

## Test Plan: Evaluation of On-Highway Motor Vehicles Operated on Federal Phase II Reformulated Gasoline

### I. INTRODUCTION

The purpose of this test program is to identify performance issues which may be associated with the operation of vehicles on federal Phase II reformulated gasoline (RFG), before the fuel is introduced beginning January 1, 2000. This test program will be supplemented with data gathered in California's Compatibility and Performance Study for California Phase 2 RFG.

To evaluate the performance of Phase II RFG in current vehicles, in-use studies are proposed. The studies will monitor the use of Phase II RFG in various vehicles driven on their normal daily routes. Control fleets that match the size and make up of the test fleets, operated on market-available gasoline, will also be monitored for comparative analyses. Four methods of data collection will be employed for the purpose of performance evaluation:

- (1) Records of incidents related to driveability and performance reported by drivers or users.
- (2) Visual inspection surveys taken on a bimonthly basis for each study vehicle.
- (3) Maintenance records, both historical and during the study period.
- (4) Individual vehicle volumetric fuel consumption and cumulative mileage or actual odometer changes.

All data will be statistically analyzed to quantify impacts which are specific to the use of Phase II RFG. The test program will cover a wintertime fueling period followed by a spring and early summer fueling period with the transition occurring as would normally occur in accordance with existing and future regulatory requirements.

### II OBJECTIVE

The objective of this test program is to evaluate the performance of vehicles currently in use, when operated on Phase II RFG, as compared to being operated on currently available Phase I RFG. If performance issues associated with Phase II fuel are identified during the course of the study, the test program will include a more specific investigation of these issues.

### III VEHICLES

#### a. Description of vehicles

Privately and/or publicly-owned fleets of vehicles will be solicited to participate in this test program. These fleets will be located in Boston, Chicago, and Houston. Fleets in each city will be divided into test and control fleets of approximately equal size; there will be approximately 100 vehicles in Boston and Chicago, and 200 vehicles in Houston, for a total of 400. The technology and age distribution of the vehicles will approximate the national distribution, to the extent possible.

#### b. Vehicle inspections

Before the Phase II RFG performance study begins, each study vehicle shall undergo a visual inspection. As described in the instructions for the various data collection forms, the inspection will verify the identity and classification of the vehicle, as well as identify obvious defects which should be noted and considered during the analysis phase of the study. A "Vehicle Description Log" will be used to record the identity and classification of the test and control vehicles. A preliminary "Fuel System Inspection Log" will also be completed for each study vehicle before testing begins to document the condition of the fuel system components. The Vehicle Description Log and Fuel System Inspection Log will be completed by EPA. EPA inspectors will be trained on how to properly perform vehicle inspections and will be specifically instructed not to disturb or tamper with any of the components under study.

### IV FUELS

#### a. Description of fuels

For these studies the baseline fuels will be the gasolines normally purchased by the fleet operators. The Phase II RFG which will be used in these studies should meet all the standards for Phase II RFG as listed in 40 CFR Part 80, Section 41, and contain detergent additives approved by EPA at commercial doses. The target properties for the test fuels are shown in Table 1 below. The actual test fuel properties will be approved by an executive review committee before the test fuels are produced.

Table 1 - Target Test Fuel Properties

	Summer MTBE	Summer MTBE+TAME	Winter MTBE	Winter Ethanol
Oxygen, wt%	2.1	1.6 (MTBE) 0.5 (TAME)	2.1	3.5
RVP, psi	6.6	6.6	12.8	13.3
Sulfur, ppm	150	150	310	300
Aromatics, vol%	24	24	23	25
Olefins, vol%	11	11	12	12
Benzene, vol%	0.8	0.8	0.9	0.8
T10, °F	133	133	110	108
T50, °F	197	196	195	191
T90, °F	320	320	324	324
(E200, vol%)	(52)	(52)	(53)	(55)
(E300, vol%)	(84)	(84)	(83)	(83)
Octane, (R+M)/2	>87	>87	>87	>87

These fuel properties represent typical properties expected for Phase II RFG complying on average. Each fuel in the table will be used in a different city, and it is possible that not all fuels shown in the table will be required in this study. Also, to ensure that the fuel represents that which will actually be sold in RFG areas, the fuel should be produced from proportions of refinery blending components similar to proportions expected in 2000. These blending proportions are shown in Table 2.

Table 2 - Blendstock blending fractions

	Maximum volume percent of blendstock in final test fuel
Reformate	29
St. run naphtha	15
Isomate	4
FCC naphtha	35
Hydrocrackate	4
Alkylate	18
Dimate	1
Raffinate	3

Finally, all test fuel properties must fall within prescribed ranges to ensure that the fuels represent expected average Phase II RFG fuels and meet ASTM guidelines. The allowable ranges for summer and winter fuels are shown in Table 3. No test fuel properties can fall outside the ranges given in Table 3.

Table 3 - Allowable ranges for Test Fuels

	Summer MTBE	Summer MTBE+TAME	Winter MTBE	Winter Ethanol
Oxygen	2.0 +	2.0 +	2.0 +	2.0 +
RVP, psi	6.4 - 6.8	6.4 - 6.8	12.3 - 13.3	12.8 - 13.8
Sulfur, ppm	125 - 175	125 - 175	285 - 335	275 - 325
Aromatics, vol%	23 - 25	23 - 25	22 - 24	24 - 26
Olefins, vol%	10 - 12	10 - 12	11 - 13	11 - 13
Benzene, vol%	0.6 - 1.0	0.6 - 1.0	0.6 - 1.1	0.6 - 1.0
T10, °F	125 - 145	125 - 145	100 - 120	100 - 120
T50, °F	190 - 210	190 - 210	190 - 210	180 - 200
T90, °F	305 - 335	305 - 335	305 - 335	305 - 335

A switch from the winter test fuel to the summer test fuel will occur in each area at a time designated by EPA. At that time, the summer test fuel and the summer control fuel will be added to whatever amounts of winter fuels are in the fleet operator's underground tanks.

b. Fuel storage and distribution

A central location may be used to receive and store the test fuel for each test fleet. The test fuel will be shipped by tank truck to the fleet operators. A fuel distributor will be designated to deliver the test fuel to locations where the test fuel is dispensed.

c. Fuel sampling and analysis

EPA-appointed inspectors will obtain samples from the bulk storage tanks of the test fuel and/or control fuel at the fueling facilities. Fuel samples are to be taken using approved EPA procedures whenever fuel is deposited into the fleet operator's storage tanks, or on a bimonthly basis, whichever is more frequent. Test fuel and control (local) fuel will be sampled at the same time.

Whenever a performance-related problem is reported via the Driveability Incident Log, a sample of fuel from the vehicle's tank should be taken. EPA will provide the fleet operators all the equipment needed to collect the fuel samples, as well as protocols for handling and shipping the sample to EPA for analysis.

## V DATA COLLECTION

Vehicle operators will be provided with fuel in such a way that they are unaware of which type of fuel (test or control) they are using. This may require that local fuel be added to bulk storage tanks for centralized refueling by each control fleet. Operators will be ordered to refuel only at approved dispensers during the period of the study. Operators will then drive the vehicles on the routes typically followed for that vehicle or fleet.

Four types of data will be collected for both test and control vehicles:

1. EPA inspectors will visually inspect each study vehicle bimonthly. Upon completion of each inspection, the EPA inspectors will complete and submit the Fuel System Inspection Log to document the condition of the vehicle's fuel system. The Fuel System Inspection Log will be completed and submitted by EPA inspectors on a continuous basis so data may be processed as soon as possible.
2. A "Driveability Incident Log" will be completed by the fleet operator's maintenance personnel for any potentially fuel-related performance problems reported by the vehicle operator. Upon a report of an incident (component failure or performance problems) the vehicle will be removed from service and inspected by fleet maintenance personnel to determine if the problem is potentially fuel related. The vehicle will be repaired according to normal procedures, and any replaced parts will be retained. If possible, a fuel sample will also be taken from the gas tank. A copy of the repair invoice should be attached to the "Driveability Incident Log" and submitted to EPA for data retrieval, along with the replaced parts and fuel sample. The "Driveability Incident Log" along with the repair invoice will be used to determine the number and causes for fuel related performance problems.
3. The third method of data collection is the review of historical maintenance and repair records obtained from fleet operators. Electronic retrieval of this data is possible from some of the fleets. Some fleets may have only paper copies of records. Any available historical records should be retrieved and provided to EPA prior to the commencement of the study. Records of maintenance and repairs occurring during the study period should be collected monthly and provided to EPA for processing.
4. The fourth method of data collection will consist of a "Refueling Report" to be completed by the fleet operator's fueling personnel for each test and control vehicle, each time fueling occurs. The Refueling Report will include the date, the odometer reading, and the amount of fuel provided. A summary of historical data on fuel consumed and the change in odometer readings over a stated period for test and control vehicles will be provided by the fleet

operator.

## VI DATA ANALYSIS AND REPORTING

Survey data and maintenance records should be provided by the fleet operator every month to EPA. A final report will be issued by EPA following the conclusion of the study. It is envisioned that the final report will include responses totaled for each survey and maintenance field and that each response should be reported as a fraction, or rate, of total responses for each survey and maintenance response category. The data should be analyzed independently for test groups and control groups. At a minimum, study results should be plotted as the incidence rates in the test group versus control group for each response category and each vehicle or equipment classification over the study period.

# FLEET DESCRIPTION

(completed by EPA representatives)

Fleet Name: \_\_\_\_\_

Fleet Code: \_\_\_\_\_

Fleet contact person: \_\_\_\_\_

Phone Number: (\_\_\_\_) \_\_\_\_\_

Street address: \_\_\_\_\_

City: \_\_\_\_\_ Zip Code: \_\_\_\_\_

Winter Fueling - Start date: \_\_/\_\_/\_\_ \_\_\_\_ (mm/dd/yy hhmm, i.e. 02/18/98 0645 - 24 hr clock)

Summer Fueling Start: \_\_/\_\_/\_\_ \_\_\_\_ (mm/dd/yy hhmm)

# VEHICLE DESCRIPTION

(completed by EPA reps)

Fleet: \_\_\_\_\_ Date: \_\_\_\_\_ Inspector: \_\_\_\_\_ Veh lic #: \_\_\_\_\_

Veh. year: \_\_\_\_\_ Mfr: \_\_\_\_\_ Model: \_\_\_\_\_ VIN: \_\_\_\_\_

Odom: \_\_\_\_\_ Trans: Auto or Man Veh type: Car or Truck or MC Fuel group: D2 or D3

**Body:** (sticker on door or door jam)

Build Date: \_\_\_\_\_ GVW: \_\_\_\_\_

**Engine compartment:** (sticker under hood)

Engine Family: \_\_\_\_\_ Emiss Cert yr: \_\_\_\_\_ # Cyls \_\_\_\_\_ Dispm't: \_\_\_\_\_ liters or cu.in.

Fuel System: Fuel inj or TBI or Carb

## Emission control device check:

AI: \_\_\_\_\_ DVAS: \_\_\_\_\_ TAC: \_\_\_\_\_ EVP: \_\_\_\_\_ PCV: \_\_\_\_\_ EGR: \_\_\_\_\_ O2S: \_\_\_\_\_

CCO: \_\_\_\_\_ EWL: \_\_\_\_\_ OC: \_\_\_\_\_ TWC: \_\_\_\_\_ EFE: \_\_\_\_\_ FR: \_\_\_\_\_ Other: \_\_\_\_\_

AI = air inj sys DVAS = diverter valve air sw. TAC = thermostatic air cleaner EVP = evap. emiss sys  
PCV = positive c'case vent valve EGR = exh gas recirc valve O2S = oxygen sensor CCO = computer control  
EWL = engine warning or check eng light OC = oxidation cat TWC = 3-way cat EFE = early fuel evap sys  
FR = fuel filler neck restrictor

Comments: \_\_\_\_\_

## Vehicle fleet records:

Odo: Winter Start: \_\_\_\_\_ Summer Start: \_\_\_\_\_ End Test: \_\_\_\_\_

Fuel quantity used: Winter Test: \_\_\_\_\_ Summer Test: \_\_\_\_\_

Fuel Econ: Winter/Test: \_\_\_\_\_ MPG Winter/Historical: \_\_\_\_\_ MPG  
Summer/Test: \_\_\_\_\_ MPG Summer/Historical: \_\_\_\_\_ MPG

Removed from program - reason: \_\_\_\_\_

Ending date, if removed from program: \_\_\_\_\_



# FUEL SYSTEM INSPECTION LOG

(completed by EPA reps)

Fleet: \_\_\_\_\_ Date: \_\_\_\_\_ Inspector: \_\_\_\_\_ Veh lic #: \_\_\_\_\_

Veh Year: \_\_\_\_\_ Make: \_\_\_\_\_ Model: \_\_\_\_\_

Odom: \_\_\_\_\_ Fuel group: D2 or D3 (circle one)

## Fuel System Inspection:

	<u>Pass/Fail</u> (circle one)	<u>Severity</u> (seep or drip or run) (circle one)
Fuel Tank	P / F	S / D / R)
Fuel Lines and Hoses	P / F	S / D / R)
Fuel Filter(s)	P / F	S / D / R)
Fuel Pump	P / F	S / D / R)

Fuel in Crankcase, smell dipstick Yes or No

Fuel Odor(s) Yes or No

Comments: \_\_\_\_\_

## Fuel Injection System:

	<u>Pass/Fail</u>	<u>Severity</u> (seep or drip or run)
Fuel Injectors:	P / F	S / D / R)
Throttle body injector unit:	P / F	S / D / R)
Other fuel inj. components:	P / F	S / D / R)

Comments: \_\_\_\_\_

## Carbureted fuel systems: yes / no

	<u>Pass/Fail</u>	<u>Severity</u> (seep or drip or run)
Carburetor	P / F	S / D / R)
Accelerator pump:	P / F	S / D / R)

Comments: \_\_\_\_\_

# DRIVEABILITY INCIDENT LOG

(completed by fleet operator)

Fleet: \_\_\_\_\_ Date of driveability incident: \_\_\_\_\_ Driver: \_\_\_\_\_

Veh lic #: \_\_\_\_\_ Veh. make: \_\_\_\_\_ Model: \_\_\_\_\_ Yr: \_\_\_\_\_

Odom: \_\_\_\_\_ Fuel group: D2 or D3 (circle one)

Weather conditions on date of incident: \_\_\_\_\_

## Type of Performance Problems:

If a driveability problem occurred, please provide a description

Hesitation: \_\_\_\_\_

Surge: \_\_\_\_\_

Stall: \_\_\_\_\_

Odor: \_\_\_\_\_

Noise: \_\_\_\_\_

Other: \_\_\_\_\_

## Driving Mode - when performance problems occurred:

Highway Driving: Yes or No City Driving: Yes or No

Cold Starting: Yes or No Hot Starting: Yes or No

Morning Driving: Yes or No Afternoon Driving: Yes or No Evening Driving: Yes or No

Idle: Yes or No Acceleration: Yes or No Cruise: Yes or No

Additional Comments: \_\_\_\_\_

Date of resulting (or next) vehicle inspection: \_\_\_\_\_ Inspector: \_\_\_\_\_ Odom: \_\_\_\_\_

# Fuel System Repair Summary

(completed by fleet maintenance personnel)

Fleet: \_\_\_\_\_ Name: \_\_\_\_\_ Fuel group: D2 or D3 (circle one)

Veh lic #: \_\_\_\_\_ Veh. make: \_\_\_\_\_ Model: \_\_\_\_\_ Yr: \_\_\_\_\_

Repair Date: \_\_\_/\_\_\_/\_\_\_ Odom: \_\_\_\_\_

Description of malfunction and symptoms: \_\_\_\_\_

\_\_\_\_\_

Did the repairs and adjustments involve any of the following components? Yes or No (circle one)

If yes, please describe.

Fuel tank: \_\_\_\_\_

Fuel lines, hoses: \_\_\_\_\_

Fuel filter(s): \_\_\_\_\_

Fuel pump: \_\_\_\_\_

Fuel injectors: \_\_\_\_\_

Fuel inj sys: \_\_\_\_\_

Carburetor: \_\_\_\_\_

Accel pump: \_\_\_\_\_

Fuel in Crankcase: \_\_\_\_\_

Seals: \_\_\_\_\_

How was the problem diagnosed? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Was a repair made to correct the problem? Yes or No

If yes, what repair was made? \_\_\_\_\_

\_\_\_\_\_

If repairs were made, were the replaced parts kept? Yes or No or Not applicable

Was a fuel sample taken following the incident? Yes or No

If yes, from which of the following tanks was the sample taken?

From vehicle's tank? Y or N From the dispenser/storage tank where vehicle was last refueled: Y or N

# VEHICLE REFUELING REPORT

(completed by driver or other vehicle refueling personnel)

Veh Lic #: \_\_\_\_\_ Make: \_\_\_\_\_ Model: \_\_\_\_\_

<u>Name</u>	<u>Date</u>	<u>Odometer</u>	<u>Gallons added</u>	<u>Gasoline tank/dispenser</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

# BULK STORAGE REFUELING REPORT

(completed by fleet operator)

<u>Name</u>	<u>Date</u>	<u>Gallons added</u>	<u>Storage tank used</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____