AD-A148 048 OCTANE REQUIREMENT INCREASE OF 1982 MODEL CARS(U) 1/1
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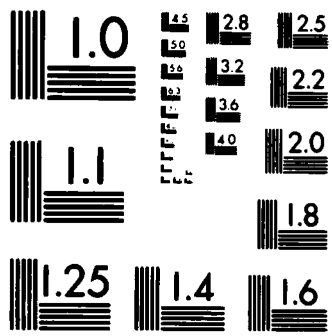
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CRC Report No. 540

OCTANE REQUIREMENT INCREASE OF 1982 MODEL CARS

AD-A148 048

September 1984

COORDINATING RESEARCH COUNCIL, INC.
219 PERIMETER CENTER PARKWAY, ATLANTA, GEORGIA 30346

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OCTANE REQUIREMENT INCREASE OF 1982 MODEL CARS
(CRC PROJECT NO. CM-124-82)

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Prepared by the

1982 Octane Requirement Increase Analysis Panel

of the

CRC Light-Duty Octane Technology and Test Procedures Group

September 1984

Light-Duty 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 one hundred fifteen 1982 model cars operated on unleaded gasoline. All ORI values were determined from the increase in maximum octane requirements irrespective of whether requirements were obtained at full- or part-throttle.

- At 15,000 miles, the mean ORI for all cars with full-boiling range unleaded (FBRU) fuels was 4.9 Research octane numbers, 3.0 Motor octane numbers, and 3.9 (R+M)/2 numbers.

- At 15,000 miles, the mean ORI with full-boiling range unleaded (FBRU) fuels for the eighty-six car subset tested on all three reference fuels was 4.7 Research octane numbers, 2.8 Motor octane numbers, and 3.8 (R+M)/2 numbers.

- At 15,000 miles, the mean ORI for eighty-six cars with full-boiling range high sensitivity unleaded (FBRSU) fuels was 5.1 Research octane numbers, 3.4 Motor octane numbers, and 4.3 (R+M)/2 numbers.

Motor Octane numbers

- At 15,000 miles, the mean ORI for ninety-six cars with primary reference fuels (PRF) was 4.0 octane numbers. The mean ORI for the eighty-six car subset tested on FBRU and FBRSU fuels was 4.1 octane numbers.

Full-boiling range unleaded Research Octane numbers

- Compared with 1981 models (86 cars), the mean ORI for all cars in the 1982 program with FBRU fuels was 0.2 lower on a RON basis, and 0.3 MON lower.

- In general, the mean ORI with FBRU fuel exhibits a slight downward trend for the 1975 through 1982 model cars.

- ORI decreases about 0.3 to 0.4 octane number per octane number increase of initial octane requirements; this relationship is 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 car 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 1981 model cars have been reported previously.[1-9] This report will summarize ORI data for 1982 model cars.

III. EXPERIMENTAL

A. Cars Tested

In the 1982 program, one hundred two US and thirteen imported cars were used to determine the ORI of 1982 model cars. Cars 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. Data on cars that did not complete 15,000 miles of testing were excluded from the analysis. Participating laboratories are listed in Appendix A.

B. Mileage Accumulation

Mileage accumulation was conducted from the fall of 1981 through the summer of 1983. All test cars 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. Unleaded Average Sensitivity Full-Boiling Range Reference Fuel (FBRU)

In general, octane number requirements of 1982 model cars were defined initially with 1981 FBRU fuel. As mileage increased, the reference fuel was replaced with the 1982 FBRU fuel. Some laboratories, however, used 1980 or 1981 reference fuels for requirements. Laboratory X used a third FBRU reference fuel series for all octane requirements it submitted. The RON-to-MON conversions used in the data analysis for 1982 cars are shown in Appendix C, Table C-I.

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

Octane requirements of eighty-six cars were defined initially with 1981 FBRSU fuel and later with 1982 FBRSU fuel as well as with FBRU and Primary Reference (PR) fuels. Some laboratories used either 1980 or 1981 FBRSU fuels. 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 were 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-15-82 technique.[10] Maximum octane number requirements were determined on one hundred fifteen cars with FBRU fuel, on eighty-six cars with FBRSU fuel, and on ninety-six with PR fuel.

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 cars 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-curve requirements.

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 interval. In general, requirements were determined initially on 1981 fuels and later on 1982 fuels; however, some laboratories measured requirements with either 1980 or 1981 fuels. 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 car 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 Tables I and III are the average FBRU and PR ORI values of the eighty-six cars 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, distribution 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 1.3 and 0.0 to 0.9 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.[11]

Members of the Analysis Panel are listed in Appendix B.

B. Comparison of 1975 through 1982 ORI Studies

The mean ORI values for 1975 through 1982 model cars are:

Model Year	Accumulated Miles	Mean ORI FBRU, RON	Mean ORI PRF
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
1975-1982 Unweighted Average:		5.3	3.9

ORI with FBRU fuel exhibits a slight downward trend from 1975 through 1982. 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 10, 11, and 12 for FBRU, FBRSU, and PR fuels, respectively. The correlation between initial requirements and ORI was determined by linear least squares regression analysis. The general form of the equation was:

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

The best-fit lines are also shown in Figures 10, 11, and 12.

Equations for the three reference fuel series are:

Reference Fuel Series	a: Estimate	a: T Value of Estimate	b: Estimate	b: T Value of Estimate	R^2
FBRU	33.0	5.1	-0.32	4.3	0.14
FBRSU	33.8	4.3	-0.32	3.6	0.14
PR	35.7	6.2	-0.37	5.5	0.24

In general, ORI decreases about 0.3 to 0.4 units per unit increase of initial requirements. Although the correlation coefficients (R^2) are small, the analysis indicates that the estimates of the slope (ORI/Initial Requirement) are statistically significant. This phenomenon was observed and reported in the recent CRC ORI studies.[8,9]

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REFERENCES

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TABLES

AND

FIGURES

TABLE I

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

		RON								MON								(R+M)/2							
	No. of Cars	Initial Requirements		5,000-Mile ORI		10,000-Mile ORI		15,000-Mile ORI		Initial Requirements		5,000-Mile ORI		10,000-Mile ORI		15,000-Mile ORI		Initial Requirements		5,000-Mile ORI		10,000-Mile ORI		15,000-Mile ORI	
Group	Tested	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 Cars	115 (86)	87.2 (87.2)	3.1 (3.1)	3.4 (3.2)	1.9 (1.9)	4.5 (4.3)	2.5 (2.5)	4.9 (4.7)	2.7 (2.7)	80.9 (81.0)	2.0 (1.8)	2.1 (1.9)	1.2 (1.1)	2.7 (2.5)	1.6 (1.5)	3.0 (2.8)	1.7 (1.7)	84.0 (84.1)	2.5 (2.5)	2.8 (2.5)	1.6 (1.5)	3.6 (3.4)	2.0 (2.0)	3.9 (3.8)	2.2 (2.2)
All Make A	24 (22)	88.2 (87.9)	3.3 (3.0)	2.8 (2.7)	1.6 (1.4)	3.6 (3.5)	2.0 (1.9)	3.9 (3.9)	2.3 (2.3)	81.7 (81.5)	1.9 (1.7)	1.6 (1.5)	0.9 (0.8)	2.1 (2.0)	1.1 (1.1)	2.3 (2.3)	1.2 (1.3)	84.9 (84.7)	2.6 (2.3)	2.2 (2.1)	1.2 (1.1)	2.8 (2.8)	1.5 (1.5)	3.1 (3.1)	1.7 (1.8)
All Make B	18 (17)	85.9 (85.8)	2.5 (2.5)	2.9 (2.7)	1.7 (1.4)	4.0 (3.8)	2.0 (1.9)	4.6 (4.5)	2.2 (2.2)	80.3 (80.2)	1.5 (1.5)	1.8 (1.6)	1.0 (0.8)	2.4 (2.3)	1.2 (1.1)	2.8 (2.7)	1.3 (1.3)	83.1 (83.0)	2.0 (2.0)	2.4 (2.2)	1.3 (1.1)	3.2 (3.1)	1.6 (1.5)	3.7 (3.6)	1.8 (1.8)
All Make C	59 (34)	87.2 (87.5)	3.0 (3.0)	3.7 (3.3)	1.8 (1.8)	4.9 (4.7)	2.5 (2.7)	5.3 (5.2)	2.7 (2 9)	80.9 (81.2)	2.0 (1.8)	2.3 (1.9)	1.2 (1.0)	3.1 (2.7)	1.6 (1.6)	3.3 (3.1)	1.7 (1.8)	84.0 (84.4)	2.5 (2.4)	3.0 (2.6)	1.5 (1.4)	4.0 (3.7)	2.0 (2.2)	4.3 (4.1)	2.2 (2.3)
All Others	14 (13)	86.7 (86.9)	3.6 (3.7)	4.1 (4.3)	2.6 (2.7)	4.8 (5.1)	3.2 (3.2)	5.2 (5.4)	3.4 (3.4)	80.7 (80.8)	2.4 (2.5)	2.5 (2.6)	1.8 (1.9)	2.9 (3.0)	2.2 (2.2)	3.1 (3.2)	2.3 (2.3)	83.7 (83.8)	3.0 (3.1)	3.3 (3.5)	2.2 (2.3)	3.9 (4.0)	2.7 (2.7)	4.1 (4.3)	2.8 (2.9)
Engine A16	11	90.7	3.1	2.0	1.7	2.3	2.0	2.4	2.0	83.1	1.7	1.1	0.9	1.4	1.1	1.5	1.2	86.9	2.4	1.5	1.3	1.9	1.5	1.9	1.6
Engine A23	8	85.9	1.3	3.4	1.3	4.4	1.4	4.7	1.7	80.3	0.8	2.0	0.7	2.5	0.8	2.7	0.9	83.1	1.0	2.7	1.0	3.4	1.1	3.7	1.3
Engine B22	11	84.8	2.5	2.8	1.7	4.0	2.4	4.4	2.7	79.6	1.5	1.6	1.0	2.4	1.4	2.7	1.6	82.2	2.0	2.2	1.3	3.2	1.9	3.5	2.1
Engine C18	14	85.6	1.4	3.4	2.0	4.7	2.8	5.1	3.0	79.9	1.2	2.2	1.3	3.0	1.8	3.2	1.9	82.8	1.3	2.8	1.7	3.8	2.3	4.1	2.4
Engine C25	13	89.0	2.5	4.1	2.0	5.4	2.5	6.0	2.7	82.0	1.6	2.4	1.3	3.3	1.6	3.9	1.8	85.5	2.0	3.2	1.6	4.4	2.1	4.9	2.3
Engine C28	9	87.6	3.1	3.3	1.6	4.7	2.7	5.0	2.6	81.2	1.9	1.9	0.9	2.8	1.6	3.0	1.6	84.4	2.5	2.6	1.3	3.7	2.2	4.0	2.1
Engine C38	6	87.7	3.7	3.9	1.9	4.6	2.8	4.7	3.0	81.2	2.3	2.4	1.0	2.9	1.6	3.0	1.8	84.4	3.0	3.1	1.4	3.8	2.2	3.9	2.4
Engine C41	5	83.8	1.3	4.5	1.4	6.0	1.5	6.5	1.8	78.4	1.2	3.1	1.1	4.0	0.8	4.3	0.8	81.1	1.2	3.8	1.2	5.0	1.1	5.4	1.3

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

TABLE II

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

Group	No. of Cars 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 Cars	86	88.2	3.2	3.5	2.0	4.6	2.5	5.1	2.8	79.5	2.2	2.4	1.4	3.1	1.7	3.4	1.9	83.9	2.7	2.9	1.7	3.9	2.1	4.3	2.4
All Make A	22	89.0	3.1	3.0	1.5	4.0	2.0	4.4	2.4	80.0	2.2	2.0	1.0	2.7	1.4	2.9	1.6	84.5	2.7	2.5	1.3	3.3	1.7	3.6	2.0
All Make B	17	87.2	2.2	2.9	1.3	4.2	1.7	4.8	2.0	78.8	1.6	2.0	0.9	2.8	1.1	3.1	1.3	83.0	1.9	2.5	1.1	3.5	1.4	4.0	1.6
All Make C	34	88.7	3.2	3.6	2.0	5.1	2.8	5.6	3.1	79.8	2.2	2.5	1.4	3.4	1.9	3.8	2.1	84.2	2.7	3.0	1.7	4.3	2.3	4.7	2.6
All Others	13	87.4	4.2	4.5	2.8	5.3	3.4	5.5	3.6	78.9	2.9	3.1	2.0	3.6	2.4	3.7	2.5	83.2	3.5	3.8	2.4	4.4	2.9	4.6	3.1
Engine A16	10	91.3	2.5	2.4	1.6	2.9	1.8	3.1	1.9	81.6	1.7	1.6	1.0	2.0	1.2	2.0	1.2	86.5	2.1	2.0	1.3	2.4	1.5	2.5	1.5
Engine A23	7	86.9	2.2	3.1	1.3	4.3	1.9	4.8	2.5	78.6	1.6	2.2	0.9	2.9	1.4	3.3	1.7	82.7	1.9	2.6	1.1	3.6	1.6	4.1	2.1
Engine B22	11	86.5	2.3	2.9	1.4	4.1	2.1	4.6	2.5	78.3	1.6	2.0	0.9	2.8	1.4	3.1	1.6	82.4	1.9	2.4	1.2	3.4	1.7	3.8	2.0
Engine C18	8	87.5	1.1	2.9	2.1	4.3	3.2	4.8	3.5	79.1	0.8	2.0	1.5	2.9	2.2	3.3	2.4	83.3	0.9	2.5	1.8	3.6	2.7	4.0	3.0
Engine C25	8	91.3	3.0	3.2	2.1	4.5	2.5	5.0	2.9	81.6	2.0	2.2	1.4	3.0	1.7	3.4	2.0	86.4	2.5	2.7	1.8	3.8	2.1	4.2	2.4
Engine C28	9	88.7	3.2	3.8	2.0	5.1	2.9	5.6	2.8	79.8	2.2	2.5	1.3	3.4	1.9	3.6	1.9	84.3	2.7	3.2	1.7	4.2	2.4	4.6	2.4

TABLE III

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

Group	No. of Cars Tested	Initial Requirements		5,000-Mile ORI		10,000-Mile ORI		15,000-Mile ORI	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
All Cars	96 (86)	86.3 (86.2)	3.3 (3.3)	2.8 (2.8)	1.9 (1.9)	3.6 (3.7)	2.3 (2.4)	4.0 (4.1)	2.5 (2.5)
All Make A	24 (22)	88.0 (87.7)	3.4 (3.1)	2.3 (2.2)	1.3 (1.3)	3.1 (3.0)	1.7 (1.7)	3.4 (3.4)	2.0 (2.0)
All Make B	18 (17)	84.4 (84.4)	2.2 (2.3)	2.8 (2.8)	1.7 (1.8)	3.8 (3.8)	2.1 (2.2)	4.2 (4.2)	2.2 (2.2)
All Make C	40 (34)	86.1 (86.0)	3.1 (3.3)	2.7 (2.7)	1.7 (1.7)	3.6 (3.7)	2.2 (2.3)	3.8 (4.0)	2.4 (2.4)
All Others	14 (13)	86.4 (86.6)	3.7 (3.8)	4.0 (4.1)	2.9 (2.9)	4.7 (4.9)	3.4 (3.5)	5.0 (5.2)	3.6 (3.6)
Engine A16	11	90.6	3.0	1.5	1.2	1.9	1.5	2.0	1.6
Engine A23	8	85.5	1.4	3.0	1.2	3.9	1.3	4.3	1.4
Engine B22	11	83.5	2.0	2.9	2.1	3.9	2.6	4.2	2.7
Engine C18	9	84.3	3.3	2.5	1.5	3.4	2.1	3.7	2.3
Engine C25	10	87.3	2.0	2.3	2.4	2.8	3.0	3.1	3.2
Engine C28	9	86.4	3.6	2.9	1.2	4.0	1.4	4.4	1.5

( ) Numbers in parentheses represent PR Fuel data on cars that were also tested on FBRU and FBRSU Fuels.

FIGURE 1

BEST-FIT-CURVE ORI ANALYSIS

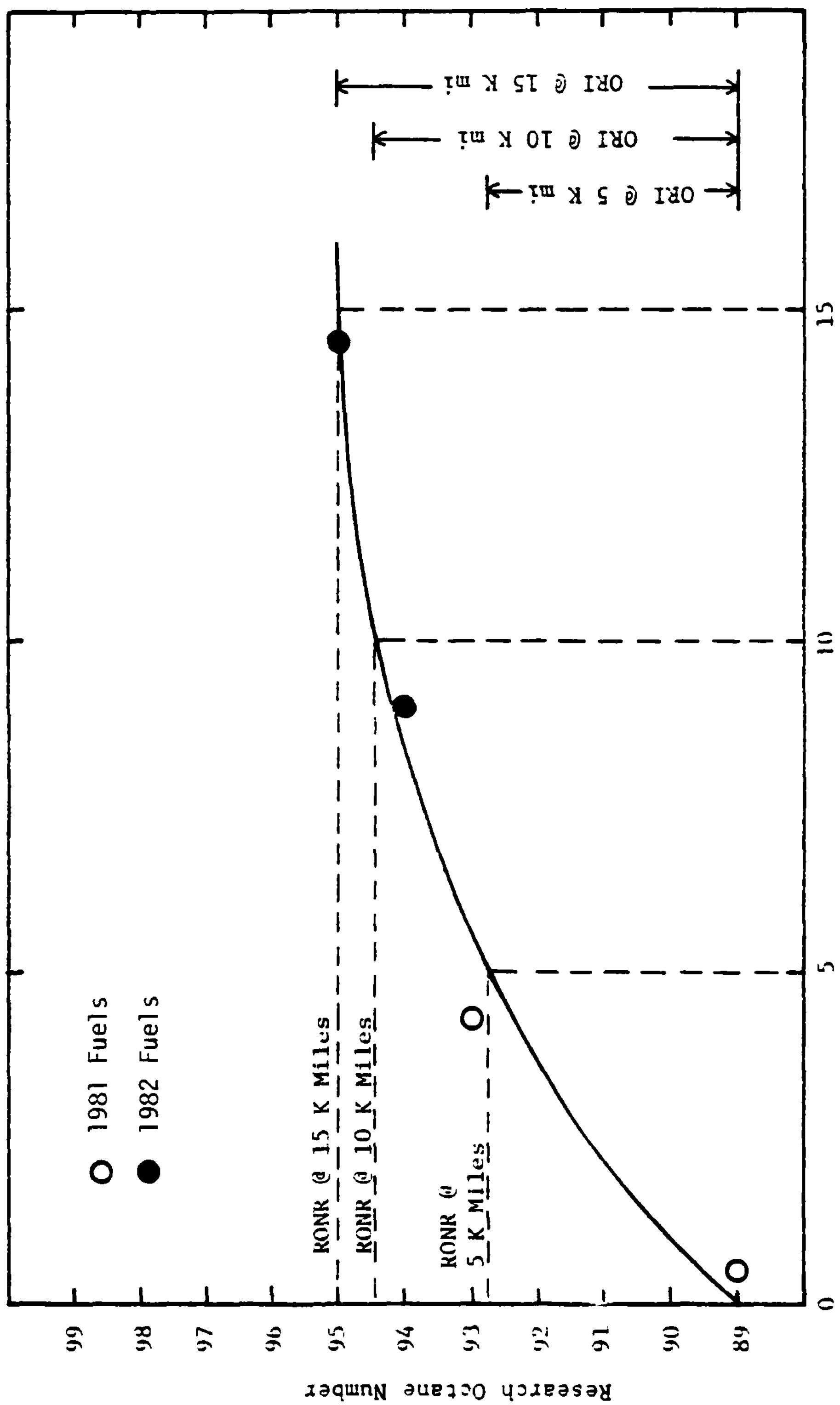


FIGURE 2

DISTRIBUTION OF INITIAL RON REQUIREMENTS

FOR 1982 MODEL CARS

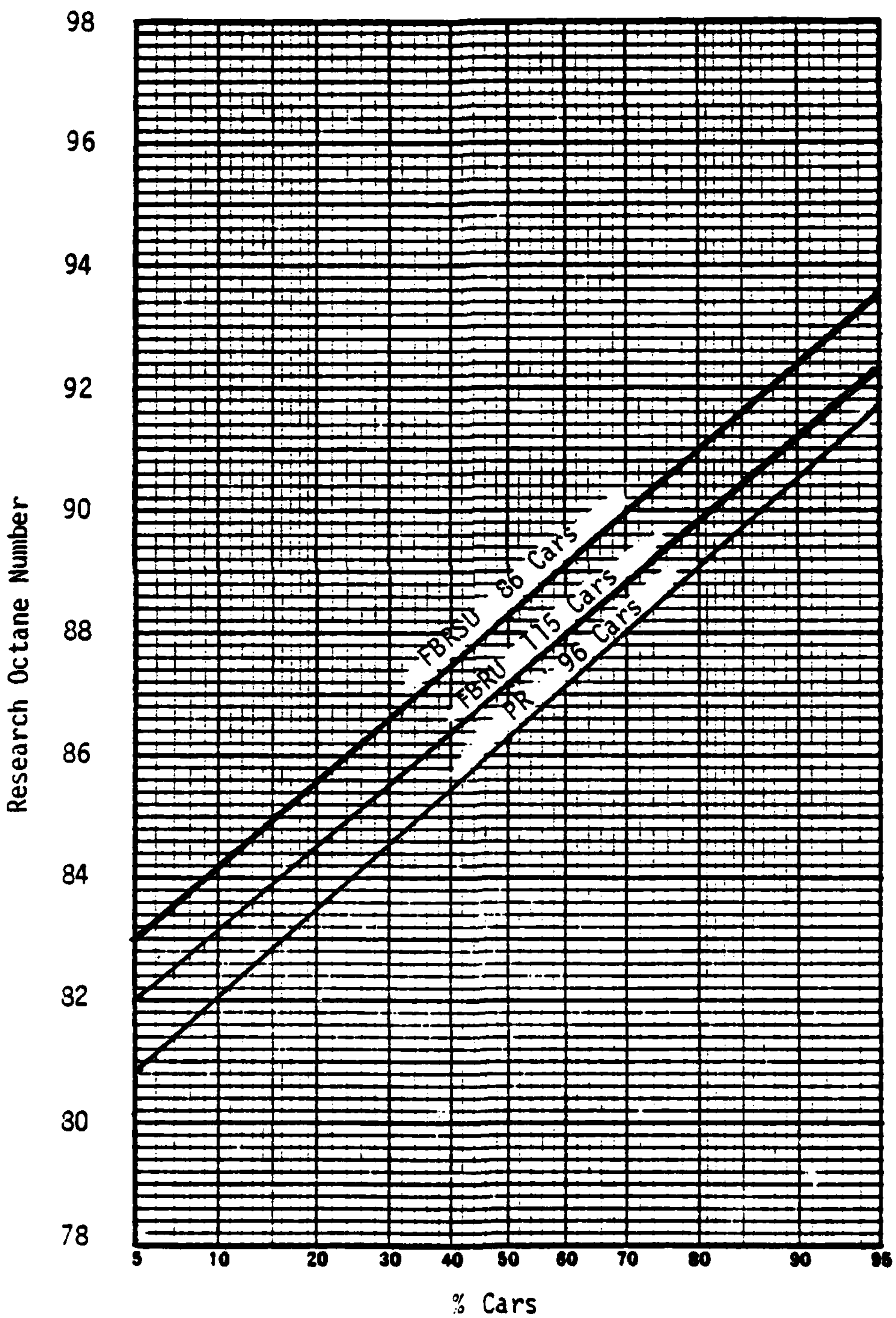


FIGURE 3

DISTRIBUTION OF RON ORI FOR
115 1982 MODEL CARS AT
VARIOUS MILEAGES ON FBRU FUEL

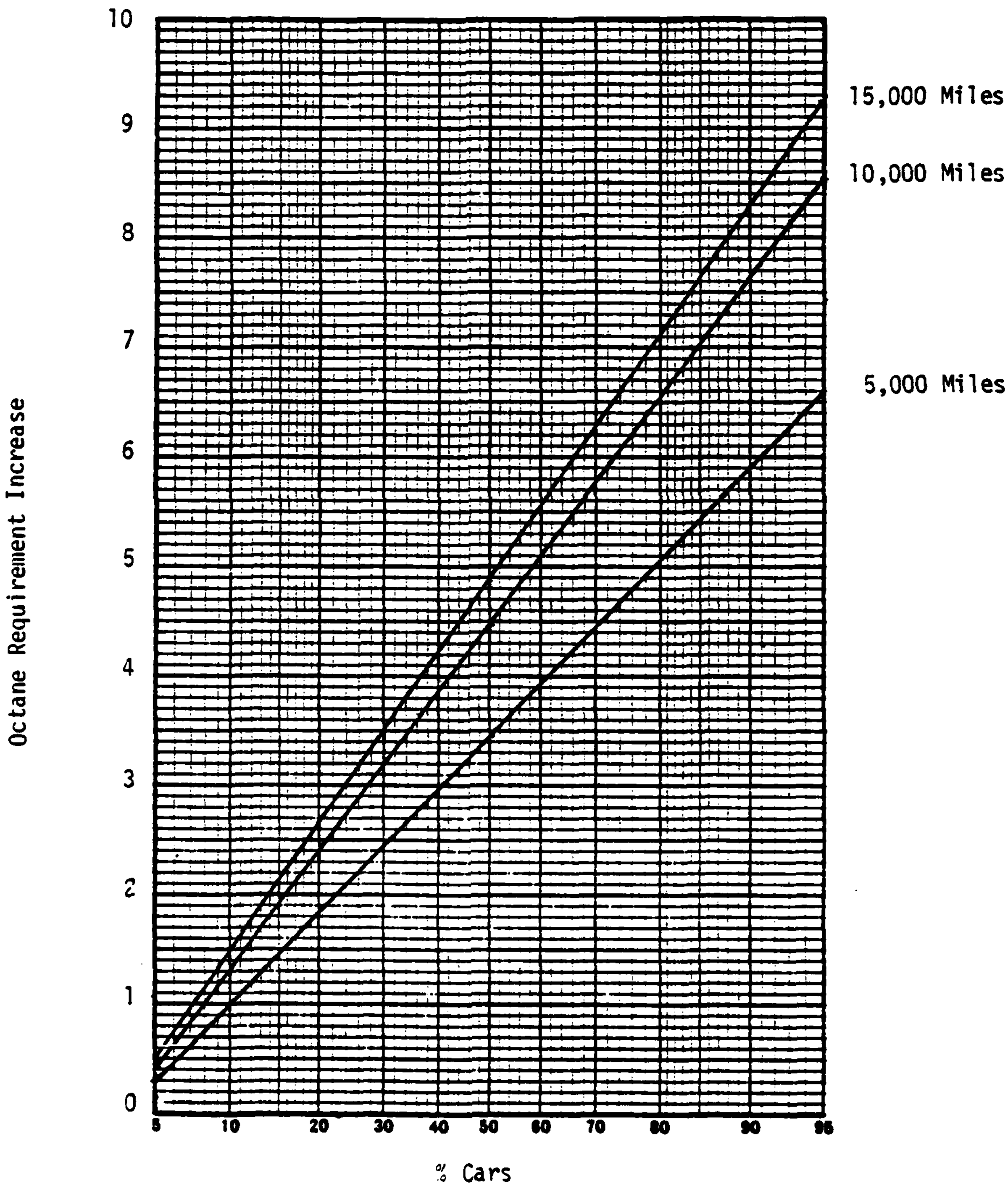


FIGURE 4

DISTRIBUTION OF MON ORI FOR
115 1982 MODEL CARS AT
VARIOUS MILEAGES ON FBRU FUEL

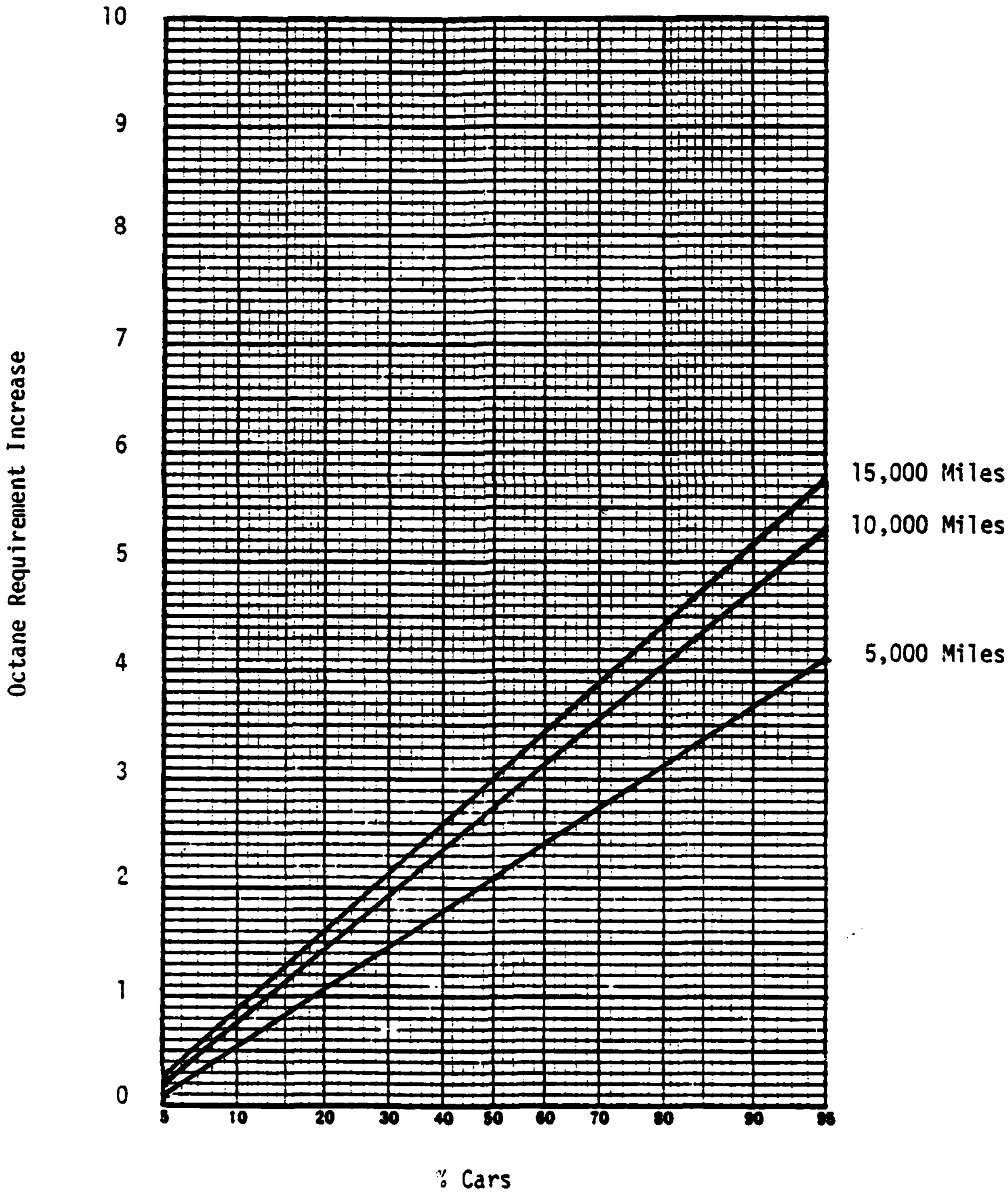


FIGURE 5

DISTRIBUTION OF (R+M)/2 ORI FOR
115 1982 MODEL CARS AT
VARIOUS MILEAGES ON FBRU FUEL

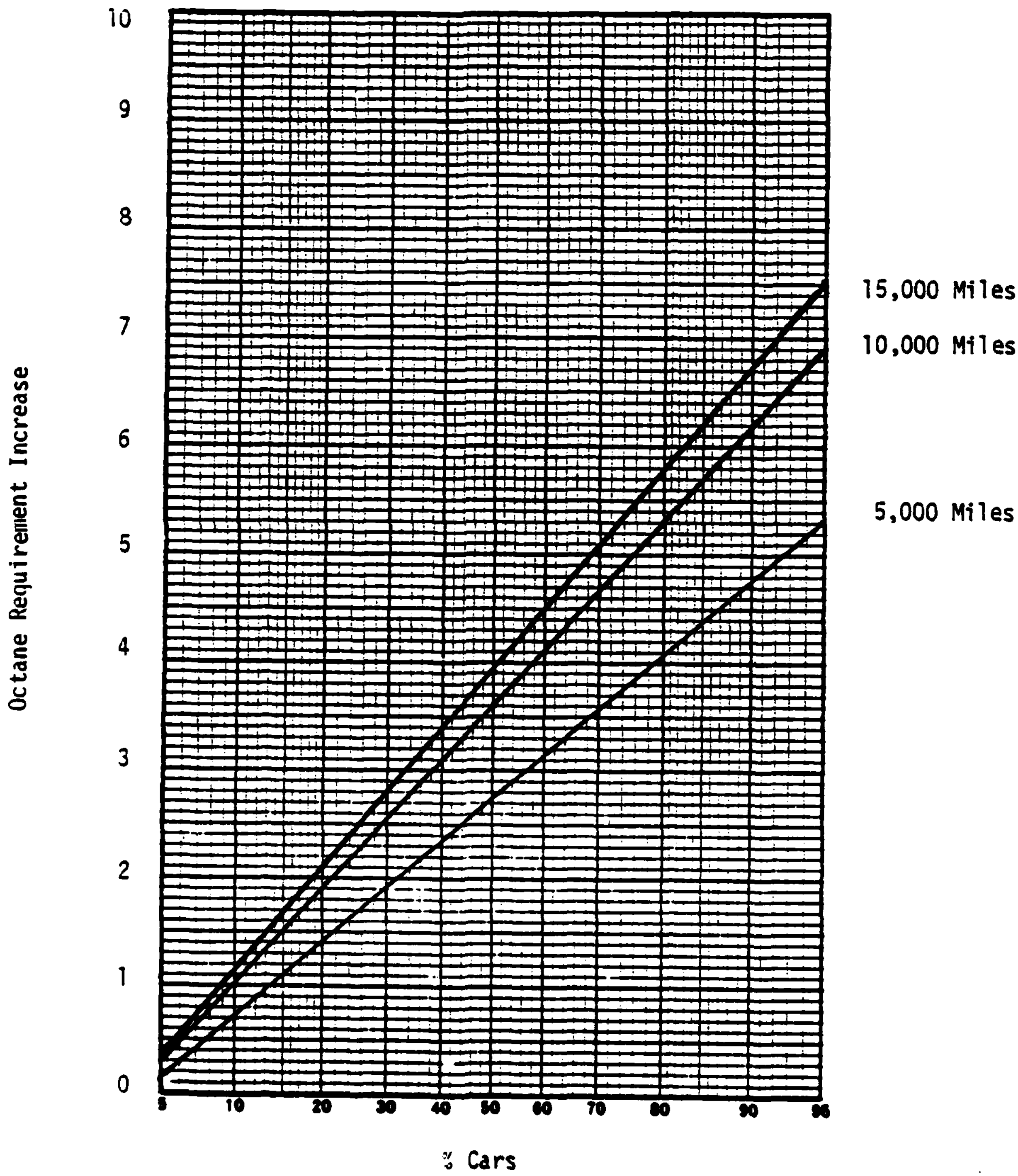


FIGURE 6

DISTRIBUTION OF RON ORI FOR
86 1982 MODEL CARS AT
VARIOUS MILEAGES ON FBRSU FUEL

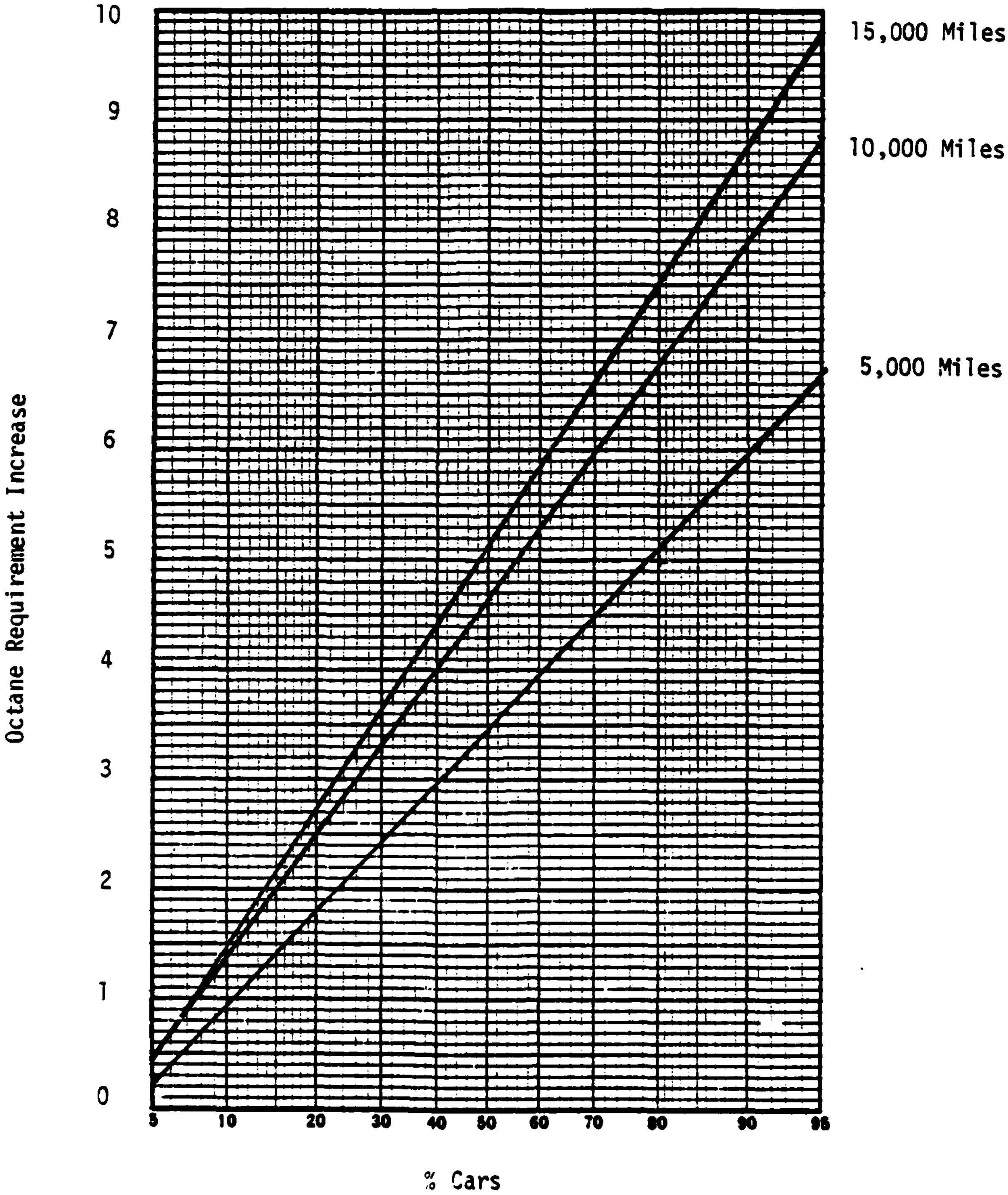


FIGURE 7

DISTRIBUTION OF MON ORI FOR
86 1982 MODEL CARS AT
VARIOUS MILEAGES ON FBRSU FUEL

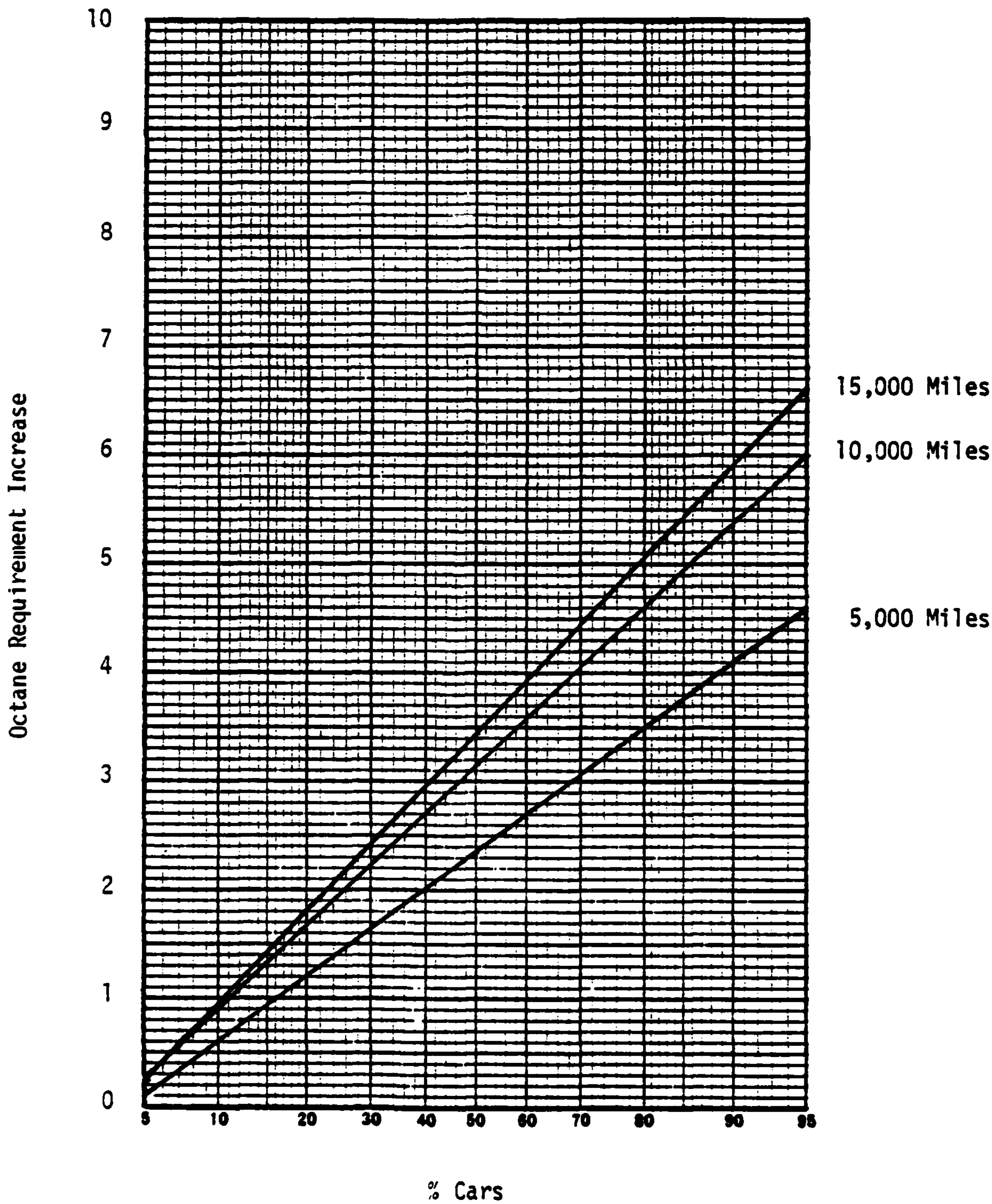


FIGURE 8

DISTRIBUTION OF (R+M)/2 ORI FOR
86 1982 MODEL CARS AT
VARIOUS MILEAGES ON FBRSU FUEL

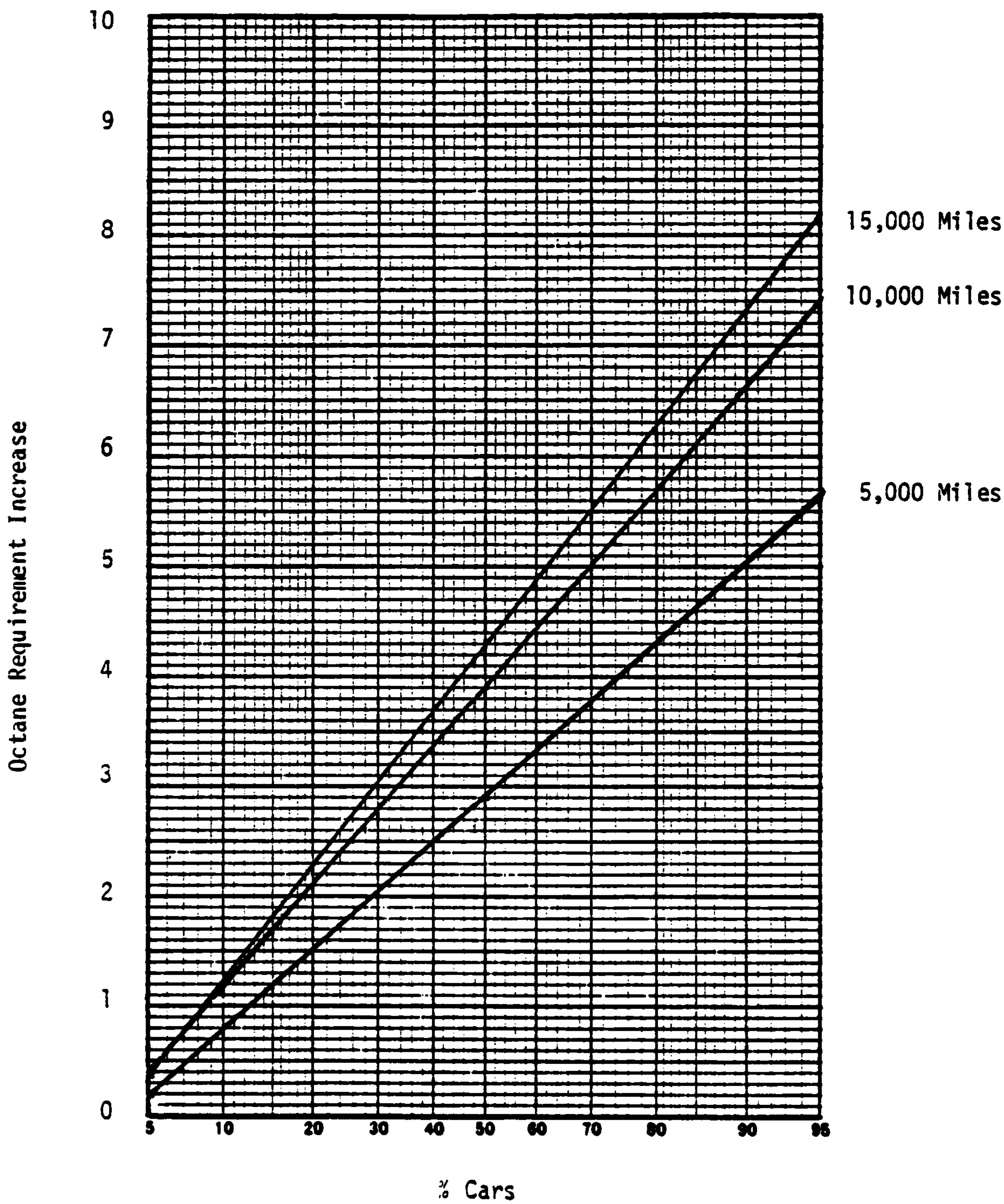


FIGURE 9

DISTRIBUTION OF ORI FOR
96 1982 MODEL CARS AT
VARIOUS MILEAGES ON PR FUEL

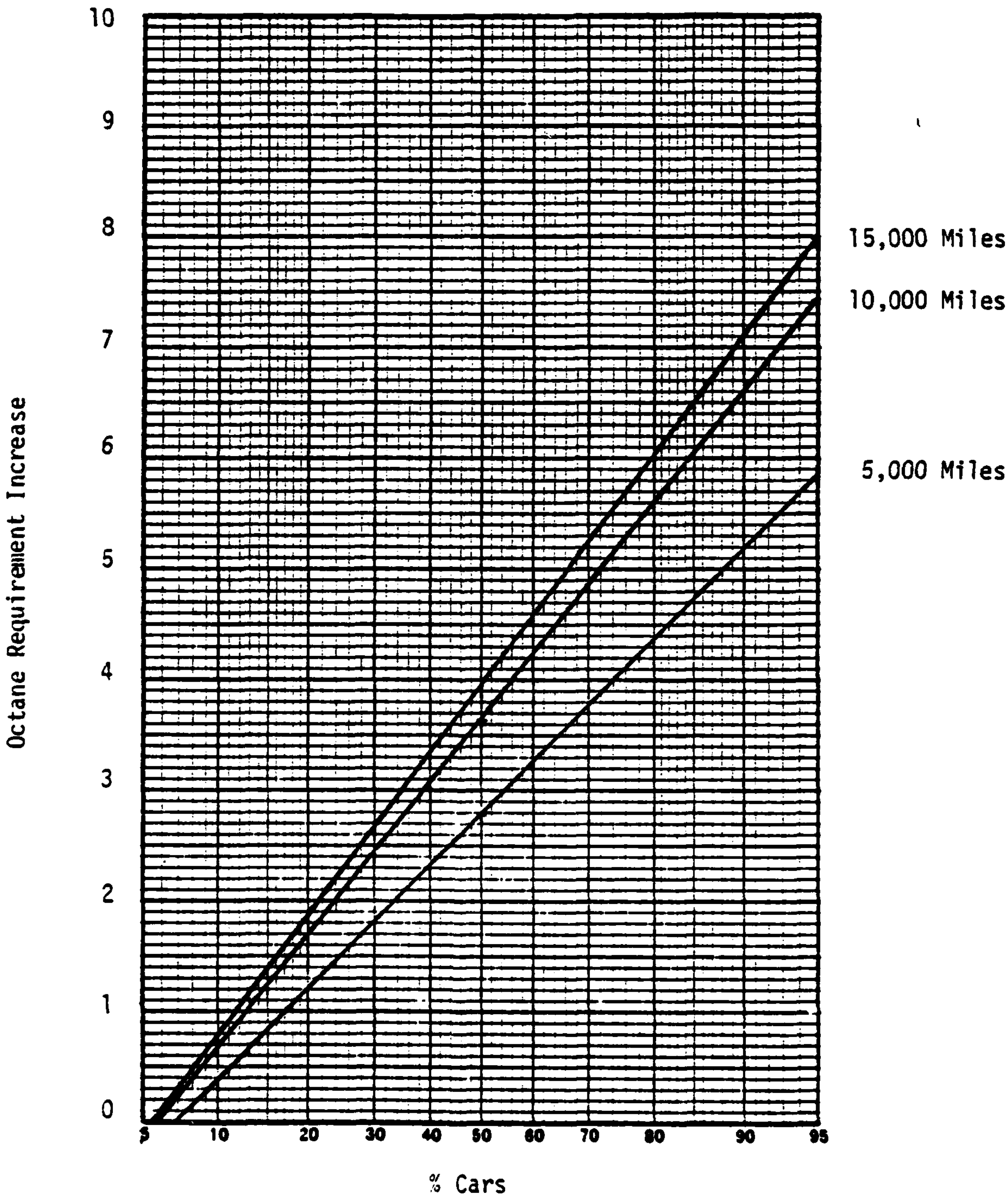


FIGURE 10

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

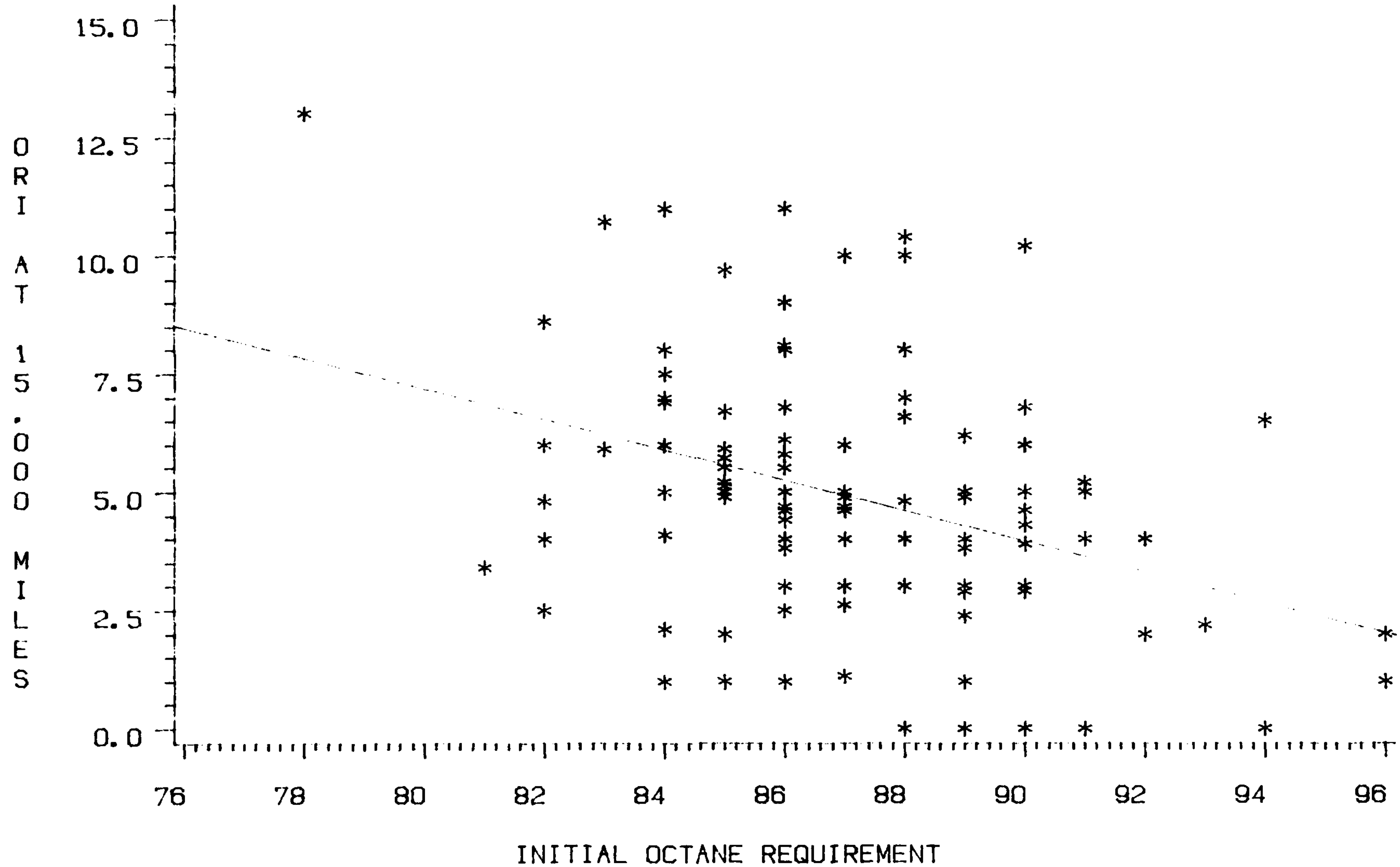


FIGURE 11

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

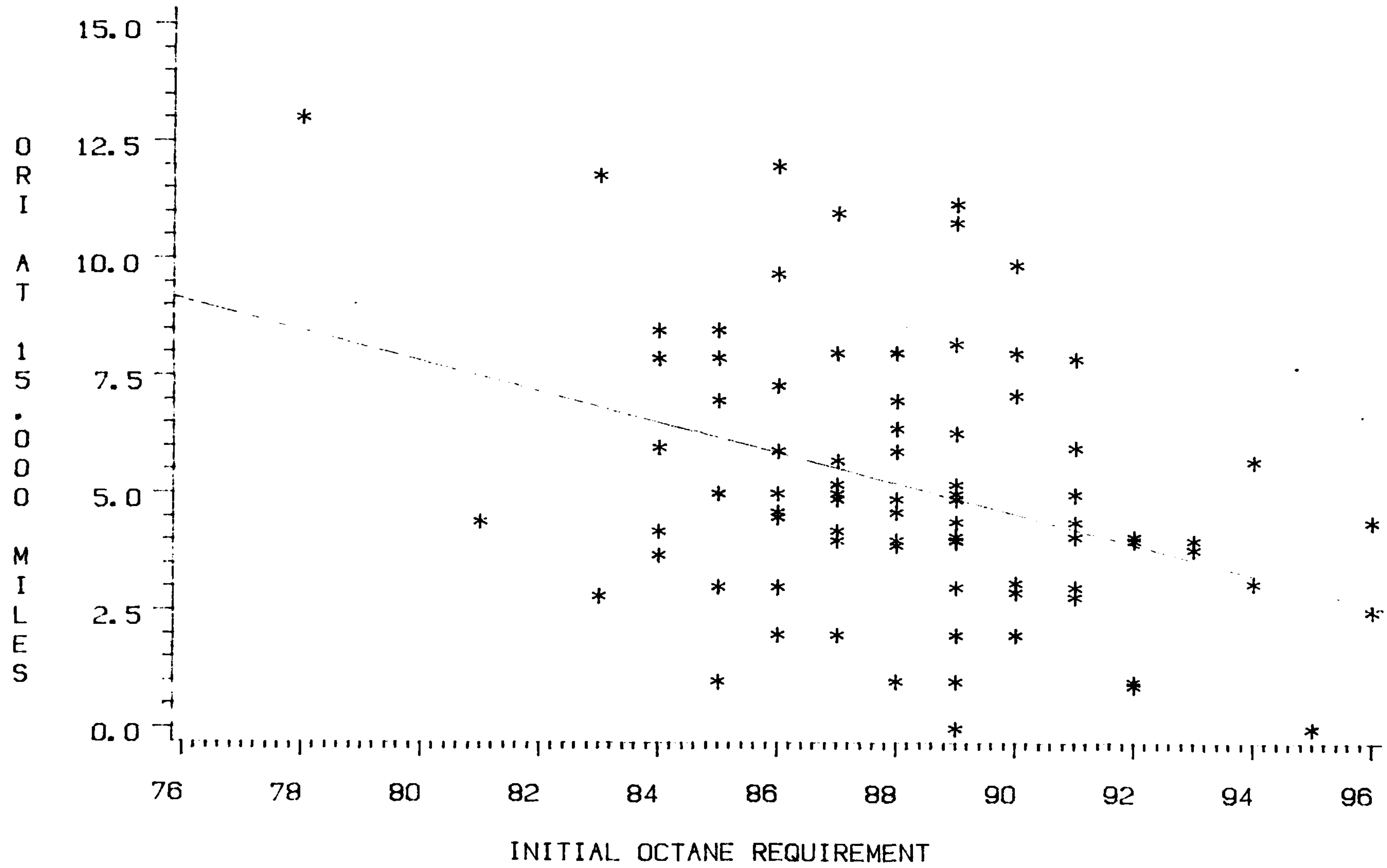
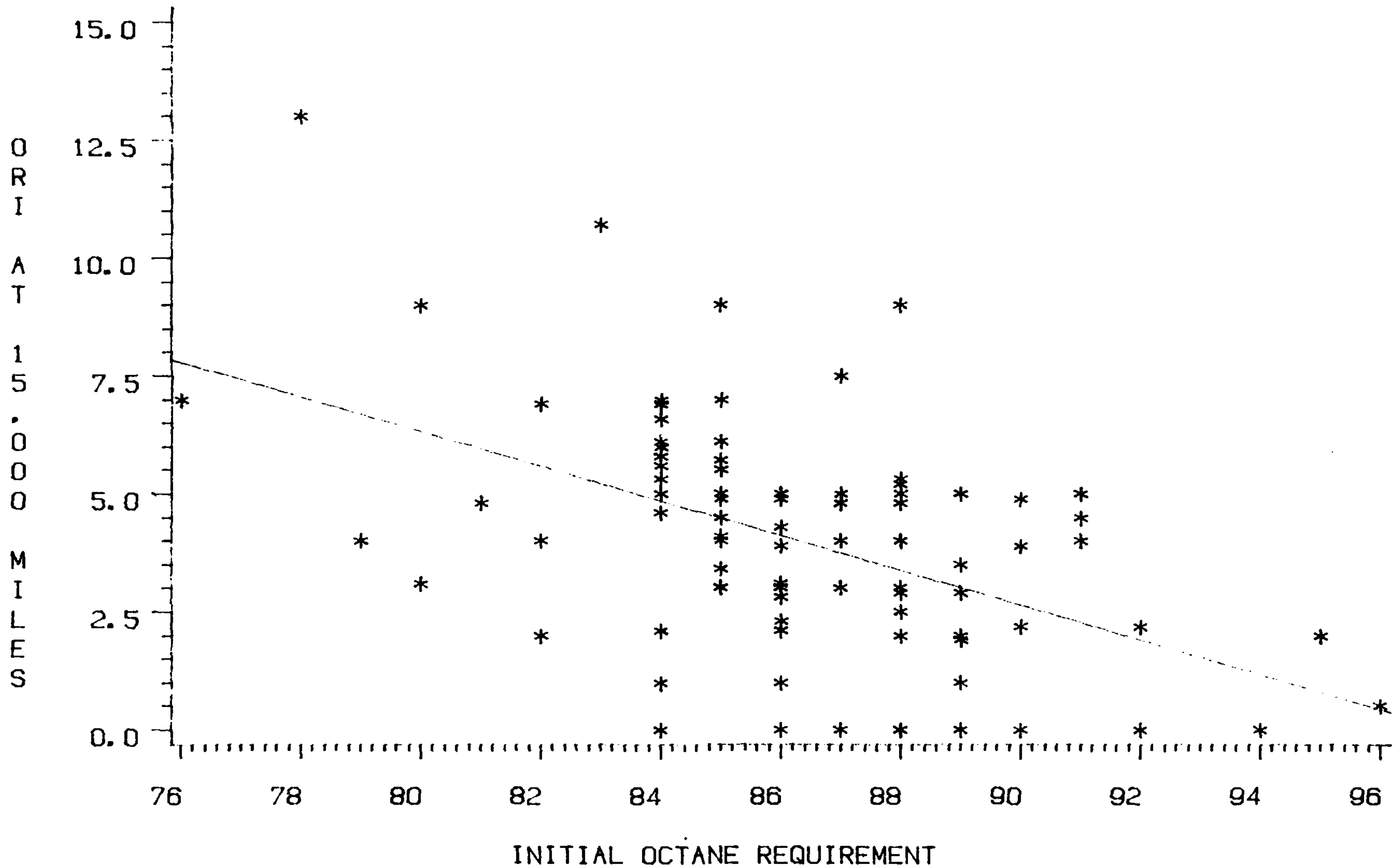


FIGURE 12

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

Phillips Petroleum Company
Bartlesville, Oklahoma

Shell Development Company
Houston, Texas

Shell Canada
Oakville, Ontario

Standard Oil Company (Ohio)
Cleveland, Ohio

Union Oil Company of California
Brea, California

APPENDIX B

MEMBERSHIP:

1982 OCTANE REQUIREMENT INCREASE
DATA ANALYSIS PANEL

1982 OCTANE REQUIREMENT INCREASE

DATA ANALYSIS PANEL

Name	Company
J. C. Callison, Leader	Amoco Oil Company
J. B. Baker	Shell Development Company
D. P. Barnard	Standard Oil Company (Ohio)

APPENDIX C

REFERENCE FUEL DATA

TABLE C-I

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

Research Octane No.	1982 Motor Octane No.	1981 Motor Octane No.	1980 Motor Octane No.	Lab X Motor Octane No.
78.0	74.0	74.3	74.5	73.2
80.0	75.8	76.1	75.9	74.9
82.0	77.6	77.8	77.5	76.6
84.0	79.2	79.2	78.9	78.2
85.0	79.9	79.8	79.7	79.0
86.0	80.5	80.4	80.4	79.7
87.0	81.1	81.0	81.0	80.4
88.0	81.7	81.6	81.7	81.1
89.0	82.2	82.1	82.3	81.8
90.0	82.8	82.7	83.0	82.5
91.0	83.3	83.2	83.6	83.2
92.0	83.7	83.7	84.2	83.9
93.0	84.2	84.3	84.8	84.6
94.0	85.0	84.9	85.5	85.4
95.0	85.7	85.5	86.1	86.2
96.0	86.4	86.0	86.7	87.1
97.0	87.1	86.7	87.3	87.8
98.0	87.8	87.4	88.1	88.5
99.0	88.5	88.1	88.8	89.3
100.0	89.3	88.8	89.6	90.1
101.0	90.2	89.6	90.3	90.8

TABLE C-II

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

Research Octane No.	1982 Motor Octane No.	1981 Motor Octane No.	1980 Motor Octane No.
78.0	71.8	72.2	72.5
80.0	73.2	73.6	74.1
82.0	74.7	75.1	75.6
84.0	76.2	76.5	77.0
85.0	76.9	77.3	77.7
86.0	77.7	78.0	78.4
87.0	78.4	78.7	79.0
88.0	79.1	79.4	79.6
89.0	79.9	80.1	80.1
90.0	80.8	80.8	80.6
91.0	81.4	81.4	81.2
92.0	82.1	82.1	81.8
93.0	82.7	82.8	82.4
94.0	83.3	83.4	83.0
95.0	83.9	84.1	83.5
96.0	84.6	84.8	84.1
97.0	85.3	85.5	84.7
98.0	86.0	86.2	85.4
99.0	86.8	86.9	86.3
100.0	87.6	87.6	87.3
101.0	88.3	88.3	87.9

A P P E N D I X   D

OCTANE REQUIREMENT DATA

TABLE D-I

OCTANE REQUIREMENTS FROM BEST-FIT-CURVES - FBRU FUEL

CRC Car Code	RON-Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
NJG 218	87.0	89.9	90.9	91.0
NJG 218	89.0	89.0	89.0	89.0
HJG 218	86.0	88.5	89.9	90.6
NJG 218	84.0	90.3	93.9	95.0
LXR F25	90.0	94.3	96.1	96.8
LXR F25	90.0	97.5	99.6	100.2
LXR F25	92.0	96.0	96.0	96.0
NXR F25	86.0	93.3	95.0	95.0
LXX F25	87.0	89.3	90.0	90.0
LXX 228	91.0	94.4	95.0	95.0
LAE 230	84.0	87.7	88.9	89.0
GC8 F41	83.0	86.3	88.5	88.9
GK8 F41	85.0	90.6	93.4	94.7
OA2 216	88.0	92.0	92.0	92.0
OA2 216	91.0	91.0	91.0	91.0
ODA 223	85.0	89.4	90.7	90.9
ODA 223	84.0	87.0	89.8	91.5
ODA 223	86.0	89.5	90.6	91.0
ODA 223	88.0	90.2	91.0	91.0
ODA 223	86.0	89.2	89.9	90.0
OD3 238	84.0	87.1	89.5	90.9
KKB 222	86.0	91.6	93.6	94.0
KKB 222	85.0	86.6	87.0	87.0
PKD 222	85.0	86.0	86.0	86.0
RB5 242	94.0	94.0	94.0	94.0
E 215	89.0	94.0	94.0	94.0
J 315	88.0	90.4	91.0	91.0
J 315	83.0	90.5	92.9	93.7
T 218	86.0	89.2	90.0	90.0
T 218	85.0	90.0	90.0	90.0
T 218	88.0	90.8	91.2	92.8
HTC 216	90.0	90.0	90.0	90.0
PKC 222	89.0	91.9	94.0	95.2
CDB 133	88.0	92.9	94.2	94.6
LB4 450	90.0	93.8	94.7	95.0
LGA 238	88.0	95.5	97.9	98.4
J 315	88.0	96.0	96.0	96.0
E 215	89.0	92.0	92.0	92.0
LXX 228	85.0	89.0	90.0	90.2
OA2 216	90.0	94.8	95.9	96.0
HJG 218	84.0	86.8	87.8	88.1
HJG 218	85.0	88.5	89.8	90.5
HJG 218	84.0	89.9	91.0	91.0

TABLE D-I
(Continued)

OCTANE REQUIREMENTS FROM BEST-FIT-CURVES - FBRU FUEL

CRC Car Code	RON-Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
HJG 218	84.0	90.5	91.8	92.0
NJG 218	86.0	88.1	89.2	89.8
HXR F25	86.0	90.9	92.0	92.1
IXR F25	86.0	92.2	93.7	94.1
LXR F25	90.0	93.1	93.9	93.9
LAE 230	84.0	88.7	90.0	90.0
LAE 230	85.0	90.0	90.0	90.0
LAE 230	84.0	90.0	90.0	90.0
HGA 238	90.0	93.0	93.0	93.0
HGA 238	88.0	92.0	92.0	92.0
HGA 238	92.0	94.0	94.0	94.0
GC8 F41	85.0	87.8	89.3	90.1
GC8 F41	84.0	88.9	89.9	90.0
GC8 F41	82.0	88.0	88.0	88.0
HFI F50	94.0	94.0	94.0	94.0
NFH F50	92.0	95.3	96.0	96.0
OA2 216	89.0	89.7	90.0	90.0
OA2 216	93.0	94.7	95.2	95.2
OA2 216	87.0	87.8	88.1	88.1
OA2 216	88.0	88.0	88.0	88.0
NJG 218	86.0	88.4	89.0	89.0
NJG 218	86.0	86.8	87.0	87.0
NAR F25	89.0	90.3	91.3	91.9
NAR F25	89.0	90.6	91.2	91.4
PKD 222	84.0	85.6	86.1	86.1
PKD 222	82.0	84.9	85.9	86.0
PKD 222	82.0	84.1	85.6	86.8
PKD 222	84.0	84.6	85.0	85.0
NGA 238	81.0	83.8	84.6	84.9
PME 252	87.0	89.0	90.5	91.7
PME 252	87.0	89.2	89.9	90.0
PME 252	89.0	91.3	92.9	93.9
MXX 228	90.0	92.0	92.7	92.9
NAX 228	86.0	92.7	96.9	97.0
NBJ 244	90.0	92.9	93.0	93.0
E 215	89.0	91.8	92.6	93.0
OA2 216	96.0	97.6	98.0	98.0
LGA 238	87.0	90.9	92.0	92.0
NTC 216	86.0	91.0	91.0	91.0
OCA 223	87.0	93.0	93.0	93.0
OD3 238	88.0	91.0	91.8	92.0
Z 215	85.0	87.0	87.0	87.0
IAR F25	87.0	91.5	95.2	97.0

TABLE D-I
(Continued)

OCTANE REQUIREMENTS FROM BEST-FIT-CURVES - FBRU FUEL

CRC Car Code	RON-Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
HJG 218	86.0	91.7	95.0	95.0
PLA 217	88.0	95.0	95.0	95.0
PKB 222	89.0	92.7	93.8	94.0
T 215	86.0	89.3	90.5	91.0
NXR F25	94.0	96.1	98.1	100.5
OA2 216	90.0	93.0	93.9	94.3
PKB 222	85.0	87.7	89.7	90.7
NXR F25	91.0	94.6	95.4	96.2
OA2 216	90.0	93.8	94.6	94.6
PKB 222	82.0	87.6	90.1	90.6
NXX 228	86.0	89.2	90.6	91.5
OBA 223	85.0	87.7	88.4	88.9
PLA 217	86.0	88.7	90.2	92.8
NXX 228	87.0	89.2	89.5	89.6
OBA 223	86.0	88.3	88.5	88.5
PLA 217	89.0	92.4	92.6	92.8
NJG 218	86.0	89.3	90.7	91.8
OD3 238	87.0	90.3	91.1	91.6
NJG 218	86.0	89.4	89.9	90.4
OD3 238	85.0	88.4	90.0	91.7
NXX 228	90.0	94.4	95.7	96.0
OA2 216	96.0	97.0	97.0	97.0
NXX 228	82.0	83.1	83.9	84.5
NTS 228	91.0	93.8	95.7	96.0
IBY 450	90.0	93.1	95.8	97.0
IBY 450	88.0	92.3	97.0	98.0
Z 215	78.0	87.7	90.3	91.0
T 220	86.0	89.3	90.3	90.7
PME 252	87.0	89.9	90.2	91.9

TABLE D-II

OCTANE REQUIREMENTS FROM BEST-FIT-CURVES - FBRSU FUEL

CRC Car Code	RON-Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
NJG 218	89.0	91.9	92.9	93.0
NJG 218	89.0	89.0	89.0	89.0
HJG 218	87.0	89.3	90.9	91.9
NJG 218	86.0	93.2	97.1	98.0
LXR F25	90.0	95.1	98.1	99.9
LXR F25	92.0	96.0	96.0	96.0
NXR F25	87.0	93.9	95.0	95.0
LXX F25	88.0	90.3	91.9	91.9
LXX 228	93.0	96.2	97.0	97.0
LAE 230	85.0	88.6	89.9	90.0
GC8 F41	84.0	87.3	89.6	90.0
GK8 F41	86.0	91.6	94.3	95.7
OA2 216	89.0	93.0	93.0	93.0
OA2 216	92.0	92.4	92.9	93.0
ODA 223	85.0	90.1	91.5	92.0
ODA 223	84.0	87.4	90.5	92.5
ODA 223	86.0	90.0	91.3	91.9
ODA 223	89.0	90.2	91.0	91.0
ODA 223	90.0	91.9	92.0	92.0
OD3 238	84.0	87.8	90.3	91.9
KKB 222	88.0	93.1	94.8	95.0
KKB 222	86.0	87.7	88.0	88.0
PKD 222	86.0	89.0	89.0	89.0
RB5 242	95.0	95.0	95.0	95.0
E 215	89.0	94.0	94.0	94.0
J 315	89.0	92.0	92.0	92.0
J 315	83.0	91.8	94.1	94.8
T 218	86.0	90.0	91.0	91.0
T 218	85.0	90.0	90.0	90.0
T 218	88.0	91.8	93.0	93.9
HTC 216	90.0	91.0	91.8	92.0
PKC 222	89.0	94.0	96.0	97.2
ODB 133	88.0	94.0	95.4	96.0
LB4 450	91.0	95.9	96.3	97.0
LGA 238	89.0	96.9	99.0	100.2
J 315	88.0	96.0	96.0	96.0
E 215	91.0	94.0	94.0	94.0
LXX 228	85.0	90.9	92.3	92.9
OA2 216	90.0	95.8	97.0	97.1
OA2 216	90.0	92.2	92.9	93.1
OA2 216	94.0	96.2	97.0	97.1
OA2 216	88.0	88.8	89.0	89.0
OA2 216	89.0	90.0	90.0	90.0

TABLE D-II
(Continued)

OCTANE REQUIREMENTS FROM BEST-FIT-CURVES - FBRSU FUEL

CRC Car Code	RON-Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
NJG 218	87.0	90.1	91.0	91.0
NJG 218	87.0	88.1	88.8	89.0
NAR F25	91.0	92.4	93.3	93.8
NAR F25	92.0	92.3	92.8	92.9
PKD 222	85.0	87.1	87.9	88.0
PKD 222	84.0	86.9	88.0	88.2
PKD 222	84.0	85.4	86.7	87.7
PKD 222	85.0	85.8	86.0	86.0
NGA 238	81.0	84.8	85.6	85.4
PME 252	87.0	89.4	91.3	92.7
PME 252	87.0	90.9	91.9	92.0
PME 252	89.0	90.3	92.9	93.9
MXX 228	90.0	92.0	92.7	92.9
NAX 228	87.0	93.8	97.8	98.0
E 215	91.0	93.2	94.0	94.1
OD3 238	89.0	92.1	93.0	93.0
PKB 222	91.0	94.8	95.8	96.0
T 215	87.0	90.0	91.0	91.2
NXR F25	96.0	98.0	99.8	100.4
OA2 216	93.0	95.1	96.2	96.8
PKB 222	88.0	89.8	91.6	92.6
NXR F25	94.0	97.5	98.8	99.7
OA2 216	92.0	95.2	95.8	96.1
PKB 222	85.0	88.8	92.1	93.5
NXX 228	89.0	91.8	92.2	94.2
OBA 223	86.0	89.5	90.2	90.5
PLA 217	89.0	92.8	94.0	95.3
NXX 228	89.0	92.8	93.1	93.1
OBA 223	88.0	90.7	91.6	92.0
PLA 217	91.0	95.0	95.2	95.4
NJG 218	88.0	90.8	93.1	94.4
OD3 238	89.0	92.6	93.2	93.4
NJG 218	87.0	91.1	91.7	92.2
OD3 238	86.0	90.1	91.8	93.3
NXX 228	90.0	95.9	97.5	98.0
OA2 216	96.0	97.8	98.4	98.5
NXX 228	83.0	84.3	85.1	85.8
NTS 228	92.0	94.2	96.0	96.1
IBY 450	91.0	94.5	97.3	98.9
IBY 450	89.0	94.3	98.3	99.8
Z 215	78.0	87.7	90.3	91.0
T 220	86.0	89.3	90.3	90.6
PME 252	88.0	91.1	92.2	92.9

TABLE D-III

OCTANE REQUIREMENTS FROM BEST-FIT-CURVES - PR FUEL

CRC Car Code	RON-Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
NJG 218	87.0	89.9	90.9	91.0
NJG 218	86.0	86.0	86.0	86.0
HJG 218	84.0	86.3	87.9	88.6
NJG 218	76.0	80.9	82.7	83.0
LXR F25	88.0	88.0	88.0	88.0
LXR F25	89.0	89.0	89.0	89.0
LXR F25	91.0	95.0	95.0	95.0
NXR F25	85.0	92.4	94.0	94.0
LXX F25	85.0	87.2	87.9	88.0
LXX 228	88.0	92.2	93.0	93.0
LAE 230	84.0	87.7	88.9	89.0
GC8 F41	82.0	85.8	88.3	88.9
GK8 F41	85.0	89.3	90.8	91.1
OA2 216	89.0	90.5	91.0	91.0
OA2 216	92.0	92.0	92.0	92.0
ODA 223	85.0	88.7	89.0	89.1
ODA 223	84.0	86.5	88.9	90.6
ODA 223	86.0	88.7	89.6	89.9
ODA 223	88.0	90.2	91.0	91.0
ODA 223	84.0	88.6	89.9	90.0
OD3 238	84.0	87.1	89.5	90.9
KKB 222	84.0	89.7	91.0	91.0
KKB 222	82.0	83.6	84.0	84.0
PKD 222	84.0	84.0	84.0	84.0
RB5 242	94.0	94.0	94.0	94.0
E 215	88.0	91.1	91.9	92.0
J 315	88.0	91.4	92.0	92.0
J 315	83.0	90.5	92.9	93.7
T 218	86.0	88.2	89.0	89.0
T 218	85.0	88.0	88.0	88.0
T 218	88.0	90.8	91.2	92.8
HTC 216	90.0	90.0	90.0	90.0
PKC 222	86.0	89.3	90.4	91.0
ODB 133	88.0	92.0	93.0	93.2
LB4 450	89.0	90.1	90.8	90.9
LGA 238	88.0	91.4	92.7	93.3
J 315	88.0	97.0	97.0	97.0

TABLE D-III
(Continued)

OCTANE REQUIREMENTS FROM BEST-FIT-CURVES - PR FUEL

CRC Car Code	RON-Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
E 215	89.0	94.0	94.0	94.0
LXX 228	86.0	88.3	88.9	89.1
OA2 216	91.0	94.2	95.3	96.0
OA2 216	89.0	89.7	90.0	90.0
OA2 216	92.0	93.7	94.2	94.2
OA2 216	86.0	87.4	88.1	88.1
OA2 216	88.0	88.0	88.0	88.0
NJG 218	86.0	87.9	88.3	88.3
NJG 218	86.0	86.8	87.0	87.0
NAR F25	88.0	88.0	88.0	88.0
NAR F25	87.0	87.0	87.0	87.0
PKD 222	84.0	85.6	86.1	86.1
PKD 222	82.0	84.9	85.9	86.0
PKD 222	81.0	83.1	84.6	85.8
PKD 222	84.0	84.6	85.0	85.0
NGA 238	79.0	81.8	82.7	83.0
PME 252	85.0	87.5	89.2	90.5
PME 252	86.0	87.6	88.4	88.8
PME 252	89.0	90.3	91.3	91.9
MXX 228	90.0	91.3	91.9	92.2
NAX 228	84.0	88.6	89.8	90.1
NBJ 244	88.0	90.0	90.0	90.0
E 215	89.0	90.5	90.9	91.0
OA2 216	95.0	96.5	97.0	97.0
LGA 238	87.0	90.0	90.0	90.0
NTC 216	85.0	89.0	89.0	89.0
OCA 223	87.0	91.9	92.0	92.0
OD3 238	88.0	89.9	90.4	90.5
Z 215	84.0	86.0	86.0	86.0
IAR F25	85.0	88.5	90.1	92.0
HJG 218	86.0	88.3	89.0	89.0
PLA 217	85.0	88.0	88.0	88.0
PKB 222	86.0	90.2	91.0	91.0
T 215	85.0	87.8	89.0	89.9
NXR F25	87.0	90.4	91.4	91.8
OA2 216	89.0	91.0	91.9	92.5

TABLE D-III
(Continued)

OCTANE REQUIREMENTS FROM BEST-FIT-CURVES - PR FUEL

CRC Car Code	RON-Requirements at 0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
PKB 222	85.0	87.7	89.7	90.7
NXR F25	88.0	90.3	90.8	90.9
OA2 216	90.0	93.6	93.9	93.9
PKB 222	80.0	87.1	89.0	89.0
NXX 228	84.0	87.8	89.7	90.9
OBA 223	85.0	86.5	87.3	88.0
PLA 217	84.0	87.0	88.9	89.6
NXX 228	85.0	87.4	88.1	88.4
OBA 223	85.0	87.1	87.8	88.0
PLA 217	87.0	90.7	91.3	91.8
NJG 218	84.0	88.0	89.1	89.8
OD3 238	86.0	89.2	90.1	90.3
NJG 218	84.0	87.4	88.4	89.3
OD3 238	85.0	87.6	88.8	90.0
NXX 228	90.0	93.7	94.7	94.9
OA2 216	96.0	96.5	96.5	96.5
NXX 228	80.0	81.7	82.5	83.1
NTS 228	91.0	93.4	95.1	95.5
IBY 450	89.0	91.5	93.5	94.0
IBY 450	87.0	92.0	94.5	94.5
Z 215	78.0	87.7	90.3	91.0
T 220	85.0	88.3	89.3	89.5
PME 252	86.0	89.0	90.2	90.9

END

FILMED

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DTIC