

AIR RESOURCES BOARD2020 L STREET
P.O. BOX 2815
SACRAMENTO, CA 95814-2815State of California
AIR RESOURCES BOARD

Notice of Public Availability of Modified Text

PUBLIC HEARING TO CONSIDER PROPOSED AMENDMENTS TO THE CALIFORNIA REGULATION REQUIRING DEPOSIT CONTROL ADDITIVES IN MOTOR VEHICLE GASOLINEPublic Hearing Date: November 16, 1995
Public Availability Date: December 22, 1995
Deadline for Public Comment: January 12, 1996

At a public hearing held November 16, 1995, the Air Resources Board (the "Board") considered amendments to the gasoline deposit control additive requirements in section 2257, title 13, California Code of Regulations, and the ARB "Test Method for Evaluating Port Fuel Injector (PFI) Deposits in Vehicle Engines." The proposed amendments affected the certification test fuel requirements, the vehicle test procedures, the recordkeeping requirements and various other provisions of the regulation and the incorporated test method. The originally proposed regulatory action is described in detail in the Staff Report, "Proposed Amendments to the California Regulation Requiring Deposit Control Additives in Motor Vehicle Gasoline," released to the public on September 29, 1995.

In resolution 95-47, the Board approved the originally proposed amendments with various modifications that were recommended by staff at the November 16, 1995, hearing. In accordance with Government Code section 11346.8(c), the Board directed the Executive Officer to make the modified text available for a supplemental written comment period of 15 days. He is then directed either to adopt the modified regulations with such additional changes as may be appropriate in light of the supplemental comments, or to present them to the Board for further consideration if he determines such an action is warranted by the comments.

The modifications to the originally proposed text consisted of the following changes:

- Section 2257(a)(3) was rewritten to allow the manual addition of a deposit control additive after a gasoline load has left the final distribution facility up to the point of retail sale of gasoline.
- Section 2257(c)(2)(D) and (E) of the original proposal was rewritten for clarity. The original proposal was further modified to provide that the T90 distillation



temperature of the certification test fuel must be typical of commercial gasoline because the 80 percent requirement of the original proposal was inappropriate for this property.

- Originally, staff had proposed to clarify the regulatory text of section 2257(d), affecting additive facility recordkeeping requirements. However, based on comments received prior to the hearing, staff recommended, and the Board agreed, to postpone making any change to this section until the United States Environmental Protection Agency (U.S. EPA) promulgates their final gasoline additive regulation sometime in 1996. The Board directed staff to evaluate the U.S. EPA additive rule to determine its impact on the California additive program and to recommend further changes as appropriate.
- At the public hearing, the Board approved the replacement of outdated Air Resources Board test methods for evaluating port fuel injectors (PFI) to incorporate the most recent American Society for Testing and Materials (ASTM) test method for PFI evaluation. Modifications were made to the originally revised Air Resources Board test method for evaluating port fuel injectors (PFI) to remove all references to engine tests. This change allows the revised Air Resources Board test method to be fully consistent with the most recent ASTM PFI test method.

The modified regulations are being made available by this notice for public comment prior to final action by the Executive Officer. Attached are the modified texts of section 2257 of title 13, California Code of regulations (Attachment A) and to the "Test Method for Evaluating Port Fuel Injector (PFI) Deposits in Vehicle Engines" (Attachment B). The originally proposed amendments are shown in *italics* to show additions to the text and ~~strikeouts~~ to show deletions to the text. Modifications to the original proposal are shown in *shadowed italics* to show additions to the text and ~~shadowed strikeouts~~ to show deletions to the text.

Written comments must be submitted to the Board Secretary, Air Resources Board, P.O. Box 2815, Sacramento, California 95812, no later than January 12, 1996, for consideration by the Executive Officer prior to final action. Only comments relating to the modifications described in this notice will be considered by the Executive Officer. The modified text which is being made available for comments are indicated by shadowed text in the following attachments.

Attachments

Attachment A

**STAFF'S PROPOSED MODIFICATIONS
TO THE ORIGINAL REGULATION ORDER
OF THE STAFF REPORT**



PROPOSED REGULATION ORDER

The text of the originally proposed amendments is shown in *italics* to indicate additions to and ~~strikeout~~ to show deletions from the existing regulation. The modifications now being made available for comments are shown in ~~shadowed italics~~ to show additions to and ~~shadowed strikeout~~ to show deletions from the original proposal.

Amend title 13, California Code of Regulations, section 2257 to read as follows:

§ 2257. Required Additives in Gasoline.

(a) Regulatory Standard.

(1) On or after January 1, 1992, no person shall sell, offer for sale, supply, or offer for supply any California gasoline unless at the time of the transaction:

[i] the producer, importer, or distributor of the gasoline has been issued a currently effective certification pursuant to subsection (c), and

[ii] the gasoline contains at least the minimum concentration of the additive or additives identified in *the* final application for certification.

(2) Subsection (a)(1) shall not apply to transactions where the person selling, supplying, or offering the gasoline demonstrates that:

[i] the gasoline has not yet been sold, offered, or supplied from the final distribution facility, and either

[ii] the person has taken reasonably prudent precautions to assure that he or she will bring the gasoline into satisfaction with the requirements of subsection (a)(1) before it is sold, supplied or offered from the final distribution facility, or

[iii] at or before the time of the transaction the person has obtained a written statement from the purchaser, recipient, or offeree of the gasoline stating that he or she is a distributor who has been issued a currently effective certification pursuant to subsection (c), and will cause the gasoline to satisfy the requirements of subsection (a)(1) before it is sold, supplied or offered from the final distribution facility.

(3) *Subsection (a)(1)[ii] shall not apply to the sale, supply, or offer of gasoline from a final distribution facility where the person selling, supplying, or offering the gasoline demonstrates that the gasoline will be corrected to comply with section (a)(1)[ii] prior to the sale of gasoline from the retail outlet to or at the time of delivery to the facility at which the gasoline will be dispensed into motor vehicles. If such corrective action is taken, the producer, importer, or distributor of the gasoline must notify the Compliance Division of the Air Resources Board by telephone or in writing within 2 business days of the correction and must maintain records to document each occurrence in accordance with subsection (d).*

(4) For the purposes of subsection (a)(1), each sale of gasoline at retail for use in a motor vehicle, and each supply of gasoline into a motor vehicle fuel tank, shall also be deemed

a sale or supply by any person who previously sold or supplied such gasoline in violation of subsection (a)(1).

(b) Definitions.

For the purposes of this section:

(1) "Additive" means any substance or mixture of substances that is intentionally added to gasoline for the purpose of reducing or preventing fuel injection system or intake valve deposits, and that is not intentionally removed prior to the gasoline's sale or use.

(2) "Bulk purchaser-consumer" means a person who purchases or otherwise obtains gasoline in bulk and then dispenses it into the fuel tanks of motor vehicles owned or operated by the person.

(3) "California gasoline" means gasoline sold or intended for sale ~~asa~~ as a motor vehicle fuel in California.

(4) "Chemical composition" means the name, percentage by weight, and chemical identification of each compound in an additive.

(5) "Distributor" means any person who transports or stores or causes the transportation or storage of gasoline, produced or imported by another person, at any point between any producer's or importer's facility and any retail outlet or wholesale purchaser-consumer's facility.

(6) "Final distribution facility" means the stationary gasoline transfer point from which gasoline is transferred into the cargo tank truck, pipeline, or other delivery vessel from which the gasoline will be delivered to the facility at which the gasoline will be dispensed into motor vehicles.

(7) "Gasoline" means any fuel which is *sold or intended for sale as a California motor vehicle fuel and is either: (a) commonly or commercially known or sold as gasoline, or (b) any fuel blend which is a mixture of gasoline as defined in (a) and alcohol in which the portion of gasoline is more than 50 percent of the total blend fuel commonly known or sold as gasoline and alcohol and which is sold or intended for sale as a motor vehicle fuel in California.*

(8) "Gasoline production facility" means a facility in California at which gasoline is produced; it does not include a facility whose sole operation is to transfer gasoline or to blend additives into gasoline.

(9) "Importer" means any person who first accepts delivery of gasoline in California.

(10) "Import facility" means the facility at which imported gasoline is first received in California, including, in the case of gasoline imported by cargo tank and delivered directly to a facility for dispensing gasoline into motor vehicles, the cargo tank in which the gasoline is imported.

(11) "Motor vehicle" has the same meaning as defined in section 415 of the Vehicle Code.

(12) "Produce" means to convert liquid compounds which are not gasoline into gasoline.

(13) "Producer" means any person who produces California gasoline in California.

(14) "Retail outlet" means any establishment at which gasoline is sold or offered for sale for use in motor vehicles.

(15) "Supply" means to provide or transfer a product to a physically separate facility,

vehicle, or transportation system.

(c) Certification Requirements.

(1)(A) No gasoline formulation shall be certified under this subsection (c) unless the applicant for certification demonstrates each of the following to the executive officer's satisfaction:

(i) The gasoline formulation meets the unlimited mileage standard of ~~an average of a~~ maximum of 100 milligrams ~~per averaged over all~~ intake valves when tested in accordance with ~~ASTM D 5500-94 the Stationary Source Division's BMW 10,000 Mile Intake Valve Test Procedure, dated March 1, 1991,~~ which is incorporated herein by reference.

(ii) The gasoline formulation does not result in a flow loss of more than five percent ~~for any fuel injector~~ when tested in accordance with ~~ASTM D 5598-94 the Stationary Source Division's Test Method for Evaluating Port Fuel Injector Deposits in Vehicle Engines, dated March 1, 1991,~~ which is incorporated herein by reference.

(iii) The gasoline formulation is capable of reducing fuel injector deposits so that no fuel injector suffers a flow loss of more than five percent when tested in accordance with the Stationary Source Division's Test Method for Evaluating Port Fuel Injector Deposits in Vehicle Engines, dated ~~March 1, 1991~~ *[insert date of adoption]*, which is incorporated herein by reference.

(B) The executive officer may approve alternative test procedures for demonstrating satisfaction with any of the performance criteria set forth in subsection (c)(1)(A) if an applicant or potential applicant demonstrates to the executive officer's satisfaction that a gasoline formulation which meets the performance criteria of the alternative test procedure would also meet the performance criteria specified in subsection (c)(1)(A).

(2) Any producer, importer, or distributor may apply to the executive officer for certification of a gasoline formulation in accordance with this subsection (c). The application shall be in writing and shall include, at a minimum, the following:

(A) The name and chemical composition of the additive or additives in the gasoline formulation, except that if the chemical composition is not known to either the applicant or to the manufacturer of the additive (if other than the applicant), the applicant may provide a full disclosure of the chemical process of manufacture of the additive in lieu of its chemical composition.

(B) The minimum concentration of each additive in the gasoline formulation *in terms of gallons of additive per thousand gallons of gasoline.*

(C) The results of tests conducted on the gasoline formulation pursuant to the test procedures set forth in subsection (c)(1), all data generated by the tests, the identity of the entity which conducted each test, and a description of the quality assurance and quality control procedures used during the testing.

(D) Data demonstrating that the ~~gasoline formulation used in the tests is representative of the gasoline produced, imported, or distributed by the applicant~~ *fuel used for certification testing ("certification test fuel") is representative of the gasoline formulation for which certification is requested. Properties of the certification test fuel must be at least 80 percent of the maximum properties of the gasoline formulation to be certified for the following: aromatic hydrocarbon content, olefin content, sulfur content, and oxygen content, and 190 distillation*

temperature. All other certification test fuel properties must be representative of typical commercial gasoline.

(E) Data demonstrating that the certification test fuel is representative of typical commercial gasoline and will be produced from typical refinery blend stocks.

(FE) The theoretical mechanism of action (if known) of the additive in meeting any of the performance criteria set forth in subsection (c)(1)(A).

(GF) Copies of all material pertaining to the additive or additives in the gasoline formulation, submitted by the applicant to the U.S. Environmental Protection Agency pursuant to 40 CFR sections 79.6, 79.10 and 79.11. If the applicant has submitted no such material, copies of all material pertaining to the additive or additives in the gasoline formulation, submitted by the additive manufacturer to the U. S. Environmental Protection Agency pursuant to 40 CFR sections 79.6, 79.20 and 79.21.

(HG) A test method reasonably adequate for determining the presence and concentration of each additive in the gasoline, *including test method reproducibility*. The test method may involve identification of the presence of a surrogate marker substance if the applicant demonstrates that such test method will adequately demonstrate the presence and concentration of the additive.

(3) Within 30 days of receipt of an application, the executive officer shall advise the applicant in writing either that it is complete or that specified additional information is required to make it complete. Within 30 days of submittal of additional information, the executive officer shall advise the applicant in writing either that the application is complete, or that specified additional information or testing is still required before it can be deemed complete.

(4) If the executive officer finds that an application meets the requirements of this section and determines that the applicant has satisfactorily made the demonstrations identified in subsection (c)(1), then he or she shall issue an Executive Order certifying the gasoline fuel formulation. The executive officer shall act on a complete application within 30 days after the application is deemed complete.

(5) If the executive officer determines that the gasoline sold by a producer, importer or distributor contains the minimum concentration of additives identified in an applicable certification, but substantially fails to meet the performance criteria set forth in subsection (c)(1), the executive officer shall evoke or modify the prior certification as is necessary to assure that gasoline sold by the producer, importer or distributor meets the performance criteria set forth in subsection (c)(1). The executive officer shall not revoke or modify a prior certification order without first affording the applicant for the certification an opportunity for a hearing in accordance with title 17, California Code of Regulations, part III, chapter 1, subchapter 1, article 4 (commencing with section 60040). If the executive officer determines that a producer, importer or distributor would be unable to comply with this regulation as a direct result of a certification revocation or modification pursuant to this subsection, the executive officer may delay the effective date of such revocation or modification for such period of time as is necessary to permit the person to come into compliance in the exercise of all reasonable diligence.

(d) Recordkeeping.

(1) Each producer, importer, and distributor who has been issued a certification pursuant

to subsection (c) ~~shall~~ *must* maintain records ~~identifying for identifying~~ each facility at which he or she adds an additive to California gasoline in order to comply with subsection (a)(1). For each such facility, ~~commencing January 1, 1992,~~ the producer, importer or distributor ~~shall must~~ ~~compile compile maintain daily records for each business day and compile those records monthly,~~ showing ~~on a monthly basis on a monthly basis~~ for each grade of gasoline:

[i] the volume of California gasoline supplied from the facility by the producer, importer or distributor,

[ii] the volume of California gasoline to which the producer, importer or distributor added the additive to comply with subsection (a)(1), ~~and and~~

[iii] the name and volume of each additive (or additive package) ~~used~~ added to the California gasoline fuel; ~~and~~

~~(iv) the actual additive usage rate achieved.~~

~~(2) For purposes of demonstrating compliance with the standard in subsection (a)(1) based on the records required under this subsection (d)(1)~~

~~(i) Monthly records must demonstrate that for each month the gasoline on average contains at least the minimum concentration of the additive or additives identified in the final application for certification.~~

~~(ii) Daily records must demonstrate that for each 24-hour period the gasoline on average contains at least 95 percent of the minimum concentration of the additive or additives identified in the final application for certification.~~

~~(3) Daily records and the monthly compilations covering a calendar month must be available for inspection 15 days after the end of the month. The daily records and monthly compilation of ~~Dr.~~ Records covering a month shall covering a month must be compiled no later than 30 days after the end of the month, and shall be compiled no later than 30 days after the end of the month, and shall must be retained for at least two years after the end of the month after the end of the month.~~

~~(422) Any person required by subsection (d)(1) to maintain and compile and retain and retain records shall provide to the executive officer any such records within 20 days of a must provide to the executive officer any such records within 20 days of a must make those records available for inspection and copying immediately upon request by the executive officer or his/her designee. Upon a written request received received from the executive officer or her/her designee, a copy of the daily records must be provided to the executive officer within 20 days of the request before expiration of the period during which the records are required to be retained before expiration of the period during which the records are required to be retained.~~ Whenever such a person fails to provide records regarding a volume of California gasoline in accordance with this subsection (d)~~(422)~~, the volume of California gasoline ~~shall~~ will be presumed to have been sold by the person in violation of subsection (a)(1).

Note: Authority cited: Sections 39600, 39601, 43013, 43018, and 43101 of the Health and Safety Code, and *Western Oil and Gas Ass'n. v. Orange County Air Pollution Control District*, 14 Cal.3d 411, 121 Cal.Rptr. 249 (1975). Reference: Sections 39000, 39001, 39002, 39003, 39500, 39515, 39516, 41511, 43000, 43016, 43018, and 43101, Health and Safety Code, and *Western Oil and Gas Ass'n. v. Orange County Air Pollution Control District*, 14 Cal.3d 411, 121 Cal.Rptr. 249 (1975).



Attachment B

**STAFF'S PROPOSED MODIFICATIONS TO THE TEST METHOD
FOR EVALUATING PORT FUEL INJECTOR (PFI) DEPOSITS
IN VEHICLE ENGINES**

1950

1950

Test Method for Evaluating Port Fuel Injector (PFI)

Deposits in Vehicle Engines

NOTE: This document is printed in a style to show both the proposed amendments to the existing Air Resources Board (ARB) test procedure dated March 1, 1991, and ARB's revisions to ASTM D 5598-94, which is incorporated by reference in the ARB test procedure. Proposed amendments to the ARB test procedure appear in *italics* to indicate additions to and ~~strikeout~~ to indicate deletions from the existing test procedure. ARB's revisions to ASTM D 5598-94 are shown in underline to denote additions to and [~~bracketed strikeout~~] to denote deletions from the ASTM test method. Staff's proposed modifications to the originally proposed test procedures which are being made available for comment are shown in ~~shaded~~ ~~strikeout~~.

1911

1912

STATE OF CALIFORNIA
AIR RESOURCES BOARD
STATIONARY SOURCE DIVISION

March 1, 1991 [insert date of adoption]

TEST METHOD FOR EVALUATING PORT FUEL INJECTOR
(PFI) DEPOSITS IN VEHICLE ENGINES

A. PURPOSE

The purpose of this test procedure is to evaluate the port fuel injector keep-clean characteristics of gasoline formulations and the effectiveness of gasoline formulations in cleaning up injector deposits. This test procedure closely follows ~~the CRC test procedure described in CRC Report No. 565, "A Program to Evaluate a Vehicle Test Method for Port Fuel Injector Deposit Forming Tendencies of Unleaded Base Gasolines", February 1989 ASTM D 5598, with some modifications to test for clean-up ability.~~

B. TEST PROCEDURE OUTLINE

1. Keep-Clean Procedure

The keep-clean test procedure shall start with a vehicle/engine equipped with new fuel injectors. To avoid variability due to engine break-in effects, testing should begin only after 4,000 miles equivalent have accumulated. At the beginning of the test, the flow capacities of the injectors are measured. The vehicle/engine is operated on the applicant's additized gasoline fuel for the prescribed test cycle and the fuel injectors ~~are~~ *may be* flow-tested ~~not more than every 1000 miles equivalent to determine their flow capacities.~~ After the vehicle/engine/vehicle is operated for 10,000 miles equivalent on the prescribed test cycle, the fuel injectors are tested again to determine their flow capacities. *If the fuel injector No. 3 maximum skin temperature does not exceed 90° C (194° F) for more than 95% (685) of the hot soak cycles, then the test will be declared invalid unless a minimum of 685 total hot soak cycles with PFI No. 3 exceeding 90° C are met within an additional 2500 miles.*

2. Clean-Up Procedure

The clean-up test procedure shall start with a vehicle/engine equipped with new fuel injectors. To avoid variability due to engine break-in effects, testing should begin only

after 4,000 miles equivalent have accumulated. At the beginning of the test, the flow capacities of the injectors are measured. The vehicle/engine is operated for the prescribed test cycle on the base *dirty-up* fuel (as described in section C.4) for 10,000 miles equivalent or for as long as needed so that at least one of the injectors is at the 10% flow restriction level. Fuel injectors are flow tested every 1000 miles equivalent. Then ~~the~~ The vehicle/engine shall *must then* be operated on the applicant's additized gasoline formulation for a maximum of an additional 10,000 miles equivalent and fuel injectors shall be tested to determine their flow capacities the prescribed test cycle up to 10,000 miles equivalent or until the fuel injectors all drop to less than a 5% flow restriction level. The fuel injectors may be flow-tested not more than every 1000 miles. After the test is completed, the fuel injectors are tested again to determine their flow capacities. If the fuel injector No. 3 maximum skin temperature does not exceed 90° C (194° F) for more than 95% of the hot soak cycles, then the test will be declared invalid.

C. TEST PROGRAM

~~1. Test Vehicle/Engine~~

~~The test vehicle/engine used for this test program shall be a Chrysler vehicle equipped with a 2.2L, I-4, turbocharged engine.~~

~~2. Vehicle/Engine Preparation~~

~~The vehicle/engine shall be tuned to perform according to the manufacturer's specifications.~~

~~3. Test Cycle~~

~~The operating cycle for both keep clean and clean-up test procedures shall consist of 15 minutes of operation at 55 mph road load followed by 45 minutes hot soak with the engine shut off.~~

~~The test cycle is repeated for 10,000 miles equivalent. Vehicle running conditions may be accomplished on a test track, road simulator or chassis dynamometer. It is important that the test vehicle be rapidly brought to 55 mph, as well as back to zero at the end. For open road operations, it is desirable to minimize the travel distance to reach the operating speed of 55 mph.~~

~~For hot soak, no special options are needed, (e.g., blankets, engine shrouds, etc). The intent is to run the vehicle in a realistic way "simulating" customer driving experiences.~~

~~NOTE: ALL TESTS, INCLUDING REPEAT RUNS, ARE TO START WITH NEW,
FLOW-RATED INJECTORS.~~

~~4. Test Fuels~~

~~The base gasoline shall be a full-boiling, commercial type unleaded base gasoline with properties approximating those in Attachment A. Another base fuel may be substituted for the fuel prescribed in Attachment A after approval by the Executive Officer. The substitute fuel must be successful in causing enough deposits to plug at least one of the injectors to the 10% flow restriction level before 10,000 miles equivalent of vehicle/engine operation.~~

~~The gasoline formulation tested shall be typical of the product sold or intended to be sold in California.~~

~~Typical properties and analyses (from tests such as listed in Attachment A) for each fuel shall be provided when the fuel batches are made available. As a check on fuel uniformity, the following tests shall be run for each fuel at the beginning and at the end of the test program:~~

~~ASTM D381 (gum)~~

~~ASTM D525 (stability)~~

~~R.V.P.~~

~~ASTM distillation~~

~~5. Engine Oil~~

~~The same crankcase engine oil, an SAE 10W-30 viscosity grade of API SE or higher quality, shall be used throughout the test program. Prior to each test run, the engine shall be flushed with fresh oil following an oil filter change. Drain the oil, change filter, and put in a fresh change of the same oil for the test.~~

~~6. Fuel Injectors~~

~~OEM part number pintle style injectors with solid plastic cap ONLY, as manufactured by Bosch, are to be used.~~

~~D. MEASUREMENTS~~

~~1. Fuel Rail Pressure~~

~~The injector fuel rail pressure in the vehicle must be at the manufacturer's specified level during engine operation and remain at about the same level during the 45-minute shutdown period. A malfunctioning pressure regulator will allow the rail pressure to~~

~~decrease during the shutdown period, which can decrease PFI deposit formation rates. Fuel rail pressure shall be checked once per day during the operation period and within 10 minutes after shutdown.~~

~~2. Injector Flow Rate Measurement~~

~~a. The laboratory flow apparatus shall control fuel pressure at about the same level as the fuel rail pressure of the vehicle/engine during operation.~~

~~b. A light hydrocarbon (isooctane, mineral spirit, or stoddard solvent) shall be used for flow rate tests.~~

~~c. The injector shall be flowed statically (wide open) for ten seconds \pm one second. Longer time intervals may risk overheating the injector solenoid. The timing interval shall be reported to hundredths of a second. Bosch indicates injectors open fully at 8 volts DC without risk of overheating, which allows longer flow times to improve measurement accuracy.~~

~~d. A minimum of three repeat flow rate tests per injector are considered necessary. If necessary, additional tests must be run until repeat results have less than 1% variability (1% variability is reasonable expectation for new injectors). The average (to two decimal places) shall be reported as the flow rate for that injector measurement.~~

~~e. Injector flow rates shall be measured as soon as possible, and in no case greater than 24 hours, after removal from the vehicle to avoid drying out and possible effects on deposit stability.~~

~~f. For clean injectors at the start of each test, run the Injector Leak Rate Test to check for leaking, dribbling, etc. (See Attachment B). As injectors become fouled, the probability of pintle leakage increases. Deposit formation may cause an improper seal between pintle and injector opening, thus causing leakage. The upper production limit of leakage with air is 2cc per min. (at approx. 50 psi). Injectors leaking above this rate shall be rejected for the test. To avoid unnecessary rejection of new injectors due to dirt particles, the injectors shall be first flowed with liquid. This will serve to flush the critical internal areas before leak testing with air.~~

~~g. Rate injectors every 1000 miles.~~

~~h. For new injectors, flow rates within a test set for an engine shall fall within \pm 2% of each other.~~

~~3. Temperature Measurement~~

~~The following temperature measurements shall be recorded:~~

- ~~a. Ambient at test site (maximum and minimum for every 24 hour time period).~~
- ~~b. Inlet air, coolant, oil and fuel tank (typical maximum for each day).~~
- ~~c. Bulk or individual cylinder exhaust gas during operation.~~

~~4. Fuel Consumption~~

~~For each test, the fuel consumed per odometer miles traveled should be recorded with reasonable accuracy. Use of a standard gasoline dispensing pump is satisfactory. One average per test program is a representative measurement.~~

~~E. PRESENTATION OF DATA~~

~~The testing laboratory is required to provide the following in their final report:~~

- ~~1. Total number of soak cycles for the complete test and number of soaks per 1,000 miles equivalent.~~
- ~~2. Tabulation of raw flow rates for each injector by cylinder position as a function of miles or cycles.~~
- ~~3. Graphs of injector flow rates versus vehicle/engine miles equivalent, per fuel.~~
- ~~4. Graph typical exhaust gas temperature during stabilized road load operation for each cycle.~~

1. *Keep-Clean Procedure*

The following procedure must be used: ASTM D 5598-94, Standard Test Method for Evaluating Unleaded Automotive Spark-Ignition Engine Fuel for Electronic Port Fuel Injector Fouling.

2. *Clean-Up Procedure*

The following procedure must be used: ASTM D 5598-94, Standard Test Method for Evaluating Unleaded Automotive Spark-Ignition Engine Fuel for Electronic Port Fuel Injector Fouling, with the following modifications:

a. Section 7. Reagents and Materials, add the following:

7.7 Dirty-Up Fuel -- The dirty-up fuel must be a full boiling, unleaded gasoline that is capable of causing enough deposits to plug at least one of the injectors to the 10% flow restriction level before 10,000 miles of vehicle operation. For example, the dirty-up fuel may have the following properties:

<u>Fuel Property</u>	<u>Level</u>
<u>Octane, (R+M)/2</u>	<u>87 min.</u>
<u>Existent gum, mg/dl</u>	<u>3 min.</u>
<u>Sulfur, ppm</u>	<u>150 min.</u>
<u>Hydrocarbon type, vol%</u>	
<u>Olefins</u>	<u>20 min.</u>
<u>Aromatics</u>	<u>30 min.</u>
<u>Reid vapor pressure, psi</u>	<u>11.5 max.</u>
<u>Distillation, °F</u>	
<u>50% evaporated</u>	<u>170 min.</u>
<u>90% evaporated</u>	<u>374 max.</u>
<u>Induction period, minutes</u>	<u>240 min.</u>

b. Section 7. Reagents and Materials, change the following:

7.5 Test Fuel -- A test fuel shall be either a base fuel or a homogeneous blend of additives and base fuel. A single batch of base fuel shall be blended before the start of the test. The fuel may be stored in drums or tankage and shall be clearly labeled to prevent misfueling. During PFI testing, the test fuel shall be tested for the following properties using standard test methods: aromatics and olefins contents, full distillation range, gum, and sulfur. Quantities of fuel and additive blended and dispensed shall be measured and recorded. [Approximately 2300 L (600 gal) of fuel are required for this test method.]

c. Section 9. Test Procedure, change the following:

9.2 Mileage Accumulation -- The mileage accumulation is divided into two parts: the dirty-up phase and the clean-up phase. Mileage is first accumulated on the dirty-up fuel until at least one of the injectors is at the 10% flow restriction level. After completing the dirty-up phase, the fuel tank is drained and flushed as in 8.2.4. The fuel tank is then filled with the test fuel and mileage accumulation will continue up to a maximum of 10,000 miles on the test fuel or until all injectors measure less than 5% flow restriction. Mileage accumulation will be performed as follows:

The dynamometer, test track, road mileage accumulation cycle, or combination thereof, consists of a series of driving cycles and engine-off hot soak cycles. The test vehicle shall be started and accelerated to 88 kph (55 mph) within 30 s of start-up. The test vehicle shall be accelerated to 88 kph, driven for 15 min, or approximately 22 km (14 miles), and then allowed to coast, or vehicle may be braked, to a stop within 30 s. The engine is then turned off and the vehicle undergoes a 45-min hot soak cycle. The vehicle shall be allowed to soak for 45 min in calm air, with all fans turned off. These test cycles may be run 24 h per day or less. The vehicle shall repeat this cycle for 16,100 km (10,000 miles). The fuel injectors may be removed and flow tested, however, not more than every 1600 km (1000 miles) during the clean-up phase.

d. Section 10. Determination of Test Results, change the following:

10.5.1.1 Test Cycle Validation Criteria -- If the fuel injector No. 3 maximum skin temperature does not exceed 90° C (194° F) for more than 95% of the hot soak cycles [~~of a 16,100 km (10,000 mile) test length (or 685 of 725 hot soak cycles)]~~ then the test will be declared invalid. However, any hot soaks during the test for which PFI No. 3 skin temperature does not exceed 90° C, may be repeated until a minimum of ~~[685]~~ 95% of the total hot soak cycles with PFI No. 3 exceeding 90° C are met [~~within an additional 4000 km (2500 miles). Thus the maximum length for any fuel injector fouling test shall be 21,100 kilometers (12,500 miles) or a maximum of 910 hot soaks]~~].

e. Section 11. Final Test Report, add the following:

11.1.5 Fuel property test results.

ATTACHMENT A

BASE FUEL PROPERTIES

Fuel Properties

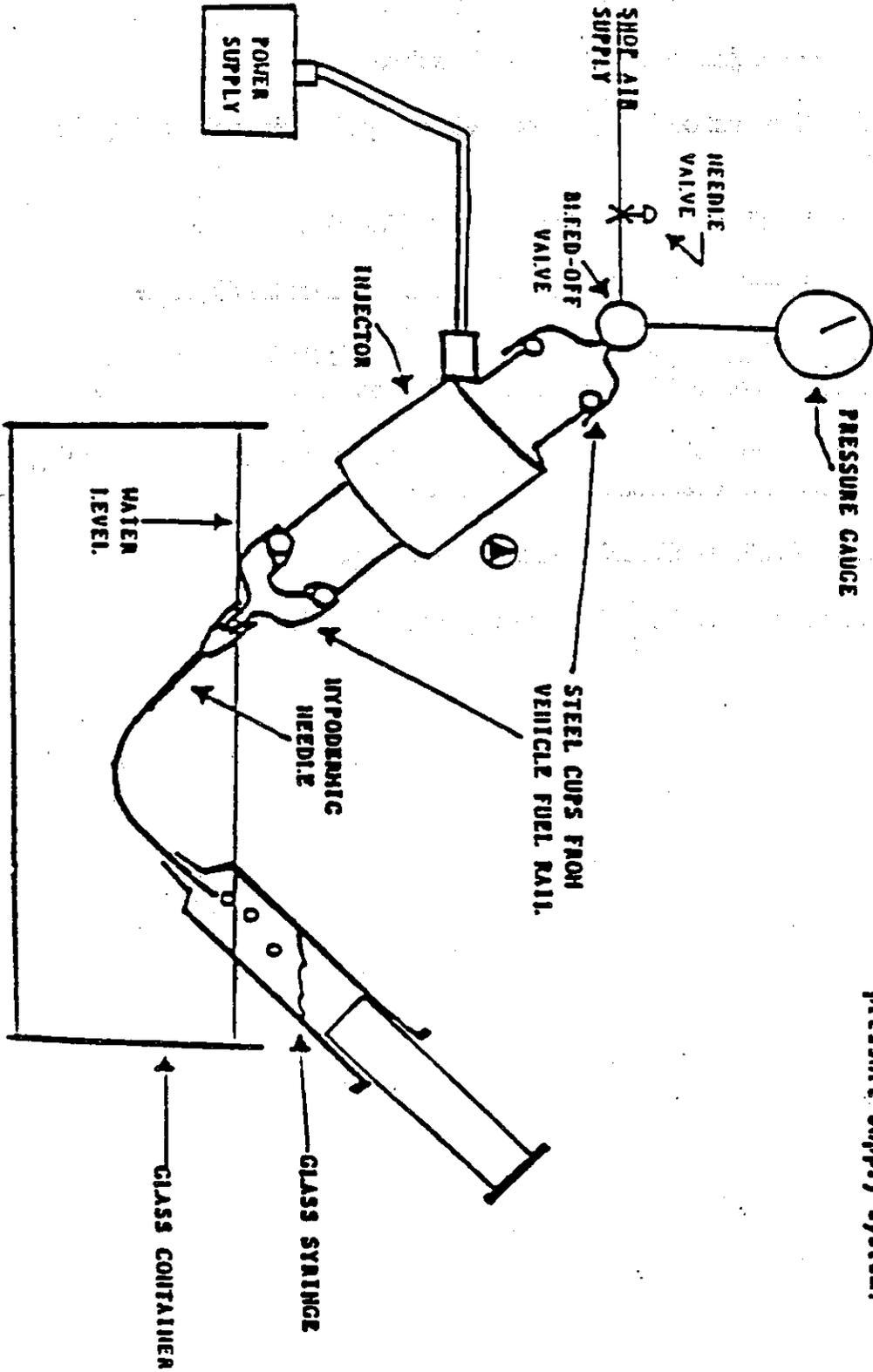
Gravity, °API	59.9
Specific Gravity @ 15.6°C	0.74
Distillation, °C	
IBP	33
10%	48
50%	106
90%	188
EP	218
Total Olefins, % vol.	35
Induction Period, minutes	270
RVP (psi)	11.8
Gum, mg/100ml	
Unwashed	7.0
Washed	6.0
Sulfur, % wt.	0.08

~~ATTACHMENT B~~

~~Injector Leak Rate Test Procedure~~

- ~~1. Blow any residual fluids out of the injector with clean, dry shop air while holding the injector open.~~
- ~~2. While the injector is still open, rinse with acetone and blow dry. Repeat.~~
- ~~3. Mount injector in rig and attach hypodermic needle assemblies in the diagram.~~
- ~~4. Place a 5 ml, water-filled syringe over the hypodermic needle tip for gas collection and volumetric measurements at 0.25, 1.0 and 5.0 ml. Immerse in bath as illustrated.~~
- ~~5. Apply 50 PSI air pressure and collect the air bubbles at the hypodermic needle tip using the 5 ml syringe measured over a suitable time period.~~
- ~~6. Record results as ml's of air collected per one minute time period.~~
- ~~7. Repeat until 3 consecutive results in the same range are obtained.~~

[DELETE]



INJECTOR LEAK TEST APPARATUS

Ⓐ NOT SHOWN: A clamping device which holds the injector body into the air pressure supply system.