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CRC Report No. 549

OCTANE REQUIREMENT INCREASE OF 1964 MODEL VEHICLES

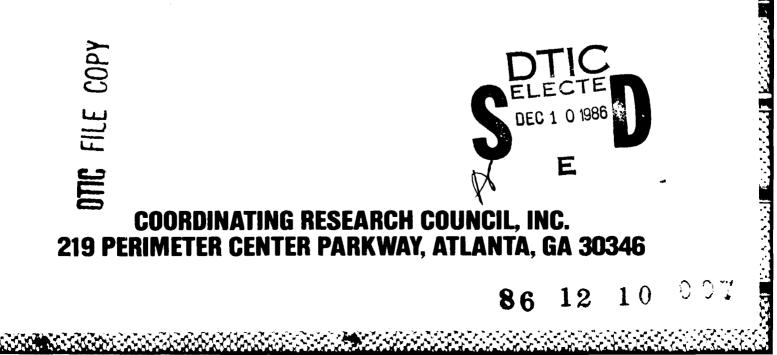
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October 1986



COORDINATING RESEARCH COUNCIL INCORPORATED 219 PERIMETER CENTER PARKWAY ATLANTA. GEORGIA 30346

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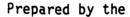
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OCTANE REQUIREMENT INCREASE OF 1984 MODEL VEHICLES (CRC Project No. CM-124-84)

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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.

This document has been approved for public strength and the distribution is unlikited.

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I. SUMMARY

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- 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 Notor octane numbers, and 3.3 (R+N)/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 highsensitivity full-boiling range unleaded (FERSU) 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 CRI 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 (CRI) with unleaded fuel became evident in 1970 when manufacturers announced that future cars would use unleaded gasoline of at least 91 RCN 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 GRI 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 GRI data from 1971 and 1973 through 1983 model cars have been reported previously. $^{(1-11)}$ This report will summarize GRI data for 1984 model vehicles.

III. EXPERIMENTAL

A. Vehicles Tested

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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. Nileage Accumulation

Mileage accumulation was conducted from the fall of 1983 through the summer of 1985. All test vehicles were operated in customertype 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 FERU 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 RCN-to-NCN conversions used in the data analysis for 1984 vehicles are shown in Appendix C, Tatle C-I.

D. <u>High Sensitivity Full-Boiling Range</u> Unleaded Reference Fuel (FBRSU)

Cotane requirements of fifty-six vehicles were defined initially with 1982 or 1983 FBRSU fuels and later with 1983 and 1984 FBPSU fuels as well as with FBRU. The RCN-to-MCN 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

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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 GRI of all vehicles at the same mileage, results were determined from best-fit curves of actual reported octane requirements. Research octane number requirements (RGN) 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.

CRI 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 RCN and corresponding MON values. The appropriate RCN-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-NON conversion in Table C-I.

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Best-fit curve octane requirements at 0, 5,000, 10,000, and 15,000 miles are listed for each vehicle in Appencix D, Tatles D-I, D-II, and D-III for FERU, 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+N)/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 RCN, NON, and (R+N)/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 GRI 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 FON.⁽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:

Mode1	Accumulated	Mean ORI	
Year	Miles	FBRU, RON	PR
1075	16 000	E C	
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 Ave	erage: 5.1	3.9

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

C. ORI Versus Initial Octane Requirements

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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:

GRI = a + b (Initial Octane Requirement)

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

Equations for the three reference fuel series are:

	i	£	l	D	
Reference Fuel Series	Estimate	T Value of <u>Estimate</u>	<u>Estimate</u>	T Value of Estimate	_ <u>R</u>
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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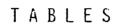
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/2 10,60 01 04	J.U	2.8	2.4	2.5	9.6	ų	2.0	6.5	J./ J.H
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5,000 Nean	2.3	2.0	2.2	1.7	3.4	2.8	•.1	2.0	5. N
a l Stores (s	. .t	4.4	3.1	3. 8	3.0	U.7	6.4	4.1	2.0
Trittal 5,000-MTC 10,000 MTC Requirements 0.001 MTC 10,000 MTC Requirements 0.001 MEan 50	84.1	85.4	84.2	85.6	8.00	61.2	86.3	64.7	82.9
50 IS	1.1	1.2	1.9	2.2	1.9	9 0	2.0	2.5	5. I
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	1.1	1.2	8.1	2.0	<u>e.</u> 1	Ð.4	1.7	2.2	• •
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	1.6	1.1	1.6	1.5	2.0	0.4	C.I	1.6	2.4 1.2
5,000 Mean	1.9	1.1	J. 8	1.4	2.8	2.3	1.1	1.6	2.4
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tuit fegele hean	4.61	80.6	19.6	R 1)11	16.9	11.2	81.4	0.44	1 11
Nite Su	2.6	1.9	2.9	3.4	2.1	8.0	J.U	3.8	2.2
15,000 <u>Meda</u>	3.9	J. b	3.7	3.4	4.9	5. I	2.9	J.9	4.7
10,000-N11e 084 Mean 50	2.5	1.6	2.6	3.0	2.1	0.6	2.1	3.4	2.1
	J.5	3.3	J. J	3.0	4.6	4.6	2.5	J. 4	4 .3
5,000-111 (111-001 081 081	2.3	1.7	2.4	2.2	2.9	9.0	2.0	2.4	1.7
	2.1	2.4	2.6	2.1	4.0	3.2	1.1	2.3	9.4
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al I Vehic lus	62 (56)	87.7 (87.6)	87.7 4.6 (87.6) (4.8)		2.8 2.3 (2.8) (2.3)	3.7 2.6 (3.7) (2.6)		4.0	2.8 (2.7)	81.2 3.1 (81.2) (3.2)	3.1 (3.2)	1.9 (1.9)	1.6 (1.6)	2.4	1.8	2.6 1.9 (2.6) (1.8)		84.4 (84.4)			6.1	1.0 2.2 (1.0) (2.1)		(1.1) (1.1)	2.4 (2.3)
Ali Mate A	21 (21)	68.9 (89.0)	88.9 4.6 (89.0) (5.2)	2.6 (2.6)	2.6 2.0 (2.6) (1.9)	1.5 2.3 (1.5) (2.0)	2.J (2.0)	1.9 (1.9)	2.4 (2.1)	62.0 3.1 (62.2) (3.4)	1.1 (1.1	1.8 1.3 (1.7) (1.2)	1.3 (1.2)	2.4	1.6 (1.3)	2.4 (2.4) (1.3)	2.1	85.5 (85.6) (3.8 (4.3)	2.2 (2.2) (1	1.6 (1.6)	2.9 2 (2.9) (1			2.1 (1.7)
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All ILLE L	37	89.]		1.9	2.0	2.8	2.6	3.2	3.0	87.4	2.6	1.2	1.2	1.1	1.6	2.0	1.9		3.4		4.4	2.2	2.1	2.6	د. د
All Uthers	71	H4. Ì	3.5	4.0	2.9	4.6	2.H	4.8	2.8	/8.8/	2.5	2.1	2.0	J.I	6.1	J.0	۲.9 ۱	81.4	3.0	1.1	2.4	3.6	2.3	6.7	.9- 5'2 6
fuglae Alst	د	0.1 €./8	1.0	4.9	2.3	ę. •	2.0	9 .6	2.1	6.00	8.0	3.2	1.5	£.4	•	. ₽	1.7	84.1	0.9	-	۲. د	- 6.3	1.7	5.5	1.9
thur Alut	'n	U4.4	0.6	2.9	0.8	4.2	0.B	5.0	8.0	19.2	0.4	2.0	0.6	2.1	0.4	3.1.6	0.5	81.8	0.5	2.5 (0.7	J. 5. L	(I. 6	4.0	0. 6
ingine Byy	۰	8 63	0.8	9.1	٤.۶	2.9	J. 2	J. 5	1.1	H?.5	U.5	1.2	4.4	1.8	2.0	2.1	2.4	86.2	0.1	1.5	8.1	2.4	۹ /	2.9	3.0
ingine Li Jb	æ	68°.2	1.3	2.2	2.1	3.1	2.9	J.6	J. 4	81.6	2.1	1.4	1.3	1.9	8.1	2.1	2.1	84.9	J. 5	1. K	1.7	5.5 5.5	2.3	3.0	2.H
figthe UT22	. 1	11C 6	2.6	J. 6	2.2	4.4	2.6	A. B	2. b	9 DH	1.1	2.3	6.1	2.8	8.1	J.0	H. H	83.6	2.2	2.9	1.8	3.6	2.2	3.6	2.2

() Numbers in parentheses represent ABMU data on vehicles that were also rested on ABKSH and PR fuels.

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TABLE III

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

5,000-Mile GRI Mean SD 2.9 2.4 2.4 1.7 3.4 2.8 1.3 1.1 4.2 3.1	
3.0	82.4 (.6 3.0
2.7	6.2 0.4 2.7
1.6	86.5 3.9 1.6
2.9	56.4 2.7 2.9

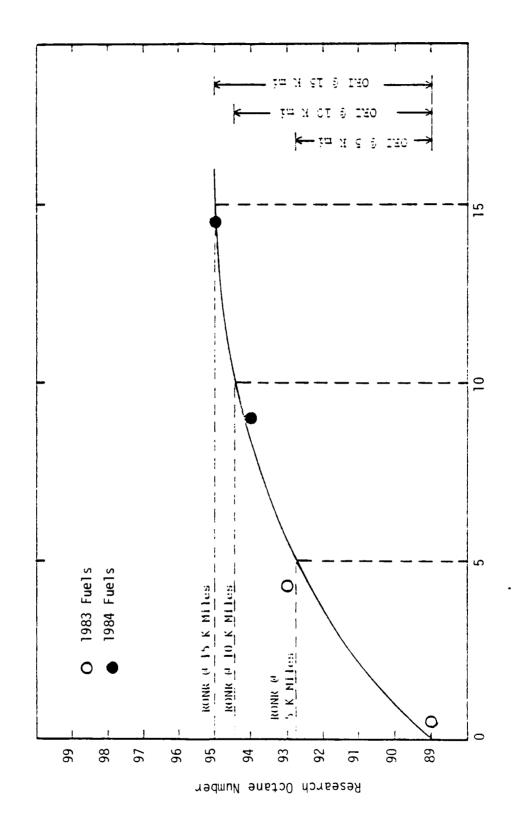
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BEST-FIT CURVE ORI ANALYSIS



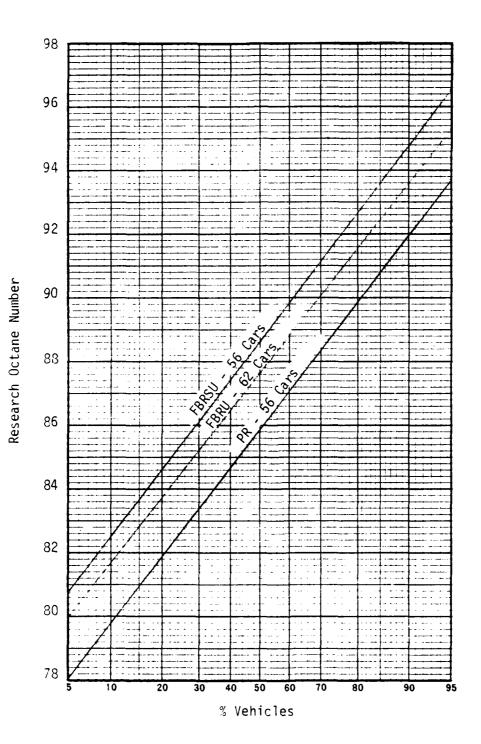
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MILES



DISTRIBUTION OF INITIAL RCN REQUIREMENTS

FOR 1984 MODEL VEHICLES



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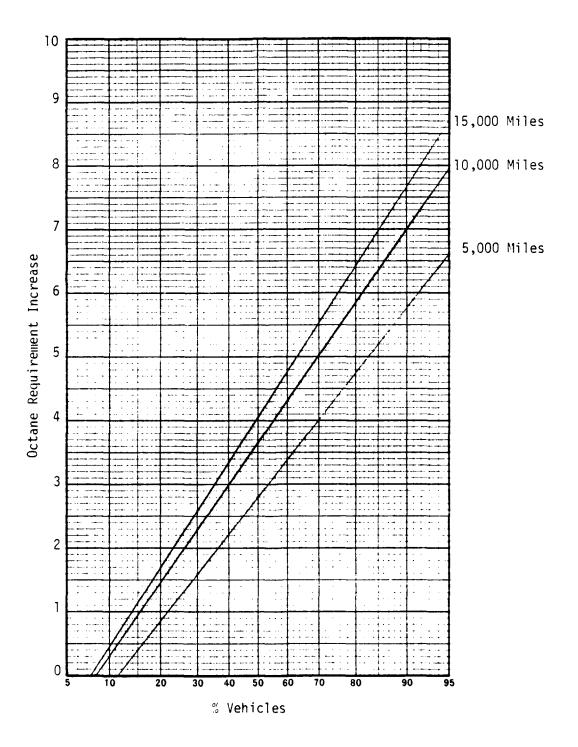
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DISTRIBUTION OF RON ORI FOR

62 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRU FUEL



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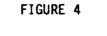
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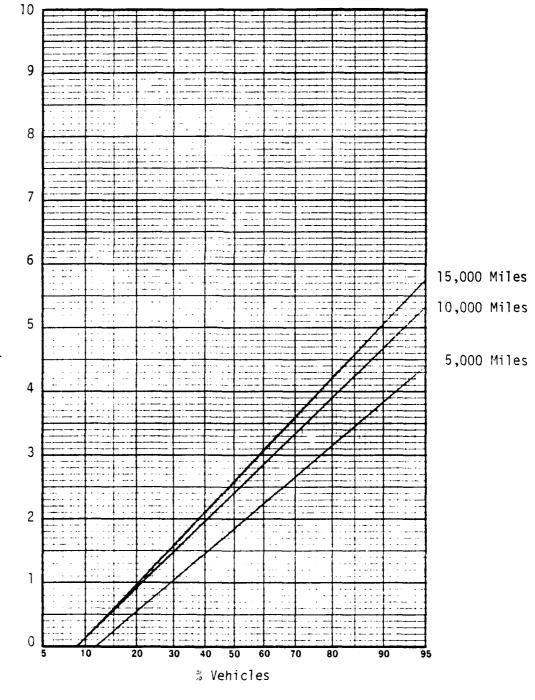
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DISTRIBUTION OF MON ORI FOR

62 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRU FUEL



Octane Requirement Increase

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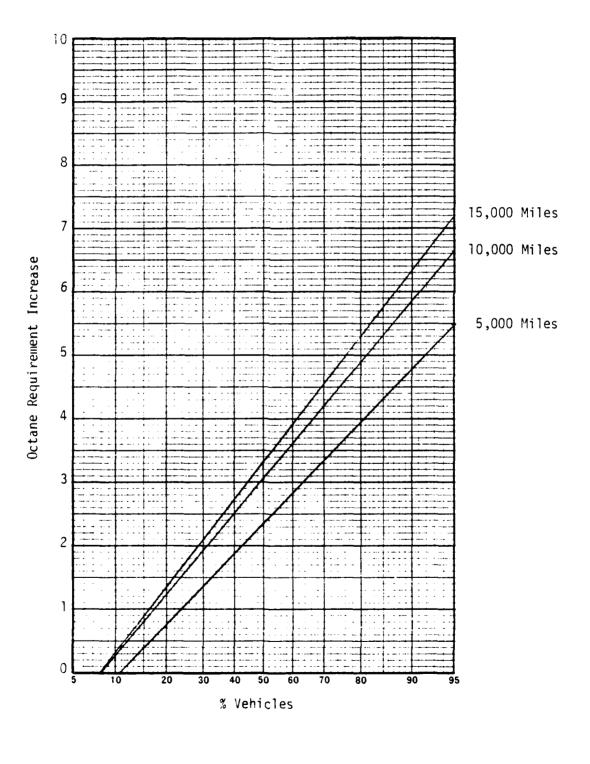
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DISTRIBUTION OF (R+M)/2 ORI FOR

62 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRU FUEL



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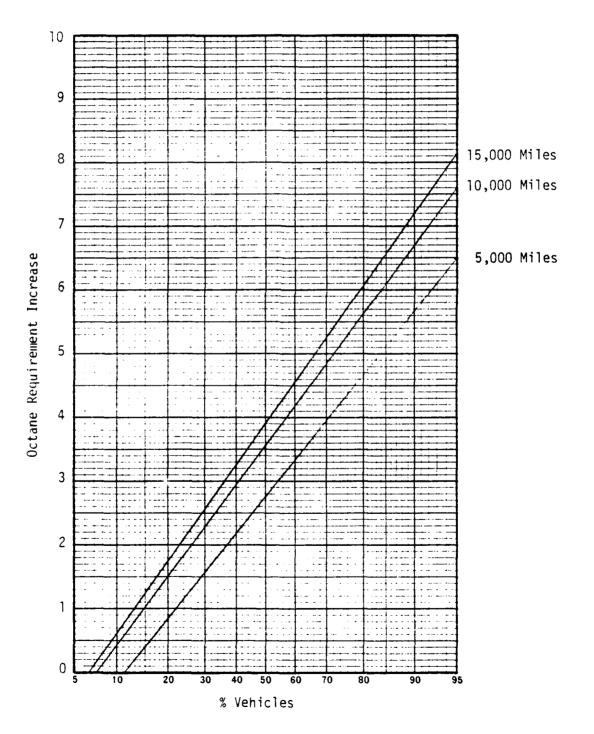
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DISTRIBUTION OF RON CRI FOR

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VARIOUS MILEAGES CN FBRSU FUEL



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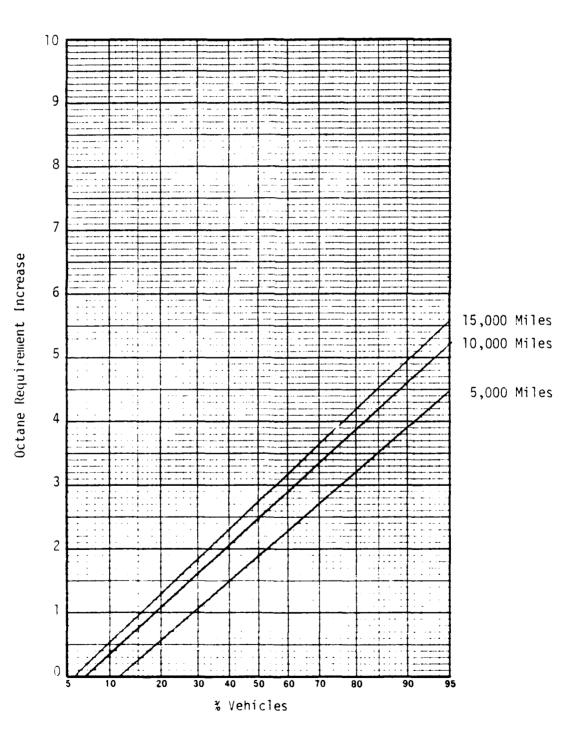


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56 1984 MODEL VEHICLES AT

VARIOUS MILEAGES ON FBRSU FUEL

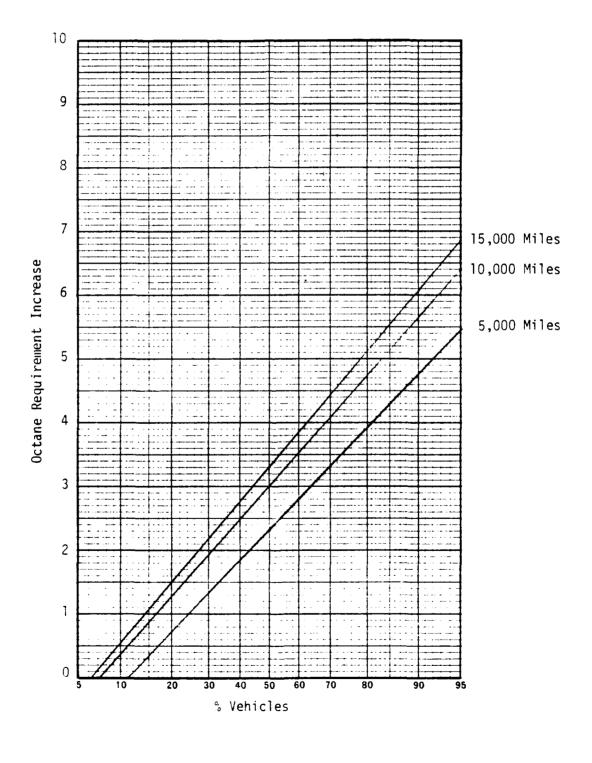




DISTRIBUTION OF (R+M)/2 ORI FOR

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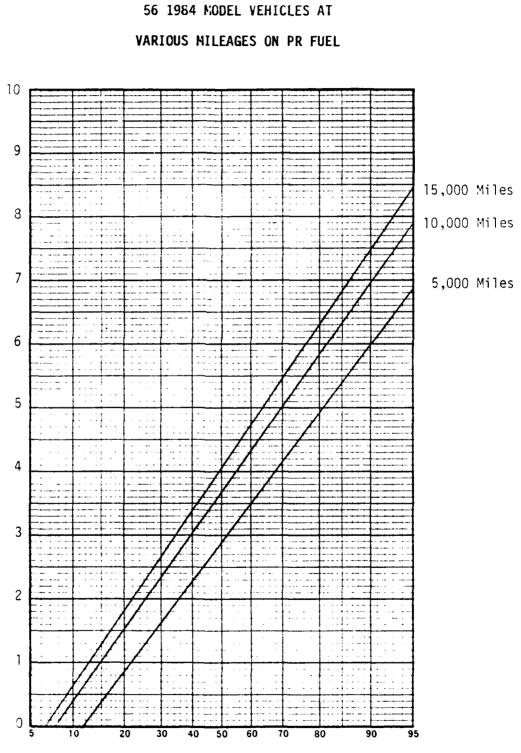
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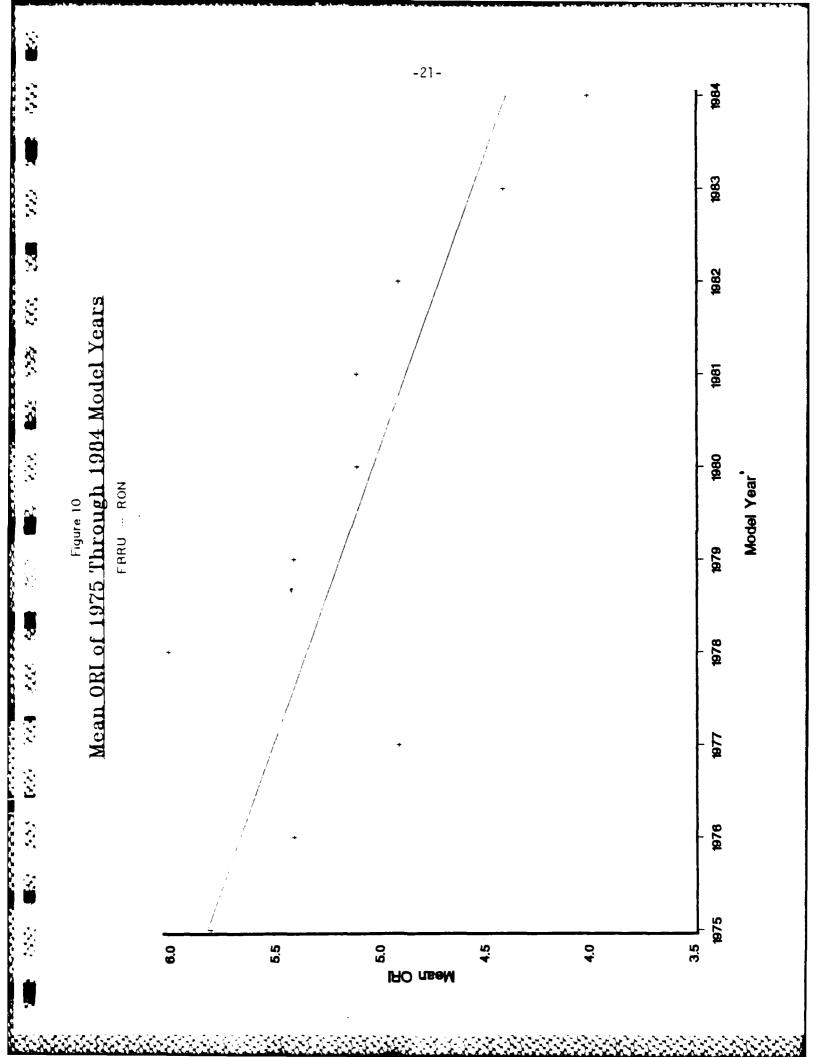
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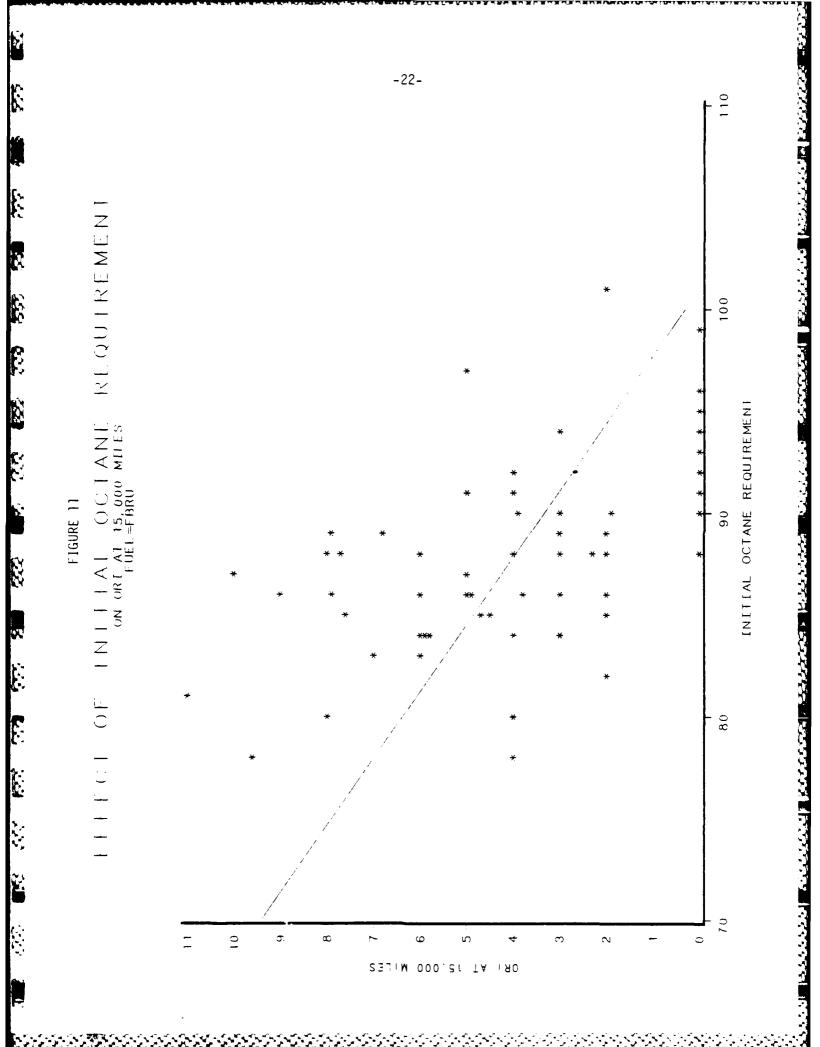
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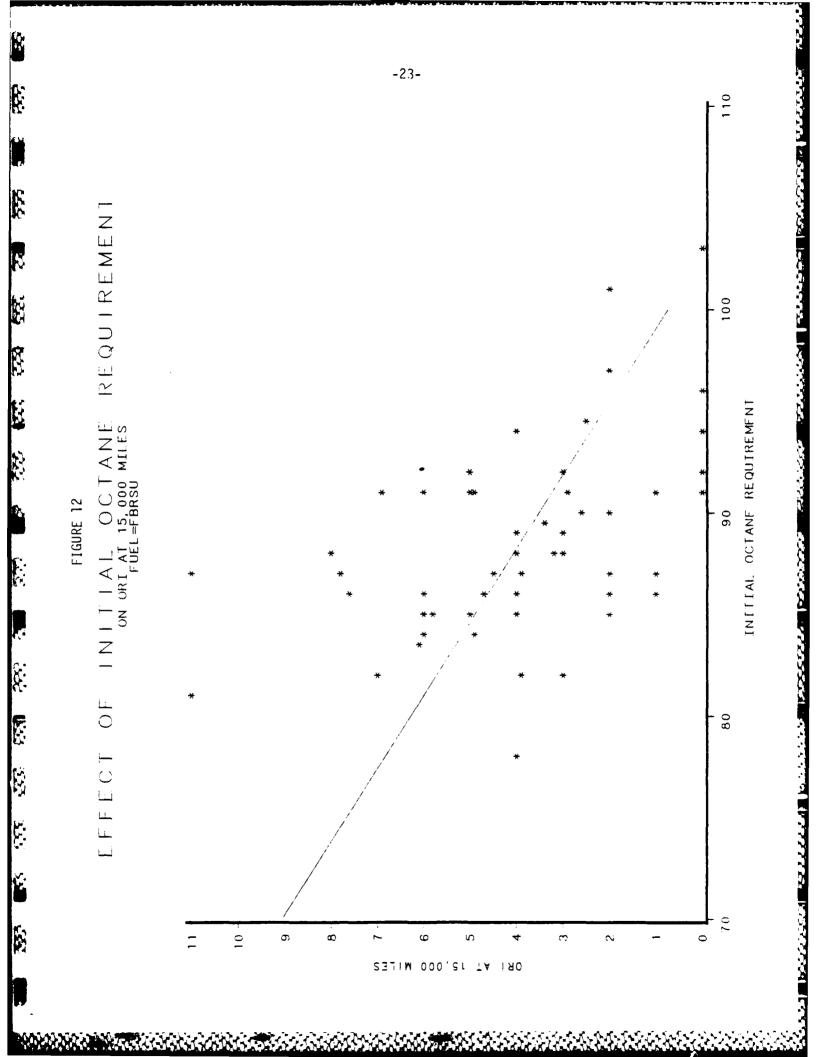
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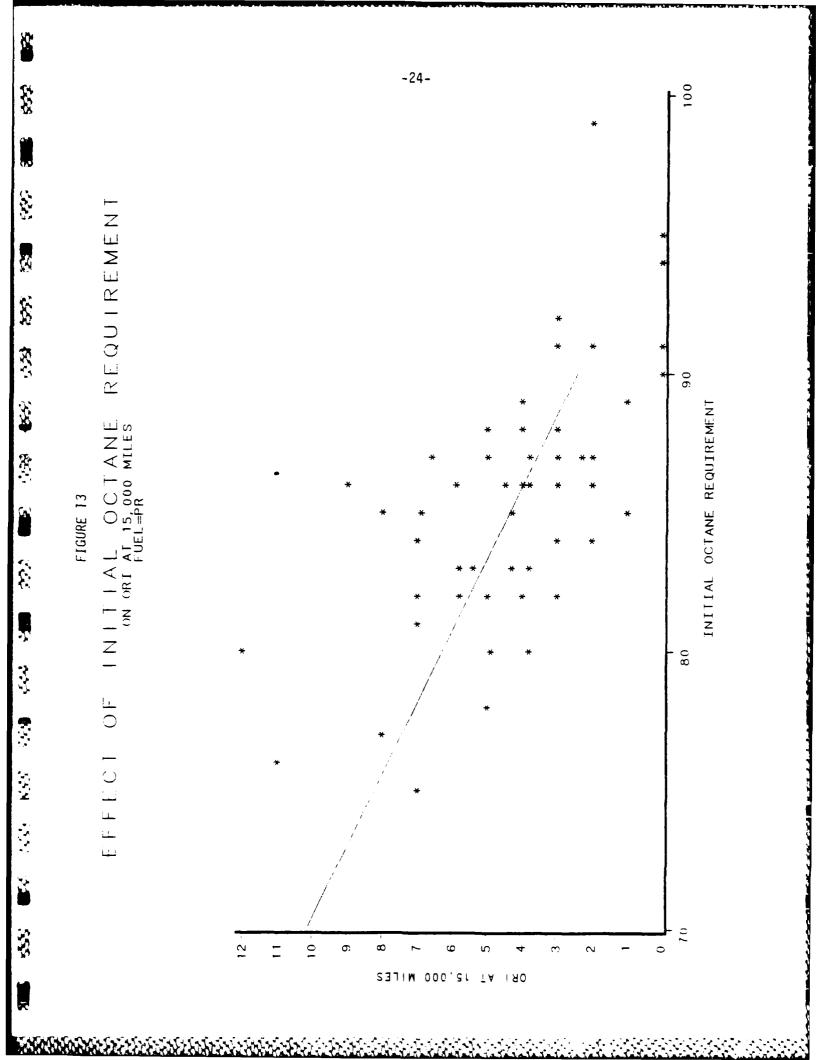
FIGURE 9

DISTRIBUTION OF CRI FOR









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LABORATURIES REPORTING OCTANE REQUIREMENT DATA AT VARIOUS MILEAGES

LABORATORIES REPORTING OCTANE REQUIREMENT DATA AT VARIOUS MILEAGES

Amoco Oil Company Naperville, Illinois

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Exxon Research and Engineering Company Linden, New Jersey

General Notors Research Laboratories Warren, Michigan

Gulf Research and Development Company Pittsburgh, Pennsylvania

Shell Development Company Houston, Texas

Unocal Corporation Brea, California

APPENDIX B

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MEMBERSHIP:

1984 OCTANE REQUIREMENT INCREASE DATA ANALYSIS PANEL

1984 OCTANE REQUIREMENT INCREASE

DATA ANALYSIS PANEL

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

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REFERENCE FUEL DATA

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

Research Octane No.	1984 Notor Octane No.	1983 Motor <u>Octane No.</u>	1982 Motor Octane No.	Lab X Notor <u>Octane No.</u>
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 . ()	78.3	78.9	79.2	78.2
85.0	79.0	79.6	79.9	79.0
86.0	79.7	80.3	20.5	79.7
87.0	80.6	80.9	81.1	80.4
0.38	81.3	81.6	81.7	81.1
0.28	82.0	82.2	82.2	81.8
\$0.0	82.6	82.8	82.8	82.5
91.0	83.3	83.5	83.3	63.2
92.0	83.9	84.1	£3.7	63.9
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
<u>99.0</u>	88.7	8.33	88.5	89.3
100.0	89.5	89.5	89.3	90.1
101.0	90.4	90.3	S0.2	3 . 02

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Letter Letter

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TABLE C-II

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HIGH SENSITIVITY FULL-BOILING RANGE UNLEADED REFERENCE FUEL SERIES (FBRSU)					
Research Cctane No.	1984 Notor <u>Octane No.</u>	1983 Notor Octane No.	1982 Motor <u>Octane No.</u>		
78.0	71.9	71.7	71.8		
٥.0	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		
£6.C	78.0	77.8	77.7		
87.Ú	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	8.03		
\$1.0	81.3	81.3	61.4		
\$2.0	82.0	81.9	82.1		
\$3.0	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		
çē.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	9.38	25.0		

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APPENDIX D

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OCTANE REQUIREMENT DATA

TABLE D-I

OCTANE REQUIREMENTS FRCM BEST-FIT CURVES - FBRU FUEL

CRC	RON Requirements at			
Vehicle Code	0 Hiles	5,000 Hiles	10,000 Miles	15,000 Miles
	66 6	сс г	01 5	02.0
ICY 450	89.0	96.5	91.5	92.0
ICY 450	88.0	8.38	85.5	90.3
T F20	۵.0	85.8	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.C	ε 7. (87.0	87.0
0F3 F38	91.0	55.0	95.0	95.0
HPR F25	88.0	G2.G	94.0	94.0
KED F22	£3.0		93.0	93.C
E 216				
E Elf	81.t	52.0	92.0	92.(
J 318	86.0	\$1.0	\$1. C	51.0
HBH 45C	92.0	96.0	96.0	96.0
E F20	83.0	89.0	89.0	89.0
1BY 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
0E5 F16	90.0	90.0	90.0	90.0
GE5 F16	0.98	94.2	96.0	96.9
CE5 F16	ç1.0	91.0	\$1.0	91. 0
6E5 F16	90.0	<u>91.0</u> 91.0	92.0	93.0
HXR F25	86.0		92.0	92.0
		92.0		
HXR F25	0.33	92.6	94.7	95.7
HPR F25	88.0	91.4	95.4	96.0
HJC 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
11011 400	101.0	102.5	10010	100.0
KED F22	95.0	95.0	95.0	95.0
KNP 252	91.0	94.7	S5.9	96.0
OTA 123	86.0	89.1	90.4	90.9
USW F23	94.0	94.0	94.0	94.0
0F3 F38	85.0	89.7	91.6	92.6
IJC F18	96.0	96.0	96.G	56.0
HAR F25	26.0	94.5	95.0 95.0	55.0
T F20		94.5 91.4	93.2	
	86.0			93.9
NJP F20	86.0	87.4	88.4	8 <u>9</u> .0
LNR F25	0.83	80.0	91.O	91.6

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TABLE D-I (Continued)

OCTANE REQUIREMENTS FROM BEST-FIT CURVES - FBRU FUEL

CRC	RON Requirements at			
Vehicle Code	<u>0 Miles</u>	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	0.88	0.38
ICY 450	87.0	89.3	91.3	92.0
LE2 210	0.93	92.2	94.2	95.8
UTA 123	80.0	87.4	0.33	0.33
UFN F16	85.0	86.1	86.7	87.0
(L3 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	0.03	82.9	63.9	84.0
Z 22C	78.0	80.9	82.0	82.0
IAE 230	84.U	88.4	6.63	89.9
IAE 230	85.0	87.9	89.0	89.5
UTA 123	84.0	88.2	89.6	90.0

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TABLE D-II

OCTANE REQUIREMENTS FROM BEST-FIT CURVES - FBRSU FUEL

CRC	RCN Requirements at			
Vehicle Code	0 Niles	5,000 Miles	10,000 Miles	15,000 hiles
	<u> </u>	61.0	00 4	62 0
ICY 450	89.0	91.0	92.4	93.0
ICY 450	88.0	89.0	90.1	91.2
T F2C	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	0.25
CF3 F38	91.0	97.0	97.0	97.0
HPR F25	92.0	94.4	95.0	95.0
KED F22	<u>4</u> .0	94.0	94.0	94.0
E 216	61.0	92.0	92.0	92.0
J 318	86.0	92.0	92.0	92.0
HBH 450	92.0	97.0	97. Ŭ	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
UE5 F16	91.0	91.0	91.0	91.0
GE5 F16	91.0 91.0	95.5	97.0	97.9
	51.0	50.0	57.0	57.5
6E5 F16	92.0	92.0	92.0	92.0
6E5 F16	91.0	91.9	92.9	93.9
LGS F38	94.C	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
UTA 123	87.0	89.4	90.4	90.9
OSW F23	94.0	94.0	94.0	94.0
UF3 F38	86.0	90.8	92.7	93.6
HJO F18	96.0	96.0	96.0	96.0
100 110	90.0	50.0	90.0	90.0
HAR F25	0.33	95.5	96.0	96.0
T F20	87.0	92.2	94.0	94.6
TJP F2C	0.38	89.7	90.8	91.0
LIR F25	2233	91.0	92.0	\$2.0
NXX 228	94.5	96.2	96.7	97.0
LAE 230	24.0 86.0	50.2 58.5	90.1	90.7
LAE 230	84.C	67.2	88.7	50.7 28.9
LAE 230	24.U 85.0			
		67.7	89.7	91.C
LGA 238	85.0	86.1	86.7	87.0 UD U
NVH 450	87.0	88.1	8.33	0 <u>9</u> .0

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TABLE D-II (Continued)

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	89.5	91.0	92.3	92.9
0E2 216	91.0	94.2	95.5	95.9
CTA 123	82.0	88.8	89.0	0.93
0FW F16	86.0	86.7	87.0	87.0
0L3 F38	91.0	91.4	91.7	\$2.0
OVT 149	83.5	85.4	87.5	89.6
DED F22	87.0	3.38	90.2	51.5
KED F22	90.0	90.9	\$1.6	92.0
KST 222	86.0	87.4	67.9	58.0
RA6 F14	87.0	88.0	0.33	0.33
RCT 125	82.0	83.6	84.5	0.33
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

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TABLE D-III

OCTANE REQUIREMENTS FROM BEST-FIT CURVES - PR FUEL

vehicle Code 0 Hiles 5,000 Hiles 10,000 Hiles 15,000 Hiles ICY 450 89.0 89.6 90.0 90.0 ICY 450 87.0 86.0 88.8 89.3 T F20 83.0 87.8 86.4 88.4 T F20 83.0 86.0 88.7 89.0 J T F20 83.0 86.0 87.2 87.3 OF3 F38 88.0 93.0 93.0 93.0 93.0 HPR F25 86.0 89.2 90.0 90.0 90.0 J 318 87.0 92.0 92.0 92.0 92.0 HBH 450 92.0 95.0 95.0 95.0 95.0 IB Y 450 89.0 91.0 92.6 93.0 NTC 216 86.0 91.9 92.0 92.0 NTC 216 86.0 91.9 92.0 92.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0	CRC	RON Requirements at			
ICY 450 $\& 7.0$ $\& 8.0$ $\& 8.8$ $\& 9.3$ T F20 $\& 6.0$ $\& 7.6$ $\& 8.4$ $\& 8.4$ T F20 $\& 6.0$ $\& 8.0$ $\& 8.7$ $\& 9.0$ T F20 90.0 90.0 90.0 90.0 90.0 PL 222 $\& 3.0$ $\& 6.0$ $\& 7.2$ $\& 7.3$ $OF3$ F38 $\& 8.0$ 93.0 93.0 93.0 HPR F25 $\& 6.0$ $\& 9.2$ 90.0 90.0 $VS10$ $E22$ 91.0 51.0 91.0 E 216 $\& 0.0$ 92.0 92.0 92.0 J 318 $\& 7.0$ 92.0 92.0 92.0 HBH 45C 92.0 95.0 95.0 85.0 E F20 $\& 2.0$ $\& 9.0$ $\& 9.0$ $\& 9.0$ HBY 450 $\& 9.0$ 91.0 92.6 93.0 NTC 216 $\& 8.0$ 91.9 92.0 92.0 PK 222 $\& 7.0$ $\& 92.0$ $\& 92.0$ PK 222 $\& 7.0$ $\& 92.0$ $\& 92.0$ PK 222 $\& 7.0$ $\& 92.0$ 89.0 T F20 $\& 6.0$ $\& 8.3$ 89.6 GE5 F16 $\& 6.0$ $\& 8.4$ $\& 9.7$ SC 5 $S1.6$ $S2.6$ 94.3 GE5 F16 $\& 6.0$ $\& 8.4$ $\& 9.7$ SC 5 $S1.0$ $S9.0$ $S9.0$ GE5 F16 $\& 6.0$ $\& 8.3$ $\& 93.3$ GE5 F16 $\& 6.0$ $\& 8.3$ $\& 9.3$ $\& 9.6$ GSW F23 94.0 94.0 94.0 94.0		<u>O Miles</u>			15,000 Miles
ICY 450 $\& 7.0$ $\& 8.0$ $\& 8.8$ $\& 9.3$ T F20 $\& 6.0$ $\& 7.6$ $\& 8.4$ $\& 8.4$ T F20 $\& 6.0$ $\& 8.0$ $\& 8.7$ $\& 9.0$ T F20 90.0 90.0 90.0 90.0 90.0 PL 222 $\& 3.0$ $\& 6.0$ $\& 7.2$ $\& 7.3$ $OF3$ F38 $\& 8.0$ 93.0 93.0 93.0 HPR F25 $\& 6.0$ $\& 9.2$ 90.0 90.0 $VS10$ $E22$ 91.0 51.0 91.0 E 216 $\& 0.0$ 92.0 92.0 92.0 J 318 $\& 7.0$ 92.0 92.0 92.0 HBH 45C 92.0 95.0 95.0 85.0 E F20 $\& 2.0$ $\& 9.0$ $\& 9.0$ $\& 9.0$ HBY 450 $\& 9.0$ 91.0 92.6 93.0 NTC 216 $\& 8.0$ 91.9 92.0 92.0 PK 222 $\& 7.0$ $\& 92.0$ $\& 92.0$ PK 222 $\& 7.0$ $\& 92.0$ $\& 92.0$ PK 222 $\& 7.0$ $\& 92.0$ 89.0 T F20 $\& 6.0$ $\& 8.3$ 89.6 GE5 F16 $\& 6.0$ $\& 8.4$ $\& 9.7$ SC 5 $S1.6$ $S2.6$ 94.3 GE5 F16 $\& 6.0$ $\& 8.4$ $\& 9.7$ SC 5 $S1.0$ $S9.0$ $S9.0$ GE5 F16 $\& 6.0$ $\& 8.3$ $\& 93.3$ GE5 F16 $\& 6.0$ $\& 8.3$ $\& 9.3$ $\& 9.6$ GSW F23 94.0 94.0 94.0 94.0					
ICY 450 $\& 7.0$ $\& 8.0$ $\& 8.8$ $\& 9.3$ T F20 $\& 6.0$ $\& 7.6$ $\& 8.4$ $\& 8.4$ T F20 $\& 6.0$ $\& 8.0$ $\& 8.7$ $\& 9.0$ T F20 90.0 90.0 90.0 90.0 90.0 PL 222 $\& 3.0$ $\& 6.0$ $\& 7.2$ $\& 7.3$ $OF3$ F38 $\& 8.0$ 93.0 93.0 93.0 HPR F25 $\& 6.0$ $\& 9.2$ 90.0 90.0 $VS10$ $E22$ 91.0 51.0 91.0 E 216 $\& 0.0$ 92.0 92.0 92.0 J 318 $\& 7.0$ 92.0 92.0 92.0 HBH 45C 92.0 95.0 95.0 85.0 E F20 $\& 2.0$ $\& 9.0$ $\& 9.0$ $\& 9.0$ HBY 450 $\& 9.0$ 91.0 92.6 93.0 NTC 216 $\& 8.0$ 91.9 92.0 92.0 PK 222 $\& 7.0$ $\& 92.0$ $\& 92.0$ PK 222 $\& 7.0$ $\& 92.0$ $\& 92.0$ PK 222 $\& 7.0$ $\& 92.0$ 89.0 T F20 $\& 6.0$ $\& 8.3$ 89.6 GE5 F16 $\& 6.0$ $\& 8.4$ $\& 9.7$ SC 5 $S1.6$ $S2.6$ 94.3 GE5 F16 $\& 6.0$ $\& 8.4$ $\& 9.7$ SC 5 $S1.0$ $S9.0$ $S9.0$ GE5 F16 $\& 6.0$ $\& 8.3$ $\& 93.3$ GE5 F16 $\& 6.0$ $\& 8.3$ $\& 9.3$ $\& 9.6$ GSW F23 94.0 94.0 94.0 94.0	ICV AED	00 0	00 0	00 0	00.0
T F20 83.0 87.6 86.4 88.4 T F20 86.0 88.0 88.7 89.0 T F20 90.0 90.0 90.0 90.0 90.0 PLC 222 83.0 86.0 87.2 87.3 06.0 HPR F25 86.0 85.2 90.0 93.0 93.0 91.0 HPR F25 86.0 92.0 92.0 92.0 92.0 92.0 J 318 87.0 92.0 92.0 92.0 92.0 92.0 HBH 450 92.0 95.0 95.0 85.0 85.0 IBY 450 89.0 91.0 92.6 93.0 85.0 NTC 216 86.0 91.9 92.0 92.0 92.0 PKC 222 87.0 89.0 89.0 89.0 89.0 90.0 91.0 92.0 92.0 PKC 222 87.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0 89.0 90.0 92.0 92.0					
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HPR F25 $\& 6.0$ $\& 9.2$ 90.0 90.0 KED F22 91.0 91.0 91.0 91.0 E 216 $\& 0.0$ 92.0 92.0 92.0 J 318 $\& 7.0$ 92.0 92.0 92.0 HBH 450 92.0 95.0 95.0 92.0 E F20 $\& 2.0$ $\& 9.0$ $\& 9.0$ $\& 9.0$ IBY 450 89.0 91.0 92.6 93.0 NTC 216 $\& 8.0$ 91.9 92.0 92.0 PKC 222 $$1.0$ 92.0 92.0 92.0 PKC 222 87.0 89.0 89.0 91.0 O E5 F16 $\& 6.0$ 91.9 92.0 92.0 PKC 222 87.0 89.0 89.0 State 91.0 91.0 91.0 O E5 F16 $\& 6.0$ $\& 6.8$ 87.6 $\& 85.0$ 91.0 91.0 91.0 O E5 F16 $\& 6.0$ $\& 8.4$ 89.7 State $$9.0$ 100.7 101.0 O E5 F16 $\& 6.0$ $\& 8.4$ 89.7 State $$9.0$ 92.0 $$94.0$ O F3 F38 $$9.0$ 100.7 101.0 O F3 F38 84.0 86.3 89.3 State $$9.0$ $$95.0$ $$95.0$ O F3 F38 84.0 88.6 O F3 F38 84.0 88.7 O F3 F38 84.0 89.7 State 93.0 93.0 T F20 85.0 89.7 State 87.0	PLC 222	83.0	86.0	87.2	87.3
HPR F25 $\& 6.0$ $\& 9.2$ 90.0 90.0 KED F22 91.0 91.0 91.0 91.0 E 216 $\& 0.0$ 92.0 92.0 92.0 J 318 $\& 7.0$ 92.0 92.0 92.0 HBH 450 92.0 95.0 95.0 92.0 E F20 $\& 2.0$ $\& 9.0$ $\& 9.0$ $\& 9.0$ IBY 450 89.0 91.0 92.6 93.0 KED F22 91.0 92.0 92.8 93.0 NTC 216 $\& 6.0$ 91.9 92.0 92.0 PKC 222 87.0 89.0 89.0 89.0 PKC 222 87.0 89.0 89.0 89.0 T F20 $\& 8.0$ 91.0 91.0 91.0 CE5 F16 $\& 6.0$ $\& 6.4$ 89.7 $$9.0$ CE5 F16 $\& 6.0$ $\& 8.4$ $\& 9.7$ $$9.0$ CE5 F16 $\& 6.0$ $\& 8.4$ 89.7 $$9.0$ CE5 F16 $\& 6.0$ $\& 8.4$ 89.7 $$9.0$ CE5 F16 $\& 6.0$ $\& 8.3$ 89.3 $$9.6$ CE5 F16 $\& 6.0$ $\& 8.3$ 89.3 $$9.6$ CE5 F16 $\& 6.0$ $\& 8.3$ 89.3 $$9.6$ CE5 F16 $\& 8.0$ 9.0 94.0 94.0 G4 23 84.0 94.0 94.0 94.0 G4 23 84.0 89.6 89.3 89.8 CSW F23 94.0 94.0 94.0 94.0 G4 238 $\& 7.0$ $\& 89.7$ $$91.4$ <	0F3 F38	88.0	93.0	93.0	93.0
KEDF22 91.0 91.0 91.0 91.0 B216 80.0 92.0 92.0 92.0 J318 87.0 92.0 92.0 92.0 HBH450 92.0 95.0 95.0 95.0 EF20 82.0 89.0 91.0 92.6 IBY450 89.0 91.0 92.6 93.0 NTC216 86.0 91.9 92.0 92.0 PK222 87.0 89.0 89.0 91.0 PK222 87.0 89.0 89.0 91.0 OESF16 86.0 92.6 94.3 95.0 CESF16 86.0 86.3 89.6 90.0 CESF16 86.0 86.3 89.6 90.8 UCSF16 86.0 86.3 89.6 90.8 UCSF22 94.0 94.0 94.0 94.0 VEDF22 94.0 94.0 94.0 94.0 UCSF16 86.0 86.3 89.3 89.8 UCSF23 91.0 93.2 93.9 94.0 VEAVEA 94.0 94.0 94.0 94.0 UFAF23 86.0 86.3 89.3 89.8 UCSF23 94.0 94.0 94.0 94.0 VEAVEA 89.6 95.0 95.0 95.0 UCAF23 86.0 86.7 95.0 95.0 <td>HPR F25</td> <td>86.0</td> <td>89.2</td> <td>90.0</td> <td>90.0</td>	HPR F25	86.0	89.2	90.0	90.0
E216 $\&0.0$ 92.0 92.0 92.0 J318 $\&7.0$ 92.0 95.0 92.0 HBH450 92.0 95.0 95.0 95.0 EF20 $\&2.0$ $\&9.0$ $\&9.0$ $\&9.0$ IBY450 89.0 91.0 92.6 93.0 NTC216 $\&8.0$ 91.9 92.0 92.0 PKC222 87.0 89.0 89.0 89.0 TF20 $\&8.0$ 91.0 91.0 91.0 QE5F16 $\&6.0$ 86.8 87.6 $\&8.0$ UE5F16 $\&6.0$ 82.6 94.3 95.0 UE5F16 $\&6.0$ $\&8.4$ $\&9.7$ $$9.5.6$ UE5F16 $\&6.0$ $\&8.4$ $\&9.7$ $$9.5.6$ UE5F16 $\&7.0$ $\&8.3$ $\&9.6$ 90.8 LG9F38 99.0 100.7 101.0 101.0 NGH 450 95.0 95.0 95.0 94.0 VKP 252 91.0 93.2 93.9 94.0 VKP 252 91.0 93.2 93.9 94.0 UF3F38 $\&4.0$ $\&8.7$ $$9.6$ 91.0 HARF25 $\$5.0$ $$92.7$ $$3.0$ $$93.0$ TF20 $\&6.0$ $&57.4$ $&86.4$ $&89.0$ HARF25 $\&5.0$ $$92.7$ $$93.0$ $$93.0$ TF20 $&86.0$ $&89.5$ $$91.4$ <td></td> <td></td> <td></td> <td></td> <td></td>					
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$					
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EF2082.089.089.089.089.089.0IBY 45089.091.092.693.0NTC 21686.091.992.092.0PKC 22287.089.089.089.0TF2068.091.091.0CE5 F1686.092.694.395.0CE5 F1686.092.694.395.0CE5 F1686.082.694.395.0CE5 F1686.086.389.690.8LG9 F3899.0100.7101.0101.0NGH 45095.095.095.095.0VMP 25291.093.293.994.0VMP 25291.093.293.994.0OTA 12386.086.389.389.8OSW F2394.094.094.094.0OF3 F3884.089.791.093.2HAR F2585.092.793.093.0T< F20	HBH 45C	92.0	95.0	95.0	95.0
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KEDF22 91.0 92.0 92.8 93.0 NTC216 86.0 91.9 92.0 92.0 PKC222 87.0 89.0 89.0 89.0 TF20 88.0 91.0 91.0 91.0 CE5F16 86.0 21.6 94.3 95.0 CE5F16 86.0 92.6 94.3 95.0 CE5F16 86.0 82.4 89.7 90.8 CE5F16 86.0 82.4 89.7 90.8 CE5F16 87.0 86.3 89.6 90.8 LG9F38 99.0 100.7 101.0 101.0 NGH 450 95.0 95.0 95.0 95.0 KEDF22 94.0 94.0 94.0 94.0 KMP252 91.0 93.2 93.9 94.0 OTA123 86.0 86.3 89.3 89.8 OSWF23 94.0 94.0 94.0 94.0 UF3F38 84.0 88.9 90.6 91.0 HJOF18 95.0 95.0 95.0 95.0 HARF25 85.0 89.7 91.4 91.9 NJPF20 86.0 87.4 89.9 90.0 LINRF25 87.0 89.5 91.8 93.6 NXX 228 87.0 89.5 91.8 93.6 NXX 228 87.0 85.7 86.2 <td< td=""><td></td><td></td><td></td><td></td><td></td></td<>					
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CE5 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 UF3 F38 84.0 88.9 90.6 91.0 HJO F18 95.0 95.0 95.0 95.0 HJO F18 95.0 95.0 95.0 93.0 T F20 85.0 89.7 91.4 91.9 NJP F20 86.0 87.4 89.0 100 LINR F25 87.0 89.5 91.8 93.6 NXX 228 87.0 89.5 91.8 93.6 NXX 228 87.0 89.2 89.9 <t< td=""><td>0E5 F16</td><td>86.0</td><td>88.4</td><td>89.7</td><td>96.5</td></t<>	0E5 F16	86.0	88.4	89.7	96.5
LG9F3899.0100.71C1.01C1.0NGH45095.095.095.095.0KEDF2294.094.094.0KMP25291.093.293.994.0OTA12386.086.389.389.8OSWF2394.094.094.094.0UF3F3884.088.990.691.0HJCF1895.095.095.095.0HARF2585.089.791.491.9NJPF2086.087.488.489.0LINRF2587.089.591.893.6NXX22867.089.591.893.6LAE23083.085.387.388.8LGA23880.085.387.388.8	CE5 F16				
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OSW F23 94.0 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 86.0 LAE 230 83.0 85.3 87.3 88.8 LGA 238 80.0 83.0 84.3 84.9					
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NVH 450 84.0 86.0 86.0 86.0					
	NVH 450	84.0	86.0	86.0	86.0

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TABLE D-III (Continued)

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OCTANE REQUIREMENTS FROM BEST-FIT CURVES - PR FUEL

CRC	RON Requirements at			
Vehicle Code	0 Miles	5,000 Miles	10,000 Miles	15,000 Miles
ICY 450	86.0	87.6	88.0	88.0
0E2 216	86.0	88.5	90.6	91.9
OTA 123	76.0	86.4	87.C	87.0
OFW F16	85.0	85.7	86.0	86.0
0L3 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	0.93	89.2	3.23	90.Û
KST 222	82.0	83.9	84.7	85.0
RA6 F14	84.0	85.4	86.5	87.0
RCT 125	0.08	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

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