State of California
AIR RESOURCES BOARD

Resolution 98-46

September 24, 1998

Agenda Item No.: 98-10-1

WHEREAS, sections 39600 and 39601 of the Health and Safety Code authorize the Air Resources Board (ARB or Board) to adopt standards, rules and regulations and to do such acts as may be necessary for the proper execution of the powers and duties granted to and imposed upon the Board by law;

WHEREAS, Health and Safety Code section 43018(a) enacted by the California Clean Air Act of 1988, directs the Board to endeavor to achieve the maximum degree of emission reduction possible from vehicular and other mobile sources in order to accomplish the attainment of the state ambient air quality standards at the earliest practicable date;

WHEREAS, Health and Safety Code section 43018(c) provides that in carrying out section 43018, the Board shall adopt standards and regulations which will result in the most cost-effective combination of control measures on all classes of motor vehicles and motor vehicle fuel, including but not limited to specification of vehicular fuel composition;

WHEREAS, Health and Safety Code section 43013 authorizes the Board to adopt and implement motor vehicle fuel specifications for the control of air contaminants and sources of air pollution, which requirements the Board has found to be necessary, cost-effective, and technologically feasible to carry out the purposes of Division 26 of the Health and Safety Code;

WHEREAS on September 28, 1990, by Resolution 90-59, the Board approved the adoption of section 2257, title 13, California Code of Regulations, prohibiting the sale or distribution of motor vehicle gasoline except gasoline certified to contain adequate levels of deposit control additives;

WHEREAS, the ARB staff has administered the Deposit Control Additive Regulation for over six years and has approved more than 370 applications for certification;

WHEREAS, the staff conducted public workshops on March 24, June 11, and July 24, 1998, regarding the latest research on combustion chamber deposits and to discuss proposed amendments to the gasoline deposit control additive requirement;

WHEREAS, based on staff evaluations and industry input provided at the March 24, June 11, and July 24, 1998 workshops, staff has proposed several amendments to section 2257, title 13, California Code of Regulations, to preclude the use of outdated Gasoline Additive Certifications, to cap the current vehicle fleet combustion chamber deposit levels, to update the certification performance standards, and to add clarity and specificity to the regulation.

WHEREAS, the California Environmental Quality Act and Board regulations require that no project that may have significant adverse environmental impacts be adopted as originally proposed if feasible alternatives or mitigation measures are available to reduce or eliminate such impacts;

WHEREAS, public hearings and other administrative proceedings have been held in accordance with provisions of chapter 3.5 (commencing with section 11340), part 1, Division 3, Title 2 of the Government Code;

WHEREAS, the Board has considered the effect of the proposed amendments on the economy of the State;

WHEREAS, the Board finds that:

The reduced vehicle combustion chamber deposit level, due to the introduction of California Reformulated Gasoline (CaRFG) and improved deposit control additive technology, has resulted in at least a five percent reduction in oxides of nitrogen (NOx) emissions from the California vehicle fleet (about 50 tons per day) relative to the combustion chamber deposit level caused by pre-CaRFG;

Eliminating outdated gasoline additive certifications will preclude the use of old technology deposit control additive formulations at dose rates which can increase vehicle combustion chamber deposit formation;

Lowering the intake valve deposit (IVD) certification performance standard to a maximum average of 50 mg/valve and eliminating the port fuel injector deposit (PFID) clean-up requirement will update the regulatory requirements to reflect improved additives and milder base gasoline properties;

Adoption of a new performance standard for combustion chamber deposits will cap the existing combustion chamber deposit level in the California vehicle fleet;

It is appropriate to revise the current referenced IVD keep-clean test method with ASTM D 5500-98 and the PFID keep-clean test method with ASTM D 5598-95a, to provide technical corrections to the procedures and to provide greater accuracy;

Adoption of the ARB's Vehicle Test Procedure for Evaluating Intake Valve Deposits and Combustion Chamber Deposits will provide an industry accepted test method for combustion chamber deposit measurement and provide consistency with the proposed updated IVD keep-clean test method; and

The other clarifying amendments to section 2257, title 13, California Code of Regulations, will provide more clarity and specificity to certification test fuel requirements;

WHEREAS, the Board further finds that:

The approved amendments do not affect the current emissions reductions associated with the regulation;

The amendments will not result in any adverse environmental impact;

All previously approved Gasoline Additive Certifications originally approved prior to July 1, 1996, will no longer continue to be effective after the amendments are implemented; and

All previously approved Gasoline Additive Certifications originally approved between July 1, 1996, and 30 days after the effective date of the approved amendments will continue to be effective if they demonstrate less than an average maximum 50 mg/valve, when tested in accordance with the referenced intake valve deposit test method;

NOW THEREFORE BE IT RESOLVED that the Board hereby approves amendments to title 13, California Code of Regulations, section 2257, and the incorporated test procedures, as set forth in Attachment A hereto.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to adopt the regulations with modifications as set forth in Attachment A, after making the regulations as modified available to the public for a period of 15 days, provided that the Executive Officer shall consider such written comments regarding the modifications as may be submitted during this period, shall make modifications as may be appropriate in light of the comments received, and shall present the regulations to the Board for further consideration if he determines that this is warranted.

BE IT FURTHER RESOLVED that following approval by the Office of Administrative Law of the amendments adopted under this resolution, the Executive Officer is directed, as appropriate, to adopt the amendments as part of the California State Implementation Plan and submit them to the U.S. Environmental Protection Agency as a revision to the California State Implementation Plan.

BE IT FURTHER RESOLVED that the Board directs staff to monitor industry research on combustion chamber deposits, and alternatives to the proposed standards and test methods, and to propose additional modifications to section 2257 if warranted.

I hereby certify that the above is a true and correct copy of Resolution 98-46, as adopted by the Air Resources Board.

Anne Shelby for

Pat Hutchens, Clerk of the Board

STAFF'S MODIFIED PROPOSED REGULATION ORDER

Note: The text of the originally proposed amendments are shown in *italics* to denote regulation text additions and ~~strikeout~~ to show regulation text deletions. The modifications now proposed are shown in *redline italic* to show additions to and ~~redline strikeout~~ to show deletions from the original proposal.

§ 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 *for California gasoline* pursuant to subsection (c), *originally dated no earlier than July 1, 1996. Existing certifications dated between July 1, 1996 and* **(insert date 30 days after the effective date of the amendments)** *that meet the standards described in ~~requirements of~~ subsection (c)(1)(A)(i) and (c)(1)(A)(ii) [including those which used test method ASTM D 5500-94] are exempted from subsection (c)(1)(A)(iii),* 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 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 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 of gasoline as defined in (a) and alcohol in which the portion of gasoline is more than 50 percent of the total blend.

(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~~ a maximum of ~~100~~*50* milligrams averaged over all intake valve*s* when tested in accordance with ASTM D 5500-~~94~~*8*, which is incorporated herein by reference, *with modifications noted in sections (D)(IV)(8.5.5.1) and (8.7.1.1) of the Stationary Source Division's Test Method for Evaluating Intake Valve and Combustion Chamber Deposits in Motor Vehicles, dated* **[insert date of adoption]** ~~July 2, 1996~~, which is also incorporated herein by reference. *As an alternative, intake valve deposits may be tested in accordance with subsection (c)(1)(A)(iii).*

(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~~*5a*, which is incorporated herein by reference.

(iii) The gasoline formulation *meeting the requirements of (c)(1)(A)(i), does not result in more than 1300 milligrams total deposit weight, averaged over all four combustion chambers* ~~is capable of reducing fuel injector deposits so that no fuel injector suffers a flow loss of more than five percent~~, *or, does not result in more than 140 percent total deposit weight from all four combustion chambers, relative to the gasoline formulation containing no additive,* when tested in accordance with the Stationary Source Division's Test Method for Evaluating *Intake Valve and Combustion Chamber* ~~Port Fuel Injector~~ Deposits in Vehicle Engines, dated **[insert date of adoption]** ~~July 2, 1996, 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 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. *The T90 distillation temperature of the certification test fuel cannot be less than 40°F below the gasoline formulation for which certification is requested* All other certification test fuel properties must be representative of typical commercial gasoline.

(E) Data demonstrating ~~that~~*how* the certification test fuel ~~will be~~*as* produced ~~from~~ *including a list of blend stocks, such as reformate, oxygenates, cracked stocks, alkylate, isomerate, straight run stocks and any other blend stocks, along with the percentage of the total which each blend stock comprises. Data may also be requested which demonstrates that the certification test fuel blend stocks are representative of* typical *California* refinery blend stocks *used for the production of California gasoline.*

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

(G) 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.

(H) 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 revoke 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) must maintain records 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, the producer, importer or distributor must compile records showing 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

[iii] the name and volume of each additive (or additive package) added to the California gasoline fuel. Records covering a month must be compiled no later than 30 days after the end of the month, and must be retained for at least two years after the end of the month.

(2) Any person required by subsection (d)(1) to compile and retain records must provide to the executive officer any such records within 20 days of a written request received from the executive officer or her/her designee 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)(2), the volume of California gasoline 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).

STATE OF CALIFORNIA
AIR RESOURCES BOARD
STATIONARY SOURCE DIVISION

[*insert date of adoption*]

TEST METHOD FOR EVALUATING FORMATION OF INTAKE VALVE AND COMBUSTION CHAMBER DEPOSITS IN MOTOR VEHICLES

E. PURPOSE

This test method is used to evaluate a gasoline formulation's potential to form intake valve deposits and combustion chamber deposits. The test method follows the procedure in ASTM D 5500-98 with modifications specified below to incorporate testing for combustion chamber deposits (CCDs).

F. SUMMARY OF TEST METHOD

This test method is designed to measure intake valve deposits (IVDs) and CCDs from a single vehicle test run. This test method requires following ASTM D 5500-98 for vehicle preparation and mileage accumulation. After mileage is accumulated, the cylinder head is removed and the CCDs are scraped and measured. Additional steps incorporated into the ASTM D 5500-98 have been included to provide guidance to obtain piston and cylinder head deposits. After CCD measurements are made, the intake valves are removed from the cylinder head and deposit weights are determined in accordance with ASTM D 5500-98.

G. TEST METHOD USE

This test method is to be used to measure IVDs and CCDs in the same test run. Additionally, this test method may be used to measure CCDs only.

H. TEST PROCEDURE

The provisions of ASTM D 5500-98 are incorporated into the Test Method for Evaluating Formation of Intake Valve and Combustion Chamber Deposits in Motor Vehicles with the following modifications to incorporate steps to obtain CCD weight measurements. [Note: Additions to the ASTM D 5500-98 test method are indicated in underline and deletions are indicated in ~~strikeout~~]

1. Scope

Refer to ASTM D 5500-98, section 1 and amend subparagraph 1.1 with the following changes:

1.1 This test method covers a vehicle test procedure for ~~evaluation~~ evaluating the formation of intake valve deposits and combustion chamber deposits (CCDs) ~~formation~~ of unleaded spark-ignition engine fuels . . . Chassis dynamometers shall not be used for this test procedure ~~as the BMW NA/SwRI IVD Test was not intended to be applicable to chassis dynamometers and~~ since no correlation between road operation and chassis dynamometers has been established for either CCD or IVD.

2. Referenced Documents (Refer to ASTM D 5500-98, section 2)

3. Terminology (Refer to ASTM D 5500-98, section 3)

4. Summary of Test Method

Refer to ASTM D 5500-98, section 4 and amend subparagraph 4.4 with the following changes:

4.4 After the required mileage (10.4.5) has been accumulated, the cylinder head is removed from the engine and ~~disassembled.~~ the CCDs are scraped and removed from the piston top and cylinder head surface for each cylinder. The CCDs are then weighed. ~~and~~ The cylinder head is then disassembled and the intake valves are weighed, visually assigned merit ratings, and photographed. Operational and mechanical criteria are then reviewed to determine if the test shall be considered valid.

5. Significance and Use

Refer to ASTM D 5500-98, section 5 and amend subparagraph 5.1 by adding the following:

5.1 *Test Method* — It was determined through field testing that intake valve deposits could adversely affect the driveability of certain automobiles. . .Minimizing intake valve deposits may be necessary to maintain vehicle driveability and tailpipe emissions control. It was also determined that accumulation of CCDs may cause octane requirement increase, CCD interference, and an increase in NOx emissions. This test method is based on established automotive testing laboratory test methods.

Amend subparagraph 5.1.1 with the following changes:

5.1.1 *State and Federal Legislative and Regulatory Action* — Legislative activity and rulemaking primarily by California Air Resources Board and the Environmental Protection Agency necessitate the acceptance of a standardized test method to evaluate the intake system and combustion chamber deposit forming tendency of an automotive spark-ignition engine fuel.

6. Apparatus (Refer to ASTM D 5500-98, section 6)

7. Reagents and Materials (Refer to ASTM D 5500-98, section 7)

8. Preparation of Apparatus

Refer to ASTM D 5500-98, section 8 and amend subparagraph 8.2.4.1 with the following changes:

8.2.4.1 Piston crowns and bore crevices shall be cleaned with a gasket scraper, fine wire brush, or

similar tools. Do not allow debris to fall into the water jacket or oil passages. Care shall be exercised so that the piston crowns and bore crevices are not damaged during cleaning. A shop-type vacuum cleaner or compressed air ~~may~~ shall be used to evacuate the loose carbon from the piston and piston/bore crevice.

9. Test Procedure

Refer to ASTM D 5500-98, section 9 and add subparagraph 9.5.1.5:

9.5.1.5 *Determination of total cylinder CCD weight* -- Upon removal of the cylinder head, measure the masses of IVD and CCD from the vehicle. Total cylinder CCD mass shall be reported as the sum of the deposits collected individually from the piston top, cylinder head, and intake valve face for each cylinder. Determination of piston top CCDs are contained in steps 9.5.1.5.1 through 9.5.1.5.4. Determination of cylinder head and valve face CCDs are contained in steps 9.5.1.5.5 through 9.5.1.5.9.

Add subparagraph 9.5.1.5.1:

9.5.1.5.1 With piston positioned slightly below Top-Dead-Center (TDC), scrape cylinder block deck surface with gasket scraper, and wipe with a rag. The objective is to produce a ring around each piston that tape will readily adhere to without picking up contamination. Do not use power equipment.

Add subparagraph 9.5.1.5.2:

9.5.1.5.2 A deposit collector with a smooth non-absorbent inside surface is attached to the cylinder block with a continuous seal that does not allow deposits to slide between the deposit collector and the cylinder block. The collector is designed to contain any deposits that become airborne from scraping.

Add subparagraph 9.5.1.5.3:

9.5.1.5.3 With piston at TDC, remove deposits from the piston top using stainless steel or other metal lab instruments that will not erode during use. Use a stainless steel wire brush to remove remaining deposits off the piston top. Continue brushing until all deposits are removed and only varnish remains. After scraping the piston top, move piston slightly below TDC and brush the deposits which are collected at the top of the cylinder wall into the deposit collector.

Add subparagraph 9.5.1.5.4:
9.5.1.5.4 After scraping is completed, carefully remove the deposit collector, and allow the deposits to accumulate in the deposit collector, where they can be poured into preweighed containers for piston deposit weight determination. Deposits from each piston are to be placed in individual containers.

Add subparagraph 9.5.1.5.5:
9.5.1.5.5 Remove spark plug from the cylinder to be scraped. Install a blanked off spark plug that has had its electrodes removed and been filled with solder.

Add subparagraph 9.5.1.5.6:
9.5.1.5.6 Place cylinder head on work bench with combustion chamber side facing up. Scrape off gasket material from around the combustion chambers with a gasket scraper and wipe with a rag. The objective is to produce a ring around each combustion chamber that tape will readily adhere to without picking up contamination. Do not use power equipment.

Add subparagraph 9.5.1.5.7:
9.5.1.5.7 A deposit collector that has a smooth non-absorbent inside surface is attached to the cylinder head with a continuous seal that does not allow deposits to slide between the deposit collector and the cylinder head. The collector is designed to contain any deposits that become airborne from scraping.

Add subparagraph 9.5.1.5.8:
9.5.1.5.8 Remove deposits from the combustion chamber and intake valve faces using stainless steel or other metal lab instruments that will not erode during use. As the deposits are scraped, they can be brushed into the deposit collector with a soft bristle brush. Use a stainless steel wire brush to remove remaining deposits off the combustion chamber. Continue brushing until all deposits are removed and only varnish remains.

Add subparagraph 9.5.1.5.9:
9.5.1.5.9 After scraping is completed, carefully remove the deposit collector, and allow the deposits to accumulate in the collector, where they can be poured into preweighed containers for cylinder head deposit weight determination. Deposits from each piston are to be placed in individual containers

10. Determination of Test Results (Refer to ASTM D 5500-98, section 10)

11. Final Test Report (Refer to ASTM D 5500-98, section 11)

12. Precision and Bias (Refer to ASTM D 5500-98, section 12)

13. Keywords (Refer to ASTM D 5500-98, section 13)