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COORDINATING RESEARCH COUNCIL INC ATLANTA GA OCT 86
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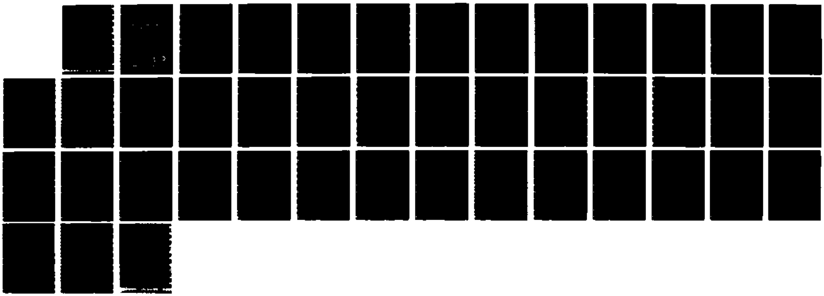

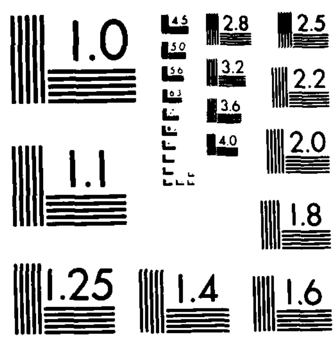

MICROCOPY RESOLUTION TEST CHART
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AD-A175 013

CRC Report No. 549

OCTANE REQUIREMENT INCREASE OF 1984 MODEL VEHICLES

October 1986

COORDINATING RESEARCH COUNCIL, INC.
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OCTANE REQUIREMENT INCREASE OF 1984 MODEL VEHICLES
(CRC PROJECT NO. CM-124-84)

Prepared by the

1984 Octane Requirement Increase Analysis Panel

of the

CRC-Automotive Octane Technology and Test Procedures Group

October 1986

Automotive Vehicle Fuel, Lubricant, and Equipment Research Committee

of the

Coordinating Research Council, Inc.

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I. SUMMARY

- Octane requirement increase (ORI) was determined for sixty-two 1984 model cars and trucks operated on unleaded gasoline. The cars tested were not selected to represent the distribution of vehicles produced in the model year; rather the data base consists of information volunteered by participants. All ORI values were determined from the increase in maximum octane requirements irrespective of whether requirements were obtained at full- or part-throttle. Though the sample size is smaller than in previous years, it does not appear to have significantly affected the conclusions.

- At 15,000 miles, the mean ORI for all vehicles with full-boiling range unleaded (FBRU) fuels was 4.0 Research octane numbers, 2.6 Motor octane numbers, and 3.3 (R+M)/2 numbers.

- At 15,000 miles, the mean ORI with full-boiling range unleaded (FBRU) fuels for the fifty-six vehicle subset tested with all three reference fuels was 4.1 Research octane numbers, 2.6 Motor octane numbers, and 3.3 (R+M)/2 numbers.

- At 15,000 miles, the mean ORI for fifty-six vehicles with high-sensitivity full-boiling range unleaded (FBRSU) fuels was 3.9 Research octane numbers, 2.7 Motor octane numbers, and 3.3 (R+M)/2 numbers.

- At 15,000 miles, the mean ORI for fifty-six vehicles with primary reference (PR) fuels was 4.0 octane numbers.

- Compared with 1983 models (seventy-nine), the mean ORI for all vehicles in the 1984 program with FBRU fuels decreased 0.4 RON, 0.3 MON, and 0.4 (R+M)/2.

- In general, the mean ORI (unweighted) with FBRU fuel exhibits a slight downward trend for the 1975 through 1984 model cars.

- ORI decreases about 0.3 to 0.4 octane number per octane number increase of initial octane requirements. This relationship is weak, but statistically significant.

II. INTRODUCTION

The need to study octane requirement increase (ORI) with unleaded fuel became evident in 1970 when manufacturers announced that future cars would use unleaded gasoline of at least 91 RON quality, and that they would require catalytic converters to meet emission standards in 1975 models. The Coordinating Research Council, Inc. (CRC) initiated a series of ORI programs in 1971 to study the effect of these changes. Since that time, manufacturers have made many engine and vehicle modifications to meet both exhaust emission and fuel economy standards. Because of continuing engineering changes and the now exclusive use of unleaded fuel, the ORI programs have been continued.

The ORI data from 1971 and 1973 through 1983 model cars have been reported previously.[1-11] This report will summarize ORI data for 1984 model vehicles.

III. EXPERIMENTAL

A. Vehicles Tested

In the 1984 program, forty-six US cars, four light-duty US trucks, and twelve imported cars were used to determine the ORI of 1984 model vehicles. Vehicles tested were not selected to represent the distribution of vehicles produced in that model year; rather the data base consists of information volunteered by participants. Participating laboratories are listed in Appendix A.

B. Mileage Accumulation

Mileage accumulation was conducted from the fall of 1983 through the summer of 1985. All test vehicles were operated in customer-type service using unleaded fuels typical of commercially available gasoline. No attempt was made to separate the data so that laboratory-to-laboratory effects could be determined.

C. Average Sensitivity Full-Boiling Range Unleaded Reference Fuel (FBRU)

In general, octane number requirements of 1984 model vehicles were defined initially with 1983 FBRU fuel. As mileage increased, the reference fuel was replaced with the 1984 FBRU fuel. Laboratory X used a third FBRU reference fuel series for all octane requirements it submitted. Another laboratory initiated their tests with 1982 FBRU fuel, switching to later fuels as mileage increased. The RON-to-MON conversions used in the data analysis for 1984 vehicles are shown in Appendix C, Table C-I.

D. High Sensitivity Full-Boiling Range Unleaded Reference Fuel (FBRSU)

Octane requirements of fifty-six vehicles were defined initially with 1982 or 1983 FBRSU fuels and later with 1983 and 1984 FBRSU fuels as well as with FBRU. The RON-to-MON conversions used in data analysis are shown in Appendix C, Table C-II.

E. Primary Reference (PR) Fuel

Standard ASTM PR fuel was used in two octane number increments from 76 to 82, and in one octane number increments from 82 to 100, to cover the range of car requirements.

F. Test Technique

Octane number requirements were determined at incremental mileages from zero to 15,000 miles by the CRC E-15-84 technique.[12] Maximum octane number requirements were determined on sixty-two vehicles with FBRU fuel and fifty-six with both FBRSU and PR fuels.

IV. DISCUSSION OF RESULTS

A. Data Analysis Technique

For this program, octane requirements were to be obtained at 0, 5,000, 10,000, and 15,000 miles; however, not all the data were obtained exactly at these mileage intervals. To compare the ORI of all vehicles at the same mileage, results were determined from best-fit curves of actual reported octane requirements. Research octane number requirements (RON) reported by the participants were plotted at the mileages at which they were obtained. Requirements at 0, 5,000, 10,000, and 15,000 miles were then read from best-fit curves as shown in Figure 1. ORI at 5,000, 10,000, and 15,000 miles were determined from these best-fit curves.

ORI on a Motor octane number (MON) basis was determined from best-fit curve RON requirements that were translated into MON requirements according to the RON-to-MON conversions in Tables C-I and C-II. Similarly, ORI on an (R+M)/2 basis was determined from (R+M)/2 requirements that were calculated from best-fit curve RON and corresponding MON values. The appropriate RON-to-MON conversion was determined by the fuel series used to determine the actual reported requirement that was closest to the 0-, 5,000-, 10,000-, or 15,000-mile intervals. Requirements were determined initially with 1982 or 1983 fuels and with later series fuels as mileage increased. Laboratory X used a third FBRU reference fuel series; all data reported by this laboratory were translated according to the Laboratory X RON-to-MON conversion in Table C-I.

Best-fit curve octane requirements at 0, 5,000, 10,000, and 15,000 miles are listed for each vehicle in Appendix D, Tables D-I, D-II, and D-III for FBRU, FBRSU, and PR fuels, respectively. Copies of raw octane requirement data and best-fit curves are on file with CRC.

Distribution of initial RON, MON, and (R+M)/2 requirements, as well as ORI values for each mileage interval, are summarized in Tables I, II, and III for FBRU, FBRSU, and PR fuels, respectively. The numbers in parenthesis in Table I are the average FBRU values of the fifty-six vehicles for which data on all three reference fuels were reported. These tables also include a breakout by manufacturer and engine type where sufficient samples exist.

Distributions of initial RON requirements are plotted in Figure 2 for all three fuel series. Distributions of ORI at various mileages for RON, MON, and (R+M)/2 on FBRU fuels are shown in Figures 3, 4, and 5, respectively, and on FBRSU fuels in Figures 6, 7, and 8. Similarly, distributions of ORI on PR fuels at various mileages are shown in Figure 9.

Because some laboratories tested cars on two different reference fuel series, the MON ORI may be different from that determined from a single reference fuel series. The difference in sensitivity (RON minus MON) ranges from 0.0 to 1.0 and 0.0 to 0.6 for the four FBRU and three FBRSU fuel series, respectively. Although an estimate of the error cannot be made from these data, work by other researchers suggest it may be as much as 0.5 MON.[13]

Members of the Analysis Panel are listed in Appendix E.

B. Comparison of 1975 through 1984 ORI Studies

The mean ORI values for 1975 through 1984 model vehicles are:

Model Year	Accumulated Miles	Mean ORI FBRU, RON	Mean ORI PR
1975	16,000	5.8	4.4
1976	15,000	5.4	3.6
1977	15,000	4.9	2.9
1978	15,000	6.0	4.2
1979	15,000	5.4	4.1
1980	15,000	5.1	3.9
1981	15,000	5.1	4.1
1982	15,000	4.9	4.0
1983	15,000	4.4	3.9
1984	15,000	4.0	4.0
1975-1984 Unweighted Average:		5.1	3.9

ORI with FBRU fuel continues a slight downward trend from 1975 and is illustrated on Figure 10. ORI with PR fuel is unchanged over this period.

C. ORI Versus Initial Octane Requirements

Initial RON requirements are plotted against ORI at 15,000 miles in Figures 11, 12, and 13 for FBRU, FBRSU, and PR fuels, respectively. The trend between initial requirements and ORI was determined by linear least squares regression analysis. The general form of the equation was:

$$ORI = a + b \text{ (Initial Octane Requirement)}$$

The best-fit lines are also shown in Figures 11, 12, and 13.

Equations for the three reference fuel series are:

Reference Fuel Series	a		b		R
	Estimate	T Value of Estimate	Estimate	T Value of Estimate	
FBRU	30.6	5.1	-0.30	-4.5	0.25
FBRSU	28.5	5.1	-0.28	-4.4	0.27
PR	37.1	7.8	-0.38	-6.9	0.47

In general, ORI decreases about 0.3 to 0.4 units per unit increase of initial requirements. The equation only weakly fits the data as indicated by the small correlation coefficients (R^2), but as in the past, the analysis has indicated that the estimates of the slope (ORI/Initial Requirement) are statistically significant.[8,9,10] This relationship, however, was not statistically significant for the 1983 model vehicles.

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REFERENCES

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13. Correspondence to R.K. Nelson (CRC) from L.M. Gibbs (Chevron Research Company), May 16, 1983, "1980 CRC Octane Requirement Increase Program."

T A B L E S

AND

F I G U R E S

TABLE II

INITIAL OCTANE NUMBER REQUIREMENTS AND ORI AT VARIOUS MILEAGES -- FBRSU FUEL

Group	No. of Vehicles Tested	RON Initial Requirements Mean	RON Initial Requirements SD	RON 5,000-Mile ORI Mean	RON 5,000-Mile ORI SD	RON 10,000-Mile ORI Mean	RON 10,000-Mile ORI SD	RON 15,000-Mile ORI Mean	RON 15,000-Mile ORI SD	MON Initial Requirements Mean	MON Initial Requirements SD	MON 5,000-Mile ORI Mean	MON 5,000-Mile ORI SD	MON 10,000-Mile ORI Mean	MON 10,000-Mile ORI SD	MON 15,000-Mile ORI Mean	MON 15,000-Mile ORI SD	(R+M)/2 Initial Requirements Mean	(R+M)/2 Initial Requirements SD	(R+M)/2 5,000-Mile ORI Mean	(R+M)/2 5,000-Mile ORI SD	(R+M)/2 10,000-Mile ORI Mean	(R+M)/2 10,000-Mile ORI SD	(R+M)/2 15,000-Mile ORI Mean	(R+M)/2 15,000-Mile ORI SD
All Vehicles	56	88.6	4.8	2.7	2.3	3.5	2.5	3.9	2.6	79.6	3.3	1.9	1.6	2.5	1.7	2.7	1.7	84.1	4.1	2.3	1.9	3.0	2.1	3.3	2.2
All Make A	21	90.1	5.2	2.4	1.7	3.3	1.8	3.6	1.9	80.6	3.6	1.7	1.1	2.3	1.2	2.5	1.2	85.4	4.4	2.0	1.4	2.8	1.5	3.1	1.6
All Make B	14	88.7	3.7	2.6	2.4	3.3	2.6	3.7	2.9	79.6	2.5	1.8	1.6	2.2	1.8	2.5	1.9	84.2	3.1	2.2	2.0	2.8	2.2	3.1	2.4
All Make C	9	90.4	4.5	2.1	2.2	3.0	3.0	3.4	3.4	80.8	3.0	1.4	1.5	2.1	2.0	2.3	2.2	85.6	3.8	1.7	1.8	2.5	2.5	2.9	2.8
All Others	12	84.8	3.5	4.0	2.9	4.6	2.7	4.9	2.7	76.9	2.6	2.8	2.0	3.3	1.9	3.5	1.9	80.8	3.0	3.4	2.4	4.0	2.3	4.2	2.3
Engine A181	5	85.2	0.8	3.2	0.6	4.6	0.6	5.1	0.8	77.2	0.6	2.3	0.4	3.3	0.4	3.6	0.6	81.2	0.7	2.8	0.5	3.9	0.5	4.3	0.7
Engine B98	5	91.2	0.4	1.7	2.0	2.5	2.7	2.9	3.0	81.4	0.3	1.1	1.3	1.6	1.7	1.9	2.0	86.3	0.4	1.4	1.7	2.0	2.2	2.4	2.5
Engine C135	6	89.3	4.9	2.3	2.4	3.4	3.4	3.9	3.8	80.0	3.3	1.6	1.6	2.4	2.2	2.7	2.5	84.7	4.1	2.0	2.0	2.9	2.8	3.3	3.2
Engine D122	5	87.2	2.4	3.4	1.7	4.3	2.1	4.7	2.2	78.7	1.7	2.4	1.2	3.0	1.4	3.3	1.5	82.9	2.0	2.9	1.5	3.7	1.8	4.0	1.6

TABLE I

INITIAL OCTANE NUMBER REQUIREMENTS AND ORI AT VARIOUS MILEAGES -- FBRU FUEL

Group	No. of Vehicles Tested	RON Initial Requirements		RON 5,000-Mile ORI		RON 10,000-Mile ORI		RON 15,000-Mile ORI		MON Initial Requirements		MON 5,000-Mile ORI		MON 10,000-Mile ORI		MON 15,000-Mile ORI		(R+M)/2 Initial Requirements		(R+M)/2 5,000-Mile ORI		(R+M)/2 10,000-Mile ORI		(R+M)/2 15,000-Mile ORI	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
All Vehicles	62 (56)	87.7 (87.6)	4.6 (4.8)	2.8 (2.8)	2.3 (2.3)	3.7 (3.7)	2.6 (2.6)	4.0 (4.1)	2.8 (2.7)	81.2 (81.2)	3.1 (3.2)	1.9 (1.9)	1.6 (1.6)	2.4 (2.4)	1.8 (1.7)	2.6 (2.6)	1.9 (1.8)	84.4 (84.4)	3.9 (4.0)	2.1 (2.3)	1.9 (1.9)	3.0 (3.0)	2.2 (2.1)	3.3 (3.3)	2.4 (2.3)
All Make A	27 (21)	88.9 (89.0)	4.6 (5.2)	2.6 (2.6)	2.0 (1.9)	3.5 (3.5)	2.3 (2.0)	3.9 (3.9)	2.4 (2.1)	82.0 (82.2)	3.1 (3.4)	1.8 (1.7)	1.3 (1.2)	2.4 (2.3)	1.6 (1.3)	2.5 (2.4)	1.7 (1.3)	85.5 (85.6)	3.8 (4.3)	2.2 (2.2)	1.6 (1.6)	2.9 (2.9)	2.0 (1.7)	3.2 (3.1)	2.1 (1.7)
All Make B	14	87.3	4.5	2.7	2.4	3.7	3.0	4.3	3.5	80.9	3.1	1.8	1.6	2.4	2.0	2.8	2.4	84.1	3.8	2.2	2.0	3.0	2.5	3.5	2.9
All Make C	9	89.3	4.1	1.9	2.0	2.8	2.6	3.2	3.0	82.4	2.6	1.2	1.2	1.7	1.6	2.0	1.9	85.9	3.4	1.6	1.6	2.2	2.1	2.6	2.5
All Others	12	84.1	3.5	4.0	2.9	4.6	2.8	4.8	2.8	78.8	2.5	2.7	2.0	3.1	1.9	3.0	1.9	81.4	3.0	3.3	2.4	3.8	2.3	3.9	2.3
Engine A151	6	87.3	1.0	4.9	2.3	6.4	2.0	6.6	2.1	80.9	0.8	3.2	1.5	4.3	1.4	4.5	1.7	84.1	0.9	4.1	1.9	5.3	1.7	5.5	1.9
Engine A181	5	84.4	0.6	2.9	0.8	4.2	0.8	5.0	0.8	79.2	0.4	2.0	0.6	2.7	0.4	3.1	0.5	81.8	0.5	2.5	0.7	3.5	0.6	4.0	0.6
Engine B98	5	89.8	0.8	1.9	2.3	2.9	3.2	3.5	3.7	82.5	0.5	1.2	1.4	1.8	2.0	2.3	2.4	86.2	0.7	1.5	1.8	2.4	2.6	2.9	3.0
Engine C135	6	88.2	4.3	2.2	2.1	3.1	2.9	3.6	3.4	81.6	2.7	1.4	1.3	1.9	1.8	2.3	2.1	84.9	3.5	1.8	1.7	2.5	2.3	3.0	2.8
Engine D122	5	86.6	2.6	3.6	2.2	4.4	2.6	4.8	2.6	80.6	1.7	2.3	1.5	2.8	1.8	3.0	1.8	83.6	2.2	2.9	1.8	3.6	2.2	3.8	2.2

( ) Numbers in parentheses represent FBRU data on vehicles that were also tested on FBRSU and PR fuels.

TABLE III

INITIAL OCTANE NUMBER REQUIREMENTS AND ORI AT VARIOUS MILEAGES -- PR FUEL

Group	No. of Vehicles Tested	Initial Requirements		5,000-Mile ORI		10,000-Mile ORI		15,000-Mile ORI	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
All Vehicles	56	85.8	4.8	2.9	2.4	3.7	2.6	4.0	2.7
All Make A	21	87.0	4.9	2.4	1.7	3.2	1.8	3.5	2.1
All Make B	14	84.9	4.5	3.4	2.8	4.5	3.0	5.1	3.1
All Make C	9	88.1	4.1	1.3	1.1	2.0	1.5	2.2	1.6
All Others	12	83.2	4.4	4.2	3.1	4.9	3.0	5.1	3.0
Engine A181	5	82.4	0.6	3.0	1.1	4.2	0.8	4.9	1.0
Engine B96	5	86.2	0.4	2.7	2.3	4.2	2.6	5.0	2.6
Engine C135	6	86.5	3.9	1.6	1.0	2.3	1.4	2.6	1.6
Engine D122	5	86.4	2.7	2.9	2.0	3.5	2.5	3.7	2.6

FIGURE 1

BEST-FIT CURVE ORI ANALYSIS

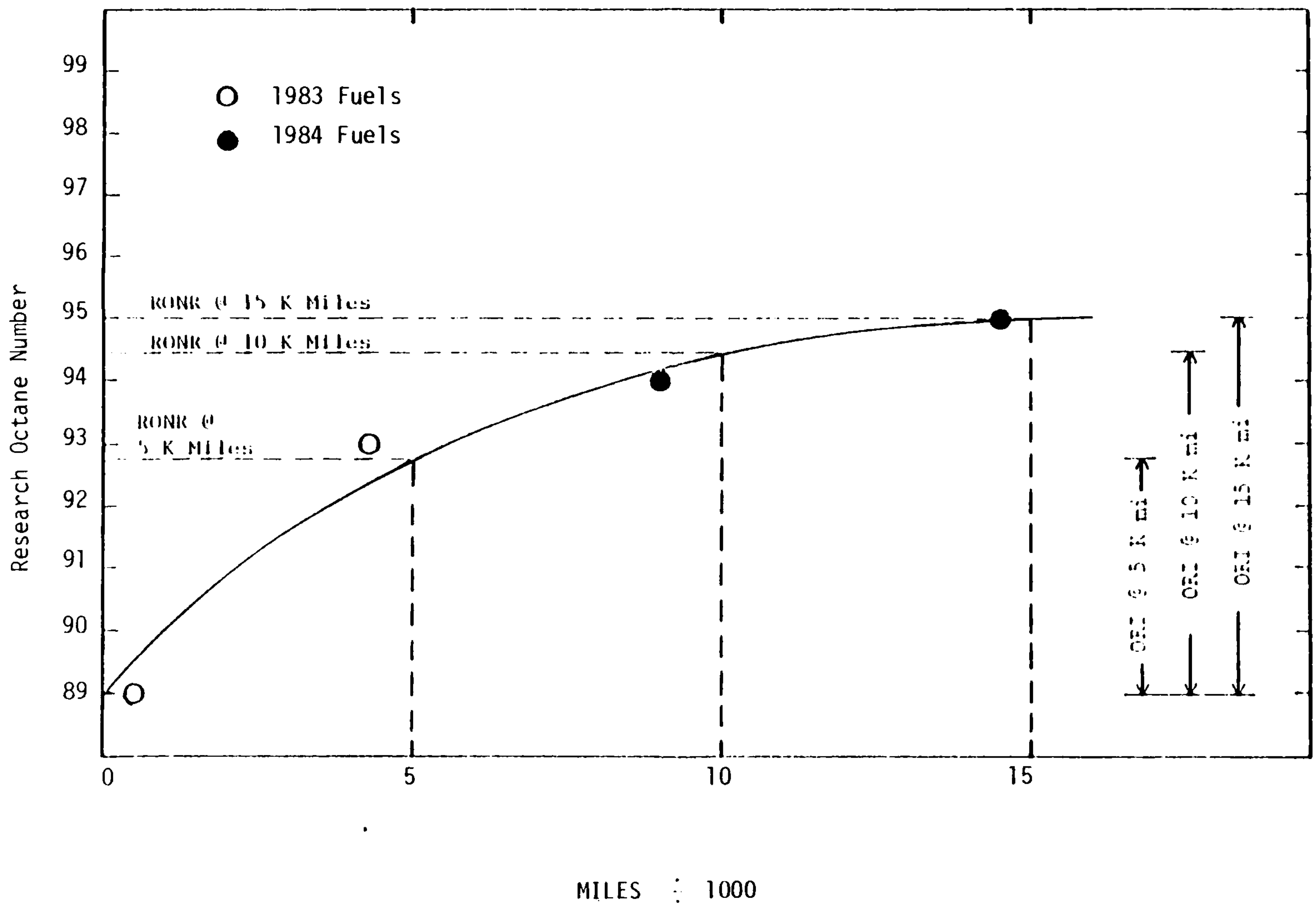


FIGURE 2

DISTRIBUTION OF INITIAL RCN REQUIREMENTS

FOR 1984 MODEL VEHICLES

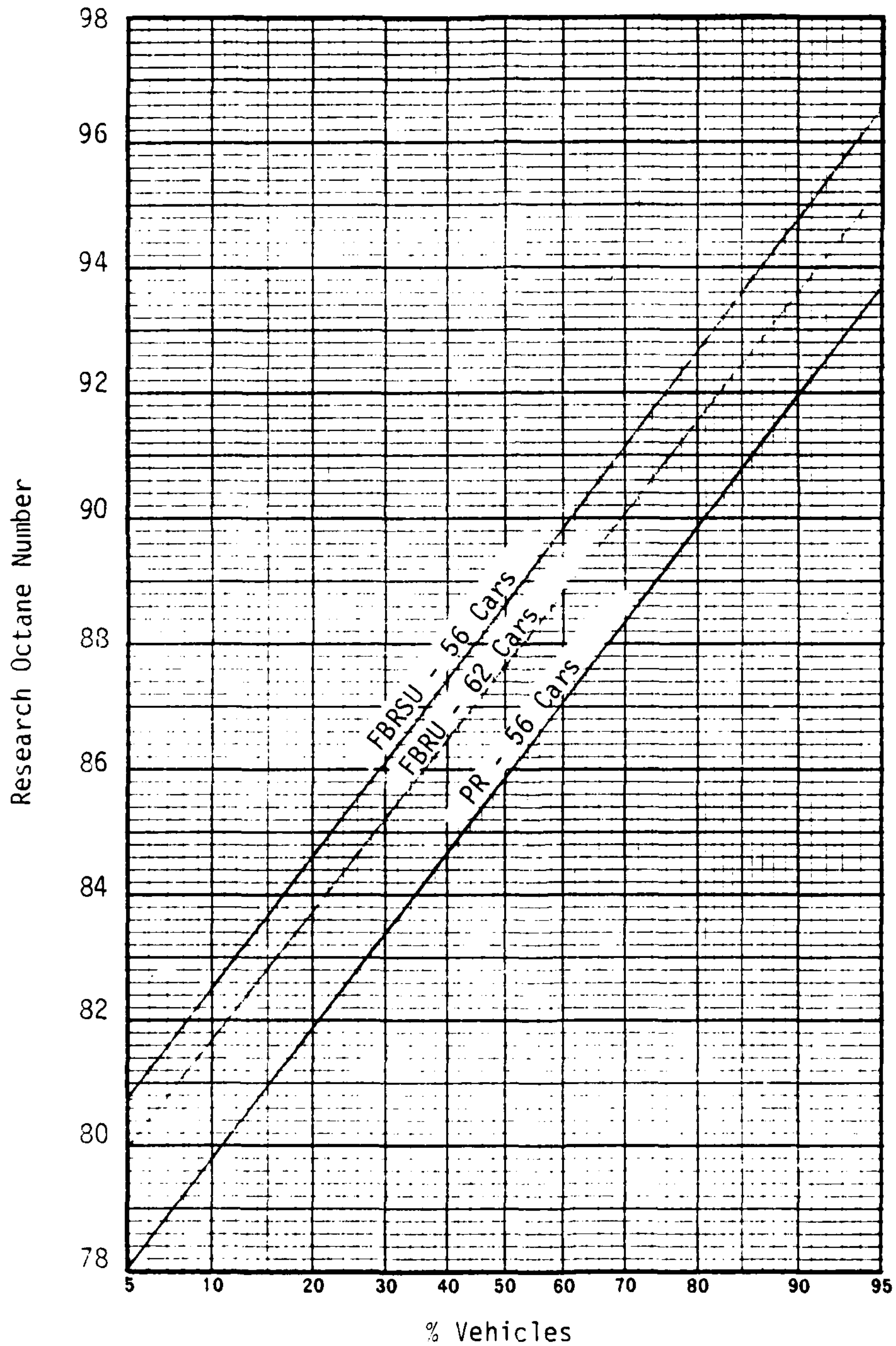


FIGURE 3

DISTRIBUTION OF RON ORI FOR

62 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRU FUEL

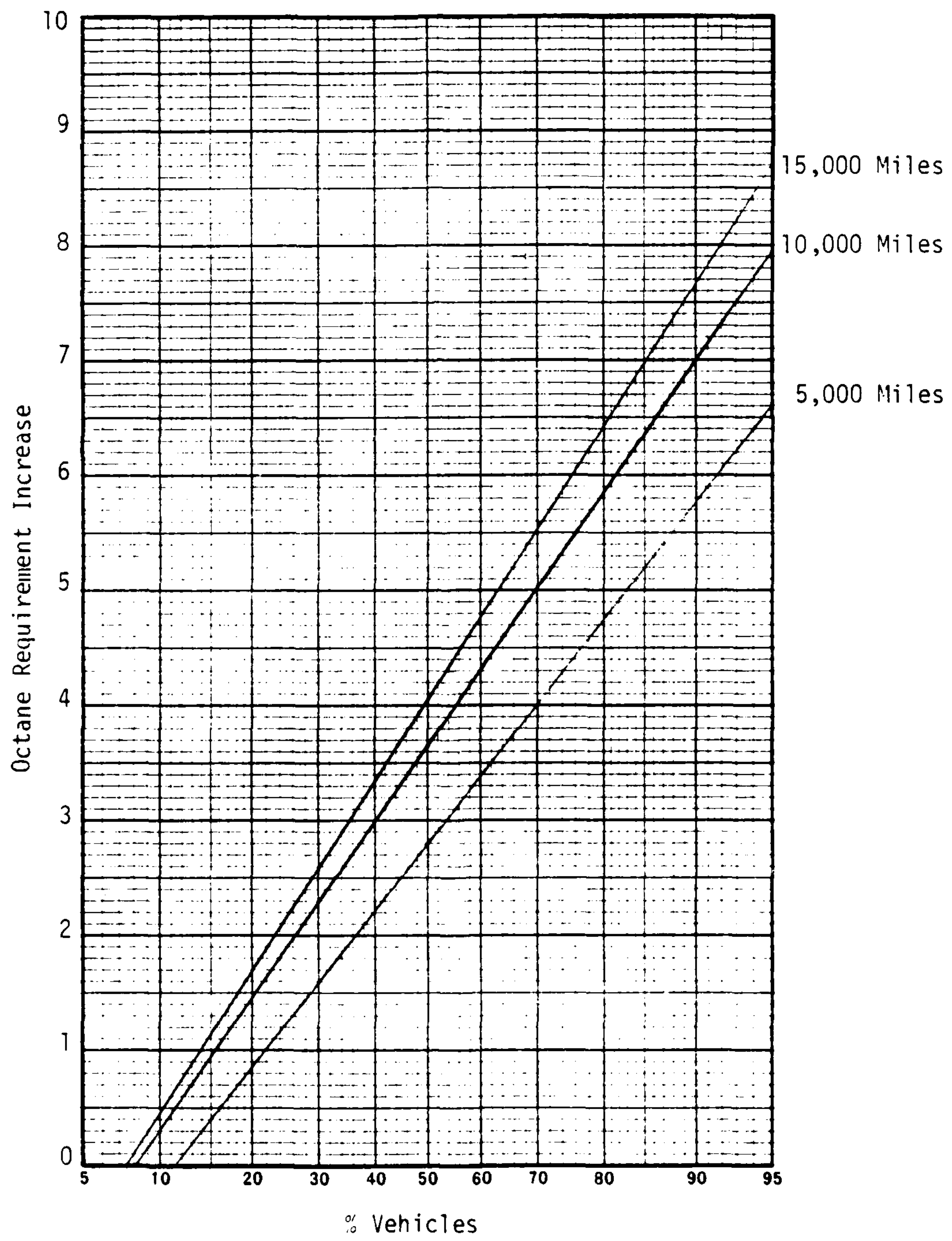


FIGURE 4

DISTRIBUTION OF MON ORI FOR

62 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRU FUEL

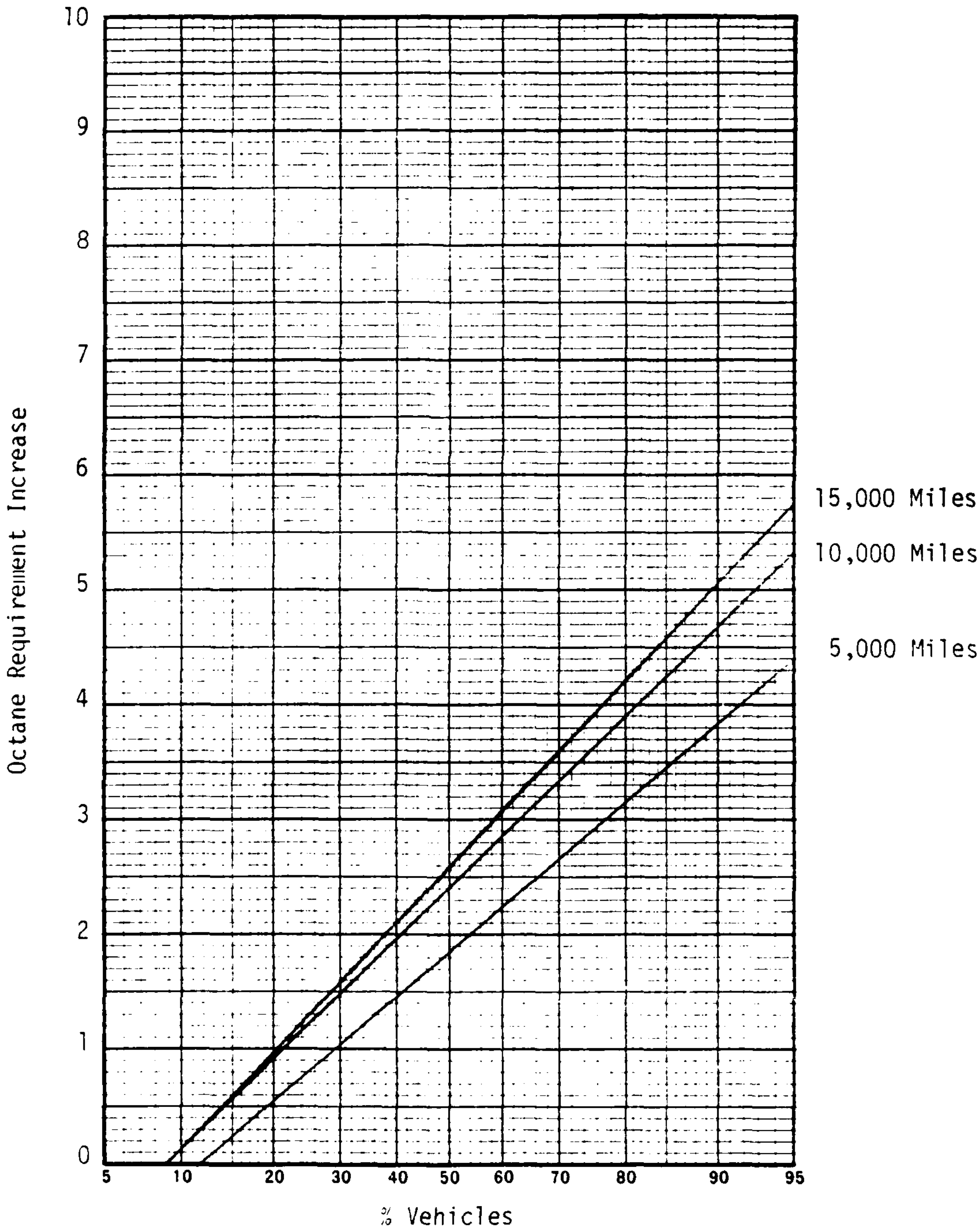


FIGURE 5

DISTRIBUTION OF (R+M)/2 ORI FOR

62 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRU FUEL

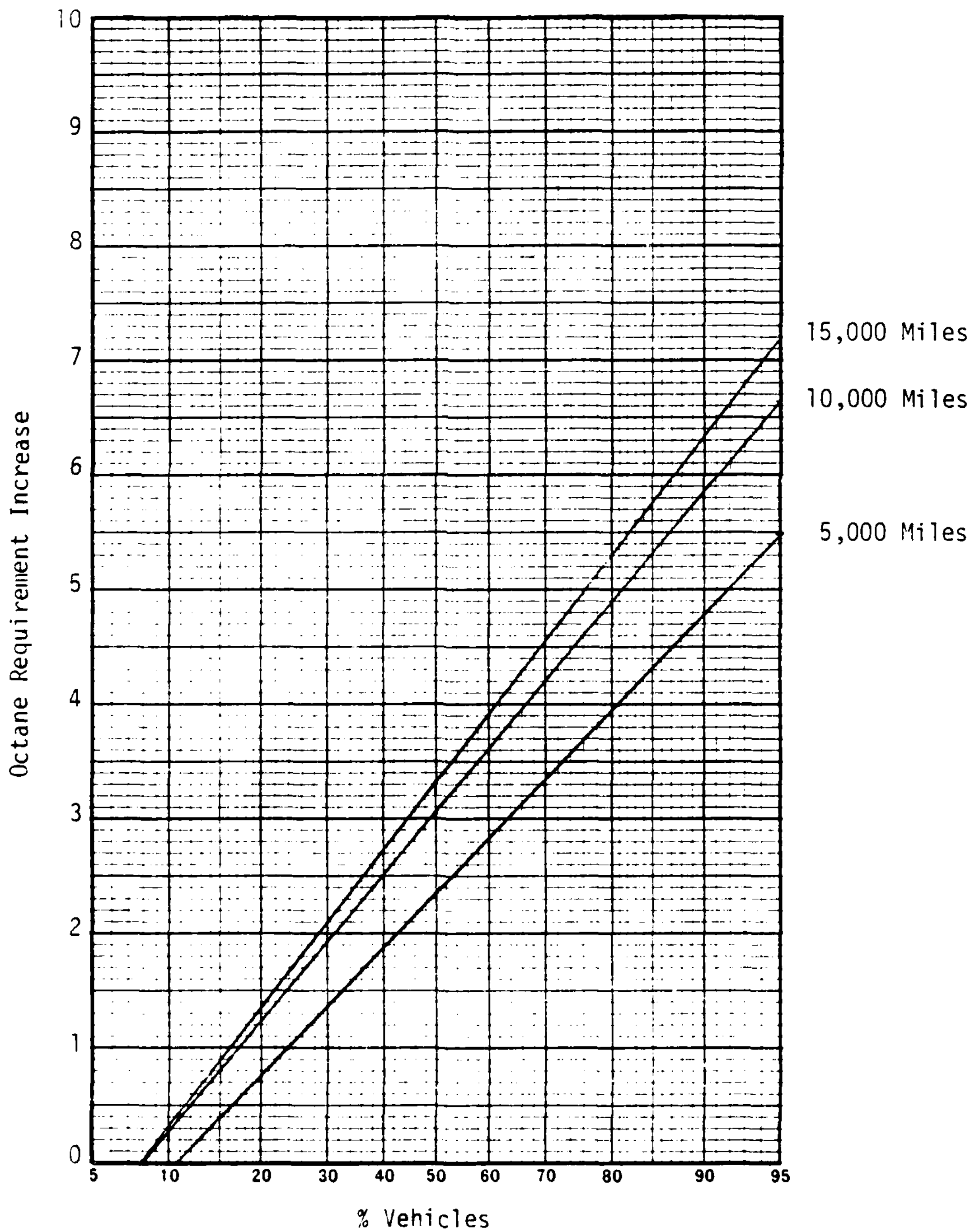


FIGURE 6

DISTRIBUTION OF RON ORI FOR

56 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRSU FUEL

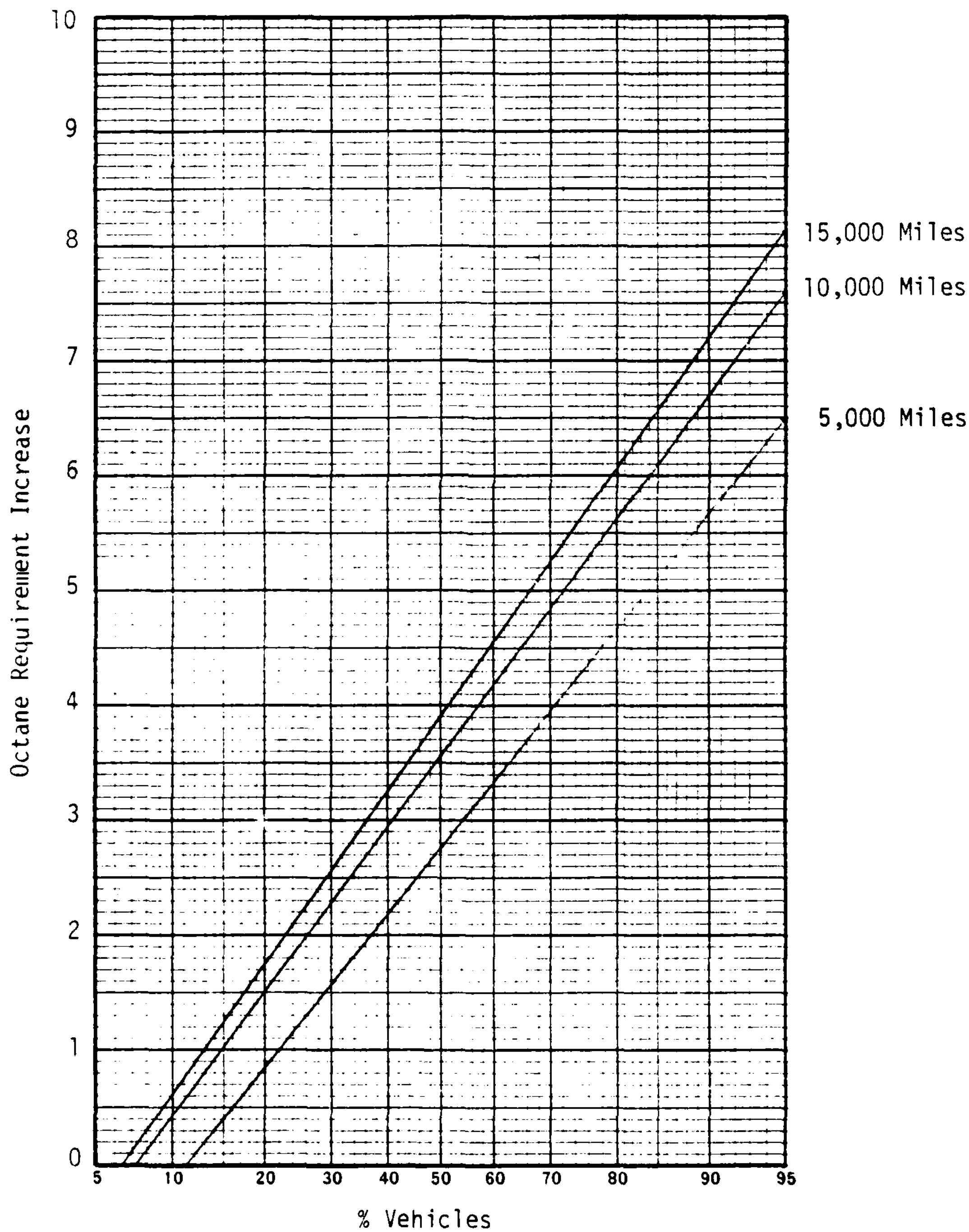


FIGURE 7

DISTRIBUTION OF MON ORI FOR

56 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRSU FUEL

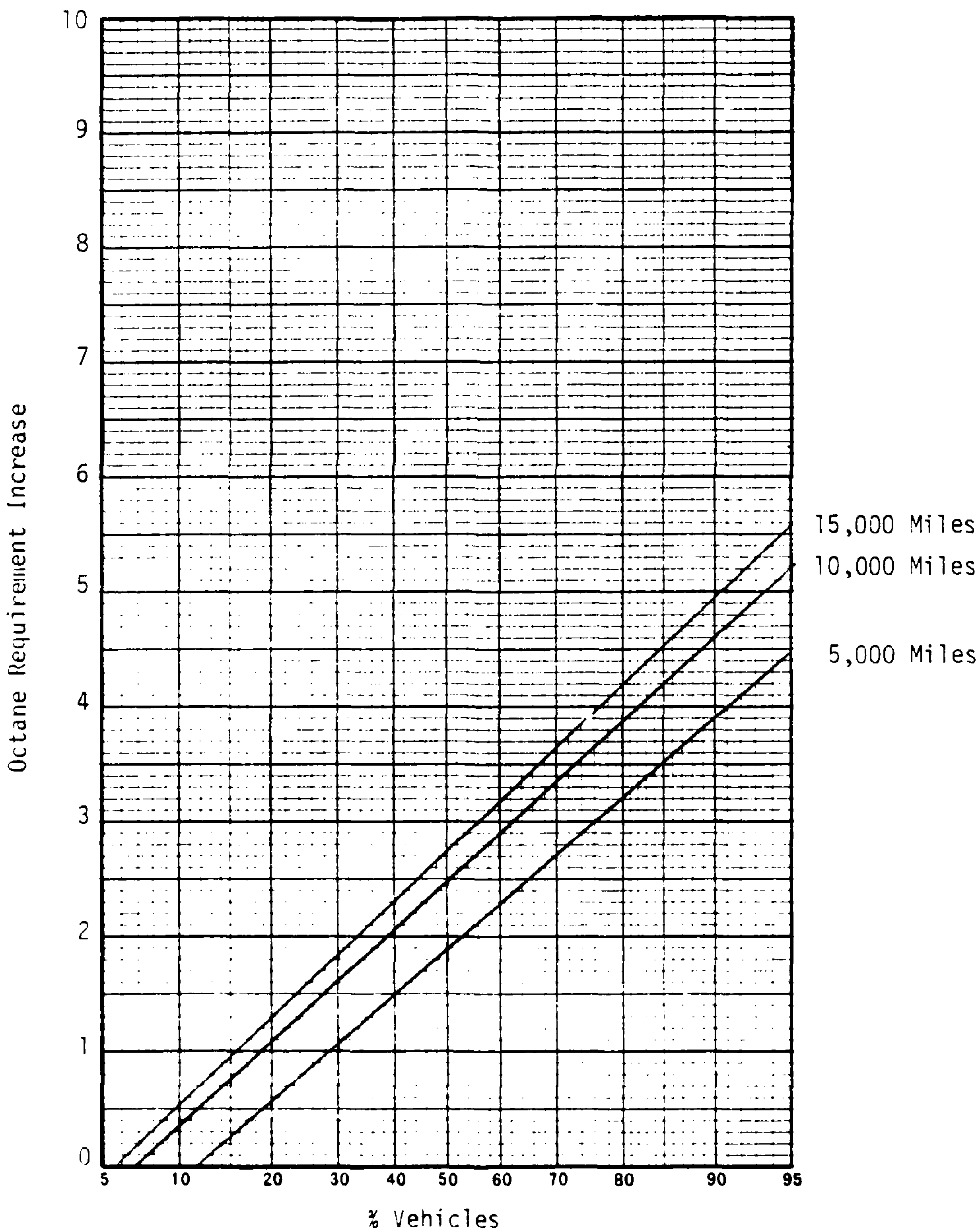


FIGURE 8

DISTRIBUTION OF (R+M)/2 ORI FOR

56 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRSU FUEL

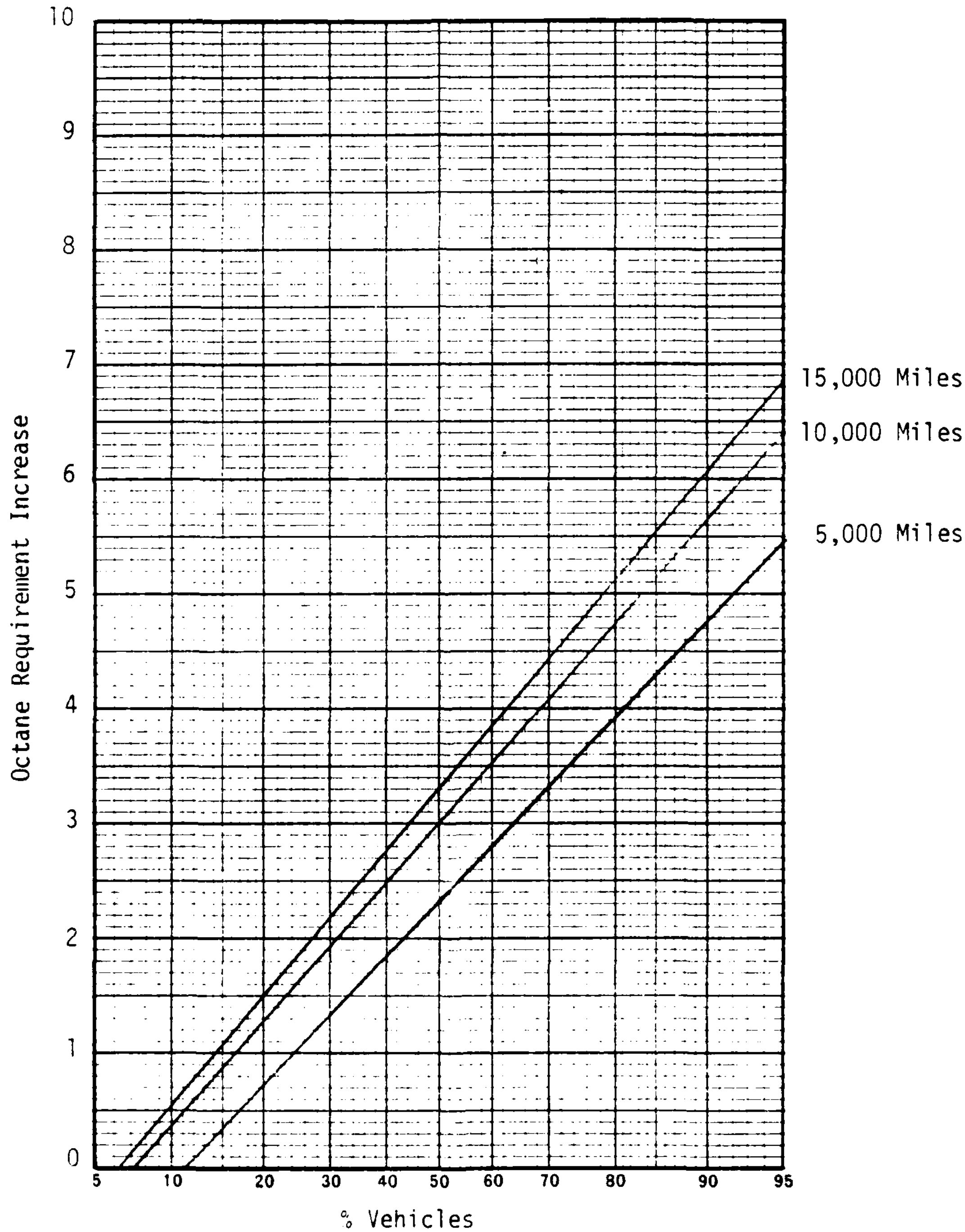


FIGURE 9

DISTRIBUTION OF CRI FOR
56 1984 MODEL VEHICLES AT
VARIOUS MILEAGES ON PR FUEL

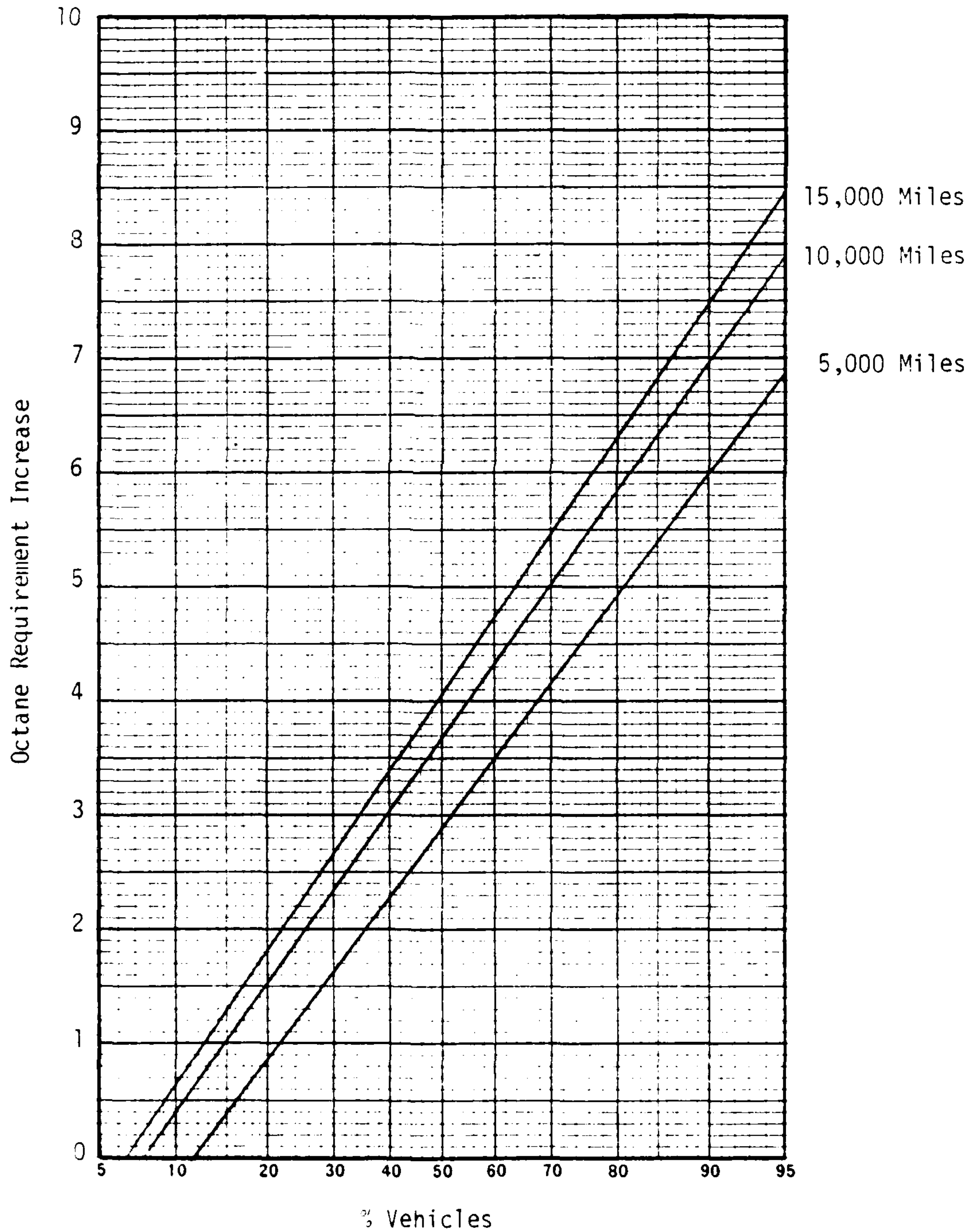


Figure 10

Mean ORI of 1975 Through 1984 Model Years

FBRU -- RON

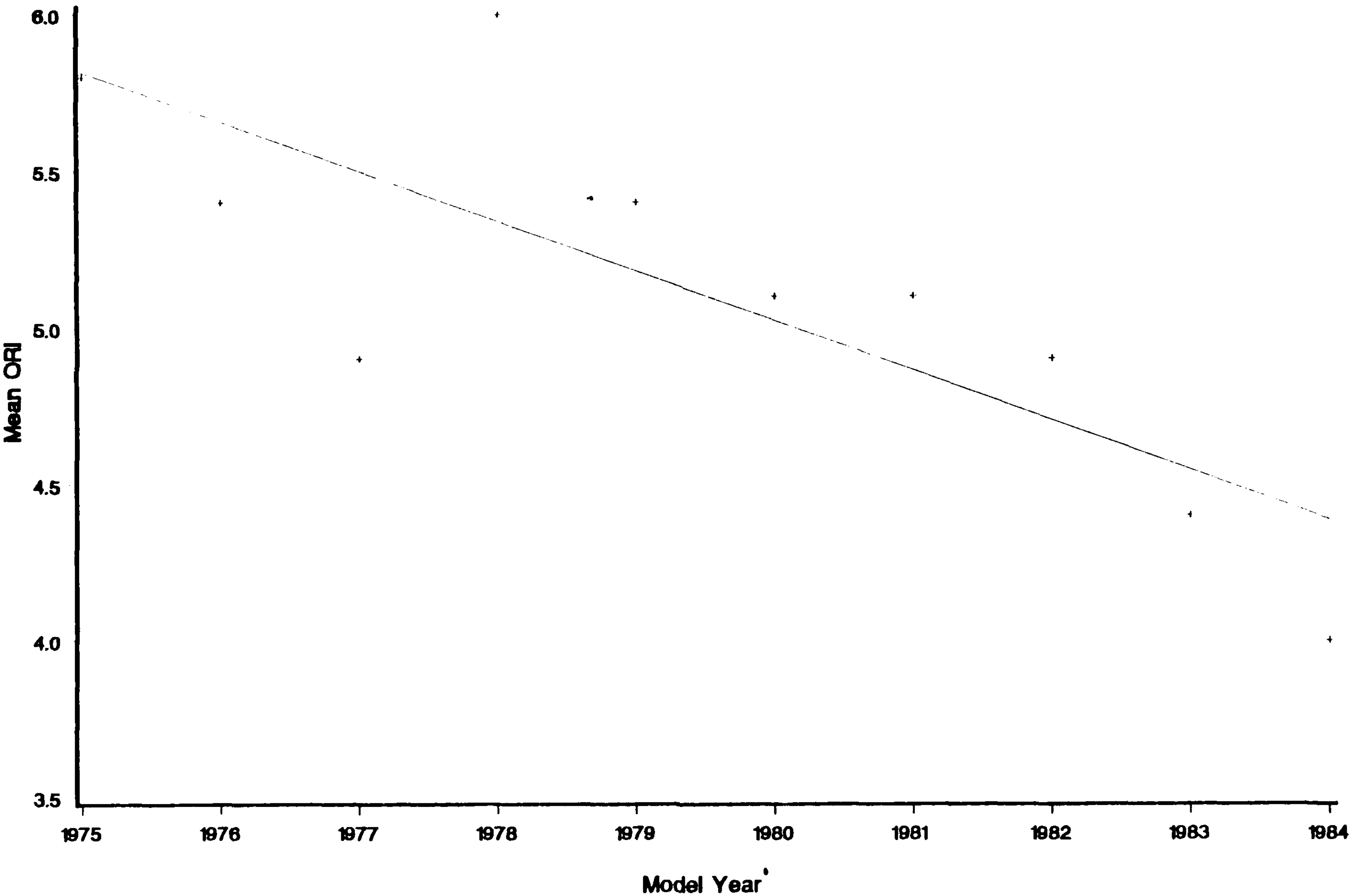


FIGURE 11

EFFECT OF INITIAL OCTANE REQUIREMENT
ON ORI AT 15,000 MILES
FUEL=FBRU

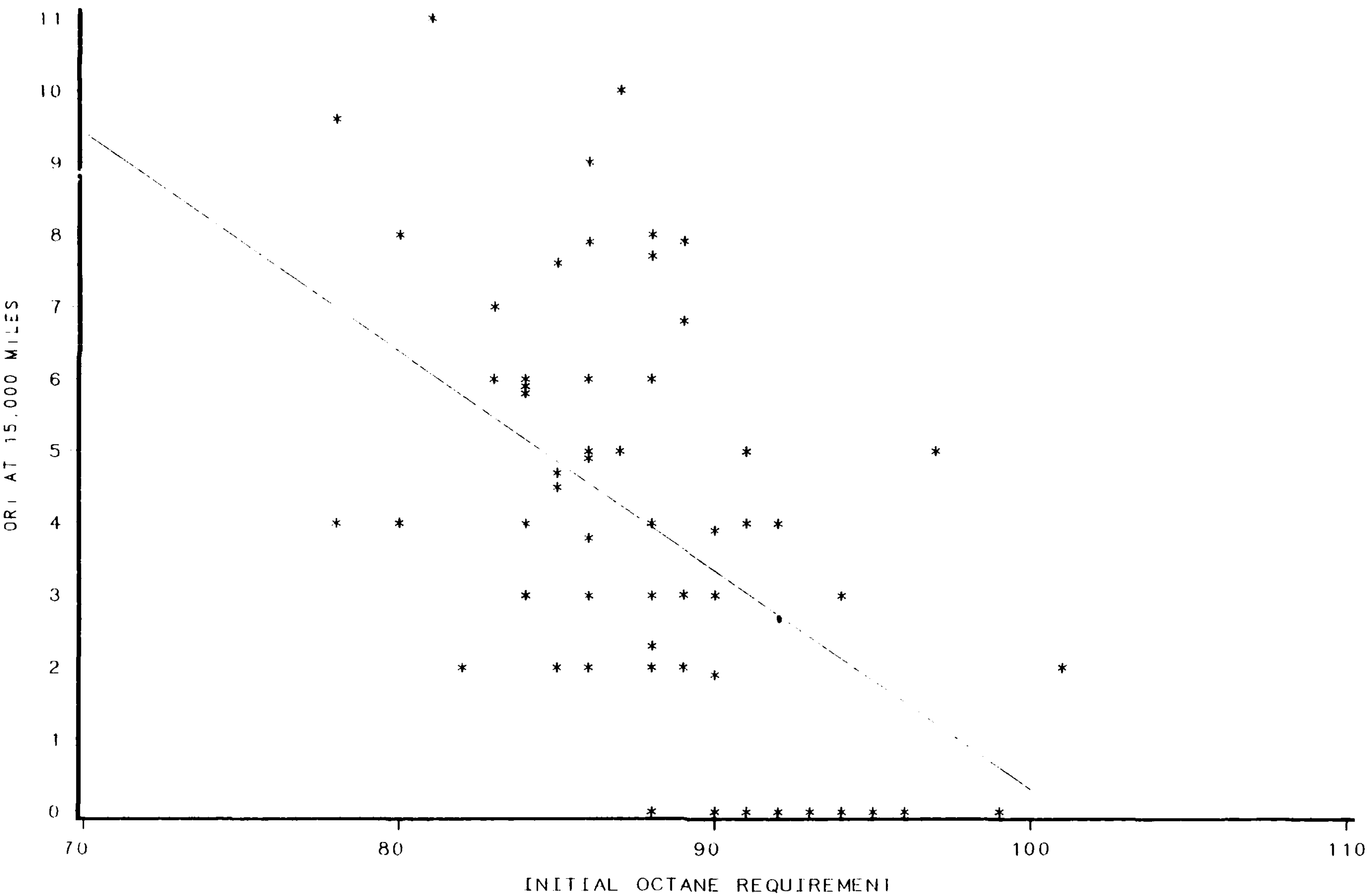


FIGURE 12

EFFECT OF INITIAL OCTANE REQUIREMENT

ON ORI AT 15,000 MILES

FUEL=FBRSU

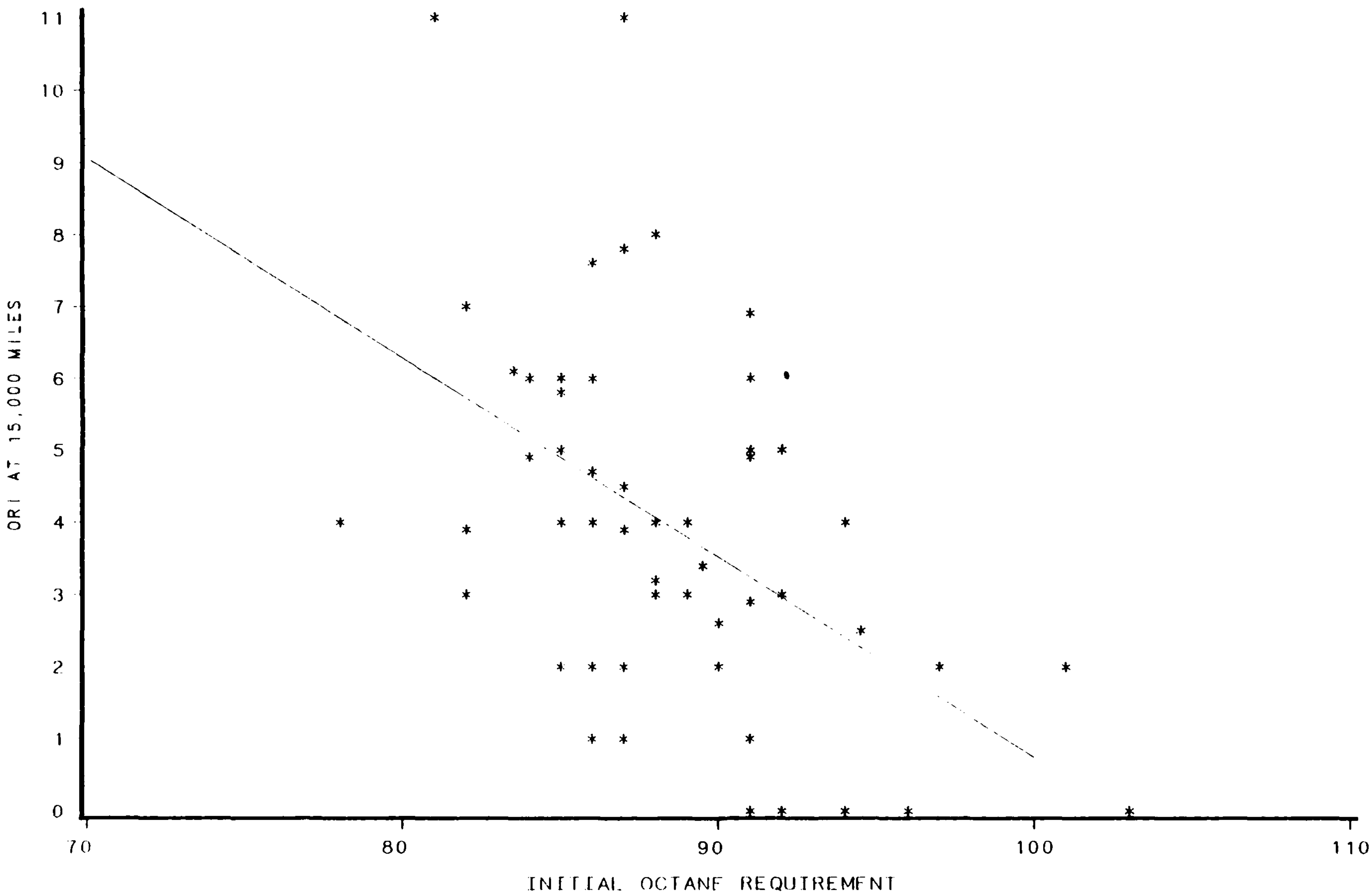
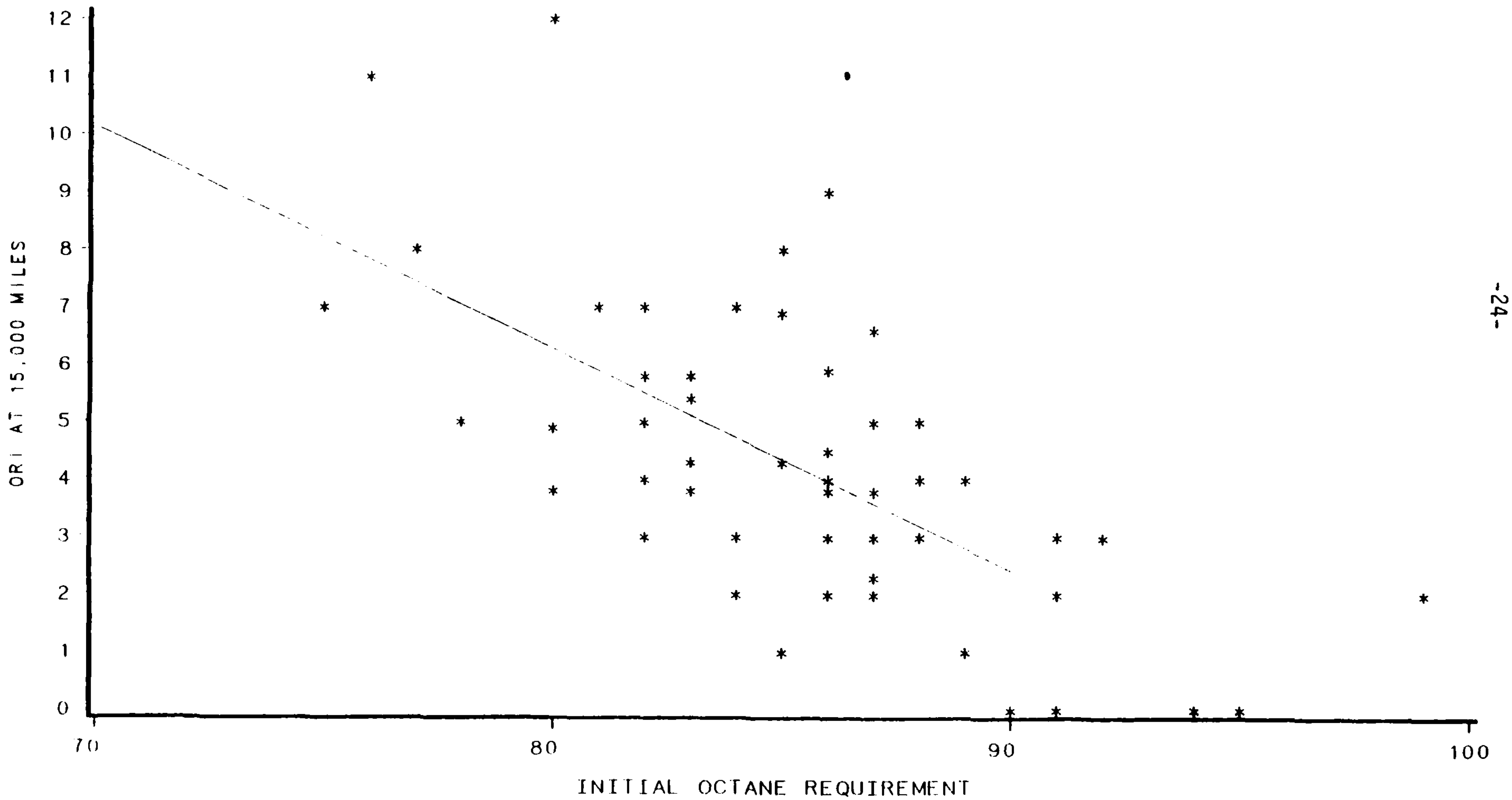


FIGURE 13

EFFECT OF INITIAL OCTANE REQUIREMENT
ON ORI AT 15,000 MILES
FUEL=PR



APPENDIX A

LABORATORIES REPORTING OCTANE REQUIREMENT DATA AT VARIOUS MILEAGES

LABORATORIES REPORTING OCTANE REQUIREMENT DATA AT VARIOUS MILEAGES

Amoco Oil Company
Naperville, Illinois

Exxon Research and Engineering Company
Linden, New Jersey

General Motors Research Laboratories
Warren, Michigan

Gulf Research and Development Company
Pittsburgh, Pennsylvania

Shell Development Company
Houston, Texas

Unocal Corporation
Brea, California

APPENDIX B

MEMBERSHIP:

1984 OCTANE REQUIREMENT INCREASE DATA ANALYSIS PANEL

1984 OCTANE REQUIREMENT INCREASE

DATA ANALYSIS PANEL

Name	Company
J. C. Callison, Leader	Amoco Oil Company
J. B. Baker	Shell Development Company
R. A. Bouffard	Exxon Research and Engineering Company

APPENDIX C

REFERENCE FUEL DATA

TABLE C-I

AVERAGE SENSITIVITY FULL-BOILING RANGE
UNLEADED REFERENCE FUEL SERIES
(FBRU)

Research Octane No.	1984 Motor Octane No.	1983 Motor Octane No.	1982 Motor Octane No.	Lab X Motor Octane No.
78.0	73.8	74.2	74.0	73.2
80.0	75.3	75.8	75.8	74.9
82.0	76.9	77.4	77.6	76.6
84.0	78.3	78.9	79.2	78.2
85.0	79.0	79.6	79.9	79.0
86.0	79.7	80.3	80.5	79.7
87.0	80.6	80.9	81.1	80.4
88.0	81.3	81.6	81.7	81.1
89.0	82.0	82.2	82.2	81.8
90.0	82.6	82.8	82.8	82.5
91.0	83.3	83.5	83.3	83.2
92.0	83.9	84.1	83.7	83.9
93.0	84.6	84.7	84.2	84.6
94.0	85.1	85.4	85.0	85.4
95.0	85.8	86.0	85.7	86.2
96.0	86.5	86.7	86.4	87.1
97.0	87.1	87.3	87.1	87.8
98.0	87.8	88.0	87.8	88.5
99.0	88.7	88.8	88.5	89.3
100.0	89.5	89.5	89.3	90.1
101.0	90.4	90.3	90.2	90.8

TABLE C-II

HIGH SENSITIVITY FULL-BOILING RANGE
UNLEADED REFERENCE FUEL SERIES
(FBRSU)

Research Octane No.	1984 Motor Octane No.	1983 Motor Octane No.	1982 Motor Octane No.
78.0	71.9	71.7	71.8
80.0	73.8	73.2	73.2
82.0	75.2	75.0	74.7
84.0	76.4	76.4	76.2
85.0	77.3	77.1	76.9
86.0	78.0	77.8	77.7
87.0	78.7	78.5	78.4
88.0	79.4	79.3	79.1
89.0	80.0	80.0	79.9
90.0	80.6	80.7	80.8
91.0	81.3	81.3	81.4
92.0	82.0	81.9	82.1
93.0	82.6	82.5	82.7
94.0	83.2	83.1	83.3
95.0	83.9	83.8	83.9
96.0	84.6	84.5	84.6
97.0	85.2	85.2	85.3
98.0	85.9	85.9	86.0
99.0	86.7	86.6	86.8
100.0	87.3	87.3	87.6
101.0	88.2	88.1	88.3
102.0	89.2	88.9	89.0

APPENDIX D

OCTANE REQUIREMENT DATA

TABLE D-I

OCTANE REQUIREMENTS FROM BEST-FIT CURVES - FBRU FUEL

CRC Vehicle Code	RON Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
ICY 450	89.0	90.5	91.5	92.0
ICY 450	88.0	88.8	89.5	90.3
T F20	83.0	88.8	90.0	90.0
T F20	86.0	88.0	88.7	89.0
T F20	90.0	90.6	91.2	91.9
PLC 222	84.0	87.0	87.0	87.0
OF3 F38	91.0	95.0	95.0	95.0
HPR F25	88.0	92.9	94.0	94.0
KED F22	93.0	93.0	93.0	93.0
E 216	81.0	92.0	92.0	92.0
J 318	86.0	91.0	91.0	91.0
HBH 450	92.0	96.0	96.0	96.0
E F20	83.0	89.0	89.0	89.0
IBY 450	91.0	93.4	95.3	96.0
KED F22	94.0	95.0	96.3	97.0
NTC 216	99.0	99.0	99.0	99.0
PKC 222	87.0	93.0	95.5	97.0
T F20	88.0	92.0	92.0	92.0
OE5 F16	90.0	90.0	90.0	90.0
OE5 F16	89.0	94.2	96.0	96.9
OE5 F16	91.0	91.0	91.0	91.0
OE5 F16	90.0	91.0	92.0	93.0
HXR F25	86.0	92.0	92.0	92.0
NXR F25	88.0	92.6	94.7	95.7
HPR F25	88.0	91.4	95.4	96.0
HJO F18	88.0	90.0	90.0	90.0
IJO F18	88.0	88.0	88.0	88.0
HJO F18	92.0	92.0	92.0	92.0
LG9 F38	97.0	101.6	102.0	102.0
NGH 450	101.0	102.9	103.0	103.0
KED F22	95.0	95.0	95.0	95.0
KMP 252	91.0	94.7	95.9	96.0
OTA 123	86.0	89.1	90.4	90.9
CSW F23	94.0	94.0	94.0	94.0
OF3 F38	85.0	89.7	91.6	92.6
HJO F18	96.0	96.0	96.0	96.0
HAR F25	86.0	94.5	95.0	95.0
T F20	86.0	91.4	93.2	93.9
NJP F20	86.0	87.4	88.4	89.0
LNR F25	88.0	89.9	91.0	91.0

TABLE D-I
(Continued)

OCTANE REQUIREMENTS FROM BEST-FIT CURVES - FBRU FUEL

CRC Vehicle Code	RON Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
NXX 228	90.0	92.6	93.6	93.9
LAE 230	85.0	87.6	88.9	89.7
LAE 230	84.0	86.5	87.5	88.0
LAE 230	84.0	86.3	88.1	89.8
LGA 238	84.0	85.8	86.5	87.0
NVH 450	86.0	87.3	88.0	88.0
ICY 450	87.0	89.3	91.3	92.0
LE2 210	89.0	92.2	94.4	95.8
UTA 123	80.0	87.4	88.0	88.0
CFW F16	85.0	86.1	86.7	87.0
CL3 F38	90.0	90.0	90.0	90.0
OVT 149	78.0	81.5	84.5	87.6
DED F22	86.0	87.7	89.0	89.8
KED F22	89.0	89.8	90.5	91.0
KST 222	85.0	86.2	86.8	87.0
RA6 F14	86.0	87.0	87.8	88.0
RCT 125	82.0	83.2	83.8	84.0
E F20	80.0	82.9	83.9	84.0
Z 220	78.0	80.9	82.0	82.0
IAE 230	84.0	88.4	89.6	89.9
IAE 230	85.0	87.9	89.0	89.5
UTA 123	84.0	88.2	89.6	90.0

TABLE D-II

OCTANE REQUIREMENTS FROM BEST-FIT CURVES - FBRSU FUEL

CRC	RON Requirements at			
Vehicle Code	0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
ICY 450	89.0	91.0	92.4	93.0
ICY 450	88.0	89.0	90.1	91.2
T F20	84.0	89.1	90.0	90.0
T F20	86.0	88.8	89.8	90.0
T F20	90.0	91.1	91.9	92.6
PLC 222	85.0	87.9	88.9	89.0
CF3 F38	91.0	97.0	97.0	97.0
HPR F25	92.0	94.4	95.0	95.0
KED F22	94.0	94.0	94.0	94.0
E 216	81.0	92.0	92.0	92.0
J 318	86.0	92.0	92.0	92.0
HBH 450	92.0	97.0	97.0	97.0
E F20	85.0	91.0	91.0	91.0
IBY 450	91.0	93.4	95.3	96.0
KED F22	97.0	97.9	98.7	99.0
NTC 216	103.0	103.0	103.0	103.0
PKC 222	87.0	93.9	96.7	98.0
T F20	89.0	92.0	92.0	92.0
GE5 F16	91.0	91.0	91.0	91.0
GE5 F16	91.0	95.5	97.0	97.9
GE5 F16	92.0	92.0	92.0	92.0
GE5 F16	91.0	91.9	92.9	93.9
LG9 F38	94.0	97.1	97.9	98.0
NGH 450	101.0	102.2	103.0	103.0
KED F22	96.0	96.0	96.0	96.0
KMP 252	92.0	95.7	96.9	97.0
OTA 123	87.0	89.4	90.4	90.9
OSW F23	94.0	94.0	94.0	94.0
CF3 F38	86.0	90.8	92.7	93.6
HJO F18	96.0	96.0	96.0	96.0
HAR F25	88.0	95.5	96.0	96.0
T F20	87.0	92.2	94.0	94.8
MJP F20	88.0	89.7	90.8	91.0
LNR F25	88.0	91.0	92.0	92.0
NXX 228	94.5	96.2	96.7	97.0
LAE 230	86.0	88.8	90.1	90.7
LAE 230	84.0	87.2	88.7	88.9
LAE 230	85.0	87.7	89.7	91.0
LGA 238	85.0	86.1	86.7	87.0
NVH 450	87.0	88.1	88.8	89.0

TABLE D-II
(Continued)

OCTANE REQUIREMENTS FROM BEST-FIT CURVES - FBRSU FUEL

CRC Vehicle Code	RON Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
ICY 450	89.5	91.0	92.3	92.9
CE2 216	91.0	94.2	95.5	95.9
CTA 123	82.0	88.8	89.0	89.0
OFW F16	86.0	86.7	87.0	87.0
OL3 F38	91.0	91.4	91.7	92.0
OVT 149	83.5	85.4	87.5	89.6
DED F22	87.0	88.8	90.2	91.5
NED F22	90.0	90.9	91.6	92.0
KST 222	86.0	87.4	87.9	88.0
RAB F14	87.0	88.0	88.0	88.0
RCT 125	82.0	83.6	84.5	85.0
E F20	82.0	84.2	85.3	85.9
Z 220	78.0	80.9	82.0	82.0
IAE 230	85.0	89.2	90.5	90.8
IAE 230	86.0	89.1	89.9	90.0
CTA 123	85.0	89.4	90.0	90.0

TABLE D-III

OCTANE REQUIREMENTS FROM BEST-FIT CURVES - PR FUEL

CRC Vehicle Code	RON Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
ICY 450	89.0	89.8	90.0	90.0
ICY 450	87.0	88.0	88.8	89.3
T F20	83.0	87.8	88.4	88.4
T F20	86.0	88.0	88.7	89.0
T F20	90.0	90.0	90.0	90.0
PLC 222	83.0	86.0	87.2	87.3
OF3 F38	88.0	93.0	93.0	93.0
HPR F25	86.0	89.2	90.0	90.0
KED F22	91.0	91.0	91.0	91.0
E 216	80.0	92.0	92.0	92.0
J 318	87.0	92.0	92.0	92.0
HBH 450	92.0	95.0	95.0	95.0
E F20	82.0	89.0	89.0	89.0
IBY 450	89.0	91.0	92.6	93.0
KED F22	91.0	92.0	92.8	93.0
NTC 216	88.0	91.9	92.0	92.0
PKC 222	87.0	89.0	89.0	89.0
T F20	88.0	91.0	91.0	91.0
OE5 F16	86.0	86.8	87.6	88.0
OE5 F16	86.0	92.6	94.3	95.0
OE5 F16	86.0	88.4	89.7	90.5
OE5 F16	87.0	88.3	89.6	90.8
LG9 F38	99.0	100.7	101.0	101.0
NGH 450	95.0	95.0	95.0	95.0
KED F22	94.0	94.0	94.0	94.0
KMP 252	91.0	93.2	93.9	94.0
OTA 123	86.0	88.3	89.3	89.8
OSW F23	94.0	94.0	94.0	94.0
OF3 F38	84.0	88.9	90.6	91.0
HJC F18	95.0	95.0	95.0	95.0
HAR F25	85.0	92.7	93.0	93.0
T F20	85.0	89.7	91.4	91.9
NJP F20	86.0	87.4	88.4	89.0
LNR F25	87.0	89.5	91.8	93.6
NXX 228	87.0	89.2	89.9	90.0
LAE 230	83.0	85.2	86.2	86.8
LAE 230	82.0	84.7	85.7	86.0
LAE 230	83.0	85.3	87.3	88.8
LGA 238	80.0	83.0	84.3	84.9
NVH 450	84.0	86.0	86.0	86.0

TABLE D-III
(Continued)

OCTANE REQUIREMENTS FROM BEST-FIT CURVES - PR FUEL

CRC Vehicle Code	RON Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
ICY 450	86.0	87.6	88.0	88.0
OE2 216	86.0	88.5	90.6	91.9
OTA 123	76.0	86.4	87.0	87.0
OFW F16	85.0	85.7	86.0	86.0
OL3 F38	86.0	88.2	89.1	89.8
CVT 149	77.0	79.8	82.4	85.0
DED F22	85.0	86.8	88.3	89.3
KED F22	89.0	89.2	89.8	90.0
KST 222	82.0	83.9	84.7	85.0
RA6 F14	84.0	85.4	86.5	87.0
RCT 125	80.0	82.2	83.3	83.8
E F20	78.0	81.4	82.6	83.0
Z 220	75.0	80.0	81.7	82.0
IAE 230	82.0	86.9	87.0	87.0
IAE 230	82.0	85.1	86.8	87.8
OTA 123	81.0	86.2	87.7	88.0

END

1-87

DTIC