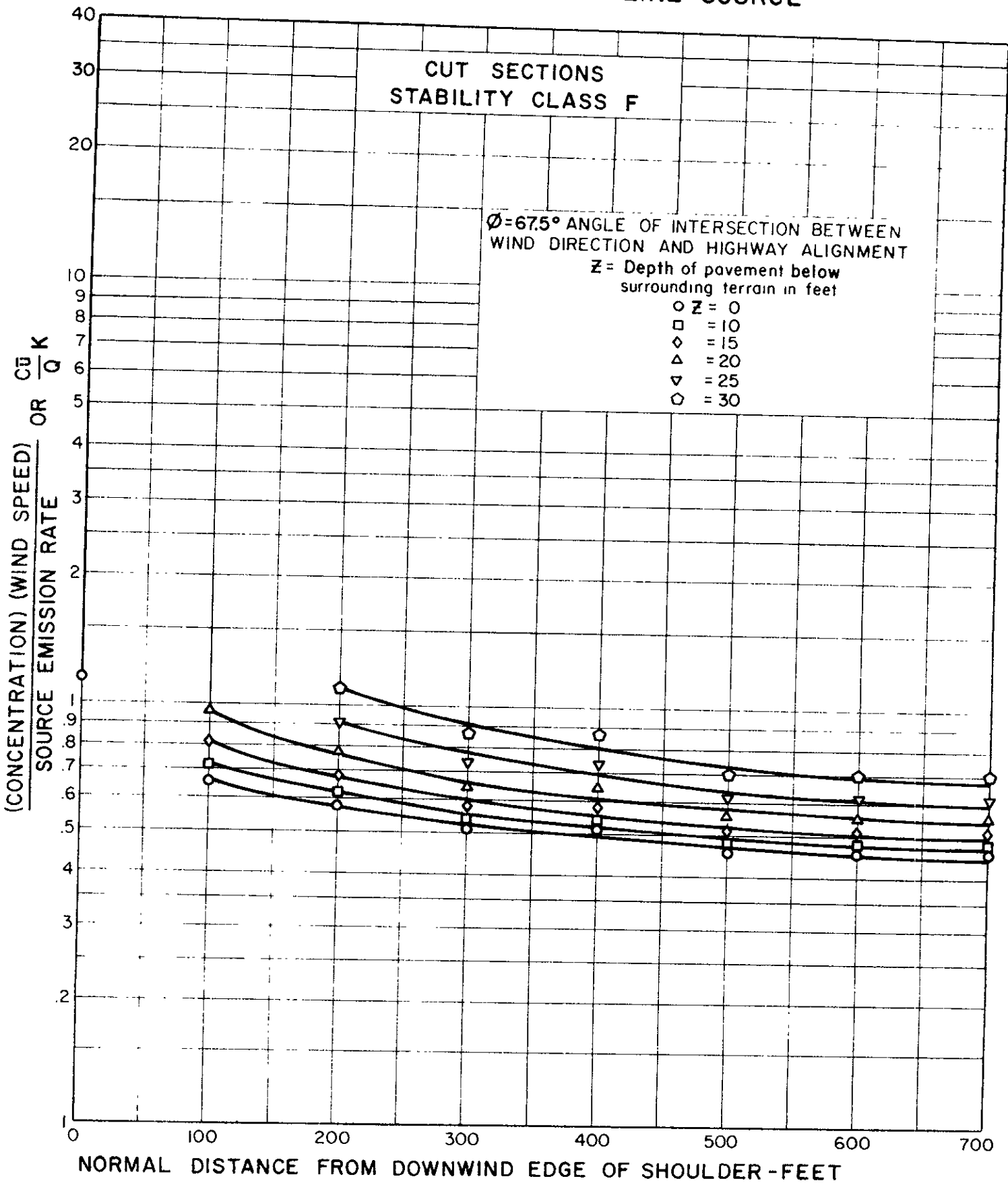

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Figure 67

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

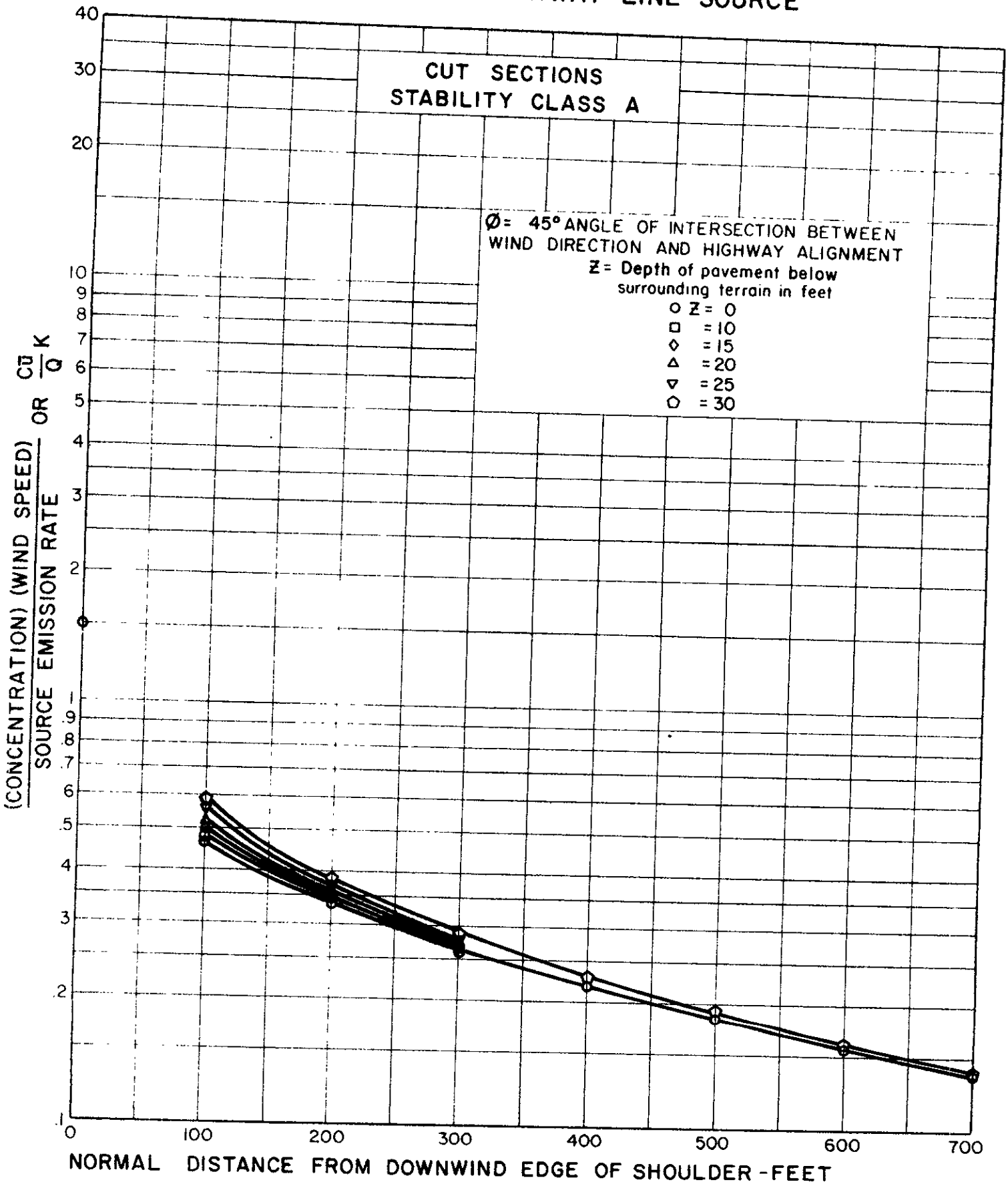

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Figure 68

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

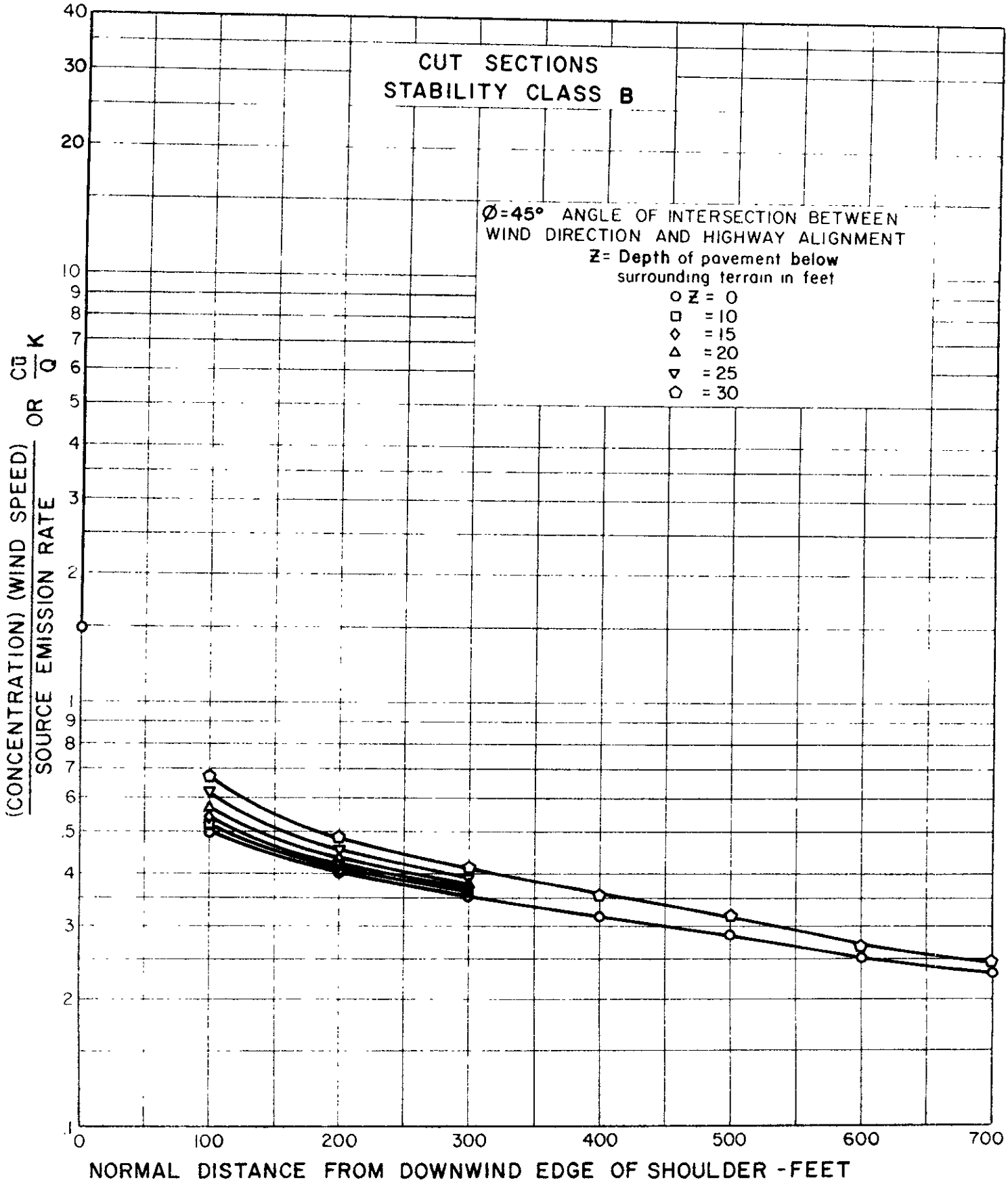

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Figure 69

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

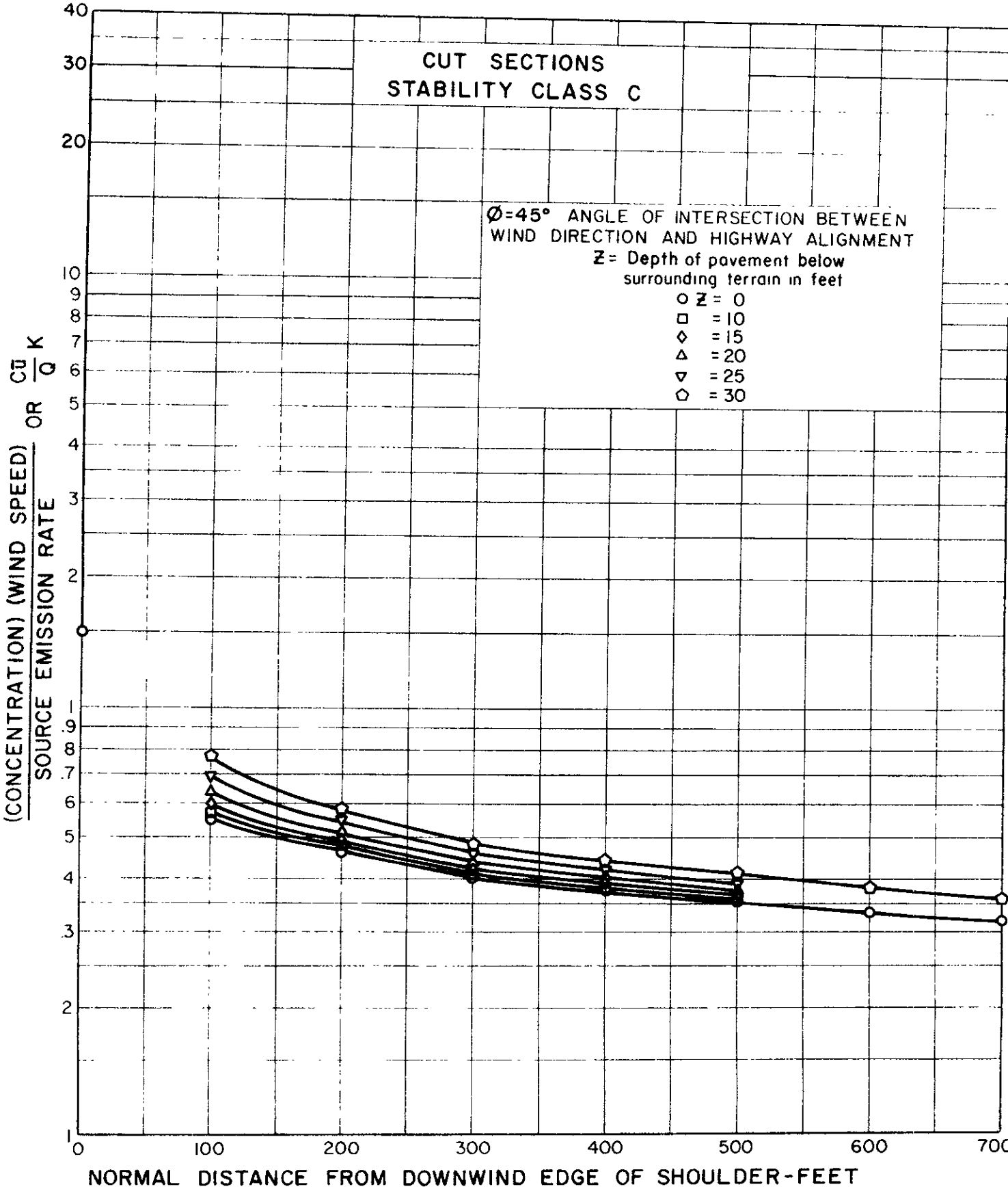

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Figure 70

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

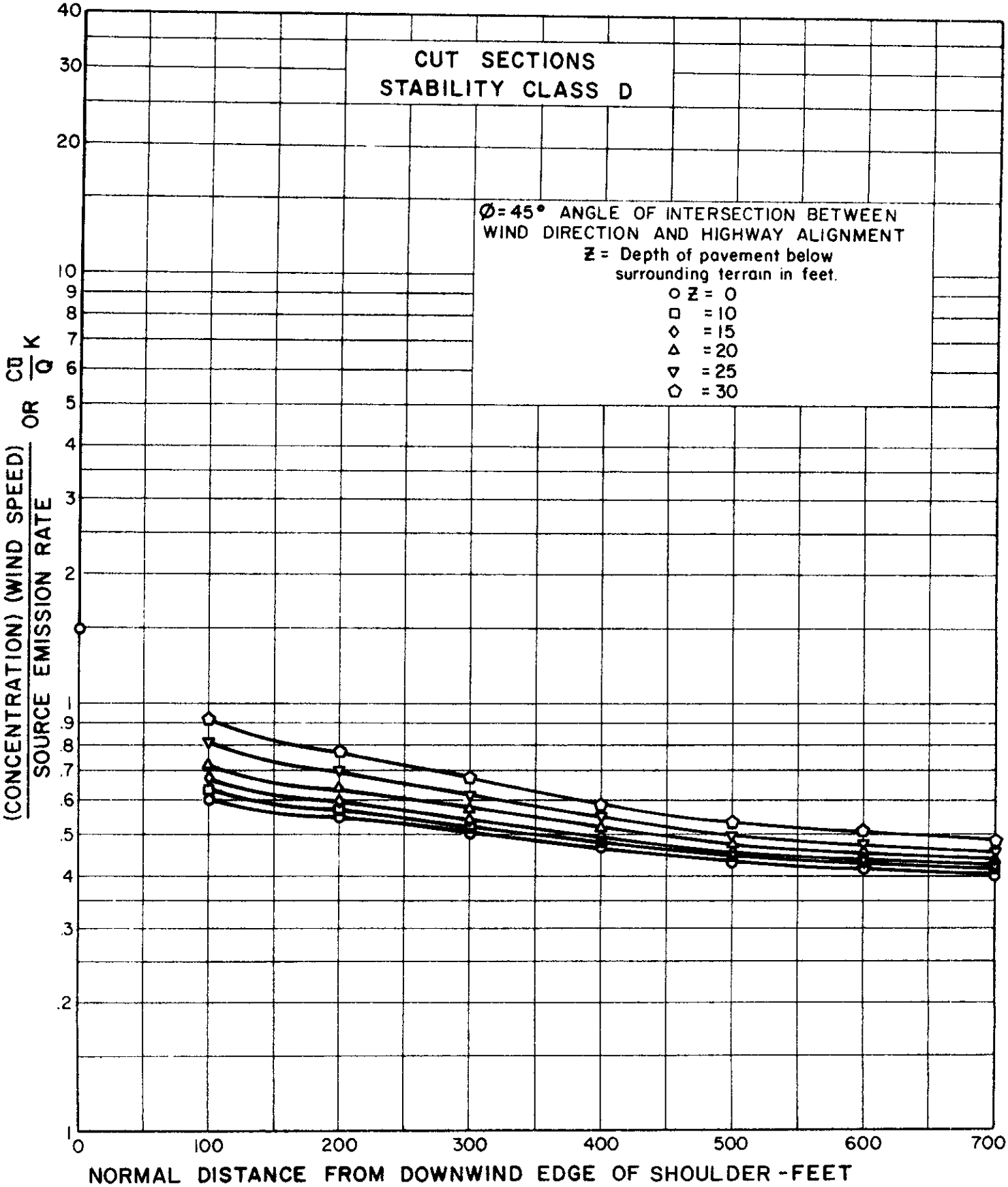

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Figure 71

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

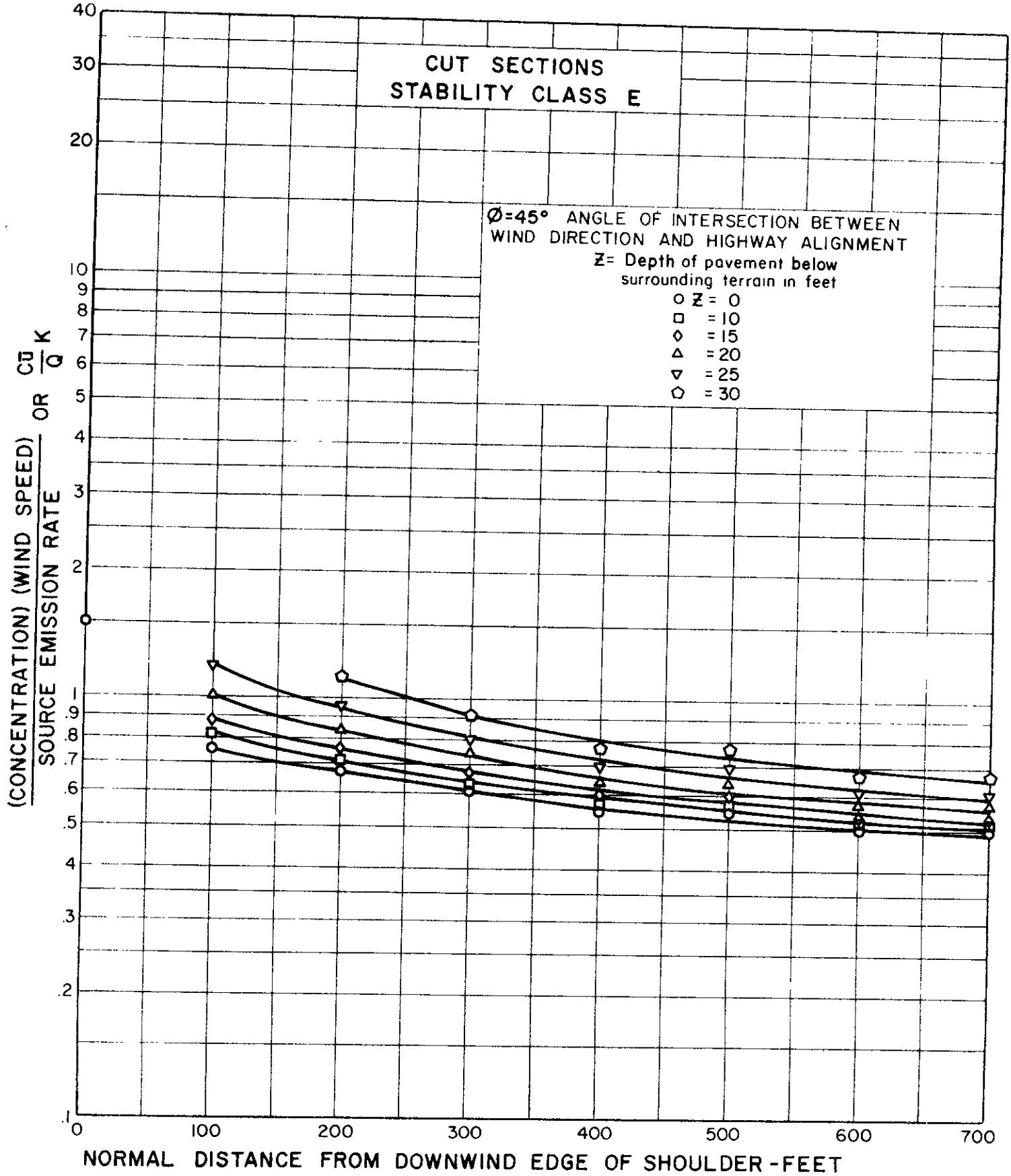

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Figure 72

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

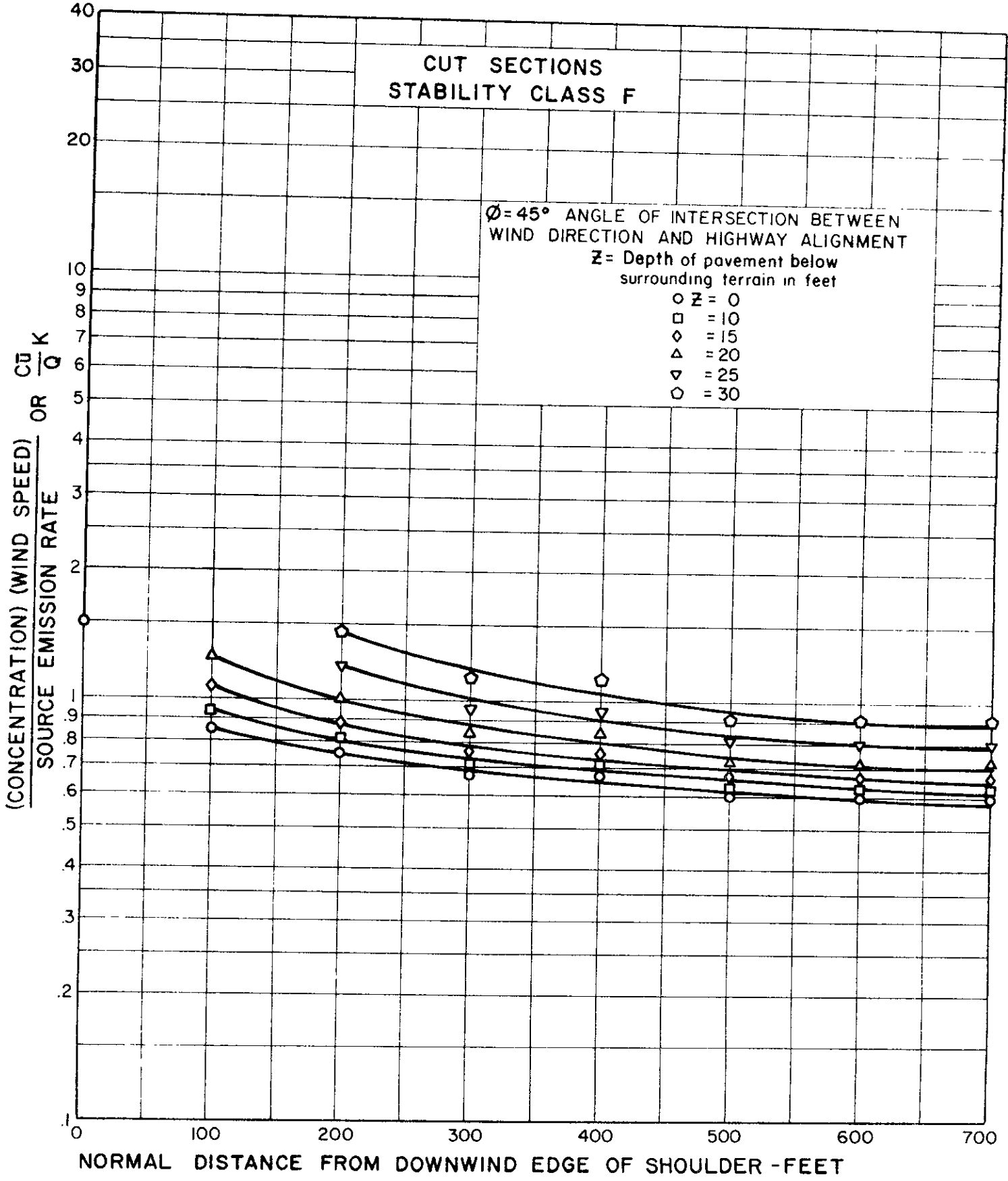

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Figure 73

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

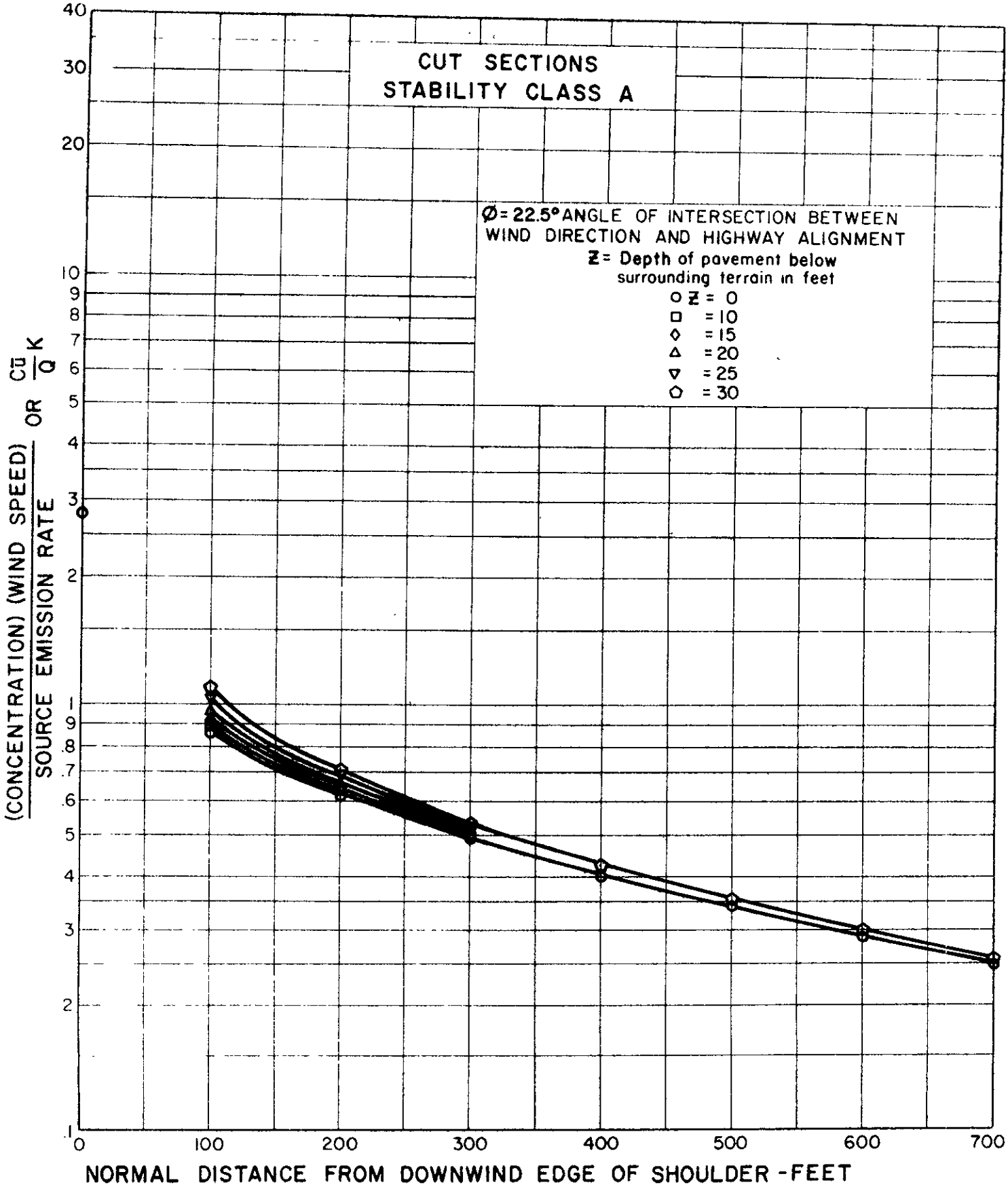

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Figure 74

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

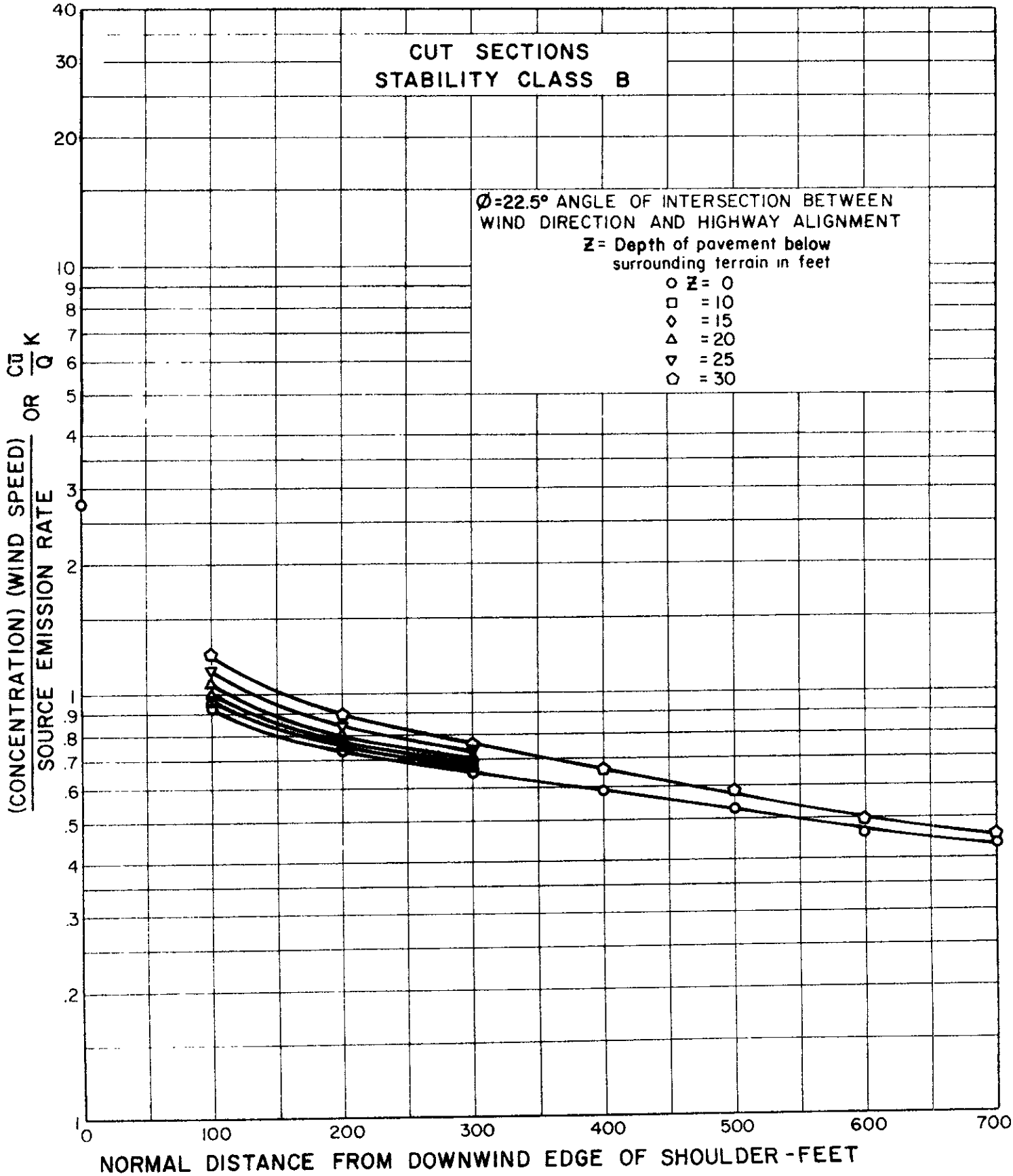

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Figure 75

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

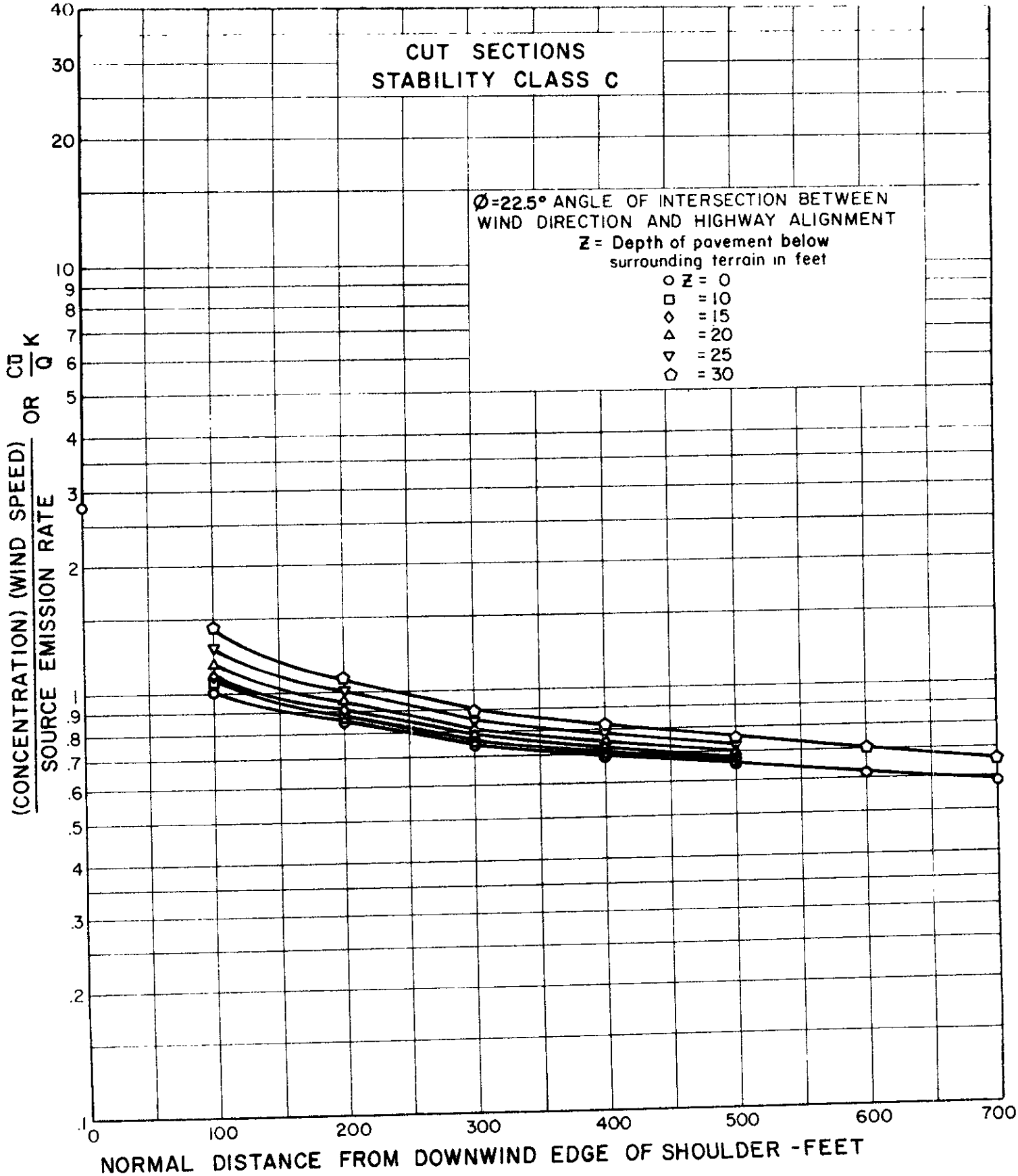

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Figure 76

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

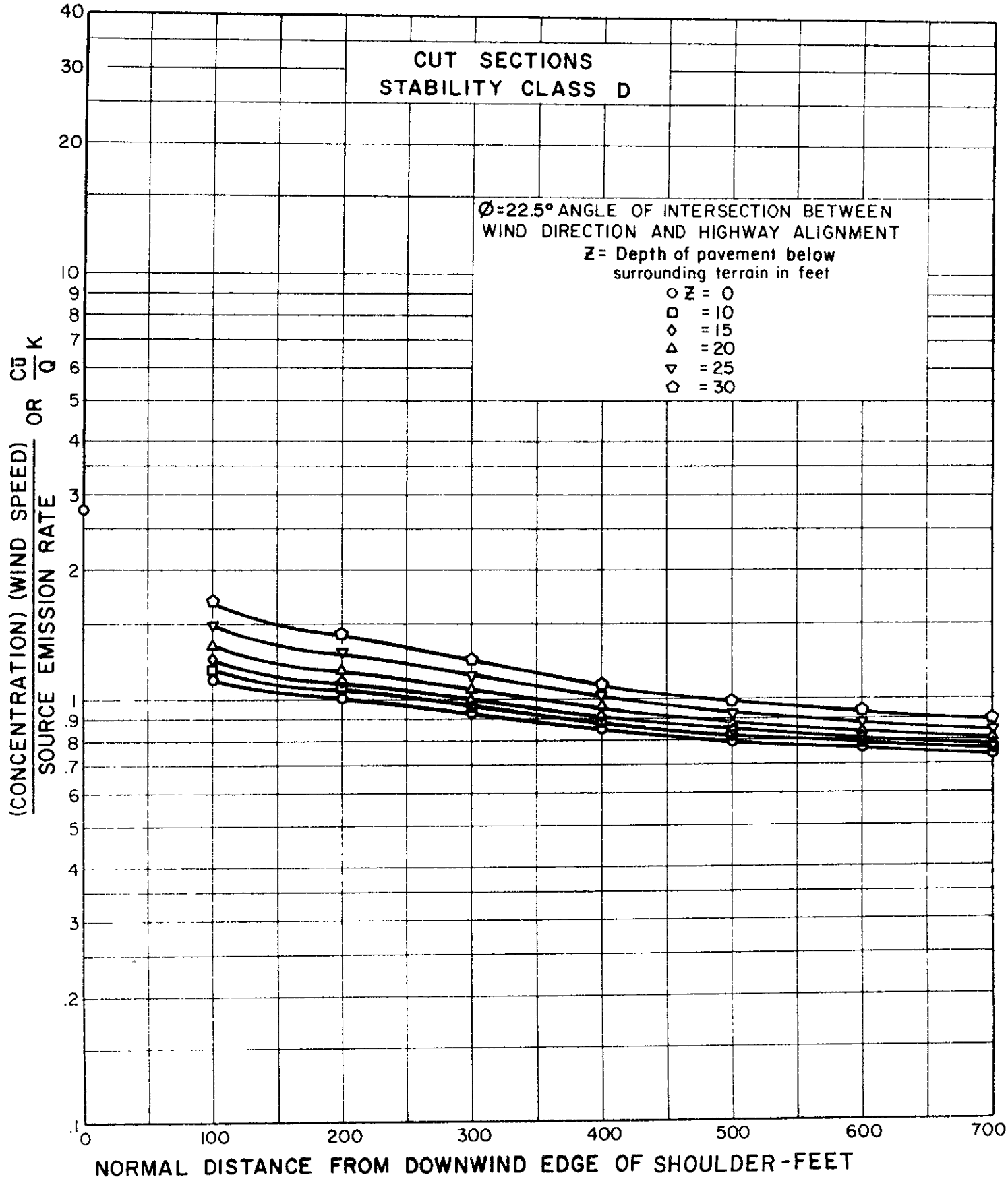

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Figure 77

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

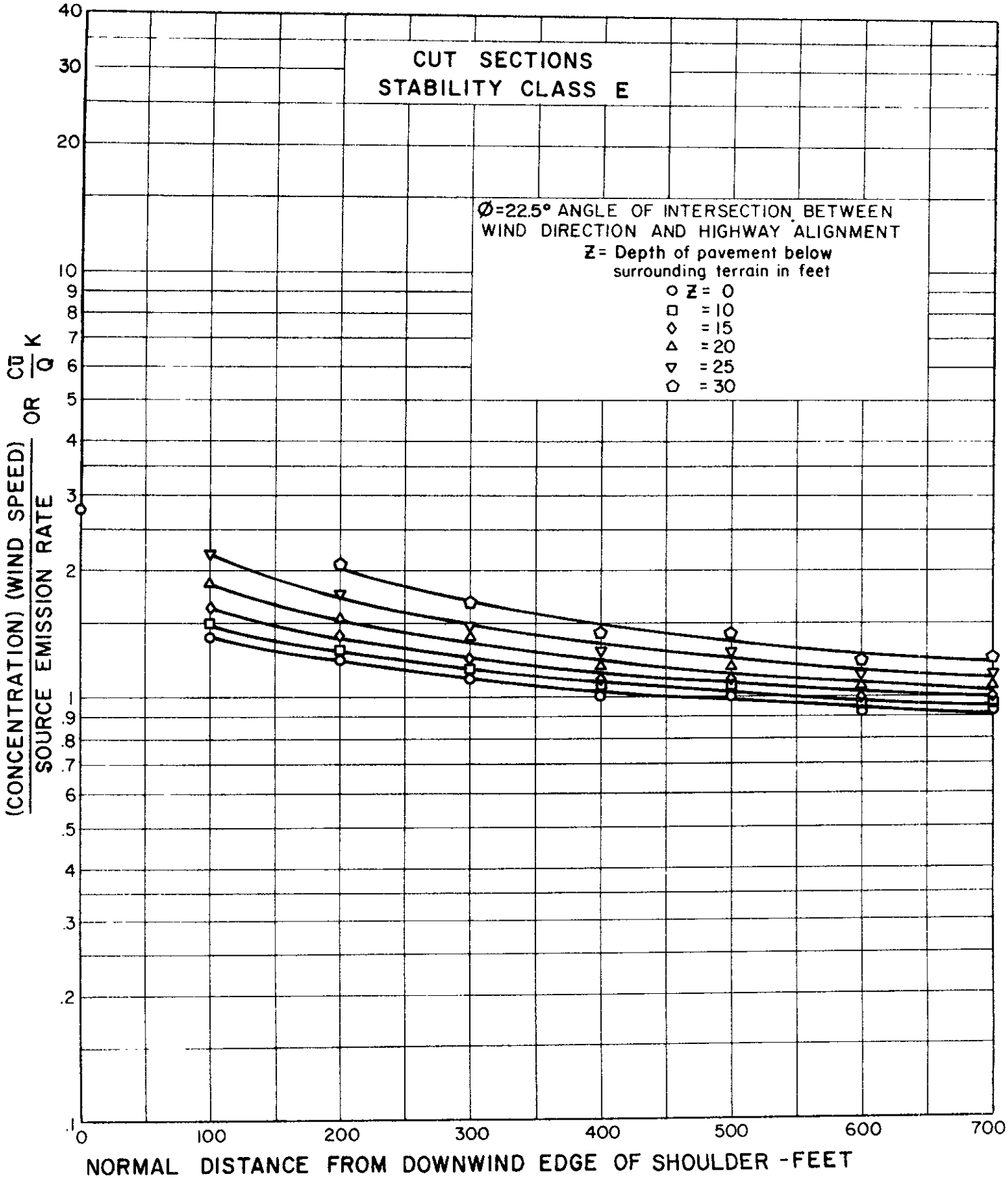

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Figure 78

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

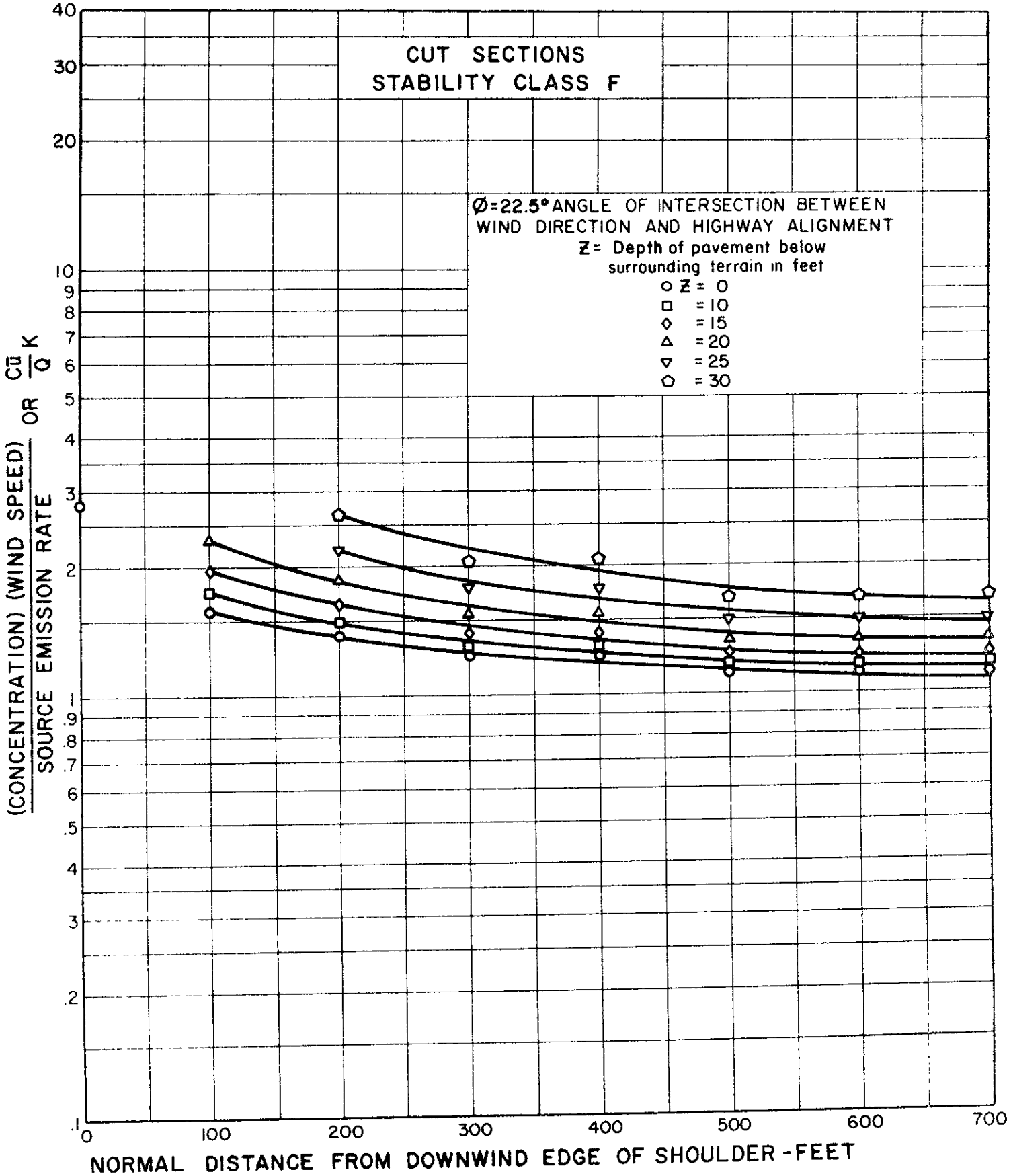

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Figure 81

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

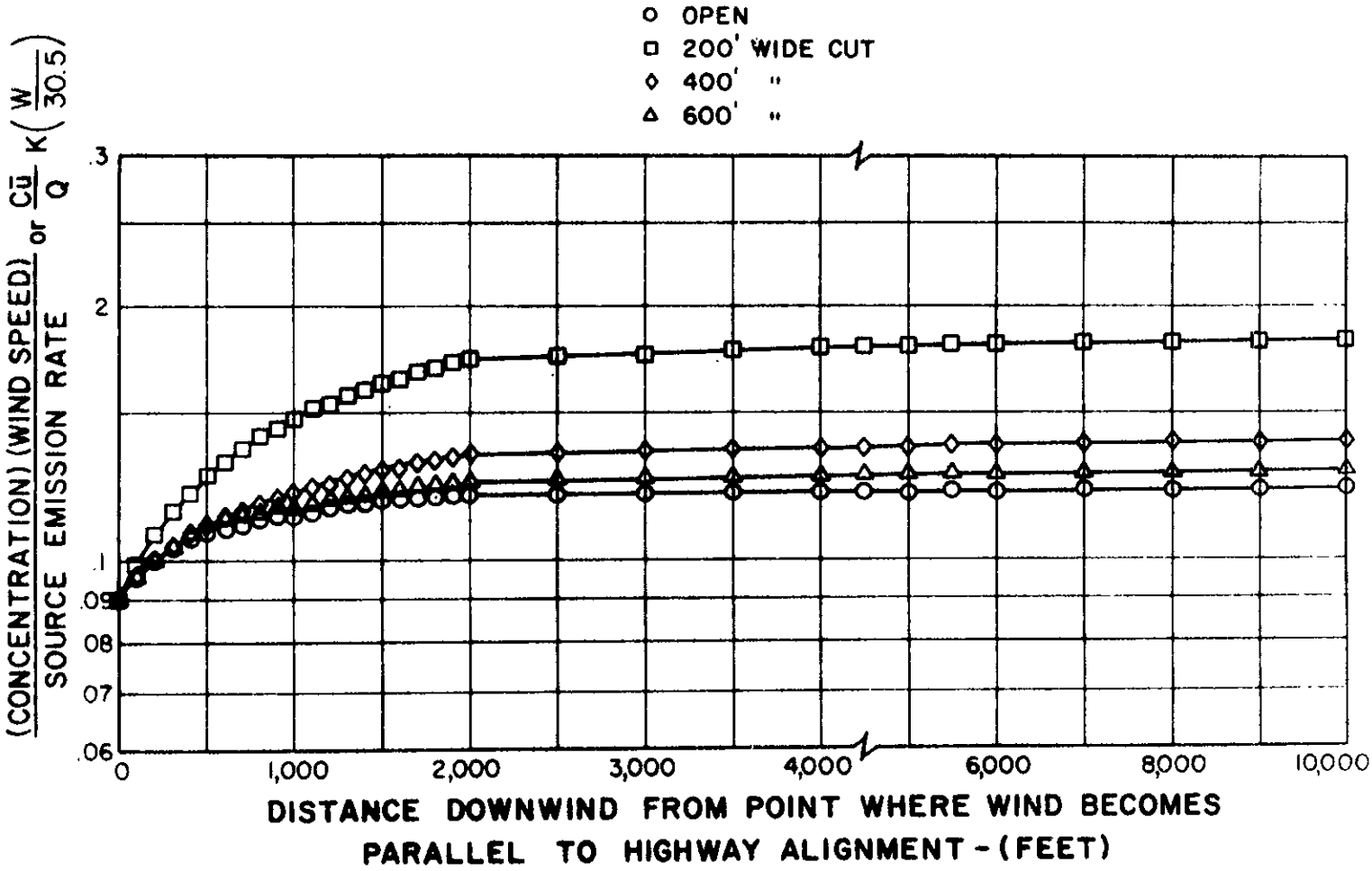

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Figure 82

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

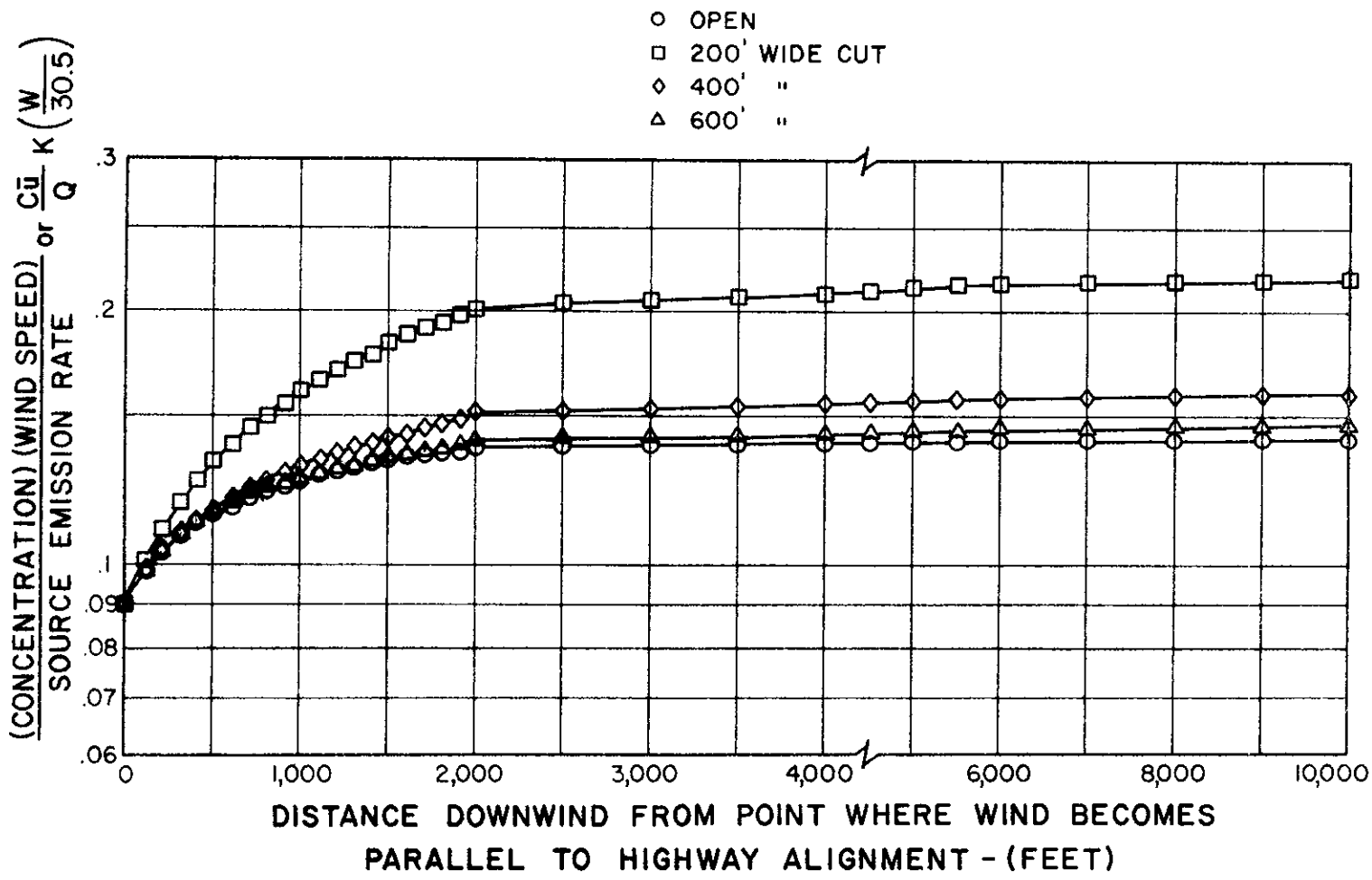

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Figure 89

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

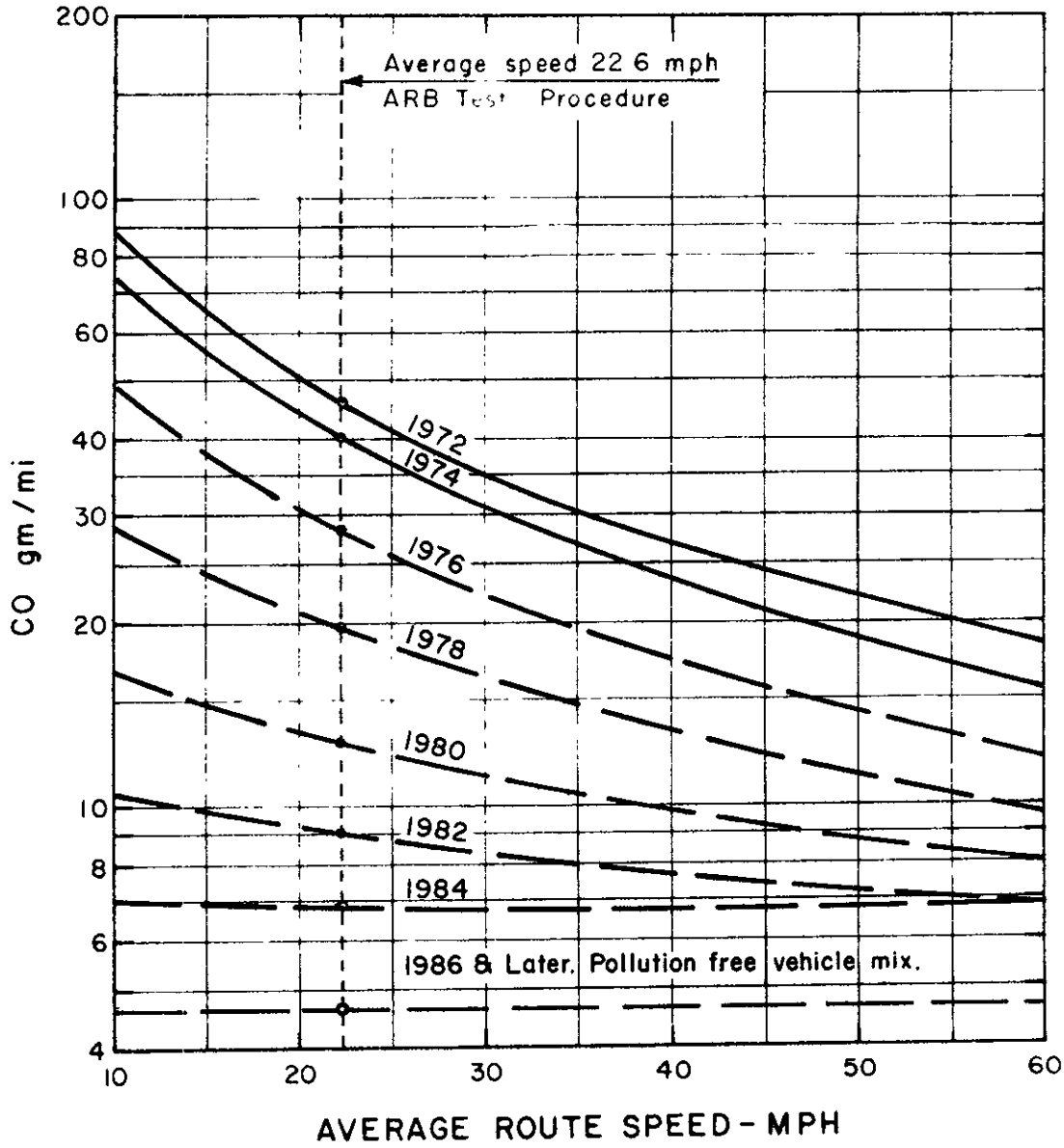

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Figure 90

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

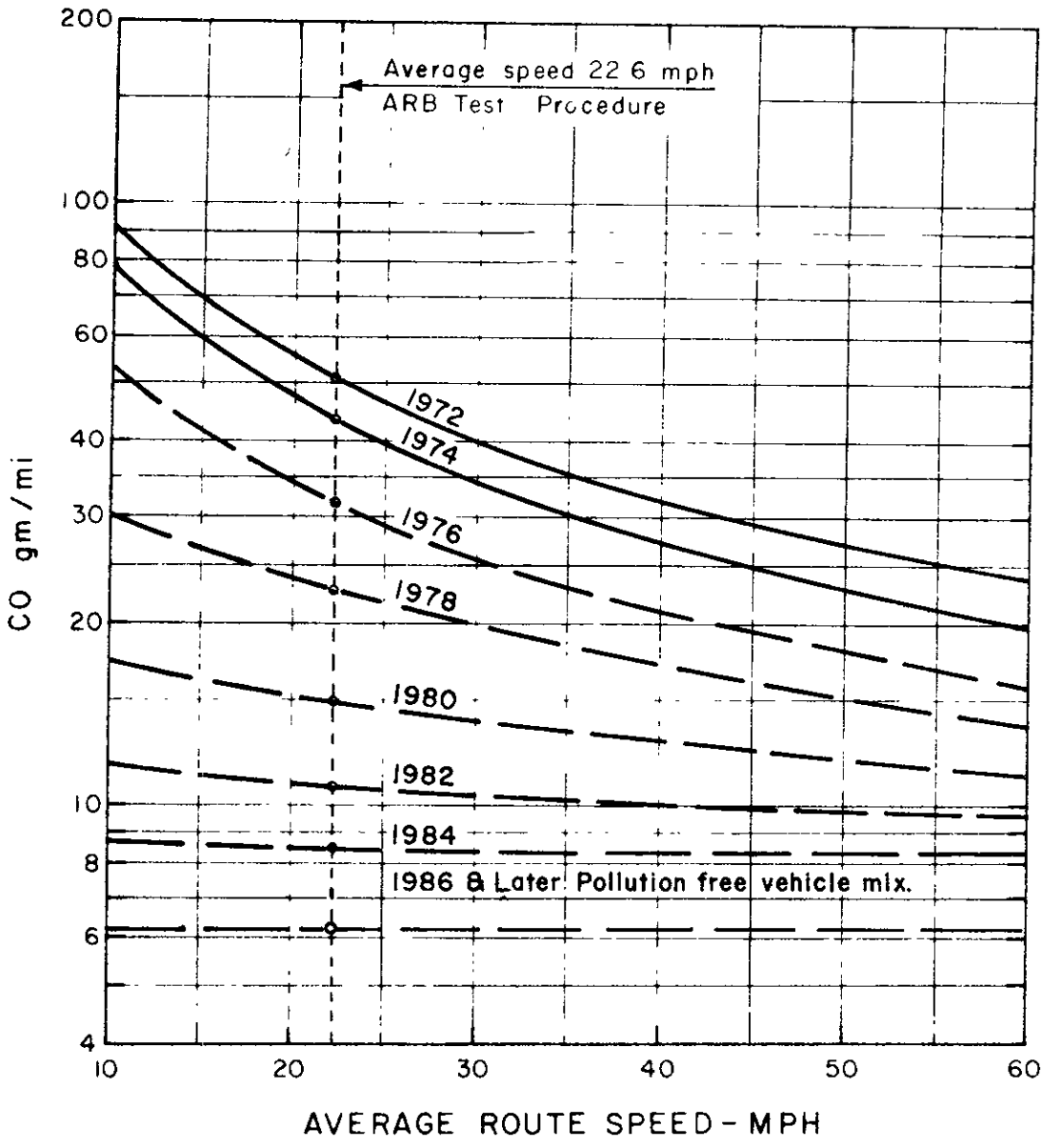

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Figure 91

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

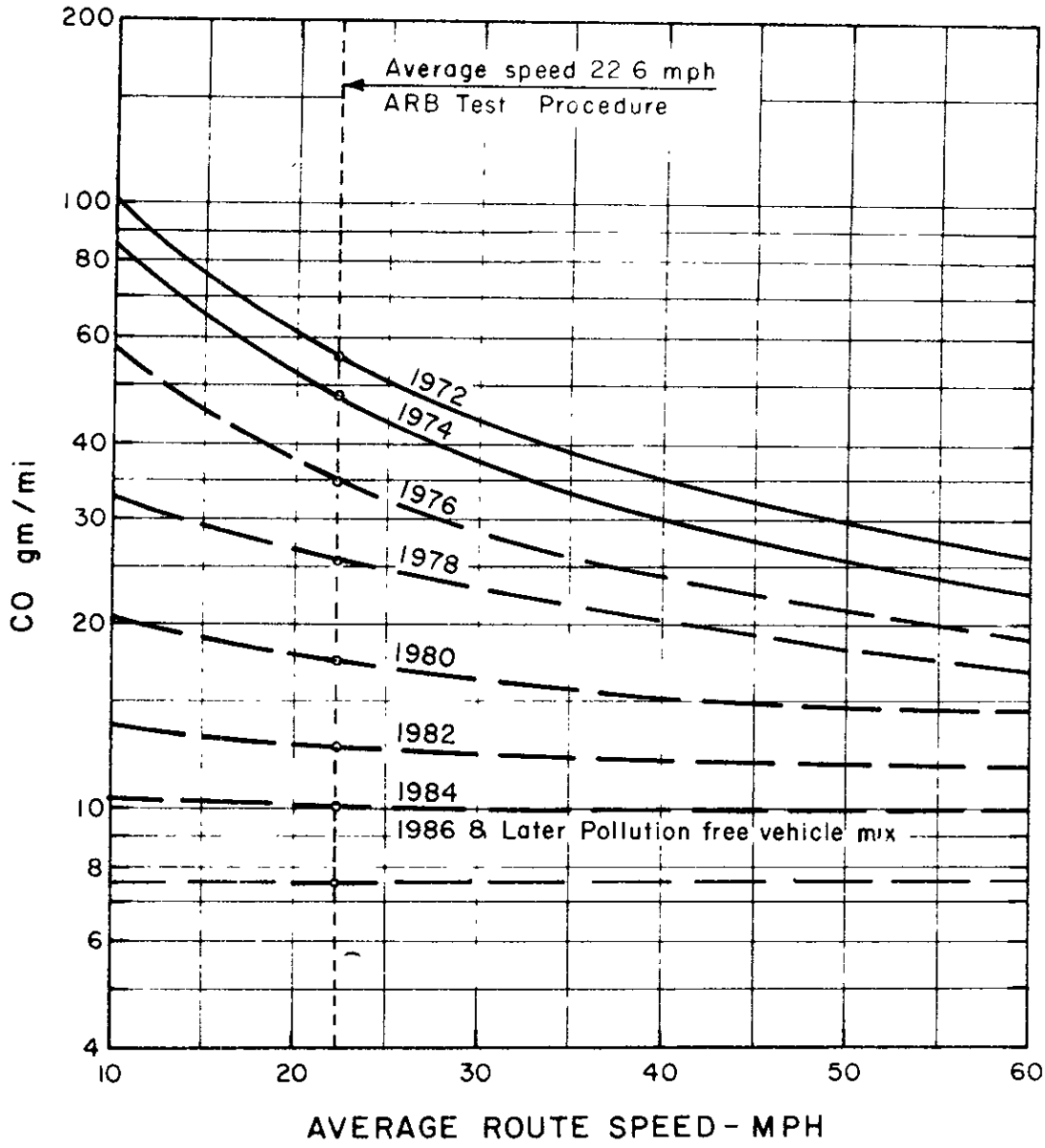

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Figure 92

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

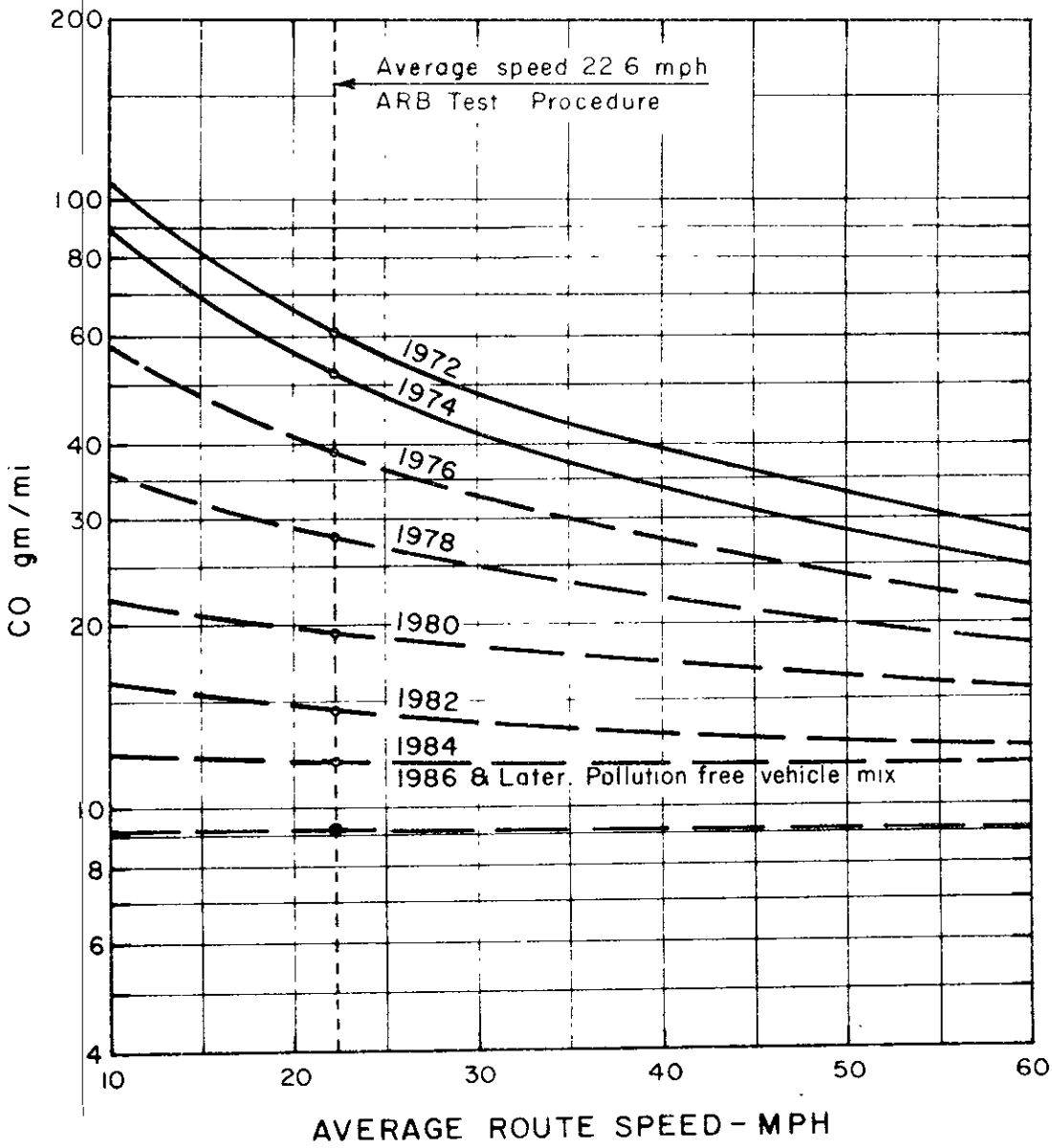

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Figure 93

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

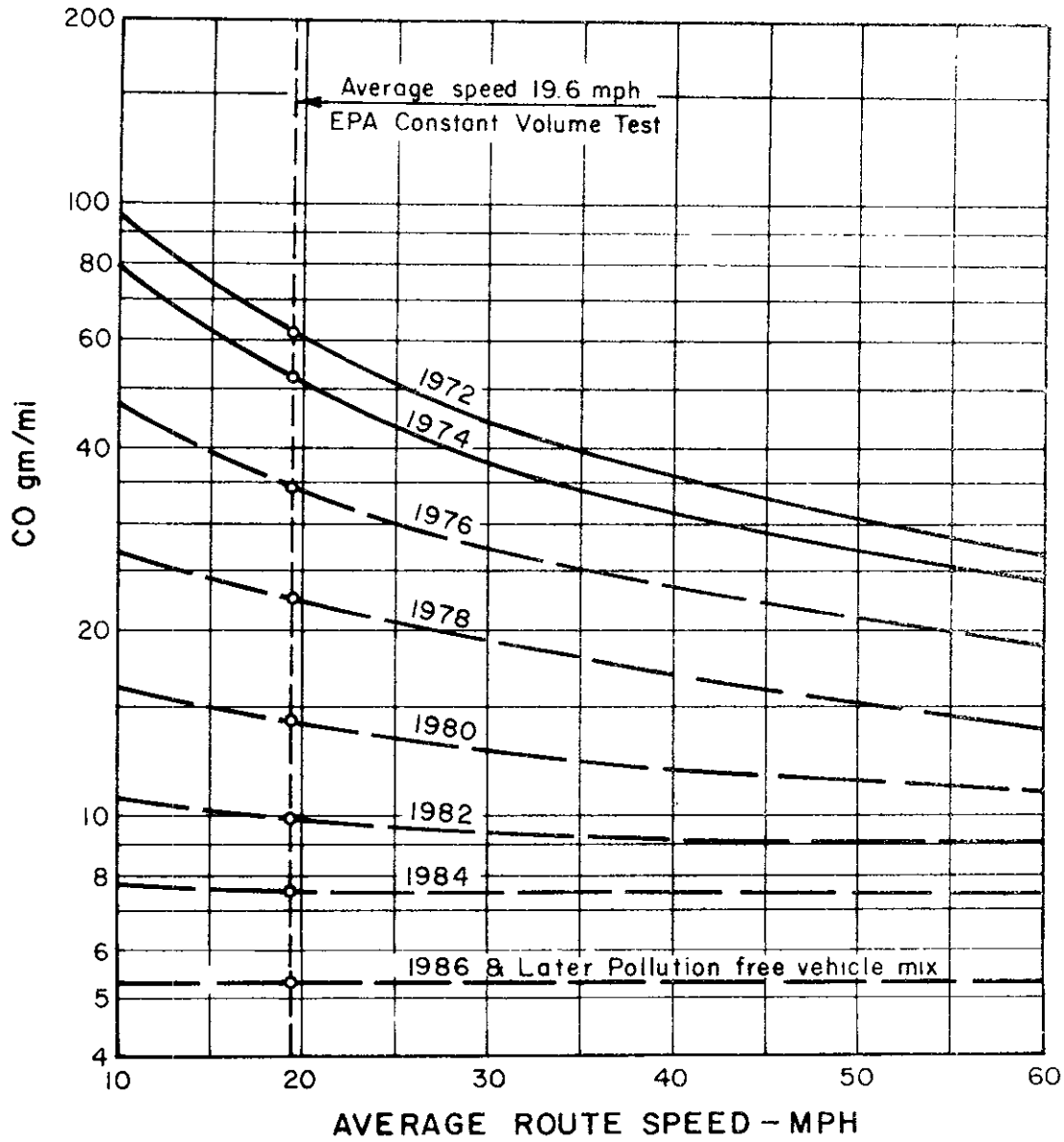

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Figure 94

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

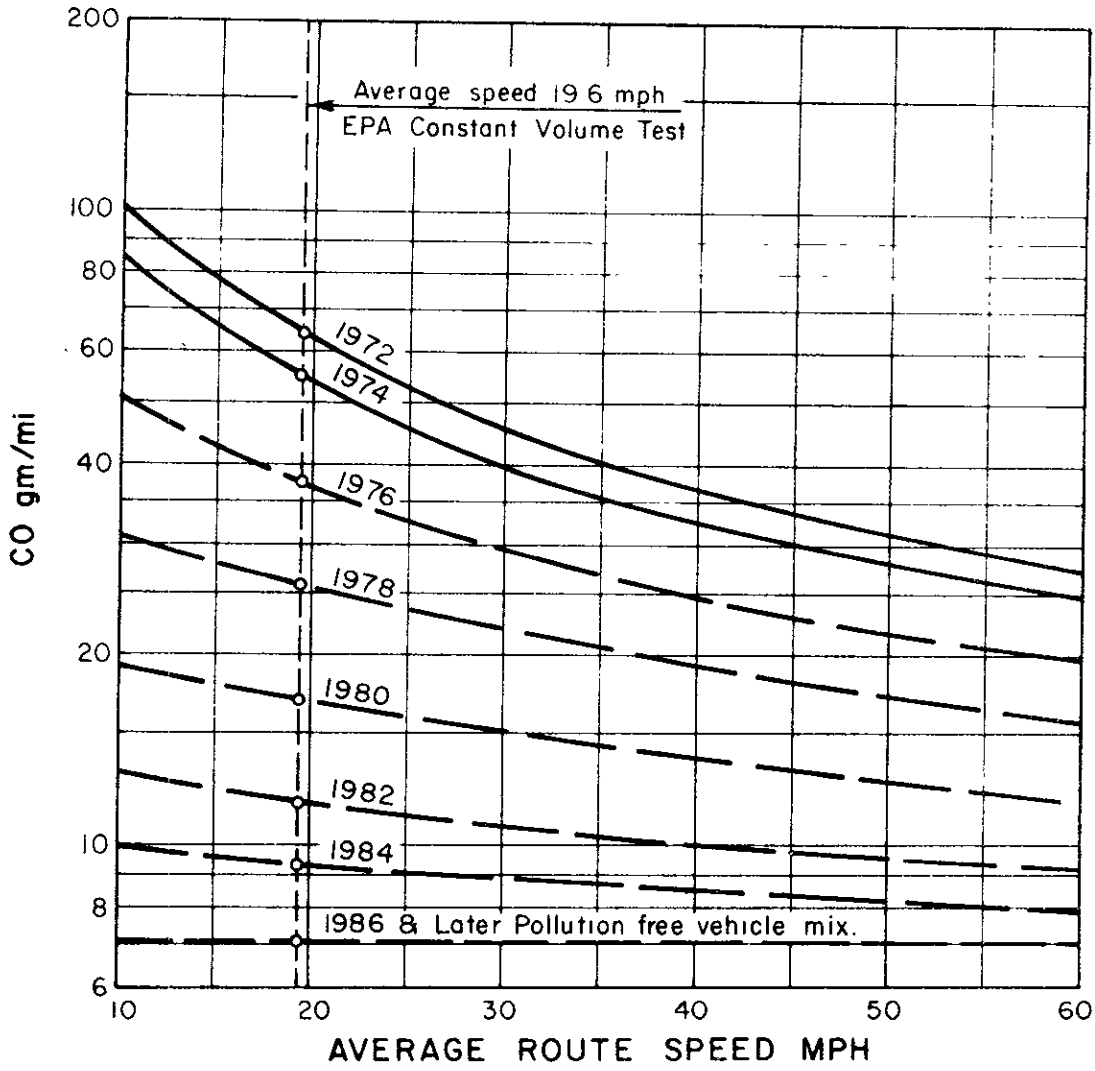

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Figure 95

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

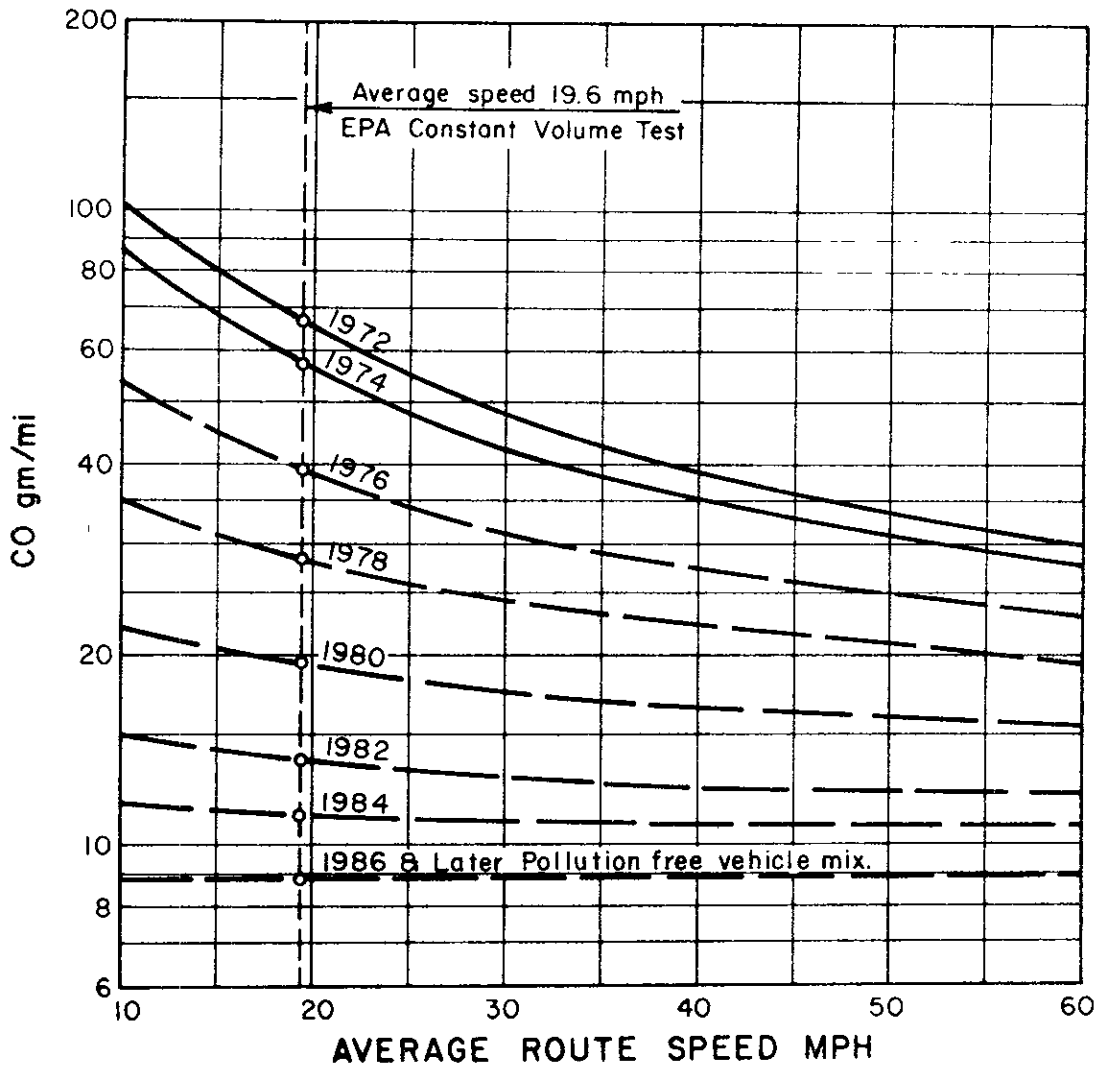

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Figure 96

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

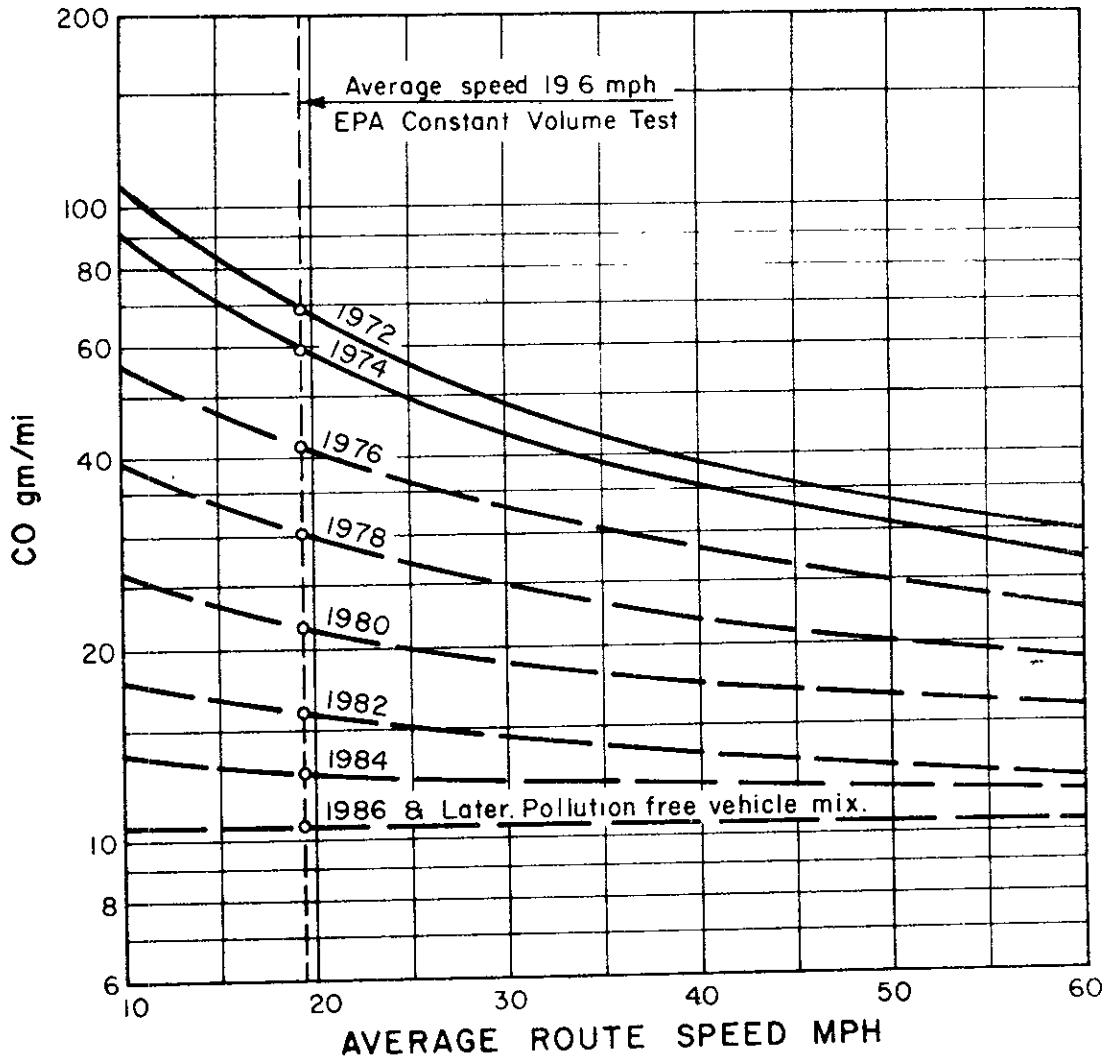

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Figure 97

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

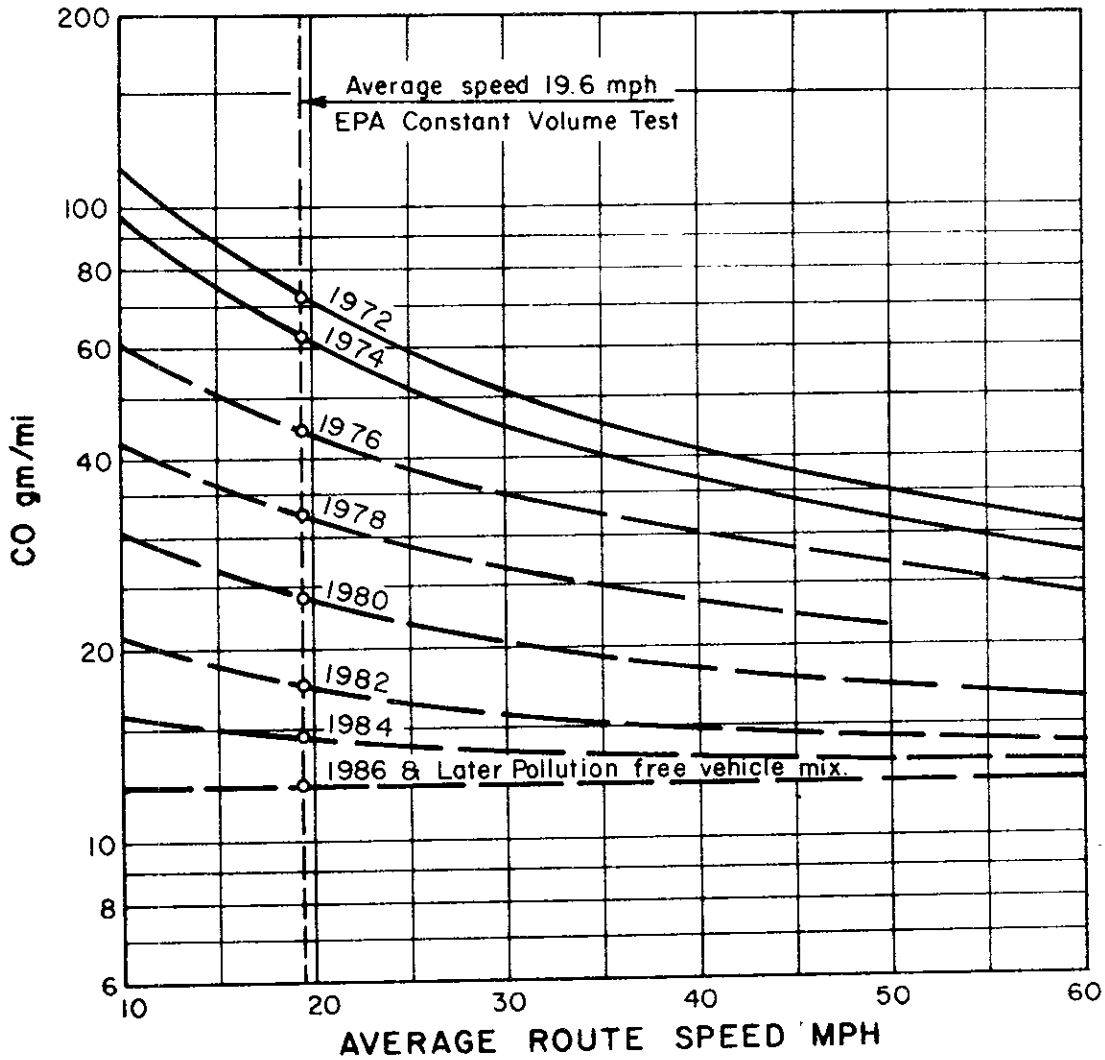

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Figure 98

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

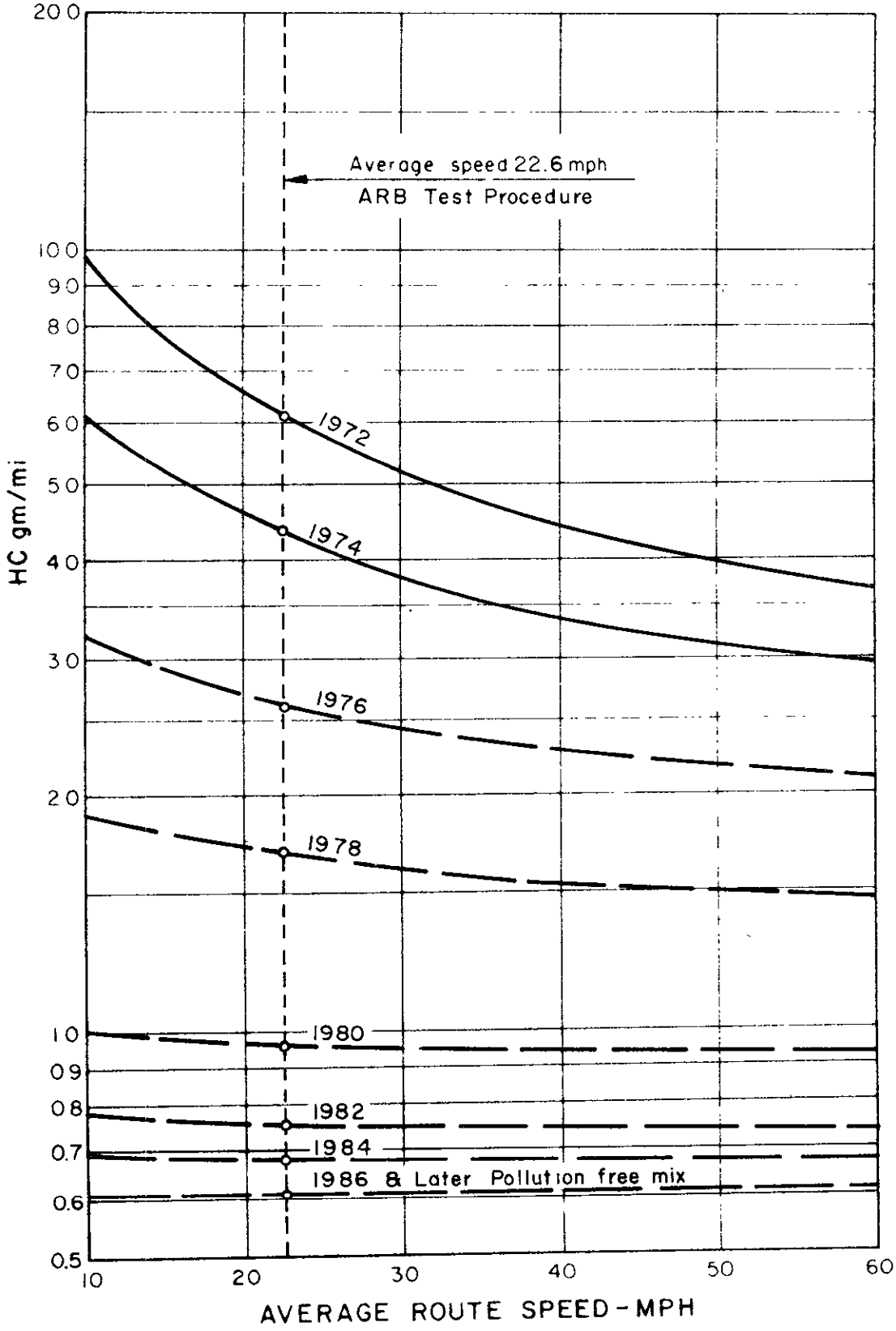

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Figure 99

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

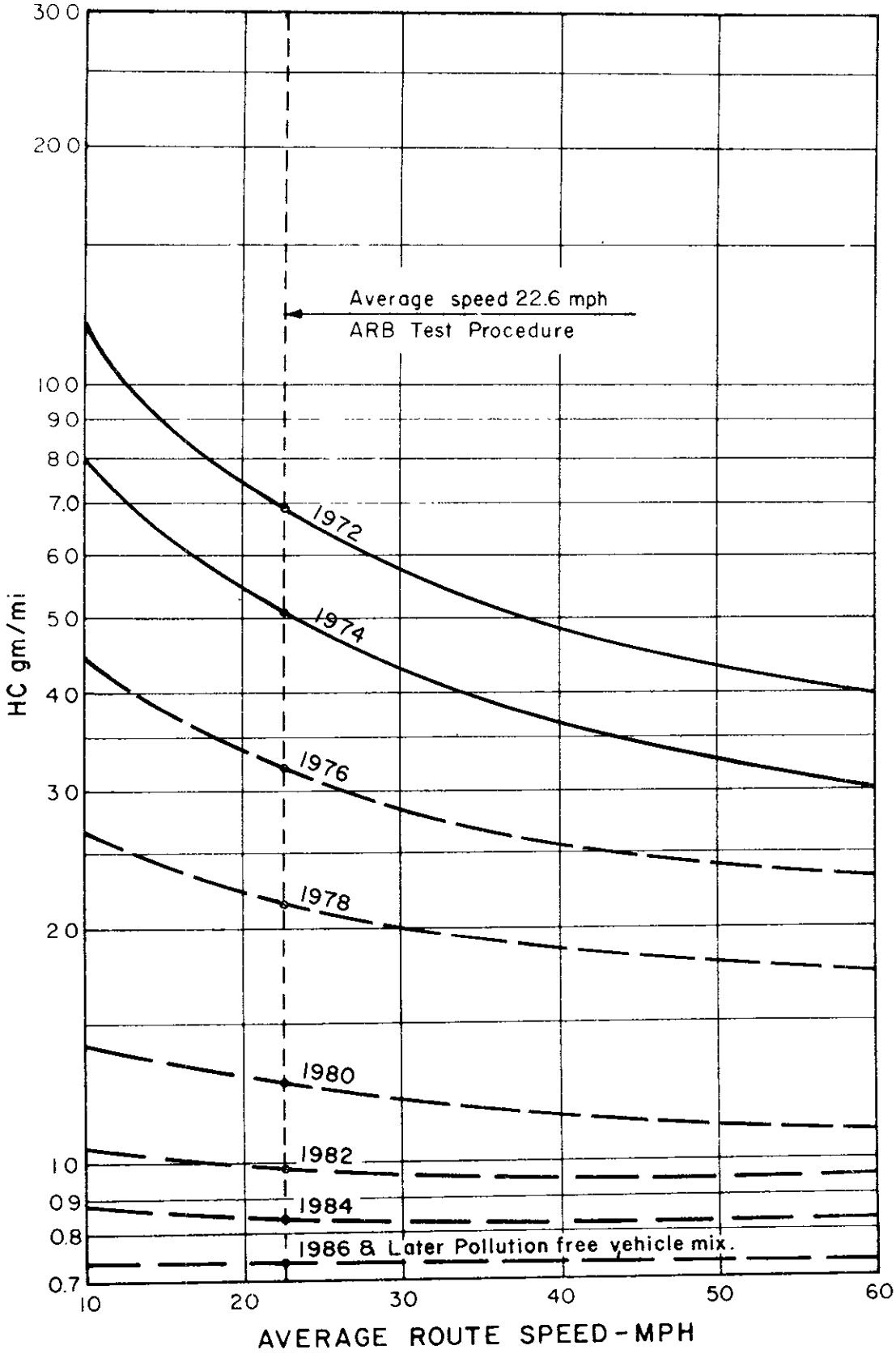

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Figure 100

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

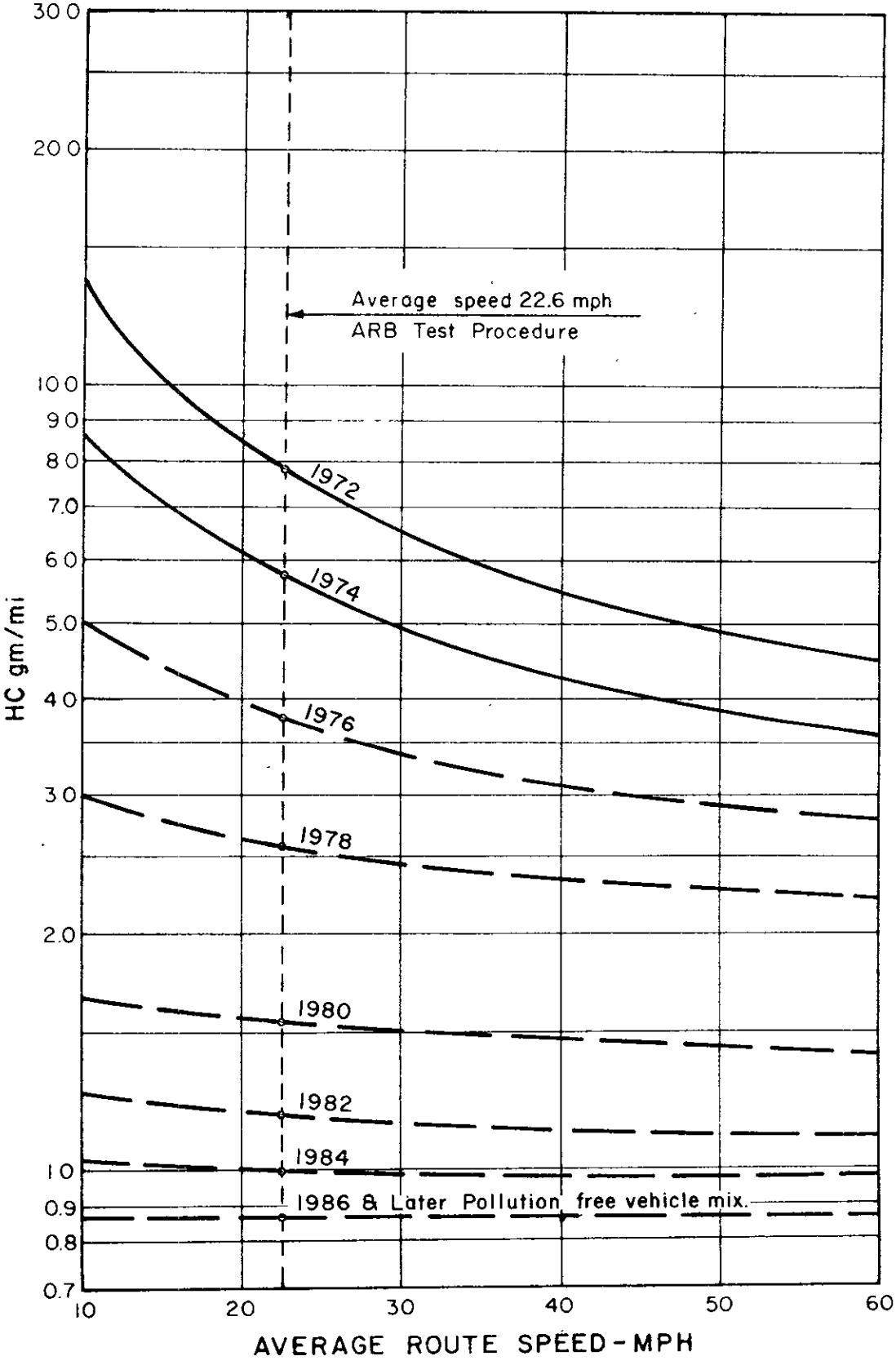

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Figure

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

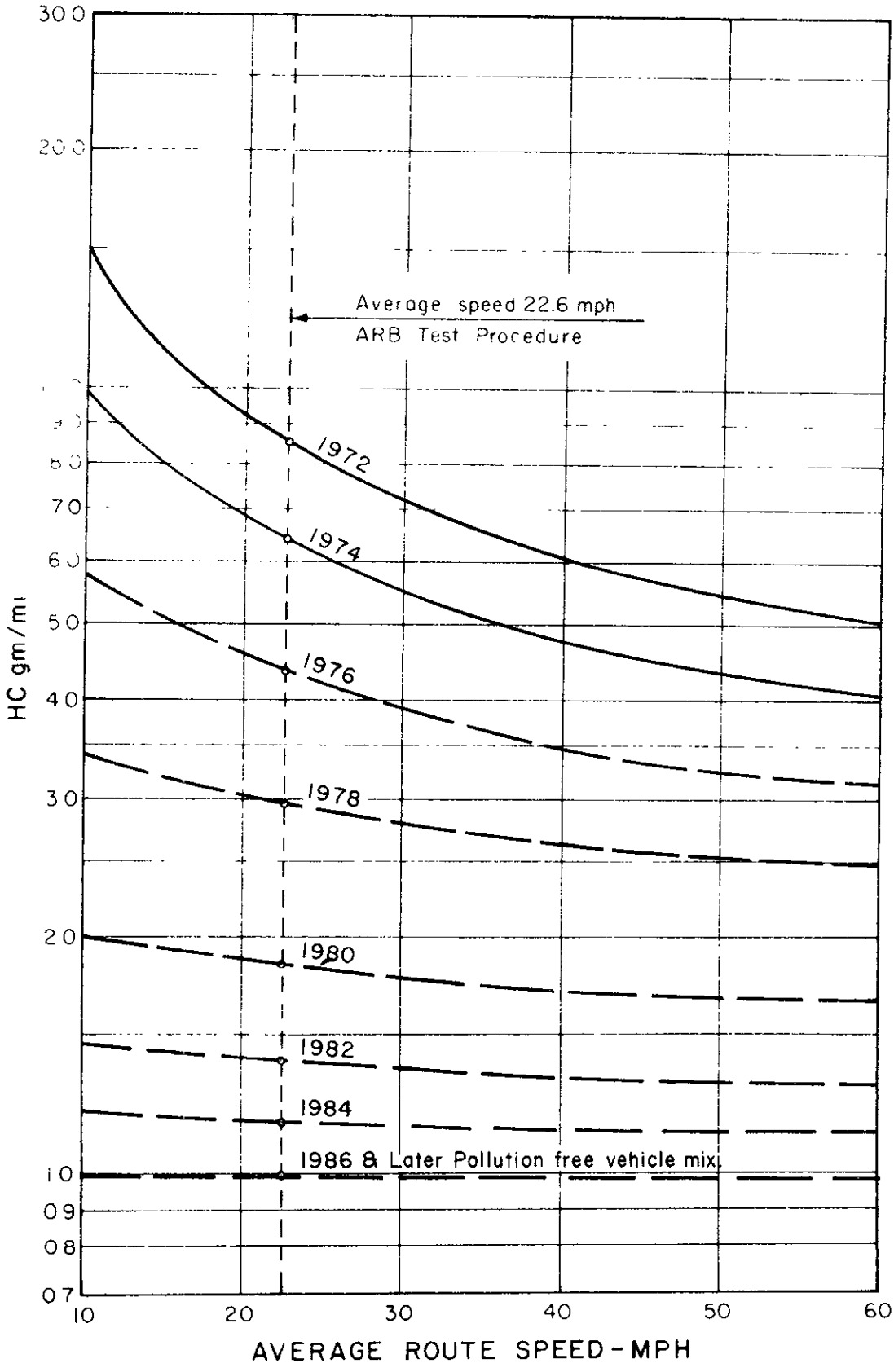

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Figure 102

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

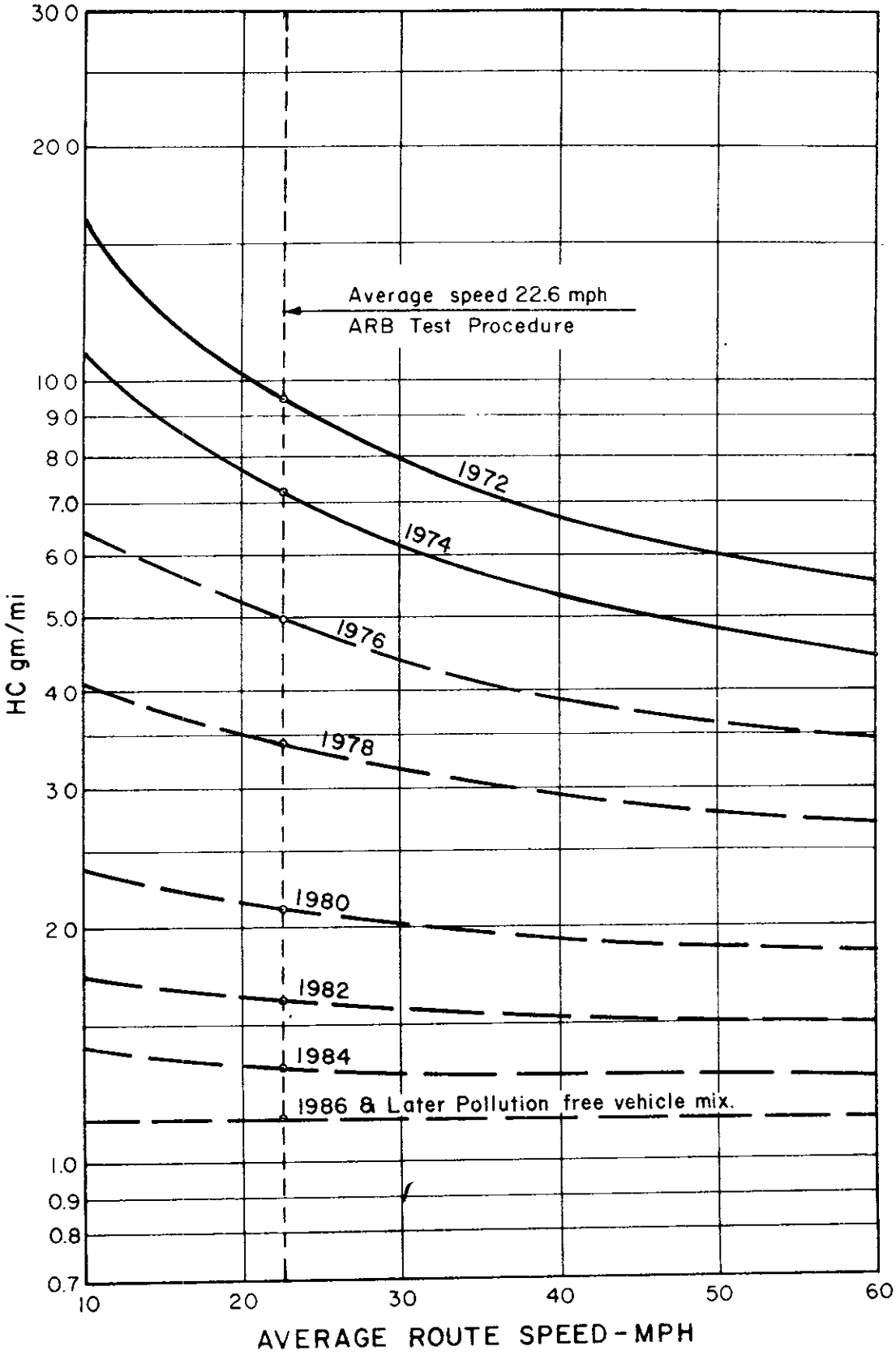

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Figure 103

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

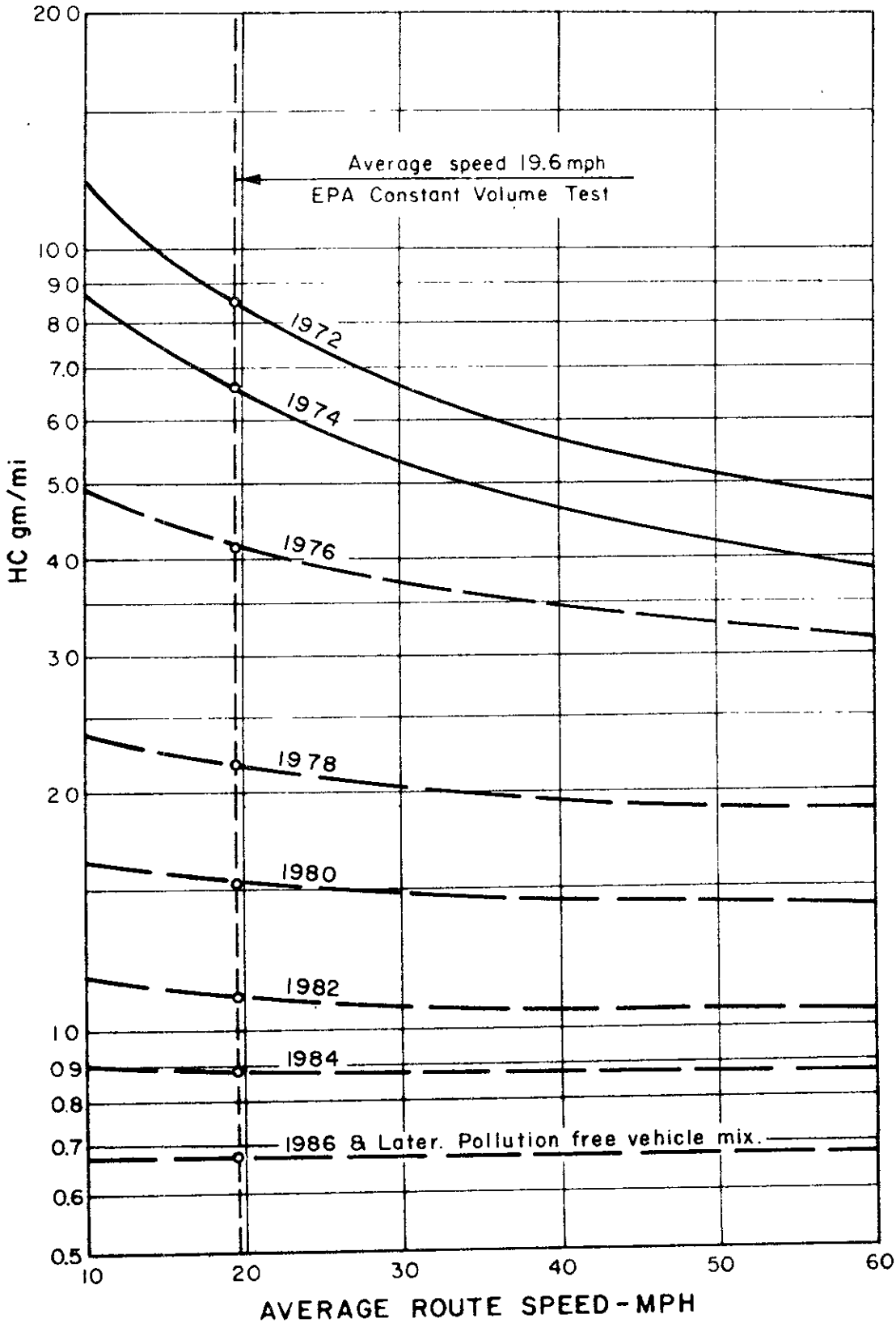

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Figure 104

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

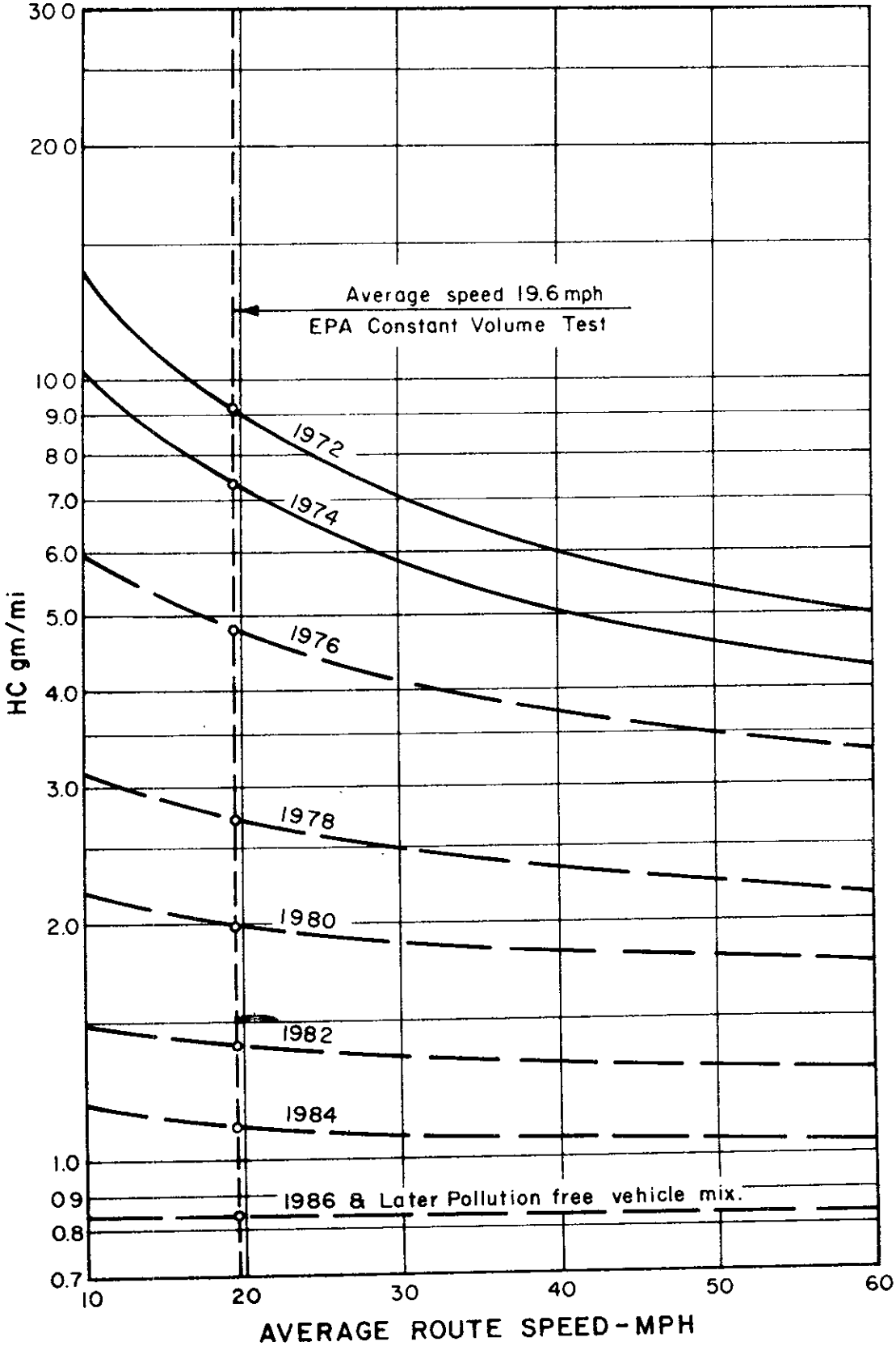

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Figure 105

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

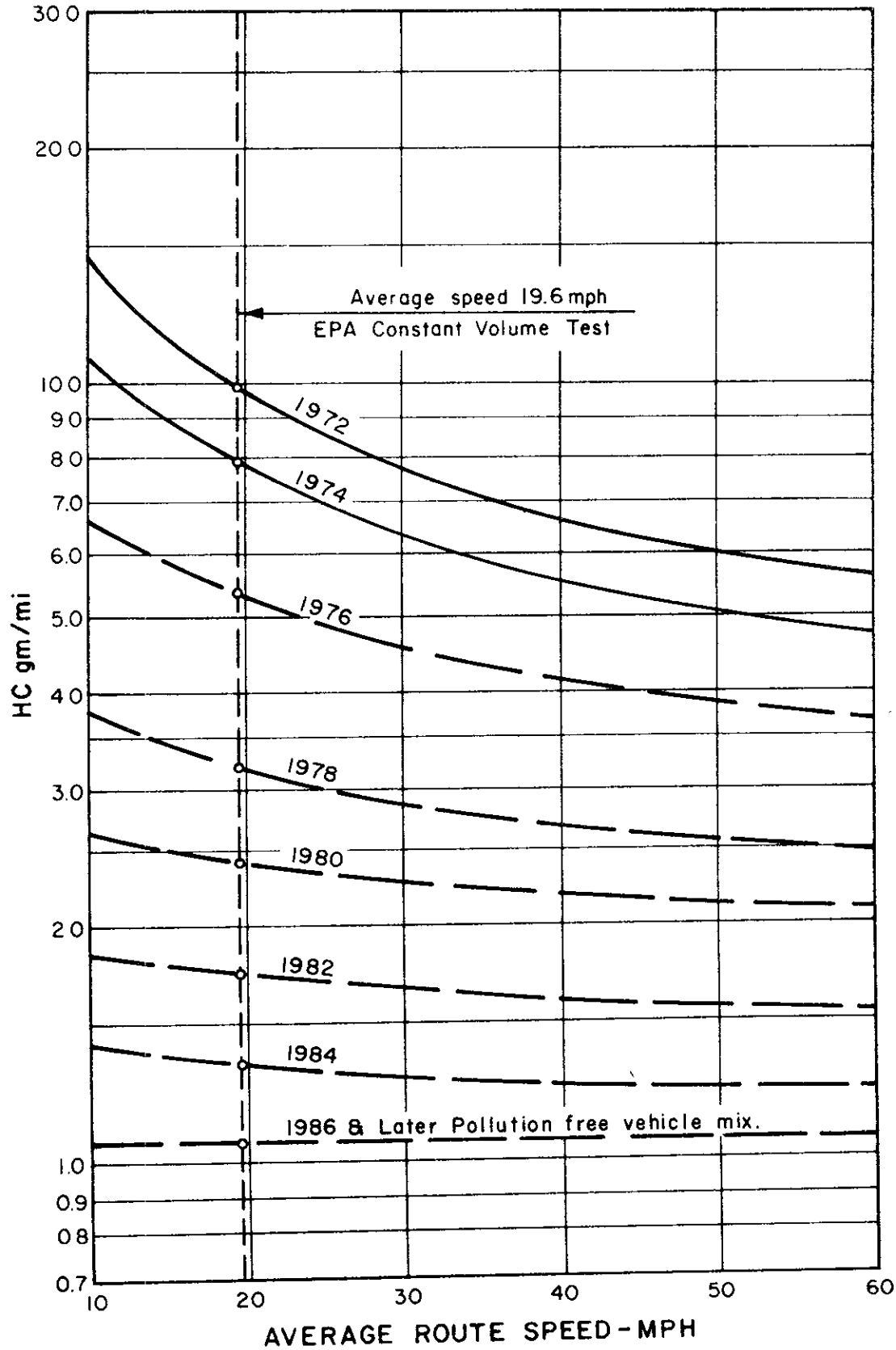

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Figure 106

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

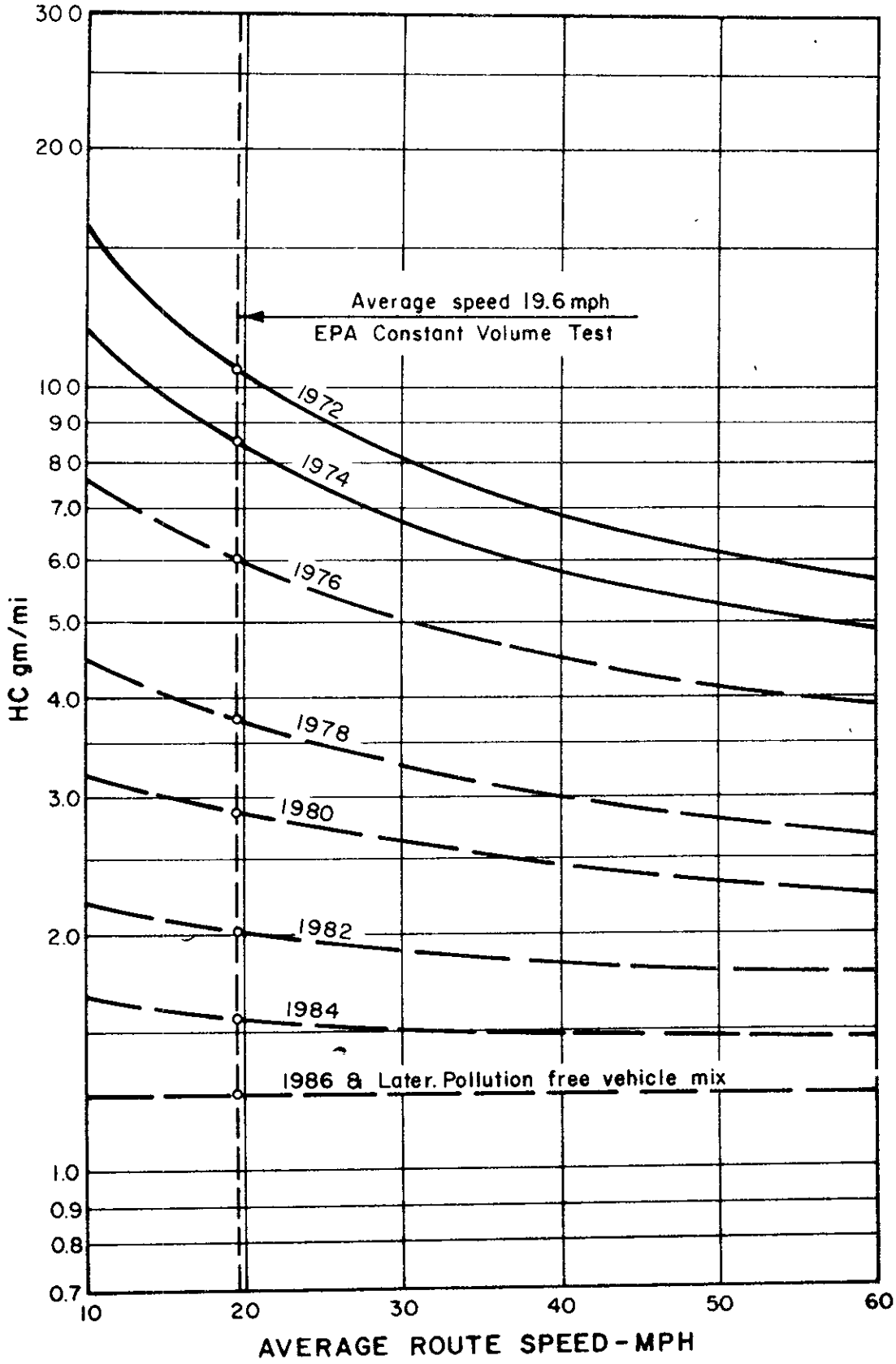

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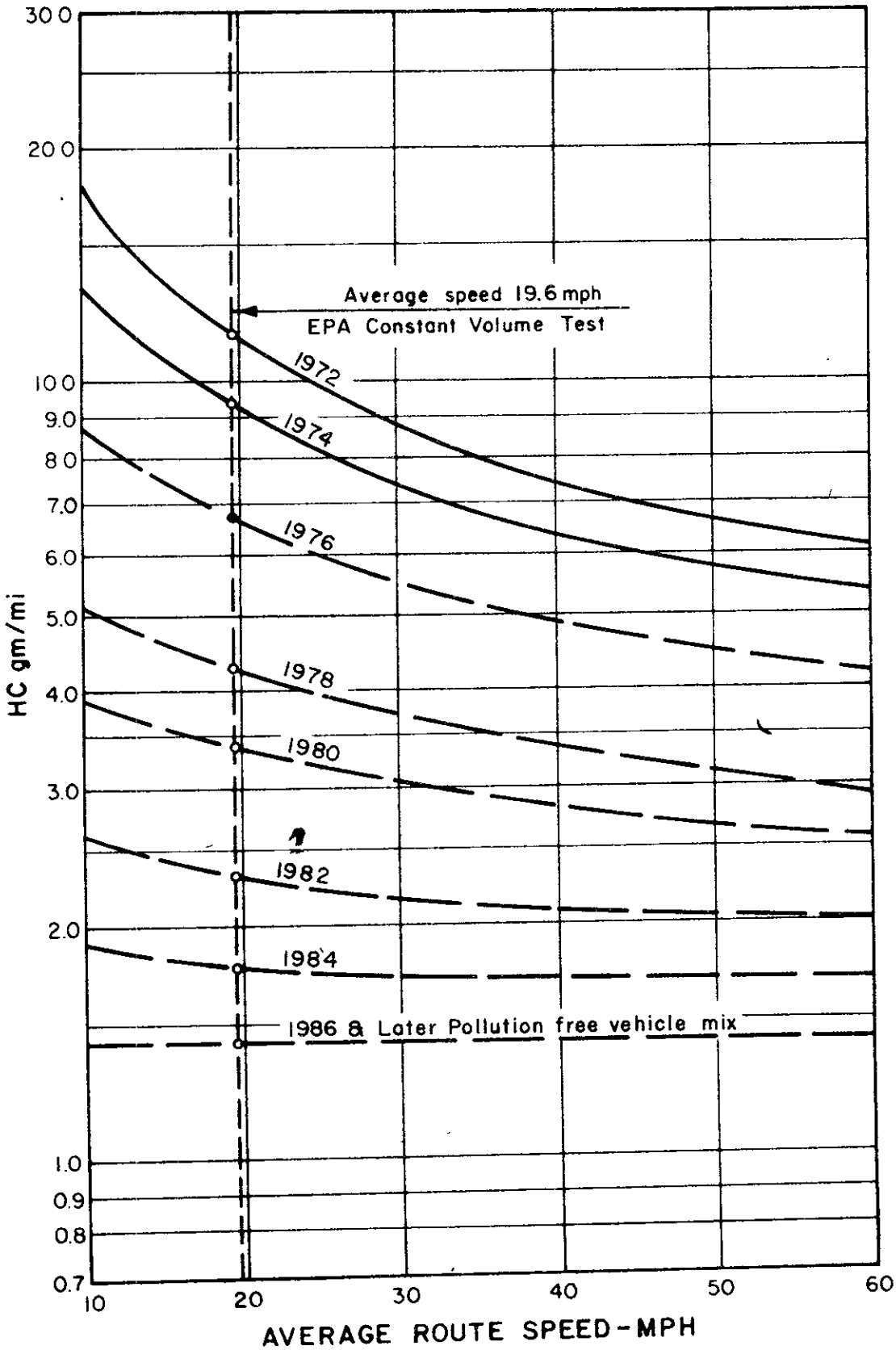
Figure 107

EMISSION FACTORS FOR HYDROCARBONS VS AVERAGE ROUTE SPEEDS ON CITY STREETS

20 % HDV



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